The Bridge to Post-16 Summer Work

Biology

OCR A

You MUST have this pack <u>completed</u> and be ready to hand this in before your first lesson in September

This pack contains a programme of activities and resources to prepare you to embark on your Post-16 course in Biology in September.

It should be completed throughout the remainder of the Summer term and over the Summer Holidays to ensure you are ready to start your course in September.

Overall you should spend around **3 hours** working through the tasks for Biology. Therefore, across your 3 subjects you should be completing in **total 9 hours** of Summer Work.

Recommended reading/useful course books/websites

1. OCR Biology subject page and specification https://www.ocr.org.uk/Images/687834-download-a-level-specification.pdf
2. CGP A Level Biology text book **ISBN 9781837741373**
3. CGP A Level Biology Revision guide **ISBN: 9781837741359**
4. CGP Essential Maths Skills for A Level Biology **ISBN: 9781847623232**
5. CGP AQA Exam practice work book **ISBN: 9781782949107**
6. Oxford Press A Level Biology text book: **ISBN: 9780198351924**
7. *http://www.s-cool.co.uk/a-level/biology/*
8. *http://www.bbc.co.uk/education/subjects/z9ddmp3*
9. *A Level Biology Padlet: https://padlet.com/rriley40/a-level-biology-t51hhbn610j6vlxo*

The Task

There are two parts to the Bridging task for A level Biology. You should attempt to complete all of these tasks to an A level standard (i.e. more detail and depth than that required for GCSE). To achieve this, you may need to do some extra reading/research, you can use the list below or any other reputable sources.

Part One

Read through the complete the How Science Works and Biological knowledge activities within this document. Be as thorough as possible with your answers and at minimum, should be answered to GCSE standard. If you sat the Combined Science Trilogy route, you will need to use BBC bitesize to help you complete activity 18. The completion of these tasks will be checked and any misconceptions corrected.

Part Two

T he first two topics of study will be about cell structure and biological molecules. Read through the attached CGP book pages and then answer the questions. Credit can be given for appropriate use of illustrations such as pictures or diagrams, the clear use of English and the correct use of technical and scientific terms. The completion of these tasks will be marked against the exam boards mark scheme and will help to form part of your baseline assessment.

Feedback

Part One

Understanding and using scientific vocabulary

Understanding and applying the correct terms are key for practical science. Much of the vocabulary you have used at GCSE for practical work will not change but some terms are dealt with in more detail at A-level so are more complex.

Activity 1 Scientific vocabulary: Designing an investigation

Link each term on the left to the correct definition on the right.

Hypothesis	The maximum and minimum values of the independent or dependent variable
Dependent variable	A variable that is kept constant during an experiment
Independent variable	The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres
Control variable	A proposal intended to explain certain facts or observations
Range	A variable that is measured as the outcome of an experiment
Interval	A variable selected by the investigator and whose values are changed during the investigation

Activity 2 Scientific vocabulary: Making measurements

Link each term on the left to the correct definition on the right.

Term	Definition
True value	The range within which you would expect the true value to lie
Accurate	A measurement that is close to the true value
Resolution	Repeated measurements that are very similar to the calculated mean value
Precise	The value that would be obtained in an ideal measurement where there were no errors of any kind
Uncertainty	The smallest change that can be measured using the measuring instrument that gives a readable change in the reading

Activity 3 Scientific vocabulary: Errors

Link each term on the left to the correct definition on the right

Random error	Causes readings to differ from the true value by a consistent amount each time a measurement is made
Systematic error	When there is an indication that a measuring system gives a false reading when the true value of a measured quantity is zero
Zero error	Causes readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next

Understanding and using SI units

Every measurement has a size (eg 2.7) and a unit (eg metres or kilograms). Sometimes, there are different units available for the same type of measurement. For example, milligram, gram, kilogram and tonne are all units used for mass.

To reduce confusion, and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

There are seven SI base units, which are given in the table.

Physical quantity	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
luminous intensity	candela	cd

All other units can be derived from the SI base units. For example, area is measured in metres square (written as m^2) and speed is measured in metres per second (written as $m\ s^{-1}$, this is a change from GCSE where it is written as m/s).

Using prefixes and powers of ten

Very large and very small numbers can be complicated to work with if written out in full with their SI unit. For example, measuring the width of a hair or the distance from Manchester to London in metres (its SI unit) would give numbers with a lot of zeros before or after the decimal point, which would be difficult to work with.

So, we use prefixes that multiply or divide the numbers by different powers of ten to give numbers that are easier to work with. You will be familiar with the prefixes milli (meaning 1/1000), centi (1/100), and kilo (1 × 1000) from millimetres, centimetres, and kilometres.

There is a wide range of prefixes. Most of the quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, we would quote a distance of 33 000 m as 33 km.

The most common prefixes you will encounter are given in the table.

Prefix	Symbol	Power of 10	Multiplication factor	
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	μ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 4 SI units and prefixes

What would be the most appropriate unit to use for the following measurements?

1. The time between heart beats
2. The diameter of a cheek cell
3. The distance that a migratory bird travelled each year
4. The thickness of a DNA helix
5. The mass of a rabbit
6. The mass of iron in the body
7. The diameter of a glucose molecule

Activity 5 Units

Choose the most appropriate unit and estimate the size of each of the following.

1. The mass of an earthworm
2. The volume of water in a teardrop
3. The volume of water in a garden pond
4. The time taken for a sunflower to grow
5. The temperature difference between the blood in the heart and in the ear on a cold day
6. The diameter of a human hair
7. The length that your fingernails grow each day
8. The total length of DNA in one human body cell

Activity 6 Converting data

Re-write the following.

1. 0.00224 metres in millimetres
2. 104 micrograms in grams
3. 6.2 kilometres in metres
4. 10 micrograms in nanograms
5. 70 decilitres in litres
6. 10 cm^3 in litres

Practical skills

The practical skills you learnt at GCSE will be further developed through the fieldwork and practicals you undertake at A-level. Your teacher will explain in more detail the requirements for fieldwork, practical work, and the research methods.

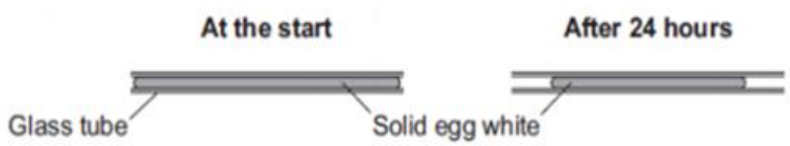
Activity 7 Investigating how temperature and pH affect enzymes

Egg white is made of protein. The students were investigating how temperature and pH affect the digestion of protein

The students carried out the following procedure:

- Filled six narrow glass tubes with fresh egg white
- Boiled the tubes so the egg white became solid
- Placed each tube into a different beaker containing human protease enzyme at different pH values at room temperature and 3 in neutral pH but at different temperatures for 24 hours
- Measured the length of solid egg white in each tube after 24 hours

The diagram shows the investigation.



The results were recorded in the tables below:

pH	Original length of solid egg white (cm)	Final length of solid egg white (cm)	% change
4	6.0	5.6	
7	6.0	3.8	
9	6.0	5.8	

Temperature (°C)	Original length of solid egg white (cm)	Final length of solid egg white (cm)	% change
15	6.0	5.7	
35	6.0	3.8	
55	6.0	5.3	

1. State a hypothesis for this investigation.
2. The students predicted that the enzyme would be most effective in conditions similar to those found in the human body. Was their prediction correct?
3. Identify the independent and dependent variables in this investigation.
4. Suggest the control variables for this investigation.
5. Describe the difference between repeatable and reproducible.
6. What would be the most likely resolution of the ruler you would use in this investigation.
7. Suggest how repeating the investigation would be an improvement.
8. Calculate the % change for each result in this investigation. Show your answers to 3 significant figures.

Analysing data

Biological investigations often result in large amounts of data being collected. It is important to be able to analyse this data carefully in order to pick out trends.

Activity 8 Mean mode median and scatter graphs

A student investigated an area of moorland where succession was occurring. The student used quadrats to measure the area covered by; different plant species, bare ground and surface water. They did this every 10 metres along a line transect. The student also recorded the depth of soil at each quadrat. Their results are shown in the table.

	Area covered in each quadrat A to E in cm^2				
	A	**B**	**C**	**D**	**E**
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

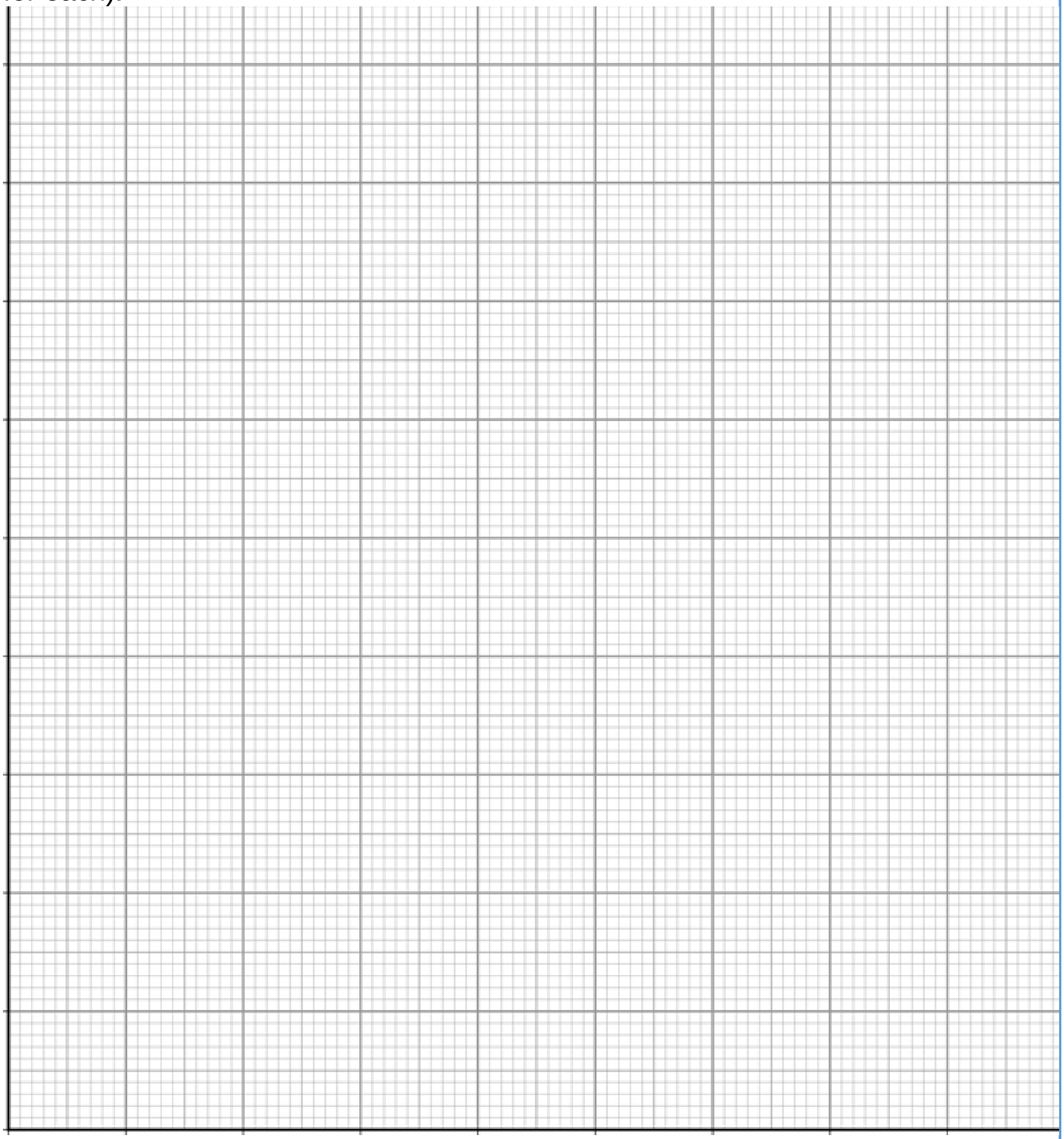
Calculate:

1. Calculate the mode area of soft rush in the sample.

2. Calculate the mean soil depth of the area of moorland sampled.

3. Calculate the median amount of bare ground in the sample.

4. Using the data in the table plot a **scatter graph** of the soil depth against the area covered by bare ground, soft rush and bog moss (use different colours or markers for each).



5. What conclusions can you draw from this graph?

6. Suggest how to improve the validity of these conclusions

Activity 9 Data in tables

A patient with a leaking heart valve may have the valve replaced. A study compared two different types of replacement heart valve:

- mechanical valves
- biological valves from pigs.

The data used in the study was collected from female patients aged 50–69. **Table 4** shows the data

Table 4

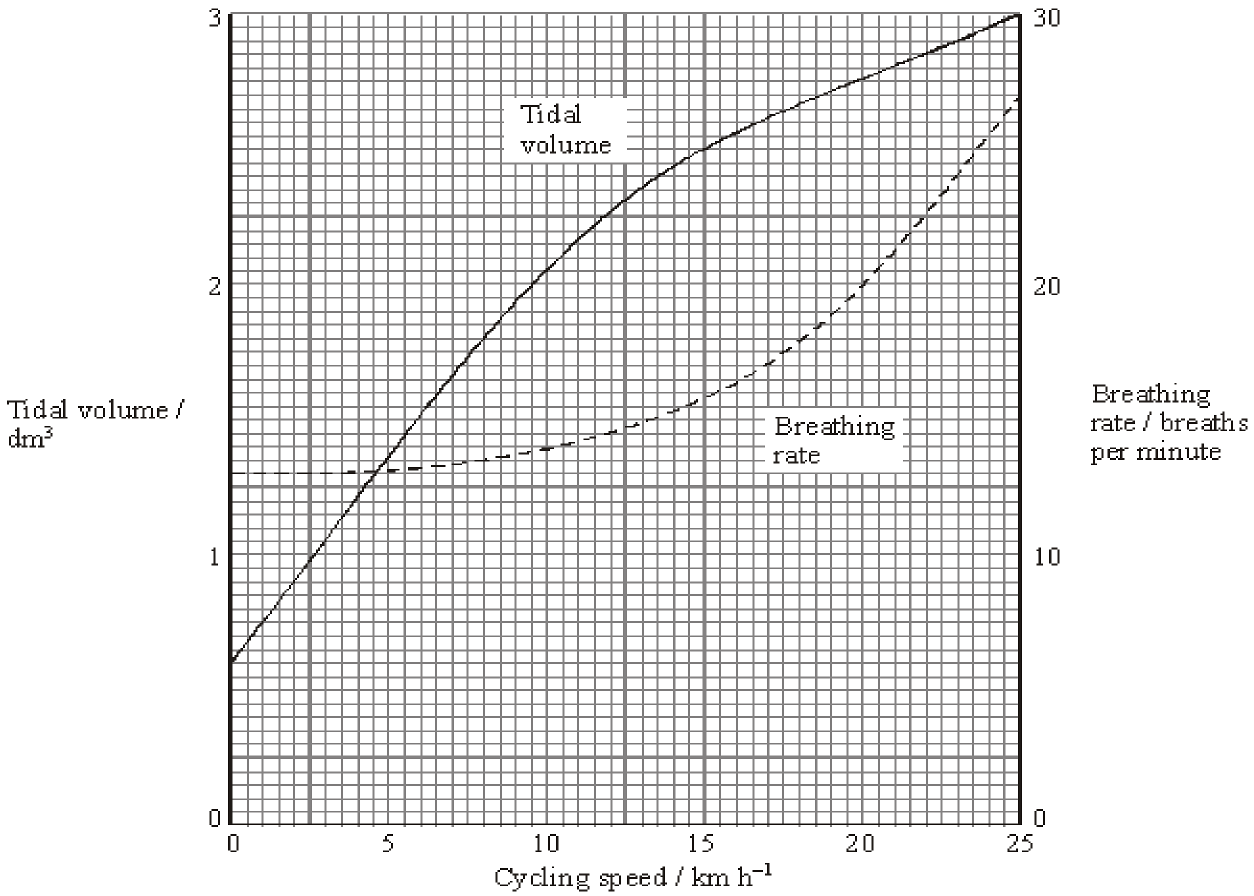
	Type of replacement heart valve	
	Mechanical	**Biological**
Number of patients given the valve	2852	1754
Number of patients who died from heart-related problems after valve replacement	180	178
Percentage of patients alive after 5 years	91	89
Percentage of patients needing a second valve replacement within 6 years	2.2	5.2
Percentage of patients who had a blood clot on the brain after surgery	5.8	0.1

1. Give **one** conclusion about the death of patients from heart-related problems after a valve replacement.
   Include calculations to support your answer.

2. Evaluate the use of mechanical replacement heart valves and biological replacement heart valves.
   Use information from **Table 4**.

Activity 10 Analysing complex graphs

The volume of air breathed in and out of the lungs during each breath is called the tidal volume. The breathing rate and tidal volume were measured for a cyclist pedaling at different speeds. The graph shows the results



1. State the tidal volume when the cycling speed was 17 km h^{-1}.

2. State the breathing rate when the cycling speed was 8 km h^{-1}.

3. Calculate the change in breathing rate when the cyclist speed changed from 10 to 20 km h^{1}.

   Express this as a percentage.

4. State the speed at which the breathing rate starts to increase.

5. The tidal volume increased linearly with the cycling speed up to about 10 km h^{-1}.

   Calculate the increase in volume for each increase in speed of 1 km h^{-1}.

Extended writing

The ability to write coherently in a logical, well-structured way is an essential skill to develop. At GCSE the 6-mark extended response questions are used so students can demonstrate this skill. At A-level you need to develop this skill further

The command word in a question, like at GCSE, is important as it gives you an indication of what to include in your answers. For example, 'explain' means you must give reasons why things are happening, not just give a description. A comparison needs advantages and disadvantages or points for and against. Your teacher will work with you on this skill during the course.

Activity 11 Extended writing

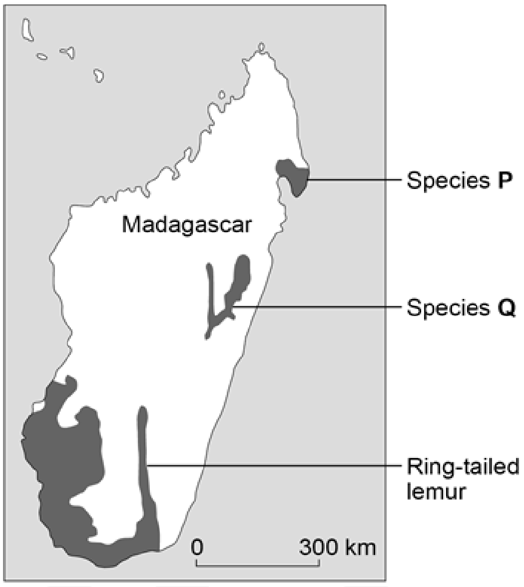
This is an 'open book' activity, meaning you can use notes/ resources to help you.

Before attempting the question below, you might want to remind yourself of the work you did on the following topics at GCSE (using notes/ textbooks/ revision guides etc):

- the theory of evolution
- the role of mutation and natural selection

Lemurs are only found on the island of Madagascar. Madagascar is off the coast of Africa. Scientists think that ancestors of modern lemurs evolved in Africa and reached Madagascar about 50-60 million years ago. Today there are many species of lemur living on Madagascar

Figure 1 shows the distribution of three species of lemur on Madagascar.



Describe how the ancestors of modern lemurs may have evolved into the three different species shown on the map (species P, species Q and ring tail lemurs)

Progression of content

What you learnt at GCSE forms the foundation to your further study at A-level. Ideas will be developed and refined, new concepts and skills will be introduced. The follow are some **optional** questions which you might like to have a go at. They are designed to help refresh your memory of some of the important concepts you will use during your study of AS and A -level Biology.

Use the questions in each section to help to identify where your knowledge and understanding is secure and which areas you may need to revisit.

Activity 12 Cell structure and magnification

Drawing images from microscope observations must be done carefully, including careful measurements for magnification calculations.
Make sure that you are clear on the organelles within different cells and their functions.
You must also be secure in the method used to make observations using a light microscope and the purpose of each method step.

Figure 1 shows an animal cell viewed using a microscope

The cell contains a nucleus.

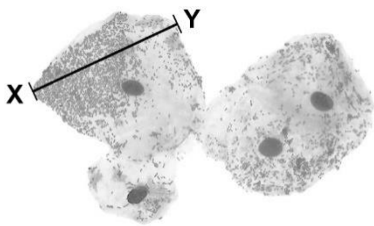
1. State the function of the nucleus.

2. Name **one** type of cell that does **not** contain a nucleus.

3. On the diagram label three parts of the cell.

4. Name **one** structure found in a plant cell but **not** found in an animal cell.

The figure below shows some different cells.
The real length from point **X** to point **Y**i s 0.06 mm.



5. Calculate the magnification.

The cells shown above were viewed using a light microscope.

Give **two** advantages of using an electron microscope instead of a light microscope.

Activity 13 Cell division

There is sometimes confusion between how and cells divide by mitosis and meiosis. You need to understand the purpose and features of each process and the role of mitosis in the cell cycle.

Cell division is needed for growth and for reproduction.

Table 3 contains three statements about cell division.
Complete **Table 3** by ticking **one** box for each statement.

Table 3

	Statement is true for		
Statement	**Mitosis only**	**Meiosis only**	**Both mitosis and meiosis**
All cells produced are genetically identical			
In humans, at the end of cell division each cell contains 23 chromosomes			
Involves DNA replication			

Activity 14: Transport across cell membranes

In Biology, many processes involve moving substances across boundaries. Ensure that you know what each of diffusion, osmosis and active transport are and where each takes place. Questions on transport across cell membranes often involve data and applying knowledge and understanding to unfamiliar contexts.
One of the required practicals at GCSE is on osmosis, make sure that you can interpret the graph used to show the results.

A student carried out an investigation using chicken eggs. This is the method used.

1. Place 5 eggs in acid for 24 hours to dissolve the egg shell.
2. Measure and record the mass of each egg.
3. Place each egg into a separate beaker containing 200 cm^3 of distilled water.
4. After 20 minutes, remove the eggs from the beakers and dry them gently with a paper towel.
5. Measure and record the mass of each egg. **Table 4** shows the results.

Table 4

Egg	Mass of egg without shell in grams	Mass of egg after 20 minutes in grams
1	73.5	77.0
2	70.3	73.9
3	72.4	75.7
4	71.6	73.1
5	70.5	73.8

Another student suggested that the result for egg **4** was anomalous.

1. Do you agree with the student?
   Give a reason for your answer.

2. Calculate the percentage change in mass of egg **3.**

3. Explain why the masses of the eggs increased.

4. Explain how the student could modify the investigation to determine the concentration of the solution inside each egg.

Chicken egg shells contain calcium. Calcium ions are moved from the shell into the cytoplasm of the egg. **Table 5** shows information about the concentration of calcium ions.

Table 5

Location	Concentration of calcium ions in arbitrary units
Egg shell	0.6
Egg cytoplasm	2.1

5. Explain how calcium ions are moved from the shell into the cytoplasm of the egg.

Activity 15 Digestion and food tests

It is important to understand the role of enzymes in digestion and how enzymes work. Recalling the food tests is important, particularly how to test for protein and sugars.

1. Describe how a student could test cow's milk to show whether it contains protein and different types of carbohydrate.

A scientist investigated the effect of bile on the breakdown of fat in a sample of milk.

The scientist used an indicator that is colourless in solutions with a pH lower than 10, and pink in solutions with a pH above 10

This is the method used.

- Add 1 drop of bile to a test tube and one drop of water to a second test tube.
- Add the following to each test tube:
  - 5 cm^3 of milk
  - 7 cm^3 of sodium carbonate solution (to make the solution above pH 10)
  - 5 drops of the indicator
  - 1 cm^3 of lipase.
- Time how long it takes for the indicator in the solutions to become colourless.

	Time taken for the indicator to become colourless in seconds
Solution with bile	65
Solution without bile	143

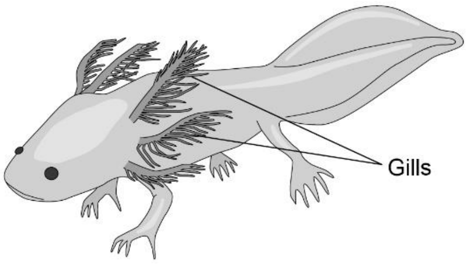
2. Explain why the indicator in both tubes became colourless.

3. Explain the difference in the results for the two test tubes in the table above

Activity 16 Circulatory system and gas exchange

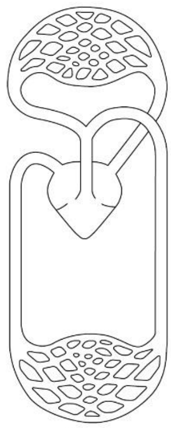
Application of your knowledge and understanding of these key concepts to unfamiliar context is a way examiners can assess the depth of your understanding.

A small animal called an axolotl lives in water. The axolotl has a double circulatory system.



1. Explain what is meant by the term double circulatory system.

2. The diagram below shows the double circulatory system of the axolotl.
   The heart of the axolotl has only one ventricle. Label the ventricle on the diagram.



3. Explain why having only one ventricle makes the circulatory system less efficient than having two ventricles.

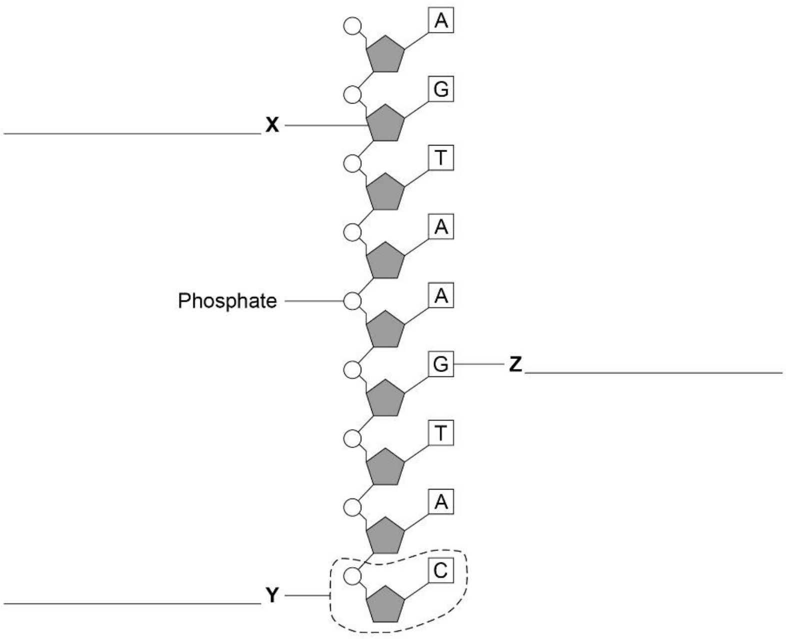
4. Explain why an axolotl may die in water with a low concentration of oxygen. Use the diagram above to help you, remember about surface area: volume ratio in gas exchange.

Activity 17 DNA and genetics

Genetic material is made of DNA.

1. Name the structures in the nucleus of a human cell which contain DNA.

The figure below shows part of one strand of a DNA molecule.



2. Label parts **X**, **Y** and **Z** with the correct word from the list below **:**

   base **fatty acid** **nucleotide** **sugar** **glycerol**

3. A complete DNA molecule is made of two strands twisted around each other. What scientific term describes this structure?

DNA codes for the production of proteins.
A protein molecule is a long chain of amino acids.

4. How many amino acids could be coded for by the piece of DNA shown in the figure above?

Activity 18 Monoclonal antibodies

Monoclonal antibodies are identical copies of a specific type of antibody. Antibodies are extremely important as they are a type of protein that is produced by lymphocytes to fight pathogens (disease causing viruses, bacteria, fungi or protists). Pathogens have antigens on them which makes them unique. When a pathogen enters an organism and causes an infection, the lymphocyte recognises the unique antigen on the pathogen and start attacking them by producing antibodies. Monoclonal antibodies (copies) can be made in the lab.

A farmer thinks a potato crop is infected with potato virus Y (PVY). The farmer wants to buy a monoclonal antibody to get rid of the potato virus.
To make the monoclonal antibodies a scientist first isolates the PVY protein from the virus.

1. Describe how the scientist would use the PVY protein to produce the PVY monoclonal antibody for the farmer.

Part Two

Read the relevant sections of the text book on microscopes, cell structure, water and glucose molecules and then answer the past exam questions on September units of work

Types of microscope

Light microscopes

They use light (no surprises there). They have a lower resolution than electron microscopes. They have a maximum resolution of about 0.2 micrometres (μm). So they're usually used to look at whole cells or tissues. The maximum useful magnification of a light microscope is about × 1500.

Laser scanning confocal microscopes

These are a special type of light microscope that use laser beams (intense beams of light) to scan a specimen that's usually tagged with fluorescent dyes.

A laser beam is focused through a lens which is aimed at a beam splitter. This splits the beam and some of the light is directed to the specimen. When the laser hits the dyes it causes them to give off fluorescent light. This light is then focused through a pinhole onto a detector. The detector is hooked up to a computer, which generates an image. The pinhole means that any out-of-focus light is blocked, so these microscopes produce a much clearer image than a normal light microscope.

These microscopes can be used to look at objects at different depths in thick specimens. Multiple images produced by the microscope can be combined by the computer to generate 3D images of a specimen.

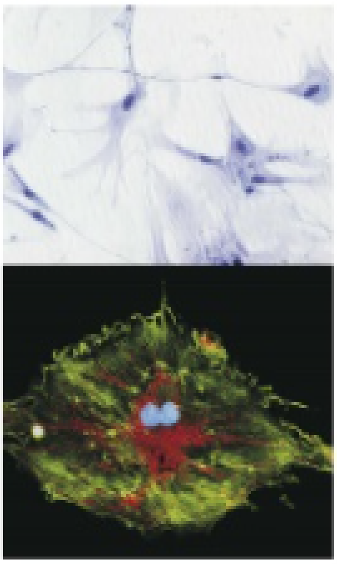


Figure 1: *Lung cells seen under a light microscope (top) and a laser scanning confocal microscope (bottom).*

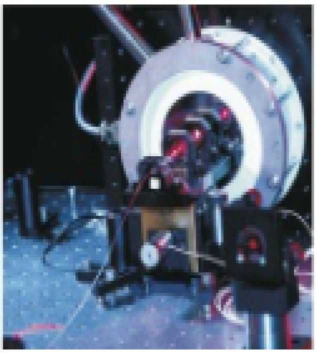


Figure 2: *The internal workings of a laser scanning confocal microscope. The image shows the laser beam (red) being focused onto the beam splitter.*

Types of electron microscope

There are two types of electron microscope:

Transmission electron microscope (TEM)

TEMs use electromagnets to focus a beam of electrons, which is then transmitted through the specimen to produce 2D images. Denser parts of the specimen absorb more electrons, which makes them look darker on the image you end up with.

TEMs are good because they provide high resolution images, so they can be used to look at very small organelles, e.g. ribosomes. They can also be used to look at the internal structures of organelles in detail. But specimens viewed on TEMs need to be quite thinly sliced. The angle at which specimens are cut can affect how they appear (see Figure 3).

Scanning electron microscope (SEM)

SEMs scan a beam of electrons across the specimen. This knocks off electrons from the specimen, which are gathered in a cathode ray tube to form an image. The images produced show the surface of the specimen and can be 3D but they give lower resolution images than TEMs.

Figure 3: *A TEM image (top), and SEM image (bottom) of* E. coli *bacteria. The* E. coli *in the TEM have been cut at different angles.*

Learning Objectives:

- Be able to explain the use of staining in light microscopy, including the use of differential staining to identify different cellular components and cell types.
- Understand representations of cell structure as seen under the light microscope using drawings and annotated diagrams of whole cells or cells in sections of tissue.
- Be able to prepare and examine microscope slides for use in light microscopy, including the use of an eyepiece graticule and stage micrometer (PAG1).

Specification Reference 2.1.1

5. Using Microscopes

Now you know how they work you need to grasp how to actually use them.

Microscopes — what you need to know

PRACTICAL ACTIVITY GROUP 1

You need to know a few things about using microscopes. These are:

- How to prepare a slide for use with a light microscope — this includes the use of stains.
- How to use a light microscope — this includes using an eyepiece graticule and stage micrometer to work out the size of specimens you're looking at.
- How to produce and interpret drawings and annotated diagrams of cells viewed under a light microscope.

Staining samples

In light microscopes the beam of light passes through the object being viewed. An image is produced because some parts of the object absorb more light than others. Sometimes the object being viewed is completely transparent. This makes the whole thing look white because the light rays just pass straight through. To get round this, the object can be stained.

For the light microscope, this means using some kind of dye. These dyes are called stains. Common stains include methylene blue and eosin (see below). The stain is taken up by some parts of the object more than others, which means that some parts become more heavily stained than others. The contrast between heavily stained and more lightly stained parts means that the different parts of cells can be seen.

Different stains can be used to make particular parts of cells show up.

Examples

Methylene blue can be used to stain DNA (see Figure 1) and Giemsa stain is commonly used to differentiate between different types of blood cells (Figure 2).

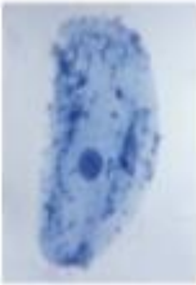


Figure 1: A cheek cell stained with methylene blue. The nucleus is visible as the roughly oval structure in the cell.

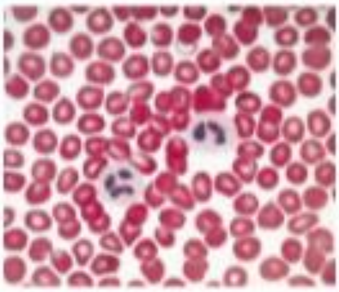


Figure 2: A human blood sample treated with Giemsa stain. Red blood cells are stained red and the nuclei present in the two white blood cells are stained purple.

Tip: An important thing to remember here is that an image is produced after staining because it makes some parts of the specimen appear darker (or a different colour) to other parts.

It's possible to use more than one stain at once.

Example

The stains haematoxylin and eosin are often used together (called H&E staining) to highlight different parts of cells (see Figure 3). Eosin dyes the cytoplasm pink. Haematoxylin stains the RNA and DNA present in cells a purple/blue colour — this highlights cell structures where these molecules are found (e.g. the nucleus and ribosomes).

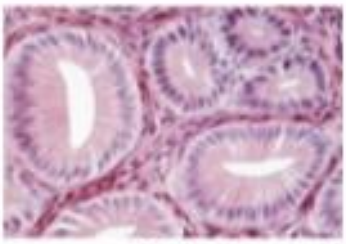


Figure 3: A light micrograph showing cells from the large intestine epithelium. Stained nuclei (purple) and cytoplasms (pink) are visible.

How to prepare a microscope slide

If you want to look at a specimen under a light microscope, you need to stick it on a slide first. A slide is a strip of clear glass or plastic. Slides are usually flat, but some of them have a small dip or well in the centre (useful if your specimen's particularly big or a liquid).

There are two main ways of preparing a microscope slide:

Dry Mount

This is the simplest way of preparing a slide for examination under a microscope. This technique is particularly useful for observing specimens such as hairs, parts of insects, pollen, parts of flowers, etc.

Here's how to dry mount a specimen:

- Firstly, your specimen needs to let light through it for you to be able to see it clearly under the microscope. So if you've got quite a thick specimen, you'll need to take a thin slice to use on your slide.
- Use tweezers to pick up your specimen and put it in the middle of a clean slide.
- Pop a cover slip (a square of thin, transparent plastic or glass) on top. Your slide is now ready to use.

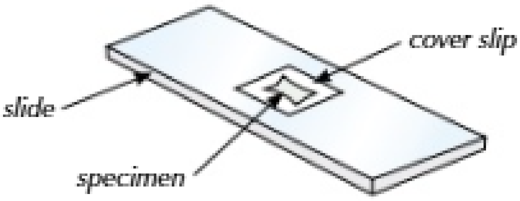


Figure 4: A dry mount slide.

Tip: Take care when preparing slides — glass slides and cover slips can expose sharp edges if they break. Also, make sure you do a risk assessment before doing any practical work like this to identify any other hazards, e.g. some stains are harmful chemicals.

Tip: In a dry mount there's just a (relatively) dry specimen under the cover slip.

Wet Mount

Wet mounts involve your specimen being in a liquid (usually water). They are more difficult to carry out than dry mounting but can produce slides that give a really clear view of a specimen. This technique can be used with a variety of specimens including living samples (e.g. tiny aquatic organisms).

Here's how to wet mount a specimen:

- Start by pipetting a small drop of water onto the slide. Then use tweezers to place your specimen on top of the water drop.
- To put the cover slip on, stand the slip upright on the slide, next to the water droplet. Then carefully tilt and lower it so it covers the specimen. Try not to get any air bubbles under there — they'll obstruct your view of the specimen.
- Once the cover slip is in position, you can add a stain. Put a drop of stain next to one edge of the cover slip. Then put a bit of paper towel next to the opposite edge. The stain will get drawn under the slip, across the specimen.

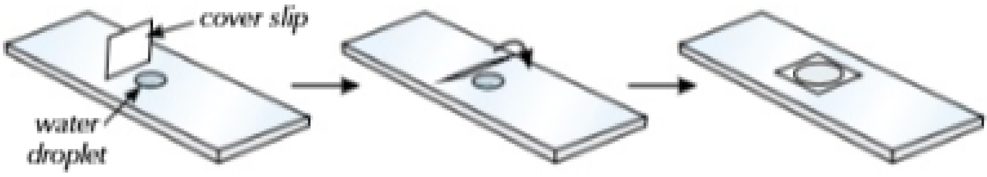


Figure 5: *A wet mount slide.*

Tip: Wet mounts are also used for liquid specimens (e.g. a sample of pond water). For these you won't need to add any water as your sample itself will provide the liquid. This is an example of when you might use a slide that has a well.

Tip: A smear slide is a special type of wet mount. These are often used for blood samples. It involves spreading the liquid thinly over the central area of the slide. A cover slip can then be applied and any excess liquid wiped off the slide.

How to use a light microscope

You're expected to be able to use a light microscope to view a specimen (e.g. a sample of plant tissue or a sample of human skin cells).

Tip: The appearance of light microscopes can vary (e.g. they might have two eyepieces rather than one) but they should have the same basic features shown in Figure 7.

How to use a light microscope to view a specimen

1. Start by clipping the slide containing the specimen onto the stage.
2. Select the lowest-powered objective lens (i.e. the one that produces the lowest magnification).
3. Use the coarse adjustment knob to bring the stage up to just below the objective lens.
4. Look down the eyepiece (which contains the ocular lens). Use the coarse adjustment knob to move the stage downwards, away from the objective lens, until the image is roughly in focus.
5. Adjust the focus with the fine adjustment knob, until you get a clear image of what's on the slide.
6. If you need to see the slide with greater magnification, swap to a higher-powered objective lens and refocus.

Figure 6: Some microscopes have a slide holder rather than clips. This grips the sides of a slide and allows fine movement of the slide on the stage.

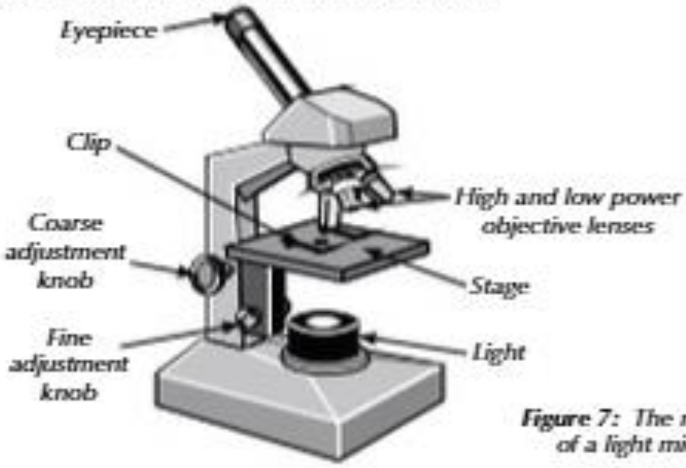


Figure 7: The main features of a light microscope.

Tip: Your drawing should be done using a sharp pencil (not pen) and take up at least half the space available.

Functions of organelles

This table contains a big list of organelles — you need to know the structure and function of them all. Sorry. Most organelles are surrounded by membranes, which sometimes causes confusion — don't make the mistake of thinking that a diagram of an organelle is a diagram of a whole cell. They're not cells — they're parts of cells.

Tip: There's more on the structure and function of the plasma membrane on pages 124-126.

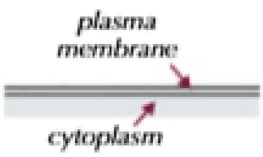
Plasma membrane (Also called the cell surface membrane)

Description

The membrane found on the surface of animal cells and just inside the cell wall of plant cells and prokaryotic cells. It's made mainly of lipids and protein.

Function

Regulates the movement of substances into and out of the cell. It also has receptor molecules on it, which allow it to respond to chemicals like hormones.



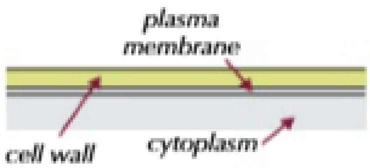
Cell wall

Description

A rigid structure that surrounds plant cells. It's made mainly of the carbohydrate cellulose.

Function

Supports plant cells.



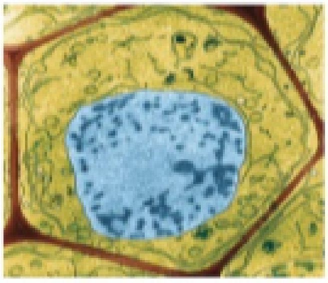


Figure 3: An electron micrograph of a plant cell. The cell walls appear red/brown.

Tip: In addition to plants, other organisms (e.g. fungi and bacteria) can have cell walls too but they aren't made of cellulose — see p. 46.

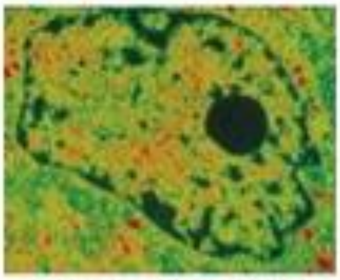


Figure 4: An electron micrograph of a nucleus, showing the nucleolus, nuclear envelope and nuclear pores.

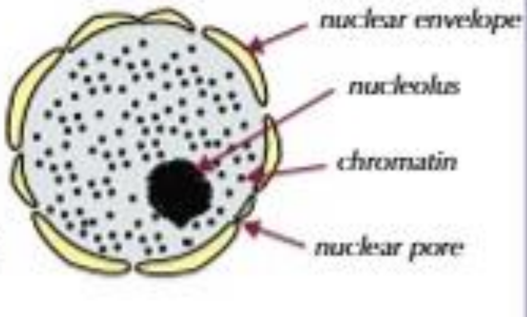
Tip: There's more on DNA and RNA on pages 88-89.

Tip: Organelles in electron micrographs won't always look exactly the same as the ones shown here, e.g. they may vary in size and shape and they can be viewed from different angles, which can affect their appearance.

Nucleus

Description

A large organelle surrounded by a nuclear envelope (double membrane), which contains many pores. The nucleus contains chromatin (which is made from DNA and proteins) and often a structure called the nucleolus.



Function

The nucleus controls the cell's activities (by controlling the transcription of DNA — see p. 99). DNA contains instructions to make proteins — see page 96. The pores allow substances (e.g. RNA) to move between the nucleus and the cytoplasm. The nucleolus makes ribosomes (see below).

Lysosome

Description

A round organelle surrounded by a membrane, with no clear internal structure.

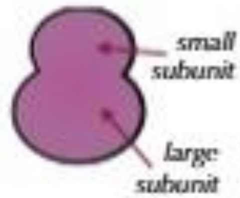
Function

Contains digestive enzymes. These are kept separate from the cytoplasm by the surrounding membrane, and can be used to digest invading cells or to break down worn out components of the cell.

Ribosome

Description

A very small organelle that either floats free in the cytoplasm or is attached to the rough endoplasmic reticulum. It's made up of proteins and RNA (see page 89). It's not surrounded by a membrane.



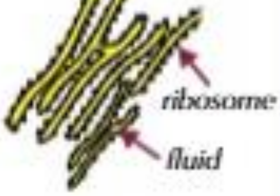
Function

The site where proteins are made.

Rough endoplasmic reticulum (RER)

Description

A system of membranes enclosing a fluid-filled space. The surface is covered with ribosomes.



Function

Folds and processes proteins that have been made at the ribosomes.

Figure 5: An electron micrograph showing SER (red-brown) and RER (blue).

Smooth endoplasmic reticulum (SER)

Description

Similar to rough endoplasmic reticulum, but with no ribosomes.

Function

Synthesises and processes lipids.

Vesicle

Description

A small fluid-filled sac in the cytoplasm, surrounded by a membrane.

Function

Transports substances in and out of the cell (via the plasma membrane) and between organelles. Some are formed by the Golgi apparatus or the endoplasmic reticulum, while others are formed at the cell surface.

Golgi apparatus

Description

A group of fluid-filled, membrane-bound, flattened sacs. Vesicles are often seen at the edges of the sacs.

Function

It processes and packages new lipids and proteins. It also makes lysosomes.

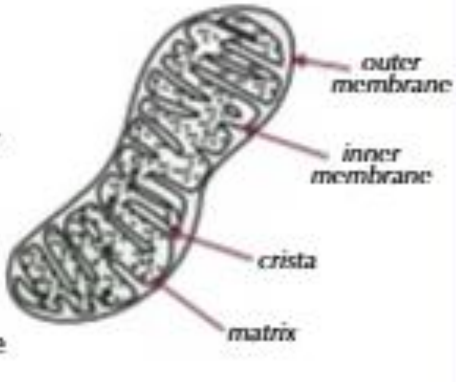
Mitochondrion

Description

It's usually oval-shaped. It has a double membrane — the inner one is folded to form structures called cristae. Inside is the matrix, which contains enzymes involved in respiration.

Function

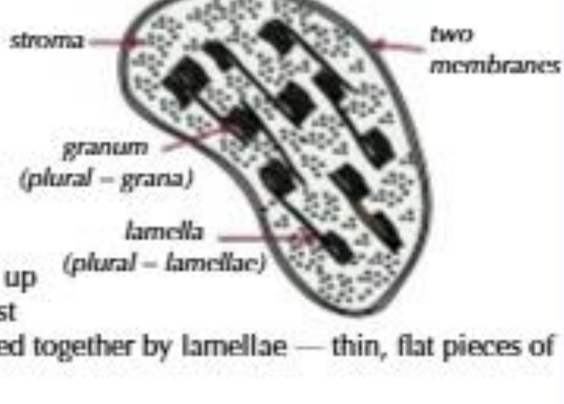
The site of aerobic respiration, where ATP is produced. Mitochondria are found in large numbers in cells that are very active and require a lot of energy.



Chloroplast

Description

A small, flattened structure found in plant cells. It's surrounded by a double membrane, and also has membranes inside called thylakoid membranes. These membranes are stacked up in some parts of the chloroplast to form grana. Grana are linked together by lamellae — thin, flat pieces of thylakoid membrane.



Function

The site where photosynthesis takes place. Some parts of photosynthesis happen in the grana, and other parts happen in the stroma (a thick fluid found in chloroplasts).

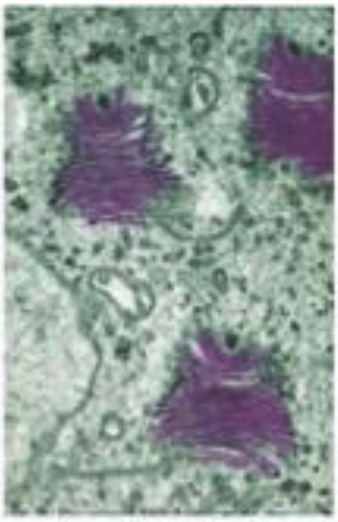


Figure 6: An electron micrograph of Golgi apparatus.

Exam Tip

Never say mitochondria produce energy in the exam — they produce ATP or release energy (energy can't be made).

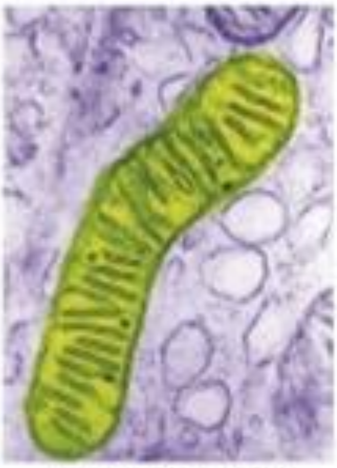


Figure 7: An electron micrograph of a mitochondrion.

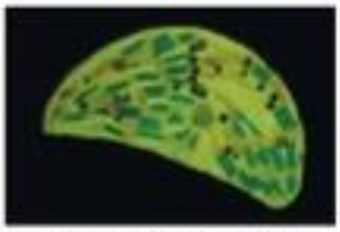


Figure 8: An electron micrograph of a chloroplast.

3. Carbohydrates

Carbohydrates are needed by living organisms for things like energy storage and support — their function is related to their structure.

What are carbohydrates made from?

Most carbohydrates are polymers. All carbohydrates are made up of the same three chemical elements — carbon (C), hydrogen (H) and oxygen (O). For every carbon atom in the carbohydrate there are usually two hydrogen atoms and one oxygen atom.

The monomers that make up carbohydrates are called **monosaccharides**. You need to know the structures of two different monosaccharides — glucose and ribose.

Glucose

Glucose is a monosaccharide with six carbon atoms. This means it's a hexose monosaccharide. There are two forms of glucose — alpha (α) and beta (β). They both have a ring structure — see Figure 1.

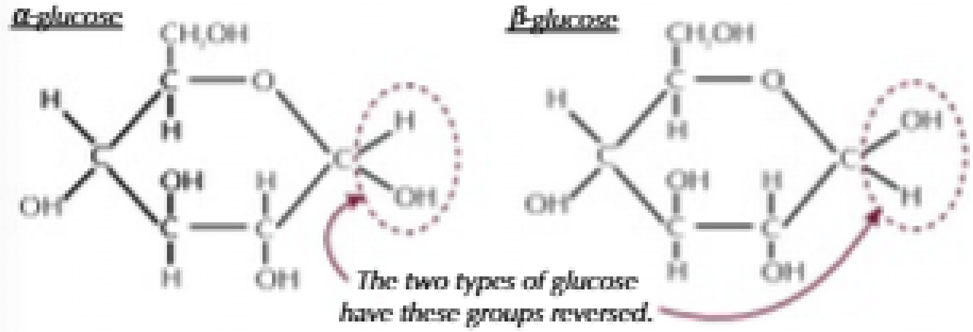


***Figure 1:** The structures of α-glucose and β-glucose.*

Glucose's structure is related to its function as the main energy source in animals and plants. Its structure makes it soluble, so it can be easily transported. Its chemical bonds contain lots of energy.

Ribose

Ribose is a monosaccharide with five carbon atoms — this means it's a pentose monosaccharide. You need to know its structure (see Figure 2).

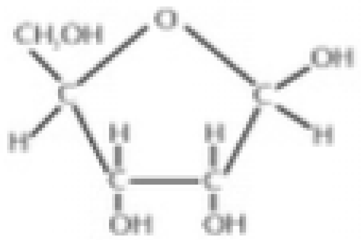


***Figure 2:** The structure of ribose.*

Ribose is the sugar component of RNA nucleotides (see p. 89).

Polysaccharide formation

Monosaccharides are joined together by **glycosidic bonds**. During synthesis, a hydrogen atom on one monosaccharide bonds to a hydroxyl (OH) group on the other, releasing a molecule of water — this is a **condensation** reaction (see previous page). The reverse of this synthesis reaction is **hydrolysis** — a molecule of water reacts with the glycosidic bond, breaking it apart.

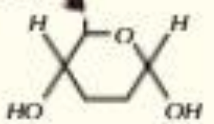
Learning Objectives:

- Know the chemical elements that make up carbohydrates (C, H and O).
- Understand the difference between a hexose and a pentose monosaccharide.
- Recall the ring structure and properties of glucose (a hexose monosaccharide) and the structure of ribose (a pentose monosaccharide).
- Understand the structural difference between α-glucose and β-glucose.
- Recall the synthesis and breakdown of disaccharides (including sucrose, lactose and maltose) and polysaccharides by the formation and breakage of glycosidic bonds.
- Recall the structure of starch (amylose and amylopectin), glycogen and cellulose molecules.
- Know how the structures and properties of glucose, starch, glycogen and cellulose molecules relate to their functions in living organisms.

Specification Reference 2.1.2

Tip: Although most carbohydrates are polymers, single monosaccharides are also called carbohydrates.

Tip: Structures aren't always drawn with everything on them, e.g. when you get a line with nothing on the end, like this

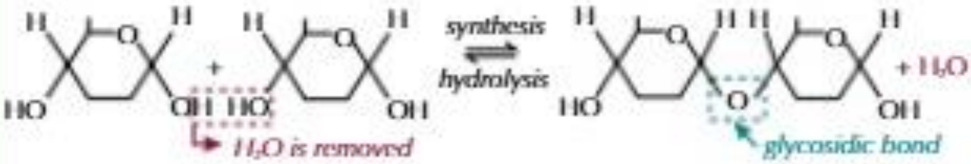


it just means there's a carbon there, with other elements (like hydrogen) attached to it.

A **disaccharide** is formed when two monosaccharides join together:

Example

Two α-glucose molecules are joined together by a glycosidic bond to form maltose.

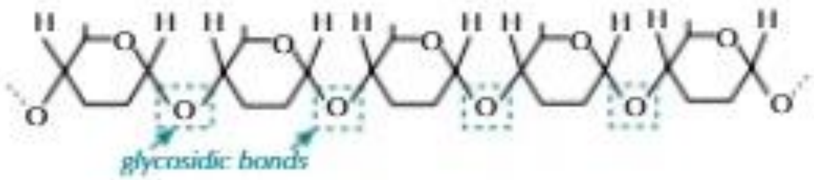


Other disaccharides are formed in a similar way. Sucrose is a disaccharide formed when α-glucose and fructose join together. Lactose is a disaccharide formed by the joining together of galactose with either α-glucose or β-glucose.

A **polysaccharide** is formed when more than two monosaccharides join together:

Example

Lots of α-glucose molecules are joined together by glycosidic bonds to form amylose.



Functions of carbohydrates

You need to know about the relationship between the structure and function of three polysaccharides — starch, glycogen and cellulose.

Starch

Starch is the main energy storage material in plants. Cells get energy from glucose and plants store excess glucose as starch (when a plant needs more glucose for energy it breaks down starch to release the glucose). Starch is insoluble in water so it doesn't cause water to enter cells by osmosis (see p. 134), which would make them swell. This makes it good for storage. Starch is a mixture of two polysaccharides of alpha-glucose — amylose and amylopectin:

- **Amylose** is a long, unbranched chain of α-glucose. The angles of the glycosidic bonds give it a coiled structure, almost like a cylinder. This makes it compact, so it's really good for storage because you can fit more in to a small space.
- **Amylopectin** is a long, branched chain of α-glucose. Its side branches allow the enzymes that break down the molecule to get at the glycosidic bonds easily. This means that the glucose can be released quickly.

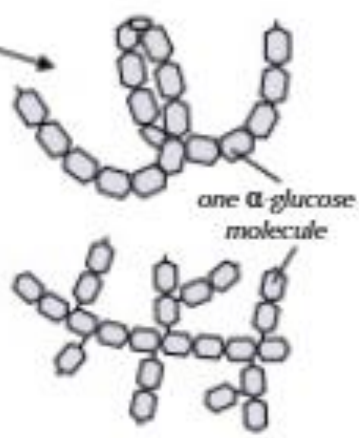


Figure 3: *The structures of amylose (top) and amylopectin (bottom).*

Tip: You can test for the presence of starch using the iodine test (see page 77).

Tip: Hydrogen bonds between α-glucose molecules help to hold amylose in its helical structure.

Exam Tip

Always specify whether you're talking about α-glucose or β-glucose — you won't get a mark for only saying glucose.

Glycogen

Glycogen is the main energy storage material in animals. Animal cells get energy from glucose too, but animals store excess glucose as glycogen — another polysaccharide of alpha-glucose. Its structure is very similar to amylopectin, except that it has loads more side branches coming off it — see Figure 4. Loads of branches means that stored glucose can be released quickly, which is important for energy release in animals. It's also a very compact molecule, so it's good for storage.

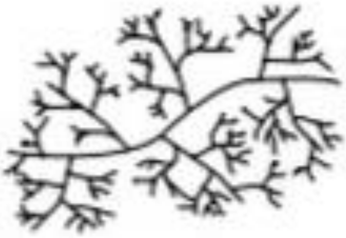


Figure 4: *The structure of glycogen.*

Exam Tip

If you're asked about the function of glycogen in the exam, make sure you say it acts as an energy store or reserve — you won't get marks just for saying it 'contains energy'.

Cellulose

Cellulose is the major component of cell walls in plants. It's made of long, unbranched chains of beta-glucose. When beta-glucose molecules bond, they form straight cellulose chains. The cellulose chains are linked together by **hydrogen bonds** to form strong fibres called **microfibrils** — see Figure 5. The strong fibres mean cellulose provides structural support for cells (e.g. in plant cell walls).

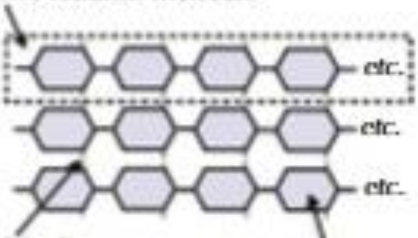


Figure 5: *The structure of a cellulose microfibril.*

Figure 6: *Coloured scanning electron micrograph (SEM) of cellulose microfibrils in a plant cell wall.*

1. Water

Water is essential for life. The next few pages will show you what it is about water that makes it so important.

Functions of water

Water is vital to living organisms. It makes up about 80% of a cell's contents and has loads of important functions, inside and outside cells, such as:

- Water is a reactant in loads of important chemical reactions, including hydrolysis reactions (see page 62).
- Water is a solvent, which means some substances dissolve in it. Most biological reactions take place in solution (e.g. in the cytoplasm of eukaryotic and prokaryotic cells) so water's pretty essential.
- Water transports substances. The fact that it's a liquid and a solvent means it can easily transport all sorts of materials, like glucose and oxygen, around plants and animals.
- Water helps with temperature control because it has a high specific heat capacity and a high latent heat of evaporation (see next page).
- Water is a habitat. The fact that it helps with temperature control, is a solvent and becomes less dense when it freezes (see next page) means many organisms can survive and reproduce in it.

Structure of water

To understand the structure of water, you need to know a bit about the chemistry involved in holding water molecules together.

Polarity of water

A molecule of water (H_2O) is one atom of oxygen (O) joined to two atoms of hydrogen (H_2) by shared electrons — see Figure 1.

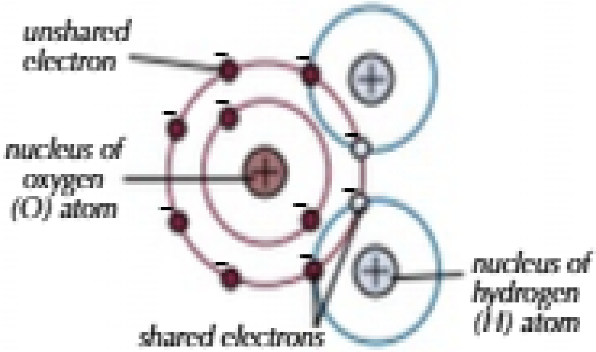


Figure 1: The structure of a water molecule.

Because the shared negative hydrogen electrons are pulled towards the oxygen atom, the other side of each hydrogen atom is left with a slight positive charge. The unshared negative electrons on the oxygen atom give it a slight negative charge. This makes water a polar molecule — it has a partial negative charge (δ–) on one side and a partial positive charge (δ+) on the other (see Figure 2).

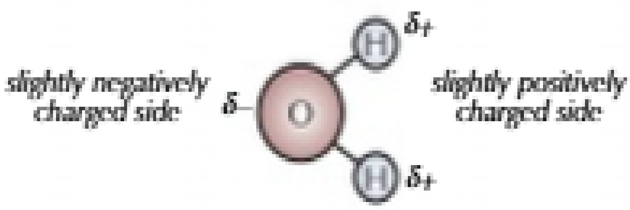


Figure 2: The slight charges on a water molecule.

Learning Objectives:

- Be able to describe how hydrogen bonding occurs between water molecules.
- Be able to relate the properties of water to the roles of water for living organisms, including as a solvent, transport medium, coolant and a habitat.
- Be able to illustrate these roles using examples of prokaryotes and eukaryotes.

Specification Reference 2.1.2

Exam Tip
Examiners like asking you to relate structure to properties and function, so make sure you're clear on the structure of water.

Tip: 'δ' is the Latin letter 'delta'. So you read δ+ as 'delta positive' and δ- as 'delta negative'.

Exam Tip
Be careful not to write that a water molecule has a positive and a negative side — you must make it clear that one side has a partial positive charge and the other side has a partial negative charge.

Hydrogen bonding

The slightly negatively-charged oxygen atoms attract the slightly positively-charged hydrogen atoms of other water molecules. This attraction is called **hydrogen bonding** and it gives water some of its useful properties.

Exam Tip
If you're asked to draw water molecules in the exam, make sure you draw the hydrogen bonds as dashed lines and include the partial charges (δ+ or δ–) on all the atoms.

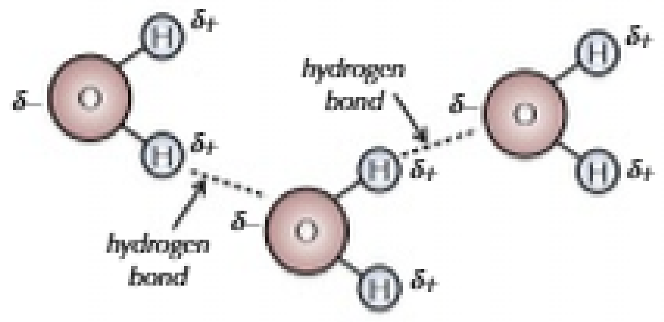


Figure 3: Diagram showing how hydrogen bonds hold water molecules together.

Properties of water

The structure of a water molecule gives it some useful properties, and these help to explain many of its functions:

High specific heat capacity

Hydrogen bonds give water a high **specific heat capacity** — this is the energy needed to raise the temperature of 1 gram of a substance by 1 °C. The hydrogen bonds between water molecules can absorb a lot of energy. So water has a high specific heat capacity — it takes a lot of energy to heat it up. This means water doesn't experience rapid temperature changes, which is one of the properties that makes it a good habitat — the temperature under water is likely to be more stable than it is on land.

High latent heat of evaporation

It takes a lot of energy (heat) to break the hydrogen bonds between water molecules. So water has a high latent heat of evaporation — a lot of energy is used up when water evaporates (changes from a liquid to a gas). This is useful for living organisms because it means water's great for cooling things. This is why some mammals, like us, sweat when they're too hot. When sweat evaporates, it cools the surface of the skin.

Tip: Latent heat is the heat energy that's needed to change a substance from one state to another, e.g. from a liquid to a gas.

Very cohesive

Cohesion is the attraction between molecules of the same type (e.g. two water molecules). Water molecules are very cohesive (they tend to stick together) because they're polar. This helps water to flow, making it great for transporting substances. It also helps water to be transported up plant stems in the transpiration stream (see page 213).

Lower density when solid

At low temperatures water freezes — it turns from a liquid to a solid. Water molecules are held further apart in ice than they are in liquid water because each water molecule forms four hydrogen bonds to other water molecules, making a lattice shape. This makes ice less dense than liquid water — which is why ice floats. This is useful for living organisms because, in cold temperatures, ice forms an insulating layer on top of water — the water below doesn't freeze. So organisms that live in water, like fish, don't freeze and can still move around.

Good solvent

A lot of important substances in biological reactions are ionic (like salt, for example). This means they're made from one positively-charged atom or molecule and one negatively-charged atom or molecule (e.g. salt is made from a positive sodium ion and a negative chloride ion). Because water is polar, the slightly positive end of a water molecule will be attracted to the negative ion, and the slightly negative end of a water molecule will be attracted to the positive ion. This means the ions will get totally surrounded by water molecules — in other words, they'll dissolve (see Figure 4).

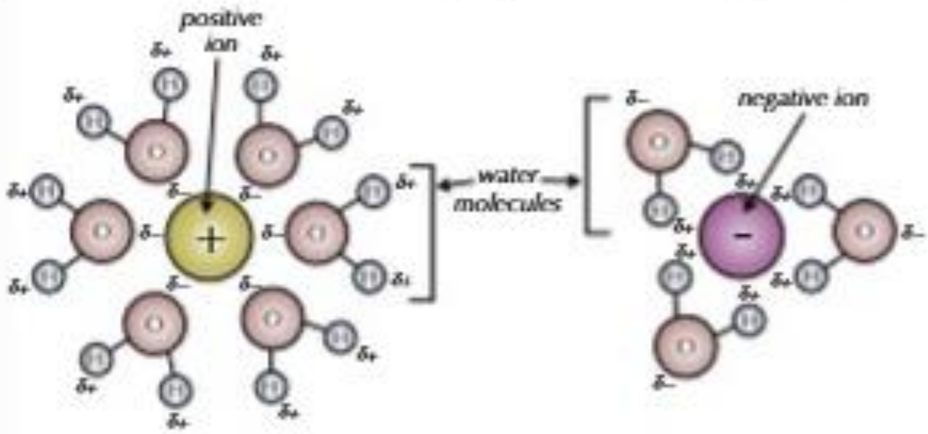


***Figure 4:** A positive ion (left) and a negative ion (right) dissolved in water.*

Water's polarity makes it useful as a solvent in living organisms. E.g. in humans, important ions (see pages 74-75) can dissolve in the water in blood and then be transported around the body.

Tip: Most biological reactions take place in solution, so water's pretty essential.

Tip: Remember — a molecule is polar if it has a slightly negatively-charged side and a slightly positively-charged side.

Tip: Polar molecules, such as glucose, dissolve in water because hydrogen bonds form between them and the water molecules.

1(a). Some students collect a sample of pond water to observe under a light microscope.

They pour some of the pond water onto a microscope slide.

Describe how they could improve their technique in preparing the microscope slide for examination under a light microscope.

[2]

i. Explain how the students would use the different objective lenses of a light microscope to focus and observe the pond water sample at high power magnification.

[2]

2. Both a transmission electron microscope (TEM) and a scanning electron microscope (SEM) can be used to view the same cell. However, the images formed will be different.

Compare the resolutions of these microscopes **and** the images formed by them.

[4]

3. The pancreas is an organ that secretes protease enzymes.

Outline how the organelles in pancreatic cells work together to produce and release these protein molecules from the cells.

In your answer you should use appropriate technical terms, spelled correctly.

[5]

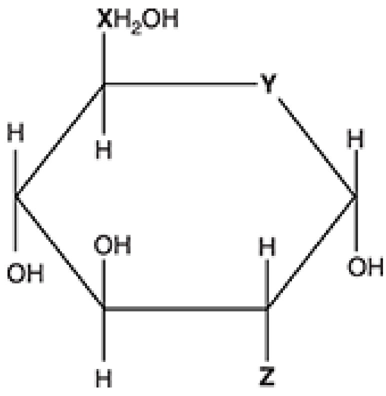
4. *The thermal properties of water allow organisms to live in an environment with relatively small changes in temperature. These properties also make water efficient as a coolant, e.g. in sweating or by absorbing large amounts of heat.

Outline how **other** properties of water are essential for sustaining life on Earth.

[6]

5. In cells, glucose can exist as α-glucose or as β-glucose.

Fig. 1.1 The figure represents the structural formula of a molecule of α-glucose.



i. Fig. 1.1 In , some atoms or groups have been replaced by the letters **X**, **Y** and **Z**.

Identify the correct atom or group that has been replaced by each letter.

X ______________________________

Y ______________________________

Z ______________________________

[3]

ii. Describe how the structure drawn in Fig. 1.1 above would be different if it represented a molecule of **β-glucose**.

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[2]

6. Describe how the structures of starch and cellulose molecules are related to their functions.

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______________________________ **[6]**