IN BRIEF

MICROBIOME

The gut microbiome and mental health

The emerging concept of bidirectional signalling between the gut microbiota and the brain is an active field of research. Studies indicated that the gut microbiota can modulate the gut–brain axis via multiple mechanisms, including alterations in microbial composition or production of microbial neuroactive metabolites. Thus far, links have mostly been reported in animal models, and human studies are limited. Raes and colleagues now report a large population cohort study in which they correlate microbial taxa with quality of life and the incidence of depression. Butyrate-producing *Faecalibacterium* and *Coprococcus* spp. were associated with higher quality of life indicators. Moreover, *Coprococcus* spp. and *Dialister* spp. were shown to be depleted in participants with depression. Finally, the potential of microbial synthesis of a dopamine metabolite positively correlated with mental quality of life, possibly linking the neuroactive metabolic capacity of the gut microbiome with mental health.

ORIGINAL ARTICLE Valles-Colomer, M. et al. The neuroactive potential of the human gut microbiota in quality of life and depression. *Nat. Microbiol.* https://doi.org/10.1038/s41564-018-0337-x (2019)

FURTHER READING Johnson, K. V.-A. & Foster, K. R. Why does the microbiome affect behaviour? *Nat. Rev. Microbiol.* **16**, 647–655 (2018)

VIRAL INFECTION

Measuring the HIV-1 reservoir

Efforts to cure HIV-1 infections are hampered by the latent viral reservoir, which can lead to viral rebound in infected individuals following discontinuation of antiretroviral therapy. The development of strategies to eliminate the persistent HIV-1 reservoir is challenging, partly owing to a lack of accurate and scalable reservoir assays, with current assays possibly underestimating the reservoir size. Siliciano and colleagues report the development of a method to detect infected cells and to distinguish intact proviruses (defined by the authors as proviruses that lack overt fatal genetic defects such as large deletions and hypermutations) from the vast excess of defective proviruses. Moreover, the assay revealed differential dynamics of intact and defective proviruses, emphasizing the importance of direct measurement of intact proviruses.

ORIGINAL ARTICLE Bruner, K. M., Wang, Z. et al. A quantitative approach for measuring the reservoir of latent HIV-1 proviruses. *Nature* https://doi.org/10.1038/s41586-019-0898-8 (2019)

BACTERIAL PHYSIOLOGY

Moving together

Bacteria form complex communities in which they interact, and interspecies interactions can lead to the emergence of new traits. Silby and colleagues co-cultured two distantly related soil bacteria, *Pseudomonas fluorescens* Pf0-1 and *Pedobacter* sp. V48, and found that a mixed colony spreads across a hard agar surface, whereas either species was immotile in monoculture. This suggests that the presence of the two species leads to changes in behaviour. The author termed this mode of co-migration interspecies social spreading. They showed that physical association of both species is required for interspecies social spreading and that both species remain associated throughout the spreading colony. Finally, interspecies social spreading was observed on low-nutrient media supplemented with sodium chloride, whereas spreading was reduced or absent on low-nutrient media without salt supplementation or on rich media, respectively.

ORIGINAL ARTICLE McCully, L. M. et al. Interspecies social spreading: interaction between two sessile soil bacteria leads to emergence of surface motility. *mSphere* https://doi.org/10.1128/mSphere.00696-18 (2019)

BACTERIAL PATHOGENESIS

Listeria pioneers

As an intracellular pathogen, *Listeria monocytogenes* uses host cell protrusions to spread between cells, for example in the intestinal epithelium during food-borne infection. The underlying molecular mechanisms, such as the formation of host actin 'comet tails' that propel the bacteria, have been studied in detail. However, little is known about the dynamics of *L. monocytogenes* populations during tissue spread. A new study that combines video microscopy and computational modelling shows that rare pioneer bacteria move beyond the original infectious focus, which might help maintain persistent infection.

To observe the dynamics of *L. monocytogenes* spread, the authors infected monolayers of a canine kidney epithelial cell line with a bacterial strain that expresses red fluorescent protein when inside the host cytosol and treated the cultures with gentamicin, which is an antibiotic that cannot penetrate the host cells. This experimental setup enables tracking of intracellular bacteria as they move between cells. Because invasion of host cells is rare, most infections likely started with a single bacterium. Despite the clonal nature of the infectious foci, the bacterial cells showed heterogeneous behaviour. A few bacteria spread much further beyond the initial roughly circular focus.

Indeed, when the authors ran computer simulations, an infection arising from a single cell resulted in roughly circular foci if the cells carried out random walks. Even if the model took into account some persistence of directional movement, which could occur due to the comet tails, and the influence of cell boundaries, from which bacteria could 'bounce off', the simulated foci were more circular than the experimentally observed ones.

PARASITE PHYSIOLOGY

Signalling to leave

Egress from infected cells is essential for the dissemination of the intracellular parasite *Toxoplasma gondii*. Egress can occur in response to environmental stressors or in the absence of extrinsic signals; after five or six cycles of asexual multiplication, *T. gondii* egresses in a coordinated manner, which is regulated by the exocytosis of secretory organelles called micronemes. Now, Soldati-Favre and colleagues show that phosphatidic acid, which is produced during infection, acts as an intrinsic signal that governs natural egress of the parasite through a guanylate cyclase signalling platform.

As acidification of the parasitophorous vacuole occurs during egress and because phosphatidic acid is an important mediator of microneme exocytosis, the authors hypothesized that a putative secreted diacylglycerol kinase 2 (DGK2; an enzyme that catalyses the synthesis of phosphatidic acid) that is encoded by *T. gondii* has a role in egress. They observed that DGK2 is constitutively secreted and accumulates in the parasitophorous vacuole, and that knockdown or knockout of *DGK2* causes a major defect in natural egress — parasites are trapped within enlarged vacuoles that eventually mechanically rupture.

The diacylglycerol (DAG) kinase activity of DGK2 was confirmed, and the authors speculated that extracellular phosphatidic acid (ePA) accumulates in the outer leaflet of the *T. gondii* plasma membrane, facilitating signal transduction that leads to microneme exocytosis. *T. gondii* expresses an atypical transmembrane guanylate cyclase (a protein that integrates extracellular signals to produce the secondary