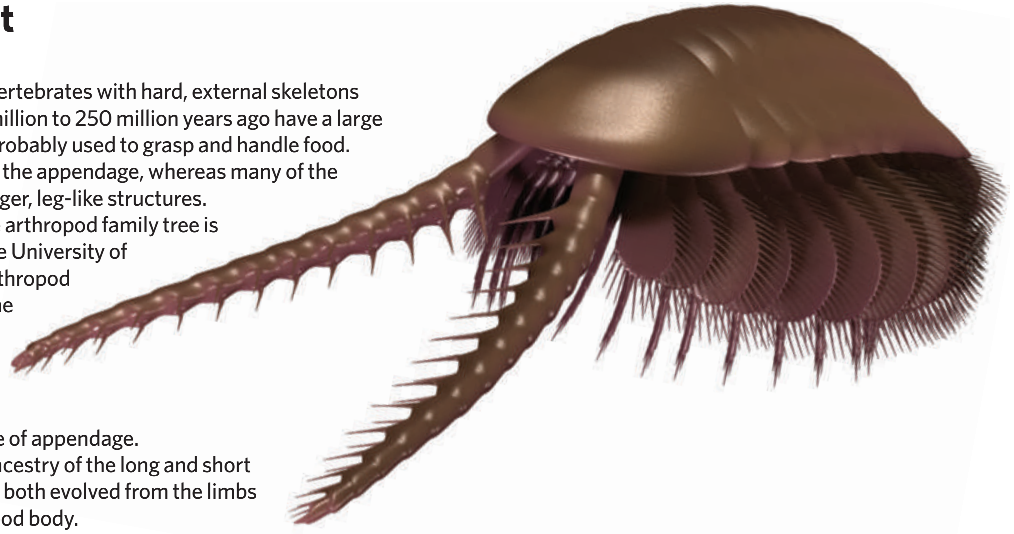
RESEARCH HIGHLIGHTS

The long and the short



M. STEIN

Zool. J. Linn. Soc. **158,** 477–500 (2010)

The fossils of many arthropods — invertebrates with hard, external skeletons and segmented bodies — from 540 million to 250 million years ago have a large pair of 'great appendages' that they probably used to grasp and handle food. Euarthropods had shorter versions of the appendage, whereas many of the now-extinct anomalocaridids had longer, leg-like structures.

The position of these animals in the arthropod family tree is controversial. Martin Stein, now at the University of Kansas in Lawrence, reports a new arthropod species that bridges a gap between the two groups.

The new species, *Kiisortoqia soperi* (reconstruction pictured), discovered in Greenland, was clearly a euarthropod but had the longer type of appendage.

Stein says this supports a shared ancestry of the long and short 'great appendages' and suggests that both evolved from the limbs of a particular segment of the arthropod body.

METABOLISM

Warm milk

Cell Metab. **11,** 206–212 (2010)

Mother's milk fires up a heat-generating metabolic pathway in newborn mice.

Newborns have to rapidly adjust to the comparatively chilly environment outside the womb. Francesc Villarroya of the University of Barcelona in Spain and his colleagues found that expression of a metabolic regulator gene called *Fgf21* increases immediately after birth. However, this increase was seen only when pups were allowed to suckle or were given a lipid-rich emulsion to drink. Pups fed a glucose solution — a diet similar to what they would have received *in utero* — did not activate *Fgf21*.

When the FGF21 protein was injected into newborns that were not allowed to nurse, genes associated with heat generation in brown fat, a tissue specialized in heat production, were activated in the pups.

CHEMISTRY

Cellulose busters

Proc. Natl Acad. Sci. USA doi:10.1073/pnas.0912073107 (2010)

Finding a safe, low-cost and high-yield way to break down cellulose — a major component of plant-fuel sources such as maize stalks — into fermentable sugars is a challenge in biofuel development. A mild mixture of acid and ionic solvent may prove quicker and cheaper than the enzymes commonly used.

Ronald Raines and Joseph Binder at the University of Wisconsin, Madison, improved an existing recipe by slowly adding water to a mixture of acid catalyst and ionic liquid as it attacked untreated cellulosic biomass. The process avoids the hazards of working with concentrated acids, and in a few hours produces sugar yields of 70–90%, which enzymes take days to achieve.

However, scaling this up for commercial use could be problematic because of the need to recycle ionic liquids, which are expensive relative to other solvents.

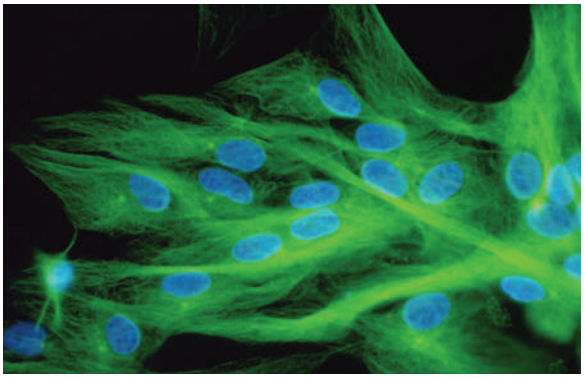
NEUROSCIENCE

Nerve cell talk

Science **327,** 1250–1254 (2010)

Neuroscientists had long believed that neural cells called astrocytes (pictured below) provide structural support and nutrients to the neurons they surround. But a debate has erupted over whether these cells also release signalling molecules that affect neuronal communication — and, if they do, how.

It is thought that an increase in astrocyte calcium-ion concentration might trigger the release of these signalling molecules. Cendra Agulhon at the University of North Carolina at Chapel Hill and her team engineered mice in which they could either stimulate or suppress calcium signalling. They showed that neither activating nor deactivating the calcium rise in astrocytes affected neurotransmission in the brain's hippocampus, suggesting that other mechanisms underlie astrocyte signalling.



A. TOUSSON/PHOTOLIBRARY

BIOMATERIALS

Squishy particles

Angew. Chem. Int. Edn doi:10.1002/anie.200906606 (2010)

Researchers have created tiny microgel particles that can squeeze through pores just one-tenth of their size. This makes them potentially useful as a biomaterial for tasks such as drug delivery — squishy nanoparticles can be easily filtered out by the kidneys, so don't need to be degradable by the body.

Grant Hendrickson and Andrew Lyon at the Georgia Institute of Technology in Atlanta found that 116-nanometre-wide microgel particles, when subject to pressure, can pass through a material with pores of 10 nanometres — similar in diameter to those of the kidneys.

CANCER BIOLOGY

Arsenic activation

Cancer Res. **70,** 1981–1988 (2010)

Arsenic, a carcinogen found at unsafe levels in drinking water in many parts of the world, may cause cancer by increasing the activity of the Hedgehog signalling pathway, which is known to promote cell proliferation.

David Robbins, now at the University of Miami, Florida, and his team have shown that arsenic destabilizes a protein that regulates Hedgehog activity, which may allow the pathway to boost cell growth. Mice exposed to arsenic-laced water had higher Hedgehog activity.

The researchers also analysed 265 human bladder cancer samples along with the arsenic levels in the patients' tap water. Higher arsenic levels correlated with increased tumour expression of a key player in the Hedgehog pathway.

PHYSICS

Photon storage for telecoms

Phys. Rev. Lett. **104,** 080502 (2010)

Photons have a quantum mechanical spin, which can be 'up', 'down' or both. Storing a photon using conventional methods alters this state, destroying its quantum information.

Björn Lauritzen and his colleagues at the University of Geneva in Switzerland have found a way to store infrared photons without changing them. The team shone a weak infrared laser pulse at a crystal containing erbium atoms, which had previously been excited with a different light pulse. As an infrared photon was absorbed by the crystal, its quantum state spread across many erbium atoms.

Using an electric-field gradient, the group triggered the crystal's re-emission of a photon encoding the same information as the incident photon a few hundred nanoseconds later. The efficiency was well below 1%, but the technique could prove useful in quantum-communication devices, the authors say.

CANCER GENOMICS

Melanoma's mutations

Genome Res. doi:10.1101/gr.103697.109 (2010)

Some cancer-associated genetic changes are not easily detected with standard technologies. Researchers have now found mutations linked to melanoma using RNA sequencing.

Levi Garraway of the Dana-Farber Cancer Institute in Boston, Massachusetts, and his colleagues used a high-speed sequencing technology to sequence RNA from ten patients' melanoma samples. They identified 11 abnormal RNAs resulting from genes that had fused in the genome — the first reported gene fusions for melanoma. They also found 12 instances in which two separate genes were transcribed, or 'read', together to produce a mutated RNA, seven of which occurred in more than one sample. In addition, the researchers confirmed previous findings that melanoma has a higher mutation rate than other cancers, reflecting DNA damage caused by exposure to ultraviolet light.

NANOTECHNOLOGY

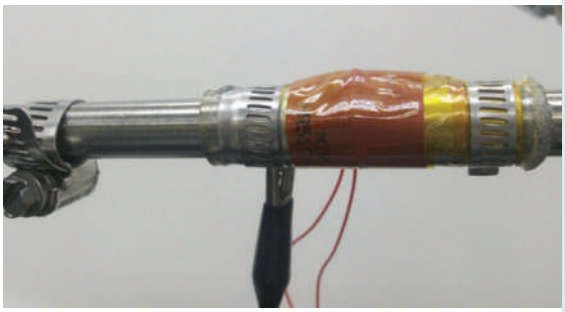
Harvesting heat

Nano Lett. doi:10.1021/nl903267n (2010)

Waste heat from vehicle exhaust pipes and industrial waste streams could offer a sustainable energy source, but current technologies for harvesting thermal energy are costly and inefficient.

Ray Baughman at the University of Texas at Dallas and his colleagues have created a 'thermocell' that can be wrapped around pipes (pictured below). Made of carbon nanotube electrodes, the device is three times as efficient as conventional platinum-based thermocells. The difference in temperature between the two electrodes creates an electrochemical potential difference, which the thermocell uses to generate electricity.

One of the team's prototypes can be attached to hot nuclear-reactor pipes.



AM. CHEM. SOC.

EVOLUTION

Creating cooperation

Evolution doi:10.1111/j.1558-5646.2010.00959.x (2010)

How cooperation evolves between species is much debated. William Harcombe, currently at Harvard University in Cambridge, Massachusetts, used bacteria to observe this evolution in the lab.

He plated out Petri dishes with an *Escherichia coli* mutant unable to produce an essential amino acid, and a *Salmonella* species that consumes waste from *E. coli* and excretes small amounts of the amino acid. In two out of ten dishes, *Salmonella* mutants arose that made large amounts of the amino acid.

When grown with *E. coli* and normal *Salmonella*, the cooperative mutants rapidly increased from 1% of the *Salmonella* population to more than 80%. When the bacteria were grown on different media such that the *Salmonella* no longer relied on the *E. coli* for food, cooperative mutant numbers crashed. This also happened when the bacteria were grown in flasks, suggesting that spatial structure of the bacterial colonies is needed for cooperation to evolve.

JOURNAL CLUB

Markus Reichstein
Max Planck Institute for Biogeochemistry, Jena, Germany

A biogeochemist looks at where all the emitted carbon dioxide is going.

Humanity is currently performing a huge global experiment, emitting increasing amounts of CO_2 into the atmosphere by burning fossil fuels. I find it astonishing that although we scientifically explore other planets, we still don't understand Earth's important carbon cycle.

Corinne Le Quéré at the University of East Anglia in Norwich, UK, and her team have put together the pieces of the contemporary global carbon cycle. They analysed observations and modelling results on fossil-fuel emissions and the terrestrial and ocean carbon cycle, which are the major contributors to the atmospheric carbon budget (C. Le Quéré *et al. Nature Geosci.* **2,** 831–836; 2009).

The bottom line is that humans are emitting more CO_2 than projected in the pessimistic scenarios outlined by the United Nations Intergovernmental Panel on Climate Change. The researchers find that only 40–45% of this CO_2 remains in the atmosphere; the rest is 'cleaned up' by the ocean and land — the 'carbon sink'. It would be interesting to know whether the fraction taken up by oceans and land remains constant, because any alterations will change the global climate–carbon-cycle feedback.

The study also indicates that we are moving towards saturation of the carbon sink, but the uncertainties are large. Many carbon pools and processes, particularly those below ground in the soil, are not well understood and are hardly accounted for in carbon-cycle models (P. Ciais *Nature* **462,** 393; 2009).

The message from Le Quéré *et al.* is that more observations are needed, that data should be fully integrated with models, and that these efforts must be more targeted and coordinated if we are to understand what is going on with the Earth system in our huge experiment.

Discuss this paper at **http://blogs.nature.com/nature/journalclub**