Contents



Epic trek p. 260

Editorials

257 Cold-war lessons for East-West science Why the journey to better European collaborations is far from over

257 A cry for help
Performance management
will worsen mental ill-health
among PhD students

258 South Africa's rooibos restitution Indigenous communities must be equal partners in research and industry

World view

259 Pandemic policy can learn from arms control

How a bioweapons treaty suggests a fix for policy flaws in dealing with infectious-disease outbreaks *Rebecca Katz*

Research highlights

260 Contagious mussel cancer / Cosmic cloud is surprisingly modern / Lone wolf's long migration / Anxiety linked to lack of sleep / Baffling brain scans in smell study

News in brief

262 Next FDA chief nominated /
Gender gap in chemistry journals/
US starts exit process from
Paris pact / Elusive mammal
'rediscovered' in Vietnam



Space shapes p. 272

News in focus

- **265** Researchers join Chile protests and seek solutions with lawmakers
- **266** Neural network 'discovers' that Sun is at centre of Solar System
- **267** South Korean academics caught naming children as co-authors
- **268** Astronomers concerned as SpaceX launches another 60 satellites
- **269** Proton really does seem to be smaller than physicists thought

Features

272 Out of thin air

Acoustic 3D shapes that float in space are closest yet to *Star Wars* SOS-message technology

275 Medicines on demand

How briefcase-sized labs could transform drug manufacturing



Sahel solutions p. 282

Books & arts

- 278 Planet junk: a journey through discards
 Edward Humes
- 280 The growing rumblings of cyberwar Brian Nussbaum
- 281 Books in brief
 Andrew Robinson

Comment

282 Avert catastrophe now in Africa's Sahel

Four ways to adapt to climate change and population growth *Alisha Graves* et al.

Correspondence

287 WHO plan for gene-edited embryos/ Ditch emissions from intensive farming/Apply kindness in research equally/A150-year-old idea to limit species invasions in Suez Canal

Careers

403 PhD poll reveals fear and joy, contentment and anguish

The results of *Nature's* 2019 survey of graduate students

Where I work

408 Noam Shomron

Virginia Gewin

Research

News & views

289 Engineering How to print multi-material devices in one go

A multi-nozzle system for the 3D printing of voxelated objects Johannes TB Overvelde See Article p.330

290 Learning

A genetically tailored education for birds

An intersection between genetics and teaching style during learning *Ofer Tchernichovski & Dalton Conley*

291 *Immunology*One ring to rule them all

DNA extrusion through a cohesin complex aids recombination in immune cells Ferenc Livak & André Nussenzweig See Article p.385

293 High-energy physics Link between antimatter and dark matter probed

Constraints on axion–antiproton interactions
Gianpaolo Carosi
See Article p.310

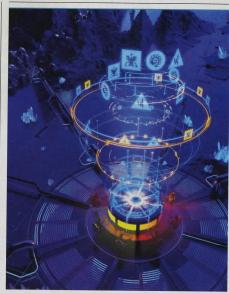
294 Medical research 'Undruggable' cancer protein targeted

A small molecule can combat oncogenic KRAS protein in patients Roy S Herbst & Joseph Schlessinger

296 Cancer

Metabolic vulnerability in tumours illuminated

Non-invasive imaging reveals cancers likely to respond to a drug treatment Aparna D Rao & Ralph J DeBerardinis See Article p.380



ON THE COVER

Game plan. StarCraft II is a real-time strategy game that is played competitively around the world. Players control one of three alien races and make strategic and tactical decisions that adapt to their opponents' actions. The game has emerged as a key challenge for artificial intelligence because its complexity and multi-player challenges echo potential real-world applications. In this week's issue, Oriol Vinyals at DeepMind and his colleagues report that thanks to a multiagent reinforcement learning algorithm, an AI program called AlphaStar now ranks among the top 0.2% of players of the game and has attained the level of Grandmaster for all three alien races. Cover image: DeepMind Technologies Ltd with thanks to Blizzard Entertainment. Page 350

Review

299 Cancer therapy
A view on drug
resistance in cancer
N Vasan, J Baselga & D M Hyman

Articles

- 310 High-energy physics
 Direct limits on the
 interaction of antiprotons
 with axion-like dark matter
 C Smorra et al.
 See N&V p.293
- 315 Condensed-matter physics
 Axionic charge-density wave in
 the Weyl semimetal (TaSe₄)₂I

 J Gooth et al.
- 320 Applied optics
 A volumetric display for visual, tactile and audio presentation using acoustic trapping
 R Hirayama, D M Plasencia,
 N Masuda & S Subramanian
- 324 Materials science
 Controlled flight of a
 microrobot powered by
 soft artificial muscles
 Y Chen et al.

330 Engineering Voxelated soft matter via multimaterial multinozzle 3D printing

MA Skylar-Scott, J Mueller, CW Visser & J A Lewis See N&V p.289

336 Chemistry
Metal-free directed
sp²-C-H borylation
JLv et al.

341 Climatescience

Large hydropower and waterstorage potential in future glacier-free basins

D Farinotti, V Round, M Huss, L Compagno & H Zekollari

Continues >

Research

- 345 Social sciences Heterogeneity in banker culture and its influence on dishonesty ZRahwan, EYoeli & BFasolo
- 350 Computer science Grandmaster level in StarCraft II using multi-agent reinforcement learning O Vinyals et al.
- 355 Developmental biology Dynamic lineage priming is driven via direct enhancer regulation by ERK WB Hamilton et al.
- 361 Cell biology Lipid signalling drives proteolytic rewiring of mitochondria by YME1L TMacVicar et al.
- 366 Autoimmunity UNC93B1 recruits syntenin-1 to dampen TLR7 signalling and prevent autoimmunity OMajer et al.
- 371 Autoimmunity Release from UNC93B1 reinforces the compartmentalized activation of select TLRs OMajer et al.
- 375 Cell biology The ADP/ATP translocase drives mitophagy independent of nucleotide exchange A Hoshino et al.

380 Cancer

In vivo imaging of mitochondrial membrane potential in nonsmall-cell lung cancer MMomcilovic et al. See N&V p.296

- 385 Immunology Fundamental roles of chromatin loop extrusion in antibody class switching XZhang et al. See N&V p.291
- 390 Molecular biology HP1 reshapes nucleosome core to promote phase separation of heterochromatin S Sanulli et al.
- 395 Structural biology Structure of the mitochondrial import gate reveals distinct preprotein paths Y Araiso et al.

Matters Arising

Social sciences Selective participation may undermine replication attempts Arising from 'Heterogeneity in banker culture and its influence

on dishonesty' by Z Rahwan et al. Nature 575, 345-349 (2019) A Cohn, E Fehr & M A Maréchal doi:10.1038/s41586-019-1729-7

CORRECTIONS & CLARIFICATIONS

Correction

A slippery target

This article (Nature **573**, S20–S21; 2019) mischaracterized the differences in causes of death between cocaine and opioid users. See https://doi.org/10.1038/d41586-019-02690-6

Correction

One step ahead

This article (Nature **555**, S5-S7; 2018) incorrectly implied that bacteria have a nucleus.

See https://doi.org/10.1038/d41586-018-02475-3

Correction

Brain work

This article erroneously stated that the Allen Institute for Brain Science's Frontiers Group gives funding for groundbreaking neuroscience ideas. In fact, the funding comes from the Paul G. Allen Frontiers Group. See https://doi.org/10.1038/d41586-019-03065-7

Correction

Earth scientists push plan to map Canada's geology

This article implied that the EarthScope programme discovered slow-moving quakes along the Cascadia fault zone. In fact, the programme discovered new details about these quakes.

See https://doi.org/10.1038/d41586-019-03030-4

Correction

A first for African neuroscience

This article erroneously stated that Africa has just nine mental-health professionals for every 100,000 people. In fact, it has nine for every one million people. See https://doi.org/10.1038/d41586-019-03108-z

Author correction

The mid-developmental transition and the evolution of animal body plans

M Levin et al.

See https://doi.org/10.1038/s41586-019-1698-x