

## The world inside us: Uncovering the secrets of the cell

We all share something amazing in common – that we developed from a single sperm and egg to become complicated, sophisticated organisms, made of trillions of cells. But what are these cells like and how do they vary from one tissue to another? The diagram below

gives a flavour of the complex make-up of a typical animal cell. The stages of the cell cycle – how the cell divides – are shown around the outside. At the bottom, explore some of our cells' vital statistics: from size to speed, number to lifespan.

### cytoskeleton

**microtubules** – small, tubular assemblies of protein, made from repeating tubulin subunits, which help maintain the cell's internal structure and move organelles and cytoplasm using molecular motors

**microfilaments** – smaller than microtubules, these are made from repeating actin subunits. Responsible for cell movement and changes in shape, and make muscle contraction possible

**vacuoles** – internal bags, surrounded by a membrane, which cells use for storage of food or waste

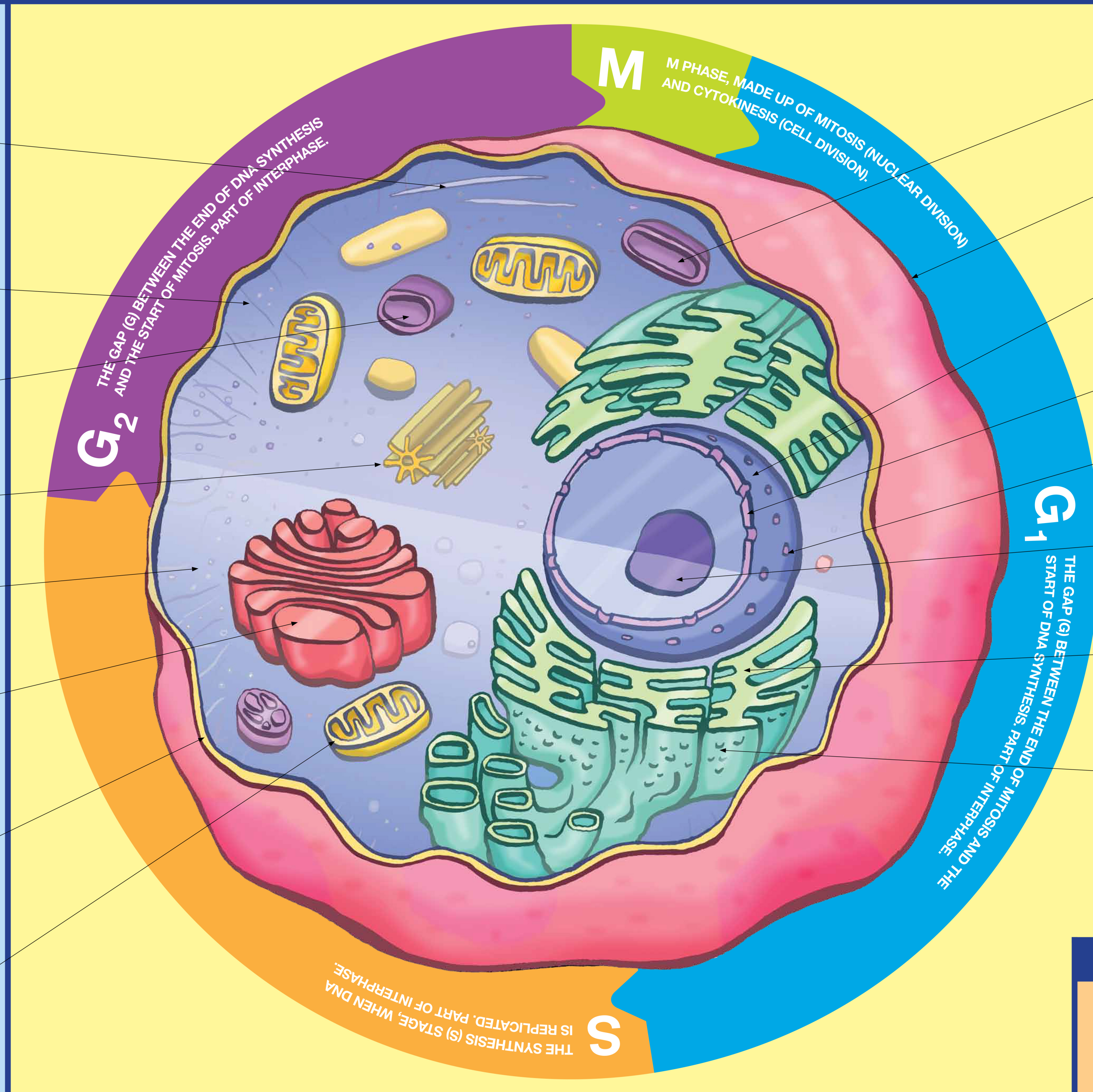
**centrioles** – a pair of organelles that organises microtubules into spindles on which chromosomes are separated when cells divide

**cytoplasm** – everything in the cell outside the nucleus; a viscous fluid containing proteins, other organic and inorganic molecules, membranes and organelles

**Golgi apparatus** – one of the wondrously complex membrane systems in the cytoplasm, which modifies, packages and directs newly made proteins to where they are needed

**plasma membrane** – a phospholipid bilayer that contains cholesterol and proteins. It surrounds the cell and enables it to communicate with its neighbours and detect and respond to changes in the environment

**mitochondria (singular: mitochondrion)** – rod-shaped bodies in the cytoplasm that supply chemical energy to the rest of the cell



**lysosomes** – membrane-bound organelles that are the cell's rubbish disposal and recycling units; contain hydrolytic enzymes

**extracellular matrix** – the material in between cells that holds tissues together, usually made of scaffolding proteins such as collagen

**nucleus** – the information centre of the eukaryotic cell, where the DNA is stored, replicated and copied into RNA (transcribed)

**nuclear envelope** – double membrane that separates the contents of the nucleus from the cytoplasm

**nuclear pores** – gaps in the nuclear envelope that allow substances to move in and out of the nucleus

**nucleolus** – part of the nucleus that produces ribosomes

**endoplasmic reticulum (ER)** – an extensive network of membranes. Rough ER is studded with ribosomes and is a site where proteins are made, modified and processed for shipping. The roles of smooth ER include lipid and steroid synthesis and drug detoxification

**ribosomes** – molecular machines, built from RNA and protein, that make new proteins. They are found in the cytoplasm and bound to the rough endoplasmic reticulum

### How small is small?

Along a 1 cm line, you could fit...

- ...around 1800 sperm heads
- ...around 1300 red blood cells
- ...around 80 egg cells

## Think you know your cells? Take a look at some of their vital statistics.

### Lifespan

#### How long does cell division take?

The cell cycle has several stages, but a simple distinction is between the periods when the components of the cell are being copied and the final stage (mitosis) when the nucleus splits and the cell then divides into two new cells. In an actively dividing human cell, mitosis takes about an hour, and the rest of the cycle averages another 23 hours.

#### What's the shortest-living cell?

The white blood cells that hunt down

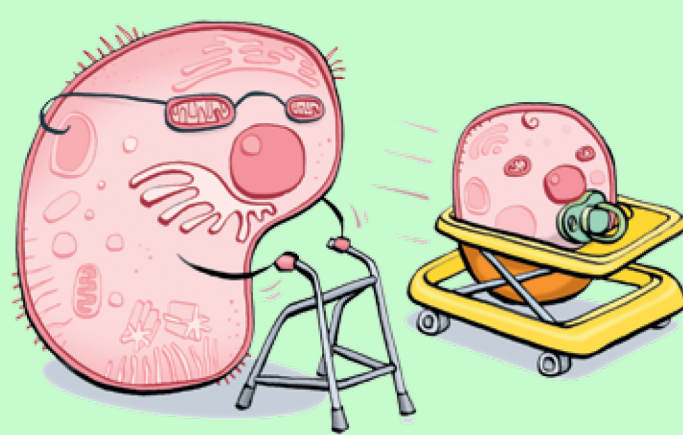
bacteria are gone in less than a day. The cells in the lining of the small intestine live for a few days.

#### What's the longest-living cell?

The neurons in your brain can last a whole lifetime.

#### How often do different cells divide?

The fastest-dividing human cells are in the skin and the lining of the intestine – they produce a new generation in less than a day (around 20 hours). Neurons do not normally divide at all.



### Size

#### What's the biggest cell in the body?

The egg or ovum is usually said to be the largest, but the anterior horn cell of the spine, a kind of specialist neuron on the front part of the nerve channel inside the spinal cord, is 135 micrometres across – a little larger than the ovum, which averages around 120 micrometres.

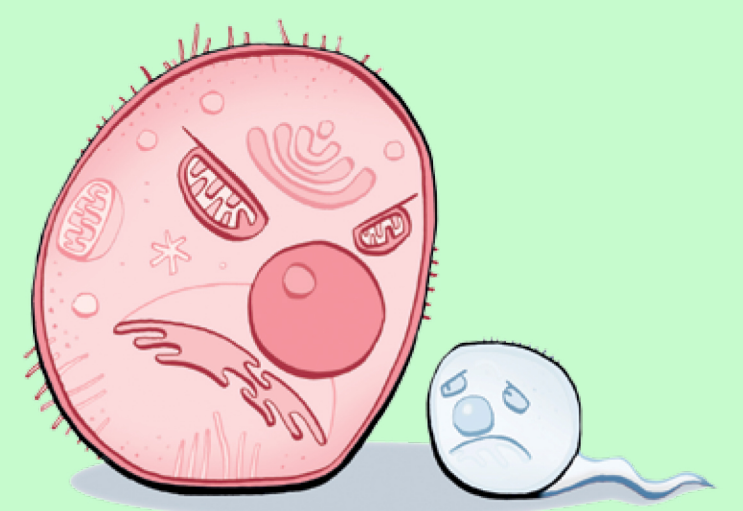
#### What limits size?

The surface area of a cell increases more slowly than its volume, so if a cell grows too

large it cannot take in food molecules or export waste fast enough to function properly. The lower limit is the size needed to enclose the nucleus, the organelles and enough cytoplasm for molecules to pass between them.

#### What's the smallest cell in the body?

Human sperm are often thought of as the smallest, but granule cells, a type of brain cell found in the cerebellum, are 4 micrometres across – a bit smaller than the head of a typical sperm, which measures 5–6 micrometres in length.



### Number

#### How many different types of cell?

Humans have at least 200 different types of cell. There are many more specialised cells in the immune system, where antibody-producing cells are the same type, but each one produces a single kind of one of the millions of possible antibody proteins, with a specific shape. Other cell types have less elaborate subdivisions.

#### How many bacterial cells in/on me?

Humans are home to many bacteria, which live in the digestive system and on the surface of the body. The total bacterial population has perhaps ten times as many cells as there are body cells – that is, 1000 trillion – though they are much smaller. They weigh around 1 kg altogether.

#### How many cells in me?

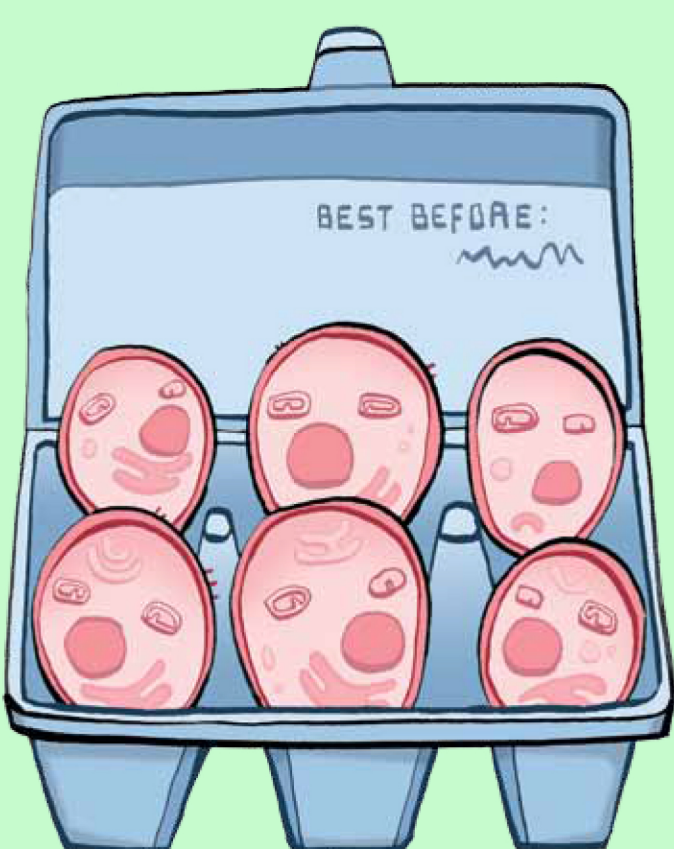
An average adult has trillions (millions of millions) of cells. Estimates vary, but the average is around 100 trillion.

#### How many cells do we get through in a lifetime?

As cell lifetimes vary, we can make only rough estimates, but the average organ replaces cells every seven to ten years, so we might use up ten or so sets of cells in 70 years, for a total of 1000 trillion.

#### Which is the most common cell?

The most common cell type is the red blood cell, which accounts for roughly a quarter of all the body's cells. The largest individual organ is the skin.



### Speed

#### How fast do organelles move?

When pulled along by the cytoskeleton, they cover about 5 micrometres per second.

#### What is the fastest cell?

A cell such as a white blood cell, which uses its internal cytoskeleton to crawl along, can manage speeds of micrometres per minute. Cells with powerful flagella to move them along, such as sperm, go faster – up to as much as a few millimetres per minute.

#### How fast are proteins made?

A single polypeptide can be made on a ribosome in 20 seconds. Larger proteins may take several minutes.

#### How fast do nerve impulses travel?

A typical fast nerve impulse, like the one you use when you pull your hand away from a fire, travels down a cell fibre at 100 metres per second (over 223 mph).

#### How fast do blood cells travel around the body?

The speed of blood depends on the size of the artery or vein, heart rate and blood pressure. In a large artery, it can move at a peak rate of 100 centimetres per second (around 2 mph). The speed in the narrow capillaries is much lower.

