<< Dog Coats Shed Genetic Secrets

The coats of domestic dogs show great variation—long, short, straight, wavy, curly, wiry, or smooth. To investigate how this variation arises, **Cadieu *et al.*** (p. 150, published online 27 August) performed genome-wide association studies on 80 different dog breeds. The coat phenotype could be dissected into three simple traits of length, curl, and growth pattern or texture with each trait controlled by one major gene, *FGF5* (fibroblast growth factor-5), *KRT71* (keratin-71), and *RSPO2* (R-spondin-2), respectively. In combination, variants in these three genes alone account for the vast majority of the coat phenotypes in purebred dogs in the United States. Thus, a small number of simply inherited traits can be remixed to create extraordinary phenotypic variation.

Ultimate Simulator

Many body problems are difficult to model analytically and are often so complex that they cannot be simulated accurately on a classical computer. Because quantum systems can be inherently correlated, it has been proposed that such systems could be used to simulate other complex problems. **Buluta and Nori** (p. 108) review the progress being made toward realizing quantum simulators, describing some of the implementations and potential applications of using such controlled quantum systems as simulator tools.

Quiet, Please

One approach for building quantum computers is based on superconductors with appropriately designed components to control the pairs of charges flowing through the circuits. However, at the single-electron level, required quantum noise—generated by quantum fluctuations and throwing offset charges into the device—presents a real problem in manipulating the delicate quantum states of the qubits. **Manucharyan *et al.*** (p. 113) present a clever piece of quantum circuit engineering that can suppress the effect of the quantum noise and allow the quantum circuit to operate without disturbance.

Unwelcome Dominance

Stratospheric ozone is depleted by many different chemicals; most prominently, chlorofluorocarbons (CFCs) responsible for causing the Antarctic ozone hole. Nitrous oxide is also an ozone-depleting substance that has natural sources in addition to anthropogenic ones. Moreover, unlike CFCs, its use and emission are not regulated by the Montreal Protocol, which has helped to reverse the rate of growth of the ozone hole. Surprisingly, **Ravishankara *et al.*** (p. 123, published online 27 August; see the Perspective by **Wuebbles**) now show that nitrous oxide is the single greatest ozone-depleting substance that, if its emissions are not controlled, is expected to remain the dominant ozone-depleting substance throughout the 21st century. Reducing nitrous oxide emissions would thus enhance the rate of recovery of the ozone hole and reduce the anthropogenic forcing of climate.

Cleaning Solid Oxide Fuel Cells

Solid oxide fuel cells, which operate between 500° and 1000°C, transport oxygen through a ceramic material. At these temperatures, metals that catalyze hydrocarbon reforming reactions can also be incorporated so that conventional fuels such as methane can power the cell. One problem, however, has been rapid deactivation by sulfur impurities and carbon buildup. **Yang *et al.*** (p. 126; see the Perspective by **Selman**) report that doping of a barium zirconate-cerate with the rare-earths Y and Yb creates a material that transports both protons and oxygen ions at 750°C. This material, when used with nickel at the fuel cell anode, resists deactivation even when traces of hydrogen sulfide are present, apparently through enhanced ability to supply or remove water during surface reactions.

Stemming Stem Cell Displacement

Adult stem cell niches can contain multiple types of stem cells with coordinated regulation, but the mechanisms for these interactions are largely unknown. In the fruit fly testis, Janus kinase-signal transducer and activator of transcription (JAK-STAT) signaling is needed for the maintenance of the resident germline and somatic stem cells. The signaling inhibitor SOCS36E is a known JAK-STAT target. **Issigonis *et al.*** (p. 153) now show that SOCS36E functions in the maintenance of the germline stem cell via suppression of JAK-STAT signaling, specifically in the somatic stem cells. This prevents the somatic stem cells from displacing neighboring germline stem cells in an integrin-dependent manner, allowing both stem cell populations to occupy the niche.

Nanotubes to Order

To exploit carbon nanotubes fully in electronic applications, one needs to be able to separate or synthesize either all semiconducting or all metallic tubes. However, unbiased synthesis conditions produce a mixture containing two-thirds semiconducting tubes and one-third metallic tubes. **Harutyunyan *et al.*** (p. 116) show that altering the carrier gas and temperature, in combination with oxidative and reductive species during the synthesis process modifies the catalyst particles during synthesis, which leads to the selective growth of metallic single-walled carbon nanotubes. Thus, the shape and morphology of the catalyst seeds can be tuned to grow carbon nanotubes of a specific chirality.

Algal Rebound

The extinction at the Cretaceous-Paleogene boundary 65.5 million years ago represented a sudden and dramatic disruption of global

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ecosystems. **Sepúlveda *et al.*** (p. 129) now show, however, that algae recovered rapidly and that photosynthesis and primary production thus also recovered. The authors tracked algal productivity in the thick boundary layer in Denmark through a series of diagnostic biomarkers and isotopes. Algal productivity dropped abruptly during the extinction event but then recovered within the boundary layer, perhaps as quickly as within 50 years of the impact.

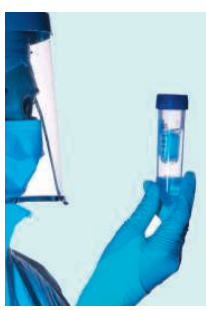
Extra Ancient Amber

Amber is fossilized tree resin, typically produced by trees in response to an injury. Most amber is Mesozoic or Cenozoic in age (dating back as far as 250 million years ago), and the most common class, produced primarily by angiosperms, is formed from distinct complex polyterpenoids. **Bray and Anderson** (p. 132; see the Perspective by **Grimaldi**) now find that amber from the Carboniferous, dating to more than 300 million years ago, long before the evolution of angiosperms, has a similar chemistry. Thus, the biosynthetic mechanism for producing complex ambers evolved long before the appearance of flowering plants.

Mosquito Vector Intervention

Mosquitoes are responsible for causing the infection of an estimated 120 million people with the nematode worms that block the lymph system and result in the gross pathology of elephantiasis and other filariases. **Kambris *et al.*** (p. 134) infected vector mosquitoes with a bacterium (*Wolbachia*), which impaired the insects' ability to act as filaria vectors and possibly would affect transmission of other pathogens, too. The infected mosquitoes were less susceptible to the worms owing to chronic up-regulation of mosquito immune responses. Immune activation bears a physiological cost for the mosquitoes, which may explain earlier observations of curtailed life spans of *Wolbachia*-infected mosquitoes.

Cultivating Farmers



Were the ancestors of modern Europeans the local hunter-gatherers who assimilated farming practices from neighboring cultures, or were they farmers who migrated from the Near East in the early Neolithic? By analyzing ancient hunter-gatherer skeletal DNA from 2300 to 13,400 B.C.E. **Bramanti *et al.*** (p. 137, published online 3 September) investigated the genetic relationship of European Ice Age hunter-gatherers, the first farmers of Europe, and modern Europeans. The results reject the hypothesis of direct continuity between hunter-gatherers and early farmers and between hunter-gatherers and modern Europeans. Major parts of central and northern Europe were colonized by incoming farmers 7500 years ago, who were not descended from the resident hunter-gatherers. Thus, migration rather than cultural diffusion was the driver of farming communities in Europe.

Mimicking Caloric Restriction

The extended life span and resistance to age-related diseases in animals exposed to caloric restriction has focused attention on the biochemical mechanisms that produce these effects. **Selman *et al.*** (p. 140; see the Perspective by **Kaeberlein and Kapahi**) explored the role of the mammalian ribosomal protein S6 kinase 1 (S6K1), which regulates protein translation and cellular energy metabolism. Female knockout mice lacking expression of S6K1 showed characteristics of animals exposed to caloric restriction, including improved health and increased longevity. The beneficial effects included reduced fat mass in spite of increased food intake. Thus, inhibition of signaling pathways activated by S6K1 might prove beneficial in protecting against age-related disease.

In and Out

For over 40 years, Ca^{2+}/H^{+} antiport has been reported across plasma cell membranes and mitochondrial inner membranes, but the molecules responsible for the exchange have not been known. **Jiang *et al.*** (p. 144; see the Perspective by **Demaurex and Poburko**) conducted a genome-wide RNA interference screen in *Drosophila* and identified a nuclear-encoded mitochondrial protein, Letm1 (leucine zipper EF–hand-containing transmembrane protein 1), as a mitochondrial Ca^{2+}/H^{+} antiporter critical for mitochondrial Ca^{2+} uptake. Furthermore, the gene's mammalian homolog is deleted in Wolf-Hirschhorn syndrome, a disorder characterized by mental retardation, microcephaly, seizures, hypotonia, and cleft lip or palate.

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