PART I: ORGANISATION IN CELLS AND ORGANISMS

STRUCTURE AND FUNCTION OF CELLS

1. (a) Distinguish between **cell organelle** and **cell inclusion** (02 Marks)
(b) Describe the fine structure of the following: (13 Marks)
(i) Golgi complex (ii) Nucleus (iii) Mitochondrion
(c) Relate structure to functioning in each of the structures in (b) above. (05 marks)

2. (a) Describe the structure of plant cell wall (10 Marks)
(b) Compare the structures of plant cell wall and plasma membrane (07 Marks)
(c) Describe how membrane structure is related to traffic of materials across. (12 marks)

3. (a) Describe the functioning of Golgi apparatus in animal cells. (14 marks)
(b) Give an account of roles of lysosomes in animal cells. (06 marks)

4. Give an account of the distribution and functions of the membranes of cells. (20 marks)

CHEMICALS OF LIFE

5. Relate the properties of water to its biological importance. (20 marks)

6. (a) Why are enzymes essential in biotic systems? **(04 marks)**
(b) How is enzyme activity regulated in cells? **(16 marks)**

7. (a) Describe the structure of triglycerides. (**06 marks)**
(b) Account for the functions of lipids in the bodies of organisms. **(14 marks)**

8. (a) Give the differences between fibrous and globular proteins. **(04 marks)**
(b) With examples, explain the factors causing protein denaturation. **(12 marks)**
(c) Give four differences between polysaccharide and polypeptide chains.

9. (a) What is a protein? **(03 marks)**
(b) Discuss with suitable examples the variety of functions of proteins. **(13 marks)**
(c) Explain how their structure permits this wide variety of functions. **(04 marks)**

10. (a) In what ways do lipids differ from carbohydrates? **(04 marks)**
    (b) Using examples, account for the functions of lipids in organisms. **(10 marks)**
    (c) Why do many organisms store lipids rather than carbohydrates? **(06 marks)**

11. (a) What structural features of carbohydrates account for the wide variety of polysaccharides?

(07 marks)

    (b) Give differences between cellulose and glycogen. **(07 marks)**
    (c) Why are lipids more suitable storage compounds in animals than glycogen? **(06 marks) CELL PHYSIOLOGY (MOVEMENT IN AND OUT OF CELLS)**

12. **Figure 1** shows changes in the different potentials of a fully plasmolysed plant cell placed in a hypotonic solution.

Figure 2 shows the rate of movement of two different substances across a phospholipid membrane;

glucose by facilitated diffusion and water by simple diffusion at varying extracellular concentration

Figure 1

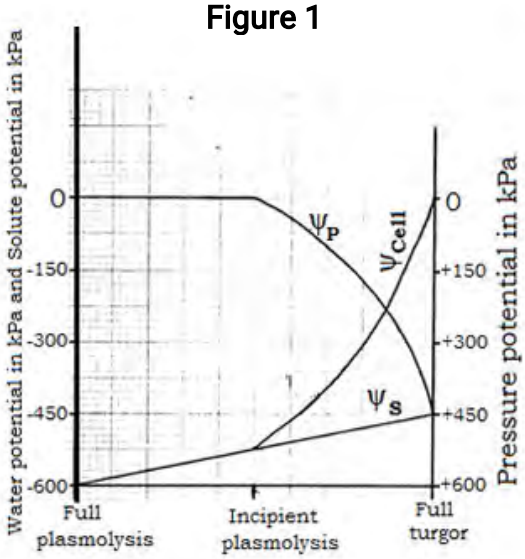
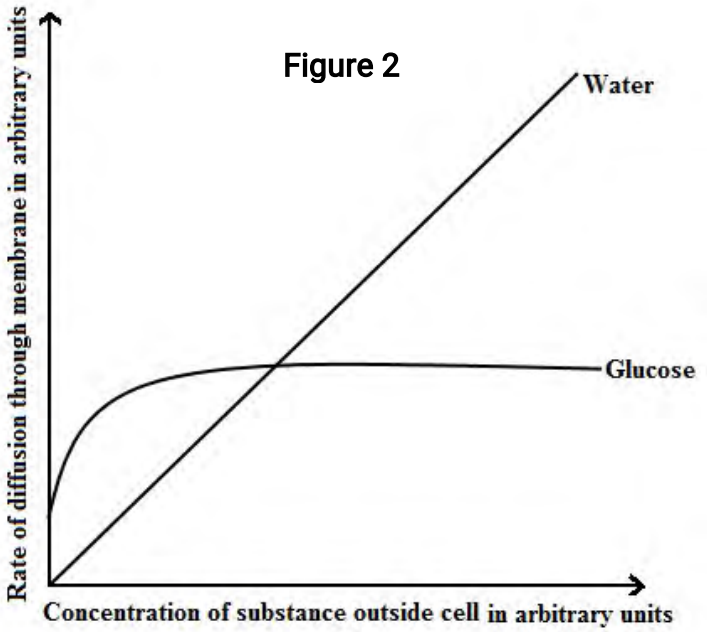


Figure 2



(a) From **figure 1,** compare the changes in pressure potential and water potential from full plasmolysis to full turgor. **(05 marks)**

(b) As indicated in **figure 1**, explain the change in water potential from full plasmolysis to full turgor.

(15 marks)

From **figure 2:**

(c) Describe the effect of increasing extracellular concentration:

(i) on glucose uptake. **(07 marks)** **(ii)** on water uptake **(05 marks)**

(d) Explain the observed rates of uptake of glucose and water. **(08 marks)**

LEVELS OF ORGANISATION AND DIVERSITY OF LIFE

13. (a) Describe the distribution and structure of simple plant tissues in stems. **(14 marks)**
    (b) Explain how the structure of tissues responsible for water transport in plants relates to function.

14. (a) State five similarities between angiosperms and conifers that allow them to be classified together. **(05 marks)**
    (b) State five differences between angiosperms and conifers which mean they belong to separate groups. **(05 marks)**
    (c) List five features which distinguish dicotyledons from monocotyledons. **(05 marks)**
    (d) Briefly explain how angiosperm reproduction is suited for terrestrial conditions. **(05 marks)**

15. (a) Outline the unique features of bacteria. **(07 marks)**
    (b) Briefly describe the four nutritional categories of bacteria **(08marks)**
    (c) How are bacteria economically important? **(05 marks)**

PART II: THE MAINTENANCE OF LIFE

NUTRITION

16. (a) Describe the basic structure of a chlorophyll molecule (07 Marks)
    (a) (b) Describe the physical and chemical mechanisms by which solar energy is converted into the chemical energy of ATP during the light stage of photosynthesis (06 Marks)
    (b) (c) Give an account of how atmospheric carbon dioxide gets incorporated into a hexose sugar in the Calvin cycle. (07 Marks)

17. (a) Explain photophosphorylation in terms of chemiosmosis. (10 marks)
(b) Outline the light-independent reactions of photosynthesis. (10 marks)

18. (a) Discuss the feeding mechanisms animals use. (10 marks)
(b) Describe the control of secretion of digestive juices in man. (10 marks)

19. (a) What are the differences between the digestive systems of herbivorous and carnivorous mammals? (08 marks)
(b) Discuss the main advantages of a parasitic mode of life. (05 marks)
(c) Give an account of the major adaptations shown by parasites, using plant and animal examples. (07 marks)

20. The dye reduction technique was used in a controlled experiment conducted to analyze the effects of different conditions on the photosynthetic rate of incubated chloroplast suspensions.

Each chloroplast suspension was mixed with **Dichloro phenol indophenol** (DCPIP), an electron acceptor that changes from blue to colourless when it is reduced. Each sample was placed individually in a spectrophotometer and the percentage transmittance was recorded.

The three samples used were prepared as follows:

- ***Sample 1*** — chloroplast suspension + DCPIP
- ***Sample 2*** — chloroplast suspension surrounded by black foil wrap + DCPIP
- ***Sample 3*** — chloroplast suspension that has been boiled + DCPIP ***Table 1***

Time (Minutes)	Transmittance (%)		
	Sample 1	Sample 2	Sample 3
0	28.8	29.2	28.8
5	48.7	30.1	29.2
10	57.8	31.2	29.4
15	62.5	32.4	28.7
20	66.7	31.8	28.5

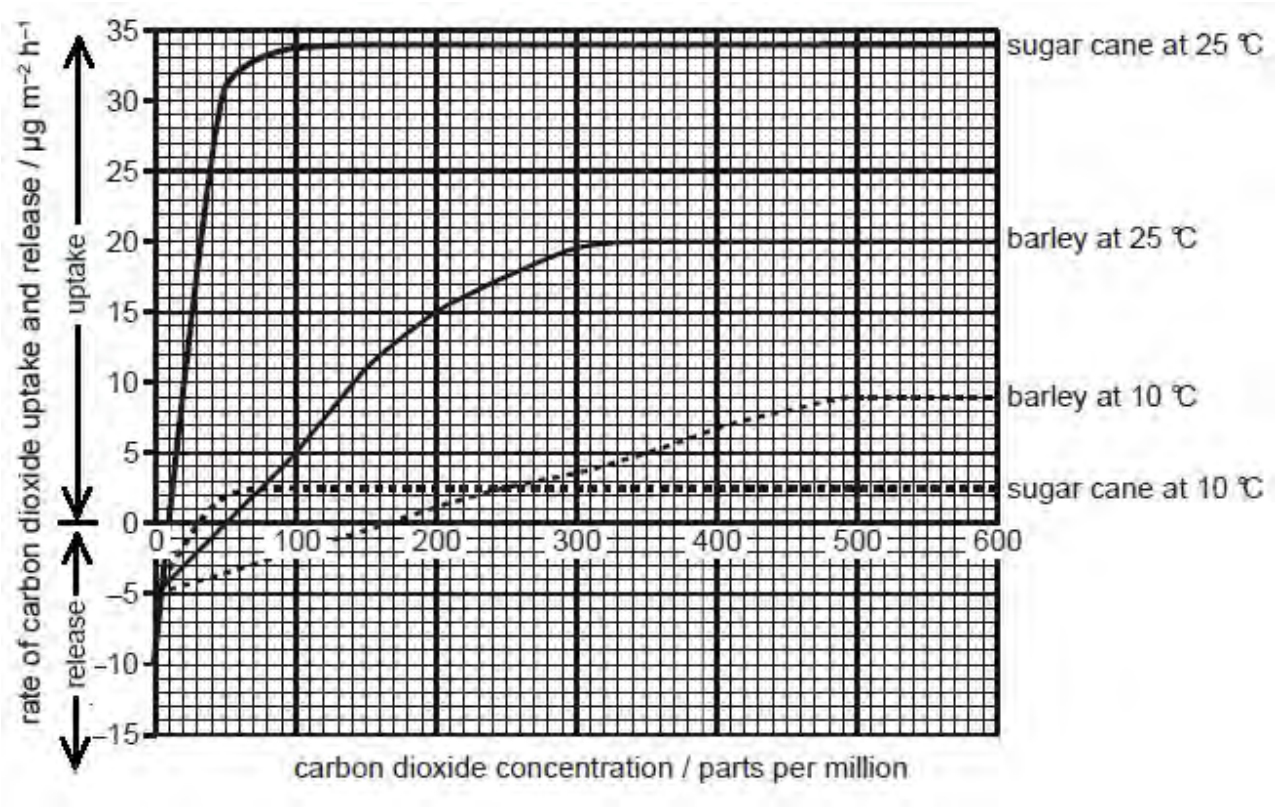
(a) On the same axes, present the results in table 1 graphically. ***(07 Marks)***

(b) From your graph, explain the difference in transmittance for the three different samples of results.

(08 Marks)

In another investigation on photosynthesis using a carbon dioxide analyser, the rate of carbon dioxide absorption by undetached leaves of two plants, barley and sugar cane, was measured. The leaves enclosed by a carbon dioxide analyser were provided with air, moving at a constant rate. Light intensity was kept constant and high, equivalent to full sunlight.

The results of the investigation



(c) Explain the observed carbon dioxide uptake / release in the two species at the different temperatures. ***(15 marks)***

(c) Explain the necessity of:

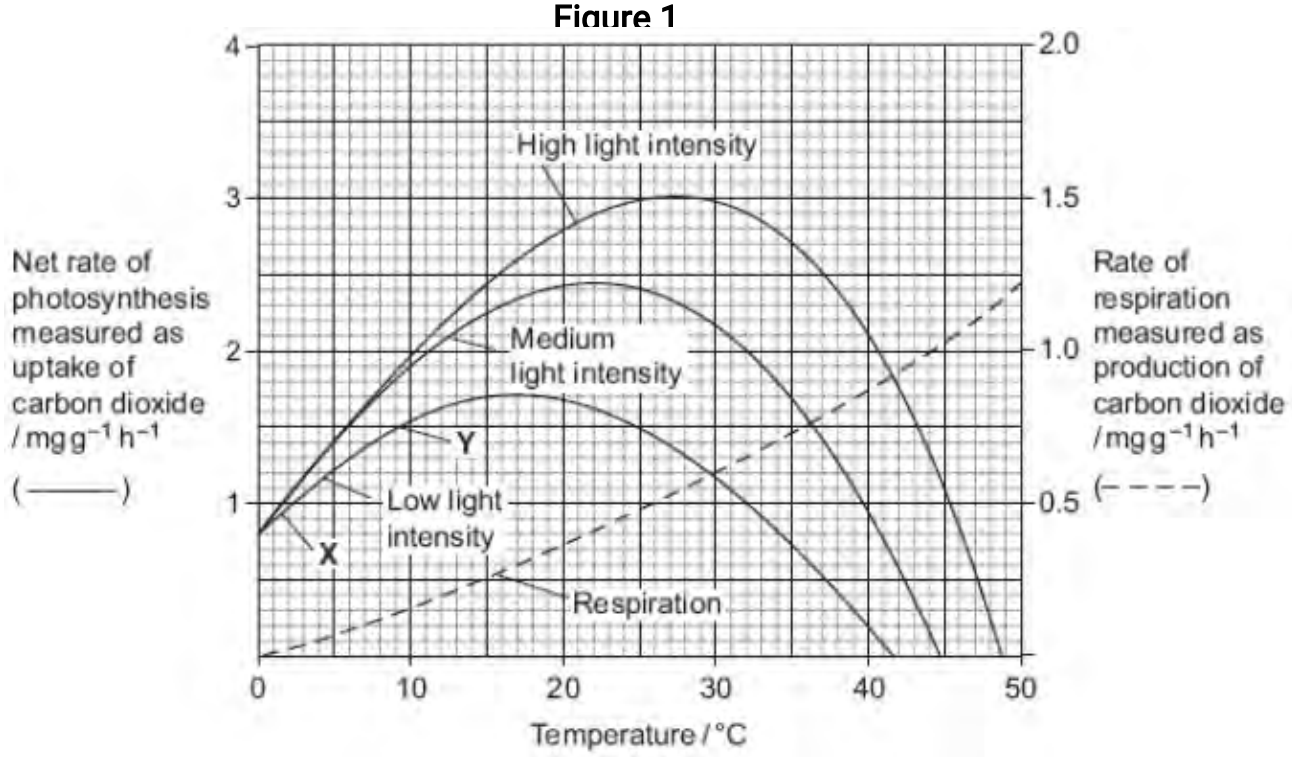
(i) Measurements being made at the same and high light intensity. ***(02 marks)***

(ii)Leaves remaining attached to the plant during the experiment. ***(02 marks)*** (e) Compare the response of the two species, sugar cane and barley, to differences in carbon

dioxide concentration and temperature. ***(06 marks)***

21. Scientists investigated the effects of temperature and light intensity on the rate of photosynthesis in creeping azalea plant. They investigated the effect of temperature on the **net rate** of photosynthesis at three different light intensities. They also investigated the effect of temperature on the rate of respiration. Figure 1 shows the results.

Figure 1



(a) What is meant by **net rate** of photosynthesis?

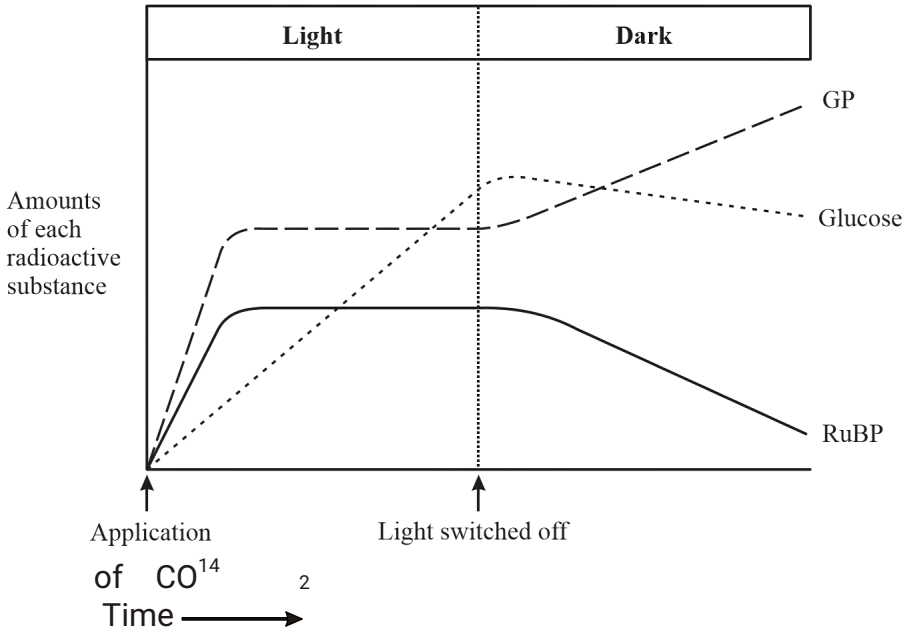
(b) (i) Explain the factors that limited the rate of photosynthesis from point marked X to Y. (ii) Comment on the photosynthetic efficiency of azalea plant at different light intensities (c) Compare respiration and photosynthesis at high light intensity.

(d) Explain the rate of respiration as shown in the graph.

Figure 2 shows the results of an experiment in which photosynthesising cells were kept in the light and then in darkness.

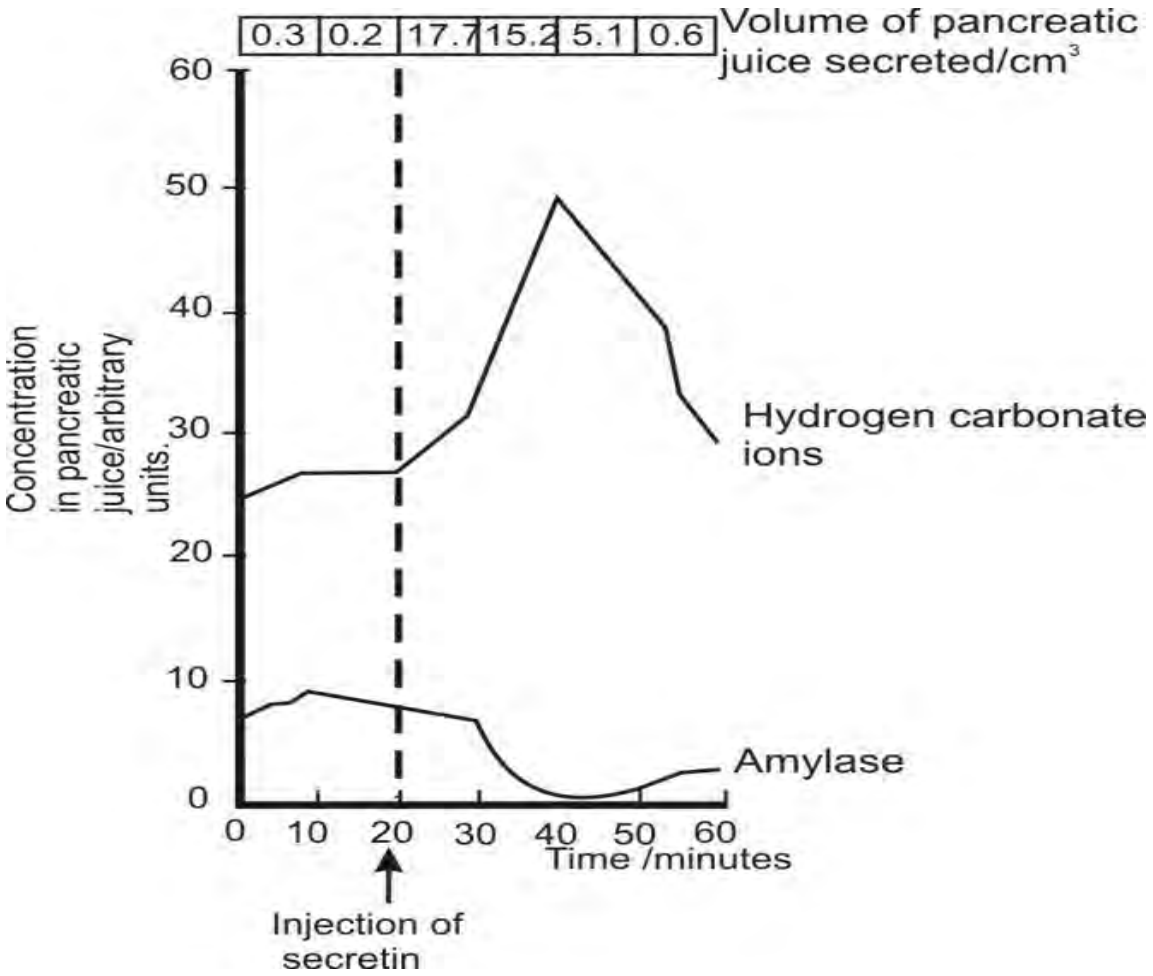
(e) Explain the effect of

Figure 2



varying illumination cycles on the amounts of each radioactive substance.

22. Figure I below shows how an injection of secretin affects the secretion of pancreatic juice by the pancreas. **Figure I**



From Figure I above:

(i) Use the graph to describe the effect of secretin on the pancreas. **(10 marks)** (ii) Explain why the concentration of amylase in the pancreatic juice decreased shortly after the

injection of secretin. **(06 marks)**

What other digestive secretion is stimulated by secretin. **(02 marks)**

Certain types of ulcer are thought of to be made worse by the production of too much acid from the stomach. Doctors have used a number of different methods to treat these ulcers. Suggest how the following treatments might reduce the amount of acid secreted by the stomach:

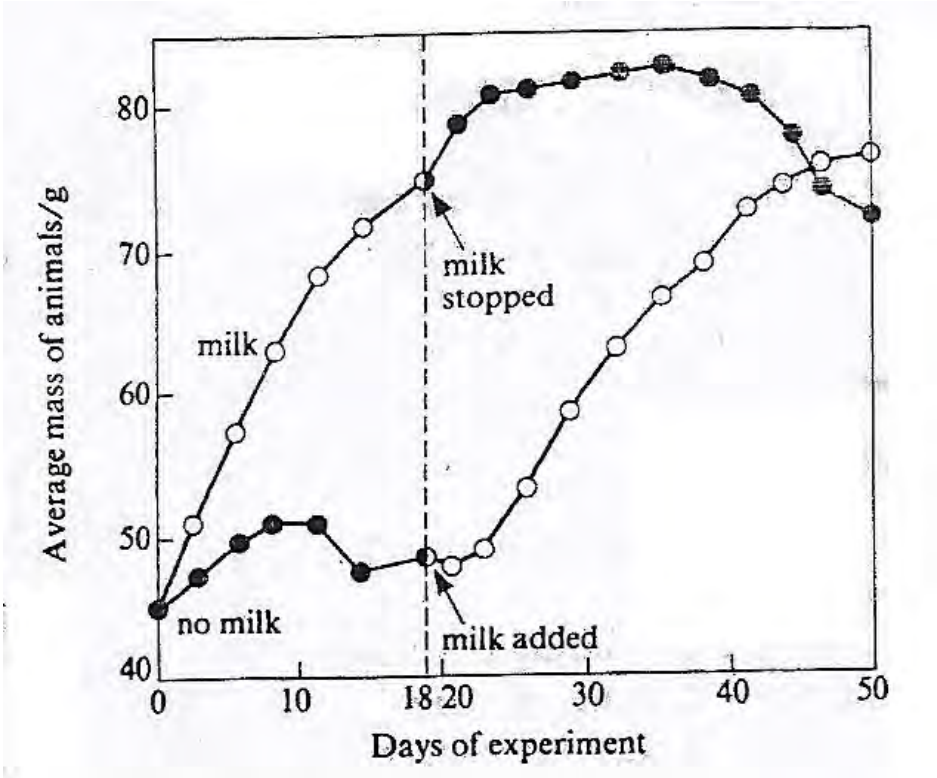
Cutting the vagus nerve to the stomach. **(05 marks)**

(ii) Giving the patient atropine, a drug which blocks the action of acetylcholine. **(05 marks)**

Figure II below shows the results of an experiment in which two sets of eight young rats were fed on a diet of pure casein, starch, sucrose, lard, inorganic salts and water.

The first set received additionally 3 cm^3 of milk per day for the first 18 days.

On day 18, the extra milk was denied the first set, but given to the second set of rats instead.



From Figure II above:

What hypothesis can you deduce from the graph? **(03 marks)**

Give reasons for your answer in (d) above. **(06 marks)**

Why is a diet of milk inadequate for an adult? **(03 marks)**

GAS EXCHANGE

23. **Figure I** below shows the pressure changes in the buccal and opercular cavities of a teleost fish obtained by using hypodermic tubing connected to a pressure recorder. Negative pressure indicates expansion while positive pressures mean contraction of the cavities.

Figure I

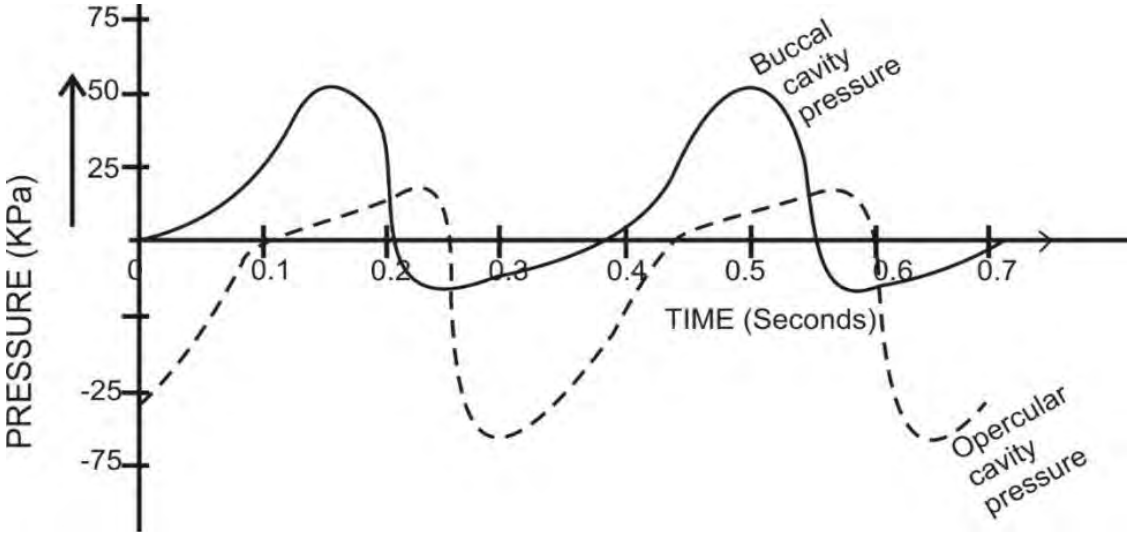
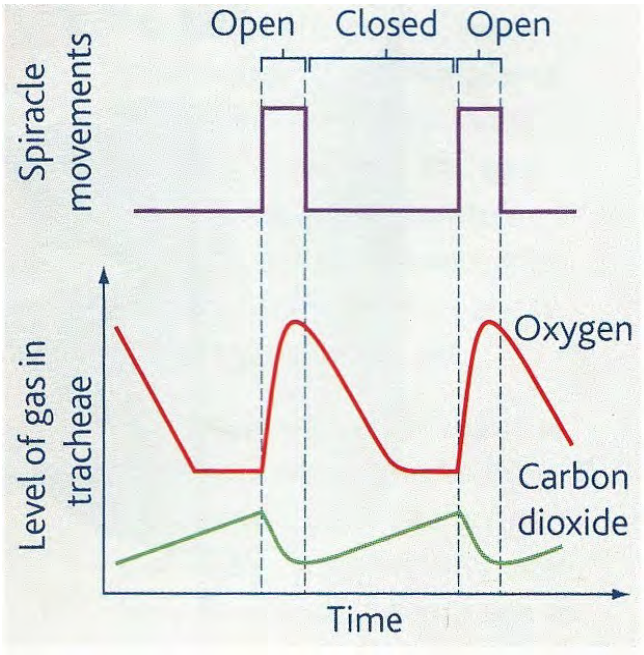


Figure II below shows results of an experiment which measured the levels of oxygen and carbon dioxide in the tracheal system of an insect over a period of time. During the experiment, the opening and closing of the insect's spiracles was observed and recorded.

Figure II



From Figure I:

(a) Compare pressure changes in the buccal cavity and opercular cavity in the first 0.4 seconds.

(08 marks)

(b) Account for the observed changes in pressure in the buccal and opercular cavities from 0.2

seconds to 0.6 seconds **(12 marks)**

(c) What is the physiological significance of the difference between the pressure in the

buccal and
opercular cavities? **(03 marks)**

From Figure II:

(d) Describe the pattern of level of gases in tracheae in relation to spiracle movements.
(04 marks)

(e) Explain the pattern of level of gases in tracheae in relation to spiracle movements.
(06 marks) (f)

(i) From the information provided by the graph, suggest the causes of spiracle opening.
(02 marks)

(ii) What is the advantage of the observed spiracle movements to a terrestrial insect?
(05 marks)

24. (a) Compare the suitability of air and water as gas exchange media. *(12 marks)*

(b) Explain why most plants lack specialized organs for gas exchange *(04 marks)*

(c) Despite the high efficiency of gills as respiratory structures in aquatic environments, terrestrial animals do not use gills for gaseous exchange. Explain. *(04 marks)*

25. (a) Compare the structures and mechanism of gaseous exchange in humans and frogs. *(10 Marks)*

(b) Describe the involuntary control of breathing in humans. *(10 Marks)*

RESPIRATION

26. (a) Explain the reactions that occur in the matrix of the mitochondrion that are part of aerobic
respiration. ***(10 marks)***

(b) Outline the role of oxygen in providing cells with energy. ***(05 marks)***

(c) Describe the central role of acetyl CoA in carbohydrate and fat metabolism. ***(05 marks)***

27. ***Figure I*** shows results from the experiment of simultaneous saccharification and fermentation of steam-pretreated sugarcane (*Saccharum officinarum*) bagasse by ***Saccharomyces cerevisiae,*** a strain of yeast. Bagasse, the fibrous residue obtained after extracting juice from sugar cane consists approximately of 50% cellulose, 25% hemicellulose, and 25% lignin. ***Figure I***

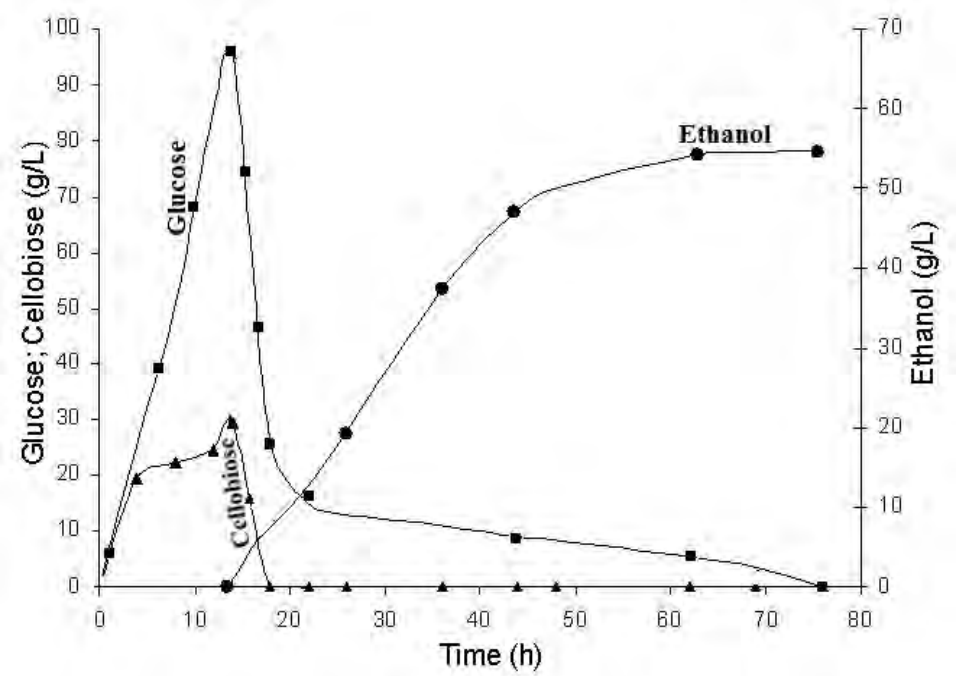
During the experiment, temperature of the medium was maintained

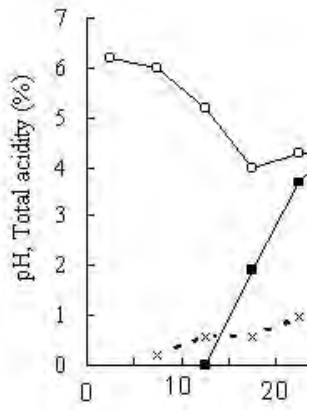
at 37^0C, and initial pH adjusted to 6.1.
Nitrogen was flushed

into the reaction vessels at the beginning of the experiment.

Figure II shows changes in pH and total acidity during the same period of time.

Figure II





(a) From **figure I:**

(i) Describe the changes in the concentration of sugars and ethanol. (10 marks) (ii) Explain the changes in the concentration of sugars and ethanol. (10 marks)

(b) Explain the necessity of the following in the experiment:

(i) Steam-pretreatment of sugarcane bagasse (05 marks)

(ii) Adjustment of pH to 6.1 (02 marks)

(iii) Flushing nitrogen into the reaction vessel. (02 marks)

From **figure II:**

(c) Explain the observed changes in pH and total acidity of the medium during the experiment. (07 marks)

(d) Suggest one reason for the observed efficiency of the experiment. (04 marks)

28. Five small discs cut from spinach leaves were floated on a small volume of buffered hydrogen carbonate solution in a flask attached to a respirometer. The discs were first exposed to bright light, then to dim light and finally left in the dark. Oxygen release was recorded as positive values and oxygen uptake as negative values.

The results obtained from this experiment are given in table 1.

Table 1

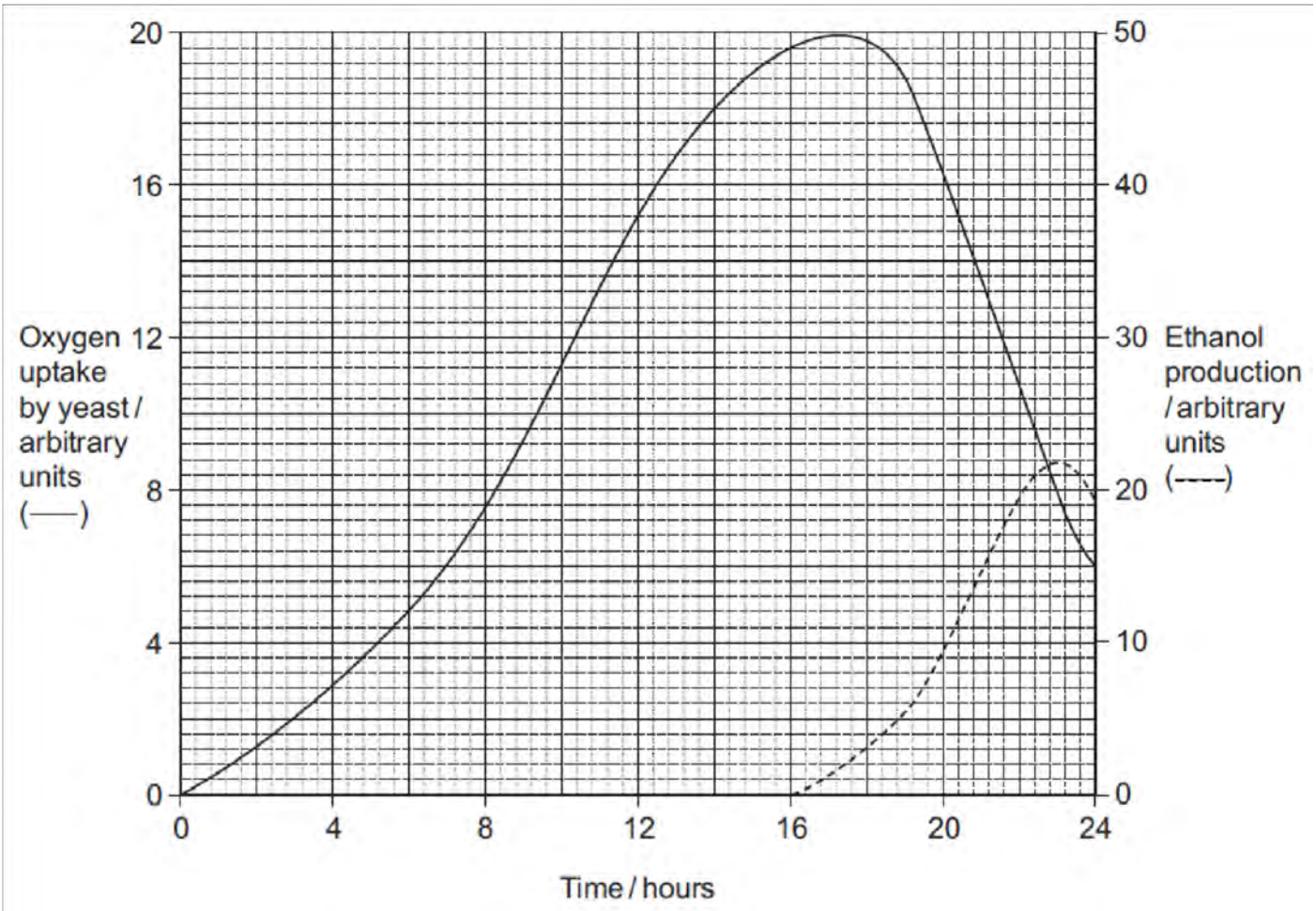
Light intensity	Time interval in minutes	Oxygen uptake or release for each 3 minutes interval in mm^3
Bright light	0 – 3 3 – 6 6 – 9 9 – 12	+57 +64 +58 +60
Dim light	12 – 15 15 – 18	+16 +3
Dark	18 – 21 21 – 24 24 – 27 27 – 30	- 16 - 12 - 15 - 14

(a) Present the data in suitable graphical form (06 Marks)

(b) (i) Calculate the mean rate of oxygen release in bright light (03 Marks)
(ii) Explain the significance of the results obtained from this experiment. (08 Marks)

(c) Explain the use of the following in the experiment above: (03 Marks) (i) Five small leaf discs, not one.
(ii) HCO_3^{2-} solution
(iii) Buffered solution

containerwhose results are shownthe graph below.



In an experiment, a student investigated respiration in a population of yeast growing in a sealed

(d) Calculate the rate of oxygen uptake between 2 and 4 hours. ***(02 marks)***

(e) During the period of investigation, account for the changes in:

(i) Oxygen uptake during this investigation. ***(06marks)***

(ii) Ethanol during this investigation. ***(05 marks)***

(f) The student repeated the investigation but added sodium azide after 4 hours. Suggest and explain how the addition of sodium azide would affect oxygen uptake and the production of ethanol.

(04 marks)

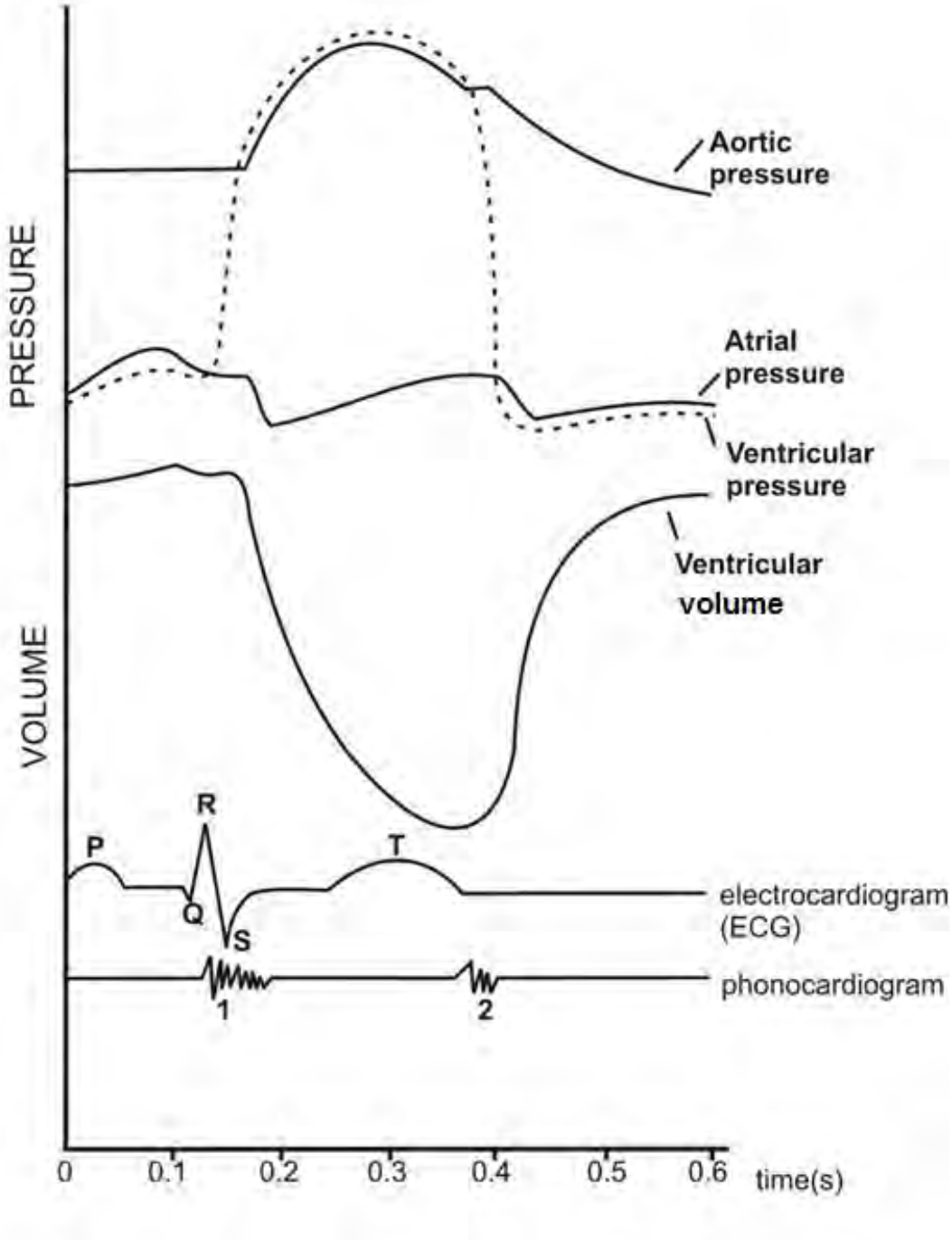
(g) Give other commercial applications of fermentation. ***(03 marks)***

TRANSPORT

29. The figure below shows the pressure and volume changes that occur during the mammalian cardiac cycle (of a dog). The pressure changes were measured in the left atrium and ventricle, and the aorta. Volume changes were measured for both ventricles.

The electrical activity in the heart wall (electrocardiogram) and heart sounds (phonocardiogram) as

recorded in a human subject are also shown.



(a) Describe the changes in:

(i) Atrial pressure. **(07 marks)**

(ii) Ventricular pressure. **(07 marks)**

(b) What are the differences in the changes in ventricular pressure and ventricular volume between 0.1 seconds and 0.5 seconds? **(03 marks)**

(c) Explain the effect of the changes in atrial, aortic and ventricular pressures to blood flow during the cardiac cycle. **(15 marks)**

(d) Explain the pattern of:
(i) Electrical activity **(03 marks)**
(ii) Sounds on the phonocardiogram. **(02 marks)**
(e) Explain how the internal heart structure is related to its functioning. **(03 marks)**

30. The table below shows the percentage saturation of haemoglobin with oxygen at varying partial pressures of oxygen in man. The experiment was carried out at two different partial pressures of carbon dioxide.

Partial pressure of oxygen/kPa	**Percentage saturation of haemoglobin with oxygen**	
	At 3 kPa partial pressure of carbon dioxide	At 6 kPa partial pressure of carbon dioxide
0	0	0
1	10	4
2	38	8
4	90	35
6	96	60
7	100	70
11	100	83
13	100	85

(a) Using the same axes, plot the results in a suitable graphical form. (08 marks)
(b) Account fully for the shape of the curve at 3 kPa partial pressure of carbon dioxide. (16 marks)
(c) Explain the position of the curve at 6 kPa with respect to that at 3 kPa partial pressure of carbon dioxide. (08 marks)
(d) Use the graph to explain why human haemoglobin:
(i) is saturated with oxygen in the lungs. (04 marks)
(ii) releases oxygen when it reaches the tissues. (04 marks)

31. The data below was obtained from experiments using plant materials treated as shown below. **Figure I** shows the uptake of potassium ions in an aerated solution by young cereal roots which had previously been thoroughly washed in pure water. After 90 minutes potassium cyanide was added to the solutions.

Figure I:

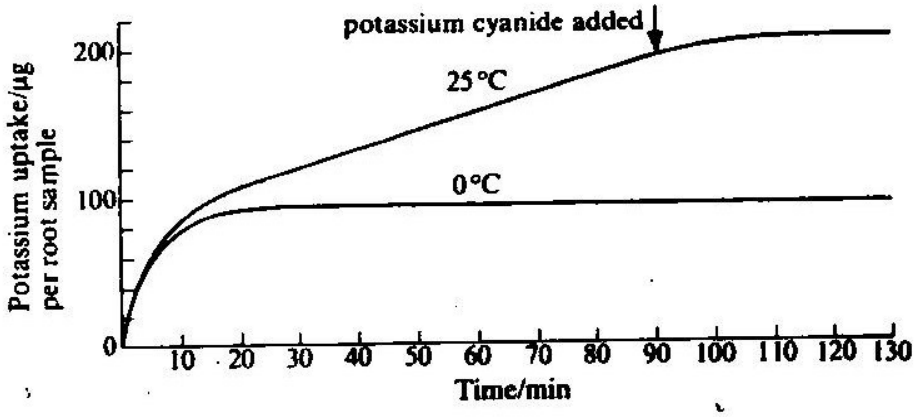
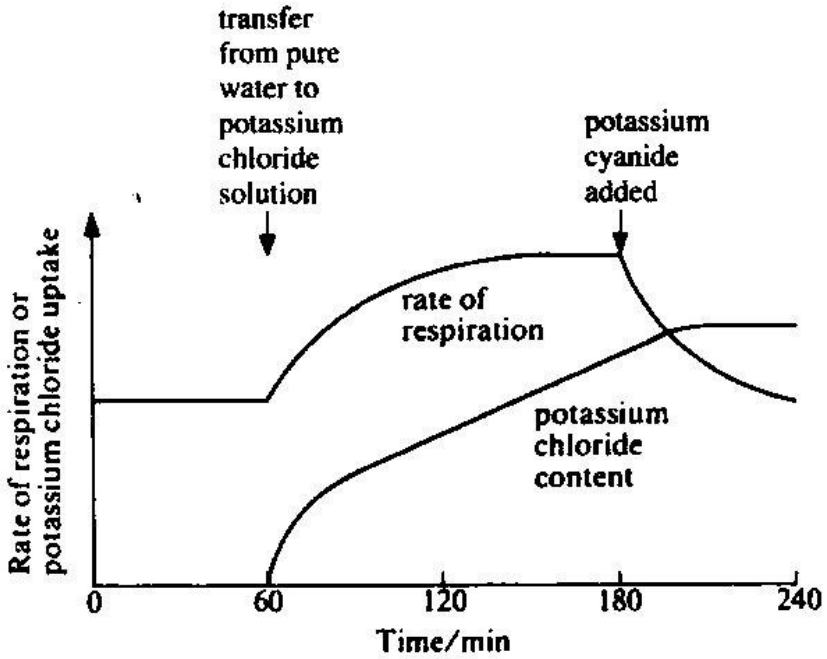


Figure II shows the rate of respiration and uptake of potassium chloride by young carrot discs. The carrot discs had previously been thoroughly washed in pure water and transferred to potassium chloride solution after 60 minutes. Potassium cyanide was added to the solution after 180 minutes. **Figure II:**



With reference to figure I:

(a)(i) Compare the change in uptake of potassium ions at 0^0C and 25^0C. (05 marks)

(ii) Explain fully the trend of uptake of potassium ions at 0^0C. (06marks)

(b) Explain why:

(i) The same rapid uptake of potassium ions occurred in the first few minutes of the experiment at both temperatures. (02 marks)

(ii) The uptake of potassium ions at the two temperatures greatly differs for much of the experiment.

(06 marks)

(iii) Potassium cyanide has the effect it does at each temperature. (03 marks) (iv) The cereal roots were washed before placing them in a solution containing potassium ions.

(01 mark)

(v) In a similar experiment, but involving phosphate uptake, 16% of the phosphate taken up by barley roots over a short period could be washed out after transferring to pure water again.

(02 marks)

(vi) Ions cannot reach the xylem entirely by means of the apoplast pathway. (03 marks)

With reference to Figure II:

(c) Explain the trend in rate of respiration:

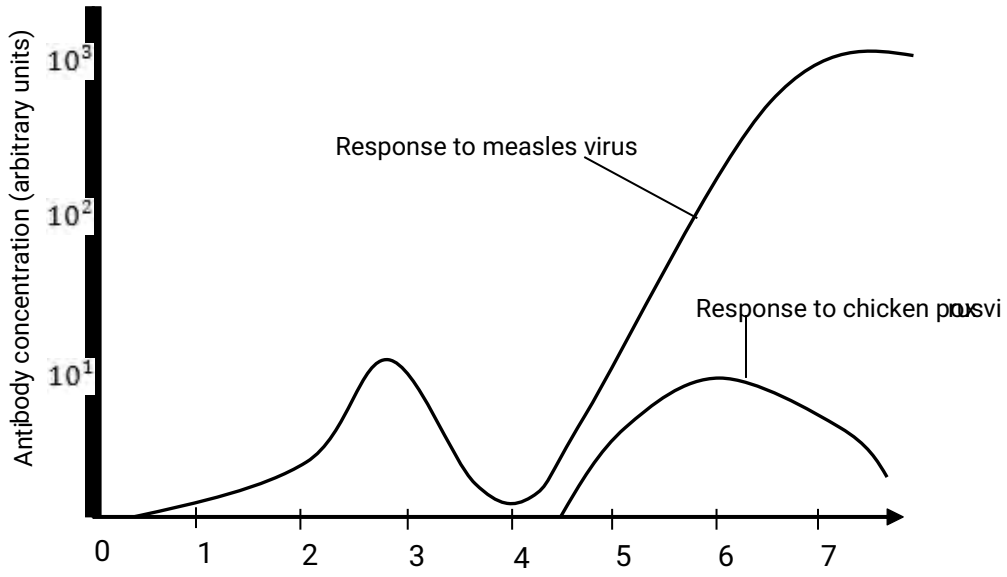
(i) Before addition of potassium cyanide. (09 marks)

(ii) After addition of potassium cyanide. (03 marks)

32. With reference to a mammal, describe the means by which blood circulation is maintained and controlled. (20 marks)

DEFENSE AGAINST DISEASE

33. The concentration of antibodies of a child was measured over a period of eight weeks. The child was exposed to the measles virus at a time 0 weeks when he inhaled droplets from the infected person. At the fourth week, the child was exposed to the measles virus, and at the same time, he was exposed to chicken pox virus. The results are shown in the graph below.



Use the information provided to answer the questions that follow.

a) Compare the variation in concentration of antibodies during the first and the second exposure to the measles virus. **(08 marks)** b) Account for the differences in (a) above. **(04 marks)**

c) Using the results above, suggest why;

(i) Children who catch measles for the first time suffer symptoms of the disease, but normally recover completely within two to three weeks of being infected. **(05 marks)** (ii) A person who has had measles normally is immune for life. **(04 marks)**

(iii) A measles patient is mostly infectious about 8-16 days after first infection.**(04 marks)**

d) How do the results above illustrate that the immune response is specific? **(01 mark)**

e) State with reasons the type of immunity illustrated. **(02 marks)**

f) How have the results of this study been applied by humans in the prevention and control of certain human disease? **(02 marks)**

g) Certain plants called Cyanogenic plants use hydrogen cyanide as a defense mechanism

against herbivores. The table below shows the average cyanide content of leaves of certain plants of different ages.

Age of leaf (weeks)	Average cyanide content of leaf (mg/100g by weight)
1	9.9
3	4.3
5	2.1
7	1.0
9	0.5
11	0.2
15	0.0

(i) Present the information in the table above graphically. **(04 marks)** (ii) State the relationship that exists between cyanide concentration and age of the leaf. **(01 mark)**

(iii)In what way could this relationship be of survival value to the plant? **(02 marks)**

(iv) Suggest any other defense mechanisms used by plants. **(03 marks)**

34. (a) Outline the various ways antibodies combat antigens in the human body. (05 marks)
(b) Explain the ways in which the human body gains immunity. (15 marks)

PART III: ADJUSTMENT AND CONTROL

GENERAL PRINCIPLES OF HOMEOSTASIS

35. Describe how unicellular organisms and cells of multicellular organisms control their internal environment

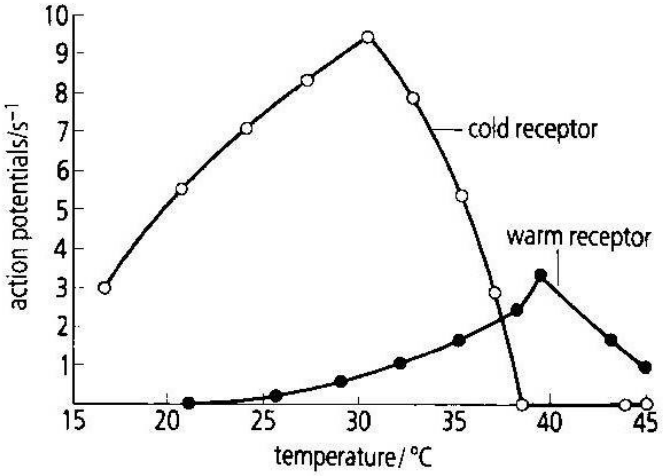
36. (a) Distinguish between **negative** and **positive** feedback loops. (2 *marks)* (b) Explain how feedback mechanisms regulate each of the following:

(i) The menstrual cycle in a non-pregnant human female (10 *marks)*

(ii)Blood glucose levels in humans. (08 *marks)* **TEMPERATURE REGULATION**

37. **Figure 1** shows the effect of temperature on heat receptors in mammalian skin.

FIGURE 1:



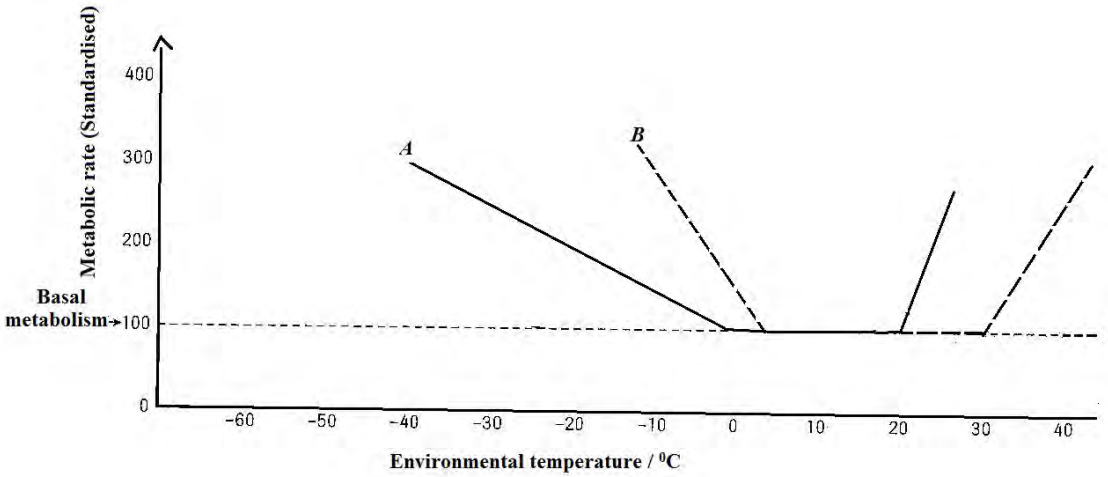
(a) Explain the effect of temperature on the response of:

(i) Cold receptor **(06 marks)**

(ii) Warm receptor **(06 marks)**

Figure 2 shows variation of metabolic rate with environmental temperature in mammals A and B.

FIGURE 2:

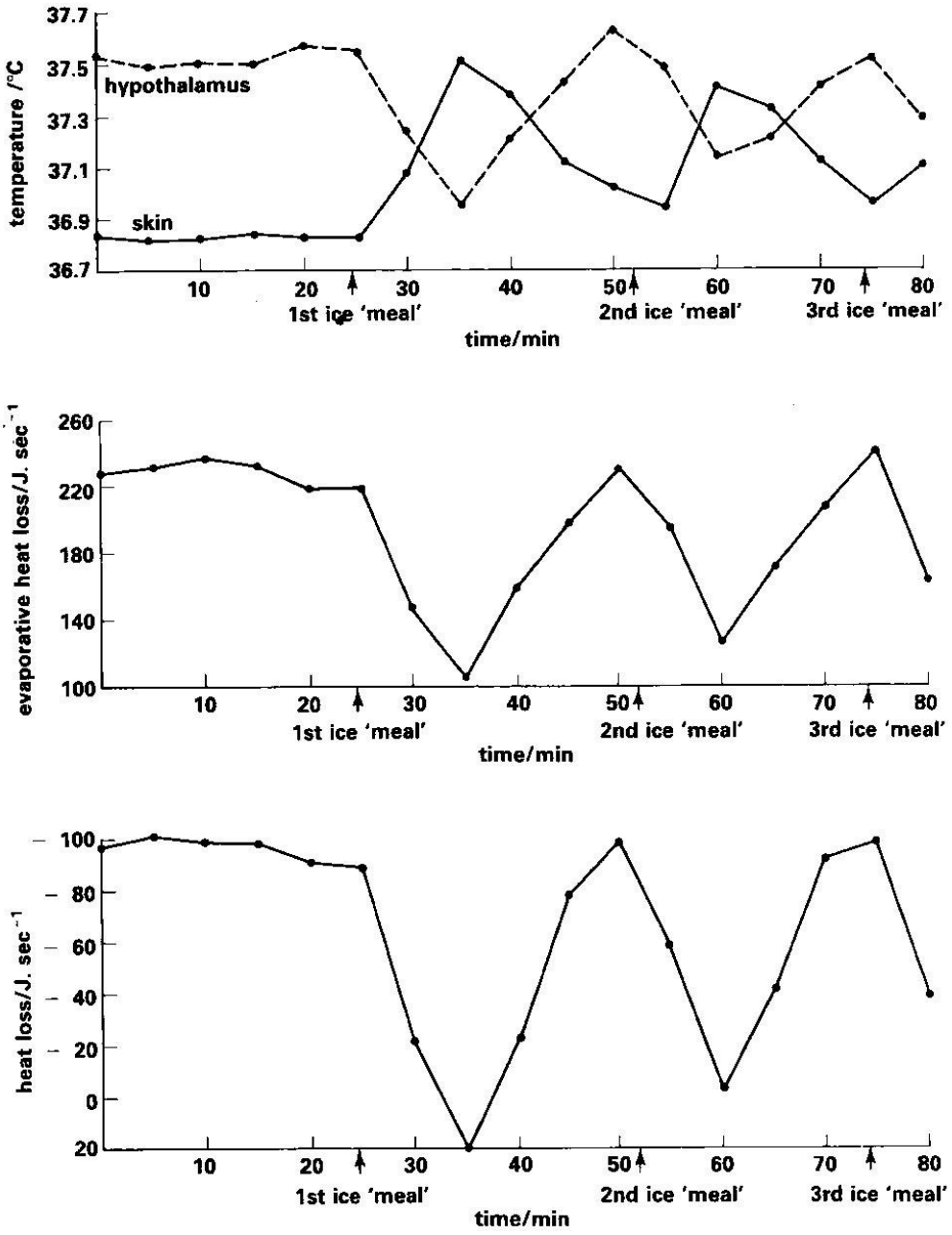


(b) Explain the relationship between metabolic rate and environmental temperature for mammal A. **(12 marks)**

(c) With reasons, suggest the possible habits of mammals A and B. **(04 marks)**

Figure 3 shows the relationship between evaporative heat loss, heat loss, skin and hypothalamus temperatures in humans following experimental ice meals for a human in a warm chamber at 45^{0}C. Iced water was swallowed at the labelled points.

FIGURE 3:



(d) Account for the relationship between the four variables between the 1st and 2nd ice meals.

(12 marks)

REGULATION OF GLUCOSE

38. In an experiment a person who does not have diabetes ate two slices of white bread. The change in her blood glucose concentration was recorded over the next 120 minutes. The experiment was repeated; first with two slices of brown bread and then with two slices of

whole meal bread. Figure 1 shows the results of the three experiments.

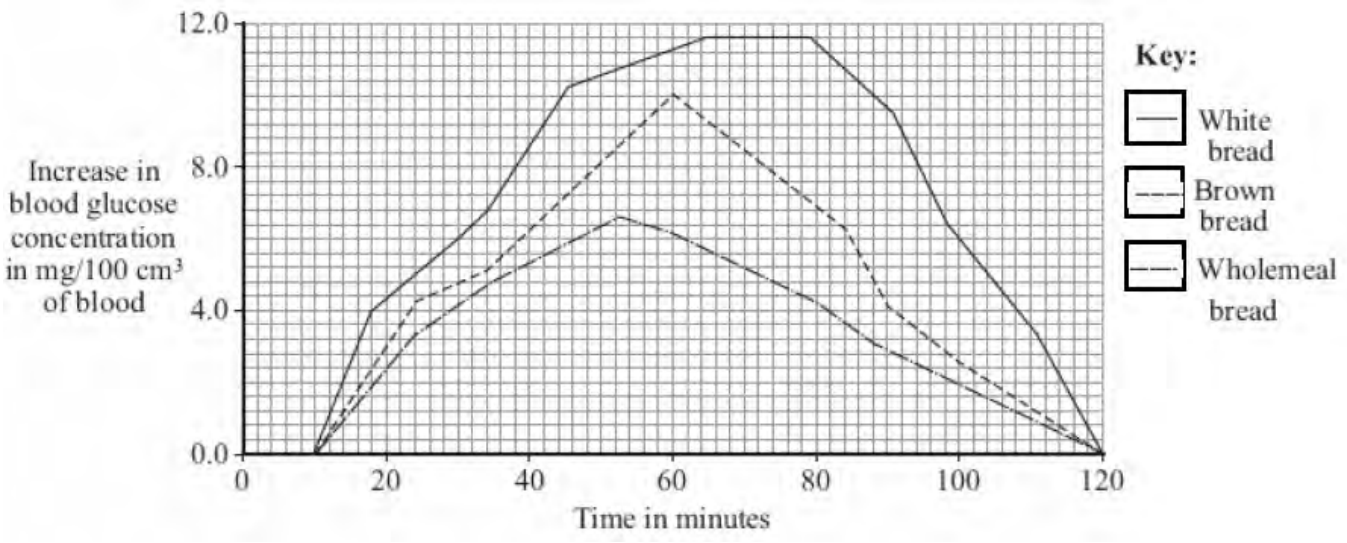
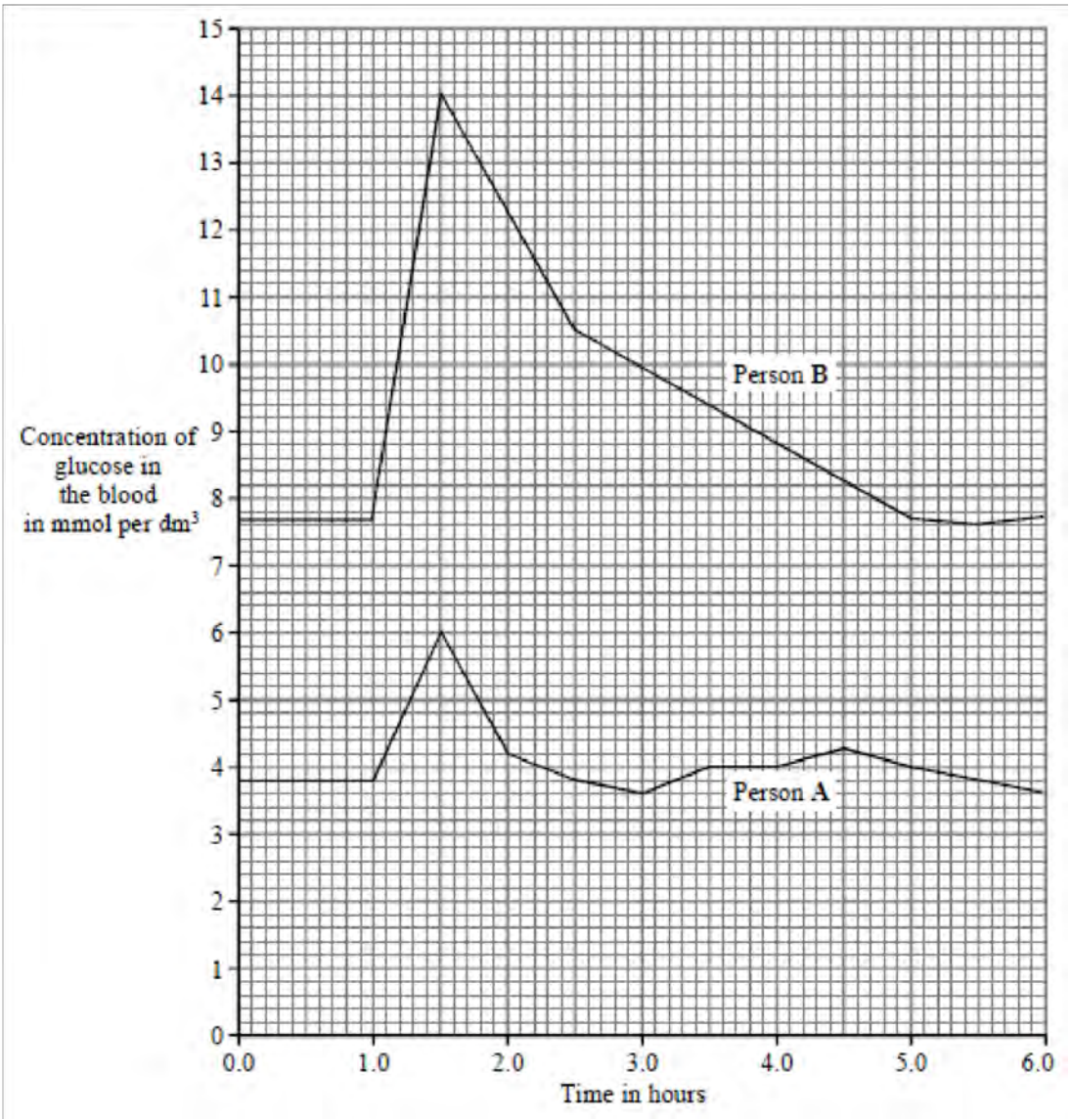


Figure 2 belowshows the concentration of glucose in the blood of two people. Person A is

non-diabetic. Person B has diabetes. Each person ate 75 grams of glucose at 1.0 hours.



FROM FIGURE 1:

(a) (i) Which type of bread would be most suitable for a person with diabetes?

(ii) Give two reasons for your answer.

(b) Explain, as fully as you can, the reasons for the changes in blood glucose concentration when the person ate the brown bread.

FROM FIGURE 2:

(c) Explain the observed changes in the glucose concentration in both persons after the meal.

(d) (i) Explain two dangers of having high concentration of glucose in the blood.

Pancreatic-cell transplantation is a new treatment for diabetes. Insulin-making cells are taken from up to three dead donors. The cells are kept alive before being injected into the diabetic in a small operation. The cells soon begin to make insulin. In one recent study 58 % of recipients of pancreaticcell transplants no longer needed insulin injections.

(ii) Give the advantages and disadvantages of the new treatment for diabetes compared with using insulin injections.

REGULATION OF PH

39. Explain how the following are involved in maintaining pH of body fluids.

(a) Chemical buffer systems **(08 marks)**

(b) Respiratory centre **(07 marks)**

(c) Kidney **(05 marks)**

EXCRETION AND OSMOREGULATION

40. Two species of amoeba were transferred from their natural habitats to different dilutions of sea water, and each individual was given time to adjust to its new environment. The table below shows data about the rate of vacuolar contractions with varying solute concentrations.

	Number of vacuolar contractions per hour	
Sea water concentration in % (normal sea water = 100%)	***Species A***	***Species B***
5	82	20
10	74	63
15	65	64
20	58	56
30	34	31
40	14	13
50	0	6
60	0	0

(a) Present the results of the experiment graphically.

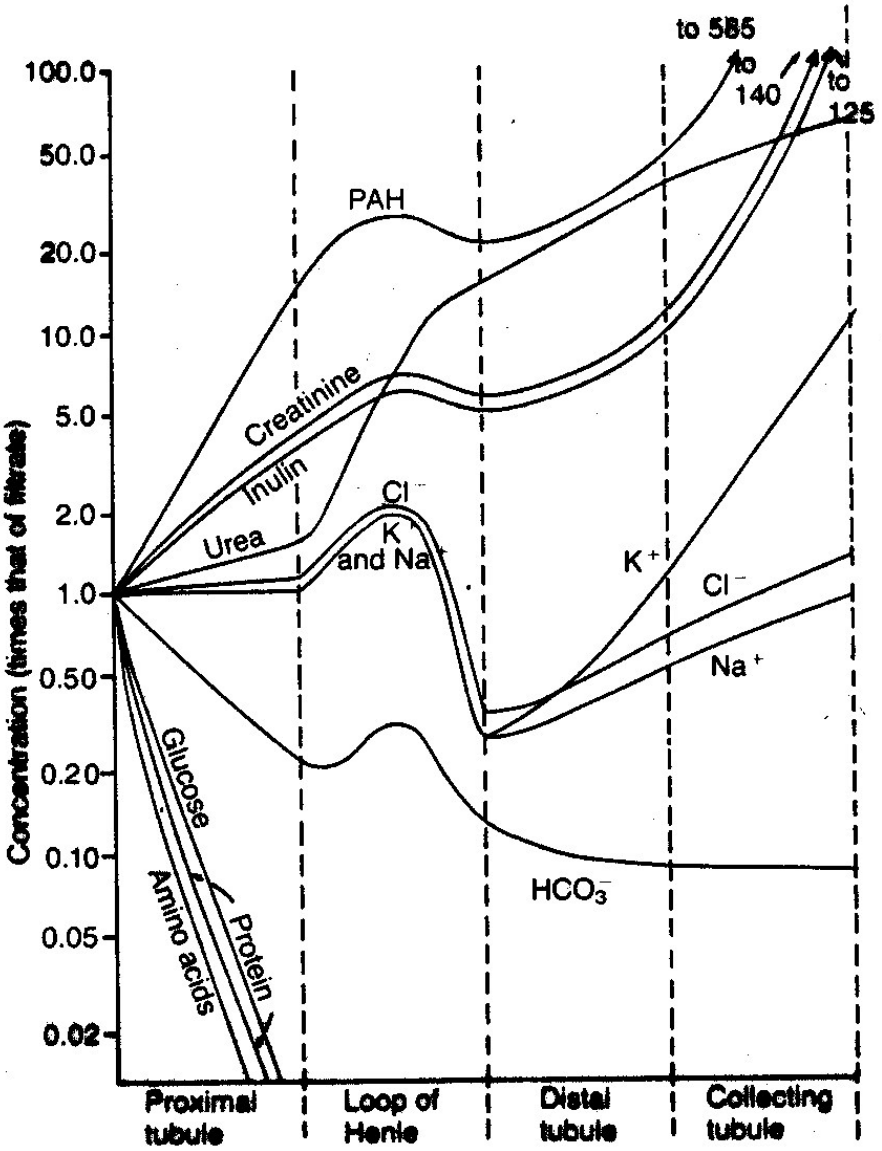
(b) Describe the activity of contractile vacuoles with changes in salinity.

(c) Explain by reference to the data, the difference in vacuolar contraction in the two species of Amoeba when placed in the higher concentrations of seawater.

(d) What information may be deduced about the natural habitats of the two species from the rates of vacuolar contractions?

41. The figure below shows variation in concentration of **cations** (K^+, Na^+), **inorganic anions** (HCO_3^-, Cl^-), **organic anion** (*p*-aminohippurate - PAH), **inulin**, (a fructose Polymer), **excretory wastes** (Urea and Creatinine – a product of muscle metabolism derived from creatine phosphate), and **metabolites** (glucose, amino acids and protein of low molecular weight)

along the different regions
of the nephron. Inulin is not synthesized, destroyed, or stored in the kidneys.



(a) Explain the concentration of the following along the different regions of the nephon:
(i) Ions (ii) Metabolites (iii) Excretory wastes

(b) ***Explain the***:
(i) Absence of cells, immunoglobulins, and large molecular weight proteins in glomerular filtrate. (ii) Clinical importance of selective filtration of cells, immunoglobulins, and large molecular weight proteins.

(c) ***Explain why the***:
(i) Rate of plasma ultrafiltration in the kidney glomeruli far exceed that in all other capillary beds.
(ii) Proximal tubular fluid is essentially isosmotic to plasma.

(d) What is the significance of producing concentrated urine osmotically to a named land dweller?

42. (a) The **table** below shows changes in percentage of total excretory material of an amphibian with age.

Age of tadpole or frog(days)	**Percentage of total excretory material**	
	Ammonia	**Urea**
50	92	8
55	88	12
65	84	16
75	83	17
90	68	32
95	20	80
100	13	87
110	12	88

(i) Represent the tabulated data graphically **(08 marks)**

(ii) Describe the change in the ammonia percentage of total excretory material. **(05 marks)** (iii) With a reason, identify the period when the animal leaves water. **(02 marks)** (iv) Explain the need to change the excretory product on transitioning from water to land.

(06 marks)

(v) State two structural changes that accompany the change in excretory product. **(01 mark)**

43. (a) Describe the source and fate of the major excretory products in living organisms.

(13 marks)

(b) Explain how fresh water fishes have been able to overcome their osmoregulatory problems.

(07 marks)

44. An investigation was carried out to determine the effect of a strong saline solution on the rate and concentration of urine produced by a dog. The experiment begun with the dog first being allowed to drink water to its full. Then minutes later, it was injected with a strong saline solution through the carotid artery. The dog was then monitored closely and the relevant measurements taken.

The table below shows the results obtained. The rate of urine production was expressed in cm^3 per minute while the corresponding concentration of the urine produced was expressed in arbitrary units. Study the table and the answer the questions that follow:

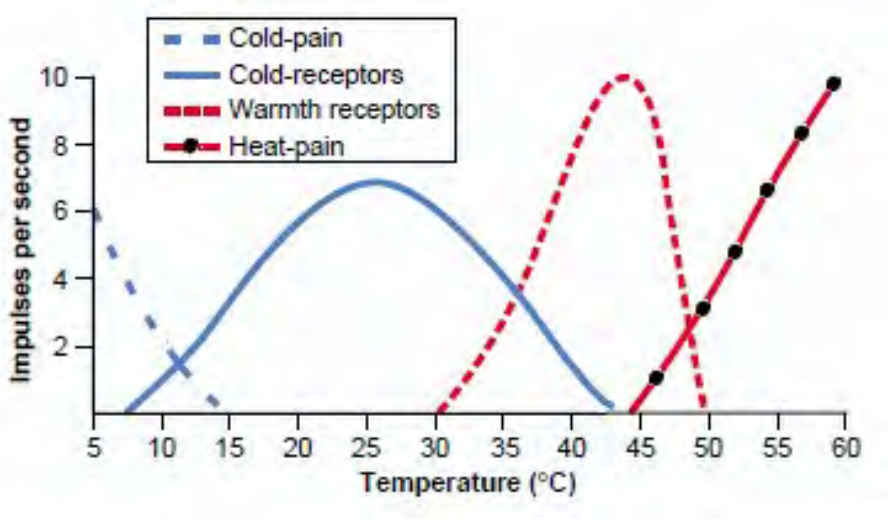
Time (minutes)	0	10	20	30	40	50	60
Rate of urine production (cm^3/min)	6.5	7.3	1.0	2.0	3.3	5.0	6.5
Concentration of urine (arbitrary units)	2.0	2.0	8.0	6.0	3.7	2.0	2.0

(a) Using appropriate scales and the same axes, draw graphs to reflect these results. **(09 marks)**
(b) Explain the inclusion of measurements recorded at time zero (0) in this investigation **(02 marks)** (c) Comment briefly on the effect of saline solution on:
(i) The rate of urine production
(ii) The concentration of urine produced by the dog during this investigation **(08 marks)**
(d) Account fully for the observed changes in (c) above. **(13 marks)**
(e) Give the main structural and physiological advantages the animals living in arid habitats have for water conservation. **(11 marks)**

PART IV: RESPONSE AND COORDINATION

RECEPTION OF STIMULI

45. Figure **I** below shows the discharge frequencies at different skin temperatures of a pain fiber stimulated by *cold,* a *cold fiber,* a *warmth fiber,* and a *heat-pain fiber.*

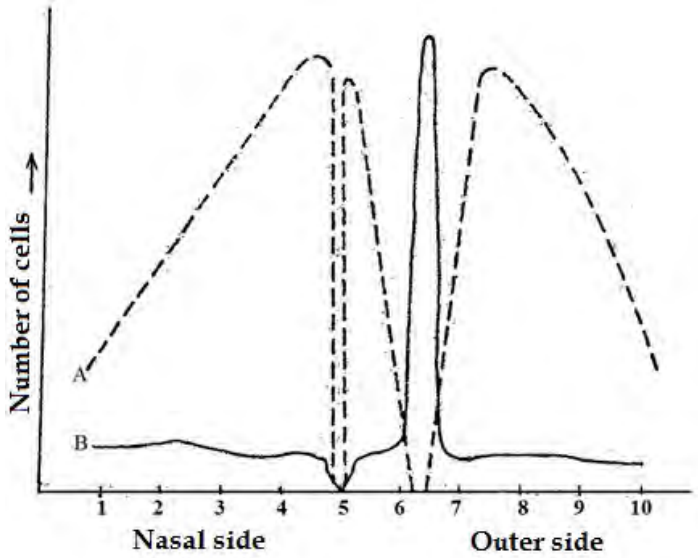


(a) From the graph, describe the relationship between temperature and the responses of the four types of nerve fibers. **(15 marks)**
(b) Explain:
(i) Why when the temperature of the skin is actively changing, a person feels much stimulation than when the temperature remains constant. **(05 marks)**
(ii) The significance of the phenomenon in (b) (i) above to an animal. **(02 marks)**
(c) From the graph above, explain:
(i) How a person determines different temperatures of the **(02**

environment. **marks)**

(ii) Why freezing cold and burning hot sensations can be painful **(01 mark)**

Figure **II** below shows the number of receptor cells **(type A – Rods, Type B - Cones)** in the human retina along a horizontal line from the nasal side of the eye to the outer side. Distances are expressed in arbitrary units.

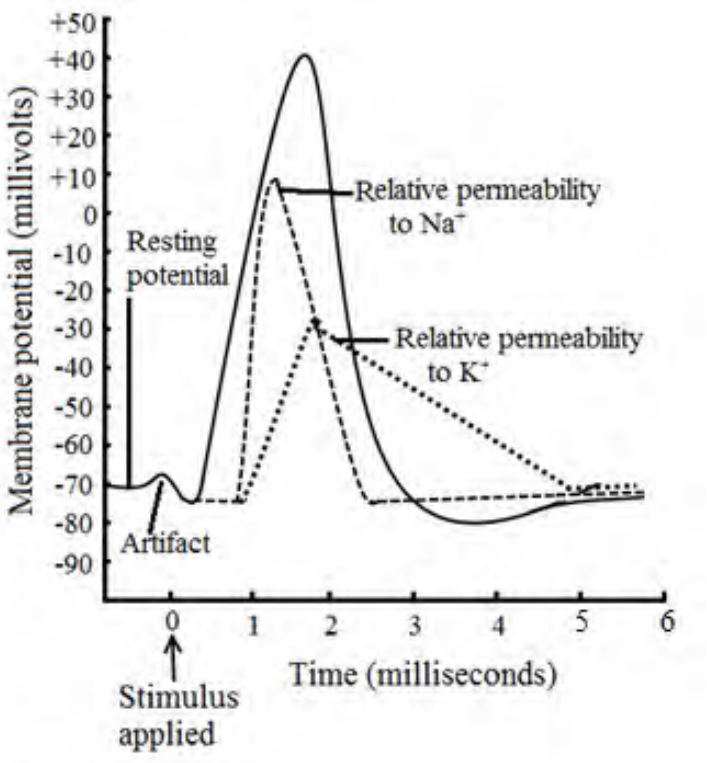


(d) From the graph, describe the distribution of both types of receptor cells in the retina. **(07 marks)**

(e) Explain the significance of the distribution of the two types of receptor cells in the retina as shown in the graph.

(08 marks) NERVOUS AND HORMONAL COORDINATION

46. The figure below shows changes in potential difference and permeability of the neurone membrane sodium ions and potassium ions during propagation of a nerve impulse in an axon.



(a) How is the potential difference of 70mV maintained across the axon membrane? (04 marks)

(b) Account fully for the changes in potential difference and number of ion channels open from 0 ms to 2 ms. (16 marks)

(c) Explain the mechanism of propagation of the nerve impulse along the length of the axon.

(d) Describe the functional properties of neurones

(e) Explain the role played by synapses in animal responses.

47. (a) What is meant by **neurosecretion**?
(b) Explain the role of the hypothalamus in the regulation of neurosecretions.
(c) Describe the mechanism of steroid hormonal action in a named mammal.

EFFECTORS

48. (a) (i) Distinguish between **synchronous** and **asynchronous** muscles in insects.
(ii) Describe the effect of action of synchronous muscles on insect locomotion.
(b) (i) Describe the sliding filament theory of muscle contraction
(ii) To what extent is the sliding filament theory of muscle contraction supported with evidence?

SUPPORT

49. (a) Describe how support is achieved in terrestrial dicots and aquatic plants. (13 marks)
(b) Comment on the suitability of exoskeleton to provide support and locomotion in arthropods. (07 marks)

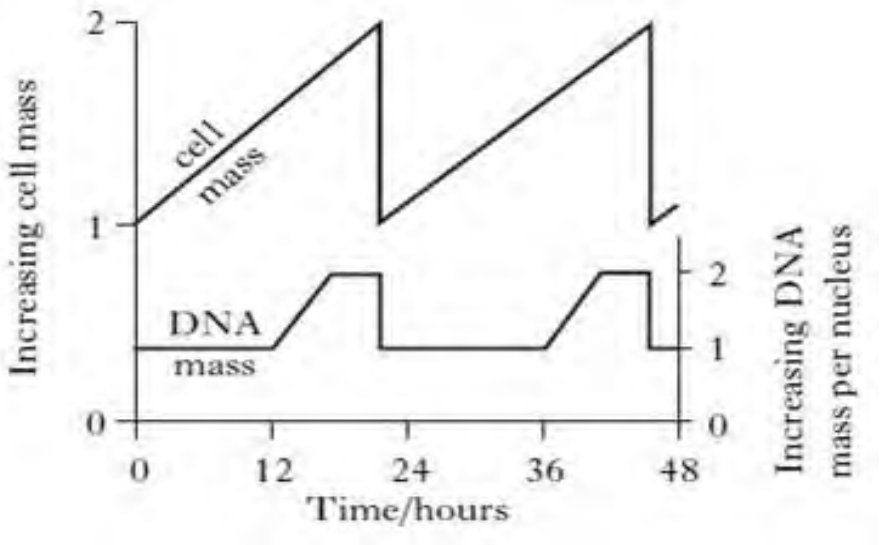
PATTERNS OF BEHAVIOUR

50. (a) Explain the role of each of the following in social behavior:
(i) Territoriality ***(05 marks)***
(ii) Dominance hierarchies ***(03 marks)***
(iii) Courtship behavior ***(03 marks)***
(b) Explain the different forms of honey bee dance communication ***(09 marks)***

PART V: REPRODUCTION, DEVELOPMENT AND HEREDITY

CELL DIVISION

51. Figure 1 below shows changes in the quantities of nuclear DNA and cell mass during repeated cell cycle.
FIGURE 1



The curves in figure 2 below represent changes during mitosis in the distance between:

(i) Centromeres of chromatids and pole of the cell.

(ii) Centromeres of sister chromatids.

Using figure 1:

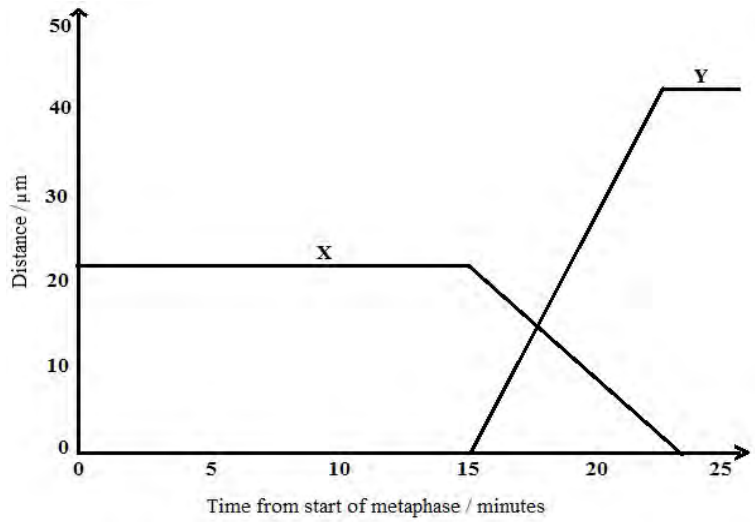


FIGURE 2

(a) For one cell cycle only, describe the changes in:

(i) Mass of DNA. (2½ marks)

(ii) Cell mass. (1½ marks)

(b) For one cell cycle only, explain the trend in:

(i) Mass of DNA. (08 marks)

(ii) Cell mass. (08 marks)

(c) Explain the significance of the observed changes in mass of DNA from 12 hours to about 23 hours.

(01 mark)

Using figure 2:

(d) Identify what curves X and Y represent. (01 mark)

(e) Explain the trend in distance represented by:

(i) Curve X. (08 marks)

(ii) Curve Y. (07 marks)

(f) Explain the variation in the maximum distance achieved in X and Y. (03 marks)

REPRODUCTION

52. (a) The table below shows the difference in percentage saturation of blood with oxygen at varying partial pressure of oxygen between a pregnant woman and that of a fetus developing in her uterus.

Partial pressure of oxygen/mmHg	Percentage saturation of blood with oxygen	
	Mother	Fetus
1.3	8	10
2.7	20	30
3.9	40	60
5.3	65	77
6.6	77	85
8.0	84	90
9.3	90	92
10.6	92	92

(i) Plot the result in a suitable graphical form. **(07 marks)**

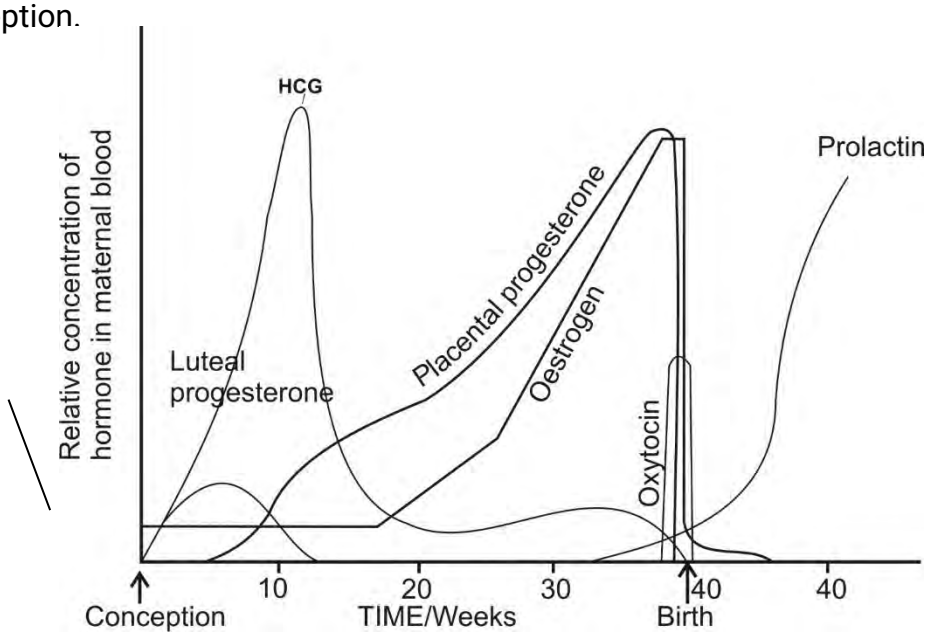
(ii) Compare the percentage saturation of blood for the mother and that of the fetus. **(03 marks)**

(iii) Suggest why the two curves plotted in (a) (i) are sigmoid. **(07 marks)**

(iv) Explain the physiological significance of the position of the fetal curve. **(03 marks)**

(b) The figure below shows the changes in the level of some reproductive hormones immediately

after conception.



(i) Compare the levels of luteal and placental progesterone. **(04 marks)**

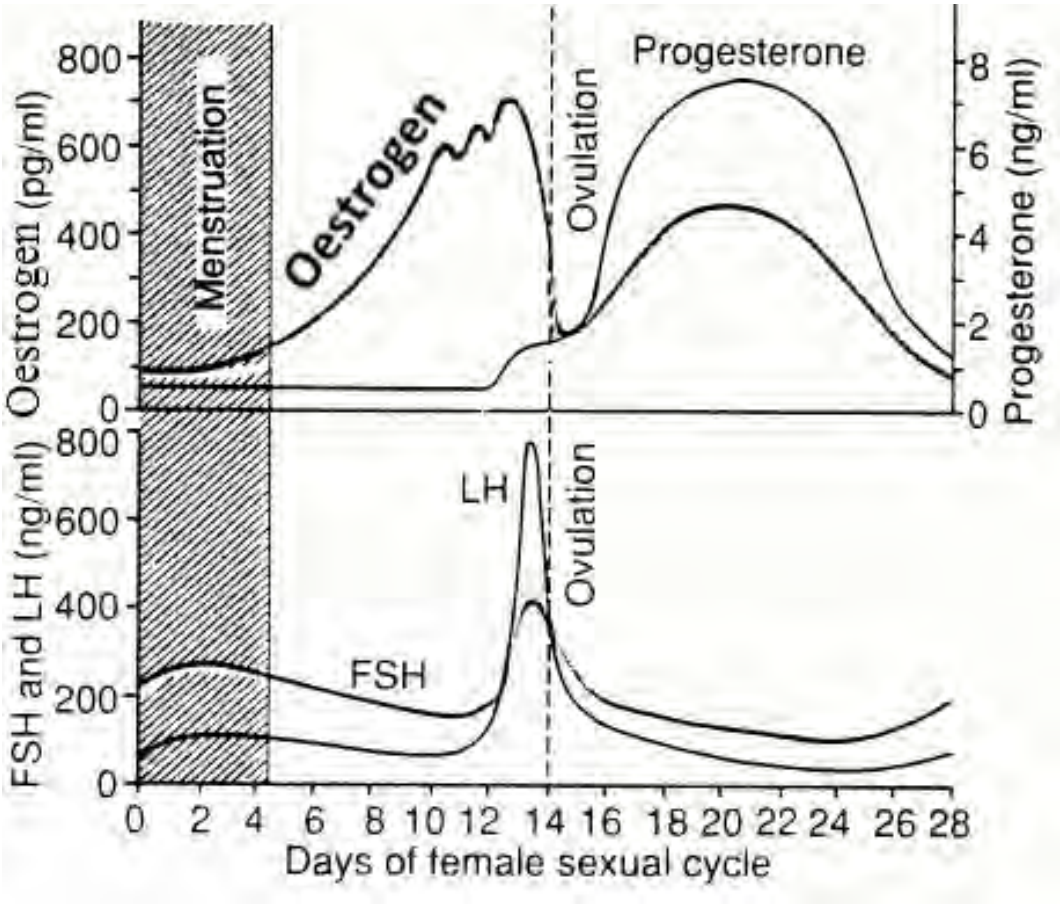
(ii) Explain the variation in the level of:

• HCG (Human Chorionic Gonadotrophin) hormone **(06 marks)**

• Oestrogen hormone **(07 marks)**

(iii) What are the effects of the hormones oxytocin and prolactin towards the end of pregnancy? **(03 marks)**

53. The graph below shows the changes in the sex hormones and thickness of the uterine wall obtained by close observations made using blood samples that were withdrawn from an adult human female at regular intervals of days and by scanning the uterus respectively. The investigation was done for over a period of one month (28 days) immediately after the previous menstruation period.



(a) Describe the changes in the concentration of

(i) Oestrogen hormone. **(05 marks)**

(ii) Progesterone hormone. **(04 marks)**

(b) Explain the different phases of the menstrual cycle **(10 marks)** (c) Explain the relationship between oestrogen and progesterone concentration. **(10 marks)** (d) Explain what would happen if fertilization had occurred on the 21st day of the month.

54. (a) Describe the structure and development of an ovule. **(10 marks)**

(b) Explain the contribution of the different types of pollination to evolutionary potential in plants. **(10 marks)**

THE CYCLE OF LIFE

55. (a) With examples, explain fully what is meant by **parthenogenesis**. **(05 marks)**

(b) Compare alternation of generation in named bryophyte and pteridophyte.

PATTERNS OF GROWTH AND DEVELOPMENT

56. The table below shows the relative changes in dry mass of the endosperm and embryo during germination of maize seeds in a well illuminated environment.

Time after planting (days)	Dry weight of endosperm	Dry weight of embryo (mg)	Total dry weight (mg)
0	43	2	45
2	40	2	42
4	33	7	40
6	20	17	37
8	10	25	35
10	6	33	39

(a) Plot a graph of the data in the date and use it to compare the changes in dry mass of the endosperm and embryo **(02 marks)**

(b) Account for the changes in each of the following during germination of maize:

(i) Dry mass of endosperm **(06 marks)**

(ii) Dry mass embryo **(06 marks)**

(iii) Total dry mass **(06 marks)**

The figure below shows the relative growth rates of the brain, teeth (dentition), whole body and reproductive organs of humans.

(c) Describe the pattern of growth of the reproductive organs. **(03 marks)**

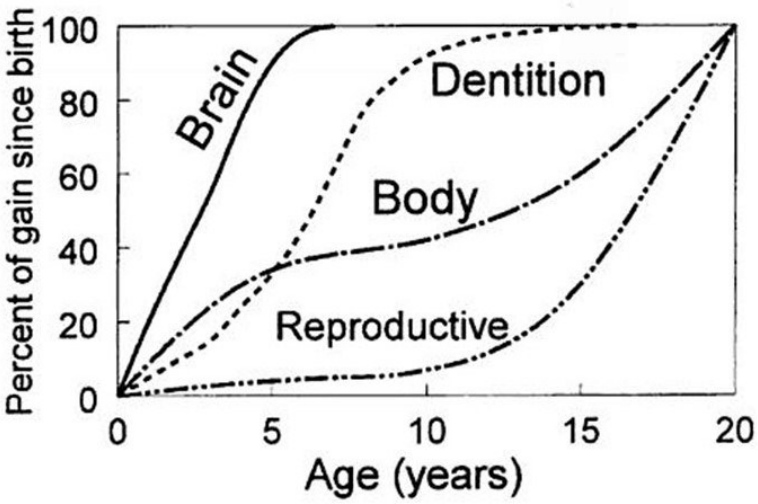
(d) Explain the rate of growth of the:

(i) Teeth. **(06 marks)**

(ii) Brain. **(06 marks)**

(iii) Whole body. **(05 marks)**

(e) Identify and explain the growth pattern exhibited in the figure. **(02 marks)**



CONTROL OF GROWTH

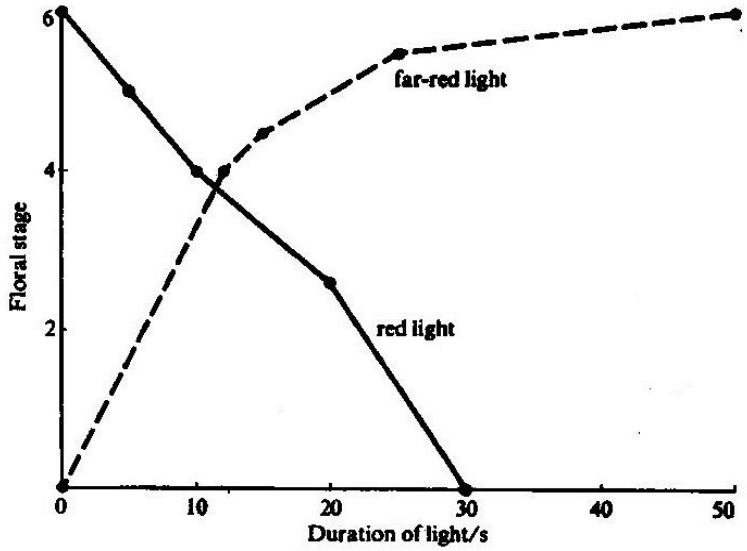
57. (a) What is meant by **photoperiodism**? **(02 marks)** (b) Explain the effect of photoperiod on:

(i) Plant flowering **(08 marks)**

(ii) Dormancy in plants **(04 marks)**

(iii) Breeding behaviour in animals **(06 marks)**

58. A study was carried out to determine the effect of red and far–red light interruptions of long night on the intensity of flowering of a short-day plant. The figure below shows the results obtained from the study.



In another experiment, three species of the genus of a plant and a hybrid between two of them were tested for their vernalisation requirements.

The sample plants of each strain were subjected to different periods of time at 4^0C before being returned to their original conditions.

The number of days which elapsed between the end of cold treatment and the onset of flowering were recorded. The results obtained are shown in the table below.

Weeks at 4^0C	Number of days between end of cold treatment and the onset of flowering			
	A	B	C	AXB (Hybrid)
0	*	40	25	75
1	160	38	25	65
2	110	36	25	50
4	90	34	25	40
8	35	32	25	32
16	24	28	25	24

KEY: *= did not flower

Use the above information in the table and figure to answer the questions that follow.

(a) Describe the effect of interruption of the night period on the intensity of flowering of each of the following types of light:

(i) Red light **(04 marks)**

(ii) Far-light **(04 marks)**

(b) Give the explanation for the effects described in (a) above. **(10 marks)**

(c) Explain how red and far–red light interruptions would have affected the intensity of flowering if they had used a long day plant **(03 marks)**

(d) (i) What was the effect of subjecting the sample plants of each strain to different periods of time at 4^0C. **(05 marks)**

(ii) Explain the results shown in the table **(08 marks)**

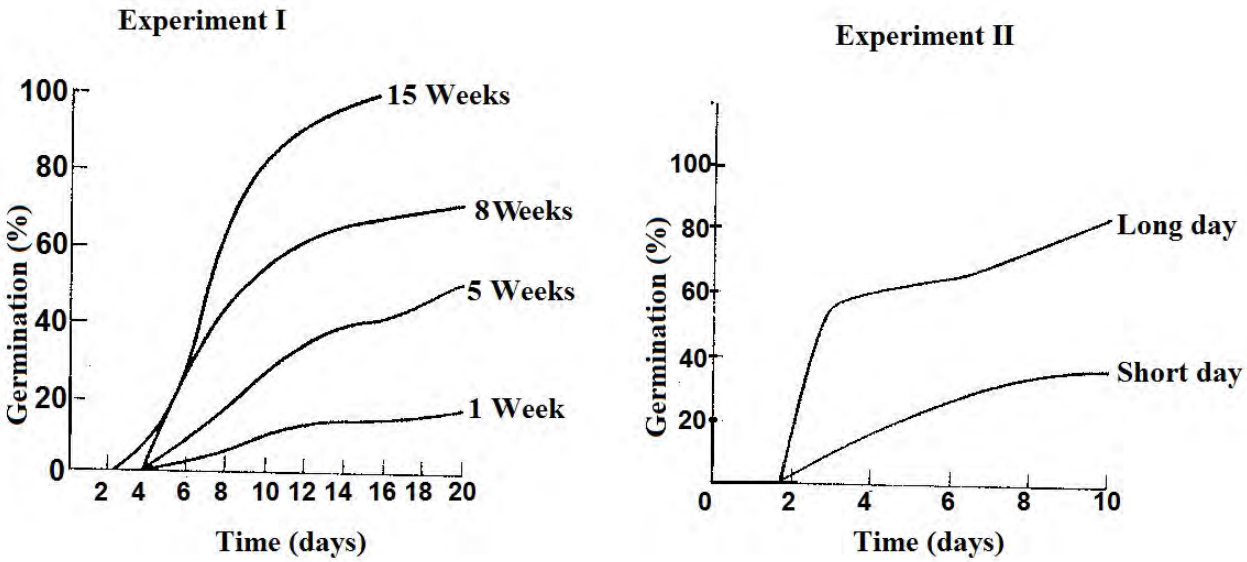
(e) Predict and explain what would happen if the experiment in the table had been carried out at 1^0C. **(03 marks)**

(f) What is the significance of the two experiments to an agriculturalist? **(03 marks)**

59. Experiments were performed to investigate some of the factors which influence flowering of a short day plant species, and the onset of germination of seeds of the same species.

Experiment I was on the effect of increasing time of dry storage on the germination of the species seeds. All the seeds were kept at 15^0C. Each curve represents a germination test on a seed sample stored for the number of weeks indicated.

Experiment II was on the germination of seeds under long-day illumination cycles (20 hours light: 4 hours dark) and short day cycles (20 hours dark: 4 hours light) separately.



Experiment III was on the germination of seeds during an eight day period. Before starting the investigation, some of the seeds and some of the intact fruits were treated as indicated in the table below:

Treatment	*Percentage germination by da y*			
	2	4	6	8

Intact fruits in air	0	6	10	10
Fruits with pericarp cut	0	12	28	38
Naked seeds in air	0	14	30	42
Seeds with testa pricked	14	45	53	53
Seeds in oxygen	40	56	72	78
Pricked seeds in oxygen	25	62	70	84

(a) Compare the percentage germination of the two seed samples in **Experiment II.** **(03 marks)**

(b) Explain the effect of:

(i) Varying illumination cycles on seed germination in **Experiment II.** **(10 marks)**

(ii) Exposed a brief flash of light in the middle of the dark period in **Experiment II** on flowering of the plant. **(04 marks)**

(c) State what would be the effect of illumination on the flowering when the same treatment of the plant in **Experiment II** was subjected to:

(i) A long day plant. **(02 marks)** (ii) A day neutral plant. **(01 mark)**

(d) Explain the effect of changing the period of day storage in **Experiment I** on seed germination. **(07 marks)**

(e) (i) Describe the effect of different seed treatments on seed germination in **Experiment III.** **(03 marks)**

(ii) Account for the observed influence in **Experiment III**. **(04 marks)**

(d) What are the advantages of spores over seeds in reproduction? **(06 marks)**

INHERITANCE

60. Two phenotypically wild-type ***Drosophila*** (with long wings and red eyes) are crossed, and two mutant phenotypes (curved wings and lozenge eyes) are seen to segregate among the progeny as follows: **Females**

600 long-wing, red eyes

200 curved wing, red eyes

Males

300 long wing, red eyes

300 long wing, lozenge eyes

100 curved wing, red eyes

100 curved wing, lozenge eyes

(a) With reasons, state the genetic nature of? **(08 marks)**

(i) The curved wing mutation

(ii) The lozenge eye mutation

(iii) The female parent (iv) The male parent

(b) Using appropriate symbols and a genetic cross, explain the observed results. **(12 marks)**

61. (a) In cats the allele for short hair is dominant to the allele for long hair; the gene involved is autosomal.

Another gene which is sex-linked produces hair colour; its alleles produce black or white coat colour, and the heterozygote combination produces tortoise-shell colour.

If a long-haired black male is mated with a tortoise-shelled female homozygous for short hair, what kind of offspring will be produced in the F_1? **(08 marks)**

(b) Gene R for red flower colour can only express itself phenotypically in the presence of gene C which complements its action to form colour. When two white-flowered plants with genotypes CCrr and ccRR were crossed, the F_1 generation all had red flowers.

What would be the phenotypic ratio of the F_2 progeny when the F_1 progeny are selfed? (Show your working). **(12 marks)**

62. In the garden pea, ***Pisum sativum***, the dominant alleles of two unlinked genes, **A**/**a** and **B**/**b**, are needed to make the pods tough and inedible. All other genotypes result in soft, edible 'sugar-snap' pea pods.

- Pods with genotypes including the dominant allele **A** have a thin layer of cells lining the pod.
- Pods with genotypes in which the recessive allele **a** is homozygous have no thin lining layer.
- Pods with genotypes including the dominant allele **B** have lignin added to the thin lining layer, when it is present.
- Pods with genotypes in which the recessive allele **b** is homozygous do not have added lignin.

(a) Explain the phenotypes of pea pods with the following genotypes: **(04 marks)** (i) **AAbb** (ii) **aaBB**

(b) Two pea plants of genotypes **AAbb** and **aaBB** were interbred to give an **F1** generation, and these in turn were interbred to give an **F2** generation.

Using an appropriate genetic cross, including gametes, show the genotypes and phenotypes of the **F1** and **F2** generations.

Give the ratio of phenotypes expected in the **F2** generation. **(16 marks)**

63. (a) Explain how meiosis can result in an almost infinite genetic variety. *(12 marks)*

(b) Describe sex linkage in humans. *(8 marks)*

GENES AND CHROMOSOMES

64. (a) Explain why a single base deletion from one Deoxyribonucleic molecule usually causes greater effect than the replacement of one base by another different base. **(10 marks)**

(b) Using a named example, describe how a gene mutation may affect a phenotype of an organism.

(10 marks)

65. (a) What is the significance of the distribution of deoxyribonucleic acid in eukaryotic cells?

(05 marks)

(b) How does the structure of deoxyribonucleic acid suit it for functioning? **(08 marks)**

(b) Describe the role of Ribonucleic acid in protein synthesis. **(07 marks)**

66. Give an account of the following disorders: *(20 marks)*

(a) Phenylketonuria (PKU)

(b) Down's syndrome

(c) Erythroblastosis foetalis

(d) Blue-baby condition

PART VI: ECOLOGY AND EVOLUTION

ORGANISM AND ITS ENVIRONMENT

67. (a) Describe energy flow through an ecosystem and the relative efficiency with which it occurs. **(10 marks)**

(b) Explain the impact of the following on ecosystems:

(i) Deforestation **(05 marks)**

(ii) Global temperature rise **(05 marks)**

68. Using named examples in each, discuss the following ecological concepts.

(a) Succession **(07 marks)**

(b) Limiting factors **(06 marks)**

(c) Carrying capacity **(07 marks)**

69. (a) Give an account of different types of survivorship curves. **(09 marks)**

(b) Account for the different types of population dispersion. **(11 marks)**

ASSOCIATIONS BETWEEN ORGANISMS

70. A scientist carried out research on two species of flour beetles (***Tribolium***) and clover (***Trifolium***).

In his research he grew the beetles in the same medium and different media under different climatic conditions.

On the other hand he grew the plants together and separately.

The following are his findings:

Table I:

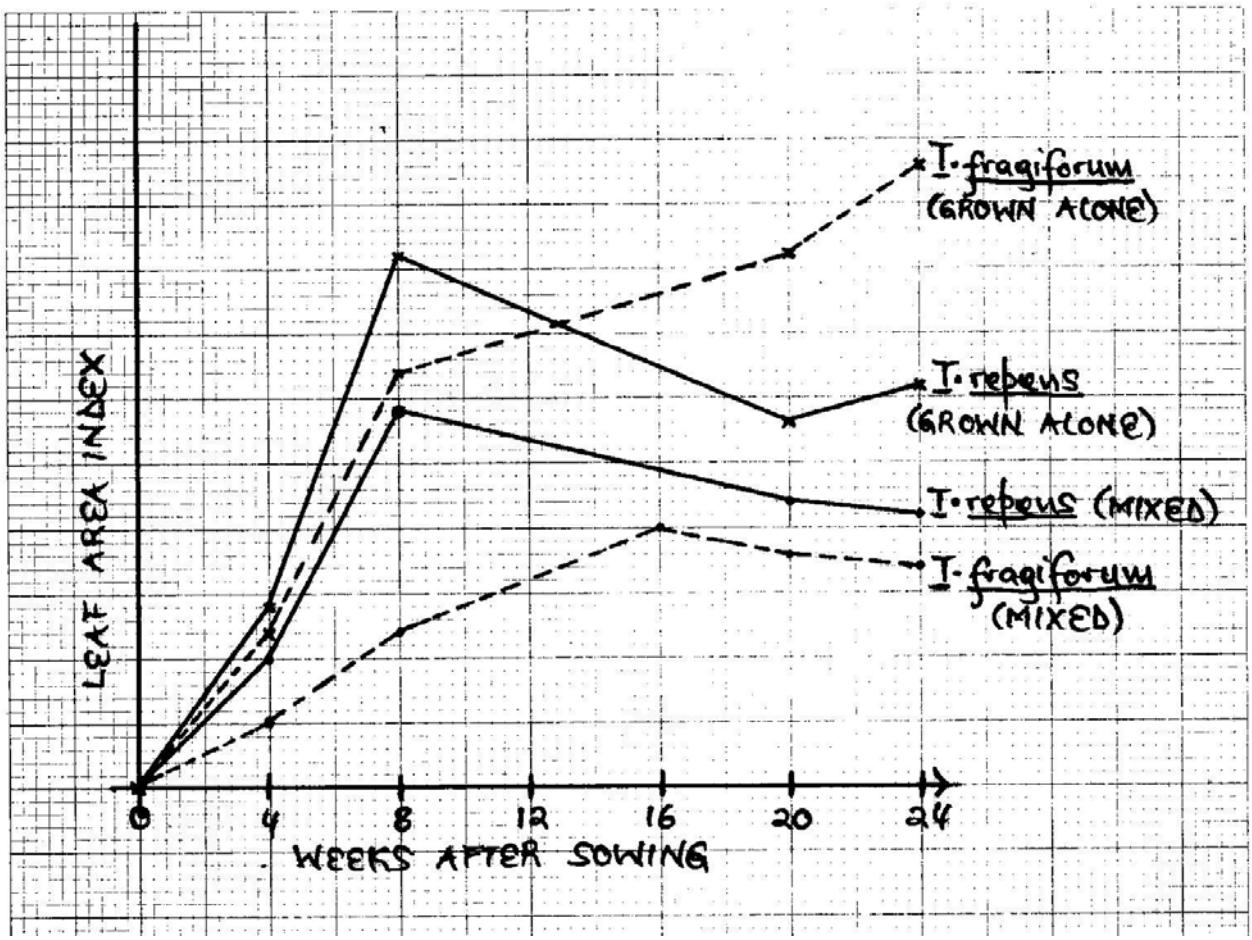
Climate	Temperature/°C	Relative humidity/%	Results of interspecific competition	
			Tribolium castenum	*Tribolium confusum*
Hot-wet	34	70	100	0
Hot-dry	34	30	10	90
Warmwet	29	70	86	14
Warmdry	29	30	13	87
Cool-wet	24	70	31	69
Cool-dry	24	30	0	100

(a) Comment on the effect of changing temperature and relative humidity on the population of *Tribolium* species. (05 marks)

(b) Explain the observed behaviour of the *Tribolium* species over time. (10 marks)

(c) What biological principle is illustrated by the result in table I? (03 marks)

The graph below show the variation of leaf area index for *Trifolium fragiforum* and *Trifolium repens* with time:



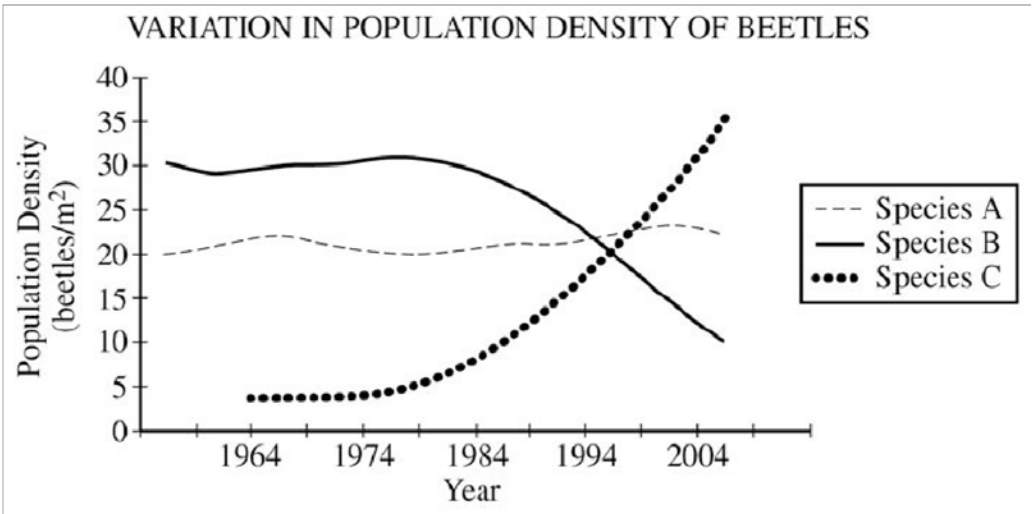
(d) Compare the growth of:

(i) ***Trifolium*** species grown separately. **(06 marks)**

(ii) ***Tribolium*** species grown together. **(06 marks)**

(e) Why did the ***Trifolium*** species grown together not behave like the case of the beetles above? Give evidence for your discussion from the graph. **(07 marks)** (f) State other ecological factors that may affect the population of the beetles and clover in an ecosystem. **(03 marks)**

71. According to fossil records and recent published observations, two species of leaf-eating beetles (species **A** and **B**) have existed on an isolated island in the Pacific Ocean for over 100,000 years. In 1964 a third species of leaf-eating beetle (species **C**) was accidentally introduced on the island. The population size of each species has been regularly monitored as shown in graph **1.**



Graph 1.

(a) Explain the pattern of population density observed in species C. **(07 marks)**

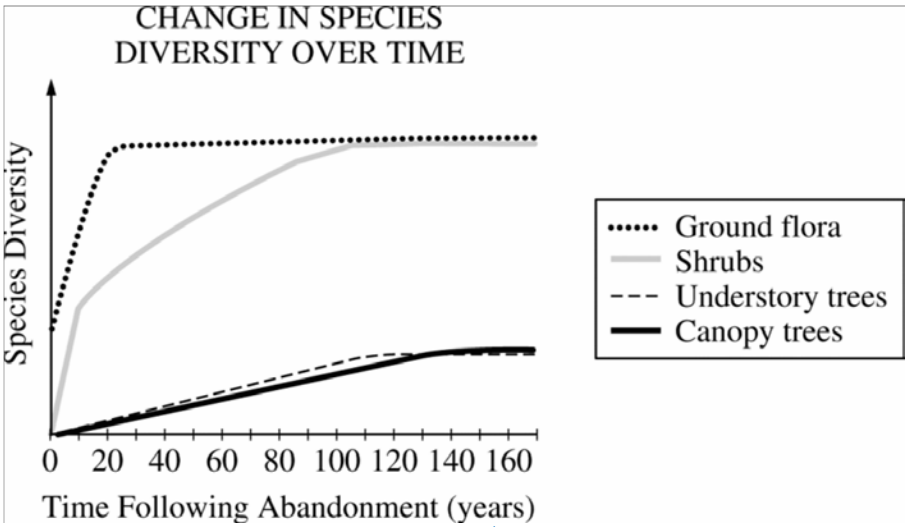
(b) Explain the effect that the introduction of beetle species C has had on the population density of species A and species B. **(05 marks)**

(c) Suggest **e**xplanation for the patterns of population density observed in species A and in species B. **(04 marks)**

(d) With a biological explanation, predict the population density of species C in 2014. **(06 marks)**

(e) Explain why invasive species are often successful in colonizing new habitats. **(08 marks)**

Graph **2** shows changes in plant diversity following the abandonment of an agricultural field in a certain biome.



Graph 2.

(f) **Describe** the differences in plant diversity shown in graph **2**. **(06 marks)**

(g) **Explain** how the changes in plant diversity affect the animal species composition between years 0 and 120. **(04 marks)** **ORIGIN OF LIFE AND SPECIATION**

72. (a) Explain the theory for the origin of species by **panspermia**. *(06 marks)*

(b) Describe the evidence for evolution provided by the geographical distribution of placental marsupial and monotreme mammals. *(04 marks)*

(c) Explain how isolation can lead to speciation. *(10 marks)*

EVOLUTION IN EVIDENCE

73. (a) Explain the modern theory of evolution by natural selection. ***(08 marks)***

(b) With named examples, discuss how natural selection explains the following phenomena:

(ii) Mimicry ***(05 marks)***

(ii) Convergent evolution ***(03 marks)***

(iii) Parallel evolution ***(04 marks)***

POPULATION GENETICS

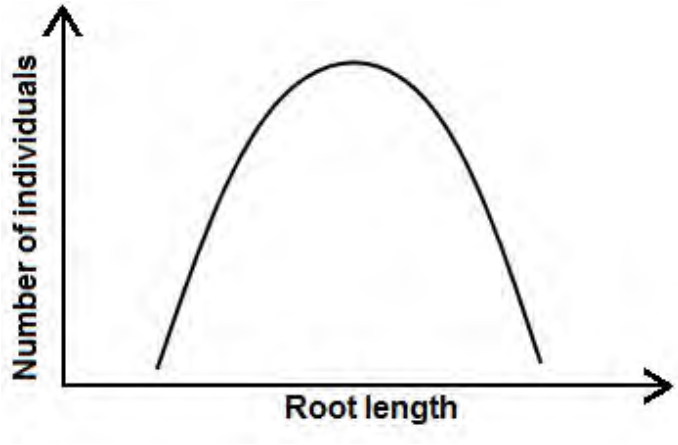
74. In a laboratory population of diploid, sexually reproducing organisms a certain trait was studied. This trait is determined by a single autosomal gene and is expressed as two phenotypes. A new population was created by crossing 51 pure breeding (homozygous) dominant individuals with 49 pure breeding (homozygous) recessive individuals. The table below shows the results obtained after four generations.

Generation	NUMBER OF INDIVIDUALS		
	Dominant	Recessive	Total
1	51	49	100
2	280	0	280
3	240	80	320
4	300	100	400

5	360	120	480

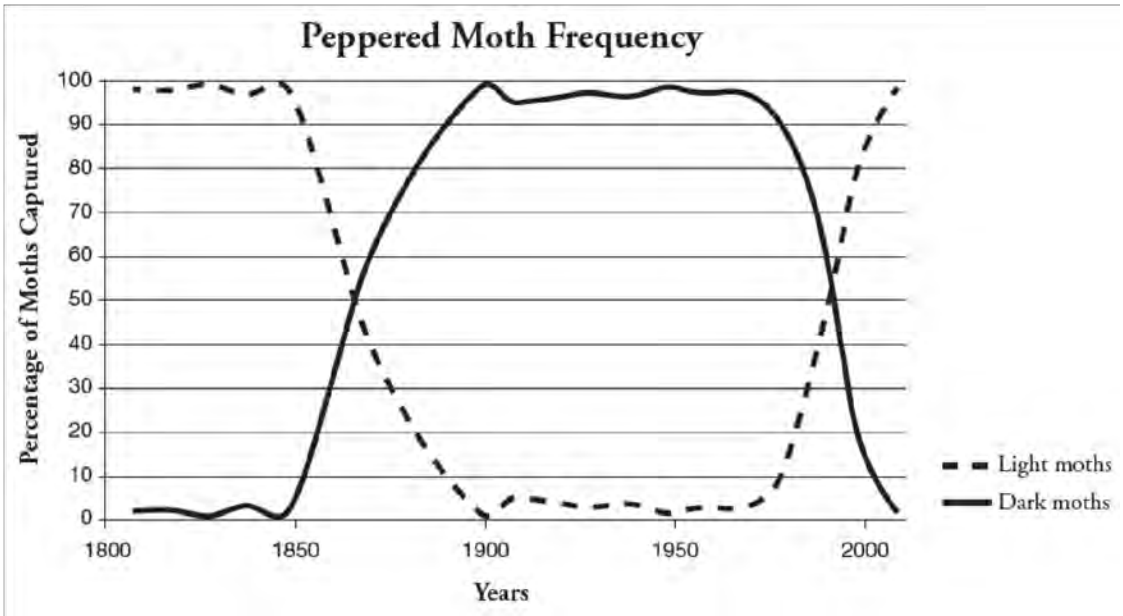
(a) Identify and explain the choice of organism used to perform this experiment. *(03 marks)*
(b) On the basis of the data in the table, suggest explanation for the change in the phenotypic frequency between the first and third generations. *(07 marks)*
(c) Explain whether or not this population is in Hardy-Weinberg equilibrium. *(05 marks)*

The graph below shows the distribution of root length in a population of a species of grass. The population inhabits an area in which the soil water is held mainly below 20 cm.



(d) Explain the type of selection in operation from the information given.
(3 *marks)*
(e) Describe the evolutionary mechanisms that cause a change in the distribution of root lengths.
(3 *marks)*

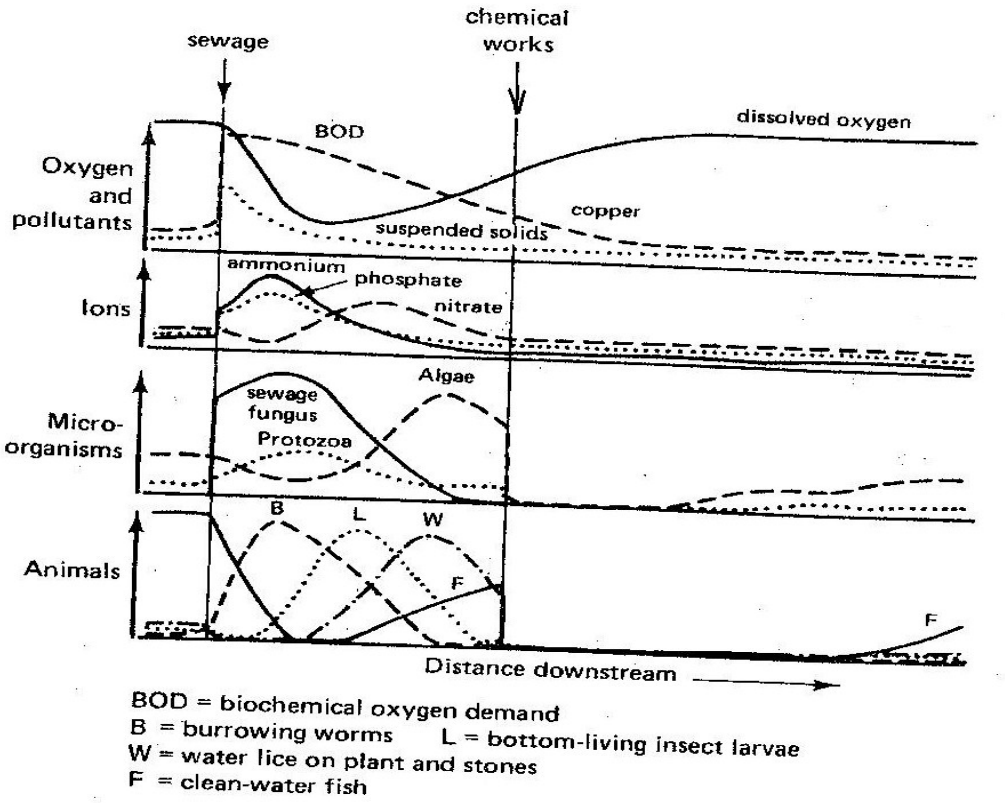
The graph below shows the change in frequency of two varieties of peppered moths in an urban centre, from the period of industrial revolution to the 21st century.



(f) Describe the changes in peppered moth frequency for the period shown. *(5 marks)*

(g) Explain the observed changes in peppered moth population for the period given. *(13 marks)*

75. The figure below shows some of the effects of sewage and waste copper discharge into a river.



(a) Account for the observed changes in:

(i) Biochemical oxygen demand.

(ii) Concentration of ions.

(iii) Population of micro-organisms

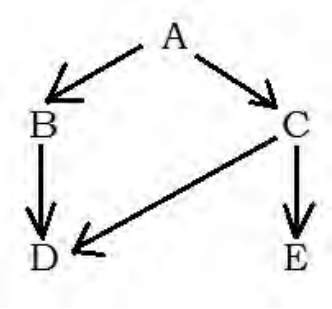
(iv) Population of fresh water vertebrates

(b) With evidence from the figure above, suggest how an organism can be used as a pollution indicator.

(c) Assuming that chemical works also emit heat, suggest the possible effects on the river's: (i) Chemical content.

(ii) Composition of organisms.

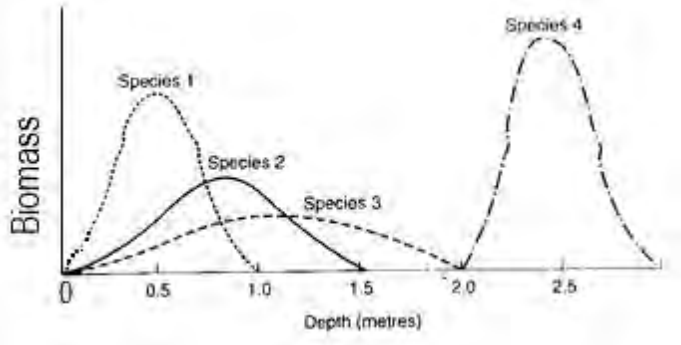
76. The figure below shows the energy flow in a simple food web of five organisms **A, B, C, D** and **E**.



(a) What is meant by the term **food web**? (3 Marks)

(b) Explain the extent to which the populations of organisms **A, B, D** and **E** might be affected over time if organism **C** were **suddenly removed** from the feeding relationship above. (12 marks)

The distribution of four species of organisms at different depths in a pond was investigated and the data presented graphically as shown below:



(c) Describe the distribution of the four species of organisms in the pond. (10 Marks)

(d) Explain the distribution of the four species of organisms in the pond. (15 Marks)

QUESTIONS ON PRACTICALS

DISSECTION

Rat dissection

Question 1 **(40 marks, 60 minutes)**

You are provided with a freshly killed specimen labeled R

i) With reference to the cover the body, give the importance of each of the structure to the animal. (03marks)

ii) Examine feet of the animal, how are they adapted for its survival in the habitat (03marks)

b) Dissect the specimen on the tray to expose the superficial structures of the ventral side of

the neck, displace the visible neck structures and their accessory structure anteriorly. Draw and label

the musculature of the neck, chest region and thoracic region.
(12 marks)

c) Open the abdomen to display vessels that carry blood

To structures responsible for chemical digestion from the heart

From structures responsible for secretion and excretion on the left back to the heart.

Draw and label your dissection excluding the heart. (24marks)

Question 2

a)i) Observe the head of specimen M from the dorsal view. Draw and label the visible structures used for sensitivity. (06marks

ii) Dissect the specimen to expose the musculature of the neck, thorax and fore limbs up to the elbows. Draw and label. (10marks)

b) Pin the specimen provided ventral side up and make a median longitudinal cut through the skin and pin back the skin. Carefully open up the thoracic cavity by cutting through the ribs on either side to the neck.

Display the heart and associated blood vessels.

Turn over the heart upside down and pin it to your left hand side.

Display the following:

Blood vessels that carry blood to the left side of the head region, fore limbs and visible structures in the thoracic cage in undisplaced state. Draw and label your dissection to show the parts you

have displayed. **(24 marks)**

c) By further dissection, display the route of blood flow from the hind limb, abdominal back muscles, and the kidney on the left. Draw and label (13 marks)

Question 3

You are provided with specimen T which is fleshly killed.

a) Examine the hind limb and state three ways it is adapted for the survival of the specimen in its habitat. (03 marks)

b) Examine the head of the specimen and draw and label the ventral view of the anterior part of the head to show the structures for sensitivity. (05 marks)

c) Dissect the abdominal region of the specimen to expose the blood vessels.

i) Returning blood from the structures for reproduction and secretion.

ii) Supplying the structures for absorption of nutrients and excretory organs.

Draw and label (27 marks)

Question 4

a) Dissect the specimen on the tray to expose the superficial structures of the ventral side of the neck and the internal structures of the thorax in undisturbed condition. Draw and

label. (22 marks) ii) Proceed with your dissection and open up the abdominal cavity. Pull and fix the liver lobes anteriorly, turn the stomach upside and displace it to the right side of the specimen. Draw and label the structures previously underlying the stomach.
(11 marks)

b) Dissect the specimen to display vessels that carry blood from structures responsible for digestion and absorption of food in the abdomen. Draw and label the structure displayed.
(17 marks)

c) By further dissection,

Cut and remove the alimentary canal,

Display the blood vessels that drain the left hind limb, kidney and the gonads. Draw and label.
(15marks)

Question 5

(a)You are provided with a freshly killed rat. Examine the animal carefully and describe:

(i) Structure and distribution of fur. (06marks) (ii) The structural features of the tail. (03marks)

(iii) Outline the significance of your observations in (a) (i) and (ii) to the survival of the animal.
(05marks)

(b) Dissect the abdominal region, and display the internal structures in this part of the body. Deflect liver lobes anteriorly, displace duodenum to the right and the rest of the intestine (ileum) to the left. Re-arrange the structures so that the structures within the mesentery can be seen clearly. Cut

and remove stomach and spleen. Draw and label. (20 marks)

Cockroach dissection

Question 1

You are provided with specimen K. Examine it carefully and answer the questions that follow:

a) Place the specimen ventral side upper most spread out the wing and then examine the anterior wing and posterior wing using a hand lens.

i) Give four structural differences observed between anterior wing and posterior wing. (04 marks)
ii) Explain one way the structures of the anterior and posterior wing relate to their function.
(04marks)

ii) Cut off the left hind limb and the outline the adaptations of the structures anterior to the foot of the hind limb that enables the animal to efficiently locomote. *(04 marks)*

b) Place the specimen dorsal side uppermost; open up the abdomen by cutting along the left lateral side. Displace the alimentary canal to the left. Immerse the specimen in water fully. Draw and label all the buoyant internal structures visible in the specimen. *(15 marks)*

c) By further dissection, Dissect the specimen by cutting along the right lateral side of the thoracic region to expose only the structures attached on the ventral cuticle. Draw and label the exposed

structures with the alimentary canal discarded. *(10 marks)*

Question 2

You are provided with specimen Y, which is freshly killed.

(a) Cut off appendages at their proximal ends, remove all the wings including the tegmina. Describe

the structure of the animal's body. (10 marks)

(b) Lay the animal dorsal side upper most, cut off the elytra and the wings close to their bases. Lift the 10^{th} abdominal tergum. Draw and label the visible structures on the ventral cuticle when the tergum is displaced. (4 marks)

(c) State the sex of the specimen. Describe the external structures used for determining the sex. (2 marks)

Question 3

(a) You are provided with a freshly killed cockroach, labeled specimen Q. lay the animal ventral side uppermost. Observe the structures posterior to the point of attachment to the cercus.

i) Count and record the number of abdominal segments visible in this region. (01 mark)

ii) Draw and label (04 marks)

(b) Lay the animal dorsal side upper most. Cut through the left lateral side of the abdomen and thorax, leaving the anterior most segment of the animal intact. Lift the dorsal cuticle and displace it to one side of the specimen. Cover the dissection with water and clear away the fat bodies and displace the alimentary canal to the right of the specimen. Draw and label the exposed structures on both cuticles. (18 marks)

Question 4

You are provided with a freshly killed cockroach.

(a) Cut off the antenna from its base:

(i) Measure and record the length of the antenna and the rest of the body (02 marks).

(ii) What is the significance of the ratio in promoting the survival of the animal (02 marks)

(b) Examine the antenna and describe its structural features. (05 marks)

(c) Explain three ways the antenna is suited to its functions. (03 marks)

(d) Identify the sex of the cockroach, and draw and label those external features which you used to determine the sex of the cockroach. (4 marks)

(e) Remove the wings of the specimen. Pin down the specimen with the dorsal side upper most. Lift the free edge of the tergum in the middle of the right lateral side of abdomen. Cut the anterior edge of the terga and remove all the terga except those posterior to the middle of the abdomen. Avoid damaging the organs.

(i) List all the visible organs after removing the terga. (4marks)

(ii) Make a fully labeled drawing of the digestive system. (8 marks)

(f) Cut off the tegmina, posterior wings, antennae and limbs, Place the specimen dorsal side upper most, cut through its right lateral side and dissect to expose the structures with in the abdominal and thoracic regions. Displace the salivary glands to the right of the specimen. Displace the alimentary canal to the left. Remove all unnecessary tissue to display the alimentary canal and the structures on the ventral cuticle. Draw and label structures exposed in your dissection.

(18 marks).

5. (a) Using a hand lens examine the compound eye, fenestra, antennary pit and antenna. Describe their structural features. (06 marks)

(b) Examine the head region, search for the mouth parts, describe their relative positions and associated structural features. (06 marks)

b) Using a low power microscope, examine the ventral view of the pretarsus.

(i) Describe the structure of the pretarsus (3 marks)

(ii) Draw and label (4 marks)

(c) Place the animal ventral side upper most. Draw and label the posterior end of the abdomen

together with its associated structures. (3 marks)

(d) Place the specimen dorsal side upper most, cut through the left hand edge of the exoskeleton of the abdomen and dissect to expose the structures with in the abdominal region. Displace the alimentary canal to the left of the animal. Remove the unnecessary tissue display all the parts of the alimentary canal and structures on the dorsal cuticle. Draw and label.

(18 marks)

Toad dissection

Question 1

You are provided with a freshly killed specimen labeled W. study it and answer the questions that follow.

a) i) Name the peculiar feature that can aid in the identification of its habitat (01 mark)

ii) Explain briefly the importance of the features named in a)i) above ($02^1/_2$ marks)

b) Give three ways in which the covering of the animal's body is adapted for its survival. **(03 marks)**

c) Lay the specimen on its back with its hind limbs away from you. Cut through the angles of

the jaws to separate.

i) Open the mouth widely. Draw and label the inner side of the lower jaw and floor of the mouth.

ii) Describe an activity which you are going to use to establish how the structures in C(i) above are adapted to their functions and explain briefly your findings.

Description of the activity

Explanation

d) Proceed to pin up the specimen and carry out a normal dissection.

i) Expose the heart turned forward, the routs of the blood vessels and the main tributaries that bring blood from the right side and taking blood away to the left side.

ii) Pull the right lung out and pin

iii) Cut off the lower jaw

iv) Deflect the alimentary canal to your left, lift the left kidney over the right and pin to display blood vessels supplying the digestive system and the kidneys.

v) Cut off and remove the ileum and the rectum.

vi) Cut off and remove other visceral structures posterior to the kidneys and ventral to expose structures attached on the vertebral column. Make one drawing of this dissection and label. (29 marks) **Question 2**

You are provided with **specimen K (Toad)** which is freshly killed. (03marks)

a) Observe the fore and hind limbs. State three observable structural differences between them.

b) Put the specimen ventral side uppermost on a dissecting board and pin with limbs fully stretched. Dissect to pull out the skin from the body wall and upper region of limbs.

i) Observe the right hind limb, draw and label the observable thigh muscles together with the remaining part of limb which should not be labeled. **(06marks)** ii) How significant is the structure of the hind to locomotion. (03marks) iii) How is the skin adapted to gaseous? (02 marks)

c) By further dissection, display the blood vessels draining blood from the thoracic and abdominal cavity organs back to an anteriorly displaced heart. Deflect the alimentary canal to the left of the specimen. Draw and label your dissection.
(26 marks)

Question 3.

You are provided with specimen **K** which is freshly killed.

(a) Examine the dorsal part of the skin and the foot of the hind limbs. How is their structure related to function for the survival of the organism in its habitat?

(i) Dorsal part of skin

(01mark)

(ii) Foot of hind limbs

(02marks) b i) Dissect the specimen to display blood vessels that

(i) Drain blood from the head region

(ii) Supply blood to the lungs

Draw and label the vessels on the left hand side of the specimen including an undisplaced heart.

(13 marks)

(ii) By carefully loosening the tissue, cut out the rectum and lower part of the ileum without damaging the capillaries around it. Displace the remaining part of alimentary canal to the left of specimen and liver lobes sideways to display blood vessels that drain blood from the abdominal region back to an undisplaced heart. Draw and label the visible structures within the abdominal region. **(23 marks)**