In This Issue

Penetration of bacterial biofilms in skin by ionic liquids

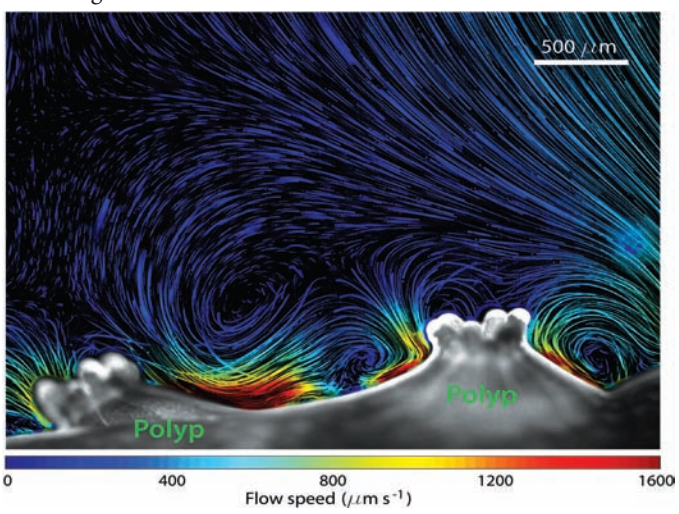
Biofilms that protect bacteria causing skin infections pose an antibiotic-resistant barrier to treatment. To penetrate biofilm layers, as well as stratum corneum skin layers, which also hinder drug delivery, Michael Zakrewsky et al. (pp. 13313–13318) synthesized and evaluated ionic liquids for efficacy in neutralizing biofilms and delivering antibiotics beneath the stratum corneum, and for cytotoxicity and skin irritation. Ionic liquids, composed of an organic cation and an organic or inorganic anion, can be paired with certain solvents to enhance penetration of skin layers and biofilms. The authors assessed biofilm survival of the pathogens *Pseudomonas aeruginosa* and *Salmonella enterica* against 12 ionic liquid formulations, most of which decreased biofilm survival by at least 90%. Additional tests of skin toxicity and irritation found that an ionic liquid composed of choline-geranate exhibited antimicrobial activity, minimal toxicity, and effective enhancement of antibiotic delivery. Model wound tissue infected with a *P. aeruginosa* biofilm revealed that an antibiotic alone decreased bacterial viability by only 20% after two hours, whereas the antibiotic paired with choline-geranate achieved a 98% reduction in bacterial viability, also within 2 hours. The penetration-enhancing properties of ionic liquids may offer additional treatment options for skin diseases, according to the authors. — P.G.

Pseudogene activity and evolution

The genome of every organism contains pseudogenes, largely nonfunctional versions of genes, but some pseudogenes are thought to help regulate gene expression. Pseudogenes may also provide insight into genome evolution because they mutate under lower selective constraints than protein-coding genes. Cristina Sisu et al. (pp. 13361–13366) analyzed genome data and curated pseudogene annotations for human, worm (*Caenorhabidis elegans*), and fruit fly (*Drosophila melanogaster*) genomes. The authors found that the pseudogene complement within the human genome is dominated by processed pseudogenes, copies of mRNA inserted into the genome, and that a burst of pseudogenes originated around the time primates first evolved. In contrast, the worm and fly pseudogene complements contain primarily duplicated pseudogenes. According to the authors, individual phyla may contain characteristic pseudogene complements that reveal genome-shaping evolutionary processes. Further, approximately 75% of pseudogenes across the three phyla displayed some degree of biochemical activity and possessed gene-like characteristics, suggesting that some pseudogenes may have undiscovered biological functions; approximately 15% of the pseudogenes in each of the three phyla are transcribed, revealing a potential similarity in pseudogene activity across phyla, according to the authors. — J.P.J.

Active transport of oxygen and nutrients in reef corals

Corals must continuously exchange oxygen and nutrients with their environment to grow and form reefs. This exchange is limited by molecular diffusion through a boundary layer on the coral surface, and corals depend entirely on ambient water flow to alleviate the limitation. Orr Shapiro et al. (pp. 13391–13396) demonstrated that corals can actively enhance mass transport by beating hair-like appendages called cilia to produce vortical flows. The authors used video microscopy to show multiple species of reef-building corals producing fast vortical flows that extended a few millimeters from the coral surface. The oxygen distribution profile next to the coral surface, measured with microelectrodes, changed significantly when ciliary beating was artificially stopped. A mathematical model indicated that ciliary flows increase mass transport several fold, compared with mass transport in the absence of such flows, especially under conditions of low ambient flow. The results suggest that corals may enhance the exchange of oxygen and nutrients by actively stirring nearby water, potentially conferring a fitness advantage in times or locations of weak ambient flow, according to the authors. — L.G.



Vortical flows around the surface of a coral.

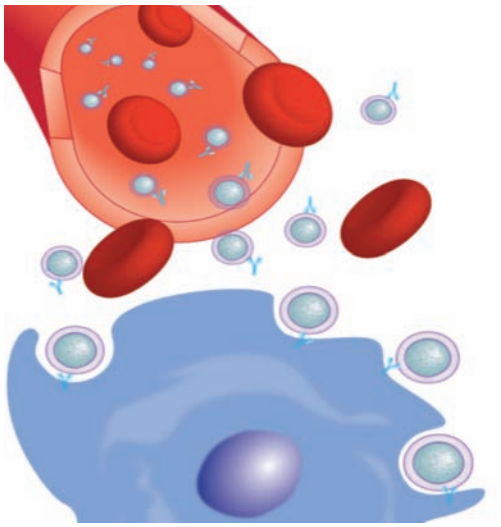
Potential biomarker for posttraumatic stress disorder

Only some individuals who experience trauma develop posttraumatic stress disorder (PTSD), highlighting the value of biomarkers to distinguish vulnerable from resilient individuals. To find such biomarkers, Nikolaos Daskalakis et al. (pp. 13529–13534) exposed male and female rats to a predator scent and classified the rodents as vulnerable or resilient based on subsequent arousal and

anxiety behavior. The authors also analyzed patterns of gene expression in the blood and in stress-responsive brain regions called the amygdala and hippocampus. About 1 week after exposure to well-soiled cat litter for 10 minutes, vulnerable rats displayed higher anxiety and stronger startle responses to loud noise, compared with resilient rats. The glucocorticoid receptor signaling pathway was associated with individual differences in behavioral responses across both sexes and all tissues at the most stringent statistical threshold. Moreover, rats treated with corticosterone, a hormone that activates the glucocorticoid receptor, 1 hour after exposure to the predator scent showed lower arousal and anxiety 1 week later, compared with untreated, trauma-exposed rats. According to the authors, the findings suggest that low glucocorticoid receptor signaling in the blood might be a potential biomarker for identifying individuals at risk of developing PTSD. — J.W.

Nanoparticle decoy therapies and autoimmune disorders

Type II immune hypersensitivities are common autoimmune diseases triggered when antibodies bind to molecules on cell surfaces, activating an immune response that destroys the cells. Current treatments that involve broad immune system suppression are not effective in all patients and can cause side effects, including infection. To address the need for tailored therapies, Jonathan Copp et al. (pp. 13481–13486) tested whether nanoparticles could act as decoys to lure potentially destructive IgG antibodies away from healthy red blood cells in a mouse model of antibody-induced anemia. The authors coated polymer-based nanoparticles with red blood cell membrane, consisting of molecules that are targeted by anemia-causing antibodies. Compared with nonmembrane-coated nanoparticles, the membrane-cloaked nanoparticles induced up to 95% less antibody binding to healthy red blood cells. Moreover, mice injected with antibodies to induce anemia followed by injection with membrane-cloaked nanoparticles showed improvements in anemia-related parameters, including red blood cell count, compared with a control group of mice injected with antibodies and nonmembrane-coated nanoparticles. According to the authors, such nanoparticle therapeutics might help treat a range of antibody-mediated autoimmune diseases while minimizing the risk of side effects associated with traditional drug-based therapies. — J.W.



Nanoparticle decoys protect red blood cells from destruction by macrophages.

Investigating word-order phylogeny

The order of subject, verb, and object in a sentence is a major characteristic of a given language, yet the historical evolution of word order syntax is largely unknown. To provide a context for studying historical word order evolution, Luke Maurits and Thomas Griffiths (pp. 13576–13581) employed Bayesian phylogenetic methods to investigate ancestral word orders. The authors evaluated 671 languages from seven language families, classified according to their subject (S), verb (V), and object (O) order. Using statistical methods, the authors calculated the probabilities of languages transitioning from one word order to another and reconstructed the likely original word order of each language family. The authors found that languages are more likely to transition from S-O-V to S-V-O than the reverse, and that V-S-O transitions to S-V-O are more likely than V-S-O to S-O-V. If all seven language families arose from a common ancestor, the authors suggest that the ancestral language likely exhibited an S-O-V word order. The results suggest that although confidence in inferences of ancestral word order from modern observations is limited, language phylogenies may help refine language histories, according to the authors. — P.G.