The LANGUAGE of the UNIVERSE

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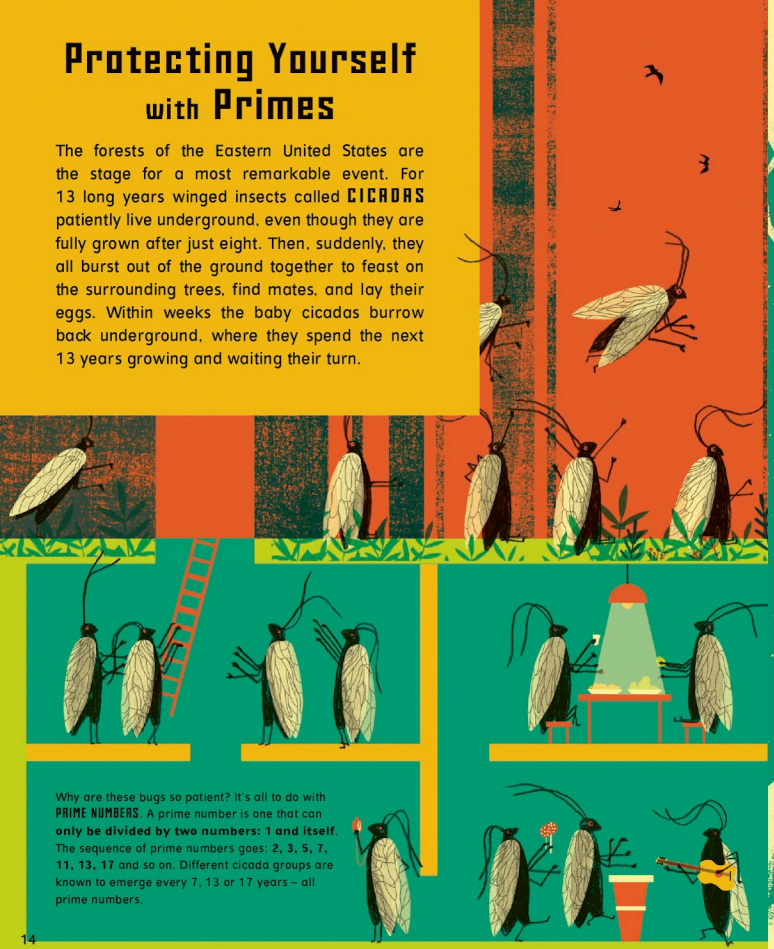
A VISUAL EXPLORATION OF MATHEMATICS

BIG PICTURE PRESS

Protecting Yourself with Primes

The forests of the Eastern United States are the stage for a most remarkable event. For 13 long years winged insects called **CICADAS** patiently live underground, even though they are fully grown after just eight. Then, suddenly, they all burst out of the ground together to feast on the surrounding trees, find mates, and lay their eggs. Within weeks the baby cicadas burrow back underground, where they spend the next 13 years growing and waiting their turn.



Why are these bugs so patient? It's all to do with **PRIME NUMBERS**. A prime number is one that can **only be divided by two numbers: 1 and itself**. The sequence of prime numbers goes: **2, 3, 5, 7, 11, 13, 17** and so on. Different cicada groups are known to emerge every 7, 13 or 17 years – all prime numbers.

In Search of the Symmetrical

Mathematicians love to explore **SYMMETRY**. If an object has **the property of symmetry, it can be rotated or flipped and still look exactly the same**. There are some fascinating examples in the natural world.

Both a starfish and snowflake have what mathematicians call **ROTATIONAL SYMMETRY – if you turn them by a certain amount they don't look any different**. How many different ways can you turn a starfish without changing its appearance?

The answer is **five**, so a mathematician would say it has **FIVE-FOLD SYMMETRY**. There are 360 degrees in a circle, so you have to turn the starfish **72 degrees** each time to reach the next matching position. What about a stunning snowflake? How would you describe its symmetry and how many degrees do you have to turn it each time?

Answer: Six-fold symmetry, 60 degrees

Fun with Fractals

Maths doesn't get much prettier than a **FRACTAL**. These **beautiful never-ending patterns have copies of themselves hidden within them** – zoom in or out and you'll see the same shape repeated over and over again.

Take a look at this fern. One of the side branches is just a miniature version of the whole plant. Look even more closely and you'll see that a side branch of that side branch is also the same!

Teamwork with Tessellation

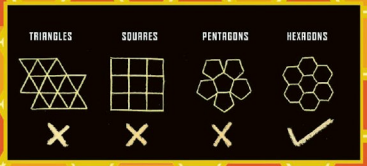
Some of the most famous animals on the planet avoid getting eaten by using a clever trick based on the mathematical idea of **TESSELLATION**. A tessellation is **a repeating pattern of shapes arranged close together without overlapping or leaving gaps**. Fill an empty area with a smaller tessellating shape, such as a square, triangle or diamond, and it's harder to see the individual tiles.

Zebras use a similar technique to confuse predators. Their distinctive **BLACK AND WHITE STRIPES** mean that it is **harder for a hungry lion to pick out an individual from a herd**. Other creatures try to **remain hidden by blending in with with their surroundings** such as trees or snowy ground. Scientists call this **CAMOUFLAGE**. The **green baron caterpillar** is a master of this art, seemingly disappearing as soon as it settles on a leaf.

Packing the Perimeter

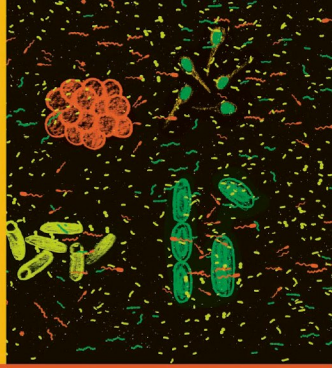
Have you ever packed a suitcase with clothes before going on a trip? If you have, you'll know some ways waste more room than others. You'd do well to take a lesson in space-saving from the honeybee – Nature's expert packer.

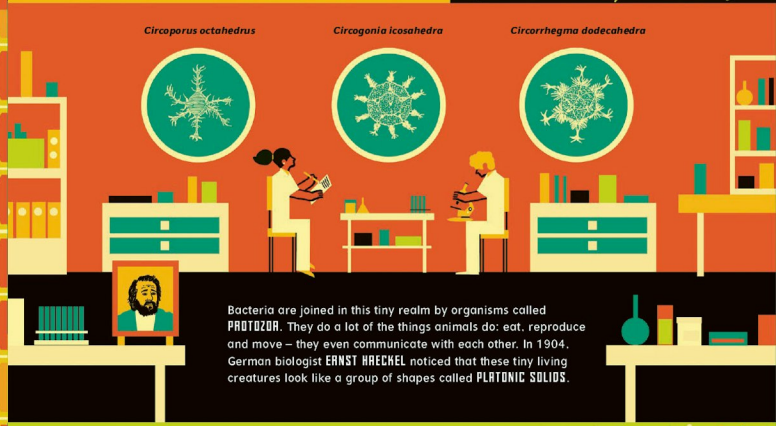
Bees skillfully construct their homes from honeycomb, which is made out of a wax produced by their bodies. Their building block of choice is the **HEXAGON**. Why this **six-sided shape** and not a triangle or a circle? It's **the best way to fill an area with the same shape without any gaps**. This means the bees can build their homes in the quickest time using the least amount of wax and get the most amount of storage space. People have marvelled at the work of the bee for centuries, but it took until 1998 for mathematician **THOMAS HALES** to officially prove there was no better way of packing space.



The Platonic Protozoa

The natural world is teeming with living things on a scale too small for your eyes to see. In your own body there are more **tiny microorganisms** called **BACTERIA** than your own cells! They're so small that more than 100 sitting side-by-side would fit across the full stop at the end of this sentence. This microscopic universe has a beautiful link to maths.





Bacteria are joined in this tiny realm by organisms called **PROTOZOA**. They do a lot of the things animals do: eat, reproduce and move – they even communicate with each other. In 1904, German biologist **ERNST HAECKEL** noticed that these tiny living creatures look like a group of shapes called **PLATONIC SOLIDS**.

More recently, biologists have discovered that **many viruses also have an icosahedral structure**.

Getting to Grips with Geometry

When it comes to love, maths can be the difference between finding a mate or not – at least if you're a member of the animal kingdom. The name of the game is **GEOMETRY – the study of points, lines and the shapes they make**. Mathematician and astronomer Johannes Kepler once said "Where there is matter, there is geometry".

One of the most famous users of geometry is the male peacock, with its bright, shimmering tail that features a pattern of colourful eyespots. Growing such an impressive fan of feathers takes many steps and things can go wrong at any stage. If the geometry of the male's pattern isn't perfect it can be a sign to a potential mate that they are not healthy and are best avoided.

The Awesome Ant

Watching a colony of ants can be hypnotic. They are the ultimate team players, all working together for the survival of the group. They're also excellent mathematicians and use their number-crunching skills when looking for a new place to live.

scout

Imagine an ant colony grows too big for its nest. The ants need to find a bigger home to move into. A few scouts are sent out to look for new digs, but how do they decide which is the biggest? After all, they don't have a tape measure to hand.

This discovery was first calculated by French mathematician **GEORGES LOUIS LECLERC** in the 1700s. He worked out the probability of random lines crossing by throwing bread baguettes on to a floor made of planks and recording when they landed over a crack. Ants have been shown to 'count' the **INTERSECTIONS** of their trails and use that to pick the biggest homes for their colony. Clever stuff! Particularly for a creature with a brain a million times small than a human's.