The Cell Wall

A Level

Cell walls are present in bacteria, archaea, plants, algae, and fungi - but not in animals. The cell wall surrounds the cell membrane, providing an extra layer of protection and support.

Part A Plants

The plant cell wall is primarily composed of microfibrils of [ ] (which is a [ ]) embedded in a pectin matrix. A thin, pectin-rich layer called the [ ] surrounds the cell wall and helps stick adjacent cells together.

Items:

protein **starch** **cellulose** **middle lamella** **capsule** **polysaccharide**

Part B Bacteria

The bacterial cell wall is composed of [ ] (also called murein): a polymer consisting of long [ ] chains linked together by short oligopeptides.

Gram-positive bacteria have a thick cell wall, whereas gram-negative bacteria have a thin cell wall that is surrounded by an extra membrane (called the bacterial outer membrane), which is made of lipoproteins and lipopolysaccharides.

Some bacteria also contain a layer outside of the cell wall/bacterial outer membrane called a [ ] - a thick, mucus-like layer of polysaccharides.

Items:

lipoprotein **polysaccharide** **cellulose** **peptidoglycan** **middle lamella** **capsule**

The Cytoskeleton, Centrosomes, Flagella and Cilia

A Level

The cytoskeleton is the network of fibres that spreads throughout the cytoplasm of a cell. It provides structural support to the cell, gives shape to the cell, and enables movement (both of the cell, and of organelles within the cell). The components of the cytoskeleton are also arranged (in some cells) into specific structures, including centrosomes, cilia, and flagella.

Part A The cytoskeleton

In eukaryotes, the cytoskeleton has three main components: microfilaments, microtubules, and intermediate filaments. All of these are made of [ ].

Microfilaments are thin strands of [ ]. They are essential for cell movement and cell contraction (which is particularly important during cytokinesis).

Microtubules are hollow cylinders of [ ], and are wider than microfilaments. They are essential for moving organelles around the cell and separating chromosomes during cell division.

Intermediate filaments are intermediate in width between microfilaments and microtubules, and include various types of proteins. They have various functions, including cell-to-cell adhesion.

Items:

auxin **proteins** **polysaccharides** **actin** **cytokinin** **tubulin**

Part B Centrosomes & centrioles

Most eukaryote cells contain an organelle called the [ ], which is responsible for chromosome separation during cell division. This organelle is made up of a pair of [ ] surrounded by microtubules and a protein matrix. Each [ ] is made of nine triplets of microtubules connected in a ring.

During cell division, the centrosome duplicates to form two centrosomes. The centrosomes move to opposite ends of the cell, and the microtubules (those that are not part of the centrioles) attach to the chromosomes and pull them apart. In this context, these microtubules are called [ ].

Items:

centromeres **microfilaments** **spindle fibres** **centriole** **centrioles** **centrosomes** **centrosome**

Part C Flagella and cilia

Flagella and cilia are cytoskeleton-based extensions of the cell. They are only present in some cell types.

Flagella are long extensions, mainly used for movement of the cell. The only human cell type that has a flagellum is the [ ]. In eukaryotes, the flagellum is made up of nine doublets of microtubules connected in a ring, with two single microtubules in the centre of the ring. This is called the [ ] arrangement. Flagella are also present in prokaryotes, but they have a different structure.

Cilia are shorter, hair-like extensions that are only present in eukaryotes. They are either motile or non-motile.

Motile cilia are used to move fluid/objects along a tissue. In humans, cells lining the trachea have cilia which move mucus upwards (away from the lungs). Most motile cilia have the same [ ] arrangement as flagella.

Non-motile cilia help [ ] the surface area of the cell, which is useful for sensory cells. Most non-motile cilia have a [ ] arrangement i.e. each cilium is made of nine doublets of microtubules connected in a ring, with no central microtubules.

Items:

9+0	**increase**	**sperm cell**	**red blood cell**	**decrease**	**9+2**	**egg cell**

Part D Identify the structure!

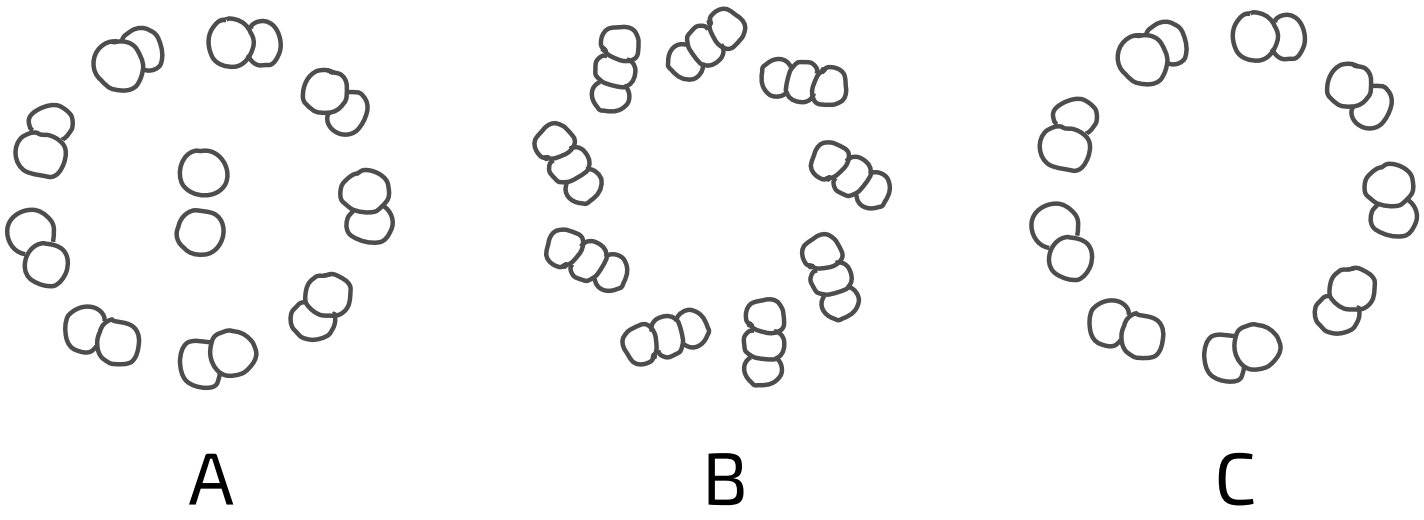


Figure 1: Three different cross-sections are shown, each of a different cytoskeleton-based structure. Each individual circle is a microtubule.

Match the structure to the letter from Figure 1.

A: [ ]

B: [ ]

C: [ ]

Items:

flagellum or motile cilium | **centromere** | **centriole** | **non-motile cilium** | **centrosome**

Created for isaacphysics.org by Lewis Thomson

Gameboard:

STEM SMART Biology Week 2

Ribosomes

A Level

Part A Structure and types

Ribosomes are small organelles composed of RNAs and [ ]. A single cell may contain millions of ribosomes. Some of these exist as "free ribosomes" in the cytoplasm, and others are bound to the endoplasmic reticulum (eukaryotes only).

Each ribosome is made up of a small subunit and a large subunit. There are two types of ribosomes: 70S ribosomes and 80S ribosomes.

70S ribosomes are found in the cytoplasm of [ ] cells, as well as in mitochondria and in [ ]. The small subunit is composed of 1 ribosomal RNA (rRNA) and several proteins, and the large subunit is composed of 2 ribosomal RNAs (rRNAs) and several proteins.

80S ribosomes are found in the cytoplasm of [ ] cells. The small subunit contains 1 ribosomal RNA (rRNA) and several proteins, and the large subunit contains 3 ribosomal RNAs (rRNAs) and several proteins.

Items:

proteins **lipids** **chloroplasts** **prokaryotic** **DNA** **eukaryotic** **lysosomes**

Part B Function of ribosomes

Ribosomes are involved in the process of [ ]. During this process, the ribosome binds to a messenger RNA (mRNA) strand and facilitates the binding of complementary transfer RNAs (tRNAs). Each type of tRNA molecule is bound to a specific [ ], and so the binding of tRNAs to an mRNA strand facilitates the formation of a protein.

Free ribosomes are used to synthesise proteins that will remain in the cell, and so these proteins are released into the cytoplasm or transported to the nucleus/mitochondria/chloroplasts.

Bound ribosomes are used to synthesise proteins that will be secreted, and so these proteins are deposited into the [ ] where they undergo post-translational modifications.

Items:

transcription | **amino acid** | **smooth endoplasmic reticulum** | **translation** | **rough endoplasmic reticulum** | **polypeptide**

Created for isaacphysics.org by Lewis Thomson

Gameboard:

STEM SMART Biology Week 2

The Endoplasmic Reticulum

A Level

Part A Structure & function

The endoplasmic reticulum (ER) is a network of tubules and flattened sacs (called [ ]). These are bound and connected by a single-membrane which is continuous with the [ ] membrane of the nucleus.

The part of the ER which has ribosomes on the surface is called the [ ]. Proteins that will eventually be secreted from the cell are stored here before being transported to the Golgi apparatus via vesicles.

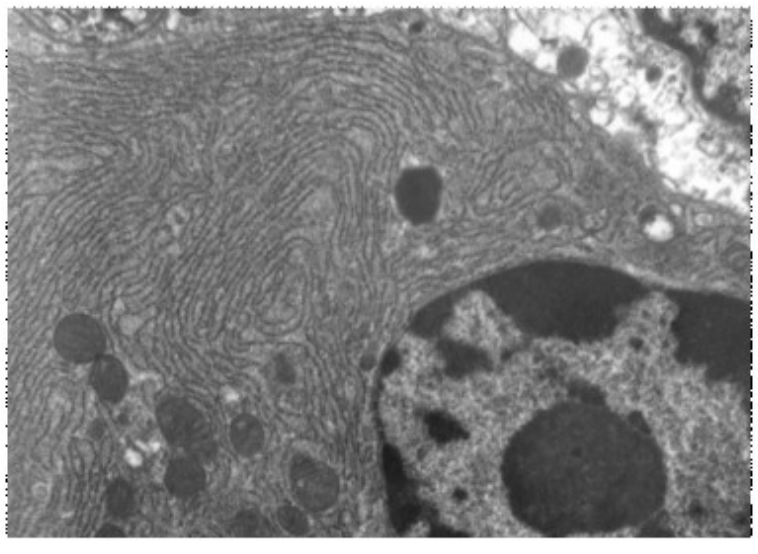
The part of the ER which does not have ribosomes on the surface is called the [ ]. Lipids and carbohydrates are synthesised and stored here.

Items:

outer **rough endoplasmic reticulum (RER)** **thylakoids** **inner**

smooth endoplasmic reticulum (SER) **cisternae**

Part B Identify the structures!



Electron microscope image of a section of mammalian lung tissue, showing part of a nucleus, mitochondria, and the endoplasmic reticulum. Image by Louisa Howard (Public Domain).

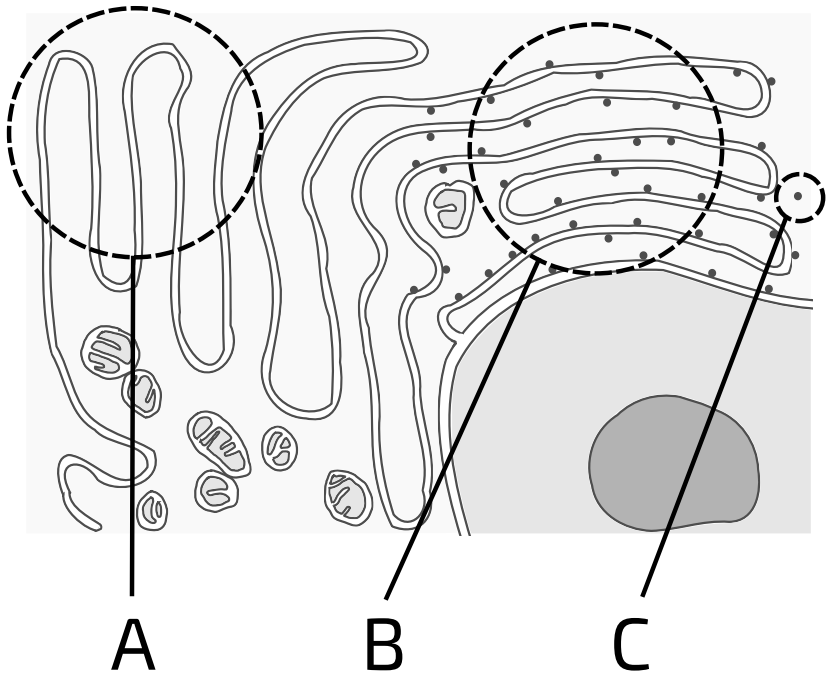


Figure 1: A simplified diagram of the electron microscope image above. The endoplasmic reticulum is show, and three structures are labelled.

What is labelled "A" in Figure 1?

What is labelled "B" in Figure 1?

What is labelled "C" in Figure 1?

The Golgi Apparatus

A Level

Part A Structure & function

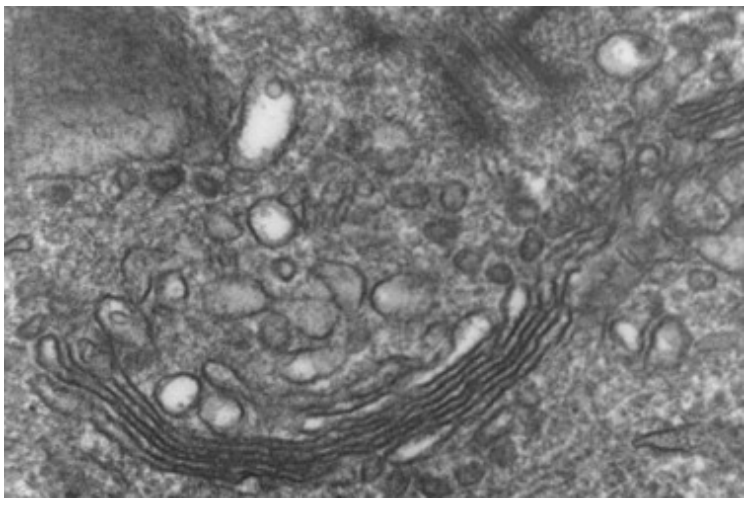
The Golgi apparatus (also called the Golgi, the Golgi body, or the Golgi complex) consists of a stack of flattened sacs (also called [ ]) and vesicles. These are enclosed by a [ ]-membrane.

Vesicles transport proteins from the [ ] and then bind to the Golgi apparatus and deposit the proteins inside. Once inside, proteins undergo modification (e.g. phosphorylation, addition of [ ] to form glycoproteins, addition of [ ] to form proteolipids, etc.). Modified proteins are then transported via Golgi vesicles to the cell membrane for secretion.

Items:

rough endoplasmic reticulum **cisternae** **double** **single** **lipids** **smooth endoplasmic reticulum** **carbohydrates**

Part B Identify the structures!



Electron microscope image of part of a human leukocyte, showing the Golgi apparatus. Image by Louisa Howard (Public Domain)

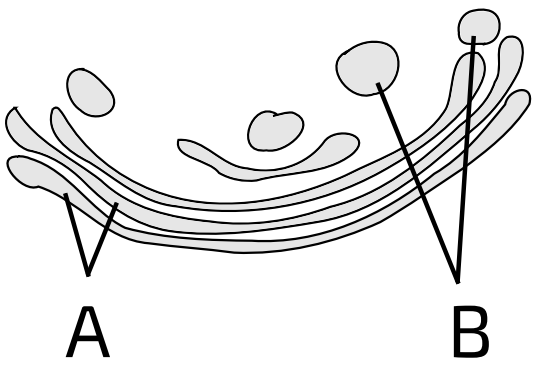


Figure 1: A simplified diagram of the electron microscope image above. The Golgi apparatus is shown, and two structures are labelled.

What is labelled "A" in Figure 1?

What is labelled "B" in Figure 1?

Created for isaacphysics.org by Lewis Thomson

Gameboard:

STEM SMART Biology Week 2

Vesicles, Lysosomes, and Vacuoles

A Level

Vesicles are small sacs, each one bound by a single membrane. They form by "budding" off from existing membranes (e.g. the endoplasmic reticulum membrane, the Golgi apparatus membrane, or the cell membrane). They move molecules around the cell as well as into and out of the cell. There are also some specialised vesicles which have specific functions: e.g. lysosomes and vacuoles.

Part A Lysosomes

Lysosomes are specialised vesicles, produced by the [ ], that contain [ ]. They are used to break down ingested material (in [ ] cells) as well as break down old organelles, and they can fuse with the cell membrane to release their contents outside the cell.

Items:

ribosomes **red blood** **digestive enzymes** **lipids** **phagocytic** **Golgi apparatus** **endoplasmic reticulum** **carbohydrates**

Part B Vacuoles

Vacuoles are large vesicles, containing mostly water. Many plant cells have one very large, permanent vacuole called the [ ]. The single-membrane around this is called the [ ] . The central vacuole helps keep plant cells [ ] by pushing other organelles and cell contents to the edges of the cell. It can also act as a store of sugars and amino acids.

Items:

vacuole wall **central vacuole** **plasmolysed** **tonoplast** **stoma** **turgid**

Magnification

A Level

Part A Magnification formula

Complete the equation for calculating the magnification of an image.

Magnification = [ ] [ ] [ ]

Items:

image size **image resolution** **actual object size** ÷ × **wavelength**

Part B Magnification calculation

A student captures an image of a white blood cell on a microscope. The white blood cell has a diameter of $15\,\mu\mathrm{m}$. In the image, the diameter is $150\,\mathrm{mm}$. What is the magnification of this image?

Part C Cell length calculation

A student captures an image of bacteria on a microscope using $600\times$ magnification. The length of a bacterium in the image produced is $1.5\,\mathrm{mm}$. What is the actual length of this bacterium?

Part D Image size calculation

A student captures an image of a zebrafish egg, using $200\times$ magnification. The egg has a diameter of $0.7\,\mathrm{mm}$. What will the diameter be in the image produced?

Created for isaacphysics.org by Lewis Thomson