

The three neurons stretched across both brain hemispheres, and one of the three wrapped around the organ's circumference like a "crown of thorns", Koch says. He adds that he has never seen neurons extend so far across brain regions.

### WELL CONNECTED

The mouse body contains other long neurons, such as a nerve projection in the leg and neurons from the brainstem that thread through the brain to release signalling molecules. But these claustrum neurons seem to connect to most or all of the outer parts of the brain that take in sensory information and drive behaviour.

Koch sees this as evidence that the claustrum could be coordinating inputs and outputs across the brain to create consciousness. Brain scans have shown that the human claustrum is one of the most densely connected areas of the brain (C. M. Torgerson *et al. Hum. Brain Mapp.* **36**, 827–838; 2015), but those images do not show the path of individual neurons.

The claustrum is a good brain region in which to test the new technique because it has been extensively studied in mice and consists of only a few cell types, says James Eberwine, a pharmacologist at the University of Pennsylvania in Philadelphia.

### TAKING STOCK

"It's quite admirable," Rafael Yuste, a neurobiologist at Columbia University in New York City, says of the method. He doesn't think that the existence of neurons encircling the brain definitively proves that the claustrum is involved in consciousness.

But he says that the technique will be helpful for censuses that identify different cell types in the brain, which many think will be crucial for understanding how the organ functions. "It's like trying to decipher language if we don't understand what the alphabet is," he says.

Yuste and Eberwine would like to see 3D reconstructions of individual neurons compared with analyses of the genes expressed in those neurons. This might offer clues to the type and function of each cell.

It is also unclear whether these gene-expression patterns correlate with the shape of the neuron, Yuste says. Imaging techniques such as that developed by the Allen Institute should help researchers to work out whether such a correlation exists.

Koch plans to continue mapping neurons emanating from the claustrum, although the technique is too expensive to be used to reconstruct all of these neurons on a large scale. He would like to know whether all the region's neurons extend throughout the brain, or whether each neuron is unique, projecting to a slightly different area. ■

### PUBLIC HEALTH

# Drug-resistant bacteria ranked

World Health Organization hopes list will drive development of much-needed antibiotics.

BY CASSANDRA WILLYARD

The World Health Organization (WHO) has for the first time released a list of the drug-resistant bacteria that pose the greatest threat to human health and for which new antibiotics are desperately needed.

The agency's aim in listing these 'priority pathogens' is to steer funds towards development of the most crucial antimicrobials. Researchers say the list is a useful reminder of the danger of bacteria that are becoming resistant to antibiotics.

The list ranks 12 bacteria or bacterial families and is topped by carbapenem-resistant *Acinetobacter baumannii*, an obscure bacterium that causes a severe infection for which almost no treatments exist, and that mainly affects people who are already critically ill. (It is resistant to carbapenem antibiotics, 'last resort' drugs used only when all other treatments have failed.) The ranking also includes several other multidrug-resistant pathogens that cause infections in hospitals, as well as better-known bacteria, such as those responsible for pneumonia and gonorrhoea (see 'Threat list').

Antibiotic resistance kills an estimated 700,000 people each year worldwide, and some experts predict that number could rise to 10 million by 2050 if efforts are not made to curtail resistance or develop new antibiotics. Despite an urgent need for these drugs, the once-robust development pipeline for antibiotics now produces little more than a trickle of viable compounds. As of September 2016, about 40 new antibiotics were in clinical development for the US market, compared with hundreds of cancer drugs.

Many drug companies see antimicrobials as a losing proposition. "Most infections are still sensitive to existing drugs," says Allan Coukell, who oversees an antibiotic-resistance initiative at the Pew Charitable Trusts in Washington DC. "And if you have a new antibiotic, you do really want to hold it in reserve for those resistant infections." That means the market for new antibiotics is relatively

**"The low-hanging fruit has been plucked."**

### THREAT LIST

**Bacterium or bacterial family (and antibiotics it resists) ranked by threat to human health**

*Acinetobacter baumannii* (carbapenem)

*Pseudomonas aeruginosa* (carbapenem)

Enterobacteriaceae, extended-spectrum- $\beta$ -lactamase-producing (carbapenem)

*Enterococcus faecium* (vancomycin)

*Staphylococcus aureus* (methicillin, vancomycin)

*Helicobacter pylori* (clarithromycin)

*Campylobacter* spp. (fluoroquinolone)

Salmonellae (fluoroquinolone)

*Neisseria gonorrhoeae* (cephalosporin, fluoroquinolone)

*Streptococcus pneumoniae* (penicillin-non-susceptible)

*Haemophilus influenzae* (ampicillin)

*Shigella* spp. (fluoroquinolone)

small, and companies might not sell enough of the medicines to recoup their costs.

To create the list, a small team comprising WHO experts and researchers in the Division of Infectious Diseases at the University of Tübingen, Germany, started with similar rankings that already exist, including a 2013 list from the US Centers for Disease Control and Prevention, and a 2016 Canadian version. The team considered factors such as the pathogens' deadlines, their level of resistance and how easily they spread.

The panel excluded microbes that can be addressed effectively by other measures, such as good sanitation or vaccination. That gave a list of 20 bacteria from 12 families. To rank them, the team handed data on each to 70 experts from around the world — but did not provide the pathogens' names, in an effort to avoid bias.

Coukell says the WHO's list is useful, but it doesn't mean that drug developers are going to start at the top and work their way down. Developing antibiotics poses scientific and economic challenges. And in terms of drug discovery, says Brad Spellberg, an infectious-disease specialist at the Keck School of Medicine at the University of Southern California, Los Angeles, "the low-hanging fruit has been plucked". ■

SOURCE: WHO