THE
Wildlife
BUMPER BOOK OF
ANSWERS

Packed with fascinating facts, strange-but-true stories and the answers to 100s of wild questions

R60.00
Why do crabs walk sideways? How do birds fly? And which came first – the chicken or the egg? In this BBC Wildlife question-and-answer special, we solve these fascinating mysteries and many more.

Nature is full of weird and wonderful species – from the tentacled star-nosed mole to the seductive bee orchid, and from the unicorn of the sea to a bird that eats like a cow. Each one is perfectly adapted to its niche, displaying innovative – and often quite incredible – solutions to everyday problems.

In this compendium of natural curiosities, we’ve pulled together a panel of 60 experts. They provide revelatory insights into familiar animals – such as why guinea pigs make wonderful listeners – and introduce more unusual creatures, including the gelatinous, deep-sea blobfish.

We reveal the special talents, evolutionary quirks and super-senses of the natural world’s most extraordinary species, and explain their peculiar – and generally brilliant – behaviour, whether it’s finding food or a mate, or just staying alive.

So if you’ve ever wanted to know how spiders spin silk, why zebras have stripes or which animal has the biggest brain, we’ve got all the answers. And if you think you already know it all, there are some fun picture quizzes along the way to test your identification skills.

Share the wonder of the natural kingdom with BBC Wildlife, amaze your friends and inspire your children. Enjoy!
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WHAT TO SEE AND DO

• More than 45 life-size dinosaurs will “come to life” before your eyes
• An excavation sandbox
• Dino rides
• A 3D Movie

WHEN AND WHERE

JOHANNESBURG 20 June – 20 July 2014
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An educational and interactive exhibition filled with more than 45 roaring, moving, life-size dinosaurs

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Whale sharks have around 4,000 teeth, although their purpose remains unknown as they don’t chew their food.
BIGGER, FASTER & LOUDER

The record-breakers of the natural world come in some unusual forms – from smelly flowers to mammoth whales

What’s the biggest fish in the world?

Running (or swimming) away with the prize is the enormous whale shark. They can reach a huge 15m in length and weigh over 23 tonnes – more than a single-decker bus. Luckily for us they only eat small fish and plankton, in a process called filter feeding. Filter feeders only have tiny teeth – adult whale sharks have a whopping 4,000 of them. They first appeared on the planet 40-60 million years ago and live until they are about 70 years old. During migration season, the giant fish cover huge distances, and appear in the same places every year for feeding and mating. Western Australia and eastern Africa are two of the best locations for seeing these gentle giants, and many people travel there to swim with them. Whale sharks are easily recognised by distinctive spots, which cover their backs. Sadly, the sharks are hunted in parts of Asia for their highly valuable dorsal fins, which are seen as a unique delicacy.

https://vk.com/readinglecture
What is the world’s fastest animal?

Reaching speeds of up to 320kph as it dives for its prey, the award for fastest animal goes to the Peregrine falcon. The fastest in level flight is the sparrow hawk, which can top 170kph, with the frigatebird next at about 150kph. Many ducks are surprisingly quick, with mallard, pintail, teal and eider all capable of reaching about 110kph.

What is the world’s largest tree?

The tallest tree is a giant sequoia named ‘Hyperion’, which grows in Redwood National Park, California, and is 115.58m tall. The ‘General Sherman’ tree in Sequoia National Park, also in California, is estimated to be 1,486.6 cubic metres, which makes it the largest tree by volume.

6 615 tonnes

Estimated weight of the world’s heaviest organism, a clonal colony of quaking aspen deciduous trees.

What animal has lived the longest?

In terms of vertebrates, this is a closely fought race between the tortoise and – no, not the hare – the whale. Research carried out on the eyeballs of bowhead whales killed by native hunters suggested that one individual was 211 when it died (give or take 34 years). An Aldabra giant tortoise was reputedly about 250 when it died, but according to Dr Justin Gerlach, scientific advisor at the Zoological Society of London, this is ‘complete speculation’. He says the most reliable record claims one was ‘close to 200’ when it died – so the bowhead takes it, by a hair’s breadth.

DID YOU KNOW?

The male wandering albatross has the largest wingspan of any bird – the widest measured at 3.63m.

It’s thought a bowhead whale can live for so long because of its low body temperature.
Fungi aren’t generally known for their speed, yet one group is quicker off the mark than perhaps any other organism on the planet.

These minuscule mushrooms *Pilobolus crystallinus*, which are known both as hat-throwers and dung-cannons, grow, feed and breed on dung. In order to reproduce, their spores are cast onto the grass, where they are swallowed by grazing mammals and then redeposited on the pasture amid a steaming pile of nutritious manure.

The problem is that grazing mammals, quite understandably, tend to avoid excrement when choosing which patch of grass to eat. So the hat-throwers have evolved a spectacular way of projecting their offspring far and wide. The spores develop in a microscopic bundle that sits atop a fluid-filled bladder on a stalk. The bladder expands until the internal pressure causes it to squirt out its contents in a powerful jet, propelling the spores away at speeds of up to 90kph. Even more impressive is that they reach their top speed in just a few millionths of a second – a rate of acceleration exceeding that of a bullet shot from an AK-47 rifle. Even though the fungi rarely reaches five centimetres in height, this small organism can project its spores up to 200m away.
What’s the world’s biggest snake?

A The female green anaconda *Eunectes murinus*, which lives in the Amazon and Orinoco basins in South America, is by far the heaviest. It grows up to 5.5m long and can weigh up to 110kg. It’s not the longest, though – it’s generally agreed that honour goes to the reticulated python. The longest specimen measured, kept in captivity in Kansas, was 7.67m long.

DID YOU KNOW?

Britain is home to the world's largest slug: Limax maximus. Found in the country's southern and western woods, it can reach up to 30cm when fully extended.

What’s the world’s biggest butterfly?

A The female Queen Alexandra’s birdwing butterfly, found in Papua New Guinea, has a wingspan in excess of 28cm. It's so big that the first specimen was brought down with a shotgun.

What’s in a name?

Australian wasp
Aha ha

'Aha!' exclaimed American entomologist Arnold Menke when he opened a package from a colleague. He found not just a new species of wasp, but a whole new family of species. He went on to describe the discovery in a 1977 paper with the title *Aha, a New Genus of Australian Sphecidae* and so the humorous name stuck!
**What's the world's rarest bird?**

A number of species have not been seen in the wild for several years, so may now be extinct. The slender-billed curlew, once found in a number of countries across Europe, the Middle East and North Africa, has not been spotted in over a decade. The last known wild Spix’s macaw, native to Brazil, was seen in 2000, though around 100 survive in captivity.

*The Spix macaw is critically endangered and may already be extinct in the wild.*

**What’s the world’s biggest spider?**

The giant tarantula or goliath bird-eating spider *Theraphosa blondi* is generally considered to be the biggest, at least by mass. One captive female weighed in at 175g, and the leg-span of another individual found in Venezuela measured 28cm. However, the giant huntsman spider *Heteropoda maxima* of Laos may be even bigger — with a leg-span that tops 30cm.

The smallest is *Patu digua*, a Colombian spider with a body size of just 0.37mm.

*Girl power! Female bird-eating spiders can live for 25 years, compared to a measly six years for their male counterparts.*

**How do fleas jump?**

Some species of flea can jump up to 200 times their own body length. The mighty leap of this tiny, wingless insect is far too explosive to be powered by muscles alone. Instead, fleas harness energy stored in two blocks of resilin — a rubbery, spring-like protein — contained in the thorax.

The mechanism works by locking the back legs in a folded position and contracting large thoracic muscles to compress the resilin. Releasing the leg-lock then allows the blocks to recoil, extending the limbs in a fraction of a second.

In flying insects, resilin serves to bounce the wings back at the end of each stroke. The flea’s technique is an elegant example of evolution finding novel and ingenious uses for existing structures.

*Mayflies have the shortest life span of any animal. They belong to the order Ephemeroptera — in Greek, ephemera means 'short-lived' and phero means 'wing'. They may spend two to three years as nymphs at the bottom of lakes and streams, and then live for as little as one hour as winged adults.*
What’s the biggest an animal can grow?

The biggest animal that is believed to have ever lived is the blue whale. Female blue whales can reach a whopping 33m in length. Unsurprisingly, whole whales have never been weighed, but the heaviest are estimated to be about 180 tonnes. And they may be getting even bigger – a 2011 study found that over several generations blue whales continue to grow in size.

Yet blue whales are unusual. Most mammal groups have become smaller since dinosaurs became extinct – possibly because, in the absence of massive predators, there was no need for most animals to be as large.

The science of size
So what does drive an evolutionary increase in size? The larger an animal grows the smaller its surface area compared with its volume (and, therefore, mass). This means it can maintain body temperature more easily and so is more energy efficient than a smaller ‘model’. This is particularly important for warm-blooded creatures in cold environments – such as whales in the ocean.

Predators can benefit from being larger because they can catch and eat more prey. In return, their quarry might also grow bigger as to avoid becoming prey.

However, many animals will have a maximum size. For example, the African elephant is approaching the biggest it could be. If it got much larger, the thickness of the legs required to support its weight would be too bulky to move. The size of flying birds may be limited by the energy that flying uses – which is why really big birds of prey mostly soar rather than flap.

Reaching the limits
Insects, too, are restricted in size. The biggest are still relatively small but nobody’s exactly sure why. The longest, at about 17cm, may be the titan or Hercules beetles of South America. It’s been suggested that larger insects are increasingly attractive to predators so its not in their interests to grow too large. Also, insects take in oxygen through tiny trachea – a passive system, unlike active breathing with lungs. If insects grow too big, they might struggle to absorb sufficient oxygen through this system.

Whales, on the other hand, breathe using lungs, are supported by the water in which they live (so don’t need legs) and can take in vast quantities of food – four tonnes or more each day. This might help explain why they reach such huge sizes.

How, though, did dinosaurs grow so large? One theory suggests that higher atmospheric levels of carbon dioxide and warmer temperatures nurtured more abundant plant life and, thus, food for bigger herbivores. A kind of predator-prey arms race between increasingly large carnivores – *Spinosaurus* may have reached 20 tonnes, three times the size of *Trex* – might have encouraged ever larger sauropods.

The truth is that we simply don’t know for sure what limits the maximum size of most animals – but it’s fascinating to read the new theories as they arise.

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**ISLAND GIANTS**

It’s a peculiar fact that some types of animals – such as giant tortoises, and the extinct moa and elephant bird – grow to surprisingly large sizes when left on an isolated island. These are examples of a phenomenon known as island gigantism – the core element of which is that small herbivores tend to grow larger on islands in the absence of large predators. Conversely, predators often become smaller on islands, where the supply of prey is limited. This is one aspect of ‘insular dwarfism’. 

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An adult titan beetle doesn’t eat, instead it spends its short adult life finding a mate.

**WHY DON’T HUMANS GROW TALLER?**

American physicist William Press calculated the maximum safe height for humans based on the fact that if two-legged creatures are too tall, they risk toppling and hitting the ground with lethal force. It is defined by the relative strengths of two cosmic forces: gravity, which dictates how hard we hit the ground; and the electromagnetic force, which sets the strength of the atomic bonds forming our bones.

This argument leads to the formula for the maximum safe height for humans, giving a figure of about three metres. Sure enough, as far as we know, no human has ever been taller than the American Robert Wadlow (1918-1940), who towered 2.72m high.

**DID YOU KNOW?**

Titan beetles’ mandibles are strong enough to break a pencil in half or cut through human flesh. Their larvae have never been found but are thought to feed inside wood.
Giant of the ocean

It’s not a fish, a whale or a shark – the Praya dubia is the unlikely giant of the underwater world. This jellyfish grows to more than 40m and lives in cold waters at depths of 50-200m. It is a colonial animal, which means it’s actually a long chain of individuals. Each one has a dedicated role – some sting and capture food, others digest and spread the nutrition throughout the colony, while the remainder are responsible for reproduction.

These creatures form a long, pliable stem that trails behind two much larger bodies that are specially adapted for swimming, pulsing rhythmically and slowly, pulling the smaller animals through the water.

A thin, gauzy curtain of stinging tentacles that can reach two metres in length hangs from the predatory cells. Any passing prey that comes into contact with these appendages is rapidly hauled up to the feeding polyps and devoured in an instant.

Though Praya is the longest and one of the most abundant predators in the ocean, it is surprisingly only as thick as a coin. So the female blue whale still wins when it comes to sheer bulk.

The Praya dubia’s sting is strong enough to kill humans, but don’t panic: its skeleton will automatically burst if it comes up to the surface.
**Which is the world’s most numerous mammal?**

At the last count, there were 5,487 species of mammal on Earth. Of these, 40% are rodents – and it’ll come as no surprise to discover that the brown rat is the most numerous. Other candidates include the 100 species of white-toothed shrews in Africa alone, most of which are indistinguishable to the untrained eye.

Most commonly found in cities, brown rats can live everywhere humans can, except Antarctica.

**Did You Know?**
The world’s smallest bee is *Pellis nervosa*, a minute species under two-millimetre long and weighing only 0.013mg. It’s native to the south-western US, where it constructs a tiny nest in sandy desert soils and feeds on the nectar and pollen of spurge flowers.

**What is Europe’s largest land mammal?**

Wisent, or European bison, are mammalian heavyweights: the adults can weigh as much as 1,000kg. They are also making a huge comeback. The species’ population has grown from just 13 individuals in the 1920s to about 2,000 free-roaming animals today, with another 2,000 in captivity. The Bialowieza Forest, which straddles the border between Poland and Belarus, is the species’ main stronghold. South Africa is home to the largest land-based mammal (the elephant), the tallest (the giraffe) and the fastest (the cheetah).

It’s no picnic being this big – an adult male wisent consumes 32kg of food a day.

**What is the world’s oldest tree?**

In 2008, scientists identified a spruce on Fulu Mountain in Sweden’s Dalarna province that is 9,550 years-old. The remains of wood and cones found under the spruce’s uppermost branches, proven to have come from the same tree by genetic fingerprinting, were taken to date the tree using radio-carbon dating. This identified that its seed would have sprouted soon after the ice sheets melted during the last glacial period.

The tree is growing among about 20 others that are more than 8,000 years old. They have managed to survive so long because the spruce rootstocks continuously generate new stems after each mature trunk dies.

**113kph**

The top speed of a cheetah. It is the fastest land animal on the planet.
**What is the world’s largest amphibian?**

The giant salamanders of the Far East are by far the biggest amphibians on the planet. The Japanese giant salamander, known locally as _hansaki_, grows up to 1.5m long from warty nose to chunky, newt-like tail. It is a stream-dwelling predator: if a fish or crab wanders too close, the cavernous mouth snaps open, sucking in both water and prey.

Even bigger than the _hansaki_ is its closest living relative, the Chinese giant salamander. This gargantuan creature, which can grow to 1.8m long and weigh up to 50kg, is known as wawuyu (‘baby fish’) in China due to the crying sound it makes when removed from water.

At least one-third of the world’s amphibian species are threatened and wawuyu, the largest member of the class _Amphibia_, is a sobering example of their plight. Ongoing threats range from habitat destruction to pollution, climate change, over-harvesting and disease. The species is now termed Critically Endangered and faces a highly uncertain future.

**DID YOU KNOW?**
The animal with the biggest eye is the giant squid – the largest eyeball measured has a diameter of about 27cm.

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**What is the world’s largest flower?**

This accolade belongs to _Rafflesia arnoldii_, which grows on the islands of Sumatra and Borneo and can grow up to one metre in diameter. It’s also the smelliest – hence the nickname ‘corpse flower’. One drawback of being a rare plant hidden deep in a forest, flowering once in a blue moon, is that it’s hard for pollinators to find you. What better way, then, to attract flies than to smell like a corpse? _Rafflesia_ is a parasitic plant that spends its entire life cycle hidden inside tropical lianas and only sporadically advertising its presence by producing its huge flower, which releases the disgusting aroma of rotting meat. It even has the visual and tactile qualities of bloody, wrinkled flesh. Delicious – if you’re a fly.
**Q Which living thing grows the fastest?**

**A** We don’t know for sure, but it’s probably something with fast DNA replication and cells that can quickly expand in size – such as organisms that inflate their cells with water. For total growth, try giant kelp. That can grow about 60cm per day, though the average is more like 57cm. Huge organisms like kilometre-scale underground honey fungus networks will probably beat this, but are difficult to measure.

Bacteria such as certain *Bacillus stearothermophilus* strains can double in size, as a percentage of body weight, every 10 minutes under optimal conditions. So, given unlimited resources, in one day a single bacterium could produce more offspring than the combined weight of all the organisms in the world. This of course, would be impossible because the resources run out long before this point, but the statistic does demonstrate their immense powers of reproduction.
Hopping might be a bit of fun for us, but it’s serious business for these red kangaroos.
MOVEMENT & MIGRATION

Whether it’s to traverse half the world or a matter of millimetres, wildlife moves in some weird and wonderful ways

How and why do kangaroos hop?

The story begins about 30 million years ago, when the ancestor of the kangaroo – a creature a lot like a small possum – climbed down from the treetops to move around on the forest floor. Its feet and ankles, previously suited to climbing, stiffened up to handle its new terrain. As this ancient kangaroo’s foot was very long, the animal couldn’t walk or run properly. However, hopping was easy – as it is for modern-day ‘roos. The large, stretchy tendons in a kangaroo’s hind legs act like giant springs. As these tendons strain and contract, they generate most of the energy needed for each hop. This is very different to the way humans jump, which uses a lot of muscular effort.

The tail is also important, acting both as a balancing aid and a counterweight, propelling the animal into each leap. And there’s the added bonus that, while hopping, kangaroos barely need to waste effort on breathing. The jumping motion drives their gut up and down, which inflates and deflates their lungs for them.

Kangaroos usually hop at about 25kph, though they can reach 70kph over short distances, covering as much as nine metres in a single hop. This energy-efficient way of travelling means they can cover vast distances in search of food and water, allowing them to thrive in the harsh climate of the Australian outback.
The orangutan may be known as the king of the swingers, but it's the grey gibbon that really wears the crown.

**DID YOU KNOW?**

Gibbons are great singers. Each mating pair develops their own unique duet, which they perform every day at dawn to mark their territory.

A male kori bustard can weigh as much as a fully grown border collie.

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**What is the world's heaviest flying bird?**

Going on typical weights, the heaviest flying bird is the kori bustard, which can weigh from 11-15kg, followed by the great bustard (six-18kg), the mute swan (six-15kg) and the Andean condor (up to 15kg). Because of its tremendous weight, a kori bustard uses a lot of energy to fly, so it will only take off when necessary.

The theoretical limits of maximum body weight for horizontal powered flight are in the region of 10-15kg. This means the largest male bustards are, technically speaking, exceeding the boundaries of what should be possible!

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**How do gibbons swing through the treetops?**

Swinging from hand to hand like a living pendulum is hard work for us, but with lean bodies, long, muscular arms, highly mobile joints and hook-like fingers that slip over branches easily, gibbons are built for the job. Their wrist bones rotate so far that they can spin around in a full circle while barely shifting their grip, and their short legs (compared to humans) improve balance during the swing. This type of movement, called brachiation, isn't unique to gibbons – some other primates, such as orangutans and spider monkeys, can manage a version of it – but gibbons are the experts.

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**Is it true that bumblebees are theoretically unable to fly?**

No. It's a myth that dates back to World War I, when engineers first developed theories of aerodynamics. They compared powered human flight with birds', but their theories didn't translate accurately to insects. Flying insects rely on a different technique to birds, generating a much faster wingbeat – up to 230 strokes per second in bees.
Flying squid

It may seem absurd, but there are a few squid species that regularly take to the air. And, though only a dozen or so studies have documented the cephalopods in action, we know that they share the same basic technique.

To move around underwater, a squid will mostly use a form of jet propulsion – sucking water into its body and forcing it out of an organ called a siphon, which it rotates to change direction. The method packs real power – some species can cruise at more than 40kph. This speed is what enables them to launch into the air.

But why do they do this? Well, it’s a great escape trick. If a squid swimming near the surface is spooked by a predator or a boat, it streamlines into a torpedo shape and fires itself out of the water. At the same time, it splays its eight tentacles into a flat, fan-like pattern in front of its face – some breeds even exude mucus to fill in the spaces, creating a unified, kite-like surface. It also flares a pair of fins near its rear end and – voilà – the squid becomes a living, breathing jet.

The cephalopod will then blast water out of its siphon for extra speed, if necessary, to avoid danger. An individual was once captured on film accelerating from 6.5 to 26kph in this way. Biologists have concluded that if the animal were to angle its siphon or its ‘wings’ the right way, it would be possible for the squid to climb higher, and achieve powered flight. If that were ever to happen, then the squid would become the only creature capable of jet-propelled flight.
How does an elephant carry its huge bulk – and how does it stand on its hind legs?

The African elephant is the heaviest land mammal on Earth, weighing up to 6.6 tonnes. Several adaptations enable the elephant to carry this bulk. Its legs are thick and columnar, and positioned directly under its body (unlike lighter, more agile mammals, such as antelopes, whose legs are slim and angle in slightly under the torso). Its feet are large, squishy pads that absorb the impact of each step and take some strain off the limbs. And instead of marrow, its leg bones are filled with a spongy type of bone that provides strength as well as new blood cells.

Elephants carry more weight on their front feet – to cope, these have a larger surface area than hind feet, and front limbs are reinforced with bigger bones. Bulls stand on their rear legs when mating and both sexes will do so when feeding on treetops. Then they have to shift their centre of gravity from the front to the back of the body. It’s risky, even when using their trunk and tail for balance.

Nevertheless, there are no documented cases of one falling over when standing on its hind legs. Practice makes perfect, no doubt – just as humans learn to stand on one leg, it takes time for an elephant to be able to stand on two.

0.0015

Speed in kph of the world’s slowest fish, the dwarf sea horse *Hippocampus zosterae*, which grows to just 2.5cm long.

How do seeds know which way to grow?

All plants can sense the direction of the gravitational field and orientate themselves accordingly. This is called geotaxis. In mature plants, phototaxis (growing towards the light source) overrides the gravitational impulse for the stalk and leaves, but the roots – and the seed while it is underground – rely on gravity for orientation.

There are two theories to explain this mechanism. It could be that the protoplasm (the living substance inside a cell) exerts greater pressure on the cell walls at the bottom of the seed. Or it may be that starch grains within the cells settle at the base. One or both of these cues influence the production of plant growth hormones that cause the plant to ‘steer’ as it grows.
Why do fish have vertical tail fins, but whales and dolphins' are horizontal?

This reflects the animals’ evolutionary history. Fish evolved more directly from a wormy creature that slithered along on the sea floor, wiggling from side-to-side, for which a vertical tail is best. Whales and dolphins are descended from land mammals that had evolved to run with limbs beneath their bodies. This means that their spines flex up and down, and so a horizontal fluke evolved to make the most of this movement.

How did some birds lose their ability to fly?

Gradually! Building wings and flying uses lots of energy and food, so natural selection weeds it out when it isn’t really needed. This happened most often when birds settled on islands that had no land predators. In these conditions, birds that spent less energy maintaining wings and flying had an advantage, so they passed on their smaller wings and weaker flight muscles to their offspring, slowly producing a flightless species.

There are about 40 species of flightless birds in the world including ostriches, emus, cassowaries, rheas, kiwis and penguins. A flightless bird has smaller wings, a smaller breastbone (which anchors the flight muscles) and more feathers than flying birds. The smallest flightless bird is the Inaccessible Island rail, which is just 12.5cm long and weighs 33g – that’s less than a small satsuma. The largest is the ostrich, which stands 2.7m tall and weighs up to 166kg. Some species were far larger but, sadly, with no fear of predators, no defences, and no ability to fly away, humans hunted many species to extinction.

HOW DO...

Moving at a snail’s pace – it’s more of a crawl than a slide.

How do slugs and snails move?

Slugs and snails move using a foot – yes, a foot! This muscular organ stretches along the bottom of the gastropod’s body. If you place a slug or snail on a sheet of glass and watch it move from below, you’ll see a rippling effect travel the length of its foot, from back to front. For a while, scientists thought that these contractions caused the animal’s sticky mucus coat to liquefy, allowing the waves to slide the foot forward in sections. But new research shows that the contractions actually lift the foot off the ground to move it, so the mucus is only needed when the animal is climbing vertical surfaces or moving upside-down.
How do birds fly?

Flight gives birds a fairly big set of advantages over other animals. It enables them to forage over a wide area and to catch food on the wing. They can migrate between regions, to take full advantage of seasonal gluts and avoid the coldest weather. Taking to the skies is also a fantastic way to escape predators and to find safe nesting sites to raise their young. Some species even use aerial displays to court mates.

With all these benefits, it’s no wonder that birds thrived once they mastered flight. But it took an impressive set of physical adaptations before birds could conquer the skies.

**TO TAKE TO THE AIR, A BIRD NEEDS:**

**Wings**
These elongated limb and ‘finger’ bones are the ideal frame for feathers. They help to create an aerofoil – similar to the shape of an aeroplane’s wing – which generates lift as the bird flies.

**Streamlined body**
An elongated shape reduces resistance through the air.

**Feathers**
Lightweight, strong and flexible, feathers provide both the wing surface to allow flight and an insulating layer to keep the bird warm and dry. Their shape and coloration may also act as camouflage from predators or, especially in males, be used to attract mates.

**Lightweight skeleton**
Fewer and lighter bones (partially hollow in some of the larger species) reduce the bird’s overall weight, to make flight easier.

**Concentrated centre of gravity**
Most of the bird’s muscles and vital organs are located in the centre of its body to provide balance.

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**THE DYNAMICS OF FLIGHT**

In flight, a bird pulls its wings down using its strong pectoral (chest) muscles, then pushes them up again with its smaller supracoracoideus (wing) muscles. This thrusts the bird forwards and upwards, creating airflow over its wings. The curved shape of the wings creates an area of low pressure in the airflow above them and high pressure below. This pressure difference creates an upward force called ‘lift.’

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**TAIL**
The feathered tail makes a great rudder.

**KEEL**
The ‘breastbone’ provides an anchor for the flight muscles.
**Movement & Migration**

**WING BONES**  
The leading wing edge is made up of the radius, ulna and humerus limb bones. These create the frame for the primary (flight) feathers.

**UPSTROKE**  
The wings are kept slightly folded as they are pushed up to reduce air resistance.

**SUPRACORACOIDEUS MUSCLES**  
These muscles push the wing up, and account for 10-15 percent of a bird’s body weight.

**EYES**  
Birds need excellent eyesight to navigate at speed while in the air.

**FEATHERS**  
Feathers are made from keratin (the same as our fingernails) and come in two forms – large, stiff vane feathers for flight and soft down feathers for insulation. The colours are made by pigments or tiny structures that scatter or reflect light.

**PECTORAL MUSCLES**  
These pull the wings down, and account for 15-25 percent of a bird’s body weight.

**TYPICAL FEATHER STRUCTURE**  
BARBS (1) branch from the main shaft or RACHIS (2). Barbs are hooked together by BARBULES (3), strengthening the structure. A down feather has hookless barbules and is less rigid.

**Why do birds’ wing shapes vary?**

So that they perfectly suit a species’ lifestyle – here are the most common shapes:

**Short and rounded**  
These are ideal for manoeuvring in tight places, so they are perfect for woodland raptors like sparrowhawks, and most passerines, or perching birds.

**Pointed**  
When flapped hard, these streamlined wings enable their owners – such as falcons and ducks – to reach tremendous speeds.

**Long and thin**  
These are ideal for birds like albatrosses, that take advantage of air currents generated above the surface of the ocean to glide effortlessly for long periods.

**Large and broad**  
The large surface area allows bigger birds, such as buzzards, eagles and storks, to soar on thermals and save the energy of wing-flapping. The slots between the primary feathers minimise turbulence.
Sand blaster

Imagine diving into a dune and swimming off like a fish. Well here’s the sandfish that does just that. The aptly named *Scincus scincus* is a small lizard found in the Sahara, and it has a very clever way of protecting itself.

To avoid predators and the relentless sun, the sandfish opts for subterranean travel, plunging head-first into the ground and navigating the safer and cooler subsurface. But, unlike a mole or prairie dog, it does not rely on a network of tunnels – it swims through the sand.

The initial dive is a lot like a swimmer’s front crawl. The lizard alternately extends and pushes back with its left and right limbs, penetrating deeper with each stroke. Once submerged, it pins its legs to its sides and zigzags like a snake, using its whole body to generate enough power. With this method, the sandfish moves itself through a sea of solid particles at about one body length per second – that’s better than an Olympic swimmer can do in the water.

The reptile’s wedge-shaped snout makes a convenient cutting edge and its clear eyelids act as protective windows while the animal moves, but its unique scales are what make its underground journeys possible. Each is covered with countless microscopic, tooth-like protrusions. Believe it or not, this rough surface actually reduces friction to almost nothing, as the weight of each grain of sand is distributed over some 20,000 contact points – the sandfish is more slippery than Teflon. This surface structure is also harder than steel, ensuring the lizard a lifetime of relatively easy travel in its hostile habitat.

Meet the lizard that thinks it’s a fish – it loves to go for a swim, in the sand.
**Q** Why do crabs walk sideways?

**A** Crabs have a wide, flattened shape that makes it easy to burrow into sand or squeeze into narrow crevices, but it does also restrict the range of motion at the ‘shoulder’ joint of each leg. Crabs can actually shuffle slowly forward, but to move much faster they flex the second joint of each leg. These joints are simple hinges, like our knees, and they only bend sideways.

Crabs can move forwards, but they choose to travel sideways.

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**Q** Do insects migrate?

**A** Yes – notably the monarch butterfly *Danaus plexippus*. This large, orange butterfly is renowned for its two-way annual migration in North America, though it’s also found in New Zealand and Australia, where it’s called ‘the wanderer’. In autumn, all of the monarchs in Canada and northern USA migrate south to Baja California and, most famously, the fir groves of Mexico’s Michoacán Province, where they take shelter through winter.

In the volcanic mountains of central Mexico, the cool, sheltered conditions provide the monarchs with a perfect winter refuge: not cold enough to kill them; not warm enough to wake them too early. They arrive in October after their 3000km journey from the USA, and cluster together in a near-hibernation-like state known as torpor. In February, awakening males begin to pursue females in fluttering courtship ballets, before heading north in March, completing the annual two-way migration. Their journey will end when they come across a belt of milkweed, the plant on which the females lay their eggs. But the next generations will press on – some as far as Canada. The full migration spans the life of three to four generations of the butterfly.

The monarch migration spans four generations, yet the butterflies always hibernate in the same trees.
Why do wildebeest undertake the Great Migration?

The circular migration of herbivores actually includes several species – as well as vast herds totalling 1.2 million blue wildebeest, hundreds of thousands of plains zebras and Thomson’s gazelles join the mass movement, along with smaller numbers of other animals (and plenty of predators tag along, too). As a rule, the herds spread across the southern plains of Tanzania’s Serengeti National Park at the end of the year, calving in February before heading north-west, crossing the crocodile-inhabited Grumeti River around July and reaching the border with Kenya’s Maasai Mara around October. They then return south along the eastern edge of Serengeti National Park to settle again in the southern plains.

The animals are driven, despite the many dangers, by the need for water and food; where there is rain, there is also grass to eat. That’s why the migration is not entirely predictable – it depends on the rains.

How did African parakeets arrive in the UK?

The origins of Britain’s rose-ringed parakeets are quite a mystery, but there’s no doubt that they are flourishing now. There are at least 6,000 living in south London! The UK’s first colony was reportedly seen in Norfolk in 1855, but it’s thought they became extinct soon afterwards. There were sightings again in north-east London in the 1930s, but these birds disappeared too. Rose-ringed parakeets were used in The African Queen, a 1951 movie that was partly filmed in Pinewood Studios in Buckinghamshire, and some of those birds did escape. Other parrots flew away from at least one domestic aviary in London during the 1960s, and American rock star Jimi Hendrix allegedly released a pair of rose-ringed parakeets, named Adam and Eve, into the capital in 1969. The species has now been recognised by the British Ornithologists’ Union as a self-sustaining breed.

DID YOU KNOW?
The rose-ringed parakeet is one of only a few parrot species that has adapted to survive in urbanised and deforested areas. So it’s not too surprising that a population thrives in our capital.
How do pond skaters ‘skate’ on the water?

Pond skaters have evolved to take advantage of the molecular forces at work on the surface of still water. H₂O molecules attract each other – this has little impact under the water, but on top, something quite interesting happens. Surface tension, a lot like a tight skin a few molecules thick, forms across the top. This means that, under the right conditions, some objects that are denser than water are able to float on the surface – and this is where the pond skater comes in.

The skater’s body is perfectly adapted to suit this very habitat. Its long middle and back legs spread the (already very light) insect’s weight so that no point bears enough pressure to break through this tension. In fact, where the skater creates indentations in the water’s surface, and it looks like its legs may break through, it actually just increases the water’s surface area. Its body is also covered with hundreds of thousands of minute, water-repelling hairs that prevent the skater from getting wet and becoming heavier.

To move around on the surface, pond skaters scull using their powerful middle legs as oars and their back legs to steer. They use their short front legs to detect even the lightest of vibrations caused by potential prey on the water surface, then to catch and eat the meal once it’s found.

71 000km
Distance of the annual flight of the Arctic tern. This is the longest migration of any bird, as it flies between the polar regions twice each year.
Digesting greenery takes a lot of effort, so hoatzins are quite lazy. They rarely fly, and when they do, they don't go far.
FEEDING
Predators and prey, parasites and plankton-feeders – animals use a spectacular array of methods to forage and feed

Do any birds eat leaves?

Yes – but only one species: the hoatzin of the Amazon Basin is a folivore, or leaf-eater. This so-called ‘stink bird’ reeks of fresh cow manure or sweet-smelling hay, because of its unusual diet. The bird has a special digestive system to process the huge quantity of foliage it needs to provide enough energy.

The hoatzin’s gullet and crop – a food storage pouch near the throat – serve as fermentation chambers. Inside are specialist bacteria that begin the process of breaking down the plant’s tissue. The bird ‘chews’ leaves before swallowing, and ridges inside its crop help to break up the leaf bulk further so it can be processed more easily.

A hoatzin digests its food incredibly slowly. A meal takes up to 45 hours to pass through their systems. This is why these birds loaf around for up to 80 percent of the time – they are effectively chewing the cud.
**Are Komodo dragons venomous?**

The dragon has what would appear to be the perfect tools for predation: 60 serrated, shark-like teeth. Yet its skull and the musculature of its jaws don’t seem up to the task; its bite is just one-sixth as powerful as that of a saltwater crocodile of the same size.

Scientists used to believe that the dragon made up for this with oral bacteria. A Komodo dragon’s mouth provides ideal conditions for up to 57 varieties of potent bacteria, such as *Staphylococcus* and *Escherichia coli*, commonly known as E. coli. Until recently, experts assumed that even a slight nick from those teeth would cause a wound that rapidly went gangrenous. The victim might stagger on for several days before succumbing, but a hungry dragon, tasting the air with its long, forked tongue, could pick up the whiff of death and decomposition to locate prey that perished long after the first bite.

But Dr Bryan Fry, a venom specialist at the University of Melbourne, dissected two dragon heads and found a pair of venom glands in their lower jaws, containing poison as potent as that of the deadliest terrestrial snakes. Fry suggested that the dragon is armed with one of the most complex venom-delivery systems of any reptile. Though snakes can strike faster, the dragon distributes its venom by raking its teeth through its prey’s flesh. The poison lowers blood pressure and impairs coagulation, leading to blood loss and shock.

**DID YOU KNOW?**

An internal examination of a dead ostrich that lived at London Zoo revealed that during its life the bird had swallowed (among other things) an alarm clock, a roll of film, three gloves, a handkerchief, a pencil and a Belgian franc.

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**What do badgers eat?**

In Western and Central Europe, earthworms make up about 25 percent of a badger’s diet. This proportion is often much higher in northern regions, while small mammals are more important in Mediterranean areas. It will also eat fruit, roots, acorns and mushrooms as well as snails, insects, frogs and toads.

While a badger will commonly feed on carrion, it is also very capable of predating birds and mammals, including rabbits and, unlike many predators, spiny hedgehogs.

With thick skin and long claws, badgers can take on the prickliest of prey.

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**How do sailfish use their swords?**

Sailfish, the fastest fish in the sea, are top predators capable of swimming at over 90kph. It was once thought that the sailfish used its long, slender bill to chop and skewer its prey, often sardines, but we now know that the reality is much more subtle. When threatened, sardines form a bait ball – a densely packed spherical shoal. The hunter employs its weapon to knock individuals off balance and away from the protection of the tightly knitted shoal. The sailfish then steers the fish into its mouth with its ‘sword’.

Sailfish often work together to herd and hunt shoals of fish.
The plant that eats shrew poo

They’re like toilets on a stick – for tree shrews. Meet *Nepenthes lowii*, the world’s only known plant that actively collects and consumes poo.

Commonly called Low’s pitcher plant, this faeces fan is found on Borneo’s mountain peaks. It begins life as a normal meat-eating vine, with ground-level pitchers that trap and digest ants and other arthropods. But after maturing and snaking up a tree, it develops a taste for faeces and grows a new type of trap that looks – and functions – a lot like a loo.

Funnel-shaped, with a permanently open lid slathered in buttery nectar, the pitcher attracts a regular patron with a sweet tooth – the mountain tree shrew. The funnel itself is wide and shallow – an ideal place for a shrew to defecate while dining. With its customer’s backside positioned directly above its mouth, the pitcher catches any droppings.

This rather clever adaptation earns the plant a continuous and abundant supply of nourishment in a nutrient-poor habitat. Biologists estimate that 57 to 100 percent of the plant’s nitrogen intake comes from shrew poo.

But it’s a two-way street, since the plant produces plenty of sap – more than any other species in its range. Moreover, the shrew cannot digest fibre – it simply chews the flesh of fruits to extract the juices – making *N. lowii*’s syrup-glazed pitchers that much more important.

Overall, it’s a win-win situation, an exchange of vital nutrients – even if one is eating loads of, well, you-know-what.
Why do squirrels and rabbits nibble bark?

A squirrel will gnaw and eat bark at any time of year, but in summer it’s known to peel off the outer layers of trunks and larger branches. This bark is often discarded, as the squirrels are actually after the phloem, or sap, just beneath the surface. It is abundant in early summer, and is full of sugars.

Squirrels are most likely to strip sycamore, beech, oak, pine, birch locally, as well as sweet chestnut and Norway spruce trees, as these have the thinnest barks. Though great for the squirrel, bark-stripping can allow fungi and insects to penetrate the trunk, causing rot and staining the wood. Not so good for the tree or for timber growers. It can also create weaknesses, leaving the trees vulnerable to high winds and likely to snap.

This is generally a localised problem and usually occurs in woods with a high density of young squirrels – it could be triggered by aggressive interactions between juveniles or exploratory feeding. It is also often claimed that grey squirrels, introduced to South Africa in the early 1900s by Cecil John Rhodes, are the main culprits, but reds are just as guilty.

For rabbits, though the bark is a rich source of food, the nutrition is hard to extract. A rabbit can digest only 14 percent of cellulose the first time it passes through the gut, which is why it will eat its own faeces – increasing the nutrients it absorbs by up to three times.

As such, a rabbit will only go for bark when other, more easily digestible foods, are in short supply.

Why do some parrots eat dirt?

Early in the morning, hundreds of green Amazon parrots and scarlet macaws snack on the clay that lines the river-edge cliffs deep in the rainforest. Yet, no one truly understands why they eat clay for breakfast.

Geophagy – the scientific term for eating dirt – is widely observed in parrots, but South America hosts the most clay-eaters. Some studies have found that the soils absorb toxins in their diet, and so may aid digestion or protect the birds from being poisoned.

However, all American macaws, whether Central or Southern, share a similar diet, and yet not all of them eat clay. Analyses show that parrot geophagy in South America is restricted to areas with the lowest available naturally occurring sodium. It is therefore likely that the parrots lick clay for its salt, rather than its anti-oxidants.

Unconventional supplement – parrots enjoy unusual snacks.
Q Why do cats play with their prey?
A Many small cats give live prey to their kittens from the age of about a month. The cubs of larger cats are offered live prey from when they leave the den, at about two months old. It may seem cruel, but it’s through play like this that kittens and cubs learn how to tire and disorientate prey before killing it, thus reducing their risk of injury.

Q Do snakes eat armoured animals, such as turtles?
A While some species of snake have a narrow range of prey, others generalise, eating a much wider variety of animals. In addition, many snakes are opportunistic, tackling anything they can overpower. Some consequently predate unusual animals, such as those that are protected by scales, shells or spines.

There are records of African rock pythons eating pangolins – also called scaly anteaters – and porcupines, and it is well known that anacondas regularly include caiman crocodiles in their diets. Similarly, Florida’s invasive Burmese python has been recorded preying on small alligators.

Despite being protected by hard shells, many tortoises, especially the younger ones, also fall prey to snakes. For example, puff adders are known to eat leopard tortoises in Southern Africa, and hatchlings are probably snatched quite often. Indigo and rat snakes feed on young gopher tortoises in North America, and the remains of baby angulate tortoises have been found in the faeces of Cape cobras.

Snakes digest tissue and bone, but not fur, feathers or scales, so evidence of their diet can be found in their excrement, if people have the inclination to look!

Large snakes can go for months without eating – this boa constrictor may only eat four or five times a year.

HOW DO...

Venus flytraps trap flies?
The Venus flytrap Dionaea muscipula is a carnivorous plant that ensnares and digests animal prey, particularly insects and spiders. The trap is sprung when an unfortunate insect brushes against two of the touch-sensitive hairs on the leaf surface within about 20 seconds of each other.

Stretch receptors in the base of the hairs then trigger an electrical signal that spreads across the leaf, causing the cells on the underside of the lobes to expand rapidly (it is still not known whether they take on water or change the shape of their cell walls). When open, the lobes curl onwards at the edges. But the swelling cells cause the lobes to buckle inwards and snap shut.

Though the plant has evolved to digest insects, larger strains have occasionally been found to contain the skeletons of small frogs.
What creatures other than mosquitoes feed on blood?

A surprisingly (or perhaps unsurprisingly) large number of species target blood. The essential sanguine fluid carries oxygen and nutrients to brains and, indeed, around the other parts of bodies. Superficially, blood may seem like a strange thing to consume. Not so – at least from an evolutionary perspective. It’s rich in protein and lipids – a power drink, if you can get to it. The trick is access.

As any fan of horror films can tell you, sucking blood relies on stealth. It requires piercing mouthparts, be they teeth, a needle-sharp proboscis or even a beak. It also often depends on special chemical contrivances to keep the blood flowing, inhibit the immune system from reacting and, of course, prevent your chosen victim from smacking you dead. Yet blood-feeding – haematophagy – has evolved again and again.

Only the female mosquito sucks blood – it’s essential for egg production. Reproduction aside, most of the insect’s fuel comes from nectar and plant juices.
**Vampire bat**

When we think of vampires, we think of bats. But of more than 1,200 bat species, only one subfamily, *Desmodontinae*, has evolved a fondness for blood. The so-called vampire bats find mammals (or, in the case of one of the three extant species, birds) by listening to their victims’ breathing and, once landed nearby, sensing the heat of blood’s friction beneath the skin to find the spot to bite. A bat can double in weight during a blood-sucking session. The most common species, and the only one to feed on humans, is *Desmodus rotundus*. Though they transmit rabies, their overall impact on humans may be beneficial. The active ingredient of the drug Desmoteplase, used to increase blood flow in stroke patients, is an anticoagulant found in the bat’s saliva. A bat might save your life...

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**Candirú fish**

No man wants a fish to swim into his penis – which is just what one catfish, the candirú, is reported to do, though the frequency of such attacks may well be exaggerated. The candirú’s usual tactic is to swim inside the gills of a fish to suck blood from its major arteries. The blood is pumped at force by the host’s blood pressure into the submarine vampire, which delights not only in the blood itself but also in the lift it catches. Candirús have been shown to ride along with hosts for thousands of kilometres: theirs is the ultimate ‘lunch to go’.

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**Vampire moth**

If you have any doubt about the irresistible temptation posed by the blood of humankind, you need to talk to Jennifer Zaspel, an entomologist at the University of Florida. She has discovered a group of formerly fructarian moths that at some point in recent history departed from their fruit-only diet in favour of human blood. The moth uses its hook-and-barb-lined mouthparts to pierce human skin and feed. It’s a fascinating snapshot of a key step in the evolution of bloodsucking.

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**Sea lamprey**

Marine mammals – lacking gills and proximity to fresh water – are exempt from assaults by the candirú (see above), but they are not entirely free from the attentions of vampires. Like salmon, the sea lamprey goes on barotrauma grimmages up rivers to reproduce before returning to the sea, followed by its offspring. But while the salmon that make it back to the open ocean go about their business of eating small fish and invertebrates, an adult sea lamprey fastens its mouthpart – a sucker lined with rasping tongue and teeth – onto the skin of fish and whales, and imbibes.

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**Vampire finch**

Charles Darwin witnessed many curiosities in the Galápagos Islands – notably, of course, the many varieties of finch that informed his theories. But Darwin missed some things, among them the darker side of *Geospiza difficilis seaptentrimonialis*, a finch subspecies endemic to the Wolf and Darwin Islands. Its main diet is seeds and insects. But this vampire finch also has a thirst for blood. It crawls onto the backs of seabirds and uses its long bill to peck into blood vessels at the bases of its hosts’ feathers. Its home islands are some of the driest among the Galápagos, so perhaps it partakes of its gory refreshment for lack of another source of liquid.

Or perhaps not. It has been speculated that the first step in the finch’s road to parasitism was feeding on the parasites, such as ticks, that themselves feed on the seabirds. It may then have evolved to cut out the middle-man, taking its feed straight from the source.
Strangely but True...

Vicious circles

It may be smaller than a koi, but the cookiecutter shark *Isistius brasiliensis*, found in warm waters throughout the world, can tear apart animals many times its size, from seals to other sharks.

Once it locks its lips onto a flank, it creates a vacuum by quickly retracting its tongue. At the same time, it sinks its saw-like teeth into the victim’s flesh and spins its body, carving out a distinctive circular ‘cookie’ of tissue. A school of cutters can make Swiss cheese out of a swordfish in a matter of seconds.

A weak swimmer, the cutter relies on stealth to feed. It spends its life at the edge of darkness, moving vertically one kilometre or more a day, rising as the sun sets. In fact, it actually produces light to hide when out in the open. Its belly is covered with bioluminescent cells called photophores that emit a greenish glow, which blends into the sunlight.

But this is not its only optical illusion – it also has a dark oval collar that spans from gill to gill, which, from below, appears to mimic the silhouette of a small fish. In this way, the shark boldly lures in some of the ocean’s quickest and most successful predators, dodging their strike to inflict a bite of its own and then melting into the darkness with a mouthful of flesh.

The shark’s brave strategy blurs the distinction between predator and prey, making victims out of adept hunters. It is the only known animal to use light to camouflage itself and the absence thereof (the dark patch) to attract attention.

Turning the tables on top predators, this little shark can attack great whites, dolphins and killer whales.
How much do lions eat?

On average, male lions need to eat about seven kilos of meat each day to survive. Females require a little less - about five kilograms. However, in the wild they may go a few days without a kill, so lions may eat much more than this in one sitting.

What did the woolly mammoth eat?

The ancestral mammoth *Mammuthus meridionalis* lived in warm tropical forests about 4.8 million years ago and probably had a similar diet to the modern Asian elephant. The woolly mammoth *Mammuthus primigenius* evolved later, as the climate cooled, and was a grazer. It likely used its tusks to shovel aside snow, then uprooted tough tundra grasses with its trunk. Both species needed to be so big because their stomachs were giant fermentation vats for grass - which is not very nutritious.

Lyuba, a baby mammoth found preserved in the Siberian permafrost in 2007, had adult feaces in her stomach, suggesting mammoth babies ate their mother’s dung in order to introduce ‘good’ bacteria into their digestive system.

Do spiders need to drink?

All living organisms need water. Web-spinning spiders catch dew in their webs and drink the droplets, or even consume the entire web – along with the water. Hunting spiders can drink dewdrops or nectar from flowers. A few desert species, such as the black widow, can get all the water they need from the bodies of their prey.

Do fish have tongues?

Most fish have a bony structure called the basilval on the floor of the mouth that superficially resembles a tongue. But it doesn’t have taste buds, isn’t muscular and has very little motion, so it isn’t directly equivalent. It probably evolved to protect the ventral aorta (the major blood vessel from the heart), which lies very close to the mouth, from impacts with large, wriggly food.

Unlike a mammal, a fish’s taste buds are not inside its mouth.
**What would be the most nutritious animal to eat?**

Some kind of marine mammal – probably a seal or a whale. Their carcasses are rich in protein and covered with thick blubber that is wonderfully caloric. In addition, the fresh meat and skin of both whales and seals are high in vitamin C.

**How do snails eat?**

A snail (or, indeed, a slug) grazes using its radula, a scraping tongue armed with rows of replaceable teeth. As the animal moves forward, it swings its head from side to side while repeatedly rasping the surface with its radula.

The radula picks up a good deal of non-edible grit, dirt and soil along with particles of food. Whatever is collected is drawn off into the first part of the gut. There, food particles are separated from the rest and moved into a side sac to be digested. Everything else carries on through the gut and is deposited as undigested green faecal strings. The colour comes from any plant material that remains mixed in.

It's possible to tell what a slug or snail has been eating by examining these green droppings, since many plant cells pass through the gut unscathed. The waste from the digested food is normally black, and forms a dark 'liver string'.

**Why do crocodiles eat stones?**

Crocodiles are renowned for their appetite for flesh, but they also swallow stones. Once these have been ingested, they become known as gastroliths.

Gastroliths have been found in the stomachs of dinosaurs, the crocodiles' long-lost cousins. Theories abound as to their purpose: could they be intestinal cleaners, or act as ballast, helping the bulky animals to dive underwater? We don’t know, but the most likely role is to grind up food into a digestible paste, in much the same way that birds swallow small stones and grit to help digestion. Like birds, crocodiles can’t chew, so they bolt down chunks of flesh whole.

Humans swing their jaws from side to side, to chomp up food before swallowing. Without articulated jaws, we too, might have to serve up stones with dinner.
Why do herbivores sometimes eat bones?

Bone-eating, or osteophagia by its scientific name, is common in herbivores, but its purpose is not fully understood. Bone contains lots of calcium and phosphate, and research on cattle and sheep has linked osteophagia to a lack of these minerals in the diet. The animals seem to develop a taste for bone when blood plasma chemicals warn them that they are drawing on the phosphate and calcium reserves in their own skeletons. As the tallest animals on Earth, giraffes have huge requirements for both minerals—particularly during their first five years—and the species is often seen tucking into a skeletal snack. Adult giraffes apparently get enough calcium by selective browsing, so the theory is that, for these long-legged grazers, bone-chewing is more about phosphate. This mineral appears to be in short supply during winter, when osteophagia is most frequently observed. Case proved, you might think. But in 2008, scientists immersed bone samples in solutions that replicated saliva and stomach acid. They found that, even after 30 days, no significant minerals had been extracted.

DID YOU KNOW?

Giraffes can spend most of their time standing still, so nutrition is wholly channelled into growth. They develop quickly, reaching a height of one metre within six months.

Being six-metres tall, giraffes need a lot of nutrients—including rare minerals.

Herbivores are a funny lot. Giraffes eat whole birds’ nests with the chicks inside, fallow deer feed on frogs and cows sometimes chew bones when they’re bored.

QUIZ

Try to identify the six mammals that use these pairs of nostrils to sniff out their food. Turn to page 130 for answers.

1 2 3

4 5 6
A sea horse has no teeth and no stomach – food passes through it so quickly it has to eat almost constantly to stay alive.
REPRODUCTION

Without it, everything would die out. But how do animals go about finding a suitable partner with whom to breed?

Why do male sea horses become ‘pregnant’?

Sea horses display a kind of reversed pregnancy – after fertilisation, eggs are transferred into the male’s brood pouch to develop. The father makes quite an investment in terms of time and energy. The eggs receive oxygen and protection, and gestation lasts from 14 to 28 days, after which the male gives birth to live young known as ‘fry’. These diminutive offspring are at the mercy of predators for the first few weeks of their lives: only a tiny fraction will survive to adulthood.

By passing the eggs to her mate, the female can invest her energies in producing more eggs immediately after transferring the previous batch – so almost as soon as the male gives birth he becomes pregnant again. Thus, each mating pair can produce and brood eggs continuously throughout the breeding season, maximising the number of offspring that might survive.

Brooding is an ideal reproductive strategy for fish that produce small numbers of eggs, resulting in greatly reduced predation. At the other extreme, ‘broadcast spawners’ each release tens of thousands of eggs into the water column for external fertilisation. Few will survive, but meaningful parental care of such large numbers of eggs would be impossible.

DID YOU KNOW?

A male sea horse may incubate broods of up to 1500 eggs.
What bird laid the biggest egg?

The largest egg on record weighed 2.589 kg and was laid by an ostrich in Sweden in 2008. However, one now-extinct bird laid much bigger eggs – the Aepyornis, or elephant bird.

The fate of the elephant bird is one of Madagascar’s great natural-history riddles. A flightless giant standing four-metres tall, this was the biggest bird ever to walk the Earth. It once thrived across the island, but vanished several centuries ago. No one is sure what caused it to die out, but it was probably ‘death by 1,000 cuts’ – a combination of egg collection by humans (though there is no proof of this), habitat loss and climate change.

Amazingly, remains of elephant bird eggs can still be found on a remote beach at Cap Sainte Marie, the island’s wind-swept southernmost point. These broken, creamy-white eggshells, each obviously the remains of a huge nest several metres wide, may have lain on this beach for 1,000 years – the last echo of an astonishing animal.

How do lichens reproduce?

A lichen is a symbiotic association between a fungus and an alga, or cyanobacterium. Although the fungus body normally completely surrounds the alga, the algal cells aren’t inside the fungal cells. Most lichens reproduce asexually, when conditions are good they will simply expand across the surface of the rock or tree. In dry conditions, they become crumbly – small pieces break off and are dispersed by the wind. The fungal component of many lichens will also sometimes reproduce sexually to produce spores. These spores must meet up with an algal partner in order to form a new lichen.

There are approximately 17,000 species of lichen.

Which mammals breed the most slowly?

Orangutans have the longest interbirth interval of any land mammal. On average, females produce one baby every seven to eight years, raising just three or four young in their lifetime – which is one reason why conservation of the species is such an important challenge. Even the female blue whale reproduces every two or three years.

Number of eggs laid by a termite queen in just one day – no wonder termite colonies grow so large.
Three times lucky

In a world where it can seem that nothing is built to last, here is a creature that takes disposability to new extremes.

Like the majority of nudibranchs, *Chromodoris reticulata* is a simultaneous hermaphrodite. Copulation is a two-way affair, with each participant inserting its penis into its partner’s vagina. But much less conventional is what they do with those penises once mating is all over: after a struggle to disentangle themselves, both partners shed and discard them.

However, this obviously presents a problem if the nudibranch needs to mate again. Fortunately, it can grow another penis within 24 hours, rolling it out from an internal coiled reserve that contains enough for at least two replacements. Substitutes are necessary because the penis is covered in backward-pointing spines – thought to scrape rival sperm out of the vagina – which can cause the organ to get jammed and damaged during separation. Disposability ensures that there’s a working penis ready for next time.
**WHAT’S IN A NAME?**

**Puffball mushroom**

*Lycoperdon spp.*

This genus of mushroom is named after the species’ circular shape and the way it ‘puffs’ out its spores. But it’s hard to look at it in the same way once you know that the literal translation of its Greek scientific name is ‘wolf fart’.

**DID YOU KNOW?**

Flamingos are not naturally pink. The tiny green algae they feed on turns pink during digestion, which is what gives flamingoes their distinctive shade.

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**Are any vertebrates hermaphrodites?**

**A**

Yes – including several species of reef fish. Most are sequential hermaphrodites, being born as one sex but then changing to become another. Barred hamlets are among the few vertebrates that are simultaneous hermaphrodites – they are sexually active as both males and females throughout adulthood. When mating at dusk they follow a ‘little but often’ approach known as egg-trading, in which the couple exchange sexual roles several times within 30 minutes to ensure that both partners perform an equal role.

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**How do frogs find their way back to the ponds in which they were born?**

**A**

The most established theory, put forward by frog scientist Ronald Maxwell Savage more than 30 years ago, is that frogs and toads follow the smell of algae growing in ponds in spring. This is supported by observations that frogs often head upwind from hibernation sites towards breeding ponds, and are notoriously pernickety about the weather – typical conditions for frog migration are mild, wet nights (to keep their skin damp) following longer sunny days (which encourage algal growth).

But other factors are likely to be involved. Frogs have been reported arriving in gardens after ponds have been filled in, in some cases spawning on the wet grass. If these individuals were returning to the sites of their natal ponds, then memory must play a part, too.

There is more experimental data about toad travel. By fitting the amphibians with tracking devices, researchers have discovered that they use a suite of sensory techniques to locate their breeding ponds: olfaction (like frogs), magnetic cues and, especially when nearing their destination, vision.

These findings aren’t particularly surprising, given that some toads can travel more than one kilometre back to their spawning grounds. For these individuals, every little cue counts.
Do other mammals produce identical twins?

Though many animals occasionally give birth to multiple identical offspring, the nine-banded armadillo produces identical quadruplets as standard.

The strategy seems to combine the worst aspects of sexual and asexual reproduction. In asexual reproduction, a parent produces clones of itself – a proven genetic winner who has survived to reproductive age. And normal sexual reproduction produces offspring with a variety of genetic combinations in the hope that at least some will prosper in an unpredictable, hostile environment. But an armadillo’s offspring are all identical copies of an unproven genetic combination. So why do they do it? A quirk of the female’s reproductive apparatus means that there is just one site in her uterus for a fertilised egg to implant. So splitting the embryo is the only way she can produce more than one baby at a time. And, against the odds, it works.

How do slugs mate?

Courtship in any animal has two functions – to ensure that mating takes place with a member of the same species, and to select the finest possible partner. So courtship involves species level identification and tests of vigour.

The mating ritual of slugs may appear bizarre, but it has evolved to fulfil both of these functions. Slugs are hermaphrodites. During intercourse, each suitor simultaneously delivers a packet of sperm to its partner’s storage organ. To do this, they evert parts of their genitalia and lock them together, as shown in this photo.

In slugs, identification of suitable mates is first by smell, second by courtship behaviour and third by the unique interlocking devices developed by each species. The leopard slug Limax maximus and its close relatives copulate while suspended from a mucus pad. This behaviour is one of the ways that slugs can ensure that they are mating with members of the same species. In addition, such exertions and the production of a lot of mucus ensure that intercourse only takes place between individuals at the peak of their physical condition.

Are pandas less fertile than other species?

No. They’re more fertile than some and less than others. The fertility rate per individual is how many offspring they have. Giant panda cubs weigh only 8.5–140g when born, rely on mother’s milk for at least a year and leave their mother at 18–24 months. So, in the wild, pandas give birth to roughly one cub every two years.

This is a minuscule fertility rate compared to rats or rabbits, but much greater than humans. Their reputation for sluggish breeding comes from their unwillingness to mate in captivity. However, the good news is that in July 2009, Chinese scientists confirmed the first birth of a panda cub using artificial insemination from frozen sperm.
The yellow spotted monitor lizard, native to Australia, is known to stand on its hind legs, using its strong, muscular tail for balance.
How do virgin births occur?

Though the ‘virgin births’ of the Komodo dragons that hatched at London Zoo in 2006 made headlines around the world, they did not come as a complete surprise to zoologists.

Parthenogenesis is most common in invertebrates, and is the only form of reproduction in some rotifers and mites. In vertebrates it occurs most frequently among lizards and snakes. In total, about 100 species of vertebrates, including amphibians and fish, are capable of reproducing from unfertilised eggs, producing clonal, all-female populations.

In some circumstances the ability to switch from sexual reproduction to parthenogenesis could be beneficial, since females can then reproduce if no males are available.

A species’ potential for parthenogenesis usually becomes apparent when females isolated from males for several years in zoos or aquaria unexpectedly produce offspring. Modern methods of DNA analysis provide unequivocal proof that the offspring are clones, eliminating the possibility that the female egg might have been fertilised by sperm stored from past male contact.

Populations of parthenogenetic females that can all give birth ought to outcompete sexual populations, because population growth rate is much greater when every individual can give birth. This prompts one of the fundamental questions in evolutionary biology: why did sexual reproduction, with its unproductive males, energetically expensive sexual ornament and courtship rituals evolve?

The decisive factor may have been pathogens. Genetically uniform, clonal populations can be devastated by diseases to which all individuals are equally susceptible. Molecular evidence shows that one unisexual fish species Poeciliopsis monacha-occidentalis has survived by parthenogenesis for 60 000 years.

Sexually reproducing populations, whose members inherit random combinations of genetic traits from two parents, are genetically variable and more likely to include disease-resistant individuals, enhancing a species’ long-term survival prospects.

Why sex matters
Whatever the cause of its evolution, sexual reproduction, with all of its accompanying courtship adornments that promote sexual selection among potential mates, has been a powerful force in evolution. Without it, red deer antlers and a robin’s song would be redundant.

In some invertebrates, such as water fleas and some gall-forming wasps, alternating between reproductive modes is a routine strategy in annual life-cycles. Genetically variable, sexually generated eggs provide the best survival insurance during periods of winter cold or summer drought, while female-only parthenogenetic reproduction allows a return to maximum reproductive potential after the eggs hatch in spring. In aphids, parthenogenetic females hatching from overwintering sexual eggs produce live young with clonal offspring already developing inside them. This strategy often generates aphid, or greenfly, population explosions in spring.

DID YOU KNOW?
Parthenogenesis occurs in lemons. Multiple plants that sometimes sprout from single ‘pips’ arise from embryos that develop without sexual fusion.

INVASION OF THE CLONAL CRAYFISH
The parthenogenetic potential of the North American marbled crayfish Procambarus fallax was discovered by German aquarists in the 1990s, and it has since been distributed on three continents via the aquarium trade. P. fallax is now invading Madagascar, threatening its native freshwater biodiversity.

Female sexually reproducing organisms that arrive alone in an isolated habitat are doomed to die out unless, like this species, they’re capable of parthenogenesis.

Every individual in the burgeoning all-female P. fallax population produces offspring. Even if each one left just two descendants, the population could double after each generation. In fact, P. fallax produces hundreds of parthenogenetic eggs and is six times more fecund than native Madagascan crayfish.
Left-handed love

Finding a compatible mate is hard enough at the best of times. But for one Latin American fresh-water fish, half of the members of the opposite sex can be ruled out before the search has begun. *Anableps anableps* is a peculiar fish for many reasons. First, as its common name – four-eyed fish – suggests, each of its eyes is divided in two, allowing it to see above and below the water at the same time. *A. anableps* also bucks the piscine convention for external fertilisation. Instead of casting his sperm into the water to mingle with the female’s eggs, the male uses a specialised fin, known as a gonopodium, to inseminate her internally.

But most baffling is that, though these fish mate side by side at the surface, the gonopodia of some males can be manoeuvred to the left, and that of others to the right, but never both left and right. Likewise, a female’s genital opening can only be entered from one side or the other. This means that ‘left-handed’ males can only mate with ‘right-handed’ females, and vice versa.

Heaven only knows why nature has made *A. anableps*’ love life so complicated. Perhaps that’s why these diminutive fish keep half an eye on the sky.
**Q** Is it true that when you cut a worm in half it becomes two worms?

**A** In most instances, if you cut an earthworm in half you end up with a dead worm. But if a cut is made near the tail and most of the body is left intact, the worm can heal and partially regenerate the tip of its body. However, if you surgically divide a flatworm (planarian) down its midline or across its middle, both halves can regenerate fully. These are not experiments we’d advise – they’re cruel, and not normal methods of reproduction!

![Earthworm](image)

Sadly, if you cut an earthworm in half you don’t end up with two worms.

**What’s in a Name?**

**Great crested grebe**

**Podiceps cristatus**

The great crested grebe’s scientific name translates from the Latin as ‘crested arsefoot’ – a light-hearted reference to its legs, which are positioned a long way back on its body. ‘Arsefoot’ is also an obsolete English name for grebes in general.

**DID YOU KNOW?**

A female leatherback sea turtle will lay approximately 200 eggs at a time. However, on average only two of these will survive to adulthood.

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**Q** Which animal has the most sex?

**A** It’s a hung jury, but several members of the animal kingdom have racked up impressive results. A North African desert rodent, Shaw’s jird was observed mating 224 times in two hours. Hamsters can have sex up to 75 times a day, and lions have been known to copulate 157 times in 35 hours. Giant water bugs are known to mate more than 100 times in 36 hours.

![Jirds](image)

The Shaw’s jird has been known to mate 224 times in just two hours.

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**Q** Do any birds feed their offspring with milk?

**A** Yes – but only two types of bird. Pigeon ‘milk’ is a cottage cheese-like fluid secreted from the lining of the crop. Flamingos are the only other birds to feed their young this way.

![Birds](image)
Why do some animals take part in mass nestings?

Though lots of the newly hatched young are taken by predators, when large numbers emerge virtually simultaneously, each individual’s chance of survival is greater when part of a crowd. Possibly the best-known mass nestings are those of turtles. In fact, only two of the world’s chelonians (turtles, terrapins and tortoises) take part in spectacular mass nesting: the olive ridley and the closely related Kemp’s ridley. So what causes the sudden rush of females? It often takes place close to the last quarter of the moon, so the lunar cycle is a strong contender. The tide might be another factor, since the largest arribadas (nests) occur at high tide. Offshore winds may also play a part as some experts think that pheromones are released en masse by females.

In Costa Rica, olive ridleys nest during the rainy season. Females start gathering off the nesting beach a few weeks before the event, which tends to start slowly at first, with the numbers building rapidly over the next three to seven days.

However, arribadas do not always occur when predicted. In fact, a typical female is more likely to nest on her own than with others, and may choose to alternate between the two strategies.

Synchronised breeding is a better-known phenomenon – any marine animals, from fish to worms, display similar sorts of behaviour. People in California and Baja California refer to the breeding behaviour of grunion, a small fish, as ‘silver tides’. During large grunion runs the surfline is swamped with fish. The females push their tails into the wet sand to lay their eggs while the males release sperm. Females spawn up to six times each season and can produce between 1,600 and 3,600 eggs each time.

Adult red crabs live in the forested interior of Christmas Island and stream to the coast in November and December to breed – the most spectacular crab migration in the world. Each female releases up to 100,000 eggs into the sea. After hatching, larvae drift in swarms of millions, attracting manta rays and whale sharks.

What is the difference between a nut and a seed?

In botanical terms, a nut is a specific type of seed – one that occurs singly and with a hard shell; an acorn is a perfect example. So all nuts are seeds, but not all seeds are nuts. Confusion also arises because the word ‘nut’ is used to describe seeds that are not true nuts, including peanuts, almonds and coconuts.
Why do some flowers look like insects?

It’s all about sexual deception – a strategy of which the orchids are masters. The orchid genus *Ophrys* contains many species that resemble female bees and wasps in order to entice male insects to attempt to mate with them – thus pollinating the flowers. *Ophrys speculum* from the Mediterranean is a prime example, it even has a blue patch that looks uncannily like light reflected from the folded wings of a wasp. But there’s another hidden sexual attractant – the orchid has evolved a scent that exactly mimics the come-hither aroma of female wasps, provoking a sexual frenzy in males. Browse the perfume counter in a department store and you’ll be left in no doubt that fragrances are potent sexual signals – an evolutionary conclusion that *Ophrys speculum* and its enslaved wasps reached millions of years ago.

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**FUR, FEATHERS, SCALES**

Animals have many different coverings to their bodies. Can you identify all six of these beasts? Turn to page 130 for answers.

1.  
2.  
3.  
4.  
5.  
6.
Scalloped hammerhead sharks live in warm, coastal regions.
If animals are to give themselves the best chance of survival, they have evolved in some strange and cunning ways.

**Why do hammerhead sharks have hammer-shaped heads?**

These sorts of 'why' questions are tricky. We can get ideas from how the various hammerhead species use their bizarre 'cephalofoil', but those aren’t necessarily why it originally evolved. Nor why other sharks manage fine without it.

Basically, the head provides extra lift and manoeuvrability, wider eye separation and greater area for sense organs, such as smell and electric-field detection. In some species, it helps pin down struggling prey. However, unless something has evolved separately several times over, it can be difficult to declare what selection pressures were involved.

Fortunately, hammerhead species with very different head shapes and sizes exist. Very recent DNA-based family trees of these eight species reveal something unexpected: species with astonishingly wide heads, like the winghead shark *Euphyra blochii*, branched off first. That implies the cephalofoil started huge before evolving into the much smaller heads seen in, say, bonnethead sharks *Sphyra tiburo*. It has been suggested that this indicates a role for extreme sensory advantage — increased binocular vision or olfaction — rather than hydrodynamics.

A team at Florida Atlantic University measured the visual fields, eye rotation and other faculties of three hammerhead species with different head widths. They found that, despite hammerheads’ eyes being so far apart, they can see beyond their noses better than other sharks. That is, when looking straight ahead, the visual fields of their two eyes have more overlap, giving them binocular vision and thus depth perception over a larger area. Also, the wider a shark’s head, the more it sees in 3D.
**How do frogs breathe?**

Though frogs have lungs, a great deal of their respiration takes place through their skin, which is permeable. As a result, hibernating frogs can survive under the ice of frozen ponds, as long as oxygen levels in the water don’t drop too low. Creating holes in the ice ensures that a pond’s oxygen supplies won’t deplete entirely.

**Are any birds poisonous?**

Yes, native to Indonesia and Papua New Guinea, the hooded pitohui *Pitohui dichrous* was the first bird discovered to be poisonous. It is thought to acquire the neurotoxin homobatrachotoxin by feasting on the chloresine beetles of the *Melyridae* family – also a likely source of the toxins found in Colombia’s poison dart frogs. The bird’s feathers and skin contain the toxin, which causes numbness and tingling in those who touch it. The local human population, who eat hooded pitohui, rub its meat in charcoal to counteract the venom.

**How do penguins dive so deep?**

Emperor penguins *Aptenodytes forsteri* go on regular underwater forays to hunt fish. They may remain submerged for 20 minutes or more and dive hundreds of metres deep, all on a single breath of air. They have normal lungs for a bird their size, so how do they do it?

Biologists from Scripps Institution of Oceanography fitted wild penguins at McMurdo Ice Shelf, Antarctica, with miniature sensors (and depth recorders) to gauge the birds’ vital signs before, during and after dives.

The data revealed some surprises. Even before a penguin hits the water, its heart starts to race and it hyperventilates, which primes its muscles with oxygen. Then it dives in and does something, well, breathtaking: it cuts off the blood supply to its muscles to conserve dissolved oxygen for the rest of its body. At the same time, the bird pumps its veins with oxygen-rich blood, possibly to plan ahead – during a long dive, its heart rate may fall to as low as six beats per minute. With so little circulation through the lungs and ever-lower air stores, it may pay to load up with the vital gas before getting in too deep, so to speak. In this way, a penguin pushes its body to, but not over, the limit. Ultimately, the bird surfaces, takes a deep breath and swiftly flushes its now-starved muscles with oxygen without delay. In just minutes, it fully recovers from its dive.

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**4.3m**

Span of the Irish elk’s antlers, an extinct species of giant deer. These mighty antlers weighed 45kg.
Big, bad, furry frog

An amphibian with fur? A frog with sharp, cat-like claws? Either might sound improbable, and Africa’s hairy frog *Trichobatrachus robustus* is certainly stranger than fiction. This 11cm-long amphibian is hairy during the mating season, when the male develops a thick bristle-like fringe along his flanks and thighs. This is actually a mass of thin strands of skin replete with blood vessels, and is a temporary organ that may boost breathing ability in times of need — the male guards his mate’s eggs and may remain underwater for days without coming up for air.

But this frog has another clever survival trick. With the flex of a foot muscle, it can produce an arsenal of sharp, curved claws that snap out of its toes like switchblades. These thorn-shaped toe bones rapidly pivot when triggered, sending the pointed tip slicing through the frog’s skin and transforming its feet into formidable weapons. A few violent kicks can lacerate a foe and draw blood from an unsuspecting biologist. People in Cameroon, who hunt these frogs for food, use spears and machetes to avoid handling them.

The triggered claw bones eventually move back into place and the toe wounds heal over — until the next time the frog needs to pull out its blades.
**Are any mammals venomous?**

Venomous mammals are only slightly more common than hens with teeth. Very few are known – namely the slow lorises, the European mole and water shrew, the short-tailed shrew, the Cuban and Haitian solenodons and the duck-billed platypus. (The European hedgehog is thought to possess venomous saliva.) All use their venom to subdue prey, except for the platypus, which exudes its poison from defensive spurs on its hind legs.

Several species of slow lorises are found across South and South-East Asia. It has a venom delivery system that is unique among primates – a venomous bite. It produces venom itself but also supplements it with toxins absorbed from its food. The poison initially oozes from brachial glands located on the insides of the lorises’ forelimbs, near the elbows, and is then transferred to its mouth by licking, where it is ‘watered down’ with saliva. When threatened, a loris pushes its hands over its head in what looks like a brace position, exposing these glands to the attacker.

The venom smells like pungent sweaty socks. But if this olfactory assault doesn’t work, the ‘hardware’ comes into play and the loris delivers a nasty bite using a collection of specialised incisors and canines known as a ‘grooming comb’, which are located at the front of its jaw. The effect of the poison depends on the victim’s sensitivity. At best, the affected area will go numb; at worst, anaphylactic shock will set in.

**Why do lions have manes?**

Manes convey a range of information about their owners’ status. Long, dark manes are signs of peak condition, attracting females and intimidating other males, whereas lions with shorter, blonder manes are perceived as less threatening. Dark-maned males are winners. They tend to be well fed, have high testosterone, are more likely to survive wounds, last longer as pride males and father more cubs that survive to adulthood.

The downside to having a dark mane is that it soaks up heat, raising body temperature and lowering sperm counts. So it is better for lions in hot regions, such as Kenya’s Tsavo National Park, to have short or no manes – the famous ‘Man-eaters of Tsavo’ were maneless.

The darker the mane, the more attractive the lion is considered.
**Do whales and dolphins ever suffer from the bends?**

No. Cetaceans don’t suffer from the bends, or caisson disease, because they don’t hold their breath underwater in the same way humans do.

When we dive, we breathe pressurised air, and nitrogen gas dissolves in our body tissues. If we return to the surface too quickly, the sudden reduction in pressure makes the nitrogen revert to gas, forming bubbles in our brains, central nervous tissue, blood vessels and joints, causing severe pain and even death.

Instead of keeping air in their lungs when they dive, like humans, cetaceans store oxygen in their bloodstream and muscles. Humans do this, too, but whales have an abundant supply of haemoglobin and myoglobin proteins that help them to absorb a much higher concentration of oxygen than we can. And, of course, they have a lot more blood.

When a cetacean dives, the water pressure causes its lungs to collapse, forcing the air into the trachea (windpipe) where it cannot be absorbed into the bloodstream. This prevents nitrogen from saturating its blood, which is the main cause of the bends.

Despite their special adaptations, there have been cases of internal haemorrhaging and symptoms of the bends in some beaked whales. There seems to be a link between these symptoms and loud sounds, such as those produced during military exercises, which may cause cetaceans to surface unusually fast.

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**How do geckos walk on ceilings?**

To understand this, you must think small – very small. Instead of using glue, suction or friction, geckos harness van der Waals forces – the tiny forces of attraction that arise between atoms when they get very close together. To achieve the closest possible contact with the surface it’s walking on, gecko feet have millions of hairs, which subdivide into many tinier ones – about a billion in total. The lizard breaks the bonds just by changing the angle of contact, which it does by peeling its toes away like tape.

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**DID YOU KNOW?**

Sperm whales are believed to be able to dive to depths of up to three km, deeper than any manned submarine, and can stay underwater for up to two hours.

Dolphins are extremely social and form tight bonds with their family members.
THE **BIG** QUESTION

A female glow-worm uses her light in order to attract a mate.
How do glow-worms glow?

Glow-worms, along with their close relatives the fireflies, are perhaps the most famous members of a diverse array of creatures that glow in the dark – a phenomenon that is known as bioluminescence.

The world is lit up with bioluminescent jellyfish, insects, molluscs, crustaceans, millipedes, fish, fungi and micro-organisms. Australia is home to a two-metre-long glowing earthworm, *Terriswalkeris terraereginae*. In fact, the only major groups without any glowing members are the flowering plants and the terrestrial vertebrates.

Central to the chemistry are molecules called luciferins (from the Latin for ‘light-bearers’). These emit light in an oxidation reaction equivalent to ‘burning’ – but with virtually all of the energy released as light rather than heat.

Nature boasts a great variety of luciferins, each producing light of a different wavelength. Glow-worm luciferin emits green light, for example, while coelenterazine, the commonest such compound found in marine creatures, produces a blue glow. Others emit shades of yellow or red.

But luciferins are only part of the story. Despite using the same compound as glow-worms, fireflies produce yellow light rather than green. The difference seems to be due to an enzyme called a luciferase, which acts as a catalyst for the oxidation. Slight variations in the glow-worms’ and fireflies’ luciferases are thought to produce the different shades seen.

The glow of cephalopods and fish is often produced by bioluminescent bacteria with which the host has a symbiotic relationship. Several species of squid house bacteria in photophores – organs that may incorporate lenses, reflectors or even shutters to control when, how much and in which direction light is emitted.

As for glow-worms, we don’t know how they control light emission – perhaps by limiting the flow of oxygen to luciferins in their photogenic organs.

**LIFE ON THE GLOW**

The female glow-worm *Lampyris noctiluca* – not a worm but, rather, a beetle – produces light at three stages of its life cycle.

1 **EGGS** are laid in summer in moist corners, such as under moss. They sometimes emit a faint glow.

2 **LARVAE** feed on gastropods for two to three years. A dim glow pulses from organs under the rear segment, perhaps to warn of a foul taste.

3 **PUPAE** form under logs or in soil; this stage lasts only about 10 days (in females).

4 **ADULTS** may be seen on spring and summer evenings, but it is in fact only the flightless female who glows, to attract winged males.

**WHEN GLOWING SAYS ‘EAT ME!’**

Research published in 2012 revealed that certain bacteria glow to attract the attention of predatory brine shrimp. This is not as suicidal as it seems: the bacteria survive the shrimp’s digestive juices and cause it to glow from within, which in turn makes it an obvious target for fish. When the shrimp is eaten, the bacteria are released into the fish’s gut – the perfect nutrient-rich habitat for them to thrive.

**DID YOU KNOW?**

Bioluminescent fungi were used to provide interior lighting for the early US submarine called the Turtle, built in 1775.

**THE MEANING OF LIGHT**

Nature’s light shows are put to a variety of ingenious uses: for attack, defence, courtship or social cohesion. Glow-worms tick two of those boxes. The flightless female uses it as a beacon to attract winged males, while the toxic larvae flash to warn would-be predators to keep away.

Bioluminescence is also used aggressively by some fireflies. The females of *Photuris* spp. – known as ‘femme fatale fireflies’ – prey on the males of other species (notably *Photinus* spp. and *Pyractomena* spp.) by mimicking their courtship displays in order to lure them close on the false promise of mating. They then kill and eat the unsuspecting males.

Bioluminescence in fungi may serve to attract insects that disperse spores, while the glow of the jack o’lantern mushroom may simply be caused by waste products accumulating in its fruiting bodies.
The queen parrotfish *Scarus vetula* is by day a beautiful and diver-friendly reef fish. By night, it’s a reclusive slime-bag. Literally.

Come sundown, this watermelon-sized Caribbean gem slips into a crevice and, using special glands behind its gills, secretes a bubble of mucus that swells up and over its head like a diving helmet. The pouch spreads towards the fish’s tail and, within 30 minutes or so, the fish is resting inside a surprisingly spacious sac of slime.

The clammy cocoon — in which the fish spends the entire night — has many benefits. It is laced with antibiotics that kill known parrotfish pathogens, and also physically blocks blood-sucking parasites from getting near the fish. In addition, it appears to seal in the sleeper’s body odour, masking it from scent-tracking predators such as moray eels.

And the instant the pod is disturbed or torn, its owner wakes up and high-tails it out of there. It’s like a high-tech tent with a mosquito net and burglar alarm system.

But the queen parrotfish’s slimy behaviour doesn’t end there. Another gland constantly churns out a second type of mucus that protects the fish’s skin against ultraviolet light — like slime sunscreen. Most fish have it, but parrotfish can control where it goes. As it flocks to shallow-water reef-tops each high tide to feed on algae, it slathers on about twice as much of the ointment over its top half as on the rest of its body. This allows the queen parrotfish to browse for food all day without burning its back, and also not waste the ‘sunscreen’ on parts where the sun rarely shines.
What's the world's most toxic animal poison?

Toxicity is usually measured by the LD50: the lethal dose needed to kill half the creatures (usually mice) to whom a poison is given. Amazingly, the worst found so far is the bacterial protein botulin – Botox. Based on mice, its LD50 when injected into humans is less than 0.1 micrograms. For poisons from animals, batrachotoxin is often mentioned. Various estimates of its equivalent LD50 give just under 100 micrograms, almost 1,000 times less toxic than Botox. This is the toxin found in Phyllobates 'poison dart' frogs and certain birds. It's now thought they ingest batrachotoxin from insects. However, palytoxin probably beats this. The human LD50 of this amazingly intricate non-protein chemical has been calculated at about four micrograms. It comes from a Hawaiian soft coral, but this animal may be obtaining the toxin from non-animal sources, namely certain dinoflagellate algae.

How do water spiders breathe underwater?

Scuba divers know the perils of running out of air all too well, and water spiders Argyneta aquatica, which occur in ponds throughout northern and central Europe, face the same problem. It is the only spider to dwell permanently underwater, inside a special bell-shaped air tanks spun from its own silk and anchored onto underwater plants. The spider fills the bell with fresh air scooped up at the water surface and carried down as air bubbles attached to short hairs on its legs and abdomens.

Handily, the water spider doesn't need to replenish its air supplies very often. The silky walls of the air tanks allow oxygen to diffuse in from the water and carbon dioxide to leak out. A new study also reveals that the spider is somehow able to monitor the carbon dioxide inside its air bell.

When the carbon dioxide in the air bell reaches dangerous levels, the spider rushes off to collect more fresh air.

Cocooned inside its air bell, face down and looking out of the entrance, the spider waits, ready to pounce on passing prey. Within its cozy chamber, it happily spends up to two years eating, mating and caring for its young, safe from land predators, such as frogs.
Why do giant anteaters have such bushy tails?

The fabulous, furry tail of the giant anteater is composed of dense, slender hairs and comprises a third of the animal’s two-metre length. It serves its owner in several important ways.

First, in contrast to most other mammals, the giant anteater has a relatively low body temperature of about 32°C. When it needs to sleep, it digs a shallow hole in the ground to lie in. To avoid losing body heat in this exposed bed, the anteater drapes itself with its insulating tail, which also shields it from rain and dew.

When the animal needs to warm up during the day, its tail comes in useful again, acting as a solar blanket. Researchers working in Brazil’s Pantanal have seen giant anteaters with their tails stretched out over the ground, almost doubling the surface area able to absorb warmth from the sun.

Another benefit of the species’ tail is camouflage. When an individual covers itself with this bushy pennant, it is transformed into a clump of dry grass, an illusion that may help to protect it from its two natural predators – pumas and jaguars.

Finally, when threatened, a giant anteater rears up on its hind legs, using its tail for balance. It can then defend itself with its front paws.

What is the hornbill’s horn for?

Hornbills mainly eat fruit and need long beaks to be able to reach the tips of branches. The horn or ‘casque’ is a structural adaptation to support the bill – the longer the bill, the larger the casque. In most species, it is made out of a layer of keratin and is hollow. However, the helmeted hornbill’s casque is a solid, ivory-like horn. Nobody knows why, but it could be linked to aerial jousting, thought to be over access to fruiting fig trees. The size and condition of the casque also help hornbills to assess the breeding fitness of potential partners.

Why are some tigers bigger than others?

Over time, subspecies of tiger have evolved to suit their surroundings, which has resulted in significant size differences between the them. It seems that body size increases as the average temperature decreases, therefore the largest subspecies are the Siberian tigers found in south-east Russia and northern China. The average size for a Siberian male is 300kg. The smallest subspecies, the Sumatran tiger, lives on the Indonesian island of Sumatra. A male Sumatran weighs up to 140kg. Its smaller size makes it easier to move through the rainforests where it lives and, as it feeds off deer and pigs, it doesn’t need to be as strong as some of the other subspecies whose prey is larger.
Do any fish live out of water?

Yes: 11 genera of fish can survive out of water for an extended period, some for minutes at a time, and others—mudskippers, for example—for days. Some even breathe air.

One species is particularly unusual. The mangrove rivulus usually lives in brackish pools but, when conditions dry up, the fish has an amazing survival response: it hides inside logs.

As their pools diminish, these intrepid fish wriggle into moist cavities in rotten wood. Packed in like sardines, they can live here for up to 66 days without even changing their metabolism. In one incident in the Florida Keys, more than 100 individuals were found crammed together inside a single log. Scientists made the discovery by accident after kicking open a lump of wood. ‘To our surprise, all these fish flipped out and tried to escape overland,’ said Ben Chapman, an ecologist at Leeds University. The scientists believe that the logs might also serve as boats when storms sweep them out to sea, transporting their fish passengers.

But one mystery is how so many fish can pack together in the logs without coming to blows, since the species is usually very aggressive. ‘They really don’t meet standard behavioural criteria for fish,’ said Scott Taylor of Florida’s Environmentally Endangered Lands Program.

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50 000+

Number of muscle units in the trunk of an African elephant – this incredible tool can lift 300kg.

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**QUIZ**

All animals have their own unique style but which species’ coverings are these? Turn to page 130 for answers.

1 [Image]
2 [Image]
3 [Image]
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5 [Image]
6 [Image]
EVOLUTION & SPECIES

From ‘superbugs’ in hospitals to giant tortoises on remote islands, the need to survive results in some miraculous changes

**Why are giant tortoises so big?**

Today, giant tortoises are found on a limited number of tropical islands, notably the Galápagos Islands, Aldabra Atoll in the Seychelles, and Mauritius. Some weigh up to 300kg and can grow to be 1.3m long. Though superficially similar, the Pacific and Indian Ocean populations aren’t closely related – but why did they grow so large? The most established theory invokes the principle of ‘island gigantism’. If an animal becomes isolated from a crowded, species-rich ecosystem, it is freed from the usual environmental limitations caused by predation or competition for food or habitat that cap its size. The planet’s remote islands are peppered with examples of animals, both living and extinct, that fit this theory: the kakapo, New Caledonian giant day gecko, elephant birds, moas and Flores giant rat.

In the case of giant tortoises, the absence of competing mammalian herbivores, intra-specific competition for food and the ability to store energy in response to fluctuating food supplies all might result in an increase in body size. Moreover, as a cold-blooded reptile, its metabolism and overall ‘running costs’ are very low.
**EVOLUTION & SPECIES**

**At which point did mammals and reptiles part ways?**

**What did mammals evolve from?**

Mammals are animals in which the females have mammary glands and produce milk, and that includes us. These glands don’t survive in fossils, so most of what we know about mammal evolution depends on the fact that mammals use two small bones for hearing, which other animals – like lizards and dinosaurs – used for eating. Although there was no abrupt transition to ‘true mammals’, the general idea is that the tetrapods (vertebrates with four legs) divided into amphibians (who lay eggs in water) and amniotes (who lay eggs on land). Amniotes then split into sauropods (including dinosaurs) and synapsids (including mammal-like reptiles), which eventually led to mammals. Once the dinosaurs were gone, early mammals could stop living nocturnally and flourish in the many forms we find today.

**Which came first – the chicken or the egg?**

The egg came first, because if there had been no egg, there would have been no chicken. We know that birds evolved from reptiles, so we can say that the first bird hatched from an egg that was laid by a reptile that was very similar to, but not quite, a bird itself.

Of course this reptile came from an egg, too, and reptiles evolved from amphibians, so the very first reptile was the offspring of an amphibian that was almost, but not quite, a reptile. In fact, any animal that is multicellular and practises sex produces what are properly called eggs. Though their name means ‘first animal’, protozoans are not animals and don’t produce eggs. Exactly what the first true animal was is unknown, but it lived about one billion years ago deep in the Precambrian – and it produced eggs.

**Where did urban feral pigeons come from?**

Feral pigeons (sometimes called city, town or street pigeons) are descended from birds that escaped from dovecotes or other captive situations. In turn, domesticated pigeons were bred from the rock dove, recently renamed the ‘wild rock pigeon’, native to Europe, North Africa and southwestern Asia (and not to be confused by our speckled or African rock pigeon).

Many city squares are famous for their large pigeon populations, like the Piazza San Marco in Venice and Trafalgar Square in London. Feral pigeons live in urban areas on every continent except Antarctica, with a global population numbering in the millions. It’s hard to tell feral from wholly wild birds, however, and hybridisation is rife, so it is difficult to map respective populations accurately.

**Species of Galápagos finches – differences between their beaks helped inform Darwin’s theories of evolution by natural selection.**

**DID YOU KNOW?**

Experiments have shown that the humble feral pigeon can be trained to distinguish music by Bach and Stravinsky, and paintings by Monet and Picasso.

A pigeon only has 40 taste buds compared to 10,000 in humans.
Double vision

It is said that bifocals were dreamt up a couple of centuries ago by Benjamin Franklin. But the larvae of the sunburst diving beetle *Thermonectus marmoratus*, an attractive native of Mexico and the south-western states of the US, might stake an earlier claim to the invention.

With 12 eyes and a fearsome array of biting and slicing mouth parts, the beetle’s hunting prowess is only matched by its ocular abilities – it is the only animal known to have naturally bifocal vision. The beetle’s four largest eyes are long, tubular, forward-facing structures that allow it to focus on its prey, both when stalking it from afar and when close enough to strike.

What’s more, behind each lens are two light-sensitive retinas, one positioned behind the other, which enable the beetle to focus simultaneously on both the foreground and the background without having to adjust when flitting between them.

The sunburst diving beetle is, arguably, nature’s best-looking beetle – in more ways than one.
Why are flamingos pink?

The pink carotenoid pigments of the greater flamingo *Phoenicopterus roseus* derive from its diet of brine shrimp and algae. The compounds build up in its blood, which nourishes its plumage, so the tints become incorporated directly into its feathers.

But that’s not all: a study in 2011 showed that the birds can also physically apply these pigments like make-up. The birds keep their plumage shiny and healthy by spreading oil over their feathers from a so-called preen gland near their tails. A team at the Doñana Biological Station, Andalusia, analysed these preen secretions and found they were packed with carotenoids – the birds secrete dietary pigments and apply them directly to the surface of their feathers as dye.

Like humans, the flamingos seem to use it selectively to make themselves more attractive. The team found that the flamingos applied the secretions 10–15 times more often during the mating season – in particular, during ritualised displays in which groups of birds gather together and strut their stuff. Apparently it pays off, since the most colourful birds hooked up and began nesting earlier than others. Moreover, early nesters got the best breeding sites.

Why are pangolins and armadillos the only mammals to have evolved armour?

Pangolins and armadillos are the only surviving armoured mammals. But a range of mammal species did evolve protective armour, most of which are now extinct. There were about 50 genera of glyptodonts, of which the most famous is * Glyptodon*. These herbivores, which lived in South America during the Pleistocene epoch, died out around 12,000 years ago. They were typically 1.5m high and over three-metres long, and protected by a rigid carapace made up of a mosaic of polygonal bony scales weighing about half a tonne – 20 percent of their total body mass. Like tortoises, *Glyptodon* had fused vertebrae and short, massive limbs to support its weight. However, it could not withdraw its head or tail into this shelter, so it had a bony ‘helmet’ and armoured tail.

There are eight surviving species of pangolin and 21 species of armadillo. Pangolins’ overlapping scales are made of keratin (like our fingernails), whereas armadillo armour comprises plates of bone covered in relatively small, overlapping epidermal scales.

When threatened, a pangolin rolls into a ball. Conversely, only one of the armadillo species depends on its armour for protection.

The nine-banded armadillo is surprisingly fast: if threatened it prefers to run for cover rather than use its armour for protection.
How can you tell a dolphin from a porpoise?

Oceanic dolphins and porpoises fall into two distinct scientific families, the Delphinidae and Phocoenidae, with many subtle yet fundamental differences between them. Globally, there are 36 dolphin species and just six types of porpoise. In general, dolphins are larger than porpoises, and at 9.8m long, the orca is the biggest of them all. The exception is Hector’s dolphin of New Zealand, which, at 1.6m, is smaller than the 2.4m Dall’s porpoise of the North Pacific.

A crucial anatomical difference is that porpoises have spade-shaped teeth, rather like those of humans, while dolphins have conical teeth similar to those of dogs and cats. Porpoises also have two rounded, bony bumps in front of their blowholes.

But these features are of little use at sea. Here, dolphins are far easier to identify by their large, swept-back dorsal fins and obvious snouts or beaks. Porpoises can be spotted by their smaller, triangular dorsal fins and blunt, beakless faces. While dolphins are often seen in pods of hundreds or even thousands, porpoises live in groups of fewer than 10.

There are some exceptions to these rules (except tooth shape), but they are largely true of cetaceans in Europe, where the harbour porpoise is the only member of this species.

How does a tree pump water to its crown?

A tree absorbs water through its roots. It then pumps the liquid to its highest branches via tiny pipes called xylem, which are composed of hollow, tubular cells. The pump is driven by transpiration: the sun’s heat causes water to evaporate through tiny pores in the leaves, creating a partial vacuum that is filled by water from deeper tissues.

As water molecules carry a small electrical charge that sticks them together, they suck up a column of water behind them through the xylem as they climb towards the pores. Most of the water absorbed is lost to transpiration, leaving as little as 10 percent for the tree.

How many new species are still to be found?

So far, science has formally described only about 1.5 million of the species alive today. How many remain undiscovered? The surprising thing is that we don’t have even the vaguest idea – estimates range from five million to well over 10 million. The WWF suggests a range of possibilities from a conservative two million up to a huge 100 million.
What is evolution?

Humans have always looked for ways to explain the origins and diversity of life on Earth. The theory of evolution provides us with most of the answers.

From bacteria to blue whales, all life on Earth owes its existence to a process of deceptive simplicity yet astonishing power: evolution. It drives the diversity of living creatures and reveals how seemingly miraculous traits can emerge from the need to survive. It also provides the insights needed to create new organisms to order.

Small wonder that evolution is so controversial. Long regarded as primarily a way of understanding past life, it is now at the forefront of concerns about the future. How can we protect species from environmental change? What are the dangers of using evolutionary processes for our own ends? Nor is the impact of evolution restricted to global issues. From the emergence of antibiotic-resistant ‘superbugs’ to the selective breeding of plants and animals, its effects are manifest at every level of life.

Fundamentalists insist that all life is the act of a divine creator. Scientists claim that the processes of evolution continue to work miracles to this day.

FROM DINOSAURS TO BIRDS

In 1860, just months after the publication of Darwin’s On the Origin of Species, evidence for the reality of evolution was discovered in a limestone quarry in Germany. It was the fossil of a winged creature about the size of a raven, which appeared to be somewhere between a reptile and a bird. Named Archaeopteryx, its apparent link to both small dinosaurs and modern birds was noted by Darwin’s contemporaries.

FROM RANDOM MUTATION... ...TO NATURAL SELECTION

At the core of evolution is change: how living organisms change in the face of changing environments. It was modifications to the beaks of finches that led Charles Darwin to first ponder the idea of evolution in On the Origin of Species. But the process by which these alterations took place was harder to explain. Darwin knew from animal breeders that the changes were random – yet they also had to be capable of being inherited by future generations, or they would be of only fleeting benefit.

It is now known that such developments take the form of random mutations of genes, the chemical instructions inside every living cell. Genes can be mutated by many means, from exposure to radiation, to blunders by the gene-reading mechanisms of cells. Most mutations are harmful, and are likely to be eliminated by the body or cause premature death. But, if the organism can breed, the mutations are passed on via DNA to its offspring.

While mutations produce change, their random nature makes them inefficient at creating organisms suited to their environments. With even simple bacteria having thousands of genes, the probability of organisms developing beneficial mutations by chance alone are tiny. What is needed is a filter to boost the effect of beneficial mutations. That filter is natural selection – the name coined by Darwin to describe the influence of the environment on living organisms.

Natural selection ensures that beneficial genes are singled out through their effect on reproductive success. For example, a mutation that makes an organism more able to defend itself has a better chance of being passed on than one that leads to premature death. Working together, random mutation and natural selection are astonishingly effective at producing successful organisms. It explains not only how life came to be as it is now, but also how it continues to change.
**ARCHAEOPTERYX**
145 million years ago
This 'first' bird shows a mix of reptilian and avian features, such as teeth and feathers.

**ENANTIONITHES (TWO TYPES)**
135-65 million years ago
Shorter tails and lighter bones gave these species an advantage in the air. However, these protobirds still retain reptilian teeth.

**ICHTHYORNITHIFORMES**
80-65 million years ago
First evidence of a keeled breastbone as an anchor for powerful flight muscles and fused bones to reduce weight.

**AVES**
Modern birds are characterised by feathers, toothless beaks and lightweight skeletons.

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**HOW HUMANS INFLUENCE EVOLUTION**
Humans have long exploited the processes of evolution to create 'designer organisms', from hardier crops to cuter pets. All domestic dogs are descended from wolves, but they have been selectively bred over the centuries to create hundreds of different breeds that come in an enormous variety of shapes and sizes.

There are limitations, however. For example, despite the best efforts of breeders, racehorses still run no faster than they did decades ago, as their physiques are now at their absolute limits.

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**TIMELINE**

- **c550 BC**
  Greek philosopher Anaximander hints at the idea of evolution by suggesting that humans are a development of other animals.

- **1809**
  French naturalist Jean Lamarck publishes the first attempt to explain the development of life on Earth.

- **1831**
  Charles Darwin begins his voyage on the Beagle, collecting evidence that will form the core of his theory on evolution.

- **1858**
  English naturalist Alfred Russel Wallace also formulates a theory of evolution, prompting Darwin to publish *On the Origin of Species* the following year.

- **1865**
  Austrian monk Gregor Mendel publishes the results of garden experiments. These reveal genes that transmit traits down through generations.

- **1944**
  Oswald Avery and colleagues at the Rockefeller Institute reveal that genetic information is carried in DNA.
Shipworms aren’t actually worms at all – they’re molluscs.

When two species become one

There are plenty of partnerships in nature, but it’s not often that a single species is actually composed of two unrelated ones.

Enter the shipworm. The nemesis of early explorers and low-lying countries, these worm-like molluscs are notorious for reducing wooden boats and sea defences to a crumbling honeycomb. Though shipworms are highly competent at demolishing wood, they cannot digest it by themselves, so they work closely with bacteria nestled in their gills. These diminutive collaborators also boost the shipworm’s nitrogen intake, harnessing the gas from air dissolved in the seawater.

Many organisms, from cows to runner beans, provide a habitat for bacteria in return for help with difficult jobs, but the shipworm’s relationship with its workforce is particularly intimate – these little helpers live right inside its cells and have never been found living independently.

Give them another few million years of coevolution and they may become integral components of the shipworm’s cellular machinery. In the same way, other cellular ‘organelles’, such as mitochondria (the cellular power plants of all complex organisms), started out as free-living bacteria.
What are the oldest creatures on the planet?

Since life changes over time, it’s tricky to name an oldest species. But some kinds of animals have remained relatively unaltered over many millions of years.

Fossils suggest that, horseshoe crabs have barely changed in appearance since the Triassic period 210 million years ago (mya), and scientists know of older related species. The oldest fossil discovered so far dates back 445 million years. In the last half a billion years there have been five major mass extinctions, and the Earth has changed its polarity many times. Yet the shallow coastal marine habitats preferred by horseshoe crabs have remained throughout, which could be why the crabs have changed so little.

Coelacanths, first swam in the ocean about 400 mya and were believed to be extinct until one was caught off South Africa in 1938. Cockroaches have existed for 300-million years. A nine centimetre fossil cockroach – double the size of a modern American roach – was found in 2001 in Ohio. When it lived there the area was a vast tropical swamp.

What South Africa species is found nowhere else?

Fynbos, literally ‘fine bush’ in Afrikaans, is the distinctive vegetation that makes up the majority of the Cape Floral Kingdom. This region is one of only five recognised globally and is both the smallest and the richest, with the highest known concentration of plant species: 1 300 per 10 000 km². (The nearest rival, the South American rain forest, has a concentration of only 300 per 10 000 km².) Constantly under threat from invading plants and urban expansion, fynbos is home to unique animal species like the rare geometric tortoise, endangered Table Mountain ghost frog and the endemic Cape sugarbird.

Of the 9 000 plant species found in the Cape Floral Kingdom, the majority are fynbos.

When did humans domesticate cats?

According to recent DNA studies by Carlos Driscoll in the USA, the domestic cat split from its wild ancestor, the African wildcat Felis silvestris lybica, about 10 000 years ago. Domestication came much later, in Egypt about 4 000 years ago. Cats were initially valued for their ability to kill rodents, but tomb paintings show that many of these felines were also household pets and a part of family life.

From Egypt, seafarers spread domestic cats around the world – their arrival in Europe dates back to the Iron Age. For the next 1 000 years, cats were highly valued as pest controllers. Between the 13th and 17th centuries, there were several periods in which cats became associated with witchcraft. Few people kept domestic cats, so their survival depended on half-wild, feral individuals. In the British Isles, cats did not become popular as pets again until the late 18th century.

What’s In A Name?

American weevil Zyzyzyva

Scientists reputedly named this genus of weevils to give it pride of place at the end of the dictionary, but they apparently overlooked a genus of jellyfish-like creatures called Zyzyzus.

DID YOU KNOW?

Great white sharks can detect the tiniest amounts of blood in water up to five km away. They can also sense a single drop of blood in 100 litres of water.

According to a 2008 survey by the World Society for the Protection of Animals, South Africa has the largest cat population – two million – in Africa.
**Q** If crocodiles haven’t changed for 100 million years, why have they stopped evolving?

**A** Darwin thought that all lineages of animals change – or evolve – slowly but continuously. But in 1971, Niles Eldredge and Stephen Jay Gould suggested that, in fact, creatures tend to stay the same unless circumstances force them to adapt, whereupon they may change quickly. They called this ‘punctuated equilibrium’. Crocodiles appear to be in ‘equilibrium’, but this is not so unusual. So too, in general, are clams, squid, beetles and sharks.

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**Q** Why do zebras have black and white stripes?

**A** Four basic explanations for zebra stripes have been proposed: defence against predators; social functions; thermoregulation; and protection from biting flies. Zebras may look conspicuous close-up, but are surprisingly hard to spot from a distance, especially at night.

Evidence for a social function is also sparse. Stripes may help with thermoregulation: when a zebra is not in shade, flesh under the black stripes is over 10°C warmer than white areas.

But a recent study suggested that their main function may be to deter biting insects, showing that stripes attract far fewer horseflies. Interestingly, despite appearances, evidence suggests that zebras are essentially black animals with white stripes.

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**Q** How many teeth does a great white shark have?

**A** Unlike humans, who only grow one set of adult teeth, great white sharks are constantly replacing theirs. This is crucial as without its sharp fangs a shark would quickly starve to death. It has five to seven rows of teeth – that’s about 300 teeth, which are all in various stages of development.

The good news is that the great white shark doesn’t actually prey on humans. Even though half of all shark attacks are from great whites, it tends to just be a ‘sample bite’ and then it releases the victim.

At six-metres long, the great white shark is the largest predatory fish.
**Why do giant pandas have such distinctive colouring?**

The giant panda’s scientific name *Ailuropoda melanoleuca* translates as ‘black and white cat-footed animal’. Pandas have white fur with black eye-patches, ears, legs and shoulder bands, and it is thought that each individual’s markings are slightly different. There are many theories but we may never know if any are actually correct.

The most widely held view is that pandas’ markings aid visibility in their mountain habitat, which is densely forested with bamboo and trees. Pandas are mostly solitary, but once a year, when it’s time to breed, males and females have to track each other down. They use several methods of communication, such as scent-marking and vocalising, and their prominent monochrome coloration may simply help them to find each other.

Another theory is protection from predators. The black and white pattern might have served to break up the bears’ outlines, similar to zebra stripes. In addition, when pandas inhabited snowier areas, their white fur may have enabled them to blend into their surroundings.

It’s thought fewer than 1600 giant pandas exist in the wild.

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**DID YOU KNOW?**

The giant panda has the digestive system of a carnivore, but has a mostly vegetarian diet. Female pandas need to eat up to 40kg of bamboo a day.
The honeybee has a special dance to let other bees know where food is in relation to their hive.
Humans aren’t the only animals to communicate. Most species have developed ways of getting their meaning across.

Do any animals other than humans use language?

This is the subject of much debate as many animals use intricate communication systems. But some experts suggest that the honeybee’s ‘waggle dance’ incorporates the elements of true language – complexity, symbolism, use of rules and arbitrary signals to signify a real object.

When a bee finds a food source, it returns to its hive and performs a series of actions. First it shimmies in a straight line, then circles one way then the other, to repeat its hip-wiggle in the same direction again and again. The series of high-frequency waggles and spins may be structured not just to look lively, but also to indicate the distance and direction to a new food source.

Austrian ethologist Karl von Frisch dedicated most of his working life to studying the species; he suggested that bees are able to navigate using the direction of the sun and the sky’s polarisation, as well as the Earth’s magnetic field. And the waggle dance is, according to von Frisch’s research, the bee’s way of communicating instructions: the angle of the waggle in relation to the vertical axis of the hive indicates the direction of food, while the duration tells hivemates how far away it is.
Do fish make noises?

Yes – life beneath the waves is far from silent. Along with snapping shrimps, spine-rattling urchins and orchestral whales, many species of fish contribute to the cacophony of underwater sound – grunting, clicking, honking, groaning, burping and even grinding their teeth for many reasons.

Triggerfish, for example, are territorial. They create a grinding noise by moving their dorsal spines in their sockets, a sound that is amplified as it resonates in the swim bladder. It serves to ward off intruders and potential predators, and alerts other fish.

Herring are also very noisy. They expel a stream of air from the swim bladder via the anus, creating high-pitched chirps that help the fish to stick together in protective shoals during the night. The phenomenon is known as the Fast Repetitive Tick (FRT). Breaking wind, it seems, helps herring to survive.

Cartilaginous fish such as sharks and rays lack swim bladders. However, divers have reported hearing eagle and manta rays emitting high-pitched squeals, so researchers are investigating whether certain species are able to produce noise without using their swim bladder.

Why do vixens scream at night?

The breeding of northern-hemisphere foxes is synonymous with noise as roaming dog foxes clash and couples begin courting. Contact calls are all-important in the dark. Females generally issue an alarming scream, while males give three short barks that sound like they’re shouting ‘hut-hut-hut’ on an in-breath. Vixens come into heat just once a year and then for no more than three weeks. January conceptions result in the birth of cubs in March, 52-53 days later. There’s been a rapid spread of foxes into urban areas, like the south of England, during the past 100 years, where cities have encroached into more rural areas.

How and why do cicadas sing?

Male cicadas sing to court females and to define territory. On each side of the first abdominal segment is a membranous organ called the tymbal. Stretched taught, the resonating surface can be flexed out of position by a muscular thread to create a click. Repeated 4 000-7 000 times per second, the clicks combine to create a loud, buzzing whine. Inside the abdomen, air sacs are tuned to the natural frequency of the vibrating tymbals and act as amplifiers. Cicada calls have been recorded at over 100db, louder than heavy-duty power tools and petrol engines. Some make the loudest noises as a startle alarm defence against attack from birds.
The male mourning cuttlefish is a master of disguise and will use extremely underhand tricks to win over a mate.

**Master of disguise**

Fierce intelligence combined with spectacular colour-changing and shape-shifting abilities make cuttlefish masters of camouflage and mimicry. But the male mourning cuttlefish *Sepia plangon* takes deception to another level. This shifty shellfish can present two faces to the world simultaneously.

The targets of duplicity are rival males. With many more males than females in the population, the competition for mates is so intense that a male will resort to disrupting the courtship of others in an attempt to win a female’s heart.

To deter potential usurpers, a suitor must think laterally, and position himself between mate and rival. On the flank facing the female, he continues his courtship display of pulsating stripes to try and win her affections. On the other, he adopts the mottled appearance of a non-receptive female. The result is a female who thinks the admirer only has eyes for her, and a competitor who’s fooled into searching elsewhere for love as he believes she’s uninterested. As long as neither sees the duplicitous male from above, his deception wins him a partner.
What are sea canaries?

Belugas are perhaps the most vocal of all whales and were dubbed ‘sea canaries’ by 19th-century mariners, a name that has stuck in some quarters. Certainly, their repertoire of sounds (some of them beyond the range of human hearing) is unparalleled. Researchers have identified more than a dozen distinctive noises, including clicks, whistles, chirps, grunts, bell-like tones and squeals. These are often clearly audible from the shore if belugas are nearby, but they also radiate through boat hulls in a cacophony of layered sound.

While belugas possess rudimentary vocal chords, their vocalisations are believed to emanate from the blowhole on top of the head. The prominent forehead contains an oil-filled organ known as the ‘melon’, and researchers believe that the whales create their unique sounds by altering the shape of this organ, using it as an acoustical lens for amplification. Returning sound is received through the fatty lower jaw and resonates to the auditory nerve. While belugas certainly communicate with one another, scientists don’t believe that they use language in the same way as humans, though captive whales have shown an ability to mimic certain sounds and seem to enjoy ‘hearing themselves talk’.

Vocalisation serves two distinct purposes in belugas: communication and echolocation. Underwater, they rely on echolocation far more than sight, especially in murky or deep water.

Why do wolves howl rather than bark?

Actually, wolves do bark. Researchers have identified at least 11 types of wolf call – the yelp, whimper, whine, whine-moan, moan, growl-moan, growl, snarl, woof, bark and howl. With the exception of the howl, these are all short- to medium-range noises communicating intimate emotions, and are directed mainly at other family members.

While the bark is used as a threat or protest – for instance, when a human or other large predator approaches the den – howling is a relatively low-frequency, elongated call designed to carry over large distances. On the open tundra, wolves can hear a howl from 11km away.

Howling has four main purposes. It helps pack members to stay in touch and co-ordinate movements across their enormous home ranges (normally 200–600km²); it enables groups to advertise their presence and claim on a territory, avoiding unnecessary encounters with rivals; it may help lone wolves to locate potential mates; and, finally, it strengthens social bonds in the pack when performed in chorus.

DID YOU KNOW?
The Portuguese man-of-war is a siphonophore – a colony of organisms working together. The man-of-war is made up of four separate polyps.
Q Why do hyenas laugh?
A Spotted hyenas mostly giggle during times of conflict – for example, when competing over a fresh kill. Scientists at the University of California at Berkeley compared the acoustics of 17 giggling hyenas in a colony at a local research station. They found that the utterances of each individual were subtly unique.

They also found that the vocalisations of older animals were lower in pitch, and that those of more dominant individuals were more orderly and reserved – less manic – than those of subordinates. A buzzing hyena essentially announces its personal identity, age, social status and perhaps more to all in the party.

Though it’s uncertain how individuals use this information, one thing is certain: a hyena would know who’s who, and where they are, without even having to lift its head.

Q Do turtles make calls underwater?
A They do – but it’s a relatively recent discovery. Like all chelonians (turtles, tortoises and terrapins), the narrow-breasted snake-necked turtle *Chelodina oblonga* of south-western Australia was thought to be silent when underwater. So when scientists in Perth housed about 100 wild-caught snake-necks in artificial ponds equipped with hydrophones, they were surprised to hear chatter.

The turtles make at least 17 distinct calls, ranging from short clicks and squawks to a 10-second ‘wild howl’ and a rhythmic drum-like sound that lasts nine minutes or more. Though nothing is yet known about what is being communicated, chirps were most common and appear to be the turtle’s version of small talk.

Q How do birds sing?
A Birdsong starts out as audible vibrations created when exhaled air passes over the membranous lining of the simple tubular voice box – the syrinx. Located at the base of the windpipe, the syrinx is an arrangement of cartilage, muscle and vibratory membranes over which exhaled and inhaled air passes, and can generate sounds of extraordinary complexity. Muscular changes to the membranes’ tension control the pitch, and the rate of airflow regulates volume. This raw sound is sculpted further by the shape of the throat and mouth. Sitting at the point where the windpipe splits to supply the lungs, the syrinx can produce different sounds from each side simultaneously. Some birds can even exhale through one side while inhaling through the other, allowing them to sing for longer without pause – some are even able to produce two notes simultaneously. The tongue plays no part in bird song, except among parrots.

DID YOU KNOW?
Hyenas’ social system requires extensive communication to keep it functional. They have at least 34 calls, from soft grunts to howl-like ‘hooops’, each of which appears to have a distinct meaning.

Like humans, hyenas can be identified by their laugh.

The snake-necked turtle is the surprising chatterbox of the underwater world.

The North American marsh wren *Cistothorus palustris* sings all day long.

1100
Song types produced by the brown thrasher, a North American bird that mimics other birds.

BBC Wildlife 85
What do the stripes and spots on insects mean?

We live in a visual world. From antelopes to ants and zebras to zebra spiders, colours and patterns dominate the senses. But what do the dots, spots, bars and stars mean? Like tourists grappling with the glottal stops of an unfamiliar tongue, deciphering the rich but sometimes bewildering graphic code used by animals is a major challenge for zoologists.

**Breaking the code**

Invertebrates are excellent but enigmatic source material for the code-breaking scientist. Though relatively small and often secretive – they are not all shrinking violets that lurk in the undergrowth. Seen close up, many species are startlingly – and perplexingly – patterned. In some cases it’s clear that markings provide defence (in the form of camouflage), but in other species the benefits are less obvious. In fact, they represent a form of communication.

We tend to think of communication as something audible or obviously visible – spoken language, song or physical gestures. But one definition of communication used by behavioural biologists is: an action or condition on the part of one organism that alters the behaviour of another organism in an adaptive way.

So while some invertebrates do use audible signals – male cicadas, for example, sing to court females and to define territory – other methods are more common. Social insects are perhaps the most interesting and sophisticated communicators. A colony of honeybees is controlled from its heart by queen mandibular pheromone (QMP), a chemical produced by the hive’s queen and spread by worker bees, while ants lay pheromone trails to manage foraging. The famed ‘waggle dance’ of the honeybee (see p81) is thought to represent the only true ‘language’ in the animal kingdom.

**Talking with patterns**

But insect markings also represent sometimes complex examples of communication, including deception and warnings. Some give vital clues to identity (differentiating rivals and mates) or warn of danger (a foul taste or toxicity).

The variety of decoration in this world of spineless wonders seems infinite, but individuals of the same species usually conform to a fixed pattern. There is nothing random about their dots and dashes.

We now know that chemical pigments are under precise genetic control, which is usually fixed at the embryo stage of development. Armed with this knowledge, we have bred insects with different colours and markings, in effect creating our own code. However, there is still much to learn and many more invertebrate ciphers left to decrypt.

**THE MYSTERY**

‘No one knows why I look so pretty’

**88 butterfly**

The sartorial elegance of this bizarre butterfly from Central and South America defies reasonable explanation. Its dapper style makes it look as though a 1960s pop artist has customised it with black ink, numbering its underwings 88 (sometimes 89) in concentric circles. Perhaps the stark motif warns birds of its acrid taste. But having crimson upper wings is the kind of trick that is normally used by camouflaged nontoxic species whose primary defence has been rumpled.
THE DECEPTION

‘I’ve got a sting in my tail.
Hoverfly

Hoverflies are bluffers. To the untrained eye they resemble bees and wasps, but there is no sting in their tail. Like the dangerous insects they impersonate, different hoaxers have different markings. Each species has a unique arrangement of black, yellow or white bars, dashes, dots or flecks. Scaeva pyrastra (below) displays three sets of paired commas – other hoverflies flaunt brackets, hyphens or apostrophes.

‘I’m watching you...’
Owl butterfly

Many invertebrates deviously deploy a fake vertebrate eye to frighten would-be predators, and none are better at this than the huge owl butterflies of Central and South America. Not only do their ‘eyes’ have a dark iris and pupil, there is also a white crescent that heightens the impression of a moist, domed lens. The butterflies take their name from the fact that a pinned specimen resembles an owl’s face.

THE WARNING

‘Eat me and I’ll kill you!’
Monarch butterfly caterpillar

Each of this larva’s 12 body segments has black, white and yellow bars. There could be no clearer ‘hands off’ signal. The species’ other common name, milkweed butterfly, refers to the highly poisonous foodplant of the caterpillar. As it munches, it absorbs cardenolides – toxic steroids that trigger heart failure in vertebrates. The adult butterfly also has warning coloration; nontoxic butterflies mimic its pattern to deter bird attacks.

‘I taste nasty!’
22-spot ladybird

Spots are, theoretically, the simplest pattern for an animal to generate. A single, focused area of pigment creates a round blob. But ladybird spots are no mere daubs; their stunning crispness and precision is human eye candy. Birds and mammals are repelled, however – they know that these beetles ‘bleed’ alkaloid toxins from their knee joints if attacked. Psyllobora vigintiduopunctata has a set pattern of 22 (or occasionally 20) oval spots. Other ladybirds, the two-spot and the harlequin for example, have more variable patterns.

THE CAMOUFLAGE

‘I’m not here.’
Zebra spider

Prowling exposed surfaces such as walls, tree trunks and stones, an eight-legged hunter is in danger of becoming the hunted if its outline is detected by a sharp-eyed bird. All-over motting is not a reliable defence: a spider’s silhouette or shadow can give its position away. The zebra spider’s contrasting bands of black and white are a neat solution – and are in keeping with the stark lights and shadows of brightly lit brick, bark or rock.

‘I’m just a leaf.’
Comma butterfly

With wings closed, this butterfly’s ragged outline is a perfect copy of a dead leaf, complete with ragged margins, a dark midrib, irregular veins and mouldy patches. But there is also an eye-catching white C. This may seem counter-intuitive, since it contrasts strongly with the mottled background. But the C is actually the final piece of deceit. It is the torn chink in the leaf, the tiny tear in the decaying vegetation through which light appears to shine. Continuing the alphabet theme, some comma butterflies are stamped with a letter O, P, D, I, G or L instead.
Bad-tempered bees

As their names suggest, bee and fly orchids mimic the shapes and colours of female pollinating insects in order to attract males, which pollinate the flowers when they try to copulate with them. The Caribbean bee orchid *Tolumnia henekenii*, however, which imitates the *Centris ferruginea* bee, employs a different strategy – it recruits males by mimicking *Centris ferruginea* males.

It’s a phenomenon known as pseudoantagonism. Amorous *Centris* bees are highly territorial. Whenever they are faced with a rival male – or even just a flower that vaguely resembles one – they are compelled to attack, violently and repeatedly – pollen is transferred and so the orchid is pollinated.

Despite all the rage and aggression elicited by the flower, the bees may stand to gain from the deception. One theory is that the practice makes them better at defending their territories when the competition is genuine.
Q Which mammal has the widest singing repertoire?

A This is difficult to measure, but it’s likely that gibbons’ territorial vocalisations represent the most extensive singing repertoire of any mammal. Gibbon songs are unique to each species, and can be lengthy—they can sing for 10-20 minutes at a stretch, or even longer. In most gibbon species, adult males and females perform elaborate duets to proclaim their pair-bond, usually twice a day with the most intense session at dawn, but singing is also used to repel other groups from their territories and to attract mates. Studies of white-handed gibbons in Khao Yai National Park, Thailand, have deciphered the meaning of some of their many whoops, waos and whoo-aals. It seems that the vocalisations also serve as alarm calls: when confronted by a predator, the gibbons uttered a sudden crescendo of up to seven separate notes, which appeared to trigger evasive action by other group members.

A male and female white-handed gibbon will ‘duet’ for half an hour every morning to mark their territory.

Q Why do parrots talk?

A Parrots are among the world’s most intelligent birds and use a complex series of vocalisations to communicate with each other, many of which are learnt from members of their social group. When living with humans, parrots continue this process by mimicking our speech. One famous African grey parrot named Alex learned a vocabulary of more than 150 different words. Incidentally, though the word ‘parroting’ implies that these birds are merely copying us, scientists working with Alex proved that he understood abstract concepts, which suggests that ‘language’ is not confined to humans.

African grey parrots can not only mimic language, but also understand what is being said.

Q Why do ladybirds have spots rather than other patterns?

A The answer is contrast. The insects’ strong warning colours signal their foul taste. Though some ladybirds have patterns verging on checks and streaks, a spot is the simplest pattern for them to develop. Spots occur throughout all animal groups, from freckles to a full dapple. All it requires are central points creating the pigment, and these are usually fixed at the embryo stage under genetic control.

The seven-spot ladybird can devour more than 5,000 aphids in its lifetime.
How do animals recognise members of their own species?

Like humans, animals recognise each other using a combination of sight, sound, behaviour, touch and smell. Whereas humans tend to rely on sight, most mammals will trust their nose over their eyes as their sense of smell is generally much better. Being able to recognise your own species is crucial when you’re looking for a mate. Courtship rituals and mating calls are partly about attracting the best possible mate and fending off love rivals, but they also function as a species recognition cue. Similarly, a mother bear can recognise the distressed calls of her offspring even when they’re not near. Hyenas, elephants and bats can also identify family members by sound. However, species recognition isn’t always hard-wired as lots of waterbirds, such as geese, will imprint on the first moving thing they see when they hatch.

Why do wagtails wag their tails?

Tail movements, such as wagging, pumping or flicking, are a feature of many bird species. Some researchers suggest that such actions are employed to flush prey, while others theorise that they have a social role or signal a state of alertness to predators. Research on wagtails in Germany revealed that tail-wagging was exhibited by both feeding and non-feeding birds (though feeding birds wagged more), supporting the suggestion that it is an honest signal of vigilance. Interestingly, the behaviour seems particularly common in species associated with running water.

What’s in a Name?

**Corncrake**

*Crex crex*

The common names of many birds, such as the cuckoo, evoke the species’ calls. The corncrake *Crex crex*, however, is a rare example of a scientific name that does the same. This makes it a much easier bird to hear than see.

The yellow wagtail summers in the UK and Africa, migrating seasonally.
Q Why do tigers have white patches on the backs of their ears?

A Most large cats have distinctive marks on the backs of their ears, such as coloured spots or tips. These may simply be something that all cats have. However, assuming that everything has a purpose, the most likely explanation is that they accentuate facial expressions.

Like most cats, tigers are solitary, but they do interact with one another. They flatten, reverse, lay back and prick forward their ears when they’re relaying different messages of threat or friendliness to rivals, mates, cubs or siblings. The reversed ear position, with spots facing forwards like extra eyes, is often used when a tiger is insecure.

The spots can be a giveaway – twitching ears in long grass can be spotted by potential prey – but do they have a survival value? They’re also known as ‘eye spots’ or ‘predator spots’. It’s possible that they help keep cubs safe from predators that are approaching from behind by appearing as eyes, or assist mothers in keeping an ‘eye’ on their cubs. (Who may in turn use them as a guide when following her in deep undergrowth. Though the white tip on the mother’s tail is probably more useful as a guide for her cubs.)

Interestingly, one other cat with conspicuous white ear spots is the ocelot of southern America. It also lives a solitary life, often in dense, dark forest implying that such spots have special signalling value in low light.

DID YOU KNOW?
The Sumatran tiger has the greatest number of stripes of all the tiger subspecies, while the Siberian tiger has the least. Tiger stripes are like human fingerprints – you will never find two tigers with the same pattern.

The tiger is the heaviest of the big cats.

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QUIZ

Can you identify the owners of these markings?

Turn to page 130 for answers

SPOTS & PATTERNS

1 2 3

4 5 6
It’s estimated that for every human there are 200 million insects – with a combined weight 12 times greater than that of humans

What is a doodlebug?

Doodlebug is the American nickname for antlion larvae, so named for the designs they make in the sand. As a doodlebug seeks an ideal location to dig its pit, it leaves meandering trails that resemble random doodles. They then dig down into the sand to create small, steep-sided, funnel-shaped pits, often next to household foundations in dry, fine, rain-protected sand. Mostly hidden in the pit, the antlion waits for unsuspecting ants and other small insects to fall into the pit. The name ‘antlion’ best describes its form: a ferocious-looking, armour-plated grey or brown creature with an oversized head, spiny jaws, short legs and a soft body covered in bristles. It is often included in lists of the ‘South African Little Five’; smaller, less-famous versions of the Big Five, like the rhino beetle. Adult antlions, also called lacewings, actually resemble dragonflies. In Britain, the flying bomb or V1 of WWII was named a doodlebug. As for their insect variety, doodle- or pill bug are two of many nicknames used for woodlouse.

Globally, there’s popular folklore surrounding the doodlebug, including poems or chants recited to make the antlion come out of its hole.
Q Why are so many people scared of spiders?

A What causes arachnophobia? Children are naturally inquisitive and tolerant of creepy-crawlies, but they will always be guided by the reactions of their parents. Some people have been turned off life by a leggy house spider dropped down their T-shirt. Others associate spiders with dirt, though they are in fact clean and pernickety.

Some experts argue that, way back in evolutionary time, our ancestors would have been afraid of unknown, potentially venomous spiders and this fear has been passed down through generations. Others believe that as spiders are nocturnal we share their creepiness with other imagined night terrors. Finally, spiders do a great scuttle, so their strangeness is tinged with a startle response, too.

We are so afraid of spiders that we invent tales to make them even more fearful. They were said to be living bottles of poison, hence their old folk name of ‘atrocip’ or ‘poison-head’, and they supposedly lick drible from our lips as we sleep. All nonsense, of course, but based on their alien appearance and sinister, nocturnal lives.

Q How do tiny insects cope with hits from raindrops?

A On the whole, insects don’t fly in wet weather. Instead, they find a roost and sit tight until the deluge is over. However, research using high-speed video footage shows that, as they head for shelter, mosquitoes can survive being hit by raindrops that are much bigger and heavier than themselves – the equivalent of humans being struck by cars.

The phenomenon – which probably applies to all tiny flying insects – has been described as ‘boxing with giant balloons’. The drops do not burst when they hit the insect, but knock it aside, a result of water surface tension and the water-repellent nature of the insect cuticle.

Occasionally, a large raindrop will completely surround an insect, dragging it down. However, provided the bug is flying high enough, it will usually be able to break free before the raindrop hits the ground.

This butterfly might not like the rain, but it can cope surprisingly well.

Q Can a cockroach really live without its head?

A The insect nervous system is based on nerve nodules (ganglia) repeated in each body segment. While the ‘brain’ ganglion in the head is important, it is not the vital, all-controlling organ we see in vertebrates. Deprived of its head, an insect can therefore survive for hours or even days with little or no change to body function, breathing or metabolism. However, without its head the animal will be unable to eat, and so will eventually starve to death.

DID YOU KNOW?

Modern cockroaches first existed about 200 million years ago, with their ancestors reaching as far back as 350 million years ago. One reason they’ve lasted so long is their speed – cockroaches are incredibly quick to react to danger and can reach speeds of 5.4km/h.

A cockroach is one of the few animals that can survive without its head.

Length of the male parasitic wasp Dicopomorpha echmepterygis – probably the world’s smallest insect.

0.139mm
Tongue twister

What’s grosser than gross? A parasite that eats your tongue – and then lives in your mouth, as your tongue. Meet the nightmarish Cymothoa exigua.

Luckily for us, the parasite, which is a type of crustacean called an isopod, is not interested in human flesh. It lives in the Pacific Ocean off the coasts of Mexico and Central America, and only infests fish.

Beginning life as a swimming form called a manca, a young isopod attaches itself to an appropriate host, passing through its gills and latching onto its tongue. Then it’s dinnertime. The uninvited guest sinks its syringe-like mouthparts into the meaty organ and begins draining it of blood.

The tick-sized isopod may grow as big as a cockroach within a few months. By then, it has extracted so much blood that the tongue withers away. That’s when things get really weird. The parasite attaches itself to the remaining stub and the fish uses the pest as it used its old tongue, to assist in swallowing prey (smaller fish). This makes the tongue-eating louse the only known animal to replace a body part of another in both form and function. It works so well that the fish eats normally and remains healthy.

How long the isopod lives and works in its host is unknown, but eventually a partner shows up and they mate. The young are raised in the fish’s mouth until they can survive on their own, leaving ‘home’ as the next generation of tongue-eaters.
# Which insect forms the densest populations?

**A** Several species vie for this title. In temperate woods and meadows across the globe, springtails *Collembola* are usually considered to be the most abundant hexapods, with numbers reaching 100,000 per cubic metre of leaf litter.

The arboreal leafcutter ants are also worthy contenders, with each nest home to several million individuals. However, density is not just a measure of numbers – it is a measure of numbers over a given area. Leafcutters wander far, which thins out the throng.

Termites, it seems, are the winners in the biomass stakes. They, too, make large nests, but because they often live inside the wood they feed on, they do not spread themselves as far as the leafcutters.

Calculated at 10,000 per square metre of rainforest, termites achieve a greater density in terms of combined body weight than the heavy, but relatively scattered, wildebeest herds on the Serengeti in Africa.

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# Why don’t honeybees hibernate when bumblebees do?

**A** Honeybees have developed a structure so they can store enough food to see them through periods when they cannot forage – cold winters, arid seasons and torrential monsoons. How? With large colonies of overlapping generations of sterile worker females produced by a long-lived, egg-laying queen.

Bumblebees also have a worker caste, but in smaller, annual colonies founded anew each spring by a single fertilised queen. The difference is partly due to the subtropical origins of honeybees and the mainly temperate homes of bumblebees. Less seasonal temperature fluctuation means that honeybees simply huddle during cooler (or drier) times.

However, recent warm winters in Europe meant bumblebees didn’t hibernate, so autumn workers overlapped with a new spring brood.

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**WHAT’S IN A NAME?**

**Happy face spider** _Theridion grallator_

Scientists named this after its spindly legs – _grallator_ means “stilt-walker”. But, its Hawaiian name, ‘nananana makakai’ (“face-patterned spider”) and its common English name capture what really make it unique.

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Termite shed their wings once they have found a good place to nest.

A hive of honeybees will fly the equivalent of three orbits of Earth to create one kilo of honey.
Q Where did larder beetles live before humans built larders?

A In corpses! *Dermestes* (larder beetles) are late carrion feeders. They visit animal remains after the initial flurry of flesh-eating fly maggots to feed on the drying sinews, tendons, skin and feathers that remain. They can be used in taxidermy to clean animal skeletons. There is a clue in the word ‘larder’, which originally meant a meat store, not just a general food cupboard.

Q What is the furriest caterpillar?

A For flannel moth caterpillars, every day is a bad hair day. Looking variously like 1980s fashion relics, worn-out toothbrushes or something dreamed up by Donald Trump’s hairdresser, these insects somehow don’t seem quite natural.

Like anyone who wakes up with a bad case of bedhead, the caterpillars are liable to take out their frustrations on anything that gets in their way. Hidden away among all that luxuriant fur are rows of sharp, stout, hollow spines – rather like porcupine quills – that inject a dose of potent venom into would-be predators.

For humans, the severe and long-lasting effects of being ‘flannelled’ include rashes and blisters, swollen limbs, nausea, headaches, muscle spasms, stomach pains and even breathing difficulties. Victims have described the pain at the site of contact as like being hit with a hammer, breaking an arm, and worse than kidney stones. So point and laugh all you like – but don’t go in for a cuddle with these furry critters.

**How do spiders make silk?**

Spider silk starts out in the silk glands as a watery gel of long protein chains that is funnelled down a gradually tapering tube. As the tube narrows, coatings are applied to the mixture – to provide stickiness and water resistance – before it emerges through tiny spigots (devices that control the flow of liquid) on the spider’s spinnerets.

The gel solidifies only when stretched, so rather than being squeezed out like toothpaste, it is pulled out by a motor-like valve in each spigot.

A battery of silk glands produces a wide array of fibres with different properties used for specific tasks – for instance, a dragline, snare, web support or egg case.
How does a caterpillar turn into a butterfly?

DID YOU KNOW?
The world’s largest butterfly, the Queen Alexandra birdwing of New Guinea, produces a chrysalis about eight centimetres long.

As day-flying insects, butterflies are brightly coloured to communicate with each other.
The transformation of a stubby, crawling caterpillar into an airborne fairy has long fascinated humans: it’s the perfect metaphor for change, improvement, escape, even life after death. But at its core it is a prosaic and very basic biological urge: the need to eat and grow in safety, then—and only then—to disperse.

The caterpillar is a veritable eating machine. During the few days or weeks that it is active, it will munch through many times its own weight in whatever its chosen foodplant might be. As in all insects, it is the larval stage that does almost all of the eating, and certainly all of the growing. The caterpillar does this quietly and secretly.

In the human-centred world, we might expect growth and development to be uniformly incremental—from small (but fully formed) baby to similar (but much larger) adult. Some insects do grow this way—earwigs, plant bugs, cicadas, termites, grasshoppers and cockroaches. Hatchlings resemble miniature adults, with wing-buds gradually increasing until the fully winged adult size is achieved. This is called holometabolous, a seemingly half or partial change.

Holometabolus, a full change, is the complete—and often dramatic—metamorphosis from worm-like larvae to large-winged adults. It’s an extremely advanced mechanism, a highly sophisticated chemical suppression of developmental processes. Though only nine of 26 insect orders are holometabolic, this accounts for 80 percent of all insects (butterflies, beetles, moths, flies, bees, wasps and ants are majority stakeholders). In short, this is a very successful strategy for growth and development.

The child inside
Even in the smallest caterpillar, bundles of cells are already primed, destined to become adult features such as antennae, wings, legs and genitalia. Called imaginal discs (being flat and round), they are prevented from growing and developing by a constant wash of a juvenile hormone. As the larva feeds, its gut, muscles and some other internal organs grow and develop, but the imaginal discs are temporarily suppressed and remain dormant. The caterpillar behaves like a free-living, eating, growing (but developmentally repressed) embryo.

When it reaches a critical size, a burst of molting hormone, ecdysone, is released (see box, above). It will shed its skin several times in response to ecdysone, each time forming a new instar (stage), but juvenile hormone keeps it a caterpillar, preventing onward development until, as it nears full size, concentrations of the latter hormone decline.

Juvenile hormone now falls below a threshold and the next ecdysone surge stimulates the change into a chrysalis.

The flattened imaginal discs now start to develop unhindered. Each folds into a concave dome, then a sock shape. The centre of each disc is destined to become an extremity—the tip of a leg or the end of a wing.

The interior is, at this stage, mostly a nutrient soup, feeding the imaginal discs as they complete their development. The last burst of ecdysone occurs at almost zero juvenile hormone and stimulates the emergence of the adult butterfly.

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**SIX DEGREES OF PRE-EMPTON**

There are usually six metamorphic transformations in the butterfly growth path, each stimulated by a burst of molting hormone ecdysone (A) from the prothoracic gland. Juvenile hormone (JH), secreted by the corpus allatum gland, slows progress towards adulthood: while levels of JH are high, it keeps the caterpillar a larva. However, JH secretion slows over time: only when it falls below a critical level (B) does a moult result in a chrysalis and pupation.

Now the adult features can finally develop. With JH levels virtually down to zero, the final moult (C) is the metamorphosis into a butterfly.
**Strange but True...**

**Bugs in space**

Superman’s got nothing on the mighty tardigrades. These tiny but almost indestructible invertebrates can endure the most extreme conditions on Earth – and even beyond.

Although these eight-legged super bugs require moisture to survive – a drop of dew is sufficient – the roughly 1,000 known species thrive in almost every habitat, from the sea floor to mountaintops, and from the poles to the equator.

Their secret? When the going gets tough, tardigrades just give up. They retract their legs into their bodies, roll up into a tight ball called a ‘tun’ and enter a coma-like state. They replace body water with preservative compounds, cover themselves in a protective wax and switch off their metabolism. They are as good as dead – and this will save their lives.

Tardigrade tuns can survive almost anything: drought, toxic chemicals and even temperature swings from -273°C to 151°C. When conditions improve, they resuscitate and start where they left off, even after a decade.

Scientists probing these critters’ limits have found that they can tolerate pressures six times as great as in the deep ocean. But the ultimate test was in 2007, when two species were sent into orbit, and exposed to the suffocating vacuum of space and enough radiation to fry humans to a crisp. Amazingly, one-third of the bugs returned to Earth alive, making the tardigrade the only animal to survive extraterrestrial conditions.

When fully grown, tardigrades are only about one-millimetre long. However, that doesn’t prevent them being the hardiest creatures on Earth.
**Why do Mexican jumping beans jump?**

**A** Mexican jumping beans are actually *Cydia deshaisiana* moth caterpillars maturing in the fallen seedpods of *Sebastiania* shrubs, which thrive in the hot, dry Mexican climate.

The adult moth lays its egg on a developing pod, and the hatched larva nibbles its way inside. The younger reacts to light and heat, violently jerking its body in an attempt to seek shade, causing the seed to jump. It only stops moving when it is out of the sun’s dangerous, drying glare. After the pupal stage, the silver-grey adult moth eats its way out of the seedpod, and the cycle starts again.

The larva of a jumping bean moth makes its home in a seedpod.

**What’s in a Name?**

**Notnops, Tisentnops & Taintnops**

These three closely related genera of spiders from Chile were once lumped together within the genus *Nops*. They were later split into *Notnops*, *Tisentnops* and *Taintnops* in 1994 by taxonomist Norman Platnick, in order to make it perfectly clear that they did not belong in the *Nops* genus.

**DID YOU KNOW?**

At night, it’s possible to tell the temperature by listening to the rate at which crickets chirp. The warmer it is, the faster the chirp rate (though this varies according to species).
12.5 trillion
Estimated number of individuals in the swarm of Rocky Mountain locusts that devastated crops in Nebraska in 1874.

Why does a bee die after it stings you?
A Worker honeybees have barbed stings that evolved for stinging other bees and insects. It’s only when they sting mammals, with their thicker skin, that the barbs become wedged. In trying to get free, the bee rips away part of its abdomen and it’s this that causes it to die a few minutes later.
Queen honeybees and almost all other species of bee and wasp have smooth stings and can sting multiple times.

How do nest insects deal with their dead?
A Living in a large ant colony is similar to being in a fantastic city. The benefits include architectural achievement on a grand scale, compartmentalised living, the promise of coordinated attack and defence, division of labour and shared food. However, one of the drawbacks is that epidemics can spread quickly and cause devastation.
To counter this threat, ants and other social insects have evolved various hygienic behaviours, such as clearing out nest debris, alien objects and dead and dying members of the colony, all of which can encourage decaying bacteria and fungi in the nest. Whether the ants in your garden died naturally or as a result of a pathogen outbreak is unclear, but their nest mates were instantly moving them to a safe distance away from the brood.
This practice started to be reflected in human society when cities reached a threshold size during the 19th century. The same necessity for hygiene led to the abandonment of small local graveyards and the creation of giant municipal cemeteries on the outskirts of towns.

Why do ladybirds swarm?
A A large population of ladybirds will emerge in the spring if a good year – warm and sunny, with many beetles surviving to hibernate – is followed by a mild winter with low hibernation mortality. If it’s still warm and sunny in the spring, then their aphid prey will also proliferate, providing ample food for the next generation.
By summer, the ladybird population will have exploded, causing aphid numbers to crash and forcing hungry beetles to take to the skies, with the biggest swarms occurring at the coast. Apparently unwilling to fly out over the sea, clouds of ladybirds settle on every surface. Those that take off over the waves in desperation will be found washed up the next day in crimson lines, which can be metres wide and kilometres long.
Q Why do flies have only two wings, while many other insects have four?

A An early insect ancestor with only two wings obviously did well enough to give rise to an entire order, with a quarter-of-a-million fly species at the last estimate.

In fact, flies (making up the order Diptera, from ‘di-PTera’, meaning ‘two wings’) do have four wings, but the hind pair are reduced to tiny balancing skittle-shaped knobs, called ‘halteres’, which oscillate at the same speed, but flex in the opposite direction to the main wings in flight.

The halteres act like an aircraft’s navigation system – their direction of swing changes according to shifts in the insect’s orientation in the air.

Two wings are easier to control and more responsive to manoeuvre than four, and two-wingedness is a more advanced evolutionary state than the four wings of dragonflies, lacewings and termites. Indeed, many four-winged insects, such as butterflies, bees and wasps, latch their front and back wings together to create single aerofoils in order to make themselves more aerodynamic.

Of course, not all insects have wings; they have evolved to live without them many times over. All fleas are wingless, jumping everywhere instead, and there are wingless species of moths, beetles, wasps and ants. With the exception of ants, it is often females that are wingless.

Aphids alternate between wingless and winged generations, and the lacewing species Psectra diptera can have either two or four wings. A fly can beat its two wings up to 200 times per second and it’s no coincidence that the most agile of airborne insects, are named after the act of flying itself.
SUPER SENSES & SKILLS

Which species has the best colour vision?

A Charles Darwin famously marveled at the complexity of the eye, but had he known about the eyes of the mantis shrimp, he would have probably dropped his tray of barnacles in amazement.

Stomatopods, a crustacean group containing some 400 species, are known for having the best colour vision in the animal kingdom. They can see shades we cannot even imagine, perceive eight colour channels (humans have to make do with a paltry red, green and blue trinity) and can also detect linear polarised light (the glare that we had to invent sunglasses to squint through).

Within the stomatopod group, members of the genus *Odontodactylus* can further stake a claim as masters of vision. In addition to linearly polarised light, these mantis shrimps can also detect its circularly polarized form. This ability could give these predators an advantage in the turbid waters they often inhabit. Parts of the male’s cuticle have also been shown to reflect circularly polarized light, hinting at a ‘secret’ communication channel between the sexes that is utilised during reproduction.

DID YOU KNOW?

A mantis shrimp not only has great sight, it also has incredibly powerful limbs. It spears or clubs its prey using a force equivalent to that of a bullet.

It might look like something from another planet, but the mantis shrimp has the best sight of all animals.
SUPER SENSES & SKILLS

Meet the overachievers of the animal world – these creatures have developed some impressive talents in their fight for survival.
**Why do cats and snakes have slits for pupils?**

*Not all of them do.* The pupils of domestic cats contract to slits in bright light, but large cats like lions and tigers have round pupils like humans. Similarly, snakes, such as pythons and boas have pupils that close as slits, but many others don’t. Slit pupils close more tightly, so can handle a broader range of light conditions. Comparisons between snakes support this idea: species active purely in the daytime don’t have slits. In bright light, slits also produce more depth-of-field horizontally than vertically. That could explain why they’re typical of ambush hunters, which need to detect prey moving across their field of vision. Additionally, slit pupils are seen in vertebrates that have ‘multifocal’ lenses, with different areas focusing different colours. Slits mean that more colours can be seen in bright light.

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**Which animal has the best hearing?**

*Mice, dogs and bats hear ‘ultrasound’, too high for humans to hear,* while elephants and rhinos communicate in ‘infrasound’, which is too low for us. A guinea pig can hear from very low to very high, which perhaps makes it the world’s best listener.
**Star performer**

The freakish, tentacled snout of the star-nosed mole *Condylura cristata* may look funny, but it’s nothing to laugh at. It could be the most skilled sniffer under the sun – even when underwater.

The mole, a hamster-sized inhabitant of North American wetlands, is nearly blind. But what it lacks in vision, it more than makes up for in feeling, so to speak.

Its nose is used more as a super-sensitive spare paw with 22 toes. The pea-sized organ is extremely perceptive, packed with over 25,000 sensory receptors – compared with 17,000 in the human hand. The mole can identify anything it touches seven times faster than a person can blink. This makes it the most sensitive organ in the animal world.

All of this means the mole’s star nose is a formidable hunting tool. The animal sweeps it back and forth along the ground like a metal detector, looking for worms and other treasures.

It scans so quickly, and its feelers are so responsive, that the whole process – from detecting to devouring prey – takes just one-fifth of a second, making the mole the fastest-foraging mammal in the world.

But the animal has another trick up its trunk. The mole can track the scent of prey underwater, like an aquatic bloodhound. To do this it blows a bubble out of each nostril. Odour molecules cross from the water into the air pocket, which the mole then sucks back in for a whiff. In this way, it sniffs out dinner in a pond as efficiently as a mouse or rat does on land. Oh, the sweet smell of evolutionary success.

They might look cute and clumsy, but star-nosed moles are some of the fastest hunters in the world.
**Q** Are elephants scared of anything (other than humans)?

**A** It takes a lot to scare an African elephant – unless you’re an African honeybee. Elephants are vulnerable to bee stings in sensitive spots such as around the eyes and inside the trunk, and their fear of bees is surprisingly profound; they even avoid empty beehives. So they turn tail and flee at the mere sound of the insects – and may even use a bee-specific call to warn other elephants of the threat. Researchers found that broadcasting the sound of disturbed bees to elephant families made them move swiftly away from the speaker, shaking their heads and tossing dust in the air, as if fending off a swarm. Fleeing elephants also produced a unique rumbling sound that, it seems, is a warning – ‘Bees! Run!’ in their own elephant language.

African elephants are not often challenged by foes. And when they are – say, by a lion or pack of hyenas – the goliaths typically charge while making a deafening roar or trumpeting. But if attacked by a swarm of bees, there’s little an elephant can do but grumble – and tell its friends and family to run. The phenomenon could be used to help reduce human-elephant conflicts – for example, by playing bee sounds in crop fields disturbed by elephants it may help to peacefully keep them away.

**DID YOU KNOW?**
Scallops have 100 eyes around the edge of their shells. These are probably used to detect shadows of their predators, such as starfish. Unlike mussels and oysters, their shells don’t close completely so they can only survive in deeper sea water.

**Q** Are we the only animal to cry?

**A** We often talk about the cry of animals, like wolves or eagles, but that’s not the same as shedding tears. Lots of animals do cry to clear debris from their eyes but, surprisingly, there’s no good evidence that any of them do this as a sign of unhappiness (our close relatives, chimps and gorillas, use vocal noises). Even elephant ‘tears’, which can be produced under stress, are quite different from ours: for example, they are not produced from a tear gland.

**What’s in a name?**

**Great Argus pheasant**
*Argusianus argus*

Many spotty creatures, from butterflies to sea cucumbers, are named after Argus, the 100-eyed giant of Greek mythology. He gets three mentions in the name of the great Argus pheasant alone.

Not only do tears express emotion, they also clean your eyes and improve vision.

**Number of taste buds on a rabbit’s tongue.**
Humans have around 10 000.
**What is it like to see with a compound eye?**

The insect compound eye is made up of many tiny facets. Beneath each of these is a narrow, conical structure called a rhabdom, which contains light receptors. Human eyes have roughly 125 million light-sensitive cells, whereas the largest insect eyes – those of dragonflies – contain only 30,000 rhabdons, resulting in a highly pixelated, mosaic-like image.

But vision is about more than just detecting light; its quality depends on how the brain interprets these patterns. Insect vision is mainly about recognising shapes and detecting movement, so it is basic in comparison with that of humans.

**Why have dogs evolved to hear higher pitches than us?**

Humans can hear frequencies up to about 20kHz, whereas dogs hear up to 45kHz. Almost all mammals have much better high-frequency hearing than other vertebrates – fish, amphibians and reptiles only hear up to about five kilohertz and birds up to eight to 12kHz. It’s not that mammals need high-frequency hearing for communication – most can hear frequencies well above the ones they make themselves. Instead, mammals have adapted in this unique way so they can locate where a sound is coming from.

Called ‘binaural spectral-difference cueing’, their special way of hearing works by comparing the frequency range of a sound as it arrives in each ear. Because the ear on the farthest side is partially ‘shadowed’ by the head, some of the frequencies will be absorbed – higher frequencies are absorbed more than lower ones. But the smaller the head, the less effect it has on lower frequency sounds, so the animal must be able to hear a higher upper frequency limit in order to be able to detect the spectral-difference effect. A mouse needs to hear up to 20kHz to use binaural spectral-difference cues, whereas an elephant manages with just 10kHz. Dogs fall somewhere in the middle because they have smaller heads than us.

**How do fish control their buoyancy?**

While some fish, such as sharks, must keep swimming to stop themselves sinking, most have an inflatable ‘swim bladder’ that provides neutral buoyancy at a range of depths. This, along with the lungs of terrestrial vertebrates, is thought to have evolved from a simple lung found in primitive, ancestral fish living in shallow, oxygen-poor pools.

The simplest swim bladders are connected to the digestive tract, inflated when the fish gulps air at the surface and emptied with a belch. More sophisticated versions are sealed units that are fed by gases dissolved in the fish’s blood.
THE BIG QUESTION

What is echolocation?

Echolocation allows creatures to move around in pitch darkness, so they can navigate, hunt, identify friends and enemies, and avoid obstacles.

For dolphins and toothed whales, this technique enables them to see in muddy waters or dark ocean depths, and may even have evolved so that they can chase squid and other deep-diving species.

Echolocation allows bats to fly at night as well as in dark caves. This is a skill they probably developed so they could locate night-flying insects that birds can’t find.

HOW CETACEANS ECHOLOCATE
Dolphins and other toothed whales do this by bouncing high-pitched clicking sounds off underwater objects, similar to shouting and listening for echoes. The sounds are made by squeezing air through nasal passages near the blowhole. These soundwaves then pass into the forehead, where a big blob of fat called the melon focuses them into a beam. If the echolocating call hits something, the reflected sound is picked up through the animal’s lower jaw and passed to its ears. Echolocating sounds are so loud that the ears of dolphins and whales are shielded to protect them.

Dolphins and whales use this method to work out an object’s distance, direction, speed, density and size. Using echolocation, dolphins can detect an object the size of a golfball about the length of a football pitch away – much further than they can see. By moving its head to aim the sound beam at different parts of a fish, a dolphin can also differentiate between species.

HOW DOES ECHOLOCATION WORK?

- **SOUND CHAMBER**
  Clicks and other sounds used in echolocation are produced in nasal passages in the top of the head.

- **LOWER JAW**
  Nerves in the lower jaw pick up the rebounding clicks, sending information about the prey’s size and density to the ears and then the brain.
HOW BATS ECHOLOCATE

Bats make echolocating sounds in their larynxes and emit them through their mouths. Fortunately, most are too high-pitched for humans to hear – some bats can scream at up to 140 decibels, as loud as a jet engine 30m away. Bats can detect an insect up to 5m away, work out its size and hardness, and can also avoid wires as fine as human hairs. As a bat closes in on the kill, it cranks up its calls to pinpoint the prey. To avoid being deafened by its own calls, a bat turns off its middle ear just before calling, restoring its hearing a split second later to listen for echoes.

MELOD
This fatty organ in the forehead concentrates the echolocating sounds into a narrow beam.

PREY
Echolocation is so sensitive that a dolphin can differentiate between fish species.

BIRDS AND MAMMALS

Whales, dolphins and bats are not the only species that use echolocation. A few birds echolocate, including the nocturnal oilbird and some insect-eating swiftlets that roost in dark caves. Both use sharp, audible clicks to navigate through the darkness. Some nocturnal shrews use ultrasonic squeaks to explore their dark surroundings, and the shrew-like tenrecs of Madagascar echolocate at night using tongue clicks, possibly to find food. An unconfirmed candidate is the hedgehog, that uses ultrasonic whistles, has excellent hearing and lives in similar habitats to tenrecs and shrews. Another intriguing possibility is humans – many blind people can find their way around simply by listening to echoes bouncing off surrounding objects.
The fish with the glass head

The Pacific barreleye fish *Macropinna microstoma* brings new meaning to the phrase ‘clear-headed’. Its skull is transparent, as is the skin on its head and most of its face. Though these features don’t actually help the fish to think, they do enable it to see things more clearly. It’s the only animal known to have eyes below the skin inside its head. This odd design protects these vital organs, on which the fish’s life depends.

The barreleye lives at depths of up to 1km throughout the northern Pacific Ocean, where little light reaches. There, this pint-sized fish – which is just a few centimetres long – specialises in stealing prey from jellyfish, tracking the ghostly predators by their shadows or faint bioluminescence.

The special tube-shaped eyes, after which it is named, make this stealthy stalking possible. Like tiny binoculars, they provide tunnel vision with a sharp focus on minute details. The fish’s green lenses also highlight any firefly-like glows in the dark.

After finding a jellyfish, the barreleye picks at the prey stuck to its stinging tentacles. This small fish is built for careful maneuvering, but its bulgy, fragile eyes could still easily be damaged if they weren’t behind a protective shield.

Keeping a clear head is also extremely convenient. Unlike any other fish, a barreleye can shift its gaze from forward to straight up without moving its body. This allows it to scan its environment for predators with little effort and in the blink of an eye.
**Q** How far can a slug see?

* Slug eye-stalks don’t have lenses and so they can’t focus on an image. All they can do is sense the surrounding light intensity. This is enough for the slug to sense if it’s in the shade, but with its eyes alone, it can’t tell whether this shadow was cast by your hand at just one metre away or a cloud at 100m.

If a slug’s eyestalk gets cut off it can grow another in a few months.

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**Q** Which animal has the best sense of smell?

* Some dogs’ sense of smell is up to 10 million times more sensitive than ours, but salmon beat that, finding their way across oceans to the rivers where they breed, guided largely by their sense of smell.

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**Q** How do owls hunt at night?

* Because we tend to think of owls as being nocturnal in their habits, we also assume that they must have well-developed senses of hearing and vision. Interestingly, the visual and auditory sensitivities of predominantly nocturnal owls, such as the tawny, are no better than our own, though they do outperform diurnal birds by quite a margin.

For owls living in open country, there is sufficient natural light at night to allow them to forage successfully by sight, but for woodland owls, the gloom and structurally diverse nature of their habitat makes this more difficult, forcing them to rely more on sound. Woodland owls often perch-hunt (looking and listening for prey) and follow regular routes through the trees, effectively flying blind, guided towards noisy quarry by acoustic cues. Owls are silent fliers thanks to their specially designed wing feathers that muffle the air, allowing them to swoop down unheard.

Even for a diurnal woodland owl, hearing may be the more important sense for locating prey (think of owls pouncing on voles foraging under the snow). Vision, however, is also essential for targeting a meal, especially when it comes to judging distance.

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A salmon can remember the smell of its ‘home’ stream even after four years at sea.

**Eyeless huntsman spider**

*Sinopoda scurion*

Discovered lurking in a remote cave in Laos, this is the only huntsman spider to completely lack eyes. It’s named after the Swiss lighting manufacturer Scurion, in return for a supply of caving lamps that will enable Laotian scientists to undertake further exploration.

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**DID YOU KNOW?**

The four-eyed fish Anableps microlepis can see in air and water at the same time. Despite its name, it only has two eyes but there are flaps in each eye that create openings. One in the water and one in the air. It means they can spot prey and look out for aerial predators.

An owl can swivel its neck through 270° thanks to its 14 neck vertebrae.
Which animal has the biggest brain?

That award goes to the sperm whale. The average weight of an adult male sperm whale's brain is 7.8 kg compared to 1.4 kg for a human's. The sperm whale's signature shape makes it instantly recognisable, particularly its squarish head that seems disproportionately big – it comprises up to a third of the whale's body length. However, it's another component of this vast cranium that historically meant the sperm whale was hunted. The spermaceti organ is filled with a pale, waxy liquid, formerly prized by whalers. It's believed to be involved in buoyancy control and a sophisticated acoustic sensory system that enables these gregarious whales to relate to their complex, three-dimensional environment, and to form intricate social bonds.

DID YOU KNOW?
Chameleons and sea horses are both able to move their eyes independently. This allows them to look in two different directions at the same time. Sea horses hunt by sight alone so being able to look forwards and backwards at the same time is incredibly useful.

What is the most intelligent bird?

Take a walnut, two beakers and a grey parrot – and you get a pretty clever boy. Grey parrots can not only talk, count and dance in rhythm, but according to new research that uses nothing more complicated than a couple of cups and a piece of walnut, they also have the reasoning abilities of a three-year-old child.

Scientists at the University of Vienna gave parrots a choice between two cups, only one of which contained a nut. When the cup holding the food was shaken, the parrots chose it based on the rattling sound. More cleverly, they could still identify the pot that contained the nut when only the empty pot was shaken.

When the birds were played a recording of the rattle without the pot being shaken, however, they did not choose the container. This suggests that, rather than associating the sound with a reward, parrots understand that it is the food itself that makes the sound when the cup is shaken.

It is a task that few species can master. Humans can do it from the age of three, as can other great apes (such as gorillas), but monkeys and dogs cannot. Intriguingly, the experiment only worked when the cup was shaken horizontally. Scientists believe this could be because vertical motion mimics the head-bobbing that parrots use to communicate.

A grey parrot can easily learn hundreds of words in its lifetime.
What is the most intelligent invertebrate?

There are several brainy contenders in the running for this prize. Octopuses in aquariums have been known to sneak out at night to pinch fish from other tanks, while squid and cuttlefish communicate with flashing lights and changing colours. All three are able to solve puzzles in the laboratory as easily as a monkey.

Cuttlefish can change colour for camouflage or to communicate with others.

QUIZ

Try to identify the six animals keeping an eye out. Turn to page 130 for answers.
BEASTLY BEHAVIOUR

Before eating a hairy caterpillar, a cuckoo will shake it to get rid of the toxins.
The different traits employed by some species may seem baffling, but there is invariably a reason for all of them.

How do cuckoos choose which birds’ nests to lay in?

Cuckoos pick numerous different hosts in many diverse habitats, with 17 of the 23 cuckoo species recorded in Africa found in South Africa. In the Kruger Park, October and November is the best time to spot the wave of intra-African migrants who arrive in large numbers following the start of the summer rains.

But what makes a particular female cuckoo choose to parasitise the nest of a certain species? Why, for example, should she be sussing out nests belonging to reed warblers while, not far away, another female prefers those of African pipits? The answer lies in her genes and parenting. If a female is raised by reed warblers, it is certain that she will embark on a career of parasitising reed warblers. Like her mother, she is genetically predisposed to choose these hosts. Furthermore, her eggs will look like those of the reed warbler.

Females that share the same host preference are collectively known as ‘gentes’ (singular ‘gens’). Each gens is behaviourally distinct from other gentes, and often occurs in different habitats. So how can this predisposition be passed on from one generation to the next when a female may copulate with all the males in the neighbourhood? Can she recognise a partner from the same gens? It appears not. Research suggests that this host-specific trait is carried only by the female chromosome, and therefore it can be passed on without any direct contribution from the male.

Research has shown that some host species are better at detecting cuckoo eggs than others. Blackcaps, for example, which would otherwise make excellent foster parents, appear to have wised up to the cuckoo’s underhand tactics and are rarely parasitised. Even among the main host species, the acceptance levels of cuckoo eggs vary. Dunnocks, for instance, seem to be especially clueless, and almost always accept a bogus egg.
Why do some animals sleep standing up, and others lying down?

In order to sleep while standing up, you need legs that can be aligned vertically, so you don’t need to use muscular effort to keep them straight. You also need knees that ‘lock’ in place. Sleeping upright is advantageous for large animals that would be slow to lumber to their feet if attacked. For smaller animals, the reduction in leg springiness outweighs this benefit. Horses, zebras and elephants sleep standing up. Cows can too, but mostly choose to lie down. Some birds also sleep standing up. Many birds roost in trees at night using an arrangement of their leg tendons that causes their body weight to pull the claw shut around the branch. Whether this counts as standing up is a matter of semantics.

Do birds give presents?

Occasionally. However, male spotted bowerbirds don’t say it with flowers. In the forests of eastern Australia, fruit is the way to a female’s heart. But the bright green fruit of the potato bush are not for eating – they’re eye-candy. The more fruit a male can pile up at his display ground, or bower, the more females he attracts. In fact, males actually cultivate a crop of the finest potato bushes, to the mutual benefit of both species.

By clearing leaf litter and vegetation from around their bowers, males provide fertile ground for the bushes that sprout from the rotting fruit. The resulting gardens provide males with new supplies to decorate their bowers, which they may occupy for up to 10 years. By gathering the most attractive fruits, the males seem to be ‘improving’ their crop by selective breeding. Plants growing around bowers produce brighter, greener fruit than those growing ‘wild’.

Bowerbirds are not the only non-human agriculturalists out there. Some ants farm aphids for their honeydew, and others cultivate colonies of edible fungi, as do certain termites, beetles and even snails. They are, however, the only animals known to grow a crop for anything other than food.

1.5 million

Number of birds in the UK’s largest starling murmurations, which gather at mass roosts on winter evenings.

How many times could a lizard regrow its tail?

It depends. The series of bones that makes up a lizard’s spine extends along the length of its tail. When the tail is shed, usually in an attempt to escape from a predator, it breaks along a fracture plane within one of the bones. When a new tail grows, the bones do not regenerate, but are replaced with cartilage. So the regrown tail cannot break and regrow again. A lizard could potentially shed its tail several times, but only the original tail material is capable of fracture and regeneration.
The Hydnora africana smells delicious — if you’re a dung beetle.

**Strange But True...**

Vampire Plant

It looks like an extra-terrestrial being that fell to Earth, but this is the flower of *Hydnora africana*, which lives in the deserts of Southern Africa. The plant is unusual in having no roots, leaves or chlorophyll and, apart from its flower, living entirely underground. It behaves like a subterranean vampire, using suckers on its stem to draw out juices from the roots of its prey, the shrubby *Euphorbia mauritanica*. The only sign of the plant above ground is when the flower bud bursts up, swells and opens its shocking pink bloom. Under good conditions it takes one year for the bloom to develop from a bud into a mature flower. It then gives off a powerful scent of rotting meat, which is often how people locate it.

The flower’s stench and bright pink colour are an irresistible draw for carrion flies and dung beetles, which are probably fooled into thinking it’s an animal carcass. As the insects enter the floral chamber, the hairy fringes around its entrance bend inwards to prevent them from escaping. The interior of the flower is smooth and slippery with wax, and insects such as small beetles slip and slide around, trapped inside. Only once the insects have pollinated the plant does its entrance open, allowing the captives to flee.
Are killer whales dangerous to humans?

There are no documented reports of wild, free-living orcas ever having intentionally attacked humans. The name ‘killer whale’ derives from ‘killers of whales’, not killers of people. Sadly, according to Rob Lott of the Whale and Dolphin Conservation Society, the same cannot be said for orcas kept in captivity, in which aggression towards trainers is common. ‘No one is sure what causes the animals to react in this way, but boredom, frustration and ill health, both physical and mental, have all been implicated,’ says Lott. ‘These incidents have resulted in serious injuries to trainers and, in one case at least, proved to be fatal.’

Do animals yawn?

Yawning is widespread among mammals, and probably serves a variety of functions. When you are tired or hungry, the brain’s temperature rises; a yawn may keep it cool and alert. It might also help mammals to stay awake and vigilant, which is why it is infectious. Some monkeys also do it to display their large canines as a threat, asserting their status.

Orcas are actually the largest of the dolphin species and can weigh up to 5443kg.

What’s in a name?

House martin
Delichon urbicum

It’s all about anagrams. The genus Delichon was created in 1854 to distinguish martins from swallows, which had been lumped together in the now-obsolete genus Chelidon (Delichon is an anagram of Chelidon). Urbicum, the species name of this urban bird, is more obviously descriptive.

DID YOU KNOW?

A lynx has excellent hearing and sight. The black tufts on the top of its ears act as hearing aids and its eyesight is so good it can spot a mouse 75m away.

It’s not just humans who yawn, as this baboon is demonstrating.
Why do lemmings commit suicide?

Don’t believe everything you see at the movies – they don’t. The number one myth about lemmings, that they commit mass suicide by jumping off cliffs to drown themselves, is quite modern. Sometimes it even comes with a ‘scientific’ justification: the suicide would benefit the species in times of overcrowding. It seems so heroic, but unfortunately such behaviour simply does not exist in the animal kingdom. This did not stop Walt Disney from including footage of a lemming suicide in White Wilderness, released in 1958. The film crew bought about 1,000 lemmings from Inuit children, transported them to Alberta and created a set on top of cliffs by a stream. The lemmings were herded together on the edge – and driven over it. Needless to say, their ‘fatal’ plunge was a huge hit with the public.

HOW DO...

How do humpback whales hunt with bubble nets?

Bubble-netting is a cooperative hunting technique used only by humpbacks. From a position below a shoal of herring, one or more hunters ascend in a shrinking spiral while exhaling air to produce a cylinder built of a dense wall of bubbles the size of those in a bottle of lemonade. Other whales may vocalise from the sidelines to herd prey into the catchment area – herring flee the sound.

With the trap set, all of the whales swim up the centre of the tube, flashing their white pectoral fins to deter the herring from escaping downwards, and gulp the concentrated seafood soup at the surface.

3600kg

The average weight of an adult male white rhinoceros – the equivalent of three small cars.

Why do stoats ‘dance’?

The stoat’s so-called ‘dance of death’ is one of the strangest in the animal kingdom. Hurling itself around as if possessed by a demonic force, this slinky carnivore performs frenzied leaps, back-flips, full-body spins and forward rolls at dizzying speeds in a display reminiscent of 1980s break-dancing.

It is often said that the stoat dances to hypnotise its prey so it can kill the entranced victim. But the frolics are more likely to be pure high jinks. If so, it is mere coincidence when a nearby rabbit attracts the stoat’s attention and ends up as dinner.

Another theory is that the stoat is the victim of a parasitic nematode worm causing abnormal bony growths that create pressure on its brain – in other words, the cavorting could be neurologically induced. Either way, it’s an extremely memorable, high-octane performance.

The average life span of a stoat is just 1.5 years.
THE BIG QUESTION

What is hibernation?

Hibernation is a way for many creatures to survive cold, dark northern-hemisphere winters without having to forage for food or migrate. Instead, they turn down their metabolisms to save energy. Animals in hot climates also undergo a form of hibernation called ‘aestivation’. For insects, fish and amphibians, this works in a similar way, creating a dormancy that enables them to survive extreme heat, drought or lack of food. Hibernating is much more profound than simply sleeping, though. Depending on the species, it can vary from long, deep unconsciousness to light spells of inactivity. But hibernation carries risks as the dormant animal is vulnerable to predators and the unpredictable climate.

HIBERNATION

WHICH ANIMALS HIBERNATE? Small mammals, such as chipmunks, dormice, hamsters, hedgehogs and bats. Southern African dormice, for example, appear either to hibernate or at least to become more sluggish during cold periods. Also, many insects, amphibians and reptiles.

HOW DOES IT WORK? Mammals feed heavily in summer and autumn, storing fat to see them through the winter. A hibernating animal’s metabolism slows and its temperature plunges — in ground squirrels, it can fall to -2°C. Breathing slows and, in bats, the heart rate can fall from 400 to 11 beats per minute. Some cold-blooded animals, such as wood frogs, produce natural antifreezes to survive being frozen solid.

WHAT ARE THE DANGERS? Animals may die during hibernation from lack of fat, severe weather or premature awakening.

A dormouse makes a cosy nest from grass, bark and twigs.

The body is curled tightly into a ball to conserve heat.

Body and tail are swollen with fat – the animal doubles its weight prior to hibernation.

AESTIVATION

WHAT IS AESTIVATION? This is the equivalent process to hibernation, but for animals in hot climates that are trying to escape extreme heat or drought.

WHICH ANIMALS AESTIVATE? Many terrestrial and aquatic animals: lungfish, earthworms, snails, reptiles, including Nile crocodiles, and amphibians like South Africa’s grey tree frogs (or ‘foam nest’ frogs).

HOW DOES IT WORK? Most animals bury themselves in the ground, which protects them from the heat. Here, they wait for the wet season or cooler temperatures. Some land snails climb trees to escape the heat of the ground, sealing themselves into their shells using dried mucus.

WHAT ARE THE DANGERS? Large numbers of aestivating animals perish in periods of prolonged drought.

1 As water in its home pool evaporates, the lungfish burrows into the soft mud at the bottom. 2 The fish surrounds itself with a sac of mucus to keep its skin moist. 3 The modified swim bladder acts as a lung so the fish can breathe air during its confinement, which may last several months. 4 A block of mucus plugs the entrance to the burrow.
**TORPOR**

**WHAT IS TORPOR?** It is a brief bout of suspended animation, usually lasting less than a day, when an animal’s breathing, heartbeat, body temperature and metabolism are reduced.

**HOW DOES IT WORK?** Torpor conserves energy in the short term and often helps the animal survive a brief bout of poor conditions, such as cold nights.

**WHICH ANIMALS ENTER TORPOR?** Birds such as hummingbirds and frogmouths, or small mammals such as bats, can go into torpor every day.

**WHAT ARE THE DANGERS?** One of the problems with torpor is that the animals are too sluggish to react to predators. And, if the cold spell is unusually long, the animal may die if its body temperature drops too low.

The feet of the Natterer’s bat lock in position when it enters torpor so that it doesn’t fall while slumbering.

Fur provides insulation during the period of torpor.

Breathing slows, which in turn reduces the bat’s heart rate and its need for energy.

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**UNUSUAL SLEEPERS**

**LEMUR LIE-DOWN**

The dwarf fat-tailed lemur of Madagascar is the only known primate to aestivate, using up fat reserves in its tail during a long dry season.

**NIGHT-NIGHT**

The common poorwill, a small species of nightjar, is the only bird known to hibernate. It conceals itself among piles of rocks to escape winter.

**COLD COD**

The Antarctic cod Nototinea coriceps can enter a state of dormancy by lowering its metabolism. Its blood also contains ‘antifreeze’.

**SNEAKY SNAKES**

Male garter snakes are the first to emerge from their winter dens in order to mate with females as they wake up. Some males emit female pheromones to trick their rivals.

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**DENNING**

**WHAT IS DENNING?** This is a light form of dormancy typical of bears, where the animal is groggy, but easily roused.

**HOW DOES IT WORK?** A bear’s body temperature only drops a few degrees, but it loses up to 40 percent of its body weight — more than true hibernators. Amazingly, many female bears give birth and suckle young while denning.

**HOW DO THEY PREPARE?** Bears eat a lot of high-energy food to build-up fat reserves that will last all winter.

**WHAT ARE THE DANGERS?** Bears can be woken easily during a mild spell of weather, but may not have enough energy to survive the rest of the winter.

A hollow among tree roots makes the perfect den for a brown bear.

A brown bear lines its den with grass, leaves and other vegetation to make a cosy mattress.
**Snakey snare**

The tentacled snake *Erpeton tentaculatum* of South-East Asia is a devilish fear-monger that will scare you to your very core – if you’re a fish. This wily, piscivorous water snake spooks prey right into its mouth.

The snake spends most of its life in shallow, murky lagoons or creeks, coming up for air every 30 minutes. It lies in ambush, stretched out along the bottom with its head and neck curved back, forming a ‘J’ shape on the mud.

When a fish enters the ‘bay’ formed between its head and body, the snake shakes its flank (the section ‘across the bay’ from its face). The alarmed fish usually turns tail and darts off in the opposite direction – often straight into the snake’s mouth. The entire process, from feint to fish dinner, takes less than 0.02 seconds.

The serpent pulls this off by tapping into a startle reaction in fish called a C-start – a neuronally hard-wired escape response in which a fish makes a U-turn away from a striking predator or other trigger (bending its body into a C shape in the process). This cannot be stopped once initiated, and the trajectory is reliable enough for the snake to take advantage of it.

But there is a catch. The fish’s escape route depends on its initial orientation to the snake. So if, for instance, it is facing the flank that the snake flicks, it may turn to its left or right before bolting. So the snake strikes where it expects the fish to go, and bags its quarry more often than not. This makes it the only animal known to consistently predict the future behaviour of its prey.
How do ducklings ‘imprint’ on their mothers?

Although it had been noticed in ducklings before, it was in the 1930s that Austrian biologist Konrad Lorenz discovered that in a ‘critical period’ of just 24-48 hours after hatching, baby geese and ducks will follow whatever large moving object they see.

For the rest of their lives, they’ll then prefer to follow this object rather than any other – including their own mother. It’s probably the best known example of imprinting – rapid learning that takes place at a particular age. The effect is stronger if the duckling is under stress, and depends more on vision than other senses, but after 48 hours it doesn’t happen at all. Clearly some critical change must be happening in the tiny bird’s brain, but so far scientists don’t understand what this change is.

What is the most dangerous animal in Africa?

Well, it’s not the hippo, as many a pub bore will claim. Research carried out by experts Craig Packer and Dennis Ikanda found that lions were responsible for more than 503 deaths in Tanzania between 1990 and 2005, and that 60 per cent of all animal attacks in the south-east of the country were carried out by lions (compared with 4.6 percent by hippos). But this ratio won’t be true for the rest of Africa because Tanzania has more lions than any other country. Between 3,529 and 32,117 deaths in Africa each year can be attributed to snake bites, and, according to Dr Robert Harrison of the Liverpool School of Tropical Medicine, two species can be singled out as the most dangerous: the saw-scaled viper *Echis ocellatus* (which is responsible for 80 percent of all bites in West Africa) and the puff adder *Bitis arietans*.

Lions and snakes aside, the Anopheles mosquito transmits malaria, which kills between 300,000 and 1.12m people in Africa every year, so it is the greatest killer of all.

How do hedgehogs wash themselves without pricking their noses?

Personal hygiene is not a hedgehog’s strong point. The skin beneath the spines is generally dirty and covered in sloughed cells – hedgehogs often have fungal infections. As with other spiny mammals, they use the long claws on their hind feet to scratch and rake through the spines, but groom the fur on their belly with their mouth. Surprisingly, they are not very concerned about parasites: even ticks within easy reach seem to be ignored.

70 000

Number of red-sided garter snakes that emerge each spring from dens in Narcisse, Canada, for a writhing mass-mating spectacle.
Do animals murder their own species?

Animals unquestionably kill members of their species, all the time. Male lions slaughter all the cubs when they join a new pride, rival ant colonies of the same species fight bloody wars, and chimpanzees have been shown to kill each other at similar per capita rates to humans.

Does any of this count as murder? That depends on your moral philosophy. Most animals are probably unaware of the moral dimension of their actions, but whether this excuses them is a matter of opinion. Humans also have plenty of circumstances that allow them to kill without committing murder – in self-defence, or during war for example – and animals generally have similar justifications.

Chimpanzees share 98 percent of their DNA with humans.

Why do some birds, such as flamingos, stand on one leg?

Though various theories have been proposed to explain this behaviour, known as ‘unipedal resting’, research has only recently produced an explanation. A study on captive Caribbean flamingos revealed that standing on one leg helps to conserve warmth. This probably also applies to other waterbirds, such as various species of wader.

Cold water draws away body heat, so, for birds that spend a lot of time wading, it makes sense to minimise losses by placing only one limb in the water, keeping the other tucked up in the plumage.

The scientists also ruled out other previous suggestions, such as reducing fatigue in the flamingo’s legs and improving balance.

A flamingo isn’t the only bird to stand on one leg – herons, ducks, geese and even pigeons do it too.

Can fish drown?

According to Collins Concise Dictionary, drowning is ‘to die or kill by immersion in liquid’ – so no, fish cannot drown. However, they can suffocate when fresh water does not contain enough dissolved oxygen – either as a result of eutrophication (an excess of nutrients) or drought. Out of water, a fish’s feathery gills stick together, reducing the space available for gas exchange, resulting in suffocation.
Do barnacles harm the whales on which they grow?

The relationship is usually described as commensal: one species benefits – the barnacles enjoy a near-constant flow of water from which to feed – while the other neither gains nor loses. However, it’s possible that barnacles both harm and benefit their host, depending on the particular situation. For the whale, barnacles may cause drag, increasing energy expenditure. Also, they are deeply rooted in their host’s skin, and excessive growth might encourage infections. Conversely, being coated with sharp barnacles may prove advantageous as males vie for position during mating.

**WHAT’S IN A NAME?**

**Mozzie**

*Anopheles* spp.

Females of this species of ‘common malaria’ mosquito, which occur in temperate, subtropical and tropical areas, are the only known carriers of malaria. The genus name comes from the Greek, *an* meaning ‘not’ and *óphelos* meaning ‘profit’ – making them useless in every sense. Mosquito is a diminutive of the Spanish word ‘mosca’ meaning fly.

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**QUIZ**

Birds’ feathers come in all different sizes and colours. Can you identify these six birds? Turn to page 130 for answers.

1. 
2. 
3. 
4. 
5. 
6. 
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Huisgenoot, YOU and Drum are inviting your school to be part of one of the most exciting exhibitions to hit South Africa. Children will be amazed at dinosaurs coming to life in front of their eyes. Each part of the Days of the Dinosaur exhibition is a new approach for kids to learn about an important and fascinating part of history by making it entertaining and educational.

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To give your school an unforgettable learning experience at the Days of the Dinosaur exhibition, contact Bea van der Vyfer on 011-886-9545 or email bea@megatrav.co.za.
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WHAT IS EVOLUTION?

WHY DO CRABS WALK SIDEWAYS?

HOW DO KANGAROOS HOP?

HOW DO VENUS FLYTRAPS WORK?

WHY ARE PEOPLE SCARED OF SPIDERS?

WHAT’S THE WORLD’S MOST POISONOUS ANIMAL?

HOW DO BIRDS FLY?

WHICH CAME FIRST – THE CHICKEN OR THE EGG?