Snapshots of science

SHERRI & BROCK FENTON

January

Evolutionary neuroscience

Ear anatomy traces a family tree for bats

Bats were previously classified into one of two suborders — Megachiroptera and Microchiroptera. But a study published in 2000 used DNA evidence to challenge this arrangement, and assembled families into two other suborders — Yinpterochiroptera and Yangochiroptera. Previously, there were no known anatomical characteristics that offered a way to distinguish between Yinpterochiroptera and Yangochiroptera. Sulser *et al.* present evidence that a structure in the inner ear called Rosenthal's canal is walled in Yinpterochiroptera and wall-less in Yangochiroptera. Using neuroanatomical data, the authors provide robust support for the molecularly based classification of Yinpterochiroptera and Yangochiroptera, and have opened up new avenues for bat research. These extend from understanding the details of how bats use echolocation, to investigating the community structure of groups of bats.

M. Brock Fenton writing in *Nature* **602**, 387–388 (2022).
Original research: *Nature* **602**, 449–454 (2022).

February

Microbiology

Lung microbes mediate spinal-cord autoimmunity

There is growing evidence that both autoimmunity and the development of normal immune responses in humans are linked to the microbiome — the community of trillions of microorganisms that colonize body surfaces. Most research so far has focused on bacteria living in the gut. There is evidence that interactions between the microbiome and the brain have a role in some brain disorders and in complex behaviours such as sociability, although most such studies have focused on the gut–brain axis in animal models. Hosang *et al.* investigated the role of the bacterial community in the lung in rat models of autoimmunity, including a model of multiple sclerosis. The authors identify a previously unknown effect of the lung microbiome on microglia, the main immune-cell type in the central nervous system. They find that specific lung-resident bacterial species and some of the molecules they produce modify neuroinflammation and associated symptoms.

Aubrey M. Schonhoff & **Sarkis K. Mazmanian** writing in *Nature* **603**, 38–40 (2022).
Original research: *Nature* **603**, 138–144 (2022).

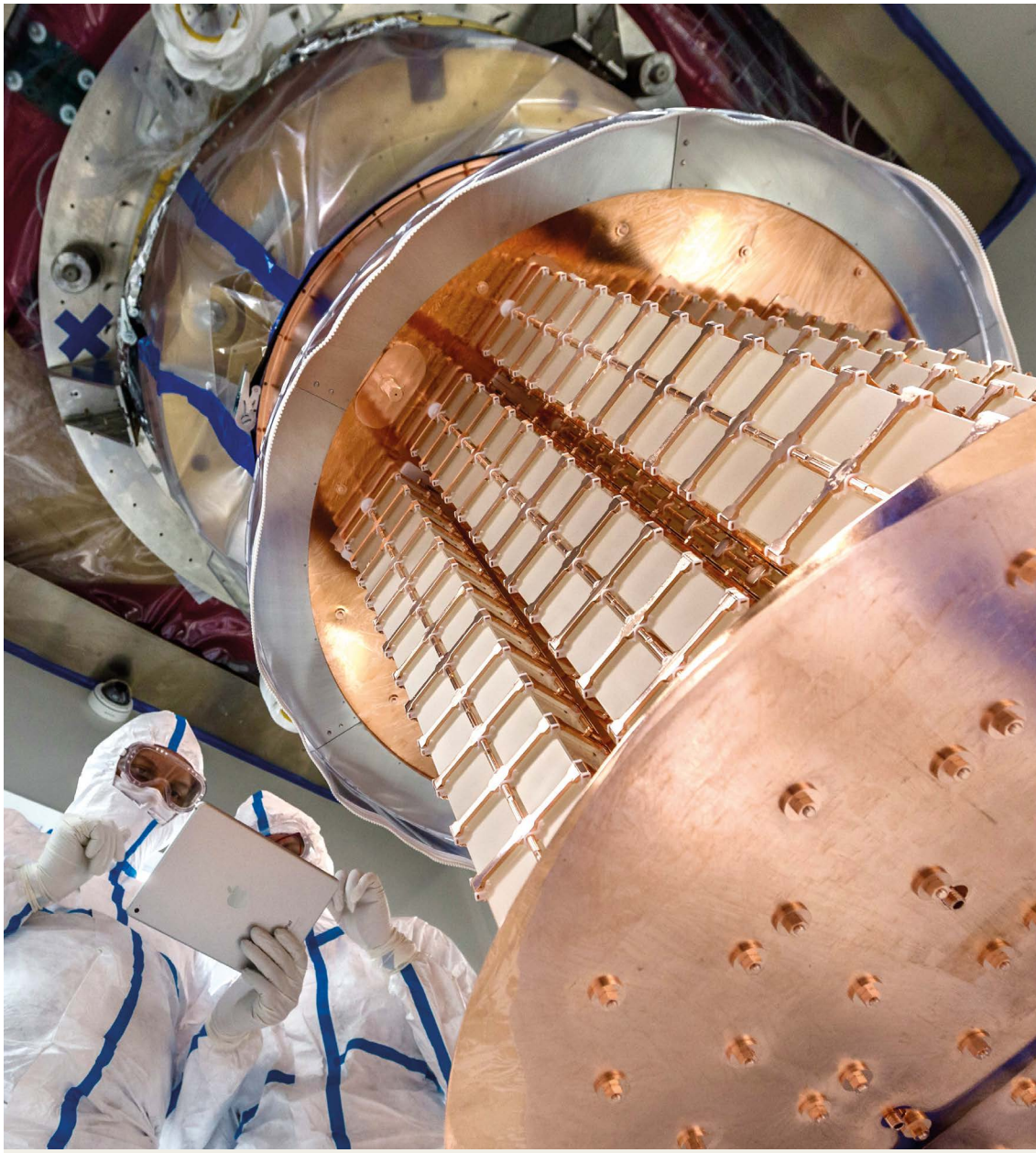
March

Neuroimaging

Brain changes after COVID revealed by imaging

In 2020, the UK Biobank (a large-scale biomedical database and research resource) launched a COVID-19 repeat-imaging study, in which participants who had completed a medical-imaging session before the pandemic returned for an identical, second scan session. Douaud *et al.* explored these data, comparing scans pre- and post-pandemic. Participants who had tested positive for SARS-CoV-2 between the two scans exhibited changes in the brain cortex that are often associated with worsening brain health. This group also displayed increases in markers of tissue damage in brain regions connected to smell and taste. There is much more work to be done to extract all the useful information from this valuable data set. The UK Biobank's data sharing and Douaud and colleagues' release of their analysis code serve as an open invitation to join the effort.

Randy L. Gollub writing in *Nature* **604**, 633–634 (2022).
Original research: *Nature* **604**, 697–707 (2022).



April

Nuclear physics

Cryogenic mastery aids bid to spot matter creation

Astrophysical observations reveal that the Universe is made almost entirely of matter, with nearly no antimatter in sight. However, laboratory and particle-collider experiments have so far observed the creation of matter and antimatter in equal parts. Big Bang theories that aim to explain the cosmic-matter imbalance predict that matter could be generated without antimatter in a 'little bang', during an ultra-rare nuclear process called neutrinoless double-β decay. The CUORE Collaboration reports the most sensitive search yet for this type of decay using isotopes of tellurium. The decay was not observed, but the engineering feat was remarkable — requiring the stable operation of more than one tonne of experimental apparatus, at cryogenic temperatures close to 10 millikelvin, over several years. The CUORE refrigerator is unofficially referred to as the coldest cubic metre in the known Universe.

Jason Detwiler writing in *Nature* **604**, 42–43 (2022).
Original Research: *Nature* **604**, 53–58 (2022).

May

Origins of life

A possible path towards encoded protein synthesis

DNA and RNA mainly consist of just four 'canonical' nucleotides, each of which contains a specific base. However, DNA and RNA also commonly include non-canonical nucleotides, which are modified versions of the canonical ones. Müller and co-workers now show that RNA molecules containing non-canonical nucleotides could have had a role in driving stepwise peptide synthesis on prebiotic Earth. The authors report a process in which an amino acid or a peptide is loaded onto the non-canonical base of the terminal nucleotide of an RNA molecule (the donor strand). The formation of a duplex between two such nucleotide-modified RNA molecules enables the amino acid or peptide to be transferred to a non-canonical base — or to a nascent peptide attached to that base — on the other RNA strand in the duplex (the acceptor strand). In other words, this transfer step either initiates peptide synthesis on the acceptor's non-canonical base, or elongates a nascent peptide on that base.

Claudia Bonfio writing in *Nature* **605**, 231–232 (2022).
Original research: *Nature* **605**, 279–284 (2022).

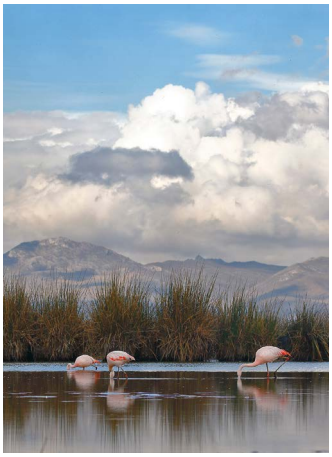
June

Molecular evolution

Mutations matter even if proteins stay the same

Although some mutations in a gene (known as non-synonymous mutations) alter the amino-acid sequence of the protein that the gene encodes, others (synonymous mutations) do not. Does it follow that synonymous mutations are unimportant? Shen *et al.* created thousands of synonymous and non-synonymous mutations in 21 yeast genes. Surprisingly, synonymous mutations were only slightly less harmful than non-synonymous mutations, on average. Why, then, is there a difference in how often these two types of mutation are retained in populations? Perhaps, the authors propose, non-synonymous changes have variable effects depending on the environment, and so are often harmful in at least one environment encountered by a species. By contrast, synonymous changes might consistently be either bad or neutral. This would mean that non-synonymous mutations are rarely retained in the long run, but synonymous changes that are always neutral can persist. Shen and colleagues' study should push researchers to evaluate long-standing assumptions about molecular evolution.

Nathaniel Sharp writing in *Nature* **606**, 657–659 (2022).
Original research: *Nature* **606**, 725–731 (2022).



July

Climate science

Sediment study finds the pulse of tropical glaciers

Rodbell and colleagues show that the timing of glacial variations in the tropical Andes is strikingly similar to that at higher latitudes over a period of nearly 700,000 years. The worldwide retreat of mountain glaciers that has occurred over the past century or so in response to industrial-age warming is an iconic demonstration of ongoing climate change. Likewise, glaciers have sensitively monitored climate changes in the past. To derive a long-term record of tropical glaciation, the authors extracted an impressive 95-metre-long sediment core from Lake Junín (pictured), which lies between the eastern and western mountain chains of the Peruvian Andes. These data suggest that glacier-derived sediment found its way into the lake basin. It is clear from the authors' innovative record that any hypothesis to explain what drove ice-age climate cycles must account for the near-simultaneity of glacial periods in the tropical Andes, and glacier and climate changes at higher latitudes in both polar hemispheres.

Aaron E. Putnam writing in *Nature* **607**, 241–243 (2022).
Original research: *Nature* **607**, 301–306 (2022).

August

Metallurgy

Magnetically soft but mechanically tough alloys

Soft magnetic materials are easily magnetized when a weak magnetic field is applied, and easily demagnetized when the field is removed or reversed slightly. A key property of these materials is coercivity, which quantifies the strength of the reverse magnetic field needed for complete demagnetization — the coercivity must be low to reduce energy loss in applications. For certain applications, soft magnetic materials must also be strong, malleable and tough. However, mechanical and soft magnetic properties are often inversely correlated, so that a compromise must be reached between low coercivity and high mechanical strength. Han *et al.* now show that it is possible to decouple the opposing effects of precipitates — particles of a new phase that can be formed within the solid solution of an alloy — so that the benefits for strength do not come at the expense of coercivity. I am optimistic that these findings will lead to further improvements in the properties of soft magnetic materials. Such enhancements could support efforts to miniaturize and improve the efficiency of electrical machines and electronic devices.

Easo P. George writing in *Nature* **608**, 270–271 (2022).
Original research: *Nature* **608**, 310–316 (2022).

L TO R: YURY SUVOROV & CUORE COLLABORATION; JONATHAN CHANCASANA/ALAMY

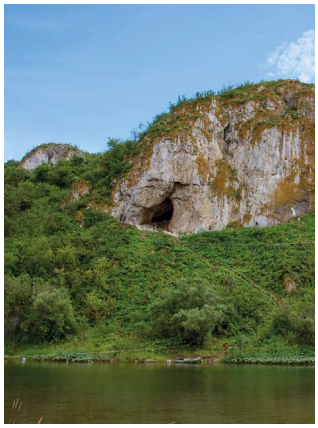
September

Chemistry

Synergistic sites observed in a solid catalyst

More than 80% of globally produced chemicals are made using solid catalysts (known in the field as heterogeneous catalysts), which are easy to separate from products formed in fluid states. However, some important industrial processes still use soluble (homogeneous) catalysts, because the best available heterogeneous catalysts do not promote the formation of the desired products with sufficiently high selectivity for commercial applications. Ro *et al.* report a solid catalyst that might change this situation for a widely used industrial process. The catalyst involves two types of active site, which can promote distinct steps in a catalytic cycle and co-localize to form isolated pairs known as pair sites. The catalyst promoted a much higher reaction rate and product selectivity than did catalysts with non-pair-site structures, as a result of the active sites working together synergistically. Because the structure of these pair sites is well defined and relatively simple, Ro *et al.* were able to deduce the catalytic mechanism by correlating experimental kinetics data with computational modelling.

Tiefeng Wang writing in *Nature* **609**, 253–254 (2022).
Original research: *Nature* **609**, 287–292 (2022).



October

Ancient genetics

The first genomic portrait of a Neanderthal family

Skov *et al.* sequenced DNA from the bones of 11 Neanderthals found in Chagyrskaya Cave in north Asia (pictured), along with those of 2 individuals from the nearby Okladnikov Cave. This is a major data milestone and attests to the continued improvements in extraction and isolation of ancient DNA spearheaded by this research group. But what makes this work particularly remarkable is that the sequenced individuals are not scattered widely across the vast expanse of Neanderthal existence, but are concentrated at a specific point in time and space, thus providing the first snapshot of a family group. The Chagyrskaya genomes contain signatures of inbreeding, and an outstanding question is whether this level of inbreeding was a common predicament for Neanderthals, or a specific feature of populations isolated at a geographical extreme. Chagyrskaya Cave and other sites across Eurasia have many more secrets to yield.

Lara M. Cassidy writing in *Nature* **610**, 454–455 (2022).
Original research: *Nature* **610**, 519–525 (2022).

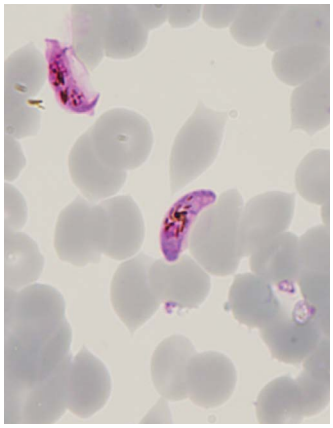
November

Statistical physics

Obstacles need not impede cooperation

From political dissenters to impurities in crystals, intuition tells us that defects can destroy order. Chen *et al.* report that this is not the case if the people or particles are active. In such systems, cooperation can be maintained as long as the active agents locally align their behaviour with that of their neighbours. There is a catch, however, in that these results apply only to systems in which the density is very high. This means that a herd of wildebeest dodging trees would establish long-range order only if the individuals are sufficiently tightly packed, almost to the point of being jammed together. One of the most intriguing outcomes of the study is the idea that obstacles could be designed that actually enhance cooperation. Such information would provide engineers with a criterion for designing materials that use active agents to perform reliably on a macroscopic scale.

Sam Cameron & **Tannie Liverpool** writing in *Nature* **611**, 668–669 (2022).
Original research: *Phys. Rev. Lett.* **129**, 188004 (2022).



December

Microbiology

How a malaria parasite becomes a male

The protozoan parasite *Plasmodium falciparum* is responsible for the vast majority of human malaria cases and deaths. Its complex life cycle involves only two developmental decision points. The first of these is whether to continue with a cycle of asexual replication or to differentiate into sexual forms, called gametocytes, that enable human-to-mosquito transmission. The second is whether gametocytes develop as male or female forms (the central pink cell pictured is a male gametocyte). Gomes *et al.* shed light on a long-standing mystery about how male sex is determined. The authors show that several types of RNA are made from the *md1* genomic region. The expression of a full-length 'sense' version of messenger RNA leads to the production of Md1 protein, and to male sex determination. The expression of an RNA that does not produce protein and is transcribed from the opposite strand of DNA is specifically associated with development into a female.

Elisabet Tintó-Font & **Alfred Cortés** writing in *Nature* **612**, 408–409 (2022).
Original research: *Nature* **612**, 528–533 (2022).

L TO R: BENCE VIOLA; ALBA PÉREZ-CANTERO