Complex systems

Predicting the unpredictable

Phys. Rev. Lett. **92,** 074105 (2004)

Some processes seem impossible to predict without actually letting them unfold and seeing what happens — they are 'computationally irreducible'. That appears to undermine the entire mission of science, which aims to understand and predict rather than merely to mimic. But all is not lost, say Navot Israeli and Nigel Goldenfeld. They show that at least some such processes can be rendered predictable by coarse-graining — in essence, by not worrying too much about the fine details.

They have looked at computationally irreducible cellular automata (CA). These are systems composed of many components distributed on a lattice, which switch between several possible states according to local rules governing the interactions between cells. CA are used to model many complex dynamical processes, from ecosystem evolution to material fracture and biological growth. Stephen Wolfram has proposed that many of the CA that evolve in complex patterns are computationally irreducible, and so are inherently unpredictable. But Israeli and Goldenfeld show that by sacrificing some level of detail (as real experiments must always do), most such CA can be reduced to computationally reducible ones. A theoretical model of the systems' behaviour then becomes feasible, introducing some predictability of their future evolution. **Philip Ball**

Apoptosis

Danse macabre

Neuron **41,** 535–547 (2004)

During normal brain development many neurons die — one way or another, these cells fall short of the high standards required. The neurons die autonomously, in an orderly manner, and their remains are removed instantly. Or so the theory went, until José Luis Marín-Teva and colleagues recently provided evidence that microglia cells, once thought to be innocent corpse collectors, may actually deliver the final blow to cells on death row.

Microglia engulf cells, moving about in the central nervous system and removing waste, including other cells. Specific signals on dying cells can flag them down. Usually, an engulfing cell binds the dying cell, and — as if embracing it — extends its membranes around the corpse and eats it.

But studies in the nematode worm had already indicated that not all engulfing cells are as innocent as they seem. When Marín-Teva *et al.* selectively removed microglia from slice preparations of postnatal mouse cerebella, numerous Purkinje neurons that would otherwise have died within 24 hours *in vitro* were reprieved. This suggested that microglia actually help the Purkinje cells to die. The authors also propose that the release of superoxide ions, which are generated during typical respiratory bursts in the engulfing cells, may cause the Purkinje cells to die 'in the arms' of microglia. **Marie-Thérèse Heemels**

Palaeobiology

Small brainer

Brain Behav. Evol. **63,** 125–140 (2004)

Mammals have tended to acquire bigger brains during their evolution. But Meike Köhler and Salvador Moyà-Solà find that this was apparently not the case for a goat-like animal, *Myotragus*, which lived in Majorca from about 5 million years ago.

From measurements of fossils, they show that the *Myotragus* brain was much smaller than that of living ruminants of the same weight (see picture), whereas the brain size of a close relative that lived on the French mainland matched that of modern-day species.

Isolated effects? Bottom, the skull and brain size of a living ruminant of the same body size as (top) the Majorcan *Myotragus*.

Köhler and Moyà-Solà invoke geographical isolation as an explanation. According to the fossil evidence, the ancestor of *Myotragus* settled in Majorca at a time when the Mediterranean Sea had largely dried out and islands were joined to the mainland. These ancestral goats would have been exposed to an array of predators and had a variety of food resources.

When the sea level rose, however, Majorca was left without large predators. The authors argue that, given the need to conserve energy, of which the brain is a large consumer, and the reduced requirement for fast-acting senses and motor responses to see off predators, a smaller brain was a predictable evolutionary upshot. **Lucy Odling-Smee**

Astronomy

Beryllium clocks on

Astrophys. J. **602,** 528–542 (2004)

Meteorites that formed roughly 4.5 billion years ago carry clues about the birth of our Solar System. They once contained radioactive beryllium-10 (^{10}Be), which is created when high-energy particles knock protons and neutrons out of carbon, nitrogen or oxygen atoms. Unlike other elements found in the same meteorites, ^{10}Be is not formed in the fusion reactions of stars or supernovae.

The ^{10}Be content of meteorites has led to speculation that radiation from the proto-Sun was the driving force in the element's synthesis. If this were the case, other elements (such as ^{26}Al) could have a similar origin, rather than being injected into the early solar nebula by a supernova explosion (as proposed in a leading theory on the genesis of the Solar System).

By modelling the flux of energetic particles in the early solar nebula, S. J. Desch *et al.* have calculated that galactic cosmic rays alone could be enough to explain the high levels of ^{10}Be, without having to invoke solar radiation. This would mean that the ratio of ^{10}Be to the stable isotope, ^{9}Be, would initially have been the same for all solid material in the solar nebula. Any variation in this ratio could therefore provide a 'beryllium chronometer' to date extreme events in the early Solar System. **Mark Peplow**

Neuroscience

Stem cells enjoy long life

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Like many other cell types, human neural stem cells only divide a finite number of times in culture. This cellular ageing has generally been put down to telomere erosion — the tips of chromosomes become progressively shorter with every round of DNA replication until the cells are no longer viable.

Now Ana Villa *et al.* describe the characteristics of a human neural stem-cell line that remains youthful. The cells, which have been growing for four years, were immortalized by the addition of the growth-promoting gene v-*myc*. The gene appears to counter the effects of progressive telomere shortening, so that although the telomeres of the cells were short, they were stable. v-*myc* also boosted levels of telomerase, an enzyme that helps keep telomeres long. Importantly, another stem-cell-like quality — the ability to generate mature cell types — was retained, and as the stem cells developed into neurons, v-*myc* expression and telomerase activity decreased.

The study provides a controlled method for the long-term culture of human neural stem cells. **Helen R. Pilcher**