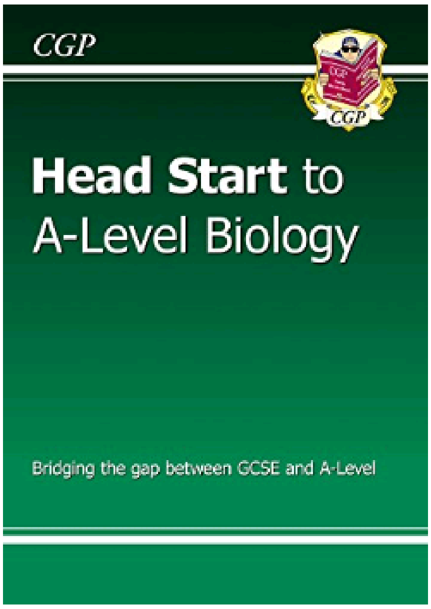
Welcome to the Biology Department.

To help you prepare for your A Level studies with us, we have the following tasks for you to work through before you join us. We hope you find it interesting and look forward to meeting you soon.

The 'Year 11 task' contains details of **a task for you to complete** before you start College.

The 'Cells and Cell Techniques' pack is a 'taster pack' for you to read through. You are not expected to complete this, but it will give you a flavour of what to expect at A Level and the types of resources you will be provided with.

If you wish to do further reading/preparation, Head Start are running a fantastic offer of their 'Head Start to A Level Biology guide for £4.70. This is available to download to kindles or the kindle app. You can access this by clicking HERE:



Head Start to A Level Biology

You may also find the following websites useful:

SnapRevise videos
https://www.youtube.com/playlist?list=PLkocNW0BSuEEMyVUCyaRPVj_cahCvjxAr

AQA A-level biology
https://www.aqa.org.uk/subjects/science/as-and-a-level/biology-7401-7402

Year 11 into Year 12 Challenge

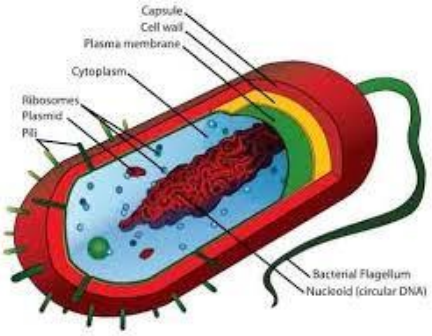
Hello all

When you start your A Level Biology Course you will find that there are a lot of new words to learn. Each time you start a new topic you will come across unfamiliar words and terms. To help familiarise yourselves with a few of these words have a go at the following tasks.

Use a full side of A4 for each drawing. Try to draw single unbroken lines rather than 'sketchy' lines. It will be easier to draw your cells 2D rather than attempting to draw them 3D.

1.Draw and label a Prokaryotic cell (all bacterial cells are prokaryotes.)

This drawing should include:



- cell membrane
- cell wall
- capsule
- cytoplasm
- small 70s ribosomes
- Loop of DNA
- plasmids
- flagellum / flagella (latter is plural – some prokaryotic cells have more than one)

The following links should help you.

https://www.youtube.com/watch?v=W_geqbT3KUc&t=32s

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

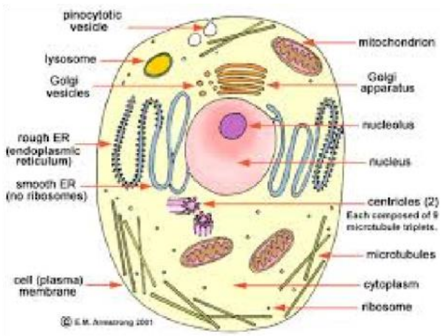
Do not worry about any structures / labels that are not mentioned in the list above i.e. you don't need to know about gram negative / gram positive bacteria, or mesosomes.

Write a sentence or two about the function of each of the structures you have labelled.

2.Draw and label two Eukaryotic cells. One should be a plant cell and the other an animal cell.

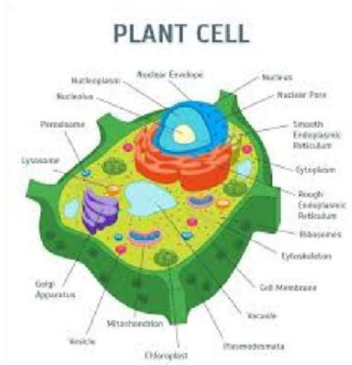
In the animal cell include the following structures:

- Cell membrane
- Cytoplasm
- Nucleus and nucleolus
- Rough endoplasmic reticulum
- Smooth endoplasmic reticulum
- Golgi body
- Large 80s ribosomes
- Mitochondria
- Lysosomes



In the plant cell include the above structures **and**

- Cell wall
- Large vacuole
- Chloroplast



The following links will help:

https://www.youtube.com/watch?v=xLcwJnTL2WM

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

https://www.youtube.com/watch?v=dLJdRs5w4u4

Again, write a sentence or two about each of the structures you have labelled.

Extension

You may want to try to do a comparison of Prokaryotic and Eukaryotic cells.

You could also do some research on other cells (and more drawings), e.g. fungi, algae.

Biology A Level AQA

Entry Requirements:

Holy Family Sixth Form entry requirements apply. You will also need two Grade 6's or above in GCSE Combined Science. These grades are additional to a passes in both GCSE Mathematics and English Language.

The Learning:

This is always a very popular choice because of the variety of topics covered, the opportunities for fieldwork, and the possibilities an A-Level in Biology opens up for Higher Education. The course is heavily reliant on practical work and every opportunity is taken to link the subject matter with the modern developments in Biology, one of the fastest evolving subjects on earth.

At the end of Year 12, students have the opportunity to undertake a number of Field Work Days when the ecology aspects of the course are studied. These days include being outside for the whole day and taking part in a sampling study of several places. Last year, we met Mr Cowen's alpaccas and spent the day samping different streams and ecosystems.

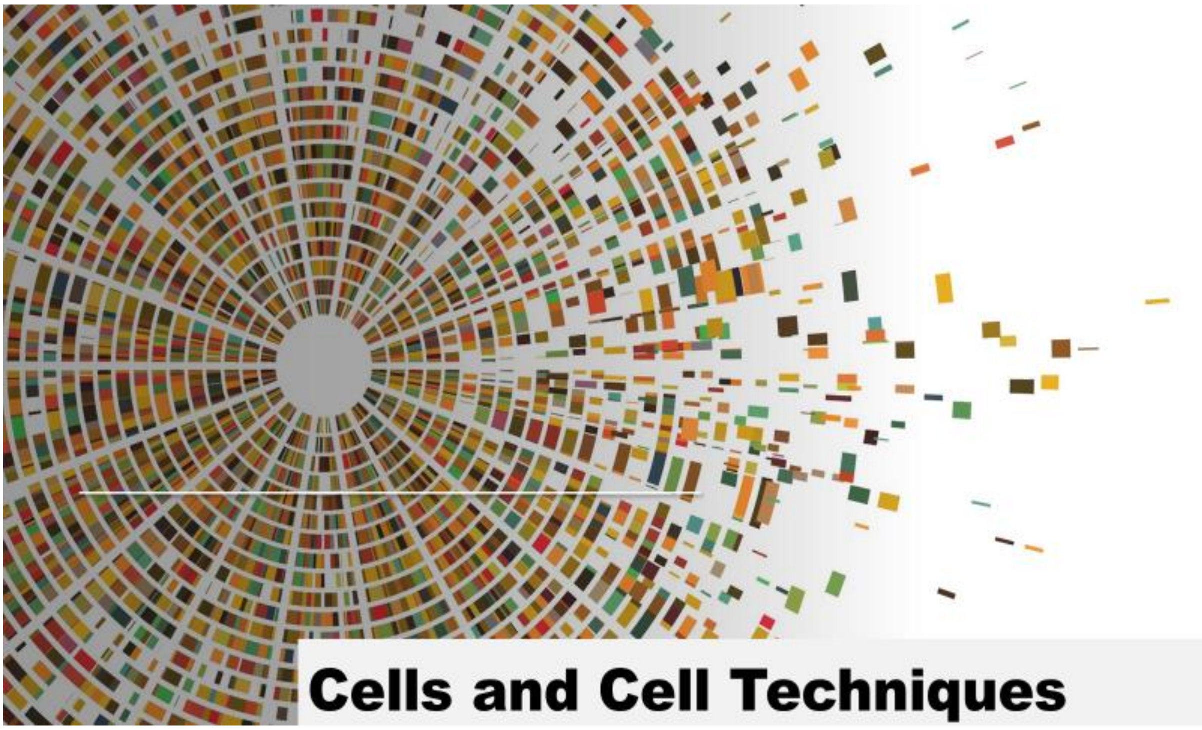
This course is a linear course with formal terminal examinations that are completed at the end of two years and is delivered by two or three specialist subject staff. Candidates will sit 3, 2hr long written papers that will form the A level Biology award. As well as biology content these papers will rely heavily on English and mathematical skills and comprise synoptic questions from the whole two years of study.

What direction this course might take you in:

Studying Biology provides students with a huge range of practical and investigative skills to be used at a later time. The links we have with outside agencies are second to none and all further education institutions look very favourability on a Science A Level.

Here is an example of a pack that we would use in Biology A Level:

The Holy Family
Catholic School



CELL STRUCTURE AND FUNCTION

Biology
holy family 6th

Cell structure and function

All life on earth exists as cells. A cell is the basic unit of life.
All cells contain:

- **a cell-surface membrane** enclosing cell contents
- **cytoplasm**
- **genetic material, made of DNA.**

Cells can be divided into two groups:

PROKARYOTIC: **bacteria**

EUKARYOTIC: Cells found in plants, fungi, algae and animals that have **internal membranes, forming organelles**

What is an organelle?

Structure of a Prokaryotic Cell

A few billion years ago, the first living organisms to evolve on earth were probably prokaryotes. Bacteria are prokaryotes**. They are much smaller than eukaryotic cells and do not contain any membrane-bound organelles in their cytoplasm.**

Prokaryotes form new cells by **binary fission**

Structure of a bacterium
Draw the structure of a typical bacterium

Features of a Prokaryotic Cell

Complete the table

Component	**Description**	**Function**
DNA		
Cell Wall		
Cytoplasm		
Cell surface membrane		
Small Ribosomes		
Simple flagellum (may be present and could be more than one)		
Plasmids (may be present and could be more than one)		
Capsule (may be present)		

Structure of a Eukaryotic Cell

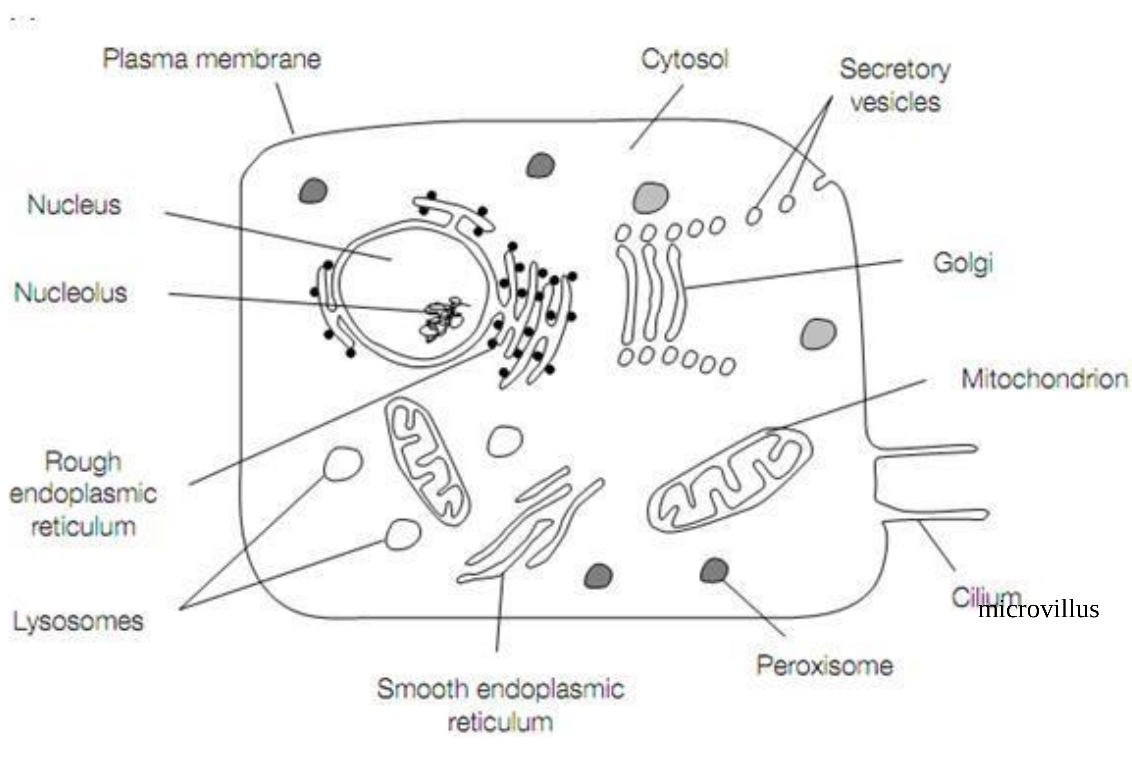
These have extra features compared to prokaryotic cells. This provides indirect evidence that they evolved from prokaryotes.

Eukaryotic cells also have **organelles,** most of which form membrane-bound compartments. Being in a compartment, the chemicals involved in a particular process are kept separate from the rest of the cytoplasm. This allows chemical reactions to take place quickly and efficiently.

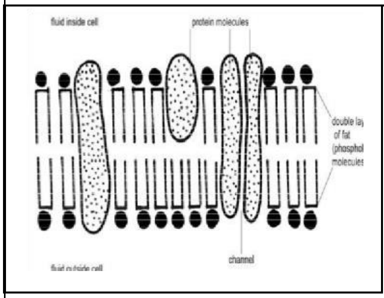
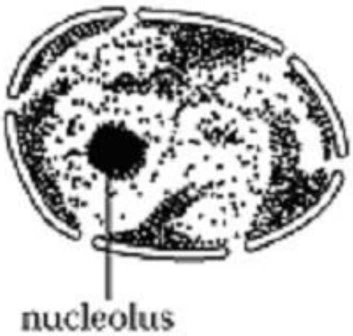
Eukaryotic cells form new cells by **mitosis and meiosis**

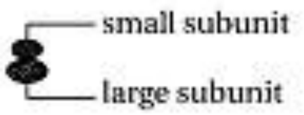
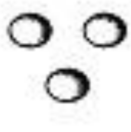
Ultrastructure of a Eukaryotic Animal Cell

The following diagram shows the fine detail or **ultrastructure** of a typical animal cell, such as an epithelial cell, as seen with an electron microscope.



Complete the summary table to show the appearance and functions of the major cell organelles:

Organelle	Description	Function
Plasma membrane 		
Nucleus 		
Mitochondrion 		

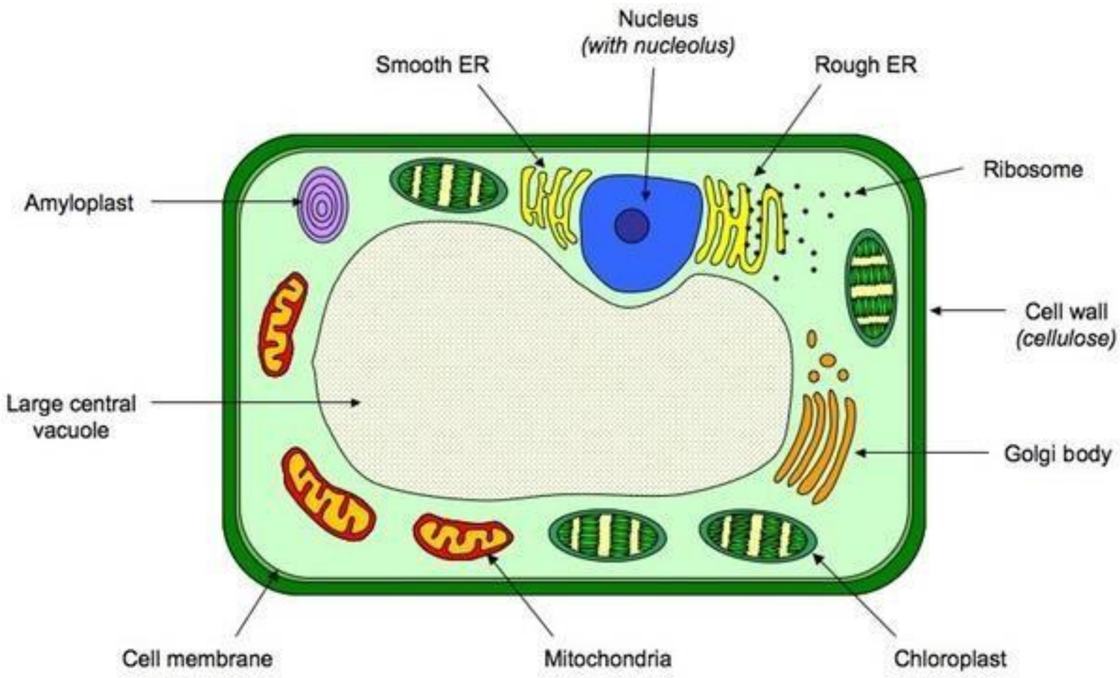
Rough Endoplasmic Reticulum 		
Organelle	**Description**	**Function**
Ribosomes 		
Smooth endoplasmic reticulum 		
Golgi Apparatus and vesicles 		
Lysosomes 		

Note: there is also the cytoplasm: this is the site of many metabolic reactions, including respiration

Cells in the pancreas produce enzymes. Explain why these cells have large amounts of rough endoplasmic reticulum, Golgi apparatus and mitochondria:

Ultrastructure of Plant Cells

Like animal cells, plant cells are eukaryotic and share many of the same organelles. **Plant cells all possess a cell wall and have a vacuole and chloroplasts, all of which are not present in animal cells.**



Cell wall

Made of **cellulose**, the wall surrounds the cell membrane and has high **tensile strength**. This allows it to resist the force of water entering the cell by osmosis - it **prevents osmotic lysis**. Fungi and algae also have cell walls. Algal cell walls are often composed of cellulose, together with other substances. The cell walls of fungi are not made of cellulose, but instead contain a substance called **chitin**.

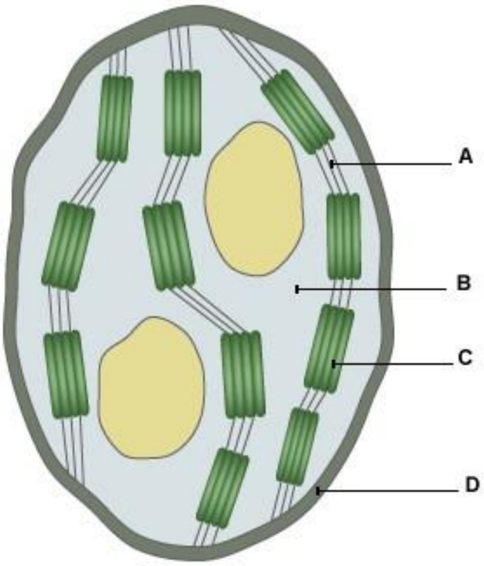
Vacuole

Filled with **cell sap** - a weak solution of sugars and salts. Helps give the cell **rigidity**.

Chloroplasts

Chloroplasts are only found in plant and algal cells. They are large organelles, typically oval in shape. In green plants most chloroplasts occur in the **mesophyll** cells of leaves. One mesophyll cell may be packed with 50 or more chloroplasts.

Photosynthesis takes place in chloroplasts, especially in the leaves of plants.



The chloroplast has several important features:

- A double membrane surrounding it forming an **envelope**.
- There are also internal membranes forming structures called **thylakoids.** These in turn form structures called **grana,** which look like stacks of coins
- **Chlorophyll** is located within these grana. This **absorbs light** for photosynthesis. Many grana means there is a large surface area to absorb light.
- Surrounding the grana, there is a solution called the **stroma** that contains enzymes needed for photosynthesis, and **starch grains**.
- Contains **DNA** like that in prokaryotes (i.e. short, circular and not associated with proteins), and also contain **ribosomes** like those found in prokaryotes (70S size).

Comparison of Prokaryotic cell with Eukaryotic cell
Complete the table

PROKARYOTE	EUKARYOTE
	Has a nucleus with linear chromosomes associated with histones
Form new cells by binary fission	
	Contains membrane-bound organelles, such as mitochondria
Has a cell wall made of murein	
Has smaller ribosomes	
May have a capsule, flagella and plasmids	

Cell Specialisation

In complex multicellular organisms, eukaryotic cells become may become **specialised**, for specific functions.

What advantages does cell specialisation provide an organism with?

Cells can be organised to form tissues; tissues can work together in the form of organs; organs can work together in systems.

Complete the definitions below, and give an example for each one. Tissue:

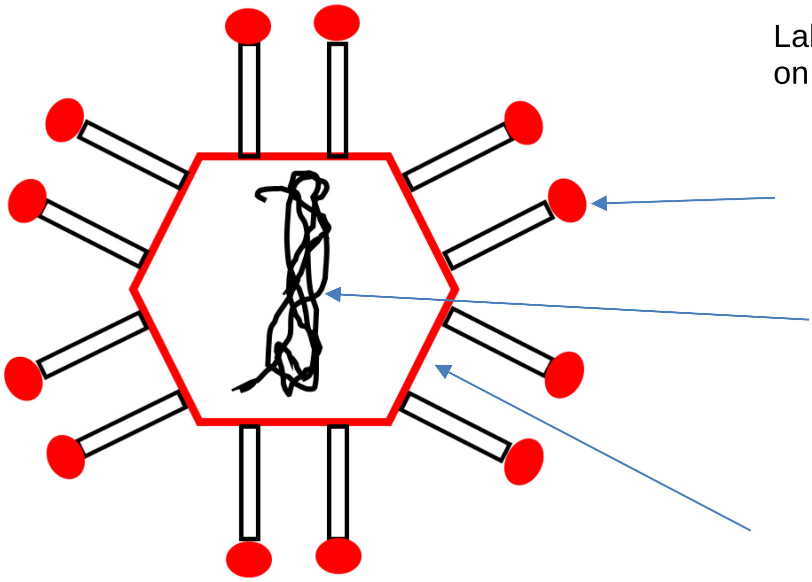
Organ:

Organ System:

Viruses

Viruses are not cells and so are non-living. They are described as **acellular.** As they are not cells, viruses cannot undergo cell division. Instead, they need to attach to and enter a host cell and use that cell's machinery to replicate**.** Virus particles consist of only 3 components:

- **Genetic material** - either DNA **or** RNA
- **Capsid** - a protein coat
- **Attachment protein** – allow the virus to attach to a host cell (complementary to receptors on host cell membrane)



Label the 3 components on the diagram

Microscopes

Microscopes are used to investigate structures too small to be seen by the naked eye. The detail seen depends on **magnification** and **resolution** **Magnification** can be defined as:

Resolution can be defined as:

Optical microscopes

Optical microscopes use **light** to illuminate the specimen, and **glass lenses** are used to focus the light. There is an **eyepiece lens** of fixed magnification (usually x10) and a selection of **objective lenses** of various magnifications. Specimens must be thin enough to transmit the light, e.g. tissue should ideally be **one cell thick**.
Light has relatively long wavelength and so the resolution is low. Staining is often required to make particular structures visible. The maximum effective magnification is 1500x. This is good enough to

see cells, larger organelles and individual bacteria, but not powerful enough to reveal smaller structures. How is the total magnification of a light microscope calculated?

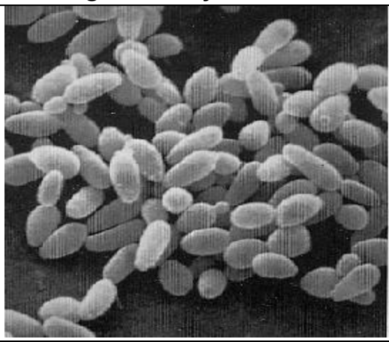
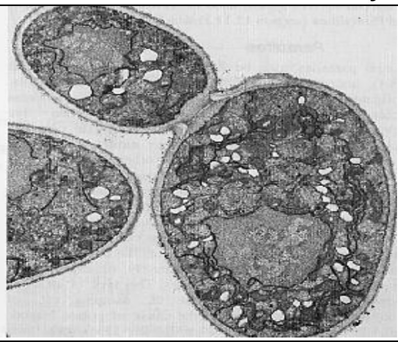
Electron microscopes
The electron microscope uses a beam of electrons instead of light. **Electrons have a much smaller wavelength than light so the resolution is higher.** This allows greater detail to be seen. The electron beam is focussed using a series of electromagnets. The specimen is stained using electron-dense substances such as heavy metal salts. The staining procedure is complex, so time-consuming, and expensive. These substances deflect electrons in the beam and a pattern is produced which is converted into an image.
Magnification can be as high as 500,000x.

There are two types of Electron Microscope:

Transmission electron microscopes (TEMs) work on the principle that the beam of electrons is transmitted **through** the specimen. The specimen must be **very thin** (thinner than for the optical microscope). The greater resolution means that **smaller organelles** such as ribosomes can be observed, as well as **internal details of organelles** (e.g. cristae in mitochondria).

Scanning electron microscopes (SEMs) can be used to study three-dimensional objects. Thin sections are not required because the SEM records the electrons that are reflected off the surface of the object rather than passing through it.

Scanning EM	Transmission EM
Lower resolution than TEM	Higher resolution than SEM
Does not require thin sections to be cut	Requires thin sections
Can have 3D images	No 3D images
Usually shows the surface of the object	Allows details of internal cell structures to be seen (e.g. organelles)

Scanning EM of yeast	Transmission EM of yeast
	

Key point

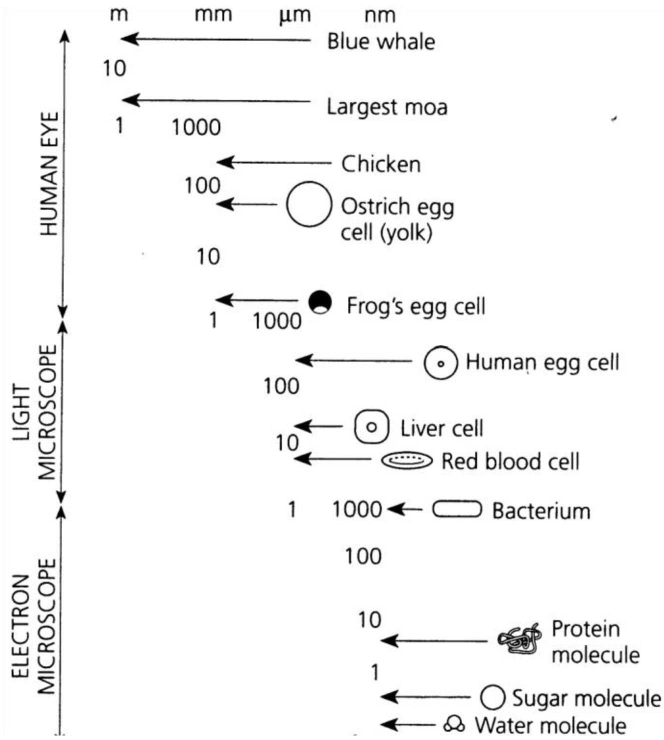
The electron microscope gives a greater resolution than the optical microscope due to shorter wavelength of electrons (compared to light)

Complete the following table comparing the light and electron microscopes.

Feature	Light Microscope	Electron Microscope
Maximum magnification		
Resolution		
Principles of use	Uses light and glass lenses	Uses a beam of electrons and electromagnets
Advantages of use		
Limitations of use		

Note: An **artefact** is something that results from the way a specimen is prepared. They may appear on a micrograph but not be part of the natural specimen. It is not always easy to distinguish artefacts from cell organelles.

How to Estimate the size of cells and organelles



The two units commonly used to describe microscopic objects are the micrometre (µm) and the nanometre (nm).

One thousandth of a millimetre is known as a micrometre (µm)

So µm = 1mm

Show in standard form

µm = 1mm

1µm = mm

The micrometre is used to measure cells and organelles. An average animal cell is 30 to 50 µm across. The nucleus has a diameter of about 10µm. Plant cells are often larger and can be 150 µm across.

Small organelles, such as ribosomes, and molecules are measured in nanometres (nm).

As a rough guide, a light microscope reveals structures that can be measured in micrometres but you need an electron microscope to see objects measured in nanometres.

A nanometre (nm) is one thousandth of a micrometre (µm)

(1nm = 0.001µm)

So there are nanometres in a micrometre. = 1µm

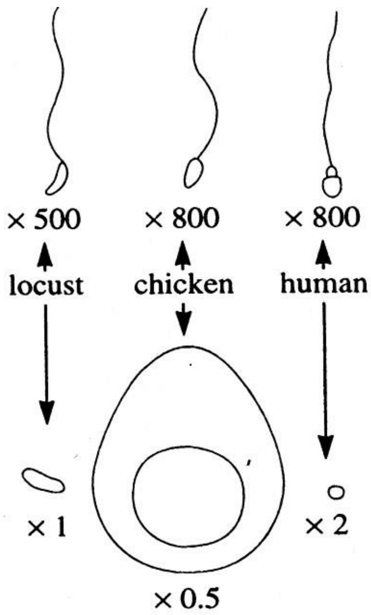
How many nanometres in a millimetre?

Photographs taken through a light microscope (**photomicrographs**) or an electron microscope (electron micrographs) normally show how many times the image on paper is magnified. This is done by showing a magnification, e.g. x400, or by using a scale bar with the actual length it represents,

e.g. |————————| 0.1mm

Calculations on size

The drawings show the sperm and eggs of three different animals.



The **magnification (M)** is how many times larger the diagram is in comparison to the object in real life. It is shown as X500, etc.

Which is the biggest sperm and why ?

The **real length (R)** is the true size of the object in real life. This is measured in μm or nm for cells or organelles.

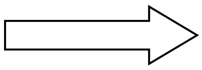
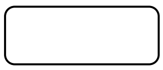
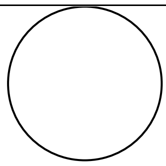
The **image size (I)** is the size of the diagram or drawing. You may have to measure this with a ruler.

These three quantities have the following relationship:-

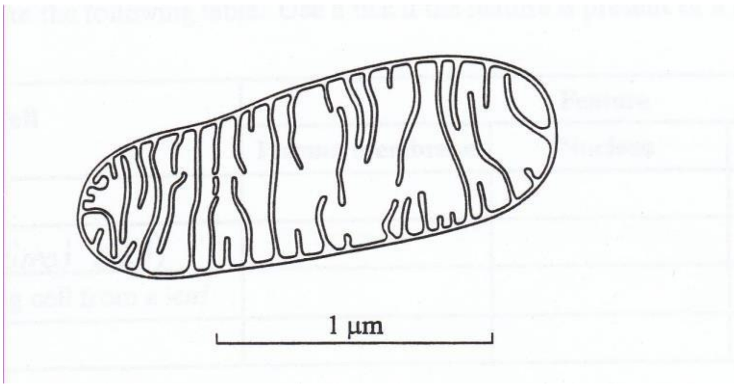
$$\frac{\mathbf{I}}{\mathbf{R} \times \mathbf{M}}$$

Questions

Try the questions in the table. The first one has been done for you.
Show your working and include correct units.

1. Calculate <u>real</u> length in □m.		Magnification = 550	Answer: R= I/ M I = 26mm or 26000□m so R= 26000/550 R= 42.27□m
2. Calculate <u>Magnification</u>		Real length =7.5□m	Answer:
3. Calculate <u>real</u> length in □m		Magnification = 70,000	Answer:
4. Calculate <u>real</u> diameter in □m		Magnification = 7500	Answer:

The drawing below has been made from a photograph:



1. Identify the organelle shown

2. What type of microscope was used to take the photograph from which this drawing was made? Give a reason for your answer.

3. Calculate: (a) the magnification and (b) the real length of the organelle.   Show your working.

Magnification =   real length =

Estimating the Size of Objects Using a Microscope

When viewing cells using an optical microscope, it is possible to **estimate** their size by comparing them with a scale of known dimensions viewed at the same magnification.

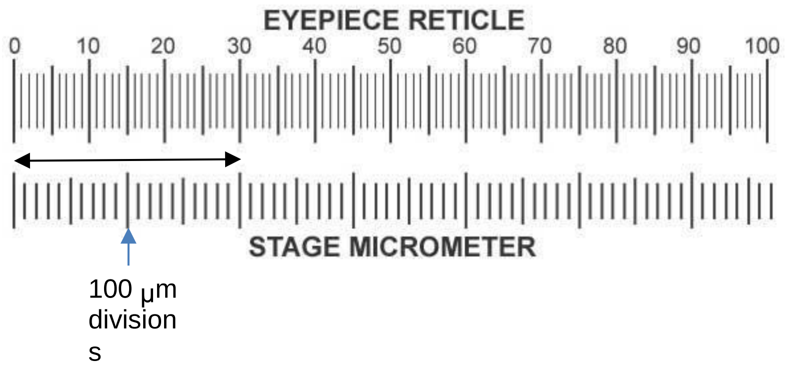
You cannot use the I = R/M formula

The diameter of a muscle fibre, for example, could be *estimated* as follows:

- Measure diameter of **field of view** using a slide with a scale on (a stage micrometer), or even just a transparent ruler!
- Estimate proportion of field of view occupied by one cell

e.g. A sample of muscle tissue was observed with an optical microscope. The diameter of the field of view was 0.2mm. A group of three fibres occupied approx. 75% of the field of view. Estimate the diameter of one fibre.

Alternatively an **eyepiece graticule** can be used. This is similar to a normal eyepiece but is engraved with an arbitrary scale. The eyepiece graticule scale is first calibrated against a **stage micrometer scale** (of known length) to work out the length that each eyepiece graticule division represents at a particular magnification (see below). The eyepiece graticule scale can then be used to measure an object under the microscope – it will be superimposed over the image.



If each small division on the micrometer scale is 10 μm, then 30 eyepiece graticule units represent 200 μm

Isolating organelles from cells – cell fractionation and ultracentrifugation

The EM shows us the detailed structure of the cell, and its organelles, but this does not give any information about the **function** of these structures. To determine organelle function, they must be isolated from the cell.

During **cell fractionation**,

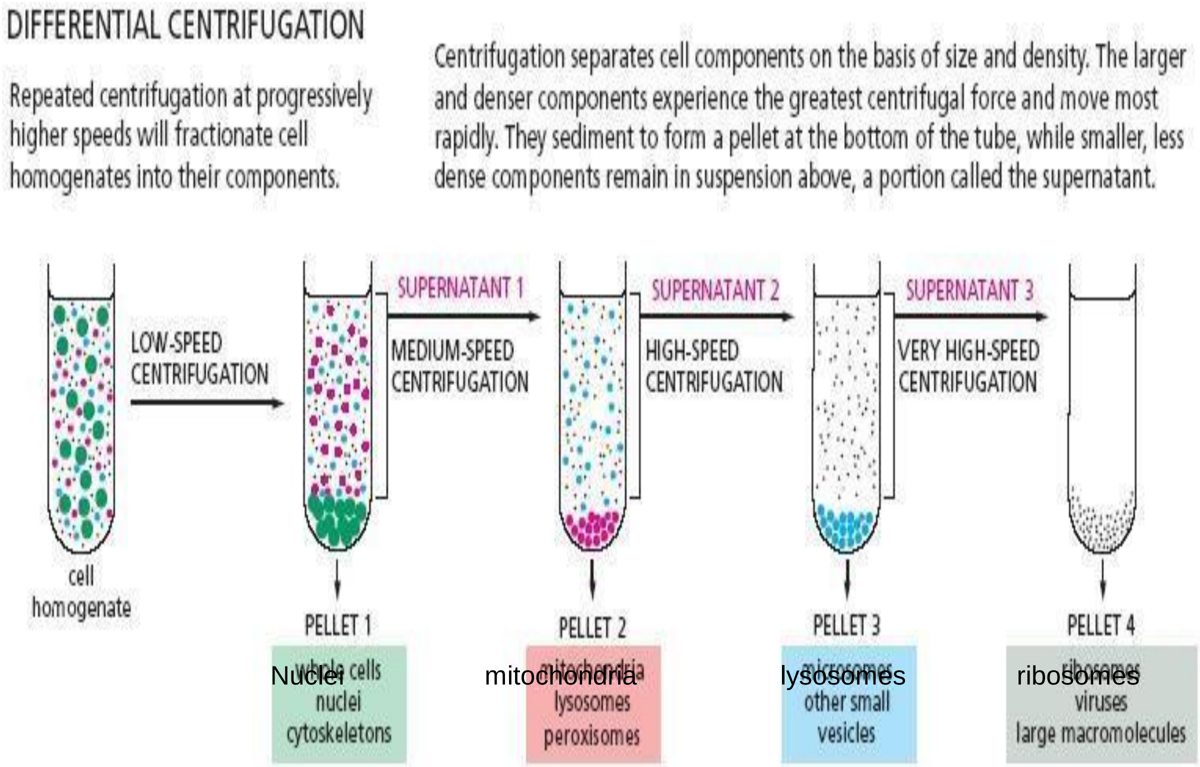
- cells are broken open using a homogeniser
- Cell debris and whole cells are filtered off to leave a suspension

During **ultracentrifugation**,

- The resultant suspension is centrifuged at a low speed
- The **most dense** organelle, the nucleus, separates out at the bottom of the tube. The rest of the organelles are still suspended in the **supernatant.**

- The supernatant is poured into a fresh tube and spun at a **higher speed** to separate off the mitochondria.

- The process is repeated at increasing speeds to separate off the less dense organelles.



NB/ in plant cells, chloroplasts will separate before mitochondria

Conditions during the separation have to be carefully controlled to prevent damage to the organelles.

The tissue is kept in cold, isotonic, buffer solution.
Explain the reason for each of these conditions

- **Cold temperature**

- **Buffer**

- **Isotonic**