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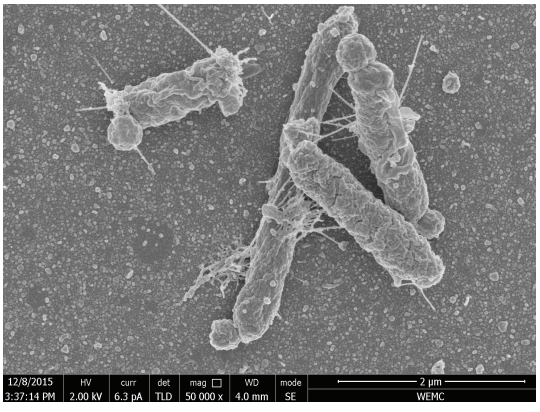
Infectious disease transmission on airplanes

More than a dozen cases of transmission of infectious diseases on board airline flights have been documented, and air travel can potentially facilitate the rapid spread of emerging infections. Despite the public health concerns surrounding inflight disease transmission, the actual risks of such transmission are unknown. Vicki Hertzberg et al. (pp. 3623–3627) documented movement patterns of passengers and crew in the economy class cabins of single-aisle aircraft during 10 transcontinental US flights. Respiratory diseases such as influenza are transmitted primarily over short distances through respiratory droplets. Movement of passengers and crew may therefore facilitate disease transmission by bringing more people into close contact with an infected individual. The authors used the data on passenger and crew movements to model influenza transmission during a flight, using the example of an infected person seated midcabin. Passengers seated within one row and within two seats laterally of the infected passenger had an 80% or greater probability of becoming infected, according to the model. For all other passengers, the probability of infection was less than 3%. An infectious crew member could infect an average of 4.6 passengers per flight, according to the authors. — B.D.

Flu transmission on airplanes. Image courtesy of iStock.com/supershabashnyi.

Viable bacterium with hybrid lipid membrane

Archaeal and bacterial cell membranes are largely composed of glycerol-1-phosphate ester lipids and glycerol-3-phosphate ester lipids, respectively, distinguishing the two groups of organisms. One theory posits that the "lipid divide" holds clues to the evolutionary time when the two groups diverged from the last universal common ancestor, an unidentified protocell whose membrane was comprised of a relatively unstable mixture of both types of lipids. Antonella Caforio et al. (pp. 3704–3709) used lipid engineering to construct a stable and viable bacterial cell with a membrane composed of both bacterial and archaeal lipids. The technique introduces the archaeal ether lipid biosynthetic pathway into *Escherichia coli* to generate a heterochiral mixed membrane, in which the complete bacterial phosphatidylglycerol pool is replaced by archaetidylglycerol, representing up to 30% of the total membrane phospholipids. More importantly, the archaeal lipids are not toxic to bacterial cells and may instead provide fitness benefits to bacteria. The results contradict theories that the inherent instability of mixed membranes drove the lipid divide. In addition, the technique could be used to generate specialized *E. coli* strains for industrial purposes, according to the authors. — T.J.



Scanning electron micrograph of engineered *E. coli*.

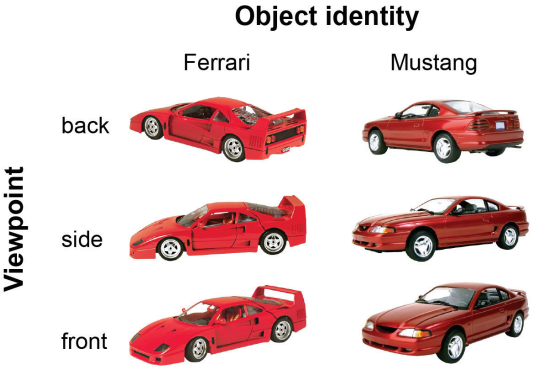
Biochemical insights may help unravel bark beetle outbreaks

Mountain pine beetles (*Dendroctonus ponderosae*) have infested more than 25 million hectares of western North American pine forests, posing an epidemic threat to forest ecosystems. Female beetles burrow into the barks of pine trees to mate and lay eggs, and developing larvae gradually gut the trees. Previous studies have found that when female beetles attack a new tree, they convert the pine defense compound α-pinene into the aggregation pheromone *trans*-verbenol, which serves as a cue for the colonization of pine trees. Christine Chiu et al. (pp. 3652–3657) report that male and female beetles accumulate variants of the aggregation pheromone—verbenyl oleate and verbenyl palmitate—during their larval and pupal stages. Whereas females retain the variants when they emerge from brood trees, males lose them as they mature. Exposure to juvenile hormone III triggered a decrease in verbenyl oleate and concomitant release of *trans*-verbenol from adult females but not from adult males; in contrast, both males and females released *trans*-verbenol when exposed to α-pinene. The ability of females to produce the aggregation pheromone in the absence of α-pinene suggests that female beetles may harbor a previously undiscovered metabolic reserve of the pheromone that functions as a detoxification system coopted for pine colonization. According to the authors, uncovering the biochemical mechanisms of pheromone release in mountain pine beetles may aid efforts to improve the prediction of outbreaks. — P.N.

Beetle-infested pine trees in Rocky Mountain National Park. Image courtesy of Wikimedia Commons/NPS Climate Change Response.

Single neurons multiply signals for object recognition

Object recognition in the brain is inherently challenging because images on the retina are a mixture of two signals. The first signal contains the object's identity, which remains constant regardless of the distance between the observer and the object. The second signal contains the specific attributes of observation, such as the angle, size, or position of the object. Precisely how the different signals are combined in high-level visual areas in the brain is unclear. N. Apurva Ratan Murty and S. P. Arun (pp. E3276–E3285) recorded signals from single neurons in the monkey inferior temporal (IT) cortex and found that neural responses are more accurately explained as the product rather than the sum of tuning for object identity and image attributes. The authors report that multiplying rather than adding signals allows either signal to be more efficiently decoded. However, when the authors tested objects created by combining multiple parts, they found that signals from the different parts were combined additively rather than multiplicatively. Signals that require separate decoding—such as object identity and image attributes—are combined multiplicatively in IT neurons, whereas signals that require integration—such as parts of an object—are combined additively, according to the authors. — S.R.



Single neurons multiply signals for object identity and image attributes to efficiently decode both signals. Copyright 2018 S.P. Arun and its licensors. All rights reserved.

Spread of agriculture into Central Anatolia

Details of the expansion of agriculture beyond the Fertile Crescent of Southwest Asia, where agriculture originated in the 10th and 9th millennia BC, are unclear. Douglas Baird et al. (pp. E3077–E3086) report archaeological evidence of agriculture from the 10th-millennium and 9th-millennium sites of Pınarbaşı and Boncuklu on the Central Anatolian plateau in Turkey. At Boncuklu, the presence of macrofossils and phytoliths of wheat chaff, along with seeds of agricultural weeds commonly found in early farming sites, suggests the cultivation of crops. The nitrogen isotope compositions of sheep and goat remains indicate a dietary signature that suggests small-scale experimentation with animal herding. By contrast, Pınarbaşı exhibited none of the evidence of crop cultivation found at Boncuklu. Analysis of stone tools

Human burial from a Neolithic house at Boncuklu, Turkey.

and ancient DNA from both sites suggests that the inhabitants represented an indigenous population, rather than migrants from agricultural communities to the south and east. According to the authors, indigenous people likely adopted cultivation and herding on a small scale, probably not for economic reasons, whereas communities such as Pınarbaşı resisted the adoption of agriculture altogether. Thus, the authors suggest, the spread of agriculture was not uniform throughout the region. — B.D.

Evolution of complex human societies

Human societies have increased in complexity since the Holocene Epoch began more than 10,000 years ago. Two key traits of complex societies are intensive resource use and sociopolitical hierarchy. The causal relationship between the two traits is a subject of debate, with "materialist" theories proposing that resource intensification drives the development of hierarchy and "cultural determinist" theories proposing the reverse relationship. Oliver Sheehan et al. (pp. 3628–3633) performed a phylogenetic analysis of the evolution of social stratification, political complexity, and a form of agriculture termed landesque capital intensive agriculture, which involves permanent changes to the landscape, in 155 Austronesian societies. Across the societies, intensive agriculture was 4–6 times as likely to emerge in the presence of high political complexity or medium-high to high social stratification, compared with the absence of these traits, thereby challenging the materialist view. However, high social stratification was more likely to emerge in the presence rather than the absence of intensive agriculture, contradicting a cultural determinist view. According to the authors, the results support a reciprocal relationship between intensive agriculture and social stratification, with each facilitating development of the other to a comparable extent, and emphasize the importance of social and political factors in driving the evolution of complex societies. — B.D.

Terraced rice fields in the Philippines. Image courtesy of Flickr/Shubert Ciencia.