Western Cape Government
Education

Directorate: Curriculum FET

LIFE SCIENCES

REVISION BOOKLET
2021 TERMS 3 AND 4

Grade 11

This revision program is designed to assist you in revising the critical content and skills that you have covered during the 3rd and 4th term. The purpose is to prepare you to understand the key concepts and to provide you with an opportunity to establish the required standard and the application of the knowledge necessary to succeed in the final Grade 11 examination.

The revision program covers the following topics:

- Gaseous exchange (32 marks in Paper 1 in Final Examination)
- Excretion in humans (32 marks in Paper 1 in Final Examination)
- Population ecology (37 marks in Paper 2 in Final Examination)
- Human impact on the environment (37 marks in Paper 2 in Final Examination)

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1. EXAMINATION WRITING TIPS:

1.1 GENERAL TIPS FOR WRITING LIFE SCIENCES:

- The final examination in Grade 11 consist of two (2) question papers of 150 marks each. Each question paper covers a variety of content topics. Ask your teacher for an outline of the content topics and weighting of each topic in each question paper.
- The duration of each of the final question papers in Grade 11 is 2½ hours.
- All questions in each question paper are COMPULSORY.
- You need to do all your drawings and graphs in pencil and labels should be in blue or black ink. You may not use graph paper when drawing graphs.
- Make sure that you have all the necessary stationery for your examination e.g. blue or black pens, a pencil, an eraser, a ruler, a non-programmable calculator, protractor and a compass.

1.2 HOW TO APPROACH YOUR LIFE SCIENCES EXAMINATION:

- Each Life Sciences question paper consists of TWO sections i.e. SECTION A (50 marks) and SECTION B (two questions of 50 marks)
- When answering a multiple choice question in Section A, read the question and four options carefully, evaluate each option and eliminate each incorrect option.
- In questions that require only a LETTER you only need to write down a LETTER e.g. 'Give only the LETTER of the part where pollen is produced in the diagram of a flower'. Other questions might require you to write down both the LETTER and a NAME e.g. 'Give the LETTER and NAME of the part of the flower in the diagram that receives the pollen'.
- Use the correct spelling when you use biological terminology in your answers. Use scientific names in terminology and avoid using common names.
- The **instructional verbs (in italics)** e.g. **name, give, describe, explain** etc. and the **mark allocation per question** give an indication of what and how much information you should provide in your answer.

Table 1: Instruction verbs and meaning

Instructional verb	Meaning
Name	Give the name of something
Differentiate	Use differences to qualify between two or more categories
Tabulate	Draw a table and indicate the answers as direct pairs.
Describe	State in sentences the main points of a process
Explain	Give your answer in a cause-effect or statement and reason sequence
Compare	Give similarities and differences between concepts

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TERM 3 CONTENT

Study the core content below on the topics gaseous exchange, excretion and population ecology.

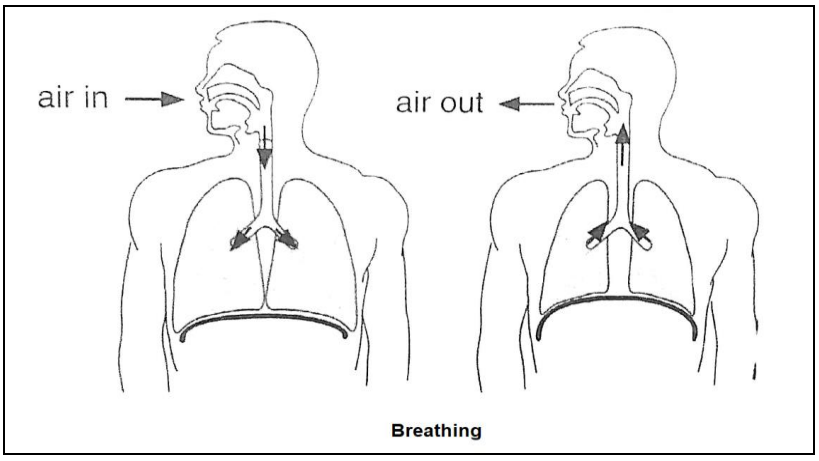
2. GASEOUS EXCHANGE

Revise cellular respiration from term 2 in Grade 11.

2.1 DIFFERENCE BETWEEN CELLULAR RESPIRATION, BREATHING AND GAS EXCHANGE

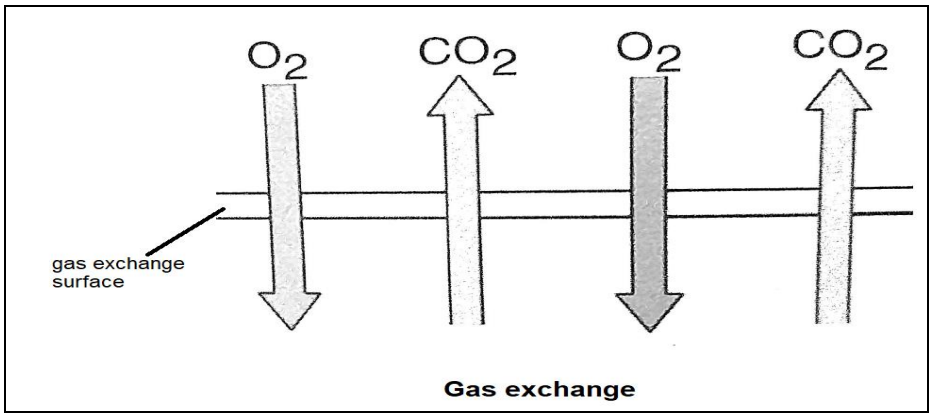
- **Breathing**– the physical process whereby air moves in and out of the lungs

Figure 1: Breathing



- **Gas exchange –** The exchange of oxygen (O_2) and carbon dioxide (CO_2) across a gaseous exchange surface.

Figure 2: Gaseous exchange



- **Cellular respiration** – a chemical process occurring inside cells in which food molecules such as glucose are broken down to release energy

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2.2 REQUIREMENTS OF EFFICIENT GAS EXCHANGE ORGANS

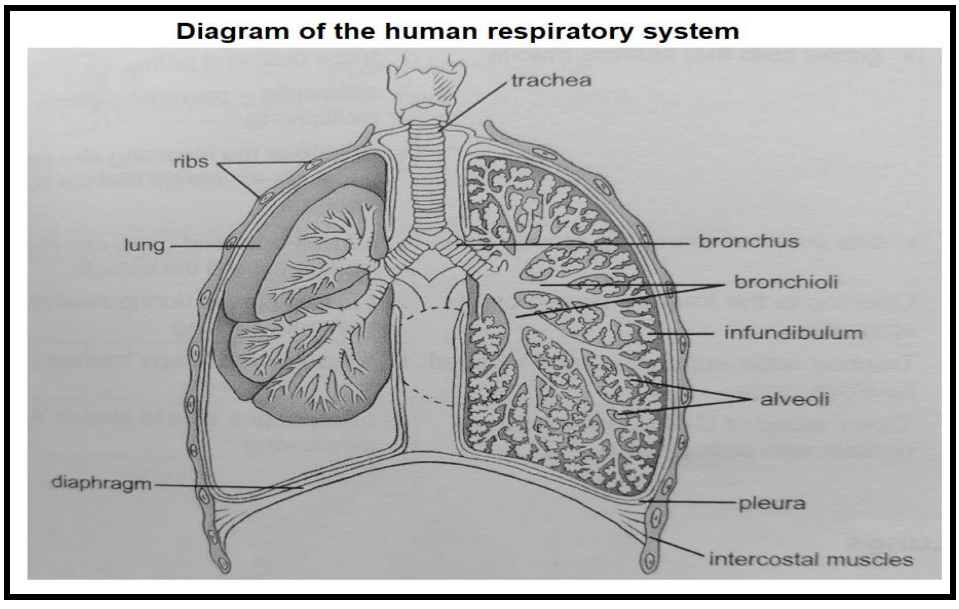
- The gas exchange surface must be **large** – to provide sufficient oxygen and to get rid of sufficient carbon dioxide
- The gas exchange surface must be **thin** – to ensure rapid diffusion of gases
- The gas exchange surface should be **moist** – to prevent cells from drying out and to ensure that gases (oxygen and carbon dioxide) can diffuse in a dissolved sate.
- The gas exchange organs must be **well-ventilated** – to ensure fresh supplies of air containing oxygen from the external environment and to remove air containing carbon dioxide.
- The gas exchange surface must be **well protected** – to prevent drying out and damage
- The gas exchange surface must have a **transport system** – for efficient transport of gases between gas exchange organs and body cells

2.3 HUMAN GAS EXCHANGE- STRUCTURE, LOCATION, FUNCTIONS AND ADAPTATIONS OF THE VENTILATION SYSTEM

The ventilation/breathing system of humans consist of the:

- Nasal cavities
- Trachea
- Two bronchi
- Many bronchioles
- Two lungs
- Respiratory muscles

Figure 3: Human respiratory system



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Nasal cavities

- The two external **nostrils** lead to two nasal cavities that are separated by a **septum**
- Small **hairs** in the nasal cavities filter large particles from the inhaled air
- Each nasal cavity is divided into three passages by three curved **turbinate bones**.
- The nasal cavities are lined with a mucous membrane that consists of **ciliated columnar epithelial cells**
- The epithelial cells are richly supplied with **blood capillaries** that warms the incoming air
- **Goblet cells** in the epithelium secrete **mucus** that moistens the incoming air, traps dust and germs and is antiseptic.
- **Cilia** on the epithelial cells perform sweeping movements in a direction away from the lungs to expel dust – carrying mucus to the outside.

Pharynx

- The nasal cavities open into the pharynx.
- The pharynx leads to two openings i.e. the opening known as the **glottis** which leads to the **trachea** and the opening that leads to the **oesophagus**

Trachea

- The trachea is a long, tubular structure located at the front of the oesophagus
- The **larynx** (voice box) with the vocal chords is located at the top of the trachea
- The **epiglottis** is at the top of the larynx and consists of cartilage
- The **epiglottis** closes the glottis during the swallowing process and prevents food from entering the trachea
- The walls of the trachea are supported and kept open by **C-shaped cartilage rings**.
- The trachea is lined with ciliated columnar epithelium with goblet cells that secrete mucus.
- The mucus moistens the incoming air and trap dust particles
- Mucus with trapped foreign particles are moved to the pharynx through the sweeping actions of the cilia

Bronchi, bronchioles and alveoli

- The trachea branches into two **bronchi** that enters the right and left lung
- The bronchi are also lined with a mucous membrane and are held open by **O-shaped cartilage rings**
- The bronchi divide into smaller branches inside the lungs and form the **bronchioles**
- The bronchioles do not have cartilage rings and their walls consist of smooth muscle that can contract and relax to alter air flow.

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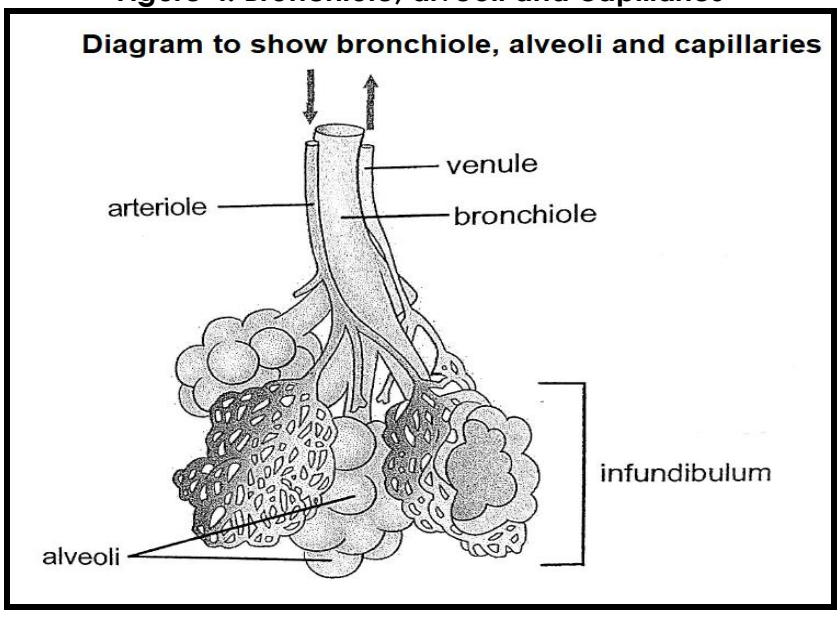
- Each bronchiole ends in an **infundibulum** which consists of groups of **alveoli.**
- The millions of alveoli increase the gaseous exchange surface
- The walls of the alveoli are thin and consists of a single layer of squamous epithelium. These thin walls allow for efficient gaseous exchange
- A thin layer of tissue fluid lines the inside surface of the alveoli and keep the surface of the alveoli moist, preventing the cells from drying out.
- The alveoli are surrounded by a network of capillaries.
- Capillaries transport oxygen to the tissues and carbon dioxide to the lungs
- The walls of the capillaries are thin and consist of a single layer of squamous epithelium to allow for efficient gaseous exchange.

Figure 4: Bronchiole, alveoli and capillaries



Lungs

- The two lungs are located in the chest and are and protected by 12 pairs of ribs.
- The lungs are spongy and elastic and can expand and contract during breathing
- The right lung has three lobes and the left lung has two lobes
- Each lung is surrounded by a double membrane, the **pleura**
- The fluid between the pleura prevents friction when the lung expands or shrinks

Respiratory muscles and the ribs

Diaphragm

- The diaphragm is a dome-shaped muscle plate which separates the chest and the abdomen
- The diaphragm contracts and flattens altering the volume of the chest cavity and is important in breathing.

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Intercostal muscles

- The intercostal muscles are located between consecutive ribs and consists of the external and internal intercostal muscles.
- The intercostal muscles contract and relax during inhalation and exhalation altering the volume of air in the chest (thoracic cavity)

Ribs

- The ribs are on either side of the sternum, **protect** the lungs from injury

2.4 VENTILATION OF THE LUNGS

Ventilation of the lungs takes place in two phases i.e.

- **Inhalation/Inspiration** – movement of air from the atmosphere into the lungs
- **Exhalation/Expiration** – movement of air from the lungs to the atmosphere

Table 2: Inhalation and exhalation

Inhalation/ Inspiration	Exhalation/ Expiration
• This is the **active** phase of breathing • The external intercostal muscles contract • Causing the ribs to move upward and outwards • The diaphragm contracts and becomes flatter • The volume of the thoracic cavity increases • The abdominal muscles relax so that the abdominal cavity can accommodate all the internal organs • The pressure in the thoracic cavity and lungs decrease • The elastic lungs expand • Atmospheric pressure is higher than the pressure of air in the lungs • Air rich with oxygen(O_2) flows into the lungs	• This is the **passive** phase of breathing • The external intercostal muscles relax • Causing the ribs to move downwards and inwards • The diaphragm relaxes and become dome-shaped • The volume of the thoracic cavity is decreased • The abdominal muscles contract and force the abdominal content upwards against the diaphragm • The pressure in the thoracic cavity and lungs increase • The elastic lungs are compressed • Air pressure in the lungs is higher than in the atmosphere • Air rich with carbon dioxide (CO_2) flows out of the lungs

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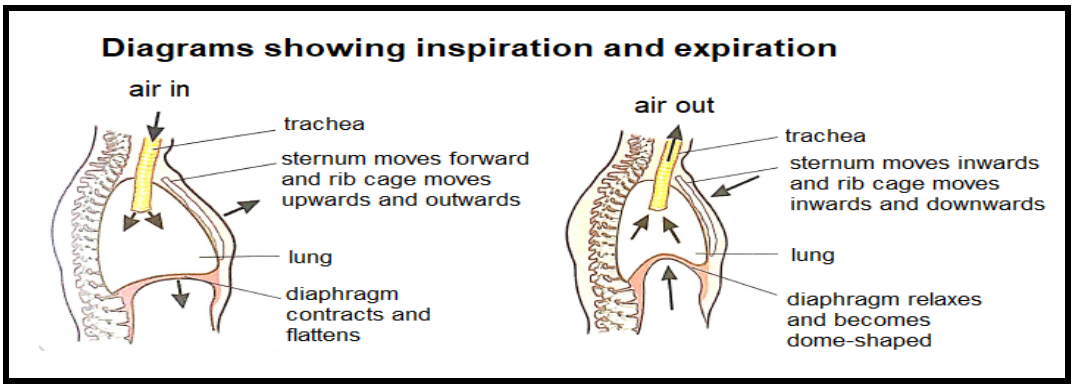
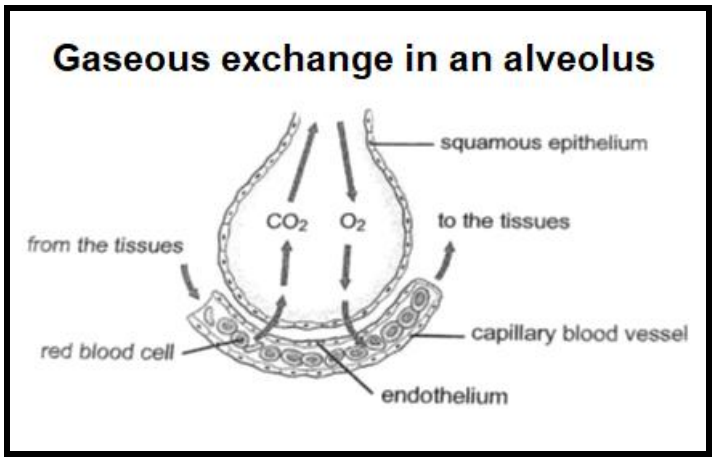
Figure 5: Inspiration and expiration



2.5 GASEOUS EXCHANGE AT THE ALVEOLI SURFACE

- The inhaled air in the alveoli has a higher oxygen concentration than the blood in the surrounding blood capillaries
- The oxygen dissolves in the thin layer of moisture that lines the alveoli and diffuses through the thin walls of the squamous epithelium of the alveoli and endothelial walls of the capillaries into the blood.
- The blood that reaches the alveoli from the tissues has a higher concentration of carbon dioxide than the air in the alveoli
- Carbon dioxide diffuses from the blood in the capillaries through the endothelial walls of the capillaries and the thin squamous epithelial walls of the alveoli into the air in the alveoli.

Figure 6: Gaseous exchange in alveolus



2.6 GASEOUS EXCHANGE BETWEEN THE BLOOD AND TISSUES

- Oxygenated blood reaches the tissues
- The blood in the capillaries has a higher oxygen concentration than the cells of the tissues
- Oxygen diffuses through the endothelial walls of the capillaries into the tissue fluid that surrounds the cells and then into the cells

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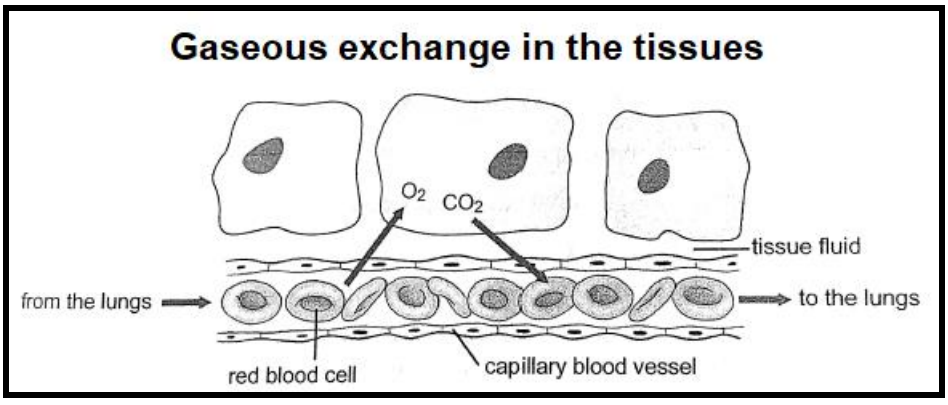
- The cells have a higher carbon dioxide concentration than the blood in the capillaries
- Carbon dioxide diffuses from the cells into the tissue fluid and then diffuses into the blood in the capillaries.

Figure 7: Gaseous exchange in the tissues



2.7 TRANSPORT OF GASES IN THE BLOOD

Transport of oxygen:

- Most of the oxygen that diffuses from the air in the alveoli to the blood in the capillaries combines with **haemoglobin** in the red blood cells (erythrocytes) to form **oxyhaemoglobin.**
- A small portion of oxygen dissolves in the **blood plasma** and is transported in solution.

Transport of carbon dioxide:

- Most of the carbon dioxide that diffuses from the cells into the blood in the capillaries is transported as **bicarbonate ions**. Carbon dioxide combines with water to form carbonic acid. The carbonic acid dissociates and is forms bicarbonate ions.
- Some of the carbon dioxide combines with heamoglobin to form **carbaminohaemoglobin**. The carbon dioxide is then transported in this form by the erythrocytes to the lungs.
- The smallest portion of carbon dioxide dissolves in the **blood plasma** and is transported in solution.

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2.8. HOMEOSTATIC CONTROL OF BREATHING

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

↓

Receptor cells in the carotid artery in the neck are stimulated

↓

Cells send impulses to the medulla oblongata in the brain

↓

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

↓

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

↓

More CO_2 is taken to and exhaled from the lungs

↓

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

3. EXCRETION IN HUMANS

3.1 EXCRETORY ORGANS AND THEIR EXCRETED PRODUCT

Table 3: Excretory organs and excretions

Excretory organ	Substances that they excrete	Origin of these substances
Lungs	**Carbon dioxide** and **water vapour** are excreted in exhaled air during breathing	• Carbon dioxide if formed as a product of **cellular respiration** • Excess water is formed as a product of **cellular respiration** as well as from the intake of fluids and food

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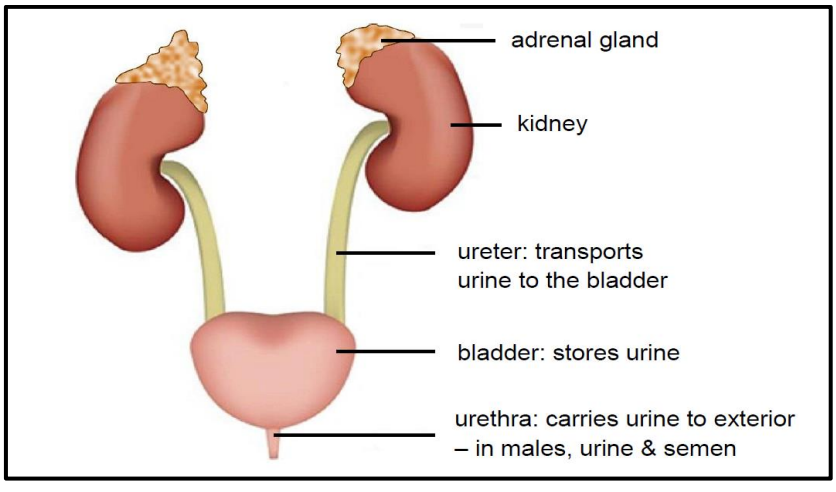
Kidneys and bladder	Urine. Urine consists of excess **water, mineral salts and nitrogenous waste e.g. urea and uric acid.** The bladder temporarily stores the urine that was formed by the kidneys. Urine passes out of the body when we urinate.	• Excess water is formed as a product of **cellular respiration** as well as from the intake of fluids and food • Urea is formed in the liver from **deamination of excess amino acids.** The urea is transported by the blood to the kidneys. • Uric acid is the end product of **metabolism of nucleic acids**
Liver	**Bile pigments and urea**	• Bile pigments are formed in the **liver** during breakdown of haemoglobin • Urea is formed in the liver from **deamination of excess amino acids.** The urea is transported by the blood to the kidneys.
Alimentary canal	**Bile pigments**	• Bile pigments are formed in the **liver** during breakdown of haemoglobin. The bile pigments from the liver enters the alimentary canal and are excreted as bile salts in the faeces.
Skin	Sweat. Sweat consists of excess **water, salts and a small amount of urea**. Sweat is excreted through sweat glands in the skin.	• Excess water is formed as a product of **cellular respiration** as well as from the intake of fluids and food

3.2 THE URINARY SYSTEM

- The two kidneys, two ureters, bladder and urethra form the urinary system

Figure 8: The urinary system



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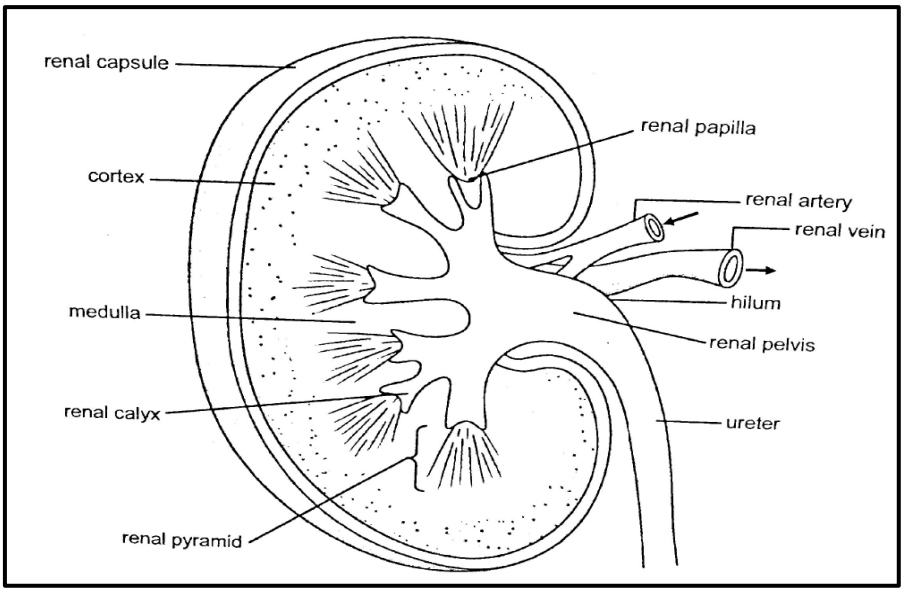
3.2.1 STRUCTURE OF THE KIDNEY

Figure 9: Structure of the kidney



- The kidneys are dark-red bean shaped organs.
- In the middle of the concave side is an indentation, the **hilum** where the renal artery enters and the renal vein and ureter leave the kidney.
- The kidneys are protected against mechanical injuries by a layer of fat that surrounds the kidneys.
- Each kidney is surrounded by a connective tissue membrane, the **renal capsule** which protects the kidney.
- A reddish-brown region, called the **cortex**, can be found just under the renal capsule.
- The **medulla** is the inner region of the kidney and is lighter in colour and contains groups of tubes.
- Each group of tubes forms a **pyramid** which project into the **renal pelvis**.
- Each kidney is made up of about one million microscopic structures called **nephrons**.
- The nephrons are the structural and functional units of the kidney.
- The main functions of the nephron are to filter the blood, regulate the waste, water and other important substances the body needs.
- Each nephron can be divided into 2 separate sections i.e. the **Malpighian body** and the **renal tubule**.

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Figure 10: Structure of a nephron

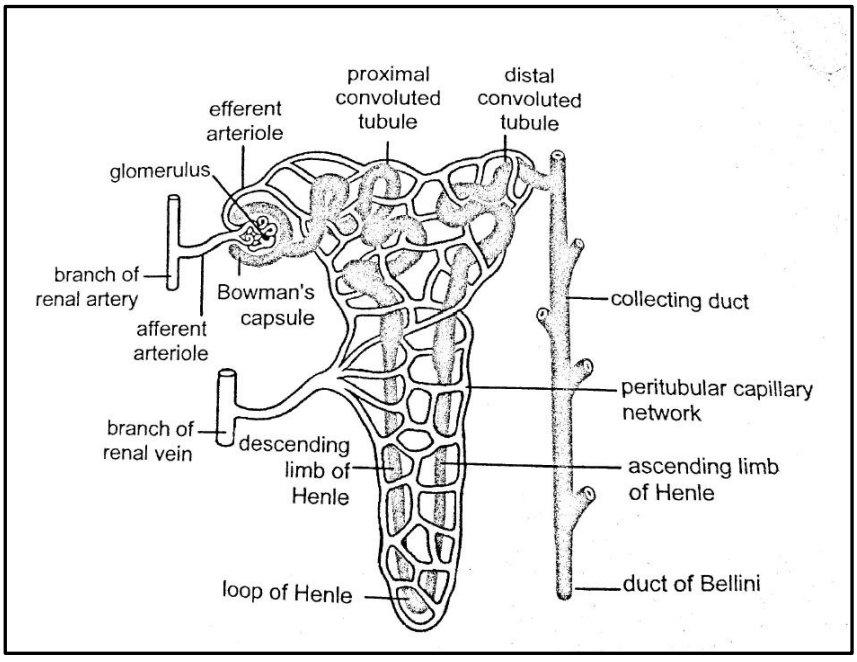
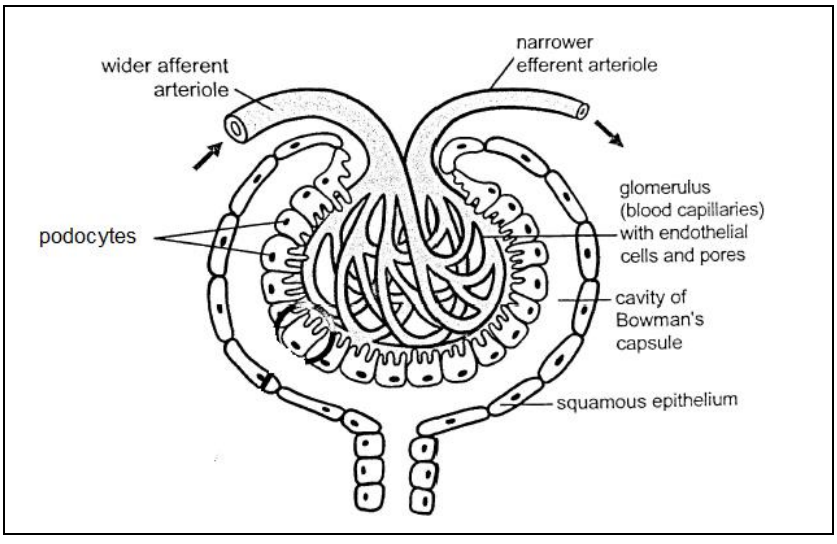


Figure 11: The Malpighian body



- The Malpighian body consists of a cup-shape structure called the **Bowman capsule** and a network of blood capillary vessels called the **glomerulus.**
- The blood capillary vessels of the glomerulus are lined with a single layer of squamous epithelial cells with pores between the cells.
- The **wider blood vessel** that transports blood to the glomerulus is called the **afferent arteriole**.
- The **narrower blood vessel** that transports blood away from the glomerulus is called the **efferent arteriole**.
- The **renal artery** that enters the kidney branches into smaller arteries. These smaller arteries eventually form the afferent arteriole.

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- The efferent arteriole branches and forms the network of capillaries, the **peritubular capillary network**, which surrounds the renal tubule.
- The peritubular capillaries combine to form venules which eventually form the **renal vein** which transports deoxygenated blood to the heart.
- The inner wall of the Bowman's capsule consists of specialized cells called **podocytes**.
- The podocytes are cells with projections between which small openings, called the **filtration slits** occur.
- The renal tubule is a long convoluted tubule that consists of the **proximal convoluted tubule**, the **loop of Henle** and the **distal convoluted tubule**.
- The renal tubule is lined with a single layer of cuboidal epithelium.
- The distal convoluted tubules open into a **collecting duct.**
- A few collecting ducts converge and form the **ducts of Bellini.**
- The ducts of Bellini form the **pyramids** that open into the renal pelvis.

3.2.2 FUNCTIONING OF THE KIDNEY: (GLOMERULAR FILTRATION, TUBULAR REABSORPTION, TUBULAR EXCRETION)

Refer to the diagrams of the nephron and Malpighian body above when studying the content below.

GLOMERULAR FILTRATION

- Glomerular filtration occurs in the Malpighian body.
- The blood in the glomerulus is under high pressure because of the wider afferent arteriole and the narrower efferent arteriole.
- The thin endothelium with pores which lines the blood capillaries of the glomerulus and the podocytes with filtration slits form an ultrafine filter through which the filterable substances in the blood are forced.
- Blood cells and plasma proteins are too large to filter and they remain in the blood of the capillaries.
- The part of the blood that filters into the Bowman's capsule is known as the **glomerular filtrate**.
- The glomerular filtrate contains useful substances e.g. water, amino acids, glucose, vitamins, mineral salts and waste products e.g. urea, uric acid and creatinine.

Try to answer the following question:

Explain how the Malpighian body is adapted for its function of filtration.

TUBULAR REABSORPTION:

- Useful substances that pass through the glomerular membrane during filtration must now be reabsorbed and returned to the bloodstream.
- The filtrate leaves the Bowman's capsule and enters the proximal convoluted tubule.

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- As the filtrate moves through the proximal convoluted tubule all the glucose, amino acids and water-soluble vitamins are actively reabsorbed into the peritubular capillary blood vessels
- Mineral salts e.g. sodium ions and fat-soluble vitamins are also actively reabsorbed as they are needed by the body.
- Most of the water is passively reabsorbed through osmosis into the peritubular capillaries.
- The filtrate enters the loop of Henle.
- An increased sodium concentration in the medulla of the kidney creates a water potential gradient which lead to the passive osmosis of water. The descending loop of Henle is permeable to water and water is passively reabsorbed by osmosis.
- Sodium ions are actively pumped out of the ascending loop of Henle into the tissue fluid of the medulla (sodium pump) and chloride ions follow passively. The ascending loop of Henle is impermeable to water.
- As the filtrate moves through the distal convoluted tubule further reabsorption of useful substances takes place.
- From the distal convoluted tubule, the filtrate moves to the collecting duct

TUBULAR EXCRETION

- Substances are secreted from the blood in the surrounding peritubular capillaries through the epithelium of the renal tubule and added to the filtrate.
- This process occurs in the proximal and distal convoluted tubules.
- Hydrogen ions, potassium ions, creatinine, urea, drugs and other foreign substances are actively added to the filtrate.
- The secretion of hydrogen ions from the blood into the tubules occurs when the pH of the blood becomes too low. The excess hydrogen ions are therefore removed from the blood and the pH of the blood increases.
- When the pH of the blood increases, fewer hydrogen ions are secreted from the blood into the tubules but more bicarbonate ions are secreted from the tubules into the blood. Bicarbonate ions increase the pH of the blood.
- The filtrate now moves into the collecting ducts and is called urine.

3.2.3 HOMEOSTATIC CONTROL OF WATER AND SALTS; ROLE OF ADH AND ALDOSTERONE

3.2.3.1 REGULATION OF THE WATER CONTENT OF THE BLOOD

- The part of the brain that controls the water balance in the body is called the **hypothalamus.**
- The hypothalamus controls the release of a hormone called **ADH** (anti-diuretic hormone)
- The hormone ADH is secreted by the **hypophysis (pituitary gland)**, which is an **endocrine gland** at the base of the brain
- ADH affects the water permeability of the walls of the distal convoluted tubule and collecting duct of the nephron

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- If the walls are permeable then more water passes out of the distal convoluted tubule into the blood and water is conserved in the body.
- If the walls are impermeable then very few water is retained in the body and it passes out of the kidneys in the form of urine.

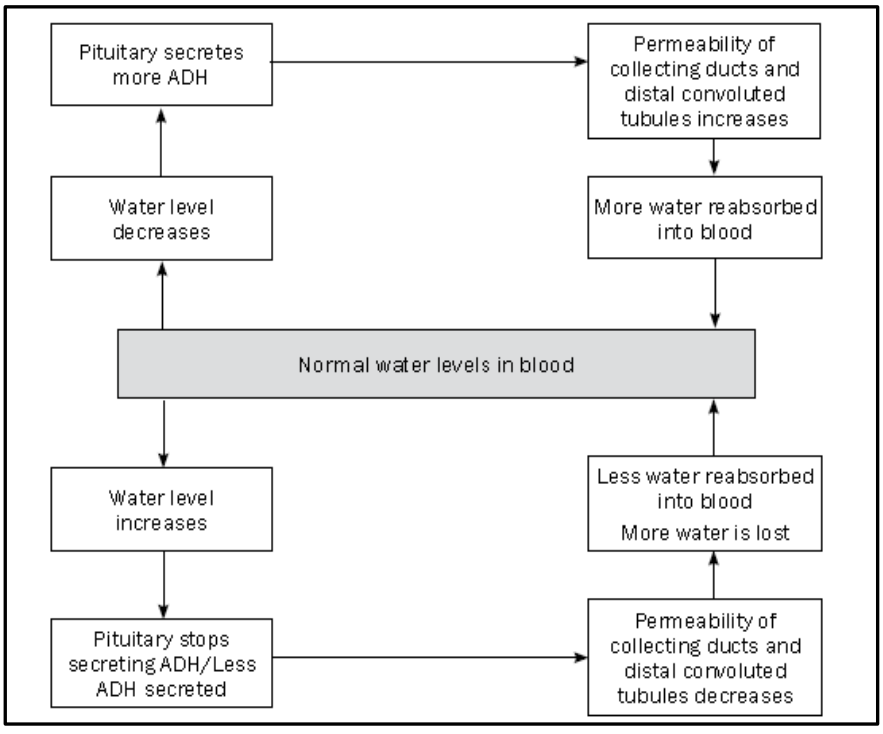

Table 4: Regulation of the water content of the blood

When the blood has more water than normal e.g. on a cold day when a person does not sweat a lot or takes in a lot of fluids	**When the blood has less water than normal e.g. on a warm day when a person sweats a lot or takes in very little fluid**
• The hypothalamus is stimulated • and sends impulses to the hypophysis to secrete less or stop secreting the hormone **ADH** • Less ADH/no ADH is transported in the blood to the kidneys • The collecting ducts and distal convoluted tubules of the kidney become less permeable to water • Less water is re-absorbed and passed to the surrounding blood vessels • More water is excreted in the urine • The urine is less concentrated (more diluted) • The water content in the blood decreases and returns to normal	• The hypothalamus is stimulated • and sends impulses to the hypophysis to secrete more of the hormone **ADH** • ADH is transported in the blood to the kidneys • The collecting ducts and distal convoluted tubules of the kidney become more permeable to water • More water is re-absorbed and passed to the surrounding blood vessels • Less water is excreted in the urine • The urine is more concentrated • The water content in the blood increases and returns to normal

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3.2.3.2 REGULATION OF THE SALT CONCENTRATION

- The hormone **aldosterone** that is secreted by the **adrenal glands** regulates the salt (e.g. sodium ions) concentration in the blood.
- The adrenal glands are **endocrine glands** that occur on top of the kidneys

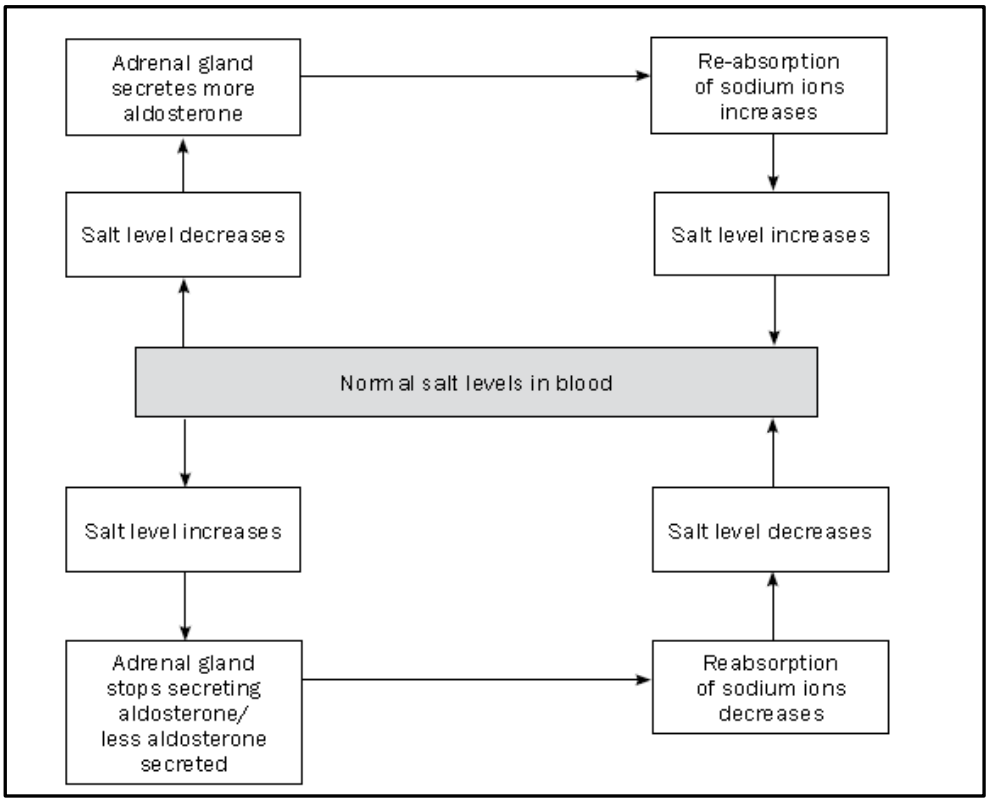

Table 5: Regulation of the salt concentration

When the salt level in the blood increases	When the salt level in the blood decreases
• Receptor cells in the afferent and efferent arterioles of the kidney detects the high salt/sodium ion level • The adrenal gland is stimulated • to stop secreting **aldosterone**/to secrete less aldosterone • The re-absorption of sodium ions from the renal tubules in the kidney into the blood vessels decreases • The sodium ion concentration in the blood decreases and returns to normal	• Receptor cells in the afferent and efferent arterioles of the kidney detects the low salt/sodium ion level • The adrenal gland is stimulated • to secrete more **aldosterone** • The re-absorption of sodium ions from the renal tubules in the kidney into the blood vessels increases • The sodium ion concentration in the blood increases and returns to normal

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4. POPULATION ECOLOGY

4.1.1 POPULATION SIZE

The following **FOUR** factors (parameters) have an effect on population size i.e.

- **Natality** – birth rate of a population. Natality causes an **increase** in population size.
- **Mortality** – death rate of a population. Mortality causes a **decrease** in population size
- **Immigration -** the one-way movement of organisms into an area where they become established. Immigration causes an **increase** in population size
- **Emigration** - the one – way movement of organisms out of an area. Emigration causes a **decrease** in population size.

4.1.2 DETERMINING POPULATION SIZE

DIRECT TECHNIQUES

- Total count of all individuals in the population e.g. census of human population, counting of large animals and aerial photographs of groups of animals.

INDIRECT TECHNIQUES

- Counting of only a part of the population e.g. mark-recapture technique and quadrat technique.

MARK -RECAPTURE TECHNIQUE

- A number of individuals are caught, counted and marked (1st sample)
- Marked individuals are released in the environment and given sufficient time to mix with the rest of the population
- Another group of individuals is caught and counted and they are known as the 2nd sample
- The number of marked individuals in the 2nd sample are counted
- Determine the estimated size of the population using the following formula:

$$P = \frac{M \; X \; S}{T}$$

- P = estimated population size
- M = total number of individuals captured and marked in 1st sample
- S = total number of individuals captured in 2nd sample
- T = number of marked individuals in 2nd sample
-

QUADRAT METHOD:

- An area where organisms must be counted is demarcated and the surface area is determined.
- A quadrat (e.g. square frame of known size e.g. $1m^2$) is placed on the ground and the organisms in the quadrat are counted

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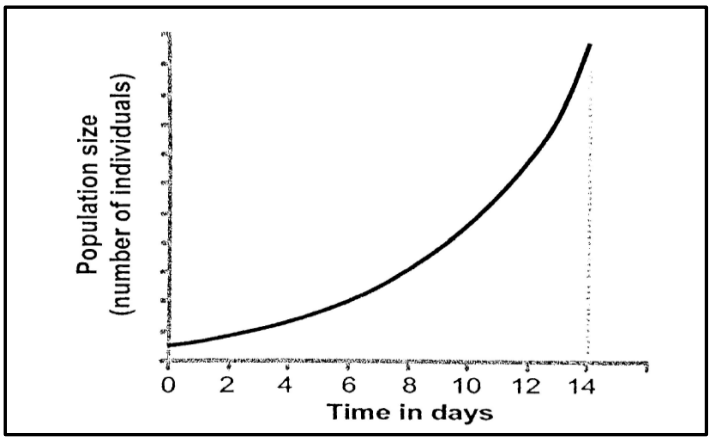
- The process is repeated a few times randomly in different areas of the demarcated area.
- The following formula is used to determine the number of organisms:

Population size = average number of individuls per quadrat X $\frac{\text{surface area of the area}}{\text{surface area of the quadrat}}$

4.1.3 POPULATION GROWTH FORMS

4.1.3.1 GEOMETRIC (J-SHAPED) GROWTH FORM

Figure 12: Geometric growth curve



- Initially the increase in population size is slow as there are a few individuals
- The population size then increases rapidly because of optimum environmental conditions.
- As environmental conditions become unfavourable (environmental resistance becomes effective) e.g. a shortage of food, oxygen etc. the increase suddenly comes to an end.

Please note: Certain factors prevent unlimited growth in a population. These factors are known as **limiting factors** e.g. shortage of food, water, living space, shelter, diseases. Together these factors are called **environmental resistance**.

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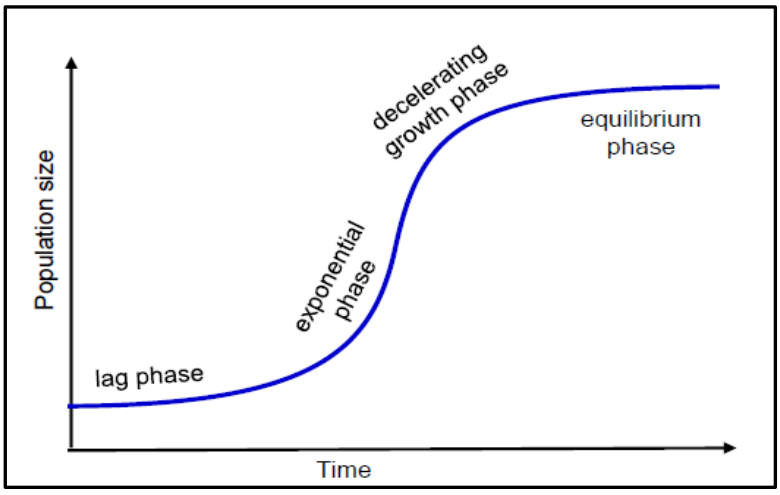
4.1.3.2 LOGISTIC (S-SHAPED) GROWTH FORM

Figure 13: Logistic growth curve



- **Lag phase:** Population growth is slow because the population takes time to acclimatise, to become sexually mature, seek partners for mating and to produce new offspring.
- **Accelerating /geometric/exponential growth phase:** The population grows rapidly and reaches its maximum growth rate because there is little or no environmental resistance. Natality is higher than mortality.
- **Decelerating growth phase:** Growth rate steadily decreases because of an increase in environmental resistance.
- **Equilibrium/stationary phase:** The population numbers reach the ***carrying capacity*** (the maximum number of individuals that a specific environment can support) of the environment and stabilize around this value. Natality is more or less equal to mortality.

4.1.4 REGULATION OF POPULATION SIZE

- Once a population reaches its maximum size the numbers will not remain constant. The numbers will **fluctuate** due to changes in environmental resistance.
- The size of a population may fluctuate seasonally or annually depending on environmental factors and available resources.
- The limiting factors play an important role in the regulation of population size. These are the factors that increase or take effect when the population numbers increase and are also called the **density dependent factors. Density dependent factors are therefore factors that take effect when population size or density increases.** Density dependent factors include food supply, living space, disease, shelter etc. An increase in population size results in a greater demand for food, water, living space, shelter etc.
- **Density independent factors e.g. extreme changes in temperature, droughts, floods, earthquakes etc. are factors that regulate population size regardless of the size or density of the population**. These factors result in a drastic decline in population numbers.

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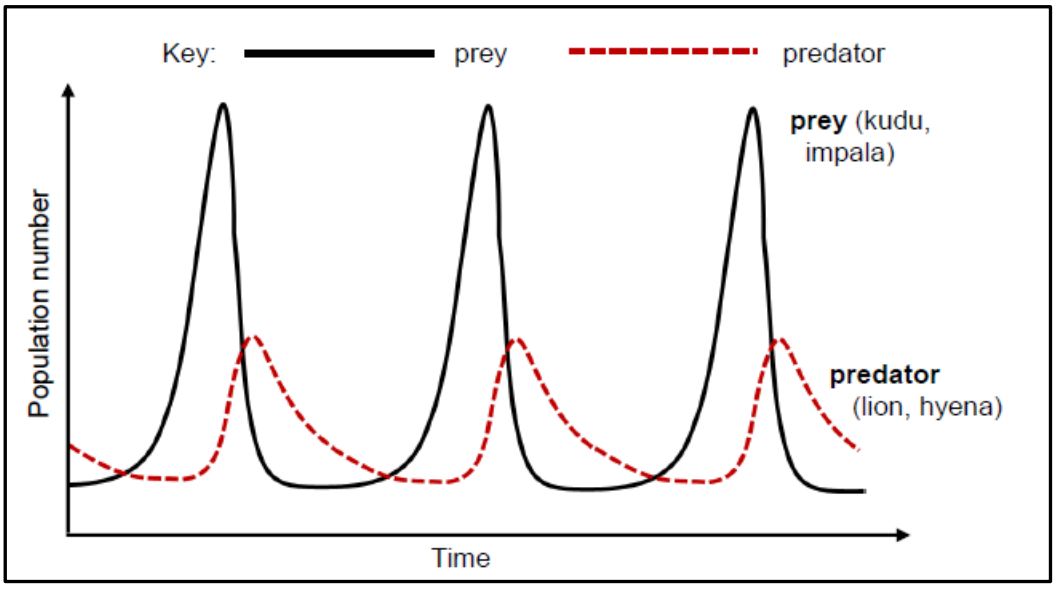
4.1.5 INTERACTIONS IN THE ENVIRONMENT

4.1.5.1 PREDATION

- Feeding interaction where one organism, the **predator** (e.g. lion), hunts, kills and eats another organism, the **prey** (e.g. zebra).
- Predation helps to control the size of populations.
- The higher the prey numbers, the more predation will occur.
- The lower the prey numbers, the fewer predators will survive due to a shortage of food.

Figure 14: Graph showing predator-prey relationship



4.1.5.2 COMPETITION

- Competition takes place when two or more individuals compete for the same limited resources e.g. food, water, mating partners etc.
- **Intraspecific competition** takes place between individuals of the **same species** e.g. male lions competing for a female
- **Interspecific competition takes** place between individuals of different species e.g. hyenas and vultures competing for the same food source.

4.1.5.3 COMPETITIVE EXCLUSION

- Two different species that need the same limited resources cannot occupy the same niche in the same habitat over a long period.
- The one species will outcompete the other which will result in the emigration or extinction of the other species.
- This is known as the principle of competitive exclusion.

4.1.5.4 RESOURCE PARTITIONING

- Two species can co-exist in one habitat but use the same resources differently e.g. one species feeds during the day and the other at night, two species feeding on different heights of the same tree etc.

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4.1.5.5 MUTUALISM

- A symbiotic relationship between two organisms of different species where **both benefit** e.g. bees getting food from a flower and the flower is cross-pollinated.

4.1.5.6 COMMENSALISM

- A symbiotic relationship between two organisms of different species where the **one benefits** and the **other neither benefits nor is harmed** e.g. the suckerfish on sharks that feeds on the leftover food and the suckerfish also gets protection.

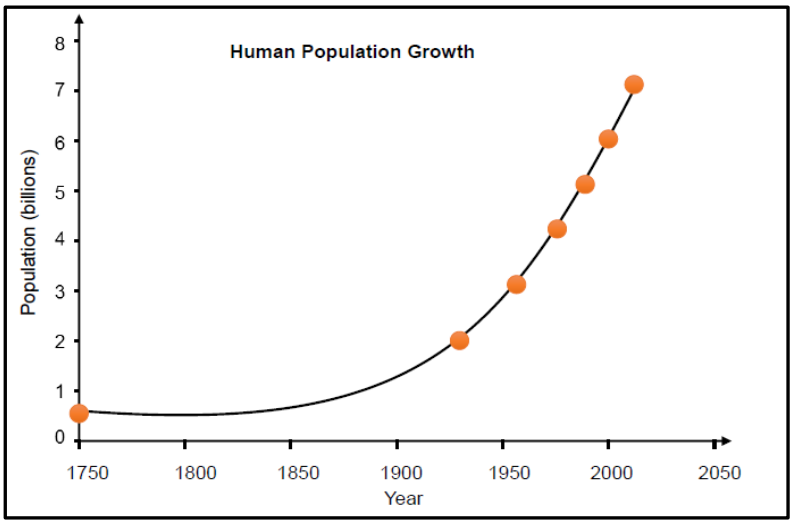
4.1.5.7 PARASITISM

- A symbiotic relationship between two organisms of different species where **one benefits (parasite)** and the **other is harmed (host)** e.g. **ectoparasites** like lice, fleas and **endoparasites** like the tapeworm.

4.1.6 HUMAN POPULATION GROWTH

- The human population growth was very slow in earlier years because of a high mortality rate as a result of diseases, plagues etc.
- The population growth became exponential around 1750 i.e. a rapid increase in population over a short period (see graph below).

Figure 15: Human popluation growth



- The following are reasons for the exponential growth:
  - Advances in the medical field e.g. improved methods for treating diseases, development of vaccinations against infectious diseases
  - Increase in agricultural productivity e.g. the cultivation of new disease – resistant food crops, the use of fertilisers and the use of more effective farming methods.
- The population growth rate in less-developed countries is higher than in more developed countries.

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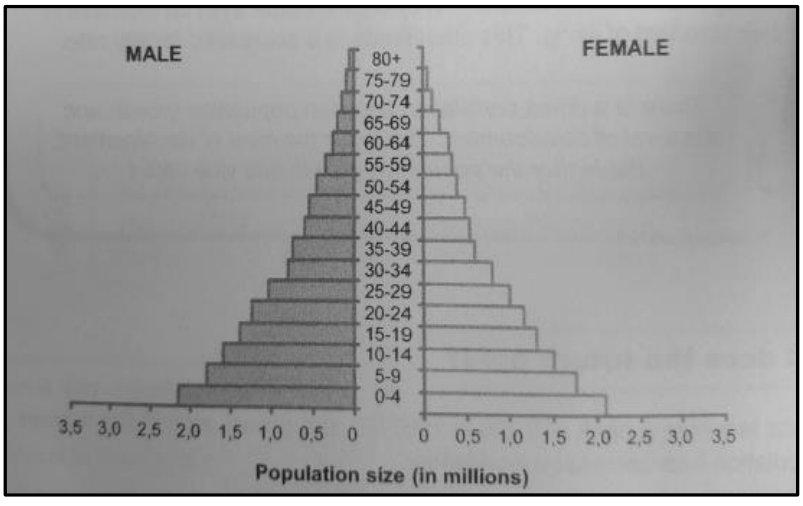
4.1.6.1 AGE AND GENDER DISTRIBUTIONS

- Age and gender distribution of populations can be presented using a **population pyramid**.
- The number of individuals is plotted on the X-axis (horizontal axis) and the ages of individuals is plotted on the Y -axis (central axis)
- One bar graph shows the number of male individuals and the other bar graph shows the number of the female individuals

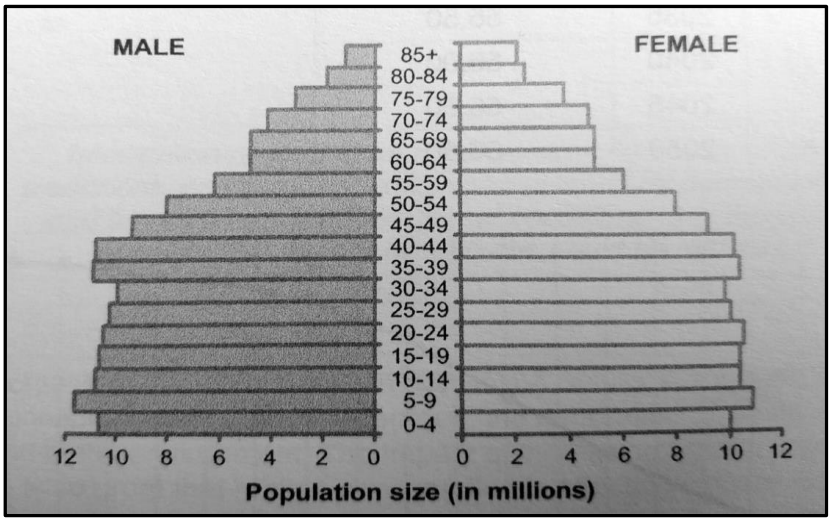
4.1.6.2 EXAMPLES OF POPULATION PYRAMIDS

Figure 16: Rapid population growth



- Pyramid has a wide base and narrow top
- The wide base indicates a high birth rate because of unavailability of contraceptives, low education levels etc.
- The narrow top indicates a high death rate because of poor medical care and nutrition
- This pyramid is characteristic of populations in less-developed countries

Figure 17: Stable population growth



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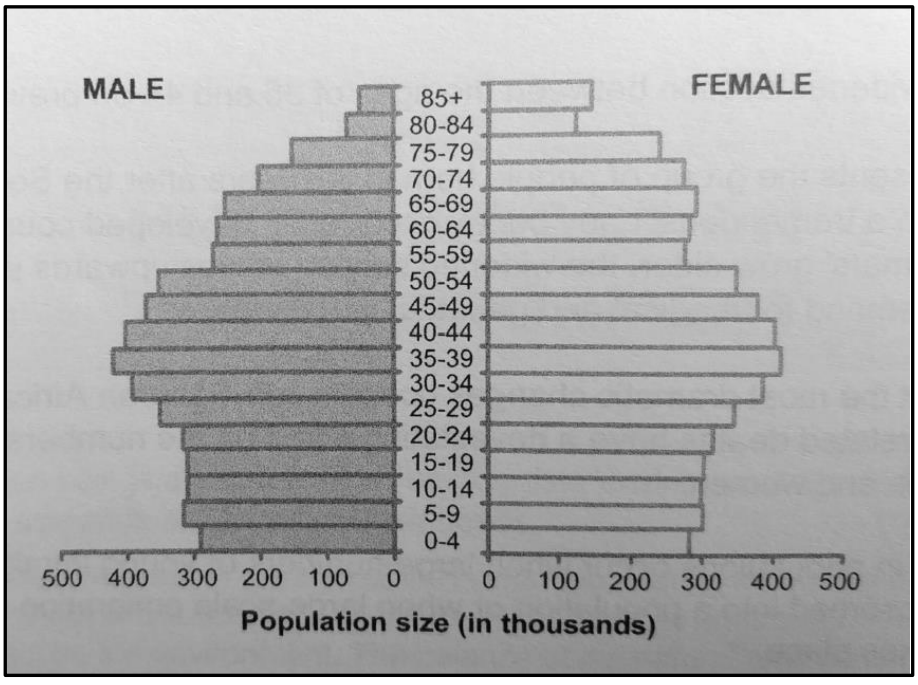
- This pyramid is characteristic of stable populations in more -developed countries
- It shows a decline in birth rate because of good family planning and high levels of education
- It shows a lower death rate because of good medical care and nutrition

Figure 18: Negative population growth



- This pyramid indicates a declining population
- Low birth rate and stable death rate
- Increased emigration
- Characteristic of populations in well-developed countries.

5. HUMAN IMPACT ON THE ENVIRONMENT

5.1 THE ATMOSPHERE AND CLIMATE CHANGE

- The atmosphere is made up of nitrogen, oxygen and other gases, which include the **greenhouse gases** such as carbon dioxide and methane.
- Greenhouse gases absorb infrared (long wave radiation) long wave radiation emitted from the Earth and prevent it from escaping back into the atmosphere. This is known as the **'greenhouse effect'**.
- The greenhouse effect is important in keeping the Earth warm so that it can sustain life.
- An increase in the concentration of greenhouse gases leads to the **'enhanced greenhouse effect'**
- 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'**.
- Effects of global warming include **desertification**, drought and floods
- **Desertification** is the process through which arid or semi-arid land is transformed into a desert

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- **Deforestation** is the cutting down of trees and removal of vegetation from the land. Deforestation decreases the amount of carbon dioxide taken up by plants during photosynthesis. This increases the amount of carbon dioxide available in the atmosphere.
- **Carbon footprint** is a measure of the total amount of carbon dioxide emissions of a person/population/company per year
- Ways of reducing our carbon footprint include re-use and recycle, driving less, insulating walls and building energy efficient homes, using alternative energy, reforestation etc.
- The **ozone layer** is a layer of gas that is located around the earth. The ozone layer absorbs the harmful ultraviolet rays from the sun before it can reach the earth. The damage to the ozone layer is caused mainly by chemicals called CFCs (chlorofluorocarbons), released by refrigerators, aerosol sprays and fast-food packaging.
- Depletion of the ozone leads to a thinning of the ozone layer.
- The effects of **ozone depletion** include: a significant increase in the number of skin cancer cases and permanent damage to our eyes.

5.2 WATER AVAILABILITY

The availability of water may be influenced by the following factors:

- **Construction of dams** - plays a major role in increasing the quantity of water stored and made available for later use.
- **Destruction of wetlands** - A wetland is land that is saturated by surface or groundwater. Wetlands should not be destroyed because they influence both the availability and quality of water.
- **Exotic plants** – plants e.g. pine, wattle etc. that are imported from other ecosystems and established in a new habitat. Plantations of exotic plants use large volumes of water and reducing the water table.
- **Water wastage** - A large amount of water used for irrigation is lost due to poor farming practices. Availability is also affected by wastage of water through leaking taps and toilets and faulty pipelines.
- **Poor farming practice** - Over-grazing leads to soil erosion. On land that is eroded, water runs off rapidly rather than soaking into the ground, and is thus wasted.
- **Droughts and floods** - During periods of drought, water availability decreases. Water used from dams during the drought periods cannot be easily replaced. Natural vegetation can hold back water from floods. If the natural vegetation is removed, flood waters are lost.
- **Boreholes and its effects on aquifers -** Constant use of boreholes eventually leads to the drying up of aquifers (the source of borehole water) thus decreasing water availability in the future.

5.3 WATER QUALITY

Water must be clean and treated so that it is safe to drink. Water is used for various purposes: domestic, industrial, agricultural and mining.
These various activities all affect the quality of the water.

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- **Eutrophication and algal bloom** - Water used for agriculture may contain pesticides, herbicides and fertilizers which pollute the water in rivers, dams and lakes, causing eutrophication. The added nutrients lead to an increase in algal growth (**algal bloom**). These algae over-use and thus deplete the oxygen in the water, thus reducing the potential for life in such water.
- **Pollution of water through domestic, agricultural and industrial use** - After water is used for domestic purposes it may contain detergents (such as from washing) and pathogenic bacteria (such as in sewage).
- **Mining** - Water returned to the environment from mines is generally acidic and toxic. This water is hot and thus also contributes to thermal pollution.
- **Alien plants** - Alien invasive water plants block the waterways, reducing light to other aquatic plants. These plants eventually die and decompose. Bacteria that decompose these plants eventually deplete the oxygen supply in the water.
- **Thermal pollution -** Thermal pollution refers to the heating of water caused by the use of water for cooling in power-stations and industries. The quality of water is affected because heated water has a lower oxygen content, making it difficult to support life.

5.4 FOOD SECURITY

- Food security refers to 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: human exponential growth, droughts and floods, alien plants and the reduction of agricultural land, the loss of wild varieties, wastage, genetically engineered foods, poor farming practices such as **monoculture**, overgrazing and the loss of topsoil, the use of fertilisers, the use of pesticides.

5.5 LOSS OF BIODIVERSITY

- Biodiversity refers to the variety of plant and animal species on Earth.
- Biodiversity ensures that we 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).

5.5.1 FACTORS THAT REDUCE BIODIVERSITY

5.5.1.1 Habitat destruction through farming methods

Overstocking livestock and overgrazing pastures for too long in one area results in:

- soil contamination from excessive dung and urine
- soil erosion
- makes way for alien plants to take over
- reduces the diversity of vegetation leading to land degradation and
- desertification

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5.5.1.2 Monoculture

Growing large quantities of these single type crops (monoculture) year after year leads to:

- loss of indigenous species and biodiversity
- environmental pollution is caused by pesticides and fertilisers
- poisoning and eutrophication of nearby water supplies

5.5.1.3 Golf estates

Most golf estates are built in ecologically sensitive areas with high natural biodiversity which is destroyed by:

- construction of building high density housing on the estates;
- indigenous bush and trees are cleared and dependent animal and bird life affected
- the same pollution impacts as for urban town-housing, with the same negative effects on birds, predators and water bodies
- private gardens on the estate increasing the threat of alien invasive species
- golf fairways that represent monoculture on a huge scale, e.g. alien kikuyu grass, requiring pesticides, fertilisers and huge amounts of water

5.5.1.4 Mining

Both surface (open-cast) mining and underground mining destroys habitats and negatively affects biodiversity in many ways:

- Open-cast (surface) mines take up more space and generate noise and dust pollution
- When vegetation and topsoil are removed for surface mining, animal and plant habitats are destroyed
- All mines produce tons of gas emissions, solid waste, liquid effluent (waste or sewage) and some result in acid mine drainage. These poison underground water supplies and seep into river systems
- Huge mining trucks destroy vegetation and compact soil reducing the drainage ability. Generally mining exposes topsoil to erosion and degradation

5.5.1.5 Urbanisation

As the population increases and cities grow, more indigenous vegetation is cleared to build more industries, road networks and high density housing.

This negatively impacts biodiversity by increasing:

- all types of pollution - air, land, water, noise and light
- physical barriers to animal migration and reproduction patterns
- rainwater run off causing flooding
- the growth of alien vegetation

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5.5.1.6 Deforestation

Deforestation is the large-scale removal of indigenous trees. The destruction of woodlands and indigenous forested areas for the purposes of timber, agriculture, fuel supplies and other human activities leads to:

- the destruction of habitats for insects, especially pollinators such as bees, and amphibians, e.g. frogs.
- the loss of many medicinal and food plant species.

5.5.1.7 Loss of wetlands and grasslands

Wetlands are the habitats of a rich biodiversity of plants of animals. Any pollution or removal of wetlands for development threatens:

- the biodiversity of soils and vegetation (including useful and medicinal plants) associated with wetlands
- the capacity for freshwater purification and storage, erosion and flood control
- the habitats of fish and other aquatic animals
- tourism, recreation, wildlife and bird conservation

Grasslands support a rich biodiversity of wild animals and bird species. If these habitats are removed, eroded or polluted we will lose:

- several endangered and threatened species which survive on grass seeds, worms and insects that populate the grasslands
- many useful and medicinal plants
- ecotourism opportunities such as hiking trails
- flood control and water filtering capacities of grasslands

5.5.1.8 Poaching

- **Poaching** is the illegal hunting or collecting of species (animal or plant) either for food or money.
- Removal of any species negatively affects all other species. This results in loss of biodiversity.
- **Culling** is the careful and legal control of animal numbers to protect biodiversity.
- In South Africa, abalone, rhino and elephants are examples of animals that are poached

5.5.5.9 Alien plant invasions

Alien plants outcompete natural vegetation. They spread quickly and become the dominant vegetation, leading to a loss of biodiversity.

5.5.2 FACTORS THAT REDUCE THE LOSS OF BIODIVERSITY

- Control of alien plant invasion using mechanical, chemical and biological methods

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- Substances from indigenous plants such as the African potato, *Hoodia*, rooibos and Devil's claw all have economic and medicinal value. These indigenous plants can be used sustainably by encouraging traditional healers to grow their own plants.

5.6 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. This way of disposing of solid waste contributes to soil and groundwater pollution because rain seeps through the waste to produce a toxic substance. To prevent the toxic leachate from reaching the groundwater, a plastic liner is placed under the dumpsite area.
- **The use of methane from dumpsites for domestic use** - 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.
- **The need for recycling -** Recycling is a process whereby used materials/waste products are recycled to make new products, for example plastic, glass, tin and paper.
  Re-using waste products includes re-using plastic shopping bags, re-using glass and plastic containers – this helps to reduce the waste produced.
- **Safe disposal of nuclear waste -** South Africa uses radioactive material such as uranium to power its nuclear power station at Koeberg in the Western Cape. A by-product of using uranium is nuclear waste that is still radioactive and dangerous to living organisms. The nuclear waste is stored in thick steel containers and buried in trenches at special protected sites.

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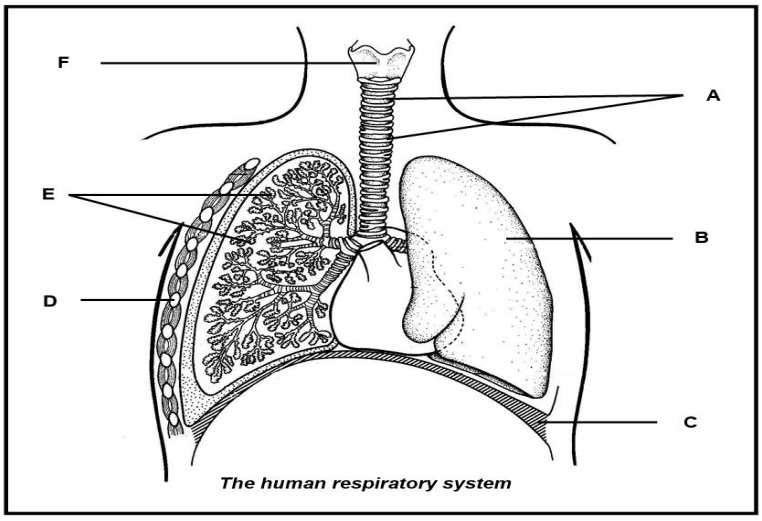
6. REVISION QUESTIONS:

- Work through and answer the questions below.
- Please note that **HIGHER ORDER questions** are in **BOLD** and marked with a **(*)**

A. QUESTIONS ON GASEOUS EXCHANGE:

1. Study the diagram below and answer the questions that follow.



1.1.1 Name the parts labelled **C** and **F**. (2)

1.1.2 Give the **letter** of the parts that are responsible for the following:

(a) Protecting the lungs (1)

(b) Increasing the surface area for gaseous exchange (1)

(c) Preventing the trachea from collapsing (1)

1.1.3 List **THREE** requirements for an efficient gaseous exchange surface. (3)

1.1.4* Explain ONE way in which the nose is better suited for breathing than the mouth. (2)

1.2 Answer the questions below based on human gaseous exchange.

1.2.1* State ONE similarity and ONE difference between the terms breathing and gaseous exchange. (3)

1.2.2 Describe the mechanism of exhalation. (6)

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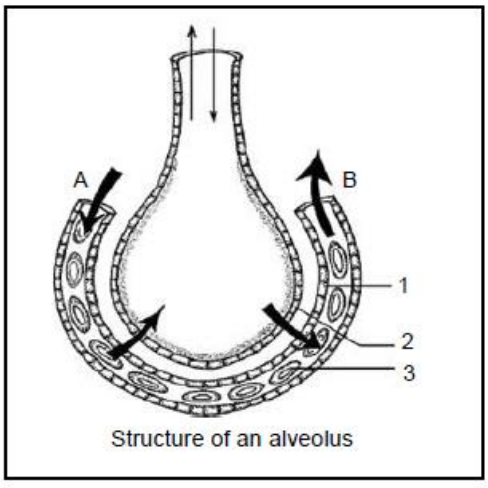
1.3 The diagram below represents a section through an alveolus and a surrounding blood capillary in the human body.



Structure of an alveolus

1.3.1 Identify the type of epithelial tissue numbered **1** and **2**. (2)

1.3.2 Identify the blood cell labelled **3**. (1)

1.3.3 What pigment is found in the cell mentioned in QUESTION 1.3.2? (1)

1.3.4 Which type of blood:

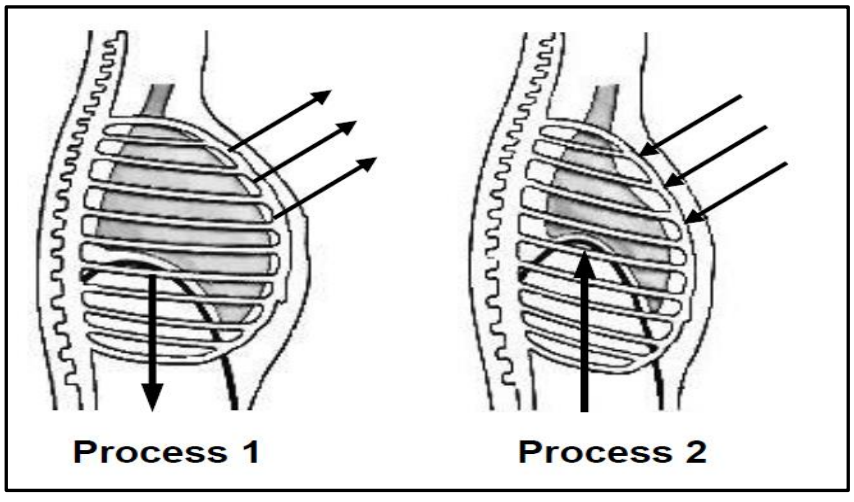
a) enters the blood capillary at **A**? (1)

b) leaves the blood capillary at **B**? (1)

1.3.5 In which form is most oxygen carried in the blood? (1)

1.3.5* State TWO structural features of the alveolus which makes it efficient for gaseous exchange in humans. (2)

1.4 Study the diagrams below showing some parts of the human respiratory system. Answer the questions that follow.



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1.4.1 Which process in the above diagram illustrates inhalation (Process 1 or Process 2)? (1)

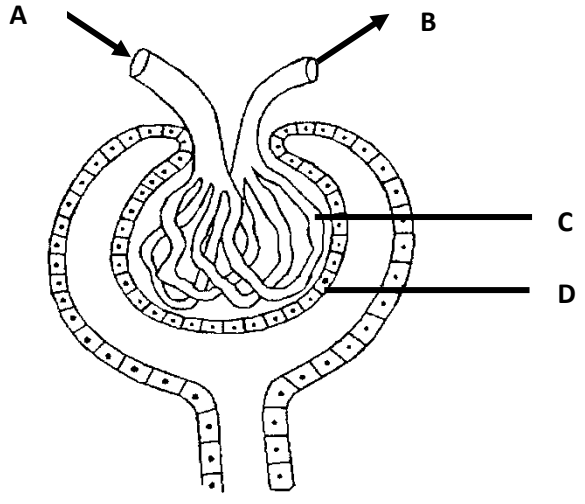
1.4.2* Give three reasons from the diagrams to support your answer to QUESTION 1.4.1. (3)

1.4.3 Give the LETTERS and the NAMES of the muscles shown in the diagram that are involved in inhalation. (4)

1.4.4* A person's thoracic wall is punctured in an accident. Explain how this injury will affect the breathing process. (2)

B. <u>QUESTIONS ON EXCRETION</u>

1.5 Study the diagram below.



Malpighian body of a human nephron

1.5.1 In which region of the kidney would you find this structure? (1)

1.5.2 Name the process of urine formation that occurs in this structure. (1)

1.5.3 Identify part **C.** (1)

1.5.4* Explain TWO structural adaptations of part C for the process mentioned in QUESTION 1.5.3 above. (4)

1.5.5* Part A is wider than part B. State why this important. (1)

1.5.6 Name the type of specialised cells found in part **D**. (1)

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1.5.7 Name the hormone secreted when there is a shortage of water in **A**. (1)

1.5.8* Describe how the hormone named in QUESTION 1.5.7 plays its role under such conditions. (2)

1.6 The table below shows the flow rate and concentration of certain substances taken at regions **A**, **B**, **C** and **D** of the nephron in the human kidney.

Part of the nephron	**Flow rate (cm^3/min)**	**Solute concentrations (g/100 cm^3)**				
		Proteins	**Glucose**	**Sodium ions**	**Ammonium ions**	**Urea**
A	4	0,0	0,0	0,6	0,04	1,80
B	200	0,0	0,10	0,72	0,0	0,05
C	40	0,0	0,0	0,3	0,0	0,15
D	2 000	7,0	0,10	0,72	0,0	0,05

1.6.1 State, with a reason, which of the parts (**A**, **B**, **C** or **D**) of the nephron represent the following:

(a) Afferent arteriole (2)
(b) Bowman's capsule cavity (2)
(c) Loop of Henlé (2)
(d) Duct of Bellini (2)

1.6.2* Explain the difference in the flow rate between B and D. (4)

1.6.3* State ONE reason why there will be no amino acids in A in a healthy person. (2)

1.6.4 Name the inorganic substance, shown in the table, that can pass out against a concentration gradient from the renal tubule into the medulla of the kidney. (2)

1.6.5* Explain TWO ways in which the Bowman's capsule is structurally suited for its function. (4)

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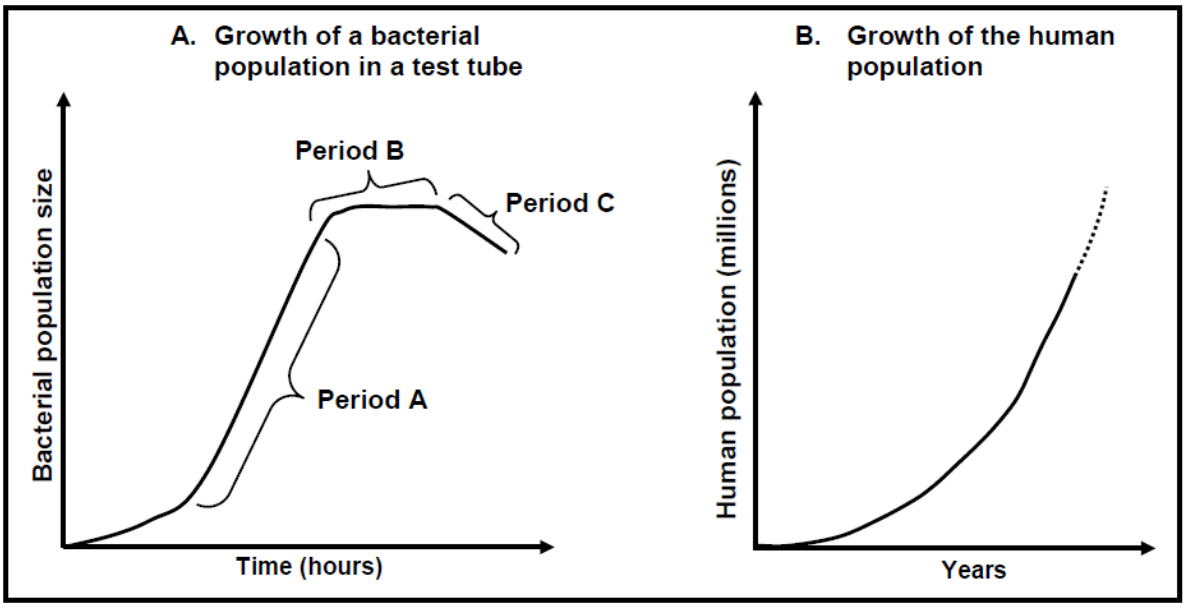
C. QUESTIONS ON POPULATION ECOLOGY

1.7 GRAPH A below represents the number of bacteria in a growth culture over a period of time. GRAPH B shows changes in the human population size over a period of time.



Use GRAPH A to answer the following questions.

1.7.1 During which period (**A**, **B** or **C**) did natality exceed mortality for many hours? (1)

1.7.2 Account for the pattern of growth during Period **B**. (3)

Use GRAPH B to answer the following questions.

1.7.3 In what way is the growth of the human population similar to that of the bacterial population? (1)

1.7.4* Explain why it may take the human population longer to reach the type of growth shown by the bacteria population in Period B. (4)

1.7.5* State TWO precautionary measures which may be implemented in South Africa to slow down the growth in the population. (2)

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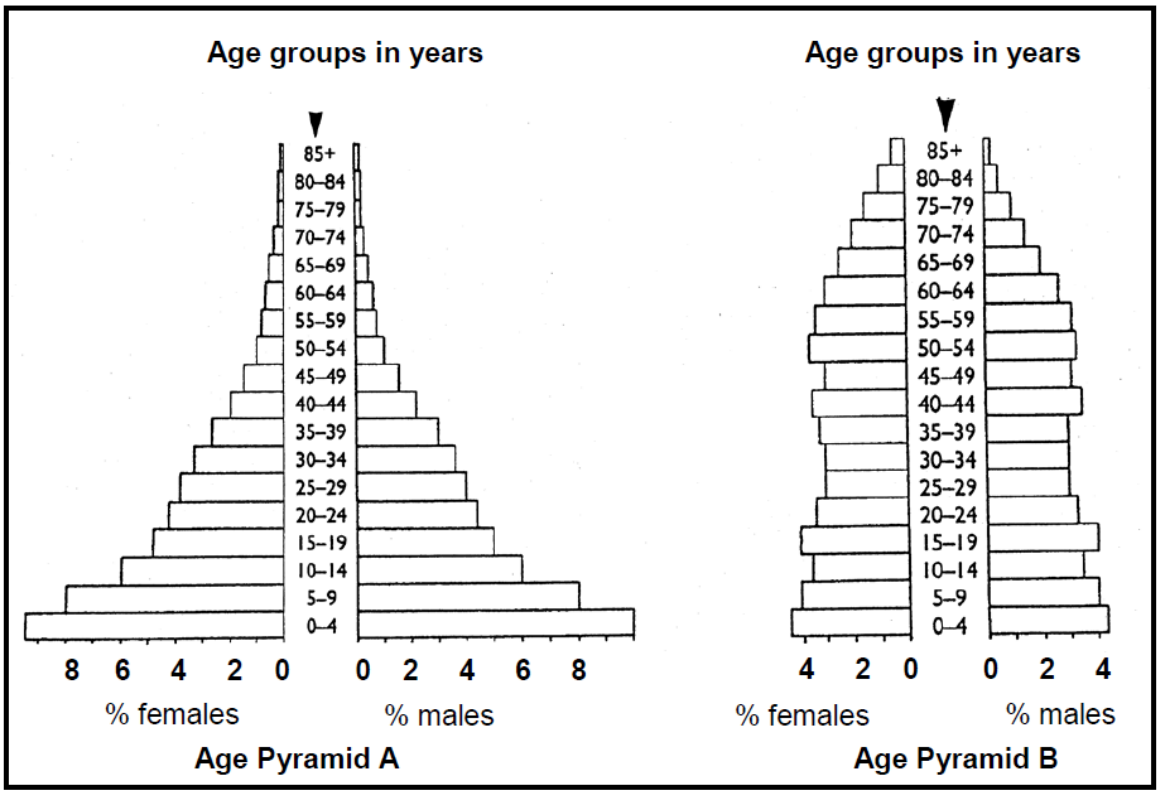
1.8 The diagrams below represent the age distribution of the human population of a developed country and a developing country in one year at a certain time.



1.8.1 What percentage of the female population is aged between 5 and 9 years in Pyramid **A**? (1)

1.8.2 Which age group makes up exactly 5% percent of the male population in Pyramid **A**? (1)

1.8.3 What percentage of the female population are aged 65 to 69 years in Pyramid **B**? (1)

1.8.4 Which group (male or female) has the larger percentage reaching old age in Pyramid **B**? (1)

1.8.5 Which pyramid represents the population distribution of a developed country? (1)

1.8.6* Give TWO reasons for your answer to QUESTION 1.8.5. (2)

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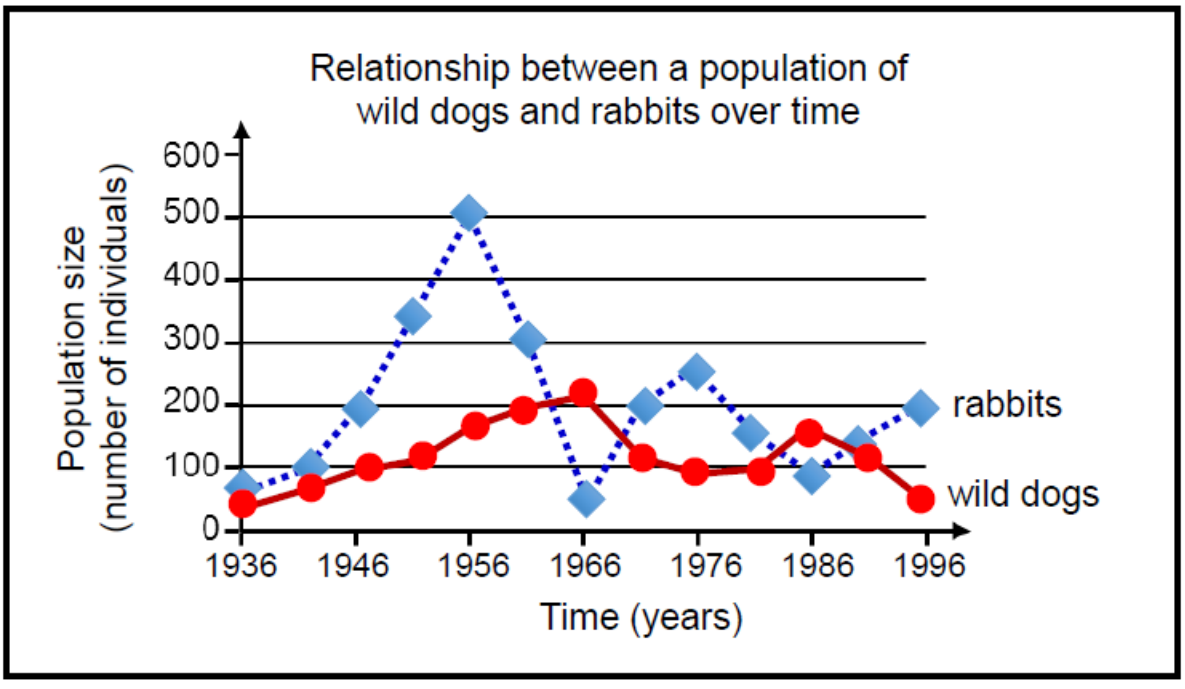
1.9 The Umfolozi Game Reserve in Zululand can support a maximum of 300 impala buck. Fifty (50) were captured, marked and released. Seventy-five (75) impala were recaptured and of these fifteen (15) were found to be marked.

1.9.1* Calculate the size of the impala population. Show your working. (4)

1.9.2* A hunting club asked permission to shoot impala in the Umfolozi Game Reserve. If you were the conservationist officer, would you allow the club to hunt and shoot impala buck? Provide reasons for your decision. (4)

1.10 Study the graph below and answer the questions that follow.



1.10.1 Which population-regulating factor is illustrated by this graph? (1)

1.10.2 How many of the following were there in 1966?

(a) Rabbits (1)

(b) Wild dogs (1)

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

1.10.4*Will the rabbit population increase or decrease when there is a small number of wild dogs? Explain your answer. (2)

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D. QUESTIONS ON HUMAN IMPACT ON THE ENVIRONMENT:

1.11 Read the extract below.

> 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.

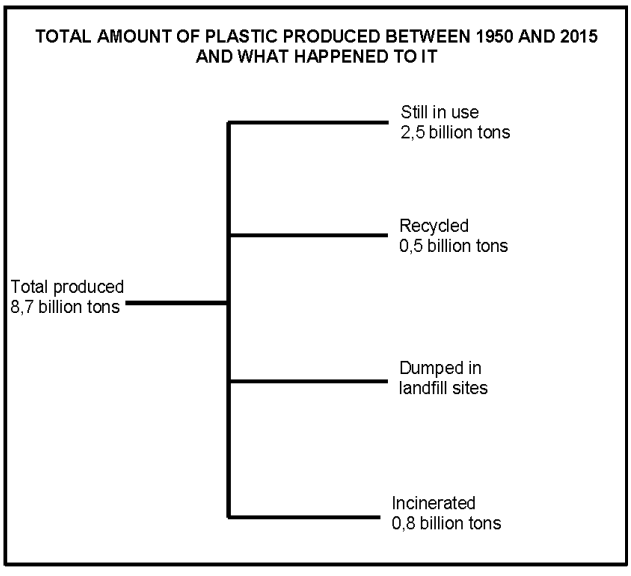
1.11.1 Define the following
(a) Biodiversity (2)
(b) Alien plants (2)

1.11.2 Give TWO factors that can reduce biodiversity other than alien plant invasions. (2)

1.11.3*Explain how biological control is applied to control alien plants. (3)

1.11.4 According to the extract list TWO criteria that should be used to control alien plants. (2)

1.12. The diagram below shows the total amount of plastic produced between 1950 and 2015 and what happened to it.



1.12.1*Calculate how much plastic (in billions of tons) produced between 1950 and 2015 ended up in landfill sites. Show ALL calculations. (2)

1.12.2* Describe the impact of incinerating (burning) plastic on global warming. (4)

1.12.3* Explain TWO strategies that municipalities could implement to increase the amount of plastic that is recycled by a community. (4)

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1.13. The table below shows the global carbon dioxide emissions from fossil fuel combustion and some industrial processes in 2008.

COUNTRY	CARBON DIOXIDE EMISSIONS (%)
China	23
European Union	13
USA	19
India and Russian Federation	12
Other	33

[Adapted from www.environmentalprotectionagency.gov/climatechange]

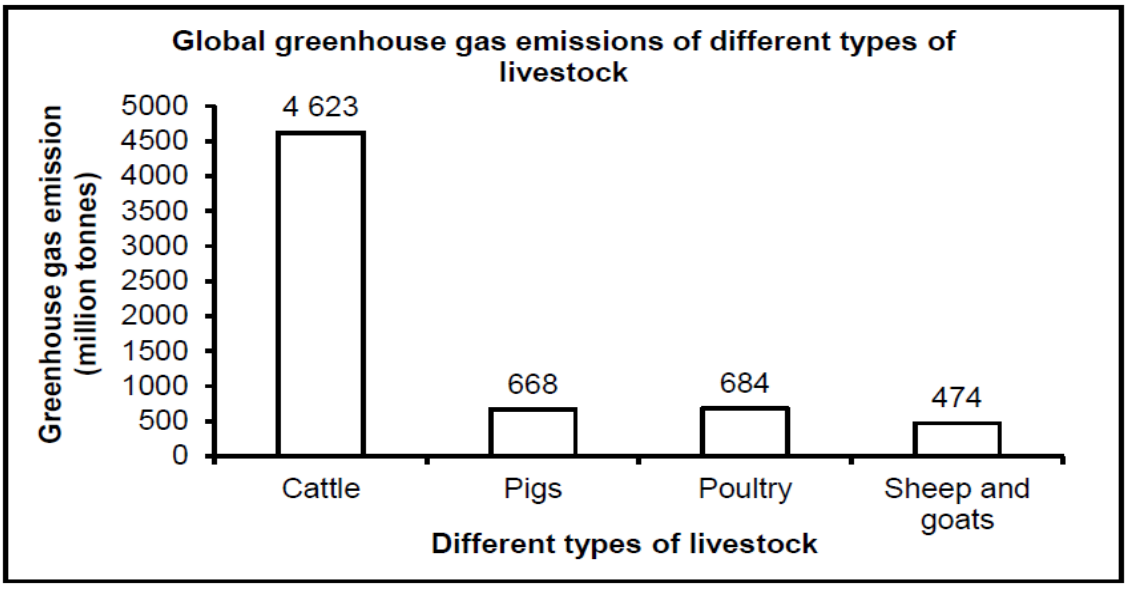
1.13.1 Draw a pie chart to represent the data in the table. (6)

1.13.2* Explain the impact of the increased carbon dioxide emissions on the environment. (3)

1.13.3 Each country has been given a mandate to reduce its carbon dioxide emissions to reach a certain target. This is reviewed annually by the Conference of the Parties (COP), a United Nations organisation comprising 195 countries that meets to assess progress in dealing with climate change.

***Explain TWO reasons why some countries are against reducing the carbon dioxide emissions by their industries. (4)**

1.14 Livestock farming contributes to approximately 14,6% of all global greenhouse gas emissions (release into atmosphere).
The graph below shows the global greenhouse gas emissions of different types of livestock.



1.14.1 Name the livestock farming that contributes the least to greenhouse gas emissions. (1)

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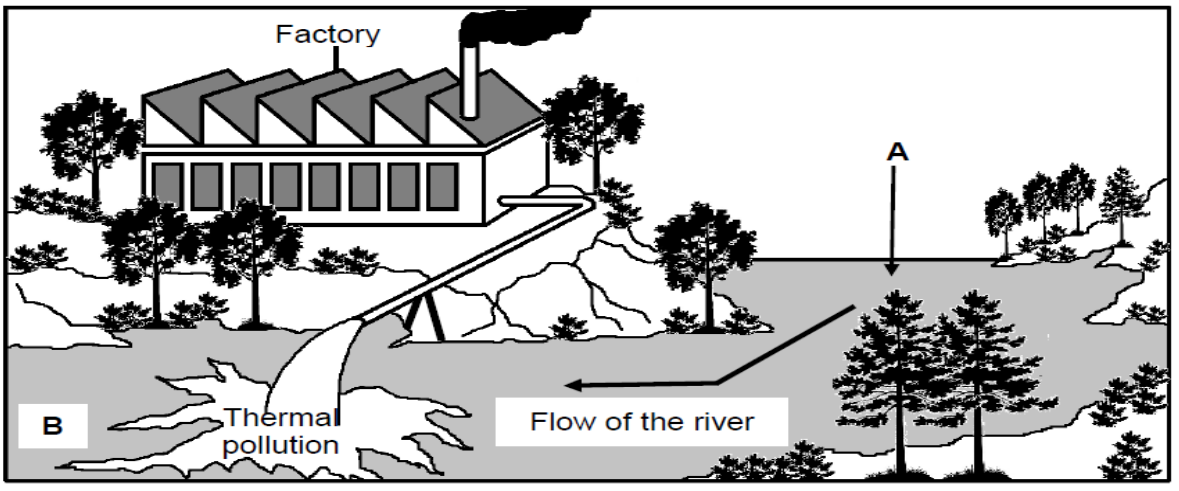
1.14.2 Give ONE advantage of greenhouse gases. (1)

1.14.3*Calculate how much more greenhouse gases are emitted by cattle compared to all other types of livestock combined. Show ALL your workings. (2)

1.14.4 One of the greenhouse gases emitted by livestock is methane.
Name ONE other source of methane. (1)

1.14.5*Explain why an increase in livestock farming may lead to global warming. (3)

1.15 A factory was built on the banks of a river close to a fishing village. The factory used water from the river to cool down the machinery. The water was then released back into the river causing thermal pollution.



1.15.1 What is *thermal pollution*? (1)

1.15.2*Describe how thermal pollution affects the water quality. (2)

1.15.3*Suggest ONE way in which the factory can reduce thermal pollution. (1)

1.15.4*How will thermal pollution affect the fishermen in the village, economically? (2)

1.15.5*During the lockdown of the country due to Covid-19 restrictions, the factory was closed for a period of 4 months.

Suggest, with a reason, the impact that this would have had on the biodiversity in area B. (2)

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