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GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

REMOTE LEARNING ACTIVITY BOOK

(RELAB)

SUBJECT: LIFE SCIENCES

GRADE: 11

TERMS ONE - FOUR

GGT2030
GROWING GAUTENG TOGETHER

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B. INTRODUCTION AND PURPOSE OF THE RELAB

The pandemic has forced schools to resort to the implementation of rotational timetables - where learners who are at home during normal schooling must continue learning. Hence RELAB as a strategy towards the deployment of remote learning.

The RELAB is underpinned by the following Legislative demands:

a) Responding to GDE Strategic goal 2: promoting quality education across all classrooms and schools
b) **DBE Circular S13 of 2020:** requires the GDE to support the implementation of the Recovery Annual Teaching Plan (RATP)
c) **GDE Circular 11 of 2020** requiring districts to issue Learning Activity Packs to support schools for lockdown learning.
   Understanding the learning constraints at home where the majority of learners do not have access to devices or data to use for online learning. Many households are depending on schools to provide them with learning resources packs.

RELAB is designed in a study guide format, where the content is briefly explained with related concepts as revision, in the form of e.g. notes, mind-maps, concept progression from the previous grade/s followed by exemplar exercises then practice exercises/problems . The exercises are pitched at different cognitive levels to expose learners at Grade 11 to these different cognitive demand levels of questioning. The NSC diagnostic reports in different subjects have revealed that learners fail to analyse questions and as a result fail to respond accordingly.

The RELAB is intended to ensure that learners work on exercises as per topics taught while at school. These exercises must be completed at home, fully and learners will receive feedback as groups or individually at school. It is therefore of paramount importance that teachers mark the work with learners in class, as a way of providing feedback. Educators must diagnose learner responses, remediate where necessary and plan further intervention.

Educators are encouraged to create WhatsApp groups to remind learners on what is expected of them in a particular week/ day(s). There shouldn't be a backlog on curriculum coverage as content will be covered simultaneously. Feedback from learners at home will confirm usage of the RELAB material.

RELAB further prepares learners for formal assessment.

Preparation for grade 12 final examinations starts already in grade 11. Grade 11 learners must work on a daily basis – whether they are at school or at home.

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Term 1

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WEEK 1: TOPIC: Biodiversity and classification of microorganisms

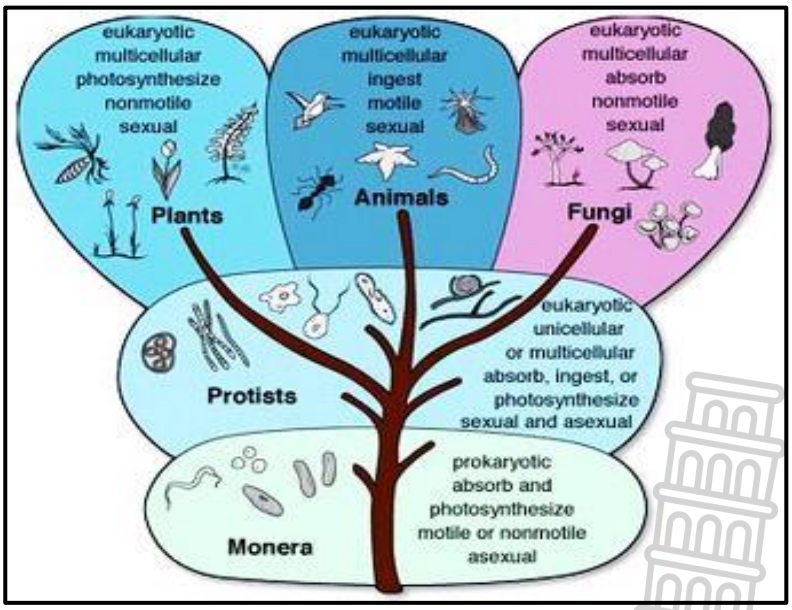
SUB-TOPIC: Basic structure of viruses, bacteria, Protista and fungi

NOTES & EXAM TIPS

Biodiversity in general, refers to the wide variety of plants, animals and microorganisms on Earth. Organisms which are too small to be seen with the naked eye are referred to as **micro-organisms**. Micro-organisms can be **unicellular** or **multicellular**. Some are harmful and cause diseases whilst others are very useful in the environment and to humans e.g. yeasts are used to make bread.

Classification of organisms

- Kingdom Monera – bacteria
- Kingdom Protista
- Kingdom Fungi
- Kingdom Plantae
- Kingdom Animalia



Biological terminology	
capsid	a protein coat surrounding the nucleic material of a virus
acellular	non-cellular
obligate parasite	obligate = forced; a parasitic organism that cannot complete its life-cycle without exploiting a suitable host (if an obligate parasite cannot obtain a host it will fail to reproduce)

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host	an organism that harbours a parasite
pathogenic	an organism that causes disease
bacteriophage	a type of virus that infects bacteria; the word "phage" means to eat"
nucleoid	an irregularly shaped region within the cell of a prokaryote that contains all or most of the genetic material
prokaryotic	an organism where the nuclear material is **not enclosed** in a membrane
eukaryotic	any single or multicellular group of organisms that have a **membrane-bound nucleus** containing genetic material
flagellum	a **whip-like**, protruding filaments that help cells or microorganisms move; plural of flagellum is flagella
saprophytic	plant or fungal microorganisms that feeds on dead or decaying issues of other organisms
plasmid	a plasmid is a small, circular, double-stranded DNA molecule that is distinct from a cell's chromosomal DNA
phytoplankton	very small plants (algae) that float on or near the surface of water
zooplankton	consisting of small animals and the immature stages of larger animals which float on or near the surface of the water
chitin	a fibrous substance consisting of polysaccharides, which is the major constituent in the exoskeleton of arthropods and the cell walls of fungi
hyphae	a network of multi-celled threadlike filaments forming the mycelium of a fungus
mycelium	a vegetative mass or network of fungal hyphae found in and on soil or organic substrates
multinucleate	cells that have more than one nucleus per cell, i.e., multiple nuclei shared in one common cytoplasm
rhizoids	threadlike structures that anchor lower plants and fungi to a surface
budding	a form of asexual reproduction which involves the pinching off of offspring from the parent cell; the offspring cell is genetically identical to the parent
Spore	a reproductive cell capable of developing into a new individual without fusion with another reproductive cell

1. Viruses

Viruses are placed in a separate group and not in a kingdom because they display some non-living as well as living characteristics.

- Viruses occur in many different shapes,
- they cannot respire, feed or excrete waste

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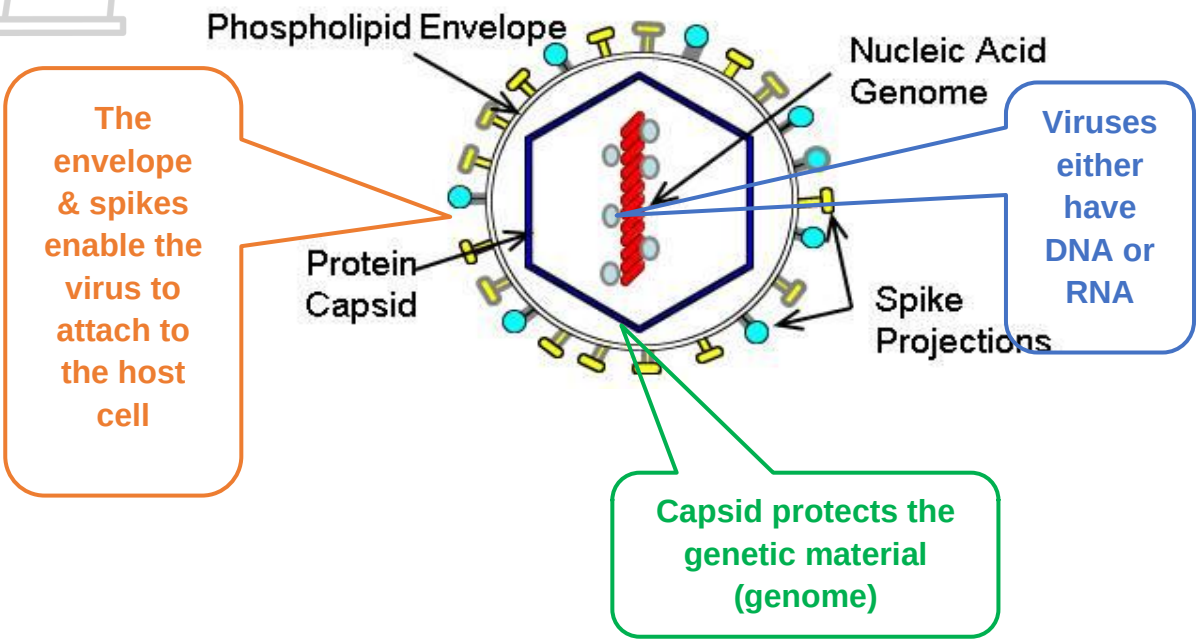
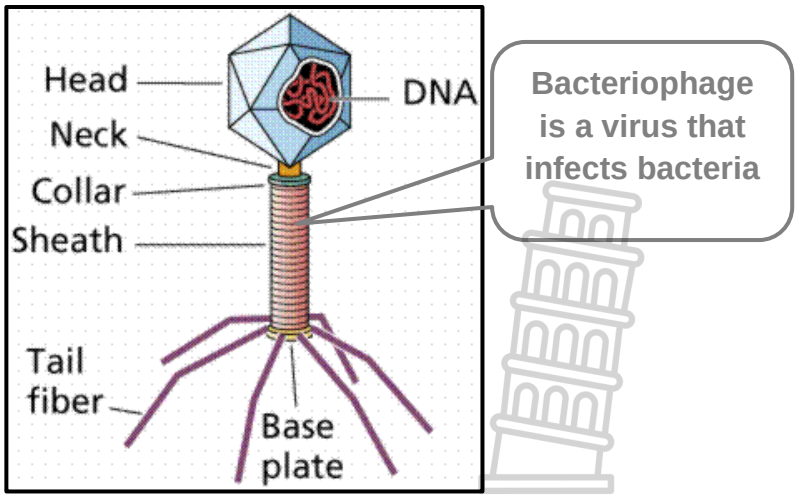
- They are acellular
- as they do not contain cytoplasm or membrane bound organelles
- If a virus cannot find a host, they can become dormant.

Introduction to viruses:
https://www.youtube.com/watch?v=8FqlTslU22s

Structure and characteristics of viruses





2. Bacteria

Bacteria belong to the Kingdom Monera. They are found everywhere on earth. Some are pathogenic and cause diseases such as tuberculosis, while most are useful.

Structure and characteristics of bacteria

- Bacteria are unicellular

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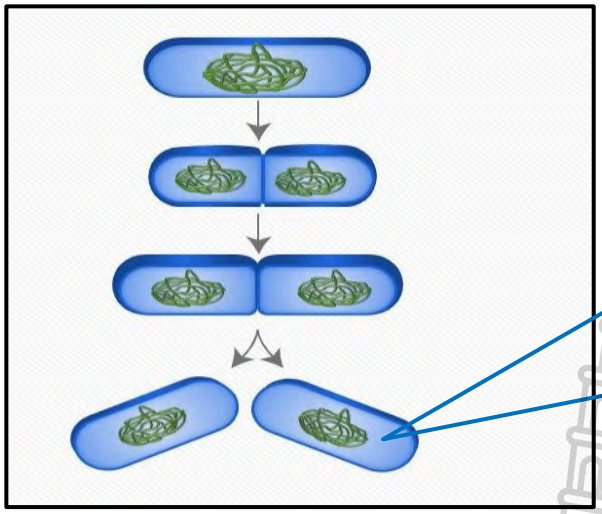
- They have no membrane around the nuclear material and therefor are said to be **prokaryotic**
- they occur in different shapes:

coccus – round	Coccus
bacillus – rod-shaped	Bacillus
spirillum – spiral-shaped	Spirillum
vibrio – comma-shaped	Vibrio

- Bacteria can be **autotrophic** or **heterotrophic**
    - **mutualistic, parasitic** or **saprophytic**
- Bacteria reproduce very rapidly by **binary fission**



The DNA replicates and then cytokinesis occurs forming two cells

Bacterial cell structure:
https://www.youtube.com/watch?v=4DYgGA9jdlE

Click on the link for a video clip

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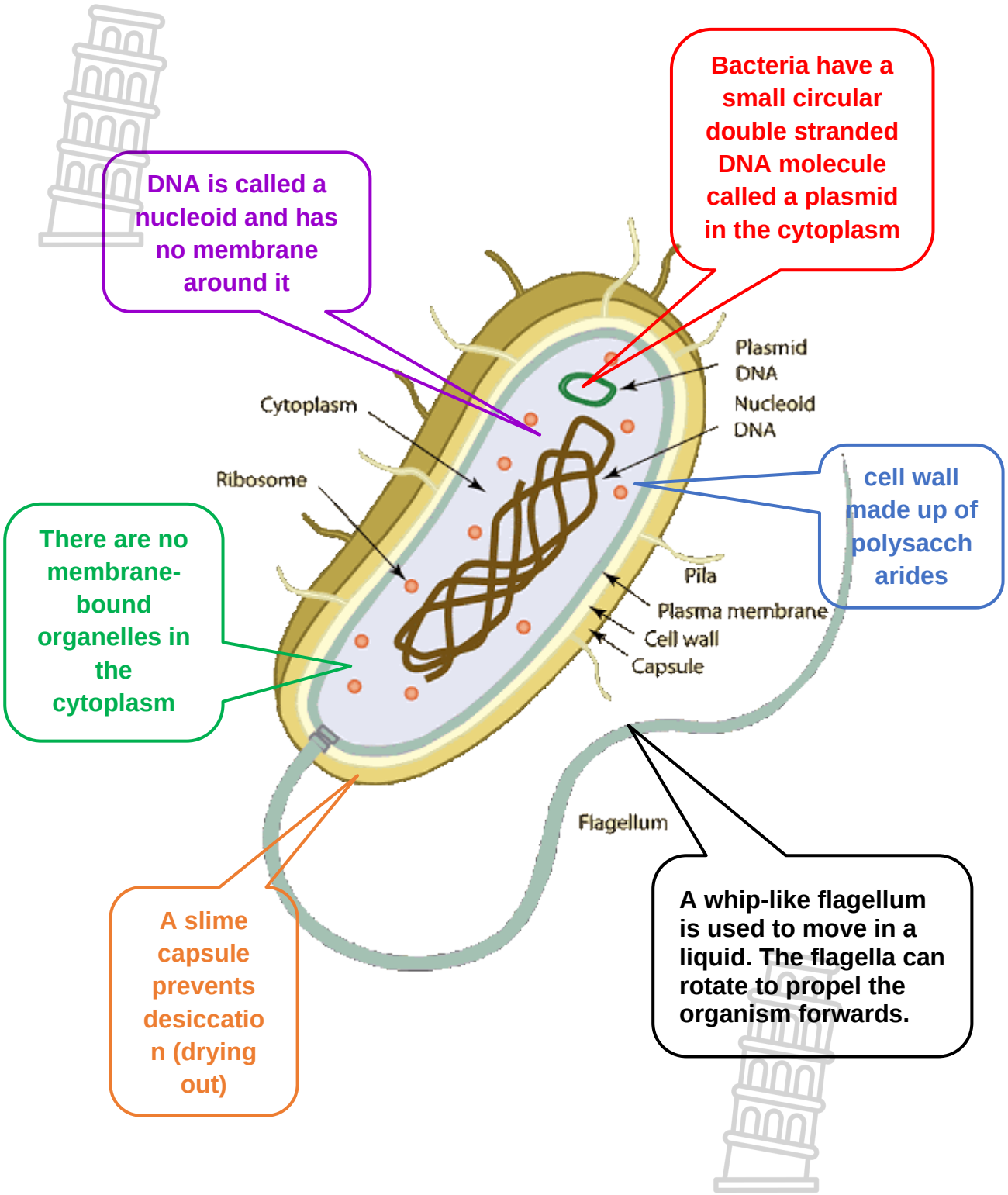

3. Protista

The **Kingdom Protista** is a collection of **eukaryotic** organisms.

Structure and characteristics of Protista

- Simple **unicellular** or **multicellular organisms**
- No tissue differentiation - **thallophytes**

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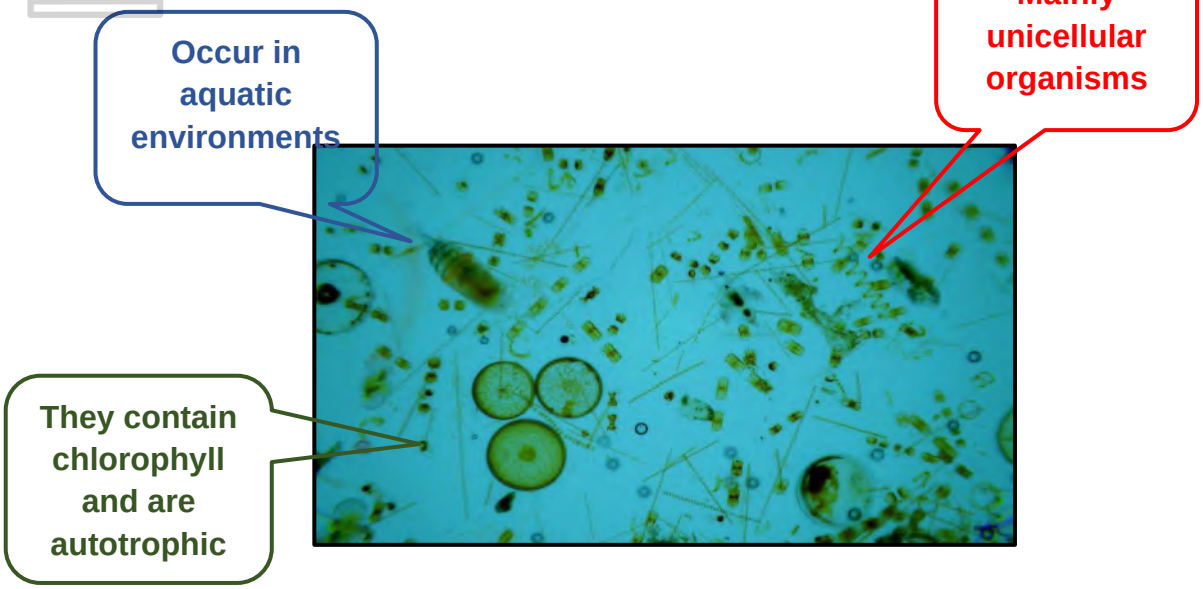
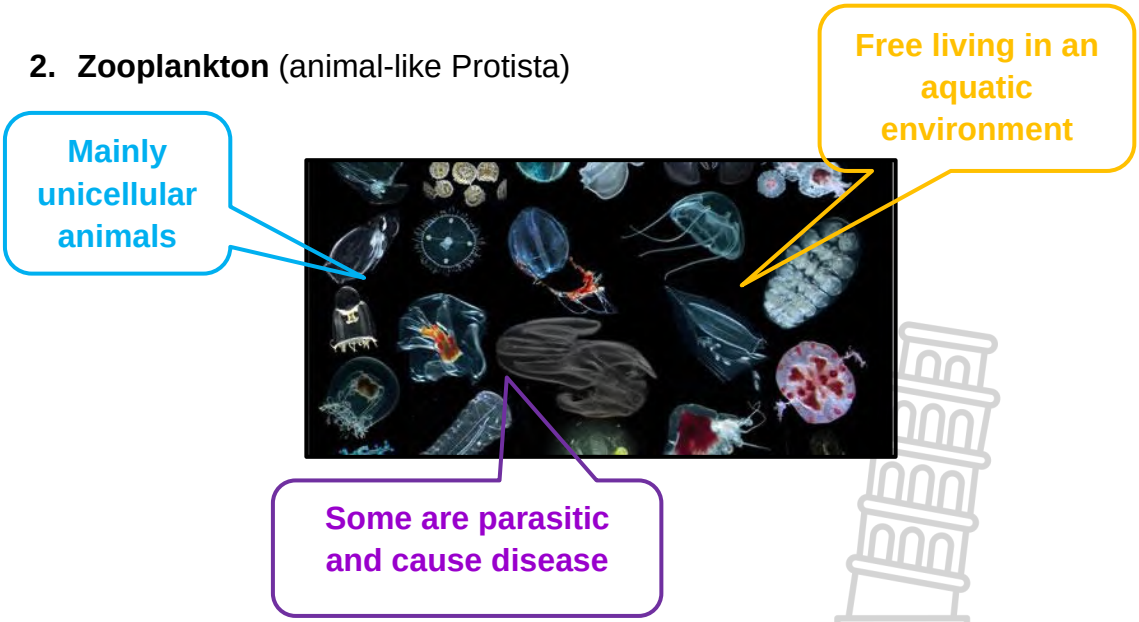
- Found mainly in water
- **autotrophic** or **heterotrophic**
- some are **sessile** (permanently attached to a substrate) or free-floating
- others can move using **flagella** or **pseudopodia** (false feet)
- they can reproduce both sexually and asexually

There are **three groups** of **Protista**

1. **Phytoplankton** (plant-like Protista)



2. **Zooplankton** (animal-like Protista)



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3. Algae

Contain photosynthetic pigment which gives them a green, red or brown colour

Either unicellular or multicellular

Algae produces up to 85% of the earth's oxygen

Multicellular macroscopic organisms called seaweed

Protista and fungi structure and characteristics:
https://www.youtube.com/watch?v=zK7Ckmxxqds

4. Fungi

The Kingdom Fungi includes **mould, yeast, mildew, rust, toadstools and mushrooms.**

Structure and characteristics of Fungi

- Fungi are **eukaryotic** organisms – they have a defined nucleus bound by a nuclear membrane
- They are **heterotrophic** as they lack chlorophyll
- Fungi are **saprophytic** - live off dead organic matter
- or **parasitic** – live off living organisms
- some are **pathogens**
- The bodies of multicellular fungi are made up of threads called **hyphae**.
- All the hyphae together form a **mycelium**.

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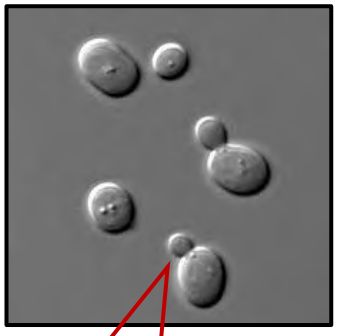
- The hyphae are often **multinucleate** (have many nuclei).

Multicellular fungi are made up of threads called hyphae

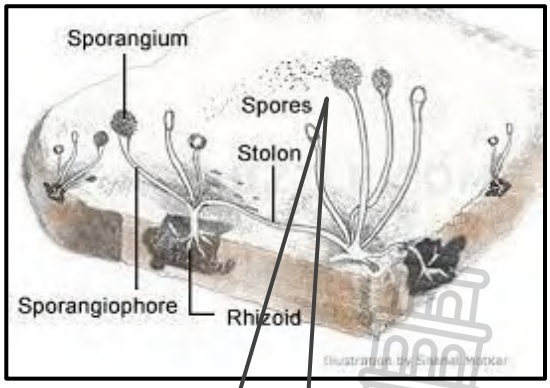
unlike plants, fungi cell walls contain chitin

Either unicellular or multicellular

- Fungi reproduce both sexually and asexually.



Asexual reproduction or budding in unicellular yeast



In multicellular fungi asexual reproduction is by means of spores

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.4) in your ANSWER BOOK, for example 1.5 D.

1.1 Which of the following is applicable to viruses?

A They are mutualistic
B They are the simplest known living organism
C They are parasitic
D They are capable of respiration

1.2 The cell walls of fungi are composed of …

A chitin.
B cellulose.
C pectin.
D lignin.

1.3 Which statement correctly describes fungi and protozoans?

A Fungi and protozoans are all unicellular
B Fungi and protozoans all have chloroplasts
C Fungi and protozoans are eukaryotic
D Fungi and protozoans all have cell walls

1.4 A bacterium cell…

A has a nuclear membrane around its genetic material.
B is a prokaryote.
C Is a eukaryote.
D Contains mitochondria, vacuoles and plastids in the cytoplasm

(4x2) **(8)**

QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 An organism that consists of a nucleic acid surrounded by a shield of protein

2.2 A type of asexual reproduction whereby unicellular organisms like bacteria reproduce

2.3 A mode of nutrition where an organism is incapable of synthesizing organ compounds from raw material, therefore depending on other organisms for food **(3)**

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QUESTION 3 *(Questions taken from various sources)*

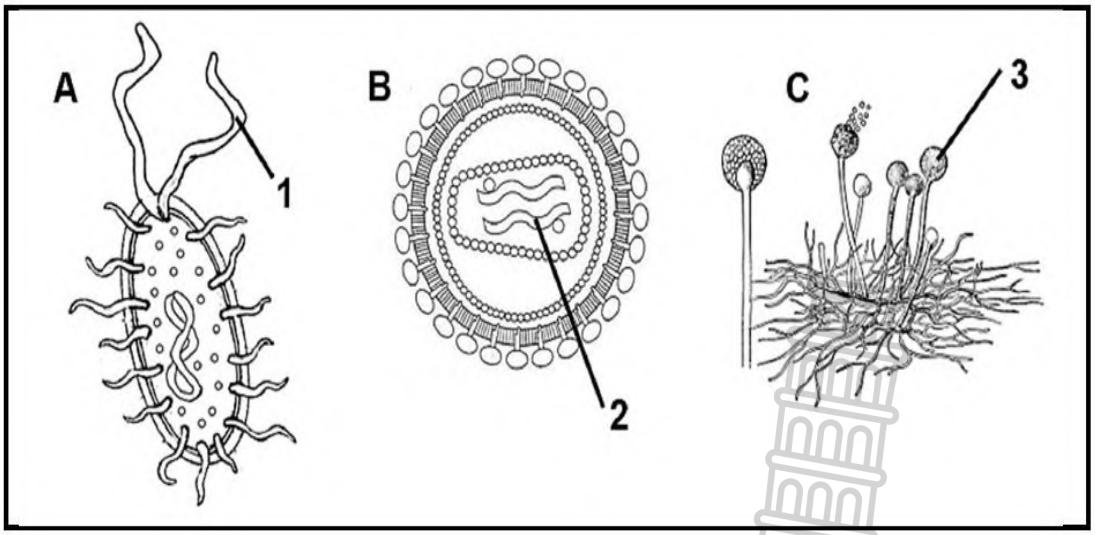
Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

	COLUMN I		COLUMN II
3.1	Comma-shaped bacteria	A B	Cocci Bacilli
3.2	Contains either DNA or RNA	A B	Bacteriophage Virus
3.3	Protective layer outside the cell wall	A B	Slime capsule Capsid

(3 x 2) **(6)**

QUESTION 4 *(EC P2 NOV 2019)*

4 Study the diagrams below of micro-organisms and answer the questions that follow.



4.1 Name the group of organisms to which **B** and **C** belong respectively. (2)

4.2 Provide labels for:
(a) **1**
(b) **2**
(c) **3** (3)

4.3 Give the LETTER of the organism that:
(a) Is not considered to be living (1)

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(b) Is eukaryotic (1)

4.4 Name the shape of the bacterium in Diagram **A**. (1)

(8)

QUESTION 5

Study the micrograph and answer the questions.

Micrograph of a wet mount preparation of *Rhizopus*.

5.1 Identify the parts labelled **A** – **E**. (5)

5.2 Use the scale line to calculate the length of the structure labelled **C**. (4)

(9)

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WEEK 2: TOPIC: Biodiversity and classification of microorganisms

SUB-TOPIC: Roles of viruses, bacteria, Protista and fungi in maintaining balance in the environment

NOTES & EXAM TIPS

MICRO-ORGANISMS AS PRODUCERS IN FOOD CHAINS

Autotrophic bacteria, phytoplankton and algae can manufacture their own food by photosynthesis. The carbohydrates they produce are available to consumers. These organisms form the first link in a food chain. Oxygen, the waste product of photosynthesis, is made available to other organisms for respiration.

1. The role of micro-organisms as decomposers

- Bacteria and fungi are the main decomposers.
- They break down dead plant and animal remains and return the nutrients to the soil.
- Organisms which break down dead organic matter to obtain nutrients are called saprophytes.

2. The role of bacteria in the nitrogen cycle

Bacteria play an important role in the nitrogen cycle.

- Free living bacteria can convert atmospheric nitrogen to ammonia and nitrates.
- Higher plants can only use nitrogen when it is in the form of nitrates, so they rely on bacteria for the conversion.
- Some plants form special relationships with nitrogen fixing bacteria.
- When plants and animals die, de-nitrifying bacteria return nitrogen to the atmosphere by a process called denitrification.

SYMBIOTIC RELATIONSHIPS

Symbiosis refers to the living together of two or more species of organism. A symbiotic relationship may benefit one or both members or it can be beneficial to one but harmful to the other one.

Three types of symbiosis occur:

- mutualism – both organisms benefit e.g. lichens
- commensalism – one species benefits whilst the other does not benefit, nor is it harmed
- parasitism – one species benefits whilst the other is harmed

1. **Relationship between nitrogen fixing bacteria and plants**

- Some nitrogen-fixing bacteria live in special nodules in the roots of legumes.
- They **produce nitrates** for the plant while the plant provides the bacterium with a **habitat**, **carbohydrates** and **water**.

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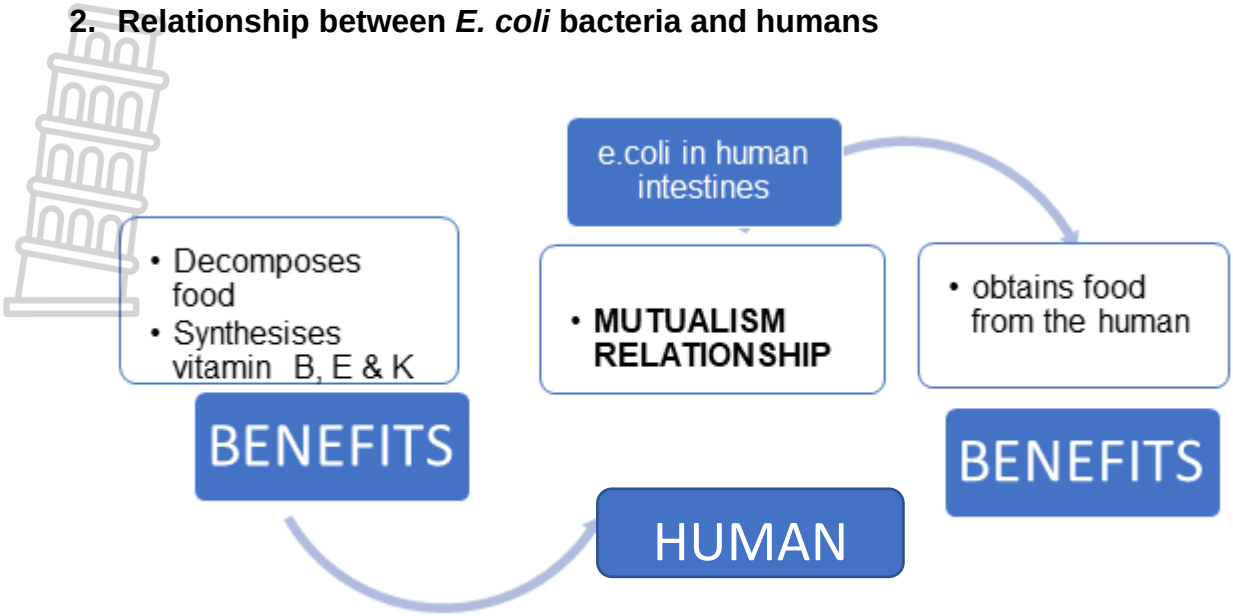
- Both the plant and the bacteria benefit in this relationship. (**mutualism**)

2. Relationship between *E. coli* bacteria and humans



ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1 *(Questions taken from various sources)*

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.3) in your ANSWER BOOK, for example 1.4 D.

1.1 Which of the following type of nutrition is a decomposer most likely to utilize?

A Ingestion
B Saprophytic
C Parasitic
D Autotrophic

1.2 De-nitrifying bacteria release nitrogen into the atmosphere through the process called…

A symbiosis.
B photosynthesis.
C nitrification.
D denitrification.

1.3 Which statement correctly describes fungi and algae?

A Fungi and algae live symbiotically as lichens
B Fungi and algae all have chloroplasts
C Fungi and algae are prokaryotic

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D Fungi and algae are heterotrophic

(3x2) **(6)**

QUESTION 2 *(Questions taken from various sources)*

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 Organisms which break down dead organic matter to obtain nutrients

2.2 Organisms that produce their own food by photosynthesis

2.3 A symbiotic relationship where one organism benefits while causing harm to their host **(3)**

QUESTION 3 *(Questions taken from various sources)*

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

	COLUMN I	COLUMN II
3.1	Can occur as saprotrophs, autotrophs or parasites	A: Fungi B: Bacteria
3.2	Algae and fungus living in a mutualistic relationship	A: Lichen B: Mycorrhizza
3.3	*E. coli* make vitamin K in the gut of humans	A: Commensalism B: Mutualism

(3 x 2) **(6)**

QUESTION 4

4.1 Name the form of nitrogen which higher plants use. (1)

4.2 Describe THREE ways in which nitrogen becomes available to higher plants. (3)

4.3 Briefly describe the ecological role of algae:

(a) as producers in ecosystems (3)

(b) in maintenance of oxygen-carbon dioxide balance (2)

(9)

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QUESTION 5

A type of bacterium called *Escherichia coli* (*E.coli*) normally lives in the large intestine of humans. To determine whether *E.coli* is present in water, a chemical indicator is used. If the chemical indicator changes from a clear red colour to a cloudy yellow colour, this indicates that *E.coli* is present.

In an investigation conducted by a group of Grade 11 learners, samples taken from three rivers (X, Y and Z) were investigated for the presence of *E.coli*. Samples were taken from each river and put into glass bottles, which contained the clear red indicator solution. The bottles were then incubated at 37°C for two days. Only river Y showed presence of *E.coli*.

5.1 Explain two safety precautions that the learners should take when conducting this investigation. (4)

5.2 Suggest one reason for incubating the sample at 37°C. (1)

5.3 State how *E.coli* could have entered river Y. (1)

(6)

WEEK 3: TOPIC: Biodiversity and classification of microorganisms

SUB-TOPICS: Diseases caused by viruses, bacteria, protista and fungi.
Immunity

NOTES & EXAM TIPS

EFFECTS AND MANAGEMENT OF DISEASES

Micro-organism	Disease	Effect	Management
Virus	Influenza	Fever, respiratory problems and muscle pains	Vaccination
Bacteria	Tuberculosis	Loss of appetite and weight, excessive coughing and sweating at night	Treatment of drugs for six months
Protista	Malaria	Headache, fever, joint pain, vomiting, convulsions and anaemia	Sleeping under mosquito nets. Insect repellents
Fungi	Ringworms	Itchy circular sores on the skin	Antifungal ointments Avoid sharing clothes

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IMMUNITY

There are two types of immunity:

- Natural immunity – it is present at birth
- Acquired immunity - develops after **exposure** to pathogens or after **vaccination/immunisation**

RESPONSE OF PLANTS AND ANIMALS AGAINST AN INFECTING MICRO-ORGANISM

Plants and animals use active and passive response for protection.

Plants use the following to prevent pathogens from entering **(Passive response):**

- Thick buck of woody plants.
- Closely packed epidermal cells
- Waxy cuticle keeps out micro-organisms
- Chemical secretions of some plants are poisonous to many organisms

Plants use the following to fight the pathogens when infected **(Active response)**

- Releases chemical compounds such as **salicylic acid**
- Unaffected cells respond by producing various chemical defences to protect themselves.

Animals use the following to prevent pathogens from entering **(Passive response):**

- A multi-layered skin
- Antiseptic tears
- Mucus lined air passages which trap pathogens
- Enzymes (lysozyme) in the saliva
- Ear wax in the ear canal
- Hydrochloric acid and enzymes in the stomach

Animals use the following to fight the pathogens when infected **(Active response)**

- White blood corpuscles in our blood produce antibodies (which are specific in function) to fight diseases.
- Inflammation (swelling and redness) of infected areas.

THE USE OF MICRO-ORGANISMS IN MEDICINE PRODUCTION.

VACCINATION

- Vaccinations or **immunisation** is the process of giving a **vaccine** either by **injection** or **orally** (by mouth) to prevent disease.
- The antibodies stay in the blood and give long lasting protection against disease. e.g. vaccination of corona Virus to prevent COVID-19

BIOTECNOLOGY

It is the use of **micro-organisms** to make products which are useful to humans. These include **medicines** such as **antibiotics** and **insulin** and foods such as **maas** (fermented milk), **bread**, **wine/beer** and **cheese**.

THE USE OF DRUGS TO FIGHT INFECTING MICRO-ORGANISMS

Antibiotics - are drugs that fight infections caused by bacteria.

- cannot fight infections caused by viruses.
- Example of antibiotic is penicillin which is produced from **fungus** called ***Penicillium***

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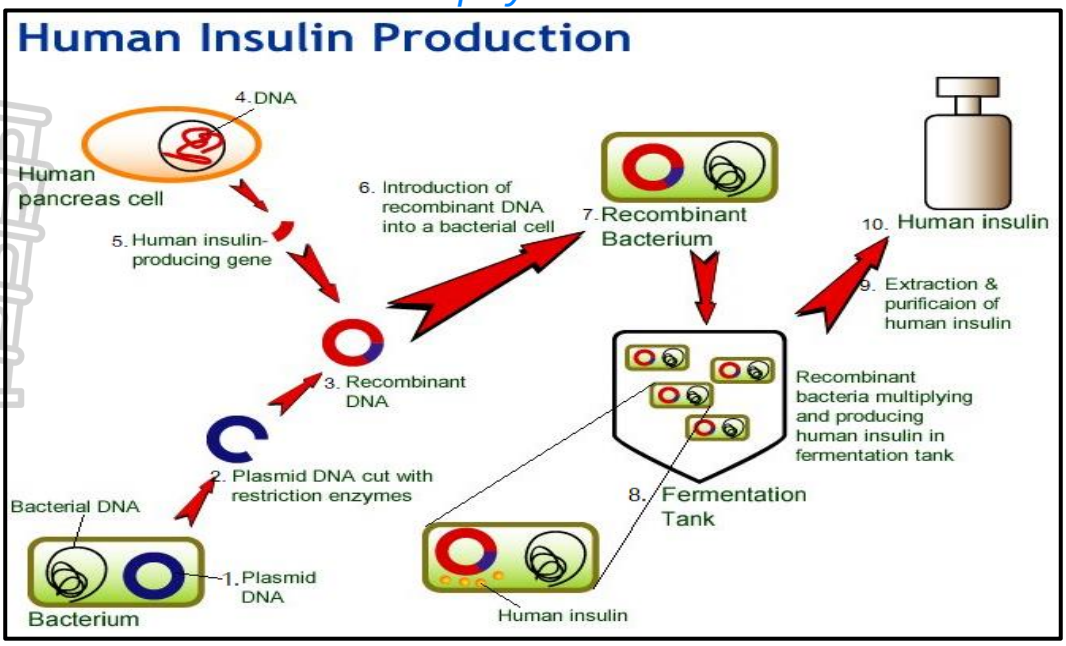

TRADITIONAL TECHNOLOGY

Micro-organisms such as yeast (fungus) can undergo alcoholic fermentation
During this process glucose is changed into ethyl alcohol, carbon dioxide and energy.

- **Beer** – Beer is made from maize, sorghum, millet, barley or rice and hops.
- **Wine** –Yeasts found on the skins of grape ferment the grape sugar after the grapes are crushed.
- **Bread** – Yeasts are used to make bread dough rise.
- **Cheese** – *Lactobacillus* bacteria can be used to convert milk sugar called lactose into lactic acid.
  - Lactic acid curdles the milk and forms a solid mass known as curds.
  - Curds are pressed and separated from the watery whey to make cheese.
- **Maas** – It is like yoghurt and is made by bacterial fermentation of milk.
  -Lactic acid thickens the milk and acts as a preservative.

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

ACTIVITY 1
QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.3) in your ANSWER BOOK, for example 1.4 D.

1.1 Viruses are mainly composed of …
- A protein and nucleic acid.
- B DNA and RNA.
- C cytoplasm and nuclei.
- D cellulose and protein.

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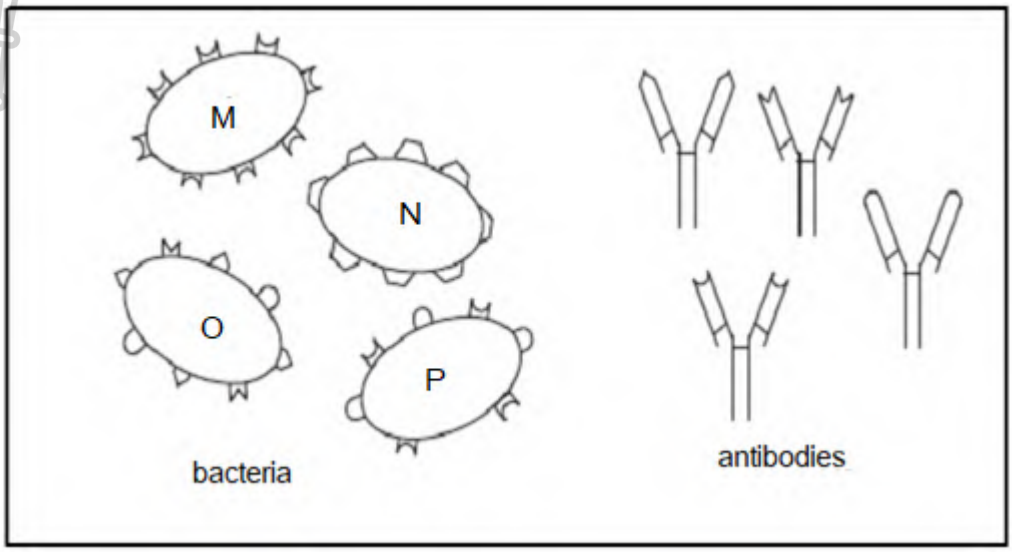
1.2 A young woman stepped on a dirty, rusty nail. The following diagrams show bacteria isolated from the wound and a range of antibodies that were already present in her body. The antibodies have a specific shape that binds with the antigen found on the surface of the bacteria.



Which type of bacterium will most likely cause a severe infection?

A M
B N
C O
D P

1.3 Antibodies are proteins that . . .

A break down pathogens.
B catalyse biochemical reactions.
C are produced by T-cells that kill disease carrying viruses.
D bind with specific antigens. **(**3x2) **(6)**

QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 A relationship between two organisms which live together for the benefit of one or both organisms.
2.2 The ability to produce antibodies. **(3)**
2.3 The use of micro-organisms to make useful substances.

QUESTION 3 *(Questions taken from various sources)*

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	Microbes which cause disease.	A B	Pathogens Vector
3.2	Malaria is caused by a…	A B	Bacteria Fungi

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3.3	The process used by lymphocytes to engulf bacteria.	A B	Phagocytosis Vaccination

(3 x 2) **(6)**

ACTIVITY 2
QUESTION 1

The table below shows the number of cases of TB and the number of deaths from TB around the world in 2009. Use the information in the table to answer the questions that follow.

REGION	NUMBER OF CASES OF TB (in 1000s)	NUMBER OF DEATHS FROM TB (in 1000s)
Africa	3 900	430
The Americas	350	20
Eastern Mediterranean	1 000	99
Europe	560	62
South-East Asia	4 900	480
Western Pacific	2 900	240

1.1 State the total number of deaths from TB in Africa. (1)

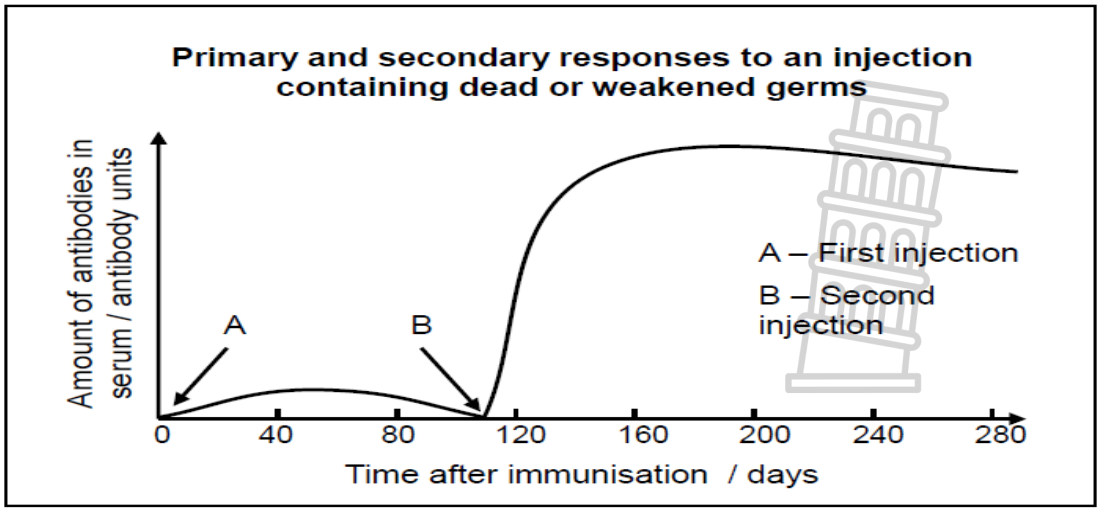
1.2 Calculate the percentage of deaths from TB compared to the number of cases of TB in Africa. Show your working. (3)

1.3 Draw a bar graph to show the number of deaths from TB for the following four regions: Africa, Eastern Mediterranean, South-East, Asia and Western Pacific. (6)

(10)

QUESTION 2

The graph below gives the body's response to a vaccination given by an injection and a booster injection. Answer the questions that follow.



2.1 What happened to the antibody level after the first injection? (2)

2.2 What would happen to the person if infected after the second injection? (2)

2.3 Mention two common ways of receiving vaccines. (2)

2.4 Which cells in the immune system produce the antibodies? (1)

(7)

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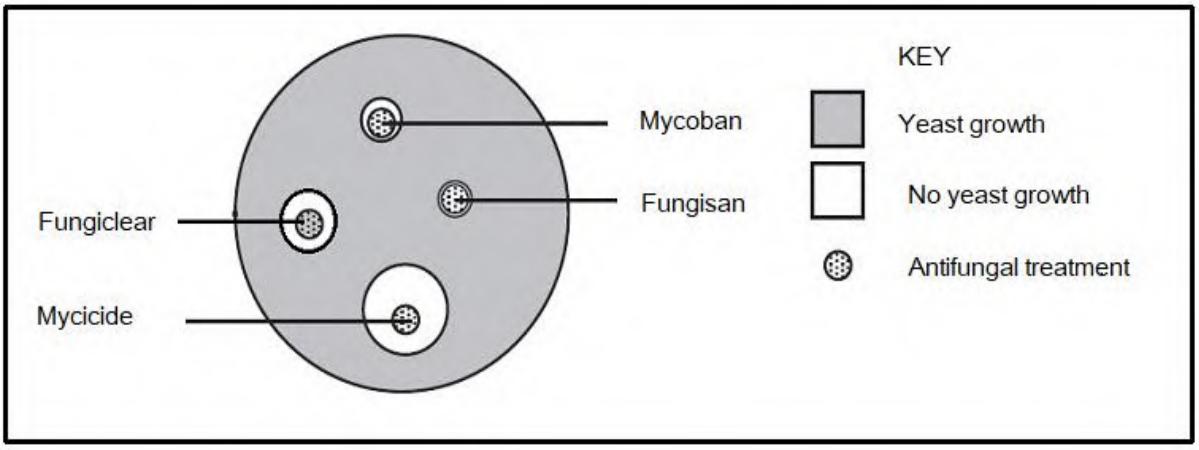
ACTIVITY 3

QUESTION 1

An investigation was carried out to test the effectiveness of four antifungal treatments (Fungiclear, Mycocide, Mycoban, and Fungisan) on preventing the growth of yeast in humans.

The petri dish with the treatments and yeast culture used in the investigation was placed in an incubator at 37^0 C.
The results are shown in the diagram below.



1.1 State the:
(a) Dependent variable (1)
(b) Independent variable (1)

1.2 Explain why the investigator put the petri dish in an incubator at 37^0 C. (2)

1.3 State any TWO factors that the investigator had to control in order for the investigation to be valid. (2)

1.4 State TWO ways in which the investigator could have increased the reliability of the investigation. (2)

1.5 Arrange the anti-fungal treatments in the order from MOST effective in preventing the growth of yeast to the LEAST effective in preventing the growth of yeast. (2)

(10)

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WEEK 4: TOPIC: Biodiversity of plants

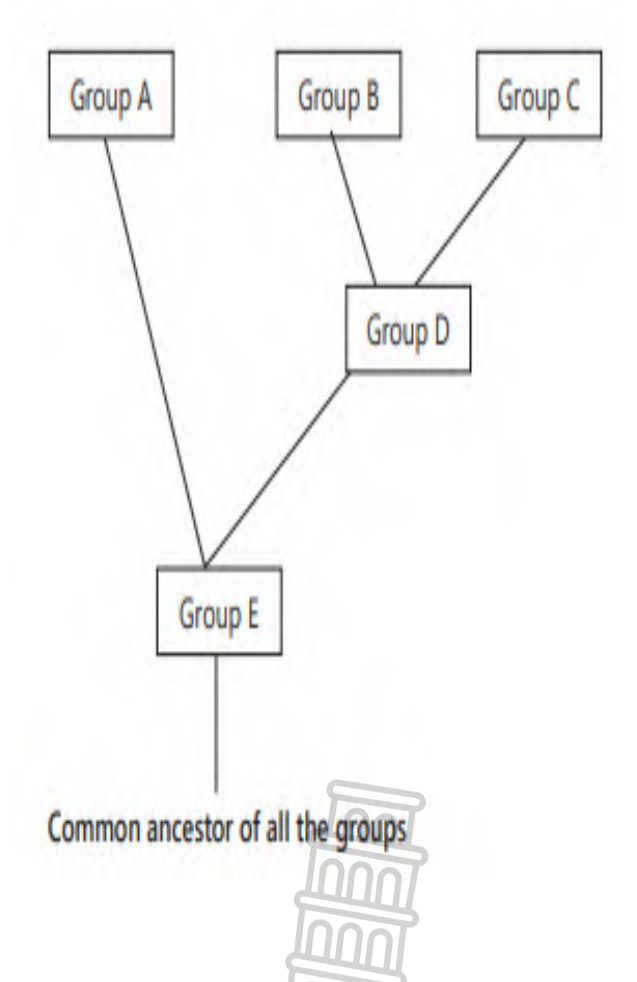
SUB-TOPIC: BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS & ANGIOSPERMS

NOTES & EXAM TIPS

Evolution of the plant groups

Evolution is a gradual process that causes changes in the characteristics in a population across many successive generations. To understand the evolutionary relationship of plants refer to the simplified phylogenetic tree alongside. A phylogenetic tree is a branching diagram that shows the evolutionary relationships between organisms. The organisms that appeared first (ancestors) are found at the base of the 'trunk' of this tree. Refer to the diagram alongside. The lines of the phylogenetic tree show the lines of descent:

- Group A, B and C all descended from the common ancestor E.
- Group E gave rise to groups A and D.
- Group D gave rise to groups B and C.
- Group B and C are closely related.
- Group A and Group B are not as closely related as Group B and C



Currently there are different plant species on earth, which are said to have emerged from a simple unicellular algae. These plants have been classified into four plant groups namely:

1. Bryophytes- mosses, liverworts, and hornworts
2. Pteridophytes-ferns
3. Gymnosperms- conifers, cycads, ginkgo biloba and pine tree
4. Angiosperms- flowering plants

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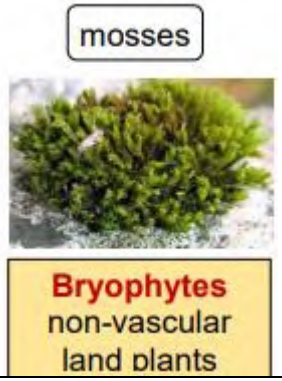
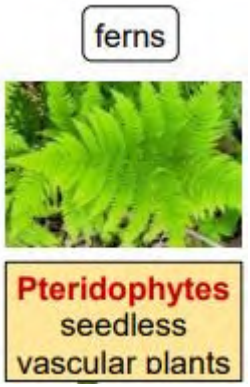
Plant group	Example	Diagram	Structure of dominant generation	Vascular tissue	Spores / seeds	Fruit bearing	Dependency on water for reproduction
BRYOPHYTES	Mosses, liverworts & hornworts		1. Thallus plant: no true roots, stems or leaves 2. Gametophyte is dominant 3. Leave-like structures, stem-like structures and rhizoid	No xylem and phloem tissues	Sperm cells and egg cells in male and female reproductive organs. Spores: spread through wind No seeds	Do not bear fruit	Needs water for reproduction
PTERIDOPHYTES	Ferns		1. True leaves, roots and stem 2. Sporophyte is dominant 3. Gametophyte: Prothallus 4. Roots: adventitious roots 5. Leaves: monocot Leaves (sessal leaves) & dicot leaves (attached to petiole)	Possess xylem and phloem	Sperm cells and egg cells on prothallus No seeds	Do not bear fruit	Needs water for reproduction

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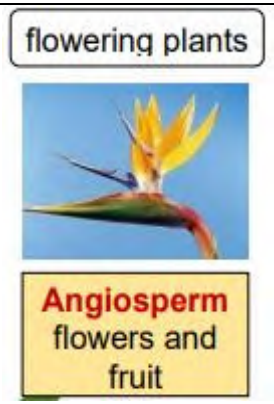
Plant group	Example	Diagram	Structure of dominant generation	Vascular tissue	Spores / seeds	Fruit bearing	Dependency on water for reproduction
GYMNOSPERM	Conifers, cycads, ginkgo biloba and pine tree		1. True roots, stem and leaves 2. Sporophyte dominant 3. Leaves: needle shaped 4. Male cone: In groups, smaller, carries pollen grains 5. Female cones: Larger cones, carries ovary 6. Stem: woody	Possess xylem and phloem	1. Produce spores 2. Produce seeds 3. Naked seeds	Do not bear fruit	Does not need water for reproduction Seeds are spread through wind
ANGIOSPERMS	Flowering plants		1. True roots, stem and leaves 2. Sporophyte dominant	Possess xylem and phloem	1. Male and female spores 2. Produces seeds 3. Seeds within fruit	Bear fruit	Does not need water for reproduction Seeds are spread through wind, water, insects and other animals

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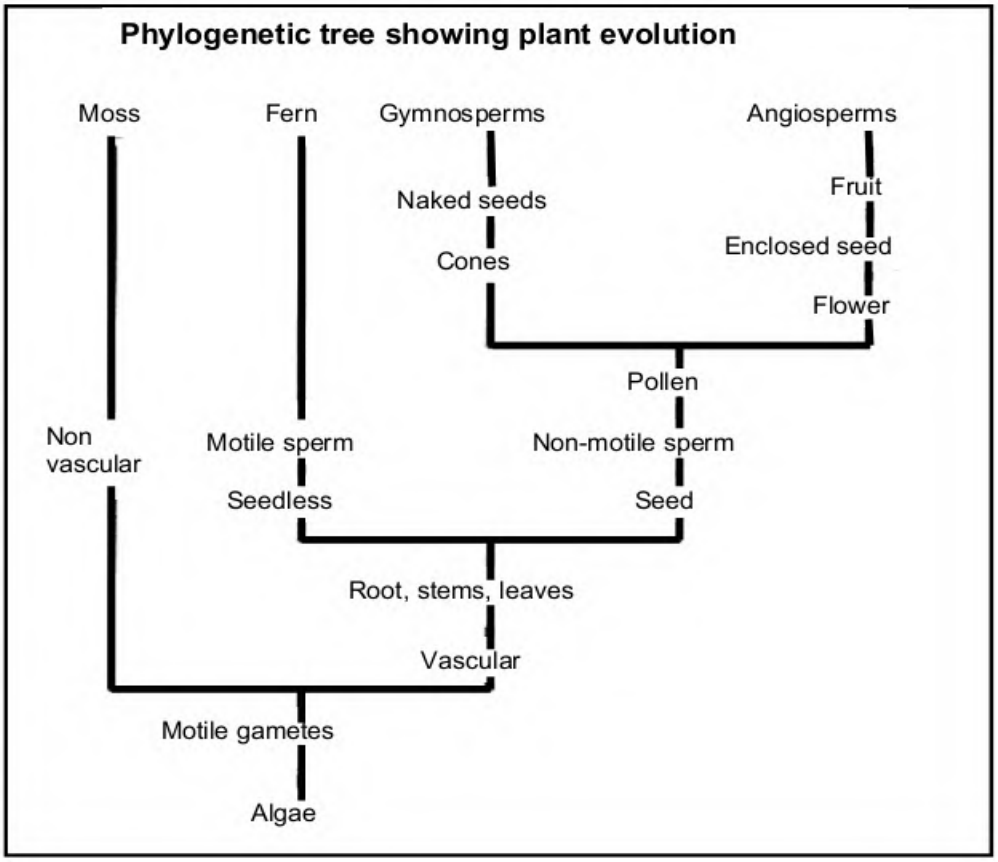
ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Study the phylogenetic tree below which shows how the four plant groups have evolved.



1.1 What is the ancestral/oldest form of all the plant groups shown? (1)

1.2 Give:
(a) TWO plants which depend on water for reproduction. (2)
(b) The plant group which is the best adapted to life on land. (1)
(c) TWO plant groups which are the most closely related. (2)

1.3 Describe how vascular tissue of gymnosperms enable them to survive on land. (2)
(8)

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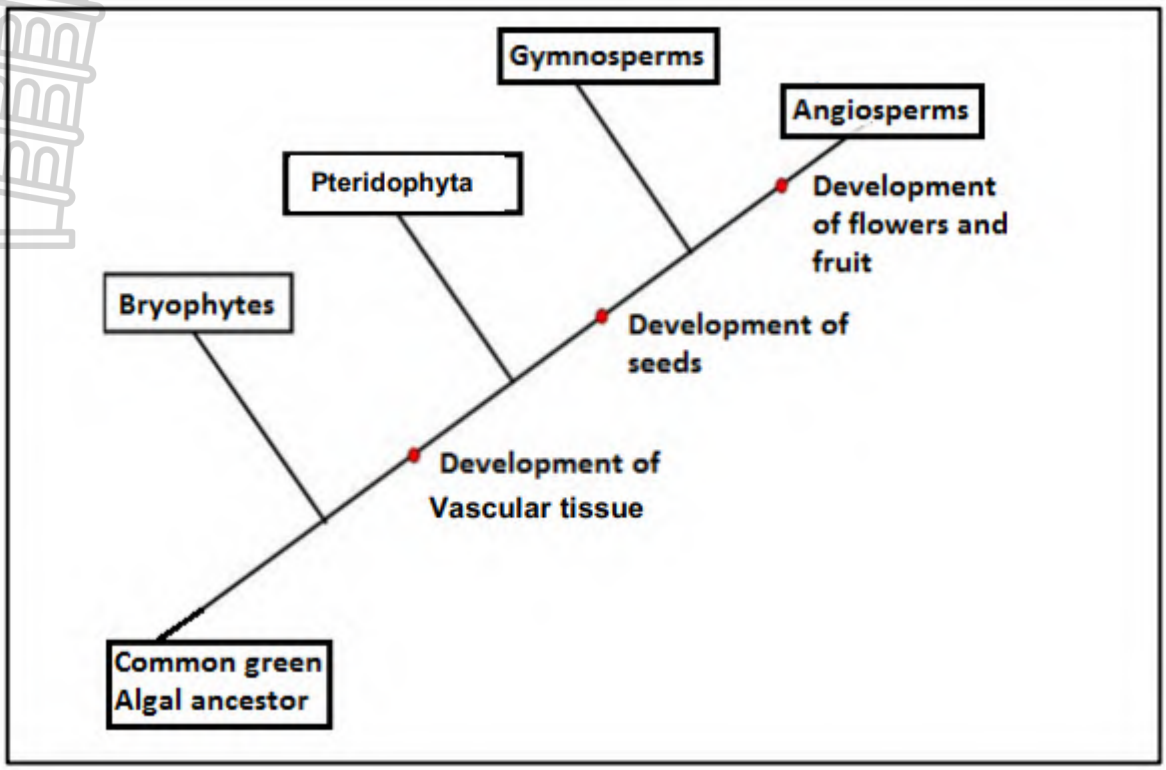
QUESTION 2

The diagram below shows the relationships between the plant groups studied.



2.1 Give a name for this type of diagram. (1)

2.2 Which terrestrial plant group is least suited to life on land? (1)

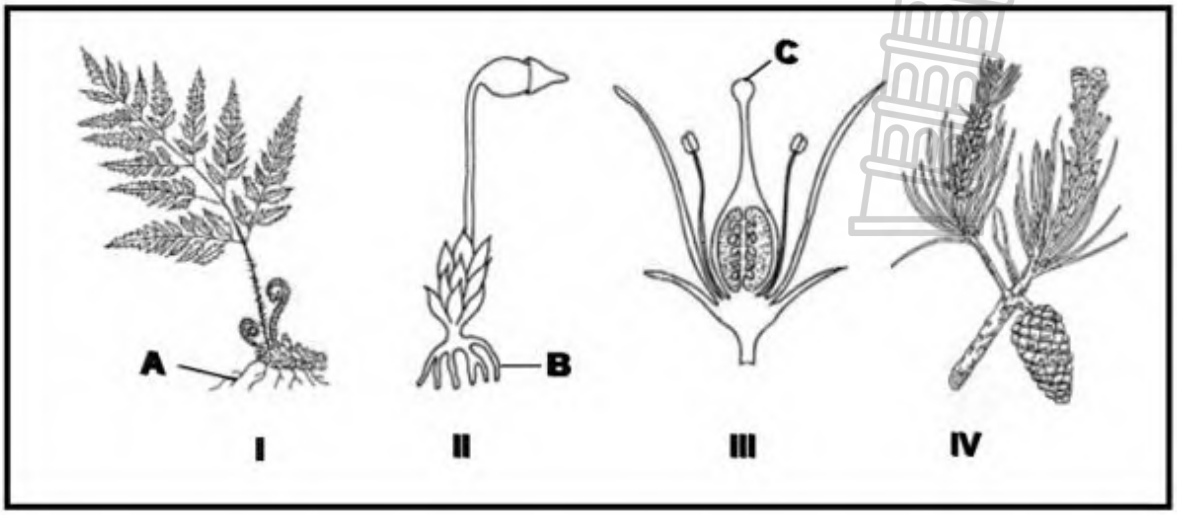
2.3 The Gymnosperms are more advanced than the Bryophytes. State TWO pieces of information from the diagram that support this statement. (2)

2.4 What feature do all four plant groups have in common with their algal ancestor? (1)

(5)

QUESTION 3

Study the diagrams below and answer the following questions.



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3.1 Label structure **A**, **B** and **C** respectively (3)

3.2 Tabulate TWO differences between plant **I** and **IV** with relation to reproduction. (4)

3.3 State only the numbers of the plant groups which:

a) has no vascular tissues (1)

b) bears fruit (1)

c) produces seeds (2)

(11)

WEEK 5: TOPIC: Biodiversity of plants

SUB-TOPIC: Asexual and sexual reproduction

NOTES & EXAM TIPS

Asexual Reproduction occurs when there is only one parent that gives rise to an offspring which has the identical genetic makeup of the parent. It occurs in most single celled organisms such as bacteria and some multicellular organisms such as fungi and some plants.

Sexual Reproduction involves the combining of genetic information from two parents to produce a new organism that is a combination of both parents. It occurs in most complex organisms.

	Sexual Reproduction	Asexual Reproduction
Advantages	• High Genetic Variability • Facilitates adaptation • "Speeds" up evolution	• Saves energy • Courtship is a non-issue • Greatest increase in fitness for each individual
Disadvantages	• Energy Costly • Courtship is time/resource consuming • Usually sacrifices the fitness of one sex to the other.	• Low Genetic Variability • Adaptation to environment is difficult • "Retards" evolution

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.5) in your ANSWER BOOK.

1.1. Provided is a table of organisms and some data on their characteristics. Based on the information in the table, which organism is likely to produce offspring with the greatest genetic diversity?

Organism	Kingdom	Mode of reproduction
Bell tree dahlia	Fungi	Asexual
Bell tree dahlia	Plantae	Asexual
Spruce	Plantae	Sexual
Hydra	Animalia	Asexual

A Black mold
B Bell tree dahlia
C Spruce
D Hydra

1.2 A plant that grows a new plant from a piece of the stem has which type of reproduction?

A Nonsexual
B Sexual
C Unisexual
D Asexual

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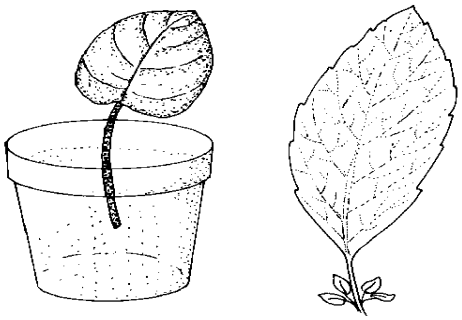
1.3 A piece of a geranium plant is cut and placed it in a jar of water in the window. Several weeks later the piece has grown into a new plant. Which of the following is true about the genetic relationship between the first plant and the new one?



A The two plants are different genetically.
B The two plants are slightly different genetically.
C The two plants are genetically identical.
D There is no way to know the genetic relationship.

1.4 One of the key advantages of asexual reproduction is…

A offspring compete for food and space
B large numbers of offspring reproduce quickly
C extreme temperatures can wipe out entire colonies
D offspring are genetic clones

1.5 A gardener noticed that the offspring of his strawberry plants looked identical, while all the flowering plants looked different. Which is likely true of the plants?

A The strawberries reproduced asexually, while the flowering plants reproduced sexually.
B The strawberries reproduced sexually, while the flowering plants reproduced asexually.
C Both the strawberries and flowering plants reproduced sexually.
D Both the strawberries and flowering plants reproduced asexually

(10)

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QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.4) in your ANSWER BOOK.

2.1 A type of reproduction that does not involve the fusion of male and female gametes.
2.2 The non-reproductive parts of a plant.
2.3 Cell that forms when a sperm fertilizes an egg.
2.4 New organism that results from reproduction. **(4)**

QUESTION 3

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	Passes genetic information onto future generations	A B	Sexual reproduction Asexual reproduction
3.2	This type of reproduction occurs by breaking off.	A B	Budding Binary fission
3.3	Biological name for egg and sperm cells	A B	Zygote Gametes

(3 x 2) **(6)**

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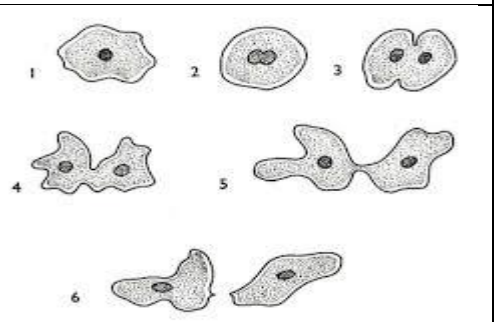
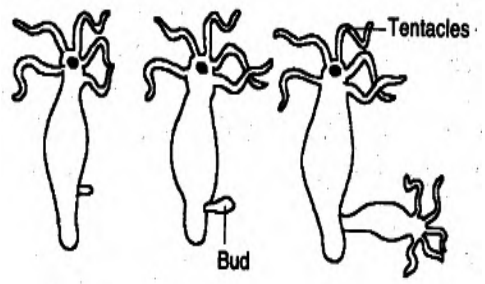
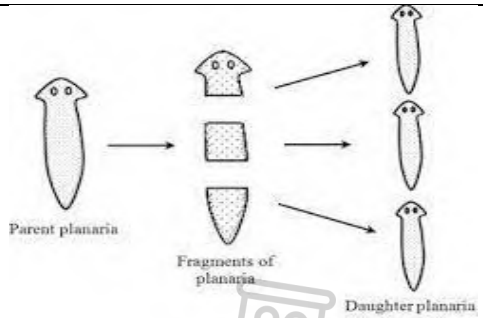
QUESTION 4

Complete the following chart below to answer the questions.

Name	Type of Reproduction (Asexual or Sexual)	What happens?	Example/Drawing
Binary Fission			
Budding			
Fragmentation			

(9)

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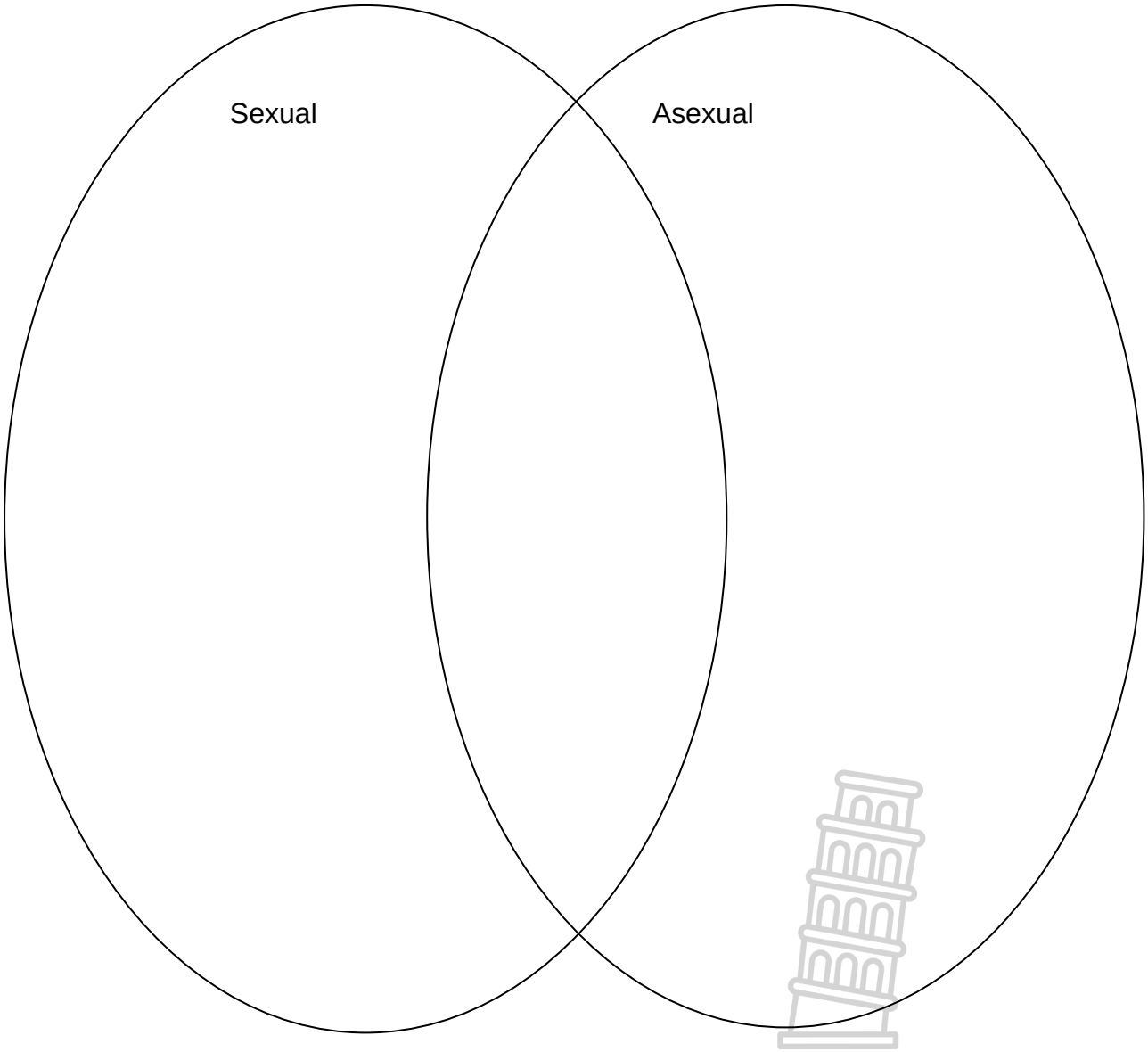
QUESTION 5

Fill in the Venn Diagram with similarities and differences between sexual and asexual reproduction. You should have at least two characteristics in each circle and in the space they overlap.

Reproduction



(6)

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QUESTION 6

6.1 Name and explain:

a) ONE advantage and
b) ONE disadvantage of sexual reproduction (6)

6.2 Name and explain:
a) ONE advantage and
b) ONE disadvantage of asexual reproduction (6)
(12)

WEEK 6: TOPIC: Biodiversity of plants

SUB-TOPIC: Flowers as reproductive structures

NOTES & EXAM TIPS

Reproduction in all biotic factors must occur to ensure that the species survive. Flowers undergoes sexual reproduction. Flowers have the following functions: to contain and protect the reproductive organs and to attract pollinators.

Key terminology

pollination	the transfer of pollen grains from the anther to the stigma of the flower
cross pollination	pollination occurs between different plants of the same species
self pollination	pollination occurs within flowers of the same plant
corolla	all the petals of a flower together form the corolla
calyx	formed by the green structures around the petals(petals) together, serves to protect the flower and its reproductive organs
receptacle	the thickened part of the stem from which the flower organs grow
perianth	the non- reproductive part of the flower, the calyx and corolla that form a protective envelope surrounding the sexual organs

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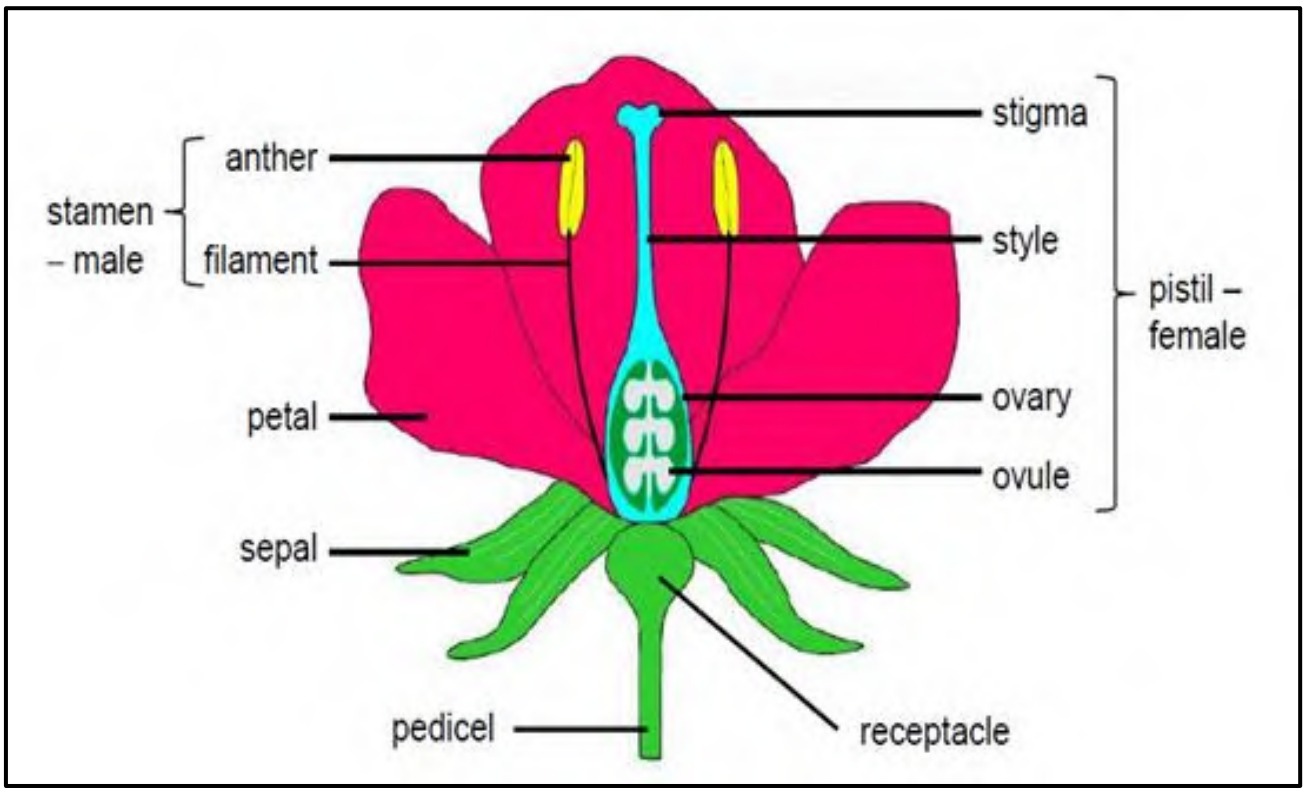
stamen	male part of the flower consisting of a filament and pollen and pollen producing anthers
pistil	female part of the flower consisting of a stigma, style and an ovary where ovules are produced
fruit	a fleshy, often sweet layer, formed around the seed in angiosperms following fertilization

In a typical plant, the outermost whorl is called the **calyx** and consists of a number of green sepals. All the floral parts are attached to a **receptacle.** The corolla is made up of coloured petals to attract pollinators. The calyx and corolla are collectively known as **perianth.**



A longitudinal section through a typical dicotyledonous flower

The stamens are the male part of the flower. Each stamen consists of a filament and a bi-lobed anther with four pollen sacs or microsporangia. Pollen (microspores) are haploid and produced by **meiosis**. The female parts of the flower usually consist of carpels fused together to form one or more pistils. Each pistil consists of a stigma, style and ovary. Ovules are formed inside by meiosis. When pollen grain lands on the stigma it germinates by growing down the style towards the ovule carrying the male gametes to fertilize the ovule. The fertilized ovule forms a seed, and the ovary wall thickens to become a fruit. In general fruit do not develop without fertilization.

Pollination

Pollination can be defined as the transfer of pollen from an anther to the stigma of the same or the stigma of a different flower of the same species. Self-pollination occurs when pollen is transferred between flowers of the plant or the anther and the stigma of the same flower.

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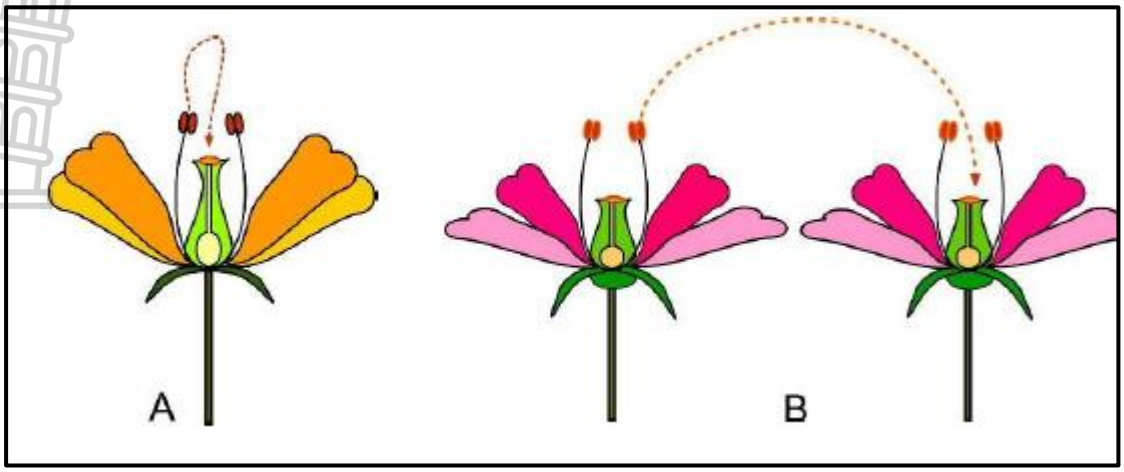
Most plants are adapted to prevent self-pollination for example, the pollen may ripen before the stigma. The pollen will then be dispersed before the stigma is mature. In other flowers, the stigma is mature before the anther mature and receive pollen from other plants of the same species. Some flowers are adapted to be incompatible with their own pollen.



Types of pollination: (A) Self-pollination (B) Cross-pollination

Cross- pollination occurs when pollen is transferred from the flower of one plant to the flower of another plant of the same species. Cross-pollination is important because it creates genetic diversity. This means that the offspring are genetically important to the parent. Genetic diversity ensures that a species has a better chance of surviving unfavourable conditions.

Pollination is vital for the production of fruit crops (e.g. apples and pears) and seed crops (e.g. maize, legumes, wheat).

Plants rely on wind, water or pollinators such as insects and birds, to transfer pollen from one flower to another.

Adaptations for pollination through insects

Flowers show a varietyof adaptations to ensure that pollination takes place.

Insects such as butterflies, bees and moths visit flowers for pollen and nectar which they use as food. When these insects visit the flowers, the pollen becomes attached to their bodies and this transferred to the stigma of the next flower they visit.

Flowers that are pollinated by insects have the following **characteristics**

- Flowers are brightly coloured. Butterflies are attracted by all brightly- coloured flowers, bees by blue, purple and red flowers and moths by white and yellow flowers.
- The flowers are usually large. In some cases, the individual flowers are small, they are grouped together to make them more visible e.g. sunflowers.
- Some flowers give off pleasant smells to attract insects such as bees, butterflies and months; others give unpleasant smell to attract insects such as flies.
- Some flowers such as Iris have hairs or special markings which lead the insects to the nectaries which produce the nectar.

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- The pollen grains are sticky or rough so that they can become attached to the insects.
- Sweet scent to attract moths and butterflies.

Wind Pollinated flowers

Examples of wind-pollinated flowers are maize, grasses, poplar and oak tree. Their flowers are adapted for wind -pollination in the following ways:

- The flowers are usually small, green, with reduced scent and nectar
- They produce a large amount of pollen to increase the chances of pollination since most of the pollen does not find its 'target'(the stigma of another flower of the same species)
- Filaments of the stamens are long and thin so that they can sway in the wind.
- The anthers are attached to their filaments in such a way that they are easily moveable
- The stigma is large and sticky to trap as pollen as possible

Birds pollinated flowers

Aloes and Strelitzia (the wild banana plant, also known as the bird of paradise) are examples of bird-pollinated flowers usually have:

- Long tube-shaped flowers
- Bright red and yellow flowers
- Produce large quantities of dilute nectar
- Stamens and stigmas protrude beyond the petals
- Open during the day
- Little or no scent because birds have a poor sense of smell

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

1.1 Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1.1 to 1.1.5) in your ANSWER BOOK, for example 1.1.6 D.

1.1.1 The part of the flower which becomes the fruit:

A. Petals
B. Ovary
C. Ovule
D. Anther

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1.1.2 Select the incorrect statement:

A. The stamen is made up of the anther and filament
B. The ovules become the seed
C. The petals are not always brightly coloured
D. The ovary becomes the fruit

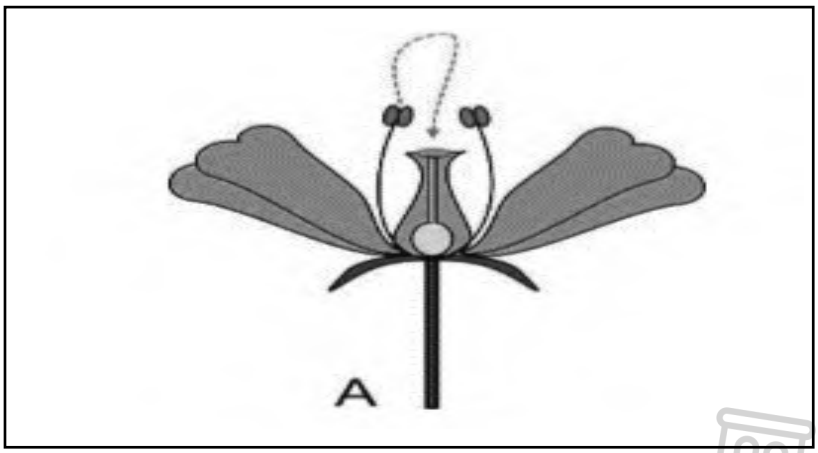
1.1.3 Which of the following is not part of the pistil?

A. Ovary
B. Filament
C. Stigma
D. Style

1.1.4 The flowers of wind pollinated plants have . . .

A. brightly coloured petals.
B. pollen that are very light and float easily.
C. stigmas that are larger and feathery.
D. nectar that produces sugary and sticky substances.

1.1.5 Which process is illustrated by the diagram below?



A. Cross pollination
B. Water pollination
C. Wind pollination
D. Self-pollination

(10)

1.2 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (1.2.1 – 1.2.6)

1.2.1 Bilobed structure at the tip of the filament containing pollen grains

1.2.2 The basal enlarged portion of the pistil of the flowers containing ovules

1.2.3 The part of the pistil of plants that receives pollen during pollination

1.2.4 Transfer of pollen from an anther to the stigma of the same or the stigma of a different flower of the same species

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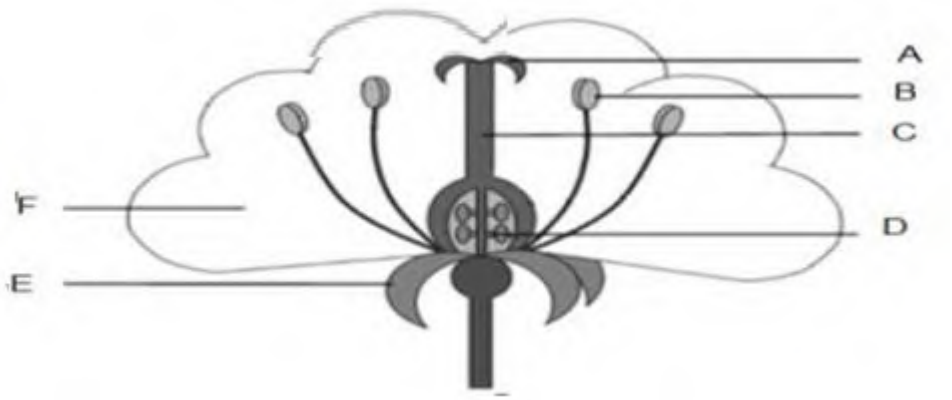
1.2.5 A fleshy often sweet layer formed around the seeds in angiosperm following fertilization

1.2.6 The thickened part of the stem from which the flower organ can grow

(6)

1.3 Study the diagram below showing the structure of a flower.



1.3.1 What type of pollination can be linked to the flower? (1)

1.3.2. Identify the parts labelled **A** and **B.** (2)

1.3.3 What do we call **F** and **E** together? (1)

1.3.4 Using the LETTER only identify the following:

a) Part which receives pollen (1)

b) Structure where a seed can form (1)

c) Part where pollen is produced (1)

(7)

QUESTION 2

2.1 A Grade 11 learner wanted to investigate the preference of two pollinating agents, sunbirds and hummingbirds to visit two different types of flower species of Salvia, *Salvia nemorasa* and *Salvia greggi.* The total number of visits to the flowers of these plant species was recorded over a period of 24 hours.
The results are shown in the table below:

Flowers species	**Number of visits to the flowers by pollinators**	
	Sunbirds	Hummingbirds
S.nemorasa	4	86
S.greggi	110	10

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2.1.1 State the dependant variable. (1)

2.1.2 State ONE way in which the investigator ensured that the investigation was valid. (1)

2.1.3 State ONE way that the investigator could increase the validity of the investigation. (1)

2.1.4 What can the researcher conclude from the results? (2)

(5)

2.2

2.2.1 The following table compares flowers pollinated by pollinators with flowers which are wind pollinated. Copy the table into your book and complete it.
The difference between pollinator and wind pollinator

Feature	**Pollination by pollinator**	**Wind pollinated**
flower	(a).	Small and inconspicuous
stigma	(b).	(g)
stamens	(c).	(h).
pollen	(d)	(i).
scent	(e).	(j).
Energy spent	(f).	(k)

(11)

2.2.2 Explain why pollinators visit flowers. (2)

2.2.3 Describe how the reproductive organs of the flower make the Angiosperm the most successful group of plants on earth at present. (4)

2.2.4 Tabulate TWO differences between self-pollination and cross pollination. (5)

(22)

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WEEK 7 & 8: TOPIC: Biodiversity of animals

SUB-TOPIC: Porifera, Cnidaria, Platyhelminthes, Annelida, Arthropoda & Chordata

NOTES & EXAM TIPS

ANIMAL PHYLA

Only six of the approximately 33 animal phyla will be discussed. The phyla will be discussed in order from the simplest to the more advanced.

Key terminology:

Invertebrates	organisms without a backbone.
Vertebrates	animals that have a backbone or spinal column.
Spicule	a minute (very small) sharp-pointed object or structure that is typically present in large numbers, found in sponges
Nematocyst	a specialized cell in the tentacles of a jellyfish or other coelenterate, containing a barbed or venomous coiled thread that can be projected in self-defense or to capture prey
Mesoglea	the tissue in jellyfish that functions as a hydro-static skeleton.
Acellular	not consisting of, or not containing cells.
Haemocoel	the body cavity of most invertebrates containing circulatory fluid.
Exoskeleton	a thick, rigid outer covering that protects and supports bodies and provides places for muscles to attach in animals, e.g. arthropods
Ecdysis (moulting)	the process of casting off the outer cuticle in arthropods.

Six phyla are studied, including:

- Phylum Porifera e.g. sponges
- Phylum Cnidaria e.g. blue bottles, jelly fish, sea anemones
- Phylum Platyhelminthes e.g. flukes, tapeworms, free-living planarians
- Phylum Annelida e.g. leeches, earthworms and polychaetas
- Phylum Arthropoda e.g. crab, spider, locust, millipede, centipede, fly
- Phylum Chordata e.g. fish, mammals, birds, reptiles, amphibians

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Phylum Porifera • aquatic (live in water) • asymmetrical with no cephalization • function at a cellular level • acoelomate • no openings to the gut • sessile organisms that feed by filtering out floating particles from the water column • the body is made up of millions of spicules which protect and support the sponge.	 Filter-feeding sponge

Phylum Cnidaria
• aquatic, mostly marine but some live in freshwater habitats
• radially symmetrical with no cephalisation
• diploblastic which means they have a cellular ectoderm and a cellular endoderm.
• they also have an acellular jelly-like layer between these two layers called the mesoglea.
• acoelomate
• one opening to the gut that acts as both the mouth and the anus. the mouth often has tentacles that help catch prey.
• Cnidarians occur in two different body forms:
  ○ a sessile polyp phase
  ○ a free-swimming medusa
 	
Cnidarians have stinging organelles in their cells called nematocysts that they use for catching their prey and for protection. Cells that contain nematocysts are called cnidocytes or nematocytes
	
	Polyp e.g. sea anemone
	
	Medusa e.g. jellyfish

Phylum Platyhelminthes • most are internal parasites but some are aquatic and free-living • bilaterally symmetrical with cephalization – a definite anterior, posterior, dorsal and ventral side because they are bilaterally symmetrical • dorsoventrally flattened which means they appear squashed from the dorsal to the	 Free-living *Planaria*

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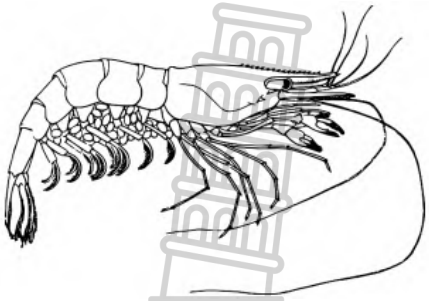
ventral side • have their sense organs and nerve tissue concentrated in the anterior region of their body (cephalisation) which allows them to detect what lies ahead of them – aids in feeding and avoiding danger • triploblastic which allows them to develop tissues and organs e.g. nervous tissue and reproductive organs • acoelomate and therefore no circulatory system • one opening to the gut – the digestive cavity branches around the body to transfer nutrients around the body	 Tapeworm
Phylum Annelida • aquatic (freshwater and marine) and terrestrial habitats • bilaterally symmetrical with cephalization • triploblastic • coelomate - coelom is a fluid-filled cavity that is used as a hydrostatic skeleton for movement • segmented which means their bodies consist of repeating segments, called metameres.	 An earthworm
Phylum Arthropoda • aquatic (freshwater and marine) and terrestrial • bilaterally symmetrical with cephalisation • triploblastic • coelomate – the coelom is filled with a fluid, which acts like blood, called a haemocoel. arthropods therefore have an open circulatory system • more advanced segmentation of body parts so that each segment has a particular form and function i.e. abdomen, thorax and head • all arthropods have jointed appendages that are used for movement and feeding • two openings to the gut (a through-gut)	 Diagram of a shrimp

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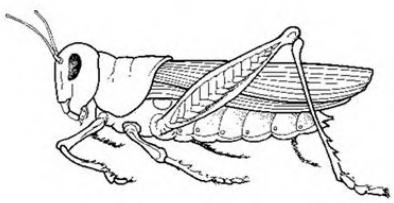
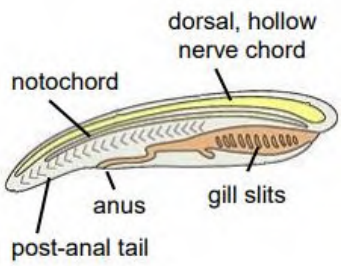
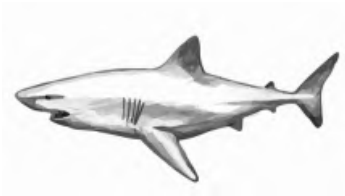
• a waterproof exoskeleton made of chitin The exoskeleton: ▪ protects the arthropod from drying out ▪ prevents diffusion of gases across its waterproof surface; arthropods have therefore developed gaseous exchange organs such as gills and lungs ▪ does not grow as the arthropod grows and it must be shed regularly (ecdysis) and regrown; the arthropod is vulnerable during regrowth of the exoskeleton because it is weaker and requires a lot of energy	 Diagram of a locust
Phylum Chordata • aquatic (freshwater and marine) and terrestrial • bilaterally symmetrical with cephalisation • triploblastic • coelomate • segmented body • two openings to the gut (through-gut) • all vertebrates have a rod-like support named a notochord which may develop into the vertebral column Vertebrates …. • have a hollow dorsal tubular nerve cord (spinal column) which often forms the anterior brain (e.g. humans) • initially develop pharyngeal gill slits that disappear in terrestrial chordates at adulthood • have a post-anal tail • Chordata can be ectothermic or endothermic. The body temperature of exothermic animals is regulated by the external environment whereas the body temperature of endothermic animals is regulated by internal metabolic reactions. Examples of endothermic animals are humans and birds.	 \ Anatomy of a lancelet  A shark - a typical chordate Diagram of a chimpanzee

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1 *(question taken from various sources)*

1.1 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (1.1.1 to 1.1.2) in your ANSWER BOOK.

1.1.1 The phylum of all animals with a vertebral column in the adult.
1.1.2 Concentration of nervous tissue and sense organs at the anterior end of an organism. **(2)**

1.2 Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (1.2.1 to 1.2.4) in the ANSWER BOOK.

COLUMN I		COLUMN II	
1.2.1	Characteristic to Chordate	A B	Endoskeleton Closed blood system
1.2.2	Phyla that are triploblastic	A B	Platyhelminthes Annelida
1.2.3	Animals that have a complete tube-like gut with two openings	A B	Arthropoda Cnidaria
1.2.4	Segmented bodies and jointed legs	A B	Annelida Arthropoda

(4 x 2) **(8)**

QUESTION 2 *(D12, June,2016)*

The diagram **A** below shows a complete animal while **B** shows a cross section through the main body stalk. Study the diagrams below and answer the questions that follow.

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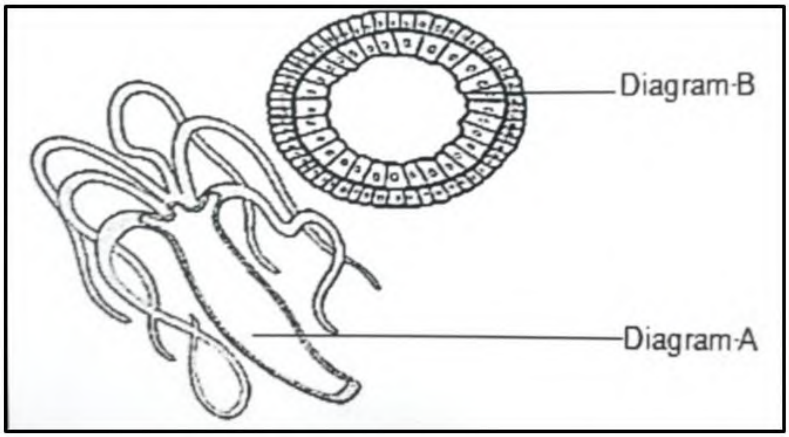

2.1 Identify the phylum to which this organism belongs. (1)

2.2 Name the kind of symmetry shown in this organism. (1)

2.3 Explain the advantage this symmetry has for the mode of living of this organism. (2)

(4)

QUESTION 3 *(KZN, March. 2020)*

Complete the following table showing different animal groups and their features. Write down only the number of the question and the answer (2)

Animal group (phylum)	Named example of	Type of symmetry	Tissue layers	Gut openings
3.1	Sponges	Asymmetrical	Cell differentiation- no tissue layers	No through-gut, filter feeding
Cnidaria	Jellyfish	Radial symmetry	3.2	Blind-gut

3.3 Differentiate between diploblastic and triploblastic animals. (2)

3.4 State ONE disadvantage of having a blind gut in the organism mentioned in QUESTION 3.1 (1)

3.5 Briefly describe THREE characteristics present in the body plans of Annelids that allows them to survive in their environment. (6)

(11)

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WEEK 9: TOPIC: Biodiversity of animals

SUB-TOPIC: Role of invertebrates in agriculture and ecosystems

NOTES & EXAM TIPS

Invertebrates perform numerous functions in the ecosystem that provide us with food, clean water and air, and even clothes. Below are three of the main roles that invertebrates play.

Key terminology

detritus	organic matter produced by the decomposition of dead organisms
humus	organic component of soil, formed by the decomposition of leaves and other plant material by soil microorganisms
aeration	the process of turning or puncturing compacted soil to allow air and water penetration

Pollination

Pollination is the transfer of pollen from the male parts of a flower to the female parts
of a flower of the same species by a pollinator.

- Pollination results in fertilisation for the production of fruits and seeds.
- Bees are the most important pollinators because they spend their entire life collecting pollen and nectar for their developing young.
- There are many other invertebrates that pollinate flowers (examples include: ants, moths, butterflies).

Soil aeration

Invertebrates like earthworms, burrow in the soil and make tunnels through the soil. These tunnels allow gases to move through and aerate the soil. The activities of earthworms are important because:

- Their tunnels accelerate the decomposition of nutrients to be reused for plant growth.
- The community structure of the habitat is dependent on soil nutrients and plant growth.
- Their tunnels improve drainage of the soil.
- The earthworms act as pumps when they move through the tunnels by pushing

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and pulling air around their tunnels

- Their tunnels loosen the soil and allow plant roots to penetrate deeper into the soil.

Decomposition

Decomposition is the process that decays or breaks down organic molecules from dead organisms into simpler organic molecules that are released into the environment and reused in nutrient cycles.

- Invertebrates (worms, beetles etc.) break down complex organic molecules (detritus), such as leaf litter, into simpler molecules.
- Microscopic decomposers (i.e. bacteria and fungi) can further break down the organic matter into humus.
- Humus is the organic part of soils which greatly improves the quality of soils for plants

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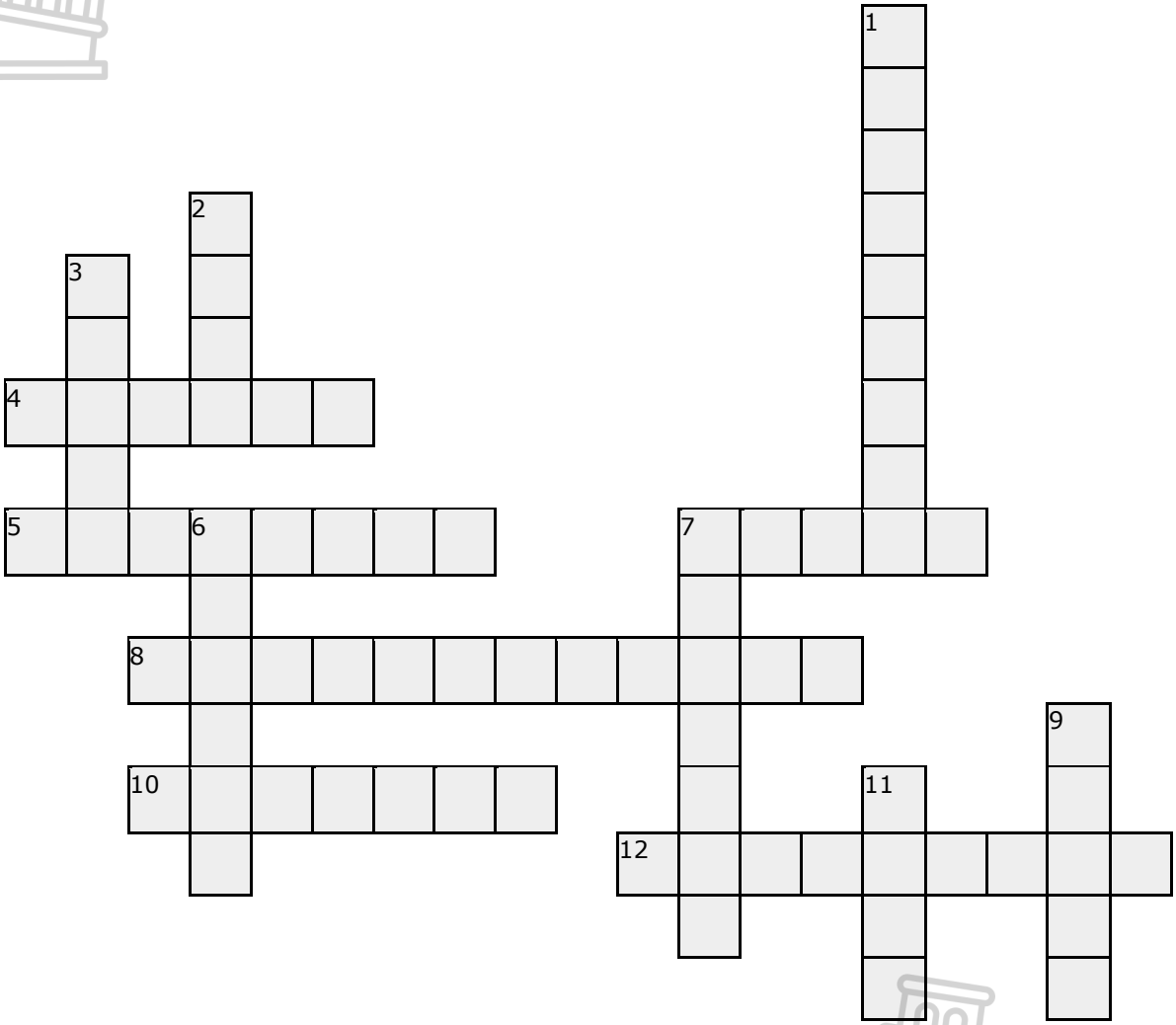
ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

Question 1

Complete the crossword puzzle.



Across

4. A sweet treat made by bees
5. It's used to make candles
7. A group of bees looking for a new home
8. It's necessary for the production of fruit

Down

1. A machine used to remove honey from frames
2. A bee house
3. A male bee
6. A tool used to calm bees

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10. A sweet liquid bees collect from flowers
12. A person who takes care of bees

7. A part of the bee's body used for defence
9. The only female that lays eggs in the hive
11. It protects the beekeeper's face from the bees

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Term 2

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WEEK 1: TOPIC: Revision

SUB-TOPIC: Basic cell structure (Focus on chloroplast and leave structure)

NOTES & EXAM TIPS

Biological terminology	
Carbohydrate	A large group of organic compounds found in cells, including glucose, sucrose, and starch.
Chloroplast	A plastid in green plant cells which contains chlorophyll and in which photosynthesis takes place.
Cuticle	A protective and waxy layer covering the epidermis of a plant
Epidermal cells	Transparent cells found in the outer layer of a plant organ. These cells do not contain chloroplasts.
Guard cells	Curved cells containing chloroplasts that surround a stoma. These cells open and close the stomata(pores)
Glucose	A simple sugar which is an important energy source in living organisms and is a component of many carbohydrates.
Mitochondrion	An organelle found in large numbers in most cells, in which the cellular respiration and energy production occur.
Nucleus	A dense organelle present in most eukaryotic cells, typically a single rounded structure bounded by a double membrane, containing the genetic material.
Palisade mesophyll	A layer of tall, thin cells containing many chloroplasts found under the upper epidermis of the leaf
Parenchyma	Photosynthesizing cells containing chloroplasts
Phloem	The vascular tissue in plants which conducts sugars and other metabolic products downwards from the leaves.
Spongy mesophyll	The inner tissue (parenchyma) of a leaf, containing many chloroplasts. These cells are loosely packed and have many air spaces between them
Starch	Stored carbohydrate found in plants
Stoma(ta)	Opening in the surface of leaves that allows gases to move in and out of the leaf
Vacuole	A space or vesicle within the cytoplasm of a cell, enclosed by a membrane and typically containing fluid.
Vascular bundle	A strand of conducting vessels in the stem or leaves of a plant, typically with phloem on the outside and xylem on the inside.

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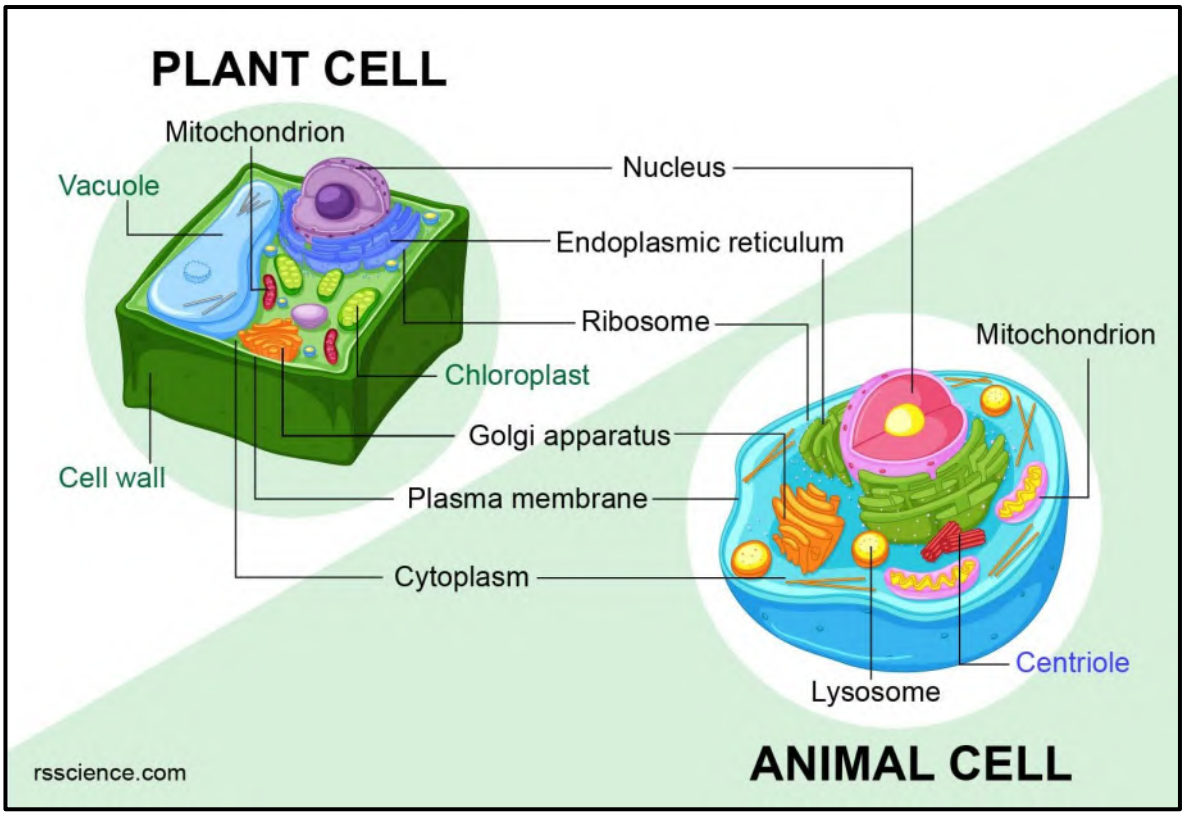
Vein	A slender rib running through a leaf or bract, typically dividing or branching, and containing a vascular bundle.
Xylem	The vascular tissue in plants which conducts water and dissolved nutrients upwards from the root and also provides support in the plants.

The structure of a cell



Cytoplasm

The cytoplasm is the **jelly-like substance** that fills the cell. It consists of up to **90% water**. It also contains **dissolved nutrients** and **waste products**. Its main function is to hold together the **organelles** which make up the cytoplasm. It also **nourishes** the cell by supplying it with salts and sugars and provides a medium for **metabolic reactions** to occur.

Nucleus

The nucleus is the **largest organelle** in the cell and contains all the cell's genetic information in the form of DNA. The presence of a nucleus is the primary factor that distinguishes eukaryotes from prokaryotes.

A nucleus has four main parts:

1. the double **nuclear membrane** – it encloses the nucleus and contains small pores to allow for the passage of substances in and out of the nucleus

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2. the **nucleoplasm** – this is a jelly-like fluid within the nucleus
3. the **nucleolus** – a dark body suspended in the nucleoplasm which contains free nucleotide bases and produces ribosomes
4. the **chromatin network** – found in the nucleoplasm, contains the **DNA** which forms the chromosomes containing the genetic code of a person / organism

Mitochondria

A mitochondrion is a membrane bound organelle found in eukaryotic cells.
This organelle **generates** the cell's supply of **chemical energy** by releasing energy stored in molecules from food and using it to produce **ATP** (adenosine triphosphate). ATP is a special type of" energy carrying" molecule.

Plastids

Plastids are organelles found only in plants. There are three different types:
1. **Leucoplasts**: White plastids found in roots.
2. **Chloroplasts**: Green-coloured plastids found in plants and algae.
3**. Chromoplasts**: Contain red, orange, or yellow pigments and are common in ripening fruit, flowers, or autumn leaves.

Chloroplast

The chloroplast is a double-membraned organelle. Within the double membrane is a gel-like substance called **stroma**.
Stroma contains enzymes for photosynthesis. Suspended in the stroma are stack-like structures called **grana** (singular = **granum**). Each granum is a stack of **thylakoid** discs.
The **chlorophyll** molecules (green pigments) are found on the surface of the thylakoid discs.
Chlorophyll absorbs energy from the sun in order for **photosynthesis** to take place in the chloroplasts. The grana are connected by **lamellae** (intergrana).
The lamellae keep the stacks apart from each other.

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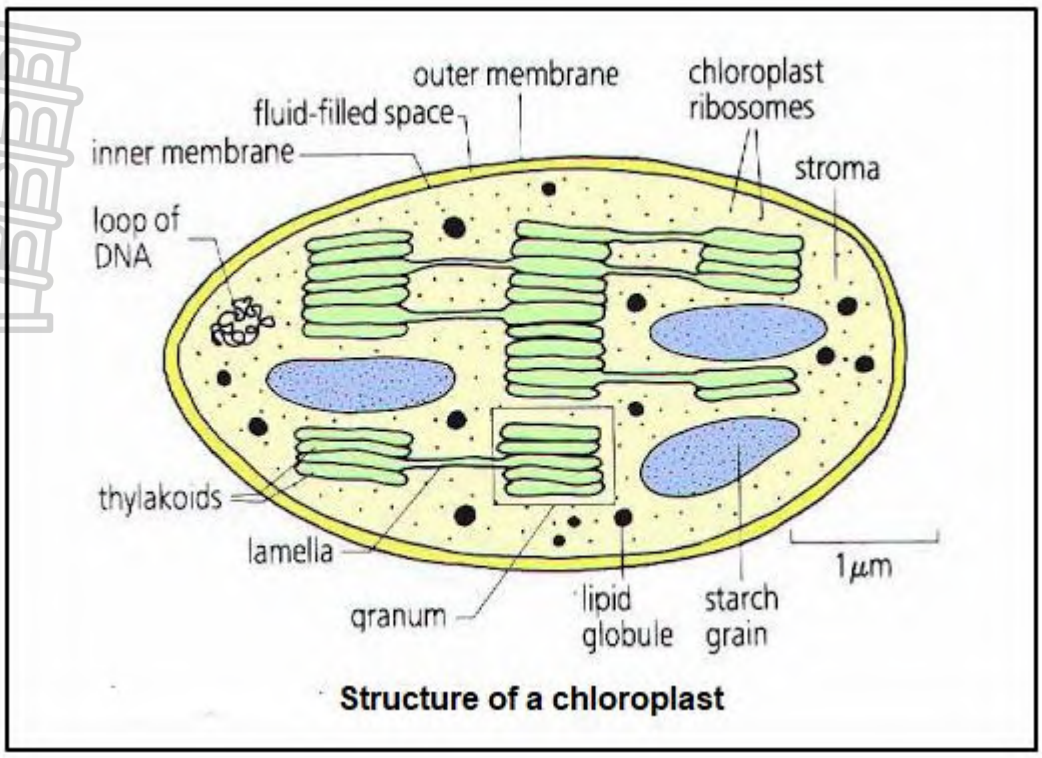

Structure of a chloroplast

Watch the following videos:
Cell structure: https://www.youtube.com/watch?v=URUJD5NEXC8
Chloroplast structure: https://www.youtube.com/watch?v=c8wA_0pfBu8

Structure of a leaf

The leaf is a collection of tissues which include:

1. The **epidermis** which covers the upper and lower surfaces.
2. The **mesophyll** inside the leaf which is rich in **chloroplasts**.
3. The **veins** contain the vascular tissue (where **xylem** and **phloem** are present).

Epidermis

Epidermal cells form the outer layer covering a leaf, separating internal tissues from the external environment. Guard cells forming stomata are found in the lower epidermis.
Epidermis tissue has several functions:

- ✓ **protection** against water loss via **stomata** and a **waxy cuticle**
- ✓ regulation of **gaseous exchange**

Mesophyll cells

The mesophyll is located between the upper and lower layers of the leaf epidermis, and is mostly made up of **parenchyma** (ground tissue) or **chlorenchyma** tissue. The mesophyll is the primary location for **photosynthesis** and is divided

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into two layers, the upper palisade layer and the spongy mesophyll layer.

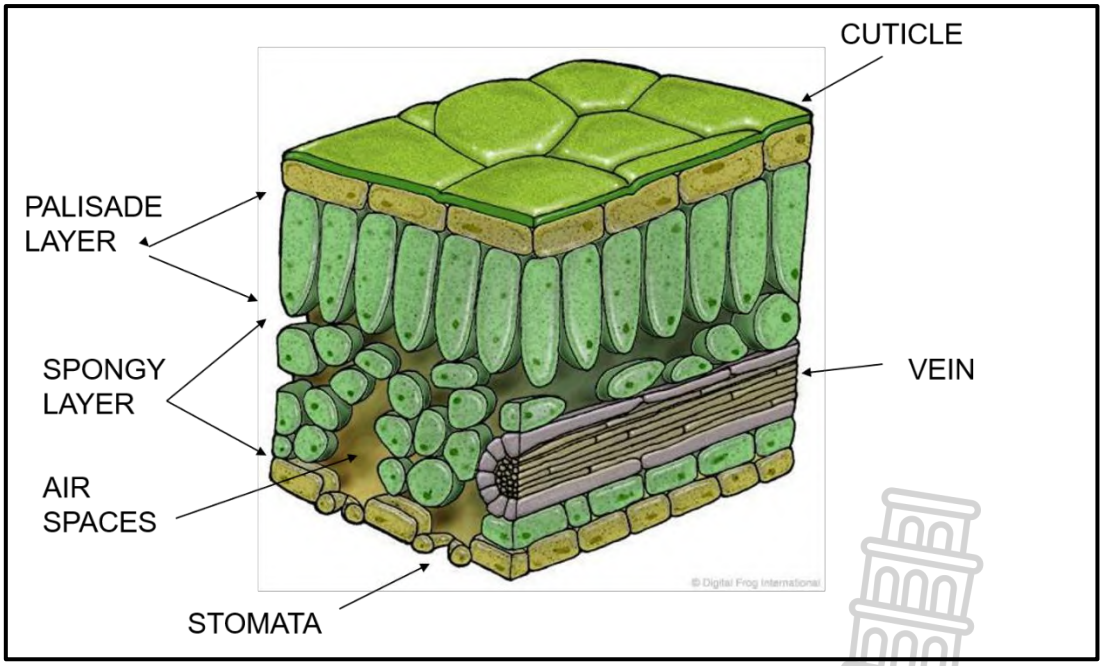
- ✓ The upper **palisade** layer lies beneath the upper epidermis and consists of vertically elongated cells that are **tightly packed** together to maximise the number of cells exposed to sunlight. In addition, these cells contain **many chloroplasts**, thus, maximising their photosynthetic ability.
- ✓ Beneath the upper palisade layer is the **spongy** mesophyll. The cells in the spongy mesophyll are slightly rounder and less densely packed and have **air spaces** to allow for **gaseous exchange**.

Vascular Tissue

Vascular tissue is made up of the **xylem** and **phloem** vessels.

- ✓ **Xylem** transports **water** and **minerals** to the leaf.
- ✓ **Phloem** transports dissolved **sucrose** made in the leaf out of its site of synthesis to the rest of the leaf.

Most leaves have a **bundle sheath** around the xylem and phloem, consisting of **sclerenchyma** or **collenchyma**, for **extra support**.



Watch the following videos:

Leaf structure: https://www.youtube.com/watch?v=HxoAAmFT5A4
https://www.youtube.com/watch?v=J7vgZI1COoE

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

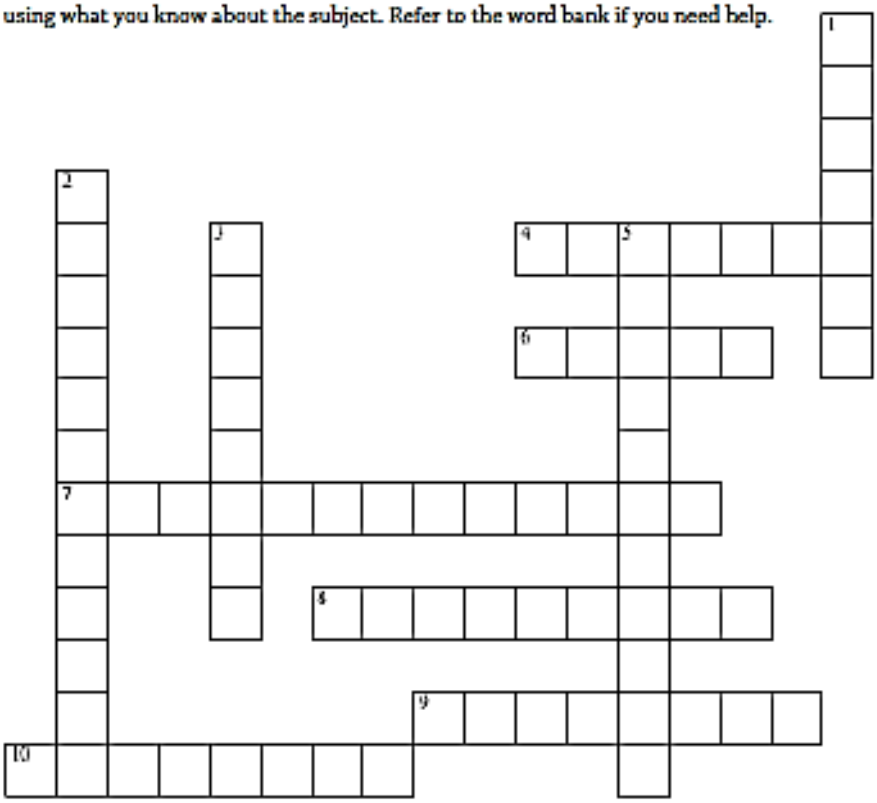
Activities

1. Complete the crossword puzzle on plant and animal cells.

LIFE SCIENCE

Plant and Animal Cells

Complete the crossword puzzle using what you know about the subject. Refer to the word bank if you need help.



Word Bank

vacuole
mitochondrion
cell membrane
golgi
nucleus
nucleolus
cell wall
lysosome
ribosome
chloroplast

Across

4. Stores nutrients and is generally much larger in plant cells than in animals'

6. Processes and packages proteins and lipids in the cell

7. Provides the energy for the cell to move

8. Within the nucleus and produces ribosomes

9. Contains the enzymes neccessary for digestion within the cell

10. Provides rigidity for the plant cell and is not found in animal cells

Down

1. Directs and controls all the other parts of the cell

2. The covering of the animal cell

3. Produces proteins and amino acids

5. Contains chlorophyll

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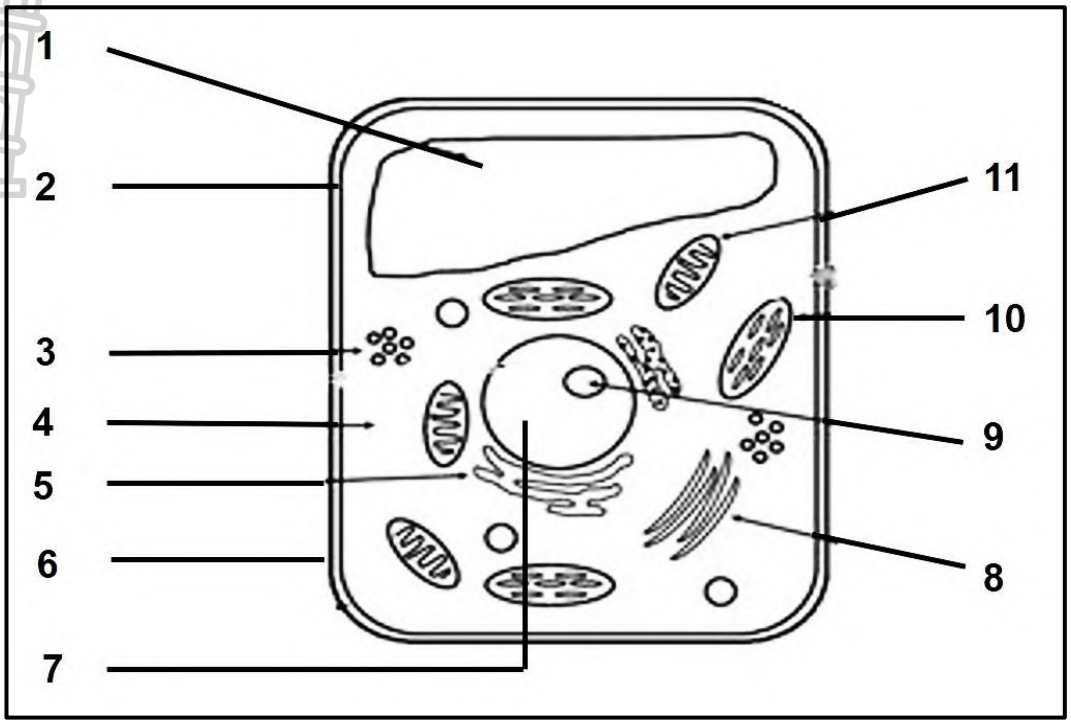
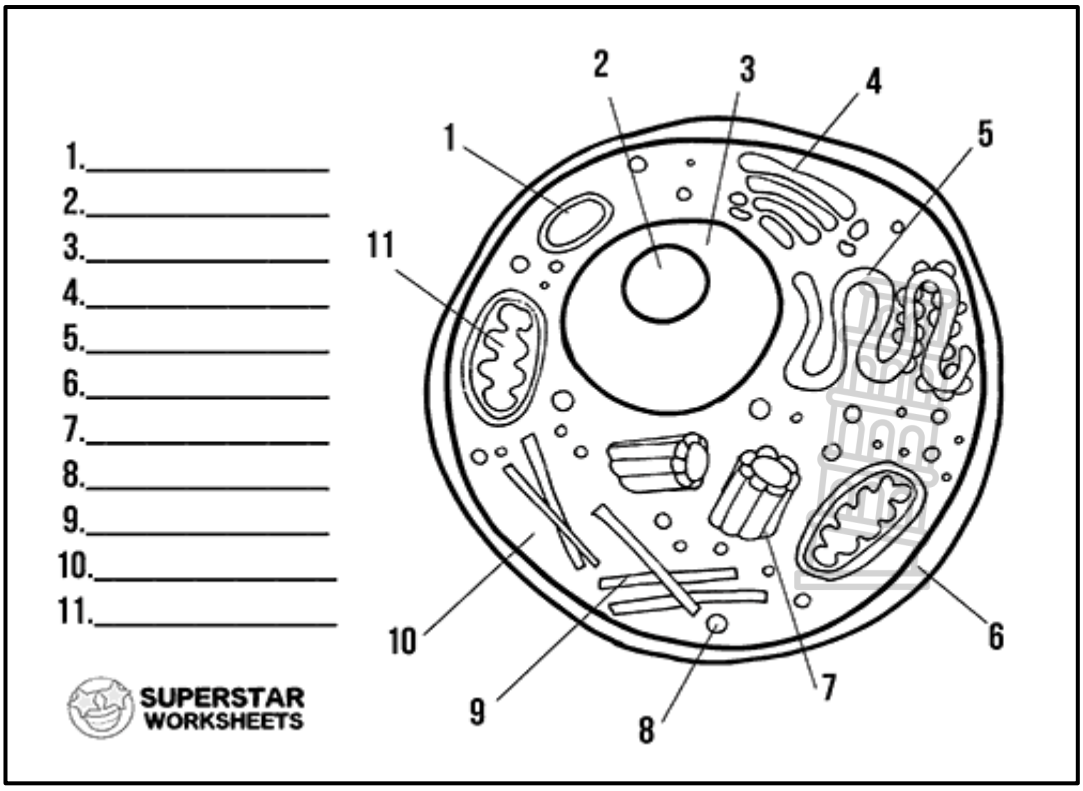
2. Fill in the labels of the following diagrams and give each diagram a heading.

A.



B.



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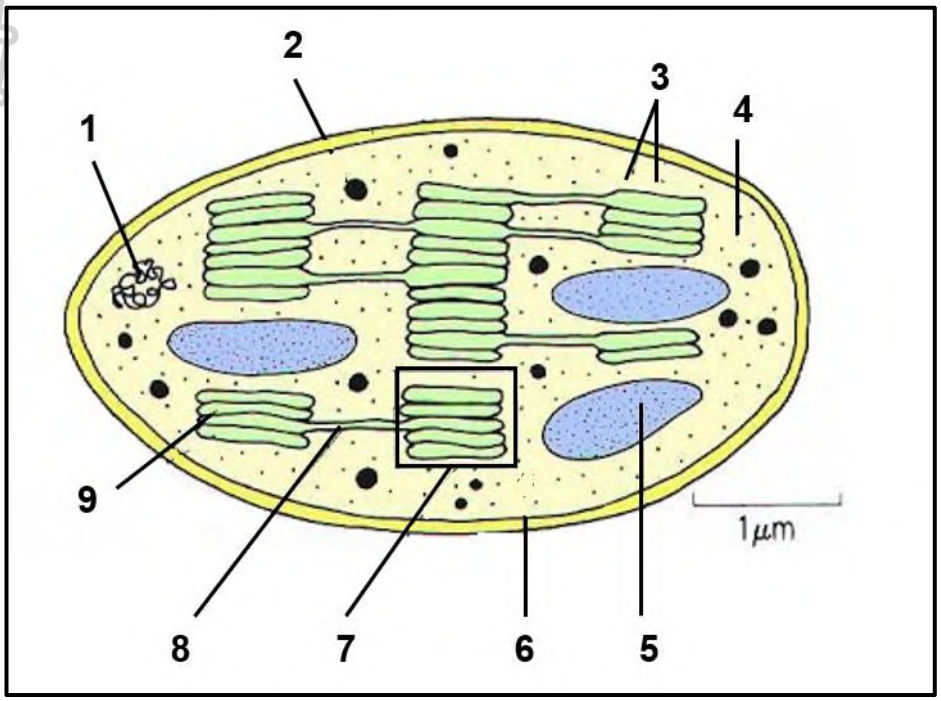
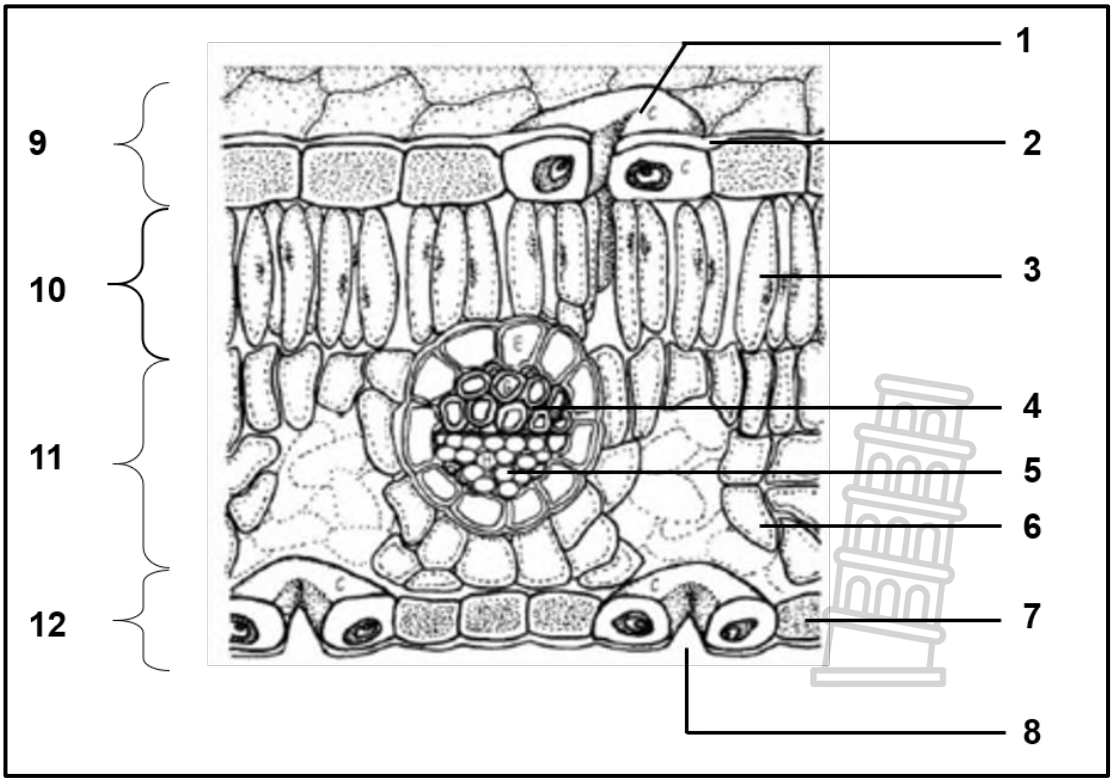
C.



D.



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EXAM QUESTIONS

QUESTION 1*(Questions taken from various sources)*

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.3) in your ANSWER BOOK, for example 1.4 D.

1.1 The basic unit of life is a…

A zygote.
B protoplasm.
C nucleus.
D cell.

1.2 Material used to store genetic information in a cell is the …

A ribosome.
B deoxyribonucleic acid.
C endoplasmic reticulum.
D centrioles.

1.3 The … are only found in animal cells.

A cellulose cell wall
B endoplasmic reticulum
C centrioles
D vacuole (3 x 2) **(6)**

QUESTION 2 *(Questions taken from various sources)*

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 Cell organelles that are the site of protein synthesis
2.2 Pigment found in green plants
2.3 Organelle that serves as a storage site for water and mineral salts **(3)**

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QUESTION 3 *(Questions taken from various sources)*

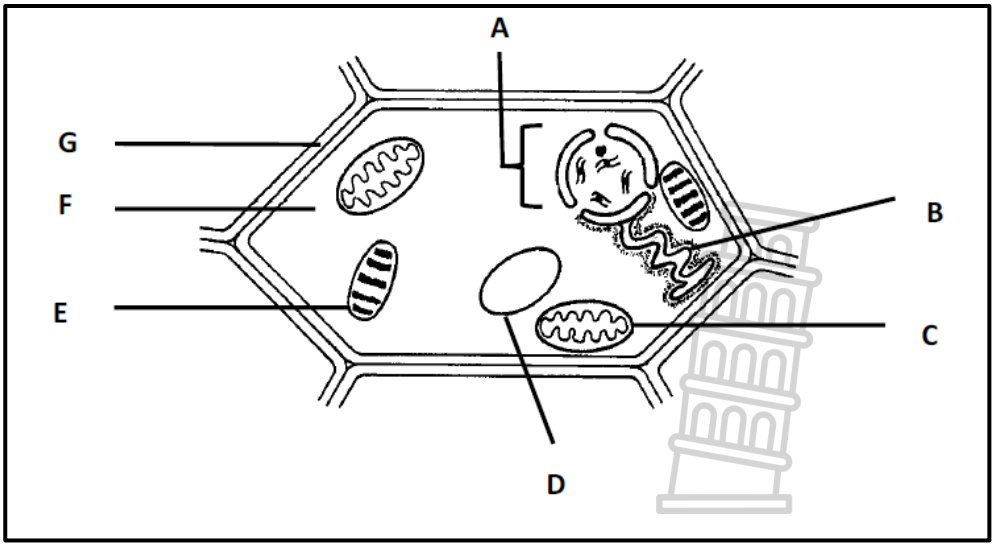
Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	Cells in the leaf that contain chloroplasts	A B	Palisade parenchyma Spongy parenchyma
3.2	Responsible for gaseous exchange in a leaf	A B	Guard cells Epidermal cells
3.3	'Powerhouse' of the cell	A B	Nucleus Mitochondria

(3 x 2) **(6)**

QUESTION 4 *(Grade 10 topic tests: Cell and mitosis)*

4 Study the diagram of a cell shown below



4.1 Write down the LETTER only of the:

(a) Nucleus (1)
(b) Endoplasmic reticulum (1)
(c) Vacuole (1)

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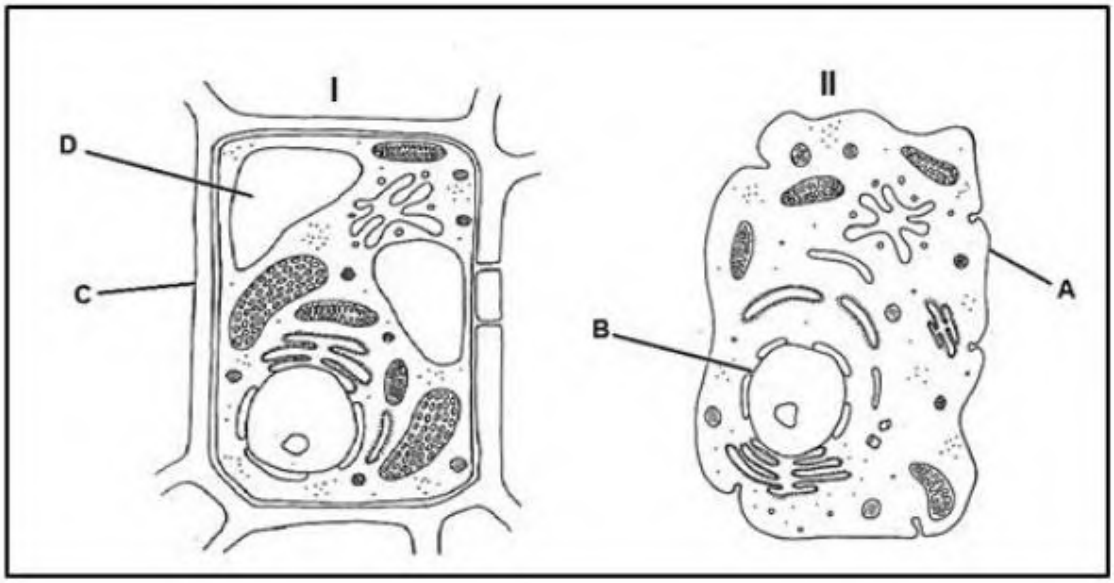
(d) Mitochondrion (1)
(e) Cytoplasm (1)
(f) Part that contains cellulose (1)

4.2 Provide one observable reason as to why this cell cannot be from the root of a plant. (1)
(7)

QUESTION 5 *(EC Grade 10 P1 Nov 2019)*

5 The following diagrams represent different types of cells.



5.1 Identify the type of cells represented by diagrams **I** and **II**. (2)

5.2 Give the NUMBER and the NAME of the organelle which serves as a storage site for water and mineral salts. (2)

5.3 Provide labels for parts **A**, **B** and **C**. (3)

5.4 State whether part **D** is a permeable, impermeable or selectively permeable membrane. Give ONE reason for your answer. (3)

5.5 A plant cell in a photograph measures 15 mm across. If the actual size of the cell is 0,015 mm, what is the magnification in the photograph? Show all your workings (3)
(13)

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WEEK 2: TOPIC: Photosynthesis

SUB-TOPIC: Process and importance of photosynthesis

NOTES & EXAM TIPS

All living organisms require energy to survive.
This energy can either be obtained directly from the sun (plants) or from the food that is eaten (animals).

DEFINITION OF PHOTOSYNTHESIS
The term photosynthesis means **light** (**photo)** to **manufacture** (**synthesise**) energy in the form of (**glucose**) carbohydrate **stored in plants** in the form of **starch** and to release **oxygen** into the atmosphere.

TERMINOLOGY	
radiant energy	energy from the sun, needed by plants for photosynthesis
chloroplast	organelle in plants, site for photosynthesis
chlorophyll	green pigment needed for photosynthesis
thylakoids	membranous sacs of the chloroplast that contains chlorophyll
grana	stacks of thylakoids (membranous sacs) where light phase of photosynthesis takes place here
stroma	part of chloroplast dark phase occurs
light phase	stage in photosynthesis which depends on light to form oxygen
dark phase	stage in photosynthesis which does not require light but occurs during light and uses products of light phase to form glucose
stomata	pores on leaves for gaseous exchange

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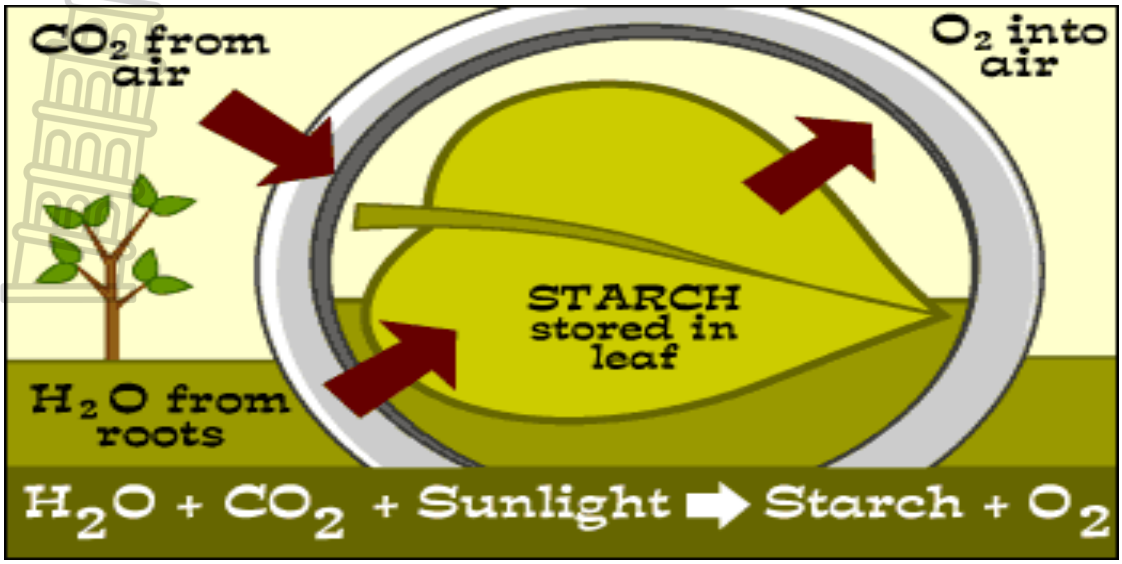
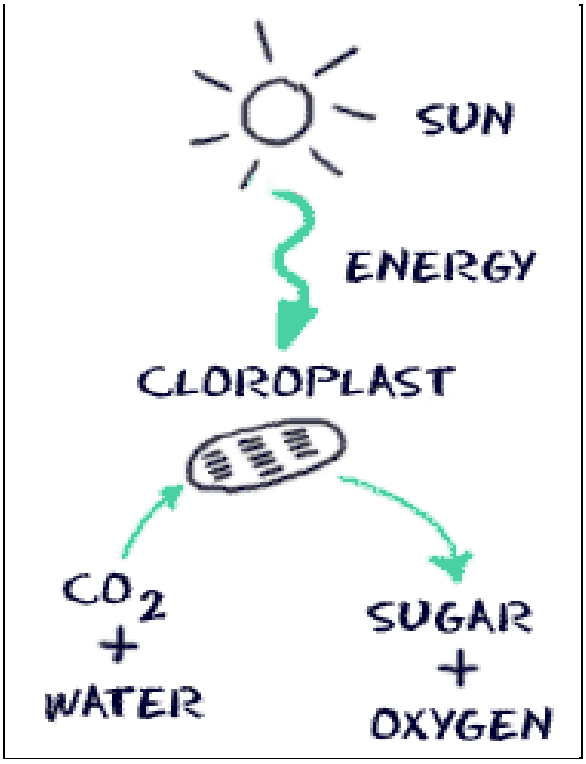
A SIMPLIFIED PRESENTATION OF PHOTOSYNTHESIS





PROCESS OF PHOTOSYNTHESIS

TERMINOLOGY	
photolysis	splitting of water molecules into oxygen and hydrogen atoms. photo = light, lysis = split
phosphorylation	formation of energy transporting molecules called ATP
ATP	adenosine triphosphate, energy carriers

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glucose	carbohydrate formed during photosynthesis

The process of photosynthesis occurs in the **choloroplast** in **two phases**:

- **LIGHT PHASE** : phase where **light** is required
- **DARK PHASE** : phase where **no light** is **required** but occurs when there is light

Both the **light and dark phase** occur in the **organelle** called the **chloroplast.**

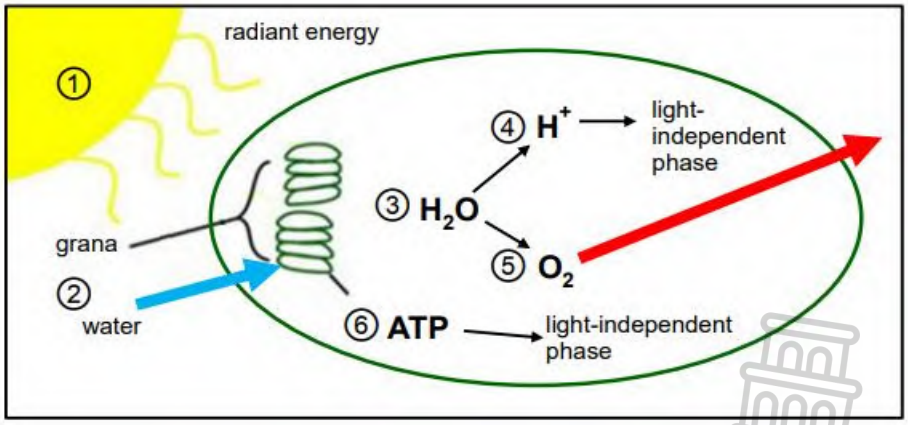
LIGHT PHASE OF PHOTOSYNTHESIS

(REQUIREMENTS AND PRODUCTS)

Word Equation

$$\text{Carbon dioxide + Water + Radiant energy} \xrightarrow[\text{Enzymes}]{\text{Chlorophyll}} \text{Glucose + Oxygen}$$

The light phase of photosynthesis takes place in the **grana of chloroplasts** as follows:



1.The required **radiant energy** is absorbed by **chlorophyll** in the **grana.**
2. **Water** is **absorbed into the grana** of the chloroplast
3. Radiant energy causes the water (**H_2O**) molecule to split (**photolysis**), into **H+** and **O_2**. This **oxygen** is released into the **atmosphere** via the **stomata.**
4. **Energy rich hydrogen (H+)** ions formed during photolysis are carried by **NADP (H- carrier**) to form **NADPH**.
5. Radiant energy causes the **energy carrier ATP** to be formed by phosphorylation.
6. **NADPH + ATP** formed during **light phase** will be used in the **dark phase**

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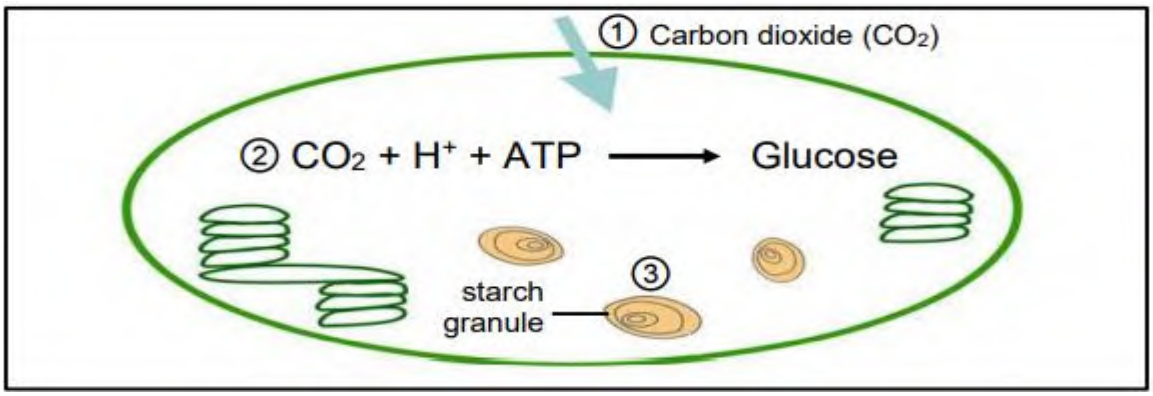
DARK PHASE OF PHOTOSYNTHESIS

Chemical Equation:

$$CO_2 + H_2O + \text{radiant energy} \xrightarrow[\text{Enzymes}]{\text{Chlorophyll}} C_6H_{12}O_6 + O_2$$

The **dark phase** of photosynthesis takes place in the **stroma of chloroplasts** as follows:



1. **Carbon dioxide (CO_2)** enters leaves via **stomata** from the atmosphere

2. Carbon dioxide **(CO_2)** and energy rich Hydrogen **(H^+)** atoms, from the light phase, are combined using **ATP**, to from carbohydrates (glucose).

3. Excess glucose is **stored** as **starch** in starch granules in the stroma of chloroplasts.

COMPARISON BETWEEN THE PHASES OF PHOTOSYNTHESIS

LIGHT PHASE	DARK PHASE
Occurs in the grana	Occurs in the stroma
Light is required	Light is not required
Radiant energy and water are absorbed and used for the reactions of photolysis & phosphorylation	Carbon dioxide is absorbed from the atmosphere

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Photolysis occurs hydrogen and oxygen formed by **splitting** **H_2O.**Phosphorylation occurs: ATP is produced and oxygen is released to the atmosphere	Hydrogen and carbon dioxide combine by using **ATP** to form glucose. Glucose is formed and excess is stored as starch.

THE IMPORTANCE OF PHOTOSYNTHESIS

Photosynthesis is important for the following reasons:

1. It supplies energy to almost all living organisms. Plants are the only organisms that can convert the sun's energy into organic compounds.

2. Plants convert the simple sugars made during photosynthesis into more complex organic compounds such as starch, fats, proteins and vitamins which form food source for all living organisms.

3. Photosynthesis regulates the concentrations of carbon dioxide, and oxygen in the atmosphere, and plays a key role in the carbon cycle in preventing global warming.

4. Plants absorb more carbon dioxide during photosynthesis than they release during cellular respiration.

5. Organisms require the oxygen released during photosynthesis for cellular respiration to provide energy to all cells and organs.

https://youtu.be/k_oXNwuNDNo

Watch this video on photosynthesis

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

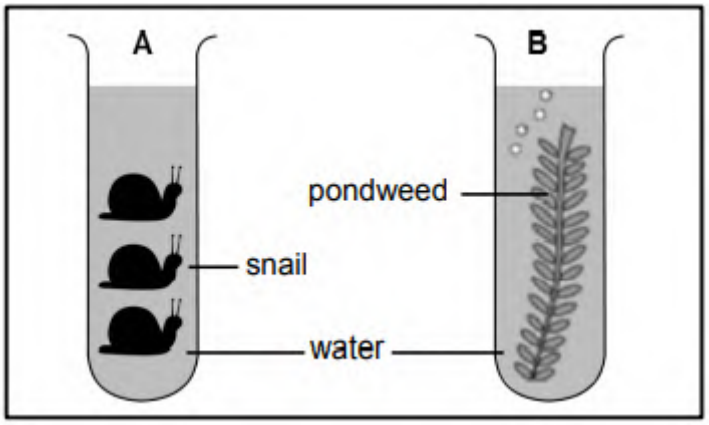
QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.3) in your ANSWER BOOK, for example 1.4 D.

1.1. Plants use oxygen…

A continuously.
B during the day only.
C during the night only.
D during photosynthesis only

1.2. Test tubes A and B below were placed in bright light.



Which of the following is correct regarding the test tubes?

A The amount of CO_2 in test tube A will decrease.
B The amount of CO_2 in test tube B will increase.
C The amount of O_2 in test tube B will increase.
D The amount of O_2 in test tube A will increase.

1.3. What are the products of the light reactions of photosynthesis that are used in the light independent phase?

A CO_2 and glucose
B ATP and H^+
C H_2O and O_2
D ADP and CO_2 (3x2=**6**)

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QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 The green, light-trapping pigment in photosynthesis found in plant leaves.

2.2 The splitting of water molecules into hydrogen and oxygen in the presence of light

2.3 Site of reactions of the light - independent phase in the chloroplast.

(3x1=**3**)

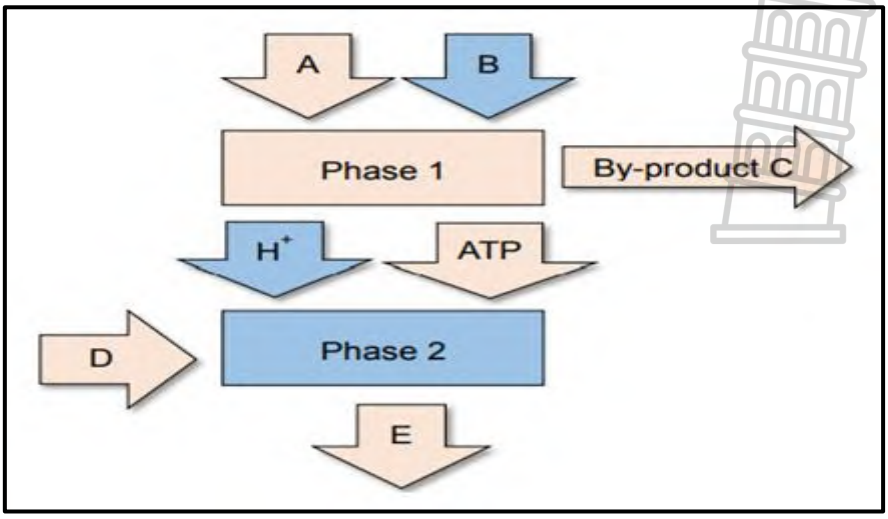
QUESTION 3 *(Questions taken from various sources)*

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	Molecule that stores energy	A B	ATP ADP
3.2	Storage of chlorophyll	A B	Grana Lamella
3.3	Hydrogen carrier in light phase	A B	NAD NADP

(3 x 2) **(6)**

QUESTION 4



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4.1. Identify the phases labelled as Phase **1** and Phase **2** (2)

4.2. Provide the two raw materials labelled as **A** and **B**. (2)

4.3. Name the by-product labelled as **C**. (1)

4.4. Which substance labelled as **D** is essential for Phase 2? (1)

4.5. Name the product **E** that is produced during Phase 2. (1)

4.6. In what form is **E** stored in plants? (1)
(8)

WEEK 3: TOPIC: Photosynthesis

SUB-TOPIC: Effects of variable amounts of light, carbon dioxide and temperature on the rate of photosynthesis

NOTES & EXAM TIPS

The rate or speed at which photosynthesis takes place depends on the following three factors:

- Light intensity
- Concentration of carbon dioxide (CO_2)
- Temperature

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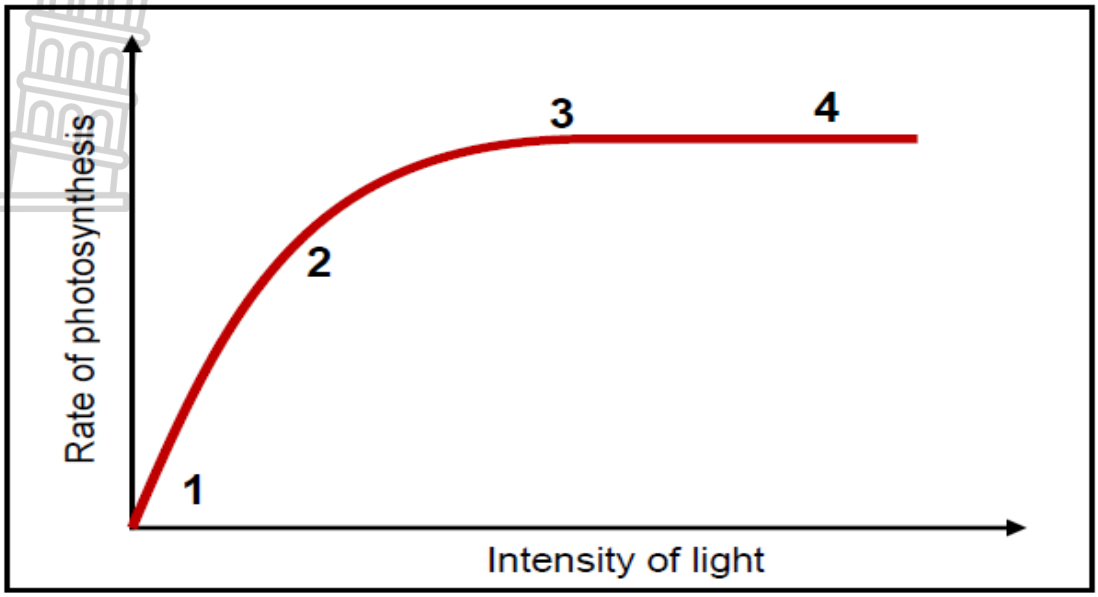
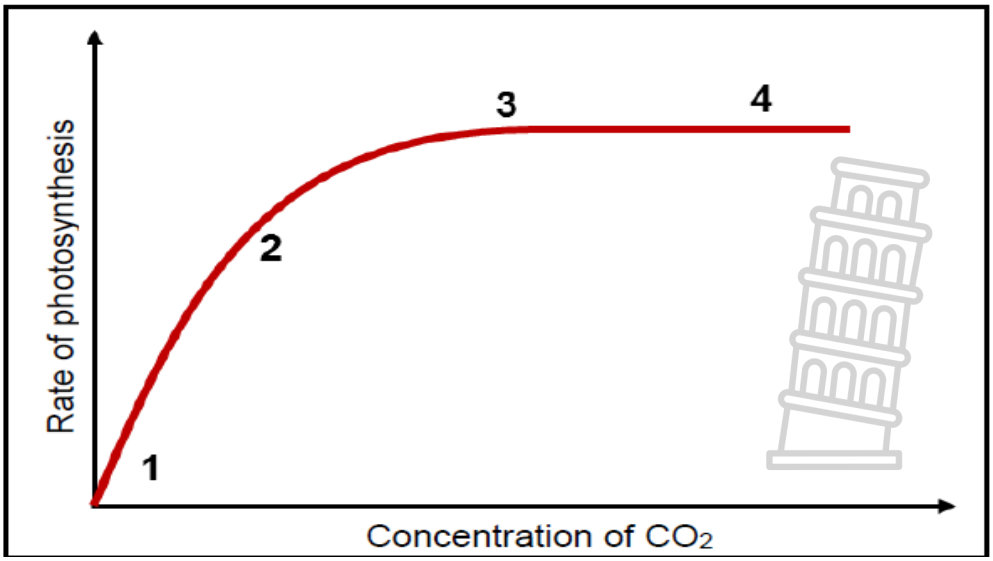
The graphs below show how different factors affect the rate of photosynthesis

1. **Light intensity**



- When light intensity **increases**, the rate of photosynthesis also **increases** to an **optimum** level. If light intensity continues to increase, there will be no effect on the rate of photosynthesis.
- When light intensity **decreases**, the rate of photosynthesis also **deceases**.
- When the light intensity is **low**, the rate of photosynthesis is **low.**

2. **Concentration of carbon dioxide**



- As the carbon dioxide concentration level **increases**, the rate of photosynthesis **increases**.
- If the carbon dioxide concentration is **higher than** the **optimum amount**, photosynthesis will **remain constant**.

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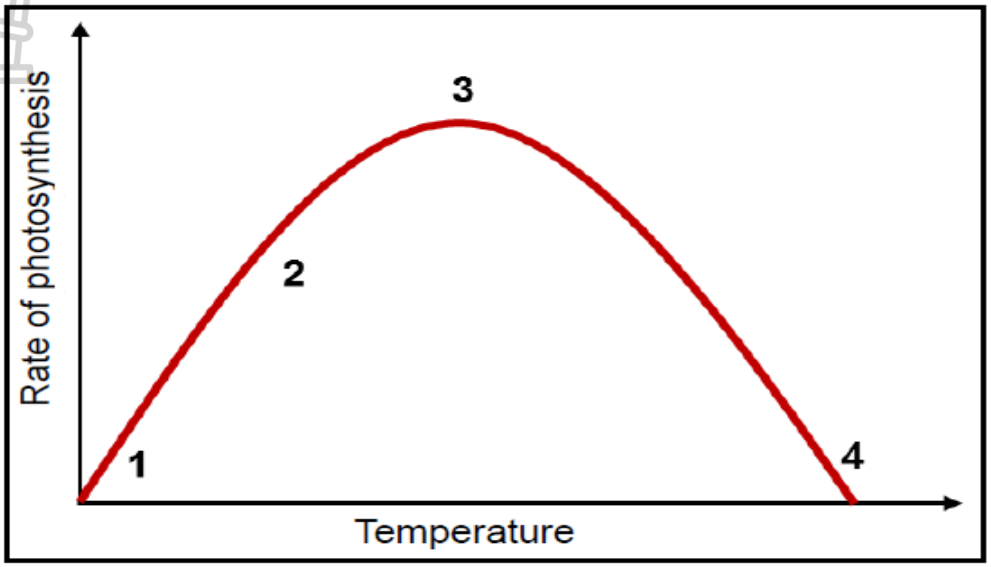
- When carbon dioxide concentration is **low**, the rate of photosynthesis is **low**.
- Light independent phase cannot take place more quickly than what it does at the optimum level of carbon dioxide concentration.

3. Temperature



- When temperature is **low,** the rate of photosynthesis is **low**.
- As temperature **increases**, the rate of photosynthesis also **increases**.
- When temperature is at the **optimum amount**, the rate of photosynthesis will reach a **maximum**.
- If the temperature is **higher than the optimum** amount, rate of photosynthesis will **decrease**.
- The **enzymes** used in the process will **denature** at high temperatures and will no longer function.

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Scientists set up an apparatus to investigate the effect of temperature, light intensity and carbon dioxide concentrations on plant growth. Using this apparatus, they could control each factor.

- The scientists set different temperatures, CO_2 concentrations and light intensity for four different groups of lettuce plants.

- The average mass of lettuce plants serves as an indication of the rate of photosynthesis.

Study the results below and answer the questions that follow.

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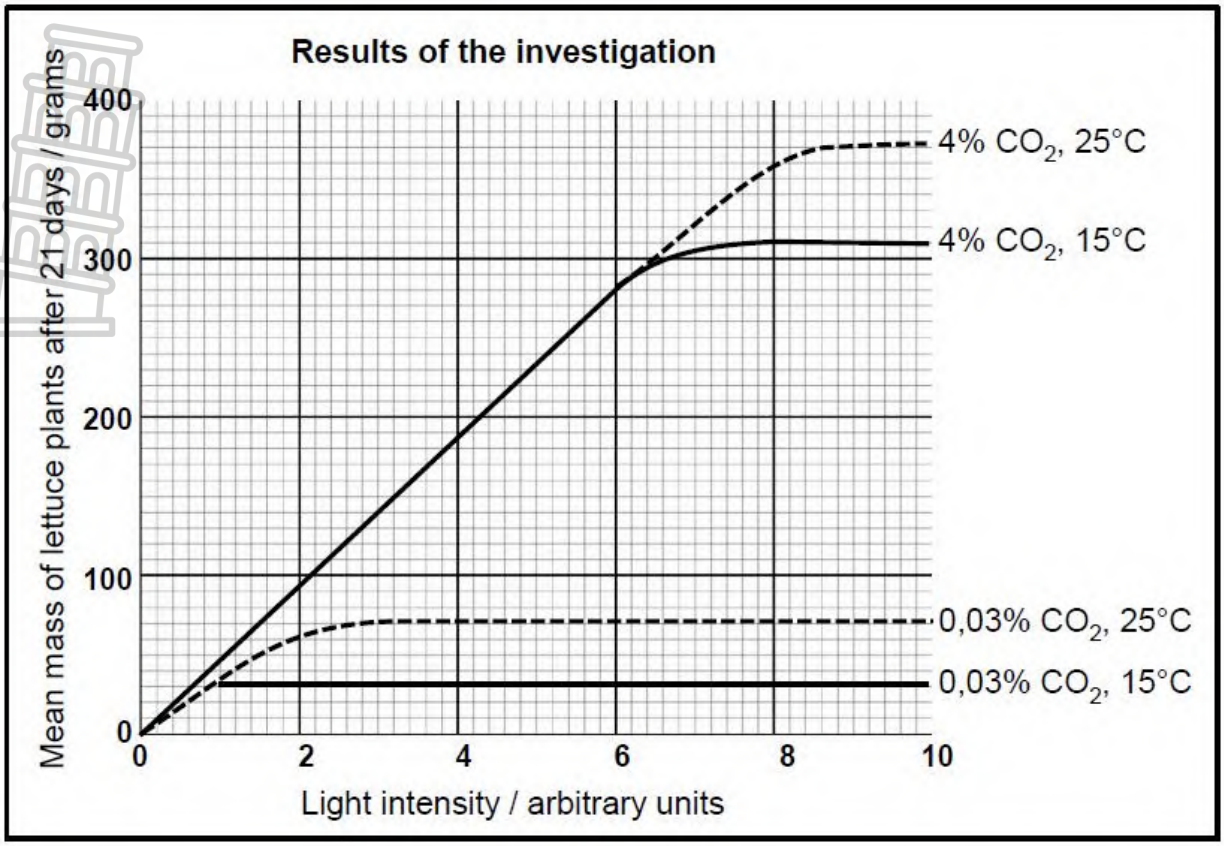

1.1 What is the influence of light intensity on average mass of lettuce plants? (3)

1.2 Name two limiting factors that influence the rate of photosynthesis as the light intensity increases? (2)

1.3 How were the scientists able to increase the rate of photosynthesis to the maximum level? (3)

1.4 What would happen to the rate of photosynthesis if the temperature is raised beyond 35°C? (1)

1.5 Give a reason for your answer in QUESTION 1.4. (1)

(10)

QUESTION 2

The diagram below shows the apparatus that was used to investigate the rate of photosynthesis in a submerged plant. The light intensity to which the plant is subjected was decreased at a regular interval by moving the light source away from the plant. The average number of bubbles minute was counted and recorded for each distance.

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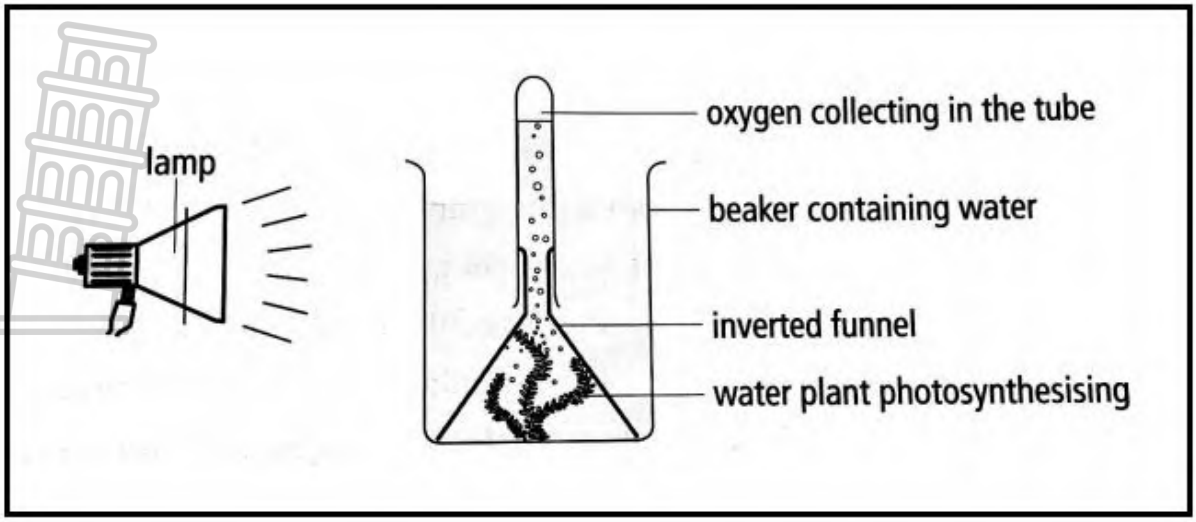

The results were recorded in a table:

Distance of lamp from the plant (cm)	**Number of bubbles per minute**
10	60
20	60
30	60
40	60
50	55
60	50
70	45
80	40
90	35
100	30

2.1 What is the aim of the investigation? (1)
2.2 Name the gas released by the plant. (1)
2.3 Describe a test to verify your answer in QUESTION 2.2. (2)
2.4 Describe the relationship between the gas released and light intensity. (2)
2.5 Name TWO other environmental factors, except light intensity which you think could change the rate of bubbles production. (2)
2.6 Draw a graph representing the results in the table above. (6)
(14)

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WEEK 4: TOPIC: Photosynthesis

SUB-TOPIC: Improved crop yields in greenhouse systems, the role of ATP as energy-carrier

NOTES & EXAM TIPS

How does a greenhouse work?

A greenhouse can help increase plant growth and fruit production and even allow you to grow **plants that wouldn't normally survive** in your climate.

Step 1: Light Comes In
In order to provide light, greenhouses need to have some way for the light to come in. This is why greenhouses are made of mostly translucent materials, like glass or clear plastic. This gives the plants inside maximum access to sunlight.

Step 2: Heat Is Absorbed
When the light comes in the glass walls of the greenhouse, it is absorbed by the plants, ground and anything else in the greenhouse, **converting it to infrared energy** (heat) in the process. The darker the surface, the more energy it can absorb and turn into heat.

Step 3: Heat Gets Trapped
Once the light energy gets converted into infrared energy (heat), it has a different "shape" than light energy - what scientists refer to as **wavelength**. The change in the wavelength makes it so that the heat can't easily escape out of the greenhouse's glass walls. So while getting in was easy, getting out is harder.

Step 4: Warming the Greenhouse
The trapped heat warms the air inside the greenhouse and because a greenhouse is relatively air-tight, the warmer air stays inside, raising the entire building's temperature.

Step 5: Staying Warm
With sufficient sunlight, the temperature inside a greenhouse may become much higher than the outdoor temperature; in fact, on a hot sunny day you may need to ventilate the greenhouse all day to keep from literally cooking the plants inside. On overcast days, less sunlight means that the greenhouse will heat up more slowly, if at all. For that reason, greenhouses are most useful in areas that have plenty of sun.

Step 6: Promoting Photosynthesis
All this light and warm temperatures give plants ample access to the sunlight and temperatures need to grow. This is because they have the right conditions for photosynthesis to occur. On average, plants need about six hours of sunlight per day, although this **varies depending on the type of plant;** placing your

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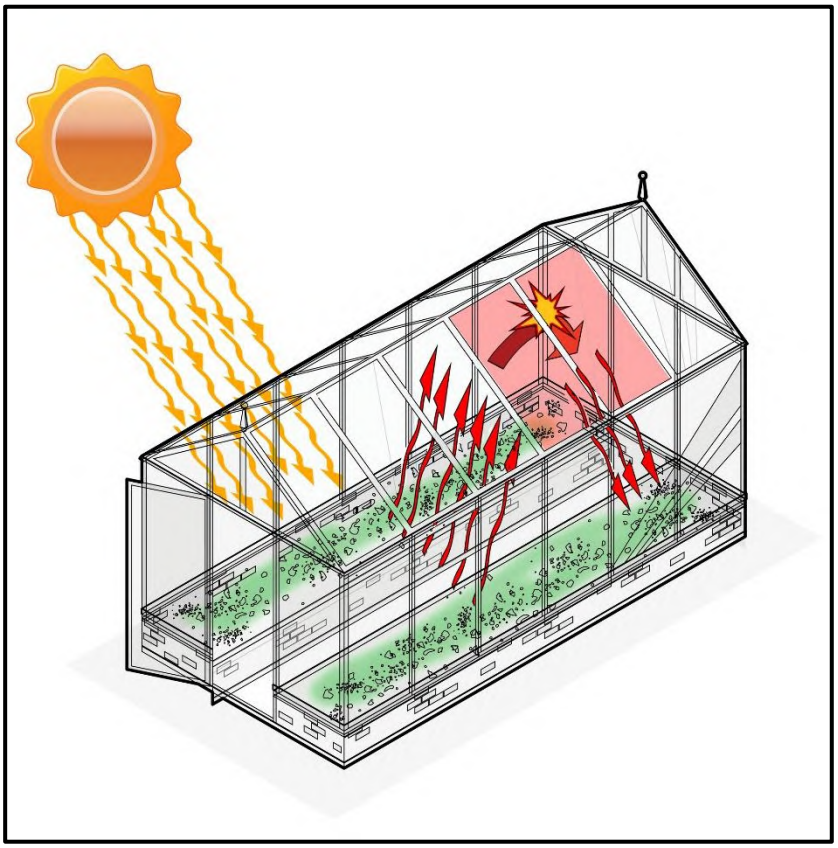
greenhouse where it will get full sun all day will ensure that the plants inside get enough light.



ATP as energy carrier in cells:

- ATP stands for adenosine triphosphate (Energy carrier)
- When a cell needs energy, ATP is broken down and the energy is released. Cells use this energy to produce important molecules such as proteins, fats etc.
- During photosynthesis the energy from ATP is used in the reaction that make energy-rich glucose from the raw material CO_2 and H_2O. When this happens, ATP loses a phosphate and ADP (adenosine diphosphate) is formed. Radiant energy from sunlight can then be used to change the less active ADP back to high energy ATP so that there is more energy available to do more work.

Investigation: Light is required for photosynthesis

Light is one of the requirements for photosynthesis. An investigation can be performed to show that without light, starch will not be produced and therefore no photosynthesis took place.

Hypothesis: Light is needed for photosynthesis.

Aim: To prove that light is required for photosynthesis

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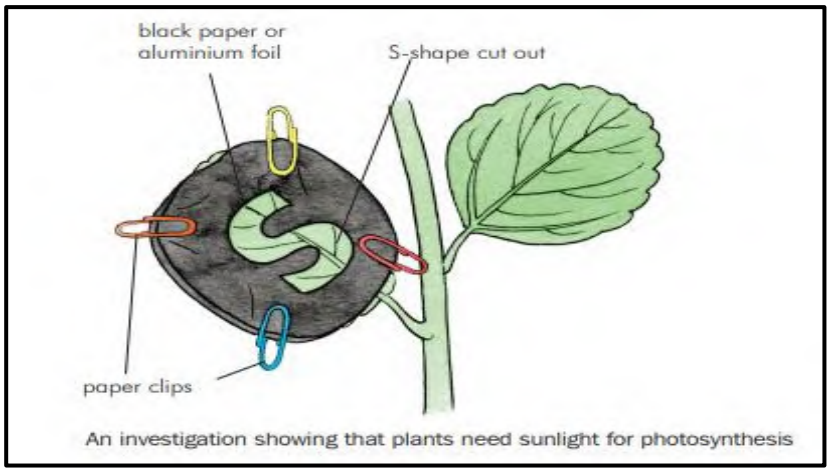
Materials/apparatus
destarched plant
alcohol
water bath
test tube
tripod & gauze
iodine solution
white spotting tile
tweezers
test tube holder, tinfoil

Method:

1. Destarch a potted plant by placing it in a dark cupboard for 48 hours
2. Cover a portion of the leaf, still attached to the plant, with aluminium foil with a pattern cut out.



An investigation showing that plants need sunlight for photosynthesis

3. Place the plant in a sunny area for 48 hours
4. Pick the leaf and remove the foil
5. Test for the presence of starch using the **starch test**.

The **experiment** is the part of the leaf covered by the foil, as it does not receive light. The part of the leaf left uncovered is the **control** as it receives all of the requirements for photosynthesis, including light.

Results:

Experiment (leaf covered with tinfoil): The parts of the leaf covered with foil remains light brown and the S-shape turns blue-black.

Control (leaf left uncovered): The complete leaf turns blue-black.

Conclusion: The parts that turn blue-black in colour contain starch. The part which remains light brown does not contain starch. Light is essential for photosynthesis to take place.

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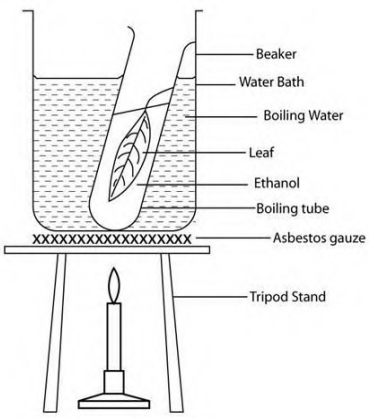
Watch the video: Investigating the effect of light intensity on the rate of photosynthesis: https://www.youtube.com/watch?v=id0aO_OdFwA

Starch Test Procedure

1. Bring water bath to boil.
2. Put leaf to be tested in the boiling water for about 30 seconds. *(This softens and kills the leaf)*
3. Remove the leaf from the water and place in tube of alcohol.
4. Put the tube back into the beaker of hot water. *(The alcohol will remove the chlorophyll).*
5. When the leaf is white, (about ten minutes) remove the leaf from the alcohol and place it once again in the hot water for a few seconds. (*The leaf will be brittle when you take it out of the alcohol and the hot water softens it).*

6. Place the leaf on the spotting tile and cover it with iodine. Leave for a minute or two.

7. The presence of a blue/black colour indicates the presence of starch.



TESTING A LEAF FOR STARCH

SAFETY PRECAUTIONS

1. Make sure that there is no naked flame lighting anywhere near the alcohol. It is particularly important if using a bunsen for the water bath that the bunsen is turned off before putting the alcohol into the bath.
2. Do not pour the alcohol down the sink.

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

The following table diagrams represent investigations involved in a process which takes place in green plants. The plant/leaves represented as **A** and **C** were exposed to sunlight for 4-5 hours.

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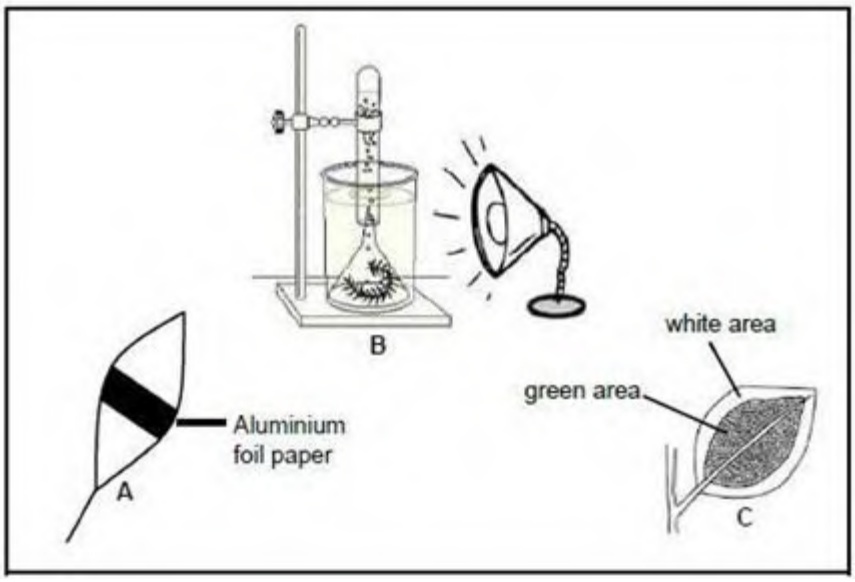

1.1 Which investigation (**A**, **B** or **C**) is designed to test the following?
   a) Chlorophyll is necessary for photosynthesis
   b) Light is required for photosynthesis
   c) Oxygen is produced during photosynthesis

1.2 Give the letter of the investigation that does not show a control.

1.3 Which investigation(s) needs a chemical to test for whether photosynthesis took place?

QUESTION 2

A tomato farmer was able to produce crops in greenhouse which were heated to between 15ºC and 22ºC. in addition, the carbon dioxide level was increased from the normal 0,03% to 0,1%.

2.1 State ONE way in which the farmer could have enriched the air inside the greenhouse with CO_2, without burning any fuel.

2.2 Explain how increasing the CO_2 levels up to 0,1% can lead to an increased production of tomatoes.

2.3 Name TWO other factors which might have to be increased to obtain an even greater yield when the CO_2 level is increased to above 0,1%.

2.4 The additional CO_2 is only provided during the daylight hours. Suggest a reason for this.

2.5 Predict what would happen if the CO_2 concentration within the greenhouse is increased to 0,5% for between 10 to 15 days if all other factors are kept constant.

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WEEK 5: TOPIC: Animal nutrition

SUB-TOPIC: Dentition for herbivorous, carnivorous and omnivorous lifestyles.

NOTES & EXAM TIPS

Mammalian animals have teeth that are adapted to eating certain types of food. There are four types of teeth, although not all mammals have all types. In the front of the mouth are **incisors**, teeth that function in chiseling or nipping. On each side of the incisors may be found the **canines**, useful in biting and piercing prey. Behind the canines are "cheek teeth": the **premolars**, that do some grinding, and the **molars**, that do most of the grinding and chewing. Muscles in the jaws are designed to put a great deal of force behind this motion.

The size and shapes of these tooth types are correlated with the different diets of mammalian species.

Herbivores (herbi, plant; vore, eater) are animals that consume plant material.

- Cow, deer, horse, giraffe, squirrel, and butterfly are examples of herbivores.

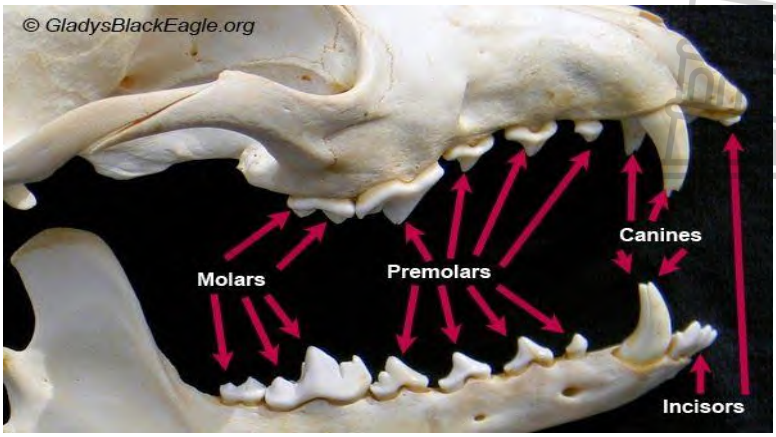
Carnivores (carni, meat; vore, eater) are meat eating animals that have to hunt and kill their prey to eat.

- Lion, tiger, jackal, vulture, owl, eagle, snake, and spider are examples of carnivores.

Omnivores (omni, all; vore, eater) are adapted to eating both plant and animal tissue.

- Bear, raccoon, crow, and human beings are examples of omnivores.

<u>Teeth of herbivores, carnivores and omnivores</u>



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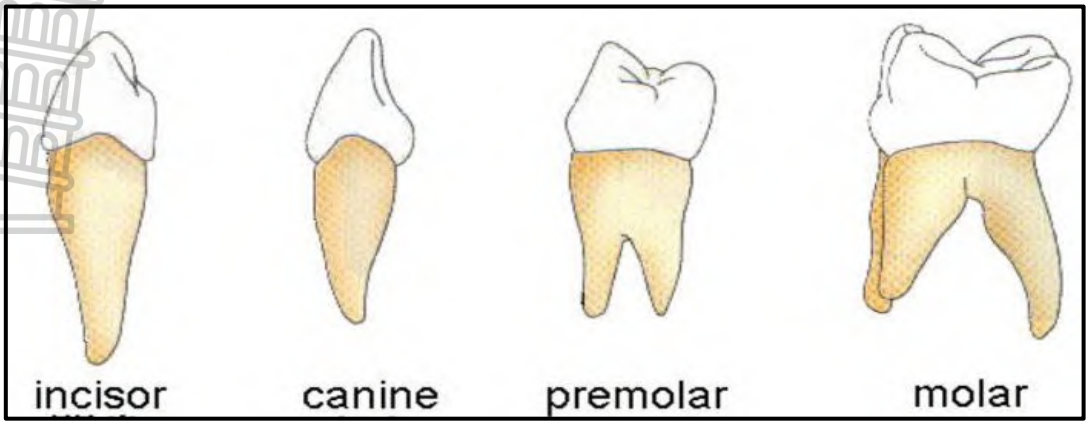
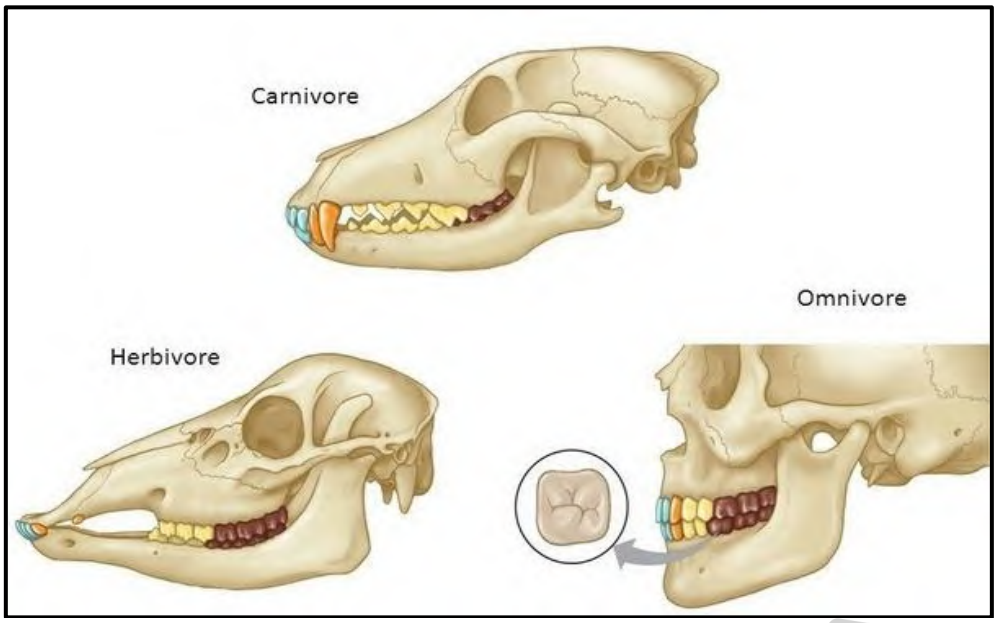
Types of teeth



Skulls of herbivores, carnivores and omnivores



Different teeth = Different diets

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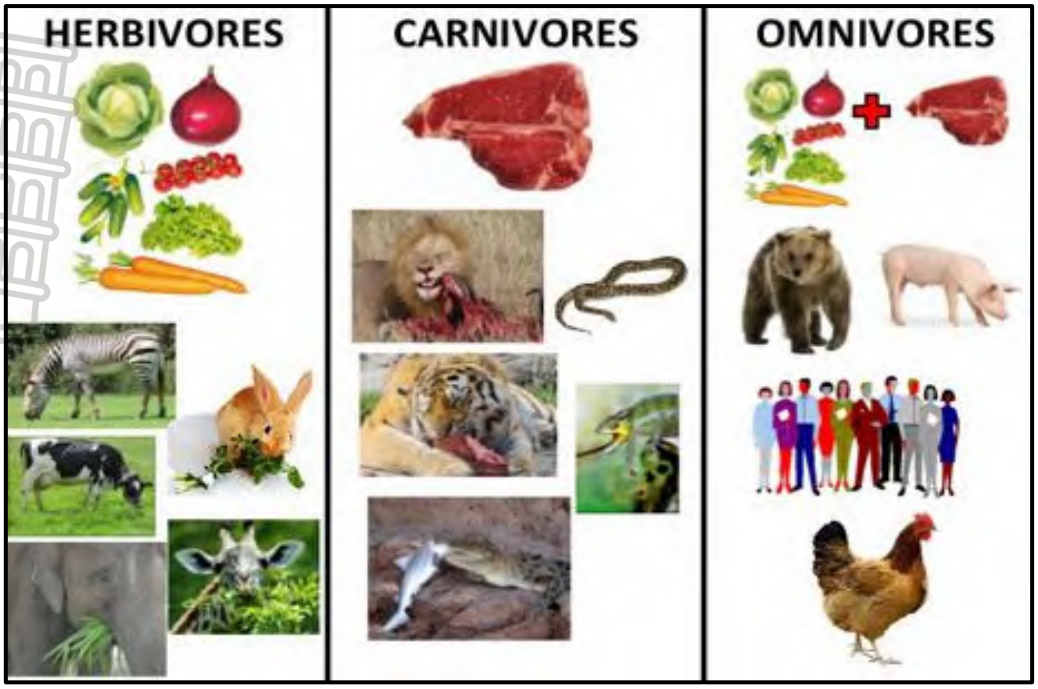
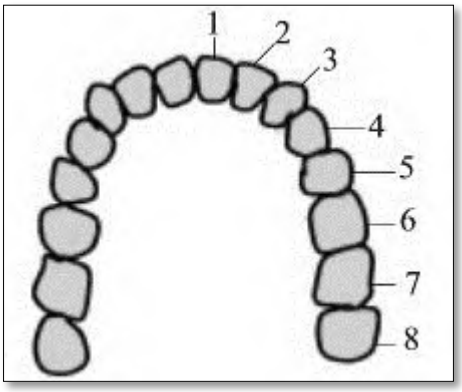


ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 and 1.2) in your ANSWER BOOK, for example 1.3. C.

1.1 What type of teeth are **1** and **2** in the following diagram?



A Incisor
B Canine
C Molar
D Premolar

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1.2 Of the four types of teeth found in mammals, which type is used for tearing and holding on to the prey?

A Canines
B Premolars
C Molars
D Incisors

QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.2) in your ANSWER BOOK.

2.1 The group of animals that feed only on plant material.
2.2 Flat and uneven teeth used for grinding and crushing food.

QUESTION 3

Complete the table below:

	Herbivore	**Carnivore**	**Omnivore**
Type of food			
Facial muscles (Complexed/Reduced)			
Example			

QUESTION 4

The following table compares the dental formulae of three animals: a horse, leopard and man. Study it and answer the questions that follow.

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Animal	I	C	P	M
A	$\frac{2}{2}$	$\frac{1}{1}$	$\frac{2}{2}$	$\frac{3}{3}$
B	$\frac{3}{3}$	$\frac{1}{1}$	$\frac{4}{4}$	$\frac{3}{3}$
C	$\frac{3}{3}$	$\frac{1}{1}$	$\frac{3}{3}$	$\frac{1}{1}$

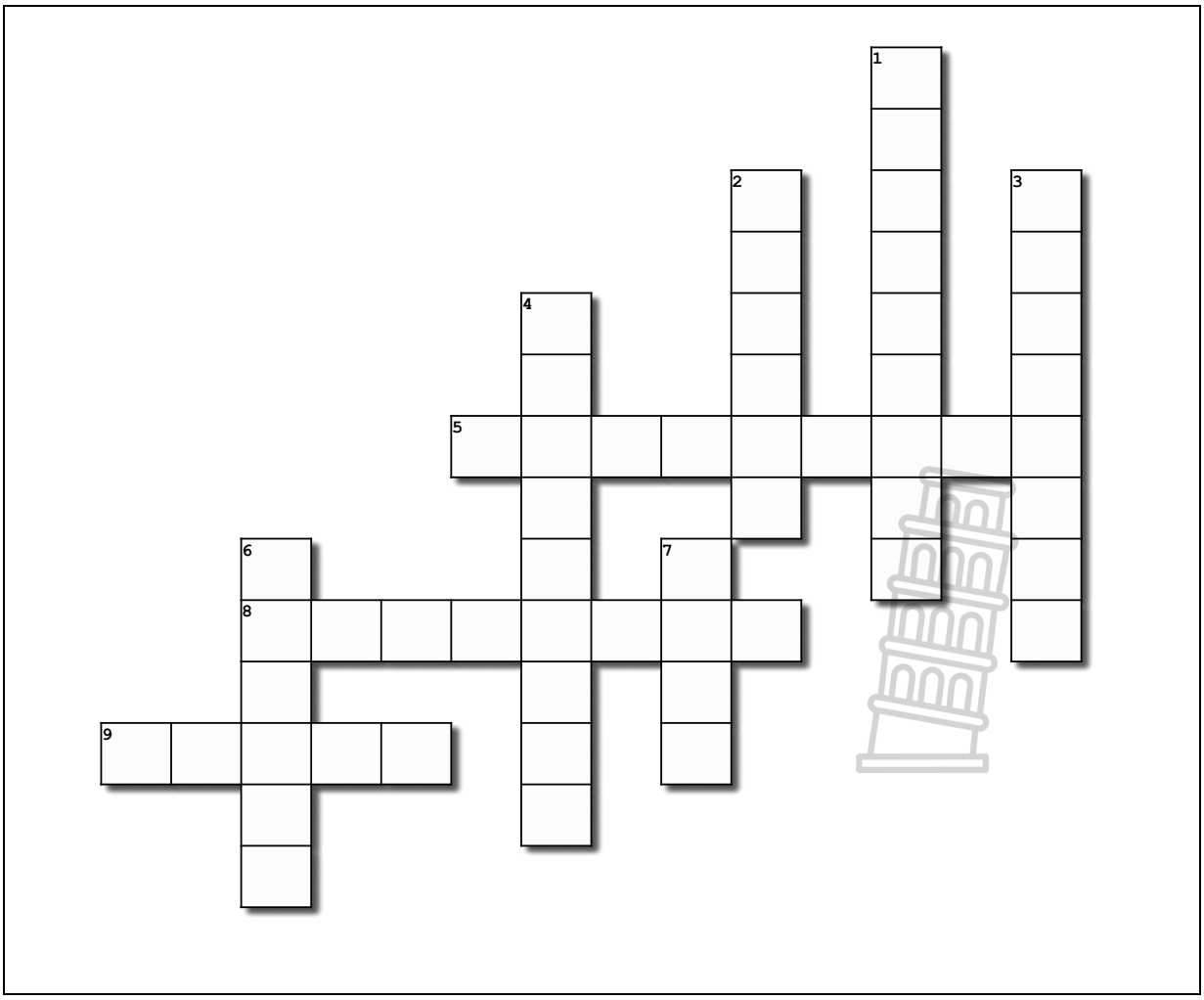
4.1 State which animal (horse, leopard and man) is represented by **A**, **B** and **C**.

4.2 Explain each of your answers to QUESTION 4.1.

4.3 Calculate the total number of teeth that each animal has.

QUESTION 5

Complete the crossword puzzle below.



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Across

5. animals which hunt other animals
8. animal that eats plants and animals
9. sharp curved nails on animal foot

Down

1. animals that eat plants only
2. warm bloodied animals with hair
3. front teeth
4. animal that eat other animals only
6. back teeth
7. animal that is hunted and eaten

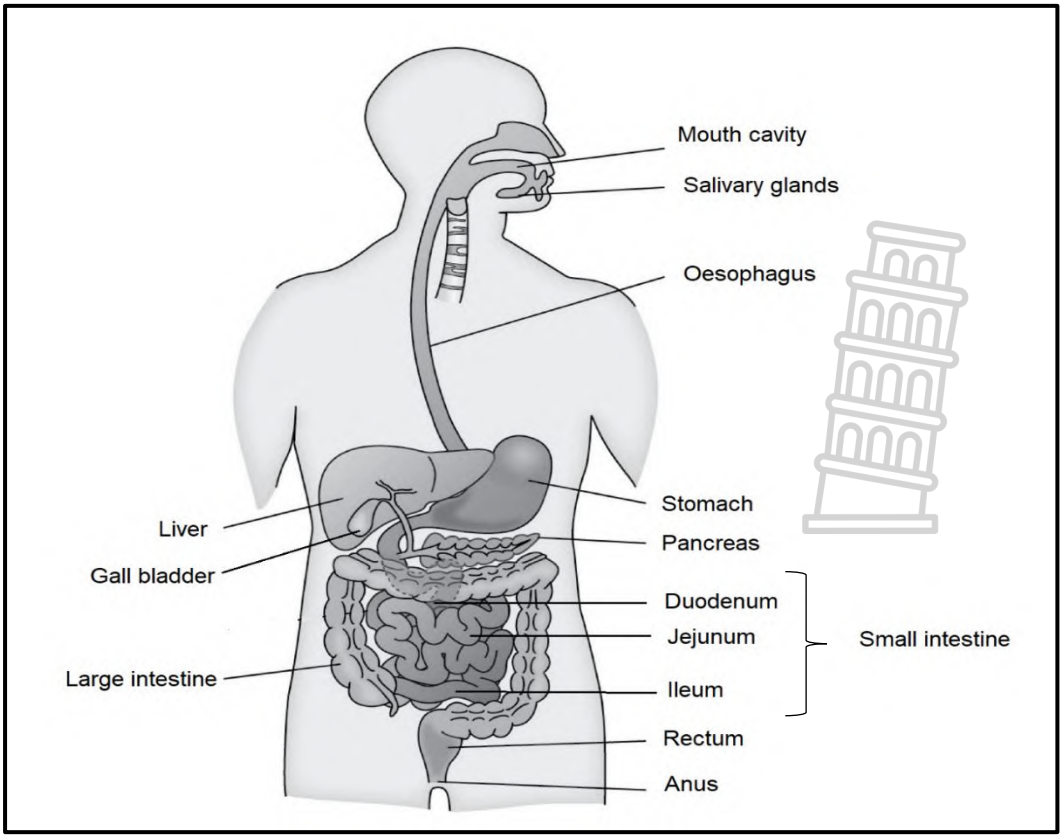
WEEK 6: TOPIC: Animal nutrition

SUB-TOPIC: Human nutrition (Organs, functions, ingestion, digestion).

NOTES & EXAM TIPS

The digestive system

The digestive system is made up of the alimentary canal and associated organs. The **alimentary canal** is made up of the mouth, pharynx, oesophagus, stomach, small intestines, and large intestines. **Accessory organs** are organs that aid in the alimentary canal to perform its digestive function. These include the tongue, teeth, salivary glands, pancreas, liver, and gall bladder.



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The alimentary canal

1. The mouth cavity, salivary glands, teeth, and tongue

The mouth cavity consists of two lips in the front, a tongue, and teeth as the floor of the mouth and teeth and palate as the roof of the mouth. The mouth is made up of stratified epithelium connective tissue that also has salivary glands that produce saliva.

The tongue is a movable muscular organ that pushes the food between the teeth for mastication, assist in mixing food with saliva, forming food into a bolus and swallowing food. It also contains taste buds and serve as the organ of taste.

The salivary glands are found in the muscles around the mouth. Salivary glands are referred to as exocrine glands since it transports secretions by means of ducts. Salivary amylase or carbohydrase are released from the salivary glands to hydrolyse carbohydrates during chemical digestion.

The teeth are embedded in the upper and lower jaws. There are four types of teeth namely incisors, canines, premolars, and molars. The human dental formula is $\frac{2.1.2.3}{2.1.2.3}$ that is half of the upper jaw. This means that the human mouth has 2 incisors, 1 canine, 2 premolar and 3 molars in one half in the upper jaw. These values are multiplied by 4 to get the total number of teeth in the human.

Types of human teeth

Type of teeth	Description	Function	Total in the human mouth
Incisors	Shaped like chisels	Used for biting off pieces of food	8 incisors
Canine	Conical in shape	Assist incisors in tearing off food	4 canines
Premolars	Flat surfaces with two pointed cusps	Grinding the food	8 premolars
Molars	Large flat surface with three to five cusps	Grinding and crushing the food	12 molars

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2. **The Pharynx**

   The area at the back of the mouth cavity that passage into oesophagus. The opening to the trachea is closed during swallowing by a leaf shaped cartilage called the epiglottis. This prevents a person from choking on food.

3. **The oesophagus**

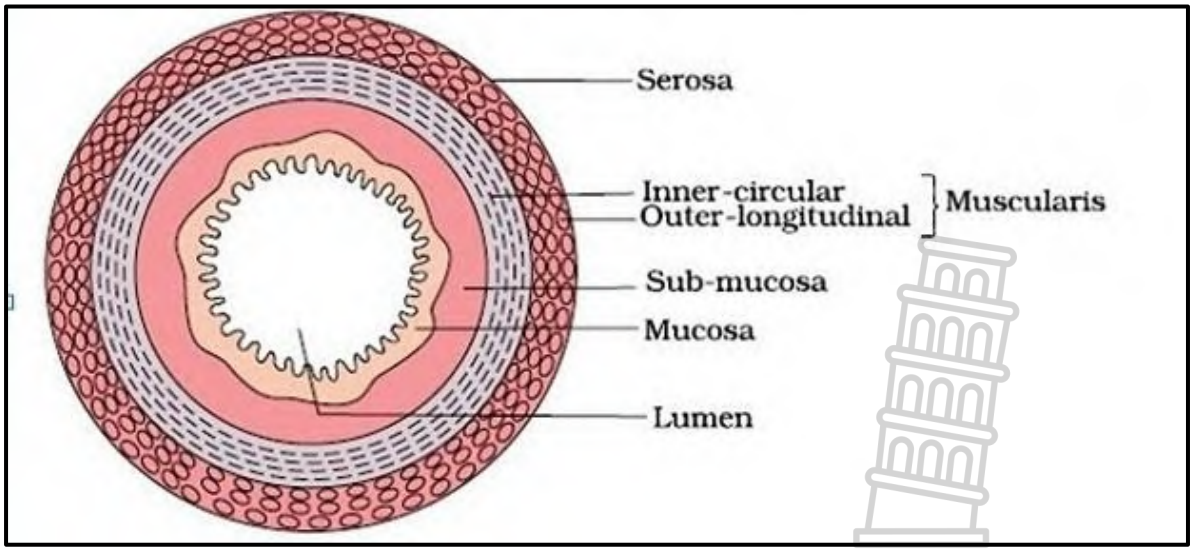
   The narrow tube that run from the pharynx to the stomach.

4. **The stomach**

   The stomach is a bag-like organ in the abdominal cavity below the diaphragm. The cardiac sphincter prevent food from pushing from the stomach back into the oesophagus. When food leave the stomach, it enters the duodenum (small intestine), and a pyloric sphincter prevents food from pushing back into the stomach.

5. **The small intestines**

   The small intestines are divided into three parts. The duodenum, jejunum, and ileum. The duodenum receives bile salts and enzyme lipase for the digestion of lipids. The jejunum is a mid-size tube that leads to the ileum which is the longest part of the small intestine. The small intestine contains four layers that helps with the digestion process.



The four layers of the small intestine. (http:// criticalcaredvm.com)

Layer 1: the serosa is on the outside of the small intestine.
Layer 2: the muscular layer that consists of longitudinal and circular muscles.
Layer 3: the submucosa made up of connective tissue with blood vessels, lymph, and nerves.

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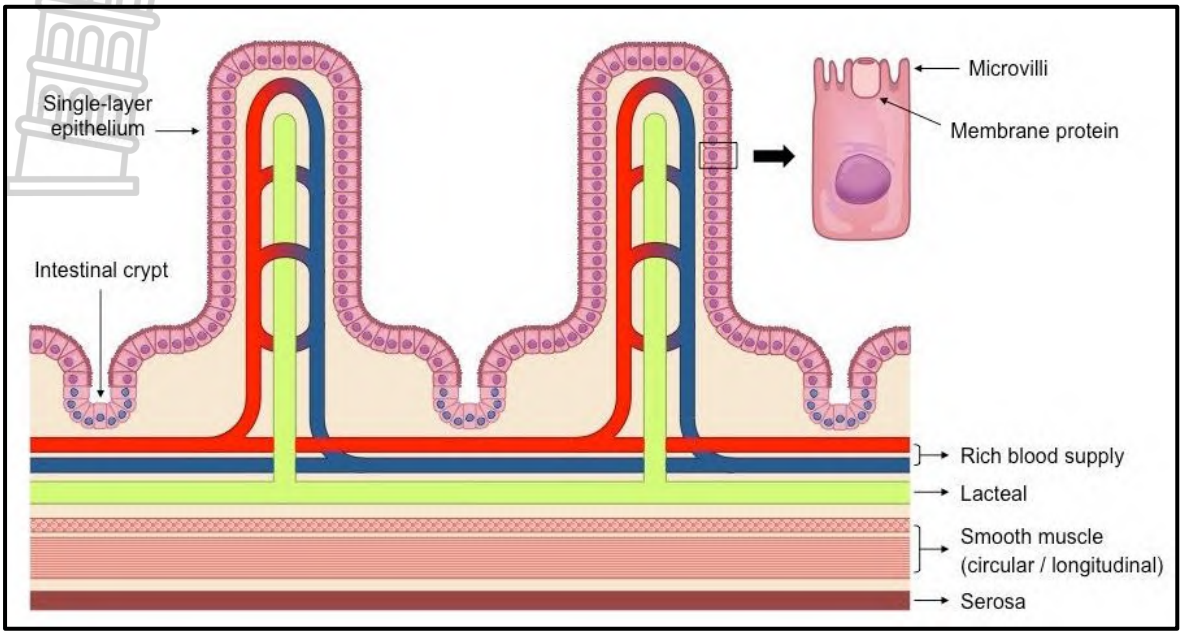
Layer 4: the mucosa that is the most inner layer with columnar epithelium that secrete mucous. The mucosa contains millions of finger-like projections called villi that plays a role in absorption.



The villi

6. **The large intestines**

The large intestines consist of three parts namely the caecum, colon, and rectum. The caecum is the sac-like portion which opens from the small intestine, the colon that leads to the rectum, and the rectum that opens into the anus. The appendix is attached to the caecum.

Accessory organs

1. **The liver and gall bladder**

The liver is a large organ lying just below the diaphragm partially covered by the stomach. The liver consists of two lobes which has two ducts known as the hepatic and cystic duct. The hepatic duct arises from the liver cells and the cystic duct arise from the gall bladder. Main functions of the liver are to act as storage place for glycogen and minerals such as iron. Secondly the liver deaminate excess amino acids which forms urea that is excreted by the kidneys and lastly to detoxify harmful substances such as drugs and alcohol.

The call bladder secretes a yellow green alkaline liquid that has no enzymes that is responsible for the emulsification of fat. Emulsification of fat refers to the break-up of fats into droplets to increase the enzyme action of lipase to digest lipids.

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2. **The pancreas**

   The pancreas is a large gland which lies in the loop of the duodenum that secretes pancreatic juice from the islets of Langerhans. These specialized cells secrete the hormone insulin and glucagon responsible for controlling the blood sugar level. Pancreatic juice contains enzymes that helps in the digestion of lipids.

Processes of the digestive system

The digestive system consists of four processes:

1. **Ingestion**
2. **Digestion**
3. Absorption and assimilation
4. Egestion

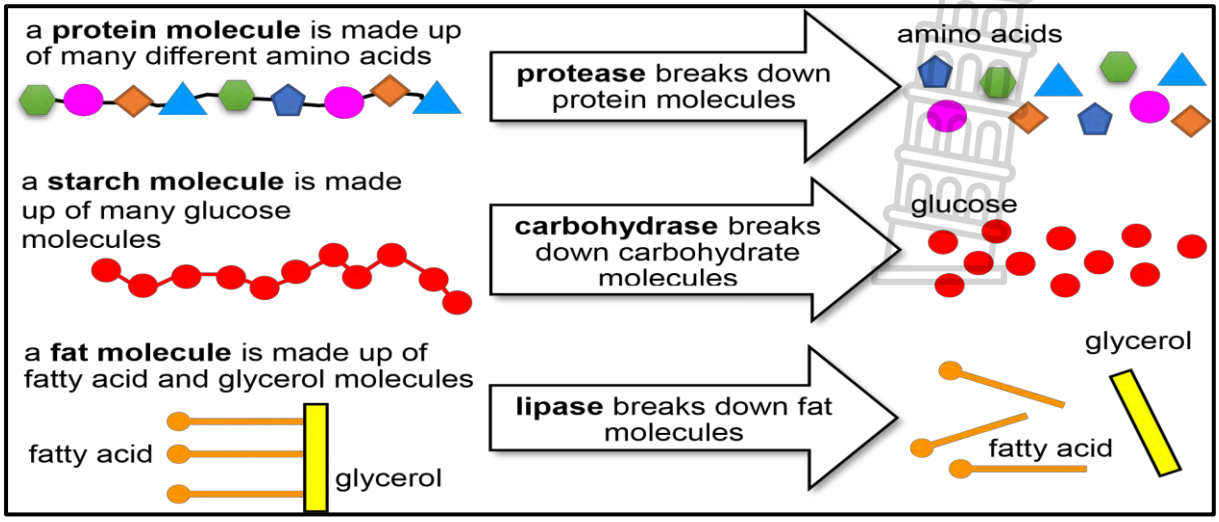
Ingestion

Ingestion is the process of taking in food through the mouth cavity. Pieces of food are bitten off by the teeth before mechanical digestion takes over digestion. Refer to the above descriptions of each organ for functions.

Digestion

Food is digested by means of chemical and mechanical digestion. Mechanical digestion refers to the breakdown of food by the action of muscles whereby chemical **digestion** involves the chemical breakdown of food by means of chemicals such as enzymes.

The enzymes that help with the breakdown of food includes:



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Group of enzymes	Carbohydrase	Protease	Lipase
Where they are produced	Saliva, pancreatic juices, intestinal juices	Stomach, pancreatic juices intestinal juices	Pancreatic juices, intestinal Juices
Substrate	Carbohydrates (starch)	Proteins	Lipids (fats and oils)
Preferred pH	Slightly alkaline	Acidic in stomach, Alkaline in small intestine	Slightly alkaline
End product of digestion	Glucose	Amino acids	Glycerol & fatty acids

Other chemicals include pancreatic juice, gastric juice, and bile. Gastric juice contains the enzyme protease as well as hydrochloric acid that breaks down protein and acts as an antiseptic to kill germs taken in with the food. Pancreatic juice meets the bile in duodenum which contains sodium bicarbonate that neutralizes the acid food coming from stomach.

Mechanical digestion includes mastication in the mouth and peristalses in the oesophagus, stomach, and the small intestines. Mastication breaks the food into a fine pulp which mix the food with saliva using the tongue. The tongue, and palate mould the food into a small bolus that helps during the swallowing process. The tongue moves back and up to close the glottis using the epiglottis to prevent the food from choking a person.

Peristalsis is the rhythmical contraction of muscles of the alimentary canal causing the food to move along the gut. This action is involuntary. The circular muscles of the oesophagus wall above the bolus contracts which narrows the tube above the bolus. The circular muscles under the bolus relax and the oesophageal wall widens forcing the bolus downward. The stomach has muscles that allow the food through peristalsis to mix the food with gastric juices and pushing the food into the small intestine.

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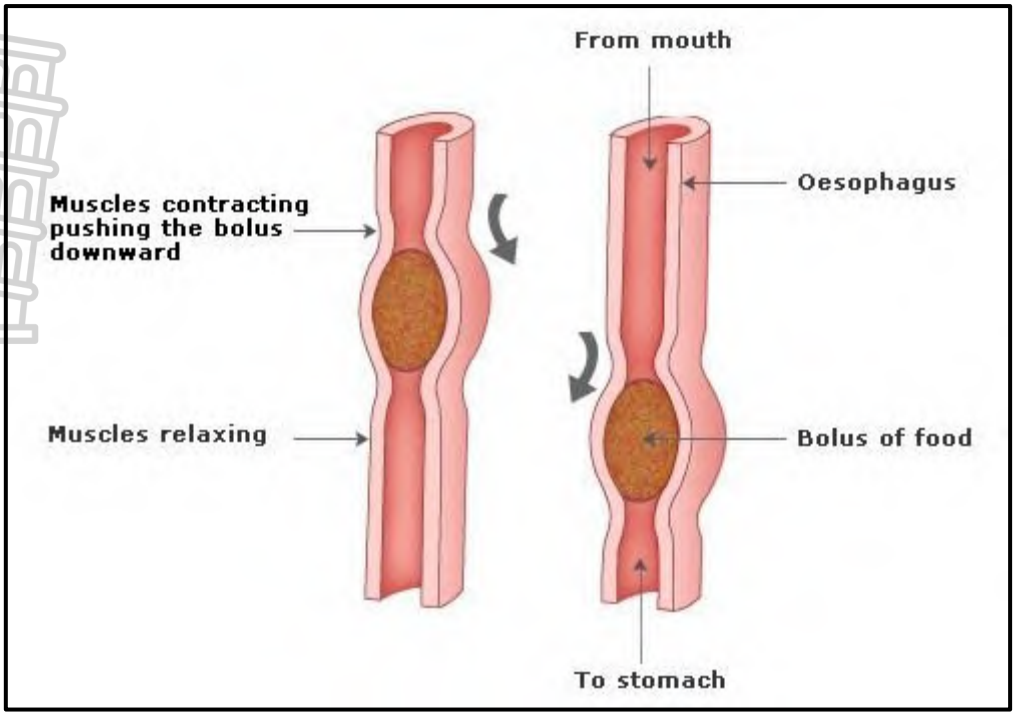

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) NEXT TO THE QUESTION NUMBER 1.1-1.6 in your ANSWER BOOK, e.g. 1.7 D.

1.1 Which ONE of the following can be absorbed into the blood without further digestion?

A Starch
B Glycogen
C Glucose
D Fats

1.2 If the pancreatic duct is cut.

A Protein digestion will not be affected
B Homeostatic control of the glucose level will be affected
C Carbohydrates digestion will be affected
D Carbohydrates digestion will be affected

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1.3 Which ONE of the following is not part of the alimentary canal?

A Stomach
B Colon
C Pancreas
D Appendix

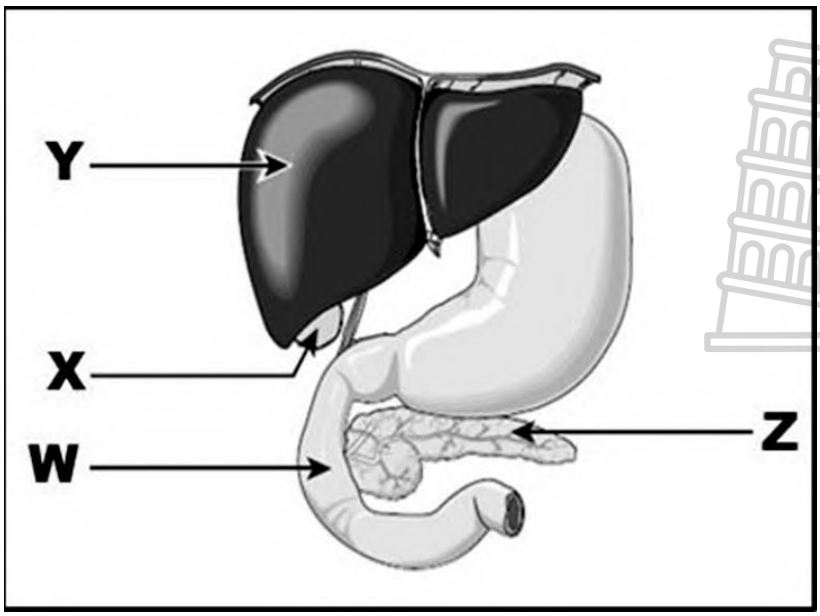
1.4 Which ONE of the following combinations of temperature and pH values will give the best conditions for a protein digesting enzyme found in the stomach?

A 25°C, pH 2
B 30°C, pH 5
C 37°C, pH 3
D 40°C, pH 7

1.5 Where does the emulsification of fat occur? In the …

A Liver.
B Colon.
C Gallbladder.
D Small intestine.

1.6 **Study the accompanying diagram and answer Question 1.6**



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Which labeled structure secretes a hormone which causes an increased production of glycogen?

A Z
B Y
C X
D W

(12)

QUESTION 2

Give the correct **biological** term for each of the following descriptions. Write only the term next to the question number.

2.1 The muscular tube that connects the mouth cavity to the stomach.

2.2 The tiny finger-like projections in the small intestine

2.3 Substance secreted by the liver to emulsify fats

2.4 Ball of chewed food mixed with saliva formed in preparation for swallowing

(4)

QUESTION 3

Indicate whether each of the descriptions in Column I applies to **A ONLY**, **B ONLY**, **BOTH A AND B,** or **NONE** of the items in Column II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number.

	Column A	**Column B**
3.1	Substances that need to be digested before absorption	A: amino acid B: glucose
3.2	The enzymes secreted by the pancreas	A: proteases B: carbohydrates
3.43	The structure where chemical digestion does not take place	A: oesophagus B: large intestine

3x2= **(6)**

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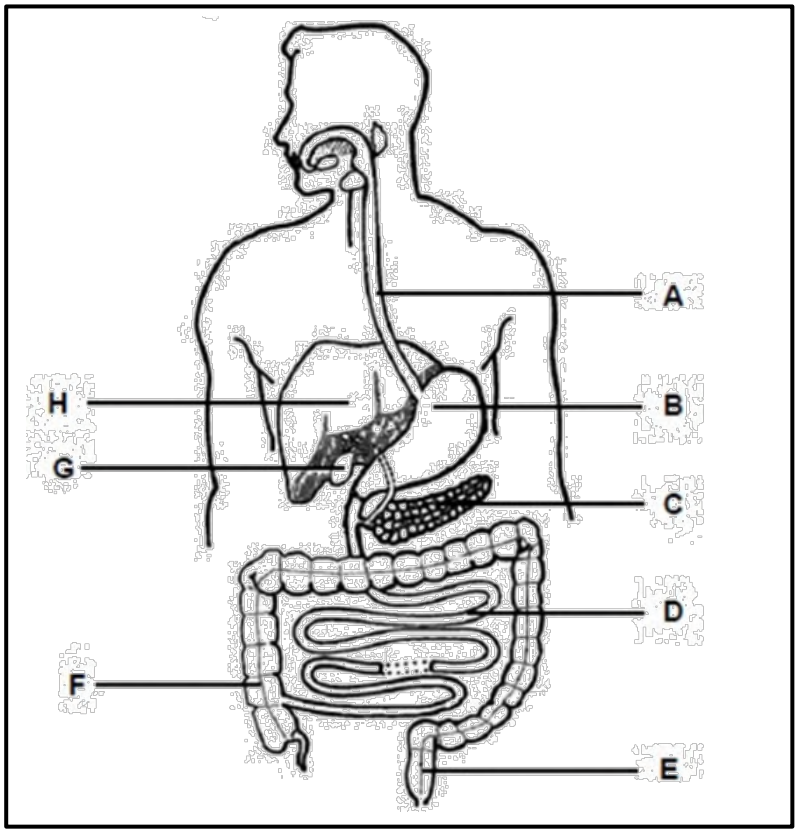
QUESTION 4

Study the diagram below which shows the human digestive system



4.1 Label parts **A**, **C**, **E** and **H** respectively (4)

4.2 Write the letter of the part …..

(a) that stores bile (1)

(b) where most enzymes are active to digest food (1)

(c) where most water and mineral salts are absorbed (1)

(7)

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QUESTION 5

In a shooting accident at the age of 19, Alexis St Martin's left side of his abdomen was shot away. A medical doctor, Dr Beaumont was quickly on the scene but did not give Alexis 36 hours to live.

Alexis however made a miraculous recovery but was left with a hole in his stomach. To prevent that food and juices pour out, he had to wear a bandage.
Dr Beaumont used this golden opportunity to study the digestion process in the stomach. He tied a string around a piece of meat and inserted it through the hole in Alexis' stomach. At frequent intervals the meat was removed to find out how long it would take for the meat to be digested.

In a series of experiments he used gastric juices from Alexis' stomach. Different types of food was placed into test tubes and covered with Alexis' gastric juice at 38°C. The digestion time of these nutrients were compared with the digestion time in the stomach.

[www.livescience.com]

The results are represented in the table below.

Type of food	**Digestion time in the stomach (min)**	**Digestion in the test tube (min)**
Raw eggs	120	255
Hard-boiled eggs	210	480
Milk	135	285
Steak	190	495
Cheese	210	

5.1 Why were the test tubes kept at 38°C? (2)

5.2 Which organic nutrient is present in all the above food types? (1)

5.3 Give the name of the enzyme responsible for the digestion of this nutrient. (1)

5.4 Why does it take longer to digest a hard-boiled egg than a raw egg? (2)

5.5 Make use of a bar graph to show the digestion time of the different types of food in the stomach only. (6)

(12)

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WEEK 7: TOPIC: Animal nutrition

SUB-TOPIC: Human nutrition (Absorption, assimilation and egestion)

NOTES & EXAM TIPS

ABSORPTION

- Digested food is now in a soluble form and ready to be absorbed into the bloodstream.
- Most absorption of digested food occurs in the small intestine.
- The **small intestine** is **structurally adapted** for maximum absorption
  - The length of the small intestine ensures that food remains for long periods, allowing enough time for maximum absorption.
  - There are transverse folds and millions of villi in the mucosa of the wall of the small intestine, which increase the absorption surface considerably.
- The soluble nutrients are mainly absorbed through the villi.

- The **villus** is **structurally adapted** for efficient absorption of these nutrients:

  - The columnar epithelium surrounding the villus is only one cell layer thick for fast and easy diffusion.
  - The villus is richly supplied with capillaries for the absorption of glucose, amino acids, vitamins, mineral salts and water.
  - The villus has a central lacteal for the absorption of fats.
  - Goblet cells in the columnar epithelium secrete mucus which is the medium in which nutrients dissolve.
  - The columnar epithelium has many mitochondria which provide energy for active transport.
  - Microvilli on the columnar epithelium increase the absorption surface.

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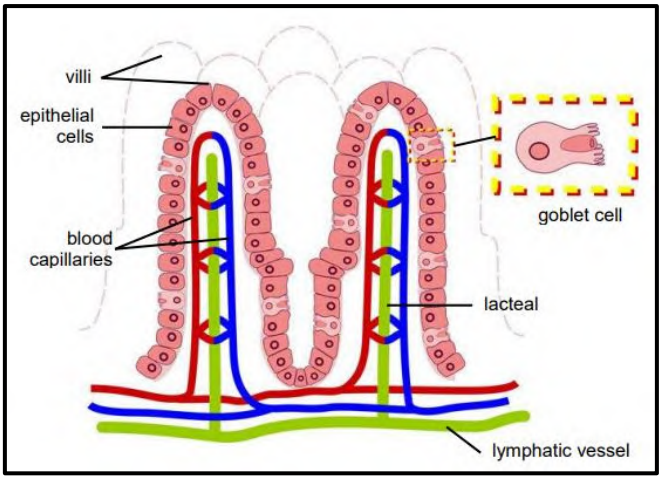

Intestinal villi

Absorption process

- The end products of digestion (glucose, amino acids, fatty acids and glycerol) as well as vitamins, mineral salts and water are absorbed by the villi in the small intestines.
  - **Glucose**, the end product of carbohydrate digestion, is actively absorbed, against the concentration gradient, into the blood capillaries of the villi.
  - **Amino acids**, the end products of protein digestion, are also actively absorbed, against the concentration gradient, into the blood capillaries.
  - **Glycerol and fatty acids**, the end products of lipid digestion, are absorbed by diffusion into the lacteals aided by bile salts.
  - **Vitamins** – fat soluble vitamins (A, D, E and K) are passively absorbed or aided by carrier molecules.
  - **Mineral salts** are both actively and passively absorbed into the capillaries.
  - **Water** is absorbed into the capillaries by osmosis.

Large amounts of water, certain vitamins and mineral salts are also absorbed in the colon.

Transport of absorbed nutrients

- Glucose, amino acids, vitamins, mineral salts and water are absorbed through the blood capillaries in the villi.
- The capillaries join to form larger veins that eventually open into the **hepatic portal vein**.
- The hepatic portal vein transports the absorbed nutrients to the liver.

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- In the liver:
  - most of the glucose is converted to glycogen and stored in this form.
  - excess amino acids undergo deamination to form urea and glucose.
- The urea is transported to the kidneys where it is excreted as part of urine.
- The remaining glucose and amino acids leave the liver via the hepatic veins and are transported in the inferior vena cava to the heart and to the rest of the body.
- A large portion of glucose is transported to the tissues (especially muscle tissues), where it is broken down by cellular respiration to CO_2 and water with the release of energy.

- Fatty acids and glycerol are absorbed by the lacteals of the villi.

- The lacteals unite and form larger lymphatic vessels that eventually open into the thoracic duct.

- Fatty acids and glycerol in the thoracic duct enter the blood system at the left subclavian vein and are transported to the rest of the body via the heart.

ASSIMILATION

- The body cells absorb the required nutrients, necessary for the building compounds and cell structures, from the blood.
- This process is known as assimilation.

EGESTION

- Large amounts of water are absorbed from the semi-solid waste in the colon, which reduces the liquidity of the content.
- Undigested and indigestible waste (faeces) is stored temporarily in the rectum.
- Muscle contractions of the rectum and relaxation of the circular muscle of the anus cause faeces to be expelled to the outside. The process is also known as defecation.

- Roughage is indigestible substance found in plant material. These include cellulose, lignin and pectin.
- Roughage is essential for the effective functioning of the digestive system in that it:
  - promotes peristalsis – decreases transit time
  - prevents constipation and haemorrhoids
  - softens faeces to facilitate defecation

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Terminology	
Ingestion	Taking in food complex foods into the body by biting and chewing
Digestion	The breaking down of complex food into simpler substances using mechanical and chemical methods.
Absorption	Absorbing simple food substances into the blood.
Assimilation	Taking the simple food substances from the blood into the body cells.
Egestion	Excreting waste products from food products the body no longer need.
Carbohydrates	Main source of macronutrients such as sugars, starches, and fibres.
Lipids	Macronutrient made from 3 fatty acids and one glycerol providing energy to the body
Protein	Macronutrient made from amino acids important for building muscles.
Alimentary canal	Continuous tube that starts at the mouth and end at the anus that consists of different organs with different functions to aid in nutrition.
Accessory organs	Organs in the digestive system that does not form part of the alimentary canal but aid the alimentary canal with digestion.
Enzyme	A biological molecule (protein) that significantly speed up the rate of chemical reactions that take place within cells. They are vital for life and serve a wide range of important functions in the body.
Protease	Enzyme that hydrolyses protein into amino acids
Lipases	Enzyme that hydrolyses lipids into fatty acids and glycerol
Carbohydrase / Salivary amylase	Enzyme that hydrolyses carbohydrates into simple sugars such as glucose
Peristalsis	The contraction and relaxation of muscles in the oesophagus to aid in the movement of food to the stomach.

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (1.1 to 1.5) in the ANSWER BOOK.

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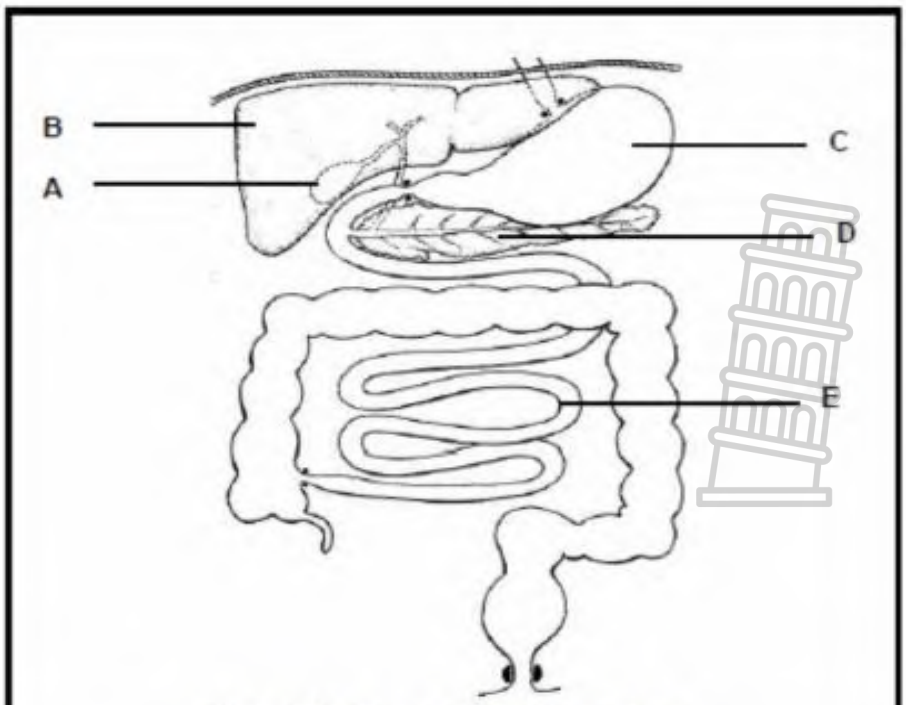
	COLUMN I		COLUMN II
1.1	Elimination of undigested food, usually via defecation	A B	Ingestion Egestion
1.2	Absorption of nutrients by body cells for building compounds	A B	Assimilation Peristalsis
1.3	A lymph vessel in the villus of the small intestine	A B	Lacteal Lymphatic node
1.4	Transports absorbed nutrients to the liver	A B	Inferior vena cava Hepatic portal vein
1.5	Actively absorbed against the concentration gradient into blood capillaries	A B	Glucose Amino acids

(5 x 2) **(10)**

QUESTION 2

Study the diagram below, which shows part of the human digestive system, and answer the question that follow



Part of the human digestive system

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2.1 Identify parts **B** and **E**. (2)

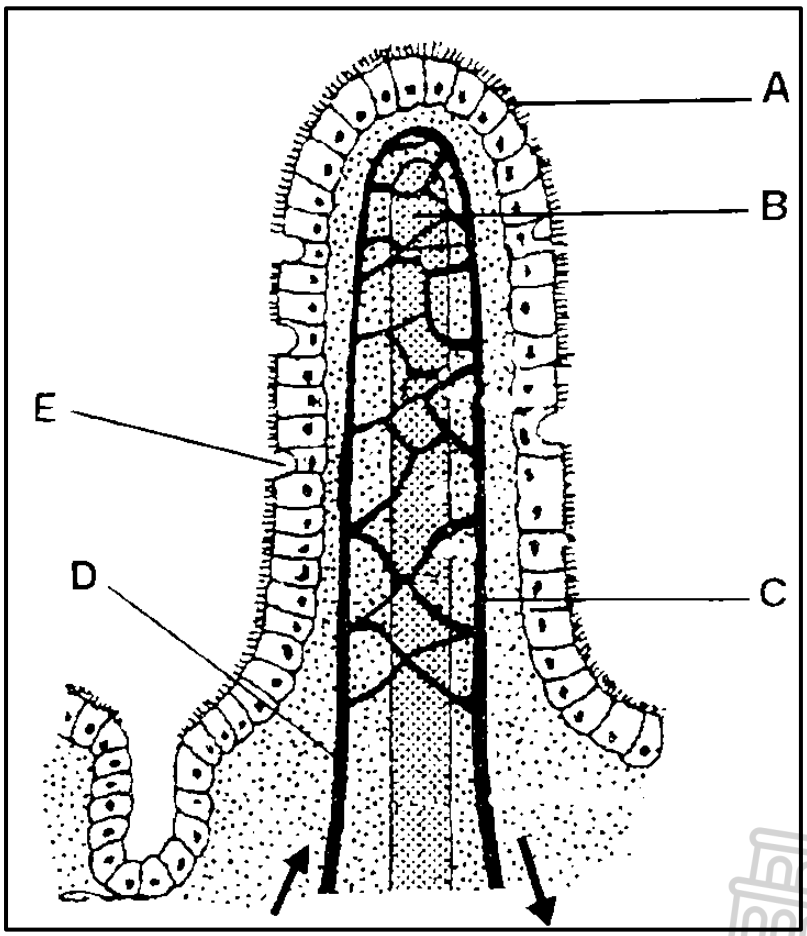
2.2. Explain THREE structural adaptations of **E** for effective absorption. (6)

2.3 State THREE functions of roughage (fibre) in the digestive system. (3)

(11)

QUESTION 3

The accompanying diagram represents a structure associated with the human digestive system. Study the diagram and answer the questions that follow.



3.1 Which structure is represented here? (1)

3.2 State the main function of the above structure. (1)

3.3 Explain TWO reasons why this structure is so efficient in its function. (4)

3.4 Name TWO substances which are found in higher concentration in **C** than in **D**. (2)

3.5 Label parts **A** and **E**. (2)

3.6 Briefly explain the function of structure **B**? (2)

(12)

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WEEK 8: TOPIC: Animal nutrition

SUB-TOPIC: Human nutrition (Homeostatic control, which involves the hormonal control of blood sugar levels).

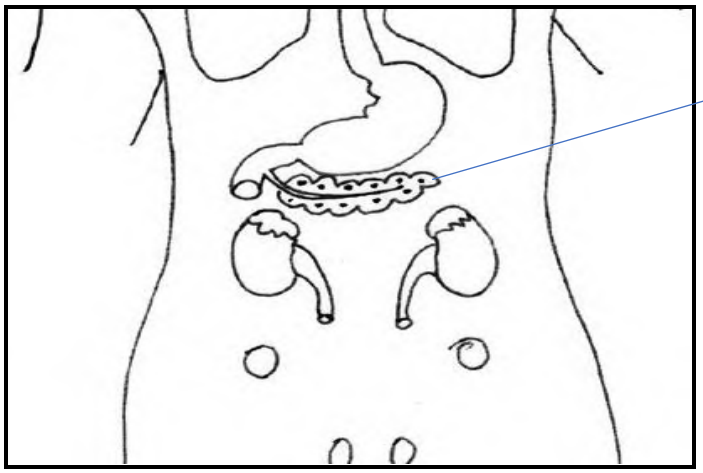
NOTES & EXAM TIPS

Terminology	
homeostasis	the ability of an organism to maintain stability of internal conditions (e.g. temperature, chemical balance) despite changes in its environment
negative feedback mechanisms	mechanisms in the human body that detect changes or imbalances in the internal conditions and restore homeostasis
blood glucose	amount of glucose in the blood
insulin	a hormone made in the pancreas and released into the blood to help convert glucose to glycogen to reduce blood glucose
glucagon	a hormone made by the pancreas that raises blood glucose levels by converting stored glycogen to glucose
glycogen	form in which glucose is stored in the liver and cells.

The following is a **general sequence of events** in a negative feedback mechanism:

Step 1	An imbalance is detected
Step 2	A control centre is stimulated
Step 3	Control centre responds
Step 4	Message is sent to target organ/s
Step 5	The target organ responds
Step 6	It opposes / reverses the imbalance
Step 7	Balance is restored.

Position of the pancreas in the body



Pancreas: Islets of Langerhans

Glucagon

Stimulates conversion from glycogen to glucose (increases blood glucose level)

Insulin

Stimulates conversion of glucose to glycogen (reduces blood glucose level)

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The following describes the regulation of blood glucose levels.

Blood glucose refers to the amount of glucose in the blood. Glucose is absorbed into the blood from the digestive system. Glucose found in the blood is taken up by the body's cells to be used for cellular respiration which releases energy.

If blood glucose levels are too low, the body cells cannot release enough energy and the body cannot function at its best. If blood glucose levels are too high, water is drawn out of the cells and into the bloodstream. This results in dehydration of the cells and therefore dehydration of the body. The pancreas monitors the amount of glucose in the blood.

After a meal, blood glucose levels will increase because more glucose is absorbed from the small intestine into the blood (Figure 9). The **pancreas** detects an increase in blood glucose and releases the hormone **insulin** which causes the glucose to be converted into glycogen. Glycogen is stored in the liver and skeletal muscles in the body. The body cells are also stimulated to take up glucose. This lowers the blood glucose level and returns it to normal.

The influence of insulin and glucagon on blood glucose levels

Blood glucose levels decrease because the body cells are constantly using glucose for cellular respiration. When blood glucose levels decrease, the pancreas will release the hormone **glucagon** which converts stored glycogen (from the liver and skeletal muscles) into glucose. This increases the blood glucose level and returns it to normal.

• Blood glucose levels are maintained at a constant level (homeostasis).

- When **blood glucose** levels are too **high**, insulin is released from the pancreas to convert blood glucose into **glycogen** in the liver and muscles to return the blood glucose level to normal.
- When blood glucose levels are too low, glucagon is released from the pancreas to convert glycogen stored in the liver and muscles into glucose, which enters the blood and returns glucose levels to normal.

When the glucose level in the blood increases above normal levels:	
Step 1	Glucose levels in the blood increase above normal levels
Step 2	The pancreas is stimulated.
Step 3	to secrete insulin into the blood
Step 4	Insulin travels in the blood to the liver
Step 5	glycogen which is then stored
Step 6	The glucose level in the blood now decreases

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Step 7	and returns to normal

When the glucose level in the blood decreases below normal levels:	
Step 1	Glucose levels in the blood decrease below normal levels
Step 2	The pancreas is stimulated
Step 3	to secrete glucagon into the blood
Step 4	Glucagon travels in the blood to the liver
Step 5	where it stimulates the conversion of stored glycogen to glucose
Step 6	The glucose level in the blood now increases
Step 7	and returns to normal

- The metabolic disorder, **diabetes mellitus,** occurs when insulin is not released or does not function properly resulting in high glucose levels.

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

Activity 1
QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.4) in your ANSWER BOOK, for example 1.5 D.

1.1 The pancreas detects the amount of glucose in the blood. What does the pancreas release if blood sugar is too LOW?

A The pancreas releases glucagon if blood sugar is low
B The pancreas releases glucose if blood sugar is too low
C The pancreas releases beta cells if blood sugar is too low
D The pancreas releases insulin if blood sugar is too low

1.2 The liver normally stores blood sugar as…

A glucose.
B glucagon.
C glycogen.
D Fats.

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1.3 After a period of fasting, the brain makes the pancreas produce…

A glucose.
B glucagon.
C glycogen.
D insulin.

1.4 How does insulin travel around the body?

A In bloodstream
B In nerve cells
C In the alimentary canal
D In the lymph

(4x2) **(8)**

QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 The ability of a living organism to maintain a constant internal environment despite the constant fluctuations in the outside environment

2.2 Mechanisms in the human body that detect changes or imbalances in the internal conditions and restore homeostasis

2.3 The metabolic disorder that occurs when insulin is not released or does not function properly resulting in high glucose levels.

(3)

QUESTION 3

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **None** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	Stable internal environment	A B	Homeostasis Metabolism
3.2	Chemical messengers that are secreted directly into the blood which carries them to organs and tissues of the body to exert their functions	A B	Enzymes Hormones

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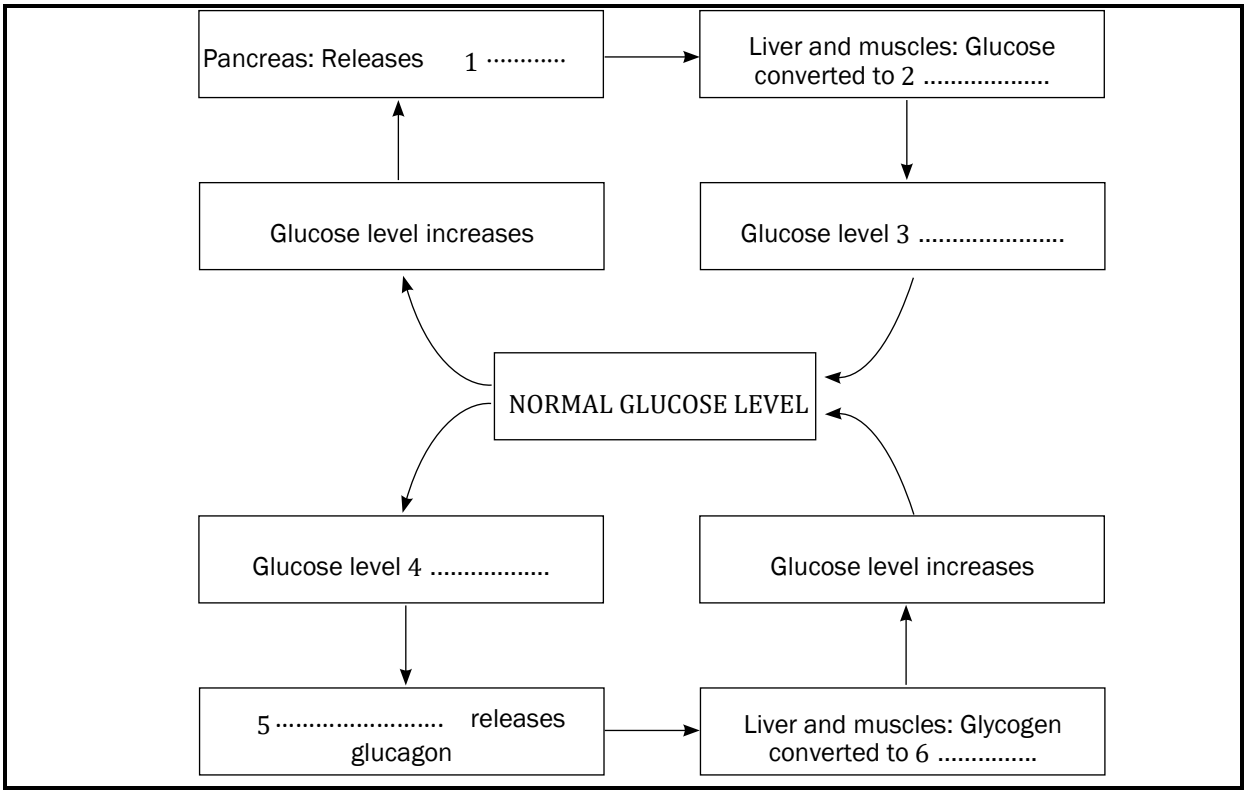
3.3	The organ that detects an increase in blood glucose	A B	Liver Pancreas

(3 x 2) **(6)**

Activity 2

The flow chart below shows the control of glucose levels. Provide labels for **1** to **6.**



(6)

Activity 3

Humans regulate the glucose concentration of their blood.

A scientist recorded the blood glucose concentration of an individual over a seven-hour period.

The results are shown in the table.

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Time of day	blood glucose concentration / mg per 100 cm3
06.00	76
07.00	77
08.00	124
09.00	91
10.00	83
11.00	81
12.00	79
13.00	130

1 What is excess blood glucose converted into in the body? (1)

2 Describe the trend in blood glucose concentration for this seven-hour period. (2)

3 Suggest reasons for the changes in blood glucose concentration in blood. (2)

WEEK 9: TOPIC: Cellular respiration

SUB-TOPIC: Process of respiration

NOTES & EXAM TIPS

Cellular respiration

Is the chemical process where glucose is broken down gradually, in the presence of oxygen (aerobic respiration) or in the absence of oxygen (anaerobic respiration), to release energy.

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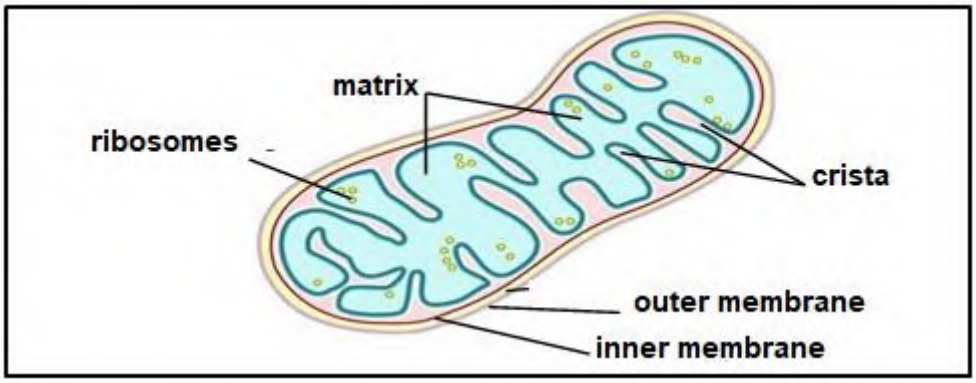
1. Aerobic respiration (needs oxygen)

Aerobic respiration takes place:
- in the presence of oxygen;
- inside the cytoplasm and mitochondria of cells.

The internal structure of a mitochondrion.



The requirements for the process are oxygen and glucose and the by-products released are carbon dioxide and water as well as ATP energy. This can be shown in the following word equation:

Glucose + Oxygen ⟶ Carbon Dioxide + Water + ATP

Aerobic respiration takes place in three stages**:**

1. Glycolysis – takes place in the cytoplasm
2. Krebs Cycle – takes place inside the mitochondrion
3. Oxidative Phosphorylation – takes place inside the mitochondrion

Glycolysis
- takes place outside the mitochondrion, in the cytoplasm of the cell
- no oxygen is required during this stage
- glucose is broken down into smaller molecules, releasing a small amount of energy that is stored in energy-rich ATP molecules
- releases high energy hydrogen ions (H^+) that are used in the third stage of cellular respiration (oxidative phosphorylation)

Krebs Cycle
- can only take place if oxygen is present

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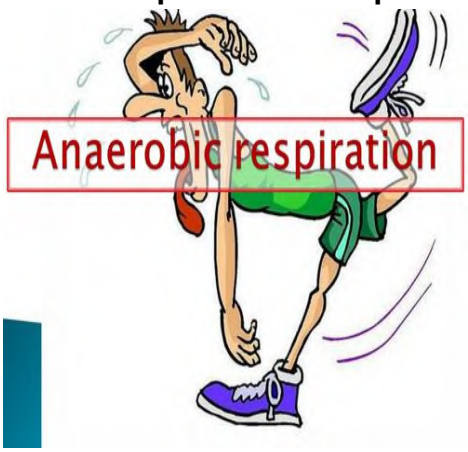
- occurs inside of the mitochondrion
- releases carbon dioxide and high energy hydrogen ions (H^+)
- transports hydrogen atoms to the third stage (oxidative phosphorylation) via hydrogen carrier enzymes

Oxidative Phosphorylation

- takes place inside of the mitochondrion and requires oxygen
- passes high energy hydrogen atoms from one hydrogen carrier enzyme to the next, releasing energy in the process
- uses released energy to combine a phosphate molecule to an ADP (Adenosine Di-phosphate) molecule to form ATP – called ***phosphorylation***
- is represented in the formula: ADP + P → ATP
- oxygen acts as a final hydrogen acceptor binding with the hydrogen forming water which is released as a waste product of cellular respiration

2. Anaerobic respiration takes place:



- without oxygen being present
- it occurs for short periods of time, mainly during physical exercise
- occurs differently in plants and animals
- produces less ATP than aerobic respiration

<u>Anaerobic respiration in **animals**</u> is known as **lactic** acid fermentation and occurs in muscles during intense exercise

<u>Anaerobic respiration in **plants**</u> is known as **alcoholic** fermentation

Uses of anaerobic respiration in industry

- Yeast and other fungi respire anaerobically and are used to produce alcoholic beverages such as beer and wine.
- Yeast cells are also used to cause bread to rise during the baking process.
- The fermentation process is also used to produce cheese.

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The differences between aerobic and anaerobic respiration

Aerobic	Anaerobic
oxygen is required	oxygen is not required
products: carbon dioxide + water	products: lactic acid (animals) or carbon dioxide + alcohol (plants /yeast)
occurs in the cytoplasm and mitochondria	occurs in the cytoplasm
large amount of ATP energy is released, glucose is completely broken down	small amount of ATP energy is released, glucose is only partially broken down

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

1.1 Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1.1 and 1.1.2) in your ANSWER BOOK, for example 1.1.3 D.

1.1.1 The conversion of pyruvic acid into lactic acid occurs during …

A Photolysis.
B glycolysis.
C anaerobic respiration.
D oxidation of glucose.

1.1.2 A phase that does not require oxygen during cellular respiration is:

A Krebs cycle
B Glycolysis.
C Oxidative phosphorylation
D All of the above **(4)**

1.2 Give the correct Biological Term for each of the following descriptions. Write only the term next to the question number (1.2.1 to 1.2.10) in your ANSWER BOOK.

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1.2.1 The process during which glucose is converted into pyruvic acid.

1.2.2 The reagent used to test for the presence of carbon dioxide.

1.2.3 The acid that accumulates in the muscles of humans during continuous strenuous physical activity.

1.2.4 The gas which is essential for the Krebs cycle to occur.

1.2.5 Folded structures found on the inner membrane of a mitochondria.

1.2.6 The stage of aerobic respiration that releases carbon dioxide.

1.2.7 Genetic material found in the mitochondrial matrix.

1.2.8 The stage during aerobic respiration when water is released as a waste product.

1.2.9 Chemical processes in organisms which are controlled by enzymes

1.2.10 The organelle in which respiration takes place **(10)**

QUESTION 2

Read the information below and answer the questions that follow.

Traditional African Beer forms a very important part of African culture. It is called *umqombothi* in isiXhosa and *iJuba* in isiZulu. The beer is mostly brewed from indigenous sorghum. The thick creamy African beer is very rich in vitamin B, it has a low alcohol content of less than 3% and it is inexpensive. The recipe for brewing beer is passed down through the generations. The traditional method of testing to see if the brew is ready is to light a match close to the container of beer. If the flame dies quickly, the brew is ready. If the flames remain lit, the brew is not ready.

2.1 Name the biochemical process used to brew this African beer. (1)

2.2 What causes the flame to die? (1)

2.3 Why would this test be an indication of whether the brew is ready or not? (1)

(3)

QUESTION 3

Tabulate the differences between Aerobic and Anaerobic respiration **(9)**

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WEEK 10: TOPIC: Cellular respiration

SUB-TOPIC: Investigation: CO_2 is produced by living organisms during respiration

NOTES & EXAM TIPS

SCIENTIFIC INVESTIGATIONS:

What is a hypothesis?

A hypothesis is an attempt to explain some event or observation using whatever information is currently available. It is a testable statement that may be accepted or rejected.

A hypothesis must:

(a) have two variables (dependent and independent variables);
(b) state the relationship between the two variables;
(c) be testable; and
(d) state the independent variable first (cause) and then the dependent variable (effect)

Variables:

Controlled / fixed variable – refers to the factors that should be kept constant so that the results of an investigation can be considered valid.

Independent variable – refers to the factor that is being investigated. This factor is usually manipulated by the investigator either at the start of or during the course of the investigation. The independent variable appears on the X-axis of a graph.

Dependent variable – refers to the effect of the independent variable. This effect is usually measured.

What is reliability?

- The idea behind reliability is that any significant results of an investigation must be more than a once-off finding and be repeatable.
- For the questions which required learners to state how the **reliability** of the investigation could have been improved, the following answers apply: Repeat the investigation OR Increase the sample size.

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What is validity?

- Validity questions show how the experiment/investigation was carried out. It is important to be sure that all the factors/variables have been controlled/ fixed except the variable/factor being tested.
- In questions which require learners to suggest some factors that might have decreased the **validity** of an investigation, the answers should centre on the criticism of the scientific process; for example, some factors/variables that were not fixed/controlled when carrying out the investigation

INVESTIGATION: CO_2 is produced by living organisms during respiration

Living organisms produce carbon dioxide as a by-product of aerobic respiration. We can test for the presence of carbon dioxide by using clear lime water which will turn a milky colour when in the presence of carbon dioxide.

Soda lime can be used to remove carbon dioxide from the atmosphere and sodium hydroxide can be added to a solution to remove carbon dioxide found in a liquid. This will ensure that no carbon dioxide can enter into any experiment so that we can prove the carbon dioxide is a result of aerobic respiration performed by an organism.

Hypothesis: Carbon dioxide is produced by living organisms during respiration

Aim: To prove that carbon dioxide is produced by living organisms during respiration

Materials/apparatus

Small organism
Alcohol
Large jar
3 test tubes
Rubber stoppers with 2 holes
Glass tubes
Electric pump
Soda lime
Sodium hydroxide solution
Lime water

Method:

- Use a small organism (e.g. snail).
- Sterilise the equipment so that no micro-organisms can influence the result.
- Place the snail into a large jar.
- Set- up the apparatus as shown in the figure below, making sure that the test tubes are tightly sealed.
- Examine the test tubes the following day and record the results.

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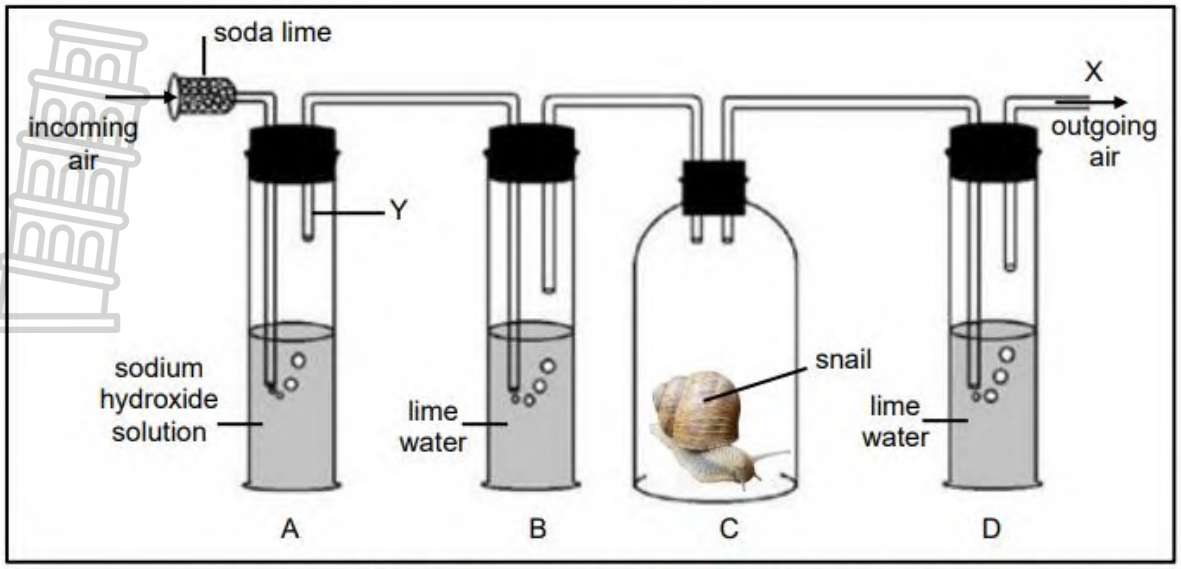

Experimental set-up to show CO_2 is produced during aerobic respiration

Results:

• Test tube B: the lime water remains clear, carbon dioxide is removed by the soda lime and sodium hydroxide.

• Test tube D: the lime water turns milky due to carbon dioxide produced by the snail.

Conclusion: Carbon dioxide is produced during respiration by living organisms (the snail)

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

The apparatus below was used to carry out an experiment on aerobic respiration. The experiment was set up as follows:

- Seeds of the same kind were used
- The seeds and the apparatus were sterilised before the investigation
- Once set up, the apparatus was placed in a dark cupboard at 35°C. A control was also set up

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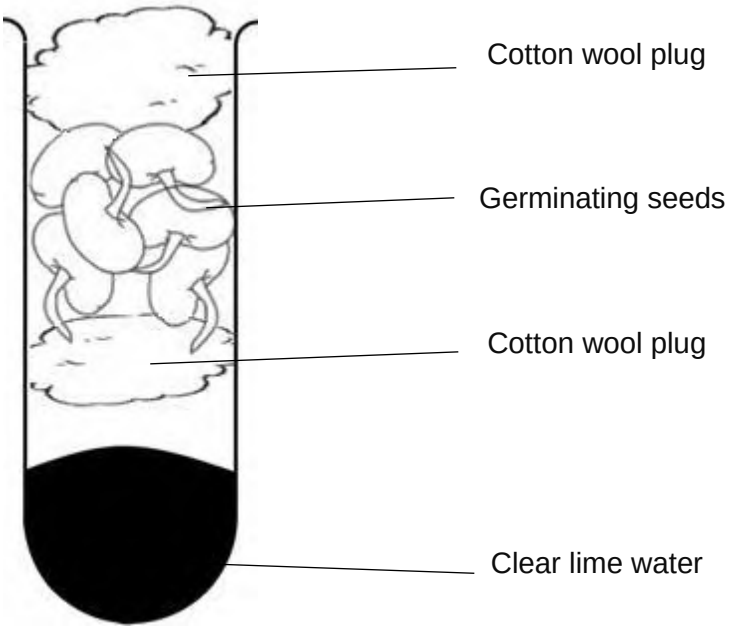

1.1 What would be the hypothesis for the experiment shown above? (2)

1.2 What is the significance of sterilizing the seeds before they are used? (1)

1.3 Give one controlled variable in this investigation. (1)

1.4 Explain how you would set up a control for this experiment. (2)

1.5 What would be the purpose of setting up a control experiment? (2)

1.6 Explain why germinating seeds were used in this investigation. (2)

(10)

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Term 3

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WEEK 1: TOPIC: Gaseous exchange

SUB-TOPIC: Difference between cellular respiration, breathing and gas exchange.

NOTES & EXAM TIPS

Biological terminology	
Aerobic	occurring in the presence of oxygen
Anaerobic	occurring in the absence of oxygen
Aquatic	(plants and animals) living in water
Breathing / ventilation	mechanical process of **inhalation** and **exhalation** through which air moves in and out of the respiratory organs enabling the uptake of oxygen and the removal of carbon dioxide
Carbohydrate	a large group of organic compounds found in cells, including glucose, sucrose, and starch
Cellular respiration	the breakdown of organic compounds (glucose / sugar) in the mitochondria of cells into inorganic products (CO2 and H2O) with the release of cellular energy (ATP); either aerobic or anaerobic
Diffusion	the movement of molecules from a region of high concentration to a region of low concentration until equilibrium is reached
Gaseous exchange	the exchange of O2 and CO2 at a respiratory surface occurring between the air and blood and blood and cells
Glucose	a simple sugar which is an important energy source in living organisms and is a component of many carbohydrates
Mitochondrion	an organelle found in large numbers in most cells, in which the cellular respiration and energy production occur
Respiratory surface	is a membrane through which gas exchange takes place
Terrestrial	(plants and animals) living on land

Introduction

It is important to distinguish between **breathing, gaseous exchange** and **cellular respiration.**

Why do we need to breathe?

All organisms, from simple, unicellular to more advanced multicellular organisms need oxygen (O_2) to sustain cellular functions. Oxygen is used to release energy from carbohydrates found in cells. Plants and animals need energy for survival. Organisms are structurally suited to ensure that the process of the exchange of

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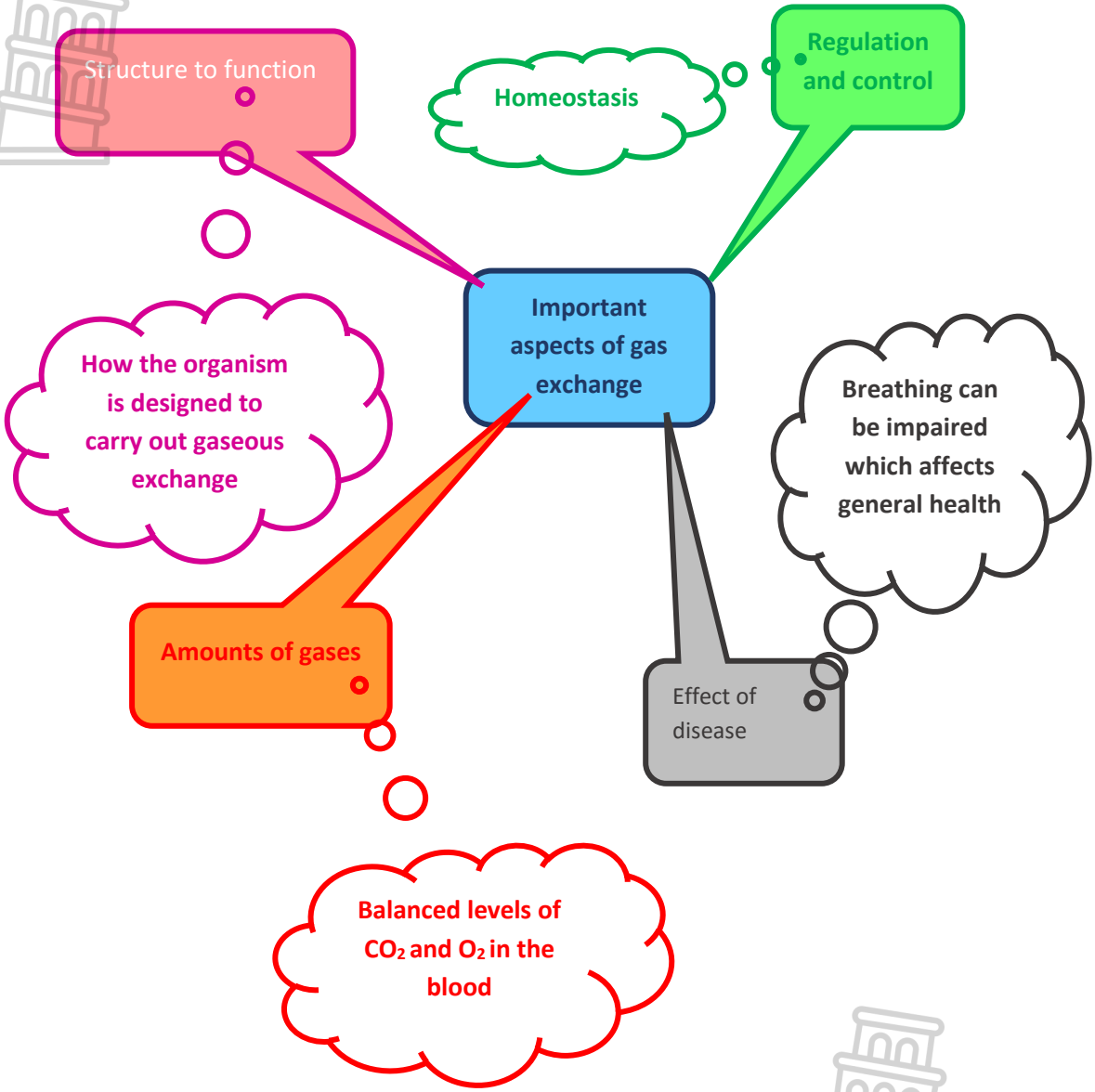
gases is optimised. More complex animals have a mechanism of breathing that ensures that gases enter their bodies, and this enables gaseous exchange and cellular respiration to occur efficiently.



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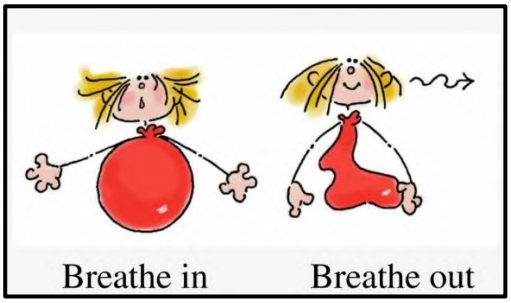
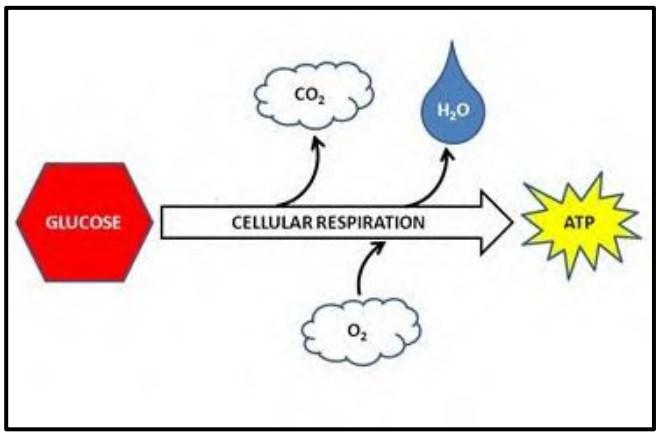
Key concepts

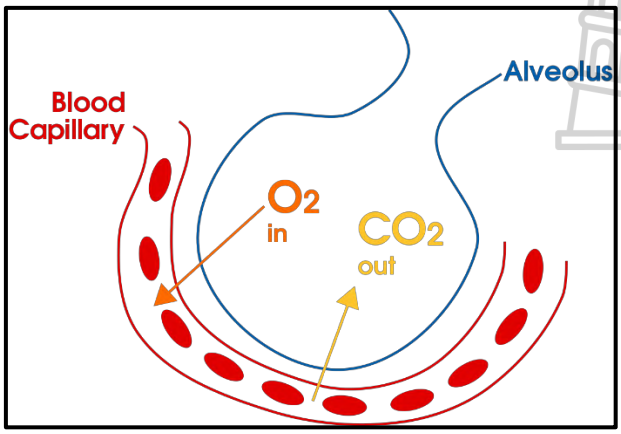
Breathing
This is a mechanical process taking oxygen into the lungs.



Cellular respiration
A chemical process which takes place in the cells to release energy.



Gaseous exchange
A physical process which involves the exchange of gases between the air and blood in the lungs.



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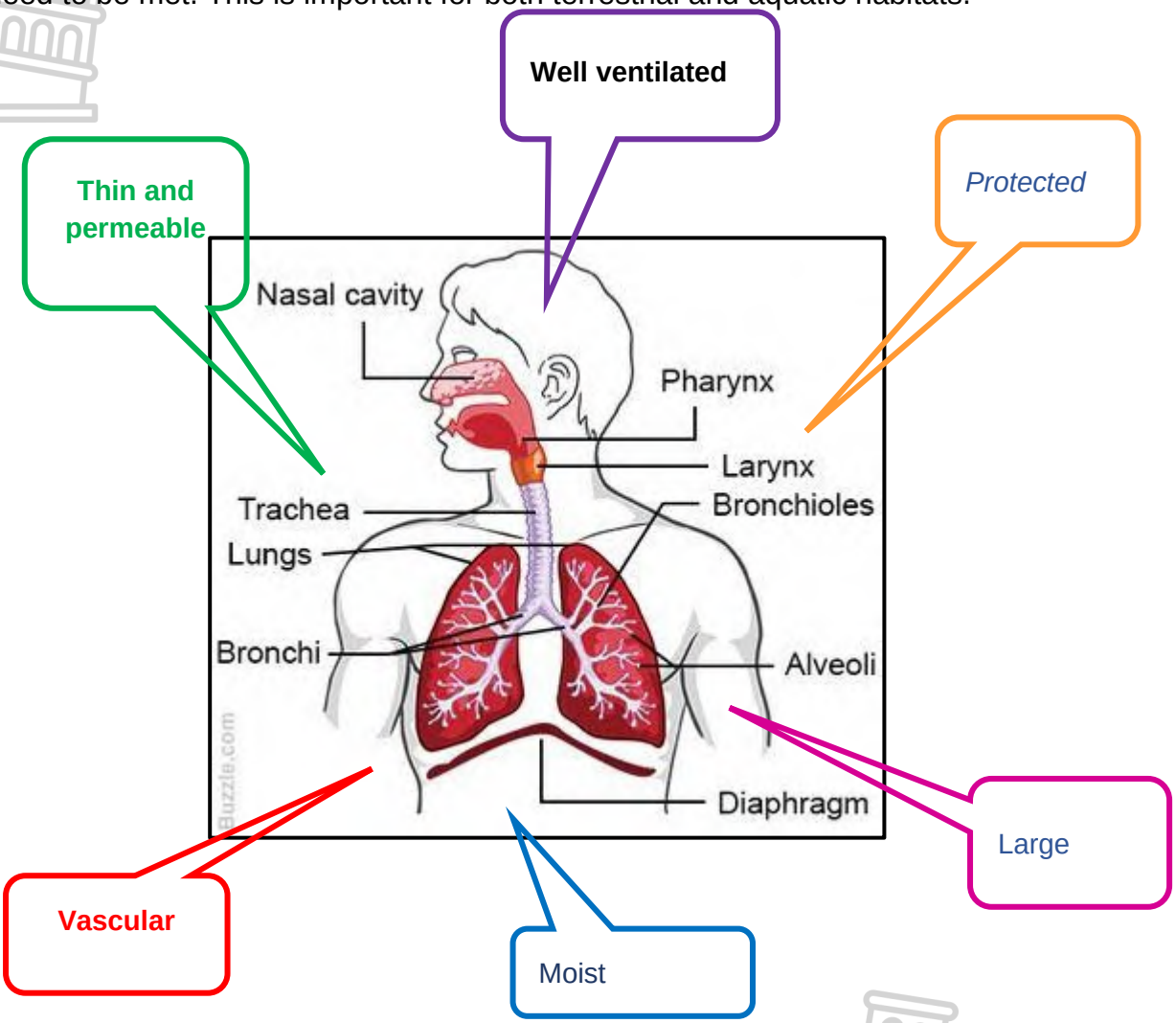
SUB-TOPIC: Requirements of efficient gas exchange organs

For gases to effectively diffuse across respiratory surfaces, certain **requirements** need to be met. This is important for both terrestrial and aquatic habitats.



Relationship between respiratory structures and efficient gaseous exchange in different organisms

All organisms, from simple unicellular to complex multicellular, rely on gaseous exchange for survival. The amount of O_2 taken up and CO_2 released depends on the ratio of surface area to volume of the organism.

What does this mean?

- Surface area is the combination of all the exposed surfaces of the organism.
- The volume is the space taken up by the same organism.
- Therefore, the surface area to volume ratio would be the amount of surface an organism has relative to its size.

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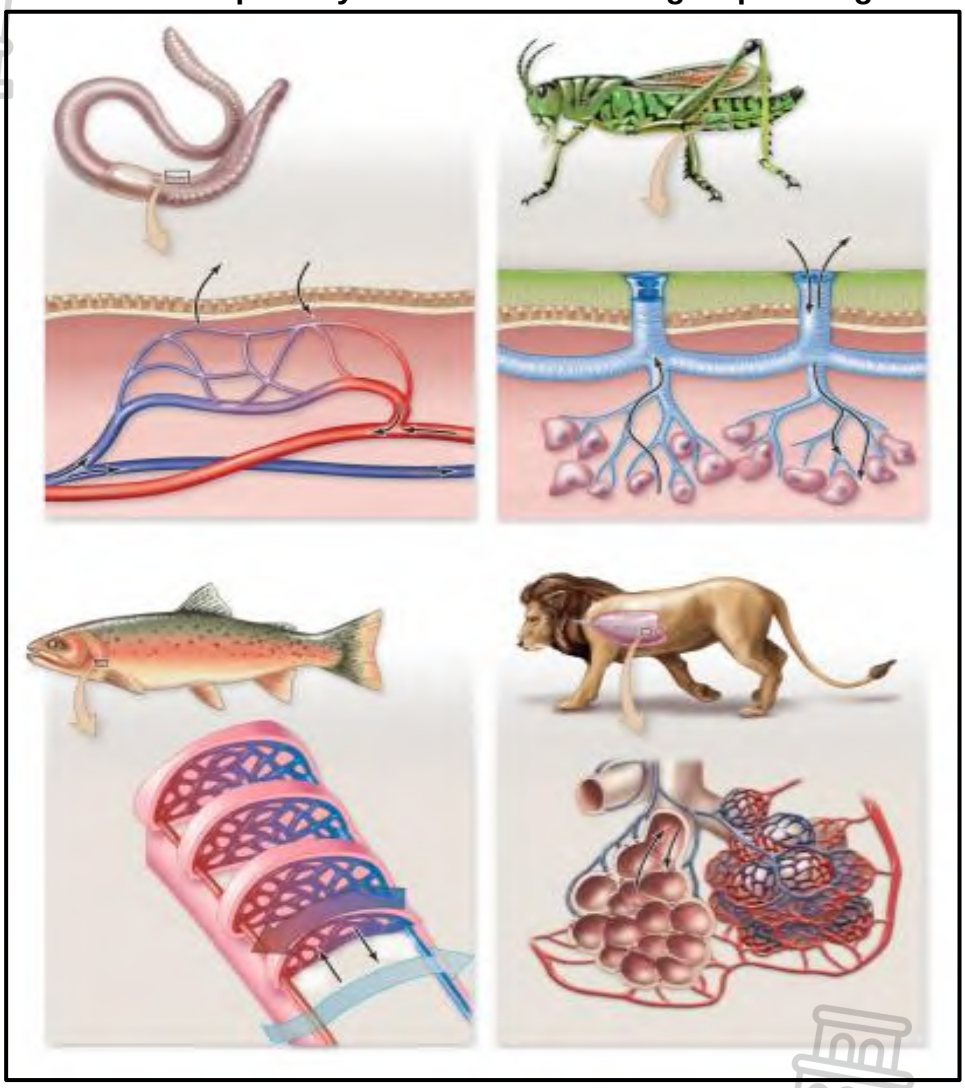
- In general, the smaller the organism the larger the surface area to volume ratio.

Both terrestrial and aquatic plants and animals have gaseous exchange surfaces and respiratory structures that ensure effective exchange of gases (O_2 and CO_2).

Comparison of the respiratory surfaces of various groups of organisms



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Requirements for effective gaseous exchange surface					
large	**thin & permeable**	**moist**	**well-ventilated**	**protection**	**transport system**
Dicotyledonous plant (leaf and spongy mesophyll)					
flat surface increases exposure to air	thin-walled cells allow for diffusion	water vapour passes through stomata	air movement around leaves	cuticle and lower epidermis	simple diffusion
Earthworm (skin)					
elongated cylindrical shape	body covering is thin	mucous glands keep the skin moist	air movement around the body	thin cuticle	diffusion
Insect (tracheal system)					
extensively branched tracheae and tracheoles	lining of tracheoles is thin	tracheoles are moist	rhythmic body movements move air in and out	exoskeleton and chitin rings	network of tubules throughout the body
Bony fish (gills)					
branched gill filaments increase surface area	thin membranes	aquatic animals live in water	water taken in through the mouth is forced out over the gills	gills are protected by a bony cover, the operculum	heart and blood vessels
Mammals (lungs)					
bronchioles divide into many alveoli	alveoli have thin squamous epithelium layer	mucus cells secrete a thin layer on moisture	diaphragm and ribcage regulate inhalation and exhalation	ribs protect the lings	circulatory system

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

Activities

Activity 1

Complete the word search on gaseous exchange below. Identify the term from the description and then find the term in the word search.

Description

1) occurring in the presence of oxygen
2) occurring in the absence of oxygen
3) (plants and animals) living in water
4) (plants and animals) living on land
5) the exchange of O_2 and CO_2 at a respiratory surface
6) mechanical process of inhalation and exhalation through which air moves in and out of the respiratory organs enabling the uptake of oxygen and the removal of carbon dioxide
7) an organelle found in large numbers in most cells, in which the cellular respiration and energy production occur
8) The movement of molecules from a region of high concentration to a region of low concentration until equilibrium is reached
9) many tiny air sacs of the lungs which allow for rapid gaseous exchange
10) small branches in the lungs ending in air sacs
11) fine tubes that make up part of the respiratory system of insects

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Gaseous exchange

Identify the term from the description and then find the term in the word search

D	M	L	L	B	E	S	G	H	N	J	J	Q	T	T	T	M	I	K	R	R	X	G	Z	W
W	O	Z	O	Y	A	R	P	N	N	I	W	K	O	T	E	K	L	D	X	O	N	P	E	I
H	U	W	I	I	B	N	X	N	Z	W	B	G	O	K	R	B	E	Z	N	P	M	C	G	M
A	N	I	C	H	T	I	F	L	M	D	O	R	H	D	R	I	D	B	F	R	I	I	N	P
G	P	N	I	B	F	K	M	N	V	R	Y	T	N	K	E	W	L	R	U	J	X	K	X	N
L	P	V	T	I	C	M	M	T	O	X	A	T	V	N	S	C	O	O	U	K	Z	D	J	B
S	G	N	A	J	N	E	C	J	P	L	K	F	G	G	T	E	Q	N	E	H	Q	E	T	V
M	Q	A	U	I	Y	L	E	R	Q	N	X	D	J	K	R	Q	W	C	M	V	Y	C	Z	L
D	G	X	Q	Z	Z	B	A	I	V	I	N	G	M	R	I	T	O	H	G	T	L	N	H	P
V	S	R	A	B	Z	T	Z	D	O	E	B	M	K	B	A	U	V	I	S	E	P	A	H	G
L	Z	M	K	I	O	Y	I	T	L	T	R	F	I	K	L	G	F	O	H	V	U	N	P	F
I	M	A	P	S	Z	F	G	L	K	R	L	J	Y	D	D	A	Y	L	H	F	S	X	Z	W
G	I	I	X	C	F	R	U	N	G	A	G	I	G	F	P	O	U	E	A	G	I	Z	V	D
U	I	H	T	U	C	K	H	B	D	C	E	S	V	O	N	T	N	S	A	M	W	J	H	F
K	A	S	S	O	N	Q	O	S	A	H	X	R	V	U	R	A	N	J	O	L	T	B	Q	P
U	J	I	M	I	C	O	M	E	U	E	J	V	O	T	I	H	O	Z	X	J	Q	A	Y	Z
H	O	E	T	L	V	H	F	E	P	O	N	O	P	B	V	O	I	T	O	Z	J	N	P	F
N	J	E	R	Q	M	N	O	G	O	L	E	N	I	G	I	O	T	G	E	Q	R	E	A	B
U	Q	K	K	Z	A	T	H	N	W	E	I	S	L	B	S	C	A	X	W	L	A	A	I	J
S	V	G	L	N	H	C	U	A	D	S	L	N	A	P	V	T	L	Y	I	K	G	R	A	E
M	U	R	B	J	U	F	E	H	G	R	A	Z	Q	G	C	L	I	Q	N	L	M	O	T	A
T	G	J	W	T	Z	Z	K	C	D	F	I	D	T	X	X	S	T	B	N	J	K	B	T	X
A	D	A	Y	Y	Q	R	R	X	I	L	J	O	C	O	T	Q	N	S	F	F	B	I	I	Z
L	X	Z	N	I	X	F	S	E	A	C	D	Y	N	R	U	F	E	S	L	N	Y	C	Q	K
W	D	D	S	K	X	O	Q	W	W	L	X	B	X	L	K	E	V	U	C	H	C	O	U	S

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Activity 2

Surface area to volume ratio

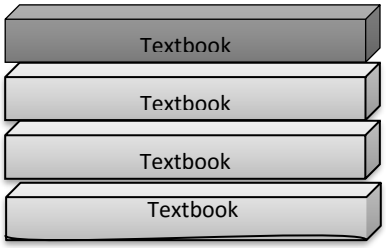
We are going to build two imaginary animals. They are called *Bookus glutinous* and *Bookus skinny*. We would like to find out how the surface area to volume ratio influences the diffusion of gasses in these two animals.

Instructions

You first have to build these **two** animals. You will need 8 textbooks of **equal size**. This is an individual activity but the 'animals' can be built together.

Animal 1:

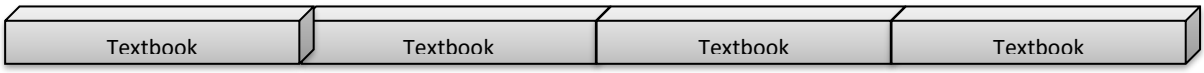
Use **four** of the textbooks on top of one another to build ***Bookus glutinous*** as the diagram indicates.



Bookus glutinous

Animal 2:

Bookus skinny will consist out of **4 textbooks** as the diagram below indicates. Remember the textbooks must be of the same size as the other textbooks which you used to build ***Bookus glutinous***.



Bookus skinny

NOTE

Surface area

To work out the surface area you multiply the length and width of each side.

Volume

To work out the volume you must multiply the length, the width and the height with one another.

Ratio of surface area to volume

To determine the surface area to volume ratio you must divide the volume into the surface area for the answer.

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Question 1

1.1 Calculate the surface area of *Bookus glutinous.*
Remember the animal has 6 sides. Therefore, work out the surface area of each side and add all the answers together to determine the total surface area. (3)

1.2 Calculate the volume of *Bookus glutinous.* (3)

1.3 Calculate the ratio of the surface area to the volume of *Bookus glutinous*. (3)

Question 2

Calculate the following:

2.1 Surface area of Bookus *skinny.* (3)

2.2 Volume of *Bookus skinny.* (3)

2.3 Ratio of the surface area to the volume of *Bookus skinny.* (3)

Question 3

3.1 Which animal has the highest surface area to volume ratio? (1)

3.2 In which animal will oxygen reach all cells through the process of diffusion? (1)

3.3 Give a reason for your answer in question 3.2. (1)

3.4 What systems are in place for an animal with a small surface area to volume ratio to ensure that all cells receive oxygen in the shortest possible time? (2)

3.5 Predict what will happen if an animal with a small surface to volume ratio does not have specialized systems in place for oxygen to reach all the cells. (2)

Question 4

Gaseous exchange is the biological process by which gases move passively by diffusion across a surface. In humans this happens in the lungs.

4.1 Name the site for gaseous exchange in the lungs. (1)

4.2 Name FOUR structural requirements of an efficient gas exchange surface. (4)

[30]

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EXAM QUESTIONS

QUESTION 1 *(Questions taken from various sources)*

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.2) in your ANSWER BOOK, for example 1.3 D.

1.1 Study the table and answer the question below

Gas	Concentration in inhaled air (%)	Concentration in exhaled air (%)
Oxygen	21	16
Carbon dioxide	0,04	4
Nitrogen	78	78
Water vapour	0,96	2

The reason for the amount of oxygen being higher in inhaled air than in exhaled air is that…

A oxygen is taken into the bloodstream and some diffuses back to the alveoli to be breathed out

B some oxygen does not reach the alveoli but remains in the bronchiole until exhalation occurs

C oxygen is used in the body, but oxygen is produced in the body as a waste product, which is then exhaled

D some oxygen from inhaled air diffuses into the blood and is used by the cells

1.2 Several features are listed below.

1. Large surface area
2. Thin surface
3. Moist surface
4. Many capillaries

Which of the above are features of an efficient gaseous exchange surface?

A 1, 2, 3 and 4

B 1, 2 and 4

C 1, 3 and 4

D 2, 3 and 4

(2 x 2) **(4)**

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QUESTION 2 *(Questions taken from various sources)*

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 The pores on the leaves of plants through which gas exchange takes place
2.2 A pigment that transports oxygen in humans
2.3 Organelle that serves as the powerhouse of the cell **(3)**

WEEK 2: TOPIC: Gaseous exchange

SUB-TOPIC: Human gas exchange –structure, location, functions and adaptations of the ventilation system.

NOTES & EXAM TIPS

When you breathe in, **air** enters your body through your nose or mouth.
It then travels down your throat through the larynx (or voice box) and into the trachea or windpipe) before entering your lungs.

LOCATION OF THE HUMAN GASEOUS SYSTEM

The human gaseous exchange /ventilation system **begins from the nose** in the head and moves down the windpipe/ trachea located in the neck and **extends into** the bronchi and lungs within the **thoracic cavity(chest).**

The **diaphragm** is the gaseous exchange **muscle** that **separates** the **thoracic (chest) cavity** from the **abdominal cavity.**

STRUCTURE OF THE HUMAN GASEOUS EXCHANGE SYSTEM

Figures 1 and **2** below show parts of the gaseous exchange system that are directly involved in breathing and gaseous exchange.

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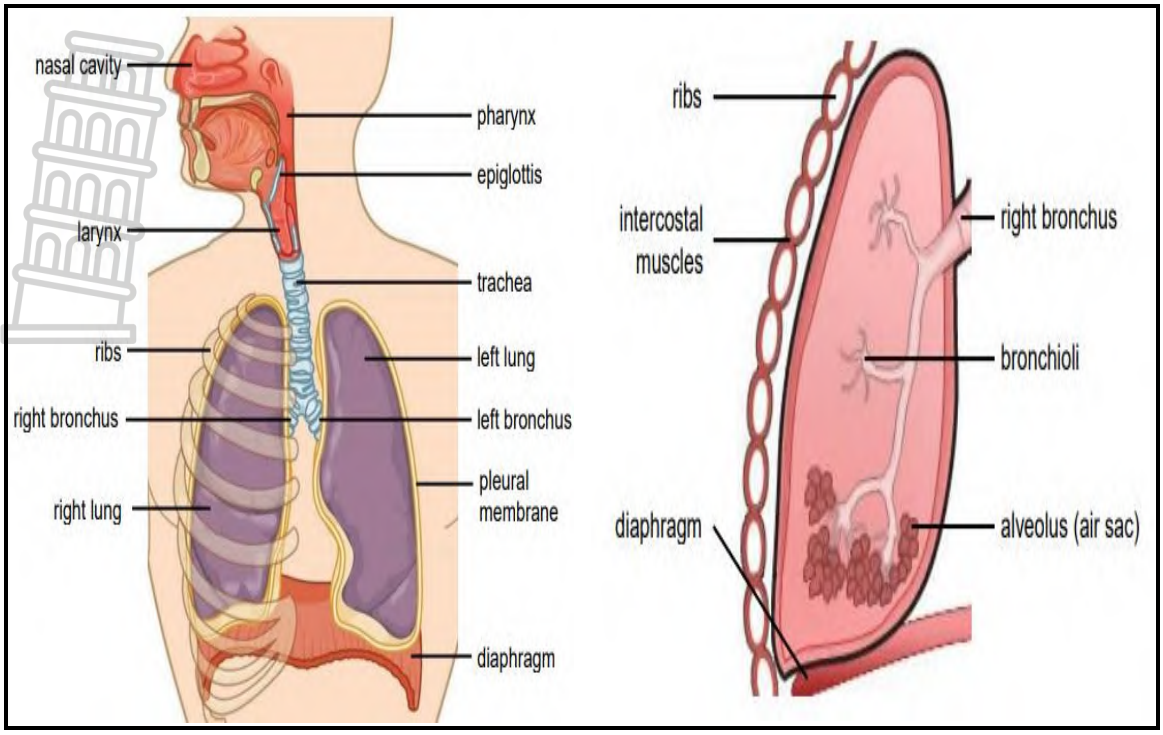
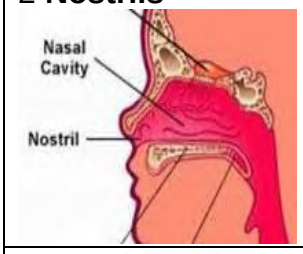
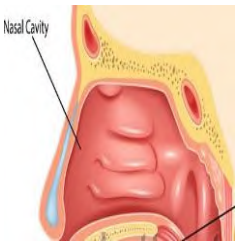


FIGURE 1 FIGURE 2

STRUCTURAL SUITABILITY OF GASEOUS EXCHANGE SYSTEM

The human gas exchange system is well designed or structurally suited to carry out the function of gaseous exchange.

STRUCTURE	FUNCTION
AIR PASSAGES	
2 **Nostrils** 	Air from atmosphere inhaled through two openings in nose called nostrils.
2 **Nasal cavities** 	Cavities are lined with ciliated columnar epithelium with goblet cells. Mucus from the goblet cells together with the cilia trap dust/dirt and sweep it out of the nose. Mucus keeps cavity moist. Blood capillaries warm the incoming air. Has turbinate bones to increase surface for airflow.
Trachea	Trachea is situated in front of the oesophagus. C-shaped cartilage rings protect trachea and keep it open for easy movement of air into the lungs.

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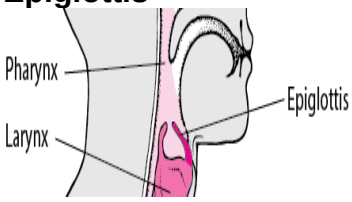
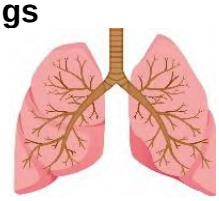
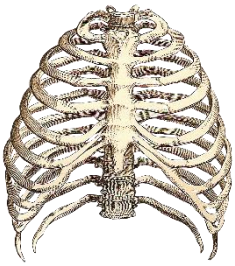
Bronchus / bronchi	Trachea branches into left and right bronchi that enter the upper lobes of the left and right lungs. Held open by C-shaped cartilage rings so that it does not collapse during breathing. Lined with mucus membranes to keep incoming air moist
Alveoli	Bronchioli end in a collection of alveoli (air sacs) that are sites for gaseous exchange. Many alveoli increase the surface area to maximise the gas exchange. Have thin walls of squamous epithelial cells allowing for easy diffusion of gases. Tissue fluid keeps the walls of the alveoli moist for easy dissolving gases. A large blood capillary network surrounds the alveoli to allow for rapid diffusion of gases between alveoli and blood.
THROAT AND LUNGS	
Pharynx (throat region)	Connects the nasal cavity with larynx. Allows entry of gases into the trachea and oesophagus
Larynx	Larynx contains the vocal cords. Air passes over the chords and sound is produced.
Epiglottis 	A cartilage structure on top of the larynx (voice box). It closes when food is swallowed preventing food from entering the trachea and **allows only air to pass over it into trachea.**
Lungs 	Two spongy, elastic lungs are surrounded by the double pleural membrane. This organ receives oxygen from air to be send throughout the body and it receives carbon dioxide from body cells to be expelled into air. Pleural fluid acts as a lubricant and helps prevent friction during inhalation and exhalation.
RIBS AND MUSCLES INVOLVED IN BREATHING	
Ribs 	Rib bones on either side of the sternum form a rib cage to protect the lungs from injury.

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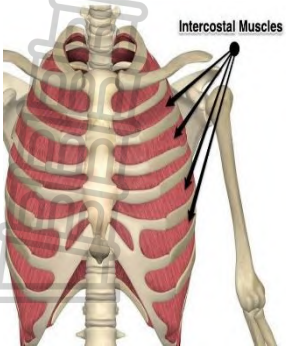
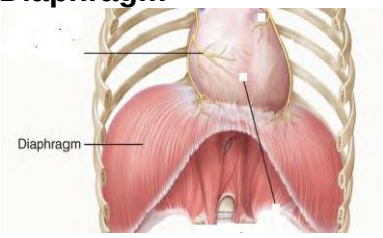
Intercostal muscles 	These are muscles found between the rib bones. They contract and relax during inhalation and exhalation altering the volume of air in the chest (thoracic cavity).
Diaphragm 	A sheet of muscle below the lungs. It contracts and relaxes altering the volume of the chest cavity which is important in the breathing mechanism.

FUNCTIONS OF THE GASEOUS EXCHANGE SYSTEM

The main function of the **gaseous exchange system** in **humans** is to **take oxygen from the air into the lungs during inhalation** and that this oxygen-rich air reaches the alveoli where gaseous exchange takes place so that the oxygen diffuses into the blood to be **transported to the cells of the body** . It then **receives carbon dioxide from the cells of the body** after cellular respiration to be **expelled out of body via exhalation.**

The exchange of gases occurs in two areas in the body: At the

1. Alveoli surface (external gaseous exchange) and

2. Between the blood and tissues (internal gaseous exchange).

GASEOUS EXCHANGE IN THE LUNGS AT THE ALVEOLI SURFACE

The **air entering the alveoli** after inhalation has a **high oxygen concentration compared** to the **oxygen concentration in the blood** of the surrounding capillaries. The inhaled air has a **lower carbon dioxide concentration** than that of the blood in the surrounding capillaries.

This results in **oxygen** diffusing **(moving) from the alveoli into the blood** and **carbon dioxide** diffusing **(moving) from the blood** and back **into the alveoli** to be **exhaled.**

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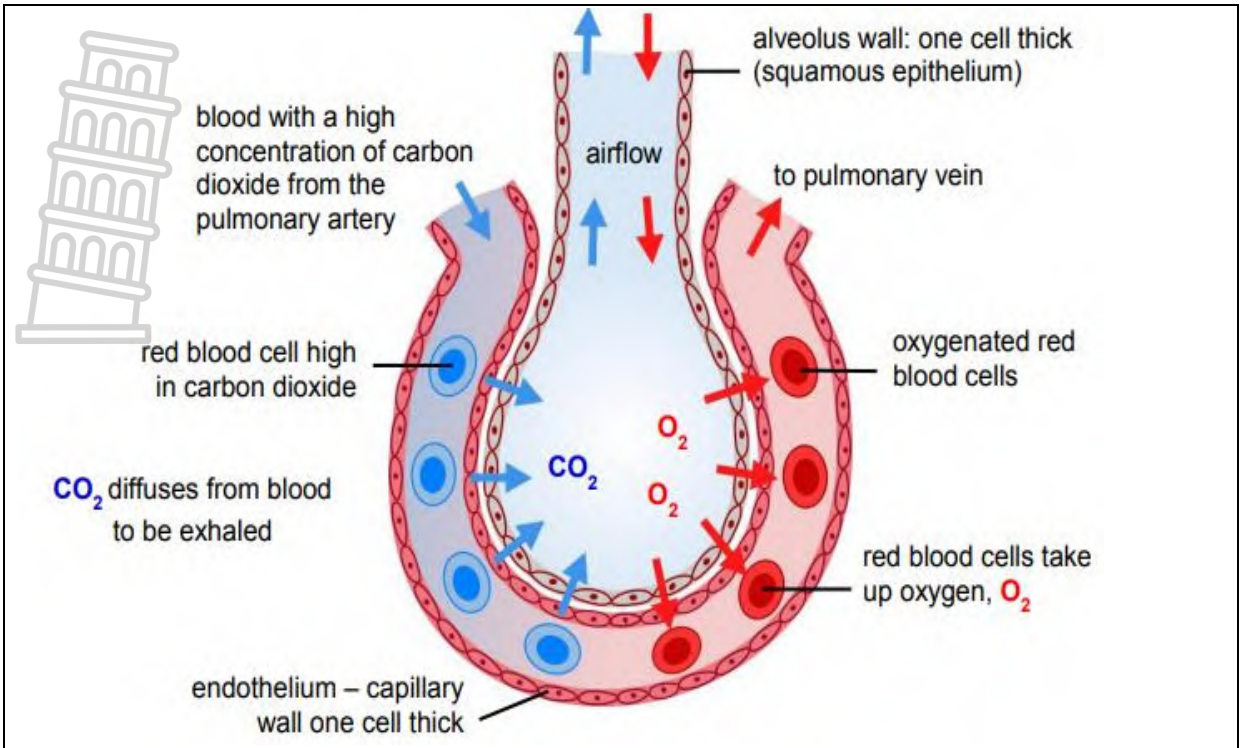


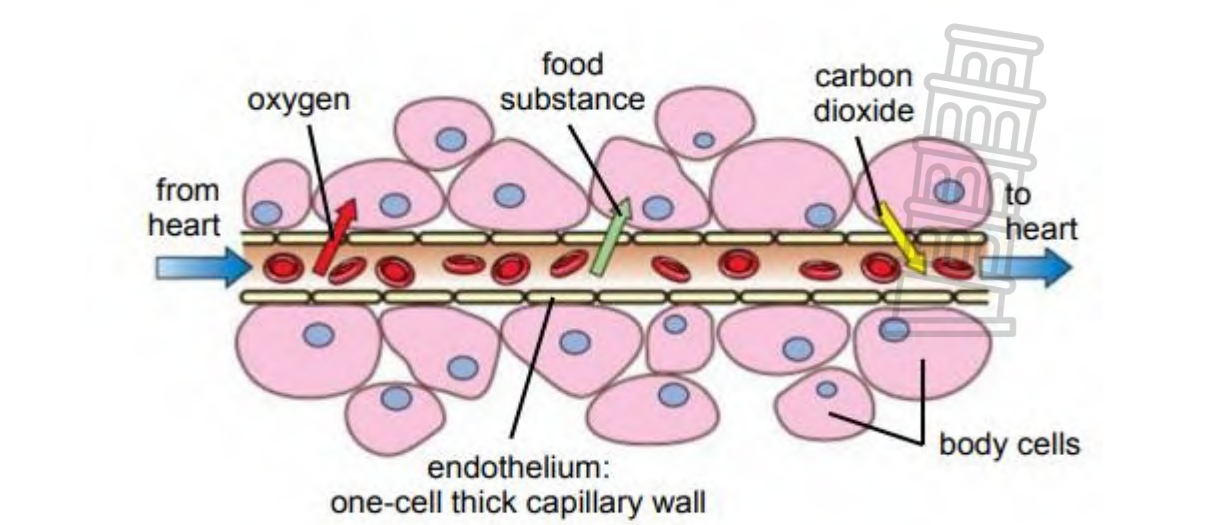
Gaseous exchange between alveolus and blood

GASEOUS EXCHANGE BETWEEN THE BLOOD AND TISSUES

The **cells** will have a **high carbon dioxide** concentration due to continuing cellular respiration. This carbon dioxide moves out of the cells and diffuses into the blood and is transported back to the heart and then **to the lungs where it is exhaled.**

Carbon dioxide is transported from the cells to the alveoli where it is removed from the body.

The **air in the alveoli will be exhaled with more carbon dioxide** than the air that had been inhaled.



Gaseous exchange between blood and cells

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Oxygen is **transported** mainly by the **red blood cells**. Most of the oxygen combines with the **pigment haemoglobin** present in the red blood cells (erythrocytes) to form **oxyhaemoglobin.** It is transported via the circulatory system to all body cells for respiration to produce energy (ATP) for the cells.

Most of the **carbon dioxide** is transported in the blood plasma in the form of **bicarbonate ions** from the cells and tissue to the lungs to be exhaled.

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.4) in your ANSWER BOOK, for example 1.5 D.

1.1 Cilia are found lining which of the following structures?

A Larynx
B Alveoli
C Trachea
D Pleural membranes

1.2 Air breathed out is different from air breathed in because it:

A contains less carbon dioxide.
B is cooler.
C is drier.
D contains less oxygen

1.3 The lungs of a long-term smoker will have:

A constricted bronchioles.
B thinner walls.
C a large surface area.
D an increased capacity for gaseous exchange.

1.4 Which of the following does not occur during inhalation in a human?

A Pressure within the thoracic cavity increases.
B The lungs expand.
C The diaphragm contracts.
D Pressure in the abdominal cavity increases. **(8)**

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QUESTION 2 *(Questions taken from various sources)*

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.5) in your ANSWER BOOK.

2.1 The double membrane that covers the outer surface of the lungs.
2.2 The cartilaginous structure that contains the vocal cords.
2.3 Tiny air sacs at the end of each bronchiole.
2.4 Dome-shaped muscle separating the thorax from the abdomen.
2.5 The main branches of the trachea that lead to the lungs. **(5)**

QUESTION 3 *(Questions taken from various sources)*

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	Breathing muscles	A B	Intercostal Diaphragm
3.2	C – shaped cartilaginous rings	A B	Oesophagus Bronchioles
3.3	The structure that prevents food particles from entering lungs	A B	Epiglottis Glottis

(6)

QUESTION 4

The diagram below represents a section through an alveolus and a surrounding blood capillary in the human body.

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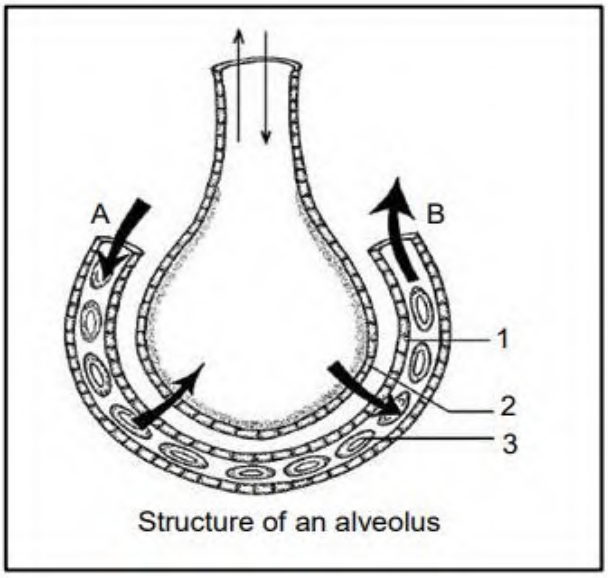
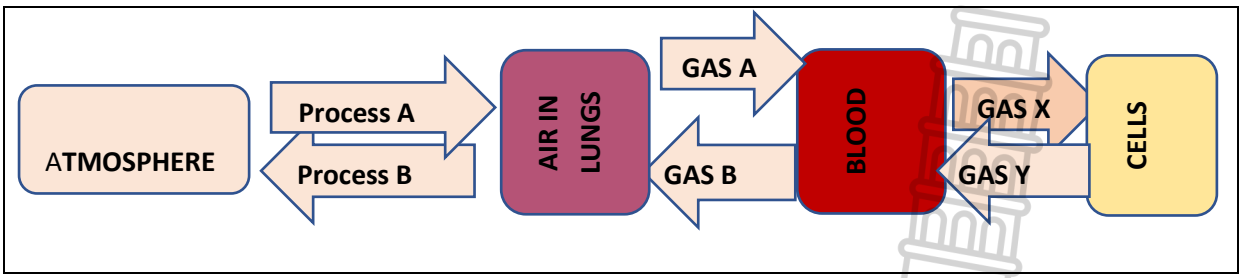


Structure of an alveolus

4.1	Name the type of epithelial tissue numbered **1** and **2**.	(2)
4.2	Identify the blood cell labelled **3**.	(1)
4.3	What pigment is found in the cell mentioned in QUESTION 4.2?	(1)
4.4	Which type of blood:	
	a) enters the blood capillary at **A**?	(1)
	b) leaves the blood capillary at **B**?	(1)
4.5	In which form is most oxygen carried in the blood?	(1)
4.6	Supply two structural adaptions of the alveoli which make them well suited for gaseous exchange.	(2)
		(9)

QUESTION 5

Use the flow chart below which summarises the gaseous exchange process in humans to answer the questions which follow.



5.1	Label process **A** and **B**.	(2)
5.2	Label gas **X** and **Y.**	(2)
		(4)

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WEEK 3: TOPIC: Gaseous exchange

SUB-TOPIC: Ventilation of the lungs. Homeostatic control of breathing

NOTES & EXAM TIPS

TERMINOLOGY

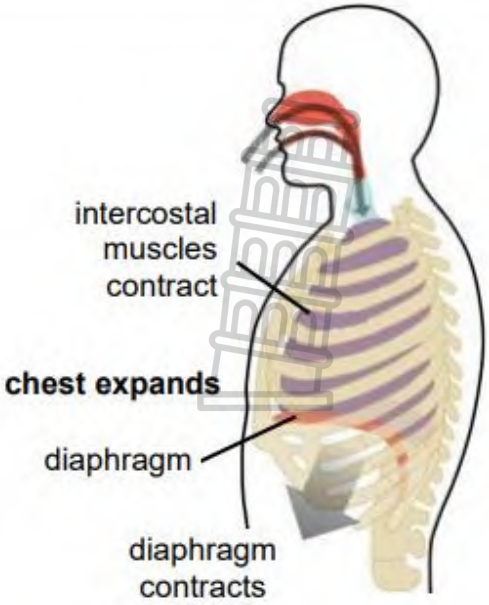
- **Ventilation**: The exchange of air between the lungs and the atmosphere so that oxygen can be exchanged for carbon dioxide in the alveoli.
- **Alveoli**: The tiny air sacs in the lungs.
- **Homeostasis**: It is a process of maintaining a constant internal environment within the body. (Level of oxygen and carbon dioxide in the body)
- **Inhalation**: The breathing in of air
- **Exhalation**: The breathing out of air
- **Spirometer**: An instrument used to measure the volume of air that enters and leaves the human lungs during inhalation and exhalation

VENTILATION

- Inhalation **is** the process of **taking** air into the **lungs**. It **is** the active phase of **ventilation** because it **is** the result of muscle contraction. During inspiration, the diaphragm contracts and the thoracic cavity increases in volume. This decreases the pressure so that air flows into the **lungs**.

Inhalation – when air moves into lungs

- diaphragm muscle contracts, it flattens and moves downwards
- external intercostal muscles between the ribs contract
- ribcage lifts upwards and pushes outwards
- air pressure in the lungs decreases as the chest volume increases
- atmospheric pressure is greater than the pressure inside the lungs and air flows in
- inhalation is an **active** process involving muscle contraction



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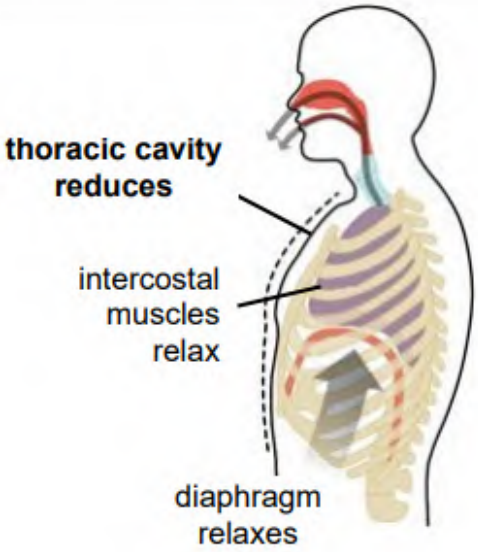
Exhalation – when air is pushed out of lungs

- diaphragm relaxes and moves upwards
- external intercostal muscles relax
- ribcage moves down and inward
- air pressure in lungs increases relative to the outside air pressure
- air is forced out to equalize the pressure
- exhalation is a **passive** process when muscles relax



HOMEOSTATIC CONTROL OF BREATHING

- When the heart rate increases, blood flow also increases.
- Rapid transport of gases to and from the cells occurs.
- When carbon dioxide levels rise, the cells in the respiratory centre of the medulla oblongata of the brain are stimulated.
- Increased rate and depth of breathing causes the intercostal muscles and the diaphragm to contract and relax.
- **More oxygen** is **inhaled**, and **more carbon dioxide** is **exhaled**.
- The levels of **carbon dioxide** in the **blood** determine the **rate and depth** of **breathing**.
- The ability of the body to **return the levels the normal** is known as **homeostasis**

The flow diagram below represents the negative feedback mechanism for homeostatic control of breathing:

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1. **Carbon dioxide (CO_2) levels** in the blood increase **above normal levels**

↓

2. Receptor cells in the carotid artery in the neck are stimulated

↓

3. Cells send impulses to the medulla oblongata in the brain

↓

4. Medulla oblongata stimulates breathing muscles (intercostal muscles and diaphragm) and heart

↓

5. Breathing muscles contract more actively – increases the rate and depth of breathing; the heart beats faster

↓

6. More CO_2 is taken to and exhaled from the lungs

↓

7. The **CO_2 levels** in the blood **return to normal**

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

ACTIVITY 1
QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.3) in your ANSWER BOOK, for example 1.4 D.

1.1 The rate of breathing is regulated by the medulla oblongata, mainly…

A under voluntary control.
B according to oxygen level of blood.
C according to the blood pressure.
D according to carbon dioxide level of blood.

1.2 The following will determine the rate of breathing in humans:

A Carbon dioxide in the blood
B Bronchioles in the lungs
C Oxygen in the exhaled air

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D haemoglobin in the tissues

1.3 The breathing centre in the medulla oblongata is most sensitive to change in the…

A glucose level of the blood
B oxygen level of the tissue fluid
C carbon dioxide levels of the blood.
D ATP levels of mitochondria **(3x2)** **(6)**

QUESTION 2 *(Questions taken from various sources)*
Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 The muscles between the ribs that are involved in the mechanism of breathing.
2.2 The tendency of living organisms to maintain a constant internal environment.
2.3 Air sacs in the lungs. **(3)**

QUESTION 3 *(Questions taken from various sources)*
Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	The exchange of air between the lungs and the atmosphere.	A B	Ventilation Homeostasis
3.2	Movement of gases with the aid of muscular activity	A B	Breathing Gaseous exchange
3.3	Controlling center for homeostatic breathing control	A B	Brain Medulla oblongata

(3 x 2) **(6)**

ACTIVITY 2

QUESTION 1 *(Question adapted from grade 12 NSC 2020 question paper: P1)*

Describe how the human body maintains the carbon dioxide concentration in the blood when it rises above normal limits. **(5)**

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QUESTION 2

An investigation was carried out on a person in which the volume of air taken in at each breath and number of breaths per minute were measured at rest and after running.

The results are shown in the table below.

	Volume of air per breath	**Breaths per minute**
At rest	450 cm^3	20
After running	1 000 cm^3	38

2.1 Explain why the amount of oxygen taken up into the blood increases after exercise. (3)

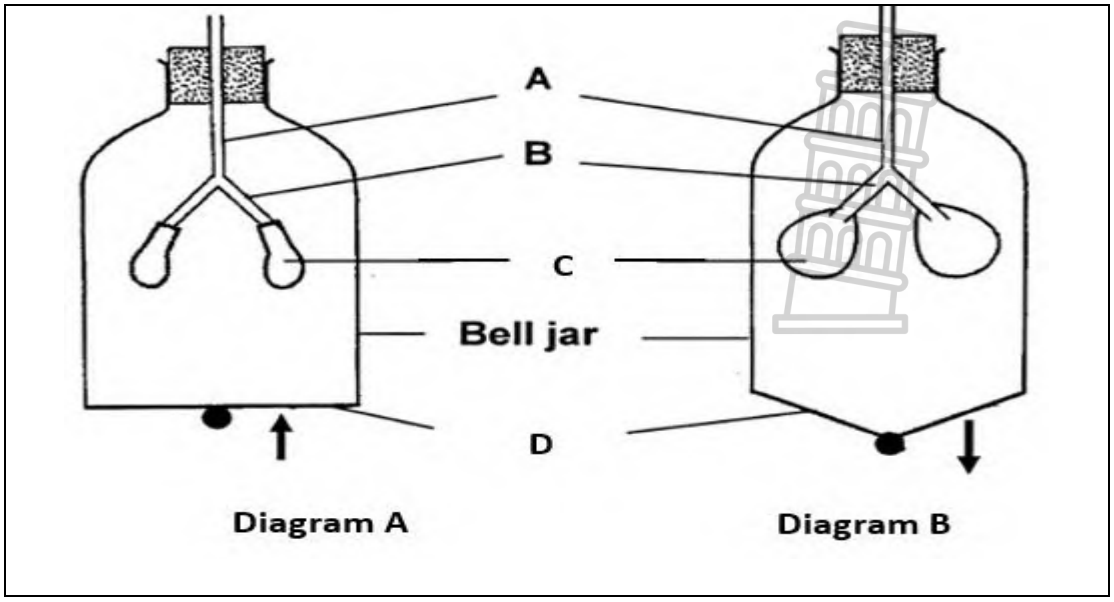
2.2 Describe the changes that took place in the human body to bring about an increase in the breathing rate of the person. (5)

2.3 20% of the air breathed in consist of oxygen, but only 16% of the air breathed out consist of oxygen. Calculate the amount of oxygen entering the blood per breath after running.
Show your calculations (3)

(11)

QUESTION 3 *(GDE 2021 Exemplar P1)*

The diagram below is a model that can be used to demonstrate the breathing mechanism in humans.



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3.1 What do each of the following parts represent in the human breathing system?
(a) **A**
(b) **B**
(c) **C** (3)

3.2 Explain ONE way in which part **A** in humans is adapted for its function. (2)

3.3 Which diagram (**A** or **B**) represents inhalation? (1)

3.4 Give TWO visible reasons from the diagrams to support your answer to QUESTION 3.3. (2)

3.5 Describe the mechanism of inhalation in humans. (5)
(13)

WEEK 4: TOPIC: Excretion in humans

SUB-TOPIC: Excretion in various organs.

NOTES & EXAM TIPS

Excretion is the process where all the metabolic wastes are removed from the body. Excretion in humans is carried out through different body parts and internal organs in a series of processes. Excretory waste products include CO_2, H_2O, bile pigments, urea and mineral salts.

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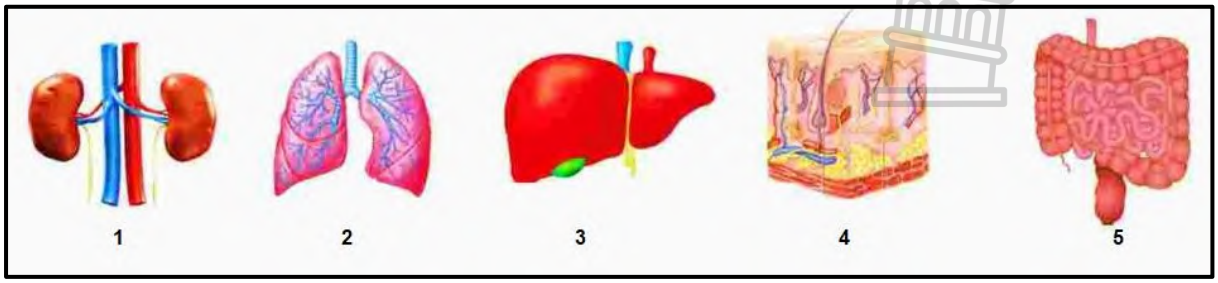
Excretory organs and their waste / excreted product

Waste products	Origin	Excreted product
Lungs		
carbon dioxide and water vapour	cellular respiration	CO_2 and $H_2O(g)$ in exhaled air
Skin (sweat glands)		
mineral salts, traces of urea, water	extracted from the blood	perspiration (sweat)
Liver		
urea	deamination of excess amino acids	faeces
bile pigments	breakdown of haemoglobin	
Colon		
bile pigments, excess mineral salts	from the breakdown of haemoglobin in the liver	faeces
Kidney		
urea	deamination of excess amino acids in the liver	urine
mineral salts	excess taken in with food	
water	excess water consumed and taken in as food	

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Identify the excretory organs labelled **1** to **5**. **(5)**



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WEEK 5: TOPIC: Excretion in humans

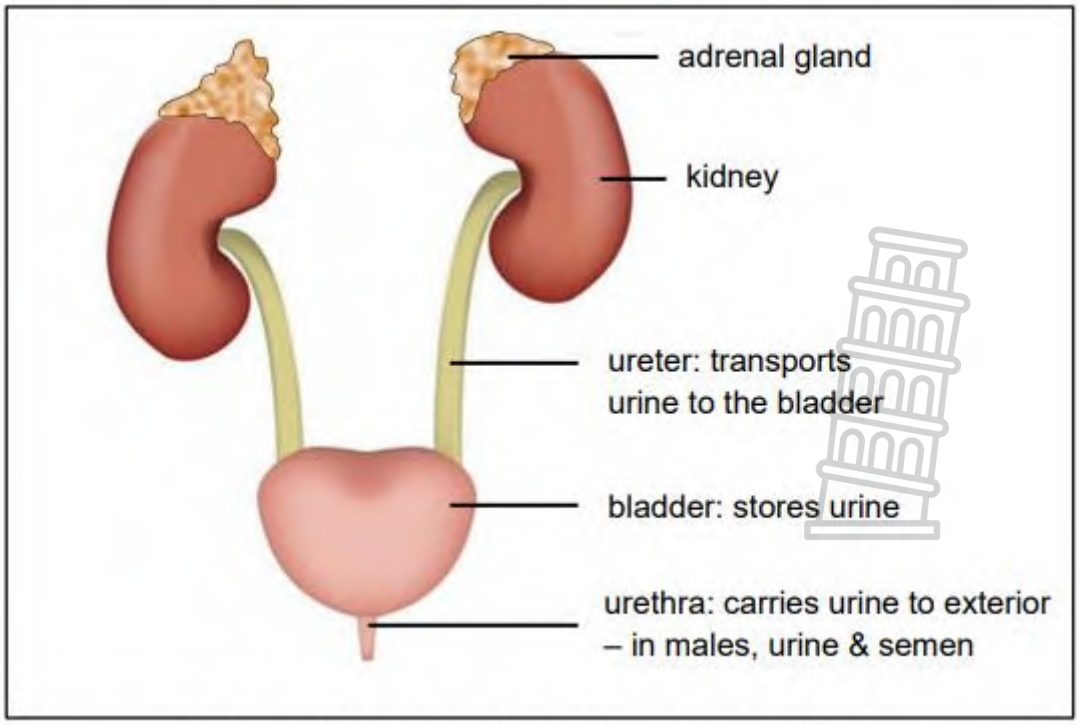
SUB-TOPIC: Urinary system- position of organs, structure and functioning of kidney. Structure and functioning of nephron

NOTES & EXAM TIPS

The excretory system of humans consists of two kidneys, two ureters, a bladder, and the urethra. The blood circulatory system is also associated with the urinary system – the renal artery and renal vein.

The function of the excretory system is to remove the toxic, poisonous substance urea, other waste salts and excess of water from the blood and excrete them in the form of a yellowish liquid called urine. Urine production and elimination are one of the most important mechanisms of homeostasis in the body.

The kidneys are bean shaped organs present at the back of our bodies just above the waist, just behind the intestines and insulated and kept in position by fat. Kidneys receive blood through the renal arteries and returning it through the renal veins. The ureters which are tiny tubes transport urine to the bladder for temporary storage while the urethra will carry urine to the outside of the body.



: Structure and functions of the different parts of the urinary system

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Kidneys

The kidney performs the following four main functions of the urinary system

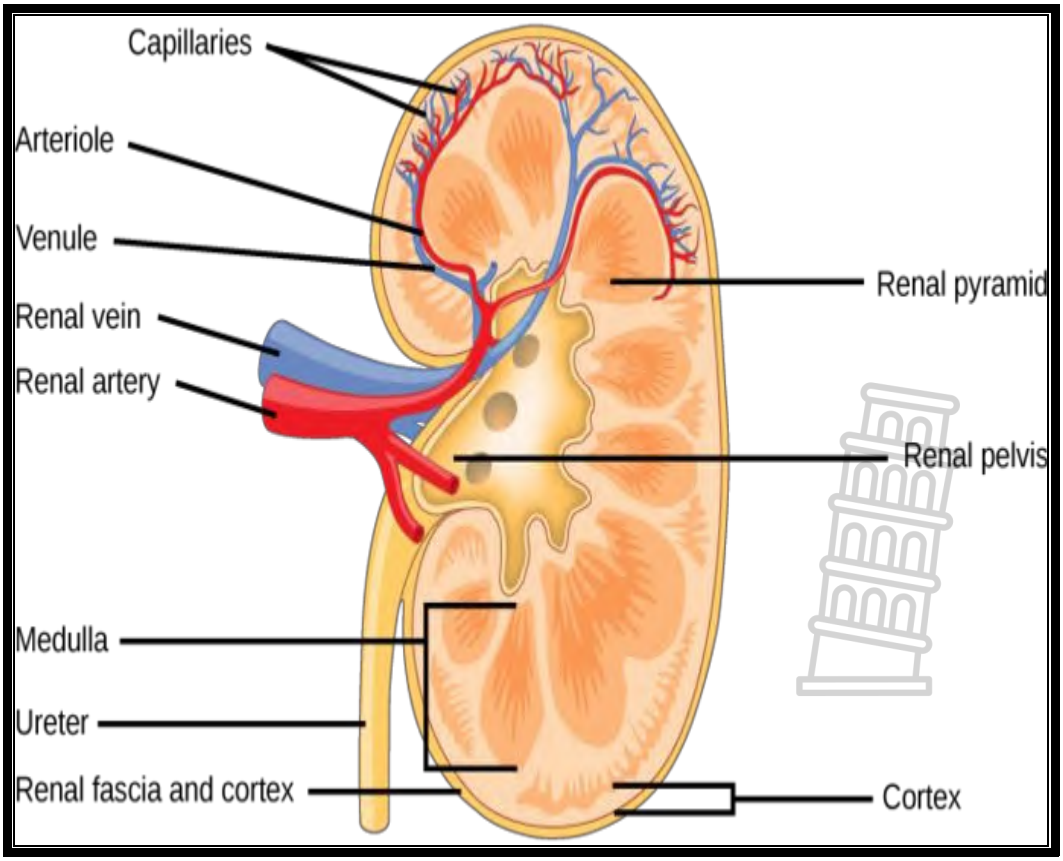
- Osmoregulation – regulation of levels of H_2O in body fluids
- Excretion – removal of nitrogenous waste e.g. urea
- Regulation of pH of body fluids
- Regulation of salt concentration of body fluids

A. General external characteristics

1. Bean shaped: concave on one side, convex on the other side.
2. Kidney is surrounded by a dense connective tissue capsule.
3. An indentation in the concave side is called the **hilum** where nerves, blood vessels and lymph vessels enter and leave the kidney.
4. **Renal pelvis** - expanded end of the ureter that connects to the hilum. A region where urine from the kidney collects and drains into the ureter.

B. The Kidney can be divided into a **cortex** and a **medulla**.

1. **Renal cortex:** contains upper portions of **nephrons**
2. **Renal medulla:** consists of parts of nephrons called **loops of Henlé**



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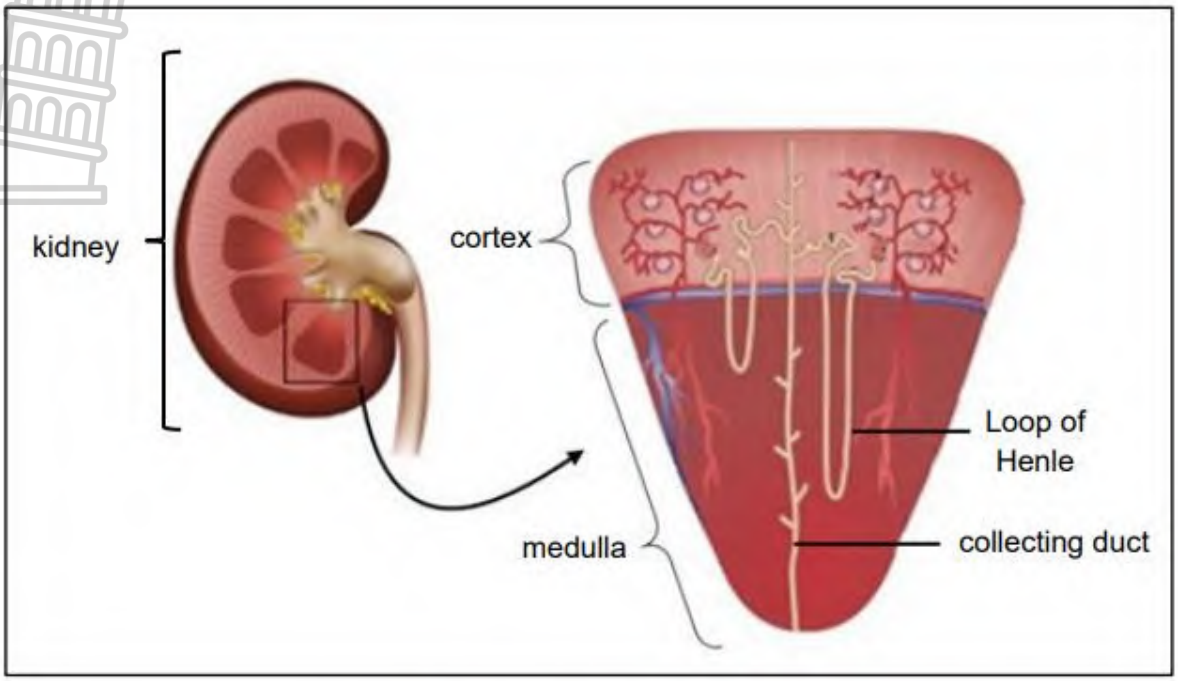
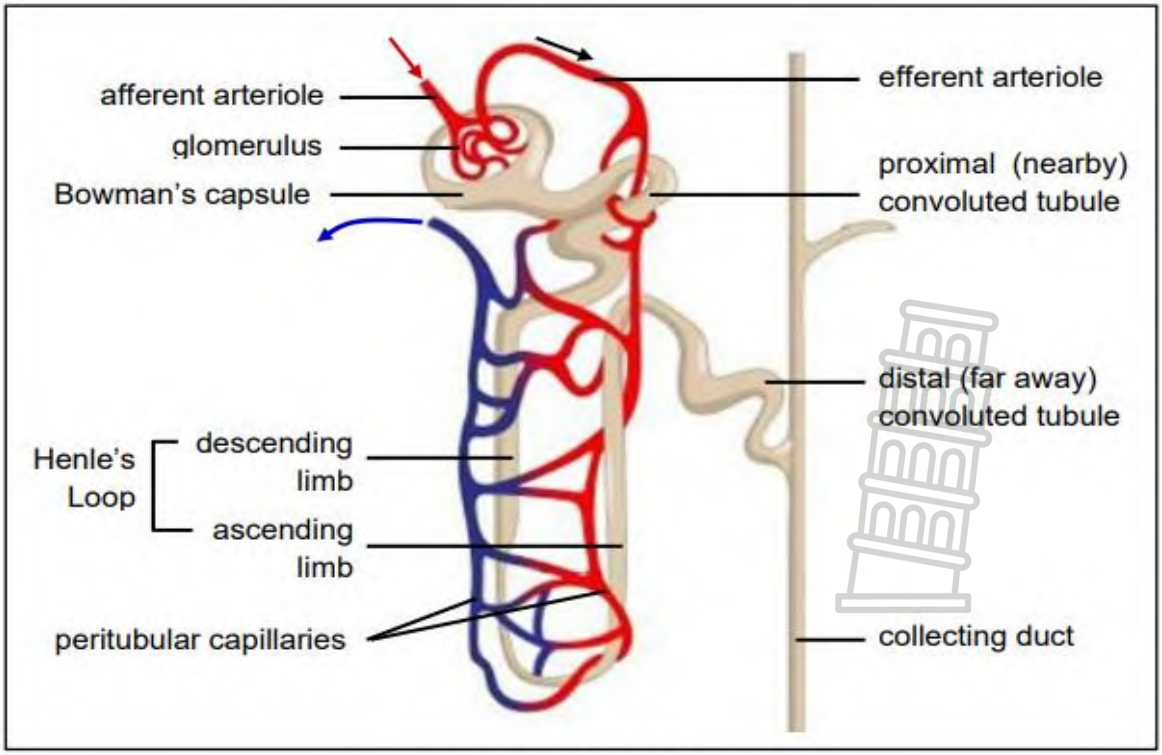
The **nephron** - the nephron is the functional unit of the kidney. There are approximately one million nephrons in each human kidney - consists of 2 components: the Malpighian body and the renal tubule.



Kidney and position of the nephrons



The structure of the nephron

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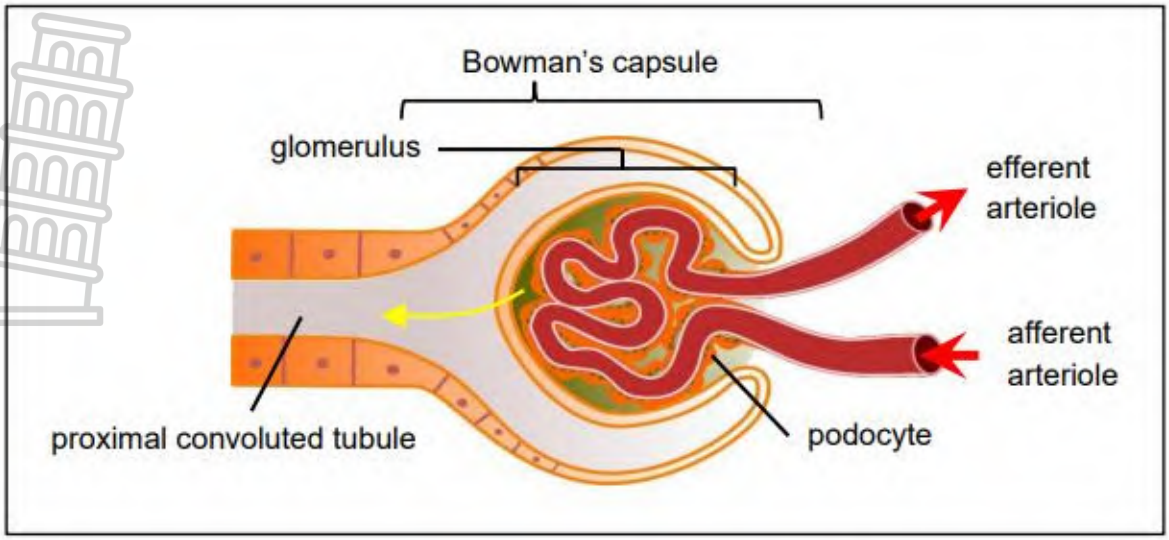

Malpighian body of the nephron

The **Malpighian body** (renal corpuscle) occurs in the cortex region of the kidney: it includes the cup-shaped Bowman's capsule and a dense capillary network in the hollowed-out region of the capsule called the glomerulus. The inner lining of the Bowman's capsule has special cells called podocytes. These cells have finger-like extensions that wrap around the capillaries of the glomerulus. There are slits between these extensions to allow substances to pass through.

The **renal tubule**: This includes the proximal (first, or close to) convoluted tubule in the cortex, the loop of Henle which runs into the medulla and the distal (second, or distant, far from) convoluted tubule back in the cortex. The distal tubule feeds into the collecting ducts that lead to the pelvic region of the kidney. The renal tubule is surrounded by a secondary capillary network known as the peritubular capillary network. Cuboidal epithelial cells line the renal tubule and have microvilli extensions on their surface. Each of these cells has a rich supply of mitochondria. Energy supplied by cellular respiration can be used to move substances against a gradient.

The formation of urine involves the following:
1. glomerular filtration or ultrafiltration
2. tubular re-absorption
3. tubular secretion
4. excretion

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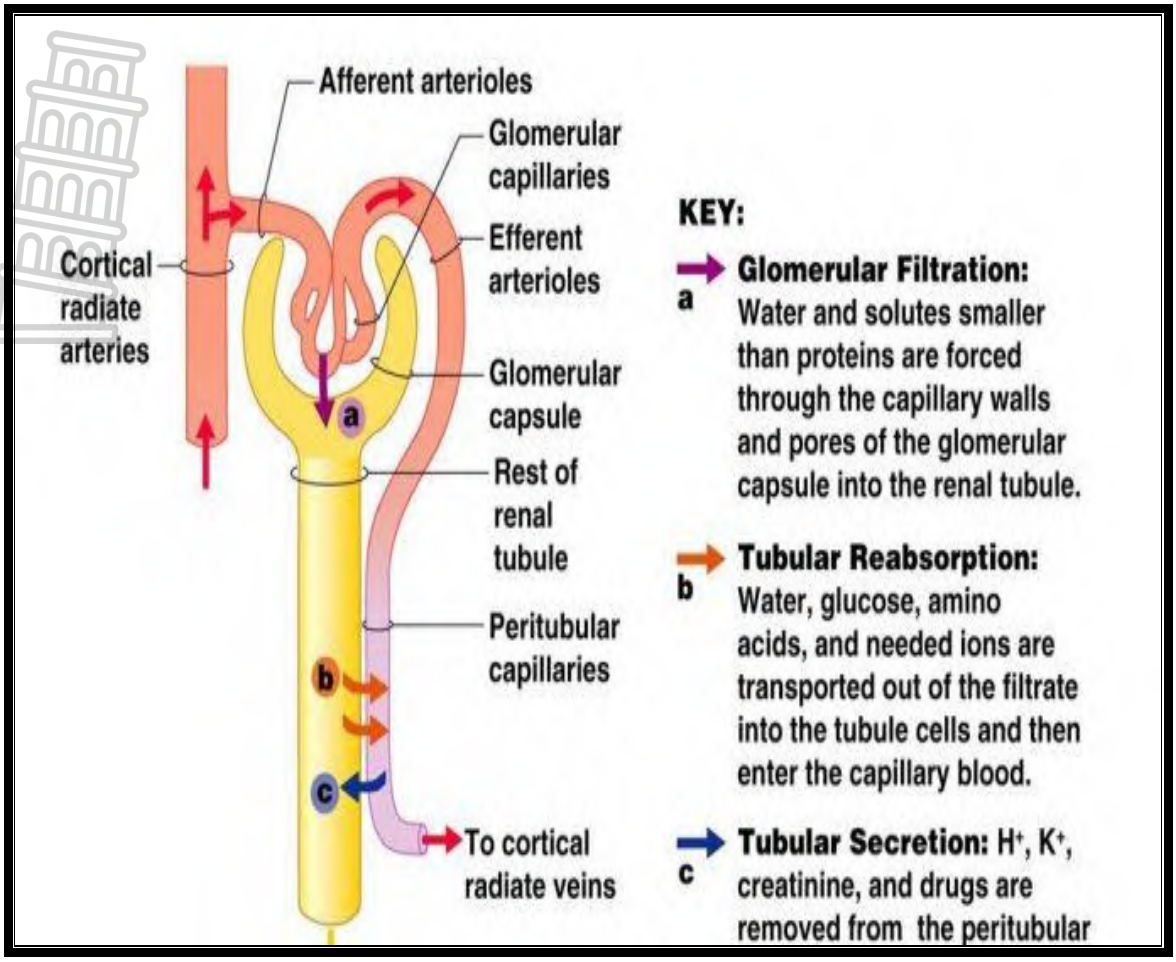
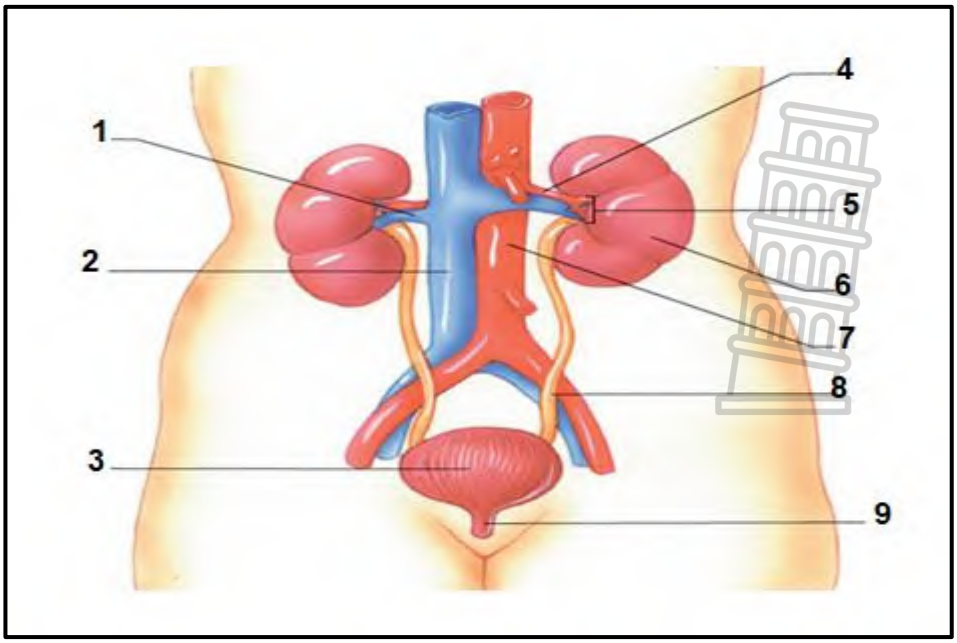


ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1



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1.1 Identify parts **1** to **9**. (9)

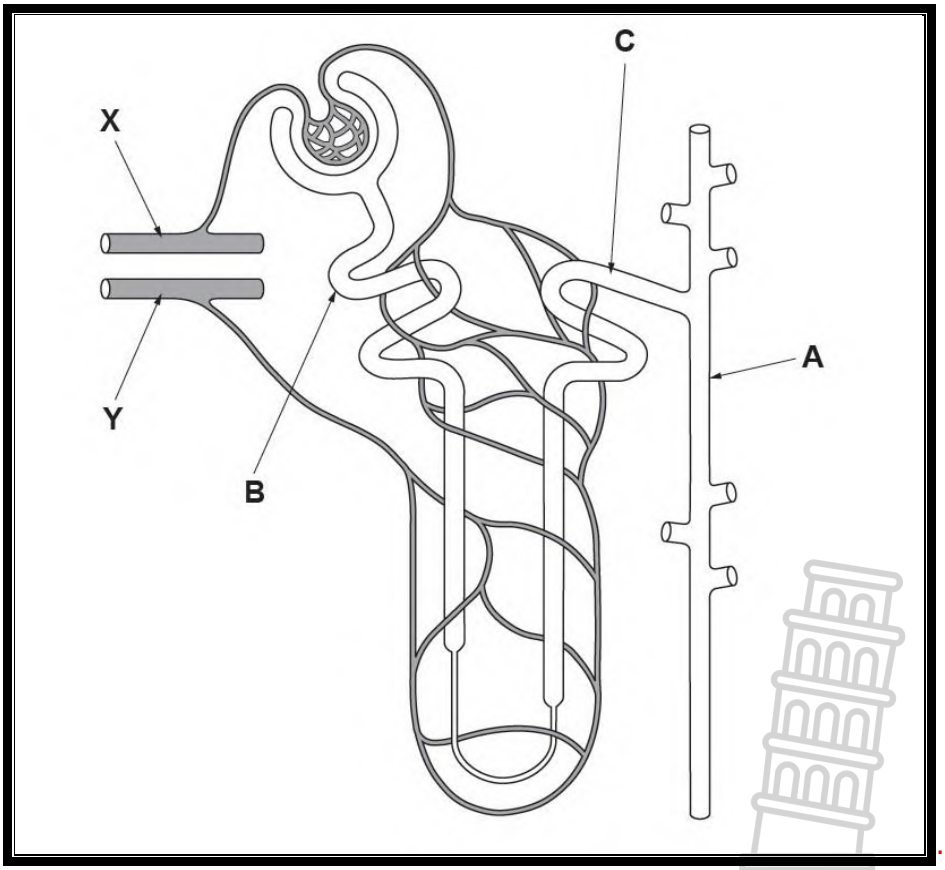
1.2 Write the names of the organs that match the functions in the following:

(i) Stores urine temporarily. (1)
(ii) Produces urine (1)
(iii) Carries urine to the external environment. (1)
(iv) Carries urine away from the kidneys. (1)
(v) Maintains composition and volume of body fluids. (1)

1.3 Name ways in which the blood in part numbered **1** differs from that in the part numbered **4**. (2)

1.4 Describe **THREE** functions of the kidneys. (3)
(19)

QUESTION 2



2.1 Name the functional unit of the kidney as represented in the diagram above. (1)

2.2 Identify part:

(a) **A** (1)
(b) **B** (1)

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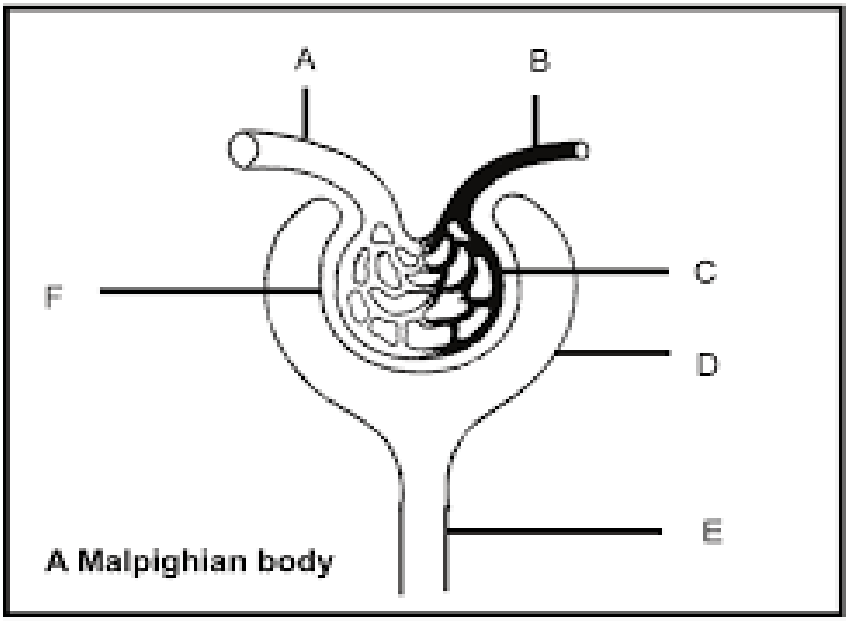
(c) **C** (1)

2.3 Name the blood vessels supplying the kidney which would connect at points **X** and **Y** shown on the diagram. (2)
(6)

QUESTION 3



3.1 Name the network of capillaries labelled **C**. (1)

3.2 Describe **TWO** structural features of part **C** that allow ultrafiltration to occur. (2)

3.3 Supply labels for:
(a) **A** (1)
(b) **B** (1)
(c) **D** (1)

3.4 Explain the significance of the differences in diameter between structure **A** and structure **B**. (2)
(8)

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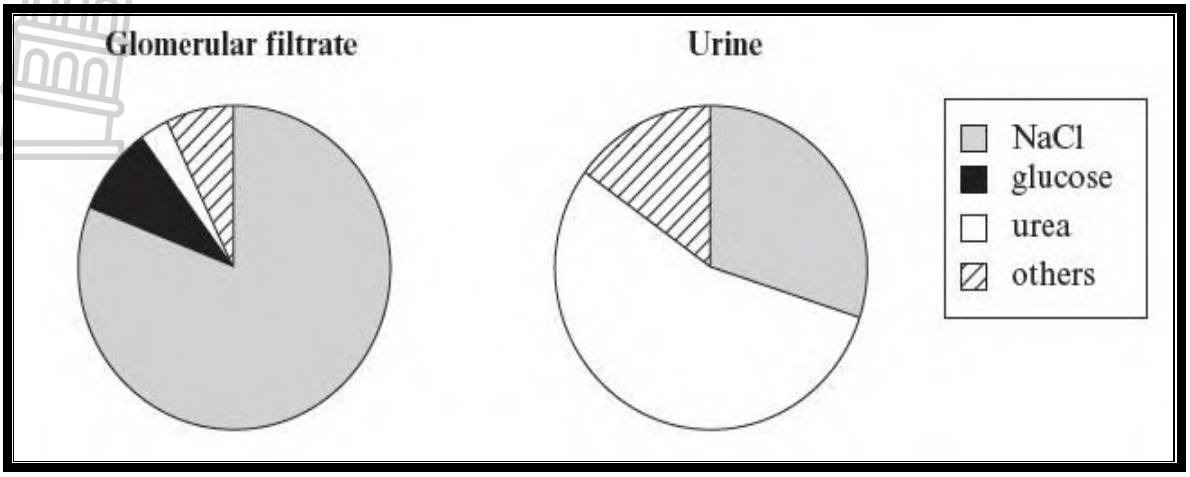
QUESTION 4

The pie charts below show the percentage composition of solutes in human glomerular filtrate and in urine.



4.1 Explain the difference in the glucose concentration between the glomerular filtrate and the urine as shown in the pie charts. (2)

4.2 **The urea concentration of urine is much higher than that of the glomerular filtrate.**
Describe the role of the nephron in achieving this increase in the urea concentration in the urine compared to the other filtrates. (5)
(7)

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WEEK 6: TOPIC: Excretion in humans

SUB-TOPIC: Homeostatic control of water and salts; role of ADH and aldosterone.

NOTES & EXAM TIPS

Homeostatic regulation by the kidneys

It is important that the body's temperature is kept within a narrow range of around 37°C.The pH of the body fluids needs to be regulated and the composition of these fluids needs to be kept constant and to be kept within certain limits for effective metabolism.

The kidney is involved in 3 homeostatic mechanisms:

- the regulation of **pH** of the blood
- the regulation of **water** levels (osmoregulation)
- the regulation of **salt** levels in the blood

Biological terminology	
Osmoregulation	The control of water content and salt balances in the blood and tissue fluid.
Homeostasis	Refers to the process of keeping the internal body environment constant/the ability of the body to maintain a stable internal environment.
Aldosterone	Hormone that is produced by the adrenal cortex that promotes sodium absorption.
ADH	Hormone that controls the amount of water absorbed by the kidneys and which is therefore responsible for osmoregulation
Hormone	A chemical messenger
Dialysis	A method of artificially removing waste products from the bloodstream if the kidneys are unable to do so on their own.

Regulation of salt levels in the blood

The blood and tissue fluids are affected by the presence of solutes (dissolved substances). Sodium and potassium are salts that are found in the body fluids. Sodium is important in the body for good nerve and muscle functioning. Constant levels must be maintained.

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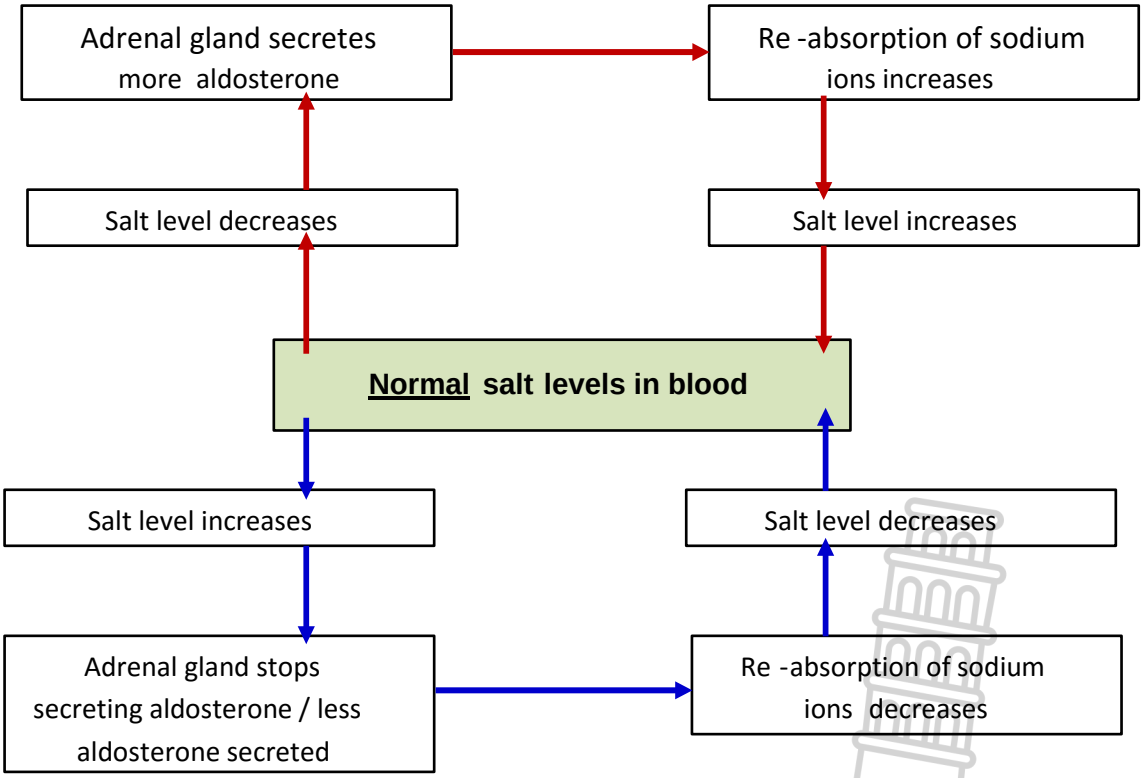
Homeostatic control of salt concentrations

Low salt levels in blood and tissue fluids make these fluids **hypotonic**	Elevated **salt levels** in the blood / tissue fluids make these fluids **hypertonic**.
Receptor cells in the afferent and efferent arterioles of the glomeruli of the kidney will detect decreased Na^+ levels.	Receptor cells in the afferent and efferent arterioles will detect an increased presence of Na^+.
The adrenal gland in the kidney secretes the hormone aldosterone.	The adrenal gland will stop releasing aldosterone.
Aldosterone stimulates the reabsorption of Na^+ from the filtrate and back into the blood.	Na^+ will not be reabsorbed.
Less sodium is excreted in the urine.	More sodium is excreted in the urine.



Homeostatic control of salt concentrations

The role of antidiuretic hormone (ADH) in osmoregulation

ADH controls the amount of water re-absorbed by the blood in the capillaries within the medulla. It is produced by the hypothalamus and released into the blood stream by the pituitary gland.

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When the water content of blood is low, osmoreceptors in the in the hypothalamus are stimulated. A message is sent to the pituitary gland, which now releases ADH in the bloodstream. ADH increases the permeability of the cells in the wall of the distal convoluted tubule and the collecting duct tube. More water now leaves the tubule by osmosis and enters the blood in capillaries in the medulla. The water content of the blood therefore increases, and the urine becomes more concentrated. When the water content of the blood is high, osmoreceptors in the hypothalamus are stimulated. A message is sent to the pituitary gland and less ADH is released in blood. Due to the low level of ADH in the blood, the permeability of the cells of the distal convoluted tubule and collecting tubules is reduced. Less water leaves the tubules. Dilute urine is passed out.

Too little water in the blood	**Too much water in the blood**
Dehydration is when the blood and tissue fluid are short of water.	Overhydration occurs when the blood and tissue fluids are very dilute.
This can be brought about by excessive exercise, hot temperatures, increased sweating or decreased water intake.	This can be because of cooler temperatures, little exercise with no sweating and an excessive intake of water.
This low level of H_2O is detected by the hypothalamus of the brain.	Water levels are elevated, and this is detected by the hypothalamus.
The pituitary gland releases antidiuretic hormone (ADH).	The pituitary gland releases less ADH.
The hormone is transported in the blood to the kidney. The permeability of the collecting duct and the distal convoluted tubule is increased.	Collecting ducts and distal convoluted tubules in the kidney become less permeable.
More H_2O is absorbed and passed into the blood.	Less H_2O is absorbed into the blood.
The blood becomes more dilute and less, concentrated urine is excreted.	Less water leaves the collecting duct and more, dilute urine is excreted.

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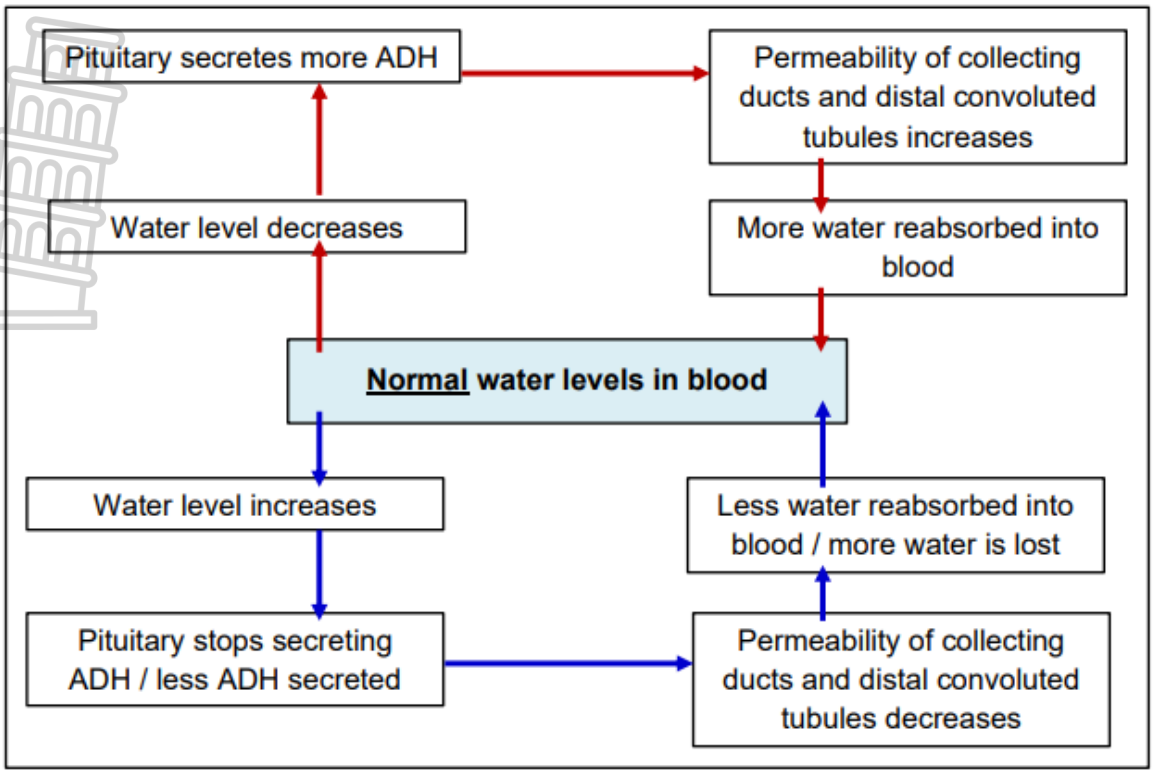

Homeostatic control of water in the body fluids

Alcoholic and caffeine containing drinks act as diuretics (they cause you to lose water by urinating frequently). ADH acts in an opposite way as it helps the body retain water.

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 and 1.2) in your ANSWER BOOK, for example 1.3 D.

1.1 A hormone which is secreted by the cortex of the adrenal gland, which regulates the concentration of sodium ions and potassium ions in the blood:

A Glucagon
B ADH
C Aldosterone
D Insulin

1.2 The glucose concentration of dialysis fluid is…

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A the same as that of blood.
B higher than that of blood.
C lower than that of blood.
D always 0g/mol of blood.

(4)

QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.5) in your ANSWER BOOK.

2.1 The control of water content and salt balances in the blood and tissue fluid.
2.2 Refers to the process of keeping the internal body environment constant/the ability of the body to maintain a stable internal environment.
2.3 The hormone which regulates the water content in the blood
2.4 Hormone that is produced by the adrenal cortex that promotes sodium absorption.
2.5 The blood vessel which carries oxygenated blood rich in metabolic waste products to the kidney **(5)**

QUESTION 3

A healthy man, with normal kidney function, is used in the following practical investigation. The amount of urine that he produces every 30 minutes (for an hour and a half) is measured by collecting it, measuring the amount, calculating the average and noting the average at a-minute point. He is then asked to drink one liter of water, and his urine is again collected at 30-minute intervals. The following table shows the results of the investigation. Answer the following questions.

Time after drinking water (minutes)	0	30	60	90	120	150	180	210	240
Urine produced (ml)	50	320	480	180	50	60	50	35	55

3.1. Identify the following:

(a) dependent variable. (1)

(b) independent variable (1)

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3.2. A hypothesis was formulated as follows: "Drinking water increases urine production".
Would you say that this investigation proves the hypothesis is accepted or is rejected?
Motivate your answer. (2)

3.3. What was the most urine that he produced in one half hour period? (1)

3.4. How long did it take for the urine production level to return to normal after he drank the water? (1)

3.5 Name the process by which the water balance in the body is maintained (1)

(7)

QUESTION 4

Study the following information:

ADH is a chemical produced in the brain that causes the kidneys to release less water, decreasing the amount of urine produced. A high ADH level causes the body to produce less urine. Normally the amount of ADH in the body is higher during the night. It is normal to urinate 1 to 2 times per night, but more frequent trips to the bathroom should send some warning signals. Normal values for ADH ranges from between 1 to 5 µg/ml.

A higher-than-normal level may occur when too much ADH is released, either from the brain where it is made, or from somewhere else in the body. This is called syndrome of inappropriate ADH (SIADH). SIADH can be caused by brain injury, brain tumours, infection in the lungs or a stroke amongst many. A lower-than-normal level may indicate damage to the hypothalamus, diabetes insipidus, excessive thirst or too much fluid in the blood vessels.

A team of scientists decided that they want to research a group of people in the A ward of the hospital and see how their ADH levels differ and provide explanations to why this is possibly happening.

The population information is as follows:

- 10 men and 10 women
- They received the same amount of water, meals and hours of sleep.
- None of them could exercise to prevent excessive sweating.
- All of them were monitored at a facility for 24 hours to see when they are using the bathroom and how much urine they are producing.

The following results were obtained.

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Males			Females		
Patient nr.	ADH levels (µg/ml)	Urinating frequency at night	Patient nr.	ADH levels (µg/ml)	Urinating frequency at night
1	2.4	1	11	5.6	1
2	3.3	2	12	7.9	0
3	6.2	0	13	1.6	2
4	2.5	1	14	2.3	1
5	6.9	0	15	2.45	1
6	0.5	5	16	0.69	4
7	1.2	2	17	4.8	2
8	2.2	1	18	3.5	2
9	0.43	4	19	2.12	1
10	2.8	2	20	2.3	1

4.1. Provide an aim for the investigation. (2)

4.2. What does the abbreviation ADH stand for? (1)

4.3. Why must the ADH levels at night be especially higher? (2)

4.4. Provide the numbers of two patients that may possibly have

(a) SIADH (2)

(b) diabetes insipidus (2)

4.5. What would be the symptom of a patient with diabetes insipidus? (1)

4.6. Calculate the percentage of this population group that are healthy. (3)

4.7. What deduction can be made in terms of ADH levels and frequency of urination, especially at night. (2)

(15)

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WEEK 7: TOPIC: Population ecology

SUB-TOPIC: Population size: Immigration, emigration, mortality, natality; fluctuations and limiting factors

NOTES & EXAM TIPS

Population Ecology*: is the part of ecology that focuses on the factors influencing the population size, growth rate, growth forms and distribution of individuals inside a population.*

Important terms:

- ***Species****: A group of organisms with similar characteristic, that are able to interbreed to produce fertile offspring. E.g. giraffe, zebra, etc.*
- ***Population****: A group of organisms of the same species occupying the same habitat at the same time and can interbreed randomly. E.g. Population of lions in Manyeleti game reserve.*
- ***Community****: A group of populations occurring in a particular area. E.g. lion, zebra, giraffe populations in Manyeleti game reserve.*
- ***Natality****: Is the birth rate of a population, normally expressed as the number of births per thousand individuals per year.*
- ***Mortality****: Is the death rate of a population, normally expressed as the number of deaths per thousand individuals per year.*
- ***Immigration****: is the one-way movement of organisms into an area where they become established.*
- ***Emigration****: is the one-way movement of organisms out of an area to become established.*

Population size*: Total number of individuals in a population*
Population density*: refers to the number of individuals of a population per unit area, e.g. 10 goats per hectare (100 m X 100 m)*

Note: Natality and immigration cause an increase in population size
Mortality and emigration cause a decrease in population size

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Factors affecting population size

The following population limiting factors prevent unlimited growth in a population:

a. Shortage of food and water
b. Shortage of shelter or living space
c. Predation
d. Diseases and parasitism
e. Accumulation of toxins

- Once population has reached its maximum size, the population size will not remain constant, but fluctuate within the narrow boundaries due to changes in the environmental resistance (limiting factors)
- Population size may fluctuate annually or seasonally.

Population size can be determined by direct and indirect techniques/methods

- Direct technique involves total counting of all individuals
- Indirect technique involves the counting of only part of the population (mark-recapture technique and quadrant technique)

Formula used to determine the estimated population size:

$$P = \frac{F \times S}{M}$$

F = Number caught in the first sample
S = Number caught in the second sample
M = Number marked in the second sample

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (1.1 to 1.4) in your ANSWER BOOK.

1.1. Method of determination of population size by counting the individuals in a representative sample area
1.2. The death of individuals in a population

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1.3. A group of organisms of the same species, occupying a particular habitat and having the ability to interbreed randomly

1.4. The inherent ability of a population to increase by birth **(4)**

QUESTION 2

A group of students wanted to determine the population size of two species of butterflies. Their results are indicated in the table below.

	October 2016	November 2016	
	Number marked and released in first sample	Number in recaptured/ second sample	Number marked in recaptured/ second sample
Species A	20	300	10
Species B	25	75	5

2.1 Define the term population. (3)

2.2 Estimate the number of butterflies of species **A** in the area by using the following formula:

$$P = \frac{F \times S}{M}$$

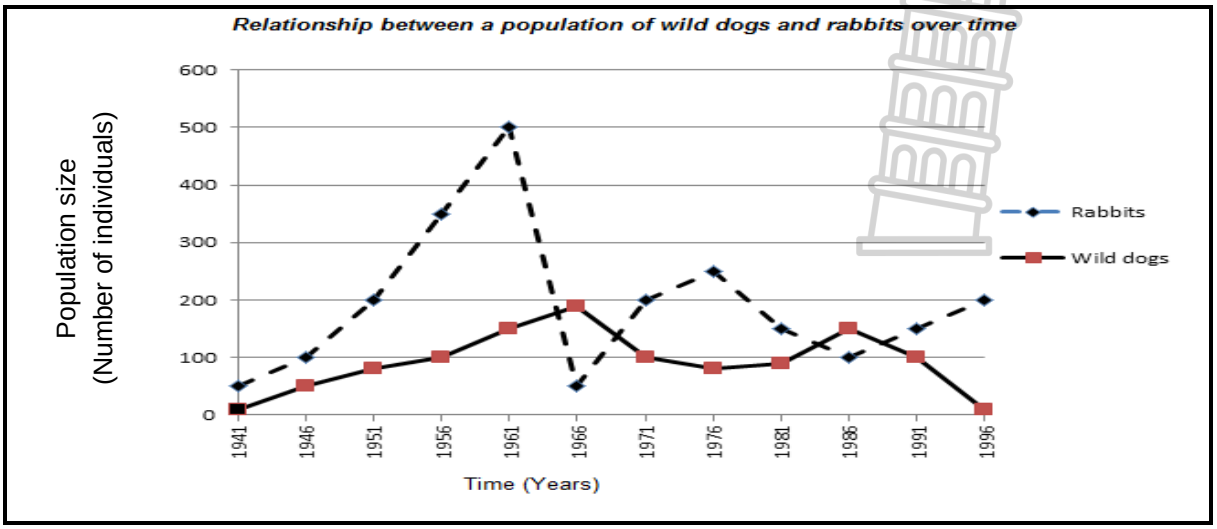
F = Number caught in the first sample
S = Number caught in the second sample
M = Number marked in the second sample

Show all your calculations. (3)

2.3 Suggest TWO reasons why there were differences in the numbers between species **A** and species **B** in the recaptured/second sample. (4)
(10)

QUESTION 3

Study the graph below and answer the questions that follow.



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3.1 How many of the following were there in 1966?

(i) Rabbits (1)
(ii) Wild dogs (1)

3.2 What is the maximum number of rabbits that have survived in this environment? (1)

3.3 What effect does a small number of wild dogs have on the rabbit population?
Explain your answer. (2)

3.4 Name ONE technique that can be used to estimate the size of the rabbit population. (1)

(6)

WEEK 8: TOPIC: Population ecology

SUB-TOPIC: Logistic and geometric growth curves with phases

NOTES & EXAM TIPS

Key terminology	
growth curves	Graphs that plot population size against time
geometric growth	A doubling after every reproductive event, i.e. exhibit exponential growth; graph has a **J-shape**
logistic growth	The type of population growth that starts with a few individuals and many resources – growth rate and consumption then increase. As resources are used up, growth rate levels off, resulting in an **S-shaped** graph
lag phase	First phase in a population growth curve where growth is slow; individuals may be acclimatizing to environment; few individuals that are sexually mature and able to reproduce
exponential growth phase	Second phase in a growth curve; individuals have acclimatized, many reproducing individuals exist; in favourable conditions can produce many offspring
decelerating growth phase	Third phase in a growth curve; environmental resistance leads to a decrease in the number of individuals; initially, natality rate is higher than the mortality rate but later the mortality rate is equal to the natality rate and eventually exceeds it

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equilibrium phase	Forth phase in a growth curve, carrying capacity is reached and factors limit size of population; carrying capacity is stable and able to maintain the population at a set value
death / extinction phase	Fifth phase in population curve; without management of resource usage, and changes to abiotic and biotic factors in their environment, the population may not be able to sustain itself and enter a population crash phase

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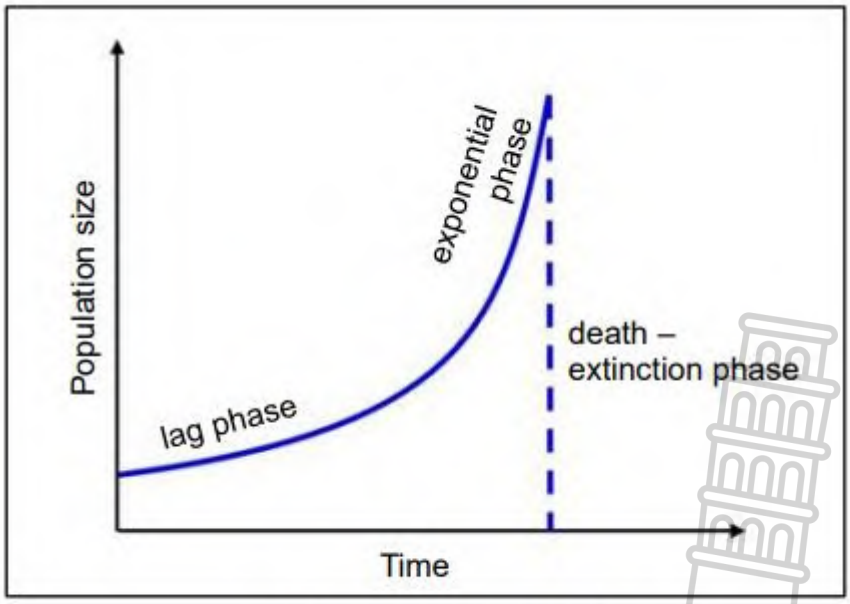
Geometric growth curve

Geometric growth is characteristic of many micro-organisms e.g., bacteria and protists. These species are able to reproduce quickly and double their numbers after every reproductive division in favourable conditions. Eventually their resources become limited and/or waste products accumulate and adversely affect the population. This causes death or an extinction event. Three distinct phases can be seen in geometric growth curves.

- **Lag phase** – population number increases slowly because:
  - o individuals may still be acclimatising to their environment.
  - o they need time to find mates.
  - o most of the population is sexually immature.
- **Geometric (or accelerated) growth phase –** individuals have acclimatised, many reproducing individuals exist and in favourable conditions produce many offspring. The birth rate is higher than the death rate. There is very little environmental resistance.
- **Extinction or death phase** – resources become limited, i.e., food, space, etc., and the population is no longer able to reproduce as effectively. The mortality rate becomes greater than the natality rate. The population decreases rapidly.



Geometric growth in a population

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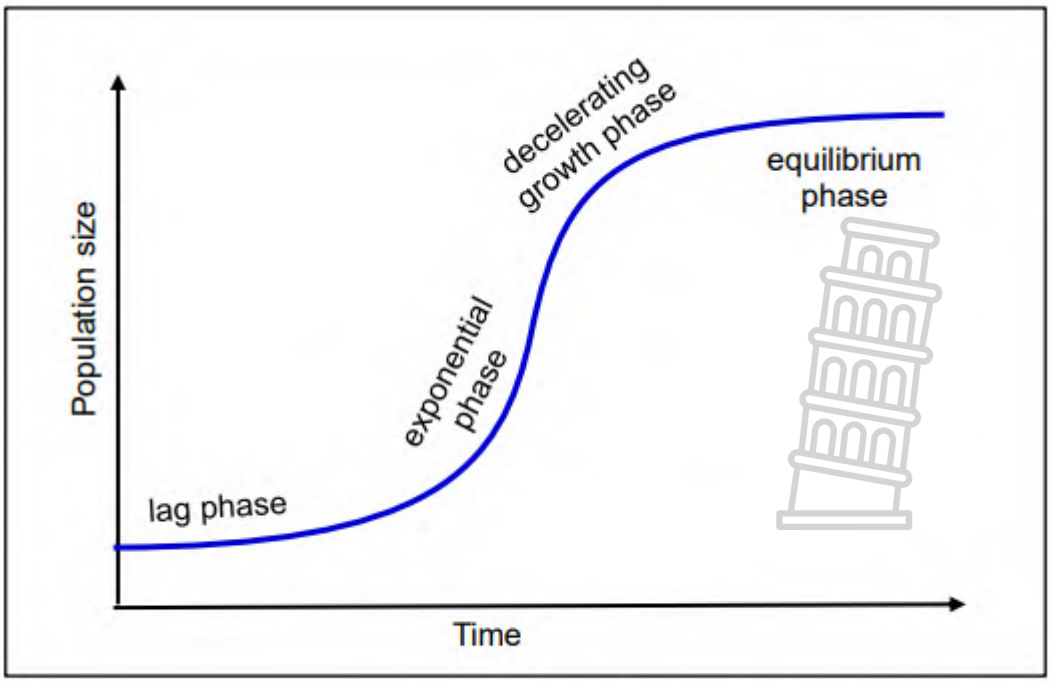
Logistic growth form

Logistic S-shaped growth is normally found in higher-order organisms (e.g., mammals) which typically reproduce slower. Populations tend not to exceed the carrying capacity and, if they do, they show higher levels of resilience to environmental resistance.

An S-shaped graph forms typically consists of five phases.

- **Lag phase:** As in the geometric growth curve, the population numbers increase slowly.
- **Exponential or accelerating growth phase**: The population can reach higher natality levels because of more sexually mature individuals procreating and environmental resistance being low (because of enough food, space and shelter).
- **Decelerating growth phase**: Natality rate is still higher than the mortality rate, however, the mortality rate is gaining momentum because of higher levels of environmental resistance and old age.
- **Equilibrium / stationary phase**: Carrying capacity of the environment has been reached. One or more limiting factors are exerting a toll on the population. The carrying capacity is somewhat stable and able to maintain the population at a set value.
- **Death / extinction phase** (not shown on graph): Some populations cannot regulate their resource usage and/or changes to abiotic and biotic factors in their environment and are then unable to sustain themselves.



Logistic growth curve

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.3) in your ANSWER BOOK, for example 1.4 D.

1.1 How many phases does a logistic growth curve have?

A 5
B 8
C 1
D 4

1.2 Which is the initial phase in logistic growth?

A Log phase
B Lag phase
C Declining phase
D Stationary phase

1.3 Which of the following initial phase is slow?

A Declaration phase
B Stationary phase
C Lag phase
D Log phase

(3x2) **(6)**

QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1 Graphs that plot population size against time

2.2 The phase in which the carrying capacity of the environment has been reached. One or more limiting factors are exerting a toll on the population

2.3 Growth form that is normally found in higher-order organisms (e.g., mammals) which typically reproduce slower. **(3)**

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QUESTION 3

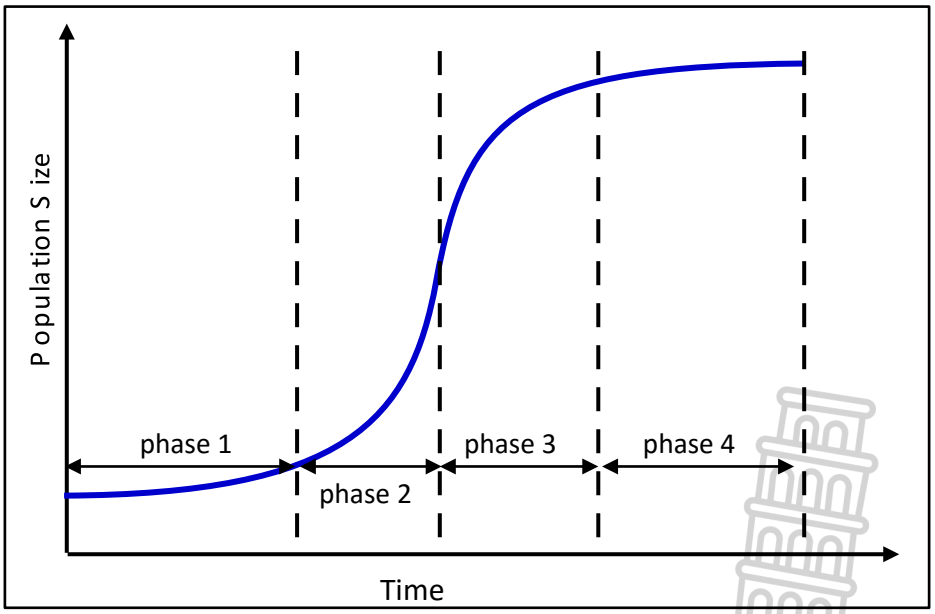
Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	The growth when responses in a population are limiting	A B	Logistic growth Stationary growth
3.2	Zero growth in phase	A B	Lag phase Log phase
3.3	Organisms in a population multiply at a faster rate?	A B	Exponential phase Log phase

(3 x 2) **(6)**

QUESTION 4

4.1 Identify the growth form in the following graph. (1)



4.2 Identify the phases **1** to **4** in the above graph. (4)

QUESTION 5

Tabulate two major differences between logistic and geometric growth forms. Include an example of a species representing each growth form. (7)

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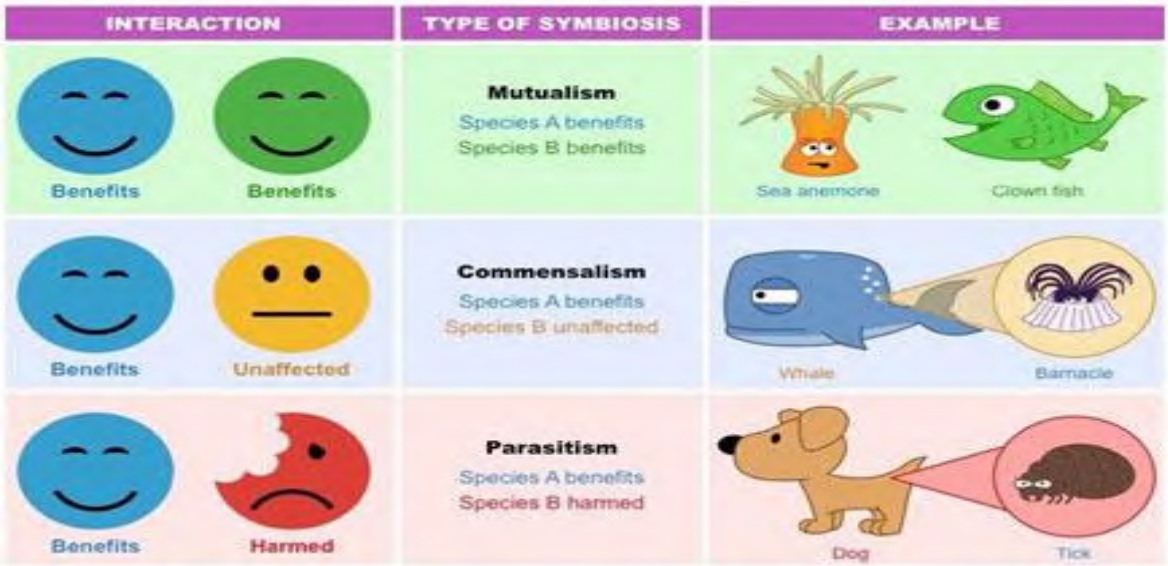
WEEK 9: TOPIC: Population ecology

SUB-TOPIC: Interactions in the environment – predation, competition, specialisation, parasitism, mutualism, commensalism

NOTES & EXAM TIPS



KEY TERMINOLOGY	
Term	**Definition/explanation**
Predation	The act of **preying** on another animal
Predator	Heterotrophic organisms (usually animals) that **hunt, kill** and eat other organisms
Predator – prey curve	A curve that describes the dynamics of biological systems in which **two species interact**
Competition	Social interaction between organisms **fighting** for dominance over the **same limited resources** (food, living space)
Interspecific competition	Competition between two or more **different** species
Intraspecific competition	Competition within members of the **same** species

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Competitive exclusion	Process whereby species can exist independently and survive; when placed in the same environment, one species will **out compete** the other and cause its **extinction / death**
Resource partitioning	A specialisation that limits interspecific competition; through resource partitioning, different carnivores, herbivores and even plant species can **co-exist** and survive in the same environment since each occupies a different ecological niche
Mutualism	Species that partake in this relationship **benefit equally**
Commensalism	Symbiotic relationship where **one** organism **benefits** without harming or affecting the other organism
Parasitism	Symbiotic relationship in which **one** organism **benefits** from the relationship (parasite) while causing **harm to their host**
Social organization	Interactions that increase the chances of survival through **shared efforts** of individuals benefiting the members of the population
Herding behavior	Individuals in a group which **act collectively** without centralized direction
Pack hunting	Typically associated with **cooperative** coordinated, purposeful movements in the catching and **killing of prey**

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

1.1 Indicate whether each of the statements in Column I applies to A ONLY, B ONLY, BOTH A AND B or NONE of the items in Column II. Write A only, B only, both A and B, or none next to the question number (1.1.1 to 1.1.4).

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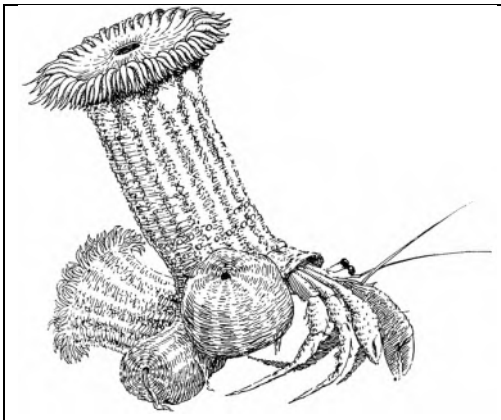
Column I	Column II
1.1.1 Kittens competing for their mother's milk	A: interspecific competition B: intraspecific competition
1.1.2 One of the species benefits and the other is unaffected	A: commensalism B: mutualism
1.1.3 Organisms have overlapping niches and compete for the same resources but they coexist because they use the resources slightly differently	A: resource partitioning. B: temporal partitioning
1.1.4 Example of social organization that increases the chances of survival	A: division of labour in bees B: a herd of zebras

(4 × 2) = **(8)**

QUESTION 2

Study the diagrams below. Identify the interactions between the organisms. Classify them as: parasitism, mutualism or commensalism.



A. As the hermit-crab moves about in search of food the anemone is brought into contact with a greater supply of food and the crab is protected by the anemone's stinging cells

(2)

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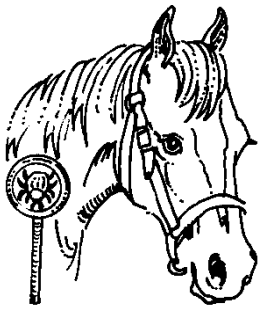
B. In return for shelter, the clownfish cleans the anemones, chasing away their predators and dropping scraps of food for the anemone to eat.

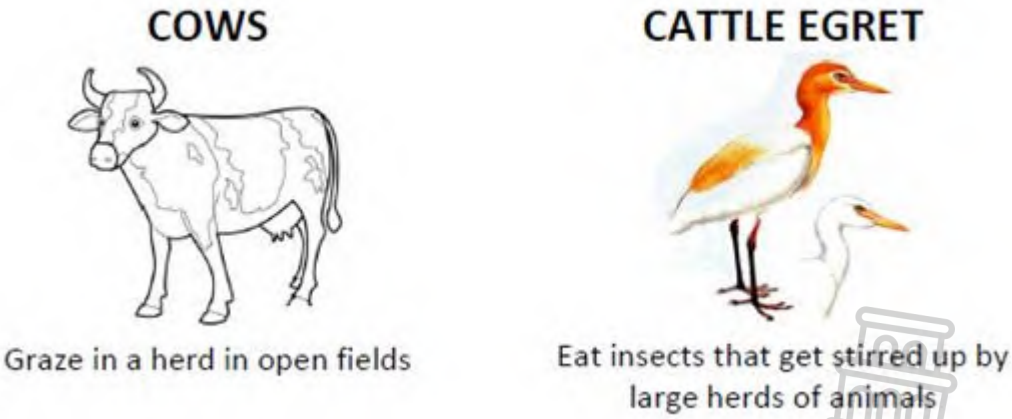
(2)



C. Ticks on horses if not treated can lead to tick fever.

(2)

D



(2)

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E Ants protect the *Acacia* from herbivores and kill any plants that start to grow near the tree. The Acacia makes nectar for the ants to eat.

(2)

(10)

QUESTION 3

The following investigation was carried out by gr.11 learners to demonstrate competition between plants:

Four pots of the same size were filled with equal amounts of soil.
Seeds of bean and pea plants from the same species were planted in each pot as follows:

Pot A – 25 bean seeds
Pot B – 3 pea seeds and 3 bean seeds
Pot C – 5 pea seeds and 7 bean seeds
Pot D – 9 pea seeds and 9 bean seeds

The seeds were watered well and left in a place with enough sunlight. After two weeks the number of plants in each pot was counted. The average height of the plants above the ground was also measured.

The results are shown in the table below.

	Number of plants	**Average height of plants (cm)**
Pot A	8	2
Pot B	6	6
Pot C	8	5
Pot D	8	3

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3.1 In which pot (**A**, **B**, **C** or **D**):

(i) Will intraspecific competition occur? (1)
(ii) Will the least competition occur? (1)
(iii) Was a single population found? (1)
(iv) Will the most interspecific competition occur? (1)

3.2 What is the carrying capacity of the pots? (1)

3.3 Why was the average height of the plants used instead of a single reading only? (1)

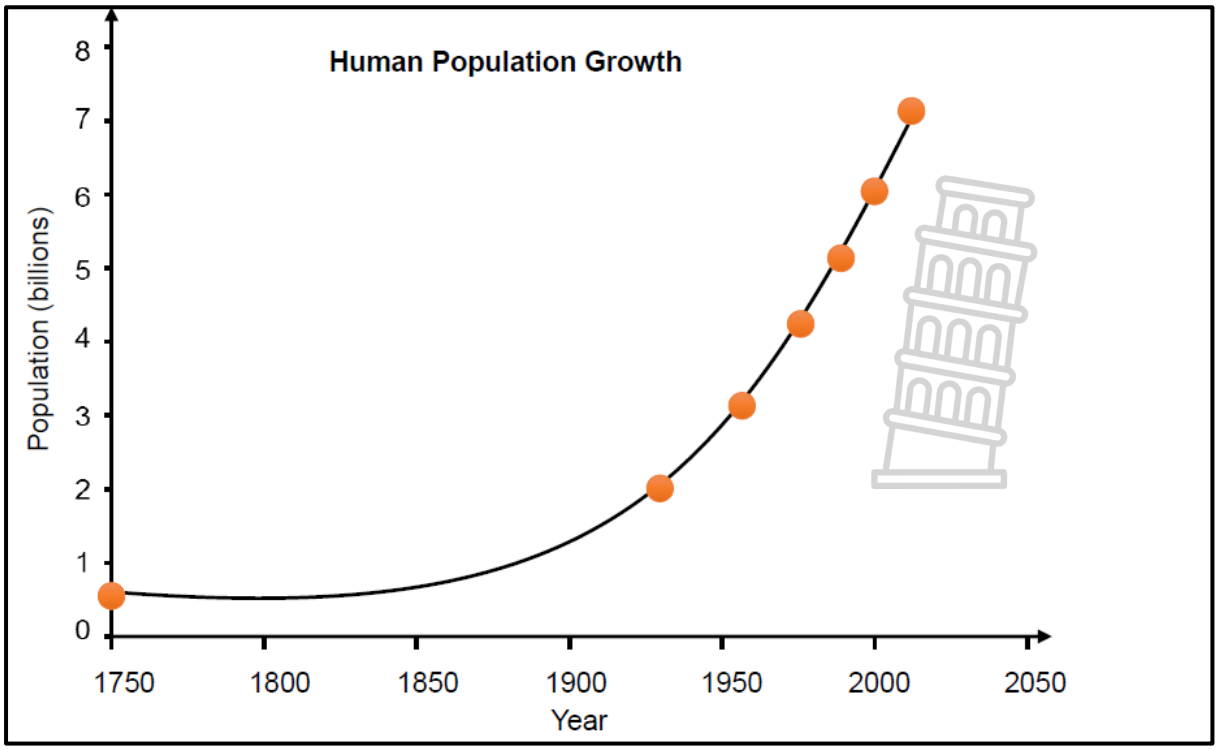
(6)

WEEK 10: TOPIC: Population ecology

SUB-TOPIC: Human population

NOTES & EXAM TIPS

Modern humans have evolved 200 000 years ago. The population size then, was probably less than several hundred. Today, the human population stands at 7,66 billion.



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The graph above shows an **exponential growth** in that:

- Population size is increasing continuously
- The rate at which the population is growing is becoming greater and greater
- The doubling period for the population is becoming shorter and shorter

Reasons for exponential growth

- **Agricultural improvements**
  Through agricultural improvements, man has been able to increase and secure food availability

- **Medicinal improvements**
  Medical technology has improved drastically in the space of few hundred years. Effects of pathogenic diseases and their subsequent spread can be countered.
- **Technological improvements**
  Technology has made our daily lives easier and more convenient. Carrying capacity was further increased.

Age-gender population pyramid

Data regarding a population can be gathered through conducting a census and ordered according to the number of individuals of a certain age category and of a certain gender. The results are then presented as a population pyramid.

Three types of population pyramids can be observed, namely:

- Expanding or growing population pyramid
- Stable population pyramid
- Declining population pyramid

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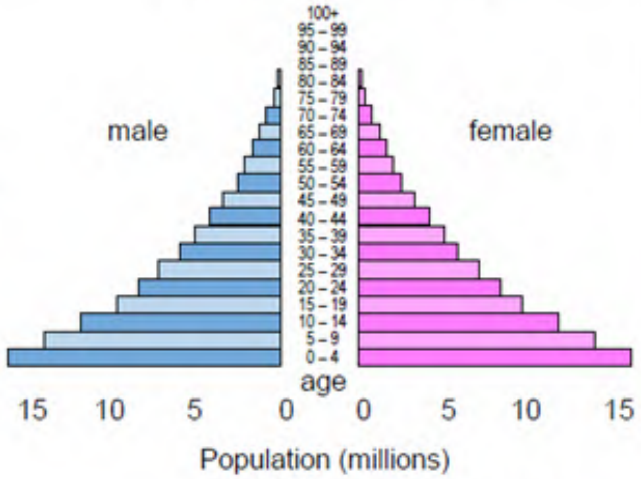
Expanding population growth pyramid

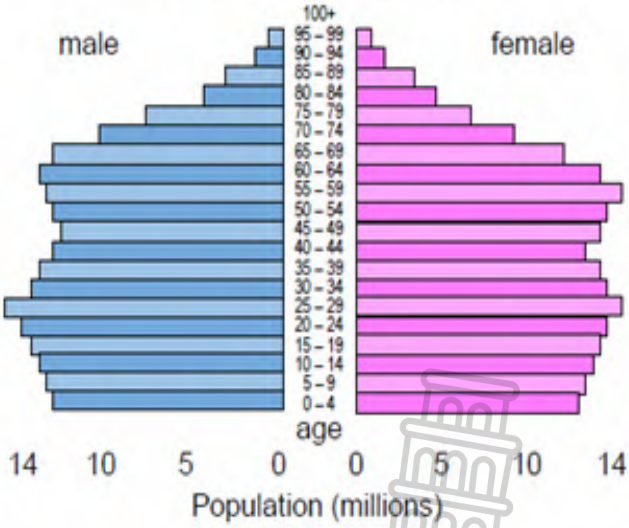
- more youth than elderly
- both natality and mortality rates are high
- few individuals reach old age - not much medical and social welfare assistance
- life expectancy, education levels, general standard of living are all quite low
- characteristic of developing countries / third world countries / many African countries



Positive growth of Nigeria's population in 2017

Stable population growth pyramid

- number of pre-reproductive individuals approximately the same as the number of reproductive individuals
- natality rates are low
- many individuals reach older ages because of medical and social welfare services
- life expectancy, education levels and general standard of living are all relatively high
- characteristic of certain developed countries, e.g. USA and China



Stable growth of the USA's population in 2017

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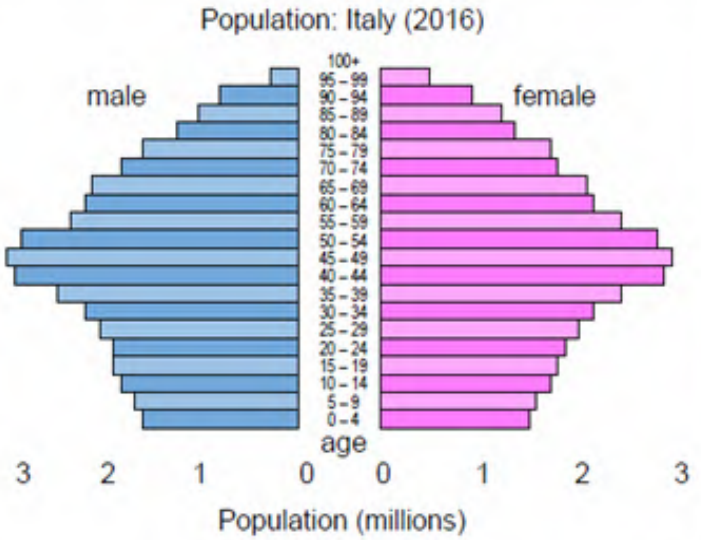
Negative or declining growth pyramid

- pre-reproductive groups are smaller than reproductive group
- natality and mortality rates are low
- many individuals reach older ages because of medical assistance and strong social welfare
- life expectancy, education levels and general standard of living are relatively high
- characteristic of developed countries, e.g. UK, Japan, Denmark and Italy

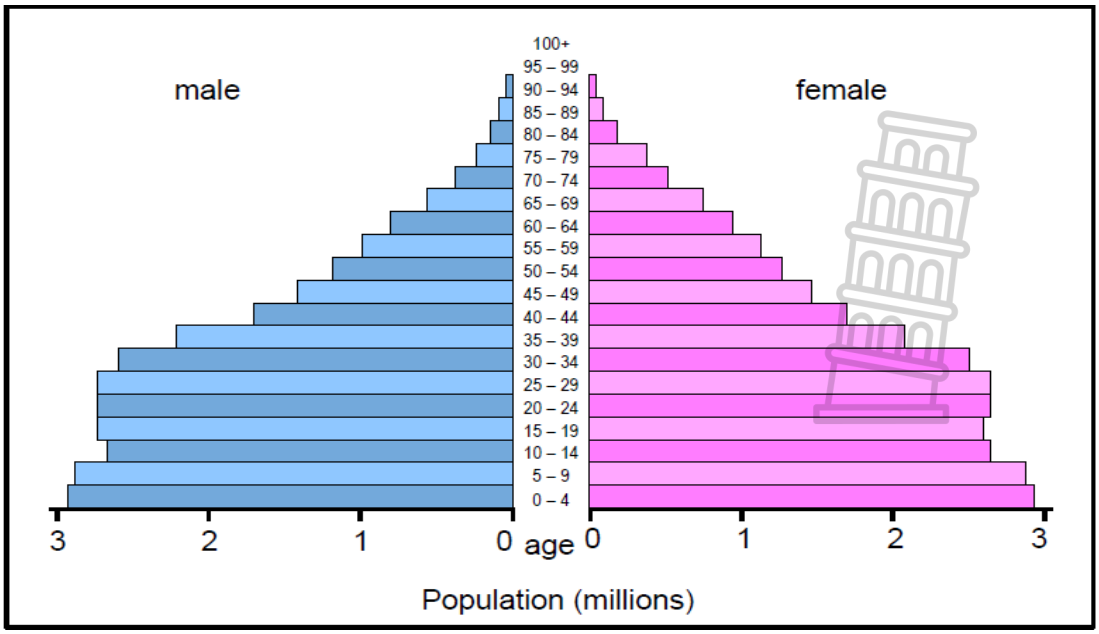


Negative growth of Italy's population in 2016

ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Study the following population pyramid before answering the questions below:



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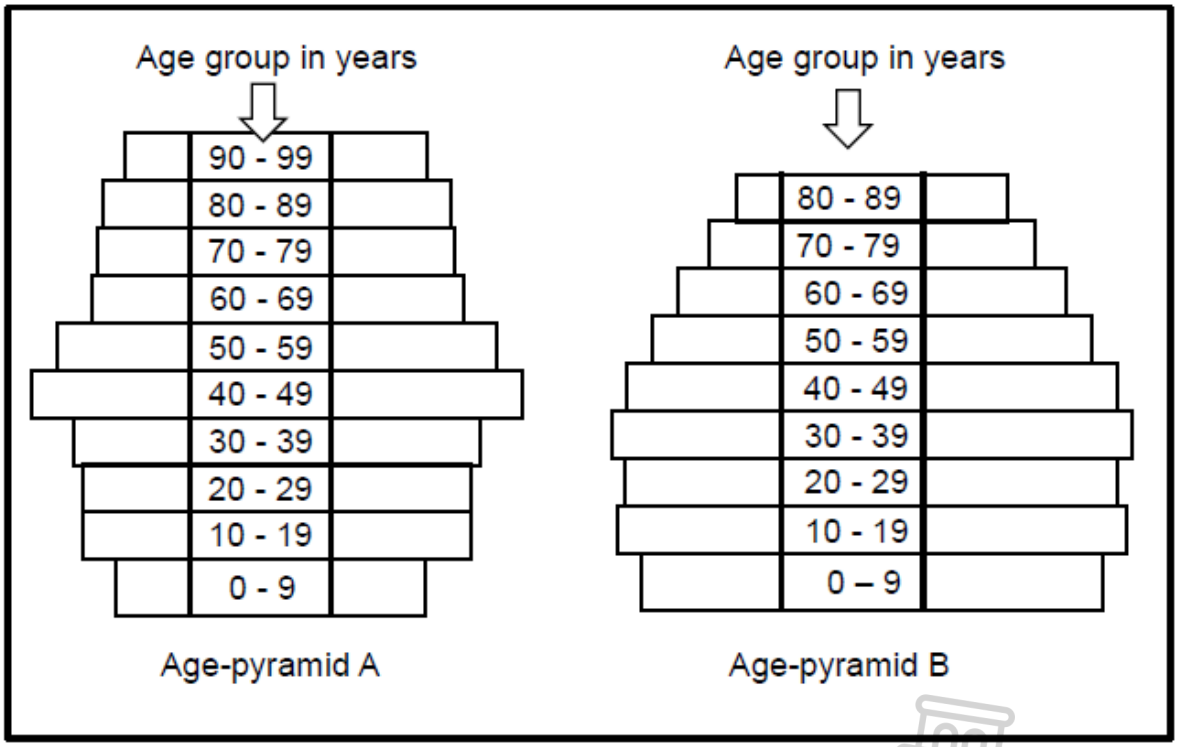
1.1 Which age-gender population pyramid is displayed in the diagram above? (1)

1.2 Give THREE reasons for your answer in QUESTION 1.1. (3)

1.3 The life expectancy of an average South African was 49 years in 1960 but reached 60 years in 2016. What can this increase in life expectancy be attributed to? Give TWO factors. (4)
(8)

QUESTION 2

Study the age-gender pyramid below representing a developing country and a Developed country.



2.1. Which pyramid represents the distribution of a developed country? (1)

2.2. Give TWO reasons for your choice in QUESTION 2.1. (2)

2.3. Which group (male or female) has the larger percentage reaching old age in pyramid B? (1)

2.4. Which TWO age groups has exactly the same percentage of male and female in pyramid A? (2)
(6)

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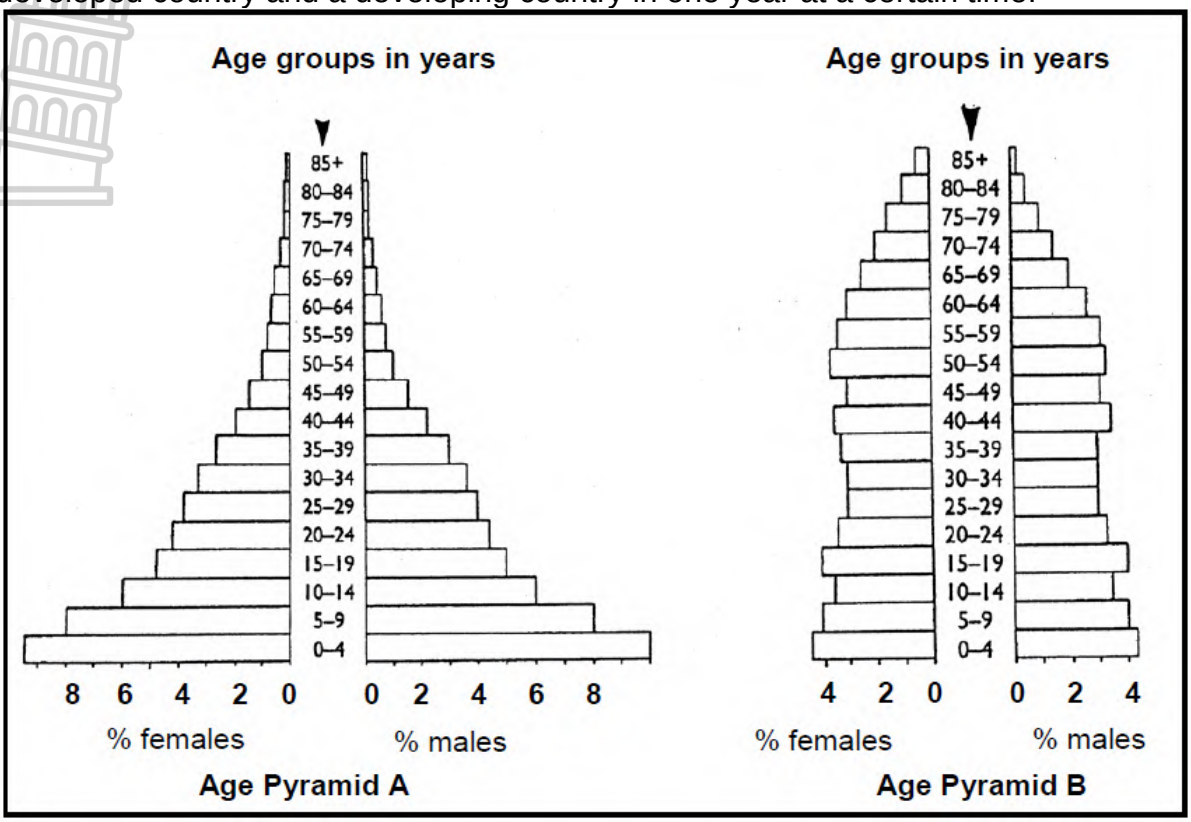
QUESTION 3

The diagrams below represent the age distribution of the human population of a developed country and a developing country in one year at a certain time.



3.1 What percentage of the female population is aged between 5 and 9 years in Pyramid **A**? (1)

3.2 Which age group makes up exactly 5% percent of the male population in Pyramid **A**? (1)

3.3 What percentage of the female population are aged 65 to 69 years in Pyramid **B**? (1)

3.4 Which group (male or female) has the larger percentage reaching old age in Pyramid **B**? (1)

3.5 Which pyramid represents the population distribution of a developed country? (1)

3.6 Give TWO reasons for your answer to QUESTION 3.5. (2)

(7)

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Term 4

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WEEK 1: TOPIC: Human impact on the environment (current crises)

SUB-TOPIC: The atmosphere and climate change

NOTES & EXAM TIPS

Humans depend on the environment for survival, but our activities are causing severe problems in the natural environment.
Our rapidly increasing population and technological growth are out of balance. Human needs are becoming greater than the natural resources available to us and we produce more waste than our ecosystems can cope with.
Our environmental equilibrium is disturbed. The quality of life on Earth is threatened.

Key terminology

greenhouse gases (GHGS)	gases which trap heat in the atmosphere: the two main GHGS are carbon dioxide and methane
emissions	released gases which are usually harmful to the environment
the greenhouse effect	warming of the surface of the earth by greenhouse gases trapping heat in the atmosphere
the natural greenhouse effect	when greenhouse gases are in balance they regulate earth's temperature and enable life on earth
the enhanced greenhouse effect	when excessive greenhouse gases are emitted they trap too much heat in the atmosphere
global warming	the rise in earth's average temperature as a result of the enhanced greenhouse effect
carbon sink	any natural system (soil, water or plant) which absorbs and stores carbon dioxide (CO_2)
carbon footprint	the amount of carbon dioxide released into the air because of individual or group energy needs
ozone depletion	reduction in the concentration of ozone in the ozone layer in the stratosphere (upper atmosphere)
deforestation	the destruction of natural forests through human activities
desertification	the process by which fertile land becomes desert

https://youtu.be/0zOvpSLXG18 (Video link for climate change)

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THE ATMOSPHERE AND CLIMATE CHANGE

The atmosphere is made up of **nitrogen, oxygen and trace gases** which include the **greenhouse gases such as carbon dioxide and methane.**

Greenhouse gases absorb long wave radiation emitted from the Earth and prevent it from escaping back into the atmosphere. **This is known as the 'greenhouse effect'.**

Climate refers to the long-term prevalent weather conditions of an area.

The greenhouse effect is important in keeping the Earth warm so that it can sustain life. However, **an increase in the concentration** of **greenhouse gases** leads to the **'enhanced greenhouse effect'**.

As a result, there may be a significant **rise** in the **average temperature** of the surface of the Earth over a period of time. **This is known as 'global warming.**

1. Increased concentration of the **carbon dioxide** in the atmosphere is due mainly to:

- **Burning of fossil fuel** (for electricity, to power vehicles and for industrial processes): Combustion of carbon-rich fuels such as coal or plants (wood) releases carbon that was stored in them, as carbon dioxide.
- **Deforestation**: Cutting down of trees and removing vegetation from the land decreases the amount of carbon dioxide that would have been taken up by the plants during photosynthesis. This increases the amount of carbon dioxide available in the atmosphere.

2. Increased concentration of the **methane** in the atmosphere is due mainly to:

- The **expansions** of **rice agriculture** and **increased** number of **landfill**: decay of organic matter in waterlogged soils such as rice paddies and landfills releases methane
- The increased number of **livestock**: ruminants such as cows releases methane gas through their digestive tracts
- **Mining** of coal

3. Increased **temperatures** may lead to:

- **More evaporation** of water which can lead to increased precipitation eventually increasing the potential of **flooding**
- **Rising sea levels** caused by melting ice in the glaciers as well as thermal expansion which can eventually increase the potential of flooding
- **Increased wildfires** increasing the chances of soil erosion and eventually desertification
- **Increased loss of biodiversity** as species are unable to cope with rapidly rising temperatures can eventually lead to desertification
- **Increased droughts** in some areas leading desertification and food insecurity

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Destruction of the ozone layer

CAUSES

Mainly caused by the chemicals called **CFCs** (chlorofluorocarbons) released by **refrigerators**, **aerosol** sprays and **fast-food packaging**.

What is OZONE?

Ozone (O_3) is a greenhouse gas that is found at low concentrations 15 – 50km above the Earth's surface. It **absorbs** the **ultraviolet rays** from the sun.

If the measures to reduce the destruction of ozone layer fail:

- There will be a significant increase in the number of **skin cancer** cases
- Ultraviolet rays reaching the Earth's surface may cause a **permanent damage** to **eyes**

CARBON FOOTPRINT

DEFINITION:

This is a measure of the total amount of greenhouse gas emissions of an individual, a defined population or a company per year.

Strategies to reduce the carbon footprint

- **Reuse and recycle** – less fossil fuels burnt in the production of some of the material
- **Drive less** – by using public transport, walking, bicycles
- **Reduce the need for heating** by insulating walls and building energy efficient homes
- **Carbon offsetting** – by using alternative energy (solar and wind) and reforestation for trees to act as carbon reservoir.
- Technological developments- **decrease** the amount of **energy** needed for **production**/ decreasing the dependency of carbon emitting fuels

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following question. Choose the correct answer and write only the letter (A to D) next to the question number (1.1) in your ANSWER BOOK, for example 1.2 D.

1.1 Which ONE of the following combination of gases are the main cause of global warming?

A Carbon dioxide and ozone
B CFCs and carbon dioxide
C Methane and carbon dioxide
D CFCs and methane **(2)**

QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.3) in your ANSWER BOOK.

2.1. The total amount of carbon released to the atmosphere by an individual, a community or a factory per year

2.2. Layer in atmosphere that makes UV light harmless

2.3. Increase in temperatures throughout the earth

(3x2=6)

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QUESTION 3

Read the following article and answer the questions that follow:

THE HEAT IS ON FOR SOUTH AFRICA

by Bobby Jordan

Rats, rising temperatures and alien vegetation on Marion Island point to drastic weather changes ahead.

Sub-Antarctic Marion Island, which houses a South African weather station, is drying up – and scientists maintain it's one of the clearest signs of global warming.

Alarming new rainfall, temperature, plant and animal data from the island, situated 1 700 km southeast of Cape Town, reveal that over the past 20 years there has been a steady decline in annual rainfall from around 2 500mm to about 1 750mm – and it is hotter than ever.

Scientists and government officials this week warned that such changes were likely to be common throughout South Africa as the planet heats up – almost certainly due to the rapid increase in greenhouse gases caused by human activity. Overall, there has been a 30% increase in carbon dioxide in the earth's atmosphere over the past 150 years and its rate of acceleration may be increasing.

The impact of global warming is clearly evident particularly in the extreme latitudes like Marion Island, where heat does not disperse as fast as along the equator. "You tend to see the signals more quickly and clearly at those (higher) latitudes," said Dr Guy Midgley, chief specialist scientist at the National Biodiversity Institute. "Once the heat has reached the poles, then where else does it go? In a sense Marion Island is like the canary in the coal mine." (***Star 2017***)

3.1 According to the article, which **THREE** factors point to drastic changes ahead on Marion Island? (3)

3.2 By how much has the annual rainfall decreased on Marion Island over the past 20 years? (Show your working) (2)

3.3 Name **TWO** human activities that can result in an increase in greenhouse gases. (2)

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WEEK 2: TOPIC: Human impact on the environment (current crises)

SUB-TOPIC: Water availability and Water quality

NOTES & EXAM TIPS

TERMINOLOGY

hydroelectricity	electricity generated by the power of water
wetland	ecosystem saturated permanently or seasonally with water
aquifer	underground layer of water-bearing, sponge-like rock
irrigation	supply of water to land or crops to help growth
eutrophication	excessive nutrients in a waterbody causing excessive growth of algae or aquatic plants
sewage	liquid waste: water and excrement (urine and faeces) in sewers
sewers	drains and pipes
sewerage system	sewers carrying sewage to a sewerage plant or place of water treatment
sanitation system	a hygienic or waterborne sewerage system
contamination	pollution or poisoning
thermal (pollution)	heat pollution (in this case from hot water)
AMD	acid mine drainage
purification	cleaning by removing contaminants
reclamation	returning something to a previous, better condition

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WATER

Availability of water

Construction of Dams
increasing the quantity of water stored

Water wastage
- water used for irrigation is lost due to poor farming practices.
- wastage of water through leaking taps and toilets and faulty pipelines.
- can be reduced by reducing the pressure in the pipes, by educating people to use water wisely and by maintaining all plumbing in good condition.

Cost of water
- The cost of water is influenced by costs involved in increasing the availability and quality of water.
- The cost per kilolitre (kl) of water **increases** with **increased use of water**. This is meant to discourage over-use of water thus allowing for its sustained use.
- certain amount of water is available free to all citizens to ensure that water is available to the poorest.

Water recycling
existing water is used for more than one purpose

Destruction of wetlands:
should not be destroyed because they influence both the **availability** and **quality** of water;
it provide water for **domestic** and **livestock** use as well as for **irrigation**.
The vegetation in the wetlands also helps in purifying the water naturally.

Boreholes and its effect on aquifers
- to increase water availability in areas that do not have direct access to other sources of water
- Constant use of boreholes eventually leads to the drying up of aquifers

Droughts and floods
- water availability decreases.
- natural vegetation can hold back water from floods.

Exotic plantations and the depth of the water table
- Some exotic plants use a large quantity of water from the ground. this decreases the level of the water table, making less water available

Quality of water

Eutrophication and algal bloom
- Water used for agriculture my contain pesticides and herbicides and fertilizers which pollute the water in rivers, dams and lakes causing eutrophication.
- lead to an increase in algal growth (algal bloom).
- thus, deplete the oxygen level in the water thus reducing the potential for life in such water.

Mining
This water is generally acidic, toxic and hot and contributes to

Alien Plants
block waterways, reducing light to other aquatic plants;decompose. Bacteria deplete the oxygen supply in the water.

Thermal pollution
- heating of water caused by using water in the cooling of power-stations and in industries
- heated water has a lower oxygen content making it difficult to support life

Water purification
quality of water is improved through purification methods

Pollution of water through domestic and agricultural use
- domestic water may contain detergents and pathogenic bacteria which must be treated before it can be used again.
- water is used for industrial purposes may contain many heavy metals, oil, heat, and fertilizers.
- Fertilisers and pesticides may run off into rivers, ponds and dams and pollute the water.

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.3) in your ANSWER BOOK, for example 1.4 D.

1.1 Eutrophication is a process in which …

A contaminated water is recycled.
B algae grows uncontrollably in the river.
C water is stored and later used for irrigation.
D indigenous forests are replaced by commercial tree plantations

1.2 The sector that uses the most water in South Africa is?

A Agriculture and forestry
B Mining
C Domestic
D Industry

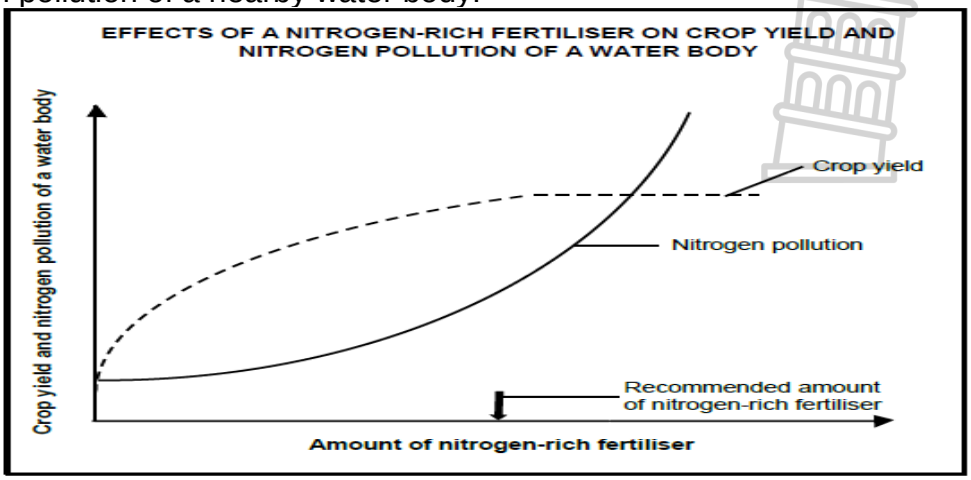
1.3 Which ONE of the following refers to an aquifer?

A An increase in the temperature of water bodies as a result of water from industries
B Planting of the same crop on the same area repeatedly
C An underground permeable rock saturated with water
D The release of water with chemicals from mines

(6)

QUESTION 2

The graph below shows the influence of a nitrogen-rich fertiliser on crop yield and nitrogen pollution of a nearby water body.



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2.1 Name the process whereby excess nutrients accumulate in a water body. (1)

2.2 Explain why it will not economically benefit the farmer to use more than the recommended amount of fertiliser. (2)

2.3 Suggest ONE reason why farmers are advised to apply fertilisers to the soil during the dry season of the year. (1)

2.4 Explain the effect that an increase in nitrogen pollution will have on the number of bacteria in the water. (4)
(8)

QUESTION 3

Western Cape water consumption data was calculated to be the following in 2018:

Consumers	**Water consumption in mm^3**
City of Cape Town	360
Agricultural sector	180
Other municipalities (Overberg, Boland, West Coast and Swartland)	40

3.1 Identify …

(a) the independent variable (1)

(b) the dependent variable (1)

3.2 Draw a pie chart to show the data in the table expressed in percentages. (6)
(8)

WEEK 3: TOPIC: Human impact on the environment (current crises)

SUB-TOPIC: Food security

NOTES & EXAM TIPS

Food insecurity is where there is evidence of malnutrition and starvation. This is often a result of socio-political conditions such as wars, refugee migrations, diseases and epidemics.

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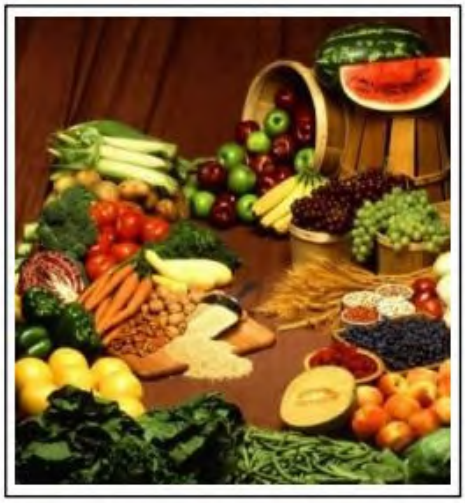
Key terminology

food security	access to enough or sufficient nutritious food at all times
exponential growth	where size increases at a greater and greater rate
famine	severe shortage of food that causes starvation
monoculture	farming a single crop or breed over a large area
pesticide	insect or rodent killer or poisons
herbicide	weed / plant killer
fertiliser	food for plants
gene pool	all the different genes in a breeding population
genetic engineering	altering the genes of organisms
subsistence farming	farming traditionally to feed themselves to survive
commercial farming	farming with machinery to sell products for profit



Healthy, nutritious fruits, grains and vegetables are often too expensive for the poor to access, even though there is a surplus to be had.

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FOOD SECURITY

DEFINITION: Food security is the access, by all people at all times, to adequate, safe and nutritious food for a healthy and productive life.

Food security may be influenced by the following factors

Exponential growth of the human population
- World's population is growing at an exponential rate (very rapidly)
- some countries cannot produce enough food to feed their growing population.
- Food production needs to increase as rapidly as the world population
- otherwise many countries would experience food insecurity.

Droughts and floods
Droughts result in crop losses and livestock death
Floods causes extensive damage in a short period of time and decrease land available to grow crops.

Poor farming practices

Monoculture
Growing of one type of crop over large areas of land year after year. Monoculture depletes nutrients and water supplies and therefore impacts negatively on the quality of the topsoil

Pest control
Use of pesticides to kill pests that compete with humans for food. Pesticides may kill or get into the tissues of healthy plants.
Many farmers now use biological control, which uses a natural predator/parasite to get rid of the pest

Loss of topsoil
Top 15 cm of soil that contain the nutrients that plants require for growth

Use of fertilizers
Inorganic (chemical) and organic (compost and manure) can increase the nutrients in the soil and keep soil fertile

Alien plants and reduction of agricultural land
Deplete the topsoil of water and nutrients. These alien plants out-compete indigenous plants; no natural predators, growing rapidly

The loss of wild varieties and its impact on gene pools
Crop plants have replaced wild varieties; wild varieties could be used as an alternative source of food; it will reduce the genetic diversity

Genetically engineered food
Produced from genetically modified organisms;
involves the inserting of a gene (with a desired characteristic) from one organism into another organism to increase the yield

Food wastage
Could occur during the storage, production and processing of food. Includes food thrown away and food not eaten. Increases the prices of food to consumers and could reduce food security in a country.

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1 to 1.3) in your ANSWER BOOK, for example 1.4 D.

1.1 Which ONE of the following is a sustainable method used to improve food security that will not damage the environment?

A Excessive use of fertilisers to improve yield.
B Continuous use of pesticides to reduce pests.
C Practice of monoculture as a farming method
D Practice of crop-rotation as a farming method

1.2 Which ONE of the following features of genetically modified crops has the potential of improving food security?

A Increase the number of alien plant species
B Increase yield
C Increase the reliance on pesticides
D Decrease genetic diversity

1.3 Which of the following represents one advantage and one disadvantage of genetic engineering in developing desirable products?

	Advantage	Disadvantage
A	Increased rate of production	Cost of development is high
B	Cost of development is high	Possible release of GMO into the environment
C	Increased range of products	Increased rate of production
D	Increased rate of production	Increased range of products

(6)

QUESTION 2

Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (2.1 to 2.2) in your ANSWER BOOK.

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2.1 The farming practice of growing a crop of a single species only.

2.2 The access by all people always, to adequate safe and nutritious food for a healthy and productive life. **(2)**

QUESTION 3

Indicate whether each of the statements in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B or NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B,** or **none** next to the question number (3.1 to 3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
3.1	Decreases food security	A B	Alien plant invasion Exponential growth of the human population
3.2	The use of plant hormones to fight alien plant invasions	A B	Chemical control Mechanical control
3.3	Planting the same crop type every year on the same piece of land	A B	Crop rotation Monoculture

(3 x 2) **(6)**

QUESTION 4

Read the extract below.

SA REAPING BIGGEST MAIZE HARVEST IN 40 YEARS

Farmers will likely harvest 14.7 million tons in 2017. This is almost 50 % more than the country needs in a year. In 2016 the harvest was 7.8 million tons. Good recent rainfalls and a larger area for planting helped boost the harvest.

The increase in harvest is good news for local consumers. However, more than 80 % of the harvest is white maize which is not in demand as yellow maize.

In other Southern African countries such as Zambia, Zimbabwe and Malawi the harvest has also

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increased. This created more competition in the export market, especially as their crops are not genetically modified.

4.1 State what is meant by *genetically modified crops.* (1)

4.2 According to the extract, state TWO reasons that contributed to the increased maize harvest in 2017. (2)

4.3 Calculate the percentage increase in maize production as compared to 2016. Show ALL working. (3)

4.4 Explain why an increase in harvest will be good news to local consumers. (2)

4.5 Explain the economic impact for South African farmers who export maize to other countries. (3)
(11)

QUESTION 5

Study the image of maize cobs and answer the questions that follow:

5.1 Give two possible advantages of GMO maize. (2)

5.2 Name two possible disadvantages of genetic engineering. (2)
(4)

WEEK 4: TOPIC: Human impact on the environment (current crises)

SUB-TOPIC: Loss of Biodiversity and Solid waste removal

NOTES & EXAM TIPS

LOSS OF BIODIVERSITY

Biodiversity is important because it maintains the provision of …

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- good quality fresh water and air quality
- climate stabilisation
- healthy quality soil formation
- pollination and natural seed dispersal
- natural fuel and food from the environment
- natural pest control with predators
- healthcare from medicinal plants and microbes
- ecotourism and recreation in nature

Key terminology

extinction	when a species has completely died out
maintain	provide for, or enable, life to keep stable and existing
diversity	a wide range of different things
biodiversity	the variety of all living organisms on Earth
biome	large community of plants and animals occupying a region with distinct climate conditions, e.g. grassland, desert, tundra
predators	organisms that capture and feed off other organisms (prey)
habitat	place where organisms live, including all living and nonliving factors or conditions of the surrounding environment.
urbanisation	the increasing development of towns and cities
migration	long-distance movement of organisms, often seasonal
sustainable	enabling or maintaining growth without depleting resources
invasion	rapidly spreading and taking over an area

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LOSS OF BIODIVERSITY

DEFINITION: Biodiversity refers to the variety of plant and animal species on Earth. Biodiversity ensures that humans have food, fresh water, medicines and fuel that we obtain from our environment. It also ensures that the climate is regulated, floods are controlled (wetlands), diseases are kept in check (predators eat the sick animals) and water is purified (filtering by wetlands). Biodiversity ensures that seeds are dispersed, nutrients are cycled (e.g. nitrogen and phosphorus) and oxygen and soil continue to form. It also helps with human quality of life by providing us with forms of recreation and ecotourism. As biodiversity declines, these things do not occur as they should and the survival of humans become threatened

Factors that Reduce our Biodiversity

Habitat destruction through:

Farming methods
Monocultures
Overgrazing

Golf Estates
A form of monoculture that require large amounts of water, pesticides and fertilisers which may runoff and poison aquatic ecosystems

Mining
Alters the environment and can negatively affect the biodiversity

Urbanization
The growth of large cities (urbanisation) negatively impacts on biodiversity. Surfaces are covered with concrete, and natural habitats are destroyed

Deforestation
Permanent destruction of indigenous forest and woodland areas. Caused by human activities such as agriculture, logging, and using trees as firewood. It leads to the destruction of the habitats of other organisms, like frogs and insects, and this leads to the destruction of biodiversity.

Loss of wetlands and grasslands
Grasslands and wetlands have unique plant and wildlife and provide many ecological services to humans. Habitat destruction will lead to the loss of species.

Poaching
Refers to the illegal hunting of animals, either for food or because certain body parts can be sold for money. Poaching may also be applied to plants that are removed and sold for profit e.g. medicinal plants.

Alien plant invasions
These plants are species that have been introduced in an area and compete with the natural plants in the area. They can outcompete indigenous plants and reduce the biodiversity

Ways in which our biodiversity can be maintained

Control of alien plant invasions
May be controlled by <u>mechanical</u> (chopping down plants or physically removing them by hand), <u>chemical</u> (spraying herbicides on the plants) and <u>biological</u> (introducing a natural enemy from the alien plant's environment and allowing it to reproduce and feed on the invasive plant methods) methods

Sustainable use of the environment
Using resources without harming the ability of future generations to use that resource. Substances from indigenous plants such as the African potato, *Hoodia*, rooibos and Devil's claw all have economical and medicinal value. Encourage traditional healers to grow their own plants and improving education of the women who generally gather the plants in the wild. Legislation should be passed to limit the numbers of plants that can be harvested at one time and seeds of medicinal plants could be collected

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ACTIVITIES/WORKSHEETS/EXAM TYPE QUESTIONS

QUESTION 1 *(FS, Sept 2020, Paper 1)*
Read the paragraph below.

> Over 18 million hectares have burned in the Australian bushfire season 2019–2020, destroying over 5 900 buildings including over 2 800 homes. In addition to human fatalities, many millions of animals are reported to have been killed. The world's terrestrial biodiversity is concentrated in forests. They are home to more than 80% of all terrestrial species of animals and plants. When forests burn, the biodiversity on which humans depend for their long-term survival also disappears, with over 1 million species currently facing extinction.
>
> [Source: https://www.unenvironment.org/australian-bushfires 2019]

1.1 The bushfires led to a huge loss in habitat.

Name ONE other way that can lead to a loss of biodiversity. (1)

1.2 Discuss THREE reasons why biodiversity is important to ensure the survival of humans. (6)
(7)

QUESTION 2 *(FS, Sept 2019, Paper 1)*

Read the following extract.

> **MANAGING INVASIVE PLANTS – METHODS OF CONTROL**
>
> Alien plant invasion is only one factor that reduces plant biodiversity. Three broad categories cover the control of invasive plants: mechanical, chemical and biological. Several techniques may be effective in controlling a single species, but there is usually one preferred method – the one that is most resource efficient with the least impact on the environment.
>
> [Extract from an article by Christopher Mattrick]

2.1 Give the meaning of:

(a) Biodiversity (2)

(b) Alien plants (2)

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2.2 Give TWO factors that can reduce biodiversity other than alien plant invasions. (2)

2.3 Explain how biological control is applied to control alien plants. (3)

2.4 According to the extract list TWO criteria that should be used to control alien plants. (2)

(11)

SOLID WASTE DISPOSAL

Key terminology

bio-degradable	organic matter that can decompose or breakdown by bacteria or other living organisms and avoid pollution
hazardous	extremely dangerous
radioactive	having or producing radiant energy that comes from breaking up of atoms
nuclear	energy produced when the nucleus of an atom is divided or joined to another nucleus
landfill	an excavated dumpsite which can be filled with rubbish
leachate	water that has filtered through solids and leached out some of the dissolved or broken-down parts of the solids
rehabilitate	return something to its former or original good condition
bio-remediation	use of biological agents, such as bacteria, fungi, or green plants, to remove or neutralize pollutants in soil or water
nuclear reactor	a structure in which controlled nuclear reactions can occur to release energy

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Solid-waste Disposal

Solid waste is any solid material that is of no use to humans and which needs to be disposed of in a safe and environmentally friendly way.

Managing dumpsites for rehabilitation and prevention of soil and water pollution

The simplest and most cost effective way of disposing of solid waste is to bury it in landfill sites. It is a hole where solid waste is dumped and then covered by soil. However, this way of disposing of solid waste contributes to soil and groundwater pollution because rain seeps through the waste to produce a toxic substance called leachate. To prevent the toxic leachate from reaching the groundwater, a plastic liner is placed under the dumpsite area.

Rehabilitation of landfill sites occurs before it is closed down. This involves the covering of the old landfill site with clay soil, which is impermeable to water, and then it is covered with topsoil. Grass or other vegetation is then planted on the old landfill site. The growth of the plants stabilizes the area and the old landfill site may be used as a recreational area such as a park or a golf course.

The need for recycling

- Re-using waste products includes re-using plastic shopping bags, re-using glass and plastic containers – this helps to reduce the waste produced.
- Recycling is a process whereby used materials/waste products are recycled to make new products, for example plastic, glass, tin and paper. The advantage of recycling is that it provides employment, reduces the use of raw materials and energy, and reduces air, ground and water pollution.

Safe disposal of nuclear waste

South Africa also uses radioactive material for example uranium, to power its nuclear power station at Koeberg in the Western Cape. Unfortunately, a by-product of using uranium is nuclear waste that is still radioactive and therefore dangerous to living organisms. The nuclear waste is stored in thick steel drums and buried in trenches at special protected sites.

Using methane from dumpsites for domestic use: heating and lighting

Methane is a gas produced as a result of the decomposition of organic waste. The methane gas can be used as a fuel. Methane can be collected from landfill sites and used to generate electricity for domestic use – heat for cooking and electricity for lighting.

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QUESTION 3

The following table shows the estimated amount of solid waste and the amount of recyclable material dumped in a South African city landfill site over a number of years.

YEAR	TOTAL AMOUNT OF SOLID WASTE (MILLIONS OF TONS)	AMOUNT OF RECYCLABLE MATERIAL IN SOLID WASTE (MILLIONS OF TONS)
2018	1,49	0,78
2019	1,59	0,82
2020	1,80	1,20
2021	1,93	1,30

3.1 Describe the general trend in the total amount of waste produced and the amount of recyclable materials dumped from 2018 to 2021 (2)

3.2 Explain TWO advantages of recycling. (4)

(6)

QUESTION 4

Read the article below.

Solid waste disposal

South Africa is an industrial country with many large cities. The population in these cities is increasing. More people need more land and consequently more waste is generated. Most of this waste is deposited in landfills and very little is recycled. Some waste is also dumped illegally which causes unsightly and unhygienic littering in many areas. Landfills are no longer suitable in many cities for the following reasons

- The city outskirts are expanding because more houses are being built.
- People are affected by odours, noxious fumes and fires.
- The landfill is overloaded with waste which means that everyday large amounts of waste are being left uncovered.
- More machines such as compactors and bulldozers are needed to work the waste

The municipalities of many cities have realized that they need to build new, modern landfills. It is estimated that the cost of building a new landfill is about R20 million.

4.1 Explain why landfills in many cities of South Africa are a problem? (2)

4.2 Describe TWO disadvantages in disposing of solid waste in landfill sites (2)

4.3 Describe TWO advantages and TWO disadvantages of solid waste disposal by means of burning (incineration). (4)

4.4 Discuss TWO strategies for solid waste management. (4)

(12)

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