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Co-ordination: Chemical and Nervous co-ordination in man.

Review

1. There is a close structural and physiological connection between the endocrine system (chemical) and the nervous system. Both hormones and nerve impulses co-ordinate the activities of the body but do this in different ways. The nervous system is responsible for quick reaction while the endocrine system brings about a slower reaction that may last for some time.

2. **Endocrine system** Made up of the endocrine glands. Endocrine glands are ductless glands that secrete their hormones directly into the blood stream. The hormones (chemical messengers) are transported via the blood to target organs where they influence the activities of these organs.

3. All hormones have the following properties:
   - They are proteins or steroids in nature
   - They are chemical messengers that react on specific target organs to bring about specific reactions in these organs
   - They inhibit or stimulate the activities of the target organs
   - As they are proteins only a minute quantity is required for reaction to take place
   - All chemically controlled reaction are slower but longer lasting
   - They are transported by the blood stream.

4. There are a number of endocrine glands in the human body:
   - Hypophysis/pituitary
   - Thyroid
   - Parathyroid
   - Adrenal
   - Thymus
   - Beta and Alpha cells of the islets of Langerhans
   - Ovary and testis
   - Endocrine tissue in the mucous membrane of the stomach and small intestine.

   N.B Before attempting to answer the question in this section summarise in a table form and study the endocrine glands under the following headings (an example is given).

Endocrine gland	Location and structure	Hormones secreted	Functions/effects of hormones	Effects of over-secretions	Effects of under-secretions	Treatment
e.g. Adenohypophysis	Anterior lobe of pituitary, at the base of the brain	Growth hormone (GH)	Stimulates normal growth, skeleton, muscles. Promotes increase in size and number of cells, Stimulate growth of cartilage in long bones between diaphysis and epiphysis	Gigantism Acromegaly in adults	Dwarfism	Hormone therapy

5. The hypophysis is called the ‘master gland’ as it produces certain hormones that control and co-ordinate the secretions of other endocrine glands.

6. The secretions of the hypophysis are controlled by the hypothalamus of the brain.

7. Negative feedback mechanisms play an important role in the secretions of the hormones e.g. a low level of thyroxine in the blood stimulates the hypophysis to secrete more thyroid stimulating hormone which results in increased secretions of thyroxine.

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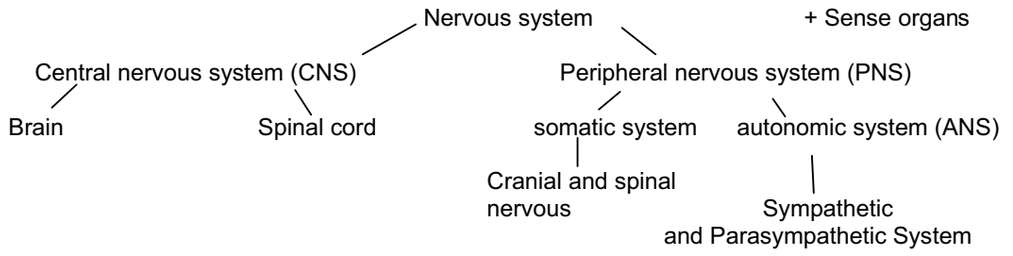
8. **Nervous system:** Divisions of the nervous system



9. Nerve tissue is specialised to react to stimuli and to conduct impulses, is made up of nerve cells called neurons.

10. Types of Neurons:
    - Sensory neuron – conducts impulses from sense organs and receptors to CNS
    - Motor (somatic) neuron – conduct impulses from the CNS to effector organ
    - Interneurons – connects sensory and motor neurons with in the CNS and between different parts of the CNS.
    - Autonomic neuron – transmit impulses to the involuntary muscles and glands.

11. Structure of the neuron: They possess a cell body, dendrites and one or more axons. The axons are surrounded by a fatty non-cellular myelin sheath and concentric layers of Schwann cells (Neurilemma). Neurilemma and myelin sheath form nodes of Ranvier along the axons. They also provide electrical insulation and speeds up the transmission of impulses. Structurally neurons are grouped into:
    - Unipolar – single process leaving the cell body then divides into axon and dendrite
    - Multipolar – an axon and many dendrites leave the cell body.
    - Bipolar – only one dendrite at one end and an axon at the other end leave the cell body.

12. Connections between neurons occur at a synapse - where the terminal branches of an axon of one neuron and the dendrites or cell body of the adjacent neuron lie in close proximity to each other but there is no direct contact.

13. A nerve impulse is an electro-chemical disturbance that passes along a nerve fibre. The triggering of an impulse follows an ‘all or non principal”.

14. Conduction of an impulse across a synaptic space is a chemical process (acetylecholine).

15. The CNS:
    - Protected by bony covering as well as the meninges
        - Meninges are Pia mater, - thin layer supplied with blood vessels
        - dura mater – strong, fibrous outer membrane
        - arachnoid – lies between the two above layers and is separated from the pia mater by the subarachnoid space, which is filled with cerebrospinal fluid.
    - Cerebrospinal fluid acts as a shock absorber against the brain being jostled.

16. Study the structure of the CNS. (L/s of the brain and c/s of the spinal cord)

17. The spinal cord relay sensory and motor impulses to and from the brain.
    Makes reflex action possible via the reflex arc.
    A reflex arc is the pathway along which a nerve impulse is conducted from a receptor organ to an effector muscle.

18. A reflex action is a rapid, involuntary response to an external stimulus received by receptor organs.

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19. Summary of the parts of the brain

Parts of the brain	Functions
Cerebrum	- Origin and control of all voluntary movements - Controls higher mental activities. - Perceptions of sensation - Seat of emotions
Mid-brain	Connects cerebral cortex with pons varolii and cerebellum
Pons Varolii	- Connects cerebrum visual, auditory and motor areas of cerebrum with the cerebellum. - Connects the two hemispheres of the cerebellum. - Conducts impulses from medulla oblongata to cerebrum
Cerebellum	- Co-ordinates the actions of all voluntary muscles to bring about controlled movement. - Control muscle tonus and balance.
Medulla oblongata	- Controls all involuntary actions e.g. respiration, heart beat, salivation, peristalsis, blood vessel dilation and constriction, sleep etc - Conducts impulses to and from spinal cord and the brain. - Allows for crossing over of nerves between spinal cord and brain.
Thalamus	- is a relay centre for all incoming sensory impulses to the appropriate part of the cerebral cortex. - regulates and co-ordinates the external manifestation of certain emotions.
Hypothalamus	- reflex control centre of control mechanisms e.g. hunger, thirst, body temperature, carbohydrate and fat metabolism, sleep, water balance blood pressure and emotions. - controls the secretions of the adenohypophysis.

20. The peripheral nervous system consists of:
    - 12 pairs of cranial nerves.
    - 31 pairs of spinal nerves.

    These nerves form a communication network all over the body.

21. The nervous pathways that are not under the control of the will form part of the ANS.

22. Each internal organ is innervated by a double set of nerve fibres- one set coming from the sympathetic nervous system, and the other from the parasympathetic nervous system.
    - The sympathetic system (SNS) is mostly excitatory in effect and prepares the body for emergency (fright and flight mechanism)
    - The parasympathetic system (PNS) is often inhibitory in effect and tries to maintain normal body activities

Questions

1. The following table shows the effects of certain hormones in the human body. Complete the table by naming the gland and hormones. **(16)**

Gland	Hormone	Effect of Hormone
1	2	Increase heart beat, respiratory rate and blood pressure.
3	4	Stimulates thyroxine production.
5	6	Induces ovulation.
7	8	Maintains the normal calcium and phosphate level of the blood.

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9	10	Normal development of immunological responses.
11	12	Increases the rate of metabolism.
13	14	Regulation of salt and water balance.
15	16	Stimulates conversion of glycogen to glucose.

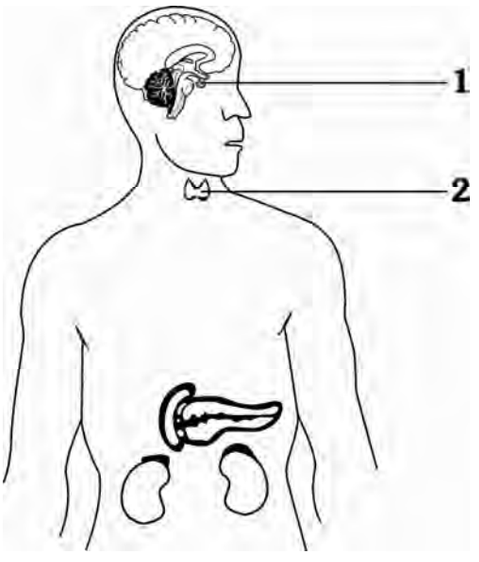
2. Study the following picture of abnormalities which are caused by abnormal secretion a certain hormone. Answer the questions that follow.

2.1 Name the endocrine gland that secretes the hormone that causes the abnormalities shown in the picture **(2)**

2.2 Name the hormone and describe its normal effects on the body. **(6)**

2.3 Name and explain why the above abnormalities occurred. **(5)**

3. Study the diagram of the endocrine system. Answer the questions that follow.



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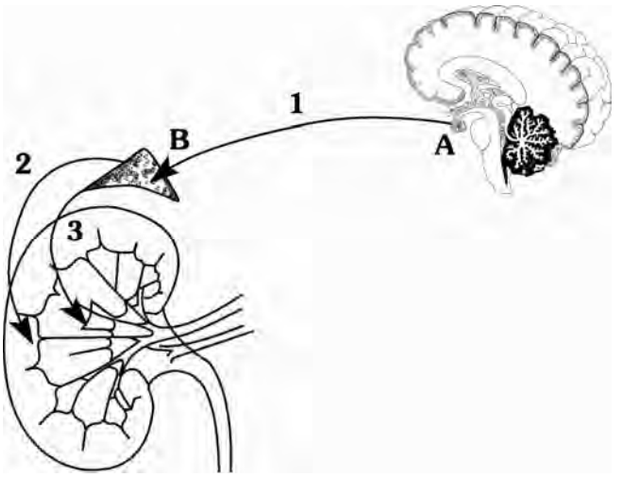
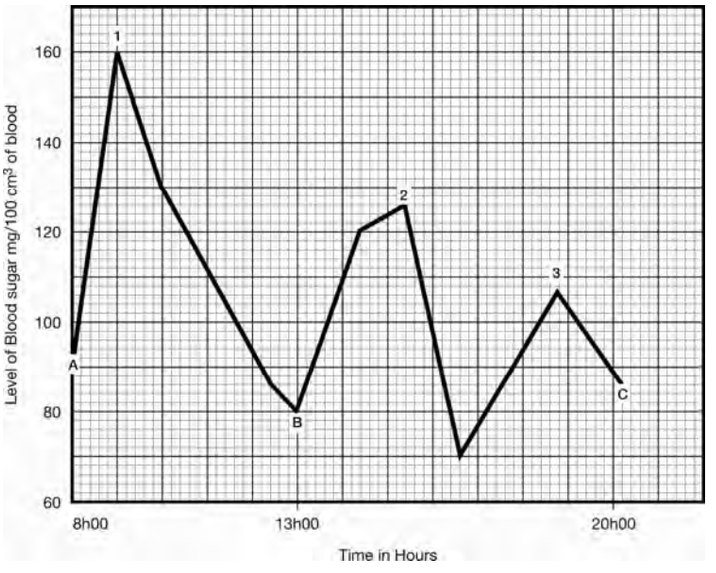
3.1 What is meant by 'co-ordination' ? **(2)**
3.2 Give reasons why there is a need for co-ordination. **(2)**
3.3 Explain what is meant by 'feedback mechanism' by using structures 1 and 2 **(13)**
3.4 List the properties of hormones. **(6)**

4. Study the following diagram. Answer the questions that follow.



4.1 Label the endocrine glands A and B. **(2)**
4.2 Name hormones represented by lines 1 and 2 and list their functions. **(9)**
4.3 Name and discuss how the hormone 3 prepares the body for an emergency **(13)**

5 The graph below illustrates the level of the blood sugar of a healthy person. Study the graph and answer the questions that follow.



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5.1 At what time of the day is the level of blood sugar:
a. the highest? b. the lowest? **(2)**

5.2 During which hour was the rate of increase in the level of blood sugar:
a. the greatest? b. the least? **(2)**

5.3 Which hormone is responsible for the decrease in blood sugar level at points 1, 2, and 3? **(1)**

5.4 In which organ (gland) is this hormone produced? **(1)**

5.5 In what form is the excess blood sugar stored and where is it stored ? What is the advantage of this form of storage? **(5)**

5.6 At point B a meal of fish was eaten. Why was there a rise in blood sugar level and therefore a rise in hormone level? **(5)**

5.7 If a person is unable to produce this hormone explain how will this affect the blood glucose level after a meal of pasta.? **(2)**

5.8 If the blood glucose level decreases below optimal level, which hormone is responsible for restoring the glucose level? How does this hormone function? **(3)**

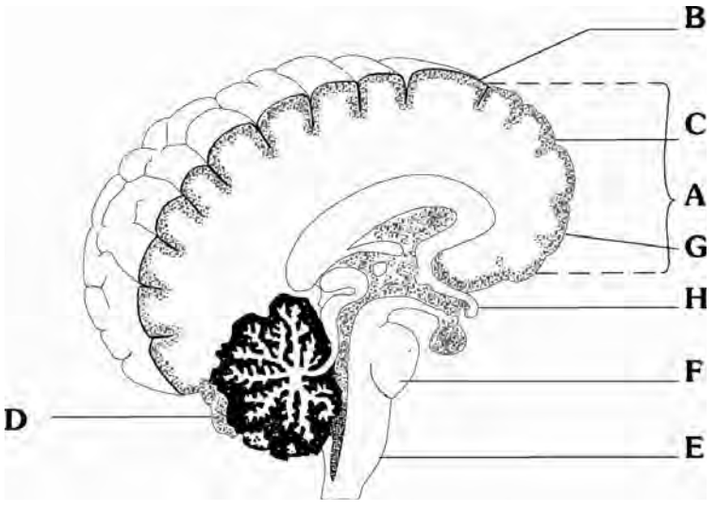
5.9 Explain the causes of:
a. Diabetus mellitus and b Diabetus insipidus. **(6)**

6 Compare the nervous and endocrine systems by completing the following table,

	Nervous System	Endocrine System
Speed	i	ii
Duration	iii	iv
Destination	v	vi
Transported by …..to parts of the body	vii	viii

(8)

7. Study the diagram below than answer the questions that follow.



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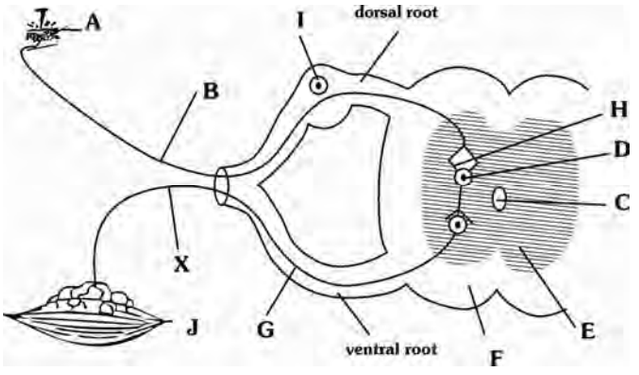
7.2 Identify and give the function of the structures labelled A, D and E **(12)**

7.1 Name that part of the brain that is responsible for:

1 – relaying incoming messages to the correct parts of the brain.
2 – controlling the release of certain hormones from the hypophysis
3 – controlling dilation and constriction of blood vessels.
4 – conducting impulses from the medulla oblongata to the more anterior parts of the brain.
5 - regulating body temperature. **(5)**

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



8.1 Define the term ' reflex action' **(3)**

8.2 Label structures I, E, and G. **(3)**

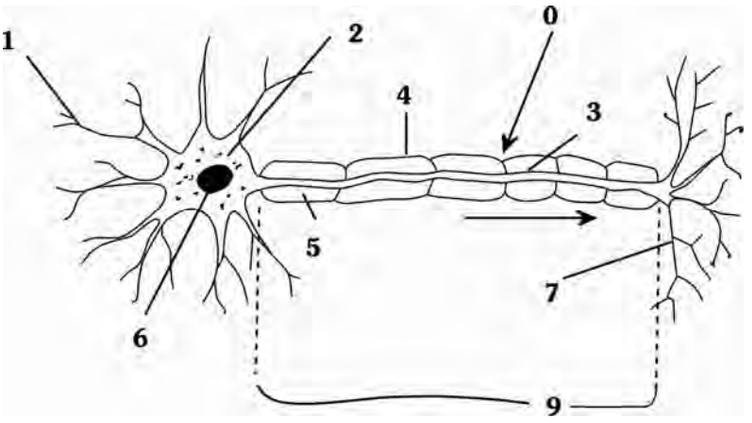
8.3 Which letter in the diagram indicates:

a. dendrite of a sensory neuron
b. A synaps
c. Area of cell axons mainly **(3)**

8.4 List the components of a reflex arc and explain their functions **(10)**

8.5 Explain what would happen if part G is cut at point X **(2)**

9 Study the diagram of a neuron and answer the question that follow.



9.1 Name the type of neuron presented in the diagram. **(1)**

9.2 List all the structural details that you can identify in 2 **(3)**

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9.3 Give the labels for the parts numbered 3, 4, 5, and 7 **(4)**
9.4 Give the functions of the parts labelled 1, 5, 7 and 8. **(5)**

Sense organs

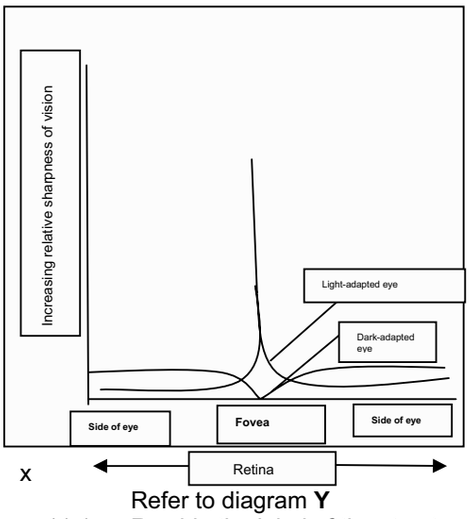
10.1 Draw the diagram of the human tongue, showing the main areas of taste **(6)**

11 Mammalian eyes may be adapted to be able to see better in light (light-adapted) or to be able to see better in the dark (dark- adapted). The degree of sharpness of vision is referred to as visual acuity.

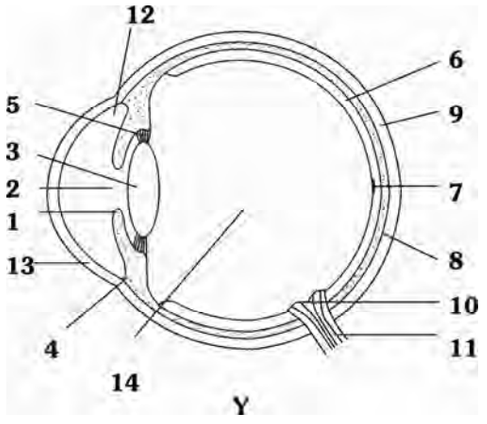
Graph X below compares the visual acuity of a light- adapted and dark adapted eye.

Diagram y illustrates a section through an eye.

Answer the questions set on the illustrations given below.



X



Y

Refer to diagram **Y**

11.1 Provide the label of the structure that represent the following statements.
a. Is tough, elastic and transparent.
b. An area in the retina that does not contain any light receptors.
c. Changes the size of the pupil under different light conditions
d. Refracts light from an object.
e. Alters shape of lens.
f. The layer that has light receptor cells.
g. Absorbs light and prevents it from scattering within the eyeball.
h. The layer that requires Vitamin A to function efficiently.
i. The area where the sharpest image is formed.
j. Gives the its colour.
k. Provides nutrition to the eye **(12)**

11.2.1 Explain the changes that take place in part 1 if the person walks from bright light into dim light. **(8)**

11.2.2. In what way does the process explained in 11.2.1. serve to protect the eye? **(3)**

Refer to diagram **X**

11.3 In which type of eye is the relative acuity of vision the greatest at the fovea? Give a reason for your answer. **(3)**

11.4 In which type of eye is the relative acuity of vision the greatest at the side of the eye?

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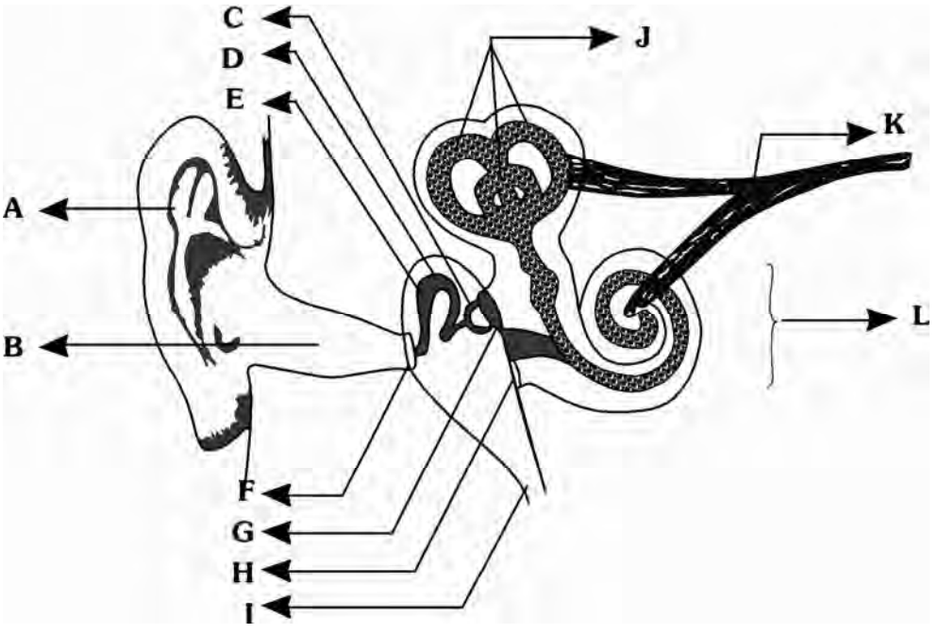
Give a reason for your answer. **(3)**

11.5 A person with normal vision who has been looking at a stage play, looks at the popcorn in his hand, finds that his vision is blurred for a split second before becomimg clear.
Explain why this occurs and how adjustment is brought in the eye. **(13)**
What is this process of adjustment called? **(1)**

11.6 List the structural defects of a person who is Hyperopic. How can this defect be corrected? **(5)**

12. Study the diagram of the human ear, then answer the questions that follow.



12.1 Name the alphabets that answers to the following statements

1. Sets perilymph of the inner ear into motion.
2. Converts sound energy into nerve impulses.
3. Equalises pressure on either side of the tympanic membrane.
4. Collects and directs sound waves into auditory canal.
5. Increases the intensity and frequency of sound waves
6. Perception of head movements.
7. Due to the surface area being small the intensity if vibration is increased as sound waves enter the perilymph of the inner ear.
8. Absorbs extra pressure set up in the scala tympani. **(8)**

12.2 Predict what would happen if:

a. Auditory canal is blocked with wax. **(4)**
b. The sacculus and utriculus is damaged. **(3)**

12.3 In severe cases when the middle ear becomes filled with thick sticky mucus, surgeons place a tube called 'grommet' in membrane **F**, to drain the mucus and also to reduce the pressure in the middle ear.
Once the grommet is in place the child should not go swimming.
Explain this instruction. **(5)**

12.4 What is the significance of the positions of the structures labelled **J?** **(3)**
Explain the role of J in maintaining balance. **(14)**

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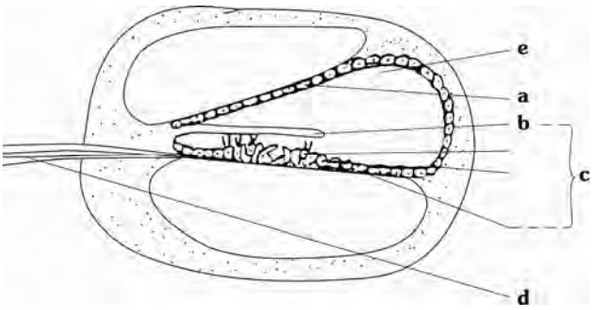
13 Study the diagram of the transverse section of the chochlea.
Answer the questions set on it.



13.1 Identify the parts numbered a. b. c. d and e **(5)**
13.2 Explain how sound is perceived in the above organ. **(24)**

14. Hearing is due to a series of vibrations. Explain this statement.

15 Complete the following table related to the sense receptors in the skin.

Receptor	Sensation	Position
Meissners corpuscle	1	All over the body , most numerous on lips, tips of fingers
2	Touch, vibration, hard pressure	Deeper layers of dermis , muscles and joints(propriceptors).
End –bulbs of Krause	Cold	3
Ruffinian corpuscle	4	Most numerous on abdominal surface and the hands.
5	Pain	All over the body

(5)

Answers:- Co-ordination

1.

1.	Adrenal medulla ✓	2.	Adrenalin ✓
3.	Hypophysis ✓	4.	TSH ✓
5.	Adenohypophysis. ✓	6.	Lutenizing hormone LH ✓
7.	Parathyroid. ✓	8.	Parathormone ✓
9.	Thymus. ✓	10.	Thymosin. ✓
11.	Thyroid. ✓	12.	Thyroxin. ✓
13.	Adrenal cortex ✓	14.	Aldosterone. ✓
15.	Alpha cells of the Islet of Langerhans. ✓	16.	Glucogon. ✓

(16)

2.1. Adenohypophysis ✓✓ **(2)**

2.2. GH ✓: Stimulates normal growth of the skeleton, muscles, and other parts of the body. ✓
Promotes increase number ✓ and size of the cells of the body. ✓
Allows bone to be laid down in the cartilages in the long bones ✓ to cause growth in long bones ✓ **(6)**

2.3. Effects of oversecretion ✓: Giantism in children ✓
Acromegaly in adults ✓
Effects of undersecretion ✓: Dwarfism ✓ **(5)**

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3.1 Co-ordination is the harmonious, integrated √ functioning of the various parts of the body with the purpose of maintaining a constant internal environment. √ **(2)**

3.2. Prevents wastage √ of secretions that are only produced when needed. √ **(2)**

3.3 The hypophysis √ is sensitive to the thyroxin √ level in the blood. When the thyroxine level in the blood falls below √ a certain level the hypophysis is stimulated to produce TSH. √
Increased √ TSH in the blood causes the thyroid gland to produce more thyroxin. √
Thyroxin level thus increases in the blood. √
If the thyroxin level in the blood increases √ above a certain level the hypophysis responds √ by decreasing the production of TSH. √
Decreased √ TSH production causes the thyroid gland to produce less thyroxin. √
Thyroxin level is thus reduced to normal level √. **(13)**

3.4
- Chemical messengers √
- Protein molecules √
- Stimulate or inhibit body functions √
- Small quantities are required to bring about a reaction √
- Transported by blood √
- Reacts on specific target organs to bring about a specific reaction. √ **(6)**

4.1 A. – Pituitary gland (hypophysis) √ B. – Adrenal gland. √ **(2)**

4.2 1.- Adrenocorticotropic hormone (ACTH) √
Regulates the development and maintenance of the adrenal cortex √
Controls the secretions of the adrenal cortex. √
2 – Mineralocorticoids (Aldosterone) √ – Regulate salt and water balance √
-- Glucocorticoids (Cortisone) √ – Help maintain blood sugar level by influencing carbohydrate and protein metabolism. √
-- Androgens √ – Regulate the development of secondary sexual characteristics. √ **(9)**

4.3 Adrenalin: √
- Increase heart beat √
- Increased blood pressure √
- Metabolic rate increases as more energy is required √
- Glycogen in the liver is converted by glucogon to glucose, - increases blood sugar level, more energy is required. √
- More blood moves to voluntary muscles as these blood vessels dialate √
- Pristalsis of stomach and intestine decreases ,blood vessels in these regions constrict, blood moves to voluntary muscles. √
- Rate and depth of breathing increased. √
- Oxygen consumption increases. √
- Increased resistance to fatigue √
- Pupils dialated √
- Hands get clammy √
- Hair become erect √ **(13)**

5.1 a. 9h.00 √ b. 16h40 √ **(2)**

5.2 a. 8h00 to 9h00. √ b. 15h00 to 16h00 √ **(2)**

5.3 Insulin √ **(1)**

5.4 Pancreas (Beta cells of the Islets of Langerhans) √ **(1)**

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5.5 Glycogen is stored in the liver √ and muscles. √ Glycogen molecules are large therefore can store more energy √. Glycogen is osmotically inactive √ therefore does not affect water potential. √ **(5)**

5.6 The final product of protein digestion is amino acids. √
Excess amino acids are not stored and undergoes deamination √ to form urea √ and glucose √ (from the non-nitrogenous part). Glucose level of the blood increases. √
Insulin level increases to regulate glucose level. **(5)**

5.7 Pasta in carbohydrates thus is broken down to glucose. √
Blood glucose level increases beyond the normal range. √ **(2)**

5.8 Glucagon √ – Converts glycogen √ to glucose. √ **(3)**

5.8 Diabetes mellitus: high blood glucose level √ and appearance of glucose in the urine √
due to deficiency of insulin √ or high dietary intake. √
Diabetes insipidus: production of abnormally large volume of watery urine √ due to deficiency of antidiuretic hormone. √ **(6)**

6.

i.	Response rapid √	ii	Response slow √
iii	Short lived √	iv	Longer lasting √
v	Effector organs. √	vi	target organs √
vii	Impulses transmitted along neurons to effector organs. √	viii	Hormones carried by blood √

(8)

7.1

A Cerebrum √	- Origin and control of all voluntary movements √ - Controls higher mental activities. √ - Perceptions of sensation √ - Seat of emotions √
D Cerebellum √	- Co-ordinates the actions of all voluntary muscles to bring about controlled movement. √ - Control muscle tonus and balance. √
E Medulla oblongata √	- Controls all involuntary actions e.g. respiration, heart beat, salivation, peristalsis, blood vessel dilation and constriction, sleep etc √ - Conducts impulses to and from spinal cord and the brain. √ - Allows for crossing over of nerves between spinal cord and brain. √

(12)

7.2 1 – Thalamus √
2 – Hypothalamus √
3 – Medulla oblongata √
4 – Pons varolii √
5 – Hypothalamus. √ **(5)**

8.1 A rapid automatic response √ to an external stimulus √ received by an organ or receptor. √ **(3)**

8.2. I. Ganglion. √
E. Grey matter √
G Motor neuron √ **(3)**

8.3 A. √
H and D √
F √ **(3)**

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8.4 Receptor √ - receive external stimuli and converts it to an impulse. √
Sensory neuron √ – transmits impulse from receptor along dorsal root of spinal nerve to the spinal cord. √
Connector neuron in the grey matter of the spinal cord √ – makes a synaptic contact between sensory and the motor neuron. √
Motor neuron √ – conducts the impulse via ventral root of spinal nerve to the effector organ. √
Effector organ √ – responds to bring about the necessary action. √ **(10)**

8.5 The impulse will not reach √ the effector organ and therefore no movement will take place. √ **(2)**

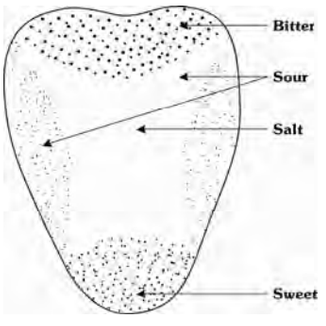
9.1 Motor neuron/multipolar neuron √ **(1)**

9.2 Nissil bodies √, cytoplasm √, nucleus √. **(3)**

9.3. 3. Axon √
4. Neurilemma √
5. Myelin sheath √
7. Terminal buds/nodes. √ **(4)**

9.4 1. Dendrites - Impulses enter cell body of the neuron via the dendrite. √
5. Myelin sheath – provides electrical insulation √
7. Terminal buds – Electrical impulses converted to chemical impulses in the terminal buds √. Impulses leave one neuron to the dendrite of another neuron via the terminal buds. √
8. Node of Ranvier – speeds up impulse transmission. √ **(5)**

10.



(6)

11.1 a. 3 √
b. 10 √
c. 1 √
d. 3, √ 12, √ 13 √ and 14 √
e. 4 √ and 5 √
f. 6 √
g. 8 √
h. 6 √
i. 7 √
j. 1 √
k. 8, √ 13 √ and 14 √ **(17)**

11.2.1. In bright light √ the radial muscles √ of the iris √ relax √ and the circular muscles √ are contracted √. The diameter of the pupil is small √ and less light enters the eye √. As the person walks into dim light radial muscles of the iris contract and circular

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muscles relax. Diameter of the pupil gets bigger and more light enters the eye.

(Dim light the opposite occurs – marks are given only once) **(8)**

11.2.2 Prevents too much light √ entering the eye and over-stimulating the retina. √
Over-stimulating the retina may damage the photoreceptors (rods and cones) √ **(3)**

11.3 Light adapted eye. √ Fovea centralis has the greatest number of cones. √
Cones are mainly used for seeing in bright light. √
Cone are both light sensitive and has the highest visual acuity. **(3)**

11.4. Dark adapted eye. √ Have more rods. √ These are mainly used for seeing in dim light. Visual acuity is greater at the sides of the retina. √ **(3)**

11.5 When a person is looking at a distance √ (as on the stage). The eye is focussing for distant vision. √ The ciliary muscles are relaxed. √
Sclera lies more backwards √, suspensary ligaments are more taut √, lens is less convex √. Focal length increases √, so that the image can fall on the retina.
When the person now has to focus on the hand √, the lens of the eye has to be adjusted to form a clear image. (Temporary blurring)
The ciliary muscles contract √. Sclera is pulled forward √. The suspensary ligaments become slack √. The lens become more convex √. The refractive power of the lens increases √. Image falls on the retina. **(13)**

Accomodation √ **(1)**

11.6 A person with hyperopia have the following characteristics:
Eye ball too short from front to back √
Retina is too close to lens √
When viewing a nearby object., the image falls behind the retina. √
Defect is corrected by: Wearing glasses with convex lenses √ which help to converge the light rays before they enter the eye. √ **(5)**

12.1
1. Oval window **G** √
2. Organ of Corti **L** √
3. Eustacian tube **I** √
4. Pinna **A** √
5 Ossicles **C** √, **D** √ and **E** √
6 Semicircular canals **J** √
7 Oval window **G** √
8 Round window. **H** √ **(10)**

12.2 Air would not be able to influence the tympanum
The pressure between the middle ear and the outer ear would not be equalized √
Thus the tympanum will not be able to vibrate equally on the side of auditory √ canal and the eustacian canal. √
Hearing would be muffled. √ **(4)**

12.3 There would loss of balance √ especially when the head is moved in different directions. √ **(2)**

12.4 The semicircular canals are positioned in the three planes, vertically, horizontally and at an angle √. (between the horizontal and vertical plane) This enables a person to maintain balance √ when there are sudden changes √ and speed √ in any direction √.
At the end of each semicircular canal is a swelling called the ampulla √. In the lining of each ampulla are patches of sensory hair cells called cristae √. These hair

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cells are embedded in a cone-shaped jelly-like substance √. Sudden head movements √
causes the endolymph √ to flow around, within the semi-circular canals. √ This movement causes the cristae to bend √. This in turn stimulates the nerves √ which send messages to the cerebellum √ from each of the semicircular canals. **(14)**

13.1
a. Reissners membrane √
b. Tectorial membrane √
c Organ of Corti √
d. Auditory nerve. √
e. Scala media. √ **(5)**

13.2
- The foot of the stapes, √ which is in contact with the oval window √, causes the membrane of the oval window to vibrate √ at an equal frequency √ as the ossicles. √
- Vibrations of the oval window, produces wave movements of equal frequency in the perilymph √ of the vestibular canal in the bony cochlea. √
- These vibrations are transmitted through the Reissner's membrane √ to the endolymph √ of the Scala media (cochlear canal) √
- Vibrations of the endolymph causes the basilar membrane to vibrate. √
- The hair of the organ of Corti √ (situated in the cochlea canal on the basilar membrane) move with the basilar membrane. √ The free ends √ of the hair rub rub against the overhanging tectorial membrane. √
- Bending √ of the hair cells in the organ of Corti causes the cells of the organ of Corti to convert tectorial impulse √ to nerve impulse. √
- The nerve impulse is carried via the auditory nerves √ to the cerebral cortex. √
- As the basilar membrane vibrates √, it also causes movements of the perilymph √ in the tympanic canal. √ These vibrations are finally absorbed by the membrane of the round window. √ **(24)**

14.
- The pinna √ of the ear directs the sound waves into the auditory canal. √
- the sound waves causes the tympanic membrane √ to vibrate with the same frequency √ as the sound waves. The vibration is possible because the pressure on both sides of the membrane is equal. √
- The vibrations are transmitted to the three ossicles. √. As the ossicles are bones √
  they increase the frequency √ and intensity of the sound waves. √
- The vigbrations form the ossicles are transmitted via the stapes √ to the oval window √
- the membrane of the oval window vibrate at an equal frequency as the ossicles. √
- Vibrations of the oval window, produces wave movements of equal frequency √ in the perilymph √of the vestibular canal √ in the bony cochlea. √
- These vibrations are transmitted through the Reissner's membrane √ to the endolymph √ of the Scala media √ (cochlear canal)
- Vibrations of the endolymph causes the basilar membrane √ to vibrate.
- The hair √ of the organ of Corti √ (situated in the cochlea canal on the basilar membrane) move with the basilar membrane. The free ends of the hair √ rub against the overhanging tectorial membrane. √
- Bending √ of the hair cells in the organ of Corti causes the cells of the organ of Corti to convert tectorial impulse √ to nerve impulse. √
- The nerve impulse is carried via the auditory nerves √ to the cerebral cortex. √
- As the basilar membrane vibrates, it also causes movements of the perilymph √
  in the tympanic canal √. These vibrations are finally absorbed by the membrane of the roundl window. √ **(30)**

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1. Light touch. √
2. Pacinian corpuscles. √
3. All over the body , most numerous on the back and arms. √
4. Heat. √
5 Free nerve endings. √ **(5)**

Excretion and homeostasis.

Review

1. Excretion is the removal of metabolic wastes from the cells and the body of an animal.

2. Secretion is the production of useful substances that are used for particular body functions.

3. Osmoregulation is the process by which water and therefore osmotic pressure is maintained in the body.

4. Waste products of metabolism, if not removed by excretion would accumulate in the body tissues and become toxic to the body.

5. Excretion refers to the removal of: CO_2, nitrogenous waste (urea, uric acid creatinine, ammonia), excess water, excess salts, and foreign substances.

6. **Excretory organs of man:**
   - Lungs – eliminate CO_2 and water vapour.
   - Skin – excrete water and some salts and urea (also brings about some water balance).
   - Alimentary canal – walls of the large intestine excretes salts of heavy metal and some bile pigments are excreted through the faeces.
   - Kidneys – excrete nitrogenous waste, excess water, salts, drugs and hormones. Kidneys also assist in the regulation of the pH of the blood.

7. Urinary system of man
   It is important to learn to draw and label:
   - the structure of the urinary system of man.
   - internal structure of the kidney(L/S).
   - structure of the nephron (the tubular functions unit of the kidney)
   - blood supply to the nephron and the kidney.

8. The major functions of the kidneys are:
   - Excretion of nitrogenous wastes e.g. urea.
   - Regulation of the water content of the body.
   - Ionic regulation :- the kidneys maintain the normal osmotic pressure of the body fluids by excreting excess salts and water.
   - Regulation of acid-base balance (pH) of body fluids.
   - Excretion of toxic substances.

9. The function of THE KIDNEY (discussed as the function of the nephron)
   The function of the kidney may be discussed under the following headings
   - Filtration
   - Reabsorbtion and
   - Tubular secretion

   Refer to diagram for the summary of the function of the nephron.

10. Adaptation of the Malphigian corpuscle for ultra-filtration:
    - Both the lining (endothelium) of the glomerular capillaries and the Bowman's capsule (simple squamous epithlium) provides a thin (single layer of cells) surface area for the filtrate to cross. In addition the capillary has small pores and the inner lining of the

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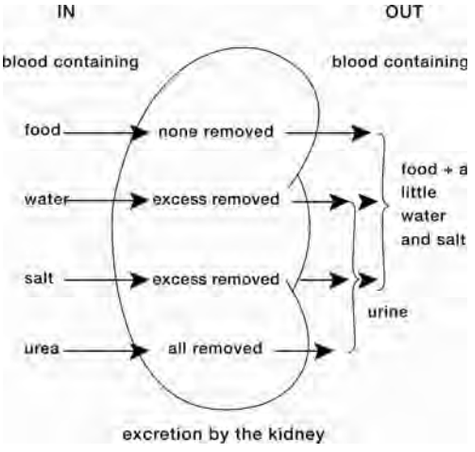
Bowman's capsule has special cells called podocytes. Small spaces between the major and minor processes of the podocytes allow the filtrate to move through relatively easily.
- The afferent aterioles have a larger diameter than the efferent aterioles. This allows hydrostatic pressure to build up in the glomerulus, allowing filtration to take place.
- The glomerulus consists of extensive network of capillaries, thus providing a large surface area for filtration
- Bowman's capsule is cup-shaped with a large surface area and a cavity to receive.

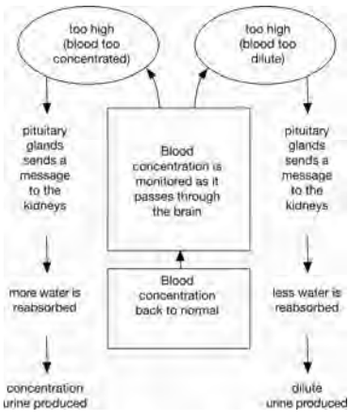
11. The kidney also plays an important role in the homeostatic control of the body.

12. If the osmotic pressure of the blood is increased, and the water content is decreased, then:
    - Sense receptors in the brain stimulate the secretion of the hormone ADH from the hypophysis.
    - ADH causes the walls of the distal convoluted tubules and collecting tubules to become permeable to water.
    - Most of the water is reabsorbed into the bloodstream.
    - Concentrated urine is formed.

13. When a large amount of water is taken into the body then:
    - The osmotic pressure of the blood decreases.
    - ADH production is inhibited.
    - The walls of the distal convoluted tubule and the collecting ducts become impermeable to water.
    - Less water is reabsorbed into the blood and a dilute urine is produced.

14. When large amounts of proteins are eaten:
    - More deamination of amino acids takes place in the liver.
    - The concentration of urea increases in the bloodstream.
    - More urea if filtered from the blood into the filtrate.
    - Blood urea is reduced to a level that is not toxic to the body.





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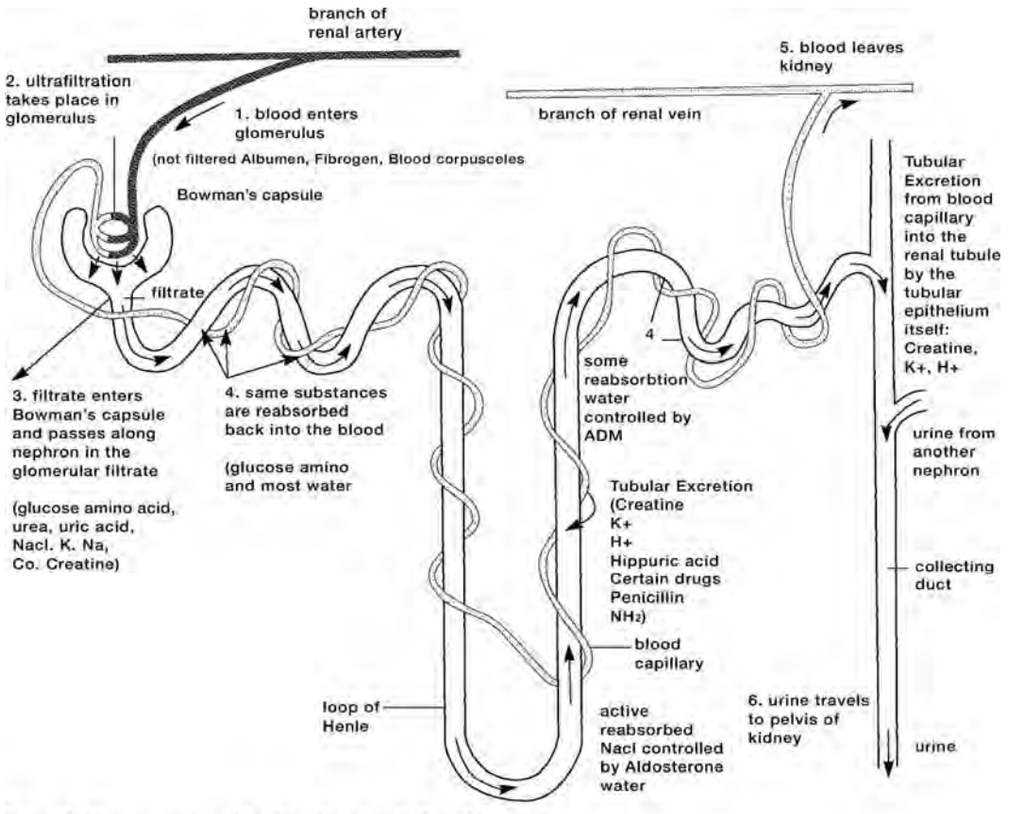
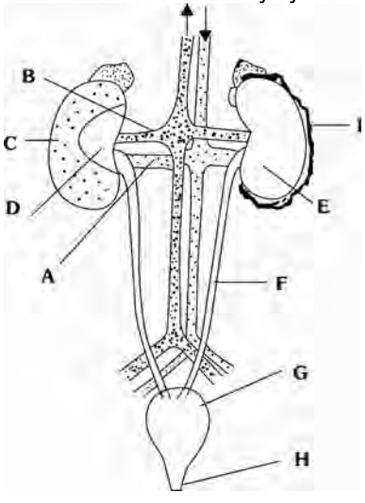


Figure 1: Urine is produced by ultra-filtration followed by selective reabsorbtion

Questions: Excretion and homeostasis.

1. The diagram below is that of the human excretory system



1.1 Name structures labelled A, B, C, G, H and I. **(6)**

1.2 Name and give the function of F and H. **(4)**

1.3 Write the letter of :

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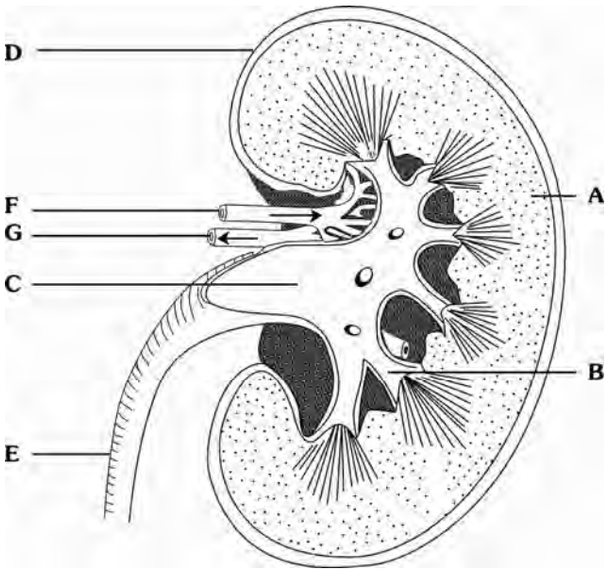
a. The vessel that has a high concentration of amino acids
b. The vessel that has a high concentration of creatinine. **(2)**

1.4 Name three other organs that have an excretory function and list these functions. **(6)**

1.5 What is understood by the term homeostasis? **(1)**

2 Study the drawing of the internal structure of the kidney below and answer the questions that follow.



2.1 Provide Labels for the parts marked A, B, C, D and E. **(5)**

2.2 Name the vessels F and G and tabulate the main difference in the composition of the blood they contain. 16 ÷ 2 = 8

2.3 Into which blood vessel does G open? **(1)**

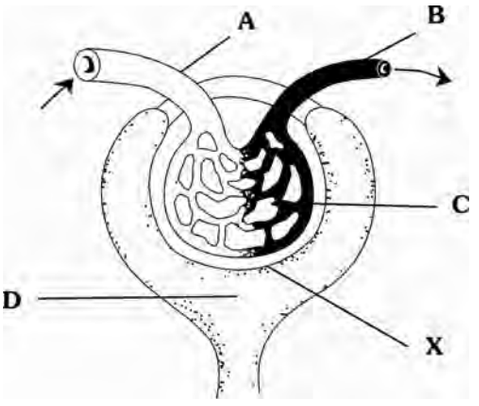
2.4. What is the fluid in E called and list its composition under normal conditions. **(9)**

2.5 Predict the probable changes in the composition of the fluid in E soon after the individual participates in strenuous physical activity on a hot day and after a meal with a high protein content. **(4)**

2.6. Explain why no protein is found in E even if it is present in F. **(2)**

2.7 What type of membrane does D represent. What other function does it serve? **(2)**

3 Study the diagram below and answer the questions that follow



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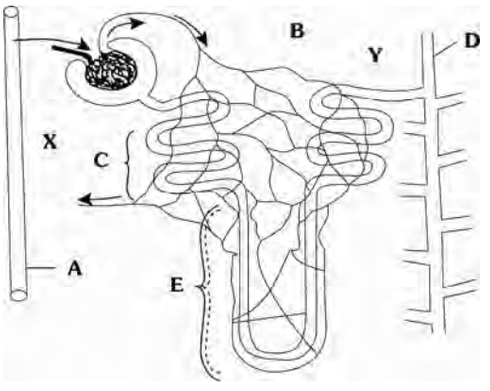
3.1 Identify the structure shown in the diagram.
Which part of the kidney would it be found in? **(2)**
3.2 Provide labels for the parts A, B, C and D. **(4)**
3.3 Discuss how this structure is adapted for ultra-filtration. **(14)**

4. An investigation was performed to determine the flow rate and composition of fluids in the human kidney. Samples of the fluid were taken at regions A, B, C and D as shown in the diagram below.



The results are recorded in the table below.

Part of nephron	Rate of flow of fluids (cm^3 / min)	Solute concentrations g / cm^3		
		albumin	amino acids	uric acid
A	500	4,5	0,2	0,03
B	50	0,0	0.2	0,03
C	10	0,0	0,1	0.12
D	1	0,0	0,1	1,70

4.1 Name the above structure. **(1)**
4.2 Identify the structures labelled A, C, Y and D **(4)**
4.3 Explain the process associated with urine production at C. **(6)**
4.4 Describe the role of E in maintaining a water potential gradient in the medulla of the Kidney. **(9)**
4.5 a. Explain how region C is structurally suited for its function.. **(4)**
b. How will the composition of the urine be altered if the cells of C were cooled excessively? **(4)**
4.6. With reference to the table, give an explanation for each of the following observations:
a) Decrease in the flow rate from region A to region C to region D **(4)**
b) The difference in albumin concentration between A and B **(3)**
c) The presence of amino acids in C and D. **(2)**
d) Change in uric acid concentration between C and D **(2)**
4.7 Name the hormone that acts on regions Y and D. Discuss the role it plays in producing a hypertonic urine, **(5)**

5 Use the information given in the table and in the graph below, regarding the substance passing through the kidney during 24 hours and answer the questions which follows

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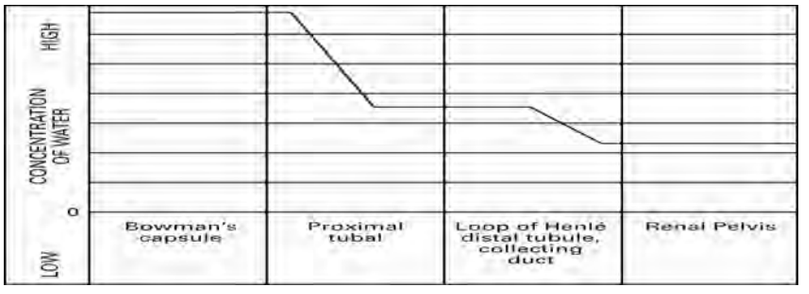
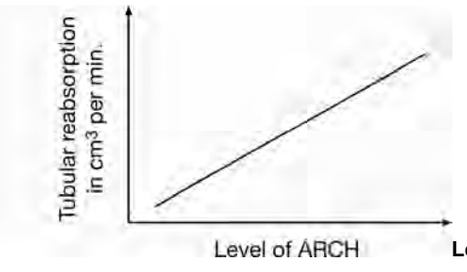
Substances	Approximate daily quantity of substances	
	in capsule	in urine
Glucose	180 mg	0 mg
Urea	53 mg	55 mg
Sodium	540 mg	03 mg
Water	180 litres	1-2 litres



5.1 In which part of the kidney is the concentration of water the lowest?
1 5.2 How do sodium ions affect the water concentration in the loop of Henlē? **(12)**
5.3 Give an explanation for each of the following observations:
a) Absence of glucose in the urine **(2)**
b) The slight increase in the amount of urea in the urine **(2)**
5.4 How will the information in the table differ if the results were taken from a person who…..
a) Had eaten a meal rich in protein? **(3)**
b) Had run a long distance race? **(3)**
c) Has a deficiency of insulin? **(2)**
d) Had consumed a large amount of alcohol? **(3)**
e) Has a deficiency of aldosterone production? **(3)**

6 The following graph shows the effect of ADH in the blood on the amount of water reabsorbed in the urine. Answer the questions set on the graph.



6.1 Describe the relationship that exists between the level of ADH and tubular reabsorbtion of water. **(2)**
6.2 What disease will result if there is a deficiency of ADH **(1)**
6.3. What symptoms will the individual display if he suffers form a deficiency of ADH. **(3)**
6.4 How does the disease mentioned in 6.2 differ from diabetes mellitus? **(2)**

Answers:- Excretion and Homeostasis

1.1 A. Renal artery √
B. Renal vein √
C. Kidney/ medulla. √

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G. Bladder. ✓
H. Urethra ✓
I. Renal capsule ✓ **(6)**

1.2 F – Ureter, ✓ transports urine from kidney to bladder. ✓
H – Bladder, ✓ store urine untill one is ready to urinate. ✓ **(4)**

1.3 a. A ✓
b. B. ✓ **(2)**

1.4 Lungs – eliminate CO_2 ✓ and water vapour. ✓
Skin – excrete water ✓ and some salts and urea (also brings about some water balance). ✓
Alimentary canal – walls of the large intestine excretes salts of heavy metal ✓ and some bile pigments are excreted through the faeces. ✓ **(6)**

1.5 The maintenance of a constant internal environment in the living body. ✓ **(1)**

2.1 A. Renal cortex. ✓
B. Major calyx ✓
C. Pelvis. ✓
D. Renal capsule. ✓
E. Ureter. ✓ **(5)**

2.2

F - Renal artery	G - Renal vein
Plasma proteins – Albumin Fibrinogen ✓	Preent in the same amount ✓
Blood corpuscles. ✓	Present in the same amount ✓
Water ✓	Excess filtered ✓
Glucose ✓	Present in the same amount (maintained) ✓
Urea ✓	None ✓
Uric acid✓	None ✓
K^+ , Na^+, Ca^+ ✓	Same amount (maintained) ✓
Creatinine ✓	None ✓

(6 ÷ 2 = 8)

2.3 Inferior vena cave. ✓ **(1)**

2.4. Urine ✓ - Water ✓
- Inorganic salts , mainly NaCl ✓
- Organic substances – urea ✓, uric acid ✓, ammonia ✓, creatinine ✓,
Traces of amino acids or electrolytes ✓ (depending on the diet) and
- Traces of bile pigments ✓. **(9)**

2.5 After exercise on a hot day – percentage water in the blood is low ✓ because it is excreted as sweat. ✓After a meal with a high protein content – percentage of urea in the urine increases ✓,as a result of deamination of amino acids in the liver ✓. **(4)**

2.6. Protein molecules are too large ✓ to move through the pores of the endothelial cells ✓. **(2)**
2.7. Differentially permeable ✓ membrane also serve a protective function ✓. **(2)**

3.1 Malphigian corpuscle ✓ in the renal cortex ✓. **(2)**

3.2 A. Afferent arteriole ✓
B. Efferent arteriole ✓
C. Glomerulus. ✓
D. Bowmans capsule. ✓ **(4)**

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3.3 Adaptation of the Malphigian corpuscle for ultra-filtration:

- Both the lining (endothelium) of the glomerular capillaries √ and the Bowman's capsule (simple squamous epithlium) √ provides a thin √ (single layer of cells) surface area for the filtrate to cross. In addition the capillary has small pores √ and the inner lining of the Bowman's capsule has special cells called podocytes √. Small spaces between the major and minor processes of the podocytes √ allow the filtrate to move through relatively easily. These also prevent blood corpuscles and large plasma proteins from passing into the filtrate. √
- The afferent aterioles have a larger diameter √ than the efferent aterioles √. This allows hydrostatic pressure to build up in the glomerulus √, allowing filtration to take place.
- The glomerulus consists of extensive network of capillaries √, thus providing a large surface area for filtration √
- Bowman's Capsule is cup-shaped √ allowing the glomerulus to fit in. It has a large surface area and a cavity to receive the filterate. √ **(14)**

4.1. Nephron. √ **(1)**

4.2
A. Renal artery/aorta √
C Proximal convoluted tubule √
Y Distal convoluted tubule √
D Duct of Bellini/collecting duct √ **(4)**

4.3 Tubular re-absorption occurs and excretion occurs
- Most of the water, all the glucose, amino acids some salts and vitamins √ are selectively and actively re-absorbed √ into the surrounding blood capillaries √
- The cuboidal epithelium √ of the tubule may extract waste such as ammonia,creatinine, certain drugs, potassium, hydrogen and bicarbonate ions from the blood √ and excrete them into the tubule √ **(6)**

4.4 - Sodium ions √ are pumped out of the loop of Henlē √ into the interstitial fluid of the medulla √
- Thus the medulla has a higher concentration of solutes √ than the filtrate in the distal convoluted tubule and the collecting duct √.
- Water leaves these tubules into the medulla by osmosis √.
- Water enters the surrounding blood vessels in the medulla. √
- Water is conserved √
- concentrated urine is extracted. √ **(9)**

4.5 a. The inner surface of the cuboidal √ cells of the proximal convoluted tubule have microvilli √ which increases the surface area for absorption.
These cells have many mitochondria √ to provide the necessary energy (from ATP) for active transport during re-absorption. √ **(4)**

b. Enzymatic action is slowed down when the temperature is lowered √. Thus respiration slows √ down and active re-absorption will slow down. √ Useful substances will be present in the urine. √ **(4)**

4.6 a) The rate of flow in the glomerulus is high because of the pressure in the aorta √ and the pressure created by the difference in diameters of the afferent and efferent aterioles √.

The rate of flow in the proximal tubule is slightly less than that in the glomerulus as the pressure in the glomerulus still influences the flow. √
The flow rate is much lower in the collecting tubule since less pressure is experienced as the fluid passes from proximal convoluted tubule to distal convoluted tubule to the collection duct. √ **(4)**

b) Albumin is a large protein molecule √ and does not diffuse √ through the pores of the endothelial cells or the podocytes. √ **(3)**

c) Amino acids were not re-absorped in at C √ into the second capillary network therefore appeared at D √ **(2)**

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d) Uric acid is not only filtered through the glomerulus ✓ but is also added to the filterate from the blood in the second capillary network during tubular excretion. ✓ **(2)**

4.7 ADH controls the size of the capillaries ✓ and the permeability ✓ of the distal convoluted tubule and the collecting ducts.
If there is a shortage of water in the body ✓, more ADH ✓ will be secreted from the hypophysis ✓This will lead to more water being reabsorbed from Y and D ✓ and the permeability will increase and a more hypertonic urine will be produced. ✓ **(5)**

5.1 Renal pelvis. ✓ **(1)**

5.2 - Sodium ions ✓ are pumped out of the loop of Henlē ✓ into the interstitial fluid of the medulla ✓
- Thus the medulla has a higher concentration of solutes ✓ than the filtrate in the distal convoluted tubule and the collecting duct. ✓
- Water leaves these tubules into the medulla by osmosis. ✓
- Water enters the surrounding blood vessels in the medulla. ✓
- Water is conserved ✓
- concentrated urine is extracted. ✓
- excess sodium ions will be eliminated in the urine ✓
- The final control of sodium uptake from the loop of Henlē into the blood vessels ✓ is controlled by aldosterone ✓, a hormone secrete by adrenal cortex ✓. **(12)**

5.3 a). All the glucose filtered into the Bowman's capsule is reabsorbed in the bloodstream ✓ at the proximal convoluted tubule ✓
If there is sufficient insulin ✓ most of the glucose is converted into glycogen, and stored in the liver. ✓ **(4)**

b) Urea is not only filtered through the glomerulus ✓ but is also added to the filtrate from the blood in the second capillary network during tubular excretion/secretion. ✓ **(2)**

5.4

a) The urea content of the urine will increase much more ✓ as more urea will be formed from the de-amination of the excess amino acids ✓
from the breakdown of proteins. ✓ **(3)**

b) The volume of urine produced is decreased. ✓ During running (any exercise) sweating occurs, ✓ water is lost to lower the temperature of the body. ✓ More water is reabsorbed from the kidney to make up for the water lost during sweating. **(3)**

c) When there is a deficiency of insulin excess glucose is not converted to glycogen, ✓ therefore glucose will appear in the urine. ✓ **(2)**

d) Alcohol reduces the production of ADH. ✓ Walls of the distal convoluted tubules and collecting ducts become less permeable. ✓ Less water is re-absorbed into the medulla. ✓ More urine is produced. **(3)**

e) Sodium will not be reabsorbed from the loop of Henlē. ✓ Critical loss of sodium in the urine; ✓ loss of water by osmosis. ✓ (reduction of blood pressure) **(3)**

6.1 Level of ADH in the blood is in direct proportion ✓ to the amount of water reabsorbed in the tubules ✓.

6.2 Diabetes Insipidus. ✓ **(1)**

6.3 Excrete large volumes ✓ and dilute ✓ urine.
Individual drinks large amounts of water ✓ **(3)**

6.4. Glucose is found in the urine ✓ - Diabetes mellitus
Water concentration of urine is great ✓. No glucose. – Diabetes insipidus. **(2)**

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Nutrition and homeostasis

3.

Organ	Special features	Enzyme	Produced by	Function/Reaction of enzyme
Mouth	Teeth, tongue Salivary amylase		Salivary glands	Chewing of food Starch → maltose
Oesophagus				Movement of bolus by peristalsis
Stomach		Pepsin Rennin Gastric lipase	Stomach wall Gastric pits	Storage of food; Proteins → peptones Curdles milk Casenogen → casein Lipids → Fatty acid + glycerol HCl – antiseptic Acid medium Sucrose → glucose + fructose Assists in curdling milk Mechanical breakdown
Small intestine	Duodenum Jejunum Ileum Villi	Pancreatic amylase Proteases:Trypsin and chymotrypsin Trypsin Lipase Nucleases Enterokinase Maltase Sucrase Lactase Lipase Peptidase Nucleotidase	Pancreas Crypts of Lieberkühn and glands of Brünner	Starch → maltose Protein → polypeptides Chymotrypsinogen → chymotrypsin Fats → Fatty acid + glycerol Nucleic acids → nucleotides Trypsinogen → Trypsin Maltose → Glucose Sucrose → Glucose + fructose Lactose → Glucose + galactose Fats → Fatty acid + glycerol Polypeptides → Amino acids Nucleotides → Phosphates Pentose sugars Nitrogenous bases Mechanical breakdown Absorption of nutrients
Large intestine				Absorption of water; storage of non-digestible remains.
Anus				Defecation of faeces

Nutrition and homeostasis

Review

1. The importance of nutrition.
   a) Proteins – mainly used as building material (growth, repair, replacement and cell division) and to a small extent as a source of energy. Excess amino acids are deaminated and converted into urea and glucose.
   b) Carbohydrates – main source of energy. Excess glucose is stored as glycogen in the liver and muscle cells.
   c) Fats – also used as energy source and formation of cell membrane. Excess fat is stored around the internal organs and under the skin as subcutaneous fat and adipose tissue where it serves as reserve energy.

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d) Trace elements, mineral salts and vitamins are needed for general health and efficient metabolism.
e) Water – is an important component of nutrition.

2. Of all the foods eaten only proteins, fats and carbohydrates need to be digested in the digestive system.

3. **The digestive system**. (It is essential that you study the structure and functions of the organs that make up the alimentary canal). The following table is a summary of the digestive system.

(see diagram on previous page)

4. Control of enzyme secretions:
   a) The secretion of saliva is controlled by reflex actions through smell, sight and taste.
   b) Food entering the stomach stimulates cells in the stomach wall to secrete the hormone **gastrin.** Gastrin and the physical contact of the food in the stomach (stimulate nerve endings) stimulate the gastric glands to produce gastric juices.
   c) The acidic chyme and the presence of food stimulate the mucosa cells in the duodenum to secrete the hormone **secretin.** Secretin causes the pancreas to produce pancreatic juice.
   d) The presence of chyme and the hormone cholecystokinin –pancreozymin produced by the mucosa of Duodenum also causes the pancreas to produce pancreatic juices and the liver to secrete bile.
   e) The presence of chyme in the intestine causes the secretion of Succus entericus (intestinal juice)

5. The function of bile
   a) Emulsifies fats.
   b) Creates an alkaline medium.
   c) It is an antiseptic.
   d) Promotes peristalsis
   e) Reduces fluidity of chyme
   f) Bile salt and fatty acid complex is soluble thus makes absorption of fats possible.
   g) Bile assists in absorption of vitamins A, D, E and K.

6. The final products of digestion are:
   a) Proteins → amino acids.
   b) Carbohydrates → monosaccharides; glucose, galactose and fructose.
   c) Fats → fatty acids and glycerol.
   d) Vitamins.
   e) Mineral salts.
   f) Water.

7. Absorption of the final products of digestion.
   a) Amino acids, glucose, galactose, fructose, vitamins, mineral salts and water are absorbed directly into the arteriols of the villi and reach the hepatic portal system via the venules.
   b) Absorption of fatty acids and glycerol:
      - Insoluble fatty acids combine with bile salts to form a soluble complex.
      - fatty acids and bile salts complex are absorbed by the columnar epithelial cells lining the villi.
      - Glycerol enters the columnar cells by active absorbtion.
      - Inside the villus the fatty acids are freed from the bile salts and recombine with glycerol to form tiny fat globules.
      - Some fat globules are absorbed by the arterioles of the villi but most are absorbed by the lacteals.
      - All the lacteals unite to form lymph vessels which join the lymphatic vessel that enters the blood system at the base of the thoracic duct.

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8. Suitability of the small intestine for the absorption of nutrients.
   a) The absorptive surface of the small intestine is increased by
      - The length of the intestine
      - Folds of the lining
      - Millions of villi , therefore rate of absorption is faster.
   b) the villus contains arterioles, venules and lacteals in which the nutrients can be absorbed
      and transported to the main blood system.
   c) The villus is lined by a thin surface area (single layer of columnar epithelium) - allows for rate of absorption to increase
   d) The secretions of goblet cells of the columnar epithelium keeps the villus moist so that nutrients are absorbed in solution.
   e) Villi are kept in motion by involuntary muscles and peristalsis ensure continuous contact of food molecules with the villi.

9. Importance of roughage in the diet.
   a) Cellulose (from fruit skins, raw vegetables, bran etc) is the best form of roughage.
   b) Roughage is essential to provide bulk as a stimulus for peristalsis and defeacation.
   c) Prevents constipation, cancer of the colon and haemorriods.

10 Function of the liver concerning nutrition.
   a) Secretes bile, which emulsifies fats.
   b) Stores glucose in the form of glycogen under the control of insulin.
   c) Changes excess amino acids into urea and glucose.
   d) Changes excess glycerol into glucose.
   e) Converts excess glucose into fatty acids, which combine with fatty acids to form fats.
   f) Synthesizes vitamin A and stores vitamin D and iron.

11. Each nutrient is kept at a constant level in the body by homeostasis.

12. A balanced diet contains all the nutrients in the correct amounts. Unbalanced diet results in diseases, e.g. under-nourishment may result in kwashiorkor, maramus, pellagra and anorexia, over-nutrition may result in obesity or arteriosclerosis.

13 Importance of water in the digestion of food
   a) Peristalsis – water and mucus assist the movement of food through the digestive tract.
   b) Absorption – water acts as a transport medium during absorption.
   c) Water acts as a solvent of nutrients (except fats). Only dissolved nutrients can be absorbed by the villi.
   d) Water maintains the fluidity of chyme.
   e) Water is needed during the chemical process of hydrolysis (to breakdown of food products).

Questions : Nutrition and Homeostasis

1 a. Why is digestion of food necessary? **(5)**
   b. Why are nutrients important to the body? **(10)**
2 Complete the following table. **(10)**

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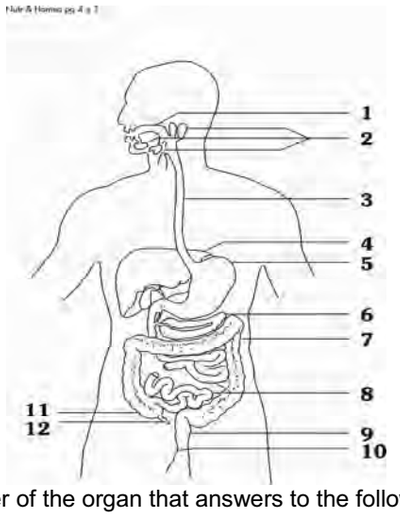
Organ	Enzyme	Substrate	Products	pH medium
2.1	Salivary Amylase	Starch	2.2	2.3
Stomach	Renin	2.4	caesin	2.5
Duodenum	2.6	2.7	Chymotrypsin	alkaline
2.8	Sucrase	Sucrose	2.9	2.10

3 The following diagram illustrates the digestive system of man. Answer the questions set on it.



3.1 Write the correct number of the organ that answers to the following statements.

a. Produces bile
b. Most amount of water is reabsorbed
c. Hydrochloric acid is secreted.
d. Secretes insulin in the endocrine section.
e. De-amination occurs here.
f. Has numerous villi.
g. Glucose is stored as glycogen
h. Salivary amylase is produced.
i. Defecation occurs.
j. Mainly made up of lymphatic tissue.

10

3.2 Name the type of movement which allows food to move along **3.** **(1)**
List functions of this type of movement. **(2)**

3.3 State how part **8** is structurally suited for absorption of nutrients. **(10)**

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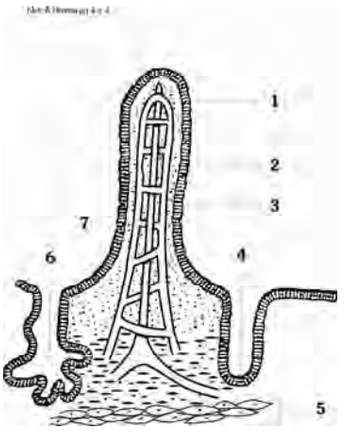
4 Study the diagram below of a portion of the human digestive system



4.1 Identify numbers 1, 2, and 3 **(3)**

4.2 Using numbers from the diagram, indicate the structure that
a. absorbs glucose and amino acids
b. secretes bicarbonate ions and succus entericus.
c. is responsible for peristaltic movement. **(3)**

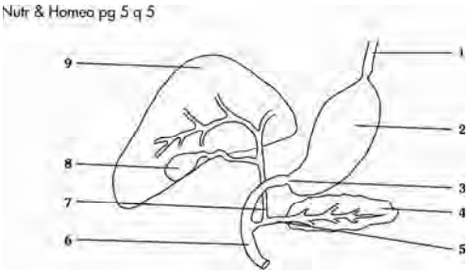
4.3 Name the enzymes secreted by part number **4** and their functions in the digestion of food. **(21)**

4.4 Discuss how part label **1** is suitable for absorption of nutrients. **(4)**

4.5 What happens to glucose when the glucose level rises in part number **7**? **(7)**

4.6 Explain how the end products of fat digestion enter part labelled 3. **(10)**

5 Study the information in the diagram and the tables below and then answer the questions that follow.



5.1 Identify the structures numbered 1-9 **(9)**

5.2 Name the substance responsible for the acidity in organ **2**. List the functions of this substance. **(5)**

5.3 Name the substance stored in **8**. Why is this substance necessary for digestion of lipids and fats. **(5)**

5.4 State the function of part labelled **9** concerning nutrition. **15)**

5.5 Discuss the endocrine function of structure **4** when the blood glucose level is very low. **(4)**

5.6 How does the exocrine function of **4** effect digestion in structure **6.** **(16)**

5.7 Two patients of similar age were confined to their beds. They ate the same amounts of the following food types at the same time.

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Carbohydrates	200g
Proteins	50g
Fats	20g

Part **7** of one patient was blocked, while 4,5 metres of part **6** of the other patient was removed surgically.

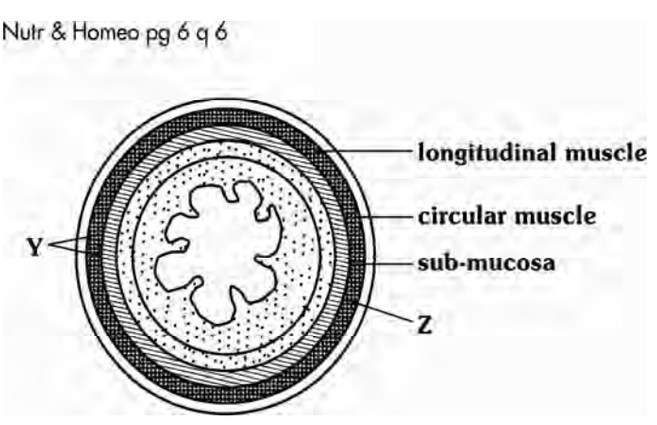
The contents of each of their colons was analysed after some time and the results are shown in the following table.

Substances	Content of colon	
	Patient X	Patient Y
Carbohydrates	125,0 g	120,0 g
Proteins	12,5 g	6,0 g
Fats	12,0 g	19,0 g
Intestinal gas	10,0 ml	28,0 ml

a. Calculate the difference between the two patients of the amount of carbohydrates absorbed. **(3)**
b. Which patient's part **7** was blocked? Give a reason for your choice. **(3)**

5.8 Ulcers of part **3** and **6** are known as peptic ulcers.
a. What causes peptic ulcers? **(2)**
b. Explain why peptic ulcers are more likely to be found in part **6** than in part **3.** **(3)**
c. State one way in which the duodenum is normally protected against the formation of ulcers. **(1)**

6 The diagram below is a plan of a transverse section through part 6 of the diagram in question 5.



6.1 Name the parts represented by **Z** and **Y.** **(2)**
6.2 Explain ways in which the muscle layers help in nutrition. **(2)**

7 The following questions are based on the data given in the diagram below.

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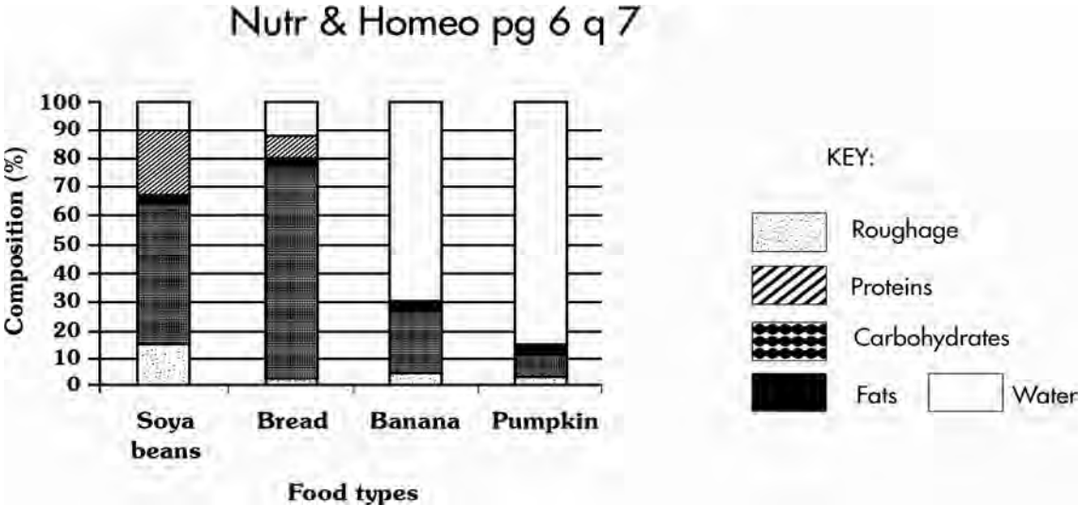


7.1 Which food type will spend more time being digested in the stomach, compared to the other food types? **(2)**

7.2 Which one of the food type contains the highest percentage of roughage? **(2)**

7.3 Give the function of roughage in the human body? **(3)**

7.4 Which food plays the most important role in the prevention of kwashiorkor? **(2)**

7.5 Which one of the foods would release the most energy per molecule? **(2)**

7.6 Which food contains the least amount of carbohydrates? **(2)**

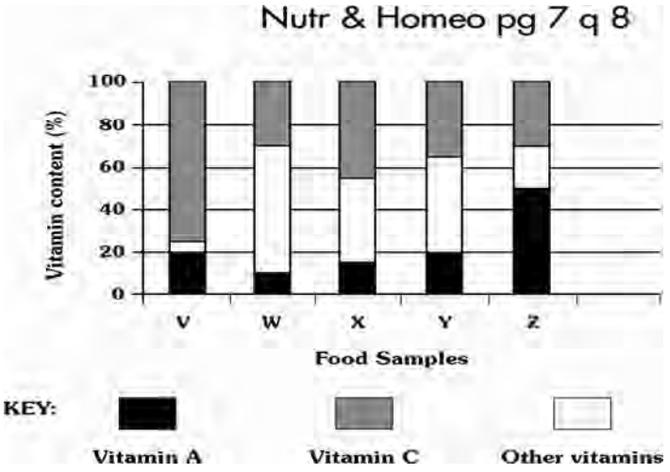
7.7 From the table, which food item would be best for each of the following?

7.8 Building up muscle

a. Supplying heat energy

b. Improving night vision **(3)**

8 Five samples of food were analysed to determine their vitamin A and C content. The results are recorded in the graph below.



8.1 Which food is most likely to be a carrot? Give a reason for your answer? **(2)**

8.2 Which food is least suitable to prevent night –blindness? **(2)**

8.3 If a person ate only food V for approximately six months, what is the most likely vitamins deficiency disease s/he will develop? **(1)**

8.4 State symptoms of the disease named in 8.3. **(2)**

8.5 What is the difference in composition between amounts of vitamins A and C in food X? (show all calculations). **(3)**

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9 A learner was given five powders A, B, C, D and E. Each powder was tested for the presence of the following:

glucose - using Benedicts test or Fehling's solutions
starch - using the iodine test
protein - using the Biuret test or Millon's reagent

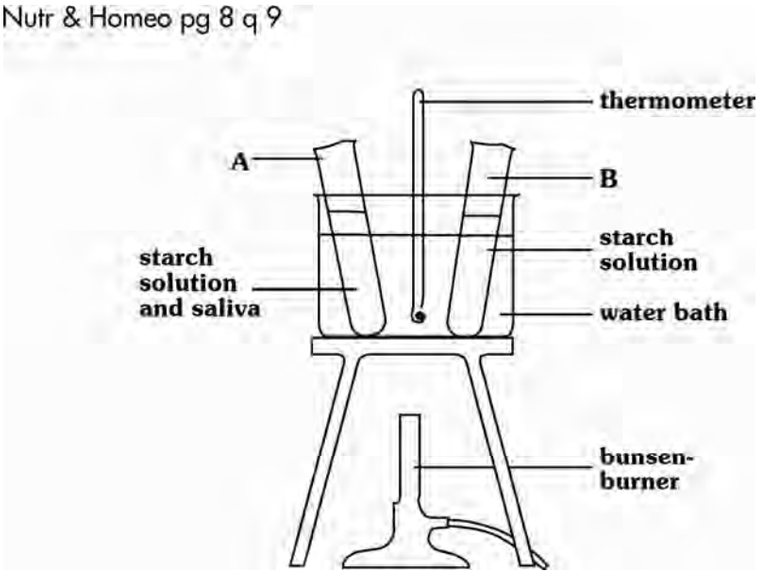
The table of results shows the final colour observed at the end of the tests.

	Powder A	Powder B	Powder C	Powder D	Powder E
Benedict's/ Fehling's test	Orange	Blue	Blue	Orange	Blue
Iodine test	Blue-black	Blue-black	Yellow/Brown	Blue-black	Yellow/Brown
Biuret/ Millon's test	Blue/White	Blue/White	Purple/Brick red	Purple/Brick red	Blue/White

9.1 Which powder contained ……
a. proteins only.
b. starch only.
c. starch and glucose only.
d. glucose, starch and protein.
e. no glucose protein or starch. **(5)**

9.2 The following apparatus was set up to demonstrate the action of saliva on starch.

Nutr & Homeo pg 8 q 9



a. Name the active substance in the solution in test tube **A** that breaks down starch. **(1)**
b. Does the substance mentioned in question a work in an alkaline, acidic or neutral medium? **(1)**

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c. Name the product present in the test tube A after the starch has been broken down. **(1)**
d. What is the process by which starch has been broken down in test tube A called? **(1)**
e. At what temperature should the water in the water bath be kept? Why? **(2)**
f. If the pH of the solution in Test tube A is 8 , how will it affect the results? **(2)**
g. How would a temperature of 100^{o}C affect the experiment? **(2)**
h. Why is the function of test tube B in this experiment? **(2)**
i. List two other properties of enzymes other than sensitivity to temperature and pH. **(2)**

10 Two individuals A and B suffer from two different condition as a result of malnutrition. Some symptoms are listed below.

Individual A	Individual B
1) Cracked and dry skin on the cheeks.	1) Overweight
2) Parts of the body exposed to the sun are dry, sore and dark	2) Increase in fatty tissue.
3) Person feels ill and has diarrhoea	3) Narrowing of the arteries.

10.1 With reference to individual A:
a. Name the disease the person has. **(1)**
b. Name the main food type his diet is made up of. **(1)**
c. Name the food types his diet lacks **(2)**

10.2 With reference to individual B:
a. What is the cause of the narrowing of the arteries? **(2)**
b. Would insulin production in the person be high or low? Give a reason for your answer. **(3)**
c. Name two diseases which would result from the condition in individual B **(2)**

11 List the functions of the liver. **(15)**

Answers: Nutrition and homeostasis

1 a. Digestion of food is necessary so that:-
- large insoluble molecules √ such as carbohydrates, lipids and proteins √
- can be broken down to smaller soluble √ molecules, such as glucose, fatty acids, glycerol and amino acids. √
- which are than absorbed via the villi to the blood system. √ **(5)**

b. The importance of nutrition.
Proteins – mainly used as building material √ (growth, repair, replacement and cell division) and to a small extend as a source of energy √. Excess amino acids are deaminated and converted into urea and glucose. √
Carbohydrates – main source of energy √ Excess glucose is stored as glycogen in the liver and muscle cells. √
Fats – also used as energy source √ and formation of cell membrane √. Excess fat is stored around the internal organs and under the skin as subcutaneous fat √and adipose tissue where it serves as reserve energy √ or insulatory √ and protective tissue. √
Trace elements, mineral salts and vitamins are needed for general heath and efficient metabolism. √
Water – is an important component of nutrition. √ **max (10)**

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2. 2.1 Mouth √ 2.6 Trypsin √
2.2 Maltose √ 2.7 Chymotrypsinogin. √
2.3 Alkaline √ 2.8 Small intestine/Jejenum and ileum √
2.4 Casenogen √ 2.9 Glucose and fructose √
2.5 Acidic √ 2.10 Alkaline√ **(10)**

3.1 a. 4 √ f. 8 √
b. 7 or 11 √ g. 4 √
c. 5 √ h. 2 √
d 6 √ i. 10 √
e. 4 √ j. 12 √ **(10)**

3,2 Peristalsis. √ **(1)**
Moves food along the digestive tract. √
Mixes food with enzymes in the stomach √
Mechanical breakdown of food. √ any **(2)**

3.3 Suitability of the small intestine for the absorption of nutrients.
a) The absorptive surface of the small intestine is increased by √
- The length of the intestine
- Folds of the lining
- Millions of villi , therefore rate of absorption is faster. √

b) the villus contains arterioles, venules and lacteals √ in which the nutrients can be absorbed and transported to the main blood system. √
c) The villus is lined by a thin surface area √ (single layer of columnar epithelium) allows for rate of absorption to increase √
d) The secretions of goblet cells of the columnar epithelium √ keeps the villus moist so that nutrients are absorbed in solution √
e) Villi are kept in motion by involuntary muscles and peristalsis ensure √ continuous contact of food molecules with the villi √ **(10)**

4.1.1 1. Simple columnar epithelium √
2. Arteriole √
3. Lacteal √ **(3)**

4.2 a. 2 √
b. 4 or 6 √
c. 5 √ **(3)**

4.3

Small intestine	Jejunum Ileum	Enterokinase √ Maltase √ Sucrase √ Lactase √ Lipase √ Peptidase √ Nucleotidase √	Crypts of Lieberkühn and glands of Brünner	Trypsinogen √ → Trypsin √ Maltose √ → Glucose √ Sucrose √ → Glucose + fructose √ Lactose √→ Glucose + galactose √ Fats √ → Fatty acid + glycerol √ Polypeptides √ → Amino acids √ Nucleotides √ → Phosphates Pentose sugars Nitrogenous bases √ **(21)**

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4.4 a) The villus is lined by a thin surface area ✓ (single layer of columnar epithelium) allows for rate of absorption to increase ✓
b) The secretions of goblet cells of the columnar epithelium keeps the villus moist ✓ so that nutrients are absorbed in solution ✓ **(4)**

4.5 Glucose absorbed in the arteriole is carried to the liver via the Hepatic portal system. ✓ Most of the glucose is used to provide energy for the functions of the body ✓. Excess glucose is converted to glycogen ✓ in the presence of insulin ✓. Glycogen is stored in the liver till it is needed. ✓ **(5)**

4.6 Absorption of fatty acids and glycerol:
- Insoluble fatty acids ✓ combine with bile salts ✓ to form a soluble complex. ✓
- fatty acids and bile salts complex are absorbed by the columnar epithelial cells lining the villi. ✓
- Glycerol ✓ enters the columnar cells by active absorbtion. ✓
- Inside the villus the fatty acids are freed from the bile salts ✓ and recombine with glycerol to form tiny fat globules. ✓
- Some fat globules are absorbed by the arterioles of the villi but most are absorbed by the lacteals. ✓
- All the lacteals unite to form lymph vessels which join the lymphatic vessel that enters the blood system at the base of the thoracic duct. ✓ **(10)**

5.1
1. Oesophagus ✓
2. Stomach ✓
3. Pylorus ✓
4. Pancreas ✓
5. Pancreatic duct ✓
6. Duodenum ✓
7. Bile duct ✓
8. Gall bladder ✓
9. Liver ✓ **(9)**

5.2 HCl ✓ – antiseptic ✓
Acid medium for action of gastric juices ✓
Sucrose → glucose + fructose ✓
Assists in curdling milk ✓ **(5)**

5.3 Bile ✓ – Emulsifies fats ✓
Many smaller fat particles increase the surface area for enzyme activity ✓
Provides alkaline medium ✓ for action of lipase ✓ **(5)**

5.4 Function of the liver concerning nutrition.
- Secretes bile ✓, which emulsifies fats ✓.
- Stores glucose ✓ in the form of glycogen ✓ conversion the control of insulin ✓.
- Changes excess amino acids ✓ into urea ✓ and glucose. ✓
- Changes glycerol into glucose ✓ when required by the body, conversion controlled by glucagon. ✓
- Converts excess glucose into fatty acids ✓, which combine with fatty acids to form fats. ✓
- Synthesizes vitamin A ✓ and stores vitamin D ✓and iron ✓. **(15)**

5.5 When the glucose level in the blood falls below a certain range, the glycogen ✓ stored in the liver is converted to glucose ✓ by the hormone glucagon ✓ produced by the alpha cells of the islets of Langerhans of the pancreas✓ **(4)**

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5.6

Small intestine	Duodenum √	Pancreas produces pancreatic juices √	Pancreatic amylase √ Proteases: Trypsin √ and chymotrypsin √ Trypsin Lipase √ Nucleases √	Starch √ → maltose √ Protein √ → polypeptides √ Chymotrypsinogen √ → chymotrypsin Fats √ → Fatty acid + glycerol √ Nucleic acids √ → nucleotides √

(16)

5.7 a. Patient X -- carbohydrates absorbed = 75 g √
Patient Y – carbohydrates absorbred = 80 g √
Difference = 5 g √ **(3)**

b. Patient Y 's √ part 7 was blocked a only 1g of fats were digested and absorbed.
Bile √ and bile salts √ did not pass into the duodenum. **(3)**

5.8 a. The cause of an ulcer may be due to the oversecretion of gastric juices due to too much nervous stimulation √ or bacterial infection. √ **(2)**

b. The gastric juices are secreted and function mainly in the stomach when food is present thus has a lesser chance in affecting the mucus lining. √ Gastric juices are not normally found in the duodenum √ so that when they do appear here they affect the lining of the duodenum. √ **(3)**

c. A thick layer of mucus protects the wall of the stomach and the first part of the duodenum. If by chance gastric juice does penetrate the mucus, pepsin starts to digest the stomach or the duodenal lining and than a ulcer results. √ **(1)**

6.1 Y - villus √
Z - lumen /gut cavity √ **(2)**

6.2 Peristalsis.
Moves food along the digestive tract. √
Mixes food with enzymes in the stomach √
Mechanical breakdown of food. √ any **(2)**

7.1 Soya beans √ and pumpkin √ (proteins and fats) **(2)**

7.2 Soya beans √ **(1)**

7.3 Importance of roughage in the diet.
Cellulose (from fruit skins, raw vegetables, bran etc) is the best form of roughage. √
Roughage is essential to provide bulk as a stimulus for peristalsis and defeacation. √
Prevents constipation, cancer of the colon and haemorriods. √ **(3)**

7.4 Soya beans (proteins) √ √ **(2)**

7.5 Bread (carbohydrate). √ √ **(2)**

7.6 Pumpkin √ √ **(2)**

7.7 a. Soya beans √
b. Bread √
c. Pumpkin (Carotene source) √ **(3)**

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8.1 Z ✓ - carrot is a great source of carotene which contains vitamin A. ✓ **(2)**

8.2 W ✓ has the least amount of vitamin A which is needed to prevent night blindness. ✓ **(2)**

8.3 Scurvy (very little vitamin C) ✓ **(1)**

8.4 Bleeding under the skin ✓
Low resistance to infectious diseases. ✓ **(2)**

8.5 Food X - Vitamin C = 40 % (2 + 20 + 18) ✓
Vitamin A = 18 % ✓

Difference = 22% ✓ **(3)**

9.1 a. C; ✓ b. B; ✓ c A; ✓ d. D; ✓ e. E. ✓ **(5)**

9.2
a. Amylase ✓ **(1)**
b. Alkaline. ✓ **(1)**
c. Maltose. ✓ **(1)**
d. Hydrolysis ✓ **(1)**
e. 37 ^{o} C ✓ body temperature. ✓ **(2)**
f. pH 8 indicates a alkaline medium ✓ so the enzyme will continue to function. ✓ **(2)**
g. very high temperatures denature the enzyme, as enzymes are proteins. ✓ The experiment will not show any results. ✓ **(2)**
h. Serves as a control. ✓ ✓ **(2)**
i. Enzymes are substrate specific. ✓
Only a small amount of enzyme is required to bring about a reaction ✓ **(2)**

10.1
a. Pellagra. ✓ **(1)**
b. Carbohydrates. ✓ **(1)**
c. Lack of protective foods (proteins) ✓ which contain vitamin niacin or nicotinic acid. ✓ **(2)**

10.2
a Deposition of fat. ✓✓ **(2)**
b. High ✓– insulin would attempt to convert the excess fat✓ to glycogen for storage in the liver ✓ **(3)**
c. Hypertension ✓ ; stroke ✓ **(2)**

.

11 Function concerned with nutrition:
1) Secrets bile ✓
2) Stores glucose ✓
3) Changes amino acids into urea and glucose ✓
4) Changes excess glycerol into glucose ✓
5) Converts excess carbohydrates into fatty acids which combine with glycerol to form fats ✓
6) Synthesizes vitamin A and stores vitamin D and iron. ✓

Functions concerned with blood:
7) Blood is temporarily stored in the liver. ✓
8) During embryonic development blood is formed in the liver. ✓
9) Manufactures plasma proteins- albumin, fibrinogen as well as heparin. ✓

Functions concerned with poisons:
10) Destroys certain poisons taken in with food or formed during decomposition of food remains. ✓ **(10)**

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PLANT PHYSIOLOGY

Review

1. Importance of water.
   - Water constitutes 95% of the total mass of the cell.
   - Protoplasm will become inactive or die if the cell looses water below certain water content.
   - Plant cell walls are filled with water.
   - Water acts as: a solvent, so that chemical reactions can occur in solution.
     as a transport medium, in the xylem and phloem, for dissolved substances
     a source of hydrogen atoms for the reduction of CO_2 in Photosynthesis.
   - Water maintains the turgor pressure of the cells and therefore the whole plant.

2. **Diffusion** is the movement of molecules (liquid or gas) from a region of higher (greater) concentration to a region of lower (lesser) concentration of those particles until a dynamic equilibrium is attained throughout a given space.

3. **Osmosis** is the movement of water from a region of high concentration (molecules of water is more = a dilute solution = solute less) to a region of low concentration (molecules of water less = concentrated solution = solute more) through a differentially (selectively) permeable membrane.

4. **Brownian movement** is the continuous random movement of particles in a liquid or gas.

5. The **osmotic potential** of a solution is defined as the solutions ability to absorb water if it were separated from another solution by a differentially permeable membrane. The cell membrane is a differentially permeable membrane. The greater the concentration of solutes within the cell cytoplasm, the lower the osmotic potential of the cell (water will not leave the cell). The lesser the concentration of the solutes within the cytoplasm, the higher the osmotic potential of the cell (water will leave the cell). Pure water has the highest osmotic potential.

6. The water molecules on either side of a differentially permeable membrane have kinetic energy and move around freely. The total amount of free energy possessed by the water in a system indicates in which direction the water molecules should move. In an osmotic system the free energy of water in the solution is known as **water potential.** The water potential of a solution therefore indicates the solutions ability to cause water to move through a differentially permeable membrane.Pure water will therefore have the highest water potential. The greater the concentration of solutes within the cell (compared to the environment), the lower the water potential of the cell (Water will not leave the cell to the environment)

7. **Turgor pressure** is the pressure inside the cell exerted on the cell wall. When a plant cell absorbs water the vacuole and protoplasm becomes larger. The cell wall has a certain amount of elasticity that is limited. This limitation causes tension on the cell wall which is measured as turgor pressure.(the cell is turgid).

8. The turgor pressure from inside the cell is resisted by counter pressure from the cell wall called **wall pressure.** When wall pressure is equal to turgor pressure osmotic uptake of water stops.

9. **Endosmosis** is the diffusion of water molecules into a cell due to the cell being in a **hypotonic** environment.

10. If a plant cell is immersed in a **hypertonic** solution **exosmosis** will take place. The cytoplasm of the cell will loose water and shrink and **plasmolysis** will occur.

11. Root hair are adapted to absorb water : Cell wall – permeable to water
    Cell membrane, tonoplact – differentially permeable
    Cytoplasm, vacuole sap. – has osmotic potential
    Water passes through the cortex by osmosis due to water potential gradients.

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12. Xylem vessels and tracheids within the roots, stem and leaves is responsible for transport of water from roots to leaves.
13. The three main forces responsible for the translocation of water from the roots, through the stem to the leaves are:
    - Transpiration pull
    - Capillarity
    - Root pressure

14. Water movement within a plant is maintained by
    - Cohesion and adhesion force
    - Transport of water inside the cells occurs by cyclosis.
    - Transpiration initiates transpiration pull

15 The loss of water vapour from the aerial parts of the plant (through stomata) is called transpiration.

16. The opening and closing of the stomata are turgor movements:
    - When the guard cells increase in turgor their thick inner walls are pulled away from each other and the pore (stoma) between them enlarges
    - When the guard cells lose turgidity their inner walls come closer together and the stoma comes closer together (close).
    - A porometer is used to measure the degree of openness or closure of the stomata.

17. Stomata open during the day and close during the night because:
    - During the day, in the presence of light, photosynthesis occurs in the guard cells.
    - CO_2 is used up during this process and therefore less carbonic acid is formed, which reduces the acidity of the guard cells. This allows conversion of insoluble starch to soluble sugar.
    - Water potential of the guard cells is decreased
    - Water from adjacent epidermal cells diffuse into the guard cells increasing their turgidity.
    - Thus the stomata open.
    - At night the reverse series of events occur which causes the stomata to close.

18. Factors influencing rate of transpiration:
    External factors:
    - High temperature, low humidity, strong winds and light intensity increases the rate of transpiration.
    - Low temperature, high humidity and no wind decrease the rate of transpiration.
    - Soil conditions. (availability of soil conditions)

    Internal factors:
    - Sunken stomata
    - Thickened cuticles
    - Hair on leaves
    - Shape, size and arrangement of leaves

19. Advantages and disadvantages of transpiration:-
    - Advantages:
      Cools the plant by means of evaporation
      Transpiration pull allows water to rise in the plant
    - Disadvantages:
      If there is insufficient water in the soil the plant may wilt and die.

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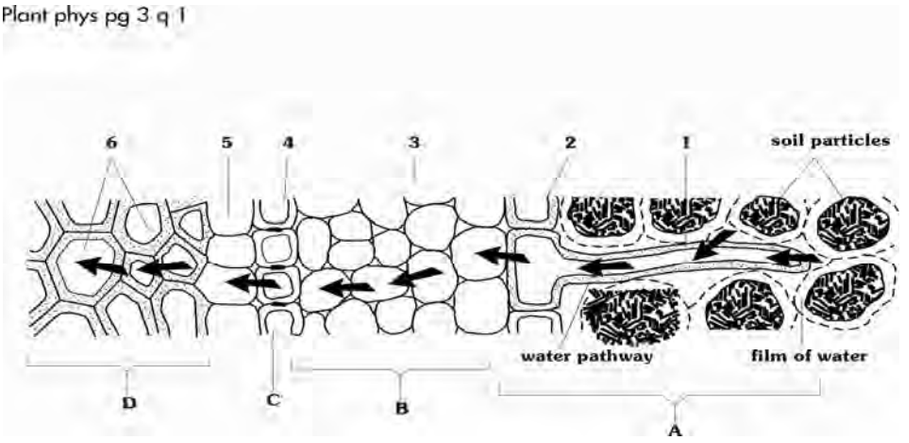
Questions

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

Plant phys pg 3 q 1



1.1 Label parts i to iv and explain the role they would play in the absorption of water by the root hair. **(8)**

1.2 Name the tissues labeled 3,4,5,and 6. **(4)**

1.3 Explain the function of the tissue labeled 4. **(4)**

1.4 How is tissue labeled 6 adapted for its function? **(8)**

1.5 Describe the absorption of water by the root hair and its transport to the tissue labeled 6. **(15)**

1.6 Explain the function of the forces responsible for the transport of water from roots to Stem and leaves. **(6)**

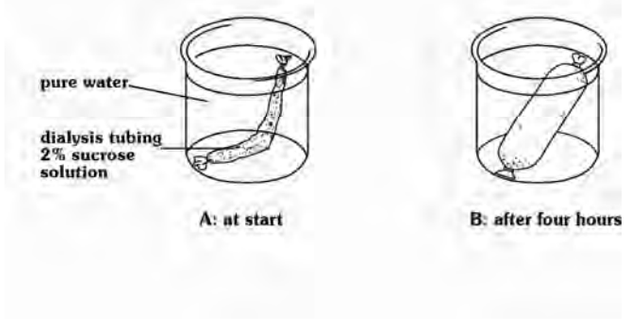
1.7 Explain the effect each of the following would have on movement of water in structure 1:

1.7.1 increasing the concentration of the film of water above that of the cytoplasm of the root hair **(5)**

1.7.2. an increase in the turgor pressure in tissue 3 **(3)**

2 An investigation was carried out as illustrated below. A length of dialysis (differentially permeable) tubing containing 5% sucrose solution was knotted at each end to represent a cell. This cell was than placed into a beaker of pure water as in A. The result is indicated in B.

Plant phys pg 3 q 2



2.1 State the aim of this investigation. **(2)**

2.2 In apparatus A, where is there

a. A higher concentration of water? **(1)**

b. A lower water potential? **(1)**

c. A higher osmotic potential? **(1)**

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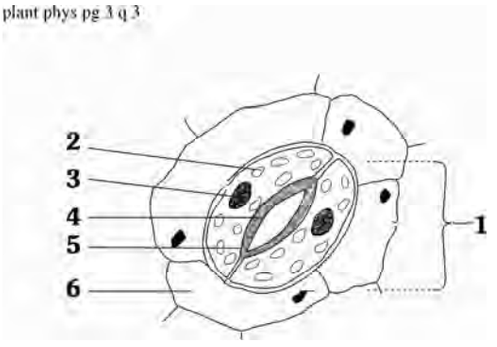
2.3 Explain the result of this investigation. **(5)**
2.4 How will the result be affected if……..
a. the temperature of pure water is increased? **(3)**
b. a 15% sucrose solution is used instead of pure water in the beaker? **(3)**
2.5 Explain what the result at B would have been if 5% starch had been used instead of Sucrose. **(4)**
2.6. Discuss the changes that occur within a plant cell when it is placed in a hypertonic solution. **(8)**

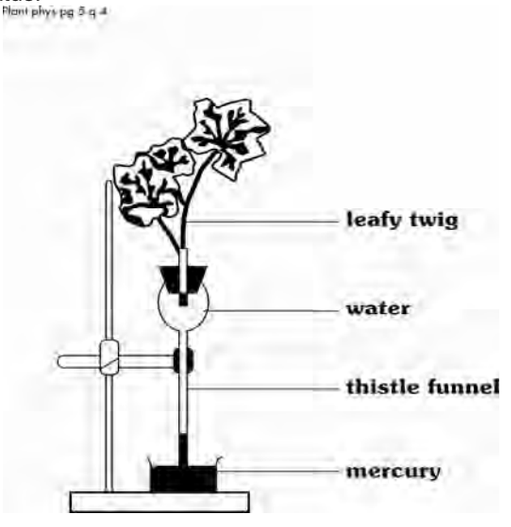
3. The following diagram represents part of the epidermis of a leaf.

plant phys pg 3 q 3



3.1 Label structures 1 to 6. **(6)**
3.2 Is this a side or surface view of the stoma? **(1)**
3.3 What instrument is used to measure the size of the opening between the cells of **1**? **(1)**
3.4 State two differences (other than shape and size) between structures **1** and **6**. **(2)**
3.5 Which of the two cells 1 or 6, has
a) A higher turgor pressure?
b) A lower water potential? **(2)**
3.6 The diagram above illustrates the stoma during mid-day. Ilustrate what changes will have occurred in the stoma at 10.00p.m. **(2)**
3.7. Explain the mechanism that caused the changes that occurred in 3.4 **(10)**
3.8 State ways in which leaves may be structurally adapted to reduce rate of transpiration. **(5)**
4. The apparatus below are set up to carry out an investigation. Answer the questions set on the apparatus.

Plant phys pg 5 q 4



4.1. Suggest a hypothesis for this experiment. **(2)**
4.2 Give a reason for each of the following precautions to be taken when setting up this experiment.

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a) The stem being cut under water. **(2)**
b) The stem being cut at an angle **(2)**
c) A leafy twig must be used. **(2)**

4.3 State two other precautions, which must be taken into consideration when setting up this experiment **(2)**

4.4 Give the results of this experiment **(2)**

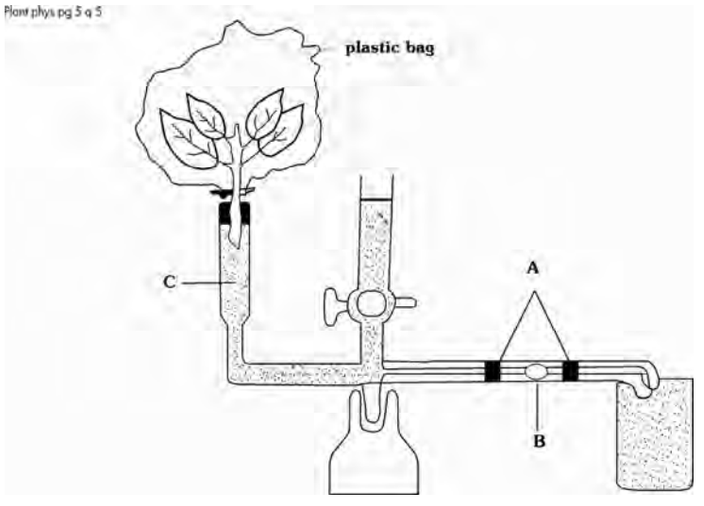
4.5 How will the results be affected if:
a) All the leaves were removed. Give reasons for your answer. **(3)**
b) Stem with leaves was exposed to strong wind by using a fan. **(3)**

4.6 Why is mercury used in this experiment? **(3)**

4.7 Why is there a need for a control experiment to be set up? **(2)**

5

6 Study the diagram below and answer the questions that follow



5.1 Identify the apparatus. **(1)**

5.2 Identify the parts labeled **A** and **B.** **(2)**

5.3 What biological process is being investigated by this apparatus? **(2)**

5.4. How would you get part **B** inside the apparatus? **(2)**

5.5. What is the significance of the tap indicated by D? **(2)**

5.6 State ways in which one would ensure that the results are reliable. **(3)**

6 The following table gives the results of experiments, carried out in the laboratory, investigating the various factors affecting the rate of transpiration. Study the table and answer the questions based on it.

Movement of air bubble in mm/minute.

Group	Humid conditions	Room temperature	Light intensity	Wind
A	10	12	15	20
B	0	0	0	0
C	40	20	9	12

6.1 Consider the result of group **A**
a) Under what conditions do plants transpire most? **(1)**
b) Can you suggest how humid conditions could be created in the laboratory to carry out such an experiment. **(4)**
c) What can you deduce about the results obtained by group A? **(4)**

6.2 Consider the result of group **B.**
a) Comment on the results of the experiment. **(1)**
b) Suggest a reason for your answer in 6.2 a). **(2)**
c) Suggest two ways to make the experiment a success. **(5)**

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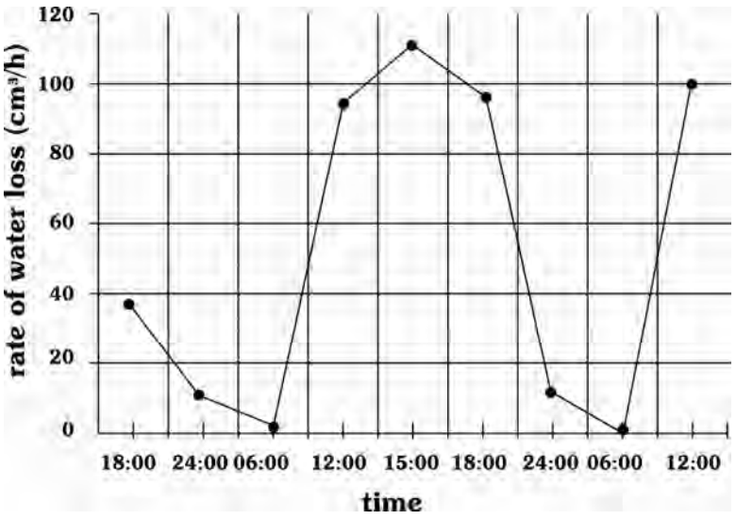
6.3.1 Consider the results of group **C**.

a) Did the experiment work? **(1)**

b) Are the results what you expected them to be? **(1)**

c) Under which conditions was transpiration the greatest in this experiment? **(1)**

7. The graph below shows the variation in the rate of water loss in the plant at different times of the day.



7.1 At what time is the rate of water loss …….

a) The greatest? **(1)**

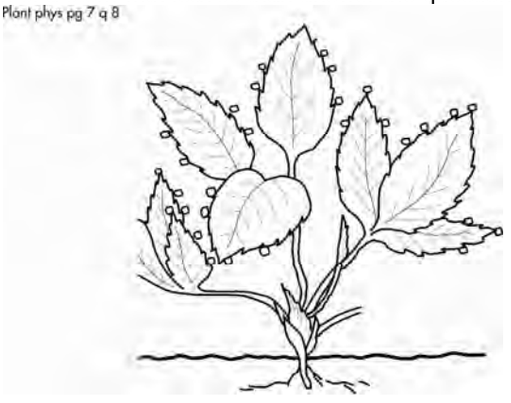
b) The lowest? **(1)**

7.2 Describe and explain the variation in the rate of water loss over the 24 period from 06:00 to 06:00. **(10)**

7.3 List other factors which would have influenced the rate of water loss **(2)**

8 Study the diagram of a stem with leaves than answer the questions that relate to it.

Plant phys pg 7 q 8



8.1 What process is illustrated in the diagram? **(1)**

8.2 Under what conditions would you expect such a process to take place? **(3)**

8.3 Explain why this process will take place during the conditions stated in 8.2. **(5)**

8.4 Tabulate the differences between the process illustrated and the process of transpiration. **(4)**

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Answers: Plant Physiology

1.1 i - Cell wall √, permeable. √
ii - Cytoplasm √, osmotically active √
iii - Vacuole sap √, osmotically active √
iv - Tonoplast √, differentially permeable √ **(8)**

1.2 3 – Cortex (parenchyma tissue). √
4 – Endodermis (with Casparian strip) √
5 – Pericycle. √
6 – Xylem. √ **(4)**

1.3 4 – has Casparian strips in most cells. √ These prevent water passing through the endodermis cells√The endodermis also has thin walled cells without Casparian strips√ which allow water to pass through water into the xylem cells next to them. √ **(4)**

1.4 6 – Xylem cells are cylindrical in shape. √
As there are perforated cross walls or no cross walls √ the cells form continuous tubes from roots, stems and leaves. √
Cell cytoplasm is non-living. √
The vessels and tracheids are lignified √-this provides support and strength √so that the strong cohesive and adhesive forces do not change the shape of the cells. √
The thickening of the cells is not complete (pitted,spiral or annular). √ The unthickened area allow lateral transport of water √. **(9)**

1.5
- the cytoplasm and vacuole sap of the root hair has a high concentration of dissolved substances. √ Therefore it has a low water potential. √
- the water in the soil has less concentration of substances √. Therefore it has a high water potential. √
- water enters the cytoplasm and vacuole sap √ through osmosis (endosmosis). √
- the epidermal cells now have a higher water potential √ than the next layer of cortical cells. √
- because of the water potential gradient being set up in this manner (epidermis down to cortical layers) √ water moves by osmosis through epidermal √ cells till the endodermal cells. √
- also water passes internally along the cell walls by diffusion√ till the endodermis. (Cell walls are permeable to water). √
- the thin walled cells of the endodermis √ allows the water to enter the xylem tissue. √
- due to transpiration√ and adhesive and cohesive forces in the xylem√ there is a continued upward movement of water from root to leaves. This allows water to continually move from endodermis to the xylem. √ **(15)**

1.6 There are strong cohesive forces √ between water molecules (forces between like molecules). √
Between the walls of the xylem cells √ and the water molecules there are strong adhesive forces(force between unlike molecules). √
These two forces together prevent the breaking of the column of water in the xylem cells from roots, stem to leaves. √ **(5)**

1.7.1 Cell sap has a low concentration √ of salts compared to that of the film of water in the soil. √
Thus the cytoplasm has a higher water potential √ than the film of water in the soil. √
Water will move from the cytoplasm to soil by osmosis (exosmosis). √ **(5)**

1.7.2 Increased turgor pressure (on the wall) results in increased wall pressure √ (inwards in the cell) This opposes the intake of water from root hair. √
Less water or no water moves into 3 √ **(3)**

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2.1 Aim: To demonstrate the process of osmosis./Diffusion of water through differentially permeable membrane √√. **(2)**

2.2 a. In the beaker √ **(1)**
b. Within the dialysis tubing. √ **(1)**
c. In the beaker. √ **(1)**

2.3 Distilled water (pure) has a high water potential. √
Sucrose solution inside the dialysis tubing has a lower water potential. √
Water diffuses into √ the dialysis tubing from the beaker till a maximum turgor pressure is reached in the tubing. √ At this point water will stop entering the tubing. √ **(5)**

2.4 a Increase in temperature will increase the kinetic energy √ of water molecules. Rate of diffusion will increase. √ **(2)**

b Beaker has a higher concentration of solutes √ therefore has a lower water potential. √ Sucrose solution in the dialysis tubing has a lower concentration of solutes √ than in the beaker thus has a higher water potential √. Water molecules will diffuse out of the dialysis tubing into the beaker √. **(5)**

2.5 Starch does not dissolve in water and settles out in the solution √. It is osmotically inactive √ and does not contribute to the water potential in any way √. No movement of water molecules is observed √ **(4)**

2.6 The solution outside has more concentration of solutes √ than the cell sap therefore it has a lower water potential than the cell sap. √
Water moves from the cell vacuole and cytoplasm to the beaker √, exosmosis occurs √.
Vacuole and cytoplasm shrinks √.
Cell membrane is pulled away from the cell wall. Cell wall remains intact √.
This contracting of the cell membrane away from the cell wall is called plasmolysis.
The space between the cell membrane and the cell wall is filled with plasmolysing solution (made up of water and sugar). √ **(8)**

3.1 1. stoma/guard cell √
2. chloroplast √
3. nucleus √
4. pore √
5. inner thickened surface of the guard cell √
6. epidermal cell √. **(1)**

3.2 surface view √ **(1)**

3.3 porometer √ **(1)**

3.4

Guard cell	Epidermal cell
Chloroplasts present	No chloroplasts √
Inner surface thickened	Cells uniformally thick √

(2)

3.5. 6 has higher turgor pressure √ **(1)**
1 has lower water potential √ **(1)**

3.6 Stomata are closed during the night because:
- During the night photosynthesis decreases in the guard cells √.
- greater amount of CO_2 √ is available therefore carbonic acid is produced in the guard cells. √
- increased acidity allows the conversion of glucose to starch √
- starch is osmotically inactive as it settles out of the solution √
- results in the increase of water potential in the guard cells √
- more water diffuses to the adjacent epidermal cells √

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- turgor pressure on the thin surface of the guard cells decreases ✓.
- the thicker surfaces of the cells are pulled together ✓
- pore closes ✓. **(10)**

3.7 - hair (trichomes) ✓
- thickened cuticle ✓
- sunken stomata ✓
- reduced surface area ✓
- arrangement of leaves on the stem in such a way that shade is provided. ✓ **(5)**

4.1 To prove that transpiration from the leaves causes a suction force that allows water to be pulled up from roots to leaves.(called transpiration pull) ✓✓. **(2)**

4.2 a Prevent air bubbles entering the xylem tissue ✓. Entry of the air bubbles would interfere with absorption of water ✓. **(2)**

b. Greater surface area of the xylem is exposed ✓ so that more water will be absorbed ✓. **(2)**

c. Transpiration occurs through the stomata of leaves. ✓✓ **(2)**

4.3 All surface areas exposed to the environment should be sealed with vaseline. ✓
Water should cover the stopper in which the leafy twig is placed. ✓ **(2)**

4.4 As water is lost at the leaves due to transpiration a suction force ✓ is created which is observed by mercury being drawn up in the tubing. (mercury level rises) ✓ **(2)**

4.5. a. mercury level does not rise. ✓ Transpiration does not occur. ✓ **(2)**

b. Wind increases transpiration rate ✓, which is demonstrated by the mercury level rising as well as at a faster rate ✓ **(2)**

4.6 Mercury is heavier than water. ✓ Demonstrate the strength of transpiration pull. ✓
It is opaque and thus easily observable. ✓ **(3)**

4.7.1 In the control experiment a leafless twig is used. ✓ **(1)**

4.7.2 To validate that transpiration takes place through the leaves. ✓ **(1)**

5.1 Potometer. ✓ **(1)**

5.2 A. Markers. ✓

B. Air bubble. ✓ **(2)**

5.3 To demonstrate how certain environmental factors (wind, humidity, temperature) ✓ affect Transpiration rate. ✓ **(2)**

5.4 Lower the beaker so that the open end of the graduated tubing is exposed to the air. ✓ As soon as the bubble enters the tubing place the end back into the beaker. ✓ **(2)**

5.5 Refills tubing, shifts the bubble to its original position. ✓ **(2)**

5.6 Water in C must be filled to the edge of the stopper. . ✓ Cover the stopper with vaseline. . ✓
Ensure that the capillary tubing is always in the beaker. . ✓ **(3)**

6.1 a. Wind ✓ **(1)**

b. - Wet leaves ✓
- Place a moist plastic bag over the plant ✓ **(2)**

c. Results are accurate. ✓ The rate of transpiration is least under humid conditions ✓ and increases from room temperature to sunlight ✓ and is highest in windy conditions ✓ **(4)**

6.2 a. Results incorrect ✓, air bubbles did not move at all under any condition. ✓ **(2)**

b. Plant could have been air locked. ✓ **(1)**

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c. Remove the plant - wipe the leave dry √- cut of the stem about 3cm under water √ at an angle √- leave it in water for at least 24 hours √.
Reset the potometer taking all precautions into account i.e:
Water to the level of the stopper √
Vaseline to seal all spaces. √
Air bubble in place. √ **(7)**

6.3 a. Yes. √ **(1)**
b. No. √ **(1)**
c Movement of Under humid conditions, which is incorrect √ **(1)**

7.1 a. 15:00 √ **(1)**
b. 06:00pm √ and 06: 00am √ **(2)**

7.2 Opening of the stomata
- During the day, in the presence of light √, photosynthesis occur in the guard cells. √
- CO_2 √ is used up during this process and therefore less carbonic acid √ is formed, which reduces the acidity √ of the guard cells. This allows conversion of insoluble starch to soluble sugar. √
- Water potential of the guard cells is decreased √
- Water from adjacent epidermal cells diffuse into the guard cells increasing their turgidity √.
- Thus the stomata open. √
- At night the reverse series of events occur which causes the stomata to close. √ **(10)**

7.3 Wind, √ humidity √ **(2)**
8.1 Guttation. √ **(1)**

8.2 Humid, √ low temperature √ plant watered well (soil has enough water) √ **(3)**

8.3 On a humid and cool day there is high concentration of water vapour around the leaves √, than within the leaf intercellular spaces. √ Transpiration does not occur or is minimal. √ Water droplets accumulate around the edges and surface of the leaves. √ **(4)**

8.4

Guttation	Transpiration
Water droplets √	Water vapour √
Occurs through hydathodes √	Occurs through stomata √

(4)

POPULATION DYNAMICS

Review

1. The study of the factors that cause change in a population is called **Population Dynamics**. **Population** Is the term used to describe the number of organisms of the <u>same specie</u>
In a particular defined environment (ecosystem) that are able to randomly breed with each other (share gene pool).

Changes in the size of a closed population (in most natural environment the population is open) are caused by factors called dynamic parameters (population determines). These are:

Growth
Natality - birth rate
Mortality – death rate
Immigration – individuals entering the population
Emigration – individuals leaving the population

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2. Under favorable (optimal) conditions the survival rate of any population is high and the specie realizes its full reproduction potential. Thus the rate of change of population size increases as population increases. This type of growth is graphically represented by a 'J curve"(graphing population size against time) and is called **Geometric growth curve**

3. **Logistic growth curve**. Usually the geometric growth (exponential growth) of a population is limited by environmental factors, example intra or inter specific competition (for food, shelter or mate). These environmental factors are referred to as environmental resistance. A typical growth curve in nature will take an 'S' form(Sigmoid) This growth pattern is called Logistic growth.

   Four distinct phases can be identified in this curve;
   a. Lag phase – At first the growth curve rises slowly because there are few individuals in the population, or, few reproducing individuals.
   b. Geometric phase – There are no limits to growth therefore there is a sudden exponential Increase in numbers. (birth rate is higher than death rate).
   c. Decelerating phase – Due to limiting factors (environmental resistance) the numbers begin to increase more slowly and eventually the population density levels out at a maximum value, called the carrying capacity of the habitat for that specie.
   d. Stationary phase – The population stabilizes at an equilibrium level. At this stage natality and mortality balance each other.

4. Natality is the inherent ability of a population to increase and is expressed as percentage increase of population per unit time.
   Mortality refers to the loss of life on a large scale over a period of time and is expressed as a proportion of the population that dies per unit time.

5. **r- strategy** organisms have a high natality, but also have a high early mortality due to lack of parental care e.g. frogs
   k- strategy organisms have low natality, but also a low mortality when young due to high level of parental care e.g. Birds

6. Estimation of population size:
   Direct technique – All individuals are counted (conducting population census), aerial photographs.
   Indirect technique – mark recapture, by repeated sweeping or by samples ((quadrant method)

7. Population growth regulation occurs by:
   a. Carrying capacity of the environment -. Carrying capacity of any habitat is the maximum number of individuals of the specie, which can be supported by that habitat at a particular time.
   b. Density dependent factors -. With increasing size of the population there is increasing competition for food, living space, shelter, disease, predation, parasitism and mate, which increases environmental resistance.
   c. Density independent factors – these are weather, temperature of the habitat, drought, floods etc.
   d. Competition.
   e. Territoriality.
   f. Predation
   g. Human population are also controlled by war, famines and floods

8. Survival strategies
   Each organism has specific survival strategies. These may be territoriality, camouflage, different type of behavioral patterns or rituals, natality patterns, competition, changes in sex ratio and altruism.

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9. Energy flow refers to the flow of energy through an ecosystem. The sun is the primary source of energy for all populations. The energy that is stored in green plants during photosynthesis is called the **gross primary production.** (GPP). Plants make use of this energy for their own metabolism and growth and the rest is stored and is called **net primary production** (NPP). Of this energy available to animals only a small % is available to produce new tissues in the animals. This stored energy is called **secondary production**. (P)

10. Energy loss in the ecosystem is due to:
    - Waste (parts of the plants not used by consumers).
    - Egestion (faeces F) and excretion (Urine U)
    - Respiration R
    - Locomotion
    - Other metabolic processes

11. The energy budget of a consumer is thus
    C (energy contained in food eaten) = P + R + U + F

12. Human population follows the same developing patterns, as do other living organisms.

13. As a result of man's influence (medical advancement, increase in agricultural output. etc.) on the natality and mortality rate, there is at present a population explosion. This causes other problems such as:
    - Feeding the worlds expanding population. (Transport, storage, finances to purchase food)
    - Loss of food due to pests and insecticide. Monoculture.

14. Solutions to the problem of rapid increase in human population numbers.
    - Educational programmes.
    - Family planning programmes.
    - Changing cultural habits e.g. food preferences, family size etc.

Questions on Population Dynamics

1 Define each of the following terms.

1.1 Population **(2)**

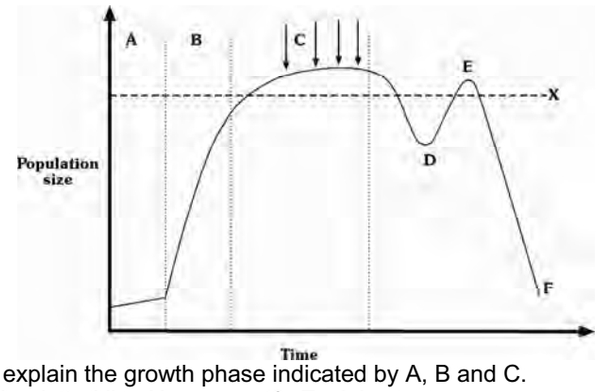
1.2 Emigration **(2)**

1.3 Intraspecific competition. **(2)**

1.4 Net primary production (NPP) **(2)**

1.5 Natality **(2)**

2. The graph below represents a population of springbucks in a grassland habitat. Answer the questions based on it.



2.1 Identify and explain the growth phase indicated by A, B and C. **(10)**

2.2 What does the dotted line X represent? Explain your answer. **(3)**

2.3 What would the arrows affecting phase C represent? Explain your answer. **(3)**

2.4 Explain what may happen to the population if the population continued to grow instead of flattening as represented by C **(5)**

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2.5 List environmental factors which may cause the growth of the population to be represented by curve EF. **(3)**

2.6. Name one direct method and one indirect method, which could be used to estimate the number of springbucks in this region. **(2)**

2.7 List three density-dependent factors that could have resulted in the decrease from C to D. **(3)**

3 The table below shows the population of field mice in a 100 hectare maize field over a 10-year period.

Year	Population of field mice
1981	12
1982	38
1983	76
1984	119
1985	129
1986	115
1987	112
1988	86
1989	110
1990	110
During 1987 two pairs of owls were sighted in the area.	

From the data given name:

3.1.1 A prey **(1)**

3.1.2 A predator **(1)**

3.1.3 Give reasons for your choices in 3.1.1. and 3.1.2. **(2)**

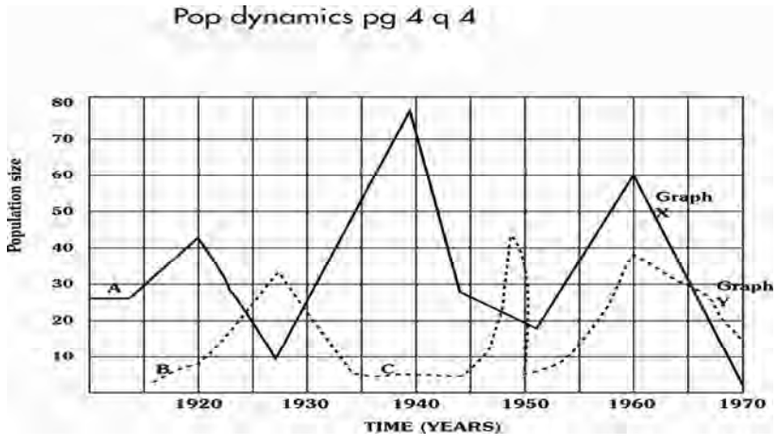
3.2. What does the term predation mean? **(2)**

3.3 Name two population parameters, which influenced the mice population up to 1985. **(2)**

3.4 If the predators are too efficient, what will happen to both the predator and prey population. **(4)**

3.5 Draw a graph to illustrate the growth curve of the mice population **(10)**

4 The accompanying graph illustrates the changes in the numbers of wild dog and rabbit population in a certain area over a period of several years. Study the graphs carefully and answer the questions that follow. (Graph X represent the rabbit population and graph Y Represent the wild dog population),



4.1 Name the relationship that exists between rabbits and wild dogs. **(1)**

4.2 In which year did the prey population reach its optimum number? **(1)**

4.3 What is the carrying capacity of the rabbit population in this area? **(1)**

4.4 What phenomena other than emigration occurred between points C and D? **(4)**

4.5 State reasons why all the energy from the rabbits in not transferred to the wild dogs **(4)**

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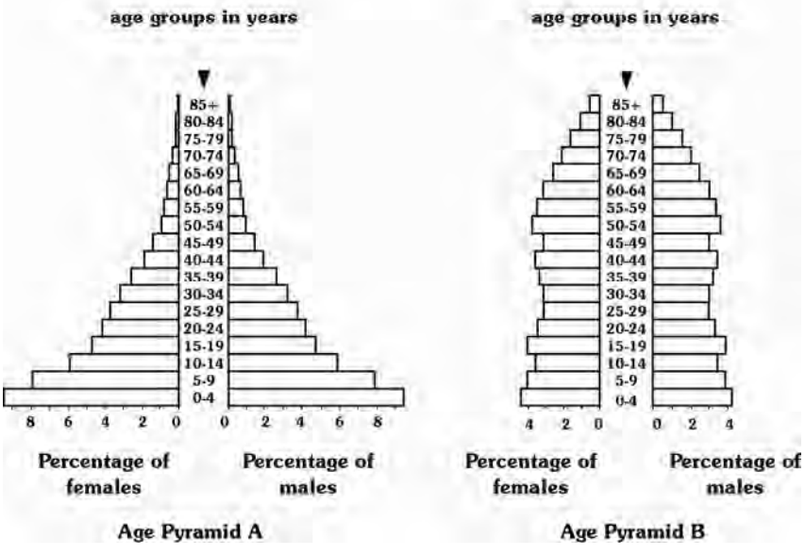
5. The diagrams below represent age distribution for the human of a developed country and a developing country in one year at a certain time. Answer the questions set on the pyramids.

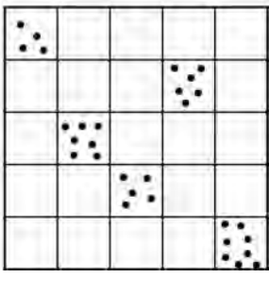
Pop dynamics pg 5 q 5



5.1 How is the number of people living in a country determined? **(1)**
5.2 What percentage of the female population is aged between 25 – 29 years in pyramid A? **(1)**
5.3 Which age groups make up exactly 3% of the male population in pyramid B? **(3)**
5.4 Which pyramid represents the population distribution of Republic of South Africa? **(1)**
5.5 Give reasons for the answer in 5.4
5.6 Explain why humans would be regarded as k – strategy specie. **(4)**
5.7 Draw a graph to illustrate the growth curve of an r-strategy specie. **(5)**

6 The following diagram represents a plot which measures 5 metres in length and 5metres in width The dots represent dandelion growing on the plot. In order to estimate the number of dandelion on the plot five quadrats, each one metre square, were selected at random as shown in the diagram.

Pop dynamics pg 5 q 6



6.6 Calculate the estimated number of dandelion on the plot. **(6)**
6.7 State ways in which you would ensure that the results would be accurate. **(2)**

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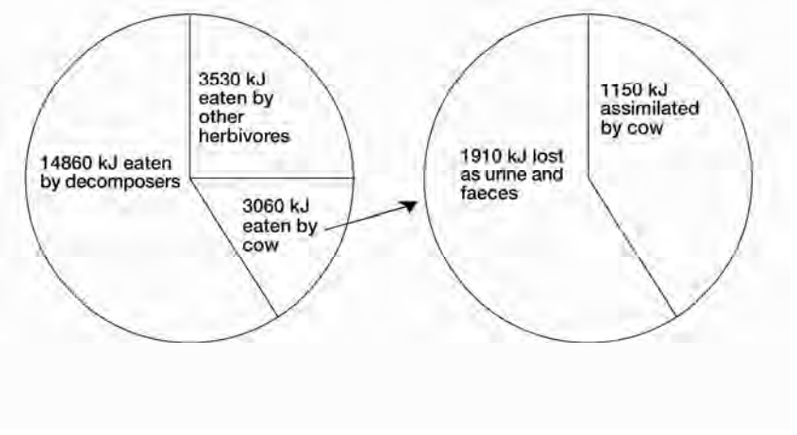
7 The following results were obtained to determine the zebra population in the Kruger National Park

Zebras caught and marked during first catch	25
Zebras caught during the second catch	50
Number of zebras marked in second catches	5

7.1 Calculate the number of zebras in the Kruger National Park. **(5)**
7.2 What is this technique called? **(1)**
7.3 List the precautions you have to consider when applying this technique. **(6)**

8. Study the pie charts below and answer the questions that follow



8.1 Define the concept energy flow. **(2)**
8.2. Distinguish between Gross Primary Production (GPP) and Net Primary Production (NPP) **(2)**
8.3 Use the information on the diagram to calculate:
a. The total Net Primary Production of one square metre of pasture in one year. **(3)**

b. The energy eliminated by the cow as urine and faeces, as a percentage of Of the total taken in by the cow (show all working) **(3)**

Answers.

1.1 A population is a group of organisms of the same species ✔ occupying and living in a a certain defined area . ✔ **(2)**

1.2 Emigration is the outward movement ✔ of individuals from a stable population ✔ **(2)**

1.3 Two or more individuals of the same specie ✔ strive to obtain the same resources (food shelter, nesting site, mate, water etc). ✔ **(2)**

1.4 The energy which is stored in the plant ✔ and is available to the next level of consumers ✔ is called the net primary production. **(2)**

1.5 Natality is the inherent ability ✔ of a population to increase ✔ **(2)**

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2.1 The lag phase (establishment) phase. ✔
At first the growth curve rises slowly because there are few reproducing individuals in the population ✔ or individuals do not find a mate because population density is low. ✔ **(3)**
Geometric (accelerating growth) phase. ✔
Due to lack of limiting factors ✔ there is geometric (sudden exponential) increase in numbers.
During this phase the birth rate is higher than the death rate. ✔ **(3)**
Decelerating growth phase. ✔
Due to limiting factors (environmental resistance) ✔ the numbers begin to increase more slowly ✔ and eventually the population density levels out at a maximum value. ✔ **(4)**

2.2 Carrying capacity of the habitat ✔ : maximum number of individuals ✔ that the environment is able to support. **(3)**

2.3 Environmental resistance ✔ – limiting factors in the environment that will prevent increase ✔
in the size of the population ✔ e.g. food, water, shelter or mate. **(3)**

2.4 Population size will increase beyond the carrying capacity ✔
This will cause deterioration of the environment. ✔
Result in decreasing the carrying capacity of the environment. ✔
Due to decreased food, water, shelter, mate etc there will be a further decrease in population size. ✔
This may lead to the extinction of the specie. ✔ **(5)**

2,5 Drought, floods, famine, Fire (natural disasters) any ✔ ✔ ✔ **(3)**

2.6. Direct counting from aerial photographs. ✔
Tagging – mark -recapture method. ✔ **(2)**

2.7 Density dependent factors : intraspecific competition for food, water, shelter, etc. ✔
Disease ✔
Predation ✔ **(3)**

3.1.1. Mice ✔ **(1)**

3.1.2. Owl ✔ **(1)**

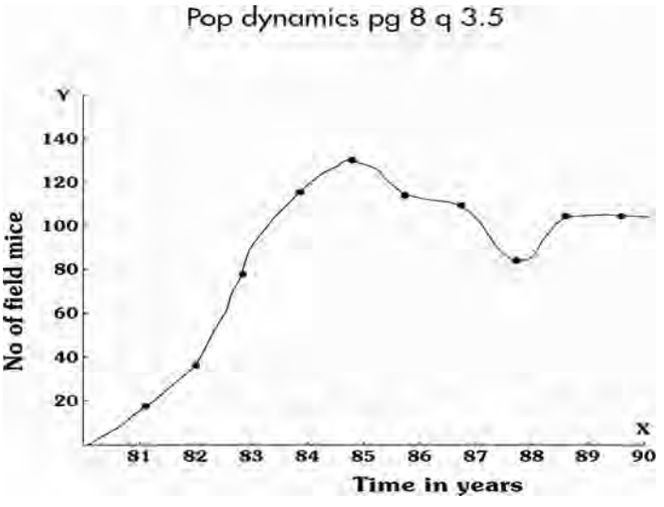
3.1.3. After the introduction of the owls there was a drastic reduction in the mice population. ✔
Owls killed the mice for food. ✔ **(2)**

3.2 An organism hunts and kills ✔ another organism for food. ✔ **(2)**

3.3 Natality , ✔ mortality. ✔ **(2)**

3.4 If the predators are too efficient they will kill more prey, ✔ and the predator population will increase. ✔ This inturn will result in mice population decreasing. ✔ There is a decrease in food supply for the owls therefore their numbers will decrease. ✔ **(4)**

3.5



(10)

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4.1 Predation. ✔ **(1)**

4.2 19:00h ✔ **(1)**

4.3 89 individuals ✔ **(1)**

4.4 Though prey population increased the number of wild dogs remained constant, This may be due to disease, ✔ deterioration of the environment, ✔ natality nil, ✔ mortality nil. ✔ **(4)**

4.5 Energy stored in the rabbit is used by the rabbit
- for it's own metabolism and growth ✔
- lost during respiration ✔
- lost in faeces and urine ✔
- lost in the parts of the rabbit that is not eaten. ✔ **(4)**

5.1 Census is taken. ✔ **(1)**

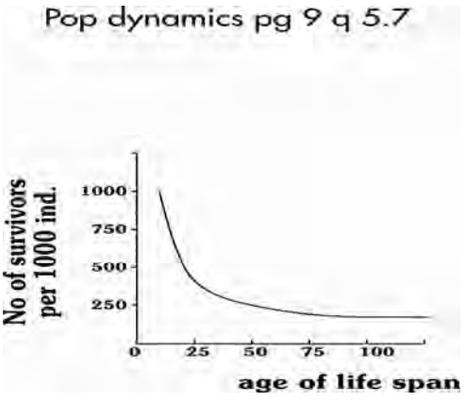
5.2 4% ✔ **(1)**

5.3 25 – 29 ✔
30 – 34 ✔
35 – 39 ✔ **(3)**

5.4 Pyramid A ✔ **(1)**
Less individuals reaching old age ✔
Life span short ✔ **(3)**

5.6 Few offsprings are produced ✔
Each has a high chance of survival ✔ as there is a greater degree of parental care ✔
Climax specie. ✔ **(4)**

5.7.



6.1 Average number of dandelion in a quadrat = $\frac{4 + 6 + 7 + 5 + 8}{5}$ ✔✔
= 6 ✔
No of quadrats in a plot = 25 ✔
Total no of dandelions in the plot = 6 x 25 ✔
= 140 ✔ **(6)**

6.2 Random selection of quadrats ✔
Average of the quadrats chosen. ✔ **(2)**

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7.6 Total no. of animals in the population = No of animals originally

No of animals in
marked and released x the second sample

No of marked animals recaptured ✔

$$= \frac{M \times C}{R} \checkmark$$

$$= \frac{25 \times 50}{5} \checkmark$$

$$= 250 \checkmark$$ **(5)**

7.2 Mark – recapture method ✔ **(1)**

7.3
- Marking should not affect the movement and behavior of the animals. ✔
- Mark does not wear off or tag get lost. ✔
- The marked animals must mingle freely with the rest of population. ✔
- The population is closed (no births or deaths, emigration or immigration) ✔
- Marked animals must not become trap-shy or trap addicted. ✔
- Behaviour of the marked animals is not affected ✔ **(6)**

8.1 Energy flow refers to the flow of energy ✔ through an ecosystem. ✔ **(2)**

8.2 The energy that is stored in plants ✔ during photosynthesis is called gross primary production (GPP) About a third of this energy is used by the plant for growth, cellular respiration and metabolism. ✔ The rest (5-8% of the original solar energy) is stored in the plant ✔ and is available to other organisms. ✔ This energy is called net primary production (NPP) **(4)**

8.3 a 3 530 + 3 060 + 14 860 ✔ = 21 450 kJ ✔ NPP of 1^2 m of grazing land /1 year **(2)**

b 3060 kJ eaten by cow
1910 kJ lost in urine

$$\% = \frac{100 \times 1910}{3060 \times 1} \checkmark$$

= 62.4% kJ lost in urine ✔ **(3)**

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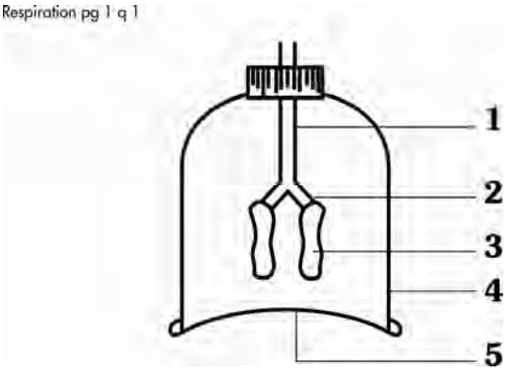
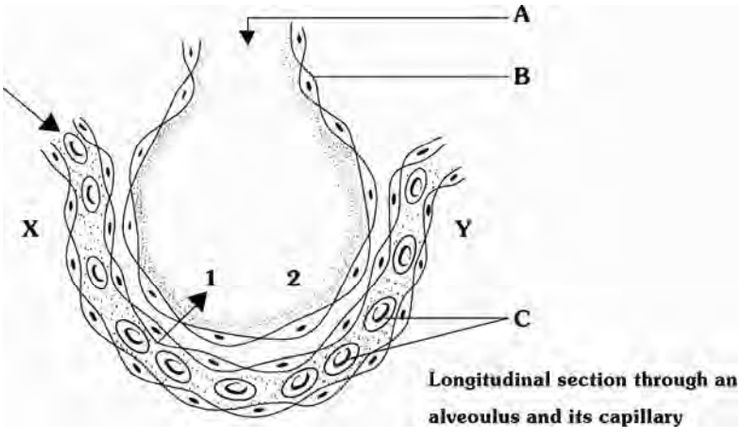
Respiration

1. The apparatus drawn below is used to demonstrate the breathing mechanism in a mammal.



1.1. What do the structures labeled 1 – 5 represent in the human body? **(5)**
1.2. What observation will you make when the part labeled 5 is pulled downwards? Explain what occurs in the human body when the representative part moves downwards. **(8)**
1.3. What aspect of the breathing mechanism cannot be demonstrated by this apparatus? **(2)**

2 Study the diagram below and answer the questions that follow



2.1 Identify parts A, B and C. **(3)**

2.2 Name the process represented by arrow 1. **(1)**

2.3. Explain two ways, as seen in the diagram, in which the alveolus satisfies the requirements for an efficient gaseous exchange surface. **(4)**
2.4 In which area (X or Y) will the blood contain a higher concentration of bicarbonate ions? Give a reason for your answer. **(3)**

2.5 Explain two ways in which C is structurally suited for its function. **(4)**
2.6 Which part of the brain controls rate and depth of breathing? **(1)**

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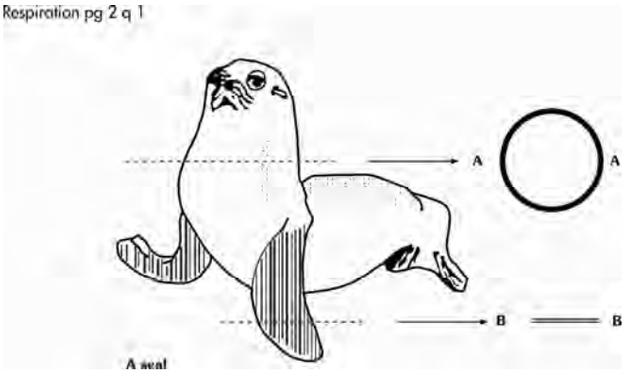
Temperature regulation

1 Study the diagram with cross sections A-A and B-B and answer the questions that follow.

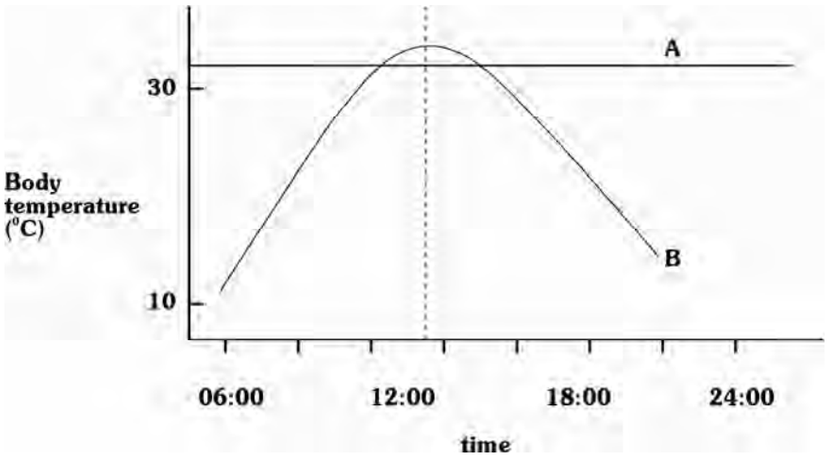


1.1 What is the function of the blubber in cross-section A-A? **(1)**

1.2 Explain the heat exchange mechanism of the above endothermic animal in cross-section B-B. **(8)**

1.3 Explain hoe the ability of some reptiles to lighten or darken their skin colour can assist in the regulation of their body temperature. **(5)**

2 The graph below illustrates the body temperature of two different animals. Study it then answer the questions which follow.



2.1 Which graph, A or B represents the body temperature of a dog? Give a reason for your answer. **(4)**

2.2 Describe how the dog would regulate its body temperature at 06:00…..

a. behaviorally **(5)**

b. physiologically **(3)**

2.3 State four ways in which an animal represented by graph B will prevent overheating at 14:00. **(4)**

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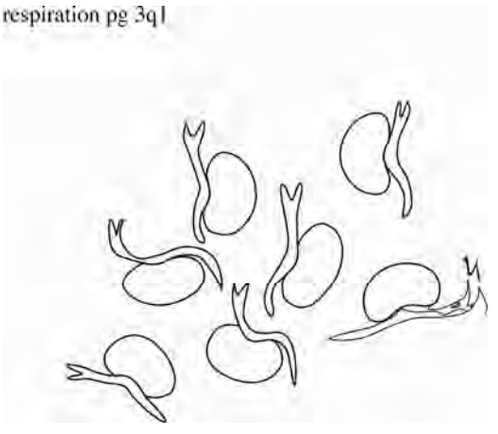
Growth and development

1. The diagram below represents seeds that were placed with the hilum facing in different directions during germination. Explain why the stems are all growing upwards. **(8)**



2. List the functions of the following plant hormones
2.1 Auxins **(5)**
2.2 Gibberellins. **(4)**
2.3 Cytokinins. **(4)**

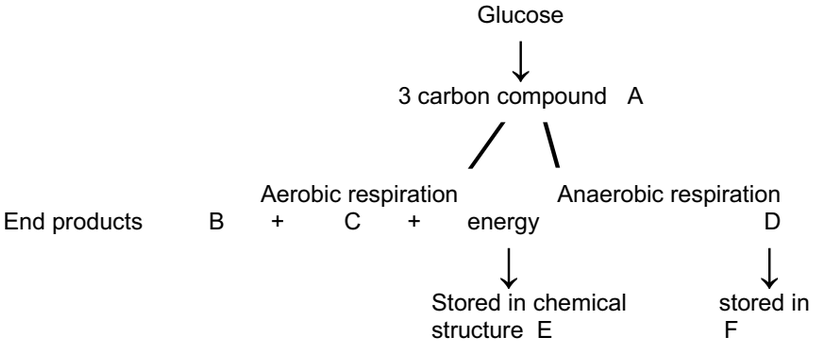
Photosynthesis

1 Discuss how a green leaf is structurally suited as an efficient photosynthetic organ. **(14)**

2.1 Name the phase in photosynthesis that occurs in the presence of light. **(1)**
2.2 In which part of the chloroplasts does this chemical activity mentioned in 2.1 take lace? **(1)**
2.3 Illustrate by means of a flow diagram the reactions that occurs in the phase mentioned in 2.1 15

Cellular respiration

1. The following diagram represents cellular respiration. Answer the questions set on it.



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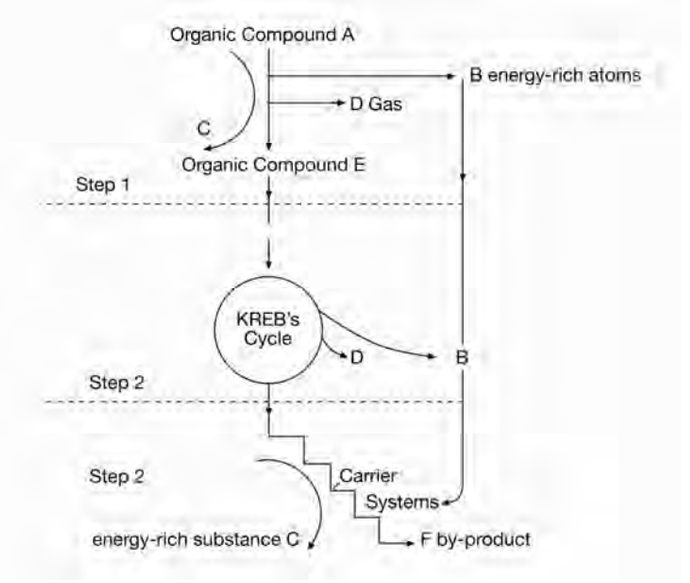
1.1 In which organelle does aerobic respiration occur? **(1)**
1.2 Under what circumstances will anaerobic respiration occur? **(1)**
1.3 Identify the substances indicated by A, B, C, D, E and F. **(6)**
1.4 Name substances that would form in plants if anaerobic respiration occurs. **(3)**

2.1 Complete the labels 1, 2, 3, and A to F in the following diagram. **(9)**



2.2 In which organelle of the cell does stages 2 and 3 occur? **(1)**

Answers

Respiration

1.1
1 Trachea √
2 Bronchus √
3 Lungs √
4 Rib cage √
5. Diaphragm √ **(5)**

1.2 In the human body inspiration occurs
- Diaphragm contracts (part labeled 5 moved downward) and becomes flattened √
- Abdominal muscles relax √
- External intercostals muscles contract √
- Ribcage raised upwards and outwards √
- Volume of thoracic cavity increases √
- Pressure in the lungs and interpleural space decreases √
- Elastic lungs expand √
- Air moves into lungs √ **(8)**

1.3 Movement of the rib cage √
Contraction of the intercostals muscles √ **(2)**

2.1
A Alveolar sac √
B Simple squamous epithelial lining of the alveolar sac √
C Erythrocytes (red blood corpuscles. √ **(3)**

2.2 Diffusion of CO_2 from blood vessels to alveolus √ **(1)**

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2.3 Thin surface area ✓ – epithelium is one layer of cells ✓
Transport system available ✓ - to transport CO_2 and O_2. ✓
Red blood corpuscles are squeezed through the capillaries virtually in a single file, ✓
maximum number is exposed to the diffusing gases. ✓ (Any 2) **(4)**

2.4 In area X bicarbonate ions are in higher concentration. Blood capillaries entering the lungs. ✓ CO_2 reacts with H_2O to form H_2CO_3 in the red blood corpuscles ✓. In the presence of carbonic anhydrase H_2CO_3 dissociates to form H^+ and HCO_3^- ✓ **(3)**

2.5 Biconcave discs ✓ provide large surface area for diffusion ✓
Presence of haemoglobin ✓ which has a great affinity for oxygen ✓ **(4)**

2.6 Respiratory centre in the medulla oblongata. ✓ **(1)**

Temperature regulation

1.1 Blubber is an insulator from heat loss to icy environment ✓ **(1)**

1.2 Flippers are not covered with blubber but are richly supplied with blood vessels. ✓
Heat exchange mechanism
The arteries, leaving the body and entering the flipper, containing warm blood ✓ are closely surrounded by veins returning blood into the body. ✓
The blood in the veins, especially at the ends of the flipper, is colder than in the arteries. ✓
Rapid heat transfer takes place from the warmer blood in the arteries ✓ to the colder blood in the veins. ✓
As a result of this heat exchanging mechanism the venous blood is warmed by the arterial blood before it re-enters the body ✓.
In this way little heat is lost to the surrounding water. ✓

1.3 Cells with pigments contract ✓ (pigments are closer together). ✓
This makes the skin darker. ✓
The darker the skin the more radiant energy is absorbed ✓ – resulting in higher body temperature. ✓
When pigment cells relax, ✓ pigments are dispersed. ✓ Skin becomes lighter. ✓ Less radiant energy is absorbed ✓ lowering body temperature. ✓ **(10) ÷ 2 = 5**

2.1 A ✓- . Homoeothermic animal ✓ Body temperature remains constant ✓ even when environmental temperature changes ✓ **(10)**

2.2 At 6.00 it is cooler
a – Lie down, curl up. ✓
Long hair on back, side and neck exposed to the cold. ✓
Short hair on head, neck, inside of legs and anterior belly are covered ✓.
Surface area exposed to the cold is reduced ✓
Reduced heat loss. ✓ **(5)**
b -- Blood vessels in the dermis ✓ constrict ✓– reducing blood flow to the skin ✓ resultingin reduced heat loss to environment ✓ by radiation ✓
Muscles attached to hair papillae contract ✓, hair erect on the skin ✓. Air is trapped between hair. ✓ These pockets of air serve as insulatory layer ✓ preventing heat loss by radiation to the environment ✓ **(10)**

2.3 Pigment cells relax, ✓ pigments are dispersed. ✓ Skin becomes lighter. ✓ Less radiant energy is absorbed ✓ lowering body temperature. ✓
Lie in the shade – body radiates heat to environment ✓
Change body position so as to expose less body surface to the sun ✓
Change body size ✓
Heat lost by greater amount of respiration ✓ **any four ways** **(4)**

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Growth and development

1

- Stems are positively phototropic ✓
- Stem bend towards light due to the following influences
- Auxins accumulate on the lower side of the stem ✓
- Because of gravity ✓ or moving away from light ✓
- A higher concentration of auxins in that part of the stem accelerates growth in that area ✓
- Uneven distribution of auxins causes uneven growth ✓
- With the lower side (away from light) growing faster in each case ✓
- And the stem grows upwards. ✓ **(8)**

2.1 Auxins
- play a role in tropisms ✓
- responsible for cell division ✓
- cell elongation ✓
- cell specialization ✓
- flower and fruit development ✓
- abscission of leaves ✓ **(6)**

2.2 Gibberellins
- stimulate root growth ✓
- promote bud development ✓
- promote the development of flowers ✓
- responsible for elongation of internodes ✓ **(4)**

2.3 Cytokinins
- in meristematic tissue they stimulate cell division ✓
- increase the resistance of plants to viral diseases ✓, low temperature ✓, ageing process ✓ **(4)**

Photosynthesis

1

- Leaves are dorso-ventrally flattened , presents large surface area to light ✓
- reduces diffusion distance of CO_2 ✓
- Chlorophyll- containing cells close to epidermis ✓
- Epidermal cells translucent, allow light to penetrate to mesophyll ✓
- Cuticle transparent, also allow light to pass to mesophyll ✓
- Palisade layer with elongated cells ✓
- numerous chloroplasts ✓
- is just below the upper epidermis ✓
- Intercellular spaces between cells of mesophyll allow rapid diffusion of CO_2 ✓
- Mesophyll cells are thin walled - allow rapid diffusion of CO_2 and H_2O ✓
- Numerous stomata for gaseous exchange ✓
- Xylem cells transport water ✓
- Phloem cells transport products of photosynthesis ✓
- Walls of mesophyll cells moist with water , CO_2 dissolves in the moisture. ✓ **(14)**

2.1 light phase. ✓ **(1)**

2.2 Thylakoids/grana ✓ **(1)**

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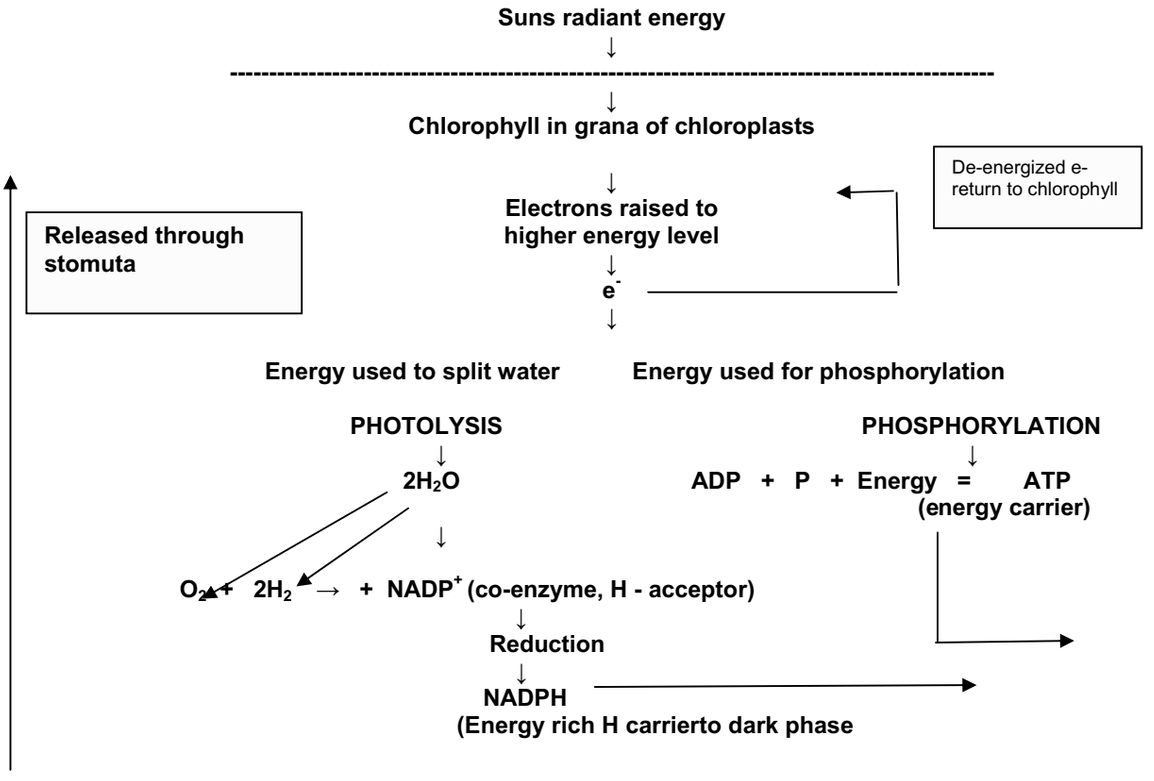
2.3



(5)

Cellular Respiration

1.1 Mitochondria √ **(1)**

1.2 Absence of oxygen √ **(1)**

1.3
A pyruvic acid √
B Carbon dioxide √
C Water √
D Lactic acid √
E ATP √
F Muscle tissue √ **(6)**

1.4 ATP, √ Alcohol, √ CO_2 √ **(3)**

2.1
1 Glycolysis √
2 Krebs cycle √
3 Oxidative phosphorylation √
A Glucose √
B Hydrogen √
C ATP √
D CO_2 √
E Pyruvic acid √
F Water √ **(9)**

2.2 Mitochondria √ **(1)**

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COMPANY PROFILE

IAT does training in the ABET Sector (In Fundamentals and Core subjects i.e. Science and Technology) and assists in Learnership Implementation and training.

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