PARK HIGH SCHOOL

GCSE to A-Level Biology Transition Booklet

Park High School 2023 (STUDENT TO PRINT ENTIRE BOOKLET)

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Summer Bridging Work: Biology Y11 → Y12

Introduction

A-level Biology is a big step up from GCSE. In order to prepare for Biology A-level, it is vital that you have an excellent understanding of the following concepts, all of which you covered at GCSE and will study in greater depth over the first year of A-level Biology:

1. Biological Molecules
2. Cell Structure
3. Disease and Immunity
4. Organisms and Exchange
5. The Circulatory System
6. Genetics and Cell Division
7. Variation, Evolution and Classification
8. Investigating and Interpreting (Mathematical and Practical Skills)

To ensure you have an excellent grounding in each of these topics, please continue to review all GCSE Biology content so that you have a solid foundation to starting A-level Biology.

Compulsory Task 1 (ALL students must complete this)

1. Complete the **GCSE prior knowledge quiz** for each of the sections outlined in this booklet.

2. Read through the information provided on **building knowledge** for A-level Biology and complete the questions that follow on for each of the **sections** in this booklet. Revise the content, **answer ALL the questions**. You must **print the booklet** and bring it to your first Biology lesson.

3. Time Permitting/Challenge: Use the information provided from the building knowledge sections to **create a multiple-choice quiz** with **50 questions** and **4 options per question**. Complete this on a **Word document**, clearly numbering each question and labelling the options as a,b,c,d. The options should be viable answers to the questions. Please also create a separate **mark scheme** that contains the correct answers for each question.

Compulsory Task 2 (ALL students must complete this)

See the document below: **A Guide to Harvard Referencing**.

1. You need to learn how to reference work properly. Read the guide and complete the 3 referencing tasks and the 3 variable tasks on the sheet. This will need to be **printed** out and **completed** and you will need to bring it in to your first lesson.
2. Visit the Website below and read the complete guide on how to reference different sources. https://www.citethisforme.com/harvard-referencing
3. Choose any 3 additional Biology Websites or Online Articles and use the website below to **generate a reference and in-text citation** for each one – this needs to be printed out. https://www.citethisforme.com/harvard/source-type

Assignment Deadlines

Date/Deadline	Topic	Booklet Section
5th August 2023	1	Biological Molecules
12th August 2023	2	Cells
19th August 2023	3	Organisms Exchange Systems
26th August 2023	4	Genetics
2nd September 2023	5	Maths Skills & Investigation Skills

Staying at Park High Sixth Form: Preparing for A-level Biology Lessons

1. Purchase a **lab coat**.
   https://www.amazon.co.uk/Dr-James-Professional-Lab-Coat/dp/B005MI212K/ref=sr_1_10?dchild=1&keywords=lab%2Bcoat&qid=1589187040&s=clothing&sr=1-10&th=1

2. Purchase **two A4 Notebooks/Exercise books** and a **A4 folder with dividers** for use in Biology Only. You also should have pens, pencil, highlighters, green pen, calculator, ruler etc. Prepare to be fully equipped every lesson.

3. Purchase the following **textbook**: Edexcel AS/A level Biology B Student Book 1 + ActiveBook (Edexcel GCE Science 2015) Paperback – 1 May 2015 (***ISBN***: 9781447991144)
   https://www.amazon.co.uk/Edexcel-Biology-Student-ActiveBook-Science/dp/1447991141

Pre-read and make notes on the first few pages from your Edexcel Biology B Book 1 Topic 1.

Assessment

Please bring ALL completed work, textbook and equipment to your FIRST Biology lesson (this could be the first day of school). There will also be a Transition test in the first week or so on all GCSE Biology content, Transition Booklet content and the first few lessons of the A-level Biology Topic 1 content. The Bridging work and TEST will determine your suitability for the course.

GCSE to A-Level Biology Transition Booklet and Quiz

Content:

This booklet is to help highlight some basic key GCSE knowledge needed to have a good start to the Edexcel B Biology A-level course.
Although other knowledge is required these questions will help determine your basic understanding of biology.

BIOLOGICAL MOLECULES GCSE PRIOR KNOWLEDGE

1) Biological Molecules

a) Carbohydrates: Starch, Cellulose and Glycogen
b) Lipids
c) Proteins and Enzymes
d) DNA, Energy and Water

Carbohydrates: Starch, Cellulose and Glycogen Prior Knowledge

QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. How may glucose be stored/used by plants? (4)			
2. What is starch made of? (1)			
3. What is the chemical formula for glucose? (1)			
4. Name two reasons starch is important in plants. (2)			
5. Which test is used to see if starch is present? (1)			
6. Which test is used to see if glucose is present? (1)			
7. Describe the method to test for glucose? (3)			
8. Where is cellulose found in a plant cell? (1)			
9. What is the function of cellulose? (1)			
10. Where is glycogen found? (1)			

11. What is the function of glycogen? (1)			
12. How is glycogen made? (2)			
13. What are carbohydrates made of? (1)			
14. What enzyme breaks down carbohydrates? (1)			
TOTAL			**/ 20**

Carbohydrates Building Knowledge

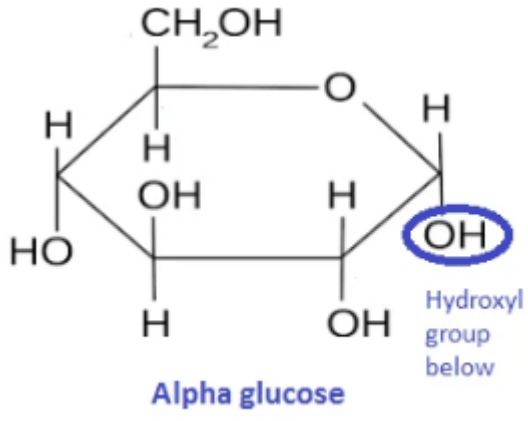
Three elements make up the carbohydrate molecule – **carbon**, **hydrogen** and **oxygen**.

There are several types of carbohydrates;

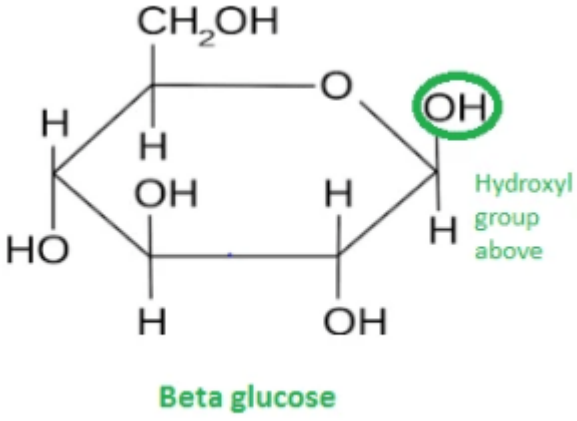
Sugars

Small, sweet, water soluble molecules. Can be **monosaccharides** (one) or **disaccharides** (two).
Monosaccharides are single units from which disaccharides are built.

Glucose occurs in 2 forms **alpha (α) glucose** and **beta (β) glucose**.

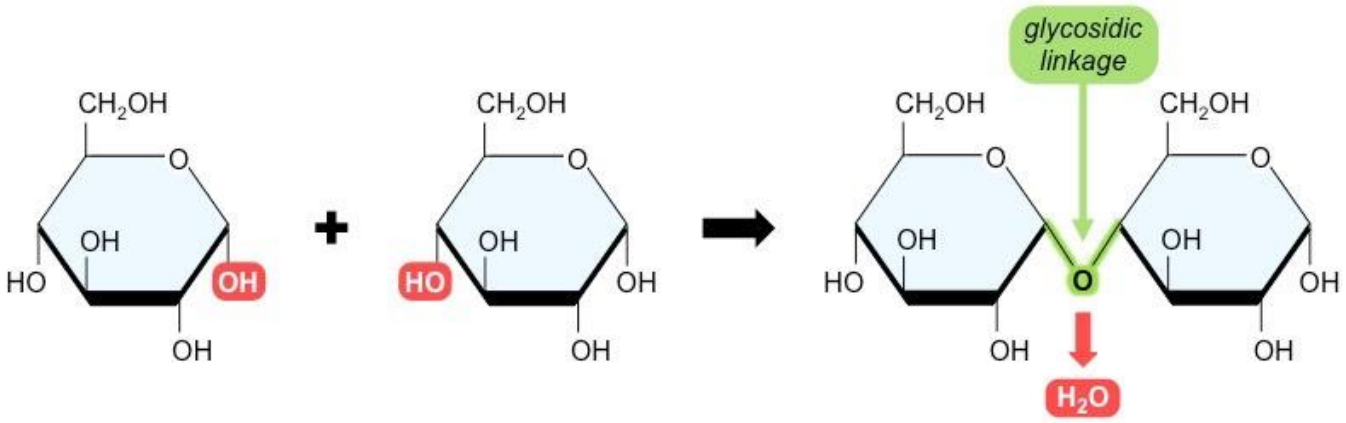


Alpha glucose



Beta glucose

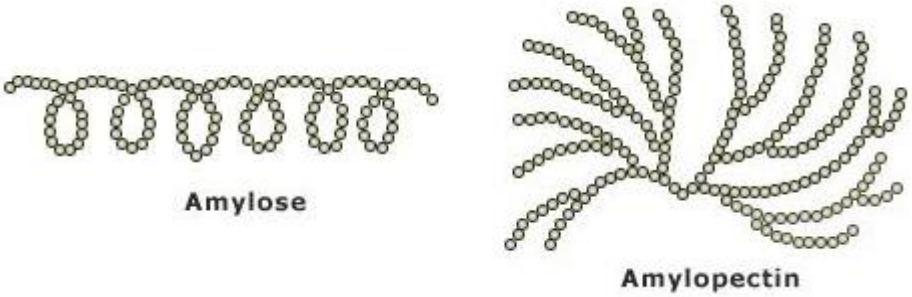
Glucose and Fructose are monosaccharides and join together to form the disaccharide sucrose.
The joining together of 2 monosaccharides occurs to release a molecule of **water** this is called a **condensation reaction**.



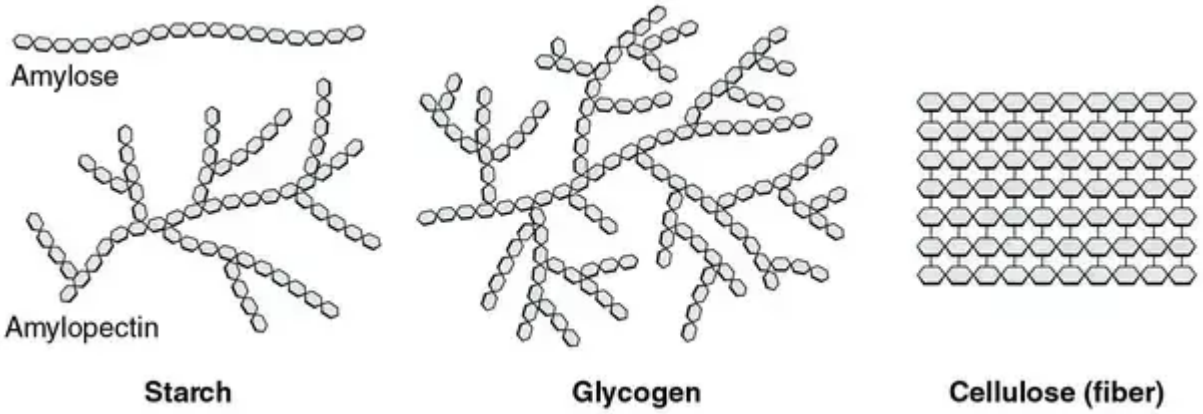
Monosaccharide Subunits **Disaccharide**

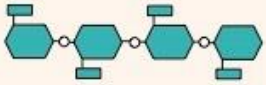
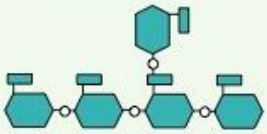
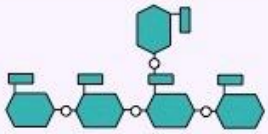
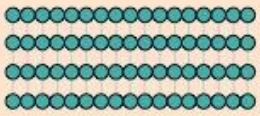
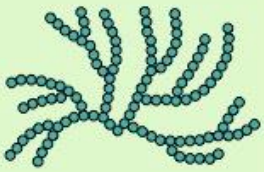
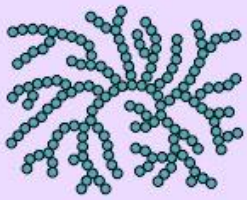
Disaccharides are made from the following monomers:
Glucose + Fructose → Sucrose + Water
Glucose + Galactose → Lactose + Water
Glucose + Glucose → Maltose + Water

Starch;
A **Polysaccharide** (a large molecule –polymer, made up of monomers). Two different polysaccharides of glucose are used to make **starch**- **amylose** and **amylopectin**. Starch is insoluble and compact, so it is a good **storage molecule** in plants. Starch is only found in plant cells.



Cellulose;
Polysaccharide; a polymer of glucose. Bonding is different in cellulose; molecules are bonded in a long straight line with weak **hydrogen bonds** between the strands. Several cellulose molecules form microfibrils to provide strength to plant cell walls.



	Cellulose	Starch		Glycogen
		Amylose	Amylopectin	
Source	Plant	Plant	Plant	Animal
Subunit	β-glucose	α-glucose	α-glucose	α-glucose
Bonds	1-4	1-4	1-4 *and* 1-6	1-4 *and* 1-6
Branches	No	No	Yes (~per 20 subunits)	Yes (~per 10 subunits)
Diagram				
Shape				

Questions:

1 Name two monosaccharides.

_____&_____

2 Which disaccharide is composed of two molecules of glucose?

_____

3 Name two polysaccharides.

_____&_____

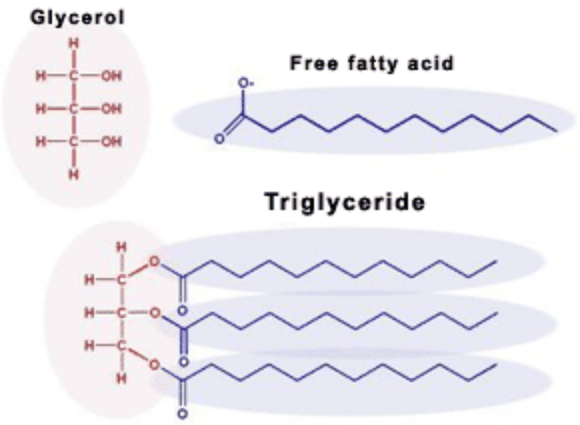
Lipids Prior Knowledge

QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. What are Lipids made up of? (1)			
2. What test is used to see if lipids are present? (1)			
3. Describe the method used to test for lipids? (3)			
4. What enzymes are used to break down lipids? (1)			
5. State 3 functions of lipids in the body (3)			
6. Name 2 foods high in lipids? (1)			
7. What disease is caused when large amounts of lipids are store (1)			
TOTAL			**/ 11**

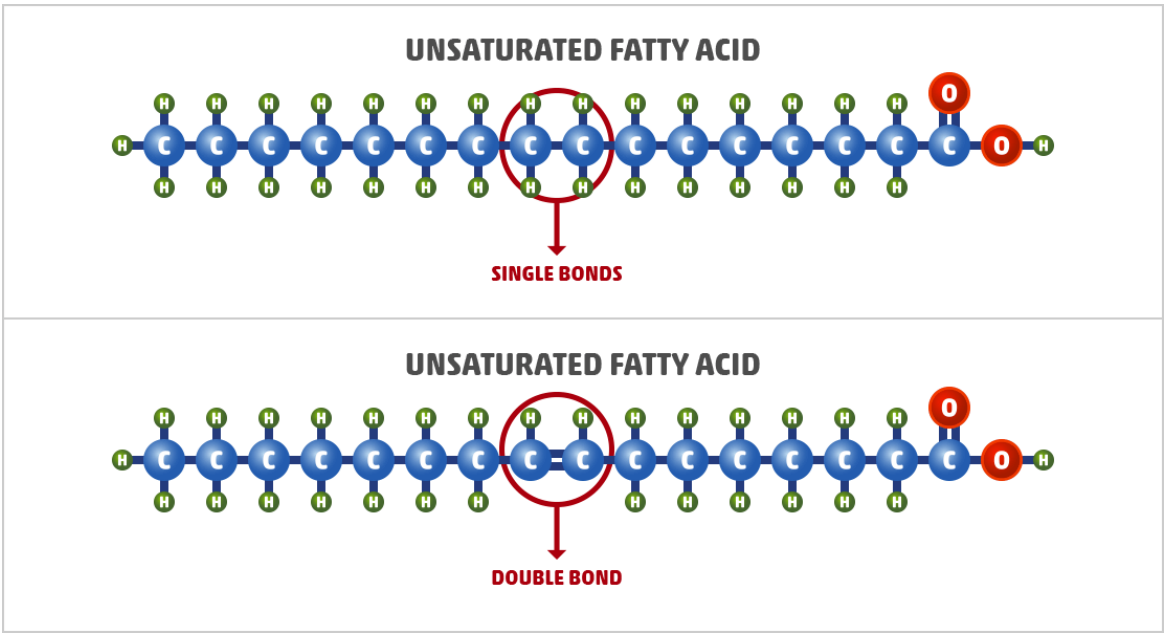
Lipids Building Knowledge

Lipids;
Three elements make up the lipid molecule – **carbon**, **hydrogen** and **oxygen**.

Lipids are fats and oils, predominantly made up of a group of lipids called **triglycerides**. These contain a molecule of **Glycerol** with **3 fatty acids**.

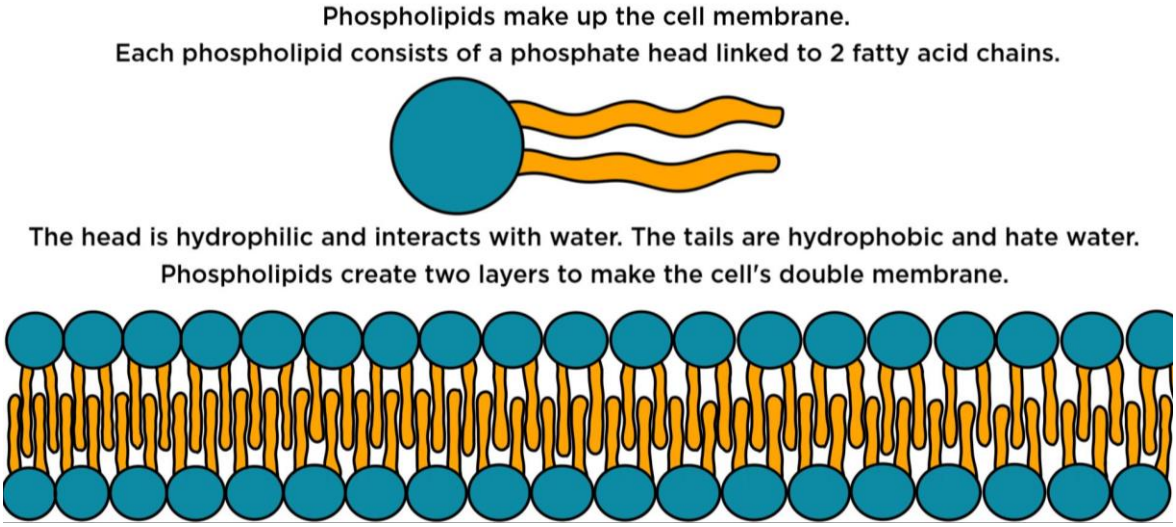


The **fatty acid** is a long chain of **Carbon** atoms with a carboxylic acid **(-COOH)** group on one end. **Hydrogen** atoms are attached to the Carbons by single bond. A single bond forms a **saturated** lipid. If there is a double bond then the lipid is **unsaturated**, many double bonds form a polyunsaturated lipid.



Phospholipids

Cell membranes are formed from two layers of **phospholipids**. They do not have 3 fatty acid chains but **2 fatty acid** chains and a **phosphate group**.



Questions:

1 Which elements are fatty acids composed of?

_____

2 What is the difference between saturated and unsaturated fatty acids?

_____

3 How are triglycerides different to phospholipids?

_____

_____

_____

Proteins and Enzymes Prior Knowledge

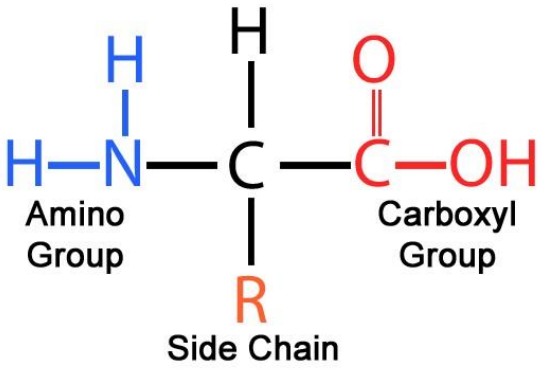
QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. What are proteins made up of? (1)			
2. What test is used to see if protein is present? (1)			
3. Describe the method used to test for proteins? (3)			
4. What are proteins needed for? (4)			
5. Define enzyme (2)			
6. What are enzymes made of? (1)			
7. Name 3 factors that affect the rate an enzyme works? (3)			
8. What happens to an enzyme is the temperature is too low? (1)			

9. What happens to an enzyme if the temperature is too high? (1)			
10. Define the answer to question 7 (1)			
11. State 3 processes in the human body enzymes where are needed (3)			
TOTAL			**/ 21**

Proteins and Enzymes Building Knowledge

Proteins

Proteins are made of long chains of **amino acids**, up to several hundred long. There are only 20 different amino acids and the combination of these 20 produce a wide range of complex proteins.



Protein structures are held together with strong bonds called **Peptide bonds**. The order of the amino acids determines the structure and how it works.

All amino acids have the same general structure however with a different **R group**. They contain; **Hydrogen**, **Oxygen**, **Nitrogen** and **Carbon**.

Proteins structure

PRIMARY STRUCTURE

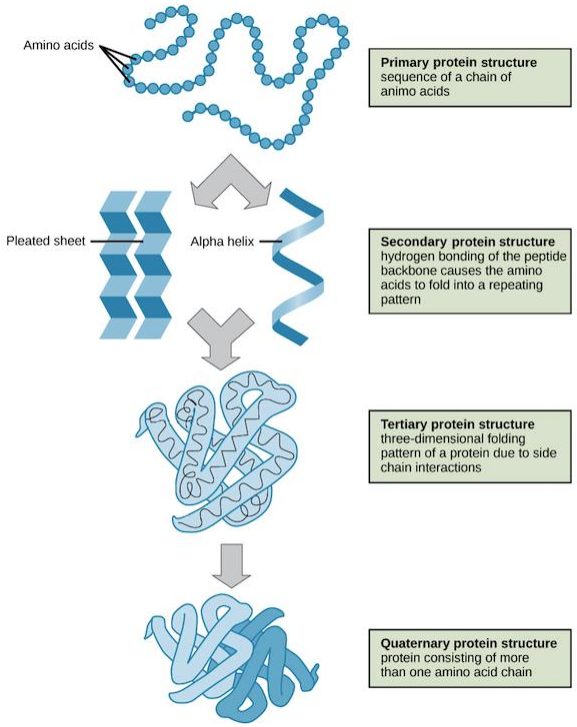
The order of the amino acids that are held together by **peptide bonds** into a **polypeptide** chain.

SECONDARY STRUCTURE

The polypeptide (protein) chain can then **coil** or **fold into pleats** which are held together by weak **hydrogen bonds**.

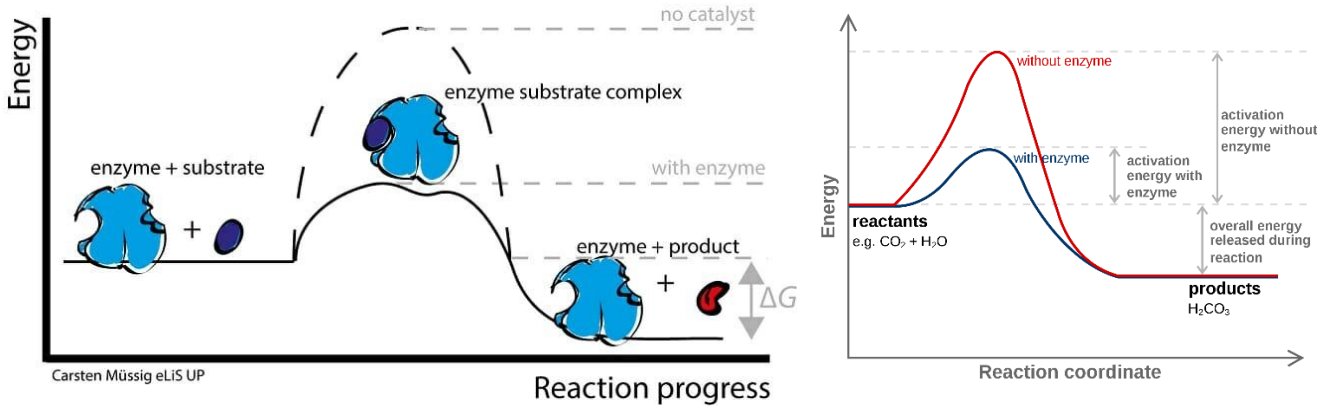
TERTIARY STRUCTURE

Enzymes have a further folding held together with hydrogen bonds as well as stronger **ionic bonds and disulphide bonds**. If the structure is almost spherical it is called a **globular protein**.

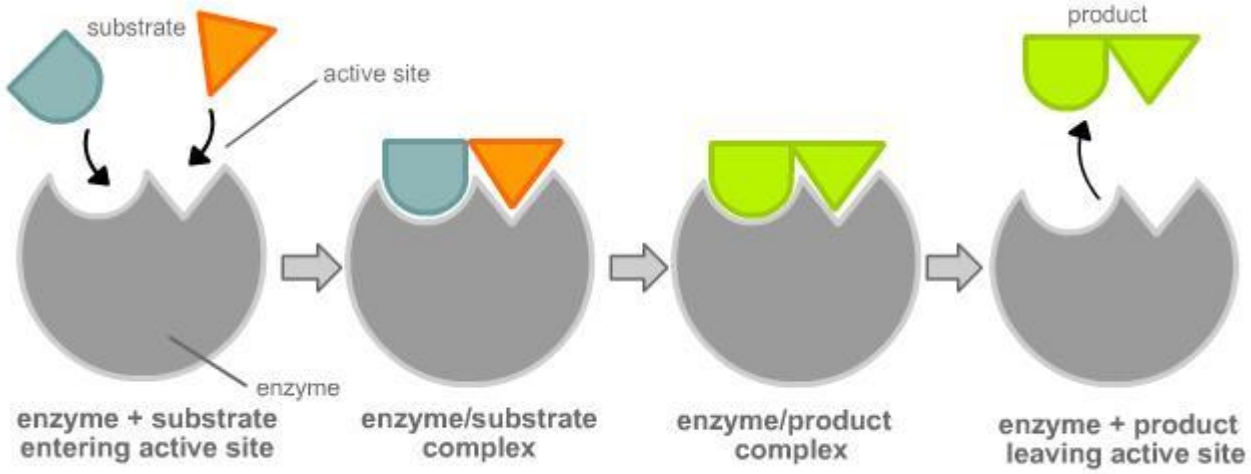


Enzymes

Speed up biochemical reactions.
Metabolism is the sum of all the biochemical reactions that occur per second and a single chain of these reactions is called a **metabolic pathway**.
Enzymes are **biological catalysts** and **increase** the **rate** of reactions. Reactions that release energy need an input energy to start. The input energy is called the **ACTIVATION ENERGY**. Enzymes lower the activation energy.



Enzymes are proteins; enzymes are **globular proteins** with a specific order of amino acids that determines what the enzyme does. Enzymes can be **catabolic** (break substrates down) or **anabolic** (build substrates up). Enzymes have a specific site called the **active site** into which the **substrates** can attach itself. The active site is **complementary** to the shape of the substrate. Once attached, they form the **enzyme-substrate complex**. The substrate then breaks bonds or makes bonds (depending on the type of enzyme) and the **product** leaves the active site. The active site is now able to accept another substrate. Enzymes are not used up in the reaction.



Denaturing enzymes; Enzymes have a specific tertiary shape held in place by weak hydrogen bonds and stronger disulphide bonds. These bonds can be broken by an increase in temperature (kinetic energy) or a change in pH (H+ in acid or OH- in alkali disrupt the bonds).

Useful enzymes; Digestive enzymes are catabolic, breaking down food into smaller molecules. Enzymes are also needed in DNA replication, building up molecules (DNA polymerase).

Questions:

1 What is the primary structure of a protein? Draw a labelled diagram of the monomer.

_____

Labelled Diagram:

2 What type of bonding is present in the secondary and tertiary structure of a protein?

Secondary Structure: _____

Tertiary Structure: _____

3 What is the role of enzymes?

_____

_____

_____

4 What is activation energy?

_____

_____

5 What is the role of digestive enzymes?

_____

_____

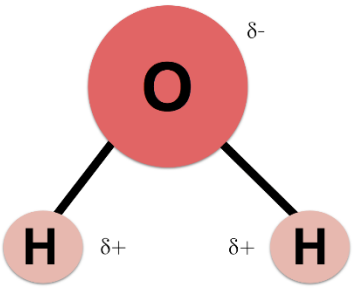
DNA, Energy and Water Prior Knowledge

QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. What does DNA stand for? (1)			
2. Describe the structure of DNA (2)			
3. Where is DNA found in a prokaryotic cell? (1)			
4. Where is DNA found in a eukaryotic cell? (1)			
5. What is the function of DNA? (1)			
6. What process is used to provide cells with energy? (1)			
7. Write the balanced symbol equation for aerobic respiration (2)			
8. Where does aerobic respiration take place? (1)			
9. Where does anaerobic respiration take place? (1)			
10. Name 4 way energy can be transferred in a cell (4)			
11. How many elements and atoms are present in a water molecule? (2)			
12. Draw the structure of water (2)			
13. State 3 ways your body losses water (3)			
TOTAL			**/ 22**

DNA, Energy and Water Building Knowledge

Water

Water is a **polar molecule** with partially positive charges on the Hydrogens and a partially negative charge on the Oxygen.
Water is an excellent **solvent** which means it can dissolve many polar and ionic substances.



Questions:

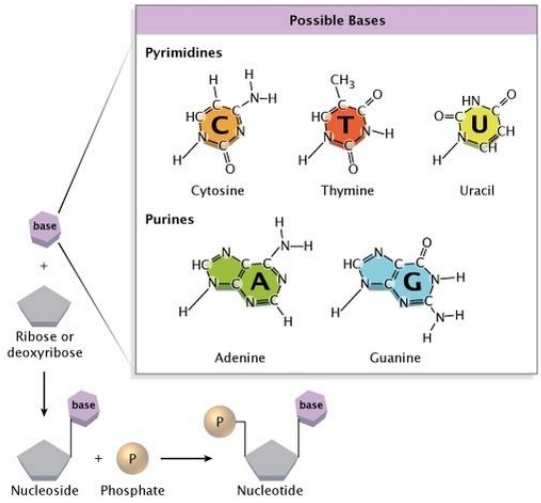
1 What charge do each of the elements on a water molecule have?

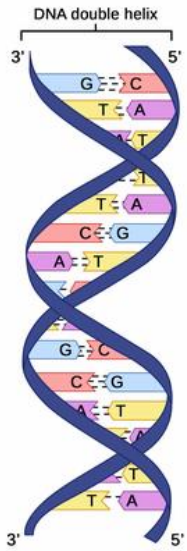
DNA and protein synthesis

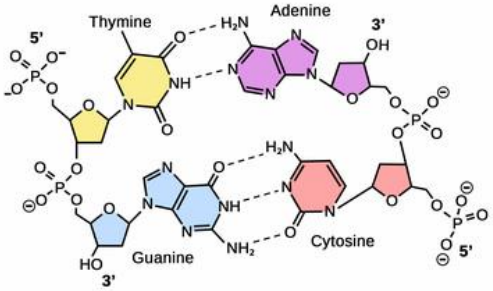
DNA is a complex chemical, found in the nucleus of eukaryotes and in the cytoplasm of prokaryotes. DNA is made up of; **pentose sugar, phosphate and nitrogenous bases** forming a **NUCLEOTIDE**.

There are 4 different nitrogenous bases;
A= Adenine
T= Thymine
C= Cytosine
G= Guanine

Complementary pair;
A pairs with T
C pairs with G



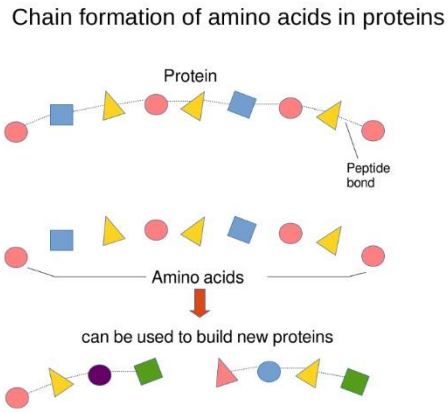




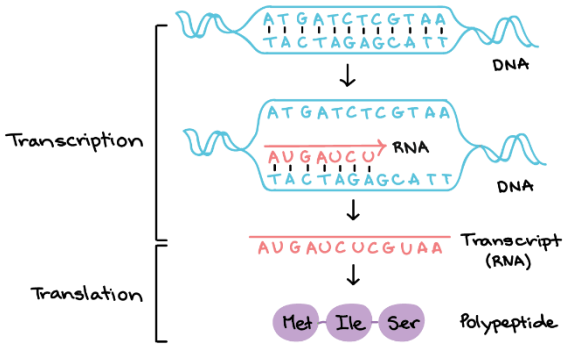
The bases pair up in the formation stated above. They are held together by **hydrogen bonds**. The two strands run in opposite directions causing the molecule to spiral forming a **DOUBLE HELIX**.

DNA controls the production of proteins. A section of DNA that codes for a protein is called a **gene**.

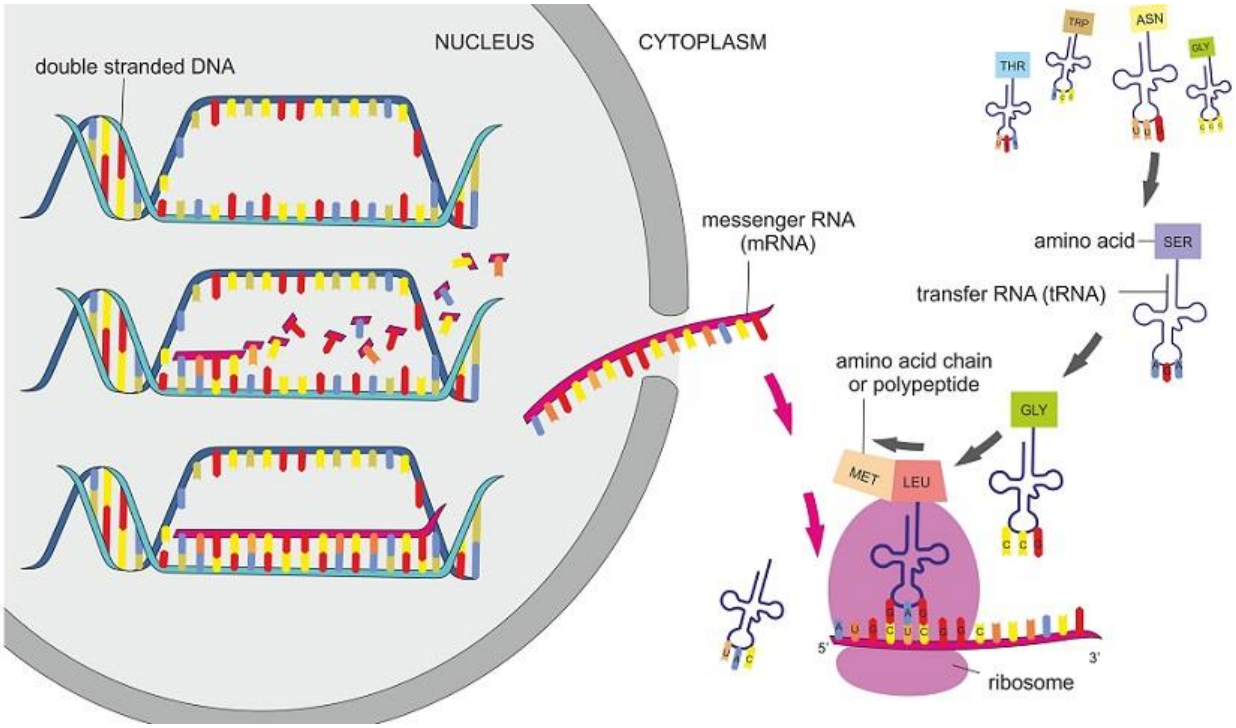
Proteins are made up of a string of **amino acids**, each protein has a different number and order of amino acids. The proteins also have different bonds which holds the molecule in a unique shape which means all proteins have a different function.



Protein synthesis:



Protein synthesis occurs in the cytoplasm, carried out by **RIBOSOMES.** When a protein is required then the gene has to be copied producing a molecule called **messengerRNA** (mRNA). mRNA is small enough to pass out of the nucleus into the cytoplasm. mRNA is a template, containing nucleotides and bases. The nucleotide on the mRNA will line up with the **complementary base**. However, on RNA there is no Thymine, RNA will have the base **URACIL** (**U**).

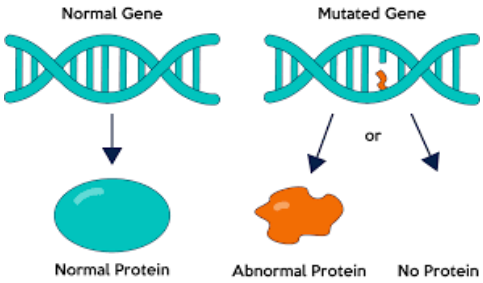


The mRNA passes out of the nucleus carrying the code for a protein. Once in the cytoplasm the mRNA binds to a ribosome.
Within the cytoplasm there is another molecule called transferRNA (tRNA). At one end, the **anticodon** is complementary to the mRNA.
At the opposite end there are three **unpaired bases** which code for an **amino acid**. The amino acid is brought in to form a **peptide bond** with the amino acids brought in by the previous tRNA. This forms a **polypeptide** chain which will form hydrogen and **ionic** and disulphide **bonds** to form the unique protein.

Mutations:
Mutations change the order of bases in the DNA. Some bases may change to a different base (**substitution**), some bases may be deleted and some bases may be added.

Mutations can cause the following:

- Incorrect protein to be produces
- No change in protein being made
- Causes a harmful proteins/ no protein to be made



Questions:

1 What are the components of a nucleotide?

_____

2 What are the four nitrogenous bases?

_____

3 What is the name given to the double-stranded structure of DNA?

_____

4 What is the name of a section of DNA that codes for a protein?

_____

5 What are proteins made from?

_____

6 What molecule contains the information from the DNA and is able to leave the nucleus?

_____

7 What organelle will this molecule attach to in the cytoplasm?

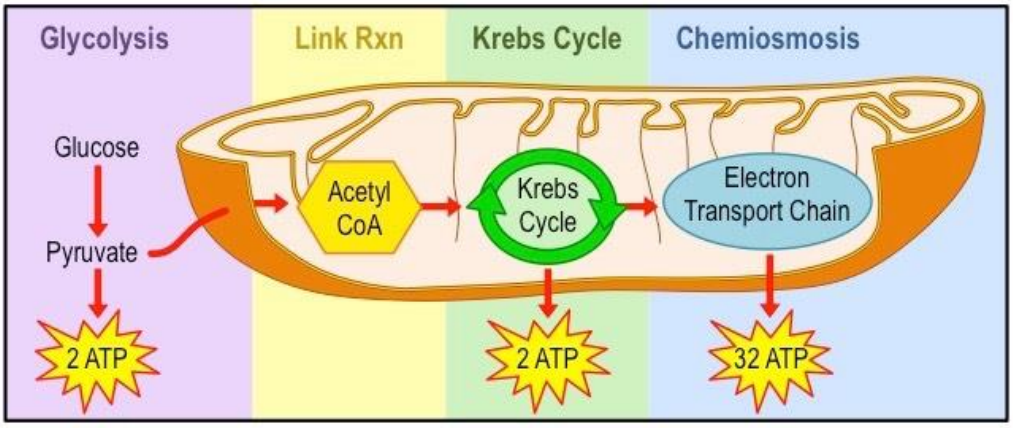
_____

8 Which molecule has a complementary anticodon and brings in the correct amino acid?

_____

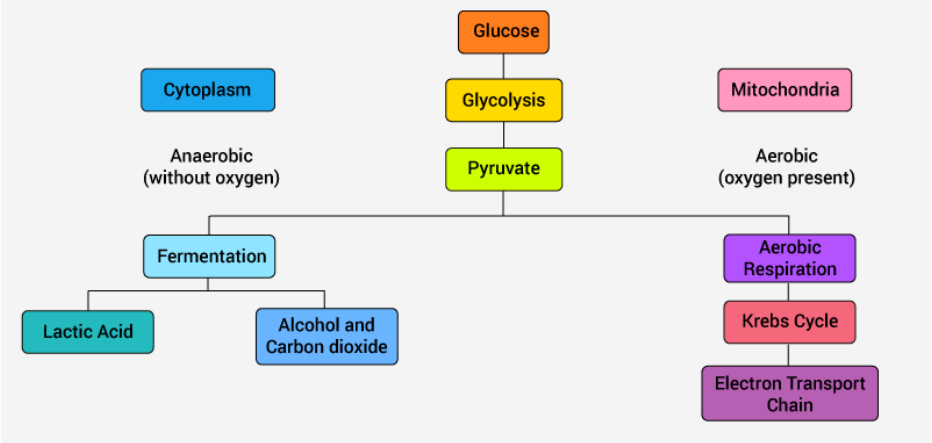
Respiration

Aerobic respiration: This occurs in the mitochondria of cells. It requires a number of small stages to break down **glucose** ($C_6H_{12}O_6$) to release a large amount of energy; **adenosine triphosphate** (ATP).
The first stage is a stage called **GLYCOLYSIS**, this occurs in the cytoplasm and converts glucose into two 3 carbon molecules called **PYRUVATE**.
Pyruvate is formed in both aerobic and anaerobic respiration, however in aerobic respiration the pyruvate passes into the matrix of the Mitochondria.
Pyruvate then goes into the **link reaction** to form **acetyl CoA** which then passes into to the **Krebs cycle** with the reduced products passing into the **electron transport chain** in the process of **oxidative phosphorylation** to form **ATP** and the waste products **carbon dioxide** and **water**.



Anaerobic respiration:
This form of respiration occurs **without oxygen**. Glucose is converted into **pyruvate**, through the process of **GLYCOLYSIS**, in the **cytoplasm** and is unable to pass into the mitochondria.
The process of glycolysis releases small amounts of energy and over a short period of time it can keep the muscles working.

Anaerobic respiration in **plants** and **yeast** forms **carbon dioxide** and **alcohol**. Anaerobic respiration in animals forms **lactic acid**. The build-up of lactic acid in muscles must be broken down as the formation of the acid alters the pH and affects enzymes in the cells, slowing down reactions. As the lactate ions build up in the muscles this causes pain called **fatigue**. The oxygen required to convert the lactate ions back to pyruvate is called the **oxygen debt**.



Questions:

1 What us the name of the stage of respiration that is common to both aerobic and anaerobic respiration?

_____

2 What are the products of the first stage of respiration?

_____

3 Name the remaining stages of aerobic respiration?

_____

4 Name the molecule that is produced and will supply energy to other parts of the body?

_____

5 Define the term anaerobic respiration.

_____

6 Write a word equation for:

a. anaerobic respiration in plants and yeast

_____

b. anaerobic respiration in mammals

_____

7. What is the oxygen debt?

_____

CELLS GCSE PRIOR KNOWLEDGE

2) Cells

a) Animal Cell Structure and Function
b) Plant Cell Structure and Function
c) Diffusion, Osmosis and Active Transport
d) Immunology

Animal Cell Structure and Function Prior Knowledge

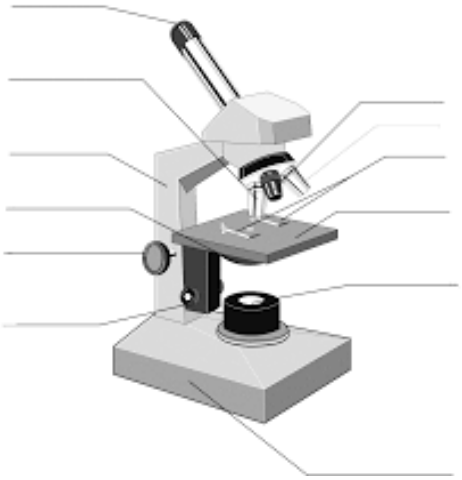
QUESTION	ANSWER	MARK (V OR X)	CORRECTION (IF NEEDED)
1. What are the 5 most common structures in an animal cell? (5)			
2. Describe the function of each of those 5 structures? (5)			
3. List 3 specialised animal cells (3)			
4. How many mm in a cm? (1)			
5. How many µm in a mm? (1)			
6. What equation links magnification, size of real object and size of image? (1)			
7. State 2 differences between electron microscope and a light microscope? (2)			
TOTAL			**/ 18**

Animal Cell Structure and Function Building Knowledge

Microscopes;

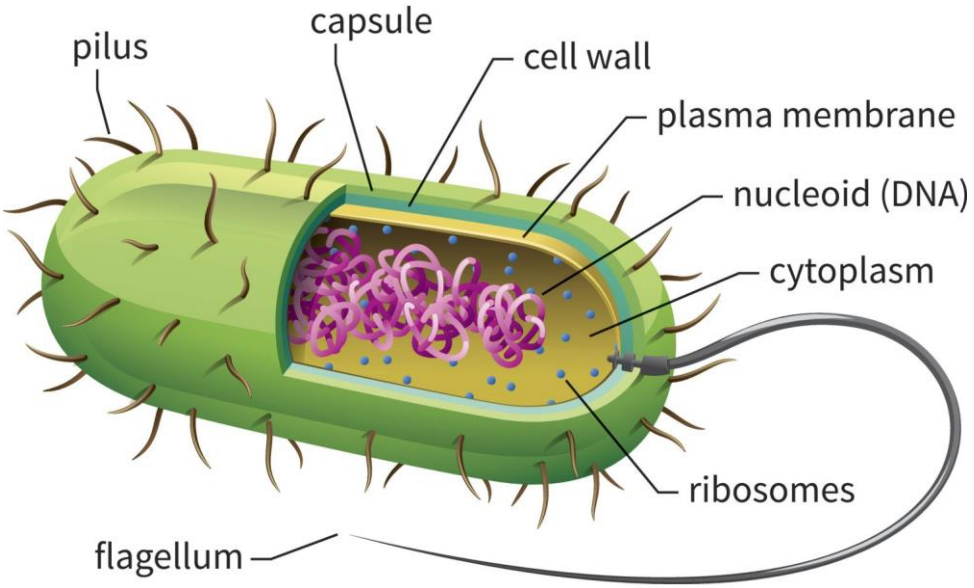
The Light microscope allows you to view animal cells. It can magnify up to 1500 times. Some organelles such as mitochondria, chloroplasts, vacuoles, cell walls, cell membranes and nuclei are visible. Staining makes these organelles visible.

Label and annotate the diagram:



The electron microscope; invented in 1950s it allows a much higher magnification (500 000x) and better resolution, allowing greater detail to be seen. Electron microscopes allowed detailed ultrastructure of the cell to be seen, such as ribosomes and the inside of mitochondria and chloroplasts.

Prokaryotes; A bacterial cell is a prokaryotic cell. It is a single celled organism.



Prokaryotes like bacteria are roughly a **tenth the size** of eukaryotic cells.

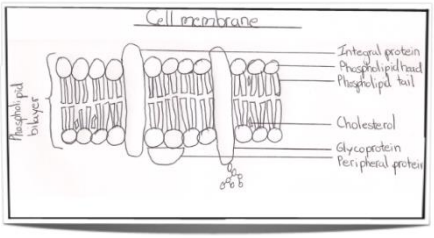
Prokaryotic cells **don't** contain a nucleus, mitochondria or chloroplasts.

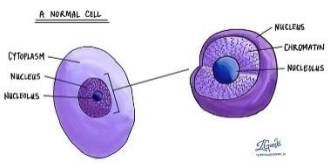
Some prokaryotes have a **rings of DNA** called **plasmids**.

Eukaryote Animal Cell

Cell structures

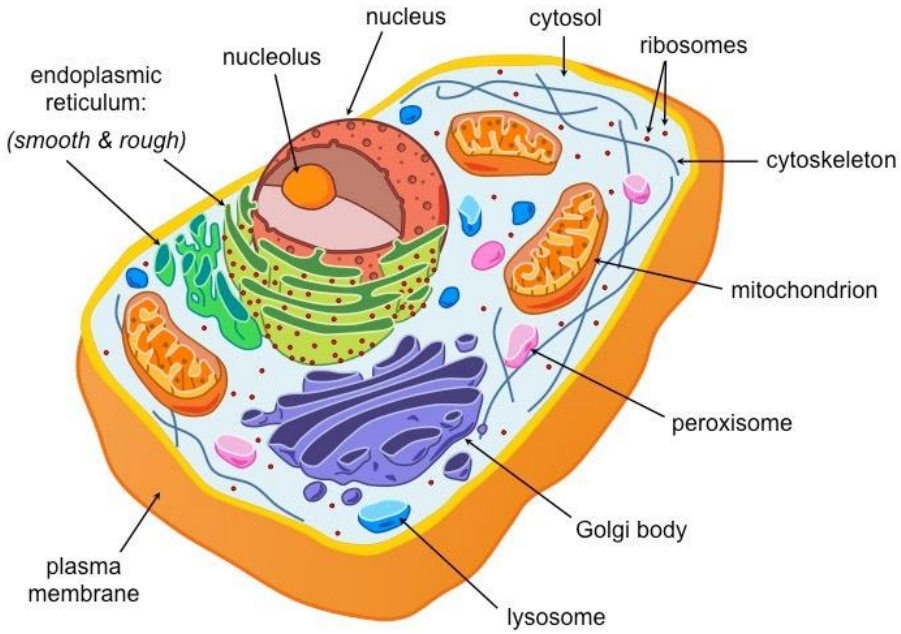
Cell surface membrane: Found around every cell, it allows the movement of substances into and out of the cell. It is a partially permeable membrane and will prevent certain substances from entering. It is made up of a double layer called the PHOSPHOLIPID BILAYER. These are molecules closely packed together in a mosaic pattern. Within the bilayer are large proteins which are also responsible for transport and for cell recognition.





Nuclei: controls the cell function, containing the DNA which is the coded information for the production of proteins. During cell division the chromosomes become shorter and thicker and can be seen with a light microscope. The chromosomes will then make a copy of themselves, one copy for each cell produced during cytokinesis. Nuclei have a double membrane called the nuclear envelope.

Mitochondria: can be seen with a light microscope, however, greater internal detail can be seen using an electron microscope. The mitochondria's function is to carry out aerobic respiration. The energy released is used to form molecules of ATP. ATP is used in the cells to provide energy for muscular contractions, active transport as well as anabolic and catabolic reactions.



Challenge:

Can you find out about the structure and function of the other organelles labelled on the diagram?

Plant Cell Structure and Function Prior Knowledge

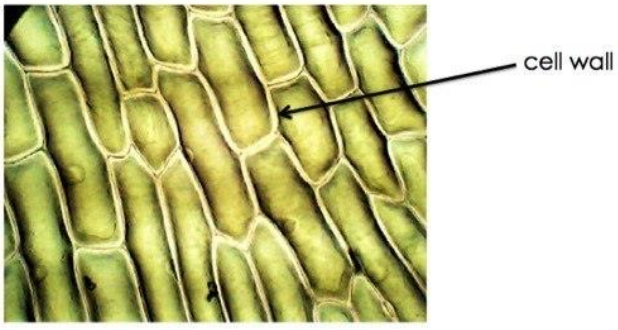
QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. State the 3 structures found in plant cells but not animal cells? (3)			
2. State the function of these 3 structures (3)			
3. What are cell walls made of? (1)			
4. What is the permanent vacuole filled with? (1)			
5. State 3 specialised plant cells (3)			
6. Name 4 tissues found in a leaf (4)			
7. Explain the roles of the 4 tissues found in a leaf (4)			
TOTAL			**/ 19**

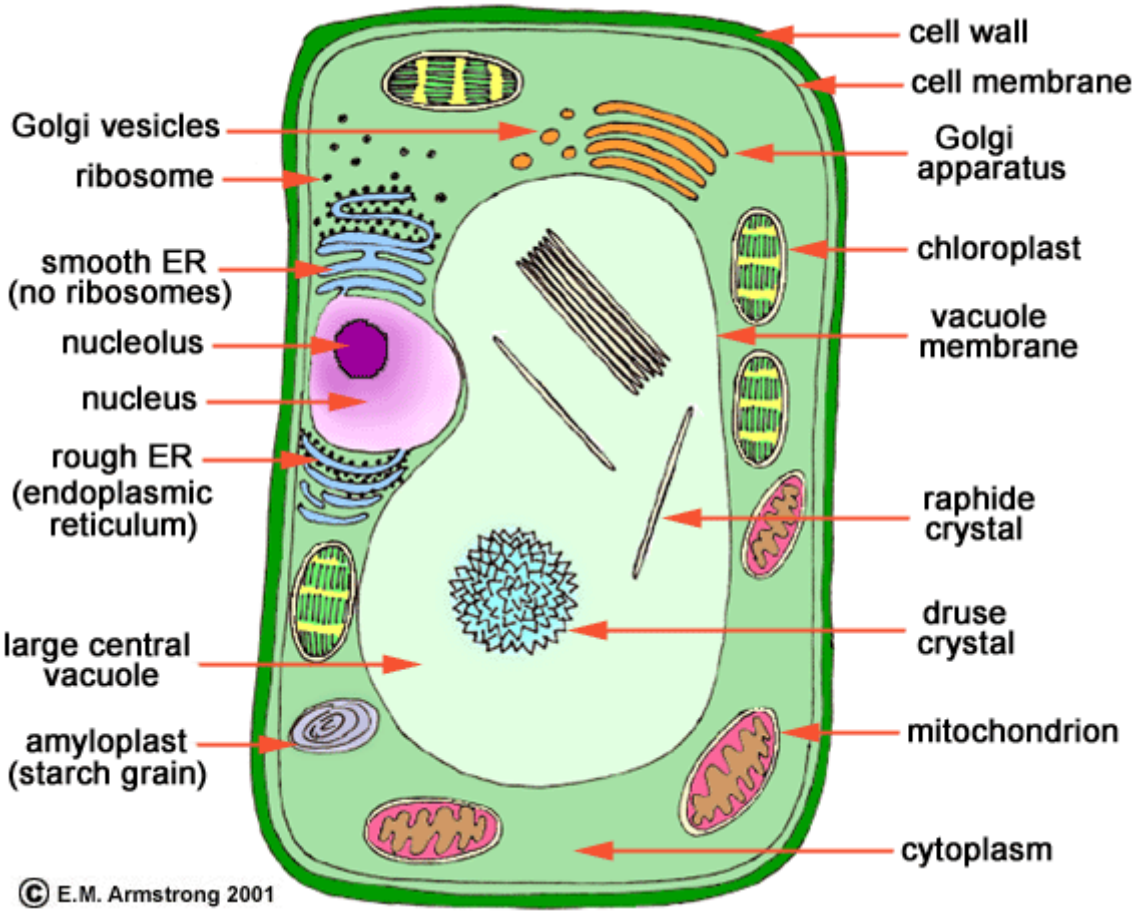
Plant Cell Structure and Function Building Knowledge

Eukaryote Plant Cell

Cell structures;

Cell wall: the plant cell wall is made up of cellulose Molecules laid side by side to form microfibrils. These provides rigidity and support for the cell.





Challenge:

Can you find out about the structure and function of the other organelles labelled on the diagram?

Questions:

1 Name three things visible with a light microscope in both animal and plant cells.

_____

2 Name four organelles that both plant and animal cells have.

_____

3 What is the equation used to calculate the magnification of an object?

_____

4 What is the function of a mitochondrion?

_____

Diffusion, Osmosis and Active Transport Prior Knowledge

QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. Define diffusion (1)			
2. Define osmosis (1)			
3. Define active transport (1)			
4. What is the main difference between diffusion and osmosis? (1)			
5. What are the 2 main differences between active transport and the other 2? (2)			
6. State and describe where in a plant Active Transport occurs (2)			
7. State and describe where in an animal Diffusion will occur? (2)			
8. State and describe where in an animal osmosis will occur? (2)			
9. State and explain 3 factor that can change the rate of diffusion (6)			
10. Put these 500 ml surcrose concentrations in order of water concentration from highest to lowest. 20%, 0%, 45%, 10% and 15%(1)			
TOTAL			**/ 19**

Diffusion, Osmosis and Active Transport Building Knowledge

Transport into and out of cells

There are 4 modes of transport you need to be aware of:

Diffusion; can be gas or liquid particles. They move from an area of high concentration to an area of low concentration down a concentration gradient. Small molecules such as oxygen, water and carbon dioxide can pass through the phospholipid bilayer. **NO ENERGY IS REQUIRED**.

Osmosis; occurs only with water. The water particles move from an area of high water concentration to an area of low water concentration, down a concentration gradient, across a partially permeable membrane. **NO ENERGY IS REQUIRED**. You will be required to refer to water potential in AS level not water concentration.

Facilitated diffusion; Some particles are too large to fit through the phospholipid bilayer and therefore require a carrier protein to assist. The protein carriers are within the bilayer, and they change shape when they come into contact with a specific molecule (i.e. Glucose). **NO ENERGY IS REQUIRED**.

Active transport; This moves substances for an area of low concentration to an area of high concentration against a concentration gradient. **ENERGY IS NEEDED** for this to occur. Specific carrier proteins are also required these can be called pumps.

Questions:

1 What do you call the diffusion of water molecules through the cell membrane?

_____

2 Give another term for the concentration of water molecules.

_____

3 Name the two types of protein involved in facilitated diffusion.

_____

4 Why does active transport require energy?

_____

Immunology Prior Knowledge

QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. What cell is responsible for immune response? (1)			
2. Define a pathogen (1)			
3. What is an antigen? (2)			
4. What is an antibody? (1)			
5. What is a monoclonal antibody? (1)			
6. State and explain the 3 ways this cell response to pathogens (6)			
7. How do vaccines work? (3)			
8. State the 3 main stages of drug testing? (3)			
9. What is a placebo and why is it used? (2)			

10. What hormone is detected in positive pregnancy tests? (1)			
TOTAL			**/ 21**

Disease and Immunology Building Knowledge

Disease

Pathogens are microorganism that can cause diseases. **Infectious diseases** can be passed on from person to person, for example TB, malaria, HIV.
Some diseases can be caused by **genetic defects** known as **mutations** in a person's genes, example includes cystic fibrosis.
Lifestyle choices can also **increase the risk** of getting certain diseases, for example smoking

Risk factor	Diseases
Smoking	Mouth, lung and throat cancer, emphysema and other lung diseases, cardiovascular disease
Drinking too much alcohol	Mouth, stomach, liver and breast cancer, possibly many other cancers, cardiovascular disease
High blood pressure	Cardiovascular disease, diabetes
Overweight/obese	Various cancers, cardiovascular disease, diabetes
Unbalanced diet	Various cancers, cardiovascular disease, diabetes
Using sun beds too much	Skin cancer

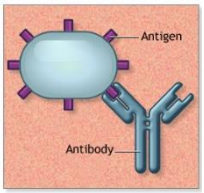
increases the chances of obtaining lung cancer.

Risk factors are things that **increase the chances** of something negative taking place, although they don't always lead to a disease. Some risk factors are unavoidable because they are inherited, however some are associated with lifestyle choices and hence avoidable.

Immunity

Phagocytes are a type of white blood cells that **engulf** pathogens carrying foreign antigens and destroying them.

Antigens are molecules on the surface of a pathogen that marks it as foreign to the body. All cells including human cells contain antigens on their surfaces.



There are different types of white blood cells.
B-cells also known as **B-lymphocytes** are white blood cells that **produce antibodies** that bind to antigens. An antibody binding to the antigen brings about the death of the pathogen carrying it.

T-cells or **T-lymphocytes** are white blood cells that communicate between phagocytes and B-cells. When a phagocyte engulfs a pathogen, it signals to the T-cells that a foreign object has been found. The T-cell then **activates** the B-cells to produce antibodies.

Vaccinations

If your **vaccinated** against a pathogen, you have **immunity** against it. This means that you can no longer get that disease. Vaccines **contain antigens** from inactivated or dead pathogens.
You body then produces **antibodies** against the antigens so If the same pathogen tries to enter or invade, the immune system can **respond rapidly** preventing you from getting the **symptoms**.
Vaccines don't stop the pathogen from entering the body, however they **get rid of it** very quickly once it does enter.

Questions:

1 Give an example of an infectious disease.

_____

2 What is a risk factor?

_____

3 List two diseases that obesity is a risk factor for.

_____

4 What do phagocytes detect?

_____

5 What kind of white blood cells produce antibodies?

_____

6 What is the role of T-cells?

_____

7 What do vaccines contain?

_____

ORGANISMS EXCHANGE GCSE PRIOR KNOWLEDGE

3) Organisms Exchange Surface

a) Diffusion and Gas Exchange Surfaces
b) Circulatory System
c) Transport in a plant

Diffusion and Gas Exchange Surfaces Prior Knowledge

QUESTION	ANSWER	MARK (V OR X)	CORRECTION (IF NEEDED)
1. Define diffusion (1)			
2. State 4 ways how the rate of diffusion is increased in the alveoli (4)			
3. Explain how the 3 ways stated in question 2 speed up the rate of diffusion. (3)			
4. Explain how capillaries are efficient for diffusion (2)			
5. What is facilitated diffusion? (1)			
6. Give 2 example in animals where diffusion is needed (2)			
7. Give 2 examples in plants where diffusion is needed (2)			

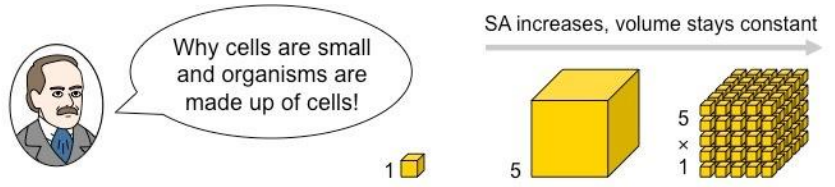
8. State 3 ways the small intestine is sufficient for diffusion (3)			
9. Explain the 3 ways the small intestine is sufficient for diffusion (3)			
TOTAL			**/ 21**

Diffusion and Gas Exchange Surfaces Building Knowledge

Exchange surfaces

All good exchange surfaces require adaptations to make the exchange efficient.

The **smaller the object,** the quicker exchange is able to occur due to it having a **large surface area to volume ratio**, however larger, more complex organisms have a much smaller surface area to volume ratio.
The larger the object, the lower the surface area to volume ratio.



Total surface area (height × width × sides × number of boxes)	**6**	**150**	**750**
Total volume (height × width × length × number of boxes)	**1**	**125**	**125**
SA:Vol ratio (surface area ÷ volume)	**6**	**1.2**	**6**

To overcome this, multicellular organisms have highly adapted exchange organs.
Adaptations include:

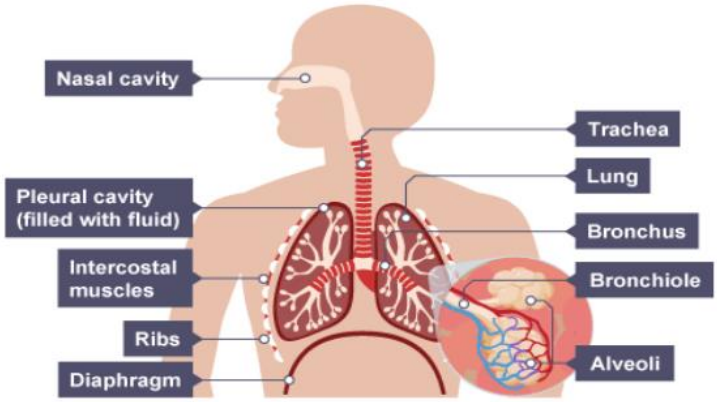
- Folded to increase the surface area to volume ratio for a faster exchange.
- A good blood supply to maintain the concentration gradient.
- One cell thick (thin) to reduce diffusion distance.

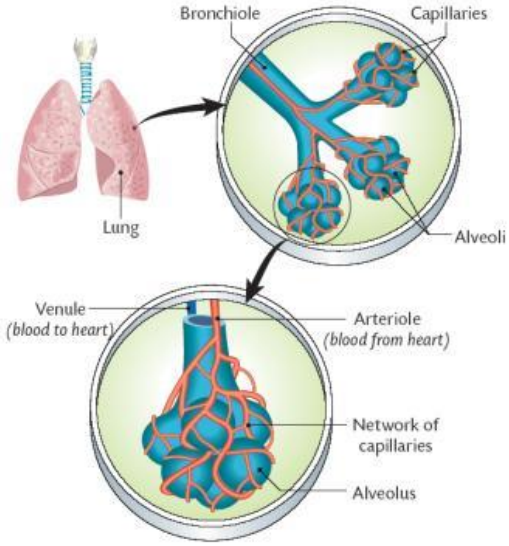
Materials that need to be exchanged between the cell and the environment include heat, oxygen, water, carbon dioxide, nutrients, and other waste products such as urea. The **adaptations allow MORE** substances to be exchanged at a **faster** rate.

Gas exchange in Animals

Lungs;

Multicellular organisms have evolved a **complex blood supply system** and a large gas exchange system (**lungs**). The lungs contain millions of tiny air sacs called **ALVEOLI** which are then folded to further increase the surface area of the lung.

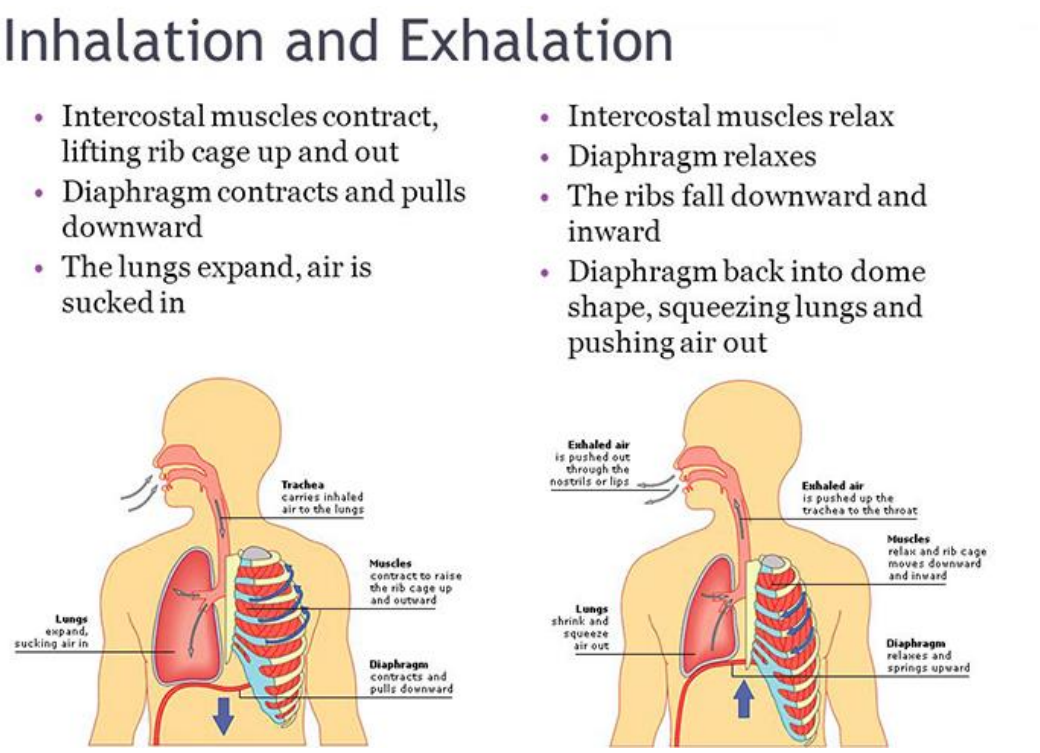




The alveoli are further adapted by having a **single flattened layer** of **epithelial squamous cells** which **shortens the diffusion distance** increasing the speed of diffusion.
Alveoli have a dense **network of capillaries** to move the blood away quickly, maintaining a **steep diffusion gradient**.
The walls of the alveoli are **fully permeable** to dissolved oxygen and carbon dioxide.

Breathing - Ventilation

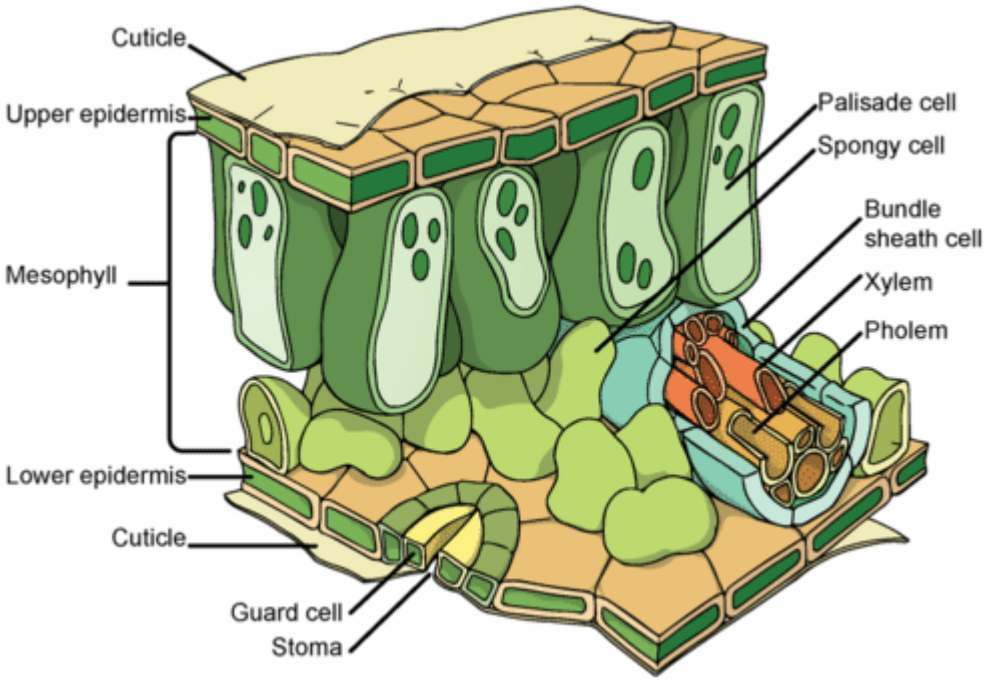
The process of maintaining a high concentration of oxygen inside the lungs and getting rid of the waste product carbon dioxide. Ventilation increases the rate of diffusion. Lungs are suspended in the airtight Thorax and any change in volume will affect the pressure in the thorax.



Gas exchange in Plants

Plants also have adaptations to allow gas exchange. The leaf is an organ that is adapted to allow the movement of water from the leaf and the diffusion of carbon dioxide into the leaf.

The **upper mesophyll layer** contains **Palisade cells** which are packed with chloroplasts to absorb as much energy from the sun as possible for photosynthesis.



The lower part of the **spongy mesophyll layer** which contains air spaces to facilitate the diffusion of gases into the cells and out of the cells.

The **upper epidermis** is covered by a waxy cuticle to prevent water loss. The **lower epidermis** has a specialised pair of cells called the **GUARD CELLS**. The guard cells have an uneven thickening in the cell wall which causes the cell to bend and open up a hole in the lower epidermis called the **STOMA**. The stoma allows the water vapour to move out of the leaf into the environment (**transpiration**) and carbon dioxide to move into the leaf.

Questions:

1 An animal has a surface area of 7.5cm2 and a volume of 1cm3. What is the SA:V ratio?.

_____

2 Which has a bigger SA:V ratio, a small organism or a large organism?

_____

3 Why have large mammals developed complex blood systems and lungs?

_____

4 What type of cells are the alveoli walls made of?

_____

5 Does the volume of the thorax increase or decrease when you breathe out?

_____

6 Which two sets of muscles contract when we breathe in?

_____

7 Describe the movement of gases in a plant.

_____

_____

_____

Circulatory System Prior Knowledge

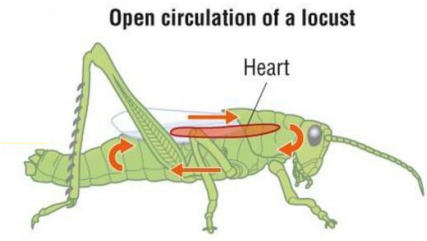
QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. Describe the function of the circulatory system? (2)			
2. State the 4 chambers of the heart (4)			
3. Name the vessel carrying oxygenated blood to the heart (1)			
4. Name the vessel carrying deoxygenated blood away from the heart (1)			
5. Name the vessel carrying oxygenated blood away from the heart (1)			

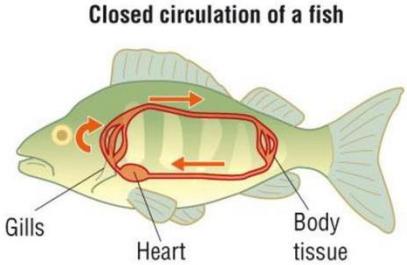
6. Name the vessel carrying deoxygenated blood to the heart (1)			
7. Describe 2 differences in structure between arteries and veins (2)			
8. What is the name given to the structures that separate the top chambers from the bottom chambers (1)			
9. Name the order of chambers the blood flows through the heart (4)			
10. Name the order of vessels the blood flows through the heart (4)			
11. What is the difference between oxygenated and deoxygenated blood (1)			
12. What is the pigment inside red blood cells that carries oxygen? (1)			
TOTAL			**/ 23**

Circulatory System Building Knowledge

The circulatory system and blood vessels

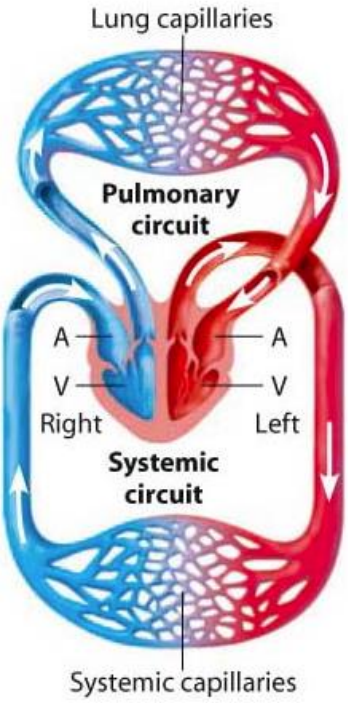
Large multicellular organisms have a small surface area to volume ratio and have evolved a complex circulatory system to transport chemicals around the body, this is called the **CIRCULATORY SYSTEM**.
Some organisms such as flat worms can diffuse oxygen and glucose across their surface.
Less active organisms such as **insects** may have a much more simplified circulatory system.





Fish have a more complex system were by the blood enters the heart once before being transported to the **systemic system** this is called a single circulatory system.

Mammals have evolved a **double circulatory system** with a **pulmonary** and a **systemic** circuit.

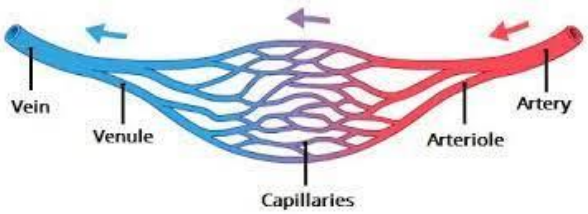


The **heart** pumps the **deoxygenated** blood to the lungs (pulmonary system) to pick up oxygen and removes carbon dioxide. The **oxygenated** blood is then returned to the heart to be pumped out to the organs (systemic system).

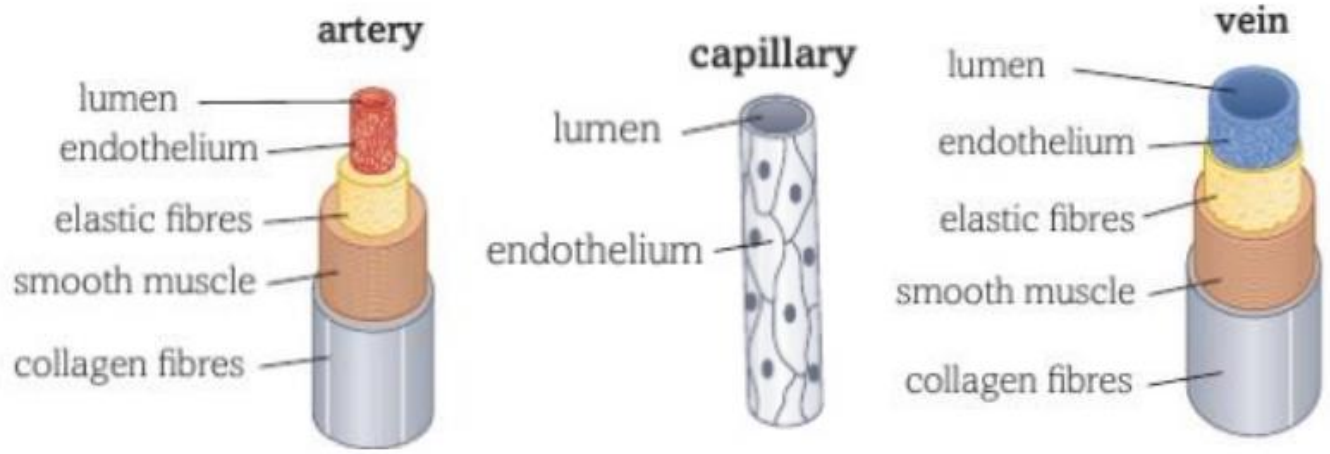
The blood travels through 3 main types of blood vessels:

1) **The Arteries;** carry blood away from the heart. They have a thick layer of elastic tissue and smooth muscle. The elastic walls stretch when the heart contracts and the elastic tissue recoils to maintain the pressure.

2) **Capillaries;** These consist of a single layer of endothelial cells. The arteries subdivide into arterioles which further divide into thousands of capillaries. The capillaries come into close contact with body cells providing a huge surface area to volume ratio and a short diffusion distance for the exchange of oxygen, glucose, carbon dioxide, urea and other substances.

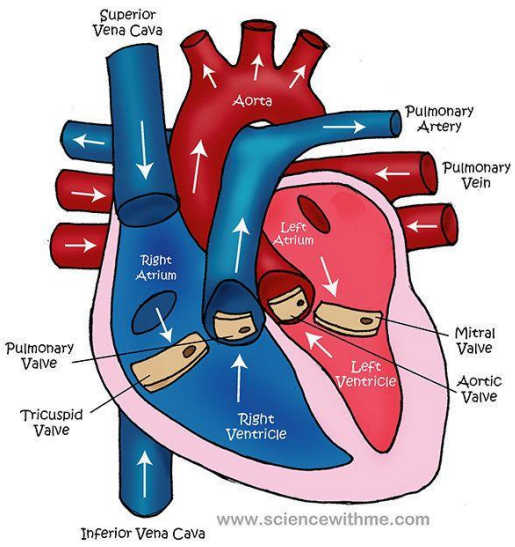


3) **Veins;** The capillaries start to come back together forming venules and then veins. Veins carry blood back towards the heart. Blood is at a lower pressure and therefore do not need such a thick layer of elastic tissue or smooth muscle. The veins contain valves to prevent the blood flowing backwards.



The heart

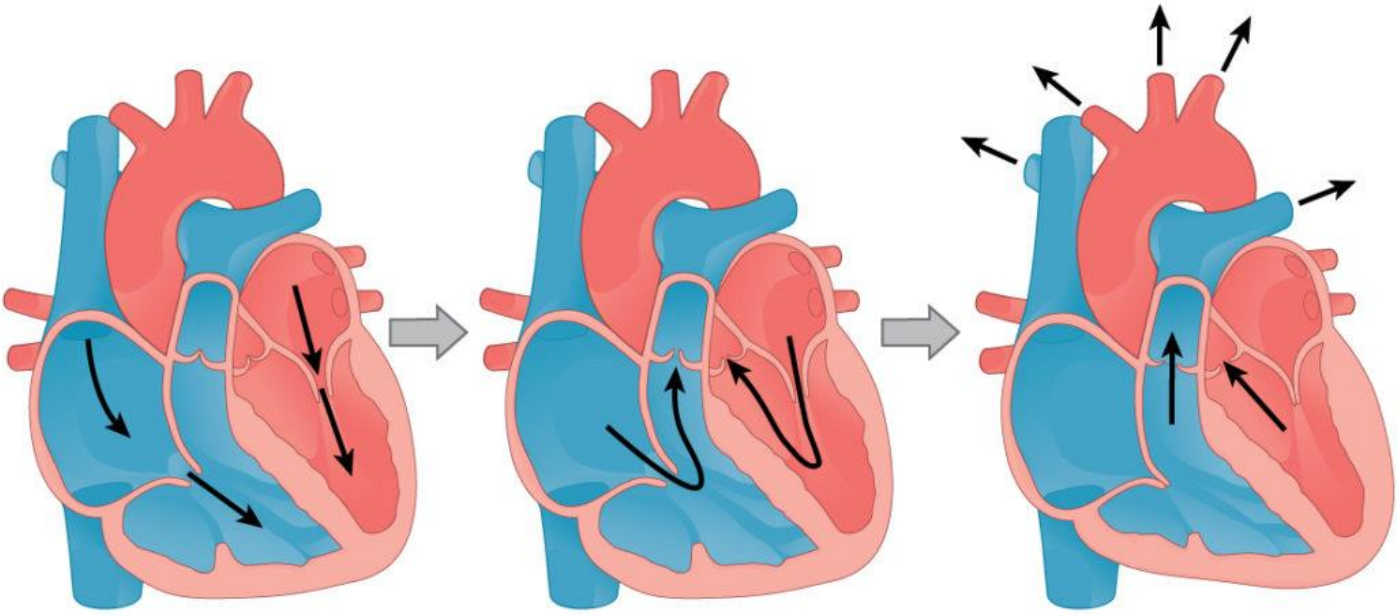
The heart has two separate pumps. The right side of the heart pumps blood to the lungs and the left side pumps blood to the body.
Blood flows from a region of **higher pressure** to a region of **lower pressure**.
Valves within the heart keep the blood flowing in the correct direction by preventing backflow. Valves open and close in response to the changes of pressure inside the chambers and do not require energy.



The heart is made up of 4 chambers; the **right atria**, the **right ventricle**, the **left atria** and the **left ventricle**. The left side of the heart has a thicker muscular wall to create enough pressure to force the blood around the whole body. The hearts contractions are initiated by a cluster of specialised cells called the **SINO-ATRIAL NODE** or the **PACEMAKER**. These cells send out electrical impulses at regular intervals. The coronary arteries are very thin and supply the muscle in the heart with blood.

The cardiac cycle

This is the sequence of events that occur in a single heartbeat.



(a) Cardiac diastole: all chambers are relaxed, and blood flows into the heart.

(b) Atrial systole, ventricular diastole: atria contract, pushing blood into the ventricles.

(c) Atrial diastole, ventricular systole: after the atria relax, the ventricles contract, pushing blood out of the heart.

Questions:

1 Name the four chambers around the heart.

_____

2 Name the three main types of blood vessels.

_____

3 In which type of blood vessel are substances exchanged between the blood and the cells?

_____

4 Where does the right-hand side of the lungs pump blood to?

_____

5 What is the function of the valves in the heart?

_____

6 Where does the blood go after leaving the atria?

_____

7 What is the function of the sino-atrial node?

_____

8 Why does the heart muscle require a blood supply?

_____

9 Name the blood vessels that supply blood to the heart muscles.

_____

10 Describe the stages of the cardiac cycle.

_____

_____

_____

Transport in a plant Prior Knowledge

QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. State the two main transport systems in plants (2)			
2. What system transports water? (1)			
3. What system transports sugar? (1)			
4. State a feature of the cells that make the system that transports sugar (1)			
5. What is transpiration? (1)			
6. What apparatus is used to measure transpiration? (1)			
7. What 3 factors can change the rate of transpiration? (3)			
8. Where does gas exchange take place? (1)			
9. What causes water to move up through the xylem? (1)			
10. What controls the opening and closing of the stomata (1)			
TOTAL			**/ 13**

Transport in a plant Prior Knowledge

Xylem

Water enters the roots of a plant from the soil by **osmosis**. It then travels through the xylem and to the leaves.

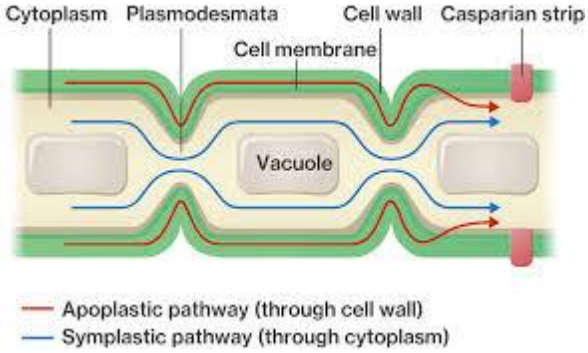
Transpiration

The movement of water from the root and out of the leaf is called the transpiration stream.

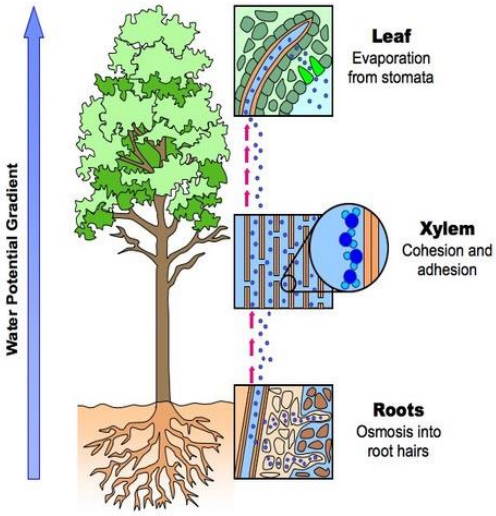
Water passes into the root by osmosis and then moves through the root by 3 different processes:

- **The symplast pathway**; water moves from root cell to root cell through the cytoplasm.

- **The apoplast pathway**; water moves through the cell wall, not passing over the cell membrane, carrying minerals with it through a process called **MASS FLOW**.



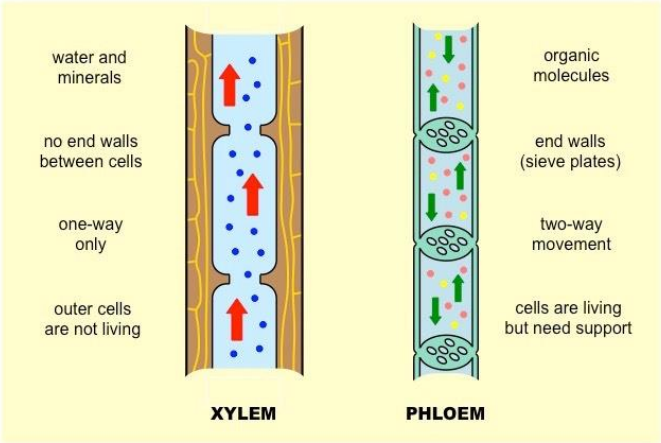
- **The vacuolar pathway**; water moves from root cell to root cell via the cytoplasm and the vacuole. Water moves out of the leaf by diffusion into the environment.



The water moves from root to leaf through a specialised tube called the **xylem**. Water is pulled up the xylem due to an attraction force between the water particles causing a tension in the xylem (**cohesion tension**) and the attraction between the water particles and the sides of the xylem vessel (**adhesion**).

Phloem

The second vessel in the plant is the phloem and this is responsible for **translocation**, the mass flow of substances from the leaf to the rest of the plant.
Sugars and other organic compounds are transported through the phloem tissue which is also arranged in tubes for easy transport. Phloem tissue contains **sieve tubes and companion cells** are found next to the sieve tubes and **actively transport** sugar into the sieve tubes and then water follows by **osmosis**.



Questions:

1 Which part of a cell does water move through in the symplast system?

_____

2 What substances are transported in the phloem tube?

_____

3 What does translocation involve?

_____

4 Why is the column of water in the xylem under tension?

_____

_____

GENETICS GCSE PRIOR KNOWLEDGE

4) Genetics

a) Genetics and Cell Division Key Definitions
b) Mutations and Evolution
c) Classification

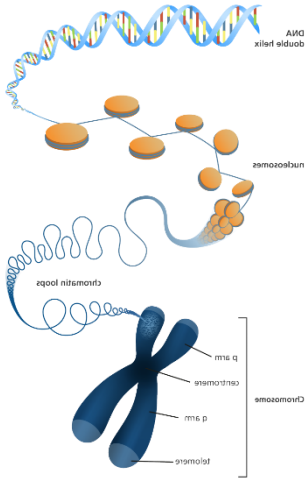
Genetics Key Definitions and Cell Division Prior Knowledge

QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. Define Mutation (1)			
2. Define Allele (1)			
3. Define Chromosome (1)			
4. Define Gene (1)			
5. Define Mitosis (1)			
6. Define Meiosis (1)			
7. Define Biodiversity (1)			
8. Define Adaptations (1)			

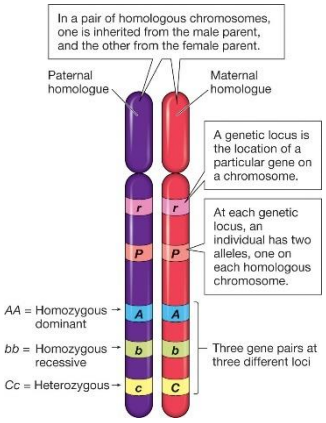
9. Define Interdependence (1)			
10. Define Genotype (1)			
11. Define Phenotype (1)			
12. Define Species (1)			
TOTAL			**/ 12**

Genetics Key Definitions and Cell Division Building Knowledge

Genetics and cell division



The **DNA** molecule contains thousands of **gene**s along its length. The DNA molecule is wound up into a **chromosome**. Each body cell in a human contains 23 pairs of chromosomes (**diploid** number), one from the mother and one from the father. These pair up to form a **homologous pair**, both the same size and containing the same **genes** (these genes can be different **alleles**).



A chromosome is often seen as an X shaped molecule. The X shape is just one chromosome attached to an exact copy of itself (2 **CHROMATIDS**). They are joined together by an attachment called a **centromere**. In preparation for cell division the chromosome will make a copy of itself. All damaged tissue and cells are replaced by a process of cell division called **MITOSIS**. Mitosis is also seen in **asexual reproduction**; the offspring are genetically identical to the parent.

Mitosis cell division;

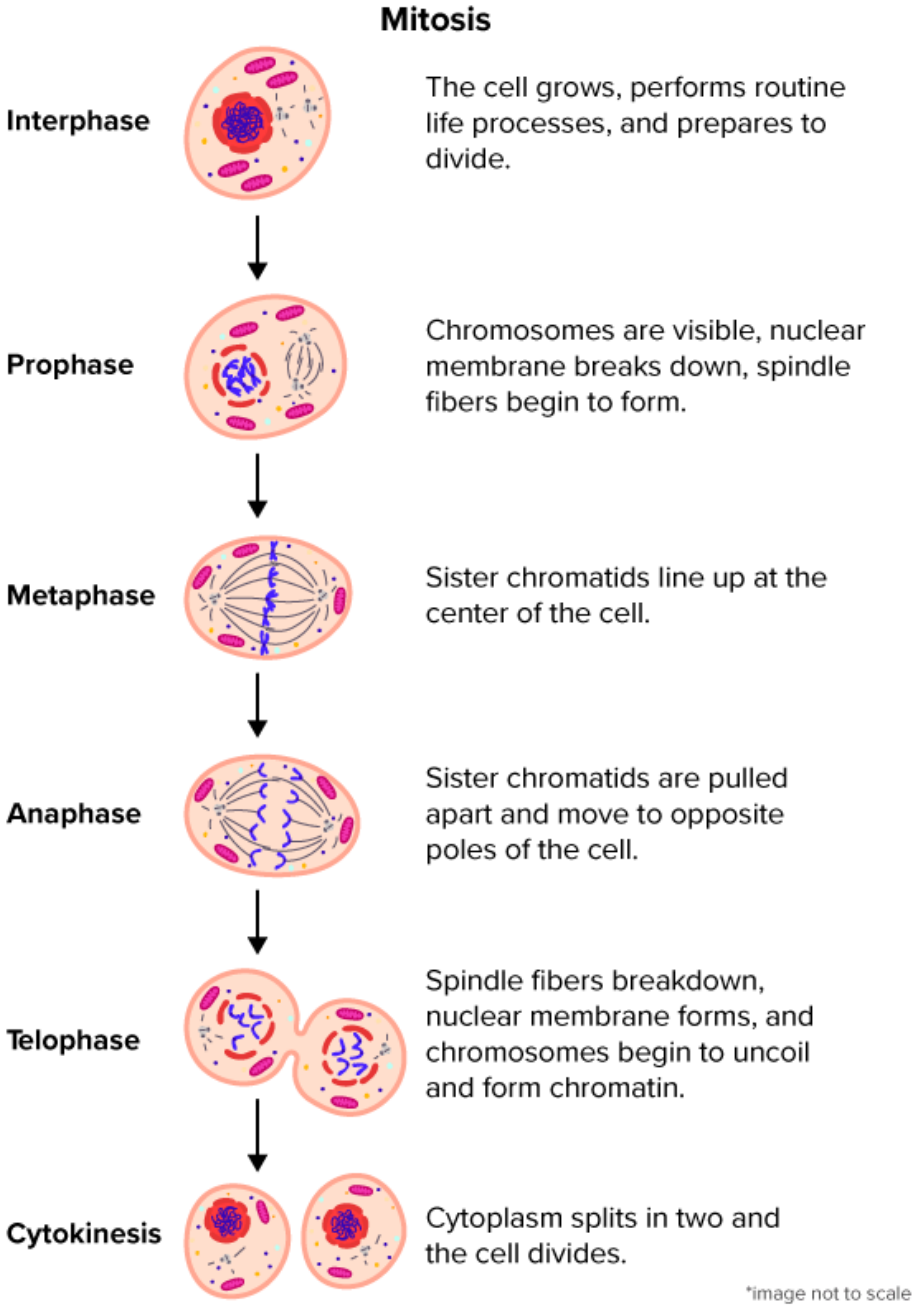
Interphase; DNA molecules are indistinct in the nucleus. They replicate their DNA, attaching at the centromeres.

Prophase; The DNA becomes **supercoiled** and **compact** and can now be seen under a light microscope. It has the X shape.

Metaphase; the nuclear membrane breaks down, the chromosomes line up along the **equator** of the cell and **spindle fibres**, produced by the **centrioles**, attach to the chromosomes.

Anaphase; The **spindle fibres** pull the **centromere** apart and the **chromatids** separate and are dragged to the poles of the cell.

Telophase; A **nuclear envelope** forms around each set of **chromatids** and the **cytoplasm divides** forming 2 genetically identical cells.



Meiosis;

This cell division is responsible for the production of sex cells and introduces genetic variation.
It results in the formation of gametes containing half the original genetic information (**haploid** number). This ensures, that during fertilisation, the embryo obtains two complete sets of genetic information.

In meiosis the cell undergoes 2 cellular divisions.

1) **Prophase I**
The chromosomes condense and the nuclear envelope breaks down. Homologous chromosomes pair up and can cross over DNA (Recombination).

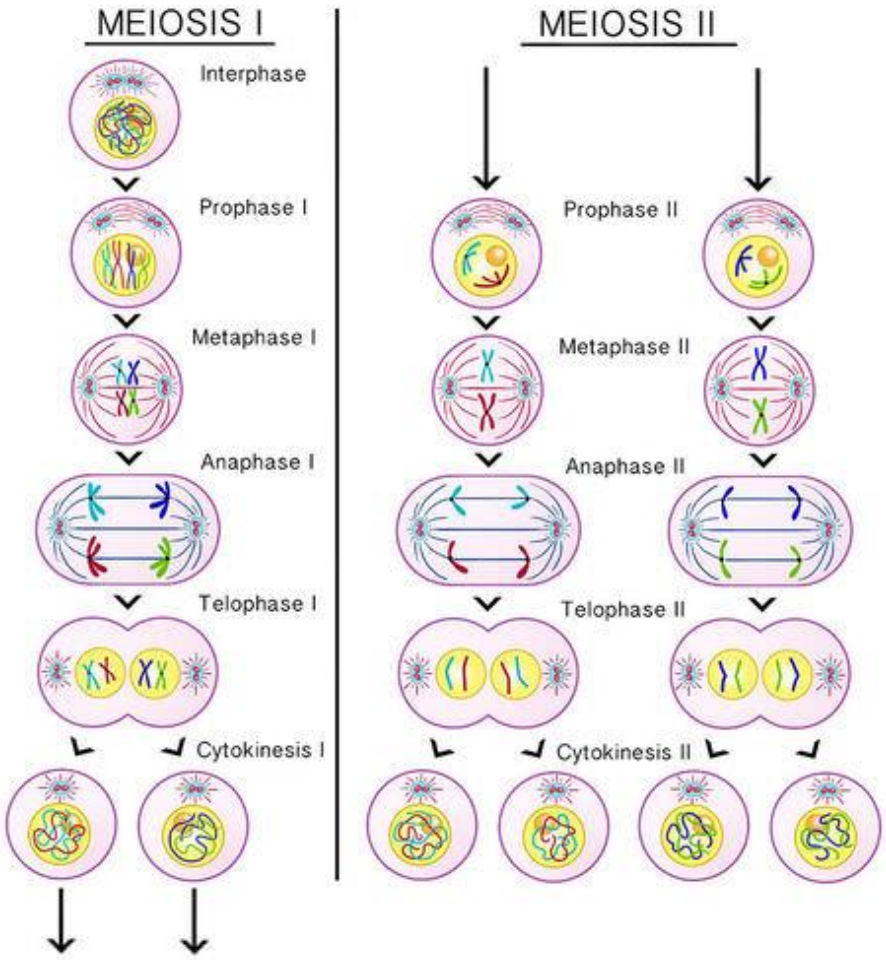
2) **Metaphase I**
The homologous pairs arrange themselves randomly along the equator.

3) **Anaphase I**
Spindle fibres attach to the centromere and pull the chromosomes to opposites poles.

4) **Telophase I**
Two nuclear envelopes surround the divided genetic information. Each contains half the number of chromosomes.

5) **Prophase 2**
New nucleus breaks down and chromosomes coil and condense.

6) **Metaphase 2**
Spindle fibres attach to the centromeres.



7) **Anaphase 2**
The spindle fibres start to drag the chromatids to opposite sides of the cell.

8) **Telophase 2**
The nuclei's start to reform and the cytoplasm spits to form 4 haploid cells that are genetically different to the parent cells.

Questions:

1 Which cell division forms haploid cells?

_____

2 What happens during prophase?

_____

3 What do centrioles do?

_____

4 Which organs produce haploid cells?

_____

5 What happens in telophase?

_____

Variation and Evolution Prior Knowledge

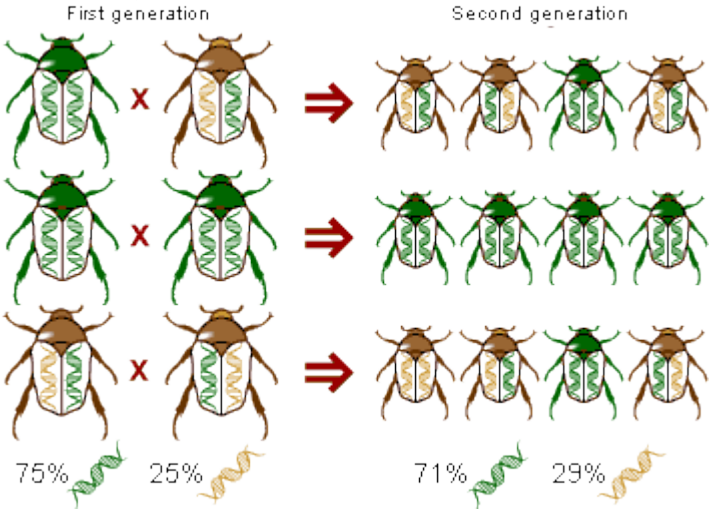
QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. What proof is there for evolution (1)			
2. How does your answer in question provide proof? (1)			
3. How does sexual reproduction give rise to variation? (1)			
4. State 2 ways there is genetic variation within a population? (2)			
5. How does selective breeding reduce genetic diversity? (1)			
6. Who is Charles Darwin? (1)			

7. Explain Natural Selection (2)			
TOTAL			**/ 9**

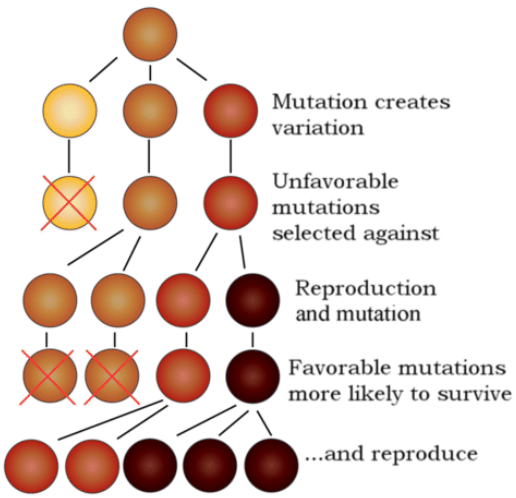
Variation and Evolution Building Knowledge

All organisms are different from each other both within species and between species. Organisms of the same species show some variation for example height, weight, favourite colour etc.
Organisms of the same species are very similar because they all have the same genes but they vary because they have alternative versions of those genes, which are called alleles.

Variation means that some organisms are better adapted.
Adaptations are characteristics that help organisms to survive and reproduce. Polar bears have thick, white fur that enables them to stay warm and camouflage in the snow.
Characteristics vary within populations, so some organisms are better adapted for some environments or conditions than others. The slightly different adaptations you get within species are coded for by **different alleles**.



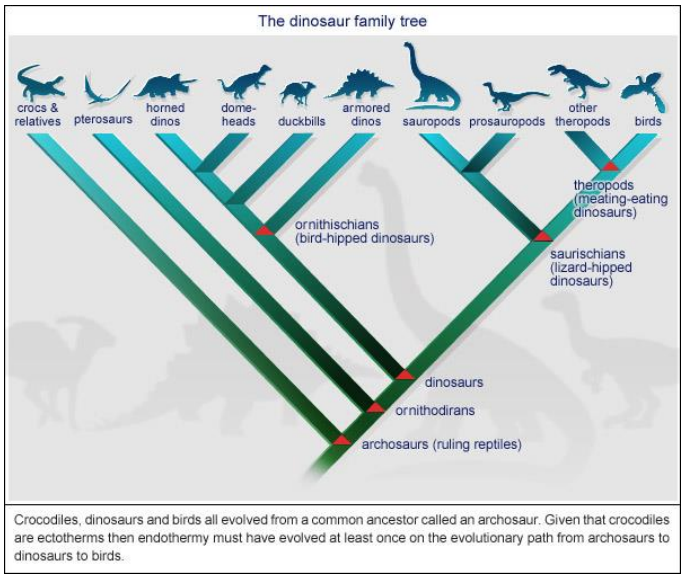
Mice Colour Variation Example



Evolution

The **gradual change** in the characteristics of a population from one generation to the next. The theory of evolution suggests that all organisms evolved from a **common ancestor** over millions of years.

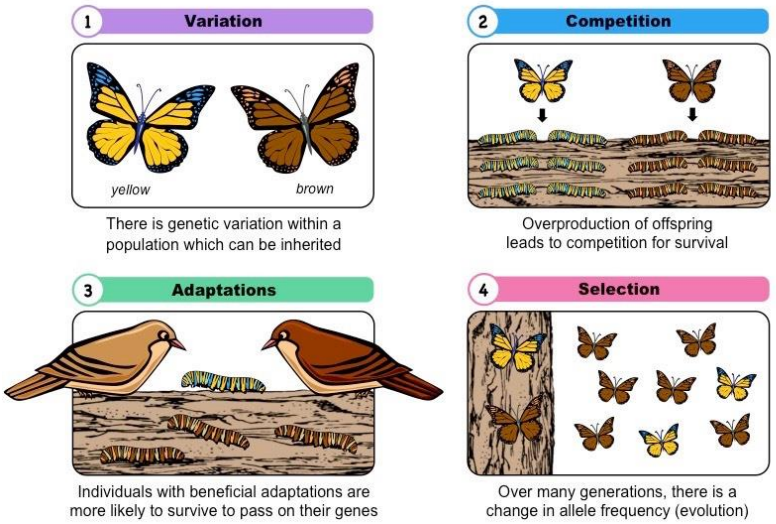
Natural selection is one of the mechanisms by which evolution occurs.

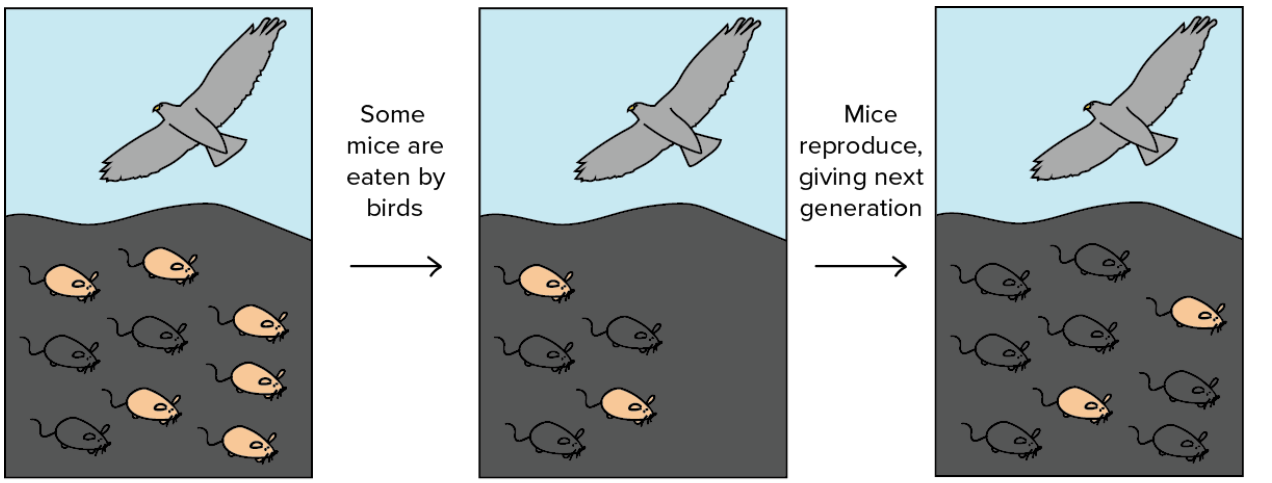


Crocodiles, dinosaurs and birds all evolved from a common ancestor called an archosaur. Given that crocodiles are ectotherms then endothermy must have evolved at least once on the evolutionary path from archosaurs to dinosaurs to birds.

Natural Selection

There is **variation** between organisms of the same populations due to mutations and differing alleles.
Organisms **complete** with each other for food, shelter, water etc.
Those with **better adaptations** will be **more successful** competitors and more likely to **survive and reproduce**.
Their advantageous **alleles** for their better adaptations will be passed on to the **next generation**.
Over time, the number of organisms with alleles for the better adaptations will increase.
The whole population of organisms **evolve** to have the better adaptations (alleles).





A population of mice has moved into a new area where the rocks are very dark. Due to natural genetic variation, some mice are black, while others are tan.

Tan mice are more visible to predatory birds than black mice. Thus, tan mice are eaten at higher frequency than black mice. Only the surviving mice reach reproductive age and leave offspring.

Because black mice had a higher chance of leaving offspring than tan mice, the next generation contains a higher fraction of black mice than the previous generation.

Questions:

1 What is an allele?

_____

2 What is an adaptation?

_____

3 Describe the process of natural selection that may lead to evolution?

_____

_____

_____

_____

4 What does the Theory of Evolution state?

_____

Classification Prior Knowledge

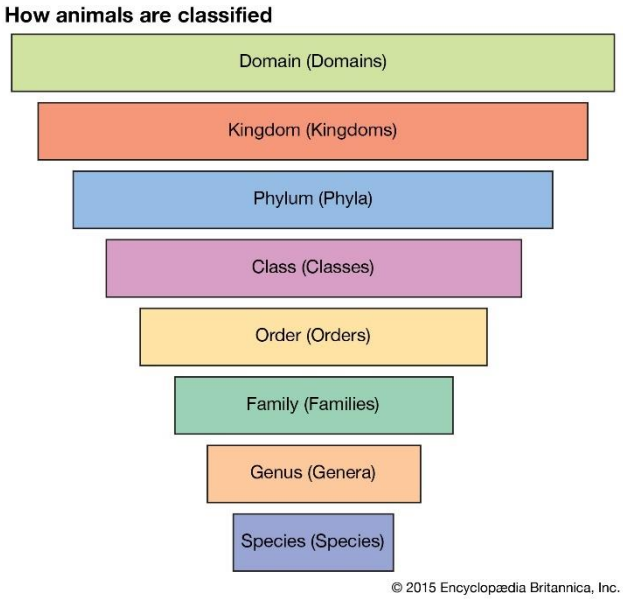
QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. Define Classification (1)			
2. How did Carl Linnaeus classify organisms? (1)			
3. Name the groups Linnaeus used. Starting from the largest (7)			
4. Organisms scientific names are based on which two groups? (2)			

5. What are the rules for writing scientific names? (3)			
6. Name the 6 kingdoms (6)			
7. Archaebacteria and Eubacteria initially formed which kingdom? (1)			
TOTAL			**/ 21**

Classification Building Knowledge

Classification involves **grouping** and **naming** organisms.
Classification allows scientists to study organisms without getting confused and being able to **communicate** universally.
Organisms are arranged based on their **similarities** and **differences** and are placed into **classification hierarchies**.

The first group has the largest number of organisms, and the last group only has one type of organism.



A **species** is a group of organisms that have similar characteristics and can reproduce to give fertile offspring.

Older classification systems are based on only how an organism looks.
New classification systems consider similarity in **DNA** base sequences, **Other molecules** such as proteins and enzymes and **Early development** (how an organism grows from an embryo to a baby).

Questions:

1 What does classification involve?

_____

2 What is a species?

_____

3 List four things newer classification systems use to group organisms.

_____

MATH SKILLS GCSE PRIOR KNOWLEDGE

5) Maths Skills

Averages, modes and range

Averages, Modes and Range Prior Knowledge

QUESTION	ANSWER	MARK (√ OR X)	CORRECTION (IF NEEDED)
1. What is the mean of these numbers: 3, 5, 7, 9? (1)			
2. Here's a list of pocket money that a class of children get. What's the mean? £3.50, £2.40}, £1.50, £2, £3.30, £2.80, £5, £6, £2.50 (1)			
3. The mean height of 5 children is 1.63m. What's the mean if they're joined by another child who's 1.75m tall? (1)			
4. Here's the number of goals scored in Premier League fixtures one Saturday: 1, 5, 3, 5, 1, 3, 4, 1, 2. What's the median? (1)			
5. Here's the number of goals scored in Premier League fixtures one Saturday: 1, 5, 3,			

5, 1, 3, 4, 1, 2. What's the mode? (1)			
6. Here's a set of marks for a maths class: 12, 45, 78, 66, 39, 98, 25, 48, 66, 41. What's the range? (1)			
7. Here are the results Owen got by throwing a dice a number of times: 1, 5, 3, 4, 2, 5, 5, 3, 6, 2, 1, 3, 2, 5, 4, 3, 3, 5. What's the mode? (1)			
8. Calculate 1% of 8.3 (1)			
9. Calculate 22.5% of 162.4 (1)			
TOTAL			**/9**

Math Skills Building Knowledge

1 Numbers and units

1.1 Units and prefixes

A key criterion for success in biological maths lies in the use of correct units and the management of numbers. The units scientists use are from the *Système Internationale* – the SI units. In biology, the most commonly used SI base units are metre (m), kilogram (kg), second (s),and mole (mol). Biologists also use SI derived units, such as square metre (m^2), cubic metre (m^3), degree Celsius (°C), and litre (l).

To accommodate the huge range of dimensions in our measurements they may be further modified using appropriate prefixes. For example, one thousandth of a second is a millisecond (ms). Some of these prefixes are illustrated in the table below.

Multiplication factor	Prefix	Symbol
10^9	Giga	G
10^6	Mega	M
10^3	Kilo	k
10^{-2}	Centi	c
10^{-3}	Milli	m
10^{-6}	Micro	μ
10^{-9}	Nano	n

Practice questions

1 A burger contains 4 500 000 J of energy. Write this in:
a kilojoules **b** megajoules.

2 HIV is a virus with a diameter of between 9.0×10^{-8} m and 1.20×10^{-7} m.
Write this range in nanometres.

1.2 Powers and indices

Ten squared = 10 × 10 = 100 and can be written as 10^2. This is also called 'ten to thepower of 2'.

Ten cubed is 'ten to the power of three' and can be written as $10^3 = 1000$.The

power is also called the index.

Fractions have negative indices:

one tenth = $10^{-1} = 1/10 = 0.1$

one hundredth = $10^{-2} = 1/100 = 0.01$

Any number to the power of 0 is equal to 1, for example, $29^0 = 1$.If

the index is 1, the value is unchanged, for example, $17^1 = 17$. When

multiplying powers of ten, you must *add* the indices.

So 100 × 1000 = 100 000 is the same as $10^2 \times 10^3 = 10^{2+3} = 10^5$

When dividing powers of ten, you must *subtract* the indices.

So $100/1000 = 1/10 = 10^{-1}$ is the same as $10^2/10^3 = 10^{2-3} = 10^{-1}$

But you can only do this when the numbers with the indices are the same.So

$10^2 \times 2^3 = 100 \times 8 = 800$

And you can't do this when adding or subtracting.10^2

$+ 10^3 = 100 + 1000 = 1100$

$10^2 - 10^3 = 100 - 1000 = -900$

Remember: You can only add and subtract the indices when you are multiplying or dividing the numbers, not adding or subtracting them.

Practice questions

3 Calculate the following values. Give your answers using indices.

a $10^8 \times 10^3$ **b** $10^7 \times 10^2 \times 10^3$

c $10^3 + 10^3$ **d** $10^2 - 10^{-2}$

4 Calculate the following values. Give your answers with and without using indices.

a $10^5 \div 10^4$ **b** $10^3 \div 10^6$

c $10^2 \div 10^{-4}$ **d** $100^2 \div 10^2$

1.3 Converting units

When doing calculations, it is important to express your answer using sensible numbers. For example, an answer of 6230 μm would have been more meaningful expressed as 6.2 mm.

If you convert between units and round numbers properly, it allows quoted measurements to be understood within the scale of the observations.

To convert 488 889 m into km:

A kilo is 10^3 so you need to divide by this number, or move the decimal point three places to theleft.

$488\,889 \div 10^3 = 488.889$ km

However, suppose you are converting from mm to km: you need to go from 10^3 to 10^{-3}, or movethe decimal point six places to the left.

333 mm is 0.000 333 km

Alternatively, if you want to convert from 333 mm to nm, you would have to go from 10^{-9} to 10^{-3}, or move the decimal point six places to the right.

333 mm is 333 000 000 nm

Practice questions

5 Calculate the following conversions:

a 0.004 m into mm **b** 130 000 ms into s

c 31.3 ml into µl **d** 104 ng into mg

6 Give the following values in a different unit so they make more sense to the reader.

Choose the final units yourself. (Hint: make the final number as close in magnitude to zero asyou can. For example, you would convert 1000 m into 1 km.)

a 0.000 057 m **b** 8 600 000 µl **c** 68 000 ms **d** 0.009 cm

2 Decimals, standard form, and significant figures

2.1 Decimal numbers

A decimal number has a decimal point. Each figure *before* the point is a whole number, and the figures *after* the point represent fractions.

The number of decimal places is the number of figures *after* the decimal point. For example, the number 47.38 has 2 decimal places, and 47.380 is the same number to 3 decimal places.

In science, you must write your answer to a sensible number of decimal places.

Practice questions

1 New antibiotics are being tested. A student calculates the area of clear zones in Petri dishesin which the antibiotics have been used. List these in order from smallest to largest.

0.0214 cm^2 0.03 cm^2 0.0218 cm^2 0.034 cm^2

2 A student measures the heights of a number of different plants. List these in order from smallest to largest.

22.003 cm 22.25 cm 12.901 cm 12.03 cm 22 cm

2.2 Standard form

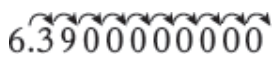
Sometimes biologists need to work with numbers that are very small, such as dimensions of organelles, or very large, such as populations of bacteria. In such cases, the use of scientificnotation or standard form is very useful, because it allows the numbers to be written easily.

Standard form is expressing numbers in powers of ten, for example, 1.5×10^7 microorganisms.Look

at this worked example. The number of cells in the human body is approximately 37 200 000 000 000. To write this in standard form, follow these steps:

Step 1: Write down the smallest number between 1 and 10 that can be derived from the numberto be converted. In this case it would be 3.72

Step 2: Write the number of times the decimal place will have to shift to expand this to the original number as powers of ten. On paper this can be done by hopping the decimalover each number like this:



until the end of the number is reached.

In this example that requires 13 shifts, so the standard form should be written as 3.72×10^{13}.

For very small numbers the same rules apply, except that the decimal point has to hopbackwards. For example, 0.000 000 45 would be written as 4.5×10^{-7}.

Practice questions

3 Change the following values to standard form.

a 3060 kJ **b** 140 000 kg **c** 0.000 18 m **d** 0.000 004 m

4 Give the following numbers in standard form.

a 100 **b** 10 000 **c** 0.01 **d** 21 000 000

5 Give the following as decimals.

a 10^6 **b** 4.7×10^9 **c** 1.2×10^{12} **d** 7.96×10^{-4}

2.3 Significant figures

When you use a calculator to work out a numerical answer, you know that this often results in alarge number of decimal places and, in most cases, the final few digits are 'not significant'. It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, toofew and you are not showing the precision and care required in scientific analysis.

Numbers to 3 significant figures (3 s.f.):

7.88 25.4 741

Bigger and smaller numbers with 3 significant figures:

0.000 147 0.0147 0.245 39 400 96 200 000 (notice that the zeros before the figures and after the figures are *not* significant – they just show you how large the number is by the position of the decimal point).

Numbers to 3 significant figures where the zeros *are* significant:

207 4050 1.01 (any zeros between the other significant figures *are* significant).

Standard form numbers with 3 significant figures:

9.42×10^{-5} 1.56×10^{8}

If the value you wanted to write to 3.s.f. was 590, then to show the zero was significant youwould have to write:

590 (to 3.s.f.) or 5.90×10^2

Remember: For calculations, use the same number of figures as the data in the question withthe lowest number of significant figures. It is not possible for the answer to be more accurate than the data in the question.

Practice questions

6 Write the following numbers to **i** 2 s.f. and **ii** 3 s.f.

a 7644 g

b 27.54 m

c 4.3333 g

d 5.995×10^2 cm^3

7 The average mass of oxygen produced by an oak tree is 11800 g per year. Give this mass in standard form and quote your answer to 2 significant figures.

3 Working with formulae

It is often necessary to use a mathematical formula to calculate quantities. You may be tested onyour ability to substitute numbers into formulae or to rearrange formulae to find specific values.

3.1 Substituting into formulae

Think about the data you are given in the question. Write down the equation and then think abouthow to get the data to substitute into the equation. Look at this worked example.

A cheek cell has a 0.06 mm diameter. Under a microscope it has a diameter 12 mm. What is the magnification?

magnification = image size (mm) ÷ object size (mm) or $M = I / O$

Substitute the values and calculate the answer:

M = 12 mm/0.06 mm = 12/0.06 = 200

Answer: magnification = ×200 (magnification has no units)

Sometimes an equation is more complicated and the steps need to be carried out in a certain order to succeed. A general principle applies here, usually known by the mnemonic BIDMAS. This stands for **B**rackets, **I**ndices (functions such as squaring or powers), **D**ivision, **M**ultiplication,**A**ddition, **S**ubtraction.

Practice questions

1. Calculate the magnification of a hair that has a width of 6.6 mm on a photograph. The hair is165 µm wide.
2. Estimate the area of a leaf by treating it as a triangle with base 2 cm and height 9 cm.
3. Estimate the area of a cell by treating it as a circle with a diameter of 0.7 µm. Give your answer in μm^2.
4. An *Amoeba* population starts with 24 cells. Calculate how many *Amoeba* cells would be present in the culture after 7 days if each cell divides once every 20 hours. Use the equation $N_t = N_0 \times 2^n$ where N_t = number after time t, N_0 = initial population, n = number of divisions in the given time t.
5. In a quadrat sample, an area was found to contain 96 aphids, 4 ladybirds, 22 grasshoppers, and 3 ground beetles. Calculate the diversity of the site using the equation: $D = 1 - \Sigma\left(\frac{n}{N}\right)^2$

   where n = number of each species, N = grand total of all species, and D = diversity.

Remember: In this equation there is a part that needs to be done several times then summed, shown by the symbol Σ.

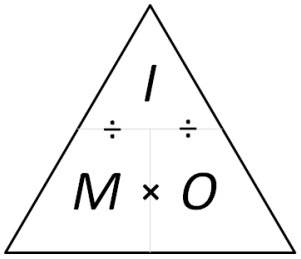
3.1 Rearranging formulae

Sometimes you will need to rearrange an equation to calculate the answer to a question. For example, the relationship between magnification, image size, and actual size of specimens in micrographs usually uses the equation M =and O = actual size of the object. M = I/O , where M is magnification, I is size of the image, and O = actual size of the object.

You can use the algebra you have learnt in Maths to rearrange equations, or you can use a triangle like the one shown.

Cover the quantity you want to find. This leaves you with either a fraction or a multiplication:

$M = I \div O$ $O = I \div M$ $I = M \times O$



6 A fat cell is 0.1 mm in diameter. Calculate the size of the diameter seen through a microscope with a magnification of ×50.

7 A Petri dish shows a circular colony of bacteria with a cross-sectional area of 5.3 cm^2. Calculate the radius of this area.

8 In a photograph, a red blood cell is 14.5 mm in diameter. The magnification stated on the image is ×2000. Calculate the real diameter of the red blood cell.

9 Rearrange the equation $34 = 2a/135 \times 100$ and find the value of a.

10 The cardiac output of a patient was found to be 2.5 $dm^3\,min^{-1}$ and their heart rate was 77 bpm. Calculate the stroke volume of the patient.

Use the equation: cardiac output = stroke volume × heart rate.

11 In a food chain, efficiency = (biomass transferred/biomass taken in) x100

A farmer fed 25 kg of grain to his chicken. The chicken gained weight with an efficiency of 0.84. Calculate the weight gained by the chicken.

Working Scientifically Glossary

Define the following key terms:

Accuracy:

Anomaly:

Calibration:

Control:

Control Variable:

Correlation:

Dependent Variable:

Fair Test:

Hypothesis:

Independent Variable:

Null hypothesis:

Peer Review:

Precision:

Probability:

Random distribution:

Random error:

Reliability:

Systematic error:

True value:

Validity:

Zero Error:

A guide to using Harvard referencing:

You will use information from a wide range of different sources when writing a report and each source needs to be referenced in a slightly different way in the bibliography at the end of your report. You will most commonly find information in books, journals and websites and so I have provided details of how to reference information from these three sources below. (Remember that the information in the text of your report also needs citations to help the reader link it to its source which you have listed in the bibliography).

How to reference a book:

Karskens, G 1997, *The Rocks: life in early Sydney,* Melbourne University Press, Carlton.

Ward, R 1966, *The Australian legend,* 2nd edn, Oxford University Press, Melbourne.

Present full bibliographic details in the following order:

- author's surname, and initial(s)
- year of publication,
- title of publication (in italics and with minimal capitalisation),
- edition (if applicable. Abbreviated as 'edn'),
- publisher,
- place of publication.

How to reference a journal (Physical copy):

Kozulin, A 1993, 'Literature as a psychological tool', *Educational Psychologist,* vol. 28, no. 3, pp. 253-265, DOI:10.1207/s15326985ep2803_5.

Place the information in the following order:

- author's surname and initial
- year of publication
- title of the article (between single quotation marks and with minimal capitalisation)
- title of the journal or periodical (in italic font using maximum capitalisation)
- volume number (vol.)
- issue number (no.)
- page range of the article
- DOI (Digital Object Identifier), if available

How to reference a journal (On-line copy):

Morris, A 2004, 'Is this racism? Representations of South Africa in the Sydney Morning Herald since the inauguration of Thabo Mbeki as president'. *Australian Humanities Review,* no. 33, accessed 11 May 2007, <http://www.australianhumanitiesreview.org/archive/Issue-August-2004/morris.html>.

Rowland, TA 2015, 'Feminism from the Perspective of Catholicism', *Solidarity: The Journal of Catholic Social Thought and Secular Ethics,* vol. 5, no. 1, accessed 12 December 2015, <http://researchonline.nd.edu.au/solidarity/vol5/iss1/1>.

Place the information in the following order:

- author(s) name and initials
- title of the article (between single quotation marks)
- title of the journal (in italics)
- available publication information (volume number, issue number)
- accessed day month year (the date you last viewed the article)
- URL or Internet address (between pointed brackets)

How to reference a website:

International Narcotics Control Board 1999, United Nations, accessed 1 October 1999, <http://www.incb.org>

Include the following information:

- author (the person or organisation responsible for the site)
- year (date created or last updated)
- name of sponsor of site (if available)
- accessed day month year (the date you viewed the site)
- URL or Internet address (between pointed brackets). If possible, ensure that the URL is included without a line-break.

CPAC 5B – Referencing articles task:

The article opposite is from a **physical** copy of the British Medical Journal 2018 volume 361, page 1 and 2. There is no issue number. The other information that you need to reference the article in a bibliography is clearly visible. Use the 'guide to using Harvard referencing' above to create a bibliography entry for this article:

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PRACTICE

WHAT YOUR PATIENT IS THINKING

Why a change of diagnosis shouldn't matter . . . but it does

From loss of identity to social stigma, Suzy Syrett describes the hidden impact of a change to her mental health diagnosis

Suzy Syrett

I'm 45 years old and since 1994 I've lived with three different psychiatric diagnoses; bipolar disorder (1994-2008), depression and psychosis (2008-16), and (2016-present) personality disorder not otherwise specified.

Identity conflicts

Each new diagnosis radically shifted how I interpreted the symptoms I was experiencing, the prognosis I was told to expect, and the treatments I was receiving. It was also a shock to witness how much my diagnosis had become integrated into others' perception of me. Unintended but hurtful comments such as, "Can I just say you still have bipolar? My friends don't mind that one" are commonplace. To say these experiences didn't impact on my understanding of who I am, and why, would be ridiculous.

Confusion and change

Having information about my new diagnosis was useful, but I found little support to help me deal with how it feels to undergo that change. I'd describe the process as being similar to grief because I felt that as I said farewell to one diagnosis it was replaced by a more stigmatising one. And there can be implications for job applications, current employment, or continuing entitlement to the personal independence payment, all of which bring stresses of their own.

Treatment and support

With each change of diagnosis I had to deal with the realisation that I might have been on the wrong medications for years and the concern these drugs might be removed. Many psychiatric drugs have the potential for damaging physiological impact, which is worrying enough, but for me the more pressing concern was coming off a drug that I believed was helping me. Glasgow's bipolar support group played a huge part in helping me accept the impact of my illness in 1994. When my diagnosis was changed my interpretation was that I could no longer attend that group. Having bipolar was no longer a story that I thought I could share in or offer my perspective on. Part of any support group's role is to bring inclusivity to those who already feel separated from society and so feeling excluded from such a group was a doubly miserable process.

Problems of miscommunication

The challenges of hearing a diagnosis of personality disorder were even more fundamental and corrosive than those I faced after my previous change of diagnosis. This change of diagnosis came without warning and during the shock of that appointment it seemed to me that the suffering I had experienced—never mind that my family and friends—was all my fault. I was to blame.

Fortunately, my psychiatrist arranged a second appointment to help clear up some of those questions. That helped a lot. But there was still the confusion of continuing to experience symptoms that didn't fit my new diagnosis.

Trust and other issues

"Do my community mental health team believe me?" is never a thought I want to have. I have an excellent team and being assured they all knew of my new diagnosis, would support me through the process of change, and that they would always take me seriously when I ask for help regardless of symptom was key. If I had a reason to doubt them, or even worse, if I felt that they doubted me, then that relationship, as concrete and enduring as it is, would be destroyed.

Delivering change

We all face decisions in life that bring changes that can be hard to cope with. Imagine dealing with an enforced change of great impact that you felt you had no involvement in? Psychiatric diagnoses have always seemed unquestionable facts and not open to debate. Making a diagnosis can be challenging, but wouldn't it be at least as challenging for a patient to accept a change of diagnosis? Discussing why the change is required

Suzanne.Syrett@glasgow.ac.uk Follow Suzy on Twitter at @SuzySyrett

CPAC 5B – Referencing websites task:

Visit the website below (you will need to print this and bring it in) and write a reference for it below.

https://emilyspiersbiology.weebly.com/alevel-biology-blog/experiment-to-investigate-how-enzyme-concentration-affects-the-inital-rate-of-a-reaction

2. ……

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CPAC 5B – Referencing books task:

Find a book of your choice. Reference that below.

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CPAC 2C Identifying and controlling variables task:

Variables

For each of the following case studies name the:-
(A) Independent variable (B) Dependant variable (C) Control variable

Case study 1 – *Measuring gravity*

The aim of this experiment is to find out how fast objects of different masses take to fall from height. To conduct this experiment we used a number of different sized steel ball-bearings, which had different masses. Each ball-baring was weighed on scales, before being dropped from a marker exactly 2 m from the floor. The time the ball bearing took to drop was timed on a stopwatch, and repeated 3 times for each ball-bearing to gain an average time.

Case study 2 – *The colour of summer*

The aim of this experiment is to find out if the colour of water a flower is grown in affects the colour of the flower. Five white roses of a similar size and shape were selected and placed into 5 separate beakers each containing 250 ml of water. Each of the 5 beakers had a few drops of one of five different colours of food dye added to it (red, green, blue, yellow and brown). The beakers were then placed on a windowsill and the colour of the flowers monitored twice a day for two weeks.

Case study 3 – *how far does the spring stretch?*

The aim of this experiment is to find out how far different masses stretch a spring. A spring was hung from a clamp stand, and its length end to end measured. A 10g mass was then added and the length of the spring measured and recorded. This was repeated adding 10g between 0g and 100g.

Variables – answer sheet:

Case study 1 – *Measuring gravity:*

(A) Independent variable:

(B) Dependant variable:

(C) Control variables + how/why:

Case study 2 – *The colour of summer:*

(A) Independent variable:

(B) Dependant variable:

(C) Control variables + how/why:

Case study 3 – *How far does the spring stretch?*

(A) Independent variable:

(B) Dependant variable:

(C) Control variables + how/why:

Challenge for Top Students

You could have a look at some of the following:

Virology & Global Health

• Explained: The Next Global Pandemic (20 mins)
https://www.netflix.com/watch/81062202?trackId=13752289&tctx=0%2C3%2C0d0 3e68c-6321-41f2-9dfa-11f336ddc8ca-52560540%2C%2C
• FutureLearn course on Coronavirus:
https://www.futurelearn.com/courses/covid19-novel-coronavirus
• The Life Scientific - viruses:
https://www.bbc.co.uk/programmes/m0009b2t

Natural Selection & Genetic Modification

• Can Science Make Me Perfect?
https://www.bbc.co.uk/iplayer/episode/b0b6q3qy/can-science-make-me-perfectwith-alice-roberts
• Explained: Designer DNA (20 mins)
https://www.netflix.com/search?q=science&jbv=80216752&jbp=2&jbr=1
• Unnatural Selection (short series)
https://www.netflix.com/watch/80208833?trackId=13752289&tctx=0%2C0%2C8bd 41505-055d-4d08-a8c9-e71150318bb2-44683054%2C%2C
• In Our Time: Neanderthals
https://www.bbc.co.uk/programmes/b00sq1nv
• The Life Scientific: evolution of cancer
https://www.bbc.co.uk/programmes/m0003ks6

Homeostasis & Hormones

• Interviews with researchers working on hormones:
https://endocrinepod.com/episodes/
• Open University course on diabetes:
https://www.open.edu/openlearn/science-maths-technology/biology/livingdiabetes/content-section-3.1

A-level Biology Core Practical Videos

	Core Practical	Video playlist
1	Investigate a factor affecting the initial rate of an enzyme controlled reaction.	Enzyme Concentration and Rate of Reaction
2	Use of the light microscope, including simple stage and eyepiece micrometers and drawing small numbers of cells from a specialised tissue.	Measuring Cells: Calibrate Eyepiece Graticule, Magnification, Resolution
3	Make a temporary squash preparation of a root tip to show stages of mitosis in the meristem under the light microscope.	Mitosis in Garlic Root Tips
4	Investigate the effect of sucrose concentrations on pollen tube growth.	Pollen Grain: Germination on Slide Experiment
5	Investigate the effect of temperature on beetroot membrane permeability.	Membrane Permeability: Beetroot Practical
6	Determine the water potential of a plant tissue.	Onion Incipient Plasmolysis Experiment
7	Dissect an insect to show the structure of the gas exchange system.	Shrewsbury School: Locust Respiratory System
8	Investigate factors affecting water uptake by plant shoots using a potometer.	Potometer Transpiration Investigations
9	Investigate factors affecting the rate of respiration using a respirometer.	Rate of Respiration in Yeast
10	Investigate the effects of different wavelengths of light on the rate of photosynthesis.	Photosynthesis with Bubbling Pondweed
11	Investigate the presence of different chloroplast pigments using chromatography.	Paper Chromatography
12	Investigate the rate of growth of bacteria in liquid culture.	n/a
13	Isolate individual species from a mixed culture of bacteria using streak plating.	Isolation of Bacterial Colonies
14	Investigate the effect of gibberellin on the production of amylase in germinating cereals using a starch agar assay.	Bean vs Starch Experiment
15	Investigate the effect of different sampling methods on estimates of the size of a population.	Sampling Strategies
16	Investigate the effect of one abiotic factor on the distribution or morphology of one species.	Transect, Quadrats and Percentage Cover to Investigate the Distribution of Clover