A Level Biology Transition project
Summer 2019
Cells and cell structure.

Learning objectives

- ⬜ Understand the ultrastructure of eukaryotic cells and their organelles.
- ⬜ Recognise the relative size and scale of cells and organelles.
  Know how to convert between the different units used in biological measurement.
- ⬜ Explain the principles of magnification and perform related calculations.

Name:	Name of previous school:		
GCSE exam' grades: Biology	Chemistry	Maths	English
Marking feedback: WWW HTI			

Task one: GCSE Review

To ensure you are confident with the subject matter, review the following list to audit your knowledge. Where you feel less familiar, use a revision guide or BBC Bitesize web site to re visit the topic before you develop your understanding in this transition unit.

What you should know from GCSE	Subject knowledge reviewed
Most human and animal cells have a nucleus, cytoplasm, cell membrane, mitochondria and ribosomes.	
Plant and algal cells also have a cell wall made of cellulose which strengthens the cells. Plant cells often have chloroplasts and a permanent vacuole filled with cell sap.	
A bacterial cell consists of cytoplasm and a membrane surrounded by a cell wall; the genes are not in a distinct nucleus.	

Task two: An introduction to eukaryotic cells.

All eukaryotic organisms whether they be fungi, plant, protist or animal are composed of cells - the basic fundamental unit of life. All cells contain DNA which they transcribe into RNA that is then translated into proteins. These cells can also regulate transport across a cell membrane and require chemical energy for some cellular processes.

Eukaryotes can be single-celled or multicellular. Eukaryotic cells contain membrane-bound organelles such as the nucleus, mitochondria, chloroplasts, golgi apparatus, and endoplasmic reticulum.   Organelles are an efficient way to organize everything that's going on in the cell - to compartmentalize cellular functions.

In this project you will learn about the ultrastructure of eukaryotic cells. This means examining the cells at a level of detail smaller than could be viewed with a light microscope. You will learn the importance of the structures in creating a fully functional cell and begin to recognize why certain structures may be more developed in certain groups of cells.

To help you complete the activities which follow you need to develop you subject knowledge. Go to the link below and take a Tour of the cell with Bozeman Science to build your knowledge. If it helps, pause the video and make your own notes to help you with the learning the key facts. You could make a revision flash card on each organelle.

A tour of the cell – Bozeman Science:
http://tinyurl.com/p784phe Biology
mad: **http://tinyurl.com/q6obqv2**
Other useful resources for learning about cell structure:
http://tinyurl.com/l8mp5te

Task three: Applying knowledge of cell ultrastructure – Eukaryotic cells

(i) Add labels to the following diagrams of the ultra-structure of a liver cell. The two different images show a 2D and 3D structure.

Nucleus (with nucleolus)	Smooth endoplasmic reticulum	Golgi body	Cell membrane
Rough Endoplasmic reticulum	Cytosol	Rough Endoplasmic reticulum	Centrioles
Mitochondrion (singular)	Lysosome	Ribosomes	Vesicle
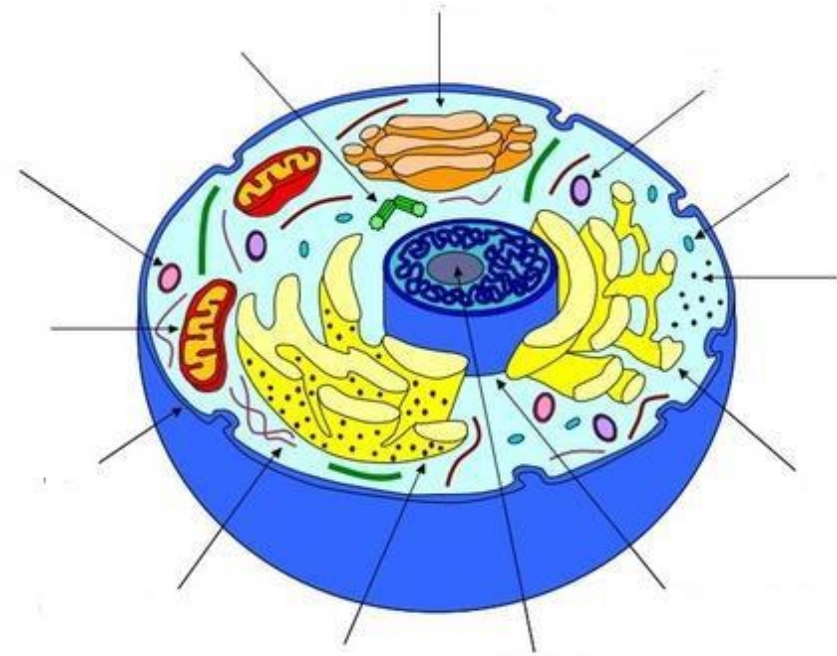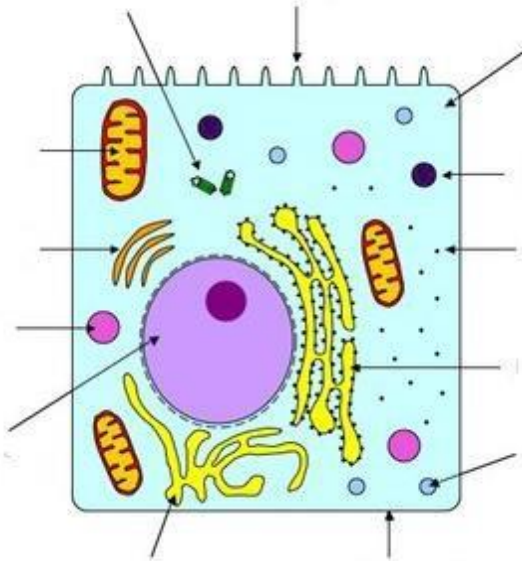
(ii) Which additional features would you expect to see if you were to be shown a palisade cell from a plant cell?

(iii) Use the internet to search for and print out a suitable image of a fully labelled eukaryotic cell from a plant, add this to your notes for this section.

Task four: Developing knowledge of cell ultra structure.

Using the knowledge you have gained in tasks two three and four, match up each organelle with the correct description of its structure and its function. You should then use the internet to research the sizes of each.

Organelle	Approx. size (Including units)	Description of structure	Description of function
Plasma membrane		Found on surface of animals cells and beneath the cell wall of plant and prokaryotic cells. Also forms a membrane around organelles. Made of lipid and protein	Provides strength. Stops the cell bursting under the pressure of water entering by osmosis. Allows water to pass through it contributing to the movement of water through a plant.
Nucleus		A round organelle with no clear structure, surrounded by a membrane. Formed from the vesicles produced by the Golgi. Contain enzymes such as protease, lipase and lysozymes	Synthesis stores and transports lipids and carbohydrates
Lysosome		System of membranes enclosing a fluid filled spaces. Forms a tubular like structure.	Provides a large surface area for the synthesis of proteins and glycoproteins. Folds and processes the proteins that have been made at the ribosomes. Provides a pathway for the transport of proteins throughout the cell.
Ribosome		Surrounded by a double membrane called the nuclear envelope which contains many pores. The outer membrane is continuous with the ER. It contains the genetic material (DNA) and often a nucleolus, suspended in nucleoplasm. Nucleoplasm is a jelly like substance which makes up most of the structure	The site of protein synthesis. 'Reads mRNA instruction, which determines the sequence of amino acids in a protein chain.
Rough Endoplasmic Reticulum (RER)		System of membranes enclosing a fluid filled space, forms a tubular like structure. Covered in ribosomes.	Selectively permeable, regulating the movement of substances into and out of the cell. Also have receptors which allow it to respond to chemical like hormones. Forms the structure of some organelles.
Smooth Endoplasmic reticulum		Can float free in the cytoplasm or be attached to RER. There are two types 80S and 70S. Made of two subunits each of which contains ribosomal RNA and protein.	Their enzymes are involved in digesting worn out organelles or bacteria which have been engulfed by phagocytes. Also release enzymes out of the cell by exocytosis to material around the cell can be digested.
Golgi apparatus		Found in plants, algae and fungi. In plants they are made of micro fibrils of cellulose, in algae from cellulose or glycoprotein and fungi it is made of a substance called chitin. Between the cells walls of two adjacent cells there is a middle lamellae cementing the cells together.	DNA (the genetic material of the cell.) is transcribed to mRNA which exits the pores of the nucleus to the ribosomes where the mRNA instruction will be translated to protein. DNA is retained in the nucleus in the form of chromosomes. The nucleolus makes the ribosomes.
Cell wall		Usually oval shaped, they have a double membrane forming their outer structure. The external membrane is smooth, the inner membrane is folded to form structures called cristae. This provides a large surface area on to which the enzymes involved in respiration can attach. Inside the organelle is a fluid filled matrix that contains the enzymes for part of respiration.	Modifies, processes (by adding new groups such as adding a carbohydrate to a protein) and packages new lipids and proteins which were made in the ER. It then sorts them and sends them to their correct destination. Also makes lysosomes.
Mitochondrion		A group of fluid filled, flattened sacs of membrane called cisternae with small, round hollow structures called vesicles.	This organelle is the site of aerobic respiration. They are found in large numbers in cells that are very metabolically active. These are ones that require lots of energy.
Chloroplast		Organelle found in plants. Surrounded by a chloroplast envelope to control entry and exit. Inside there are stacks of thylakoids forming grana. Extensions between thylakoids join grana together. A fluid filled matrix surrounds these structures. This is called stroma.	The reactions involved in photosynthesis occur here. (light absorption in the grana and synthesis of sugar in the stroma.)
Vacuoles		Fluid filled sac bound by a single membrane called a tonoplast. The solution inside contains mineral salts, amino acids, sugars and pigments	Provide support to parts of plants by making the cell turgid. Provide a temporary food store. The pigment colours may help to attract insects.

(i). Which of the organelles listed above are not bound by a membrane?

(ii). Which of the organelles contains nucleic acid?

(iii). Write down two or three sentences to describe the links between the functions of the nucleus, ribosomes and endoplasmic reticulum.

Task five: Tackling A level exam style questions

Using the knowledge that you have acquired answer the following questions.

1. The diagram on the right shows two organelles found in eukaryotic cells.

a. Name organelles A and B (2 marks)


A   **B**
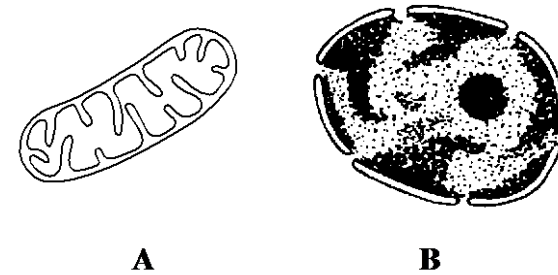
b. Explain how the inner membrane is adapted to its function in organelle A (2 marks)

2. The photograph on the right shows an image of a eukaryotic cell.

a. Organelle X is a mitochondrion. What is the function of this organelle? (1 mark)

b. Name organelle Y. (1 mark)

c. This photograph was taken using a transmission electron microscope. The structures present could not have been seen using an optical (light) microscope. Explain why. (2 marks)
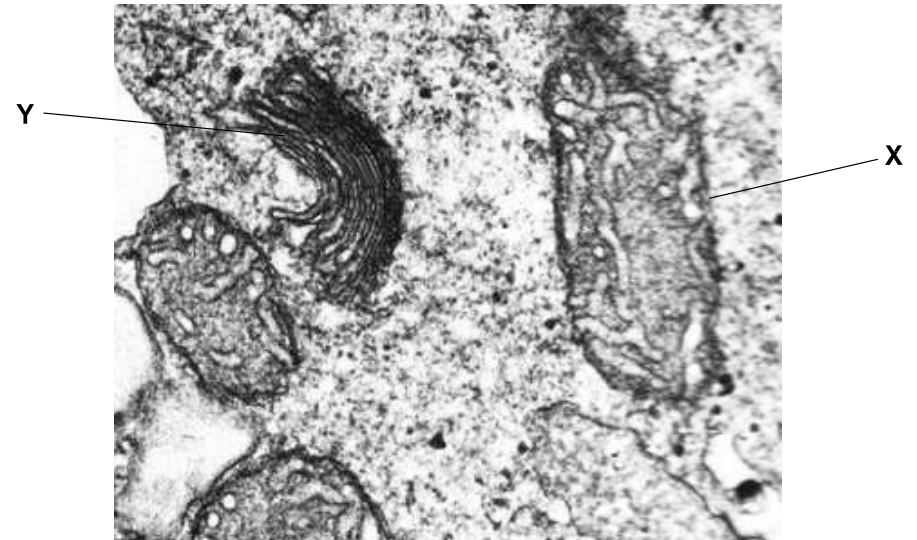
Task six: Developing maths skills in Biology – Size and scale of cells and cellular structures.

Thinking about cells and organelles can be tricky to get your head around. Follow through the slides in the presentation on the link below which will help you make relative comparisons of the sizes of each part. Remember here everything has been scaled up 1000 000 times! (Can you spot the spelling mistakes?!).

http://tinyurl.com/6hx4z8

As you can appreciate from this presentation when we are studying scales we are thinking about very small structures so using units such and metres and centimetres is not going to be appropriate. Click on the link below and use the sliding bar on the animation to view the relative sizes of objects, cells, organelles, biological molecules and even atoms!

http://tinyurl.com/komwg

You will notice that some units, which you may be less familiar with, were used for viewing some structures. Look at resource 1 to help you get head around how these units relate to a metre and the terms used to describe the units.

You need to be able to convert between the units used when measuring cells and parts of cells. e.g. mm to µm. This will be a very important skill when we do some practical microscopy and calculations on cell size and magnification so it is important to get your head around it now.

(i) Complete the gaps in the table to show the sizes of different organelles when expressed as different units.

Structure	metres	millimetres	micrometres	nanometres
Human egg cell			130	
Amoba proteus		0.5		
length of a sperm cell	0.00006			60000
length of an E.Coli bacterium				3000
Diameter of a lysosome		0.001		
Width of a mitochondrion			0.8	
Diameter of the measles virus				220
Diameter of the rhinovirus (cold virus)				30
Ribosome		0.00003		
Antibody				12

Divide by 1000 for each step to convert in this direction →

nano	micro	milli	whole unit	kilo
e.g nm	e.g µm	e.g mm	e.g m	eg km

←**Multiply by 1000 for each step to convert in this direction**

When we convert between square or cube units we need to take a little more care.

For example to convert 1m² to mm², you need to remember that it is x1000 x1000, so your conversion factor is x or ÷ 1000 000 →**1m² = 1000 000mm²**
To convert m³ to mm³ is x1000 x1000 x1000 , so your conversion factor is x or ÷ 1000 000 000 **1m³ = 1000 000 000 mm³**

(ii) Convert the following:

- 10m² to km²
- 2m² to mm²
- 6 000 000 mm³ to m³
- 0.007m³ to mm³

Task seven: Calculations related to images from a microscope.

In A-level Biology, you will also need to retain your GCSE skill of calculating the magnification factor of images and the actual size of cells and their components.
Look through the power point slides (full screen) as you complete Q1, Q2 and Q3a of the 'Magnification question sheet' (Resource 2), then complete the rest of these calculation questions.

The last question in this series is taken from a recent A Level paper!

# Resource 1 Measurement of size in biology – Unit prefixes and their standard form.
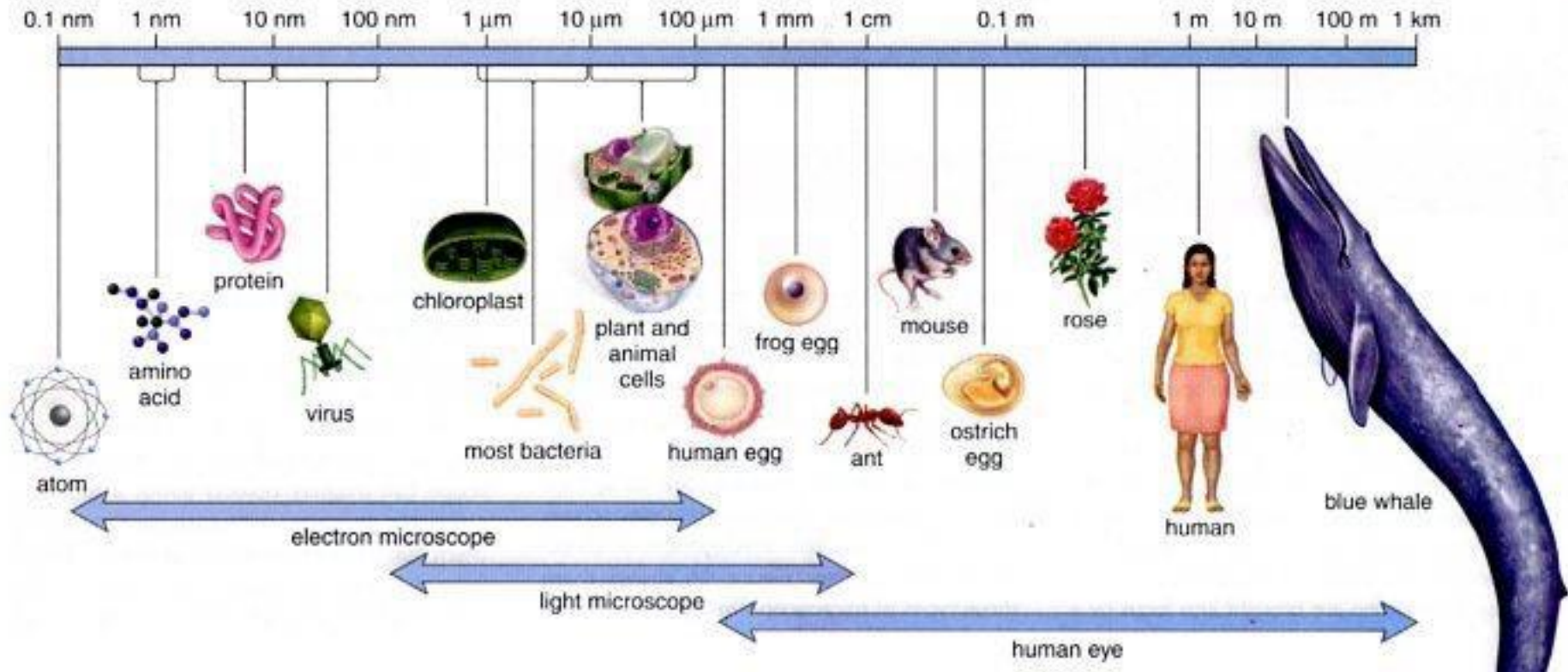
Name	Number	Symbol	Standard form	Getting it in perspective
deci	0.1m	d	10^{-1}	One tenth of a metre
centi	0.01m	c	10^{-2}	One hundredth of a metre
milli	0.001m	m	10^{-3}	Thousandth of a metre
micro	0.000001m	µ	10^{-6}	Millionth of a metre
nano	0.000000001m	n	10^{-9}	Billionth of a metre
pico	0.000000000001m	p	10^{-12}	Trillionth of a metre

Q1. The diagram below is a drawing of an organelle from a ciliated cell as seen with an electron microscope.
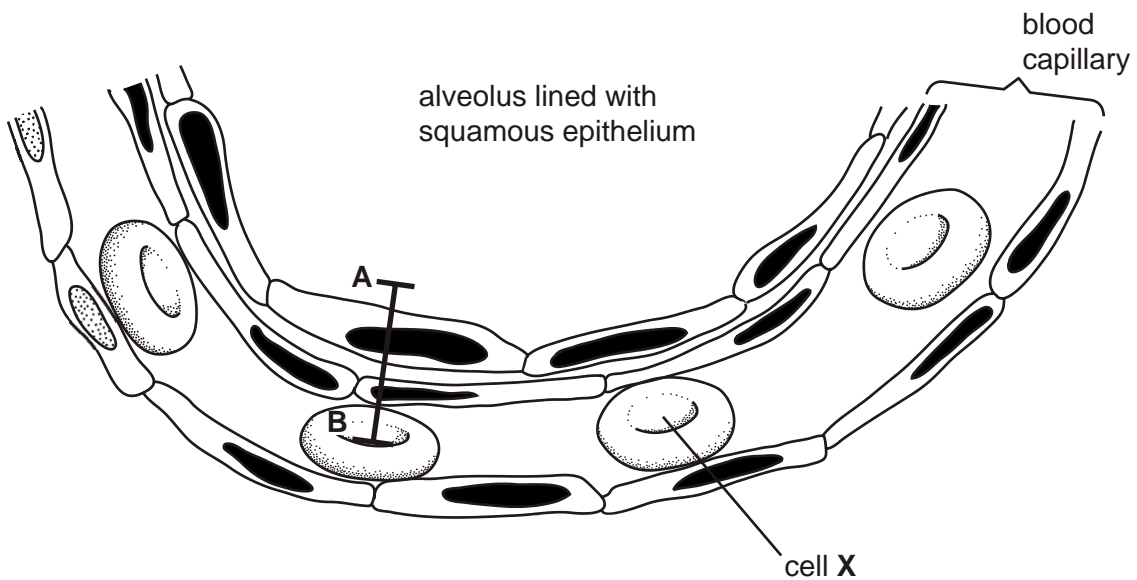
A ⊢———————————————————————————⊣ B

× 20 000
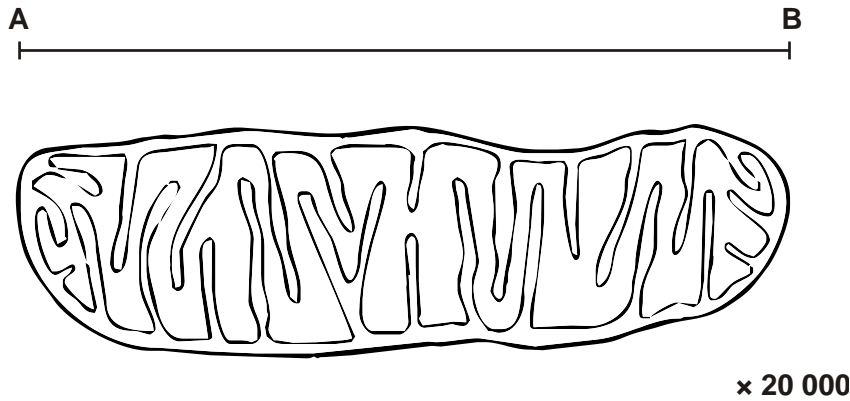
Calculate the actual length of the organelle as shown by the line AB in the diagram. Express your answer to the nearest micrometer (◻m).

Show your working.

Answer = ... ◻m

Q2. The diagram below is a drawing of an alveolus together with an associated blood capillary.

blood
capillary

alveolus lined with
squamous epithelium

A

B

cell **X**
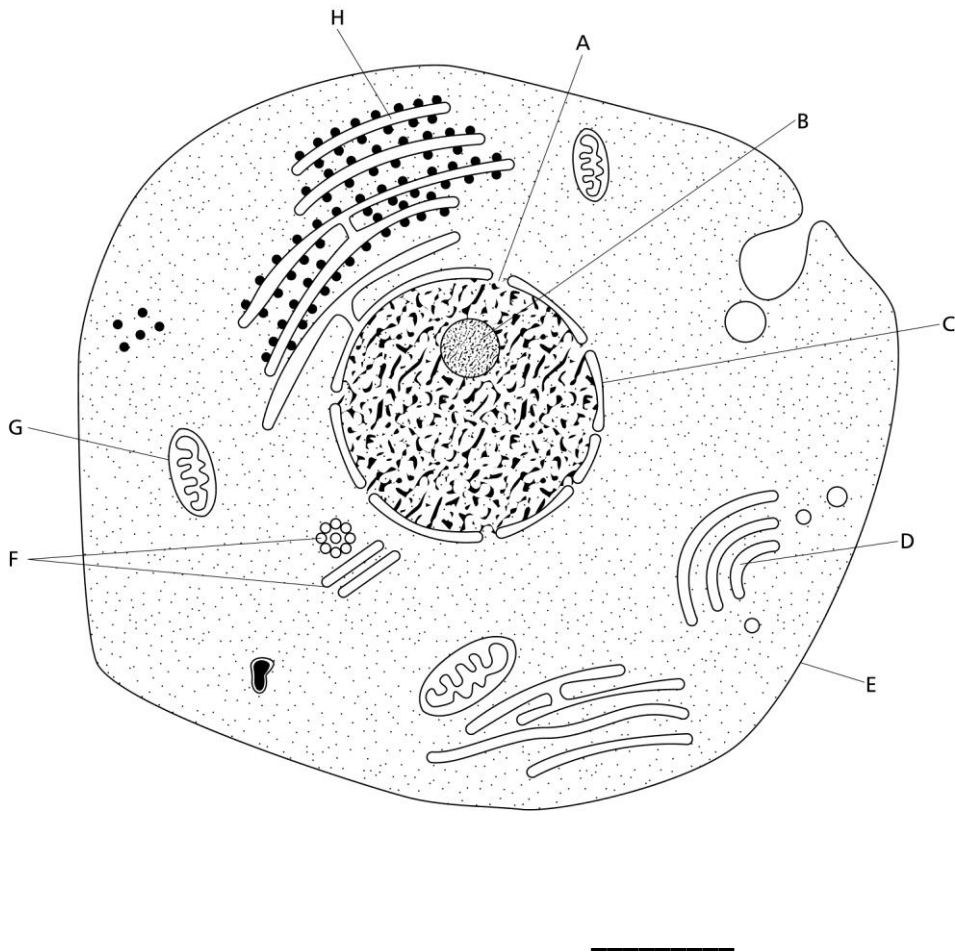
The line **AB** in the diagram represents an actual distance of 1.5 μm.

Calculate the magnification of the drawing. Show your working.

Answer = × ....

Q3. The diagram below shows the general structure of an animal cell as seen under an electron microscope.

5μm

a. Calculate the magnification factor of the diagram

b. Calculate the actual length of structure G

b. Calculate the diameter of the nucleolus (structure B)

d. Calculate the diameter of the nucleus

e. Calculate the diameter of the cell at its widest point

Q4 . The diagram below shows the general structure of a plant cell when viewed under and electron microscope.

_____
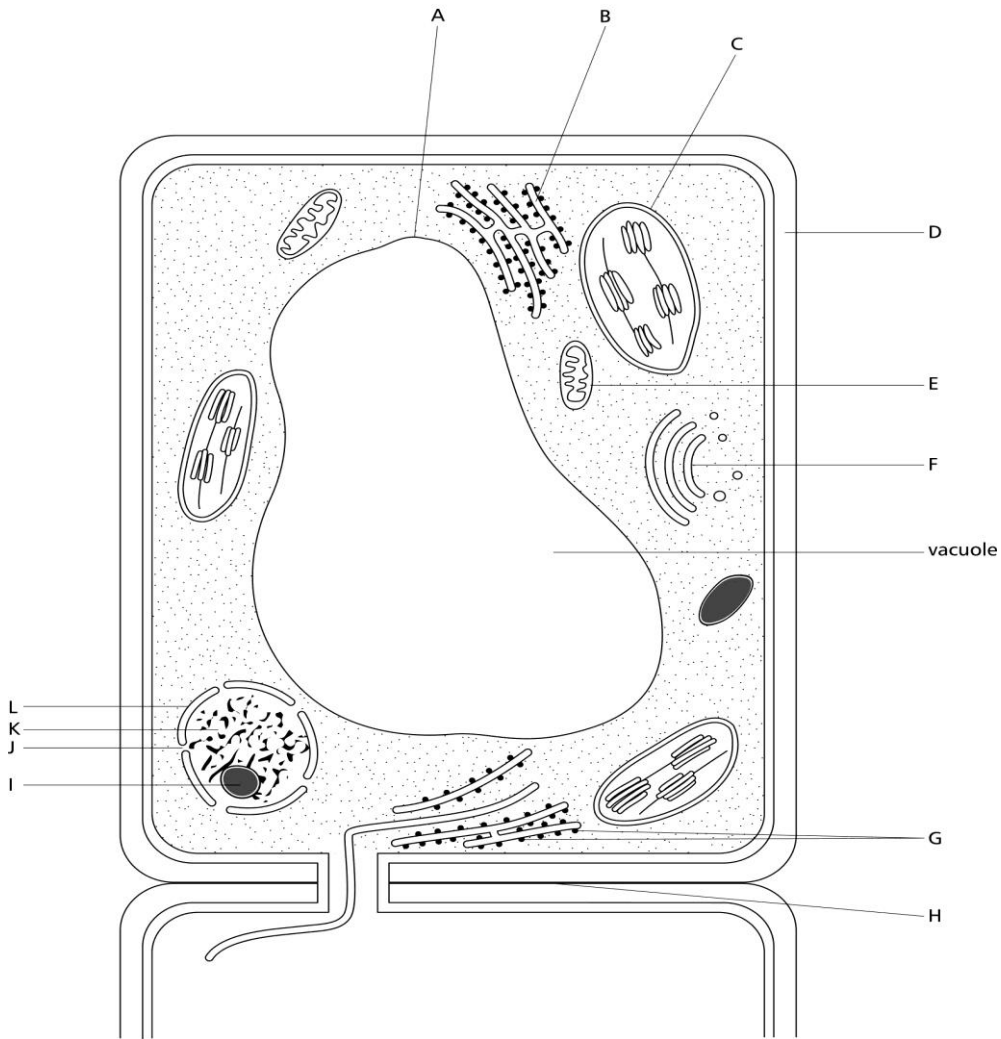
40µm

1) Calculate the magnification factor of the diagram

2) Calculate the thickness of the cellulose cell wall.

3) Calculate the length of the cell.

4) Calculate the length of structure C.

5) Calculate the length of the vacuole.

Fig. 1.1 is a diagram of an animal cell as seen using a transmission electron microscope.
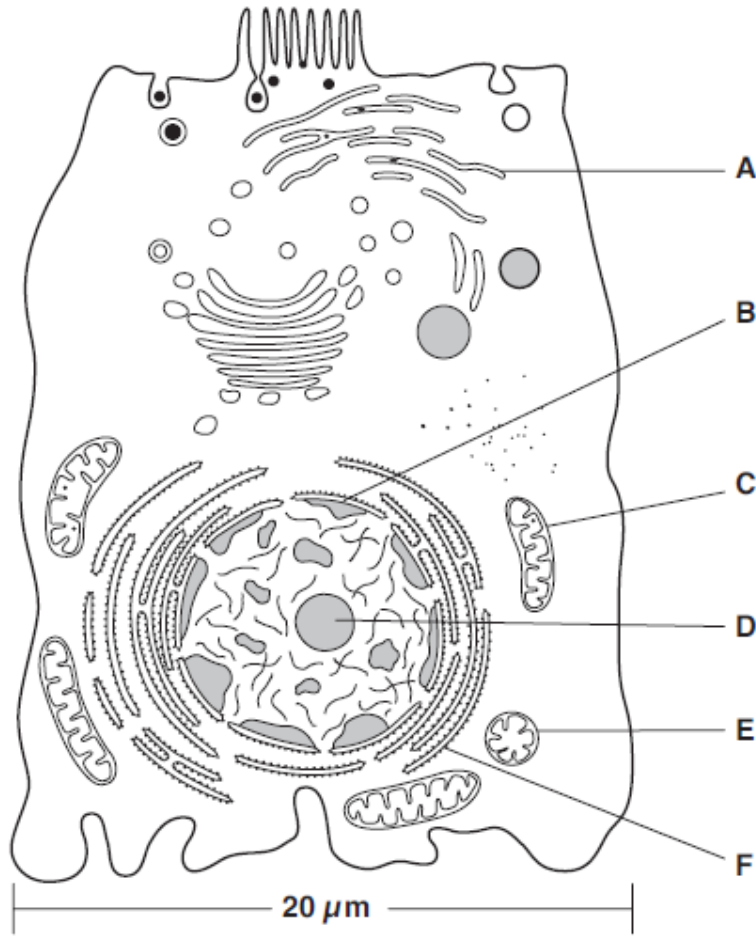
Fig. 1.1

Label the parts of the cell indicated by A - F

Calculate the actual length of structure C.

Show your working and give your answer in micrometres (μm).

Answer = …………………………….. μm