Exclusively for IGCSE students

COMPILED NOTES

0610-BIOLOGY

2023-2025

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Cambridge Assessment International Education

Syllabus

Cambridge IGCSE™

Biology 0610

Use this syllabus for exams in 2023, 2024 and 2025.
Exams are available in the June and November series.
Exams are also available in the March series in India only.

Version 1

Cambridge Pathway

Why choose Cambridge International?

Cambridge International prepares school students for life, helping them develop an informed curiosity and a lasting passion for learning. We are part of the University of Cambridge.

Our Cambridge Pathway gives students a clear path for educational success from age 5 to 19. Schools can shape the curriculum around how they want students to learn – with a wide range of subjects and flexible ways to offer them. It helps students discover new abilities and a wider world, and gives them the skills they need for life, so they can achieve at school, university and work.

Our programmes and qualifications set the global standard for international education. They are created by subject experts, rooted in academic rigour and reflect the latest educational research. They provide a strong platform for learners to progress from one stage to the next, and are well supported by teaching and learning resources.

Our mission is to provide educational benefit through provision of international programmes and qualifications for school education and to be the world leader in this field. Together with schools, we develop Cambridge learners who are confident, responsible, reflective, innovative and engaged – equipped for success in the modern world.

Every year, nearly a million Cambridge students from 10 000 schools in 160 countries prepare for their future with the Cambridge Pathway.

'We think the Cambridge curriculum is superb preparation for university.'

Christoph Guttentag, Dean of Undergraduate Admissions, Duke University, USA

Quality management

Cambridge International is committed to providing exceptional quality. In line with this commitment, our quality management system for the provision of international qualifications and education programmes for students aged 5 to 19 is independently certified as meeting the internationally recognised standard, ISO 9001:2015. Learn more at **www.cambridgeinternational.org/ISO9001**

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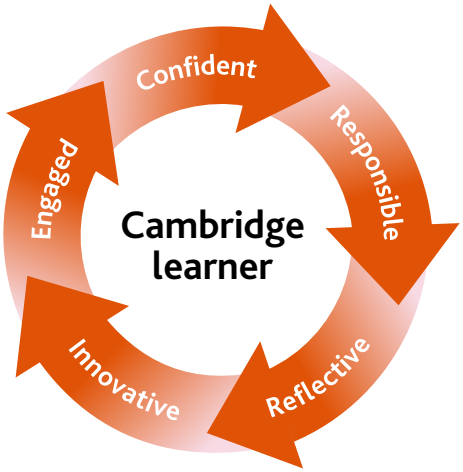
Important: Changes to this syllabus

For information about changes to this syllabus for 2023, 2024 and 2025, go to page 58

1 Why choose this syllabus?

Key benefits



Cambridge IGCSE is the world's most popular international qualification for 14 to 16 year olds, although it can be taken by students of other ages. It is tried, tested and trusted.

Students can choose from 70 subjects in any combination – it is taught by over 4800 schools in over 150 countries.

Our programmes balance a thorough knowledge and understanding of a subject and help to develop the skills learners need for their next steps in education or employment.

Cambridge IGCSE Biology develops a set of transferable skills including handling data, practical problem-solving and applying the scientific method. Learners develop relevant attitudes, such as concern for accuracy and precision, objectivity, integrity, enquiry, initiative and inventiveness. They acquire the essential scientific skills required for progression to further studies or employment.

Our approach in Cambridge IGCSE Biology encourages learners to be:

confident, interested in learning about science, questioning ideas and using scientific language to communicate their views and opinions

responsible, working methodically and safely when working alone or collaboratively with others

reflective, learning from their experiences and interested in scientific issues that affect the individual, the community and the environment

innovative, solving unfamiliar problems confidently and creatively

engaged, keen to develop scientific skills, being curious about scientific principles and their application in the world.

'The strength of Cambridge IGCSE qualifications is internationally recognised and has provided an international pathway for our students to continue their studies around the world.'

Gary Tan, Head of Schools and CEO, Raffles International Group of Schools, Indonesia

International recognition and acceptance

Our expertise in curriculum, teaching and learning, and assessment is the basis for the recognition of our programmes and qualifications around the world. The combination of knowledge and skills in Cambridge IGCSE Biology gives learners a solid foundation for further study. Candidates who achieve grades A* to C are well prepared to follow a wide range of courses including Cambridge International AS & A Level Biology or Marine Science.

Cambridge IGCSEs are accepted and valued by leading universities and employers around the world as evidence of academic achievement. Many universities require a combination of Cambridge International AS & A Levels and Cambridge IGCSEs or equivalent to meet their entry requirements.

UK NARIC, the national agency in the UK for the recognition and comparison of international qualifications and skills, has carried out an independent benchmarking study of Cambridge IGCSE and found it to be comparable to the standard of the reformed GCSE in the UK. This means students can be confident that their Cambridge IGCSE qualifications are accepted as equivalent to UK GCSEs by leading universities worldwide.

Learn more at **www.cambridgeinternational.org/recognition**

'Cambridge IGCSE is one of the most sought-after and recognised qualifications in the world. It is very popular in Egypt because it provides the perfect preparation for success at advanced level programmes.'

Managing Director of British School in Egypt BSE

Supporting teachers

We provide a wide range of resources, detailed guidance and innovative training and professional development so that you can give your students the best possible preparation for Cambridge IGCSE. To find out which resources are available for each syllabus go to our School Support Hub.

The School Support Hub is our secure online site for Cambridge teachers where you can find the resources you need to deliver our programmes. You can also keep up to date with your subject and the global Cambridge community through our online discussion forums.

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2 Syllabus overview

Aims

The aims describe the purposes of a course based on this syllabus.

You can deliver some of the aims using suitable local, international or historical examples and applications, or through collaborative practical work.

The aims are to enable students to:

- acquire scientific knowledge and understanding of scientific theories and practice
- develop a range of experimental skills, including handling variables and working safely
- use scientific data and evidence to solve problems and discuss the limitations of scientific methods
- communicate effectively and clearly, using scientific terminology, notation and conventions
- understand that the application of scientific knowledge can benefit people and the environment
- enjoy science and develop an informed interest in scientific matters which support further study.

Cambridge Assessment International Education is an education organisation and politically neutral. The contents of this syllabus, examination papers and associated materials do not endorse any political view. We endeavour to treat all aspects of the exam process neutrally.

Content overview

Candidates study the following topics:

1 Characteristics and classification of living organisms
2 Organisation of the organism
3 Movement into and out of cells
4 Biological molecules
5 Enzymes
6 Plant nutrition
7 Human nutrition
8 Transport in plants
9 Transport in animals
10 Diseases and immunity
11 Gas exchange in humans
12 Respiration
13 Excretion in humans
14 Coordination and response
15 Drugs
16 Reproduction
17 Inheritance
18 Variation and selection
19 Organisms and their environment
20 Human influences on ecosystems
21 Biotechnology and genetic modification

Assessment overview

All candidates take three papers.

Candidates who have studied the Core syllabus content, or who are expected to achieve a grade D or below, should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G.

Candidates who have studied the Extended syllabus content (Core and Supplement), and who are expected to achieve a grade C or above, should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades A* to G.

Core assessment

Core candidates take Paper 1 and Paper 3. The questions are based on the Core subject content only:

Paper 1: Multiple Choice (Core)		**Paper 3: Theory (Core)**	
45 minutes		1 hour 15 minutes	
40 marks	30%	80 marks	50%
40 four-option multiple-choice questions		Short-answer and structured questions	
Externally assessed		Externally assessed	

Extended assessment

Extended candidates take Paper 2 and Paper 4. The questions are based on the Core and Supplement subject content:

Paper 2: Multiple Choice (Extended)		**Paper 4: Theory (Extended)**	
45 minutes		1 hour 15 minutes	
40 marks	30%	80 marks	50%
40 four-option multiple-choice questions		Short-answer and structured questions	
Externally assessed		Externally assessed	

Practical assessment

All candidates take one practical paper from a choice of two:

Paper 5: Practical Test			**Paper 6: Alternative to Practical**	
1 hour 15 minutes			1 hour	
40 marks	20%		40 marks	20%
Questions will be based on the experimental skills in Section 4		**OR**	Questions will be based on the experimental skills in Section 4	
Externally assessed			Externally assessed	

Information on availability is in the **Before you start** section.

Assessment objectives

The assessment objectives (AOs) are:

AO1 Knowledge with understanding

Candidates should be able to demonstrate knowledge and understanding of:

- scientific phenomena, facts, laws, definitions, concepts and theories
- scientific vocabulary, terminology and conventions (including symbols, quantities and units)
- scientific instruments and apparatus, including techniques of operation and aspects of safety
- scientific and technological applications with their social, economic and environmental implications.

Subject content defines the factual material that candidates may be required to recall and explain.

Candidates will also be asked questions which require them to apply this material to unfamiliar contexts and to apply knowledge from one area of the syllabus to another.

AO2 Handling information and problem-solving

Candidates should be able, in words or using other written forms of presentation (i.e. symbolic, graphical and numerical), to:

- locate, select, organise and present information from a variety of sources
- translate information from one form to another
- manipulate numerical and other data
- use information to identify patterns, report trends and form conclusions
- present reasoned explanations for phenomena, patterns and relationships
- make predictions based on relationships and patterns
- solve problems, including some of a quantitative nature.

Questions testing these skills may be based on information that is unfamiliar to candidates, requiring them to apply the principles and concepts from the syllabus to a new situation, in a logical, deductive way.

AO3 Experimental skills and investigations

Candidates should be able to:

- demonstrate knowledge of how to select and safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate)
- plan experiments and investigations
- make and record observations, measurements and estimates
- interpret and evaluate experimental observations and data
- evaluate methods and suggest possible improvements.

Weighting for assessment objectives

The approximate weightings allocated to each of the assessment objectives (AOs) are summarised below.

Assessment objectives as a percentage of the qualification

Assessment objective	Weighting in IGCSE %
AO1 Knowledge with understanding	50
AO2 Handling information and problem-solving	30
AO3 Experimental skills and investigations	20
Total	100

Assessment objectives as a percentage of each component

Assessment objective	Weighting in components %		
	Papers 1 and 2	Papers 3 and 4	Papers 5 and 6
AO1 Knowledge with understanding	63	63	–
AO2 Handling information and problem-solving	37	37	–
AO3 Experimental skills and investigations	–	–	100
Total	100	100	100

3 Subject content

This syllabus gives you the flexibility to design a course that will interest, challenge and engage your learners. Where appropriate you are responsible for selecting resources and examples to support your learners' study. These should be appropriate for the learners' age, cultural background and learning context as well as complying with your school policies and local legal requirements.

All candidates should be taught the Core subject content. Candidates who are only taught the Core subject content can achieve a maximum of grade C. Candidates aiming for grades A* to C should be taught the Extended subject content. The Extended subject content includes both the Core and the Supplement.

Scientific subjects are, by their nature, experimental. Learners should pursue a fully integrated course which allows them to develop their experimental skills by doing practical work and investigations across a range of topics.

Practical work helps students to:

- use equipment and materials accurately and safely
- develop observational and problem-solving skills
- develop a deeper understanding of the syllabus topics and the scientific approach
- appreciate how scientific theories are developed and tested
- transfer the experimental skills acquired to unfamiliar contexts
- develop positive scientific attitudes such as objectivity, integrity, cooperation, enquiry and inventiveness
- develop an interest and enjoyment in science.

1 Characteristics and classification of living organisms

1.1 Characteristics of living organisms

Core	Supplement
1 Describe the characteristics of living organisms by describing: (a) movement as an action by an organism or part of an organism causing a change of position or place (b) respiration as the chemical reactions in cells that break down nutrient molecules and release energy for metabolism (c) sensitivity as the ability to detect and respond to changes in the internal or external environment (d) growth as a permanent increase in size and dry mass (e) reproduction as the processes that make more of the same kind of organism (f) excretion as the removal of the waste products of metabolism and substances in excess of requirements (g) nutrition as the taking in of materials for energy, growth and development	

1.2 Concept and uses of classification systems

Core

1 State that organisms can be classified into groups by the features that they share

2 Describe a species as a group of organisms that can reproduce to produce fertile offspring

3 Describe the binomial system of naming species as an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and species

4 Construct and use dichotomous keys based on identifiable features

Supplement

5 Explain that classification systems aim to reflect evolutionary relationships

6 Explain that the sequences of bases in DNA are used as a means of classification

7 Explain that groups of organisms which share a more recent ancestor (are more closely related) have base sequences in DNA that are more similar than those that share only a distant ancestor

1.3 Features of organisms

Core

1 State the main features used to place animals and plants into the appropriate kingdoms

2 State the main features used to place organisms into groups within the animal kingdom, limited to:

(a) the main groups of vertebrates: mammals, birds, reptiles, amphibians, fish

(b) the main groups of arthropods: myriapods, insects, arachnids, crustaceans

3 Classify organisms using the features identified in 1.3.1 and 1.3.2

Supplement

4 State the main features used to place all organisms into one of the five kingdoms: animal, plant, fungus, prokaryote, protoctist

5 State the main features used to place organisms into groups within the plant kingdom, limited to ferns and flowering plants (dicotyledons and monocotyledons)

6 Classify organisms using the features identified in 1.3.4 and 1.3.5

7 State the features of viruses, limited to a protein coat and genetic material

2 Organisation of the organism

2.1 Cell structure

Core

1 Describe and compare the structure of a plant cell with an animal cell, limited to: cell wall, cell membrane, nucleus, cytoplasm, chloroplasts, ribosomes, mitochondria, vacuoles

2 Describe the structure of a bacterial cell, limited to: cell wall, cell membrane, cytoplasm, ribosomes, circular DNA, plasmids

3 Identify the cell structures listed in 2.1.1 and 2.1.2 in diagrams and images of plant, animal and bacterial cells

4 Describe the functions of the structures listed in 2.1.1 and 2.1.2 in plant, animal and bacterial cells

5 State that new cells are produced by division of existing cells

6 State that specialised cells have specific functions, limited to:

- (a) ciliated cells – movement of mucus in the trachea and bronchi
- (b) root hair cells – absorption
- (c) palisade mesophyll cells – photosynthesis
- (d) neurones – conduction of electrical impulses
- (e) red blood cells – transport of oxygen
- (f) sperm and egg cells (gametes) – reproduction

7 Describe the meaning of the terms: cell, tissue, organ, organ system and organism as illustrated by examples given in the syllabus

Supplement

2.2 Size of specimens

Core

1 State and use the formula:
magnification = image size ÷ actual size

2 Calculate magnification and size of biological specimens using millimetres as units

Supplement

3 Convert measurements between millimetres (mm) and micrometres (μm)

3 Movement into and out of cells

3.1 Diffusion

Core

1 Describe diffusion as the net movement of particles from a region of their higher concentration to a region of their lower concentration (i.e. down a concentration gradient), as a result of their random movement

2 State that the energy for diffusion comes from the kinetic energy of random movement of molecules and ions

3 State that some substances move into and out of cells by diffusion through the cell membrane

4 Describe the importance of diffusion of gases and solutes in living organisms

5 Investigate the factors that influence diffusion, limited to: surface area, temperature, concentration gradient and distance

Supplement

3.2 Osmosis

Core

1 Describe the role of water as a solvent in organisms with reference to digestion, excretion and transport

2 State that water diffuses through partially permeable membranes by osmosis

3 State that water moves into and out of cells by osmosis through the cell membrane

4 Investigate osmosis using materials such as dialysis tubing

5 Investigate and describe the effects on plant tissues of immersing them in solutions of different concentrations

6 State that plants are supported by the pressure of water inside the cells pressing outwards on the cell wall

Supplement

7 Describe osmosis as the net movement of water molecules from a region of higher water potential (dilute solution) to a region of lower water potential (concentrated solution), through a partially permeable membrane

8 Explain the effects on plant cells of immersing them in solutions of different concentrations by using the terms: turgid, turgor pressure, plasmolysis, flaccid

9 Explain the importance of water potential and osmosis in the uptake and loss of water by organisms

3.3 Active transport

Core

1 Describe active transport as the movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration (i.e. against a concentration gradient), using energy from respiration

Supplement

2 Explain the importance of active transport as a process for movement of molecules or ions across membranes, including ion uptake by root hairs

3 State that protein carriers move molecules or ions across a membrane during active transport

4 Biological molecules

4.1 Biological molecules

Core

1 List the chemical elements that make up: carbohydrates, fats and proteins

2 State that large molecules are made from smaller molecules, limited to:
   (a) starch, glycogen and cellulose from glucose
   (b) proteins from amino acids
   (c) fats and oils from fatty acids and glycerol

3 Describe the use of:
   (a) iodine solution test for starch
   (b) Benedict's solution test for reducing sugars
   (c) biuret test for proteins
   (d) ethanol emulsion test for fats and oils
   (e) DCPIP test for vitamin C

Supplement

4 Describe the structure of a DNA molecule:
   (a) two strands coiled together to form a double helix
   (b) each strand contains chemicals called bases
   (c) bonds between pairs of bases hold the strands together
   (d) the bases always pair up in the same way: A with T, and C with G (full names are **not** required)

5 Enzymes

5.1 Enzymes

Core	Supplement
1 Describe a catalyst as a substance that increases the rate of a chemical reaction and is not changed by the reaction	
2 Describe enzymes as proteins that are involved in all metabolic reactions, where they function as biological catalysts	
3 Describe why enzymes are important in all living organisms in terms of a reaction rate necessary to sustain life	
4 Describe enzyme action with reference to the shape of the active site of an enzyme being complementary to its substrate and the formation of products	6 Explain enzyme action with reference to: active site, enzyme-substrate complex, substrate and product
	7 Explain the specificity of enzymes in terms of the complementary shape and fit of the active site with the substrate
5 Investigate and describe the effect of changes in temperature and pH on enzyme activity with reference to optimum temperature and denaturation	8 Explain the effect of changes in temperature on enzyme activity in terms of kinetic energy, shape and fit, frequency of effective collisions and denaturation
	9 Explain the effect of changes in pH on enzyme activity in terms of shape and fit and denaturation

6 Plant nutrition

6.1 Photosynthesis

Core	Supplement
1 Describe photosynthesis as the process by which plants synthesise carbohydrates from raw materials using energy from light	
2 State the word equation for photosynthesis as: carbon dioxide + water → glucose + oxygen in the presence of light and chlorophyll	10 State the balanced chemical equation for photosynthesis as: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$
3 State that chlorophyll is a green pigment that is found in chloroplasts	
4 State that chlorophyll transfers energy from light into energy in chemicals, for the synthesis of carbohydrates	

continued

6.1 Photosynthesis continued

Core

5 Outline the subsequent use and storage of the carbohydrates made in photosynthesis, limited to:
   (a) starch as an energy store
   (b) cellulose to build cell walls
   (c) glucose used in respiration to provide energy
   (d) sucrose for transport in the phloem
   (e) nectar to attract insects for pollination

6 Explain the importance of:
   (a) nitrate ions for making amino acids
   (b) magnesium ions for making chlorophyll

7 Investigate the need for chlorophyll, light and carbon dioxide for photosynthesis, using appropriate controls

8 Investigate and describe the effects of varying light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis

9 Investigate and describe the effect of light and dark conditions on gas exchange in an aquatic plant using hydrogencarbonate indicator solution

Supplement

11 Identify and explain the limiting factors of photosynthesis in different environmental conditions

6.2 Leaf structure

Core

1 State that most leaves have a large surface area and are thin, and explain how these features are adaptations for photosynthesis

2 Identify in diagrams and images the following structures in the leaf of a dicotyledonous plant: chloroplasts, cuticle, guard cells and stomata, upper and lower epidermis, palisade mesophyll, spongy mesophyll, air spaces, vascular bundles, xylem and phloem

3 Explain how the structures listed in 6.2.2 adapt leaves for photosynthesis

Supplement

7 Human nutrition

7.1 Diet

Core

1 Describe what is meant by a balanced diet

2 State the principal dietary sources and describe the importance of:
   (a) carbohydrates
   (b) fats and oils
   (c) proteins
   (d) vitamins, limited to C and D
   (e) mineral ions, limited to calcium and iron
   (f) fibre (roughage)
   (g) water

3 State the causes of scurvy and rickets

Supplement

7.2 Digestive system

Core

1 Identify in diagrams and images the main organs of the digestive system, limited to:
   (a) alimentary canal: mouth, oesophagus, stomach, small intestine (duodenum and ileum) and large intestine (colon, rectum, anus)
   (b) associated organs: salivary glands, pancreas, liver and gall bladder

2 Describe the functions of the organs of the digestive system listed in 7.2.1, in relation to:
   (a) ingestion – the taking of substances, e.g. food and drink, into the body
   (b) digestion – the breakdown of food
   (c) absorption – the movement of nutrients from the intestines into the blood
   (d) assimilation – uptake and use of nutrients by cells
   (e) egestion – the removal of undigested food from the body as faeces

Supplement

7.3 Physical digestion

Core

1 Describe physical digestion as the breakdown of food into smaller pieces without chemical change to the food molecules

2 State that physical digestion increases the surface area of food for the action of enzymes in chemical digestion

3 Identify in diagrams and images the types of human teeth: incisors, canines, premolars and molars

4 Describe the structure of human teeth, limited to: enamel, dentine, pulp, nerves, blood vessels and cement, and understand that teeth are embedded in bone and the gums

5 Describe the functions of the types of human teeth in physical digestion of food

6 Describe the function of the stomach in physical digestion

Supplement

7 Outline the role of bile in emulsifying fats and oils to increase the surface area for chemical digestion

7.4 Chemical digestion

Core

1 Describe chemical digestion as the break down of large insoluble molecules into small soluble molecules

2 State the role of chemical digestion in producing small soluble molecules that can be absorbed

3 Describe the functions of enzymes as follows:

(a) amylase breaks down starch to simple reducing sugars

(b) proteases break down protein to amino acids

(c) lipase breaks down fats and oils to fatty acids and glycerol

4 State where, in the digestive system, amylase, protease and lipase are secreted and where they act

5 Describe the functions of hydrochloric acid in gastric juice, limited to killing harmful microorganisms in food and providing an acidic pH for optimum enzyme activity

Supplement

6 Describe the digestion of starch in the digestive system:

(a) amylase breaks down starch to maltose

(b) maltase breaks down maltose to glucose on the membranes of the epithelium lining the small intestine

7 Describe the digestion of protein by proteases in the digestive system:

(a) pepsin breaks down protein in the acidic conditions of the stomach

(b) trypsin breaks down protein in the alkaline conditions of the small intestine

8 Explain that bile is an alkaline mixture that neutralises the acidic mixture of food and gastric juices entering the duodenum from the stomach, to provide a suitable pH for enzyme action

7.5 Absorption

Core	Supplement
1 State that the small intestine is the region where nutrients are absorbed	3 Explain the significance of villi and microvilli in increasing the internal surface area of the small intestine
	4 Describe the structure of a villus
	5 Describe the roles of capillaries and lacteals in villi
2 State that most water is absorbed from the small intestine but that some is also absorbed from the colon	

8 Transport in plants

8.1 Xylem and phloem

Core	Supplement
1 State the functions of xylem and phloem: (a) xylem – transport of water and mineral ions, and support (b) phloem – transport of sucrose and amino acids	3 Relate the structure of xylem vessels to their function, limited to: (a) thick walls with lignin (details of lignification are **not** required) (b) no cell contents (c) cells joined end to end with no cross walls to form a long continuous tube
2 Identify in diagrams and images the position of xylem and phloem as seen in sections of roots, stems and leaves of non-woody dicotyledonous plants	

8.2 Water uptake

Core	Supplement
1 Identify in diagrams and images root hair cells and state their functions	
2 State that the large surface area of root hairs increases the uptake of water and mineral ions	
3 Outline the pathway taken by water through the root, stem and leaf as: root hair cells, root cortex cells, xylem, mesophyll cells	
4 Investigate, using a suitable stain, the pathway of water through the above-ground parts of a plant	

8.3 Transpiration

Core

1 Describe transpiration as the loss of water vapour from leaves

2 State that water evaporates from the surfaces of the mesophyll cells into the air spaces and then diffuses out of the leaves through the stomata as water vapour

3 Investigate and describe the effects of variation of temperature and wind speed on transpiration rate

Supplement

4 Explain how water vapour loss is related to: the large internal surface area provided by the interconnecting air spaces between mesophyll cells and the size and number of stomata

5 Explain the mechanism by which water moves upwards in the xylem in terms of a transpiration pull that draws up a column of water molecules, held together by forces of attraction between water molecules

6 Explain the effects on the rate of transpiration of varying the following factors: temperature, wind speed and humidity

7 Explain how and why wilting occurs

8.4 Translocation

Core

Supplement

1 Describe translocation as the movement of sucrose and amino acids in phloem from sources to sinks

2 Describe:

(a) sources as the parts of plants that release sucrose or amino acids

(b) sinks as the parts of plants that use or store sucrose or amino acids

3 Explain why some parts of a plant may act as a source and a sink at different times

9 Transport in animals

9.1 Circulatory systems

Core

1 Describe the circulatory system as a system of blood vessels with a pump and valves to ensure one-way flow of blood

Supplement

2 Describe the single circulation of a fish

3 Describe the double circulation of a mammal

4 Explain the advantages of a double circulation

9.2 Heart

Core

1 Identify in diagrams and images the structures of the mammalian heart, limited to: muscular wall, septum, left and right ventricles, left and right atria, one-way valves and coronary arteries

2 State that blood is pumped away from the heart in arteries and returns to the heart in veins

3 State that the activity of the heart may be monitored by: ECG, pulse rate and listening to sounds of valves closing

4 Investigate and describe the effect of physical activity on the heart rate

5 Describe coronary heart disease in terms of the blockage of coronary arteries and state the possible risk factors including: diet, lack of exercise, stress, smoking, genetic predisposition, age and sex

6 Discuss the roles of diet and exercise in reducing the risk of coronary heart disease

Supplement

7 Identify in diagrams and images the atrioventricular and semilunar valves in the mammalian heart

8 Explain the relative thickness of:

(a) the muscle walls of the left and right ventricles

(b) the muscle walls of the atria compared to those of the ventricles

9 Explain the importance of the septum in separating oxygenated and deoxygenated blood

10 Describe the functioning of the heart in terms of the contraction of muscles of the atria and ventricles and the action of the valves

11 Explain the effect of physical activity on the heart rate

9.3 Blood vessels

Core

1 Describe the structure of arteries, veins and capillaries, limited to: relative thickness of wall, diameter of the lumen and the presence of valves in veins

2 State the functions of capillaries

3 Identify in diagrams and images the main blood vessels to and from the:
- (a) heart, limited to: vena cava, aorta, pulmonary artery and pulmonary vein
- (b) lungs, limited to: pulmonary artery and pulmonary vein
- (c) kidney, limited to: renal artery and renal vein

Supplement

4 Explain how the structure of arteries and veins is related to the pressure of the blood that they transport

5 Explain how the structure of capillaries is related to their functions

6 Identify, in diagrams and images, the main blood vessels to and from the liver as: hepatic artery, hepatic veins and hepatic portal vein

9.4 Blood

Core

1 List the components of blood as: red blood cells, white blood cells, platelets and plasma

2 Identify red and white blood cells in photomicrographs and diagrams

3 State the functions of the following components of blood:
- (a) red blood cells in transporting oxygen, including the role of haemoglobin
- (b) white blood cells in phagocytosis and antibody production
- (c) platelets in clotting (details are **not** required)
- (d) plasma in the transport of blood cells, ions, nutrients, urea, hormones and carbon dioxide

4 State the roles of blood clotting as preventing blood loss and the entry of pathogens

Supplement

5 Identify lymphocytes and phagocytes in photomicrographs and diagrams

6 State the functions of:
- (a) lymphocytes – antibody production
- (b) phagocytes – engulfing pathogens by phagocytosis

7 Describe the process of clotting as the conversion of fibrinogen to fibrin to form a mesh

10 Diseases and immunity

10.1 Diseases and immunity

Core

1 Describe a pathogen as a disease-causing organism

2 Describe a transmissible disease as a disease in which the pathogen can be passed from one host to another

3 State that a pathogen is transmitted:
- (a) by direct contact, including through blood and other body fluids
- (b) indirectly, including from contaminated surfaces, food, animals and air

4 Describe the body defences, limited to: skin, hairs in the nose, mucus, stomach acid and white blood cells

5 Explain the importance of the following in controlling the spread of disease:
- (a) a clean water supply
- (b) hygienic food preparation
- (c) good personal hygiene
- (d) waste disposal
- (e) sewage treatment (details of the stages of sewage treatment are **not** required)

Supplement

6 Describe active immunity as defence against a pathogen by antibody production in the body

7 State that each pathogen has its own antigens, which have specific shapes

8 Describe antibodies as proteins that bind to antigens leading to direct destruction of pathogens or marking of pathogens for destruction by phagocytes

9 State that specific antibodies have complementary shapes which fit specific antigens

10 Explain that active immunity is gained after an infection by a pathogen or by vaccination

11 Outline the process of vaccination:
- (a) weakened pathogens or their antigens are put into the body
- (b) the antigens stimulate an immune response by lymphocytes which produce antibodies
- (c) memory cells are produced that give long-term immunity

12 Explain the role of vaccination in controlling the spread of diseases

13 Explain that passive immunity is a short-term defence against a pathogen by antibodies acquired from another individual, including across the placenta and in breast milk

14 Explain the importance of breast-feeding for the development of passive immunity in infants

15 State that memory cells are not produced in passive immunity

continued

10.1 Diseases and immunity continued

Core	Supplement
	16 Describe cholera as a disease caused by a bacterium which is transmitted in contaminated water
	17 Explain that the cholera bacterium produces a toxin that causes secretion of chloride ions into the small intestine, causing osmotic movement of water into the gut, causing diarrhoea, dehydration and loss of ions from the blood

11 Gas exchange in humans

11.1 Gas exchange in humans

Core	Supplement
1 Describe the features of gas exchange surfaces in humans, limited to: large surface area, thin surface, good blood supply and good ventilation with air	
2 Identify in diagrams and images the following parts of the breathing system: lungs, diaphragm, ribs, intercostal muscles, larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries	6 Identify in diagrams and images the internal and external intercostal muscles
	7 State the function of cartilage in the trachea
	8 Explain the role of the ribs, the internal and external intercostal muscles and the diaphragm in producing volume and pressure changes in the thorax leading to the ventilation of the lungs
3 Investigate the differences in composition between inspired and expired air using limewater as a test for carbon dioxide	9 Explain the differences in composition between inspired and expired air
4 Describe the differences in composition between inspired and expired air, limited to: oxygen, carbon dioxide and water vapour	
5 Investigate and describe the effects of physical activity on the rate and depth of breathing	10 Explain the link between physical activity and the rate and depth of breathing in terms of: an increased carbon dioxide concentration in the blood, which is detected by the brain, leading to an increased rate and greater depth of breathing
	11 Explain the role of goblet cells, mucus and ciliated cells in protecting the breathing system from pathogens and particles

12 Respiration

12.1 Respiration

Core

1 State the uses of energy in living organisms, including: muscle contraction, protein synthesis, cell division, active transport, growth, the passage of nerve impulses and the maintenance of a constant body temperature

2 Investigate and describe the effect of temperature on respiration in yeast

Supplement

12.2 Aerobic respiration

Core

1 Describe aerobic respiration as the chemical reactions in cells that use oxygen to break down nutrient molecules to release energy

2 State the word equation for aerobic respiration as:

glucose + oxygen → carbon dioxide + water

Supplement

3 State the balanced chemical equation for aerobic respiration as:

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

12.3 Anaerobic respiration

Core

1 Describe anaerobic respiration as the chemical reactions in cells that break down nutrient molecules to release energy without using oxygen

2 State that anaerobic respiration releases much less energy per glucose molecule than aerobic respiration

3 State the word equation for anaerobic respiration in yeast as:

glucose → alcohol + carbon dioxide

4 State the word equation for anaerobic respiration in muscles during vigorous exercise as:

glucose → lactic acid

Supplement

5 State the balanced chemical equation for anaerobic respiration in yeast as:

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

6 State that lactic acid builds up in muscles and blood during vigorous exercise causing an oxygen debt

continued

12.3 Anaerobic respiration continued

Core	Supplement
	7 Outline how the oxygen debt is removed after exercise, limited to: (a) continuation of fast heart rate to transport lactic acid in the blood from the muscles to the liver (b) continuation of deeper and faster breathing to supply oxygen for aerobic respiration of lactic acid (c) aerobic respiration of lactic acid in the liver

13 Excretion in humans

13.1 Excretion in humans

Core	Supplement
1 State that carbon dioxide is excreted through the lungs 2 State that the kidneys excrete urea and excess water and ions 3 Identify in diagrams and images the kidneys, ureters, bladder and urethra	4 Identify in diagrams and images the structure of the kidney, limited to the cortex and medulla 5 Outline the structure and function of a nephron and its associated blood vessels, limited to: (a) the role of the glomerulus in the filtration from the blood of water, glucose, urea and ions (b) the role of the nephron in the reabsorption of all of the glucose, some of the ions and most of the water back into the blood (c) the formation of urine containing urea, excess water and excess ions (details of these processes are **not** required) 6 Describe the role of the liver in the assimilation of amino acids by converting them to proteins 7 State that urea is formed in the liver from excess amino acids 8 Describe deamination as the removal of the nitrogen-containing part of amino acids to form urea 9 Explain the importance of excretion, limited to toxicity of urea

14 Coordination and response

14.1 Coordination and response

Core

1 State that electrical impulses travel along neurones

2 Describe the mammalian nervous system in terms of:

(a) the central nervous system (CNS) consisting of the brain and the spinal cord

(b) the peripheral nervous system (PNS) consisting of the nerves outside of the brain and spinal cord

3 Describe the role of the nervous system as coordination and regulation of body functions

4 Identify in diagrams and images sensory, relay and motor neurones

5 Describe a simple reflex arc in terms of: receptor, sensory neurone, relay neurone, motor neurone and effector

6 Describe a reflex action as a means of automatically and rapidly integrating and coordinating stimuli with the responses of effectors (muscles and glands)

7 Describe a synapse as a junction between two neurones

Supplement

8 Describe the structure of a synapse, including the presence of vesicles containing neurotransmitter molecules, the synaptic gap and receptor proteins

9 Describe the events at a synapse as:

(a) an impulse stimulates the release of neurotransmitter molecules from vesicles into the synaptic gap

(b) the neurotransmitter molecules diffuse across the gap

(c) neurotransmitter molecules bind with receptor proteins on the next neurone

(d) an impulse is then stimulated in the next neurone

10 State that synapses ensure that impulses travel in one direction only

14.2 Sense organs

Core

1 Describe sense organs as groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals

2 Identify in diagrams and images the structures of the eye, limited to: cornea, iris, pupil, lens, retina, optic nerve and blind spot

3 Describe the function of each part of the eye, limited to:

- (a) cornea – refracts light
- (b) iris – controls how much light enters the pupil
- (c) lens – focuses light on to the retina
- (d) retina – contains light receptors, some sensitive to light of different colours
- (e) optic nerve – carries impulses to the brain

4 Explain the pupil reflex, limited to changes in light intensity and pupil diameter

Supplement

5 Explain the pupil reflex in terms of the antagonistic action of circular and radial muscles in the iris

6 Explain accommodation to view near and distant objects in terms of the contraction and relaxation of the ciliary muscles, tension in the suspensory ligaments, shape of the lens and refraction of light

7 Describe the distribution of rods and cones in the retina of a human

8 Outline the function of rods and cones, limited to:

- (a) greater sensitivity of rods for night vision
- (b) three different kinds of cones, absorbing light of different colours, for colour vision

9 Identify in diagrams and images the position of the fovea and state its function

14.3 Hormones

Core

1 Describe a hormone as a chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs

2 Identify in diagrams and images specific endocrine glands and state the hormones they secrete, limited to:
- (a) adrenal glands and adrenaline
- (b) pancreas and insulin
- (c) testes and testosterone
- (d) ovaries and oestrogen

3 Describe adrenaline as the hormone secreted in 'fight or flight' situations and its effects, limited to:
- (a) increased breathing rate
- (b) increased heart rate
- (c) increased pupil diameter

4 Compare nervous and hormonal control, limited to speed of action and duration of effect

Supplement

5 State that glucagon is secreted by the pancreas

6 Describe the role of adrenaline in the control of metabolic activity, limited to:
- (a) increasing the blood glucose concentration
- (b) increasing heart rate

14.4 Homeostasis

Core

1 Describe homeostasis as the maintenance of a constant internal environment

2 State that insulin decreases blood glucose concentration

Supplement

3 Explain the concept of homeostatic control by negative feedback with reference to a set point

4 Describe the control of blood glucose concentration by the liver and the roles of insulin and glucagon

5 Outline the treatment of Type 1 diabetes

6 Identify in diagrams and images of the skin: hairs, hair erector muscles, sweat glands, receptors, sensory neurones, blood vessels and fatty tissue

7 Describe the maintenance of a constant internal body temperature in mammals in terms of: insulation, sweating, shivering and the role of the brain

8 Describe the maintenance of a constant internal body temperature in mammals in terms of vasodilation and vasoconstriction of arterioles supplying skin surface capillaries

14.5 Tropic responses

Core

1 Describe gravitropism as a response in which parts of a plant grow towards or away from gravity
2 Describe phototropism as a response in which parts of a plant grow towards or away from the direction of the light source
3 Investigate and describe gravitropism and phototropism in shoots and roots

Supplement

4 Explain phototropism and gravitropism of a shoot as examples of the chemical control of plant growth
5 Explain the role of auxin in controlling shoot growth, limited to:
   (a) auxin is made in the shoot tip
   (b) auxin diffuses through the plant from the shoot tip
   (c) auxin is unequally distributed in response to light and gravity
   (d) auxin stimulates cell elongation

15 Drugs

15.1 Drugs

Core

1 Describe a drug as any substance taken into the body that modifies or affects chemical reactions in the body
2 Describe the use of antibiotics for the treatment of bacterial infections
3 State that some bacteria are resistant to antibiotics which reduces the effectiveness of antibiotics
4 State that antibiotics kill bacteria but do not affect viruses

Supplement

5 Explain how using antibiotics only when essential can limit the development of resistant bacteria such as MRSA

16 Reproduction

16.1 Asexual reproduction

Core

1 Describe asexual reproduction as a process resulting in the production of genetically identical offspring from one parent
2 Identify examples of asexual reproduction in diagrams, images and information provided

Supplement

3 Discuss the advantages and disadvantages of asexual reproduction:
   (a) to a population of a species in the wild
   (b) to crop production

16.2 Sexual reproduction

Core

1 Describe sexual reproduction as a process involving the fusion of the nuclei of two gametes to form a zygote and the production of offspring that are genetically different from each other

2 Describe fertilisation as the fusion of the nuclei of gametes

Supplement

3 State that nuclei of gametes are haploid and that the nucleus of a zygote is diploid

4 Discuss the advantages and disadvantages of sexual reproduction:
- (a) to a population of a species in the wild
- (b) to crop production

16.3 Sexual reproduction in plants

Core

1 Identify in diagrams and images and draw the following parts of an insect-pollinated flower: sepals, petals, stamens, filaments, anthers, carpels, style, stigma, ovary and ovules

2 State the functions of the structures listed in 16.3.1

3 Identify in diagrams and images and describe the anthers and stigmas of a wind-pollinated flower

4 Distinguish between the pollen grains of insect-pollinated and wind-pollinated flowers

5 Describe pollination as the transfer of pollen grains from an anther to a stigma

Supplement

9 Describe self-pollination as the transfer of pollen grains from the anther of a flower to the stigma of the same flower or a different flower on the same plant

10 Describe cross-pollination as the transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species

11 Discuss the potential effects of self-pollination and cross-pollination on a population, in terms of variation, capacity to respond to changes in the environment and reliance on pollinators

continued

16.3 Sexual reproduction in plants continued

Core

6 State that fertilisation occurs when a pollen nucleus fuses with a nucleus in an ovule

7 Describe the structural adaptations of insect-pollinated and wind-pollinated flowers

8 Investigate and describe the environmental conditions that affect germination of seeds, limited to the requirement for: water, oxygen and a suitable temperature

Supplement

12 Describe the growth of the pollen tube and its entry into the ovule followed by fertilisation (details of production of endosperm and development are **not** required)

16.4 Sexual reproduction in humans

Core

1 Identify on diagrams and state the functions of the following parts of the male reproductive system: testes, scrotum, sperm ducts, prostate gland, urethra and penis

2 Identify on diagrams and state the functions of the following parts of the female reproductive system: ovaries, oviducts, uterus, cervix and vagina

3 Describe fertilisation as the fusion of the nuclei from a male gamete (sperm) and a female gamete (egg cell)

4 Explain the adaptive features of sperm, limited to: flagellum, mitochondria and enzymes in the acrosome

5 Explain the adaptive features of egg cells, limited to: energy stores and the jelly coat that changes at fertilisation

6 Compare male and female gametes in terms of: size, structure, motility and numbers

7 State that in early development, the zygote forms an embryo which is a ball of cells that implants into the lining of the uterus

8 Identify on diagrams and state the functions of the following in the development of the fetus: umbilical cord, placenta, amniotic sac and amniotic fluid

Supplement

9 Describe the function of the placenta and umbilical cord in relation to the exchange of dissolved nutrients, gases and excretory products between the blood of the mother and the blood of the fetus

10 State that some pathogens and toxins can pass across the placenta and affect the fetus

16.5 Sexual hormones in humans

Core

1 Describe the roles of testosterone and oestrogen in the development and regulation of secondary sexual characteristics during puberty

2 Describe the menstrual cycle in terms of changes in the ovaries and in the lining of the uterus

Supplement

3 Describe the sites of production of oestrogen and progesterone in the menstrual cycle and in pregnancy

4 Explain the role of hormones in controlling the menstrual cycle and pregnancy, limited to FSH, LH, progesterone and oestrogen

16.6 Sexually transmitted infections

Core

1 Describe a sexually transmitted infection (STI) as an infection that is transmitted through sexual contact

2 State that human immunodeficiency virus (HIV) is a pathogen that causes an STI

3 State that HIV infection may lead to AIDS

4 Describe the methods of transmission of HIV

5 Explain how the spread of STIs is controlled

Supplement

17 Inheritance

17.1 Chromosomes, genes and proteins

Core

1 State that chromosomes are made of DNA, which contains genetic information in the form of genes

2 Define a gene as a length of DNA that codes for a protein

3 Define an allele as an alternative form of a gene

4 Describe the inheritance of sex in humans with reference to X and Y chromosomes

Supplement

5 State that the sequence of bases in a gene determines the sequence of amino acids used to make a specific protein (knowledge of the details of nucleotide structure is **not** required)

6 Explain that different sequences of amino acids give different shapes to protein molecules

continued

17.1 Chromosomes, genes and proteins continued

Core

Supplement

7 Explain that DNA controls cell function by controlling the production of proteins, including enzymes, membrane carriers and receptors for neurotransmitters

8 Explain how a protein is made, limited to:

- the gene coding for the protein remains in the nucleus
- messenger RNA (mRNA) is a copy of a gene
- mRNA molecules are made in the nucleus and move to the cytoplasm
- the mRNA passes through ribosomes
- the ribosome assembles amino acids into protein molecules
- the specific sequence of amino acids is determined by the sequence of bases in the mRNA

(knowledge of the details of transcription or translation is **not** required)

9 Explain that most body cells in an organism contain the same genes, but many genes in a particular cell are not expressed because the cell only makes the specific proteins it needs

10 Describe a haploid nucleus as a nucleus containing a single set of chromosomes

11 Describe a diploid nucleus as a nucleus containing two sets of chromosomes

12 State that in a diploid cell, there is a pair of each type of chromosome and in a human diploid cell there are 23 pairs

17.2 Mitosis

Core

Supplement

1 Describe mitosis as nuclear division giving rise to genetically identical cells (details of the stages of mitosis are **not** required)

2 State the role of mitosis in growth, repair of damaged tissues, replacement of cells and asexual reproduction

3 State that the exact replication of chromosomes occurs before mitosis

4 State that during mitosis, the copies of chromosomes separate, maintaining the chromosome number in each daughter cell

5 Describe stem cells as unspecialised cells that divide by mitosis to produce daughter cells that can become specialised for specific functions

17.3 Meiosis

Core

Supplement

1 State that meiosis is involved in the production of gametes

2 Describe meiosis as a reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells (details of the stages of meiosis are **not** required)

17.4 Monohybrid inheritance

Core

1 Describe inheritance as the transmission of genetic information from generation to generation

2 Describe genotype as the genetic make-up of an organism and in terms of the alleles present

3 Describe phenotype as the observable features of an organism

4 Describe homozygous as having two identical alleles of a particular gene

5 State that two identical homozygous individuals that breed together will be pure-breeding

6 Describe heterozygous as having two different alleles of a particular gene

7 State that a heterozygous individual will not be pure-breeding

8 Describe a dominant allele as an allele that is expressed if it is present in the genotype

9 Describe a recessive allele as an allele that is only expressed when there is no dominant allele of the gene present in the genotype

10 Interpret pedigree diagrams for the inheritance of a given characteristic

11 Use genetic diagrams to predict the results of monohybrid crosses and calculate phenotypic ratios, limited to 1 : 1 and 3 : 1 ratios

12 Use Punnett squares in crosses which result in more than one genotype to work out and show the possible different genotypes

Supplement

13 Explain how to use a test cross to identify an unknown genotype

continued

17.4 Monohybrid inheritance continued

Core	Supplement
	14 Describe codominance as a situation in which both alleles in heterozygous organisms contribute to the phenotype
	15 Explain the inheritance of ABO blood groups: phenotypes are A, B, AB and O blood groups and alleles are I^A, I^B and I^o
	16 Describe a sex-linked characteristic as a feature in which the gene responsible is located on a sex chromosome and that this makes the characteristic more common in one sex than in the other
	17 Describe red-green colour blindness as an example of sex linkage
	18 Use genetic diagrams to predict the results of monohybrid crosses involving codominance or sex linkage and calculate phenotypic ratios

18 Variation and selection

18.1 Variation

Core	Supplement
1 Describe variation as differences between individuals of the same species	
2 State that continuous variation results in a range of phenotypes between two extremes; examples include body length and body mass	
3 State that discontinuous variation results in a limited number of phenotypes with no intermediates; examples include ABO blood groups, seed shape in peas and seed colour in peas	
4 State that discontinuous variation is usually caused by genes only and continuous variation is caused by both genes and the environment	
5 Investigate and describe examples of continuous and discontinuous variation	
6 Describe mutation as genetic change	9 Describe gene mutation as a random change in the base sequence of DNA
7 State that mutation is the way in which new alleles are formed	10 State that mutation, meiosis, random mating and random fertilisation are sources of genetic variation in populations
8 State that ionising radiation and some chemicals increase the rate of mutation	

18.2 Adaptive features

Core

1 Describe an adaptive feature as an inherited feature that helps an organism to survive and reproduce in its environment

2 Interpret images or other information about a species to describe its adaptive features

Supplement

3 Explain the adaptive features of hydrophytes and xerophytes to their environments

18.3 Selection

Core

1 Describe natural selection with reference to:
- (a) genetic variation within populations
- (b) production of many offspring
- (c) struggle for survival, including competition for resources
- (d) a greater chance of reproduction by individuals that are better adapted to the environment than others
- (e) these individuals pass on their alleles to the next generation

2 Describe selective breeding with reference to:
- (a) selection by humans of individuals with desirable features
- (b) crossing these individuals to produce the next generation
- (c) selection of offspring showing the desirable features

3 Outline how selective breeding by artificial selection is carried out over many generations to improve crop plants and domesticated animals and apply this to given contexts

Supplement

4 Describe adaptation as the process, resulting from natural selection, by which populations become more suited to their environment over many generations

5 Describe the development of strains of antibiotic resistant bacteria as an example of natural selection

6 Outline the differences between natural and artificial selection

19 Organisms and their environment

19.1 Energy flow

Core	Supplement
1 State that the Sun is the principal source of energy input to biological systems	
2 Describe the flow of energy through living organisms, including light energy from the Sun and chemical energy in organisms, and its eventual transfer to the environment	

19.2 Food chains and food webs

Core	Supplement
1 Describe a food chain as showing the transfer of energy from one organism to the next, beginning with a producer	
2 Construct and interpret simple food chains	
3 Describe a food web as a network of interconnected food chains and interpret food webs	
4 Describe a producer as an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis	
5 Describe a consumer as an organism that gets its energy by feeding on other organisms	
6 State that consumers may be classed as primary, secondary, tertiary and quaternary according to their position in a food chain	
7 Describe a herbivore as an animal that gets its energy by eating plants	
8 Describe a carnivore as an animal that gets its energy by eating other animals	
9 Describe a decomposer as an organism that gets its energy from dead or waste organic material	
10 Use food chains and food webs to describe the impact humans have through overharvesting of food species and through introducing foreign species to a habitat	
11 Draw, describe and interpret pyramids of numbers and pyramids of biomass	15 Draw, describe and interpret pyramids of energy
12 Discuss the advantages of using a pyramid of biomass rather than a pyramid of numbers to represent a food chain	16 Discuss the advantages of using a pyramid of energy rather than pyramids of numbers or biomass to represent a food chain
13 Describe a trophic level as the position of an organism in a food chain, food web or ecological pyramid	

continued

19.2 Food chains and food webs continued

Core

14 Identify the following as the trophic levels in food webs, food chains and ecological pyramids: producers, primary consumers, secondary consumers, tertiary consumers and quaternary consumers

Supplement

17 Explain why the transfer of energy from one trophic level to another is often not efficient

18 Explain, in terms of energy loss, why food chains usually have fewer than five trophic levels

19 Explain why it is more energy efficient for humans to eat crop plants than to eat livestock that have been fed on crop plants

19.3 Nutrient cycles

Core

1 Describe the carbon cycle, limited to: photosynthesis, respiration, feeding, decomposition, formation of fossil fuels and combustion

Supplement

2 Describe the nitrogen cycle with reference to:

- decomposition of plant and animal protein to ammonium ions
- nitrification
- nitrogen fixation by lightning and bacteria
- absorption of nitrate ions by plants
- production of amino acids and proteins
- feeding and digestion of proteins
- deamination
- denitrification

3 State the roles of microorganisms in the nitrogen cycle, limited to: decomposition, nitrification, nitrogen fixation and denitrification (generic names of individual bacteria, e.g. *Rhizobium*, are **not** required)

19.4 Populations

Core	Supplement
1 Describe a population as a group of organisms of one species, living in the same area, at the same time	
2 Describe a community as all of the populations of different species in an ecosystem	
3 Describe an ecosystem as a unit containing the community of organisms and their environment, interacting together	
4 Identify and state the factors affecting the rate of population growth for a population of an organism, limited to food supply, competition, predation and disease	
5 Identify the lag, exponential (log), stationary and death phases in the sigmoid curve of population growth for a population growing in an environment with limited resources	7 Explain the factors that lead to each phase in the sigmoid curve of population growth, making reference, where appropriate, to the role of limiting factors
6 Interpret graphs and diagrams of population growth	

20 Human influences on ecosystems

20.1 Food supply

Core	Supplement
1 Describe how humans have increased food production, limited to: (a) agricultural machinery to use larger areas of land and improve efficiency (b) chemical fertilisers to improve yields (c) insecticides to improve quality and yield (d) herbicides to reduce competition with weeds (e) selective breeding to improve production by crop plants and livestock	
2 Describe the advantages and disadvantages of large-scale monocultures of crop plants	
3 Describe the advantages and disadvantages of intensive livestock production	

20.2 Habitat destruction

Core

1 Describe biodiversity as the number of different species that live in an area

2 Describe the reasons for habitat destruction, including:

(a) increased area for housing, crop plant production and livestock production

(b) extraction of natural resources

(c) freshwater and marine pollution

3 State that through altering food webs and food chains, humans can have a negative impact on habitats

4 Explain the undesirable effects of deforestation as an example of habitat destruction, to include: reducing biodiversity, extinction, loss of soil, flooding and increase of carbon dioxide in the atmosphere

Supplement

20.3 Pollution

Core

1 Describe the effects of untreated sewage and excess fertiliser on aquatic ecosystems

2 Describe the effects of non-biodegradable plastics, in both aquatic and terrestrial ecosystems

3 Describe the sources and effects of pollution of the air by methane and carbon dioxide, limited to: the enhanced greenhouse effect and climate change

Supplement

4 Explain the process of eutrophication of water, limited to:

- increased availability of nitrate and other ions
- increased growth of producers
- increased decomposition after death of producers
- increased aerobic respiration by decomposers
- reduction in dissolved oxygen
- death of organisms requiring dissolved oxygen in water

20.4 Conservation

Core	Supplement
1 Describe a sustainable resource as one which is produced as rapidly as it is removed from the environment so that it does not run out	
2 State that some resources can be conserved and managed sustainably, limited to forests and fish stocks	5 Explain how forests can be conserved using: education, protected areas, quotas and replanting 6 Explain how fish stocks can be conserved using: education, closed seasons, protected areas, controlled net types and mesh size, quotas and monitoring
3 Explain why organisms become endangered or extinct, including: climate change, habitat destruction, hunting, overharvesting, pollution and introduced species	
4 Describe how endangered species can be conserved, limited to: (a) monitoring and protecting species and habitats (b) education (c) captive breeding programmes (d) seed banks	7 Describe the reasons for conservation programmes, limited to: (a) maintaining or increasing biodiversity (b) reducing extinction (c) protecting vulnerable ecosystems (d) maintaining ecosystem functions, limited to nutrient cycling and resource provision, including food, drugs, fuel and genes 8 Describe the use of artificial insemination (AI) and *in vitro* fertilisation (IVF) in captive breeding programmes 9 Explain the risks to a species if its population size decreases, reducing genetic variation (knowledge of genetic drift is **not** required)

21 Biotechnology and genetic modification

21.1 Biotechnology and genetic modification

Core	Supplement
1 State that bacteria are useful in biotechnology and genetic modification due to their rapid reproduction rate and their ability to make complex molecules	2 Discuss why bacteria are useful in biotechnology and genetic modification, limited to: (a) few ethical concerns over their manipulation and growth (b) the presence of plasmids

21.2 Biotechnology

Core

1 Describe the role of anaerobic respiration in yeast during the production of ethanol for biofuels

2 Describe the role of anaerobic respiration in yeast during bread-making

3 Describe the use of pectinase in fruit juice production

4 Investigate and describe the use of biological washing powders that contain enzymes

Supplement

5 Explain the use of lactase to produce lactose-free milk

6 Describe how fermenters can be used for the large-scale production of useful products by bacteria and fungi, including insulin, penicillin and mycoprotein

7 Describe and explain the conditions that need to be controlled in a fermenter, including: temperature, pH, oxygen, nutrient supply and waste products

21.3 Genetic modification

Core

1 Describe genetic modification as changing the genetic material of an organism by removing, changing or inserting individual genes

Supplement

3 Outline the process of genetic modification using bacterial production of a human protein as an example, limited to:

(a) isolation of the DNA making up a human gene using restriction enzymes, forming sticky ends

(b) cutting of bacterial plasmid DNA with the same restriction enzymes, forming complementary sticky ends

(c) insertion of human DNA into bacterial plasmid DNA using DNA ligase to form a recombinant plasmid

(d) insertion of recombinant plasmids into bacteria (specific details are **not** required)

(e) multiplication of bacteria containing recombinant plasmids

(f) expression in bacteria of the human gene to make the human protein

continued

21.3 Genetic modification continued

Core

2 Outline examples of genetic modification:

(a) the insertion of human genes into bacteria to produce human proteins

(b) the insertion of genes into crop plants to confer resistance to herbicides

(c) the insertion of genes into crop plants to confer resistance to insect pests

(d) the insertion of genes into crop plants to improve nutritional qualities

Supplement

4 Discuss the advantages and disadvantages of genetically modifying crops, including soya, maize and rice

4 Details of the assessment

All candidates take three papers.

Candidates who have studied the Core subject content, or who are expected to achieve a grade D or below should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G.

Candidates who have studied the Extended subject content (Core and Supplement), and who are expected to achieve a grade C or above should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades A* to G.

Core assessment

Core candidates take the following papers. The questions are based on the Core subject content only.

Paper 1: Multiple Choice (Core)		Paper 3: Theory (Core)
45 minutes		1 hour 15 minutes
40 marks		80 marks
Forty compulsory multiple-choice items of the four-choice type.		Compulsory short-answer and structured questions
This paper tests assessment objectives AO1 and AO2	**AND**	This paper tests assessment objectives AO1 and AO2
This paper assesses grades C to G		This paper assesses grades C to G
Externally assessed		Externally assessed

Extended assessment

Extended candidates take the following papers. The questions are based on the Core and Supplement subject content.

Paper 2: Multiple Choice (Extended)		Paper 4: Theory (Extended)
45 minutes		1 hour 15 minutes
40 marks		80 marks
Forty compulsory multiple-choice items of the four-choice type.		Compulsory short-answer and structured questions
This paper tests assessment objectives AO1 and AO2	**AND**	This paper tests assessment objectives AO1 and AO2
This paper assesses grades A* to G		This paper assesses grades A* to G
Externally assessed		Externally assessed

Practical assessment

All candidates take one practical component from a choice of two:

Paper 5: Practical Test		Paper 6: Alternative to Practical
1 hour 15 minutes		1 hour
40 marks		40 marks
This paper tests assessment objective AO3		This paper tests assessment objective AO3
This paper assesses grades A* to G	**OR**	This paper assesses grades A* to G
Candidates will be required to do experiments in a laboratory as part of this test		Candidates will not be required to do experiments as part of this test
Questions in the practical papers are structured to assess performance across the full grade range.		

The Practical Test and Alternative to Practical:

- require the same experimental skills to be developed and learned
- require an understanding of the same experimental contexts
- test the same assessment objective, AO3.

Candidates are expected to be familiar with and may be asked questions on the following experimental contexts:

- simple quantitative experiments, including the measurement of:
  - volumes of gases and liquids
  - masses
  - temperatures
  - times
  - lengths
- diffusion
- osmosis
- food tests
- rates of enzyme-catalysed reactions, including judging end-points, e.g. colour changes
- pH and the use of hydrogencarbonate indicator, litmus and universal indicator
- photosynthesis (rate and limiting factors)
- transpiration
- heart rate and breathing rate
- respiration
- tropic responses
- observation and dissection of seeds and flowers
- germination
- continuous and discontinuous variation
- use methods of sampling that are representative and avoid bias, e.g. consideration of sample size and simple random sampling
- observe, record and measure images of familiar and unfamiliar biological specimens
- make clear line drawings of biological specimens, calculating the magnification or actual size and adding labels as required
- use simple apparatus in situations where the method may not be familiar to the candidate.

Candidates may be required to do the following:

- **demonstrate knowledge of how to select and safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate):**
  - identify apparatus from diagrams or descriptions
  - draw, complete or label diagrams of apparatus and biological specimens
  - use, or explain the use of, common techniques, apparatus and materials
  - select the most appropriate apparatus or method for the task and justify the choice made
  - describe food tests
  - describe how the pH of a solution or substance can be tested
  - describe and explain hazards and safety precautions
  - describe and explain techniques used to ensure the accuracy of observations and data

- **plan experiments and investigations:**
  - identify the independent variable and dependent variable
  - describe how and explain why variables should be kept constant
  - suggest an appropriate number and range of values for the independent variable
  - suggest the most appropriate apparatus or technique and justify the choice made
  - describe experimental procedures, including a suitable control experiment
  - identify risks and suggest safety precautions
  - describe how to record the results of an experiment
  - describe how to process the results of an experiment to form a conclusion or to evaluate a prediction
  - make reasoned predictions of expected results

- **make and record observations, measurements and estimates:**
  - take readings from apparatus (analogue and digital) or from diagrams of apparatus with appropriate precision
  - take sufficient observations or measurements, including repeats and replicates where appropriate
  - record qualitative observations from food and other tests
  - record observations and measurements systematically, for example in a suitable table, to an appropriate degree of precision and using appropriate units

- i**nterpret and evaluate experimental observations and data:**
  - process data, including for use in further calculations or for graph plotting, using a calculator as appropriate
  - present data graphically
  - analyse and interpret observations and data, including data presented graphically
  - use interpolation and extrapolation graphically to determine a gradient or intercept
  - form conclusions justified by reference to observations and data and with appropriate explanation
  - evaluate the quality of observations and data, identifying any anomalous results and taking appropriate action

- **evaluate methods and suggest possible improvements:**
  - evaluate experimental arrangements, methods and techniques, including the use of a control
  - identify sources of error
  - suggest possible improvements to the apparatus, experimental arrangements, methods and techniques.

Apparatus, materials and reagents

These lists give items candidates should be familiar with using, whether they are taking the Practical Test or the Alternative to Practical.

These items should be available for use in the Practical Test. These lists are not exhaustive and we may also require other items to be sourced for specific exams. The Confidential Instructions we send before the Practical Test will give the detailed requirements for the exam.

Every effort is made to limit the resources required by centres and so minimise the costs. Experiments will be designed around basic apparatus and materials which should be available in most school laboratories or are easily obtainable.

Hazard codes are used where relevant and in accordance with information provided by CLEAPSS (**www.cleapss.org.uk**). Candidates should be familiar with the meanings of these codes and terms but will **not** be assessed on them.

C corrosive
HH health hazard
F flammable
N hazardous to the aquatic environment
MH moderate hazard
T acutely toxic
O oxidising

The attention of centres is drawn to any local regulations relating to safety, first aid and disposal of chemicals. 'Hazard Data Sheets' should be available from your chemical supplier.

Candidates must be provided with appropriate safety equipment, such as suitable eye protection and gloves, during practical work.

The Confidential Instructions will indicate which hazard symbols are applicable for the materials required for each Practical Test exam.

Chemicals, reagents and indicators

The list below is not intended to be comprehensive but shows the types of chemicals, reagents and indicators that candidates should be familiar with.

- Benedict's solution
- biuret reagent
- carbohydrates (starch, glucose, sucrose), proteins, lipids
- DCPIP
- dilute acid
- dilute alkali
- distilled or deionised water
- enzymes (e.g. amylase, a protease, lipase)
- ethanol
- indicators (universal indicator solution, hydrogencarbonate indicator, litmus solution)
- hydrogen peroxide solution
- iodine in potassium iodide solution (iodine solution)

- limewater
- methylene blue dye
- petroleum jelly (Vaseline® or similar)
- sodium chloride
- sodium hydrogencarbonate (sodium bicarbonate)

Apparatus

Other materials may be required for examinations.

- balance to measure up to 500 g, with precision of at least 0.1 g
- beakers (various sizes, 100 cm^3, 250 cm^3)
- bungs to fit small test-tubes and large test-tubes
- bungs with delivery tubes to fit small test-tubes and large test-tubes
- filter funnels
- filter paper
- forceps
- glass rods
- hand lenses (at least ×6 magnification)
- lamps for photosynthesis experiments
- means of cutting biological materials (e.g. scalpels or sharp knives)
- means of writing on glassware (e.g. wax pencils or water-resistant markers)
- measuring cylinders (e.g. 10, 25 and 100 cm^3)
- mounted needles or seekers or long pins with large heads
- rulers, graduated in mm
- scissors
- partially permeable membrane (e.g. Visking® or dialysis tubing)
- Pasteur or dropping pipette
- Petri dishes
- spotting tiles
- stop-clocks, reading to 1 s or better
- syringes (various sizes, 1 cm^3, 5 cm^3, 10 cm^3)
- test-tubes – small (125 mm × 15 mm) and large (150 mm × 25 mm)
- test-tube racks and test-tube holders
- thermometers, –10 °C to +110 °C, with 1 °C graduations
- wash bottles
- white tiles or other suitable cutting surfaces

Safety in the laboratory

Teachers should make sure they do not contravene any school, education authority or government regulation. Responsibility for safety matters rests with centres. Further information can be found from the following UK associations, publications and regulations.

Associations

CLEAPSS is an advisory service providing support in practical science and technology.
www.cleapss.org.uk

Publications

CLEAPSS Laboratory Handbook, updated 2015 (available to CLEAPSS members only)

CLEAPSS Hazcards, 2019 update of 2016 edition (available to CLEAPSS members only)

UK regulations

Control of Substances Hazardous to Health Regulations (COSHH) 2002 and subsequent amendment in 2004

www.legislation.gov.uk/uksi/2002/2677/contents/made

www.legislation.gov.uk/uksi/2004/3386/contents/made

A brief guide may be found at **www.hse.gov.uk/pubns/indg136.pdf**

Mathematical requirements

It is expected that these requirements will be covered as part of a mathematics curriculum at this level of study.

Calculators may be used in all parts of the exam.

Number

- add, subtract, multiply and divide
- use decimals, fractions, ratios and reciprocals
- calculate and use percentages and percentage change
- use standard form
- express answers to an appropriate or given number of significant figures
- express answers to an appropriate or given number of decimal places
- round answers appropriately

Algebra

- recognise and use direct and inverse proportion
- solve simple algebraic equations for any one term when the other terms are known
- substitute physical quantities into a formula

Geometry and measurements

- convert between units, including cm^3 and dm^3, mg, g and kg, µm, mm, cm and m
- understand the meaning of angle, curve, circle, radius, diameter, circumference, square, rectangle and diagonal
- recall and use equations for the area of a rectangle, the area of a triangle and the area of a circle
- recall and use equations for the volume of a rectangular block and the volume of a cylinder
- use a ruler
- make estimates of numbers, quantities and lengths
- understand surface area and use surface area : volume ratio
- use scale diagrams
- select and use the most appropriate units for recording data and the results of calculations

Graphs, charts and statistics

- draw charts and graphs from data
- interpret line graphs, bar charts, pie charts and histograms with equal intervals
- interpolate and extrapolate from data
- determine the gradient and intercept of a graph, including units where appropriate
- select suitable scales and axes for graphs
- recognise direct and inverse proportionality from a graph
- calculate the mean and range of a set of values
- use simple probability

Presentation of data

Taking and recording readings

- Data should be recorded so as to reflect the precision of the measuring instrument, i.e. the smallest difference that can reliably be detected on the measuring instrument scale should be reflected by the number of decimal places given in the measurement.
- A measurement or calculated quantity must be accompanied by a correct unit, where appropriate.
- Each column of a table should be headed with the observation or physical quantity and the unit where appropriate, e.g. time / s. The solidus (/) is to be used for separating the quantity and the unit in tables, graphs and charts.
- Units should not be included with data in the body of a table.
- Data should be recorded to the appropriate number of significant figures.

Graphs

- The column headings of a correctly headed table can be directly transferred to the axes of a constructed graph.
- A graph should be drawn with a sharp pencil.
- Each axis should be labelled with the observation or physical quantity and the unit where appropriate, e.g. time / s.
- Unless instructed otherwise, the independent variable should be plotted on the *x*-axis (horizontal axis) and the dependent variable plotted on the *y*-axis (vertical axis).

- Unless instructed otherwise, the scales for the axes should allow more than half of the graph grid to be used in both directions, and be based on sensible ratios, e.g. 2 cm on the graph grid representing 1, 2 or 5 units of the variable. The axes do not have to include (0,0).
- Points on the graph should be clearly marked as crosses (×) or encircled dots (⊙) of appropriate size.
- Each data point should be plotted to an accuracy of one half of one of the smallest squares on the grid.
- A best-fit line (trend line) should be a single, thin, smooth straight line or curve. The line does not need to coincide exactly with any of the points; where there is scatter evident in the data, examiners would expect a roughly even distribution of points either side of the line over its entire length. Points that are clearly anomalous should be ignored when drawing the best-fit line.
- A best-fit line or curve should only be drawn if there is good reason to believe that the intermediate values can be predicted.
- Candidates should be able to take readings from the graph by extrapolation or interpolation and indicate on the graph how they determined the reading.
- Data values should be read from a graph to an accuracy of one half of the smallest square on the grid.

Drawings

- Drawings should be drawn using a sharp pencil to give fine lines that are clear and unbroken.
- Drawings should use most of the available space and show all the features observed in the specimen, with no shading or use of colour.
- Label lines should be drawn with a ruler and touch the object or feature labelled.

Charts

- Pie charts are generally used to show percentage or proportionality.
- Bar charts should be drawn for categorical or discrete data. They should be made up of bars of equal width that do **not** touch.
- Histograms should be drawn for continuous data. They should have bars that touch.

Further guidance can be found in the following publications:

ASE, The Language of Mathematics in Science: A Guide for Teachers of 11–16 Science (2016).

ASE, The Language of Mathematics in Science: Teaching Approaches (2016).

www.ase.org.uk/mathsinscience

Conventions (e.g. signs, symbols, terminology and nomenclature)

Candidates are expected to be familiar with the nomenclature used in the syllabus.

The syllabus and question papers conform with accepted international practice. In particular, the following document, produced by the Association for Science Education (ASE), should be used as a guideline.

Signs, Symbols and Systematics: The ASE Companion to 16–19 Science (2000).

Decimal markers

In accordance with current ASE convention, decimal markers in examination papers will be a single dot on the line. Candidates are expected to follow this convention in their answers.

Numbers

Numbers from 1000 to 9999 will be printed without commas or spaces. Numbers greater than or equal to 10 000 will be printed without commas. A space will be left between each group of three digits, e.g. 4 256 789.

Variables

Independent variables are the variables that are changed in a scientific experiment by the scientist. Changing an independent variable may cause a change in the dependent variable.

Dependent variables are the variables that are observed or measured in a scientific experiment. Dependent variables may change based on changes made to the independent variables.

Units

To avoid any confusion concerning the symbol for litre, the equivalent quantity, the cubic decimetre (dm^3) will be used in place of *l* or litre.

In practical work, candidates will be expected to use SI units or, where appropriate, units approved for use with the SI (e.g. minute).

In all examinations, where data is supplied for use in questions, candidates will be expected to use units that are consistent with the units supplied and should not attempt conversion to other systems of units unless this is a requirement of the question.

Command words

Command words and their meanings help candidates know what is expected from them in the exams. The table below includes command words used in the assessment for this syllabus. The use of the command word will relate to the subject context.

Command word	What it means
Calculate	work out from given facts, figures or information
Compare	identify/comment on similarities and/or differences
Define	give precise meaning
Describe	state the points of a topic / give characteristics and main features
Determine	establish an answer using the information available
Evaluate	judge or calculate the quality, importance, amount, or value of something
Explain	set out purposes or reasons / make the relationships between things evident / provide why and/or how and support with relevant evidence
Give	produce an answer from a given source or recall/memory
Identify	name/select/recognise
Outline	set out main points
Predict	suggest what may happen based on available information
Sketch	make a simple freehand drawing showing the key features, taking care over proportions
State	express in clear terms
Suggest	apply knowledge and understanding to situations where there are a range of valid responses in order to make proposals / put forward considerations

5 What else you need to know

This section is an overview of other information you need to know about this syllabus. It will help to share the administrative information with your exams officer so they know when you will need their support. Find more information about our administrative processes at **www.cambridgeinternational.org/eoguide**

Before you start

Previous study

We recommend that learners starting this course should have studied a biology curriculum such as the Cambridge Lower Secondary programme or equivalent national educational framework.

Guided learning hours

We design Cambridge IGCSE syllabuses based on learners having about 130 guided learning hours for each subject during the course but this is for guidance only. The number of hours a learner needs to achieve the qualification may vary according to local practice and their previous experience of the subject.

Availability and timetables

All Cambridge schools are allocated to one of six administrative zones. Each zone has a specific timetable.

You can view the timetable for your administrative zone at **www.cambridgeinternational.org/timetables**

You can enter candidates in the June and November exam series. If your school is in India, you can also enter your candidates in the March exam series.

Check you are using the syllabus for the year the candidate is taking the exam.

Private candidates can enter for this syllabus. For more information, please refer to the *Cambridge Guide to Making Entries*.

Combining with other syllabuses

Candidates can take this syllabus alongside other Cambridge International syllabuses in a single exam series. The only exceptions are:

- Cambridge O Level Biology (5090)
- Cambridge IGCSE (9–1) Biology (0970)
- Cambridge IGCSE Combined Science (0653)
- Cambridge IGCSE Co-ordinated Sciences (Double Award) (0654)
- Cambridge IGCSE (9–1) Co-ordinated Sciences (Double Award) (0973)
- Cambridge O Level Combined Science (5129)
- syllabuses with the same title at the same level.

Cambridge IGCSE, Cambridge IGCSE (9–1) and Cambridge O Level syllabuses are at the same level.

Group awards: Cambridge ICE

Cambridge ICE (International Certificate of Education) is a group award for Cambridge IGCSE. It allows schools to offer a broad and balanced curriculum by recognising the achievements of learners who pass exams in a range of different subjects.

Learn more about Cambridge ICE at **www.cambridgeinternational.org/cambridgeice**

Making entries

Exams officers are responsible for submitting entries to Cambridge International. We encourage them to work closely with you to make sure they enter the right number of candidates for the right combination of syllabus components. Entry option codes and instructions for submitting entries are in the *Cambridge Guide to Making Entries*. Your exams officer has a copy of this guide.

Exam administration

To keep our exams secure, we produce question papers for different areas of the world, known as administrative zones. We allocate all Cambridge schools to one administrative zone determined by their location. Each zone has a specific timetable. Some of our syllabuses offer candidates different assessment options. An entry option code is used to identify the components the candidate will take relevant to the administrative zone and the available assessment options.

Support for exams officers

We know how important exams officers are to the successful running of exams. We provide them with the support they need to make your entries on time. Your exams officer will find this support, and guidance for all other phases of the Cambridge Exams Cycle, at **www.cambridgeinternational.org/eoguide**

Retakes

Candidates can retake the whole qualification as many times as they want to. Information on retake entries is at **www.cambridgeinternational.org/entries**

Equality and inclusion

We have taken great care to avoid bias of any kind in the preparation of this syllabus and related assessment materials. In our effort to comply with the UK Equality Act (2010) we have taken all reasonable steps to avoid any direct and indirect discrimination.

The standard assessment arrangements may present barriers for candidates with impairments. Where a candidate is eligible, we may be able to make arrangements to enable that candidate to access assessments and receive recognition of their attainment. We do not agree access arrangements if they give candidates an unfair advantage over others or if they compromise the standards being assessed.

Candidates who cannot access the assessment of any component may be able to receive an award based on the parts of the assessment they have completed.

Information on access arrangements is in the *Cambridge Handbook* at **www.cambridgeinternational.org/eoguide**

Language

This syllabus and the related assessment materials are available in English only.

After the exam

Grading and reporting

Grades A*, A, B, C, D, E, F or G indicate the standard a candidate achieved at Cambridge IGCSE.

A* is the highest and G is the lowest. 'Ungraded' means that the candidate's performance did not meet the standard required for grade G. 'Ungraded' is reported on the statement of results but not on the certificate.

In specific circumstances your candidates may see one of the following letters on their statement of results:

- Q (PENDING)
- X (NO RESULT).

These letters do not appear on the certificate.

On the statement of results and certificates, Cambridge IGCSE is shown as INTERNATIONAL GENERAL CERTIFICATE OF SECONDARY EDUCATION (IGCSE).

How students and teachers can use the grades

Assessment at Cambridge IGCSE has two purposes:

- to measure learning and achievement

  The assessment:
  - confirms achievement and performance in relation to the knowledge, understanding and skills specified in the syllabus, to the levels described in the grade descriptions.
- to show likely future success

  The outcomes:
  - help predict which students are well prepared for a particular course or career and/or which students are more likely to be successful
  - help students choose the most suitable course or career.

Grade descriptions

Grade descriptions are provided to give an indication of the standards of achievement candidates awarded particular grades are likely to show. Weakness in one aspect of the examination may be balanced by a better performance in some other aspect.

Grade descriptions for Cambridge IGCSE Biology will be published after the first assessment of the syllabus in 2023. Find more information at **www.cambridgeinternational.org/0610**

Changes to this syllabus for 2023, 2024 and 2025

The syllabus has been reviewed and revised for first examination in 2023.

You must read the whole syllabus before planning your teaching programme.

Changes to syllabus content	• The learner attributes have been included in the key benefits section. • The structure of the subject content has changed to ensure a coherent topic structure. • The wording in the learning objectives has been updated to provide clarity on the depth to which each topic should be taught. Although the wording will look different in many places, the content to teach remains largely the same. Some content has been updated and expanded. Some examples are shown below. • Sub-topics moved in the content: – 1.4 Dichotomous keys – 6.3 Mineral requirements – 15.2 Medicinal drugs – 17.1 Inheritance • Sub-topics removed from the content: – 15.3 Misused drugs – 16.6 Methods of birth control in humans • The teaching time still falls within the recommended guided learning hours. • The learning objectives have been numbered, rather than listed by bullet points. • The **Details of the assessment** section has been updated and further explanation has been provided. This includes revisions to the apparatus list, the mathematical requirements and the information on the presentation of data. • A list of command words has been provided and replaces the previous glossary of terms.
Changes to assessment (including changes to specimen papers)	• The syllabus aims have been updated to improve the clarity of wording and the consistency between IGCSE Biology, Chemistry and Physics. • The wording of the assessment objectives (AOs) has been updated to ensure consistency across IGCSE Biology, Chemistry and Physics. The assessment objectives still test the same knowledge and skills as previously.

In addition to reading the syllabus, you should refer to the updated specimen assessment materials. The specimen papers will help your students become familiar with exam requirements and command words in questions. The specimen mark schemes explain how students should answer questions to meet the assessment objectives.

Any textbooks endorsed to support the syllabus for examination from 2023 are suitable for use with this syllabus.

‘While studying Cambridge IGCSE and Cambridge International A Levels, students broaden their horizons through a global perspective and develop a lasting passion for learning.’

Zhai Xiaoning, Deputy Principal, The High School Affiliated to Renmin University of China

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Chapter 1 : Characteristics and classifications of living organisms

01 Characteristics of living organisms

1. **Movement -** action by an organism or part of an organism causing a change of position or place
2. **Respiration -** the chemical reactions in cells that break down nutrient molecules and release energy for metabolism
3. **Sensitivity -** the ability to detect or sense stimuli in the internal or external environment and to make appropriate responses
4. **Growth -** permanent increase in size and dry mass by an increase in cell number or cell size or both
5. **Reproduction -** the processes that make more of the same kind of organism
6. **Excretion -** removal from organisms of the waste products of metabolism, toxic materials, and substances in excess of requirements
7. **Nutrition -** taking in of materials for energy, growth and development; plants require light, carbon dioxide, water and ions; animals need organic compounds and ions and usually need water

02 How can organisms be classified into groups?

- by features that they share

03 Species - a group of organisms that can reproduce to produce fertile offspring

04 Binomial system

- an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and species
- ex: Homo (genus name) sapiens (trivial name)

05 Traditional method of classification

- studies of morphology and anatomy

06 More accurate method of classification

- comparing sequences of bases in DNA and of amino acids in proteins

07 How can organisms that share recent common ancestors be identified?

- analyse organism's DNA
- organisms which share a more recent ancestor have base sequences in DNA that are more similar

08 What are the 5 kingdoms?

1. Animal
2. Plant
3. Fungus
4. Prokaryote
5. Protoctist

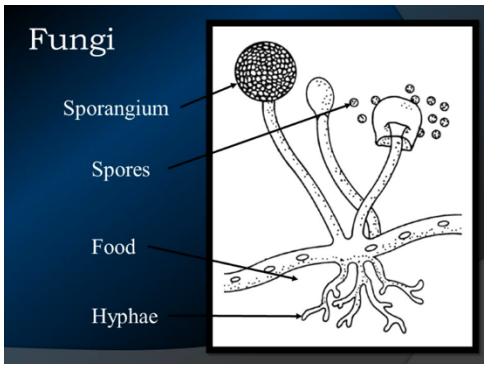
09 Features of animal kingdom

- nucleus
- no cell wall
- no chloroplast
- multicellular

10 Features of plant kingdom

- nucleus
- cell wall made of cellulose
- chloroplast
- multicellular

11 Features of fungus kingdom



- nucleus
- cell wall made of chitin
- no chloroplast
- multicellular
- Adaptation to obtain food:
    - Hyphae is branched has a large surface area
    - They grow over food and releases enzymes
    - External digestion is carried out and food is absorbed

12 Features of prokaryote(bacteria) kingdom

- no nucleus - loop of DNA
- cell wall made of peptidoglycan
- no chloroplast
- unicellular
- flagellum (swim)
- plasmid

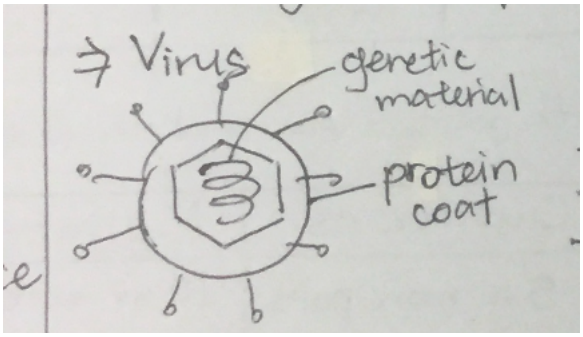
13 Features of protoctist kingdom

- nucleus
- cell wall made of cellulose
- may have chloroplast
- mostly unicellular

14 Features in cells of all living organisms

1. cytoplasm
2. cell membrane
3. DNA (genetic material)
4. ribosomes (protein synthesis)
5. enzymes (respiration)

15 Structure of virus



16 Why are viruses not living?

- they need host cell to reproduce
- cannot reproduce on their own
- they do not have all of the 7 characteristics of living organisms

17 Two broad groups of animals

1. Vertebrates - have backbone
2. Invertebrates - no backbone

18 Main groups of vertebrates

1. mammals
2. birds
3. reptiles
4. amphibians
5. fish

19 Features of mammals

- Body covered with fur
- Move with 4 limbs
- Produce live young
- Sense organs:
    - eyes
    - ears with pinna
- Warm-blooded (homeothermic)
- Female have mammary glands to produce milk to feed young
- Breath via lungs

20 Features of birds

- Body covered with feathers
- Move with 2 wings and 2 legs
- Produce eggs with hard shells on land
- Sense organs:
    - eyes
    - ears
- Warm-blooded (homeothermic)
- Breath via lungs
- Have beak

21 Features of reptiles

- Dry skin with scales
- Move with 4 legs (except snakes)
- Produce eggs with rubbery waterproof shells on land
- Sense organs:
    - eyes
    - ears
- Cold-blooded
- Breath via lungs

22 Features of amphibians

- Moist skin
- Move with 4 limbs
- Produce jelly-covered eggs in water
- Sense organs:
    - eyes
    - ears
- Cold-blooded
- Breath via skin & lungs

23 Features of fish

- Body covered with scale
- Move with fins
- Produce jelly-covered eggs in water
- Sense organs:
    - eyes
    - lateral lines (detect vibration in water)
- Cold-blooded
- Breath via gills

24 What is the main type of invertebrate?

- Arthropods
- segmented animals with jointed legs and an exoskeleton

25 Main groups of arthropods

1. myriapods
2. insects
3. arachnids
4. crustaceans

26 Features of insects

- 3 pairs of legs
- Body division:
    - head, thorax, abdomen
- 1 pair of antennae
- 1 pair of compound eyes
- may have wings

27 Features of arachnids

- 4 pairs of legs
- Body division:
    - cephalothorax, abdomen
- No antennae
- Several pairs of simple eyes
- Poisonous fangs

28 Features of crustaceans

- 5 or more pairs of legs
- Body division:
    - cephalothorax, abdomen
- 2 pairs of antennae
- 1 pair of compound eyes
- Hard, chalky exoskeleton

29 Features of myriapods

- 10 or more pairs of legs
- Body division:
    - head, thorax & abdomen not divided clearly
- 1 pair of antennae
- Simple eyes

30 Two broad groups of plants

1. Flowering plants
2. Ferns

31 Features of ferns

- Reproduce by spores
- Spores found on the underside of leaves

32 Features of flowering plants

- Reproduce by flowers and seeds
- Seeds are produced in ovary

33 Main groups of flowering plants

1. Monocotyledons
2. Dicotyledons

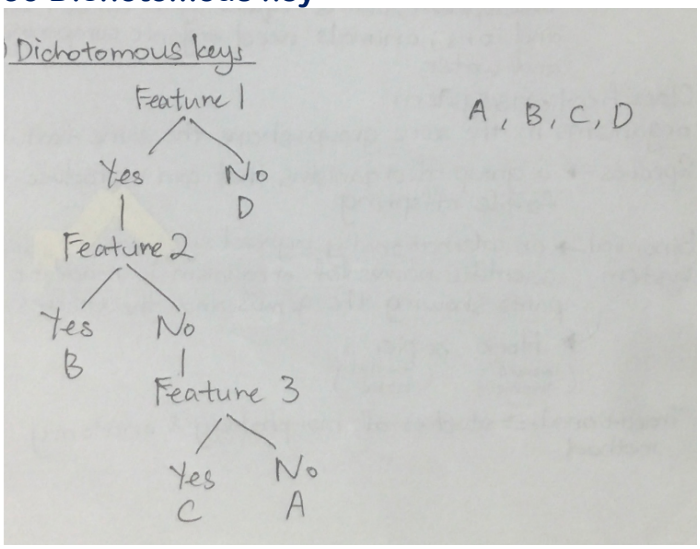
34 Features of monocotyledons

- Long and narrow leaves
- Parallel leaf veins
- Contain only 1 cotyledon
- Grouping of flower parts in threes

35 Features of dicotyledons

- Broad leaves
- Branching leaf veins
- Contains 2 cotyledons
- Grouping of flower parts in fives

36 Dichotomous key



37 Molluscs

- segmented shell
- soft unsegmented body

38 What are annelids?

- segmented worms

39 What are nematodes?

- worms with smooth, unsegmented bodies

Chapter 2 : Organisation of the organism

01 Parts of an animal cell visible under a light microscope

- Nucleus
- Cytoplasm
- Cell membrane

02 Parts of a plant cell visible under a light microscope

- Cell wall
- Nucleus
- Cytoplasm
- Chloroplasts
- Vacuole
- Cell membrane

03 Organelles only found in plant cells (not animal cell)

- cellulose cell wall
- permanent vacuole
- chloroplasts

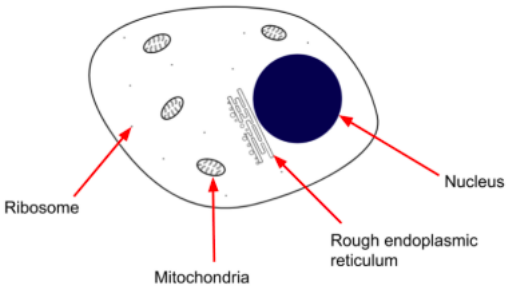
04 What structures do cytoplasm of all cells contain?

- ribosomes
- vesicles

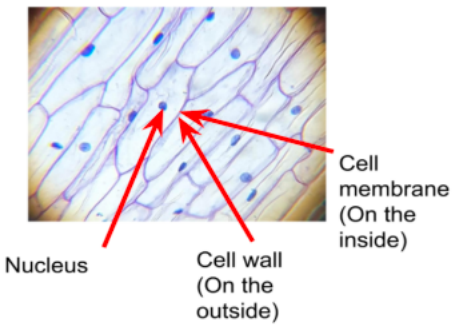
05 What structures do all eukaryotes have?

- mitochondria
- rough endoplasmic reticulum

06 Labelled cell diagram:



07 Labelled light micrograph of an onion epidermal cell:



08 Function of nucleus

- controls all the activities in the cell
- contains genetic material DNA

09 Function of cytoplasm and cell membrane

- Cytoplasm:
  - where many chemical reactions take place
- Cell membrane:
  - controls substances entering and leaving cell

10 Function of cell wall & what it is made of

- gives cell structure
- prevents bursting
- cellulose (plants)

11 Function of chloroplasts

- site of photosynthesis

12 Function of permanent vacuole

- contains cell sap (a solution of sugars and salts)

13 Function of mitochondria

- site of aerobic respiration
- providing energy in form of ATP

14 Function of ribosomes

- site of protein synthesis

15 Function of rough endoplasmic reticulum

- produce and transport proteins

16 Function of vesicles

- transport materials in the cell

17 What organelle does a very metabolically active cell likely to have lots of?

- Mitochondria as they provide energy through aerobic respiration

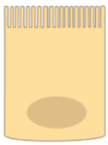
18 Magnification

$$\text{Magnification} = \frac{\text{image size}}{\text{actual size}}$$

19 How do you convert from μm to mm?

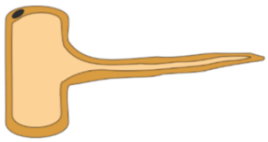
- 1000 micrometre = 1 millimetre

20 Ciliated cells



- have long and thin cilia (increases surface area)
- which beat to move mucus upwards to throat in the trachea and bronchi

21 Root hair cells

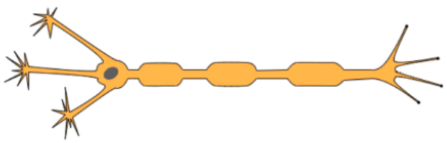


- absorbs water and ions from soil
- have lots of mitochondria to provide energy for active transport
- have long extension to maximise the surface area available for uptake

22 Xylem vessels

- transport water from roots to rest of the plant
- supports the plant
- waterproofed with lignin
- small diameter to maintain continuous column of water
- dead cells do not interrupt the flow of water

23 Nerve cells

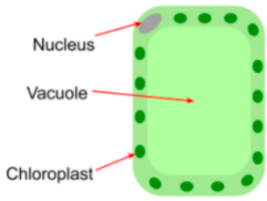


- transmit nerve impulses
- ends contain neurotransmitters to send impulses to other neurones
- long axon to transmit impulses long distances
- thin to transmit impules faster
- covered in myelin sheath to speed up transmission

24 Red blood cells

- transports oxygen
- no nucleus (more space for haemoglobin)
- contains a lot of haemoglobin to carry oxygen
- biconcave disc shape (large surface area to volume ratio)
- thin membrane minimise diffusion distance

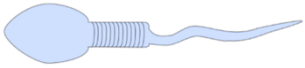
25 Palisade mesophyll cells



- absorb light and carry out photosynthesis
- contains lots of chloroplasts
- thin and tall so many chloroplasts can be packed
- large vacuole
- thin cell wall minimise diffusion distance

26 Sperm cell

- travel to penetrate and fertilise an egg cell
- long flagellum to help swim to the egg
- middle section contains lots of mitochondria which provide the cell with energy for swimming to the egg
- an acrosome at the tip containing enzymes to digest the outer membrane of the egg



27 Egg cell

- halpoid nucleus: after fusing with a sperm it produces diploid organism
- lots of cytoplasm for many divisions
- lots of nutrients to support the egg until it reaches the uterus
- It contains lots of fats and protein to:
  - make new cells after fertilisation
  - make cell membrane
  - make enzymes
  - make cytoplasm
  - fat / protein provide source of energy
  - energy for cell division
- The purpose of the jelly-coating:
  - changes shape after fertilisation
  - to prevent entry of other sperm
  - fuse with a sperm cell for reproduction

28 Tissue

- a group of cells with similar structures, working together to perform a shared function

29 Organ

- a structure made up of a group of tissues, working together to perform specific body functions

30 Organ system

- a group of organs with related functions, working together to perform body functions

31 Name 3 organ systems in the body

1. respiratory system
2. circulatory system
3. reproductive system

32 What organs make up the digestive system?

- Oesophagus
- Stomach
- Small intestine
- Large intestine
- Liver
- Pancreas
- Gallbladder
- Anus

33 What organs make up the circulatory system?

- heart
- lungs
- blood vessels

34 What type of tissue is the heart made up of?

- cardiac muscle

35 What tissues make up a plant leaf?

- Mesophyll tissue (spongy mesophyll & palisade mesophyll)
- Epidermis (upper and lower)
- Veins (xylem and phloem)

Chapter 3 : Movement in and out of cells

01 How do substances move into and out of cells?
- by diffusion through the cell membrane

02 Diffusion
- The net movement of particles from a region of higher concentration to a region of lower concentration down a concentration gradient

03 Factors that influence diffusion
- Surface area
- Temperature
- Concentration gradients
- Diffusion distance

04 How does the surface area of the membrane affect the rate of diffusion?
- As the surface area increases, the rate of diffusion increases as there is more space for particles to diffuse through

05 How does temperature affect the rate of diffusion?
- As temperature increases, particles have more kinetic energy and move faster, which increases the rate of diffusion

06 How does the concentration gradient affect the rate of diffusion?
- As the concentration gradient increases, the rate of diffusion increases

07 How does the diffusion distance affect the diffusion rate?
- The larger the diffusion distance, the slower the rate of diffusion as the particles have to move further

08 Where does the energy for diffusion come from?
- from kinetic energy of random movement of molecules and ions

09 Why is the diffusion of gases important?
- It allows for gas exchange in organisms to provide useful gases for processes like respiration and to remove waste gases

10 Why is the diffusion of solutes important?
- It is useful for the uptake of solutes (ions) from the soil in plants

11 How does water move in and out of cells
- by osmosis through the cell membrane

12 Osmosis

- The net movement of water molecules from a region of higher water potential to a region of lower water potential down a water potential gradient through a partially permeable membrane

13 How is a plant cell supported?

- by the pressure of water inside the vacuole of cells pressing outwards on the cell wall

14 Explain how the water in cells support them

- The water creates turgor pressure which pushes the cell membrane against the inelastic cell wall

15 What is a hypertonic solution?

- A solution that has a lower water potential than the water potential of the cell

16 What is a hypotonic solution?

- A solution that has higher water potential than the water potential of the cell

17 What is an isotonic solution?

- A solution that has the same water potential as the water potential of the cell

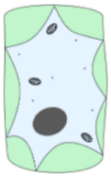
18 What happens if you place an animal cell in a hypertonic solution?

- Water moves out of cell via osmosis
- animal cell shrinks (crenate)

19 What happens if you place an animal cell in a hypotonic solution?

- Water moves into the cell via osmosis
- animal cell burst (lysis)

20 What happens if you place a plant cell in a hypertonic solution?



- Water moves out of cell via osmosis
- Plant cell becomes plasmolysed
- (cell membrane moves away from cell wall)

21 What happens if you place a plant cell in a hypotonic solution?

- Water moves into cell via osmosis
- Plant cells become turgid
- Turgor pressure is formed

(it does not burst due to strong cell wall)

22 What happens if you put a cell in an isotonic solution?

- No net movement of water in or out of cell

23 Active transport

- The movement of particles through a cell membrane from a region of lower concentration to a region of higher concentration against the concentration gradient using energy from respiration

24 Explain how active transport involves proteins

- Carrier proteins move substances from one side of the membrane to the other using energy

25 Use of active transport in humans

- Uptake of glucose by epithelial cell of villi and kidney tubules in the nephron

26 Use of active transport in plants

- Uptake of ions by root hairs

Chapter 4 : Biological molecules

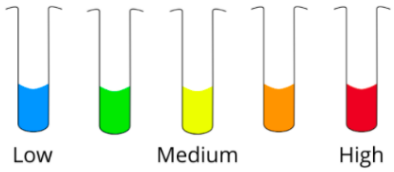
01 What chemical element make up carbohydrates?
- carbon, hydrogen, oxygen

02 What smaller molecules are starch and glycogen made from?
- glucose

03 What smaller molecules are cellulose made of?
- glucose

04 How do you test for reducing sugars?
1. Add a few drops of Benedict's solution
2. Warm in a water bath for 5 minutes

05 Observation in a positive test for reducing sugars
- The more reducing sugar present, the closer to red the colour is



- High - brick red

06 How do you test for starch?
- Add iodine solution to sample

07 Observation in a positive test for starch
- yellow/brown solution turns blue-black

08 What chemical element make up proteins?
- carbon, hydrogen, oxygen, sulfur and nitrogen

09 What smaller molecules are proteins made of?
- amino acids

09.1 How does the sequence of amino acids affect the protein produced?
- Different sequences of amino acids make up different proteins with different shape

10 Two functions of proteins
1. Antibodies
2. Enzymes

11 How to test for proteins?

- Biuret test
  - Add equal volumes of sodium hydroxide and copper sulfate to the sample and shake

12 Observation in a positive test for protein

- solution turns from blue to purple

13 What chemical element make up fats/lipids?

- carbon, hydrogen and oxygen

14 What smaller molecules are fats and oils made from?

- fatty acids and glycerol

15 How to test for lipids?

- Ethanol emulsion test
  - add 2cm³ of ethanol to the sample
  - shake to dissolve
  - add 2cm³ of distilled water to the sample

16 Observation in a positive test for lipids

- a white cloudy emulsion will form

17 How to test for Vitamin C?

- Add DCPIP to solution drop by drop until solution permanently changes colour

18 Observation in a positive test for Vitamin C

- solution will turn the DCPIP from dark blue to colourless permanently

19 Describe the structure of DNA

- two strands coiled together to form a double helix
- each strand contains chemicals called bases
- cross-links between the strands are formed by pairs of bases
- the bases always pair up in the same way:
  - A with T, and C with G

20 Four bases in DNA

- A, T, C, G

21 How do the bases in DNA pair up?

- A - T
- C - G

22 State one use of water in the body

- Water is used as a solvent in the body

23 Three processes in which water is used as a solvent

1. digestion
2. excretion
3. transport

Chapter 5 : Enzymes

01 Catalyst

- A substance that increases the rate of a chemical reaction but remains unchanged

02 Enzymes

- Proteins that function as biological catalysts

03 Why enzymes are important in organisms

- Without enzymes, reactions would be too slow to sustain life
- they maintain reaction speeds of all metabolic reactions (all the reactions that keep an organism alive) at a rate that can sustain life

04 Enzyme action

1. Enzymes catalyse reactions via lock and key mechanism
2. Substrate fits into enzyme if shape of substrate is complementary to active site
3. They form an enzyme-substrate complex
4. Product formed leaves enzyme
5. Enzyme remains unchanged

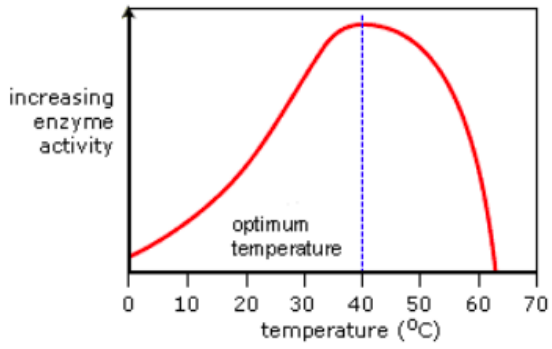
05 Why enzymes are highly specific

- The active site of the enzyme must bind to a substrate that has a complementary shape
- Only specific reactions can be catalysed

06 Factors that affect enzyme activity

- Temperature
- pH

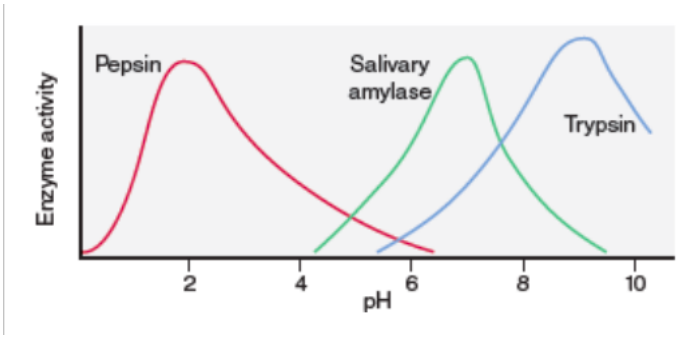
07 How temperature affects enzyme activity



- At low temperatures
  - Enzyme is inactive
- As temperature increases up to optimum temperature
  - Molecules gain more kinetic energy and move faster
  - Increases frequency of effective collisions
  - Rate of reaction increases

- At optimum temperature
  - Rate of reaction is the fastest
- As temperature increases beyond the optimum temperature
  - Enzyme denatures
  - Active site changes shape and no longer fits with substrate
  - Rate of reaction decreases to zero

08 How pH affects enzyme activity



- At optimum pH
  - Rate of reaction is the fastest
- pH too high or low
  - Enzymes denature
  - Active site changes shape and no longer fits with substrate
  - Rate of reaction decreases to zero

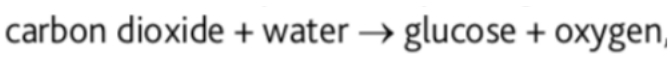
Chapter 6 : Plant nutrition

01 Photosynthesis

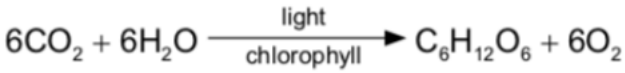
- The process by which plants manufacture carbohydrates from raw materials using energy from light

02 Equation for photosynthesis

- Word equation:



  - in the presence of light and chlorophyll
- Chemical equation :



03 Chlorophyll

- Traps light energy
- Transferred into chemical energy in molecules
- Used to produce carbohydrates
- *gives green colour

04 Use and storage of carbohydrates

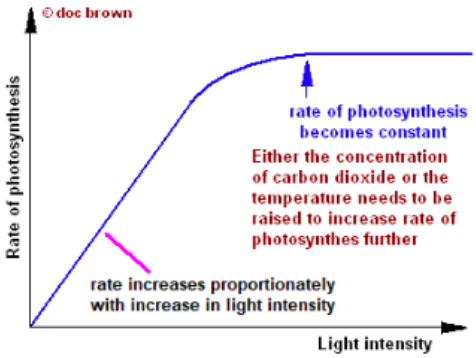
- Glucose
  - Respiration to provide energy
  - Converted into starch for storage
  - Converted to cellulose to make cell walls
  - Converted into sucrose to be transported to other parts of the plant
  - Combine with nitrates absorbed from soil to form amino acids (proteins)
  - Converted into oils stored in seeds

05 Limiting factor

- Something present in the environment in such short supply that it restricts life processes

06 Limiting factors of photosynthesis

- Light intensity:
  - As light intensity increases, rate of photosynthesis increases
- Temperature:
  - As temperature increases, rate of photosynthesis increases
- Carbon dioxide concentration:
  - As CO_2 conc. increases, rate of photosynthesis increases



07 Greenhouses

- Temperature:
  - glass prevents heat from escaping
  - ventilator flaps opened on hot days
  - electric heaters used in cold weather
- Light:
  - artificial light used to achieve optimum light
  - blinds keep out very strong light
- Carbon dioxide:
  - burn butane / natural gas
- Water:
  - automatic watering system

08 Investigating gas exchange

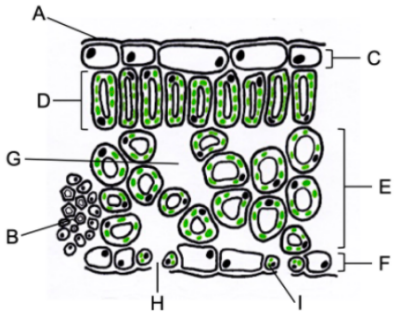
- Hydrogencarbonate indicator solution:

CONCENTRATION OF CARABON DIOXIDE	COLOUR OF HYDROGEN CARBON INDICATOR		CONDITIONS IN PLANT
HIGHEST	YELLOW		MORE RESPIRATION > PHOTOSYNTHESIS – LOWER pH (MORE ACID)
HIGHER	ORANGE		
ATMOSPHERIC LEVEL	RED		PHOTOSYNTHESIS = RESPIRATION
LOWER	MAGENTA		MORE PHOTOSYNTHESIS > RESPIRATION – HIGHER pH (MORE ALKALINE)
LOWEST	PURPLE		

- Plants in light vs dark:

TUBE	CONTENTS	CONDITIONS	INDICATOR TURNS	CONCLUSION
A	LEAF	LIGHT	PURPLE	THERE IS A NET INTAKE OF OXYGEN BY A LEAF IN LIGHT
B	LEAF	DARK	YELLOW	THERE IS A NET INTAKE OF CARBON DIOXIDE BY A LEAF IN THE DARK
C	NO LEAF	LIGHT	RED	THIS IS THE CONTROL – THE TWO OTHER TUBES CAN BE COMPARED WITH IT

09 Labelled leaf structure:



A	waxy cuticle	F	lower epidermis
B	vascular bundle	G	air-filled space
C	upper epidermis	H	stoma
D	palisade mesophyll tissue	I	guard cell
E	spongy mesophyll tissue		

- Chloroplasts (green pigmentation)
- xylem (inside of the vascular bundle)
- phloem (outside of the vascular bundle)

10 Internal structure of a leaf

- Cuticle
  - transparent to allow light to penetrate into the leaf
- Stomata
  - open and close to allow movement of gas
- Palisade mesophyll
  - absorbs light for photosynthesis
- Spongy mesophyll
  - diffusion of gas
- Guard cells
  - open and closes stomata
-

11 Adaptations of leaves (on water)

- Large air spaces
  - leaves float
- Stomata in the upper epidermis
  - movement of gases from air

- Thin cuticle
  - no need to reduce water loss by transpiration

12 Nitrate ions

- make amino acids

13 Magnesium ions

- make chlorophyll

14 Effects of nitrate ion and magnesium ion deficiency on plant growth

- stunted growth (fewer plants)
- yellow leaves

Chapter 7 : Human nutrition

01 Balanced diet

- A diet that provides:
  - materials for metabolism
  - all nutrients
  - in the correct proportions
  - e.g. carbohydrate.....
  - sufficient energy

02 Factors that influence dietary needs

- Age
- Gender
- Activity
- Pregnancy / breast-feeding

03 Effects of malnutrition

- Starvation - lack food in general
- Constipation - lack fibre
- Coronary heart disease - too much fat
- Obesity - too much food in general
- Scurvy - lack of vitamin C
- Rickets - lack of vitamin D / calcium

04 Types of food

- Carbohydrates
- Fats
- Proteins
- Vitamins (C, D)
- Mineral salts (calcium, iron)
- Fibre
- Water

05 Carbohydrates

- Sources: bread, rice, potato
- Use: source of energy for respiration

06 Fats

- Sources: cheese, butter, nuts
- Uses:
  - energy storage
  - thermal insulation
  - protect internal organs

07 Proteins

- Sources: meat, fish, eggs
- Use: growth and repair

08 Vitamin C

- Source: citrus fruits (orange)
- Uses:
  - tissue repair
  - resistance to disease
- Deficiency: Scurvy - bleeding gums

09 Vitamin D

- Sources: fish oil, eggs
- Use: strengthens bones and teeth
- Deficiency: Rickets - soft bones

10 Calcium

- Sources: milk, cheese
- Use: strengthen bones and teeth
- Deficiency: Rickets - soft bones

11 Iron

- Source: red meat
- Use: make haemoglobin (red blood cells)
- Deficiency: Anaemia - tiredness, lack of energy

12 Fibre

- Use: provides roughage
- Sources: vegetables, fruits

13 Water

- Use: medium for chemical reactions

14 Protein-energy malnutrition

1. Kwashiorkor
   - Cause: lack of protein
   - Effects:
     - flaky dry skin
     - fat accumulation in liver
     - oedema / pot belly

2. Marasmus
    - Cause: lack of energy and protein
    - Effects:
        - low body mass
        - fatigue
        - muscle wasting
        - diarrhoea
3. Similarities:
    - Both are caused by protein deficiency
    - Both affect children primarily

15 Ingestion

- Taking of substances into the body through the mouth

16 Mechanical digestion

- The breakdown of food into smaller pieces without chemical change to the food molecules

17 Chemical digestion

- The breakdown of large, insoluble molecules into small, soluble molecules

18 Absorption

- The movement of small food molecules and ions through the wall of the intestine into the blood

19 Assimilation

- The movement of digested food molecules into the cells of the body where they are used, becoming part of the cells

20 Egestion

- The passing out of food that has not been digested or absorbed, as faeces, through the anus

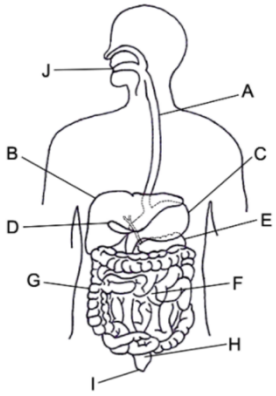
21 Diarrhoea

- The loss of watery faeces
- Treatment:
    - oral rehydration therapy
        - a drink with a small amount of salt and sugar

22 Cholera

- A disease caused by a bacterium
- Explanation:
  - Cholera bacterium produces a toxin
  - Toxin causes secretion of chloride ions
  - Into the small intestine
  - Lowering water potential
  - Movement of water into the gut
  - by osmosis
  - results in diarrhoea
- Effects:
  - diarrhoea
  - dehydration
  - loss of salts from blood

23 Alimentary canal



A	oesophagus	F	small intestine
B	liver	G	large intestine
C	stomach	H	rectum
D	gall bladder	I	anus
E	pancreas	J	mouth

- salivary glands (below mouth)
- duodenum (first part of small intestine)
- ileum (second part of small intestine)
- large intestine (colon)

24 Describe the passage of food through the alimentary canal

Mouth → oesophagus → stomach → small intestine → large intestine → rectum

25 Mouth

- (ingestion)
- Teeth chew food (mechanical digestion)

26 Salivary gland

- Produces saliva containing amylase (chemical digestion)

27 Oesophagus

- Moves food from mouth to stomach by peristalsis:
  - Circular muscles contract
  - Above food to push food forward

28 Stomach

- Muscular wall churns food (mechanical digestion)
- Walls produce gastric juice:
- Hydrochloric acid
  - killing bacteria in food & giving an acid pH for enzyme
  - by denaturing enzymes in harmful microorganisms in food
  - giving the optimum pH for pepsin activity
- Pepsin (chemical digestion)

29 Small intestine

- Duodenum
  - Connected to pancreas (secretion of pancreatic juice)
- Ileum
  - (absorption) of digested food

30 Pancreas

- Produces pancreatic juice (chemical digestion):
  - Amylase
  - Trypsin
  - Lipase
- Secreted into the duodenum

31 Liver

- Produces bile (mechanical digestion):
- Provide suitable pH for enzyme action
  - neutralising the acidic mixture of food and gastric juices
  - entering the duodenum
  - from the stomach
- Emulsify fats
  - (breakdown of large globules of fats into small globules of fat)
  - increase surface area
  - for enzyme action of lipase
  - fat to fatty acids and glycerol

32 Gall bladder

- Stores bile

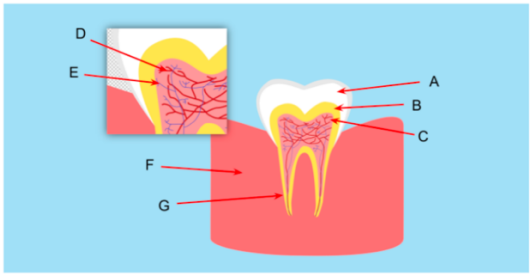
33 Large intestine

- Colon - (absorption) water
- Rectum - stores faeces
- Anus - (egestion)

34 Types of human teeth

- Incisors - biting & breaking sections of food
- Canines - ripping & shredding food
- Premolars - chewing & grinding food
- Molars - chewing & grinding food

35 Structure of human teeth



A	Enamel	F	Gums
B	Dentine	G	Cement
C	Pulp		
D	Blood vessel		
E	Nerve		

36 Dental decay

1. Bacteria coating on teeth
2. respire sugar remains on teeth
3. producing acid
4. dissolves enamel and dentine

37 Proper care of teeth

- Regular visits to the dentist
- Avoid eating sugary food
- Regular brushing of teeth with toothpaste:
  - alkaline pH neutralises acid in mouth
  - contains fluoride which hardens enamel
  - anti-bacterial agent that kills bacteria which produces acid

38 Why chemical digestion is important

- It produces small, soluble molecules that can be absorbed

39 Enzymes

- Amylase - starch to simpler sugars
- Protease - protein to amino acids
- Lipase - fats to fatty acids & glycerol

40 Digestion of starch in the alimentary canal

- Amylase is secreted into the alimentary canal
- Breaks down starch to maltose
- Maltose is broken down by maltase to glucose
- In the membranes of the epithelium lining the small intestine

41 Where are enzymes secreted

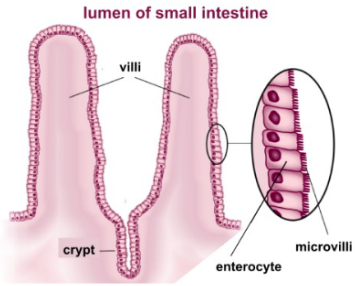
- Amylase - salivary glands, pancreas
- Protease - stomach (pepsin), pancreas (trypsin)
- Lipase - pancreas

42 Types of protease

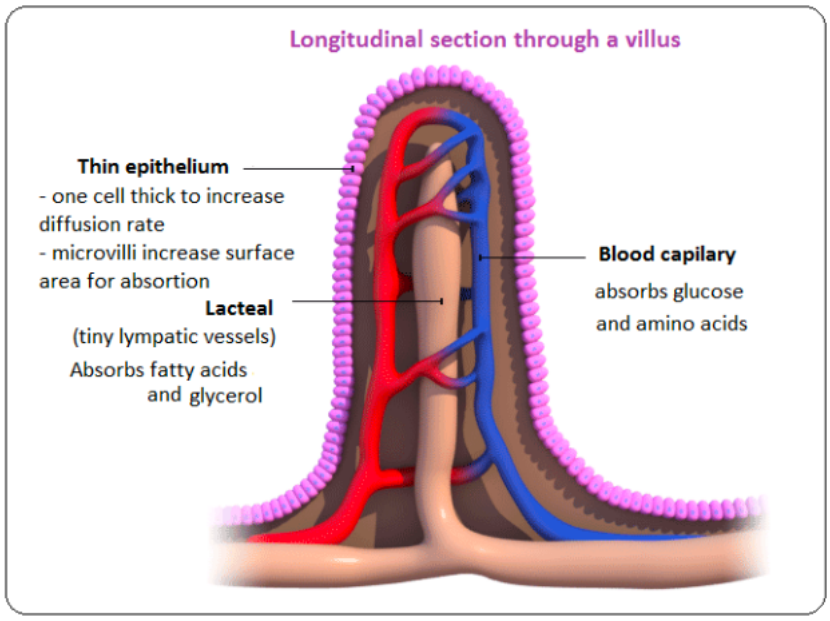
- Pepsin - found in stomach
- Trypsin - found in small intestine

43 Villi and microvilli

- Adaptations for absorption:
  - Microvilli give large surface area
  - for diffusion & active transport
  - Contain carrier proteins
  - Contains mitochondria to provide energy



44 Structure of villus



45 Where is water absorbed

- In both the small intestine and colon
- Most absorption happens in the small intestine

Chapter 8 : Transport in plants

01 Xylem

- Transports water and minerals
- From roots to other parts of the plant (stem, leaves)
- Adaptations:
  - Made of lignin
    - cell walls are waterproof (no water leaks out)
  - Long hollow tubes
    - water passes through easily with low resistance

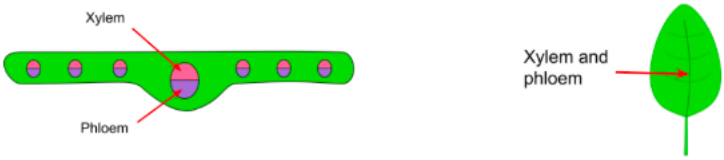
02 Phloem

- Transports sucrose and amino acids
- Made in leaves during photosynthesis and in storage organs
- To other parts of the plant

03 Identify position of xylem and phloem

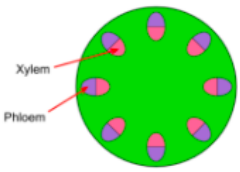
- In leaf:

The xylem is on the top of the phloem



- In stem:

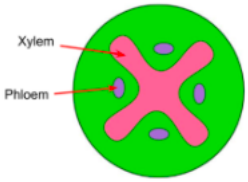
The xylem is on the inside of the stem



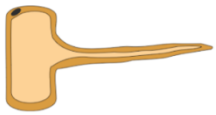
- In root:

The xylem is in the middle in an X shape

The phloem is on the outside of the xylem



04 Root hair cells



- Adaptation:
- Large surface area of root hairs
  - Increases rate of absorption of water by osmosis
  - And ions by active transport
- Function: absorbs water and ions

05 Pathway of water through root, steam and leaf

Root hair cell → Root cortex cells →
Xylem → Mesophyll cells

06 Transpiration

- Loss of water vapour from plant leaves by evaporation of water at the surfaces of the mesophyll cells followed by diffusion of water vapour through the stomata

07 Why is water lost from plants

- Large surface area
- Large air spaces
- Stomata

08 Explain the movement of water through a plant

- Water moves upward in the xylem
- By a transpiration pull
- Draws up a continuous column of water molecules
- Held together by cohesion
- Transpiration stream

09 Wilting

- Cause: lack of water
  - Plant cells are no longer turgid
  - Lack of turgor pressure
  - No longer a push against cell wall
  - Cells not providing support
  - Become plasmolyse

10 Factors of rate of transpiration

- Temperature
- Humidity

11 How temperature affects rate of transpiration

- As temperature increases
- Water molecules have more kinetic energy
- Evaporation happens faster
- Rate of transpiration increases

12 How humidity affects rate of transpiration

- As humidity increases
- More water vapour in air
- Air is saturated
- Concentration gradient between water in the atmosphere and water inside the leaf is less steep
- Rate of transpiration decreases

13 Translocation

- The movement of sucrose and amino acids in phloem:
  - from regions of production (source)
  - to regions of storage OR to regions where they are used in respiration or growth (sink)

14 Source and sink

- Some parts of a plant may act as a source and a sink at different times (seasons) during the life of a plant:
  - Substances are transported from source to sink
  - During growing season when food is made
  - Substances are transported to the roots
  - During winter when food is not made
  - Substances are transported from roots / storage organs

Chapter 9 : Transport in animals

01 Circulatory system

- A system of blood vessels with a pump and valves to ensure one-way flow of blood

02 Single circulation of fish

- The blood passes through the heart once for every one circuit of the body

Heart → Gills → Body

03 Double circulation of mammal

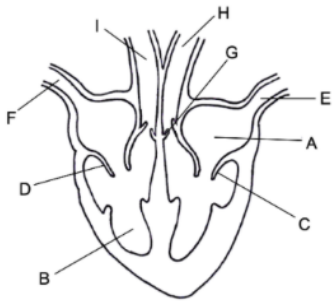
- The blood passes through the heart twice for every
- one circuit of the body

Heart → Body → Heart → Lungs

04 Advantages of double circulation

- Maintains high blood pressure
- Allow animals to have high metabolic rates
- Prevent mixing of oxygenated & deoxygenated blood

05 Structure of the heart (mammalian)

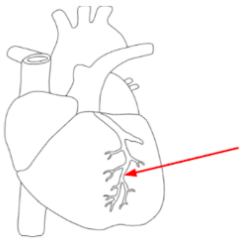


A	left atrium	F	vena cava
B	right ventricle	G	semi-lunar valve
C	bicuspid valve	H	aorta
D	tricuspid valve	I	pulmonary artery
E	pulmonary vein		

- Septum - separates the right and left sides of the heart
- *Bicuspid & tricuspid valve aka Atrioventricular valve

06 Coronary arteries

- It supplies the heart muscle with blood



07 Thickness of the muscle walls

- Ventricles > Atria:
  - Ventricles pump blood to the lungs / whole body
  - longer distance
  - requires higher pressure
  - Atria only pump blood to the ventricles
  - shorter distance
  - requires lower pressure
- Left ventricle > Right ventricle:
  - Left ventricle pumps blood to the whole body
  - longer distance
  - requires higher pressure
  - Right ventricle pumps blood to the lungs
  - shorter distance
  - requires lower pressure

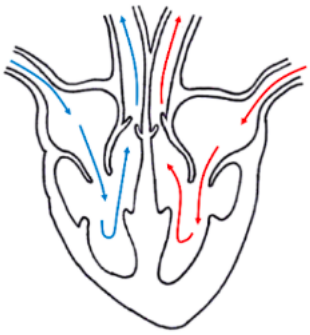
08 Arteries and veins

- Veins - carry blood to the heart
- Arteries - carry blood away from the heart

09 Why the septum is important

- It separates the oxygenated blood from the deoxygenated blood

10 Direction of blood flow through the heart



1. Deoxygenated blood enters heart at the right atrium via vena cava
2. Right atrium contracts
3. Tricuspid valve opens
4. Blood enters the right ventricle
5. Right ventricle contracts
6. Semilunar valve opens
7. Blood is pumped out of heart to the lungs via the pulmonary artery
8. Gas exchange occurs
9. CO_2 diffuses out of capillaries into alveoli
10. O_2 diffuses from alveoli into capillaries
11. Blood is oxygenated

12. Oxygenated blood enters heart at left atrium via pulmonary veins
13. Left atrium contracts
14. Bicuspid valve opens
15. Blood enters the left ventricle
16. Left ventricle contracts
17. Semi-lunar valves open
18. Blood is pumped out of the heart to the rest of the body via aorta

19. Gas exchange occurs
20. O_2 diffuse from capillaries to cells
21. CO_2 diffuse from cells to capillaries
22. Blood is deoxygenated

23. Blood returns to right atrium via vena cava

11 Ways of monitoring heart activity

- ECG
- Pulse rate
- Listening to sounds of valves closing

12 Effect of physical exercise on heart rate

- Physical exercise increases heart rate:
  - Muscle contraction requires more energy from respiration
  - Increased respiration increases demand for oxygen and removal of carbon dioxide
  - Heart pumps faster to provide more oxygen to the muscles and to remove carbon dioxide at the lungs

13 Coronary heart disease (CHD)

- CHD - the blockage of coronary arteries (artery providing blood to heart tissue) due to a build-up of fatty deposits which narrows the artery thus limiting blood flow to the heart
- Risk factors:
  - Diet (too much saturated fat)
  - Stress
  - Smoking
  - Genetic predisposition
  - Age
  - Gender
- Prevention:
  - Exercise :
    - prevents blocked arteries
    - lowers blood pressure
    - heart muscles become stronger
    - weight loss
    - lowers fats
  - Stop smoking

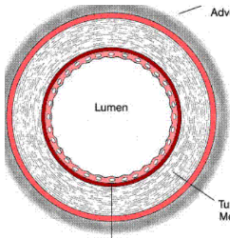
  - Reduced stress
  - Healthy diet (eat less saturated fats)
- Treatment:
  - Surgery:
    - Stent
      - small mesh tube inserted in artery
      - opens artery
    - Angioplasty
      - balloon inserted into artery
      - inflate balloon to widen artery
    - By-pass
      - another blood vessel joined to the artery
  - Drug treatment:
    - Aspirin
      - prevents blood clots from forming that can block the blood vessels

14 Types of blood vessels

- Arteries
- Veins
- Capillaries

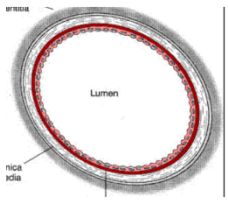
15 Arteries

- Function:
  - Carry blood away from the heart
- Structure:
  - Thick wall to withstand pressure
  - Muscular tissue for vasoconstriction / vasodialtion
  - Elastic tissue recoils to maintain pressure
  - Narrow lumen maintains pressure

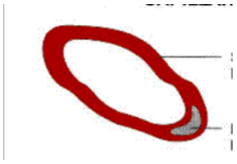


16 Veins

- Function:
  - Carry blood to the heart
  - Structure:
  - Thin wall to withstand low pressure
  - Large lumen maintains low pressure
  - Contains semi-lunar valves to prevent backflow of blood
  - Less elastic wall (surrounding body muscles contract to exert pressure to push blood along)



17 Capillaries



- Function:
  - Allow exchange of substances to tissues
  - Structure:
  - Gaps in capillary wall allows movement of small molecules
  - Wall is one cell thick, provides short diffusion distance
  - Small, blood moves slowly for exchange
  - Large numbers of capillaries provide large surface area

18 Main blood vessels

ORGAN	TOWARDS ORGAN	AWAY FROM ORGAN
HEART	VENA CAVA, PULMONARY VEIN	AORTA, PULMONARY ARTERY
LUNG	PULMONARY ARTERY	PULMONARY VEIN
KIDNEY	RENAL ARTERY	RENAL VEIN

- Liver
  - Towards:
    - Hepatic artery
    - Hepatic portal vein
  - Away
    - Hepatic vein

19 Arterioles

- Carry blood to capillary
- Regulate blood pressure (constriction / dilation) for capillaries
- To prevent capillaries from bursting
- Control blood flow towards surface of skin

20 Venules

- Carry blood away from capillary

21 Shunt vessels

- Vasoconstriction & vasodilation
- Control blood flow by constriction & dilation
- Links an artery directly to a vein

22 Lymphatic system

- A system of lymphatic vessels and lymph nodes that transports lymph (plasma, white blood cells, small plasma proteins)
  - no pump
  - flow of lymph is slow
  - contraction of surrounding muscles help make it flow
  - lymphatic vessels have thin walls & semi-lunar valves to ensure one-way flow of lymph

23 Functions of lymphatic system

- Defence against disease
- Transports fat
- Drains tissue fluid
- Returns lymph to blood

24 Components of blood

- Red blood cells
- White blood cells
- Platelets
- Plasma

24 Types of white blood cells

- Phagocytes

  - Function: Phagocytosis
    - Engulf pathogens into vacuole
    - Use enzymes to digest pathogen
- Lymphocytes

  - Function: Antibody production

25 Platelets

- Function: Clotting
  - Platelets promote clotting
  - Convert fibrinogen to fibrin
  - Soluble to insoluble
  - Forms a mesh to trap blood
  - Forms a scab
- Role of blood clotting:
  - Prevent blood loss
  - Prevent entry of pathogens

26 Red blood cells

- Function: Transport oxygen
  - Biconcave discs
  - No nucleus (more space to carry oxygen)
  - Contains haemoglobin

27 Plasma

- Function:
  - Transport blood cells, ions, soluble nutrients, hormones and carbon dioxide

28 Transfer of materials between capillaries and tissue fluid

- From capillaries to cells:
  - Oxygen
  - Glucose
  - Amino acids
  - Ions
  - Vitamins
- From cells to capillaries:
  - Carbon dioxide
  - Excess ions, vitamins
  - Urea
  - Water
- They diffuse across membranes from high concentration to low concentration

Chapter 10 : Disease and immunity

01 Pathogen

- a disease-causing organism

02 Transmissible disease

- a disease in which the pathogen can be passed from one host to another

03 Ways disease are transmitted

- Through air droplets
- Contaminated food and drink
- Direct contact
- Insect vector
- Bodily fluids
- Sexual activity

04 Body defence against infection

- 1st line of defence:
  - Mechanical barriers - skin, hair in nose
  - Chemical barriers - mucus, stomach acid
- 2nd line of defence:
  - Blood defence - white blood cells:
  - Phagocytes - phagocytosis
  - Lymphocytes - antibody production
  - *can be enhanced by vaccination

05 Ways antibodies attack pathogens

- Antibodies lock on to antigens leading to:
  - destroy pathogens directly
  - mark pathogens for destruction by phagocytes

06 How antibodies attack pathogens

- Pathogens have antigens
- Antibodies lock on to antigens
- Antibody is specific to antigen
- Antibody has a complementary shape to antigen
- Antibody marks pathogen for destruction by phagocytes
- Antibodies destroy pathogens

06.1 Why are different types of antibodies needed

- As each type of pathogen has different specific antigens, a specific antibody which is complementary to this antigen must be made for each disease

07 Active immunity

- long-lasting defence against a pathogen by antibody production in the body

08 How is active immunity gained

- after an infection by a pathogen
- by vaccination

09 Process of vaccination

- Harmless pathogens are injected into the body
- Antigens trigger an immune response by lymphocytes which produce antibodies
- Memory cells are produced that give long-term immunity
- Active immunity gained

10 How vaccination can control spread of disease

- by providing herd immunity
- large amount of the population is vaccinated and are immune to the pathogen
- the disease cannot spread [few people can be infected]
- people who cannot be vaccinated are protected against the disease

11 Methods of controlling the spread of disease

- Hygienic food preparation
  - store food in appropriate conditions, prevent contamination
- Good personal hygiene
  - using tissues, washing hands and cleaning regularly, prevent infection
- Waste disposal
  - prevent attracting rats/ files which spread disease
- Sewage treatment
  - prevent contamination of drinking water

12 Passive immunity

- short-term defence against a pathogen by antibodies acquired from another individual
- ex: mother to infant, injections of antibodies from a donor

13 Why is passive immunity only short term

- memory cells are not produced in passive immunity

14 Importance of passive immunity for breast-fed infants

- to reduce the risk of disease
- infants have not yet develop their own antibodies as they have not been exposed to as many pathogens

15 Autoimmune disease

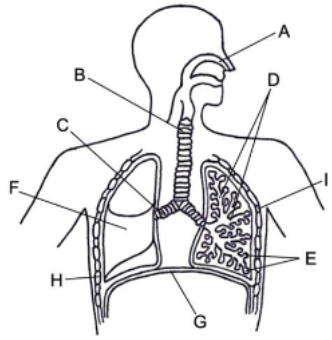
- a disease caused by the immune system targeting and destroying body cells
- ex: Type 1 diabetes

Chapter 11 : Gas exchange in humans

01 Features of gas exchange surfaces in human

- large surface area
- thin walls
- good blood supply
- good ventilation with air
- ~ moist

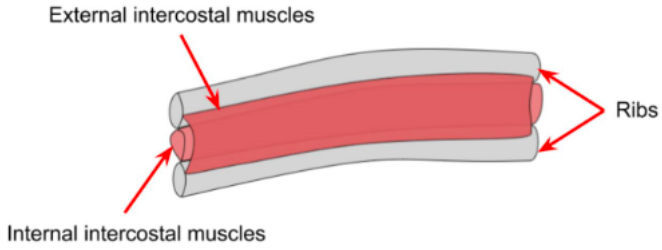
02 Labelled human respiratory system



A	nasal cavity	F	lung
B	trachea	G	diaphragm
C	bronchus	H	rib
D	bronchioles	I	intercostal muscle
E	alveoli		

- Extra: larynx, capillaries

03 Labelled muscle and between ribs



04 Function of cartilage in trachea

- The cartilage supports the trachea and keep them open
- prevent collapsing
  - Keeps airways open
  - Allows air into lungs

05 Breathing in [Inspiration]

- internal intercostal muscles relax
- external intercostal muscles contract
- raise ribs upwards and outwards
- diaphragm flattens
- volume in thorax increases
- pressure inside thorax decreases
- air flows in down a pressure gradient

06 Breathing out [Expiration]

- internal intercostal muscles contract
- external intercostal muscles relax
- lowers ribs downwards and inwards-
- diaphragm curves upwards
- volume inside the thorax decreases
- pressure inside the thorax increases
- air is forced out of lungs

07 Composition in inspired air

- Nitrogen- 78%
- Oxygen- 21%
- Carbon dioxide- 0.04%
- Water vapour- variable

08 Composition in exhaled air

- Nitrogen- 78%
- Oxygen- 16%
- Carbon dioxide- 4%
- Water vapour- saturated

09 Why is % of nitrogen same in inhaled and exhaled air

- The body does not absorb nitrogen from the air
- All nitrogen that is taken in is released again

10 Why is the % of CO2 higher in exhaled air

- extra carbon dioxide from respiration is removed

11 Why is the % of O2 in exhaled air lower

- Some oxygen is absorbed by the body

12 State the effects of physical activity on rate and depth of breathing

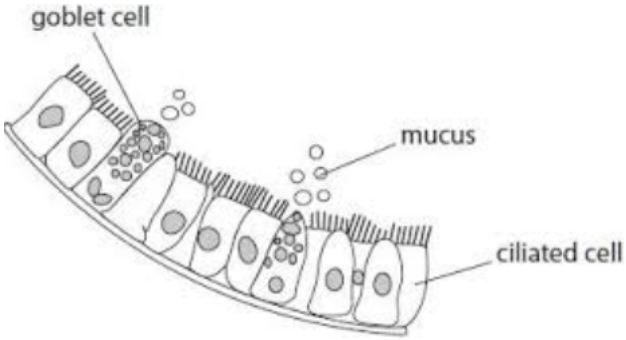
- increased breathing rate
- increased breathing depth

13 Explain link between physical activity and rate and depth of breathing

- physical activity increases
- rate of aerobic respiration increases
- concentration of carbon dioxide increases
- [pH decreases]
- detected by the brain
- triggers an increase in breathing rate and depth
- to remove CO_2 faster [pH increases]

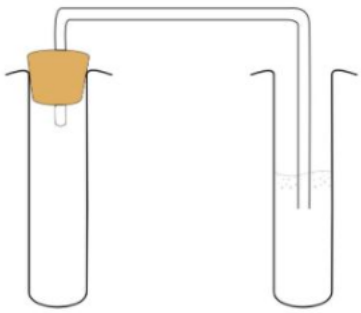
14 How do the goblet cells, mucus and ciliated cells protect the gas exchange system from pathogens and particles

- Goblet cells [trachea, bronchi] produce mucus which traps particles and pathogens
- Ciliated cells beat to move mucus up to the throat to be swallowed



15 Chemical used to test for CO_2

- Limewater - calcium hydroxide, $Ca(OH)_2$
- bubble gas through limewater
- turns from colourless to cloudy if CO_2 present



Chapter 12 : Respiration

01 Respiration

- the chemical reactions in cells that break down nutrient molecules and release energy for metabolism

02 Uses of energy in human body

- muscle contraction
- protein synthesis
- cell division
- active transport
- growth
- passage of nerve impulses
- maintaining constant body temperature

03 What does respiration also involve?

- the action of enzymes in cells
  - both types of respiration are catalysed by enzymes
  - rate of respiration can be influenced by temperature and pH

04 Types of respiration

- Aerobic respiration
- Anaerobic respiration

05 Aerobic respiration

- the chemical reactions in cells that use oxygen to break down nutrient molecules to release energy
  - glucose + oxygen $\longrightarrow$ carbon dioxide + water
  - $C_6H_{12}O_6 + 6O_2 \longrightarrow CO_2 + 6H_2O$

06 Anaerobic respiration

- the chemical reactions in cells that break down nutrient molecules to release energy without using oxygen
- Muscles (vigorous exercise)
  - Glucose $\longrightarrow$ lactic acid
  - $C_6H_{12}O_6 \longrightarrow 2C_3H_6O_3$
- Microorganism yeast
  - Glucose $\longrightarrow$ alcohol + carbon dioxide
  - $C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$

07 Which type of respiration releases more energy

- Aerobic respiration releases more energy per glucose than anaerobic respiration

08 What builds up in muscles during vigorous exercise

- Lactic acid is produced in muscles by anaerobic respiration
- Creating an oxygen debt

09 How is the oxygen debt removed after exercise

- Lactic acid is produced in muscles by anaerobic respiration
- Liver absorbs lactic acid from blood
- Carries out aerobic respiration to break it down into carbon dioxide and water
- Heart rate remains high after exercise to transport lactic acid in blood from muscles to liver
- Breathing rate remains high after exercise to supply oxygen for aerobic respiration of lactic acid

Chapter 13 : Excretion in humans

01 Two main excretory products of human

1. Carbon dioxide
2. Urea

02 Why excretion of urea and carbon dioxide is needed?

- toxic

03 Which organ excretes carbon dioxide?

- Lungs

04 Formation of urea

- In the liver from excess amino acids

05 Deamination

- the removal of the nitrogen-containing part of amino acids to form urea

06 Role of the liver in the assimilation of amino acids

- the liver converts excess amino acids to proteins including plasma proteins such as fibrinogen

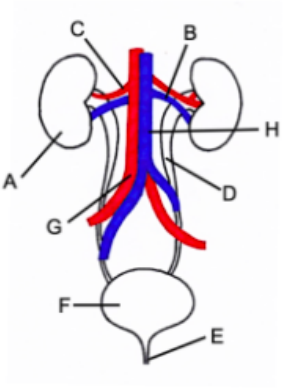
07 State 3 things that the kidneys excrete

1. Urea
2. Excess water
3. Excess salts

08 Factors that alter the volume of urine produced

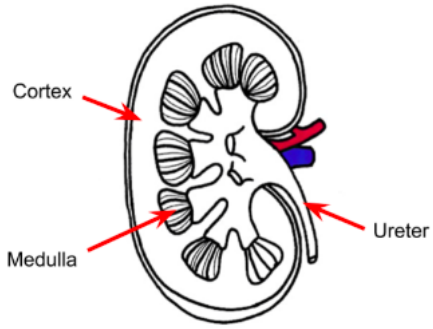
- Water intake
- Temperature
- Exercise

09 Identify the structures of the excretory system

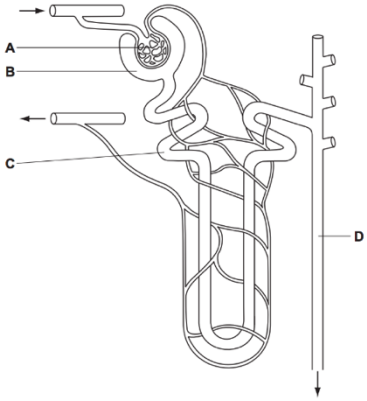


A	kidney	E	urethra
B	renal vein	F	bladder
C	renal artery	G	aorta
D	ureter	H	vena cava

10 Structure of kidney



11 Structure and function of a kidney tubule (nephron)



part	name of part	function
A	glomerulus ; **A** knot of capillaries **R** capillaries	filtration / filtering (blood) ; **A** increase in (blood) pressure / ref to high pressure **A** 'substances forced out' **R** diffusion
B	capsule ; **R** cup	collects filtrate / allows filtration ;
C	tubule ; *distal is neutal* **R** nephron / tube	(selective) reabsorption ; reabsorbs, water / glucose / salts / minerals / ions / amino acids ; *ignore* nutrients **A** description of reabsorption, e.g. active uptake of glucose absorption back into blood
D	collecting duct ;	(re)absorbs water / passes urine to pelvis *or* ureter ; **R** urea unless with water **A** waste substances

12 Role of glomerulus in kidney

- Filters water, glucose, urea and salts (small molecules) from the blood

13 Role of tubule in kidney

- Reabsorption of all the glucose, most of the water and some salts back into the blood
- leading to the concentration of urea and loss of excess water and salts in the urine

14 How is blood filtered in the kidney tubule?

- ultrafiltration takes place
- high blood pressure due to the narrowing of capillaries forces filtrate to pass through glomerulus into capsule
- filtrate are small enough to move through
- proteins & blood cells are too big to move out of glomerulus
- filtrate consists of glucose, water, urea and salts

15 What does kidney dialysis do?

- Removes urea from the blood
- Balances salt
- Maintains glucose concentration

16 What happens during dialysis in kidney machine?

- dialysis membrane is partially permeable
- salt / urea diffuse
- water moves by osmosis
- proteins / blood cells too large to move across membrane
- glucose not removed by dialysate (same conc. as blood)

17 Advantages and disadvantages of kidney transplants compared with dialysis

- Advantages:
  - patient does not need to return to clinic for dialysis
  - can eat normally
  - better quality of life
  - reduced pain
- Disadvantages:
  - need immunosuppressant drugs
  - risk of rejection of kidney
  - risk of death during operation

Chapter 14 : Coordination and response

01 Nerve impulse

- An electrical signal that passes along nerve cells called neurones

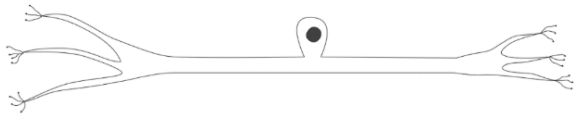
02 What is the human nervous system made up of?

- central nervous system
- peripheral nervous system
- coordination and regulation of body functions

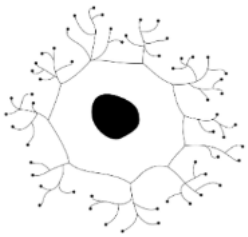
02.1 What is the difference between the central nervous system and the peripheral nervous system?

- CNS - brain and spinal cord
- PNS - motor and sensory neurones

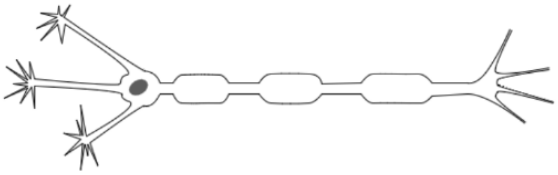
03 Sensory neurone



04 Relay (connector) neurone



05 Motor (effector) neurone



06 What is a voluntary action?

- An action that involves conscious thought

07 What is an involuntary action?

- An action that does not involve conscious thought in which a stimulus always leads to the same response

08 What is a reflex action?

- A rapid, automatic response of effectors to a sensory stimulus by the body

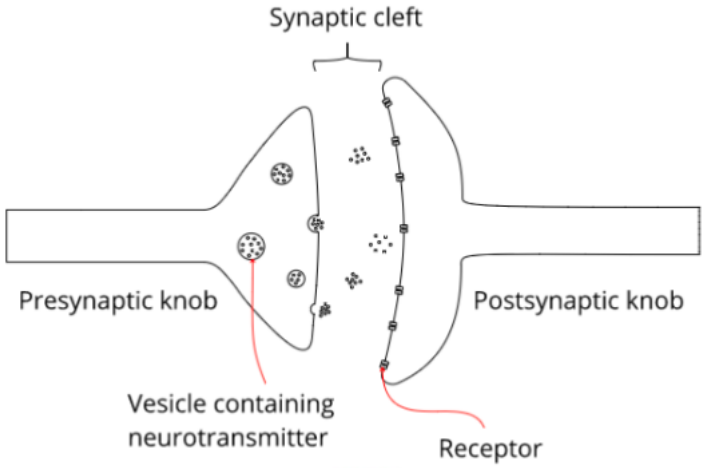
09 Describe a simple reflex arc

- Stimulus detected by receptor
- Impulse passed along sensory neurone to relay neurone in the central nervous system
- Impulse passed along motor neurone to effector
- Effector brings about the response

10 Define synapse

- A junction between two neurones

11 Labelled synapse



12 How is an impulse transmitted between two neurones?

- The impulse reaches the presynaptic neurone
- Vesicles fuse with membrane, releasing neurotransmitter into the synaptic gap
- The neurotransmitter diffuses across the synaptic gap and binds to receptors on the postsynaptic neurone membrane
- A new impulse is triggered in the postsynaptic neurone, impulse continues

13 What is the purpose of synapses?

- To ensure that impulses travel in one direction only

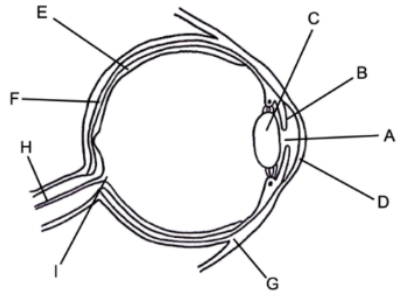
14 Give 3 examples of drugs that affect synapses

1. Alcohol
2. Heroin
3. Nicotine

15 Define sense organs

- Groups of receptor cells responding to specific stimuli

16 Structure of the eye



A	pupil	F	choroid
B	iris	G	sclera
C	lens	H	optic nerve
D	cornea	I	blind spot
E	retina		

17 Function of cornea

- refracts light

18 Function of iris

- controls how much light enters pupil

19 Function of lens

- focuses light onto retina

20 Function of retina

- contains light receptors, some sensitive to light of different colours

21 Function of optic nerve

- carries impulses to brain

22 State the response of the eye to bright light

- The pupil constricts to let less light in

23 Explain the pupil reflex to bright light

- Circular muscle contracts
- Radial muscles relax
- Pupil constricts

24 State the response of the eye to dim light

- The pupil dilates to let more light in

25 Explain the response of the eye to dim light

- Circular muscles relax
- Radial muscles contract
- Pupil dilates

26 Explain how the eye focuses (accommodation) on distant objects

- Ciliary muscles relax
- Suspensory ligaments contract

- Lens become thinner
- Less light is refracted

27 Explain how the eye focuses (accommodation) on near objects

- Ciliary muscles contract
- Suspensory ligaments slacken
- Lens become thicker
- Light is refracted more

28 Describe the distribution of rods and cones in the human eye

- fovea contains cones and no rods
- more rods than cones in the rest of eye

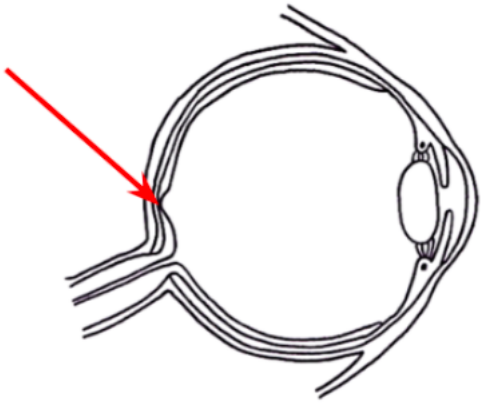
29 Function of cones

- used for colour vision
- distinguish between different colours in bright light
- 3 types of cones absorbing light of different colours: red, blue, green (different wavelengths)
- greater sensitivity to high light intensity

30 Function of rods

- used for night vision
- sensitive to low light intensity

31 Labelled fovea



32 Define hormone

- A chemical substance produced by a gland and carried by the blood, which alters the activity of one or more specific target organs

33 Where are the adrenal glands located? What do they secrete?

- behind the kidneys
- Adrenaline

34 When is adrenaline secreted?

- during 'fight or flight' situations

35 Three examples of situations in which adrenaline secretion increases

- scary situations
- stressful situations
- exciting situations

36 Three effects of adrenaline

- increased breathing rate
- increased pulse rate
- widened pupils
- increased blood glucose concentration

37 Role of hormone adrenaline in chemical control of metabolic activity

- Increasing blood glucose concentration
  - for increased respiration in muscle cells
- Increasing pulse rate and breathing rate
  - so glucose and oxygen can be delivered to muscle cells, and carbon dioxide taken away from muscles cells more quickly
- Dilate arterioles in brain and muscles
  - to deliver more glucose and oxygen for respiration
- Constrict arterioles in gut and other organs
  - to divert blood to muscles

38 Where is the pancreas located? What does it secrete?

- behind the stomach
- Insulin

38.1 Function of insulin

- decrease blood glucose concentration by stimulating liver cells to convert glucose in the liver to glycogen

39 What hormone do the ovaries secrete?

- Oestrogen

40 Function of oestrogen

- development of female secondary sexual characteristics
- control menstrual cycle

41 What hormone do the testes secrete?

- Testosterone

42 Function of testosterone

- development of the male secondary sexual characteristics

43 Two differences between nervous and hormonal system

Nervous	Hormonal
Fast to take effect	Slow to take effect
Short lasting	Long lasting

44 Define homeostasis

- the maintenance of a constant internal environment within set limits despite internal and external changes

45 What mechanism is used to achieve homeostasis?

- negative feedback

46 What happens when blood glucose concentration is high?

- pancreas detects high glucose conc. in blood
- it secretes insulin in blood
- insulin stimulates liver cells to convert glucose in the liver to glycogen
- glucose conc. decreases and returns to normal

47 What does insulin do in the body?

- insulin decreases blood glucose concentration by stimulating liver cells to convert glucose in the liver to glycogen

48 What happens when blood glucose concentration is low?

- pancreas detects low glucose conc. in blood
- it secretes glucagon into the blood
- glucagon stimulates liver cells to convert glycogen in the liver to glucose
- glucose conc. increases and returns to normal

49 What does glucagon do in the body?

- Glucagon increases blood glucose concentration by stimulating liver cells to convert glycogen in the liver to glucose

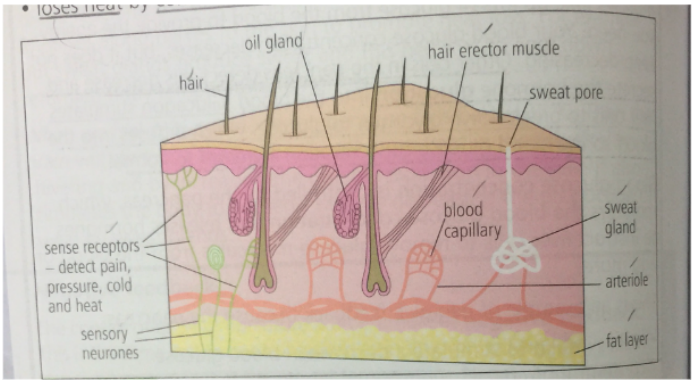
50 Three symptoms of type 1 diabetes

- thirst
- tiredness or weakness
- weight loss
- blurred vision

51 Three methods of treating type 1 diabetes

- insulin injections
- diet monitoring
- pancreas transplant

52



53 Four ways to keep body warm

1. Vasoconstriction
2. Shivering
3. Erection of hairs on skin
   - hair muscles contract
   - hair stands which traps layer of air
   - heat insulation
4. Fatty tissue under skin (insulation)

54 Describe the process of vasoconstriction

- body detects drop in temperature
- arterioles supplying the capillaries at the skin surface constrict
- less blood flows closer to the skin surface
- less heat is lost to surroundings
- by conduction

55 Three processes involving the skin that cool the body down

1. Sweating
   - more heat is lost by evaporation from the skin surface
2. Vasodilation
   - allows blood to flow closer to the surface of skin where it can lose more heat to surroundings
3. Hair lie flat

56 Describe the process of vasodilation

- body detects rise in temperature
- arterioles supplying the capillaries at the skin surface dilate
- more blood flows closer to the skin
- more heat is loss to surroundings
- by conduction

57 Define gravitropism

- a response in which parts of a plant grow towards or away from gravity

58 Which part of a plant is positively gravitropic?

- roots - grow down in the same direction as the pull of gravity

59 Define phototropism

- a response in which parts of a plant grow towards or away from the direction from which light is coming

60 Which part of a plant is positively phototrophic?

- shoots - grow towards the light source

61 What are gravitropism and phototropism examples of?

- Chemical control in plants

62 Explain how auxin controls shoot growth

- auxin made in the tip
- auxin diffuses down the shoot
- auxin collects on the shaded side / lower side of plant
- auxin stimulates cell elongation
- plants bends ___

63 Use of synthetic plant hormone 2,4-D in weedkillers

- selective weedkillers
- only affect weeds not crop
- makes weeds grow faster so they die faster

Chapter 15 : Drugs

01 Drug

- Any substance taken into the body that modifies or affects chemical reactions in the body

02 How can the development of resistant bacteria be minimised

- Using antibiotics only when essential
- Ensuring treatment is completed (complete entire course)

03 Why antibiotics kill bacteria but do not affect viruses

- Antibiotics work by disrupting formation of cell walls
- Viruses do not have cell walls

04 Effects of excessive alcohol

- Short-term:
  - Depressant
  - Lengthens reaction time
  - Reduces self-control
- Long-term:
  - Addiction
  - Liver damage

05 How does Heroin affect the function of the synapse?

- Heroin diffuses into synapse
- Heroin binds to receptors
- Heroin is complementary to receptors
- Blocks neurotransmitter entering receptor site
- Reduced pain perception

06 Tobacco smoking

- Effects:
  - Chronic obstructive pulmonary disease (COPD)
  - Lung cancer
  - Coronary heart disease

07 Major toxic components of tobacco smoke

- Carbon monoxide
  - binds to haemoglobin
  - reduced oxygen
- Nicotine
  - addictive
- Tar
  - carcinogenic (causes lung cancer)
  - sticks to alveoli / cilia
  - produce more mucus

08 Hormones used to improve sporting performance

- Testosterone
- Anabolic steroids

09 Where is alcohol and other toxins broken down in the body?

- The liver

10 Harmful effects of alcohol on fetus

- Miscarriage
- Premature birth
- Low birth weight
- Addiction

11 Harmful substances that can cross placenta

- Alcohol
- Nicotine

Chapter 16 : Reproduction

01 Asexual reproduction

- the production of genetically identical offspring from one parent

02 Advantages of asexual reproduction

- Only one parent is required
  - helpful for isolated organisms
- Can reproduce quickly
- Requires less energy

03 Disadvantages for asexual reproduction

- Lack of diversity
- Prone to extinction
  - whole population can be killed by one pathogen
- Cannot adapt
- Overpopulation

04 Sexual reproduction

- the production of genetically different offspring from the fusion of the nuclei of two gametes to form a zygote

05 Advantages of sexual reproduction

- Wide diversity
- Promotes survival
- Organism can adapt

06 Disadvantages of sexual reproduction

- Two parents are required
- Fewer offspring produced (reproduce slower)

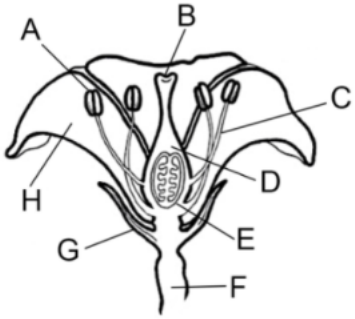
07 Fertilisation

- the fusion of two gamete nuclei

08 The no. of chromosomes (gametes VS zygotes)

- Gamete - haploid nucleus (23 chromosomes)
- Zygote - diploid nucleus (46 chromosomes)

09 Structure of insect pollinated flower



A	Anther	E	Ovary
B	Stigma	F	Pedicel
C	Filament	G	Sepal
D	Style	H	Colourful petal

- stamen = anther + filament
- carpel = stigma + style + ovary
- ovule

10 Function of sepals

- protect the flower when it is in a bud (unopened)

11 Function of petals

- attract insects so that they can pollinate the plant

12 Function of anthers

- produce pollen (male gametes)

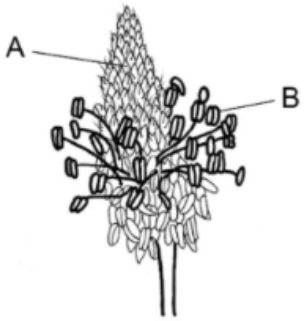
13 Function of stigmas

- collects pollen (female part)

14 Function of ovaries (plant)

- produces female gametes (contained in the ovules)

15 Structure of wind pollinated plant



A - Stigma

B - Anthers

15.1 Describe the anthers and stigma of a wind-pollinated flower

- they hang outside of the flower

16 What type of pollen grain is this and why?

- Pollen from an insect-pollinated flowers
- Large
- Sticky / Has spikes

17 What type of pollen grain is this and why?

- pollen from wind-pollinated flowers
- Smooth
- Small
- Light

18 Structural adaptations of insect-pollinated flowers vs wind-pollinated flowers

feature	insect-pollinated flowers	wind-pollinated flowers
petals	present – colourful and scented to attract insects	absent or very small and difficult to see
nectaries	present – make nectar which is a sugary liquid food for pollinating insects	absent
stamens	present – usually with short filaments; anthers attached firmly to filaments; inside the flower for insects to rub against	long filaments so anthers hang outside the flower; anthers loosely attached to the filaments so pollen is easily blown away
pollen	small quantities of sticky, spiky pollen grains that stick easily to insects' bodies	large quantities of smooth, light pollen that can easily be carried by the wind
carpels	sticky, small stigmas usually inside the flower for insects to rub against	large, feathery stigmas to catch pollen grains in the air

19 Pollination

- the transfer of pollen grains from the anther to the stigma

20 Self-pollination

- the transfer of pollen grains from the anther of a flower to the stigma of the same flower or different flower on the same plant

21 Advantages of self-pollination

- Only one plant needed
- Greater chance of pollination

22 Disadvantages of self-pollination

- Less genetic variation
- Less chances of survival
- Greater risk of extinction

24 Cross-pollination

- the transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species

25 Advantages of cross-pollination

- More genetic diversity
- Can adapt
- More resilient to disease

26 Disadvantages of cross-pollination

- Uses more energy
  - attract pollinators
- Cannot spread to areas where the species does not currently exist
- Only occur when the flowers are open

27 When does fertilisation occur in plants?

- When a pollen nucleus fuses with an ovum nucleus in the ovum

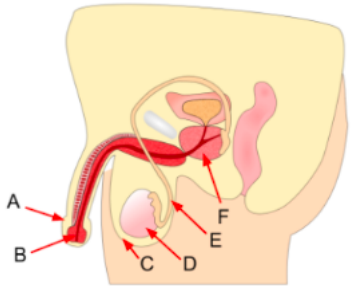
28 What happens when a pollen grain lands on the stigma of a plant?

1. A pollen tube grows
2. Pollen moves down the pollen tube through the style to the ovary, into the ovule
3. Nucleus of pollen grain fuses with nucleus in ovule

29 Environmental conditions that affect seed germination

- Water
  - needed for seeds to swell (grow)
- Oxygen
  - aerobic respiration to produce energy for growth
- A Suitable Temperature
  - enzymes work efficiently

30 Structure of the male reproductive system



A	Penis
B	Urethra
C	Scrotum
D	Testes
E	Sperm duct
F	Prostate gland

31 Function of testes
- produce hormones and sperm

32 Function of scrotum
- holds and protects the testes
- keeps testes maintained at temperature slightly lower than body temperature for sperm production

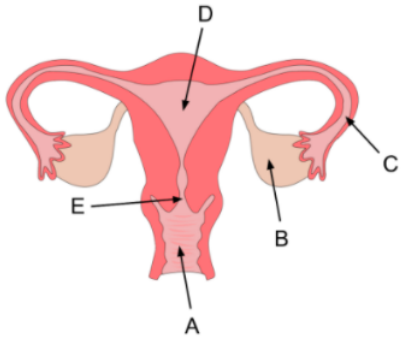
33 Function of sperm duct
- carries sperm from the testes to the urethra

34 Function of prostate gland
- produces prostate fluid which helps the sperm to swim (semen)

35 Function of male urethra
- allows urine to exit the body from the bladder
- used during ejaculation to release semen

36 Function of penis
- used as the male sex organ
- used as the excretory organ

37 Structure of the female reproductive system



A	Vagina
B	Ovary
C	Oviduct
D	Uterus
E	Cervix

38 Function of ovaries
- produce eggs and hormones

39 Function of oviduct
- To create a passage between the ovary and the uterus for the egg to travel down

40 Function of uterus
- where the foetus develops

41 Function of cervix
- allow menstrual blood to flow out of vagina
- channel the sperm into the uterus

42 Function of vagina
- receive penis during intercourse
- used as the birth canal during childbirth

43 Describe fertilisation

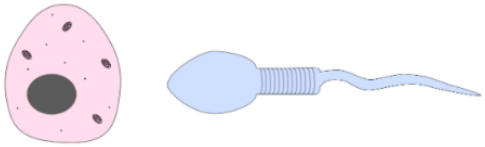
- the fusion of the nuclei from a male gamete (sperm) and a female gamete (egg cell/ovum)

44 Compare sperm and egg cells in terms of size

- sperm cells are significantly smaller than eggs cells

45 Compare sperm and egg cells in terms of structure and shape

- Sperm cells are long and thin with a head and tail
- Egg cells are large and sphere / ovoid in shape



Not to scale

46 Compare sperm and egg cells in terms of their ability to move

- sperm cells have large energy stores and a long tail to help them move quickly
- egg cells do not have this and so are relatively non-motile

47 Compare sperm and egg cells in terms of the number of each cell

- There are many more sperm cells than egg cells (up to 100 million sperm per millilitre of ejaculate)

48 State adaptive features of sperm

- long flagellum
- contain enzymes

49 Explain adaptive features of sperm cells

- lots of mitochondria in the neck to provide energy for movement
- enzymes in the acrosome digest the jelly-coating of the egg cell
- long whip-like flagellum used for movement

50 State adaptive features of egg cells

- large energy stores
- jelly coating

51 Explain adaptive features of egg cells

- large energy stores allow for lots of cell divisions and growth
- jelly coating ensures that only one sperm can fertilise the egg as it changes after fertilisation

52 Describe the early development of an embryo

- After fertilisation a zygote is formed
- It undergoes mitosis to form an embryo
- The embryo implants itself in the uterus lining

53 Describe the growth and development of the foetus over time

- The foetus begins by developing and becoming more complex
- In the later stages of pregnancy, the foetus increases in size

54 Function of umbilical cord

- transfer of nutrients from mother to foetus
- carries foetal blood to and from the placenta

55 Function of placenta

- separates mother's blood supply from the foetus' blood supply
- barrier for toxins and pathogens
- allows exchange between mother and foetus
- to provide the foetus with dissolved nutrients
- to allow the removal of waste gases and excretory products from the foetus

56 Function of amniotic sac and amniotic fluid

- Amniotic sac contains the amniotic fluid
- The sac prevents entry of pathogens
- It protects the foetus against damage
- It provides constant temperature
- It allows foetus to move
- It provides a sterile environment

57 How can certain toxins and pathogens be harmful to the developing foetus?

- The toxins and pathogens can pass across the placenta and can damage the foetus

58 Name one toxin that can affect a developing foetus

- nicotine found in cigarette smoke

59 Name one pathogen that can affect a developing foetus

- rubella virus

60 Describe how women should control their diet during pregnancy (Antenatal care)

- avoid smoking or drinking as this can damage the foetus
- make sure to have a balanced diet with a focus on nutrients like iron for the development of blood and calcium for the development of bones

61 Stages of birth

1. Amniotic sac breaks
2. Muscles in the uterus wall contracts
3. Cervix dilates/widens
4. Passage of baby through the vagina
5. Tying and cutting the umbilical cord
6. Delivery of the afterbirth

62 Advantages of breastfeeding over bottle feeding using formula milk

- contains all the essential nutrients for the baby
- easier for baby to digest
- provides the child with antibodies
- provides protection against disease
- free/cheap
- bonding with mother
- reduce risk of allergies

63 Disadvantage of breastfeeding over bottle feeding using formula milk

- may be painful for the mother
- stressful
- can only occur when the mother is present
- transfer of viruses
- medications/drugs/alcohol can pass to baby

64 What roles of testosterone play during puberty?

- triggers growth and development of penis and testes
- causes voice to deepen
- triggers the growth of pubic hair
- increases muscle mass

65 What role does oestrogen play during puberty?

- growth and development of breasts
- start of first menstrual cycle
- widening of hips

66 Describe the menstrual cycle

- D1-7:
  - The uterus lining is shed during menstruation
- D7-14:
  - The uterus lining begins to grow again in preparation to receive an egg
- D14:
  - An egg is released
- D14-28:
  - The lining of the uterus is maintained

67 Where is oestrogen secreted from?

- Ovaries

68 Where is progesterone secreted from?

- Ovaries

69 What does follicle stimulating hormone (FSH) do?

- stimulates development of egg

70 What does luteinising hormone (LH) do?

- causes the release of an egg from a follicle (ovulation)

71 What does progesterone do?

- maintains the uterus lining

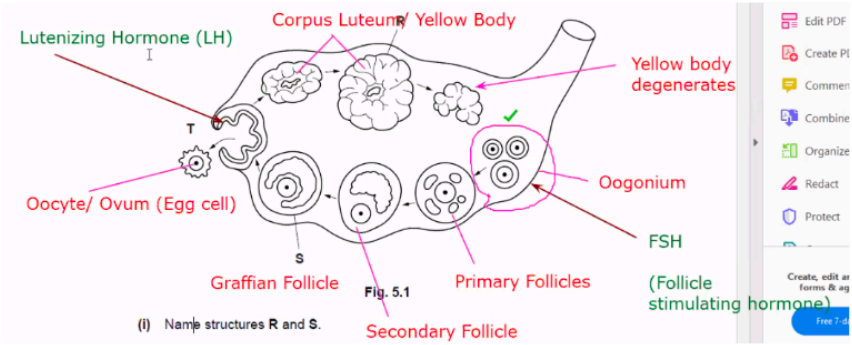
72 What hormone does progesterone inhibit?

- follicle stimulating hormone (FSH) & luteinising hormone (LH)

73 Explain the process of the menstrual cycle

- FSH:
  - stimulates development of egg
  - stimulates secretion of oestrogen
- Oestrogen:
  - stimulates growth of uterus lining
  - stops secretion of FSH
  - stimulates secretion of LH
- LH:
  - stimulates follicle to burst, releasing its egg (ovulation)
  - remains of follicle (yellow body) secretes progesterone
- Progesterone:
  - maintain uterus lining
  - inhibits secretion of FSH & LH

74 Development of egg in the ovary



75 Types of birth control

- Natural methods
- Chemicals
- Barriers
- Surgical

76 Examples of natural methods of birth control

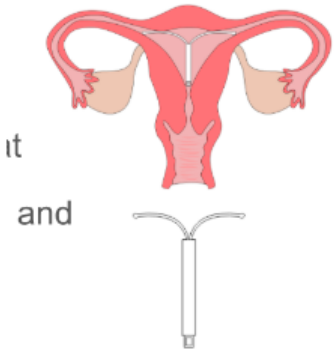
- Abstinence (refraining from sex)
- Monitoring body temperature and cervical mucus to predict ovulation

77 Examples of chemical methods of birth control

- IUS (Intra-uterine system)
- Contraceptive pill
- Implant
- Injection
- IUD (Intra-Uterine Device)

77.1 Describe use of IUD as a contraceptive device

- small copper-coated tubes placed inside the uterus
- prevent sperm from reaching the uterus
- prevent embryo implantation in the uterus



77.2 Describe the use of an IUS as a contraceptive device

- similar to IUD
- contain and release progesterone
- thickens cervical mucus (difficult for sperm to swim into the uterus)
- thins the uterus lining (difficult for fertilised egg to implant)

77.3 How does the contraceptive pill work?

- contains oestrogen and progesterone
- prevents ovulation

77.4 Describe the use of an implant as a contraceptive device

- small rod
- inserted under the skin of the upper arm
- releases progestogen into bloodstream which prevents ovulation

77.5 How does the contraceptive injection prevent pregnancy?

- releases progesterone into the bloodstream
- prevents ovulation

78 Examples of barriers that act as birth control

- Condom
- Femidom:
  - female equivalent condom inserted into vagina
- Diaphragm:
  - inserted into vagina to cover cervix before intercourse
- *stops sperm from reaching uterus

79 Surgical methods of contraception
- Vasectomy
- Female sterilisation

79.1 How does a vasectomy work to prevent pregnancy?
- vas deferens (sperm duct) are cut & tied
- prevents sperm released from testes

79.2 How does female sterilisation work?
- oviducts are cut / tied off
- prevents release of egg from ovaries

80 Describe artificial insemination (AI)
- Sperm are placed within a women's uterus

81 Describe how in vitro fertilisation (IVF) is carried out
- provide fertility drug (FSH) early in menstrual cycle
- when follicles are developing / 14 days before AI
- collect sperm
- place sperm into uterus
- around time of ovulation

82 Sexually transmitted infection (STI)
- An infection that is transmitted via body fluids through sexual contact

83 Give an example of an STI
- HIV (human immunodeficiency virus)

84 Ways of preventing the spread of STIs
- wearing condoms during sex
- educational programmes about STIs
- don't share needles
- careful screening of donated blood used in transfusion

85 How is HIV spread?
- sharing needles with an infected person
- blood transfusion with infected blood
- unprotected sexual intercourse
- from mother to foetus via placenta
- mother to baby via breastfeeding

86 How does HIV affect the immune system?
- decrease lymphocyte numbers
- reduced ability to produce antibodies
- weakens immune system
- phagocytes unable to destroy infected cells

87 What can HIV infection lead to?

- AIDS (Acquired Immunodeficiency syndrome)

Chapter 17 : Inheritance

01 Inheritance

- The transmission of genetic information from generation to generation

02 Chromosome

- A thread-like structure of DNA, carrying genetic information in the form of genes

03 Gene

- A length of DNA that codes for a protein

04 Allele

- A version of a gene

05 Describe inheritance of sex in humans

- One of the 23 pairs of chromosomes determines se
- The pair can either be:
    - XX for a female
    - XY for a male

06 How genes determine the order of amino acids in a protein

- The sequence of bases in a gene is the genetic code
- For putting together amino acids in the correct order
- To make specific protein

07 How DNA controls cell function

- By controlling the production of :
    - Proteins (some of which are enzymes)
    - Antibodies
    - Receptors for neurotransmitters

08 How a protein is made (protein synthesis)

- Gene coding for the protein remains in the nucleus
- mRNA molecules carry a copy of the gene to the cytoplasm
- mRNA passes through ribosomes
- Ribosome assembles amino acids into protein molecules
- The specific order of amino acids is determined by the sequence of bases in the mRNA

09 Comparing genes found in all body cells

- All body cells in an organism contain the same genes
- Many genes in a particular cell are not expressed
- The cell only makes the specific proteins it needs

10 Haploid nucleus

- A nucleus containing a single set of unpaired chromosomes, e.g. in gametes

11 Diploid nucleus

- A nucleus containing two sets of chromosomes, e.g. in body cells
    - There is a pair of each type of chromosome
    - In human diploid cell there are 23 pairs

12 Mitosis

- Nuclear division that produces two genetically identical daughter cells
- The process:
    - Chromosomes duplicate
    - Chromosomes separate
    - Mitosis happens
    - Zygote/cell splits into two
    - Mitosis is repeated
    - Forming a ball of cells
    - Cells are genetically identical

13 Roles of mitosis

- Growth
- Repair of damaged tissues
- Replacement of cells
- Asexual reproduction

14 When does the duplication of chromosomes happen?

- The duplication of chromosomes happens before mitosis

15 Maintaining the chromosome number during mitosis

- Chromosome number doubles before mitosis
- During mitosis, the copies of chromosome separate

16 Stem cells

- Unspecialised cells
- Divide by mitosis to produce daughter cells
- That can become specialised for specific functions

17 Meiosis

- Reduction division in which the chromosome number is halved from diploid to haploid resulting in genetically different cells

18 What type of cell does meiosis produce?

- Gametes

19 How meiosis produces variation

- By forming new combinations of maternal and paternal chromosomes

20 Genotype

- The genetic make-up of an organism in terms of the alleles present

21 Phenotype

- The observable features of an organism

22 Homozygous

- Having two identical alleles of a particular gene
  - Two homozygous individuals
  - Breed together
  - Known as pure-breeding

23 Heterozygous

- Having two different alleles of a particular gene
  - Heterozygous individual
  - Not pure-breeding

24 Dominant

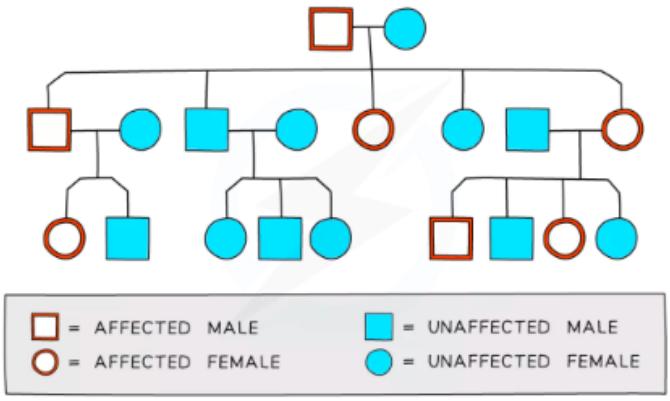
- An allele that is expressed if it is present

25 Recessive

- An allele that is only expressed when there is no dominant allele of the gene present

26 Pedigree diagrams

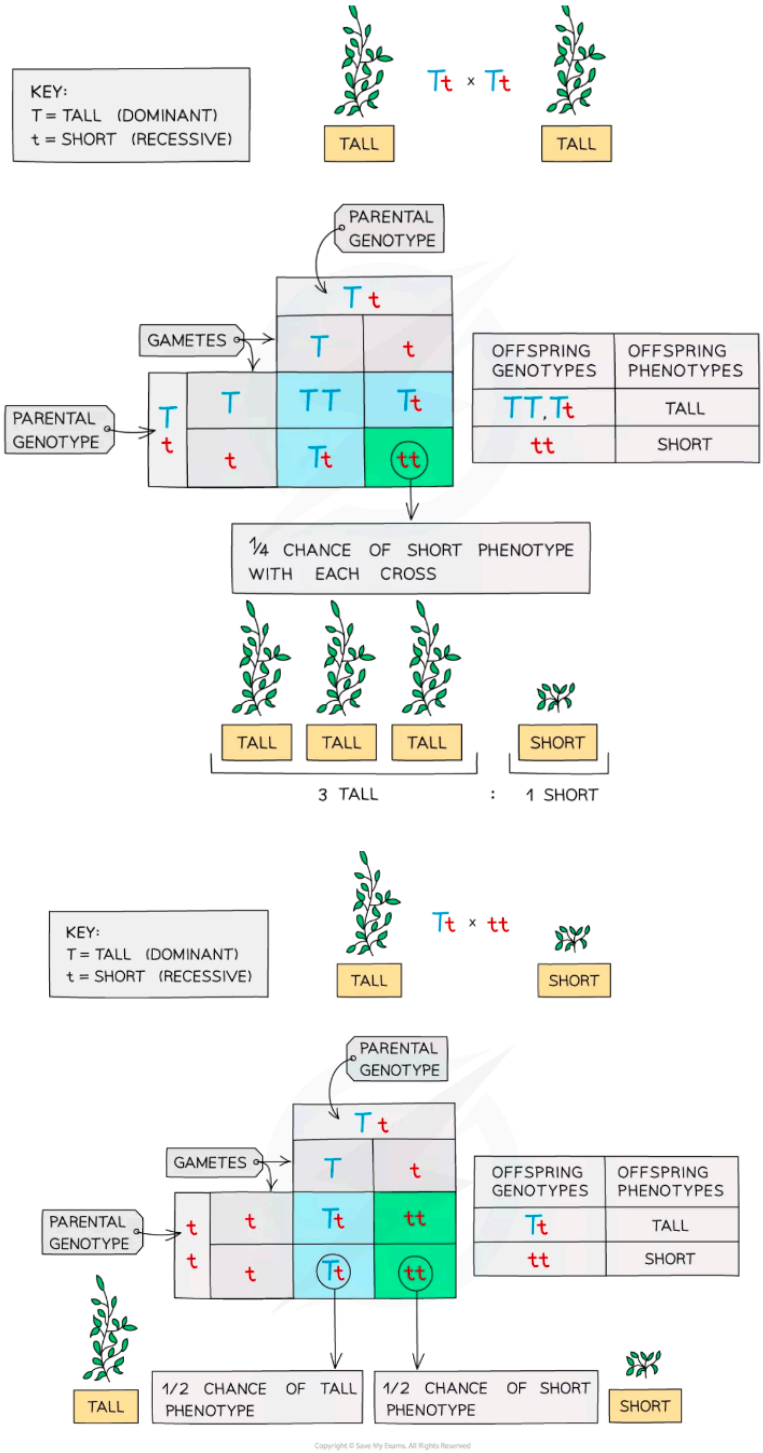
- Show the inheritance of a given characteristic (allele)



- The family pedigree above shows:
  - Both males and females are affected
  - Every generation has affected individuals
  - There is one family group that has no affected parents or children
  - The other two families have one affected parent and affected children as well

27 Monohybrid inheritance

- The inheritance of a single characteristic controlled by one gene with two or more alleles



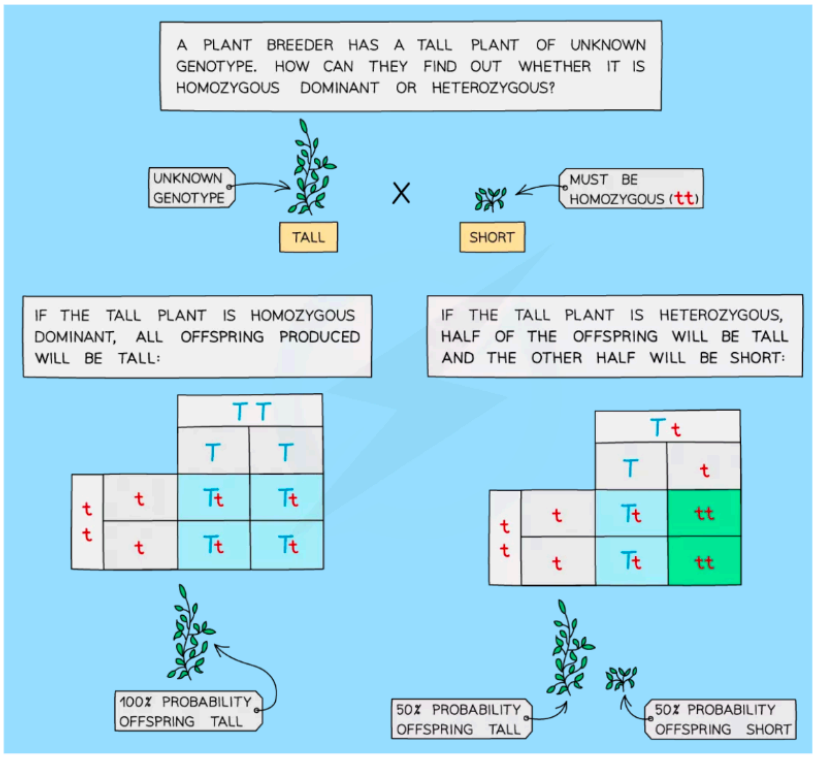
save my exams

A cross between a heterozygous plant with a short plant

- In this cross, there is a **1:1 ratio of tall to short**, meaning a **50%** chance of the offspring being tall and a **50%** chance of the offspring being short

28 Test cross

- Used to identify an unknown genotype



29 Punnet squares

	B	b
b	Bb	bb
b	Bb	bb

50% brown eyes	Bb
50% blue eyes	bb

	R	R
r	Rr	Rr
r	Rr	Rr

100% Red flowers	Rr

	F	f
F	FF	Ff
f	Ff	ff

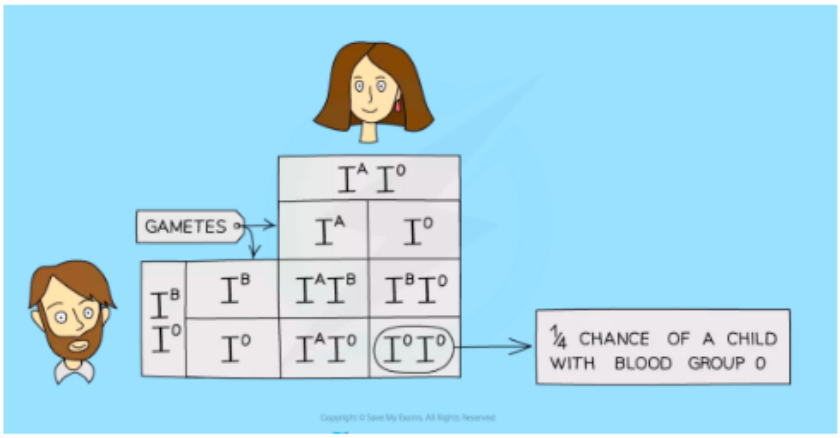
25% healthy	FF
50% carriers	Ff
25% have CF	ff

30 Co-dominance

- When both alleles are expressed in the phenotype, as neither is dominant over the other
- Ex: Blood groups

GENOTYPE	PHENOTYPE
$I^A I^A$ OR $I^A I^O$	A
$I^B I^B$ OR $I^B I^O$	B
$I^A I^B$	AB
$I^O I^O$	O

- IA, IB, are codominant
- IO is recessive to both IA and IB



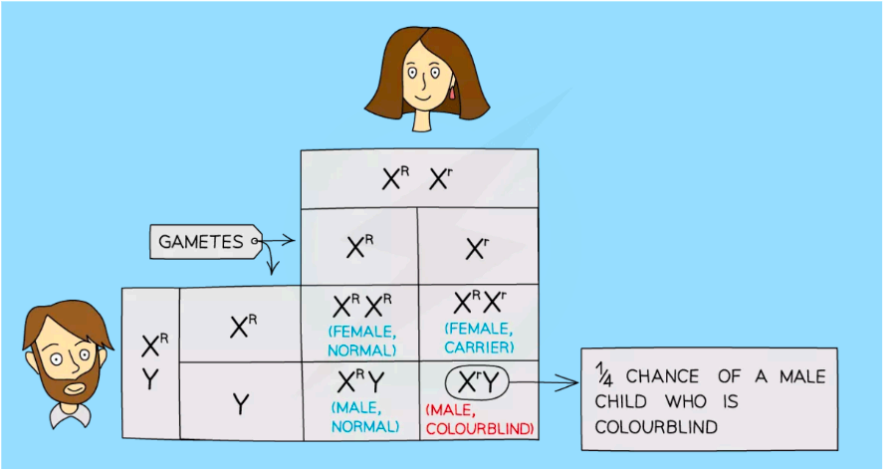
31 Sex-linked characteristic

- A characteristic in which the gene responsible
- Located on a sex chromosome
- This makes it more common in one sex

32 Examples of sex linkage

- Colour blindness

33 Colour blindness punnet square



Chapter 18 : Variation and selection

01 Variation

- The differences between individuals of the same species

02 What causes variation?

- Mutations in the genetic code

03 Phenotypic variation

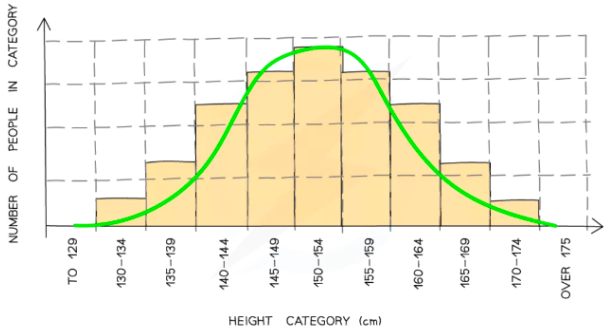
- The difference in features between individuals of the same species
    - caused by both genetic and environmental factors

04 Genetic variation

- The difference between the genotypes of individuals of the same species

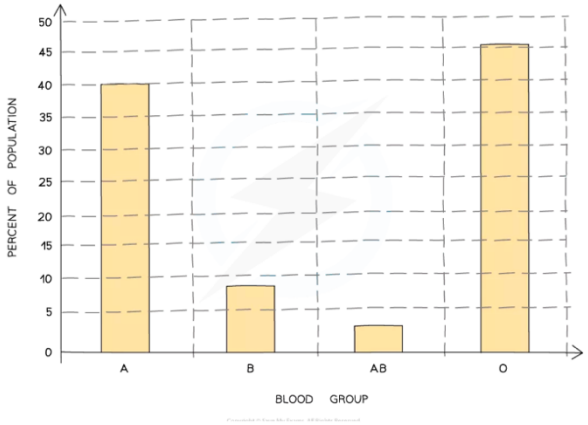
05 Continuous variation

- Results in a range of phenotypes between two extremes e.g. height in humans (contains intermediates)
    - Mostly caused by both genes and environment



06 Discontinuous variation

- Results in a limited number of phenotypes with no intermediates e.g. tounge rolling (distinct phenotypes)
    - Mostly caused by genes alone
    - Ex: blood groups in humans



07 Mutation

- genetic change

08 Gene mutation

- A change in the base sequence of DNA

09 How new alleles are formed

- Through mutation

10 Things that increase the rate of mutation

- Ionising radiation
- Some chemicals

11 Symptoms of sickle-cell anaemia

- Headaches
- Fatigue
- Fainting

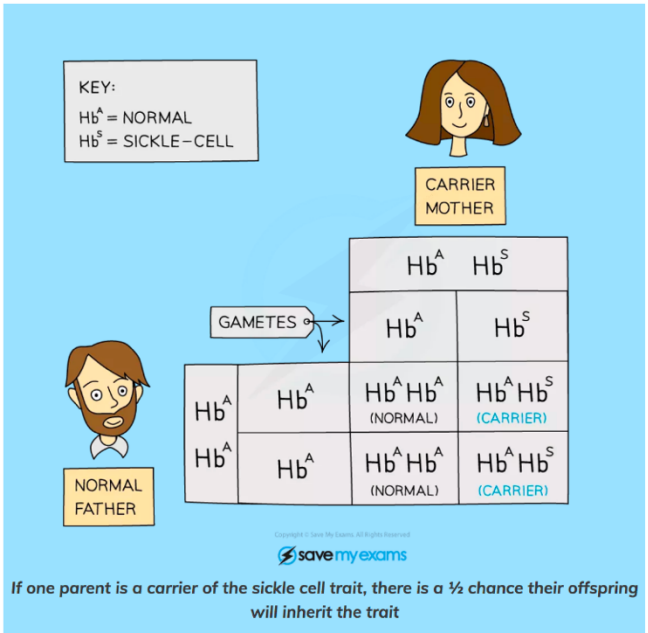
12 Explain why sickle cell anaemia reduces the delivery of oxygen to tissues

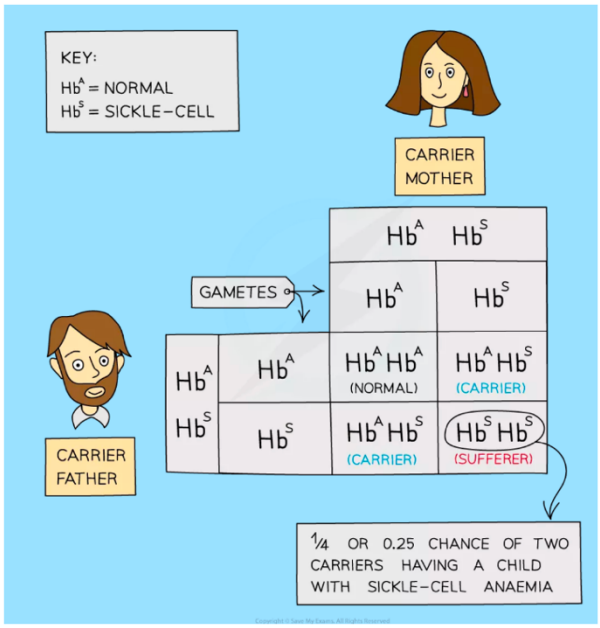
- Haemoglobin becomes abnormal
- It carries less oxygen than normal haemoglobin
- Red blood cells become sickle shaped
- These sickle cells clot in blood vessels and reduce flow of healthy blood

12.1 How does sickle cell anaemia arise?

- Mutation
- A change in the base sequence of DNA
- in gene for haemoglobin

13 Inheritance of sickle-cell anaemia





14 What disease do people who are heterozygous for sickle-cell anaemia have resistance to?

- Malaria

15 Distribution of sickle-cell allele in human populations

- Sickle-cell anaemia tends to be found more in places where malaria is common

16 How sickle-cell anaemia distributes?

- People who have sickle cell anaemia are resistant to malaria
- Those without sickle cell anaemia are not immune and are more likely to die from malaria
- Over time, a majority of the population will carry the sickle cell anaemia gene

17 Adaptive feature

- The inherited functional feature of an organism that increase its fitness

18 Fitness

- The probability of an organism surviving and reproducing in the environment in which it is found

19 Hydrophytes

- Plants adapted to live in extremely wet conditions
- Adaptations:
    - Large air spaces - leaves float
    - Stomata in the upper epidermis - movement of gases from air
    - Thin cuticle - no need to reduce water loss by transpiration

20 Xerophytes

- Plants adapted to live in extremely dry conditions
- Adaptations:
    - Thick waxy cuticles - reduces transpiration
    - Leaves reduced to spines - reduces surface area of leaves reducing water lost
    - Rolled leaves - reduces surface area of leaves
    - Few stomata - reduce transpiration
    - Deep roots - absorb water

21 Natural selection

- Variation within population
- Production of many offspring
- Competition for resources
- Struggle for survival
- Reproduction by individuals that are better adapted to the environment than others
- Passing on of their alleles to the next generation

22 Evolution

- The change in adaptive features of a population over time as the result of natural selection

23 Process of adaptation

- The process resulting from natural selection in which populations become more suited to their environment over many generations

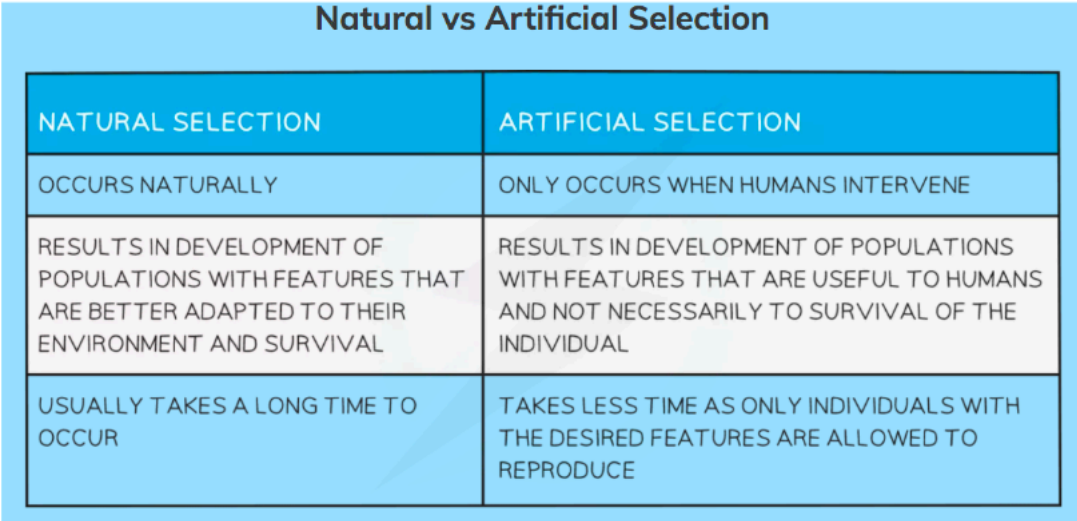
24 Development of strains of antibiotic resistant bacteria

- Resistance is developed by mutation in small number of bacteria
- Antibiotic kills bacteria that do not have mutation
- Resistant bacteria have no competition
- They reproduce and pass on the gene for resistance
- This is known as natural selection

25 Selective breeding

- Choose organisms best adapted to conditions
- Breed them together
- Select offspring that show desired features
- Breed them together again

26 Differences between natural and artificial selection



27 Selective breeding by artificial selection to improve plants and animals

- Outbreeding:
  - Breeding of unrelated animals / plants
  - To combine good characteristics of separate individuals such as:
    - disease resistance
    - increasing crop yield
  - Resulting in tougher individuals with a better chance of survival
  - This is called hybrid vigour
- Inbreeding:
  - Breeding close relatives
  - To retain desirable characteristics
  - However, there can be harmful effects such as:
    - Loss of vigour (physical strength and good health)
    - Lack of diversity
    - Reduced fertility
    - Greater risk of disease

Chapter 19 : Organisms and their environment

01 The principal source of energy

- Sun

02 Food chain

- Showing the transfer of energy from one organism to the next, beginning with a producer

03 Trophic level

- The position of an organism in a food chain, food web, pyramid of numbers or pyramid of biomass

04 Why food chains have fewer than five trophic levels

- Energy is lost between and within trophic levels
- to material that is inedible or indigestible
- Only small total percentage of energy will reach fourth level
- Not enough energy in fourth trophic level to support another level

05 Why there is a greater efficiency in supplying plants as human food than livestock

- Plants are at a lower trophic level than livestock
- Energy is lost between and within trophic levels
- Only 10% of energy is transferred
- Energy is lost in respiration
- Energy is lost in movement
- Energy is lost to material that is inedible and indigestible

06 Food web

- A network of interconnected food chains

07 Producer

- an organism that makes its own organic nutrients, using energy from sunlight through photosynthesis

08 Consumer

- an organism that gets its energy by feeding on other organisms

09 Number of levels in a pyramid

1. Producers
2. Primary consumers
3. Secondary consumers
4. Tertiary consumers
5. Quaternary consumers

10 Herbivore

- an animal that gets its energy by eating plants

11 Carnivore

- an animal that gets its energy by eating other animals

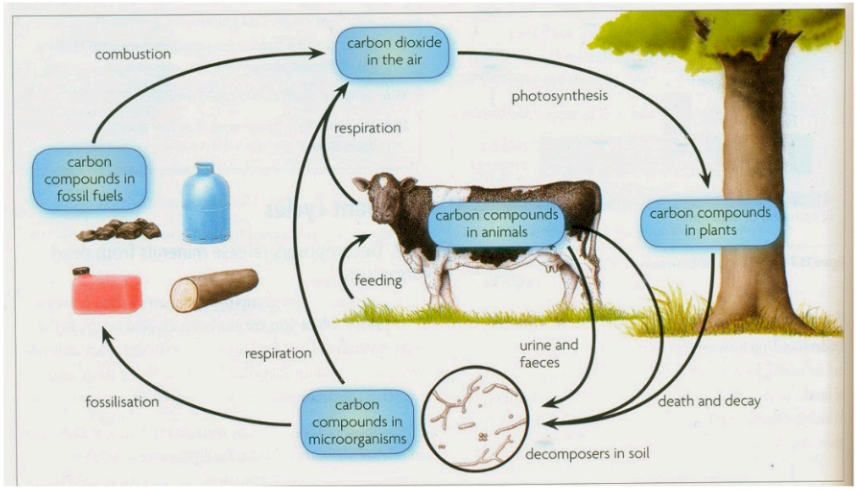
12 Decomposer

- an organism that gets its energy from dead or waste organic material

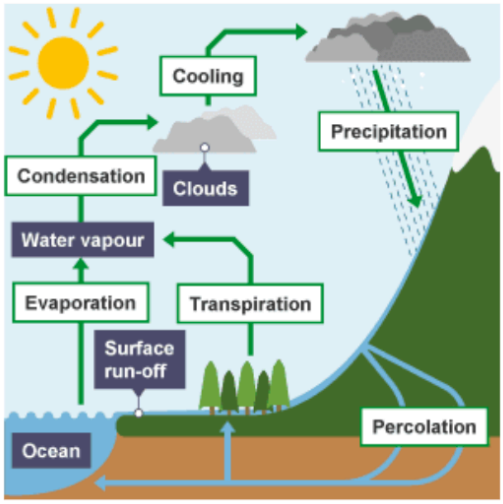
13 Advantages of using a pyramid of biomass rather than a pyramid of numbers to represent a food chain

- In a pyramid of numbers one large individual is shown in the same way as one very tiny individual
- Biomass indicates how much food there is available
- Biomass is an indicator of the energy available
- Pyramid of biomass is pyramid shaped whereas a pyramid of numbers is not always

14 Carbon cycle



15 Water cycle



16 Nitrogen cycle

- Decomposition of plants and animals
- Deamination: amino acids to ammonium ions
- Nitrification: ammonium ions to nitrate ions
- Nitrogen fixation by lightning and bacteria in root nodules: nitrogen gas to nitrate ions
- Absorption of nitrate ions by plants
    - Production for amino acids and proteins
    - Feeding and digestion of proteins
- Denitrification by denitrifying-bacteria in anaerobic conditions: nitrate ions to nitrogen gas

17 Population

- a group of organisms of one species, living in the same area, at the same time

18 Community

- All of the populations of different species in an ecosystem

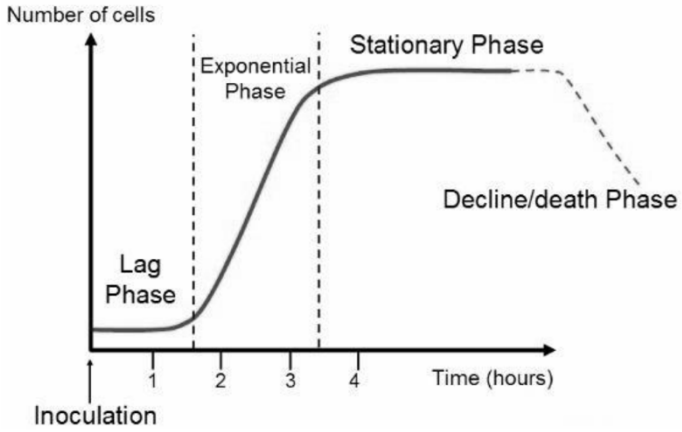
19 Ecosystem

- A unit containing the community of organisms and their environment, interacting together

20 Factors that affect rate of population growth

- Food supply
- Predation
- Disease

21 Sigmoid population growth curve



22 Reasons for increase in human population

- More births than deaths
- More immigration than emigration
- Increased food supply
- Reduced poverty
- Improved health care

Chapter 20 : Biotechnology and genetic engineering

01 Genetic engineering

- Changing the genetic material of an organism by removing, changing or inserting individual genes

02 Process of genetic engineering

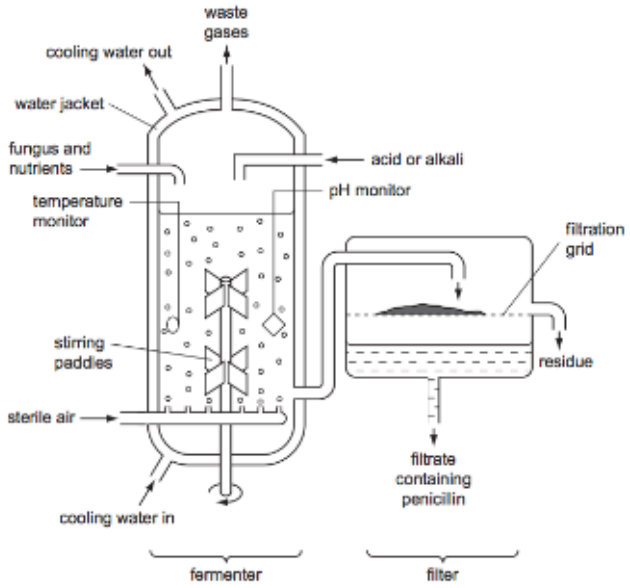
- Isolate DNA making up a human gene using restriction enzyme, forming sticky ends
- Cutting of bacterial plasmid DNA with the same restriction enzymes, forming complementary sticky ends
- Insertion of human DNA into bacterial plasmid DNA using DNA ligase to form a recombinant plasmid
- Insertion of plasmid into bacteria
- Replication of bacteria containing recombinant plasmids which make human protein as they express the gene

Letter from fig	Name	Descrip
M	chromosomes	threads of DNA found in the nucleus
N	gene / allele ;	section of DNA removed from human cell
Q	plasmid	vector / loop / circle, of DNA (that can carry a foreign section of DNA) / separate piece of DNA (from chromosome) ;
R	bacterial (cell) ; **A** yeast	type of cell that is genetically engineered
O	insulin / protein ;	specific chain of amino acids coded by the section of DNA removed from the human cell
P	fermenter	(container in which) bacteria / microorganisms / cells, reproduce / grow / produce insulin ;

03 Why bacteria are useful in biotechnology and genetic engineering

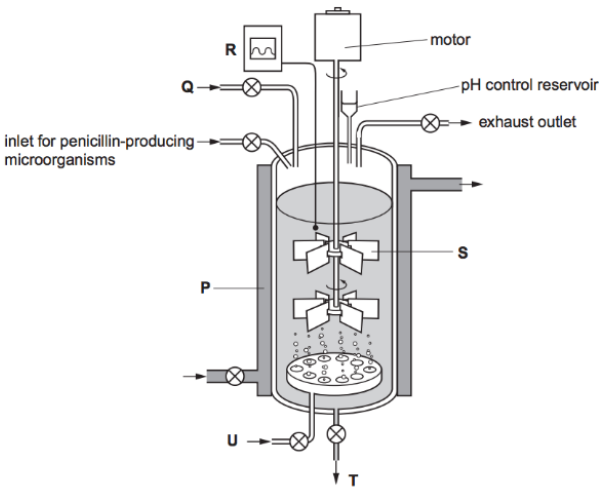
- Fast reproduction rate
- Have plasmids
- Share a universal genetic code
- Identical offspring

04 Penicillin production (fermenter)



- Water jacket
  - Maintain optimum temperature
  - To prevent enzymes denaturing
  - Because as fungus respires
  - It releases heat so temperature in fermenter increases
  - Which would kill fungus
- Addition of acids and alkalis
  - Maintains pH
  - Enzyme need optimum pH
  - to give maximum enzyme activity
  - to give maximum yield
  - stop enzymes denaturing

05 Structure of fermenter



letter from Fig. 1.1	name	function
P	water jacket	Maintain / control, temperature;
S	paddles / stirrers / mixers / vanes	mixes / stirs / maintains a suspension / stops solids settling / keeps nutrients moving / gives uniform mixture;
Q	nutrient inlet	supplies glucose / ammonia / amino acids / nutrients for growth / nutrients for respiration / energy;
R	Probe / sensor / data logger	monitors, temperature / pH;
U	air supply	supplies oxygen for respiration;
T	outlet	allows collection of the liquid containing penicillin after fermentation

06 Advantages of using biofuels over fossil fuels

- Biofuels are renewable
- Plants absorb carbon dioxide from surroundings
- for photosynthesis
- This balances carbon dioxide emissions

Chapter 21 : Human influences on ecosystems

01 Ways modern technology has resulted in increased food production

- Agricultural machinery to work larger fields
- Chemical fertilisers to increase plant growth
- Insecticides to kill pests to prevent crop destruction
- Herbicides to kills weeds to reduce competition
- Selective breeding to increase crop yield

02 Impacts on ecosystem of large scale monocultures

- Spreading of disease
- Extinction of species
- Disruption to food chains
- Loss in variety of habitats

03 Negative impacts to an ecosystem on intensive livestock production

- Waste causes eutrophication of water supplies
- Spread of disease to humans/wildlife
- Use of antibiotics causing antibiotic resistance
- Disturbance to food chains
- Loss of habitat
- Livestock produce methane which is a greenhouse gas
- Global warming

04 Problems that contribute to famine

- Unequal distribution of food
- Drought and flooding
- Increasing population
- Increase demand for food
- Poverty

05 Reasons for habitat destruction (forests)

- Uses of trees
    - Paper
    - For furniture
    - Fuel
- Clearance of trees for
    - Agriculture
    - Urbanisation
    - Extraction of natural resources

06 Effects of deforestation

- Loss of habitat
- Extinction of species
- Disruption to food chain
- Soil erosion
- Increased risk of flooding
- Increase of carbon dioxide in the atmosphere

07 Eutrophication

1. Fertiliser enter rivers
2. Causing algae growth
3. Algae block sunlight from entering water
4. So rooted plants unable to photosynthesis
5. So plants die
6. Bacteria decompose on dead plants
7. So bacterial population increases
8. Bacteria respire aerobically
9. Bacteria use up the oxygen in the water
10. Organisms die due to lack of oxygen

08 Effects of non-biodegradable plastics on aquatic animals

- Direct effect:
    - Plastic does not break down
    - Swallowed, suffocate
    - Toxic
    - Restrict movements
    - Affect ability to gain nutrients
    - Death
- Indirect effect:
    - Plastic blocks light for photosynthesis
    - Plants die
    - Disruption in food chain
    - Animals die due to lack of food

09 Consequences of an increase in conc. of greenhouse gases in the atmosphere

- Global warming
- Increase in rate of photosynthesis
- Causes increase in plant growth
- Extreme weather conditions
- Reduced biodiversity

09.1 How increasing conc. of carbon dioxide contribute to global warming

- Carbon dioxide is a greenhouse gas
- It enhances the greenhouse effect
- Heat emitted from the sun
- is absorbed by greenhouse gases
- Heat cannot leave from the atmosphere

10 Acid rain

- Causes
  - Sulfur dioxide
  - Nitrogen dioxide
- Effects
  - Kills plants
  - Soil leaching
  - Releases aluminium
  - Nutrients in soil no longer available to plants
  - Acidifies lakes
  - Fish die
- Methods to reduce it
  - Flue gas desulfurisation in power stations
  - Use less fossil fuels
  - Use renewable sources of energy
  - Catalytic converters in car engines

11 Negative impacts of female contraceptive hormones in water courses

- Feminisation of aquatic organisms
- Reduced sperm count in men
- Reduced sperm count in aquatic organisms
- Reduction in population of aquatic organisms

12 Sustainable resource

- One which is produced as rapidly as it is removed from the environment so that it does not run out

13 Sustainable development

- Development providing the needs of an increasing human population without harming the environment

14 How stock (fish) is maintained

- Fish
  - Quotas
  - Fines for overfishing
  - Restrictions on times when fishing can occur
  - Exclusive zones
  - Total ban for some species
  - Education
  - Captive breeding
  - Re-stocking

15 Recycling paper

1. Paper sent to recycling centre
2. Shredding
3. Pulping
4. Requires soaking
5. Deinking
6. Requires bleach
7. Flattened

16 Sewage treatment

1. Filtration
2. Sedimentation to settle particles
3. Digestion by bacteria
4. With aeration tank
5. Sludge treated with anaerobic digestion
6. Treated with chlorine
7. Distillation

17 Roles bacteria in the aerobic digestion

- Secrete enzymes
- Breakdown insoluble substances to soluble substances
- Protease
- Breaks down protein to amino acids
- Amylase
- Breaks down starch to glucose
- Lipase breaks down fat to fatty acids and glycerol

18 Why organisms become endangered or extinct

- Hunting
- Deforestation
- Pollution
- Predation by new introduced species
- Climate change
- Disease

19 Conservation methods for endangered species

- Prevent destruction of habitat
- Reserve
- Educating local population
- Captive breeding programmes
- Seed banks

20 Reasons for conservation programmes

- Reducing extinction
- Protecting vulnerable environments
- Maintaining ecosystem functions such as nutrient cycling and providing resources such as food, drugs, fuel and genes

MEGA LECTURE

IGCSE Biology Notes

Refined by KmQ

Unit 1 : *Characteristics of living things*

Biology is the study of living organisms. For something to be alive it needs to perform all seven functions of living things.MRS GREN

Movement, Respiration, Sensitivity, Growth, Reproduction, Excretion, Nutrition.

1. Movement

Most organisms are able to move their whole body even plants can shift their stem towards the sunlight and their roots move towards healthy soil.

2. Respiration

IT is the breakdown of food inside a living organism IT IS VITAL for survival. 2 types

Aerobic Respiration which involves O2 & glucose breaking down to form CO2 water & ENERGY.

Anaerobic Respiration which is the incomplete breakdown of food. Happens when there is not enough oxygen. Equation, Glucose & O2 (not enough) to form CO2 Lactic Acid or Alcohol (depending on the organism) & a little ENERGY.

3. Sensitivity

It is the ability to detect and respond to a stimulus.

4. Growth

It is the permanent increase in size and quantity of cells using materials absorbed from the environment.

5. Reproduction

It is forming new individuals of the same species either sexual (2 parents) or asexual (1 parent) \

6. Excretion

It is removal of harmful products of metabolism. Egestion is the removal of undigested products which haven't entered the cell.

7. Nutrition

It is the intake of food material from the environment.

Autotrophic nutrition: Organisms that make their own food such as plants.

Heterotrophic nutrition: Organisms that need readymade food including herbivores, carnivores & omnivores.

Unit 2 : *Classification*

Classification is sorting organisms into smaller groups based on their similarities which then allows us to make comparison between them. Organisms are split into the following:

MEGA LECTURE

- Kingdom
- Phylum
- Class
- Order
- Families
- Genus
- Species

Many Organisms → Individual Organism

Few features in common → Many features in common

A specie is a group of organisms that share the many similar appearances and can bread with each other. Species are scientifically named by two names in Latin to avoid differences in languages. The first name is the name of the genus while the second name is the species name e.g. WOLF (*Cannis Lupus*) (must be italic and underlined)

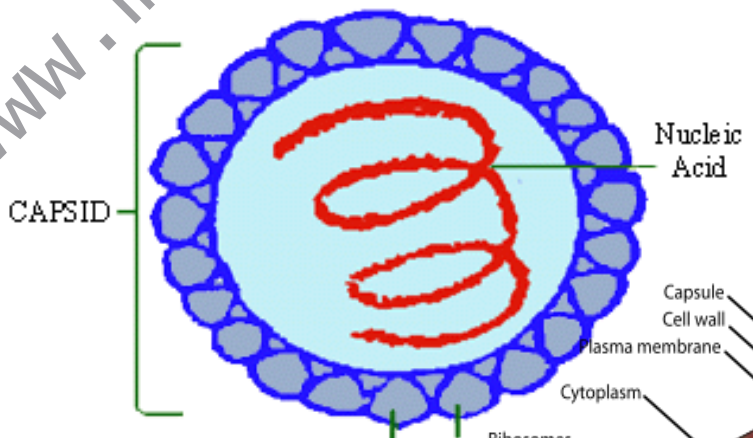
The main groups of living are the 5 kingdoms. They don't include virus since it doesn't obey some characteristics of life. The five kingdoms are: Bacteria, Protoctista, Fungi, Plants, and Animals.

Virus

The size of a virus about 30-300 nm and its only visible with an electron microscope. IT has a protein coat around the DNA or RNA sometimes has spikes. It has no cell structures.

How a virus multiplies

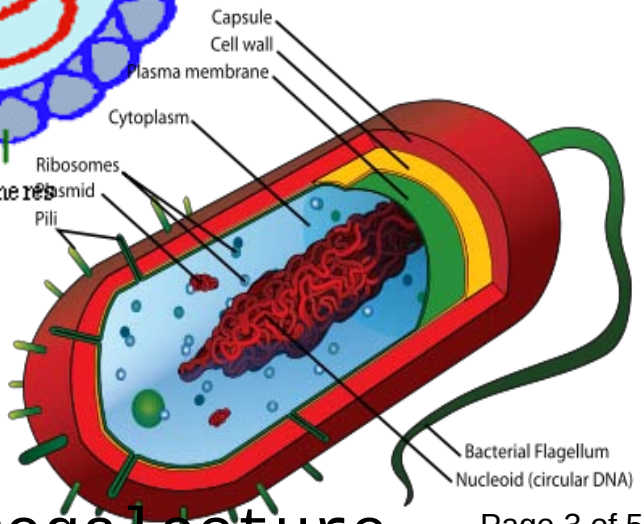
1. Virus ejects its DNA or RNA into the cell
2. The genetic material multiplies
3. Mew viruses are formed inside the cell and then burst out of the cell.



Bactria

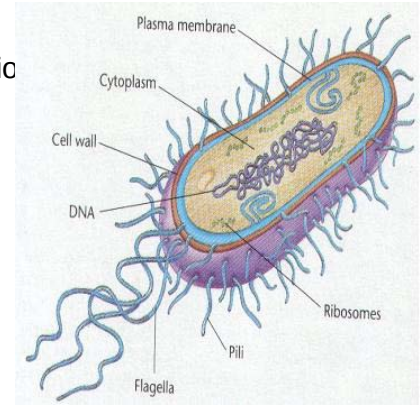
The size of bacteria is about 0.2 to 10 um. It is only seen under high powered microscopes. **Structure:** No Nucleus

- No mightocondria



- No chloroplast in most of them
- They are either saprophytes or parasites
- cell wall (not made of cellulose)

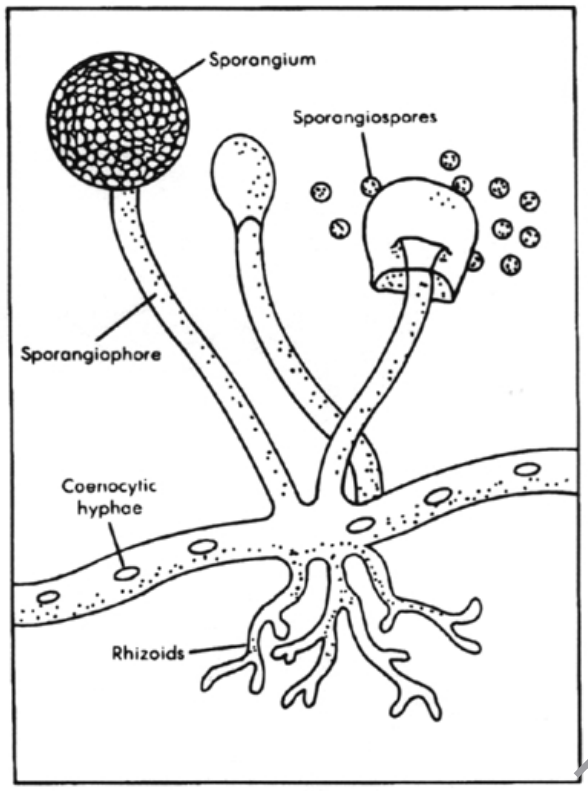
Bacteria reproduce asexually by binary fission every 20 min's (if conditio conditions are not well some species can for spores for survival.



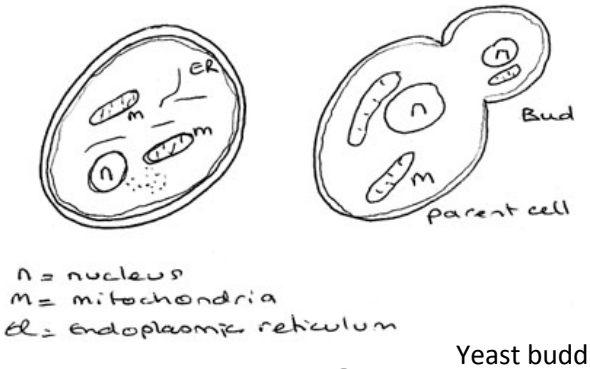
Fungi

- Mostly multicellular (many cells) (yeast is an exception)
- Cell wall made of chitin
- IT has cytoplasm & it may be a saprophyte or a parasite

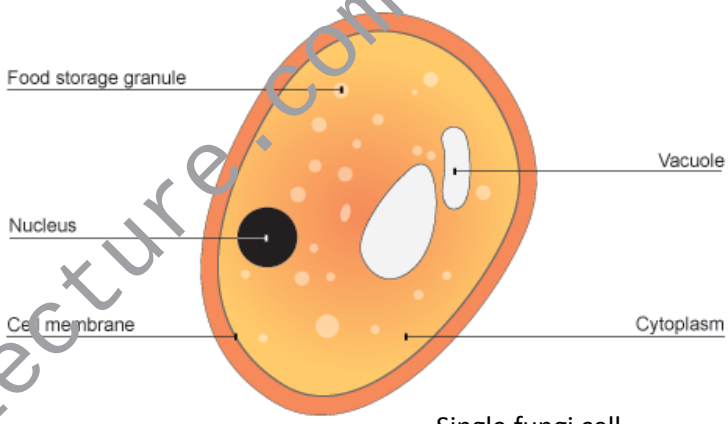
- It reproduces asexually by spore formation or by budding (in yeast) but in bad conditions it reproduces sexually for survival



Structure of a mould fungus



Yeast budding



Single fungi cell

Budding is when a yeast cell splits into two cells and it keeps happening over and over again numbers can get up to millions in just a day.

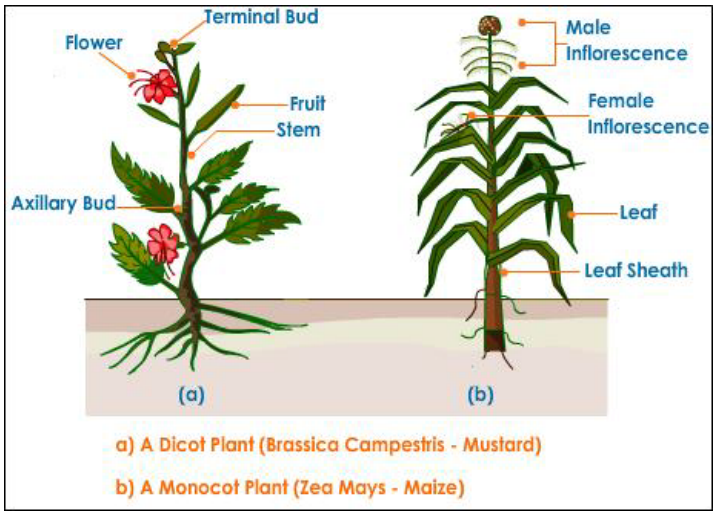
A mushroom is an example of a parasitic fungus.

Plants

MEGA LECTURE

Plants produce seeds from inside the flower. The plant kingdom is divided into algae, ferns, mosses, and seed plants. Seed plants are divided into conifers and angiosperms. Angiosperms are devided into two groups Monocotyledons and Dicotyledons.

Feature	Monocotyledons	Dicotyledons
Seed	Seed containing one cotyledon	Seed containing two cotyledons
Leaves	Leaves containing parallel veins	Leaves containing branched veins
Root	Fibrous root system (adventitious)	Tap root system with lateral roots.



Conifers

Ferns

Algae

MEGA LECTURE

Animals

There are two main groups in the animal kingdom. The chordates and the invertebrates. The invertebrates consist of Nematodes, Annelids, Molluscs and Arthropods.

Comparison between Annelids, Nematodes and Molluscs.

Annelid, nematode or mollusc?

	Annelid	Nematode	Mollusc
Body covering	Hard, slightly waterproof	Soft, not waterproof	Soft – shell helps to save water
Segments visible	Yes	No	No
Movement	Uses chaetae (bristles) to move from place to place	Wriggles but lives in one place	Creeps on foot from place to place
Feeding method	Herbivores	Mainly parasites	Mainly herbivores – some carnivores

Arthropods are divided into insects, crustacians and arachnids.

	1- Insect	2- Crustacian	3- Arachnids
Examples	Bees, butterflies, locust	Crabs, lobsters, shrimps.	Spider, scorpion
Body segment	3 body segment: head, thorax and abdomen	2 body segment: cephalothorax and abdomen	2 body segment: cephalothorax and abdomen
Jointed legs	3 pairs	More than 4 pairs	4 pairs of jointed legs
Antennae	1 pair	2 pairs sensitive to touch and chemicals	No Instead there is a pair of chelicerae to hold prey
Wings	1 or 2 pairs	No	No
Eyes	Compound and simple eyes	1 pair of compound eyes	Simple eyes
Breathing	Through tracheae "spiracles"	Gills	Book lungs

And 4- Myriapoda:

- Like Millipede and centipade.
- Two body segment.
- Many legs. 1 or 2 pairs of legs on every Segement of the body
- 1 pair of antenna.
- No wings.
- Simple eyes.

Adaptation to insects on life on lands

- Body covered in flexible chateaus exoskeleton
- 1 or 2 pair of wings
- Joined legs for quick movement
- Can live on all food materials
- Can camouflage to hide from enemies

Chordates (or Vertebrates)

Chordates are vertebrates which are animals with back bones they consist of: Fish, Amphibians, Reptiles, Birds, and Mammals.

1. Fish

- Body covered in moist scales
- Has fins to swim and gills for gas-exchange
- Lays eggs in large amounts (eggs are soft with no shells)

2. Amphibians

- Moist, smooth and non scaly skin.
- Some can camouflage e.g. frogs
- Young live in water & have gills & adults live on land & have lungs
- Have 4 limbs
- Lays soft non shell eggs
- Has an ear drum

3. Reptiles

- Covered in dry scaley skin to prevent water loss
- 4 limbs (except snakes)
- Lay water proof eggs with hard shells
- Has a third transparent eye lid for protection

4. Birds

- Body covered in feathers
- Beak for feeding
- 2 limbs and 2 wings
- Lays water proof hard shells

5. Mammals

- Body covered in hair
- 4limbs
- Breath through lungs
- Milk from mammary glands
- External ear pinna
- 4 kinds of teeth: Incisors, Canines, Premolar, and molars
- Have sweat glands
- Have a diaphragm

MEGA LECTURE

Unit 3 : *Cell Structure*

A cell is the smallest part of an organism all cels consist of a membrane, cytoplasm and a nucleus.

Difference between plant and animal cells

Feature	Plant cell	Animal cell
Cell wall	• Present and made from cellulose	• Absent
Chloroplast	• Present	• Absent
Vacuole	• Present	• Absent
Food stored within **Carbohydrates** **Protein** **fats**	• • Starch, glucose • Can store protein • Oil	• • Glycogen • Cant store protein • Fats
Shape	• Regular shape because of cell wall	• Irregular shape
Size	• Large	• small

Similarities of animal and plant cells

1. Cell membrane
2. Nucleus
3. Cytoplasm
4. Organelles
   Organelles are found in the cytoplasm each one has a specific job e.g. mitochondria.

Main cell parts description

1. **Cell wall:** Non living structure which is made of cellulose. It supports the plant from pressure and regulars its shape.
2. **Cell membrane:** A complex semi permeable structure which allows substances in and out the cell
3. **Cytoplasm:** jelly like substance where most chemical reactions happen
4. **Nucleus**: Contains DNA. It controls the activities of the cell and carries genetic materials.
5. **Vacuole:** A fluid made of cell sap. It contains some usefull materials and waste
6. **Chloroplast:** Large bodies containing chlorophyll e=where Photosynthesis takes place
7. **Mitochondria**: It consists of a double membrane and is the site of aerobic respiration.

Specialization of cells 1-4 (plants) 5-9 (animal)

1. Root hair cell: It has long hairs to increase surface area of the cell. It has a large number of mitochondria to provide energy for active up take.

2. Xylem vessels: It transports water and minerals to the plant. The xylem cells are dead and are made of long hollow tubes running throughout the root, stem, and leaves. It has thick cell walls.

3. Phloem cells: They transport sugar and amino acids to the body from the place they were made (the leaf). The phloem cells are long cells joined together. The cell wall where 2 phloem cells join together has holes which allows the cytoplasm of both cells to communicate passing down the dissolved food.

4. Guard cell (stomata): Allows O2 and CO2 to pass in and out the leaf. They can change their shape thus can open and close their holes.

5. Red blood cells: It transports oxygen from the lungs to tissues. It has no nucleus, t has hemoglobin which absorbs oxygen, its shape gives it a high surface area and it is small to fit in capillaries.

6. Nerve cells: they conduct electrical impulses which travel to & from the brain. They are very long and their chemical reactions cause impulses to travel through their fibers. They also have a layer of fat for insulation.

7. White blood cells: These occur in large amounts in the blood stream. They get rid of bacteria and viruses. They are able to change shape and can penetrate the blood vassals to enter tissues. They also contain enzymes that kill microorganisms in their cytoplasm.

8. Ciliared cell: These have cilia (hairs) which can move mucus away from the lungs by a wavy motion.

9. Muscle cells: These can contract to move the body (they don't relax but they return to their original shape by the influence of other cells) they contain a lot of mitochondria to provide the energy needed.

Tissue, organs & systems

Cells are the *structural unit* of life many cells join together to form tissues. *Tissues* area group of cells working together to perform *a function*. Many tissues join together to make an organ. An *organ* is a group of tissues working together to perform a *job.* Organs join together to make *systems* which are groups of organs working together to make a *certain job.* Systems join together to make an *organism which is a living individual.*

MEGA LECTURE

Unit 4 : *Diffusion, active transport and osmosis*

All the chemicals reacting in the cells need to get in and out either by a **Passive process**: This doesn't need energy e.g. osmosis and diffusion or an **active process:** one that requires energy *e.g. active transport.*

1. Diffusion:

   It is the movement of a molecule from a reign of high concentration to a reign of low concentration down the concentration gradient which is the difference in concentration of the substance, the greater the difference the higher the rate of diffusion.

   The rate of diffusion depends on :

   - Concentration gradient
   - Temperature
   - Size of molecule
   - Surface area
   - Permeability of membrane

2. Osmosis:

   It is the movement of water from a reign of high concentration (a dilute solution) to a reign of low concentration (a concentrated solution) down the concentration gradient through a semi permeable membrane. A hypertonic solution has higher concentration of salt; a hypotonic solution has a higher concentration of water and an isotonic solution as an equal concentration of water and salt.

3. Active transport:

   It is the uptake of substances from a reign of low concentration to a reign of high concentration, against the concentration gradient requiring protein carriers.

Diffusion	*Osmosis*	*Active transport*
Not selective	Not selective	Selective, cells absorb what they need
Substances move down a concentration gradient	Water move down concentration gradients	Substances move against concentration gradient.
Do not need energy	Doesn't need energy	Needs energy
A partially permeable membrane is not necessary	A partially permeable membrane is necessary (living or non living)	A partially permeable membrane is essential (must be living).

MEGA LECTURE

Unit 5 : *Enzymes*

Enzymes are portions that act like biological catalysts which speed up reactions. Each enzyme is specific for 1 chemical reaction or in a stage in a series reaction. Most enzymes are inside the cell but some act outside it.

- General characteristics of enzymes:
- Catalyst: Speed up reactions
- Specific: their shape is specialized for 1 reaction only
- Temperature and PH : enzymes are sensitive to a certain temp and PH they work at an optimum temp or PH each enzyme has different optimums. If the PH is too high or too low then the enzyme will be denatured and won't work.

Enzymes are also used in washing powders as they can remove stains such as (blood and milk) they are quick but some people are allergic to them.

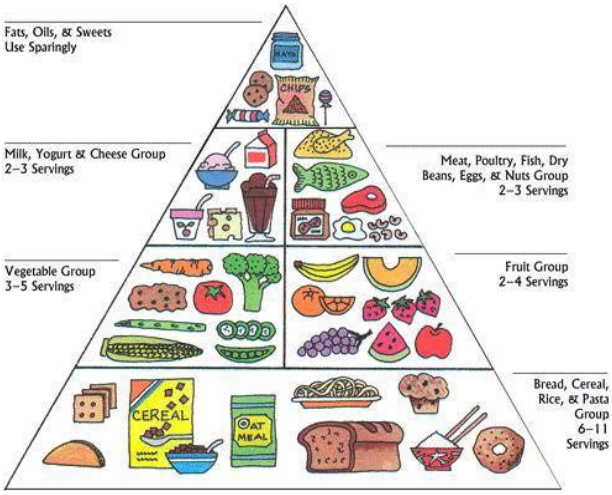
MEGA LECTURE

Unit 6 : *Nutrition and digestion*

Nutrition is obtaining food materials from the environment for growth and repair.

Food classes:

1. Protein
2. Fats
3. Carbohydrates
4. Vitamins
5. Minerals
6. Fibers
7. Water



Tests for Food

FOOD TEST

Type of food	Method	Positive observation	Negative observation
1-Starch	-Add iodine solution *(has a yellow brown color)*	-Blue black or dark blue colour	-The colour remains yellow brown
2-Reducing sugar or simple sugar (e.g. glucose)	-Add Benedict's solution and ***heat***. *(it has a blue colour* as it contains copper salts) **Precautions** 1- Hold the tube with a holder. 2- Direct the opening of the tube away from your face. 3- Do not fill more than half of the tube to avoid splashes when the solution boils. 4- It is preferable to use a water bath .	-Orange red or brick red precipitate is formed *(the gradual change in colour from blue to green, yellow, orange then red)*	- The color remains blue.
3- Proteins	(*This test is known as* ***biuret*** *test*) - Add potassium hydroxide ,then add drops of copper sulphate, the colour becomes blue .	-Purple color (mauve or lilac)	-The colour remains blue.
4- Fats or lipids.	(*This test is known as* ***ethanol*** *or* ***emulsion*** *test*) -Add ethanol , fats dissolve in ethanol forming clear solution. -Add drops of water to the clear solution.	-Milky emulsion or turbid solution is formed .	-The solution remains clear

MEGA LECTURE

Carbohydrates

Carbohydrates are made in the chemical structure of carbon , hydrogen and oxygen.

Monosaccharide's: they are the simplest carbohydrate units; they are soluble in water and have a sweet taste. E.g. glucose. Their formula, C6H12O6

Disaccharides: e.g. sucrose. These are 2 monosaccharides joined together; they are sweeter than monosaccharide's and dissolve in water. Their formula C12, H22, O12

Polysaccharides: e.g. starch. Made out of many mono and disaccharides, they are insoluble in water and don't have a sweet taste. Their formula (C12, H22, O12) n.

Carbohydrates are very important because they produce energy. In plants cells they are stored as starch and in animal cells they are stored as glycogen. Carbohydrates are always stored as polysaccharides because this does not affect the osmotic pressure. Excess carbohydrates can be stored as fats under the skin.

Fats

Fats are a source of energy. They produce double the amount of energy produced by carbohydrates they are formed from fatty acids and glycerol and from the atoms carbon, hydrogen and oxygen. (the amount of oxygen in fats is about half the one in carbohydrates). Fats form a part of the cell membrane and they form a waterproof layer under the skin.

Proteins

Proteins are made from amino acids and the elements carbon, hydrogen, nitrogen and sometimes sulphur. They are present in foods such as milk and meat. They are used in growth and repair and in enzymes and make up antibodies.

Fibers

Fibers are present in all plant foods. They are not digested but give the stomach something to push against and work harder. They also clear all the remaining foods from the alimentary canal.

Minirals

MINERAL SALTS

Mineral	Sources	Importance	Deficiency symptoms
1-Calcium	-Milk and its products. -Many fruits and vegetables.	1-Necessary for formation of bones and teeth. 2- Necessary for blood clotting. 3- Necessary for lactation.	1- Brittle (soft) bones. 2- Brittle teeth. 3- Slow dentition in children.
2- Iron	-Liver. -Egg yolk. - Red meat. -Leafy vegetables.	- Necessary for formation of haemoglobin of the red blood cells.	- Anaemia *(rapid tiredness and shortness of breathing due to lack of haemoglobin which is used to carry oxygen to the different parts of the body to be used in production of energy by the process of aerobic respiration)*

More mineral salts are needed

a- In hot days or in case of carrying out strenuous exercise because perspiration rate is higher leading to loss of salts in sweat.

b- In cases of diarrhea due to rapid loss of mineral salts.

MEGA LECTURE

Vitamins

VITAMINS

DEFINITION : are organic substances only needed in small amounts in the body to perform specific functions.

Vitamin	Sources	Importance	Deficiency symptoms	Properties
C (also known as ascorbic acid)	-Citrus fruits such as orange and lemon. -Fresh vegetables	-Helps wounds to heal . -Keeps blood vessels healthy. -Keeps cement of teeth healthy. -Keeps gum and teeth healthy. - Helps the body to use iron. - Stimulates the immune system.	-Its lack causes a disease known as **scurvy.** **Symptoms of scurvy** 1- Pain in joints and muscles . 2-Bleeding from gum and other parts of the body. 3- Delayed healing of wounds.	-***Water soluble*** vitamin therefore it can not be stored in the body. - ***Spoils*** if food is heated or canned. -***Destroyed*** by being exposed to aire.g.if food is grated or minced as this activates enzymes in food which destroy vitamin C . - ***Refrigeration*** keeps the vitamin C content of the food but to a certain limit.
D (also known as calcifer-ol)	- Butter, eggs and cod- liver oil . -Can be formed in the skin by being exposed to sun rays .	-Helps absorption of calcium and phosphorus. -Helps the deposition of calcium and phosphorus in bones and teeth.	-***Rickets in children*** . *Causes bones to be soft and deformed* -Soft bones or osteomalicia in adults. -Slow dentition	-***Fat soluble*** vitamin, therefore it can be stored in the body (in liver).

Notice

1-Sailors are liable to be infected by scurvy **because** they use stored or canned food .

2-It is important to expose children to sun rays to avoid rickets, **because** vitamin D can be formed in their bodies by the effect of the ultra violet rays of the sun.

3- Modern opinions describe vitamin D as a hormone because it is made in a region (skin), then carried by blood to affect other regions
(It is necessary for absorption of calcium in the small intestine).

MEGA LECTURE

Digestion

- Ingestion: taking food into a living organism
- Digestion: Breaking down large insoluble food molecules into small soluble ones
- Absorption: The process by which food molecules enter the blood stream
- Assimilation: Making use of the absorbed food substances
- Egesting: Getting rid of undigested materials.

The digestive system is made up of the alimentary canal and the associated organs. The alimentary canal is lined with (epithelial, Goblet, and Muscle cells)

The mouth

Food is ingested and chewed. The teeth help to tear and grind the food into small pieces. This increases the surface area for the action of enzymes. The food is mixed with saliva which has two functions.

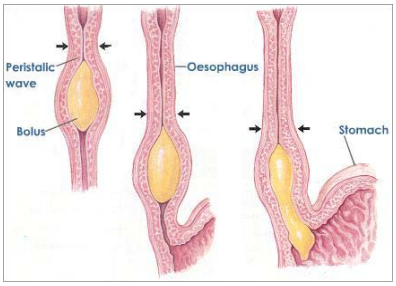
1. The saliva contains mucus which is a slimy substance which helps the food to be swallowed.
2. It contains the enzyme amylase which begins the digestion of starch into the sugar maltose. As food does not remain in the mouth for very long, only a small amount of starch is digested here.

The food is then turned to a bollus shape by the action of the mouth and then swallowed.

Oesophagus

This tube pushes the food to the stomach by way of rhythmic contractions. There are two sets of muscles in the oesophagus.

1. Circular muscles - these make the oesophagus narrower.
2. Longitudinal muscles - these make the oesophagus wider.



They work in conjunction with each other to force the food down to the stomach in a rhythmic wave. This is the way food is move all way along the alimentary canal. It is called *peristalsis*. The moment the food is swallowed a flap called the epiglottis closes so food isn't swallowed in the trachea.

Stomach

When the food reaches the stomach gastric juice is released from the stomach lining. Gastric juice contains two substances.

1. Pepsin - an enzyme which breaks proteins down into shorter chains called polypeptides.
2. Hydrochloric acid - needed to help pepsin work and also helps to kill any ingested bacteria.

The stomach has two rings of muscles at the top and bottom, called sphincter muscles which prevent food from leaving the stomach while it is being churned around. After a few hours, the food is now a mushy liquid called chyme. It is then allowed to continue on its journey a bit at a time.

Duodenum, Liver, Gall Bladder and Pancreas

When food enters the duodenum (the first 30cm of the small intestine) a number of secretions are added to it. Digestive enzymes from the wall of the duodenum and from the pancreas are added. There are a number of enzymes here which will complete the digestive process.

Another substance is added from the gall bladder. Bile, made in the liver and stored in the gall bladder, contains no digestive enzymes. It contains bile, which play a vital role in fat digestion. Fats and oils do not mix with water, but the enzyme lipase which digests them needs water in order to work. Bile salts breakdown the large fat drops into tiny droplets which can mix better with water to create an emulsion. This makes it easier for lipase digest the chemicals as it increases the surface area of the fat.

The pancreatic secretions contain hydrogen carbonate ions to neutralize the stomach acid. The

Digestive enzymes of the small intestine

Enzyme	Food Type Digested	Products
Amylase	Starch	Maltose
Maltase	Maltose	Glucose
Protease (eg trypsin)	Polypeptides	Amino acids
Lipase	Fats and oils	Fatty acids and glycerol

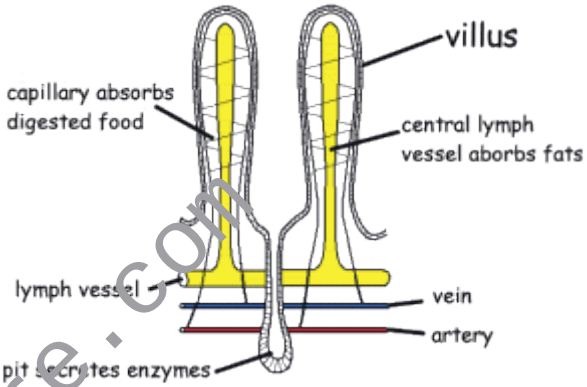
enzymes of the small intestine work best in a slightly alkaline environment.

MEGA LECTURE

Ileum

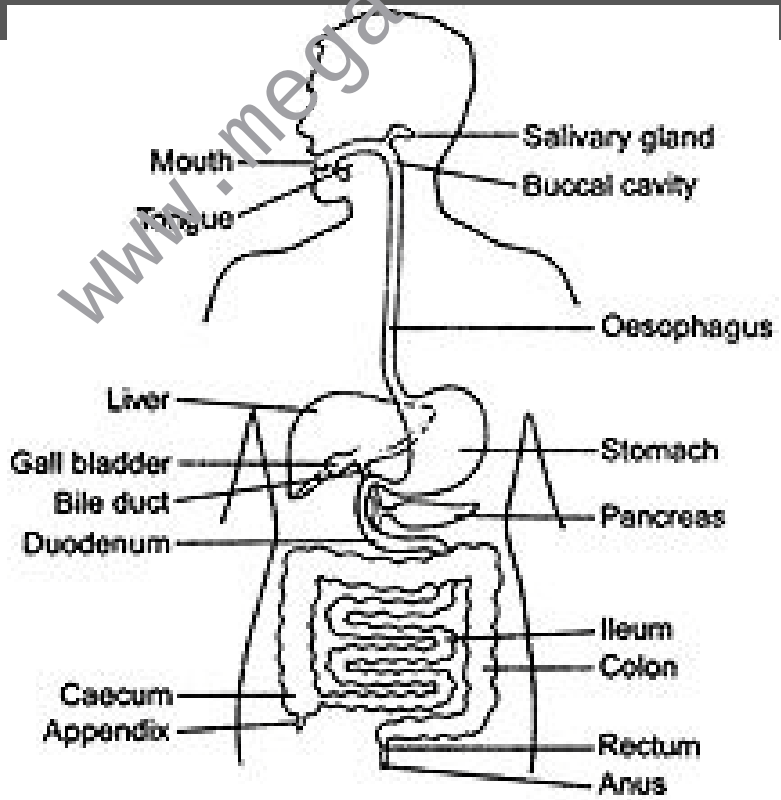
As food is digested the products are absorbed into the blood. There are a number of adaptations which increases the surface area for absorption.

1. The ileum is long and narrow which produces a larger surface area than a short broad tube.
2. The ileum is folded which increases the surface area.
3. The surface is covered with tiny (about 1mm long) fingerlike projections called *villi*.
4. The cells on the surface of the villi have tiny fingerlike projections on their cell membrane called *micro-villi*.



Colon

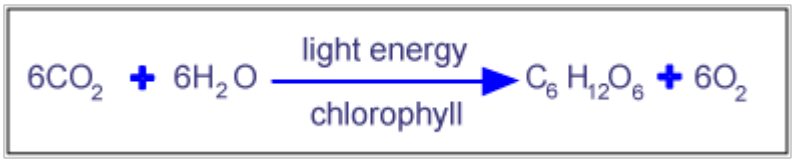
By the time the food reaches the large intestine all nutrients have been absorbed. What remains is indigestible fiber, bile salts and water. The water is absorbed here. The remaining substances are passed along to the rectum before passing out through the anus.



MEGA LECTURE

Unit 7 : *Plant nutrition (photosynthesis)*

Green plants make their own food from sunlight.

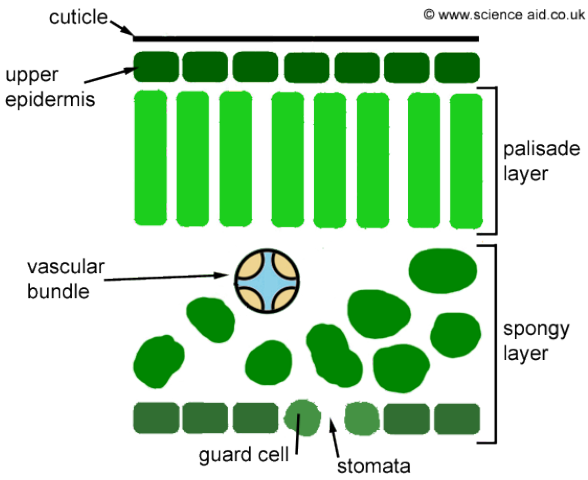


Carbon dioxide + water = glucose + oxygen

Test for starch

- A plant is left in a dark cupboard for a few days so it doesn't produce any more starch
- A leaf is boiled in a beaker to kill all cells
- It is then put in a boiling tube of ethanol and then boiled to remove chlorophyll
- The leaf is then left in a beaker of water to remove the ethanol
- Iodine solution is added (blue-black means starch h is present)

The structure of the leaf



- The leaf has a waxy cuticle to stop it losing water and drying out.
- The epidermis is a protective layer of cells and contains no chloroplasts.
- The palisade layer contains the most chloroplasts as it is near the top of the leaf. It is here that photosynthesis takes place. The palisade cells are arranged upright so increases the chance of photosynthesis.
- The spongy layer contains fewer chloroplasts, enough to catch what the palisade layer cannot absorb.The spongy layer has air spaces to make it easier for gases to circulate in the leaf.
- The vascular bundle provides the leaf with water via the xylem vessels. Food, such as sugar, made in the leaf is transported in the phloem vessels to the rest of the leaf.
- The stomata (stoma - singular) are tiny pores that allow carbon dioxide to enter the leaf while oxygen leaves the leaf.
- Guard cells can open or close the stomata pores to regulate how much gas can enter or leave the leaf. At night the pores close, opening in the daytime.

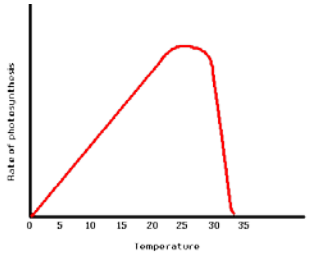
MEGA LECTURE

Limiting factors

There are factors that affect photosynthesis changing these factors are: Temperature, Light intensity, and concentration of carbon dioxide.

Temperature

When the temperature rises the rate of photosynthesis rises also. This is because the particles in the reaction move quicker and collide more. There is an optimum temperature however. At this point the rate of photosynthesis progresses as fast as it can, limited only by the other factors. Beyond this temperature the enzymes controlling the reaction become denatured and the reaction quickly comes to a halt.

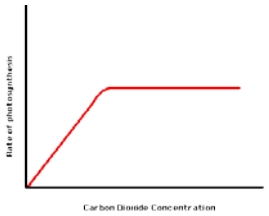


Light Intensity

The plant can photosynthesize faster as a result of a higher light intensity. As the light intensity decreases the rate of photosynthesis decreases. Light is a limiting factor at low light intensities. There comes a point though that any extra light energy will not increase the rate of the reaction. This is because the enzymes controlling the reaction are working as fast as possible. At this point light is no longer a limiting factor.

Concentration of CO2

When the concentration of carbon dioxide is low the rate of photosynthesis is also low. This is because the plant has to spend a certain amount of time doing nothing, waiting for more carbon dioxide to arrive. Increasing the concentration of carbon dioxide increases the rate of photosynthesis. There is a point at which further addition of carbon dioxide will not increase the rate of photosynthesis. The enzymes controlling the reaction are working as fast as possible, so the excess carbon dioxide won't effect.



MEGA LECTURE

Plant mineral requirements.

Plants need a number of minerals to live healthily. These mineral ions may be needed to make certain chemicals or needed to make certain reactions work properly. Plant absorbs these minerals from the soil when water is absorbed.

Below is a table of some of the common minerals and their uses.

Element	Mineral Salt	Why it is needed	Deficiency Disease
Nitrogen	Nitrates	To make proteins	Poor growth, yellow leaves.
Sulphur	Sulphates	To make proteins	Poor growth, yellow leaves.
Phosphorus	Phosphates	Needed to make DNA and chemicals involved in respiration	Poor growth,especially of roots.
Magnesium	Magnesium salts	To make chlorophyll	Yellowing between veins of leaves.
Iron	Iron salts	To make chlorophyll; iron is not contained in chlorophyll but is needed for its manufacture.	Yellowing in young leaves.
Potassium	Potassium salts	To keep correct salt balance for cells	Mottled leaves

MEGA LECTURE

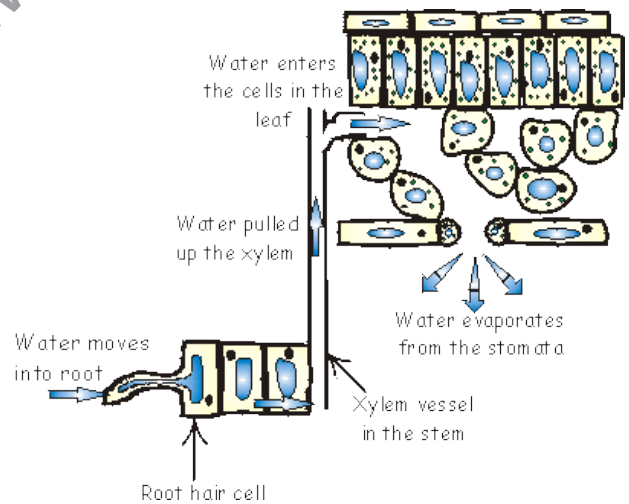
Unit 8: *Transport in plants*

Transport is the movment or flow of different substances within a living organism. The transport system in plants is the vascular bundles (xylem and phloem)

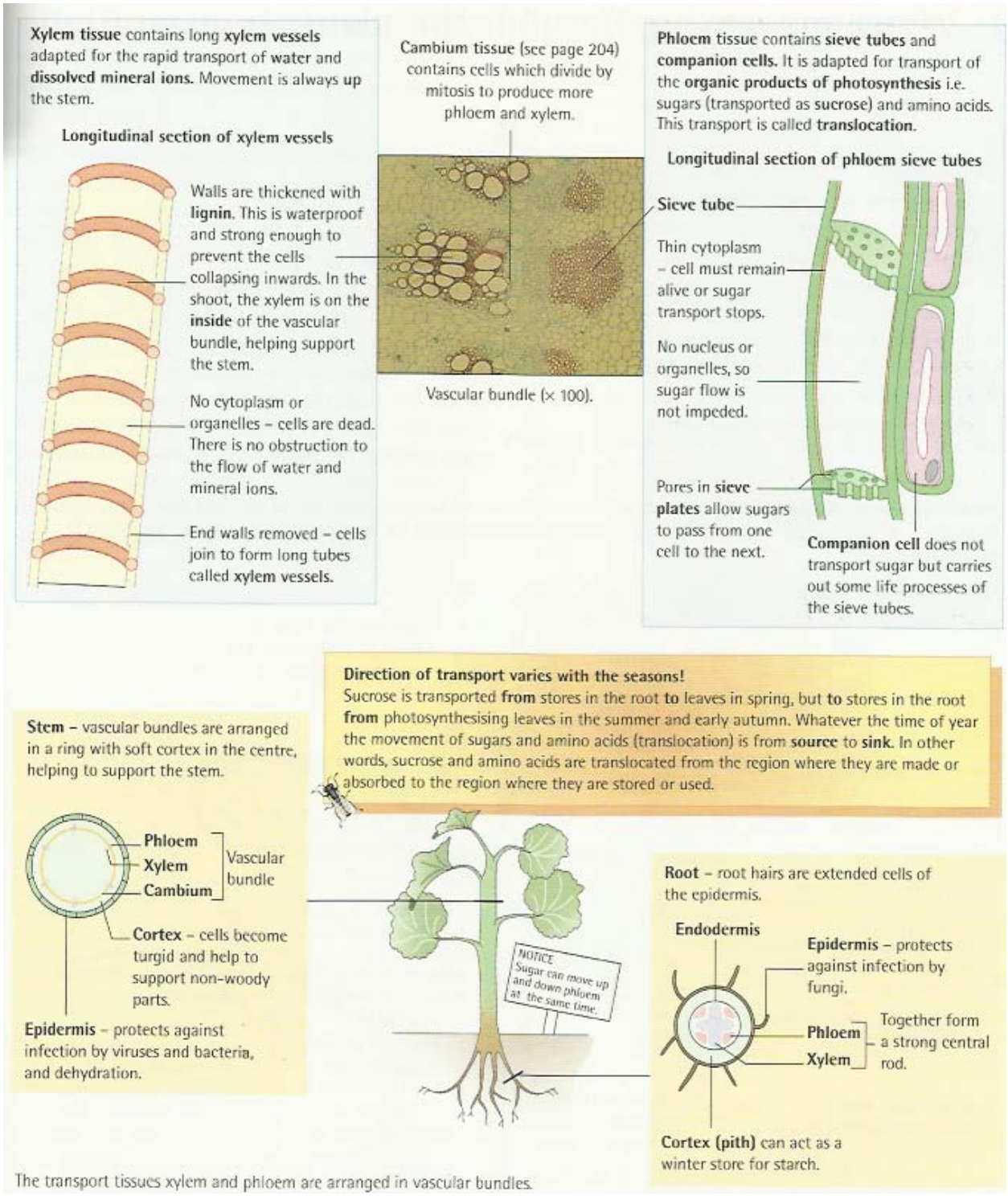
Comparison between xylem and phloem

Comparison	Xylem	Phloem
Description	Consists of non – living woody (lignified) cells (**elements**) joined together to form continuous tubes (**vessels**).	Consists of living cells (**seive elements**)
Substances carried	**Sap**: water and mineral salts	Solution of organic molecules made by the plant, including hormones and the products of photosynthesis.
Direction of transport	Unidirectional: mostly upward, from root to stem and leaves.	Bidirectional : movement of substances occurs downward and upward.
Mechanisms of transport	Mostly passive processes including osmosis. Capillary action and evaporation.	Mostly active processes. Involving the use of energy, the mechamisms are not fully understood.

Water enters the plant via the roots by osmosis they are then carried up the xylem vassals through transpiration which is when water is lost through the stomata. When water is lost through the stomata if forces the water to be sucked upwards.



The xylem vessels themselves are very thin tubes, like capillary tubes. They have very hard and waterproof walls. The cells which made the xylem vessels died to produce a continuous column or tube.



The transport tissues xylem and phloem are arranged in vascular bundles.

MEGA LECTURE

The rate of transpiration depends on:

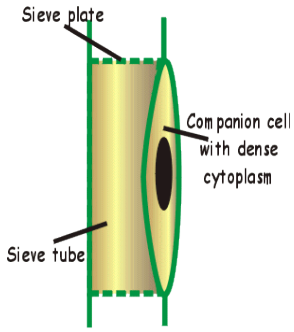
- Temperature: the higher the temperature the faster the uptake
- Humidity: The higher the humidity the lower the uptake
- Air current: The higher the air current the higher the uptake
- Water availability in soil
- Surface area of the leaf
- Density of stomata
- Thickness of cuticle
- Number of leaves

Adaptation

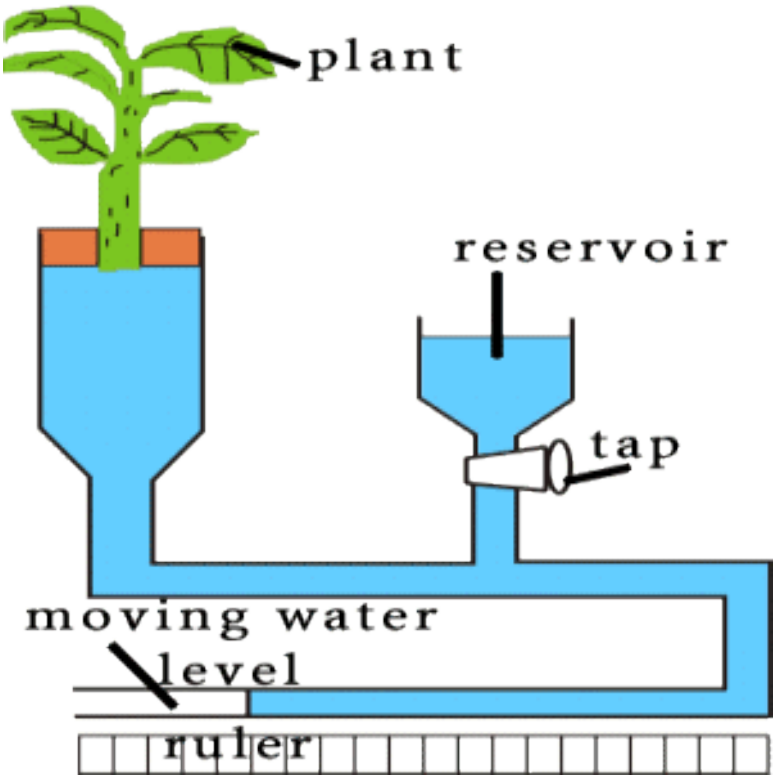
- Plants with a thick waxy layer will cut down on water loss through the leaves.
- Plants can have needle-like leaves. This cuts down the surface area of the leaf and thereby cuts down the numbers of stomata on each leaf.
- -like fibers. These trap air close to the leaf. It creates a microclimate around the leaf. As water is lost from the leaf the microclimate becomes very humid. The hairs prevent this humid air from being blown away. As humidity slows down the rate of transpiration the leaf conserves water.
- Leaves can be folded. Marram grass, which grows on sand dunes, is a good example. The leaf blade is curled in on itself so that the stomata are on the inside. This creates a humid micro-climate which slows down water loss

Phloem

The leaf is the site of photosynthesis, where food chemicals are created for the whole plant. These substances need to be transported to the parts of the plant which cannot make their own food. The chemicals are transported in phloem tubes. Sieve tube elements (the cells which make up phloem tubes) are arranged in long columns. Unlike xylem vessels they are filled with cytoplasm, though they have no nucleus. The cell walls at each end of the phloem cell are perforated to form sieve plates. The phloem cells have associated companion cells which do have a nucleus. The companion cell supplies the sieve tube elements with some requirements as the sieve tube element cannot make things like proteins on its own.



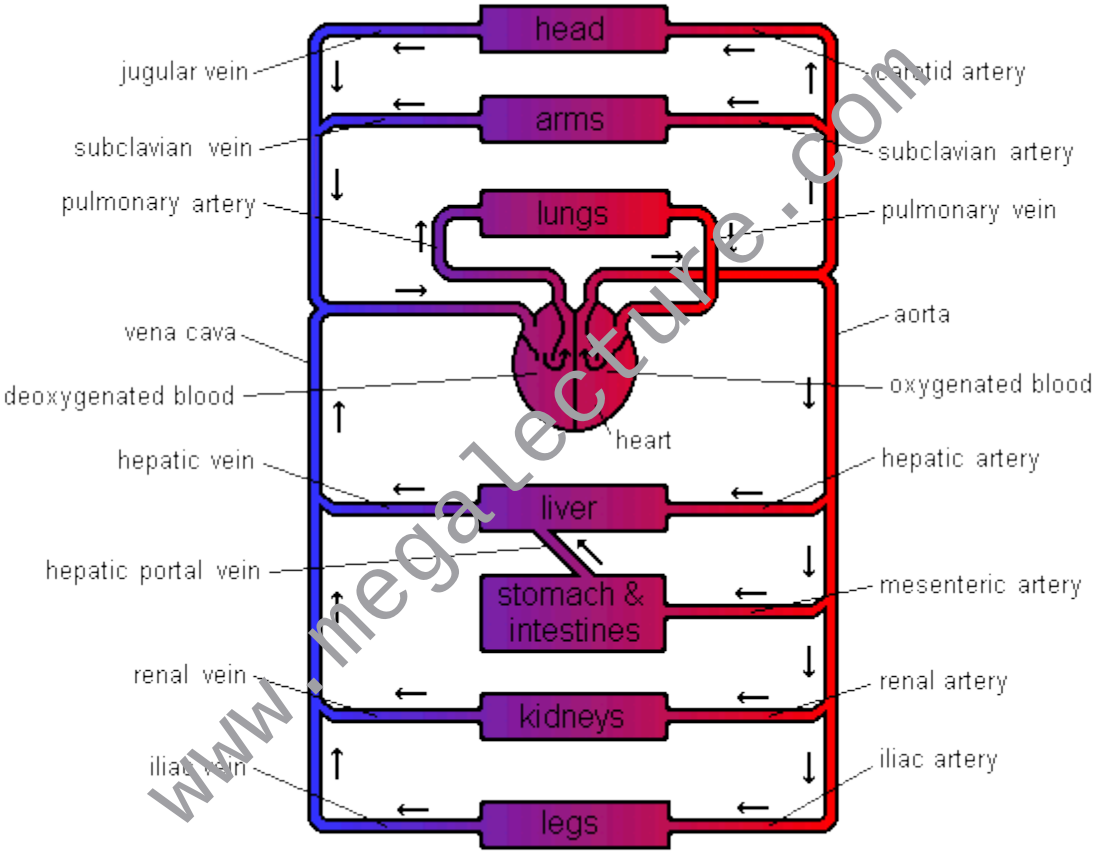
A piece of apparatus called a *potometer* can be used to investigate water loss from a plant in different environmental conditions. The effect of temperature, humidity, wind speed and light intensity can therefore be looked at.

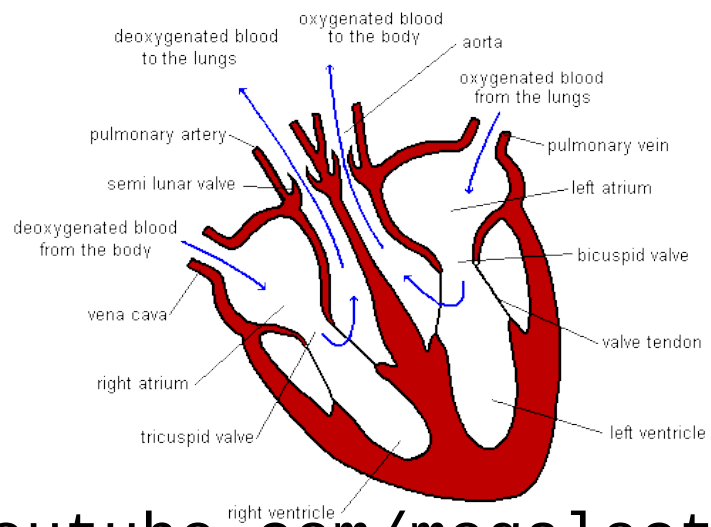

plant
reservoir
tap
moving water
level
ruler

MEGA LECTURE

Unit 9: *Transport in humans*

Transportation in humans is done by the circulatory system which involves blood being pumped around the body by the heart. Humans have a double circulatory system which means that the blood is pumped twice around the body once to the heart and another to the rest of the body. Blood transports O2, CO2, nutrients, hormones and waste products so the movement should be quick. The blood traveling through to the body doesn't pass through them one at a time but rather the blood is separated amongst them such as a parallel circuit in physics.





The heart is really two pumps stuck together. There are two chambers to each side of the heart. The first chamber is called the atrium and is the smaller of the two chambers. The larger one is called the ventricle. This chamber is the more powerful of the two as it forces blood out of the heart. The right side of the heart receives deoxygenated blood from the body and pumps it to the lungs, however the left side of the body receives oxygenated blood and pumps it around the body so its force must be stronger. (both of the sides of the heart are separated by valves so the blood doesn't flow backwards).

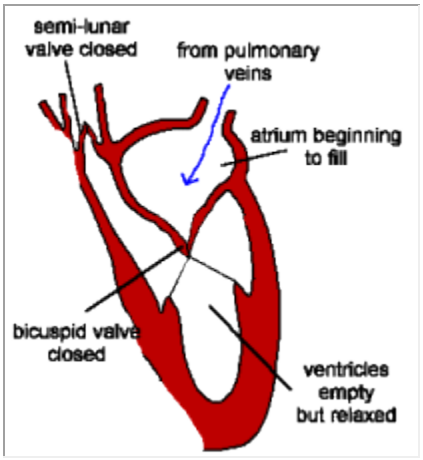
In the heart both sides are pumped together and at the same time. The blood must flow through the heart in one direction. Blood enters the atria from the veins and is then forced into the ventricles. The ventricles force the blood into the arteries. There are a number of sphincter muscles and valves that prevent blood flowing the wrong way. The valves are a little like parachutes. When blood flows the wrong way the valves bulge out, blocking the path.

Heartbeat involves three distinct stages:

1) relaxation phase - **diastole**

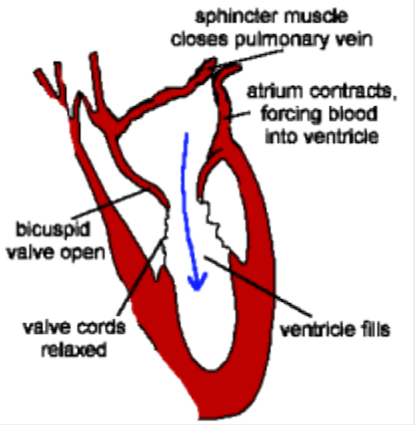
2) atria contract - **atrial systole**

3) ventricles contract - **ventricular systole**

Events in Phase	**Diagram (only one side shown)**
DIASTOLE 1) The atria and the ventricles relax. 2) The semi-lunar valves close, preventing back flow into the ventricles. 3) The elastic walls of the aorta & pulmonary artery contract, forcing blood towards the body & the lungs. 4) Blood from the veins flows into the atria, which begin to fill. Deoxygenated blood enters the right atrium, and oxygenated blood flows into the left atrium.	

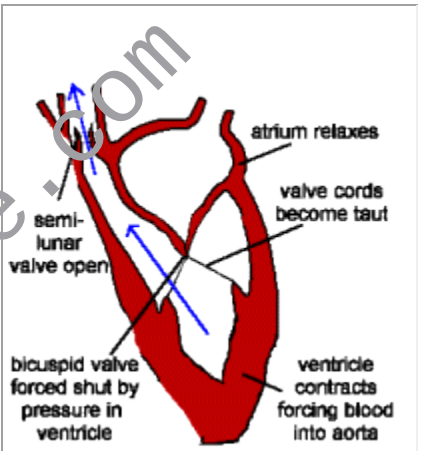
ATRIAL SYSTOLE

1) The atria contract, forcing blood into the ventricles, which fill.
2) Sphincter (ring) muscles closing off the venae cavae and the pulmonary veins prevents backflow from the atria into the main veins.



VENTRICULAR SYSTOLE

1) The ventricles contract, forcing blood into the aorta & pulmonary artery.
2) The main heart valves (tricuspid & bicuspid) are forced shut, so preventing backflow into the atria. This happens because the pressure of blood in the ventricles is higher than the pressure in the atria. The valve cords prevent the valve being pushed back too far.
3) The walls of the aorta & pulmonary artery expand.



Phase	Atria	Ventricles	Cuspid valves	Semi-lunar valves
Diastole	Relaxed	Relaxed	Closed	Closed
Atrial systole	Contracting	Relaxed	Open	Closed
Ventricular systole	Relaxed	Contracting	Closed	Open

The heart rate can be measured by measuring the heart pace. There are muscles in the wall of the heart that receive hormones from the brain telling it to speed up or slow down e.g. adrenaline.

The vessel supplying the heart with blood is called the coronary artery. This is one of the most important arteries in the body because it supplies the heart with all the nutrients it needs. If this artery is blocked then the heart will slow down then stop causing a heart attack. This is how coronary heart diseases (CHD) happen by the buildup of fats on the inside of the vessel. The more fats build up the slower the heart is and the more the heart gets tiered and the person is unhealthy.

Reasons for CHD:

- Inheritance
- Fatty diet: eating too much fats.
- Smoking: it contains nicotine which increases the rate of fat deposition
- Stress and lack of exercise

Blood vessels are tubes, which carry the blood around the body. There are different types of blood vessels. Arteries carry blood away from the heart. These vessels split up into smaller ones called arterioles. Arterioles split up into tiny blood vessels called capillaries. It is from these vessels that movement of particles to & from the blood takes place. Capillaries join together to form larger vessels called venules which join together to form veins .

Veins	**Arteries**
Blood travels to heart	Blood travels away from heart
Large Lumen	Narrow Lumen
Thin wall with few elastic fibres	Thick wall with lots of elastic fibres
Thin muscular layer	Thick muscular layer
Valves present to prevent back flow	No valves
Blood travels constantly	Blood travels in pulses
Blood under low pressure	Blood under high pressure
Blood moves slowly	Blood moves rapidly

Blood

The blood transport5 nutrients, gases, waste, hormones and heat The blood is also the main defense against diseases as it has platelets that form clots and they have white blood cells which have phagocytes which engulfs bacteria and lymphocytes which produce antibodies.

There are about 5-7 liters of blood in an adult body the distrobution is as follows: 55% is olasma which is 90% water and 10% soluble materials and the other 45 % are the cells.

MEGA LECTURE

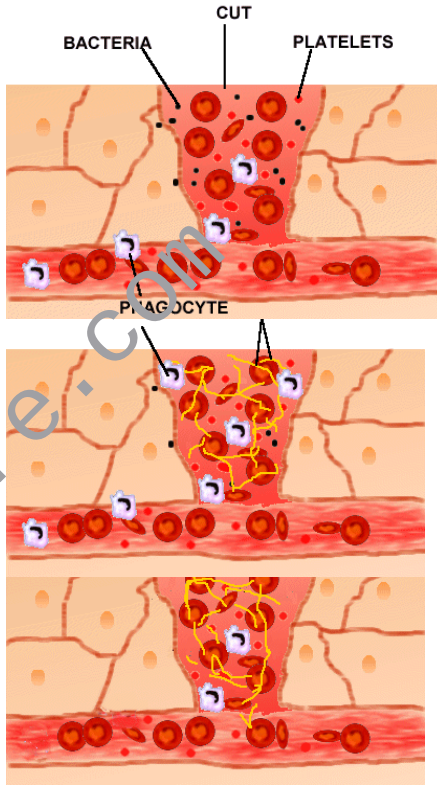
Clotting

When we cut ourselves we not only lose blood but we also make it easier for bacteria to get inside our bodies. Therefore the body must stop the flow of blood and block the breach in the skin to prevent blood loss and infection. For this to be effective it needs to be quick.

Platelets in the blood carry an enzyme. This enzyme is released into the plasma when the platelets come into contact with air or damaged cells.

The enzyme changes the soluble plasma protein fibrinogen into the insoluble fibrin. Fibrin is sticky and forms long threads creating a net, which traps some red blood cells. This makes a plug called a blood clot. Phagocytes, attracted to the damaged site, engulf the pathogens.

The clot hardens and becomes a scab. This protects the wound as the skin heals beneath.



MEGA LECTURE

White blood cells and immunity

There are two types of white blood cell, phagocytes and lymphocytes. Their role in defence against disease is different.

Phagocytes wander around the blood looking for foreign bodies. When these are encountered a phagocyte will surround the foreign body and engulf it. The phagocyte then digests the body, killing it.

There are two types of lymphocytes, B-lymphocytes and T-lymphocytes. They work in different ways.

B-cells make special proteins called antibodies. These proteins will stick onto the surface of foreign bodies. They work in a number of ways but all ways are effective.

T-cells hunt foreign cells, cells infected by viruses and cancer cells. When they find them they inject them with toxins, which destroy them.

Immunity

When you become ill through a disease-causing organism you eventually recover as your body's defenses defeat the invading pathogen. When you encounter the pathogen again, your body remembers the past infection and is ready to fight it. The invader is usually defeated before you even get any symptoms of being ill. This is known as immunity. The cells responsible for immunity are the lymphocytes. All cells have on their surface proteins, which are called antigens. The lymphocytes learn the antigens, which belong in the body, and therefore all others are foreign.

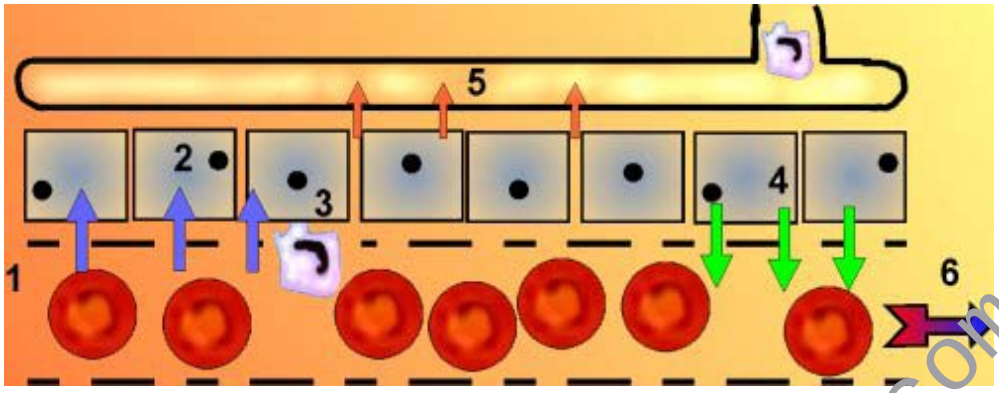
Transplant

Sometimes people get transplant s from other people with organs that have different antigens so the body might attack the new organ. That’s why the donors tissues are checked to see if the antigens are close to the one of the actual person, the closer the antigens are the less the chance of a failure transplant.

MEGA LECTURE

Material exchange

Blood travels via arteries until it reaches smaller vessels called capillaries. It is here that materials are exchanged between blood and the tissue cells.



1. The blood enters a capillary bed. These vessels are very leaky and are only wide enough for one cell at a time to pass through. The capillary walls are only 1 cell thick!
2. The blood pressure forces some of the blood plasma to leak out of the capillary. This fluid is high in nutrients and oxygen (from the red blood cells). Large objects like red blood cells and protein molecules cannot pass through the walls of the capillary. The fluid that is surrounding the tissue cells is called *tissue fluid*. It is from this fluid that materials will diffuse into the cells.
3. White blood cells are the only cells, which can leave the blood, so they can hunt down pathogens.
4. Waste materials like carbon dioxide and urea diffuse from the cells into the tissue fluid. This fluid is drawn back into the blood capillary by an osmotic pressure supplied by the large proteins in the blood.
5. Not all the tissue fluid flows back into the blood. If it did not return the tissues would swell with fluid. Sets of vessels, called lymph vessels, drain this tissue fluid and carry it away from the tissues. Eventually the fluid (called lymph) drains back into the blood.
6. The blood leaves the capillary beds and travels back to the heart via veins.

Respiration

Respiration is the chemical breakdown of food molecules to release energy. **Breathing** is the mechanical movement to ventilate the respiratory surface, it includes inhaling and exhaling. **Gaseous exchange** is diffusion of O2 on a moist surface into an organism and the diffusion of CO2 out of the organism**. 2 types of respiration:**

Aerobic respiration

It is the breakdown of glucose in the presence of O2. In this process glucose is completely oxidized into carbon dioxide and water. This process is slow and is controlled by many enzymes & the energy produced is not used immediately but stored as ATP. **The energy released from ADP can be used in many activities such as ;**

- Cell division
- Maintaining temperature
- Active transport in the membrane
- Conduction of nerve impulses

Anaerobic respiration

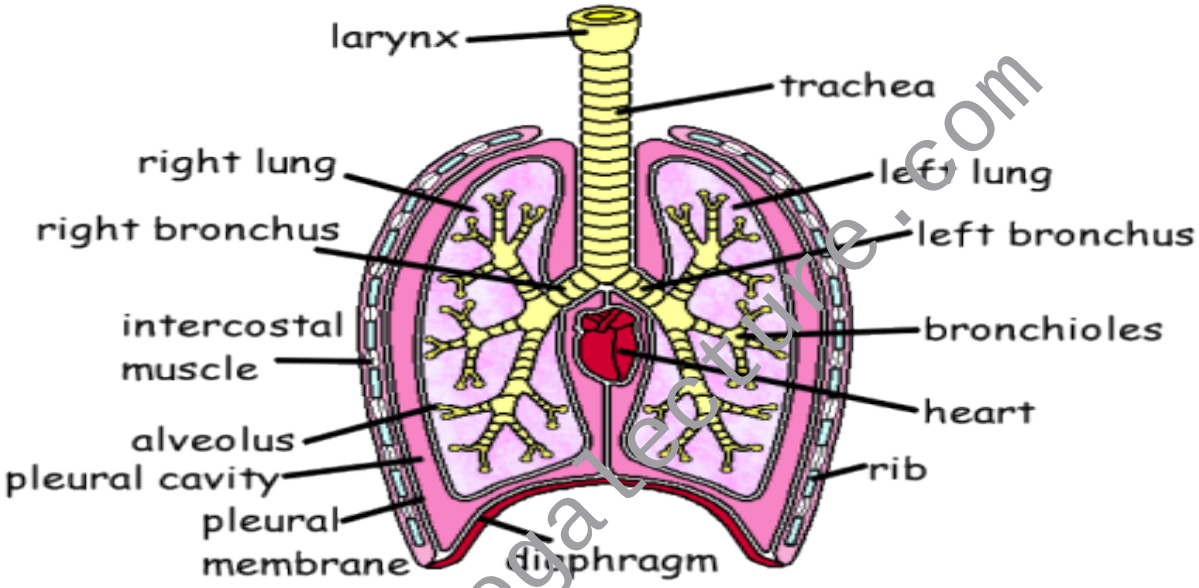
This is the breakdown of glucose without using oxygen. In this process the energy produced is relatively small and the product is variable.

Alcohol can be produced when anaerobic respiration happens in the fermentation in yeast. In the human body lactic acid is a product to anaerobic respiration during heavy exercise. The lactic acid produced needs to be broken down further more by oxygen. That's why we continue breathing heavily after exercise the breakdown of lactic acid is called **Oxygen dept**.

MEGA LECTURE

Unit 10 : *Gas Exchange*

The lungs are located in the chest inside a lubricated membrane called the pleural membrane.This allows the lungs to move freely inside the pleural cavity. The lungs are connected to the outside via the trachea (windpipe). The trachea is a tube kept in a rigid shape due to rings of cartilage. The larynx or voice box is located at the top of the trachea while at the bottom end it branches into two bronchi. These lead into the lungs.



The bronchi in turn branch off into smaller and smaller bronchioles. These end in tiny air sacs called alveoli. It is here that gaseous exchange takes place. The surface area of all these alveoli is very large so as to be able to absorb oxygen very quickly.

The lungs are very delicate and can easily be damaged. The cells lining the airways have very tiny hair like structures called cilia on them. These cilia are coated in a sticky mucus. The beating cilia force the mucus and any particles of dirt up out of the lungs. It eventually drops down into the esophagus so the mucus is attacked by the stomach acid, destroying any pathogens.

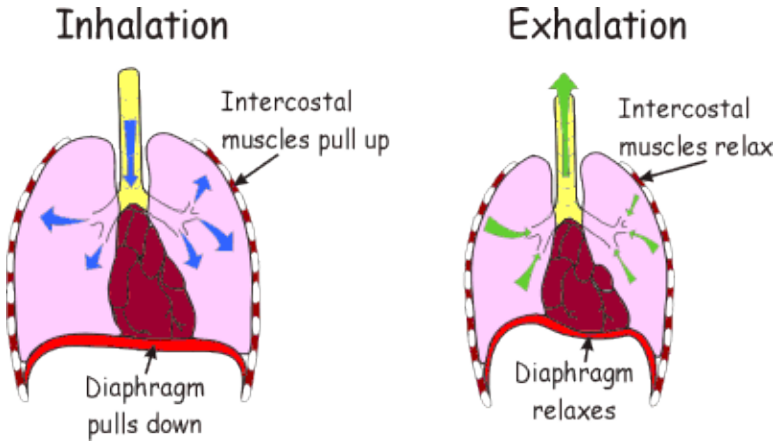
Characteristics of the alveoli

- Large surface area: Big amounts of O2 can diffuse
- Thin walls so gas exchange can happen
- Rich supply of capillaries
- Moist so gas dissolves in water

MEGA LECTURE

The diaphragm and breathing

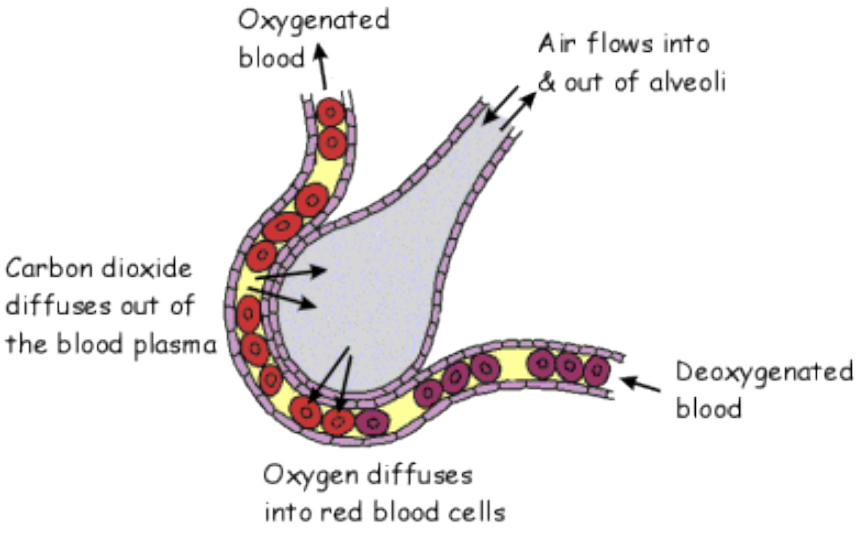
When we breathe in the diaphragm muscle contracts, pulling the sheet down. The intercostal muscles in between the ribs also contract which pulls the whole ribcage upwards and outwards. These together increase the volume of the chest. Air is drawn into the lungs because the the pressure inside them is lowered as the chest volume is increased.



When we breathe out the diaphragm relaxes as does the intercostal muscles. This decreases the volume of the chest, increasing the pressure. This forces air out of the lungs. So it is the changing volume of the chest which causes air to enter and leave the lungs. The lungs themselves are just like balloons which are inflated and deflated.

The exchange

The walls of the alveoli are very thin and so are the walls surrounding the alveoli so that's why diffusion of O_2 and CO_2 happens. Note that other gasses don't diffuse because the concentration of them in and out of the body are not different.



MEGA LECTURE

Smoking

Smoking causes a number of diseases, some of them life threatening.

- **Nicotine** This is the substance which makes smoking addictive. Nicotine is a stimulant which can make the heart beat faster and increase the amount of adrenaline released. It also makes the smoker more shaky. It causes stress.
- **Carbon Monoxide** This is created due to incomplete burning of the tobacco. This gas binds irreversibly to the haemoglobin in red blood cells preventing them from carrying oxygen. If the smoker is pregnant then the baby will get less oxygen than usual.
- **Tar** is a mixture of many different chemicals. It prevents the cilia in the lungs from working and so the dirt and tar cannot be removed from the lungs. Also damages the alveoli and decrease the lungs surface area.

MEGA LECTURE

Unit 11 :*Excretion*

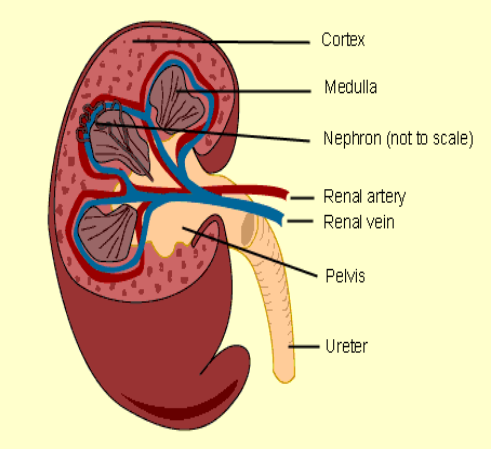
It is the removal of waste products of metabolism and substances in excess of requirements from organisms. (don't mix it with egesting).

Organs that excrete:

Mammalia excretory organs :

Organs	*Excretory products*
1- the lungs	CO_2, water vapour " expired air"
2- the kidneys	Water, urea, uric acid, excess salts, drugs and inactive hormone in the form of urine
3- the liver	bile pigement result from destruction of old RBCs released with bile, in faeces.
4) the skin	Water, salt and few urea " sweat" N.B sweat is a response of rise in temperature & not due to change in blood composition so it is not considered as real excretory organ.

The urinary system consists of two kidneys, two ureters a bladder and a urethra. The job of the kidney is to purify the blood as it enters it. The blood is entered to the kidney by the aorta and id filtered the clean blood then returns to the heart and the urine then goes down the ureters and to the bladder then to the urethra. The outside part of the kidney is called the cortex and the inner part is called the medulla and the part connecting to the ureters is called the pelvis (the very part in the middle). Urea is a harmful substance made in the liver it is made when proteins are broken down.



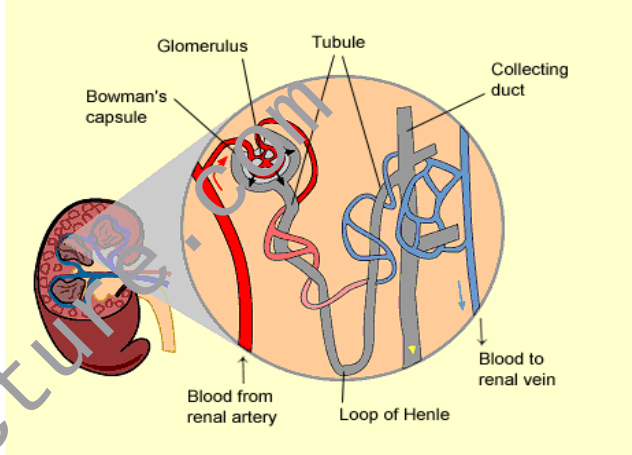
MEGA LECTURE

The kidneys have four functions:

- Regulation of blood water levels
- Reabsorption of useful substances into the blood
- Adjustment of the levels of salts and ions in the blood
- Excretion of urea and other metabolic wastes

A nephron is a the smallest unit that filters the blood

Blood at high pressure entering the aorta passes through the walls of the bowman's capsule except the blood cells and protein (O2, CO2 glucose, Urine salts and amino acids only enter). Most substances including O2 glucose most of the water and some salts are absorbed at the tubules to join the renal artery. The rest of the substances then go down the loop of Henle. Then the rest of the unwanted substances are passed to the urter and then out of the body. Most of the nephrone is in the cortex only the loop of Henle is in the medulla and the collecting duct heads to the pelvis and collected as the ureter (there are about 1 million nephrons in each kidney.)



Osmoregulation

Is keeping the water and salt levels constant in the blood. They are regulated by the hypothalamus. If the concentration of water is too low e.g. during heavy exercise as a lot of water is removed by sweating the blood becomes too concentrated so the hypothalamus senses too little water in the blood. A message is sent to the pituitary gland to release anti-diuretic hormone. This makes the membranes of the collecting ducts become more permeable to water so more water passes. Usually when someone goes to the toiled during exercise the urine is concentrated and is a t low quantity. If the concentration of water in the blood is too high then water moves into the cells by osmosis and could cause them to burst so the water in the blood stops the hypothalamus signalling the pituitary. The membranes of the collecting ducts become lass permeable to water and large amounts of dilute urine produced. The concentration of urine depends on many factors e.g. diet, exercise and temperature.

Kidney failure

This is when a kidney of a person faiols then he has to either get a transplant or get dialysis

- Transplant:
  This is when the diseased kidney is surgically removed and replaced by a fully functioning kidney from a deceased or a live donor. It is only possible after a satisfactory tissue-match. Even after a successful tissue-match the recipient's immune system has to be drugged or suppressed to stop it from rejecting the new kidney.
- Dialysis:
  In the absence of a suitable donor kidney, the alternative solution is for the patient to be hooked-up to a dialysis machine every 2 - 3 days. A dialysis machine mimics the functioning of the kidney. Blood from an artery in the patient's arm is pumped into the kidney machine which removes **urea** and excess salts from it. The blood is checked for air bubbles before being returned to a vein in the arm.

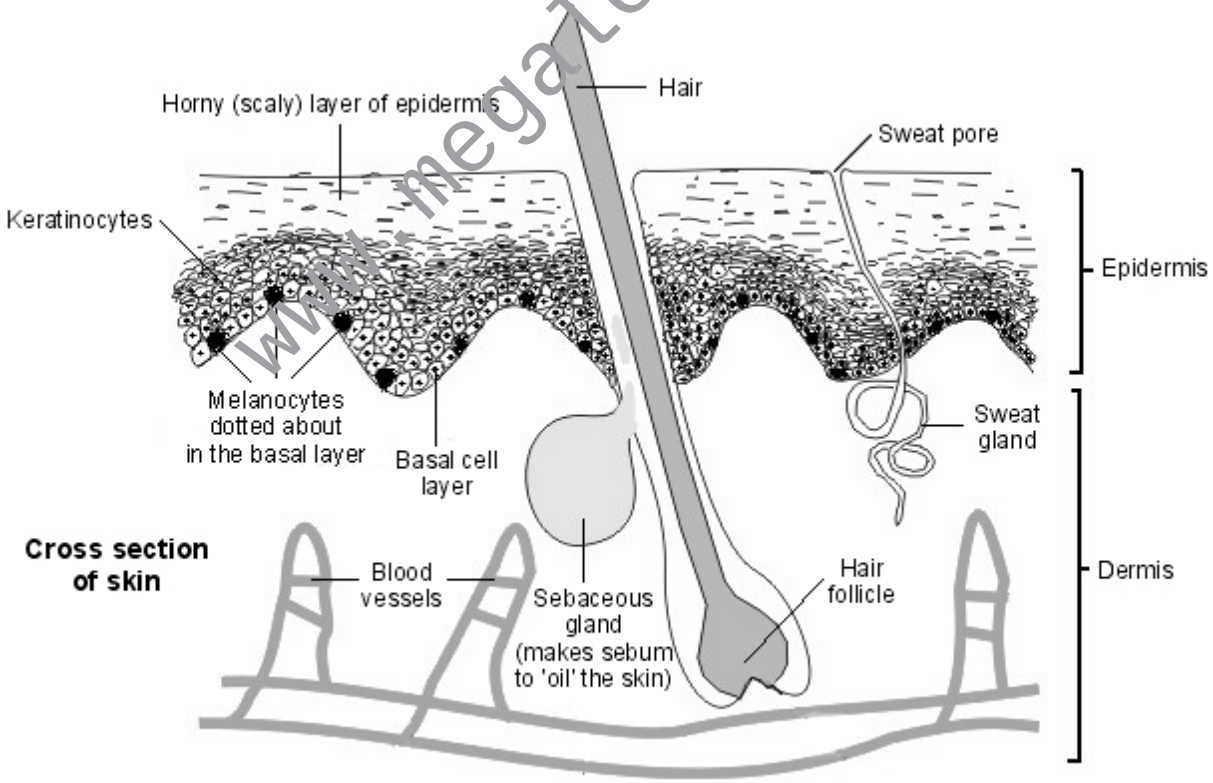
MEGA LECTURE

Unit 12: *Homeostasis and Hormones*

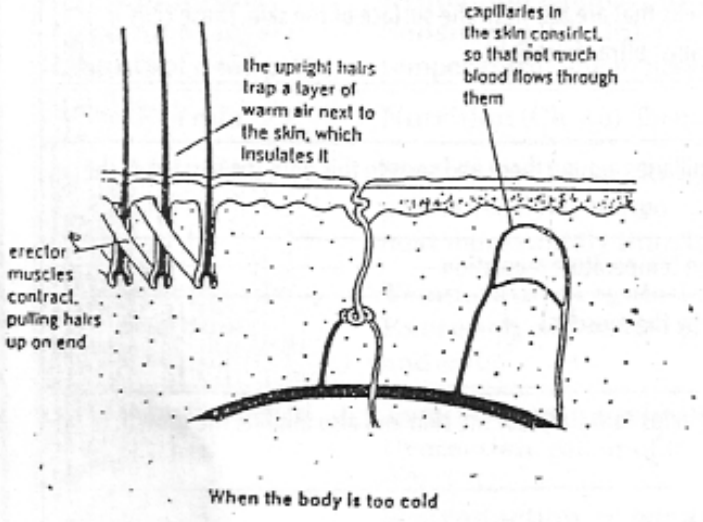
IT is the maintenance of the conditions of the internal body environment. The conditions are maintained by hormones which are secreted by some organs. Hormones are chemical messages and chemicals released from an endocrine gland into the blood controlled by the brain. Negative feedback is when the hormone has done its affect and the brain orders it to stop.

Temperature cam be maintained by the skin.

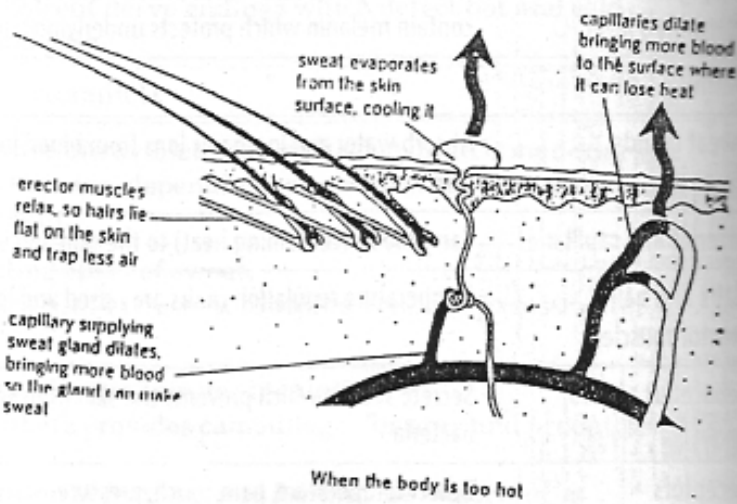
- Sweat glands: Release sweat which evaporates by taking heat from the body decreasing the body temperature.
- Hair: Sleeps and stands up to trap air which insulates temperature.
- Blood vessels: become narrower and wider to heat and cool.



	On a cold day	On a warm day
1-Detection by skin receptor and hypothalamus in the brain	Message are immediately sent out in nerves to switch on the warming mechanism.	Messages are immediately sent out in nerves to switch on the cooling mechanism.
2- Blood vessels (arterioles)	**Vasoconstriction** – arterioles become narrower so that less blood flows through the capillaries	**Vasodilation** – arterioles dilate so that more blood flows thhrough the capillaries close to the skin surface, more heat lost from the skin
3- Hairs	Hair erector muscles **contract** causing hairs to stand on. Thick trapped layer of air between the hairs."thick insulater layer"	Hair erector muscles **relax** causing hairs to become flat. The layer of air trapped is very thin Heat is easily lost from the body by radiation and convection
4- sweat glands	Less active so that latent heat is not lost from the body	Very active more water is brough to the sweat glands during vasodilation, thus more sweat is secreted and more latent heat is lost when sweat evaporates
5- Metaboolic rate	Increases More heat is produced. Shivering due to involuntary contraction of the muscles	Decreases Less heat produced



When the body is too cold



When the body is too hot

Blood sugar levels should be maintained. This is how it is maintained:

- *Blood sugar is too high*
- Messages sent to pancreas to produce insulin
- Insulin converts glucose to glycogen
- Sugar level maintained
- Message sent to pancreases to stop insulin.
- *Blood sugar too low*
- Messages sent to pancreas to produce glucagon
- Glucagon converts glycogen to glucose
- Messages sent to pancreas to stop glucagon.

Diabetic people can't control their blood sugar level so they take in insulin pills e.c.t to try to maintain the blood sugar level. A symptom of this illness is the presence of glucose in urine.

Plants hormones

Tropisms:

Growing in response to a stimuli is called a tropism. Phototropism is growth in response to light. This is an example of a positive tropism, growing towards the stimulus. Hydrotropism is a response to water whereby the roots grow towards it. Geotropism is a response to gravity. Roots show positive geotropism while shoots show negative geotropism (in that they grow away from gravity).

Uses of Plant Hormones:

Plant hormones including auxins have been used in agriculture and by horticulturalists for number purposes. Plant hormones are used in rooting powder to stimulate the development of roots from plant cuttings. They are also used in fruit ripening to make sure that all the fruit ripens at once to aid harvesting.

MEGA LECTURE

Unit 13 :*The nervous system*

Any nervous action is a result of a stimulus.

- **A Stimulus**

  is any change either internal or external which leads to a response. This could be a noise, smell or the changes in blood sugar level.

- **A Receptor**

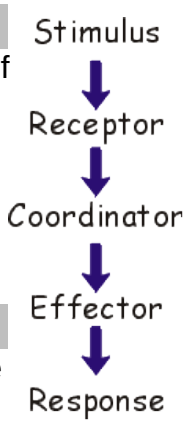
  is a specialized cell which can sense the stimulus. There are lots of different types of receptors; some can sense light, while others can sense heat etc.

- **A Coordinator**

  is a cell or organ which 'decides' what to do. It gives a message to the effectors to do something.

- **The Effectors**

  is an organ which responds to the stimulus. This could be a muscle which contracts or organs like the liver which may perform a complex task like lowering the blood sugar levels after a meal.



- **The Response**

  is what happens when the organism reacts to the stimulus.

  A stimulus cam be internal or external. External stimulus's can be like light from the sun, this will be the stimulus, and the receptor will be the light sensitive cells on the retina, the coordinator is always the brain and the effecter is the muscles of the iris and the response will be the iris narrowing down. An example of an internal stimulus will be an increase in body temperature.

  The nervous system

  The nervous system is made up of the Brain, the spinal cord (CNS central nervous system) and the nerves.

Nerve cells

- **Motor neurons:** transmit impulses from the CNS to the effecter muscle
- **Sensory neuron:** transmits messages from the sensory neuron to the CNS
- **Relay neuron:** Links the motor with the sensory neuron.

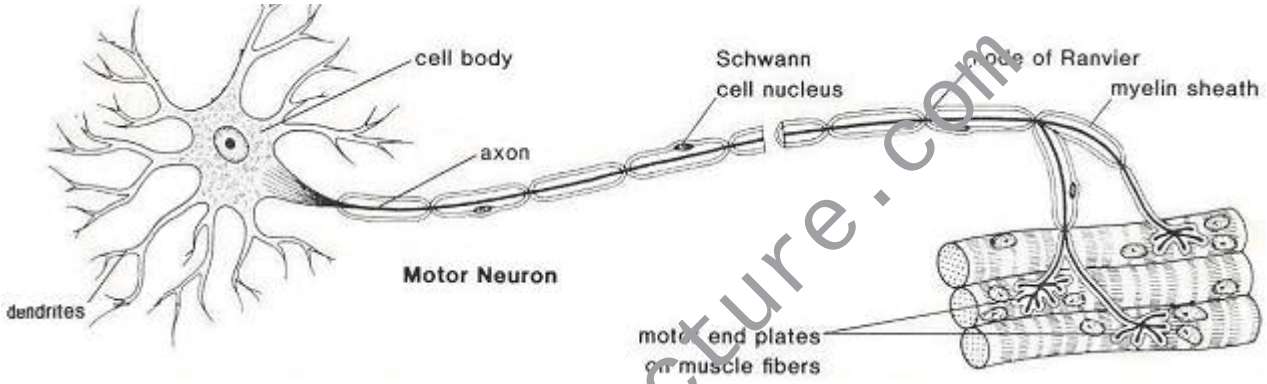
MEGA LECTURE

Info about neurons

- Made up of a bundle of axons which are surrounded by myelin sheath.
- A synapse joins two neurons together. It contains chemical messages.
- Have branched ends that receives impulses.

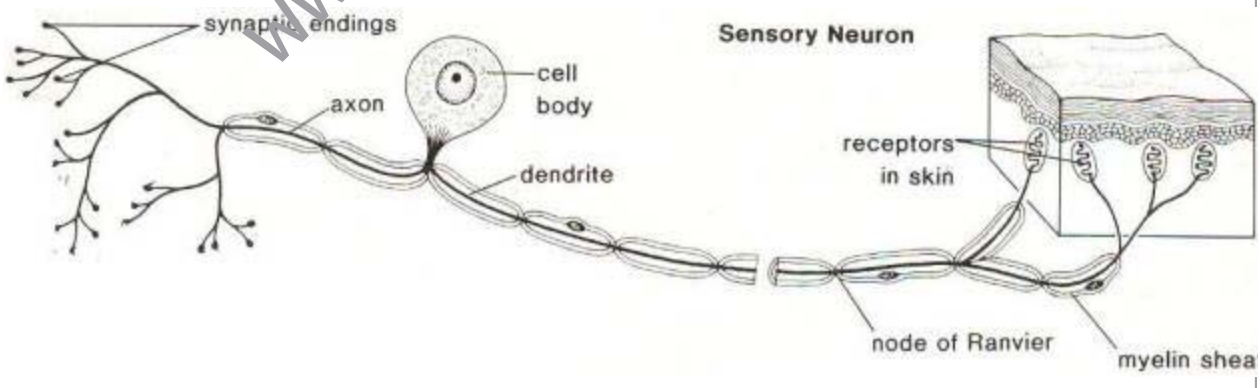
Motor Neurone:

- Efferent Neuron – Moving toward a central organ or point
- Relays messages from the brain or spinal cord to the muscles and organs



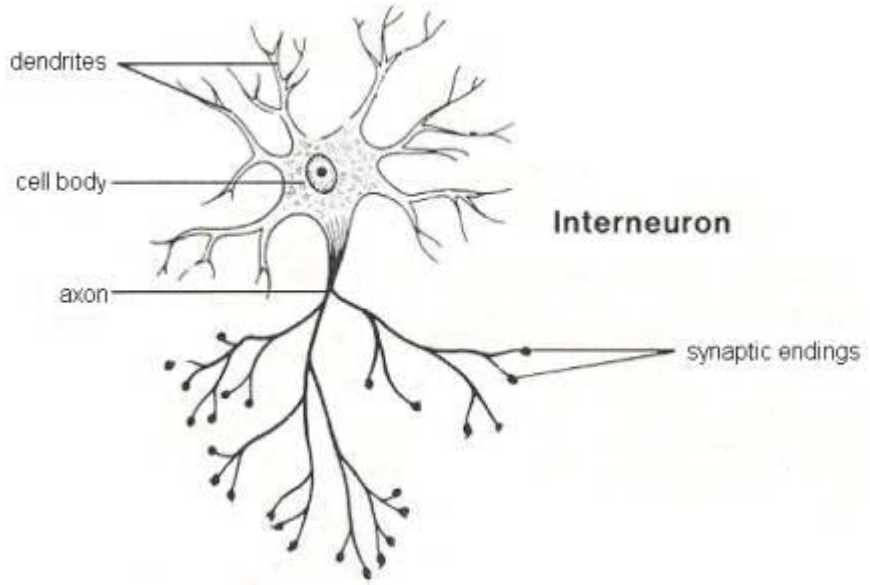
Sensory Neurone:

- Afferent Neuron – Moving away from a central organ or point
- Relays messages from receptors to the brain or spinal cord

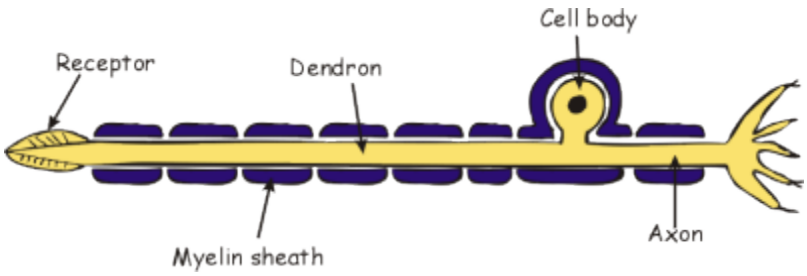


Interneuron (relay neurone):

- Relays message from sensory neurone to motor neurone
- Make up the brain and spinal cord

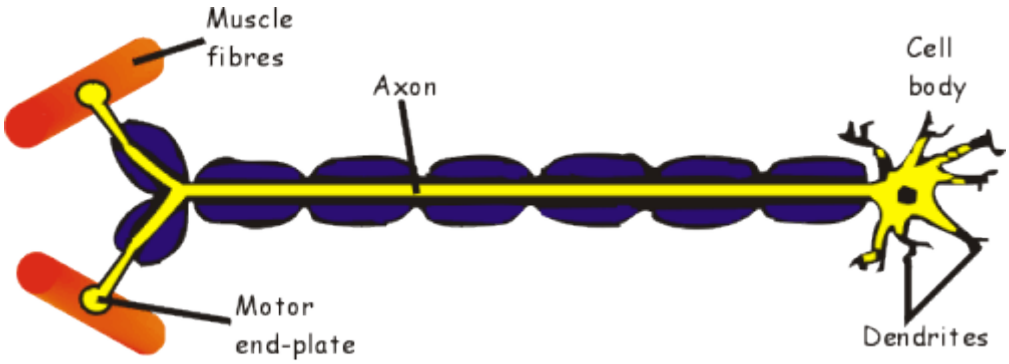


Sensory neurone



The sensory neuron gathers information from the senses and passes it on to the central nervous system (*CNS*). It is attached to special receptor cells or in some cases the nerve's end is a receptor itself. When stimulated it carries an electrical impulse along its length, passed the cell body and down the axon to the nerve endings. It is here that the cell meets with another neuron (or neuron) at a junction called a synapse. The cell bodies of sensory neurons can all be found together in a nerve. This causes a swelling called a ganglion.

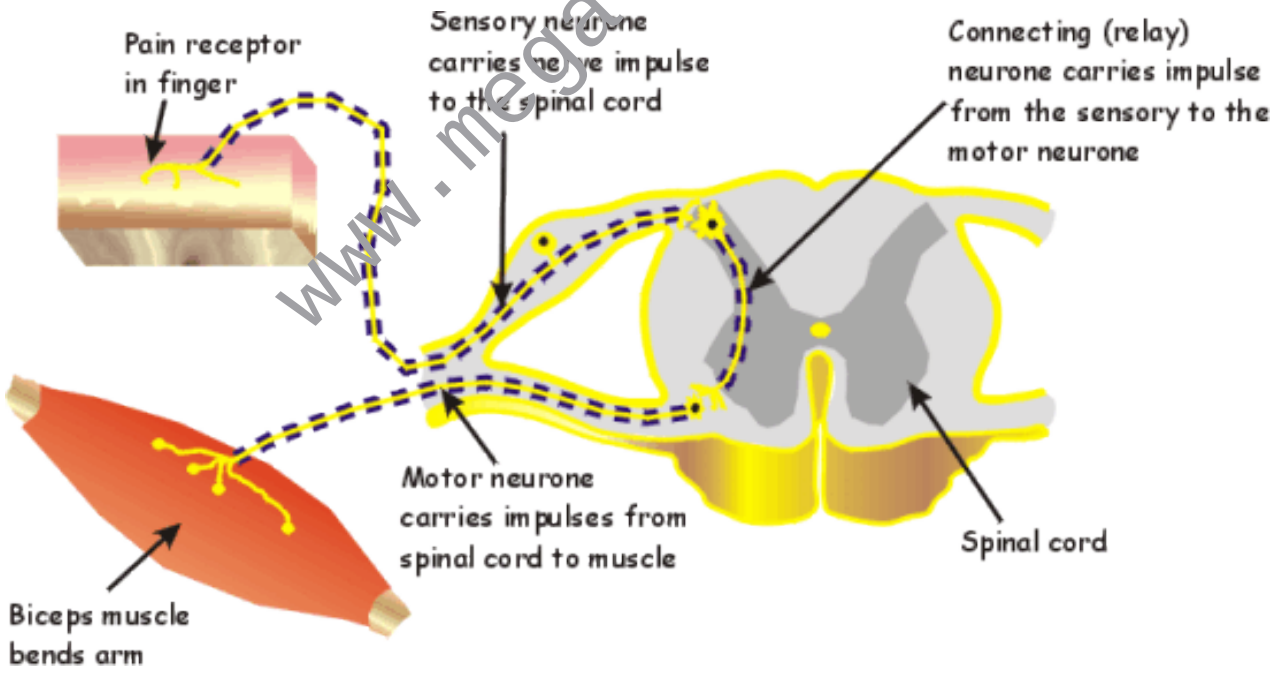
Motor neuron



These neurons carry impulses away from the CNS towards effecter organs like muscles or glands. These cells have very long axons at the end of which are motor end plates where the nerve cell can stimulate the effecter organ.

The reflex arc

A reflex action is usually quick passive action it is usually for protection. The spinal reflex does not need to pass through the brain but pass through a relay neuron. So a stimulus happens and a receptor (the sensory organ) passes the impulse to the sensory neuron and then to the relay neuron and then to the motor neuron.

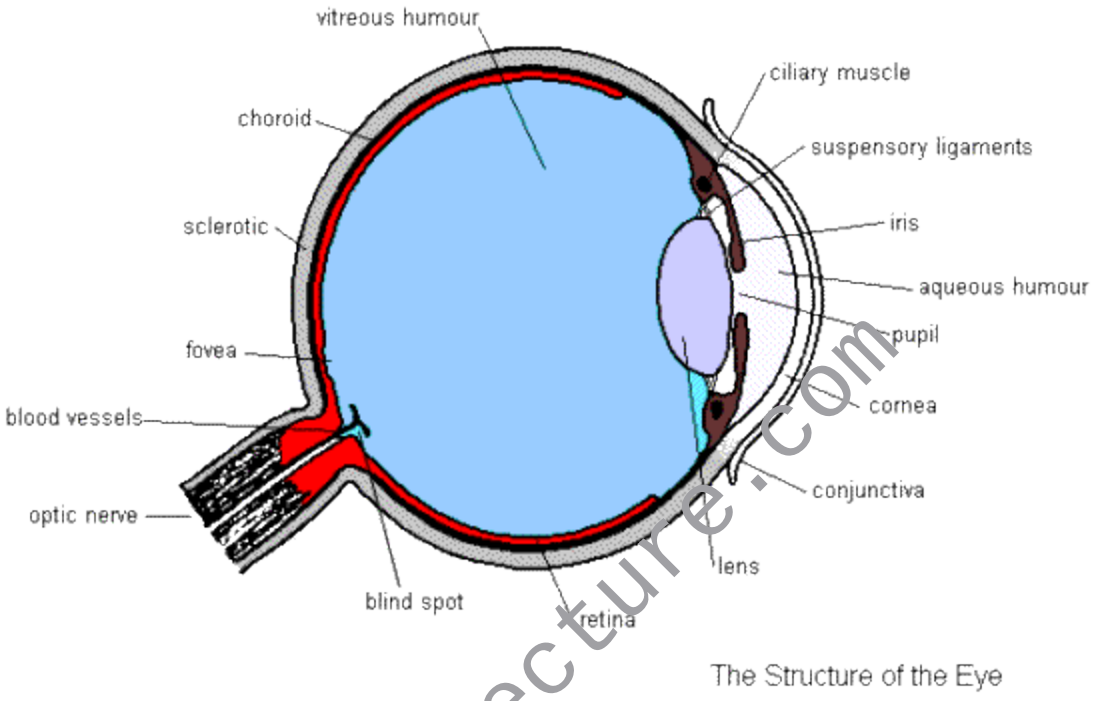


Synapse

The synapse is a junction where two or more nerve cells meet. The synapse allows the nerve cells to pass on their electrical impulse to another cell. The synapse is also a way of controlling the direction in which impulses travel. They can only travel one way through a synapse. When an impulse reaches the synaptic knob, it releases vesicles of a chemical called a neurotransmitter to be released into the synaptic cleft. They quickly diffuse across the gap and bind with receptors on the surface of the connecting neuron. When enough of the receptors have been filled an electrical impulse is triggered in this neuron and off it travels.

MEGA LECTURE

Unit 14 : *The Eye*



The Structure of the Eye

- **Sclera**: a tough coat that protects the eye from the inside.
- **Choroid**: A layer that absorbs light so no internal reflection happens
- **Retina**: contains light sensitive cells.
- **Yellow spot**: The highest concentration of rods and cones
- **Blind spot**: the least concentration of light sensitive cells
- **Optic** nerve: transmits impulses generated by the retina.
- **Vitreous humour**: Helps maintain the shape of the eyeball
- **Lense**: Responsible for the refraction of light in the eye
- **Suspensory ligament**: Adjust the lenses shape
- **Iris**: Controls the entry of light.
- **Pupil**: The circular opening which lets light in
- **Cornea**: The outer layer of the eye (transparent)
- **Aqueous Humour**: Maintains the curvature of the choroid
- **Rectus muscles**: Adjust the position of the eyeball
- **Tears**: contain NACL, water, sodium bicarbonate and lysozem

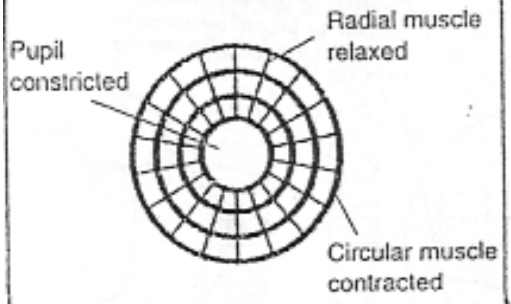
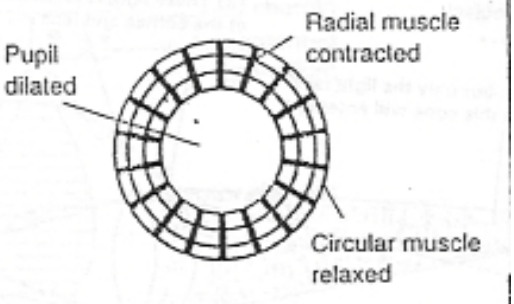
The retina is the light sensitive layer which is responsible for 'seeing' light. The retina is composed of two types of light sensitive cells.

Rod cells

These cells are capable of seeing only different degree's of light intensity and cannot distinguish colour. As a result they can only see in black and white. They are able to sense low levels of light and so are used for seeing in dim light such as at night but do not work in bright light.

Cone Cells

There are three different types of cone cell, each sensitive to a different colour of light. The three cells are sensitive to the three primary colours of light, red, green and blue. These cells need a great deal of light in order to work and as a result are not able to 'see' in dim light. The cells are mixed together so that different colours can be seen.

BRIGHT LIGHT	DIM LIGHT
More photoreceptor cells in the retina are stimulated by an increase in light intensity	Fewer photoreceptor cells are stimulated due to decrease in light intensity
Greater number of impulses pass along sensory neurones to the brain	Fewer impulses pass along sensory neurones to the brain
In the iris diaphragm, circular muscle contracts and radial muscle relaxes	In the iris diaphragm, circular muscle relaxes and radial muscle contracts
Pupil constricts	Pupil dilates
Less light enters the eye	More light enters the eye
Anterior view of iris and pupil 	Anterior view of iris and pupil 

not to damage photo-receptor cells on the retina.

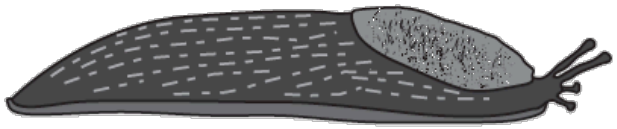
Accommodation

It means the ability of the lens to detect far and near objects by changing its thickness to be able to see far and near.

Tips for Paper 6 Biology

Drawings

Fig. 3.1 shows the external appearance of animal **A**.



animal **A**

Fig. 3.1

(a) (i) Make a large, labelled drawing of animal **A**.

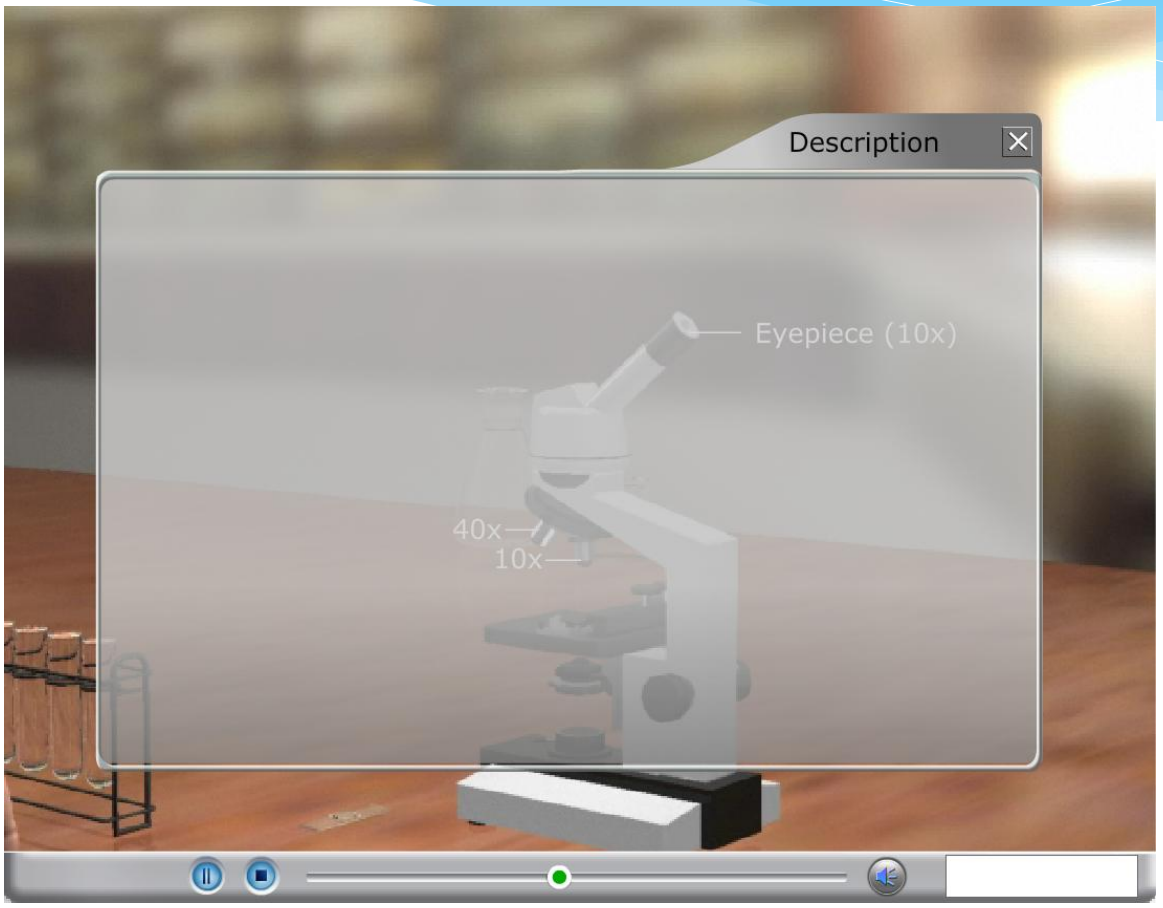
Label **two** features that are characteristic of this group of animals.

Drawings

When you will be asked to draw diagrams of fruits, insects..etc. in the exam.

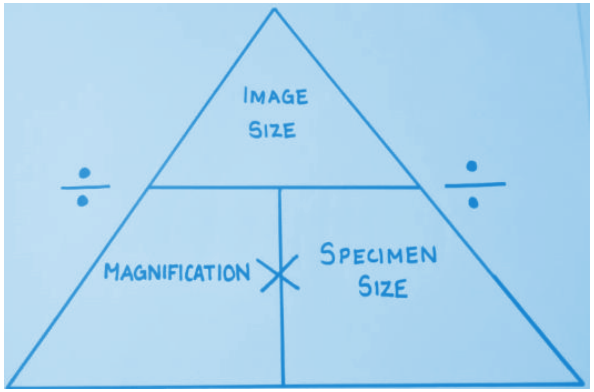
- Make sure you use a sharp pencil
- your outline is clear.
- The drawing should be as large as you can fit into the space provided.
- It has definite outlines (no 'sketchy' lines)
- No shading,
- No arrow heads when labelling
- Lines point exactly at the labelled part.

Calculating Magnification



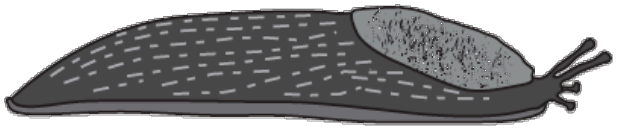
Calculating Magnification

Units used should be mm and the magnification given as ‘ x’
correct at least to one decimal place and to not more than two.



Drawings

3 Fig. 3.1 shows the external appearance of animal **A**.

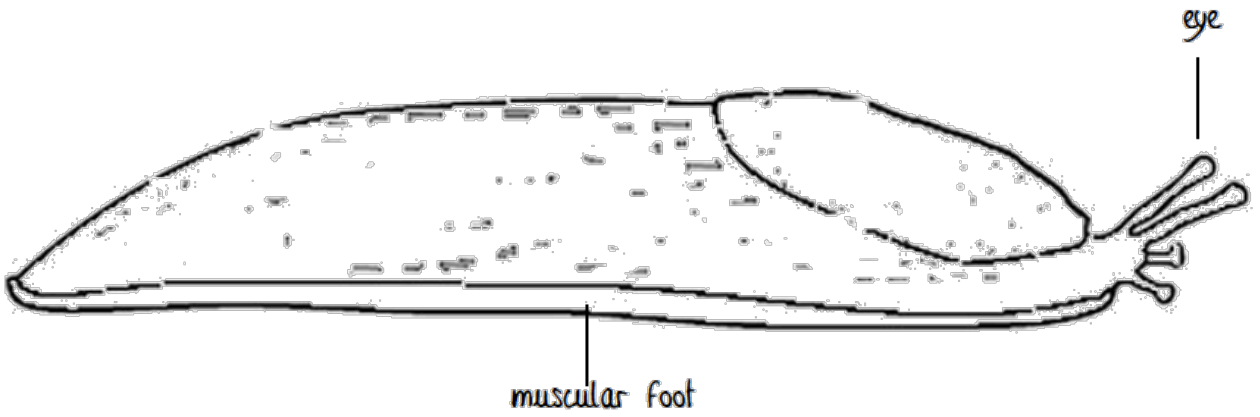


animal **A**

Fig. 3.1

(a) (i) Make a large, labelled drawing of animal **A**.

Label **two** features that are characteristic of this group of animals.



Magnification

Measure the length of animal **A** in Fig. 3.1 and in your drawing. Calculate the magnification of your drawing.

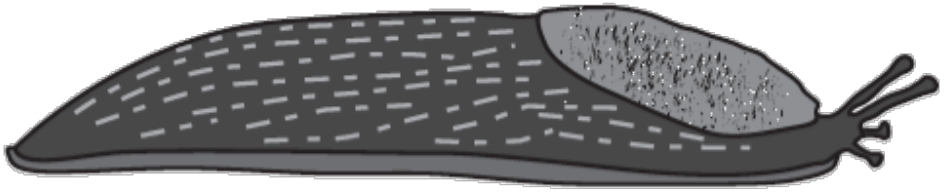
*length of animal **A**: in Fig. 3.1* ..... 75 mm .....

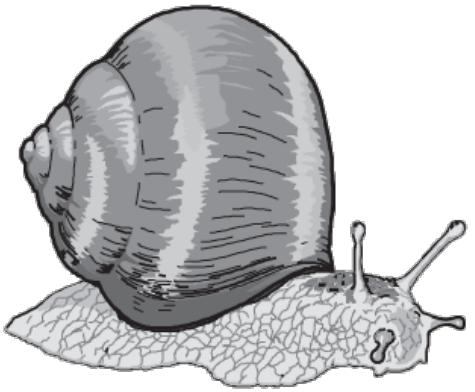
in drawing ..... 135 mm .....

magnification ..... $\frac{135}{75}$ = x 1.8 .....[2]

Comparisons

State one similarity which indicates that these two animals are classified in the same group and state one difference between them.



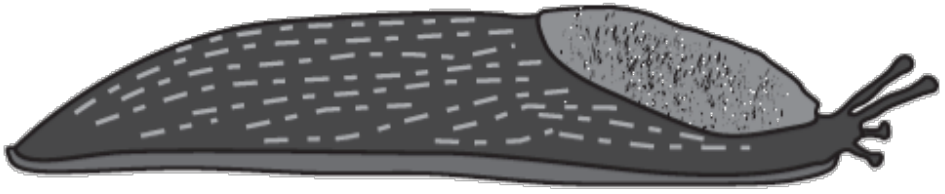


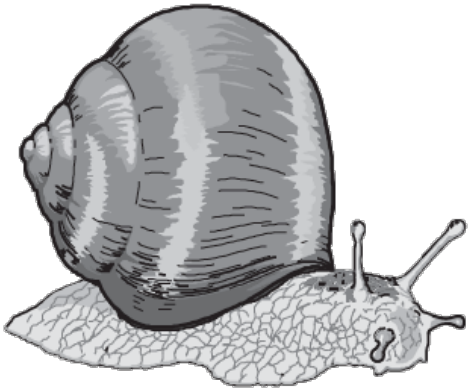
Comparisons

- Make sure the points you use to compare diagrams are visible in the diagrams
- Use labels on the diagrams as your guide
- You can compare numbers shape and proportional sizes.
- Don't compare sizes unless you're given a scale.

Comparisons

State one similarity which indicates that these two animals are classified in the same group and state one difference between them.





similarity They both have tentacles

difference Animal B has a large external shell (absent in animal A) [2]

Designing an Experiment

Describe an investigation that you could carry out to show the need in seed germination for suitable temperature

Designing an Experiment

- Find the variable which is to be changed (from the question) and mention how you are going to change it
- List all variables that you have to keep constant throughout the experiment
- Mention how long your experiment will last.
- Say how you will measure experiments' results (change in colour for example)
- Write: 'repeat experiment to get more reliable results and minimise error.
- Set a control for your experiment.

Designing an Experiment

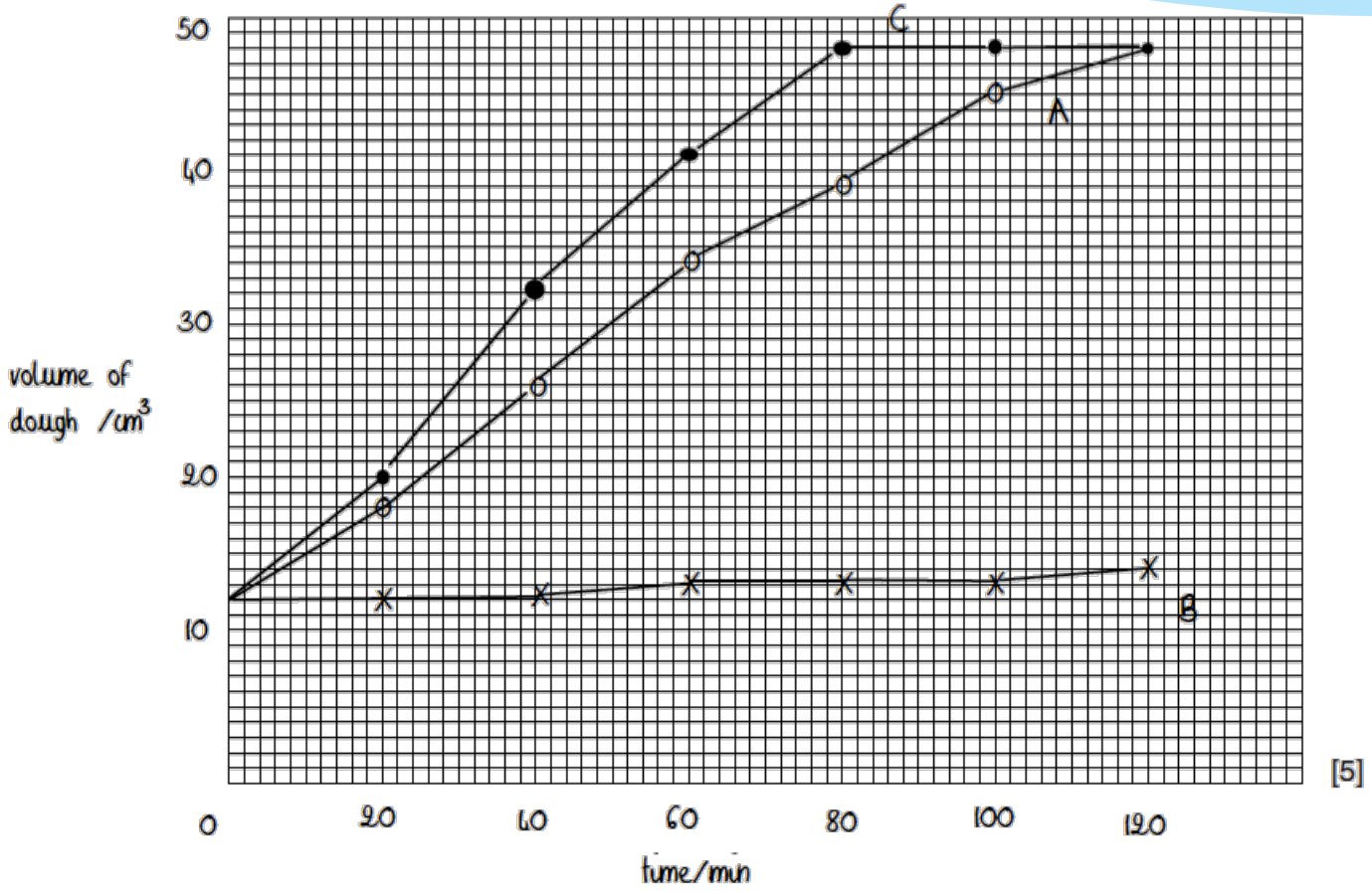
Describe an investigation that you could carry out to show the need in seed germination for suitable temperature

two identical sets of apparatus are set up. Each set of apparatus should contain many seeds – all of the same species – placed on damp cotton wool in a glass jar the lid of which is open to allow entry of air. One set is placed on a bench in a warm laboratory (or, better, in a temperature-controlled propagator for growing seeds). The second set is placed in a refrigerator at 4°C. Both sets of seeds are watered daily over a period of several days. Only the seeds in the suitable temperature should germinate. [3] [Total : 4]

Drawing a Graph

- Use a sharp pencil
- Label both axes including the units
- Choose an even scale for each axis that uses up as much of the grid as possible.
- The controlled variable (time) is plotted on the x (horizontal) axis
- Dependent variable (i.e. the one that changes as a result in a change of the other) is plotted on the y (vertical) axis.
- Join your plotted points with ruled lines
- When drawing bar charts, all bars must be of the same width

Drawing a Graph



[5]

Test of Reducing Sugars

Safety:

- test tube holders;
- Safety Goggles
- use of lab coat
- hair tied back

Procedure:

- Take equal samples for comparison
- Crush the sample (if it's needed) or extract with water
- Add Benedict's Solution
- Heat (not warming) with a water bath
- Same time of Boiling for comparision
- The colour changes blue → green → yellow → orange → red
- Or it remains blue if there is no reducing sugars (negative result)

Test of Reducing Sugars

Test of Reducing Sugars

The reducing sugar test can tell you that:

- reducing sugar is absent
- reducing sugar is present at a low concentration
- reducing sugar is present at a high concentration

Explain how you can tell the difference between these possible results.

.....

.....

.....

.....

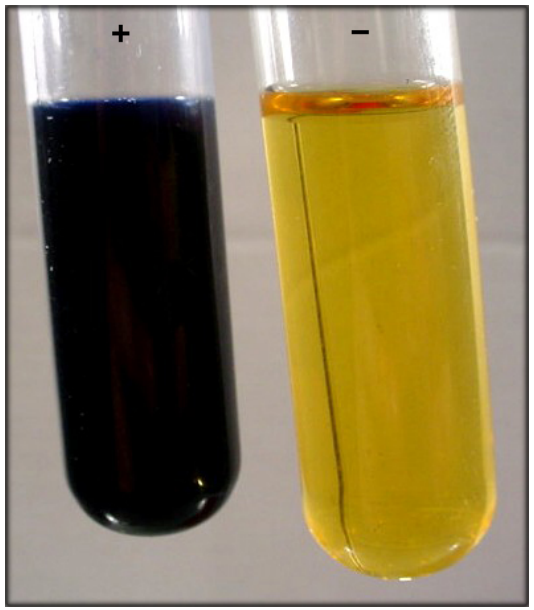
.....

..... [3]

Starch Test

- Crush the sample (if it's needed) or extract with water
- Add drops of iodine
- Observe colour change

brown → blue black

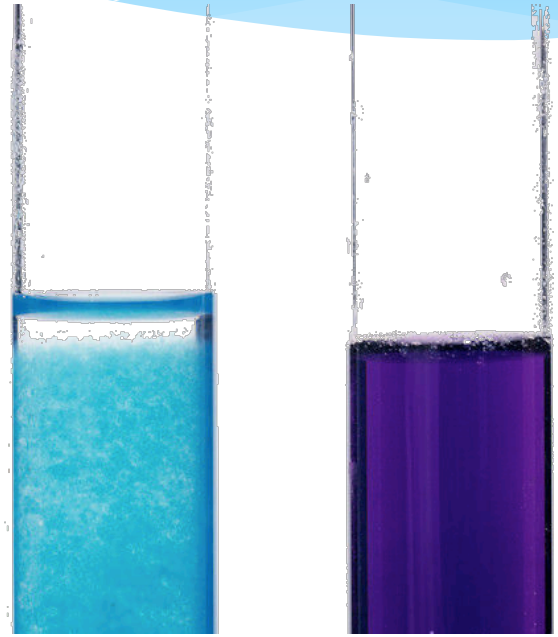


Starch Test

Protein Test

* Add a measured volume of Biuret solution
* In a test tube or a beaker
* Colour changes from

  blue → purple



Protein Test

Test of Fats

Add a measured volume of ethanol to the sample

Add an equal volume of water to the mixture

A white emulsion forms which is a sign of

Tests of Gases

* Test of Oxygen:

It relights a glowing splint

* Test of Carbon dioxide:

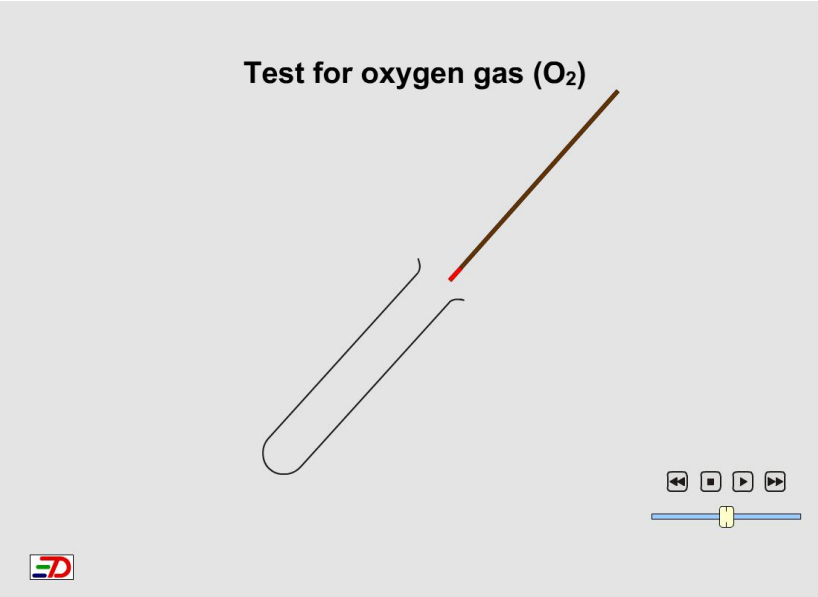
Bubble gas in limewater

Limewater turns milky white

Note:

Carbon dioxide is an acidic gas, it lowers the pH

Tests of Gases



Tests of Gases