

UNIVERSITY OF NORTH BENGAL

Accredited by NAAC with Grade “A”

# JOURNAL CONTENTS

Library General  
[Science & Technology]

2020



"সমানো মন্ত্র সমিতি: সমানী"

UNIVERSITY LIBRARY

UNIVERSITY OF NORTH BENGAL

Raja Rammohunpur, P.O- North Bengal University

Dist- Darjeeling, Pin- 734013, West Bengal

## Contents

<b>Sl No.</b>	<b>Journal Title</b>	<b>Vol./Issue</b>	<b>Page no.</b>
1	Current Science	118(1-12), 119(1-12)	1-32
2	Science	367(6473- 6485), 368(6486- 6498), 369(6499- 6511), 370(6512- 6523)	33-134
3	Science and Culture	86(1-12)	135-145
4	Science Reporter	57(2-3)	146-148
5	Science Technology and Society	25(1-3)	149-151
6	Scientific American	322(1-6), 323(1,3-6)	152-173

# CURRENT SCIENCE

Volume 118 Number 1

10 January 2020

6 **In this issue**

**EDITORIAL**

- 7 **Conservation of species, all, big and small**  
K. Chandrashekara

**CORRESPONDENCE**

- 9 **Congruence of endemism among four global biodiversity hotspots in India**  
V. S. Chitale, M. D. Behera and P. S. Roy
- 9 **UGC-CARE List**  
Bhushan Patwardhan and Shubhada Nagarkar; *Response by V. Venkateswara Sarma*

**NEWS**

- 11 **Science Last Fortnight**
- 15 **Precambrian geodynamics**  
E. V. S. S. K. Babu, V. M. Tiwari and Somnath Dasgupta
- 17 **Current challenges in the management of forest insect pests and diseases**  
Shailesh Pandey, Sudhir Singh, Mohd. Yusuf and Amit Pandey
- 19 **Indian Academy of Sciences, Bengaluru – 85th annual meeting**  
Pratik Pawar and S. Priya

**COMMENTARY**

- 22 **Data and ideology of science**  
Sumit Bhaduri

**SCIENTIFIC CORRESPONDENCE**

- 24 **Optimal Ph D student–teacher ratio for Indian research universities: a production function approach**  
Pranab Mukhopadhyay, P. K. Sudarsan and M. P. Tapaswi
- 26 **Influence of rake angle, bucket width and teeth depth of dragline bucket on the resistive force in different rock types**  
Shah Fateh Azam and Piyush Rai

**TECHNICAL NOTE**

- 29 **Improvement on the characteristics of transformer oil using nanofluids**  
S. Sumathi and R. Rajesh

**GENERAL ARTICLES**

- 34 **Normalization of marks in multi-session examinations**  
Abhay G. Bhatt, Sourish Das and Rajeeva L. Karandikar
- 40 **Violence against doctors: a multisystem failure**  
Gautam Ganguly



## RESEARCH ARTICLES

- 45 **Solar X-ray Monitor onboard Chandrayaan-2 Orbiter**  
M. Shanmugam, S. V. Vadawale, Arpit R. Patel, Hitesh Kumar Adalaja, N. P. S. Mithun, Tinkal Ladiya, Shiv Kumar Goyal, Neeraj K. Tiwari, Nishant Singh, Sushil Kumar, Deepak Kumar Painkra, Y. B. Acharya, Anil Bhardwaj, A. K. Hait, A. Patinge, Abinandhan Kapoor, H. N. Suresh Kumar, Neeraj Satya, Gaurav Saxena and Kalpana Arvind
- 53 **Alpha Particle X-ray Spectrometer onboard Chandrayaan-2 Rover**  
M. Shanmugam, S. V. Vadawale, Arpit R. Patel, N. P. S. Mithun, Hitesh Kumar Adalaja, Tinkal Ladiya, Shiv Kumar Goyal, Neeraj K. Tiwari, Nishant Singh, Sushil Kumar, Deepak Kumar Painkra, A. K. Hait, A. Patinge, Abhishek Kumar, Saleem Basha, Vivek R. Subramanian, R. G. Venkatesh, D. B. Prashant, Sonal Navle, Y. B. Acharya, S. V. S. Murty and Anil Bhardwaj
- 62 **Effect of community structures in protein-protein interaction network in cancer protein identification**  
Sminu Izudheen, Eljose S. Sajan, Ivan George, Jeevan John and Chris Shaju Attipetty
- 70 **Calibration of accelerated corrosion protocol for reinforced concrete columns**  
Aditya Singh Rajput and Umesh Kumar Sharma
- 79 **Occurrence of Aflatoxin M1 in raw, pasteurized and UHT milk from Punjab, India**  
Anil Patyal, Jatinder Paul Singh Gill, Jasbir Singh Bedi and Rabinder Singh Aulakh
- 87 **Study the effect of star anise extract and the pulp of kiwifruit on mice infected with cancer**  
Dalia I. Hemdan and Nabila Y. Mahmoud Abdulmaguid
- 94 **Environmental influence on the euglenoid species diversity and their abundance in Museum Lake, Thiruvananthapuram, India**  
Anila P. Ajayan, Jan W. Rijstenbil and K. G. Ajit Kumar

---

## RESEARCH COMMUNICATIONS

- 103 **Effects of projected climate change on quantity and quality of soybean yield under different emission scenarios**  
Hamidreza Ahmadzadeh Araji, Aimrun Wayayok, Jahanfar Daneshian, Majid Mirzaei, Ali Reza Massah Bavani, C. B. S. Teh, Ahmad Fikri Abdullah and Parisa Ahmadi
- 108 **Is rubber monoculture banishing agrobiodiversity and happiness? evidences from shifting cultivation landscape of Tripura, northeast India**  
D. K. Pandey, P. Adhiguru, Uma Sah, N. Devachandra, S. K. Dubey and Chandra Deo
- 114 **Optimization of process variables for preparation of pomegranate juice-fortified aonla candy**  
Vijay Singh Meena, Kirti Jalgaonkar, Manoj Kumar Mahawar, Bharat Bhushan, Bhushan Bibwe and Poonam Kashyup
- 118 **Potential application of yellow gypsum from LD slag as a soil conditioner**  
Shrenivas Ashrit, Ravikrishna V. Chatti, S. Sarkar, R. Venugopal and G. Udayabhanu
- 123 **Prediction of rock load emphasizing excavation damage of *in situ* rocks caused by blasting in coal mines**  
Avinash Paul, Vemavarapu Mallika Sita Ramachandra Murthy, Amar Prakash and Ajoy Kumar Singh
- 132 **An early case of lithic recycling in India: evidence from the Acheulian site at Damdongri, Madhya Pradesh**  
S. B. Ota, Niharika Srivastava and Suman Pandey



## BOOK REVIEWS

- 140 **Dust in the Atmosphere of Mars and its Impact on Human Exploration.** Joel S. Levine, Daniel Winterhalter and Russell L. Kerschmann; *reviewed by* Prakash Chauhan
- 142 **Annual Review of Genetics, 2018.** Nancy M. Bonini, Andrew G. Clark and Michael Lichten; *reviewed by* G. Subrahmanyam, M. Chutia and K. P. Arunkumar
- 143 **Annual Review of Physiology, 2019.** Mark T. Nelson and Kenneth Walsh; *reviewed by* Mario Vaz

---

## PERSONAL NEWS

- 145 **Nanjundappa Rudraiah (1932–2019)**  
M. Venkatachalappa, I. S. Shivakumara and P. Kandaswamy

---

## HISTORICAL NOTES

- 147 **The spark that fired the Great Trigonometrical Survey of India: the triangulation survey made between Fort St. George (13°08'N) and Mangalore (12°91'N) by William Lambton in the early 1800s**  
Anantanarayanan Raman and Vancheeswar Balakrishnan
- 



- ◀ COVER. Pomegranate tree (Source: Google). See page 114 for an article on optimization of process variables for preparation of pomegranate juice-fortified aonla candy.

Indexed in CURRENT CONTENTS/GEODATA/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE

# CURRENT SCIENCE

Volume 118 Number 2

25 January 2020

---

**174 In this issue**


---

**GUEST EDITORIAL**

- 175 The Saha equation turns hundred**  
Rajaram Nityananda
- 

**NEWS**

- 177 Science Last Fortnight**
- 181 Science education for the visually impaired**  
Raka Ray Mandal
- 182 Luminescence dating**  
Sheikh Nawaz Ali and Shubhra Sharma
- 

**OPINION**

- 184 Punitive provision to tackle predatory journals**  
Koushik Sau
- 

**COMMENTARY**

- 186 The Department of Geology, Institute of Science, Banaras Hindu University, Varanasi: A success story of 100 years**  
N. V. Chalapathi Rao
- 189 Emergence and burden of antibiotic drug resistance: an endogenous cycle**  
Bhawna Malik and Samit Bhattacharyya
- 

**SCIENTIFIC CORRESPONDENCE**

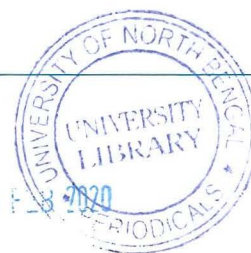
- 192 Treeline migration and settlement recorded by Himalayan pencil cedar tree-rings in the highest alpine zone of western Himalaya, India**  
Krishna G. Misra, Vikram Singh, Akhilesh K. Yadava, Sandhya Misra and Ram R. Yadav
- 195 *In vitro* rearing and gallery tunnelling pattern of Island pinhole borer, *Xyleborus perforans* (Wollaston), a scolytid associated with pomegranate wilt complex**  
P. D. Kamala Jayanthi, T. Raghava, T. Nagaraja and K. Sreedevi
- 

**GENERAL ARTICLE**

- 199 Policy matrix for sustainable soil management and climate-resilient agriculture**  
P. Dey
- 

**RESEARCH ARTICLES**

- 202 CHandra's Atmospheric Composition Explorer-2 onboard Chandrayaan-2 to study the lunar neutral exosphere**  
Tirtha Pratim Das, Smitha V. Thampi, M. B. Dhanya, Neha Naik, P. Sreelatha, P. Pradeepkumar, G. Padma Padmanabhan, B. Sundar, Dinakar Prasad Vajja, Amarnath Nandi, R. Satheesh Thampi, Vipin K. Yadav, J. K. Abhishek, Md. Nazeer, P. T. Lali, Rosmy John, A. V. Aliyas, Vijay Kumar Sen, M. Ramprabhu and A. Ajay Krishna



- 210 **Dual Frequency Radio Science experiment onboard Chandrayaan-2: a radio occultation technique to study temporal and spatial variations in the surface-bound ionosphere of the Moon**

R. K. Choudhary, K. R. Bindu, Kumar Harshit, Rahul Karkara, K. M. Ambili, T. K. Pant, Devadas Shenoy, Chandrakanta Kumar, N. Hemanth Kumar Reddy, T. K. Rajendran, M. Nazer and M. Shajahan



- 219 **Chandrayaan-2 Large Area Soft X-ray Spectrometer**

V. Radhakrishna, A. Tyagi, S. Narendranath, Koushal Vadodariya, Reena Yadav, Brajpal Singh, G. Balaji, Neeraj Satya, Akash Shetty, H. N. Suresha Kumar, Kumar, S. Vaishali, Netra S. Pillai, S. Tadepalli, Venkata Raghavendra, P. Sreekumar, Anil Agarwal and N. Valarmathi

- 226 **L- and S-band Polarimetric Synthetic Aperture Radar on Chandrayaan-2 mission**

Deepak Putrevu, Sanjay Trivedi, Anup Das, Dharmendra Pandey, Priyanka Mehrotra, S. K. Garg, Venkata Reddy, Shalini Gangele, Himanshu Patel, Devendra Sharma, R. Sijwali, Nikhil Pandya, Amit Shukla, Gaurav Seth, V. M. Ramanujam and Raj Kumar

- 234 **Evaluation on physico-chemical and corrosion properties of anodized aluminium surface using sodium oxalate–sodium silicate bath at room temperature**

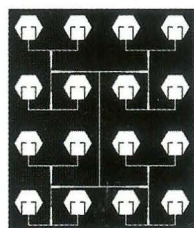
M. Mubarak Ali and S. Sathiya

- 243 **Occupational accidents: a comparative study of construction and manufacturing industries**

Shabir Hussain Khahro, Tauha Hussain Ali, Nafees Ahmed Memon and Zubair Ahmed Memon

- 249 **Performance enhancement of hexagonal-patch dual-band array antenna with omega-shaped DGS for dual Band RADAR Applications**

Kanchan Wagh and S. S. Shriramwar



- 255 **Field experience of Fluoride Nilogon: a method of fluoride removal from groundwater**

Rajkamal Mohan, Sweety Gogoi, Anup J. Bora, Gautam Baruah, Shreemoyee Bordoloi, Asadulla A. Ali, Hridip R. Sarma and Robin K. Dutta

- 264 **Ecological determinants of occupancy and abundance of chinkara (*Gazella bennettii*) in Yadahalli Wildlife Sanctuary, Karnataka, India**

Dinesh Kumar, Avadhoot D. Velankar, Nitin Venkatesh Ranga Rao, Honnavalli N. Kumara, Partha Sarathi Mishra, Prodyut Bhattacharya and Vijay Mohan Raj

#### RESEARCH COMMUNICATIONS

- 271 **Linguistic resources to facilitate science education**

Uma Maheswari Viswanathan, A. Shahin Sultana and Suhasini Shankar

- 273 **Design and development of a low-cost GNSS drifter for rip currents**

Surisetty V. V. Arun Kumar, Rakesh Kumar Luhar, Rashmi Sharma and Raj Kumar

- 280 **Bioprocess development for enhanced production of probiotic *Bifidobacterium bifidum***

Suhail Mohammed Hussain, Manali Naik, L. Arbaaz Ahmed, Minal Udipi and Sunil Kumar Sukumaran



- 285 **Pigment analysis of palm leaf manuscripts of India**

Deepakshi Sharma, Manoj Singh, Gabriela Krist and M. Velayudhan Nair

- 292 **Mtb-HID: a unified database of host–pathogen interaction for various *Mycobacterium tuberculosis* strains**

Kumud Pant, Devvret, Neema Tufchi, Ajay Pandaya and Ashish Thapliyal

- 297 **Effect of storage conditions on vermicompost quality**

Pankaj Kumar, Pawan Sharma, Tilak Ranjan Kumar, H. C. Sharma and R. C. Dubey

- 300 **A comparative study of antioxidant activity and total phenolic content of fresh juices of some common Indian fruits with their commercial counterparts**  
Brototi Roy, Jyoti Singh and Tanya Dewan

---

**BOOK REVIEWS**

- 305 **Annual Review of Medicine, 2019.** Mary E. Klotman, Michael S. Parmacek and Howard A. Rockman (eds); *reviewed by* C. C. Kartha
- 307 **Ultrafast Optics and Spectroscopy in Physical Chemistry.** Atanu Bhattacharya; *reviewed by* Sivarama Krishnan

---

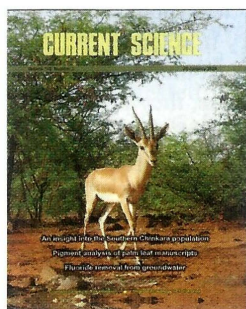
**PERSONAL NEWS**

- 309 **M. V. George (1928–2019)**  
Suresh Das; H. Ila (nee Ila Bhatnagar) and S. Sivaram

---

**HISTORICAL NOTES**

- 312 **Bhagawati Charan Guha and discovery of the molecular magnet**  
Rajarshi Ghosh
- 



◀ COVER. The Chinkara of Yadahalli. (Photo: Mr H. B. Doni). See page 264.

Indexed in CURRENT CONTENTS/GEOBASE/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE

# CURRENT SCIENCE

Volume 118 Number 3

10 February 2020



330 In this issue

**GUEST EDITORIAL**

331 100 Years of Biochemistry at the Indian Institute of Science

Pundi N. Rangarajan

**NEWS**

333 Science Last Fortnight

337 Towards a sustainable water future

Pratik M. Pawar and S. Priya

**IN CONVERSATION**

339 Ken Ono

Tirthankar Bhattacharyya

**RESEARCH NEWS**

345 Exploring North East India's non-mulberry silk based bioinks for three dimensional bioprinting

Rocktotpal Konwarh

**COMMENTARY**

348 Science and innovation in the 21st century: new paradigms and challenges for policy design

Sujit Bhattacharya

**SCIENTIFIC CORRESPONDENCE**

350 Uraninite-bearing leucosomes from migmatites of Chhotanagpur Granite Gneiss Complex, Karke area, Garhwa district, Jharkhand, India

A. P. Kushwaha, S. P. Upadhyay, Kuldeep Nautiyal, B. V. S. N. Raju and D. K. Sinha

**GENERAL ARTICLES**

352 Eleven years of Dr D. S. Kothari Postdoctoral Fellowship scheme of the University Grants Commission

Rohit A. Kale, Subodh S. Khire, Sunil K. Hode, Dilip S. Joag and Shridhar R. Gadre

356 Professional competence of teachers in Indian higher agricultural education

P. Ramesh and P. Krishnan

**REVIEW ARTICLE**

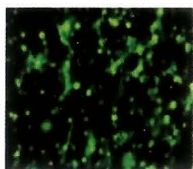
362 The forests and elephants of Wayanad: challenges for future conservation

N. R. Anoop and T. Ganesh

**RESEARCH ARTICLES**

368 Imaging Infrared Spectrometer onboard Chandrayaan-2 Orbiter



Arup Roy Chowdhury, Arup Banerjee, S. R. Joshi, Moumita Dutta, Ankush Kumar, Satadru Bhattacharya, Amitabh, Sami Ur Rehman, Sunil Bhati, J. C. Karella, Amiya Biswas, Anish R. Saxena, Satish Sharma, Sandip R. Somani, H. V. Bhagat, Jitendra Sharma, D. N. Ghonia, B. B. Bokarwadia and Ajay Parasar



- 376 **Instrument for Lunar Seismic Activity Studies on Chandrayaan-2 Lander**  
J. John, V. Thamarai, M. M. Mehra, Teena Choudhary, M. S. Giridhar, Ashwini Jambhalikar, Gogulapati Supriya, Gaurav Saxena, K. V. Shila, B. Ramesh, T. K. Pratheek, Deepak Kumar Sharma, R. Islam, P. Selvaraj, A. Kalpana, S. Ajith Kumar, K. V. Sriram and A. S. Laxmiprasad
- 383 **Lunar near surface plasma environment from Chandrayaan-2 Lander platform: RAMBHA-LP payload**  
G. Manju, Tarun K. Pant, P. Sreelatha, Santhosh J. Nalluveetil, P. Pradeep Kumar, Nirbhay Kumar Upadhyay, Md. Mosarraf Hossain, Neha Naik, Vipin Kumar Yadav, Rosmy John, R. Sajeev, Jothi Ramalingam, Philip George, Amarnath Nandi, N. Mridula, Aswathy R. P. Janmejaya Jaiswal Rana, Snehil Srivastava and Satheesh Thampi
- 392 **Analysing impact of major solar flares on ionospheric total electron content using NavIC signals**  
Sonal Parmar, Upena Dalal and Kamlesh Pathak
- 401 **Simulating reinforcement corrosion-induced strain in concrete using expansive grout**  
Prasanna Kumar Behera, K. Mondal and Sudhir Misra
- 411 **Assessment of sedimentation and useful life of Tehri reservoir using integrated approaches of hydrodynamic modelling, satellite remote sensing and empirical curves**  
Ayan Anil Garg, Alemayehu A. Shawul and Sumedha Chakma
- 421 **Electrical signature of the October 2013 very severe cyclonic storm *Phailin***  
Adarsh Dube, Ajeet K. Maurya and Rajesh Singh
- 428 **Identifying critical links on disruption-prone road networks: an approach that obviates scenario enumeration**  
Gopal R. Patil and B. K. Bhavathrathan

---

#### RESEARCH COMMUNICATIONS

- 439 **Development of artificial neural network-based model for prediction of temperature field in host rock of a geological disposal facility for radioactive waste**  
Vrinda Brajesh Gupta, T. K. Pal and R. K. Bajpai
- 444 **Climate change smart option and doubling farmer's income through *Melia dubia*-based agri-silviculture system**  
P. Chandana, A. Madhavi Lata, M. A. Aariff Khan and A. Krishna
- 448 **Energy use pattern in wheat crop production system among different farmer groups of the Himalayan Tarai region**  
Rajat Kumar Sharma, T. K. Bhattacharya, Akanksha Kumain, Priyanka Chand, Sandip Mandal and Deepshikha Azad
-  455 **Iron and zinc bioavailability from Madhukar × Swarna derived biofortified rice lines**  
Raghu Pullakhandam, Surekha Agarwal, V. G. N. Tripura Venkata, C. V. Ratnavathi, K. Madhavan Nair and Sarla Neelamraju
- 461 **A significant shift in particulate organic matter characteristics during flooding of River Krishna, eastern peninsular India**  
C. Prakash Babu, V. Ramaswamy, P. S. Rao, V. V. S. S. Sarma and P. Praveen Kumar
-  467 **Unique breeding activity and oviposition in Annandale's high-altitude tree frog, *Kurixalus naso* (Annandale, 1912) in Meghalaya, North East India**  
P. W. Shangpliang, R. N. K. Hooroo and S. K. Dutta

- 473 **Small hydropower using pump as turbine: an alternative for energy generation in Southern Africa**  
Jinfeng Zhang, Daniel Adu, Mao Jioyin, Samuel Joe Acquah and Stephen Ntiri Asomani
- 

**BOOK REVIEWS**

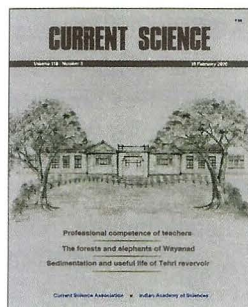
- 479 **Pillars of Life: Magnificent Trees of the Western Ghats.** Divya Mudappa and T. R. Shankar Raman with Botanical illustrations by Nirupa Rao and sketches by Sartaj Ghuman; *reviewed by* M. Sanjappa and P. Venu
- 480 **Annual Review of Immunology, 2018.** Dan R. Littman and Wayne M. Yokoyama (eds); *reviewed by* Beneeta Kalha, Ruchi Sachdeva, Anjali Bose, Moumita Sarkar, Hritika Sharma, Monika Malik and Rahul Pal
- 

**PERSONAL NEWS**

- 486 **Kailasam Venkatesan (1932–2019)**  
T. N. Guru Row
- 488 **R. Jayaraman (1937–2019)**  
M. Hussain Munavar and K. Dharmalingam
- 

**ACADEMY NEWS**

- 490 **Indian Academy of Sciences announces new Fellows and Honorary Fellow for 2020**
- 



- ◀ **COVER.** A pencil sketch of the old building of the Biochemistry Department, Indian Institute of Science, Bangalore. See page 331.

Indexed in CURRENT CONTENTS/GEODATABASE/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE

# CURRENT SCIENCE

Volume 118 Number 4

25 February 2020

05 MAR 2020

510 In this issue

**GUEST EDITORIAL**

511 **Is ambient space a determinant of human health?**  
A. Anandkumar and C. C. Kartha

**CORRESPONDENCE**

513 **Bacteria-on-a-chip: emergence of digital medicine**  
Partha Pratim Ray and Poulami Majumder

513 **Research performance in India during the 2011–2015 window**  
Gangan Prathap

**NEWS**

515 **Science Last Fortnight**

**IN CONVERSATION**

519 **Jay Yagnik**  
Pratik Pawar

**COMMENTARY**

522 **India needs a comprehensive space policy**  
Munikrishnappa Anilkumar and Chetan Singai

**SCIENTIFIC CORRESPONDENCE**

524 ***Aquarius cordifolius* (L.) Christenh. & Byng (Alismataceae), an invasive alien species: its introduction, colonization and plausible threats in India**  
Anant Kumar and W. Arisdason

**GENERAL ARTICLES**

526 **Work environment in the wheat mills of Punjab, India**  
Indu Rawat and Nilesh Gaikwad

532 **Global research landscape of high-level studies in geosciences based on highly cited papers**  
Yanlin Cui

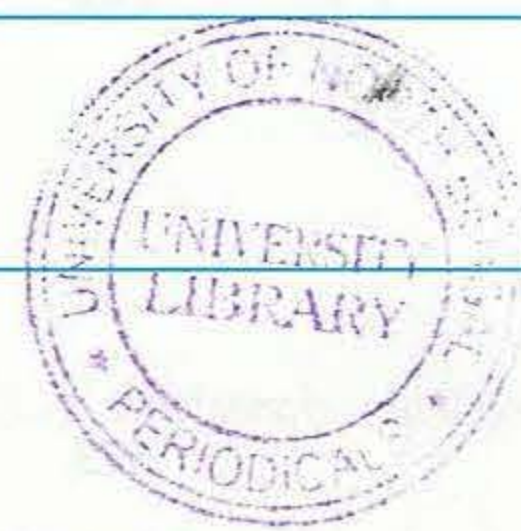
**REVIEW ARTICLES**

543 **Current status of thermionic conversion of solar energy**  
O. C. Olawole, D. K. De, S. O. Oyedepo, O. F. Olawole and E. S. Joel

553 **Compound feed production for livestock**  
D. J. Shrinivasa and S. M. Mathur

**RESEARCH ARTICLES**

560 **Orbiter High Resolution Camera onboard Chandrayaan-2 Orbiter**  
Arup Roy Chowdhury, Manish Saxena, Ankush Kumar, S. R. Joshi, Amitabh, Aditya Dagar, Manish Mittal, Shweta Kirkire, Jalshri Desai, Dhruv Shah, J. C. Karelia, Anand Kumar, Kailash Jha, Prasanta Das, H. V. Bhagat, Jitendra Sharma, D. N. Ghonia, Meghal Desai, Gaurav Bansal and Ashutosh Gupta



- 566 **Terrain Mapping Camera-2 onboard Chandrayaan-2 Orbiter**  
Arup Roy Chowdhury, Vishnukumar D. Patel, S. R. Joshi, A. S. Arya, Ankush Kumar, Sukamal Paul, Dhruv Shah, Pradeep Soni, J. C. Karelia, Minal Sampat, Satish Sharma, Sandip Somani, H. V. Bhagat, Jitendra Sharma, Amitabh, K. Suresh, R. P. Rajasekhar, B. B. Bokarwadia, Mukesh Kumar and D. N. Ghonia
- 573 **Laser Induced Breakdown Spectroscopy on Chandrayaan-2 Rover: a miniaturized mid-UV to visible active spectrometer for lunar surface chemistry studies**  
A. S. Laxmiprasad, R. V. L. N. Sridhar, Adwaita Goswami, K. A. Lohar, M. V. H. Rao, K. V. Shila, Monika Mahajan, Bijoy Raha, T. S. Smaran and B. Krishnamprasad
- 582 **Nuclear Hulthén potential and the scattering phase shifts for  $\ell=3$**   
U. Laha
- 587 **Effect of long-term nutrient management on soil organic carbon sequestration in rice-rice-fallow rotation**  
Umme Aminun Naher, M. B. Hossain, M. M. Haque, M. Maniruzzaman, A. K. Choudhury and J. C. Biswas
- 593 **Exploitation of mica deposits at Nellore mica belt, Andhra Pradesh, India**  
Subhashish Tewari, Vivek Kumar Himanshu, John Loui Porathur, Rana Bhattacharjee, Arka Jyoti Das and Prabhat Kumar Mandal
- 603 **Fungal biotransformation of clobazam – induction, inhibition and kinetic studies**  
M. Keerthana and M. Vidyavathi
- 612 **Evaluating the effect of music intervention on hypertension**  
Vijay Mani Shankar, B. Geethanjali, Mahesh Veezhinathan, Jayaram Hariharakrishnan, Nikhil Balakrishnan and L. Lakshmi

#### RESEARCH COMMUNICATIONS

- 621 **Purification and partial characterization of a haemagglutinin from *Ulva fasciata***  
Sudhir Kumar and Urmila Barros
- 625 **Marker validation and sequencing in aromatic landrace Mushk Budji**  
Aafreen Sakina and Amjad M. Husaini
- 630 **Palaeo and present channel of Assi river, Uttar Pradesh, India**  
Mallikarjun Mishra, K. N. Prudhvi Raju and P. V. Raju
- 639 **Influence of different sources and methods of potassium application on the quality of grapes cv. Sharad Seedless (*Vitis vinifera* L.)**  
Y. Pushpavathi, J. Satisha, G. C. Satisha, K. S. Shivashankara, M. Lakshminarayana Reddy and S. Sriram
- 644 **Glucose uptake rate of microorganisms living in hot springs above 70°C temperature: a study of Panamik and Puga hot springs in the Ladakh region, Jammu and Kashmir, India**  
A. H. Ansari, Mukund Sharma, S. Ahmad, Veeru Kant Singh, S. K. Pandey and Yogesh Kumar
- 648 **Some aspects of seed dispersal by Asian elephants (*Elephas maximus*) in Kaudulla National Park, Sri Lanka**  
Perera Mahesha and Vandercone Rajnish
- 654 **Reliability modelling on drivers' decision during the yellow phase of a signal intersection**  
Sabyasachi Biswas and Indrajit Ghosh

#### BOOK REVIEWS

- 662 **Atlas of Hematopathology: Morphology, Immunophenotype, Cytogenetics, and Molecular Approaches, 2nd Edition.** Faramarz Naeim, P. Nagesh Rao, Sophie X. Song and Ryan T. Phan; reviewed by Swati Pai and Roshini Shekhar



- 662 **Philosophy of Science (At the end of the twentieth century), Revised Edition.** B. V. Sreekantan; *reviewed by* Varun S. Bhatta

---

**HISTORICAL NOTES**

- 664 **Historical methodology and expert opinion in the Aryan Debate**  
T. R. S. Prasanna

- 
- 671 **Publications received – 2019**
- 



- ◀ **COVER.** Patch of a colony of *Aquarius cordifolius* (L.) Christenh. & Byng, an invasive alien species (*inset*, Flower). See page 524.

Indexed in CURRENT CONTENTS/GEODATABASE/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE

# CURRENT SCIENCE

Volume 118 Number 5

10 March 2020

---

**690 In this issue**


---

**GUEST EDITORIAL**

- 691 The need to become science-friendly**  
Jayant Narlikar
- 

**NEWS**

- 693 Science Last Fortnight**
- 697 'Superbugs' and antibiotic resistance, Parul R. Sheth**
- 

**COMMENTARY**

- 698 Bioinformatics: how it helps to boost modern biological research**  
Suvakanta Barik, Nilesh Rai, Pradeep Mishra, Santosh K. Singh and Vibhav Gautam
- 

**SCIENTIFIC CORRESPONDENCE**

- 700 Assessing the response of forests to environmental variables using a dynamic global vegetation model: an Indian perspective**  
Manoj Kumar, Naveen Kalra and N. H. Ravindranath
- 701 Earthquake swarms in Palghar district, Maharashtra, Deccan Volcanic Province**  
P. Mahesh, A. Sateesh, Charu Kamra, Santosh Kumar, Sumer Chopra and M. Ravi Kumar
- 

**GENERAL ARTICLES**

- 705 Duality in science**  
Varun S. Bhatta and Sundar Sarukkai
- 714 Visualization analysis of health informatics research from 2001 to 2018**  
Lu-Xi Zou and Ling Sun
- 

**RESEARCH ARTICLES**

- 722 Functional prediction from conformational dynamics of glycated and glutathionylated HbE and HbD Punjab**  
Sreekala Narayanan, Boby Mathew, Bindu Y. Srinivasu, Monita Muralidharan, Vijay Bhat and Amit Kumar Mandal
- 728 A geospatial approach to assess health coverage and scaling-up of healthcare facilities**  
Oinam Bakimchandra, Joymati Oinam and R. K. Kajal
- 737 Impact assessment of a severe dust storm on atmospheric aerosols over an urban site in India**  
Kanika Taneja, Shamshad Ahmad, Kafeel Ahmad and S. D. Attri
- 750 Changes in *pmoA* gene containing methanotrophic population and methane oxidation potential of dry deciduous tropical forest soils**  
Yashpal Bhardwaj and Suresh Kumar Dubey
- 759 Seismic behaviour of RC building with raft foundation in the Ganges basin, India**  
J. S. Rajeswari, Rajib Sarkar, Sekhar Chandra Dutta, Jai Prakash Singh and Ranjeet Saw



- 771 **Pedo-transfer functions for saturated hydraulic conductivity of cultivated soils in the mid hills of Sikkim**  
G. T. Patle and P. C. Vanlalnunchhani
- 778 **Role of meteorology and local orography on a flood event in the Lower Subansiri Basin and post-flood changes to land use and land cover**  
Partha Pratim Gogoi, V. Vinoj and Parag Phukon

---

#### RESEARCH COMMUNICATIONS

- 786 **Analysis of various factors responsible for hair loss and awareness level in Delhi and the National Capital Region of India**  
Archana Aggarwal, Rakhi Gupta, Navdha Thukral, Gargi Nandi and Garima Bora
- 791 **A comparative study of physical properties of yarns and fabrics produced from fresh and recycled fibres**  
Neelam Saini, Saroj Yadav and Neelam M. Rose
- 796 **Anticandidal efficiency of *Cinnamomum zeylanicum* extracts against vulvovaginal candidiasis**  
Mohamed Taha Yassin, Ashraf Abdel-Fattah Mostafa and Abdulaziz Abdulrahman Al-Askar
- 801 **First record of circa 970 Ma post-collisional A-type magmatism in the Sendra Granitoid Suite, central Aravalli orogen, northwest India**  
Jaideep K. Tiwana, Parampreet Kaur, Naveen Chaudhri and Manisha
- 809 **Occurrence of liddicoatite-bearing LCT pegmatites in Sirohi region, northwest India and their rare metal potentiality**  
Manideepa Roy Choudhury, Nikhil Agarwal and Suresh Chander
- 819 **Studies on butterfly (Insecta: Lepidoptera) diversity across different urban landscapes of Delhi, India**  
Monalisa Paul and Aisha Sultana
- 827 **Functional response of three species of predatory pirate bugs to different densities of blossom thrips, *Frankliniella schultzei* Trybom (Thysanoptera: Thripidae)**  
Richa Varshney, Neeraj Budhlakoti and Chandish R. Ballal

---

#### BOOK REVIEWS

- 834 **Retrovirus-Cell Interactions.** Leslie J. Parent (ed.); *reviewed by* Matto Rohini
- 835 **Space and Human Development, Revised Edition.** Mohan Sundara Rajan; *reviewed by* Ranganath Navalgund
- 836 **Sambhu Nath De: The Discovery of Cholera Toxin.** M. S. S. Murthy; *reviewed by* Anisha Maria Fernandes and Sanjay A. Pai

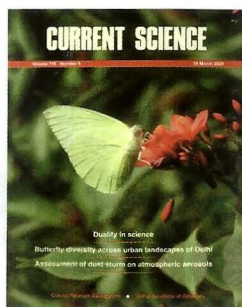
---

#### PERSONAL NEWS

- 837 **M. K. Bhan (1947–2020),** Renu Swarup
- 



- ◀ **COVER.** Oriental Lemon Emigrant *Catopsilia pomona* F. at Aravalli Biodiversity Park, New Delhi (Photo credit Dr Aisha Sultana). See page 819.



# CURRENT SCIENCE

Volume 118 Number 6

25 March 2020

854 **In this issue**

**GUEST EDITORIAL**

855 **Will Coronavirus Pandemic eventually evolve as Pan-endemic?**  
T. Jacob John

**CORRESPONDENCE**

857 **International Year of Plant Health 2020 to focus on threat of pests on food security**, H. R. Gautam and M. L. Bhardwaj

**NEWS**

858 **2020 King Faisal International Prize for Science and Medicine**  
Sameen Ahmed Khan

859 **Science Last Fortnight**

**COMMENTARY**

863 **Preaching objectivity – practicing obfuscation**, Deepak Pental; *A reply by Gutierrez et al.*

869 **A century of biochemistry at IISc**, K. Muniyappa

**GENERAL ARTICLES**

872 **Low cost drinking water technology – rainwater harvesting with solar purification**  
Shivam D. Patange, Nandini Nimbkar and Anil K. Rajvanshi

877 **Challenges in geospatial documentation of unprotected built heritage sites in India**  
Kuili Suganya

**REVIEW ARTICLE**

883 **Sources and leaching of nitrate contamination in groundwater**  
Saurabh Shukla and Abhishek Saxena

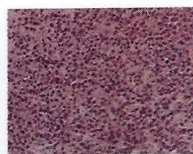
**RESEARCH ARTICLES**

892 **Anti-tumour and immune enhancing activities of MLAA-22<sub>379-387</sub> on acute myeloid leukemia**  
Jing Li, Wanggang Zhang, Ju Bai, Bo Zhong, Huiyuan Wang, Yan Geng, Qiaoyan Jin, Juanjuan Hao and Yang Zhang

901 **Blasting technique for stabilizing accident-prone slope for sustainable railway route**  
N. K. Bhagat, A. K. Mishra, M. M. Singh, Aditya Rana, S. Tewari and P. K. Singh

910 **Petrogenesis of the Palaeoarchean Keonjhar Granite, Singhbhum Craton, India: product of crustal reworking or subduction?**  
Ajay Dev Asokan, Kumar Krishna, R. Elangovan and M. Ram Mohan

920 **Aqueous extract of *Cleistanthus collinus* induces activity of peroxidase and catalase in the seedlings of cucumber and chilli**  
Monal R. Kadoo and Rupesh S. Badere



- 931 *Averrhoa bilimbi* in organic transformation: a highly efficient and green biosurfactant for the synthesis of multi-functional chromenes and xanthenes  
Bhagyashree M. Patil, Snehali R. Mali, Bhimrao M. Patil and Suresh S. Patil
- 946 Stigmasterol-3-*O*-glucoside, an allelopathic molecule responsible for pest resistance of Thenkaali (AAB), a *Musa* cultivar against *Odoiporus longicollis* [Olivier]  
K. J. Kavitha, J. Anil John and D. A. Evans




---

### RESEARCH COMMUNICATIONS

- 954 Efficient and improved edge detection via a hysteresis thresholding method  
Sajid Khan, Dong-Ho Lee, Muhammad Asif Khan, Abdul Rehman Gilal, Junaid Iqbal and Ahmad Waqas
- 961 Fractionalization of *h*-index for multiple authorship – an impact-based interpretation conserving counts  
Gangan Prathap
- 966 Effect of extractive content on fuelwood characteristics of certain woody and non-woody biomass  
Ritesh Kumar, N. Chandrashekar, N. R. R. Prasad and Ritesh Tailor
- 969 Smart automatic irrigation controller  
Faruk Poyen, Sayan Hazra, Nabarun Sengupta, Apurba Ghosh and Palash Kundu
- 977 Ingestion of unusual items by wetland birds in urban landscapes  
Abey Francis, B. Anjan Kumar Prusty and P. A. Azeez
- 983 Tunnel wells, the traditional water harvesting structures of Kasaragod, Kerala: re-visited  
E. Shaji, K. V. Sarath, Pranav Prakash, Adithya Pazhoor Abraham, V. Deepchand, V. Kunhambu and A. P. Pradeepkumar




---

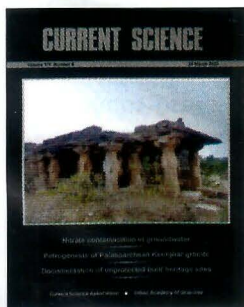
### BOOK REVIEWS

- 988 Clay, Craft, Music and Science: Purnima Sinha's Life. Rajinder Singh and Suprakash C. Roy; reviewed by Hardev Singh Virk
- 989 Voyage to Antarctica: An Odyssey to the Past, Present and Future of the Gelid Mysterious Continent. Felix Bast; reviewed by Rahul Mohan

---

### PERSONAL NEWS

- 992 Sambasiva Swaminathan (1923–2020), S. Chandrasekaran and K. Nagarajan
- 



◀ COVER. Temple in ruins at Arasibidi in North Karnataka, India. See page 877.

# CURRENT SCIENCE

## Print/Online Advertisement Rates

CURRENT SCIENCE

### Volume 118 – Issue 7: 10 Apr, 2020

---

#### In this Issue

##### **In this issue**

p. 1010

#### Guest Editorial

##### **Academic and post-academic research, and national development**

p. 1011 | [Grover, R. B.](#)

#### News

##### **Science Last Fortnight**

p. 1013

#### Opinion

##### **Revamping of doctoral education in agricultural sciences in India**

p. 1017 | [Sinha, Aditya](#); [Nayak, Roshan](#); [Singh, Raj Narain](#)

#### Scientific Correspondence

##### **Development of analytical hierarchy process based dairy index for assessment of the dairy sector in different states of India**

p. 1019 | [Kumar, Ashish](#); [Rao, Bakul](#); [Jain, Rahi](#)

##### **Selfing in *Buxus wallichiana* Baill.: a trait or strategy?**

p. 1021 | [Sharma, Eshan](#); [Bharti, Uma](#); [Bhushan, Upvan](#); [Sharma, Namrata](#)

##### **Model-based retrospective estimates for COVID-19 or coronavirus in India: continued efforts required to contain the virus spread**

p. 1023 | [Rao, Arni S. R. Srinivasa](#); [Krantz, Steven G.](#); [Kurien, Thomas](#); [Bhat, Ramesh](#); [Kurapati, Sudhakar](#)

#### General Articles

##### **Suggestions for a National Framework for Publication of and Access to Literature in Science and Technology in India**

p. 1026 | [Chakraborty, S.](#); [Gowrishankar, J.](#); [Joshi, A.](#); [Kannan, P.](#); [Kohli, R. K.](#); [Lakhotia, S. C.](#); [Misra, G.](#); [Nautiyal, C. M.](#); [Ramasubramanian, K.](#); [Sathyamurthy, N.](#); [Singhvi, A. K.](#)

doi: 10.18520/cs/v118/i7/1026-1034

## Research Articles

### **Macrocycles of axially chiral and racemic *N*-heterocyclic carbene silver(I), gold(I) and palladium(II) complexes: synthesis, characterization and computational structures**

p. 1035 | Mahule, Sonali Ramgopal  
doi: 10.18520/cs/v118/i7/1035-1041

### **Microbial diversity analysis in the oxygen minimum zones of the Arabian Sea using metagenomics approach**

p. 1042 | Paingankar, Mandar S.; Ahire, Kedar; Mishra, Pawan; Rajpathak, Shriram; Deobagkar, Deepti D.  
doi: 10.18520/cs/v118/i7/1042-1051

### **Effect of charring on rice grain morphology and carbon isotopic composition**

p. 1052 | Biswas, Arpita; Kaushal, Ritika; Ghosh, Prosenjit  
doi: 10.18520/cs/v118/i7/1052-1059

### **Engineering properties of bacterially induced calcite formations**

p. 1060 | Shougrakpam, Sangeeta; Trivedi, Ashutosh  
doi: 10.18520/cs/v118/i7/1060-1068

### **Source of unusual monochromatic wave packets recorded globally in the seismograms of 11 November 2018**

p. 1069 | Bhattacharya, S. N.; Gahalaut, V. K.; Pandey, Narendra; Pal, Shankar; Manhas, Rajeev; Suresh, G.  
doi: 10.18520/cs/v118/i7/1069-1076

### **Effect of lintel beam on response reduction factor of RC-infilled frames**

p. 1077 | Shendkar, Mangeshkumar R.; Mandal, Sasankasekhar; Kumar, Ramancharla Pradeep  
doi: 10.18520/cs/v118/i7/1077-1086

### **Molecular docking analysis of selected natural products from plants for inhibition of SARS-CoV-2 main protease**

p. 1087 | Sampangi-Ramaiah, Megha Hastantram; Vishwakarma, Ram; Shaanker, R. Uma  
doi: 10.18520/cs/v118/i7/1087-1092

## Research Communication

### **Evaluating risk factors in patients with severe asthma: a cross-sectional study**

p. 1093 | Foumani, Ali Alavi; Jafari, Alireza; Leili, Ehsan Kazem Nejad; Daraie, Elnaz; Sheikhlil, Negar; Ildari, Shima; Shabaniyan, Reyhaneh  
doi: 10.18520/cs/v118/i7/1093-1098

### **Soil organic carbon pools under *Terminalia chebula* Retz. based agroforestry system in Himalayan foothills, India**

p. 1098 | Kumar, Amit; Dwivedi, G. K.; Tewari, Salil; Jaipaul, Sah, V. K.; Singh, Hukum; Kumar, Parmanand; Kumar, Narendra; Kaushal, Rajesh  
doi: 10.18520/cs/v118/i7/1098-1103

### **GPR data interpretation using continuous wavelet transform: a different approach**

p. 1104 | Kumar, Sarvesh; Pal, Sanjit Kumar; Rani, Soma; Saurabh  
doi: 10.18520/cs/v118/i7/1104-1111

### **Detection of atmospheric lightning activity with ground-based radiofrequency receivers – establishment and initial results**

p. 1112 | Taori, Alok; Suryavanshi, Arun; Goenka, R.; Gharai, B.; Haridas, M. K. Madhav; Seshasai, M. V. R.; Dutta, D.; Raj, Uday; Jayaram, Chiranjivi  
doi: 10.18520/cs/v118/i7/1112-1117

### **Morphology of the two unnamed seamounts in the Arabian Basin and their probable tectonic implications**

p. 1118 | Bijesh, C. M.; Kurian, P. John  
doi: 10.18520/cs/v118/i7/1118-1123

### **Characteristics of Mesoproterozoic felsic meta-volcanics from the Shillong Group of rocks, Meghalaya, North East India**

p. 1123 | Naik, R. R.; Theunuo, K.; Khonglah, M. A.; Pal, T.; Tripathy, S. K.; Goswami, T. K.  
doi: 10.18520/cs/v118/i7/1123-1128

## Book Reviews

### **Vedic Mathematics and Science in Vedas. S. Balachandra Rao**

p. 1129 | Shylaja, B. S.

### **The Scientific Temper. V. Rajagopal**

p. 1130 | Nair, Amruta

## Advertisements

### **PRL Junior Research Fellowships (JRFs) – 2020 - Physical Research Laboratory, Ahmedabad**

p. 1132

### **Nominations are invited for G N Ramachandran Gold Medal for Excellence in Biological Sciences and Technology 2020**

p. 1133

### **Invites Applications for the Post of DIRECTOR, The Institute of Mathematical Sciences**

p. 1133

### **Workshop on Science Writing**

p. 1134

**Junior Research Fellow - SRM Institute of Science and Technology**

p. 1134

**Admission to Postgraduate Programmes/Ph.D. 2020-21 - Indian Institute of Technology Bombay**

p. 1134

**Call for Applications/Nominal for Appointment of Director - Raman Research Institute, Bengaluru**

p. 1135

---

# CURRENT SCIENCE

Volume 118 Number 8

25 April 2020

---

**1146 In this issue**


---

**EDITORIAL**

- 1147 Pandemics and climate change**  
J. Srinivasan
- 

14 AUG 2020

**CORRESPONDENCE**

- 1149 Novel coronavirus epidemic: new dimension for disaster management and health resilience**, Atisha Sood, Anjali Barwal, Anil K. Gupta and Jugal Kishore ■ **1150 Coronavirus: a novel threat and ICT-based mitigation**, Partha Pratim Ray and Poulami Majumder ■ **1152 Litchi is safe and harmless in normal individuals**, T. Jacob John, Mukul Das and Abhirup Sarkar
- 

**NEWS**

- 1153 Science Last Fortnight**
- 

**OPINION**

- 1157 Membrane cholesterol and SARS-CoV-2 infection: a possible connection**  
Hirak Chakraborty
- 

**COMMENTARY**

- 1158 Ayurveda rasayana in prophylaxis of COVID-19**  
Bhushan Patwardhan, Preeti Chavan-Gautam, Manish Gautam, Girish Tillu, Arvind Chopra, Sunil Gairola and Suresh Jadhav
- 

**SCIENTIFIC CORRESPONDENCE**

- 1161 Structure and genetic variability of new populations of *Amentotaxus assamica* in the Eastern Himalaya, India**  
N. Lyngdoh, S. Chakraborty, G. Ravikanth, A. A. Mao and A. K. Pandey
- 

**GENERAL ARTICLES**

- 1163 Micro-irrigation development in India: challenges and strategies**  
A. Suresh and Manoj P. Samuel
- 1169 Field dependence of citation data validation of premier peer-review decisions in India**  
Gangan Prathap
- 

**SPECIAL SECTION: VIKRAM SARABHAI BIRTH CENTENARY**

- 1173 Foreword**  
K. Kasturirangan
- 1177 Scientist, businessman, visionary institution builder**  
E. V. Chitnis
- 1180 There is nobody to be ruled**  
Praful D. Bhavsar
- 1182 Tribute to Vikram Sarabhai**  
C. N. R. Rao

- 1183 **Vikram Sarabhai – A scientist’s scientist**  
M. S. Swaminathan
- 1184 **Vikram Sarabhai – Visionary motivator**  
Pramod Kale
- 1188 **My reminisces of interaction with Vikram Sarabhai**  
Govind Swarup
- 1190 **The man with big ears, and big dreams that took India to the moon**  
Amrita Shah
- 1191 **Vikram Sarabhai: his vision for the development of atomic energy in India**  
R. B. Grover and M. R. Srinivasan
- 1196 **Sowing the seeds of an Indian fusion programme – an untold legacy of Vikram Sarabhai**  
Abhijit Sen
- 1199 **Vikram Sarabhai: his vision of India as a space power and its fulfilment**  
R. Aravamudan
- 1203 **Vikram Sarabhai: science in developing countries**  
Kartikeya V. Sarabhai and Padmanabh Joshi
- 1207 **Propagating and practising ‘horizontal control’: Vikram Sarabhai, management and American social science**  
Joseph Francombe
- 1213 **Vikram A Sarabhai Community Science Centre**  
Dilip Surkar
- 1215 **Photo Gallery**

---

#### RESEARCH ARTICLES

- 1219 **Nitrous oxide emissions from turfgrass lawns as a result of fertilizer application: a meta-analysis of available literature**  
Neesha Dutt and Tushar Tanwar
- 1227 **Parameter uncertainty in HEC-RAS 1D CSU scour model**  
Praveen Rathod and V. L. Manekar
- 1235 **Impact of climate variability and change on crop production in Maharashtra, India**  
Saurabh M. Kelkar, Ashwini Kulkarni and K. Koteswara Rao
- 1246 **Site-suitability analysis for turmeric in Jaintia Hills of Meghalaya, India, using analytical hierarchical process and weighted overlay analysis: a comparative approach**  
Ashu Negi, Tapan Adhikari, Chandan Goswami, B. K. Handique and P. L. N. Raju
- 1255 **Control of an irrigation branch canal using model predictive controller**  
Jailakshmi Menon, B. V. Mudgal, M. Guruprasath and S. Sivalingam
- 1265 **Performance evaluation of anaerobic baffled biodigester for treatment of black water**  
Ligy Philip, K. Kalaivani, Praveen Rosario, Vamsi Krishna and S. SriShalini

---

#### RESEARCH COMMUNICATIONS

- 1275 **Detection and mapping of seagrass meadows at Ritchie’s archipelago using Sentinel 2A satellite imagery**  
Sharad Bayyana, Satish Pawar, Swapnali Gole, Sohini Dudhat, Anant Pande, Debashis Mitra, Jeyaraj Antony Johnson and Kuppusamy Sivakumar



- 1282 **Development of wind speed retrieval model using RISAT-1 SAR cross-polarized observations**  
Jagdish Prajapati, Abhisek Chakraborty, Bipasha Paul Shukla and Raj Kumar
- 1286 **Correlation between Earth tides and the 2008  $M_S$  8.0 Wenchuan earthquake sequence**  
Ruyu Yan, Chaodi Xie, Xinglin Lei, Han Zhang, Rui Jia and Jianping Liao
- 1292 **Geochemical pathways of fluoride and boron in the alluvial aquifer of the Dwarka river basin, India**  
Raju Thapa, Srimanta Gupta and Harjeet Kaur
- 1296 **Financialization and its impact on the nature of knowledge production in bioeconomy**  
P. Omkar Nadh
- 1304 **Finding clues in cities: nest site selection by house sparrows across a varied habitat matrix in Delhi, India**  
Shikha Choudhary, N. P. S. Chauhan and Rajiv Kalsi

---

#### BOOK REVIEWS

- 1310 **Annual Review of Earth and Planetary Sciences, 2019.** Raymond Jeanloz and Katherine H. Freeman (eds); *reviewed by* C. P. Rajendran
- 1311 **An Autobiography of the Moon.** Ramesh Shishu; *reviewed by* Ranganath Navalgund

---

#### HISTORICAL NOTES

- 1313 **On the 200th anniversary of the Madras Eye Infirmary, the first ophthalmic hospital in Asia**  
Ramya Raman and Anantanarayanan Raman
- 



◀ COVER. Vikram Sarabhai: A visionary scientist. See special section.

Indexed in CURRENT CONTENTS/GEODATABASE/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE

# CURRENT SCIENCE

**1330 In this issue**

**GUEST EDITORIAL**

- 1331 On interdisciplinarity**  
Sushanta Dattagupta

**CORRESPONDENCE**

- 1333 Bioinformatics: genomics to phenomics and beyond**, Rajiv Angrish and Sarita Devi  
**■ 1333 Deciphering asymptomatic malaria – the missing link in India’s fight against the disease?**, Saurav Jyoti Patgiri, Dibya Ranjan Bhattacharyya, Ipsita Pal Bhowmick and Md Atique Ahmed

**OPINION**

- 1335 Obesity and COVID-19 outcomes: a risk factor that needs attention**  
Anurag Bhargava and Madhavi Bhargava
- 1337 Soil health cards: limitations and ways to fix the loopholes**  
Ankita Trivedi and Asik Dutta

**SCIENTIFIC CORRESPONDENCE**

- 1339 Are traditional bamboo products green?**  
Rajashree Ray, Karabi Pathak, Arun Jyoti Nath and Ashesh Kumar Das

**GENERAL ARTICLES**

- 1343 India’s potential to develop particle accelerators for societal, industrial and environmental applications**  
R. K. Bhandari
- 1349 Thirsty crops and virtual water flows – making sense of the economically invisible water flows**  
Gurudas Nulkar
- 1354 The spatial model of the classroom and its immediate surroundings: a variety of learning spaces**  
Milan Tanić, Vojislav Nikolić and Željko Žugić

**REVIEW ARTICLES**

- 1365 Plurality of wave–particle duality**  
Varun S. Bhatta
- 1375 Cow milk protein allergy and lactose intolerance**  
Rajendra Prasad and Yashbir Singh Shivay

**RESEARCH ACCOUNT**

- 1379 Insights into riverscape dynamics with the hydrological, ecological and social dimensions for water sustenance**  
T. V. Ramachandra, S. Vinay, S. Bharath, M. D. Subash Chandran and Bharath H. Aithal

**RESEARCH ARTICLES**

- 1394 Chia seed-based nutri bar: optimization, analysis and shelf life**  
Jyoti Singh, Bhavna Sharma, Mokshi Madaan, Pooja Sharma, Tarandeep Kaur, Navjot Kaur, Inderdeep Kaur Bhamra, Sawinder Kaur and Prasad Rasane



- 1401 **Mechanisms underlying diurnal variations in the canopy spectral reflectance of winter wheat in the jointing stage**  
Yinghao Lin, Huaifei Shen, Qingjiu Tian, Xingfa Gu, Ranran Yang and Baojun Qiao
- 1407 **A method for the identification and evaluation of stay-green wheat variety**  
Huiyan Wang, Shuguang Wang, Zenghao Liang, Xue Yan, Jianming Wang and Daizhen Sun
- 1415 **A socio-economic survey of the Singchung Bugun Village Community Reserve, Arunachal Pradesh, India**  
Binod Borah, Nandini Velho and Umesh Srinivasan
- 1420 **Mapping of greenstone belts using aeromagnetic data in Eastern Dharwar Craton, India**  
M. Prasanthi Lakshmi, S. Parveen Begum, A. Manglik and D. Seshu

---

### RESEARCH COMMUNICATIONS

- 1432 **A tournament metaphor for dominance hierarchy**  
Gangan Prathap
- 1436 **Molecular association and gelling characteristics of curdlan**  
Jagadeeshwar Kodavaty, Gayathri Venkat, Abhijit P. Deshpande and Satyanarayana N. Gummadi
- 1442 **Source change of lead materials for mirror-making industry in Western Han, China: evidence from Nanyang bronze mirrors**  
Dian Chen, Qingshuo Zeng, Benxin Cui and Wugan Luo
- 1448 **Endophytic fungi of salt adapted *Ipomea pes-caprae* L. R. Br: their possible role in inducing salinity tolerance in paddy (*Oryza sativa* L.)**  
K. M. Manasa, M. M. Vasanthakumari, K. N. Nataraja and R. Uma Shaanker
- 1454 **Incipient infestations and threat of pink bollworm *Pectinophora gossypiella* (Saunders) on Bollgard-II cotton in the northern cotton-growing zone of India**  
Rishi Kumar, D. Monga, V. Chinna Babu Naik, Paramjit Singh and V. N. Waghmare
- 1456 **Identification of Indian butterflies and moths with deep convolutional neural networks**  
V. Sagar, R. Sachin, K. Chandrashekara and K. N. Ganeshaiah




---

### BOOK REVIEWS

- 1463 **Zhuangzi: The Way of Nature.** Adapted and Illustrated by C. C. Tsai; *reviewed by* Rajan Gurukkal
- 1464 **Why Trust Science?.** Naomi Oreskes; *reviewed by* Raghavendra Gadagkar



- ◀ COVER. Perennial stream amidst sacred grove at Vibuthi, Near Yana, Uttara Kannada District, Central Western Ghats. See page 1379.

Indexed in CURRENT CONTENTS/GEODATABASE/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE

# CURRENT SCIENCE

Volume 118 Number 10

25 May 2020

**1482 In this issue**

**EDITORIAL**

- 1483 A tale of two views: why are scientists polarized?**  
R. Uma Shaanker

**NEWS**

- 1485 Brainstorming on the future of the highly threatened medicinal plants of the Western Himalaya, India**  
Manisha Mathela, Himanshu Bargali, Monika Sharma, Rupali Sharma and Amit Kumar

**OPINION**

- 1487 Critical zone: an emerging research area for sustainability**  
Paras R. Pujari, V. Jain, V. Singh, K. Sreelash, S. Dhyani, M. Nema, P. Verma, R. Kumar, S. Jain and M. Sekhar

**COMMENTARY**

- 1489 Hydroxychloroquine: A relatively obscure antimalarial takes centre stage in COVID-19**  
Govindarajan Padmanaban and Viswanathan Arun Nagaraj

**SCIENTIFIC CORRESPONDENCE**

- 1492 Presence of air cavities in pods of an endemic legume *Crotalaria pusilla* DC. (Leguminosae, Papilionoideae)**  
Shweta Subramaniam, Shabir A. Rather, Shagun Danda and Arun K. Pandey
- 1494 Cry toxin expression in *Bt*-cotton hybrid seeds: impact on 'refuge-in-bag' strategy for managing resistance in bollworms**  
K. Muralimohan and H. M. Mahesh

**GENERAL ARTICLES**

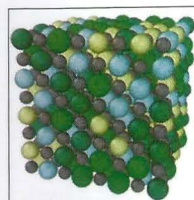
- 1496 Who should certify the sustainability of our fisheries? A property rights perspective on ecolabelling**  
C. Ramachandran and Shinoj Parappurathu
- 1500 Rare diseases in India: time for cure-driven policy initiatives and action**  
Anjali Taneja, L. S. Shashidhara and Alok Bhattacharya

**REVIEW ARTICLES**

- 1507  $\text{Na}_{1/2}\text{Bi}_{1/2}\text{TiO}_3$ -based lead-free piezoceramics: a review of structure-property correlation**  
Rajeev Ranjan
- 1520 High-entropy materials: critical review and way forward**  
Nilesh P. Gurao and Krishanu Biswas
- 1540 Biopolymer based hydrogels for arsenic removal**  
Shabnam Pathan and Suryasarathi Bose

**RESEARCH ARTICLES**

- 1547 Critical analysis of process cycle by numerical modelling for faster development of drives in hard-rock underground mine – a case study**  
K. K. Rao, B. S. Choudhary<sup>25</sup>, Ajay Ghade and Chandrasah



- 1557 **Co-authorship network in cardiology research studies: case study of Iranian output**  
Eskrootchi Rogheyyeh, Ashoori Mhranjani Forouzan, Shahrabi Farahani Helia and Mayank Yuvaraj
- 1563 **Mapping spatial relationship of Van Panchayats and Forest Fire of 2019 in Almora district, Uttarakhand**  
Stutee Gupta, Shikha Anand, Vishesh Mathur, K. M. Reddy and T. Ravisankar
- 1569 **Geometric characteristics of slope toppling failure and its interpretation**  
Jiayuan Cao, Fengshan Ma, Jiamo Xu, Jie Guo and Rong Lu
- 1575 **The impact of crop diversification towards high-value crops on economic welfare of agricultural households in eastern India**  
A. R. Anuja, Anjani Kumar, Sunil Saroj and K. N. Singh
- 1583 **Nanoformulated CPMSN biomaterial regulates proinflammatory cytokines to heal wounds and kills drug-resistant bacteria**  
Chandran Murugan, Manickam Rajkumar, Nagarajan Kanipandian, Ramasundaram Thangaraj, Karuppaiya Vimala and Soundarapandian Kannan



### RESEARCH COMMUNICATIONS

- 1592 **An appraisal of recent earthquake activity in Palghar region, Maharashtra, India**  
D. Srinagesh, Dhiraj Kumar Singh, G. Vikas, B. Naresh, Sunil Roy, Y. V. V. B. S. N. Murthy, P. Solomon Raju, G. Suresh, Prantik Mandal, A. N. S. Sharma, M. Shekar and V. M. Tiwari
- 1598 **Inheritance of fruiting habit traits in chilli (*Capsicum annuum* L.)**  
C. Anilkumar, A. Mohan Rao, S. Ramesh, B. Bhavani and Pranesh
- 1602 **Ladybird, *Menochilus sexmaculatus* (Fabricius) can survive on oophagy but with altered fitness than aphidophagy**  
Shashwat Singh, Geetanjali Mishra and Omkar
- 1609 **Antimicrobial activity of Indian meal moth silk, *Plodia interpunctella***  
Olgica Stefanović, Filip Vukajlović, Tamara Mladenović, Dragana Predojević, Ljiljana Čović and Snežana B. Pešić
- 1615 ***In situ* observation of scorpionfish in seagrass meadows of the Gulf of Mannar, India**  
R. Jeyabaskaran, S. Lavanya, Shelton Padua and V. Kripa

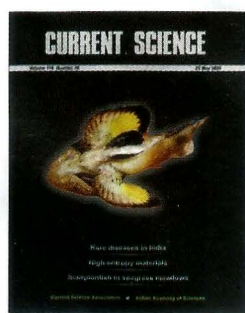


### BOOK REVIEWS

- 1621 **Applied Evaluative Informetrics.** Henk F. Moed; *reviewed by* Subbiah Arunachalam
- 1622 **Annual Review of Entomology, 2019.** A. E. Douglas, J. Trumble and M. P. Zalucki (eds); *reviewed by* S. Ignacimuthu

### PERSONAL NEWS

- 1624 **P. W. Anderson (1923–2020)**  
G. Baskaran, V. N. Muthukumar, K. A. Muttalib and T. V. Ramakrishnan
- 1628 **M. C. Wani (1925–2020)**  
Nisheeth Desai and Anamik K. Shah



- ◀ **COVER.** Colour changes in blackband scorpionfish: Presence of pale yellowish with black spots in the axial of pectoral fins. See page 1615.

Indexed in CURRENT CONTENTS/GEODATABASE/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE



# CURRENT SCIENCE

1638 In this issue

12 OCT 2020

## GUEST EDITORIAL

1639 **Assessment and implementation of environmental flows**  
Sharad K. Jain

## CORRESPONDENCE

1641 **COVID-19 imposed lockdown might be a boon for aquatic ecosystem**, Sumit Mandal ■ **1641 Beehive charcoal briquettes: clean cooking fuel for rural households**, Sandip Mandal

## COMMENTARY

1643 **The sugarcane variety Co 0238 – a reward to farmers and elixir to India’s sugar sector**  
Bakshi Ram and G. Hemaprabha

1646 **Imported superfood quinoa versus Indian nutricereal millets**  
Annvi Dhaka and Manoj Prasad

## SCIENTIFIC CORRESPONDENCE

1650 **Elevated CO<sub>2</sub> causes earlier flowering in an alpine medicinal herb *Aconitum heterophyllum* Wall.**  
Sudeep Chandra, Vaishali Chandola, M. C. Nautiyal and V. K. Purohit

## GENERAL ARTICLE

1652 **Light harvesting using solar cells and luminescent solar concentrators**  
Renju Rajan, P. Ramesh Babu and K. Senthilnathan

## REVIEW ARTICLES

1656 **Something more than graphene – futuristic two-dimensional nanomaterials**  
Inderdeep Singh Bhatia and Deep Kamal Kaur Randhawa

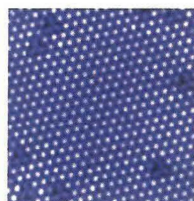
1672 **Optimization of superplasticizer dosage for cementitious suspension involved in high shear applications**  
P. V. P. Moorthi and Prakash Nanthagopalan

## SPECIAL SECTION: SUSTAINABLE OCEAN TECHNOLOGIES

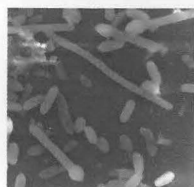
1679 **Preface**  
Shailesh Nayak

1681 **Unmanned underwater vehicles: Design considerations and outcome of scientific expeditions**  
G. A. Ramadass, S. Ramesh, N. Vedachalam, AN. Subramanian, D. Sathianarayanan, R. Ramesh, G. Harikrishnan, T. Chowdhury, V. B. N. Jyothi, S. B. Pranesh, V. Doss Prakash and M.-A. Atmanand

1687 **Challenges in developing deep-water human occupied vehicles**  
G. A. Ramadass, N. Vedachalam, S. Ramesh, D. Sathianarayanan, AN. Subramanian, R. Ramesh, T. Chowdhury, S. B. Pranesh and M. A. Atmanand



- 1694 **Studies on nonlinear behaviour of floating components for offshore desalination plants**  
Ashwani Vishwanath, Purnima Jalihal and Abhijeet Sajjan
- 1702 **Development of wide band underwater acoustic transducers**  
Dhilsha Rajapan, P. M. Rajeshwari and Shijo Zacharia
- 1707 **Source localization in shallow waters using an acoustic vector sensor array**  
G. Latha, A. Malarkodi, M. Ashokan and A. Thirunavukkarasu
- 1712 **Performance evaluation of power module during demonstration of wave-powered navigational buoy**  
Biren Pattanaik, Ashwani Vishwanath, Purnima Jalihal, Y. V. N. Rao, A. Karthikeyan, K. S. Sajeev and V. P. Shipin
- 1718 **Influence of non-condensable gases on performance of the low temperature thermal desalination plants**  
G. Venkatesan, L. S. S. Prakash Kumar and Purnima Jalihal
- 1725 **Production and characterization of antimicrobial peptides from *Bacillus subtilis* isolated from deep-sea core samples**  
A. Ganesh Kumar, G. Dharani, R. Kirubakaran and M. A. Atmanand
- 1731 **Mass culture of marine microalgae *Chlorella vulgaris* (NIOT-74) and production of biodiesel**  
G. Dharani, D. Magesh Peter, J. T. Mary Leema, T. S. Kumar, K. Thirupathi, A. Josephine, R. Kirubakaran and M. A. Atmanand
- 1739 **Surface circulation off the Andaman Islands from HF radar observations**  
B. K. Jena, K. S. Arunraj, V. Suseentharan and M. V. Ramanamurthy
- 1746 **Simulated wave climate and variability over the North Indian Ocean**  
Basanta Kumar Jena, J. Rajkumar, Aruna Kumar Avula, K. Jossia Joseph and M. V. Ramana Murthy
- 1753 **Are we ready for a major tsunami in the Indian Ocean?**  
S. S. C. Shenoi, P. L. N. Murty, Ch. Patanjali Kumar, B. Ajay Kumar, M. V. Sunanda, K. Siva Srinivas, J. Padmanabham, Dipankar Saikia, E. Pattabhi Rama Rao and Shailesh Nayak
- 1760 **Differential upper ocean response depicted in moored buoy observations during the pre-monsoon cyclone *Viyaru***  
R. Venkatesan, K. Jossia Joseph, C. Anoop Prasad, M. Arul Muthiah, S. Ramasundaram and P. Muruges
- 1768 **Shore protection measures along Indian Coast – Design to implementation based on two case studies**  
M. V. Ramana Murthy, Vijaya Ravichandran, Mullai Vendhan, A. S. Kiran, Satya Kiran Raju, Aruna Kumar Avula, Shyamala Varthini and T. Abhishek
- 1774 **Offshore wind projects for the Indian Coast – Experiences and challenges for its realization**  
Satya Kiran Raju Alluri, Devender Gujjula, G. Dhinesh, S. V. S. Phani Kumar and M. V. Ramana Murthy
- 1778 **Ocean current mapping with indigenous drifting buoys**  
R. Srinivasan, Shijo Zacharia, V. Gowthaman, Tata Sudhakar and M. A. Atmanand
- 1782 **Reliability assessment and system performance improvement of ORV *Sagar Nidhi* propulsion system**  
D. Rajasekhar, P. S. Deepak Sankar, Anantha Krishna Rao, D. Narendrakumar and K. Ramasundaram



## RESEARCH ARTICLES

- 1786 **Genomics of Indian SARS-CoV-2: Implications in genetic diversity, possible origin and spread of virus**  
Mainak Mondal, Ankita Lawarde and Kumaravel Somasundaram
- 1792 **Fault detection for scraper chain using an observer-based tension distribution estimation algorithm**  
Xing Zhang, Wei Li, Zhencai Zhu and Fan Jiang
- 1803 **Evaluation of PM<sub>2.5</sub> forecast using chemical data assimilation in the WRF-Chem model: a novel initiative under the Ministry of Earth Sciences Air Quality Early Warning System for Delhi, India**  
Sachin D. Ghude, Rajesh Kumar, Chinmay Jena, Sreyashi Debnath, Rachana G. Kulkarni, Stefano Alessandrini, Mrinal Biswas, Santosh Kulkarni, Prakash Pithani, Saurab Kelkar, Veeresh Sajjan, D. M. Chate, V. K. Soni, Siddhartha Singh, Ravi S. Nanjundiah and M. Rajeevan
- 1816 **Seasonal variations in indoor air quality of urban and rural Asian households**  
Amtul Bari Tabinda, Ruby Safdar, Abdullah Yasar, Rizwan Rasheed, Adeel Mahmood and Anum Iqbal
- 1822 **Forging technology of high-tin bronzes in ancient Bengal**  
Pranab K. Chattopadhyay, Prasanta Kumar Datta and Barnali Maji
- 1832 **Assessing the costs of droughts in rural India: a comparison of economic and non-economic loss and damage**  
Chandra Sekhar Bahinipati



---

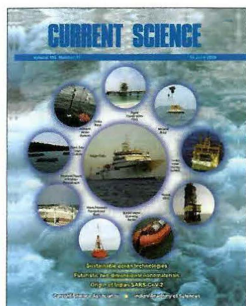
## BOOK REVIEWS

- 1842 **Soil Basics, Management and Rhizosphere Engineering for Sustainable Agriculture.** Channarayappa and D. P. Biradar; *reviewed by* K. P. Viswanatha
- 1843 **Darwin Comes to Town: How the Urban Jungle Drives Evolution.** Menno Schilthuizen; *reviewed by* K. S. Chetan Nag

---

## PERSONAL NEWS

- 1845 **Sharad S. Shrikhande (1917–2020),** N. M. Singhi and K. S. Vijayan
- 1847 **Virender Lal Chopra (1936–2020),** P. C. Kesavan and M. S. Swaminathan
- 



- ◀ COVER. Quarter century of sustainable ocean technologies. See special section.

The editor thanks Dr Shailesh Nayak (National Institute of Advanced Studies, Bengaluru, India) for agreeing to be Guest Editor for special section.

Indexed in CURRENT CONTENTS/GEOTitles/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE

# CURRENT SCIENCE



**1862 In this issue**

**EDITORIAL**

- 1863 Low dose lung radiotherapy – an alternative route to treat pneumonia linked to COVID-19**

P. C. Kesavan

14 AUG 2020

**CORRESPONDENCE**

- 1865 Mission-oriented higher education institution: some concerns**

Rangan Banerjee

- 1865 Researchable issues in livestock and fodder sector under COVID-19 pandemic and beyond**

D. R. Palsaniya

**NEWS**

- 1867 2019 UNESCO Sultan Qaboos Prize for Environmental Preservation awarded to Ashoka Trust, Bengaluru, India**

Sameen Ahmed Khan

**OPINION**

- 1868 Higher education: *quo vadis?***

H. A. Ranganath

**COMMENTARY**

- 1869 Assessing research: the slippery slope**

Bhushan Patwardhan and Gautam R. Desiraju

- 1870 Reconciling biodiversity conservation with agricultural intensification: challenges and opportunities for India**

Vikram Aditya, P. S. Sumashini, N. A. Aravind, G. Ravikanth, Chandrashekara Krishnappa and R. Uma Shaanker

**SCIENTIFIC CORRESPONDENCE**

- 1874 Monitoring of volcanic eruption (Barren Island) using EO satellites**

Goutham Krishna Teja Gunda, P. K. Champatiray, Mamta Chauhan and Prakash Chauhan

- 1876 Occurrence of Nuclear Polyhedrosis Virus of invasive fall armyworm, *Spodoptera frugiperda* (J. E. Smith) in Meghalaya, North East India**

D. M. Firake, S. K. Sharma and G. T. Behere

**GENERAL ARTICLES**

- 1878 Communication and management of public risks (with specific reference to the COVID-19 global pandemic)**

V. S. Ramamurthy and D. K. Srivastava



- 1885 **Freedom for research, and national development**  
R. B. Grover

---

**REVIEW ARTICLE**

- 1893 **Observations of trace gases in the earth's lower atmosphere: instrumentation and platform**  
L. K. Sahu, Nidhi Tripathi and Ravi Yadav

---

**RESEARCH ARTICLES**

- 1903 **Different anisotropic silver nanocrystals show different antibacterial activities – an effect of different prominent crystallographic orientations in different shapes**  
Sumit Sarkar, Biraj Sarkar, Sukhendu Mandal and Ratan Das

- 1911 **Modelling of flexural response of simply supported RC skew slab**  
Madhu Sharma, Naveen Kwatra and Harvinder Singh

- 1922 **Characterization of eddy scales over tandem obstacles for surface wave-dominated flow**  
Krishnendu Barman, Sayahnya Roy and Koustuv Debnath

- 1930 **Increase in spatial spread of extreme warm day temperature events: regional to national perspective for India (1951–2014)**  
Debasish Chakraborty, Vinay Kumar Sehgal, Rajkumar Dhakar, Eldho Varghese and Deb Kumar Das



- 1939 **Wheat production functions under irrigated saline environment and foliar potassium fertigation**  
Mukesh Kumar, A. Sarangi, D. K. Singh, S. Sudhishri and A. R. Rao

- 1946 **Prevalence and spread of potato cyst nematodes, *Globodera* spp. in northern hilly areas of India**  
Y. S. Chandel, Surendra Singh Bhadu, Rajan Salalia, Sharmishtha Thakur, Satya Kumar, Vishal Singh Somvanshi, Abhishek Mukherjee and R. K. Walia

- 1953 **Non-destructive selection of genotypes with better wood properties from morphologically superior genotypes of *Eucalyptus pellita***  
A. N. Arunkumar and S. S. Chauhan

- 1959 **Characteristic properties of pine needle biochar blocks with distinctive binders**  
Hemant Kumar Sharma, Akanksha Kumain and T. K. Bhattacharya

- 1968 **Chennai extreme rainfall event of 2015 under future climate projections using the pseudo global warming dynamic downscaling method**  
P. Jyoteshkumar, P. V. Kiran and C. Balaji

---

**RESEARCH COMMUNICATIONS**

- 1980 **Remote sensing for the detection of bio- and non-bioaerosols for defence applications**  
Mohit Mann, Subodh Kumar, A. S. Rao and Ramesh C. Sharma

- 1984 **Line-source field dripper for the measurement of *in situ* unsaturated hydraulic conductivity function**  
Rohit Pratap Ojha, Chhedi Lal Verma, Derrick M. Denis and Sanjay Arora

---

**PERSONAL REMINISCENCES**

- 1991 **Seventy years in scientific research**  
C. N. R. Rao

---

**BOOK REVIEWS**

- 1997 **MM Vijayan: A Life Among Men, Women and Molecules. Memoirs of an Indian Scientist, Edited and Coordinated by A. K. Singhvi; reviewed by P. Balaramam**

- 1998 **Einstein Rediscovered: Interactions with Indian Academics.** Rajinder Singh; reviewed by Banibrata Mukhopadhyay
- 2000 **Annual Reviews of Biochemistry, 2019.** Roger D. Kornberg, James E. Rothman, JoAnne Stubbe and Jeremy W. Thorner (eds); reviewed by Prasanna K. Santhekadur

---

**PERSONAL NEWS**

- 2002 **S. K. Joshi (1935–2020)**  
T. V. Ramakrishnan
- 2003 **Melkote K. Ramaswamy (1931–2020)**  
Rajesh Melkote
- 2004 **Tangirala Ramasarma (1932–2020)**  
R. Manjunath
- 



- ◀ **COVER.** Active cinder cone of Barren Island erupting ash and surrounded by caldera (small ridges) and pyroclasts (dark-coloured fragmented material). See page 1874.

Indexed in CURRENT CONTENTS/GEOBASE/CHEMICAL ABSTRACTS/IndMED/SCOPUS/  
WEB OF SCIENCE

# CONTENTS

10 NOV 2020

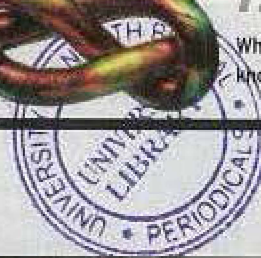
Science



71

What makes knots tight?

3 JANUARY 2020 • VOLUME 367 • ISSUE 6473



9

Afterglow of a 1962 nuclear test in space

## NEWS

### IN BRIEF

6 What's coming up in 2020

PODCAST

### IN DEPTH

9 **U.S. military tests radiation belt cleanup in space**

Radio waves could sweep belts clean of satellite-killing particles after nuclear sneak attack *By R. Stone*

10 **Past megadroughts hit North and South America in tandem**

Strong La Niña conditions drove deep medieval droughts *By P. Voosen*

11 **Study pushes emergence of measles back to antiquity**

The virus may have entered the human population when cities grew large enough to sustain outbreaks *By K. Kupferschmidt*

12 **Computer scientist in line to become next NSF director**

Sethuraman Panichanathan would succeed France Córdova *By J. Mervis*

13 **Congress again rejects Trump cuts, smiles on science agencies**

2020 spending bill increases research budgets, but next year will be tougher as lawmakers will have less to spend *By J. Mervis*

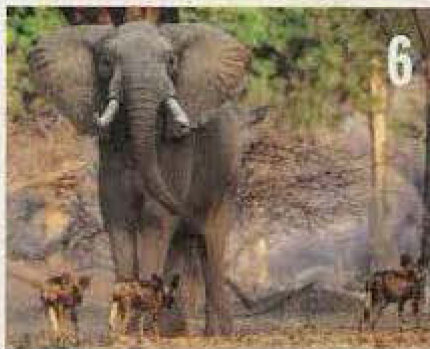
14 **Global polio eradication falters in the final stretch**

Vaccine-derived outbreaks may force a change in "endgame" strategy *By L. Roberts*

### FEATURES

16 **Fighting words**

Virologist Roberto Burioni has become a celebrity in Italy by sparring with vaccine skeptics *By D. Starr*



## INSIGHTS

### BOOKS ET AL.

20 **Asimov at 100**

From epic space operas to rules for robots, the prolific author's literary legacy endures *By J. Gunn*

### PERSPECTIVES

22 **Uncovering the ART of antimalarial resistance**

A key mechanism of resistance to the antimalarial drug artemisinin is identified *By D. Marapana and A. F. Cowman*  
RESEARCH ARTICLE p. 51

23 **Majorana fermions go for a ride**

Evidence for propagating Majorana quasiparticles is found in a topological superconductor *By S. Tewari and T. D. Stanescu*  
REPORT p. 104

24 **Building a carnivorous trap**

Experiments and computations reveal developmental origins of cup-shaped leaves *By D. E. Moulton and A. Goriely*  
REPORT p. 91



## 26 Electrostatics affect the glow

Chromophore twisting is probed with unnatural amino acids. *By C. Hu et al.*  
REPORT p. 76

## 27 Cancer in sub-Saharan Africa

Knowledge of cancer in Africa brings needed diversity to improve health worldwide. *By T. R. Rebbeck*

## 29 Gene expression regulated by RNA stability

The factor responsible for autoregulation of tubulin RNA stability is identified. *By O. Shoshani and D. W. Cleveland*  
REPORT p. 100

## POLICY FORUM

### 30 Sustainable minerals and metals for a low-carbon future

Policy coordination is needed for global supply chains. *By B. K. Sovacool et al.*

## LETTERS

### 34 NextGen Voices: Making science accessible

# RESEARCH

## IN BRIEF

36 From *Science* and other journals

## REVIEW

### 39 Neuroscience

Memory engrams: Recalling the past and imagining the future. *S. A. Josselyn and S. Tonegawa*  
REVIEW SUMMARY; FOR FULL TEXT, [DX.DOI.ORG/10.1126/SCIENCE.AAW4325](https://doi.org/10.1126/SCIENCE.AAW4325)

## RESEARCH ARTICLES

### 40 Nanoparticles

Oriented attachment induces fivefold twins by forming and decomposing high-energy grain boundaries. *M. Song et al.*

### 45 Multiplex genomics

Massively multiplex chemical transcriptomics at single-cell resolution. *S. R. Srivatsan et al.*

### 51 Malaria

A Kelch13-defined endocytosis pathway mediates artemisinin resistance in malaria parasites. *J. Birnbaum et al.*  
PERSPECTIVE p. 22

## REPORTS

### 59 Topological optics

A single photonic cavity with two independent physical synthetic dimensions. *A. Dutt et al.*

### 64 Topological matter

Absence of evidence for chiral Majorana modes in quantum anomalous Hall-superconductor devices. *M. Kayyalha et al.*

### 68 Superconductivity

Atomic manipulation of the gap in  $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8+x}$ . *F. Massee et al.*

### 71 Applied physics

Topological mechanics of knots and tangles. *V. P. Patil et al.*

### 76 Fluorescent proteins

Electrostatic control of photoisomerization pathways in proteins. *M. G. Romei et al.*  
PERSPECTIVE p. 26

### 79 Optics

On-chip integrated laser-driven particle accelerator. *N. V. Sapiro et al.*

## 83 Neuroscience

Dendritic action potentials and computation in human layer 2/3 cortical neurons. *A. Gidon et al.*

## 87 Archaeology

Cooked starchy rhizomes in Africa 170 thousand years ago. *L. Wadley et al.*

## 91 Plant science

Evolution of carnivorous traps from planar leaves through simple shifts in gene expression. *C. D. Whitewoods et al.*  
PERSPECTIVE p. 24; PODCAST

## 96 Evolutionary biology

Protein-coding changes preceded cis-regulatory gains in a newly evolved transcription circuit. *C. S. Britton et al.*

## 100 Tubulin

TTC5 mediates autoregulation of tubulin via mRNA degradation. *Z. Lin et al.*  
PERSPECTIVE p. 29

## 104 Topological matter

Evidence for dispersing 1D Majorana channels in an iron-based superconductor. *Z. Wang et al.*  
PERSPECTIVE p. 23

## DEPARTMENTS

### 5 Editorial

Clarity in 2020. *By H. Holden Thorp*

### 114 Working Life

Strange dreams. *By Desiree Dickerson*

## ON THE COVER



Immature trap of the carnivorous plant *Utricularia gibba* (~200  $\mu\text{m}$  in width), illustrating its two-layered cellular structure. Such cup-shaped leaves have evolved multiple times as a mechanism for trapping animals. Analyzing *U. gibba*, researchers used a combination of molecular genetics and computer modeling to reveal how shifts in gene expression domains can account for repeated evolution of cup shapes from species with planar leaves. See pages 24 and 91. *Image: Karen Lee and Claire Bushell*

New Products ..... 110  
Science Careers ..... 111

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2348. Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 36178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org. Bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

10 JANUARY 2020 • VOLUME 367 • ISSUE 6474

134

## NEWS

### IN BRIEF

126 News at a glance

### IN DEPTH

**128 Study disputes carbon dioxide-fish behavior link**

Three-year effort fails to replicate alarming findings about effects of ocean acidification  
By M. Enserink

**129 Articles in 'predatory' journals receive few or no citations**

Study counters fears that mediocre or misleading papers contaminate the literature  
By J. Brainard

**130 China delivers verdict on gene editing of babies**

He Jiankui gets prison sentence, but legal proceedings fail to satisfy calls for transparency  
By J. Cohen and D. Normile

**131 How safe is a popular gene therapy vector?**

Dog study suggests virus-delivered DNA can invade chromosomes near cancer genes  
By J. Kaiser

**132 Russian academy probe triggers more than 800 retractions**

Fraud commission's work causes "tension and conflict"  
By D. Singh Chawla

**133 In two-person MRI, brains socialize at close range**

In pursuit of natural interactions, researchers push the limits of neuroimaging  
By K. Servick  
PODCAST

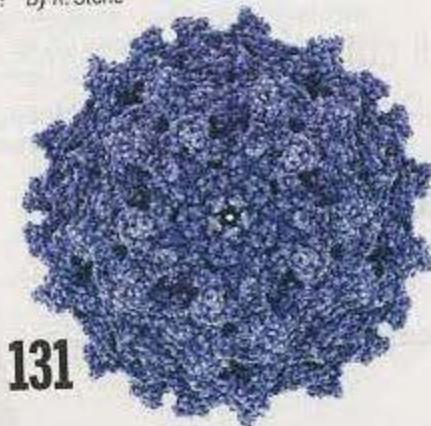
### FEATURES

**134 Need for speed**

Despite hype and technological hurdles, a hypersonic arms race is accelerating  
By R. Stone

**136 In Russia, hypersonic rivalry feeds suspicions and arrests**

By R. Stone



131

## INSIGHTS

### PERSPECTIVES

**140 Completing Wallace's journey**

A global inventory of species diversity is critical for understanding the evolution of life on Earth  
By J. D. Kennedy and J. Fjeldså  
RESEARCH ARTICLE p. 167

**141 Tolerance to antibiotics affects response**

Bacterial tolerance to antibiotics reduces the ability to prevent resistance  
By A. D. Berti and E. B. Hirsch  
REPORT p. 200

**143 Improving cancer screening programs**

Evaluating diagnostic tests in learning screening programs could improve public health  
By M. Kalager and M. Bretthauer

**145 Counting on Majorana modes**

Quantized conductance is a prerequisite of a topologically robust Majorana qubit  
By J. Sau  
REPORT p. 189

**146 A sugary input to leucine sensing**

Glucose channels the amino acid leucine into synthetic versus degradative pathways  
By E. Lehman and R. T. Abraham  
REPORT p. 205



**147 A younger “earliest human migration” to Southeast Asia**

New dating suggests that hominids arrived at the Sangiran dome later than had been thought *By B. Brasseur*  
REPORT p. 210

**148 Flipping carbon monoxide on a salt surface**

Advanced mid-infrared techniques identify orientational isomers *By S. Wu*  
REPORT p. 175

**POLICY FORUM**

**150 Waiting for data: Barriers to executing data use agreements**

Delays stem from institutional factors and negotiating challenges, some of which appear amenable to reform *By M. M. Mello et al.*

**BOOKS ET AL.**

**153 People-powered discovery**

A physicist reveals how citizen science is reshaping research *By L. A. Shanley*

**154 Fun and games and ecosystems**

Video games—even those without explicit educational goals—can offer insights into ecology *By S. LeMenager*

**LETTERS**

**155 Retraction**

*By I. Cho et al.*

**Brazil oil spill response**

**155 Time for coordination**

*By M. O. Soares et al.*

**155 Government inaction**

*By H. D. Brum et al.*

**156 Protect rhodolith beds**

*By M. Nasri Sissini et al.*

**RESEARCH**

**IN BRIEF**

**158** From *Science* and other journals

**RESEARCH ARTICLES**

**161 Stem cell biology**

Dermal sheath contraction powers stem cell niche relocation during hair cycle regression *N. Heitman et al.*

**167 Biodiversity**

A lost world in Wallacea: Description of a montane archipelagic avifauna *F. E. Rheindt et al.*  
PERSPECTIVE p. 140

**REPORTS**

**171 Metallurgy**

Observation of hydrogen trapping at dislocations, grain boundaries, and precipitates *Y.-S. Chen et al.*

**175 Quantum chemistry**

Observation of an isomerizing double-well quantum system in the condensed phase *J. A. Lau et al.*  
PERSPECTIVE p. 148

**179 Chemical physics**

Observation of the fastest chemical processes in the radiolysis of water *Z.-H. Loh et al.*

**183 Lightning**

A terrestrial gamma-ray flash and ionospheric ultraviolet emissions powered by lightning *T. Neubert et al.*

**186 Quantum simulation**

Time-resolved observation of spin-charge deconfinement in fermionic Hubbard chains *J. Vijayan et al.*

**189 Topological matter**

Nearly quantized conductance plateau of vortex zero mode in an iron-based superconductor *S. Zhu et al.*  
PERSPECTIVE p. 145

**193 Catalysis**

Hydrophobic zeolite modification for in situ peroxide formation in methane oxidation to methanol *Z. Jin et al.*

**197 Developmental biology**

Programmed cell death along the midline axis patterns ipsilaterality in gastrulation *L. Maya-Ramos and T. Mikawa*

**200 Antibiotic resistance**

Effect of tolerance on the evolution of antibiotic resistance under drug combinations *J. Liu et al.*  
PERSPECTIVE p. 141

**205 Signal transduction**

Glucose-dependent control of leucine metabolism by leucyl-tRNA synthetase 1 *I. Yoon et al.*  
PERSPECTIVE p. 146

**210 Paleoanthropology**

Age control of the first appearance datum for Javanese *Homo erectus* in the Sangiran area *S. Matsu'ura et al.*  
PERSPECTIVE p. 147

**DEPARTMENTS**

**125 Editorial**

Stick to science *By H. Holden Thorp*

**222 Working Life**

A refreshing change *By Lila Westreich*

**ON THE COVER**



An artist's impression of multiwavelength emission above a thunderstorm, based on data from the Atmosphere-Space Interactions Monitor on the International Space Station. The high electric field associated with

lightning (light blue) generates a terrestrial gamma-ray flash (magenta). The resulting electromagnetic pulse causes an elve—an expanding ring of ultraviolet emission (red and white). See page 183. *Image: Birkeland Centre for Space Science, Daniel Schmelling/Mount Visual*

New Products ..... 218  
Science Careers ..... 219

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$174 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra. Air assist delivery: \$96. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125498822. Publications Mail Agreement Number: 10889674. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

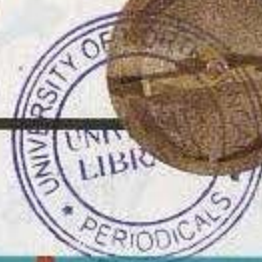
10 NOV 2020

Science

255

Seeking our  
destiny in data

17 JANUARY 2020 • VOLUME 367 • ISSUE 6475



240

## NEWS

### IN BRIEF

230 News at a glance

### IN DEPTH

#### 234 New SARS-like virus in China triggers alarm

Pneumonia outbreak in Wuhan appears to subside, but the virus could re-emerge

By J. Cohen and D. Normile

#### 235 Electron-Ion Collider would lay bare the proton's innards

Department of Energy picks site for billion-dollar machine

By A. Cho

#### 236 New front emerges in battle to build giant telescope in Hawaii

TMT opponents try to win over other astronomers in priority-setting decadal survey

By D. Clery

#### 238 In effort to save hemlocks, a rare glimpse of hope

Introduced predatory beetle eats deadly aphidlike pest, long-term study finds, but trees are still at risk

By G. Popkin

#### 239 'Diversity statements' divide mathematicians

Hundreds choose sides both for and against requiring such statements in academic hiring

By M. Price

### FEATURES

#### 240 Transparency on trial

Many clinical trial results aren't posted publicly, as U.S. law requires—and a promised crackdown has fizzled

By C. Piller

#### 243 Gaming the system

By C. Piller

PODCAST

## INSIGHTS

### PERSPECTIVES

#### 244 Eat and listen—how chewing and hearing evolved

Mammalian middle ear bones separated from the jaw of vertebrate ancestors

By J. A. Schultz  
REPORT p. 305

#### 246 Water loss regulates cell and vesicle volume

Active control of vesicle water content ensures that cell size is maintained when extracellular fluid is taken up

By J. S. King and E. Smythe

REPORT p. 301

#### 247 Enforcing T cell innocence

Inhibitory signaling on T cells maintains "naivety" to self-antigen

By C. Brown and A. Y. Rudensky

RESEARCH ARTICLE p. 264

#### 249 High-resolution dating of Paleozoic fossils

Refined ages of marine fossils clarify the timing of diversification and extinction events

By P. Wagner

RESEARCH ARTICLE p. 272

#### 250 Are noncommunicable diseases communicable?

Numerous noncommunicable diseases could have a transmissible microbial component

By B. B. Finlay et al.

PODCAST

### POLICY FORUM

#### 252 Mobile protected areas for biodiversity on the high seas

Protecting mobile marine species and habitats under climate change will require innovative and dynamic tools

By S. M. Maxwell et al.

### BOOKS ET AL.

#### 255 Patterns, statistics, and the stars

Highlights from the history of astrology reveal the origins of our quest to find meaning in data

By S. Vanden Broecke

**256 Knowledge in the Anthropocene**

To save society, science should embrace ethical projects *By D. R. Coen*

## LETTERS

**257 Losing Mexican manatees**

*By G. Núñez-Nogueira and M. Uribe-López*

**257 Support Austria's glyphosate ban**

*By W. Peng et al.*

**258 Fund plant conservation to solve biodiversity crisis**

*By E. B. Roberson et al.*

**RESEARCH**

## IN BRIEF

**260** From Science and other journals

## REVIEW

**263 Quantum materials**

Quantum spin liquids

*C. Broholm et al.*

REVIEW SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.AAY0668

## RESEARCH ARTICLES

**264 T cells**

VISTA is a checkpoint regulator for naive T cell quiescence and peripheral tolerance

*M. A. ElTanbouly et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.AAY0524

PERSPECTIVE p. 247

**265 Advanced imaging**

Correlative three-dimensional super-resolution and block-face electron microscopy of whole vitreously frozen cells *D. P. Hoffman et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.AAZ5357

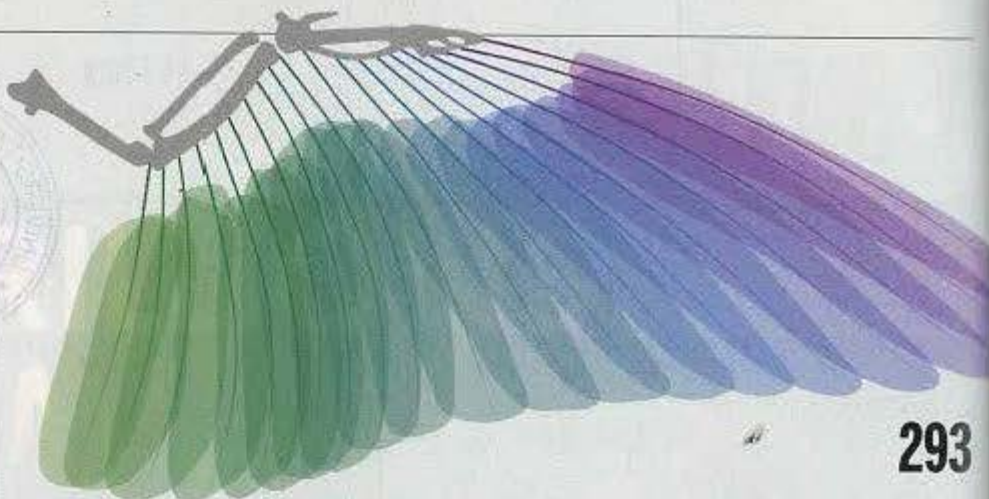
**266 Mass extinction**

On impact and volcanism across the Cretaceous-Paleogene boundary *P. M. Hull et al.*

**272 Paleontology**

A high-resolution summary of Cambrian to Early Triassic marine invertebrate biodiversity *J. Fan et al.*

PERSPECTIVE p. 249



293

## REPORTS

**278 Solar physics**

Decay of the coronal magnetic field can release sufficient energy to power a solar flare *G. D. Fleishman et al.*

**281 Organic chemistry**

Nitromethane as a nitrogen donor in Schmidt-type formation of amides and nitriles *J. Liu et al.*

**285 Quantum criticality**

Singular charge fluctuations at a magnetic quantum critical point *L. Prochaska et al.*

**288 Optics**

Subwavelength dielectric resonators for nonlinear nanophotonics *K. Koshelev et al.*

**293 Biomechanics**

How flight feathers stick together to form a continuous morphing wing *L. Y. Matloff et al.*

SCIENCE ROBOTICS RESEARCH ARTICLE BY E. CHANG ET AL. 10.1126/SCIROBOTICS.AAY1246

**297 Martian atmosphere**

Stormy water on Mars: The distribution and saturation of a tmospheric water during the dusty season *A. A. Fedorova et al.*

**301 Cell biology**

Lipid-gated monovalent ion fluxes regulate endocytic traffic and support immune surveillance *S. A. Freeman et al.*

PERSPECTIVE p. 245

**305 Mammalian evolution**

Integrated hearing and chewing modules decoupled in a Cretaceous stem therian mammal *F. Mao et al.*

PERSPECTIVE p. 244

**309 Thermal conductivity**

Phonon hydrodynamics and ultrahigh-room-temperature thermal conductivity in thin graphite *Y. Machida et al.*

**313 Organometallics**

Fluorination of arylboronic esters enabled by bismuth redox catalysis *O. Planas et al.*

## DEPARTMENTS

**229 Editorial**

Do bans help modern public health? *By Lawrence O. Gostin*

**334 Working Life**

Getting personal *By Erin Gibson*

## ON THE COVER



Translucently colored nucleus of a mammalian cerebellar granule neuron. This 3D rendering illustrates the specific heterochromatin subdomain type defined by the overlap of histones imaged by

electron microscopy (EM) and cryogenic super-resolution fluorescence microscopy. A thin translucent shell surrounding the nucleus represents the nuclear membrane, and a thin slab of 3D-rendered EM data (gray) slices through the nucleus. The circles at lower right are cross-sectional views of mitochondria. See page 265.

Image: *D. Hoffman, G. Shtengel, E. Betzig, H. Hess, Janelia Research Campus; K. Campbell, D. Stabley, D. Solecki, St. Jude Children's Research Hospital*

New Products.....	318
AAAS Meeting Program.....	319
Science Careers.....	329

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #125488122. Publications Mail Agreement Number 3065624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.scientific.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

24 JANUARY 2020 • VOLUME 367 • ISSUE 6476

## SPECIAL SECTION

# Chemistry for Tomorrow's Earth

Can linings  
be a challenge  
for chemists.

## INTRODUCTION

**378** A cleaner, greener future for chemicals

## NEWS

**380** Can do *W. Cornwall*

PODCAST; VIDEO

## REVIEWS

**384** Learning from the past and considering the future of chemicals in the environment *A. C. Johnson et al.*

**388** Tracking complex mixtures of chemicals in our changing environment *B. I. Escher et al.*

PODCAST

**392** The exposome and health: Where chemistry meets biology *R. Vermeulen et al.*

**397** Designing for a green chemistry future *J. B. Zimmerman et al.*

## ON THE COVER



Synthetic chemicals are important components of modern life, but the current system of global production, distribution, and disposal has, in many instances,

caused damage to the environment and human health. Innovations in chemical synthesis, environmental monitoring, and analysis of exposure and risk will ensure that tomorrow's chemicals are less persistent, have greater potency, and move us toward a sustainable future. See page 378. *Illustration: Adam Simpson*

SEE ALSO POLICY FORUM P. 360  
PERSPECTIVE P. 369

## NEWS

### IN BRIEF

**346** News at a glance

### IN DEPTH

**348** **United Kingdom breaks from EU farm subsidies**

"Revolutionary" change will focus payments on environmental benefits, not food production *By E. Stokstad*

**349** **Campus attack and police violence alarm Indian academics**

Many scientists are at odds with Hindu nationalists *By S. Kumar*

**350** **Planetary turmoil unleashed during Solar System infancy**

Models and observations suggest that an earlier date for the upheaval can explain puzzles including a puny Mars *By P. Voosen*

**351** **Florida center details fired scientists' links to China**

Report finds six cancer researchers didn't disclose Thousand Talents deals *By J. Mervis*

**352** **NSF rolls out huge makeover of science statistics**

Agency wants its biennial *Indicators* to be more timely in tracking global trends *By J. Mervis*

## FEATURES

**354** **Cheap shots**

Cryo-EM reveals exquisite molecular structures—at high cost. A cheaper microscope could bring the resolution revolution to the masses *By E. Hand*

## INSIGHTS

## POLICY FORUM

**360** **Overhaul environmental risk assessment for pesticides**

Align regulation with environmental reality and policy *By C. J. Topping et al.*

CHEMISTRY FOR TOMORROW'S EARTH SECTION  
P. 378

## PERSPECTIVES

10 NOV 2020

**364** **Can phase separation buffer cellular noise?**

By suppressing concentration fluctuations, condensation may stabilize cellular processes *By J. A. Riback and C. P. Brangwynne*  
REPORT p. 464

**365** **Support cells in the brain promote longevity**

Glial cells in the brain use neuropeptides to communicate stress responses and longevity *By J. W. Miklas and A. Brunet*  
REPORT p. 436

**366** **The stillness of sleep**

A key neuron in the basal ganglia commands both sleep and immobility *By W. Wisden and N. P. Franks*  
REPORT p. 440

**368** **Coherent scanning tunneling microscopy**

Ultrafast phase-stabilized optical pulses add temporal resolution to high spatial resolution *By C. D. Aiello*  
REPORT p. 411

**369** **Rethinking chemistry for a circular economy**

Chemical complexity complicates product recycling and manufacturing sustainability *By K. Kümmeler et al.*  
CHEMISTRY FOR TOMORROW'S EARTH SECTION  
P. 378

## BOOKS ET AL.

**371** **A notorious Nazi, revealed**

A U.S. Department of Justice insider's biography reveals new details about Josef Mengele *By P. Heberer Rice*

**372 Confronting campus sexual assault**

Inadequate sex education and socialization collide in built spaces that stymie consent. *By C. M. Renzetti*

**LETTERS****373 Time to update China's panda loan terms**

*By Q. Yan et al.*

**373 China's dams isolate Asian elephants**

*By Z. Wang et al.*

**374 Conservationists must address meat and dairy**

*By L. F. Marin da Fonte and A. P. Foletto Marin*

**RESEARCH****IN BRIEF**

**401** From *Science* and other journals

**RESEARCH ARTICLES****404 Neurogenetics**

Chromatin accessibility dynamics in a model of human forebrain development. *A. E. Trevino et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY1645](https://doi.org/10.1126/SCIENCE.AAY1645)

**405 Research methods**

Single-cell transcriptional diversity is a hallmark of developmental potential. *G. S. Gulati et al.*

**REPORTS****411 Nanophotonics**

Attosecond coherent manipulation of electrons in tunneling microscopy. *M. Garg and K. Kern*  
PERSPECTIVE p. 368

**415 Supernovae**

A type Ia supernova at the heart of superluminous transient SN 2006gy. *A. Jerkstrand et al.*

**418 Nanomaterials**

Rational construction of a scalable heterostructured nanorod megalibrary. *B. C. Steimle et al.*

**425 Quantum sensing**

Entanglement-based single-shot detection of a single magnon with a superconducting qubit. *D. Lachance-Quirion et al.*

**428 Surface microscopy**

Visualizing H<sub>2</sub>O molecules reacting at TiO<sub>2</sub> active sites with transmission electron microscopy. *W. Yuan et al.*

**431 Plant science**

A two-way molecular dialogue between embryo and endosperm is required for seed development. *N. M. Doll et al.*

**436 Life-span extension**

Four glial cells regulate ER stress resistance and longevity via neuropeptide signaling in *C. elegans*. *A. E. Frakes et al.*  
PERSPECTIVE p. 365

**440 Neuroscience**

A common hub for sleep and motor control in the substantia nigra. *D. Liu et al.*  
PERSPECTIVE p. 366

**446 Cancer immunotherapy**

An RNA vaccine drives expansion and efficacy of claudin-CAR-T cells against solid tumors. *K. Reinhard et al.*

**453 Developmental biology**

A tensile ring drives tissue flows to shape the gastrulating amniote embryo. *M. Saadaoui et al.*

**458 Organic chemistry**

Total synthesis reveals atypical atropisomerism in a small-molecule natural product, tryptorubin A. *S. H. Reisberg et al.*

**464 Phase separation**

Phase separation provides a mechanism to reduce noise in cells. *A. Klosin et al.*  
PERSPECTIVE p. 364

**DEPARTMENTS****345 Editorial**

Drop the chalk  
*By H. Holden Thorp*

**478 Working Life**

A lesson from Bollywood  
*By Anurag Srivastava*

Science Staff ..... 344  
Science Careers ..... 470



# CONTENTS

10 NOV 2020  
Science



506 & 537  
Coaxial nanotubes

31 JANUARY 2020 • VOLUME 367 • ISSUE 6477

This jaw belonged to an ancient teenager whose home is now submerged beneath the North Sea.



499

## NEWS

### IN BRIEF

490 News at a glance

### IN DEPTH

#### 492 New coronavirus threat galvanizes scientists

As China outbreak spreads worldwide, researchers probe its origins and how to fight it *By J. Cohen*

#### 494 After Brexit, a long road to mend ties with Europe

U.K. scientists want to join EU research program, but Europe may balk *By K. Kupferschmidt*

#### 495 Black holes caught in the act of swallowing stars

Dozens of tidal disruption events found in galaxy surveys shed light on violent events *By D. Clery*

#### 496 Electricity turns garbage into high-quality graphene

Method could supply graphene in bulk, opening new uses *By R. F. Service*

#### 496 Monkey facility in China lures neuroscientist

Animal rights conflict spurs move of major German lab *By G. Vogel*

#### 497 Africans, too, carry Neanderthal genetic legacy

Ancient Europeans took Neanderthal DNA back to Africa *By M. Price*

#### 498 Screen for childhood trauma triggers debate

Testing across California could have unexpected downsides, critics say *By E. Underwood*

### FEATURES

#### 499 Europe's lost frontier

Aided by dedicated amateurs and new methods, scientists reconstruct a now-submerged ancient landscape—and the people who lived there *By A. Curry*

## INSIGHTS

### PERSPECTIVES

#### 504 A microbiome silver bullet for honey bees

A genetically engineered honey bee gut bacterium knocks down two major bee threats *By R. J. Paxton*  
REPORT p. 573

#### 506 Nested hybrid nanotubes

Material made with atom-thin tubular crystals portends the creation of inventive nanodevices *By Y. Gogotsi and B. I. Yakobson*  
RESEARCH ARTICLE p. 537

#### 507 Liquid but not contactless

The endoplasmic reticulum makes molecular contact with membraneless organelles *By B. Kornmann and K. Weis*  
RESEARCH ARTICLE p. 527

#### 509 Stitching two chiral centers with one catalyst

A single catalyst joins alkyl groups with control over stereochemistry of both fragments *By J. Xu and M. P. Watson*  
REPORT p. 559

#### 510 Monitoring neuronal health

A multiscale imaging approach reveals a neuroimmune communication pathway *By A. Nimmerjahn*  
RESEARCH ARTICLE p. 528

#### 512 Unpicking the proteome in single cells

Single-cell mass spectrometry will help reveal mechanisms that underpin health and disease *By N. Slavov*

### DEPARTMENTS

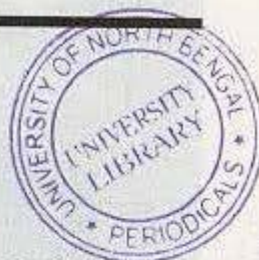
#### 489 Editorial

Envision a future, make it so  
*By Sudip Parikh*

#### 594 Working Life

Avoiding immigration limbo  
*By Jaivime Evaristo*

Science Staff ..... 486  
AAAS News & Notes ..... 520  
Science Careers ..... 591



## POLICY FORUM

**514 Progress in natural capital accounting for ecosystems**

Global statistical standards are being developed. *By L. Hein et al.*

## BOOKS ET AL.

**516 Game over**

A high-stakes game of battleship helped turn the tide in World War II's Battle of the Atlantic. *By S. L. Pettyjohn*

**517 Profits, prejudice, and plant patents**

A journalist investigates a surprising act of espionage. *By H. A. Curry*

## LETTERS

**518 Agricultural lands key to mitigation and adaptation**

*By R. D. Harrison and A. Gassner*

**518 Response**

*By M. D. Morecroft et al.*

**519 Cancel cuts to Graduate Research Fellowships**

*By G. Muller-Parker et al.*

**RESEARCH**

## IN BRIEF

**522** *From Science and other journals*

## REVIEW

**525 Cancer immunotherapy**

Neoadjuvant checkpoint blockade for cancer immunotherapy. *S. L. Topalian et al.*  
REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAX0182

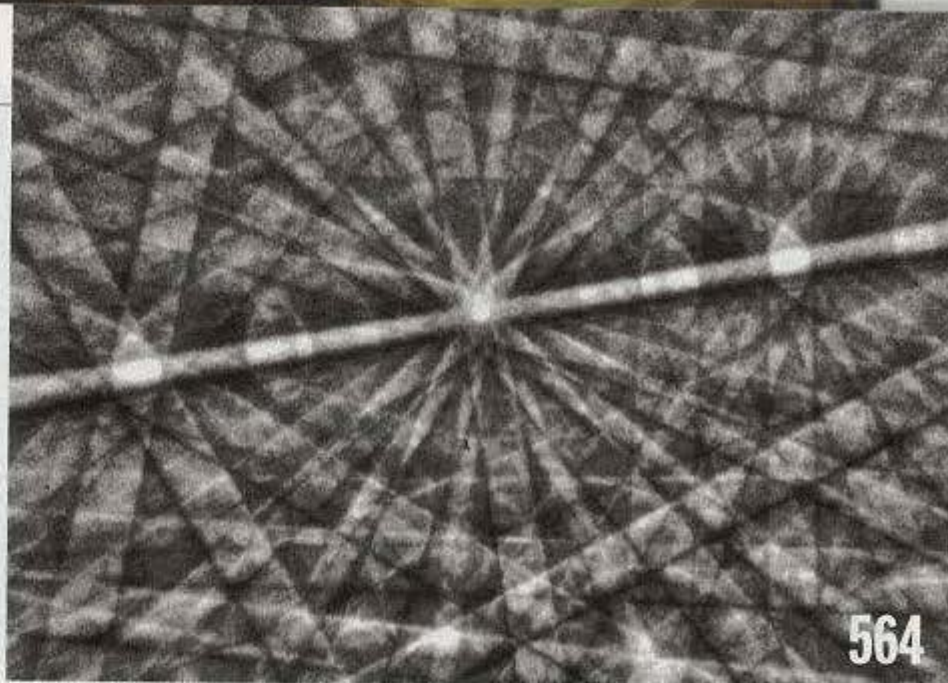
## RESEARCH ARTICLES

**526 Neuroscience**

Monosomes actively translate synaptic mRNAs in neuronal processes  
*A. Biever et al.* RESEARCH ARTICLE SUMMARY;  
FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.  
AAY4991

**527 Cell biology**

Endoplasmic reticulum contact sites regulate the dynamics of membraneless organelles. *J. E. Lee et al.*  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY7108  
PERSPECTIVE p. 507



564

**528 Cellular neuroscience**

Microglia monitor and protect neuronal function through specialized somatic purinergic junctions. *C. Cserép et al.*  
PERSPECTIVE p. 510

**537 Nanomaterials**

One-dimensional van der Waals heterostructures. *R. Xiang et al.*  
PERSPECTIVE p. 506

**542 Catalysis**

Highly active cationic cobalt(II) hydroformylation catalysts. *D. M. Hood et al.*

**549 Neuroscience**

Local D2- to D1-neuron transmodulation updates goal-directed learning in the striatum. *M. Matamales et al.*

## REPORTS

**555 Thermal conductivity**

Ultrahigh thermal conductivity in isotope-enriched cubic boron nitride. *K. Chen et al.*

**559 Organic chemistry**

Catalyst-controlled doubly enantioconvergent coupling of racemic alkyl nucleophiles and electrophiles. *H. Huo et al.*  
PERSPECTIVE p. 509

**564 Crystallography**

Crystal symmetry determination in electron diffraction using machine learning. *K. Kaufmann et al.*

**569 Human genetics**

Genetics of schizophrenia in the South African Xhosa. *S. Gulsuner et al.*  
PODCAST

**573 Bee health**

Engineered symbionts activate honey bee immunity and limit pathogens. *S. P. Leonard et al.*  
PERSPECTIVE p. 504

**577 Gravitation**

Lense-Thirring frame dragging induced by a fast-rotating white dwarf in a binary pulsar system. *V. Venkatraman Krishnan et al.*

**580 Molecular biology**

*N*<sup>6</sup>-methyladenosine of chromosome-associated regulatory RNA regulates chromatin state and transcription. *J. Liu et al.*

**586 Cancer**

Therapeutic targeting of preleukemia cells in a mouse model of *NPM1* mutant acute myeloid leukemia. *H. J. Uckelmann et al.*

## ON THE COVER



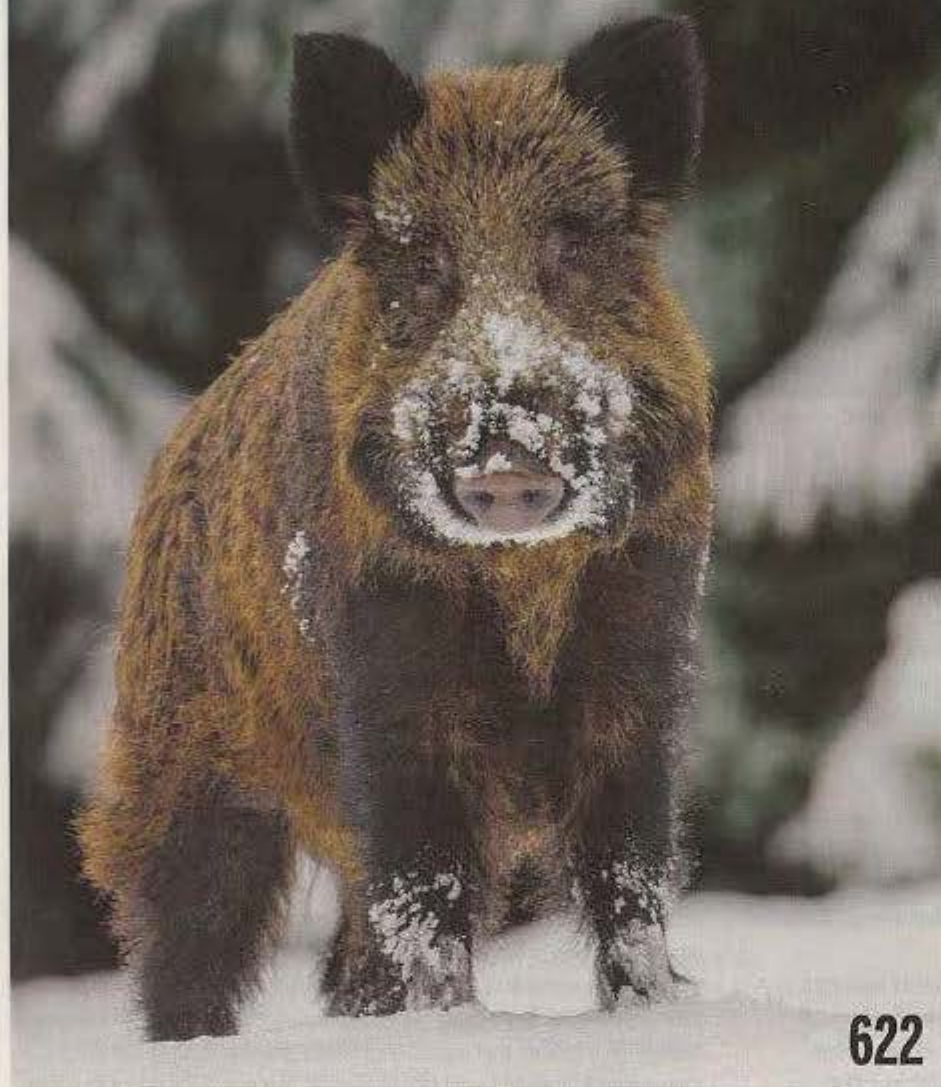
Focus-stacked photograph of a *Varroa* mite on the abdomen of a honey bee. *Varroa* mites are major pests that weaken honey bee colonies by parasitizing bees and spreading viral disease. Researchers

have genetically engineered bacterial gut symbionts of bees to kill these mites and boost bee resistance to RNA viruses, an approach that may eventually support honey bee health. See pages 504 and 573. *Image: Alexander Wild*

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484-660) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra: Air airmail delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1068524. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair-use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

7 FEBRUARY 2020 • VOLUME 367 • ISSUE 6478



622

## NEWS

### IN BRIEF

606 News at a glance

### IN DEPTH

#### 610 Will novel virus go pandemic or be contained?

Modelers are trying to forecast how the coronavirus will move, but they need better data. *By K. Kupferschmidt and J. Cohen*

#### 611 Combo of two HIV vaccines falls its big test

South African trial halted early because of "futility" *By J. Cohen*

#### 612 Climate change spurs global speedup of ocean currents

Rising winds boost flows in tropics and Southern Ocean. *By P. Voosen*  
SCIENCE ADVANCES RESEARCH ARTICLE  
BY S. HU ET AL. 10.1126/SCIADV.AAX7727

#### 613 Prominent spider biologist spun a web of questionable data

Two retractions spark scrutiny of dozens of papers. *By E. Pennisi*

#### 614 Prosecutor details China probe that snared chemist

Department of Justice initiative aims to counter "corrupting" influence of foreign money on scientists. *By J. Mervis*

#### 616 CRISPR takes on cancer

Gene edits appear safe in first three patients  
*By J. Couzin-Frankel*  
RESEARCH ARTICLE BY E. A. STADTMAUER ET AL. 10.1126/SCIENCE.ABA7365; PERSPECTIVE BY J. R. HAMILTON AND J. A. DOUDNA 10.1126/SCIENCE.ABA9844

#### 617 Underground oil fires liberate carbon-free fuel

Company ignites heavy oil fields to make green hydrogen while leaving carbon trapped  
*By E. Hand*

### FEATURES

#### 618 Rekindling the flame

After decades of decline, the U.S. government's fusion lab seeks a rebirth  
*By A. Cho*

## INSIGHTS

### PERSPECTIVES

#### 622 No hasty solutions for African swine fever

African swine fever vaccines could pose risk of causing disease and spreading the virus further. *By D. Gavrier-Widén et al.*

#### 624 Porous crystals as membranes

Microporous crystalline membranes are designed for gas separation and potential scale-up. *By M. A. Carreon*  
REPORT p. 667

#### 626 Discovering the limits of ecological resilience

Bumble bee declines reveal species pushed to the edge of their environmental tolerances  
*By J. Bridle and A. van Rensburg*  
REPORT p. 685

#### 627 Room-temperature magnetoelastic coupling

Magnetic fields alter the ferroelectric properties of a paramagnetic ytterbium-zinc complex. *By Y. Zhou and S.-T. Han*  
REPORT p. 671

#### 628 In the heat of the night

An ancestral receptor plays a key role in host detection by malaria-carrying mosquitoes. *By C. R. Lazzari*  
REPORT p. 681

### POLICY FORUM

#### 630 Using sewage for surveillance of antimicrobial resistance

A global system would exploit metagenomic sequencing  
*By Frank M. Aarestrup and M. E. J. Woolhouse*

## BOOKS ET AL.

**633 Death dollhouses and the birth of forensics**

A wealthy patron's vision and macabre models helped forge the field of forensic medicine *By A. Adam*

**634 Hidden figures**

Missing population data hinder good accounting and fair resource distribution *By W. P. O'Hare*

## LETTERS

**635 Marine heat waves threaten kelp forests**

*By N. Arafeh-Dalmau et al.*

**635 Marine restoration projects are undervalued**

*By T. A. C. Gordon et al.*

**636 U.S. action lowers barriers to invasive species**

*By D. Simberloff et al.*

## RESEARCH

## IN BRIEF

**637** From *Science* and other journals

## REVIEW

**640 Medicine**

The biology, function, and biomedical applications of exosomes *R. Kalluri and V. S. LeBleu*  
REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAU6977

## RESEARCH ARTICLES

**641 Plant science**

Enhanced sustainable green revolution yield via nitrogen-responsive chromatin modulation in rice *K. Wu et al.*  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAZ046

**642 Immunology**

Butyrophilin 2A1 is essential for phosphoantigen reactivity by  $\gamma\delta$  T cells *M. Rigau et al.*  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY5516

**643 Signal transduction**

Mechanism of homodimeric cytokine receptor activation and dysregulation by oncogenic mutations *S. Wilmes et al.*



628 &amp; 681

**652 Signal transduction**

An AMPK-caspase-6 axis controls liver damage in nonalcoholic steatohepatitis *P. Zhao et al.*

## REPORTS

**661 Electrochemistry**

CO<sub>2</sub> electrolysis to multicarbon products at activities greater than 1 A cm<sup>-2</sup> *F. P. Garcia de Arquer et al.*

**667 Catalysis**

Na<sup>+</sup>-gated water-conducting nanochannels for boosting CO<sub>2</sub> conversion to liquid fuels *H. Li et al.*

PERSPECTIVE p. 624

**671 Multiferrolics**

Room temperature magnetoelectric coupling in a molecular ferroelectric ytterbium(III) complex *J. Long et al.*  
PERSPECTIVE p. 627

**676 Organic chemistry**

Total synthesis of the complex taxane diterpene canatxpropellane *F. Schneider et al.*

**681 Mosquito biology**

Mosquito heat seeking is driven by an ancestral cooling receptor *C. Greppi et al.*  
PERSPECTIVE p. 628

**685 Pollinator decline**

Climate change contributes to widespread declines among bumble bees across continents *J. P. Soroye et al.*  
PERSPECTIVE p. 626

**688 Neuroscience**

Microglia mediate forgetting via complement-dependent synaptic elimination *C. Wang et al.*

**694 Phase separation**

Valence and patterning of aromatic residues determine the phase behavior of prion-like domains *E. W. Martin et al.*

**700 Structural biology**

Structure of an active human histone pre-mRNA 3'-end processing machinery *Y. Sun et al.*

## DEPARTMENTS

**605 Editorial**

For science, Brexit isn't done yet *By James Wilsdon*

**710 Working Life**

Just for fun *By Bill D. Roebuck*

## ON THE COVER



Rice paddy terraces in Guangxi, China. The nitrogen fertilizers used in green revolution rice cultivation increase the number of flowering branches per plant, in turn enhancing grain yield. Researchers have

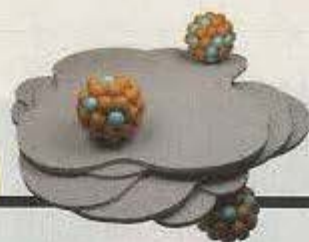
now discovered the gene that promotes this branching response to nitrogen. Future breeding efforts will use natural gene variants to increase grain yield and reduce fertilizer need, thus boosting agricultural sustainability. See page 641. Photo: Chris Stenger/Minden Pictures

Science Staff .....	602
New Products .....	704
Science Careers .....	705

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and E-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

## Science



737 & 777

Catalysis on the edge

14 FEBRUARY 2020 • VOLUME 367 • ISSUE 6479

10 NOV 2020



722

## NEWS

### IN BRIEF

720 News at a glance

### IN DEPTH

#### 722 Scientists in Indonesia fear political interference

French researcher is deported after publishing unwelcome data on wildfires  
By D. Rochmyaningsih

#### 723 Trump's new budget cuts all but a favored few science programs

NIH, NSF, NASA, and energy research again take hits in 2021 request, but "industries of the future" on the rise  
By J. Mervis

#### 724 Big telescopes join the hunt for flashes in the sky

Automated networks aim to catch "transients" such as comets, supernovae, and colliding neutron stars  
By D. Clery

#### 726 NIH hopes 'cluster hiring' will improve diversity

Hiring faculty in batches could help erase racial gap in NIH awards  
By J. Mervis

PODCAST

#### 727 Labs scramble to produce new coronavirus diagnostics

Lack of antibody tests obscures impact of the novel virus  
By J. Cohen and K. Kupferschmidt

#### 728 AI shortcuts speed up simulations by billions of times

With little training, neural networks create accurate emulators for physics, astronomy, and earth science  
By M. Hutson

### FEATURES

#### 730 The health carer

WHO's empathetic head confronts the threat of a new virus—and the tricky diplomacy it brings  
By K. Kupferschmidt

## INSIGHTS

### PERSPECTIVES

#### 734 Resilience to trauma: Just a matter of control?

Deficits in memory control may facilitate posttraumatic stress disorder  
By K. D. Ersche

RESEARCH ARTICLE p. 756

#### 735 Rectifying ionic current with ionoelastomers

A solvent-free polyamorphous heterojunction creates logic circuits and transistors

By D. Gao and P. S. Lee

REPORT p. 773

#### 737 Fewer defects, better catalysis?

Defect-free magnesium oxide provides a better route for carbon dioxide conversion  
By L. Chen and Q. Xu

REPORT p. 777

#### 738 "Breaking" news for the ocean's carbon budget

Fragmentation of particle aggregates helps regulate carbon sequestration in the ocean

By A. R. Nayak and M. S. Twardowski

REPORT p. 791

#### 739 Crossing thresholds on the way to ecosystem shifts

Meshing evidence from multiple datasets unveils Earth's mechanisms for adapting to environmental changes

By M. Hirota and R. Oliveira

REPORT p. 787

#### 740 Marching to another clock

Robust daily rhythms of RNA and protein expression occur in "clockless" cells

By S. A. Brown and M. Sato

REPORT p. 800

#### 742 Translating preclinical models to humans

Computational models for cross-species translation could improve drug development

By D. K. Brubaker and D. A. Lauffenburger

#### 744 Sidney Holt (1926–2019)

Influential fisheries scientist and savior of whales  
By D. Pauly

### POLICY FORUM

#### 745 When health tech companies change their terms of service

Consumers may have limited control over their data  
By J. L. Roberts and J. Hawkins

### BOOKS ET AL.

#### 747 The art of misleading the public

A government insider exposes the industry playbook for undermining evidence-based policy  
By S. Kirshenbaum

**748 Physics meets Bohemia**

A historian dives deep into Einstein's brief, often overlooked time in Prague  
By T. Sauer

**LETTERS****749 The Caribbean needs big marine protected areas**

By A. J. Gallagher et al.

**749 Imposter syndrome threatens diversity**

By G. P. Chrousos and A.-F. Mentis

**750 Wildfire puts koalas at risk of extinction**

By S. S. Lam et al.

**RESEARCH****IN BRIEF**

**752** From *Science* and other journals

**RESEARCH ARTICLES****755 Developmental biology**

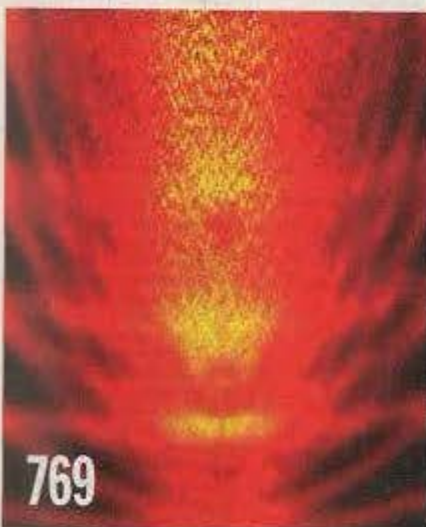
Lineage tracing on transcriptional landscapes links state to fate during differentiation  
C. Weinreb et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAW3381

**756 Neuroscience**

Resilience after trauma: The role of memory suppression  
A. Mary et al.  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY8477

PERSPECTIVE p. 734; PODCAST

**757 Germ cell biology**

Transcription factor AP2 controls cnidarian germ cell induction  
T. Q. DuBuc et al.

**763 Plant pathology**

The pan-genome effector-triggered immunity landscape of a host-pathogen interaction  
B. Lafiamme et al.

**REPORTS****769 Solid-state physics**

Pascal conductance series in ballistic one-dimensional  $\text{LaAlO}_3/\text{SrTiO}_3$  channels  
M. Briggeman et al.

**773 Materials science**

Ionoelastomer junctions between polymer networks of fixed anions and cations  
H. J. Kim et al.

PERSPECTIVE p. 735

**777 Catalysis**

Dry reforming of methane by stable Ni-Mo nanocatalysts on single-crystalline MgO  
Y. Song et al.

PERSPECTIVE p. 737

**781 Topological matter**

Helical quantum Hall phase in graphene on  $\text{SrTiO}_3$   
L. Veyrat et al.

**787 Dryland ecology**

Global ecosystem thresholds driven by aridity  
M. Berdugo et al.

PERSPECTIVE p. 739

**791 Carbon cycle**

Major role of particle fragmentation in regulating biological sequestration of  $\text{CO}_2$  by the oceans  
N. Briggs et al.

PERSPECTIVE p. 738

**Physics****794 Twisted bulk-boundary**

correspondence of fragile topology  
Z.-D. Song et al.

**797 Experimental characterization**

of fragile topology in an acoustic metamaterial  
V. Peri et al.

**800 Circadian rhythms**

Circadian rhythms in the absence of the clock gene *Bmal1*  
S. Ray et al.

PERSPECTIVE p. 740

**Structural biology**

**806** Structural basis of second-generation HIV integrase inhibitor action and viral resistance  
N. J. Cook et al.

**810** Structural basis for strand-transfer inhibitor binding to HIV intasomes  
D. O. Passos et al.

**814 Biodiversity loss**

Tropical snake diversity collapses after widespread amphibian loss  
E. F. Zipkin et al.

**DEPARTMENTS****719 Editorial**

Life without ice  
By Mark C. Urban

**822 Working Life**

My best is good enough  
By Katherine Still

**ON THE COVER**

A satiny parrot snake (*Leptophis depressirostris*) preys on a frog. Tropical snake diversity declined after a fungal pathogen led to mass mortality of amphibians, a key food source. Snakes are generally rare and difficult

to detect, but researchers estimate a high probability that the snake community is now smaller and more homogeneous, with lower occurrence rates and poorer body conditions for many species. See page 814.  
Photo: Bence Mate/Minden Pictures

Science Staff .....	718
New Products .....	817
Science Careers .....	818

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; Foreign postage extra: Air assist delivery: \$96. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 3069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair-use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

21 FEBRUARY 2020 • VOLUME 367 • ISSUE 6480

## NEWS

### IN BRIEF

832 News at a glance

### IN DEPTH

#### 836 Coronavirus epidemic snarls science worldwide

Experiments are halted as China remains locked down; many conferences are canceled  
By R. F. Service

#### 837 Microbiome researcher accused of sexual misconduct

Questions arise about the work of researcher Jeff Leach, known for studies of Hadza hunter-gatherers in Tanzania  
By G. Vogel



#### 838 Strange bedfellows for human ancestors

*Homo erectus* and other "super-archaics" may have interbred with ancient humans  
By A. Gibbons  
SCIENCE ADVANCES RESEARCH ARTICLES BY A. DURVASULA AND S. SANKARARAMAN 10.1126/SCIADV.AAX5097 AND A. R. ROGERS ET AL. 10.1126/SCIADV.AAY5483

#### 840 Tough microbe's DNA could be a lasting archive

Artist and DNA storage pioneer says microbes could preserve a record of humanity  
By S. Nadis

#### 841 In 'living materials,' microbes are the makers

Cells enable materials to reproduce or manufacture medicines  
By R. F. Service  
PODCAST

### FEATURES

#### 842 #MeToo moves south

The fight against harassment in Latin American science gains strength  
By L. Wessel and R. Pérez Ortega

828 21 FEBRUARY 2020 • VOL 367 ISSUE 6480

## INSIGHTS

### PERSPECTIVES

#### 846 Old methane and modern climate change

Old methane is less important for our immediate future than contemporary sources  
By J. F. Dean  
REPORT p. 907

#### 848 Two paths to intrinsic quantization

A pair of materials demonstrate new and different routes to an exotic quantum behavior  
By J. P. Wakefield and J. G. Checkelsky  
REPORTS pp. 895 & 900

#### 850 Cross-modal sensory transfer: Bumble bees do it

Stored sensory input permits two sensory channels to exchange and compare information  
By G. von der Ernde and T. Burt de Perera  
REPORT p. 910

#### 851 A time to grow and a time to pause

Mechanisms of programmed arrest protect animals from the passage of time  
By M. Van Gilst  
RESEARCH ARTICLE p. 870

#### 852 Toward a universal flu vaccine

A vaccine adjuvant elicits broad protection against influenza in animals  
By S. Herold and L.-E. Sander  
RESEARCH ARTICLE p. 869

#### 854 Stem cells and the heart—the road ahead

After 20 years of research, pluripotent stem cells move to the fore to treat heart disease  
By C. E. Murry and W. R. MacLellan

### POLICY FORUM

#### 856 Promoting biosecurity by professionalizing biosecurity

A credential system could improve policy and practice  
By R. L. Moritz et al.

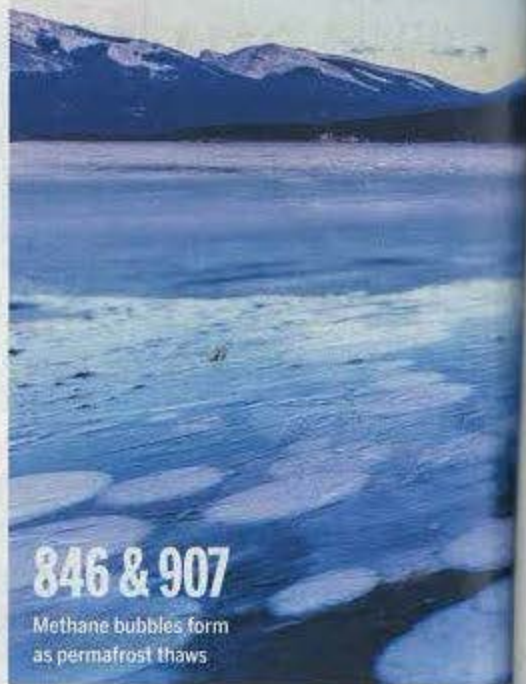
### BOOKS ET AL.

#### 859 Recording waves, reading minds

A neuroscientist confronts the history and future of our quest to understand electricity's role in brain function  
By C. James

#### 860 Etymology of the elements

Charming anecdotes and historical diversions come to life in tales of how the chemical elements were named  
By N. Pohl



846 &amp; 907

Methane bubbles form as permafrost thaws

### LETTERS

#### 861 Conservationists deserve protection

By M. Böhm et al.

#### 861 Public health scientists in the crosshairs

By L. Wandschneider et al.

#### 862 Illegal poachers turn to helmeted hornbills

By W. Li and W. Huang

### 863 ERRATA

## RESEARCH

### IN BRIEF

864 From *Science* and other journals

### REVIEW

#### 867 Plant ecology

How mycorrhizal associations drive plant population and community biology  
L. Tedersoo et al.  
REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA1223

### RESEARCH ARTICLES

#### 868 Immunogenomics

A cell atlas of human thymic development defines T cell repertoire formation  
J.-E. Park et al.  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY3224



### 869 Vaccines

Pulmonary surfactant–biomimetic nanoparticles potentiate heterosubtypic influenza immunity *J. Wang et al.*  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAU0810](https://doi.org/10.1126/SCIENCE.AAU0810)  
PERSPECTIVE p. 852

### 870 Developmental biology

Vertebrate diapause preserves organisms long term through Polycomb complex members *C.-K. Hu et al.*  
PERSPECTIVE p. 851; VIDEO

### 875 Structural biology

Structure of nucleosome-bound human BAF complex *S. He et al.*

### 881 Structural biology

Molecular mechanism of biased signaling in a prototypical G protein–coupled receptor *C.-M. Suominen et al.*  
REPORT p. 888

## REPORTS

### 888 Structural biology

Angiotensin and biased analogs induce structurally distinct active conformations within a GPCR *L. M. Winkler et al.*  
RESEARCH ARTICLE p. 881

### 892 Optomechanics

Cooling of a levitated nanoparticle to the motional quantum ground state *U. Delić et al.*

### Topological matter

895 Quantum anomalous Hall effect in intrinsic magnetic topological insulator  $MnBi_2Te_4$  *Y. Deng et al.*

900 Intrinsic quantized anomalous Hall effect in a moiré heterostructure *M. Serlin et al.*  
PERSPECTIVE p. 848

### 903 Nanomaterials

Disassembling 2D van der Waals crystals into macroscopic monolayers and reassembling into artificial lattices *F. Liu et al.*

### 907 Atmospheric methane

Old carbon reservoirs were not important in the deglacial methane budget *M. N. Dyonisius et al.*  
PERSPECTIVE p. 846

### 910 Animal cognition

Bumble bees display cross-modal object recognition between visual and tactile senses *C. Solvi et al.*  
PERSPECTIVE p. 850

### 912 Enzyme regulation

Ancient origins of allosteric activation in a Ser-Thr kinase *A. Hadzipasic et al.*

### 917 Biocatalysis

Biocatalytic synthesis of planar chiral macrocycles *C. Gagnon et al.*

## DÉPARTMENTS

### 831 Editorial

Smaller, greener, better  
*By H. Holden Thorp*

### 950 Working Life

Stepping down to step forward  
*By Gursel Alici*

## ON THE COVER



American witch hazel (*Hamamelis virginiana*) flowers encased in ice from a late winter storm. The effects of climate change on biological systems may be especially pronounced in winter.  
The Gordon Research

Conference on the Biology of Winter will be held from 21 to 26 June 2020 in Waterville Valley, New Hampshire. See page 922 for the Gordon Research Conference schedule and preliminary programs. *Photo: Brent J. Sinclair*

Gordon Research Conferences.....922  
Science Careers.....947

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484-650) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number: 3069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

28 FEBRUARY 2020 • VOLUME 367 • ISSUE 6481

968

## NEWS

### IN BRIEF

960 News at a glance

### IN DEPTH

#### 962 Strategies shift as coronavirus pandemic looms

The virus seems unstoppable, but mitigating its speed and impact is possible

By J. Cohen and K. Kupferschmidt

EDITORIAL p. 959

#### 963 Preprints bring 'firehose' of outbreak data

COVID-19 has upended the ways researchers share findings and collaborate

By K. Kupferschmidt

EDITORIAL p. 959

#### 965 Satellite megaconstellations menace giant survey telescope

Darkening the orbiters could limit damaging light trails in wide-field images from the Vera C. Rubin Observatory

By D. Clery

#### 966 Safety benefits of 'biased' opioids scrutinized

Mouse studies challenge premise of efforts to reduce painkillers' fatal side effect

By K. Servick

#### 967 Cheap balloon-borne telescopes aim to rival space observatories

Stable pointing system enables SuperBIT to deliver images almost as sharp as those from the Hubble Space Telescope

By A. Cho

## FEATURES

### 968 The arrival of strangers

New evidence points to a clash between two ancient Mesoamerican cultures, Teotihuacan and the Maya

By L. Wade

PODCAST

## INSIGHTS

### PERSPECTIVES

#### 974 Splitting speech and music

Brain asymmetries for words and melodies of songs depend on opposite acoustic cues

By D. Sammler

REPORT p. 1043

#### 976 Knocking out barriers to engineered cell activity

CRISPR-Cas9 gene-edited T cells show safety and long-term engraftment in humans

By J. R. Hamilton and J. A. Doudna

RESEARCH ARTICLE p. 1001

#### 978 Maternal microbial molecules affect offspring health

Intestinal molecules during pregnancy in mice may protect offspring from metabolic disease

By J. Ferguson

RESEARCH ARTICLE p. 1002

#### 979 Cobalt in lithium-ion batteries

Replacements are sought for cobalt, a costly element used in lithium-ion battery cathodes

By M. Li and J. Lu

### 980 A deep dive into the abyss

The flyby of the Kuiper Belt object Arrokoth provides quick and tantalizing observations

By D. C. Jewitt

RESEARCH ARTICLES pp. 998, 999, 1000

### 982 Artificial intelligence in cancer therapy

Artificial intelligence can optimize cancer drug discovery, development, and administration

By D. Ho

### POLICY FORUM

#### 984 Recalibrating global data center energy-use estimates

Growth in energy use has slowed owing to efficiency gains that smart policies can help maintain in the near term

By E. Masanet et al.

### BOOKS ET AL.

#### 987 Out of sight

A historian investigates the Cold War competition to create an invisible aircraft

By F. R. van der Linden

#### 988 When life meets research

The personal and professional collide in a scientist's story of early human development

By J. Rossant

### LETTERS

#### 989 Giant salamanders: Farmed yet endangered

By C. Lu et al.

## 989 The U.S. military is not sustainable

By O. Belcher et al.

## 990 Brazilian national parks at risk

By R. Ruaro et al.

# RESEARCH

### IN BRIEF

995 From *Science* and other journals

### RESEARCH ARTICLES

#### Outer solar system

998 The geology and geophysics of Kuiper Belt object (486958) Arrokoth

J. R. Spencer et al.

RESEARCH ARTICLE SUMMARY: FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY3999](https://doi.org/10.1126/SCIENCE.AAY3999)

999 Color, composition, and thermal environment of Kuiper Belt object (486958) Arrokoth

W. M. Grundy et al.

RESEARCH ARTICLE SUMMARY: FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY3705](https://doi.org/10.1126/SCIENCE.AAY3705)

1000 The solar nebula origin of (486958) Arrokoth, a primordial contact binary in the Kuiper Belt

W. B. McKinnon et al.

RESEARCH ARTICLE SUMMARY: FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY6620](https://doi.org/10.1126/SCIENCE.AAY6620)

PERSPECTIVE p. 980

#### 1001 Clinical trials

CRISPR-engineered T cells in patients with refractory cancer

E. A. Stadtmauer et al.

RESEARCH ARTICLE SUMMARY: FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABA7365](https://doi.org/10.1126/SCIENCE.ABA7365)

PERSPECTIVE p. 976

#### 1002 Microbiota

Maternal gut microbiota in pregnancy influences offspring metabolic phenotype in mice

I. Kimura et al.

RESEARCH ARTICLE SUMMARY: FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAW8429](https://doi.org/10.1126/SCIENCE.AAW8429)

PERSPECTIVE p. 978

#### 1003 Plant science

Pectin homogalacturonan nanofilament expansion drives morphogenesis in plant epidermal cells

K. T. Haas et al.

#### 1008 Immunology

Structure of the secretory immunoglobulin A core

N. Kumar et al.

### REPORTS

#### 1014 Immunology

Structural insights into immunoglobulin M

Y. Li et al.

#### 1018 Optics

Ultrafast control of vortex microlasers

C. Huang et al.

#### 1021 Organic chemistry

Aminoalkyl radicals as halogen-atom transfer agents for activation of alkyl and aryl halides

T. Constantin et al.

#### 1026 Fluid dynamics

Hidden fluid mechanics: Learning velocity and pressure fields from flow visualizations

M. Raissi et al.

#### 1030 Batteries

Kinetic pathways of ionic transport in fast-charging lithium titanate

W. Zhang et al.

#### 1035 Ecological speciation

Ecologically diverse clades dominate the oceans via extinction resistance

M. L. Knope et al.

#### 1039 Cell biology

Polymerization in the actin ATPase clan regulates hexokinase activity in yeast

P. R. Stoddard et al.

#### 1043 Neuroscience

Distinct sensitivity to spectrotemporal modulation supports brain asymmetry for speech and melody

P. Albouy et al.

PERSPECTIVE p. 974



### DEPARTMENTS

#### 959 Editorial

The costs of secrecy

By H. Holden Thorp

NEWS SOTRIES pp. 962 & 963

#### 1050 Working Life

Adapting to my brain

By Luis Batista

### ON THE COVER



CRISPR-Cas9 technology acts as molecular scissors to edit DNA. Genetically modified T cells are revolutionizing cancer therapy but do not successfully treat all patients. Researchers used CRISPR to cut out sections of

DNA on three genes in T cells from patients with advanced cancer. This pioneering therapeutic application of genome editing paves the way for next-generation cell-based therapies for human disease. See pages 976 and 1001.

Illustration: V. Altounian/Science

Science Staff ..... 959

AAAS News & Notes ..... 991

Science Careers ..... 1048



An ecologically, taxonomically diverse coral reef community teeming with fish and corals at Miloli'i, Hawaii, USA

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 3069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

## Science

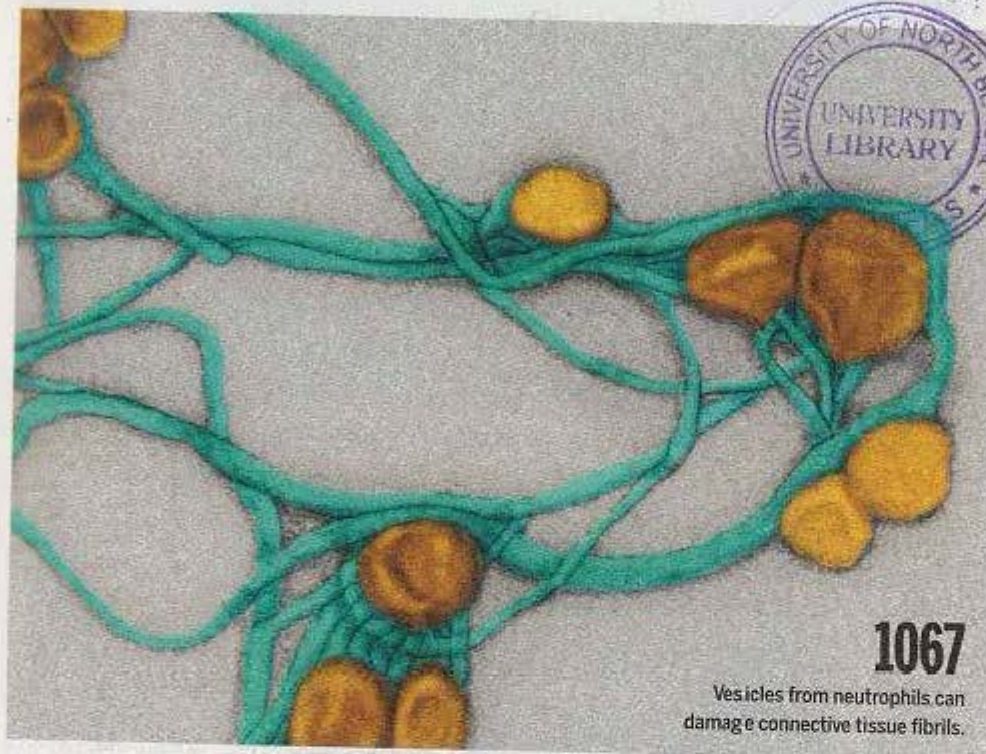


1070

How are health outcomes related to breastmilk?

6 MARCH 2020 • VOLUME 367 • ISSUE 6482

02 FEB 2021



1067

Vesicles from neutrophils can damage connective tissue fibrils.

### 1072 Origins of peanut allergy-causing antibodies

Analysis of gut-produced antibodies raises questions about how food allergy arises

By D. R. Wesemann and C. R. Nagler

SCIENCE IMMUNOLOGY RESEARCH ARTICLE BY R. A. HOH ET AL. 10.1126/SCIIMMUNOL.AAY4209

### 1074 Coding functions of “noncoding” RNAs

Hundreds of RNA regions that encode microproteins are found to regulate cell growth

By L.-H. Wei and J. U. Guo

REPORT p. 1140

### 1075 Rings rule three-dimensional active matter

Dynamical defect networks are imaged in viral-particle liquid crystals driven by biomotors

By D. Bartolo

REPORT p. 1120

### 1077 Frank Press (1924–2020)

Policy adviser and National Academy of Sciences president

By M. McNutt

## POLICY FORUM

### 1078 Overcoming obstacles to experiments in legal practice

The biggest ethical concern is failing to seek reliable evidence to guide the legal profession

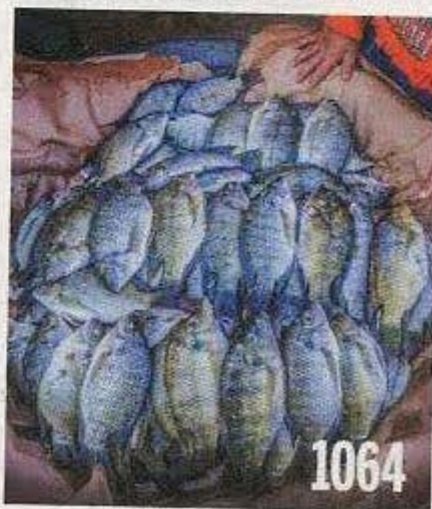
By H. Fernandez Lynch et al.

## BOOKS ET AL.

### 1081 Evolution makes a splash

An underwater arms race drives a vibrant new game

By A. Chuang and O. Schwery



1064

## NEWS

### IN BRIEF

1058 News at a glance

### IN DEPTH

### 1061 Can China’s COVID-19 strategy work elsewhere?

Rapid decline in case numbers is real, expert mission concludes—but it came at a high cost

By K. Kupferschmidt and J. Cohen

### 1062 Why weather systems are apt to stall

A new theory tries to explain enigmatic “blocks” that bring heat waves and drought

By P. Voosen

### 1064 Unplanned experiment could help save a key farmed fish

Random outbreak at research center points to tilapia variants that resist the deadly emerging tilapia lake virus

By E. Stokstad

### 1065 Pentagon’s social science research faces threat

Minerva initiative falls out of favor in latest DOD review of spending priorities

By J. Mervis

### 1066 New telescope promises boon for Turkish science

The 4-meter Eastern Anatolia Observatory aims to become an affordable regional hub

By U. Farooq

## FEATURES

### 1067 The body’s dangerous defenders

Neutrophils fiercely attack infections, but can also trigger disease. Researchers are trying to tame them

By M. Leslie

## INSIGHTS

## PERSPECTIVES

### 1070 Understanding the mother-breastmilk-infant “triad”

Breastmilk research holds important opportunities to improve maternal-child health

By L. Bode et al.

CREDITS (FROM TOP): N. CARY/SCIENCE; TOMASEK SZUL AND DEREK W. RUSSELL; WIKI/DPISHA/FLICKR/CC BY-NC-ND

**1082 The landmark case that almost never was**

A law professor investigates the legal decision to regulate U.S. greenhouse gases  
By M. B. Gerrard

**LETTERS****1083 Protect Australia's Gondwana Rainforests**

By R. M. Kooyman et al.

**1083 Post-2020 goals overlook genetic diversity**

By L. Laikre et al.

**1084 Outreach that sticks**

By L. Jardine-Wright

**RESEARCH****IN BRIEF**

**1086** From *Science* and other journals

**RESEARCH ARTICLES****1089 Germ cell development**

ZGLP1 is a determinant for the oogenic fate in mice S. I. Nagaoka et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.AAW4115

**1090 Integrative omics**

An atlas of the protein-coding genes in the human, pig, and mouse brain  
E. Sjöstedt et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.AAY5947

**1091 Cell surface mapping**

Microenvironment mapping via Dexter energy transfer on immune cells  
J. B. Geri et al.

**1097 Solar cells**

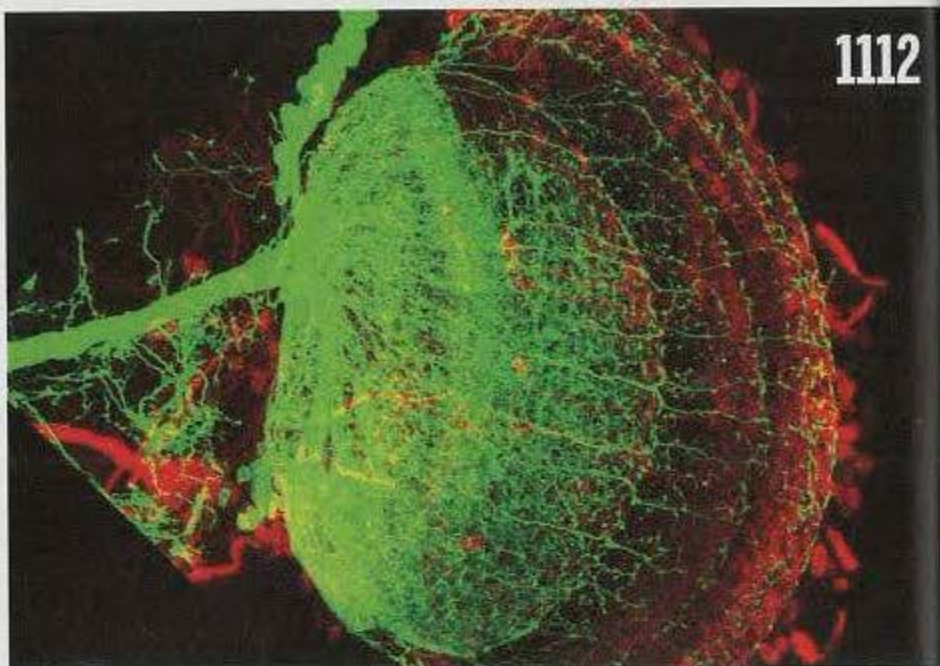
Triple-halide wide-band gap perovskites with suppressed phase segregation for efficient tandems J. Xu et al.

**1105 Neuroscience**

A central master driver of psychosocial stress responses in the rat  
N. Kataoka et al.

**1112 Neurodevelopment**

A neurodevelopmental origin of behavioral individuality in the *Drosophila* visual system  
G. A. Linneweber et al.



Developmental randomness drives behavioral divergence among individual *Drosophila* flies.

**REPORTS****1120 Liquid crystals**

Topological structure and dynamics of three-dimensional active nematics G. Duclos et al.

PERSPECTIVE p. 1075

**1124 Electron microscopy**

Single-atom vibrational spectroscopy in the scanning transmission electron microscope  
F. S. Hage et al.

**1128 Quantum simulation**

A scalable realization of local U(1) gauge invariance in cold atomic mixtures A. Mil et al.

**1131 Neuroscience**

Replay of cortical spiking sequences during human memory retrieval A. P. Vaz et al.

**1135 Solar cells**

Efficient tandem solar cells with solution-processed perovskite on textured crystalline silicon Y. Hou et al.

**1140 Molecular biology**

Pervasive functional translation of noncanonical human open reading frames  
J. Chen et al.

PERSPECTIVE p. 1074

**1147 Microbiology**

PE/PPE proteins mediate nutrient transport across the outer membrane of *Mycobacterium tuberculosis* Q. Wang et al.

**1151 Transcription**

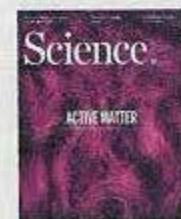
Sequencing metabolically labeled transcripts in single cells reveals mRNA turnover strategies  
N. Battich et al.

**DEPARTMENTS****1057 Editorial**

Learning to deal with dual use  
By Megan J. Palmer

**1162 Working Life**

Learning to say 'yes, and'  
By Ellen K. W. Brennan

**ON THE COVER**

Fluorescence microscopy image of a composite three-dimensional active nematic liquid crystal. Light-sheet microscopy reveals the structure and dynamics of disclination defects, which are fundamental features of nematic liquid crystals and other fluids with orientational order. See pages 1075 and 1120.  
Image: Ray Adkins

New Products ..... 1157  
Science Careers ..... 1158

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request, Canadian rates with GST available upon request, GST #125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

21 JAN 2021

## INSIGHTS

### BOOKS ET AL.

**1188 Science at Sundance 2020**

### PERSPECTIVES

**1192 Threatening the vigor of the Colorado River**

Loss of sunlight-reflecting snow spurs evaporation and ebbs river flow

By M. Hobbins and J. Barsugli

REPORT p. 1252

**1193 Liquid droplets in the skin**

Creating enough glue to protect the body may require phase separation in skin cells

By A. Rai and L. Pelkmans

RESEARCH ARTICLE p. 1210

**1195 Opening the floodgates to the brain**

Cerebrospinal fluid influx dictates early edema in response to ischemic large-vessel stroke

By J. Moss and A. Williams

RESEARCH ARTICLE p. 1211

**1196 Seeking new, highly effective thermoelectrics**

Operating across a wide temperature range is a priority for thermoelectric materials

By Y. Xiao and L.-D. Zhao

**1198 Treating sickle cell anemia**

New drugs, stem cell transplants, and gene therapy show promise in treating sickle cell anemia

By J. F. Tisdale et al.

### POLICY FORUM

**1200 Rethink the expansion of access and benefit sharing**

Several UN policy processes are embracing a calcified approach to conservation and equity in science

By S. Laird et al.

### LETTERS

**1203 Ease conflict in Asia with snow leopard peace parks**

By A. Maheshwari

**1203 Mass mortality of migratory birds in Iran**

By J. Parchizadeh and J. L. Belant



**1177**

The limits of airport infection screening

## NEWS

### IN BRIEF

**1172** News at a glance

### IN DEPTH

**1176** Genome analyses help track coronavirus' moves

Mutations can reveal connections between outbreaks—but it's easy to overinterpret them

By K. Kupferschmidt

**1177** Airport screening is largely futile, research shows

Thermometer guns and health questionnaires may look reassuring, but very rarely catch infected travelers

By D. Normile

**1178** Madagascar's mysterious, murderous cats identified

Ancestors of large cats likely hopped off Arabian trading ships more than 1000 years ago

By J. Sokol

**1179** Publishers try out alternative pathways to open access

But can they overcome free riders and price concerns?

By J. Brainard

**1180** EPA expands controversial 'transparency' plan

Critics blast revised proposal that covers a wider range of research, saying it will undermine protections

By E. Stokstad

**1181** New electrolyzer splits water on the cheap

Devices that forgo expensive metals could turn renewable electricity into hydrogen

By R. F. Service

### FEATURES

**1182** Saving grace

Scientists are leading Notre Dame's restoration—and probing mysteries laid bare by a fire

By C. Lesté-Lasserre

PODCAST

**1204 NIH progress toward inclusive excellence**

By H. A. Valentine and F. Collins

**PRIZE ESSAY****1205 Aging eyes and the immune system**Reining in age-related inflammation may enhance stem cell therapies for retinal disease *By J. Neves***RESEARCH****IN BRIEF****1207** From Science and other journals**RESEARCH ARTICLES****1210 Cell biology**

Liquid-liquid phase separation drives skin barrier formation

*F. Garcia Quiroz et al.*RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAX9554](https://doi.org/10.1126/SCIENCE.AAX9554)

PERSPECTIVE p. 1193; PODCAST

**1211 Neuroscience**

Cerebrospinal fluid influx drives acute ischemic tissue swelling

*H. Mestre et al.*RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAX7171](https://doi.org/10.1126/SCIENCE.AAX7171)

PERSPECTIVE p. 1195

**1212 Cometary science**

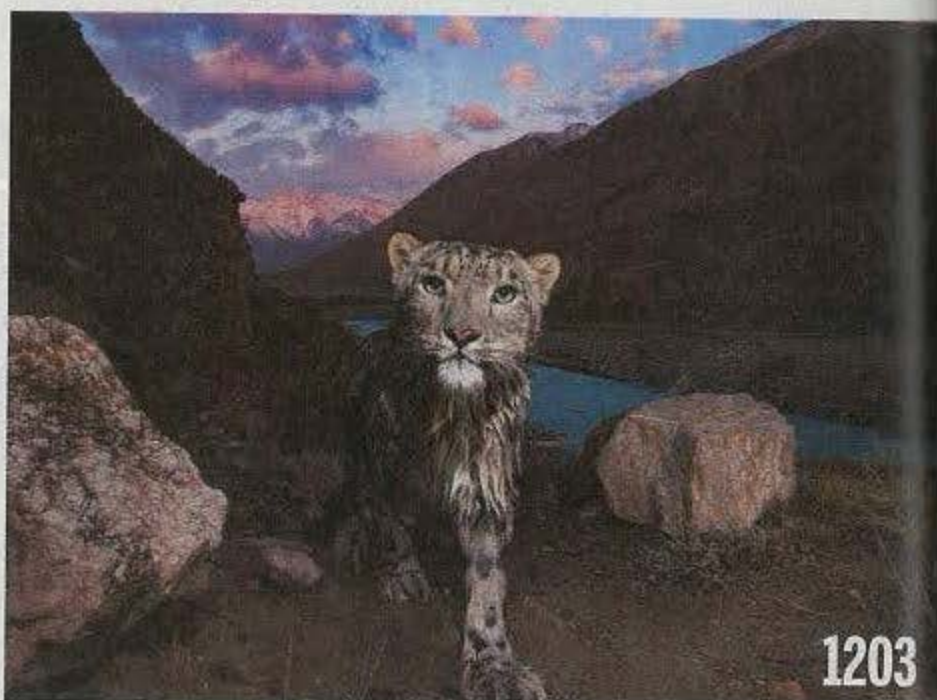
Ammonium salts are a reservoir of nitrogen on a cometary nucleus and possibly on some asteroids

*O. Poch et al.*RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAW7462](https://doi.org/10.1126/SCIENCE.AAW7462)**1213 Spectroscopy**

Quantum-nondemolition state detection and spectroscopy of single trapped molecules

*M. Sinhal et al.***1218 Frustrated magnetism**

Realization of the kagome spin ice state in a frustrated intermetallic compound

*K. Zhao et al.***1224 Structural biology**Structure of CD20 in complex with the therapeutic monoclonal antibody rituximab *L. Rougé et al.***REPORTS****1230 Functional amyloids**Cryo-EM structure of a neuronal functional amyloid implicated in memory persistence in *Drosophila* *R. Hervas et al.***1235 Glacial cycles**Persistent influence of obliquity on ice age terminations since the Middle Pleistocene transition *P. Bajo et al.***1240 Structural biology**Structure of V-ATPase from the mammalian brain *Y. M. Abbas et al.***1246 Organic chemistry**Enantioselective remote C-H activation directed by a chiral cation *G. R. Genov et al.***1252 Water resources**Colorado River flow dwindles as warming-driven loss of reflective snow energizes evaporation *P. C. D. Milly and K. A. Dunne*

PERSPECTIVE p. 1192

**1255 Immunology**mRNA destabilization by BTG1 and BTG2 maintains T cell quiescence *S. S. Hwang et al.***1260 Coronavirus**Cryo-EM structure of the 2019-nCoV spike in the prefusion conformation *D. Wrapp et al.***1264 Cancer**Rare driver mutations in head and neck squamous cell carcinomas converge on NOTCH signaling *S. K. Loganathan et al.***DEPARTMENTS****1169 Editorial**Do us a favor  
*By H. Holden Thorp***1274 Working Life**Teamwork, the Cuban way  
*By Paul Bierman***ON THE COVER**

The spire of Notre Dame cathedral collapses in a cloud of smoke. The Paris landmark was nearly destroyed on 15 April 2019, after a fire swept through attic timbers, melted its lead roof, and damaged

stone walls. Scientists are now guiding its restoration. By opening the cathedral up to inspection, the fire is also enabling new historical research. See page 1182.  
*Photo: Geoffroy Van Der Hasselt/AFP/Getty Images*

Science Careers ..... 1270

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals postage (publication No. 494480) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$174 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 3069524. Printed in the U.S.A.

**Change of address:** Allow 4 weeks, giving old and new addresses and B-digit account number. **Postmaster:** Send change of address to AAAS, P.O. Box 16178, Washington, DC 20030-6178. **Single-copy sales:** \$15 each plus shipping and handling available from backissues.science.org. Bulk rate on request. **Authorization to reproduce:** material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

## Science

20 MARCH 2020 • VOLUME 367 • ISSUE 6484



1294

Seasonal changes in humidity, temperature, and other factors may affect the viability of viruses in droplets produced when people sneeze or cough.

## NEWS

### IN BRIEF

1284 News at a glance

### IN DEPTH

#### 1287 Countries test tactics in 'war' against COVID-19

Lockdowns and closings proliferate, but virus testing and contact tracing are lagging. *By J. Cohen and K. Kupferschmidt*

#### 1289 Coronavirus disruptions reverberate through research

Scientists grapple with halted projects and locked-down labs. *By K. Servick, A. Cho, J. Couzin-Frankel, and G. Guglielmi*

#### 1290 Oldest fossil of modern birds is a 'turducken'

Ancestral bird skull looks like a duck from the back and a chicken from the front. *By G. Vogel*

#### 1291 After Brexit, U.K. budget offers boost to science

Unprecedented increase includes money to set up high-risk research agency. *By E. Stokstad*

#### 1292 Unrest imperils India's census

Opposition to citizenship policies could lead to undercount. *By V. Chandrasekhar*

#### 1293 Top neuroscientist leaving Mexican university

Alleged incidents of sexual harassment by Ranulfo Romo Trujillo began years ago. *By I. Gutiérrez and R. Pérez Ortega*

## FEATURES

### 1294 Sick time

Dozens of diseases wax and wane with the seasons. Will COVID-19? *By J. Cohen*

## INSIGHTS

### PERSPECTIVES

#### 1298 Challenges of human nutrition research

Facilities to house and feed subjects could increase rigor and advance nutrition science. *By K. D. Hall*

#### 1300 Is it worth the effort?

Individual variation in dopamine affects the weighting of benefits relative to costs. *By A. C. Janes*

REPORT p. 1362

#### 1301 Thermal light tunnels its way into electricity

New devices convert low-temperature heat into electricity. *By A. P. Raman*

RESEARCH ARTICLE p. 1341



1304 & 1377

#### 1303 Neuron-targeted electrical modulation

Engineering neurons to make conductive polymers enables cell type-specific behaviors. *By K. J. Otto and C. E. Schmidt*

REPORT p. 1372

#### 1304 Shallow ponds prompt fitness-favorable species interbreeding

Dry conditions liberate female toads to drive sexual selection of male mates. *By M. Zuk*

REPORT p. 1377

#### 1305 Taking on all of the biomass for conversion

A catalytic process converts hardwood into phenol, propylene, and other valuable products. *By T. Zhang*

REPORT p. 1385

#### 1307 Stanley Cohen (1922–2020)

Award-winning biochemist who shed light on cell growth. *By G. Carpenter and R. Coffey*

EDITORIAL p. 1283

## POLICY FORUM

#### 1308 Time for NIH to lead on data sharing

A draft policy is generally supportive but should start mandating data sharing. *By I. Sim et al.*

## BOOKS ET AL.

#### 1311 Sexism and the stars

A new biography tells the tale of an accomplished astronomer's barrier-breaking life. *By J. Carson*

#### 1312 Vanquishing false idols, then and now

Francis Bacon's 400-year-old list of scientific foibles holds lessons for modern scientists. *By K. P. Weinfurt*

SPECIAL SECTION

## ANTARCTICA

## INTRODUCTION

1316 The frozen continent

## NEWS

1318 The lost colony *E. Kintisch*

## REVIEWS

1321 History, mass loss, structure, and dynamic behavior of the Antarctic Ice Sheet *R. E. Bell and H. Seroussi*1326 The Southern Ocean and its interaction with the Antarctic Ice Sheet *D. M. Holland et al.*1331 The uncertain future of the Antarctic Ice Sheet *F. Pattyn and M. Morlighem*

## ON THE COVER



An iceberg from Antarctica drifts in the Southern Ocean. Mass loss from the Antarctic Ice Sheet, whether by iceberg calving or melting, will help determine the future of sea

level in our warming climate. How the ice sheet changes over the coming decades to centuries will depend on its structure, dynamics, and interactions with the atmosphere and surrounding ocean. See page 1316. Photo: Michel Roggo

## LETTERS

1313 Preventing COVID-19 prejudice in academia

By *P. Rzymski and M. Nowicki*

1313 Humpback dolphins at risk of extinction

By *S. Li*

1314 A first step for the Yangtze

By *Z. Mei et al.*

1314 Technical Comment abstracts

## RESEARCH

## IN BRIEF

1336 From *Science* and other journals

## RESEARCH ARTICLES

1339 Human genetics

Insights into human genetic variation and population history from 929 diverse genomes *A. Bergström et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY5012](https://doi.org/10.1126/SCIENCE.AAY5012)

1340 Cortical genetics

The genetic architecture of the human cerebral cortex *K. L. Grasby et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY6690](https://doi.org/10.1126/SCIENCE.AAY6690)

1341 Applied physics

Electrical power generation from moderate-temperature radiative thermal sources

By *P. S. Davids et al.*

PERSPECTIVE p. 1301

1346 Structural biology

Structural basis of G<sub>s</sub> and G<sub>i</sub> recognition by the human glucagon receptor

By *A. Qiao et al.*

1352 Solar cells

Resolving spatial and energetic distributions of trap states in metal halide perovskite solar cells *Z. Ni et al.*

## REPORTS

1358 Geomorphology

Latitudinal effect of vegetation on erosion rates identified along western South America

By *J. Starke et al.*

1362 Neuroscience

Dopamine promotes cognitive effort by biasing the benefits versus costs of cognitive work

By *A. Westbrook et al.*

PERSPECTIVE p. 1300

1366 Cell biology

Golgi-derived PI(4)P-containing vesicles drive late steps of mitochondrial division

By *S. Nagashima et al.*

1372 Biotechnology

Genetically targeted chemical assembly of functional materials in living cells, tissues, and animals *J. Liu et al.*

PERSPECTIVE p. 1303

1377 Hybridization

Female toads engaging in adaptive hybridization prefer high-quality heterospecifics as mates

By *C. Chen and K. S. Pfennig*

PERSPECTIVE p. 1304

1379 Pyroptosis

cFLIP<sub>L</sub> protects macrophages from LPS-induced pyroptosis via inhibition of complex II formation

By *H. I. Muendlein et al.*

1385 Chemical engineering

A sustainable wood biorefinery for low-carbon footprint chemicals production *Y. Liao et al.*

PERSPECTIVE p. 1305

## DEPARTMENTS

1282 Editorial

Time to pull together *By H. Halden Thorp*

1283 Editorial

Better late than never *By H. Holden Thorp*

PERSPECTIVE p. 1307

1398 Working Life

How I faced my coronavirus anxiety *By Kai Liu*

New Products ..... 1394  
Science Careers ..... 1395

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months), \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069524. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair-use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

02 DEC 2020

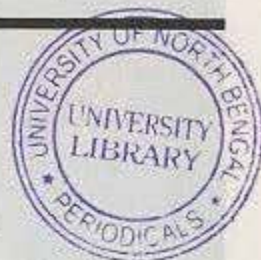
## Science



1422 & 1443

Neanderthals see  
seashells on the sea shore

27 MARCH 2020 • VOLUME 367 • ISSUE 6485



## INSIGHTS

### PERSPECTIVES

#### 1422 Neanderthal surf and turf

Did our closest ancestors adapt to the sea in the same way as early *Homo sapiens*?

By M. Will

RESEARCH ARTICLE p. 1443

#### 1424 Deciphering cancer clues from blood

Circulating tumor cells are accessible indicators of real-time cancer biology

By N. Ma and S. S. Jeffrey

REPORT p. 1468

#### 1425 Surprises for climate stability

An ocean sediment record reveals chaotic ocean circulation changes during warm climates

By T. F. Stocker

REPORT p. 1485

#### 1426 Quantifying mutations in healthy blood

Mutated clones in healthy tissues may hold clues for the earlier detection of malignancy

By C. Curtis

RESEARCH ARTICLE p. 1449

#### 1428 Antisense oligonucleotides for neurodegeneration

Promising clinical results for Huntington's disease give hope for other diseases

By B. R. Leavitt and S. J. Tabrizi

### POLICY FORUM

#### 1430 Leadership to change a culture of sexual harassment

The U.S. National Science Foundation is implementing and refining policies aimed at combatting harassment

By F. Córdova

### BOOKS ET AL.

#### 1432 Evolution gets personal

Engaging anecdotes add intimacy to tales of Earth's 4 billion years of evolution

By M. A. Goldman

#### 1433 Reversing the rise in midlife mortality

Stronger safety nets and health care reform could help mitigate

"deaths of despair" in America

By D. Canning

1418

## NEWS

### IN BRIEF

1408 News at a glance

### IN DEPTH

#### 1412 Race to find COVID-19 treatments accelerates

WHO launches megatrial of repurposed and experimental drugs

By K. Kupferschmidt and J. Cohen

1414 Fauci's straight talk

By J. Cohen

#### 1414 With COVID-19, modeling takes on life and death importance

Epidemic simulations shape national responses

By M. Enserink and K. Kupferschmidt

#### 1415 New mercury compound spotted in mass poisoning

Chemical found in 60-year-old cat brain reopens debate over Minamata disaster

By J. Sokol

#### 1417 Can 'sentinel trees' warn of devastating pests?

By planting groves of exotic species, nations hope to identify potential insect invaders

By G. Popkin

### FEATURES

#### 1418 The bias detective

Psychologist Jennifer Eberhardt explores the roots of unconscious bias—

and its tragic consequences for U.S. society

By D. Starr

1482



## LETTERS

## 1434 Misguided drug advice for COVID-19

By G. A. FitzGerald

## 1434 Permanently ban wildlife consumption

By N. Yang et al.

## 1435 Wildlife consumption ban is insufficient

By H. Wang et al.

## 1436 COVID-19 drives new threat to bats in China

By H. Zhao

## 1436 Travel restrictions violate international law

By B. Mason Meier et al.

## RESEARCH

## IN BRIEF

1438 From *Science* and other journals

## REVIEW

## 1441 Economic history

The historical roots of economic development  
N. NunnREVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAZ9986

## RESEARCH ARTICLES

## 1442 Topological matter

Flux-induced topological superconductivity in full-shell nanowires  
S. Vaitiekėnas et al.RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAV3392

## 1443 Archaeology

Last Interglacial Iberian Neandertals as fisher-hunter-gatherers  
J. Zilhão et al.RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAZ7943

PERSPECTIVE p. 1422

## 1444 Coronavirus

Structural basis for the recognition of SARS-CoV-2 by full-length human ACE2  
R. Yan et al.

## 1449 Clonal expansion

The evolutionary dynamics and fitness landscape of clonal hematopoiesis  
C. J. Watson et al.

PERSPECTIVE p. 1426

## REPORTS

## 1454 Superconductivity

Type-II Ising pairing in few-layer stanene  
J. Falson et al.

## 1458 Spectroscopy

Frequency-comb spectroscopy on pure quantum states of a single molecular ion  
C. W. Chou et al.

## 1461 Quantum gases

Observation of dynamical fermionization  
J. M. Wilson et al.

## 1465 Astroparticle physics

The dark matter interpretation of the 3.5-keV line is inconsistent with blank-sky observations  
C. Dessert et al.

## 1468 Cancer

Deregulation of ribosomal protein expression and translation promotes breast cancer metastasis  
R. Y. Ebright et al.

PERSPECTIVE p. 1424

## 1473 Glasses

Ultrahigh-field  $^{67}\text{Zn}$  NMR reveals short-range disorder in zeolitic imidazolate framework glasses  
R. S. K. Madsen et al.

## 1477 Climate forcing

No consistent ENSO response to volcanic forcing over the last millennium  
S. G. Dee et al.

## 1482 Plant science

Peptide signaling for drought-induced tomato flower drop  
S. Reichardt et al.

## 1485 Ocean circulation

Interglacial instability of North Atlantic Deep Water ventilation  
E. V. Gelaasen et al.  
PERSPECTIVE p. 1425

## DEPARTMENTS

## 1405 Editorial

Underpromise, overdeliver  
By H. Holden Thorp

## 1407 Editorial

COVID-19 needs a Manhattan Project  
By Seth Berkley

## 1494 Working Life

Stepping up to leadership  
By Michael Palladino

## ON THE COVER



The novel coronavirus (SARS-CoV-2; blue) approaches a human cell (pale pink). The viral spike protein (gray) binds to a receptor (ACE2; dark pink) on the cell surface. This allows SARS-CoV-2, the virus

responsible for the COVID-19 pandemic, to infect human cells. The structures of the viral spike protein, the full-length ACE2, and the complex of ACE2 with the receptor binding domain of SARS-CoV-2 have been elucidated, providing structural basis for development of antiviral drugs and vaccines. See page 1444 and [www.sciencemag.org/coronavirus-research-commentary-and-news](http://www.sciencemag.org/coronavirus-research-commentary-and-news).

Illustration: V. Altounian/Science; Data: PDB ID 6VSB (viral spike protein), PDB ID 6M17 (ACE2)

Science Staff ..... 1406  
AAAS News & Notes ..... 1437  
Science Careers ..... 1490

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months), \$165 (\$34 allocated to subscription). Domestic institutional subscription (51 issues), \$2148. Foreign postage extra. Air assist delivery, \$95. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 3069524. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from [backissues.sciencemag.org](http://backissues.sciencemag.org); bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), [www.copyright.com](http://www.copyright.com). The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

3 APRIL 2020 • VOLUME 368 • ISSUE 6486



21

## NEWS

### IN BRIEF

10 News at a glance

### IN DEPTH

**14 Vaccine designers take first shots at COVID-19**

Two candidate vaccines start trials while dozens more are rushed into development *By J. Cohen*

**16 Infect volunteers to speed a coronavirus vaccine?**

*By J. Cohen*

**17 United States strains to act as cases set record**

Conflicting messages, lack of coordination plague chaotic efforts to slow coronavirus *By Science News Staff*

**18 As normalcy returns, can China keep COVID-19 at bay?**

Infected travelers pose a continuing threat, but local coronavirus transmission still occurs as well *By D. Normile*

**19 Lead pollution tracks the rise and fall of medieval kings**

Ice core preserves precise record of lead dust from English mines *By A. Gibbons*

### FEATURES

**21 Where are the women?**

Female scientists allege discrimination and neglect of research on women at NIH's child health institute *By M. Wadman*

**24 How women at NIH's Clinical Center lost childbearing chances**

*By M. Wadman*

## INSIGHTS

### LETTERS

**26 NextGen Voices: Seeking career clarity**

### PERSPECTIVES

**29 Toward a universal glacier slip law**

A new friction rule may describe ice flow over rigid or deformable surfaces *By B. Minchew and I. Joughin*  
REPORT p. 76

**30 Tuning drug binding**

Understanding anticancer drug binding to its target could improve drug discovery and efficacy *By D. Slade and S. Eustermann*  
RESEARCH ARTICLE p. 46

**32 Straining quantum materials even further**

A nanoscale membrane enables exploration of large tensile strains on complex oxides *By C. Beekman*  
REPORT p. 71

**33 Revealing animal emotions**

Facial expressions in mice are detected and classified by machine learning *By B. Girard and C. Bellone*  
REPORT p. 89

**34 All who wander are not lost**

New hominin cranial fossils highlight the early exploits of *Homo erectus* *By S. C. Antón*  
RESEARCH ARTICLE p. 47

### POLICY FORUM

**36 Granular technologies to accelerate decarbonization**

Smaller, modular energy technologies have advantages *By C. Wilson et al.*

### BOOKS ET AL.

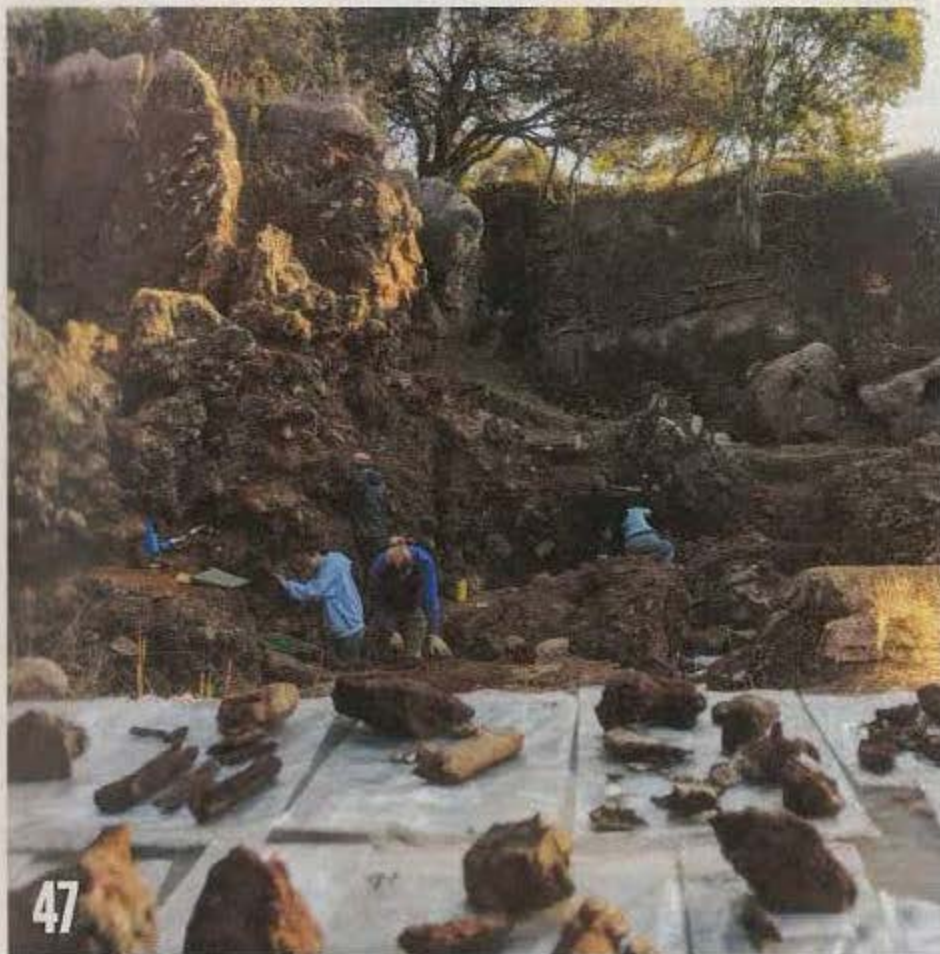
**40 Colonizing the final frontier**

Commercial interest in space is high, and the technology to get us there is nearly ready *By D. P. D. Munns*

**41 The things we make that make us who we are**

Our cultural values get baked into the materials we create, changing humanity along the way *By M. Miodownik*

ILLUSTRATION: STEFANIA INFANTE



**47** Excavations in the Drimolen quarry in South Africa have yielded several distinct, contemporaneous hominin species fossils from 2 million years ago.

## RESEARCH

### IN BRIEF

**42** From *Science* and other journals

### REVIEW

#### 45 Plant science

A plant's diet, surviving in a variable nutrient environment. *G. E. D. Oldroyd and O. Leyser*

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA0196

### RESEARCH ARTICLES

#### 46 Molecular biology

Structural basis for allosteric PARP-1 retention on DNA breaks. *L. Zandarashvili et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAX6367

PERSPECTIVE p. 30

#### 47 Paleoanthropology

Contemporaneity of *Australopithecus*, *Paranthropus*, and early *Homo erectus* in South Africa. *A. I. R. Herries et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAW7293

PERSPECTIVE p. 34

#### 48 Neurodevelopment

Maintenance of neural stem cell positional identity by *mixed-lineage leukemia 1*. *R. N. Delgado et al.*

#### 54 Cell biology

Endoplasmic reticulum-associated degradation regulates mitochondrial dynamics in brown adipocytes. *Z. Zhou et al.*

#### 60 Nanomaterials

Critical differences in 3D atomic structure of individual ligand-protected nanocrystals in solution. *B. H. Kim et al.*

## REPORTS

#### 67 Asteroids

An artificial impact on the asteroid (162173) Ryugu formed a crater in the gravity-dominated regime. *M. Arakawa et al.*

#### 71 Complex oxides

Extreme tensile strain states in  $\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3$  membranes. *S. S. Hong et al.*  
PERSPECTIVE p. 32

#### 76 Ice sheets

A slip law for glaciers on deformable beds. *L. K. Zoet and N. R. Iverson*  
PERSPECTIVE p. 29

#### 78 Protein design

De novo design of protein logic gates. *Z. Chen et al.*

#### 85 Cancer

Cysteine depletion induces pancreatic tumor ferroptosis in mice. *M. A. Badgley et al.*

#### 89 Neuroscience

Facial expressions of emotion states and their neuronal correlates in mice. *N. Dolensek et al.*  
PERSPECTIVE p. 33; PODCAST

## DEPARTMENTS

### 7 Editorial

This is real. *By H. Holden Thorp*

### 9 Editorial

Emerging from AI utopia  
*By Edward Santow*

### 98 Working Life

Making allowances for COVID-19. *By Ye Zhou*

## ON THE COVER



A selection of three-dimensional (3D) atomic structures of platinum nanocrystals in solution. Transmission electron microscopy images of individual rotating nanocrystals were reconstructed to generate the 3D density maps. The resultant atomic structures represent the intrinsic structural heterogeneity of ligand-protected nanocrystals synthesized in a single batch. See page 60. *Illustration: Younghee Lee*

Science Staff ..... 6  
Science Careers ..... 95

# CONTENTS

10 APRIL 2020 • VOLUME 368 • ISSUE 6487



124

## NEWS

### IN BRIEF

114 News at a glance

### IN DEPTH

#### 116 Pandemic brings mass vaccinations to a halt

Polio, measles, other diseases set to surge as COVID-19 forces suspension of campaigns. *By L. Roberts*

#### 117 Tested by HIV and TB, South Africa confronts new pandemic

Infrastructure and tactics developed for existing epidemics could aid the coronavirus fight. *By L. Nordling*

#### 118 Can prophylactic drugs keep fragile health systems running?

A raft of trials will test whether chloroquine and other treatments can protect health workers from COVID-19. *By K. Kupferschmidt*

#### 119 NAS letter suggests 'normal breathing' can expel coronavirus

But some experts are skeptical that small respiratory particles transmit infectious virus. *By R. F. Service*

#### 120 European Union gets in the venture capital game

Flush with cash, new EU innovation agency buys shares in disruptive technology startups. *By N. Wallace*

#### 121 United States aims to curb vaccination injury payouts

Proposal would make it harder to get compensated for shoulder injuries after misplaced injections. *By M. Wadman*

#### 122 Help for a wheat fungal disease comes from a surprising source

Resistance gene found in wild grass originated in a fungus. *By E. Stokstad*

### FEATURES

#### 124 Rethinking anorexia

Challenging long-standing theories about the eating disorder, new research suggests biology is a powerful driver. *By J. Couzin-Frankel*  
PODCAST

## INSIGHTS

### PERSPECTIVES

#### 128 Tree diversity reduced to the bare essentials

Tropical forest dynamics can be explained by merely two functional trait axes. *By H. Bugmann*  
REPORT p. 165

#### 129 The "iron will" of the gut

A gut-derived hormone controls iron concentrations, microbiota composition, and mucosal healing. *By M. Rescigno*  
REPORT p. 186

#### 131 The smallest particle collider

A new experiment finds direct evidence for anyons in a semiconductor heterostructure. *By D. E. Feldman*  
REPORT p. 173

#### 132 Autoimmunity provoked by foreign antigens

In celiac disease, exogenous gluten drives T cell-B cell interactions that cause autoimmunity. *By R. Iversen and L. M. Sollid*

#### 134 Epigenetic tinkering with neurotransmitters

Some neurotransmitters modify chromatin and modulate gene expression. *By J.-A. Girault*  
REPORT p. 197

#### 135 Spin pumping gathers speed

Coherent spin pumping from an antiferromagnet into a metal occurs at ~400 gigahertz. *By A. Hoffmann*  
RESEARCH ARTICLE p. 160

#### 136 Rafting on a wide and wild ocean

During the Oligocene, now-extinct monkeys crossed the treacherous ocean from Africa to South America. *By M. Godinot*  
REPORT p. 194



## POLICY FORUM

**138 Embrace experimentation in biosecurity governance**

We must rethink and test assumptions about relationships among biological research, security, and society. *By S. W. Evans et al.*

## BOOKS ET AL.

**142 Adaptation in the Anthropocene**

Through actions big and small, intentional and unintentional, we are reshaping life on Earth. *By M. Schilthuizen*

**143 Considering nonhuman culture**

Animals have much to teach us about communication, mate preference, and social hierarchy. *By M. E. Hannibal*

## LETTERS

**145 Protecting older adults during social distancing**

*By A. Jawaid*

**145 Aggregated mobility data could help fight COVID-19**

*By C. O. Buckee et al.*

**146 Disinfection threatens aquatic ecosystems**

*By H. Zhang et al.*

**147 Technical Comment abstracts****147 Errata**

## RESEARCH

## IN BRIEF

**149 From Science and other journals**

## REVIEW

**152 Cancer**

Metabolic reprogramming and cancer progression. *B. Faubert et al.*

REVIEW SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAW5473](https://doi.org/10.1126/SCIENCE.AAW5473)

## RESEARCH ARTICLES

**153 Molecular biology**

Transcription polymerase-catalyzed emergence of novel RNA replicons

*N. Jain et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY0688](https://doi.org/10.1126/SCIENCE.AAY0688)

**154 Neuroscience**

Widespread receptor-driven modulation in peripheral olfactory coding

*L. Xu et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAZ5390](https://doi.org/10.1126/SCIENCE.AAZ5390)

**155 Solar cells**

Efficient, stable silicon tandem cells enabled by anion-engineered wide-bandgap perovskites. *D. Kim et al.*

**160 Spintronics**

Subterahertz spin pumping from an insulating antiferromagnet

*P. Vaidya et al.*

PERSPECTIVE p. 135

## REPORTS

**165 Tropical forests**

Demographic trade-offs predict tropical forest dynamics. *N. Röger et al.*

PERSPECTIVE p. 128

**169 Brown dwarfs**

A measurement of the wind speed on a brown dwarf. *K. N. Allers et al.*

**173 Mesoscopic physics**

Fractional statistics in anyon collisions. *H. Bartolomei et al.*

PERSPECTIVE p. 131

**177 Device technology**

Ratcheting quasi-ballistic electrons in silicon geometric diodes at room temperature

*J. P. Custer Jr. et al.*

**181 Developmental biology**

Intravital imaging of mouse embryos

*Q. Huang et al.*

**186 Immunology**

Dendritic cell-derived hepcidin sequesters iron from the microbiota to promote mucosal healing

*N. J. Bessman et al.*

PERSPECTIVE p. 129

**190 Quantum gases**

Bose polarons near quantum criticality

*Z. Z. Yan et al.*

**194 Paleontology**

A parapathecid stem anthropoid of African origin in the Paleogene of South America. *E. R. Seiffert et al.*

PERSPECTIVE p. 136

**197 Neuroscience**

Dopaminylation of histone H3 in ventral tegmental area regulates cocaine seeking

*A. E. Lepack et al.*

PERSPECTIVE p. 134

## DEPARTMENTS

**111 Editorial**

G20 leaders must answer to COVID-19

*By Caroline Atkinson*

**113 Editorial**

Arab women in science

*By Sumaya bint El Hassan*

**206 Working Life**

Finding community during a pandemic

*By Arpit Sharma*

## ON THE COVER



Artist's impression of an anyon collider implemented in a two-dimensional conductor. When colliding on the beamsplitter (at center), fermions (gray) always exit in two different outputs whereas bosons

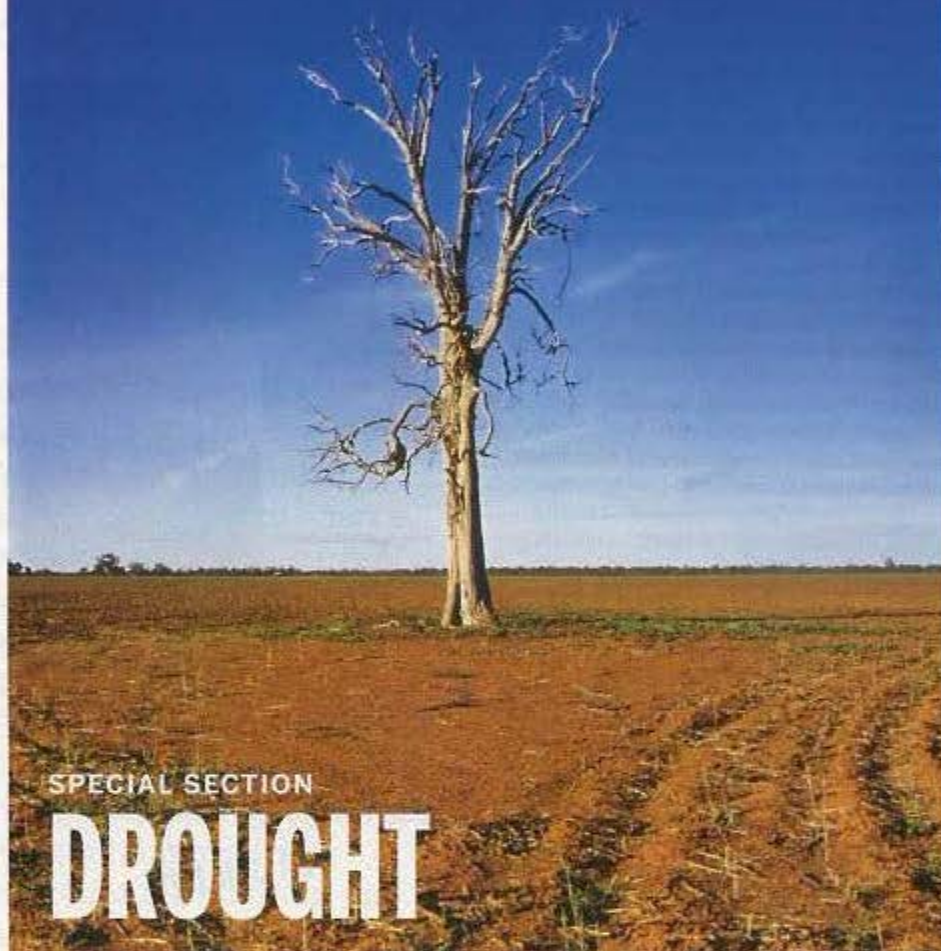
(yellow) always bunch together in the same output. Anyons (orange) display an intermediate behavior, revealing that their fractional statistics interpolate between those of bosons and fermions. See pages 131 and 173. *Illustration: C. Bickel/Science*

Science Staff .....	108
New Products .....	202
Science Careers .....	203

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 494460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership (including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1093624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from back issues: sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

17 APRIL 2020 • VOLUME 368 • ISSUE 6488



SPECIAL SECTION

## DROUGHT

### INTRODUCTION

254 Dry times

### NEWS

226 The hunger forecast. *P. Voosen*

VIDEO

230 Deep deficit. *E. Stokstad*

234 Engineering an empire. *L. Wade*

PODCAST

### REVIEWS

256 On the essentials of drought in a changing climate. *T. R. Ault*

261 Hanging by a thread? Forests and drought. *T. J. Brodribb et al.*

266 The physiology of plant responses to drought. *A. Gupta et al.*

270 Harnessing rhizosphere microbiomes for drought-resilient crop production. *F. T. de Vries et al.*

274 The effects of drinking water service fragmentation on drought-related water security. *M. Mullin*

### ON THE COVER



Famines related to droughts can take a heavy toll. In 2011, dry conditions exacerbated hardships for some 430,000 refugees fleeing violence in Somalia. Here, Somali refugees seek aid in

a camp near Dadaab, Kenya. Scientists are using new monitoring tools to identify regions at risk of famine and help ward off hunger before it is too late. See page 254. Photo: *Jacky Ghossein/The Sydney Morning Herald/Fairfax Media via Getty Images*

PERSPECTIVE p. 238 BOOKS ET AL. p. 250

LETTERS pp. 251 & 252 REPORT p. 314

## NEWS

### IN BRIEF

216 News at a glance

### IN DEPTH

**218 The lockdowns worked—but what comes next?**

Easing the rules while keeping the virus at bay will be a process of trial and error

*By K. Kupferschmidt*

**220 Pandemic carves gaps in long-term field projects**

2020 is becoming the year of missing data for ecological projects and oceanographic cruises. *By E. Pennisi*

**221 From mice to monkeys, animals studied for coronavirus answers**

Infected lab animals can assess drugs and vaccines. *By J. Cohen*

**223 Top EU scientist ousted over plans for coronavirus research**

European Research Council president resigns over spat about agency's role in guiding funding to specific fields. *By N. Wallace*

**224 Ice monitor delivers a bonus: seafloor maps**

Laser aboard NASA ICESat-2 satellite probes reefs and shallows near coastlines

*By P. Voosen*

## INSIGHTS

### PERSPECTIVES

**238 Anthropogenic megadrought**

Human-driven climate warming worsens an otherwise moderate drought. *By D. W. Stahle*

DROUGHT SECTION p. 254; REPORT p. 314

**240 Burning bridges in cancer genomes**

Cytoskeletal forces break chromosomal fusions and trigger mutational avalanches

*By J. Paiano and A. Nussenzweig*

RESEARCH ARTICLE p. 282

**241 Probing metabolism in time and space**

Mass spectrometry imaging detects hotspots of metabolite production within cells

*By T. Alexandrov*

RESEARCH ARTICLE p. 283

**242 Light expands a catalyst's repertoire**

Visible light helps a Pd carbonylation catalyst both break and make carbon-halogen bonds

*By P. Kathe and J. Fleischer*

REPORT p. 318

### 244 Robots with insect brains

A literal approach to mechanistic explanation provides insight in neuroscience *By B. Webb*

### 246 Daniel S. Greenberg (1931–2020)

Incisive science journalist and commentator *By C. Norman*

### POLICY FORUM

#### 247 Deep flaws in a mercury regulatory analysis

The U.S. EPA ignores scientific evidence, economic best practice, and its own guidance *By J. Aldy et al.*

EDITORIAL p. 215

### BOOKS ET AL.

#### 249 Repairing damaged brains

Stem cell therapies slowly gain traction as viable treatments for brain disorders *By A. Woolfson*

#### 250 What tree rings can tell us

From ancient timbers to mountaintop forests, trees hold important climate clues *By L. Daniels*

DROUGHT SECTION p. 254

### LETTERS

#### 251 Protect Indigenous peoples from COVID-19

*By L. Ferrante and P. M. Fearnside*

### 251 Ecosystem aridity and atmospheric CO<sub>2</sub>

*By T. F. Keenan et al.*  
DROUGHT SECTION p. 254

### 252 Response

*By M. Berdugo et al.*  
DROUGHT SECTION p. 254

### 252 Technical Comment abstracts

## RESEARCH

### IN BRIEF

278 From *Science* and other journals

### RESEARCH ARTICLES

#### 281 Biochemistry

The Ccr4-Not complex monitors the translating ribosome for codon optimality *R. Buschauer et al.*  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY6912](https://doi.org/10.1126/SCIENCE.AAY6912)

#### 282 Cancer genomics

Mechanisms generating cancer genome complexity from a single cell division error *N. T. Umbreit et al.*  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABA0712](https://doi.org/10.1126/SCIENCE.ABA0712)  
PERSPECTIVE p. 240

### 283 Biosynthetic enzymes

Metabolomics and mass spectrometry imaging reveal channeled de novo purine synthesis in cells *V. Pareek et al.*  
PERSPECTIVE p. 241

### 290 Gene editing

Unconstrained genome targeting with near-PAMless engineered CRISPR-Cas9 variants *R. T. Walton et al.*

### 297 Gas storage

Balancing volumetric and gravimetric uptake in highly porous materials for clean energy *Z. Chen et al.*

### REPORTS

#### 303 Sex determination

Temperature-dependent sex determination is mediated by pSTAT3 repression of *Kdm6b* *C. Weber et al.*

#### 307 Coral reefs

Meeting fisheries, ecosystem function, and biodiversity goals in a human-dominated world *J. E. Cinner et al.*

#### 311 Topological optics

Topological funneling of light *S. Weidemann et al.*

#### 314 Drought

Large contribution from anthropogenic warming to an emerging North American megadrought *A. P. Williams et al.*  
PERSPECTIVE p. 238; DROUGHT SECTION p. 254

#### 318 Catalysis

A dual light-driven palladium catalyst: Breaking the barriers in carbonylation reactions *G. M. Torres et al.*  
PERSPECTIVE p. 242

### DEPARTMENTS

#### 214 Editorial

The moment to see the poor  
*By Joachim von Braun, Stefano Zamagni, and Marcelo Sánchez Sorondo*

#### 215 Editorial

Earth Day at 50  
*By James Morton Turner and Andrew C. Isenberg*  
POLICY FORUM p. 247

#### 330 Working Life

My career earthquake *By Caitlyn A. Hall*

New Products ..... 324  
Science Careers ..... 325

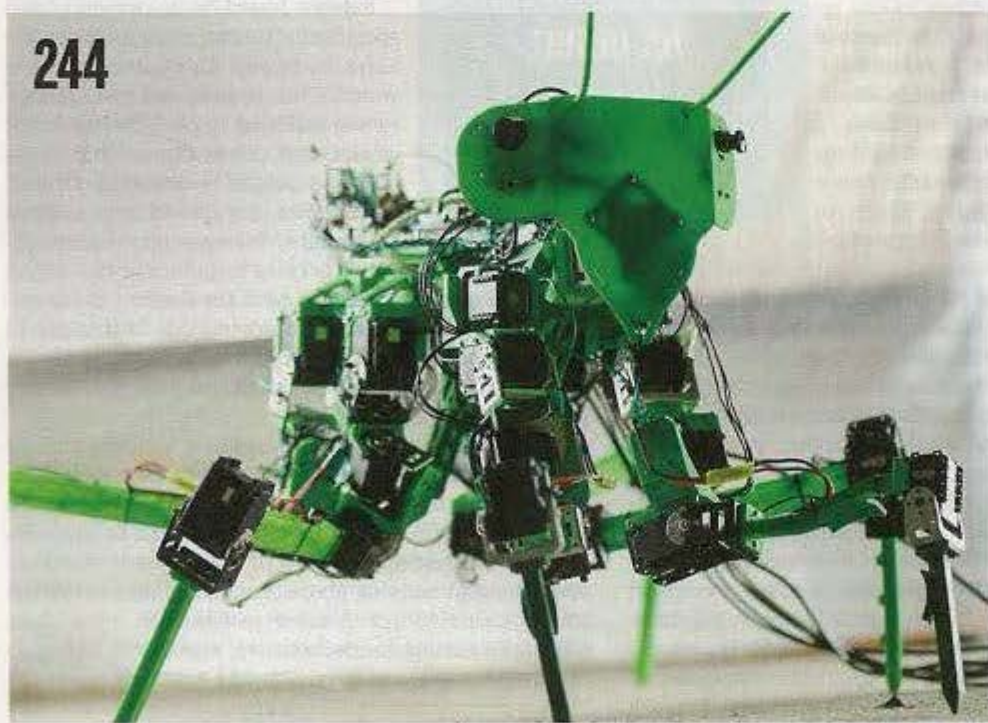


PHOTO: CASE WESTERN RESERVE UNIVERSITY

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 454460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 56178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

## Science



363 & 405

Winds on Venus

24 APRIL 2020 • VOLUME 368 • ISSUE 6489



356

## INSIGHTS

### PERSPECTIVES

#### 362 Mucosal immunity and the eradication of polio

Completing global polio eradication will require a new oral vaccine

By A. N. Donlan and W. A. Petri Jr.

RESEARCH ARTICLE p. 401

#### 363 Super-rotating the venusian atmosphere

Analysis of spacecraft observations deciphers the source of fast atmospheric rotation

By S. Lebonnois

REPORT p. 405

#### 365 Cultivating fungal research

Growing interest in host-fungal interactions has implications for human health and disease

By H. H. Kong and J. A. Segre

#### 367 Next-generation epigenetic inhibitors

Selective bromodomain inhibitors provide new opportunities to modulate transcription

By P. Filippakopoulos and S. Knapp

RESEARCH ARTICLE p. 387

#### 368 Nuanced changes in insect abundance

Trends in insect abundance vary across time, ecosystems, and continents

By M. Dornelas and G. N. Daskalova

REPORT p. 417

#### 369 Calcium as a biased cofactor

Crystal structure of an anti-obesity drug target reveals an important calcium-binding site

By M. Chaturvedi and A. K. Shukla

REPORT p. 428

#### 371 Mary Lowe Good (1931–2019)

Renowned chemist, respected leader, and inspiring mentor

By M. A. Cavanaugh

### POLICY FORUM

#### 372 Dissolved oxygen and pH criteria leave fisheries at risk

Regulations have not kept pace with scientific understanding of coastal hypoxia and acidification

By S. J. Tomasetti and C. J. Gobler

## NEWS

### IN BRIEF

348 News at a glance

### IN DEPTH

#### 350 First antibody surveys draw fire for quality, bias

Some study authors use serology data to call for easing lockdowns, but critics push back

By G. Vogel

#### 351 NIH organizes hunt for drugs

Firms to help prioritize treatment and vaccine trials

By J. Kaiser

#### 352 Indigenous communities in Brazil fear pandemic's impact

Other infections and scant medical care may worsen toll

By I. Amigo

#### 353 Mass screening weighed for type 1 diabetes risk

Studies find benefit to testing thousands of children for antibodies that precede symptoms

By J. Couzin-Frankel

#### 354 Diamond microscope unlocks ancient rocks' magnetic secrets

Quantum sensor reveals clues about plate tectonics, planet formation, and climate change with exquisite resolution

By P. Voosen

SCIENCE ADVANCES RESEARCH ARTICLE BY A. R. BRENNER ET AL. 10.1126/SCIADV.AAZ8670; PODCAST

#### 355 Heat-protected plants offer cool surprise—greater yields

Engineered rice grows better at normal temperatures

By E. Stokstad

### FEATURES

#### 356 A rampage through the body

The lungs are ground zero, but COVID-19 also tears through organ systems from brain to blood vessels

By M. Wadman et al.

#### 359 Survivors' burden

By K. Servick

PODCAST



## BOOKS ET AL.

**374 The trouble with turning to nature**

Our obsession with "natural" products and practices is a proxy for other values  
By S. Camporesi

**375 A history of the metaphorical brain**

Analogies abound and inform our quest to understand the nervous system  
By A. Gomez-Marín

## LETTERS

**376 Retraction**

By C. Sow et al.

**376 Canada's mines pose transboundary risks**

By E. K. Sexton et al.

**377 Investments' role in ecosystem degradation**

By M. G. Ceddia

**377 Response**

By S. Díaz et al.

## RESEARCH

## IN BRIEF

**381** From *Science* and other journals

## REVIEW

**384 Proteostasis**

The integrated stress response:  
From mechanism to disease  
M. Costa-Mattoli and P. Walter

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAT5314

## RESEARCH ARTICLES

**385 Structural biology**

Structural basis of ER-associated protein degradation mediated by the Hrd1 ubiquitin ligase complex  
X. Wu et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AA22449

**386 Ultrafast microscopy**

Ultrafast vector imaging of plasmonic skyrmion dynamics with deep subwavelength resolution  
T. J. Davis et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA6415

**387 Drug discovery**

Selective targeting of BD1 and BD2 of the BET proteins in cancer and immunoinflammation  
O. Gilan et al.

PERSPECTIVE p. 367

**395 Coronavirus**

The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak  
M. Chinazzi et al.

**401 Poliovirus**

Evolving epidemiology of poliovirus serotype 2 following withdrawal of the serotype 2 oral poliovirus vaccine  
G. R. Macklin et al.

PERSPECTIVE p. 362

## REPORTS

**405 Atmospheric physics**

How waves and turbulence maintain the super-rotation of Venus' atmosphere  
T. Harinouchi et al.

PERSPECTIVE p. 353

**409 Coronavirus**

Crystal structure of SARS-CoV-2 main protease provides a basis for design of improved  $\alpha$ -ketoamide inhibitors  
L. Zhang et al.

**413 RNA structure**

Structural basis for transcriptional start site control of HIV-1 RNA fate  
J. D. Brown et al.

**417 Insect populations**

Meta-analysis reveals declines in terrestrial but increases in freshwater insect abundances  
R. van Klink et al.

PERSPECTIVE p. 368

**420 Paleontology**

The spatial structure of Phanerozoic marine animal diversity  
R. A. Close et al.

**424 Protein radicals**

Structure of a trapped radical transfer pathway within a ribonucleotide reductase holocomplex  
G. Kang et al.

**428 Structural biology**

Determination of the melanocortin-4 receptor structure identifies  $Ca^{2+}$  as a cofactor for ligand binding  
J. Yu et al.

PERSPECTIVE p. 369

## DEPARTMENTS

**341 Editorial**

Why WHO?

By H. Holden Thorp

**343 Editorial**

Lost in transition

By Kathleen Newland

**438 Working Life**

Advice for the worried

By Jennifer Kong and Steven Chan

## ON THE COVER



A collection of insects from different orders, representing some of the diversity of species found in North America. A new synthesis of existing data indicates overall declines among terrestrial

insect assemblages but increases among freshwater assemblages. To accommodate as many orders as possible, insect sizes are not shown to scale. See pages 368 and 417.  
Photo: David Liittschwager

Science Staff	342
AAAS News & Notes	379
Science Careers	434

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 494460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (GST allocated to subscribers). Domestic institutional subscription (51 issues): \$2140. Foreign postage extra. Air mail delivery: \$38. First class, annual student and emeritus rates on request. Canadian rates with GST available upon request. GST #R123456789. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96179, Washington, DC 20090-6179. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use, under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

1 MAY 2020 • VOLUME 368 • ISSUE 6490



## NEWS

### IN BRIEF

452 News at a glance

### IN DEPTH

#### 455 The mystery of the pandemic's 'happy hypoxia'

Doctors debate how to treat patients with low blood oxygen but without trouble breathing  
By J. Couzin-Frankel

#### 456 COVID-19 shot protects monkeys

Vaccine from Chinese firm uses old-fashioned "killed" virus  
By J. Cohen

#### 457 Scientists discover upsides of virtual meetings

As the COVID-19 pandemic pushes conferences online, audiences grow  
By M. Price

#### 458 Critics say EPA's 'transparency' rules would favor industry

Agency could consider studies available only by cumbersome Freedom of Information Act requests  
By J. Mervis

#### 459 Carbon dioxide increase may promote 'insect apocalypse'

Study links low-nutrient plants to fewer grasshoppers  
By E. Pennisi

#### 460 Autistic people take the helm of studies

Trend brings new focus on well-being of autistic adults  
By E. Willingham

#### 461 Cancer DNA blood test gets real-world trial

Early detection test spots tumors in 26 women, but also produces false positives  
By J. Kaiser  
PODCAST

### FEATURES

#### 462 The coronavirus czar

The COVID-19 pandemic has made German virologist Christian Drosten an unlikely cult figure  
By K. Kupferschmid

## INSIGHTS

### PERSPECTIVES

#### 466 What future awaits the Sun?

Stellar data question the notion that the Sun is stemming its magnetic activity cycle  
By Á. R. G. Santos and S. Mathur  
REPORT p. 518

#### 467 Profiling prostate biology

Prostate luminal secretory cells can function as facultative stem cells  
By K. Kelly  
RESEARCH ARTICLE p. 497

#### 469 $\pi^0$ decay precision-tests the chiral anomaly

More precise neutral pion lifetime measurements probe quantum symmetry breaking  
By H. B. Meyer  
REPORT p. 506

#### 470 Exercised cytokines promote endurance

Muscle tissue secretory response to exercise promotes beneficial metabolism  
By J. C. Correia and J. L. Ruas  
RESEARCH ARTICLE p. 488

#### 471 Dampening light sensitivity

An inhibitory signal from the retina limits the response to light  
By J. Ding and W. Wei  
REPORT p. 527

#### 473 Cytokine release syndrome in severe COVID-19

Lessons from arthritis and cell therapy in cancer patients point to therapy for severe disease  
By J. B. Moore and C. H. June

#### 475 Philip W. Anderson (1923–2020)

Intellectual giant of condensed matter physics  
By P. A. Lee and N. P. Ong

## POLICY FORUM

**476 Against pandemic research exceptionalism**

Crises are no excuse for lowering scientific standards. *By A. J. London and J. Kimmelman*

## BOOKS ET AL.

**478 Tinctures of time and Schrödinger's virus**

Literature and science converge in a pandemic. *By L. Campos*

**480 The other public health crisis**

Social connection is critical, but many struggle to form and maintain meaningful relationships. *By J. Schug*

## LETTERS

**481 Brazil policy invites marine invasive species**

*By R. J. Miranda et al.*

**481 Brazil threatens indigenous lands**

*By L. Ferrante and P. M. Fearnside*

**482 Call for transparency of COVID-19 models**

*By C. M. Barton et al.*

## 483 Errata

## RESEARCH

## IN BRIEF

**484** From *Science* and other journals

## REVIEW

**487 Antimicrobial peptides**

Antimicrobial peptides: Application informed by evolution. *B. P. Lazzaro et al.*

REVIEW SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAU5480

## RESEARCH ARTICLES

**488 Immunometabolism**

Interleukin-13 drives metabolic conditioning of muscle to endurance exercise

*N. H. Knudsen et al.*

RESEARCH ARTICLE SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAT3987

PERSPECTIVE p. 470

**489 Coronavirus**

Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV-2). *R. Li et al.*

**493 Coronavirus**

The effect of human mobility and control measures on the COVID-19 epidemic in China. *M. U. G. Kraemer et al.*

**497 Tissue regeneration**

Regenerative potential of prostate luminal cells revealed by single-cell analysis. *W. R. Karthaus et al.*

PERSPECTIVE p. 467

## REPORTS

**506 Nuclear physics**

Precision measurement of the neutral pion lifetime. *I. Larin et al.*

PERSPECTIVE p. 469

**510 Nanophotonics**

Three-dimensional cross-nanowire networks recover full terahertz state. *K. Peng et al.*

**513 Catalysis**

Water-promoted interfacial pathways in methane oxidation to methanol on a CeO<sub>2</sub>-Cu<sub>2</sub>O catalyst. *Z. Liu et al.*

**518 Stellar physics**

The Sun is less active than other solar-like stars. *T. Reinhold et al.*

PERSPECTIVE p. 466; PODCAST

**521 Ceramics**

A general method to synthesize and sinter bulk ceramics in seconds. *C. Wang et al.*

**527 Neuroscience**

A noncanonical inhibitory circuit dampens behavioral sensitivity to light. *T. Sonoda et al.*

PERSPECTIVE p. 471

**532 Superconductivity**

Ferromagnetic order beyond the superconducting dome in a cuprate superconductor. *T. Sarkar et al.*

**534 Mesoscopic physics**

Evidence for an edge supercurrent in the Weyl superconductor MoTe<sub>2</sub>. *W. Wang et al.*

## DEPARTMENTS

**445 Editorial**

COVID-19 amidst Ebola's retreat. *By John Ditekemena*

**447 Editorial**

A COVID-19 recovery for climate. *By Daniel Rosenbloom and Jochen Markard*

**542 Working Life**

Clocking your work. *By Anouschka Foltz*

## ON THE COVER



Heat from two carbon strips surrounding an oxide mixture sinters the particles into a dense ceramic composite. Conventional ceramic sintering techniques are limited by long processing times and

poor compositional control. To overcome these constraints, an ultrafast high-temperature sintering method has been developed to fabricate ceramic materials from oxide precursors in ~10 seconds, enabling rapid screening and discovery of high-performance ceramics. See page 521. *Image: Jiaqi Dai and Liangbing Hu*

Science Staff ..... 446  
Science Careers ..... 538

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 494460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R123456789. Publications Mail Agreement Number 1069624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and E-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20009-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.





## SPECIAL SECTION

## EARLY LIFE IMMUNOLOGY

## INTRODUCTION

598 The immune system's first steps

## REVIEWS

600 Prenatal development of human immunity *J.-E. Park et al.*604 Microbial–host molecular exchange and its functional consequences in early mammalian life *S. C. Ganai-Voraburg et al.*608 Contributions of maternal and fetal antiviral immunity in congenital disease *L. J. Yockey et al.*612 Vaccination strategies to enhance immunity in neonates *T. R. Kollmann et al.*

## ON THE COVER



Illustrated mosaic of a mother with child, assembled from various immune cell types. The developing immune system interacts with and is influenced by several factors, including

the mother's cells (and her commensal microbiota) in utero and after birth. This special issue celebrates recent advances in early life immunology, which will help inform strategies to combat both childhood infections and immune disorders in later life. See page 598.

Illustration: Charis Tsevis

## LETTERS

## 594 Research opportunities in pandemic lockdown

By *R. Saraswat and D. A. Saraswat*

## 595 The inherent challenges of classifying senescence

By *A. Zhavoronkov*

## 595 Response

By *S. R. G. Calimport et al.*

## 596 Technical Comment abstracts

## RESEARCH

## IN BRIEF

616 From *Science* and other journals

## RESEARCH ARTICLES

## 619 Coronavirus

Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing *L. Ferretti et al.*

RESEARCH ARTICLE SUMMARY: FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABB6936](https://doi.org/10.1126/SCIENCE.ABB6936)

## 620 Biomedicine

Elesclomol alleviates Menkes pathology and mortality by escorting Cu to cuproenzymes in mice *L. M. Guthrie et al.*

PERSPECTIVE p. 584

## REPORTS

## 626 Ultracold chemistry

Imaging the onset of the resonance regime in low-energy NO–He collisions

*T. de Jongh et al.*

PERSPECTIVE p. 582

## 630 Coronavirus

A highly conserved cryptic epitope in the receptor binding domains of SARS-CoV-2 and SARS-CoV

*M. Yuan et al.*

## 634 Bioinspired robots

Aerodynamic imaging by mosquitoes inspires a surface detector for autonomous flying vehicles

*T. Nakata et al.*

PERSPECTIVE p. 586

## 638 Coronavirus

An investigation of transmission control measures during the first 50 days of the COVID-19 epidemic in China

*H. Tian et al.*

## 642 Colloids

Emergence of complexity in hierarchically organized chiral particles

*W. Jiang et al.*

## 649 Synthetic biology

Light-powered CO<sub>2</sub> fixation in a chloroplast mimic with natural and synthetic parts

*T. E. Miller et al.*

PERSPECTIVE p. 587

## 654 Asteroids

Sample collection from asteroid (162173) Ryugu by Hayabusa2: Implications for surface evolution *T. Morota et al.*

## 660 3D printing

Controlling interdependent meso-nanosecond dynamics and defect generation in metal 3D printing *S. A. Khairallah et al.*

PERSPECTIVE p. 583

## 665 Chemical physics

Intermolecular vibrational energy transfer enabled by microcavity strong light–matter coupling

*B. Xiang et al.*

## DEPARTMENTS

## 551 Editorial

Combination prevention for COVID-19  
By *Myron S. Cohen and Lawrence Corey*

## 553 Editorial

Beat COVID-19 through innovation  
By *Pierre Azoulay and Benjamin Jones*

## 674 Working Life

A Ph.D. on hold—indefinitely  
By *Kara Fikrig*

Science Staff	550
New Products	669
Science Careers	670

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$365 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air airmail delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488322. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

15 MAY 2020 • VOLUME 368 • ISSUE 6492

## Science



700

## NEWS

### IN BRIEF

688 News at a glance

### IN DEPTH

#### 690 As labs move to reopen, safety worries abound

Challenges include reorganizing work spaces and protecting human research subjects *By D. Grimm*

#### 692 U.S. 'Warp Speed' vaccine effort comes out of the shadows

Goal is to vaccinate 300 million Americans by January *By J. Cohen*

#### 693 Pandemic could add noise to clinical trial data

Experimental treatments continue for conditions other than COVID-19, but the outbreak could affect results *By K. Servick*

#### 694 How mountains stir up a hot spot of turbulence

Aircraft finds atmospheric gravity waves bending toward Antarctica's polar vortex *By E. Hand*

#### 695 Growth of cities could boost mosquito-borne diseases

In Africa, *Aedes* mosquitoes predicted to shift from biting animals to humans *By E. Pennisi*

#### 697 Oldest *Homo sapiens* bones found in Europe

Pendants of cave bear teeth spark debate about cultural links to Neanderthals *By A. Gibbons*

#### 699 Antivaccine forces gaining online

Growth of Facebook influence alarms public health experts *By M. Wadman*

### FEATURES

#### 700 An unequal blow

In past pandemics, people on the margins suffered the most *By L. Wade*  
PODCAST

## INSIGHTS

### PERSPECTIVES

#### 704 Mount St. Helens at 40

The hydrogeomorphic legacy from a volcanically battered landscape endures *By J. J. Major*  
EDITORIAL p. 683

#### 706 How interference reveals geometric phase

Quantum phase effects are probed at energies below the H + HD reaction conical intersection *By F. J. Aoiz*  
REPORT p. 767

#### 707 Twisted light on a chip

Compact devices provide new ways to generate and detect optical vortex beams *By L. Ge*  
REPORTS pp. 760 & 763

#### 708 Seismicity from the deep magma system

Deep seismicity may reflect magma cooling beneath volcanoes *By R. S. Matoza*  
REPORT p. 775

#### 710 Incompatibilities between emerging species

Natural hybridization in swordtail fish uncovers cancer genes involved in speciation *By A. J. Dagilis and D. R. Matute*  
RESEARCH ARTICLE p. 731

#### 711 Microclimate shifts in a dynamic world

Disparate rates of micro- and macroclimate warming forge future biodiversity and ecosystems *By J. J. Lembrechts and I. Nijs*  
REPORT p. 772

#### 713 Modeling infectious disease dynamics

The spread of the coronavirus SARS-CoV-2 has predictable features *By S. Cobey*

#### 715 Freeman Dyson (1923–2020)

Brilliant polymath who reshaped quantum physics *By F. Wilczek*

## POLICY FORUM

**716 Policy opportunities to enhance sharing for pandemic research**

COVID-19 reveals gaps in international law that can inhibit timely sharing of information, samples, and sequences *By M. Rourke et al.*

**719 Blockchain-facilitated sharing to advance outbreak R&D**

Technology may help overcome nontechnological barriers *By M. B. van der Waal et al.*

## BOOKS ET AL.

**722 The fantastical lives of fungi**

An ode to an underappreciated life form reminds readers that the mundane can be sublime *By R. Dunn*

**723 Making the ivory tower more inclusive**

Scholars urge graduate programs to do better by women of color *By S. Zárate*

## LETTERS

**724 Impact of COVID-19 on academic mothers**

*By F. Stanislauski et al.*

**724 Support early-career field researchers**

*By D. W. Inouye et al.*

**725 Preserve Global South's research capacity**

*By D. Reidpath et al.*

**725 Technical Comment abstracts**

## RESEARCH

## IN BRIEF

**726** From *Science* and other journals

## REVIEW

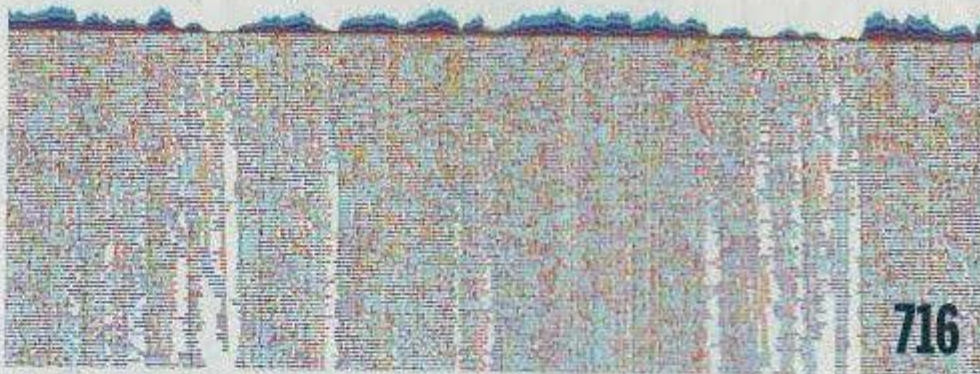
**729 Nitrogen fixation**

Changing perspectives in marine nitrogen fixation *J. P. Zehr and D. G. Capone*  
REVIEW SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY9514

## RESEARCH ARTICLES

**730 Vaccinology**

De novo protein design enables the precise induction of RSV-neutralizing antibodies *F. Sesterhenn et al.*  
RESEARCH ARTICLE SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY9051



716

**731 Hybrid genomics**

Natural hybridization reveals incompatible alleles that cause melanoma in swordtail fish *D. L. Powell et al.*  
PERSPECTIVE p. 710

**736 C–H bond activation**

Diverse functionalization of strong alkyl C–H bonds by undirected borylation *R. Oeschger et al.*

**742 Coronavirus**

Effective containment explains subexponential growth in recent confirmed COVID-19 cases in China *B. F. Maier and D. Brockmann*

**Malaria**

**746** The malaria parasite has an intrinsic clock *F. Rijo-Ferreira et al.*

**754** An intrinsic oscillator drives the blood stage cycle of the malaria parasite *Plasmodium falciparum* *L. M. Smith et al.*

## REPORTS

**Topological optics**

**760** Tunable topological charge vortex microlaser *Z. Zhang et al.*

**763** Photocurrent detection of the orbital angular momentum of light *Z. Ji et al.*  
PERSPECTIVE p. 707

**767 Chemical physics**

Quantum interference in  $H + HD \rightarrow H_2 + D$  between direct abstraction and roaming insertion pathways *Y. Xie et al.*  
PERSPECTIVE p. 706

**772 Forest ecology**

Forest microclimate dynamics drive plant responses to warming *F. Zellweger et al.*  
PERSPECTIVE p. 711

**775 Volcanology**

Deep long-period earthquakes generated by second boiling beneath Mauna Kea volcano *A. G. Wech et al.*  
PERSPECTIVE p. 708; PODCAST

**779 Coronavirus**

Structure of the RNA-dependent RNA polymerase from COVID-19 virus *Y. Gao et al.*

## DEPARTMENTS

**681 Editorial**

Both/and problem in an either/or world *By H. Holden Thorp*

**683 Editorial**

Lessons from the crucible of crisis *By Marcia McNutt*  
PERSPECTIVE p. 704

**786 Working Life**

Branching out as a mentor *By Bob Hickey*

## ON THE COVER



Light shines through the trees of Eilenriede city forest, Hanover, Germany. Increased tree cover reduces below-canopy temperature extremes. This temperature-buffering effect slows local

warming and protects plants against climate change. By contrast, plant community changes are most pronounced in forests where tree cover is reduced over time. These findings will have important implications for forest management and biodiversity conservation. See pages 711 and 772. Photo: *Julian Stratenschulte/DPA/AFP via Getty Images*

New Products ..... 783  
Science Careers ..... 784

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (21 issues): \$2148. Foreign postage extra. Air asset delivery: \$96. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96078, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair-use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

## Science

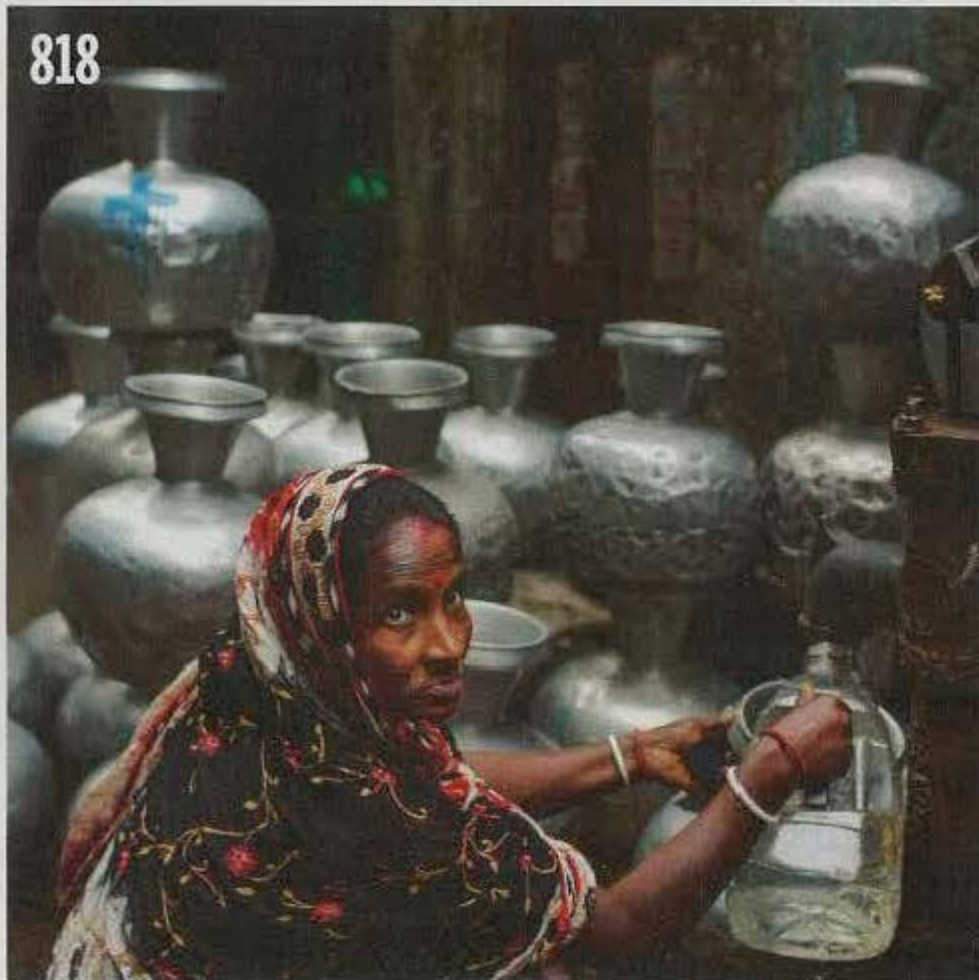


835

Seeking the butterfly's secrets

22 MAY 2020 • VOLUME 368 • ISSUE 6493

818



## NEWS

### IN BRIEF

804 News at a glance

### IN DEPTH

#### 807 Long-acting drug acts like a short-term AIDS vaccine

Simpler than daily pills, injections to prevent HIV infections protect people for 2 months *By J. Cohen*

#### 808 Case clustering emerges as key pandemic puzzle

Why do some patients infect many others, whereas many don't spread the virus at all?

*By K. Kupferschmidt*

#### 809 T cells found in coronavirus patients 'bode well' for long-term immunity

New findings suggest past infections may offer some protection against the novel coronavirus *By M. Leslie*

#### 810 AI systems aim to sniff out coronavirus outbreaks

Alerts would not substitute for on-the-ground sleuthing, experts warn *By A. Cho*

#### 811 Crewed launch deepens ties between NASA and SpaceX

Bold company's rise brings benefits and risks for space science *By A. Mann*

#### 813 Tropical forests store carbon despite warming

But if global temperatures reach key threshold, dying trees will release warming gases *By E. Pennisi*

REPORT P. 869

## FEATURES

### 814 Hard lessons

Carlos Castillo-Chavez trained a record number of minority mathematicians—but his tough-love approach took a toll *By J. Mervis and M. Stellino*

## INSIGHTS

### PERSPECTIVES

#### 818 Global solutions to a silent poison

Modeling arsenic in domestic well water highlights large data gaps in testing

*By Y. Zheng*

REPORT p. 845

#### 820 Tracking both ultrafast electrons and nuclei

Electron diffraction correlates the excited-state decay of pyridine with its ring distortion

*By W. Domcke and A. L. Sobolewski*

REPORT p. 855

#### 821 Solitons and topological waves

A laser-fabricated waveguide array creates a nonlinear medium that supports solitons

*By Mark J. Ablowitz and Justin T. Cole*

REPORT p. 856

#### 822 Breeding a fungal gene into wheat

An ancient cross-kingdom gene transfer enables wheat resistance to a fungal toxin

*By B. B. H. Wulff and J. D. G. Jones*

REPORT p. 844

#### 824 The secret lives of bees as horticulturists?

Pollen-starved bumble bees may manipulate plants to fast-forward flowering

*By L. Chittka*

REPORT p. 881

#### 825 Synchronized to an optical atomic clock

Microwave generation using optical frequency comb technology hits new milestones

*By E. A. Curtis*

REPORT p. 889

#### 827 Restoring vision to the blind

Ideas abound to restore vision to people blinded by retinal disease *By J. E. Dowling*

**829 Rapid repurposing of drugs for COVID-19**

The emergence of a new coronaviral respiratory disease calls for repurposing existing drugs. *By R. K. Guy et al.*

**831 John Horton Conway (1937–2020)**

Innovative mathematician and passionate educator. *By M. Baker*

**POLICY FORUM****832 Ethics of controlled human infection to address COVID-19**

High social value is fundamental to justifying these studies. *By S. K. Shah et al.*

**BOOKS ET AL.****835 Butterflies and the people who love them**

A meandering investigation hints at how much is left to learn about these charismatic insects. *By A. A. Agrawal*

**836 Diversity and the dinner plate**

An intimate exploration of foraged flavors brings nuance to the wild food discussion. *By L. Newman*

**LETTERS****838 China's wild turtles at risk of extinction**

*By J. Wu et al.*

**838 COVID-19 recovery can benefit biodiversity**

*By R. M. Pearson et al.*

**839 COVID-19 spotlights medical diagnostics**

*By M. Jankowski et al.*

**RESEARCH****IN BRIEF**

**840** From *Science* and other journals

**REVIEW****843 Social environment**

Social determinants of health and survival in humans and other animals

*N. Snyder-Mackler et al.*

REVIEW SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.AAX9553

VIDEO

**RESEARCH ARTICLES****844 Plant science**

Horizontal gene transfer of *Fhb7* from fungus underlies *Fusarium* head blight resistance in wheat. *H. Wang et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.ABA5435

PERSPECTIVE p. 822

**845 Water resources**

Global threat of arsenic in groundwater

*J. Podgorski and M. Berg*

PERSPECTIVE p. 818; PODCAST

**850 Device technology**

Aligned, high-density semiconducting carbon nanotube arrays for high-performance electronics

*L. Liu et al.*

REPORTS p. 874 & 878

**REPORTS****856 Topological optics**

Observation of Floquet solitons in a topological bandgap

*S. Mukherjee and M. C. Rechtsman*

PERSPECTIVE p. 821

**860 Coronavirus**

Projecting the transmission dynamics of SARS-CoV-2 through the postpandemic period. *S. M. Kissler et al.*

**869 Tropical forest**

Long-term thermal sensitivity of Earth's tropical forests. *M. J. P. Sullivan et al.*

NEWS STORY p. 813

**Device technology**

**874** Precise pitch-scaling of carbon nanotube arrays within three-dimensional DNA nanotrenches. *W. Sun et al.*

**878** DNA-directed nanofabrication of high-performance carbon nanotube field-effect transistors

*M. Zhao et al.*

RESEARCH ARTICLE p. 850

**881 Pollinators**

Bumble bees damage plant leaves and accelerate flower production when pollen is scarce. *F. G. Pashalidou et al.*

PERSPECTIVE p. 824

**885 Chemical physics**

Simultaneous observation of nuclear and electronic dynamics by ultrafast electron diffraction. *J. Yang et al.*

PERSPECTIVE p. 820

**889 Metrology**

Coherent optical clock down-conversion for microwave frequencies with  $10^{-16}$  instability. *T. Nakamura et al.*

PERSPECTIVE p. 825

**893 Structural biology**

Ion transport and regulation in a synaptic vesicle glutamate transporter. *F. Li et al.*

**897 Cell biology**

Supramolecular attack particles are autonomous killing entities released from cytotoxic T cells. *S. Bálint et al.*



906

**DEPARTMENTS****797 Editorial**

Suspend tests and rankings. *By H. Holden Thorp*

**906 Working Life**

An end and a beginning. *By Logan Brenner*

**ON THE COVER**

*Fusarium graminearum* fungus (orange) growing in a wheat spikelet. The disease *Fusarium* head blight (FHB; also known as wheat scab) threatens the world's wheat supply by reducing grain yield and quality. Researchers

have isolated a gene from wheatgrass (*Thinopyrum elongatum*), a wild relative of cultivated wheat, that decreases *Fusarium* infection and detoxifies mycotoxins in wheat grains. This gene can be introduced to wheat cultivars through breeding to minimize FHB-related losses. See pages 822 and 844. *Photo: Qihui Chen/Jiayang Agricultural Bureau*

Science Staff ..... 794  
Science Careers ..... 902

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484450) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$365 (\$34 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

## Science

29 MAY 2020 • VOLUME 368 • ISSUE 6494



## NEWS

### IN BRIEF

920 News at a glance

### IN DEPTH

#### 922 Scientists put survivors' blood plasma to the test

Randomized trials are underway after small studies suggest transfusions can save lives. *By K. Kupferschmidt*

#### 923 Doctors race to understand inflammatory condition in kids

Studies are launching to pinpoint children most at risk. *By J. Couzin-Frankel*

PODCAST

#### 924 New tools aim to tame pandemic paper tsunami

Researchers harness AI and old-fashioned expertise to glean findings, but face challenges. *By J. Brainard*

#### 926 UV radiation blamed in ancient mass extinction

Malformed spores suggest powerful storms drove ozone loss as climate warmed. *By P. Voosen*

SCIENCE ADVANCES RESEARCH ARTICLE BY J. E. A. MARSHALL ET AL. 10.1126/SCIADV.ABA0768

#### 927 Core progress in AI has stalled in some fields

When tuned up, old algorithms can match the abilities of their successors. *By M. Hutson*

#### 928 Sick chinchillas languish at farms that supply researchers

Years of animal welfare violations documented by USDA. *By M. Wadman*

### FEATURES

#### 930 Forced into battle

Bispecific antibodies unleash T cells against cancer by physically tethering them to tumor cells. *By J. Kaiser*

## INSIGHTS

### PERSPECTIVES

#### 934 Exotic plants get a little help from their friends

Interactions with herbivores and microbes link exotic-plant success with carbon cycling. *By C. Urcelay and A. T. Austin*

RESEARCH ARTICLE p. 967

#### 936 Remote activation of cellular signaling

Electric fields stimulate genetically modified pancreatic  $\beta$  cells to secrete insulin in mice. *By M. I. Brier and J. S. Dordick*

RESEARCH ARTICLE p. 993

#### 938 Probing the tumor micro(b)environment

Bacteria are widespread in tumors, are found within cells, and differ by cancer type. *By C. E. Atreya and P. J. Turnbaugh*

RESEARCH ARTICLE p. 973

#### 939 Tracking the rapid pace of a retreating ice sheet

Seafloor mapping shows that Antarctic ice sheets retreated faster during the last deglaciation than today. *By M. Jakobsson*

REPORT p. 1020

#### 941 Catching up to nature's ribosomes

Flow chemistry enables total chemical synthesis of proteins without solution-phase ligation. *By C. Proulx*

RESEARCH ARTICLE p. 980

#### 942 The search for a COVID-19 animal model

A comparison of SARS CoV-2 replication, transmission, and disease in mice to monkeys. *By S. S. Lakdawala and V. D. Menachery*

REPORTS pp. 1012 & 1016

#### 943 Killer cells add fire to fuel immunotherapy

Cytotoxic lymphocytes induce inflammatory target cell death, amplifying antitumor immunity. *By C. J. Nicolai and D. H. Raulet*

REPORT p. 965

## 945 Rapid COVID-19 vaccine development

Finding the fastest pathway to vaccine availability includes the avoidance of safety pitfalls. *By B. S. Graham*

## 947 Eleanor Margaret Burbridge (1919–2020)

Astronomer, astrophysicist, and champion of gender equality. *By A. Boksenberg*

## POLICY FORUM

### 948 A strategic approach to COVID-19 vaccine R&D

A public-private partnership and platform for harmonized clinical trials aims to accelerate licensure and distribution. *By L. Corey et al.*

### 951 Ethics and governance for digital disease surveillance

The question is not whether to use new data sources but how. *By M. M. Mello and C. J. Wang*

## BOOKS ET AL.

### 955 Revisiting rights in an ever-evolving world

Data and genetic policy join proposed privileges for nonhumans, robots, and nature. *By D. Greenbaum*

### 956 The will to act when the data are dire

Then and now, American politicians have failed to heed scientific warnings. *By E. L. Milam*

## LETTERS

### 957 Ease restrictions on U.S. blood donations

*By C. Vasavda et al.*

### 957 The precarious position of postdocs during COVID-19

*By M. A. Ahmed et al.*

### 958 Sumatran rhinoceros on the brink of extinction

*By S. S. Lam et al.*

### 958 Technical Comment abstracts

# RESEARCH

## IN BRIEF

961 From Science and other journals

## REVIEW

### 964 Forest ecology

Pervasive shifts in forest dynamics in a changing world. *N. G. McDowell et al.*

REVIEW SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAZ9463](https://doi.org/10.1126/SCIENCE.AAZ9463)

## RESEARCH ARTICLES

### 965 Immunology

Granzyme A from cytotoxic lymphocytes cleaves GSDMB to trigger pyroptosis in target cells. *Z. Zhou et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAZ7548](https://doi.org/10.1126/SCIENCE.AAZ7548)  
PERSPECTIVE p. 943

### 966 Magnetism

Self-induced spin glass state in elemental and crystalline neodymium. *U. Kamber et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY6757](https://doi.org/10.1126/SCIENCE.AAY6757)

### 967 Invasive species

Biotic interactions drive ecosystem responses to exotic plant invaders. *L. P. Waller et al.*

PERSPECTIVE p. 934

### 973 Cancer

The human tumor microbiome is composed of tumor type-specific intracellular bacteria. *D. Nejman et al.*

PERSPECTIVE p. 938

### 980 Peptide synthesis

Synthesis of proteins by automated flow chemistry. *N. Hartrampf et al.*

PERSPECTIVE p. 941

### 988 Ocean circulation

Strengthening of the Kuroshio current by intensifying tropical cyclones. *Y. Zhang et al.*

### 993 Synthetic biology

Electrogenetic cellular insulin release for real-time glycemic control in type 1 diabetic mice. *K. Krawczyk et al.*

PERSPECTIVE p. 936

## REPORTS

### 1002 Separations

Control of zeolite pore interior for chemoselective alkyne/olefin separations. *Y. Chai et al.*

### 1007 Organic chemistry

Total synthesis of bryostatin 3. *B. M. Trost et al.*

## Coronavirus

1012 Comparative pathogenesis of COVID-19, MERS, and SARS in a nonhuman primate model. *B. Rockx et al.*

1016 Susceptibility of ferrets, cats, dogs, and other domesticated animals to SARS-coronavirus 2. *J. Shi et al.*

PERSPECTIVE p. 942

## 1020 Ice sheets

Delicate seafloor landforms reveal past Antarctic grounding-line retreat of kilometers per year. *J. A. Dowdeswell et al.*

PERSPECTIVE p. 939; PODCAST

## DEPARTMENTS

### 919 Editorial

COVID-19 research in Africa

*By Linda-Gail Bekker and Valerie Mizrahi*

### 1026 Working Life

You never know until you try. *By Tess Torregrosa*

## ON THE COVER



Illustration of bacteria in tissue sections from multiple human tumor types. Bacteria are frequently found in tumors, and different tumor types have distinct microbial compositions, as represented here by the different colors of

bacteria. The image also reflects the observed intracellular localization of tumor bacteria, mostly inside cancer and immune cells. Future studies will explore the role of these bacteria in tumor development and treatment response. See pages 938 and 973. *Illustration: V. Altounian/Science*

Science Staff .....	916
AAAS News & Notes .....	959
Science Careers .....	1025

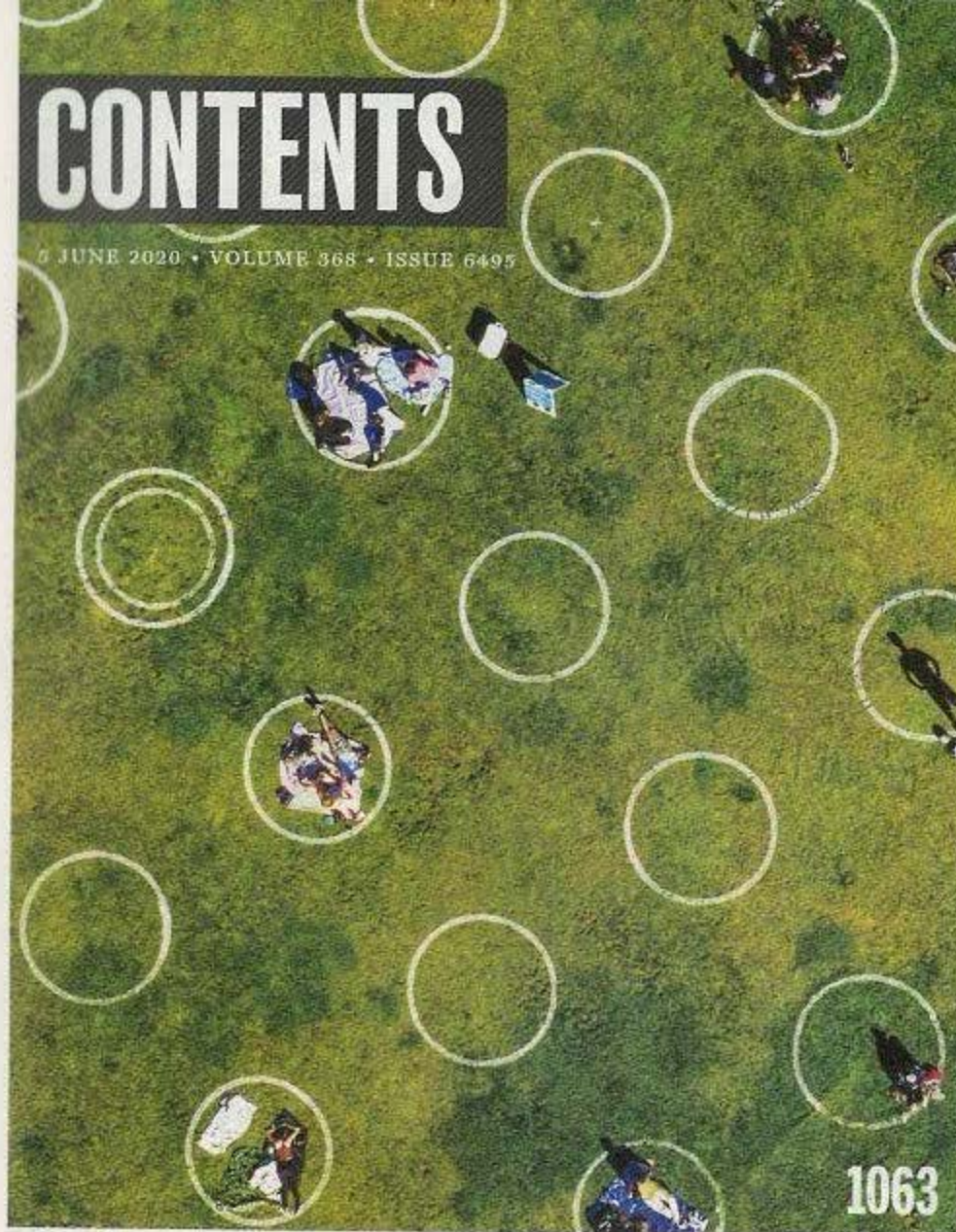


SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484450) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$248. Foreign postage extra: Air airmail delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069524. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

5 JUNE 2020 • VOLUME 368 • ISSUE 6495



1063

## NEWS

### IN BRIEF

1036 News at a glance

### IN DEPTH

1038 **Sex hormones signal why virus hits men harder**

Emerging role of androgens suggests potential therapies to suppress infection *By M. Wadman*  
PODCAST

1039 **Blood vessel injury may spur disease's fatal second phase**

Damage to vessel lining may drive mysterious clotting disorders, inflammation  
*By C. Maticic*

1041 **The pandemic's first major research scandal erupts**

Critics question patient data used to challenge malaria drugs *By K. Servick and M. Enserink*

1042 **Shattered natural history museums fight for survival**

But creative scientists vow recovery and move research and public programs online *By E. Pennisi*

1044 **Europe bets R&D spending will bring jobs to battered economy**

Horizon Europe gets €13.5 billion to spend fast, spur growth  
*By N. Wallace*

1045 **Bill would supersize NSF's budget—and role**

Legislation calls for \$100 billion increase, new technology directorate, and new name  
*By J. Mervis*

### FEATURES

1046 **Double trouble**

The brightest supernovae, used as cosmic yardsticks, have an unexpected trigger: pairs of dead stars *By D. Clery*

## INSIGHTS

### PERSPECTIVES

1050 **Blue carbon from the past forecasts the future**

Coastal mangrove ecosystems must rise above sea level to survive *By C. E. Lovelock*  
REPORT p. 1118

1052 **The specifics of innate immune memory**

Innate immune cells develop specific memory involved in transplant rejection in mice  
*By J. Domínguez-Andrés and M. G. Netea*  
REPORT p. 1122

1053 **Testicular-borne factors affect sperm fertility**

Immature testicular germ cells secrete factors that influence sperm maturation in mice  
*By T. Lord and J. M. Oatley*  
REPORT p. 1132

1055 **Deep-ocean seafloor islands of plastics**

The processes controlling sediment transport also concentrate microplastics *By D. Mohrig*  
REPORT p. 1140

1056 **The link between electrolytes and metals**

Photoelectron spectroscopy maps a gradual transition for solvated electrons in ammonia *By C. M. Isborn*  
RESEARCH ARTICLE p. 1086

1057 **Unblinding with infrared nanosensors**

Gene therapy and nanotechnology come together to fight degenerative blindness  
*By K. Franke and A. Vlasits*  
REPORT p. 1108

1058 **Follow the barcoded microbes**

Genetically engineered spores give object provenance technology new avenues  
*By J. Nivala*  
REPORT p. 1135

1060 **Serology assays to manage COVID-19**

Measurement of antibodies to SARS-CoV-2 will improve disease management if used correctly  
*By F. Krammer and V. Simon*

1062 **Donald Kennedy (1931–2020)**

Eminent public intellectual who served science and society *By G. C. Daily and P. R. Ehrlich*

### POLICY FORUM

1063 **Which interventions work best in a pandemic?**

We can exploit randomized controlled trials, compartmental models, and spillovers  
*By J. Haushofer and C. J. E. Metcalf*



1071

### 1066 Filling gaps in science exposes gaps in chemical regulation

Examination of U.S. and EU regulatory systems raises more questions than answers  
By S. C. Gold and W. E. Wagner  
REPORT p. 1103

### BOOKS ET AL.

#### 1071 Colonialism and its consequences

A ravaged Arctic ecosystem serves as a warning of the perils of human advancement  
By M. E. Hannibal

#### 1072 Where logic meets emotion

A computer scientist gets candid about her quest to bring empathy to artificial intelligence  
By V. Venkatraman

### LETTERS

#### 1074 Recovery hopes for the world's rarest primate

By H. Liu et al.

#### 1074 Cetaceans under threat in South China Sea

By S. Li et al.

#### 1075 Tenure and promotion after the pandemic

By M. Htun

#### 1075 Technical Comment abstracts

## RESEARCH

### IN BRIEF

1076 From *Science* and other journals

### REVIEW

#### 1079 Computer science

There's plenty of room at the Top: What will drive computer performance after Moore's law?  
C. E. Leiserson et al.

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAM9744

### RESEARCH ARTICLES

#### 1080 Plasmid evolution

Unexpected conservation and global transmission of agrobacterial virulence plasmids  
A. J. Weisberg et al.  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA5256

#### 1081 Structural biology

The structure of human CST reveals a decameric assembly bound to telomeric DNA  
C. J. Lim et al.

#### 1086 Chemical physics

Photoelectron spectra of alkali metal-ammonia microjets: From blue electrolyte to bronze metal  
T. Buttersack et al.  
PERSPECTIVE p. 1056

#### 1091 Wearable devices

Giant thermopower of ionic gelatin near room temperature  
C.-G. Han et al.

### REPORTS

#### 1098 Organic chemistry

Iridium-catalyzed acid-assisted asymmetric hydrogenation of oximes to hydroxylamines  
J. Mas-Roselló et al.

#### 1103 Analytical chemistry

Nontargeted mass-spectral detection of chloroperfluoropolyether carboxylates in New Jersey soils  
J. W. Washington et al.  
POLICY FORUM p. 1066

#### 1108 Neuroscience

Restoring light sensitivity using tunable near-infrared sensors  
D. Nelidova et al.  
PERSPECTIVE p. 1057

#### 1114 Topological optics

A fractional corner anomaly reveals higher-order topology  
C. W. Peterson et al.

#### 1118 Paleocology

Thresholds of mangrove survival under rapid sea level rise  
N. Saintilan et al.  
PERSPECTIVE p. 1050

#### 1122 Immunology

PIRs mediate innate myeloid cell memory to nonself MHC molecules  
H. Dai et al.  
PERSPECTIVE p. 1052

#### 1127 Cancer

MTOR signaling orchestrates stress-induced mutagenesis, facilitating adaptive evolution in cancer  
A. Cipponi et al.

#### 1132 Reproductive biology

NELL2-mediated lumicrine signaling through OVCH2 is required for male fertility  
D. Kiyozumi et al.  
PERSPECTIVE p. 1053

#### 1135 Molecular biology

Barcoded microbial system for high-resolution object provenance  
J. Qian et al.  
PERSPECTIVE p. 1058; PODCAST

#### 1140 Plastic pollution

Seafloor microplastic hotspots controlled by deep-sea circulation  
J. A. Kane et al.  
PERSPECTIVE p. 1055

### DEPARTMENTS

#### 1035 Editorial

Patents, economics, and pandemics  
By Will Zerhouni et al.

#### 1150 Working Life

No place like home  
By Guilherme Santos

### ON THE COVER



Artistic abstraction of how ammonia solutions change with increasing excess electron concentration. Microjets of liquid ammonia can be used to track how an electrically insulating liquid becomes a metal,

with an accompanying color change from transparent blue through deeper blue to bronze. Mapping energy levels spectroscopically and theoretically reveals a gradual transition from electrolyte to liquid metal. See pages 1056 and 1086.

Illustration: C. Bickel/Science

Science Staff .....1034  
New Products .....1146  
Science Careers .....1147

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request, GST #125488122. Publications Mail Agreement Number 1069524. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling, available from back issues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.



# CONTENTS

12 JUNE 2020 • VOLUME 368 • ISSUE 6496

1174

## NEWS

### IN BRIEF

1164 News at a glance

### IN DEPTH

#### 1166 Big studies dim hopes for hydroxychloroquine

Amid politicization and scandal, a disappointing scientific picture is emerging  
By K. Kupferschmidt

#### 1167 Authors, elite journals under fire after major retractions

Editors, co-authors missed warning signs, critics say  
By C. Piller and J. Travis

#### 1169 Coronavirus rips through Dutch mink farms, triggering culls

Public concerns rise as two workers catch the disease  
By M. Enserink

#### 1170 Vaccines that use human fetal cells draw fire

Abortion opponents urge United States and Canada to avoid "ethically-tainted" cell lines  
By M. Wadman

#### 1171 Galactic flash points to source of enigmatic fast radio bursts

CHIME telescope catches burst generated by a highly magnetized neutron star in the Milky Way  
By D. Clery

#### 1172 Prominent Harvard anthropologist put on leave

Three former students accuse Inca scholar Gary Urton, alleging propositions or "traumatic" affairs  
By A. Gibbons

### FEATURES

#### 1174 Computing cancer's weak spots

An algorithm to unmask tumors' molecular linchpins is tested in patients  
By R. Khamisi

## INSIGHTS

### PERSPECTIVES

#### 1178 Costs and benefits of living with predators

Integrating ecology and economics reveals a net monetary benefit from sea otters  
By J. A. Estes and L. P. Carswell  
REPORT p. 1243

#### 1180 CRISPR at lightning speeds

Breaking the genome with the flick of a (light) switch  
By D. Medhi and M. Jasin  
REPORT p. 1265

#### 1181 Electrification of the chemical industry

Performing chemical synthesis with renewable electricity can reduce carbon emissions  
By J. L. Barton  
REPORT p. 1228

#### 1183 Mapping Earth's deepest secrets

Sequencing seismograms pinpoint new structures near Earth's core-mantle boundary  
By M. S. Miller  
REPORT p. 1223

#### 1184 The global odyssey of plastic pollution

Thinking big about small particles reveals new features of the microplastic cycle  
By C. M. Rochman and T. Hoellein  
REPORT p. 1257

#### 1185 A gene for color differences between sexes

Sex differences in plumage color in hybrid canaries are controlled by a single enzyme  
By N. Chen  
REPORT p. 1270

#### 1187 Can existing live vaccines prevent COVID-19?

Live vaccines can prevent unrelated infections and may temporarily protect against COVID-19  
By K. Chumakov et al.

#### 1189 Lord Robert May (1936–2020)

Pioneering ecologist and a founder of chaos theory  
By H. C. J. Godfray and A. R. McLean

### POLICY FORUM

#### 1190 Moving academic research forward during COVID-19

A gradual, stepwise approach to reopening, informed by public health expertise, will be essential  
By N. S. Wigginton et al.

#### 1193 A biodiversity target based on species extinctions

A single target comparable to the 2°C climate target may help galvanize biodiversity policy  
By M. D. A. Rounsevell et al.

### BOOKS ET AL.

#### 1196 Discounting lives

Are COVID-19 deaths "sacrifices"? If so, to what?  
By A. J. Wolfe

#### 1197 Labeling fish, labeling people

A science reporter grapples with an ichthyologist's all-consuming passion for categorization  
By E. Landau

## LETTERS

### 1198 Saving the Sundarbans from development

By S. A. Mukul et al.

### 1198 Aggregating data from COVID-19 trials

By E. L. Ogburn et al.

### 1199 Brazil undermines parks by relocating staff

By P. R. Gonçalves et al.

## RESEARCH

### IN BRIEF

1201 From *Science* and other journals

### REVIEW

#### 1204 Neuroscience

Linking glutamate receptor movements and synapse function *L. Groc and D. Choquet*  
REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY4631

### RESEARCH ARTICLES

#### 1205 Cell biology

Membrane-proximal F-actin restricts local membrane protrusions and directs cell migration *A. Bisaria et al.*

#### 1211 Structural biology

Structures of cell wall arabinosyltransferases with the anti-tuberculosis drug ethambutol *L. Zhang et al.*

### REPORTS

#### 1219 Nanophotonics

Far-field excitation of single graphene plasmon cavities with ultracompressed mode volumes *I. Epstein et al.*

#### 1223 Geophysics

Sequencing seismograms: A panoptic view of scattering in the core-mantle boundary region *D. Kim et al.*  
PERSPECTIVE p. 1183

#### 1228 Electrochemistry

Chloride-mediated selective electrosynthesis of ethylene and propylene oxides at high current density *W. R. Leow et al.*  
PERSPECTIVE p. 1181

#### 1234 Mesoscopic physics

$h/e$  oscillations in interlayer transport of delafossites *C. Putzke et al.*



#### 1239 Ice sheets

Pervasive ice sheet mass loss reflects competing ocean and atmosphere processes *B. Smith et al.*

#### 1243 Ecological economics

Cascading social-ecological costs and benefits triggered by a recovering keystone predator *E. J. Gregr et al.*  
PERSPECTIVE p. 1178; PODCAST

#### 1247 Molecular machines

A precise polyrotaxane synthesizer *Y. Qiu et al.*

#### 1253 Protein folding

Disordered proteins follow diverse transition paths as they fold and bind to a partner *J.-Y. Kim and H. S. Chung*

#### 1257 Plastic pollution

Plastic rain in protected areas of the United States *J. Brahney et al.*  
PERSPECTIVE p. 1184

#### 1261 Cell cycle

Temporal integration of mitogen history in mother cells controls proliferation of daughter cells *M. Min et al.*

#### 1265 Biotechnology

Very fast CRISPR on demand *Y. Liu et al.*  
PERSPECTIVE p. 1180

#### 1270 Sexual dimorphism

A genetic mechanism for sexual dichromatism in birds *M. A. Gazda et al.*  
PERSPECTIVE p. 1185

#### 1274 Coronavirus

A noncompeting pair of human neutralizing antibodies block COVID-19 virus binding to its receptor ACE2 *Y. Wu et al.*

### DEPARTMENTS

#### 1168 Editorial

Time to look in the mirror *By H. Holden Thorp*

#### 1163 Editorial

COVID-19 and flu, a perfect storm  
*By Edward A. Belongia and Michael T. Osterholm*

#### 1282 Working Life

Helping others—and myself  
*By Moamen M. Elmassy*

### ON THE COVER



Male (left) and female (right) canaries (*Serinus canaria*) exhibiting sexual dichromatism—i.e., color difference between sexes. These mosaic canaries were created by crossing common canaries with red siskins and selecting

the progeny for sexual dichromatism. The pronounced differences in plumage coloration are driven by a single gene that mediates sexual dichromatism in birds. See pages 1185 and 1270. Photo: Ricardo Jorge Lopes

Science Staff ..... 1160  
Science Careers ..... 1279

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (Publication No. 484-660) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2348; foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org, bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the *Rivista di Letteratura* and in several specialized indexes.

# CONTENTS

19 JUNE 2020 • VOLUME 368 • ISSUE 6497

Science

1302

## NEWS

### IN BRIEF

1292 News at a glance

### IN DEPTH

**1295 Pandemic vaccines are about to face the real test**

U.S. and global efforts are taking different approaches to key efficacy trials of candidates *By J. Cohen*

**1296 Can phone apps slow the spread of the coronavirus?**

Digital contact tracing is growing—and facing its first real-world tests *By K. Servick*

**1298 U.S. academic research funding stays healthy despite pandemic**

Labs reopening even as campuses struggle

*By J. Mervis*

PODCAST

**1299 Incest in ancient Ireland suggests an elite ruled early farmers**

DNA from massive Newgrange tomb reveals a practice linked to royalty around the world

*By A. Curry*

**1300 New tensions dim hopes for salvaging Iran nuclear deal**

Monitoring agency seeks clarity about clandestine R&D *By R. Stone*

**1301 NIH requires disclosure about sexual harassment by grantees**

Changes aimed in part at making sure institutions don't "pass the harassment" *By J. Kaiser*

### FEATURES

**1302 Weather makers**

Forests supply the world with rain. A controversial Russian theory claims they also make wind. *By F. Pearce*

## INSIGHTS

### PERSPECTIVES

**1306 The origins of flowering plants and pollinators**

New research raises questions about when flowering plants and their pollinators evolved *By C. J. van der Kooij and J. Ollerton*

**1309 Perovskite solar cells take a step forward**

A new encapsulation technique helps move a photovoltaic toward commercialization

*By E. J. Juarez-Perez and M. Haro*

RESEARCH ARTICLE p. 1328

**1310 Dating the emergence of human pathogens**

Ancient genomes can narrow the search for the sources of zoonotic transmissions

*By S. Y. W. Ho and S. Duchêne*

REPORT p. 1367

**1311 Getting a grip on touch receptors**

Meissner corpuscles are anatomically complex mechanosensors critical for tactile acuity

*By H. Marshall and A. Patapoutian*

RESEARCH ARTICLE p. 1330

**1312 Closing the radical gap in chemical synthesis**

Unstable radical intermediates are harnessed in a microfluidic electrochemical cell *By J.-Q. Liu et al.*

REPORT p. 1352

**1314 Drug modulation by nuclear condensates**

Concentration of antineoplastic agents into spatial compartments influences activity *By A. D. Viny and R. L. Levine*

REPORT p. 1386

**1315 Using information theory to decode network coevolution**

Communication clashes shape the coevolution of insect-plant ecosystems *By R. Solé*

REPORT p. 1377

### POLICY FORUM

**1317 Understanding persistent gender gaps in STEM**

Does achievement matter differently for men and women?

*By Joseph R. Cimpian et al.*

PHOTO: BRUNO AURELIEN HEMISALAMY/STOCK PHOTO

## BOOKS ET AL.

**1320 Creating a culture of change**

Urging action, a new film paints a harrowing portrait of female scientists' experiences in academia *By D. Riley*

**1321 What to do with our days**

When wielded correctly, boredom can be a powerful tool *By E. Westgate*

## LETTERS

**1322 Academic societies' role in curbing police brutality**

*By P. Phillips and M. B. Weissman*

**1322 Pandemics' historical role in creating inequality**

*By L. M. Dávalos et al.*

**1323 Recent immigrants at increased pandemic risk**

*By P. Galanaud and A. Galanaud*

## RESEARCH

## IN BRIEF

**1324** From Science and other journals

## REVIEW

**1327 Forest and climate**

Climate-driven risks to the climate mitigation potential of forests *W. R. L. Anderegg et al.*

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAZ7005

## RESEARCH ARTICLES

**1328 Solar cells**

Gas chromatography–mass spectrometry analyses of encapsulated stable perovskite solar cells *L. Shi et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA2412  
PERSPECTIVE p. 1309

**1329 Neuroscience**

Manipulating synthetic optogenetic odors reveals the coding logic of olfactory perception *E. Chong et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA2357

**1330 Neuroscience**

Meissner corpuscles and their spatially intermingled afferents underlie gentle touch perception *N. L. Neubarth et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB2751  
PERSPECTIVE p. 1311

**1331 Coronavirus**

Structure-based design of antiviral drug candidates targeting the SARS-CoV-2 main protease *W. Dai et al.*

**1335 Influenza**

Different genetic barriers for resistance to HA stem antibodies in influenza H3 and H1 viruses *N. C. Wu et al.*

**1341 Biodiversity change**

Landscape-scale forest loss as a catalyst of population and biodiversity change *G. N. Daskalova et al.*

## REPORTS

**1347 Metallurgy**

Making ultrastrong steel tough by grain-boundary delamination *L. Liu et al.*

**1352 Electrochemistry**

Microfluidic electrochemistry for single-electron transfer redox-neutral reactions *Y. Mo et al.*

PERSPECTIVE p. 1312

**1357 Geophysics**

3D fault architecture controls the dynamism of earthquake swarms *Z. E. Ross et al.*

**1362 Coronavirus**

Rapid implementation of mobile technology for real-time epidemiology of COVID-19 *D. A. Drew et al.*

**1367 Measles**

Measles virus and rinder pest virus divergence dated to the sixth century BCE *A. Düx et al.*

PERSPECTIVE p. 1310

**1371 Immunometabolism**

T cells with dysfunctional mitochondria induce multimorbidity and premature senescence *G. Desdin-Micó et al.*

**1377 Chemical ecology**

Information arms race explains plant-herbivore chemical communication in ecological communities *P. Zu et al.*

PERSPECTIVE p. 1315

**1381 Metalloenzymes**

Structural evidence for a dynamic metallocofactor during N<sub>2</sub> reduction by Mo-nitrogenase *W. Kang et al.*

**1386 Phase separation**

Partitioning of cancer therapeutics in nuclear condensates *I. A. Klein et al.*

PERSPECTIVE p. 1314

## DEPARTMENTS

**1290 Editorial**

COVID-19 and cancer *By Norman E. Sharpless*

**1291 Editorial**

Combating sexual harassment *By Carrie D. Wolinetz, Michael S. Lauer, Francis S. Collins*

**1394 Working Life**

Undergrads in charge *By Akira Nishii*

## ON THE COVER



Upon infection, SARS-CoV-2 (blue) uses host machinery to produce polyproteins for replication. The viral main protease (yellow) plays a key role in polyprotein cleavage and thus is a potential drug target.

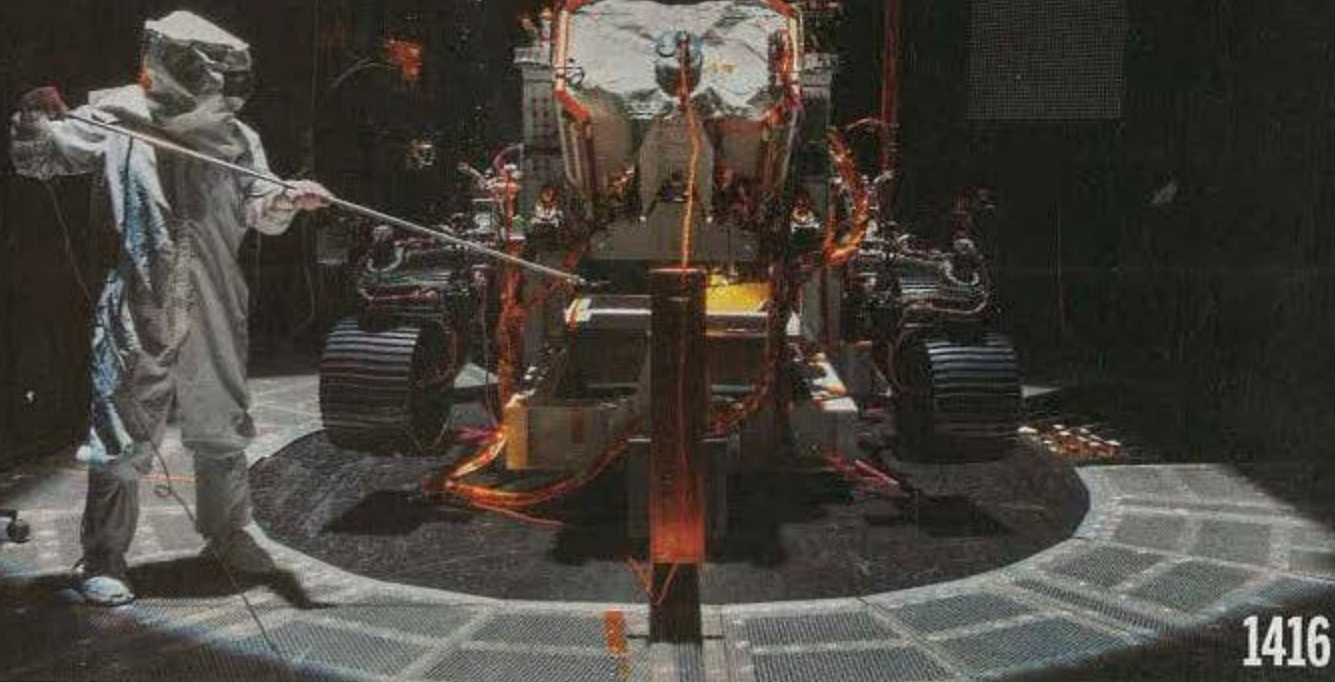
Researchers have designed two antiviral compounds that inhibit activity of the main protease to prevent viral replication. Preclinical studies show that these compounds are promising therapeutic candidates. See page 1331. *Illustration: C. Bickel/Science; Data: PDB ID 6MOK (SARS-CoV-2 main protease)*

Science Careers ..... 1393

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (24 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488322. Publications Mail Agreement Number 1068624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

26 JUNE 2020 • VOLUME 368 • ISSUE 6498



1416

## NEWS

### IN BRIEF

1406 News at a glance

### IN DEPTH

#### 1408 Hope grows for targeting the brain with ultrasound

Noninvasive method of tweaking neural activity enters new tests in human *By K. Servick*

#### 1409 Lawsuit alleges scientific misconduct at weapons lab

Dispute underscores the challenges of using simulations to "test" warheads *By A. Cho*

#### 1411 Dawn of the chicken revealed in Southeast Asia

Chicken domestication—debated since Charles Darwin—tracked by genomic survey *By A. Lawler*

#### 1412 Charities that fund research face deep revenue declines

Cancellation of major fundraisers forces groups to lay off staff and delay, trim, or cancel grants to scientists *By E. Cahan*

#### 1413 Could a blood 'observatory' stop pandemics?

Proposal calls for screening blood from around the world for thousands of antibodies *By R. Bazell*

#### 1414 Online GRE test heightens equity concerns

Pandemic spurs graduate programs to drop standardized test requirements *By J. C. Hu*

#### 1415 Senate bill to curb foreign threats raises alarms

Sweeping changes to protect research could hamper academic collaboration, critics say *By J. Mervis*

### FEATURES

#### 1416 Martian chronicler

NASA's Perseverance rover aims to find out whether ancient Mars was warm and wet or cold and dry *By P. Voosen*

#### 1420 Mars mission would put China among space leaders

*By D. Normile*

## INSIGHTS

### PERSPECTIVES

#### 1422 Reducing transmission of SARS-CoV-2

Masks and testing are necessary to combat asymptomatic spread in aerosols and droplets *By K. A. Prather et al.*

PODCAST

#### 1424 Evolution after genome duplication

Genetic interactions in yeast reveal factors governing duplicate gene retention and divergence *By I. M. Ehrenreich*

RESEARCH ARTICLE p. 1446

#### 1426 Action spectra of chiral secondary structure

Mass spectra of DNA complexes photoreduced with polarized light reveal their handedness *By P. Barran*

REPORT p. 1465

#### 1427 The simplicity of robust light harvesting

A universal design principle underlies photosynthetic antenna systems *By C. D. P. Duffy*

REPORT p. 1490

#### 1428 Guide cells help navigate axon regeneration

Rebuilding the flatworm visual system after injury requires guidepost-like muscle cells *By R. Roberts-Galbraith*

RESEARCH ARTICLE p. 1447

#### 1430 Microplastic in terrestrial ecosystems

Research shifts from ecotoxicology to ecosystem effects and Earth system feedbacks *By M. C. Rillig and A. Lehmann*



1428  
& 1447

Muscle guidepost-like cells (magenta) affiliate with the axons of the planarian visual system in yellow (nuclei, blue).

### 1432 Multiple, quiet, and close by

A planetary system around a nearby star offers the prospect for atmospheric study  
By *M. B. Davies*

REPORT p. 1477

### POLICY FORUM

#### 1433 “Explaining” machine learning reveals policy challenges

The need to make objectives explicit may expose policy trade-offs that had previously been implicit and obscured  
By *D. Coyle and A. Weller*

### BOOKS ET AL.

#### 1435 Confronting bias

Prejudice and discrimination are deeply personal, but their effects are profound  
By *C. K. Lai*

#### 1436 Like other species, we have always been on the move

Human migration and cultural exchange represent progress, not peril, argues a journalist  
By *K. Koser*

### LETTERS

#### 1438 COVID-19’s unsustainable waste management

By *S. You et al.*

#### 1438 Misguided forest action in EU Biodiversity Strategy

By *N. Selva et al.*

#### 1439 Afforestation falls short as a biodiversity strategy

By *S. Gómez-González et al.*

## RESEARCH

### IN BRIEF

1443 From *Science* and other journals

### RESEARCH ARTICLES

#### 1446 Genomic duplications

Exploring whole-genome duplicate gene retention with complex genetic interaction analysis  
*E. Kuzmin et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AA25667](https://doi.org/10.1126/SCIENCE.AA25667)

PERSPECTIVE p. 1424

#### 1447 Developmental biology

Muscle and neuronal guidepost-like cells facilitate planarian visual system regeneration  
*M. L. Scimone et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABA3203](https://doi.org/10.1126/SCIENCE.ABA3203)

PERSPECTIVE p. 1428

#### 1448 Neuroscience

Flexible recruitment of memory-based choice representations by the human medial frontal cortex  
*J. Minxha et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABA3313](https://doi.org/10.1126/SCIENCE.ABA3313)

#### 1449 Chromatin sequencing

Single-molecule regulatory architectures captured by chromatin fiber sequencing  
*A. B. Stergachis et al.*

#### 1454 Structural biology

Cryo-EM structure of the human cohesin-NIPBL-DNA complex  
*Z. Shi et al.*

#### 1460 Structural biology

Mechanisms of OCT4-SOX2 motif readout on nucleosomes  
*A. K. Michael et al.*

### REPORTS

#### 1465 Spectroscopy

Mass-resolved electronic circular dichroism ion spectroscopy  
*S. Daly et al.*

PERSPECTIVE p. 1426

#### 1469 Solar physics

Meridional flow in the Sun’s convection zone is a single cell in each hemisphere  
*L. Gizon et al.*

#### 1472 Plasmonic materials

Micelle-directed chiral seeded growth on anisotropic gold nanocrystals  
*G. González-Rubio et al.*

#### 1477 Exoplanets

A multiple planet system of super-Earths orbiting the brightest red dwarf star GJ 887  
*S. V. Jeffers et al.*

PERSPECTIVE p. 1432

#### 1482 Coronavirus

Changes in contact patterns shape the dynamics of the COVID-19 outbreak in China  
*J. Zhang et al.*

#### 1497 Quantum optics

Metallens-array-based high-dimensional and multiphoton quantum source  
*L. Li et al.*

#### 1490 Photosynthesis

Quieting a noisy antenna reproduces photosynthetic light-harvesting spectra  
*T. B. Arp et al.*

PERSPECTIVE p. 1427

#### 1495 Dog genomics

Arctic-adapted dogs emerged at the Pleistocene-Holocene transition  
*M.-H. S. Sinding et al.*

PODCAST

#### 1499 Coronavirus

Structural basis for inhibition of the RNA-dependent RNA polymerase from SARS-CoV-2 by remdesivir  
*W. Yin et al.*

### DEPARTMENTS

#### 1405 Editorial

Persuasive words are not enough  
By *H. Holden Thorp*

#### 1506 Working Life

The pressure to assimilate  
By *Montraí Spikes*

### ON THE COVER



Greenland sled dogs do the same job their ancestors have done for countless generations. Sequencing of a 9500-year-old dog genome reveals that modern dogs—particularly sled

dogs—were genetically distinct from wolves by the early Holocene. Of all modern sled dogs, the Greenland sled dog shares the most genomic ancestry with the first sled dogs, emphasizing the conservation value of this breed. See page 1495. Photo: Carsten Egevang

Science Staff ..... 1402  
AAAS News & Notes ..... 1440  
Science Careers ..... 1505

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 48-4460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$174 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra. Air asset delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125468122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96378, Washington, DC 20090-6378. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use, under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

3 JULY 2020 • VOLUME 369 • ISSUE 6499

## Science

20

## NEWS

### IN BRIEF

12 News at a glance

### IN DEPTH

#### 14 Officials gird for a war on vaccine misinformation

Fears of a rushed COVID-19 vaccine and rise of social media demand new messaging strategy  
By *W. Cornwall*

#### 15 The line starts to form for a coronavirus vaccine

U.S. and others debate who should get priority if vaccine doses are scarce  
By *J. Cohen*

#### 17 Rock seen inside Venus's orbit could solve puzzle

Mineral in first object so close to the Sun may be a clue to missing "mantle" asteroids  
By *N. Redd*



#### 18 A colorful chemotherapy agent could be made less toxic

Safer forms of doxorubicin, which kill tumor cells without damaging DNA, could spare hearts of cancer patients  
By *J. Kaiser*

#### 19 Greenland rock cores to trace ice's past melting

U.S. drilling campaign could also date controversial Hiawatha impact crater  
By *P. Voosen*

### FEATURES

#### 20 Improbable oasis

Pools in the Mexican desert are a hot spot of microbial diversity—and a window into early life  
By *R. P. Ortega*

PODCAST: VIDEO

## INSIGHTS

### LETTERS

#### 26 Nextgen voices: News from a postpandemic world

### PERSPECTIVES

#### 30 Tracing cell trajectories in a biofilm

Single bacterial cells are programmed to form multicellular structures

By *A. Dal Co* and *M. P. Brenner*

RESEARCH ARTICLE p. 71

#### 31 Shutting down RNA-targeting CRISPR

The discovery of an anti-CRISPR reveals viral escape from CRISPR immunity

By *R. Barrangou* and *E. J. Sontheimer*

RESEARCH ARTICLE p. 54

#### 33 The secret life of histones

Histone H3 leads a double life as a copper reductase  
By *J. Rudolph* and *K. Luger*

RESEARCH ARTICLE p. 59

#### 34 Stronger bonds bring bigger challenges

A polyoxometalate photocatalyst enables selective bond activation of light alkanes  
By *G. Oksdath-Mansilla*

REPORT p. 92

#### 35 When do fish succumb to heat?

Greater sensitivity in fish reproductive stages reveals vulnerability to climate change  
By *J. Sunday*

RESEARCH ARTICLE p. 65

#### 37 Rewilding immunology

Integrating comparative immunology can improve human, animal, and ecosystem health  
By *A. S. Files* and *Wild Comparative Immunology Consortium*

### POLICY FORUM

#### 39 Improve alignment of research policy and societal values

The EU promotes Responsible Research and Innovation in principle, but implementation leaves much to be desired  
By *P. Novitzky* et al.

### BOOKS ET AL.

#### 42 Better homes and safer spaces

Evidence-based indoor design is more important than ever  
By *B. Brown*

#### 43 Physics meets America's defense agenda

War transformed 20th-century physics in sometimes subtle ways  
By *M. Frappier*

# RESEARCH

## IN BRIEF

45 From *Science* and other journals

## REVIEW

### 48 Microbiology

Sharing vitamins: Cobamides unveil microbial interactions

O. M. Sokolovskaya et al.

REVIEW SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABA0165

## RESEARCH ARTICLES

### 49 Cancer

Feasibility of blood testing combined with PET-CT to screen for cancer and guide intervention A. M. Lennon et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABB9601

### 50 Coronavirus

SARS-CoV-2 productively infects human gut enterocytes

M. M. Lamers et al.

### 54 CRISPR biology

A phage-encoded anti-CRISPR enables complete evasion of type VI-A CRISPR-Cas immunity A. J. Meeske et al.

PERSPECTIVE p. 31

### 59 Histone function

The histone H3-H4 tetramer is a copper reductase enzyme N. Attar et al.

PERSPECTIVE p. 33

### 65 Climate responses

Thermal bottlenecks in the life cycle define climate vulnerability of fish F. T. Dahlke et al.

PERSPECTIVE p. 35

### 71 Biofilms

Cell position fates and collective fountain flow in bacterial biofilms revealed by light-sheet microscopy B. Qin et al.

PERSPECTIVE p. 30

## REPORTS

### 77 Coronavirus

Development of an inactivated vaccine candidate for SARS-CoV-2 Q. Gao et al.

### 81 Dielectrics

Ultrahigh capacitive energy density in ion-bombarded relaxor ferroelectric films J. Kim et al.



Fish embryos, like these cod, are especially sensitive to warming.

## Quantum gases

84 Strongly correlated superfluid order parameters from dc Josephson supercurrents W. J. Kwon et al.

89 An ideal Josephson junction in an ultracold two-dimensional Fermi gas N. Luick et al.

## 92 Organic chemistry

C(sp<sup>3</sup>)-H functionalizations of light hydrocarbons using decatungstate photocatalysis in flow G. Laudadio et al.

PERSPECTIVE p. 34

## 96 Solar cells

A piperidinium salt stabilizes efficient metal-halide perovskite solar cells Y.-H. Lin et al.

## 103 HIV

Number of HIV-1 founder variants is determined by the recency of the source partner infection Ch. J. Villabona-Arenas et al.

## DEPARTMENTS

### 11 Editorial

Surviving the trauma of COVID-19  
By Roxane Cohen Silver

### 110 Working Life

A child of the slums By Shalini Arya

## ON THE COVER



Tinged blue with minerals, La Poza Azul II is one of hundreds of spring-fed pools in Cuatro Ciénegas, an oasis in the desert of northern Mexico that preserves a vast diversity of microbes resembling those in

ancient oceans. Drainage for agriculture threatens the unique ecosystems of this oasis. See page 20. Photo: Miguel Angel de la Cueva

Science Staff ..... 8  
Science Careers ..... 109

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125489122. Publications Mail Agreement Number 3069624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

Science

10 JULY 2020 • VOLUME 369 • ISSUE 6500



130

## NEWS

### IN BRIEF

122 News at a glance

### IN DEPTH

#### 124 U.K. megatrial outshines other drug studies

Efficient recruitment and simple design are key to Recovery trial's success

By K. Kupferschmidt

PODCAST

#### 125 Can interferons stop COVID-19 before it takes hold?

Biology of infection supports early treatment with body's own viral defenses

By M. Wadman

#### 127 UAE probe aims for Mars—and payoffs on Earth

Even before launch, the Hope satellite has boosted Emirati space science

By S. el-Shawk

#### 128 Polynesians, Native Americans met and mingled long ago

Islanders' DNA suggests contact before European arrival

By L. Wade

#### 129 New security law rattles Hong Kong universities

Researchers worry about academic freedom and city's ability to attract foreign talent

By D. Normile

## FEATURES

### 130 No room for error

Developers of quantum computers face their true challenge: taming the noise that plagues the intertwined quantum bits

By A. Cho

## INSIGHTS

### POLICY FORUM

#### 134 How to build a more open justice system

Court records are unstructured and costly to access—here's how to fix it

By A. R. Pah et al.

### PERSPECTIVES

#### 137 Climate change tweaks Arctic marine ecosystems

Nutrient input might enhance productivity in the Arctic Ocean of the future

By M. Babin

REPORT p. 198



137 & 198

#### 138 Fuel cells that operate at 300° to 500°C

High-conductivity electrolytes are needed for electrochemical systems

By M. Ni and Z. Shao

REPORT p. 184

#### 140 Reining in dissolved transition-metal ions

Approaches are needed for stabilizing transition metals in lithium-ion battery cathodes

By H. Yaghoobnejad Asl and A. Manthiram

#### 142 Bats navigate with cognitive maps

Tagging and tracking systems reveal the way-finding strategies of fruit bats

By M. B. Fenton

REPORTS pp. 188 & 194

#### 143 Exploring the source of human brain fluids

Human organoid cultures can be used to probe secretion and drug permeability into and out of the brain

By V. Silva-Vargas and F. Doetsch

RESEARCH ARTICLE p. 159

#### 144 Exercising your mind

A circulating factor induced by exercise contributes to keeping the brain young in mice

By V. A. Ansere and W. M. Freeman

RESEARCH ARTICLE p. 167

#### 145 Rigorous wildlife disease surveillance

A decentralized model could address global health risks associated with wildlife exploitation

By M. Watsa and Wildlife Disease Surveillance Focus Group

## BOOKS ET AL.

### 148 Paleart comes into its own

A renaissance is occurring in the way we render extinct species. *By I. Nieuwland*

### 149 Changing course

Navigational skills require nurturing, lest we lose our way. *By L. Rosen*

## LETTERS

### 150 Preparing for proactive dam removal decisions

*By F. Vahedifard et al.*

### 150 Unnecessary hesitancy on human vaccine tests

*By N. Eyal*

### 151 Response

*By S. K. Shah et al.*

## PRIZE ESSAY

### 152 Poised for tissue repair

Skin microbes interact with the immune system to aid wound healing. *By O. Harrison*

# RESEARCH

## IN BRIEF

154 From Science and other journals



*Radotina*, one of the earliest jawed, toothed vertebrates, hiding in a nautiloid shell

## REVIEW

### 157 Lymphatic biology

Biological functions of lymphatic vessels. *T. V. Petrova and G. Y. Koh*

REVIEW SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAX4063](https://doi.org/10.1126/SCIENCE.AAX4063)

## RESEARCH ARTICLES

### 158 Developmental biology

Contact area-dependent cell communication and the morphological invariance of ascidian embryogenesis. *L. Guignard et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAR5663](https://doi.org/10.1126/SCIENCE.AAR5663)

### 159 Organoids

Human CNS barrier-forming organoids with cerebrospinal fluid production. *L. Pellegrini et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAZ5626](https://doi.org/10.1126/SCIENCE.AAZ5626) PERSPECTIVE p. 143

### 160 Coronavirus

Inferring change points in the spread of COVID-19 reveals the effectiveness of interventions. *J. Dehning et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABB9789](https://doi.org/10.1126/SCIENCE.ABB9789) REPORT p. 208

### 161 Structural biology

Structure and selectivity engineering of the M<sub>2</sub> muscarinic receptor toxin complex. *S. Maeda et al.*

### 167 Aging

Blood factors transfer beneficial effects of exercise on neurogenesis and cognition to the aged brain. *A. M. Horowitz et al.*

PERSPECTIVE p. 144; PODCAST

### 174 Quantum physics

Light-mediated strong coupling between a mechanical oscillator and atomic spins 1 meter apart. *T. M. Karg et al.*

## REPORTS

### 179 Topological matter

Observation and control of maximal Chern numbers in a chiral topological semimetal. *N. B. M. Schröter et al.*

### 184 Fuel cells

Proton transport enabled by a field-induced metallic state in a semiconductor heterostructure. *Y. Wu et al.*

PERSPECTIVE p. 138

## Cognitive maps

188 Cognitive map-based navigation in wild bats revealed by a new high-throughput tracking system. *S. Toledo et al.*

194 The ontogeny of a mammalian cognitive map in the real world. *L. Harten et al.* PERSPECTIVE p. 142

## 198 Arctic productivity

Changes in phytoplankton concentration now drive increased Arctic Ocean primary production. *K. M. Lewis et al.* PERSPECTIVE p. 137

## 202 Immunodeficiencies

HEM1 deficiency disrupts mTORC2 and F-actin control in inherited immunodysregulatory disease. *S. A. Cook et al.*

## 208 Coronavirus

Estimating the burden of SARS-CoV-2 in France. *H. Salje et al.* RESEARCH ARTICLE p. 160

## 211 Paleontology

Marginal dentition and multiple dermal jawbones as the ancestral condition of jawed vertebrates. *V. Vaškaninová et al.*

## DEPARTMENTS

### 120 Editorial

Immigrants help make America great. *By Sudip Parikh*

### 121 Editorial

Monumental patience. *By H. Holden Thorp*

### 218 Working Life

The day I left the lab. *By Kelsey Hodge-Hanson*

## ON THE COVER



Monitoring large numbers of Egyptian fruit bats, like this one leaving its colony, and doing so as they mature into adults, suggests that bats navigate through their complex environment using a cognitive map. See pages 142, 188, and 194. *Photo: Ivan Kuzmin/Science Source*

Science Careers ..... 217

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 494460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R123488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 9-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

17 JULY 2020 • VOLUME 369 • ISSUE 6501

## Science



241

## NEWS

### IN BRIEF

230 News at a glance

### IN DEPTH

#### 233 Famous psychologist faces posthumous reckoning

Dozens of papers on personality and health by Hans Eysenck have been retracted or are under suspicion. *By C. O'Grady*

#### 234 X-ray source gets a 100-fold boost in brightness

Rebuilt synchrotron is the first of more than a dozen of its kind in the works. *By A. Cho*

#### 236 An optimist takes the helm at NSF

Sethuraman Panchanathan has spent his career finding "win-win" situations. *By J. Mervis*

EDITORIAL p. 229; PODCAST

#### 237 'Huge hole' in testing data blurs racial, ethnic disparities

Researchers seek better data on pandemic's uneven burden. *By K. Servick*

#### 238 The pandemic virus is slowly mutating. But does it matter?

Linking genomic changes to viral behavior proves difficult. *By K. Kupferschmidt*

#### 239 Courses bring field sites and labs to the small screen

Some pandemic-induced changes to hands-on classes may be here to stay. *By E. Pennisi*

### FEATURES

#### 241 Not open and shut

School openings across the globe suggest ways to keep the coronavirus at bay, despite outbreaks. *By J. Couzin-Frankel, G. Vogel, and M. Weiland*  
PODCAST

## INSIGHTS

### POLICY FORUM

#### 246 The rotten apples of Brazil's agribusiness

Brazil's inability to tackle illegal deforestation puts the future of its agribusiness at risk. *By R. Rajão*

### PERSPECTIVES

#### 249 Can genomes predict coral bleaching?

Expansion of the coral genomic tool kit could facilitate more informed conservation. *By R. A. Bay and L. Guerrero*  
RESEARCH ARTICLE p. 268

#### 250 Nailing a Fe-rocious form of cancer

Disseminated cancer cells in brain fluids hijack iron from macrophages for metastatic survival. *By L. Garzia and M. D. Taylor*  
RESEARCH ARTICLE p. 276

#### 252 Less can be more in functional materials

Nanopillar defects in  $\text{NaNbO}_3$  induce a large piezoelectric response at high electric fields. *By N. Bassiri-Gharb*  
REPORT p. 292

#### 253 A synapse census for the ages

A molecular imaging survey reveals the evolution of mouse brain synapse populations from birth through old age. *By K. D. Micheva et al.*  
RESEARCH ARTICLE p. 270

#### 254 Reimagining petroleum refining

Rigid polymer membranes separate crude oil components without distillation. *By J. F. Brennecke and B. Freeman*  
REPORT p. 310

#### 256 Aging immunity may exacerbate COVID-19

Increased general inflammation in aging inhibits immunity and affects responses to infections. *By A. N. Akbar and D. W. Gilroy*

### BOOKS ET AL.

#### 258 Overseeing innovation

75 years after Vannevar Bush's impactful report, debate continues about directing science. *By E. K. Gibson*  
EDITORIAL p. 227

#### 259 Color vision

An ambitious volume lends scientific and cultural context to an expansive concept. *By M. Rossi*



08 FEB 2021

## LETTERS

**261 COVID-19 policies: Remember measles**

By D. Guha-Sapir et al.

**262 Restart science stronger after COVID-19**

By A. I. Leshner

**262 Uphold the nuclear weapons test moratorium**

By J. King et al.

## RESEARCH

## IN BRIEF

264 From *Science* and other journals

## REVIEW

**267 Metrology**

Optical frequency combs: Coherently uniting the electromagnetic spectrum

S. A. Diddams et al.

REVIEW SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.AAY3676

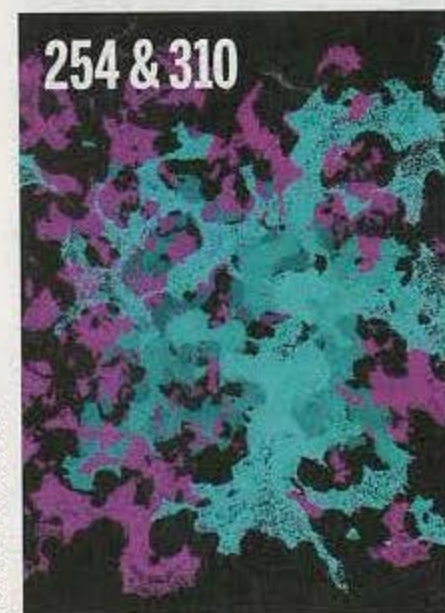
## RESEARCH ARTICLES

**268 Coral genomics**Population genetics of the coral *Acropora millepora*: Toward genomic prediction of bleaching

Z. L. Fuller et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.ABA4674

PERSPECTIVE p. 249

**269 Cancer**Tumor-initiating cells establish an IL-33-TGF- $\beta$  niche signaling loop to promote cancer progression

S. Taniguchi et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.AAY1813

**270 Neurodevelopment**

A brainwide atlas of synapses across the mouse life span

M. Cizeron et al.

PERSPECTIVE p. 253

**276 Cancer**

Cancer cells deploy lipocalin-2 to collect limiting iron in leptomenigeal metastasis

Y. Chi et al.

PERSPECTIVE p. 250

**282 Human evolution**

Ancient DNA indicates human population shifts and admixture in northern and southern China

M. A. Yang et al.

## REPORTS

**289 Chemical physics**

Second critical point in two realistic models of water

P. G. Debenedetti et al.

PERSPECTIVE p. 252

**292 Piezoelectrics**

Giant piezoelectricity in oxide thin films with nanopillar structure

H. Liu et al.

PERSPECTIVE p. 252

**297 Coronavirus**

Introductions and early spread of SARS-CoV-2 in the New York City area

A. S. Gonzalez-Reiche et al.

**302 Organic chemistry**

Boron-enabled geometric isomerization of alkenes via selective energy-transfer catalysis

J. J. Molloy et al.

**307 Chemical physics**

Molecular square dancing in CO-CO collisions

Z.-F. Sun et al.

**310 Organic separations**

N-Aryl-linked spirocyclic polymers for membrane separations of complex hydrocarbon mixtures

K. A. Thompson et al.

PERSPECTIVE p. 254; PODCAST

**315 Coronavirus**

Susceptible supply limits the role of climate in the early SARS-CoV-2 pandemic

R. E. Baker et al.

**320 Immunology**

Autoreactivity in naïve human fetal B cells is associated with commensal bacteria recognition

J. W. Chen et al.

**325 Aging**

A programmable fate decision landscape underlies single-cell aging in yeast

Y. Li et al.

**330 Coronavirus**

Site-specific glycan analysis of the SARS-CoV-2 spike

Y. Watanabe et al.

**333 Genome editing**CRISPR-Cas $\Phi$  from huge phages is a hypercompact genome editor

P. Pausch et al.



## DEPARTMENTS

**227 Editorial**

Science has always been political

By H. Holden Thorp

EDITORIAL p. 229; BOOKS p. 258

**229 Editorial**

Advice for the new NSF director

By Mary Sue Coleman

EDITORIAL p. 227; NEWS STORY p. 236

**342 Working Life**

When the jokes aren't funny

By Lala Tammy Das

## ON THE COVER



Synaptome maps of the developing mouse brain (relative brain size is shown to scale). The diversity of excitatory synapses (low to high: blue, green, yellow, red) changes with age (top to bottom: 1 day, 2 weeks, 3 weeks, 3 months, 12

months), peaking in the 3-month-old cortex and hippocampus and declining in old age, potentially mirroring life-span trajectories in brain function. See pages 253 and 270. Image: Zhen Qiu, Mélissa Cizeron, and Seth Grant, Edinburgh University

Science Staff ..... 226  
Science Careers ..... 341

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484-660) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair-use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

24 JULY 2020 • VOLUME 369 • ISSUE 6502

## Science



## NEWS

### IN BRIEF

352 News at a glance

### IN DEPTH

#### 354 Earth's climate destiny finally seen more clearly

Critical study narrows bounds for "climate sensitivity," ruling out benign warming  
By P. Voosen

#### 355 Tools suggest people reached Americas early

Skeptics question Mexican finds that suggest settlement during the last ice age  
By A. Curry

#### 356 Data secrecy may cripple U.S. attempts to slow pandemic

California and other states don't release as much detail on cases and contacts as epidemiologists want  
By C. Piller

#### 358 Research cruises gingerly resume

With quarantines, social distancing, and smaller crews, U.S. ocean science sets sail again  
By I. Gruber-Stiehl

#### 359 University reopening plans under fire

As the pandemic surges in the United States, academics worry returning students could spread the virus  
By J. Madhusoodanan

#### 360 Polio vaccinators are back after pandemic pause

Mass campaigns resume after modelers warn about risk of "explosive" outbreaks  
By L. Roberts

### FEATURES

#### 361 Aftermath

By allowing scientists to study their suffering, atomic bomb survivors have transformed our understanding of radiation's health effects  
By D. Normile  
EDITORIAL P. 350; PODCAST

## INSIGHTS

### PERSPECTIVES

#### 366 COVID-19 affects HIV and tuberculosis care

The COVID-19 response should be balanced with the need to manage other diseases  
By Q. A. Karim and S. S. A. Karim

#### 368 Mathematical models to guide pandemic response

Models can be used to learn from the past and prepare for the future  
By C. J. E. Metcalf et al.  
RESEARCH ARTICLE p. 413

#### 370 The COVID-19 pandemic and human fertility

Birth trends in response to the pandemic will vary according to socioeconomic conditions  
By A. Aassve et al.

#### 372 Tying amines down for stable CO<sub>2</sub> capture

Sequestering greenhouse gas for different fuel mixes requires better sorbent stability  
By S. B. Peh and D. Zhao  
RESEARCH ARTICLE p. 392

#### 373 Fine-tuning stemness

Targeted degradation determines whether embryonic stem cells undergo differentiation  
By M. Borsa and A. K. Simon  
RESEARCH ARTICLE p. 397

#### 375 Interrogating hot electrons in tunnel junctions

Electronic transport reveals excited-carrier energy distribution in plasmonic nanostructures  
By L. Martín-Moreno  
REPORT p. 423

#### 376 Was smallpox a widespread mild disease?

Ancient DNA from the Viking Age suggests a rethink about the origin and evolution of smallpox  
By A. Alcamí  
RESEARCH ARTICLE p. 391

#### 378 Beth Cindy Levine (1960–2020)

Visionary physician scientist who linked autophagy to disease  
By H. W. Virgin et al.

## POLICY FORUM

### 379 Ecology and economics for pandemic prevention

Investments to prevent tropical deforestation and to limit wildlife trade will protect against future zoonosis outbreaks *By A. P. Dobson et al.*

## BOOKS ET AL.

### 382 The pull of the red planet

Two candid accounts consider the history and future of life on Mars *By M. Shindell*

### 384 Fiction meets the near future

An action-packed thriller explores the implications of emerging technologies *By G. Lucas*

## LETTERS

### 385 Nicaragua's COVID-19 crisis demands a response

*By J. Huete-Pérez and J. Hildebrand*

### 385 A community-led approach to COVID-19

*By K. A. Artelle et al.*

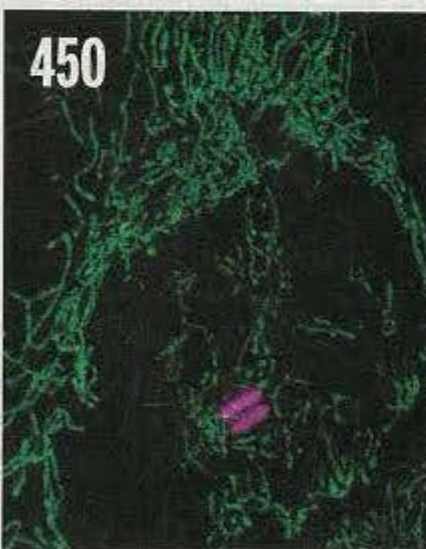
### 386 Lessons from viruses that affect lagomorphs

*By C. Rouco et al.*

# RESEARCH

## IN BRIEF

387 From *Science* and other journals



450

## RESEARCH ARTICLES

### 390 Systems biology

Simultaneous cross-evaluation of heterogeneous *E. coli* datasets via mechanistic simulation *D. N. Macklin et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAV3751](https://doi.org/10.1126/SCIENCE.AAV3751)

### 391 Smallpox

Diverse variola virus (smallpox) strains were widespread in northern Europe in the Viking Age *B. Mühlemann et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAW8977](https://doi.org/10.1126/SCIENCE.AAW8977)  
PERSPECTIVE p. 376

### 392 Gas separations

Cooperative carbon capture and steam regeneration with tetraamine-appended metal-organic frameworks *E. J. Kim et al.*  
PERSPECTIVE p. 372

### 397 Stem cell biology

Chaperone-mediated autophagy regulates the pluripotency of embryonic stem cells *Y. Xu et al.*

PERSPECTIVE p. 373

### 403 Drug development

The activities of drug inactive ingredients on biological targets *J. Pottel et al.*

### 413 Coronavirus

The impact of COVID-19 and strategies for mitigation and suppression in low- and middle-income countries *P. G. T. Walker et al.*  
PERSPECTIVE p. 368

## REPORTS

### 423 Nanophotonics

Determining plasmonic hot-carrier energy distributions via single-molecule transport measurements *H. Reddy et al.*

PERSPECTIVE p. 375

### 427 Metallurgy

Ultrahigh-strength and ductile superlattice alloys with nanoscale disordered interfaces *T. Yang et al.*

### 433 Structural biology

Structural basis for membrane insertion by the human ER membrane protein complex *T. Pleiner et al.*

### 436 Nanophotonics

Remote structuring of near-field landscapes *V. Ginis et al.*

### 440 Protein design

An evolution-based model for designing chorismate mutase enzymes *W. P. Russ et al.*

### 446 Materials science

Anomalous absorption of electromagnetic waves by 2D transition metal carbonitride  $Ti_2CNT_x$  (MXene) *A. Iqbal et al.*

### 450 Host defense

Itaconate is an effector of a Rab GTPase cell-autonomous host defense pathway against *Salmonella* *M. Chen et al.*

### 456 Human evolution

Genomic insights into the early peopling of the Caribbean *K. Nägele et al.*

### 460 Ecological genomics

Large-scale mutation in the evolution of a gene complex for cryptic coloration *R. Villoutreix et al.*

### 466 Cell cycle

Cell growth dilutes the cell cycle inhibitor Rb to trigger cell division *E. Zatulovskiy et al.*

## DEPARTMENTS

### 350 Editorial

Avoiding another Hiroshima *By Madeleine K. Albright*  
NEWS STORY p. 361

### 351 Editorial

Systemic racism persists in the sciences *By Adia Harvey Wingfield*

### 474 Working Life

Working through grief *By Anna Nordseth*

## ON THE COVER



Every 6 August, mourners and peace activists release candlelit paper lanterns on Hiroshima's Motoyasu River to mark the anniversary of the atomic bombing of the city, which occurred 75 years ago next month.

Many survivors of the Hiroshima and Nagasaki bombings have cooperated with a large, long-running cohort study that has produced most of what is known about the long-term health effects of radiation. See pages 350 and 361. *Photo: The Asahi Shimbun via Getty Images*

New Products ..... 472  
Science Careers ..... 473

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484-660) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125498122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling, available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

31 JULY 2020 • VOLUME 369 • ISSUE 6503

493 & 578

*Rhododendron* and other alpine flowers at 4300-meter elevation in the Hengduan Mountains in China, home to the world's oldest alpine plant community.

## NEWS

### IN BRIEF

484 News at a glance

### IN DEPTH

#### 487 Wuhan coronavirus hunter Shi Zhengli speaks out

China's "Bat Woman" denies responsibility for the pandemic, demands apology from Trump *By J. Cohen*

PODCAST

#### 489 Global plan seeks to promote vaccine equity, spread risks

Poor countries fear ending up at the end of the queue *By K. Kupferschmidt*

#### 490 Hidden predictability in winds could improve climate forecasts

Study finds climate models are missing wind patterns, casting doubt on long-term forecasts of rain and storms *By P. Voosen*

#### 491 How an ancient microbial arms race remodeled human cells

Study traces genetic responses to pathogens back to ancestor of Neanderthals and modern humans *By A. Gibbons*

#### 493 Mountains and monsoons created Tibetan biodiversity

The rise of the Hengduan range 30 million years ago kick-started evolution of world's oldest alpine flora *By E. Stokstad*

REPORT p. 578

#### 494 This man can read letters but numbers are a blank

Case exposes complex roots of consciousness *By S. Kean*

#### 495 Altered DNA base could play key role in pregnancy

In mice, methylated adenine enables the placenta to grow *By E. Pennisi*

### FEATURES

#### 496 Lizard man

For Jonathan Losos, tiny Caribbean islands and their reptile inhabitants are test tubes of evolution *By E. Pennisi*

## INSIGHTS

### POLICY FORUM

#### 500 COVID-19 risks to global food security

Economic fallout and food supply chain disruptions require attention from policy-makers *By D. Laborde et al.*

### PERSPECTIVES

#### 503 Mapping the clean air havens and have-nots

The distribution of air pollution has changed little, perpetuating disparities in exposure *By L. Ma*

REPORT p. 575

#### 504 Can we predict solar flares?

A physics-based model may help improve space weather forecasts *By A. M. Veronig*  
REPORT p. 587

#### 506 Evolution of the human brain

A human-specific gene is a determinant of the cognitive architecture of the human cerebral cortex *By C. Dehay and H. Kennedy*  
REPORT p. 546

#### 507 Fine-tuning receptor-G protein activation and signaling

The activation rate of downstream G proteins imprints receptor signaling *By G. Lebon*  
RESEARCH ARTICLE p. 523

#### 509 Ductile van der Waals materials

Normally brittle, single crystals of InSe can be mechanically rolled like a metal into thin films *By X. Han*  
REPORT p. 542

#### 510 How does SARS-CoV-2 cause COVID-19?

The viral receptor on human cells plays a critical role in disease progression *By N. J. Matheson and P. J. Lehner*

#### 512 William C. Dement (1928–2020)

Father of sleep medicine *By R. Pelayo and P. Murrain*

### BOOKS ET AL.

#### 513 Confronting illness with empathy

A journalist paints a thoughtful portrait of a disease that defies scientific characterization *By F. R. Davis*

## 514 Context is key to olfaction

How we experience smell has more to do with us than with the odor itself *By J. P. McGann*

### LETTERS

## 515 China and India: Toward a sustainable world

*By K. S. Bawa et al.*

## 515 Conservation needs a COVID-19 bailout

*By R. A. McCreery et al.*

## 516 Extinct-in-the-wild species' last stand

*By A. Trask et al.*

# RESEARCH

### IN BRIEF

519 From *Science* and other journals

### REVIEW

## 522 Immunology

The function of the thymus and its impact on modern medicine *J. F. A. P. Miller*  
REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA2429

### RESEARCH ARTICLES

## 523 Structural biology

Structural insights into differences in G protein activation by family A and family B GPCRs *D. Hilger et al.*  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA3373  
PERSPECTIVE p. 507

## 524 Biochemistry

ANGEL2 is a member of the CCR4 family of deadenylases with 2',3'-cyclic phosphatase activity *P. H. Pinto et al.*

## 530 Immunogenomics

Human fetal microglia acquire homeostatic immune-sensing properties early in development *L. Kracht et al.*

### REPORTS

## 537 Molecular diffusion

Boosted molecular mobility during common chemical reactions *H. Wang et al.*

## 542 Materials science

Exceptional plasticity in the bulk single-crystalline van der Waals semiconductor InSe *T.-R. Wei et al.*  
PERSPECTIVE p. 509

## 546 Neurodevelopment

Human-specific *ARHGAP11B* increases size and folding of primate neocortex in the fetal marmoset *M. Heide et al.*  
PERSPECTIVE p. 506

## 550 Ultracold matter

Cooling and entangling ultracold atoms in optical lattices *B. Yang et al.*

## 554 Structural biology

In-cell architecture of an actively transcribing-translating expressome *F. J. O'Reilly et al.*

## 557 Organic chemistry

Direct reversible decarboxylation from stable organic acids in dimethylformamide solution *D. Kong et al.*

## 561 Neurogenomics

Aallele-specific open chromatin in human iPSC neurons elucidates functional disease variants *S. Zhang et al.*

## 566 Biotechnology

DNA capture by a CRISPR-Cas9-guided adenine base editor *A. Lapinaite et al.*

## 571 Nanomaterials

Rational synthesis of atomically precise graphene nanoribbons directly on metal oxide surfaces *M. Kolmer et al.*

## 575 Air pollution

Disparities in PM<sub>2.5</sub> air pollution in the United States *J. Colmer et al.*  
PERSPECTIVE p. 503

## 578 Paleobotany

Ancient orogenic and monsoon-driven assembly of the world's richest temperate alpine flora *W.-N. Ding et al.*  
NEWS STORY p. 493

## 582 Coronavirus

Genomic surveillance reveals multiple introductions of SARS-CoV-2 into Northern California *X. Deng et al.*

## 587 Solar physics

A physics-based method that can predict imminent large solar flares *K. Kusano et al.*  
PERSPECTIVE p. 504

### DEPARTMENTS

## 483 Editorial

Cautious optimism  
*By H. Holden Thorp*  
PODCAST

## 594 Working Life

My womb is my business  
*By Wen-Jing Lin*

### ON THE COVER



An extreme ultraviolet image of a large (X-class) solar flare that occurred on 7 March 2012, combining observations taken at 131 Å (blue) and 171 Å (yellow) using the Solar Dynamics Observatory spacecraft. This flare

disrupted radio communications on Earth. Predicting when X-class flares will occur will help to forecast Earth's space weather. See pages 504 and 587. *Credit: NASA/GSFC/SDO*

Science Staff	482
AAAS News & Notes	517
New Products	592
Science Careers	593



571

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484-667) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra; Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

7 AUGUST 2020 • VOLUME 369 • ISSUE 6504

612

## NEWS

### IN BRIEF

604 News at a glance

### IN DEPTH

606 **Why infection poses a special risk to pregnant women**

Cardiovascular and immune system changes in moms-to-be make them more vulnerable to serious disease. *By M. Wadman*

607 **COVID-19 unlikely to cause birth defects, but doctors await fall births**

*By M. Wadman*

### PODCAST

608 **Fast, cheap tests could enable safer reopening**

Models show test accuracy matters less than speed and frequency for curbing outbreaks. *By R. F. Service*

609 **Pandemic hits scientist parents hard**

New data quantify lost work hours and productivity. *By K. Langin*

610 **Abortion opponents dominate Trump's fetal tissue review board**

Ethics advisory board will rule on federal funding for research that uses fetal organs and cells. *By M. Wadman and J. Kaiser*

600 7 AUGUST 2020 • VOL 369 ISSUE 6504

611 **Trump directive on state counts said to threaten rigor of census**

Experts decry order to exclude undocumented residents. *By J. Mervis*

612 **Siberia's 'gateway to the underworld' hit by heat wave**

Thawing Batagay permafrost holds deep climate history. *By R. Stone*

613 **Deforestation in the Brazilian Amazon is still rising sharply**

Satellite images suggest clearings are up by at least 28%. *By H. Escobar*  
LETTERS pp. 634 & 635

### FEATURES

614 **The long haul**

Some COVID-19 survivors are still sick months later. Doctors want to learn why and what they can do. *By J. Couzin-Frankel*

## INSIGHTS

### PERSPECTIVES

618 **Chimeric plants—the best of both worlds**

Overcoming graft incompatibility between species could protect future crop yields. *By M. C. McCann*  
REPORT p. 698

620 **Specificity in legume nodule symbiosis**

Structural variation in recognition molecules shapes symbiotic partnerships. *By T. Bisseling and R. Geurts*  
RESEARCH ARTICLE p. 663

621 **Opening the floodgates at Fukushima**

Tritium is not the only radioisotope of concern for stored contaminated water. *By K. O. Buesseler*

623 **Unifying the synthesis of nucleoside analogs**

A short, versatile synthetic pathway transforms achiral reactants into nucleoside analogs. *By G. J. Miller*  
REPORT p. 725

624 **COVID-19 in Africa: Dampening the storm?**

The dampened course of COVID-19 in Africa might reveal innovative solutions. *By M. Mbow et al.*

626 **Interferon responses in viral pneumonias**

Are interferon-mediated antiviral immune responses beneficial or detrimental in COVID-19? *By G. E. Grajales-Reyes and M. Colonna*  
REPORTS pp. 706, 712, & 718

628 **John D. Gearhart (1943–2020)**

Pioneer of human pluripotent stem cell research. *By P. J. Donovan and K. S. Zaret*

sciencemag.org SCIENCE

## POLICY FORUM

### 629 Engage with animal welfare in conservation

Conservation could better promote not just the quantity of species but the quality of animal life  
By N. Sekar and D. Shiller

## BOOKS ET AL.

### 632 The unlikely role of dinosaurs in the diversity discourse

Western civilization's appreciation of variety may be related to the discovery of sudden extinction events  
By J. M. Determann

### 633 Saving species, one roll at a time

Players collaborate to rescue endangered animals in a new conservation-themed game  
By A. Chuang

## LETTERS

### 634 The Amazon's road to deforestation

By L. Ferrante and P. M. Fearnside  
NEWS STORY p. 613

### 634 Smoke pollution's impacts in Amazonia

By G. de Oliveira et al.  
NEWS STORY p. 613

### 635 Investors can help rein in Amazon deforestation

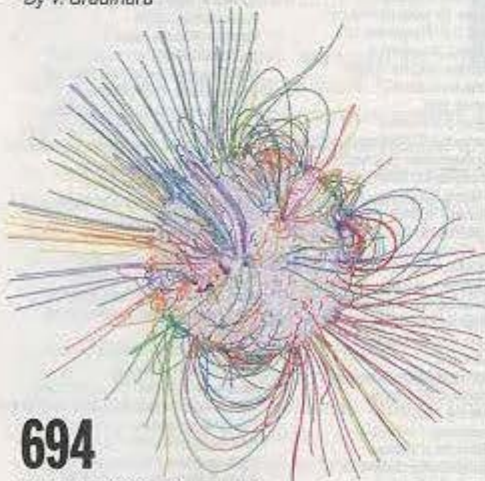
By A. G. Nazareno and W. F. Laurance  
NEWS STORY p. 613

### 636 Technical Comment abstracts

## PRIZE ESSAY

### 637 Expanding the brain researcher's toolkit

Better delivery vectors and opsins enable precise, minimally invasive neuromodulation  
By V. Gradinaru



# 694

Model prediction of magnetic field lines in the Sun's corona

# RESEARCH

## IN BRIEF

639 From *Science* and other journals

## RESEARCH ARTICLES

### 642 Cell biology

The proteasome controls ESCRT-III-mediated cell division in an archaeon  
G. Tarrason Risa et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAZ2532](https://doi.org/10.1126/SCIENCE.AAZ2532)

### Coronavirus

643 Potent neutralizing antibodies from COVID-19 patients define multiple targets of vulnerability  
P. J. M. Brouwer et al.

650 A neutralizing human antibody binds to the N-terminal domain of the Spike protein of SARS-CoV-2  
X. Chi et al.

### 656 Structural biology

Structural insight into precursor ribosomal RNA processing by ribonuclease MRP  
P. Lan et al.

### 663 Plant science

Ligand-recognizing motifs in plant LysM receptors are major determinants of specificity  
Z. Bozsoki et al.

PERSPECTIVE p. 620

## REPORTS

### 670 Nanomaterials

Chemical vapor deposition of layered two-dimensional MoSi<sub>2</sub>N<sub>4</sub> materials  
Y.-L. Hong et al.

### 674 Framework materials

Sequencing of metals in multivariate metal-organic frameworks  
Z. Ji et al.

### 680 Ferroelectrics

Emergent helical texture of electric dipoles  
D. D. Khalyavin et al.

### 685 Fluid mechanics

A new wrinkle on liquid sheets; Turning the mechanism of viscous bubble collapse upside down  
A. T. Oratis et al.

### 689 Metallurgy

How hair deforms steel  
G. Roscioli et al.  
PODCAST; VIDEO

### 694 Solar physics

Global maps of the magnetic field in the solar corona  
Z. Yang et al.

### 698 Plant science

Cell-cell adhesion in plant grafting is facilitated by  $\beta$ -1,4-glucanases  
M. Notaguchi et al.  
PERSPECTIVE p. 618

### 702 Coronavirus

Unexpected air pollution with marked emission reductions during the COVID-19 outbreak in China  
T. Le et al.

## Coronavirus

706 Type III interferons disrupt the lung epithelial barrier upon viral recognition  
A. Broggi et al.

712 Type I and III interferons disrupt lung epithelial repair during recovery from viral infection  
J. Major et al.

718 Impaired type I interferon activity and inflammatory responses in severe COVID-19 patients  
J. Hadjadj et al.

PERSPECTIVE p. 626

### 725 Organic chemistry

A short de novo synthesis of nucleoside analogs  
M. Meanwell et al.  
PERSPECTIVE p. 623

### 731 Coronavirus

Broad neutralization of SARS-related viruses by human monoclonal antibodies  
A. Z. Wee et al.

## DEPARTMENTS

### 603 Editorial

Productivity in a pandemic  
By Caitlyn Collins

### 738 Working Life

Building bridges  
By Ruofan Yu

## ON THE COVER



Thirty-six wrinkles develop during the sudden collapse of a centimeter-sized bubble of silicone oil, 100 times as viscous as honey. The black hole (center) is the opening of the bubble as it pops. Surface tension, not

gravity, drives bubble collapse and initiates a rapid compression that dynamically buckles the film. This event highlights how physical intuition around gravity may prove erroneous when applied to interfacial phenomena. See page 685. Photo: Oliver McRae/Boston University

Science Staff ..... 602  
Science Careers ..... 737

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra. Air assist delivery: \$38. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from [backissues.sciencemag.org](https://backissues.sciencemag.org); bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), [www.copyright.com](https://www.copyright.com). The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

14 AUGUST 2020 • VOLUME 369 • ISSUE 6505



## NEWS

### IN BRIEF

750 News at a glance

### IN DEPTH

#### 752 Antibodies may curb pandemic before vaccines

Now in efficacy trials, monoclonal antibodies promise to both prevent and treat disease

By J. Cohen

#### 753 For science in Latin America, 'a fascinating challenge'

Pandemic shows benefits of investments in research but also poses grave threats

By R. Pérez Ortega and L. Wessel

#### 755 Looking for the light in Haiti

For physician Marie Marcelle Deschamps, COVID-19 is just the latest challenge

By R. Bazell

#### 756 Africa's pandemic puzzle: why so few cases and deaths?

Antibody surveys tell a different story than official tolls

By L. Nordling

#### 757 Fed-up archaeologists aim to fix field schools' party culture

Drinking and harassment spur experiments, including local projects and student stipends, for core training course

By L. Wade

#### 758 Don't crush that ant—it could plant a wildflower

New findings show how ants choose and protect the seeds they disperse

By E. Pennisi

### FEATURES

#### 760 Lucky strike

Last year, an unusual meteorite crashed in a Costa Rican rainforest. Rich in the building blocks of life, it has captivated collectors and researchers

By J. Sokol

## INSIGHTS

### POLICY FORUM

#### 766 Distorting science, putting water at risk

A recent rule is inconsistent with science and will compromise the integrity of U.S. waters

By S. M. P. Sullivan et al.

### PERSPECTIVES

#### 769 Can playing together help us live together?

A field experiment in Iraq shows that having Muslim teammates reduced Christian soccer players' prejudice

By E. L. Paluck and C. S. Clark

REPORT p. 866

#### 770 Marine food webs destabilized

A combination of warming and acidification threaten marine biomass and productivity

By S. L. Chown

REPORT p. 829

#### 771 An early start to Huntington's disease

The huntingtin gene mutation interferes with neurogenesis in human fetal cortex

By M. DiFiglia

RESEARCH ARTICLE p. 787

#### 773 Designing a wider superelastic window

Adding chromium to an iron alloy enables shape recovery over a wide temperature range

By P. La Roca and M. Sade

REPORT p. 855

#### 774 The importins of pain

A nuclear protein importer modulates gene expression to control the persistence of neuropathic pain

By M. S. Yousef and T. J. Price

REPORT p. 842

#### 775 A coexistence that CuO<sub>2</sub> planes can see

Antiferromagnetism and superconductivity are not at odds in a quintuple-layer cuprate

By I. Vishik

REPORT p. 833

#### 777 Michael Soulé (1936–2020)

Founder of conservation biology

By D. W. Inouye and P. R. Ehrlich

## BOOKS ET AL.

### 778 How it all ends

A light-hearted exploration of the death of the Universe serves as an effective antidote for everyday worries. *By P. Halpern*

### 779 Science meets politics

A passion for promoting the public good guided geneticist J. B. S. Haldane's scholarship. *By P. W. Hughes*

## LETTERS

### 780 Retraction

*By S. Licht et al.*

### 780 Controlling the COVID-19 narrative

*By N. Bharti*

### 780 Dismantling systemic racism in science

*By E. A. Odekunle*

### 781 Untapped resources for medical research

*By O. A. Pérez-Escobar et al.*

# RESEARCH

## IN BRIEF

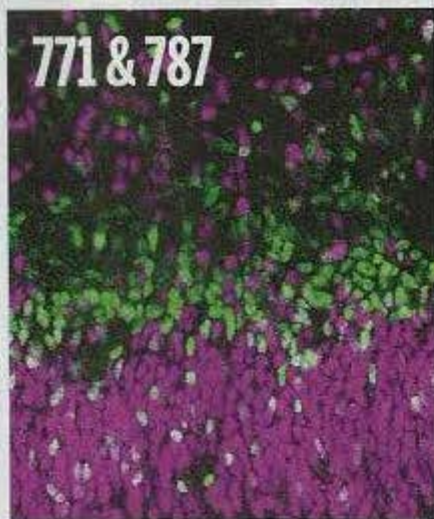
783 From Science and other journals

## REVIEW

### 786 Catalysis

Using nature's blueprint to expand catalysis with Earth-abundant metals. *R. M. Bullock et al.*

REVIEW SUMMARY; FOR FULL TEXT: [OX.DOI.ORG/10.1126/SCIENCE.ABC3183](https://doi.org/10.1126/SCIENCE.ABC3183)



## RESEARCH ARTICLES

### 787 Neurodevelopment

Huntington's disease alters human neurodevelopment. *M. Barnat et al.*  
PERSPECTIVE p. 771

### 793 Structural biology

Binding mechanisms of therapeutic antibodies to human CD20. *A. Kumar et al.*

### 799 Organic chemistry

Divergent synthesis of complex diterpenes through a hybrid oxidative approach. *X. Zhang et al.*

## Coronavirus

806 DNA vaccine protection against SARS-CoV-2 in rhesus macaques. *J. Yu et al.*

812 SARS-CoV-2 infection protects against rechallenge in rhesus macaques. *A. Chandrashekar et al.*

REPORT p. 818

## REPORTS

### 818 Coronavirus

Primary exposure to SARS-CoV-2 protects against reinfection in rhesus macaques. *W. Deng et al.*

RESEARCH ARTICLES pp. 806 & 812

### 823 Immunology

BAF restricts cGAS on nuclear DNA to prevent innate immune activation. *B. Guey et al.*

### 829 Trophic resilience

Trophic pyramids reorganize when food web architecture fails to adjust to ocean change. *I. Nagelkerken et al.*  
PERSPECTIVE p. 770

### 833 Superconductivity

Observation of small Fermi pockets protected by clean CuO<sub>2</sub> sheets of a high-T<sub>c</sub> superconductor. *S. Kunisada et al.*  
PERSPECTIVE p. 775

### 838 Tropical forest

Active restoration accelerates the carbon recovery of human-modified tropical forests. *C. D. Philipson et al.*

### 842 Neuroscience

Importin  $\alpha 3$  regulates chronic pain pathways in peripheral sensory neurons. *L. Marvaldi et al.*  
PERSPECTIVE p. 774

### 846 Coronavirus

A mathematical model reveals the influence of population heterogeneity on herd immunity to SARS-CoV-2. *T. Britton et al.*

### 850 Electrochemistry

A molecular mediator for reductive concerted proton-electron transfers via electrocatalysis. *M. J. Chalkley et al.*

### 855 Metallurgy

Iron-based superelastic alloys with near-constant critical stress temperature dependence. *J. Xia et al.*  
PERSPECTIVE p. 773

### 858 Neurodevelopment

Mitochondrial dynamics in postmitotic cells regulate neurogenesis. *R. Iwata et al.*

### 863 Paleoanthropology

Fire and grass-bedding construction 200 thousand years ago at Border Cave, South Africa. *L. Wadley et al.*

### 866 Intergroup relations

Building social cohesion between Christians and Muslims through soccer in post-ISIS Iraq. *S. Mousa*  
PERSPECTIVE p. 769; PODCAST

## DEPARTMENTS

### 749 Editorial

Vaccine nationalism's politics  
*By David P. Fidler*

### 874 Working Life

Interrupted—again. *By Kathy Gillen*

## ON THE COVER



A soccer game at Khazir refugee camp outside Erbil, northern Iraq. A randomized study assigned displaced Christians to a soccer team with displaced Muslims or to an all-Christian team. Playing on a mixed team improved Christians' behaviors toward Muslim peers, but not toward Muslims more broadly. The results highlight the potential and limitations of intergroup contact after war. See pages 769 and 866. Photo: Associated Press

Science Staff	746
New Products	871
Science Careers	872

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484-660) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2348; foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125489122. Publications Mail Agreement Number 1069524. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling, available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

21 AUGUST 2020 • VOLUME 369 ISSUE 6506

## SPECIAL SECTION

# MUD

### 894 INTRODUCTION

By D. Malakoff

### 896 MUD ON THE MOVE

By D. Malakoff, N. Desai, and X. Liu

### 898 A MUDDY LEGACY

A dozen years after two scientists showed how centuries-old mud has smothered many U.S. streams, their ideas are guiding restoration efforts. *By P. Voosen*

### 902 THE MUD IS ELECTRIC

Bacteria that conduct electricity are transforming how we see sediments

By E. Pennisi

### 904 Next up: a phone powered by microbial wires?

By E. Pennisi

PODCAST

### 906 A DAM BIG PROBLEM

A string of catastrophic failures has raised alarm about dams meant to contain muddy mine wastes

By W. Cornwall

### 910 RED ALERT

Researchers are working to find new uses for red mud, the caustic byproduct of aluminum production

By R. F. Service

### ON THE COVER



The muddy Markarfljót River in Iceland carries a heavy load of sediment to the sea. Throughout the world, mud—a mix of fine sediment and water—is one of the most common and consequential substances. For better and worse, humans are now heavily influencing how mud forms and where it piles up. See page 894.

Photo: Arctic-Images/Getty Images

### 890 Coronavirus creates a flu season guessing game

SARS-CoV-2's interactions with other pathogens remain unknown as winter looms

By K. Servick

### 892 Pandemic's fallout on malaria control appears limited so far

Countries avert disaster by resuming bed net campaigns

By L. Roberts

### 893 Pandemic lockdown stirs up ecological research

Biologists launch studies of how wildlife around the world responded to the "anthropause"

By E. Stokstad

PODCAST

## NEWS

### IN BRIEF

886 News at a glance

### IN DEPTH

### 888 Critics question whether novel reactor is 'walk-away safe'

Design approval nears for NuScale Power's small modular reactors, but deployment plans slip 3 years

By A. Cho

### 889 Paradox puts objectivity on shaky footing

Quantum test of venerable thought experiment suggests facts are relative

By G. Musser

882 21 AUGUST 2020 • VOL 369 ISSUE 6506

## INSIGHTS

### POLICY FORUM

### 912 Knowledge transfer for large-scale vaccine manufacturing

Massive, rapid production will require firms to share know-how not just about what to make but how to make it

By W. Nicholson Price II et al.

### PERSPECTIVES

### 915 The foundation of efficient robot learning

Innate structure reduces data requirements and improves robustness

By L. P. Kaelbling

### 917 A glycoprotein in urine binds bacteria and blocks infections

Direct imaging of a human fluid illuminates the molecular basis of urinary tract protection from disease

By W. Kukulski

REPORT p. 1005

### 918 When the smallest details count

The type of liquid crystals formed by smooth colloidal rods depends on their degree of curvature

By M. H. Godinho

RESEARCH ARTICLE p. 950

### 919 Remodeling vasculature to avoid blindness

Pathological vasculature marks itself for repair by deploying neutrophil extracellular traps

By E. A. Podrez and T. V. Byzova

RESEARCH ARTICLE p. 934

### 921 Immunotherapy with a sting

New agonists of an innate immune pathway induce antitumor immunity in mice

By T. F. Gajewski and E. F. Higgs

RESEARCH ARTICLE p. 935; REPORT p. 993

### 923 Past, present, and future of lead-acid batteries

Improvements could increase energy density and enable power-grid storage applications

By P. P. Lopes and V. R. Stamenkovic

### 925 James G. Townsel (1935–2020)

Neuroscientist and devoted mentor of diverse scientists

By R. Nishi et al.

### BOOKS ET AL.

### 926 One step forward, two steps back

Interest groups and state-level political inertia have stalled many of America's clean energy initiatives

By S. H. Ali

### 927 Ray Bradbury, luminary of the space age, at 100

A new biography chronicles the golden years of Earth's first martian

By I. Ockert

## LETTERS

### 928 Baer's pochard duck at risk of extinction

By X. Tong

### 928 Waterbirds' coastal habitat in danger

By Y. Wu et al.

### 929 Protect the giant ibis through the pandemic

By H. Yang et al.

### 929 Errata

## RESEARCH

### IN BRIEF

930 From *Science* and other journals

### REVIEW

#### 933 Photosynthesis

Light harvesting in oxygenic photosynthesis: Structural biology meets spectroscopy

R. Croce and H. van Amerongen

REVIEW SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.AAY2058

### RESEARCH ARTICLES

#### 934 Biomedicine

Neutrophil extracellular traps target senescent vasculature for tissue remodeling in retinopathy

F. Binet et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.AAY5356

PERSPECTIVE p. 919

#### 935 Drug development

An orally available non-nucleotide STING agonist with antitumor activity

B.-S. Pan et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABA6098

PERSPECTIVE p. 921; REPORT p. 993

#### 936 Cancer immunology

Cross-reactivity between tumor MHC class I-restricted antigens and an enterococcal bacteriophage

A. Fluckiger et al.

#### 942 Cancer immunology

BTN3A1 governs antitumor responses by coordinating  $\alpha\beta$  and  $\gamma\delta$  T cells

K. K. Payne et al.

#### 950 Liquid crystals

Shaping colloidal bananas to reveal biaxial, splay-bend nematic, and smectic phases

C. Fernández-Rico et al.

PERSPECTIVE p. 918

Ice core drilled at Concordia Station in Antarctica suggests fast, pulse-like jumps in atmospheric CO<sub>2</sub> of the distant past.

1000



#### 956 Coronavirus

Isolation of potent SARS-CoV-2 neutralizing antibodies and protection from disease in a small animal model

T. F. Rogers et al.

#### 963 Global climate change

Synchronous timing of abrupt climate changes during the last glacial period

E. C. Corrick et al.

### REPORTS

#### 970 Organic chemistry

Asymmetric remote C-H borylation of aliphatic amides and esters with a modular iridium catalyst

R. L. Reyes et al.

#### 974 Chemical physics

Attosecond spectroscopy of liquid water

I. Jordan et al.

#### 979 Surface chemistry

Covalent surface modifications and superconductivity of two-dimensional metal carbide MXenes

V. Kamysbayev et al.

#### 984 Immunology

SOSTDC1-producing follicular helper T cells promote regulatory follicular T cell differentiation

X. Wu et al.

#### 988 Neuroscience

Julich-Brain: A 3D probabilistic atlas of the human brain's cytoarchitecture

K. Arnouts et al.

#### 993 Drug development

Antitumor activity of a systemic STING-activating non-nucleotide cGAMP mimetic

E. N. Chin et al.

PERSPECTIVE p. 921; RESEARCH ARTICLE p. 935

#### 1000 Global carbon cycle

Abrupt CO<sub>2</sub> release to the atmosphere under glacial and early interglacial climate conditions

C. Nehrbass-Ahles et al.

#### 1005 Microbiology

Architecture and function of human uromodulin filaments in urinary tract infections

G. L. Weiss et al.

PERSPECTIVE p. 917

### Coronavirus

1010 Studies in humanized mice and convalescent humans yield a SARS-CoV-2 antibody cocktail

J. Hansen et al.

1014 Antibody cocktail to SARS-CoV-2 spike protein prevents rapid mutational escape seen with individual antibodies

A. Baum et al.

### DEPARTMENTS

#### 884 Editorial

Black scientists matter

By Malegapuru William Makgoba

#### 885 Editorial

A dangerous rush for vaccines

By H. Holden Thorp

#### 1026 Working Life

Choose your adviser wisely

By Akshata Naik

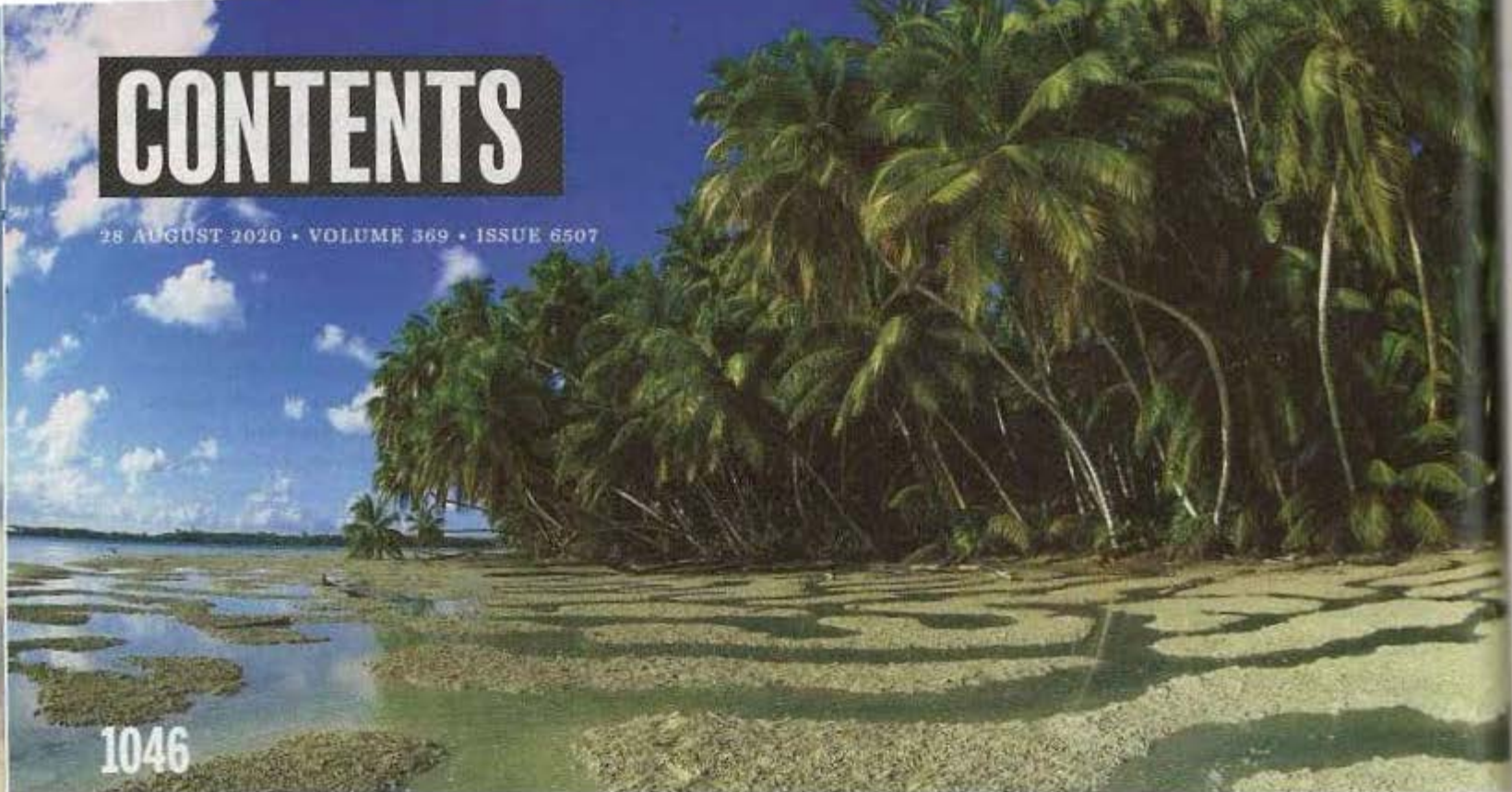
Science Careers ..... 1019

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra; Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R123456789. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20009-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

28 AUGUST 2020 • VOLUME 369 • ISSUE 6507



1046

On Palmyra Atoll in the central Pacific, a restoration project seeks to remove millions of invasive coconut palms.

## NEWS

### IN BRIEF

1036 News at a glance

### IN DEPTH

**1038 In plasma OK, critics see politics, not science**

FDA's emergency move raises fears of rushed approval for other experimental medicines  
By K. Kupferschmidt and J. Cohen

**1039 Critics slam NIH for demands on bat grant targeted by Trump**

Nobelists, former agency leaders deplore politicization  
By M. Wadman

**1040 How Italy's 'father of the swabs' fought the virus**

Microbiologist Andrea Crisanti defied the authorities to launch his testing campaign  
By D. Starr

**1041 Spit shines for easier coronavirus testing**

Tests using saliva are cheaper and faster than those with nasal swabs—and can be just as accurate  
By R. F. Service

**1042 Hidden web of fungi could shape the future of forests**

Plants' fungal partners can help their hosts resist drought and heat—or make them more vulnerable  
By E. Pennisi and W. Cornwall

**1043 New feedbacks speed up the demise of Arctic sea ice**

Wave action and a growing underwater blob of heat add to impact of warming air  
By P. Voosen  
PODCAST

**1045 How 'elite controllers' tame HIV without drugs**

Rare people who naturally subdue the virus may weed out cells with active HIV genomes  
By J. Cohen

### FEATURES

**1046 Ridding paradise of palms**

On Pacific islands, coconut palms are an aggressive invader. Biologists are trying to eradicate millions of palms from one atoll  
By K. R. Weiss

## INSIGHTS

### PERSPECTIVES

**1050 Bridging digital health divides**

COVID-19 is accelerating digital transformation in the Indian health sector  
By A. Agrawal

**1052 Restoring neuron connections**

A synthetic peptide promotes functional recovery in neurodegeneration and spinal cord injury models  
By P. C. Salinas  
RESEARCH ARTICLE p. 1074

**1054 A quantum-computing advantage for chemistry**

Error-mitigated Hartree-Fock computation is performed with up to 12 superconducting qubits  
By X. Yuan  
RESEARCH ARTICLE p. 1084

**1055 Zika virus increases risk of dengue disease**

Interactions between Zika virus immunity and dengue disease have implications for vaccination  
By H. Clapham  
REPORT p. 1123

**1056 Strategies for navigating a dynamic world**

A rich neural representation of its environment enables an adaptable organism to respond to changes  
By S. Steiner-Kumar and J. Gläscher  
RESEARCH ARTICLE p. 1076

**1058 The origins of water**

New measurements of Earth's building blocks point to a simpler water source  
By A. H. Peslier  
REPORT p. 1110

**1059 Zena Werb (1945–2020)**

Pioneering cancer biologist and beloved mentor  
By N. Boudreau and M. Bissell

### POLICY FORUM

**1060 Computational social science: Obstacles and opportunities**

Data sharing, research ethics, and incentives must improve  
By D. M. J. Lazer et al.

## BOOKS ET AL.

### 1063 Secrets of the Vikings

The violent seafarers are brought to vivid life in a rich synthesis of old and new scholarship  
By T. H. McGovern

### 1064 A history of insatiable intellectuals

Proficient in a range of topics, polymaths are overlooked as often as they are celebrated  
By A. Robinson

## LETTERS

### 1065 Development projects jeopardize India's forests

By S. Khadakkar

### 1065 North African forests falling to charcoal

By R. Khelifa

### 1066 Protect Iran's Zagros forests from wildfires

By M. Kheshti

### 1066 Errata

# RESEARCH

## IN BRIEF

1069 From Science and other journals

## REVIEW

### 1072 Paleocology

Using paleo-archives to safeguard biodiversity under climate change  
D. A. Fordham et al.

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC5654  
PODCAST

## RESEARCH ARTICLES

### 1073 Microbial engineering

A heterogeneous microbial consortium producing short-chain fatty acids from lignocellulose  
R. L. Shahab et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB1214



### 1074 Neuroscience

A synthetic synaptic organizer protein restores glutamatergic neuronal circuits  
K. Suzuki et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB4853  
PERSPECTIVE p. 1052

### 1075 Cell biology

Seeing around corners: Cells solve mazes and respond at a distance using attractant breakdown  
L. Tweedy et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY9792

### 1076 Neuroscience

Neural mechanisms resolving exploitation-exploration dilemmas in the medial prefrontal cortex  
P. Domenech et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB0184  
PERSPECTIVE p. 1056

### 1077 Microbiology

Diverse enzymatic activities mediate antiviral immunity in prokaryotes  
L. Gao et al.

### 1084 Quantum computing

Hartree-Fock on a superconducting qubit quantum computer  
Google AI Quantum and Collaborators

PERSPECTIVE p. 1054

### 1089 Structural biology

Architecture of a catalytically active homotrimeric plant cellulose synthase complex  
P. Purushotham et al.

## REPORTS

### 1094 Bacterial metabolism

A nitrogenase-like enzyme system catalyzes methionine, ethylene, and methane biogenesis  
J. A. North et al.

### 1099 Electrochemistry

Accelerating water dissociation in bipolar membranes and for electrocatalysis  
S. Z. Oener et al.

### 1104 Carbon nanotubes

Super-durable ultralong carbon nanotubes  
Y. Bai et al.

### 1106 Coronavirus

Serial interval of SARS-CoV-2 was shortened over time by nonpharmaceutical interventions  
S. T. Ali et al.

### 1110 Cosmochemistry

Earth's water may have been inherited from material similar to enstatite chondrite meteorites  
L. Piani et al.  
PERSPECTIVE p. 1058

### 1113 Organic chemistry

Static to inducibly dynamic stereocontrol: The convergent use of racemic  $\beta$ -substituted ketones  
J. S. DeHovitz et al.

### 1119 Coronavirus

Structural basis of a shared antibody response to SARS-CoV-2  
M. Yuan et al.

### 1123 Flaviviruses

Zika virus infection enhances future risk of severe dengue disease  
L. C. Katzelnick et al.  
PERSPECTIVE p. 1055

### 1128 Immunogenomics

Mosquito cellular immunity at single-cell resolution  
G. Raddi et al.

### 1132 Protein design

Expanding the space of protein geometries by computational design of de novo fold families  
X. Pan et al.

## DEPARTMENTS

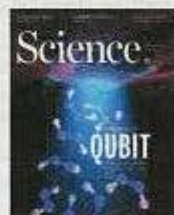
### 1035 Editorial

The danger of DIY vaccines  
By Arthur L. Caplan and Alison Bateman-House

### 1138 Working Life

One, two, three, thrive  
By Sleun Ruth Lee

## ON THE COVER



The Sycamore quantum processor, composed of an array of superconducting transmon qubits, simulates the energy of the diazene molecule in various conformations. By combining error mitigation and improved qubit calibration techniques, the simulation accurately models the isomerization pathway that reorients the hydrogen atoms (white) about the central bonds between nitrogen atoms (blue). See pages 1054 and 1084. *Illustration: C. Bickel/Science*

Science Staff .....1034  
AAAS News & Notes .....1067  
Science Careers .....1137

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484480) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R123456789. Publications Mail Agreement Number 3069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

4 SEPTEMBER 2020 • VOLUME 369 • ISSUE 6508



## SPECIAL SECTION

## DEMOCRACY IN THE BALANCE

## INTRODUCTION

**1174** In flux and under threat

## POLICY FORUMS

**1176** Racial authoritarianism in U.S. democracy *By V. M. Weaver and G. Prowse*

**1179** Human-centered redistricting automation in the age of AI *By W. K. T. Cho and B. E. Cain*

## PERSPECTIVE

**1181** Campaigns influence election outcomes less than you think *By D. W. Nickerson and T. Rogers*

## REVIEWS

**1183** Diversity and prosocial behavior *D. Baldassarri and M. Abascal*

**1188** Can democracy work for the poor? *R. Pande*  
PODCAST

**1192** Democracy's backsliding in the international environment *S. D. Hyde*  
VIDEO

**1197** False equivalencies: Online activism from left to right *D. Freelon et al.*

## ON THE COVER

Democracy is a global phenomenon, but so are the myriad challenges that threaten to throw it off balance. Violence and repression, polarization and disinformation, diversity and

inequality—all highlight the need for social and behavioral scientists to understand how democracy might adapt and even thrive in the face of such obstacles. See page 1174. *Illustration: Davide Bonazzi/salzmanart*



SEE ALSO EDITORIAL p. 1147 SCIENCE ADVANCES RESEARCH ARTICLE BY M. BARBER AND J. B. HOLBEIN 10.1126/SCIADV.ABC7685

## INSIGHTS

## PERSPECTIVES

### 1160 High-precision molecular measurement

Spectroscopy of hydrogen deuteride ions provides the proton-to-electron mass ratio *By M. Hori*

REPORT p. 1238

### 1161 Soil age alters the global silicon cycle

As rocks undergo prolonged chemical weathering, plants become more important for supplying bioavailable silicon *By J. Carey*

REPORT p. 1245

### 1163 Dynamics of death by heat

Time at high temperature modulates fly mortality in nature *By R. B. Huey and M. R. Kearney*

REPORT p. 1242

### 1164 Sexual dimorphism in body clocks

Sexual dimorphism in chronobiology has implications for the health of our 24-hour society *By S. T. Anderson and G. A. FitzGerald*

### 1166 Can proteins be truly designed sans function?

A new unit of local protein structure can aid in the de novo design of ligand-binding proteins *By A. Peacock*

RESEARCH ARTICLE p. 1227

### 1167 A molecular trap against COVID-19

Structure-function studies reveal a new receptor decoy to block virus entry *By B. J. DeKosky*

REPORT p. 1261

## BOOKS ET AL.

### 1169 The Stepford wife gets smart

A pair of digital scholars confront the troubling implications of feminized household management technologies *By M. E. Sweeney*

### 1170 Biology's brave new world

The promise and perils of synthetic biology take center stage in a fast-paced new series. *By D. Greenbaum*

## LETTERS

### 1171 Editorial Expression of Concern

*By H. Holden Thorp*

### 1171 The dangers of Arctic zombie wildfires

*By M. Irannezhad et al.*

## NEWS

## IN BRIEF

**1148** News at a glance

## IN DEPTH

### 1151 Can Europe tame the pandemic's next wave?

Countries seek new strategies as coronavirus cases are rising again across the continent *By K. Kupferschmidt*

PODCAST

### 1152 Bill threatens key Brazilian universities

Proposal to strip São Paulo institutions of reserve funds draws fierce opposition *By I. Amigo*

### 1153 Malaria fighters' latest chemical weapon may not last long

Clothianidin-resistant mosquitoes already seen in Cameroon *By M. Makoni*

### 1154 An ecosystem goes topsy-turvy as a tiny fish takes over

Predator-prey reversal has dramatically altered the underwater ecosystem along the Baltic Coast archipelago *By E. Pennisi*

### 1155 Cannabis research data reveals a focus on harms of the drug

Funding for therapies grows slowly, new analysis finds *By C. O'Grady*

## FEATURES

### 1156 The carbon vault

Industrial waste can combat climate change by turning carbon dioxide into stone *By R. F. Service*

**1171 Support transgender scientists post-COVID-19**

By S. Turney et al.

**1172 Adapt taxonomy to conservation goals**

By D. P. O'Connell et al.

**RESEARCH****IN BRIEF****1203** From *Science* and other journals**RESEARCH ARTICLES****1206 Cell biology**

Reconstitution of autophagosome nucleation defines Atg9 vesicles as seeds for membrane formation

J. Sawa-Makarska et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAZ7714](https://doi.org/10.1126/SCIENCE.AAZ7714)**1207 Regeneration**

Changes in regeneration-responsive enhancers shape regenerative capacities in vertebrates

W. Wang et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAZ3090](https://doi.org/10.1126/SCIENCE.AAZ3090)**1208 Neuroscience**

Regulation of sleep homeostasis mediator adenosine by basal forebrain glutamatergic neurons

W. Peng et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABB0556](https://doi.org/10.1126/SCIENCE.ABB0556)**Coronavirus****1209** Deep immune profiling of COVID-19 patients reveals distinct immunotypes with therapeutic implications

D. Mathew et al.

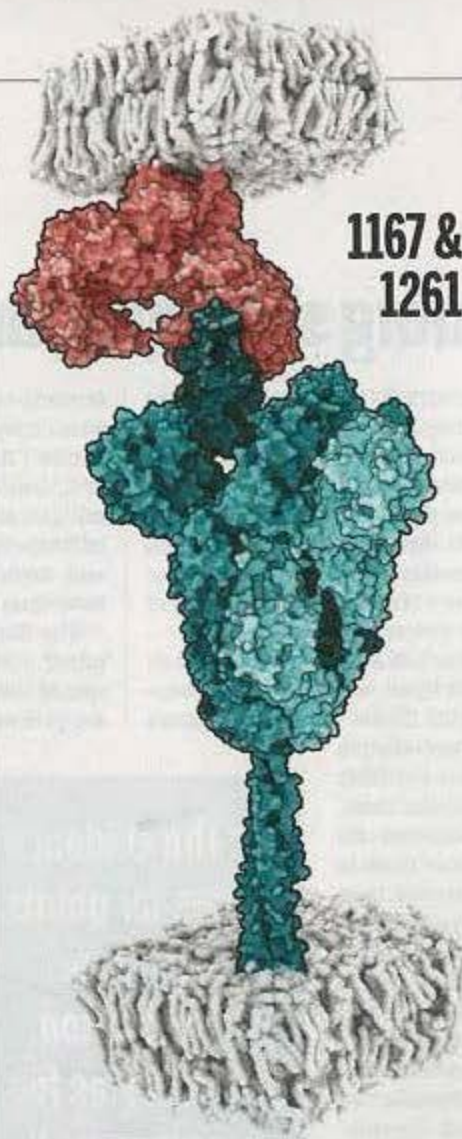
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABC8511](https://doi.org/10.1126/SCIENCE.ABC8511)**1210** Systems biological assessment of immunity to mild versus severe COVID-19 infection in humans

P. S. Arunachalam et al.

SCIENCE IMMUNOLOGY RESEARCH ARTICLE BY L. KURI-CERVANTES ET AL. [10.1126/SCIIMMUNOL.ABD7114](https://doi.org/10.1126/SCIIMMUNOL.ABD7114)**1220 Structural biology**

Structure of a human 48S translational initiation complex

J. Brito Querido et al.

**1227 Protein design**

A defined structural unit enables de novo design of small-molecule-binding proteins

N. F. Polizzi and W. F. DeGrado

PERSPECTIVE p. 1165

**REPORTS****1233 Stellar astrophysics**

A triple-star system with a misaligned and warped circumstellar disk shaped by disk tearing

S. Kraus et al.

**1238 Metrology**Proton-electron mass ratio from laser spectroscopy of HD<sup>+</sup> at the part-per-trillion level

S. Patra et al.

PERSPECTIVE p. 1160

**1242 Climate responses**Predicting temperature mortality and selection in natural *Drosophila* populations

E. L. Rezende et al.

PERSPECTIVE p. 1163

**1245 Biogeochemistry**

Plants sustain the terrestrial silicon cycle during ecosystem retrogression

F. de Tombeur et al.

PERSPECTIVE p. 1161

**1249 Coronavirus**

Structural basis for translational shutdown and immune evasion by the Nsp1 protein of SARS-CoV-2

M. Thoms et al.

**1255 Coronavirus**

Evolution and epidemic spread of SARS-CoV-2 in Brazil

D. S. Candido et al.

**1261 Coronavirus**

Engineering human ACE2 to optimize binding to the spike protein of SARS coronavirus 2

K. K. Chan et al.

PERSPECTIVE p. 1167

**DEPARTMENTS****1146 Editorial**

Reopening schools during COVID-19

By Ronan Jordan et al.

**1147 Editorial**

Enshrining equity in democracy

By Evelyn M. Hammonds

DEMOCRACY IN THE BALANCE SECTION p. 1174

**1270 Working Life**

Mentoring with trust

By René S. Shahmohammadloo

New Products ..... 1266  
Science Careers ..... 1267

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

11 SEPTEMBER 2020 • VOLUME 369 • ISSUE 6509

## 1288

A Fresnel lens could capture the flash of an alien laser.



## NEWS

04 JAN 2021

### IN BRIEF

1278 News at a glance

### IN DEPTH

#### 1280 Why obesity worsens COVID-19

Even people in the overweight category face higher risk of serious disease  
By M. Wadman

#### 1282 Speaking science to power

A young disease modeling expert has found her voice during the pandemic  
By K. Servick

#### 1283 Narrow path charted for editing genes of human embryos

Panel outlines most justifiable uses if safety is ensured  
By J. Cohen

#### 1284 Indigenous Alaskans demand a voice in research on warming

NSF program struggles to bridge scientists and communities  
By R. Stone

#### 1285 Census experts fear rush to finish tally will yield flawed data

Mounting fears of massive U.S. undercount spur push for independent oversight, more time to complete 2020 count  
By J. Mervis

#### 1286 Massive project reveals complexity of gene regulation

Data from tissues around the body boost search for genetic basis of disease  
By E. Pennisi  
GENETIC VARIATION SECTION p. 1316

### FEATURES

#### 1288 Listen up

Flush with money and a hard-won respectability, alien hunters are deploying new telescopes and tactics  
By D. Clery  
PODCAST

## INSIGHTS

### BOOKS ET AL.

1292 A reading list for uncertain times

### PERSPECTIVES

#### 1298 Searching for sex differences

Evolved sex differences in gene expression are pervasive, but so too is sampling bias  
By M. A. Wilson  
GENETIC VARIATION SECTION P. 1316;  
LETTER P. 1313

#### 1299 Quiet Anthropocene, quiet Earth

Seismic noise levels that correlate with human activities fell when pandemic lockdown measures were imposed  
By M. A. Denolle and T. Nissen-Meyer  
REPORT p. 1338

#### 1300 A key piece of the ferroelectric hafnia puzzle

Dipolar slices explain the origin of ferroelectricity in a material now used for memory devices  
By B. Noheda and J. Íñiguez  
REPORT p. 1343

#### 1302 Modulating gut microbes

Fecal microbiota transplant and modulation of microbial species show therapeutic promise  
By J. A. Wargo

#### 1304 Laser cooling of larger quantum objects

A nonlinear polyatomic molecule,  $\text{CaOCH}_3$ , has been laser-cooled to below 1 millikelvin  
By E. R. Hudson  
REPORT p. 1366

#### 1305 Reactive polymers guide nanoparticle clustering

Tailored polymer shells drive the assembly of a desired class of nanoparticle architectures  
By O. Gang  
REPORT p. 1369

#### 1306 Coronavirus dons a new crown

A transmembrane pore reveals parallels with other viruses  
By N. Unchwaniwala and P. Ahlquist  
REPORT p. 1395



## SPECIAL SECTION

## GENETIC VARIATION

## INTRODUCTION

1316 The custom transcriptome

## RESEARCH

1318 The GTEx Consortium atlas of genetic regulatory effects across human tissues *GTEx Consortium*

1331 The impact of sex on gene expression across human tissues *M. Oliva et al.*

1332 Cell type-specific genetic regulation of gene expression across human tissues *S. Kim-Hellmuth et al.*

1333 Determinants of telomere length across human tissues *K. Demanelis et al.*

## PODCAST

1334 Transcriptomic signatures across human tissues identify functional rare genetic variation *N. M. Ferraro et al.*

## ON THE COVER

Genetic variation among individuals affects the transcriptome differently. Here, heatmaps of differential gene expression are shown within individual bodies to visualize the results obtained by the Genotype-Tissue Expression (GTEx) Project. This special issue



presents research from the final phase of the project. See page 1316.

Illustration: *V. Altounian/Science, in collaboration with Christian Stolte; (Data) GTEx Consortium*

SEE ALSO: NEWS STORY p. 1286; PERSPECTIVE p. 1298; SCIENCE ADVANCES RESEARCH ARTICLE BY M. PIVORNI ET AL. 10.1126/SCIADV.ABA2083; SCIENCE ADVANCES RESEARCH ARTICLE BY A. DUFFY ET AL. 10.1126/SCIADV.ABB6242; SCIENCEMAG.ORG/COLLECTIONS/GENETIC-VARIATION

## 1308 Flossie Wong-Staal (1946–2020)

Trailblazing HIV researcher

By *G. Franchini*

## POLICY FORUM

## 1309 An ethical framework for global vaccine allocation

The Fair Priority Model offers a practical way to fulfill pledges to distribute vaccines fairly and equitably

By *E. J. Emanuel et al.*

## LETTERS

## 1313 NIH must confront the use of race in science

By *M. Yudel*

PERSPECTIVE p. 1298

## 1314 Accumulation of plastic waste during COVID-19

By *T. M. Adyel*

## 1315 Microplastic's role in antibiotic resistance

By *M. S. Bank et al.*

## 1315 TECHNICAL COMMENT ABSTRACTS

## RESEARCH

## IN BRIEF

1335 From *Science* and other journals

## REPORTS

## 1338 Seismology

Global quieting of high-frequency seismic noise due to COVID-19 pandemic lockdown measures *T. Lecocq et al.*

PERSPECTIVE p. 1299

## 1343 Ferroelectrics

Scale-free ferroelectricity induced by flat phonon bands in  $\text{HfO}_2$  *H.-J. Lee et al.*

PERSPECTIVE p. 1300

## 1347 Cosmology

An excess of small-scale gravitational lenses observed in galaxy clusters *M. Meneghetti et al.*

## 1351 Trophic cascades

Keystone predators govern the pathway and pace of climate impacts in a subarctic marine ecosystem *D. B. Rasher et al.*

## Structural biology

1355 Structural basis of transcription-translation coupling and collision in bacteria *M. W. Webster et al.*

1359 Structural basis of transcription-translation coupling *C. Wang et al.*

## 1366 Ultracold physics

Direct laser cooling of a symmetric top molecule *D. Mitra et al.*

PERSPECTIVE p. 1304

## 1369 Colloids

Self-limiting directional nanoparticle bonding governed by reaction stoichiometry *C. Yi et al.*

PERSPECTIVE p. 1305

## 1374 Atmospheric aerosols

Multiphase buffer theory explains contrasts in atmospheric aerosol acidity *G. Zheng et al.*

## 1378 Tropical forest

Long-term forest degradation surpasses deforestation in the Brazilian Amazon *E. A. T. Matricardi et al.*

## 1383 Global climate

An astronomically dated record of Earth's climate and its predictability over the last 66 million years *T. Westerhold et al.*

## 1388 Circadian rhythms

The hepatocyte clock and feeding control chronophysiology of multiple liver cell types *D. Guan et al.*

## 1395 Coronavirus

A molecular pore spans the double membrane of the coronavirus replication organelle *G. Wolff et al.*

PERSPECTIVE p. 1306

## DEPARTMENTS

## 1277 Editorial

Systemic equity in education *By Gilda A. Barabino*

## 1402 Working Life

Data-driven advice for grad school *By Abigail M. Brown*

New Products ..... 1399  
Science Careers ..... 1400

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484660) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$174 allocated to subscription). Domestic and international subscription rates for libraries and institutions: \$2148. Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and E-mail account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

18 SEPTEMBER 2020 • VOLUME 369 • ISSUE 6510

1419

Stigma adds to the anguish of an HIV-positive woman.

## NEWS

### IN BRIEF

1410 News at a glance

### IN DEPTH

1412 **Pandemic inspires push to shrink jails, prisons**

New research focuses on the health and public safety impacts of “decarceration” *By K. Servick*  
PODCAST

1414 **Viral heart damage under scrutiny**

Researchers are hunting for myocarditis in COVID-19 survivors *By J. Couzin-Frankel*

1415 **Trials begin for a new weapon against Parkinson’s: light**

Patients report benefits, but how near-infrared protects brain cells is unclear, and some scientists are skeptical *By G. Sinha*

1416 **Ancient DNA tracks Vikings across Europe**

Massive sequencing effort shows people of diverse genetic backgrounds adopted Viking culture *By A. Curry*

1418 **Global efforts to protect biodiversity fall short**

New report finds glimmers of progress, but nations are not achieving targets *By E. Stokstad*

### FEATURES

1419 **The burden of stigma**

Past epidemics reveal how social stigma amplifies the dangers of infectious disease *By V. Chandrasekhar*

## INSIGHTS

### PERSPECTIVES

1424 **An unexpected audience**

Experiments with magic effects might be informative about cognition in animals *By E. Garcia-Pelegrin et al.*  
PODCAST

1426 **The gut microbiota in kidney disease**

Dietary changes induce posttranslational modifications of microbial proteins to alter metabolite production *By J. L. Pluznick*  
REPORT p. 1518

1427 **Messengers from the microbiota**

Microbiota produce inosine, a metabolite that modulates effector T cells and tumor immunity *By F. Y. Shaikh and C. L. Sears*  
REPORT p. 1481

1429 **Protecting the sewershed**

As cities use sewage as a water source, proactive policies must safeguard public health *By S. Harris-Lovett and D. Sedlak*

1431 **Tempus fugit: How time flies during development**

Developmental-timing differences between species are linked to protein turnover *By R. Iwata and P. Vanderhaeghen*  
RESEARCH ARTICLES pp. 1449 & 1450

1432 **Multiplicative suppression of decoherence**

Combining different protocols extends the life of a quantum system *By P. Hemmer*  
REPORT p. 1493

1433 **Advance in global ocean acoustics**

Earthquakes can be used to define changes in ocean heat content *By C. Wunsch*  
REPORT p. 1510

### POLICY FORUM

1435 **Global citizen deliberation on genome editing**

Global governance can be informed by a deliberative assembly composed of lay citizens *By J. S. Dryzek et al.*

### BOOKS ET AL.

1438 **Why the West is WEIRD**

Catholicism’s policy forbidding cousins to wed may have led to the distinctive characteristics of Western society *By P. Grasjean*

**1439 A case study of Oliver Sacks**

Interviews and archival footage paint a tender portrait of neurology's greatest storyteller. *By L. J. Snyder*

**LETTERS****1440 Portugal's airport plans threaten wetlands**

*By J. A. Alves and M. P. Dias*

**1440 Systemic racism in higher education**

*By P. H. Barber et al.*

**1441 University-pharmacy partnerships for COVID-19**

*By V. J. Venditto et al.*

**RESEARCH****IN BRIEF**

**1443** From *Science* and other journals

**REVIEW****1446 Urban ecology**

The ecological and evolutionary consequences of systemic racism in urban environments. *C. J. Schell et al.*

REVIEW SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY4497](https://doi.org/10.1126/SCIENCE.AAY4497)

**1447 Neurodevelopment**

Looking at neurodevelopment through a big data lens. *J. Briscoe and O. Marin*

REVIEW SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AA28627](https://doi.org/10.1126/SCIENCE.AA28627)

**RESEARCH ARTICLES****1448 Inflammasomes**

HDAC6 mediates an aggresome-like mechanism for NLRP3 and pyrin inflammasome activation. *V. G. Magupalli et al.*

**Developmental biology**

**1449** Species-specific pace of development is associated with differences in protein stability. *T. Rayon et al.*

RESEARCH ARTICLE SUMMARY;  
FOR FULL TEXT:  
[DX.DOI.ORG/10.1126/SCIENCE.ABA7667](https://doi.org/10.1126/SCIENCE.ABA7667)

**1450** Species-specific segmentation clock periods are due to differential biochemical reaction speeds. *M. Matsuda et al.*

PERSPECTIVE p. 1431

**1455 Plastic pollution**

Evaluating scenarios toward zero plastic pollution. *W. W. Y. Lau et al.*

REPORT p. 1515

**1461 Surface chemistry**

Following the microscopic pathway to adsorption through chemisorption and physisorption wells. *D. Borodin et al.*

**1465 Coronavirus**

Assessing the impact of coordinated COVID-19 exit strategies across Europe. *N. W. Ruktanonchai et al.*

**1470 Structural biology**

90S pre-ribosome transformation into the primordial 40S subunit. *J. Cheng et al.*

REPORT p. 1477

**REPORTS****1477 Structural biology**

Cryo-EM structure of 90S small ribosomal subunit precursors in transition states. *Y. Du et al.*

RESEARCH ARTICLE p. 1470

**1481 Microbiome**

Microbiome-derived inosine modulates response to checkpoint inhibitor immunotherapy. *L. F. Mager et al.*

PERSPECTIVE p. 1427

**1490 Water structure**

Reversible structural transformations in supercooled liquid water from 135 to 245 K. *L. Kringle et al.*

**1493 Quantum systems**

Universal coherence protection in a solid-state spin qubit. *K. C. Miao et al.*

PERSPECTIVE p. 1432

**1497 Stellar evolution**

(Sub)stellar companions shape the winds of evolved stars. *L. Decin et al.*

**1501 Coronavirus**

Structure-based design of prefusion-stabilized SARS-CoV-2 spikes. *C.-L. Hsieh et al.*

**1505 Coronavirus**

Structural basis for neutralization of SARS-CoV-2 and SARS-CoV by a potent therapeutic antibody. *Z. Lv et al.*

**1510 Ocean warming**

Seismic ocean thermometry. *W. Wu et al.*

PERSPECTIVE p. 1433; VIDEO

**1515 Plastic pollution**

Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *S. B. Borrelle et al.*

RESEARCH ARTICLE p. 1455

**1518 Microbiota**

Diet posttranslationally modifies the mouse gut microbial proteome to modulate renal function. *L. Lobel et al.*

PERSPECTIVE p. 1426

**DEPARTMENTS****1409 Editorial**

Trump lied about science. *By H. Holden Thorp*

**1534 Working Life**

Delivering a difference. *By Dennis Macejak*

**ON THE COVER**

Plastic waste collects at a landfill near Talesh, northern Iran. Plastic production has surged in recent decades, and plastic waste is accumulating rapidly in every



area of the environment. Reducing the amount of plastic pollution in the near future will require concerted global intervention. See pages 1455 and 1515. Photo: Ashkan Shabani/Redux

Science Careers ..... 1525

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$24 allocated to subscription). Domestic institutional subscription (12 issues): \$2148; foreign postage extra. Air assist delivery: \$98. First class, animal, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125498122. Publications Mail Agreement Number 1069524. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

25 SEPTEMBER 2020 • VOLUME 369 • ISSUE 6511 19 MAR 2021

## 1558

Costa Rica's biodiversity has been a magnet for outside scientists.

## NEWS

### IN BRIEF

**1548** News at a glance

### IN DEPTH

**1550 Flawed interferon response spurs severe illness**

Antibodies or mutations that cripple key antiviral protein underlie 14% of severe cases  
By M. Wadman

RESEARCH ARTICLE BY Q. ZHANG ET AL.  
DX.DOI.ORG/10.1126/SCIENCE.ABD4570;  
RESEARCH ARTICLE BY P. BASTARD ET AL.  
DX.DOI.ORG/10.1126/SCIENCE.ABD4585

**1551 Fighting to be counted**

The pandemic has fueled Abigail Echo-Hawk's quest for health data on Indigenous people in the United States  
By L. Wade

**1553 Despite obstacles, WHO unveils plan to distribute vaccine**

Nations with nearly two-thirds of world's population have joined, but not the United States, Russia, or China  
By K. Kupferschmidt

**1554 Turkey targets critics of its pandemic response**

Researchers and physicians who question data or policies face lengthy investigations  
By K. McTighe

**1555 Curved scour marks trace the directions of ancient quakes**

"Slickenlines" etched in rocks could help refine shaking hazard for cities near the ends of faults  
By P. Voosen

**1556 The short, strange life of quantum radar**

In spite of military interest, quantum mechanics won't defeat stealth technologies  
By A. Cho

**1557 Sizing up a green carbon sink**

Studies zero in on forests' potential to fight warming  
By G. Popkin

### FEATURES

**1558 Seeking a niche**

Costa Rica is producing a new generation of skilled tropical biologists. But many can't find jobs at home  
By J. Kaiser

**1561 A tropical research treasure faces difficult times**

By J. Kaiser

## INSIGHTS

### PERSPECTIVES

**1562 Transformative tools for parasitic flatworms**

Schistosome single-cell atlas and genome-wide functional dissection reveal druggable targets  
By T. J. C. Anderson and M. T. Duraisingh  
REPORTS pp. 1644 & 1649

**1564 Preventing pores and inflammation**

Metabolite-directed modification of pore-forming cell death protein limits inflammation  
By R. J. Pickering and C. E. Bryant  
REPORT p. 1633

**1565 The last pieces of a puzzling early meeting**

Y chromosomes transferred from *Homo sapiens* to Neanderthals between 350,000 to 150,000 years ago  
By M. H. Schierup  
REPORT p. 1653

**1567 Birds do have a brain cortex—and think**

Like mammals, birds have a pallium that sustains correlates of consciousness  
By S. Herculano-Houzel  
RESEARCH ARTICLE p. 1585; REPORT p. 1626

**1568 Intense x-rays can be (slightly) exciting**

Imaging of neutral "survivor" atoms excited by x-ray blasts fights radiation damage  
By T. Pfeifer  
REPORT p. 1630

### POLICY FORUM

**1570 Self-experimentation, ethics, and regulation of vaccines**

DIY COVID-19 vaccines raise legal and ethical questions  
By C. J. Guerrini et al.

### BOOKS ET AL.

**1573 Understanding quantum cause and effect**

Correlations at a distance needn't necessarily be "spooky"  
By A. Stairs

**1574 The race to decipher Egyptian hieroglyphs**

A pair of scholars recount the rivalry that defined efforts to interpret the Rosetta stone  
By A. Robinson

1562, 1644,  
& 1649

## LETTERS

**1575 India needs an effective flood policy**

By Y. Jameel et al.

**1576 Traditional Knowledge underlies One Health**

By J. Copper Jack et al.

**1576 Swiss law would weaken wildlife protection**

By R. Arlettaz and G. Chapron

## RESEARCH

## IN BRIEF

**1579** From Science and other journals

## REVIEW

**1582 Immunology**The science and medicine of human immunology *B. Pulendran and M. M. Davis*REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY4014

## RESEARCH ARTICLES

**1583 Structural biology**The endoplasmic reticulum P5A-ATPase is a transmembrane helix dislocase  
*M. J. McKenna et al.*RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC5809**1584 Prebiotic chemistry**Synthetic connectivity, emergence, and self-regeneration in the network of prebiotic chemistry *A. Wołos et al.*RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAW1955**1585 Neuroscience**A cortex-like canonical circuit in the avian forebrain *M. Stacho et al.*RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC5534  
PERSPECTIVE p. 1567**1586 Coronavirus**Distinct conformational states of SARS-CoV-2 spike protein *Y. Cai et al.***1592 Chemical physics**Rotational resonances in the H<sub>2</sub>CO roaming reaction are revealed by detailed correlations  
*M. S. Quinn et al.***1597 Graphene**Inducing metallicity in graphene nanoribbons via zero-mode superlattices *D. J. Rizzo et al.***1603 Coronavirus**Adaptation of SARS-CoV-2 in BALB/c mice for testing vaccine efficacy *H. Gu et al.***1608 Immune systems**The immunogenetics of sexual parasitism  
*J. B. Swann et al.*

## REPORTS

**1615 Solar cells**Stable perovskite solar cells with efficiency exceeding 24.8% and 0.3-V voltage loss  
*M. Jeong et al.***1621 Ocean temperature**High-impact marine heatwaves attributable to human-induced global warming  
*C. Laufkötter et al.***1626 Consciousness**A neural correlate of sensory consciousness in a corvid bird *A. Nieder et al.*  
PERSPECTIVE p. 1567**1630 Spectroscopy**Photon-recoil imaging: Expanding the view of nonlinear x-ray physics *U. Eichmann et al.*  
PERSPECTIVE p. 1568**1633 Immunometabolism**Succination inactivates gasdermin D and blocks pyroptosis *F. Humphries et al.*  
PERSPECTIVE p. 1564**1637 Protein design**Designed protein logic to target cells with precise combinations of surface antigens  
*M. J. Lajole et al.*

## Parasite genetics

**1644** A single-cell RNA-seq atlas of *Schistosoma mansoni* identifies a key regulator of blood feeding  
*G. Wendt et al.***1649** Large-scale RNAi screening uncovers therapeutic targets in the parasite *Schistosoma mansoni* *J. Wang et al.*

PERSPECTIVE p. 1562

**1653 Y evolution**The evolutionary history of Neanderthal and Denisovan Y chromosomes *M. Petr et al.*  
PERSPECTIVE p. 1565; PODCAST

## DEPARTMENTS

**1543 Editorial**Dark skies and bright satellites  
By *Anthony Tyson and Joel Parriott***1662 Working Life**Full disclosure  
By *Emily Ashkin and Michelle Atallah*

## ON THE COVER

The ancestors of the carrion crow diverged from the mammalian lineage as early as 320 million years ago. Carrion crow brain activity suggests that sensory consciousness developed either before the emergence

of mammals or independently in the avian lineage and may not require a cerebral cortex, as we know it. See pages 1567 and 1626. Photo: *Tobias Machts, University of Tübingen*

Science Staff .....	1542
AAAS News & Notes .....	1577
Science Careers .....	1657

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$34 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

2 OCTOBER 2020 • VOLUME 370 • ISSUE 6512

SPECIAL SECTION

## NEURODEGENERATION

### INTRODUCTION

**48** A cruel end to too many lives

### REVIEWS

**50** Glymphatic failure as a final common pathway to dementia

*M. Nedergaard and S. A. Goldman*

**56** Beyond aggregation: Pathological phase transitions in neurodegenerative disease *C. Mathieu et al.*

**61** Translating genetic risk of Alzheimer's disease into mechanistic insight and drug targets *A. Sierksma et al.*

**66** Microglia modulate neurodegeneration in Alzheimer's and Parkinson's diseases *T. Bartels et al.*

### ON THE COVER

Neurodegeneration in later life robs us of our abilities and our memories, slowly and inexorably, like leaves falling from a tree. A greater understanding of the pathophysiological underpinnings within the



may provide crucial hints that will help us delay and perhaps even reverse symptoms. See page 48. *Illustration: Simon Prades*

SEE ALSO PERSPECTIVE p. 32

### 19 Stem cell studies probe origins of the placenta

Lab models of organ will track how it emerges—and what can go wrong  
*By K. Servick*

### 20 The 'bat man' tackles COVID-19

After a career investigating why so many viruses come from bats, Linfa Wang eyes a new challenge *By K. Kupferschmidt*

### 22 A call for diagnostic tests to report viral load

Measure could help officials know who is most contagious *By R. F. Service*

### FEATURES

#### 24 Official inaction

A *Science* investigation shows that FDA oversight of clinical trials is lax, slow moving, and secretive—and that enforcement is declining *By C. Piller*

#### 27 Disgraced researchers can still reap drug industry payouts

*By C. Piller*

PODCAST

## INSIGHTS

### LETTERS

**30** NextGen Voices:  
Funding fix: Spend time

### PERSPECTIVES

**32** Shifts and drifts in prion science  
Important questions remain unanswered since prions were discovered four decades ago *By A. Aguzzi and E. De Cecco*  
NEURODEGENERATION SECTION p. 48

#### 34 Mutational selection in normal urothelium

Mutations in normal tissue point to causes of DNA damage and set the stage for cancer  
*By S. G. Rozen*  
RESEARCH ARTICLES pp. 75 & 82

#### 36 Coaxing stem cells to repair the spinal cord

Spinal cells in mice can be induced to generate protective oligodendrocytes after injury *By C. G. Becker and T. Becker*  
RESEARCH ARTICLE p. 73

#### 37 A rival to superalloys at high temperatures

Slip-pathway activation provides plasticity in a multiprincipal element alloy with high-temperature strength *By J. Cairney*  
RESEARCH ARTICLE p. 95

## NEWS

### IN BRIEF

**14** News at a glance

### IN DEPTH

**16** Europe builds 'digital twin' of Earth to hone climate forecasts

Ingesting more data than ever before, exascale model will simulate the impact of climate change on humans *By P. Voosen*

#### 17 China's bold climate pledge earns praise—but is it feasible?

Plan to achieve carbon neutrality by 2060 would make China a global leader, but abandoning coal will be hard  
*By D. Normile*

#### 18 Record U.S. and Australian fires raise fears for many species

Scientists say fires likely wiped out some rare Australian organisms, and worry U.S. blazes now threaten more  
*By J. Pickrell and E. Pennisi*  
EDITORIAL p. 13

38 &amp; 117

**38 A boost for freshwater conservation**

Integrating freshwater and terrestrial conservation planning has high returns

By R. Abell and I. J. Harrison

REPORT p. 117

**POLICY FORUM****40 How to fix the GDPR's frustration of global biomedical research**

Sharing of data for research beyond the EU must improve

By J. Bovenberg et al.

**BOOKS ET AL.****43 Flawed research and its enduring repercussions**

A journalist recounts how he exposed problems with a study linking vaccines and autism

By P. A. Offit

**44 Training tomorrow's scientists**

Prioritizing STEM diversity, equity, and inclusion requires rethinking graduate education

By A. Huderson

**PRIZE ESSAY****45 The origins of thirst**

Sensory signals arise throughout the body and converge in the brain to regulate drinking

By C. A. Zimmerman

**RESEARCH****IN BRIEF**

70 From Science and other journals

**RESEARCH ARTICLES****73 Neurodevelopment**

A latent lineage potential in resident neural stem cells enables spinal cord repair

E. Llorens-Bobadilla et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.ABB8795

PERSPECTIVE p. 36

**74 Solar cells**

Vapor-assisted deposition of highly efficient, stable black-phase  $\text{FAPbI}_3$  perovskite solar cells

H. Lu et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.ABB8985

**Mutation**

75 Extensive heterogeneity in somatic mutation and selection in the human bladder

A. R. J. Lawson et al.

82 Macroscopic somatic clonal expansion in morphologically normal human urothelium

R. Li et al.

PERSPECTIVE p. 34

**89 Coronavirus**

Selective and cross-reactive SARS-CoV-2 T cell epitopes in unexposed humans

J. Mateus et al.

**95 Metallurgy**

Multiplicity of dislocation pathways in a refractory multiprincipal element alloy

F. Wang et al.

PERSPECTIVE p. 37

**101 Organic chemistry**

A universal system for digitization and automatic execution of the chemical synthesis literature

S. H. M. Mehr et al.

**REPORTS****108 Solar cells**

Impact of strain relaxation on performance of  $\alpha$ -formamidinium lead iodide perovskite solar cells

G. Kim et al.

**113 Developmental biology**

An adhesion code ensures robust pattern formation during tissue morphogenesis

T. Y.-C. Tsai et al.

**117 Conservation planning**

Integrated terrestrial-freshwater planning doubles conservation of tropical aquatic species

C. G. Leal et al.

PERSPECTIVE p. 38

**121 Sex determination**

The mouse *Sry* locus harbors a cryptic exon that is essential for male sex determination

S. Miyawaki et al.

**Electrocalorics**

125 Giant temperature span in electrocaloric regenerator

A. Torelló et al.

129 A high-performance solid-state electrocaloric cooling system

Y. Wang et al.

**DEPARTMENTS****13 Editorial**

Fire in our future

By William Wallace Covington and Stephen Pyne

NEWS STORY p. 18

**138 Working Life**

A leap of faith

By Rachel Mason

Science Staff .....	10
New Products .....	134
Science Careers .....	135

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$174 allocated to subscription). Domestic institutional subscription (51 issues): \$2148; foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single copy sales: \$15 each plus shipping and handling available from backissues.science.org, bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

9 OCTOBER 2020 • VOLUME 370 • ISSUE 6513



159

As COVID-19 cases climbed in May, Stockholm remained busy—and largely maskless.

## NEWS

### IN BRIEF

150 News at a glance

### IN DEPTH

#### 153 Astronomy is—and has—a climate problem

Big carbon footprints and rising vulnerabilities push astronomers to take action *By D. Clery*

#### 154 A call to test new vaccines head to head, in monkeys

Proposed comparison study could clarify safety and which vaccines work best *By J. Cohen*

#### 156 With to-do list checked off, U.S. physicists ask, 'What's next?'

Giant neutrino experiment is only sure thing for the field *By A. Cho*

#### 157 Newly found viruses suggest rubella originated in animals

Two relatives discovered in bats, mice, and zoo animals suggest "German measles" jumped the species barrier *By A. Gibbons*

#### 158 NASA mission set to sample carbon-rich asteroid

Bennu's thick carbonate veins suggest past life as a water world *By P. Voosen*

10.1126/SCIENCE.ABC3660; 10.1126/SCIENCE.ABC3522; 10.1126/SCIENCE.ABC3557; 10.1126/SCIADV.ABC3550; 10.1126/SCIADV.ABD3649; 10.1126/SCIADV.ABC3699

### FEATURES

#### 159 Sweden's gamble

The country's pandemic policies came at a high price—and created painful rifts in its scientific community *By G. Vogel*

## INSIGHTS

### PERSPECTIVES

#### 164 Novel communities are a risky business

High turnover leads to novel combinations of species and involves high extinction *By M. Dornelas and J. S. Madin*  
REPORT p. 220

#### 166 Making a bed for viral infections

An inflamed mucosal niche is permissive for symptomatic respiratory syncytial virus infection *By A. S. Mirchandani and S. R. Walmsley*  
RESEARCH ARTICLE p. 183

#### 167 Inhibiting Ebola virus and SARS-CoV-2 entry

Screening identifies CD74 as a cellular antiviral protein against Ebola virus and SARS-CoV-2 *By A. I. Wells and C. B. Coyne*  
REPORT p. 241

#### 168 A new villain in neuronal death

A newly discovered partnership for glutamate triggers brain toxicity *By S. Jones*  
RESEARCH ARTICLE p. 191

#### 170 Layer-cake 2D superconductivity

An easy-to-synthesize quantum material may help unveil quantum effects *By L. M. Schoop*  
REPORT p. 231

#### 171 Better, faster, and even cheap

An inexpensive gold grid with submicrometer holes minimizes protein sample movement *By M. Rapp and B. Carragher*  
REPORT p. 223

#### 172 Contextualizing bats as viral reservoirs

Preventing zoonotic emergence from bats requires integrative research *By D. G. Streicker and A. T. Gilbert*

### POLICY FORUM

#### 174 U.S. policy puts the safe development of space at risk

Promoting national regulation of space mining rather than multilateral governance risks a "race to the bottom" *By A. Boley and M. Byers*

### BOOKS ET AL.

#### 177 Plotting a path to a more sustainable future

Persistent political pressure staves off global warming in a new climate allegory *By C. Abbott*

#### 178 Moving beyond buzzwords

Rejecting conventional connotations, two books urge readers to rethink innovation *By D. Greenbaum and M. Gerstein*

### LETTERS

#### 179 Retraction

*By Y. Wu et al.*

**179 Hidden ethical costs of conservation**

By K. E. Lynch and D. T. Blumstein

**180 Pragmatic animal welfare is independent of feelings**

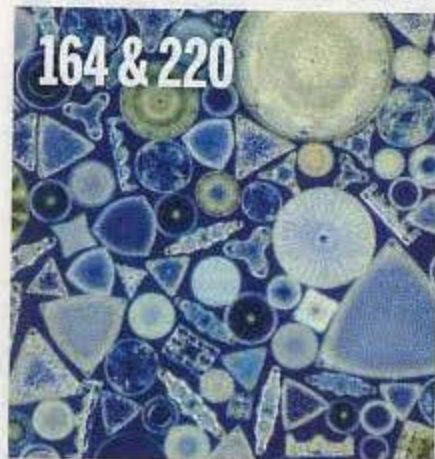
By R. Arlinghaus et al.

**180 Animal welfare science aids conservation**

By J. O. Hampton et al.

**181 Response**

By N. Sekar and D. Shiller

**181 Technical comment abstracts****RESEARCH****IN BRIEF****182** From *Science* and other journals**REVIEW****185 Biotechnology**Bioengineered human blood vessels  
L. E. Niklason and J. H. LawsonREVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAW8682**186 Electrochemistry**Recent advances in solid oxide cell  
technology for electrolysis A. Hauch et al.REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA6118**RESEARCH ARTICLES****187 HIV**Reconstitution and visualization of HIV-1  
capsid-dependent replication and integration  
in vitro D. E. Christensen et al.RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC8420**188 Viral infections**Neutrophilic inflammation in the  
respiratory mucosa predisposes to RSV  
infection M. S. Habib et al.RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA9301  
PERSPECTIVE p. 166**189 Structural biology**Conformational states dynamically  
populated by a kinase determine  
its function T. Xie et al.RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC2754**190 Metallurgy**The heterogeneity of persistent slip band  
nucleation and evolution in metals at the  
micrometer scale S. Lavenstein et al.RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB2690**191 Neuroscience**Coupling of NMDA receptors and  
TRPM4 guides discovery of unconventional  
neuroprotectants J. Yan et al.RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY3302  
PERSPECTIVE p. 168**192 Batteries**Black phosphorus composites with  
engineered interfaces for high-rate  
high-capacity lithium storage H. Jin et al.**198 Quantum gravity**

Spacetime from bits M. Van Raamsdonk

**203 Coronavirus**In situ structural analysis of  
SARS-CoV-2 spike reveals flexibility  
mediated by three hinges  
B. Turoňová et al.**208 Developmental biology**The mole genome reveals regulatory  
rearrangements associated  
with adaptive intersexuality  
F. M. Real et al.**REPORTS****214 Organic chemistry**Electro-inductive effect: Electrodes as  
functional groups with tunable electronic  
properties J. Heo et al.**220 Novel communities**Increased extinction in the emergence  
of novel ecological communities  
J. M. Pandolfi et al.

PERSPECTIVE p. 164

**223 Electron microscopy**Cryo-EM with sub-1 Å specimen  
movement K. Naydenova et al.  
PERSPECTIVE p. 171**227 Plant science**WUSCHEL triggers innate antiviral immunity  
in plant stem cells H. Wu et al.**231 Superconductivity**Clean 2D superconductivity in a bulk van der  
Waals superlattice A. Devarakonda et al.  
PERSPECTIVE p. 170**237 Vaccines**Influenza vaccine-induced human bone  
marrow plasma cells decline within a year  
after vaccination C. W. Davis et al.**241 Coronavirus**MHC class II transactivator CIITA induces  
cell resistance to Ebola virus and  
SARS-like coronaviruses A. Bruchez et al.  
PERSPECTIVE p. 167**247 Neuroscience**Alternating sequences of future and  
past behavior encoded within hippocampal  
theta oscillations M. Wang et al.**DEPARTMENTS****149 Editorial**Here today, gone tomorrow  
By Peter H. Raven and Scott E. Miller**258 Working Life**

A pandemic journey By Sergio E. Ramos

**ON THE COVER**The spike protein (teal), covered in pro-  
tective glycan molecules, on the surface  
of SARS-CoV-2 is the primary target for  
COVID-19 vaccine development. The spike  
contains three hinges that enable it to be  
highly flexible on the viral surface and may  
facilitate host cell entry. The spike positionsshown here are from  
structural data of intact  
SARS-CoV-2 virions. See  
page 203. Illustration: V.  
Altounian/Science; Data:  
Paul Ehrlich Institute,  
European Molecular Biology  
Laboratory, and Max Planck  
Institute of Biophysics

Science Staff .....	148
New Products .....	254
Science Careers .....	255

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

16 OCTOBER 2020 • VOLUME 370 • ISSUE 6514

## U.S. ELECTIONS

### FEATURES

#### 278 Weathering the storm

As president, Donald Trump has battered science. But increased spending by Congress and some supportive agency heads have provided relief *By J. Mervis*

#### 283 Scientists and science are on the ballot

*By J. Mervis*

#### 284 What if Biden wins?

A new president will have vast authority to rapidly shift science policy, but will confront obstacles beyond his control *By D. Malakoff*

### ON THE COVER

Donald Trump's presidency has been marked by a dismissal of science and evidence. Now, voters are deciding who will occupy the White



House amid a host of science-related crises, including the COVID-19 pandemic, forest fires and climate change, and fierce debates over immigration and racial justice. See pages 267 and 278. *Illustration: Zoë van Dijk*

SEE ALSO: EDITORIAL p. 267

## INSIGHTS

20 APR 2021

### PERSPECTIVES

#### 286 COVID-19 in children and young people

Children have a low risk of COVID-19 and are disproportionately harmed by precautions *By M. D. Snape and R. M. Viner*

#### 288 Lubricating lipids in hydrogels

A self-renewing lipid layer substantially reduces friction and wear of a hydrogel surface *By T. A. Schmidt*  
REPORT p. 335

#### 290 Advancing limb neural prostheses

Neurotechnology can overcome communication difficulties between prostheses and amputees *By S. Raspopovic*

#### 292 Reconstituting tissue patterning

A synthetic morphogen reveals quantitative principles of tissue patterning *By N. Barkai and B.-Z. Shilo*  
RESEARCH ARTICLE p. 321; REPORT p. 327

#### 294 Immiscible immunity

Mammalian metabolism meets immunity at mitochondria-adjacent lipid droplets *By D. R. Green*  
RESEARCH ARTICLE p. 309

#### 295 A cellular sense of space and pressure

The nucleus measures cell confinement with a mechanosensitive phospholipase *By Z. Shen and P. Niethammer*  
RESEARCH ARTICLES pp. 310 & 311

#### 297 Joe L. Martinez Jr. (1944–2020)

Neuroscientist and advocate of inclusion *By K. A. Trujillo et al.*

### POLICY FORUM

#### 298 COVID-19 recovery funds dwarf clean energy investment needs

A modest fraction of current global stimulus funds can put the world on track to achieve Paris Agreement goals *By M. Andrijevic et al.*

### BOOKS ET AL.

#### 301 Experiments in creativity

Artists and engineers joined forces in the 1960s, blurring the line between art and technology *By J. Ockert*

#### 302 Tales from times long past

Field adventures and human origin stories combine in a paleoanthropologist's compelling new memoir *By B. J. King*

## NEWS

### IN BRIEF

268 News at a glance

### IN DEPTH

#### 270 Lava lake rises at dangerous African volcano

Funding for volcano's lone monitoring station lost as warning signs flash *By R. Pease*

#### 271 A cut above: pair that developed CRISPR earns historic award

Chemistry Nobel honors biology's powerful genome editor *By J. Cohen*

#### 272 U.S. faculty job market tanks

As COVID-19 upends university finances, postdocs worry about their future *By K. Langin*

#### 273 At last, room temperature superconductivity achieved

But the hydrogen-based material requires high pressure *By R. F. Service*

#### 274 Satellite swarm threatens radio array

"Megaconstellations" already bedevil optical telescopes. Now, radio astronomers are concerned *By D. Clery*

#### 275 Found: genes that sway the course of the coronavirus

Host variants boost severity risk, may point to drug options *By J. Kaiser*

#### 276 The United Kingdom's mask crusader

Trisha Greenhalgh argues COVID-19 shows that health policy need not wait for perfect evidence *By E. Ruppel Shell*

## LETTERS

**303 Save Kazakhstan's shrinking Lake Balkhash**

By A. Ussenaliyeva

**303 Airborne transmission of SARS-CoV-2**

By K. A. Prather et al.

**304 Deliberate poisoning of Africa's vultures**

By M. Henriques et al.

**RESEARCH**

## IN BRIEF

**305** From *Science* and other journals

## REVIEW

**308 Neurodevelopment**

Transient cortical circuits match spontaneous and sensory-driven activity during development Z. Molnár et al.

REVIEW SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABB2153

## RESEARCH ARTICLES

**309 Innate immunity**

Mammalian lipid droplets are innate immune hubs integrating cell metabolism and host defense M. Bosch et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.AAY8085

PERSPECTIVE p. 294

## Cell biology

**310** The nucleus acts as a ruler tailoring cell responses to spatial constraints

A. J. Lomakin et al.

RESEARCH ARTICLE SUMMARY;

FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABA2894

**311** The nucleus measures shape changes for cellular proprioception to control dynamic cell behavior

V. Venturini et al.

RESEARCH ARTICLE SUMMARY;

FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABA2644

PERSPECTIVE p. 295

**312 Developmental biology**

Apical stress fibers enable a scaling between cell mechanical response and area in epithelial tissue J. M. López-Gay et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABB2169

**313 Neuroscience**

Behavioral state coding by molecularly defined paraventricular hypothalamic cell type ensembles S. Xu et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABB2494

**314 Microbiota**Microbiota-modulated CART<sup>+</sup> enteric neurons autonomously regulate blood glucose P. A. Muller et al.**321 Morphogens**

Patterning and growth control in vivo by an engineered GFP gradient

K. S. Stapornwongkul et al.

PERSPECTIVE p. 292; REPORT p. 327

## REPORTS

**327 Morphogens**

Engineering synthetic morphogen systems that can program multicellular patterning S. Toda et al.

PERSPECTIVE p. 292; RESEARCH ARTICLE p. 321

**331 Ultracold chemistry**

Coherently forming a single molecule in an optical trap X. He et al.

**335 Hydrogels**

Cartilage-inspired, lipid-based boundary-lubricated hydrogels W. Lin et al.

PERSPECTIVE p. 288

**339 Spectroscopy**

Zeptosecond birth time delay in molecular photoionization S. Grundmann et al.

**342 Thermogalvanics**

Thermosensitive crystallization-boosted liquid thermocells for low-grade heat harvesting B. Yu et al.

**346 Ecology**

Species richness and redundancy promote persistence of exploited mutualisms in yeast M. C. Vidal et al.

**351 Signal transduction**

The GATOR-Rag GTPase pathway inhibits mTORC1 activation by lysosome-derived amino acids G. G. Hesketh et al.

**356 Inorganic chemistry**

Structural and spectroscopic characterization of an Fe(VI) bis(imido) complex J. L. Martínez et al.

**360 Structural biology**

Structural and mechanistic bases for a potent HIV-1 capsid inhibitor S. M. Bester et al.

**364 Physiology**

Comprehensive quantification of fuel use by the failing and nonfailing human heart D. Murashige et al.

PODCAST

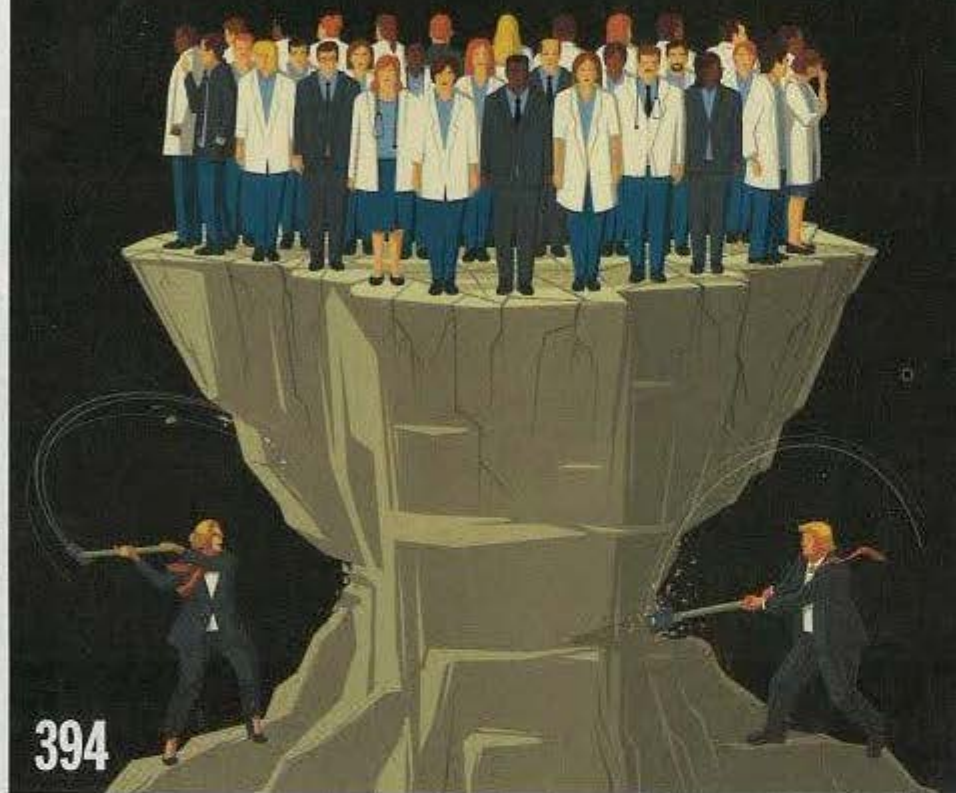


## DEPARTMENTS

**266 Editorial**Not throwing away our shot  
By H. Holden Thorp**267 Editorial**Speed and American elections  
By Jill Lepore  
U.S. ELECTIONS SECTION p. 278**374 Working Life**My last drop  
By John C. AyersNew Products..... 369  
Science Careers..... 370

# CONTENTS

23 OCTOBER 2020 • VOLUME 370 • ISSUE 6515



## NEWS

### IN BRIEF

386 News at a glance

### IN DEPTH

#### 388 Global trial eliminates drugs, pivots to new ones

Definitive results on remdesivir and interferon demonstrate power of massive WHO study. *By K. Kupferschmidt*

#### 389 First vaccine may stymie hunt for better ones

Should trials keep using placebos once an approved vaccine exists? *By J. Cohen*  
PODCAST

#### 391 Nature journals ink open-access deal

German pact has costs of €9500 per published article. *By J. Brainard*

#### 391 Census needs review, panel says

Statisticians call for evaluation of quality of 2020 U.S. count. *By J. Mervis*

#### 392 In new strategy, Wellcome Trust takes on global health concerns

Giant philanthropy will focus on infectious disease, mental health, and the health effects of global warming. *By K. Kupferschmidt*

#### 393 Troubles escalate at Ecuador's young research university

Dozens of professors depart from Yachay Tech amid conflicts that could scuttle its move toward independence. *By L. Wessel and R. Pérez Ortega*

### FEATURES

#### 394 Undermining CDC

Deborah Birx, President Donald Trump's COVID-19 coordinator, helped shake the foundation of a premier public health agency. *By C. Piller*

#### 396 How CDC foundered

*By C. Piller*

19 MAR 2021

## INSIGHTS



### PERSPECTIVES

#### 400 Creating value from plastic waste

Polyethylene can be upcycled into alkylaromatic compounds for the production of detergents. *By B. M. Weckhuysen*  
REPORT p. 437; PODCAST

#### 402 Forming a mucus barrier along the colon

Optimal barrier function requires both proximal colon- and distal colon-derived mucus. *By G. M. H. Birchenough and M. E. V. Johansson*  
REPORT p. 467

#### 403 The upside of aging

Chimpanzees, like humans, place a higher value on positive social relationships as they grow older. *By J. Silk*  
REPORT p. 473

#### 404 Susceptibility to severe COVID-19

Genetic variants and autoantibodies that suppress antiviral immunity are linked to severe COVID-19. *By D. B. Beck and I. Aksentijevich*  
RESEARCH ARTICLES pp. 422 & 423

#### 406 The engines of SARS-CoV-2 spread

Fighting SARS-CoV-2 requires a clear framework for understanding epidemic spread. *By E. C. Lee et al.*

#### 408 COVID-19 can affect the heart

COVID-19 has a spectrum of potential heart manifestations with diverse mechanisms. *By E. J. Topol*

#### 410 Joseph H. Connell (1923–2020)

Innovative experimental ecologist. *By W. W. Murdoch and W. P. Sousa*

### POLICY FORUM

#### 411 Set ambitious goals for biodiversity and sustainability

Multiple, coordinated goals and holistic actions are critical. *By S. Diaz et al.*

### BOOKS ET AL.

#### 414 The disruption of divisions

Psychological stress is a pervasive aspect of border life, argues a journalist. *By M. Diaz-Barriga and M. E. Dorsey*

#### 415 A case for “we” in an “I” country

An eerily similar era gave way to social progress in the United States—will it happen again? *By J. A. Morone*



## LETTERS

**416 Narwhals require targeted conservation**

By M. P. Heide-Jørgensen et al.

**416 Wildfire debate needs science, not politics**

By A. B. Leverkus et al.

**417 "Forest mismanagement" misleads**

By M. W. Schwartz et al.

## RESEARCH

## IN BRIEF

**418** From *Science* and other journals

## REVIEW

**421 Oxygen sensing**

Oxygen-sensing mechanisms across eukaryotic kingdoms and their roles in complex multicellularity

E. U. Hammarlund et al.

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA3512

## RESEARCH ARTICLES

## Coronavirus

**422** Inborn errors of type I IFN immunity in patients with life-threatening COVID-19  
Q. Zhang et al.RESEARCH ARTICLE SUMMARY;  
FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABD4570

**423** Autoantibodies against type I IFNs in patients with life-threatening COVID-19  
P. Bastard et al.RESEARCH ARTICLE SUMMARY;  
FOR FULL TEXT:

DX.DOI.ORG/10.1126/SCIENCE.ABD4585

PERSPECTIVE p. 404

**424 Framework materials**

Design of higher valency in covalent organic frameworks C. Groppe et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABD6406**425 Geochemistry**

Deep abiotic weathering of pyrite X. Gu et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB8092**426 Coronavirus**

De novo design of picomolar SARS-CoV-2 miniprotein inhibitors L. Cao et al.

**431 Neurodevelopment**

Orderly compartmental mapping of premotor inhibition in the developing zebrafish spinal cord S. Kishore et al.

## REPORTS

**437 Polymer chemistry**

Polyethylene upcycling to long-chain alkylaromatics by tandem hydrogenolysis/aromatization F. Zhang et al.

PERSPECTIVE p. 400

**442 Nanomaterials**

Supertwisted spirals of layered materials enabled by growth on non-Euclidean surfaces Y. Zhao et al.

**446 Atmospheric oxygen**

Triple iron isotope constraints on the role of ocean iron sinks in early atmospheric oxygenation A. W. Heard et al.

## Structural biology

**450** Structural basis of nucleosome-dependent cGAS inhibition  
J. A. Boyer et al.**455** Structural basis for the inhibition of cGAS by nucleosomes T. Kujirai et al.**459 Display technology**Metasurface-driven OLED displays beyond 10,000 pixels per inch  
W.-J. Joo et al.**463 Developmental biology**Lineage analysis reveals an endodermal contribution to the vertebrate pituitary  
P. Fabian et al.**467 Microbiota**

Proximal colon-derived O-glycosylated mucus encapsulates and modulates the microbiota K. Bergstrom et al.

PERSPECTIVE p. 402

**473 Sociality**

Social selectivity in aging wild chimpanzees A. G. Rosati et al.

PERSPECTIVE p. 403

**476 Adaptation**

Experimental evolution makes microbes more cooperative with their local host genotype R. T. Batstone et al.

## DEPARTMENTS

**383 Editorial**Saving the poor and vulnerable  
By Sir Ian L. Boyd**385 Editorial**Science, politics, and public health  
By William Roper**494 Working Life**Mentorship at a distance  
By Naomi A. Rankin et al.

## ON THE COVER

Lanjo, a 25-year-old male chimpanzee living in the Kanyawara community in Kibale National Park, Uganda. Long-term observations show that wild chimpanzees, like humans, increasingly prioritize strong, mutual social bonds and



positive social interactions during the aging process. Social selectivity in our close relatives reveals the evolutionary roots of successful social aging. See pages 403 and 473. Photo: Suzi Eszterhas/Minden Pictures

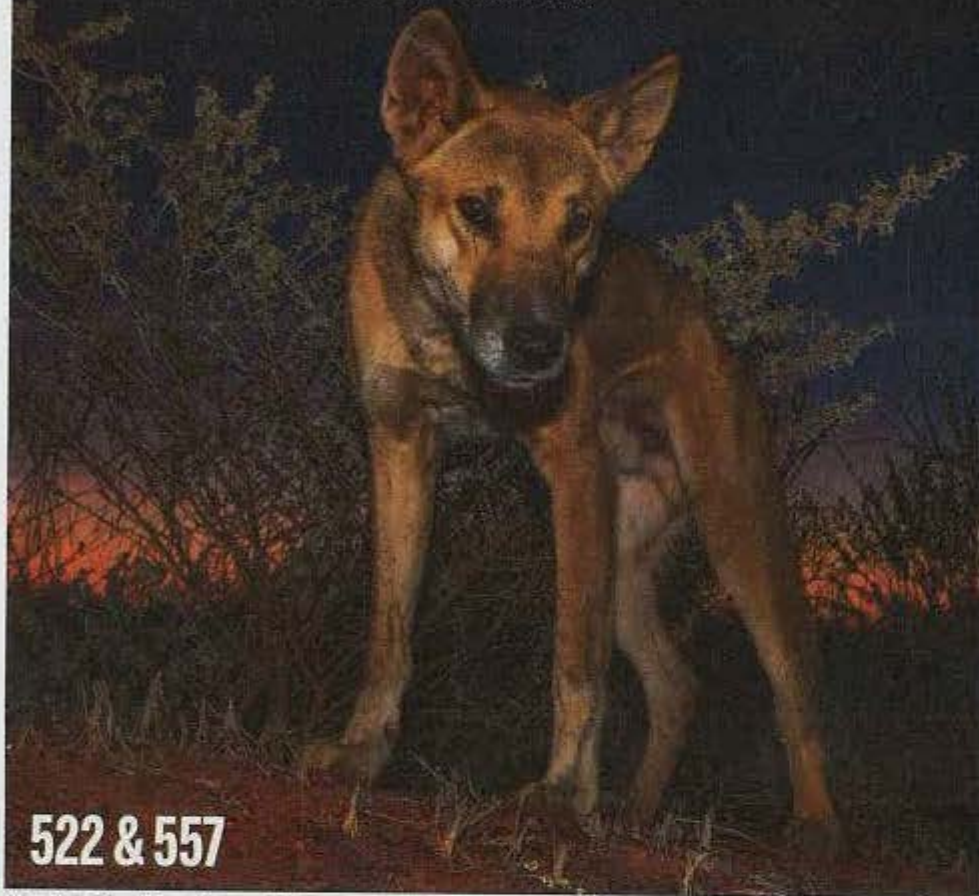
Science Staff .....	382
AAAS Meeting Program .....	479
Science Careers .....	490

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$7148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125486122. Publications Mail Agreement Number 1066624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair-use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

30 OCTOBER 2020 • VOLUME 370 • ISSUE 6516



522 & 557

Dogs, including this endangered dingo, were the first domesticated animal. Researchers have examined ancient dog genomes to identify the complex way in which man's best friend evolved.

## NEWS

### IN BRIEF

508 News at a glance

### IN DEPTH

#### 511 U.S. funds new fleet of probes to explore ocean biogeochemistry

Drifting Argo floats will track oxygen loss from global warming and the oceans' ability to soak up carbon. *By P. Voosen*

#### 512 Denisovan DNA found in cave on Tibetan Plateau

"Molecular caving" shows archaic humans visited high-altitude cave over long period. *By A. Gibbons*

REPORTS pp. 579 & 584

#### 513 Herd immunity? India still has a long way to go, scientists say

Cases are dropping, but critics question optimistic forecast. *By V. Chandrashekar*

#### 514 How an immunologist pivoted to tackle COVID-19

For Akiko Iwasaki, the pandemic has brought new research priorities—and new urgency. *By J. Couzin-Frankel*

#### 515 Edit reviews without permission? Some journal editors say it's OK

Deleting offensive language is common, but some editors alter reviewers' overall recommendation. *By C. O'Grady*

#### 516 Efforts to control monkey brains get a boost

With open data project, primate optogenetics confronts stumbling blocks. *By K. Servick*

### FEATURES

#### 518 Power to the people

Nations are turning to citizen assemblies to weigh up climate policies. *By C. O'Grady*

PODCAST

## INSIGHTS

### PERSPECTIVES

#### 522 Of dogs and men

Ancient genomes reveal the common history of human and dog. *By P. Pavlidis and M. Somel*  
RESEARCH ARTICLE p. 557

#### 523 The quiet spring of 2020

Anthropogenic noise has no legacy effects on bird song. *By W. Halfwerk*  
REPORT p. 575

#### 525 Speeding protons with metal vacancies

Membranes made from nanosheets derived from CdPS<sub>3</sub> have high proton conductivity. *By F. Wang and J. He*  
REPORT p. 596

#### 526 Should I stay or should I go?

Pinpointing genetic alleles that influence the timing of salmon migration might aid restoration efforts. *By G. McKinney*  
REPORT p. 609

#### 527 Will SARS-CoV-2 become endemic?

Reinfection, seasonality, and viral competition will shape endemic transmission patterns. *By J. Shaman and M. Galanti*

#### 530 Charles H. Turner, pioneer in animal cognition

An African American scientist's early discoveries are forgotten for all the wrong reasons. *By H. S. Galpayage Dona and L. Chittka*  
PODCAST

#### 532 Paolo Sassone-Corsi (1956–2020)

Groundbreaking molecular biologist and epigeneticist. *By E. Verdin*

### POLICY FORUM

#### 533 Political sectarianism in America

A poisonous cocktail of othering, aversion, and moralization poses a threat to democracy. *By E. J. Finkel et al.*

### BOOKS ET AL.

#### 537 The vibrant lives of Neanderthals

A nuanced portrait of our evolutionary cousins encourages empathy and understanding. *By E. Pomeroy*

#### 538 A profound plan to save the seas

Rejecting piecemeal strategies, a conservationist encourages total ocean protection. *By M. E. Hannibal*

### LETTERS

#### 539 Ban unsustainable mink production

*By C. Xia et al.*



512, 579,  
& 584

Excavation in Baishiya Karst Cave identified Denisovan mitochondrial DNA dating to 100,000 years ago.

**539 Support U.S. research during COVID-19**

By M. M. Crow et al.

**540 Hainan peacock-pheasant needs focused protection**

By S. Guan et al.

**RESEARCH**

**IN BRIEF**

**543** From *Science* and other journals

**REVIEW**

**546 Cancer**

Physical traits of cancer H. T. Nia et al.

REVIEW SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.AAZ0858

**RESEARCH ARTICLES**

**547 Structural biology**

The coupling mechanism of mammalian respiratory complex I

D. Kampjut and L. A. Sazanov

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.ABC4209

**548 Hybrid perovskites**

Atomic-scale microstructure of metal halide perovskite M. U. Rothmann et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.ABB5940

**549 Microbiota**

Multi-omics analyses of radiation survivors identify radioprotective microbes and metabolites H. Guo et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: DX.DOI.ORG/10.1126/SCIENCE.AAY9097

**550 Plant science**

Receptor kinase module targets PIN-dependent auxin transport during canalization J. Hajny et al.

**557 Ancient dog genomics**

Origins and genetic legacy of prehistoric dogs A. Bergström et al.

PERSPECTIVE p. 522

**564 Coronavirus**

The emergence of SARS-CoV-2 in Europe and North America M. Worobey et al.

REPORT p. 571

**REPORTS**

**571 Coronavirus**

Cryptic transmission of SARS-CoV-2 in Washington state T. Bedford et al.

RESEARCH ARTICLE p. 564

**575 Pandemic pause**

Singing in a silent spring: Birds respond to a half-century soundscape reversion during the COVID-19 shutdown E. P. Derryberry et al.

PERSPECTIVE p. 523

**579 Human evolution**

Denisovan ancestry and population history of early East Asians D. Massilani et al.

NEWS STORY p. 512; REPORT p. 584

**584 Paleogenomics**

Denisovan DNA in Late Pleistocene sediments from Baishiya Karst Cave on the Tibetan Plateau D. Zhang et al.

NEWS STORY p. 512; REPORT p. 579

**587 Magnetism**

Metal-organic magnets with large coercivity and ordering temperatures up to 242°C P. Perlepe et al.

**592 Quantum systems**

Parallel single-shot measurement and coherent control of solid-state spins below the diffraction limit S. Chen et al.

**596 Proton membranes**

CdPS<sub>3</sub> nanosheets-based membrane with high proton conductivity enabled by Cd vacancies X. Qian et al.

PERSPECTIVE p. 525

**600 Topological systems**

Generation of helical topological exciton-polaritons W. Liu et al.

**605 Geophysics**

Surface deformation associated with fractures near the 2019 Ridgecrest earthquake sequence X. Xu et al.

**609 Migration**

A complex phenotype in salmon controlled by a simple change in migratory timing N. F. Thompson et al.

PERSPECTIVE p. 526

**DEPARTMENTS**

**502 Editorial**

Untapped computer scientists By Henry T. Frierson et al.

**503 Editorial**

It's just louder this time By H. Holden Thorp

**630 Working Life**

The things I wish I could say By Anonymous

**ON THE COVER**

Chinook salmon swimming in the Rogue River, Oregon. Genome sequencing and analysis of tribal fishery catch in the Klamath River, California, show that salmon ecotypes in diverse populations result from a simple Mendelian polymorphism that affects seasonality of spawning migration. Physiological and



reproductive differences long thought to distinguish ecotypes appear as a result of environmental effects from summer residence in different ecosystems. See pages 526 and 609. Photo: Mark Conlin/Alamy Stock Photo

AAAS News & Notes ..... 541  
Science Careers ..... 614

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, annual, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 3069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rates on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

6 NOVEMBER 2020 • VOLUME 370 • ISSUE 6517



654

## NEWS

### IN BRIEF

640 News at a glance

### IN DEPTH

#### 642 'A very, very bad look' for remdesivir

FDA and Europe anointed it as a key therapy just after a major study found it has little value

By J. Cohen and K. Kupferschmidt

#### 644 Europe is locking down again—but its strategy is unclear

Without a plan to eliminate the virus, countries may face shutdowns over and over, scientists warn

By K. Kupferschmidt

#### 645 Growth spurt for height genetics

By tallying thousands of genetic variants, researchers account for height's remaining "missing heritability"

By J. Kaiser

#### 646 How the horse powered human prehistory

Wide-ranging warriors made Mongolian empire a melting pot, sweeping gene study shows

By A. Curry

#### 647 New chip-based lasers promise practical terahertz imaging

Semiconductor lasers work with small coolers, enabling medical imaging and contraband detection

By R. F. Service

#### 648 Black holes by the dozens challenge theorists

Trove of gravitational wave detections allows black holes to be studied en masse

By A. Cho

PODCAST

### FEATURES

#### 649 The long shot

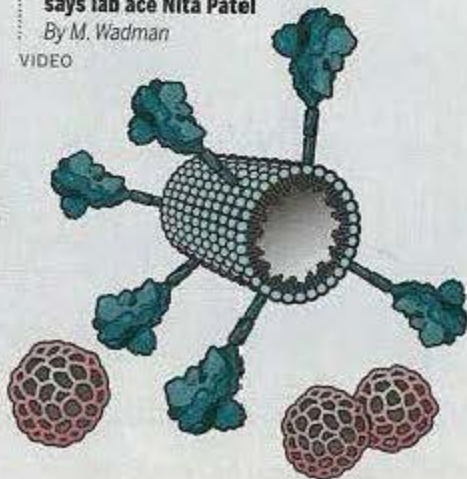
A little company chases its bigger competitors in the race for a coronavirus vaccine

By M. Wadman

#### 652 'Nothing is impossible,' says lab ace Nita Patel

By M. Wadman

VIDEO



## INSIGHTS

### PERSPECTIVES

#### 654 A surprising fossil vertebrate

An ancient amphibian converged on a chameleon-like way of feeding

By D. B. Wake

RESEARCH ARTICLE p. 687

#### 655 The genetic law of the minimum

The genetic code evolved to reduce the impact of nutrient limitations

By M. F. Polz and O. X. Cordero

RESEARCH ARTICLE p. 683

#### 657 Regulation in common: Sponge to zebrafish

Developmental enhancers from a sponge regulate gene expression in zebrafish neurons

By N. Harmston

RESEARCH ARTICLE p. 681

#### 658 Nudging people to court

Behavioral interventions may improve court attendance, but how to reform the system remains unclear

By I. Kohler-Hausmann

RESEARCH ARTICLE p. 682

#### 660 Food for thought

The nuclear metabolic-epigenetic axis bridges the environment and genes to modulate behavior

By G. Egervari et al.

#### 662 Steering iceberg armadas

The Asian-Pacific tropics likely instigated millennial-scale climate changes

By J. M. Jaeger and A. E. Shevenell

REPORT p. 716

#### 663 Public health during the pandemic in India

Data from two Indian states give detail about variation in transmission and disease outcomes

By J. John and G. Kang

RESEARCH ARTICLE p. 691

### POLICY FORUM

#### 665 Species protection will take more than rule reversal

Key improvements are needed for implementation of the Endangered Species Act

By Y.-W. Li et al.

### BOOKS ET AL.

#### 667 The ascent of Wikipedia

Scholars reflect on 20 years of crowdsourced knowledge

By A. Robinson

#### 668 Recognizing the work of women

Despite several stumbles, a new volume about women in paleontology will likely prove valuable to future scholars

By J. Miller-Camp

## LETTERS

## 669 Aquaculture jeopardizes migrating Oriental storks

By Y. Sun et al.

## 669 Indigenous rights to Patagonia

By P. A. Marquet et al.

## 670 Fisheries rely on threatened salt marshes

By R. Baker et al.

## RESEARCH

## IN BRIEF

677 From Science and other journals

## REVIEW

## 680 Climate change

Past climates inform our future J. E. Tierney et al.

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY3701

## RESEARCH ARTICLES

## 681 Enhancer genomics

Deep conservation of the enhancer regulatory code in animals

E. S. Wong et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAX8137  
PERSPECTIVE p. 657

## 682 Criminal justice

Behavioral nudges reduce failure to appear for court A. Fishbane et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB6591  
PERSPECTIVE p. 658

## 683 Metabolic genomics

Resource conservation manifests in the genetic code L. Shenhav and D. Zeevi

PERSPECTIVE p. 655

## 687 Paleontology

Enigmatic amphibians in mid-Cretaceous amber were chameleon-like ballistic feeders J. D. Daza et al.

PERSPECTIVE p. 654

## 691 Coronavirus

Epidemiology and transmission dynamics of COVID-19 in two Indian states

R. Laxminarayan et al.

PERSPECTIVE p. 663

## REPORTS

## 698 Organic devices

Large-area low-noise flexible organic photodiodes for detecting faint visible light C. Fuentes-Hernandez et al.

## 701 Topological optics

Nonlinearity-induced photonic topological insulator L. J. Maczewsky et al.

## 705 Climate change

Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets M. A. Clark et al.

## 708 Batteries

Rational design of layered oxide materials for sodium-ion batteries C. Zhao et al.

## 712 Ecological monitoring

Ecological insights from three decades of animal movement tracking across a changing Arctic S. C. Davidson et al.

PODCAST

## 716 Paleoclimate

Phasing of millennial-scale climate variability in the Pacific and Atlantic Oceans M. H. Walczak et al.

PERSPECTIVE p. 662

## 721 Ecological genomics

Genomic architecture of a genetically assimilated seasonal color pattern K. R. L. van der Burg et al.

## 725 Coronavirus

Free fatty acid binding pocket in the locked structure of SARS-CoV-2 spike protein C. Toelzer et al.

## DEPARTMENTS

## 639 Editorial

Gradually, then suddenly  
By H. Holden Thorp

## 738 Working Life

A sabbatical reboot  
By Thomas GernonScience Staff ..... 636  
Science Careers ..... 734

## SPECIAL SECTION

## OSIRIS-REx at Bennu

## INTRODUCTION

672 Sampling the early solar system

## RESEARCH

674 Variations in color and reflectance on the surface of asteroid (101955) Bennu D. N. DellaGiustina et al.

RESEARCH ARTICLE SUMMARY;  
FOR FULL TEXT: DX.DOI.ORG/10.1126/  
SCIENCE.ABC3660

675 Widespread carbon-bearing materials on near-Earth asteroid (101955) Bennu A. A. Simon et al.

RESEARCH ARTICLE SUMMARY;  
FOR FULL TEXT: DX.DOI.ORG/10.1126/  
SCIENCE.ABC3522

676 Bright carbonate veins on asteroid (101955) Bennu: Implications for aqueous alteration history H. H. Kaplan et al.

RESEARCH ARTICLE SUMMARY;  
FOR FULL TEXT: DX.DOI.ORG/10.1126/  
SCIENCE.ABC3557

## ON THE COVER

The near-Earth carbonaceous asteroid (101955) Bennu, as observed by the OSIRIS-REx spacecraft. A lidar-derived shape model is overlain in grayscale with the albedo, and in color with a map of the abundance of carbon-bearing material (center; see page 675) and a false-color image indicating the near-ultraviolet and



near-infrared spectral slopes (right; see page 674). Graphic: NASA's Scientific Visualization Studio; Data: Daly et al./Sci. Adv. 6, eabd3649/DellaGiustina et al./Simon et al./OSIRIS-REx Team

SEE ALSO SCIENCE ADVANCES RESEARCH ARTICLES BY D. J. SCHEERES ET AL. 10.1126/SCIADV.ABC3350, M. G. DALY ET AL. 10.1126/SCIADV.ABD3649, AND B. ROZITIS ET AL. 10.1126/SCIADV.ABC3699

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request, GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.

Change of address: Allow 4 weeks, giving old and new addresses and B-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org. Bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

13 NOVEMBER 2020 • VOLUME 370 • ISSUE 6518

756

Larvae of the emerald ash borer, an introduced beetle, have killed millions of ash trees in North America by tunneling beneath their bark.

## NEWS

### IN BRIEF

746 News at a glance

### IN DEPTH

#### 748 Effective vaccine offers shot of hope for pandemic

Pioneering RNA candidate seems to work well, although its makers revealed scant data *By J. Cohen*

#### 749 A divided Congress could narrow Biden's ambitious plans

But president-elect has vowed to flex executive power *By J. Mervis*

#### 750 To tackle pandemic, Biden must overcome distrust and division

President-elect vows "bedrock of science" will drive his administration's response to worsening U.S. crisis *By M. Wadman and W. Cornwall*

#### 751 New polio vaccine could boost faltering eradication drive

Sabin's oral vaccine has itself become a source of polio outbreaks. A modern, stabler version may reduce the risk *By L. Roberts*

#### 752 India's COVID-19 teacher

Kerala health minister K. K. Shailaja has fought the pandemic with preparation, calm, and compassion *By V. Chandrashekar*

#### 754 Pandemic dooms Danish mink—and mink research

Mass culling ordered after discovery of mutations that may affect vaccine efficacy *By C. Lesté-Lasserre*

#### 755 Dust storms on Mars propel water's escape to space

Orbiters spy potential ongoing planetary "death spiral" *By P. Voosen*  
RESEARCH ARTICLE p. 824

### FEATURES

#### 756 Rising from the ashes

An effort to breed North American ash trees that can resist a deadly beetle could accelerate the return of a forest icon *By G. Popkin*

## INSIGHTS

### POLICY FORUM

#### 760 What's next for COVID-19 apps? Governance and oversight

Adaptive governance can help earn social license *By A. Blasimme and E. Vayena*

### PERSPECTIVES

#### 763 Understanding COVID-19 vaccine efficacy

Vaccine efficacy in high-risk groups and reduced viral shedding are important for protection *By M. Lipsitch and N. E. Dean*

#### 765 Enhancing host cell infection by SARS-CoV-2

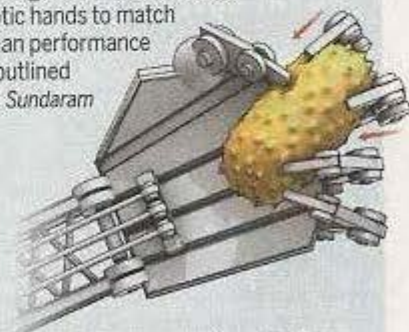
Neuropilin-1 binds the furin-processed spike protein of SARS-CoV-2 to promote virus entry *By M. Kielian*  
REPORTS pp. 856 & 861

#### 767 Peptide synthesis at the origin of life

Small-molecule organocatalysis might have driven the emergence of peptide biochemistry *By K. B. Muchowska and J. Moran*  
REPORT p. 865

#### 768 How to improve robotic touch

Challenges for instrumenting robotic hands to match human performance are outlined *By S. Sundaram*



#### 770 James S. Jackson (1944–2020)

Social psychologist who pioneered the study of Black culture *By T. A. Parham*

### BOOKS ET AL.

#### 771 Moving beyond the paradigm

A provocative 1975 call to leave behind dogmatic thinking could help scientists strengthen ties with the public *By J. Swift*

## SPECIAL SECTION

## Cooling technology

## INTRODUCTION

776 Cooling in a warming world

## NEWS

778 Living with heat *E. Pennisi*

## PODCAST

## PERSPECTIVES

782 Adapting to the challenges of warming  
*S. C. Sherwood*783 Cooling our insatiable demand for data  
*Amy S. Fleischer*784 Photon-engineered radiative cooling textiles  
*P.-C. Hsu and X. Li*  
PODCAST

## REVIEWS

786 Terrestrial radiative cooling: Using the cold universe as a renewable and sustainable energy source  
*X. Yin et al.*791 New refrigerants and system configurations for vapor-compression refrigeration  
*M. O. McLinden et al.*797 Caloric materials for cooling and heating  
*X. Moya et al.*

## ON THE COVER



Air-conditioning units hang off the back side of a row of buildings in Shenyang, Liaoning province, China. Many Chinese people spend sanfu, the hottest period of the year, in air-conditioned buildings. As the planet continues to warm, the need for innovative and environmentally friendly cooling technologies becomes more important. See page 776.  
Photo: Visual China Group via Getty Images

## 772 Imaginary demons and scientific discoveries

A new history acts as a field guide to the fictional imps invoked by scientific thinkers  
*By J. G. Michel*

## LETTERS

## 773 EcoHealth reframing of disease monitoring

*By M. P. M. Vanhove et al.*

## 773 Build international biorepository capacity

*By J. P. Colella et al.*

## 774 Response

*By M. Watsa and Wildlife Disease Surveillance Focus Group*

## RESEARCH

## IN BRIEF

805 From Science and other journals

## RESEARCH ARTICLES

## Human genomics

808 A human cell atlas of fetal gene expression  
*J. Cao et al.*

RESEARCH ARTICLE SUMMARY:  
FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABA7721](https://doi.org/10.1126/SCIENCE.ABA7721)

809 A human cell atlas of fetal chromatin accessibility  
*S. Domcke et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABA7612](https://doi.org/10.1126/SCIENCE.ABA7612)

## 810 Plant science

Vascular transcription factors guide plant epidermal responses to limiting phosphate conditions  
*J. R. Wendrich et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY4970](https://doi.org/10.1126/SCIENCE.AAY4970)

## 811 Coronavirus

Immune life history, vaccination, and the dynamics of SARS-CoV-2 over the next 5 years  
*C. M. Saad-Roy et al.*

## 819 Plant science

Cell wall remodeling and vesicle trafficking mediate the root clock in *Arabidopsis*  
*G. Wachsmann et al.*

## 824 Martian atmosphere

Hydrogen escape from Mars is driven by seasonal and dust storm transport of water.  
*S. W. Stone et al.*  
NEWS STORY p. 755

## REPORTS

## 831 Metallurgy

Constrained minimal-interface structures in polycrystalline copper with extremely fine grains  
*X. Y. Li et al.*

## 837 Cosmochemistry

Astronomical context of Solar System formation from molybdenum isotopes in meteorite inclusions  
*G. A. Brennecka et al.*

## 840 Optomechanics

Nano-acoustic resonator with ultralong phonon lifetime  
*G. S. MacCabe et al.*

## 844 Neuroscience

A thalamocortical top-down circuit for associative memory  
*M. B. Pardi et al.*

## 848 Sensors

Stretchable distributed fiber-optic sensors  
*H. Bai et al.*

## 853 Translation regulation

A phosphorylation-regulated eIF3d translation switch mediates cellular adaptation to metabolic stress  
*A. M. Lamper et al.*

## Coronavirus

856 Neuropilin-1 facilitates SARS-CoV-2 cell entry and infectivity  
*L. Cantuti-Castelvetri et al.*861 Neuropilin-1 is a host factor for SARS-CoV-2 infection  
*J. L. Daly et al.*  
PERSPECTIVE p. 765

## 865 Prebiotic chemistry

Prebiotic synthesis of cysteine peptides that catalyze peptide ligation in neutral water  
*C. S. Foden et al.*  
PERSPECTIVE p. 767

## DEPARTMENTS

## 745 Editorial

The disease of distrust  
*By Reed V. Tuckson*

## 874 Working Life

Difficult conversations  
*By Sasha McDowell*

New Products.....870  
Science Careers.....871

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription); Domestic institutional subscription (61 issues): \$2148; Foreign postage extra; Air assist delivery: \$38. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 6-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

20 NOVEMBER 2020 • VOLUME 370 • ISSUE 6519



## NEWS

### IN BRIEF

892 News at a glance

### IN DEPTH

#### 894 Vaccine wagers on coronavirus surface protein pay off

Moderna reports early evidence of excellent efficacy, moving its mRNA candidate closer to widespread use. *By J. Cohen*

#### 895 Reinfections, still rare, provide clues on immunity

The growing group of people who get sick twice suggests protection can wane relatively quickly. *By J. de Vriese*

#### 897 'Magic angle' graphene's next trick: superconducting devices

Twisted carbon sheets turned into switches that could make quantum computers smaller and more controllable. *By C. Wood*

#### 898 Like CRISPR, mystery gene editor began as a virus fighter

The genetic elements called retrons can only edit single-cell organisms, so far. *By E. Pennisi*

#### 900 China set to bring back rocks from the Moon

Chang'e-5's lunar samples could firm up shaky crater count dating system for the rocky planets. *By D. Normile*

#### 901 Seas are rising faster than ever

A new satellite will monitor coastal hot spots, where currents amplify global trends. *By P. Voosen*

### FEATURES

#### 902 Tomorrow's catch

Genomic technologies promise dramatic gains for aquaculture by accelerating the breeding of better strains. *By E. Stokstad*

PODCAST

## INSIGHTS

### PERSPECTIVES

#### 906 Drugs from bugs in creatures of the sea

A bacterium from the sea squirt microbiome makes a natural product with antifungal activity. *By L. E. Cowen*  
REPORT P. 974

#### 907 Transferring allergies in the womb

Maternal antibodies prime fetal mast cells in utero for subsequent postnatal allergy responses. *By M. E. Rothenberg*  
RESEARCH ARTICLE P. 941

#### 909 The origin of diarrhea in rotavirus infection

Messengers from rotavirus-infected cells induce pathogenic signaling in neighboring cells. *By M. Stanifer and S. Boulant*  
RESEARCH ARTICLE P. 930

#### 910 The more and less of electronic-skin sensors

Sensors can measure both strain and temperature or measure force without affecting touch. *By X. Liu*  
REPORTS pp. 961 & 966

#### 912 The molecular wagon that stays on track

Single molecules are sent and received accurately over long distances across a surface. *By F. Esch and B. A. J. Lechner*  
REPORT P. 957

#### 913 Advancing new tools for infectious diseases

Therapeutics and vaccine development for infectious diseases could be transformed. *By R. Gupta*

#### 915 Georgina Mace (1953–2020)

Pioneering conservation biologist and sustainability scientist. *By A. Purvis and K. E. Jones*

### POLICY FORUM

#### 916 Community-led governance for gene-edited crops

A post-market certification process could promote transparency and trust. *By J. Kuzma and K. Grieger*

### BOOKS ET AL.

#### 919 Alphabets and their origins

A new documentary series surveys the inception and evolution of the written word. *By A. Robinson*

**920 Probing COVID's complexity in real time**

The pandemic is as much about society, leaders, and values as it is about a pathogen

By S. V. Scarpino

## LETTERS

**921 Retraction**

By T. Sijen et al.

**921 Eroded protections threaten U.S. forests**

By K.-V. Pérez-Hammerle et al.

**922 Space debris puts exploration at risk**

By D. Greenbaum

**922 Technical Comment abstracts****922 Errata**

## PRIZE ESSAY

**924 Tracking development at the cellular level**

Single-cell genomic methods enable developmental mapping of entire organisms

By J. Cao

**RESEARCH**

## IN BRIEF

**926** From *Science* and other journals

## REVIEW

**929 Fire ecology**

Fire and biodiversity in the Anthropocene

L. T. Kelly et al.

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB0355

## RESEARCH ARTICLES

**930 Virology**

Rotavirus induces intercellular calcium waves through ADP signaling

A. L. Chang-Graham et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC3621

PERSPECTIVE p. 909

**931 Photosynthesis**

Architecture of the photosynthetic complex from a green sulfur bacterium

J.-H. Chen et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB6350

**932 Neurodegeneration**

Autosomal dominant VCP hypomorph mutation impairs disaggregation of PHF-tau

N. F. Darwich et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY8826

**933 Wildlife disease**

Divergent impacts of warming weather on wildlife disease risk across climates

J. M. Cohen et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB1702

**934 Neurodevelopment**

Gene regulatory networks controlling vertebrate retinal regeneration

T. Hoang et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB8598

**935 Developmental biology**

A human tissue screen identifies a regulator of ER secretion as a brain-size determinant

C. Esk et al.

**941 Immunology**

Fetal mast cells mediate postnatal allergic responses dependent on maternal IgE

R. Msallam et al.

PERSPECTIVE p. 907

**950 Coronavirus**

Ultrapotent human antibodies protect against SARS-CoV-2 challenge via multiple mechanisms

M. A. Tortorici et al.

## REPORTS

**957 Surface science**

Control of long-distance motion of single molecules on a surface

D. Civita et al.

PERSPECTIVE p. 912

**Materials science**

**961** Artificial multimodal receptors based on ion relaxation dynamics

I. You et al.

**966** Nanomesh pressure sensor for monitoring finger manipulation without sensory interference

S. Lee et al.

PERSPECTIVE p. 910

**970 Stellar astrophysics**

An extremely metal-deficient globular cluster in the Andromeda Galaxy

S. S. Larsen et al.

**974 Antifungal discovery**

A marine microbiome antifungal targets urgent-threat drug-resistant fungi

F. Zhang et al.

PERSPECTIVE p. 906

**978 Water phases**

Experimental observation of the liquid-liquid transition in bulk supercooled water under pressure

K. H. Kim et al.

**983 Geophysics**

Oceanic plateau of the Hawaiian mantle plume head subducted to the uppermost lower mantle

S. S. Wei et al.

**987 Developmental biology**

Tissue topography steers migrating *Drosophila* border cells

W. Dai et al.

**991 Zika virus**

Enhanced Zika virus susceptibility of globally invasive *Aedes aegypti* populations

F. Aubry et al.



## DEPARTMENTS

**886 Editorial**

The excellence question

By Ottoline Leyser

**887 Editorial**

Let's not overthink this

By H. Holden Thorp

**1006 Working Life**

Should I stay or should I go?

By Jessica Toothaker

## ON THE COVER

Spatial control over molecular movement is typically limited because motion at the atomic scale follows stochastic processes. When single dibromofluorene molecules are aligned along a specific direction on a silver surface, they become highly mobile and can be controllably transferred between two sharp probes, as illustrated here. Such a sender-



receiver experiment enables transport of information, encoded in individual molecular entities, between precisely defined locations. See pages 912 and 957. Illustration: C. Bickel/Science

New Products..... 1000  
Science Careers..... 1001

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 494460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$14 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra. Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request, GST #R125488122. Publications Mail Agreement Number 3069524. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and B-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

27 NOVEMBER 2020  
VOLUME 370 • ISSUE 6520

1023



## NEWS

### IN BRIEF

1016 News at a glance

### IN DEPTH

#### 1018 Arecibo radio telescope to be decommissioned

Famed observatory set for demolition after cable failures put it on the brink of collapse *By D. Clery*

#### 1019 Laser fusion reactor approaches 'burning plasma' milestone

After a decade, National Ignition Facility nears a self-heated, sustained reaction, though net energy gain is still elusive *By D. Clery*

#### 1020 Study homes in on 'exceptional responders' to cancer drugs

Project reveals clues to why some patients respond much better than others *By J. Kaiser*

#### 1021 Potential signs of life on Venus are fading fast

Amid mounting criticism, claims for cloud-borne phosphine are downgraded *By P. Voosen*

#### 1022 Public needs to prep for vaccine side effects

"Take Tylenol and suck it up," says one researcher. Fever, aches show vaccine works *By M. Wadman*

### FEATURES

#### 1023 Grade: Incomplete

As COVID-19 soars in many communities, schools attempt to find ways through the crisis *By G. Vogel and J. Couzin-Frankel*  
PODCAST

#### 1028 Guiding lights

Precise maps of millions of bright quasars show our place in the cosmos as never before *By J. Sokol*

## INSIGHTS

### PERSPECTIVES

#### 1030 Surplus and stress control autumn timing

Climate change might cause an early shedding of leaves if trees have stored enough carbon *By C. R. Rollinson*  
RESEARCH ARTICLE p. 1066; PODCAST

#### 1031 Witnessing ice habitat collapse in the Arctic

Abrupt ice loss signals major changes ahead in a north polar conservation zone *By W. F. Vincent and D. Mueller*

#### 1033 Crisis and catharsis in atomic physics

Precise measurement of an atomic hydrogen transition resolves the proton size puzzle *By W. Ubachs*  
RESEARCH ARTICLE p. 1061

#### 1034 Engineering cytokines and cytokine circuits

Learning to speak the secret language of immune cells could improve immunotherapies *By A. W. Li and W. A. Lim*

#### 1036 Staying connected under tension

A tyrosine kinase connects tension with strength of junctions between three adjacent cells *By S. Raghavan and V. Vasioukhin*  
RESEARCH ARTICLE p. 1060

#### 1037 Tree rings circle an abrupt shift in climate

A recent drier-hotter climate stands out in the context of past climate variability *By Q.-B. Zhang and O. Fang*  
REPORT p. 1095

#### 1038 Sequencing perturbed cortex development

Single-cell genomics show promise for understanding neurodevelopmental disorders *By B. Treutlein and J. G. Camp*  
RESEARCH ARTICLE p. 1057

### POLICY FORUM

#### 1040 Protecting consumers from collusive prices due to AI

Price-setting algorithms can lead to noncompetitive prices, but the law is ill equipped to stop it *By E. Calvano et al.*

### BOOKS ET AL.

#### 1043 Learning to think long-term

Lessons from nuclear waste management could help us move beyond shortsighted climate thinking *By J. D. Hamblin*

**1044 Purse strings, patients, and personal glory**

An anthropologist investigates the factors shaping modern genetic medicine  
By S. Güttinger

**LETTERS****U.S. space policy****1045 Multilateral mining**

By A. Gilbert et al.

**1045 An international model**

By M. J. Sundahl

**1046 Response**

By A. Boley and M. Byers

**1046 Technical Comment abstracts****RESEARCH****IN BRIEF**

**1053** From *Science* and other journals

**REVIEW****1056 Protein modeling**

Protein storytelling through physics  
E. Brini et al.

REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AA23041

**RESEARCH ARTICLES****1057 Neurogenomics**

In vivo Perturb-Seq reveals neuronal and glial abnormalities associated with autism risk genes  
X. Jin et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AA26063

PERSPECTIVE p. 1038

**1058 Coronavirus**

Viral epitope profiling of COVID-19 patients reveals cross-reactivity and correlates of severity  
E. Shrock et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABD4250

**1059 Transcription**

Identification of Integrator-PP2A complex (INTAC), an RNA polymerase II phosphatase  
H. Zheng et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB5872

**1060 Cell biology**

Abl and Cdc42 mediate mechanotransduction at tricellular junctions  
H. H. Yu and J. A. Zallen

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA5528

PERSPECTIVE p. 1036

**1061 Fundamental physics**

Two-photon frequency comb spectroscopy of atomic hydrogen  
A. Grinin et al.

PERSPECTIVE p. 1033

**1066 Forest ecology**

Increased growing-season productivity drives earlier autumn leaf senescence in temperate trees  
D. Zani et al.

PERSPECTIVE p. 1030; PODCAST

**REPORTS****1072 Chemical physics**

Capturing roaming molecular fragments in real time  
T. Endo et al.

**1077 Topological systems**

Exceptional nexus with a hybrid topological invariant  
W. Tang et al.

**1080 3D printing**

Critical instability at moving keyhole tip generates porosity in laser melting  
C. Zhao et al.

**1086 Conservation genetics**

Individual heterozygosity predicts translocation success in threatened desert tortoises  
P. A. Scott et al.

**1089 Coronavirus**

Structural analysis of full-length SARS-CoV-2 spike protein from an advanced vaccine candidate  
S. Bangaru et al.

**1095 Climatology**

Abrupt shift to hotter and drier climate over inner East Asia beyond the tipping point  
P. Zhang et al.

PERSPECTIVE p. 1037

**1099 Synthetic biology**

Precise T cell recognition programs designed by transcriptionally linking multiple receptors  
J. Z. Williams et al.

**1105 Ribosome structure**

Elongational stalling activates mitoribosome-associated quality control  
N. Desai et al.

**1110 Coronavirus**

REGN-COV2 antibodies prevent and treat SARS-CoV-2 infection in rhesus macaques and hamsters  
A. Baum et al.

**1115 Sex determination**

A chimeric gene paternally instructs female sex determination in the haplodiploid wasp *Nasonia*  
Y. Zou et al.

**DEPARTMENTS****1015 Editorial**

Modeling post COVID-19

By William H. Press and Richard C. Levin

**1130 Working Life**

Credit where credit is due  
By Emily Fogarty

**ON THE COVER**

For many imperiled species, including the Mojave desert tortoise (*Gopherus agassizii*), translocation of individuals to augment populations is an important conservation strategy. Researchers now demonstrate that individual heterozygosity is a key predictor



of translocation success in these tortoises—a finding that may have broad implications for improving survival outcomes for many endangered species. See page 1086. Photo: Cameron Rognan

Science Staff .....	1014
AAAS News & Notes .....	1048
Science Careers .....	1119

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484450) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, air mail, student, and emeritus rates on request. Canadian rates with GST available upon request: GST #R125486128. Publications Mail Agreement Number 3009624. Printed in the U.S.A.

**Change of address:** Allow 4 weeks, giving old and new addresses and 8-digit account number. **Postmaster:** Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. **Single-copy sales:** \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. **Authorization to reproduce** material for internal or personal use, under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

4 DECEMBER 2020 • VOLUME 370 • ISSUE 6521

## NEWS

### IN BRIEF

**1142** News at a glance

### IN DEPTH

**1144 'The game has changed! AI triumphs at protein folding**

In milestone, software predictions finally match structures calculated from experimental data *By R. F. Service*

**1145 Why were salmon dying? The answer washed off the road**

Common tire chemical implicated in coho salmon kills *By E. Stokstad*

REPORT BY Z. TIAN ET AL.  
10.1126/SCIENCE.ABD6951

**1146 Scientists fear no-deal Brexit as deadline looms**

U.K. researchers in limbo, weeks from crashing out of EU trade and travel rules *By C. O'Grady*

**1147 How cats get their stripes and spots**

Newly uncovered mechanism may pattern the coats of other mammals, too *By E. Pennisi*

**1148 Federal hospital data system falters at tracking pandemic**

HHS Protect data, which influence how pandemic supplies and support are allocated, conflict with other data sources *By C. Piller*

**1150 New challenges emerge for planned human challenge trials**

Scientists debate risks and benefits of intentionally exposing volunteers to dangerous virus *By W. Cornwall*

**1151 Amid the cheering, some vaccines face questions**

A candidate from AstraZeneca and the University of Oxford has puzzling efficacy data *By J. Cohen*

### FEATURES

**1152 Saving sanctuaries**

Critics charge that sanctuaries for retired research chimpanzees are failing their animals. Can a new tool help? *By D. Grimm*

## INSIGHTS

### BOOKS ET AL.

**1156 Fodder for future scientists**

### PERSPECTIVES

**1162 Quantum-limited sound attenuation**

Resonantly interacting atoms confined by lasers have implications for neutron stars *By T. Schaefer*

REPORT p. 1222



**1152**

Celebrity chimpanzee Hercules is making new friends at Project Chimps.

**1163 Enzyme formation by immune receptors**

Upon pathogen recognition, some plant immune receptors assemble into active enzyme complexes *By L. Tian and X. Li*  
RESEARCH ARTICLES pp. 1184 & 1185

**1165 Miniaturization of robots that fly on beetles' wings**

The shock-absorbing wings of the rhinoceros beetle battle in-flight collisions *By J. Sun*

REPORT p. 1214

**1166 Probing the dark side of the exciton**

Photoemitted electrons reveal large-momentum ("dark") excitons in monolayer WSe<sub>2</sub> *By M. X. Na and Z. Ye*

REPORT p. 1199

**1167 Constraints on selfish behavior in plants**

Plants overproduce roots to secure resources nearby but avoid costly trips to neighbors' patches *By M. Semchenko*

REPORT p. 1197

**1168 Stimulating the brain to restore vision**

High-definition brain prostheses are developed for treating blindness *By M. S. Beauchamp and D. Yoshor*

RESEARCH ARTICLE p. 1191

**1170 Mario J. Molina (1943–2020)**

Visionary environmental chemist *By K. A. Prather*

### POLICY FORUM

**1171 Fossil electricity retirement deadlines for a just transition**

A 2035 deadline for decarbonizing U.S. electricity would strand only about 15% of fossil capacity-years

*By E. Grubert*



1156

## LETTERS

### 1174 Evidence-based hunting policy needed in Slovakia

By M. Kotal and M. Dula

### 1174 Computational social science: On measurement

By A. X. Wu et al.

### 1175 Chinese sturgeon needs urgent rescue

By X. Zhou et al.

### 1175 Errata

## RESEARCH

### IN BRIEF

1177 From *Science* and other journals

### REVIEW

#### 1180 Microbiota

The role of the microbiota in human genetic adaptation

T. A. Suzuki and R. E. Ley

REVIEW SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAZ6827](https://doi.org/10.1126/SCIENCE.AAZ6827)

### RESEARCH ARTICLES

#### 1181 Coronavirus

Comparative host-coronavirus protein interaction networks reveal pan-viral disease mechanisms

D. E. Gordon et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABE9403](https://doi.org/10.1126/SCIENCE.ABE9403)

#### 1182 Innate immunity

Enteroviral 3C protease activates the human NLRP1 inflammasome in airway epithelia

K. S. Robinson et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.AAY2002](https://doi.org/10.1126/SCIENCE.AAY2002)

#### 1183 Evolution

Selection enhances protein evolvability by increasing mutational robustness and foldability

J. Zheng et al.

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: [DX.DOI.ORG/10.1126/SCIENCE.ABB5962](https://doi.org/10.1126/SCIENCE.ABB5962)

### Plant science

#### 1184 Direct pathogen-induced assembly of an NLR immune receptor complex to form a holoenzyme

S. Ma et al.

RESEARCH ARTICLE SUMMARY;

FOR FULL TEXT:

[DX.DOI.ORG/10.1126/SCIENCE.ABE3069](https://doi.org/10.1126/SCIENCE.ABE3069)

#### 1185 Structure of the activated ROQ1

resistosome directly recognizing the

pathogen effector XopQ

R. Martin et al.

RESEARCH ARTICLE SUMMARY;

FOR FULL TEXT:

[DX.DOI.ORG/10.1126/SCIENCE.ABD9993](https://doi.org/10.1126/SCIENCE.ABD9993)

PERSPECTIVE p. 1163

#### 1186 Developmental biology

The N-glycome regulates the endothelial-to-hematopoietic transition

D. M. Kasper et al.

#### 1191 Neuroscience

Shape perception via a high-channel-count neuroprosthesis in monkey visual cortex

X. Chen et al.

PERSPECTIVE p. 1168; PODCAST

### REPORTS

#### 1197 Plant science

The exploitative segregation of plant roots

C. Cabal et al.

PERSPECTIVE p. 1167

#### 1199 Physics

Directly visualizing the momentum-forbidden dark excitons and their dynamics in atomically thin semiconductors

J. Madéo et al.

PERSPECTIVE p. 1166

#### 1204 Spectroscopy

Super-resolution lightwave tomography of electronic bands in quantum materials

M. Borsch et al.

#### 1208 Coronavirus

De novo design of potent and resilient hACE2 decoys to neutralize SARS-CoV-2

T. W. Linsky et al.



#### 1214 Biomechanics

Mechanisms of collision recovery in flying beetles and flapping-wing robots

H. V. Phan and H. C. Park

PERSPECTIVE p. 1165

#### 1219 Tropical forest

Long-term collapse in fruit availability threatens Central African forest megafauna

E. R. Bush et al.

#### 1222 Quantum gases

Universal sound diffusion in a strongly interacting Fermi gas

P. B. Patel et al.

PERSPECTIVE p. 1162

#### 1227 Coronavirus

Robust neutralizing antibodies to SARS-CoV-2 infection persist for months

A. Wajnberg et al.

#### 1230 Deep biosphere

Temperature limits to deep subseafloor life in the Nankai Trough subduction zone

V. B. Heuer et al.

### DEPARTMENTS

#### 1141 Editorial

Low-income students lose ground

By Christopher Avery et al.

#### 1242 Working Life

Coming out

By Bec Roldan

### ON THE COVER

Root systems of two different plants, stained with red and blue dye for fresh cut flowers.

Root dyeing provided experimental validation of theoretical predictions regarding plants'

response to competition. Neighbor plants segregate their root systems in the soil space but develop more roots locally when a competitor is close than when growing alone. See pages 1167 and 1197. Photo: Mikel Ponce



New Products.....1235  
Science Careers.....1236

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra; Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request; GST #R125488122. Publications Mail Agreement Number 1069624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS

11 DECEMBER 2020 • VOLUME 370 • ISSUE 6522



1263

## NEWS

### IN BRIEF

**1252** News at a glance

### IN DEPTH

#### **1254** Tweaking genes with CRISPR or viruses fixes blood disorders

People with sickle cell disease or beta-thalassemia could be freed of debilitating symptoms for a lifetime  
*By J. Kaiser*

#### **1255** Spare a thought for the teeming ecosystem beneath your feet

Global review of soil biodiversity calls for protecting often overlooked subterranean life  
*By E. Pennisi*

#### **1256** HIV researcher named to lead battered CDC

Biden also picks California attorney general for health and human services  
*By J. Kaiser*

#### **1257** Tasmanian devils claw their way back from extinction

Genomes show spread of deadly cancer is slowing  
*By E. Pennisi*

#### **1258** Scientists rally around plan for fusion power plant

Road map calls for Department of Energy to fund applied as well as basic research  
*By A. Cho*

#### **1259** Europe ramps up defense R&D

A €7 billion fund is launched to bolster meager military spending by EU nations  
*By N. Wallace*

#### **1260** Ecologists push for more reliable research

Psychology's replication crisis inspires efforts to expand samples and stick to a research plan  
*By C. O'Grady*  
PODCAST

#### **1261** Mexico's controversial coronavirus czar

Hugo López-Gatell Ramírez's response has drawn criticism and praise  
*By R. Pérez Ortega*

### FEATURES

#### **1263** China's vaccine gambit

With its global campaign to test and promote COVID-19 vaccines, China aims to win friends and cut deals  
*By J. Cohen*

## INSIGHTS

### PERSPECTIVES

#### **1268** Diversity hotspots: Coldspots of speciation?

Phylogeny of subsocial passerine birds finds lower speciation rates in biodiverse regions  
*By H. Mordon*  
REPORT p. 1343

#### **1269** Using genetics to reveal protein structure

Measurements of genetic interactions in vivo can be used to determine protein structure  
*By D. Wang*  
RESEARCH ARTICLE p. 1294

#### **1271** The glassiness of hardening protein droplets

Protein condensates can age to form glasses that increase in viscosity but retain elasticity  
*By H. Zhang*  
REPORT p. 1317

#### **1272** Remembering seasonal coronaviruses

Antibodies against seasonal coronaviruses react with SARS-CoV-2  
*By J. J. Guthmiller and P. C. Wilson*  
REPORT p. 1339

#### **1274** Ensuring vaccine safety

Comprehensive safety testing is based on experience with prior vaccines  
*By D. M. Kripe et al.*

#### **1276** Angelika Amon (1967–2020)

Trailblazing cell cycle biologist  
*By J. M. Sheltzer and R. Visintin*

### POLICY FORUM

#### **1277** COVID-19 vaccine trial ethics once we have efficacious vaccines

Some placebo-controlled trials can continue ethically after a candidate vaccine is found to be safe and efficacious  
*By D. Wendler et al.*

## BOOKS ET AL.

### 1280 An outside-the-box take on time

A physicist's provocative theory offers an optimistic view of our cosmic destiny  
By M. Johnson

### 1281 Social capital's value in the courtroom

Inequalities are reinforced during court proceedings and deliberations, finds a sociologist  
By L. Seamster

## LETTERS

### 1282 Renewables in Spain threaten biodiversity

By D. Serrano et al.

### 1283 Small Aral Sea brings hope for Lake Balkhash

By N. V. Aladin et al.

### 1283 Brazil's areas of not-so-permanent preservation

By M. A. U. de Andrade Junior and W. C. Fonseca

### 1284 Technical Comment abstracts

# RESEARCH

## IN BRIEF

1286 From Science and other journals

## REVIEW

### 1289 Economics

Poverty, depression, and anxiety: Causal evidence and mechanisms  
M. Ridley et al.  
REVIEW SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAY0214

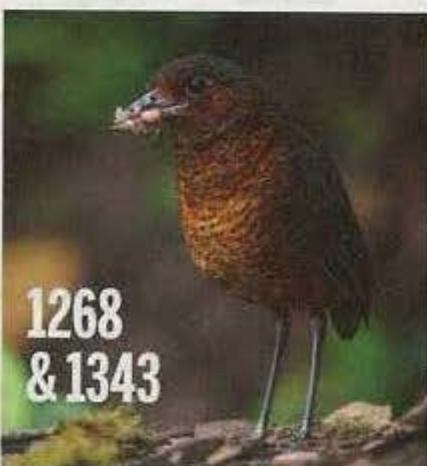


PHOTO: MURRAY COOPER/MINDEN PICTURES

## RESEARCH ARTICLES

### 1290 Molecular biology

CIBER-seq dissects genetic networks by quantitative CRISPRi profiling of expression phenotypes  
R. Muller et al.  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB9662

### 1291 Developmental biology

Mouse embryonic stem cells self-organize into trunk-like structures with neural tube and somites  
J. V. Veenvliet et al.  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABA4937

### 1292 Developmental biology

Developmental clock and mechanism of de novo polarization of the mouse embryo  
M. Zhu et al.  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABD2703

### 1293 Disease dynamics

A transmissible cancer shifts from emergence to endemism in Tasmanian devils  
A. H. Patton et al.  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABB9772  
PODCAST

### 1294 Systems biology

Genetic interaction mapping informs integrative structure determination of protein complexes  
H. Braberg et al.  
RESEARCH ARTICLE SUMMARY; FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AA24910  
PERSPECTIVE p. 1269

### 1295 Climate change

Recent global decline of CO<sub>2</sub> fertilization effects on vegetation photosynthesis  
S. Wang et al.

### 1300 Solar cells

Monolithic perovskite/silicon tandem solar cell with >29% efficiency by enhanced hole extraction  
A. Al-Ashouri et al.

## REPORTS

### 1309 Quantum information

Optically addressable molecular spins for quantum information processing  
S. L. Bayliss et al.

### 1313 Batteries

Reversible planar gliding and microcracking in a single-crystalline Ni-rich cathode  
Y. Bi et al.

### 1317 Biophysics

Protein condensates as aging Maxwell fluids  
L. Jawerth et al.  
PERSPECTIVE p. 1271

### 1324 Ultracold chemistry

Resonant collisional shielding of reactive molecules using electric fields  
K. Matsuda et al.

### 1328 Cancer immunotherapy

Stem-like CD8 T cells mediate response of adoptive cell immunotherapy against human cancer  
S. Krishna et al.

### 1335 Indian monsoon

Indian monsoon derailed by a North Atlantic wavetrain  
P. J. Borah et al.

### 1339 Coronavirus

Preexisting and de novo humoral immunity to SARS-CoV-2 in humans  
K. W. Ng et al.  
PERSPECTIVE p. 1272

### 1343 Evolution

The evolution of a tropical biodiversity hotspot  
M. G. Harvey et al.  
PERSPECTIVE p. 1268

### 1348 Paleoclimate

Southern Ocean upwelling, Earth's obliquity, and glacial-interglacial atmospheric CO<sub>2</sub> change  
X. E. Ai et al.

## DEPARTMENTS

### 1251 Editorial

An opportunity to improve innovation  
By H. Holden Thorp

### 1366 Working Life

Dare to be different  
By Chee Kiang Ewe

## ON THE COVER

Schematic representation of the gliding phenomenon in a micrometer-sized cathode crystal charged to high voltages. Crystal gliding, induced by localized stress, is partially reversible



and eventually evolves into microcracks after extensive battery cycling. A critical crystal size has been predicted to prevent such gliding in battery cathode crystals.  
See page 1313. Illustration: C. Bickel/Science

Science Staff .....	1250
New Products .....	1353
Science Careers .....	1354

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125488122. Publications Mail Agreement Number: 1069624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.science.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC): www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# CONTENTS



18 DECEMBER 2020 • VOLUME 370 • ISSUE 6523

## SPECIAL SECTION

### BREAKTHROUGH *of the YEAR*

**1392 Shots of hope** Desperately needed vaccines against COVID-19, developed and tested at record speed, are 2020's breakthrough *By J. Cohen*

**1395 A divisive disease** As scientists struggled to understand and quell COVID-19, a second pandemic of misinformation and political mayhem raged *By K. Kupferschmidt*

**1398 Ones we've lost** Scientists, too, died in the pandemic

#### RUNNERS-UP

**1402** AI disentangles protein folding

**1403** First CRISPR cures?

**1403** Global warming forecasts sharpen

**1404** Found: elusive source of fast radio bursts

**1405** World's oldest hunting scene revealed

**1405** Scientists speak up for diversity

**1406** How elite controllers keep HIV at bay

**1406** Room temperature superconductivity finally achieved

**1407** Birds are smarter than you think

#### ON THE COVER

As the COVID-19 pandemic exploded in 2020, scientists mobilized to develop and test dozens of candidate vaccines targeting the new coronavirus. Many aim to stimulate antibodies against the virus' protruding spike proteins, which enable it to infect human cells. In record time, several vaccines showed strong evidence of efficacy, giving a beleaguered world new hope. See page 1392.



*Illustration: Adam Simpson/Heart Agency*

SEE ALSO EDITORIAL P. 1381 VIDEO  
PODCAST CROSSWORD

## NEWS

### IN BRIEF

**1382** News at a glance

### IN DEPTH

**1384** **People with Down syndrome face high risk from coronavirus**

Advocates call for early vaccination of group made vulnerable by genetics and immune dysfunction *By M. Wadman*

**1385** **As vaccines emerge, a global waiting game begins**

Rich countries snapped up limited supplies, so protection will lag for others *By J. Cohen and K. Kupferschmidt*

**1387** **Mars lander spies the planet's deep boundaries**

Despite lack of large quakes, InSight team fixes size of crust, mantle, and core *By P. Voosen*

**1388** **mRNA's next challenge: Will it work as a drug?**

A winner in the vaccine race, messenger RNA faces obstacles in therapeutics *By K. Servick*

**1390** **Five years in, Paris pact still a work in progress**

Countries mark anniversary by increasing commitments, but 2°C goal elusive *By W. Cornwall*

**1391** **LGBTQ researchers say they want to be counted**

Scientists call for National Science Foundation's workforce surveys to tally sexual and gender minorities *By K. Langin*

## INSIGHTS

### PERSPECTIVES

**1408** **Wildfire smoke, a potential infectious agent**

Bacteria and fungi are transported in wildland fire smoke emissions *By L. N. Kobziar and G. R. Thompson III*

**1410** **A gatekeeper for learning**

During associative learning, the perirhinal cortex controls burst firing of sensory neurons *By F. Donato*

RESEARCH ARTICLE p. 1435

**1411** **Adding cognitive connections to the cerebellum**

During evolution, duplication of subnuclei generates broader cerebellar projections *By M. E. Hatten*

RESEARCH ARTICLE p. 1436

**1413 A new spin on special relativity**

Magnetic domain walls have their own speed limit. *By M. W. Daniels and M. D. Stiles*  
REPORT p. 1438

**1414 Bespoke myelin tailored to neuron type**

Experience changes neural circuits through myelination of distinct neuron classes  
*By B. Yalcin and M. Monje*  
RESEARCH ARTICLE p. 1437

**1415 Celebrating Marie Tharp**

Her maps of the ocean floor were crucial to the plate tectonic revolution  
*By M. Romano and F. L. Chiocci*

**POLICY FORUM****1417 Core commitments for field trials of gene drive organisms**

We must ensure that trials are scientifically, politically, and socially robust, publicly accountable, and widely transparent  
*By K. C. Long et al.*

**BOOKS ET AL.****1420 Datafication of digital natives**

An anthropologist investigates how data surveillance intersects with the 21st-century family  
*By K. Eichhorn*

**1421 Science detractors and their discontents**

A nuanced history interrogates critiques leveraged against science in the United States  
*By C. J. Phillips*

**LETTERS****1422 Transparency is key to ethical vaccine research**

*By P. W. Estep and G. M. Church*

**1423 Response**

*By C. J. Guerrini et al.*

**1423 Response**

*By A. Caplan and A. Bateman-House*

**1424 Technical Comment abstracts****RESEARCH****IN BRIEF**

**1428** From *Science* and other journals

**RESEARCH ARTICLES****Molecular biology**

**1431** The ZSWIM8 ubiquitin ligase mediates target-directed microRNA degradation  
*C. Y. Shi et al.*  
RESEARCH ARTICLE SUMMARY:  
FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC9359

**1432** A ubiquitin ligase mediates target-directed microRNA decay independently of tailing and trimming  
*J. Han et al.*  
RESEARCH ARTICLE SUMMARY:  
FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC9546

**1433 Spliceosome**

Mechanism of protein-guided folding of the active site U2/U6 RNA during spliceosome activation  
*C. Townsend et al.*  
RESEARCH ARTICLE SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC3753

**1434 Nonhuman genomics**

Sequence diversity analyses of an improved rhesus macaque genome enhance its biomedical utility  
*W. C. Warren et al.*  
RESEARCH ARTICLE SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABC6617

**1435 Neuroscience**

Perirhinal input to neocortical layer 1 controls learning  
*G. Doron et al.*  
RESEARCH ARTICLE SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.AAZ3136  
PERSPECTIVE p. 1410

**1436 Brain evolution**

Cerebellar nuclei evolved by repeatedly duplicating a conserved cell-type set  
*J. M. Kiebschull et al.*  
RESEARCH ARTICLE SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABD5059  
PERSPECTIVE p. 1411

**1437 Neurodevelopment**

Neuron class-specific responses govern adaptive myelin remodeling in the neocortex  
*S. M. Yang et al.*  
RESEARCH ARTICLE SUMMARY: FOR FULL TEXT:  
DX.DOI.ORG/10.1126/SCIENCE.ABD2109  
PERSPECTIVE p. 1414

**REPORTS****1438 Spintronics**

Relativistic kinematics of a magnetic soliton  
*L. Caretta et al.*  
PERSPECTIVE p. 1413

**1442 Directed evolution**

How directed evolution reshapes the energy landscape in an enzyme to boost catalysis  
*R. Otten et al.*

**1447 Phononic crystals**

Direct observation of Klein tunneling in phononic crystals  
*X. Jiang et al.*

**1450 Neutron stars**

Multimessenger constraints on the neutron-star equation of state and the Hubble constant  
*T. Dietrich et al.*

**1454 Catalysis**

Tailored quinones support high-turnover Pd catalysts for oxidative C-H arylation with O<sub>2</sub>  
*C. A. Salazar et al.*

**1460 Quantum computing**

Quantum computational advantage using photons  
*H.-S. Zhong et al.*

**1464 Coronavirus**

SARS-CoV-2 D614G variant exhibits efficient replication *ex vivo* and transmission *in vivo*  
*Y. J. Hou et al.*

**1469 Trophic ecology**

Novel trophic interactions under climate change promote alpine plant coexistence  
*P. Descombes et al.*

**Coronavirus**

**1473** An ultrapotent synthetic nanobody neutralizes SARS-CoV-2 by stabilizing inactive Spike  
*M. Schoof et al.*  
**1479** Versatile and multivalent nanobodies efficiently neutralize SARS-CoV-2  
*Y. Xiang et al.*

**DEPARTMENTS****1381 Editorial**

A breakthrough for us all *By H. Holden Thorp*  
BREAKTHROUGH OF THE YEAR SECTION p. 1392

**1522 Working Life**

A bearer of good news *By Romaric Bouveret*

Science Staff ..... 1378  
AAAS News & Notes ..... 1425  
Science Careers ..... 1489

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2020 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership, including subscription (12 months): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$2148. Foreign postage extra: Air assist delivery: \$98. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R125486222. Publications Mail Agreement Number 1069624. Printed in the U.S.A.  
Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20009-6178. Single-copy sales: \$15 each plus shipping and handling available from backissues.sciencemag.org; bulk rate on request. Authorization to reproduce material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act can be obtained through the Copyright Clearance Center (CCC), www.copyright.com. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

# SCIENCE AND CULTURE

JANUARY-FEBRUARY 2020/VOLUME 86/NO. 1-2

A JOURNAL OF NATURAL AND CULTURAL SCIENCES

PUBLISHED BY THE

## INDIAN SCIENCE NEWS ASSOCIATION

EDITORIAL BOARD

**Professor S. C. Roy** Editor-in-Chief

**Shri Biman Basu**

**Dr. Satyabrata Chakrabarti**

**Professor Syamal Chakrabarti**

**Professor Manas Chakrabarty**

**Professor Barun Kumar Chatterjee**

**Dr. Sabyasachi Chattopadhyay**

**Dr. Amit Krishna De**

**Professor Sudhendu Mandal**

**Professor Vasant Natarajan**

COLLABORATORS

Amiya Kumar Bagchi (Kolkata)	Irfan Habib (Delhi)
D. Balasubramanian (Hyderabad)	A. K. Hati (Kolkata)
Indrani Bose (Kolkata)	Mridul Hazarika (Guwahati)
S Chandrasekhar (Hyderabad)	S. Kailas (Mumbai)
D. P. Chattopadhyaya (Kolkata)	Punam Kakkar (Lucknow)
Samit Chattopadhyaya (Kolkata)	Abhijit Lahiri (Delhi)
Mihir Kanti Choudhuri (Tejpur)	A. N. Lahiri Majumder (Kolkata)
Mrinal K. Dewanjee (U.S.A.)	B. K. Pattnaik (Kanpur)
R. Gadagkar (Bangalore)	V. Ravichandran (Kolkata)
Ajoy Ghatak (Delhi)	Ashoke Sen (Allahabad)
	Rajinder Singh (Germany)
	Srinivasan Srikanthan (Chennai)

### EDITORIAL

Weak Response to Climate Crisis

— *D. Raghunandan and Alak Ray* ... 1

### ARTICLE

The Science of Climate Change

— *Nagraj Adve* ... 4

India, Paris Agreement and Domestic Actions

— *D. Raghunandan* ... 10

Climate Change and Urban Areas of India

— *Ankush Gupta* ... 21

Research and Education in India on  
Climate Change

— *Alak Ray* ... 28

Ten Years After: Evaluating State Action  
Plans in India

— *Anu Jogesh and Mridula Mary Paul* ... 38

The Human Sciences and Climate Change:  
A Crisis of Anthropocentrism

— *Dipesh Chakrabarty* ... 46

### OPINION

Pulicat Development Authority – Need of  
the Hour

— *Kannan Vaithianathan* ... 49

### A TRAVELLER'S JOURNAL

Parallel Lives Alyque Padamsee and Jim  
Haynes – Part II – Achievements

— *Antonia Hoogewerf* ... 51

Contd. next page.



Indian Science News Association

## MEMBERS OF THE COUNCIL

### *President*

Dr. K. Muraleedharan

### *Vice-Presidents*

Professor S. K. Talapatra

Professor Amalendu Bandyopadhyay

Professor Sanghamitra Bandyopadhyay

Professor Biswapati Mukherjee

Professor (Mrs.) Julie Banerji

Professor Bikas. K. Chakrabarti

### *Honorary Secretaries*

Professor Sudhendu Mandal

Professor Manas Chakrabarty

### *Honorary Treasurer*

Professor Barun Kumar Chatterjee

### *Members*

Shri Biman Basu

Shri Prasanta K. Bose

Dr. Manoj Kumar Chakrabarti

Dr. Satyabrata Chakrabarti

Prof. Syamal Chakrabarti

Professor Dhruvajyoti Chattopadhyay

Dr. Sabyasachi Chattopadhyay

Dr. Manas Pratim Das

Dr. Amit Krishna De

Shri Pathik Guha

Professor Dipak Kumar Kar

Dr. Sisir Kumar Majumdar

Dr. Balaram Majumder

Dr. Hemanta Kumar Majumder

Professor Partha P. Majumder

Dr. Shankarashis Mukherjee

Professor Vasant Natarajan

Professor Sajal Ray

Professor S. C. Roy

Professor Devdatta Sinha

Dr. D. K. Srivastava

Professor (Mrs.) Bani Talapatra

## RESEARCH COMMUNICATION

Application of Leith's Model for the Energy Transfer Process in an Isotropic Gas-Solid Turbulent Flow

— S. De, S. Ghorai and H. P. Mazumdar ... 54

## REPORT

Nobel Prizes in Science : 2019

Chemistry

— Manas Chakrabarty ... 62

Physics

— Biman Basu ... 64

Physiology or Medicine

— Biman Basu ... 65

Economics

— Anindya S. Chakrabarti ... 67

## BOOK REVIEW

D.M. Bose – His Life, Science and Connection with Global Elites

— Jayanta Sthanapati ... 69

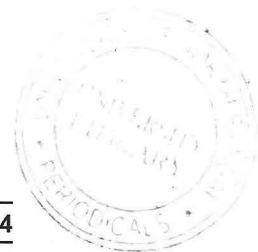
## NOTES AND NEWS

... 71

**Cover :** Retreat of the Gangotri Glacier (Courtesy : NASA's Earth Observatory)

# SCIENCE AND CULTURE

10 SEP 2020



MARCH-APRIL 2020/VOLUME 86/NO. 3-4

A JOURNAL OF NATURAL AND CULTURAL SCIENCES

PUBLISHED BY THE  
**INDIAN SCIENCE  
NEWS ASSOCIATION**

## EDITORIAL BOARD

**Professor S. C. Roy** Editor-in-Chief

**Shri Biman Basu**

**Dr. Satyabrata Chakrabarti**

**Professor Syamal Chakrabarti**

**Professor Manas Chakrabarty**

**Professor Barun Kumar Chatterjee**

**Dr. Sabyasachi Chattopadhyay**

**Dr. Amit Krishna De**

**Professor Sudhendu Mandal**

**Professor Vasant Natarajan**

## COLLABORATORS

Amiya Kumar Bagchi (Kolkata)	Irfan Habib (Delhi)
D. Balasubramanian (Hyderabad)	A. K. Hati (Kolkata)
Indrani Bose (Kolkata)	Mridul Hazarika (Guwahati)
S Chandrasekhar (Hyderabad)	S. Kailas (Mumbai)
D. P. Chattopadhyaya (Kolkata)	Punam Kakkar (Lucknow)
Samit Chattopadhyaya (Kolkata)	Abhijit Lahiri (Delhi)
Mihir Kanti Choudhuri (Tejpur)	A. N. Lahiri Majumder (Kolkata)
Mrinal K. Dewanjee (U.S.A.)	B. K. Pattnaik (Kanpur)
R. Gadagkar (Bangalore)	V. Ravichandran (Kolkata)
Ajoy Ghatak (Delhi)	Ashoke Sen (Allahabad)
	Rajinder Singh (Germany)
	Srinivasan Srikanthan (Chennai)

## EDITORIAL

COVID-19: Contemporary Challenges

— *S. C. Roy*

... 77

## ARTICLE

Ayurveda, Our Traditional System of Medicine, and Its Importance in Today's Drug Development

— *Julie Banerji, Anupam Nayak  
and Saswati Tarafdar*

... 79

A Glimpse of the Geometrical Works of Indian Mathematician Syamadas Mukhopadhyaya

— *Sabitri Ray Chaudhuri*

... 85

Bibha Chowdhuri – From an Unsung Heroine to a Star in Heaven

— *Rajinder Singh and S.C. Roy*

... 90

Air Conditioning and Local Heating

— *R N Misra*

... 96

Value of Education

— *Basudeb Barman*

... 99

Science and Technology in Vedic Literature

— *Asok Kumar Sinha*

... 102

## OPINION

Plasma Gasification – A Sustainable Solution for Municipal Solid Waste

— *Vasant Natarajan*

... 107

## FOCUS

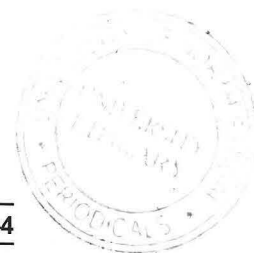
From Dirt to Art

— *Michael Gallant*

... 108

# SCIENCE AND CULTURE

10 SEP 2020



MARCH-APRIL 2020/VOLUME 86/NO. 3-4

A JOURNAL OF NATURAL AND CULTURAL SCIENCES

PUBLISHED BY THE  
**INDIAN SCIENCE  
NEWS ASSOCIATION**

## EDITORIAL BOARD

**Professor S. C. Roy** Editor-in-Chief

**Shri Biman Basu**

**Dr. Satyabrata Chakrabarti**

**Professor Syamal Chakrabarti**

**Professor Manas Chakrabarty**

**Professor Barun Kumar Chatterjee**

**Dr. Sabyasachi Chattopadhyay**

**Dr. Amit Krishna De**

**Professor Sudhendu Mandal**

**Professor Vasant Natarajan**

## COLLABORATORS

Amiya Kumar Bagchi (Kolkata)	Irfan Habib (Delhi)
D. Balasubramanian (Hyderabad)	A. K. Hati (Kolkata)
Indrani Bose (Kolkata)	Mridul Hazarika (Guwahati)
S Chandrasekhar (Hyderabad)	S. Kailas (Mumbai)
D. P. Chattopadhyaya (Kolkata)	Punam Kakkar (Lucknow)
Samit Chattopadhyaya (Kolkata)	Abhijit Lahiri (Delhi)
Mihir Kanti Choudhuri (Tejpur)	A. N. Lahiri Majumder (Kolkata)
Mrinal K. Dewanjee (U.S.A.)	B. K. Pattnaik (Kanpur)
R. Gadagkar (Bangalore)	V. Ravichandran (Kolkata)
Ajoy Ghatak (Delhi)	Ashoke Sen (Allahabad)
	Rajinder Singh (Germany)
	Srinivasan Srikanthan (Chennai)

## EDITORIAL

COVID-19: Contemporary Challenges  
— S. C. Roy ... 77

## ARTICLE

Ayurveda, Our Traditional System of Medicine, and Its  
Importance in Today's Drug Development  
— Julie Banerji, Anupam Nayak  
and Saswati Tarafdar ... 79

A Glimpse of the Geometrical Works of Indian  
Mathematician Syamadas Mukhopadhyaya  
— Sabitri Ray Chaudhuri ... 85

Bibha Chowdhuri – From an Unsung Heroine  
to a Star in Heaven  
— Rajinder Singh and S.C. Roy ... 90

Air Conditioning and Local Heating  
— R N Misra ... 96

Value of Education  
— Basudeb Barman ... 99

Science and Technology in Vedic Literature  
— Asok Kumar Sinha ... 102

## OPINION

Plasma Gasification – A Sustainable Solution  
for Municipal Solid Waste  
— Vasant Natarajan ... 107

## FOCUS

From Dirt to Art  
— Michael Gallant ... 108



Indian Science News Association

## MEMBERS OF THE COUNCIL

### *President*

Dr. K. Muraleedharan

### *Vice-Presidents*

Professor S. K. Talapatra

Professor Amalendu Bandyopadhyay

Professor Sanghamitra Bandyopadhyay

Professor Biswapati Mukherjee

Professor (Mrs.) Julie Banerji

Professor Bikas. K. Chakrabarti

### *Honorary Secretaries*

Professor Sudhendu Mandal

Professor Manas Chakrabarty

### *Honorary Treasurer*

Professor Barun Kumar Chatterjee

### *Members*

Shri Biman Basu

Shri Prasanta K. Bose

Dr. Manoj Kumar Chakrabarti

Dr. Satyabrata Chakrabarti

Prof. Syamal Chakrabarti

Professor Dhruvajyoti Chattopadhyay

Dr. Sabyasachi Chattopadhyay

Dr. Manas Pratim Das

Dr. Amit Krishna De

Shri Pathik Guha

Professor Dipak Kumar Kar

Dr. Sisir Kumar Majumdar

Dr. Balaram Majumder

Dr. Hemanta Kumar Majumder

Professor Partha P. Majumder

Dr. Shankarashis Mukherjee

Professor Vasant Natarajan

Professor Sajal Ray

Professor S. C. Roy

Professor Devdatta Sinha

Dr. D. K. Srivastava

Professor (Mrs.) Bani Talapatra

## A TRAVELLER'S JOURNAL

Safari through South Africa - I

— *Antonia Hoogewerf*

... 110

## RESEARCH COMMUNICATION

Allelopathic Effect of Fagopyrum Plant

Extracts on Crop Seed Species

— *Subhojy Ojhai, Chandan Kumar Pari  
and Mousumi Sen*

... 113

## BOOK REVIEW

'Paper Lioness': Margaret Noble

— *Kanishka Chaudhury*

... 116

## NOTES AND NEWS

... 119

**Cover :** (Top Left) Bibha Chowhuri (1913-1991); (Top Right) The Star HD 86081 named 'Bibha' after the name of the pioneering high energy physicist Bibha Chowdhuri; (Bottom) Participating in the 'IAU 100 Name ExoWorlds' competition, India named the Star 'Bibha' and its Exoplanet 'Santamasa' which was globally accepted (for more details, see page 90).

# SCIENCE AND CULTURE

MAY-JUNE 2020/VOLUME 86/NO. 5-6

A JOURNAL OF NATURAL AND CULTURAL SCIENCES



PUBLISHED BY THE

## INDIAN SCIENCE NEWS ASSOCIATION

EDITORIAL BOARD

**Professor S. C. Roy** Editor-in-Chief**Shri Biman Basu****Dr. Satyabrata Chakrabarti****Professor Syamal Chakrabarti****Professor Manas Chakrabarty****Professor Barun Kumar Chatterjee****Dr. Sabyasachi Chattopadhyay****Dr. Amit Krishna De****Professor Sudhendu Mandal****Professor Vasant Natarajan**

COLLABORATORS

Amiya Kumar Bagchi (Kolkata)	Irfan Habib (Delhi)
D. Balasubramanian (Hyderabad)	A. K. Hati (Kolkata)
Indrani Bose (Kolkata)	Mridul Hazarika (Guwahati)
S Chandrasekhar (Hyderabad)	S. Kailas (Mumbai)
D. P. Chattopadhyaya (Kolkata)	Punam Kakkar (Lucknow)
Samit Chattopadhyaya (Kolkata)	Abhijit Lahiri (Delhi)
Mihir Kanti Choudhuri (Tejpur)	A. N. Lahiri Majumder (Kolkata)
Mrinal K. Dewanjee (U.S.A.)	B. K. Pattnaik (Kanpur)
R. Gadagkar (Bangalore)	V. Ravichandran (Kolkata)
Ajoy Ghatak (Delhi)	Ashoke Sen (Allahabad)
	Rajinder Singh (Germany)
	Srinivasan Srikanthan (Chennai)

## EDITORIAL

Learnings from COVID-19 Pandemic

— S. C. Roy ... 135

## ARTICLE

Corona Virus – Its Origin, Replication and Remedy  
for Future Threat

— Satyesh Chandra Roy ... 138

Evaluating the Evolution of Health Policy  
in India

— Nataraj Malakar ... 145

85<sup>th</sup> Anniversary of *Science and Culture* :  
An Introspection

— Rajinder Singh and S.C. Roy ... 150

Dominant Factors Determining Differences of  
COVID-19 Fatalities Between India and Other  
Large-Population Regions— Sudhakar Yarlagadda and  
Satyaki Kar ... 164

## OPINION

Customary Consumption of the Fourteen  
Varieties of Vegetable on the Day Preceding  
Dewāli : A Note

— Pranada Sankar Chakraborty ... 171

## FOCUS

Solving the Burning Problem

— Michael Gallant ... 173



Indian Science News Association

## MEMBERS OF THE COUNCIL

### *President*

Dr. K. Muraleedharan

### *Vice-Presidents*

Professor S. K. Talapatra

Professor Amalendu Bandyopadhyay

Professor Sanghamitra Bandyopadhyay

Professor Biswapati Mukherjee

Professor (Mrs.) Julie Banerji

Professor Bikas. K. Chakrabarti

### *Honorary Secretaries*

Professor Sudhendu Mandal

Professor Manas Chakrabarty

### *Honorary Treasurer*

Professor Barun Kumar Chatterjee

### *Members*

Shri Biman Basu

Shri Prasanta K. Bose

Dr. Manoj Kumar Chakrabarti

Dr. Satyabrata Chakrabarti

Prof. Syamal Chakrabarti

Professor Dhrubajyoti Chattopadhyay

Dr. Sabyasachi Chattopadhyay

Dr. Manas Pratim Das

Dr. Amit Krishna De

Shri Pathik Guha

Professor Dipak Kumar Kar

Dr. Sisir Kumar Majumdar

Dr. Balaram Majumder

Dr. Hemanta Kumar Majumder

Professor Partha P. Majumder

Dr. Shankarashis Mukherjee

Professor Vasant Natarajan

Professor Sajal Ray

Professor S. C. Roy

Professor Devdatta Sinha

Dr. D. K. Srivastava

Professor (Mrs.) Bani Talapatra

## A TRAVELLER'S JOURNAL

Safari through South Africa - II

Kruger National Park

— *Antonia Hoogewerf*

... 175

## RESEARCH COMMUNICATION

Progress on Research & Development in

Pineapple Harvesting : Special Emphasis

on Indian Scenario

— *Hijam Jiten Singh, H. Dayananda Singh*

*J. S. Chauhan and Sougata Karmakar*

... 178

## BOOK REVIEW

The Story of Econophysics

— *Rajinder Singh*

... 188

## NOTES AND NEWS

... 191

**Cover :** (Top) Showing origin of Corona virus. (Taken from Trends in Microbiology, April 2020,28: 239-240); (Bottom) Showing the way of spread of COVID 19 (for more details, see pages 139 and 142).

# SCIENCE AND CULTURE

JULY-AUGUST 2020/VOLUME 86/NO. 7-8

A JOURNAL OF NATURAL AND CULTURAL SCIENCES

PUBLISHED BY THE  
**INDIAN SCIENCE  
NEWS ASSOCIATION**

EDITORIAL BOARD

**Professor S. C. Roy** Editor-in-Chief

**Shri Biman Basu**

**Dr. Satyabrata Chakrabarti**

**Professor Syamal Chakrabarti**

**Professor Manas Chakrabarty**

**Professor Barun Kumar Chatterjee**

**Dr. Sabyasachi Chattopadhyay**

**Dr. Amit Krishna De**

**Professor Sudhendu Mandal**

**Professor Vasant Natarajan**

COLLABORATORS

Amiya Kumar Bagchi (Kolkata)	Irfan Habib (Delhi)
D. Balasubramanian (Hyderabad)	A. K. Hati (Kolkata)
Indrani Bose (Kolkata)	Mridul Hazarika (Guwahati)
S Chandrasekhar (Hyderabad)	S. Kailas (Mumbai)
D. P. Chattopadhyaya (Kolkata)	Punam Kakkar (Lucknow)
Samit Chattopadhyaya (Kolkata)	Abhijit Lahiri (Delhi)
Mihir Kanti Choudhuri (Tejpur)	A. N. Lahiri Majumder (Kolkata)
Mrinal K. Dewanjee (U.S.A.)	B. K. Pattnaik (Kanpur)
R. Gadagkar (Bangalore)	V. Ravichandran (Kolkata)
Ajoy Ghatak (Delhi)	Ashoke Sen (Allahabad)
	Rajinder Singh (Germany)
	Srinivasan Srikanthan (Chennai)

## EDITORIAL

Vaccine: Prayer and War  
— S. C. Roy ... 197

LETTERS TO THE EDITOR ... 200

## ARTICLE

Zinc Supplementation : A Must for Athletes  
— Amit Krishna De ... 201

Policy Challenges and Opportunities in  
Post-Covid India  
— Debashis Bandyopadhyay ... 206

85<sup>th</sup> Anniversary of the Indian Science News  
Association  
— Rajinder Singh and S.C. Roy ... 214

Civilisation and Creativity  
— Dhruba Chakrabarty ... 231

Dr. Atma Ram- A Personal Tribute  
— Anil K. Rajvanshi ... 242

## FOCUS

Borosilicate Glass Beads: An Indigenous  
Technology for Immobilizing High-Level  
Nuclear Waste  
— S. Mandal, S. Sen, S. Ghorui,  
S. Barik, P G Pal Chowdhury and  
A. Roy Chowdhury ... 247

## A TRAVELLER'S JOURNAL

Safari through South Africa - III  
The Garden Route & Back to Cape Town  
— Antonia Hoogewerf ... 250

# SCIENCE AND CULTURE

SEPTEMBER-OCTOBER 2020/VOLUME 86/NO. 9-10

A JOURNAL OF NATURAL AND CULTURAL SCIENCES

PUBLISHED BY THE  
**INDIAN SCIENCE  
NEWS ASSOCIATION**

EDITORIAL BOARD

**Professor S. C. Roy** Editor-in-Chief

**Shri Biman Basu**

**Dr. Satyabrata Chakrabarti**

**Professor Syamal Chakrabarti**

**Professor Manas Chakrabarty**

**Professor Barun Kumar Chatterjee**

**Dr. Sabyasachi Chattopadhyay**

**Dr. Amit Krishna De**

**Professor Sudhendu Mandal**

**Professor Vasant Natarajan**

COLLABORATORS

Amiya Kumar Bagchi (Kolkata)	Irfan Habib (Delhi)
D. Balasubramanian (Hyderabad)	A. K. Hati (Kolkata)
Indrani Bose (Kolkata)	Mridul Hazarika (Guwahati)
S Chandrasekhar (Hyderabad)	S. Kailas (Mumbai)
D. P. Chattopadhyaya (Kolkata)	Punam Kakkar (Lucknow)
Samit Chattopadhyaya (Kolkata)	Abhijit Lahiri (Delhi)
Mihir Kanti Choudhuri (Tejpur)	A. N. Lahiri Majumder (Kolkata)
Mrinal K. Dewanjee (U.S.A.)	B. K. Pattnaik (Kanpur)
R. Gadagkar (Bangalore)	V. Ravichandran (Kolkata)
Ajoy Ghatak (Delhi)	Ashoke Sen (Allahabad)
	Rajinder Singh (Germany)
	Srinivasan Srikanthan (Chennai)

## EDITORIAL

A Tribute to Satyajit Ray  
— S. C. Roy ... 269

LETTERS TO THE EDITOR ... 271

## ARTICLE

Satyajit Ray Birth Centenary : A Blueprint  
for Action  
— Amitabha Bhattacharya ... 273

Satyajit, His Family and Rabindranath:  
An Enduring Relation  
— Prasadranjan Ray ... 276

Satyajit Ray: The Teacher  
— Rochona Majumdar ... 285

Communication in a Connected World:  
Challenges and Opportunities  
— V. S. Ramamurthy and  
D. K. Srivastava ... 292

A Tale of Three Science Academies of India  
— Rajinder Singh ... 299

## OPINION

Life in the Time of COVID:  
Spread of an Epidemic, Rumours, Myths  
and Public Opinion  
— Sabyasachi Chatterjee ... 309

## FOCUS

A Cool Idea  
— Burton Bollag ... 312



Indian Science News Association

## MEMBERS OF THE COUNCIL

### *President*

Dr. K. Muraleedharan

### *Vice-Presidents*

Professor S. K. Talapatra  
Professor Sanghamitra Bandyopadhyay  
Professor Biswapati Mukherjee  
Professor (Mrs.) Julie Banerji  
Professor Bikas. K. Chakrabarti

### *Honorary Secretaries*

Professor Sudhendu Mandal  
Professor Manas Chakrabarty

### *Honorary Treasurer*

Professor Barun Kumar Chatterjee

### *Members*

Shri Biman Basu  
Shri Prasanta K. Bose  
Dr. Manoj Kumar Chakrabarti  
Dr. Satyabrata Chakrabarti  
Prof. Syamal Chakrabarti  
Professor Dhrubajyoti Chattopadhyay  
Dr. Sabyasachi Chattopadhyay  
Dr. Manas Pratim Das  
Dr. Amit Krishna De  
Shri Pathik Guha  
Professor Dipak Kumar Kar  
Dr. Sisir Kumar Majumdar  
Dr. Balaram Majumder  
Dr. Hemanta Kumar Majumder  
Professor Partha P. Majumder  
Dr. Shankarashis Mukherjee  
Professor Vasant Natarajan  
Professor Sajal Ray  
Professor S. C. Roy  
Professor Devdatta Sinha  
Dr. D. K. Srivastava  
Professor (Mrs.) Bani Talapatra

## A TRAVELLER'S JOURNAL

Safari through South Africa - IV  
— *Antonia Hoogewerf* ... 314

## RESEARCH COMMUNICATION

Alleviation of Fluoride-Mediated Toxicity  
via Seed Priming with Calcium Oxide in *Oryza  
sativa* L. cv. *Khitish*  
— *Ankir Singh, Aditya Banerjee,  
Aryadeep Roychoudhury* ... 317

## BOOK REVIEW

Pathology of Modern Indian Science :  
Genesis of its eco-System  
— *S. C. Roy* ... 322

NOTES AND NEWS ... 324

## OBITUARY

Dr. Maharaj Kishan Bhan (1947 - 2020)  
— *Kaushik Bharati* ... 335

Cover : Satyajit Ray (Courtesy - Rochona Majumdar)

# SCIENCE AND CULTURE



19 FEB 2021

NOVEMBER-DECEMBER 2020/VOLUME 86/NO. 11-12

A JOURNAL OF NATURAL AND CULTURAL SCIENCES

PUBLISHED BY THE  
**INDIAN SCIENCE  
NEWS ASSOCIATION**

EDITORIAL BOARD

**Professor S. C. Roy** Editor-in-Chief

**Shri Biman Basu**

**Dr. Satyabrata Chakrabarti**

**Professor Syamal Chakrabarti**

**Professor Manas Chakrabarty**

**Professor Barun Kumar Chatterjee**

**Dr. Sabyasachi Chattopadhyay**

**Dr. Amit Krishna De**

**Professor Sudhendu Mandal**

**Professor Vasant Natarajan**

COLLABORATORS

Amiya Kumar Bagchi (Kolkata)	Irfan Habib (Delhi)
D. Balasubramanian (Hyderabad)	A. K. Hati (Kolkata)
Indrani Bose (Kolkata)	Mridul Hazarika (Guwahati)
S Chandrasekhar (Hyderabad)	S. Kailas (Mumbai)
D. P. Chattopadhyaya (Kolkata)	Punam Kakkar (Lucknow)
Samit Chattopadhyaya (Kolkata)	Abhijit Lahiri (Delhi)
Mihir Kanti Choudhuri (Tejpur)	A. N. Lahiri Majumder (Kolkata)
Mrinal K. Dewanjee (U.S.A.)	B. K. Pattnaik (Kanpur)
R. Gadagkar (Bangalore)	V. Ravichandran (Kolkata)
Ajoy Ghatak (Delhi)	Ashoke Sen (Allahabad)
	Rajinder Singh (Germany)
	Srinivasan Srikanthan (Chennai)

## EDITORIAL

Physics Nobel 2020 and Kolkata Connections  
— *S. C. Roy* ... 337

LETTERS TO THE EDITOR ... 340

## ARTICLE

AKR's Quest for Excellence :  
Seeds of Physics Nobel 2020  
— *Parthasarathi Majumdar* ... 342

Internet of Human Centric Lighting: A Brief  
overview on Indian Aspects  
— *Arijt Ghosh, Palash Kumar Kundu  
and Gautam Sarkar* ... 350

'Medicalization' of Diseases : A Crisis in the  
Domain of Social Health  
— *Amrita Bagchi* ... 357

N. R. Sen and His Contribution to Turbulence  
Research  
— *Ranider Singh and  
Suprakash C. Roy* ... 363

## OPINION

Are Scientists Incapable of Solving  
Human Problems?  
— *Bikash K. Chakrabarti* ... 372

## FOCUS

Sweet Solutions  
— *Steve Fox* ... 374

## A TRAVELLER'S JOURNAL

Kolkata in Lockdown – March 2020  
— *Antonia Hoogewerf* ... 376



Indian Science News Association

## MEMBERS OF THE COUNCIL

### *President*

Dr. K. Muraleedharan

### *Vice-Presidents*

Professor S. K. Talapatra  
Professor Sanghamitra Bandyopadhyay  
Professor Biswapati Mukherjee  
Professor (Mrs.) Julie Banerji  
Professor Bikas. K. Chakrabarti

### *Honorary Secretaries*

Professor Sudhendu Mandal  
Professor Manas Chakrabarty

### *Honorary Treasurer*

Professor Barun Kumar Chatterjee

### *Members*

Shri Biman Basu  
Shri Prasanta K. Bose  
Dr. Manoj Kumar Chakrabarti  
Dr. Satyabrata Chakrabarti  
Professor Syamal Chakrabarti  
Professor Dhruvabjyoti Chattopadhyay  
Dr. Sabyasachi Chattopadhyay  
Dr. Manas Pratim Das  
Dr. Amit Krishna De  
Shri Pathik Guha  
Professor Dipak Kumar Kar  
Dr. Sisir Kumar Majumdar  
Dr. Balam Majumder  
Dr. Hemanta Kumar Majumder  
Professor Partha P. Majumder  
Dr. Shankarashis Mukherjee  
Professor Vasant Natarajan  
Professor Sajal Ray  
Professor S. C. Roy  
Professor Devdatta Sinha  
Dr. D. K. Srivastava  
Professor (Mrs.) Bani Talapatra

## RESEARCH COMMUNICATION

In-vitro Study of Moringa Oleifera and *Casia Fistula* on Multi Drug Resistant Bacteria, Insolated from Bovine Mastitis Milk  
— Jayanta Chowdhury, Nilanjana Dey, Sayani Marick, Shatabdi Das, Arnab Ganguli, Tapan Kumar Mondal, Sandhimita Mondal ... 379

## BOOK REVIEW

Instrumental Lives : An Intimate Biography of an Indian Laboratory  
— S. C. Roy ... 383

## REPORT

Nobel Prizes in Science : 2020  
Chemistry  
— Manas Chakrabarty ... 385  
Physics  
— Sabyasachi Chatterjee ... 387  
Physiology or Medicine  
— Uday Bandyopadhyay ... 390  
Economics  
— Achin Chakraborty ... 392

## NOTES AND NEWS ... 394

Amalkumar Raychaudhuri's Paper Published in the Physical Review (1955) ... R-1

R. C. Jennison and M. K. Das Gupta's Paper Published in the Nature (1953) ... R-5

**Cover** : Amal Kumar Raychaudhuri : With passage of time. (Photos received from personal collection of his daughter Prof. Parongama Sen)



**ARTICLES/SHORT FEATURES**

**In Defence of Curiosity Driven Basic Scientific Research**.....Pg 21  
Felix Bast

**Cryptography: The Art of Secret Writing** .....Pg 25  
Abhishek Sinha

**Intricate but Intriguing Concept of Particle Spin**.....Pg 29  
P.K. Mukherjee

**The Fabric of Space** .....Pg 36  
Anirban Dutta and Arindam Dutttagupta

**Mesmerising Liquid Magnets** .....Pg 40  
T.V. Venkateswaran

**Science Fair Projects – Observing, Questioning, Experimenting** .....Pg 45  
R.V.M. Chokkalingam

**For Uddhab Bharali Innovation is the only Profession**.....Pg 47  
Basudev Mandal

**COVER STORY**

**Harnessing Science, Technology & Innovation** Pg 14  
*Making India a Global Player*

**Shekhar C. Mande**



**CSIR Technology Showcase**

**CSIR-NPL Develops Advanced Security Ink**  
Meher Wan Pg 32

**REPORT**

**CSIR-NISCAIR Organises Workshop and Panel Discussion during 28th World Book Fair**  
Theme: Communicating Science to Children  
Meher Wan Pg 42

**BOOK REVIEW**

**Know the past, comprehend the present, prepare for the future**  
G. Venkatesh Pg 49

**DEPARTMENTS**

REACTIONS ..... 8	PUZZLE CORNER ..... 52	NATURE'S MARVELS ..... 60
EDITORIAL ..... 9	WHAT'S NEW ..... 54	TEST YOUR KNOWLEDGE ..... 62
PHOTO FEATURE ..... 34	CURIOSITY CORNER ..... 56	POEM ..... 64
READERSHIP SURVEY ..... 51	INNOVATIVE MINDS ..... 58	



**OBITUARY**

**Dr Raj Bhan – An Institution.....Pg 10**

Dr R.A. Mashelkar

**Dr M.K. Bhan – A True Leader & Visionary.....Pg 12**

Dr Renu Swarup

**My Fond Remembrances of Dr M.K. Bhan.....Pg 13**

Dr Shekhar C. Mande

**Biotech Maharaja Leaves Behind a Glorious Legacy.....Pg 15**

Alpana Saha

**ARTICLES/SHORT FEATURES**

**Invasive Species in Indian Islands – The Time to Act is Now.....Pg 23**

S. Sandilyan



**Wildlife Conservation – Technology Takes a Front Seat.....Pg 26**

Preeti Lata and Shivani

**Novel Coronavirus-2019 – Prevention is the Only Cure.....Pg 30**

Kanti Bhooshan Pandey

**Birds are Smart Too.....Pg 36**

P.K. Mukherjee

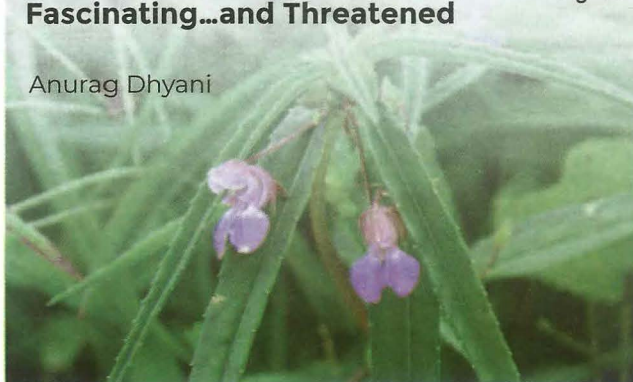
**Birds on Postage Stamps of India.....Pg 39**

Rahul Rohitashwa

**COVER STORY**

**Plants of the World – Diverse, Fascinating...and Threatened Pg 18**

Anurag Dhyani



**CSIR Technology Showcase**

**CSIR-CDRI Discovers Researchers Peptide Effective in Fighting Rheumatoid Arthritis Pg 32**

Meher Wan

**BOOK REVIEW**

**Around the World in 80 Trees Pg 42**

S. Suresh Ramanan

**The Secret Life of Elephants Pg 43**

Kanchan Puri

**REPORT**

**Science Communicators’ Meet (107<sup>th</sup> Indian Science Congress) Pg 45**

Biju Dharmapalan

**Sustainable Future for J&K and Ladakh with Balanced Ecology and Economy Pg 48**

Sonali Nagar



**DEPARTMENTS**

REACTIONS .....	8	PUZZLE CORNER .....	52	INNOVATIVE MINDS .....	58
EDITORIAL .....	9	WHAT'S NEW .....	54	WILDLIFE QUIZ.....	60
PHOTO FEATURE .....	34	NATURE'S MARVEL .....	56	CROSSWORD .....	64
READERSHIP SURVEY .....	51				

# *Science, Technology and Society*

Volume 25

Number 1

March 2020

---

**Special Issue:** Science, Technology and Food Security

**Guest Editors:** Antoine Bernard de Raymond and Frédéric Goulet

## CONTENTS

### Special Issue Articles

- Science, Technology and Food Security: An Introduction 7  
ANTOINE BERNARD DE RAYMOND and FRÉDÉRIC GOULET
- Aligning Competing Risks? Global Food Security as a Trade-Offs-Based Approach to Risk and Food Policy 19  
ANTOINE BERNARD DE RAYMOND
- Bounded Futures: Growing a Boundary Foreknowledge Infrastructure in Food Security Research 38  
VINCENT CARDON
- Debating Global Food Security Through Models The Agrimonde Foresight Study (2008–2010) and Criticism of Economic Models and of Their ‘Productionist’ Translations 67  
GILLES TÉTART
- Family Farming and The Emergence of an Alternative Sociotechnical Imaginary in Argentina 86  
FRÉDÉRIC GOULET
- Technovisions for Food Security as Sweden Restores Its Civil Defence 106  
CAMILLA ERIKSSON, KLARA FISCHER and EBBA ULFBECKER
- The Rise, Regulation and Risks of Genetically Modified Insect Technology in Global Agriculture 124  
SANDRA SCHWINDENHAMMER
- Do Agricultural Companies that Own Intellectual Property Rights on Seeds and Plant Varieties have a Right-to-Food Responsibility? 142  
EMMANUEL KOLAWOLE OKE

### General Articles

- Exploring Industrial Knowledge Flow for Identifying Technological Development Strategy: The Case of Korea’s TFT-LCD Industry 159  
SANGHOON LEE, SUNYOUNG YUN and JEONGHWAN JEON
- The Influence of Network Positions on Exploratory Innovation: An Empirical Evidence from China’s Patent Analysis 184  
DING MA, YA-RUI ZHANG and FAN ZHANG

# *Science, Technology and Society*

Volume 25

Number 2

July 2020

**Special Issue:** Responsible Research and Innovation in the Global South: Agriculture, Renewable Energy and the Pursuit of Symmetry

**Guest Editors:** Poonam Pandey, Govert Valkenburg, Annapurna Mamidipudi and Wiebe Bijker

## CONTENTS

### Introduction

- Responsible Research and Innovation in the Global South: Agriculture, Renewable Energy and the Pursuit of Symmetry 215  
POONAM PANDEY, GOVERT VALKENBURG,  
ANNAPURNA MAMIDIPUDI and WIEBE BIJKER

### Articles

- Turning Straw to Gold: Mobilising Symmetry in Responsible Research and Innovation 223  
ANNAPURNA MAMIDIPUDI and NINA FRAHM
- RRI's Commitment to Care and Vulnerability of Agrarian Systems: The 'Problem' of Rice Straw Burning in India 240  
POONAM PANDEY
- The Future of Farming: To What End and For What Purpose? 256  
BHARAT BHUSHAN TYAGI and RICHA KUMAR
- RRI Beyond Its Comfort Zone: Initiating a Dialogue with Frugal Innovation by 'the Vulnerable' 273  
SARADINDU BHADURI and NAZIA TALAT
- Constructing Alternative Socio-technical Worlds: Re-imagining RRI through SRI in India 291  
C SHAMBU PRASAD
- 'We Do Not Want Fake Energy': The Social Shaping of a Solar Micro-grid in Rural India 308  
AVIRAM SHARMA
- Responsibility, Representation and Participation: Bureaucratic Steering of Biofuel Research 325  
MAHENDRA SHAHARE and NAVEEN THAYYIL
- Consensus or Contestation: Reflections on Governance of Innovation in a Context of Heterogeneous Knowledges 341  
GOVERT VALKENBURG

# *Science, Technology and Society*

Volume 25

Number 3

November 2020

---

**Special Issue:** Technologies without Borders? The Digitization of Society in a Postcolonial World

**Guest Editor:** Mathieu Quet

## CONTENTS

### Editorial

- Technologies Without Borders? The Digitization of Society in a Postcolonial World 368  
MATHIEU QUET and MARINE AL DAHDAH

### Special Issue Articles

- Governance and Accountable Citizenship Through Identification Infrastructures: Database Politics of Copernicus (France) and National Register of Citizens (India) 368  
ÉRIC DAGIRAL and KHETRIMAYUM MONISH SINGH
- From Expression to Expulsion: Digital Public Spaces as Theatres of Operations in Nepal 386  
SOHAN SHA and MATHIEU QUET
- Tweet, Set, Match: Negotiating the Boundaries of Digital Technologies in Elite Tennis 404  
VIDYA SUBRAMANIAN, MARIANNE NOEL and HARMONY PAQUIN
- Smart Cards for All: Digitalisation of Universal Health Coverage in India 426  
MARINE AL DAHDAH and RAJIV K. MISHRA
- If You Build It, Will They Come? Exploring Narratives That Shape the Internet in Nepal 444  
SHAILESH B. PANDEY and NISCHAL REGMI

### General Articles

- Innovation and Firm-level Labour Productivity: A Comparison of Chinese and Indian Manufacturing Based on Enterprise Surveys 465  
POULOMI BHATTACHARYA and BADRI NARAYAN RATH
- Evaluation of Technological Innovations and the Industrial Ecosystem of Science Parks in Shanghai: An Empirical Study 482  
MIN-REN YAN, HAIYAN YAN, LINGYUN ZHAN, XINYUE YAN and MENG XU



EVOLUTION

**26 Why Your Brain Needs Exercise**

The evolutionary history of humans may explain why physical activity can slow brain aging.  
*By David A. Raichlen and Gene E. Alexander*

SPACE

**32 The Galactic Archipelago**

Even if the Milky Way is crawling with spacefaring aliens, we should not be surprised that they haven't visited Earth.  
*By Caleb Scharf*

HEALTH

**40 Unbound from Opioids**

More than seven million chronic pain patients continue to take risky painkillers. Researchers



**ON THE COVER**

Exercise is well known to have positive effects on the aging brain. New research hints at why this is the case and suggests that combining cognitive tasks with physical activity can enhance those benefits.  
Illustration by Bryan Christie Design.

are finding better ways to wean people off them while keeping distress low.  
*By Claudia Wallis*

ANIMAL COGNITION

**48 The Surprising Power of the Avian Mind**

Some bird species use tools and can recognize themselves in the mirror. How do tiny brains pull off such big feats?  
*By Onur Güntürkün*

PHYSICS

**56 The Triple-Slit Experiment**

An update to a classic experiment establishes new quantum-mechanical truths and paves the way toward a novel strategy for quantum computing.  
*By Urbasi Sinha*

INNOVATIONS IN

**S1 The DNA Drug Revolution**

By manipulating life's master molecule, scientists are treating the root causes of disease.

**S3 The Power of Spheres**

New arrangements of DNA and RNA can treat illnesses conventional drugs cannot.  
*By Chad A. Mirkin, Christine Laramy and Kasper Skakuj*

**S8 23 and Baby**

Should newborns receive genetic screening?  
*By Tanya Lewis*

**S12 Gene Therapy Arrives**

What's in the pipeline.  
*By Jim Daley*

**S14 All of Us**

Fixing bias in DNA medicine.  
*By Stephanie Devaney*

# SCIENTIFIC AMERICAN



10



12



64

## 4 From the Editor

## 6 Letters

## 10 Science Agenda

Time to stop targeting teens with “anti-gay therapy.”  
*By the Editors*

## 11 Forum

Congress must protect scientific integrity with legislation and stop abuses of power. *By Chuck Hagel*

## 12 Advances

Abandoned buildings’ dangerous mosquitoes. Microbes engineered to produce psychedelic drugs. Solving puzzles while asleep. New chemical maps of exploding stars.

## 22 Meter

Poetry returns to the pages of *Scientific American*.  
*By Diane Ackerman*

## 23 The Science of Health

Our gut microbes activate some medicines, inactivate others and provoke side effects. *By Claudia Wallis*

## 24 Ventures

Technology will make elections secure—but not by 2020.  
*By Wade Rouse*

## 63 Recommended

Birds of a feather must stick together. Love potions of the future. SETI, phone home. Math can be a matter of life and death. *By Andrea Gawrylewski*

## 64 Observatory

Why we shouldn’t fact-check scientific judgment calls.  
*By Naomi Oreskes*

## 66 Anti Gravity

Rats learned to drive tiny cars as a model for acquiring new skills. *By Steve Mirsky*

## 67 50, 100 & 150 Years Ago

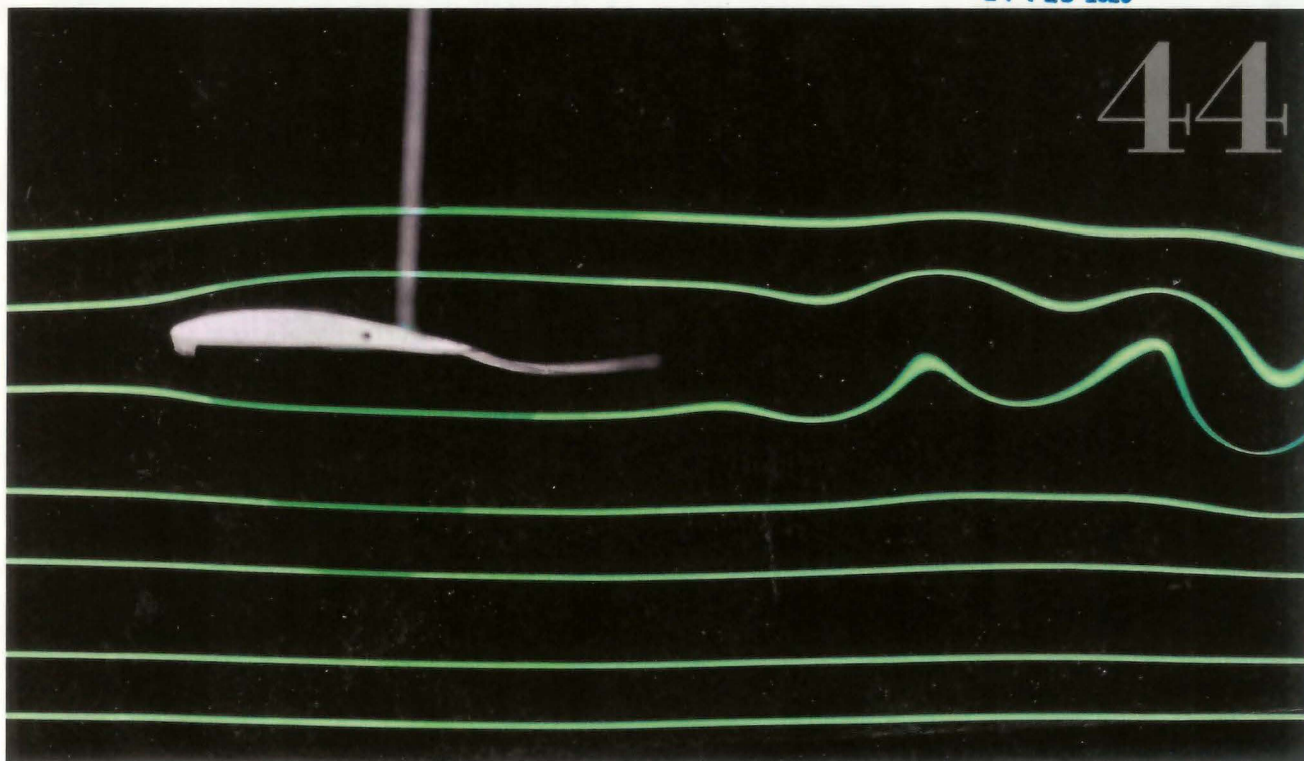
## 70 Graphic Science

The colorful past 175 years of *Scientific American* covers.  
*By Jen Christiansen and Nicholas Rougeux*



27 FEB 2020

44



## NEUROSCIENCE

**30 The Brain's Social Road Maps**

Neural circuits that track our whereabouts in space and time may also play roles in determining how we relate to other people. *By Matthew Schafer and Daniela Schiller*

## ENERGY

**36 The H<sub>2</sub> Solution**

After fading from relevance in the clean-tech scene, hydrogen could make a comeback as an important piece of the all-renewable energy puzzle. *By Peter Fairley*

## PHYSICS

**44 The Enigma of Aerodynamic Lift**

No one can completely explain why planes stay in the air. *By Ed Regis*

## TECHNOLOGY

**52 Autonomous Warfare**

Ensuring meaningful human control over killer machines is vital to global security. *By Noel Sharkey*

## ASTROCHEMISTRY

**58 First Molecule in the Universe**

Scientists have identified mystery molecules in space and the compound thought to have started chemistry in the cosmos. *By Ryan C. Fortenberry*



## ON THE COVER

Brain regions compute mental maps that tell us where we are in relation to our surroundings. New research reveals that these same areas may be involved in knowing our whereabouts in relation to other people and within the rankings of a social hierarchy. **Illustration by Richard Borge.**

## INNOVATIONS IN

**S1 AI AND DIGITAL HEALTH****S2 How Artificial Intelligence Will Change Medicine****S3 Hunting for New Drugs with AI**

Can intelligent machines fix the drug-discovery slump? *By David H. Freedman*

**S8 Rise of Robot Radiologists**

Peering into MRIs and x-rays with unmatched vision. *By Sara Reardon*

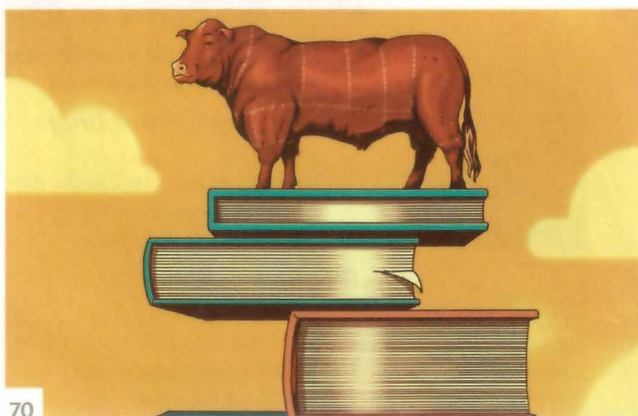
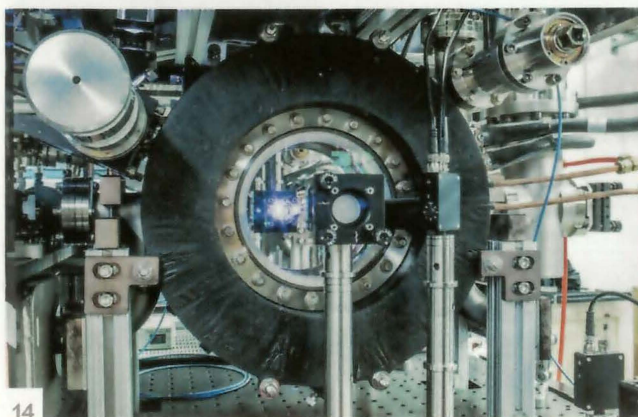
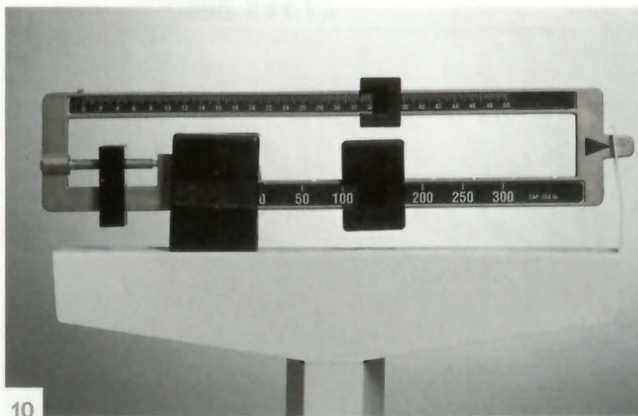
**S13 Can AI Fix Medical Records?**

Solving the problem of digitized patient charts. *By Cassandra Willyard*

**S16 Wiring Minds**

Training innovators to meld AI and biomedicine. *By Amit Kaushal and Russ B. Altman*

# SCIENTIFIC AMERICAN



## 4 From the Editor

## 6 Letters

## 10 Science Agenda

Weight-centric health care is not making patients healthier.  
*By the Editors*

## 12 Forum

The EPA proposes a risky rule. *By Andrew Rosenberg*

## 14 Advances

Atoms stretched to the size of a room. Cooperation with undercover robots. A model for boosting biodiversity. A fungus's tiny opioid secret. Remarkably vicious beetles.

## 26 Meter

The poetry of mathematics sets sail. *By Jennifer Gresham*

## 27 The Science of Health

Medical therapy may be better for the heart than surgical procedures. *By Claudia Wallis*

## 28 Ventures

Augmented reality has a toehold in the real world.  
*By Wade Rouse*

## 67 Recommended

The eclectic works of *Scientific American's* founder Rufus Porter make for a lively new catalog and exhibition.  
*By Andrea Gawrylewski*

## 70 Observatory

Science must remain open to new evidence, even in the face of bad or reckless published studies. *By Naomi Oreskes*

## 71 Anti Gravity

Light pollution is contributing to the "insect apocalypse."  
*By Steve Mirsky*

## 72 50, 100 & 150 Years Ago

## 74 Graphic Science

What's in that burger imitator? *By Mark Fischetti and MSJONESNYC*

Scientific American (ISSN 0036-8733), Volume 322, Number 2, February 2020, published monthly by Scientific American, a division of Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. **Individual Subscription rates:** 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). **Institutional Subscription rates:** Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). **Businesses and Colleges/Universities:** 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: (212) 451-8415. To request single copies or back issues, call (800) 333-1199. **Subscription inquiries:** U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to [scacustserv@cdsfulfillment.com](mailto:scacustserv@cdsfulfillment.com). Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.



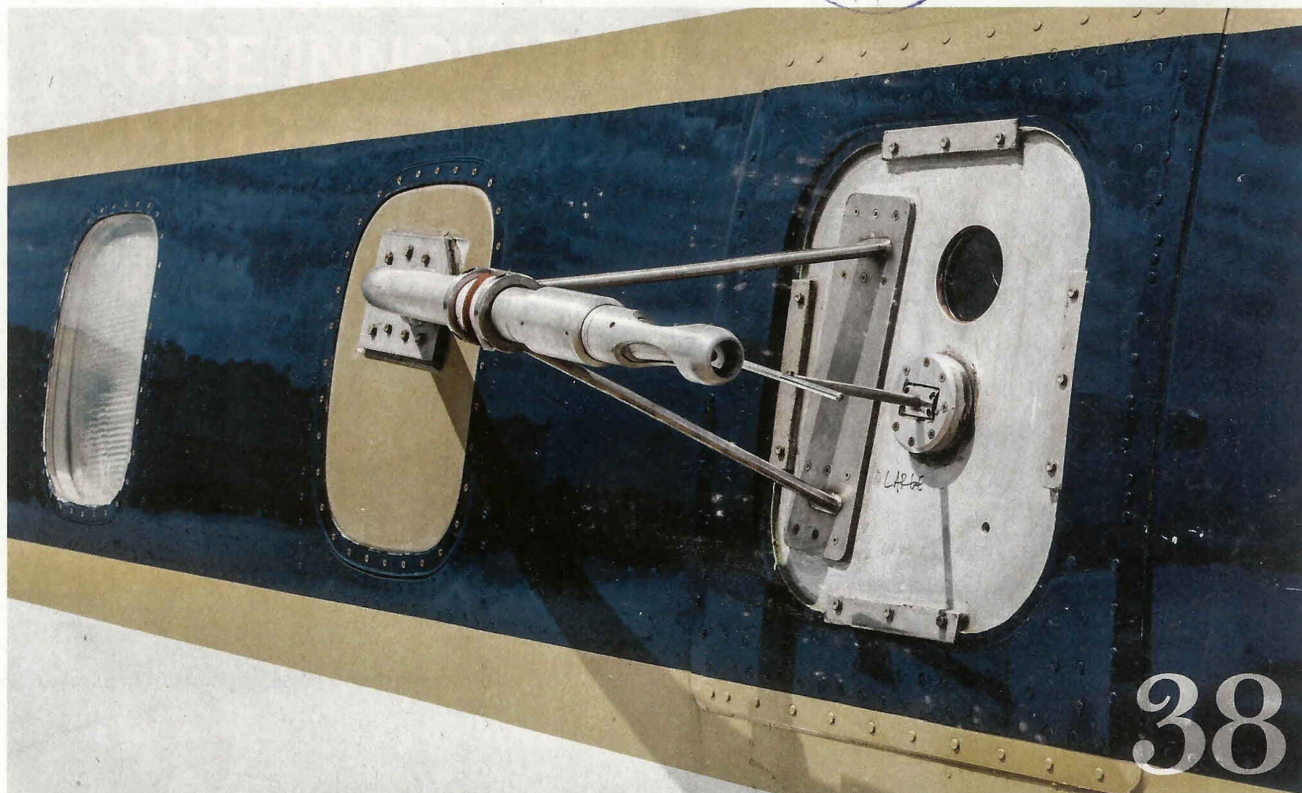
Scientific American is part of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at [www.springernature.com/us](http://www.springernature.com/us)). Scientific American maintains a strict policy of editorial independence in reporting developments in science to our readers. Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

06 JUL 2020

MARCH 2020

VOLUME 322, NUMBER 3

# SCIENTIFIC AMERICAN



## COSMOLOGY

### 30 A Cosmic Crisis

Two divergent measurements of how fast the universe is expanding cannot both be right. Something must give—but what?

*By Richard Panek*

## CHEMISTRY

### 38 The Hidden Toll of Wildfire

As wildfires worsen globally, an aerial campaign seeks to understand how biomass smoke affects human health. *By Kyle Dickman*

## ANTISENSE THERAPY

### 46 Finally Making Sense

A long-disdained therapy that targets RNA is achieving spectacular success. *By Lydia Denworth*

## ANTISENSE THERAPY

### 54 Preventing Prions

Treating susceptible individuals while they are still healthy offers the best hope for warding

off a deadly brain disease.

*By Sonia Minikel Vallabh and Eric Vallabh Minikel*

## ECOLOGY

### 60 What Is Killing the Monarchs?

It seemed simple: Roundup herbicide was killing America's favorite butterfly. But there may be other causes, and the way to save the insect is not clear. *By Gabriel Popkin*

## ARCHAEOLOGY

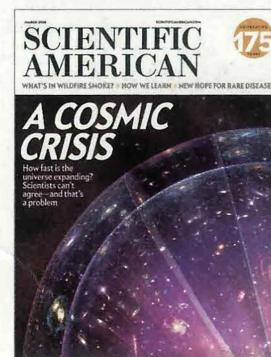
### 68 The First Story

A cave painting from Sulawesi is the oldest known example of narrative art. *By Kate Wong*

## NEUROBIOLOGY

### 74 The Brain Learns in Unexpected Ways

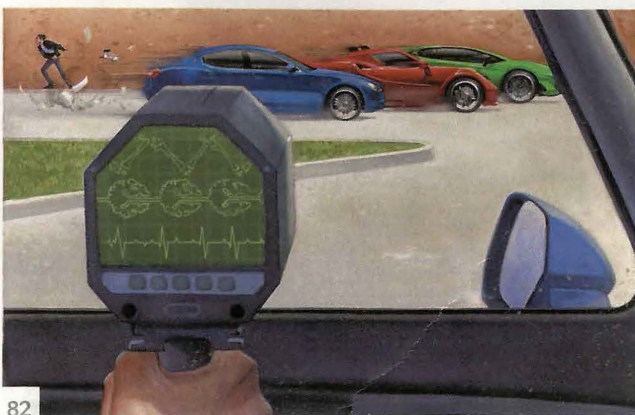
Neuroscientists have discovered a set of unfamiliar cellular mechanisms for making fresh memories. *By R. Douglas Fields*



## ON THE COVER

The value of the Hubble constant—the rate of the universe's expansion—may be the most important number in all of cosmology. Yet measurements of it from the "early" universe shortly after the big bang and the "late" universe of today disagree. Resolving this discrepancy could lead to a scientific revolution. Illustration by Mark Ross Studios.

# SCIENTIFIC AMERICAN



## 4 From the Editor

## 6 Letters

## 12 Science Agenda

Don't let 5G mess with weather forecasting.

*By the Editors*

## 14 Forum

Medical students need to know how social factors determine health. *By Erin Paquette and Angira Patel*

## 16 Advances

The promise of vibration-detecting fiber optics. Secret signals from sweet potatoes. The trouble with manure. A new map of Antarctica under the ice.

## 26 Meter

New poetry on the nature of eclipses.

*By Christopher Cokinos*

## 28 The Science of Health

Taking delirium seriously can help prevent it in older hospitalized patients. *By Claudia Wallis*

## 29 Ventures

Pricey storm-surge barriers may be worth the money.

*By Wade Roush*

## 80 Recommended

Saving the Florida panther. Cornfield espionage and FBI racial profiling. AI learning versus brainpower. Early female astronomer Cecilia Payne-Gaposchkin.

*By Andrea Gawrylewski*

## 81 Observatory

Instrument calibration can avoid the miscarriage of justice. *By Naomi Oreskes*

## 82 Anti Gravity

Driving habits among doctors differ according to medical specialty. *By Steve Mirsky*

## 83 50, 100 & 150 Years Ago

*By Daniel C. Schlenoff*

## 84 Graphic Science

The ways carbon taxes create jobs. *By Mark Fischetti and Amanda Montañez*

Scientific American (ISSN 0036-8733), Volume 322, Number 3, March 2020, published monthly by Scientific American, a division of Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. **Individual Subscription rates:** 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). **Institutional Subscription rates:** Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: (212) 451-8415. To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to [scacustserv@cdsfulfillment.com](mailto:scacustserv@cdsfulfillment.com). Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.

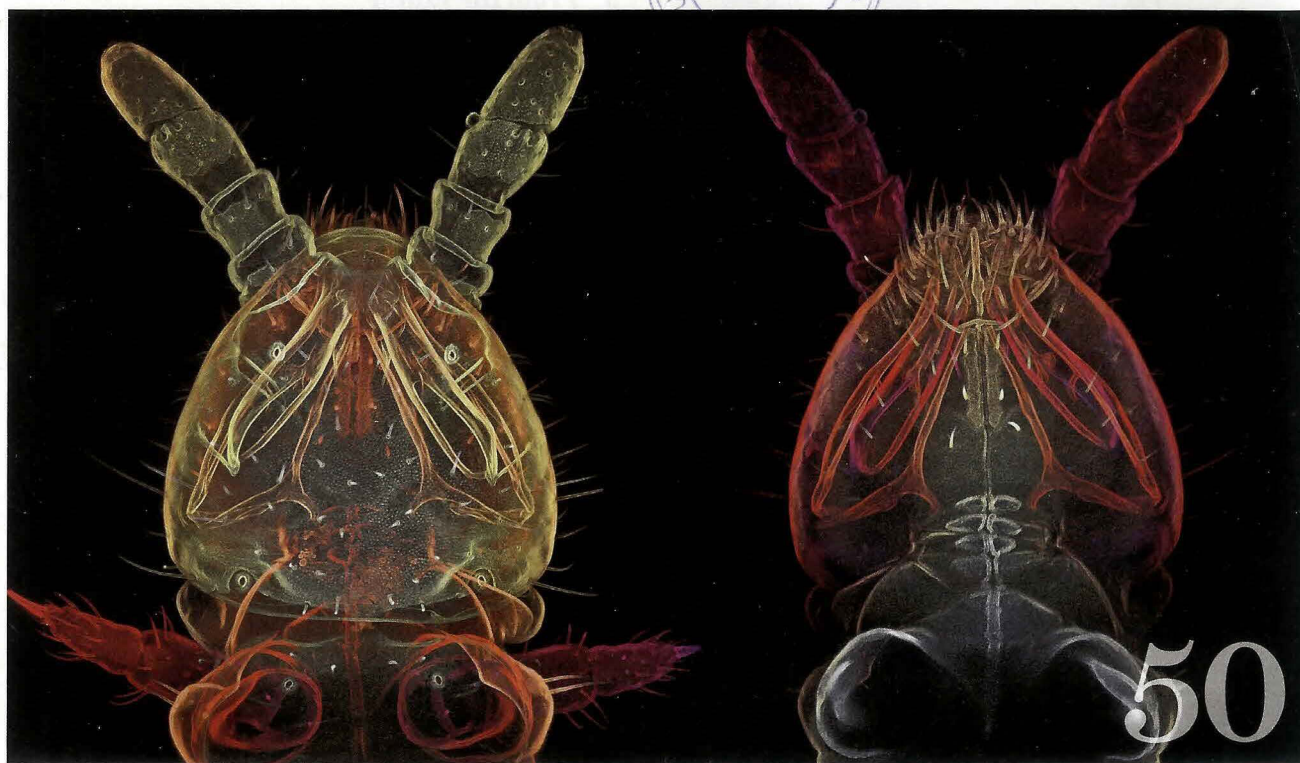


06 OCT 2020

APRIL 2020

VOLUME 322, NUMBER 4

# SCIENTIFIC AMERICAN



## ASTRONOMY

### 28 **New View of the Milky Way**

A recent effort to map the spiral structure of our galaxy has produced an unprecedented view of our cosmic home. *By Mark J. Reid and Xing-Wu Zheng*

## CONSERVATION

### 36 **Cat vs. Woodrat**

Feral cats kill a lot of wildlife, but methods to solve the problem are controversial and understudied. In Key Largo, Fla., conservationists are trying new ways to save the endangered woodrat without having to exterminate felines.

*By Carrie Arnold*

## EVOLUTION

### 44 **The Trouble with Teeth**

Our teeth are crowded, crooked and riddled with cavities. It hasn't always been this way. *By Peter S. Ungar*

## BIOLOGY

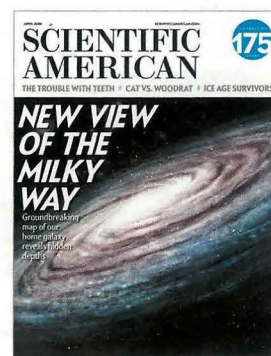
### 50 **Extreme Survivor**

A tiny, six-legged creature called *Tullbergia* has persevered through more than 30 ice ages in the harshest badlands of the Transantarctic Mountains. Scientists are just starting to figure out how. *By Douglas Fox*

## ANTHROPOLOGY

### 58 **The Aid Tsunami**

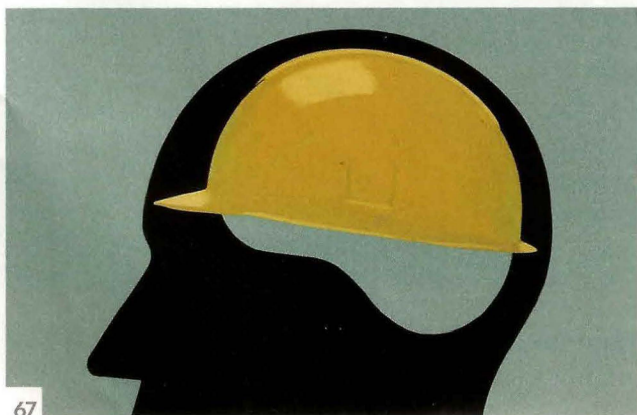
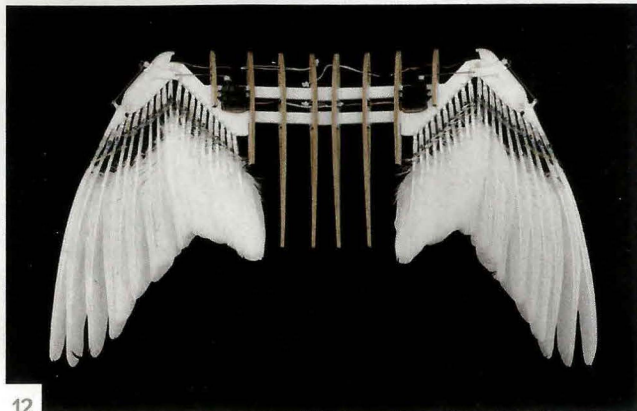
The ocean took their loved ones and destroyed their villages. But it was misguided disaster relief that destroyed their way of life. 158



## ON THE COVER

Despite centuries of study, astronomers are only now learning how our home galaxy, a spiral of at least 100 billion stars spanning more than 100,000 light-years, really appears from outside. New surveys are revealing the Milky Way's structure in more detail than ever before.

# SCIENTIFIC AMERICAN



## 3 From the Editor

## 4 Letters

## 8 Science Agenda

The nuclear trigger should not be under the sole control of the U.S. president. *By the Editors*

## 10 Forum

Female surgeons cannot perform at their best if they are battling workplace sexual abuse. *By Chethan Sathya*

## 12 Advances

A flier flexing real pigeon wings. Humans' oversize impact on future fossils. A trap for dengue virus made from DNA. Prismlike blocks to build morphing objects.

## 24 Meter

Lichen as model and metaphor for intimacy. *By Forrest Gander*

## 25 The Science of Health

Sleep apnea often follows a different pattern in women and may therefore be overlooked. *By Claudia Wallis*

## 26 Ventures

Investing in technology for the toughest problems on the planet. *By Wade Rouse*

## 66 Recommended

Bird's-eye view of our changing Earth. CSI pioneer. The mysterious death of a Civil War submarine. Intertwining technology and human behavior. *By Andrea Gawrylowski*

## 67 Observatory

Why do white men and scientists tend to downplay the risks of technology? *By Naomi Oreskes*

## 68 Anti Gravity

One U.S. senator thinks Saturn's moon Titan is a fixer-upper real estate possibility. *By Steve Mirsky*

## 69 50, 100 & 150 Years Ago

*By Daniel C. Schlenoff*

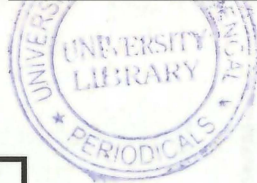
## 70 Graphic Science

Child mortality is decreasing, yet certain countries still struggle. *By Amanda Montañez and Mapping Specialists*

Scientific American (ISSN 0036-8733), Volume 322, Number 4, April 2020, published monthly by Scientific American, a division of Springer Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. Individual Subscription rates: 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). Institutional Subscription rates: Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: (212) 451-8415. To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to [scacustserv@cdsfulfillment.com](mailto:scacustserv@cdsfulfillment.com). Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.



Scientific American is part of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at [www.springernature.com/us](http://www.springernature.com/us)). Scientific American maintains a strict policy of editorial independence in reporting developments in science to our readers. Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



06 OCT 2020

MAY 2020

VOLUME 322, NUMBER 5

# SCIENTIFIC AMERICAN



## SPECIAL REPORT THE FUTURE OF MEDICINE

### 26 A NEW ERA FOR ALZHEIMER'S

Rethinking its causes and potential cures.

#### 28 The Human Toll

Alzheimer's took the author's wife and tortured his family. There was nothing they—or medicine—could do to stop it. *By Joel Shurkin*

#### 30 The Way Forward

The failure to find good treatments for Alzheimer's means it is time to reexamine the basic biology of the disease. Progress in five areas could provide new hope. *By Kenneth S. Kosik*

#### 34 The Amyloid Drug Struggle

A leading target for Alzheimer's treatment is getting a harder, and more skeptical, look. *By Tanya Lewis*

#### 37 The Menopause Connection

Aging is the biggest risk factor for Alzheimer's. Being female is a close second. Why? *By Jena Pincott*

#### 42 The Role of Air Pollution

Airborne particles in car exhaust are strongly linked to Alzheimer's. Recent research shows how they can reach the brain. *By Ellen Ruppel Shell*

## GEOLOGY

### 48 Massif Redo

A novel explanation for the giant Tamu Massif volcano rewrites the story of how the seafloor formed.

*By William W. Sager*

## SUSTAINABILITY

### 54 Living with the Forest

Pygmies thrived in the Congo Basin—until development coupled with conservation arrived. *By Jerome Lewis*

## PHYSICS

### 64 Quantum Steampunk

A new branch of physics is updating 19th-century thermodynamics for today's quantum systems. *By Nicole Yunger Halpern*

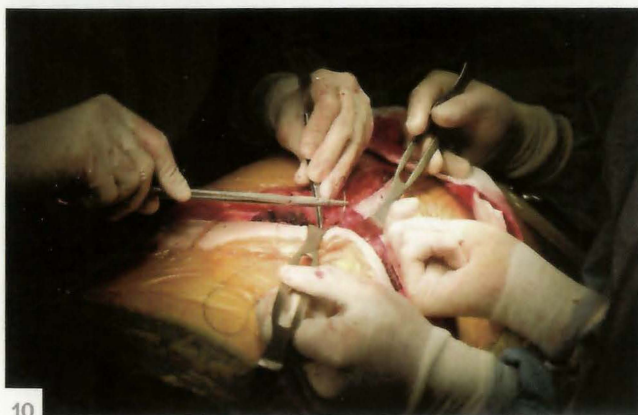
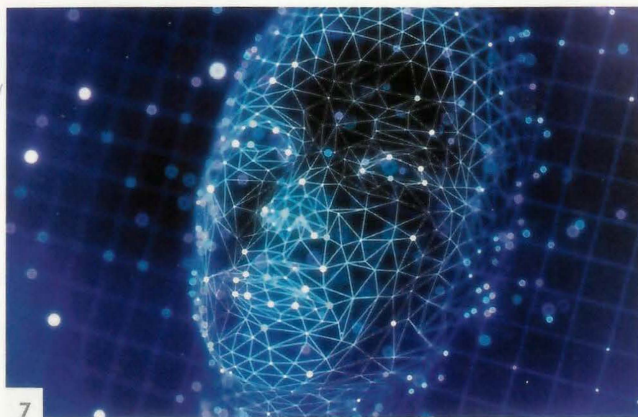
## ON THE COVER

After recent failed efforts to develop treatments for Alzheimer's disease, many scientists are taking a fresh look at causes of the illness. New research areas include the origins of abnormal proteins and wayward brain signals, the surprising role of air pollution, and factors that lead to higher risk for women.

Illustration by Galen Dara.



# SCIENTIFIC AMERICAN



## 4 From the Editor

## 5 Letters

## 7 Science Agenda

Facial-recognition tech is an invasion of privacy that needs immediate regulation. *By the Editors*

## 8 Forum

Thousands of new satellites could ruin our view of the night sky. *By Ronald Drimmel*

## 10 Advances

Keeping livers alive before transplant. Countdown to commercial crew space launches. Lizard embryos' tiny brain parasites. A DIY tool to open cell membranes.

## 22 Meter

The poetic geology of Yosemite's Lyell Canyon. *By Janet MacFadyen*

## 23 The Science of Health

A way to make it easier for the terminally ill to donate organs. *By Claudia Wallis*

## 24 Ventures

When will speech-recognition software finally be good enough? *By Wade Rouse*

## 70 Recommended

Harnessing fungi's ability to shape our future. Early organic food champion. Diving into understanding the brain. Humanizing technology. *By Andrea Gawrylewski*

## 71 Observatory

Curtailed federal funding for basic research threatens American science. *By Naomi Oreskes*

## 72 Anti Gravity

Flat-earthers aren't wrong only about the shape of the planet. *By Steve Mirsky*

## 73 50, 100 & 150 Years Ago

*By Daniel C. Schlenoff*

## 74 Graphic Science

The growing cloud of low-orbit satellites. *By Mark Fischetti and Nadieh Bremer*

Scientific American (ISSN 0036-8733), Volume 322, Number 5, May 2020, published monthly by Scientific American, a division of Springer Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. **Individual Subscription rates:** 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). **Institutional Subscription rates:** Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: (212) 451-8415. To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to RandP@sciam.com. Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.



Scientific American is part of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at [www.springernature.com/us](http://www.springernature.com/us)). Scientific American maintains a strict policy of editorial independence in reporting developments in science to our readers. Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

06 OCT 2020

JUNE 2020

VOLUME 322, NUMBER 6

# SCIENTIFIC AMERICAN



24

SPECIAL REPORT

## 24 THE CORONAVIRUS PANDEMIC

### 26 Chasing Plagues

A virologist crawled through bat caves to find the origins of the SARS-CoV-2 virus. *By Jane Qiu*

### 32 Fast-Track Drugs

With no time to make treatments from scratch, scientists are searching for existing compounds that reduce harm. *By Michael Waldholz*

### 36 Frontline Trauma

Stress from fighting COVID-19 poses an unprecedented threat to health care workers. *By Jillian Mock*

### 38 How the Healers Feel

*Interviews by Jillian Mock and Jen Schwartz*

### 40 The Vaccine Quest

Only genetic engineering can create a protective serum in months rather than years. *By Charles Schmidt*

### 44 What Comes Next

Large outbreaks of disease in the past suggest how the current crisis might play out. *By Lydia Denworth*

#### EVOLUTION

### 46 The Unexpected Origin of Fingers

A remarkable fossil shows that the digits in our hands evolved before vertebrates emerged from the water to colonize land. *By John A. Long and Richard Cloutier*

#### ASTRONOMY

### 54 A Planet Is Born

High-resolution imaging of circumstellar disks—the swirls of dust left behind after stars form—is revealing hidden planets and insights about how solar systems evolve. *By Meredith A. MacGregor*

#### CLIMATE CHANGE

### 62 What Should Carbon Cost?

Smart math, combined with fundamental policy choices, can determine a practical tax that will drive down CO<sub>2</sub> emissions. *By Gilbert E. Metcalf*

#### CONSCIOUSNESS

### 70 Tales of the Dying Brain

A brush with death can leave a lasting legacy in the mind—and may help us understand how the brain functions in extreme conditions. *By Christof Koch*



#### ON THE COVER

In a matter of weeks the SARS-CoV-2 virus infected millions, killing thousands and bringing the global economy to a halt. Read our special report on the origins of the plague, the human toll, and the search for treatments and a vaccine. **Illustration by Richard Borge.**

# SCIENTIFIC AMERICAN



## 4 From the Editor

## 6 Letters

## 8 Science Agenda

To prevent future pandemics, stop deforestation.  
*By the Editors*

## 9 Forum

Leaders who belittle science during a global health crisis are a danger to us all. *By Ben Santer*

## 10 Advances

A collision model shakes up Pluto. New strategy to prevent tropical extinction. Lightweight vaccine-delivery technology. A poultry domestication mystery.

## 20 Meter

The poetic landscape of boreal forests.  
*By Jessica Goodfellow*

## 22 The Science of Health

As drug-resistant superbugs spread, researchers are turning to viruses that kill bacteria.  
*By Claudia Wallis*

## 76 Recommended

Women ran Britain's most extraordinary World War I hospital. Why innovation flourishes in freedom. The fury of hurricanes. How Dr. Claire Weekes cracked the anxiety code. *By Andrea Gawrylewski*

## 77 Observatory

How we can best quantify "small" benefits.  
*By Naomi Oreskes*

## 78 Anti Gravity

Misinformation and miscalculation in the time of the coronavirus. *By Steve Mirsky*

## 79 50, 100 & 150 Years Ago *By Daniel C. Schlenoff*

## 80 Graphic Science

Globe-trotting humans spread COVID-19 around the world. *By Mark Fischetti and Martin Krzywinski*

Scientific American (ISSN 0036-8733), Volume 322, Number 6, June 2020, published monthly by Scientific American, a division of Springer Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. Individual Subscription rates: 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). Institutional Subscription rates: Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: RandP@sciam.com. To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to scacustserv@cdsfulfillment.com. Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.



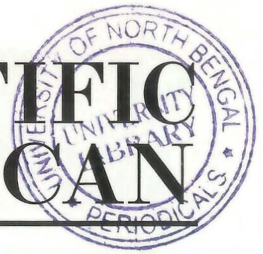
Scientific American is part of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at [www.springernature.com/us](http://www.springernature.com/us)). Scientific American maintains a strict policy of editorial independence in reporting developments in science to our readers. Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

02 DEC 2020

JULY 2020

VOLUME 323, NUMBER 1

# SCIENTIFIC AMERICAN



## HEALTH AND MEDICINE

### 22 **Treating Patients without the Scale**

Focusing on weight loss isn't making people healthier.

*By Virginia Sole-Smith*

### 26 **The Racist Roots of Fighting Obesity**

*By Sabrina Strings and Lindo Bacon*

## MOLECULAR BIOLOGY

### 32 **Inside the Coronavirus**

What scientists know about the inner workings of the pathogen that has infected the world.

*By Mark Fischetti, Veronica Falconieri Hays, Jen Christiansen and Britt Glaunsinger*

## RESILIENCY

### 38 **The Biggest Psychological Experiment**

What can the pandemic teach us about how people respond to adversity? *By Lydia Denworth*

## PHYSICS

### 46 **The Darkest Particles**

An experiment aims to find a new type of neutrino that could be a key to the universe's dark sector.

*By William Charles Louis and Richard G. Van de Water*

## METEOROLOGY

### 54 **Your 28-Day Weather Forecast**

Meteorologists are getting better at predicting whether it will be warm, cold, wet or dry four weeks from now.

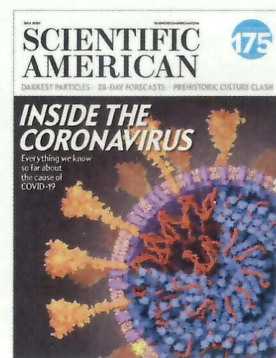
*By Kathy Pegion*

## ARCHAEOLOGY

### 60 **How Farmers Conquered Europe**

When Neolithic agriculturists encountered seminomadic hunter-gatherers, a disturbing hierarchy may have evolved.

*By Laura Spinney*



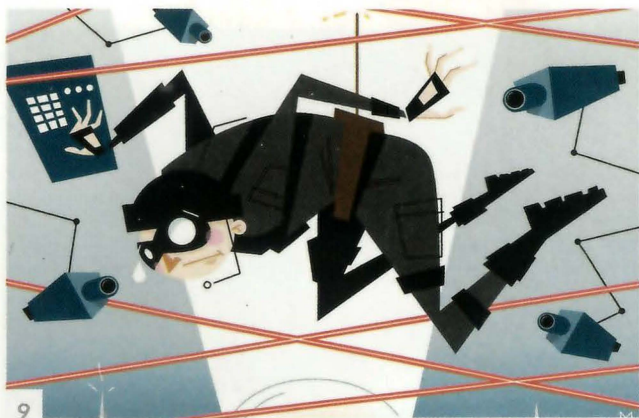
## ON THE COVER

Although much remains unknown about the virus responsible for the ongoing global pandemic, scientists have developed a detailed picture of the molecular biology of SARS-CoV-2 in a surprisingly short time. Our synthesis of this work begins on page 32.

Illustration by Veronica Falconieri Hays.

JOHN FINNEY Getty Images; COVER SOURCE: LORENZO CASALINO, ZIED GAIEB AND ROMMIE AMARO U.C. San Diego (spike model)

# SCIENTIFIC AMERICAN



## 4 From the Editor

## 6 Letters

## 8 Science Agenda

Mandating the testing of all evidence kits will bring justice for rape victims. *By the Editors*

## 9 Forum

How best to guard against the threat of science theft. *By Mary Sue Coleman*

## 10 Advances

A compact footprint tracker that makes the whole floor a sensor. The first marine fish extinction. A strange creature's endless fertility. Artificial detox cells.

## 20 Meter

The poetry and poignancy of pathology. *By Rafael Campo*

## 21 The Science of Health

Boost your immunity against viruses with a regimen of sleep, diet and vitamins. *By Claudia Wallis*

## 68 Recommended

Commemorating the life's work of magazine and fish illustrator Stanley Meltzoff. *By Andrea Gawrylewski*

## 69 Observatory

When pro-business initiatives promote antiscience policies, we all lose. *By Naomi Oreskes*

## 70 Anti Gravity

Descendants of Galileo and of the science deniers who plagued him are still fighting today. *By Steve Mirsky*

## 71 50, 100 & 150 Years Ago

*By Daniel C. Schlenoff*

## 72 Graphic Science

One million frozen seed samples in a Norwegian vault provide a hedge against climate change. *By Mark Fischetti and Accurat*

Scientific American (ISSN 0036-8733), Volume 323, Number 1, July 2020, published monthly by Scientific American, a division of Springer Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. Individual Subscription rates: 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). Institutional Subscription rates: Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: RandP@sciam.com. To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to scacustserv@cdsfulfillment.com. Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.



Scientific American is part of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at [www.springernature.com/us](http://www.springernature.com/us)). Scientific American maintains a strict policy of editorial independence in reporting developments in science to our readers. Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

10 NOV 2020

SEPTEMBER 2020

VOLUME 323, NUMBER 3

# SCIENTIFIC AMERICAN



## 24 175 Years of Discovery

### HISTORY OF SCIENCE

#### 26 The Language of Science

How the words this magazine uses have evolved over time. *By Moritz Stefaner, Lorraine Daston and Jen Christiansen*

#### 36 Reckoning with Our Mistakes

Some of the cringiest articles in the magazine's history reveal bigger questions about scientific authority. *By Jen Schwartz and Dan Schlenoff*

### TECHNOLOGY

#### 42 The Information Manipulators

By moving matter and energy, innovators have democratized information. *By Naomi Oreskes and Erik M. Conway*

#### 49 Subway to Nowhere

Scientific American's editor secretly built New York City's first underground train—powered by air—only to have it crushed by political opposition. *By Katherine Harmon Courage*

### MEDICINE

#### 50 Return of the Germs

For more than a century drugs and vaccines made astounding progress against infectious diseases. Now our best defenses may be social changes. *By Maryn McKenna*

#### 57 Science vs. the Supernatural

This magazine launched a contest to prove, or disprove, the existence of ghosts. *By Katherine Harmon Courage*

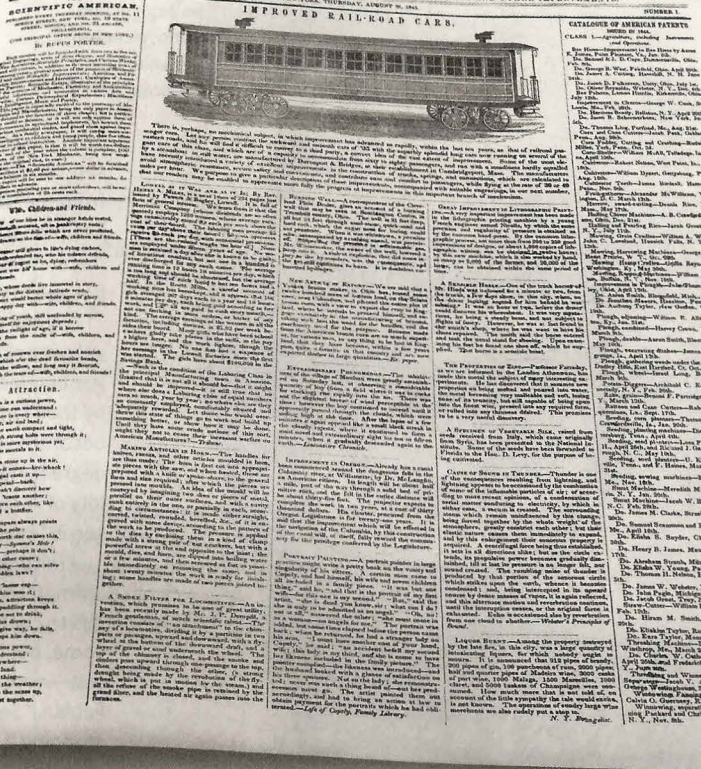
### ASTRONOMY

#### 58 Our Place in the Universe

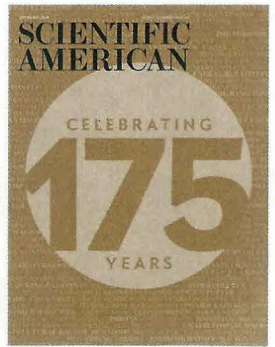
How astronomers revealed a much bigger and stranger cosmos than anyone suspected. *By Martin Rees*

#### 65 The Symmetry Pair

In the 1960s Martin Gardner helped to turn the artist M. C. Escher into a sensation. *By Stephen Ornes*



**ON THE COVER**  
From the telegraph to COVID-19, a chronological selection of inventions, discoveries, scientific breakthroughs and historical events that have helped determine the course of the world 175 years, for this magazine and the world at large.



### EVOLUTION

#### 66 The Origin of Us

Fossils and DNA have revealed the complexity of human evolution. Darwin would be delighted. *By Kate Wong*

#### 73 Nuclear Reaction

How an article about the H-bomb landed this magazine in the middle of the Red Scare. *By Alfred W. McCoy*

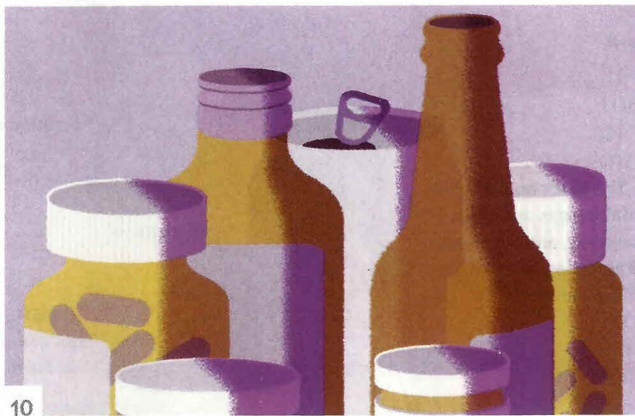
### GEOLOGY

#### 74 The Worst Times on Earth

Mass extinctions send us a warning about the future of life on this planet. *By Peter Brannen*

SCIENTIFIC AMERICAN, VOLUME 1, NUMBER 1, THURSDAY, AUGUST 28, 1845

# SCIENTIFIC AMERICAN



10



16



82

## 4 From the Editor

## 6 Letters

## 8 Science Agenda

Law and order at a local level must be reinvented.  
*By the Editors*

## 10 Forum

Fighting the stigma of addiction can be as fraught as overcoming addiction itself.  
*By Nora D. Volkow*

## 12 Advances

An intriguing update to radiocarbon dating. The math of better ocean rescues. New use for polar bears' discarded tracking collars. A fish egg's long, strange journey.

## 22 Meter

Musings on how to begin again by the U.K. Poet Laureate.  
*By Simon Armitage*

## 23 The Science of Health

Is the trendy intermittent fasting diet better than others?  
*By Claudia Wallis*

## 82 Recommended

Forest bathing for the soul. Shutting down racist arguments. Asexuality has its place in society. Humanizing cyberattacks. *By Andrea Gawrylewski*

## 84 Observatory

Sex offender Jeffrey Epstein bought influence among scientists at Harvard University.  
*By Naomi Oreskes*

## 86 Anti Gravity

A timely look at the ways our health depends on our homes and work spaces. *By Steve Mirsky*

## 87 50, 100 & 150 Years Ago

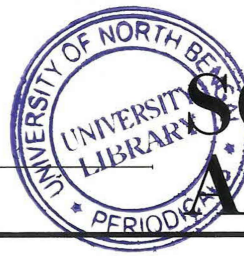
*By Dan Schlenoff*

## 88 Graphic Science

A Ph.D. dissertation helped to make a pulsar a pop culture icon.  
*By Jen Christiansen and Harold D. Craft, Jr.*

Scientific American (ISSN 0036-8733), Volume 323, Number 3, September 2020, published monthly by Scientific American, a division of Springer Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. Individual Subscription rates: 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). Institutional Subscription rates: Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: RandP@sciam.com. To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to [scacustserv@cdsfulfillment.com](mailto:scacustserv@cdsfulfillment.com). Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.





## MIND

**30 Infectious Dreams**

How the COVID-19 pandemic is changing our sleeping lives.

*By Tore Nielsen*

## VIROLOGY

**36 What We Learned from AIDS**

Lessons from another pandemic for fighting COVID-19.

*By William A. Haseltine*

## ASTRONOMY

**42 Interstellar Interlopers**

Two recently sighted space rocks that came from beyond the solar system have puzzled astronomers.

*By David Jewitt and Amaya Moro-Martín*

## PUBLIC HEALTH

**50 Born Unequal**

Improving newborn health and why it matters now more than ever.

*By Janet Currie*

## SOCIAL SCIENCES

**58 How to Unlearn Racism**

Implicit bias training isn't enough. What actually works?

*By Abigail Libers*

## PSYCHOLOGY

**64 All Together Now**

Synchronized activities such as group dancing and exercise promote surprisingly strong bonds, probably through changes in brain chemistry.

*By Marta Zaraska*

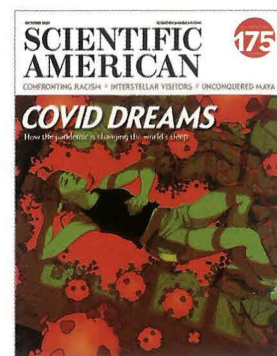
## ARCHAEOLOGY

**70 Fate of the Unconquered Maya**

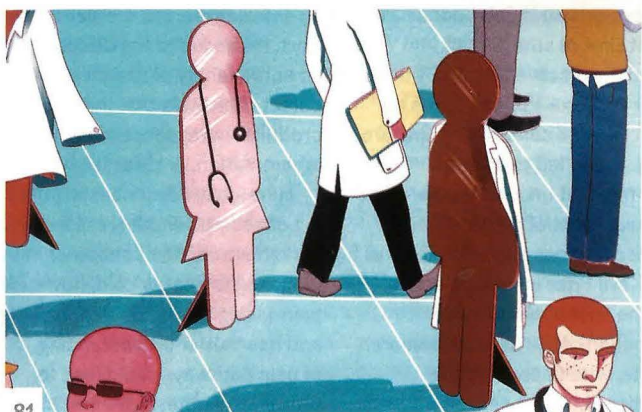
The Lacandon Maya eluded the Spanish conquistadors and survived in the jungle for hundreds of years.

Archaeological discoveries are revealing their past.

*By Zach Zorich*

**ON THE COVER**

Dreams can be strange, but the COVID-19 pandemic has made them more bizarre. Many people report dreams about being threatened or being unable to cope. Lockdowns and social distancing, so alien to our normal lives, may also be overwhelming useful functions that dreams provide, such as helping us regulate our emotions. Illustration by Goñi Montes.



## 6 From the Editor

## 8 Letters

## 12 Science Agenda

The U.S. November election is literally a matter of life and death. Vote for health, science and Joe Biden for President. *By the Editors*

## 14 Forum

Digital listening devices are linguistically biased. *By Claudia Lopez-Lloreda*

## 16 Advances

A slice of supernova in the lab. A new trick to finding metal deposits. Freeze-proof concrete inspired by nature. Fossilized remains inside a precious gem.

## 26 Meter

The poetry of spinning black holes and gravitational waves. *By Kip Thorne and Lia Halloran*

## 28 The Science of Health

A mouth bacterium can drive some deadly metastatic cancers. *By Claudia Wallis*

## 30 Recommended

A mustard gas disaster led to curative chemotherapy. Embracing the randomness of the world. The glory and tragedy of spaceflight. *By Andrea Gawrylewski*

## 31 Observatory

Sexism and racism in science won't miraculously go away. *By Naomi Oreskes*

## 32 Anti Gravity

The hellscape of a pandemic summer. *By Steve Mirsky*

## 33 50, 100 & 150 Years Ago

*By Dan Schlenoff*

## 34 Graphic Science

Lead pollution tracks dramatic world events. *By Mark Fischetti and Nadieh Bremer*

Scientific American (ISSN 0036-8733), Volume 323, Number 4, October 2020, published monthly by Scientific American, a division of Springer Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. Individual Subscription rates: 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). Institutional Subscription rates: Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: [RandP@sciam.com](mailto:RandP@sciam.com). To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to [scaustserv@cdfsulfillment.com](mailto:scaustserv@cdfsulfillment.com). Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.



Scientific American is part of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at [www.springernature.com/us](http://www.springernature.com/us)). Scientific American maintains a strict policy of editorial independence in reporting developments in science to our readers. Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



44

28 SPECIAL REPORT

**30 How to Get Through This Election**

*By Claire Wardle*

**32 The Roots of Vaccine Mistrust**

It's not just "antiscience" thinking.

*By Zakiya Whatley and Titilayo Shodiya*

**34 Truth Activism**

The history of online protest movements.

*By Joan Donovan*

**39 Power Play**

Can live simulation games help journalists fight disinformation?

*By Jen Schwartz*

**41 COVID-19 Misinformation That Won't Go Away**

The most insidious falsehoods about the novel coronavirus—and why people believe them. *By Tanya Lewis*

EVOLUTION

**44 How Birds Branched Out**

Modern birds are incredibly diverse. A new study reveals how they achieved their spectacular evolutionary success. *By Kate Wong*

SPACE

**50 Orbital Aggression**

How do we prevent war in space?

*By Ann Finkbeiner*

NEUROSCIENCE

**58 A Disorder of Mind and Brain**

A mysterious condition once known as hysteria is challenging the divide between psychiatry and neurology. *By Diana Kwon*

SOCIOLOGY

**66 The Pandemic We Forgot**

The 1918 flu killed millions, then faded from collective memory. Could the same happen with COVID-19? *By Scott Hershberger*

ARCHAEOLOGY

**70 Ancient Plagues Shaped the World**

DNA of bacteria and viruses, recovered from human remains, shows how pathogens helped to topple empires from Europe to the Americas.

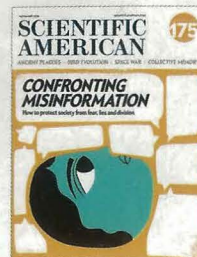
*By James P. Close*



ON THE COVER

Uncertainty creates conditions for misinformation to flourish—and flourish it has. As the world continues to grapple with the pandemic and the U.S. faces a high-stakes election season, how can society be less fragile to toxic media manipulation, whether it is from the highest levels of governments or homegrown?

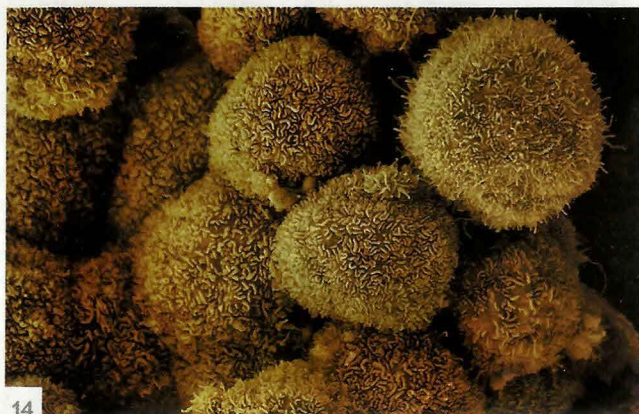
Illustration by Hanna Barczyk.



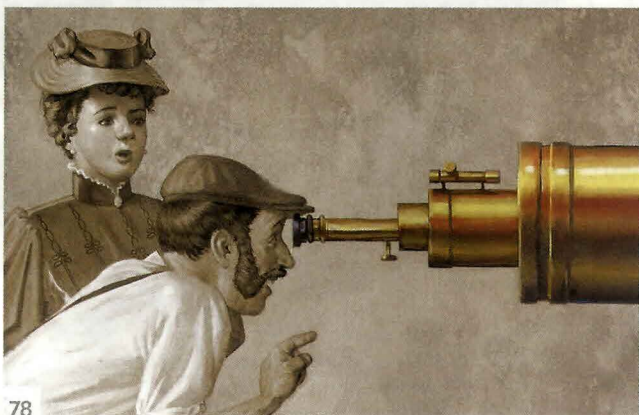
# SCIENTIFIC AMERICAN



12



14



78

## 6 From the Editor

## 8 Letters

## 12 Science Agenda

Who will we be after the pandemic?

*By the Editors*

## 13 Forum

The new U.S. Arctic coordinator has little experience with climate change, which is the biggest issue facing the region. *By Victoria Herrmann*

## 14 Advances

Cancer cells in a tiny maze. Hurricane-surfing parasites. A nationwide look at housing's carbon footprint. Building with metal-breathing microbes.

## 24 Meter

Now let us praise the noble gases.

*By Douglas O. Linder*

## 25 The Science of Health

Yoga may boost neural regions, brain scans hint.

*By Claudia Wallis*

## 76 Recommended

The practice of mapping geologic layers. A podcast exploring extraterrestrial intelligence. Oliver Sacks and the art of telling patients' stories. *By Andrea Gawrylewski*

## 77 Observatory

With lives at stake, medical guidance on wearing masks should not be confusing.

*By Naomi Oreskes*

## 78 Anti Gravity

Einstein wrote for this publication, as did some non-Einsteins. *By Steve Mirsky*

## 79 50, 100 & 150 Years Ago

*By Dan Schlenoff*

## 80 Graphic Science

Influenza seems to have skipped its southern season.

*By Katie Peek*

Scientific American (ISSN 0036-8733), Volume 323, Number 5, November 2020, published monthly by Scientific American, a division of Springer Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652R; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. Individual Subscription rates: 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). Institutional Subscription rates: Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: [RandP@sciam.com](mailto:RandP@sciam.com). To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to [scacustserv@cdsfulfillment.com](mailto:scacustserv@cdsfulfillment.com). Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.



Scientific American is part of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at [www.springernature.com/us](http://www.springernature.com/us)). Scientific American maintains a strict policy of editorial independence in reporting developments in science to our readers. Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



ASTRONOMY

**26 Explosions at the Edge**

Most stars die in fairly predictable ways, but astronomers have discovered a growing number of unusual supernovae that challenge the traditional picture. *By Anna Y. Q. Ho*

MEDICINE

**46 The Viruses Inside You**

Trillions of viruses make up the human virome. Some can harm us, but some could help us, if we can figure out how to use them. *By David Pride*

SOCIAL MEDIA

**54 The Attention Economy**

Understanding how algorithms and manipulators exploit our cognitive vulnerabilities empowers us to fight back. *By Filippo Menczer and Thomas Hills*

NEUROPLASTICITY

**62 New Connections**

What hand transplants are teaching us about the brain. *By Scott H. Frey*

PHYSICS

**70 Fusion Dreams**

Assembly has begun on ITER, the world's largest nuclear fusion reactor. *By Clara Moskowitz*

34

SPECIAL REPORT

TOP 10 EMERGING TECHNOLOGIES OF 2020

Spatial computing, digital medicine, low-carbon cement, whole-genome synthesis, green hydrogen, quantum sensing, and four other potentially transformative inventions. A collaboration between *Scientific American* and the World Economic Forum.

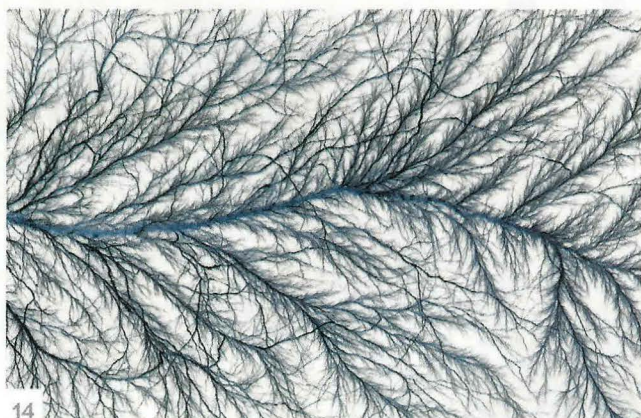
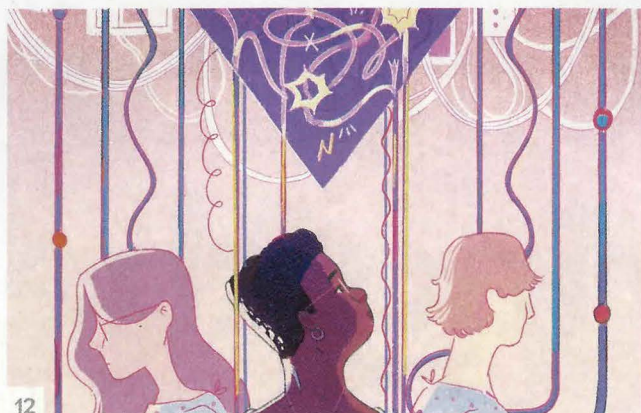


ON THE COVER

Giant stars explode in a myriad of ways, recent discoveries show. Astrophysicist Anna Y. Q. Ho surveys several unusual supernovae sighted recently and explores what they can teach us about how stars live and die.

Illustration by Kenn Brown, Mondolith Studios.

# SCIENTIFIC AMERICAN



## 6 From the Editor

## 8 Letters

## 12 Science Agenda

Tools used in health care are harming people of color. It's time to fix this. *By the Editors*

## 13 Forum

We need to commit to protecting 30 percent of U.S. lands and waters from development by the year 2030. *By David Schiffman*

## 14 Advances

Probing electricity-conducting bacteria's strange nano-wires. Radiation's impact on Chernobyl animals. Decoding fast radio bursts. A DNA-based water-contaminant test.

## 24 Meter

The poetics of an astronomer who takes the time to stop and stare into the universe. *By Wyatt Townley*

## 25 The Science of Health

How to maintain mental equilibrium in challenging times. *By Claudia Wallis*

## 80 Recommended

The grim politics of Ebola. What would happen if the arrow of time flew backward? Racism and organ transplants. *By Andrea Gawrylewski*

## 81 Observatory

Rejection of expert evidence and promotion of disinformation have roots in the history of tobacco. *By Naomi Oreskes*

## 82 Anti Gravity

On aging, the passage of time and learning to love chitin. *By Steve Mirsky*

## 83 50, 100 & 150 Years Ago

*By Dan Schlenoff*

## 84 Graphic Science

COVID-19 lockdowns calmed seismic activity on a global level. *By Mark Fischetti and Shirley Wu*

Scientific American (ISSN 0036-8733), Volume 323, Number 6, December 2020, published monthly by Scientific American, a division of Springer Nature America, Inc., 1 New York Plaza, Suite 4600, New York, N.Y. 10004-1562. Periodicals postage paid at New York, N.Y., and at additional mailing offices. Canada Post International Publications Mail (Canadian Distribution) Sales Agreement No. 40012504. Canadian BN No. 127387652RT; TVQ1218059275 TQ0001. Publication Mail Agreement #40012504. Return undeliverable mail to Scientific American, P.O. Box 819, Stn Main, Markham, ON L3P 8A2. Individual Subscription rates: 1 year \$49.99 (USD), Canada \$59.99 (USD), International \$69.99 (USD). Institutional Subscription rates: Schools and Public Libraries: 1 year \$84 (USD), Canada \$89 (USD), International \$96 (USD). Businesses and Colleges/Universities: 1 year \$399 (USD), Canada \$405 (USD), International \$411 (USD). Postmaster: Send address changes to Scientific American, Box 3187, Harlan, Iowa 51537. Reprints inquiries: RandP@sciam.com. To request single copies or back issues, call (800) 333-1199. Subscription inquiries: U.S. and Canada (800) 333-1199; other (515) 248-7684. Send e-mail to scacustserv@cdsfulfillment.com. Printed in U.S.A. Copyright © 2020 by Scientific American, a division of Springer Nature America, Inc. All rights reserved.



Scientific American is part of Springer Nature, which owns or has commercial relations with thousands of scientific publications (many of them can be found at [www.springernature.com/us](http://www.springernature.com/us)). Scientific American maintains a strict policy of editorial independence in reporting developments in science to our readers. Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.