Biology loves technology

Slimebots, techno-noses, coughing pigs,
online plagues, and other interesting stuff that happens
when **biology** meets **computing**

CS4FN

Queen Mary
University of London

Centre of the Cell

The slimy, messy world of biology and the clean, logical world of computing can make the perfect combination. In fact, sometimes it turns out it's the computing that's slimy and the biology that's logical. Computer scientists and biologists are teaming up, and finding that they are good at helping one another.

This book is filled with facts that come from scientists who are combining computing and biology. Dive in and explore the weird and fascinating science inside. You can find out more about each story by visiting the web address on each page. Have fun!

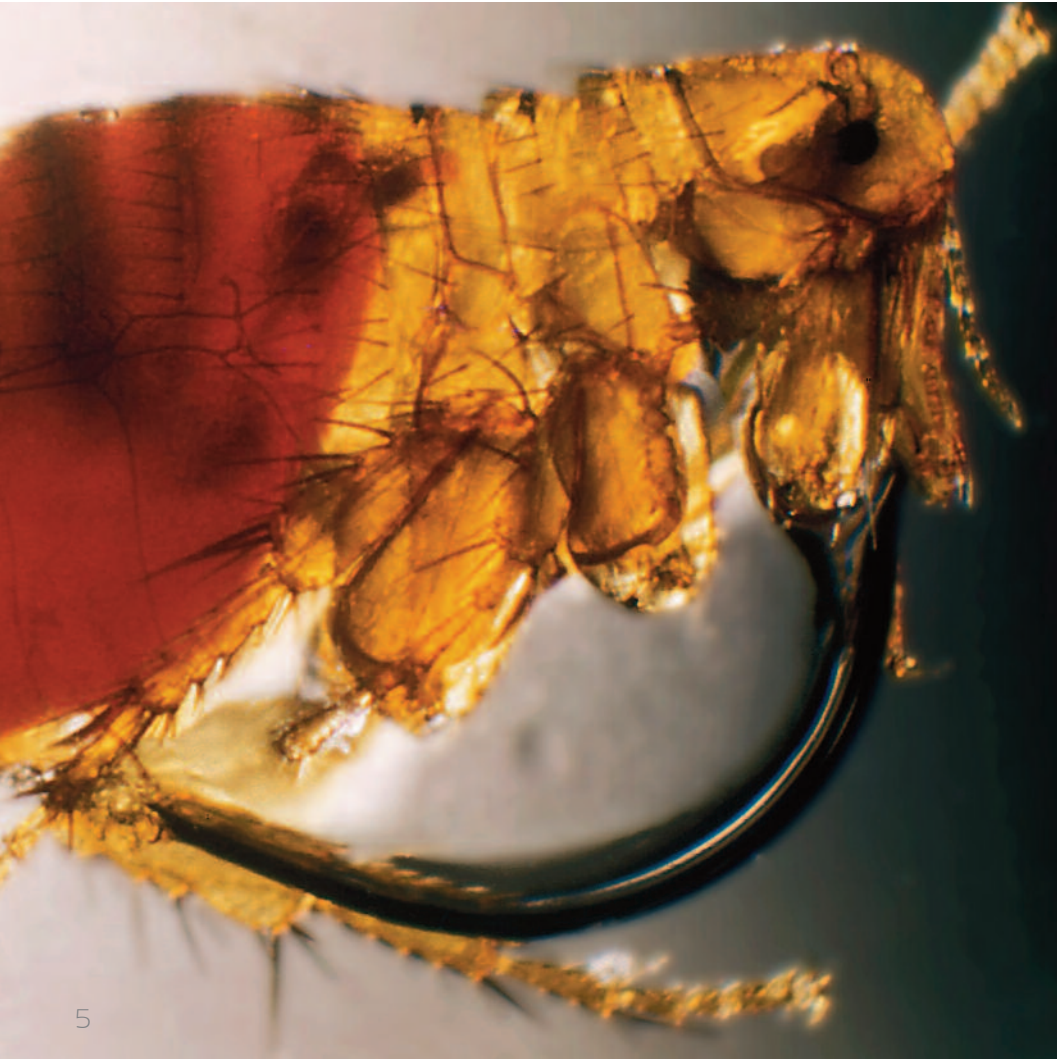
Image credit: istockphoto.com/Shljapka

cs4fn.org/pathways

Drugs work through biochemical pathways in cells. This means that a series of chemical reactions begins at the cell membrane and carries a ‘signal’ into the nucleus. Computer scientists realised that the biochemical pathways look a lot like telephone and computer networks, and now computerised tools developed for studying communication could help develop new drugs.

Brain pathways

Image credit: Science Photo Library



cs4fn.org/plague

In 2005 a plague shot through the online game World of Warcraft. It turned out to be a help to researchers who want to know how people behave in epidemics. People don't always do the smartest thing. For example, some curious players went to go see what was happening in the plague area. Not only did many of them get infected, when they left they helped spread the disease.

A plague-infected oriental rat flea engorged with blood

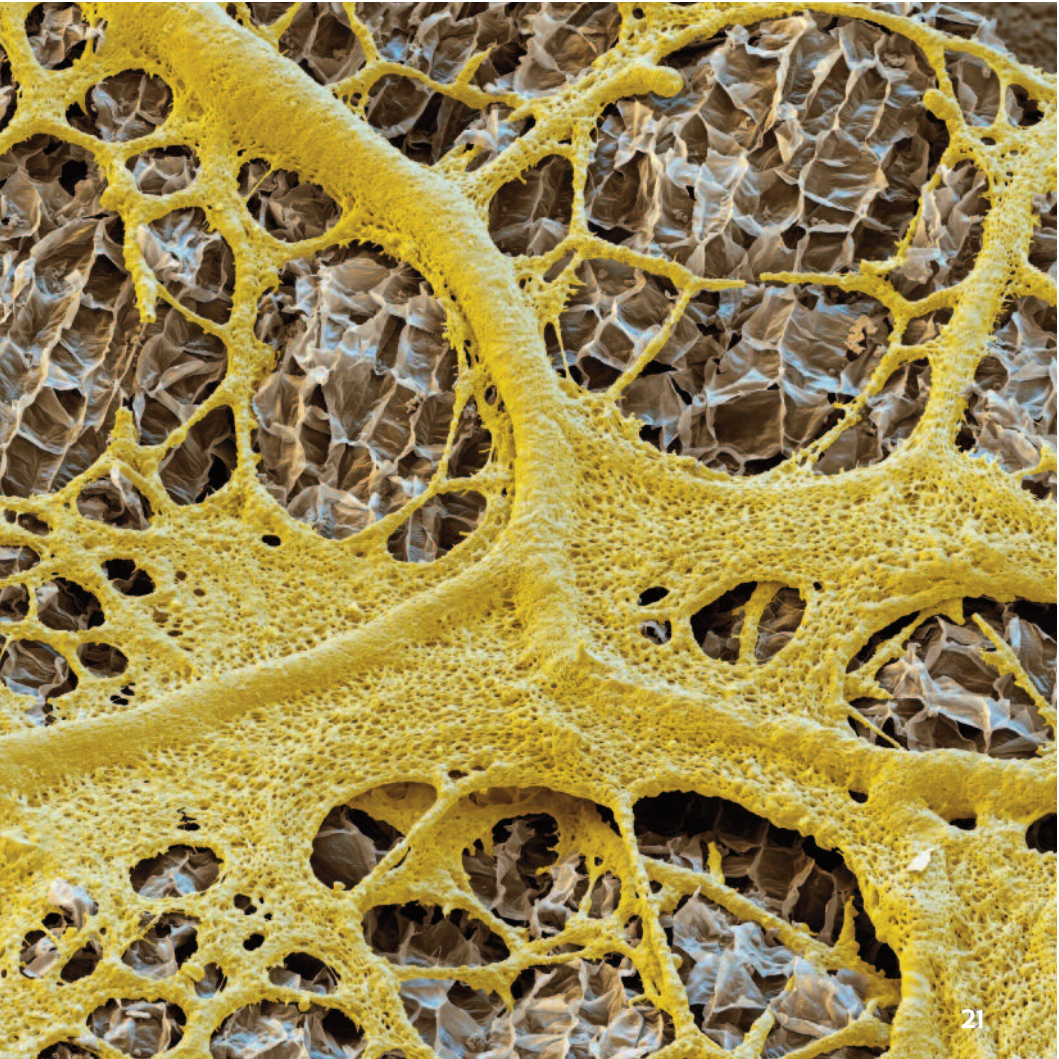
Image credit: Science Photo Library

cs4fn.org/slime

Researchers at the University of the West of England are making a robot out of slime. Plasmobot, made from a slime mould, will be the world's first biological robot. It can find the shortest path between points, which is a very difficult computational problem. Plasmobot is also able to carry things while it moves around, making it useful as well as slimy.

A slime mould feeding on the surface of an almond, seen through a scanning electron microscope

Image credit: Science Photo Library



cs4fn.org/ranking

Google ranks a web page's importance partially by looking at how many other pages link to it. Some biologists have recently tried the same approach to rank the importance of species in an ecosystem. By looking at how species depend on each other for food, they can figure out which ones are the most crucial for other species' survival. This could help conservationists know which species need protection.

A male African lion attacking the head of an African buffalo

Image credit: Science Photo Library

cs4fn.org/nose

Researchers at Lancaster University in the north-west of England are developing an electronic nose that can smell when a plant has been attacked by pests. Plants are always giving off chemicals – that's where they get their smell. But after they've been attacked they give off a bit more. The electronic nose detected the small change in the plants' chemical signatures after they'd been attacked.

Potato aphids feeding on a tomato leaf

Image credit: Science Photo Library

cs4fn.org/ants

When ants look for food, they leave a trail of chemicals for other ants to follow. As more ants use the trail, it gradually gets smoother and more efficient. That's because the ants are in such a hurry to get to the food, they don't follow all the twists and turns of the trail. Computer scientists have been inspired to write programs that use lots of different 'agents' to find an efficient solution, just like many ants can make an efficient path to food.

Two wood ants communicating, as seen through a scanning electron microscope

Image credit: Science Photo Library

cs4fn.org/petrels

The best way to test a new technology is under really harsh conditions. So when a computer chip manufacturer developed a tiny, dust-sized computer, they tested it by putting it in the nests of seabirds called storm petrels. Field biologists used the computers to read conditions inside the nests, and the manufacturer found out their computers could withstand all the heat, jostling, harsh weather and even poo found in a petrel nest.

Wilson's storm petrel

Image credit: Science Photo Library

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cs4fn.org/zebrafish

It is often hard for humans to find patterns in data, but we are really good at finding patterns in music. By turning data into sounds, scientists can help themselves make sense out of complicated findings. For example, researchers at Queen Mary, University of London have monitored calcium levels in zebrafish cells, then listened to the data as sounds. They can hear the difference in developmental stages of a zebrafish embryo.

A zebrafish embryo, as seen through a scanning electron microscope

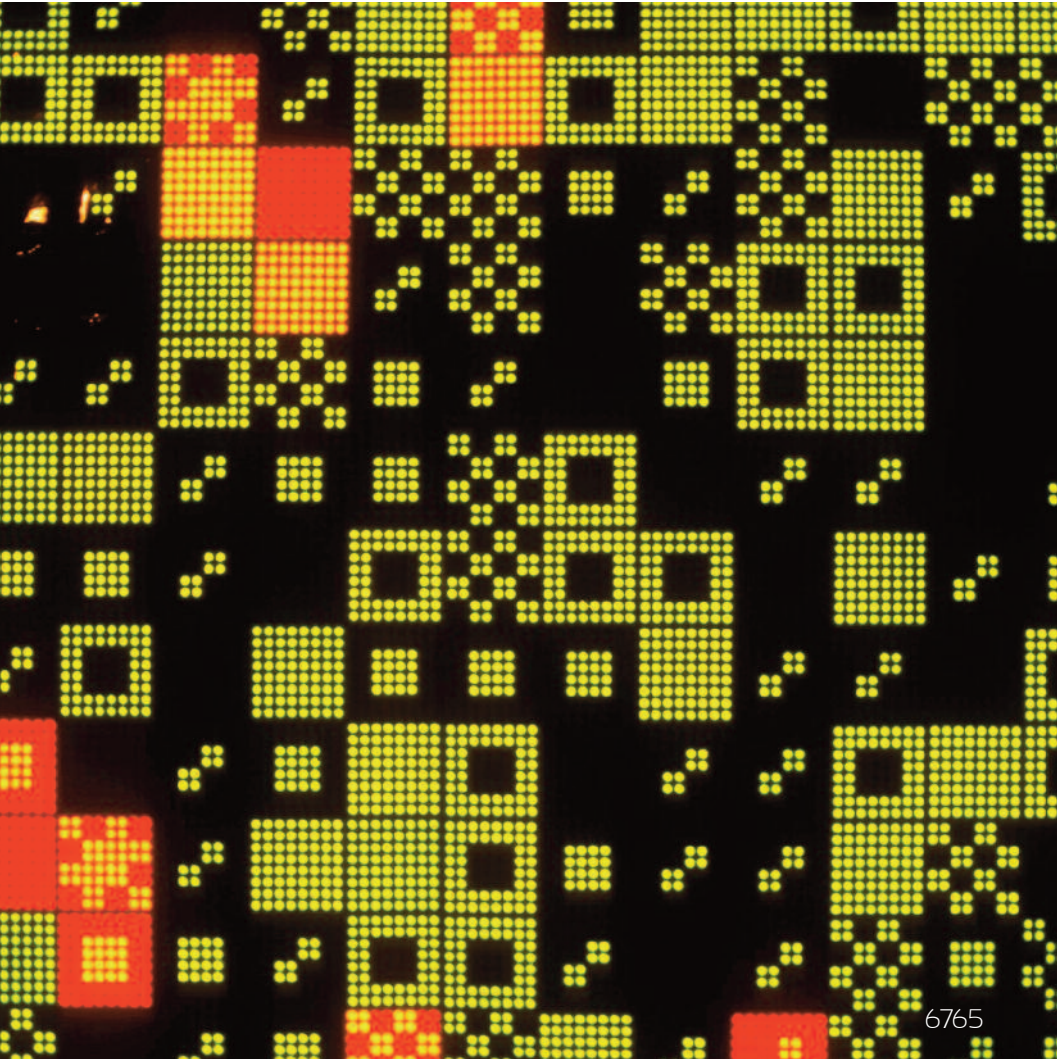
Image credit: Science Photo Library

cs4fn.org/simulatinglife

Some computer scientists work in the field of artificial life. They simulate life in digital form to try and figure out how life as we know it came about. Some try to figure out what life on other planets might be like. Others, who believe in what's called 'strong' artificial life, argue that they are not just simulating life in a computer, but really creating it.

A display of artificial life in which the state of the square segments is determined by the random movements of virtual ants

Image credit: Science Photo Library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cs4fn.org/pigs

Computers can learn to tell the difference between a healthy pig's cough and that of a pig that's poorly. Healthy coughs actually last a little bit longer than infectious coughs, and have a slightly different frequency. Having a computer detection system in place helps farmers separate infectious pigs before the illness spreads through the herd.

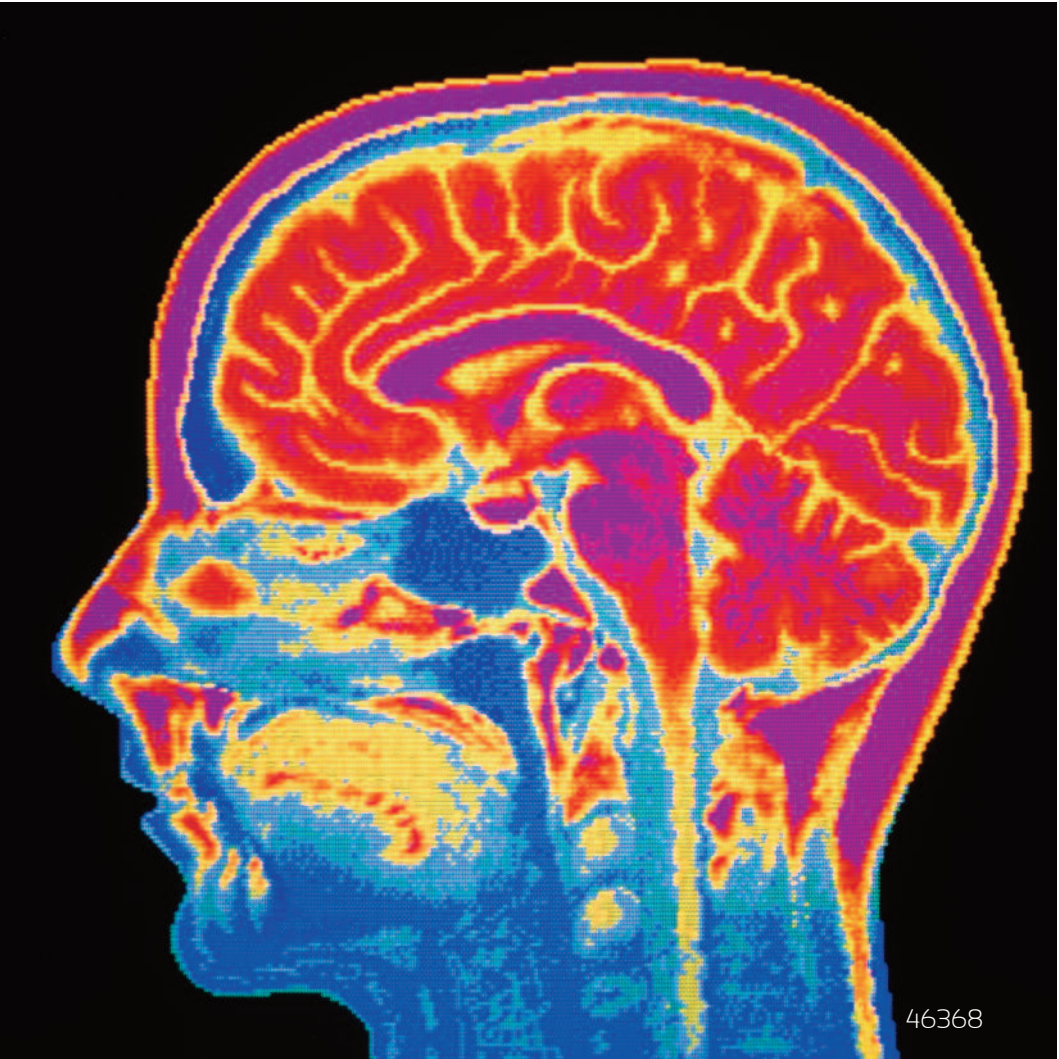
Le Porc Fleuri pigs

Image credit: Science Photo Library

cs4fn.org/mri

Computer technology can help us look into our bodies with magnetic resonance imaging (MRI). It works because our bodies have lots of water in them. Using a combination of magnetic fields and radio waves, the MRI makes the protons in the body's water jiggle around. The moving protons send out energy that the MRI measures. The machine then turns that energy into a detailed image.

A magnetic resonance image of the head of a normal 42 year-old woman, showing the brain, spine & facial tissues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cs4fn.org/bees

Without bees, there wouldn't be plants, and life on Earth would be pretty bleak. So it's important for conservationists to be able to understand how they behave in the wild. One way to do this is to attach small radio frequency identification (RFID) tags to bees. RFID tags are tiny computer chips that send out a signal to an electronic reader. If researchers put a reader near the entrance to a hive, they can track all the bees easily.

A transmitter mounted on a bee

Image credit: Science Photo Library

cs4fn.org/antivirus

Computer viruses, like biological viruses, are self-replicating. But biological viruses can only replicate their genetic material inside living cells. Computer viruses replicate their own code, often by attaching themselves to legitimate programs and using their permissions to write to the computer's memory. And just like their biological counterparts, some computer viruses produce no visible symptoms while others are deadly for their host.

Rhinovirus, a species of virus that is the main cause of the common cold in humans

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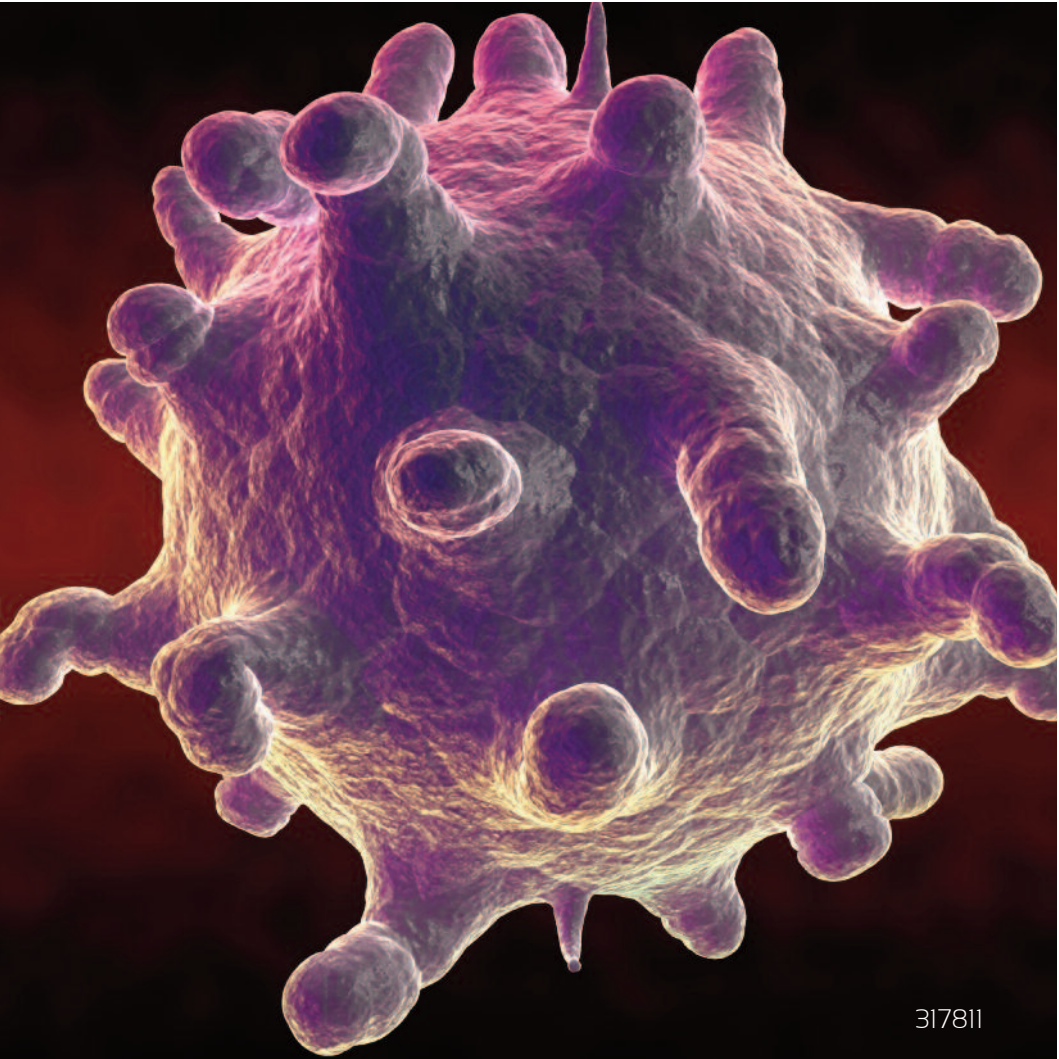
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cs4fn.org/haptics

Trainee surgeons watch a lot of surgeries performed and maybe help out here and there. But that is still very different from performing one on your own. A field of electronics called haptics can help out. Haptics is about giving feedback through touch. Simulators that use haptics provide student surgeons with the 'feel' of a real body to work on. The simulator gives back the same movement and resistance you might get if you were genuinely suctioning blood or drilling into bone.

Performing a surgery

Image credit: istockphoto.com/DOUGBERRY

cs4fn.org/mistakes

Everyone makes mistakes, but it's important that doctors and nurses don't. After all, lives are in their hands. Computer scientists who work in human-computer interaction can help by designing equipment that is easy and clear to use. It's especially important because hospitals are busy places, and humans tend to make more mistakes when they work under stress.

A doctor scans a patient in a magnetic resonance imaging machine

Image credit: istockphoto.com/uwphotographer

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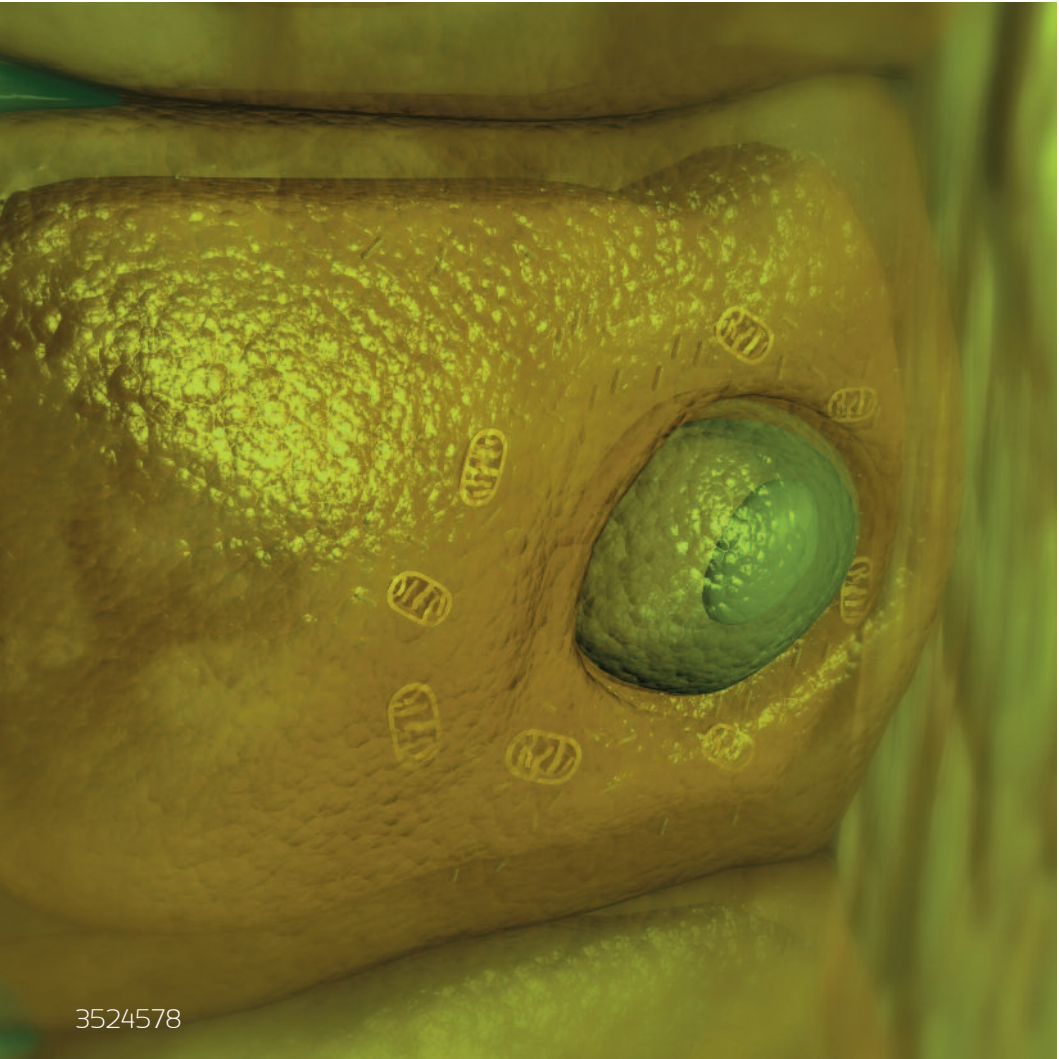
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cs4fn.org/flu

It's important for doctors to know what parts of the country are feeling the flu. One of the best clues to who's feeling ill is Google. Long before people feel so bad that they go to the doctor, they probably search for their symptoms on the internet. Google Flu Trends tells doctors where the most flu searches are coming from, and it can help predict how viruses will spread a week or two before other systems.

A mucous cell, as seen through a scanning electron microscope

Image credit: Science Photo Library

cs4fn.org/folding

Proteins help your body do lots of jobs such as digesting food, sending signals to your brain, and fighting infection. The particular shape a protein molecule folds itself up into determines what jobs it does. How proteins fold themselves up efficiently is a mystery, so researchers are getting help by making a computer game in which players bend proteins into the smallest shapes they can find.

A display of 156 protein folding configurations, simulated using a supercomputer

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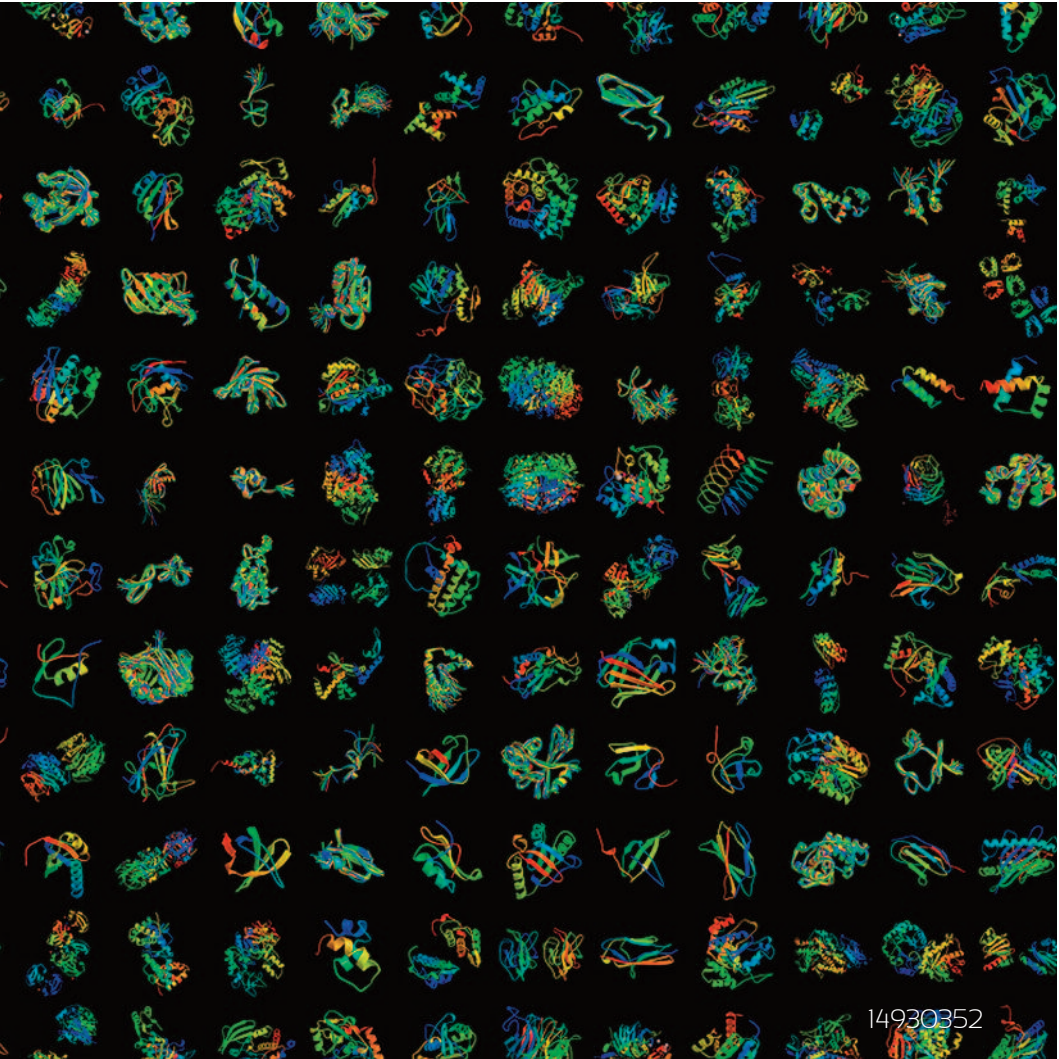

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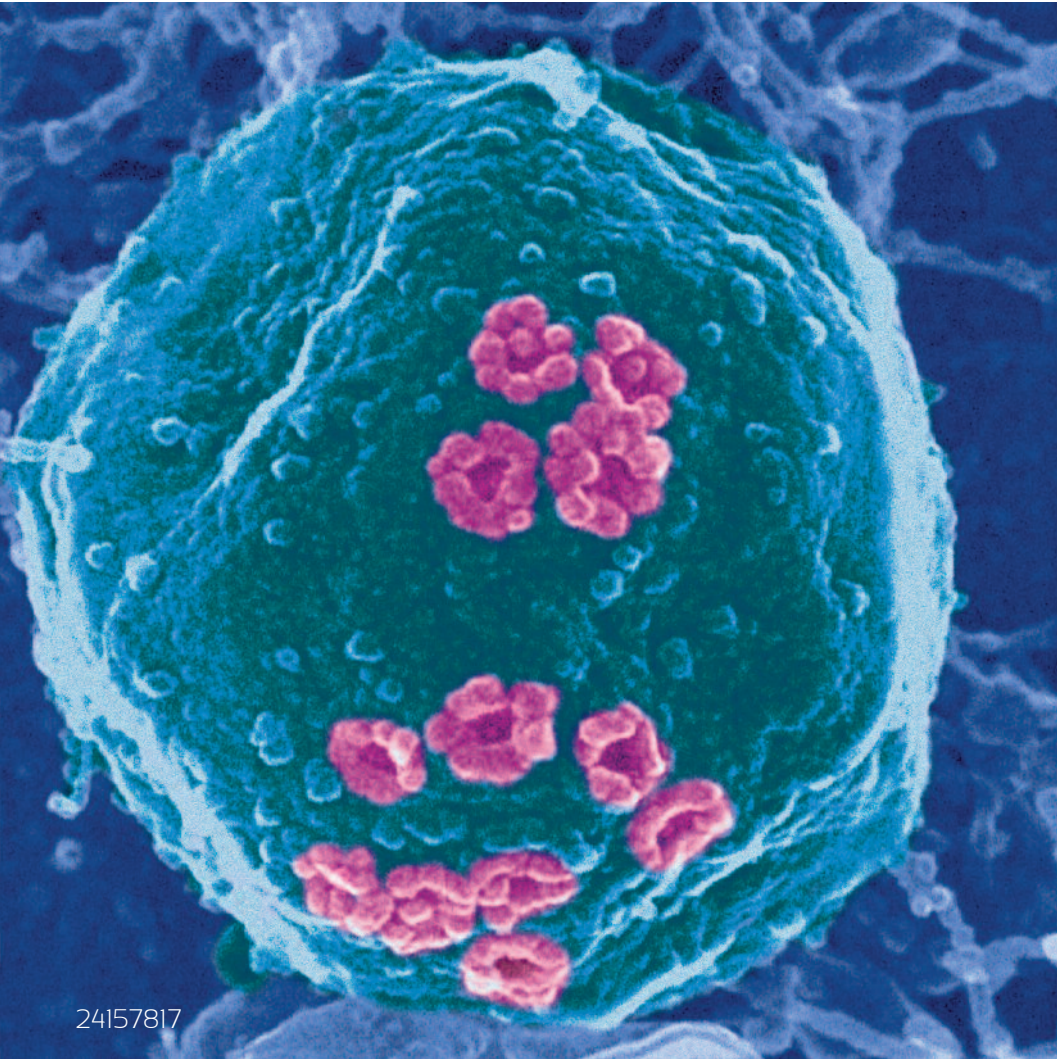
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cs4fn.org/adam

Adam is a geneticist who is also the world's first robot scientist. Researchers in Aberystwyth and Cambridge made him to find genes in yeast that produce the catalysts for chemical reactions. Adam has a program for making and testing his own hypotheses, and he even comes with his own laboratory. His innards contain a freezer stocked with yeast strains, three incubators, some robot arms, a plate washer, barcode readers, cameras, twenty environmental sensors and four personal computers.

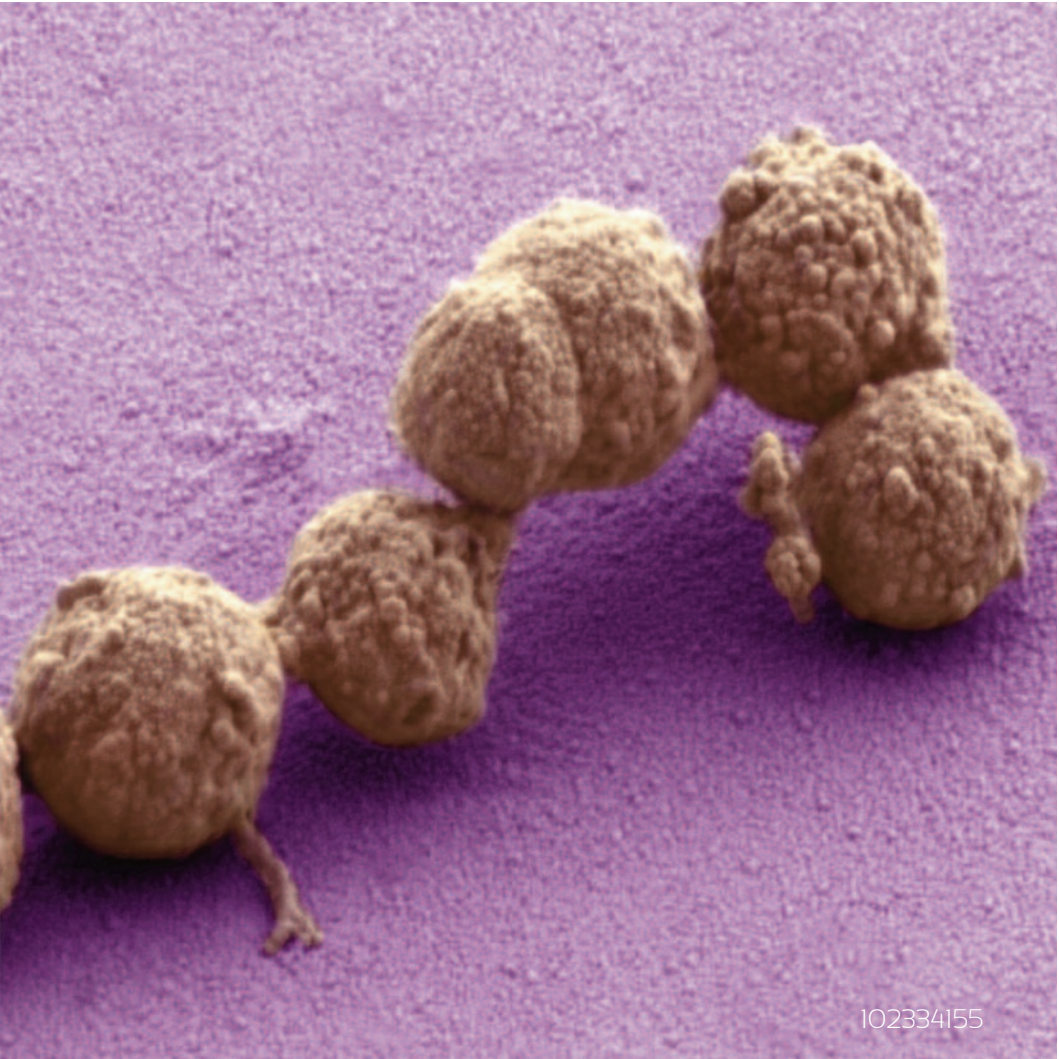
The nucleus of a yeast cell, as seen through a scanning electron microscope

Image credit: Science Photo Library

cs4fn.org/synthetic

Synthetic biology is a field whose researchers are trying to build new forms of life that aren't found in nature. One of the ways they are doing this is by making biological components – strings of DNA that they can install into a system, similar to how electronic components fit into a computer. Synthetic biologists have made *E.coli* bacteria that smell like banana or mint!

Synthetic bacteria, as seen through a scanning electron microscope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cs4fn.org/stripes

Scientists who study morphogenesis are interested in how cells come together to create bodies. They are usually biologists, but Alan Turing, one of the very first computer scientists, made an important discovery in morphogenesis. He wondered why some animals are covered in patterns like spots or stripes. Turing figured out that a certain kind of chemical reaction, in which chemicals turn into one another and back again, can follow simple rules to produce elaborate patterns like the ones found in nature.

The eye and facial stripes of a Burchell's zebra

Image credit: Science Photo Library

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A computer illustration of neurons in the brain. Artificial neural networks are useful in artificial intelligence research

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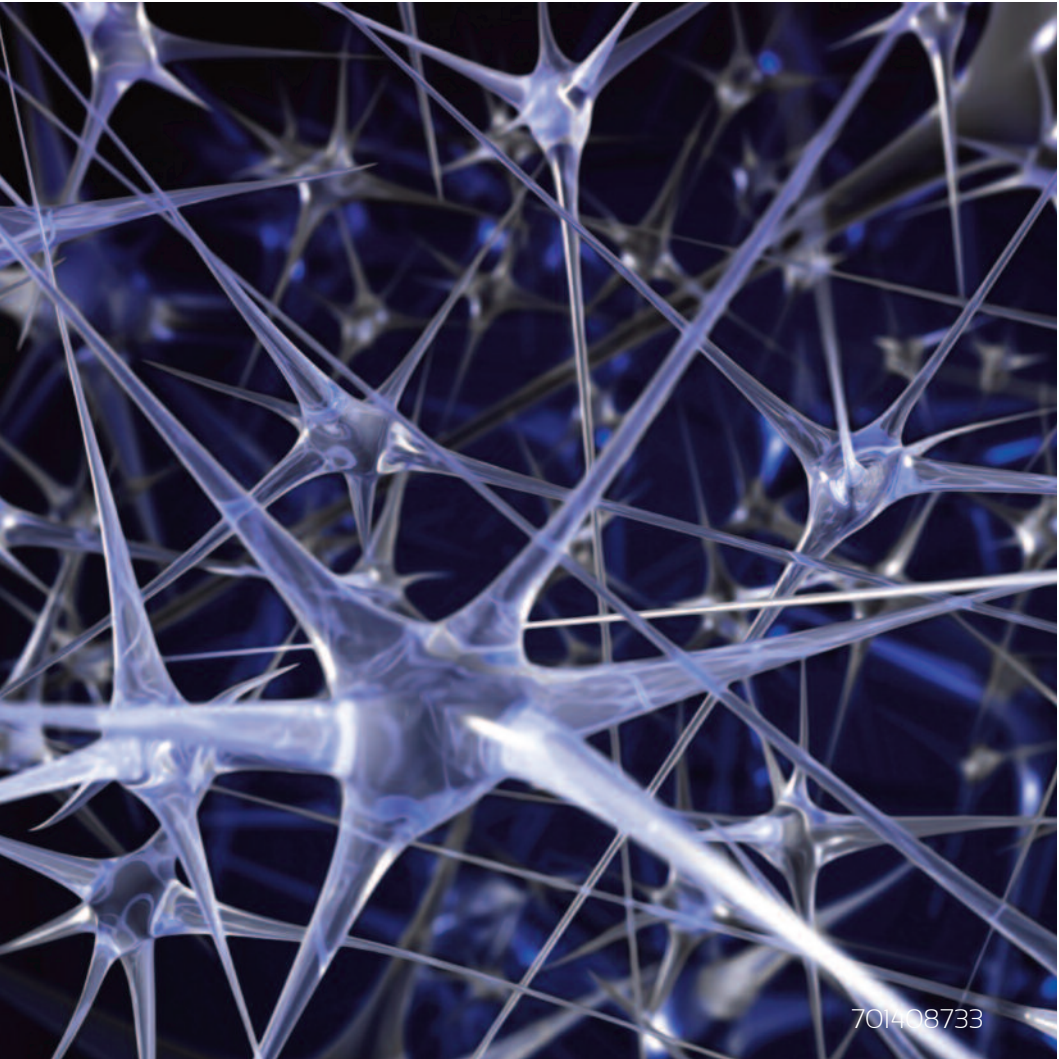

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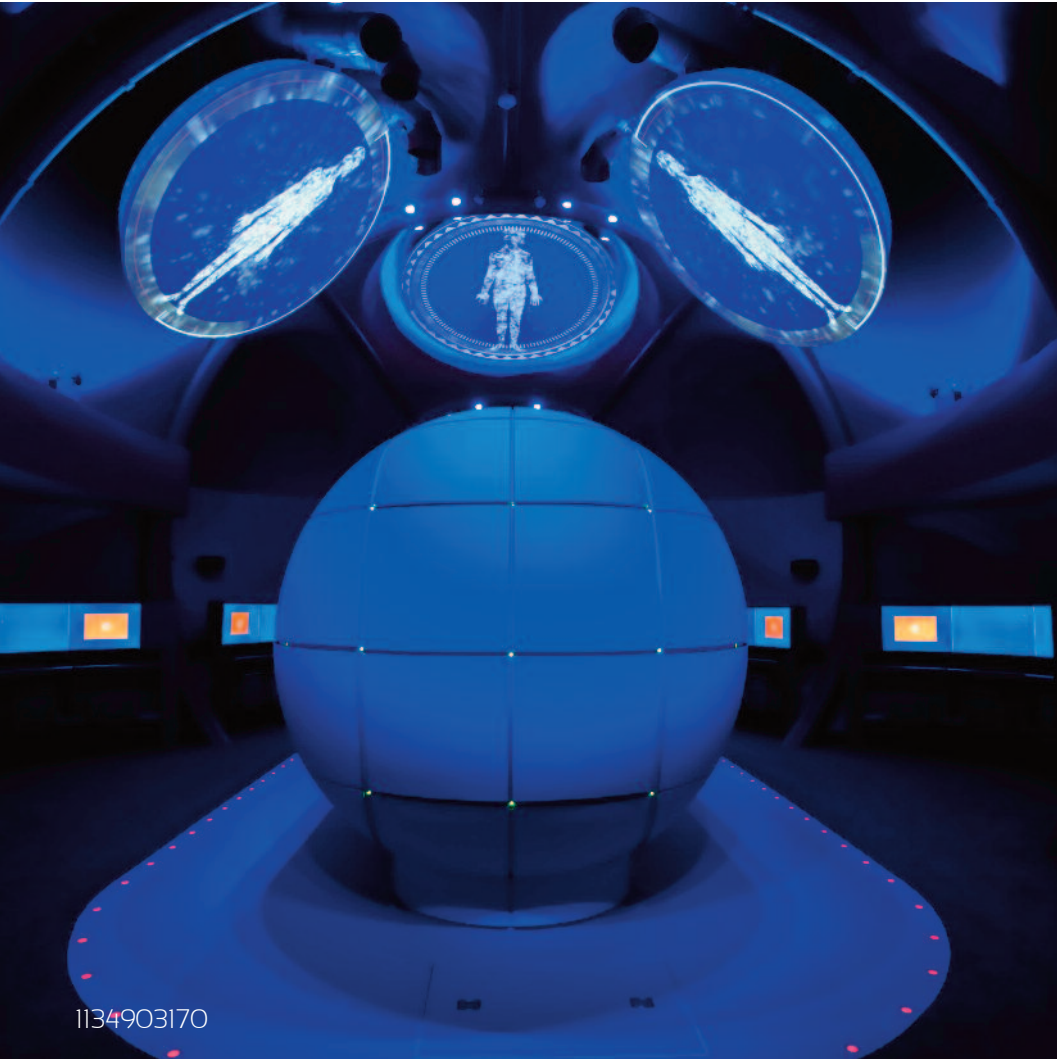
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Centre of the Cell is dedicated to inspiring curiosity and learning by connecting science to everyday life. Come and see a show inside the amazing digital interactive 'Pod' that is suspended above medical research laboratories at Queen Mary, University of London.

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The Pod at Centre of the Cell

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Did you spot the weird numbering system for the pages in this book? It's a number sequence that is important for biologists and computer scientists. See if you can figure out how the numbers in the sequence relate to each other.

Find out more about it at **www.cs4fn.org/pages**