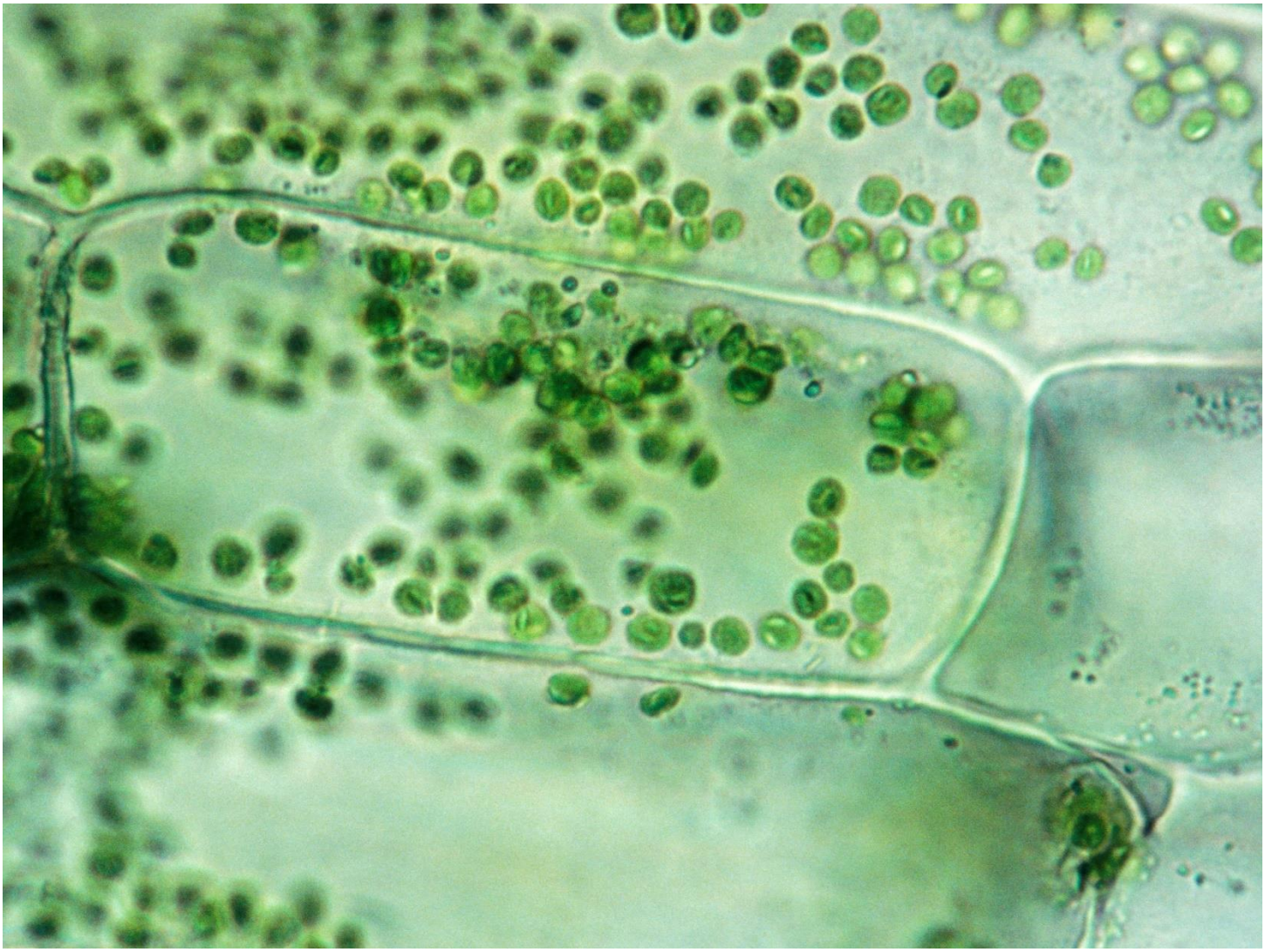
A-level Biology



Bridging Course - Week 1

Entry Requirements for Studying A-level Biology?

- Students who are expected to achieve at least a grade 7 in GCSE Biology Separate Science or a grade 7 in Combined Science.
- Students who have enjoyed their GCSE Biology course, and who enjoy extra reading and research.
- Students should be competent in both Mathematics and Chemistry.

What to expect from A-level Biology.

The study of A Level Biology compliments a large number of university courses such as Medicine, Dentistry, Biomedical Science, Genetic Engineering, Environmental Science along with many others. It can also provide academic credentials for unrelated courses such as Law and Architecture.
The course covers both animal, plant and environmental Biology, which will be taught through a combination of theory and practical work. This is a demanding A level, and students will need to be competent in both Maths and Chemistry.

This bridging course will provide you with a mixture of information about A-level Biology, and what to expect from the course, as well as key work to complete. Students who are expecting to study Biology at A-level, and are likely to meet the entry requirements, must complete the bridging course fully and thoroughly, to the best of their ability. You should complete all work digitally if possible, so it is available to print and place in your file at the start of the course. You will submit it to your teacher in September. All of the work will be reviewed and selected work will be assessed, and you will be given feedback on it. This work will be signalled to you. If you do not have access to the internet, please contact the school and appropriate resources will be sent to you. If you are thinking about studying Biology at A-level you should attempt this work to see whether or not you think studying a subject like this is right for you. If you later decide to study Biology, you must ensure you complete this work in full. This work should be completed after you have read and completed the Study Skills work that all of Year 12 should complete.

Course outline

Paper 1	Paper 2	Paper 3
What's assessed • Any content from topics 1–4, including relevant practical skills	**What's assessed** • Any content from topics 5–8, including relevant practical skills	**What's assessed** • Any content from topics 1–8, including relevant practical skills
Assessed • written exam: 2 hours • 91 marks • 35% of A-level	**Assessed** • written exam: 2 hours • 91 marks • 35% of A-level	**Assessed** • written exam: 2 hours • 78 marks • 30% of A-level
Questions • 76 marks: a mixture of short and long answer questions • 15 marks: extended response questions	**Questions** • 76 marks: a mixture of short and long answer questions • 15 marks: comprehension question	**Questions** • 38 marks: structured questions, including practical techniques • 15 marks: critical analysis of given experimental data • 25 marks: one essay from a choice of two titles

The topics that you will study over the two years are as follows;

Year 12

- Topic 1 - Biological molecules
- Topic 2 – Cells
- Topic 3 – Organisms exchange substances with their environment
- Topic 4 – Genetic information, variation and relationships between organisms
- Topic 5 – Energy transfers between organisms - Respiration and photosynthesis

Year 13

- Topic 5 - Energy transfers between organisms – Energy and ecosystems
- Topic 6 - Organisms respond to changes in their environment
- Topic 7 - Genetics, populations, evolution and ecosystems
- Topic 8 - The control of gene expression

The following work will introduce key aspects of the Year 12 content along with some of the skills required during the A-level Biology course. This week we will be looking at cells.

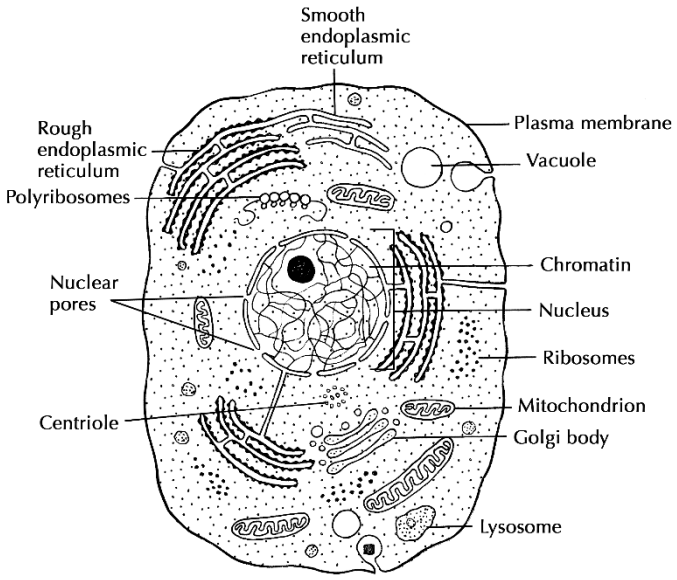
Cells

1. Cell Structure

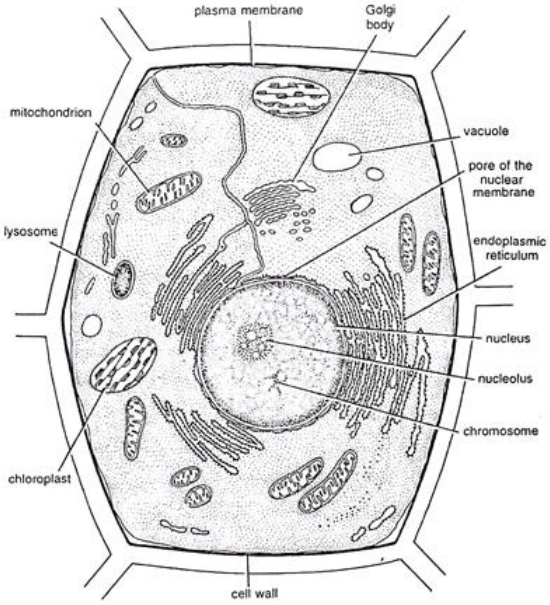
During your GCSE course you have studied the basics of cell structure. At A-level we look at cells in much more detail. For the purpose of this course we are going to concentrate on eukaryotic cells, but the A-level course also requires knowledge of prokaryotic cells.

Below is a diagram of an animal and plant cell, viewed with the level of detail you would expect to see using a transmission electron microscope.

Animal Cell



Plant Cell



1a. Complete the table to describe the function of the cell organelles listed (expand the cells as necessary. Try to find detailed diagrams of each of the organelles. To help you do this you should use the following resources;

https://www.youtube.com/watch?v=URUJD5NEXC8

https://www.youtube.com/watch?v=1Z9pqST72is

3.4 Eukaryotic cell structure

Each cell can be regarded as a metabolic compartment, a separate place where the chemical processes of that cell occur. Cells are often adapted to perform a particular function. Depending on that function, each cell type has an internal structure that suits it for its job. This is known as the **ultrastructure** of the cell. **Eukaryotic** cells have a distinct nucleus and possess membrane-bounded organelles. They differ from **prokaryotic** cells, such as bacteria. More details of these differences are given in Topic 3.6. Using an electron microscope, we can see the structure of organelles within cells, details of which are described below. The most important of these organelles are described below, with the exception of the cell-surface membrane.

Learning objectives

- Describe the structure and functions of the nucleus, mitochondria, chloroplasts, rough and smooth endoplasmic reticulum, Golgi apparatus, Golgi vesicles and lysosomes.
- Describe the structure and function of the cell wall in plants, algae and fungi.
- Describe the structure and function of the cell vacuole in plants.

Specification reference: 3.2.1.1

The nucleus

The nucleus (Figure 1) is the most prominent feature of a eukaryotic cell, such as an epithelial cell. The nucleus contains the organism's hereditary material and controls the cell's activities. Usually spherical and between 10 and 20 µm in diameter, the nucleus has a number of parts.

- The **nuclear envelope** is a double membrane that surrounds the nucleus. Its outer membrane is continuous with the endoplasmic reticulum of the cell and often has ribosomes on its surface. It controls the entry and exit of materials in and out of the nucleus and contains the reactions taking place within it.
- **Nuclear pores** allow the passage of large molecules, such as messenger RNA, out of the nucleus. There are typically around 3000 pores in each nucleus, each 40–100 nm in diameter.
- **Nucleoplasm** is the granular, jelly-like material that makes up the bulk of the nucleus.
- **Chromosomes** consist of protein-bound, linear DNA.
- The **nucleolus** is a small spherical region within the nucleoplasm. It manufactures ribosomal RNA and assembles the ribosomes. There may be more than one nucleolus in a nucleus.

The functions of the nucleus are to:

- act as the control centre of the cell through the production of mRNA and tRNA and hence protein synthesis (see Topic 8.4)
- retain the genetic material of the cell in the form of DNA and chromosomes
- manufacture ribosomal RNA and ribosomes.

The mitochondrion

Mitochondria (Figures 2 and 3) are usually rod-shaped and 1–10 µm in length. They are made up of the following structures:

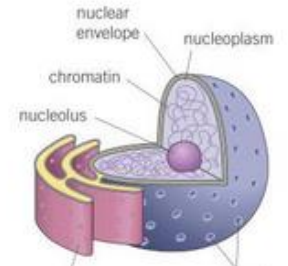
- Around the organelle is a **double membrane** that controls the entry and exit of material. The inner of the two membranes is folded to form extensions known as cristae.

Hint

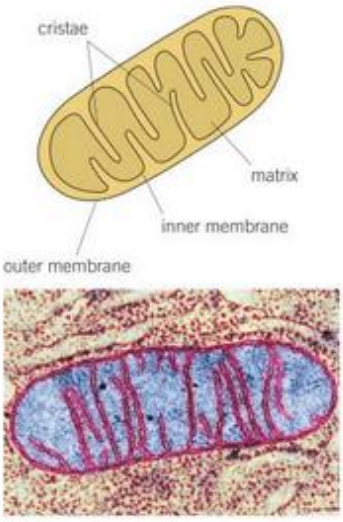
When you look at a group of animal cells, such as epithelial cells, under a light microscope you cannot see the cell-surface membrane because it is too thin to be observed. What you actually see is the boundary between cells.

Synoptic link

The cell-surface membrane is covered in Topic 4.1, and DNA is covered in Topics 2.1, 2.2 and 8.2.



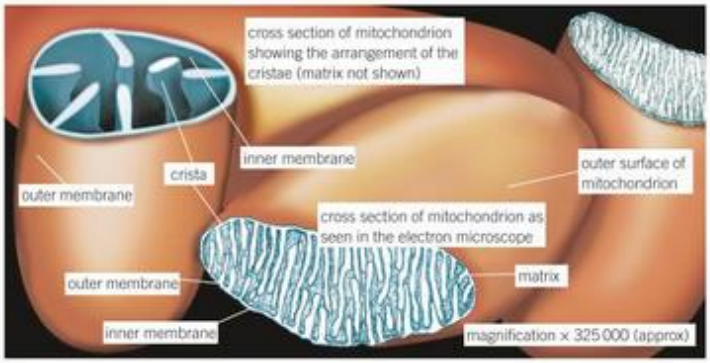
▲ **Figure 1** *The nucleus*



▲ **Figure 2** *The basic structure of a mitochondrion (top); false-colour TEM of a mitochondrion (bottom)*

- **Cristae** are extensions of the inner membrane, which in some species extend across the whole width of the mitochondrion. These provide a large surface area for the attachment of enzymes and other proteins involved in respiration.
- The **matrix** makes up the remainder of the mitochondrion. It contains protein, lipids, ribosomes and DNA that allows the mitochondria to control the production of some their own proteins. Many enzymes involved in respiration are found in the matrix.

Mitochondria are the sites of the aerobic stages of respiration (the Krebs cycle and the oxidative phosphorylation pathway). They are therefore responsible for the production of the energy-carrier molecule, **ATP**, from respiratory substrates such as glucose. Because of this, the number and size of the mitochondria, and the number of their cristae, are high in cells that have a high level of metabolic activity and therefore require a plentiful supply of ATP. Examples of metabolically active cells include muscle and epithelial cells. Epithelial cells in the intestines require a lot of ATP in the process of absorbing substances from the intestines by **active transport**.



▲ **Figure 3** *Mitochondria*

Chloroplasts

Chloroplasts (Figure 4) are the organelles that carry out photosynthesis (see Topic 11.2). They vary in shape and size but are typically disc-shaped, 2–10 µm long and 1 µm in diameter. The following are their main features:

- **The chloroplast envelope** is a double plasma membrane that surrounds the organelle. It is highly selective in what it allows to enter and leave the chloroplast.
- **The grana** are stacks of up to 100 disc-like structures called **thylakoids**. Within the thylakoids is the photosynthetic pigment called **chlorophyll**. Some thylakoids have tubular extensions that join up with thylakoids in adjacent grana. The grana are where the first stage of photosynthesis (light absorption) takes place.
- **The stroma** is a fluid-filled matrix where the second stage of photosynthesis (synthesis of sugars) takes place. Within the stroma are a number of other structures, such as starch grains.

Chloroplasts are adapted to their function of harvesting sunlight and carrying out photosynthesis in the following ways:

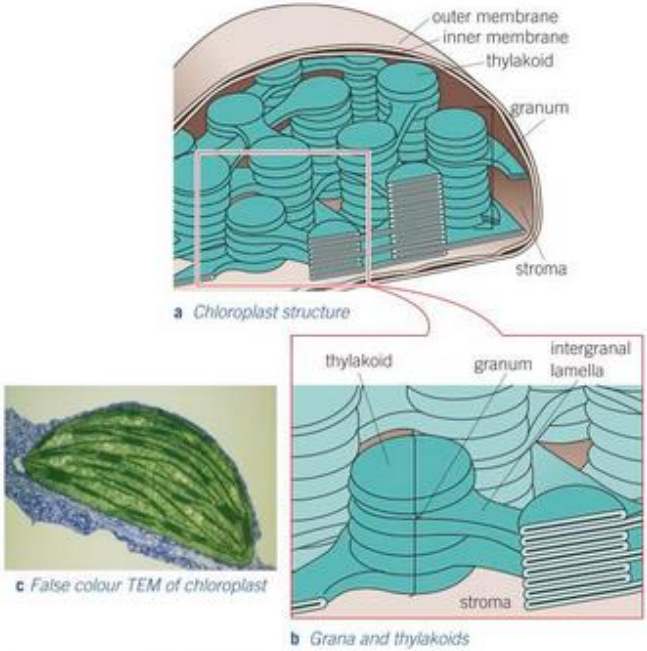
Hint

Chloroplasts have DNA and may have evolved from free-living prokaryotic cells, but they are organelles, not cells.

- The granal membranes provide a large surface area for the attachment of chlorophyll, electron carriers and enzymes that carry out the first stage of photosynthesis. These chemicals are attached to the membrane in a highly ordered fashion.
- The fluid of the stroma possesses all the enzymes needed to make sugars in the second stage of photosynthesis.
- Chloroplasts contain both DNA and ribosomes so they can quickly and easily manufacture some of the proteins needed for photosynthesis.

Study tip

Not all plant cells have chloroplasts. Think about root cells. These are below the soil surface where light rarely penetrates and so no photosynthesis is possible.



a *Chloroplast structure*

c *False colour TEM of chloroplast*

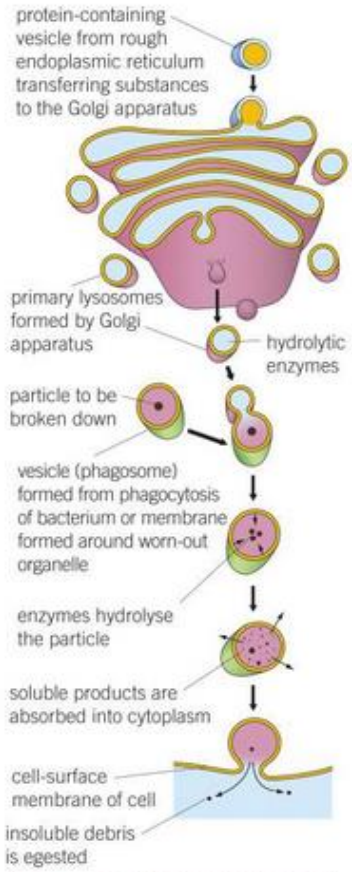
b *Grana and thylakoids*

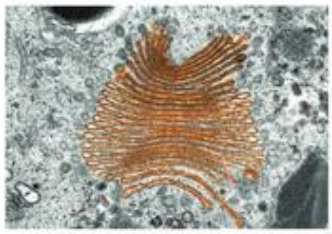
▲ **Figure 4** *Chloroplast structure*

Endoplasmic reticulum

The endoplasmic reticulum (ER) is an elaborate, three-dimensional system of sheet-like membranes, spreading through the cytoplasm of the cells. It is continuous with the outer nuclear membrane. The membranes enclose a network of tubules and flattened sacs called cisternae (see Figure 5). There are two types of ER:

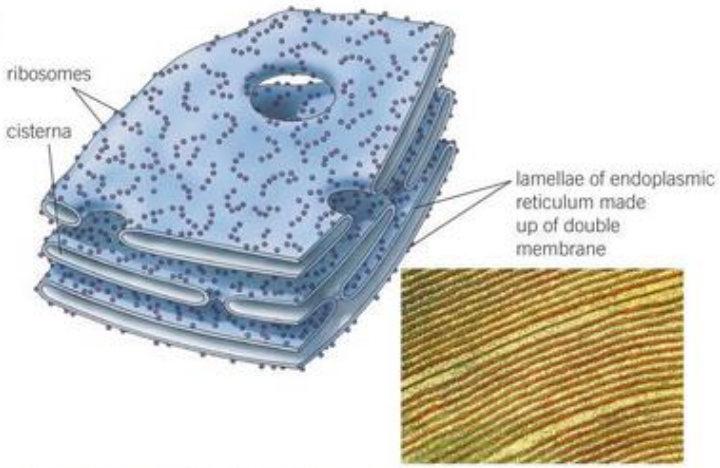
- **Rough endoplasmic reticulum (RER)** has ribosomes present on the outer surfaces of the membranes. Its functions are to:
  - a provide a large surface area for the synthesis of proteins and glycoproteins
  - b provide a pathway for the transport of materials, especially proteins, throughout the cell.
- **Smooth endoplasmic reticulum (SER)** lacks ribosomes on its surface and is often more tubular in appearance. Its functions are to:
  - a synthesise, store and transport lipids
  - b synthesise, store and transport carbohydrates.





▲ **Figure 6** *The Golgi apparatus and the formation and functioning of a lysosome (top); false-colour TEM of a Golgi apparatus (orange) (bottom)*

It follows that cells that manufacture and store large quantities of carbohydrates, proteins and lipids have a very extensive ER. Such cells include liver and secretory cells, for example the epithelial cells that line the intestines.



▲ **Figure 5** *Structure of RER (above); false-colour TEM of a section through RER (RER; red) (right)*

Golgi apparatus

The Golgi apparatus occurs in almost all eukaryotic cells and is similar to the SER in structure except that it is more compact. It consists of a stack of membranes that make up flattened sacs, or **cisternae**, with small rounded hollow structures called vesicles. The proteins and lipids produced by the ER are passed through the Golgi apparatus in strict sequence. The Golgi modifies these proteins often adding non-protein components, such as carbohydrate, to them. It also 'labels' them, allowing them to be accurately sorted and sent to their correct destinations. Once sorted, the modified proteins and lipids are transported in Golgi vesicles which are regularly pinched off from the ends of the Golgi cisternae (Figure 6). These vesicles may move to the cell surface, where they fuse with the membrane and release their contents to the outside.

The functions of the Golgi apparatus are to:

- add carbohydrate to proteins to form glycoproteins
- produce secretory enzymes, such as those secreted by the pancreas
- secrete carbohydrates, such as those used in making cell walls in plants
- transport, modify and store lipids
- form lysosomes.

The Golgi apparatus is especially well developed in secretory cells, such as the epithelial cells that line the intestines.

Lysosomes

Lysosomes are formed when the vesicles produced by the Golgi apparatus contain enzymes such as proteases and lipases. They also contain lysozymes, enzymes that hydrolyse the cell walls of certain bacteria. As many as 50 such enzymes may be contained in a single lysosome. Up to 1.0 µm in diameter, lysosomes isolate these enzymes from the rest of the cell before releasing them, either to the outside or into a **phagocytic** vesicle within the cell (Figure 6).

The functions of lysosomes are to:

- hydrolyse material ingested by phagocytic cells, such as white blood cells and bacteria
- release enzymes to the outside of the cell (exocytosis) in order to destroy material around the cell
- digest worn out organelles so that the useful chemicals they are made of can be re-used
- completely break down cells after they have died (autolysis).

Given the roles that lysosomes perform, it is not surprising that they are especially abundant in secretory cells, such as epithelial cells, and in **phagocytic** cells.

Hint

To help you understand the functions of the Golgi apparatus, think of it as the cell's post office, but receiving, sorting and delivering proteins and lipids, rather than letters.

Hint

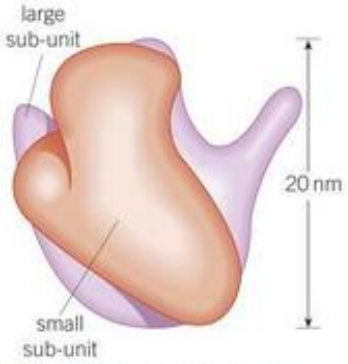
Lysosomes can be thought of as refuse disposal operatives. They remove useless and potentially dangerous material (e.g., bacteria) and reuse the useful parts, disposing of only that which cannot be recycled.

Ribosomes

Ribosomes are small cytoplasmic granules found in all cells. They may occur in the cytoplasm or be associated with the RER. There are two types, depending on the cells in which they are found:

- **80S** – found in eukaryotic cells, is around 25 nm in diameter.
- **70S** – found in prokaryotic cells, mitochondria and chloroplasts, is slightly smaller.

Ribosomes have two subunits – one large and one small (Figure 7) – each of which contains ribosomal RNA and protein. Despite their small size, they occur in such vast numbers that they can account for up to 25 % of the dry mass of a cell. Ribosomes are the site of in protein synthesis.



▲ **Figure 7** *Structure of a ribosome*

Cell wall

Characteristic of all plant cells, the cell wall consists of microfibrils of the polysaccharide cellulose, embedded in a matrix. Cellulose microfibrils have considerable strength and so contribute to the overall strength of the cell wall. Cell walls have the following features:

- They consist of a number of polysaccharides, such as cellulose.
- There is a thin layer, called the **middle lamella**, which marks the boundary between adjacent cell walls and cements adjacent cells together.

The functions of the cellulose cell wall are:

- to provide mechanical strength in order to prevent the cell bursting under the pressure created by the osmotic entry of water

Synoptic link

Look back to Topic 1.4, to refresh your knowledge of cellulose. Osmosis will be covered in Topic 4.3.

Study tip

Plant cells have a cell-surface membrane *and* a cell wall, not just a cell wall.

- to give mechanical strength to the plant as a whole
- to allow water to pass along it and so contribute to the movement of water through the plant.

The cell walls of algae are made up of either cellulose or glycoproteins, or a mixture of both.

The cell walls of fungi do not contain cellulose but comprise a mixture of a nitrogen-containing polysaccharide called **chitin**, a polysaccharide called glycan and glycoproteins.

Vacuoles

A fluid-filled sac bounded by a single membrane may be termed a vacuole. Within mature plant cells there is usually one large central vacuole. The single membrane around it is called the **tonoplast**. A plant vacuole contains a solution of mineral salts, sugars, amino acids, wastes and sometimes pigments such as anthocyanins.

Plant vacuoles serve a variety of functions:

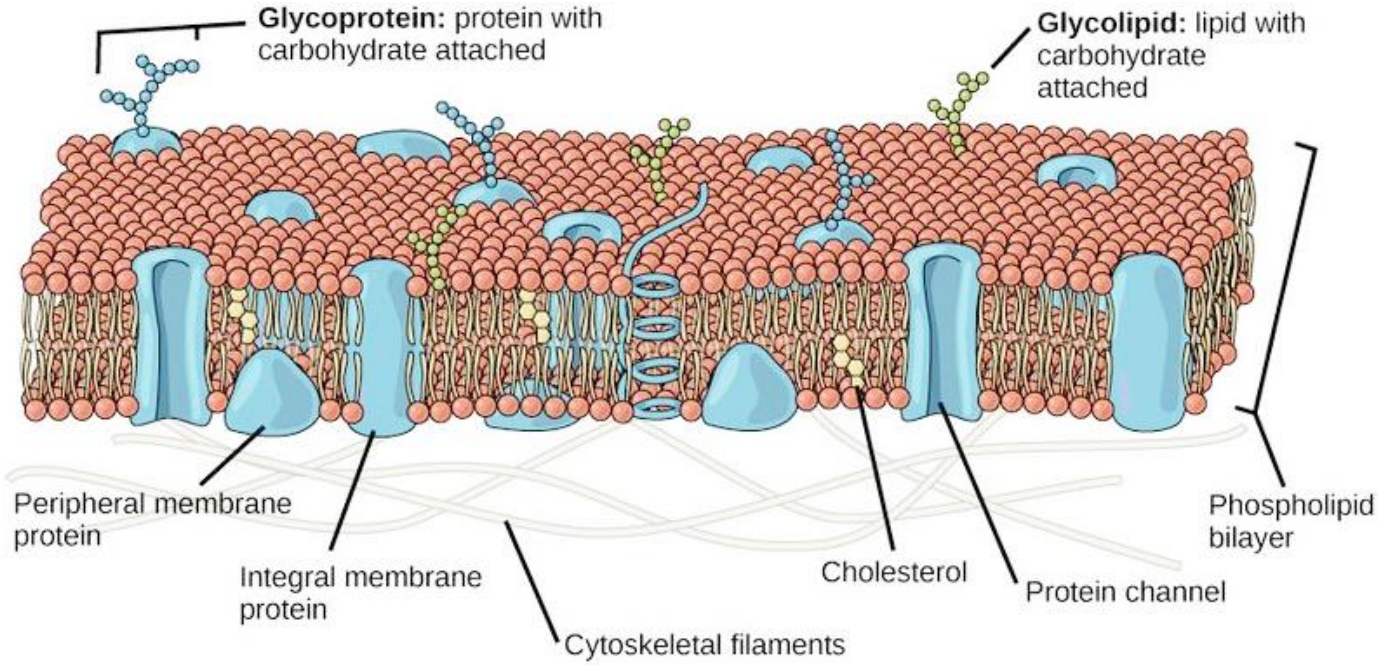
- They support herbaceous plants, and herbaceous parts of woody plants, by making cells turgid.
- The sugars and amino acids may act as a temporary food store.
- The pigments may colour petals to attract pollinating insects.

Relating cell ultrastructure to function

As each organelle has its own function, it is possible to deduce, with reasonable accuracy, the role of a cell by looking at the number and size of the organelles it contains. For example, as mitochondria produce ATP that is used as a temporary energy store, it follows that cells with many mitochondria are likely to require a lot of ATP and therefore have a high rate of metabolism. Even within each mitochondrion, the more dense and numerous the cristae, the greater the metabolic rate of the cell possessing these mitochondria.

Organelle	Structure and function	Diagram
Cell-surface membrane		
Nucleus		
Mitochondria		
Chloroplasts (in plants and algae)		
Golgi apparatus and Golgi vesicles		
Lysosomes		
Ribosomes		
Rough endoplasmic reticulum		
Smooth endoplasmic reticulum		
Cell wall (in plants, algae and fungi)		
Cell vacuole (in plants)		

The cell membrane



The diagram above shows a detailed view of the cell membrane.

1b. Describe the role of the protein channels and the glycoproteins in the cell membrane

TextBook

Learning objectives

- Describe the structure of the cell-surface membrane.
- Describe the functions of the various components of the cell-surface membrane.
- Explain the fluid-mosaic model of cell membrane structure.

Specification reference: 3.2.3

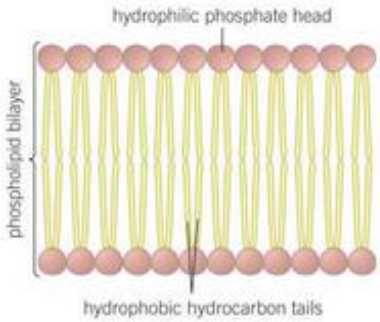
and within cell organelles) have the same basic structure and are known as **plasma membranes**.

The cell-surface membrane is the name specifically given to the plasma membrane that surrounds cells and forms the boundary between the cell cytoplasm and the environment. It allows different conditions to be established inside and outside a cell. It controls the movement of substances in and out of the cell. Before we look at how the cell-surface membrane achieves this, we need first to look in more detail at the molecules that form its structure.

Phospholipids

We looked at the molecular structure of a phospholipid in Topic 1.5. Phospholipids form a bilayer (see Figure 1). They are important components of cell-surface membranes for the following reasons:

- The hydrophilic heads of both phospholipid layers point to the outside of the cell-surface membrane attracted by water on both sides.
- The hydrophobic tails of both phospholipid layers point into the centre of the cell membrane, repelled by the water on both sides.



▲ **Figure 1** *A simplified diagram of a phospholipid bilayer.*

Lipid-soluble material moves through the membrane via the phospholipid portion. The functions of phospholipids in the membrane are to:

- allow lipid-soluble substances to enter and leave the cell
- prevent water-soluble substances entering and leaving the cell
- make the membrane flexible and self-sealing.

Proteins

Proteins are interspersed throughout the cell surface membrane. They are embedded in the phospholipid bilayer in two main ways:

- Some proteins occur in the surface of the bilayer and never extend completely across it. They act either to give mechanical support to the membrane or, in conjunction with glycolipids, as cell receptors for molecules such as hormones.
- Other proteins completely span the phospholipid bilayer from one side to the other. Some are **protein channels**, which form water-filled tubes to allow water-soluble ions to diffuse across the membrane. Others are **carrier proteins** that bind to ions or molecules like glucose and amino acids, then change shape in order to move these molecules across the membrane.

Hint

Organelles such as mitochondria and chloroplasts are surrounded by two plasma membranes. The term *cell-surface membrane* is reserved only for the plasma membrane around the cell.

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The functions of the proteins in the membrane are to:

- provide structural support
- act as channels transporting water-soluble substances across the membrane
- allow active transport across the membrane through carrier proteins
- form cell-surface receptors for identifying cells
- help cells adhere together
- act as receptors, for example for hormones.

Cholesterol

Cholesterol molecules occur within the phospholipid bilayer of the cell-surface membrane. They add strength to the membranes. Cholesterol molecules are very hydrophobic and therefore play an important role in preventing loss of water and dissolved ions from the cell. They also pull together the fatty acid tails of the phospholipid molecules, limiting their movement and that of other molecules but without making the membrane as a whole too rigid.

The functions of cholesterol in the membrane are to:

- reduce lateral movement of other molecules including phospholipids
- make the membrane less fluid at high temperatures
- prevent leakage of water and dissolved ions from the cell.

Glycolipids

Glycolipids are made up of a carbohydrate covalently bonded with a lipid. The carbohydrate portion extends from the phospholipid bilayer into the watery environment outside the cell where it acts as a cell-surface receptor for specific chemicals, for example the human ABO blood system operates as a result of glycolipids on the cell-surface membrane.

The functions of glycolipids in the membrane are to:

- act as recognition sites
- help maintain the stability of the membrane
- help cells to attach to one another and so form tissues.

Glycoproteins

Carbohydrate chains are attached to many extrinsic proteins on the outer surface of the cell membrane. These glycoproteins also act as cell-surface receptors, more specifically for hormones and neurotransmitters.

The functions of glycoproteins in the membrane are to:

- act as recognition sites
- help cells to attach to one another and so form tissues
- allows cells to recognise one another, for example **lymphocytes** can recognise an organism's own cells.

Study tip

When representing a phospholipid it is important to be accurate. It has a *single* phosphate head and *two* fatty acid tails. All too often students show too many heads and/or too many tails.

Hint

All plasma membranes found around and inside cells have the same phospholipid bilayer structure. What gives plasma membranes their different properties are the different substances they contain – especially proteins.

Functions of membranes within cells
control the entry and exit of materials in discrete organelles such as mitochondria and chloroplasts
separate organelles from cytoplasm so that specific metabolic reactions can take place within them
provide an internal transport system, e.g., endoplasmic reticulum
isolate enzymes that might damage the cell, e.g., lysosomes
provide surfaces on which reactions can occur, e.g., protein synthesis using ribosomes on rough endoplasmic reticulum

Practical link

Required practical 4. Investigation into the effect of a named variable on the permeability of cell-surface membranes.

Summary questions

1 State the overall function of the cell-surface membrane.

2 State which end of the phospholipid molecule lies towards the inside of the cell-surface membrane.

3 State through which molecule in the cell-surface membrane each of the following are likely to pass in order to get in or out of a cell.

- **a** a molecule that is soluble in lipids
- **b** a mineral ion

4 From your knowledge of the cell-surface membrane, suggest *two* properties that a drug should possess if it is to enter a cell rapidly.

Permeability of the cell-surface membrane

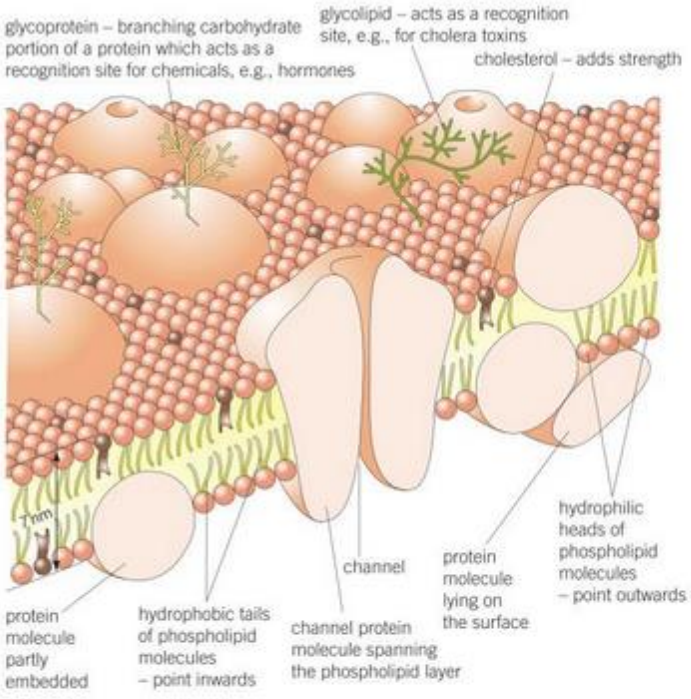
The cell-surface membrane controls the movement of substances into and out of the cell. In general most molecules do not freely diffuse across it because many are:

- not soluble in lipids and therefore cannot pass through the phospholipid layer
- too large to pass through the channels in the membrane
- of the same charge as the charge on the protein channels and so, even if they are small enough to pass through, they are repelled
- electrically charged (in other words are polar) and therefore have difficulty passing through the non-polar hydrophobic tails in the phospholipid bilayer.

Fluid-mosaic model of the cell-surface membrane

The way in which all the various molecules are combined into the structure of the cell-surface membrane is shown in Figure 2. This arrangement is known as the **fluid-mosaic model** for the following reasons:

- **fluid** because the individual phospholipid molecules can move relative to one another. This gives the membrane a flexible structure that is constantly changing in shape
- **mosaic** because the proteins that are embedded in the phospholipid bilayer vary in shape, size and pattern in the same way as the stones or tiles of a mosaic.



▲ **Figure 2** *The fluid-mosaic model of the cell-surface membrane*

Write your answer here

1c. Which of these organelles are linked to protein synthesis? Explain how these organelles interact with each other to allow the cell to manufacture proteins.

Write your answer here

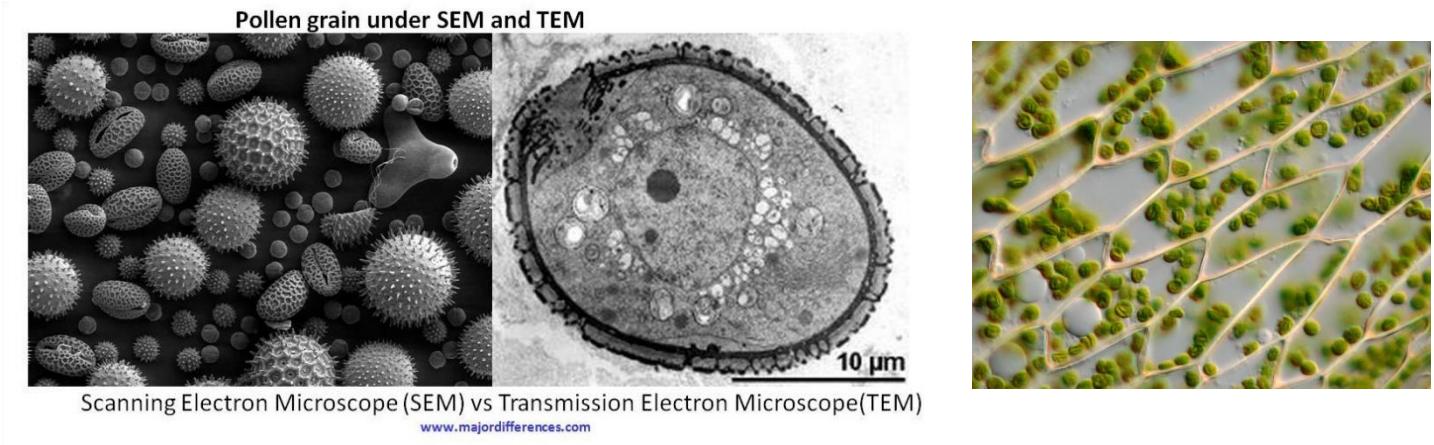
2. Studying Cells

Types of Microscope

Cells are microscopic, and our understanding of cells has largely developed in parallel to the development of the microscope.

There are many different types of microscopes, but they can be divided into those that use light (light microscopes), and those that use an electron beam (electron microscopes). You need to know the main properties and uses of each, and understand the concept of magnification and resolution.

The images below are from a scanning electron microscope, transmission electron microscope and a light microscope (from left to right).



The table summarises the main features of each type of microscope.

Light microscope	Low magnification Maximum magnification x1500 Low resolution Colour image
Scanning electron microscope	High magnification Maximum magnification x500000 High resolution 3D image Black and white image
Transmission electron microscope	Highest magnification Maximum magnification x500000 Highest resolution 2D image Black and white image

2a. Use the information above to evaluate the advantages and disadvantages of the different types of microscopes described for different functions.

Write your answer here

Resolution and Magnification

Magnification – We increase magnification by using lenses. The more lenses we use and the more powerful they are, the greater the magnification will be.

Eg. A light microscope with a x10 eye piece lens and a x40 objective lens will have a total magnification of 400.

$$10 \times 40 = 400$$

If an object is 5mm long, and we look at an image of it which is 10mm long, the object has been magnified by 2 times.

$$\text{Actual size(A)} \times \text{Magnification(M)} = \text{Image size(I)}$$

$$5 \quad x \quad 2 \quad = \quad 10$$

This formulae can also be expressed as;

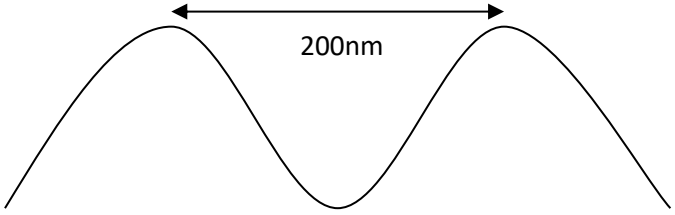
$$\text{Actual size} = \frac{\text{Image size}}{\text{Magnification}}$$

$$\text{Magnification} = \frac{\text{Image size}}{\text{Actual size}}$$

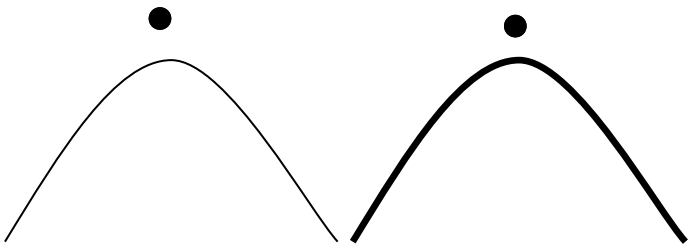
You need to be able to make calculations using these 3 formulae, expressing the results in standard form in the required unit.

Resolution

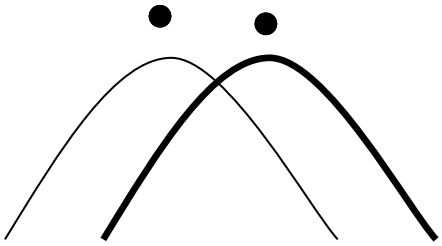
There is a limit to what you are able to see under a light microscope. Regardless of how good your microscope is, and how powerful the lenses are, you will never be able to distinguish 2 points that are less than 200nm apart. This is known as resolution. The resolving power is determined by the wave length of light.



The wave length of light is 200nm

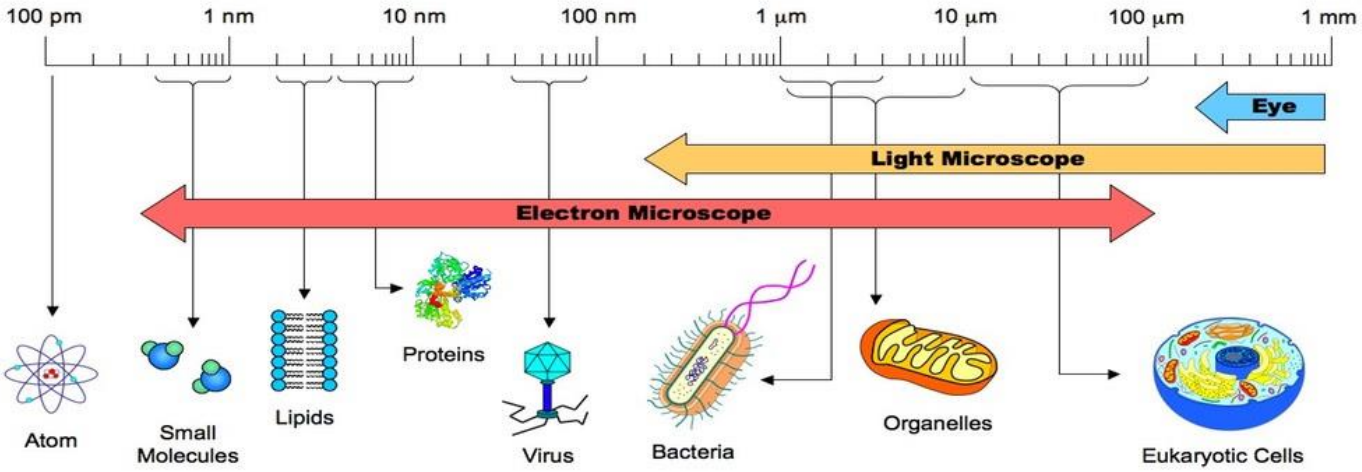


As long as the points are at least 200nm apart there is no overlap in the waves and they will appear as 2 separate objects.



If the points are closer than 200nm the waves will overlap and interfere with each other, and the 2 points will appear as a single object.

If we want to look at objects that are smaller than 200nm we need to use an electron microscope. Instead of using beams of light an electron microscope uses an electron beam. The wave length of an electron beam is 0.2nm.



2b. Look at the information above. What is the smallest object you could sucessfully use a light microscope to veiw. Explain your answer.

Write your answer here

We will concentrate on magnification calculations in the next section.

Biological Drawings

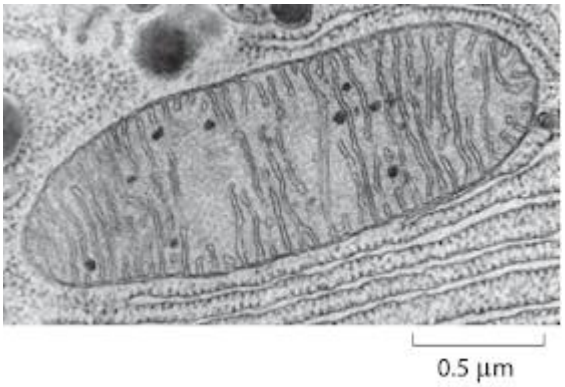
The AQA rules for biological drawings are;

Drawings should always be in pencil. Fine detail cannot be represented accurately unless the pencil has a sharp point.

The outlines of any structures should be drawn but there should be no colouring or shading. The relative sizes of the structures drawn should be accurate. Construction lines or frames could be used to solve this problem. If the relative size of any structure has been exaggerated, e.g., because an actual cell wall was too thin to be able to draw its outline using two pencil lines, a note should be added to the drawing to explain this.

If required, the drawn structures should be labelled with brief annotations about their functions or interrelationships.

The drawing should have an explanatory title and an indication of the real size of the structures drawn or of the magnification used.



Labels identify a structure or object.

Annotations are descriptive statements.

2c. In the box below produce a scientific drawing of the mitochondria shown in the photo. The drawing should be labelled and annotated. (You could produce this on a separate piece of paper, photograph it on your phone and insert the image.)

3. Magnification Calculations

In A-level Biology you need to be familiar with, and be able to convert between the following units;

1mm = 1000µm = 1000nm

You need to be able to carry out magnification calculations.

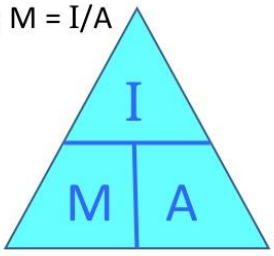
Magnification

- The size of an image of an object compared to its actual size.
- Calculated using the formula M = I/A

I = size of image

A = actual size of object

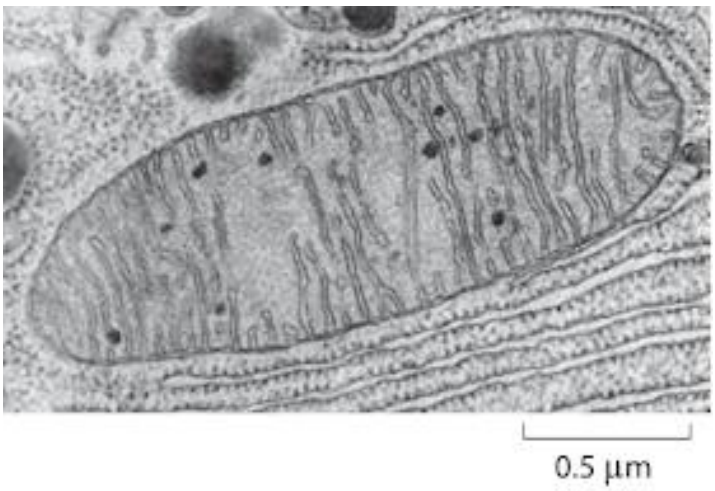
M = magnification



BUT you must remember to convert values to the same unit FIRST

In the following calculations carry out the steps in this order;

- State the formulea you will use
- Add the values you will use including the units
- Convet all values to the same unit (it is usually easier if you use the smallest unit)



3a. Calculate the magnification of this image.

Write your answer here

3b. Calculate the maximum length of the mitochondria. Express your answer in µm.

Write your answer here

4. Exam Questions

The answers for Q1 and Q2 are at the end of this document. Q3, Q4 and Q5 will be marked by your teacher and feedback given.

Q1.

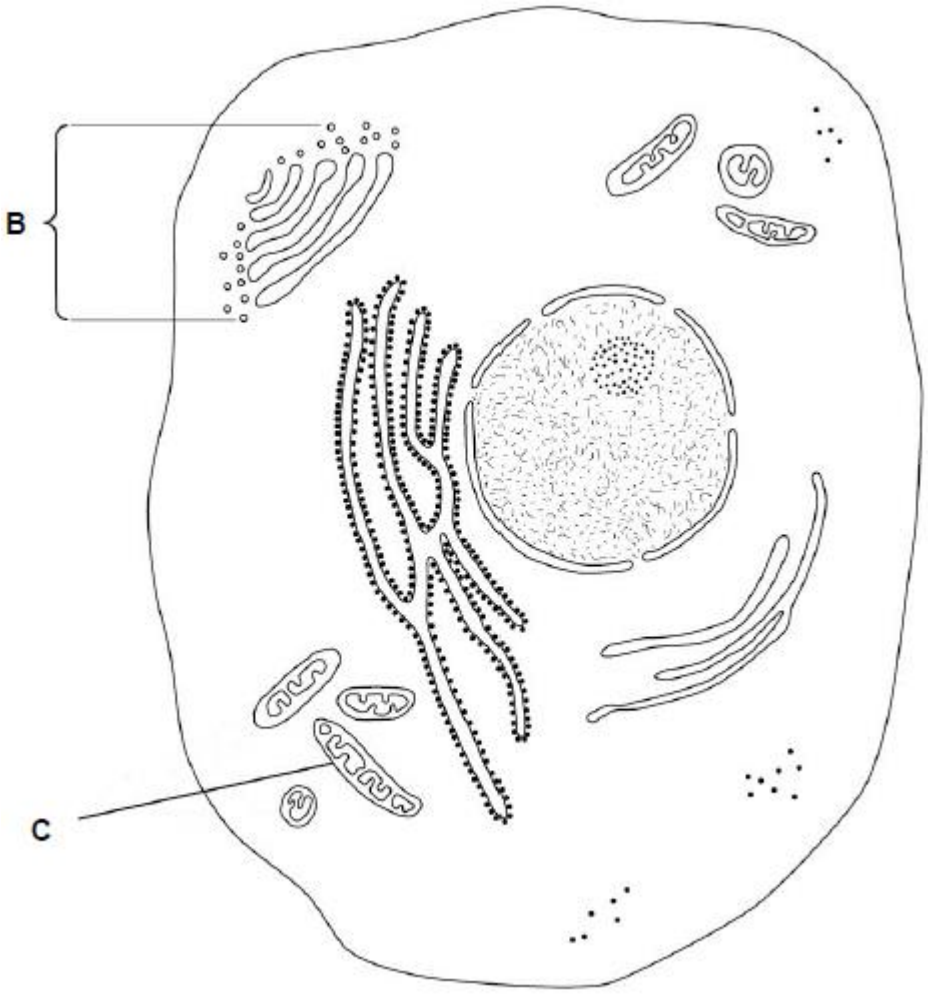
(a) Contrast how an optical microscope and a transmission electron microscope work **and** contrast the limitations of their use when studying cells.

(6)

(Total 6 marks)

Q2.

Below is a diagram of an animal cell.



(a) Name the organelles labelled:

B _____

C _____

(2)

(b) Name **two** structures present in plant cells that are **not** present in animal cells.

1. _____

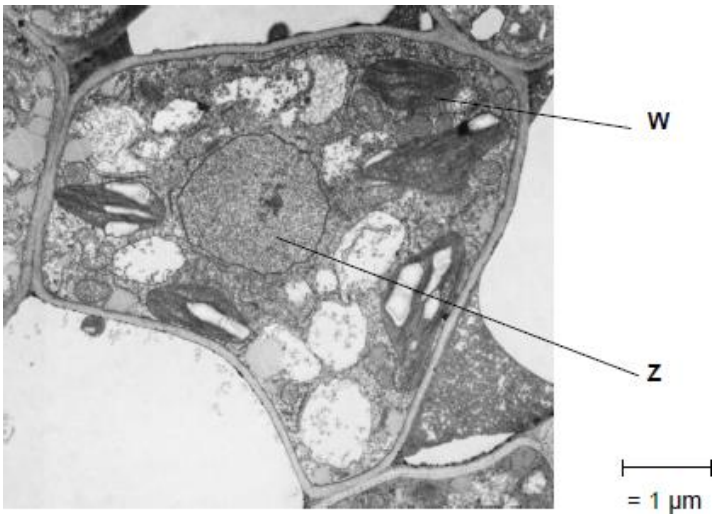
2. _____

(1)

(Total 3 marks)

Q3.

The figure below shows a microscopic image of a plant cell.



(a) Give the name and function of the structures labelled **W** and **Z**.

Name of **W** _____

Function of **W** _____

Name of **Z** _____

Function of **Z** _____

(2)

(b) A transmission electron microscope was used to produce the image in the figure above.
Explain why.

_____

_____

_____

_____

(2)

(c) Calculate the magnification of the image shown in the figure in part (a).

Answer = _____

(1)

(Total 5 marks)

Q4.

The image below shows the cell-surface membrane of a red blood cell seen with a transmission electron microscope.

(a) The cell-surface membrane can be seen with a transmission electron microscope but **not** with an optical microscope.

Explain why.

_____

_____

_____

(1)

(b) No organelles are visible in the cytoplasm of this red blood cell.

Suggest why.

_____

_____

(1)

(c) Before the cell was examined using the electron microscope, it was stained. This stain caused parts of the structure of the cell-surface membrane to appear as two dark lines.

Suggest an explanation for the appearance of the cell-surface membrane as two dark lines.

_____

_____

_____

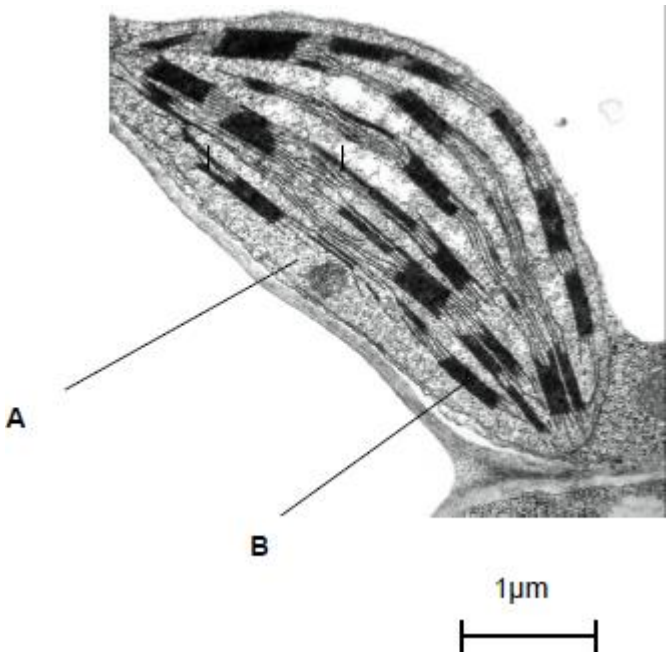
_____

(3)

(Total 5 marks)

Q5.

The figure below shows a photograph of a chloroplast taken with an electron microscope.



(a) Name the parts of the chloroplast labelled **A** and **B**.

Name of **A** _____

Name of **B** _____

(2)

(b) Calculate the length of the chloroplast shown in the figure above.

Answer _____

(1)

(c) Name **two** structures in a eukaryotic cell that **cannot** be identified using an optical microscope.

1. _____

2. _____

(1)

(Total 4 marks)

Answers

1b. Channel proteins allow molecules to pass through the membrane by diffusion and active transport.

Glycoproteins act as antigens and allow cell recognition.

1c. DNA in nucleus codes for proteins, ribosomes read the code and manufacture the protein. It is modified in the endoplasmic reticulum and packaged in the golgi apparatus.

2b. Bacteria. Larger than 200nm.

3a. M=I/A I (length of scale bar)=21mm, A=0.5µm so M=21mm/0.5 µm, M=21000 µm/0.5 µm = 42000

3b. Maximum length of mitochondria on image is 85mm. A=I/M co A=85mm/42000=0.002mm = 2 µm

Exam Questions

Q1.

(a)
1. TEM use electrons **and** optical use light;
2. TEM allows a greater resolution;
3. (So with TEM) smaller organelles / named cell structure can be observed
   OR
   greater detail in organelles / named cell structure can be observed;
4. TEM view only dead / dehydrated specimens **and** optical (can) view live specimens;
5. TEM does not show colour **and** optical (can);
6. TEM requires thinner specimens;
7. TEM requires a more complex/time consuming preparation;
8. TEM focuses using magnets **and** optical uses (glass) lenses;

3. 'clearer' is not equivalent to 'detail'

4. Accept 'Only optical can view live specimens'

5. Accept 'Only optical can show colour'

7. Accept 'TEM requires a more difficult preparation'

Ignore references to artefacts

6 max

[6]

Q2.

(a) **B** Golgi (body / apparatus);

C Mitochondria / mitochondrion;

2

(b)
1. Chloroplasts / plastids
2. Cell wall
3. Cell vacuole
4. Starch grains / amyloplasts;

*Any **2** for **1** mark*

1 max

[3]