



SUBJECT: **Biology**
 PAPER NUMBER: I
 DATE: 10th September 2020
 TIME: 4:00 p.m. to 6:05 p.m.

Answer **ALL** questions in this paper in the spaces provided.

1. a. i) Complete the following table to demonstrate evolutionary trends by four classes of vertebrates.

Evolutionary trend	Fish	Amphibians	Reptiles	Birds
Outer covering	covered in scales			
Terrestrial or aquatic evolutionary adaptation	aquatic			terrestrial
Laying of eggs	in water			on land
Body temperature control		ectothermic		

(5)

- ii) Distinguish between the eggs of reptiles and those of birds.

_____ (2)

- iii) Several species of mammals show highly evolved parental care. State **ONE** mammalian structural characteristic that evolved to provide parental care.

_____ (1)

- b. Carolus Linnaeus created a scheme of classification of organisms. He classified organisms into various groups of different ranks such as kingdom, phylum, class etc. Explain why it is important to classify organisms.

_____ (2)

(Total: 10 marks)

2. The aquatic ecosystem of an aquarium is controlled by various organisms and processes related to the nitrogen cycle. Figure 2.1 shows the management of waste in an aquarium.

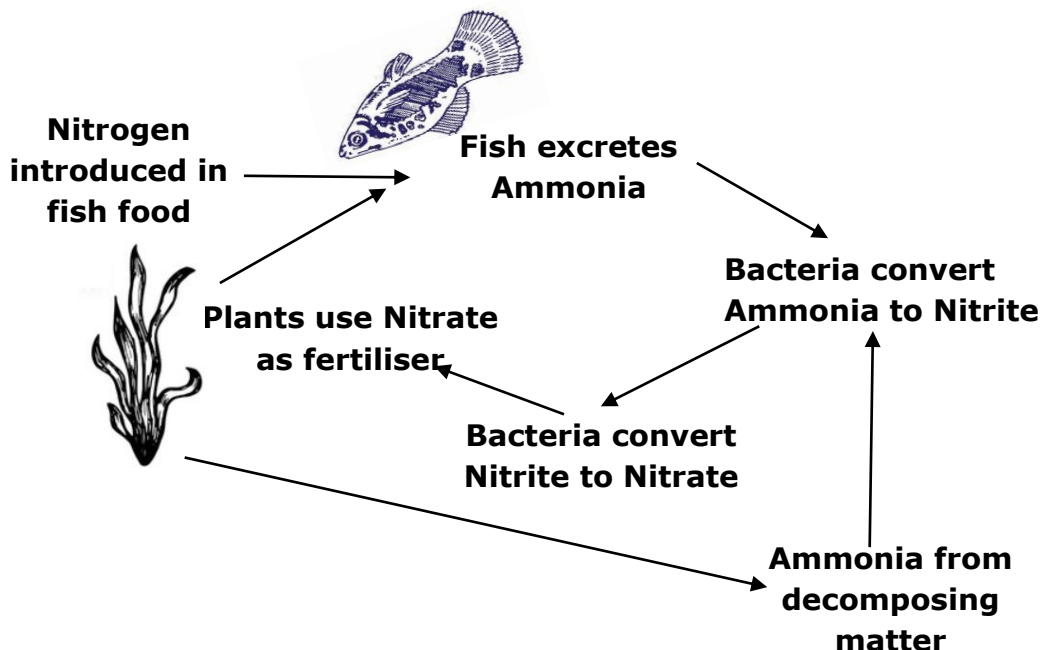


Figure 2.1: Nitrogen cycle in an aquarium
Source: <https://theaquarium.club/understanding-the-nitrogen-cycle/>

a. The decay of waste products and dead matter is the result of organisms acting on this matter.

i) Name **ONE** type of organism (other than bacteria) that decompose matter.

_____ (1)

ii) Give the term used to describe organisms that get energy from dead, decaying matter.

_____ (1)

b. Ammonia in aquariums will destroy the gills of fish. Explain why the breakdown of gill structure decreases the metabolic rate of the fish in the aquarium.

_____ (3)

c. How do nitrates in the aquarium affect this small ecosystem?

(2)

d. Excess nitrates in the aquarium are removed from partial changing of water. In a soil ecosystem, some nitrates are converted to nitrogen gas.

i) Name the type of bacteria that convert nitrates to nitrogen gas.

(1)

ii) Explain why it is impossible for nitrates to be converted to nitrogen gas by such anaerobic bacteria in an aquarium.

(2)

e. The native Carob tree (*Ceratonia siliqua*) is a legume able to convert nitrogen gas into ammonium salts. The Carob tree is found in the same family of other legumes such as peas. Describe the roots of this tree and other legumes.

(2)

(Total: 12 marks)

3. Translocation is a process that occurs in plants.

a. i) Define translocation.

(2)

ii) Name the main substance that is translocated.

(1)

This question continues on next page.

b. A group of scientists carried out an experiment to show translocation in three unripe apples growing on three different branches on an apple tree.

They measured the circumference of each unripe apple.

Then, the scientists removed a ring of phloem from the base of two branches. The xylem was neither removed nor damaged.

After 4 weeks the diameter of each apple was measured.

The table below shows the results obtained.

Branch No.	Treatment of branch	Circumference of unripe apple at start of experiment/mm	Circumference of unripe apple after 4 weeks/mm
1	Phloem not removed	250	275
2	Phloem removed	250	255
3	Phloem removed	250	

i) Explain how the results obtained show that the apple on branch 1 had a faster growth rate than the apple on branch 2.

_____ (2)

ii) Give **ONE** reason why the apple on branch 1 had a faster growth rate than the apple on branch 2.

_____ (2)

iii) Predict the circumference of the unripe apple on branch number 3. Write the value in the space provided in the table. Give a reason for your answer.

_____ (1, 2)

(Total: 10 marks)

4. In a problem-solving investigation, students were asked to investigate conditions for pin mould to grow on bread. The table below shows the bread conditions the students investigated:

Bread slice	Dry/moist	Temperature
A	dry	cold (less than 5°C)
B	moist	cold (less than 5°C)
C	dry	room (around 20°C)
D	moist	room (around 20°C)
E	dry	warm (around 30°C)
F	moist	warm (around 30°C)

a. Describe the structure of a pin mould.

(4)

b. i) Predict on which bread slice the pin mould will grow the most.

(1)

ii) Give **TWO** reasons for your answer to part bi).

(2)

c. All the bread slices above were left in open translucent plastic bags. In a second experiment, bread slices were tightly sealed in the translucent plastic bags.

i) Describe the effect of the sealed bag on the growth of mould.

(1)

ii) Explain why the above effect would be observed.

(2)

(Total: 10 marks)

Please turn the page.

5. a. Name the structures in the diagram of the mammalian urinary system. (3)

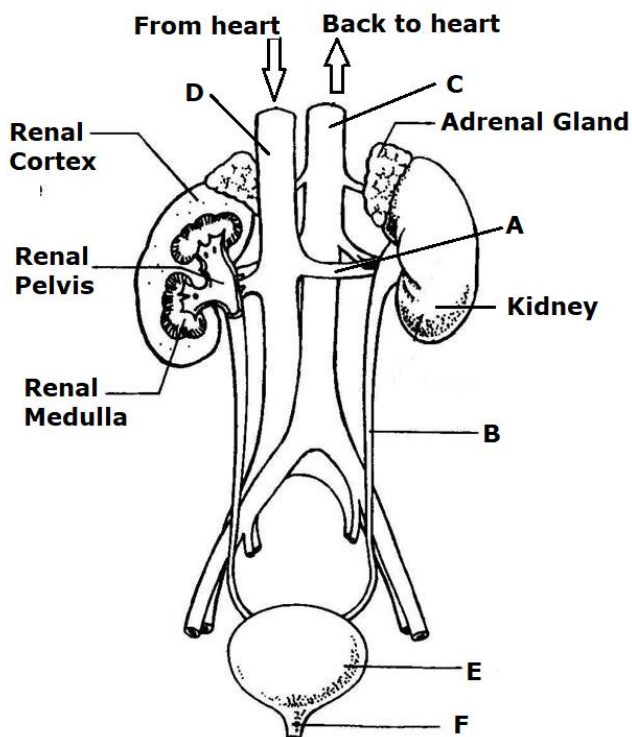


Diagram from: <https://slideplayer.com/slide/4651364/>
 Figure 5.1: The urinary system

A _____ B _____ C _____
 D _____ E _____ F _____

b. The kidney filters blood. The filtered fluid passes along a tubule where some of the substances are absorbed back into the blood. The fluid that remains in the end part of the tubule is urine. The table below shows some of the substances in the blood, the filtered fluid and urine. The numbers show the mass in mg per litre.

Fluid/Substance	Blood plasma	Filtered fluid	Urine
Urea	0.4	0.4	20.0
Glucose	1.5	1.5	0.0
Amino acids	0.8	0.8	0.0
Salts	8.0	8.0	16.5
Proteins	82.5	0.0	0.0

Table from: *Biology GCSE Revise*

i) Using the information in the table, list those substances that pass out of the blood into the tubule.

(2)

ii) Using the information in the table, name those substances reabsorbed into the blood.

(1)

iii) Explain the result for the proteins.

(2)

iv) State the **TWO** main functions of the kidneys.

(2)

(Total: 10 marks)

6. The graph below shows the fluctuating populations of the hare and lynx in a study during the years 1900 to 1920.

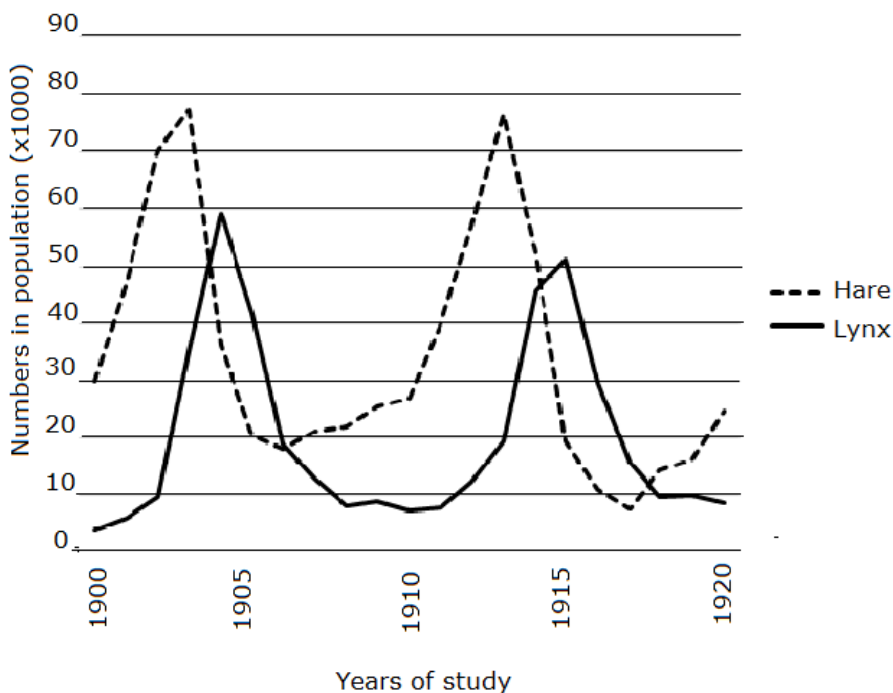


Figure 6.1: Populations of Hare and Lynx between 1900 and 1920

Source: <https://studylib.net/doc/25226280/inquiry-hare---lynx-populations>

a. Describe **TWO** trends observed from the graph.

(2)

b. Give **ONE** reason for an increase in hare population in 1902 and 1912.

(1)

c. Explain why the pattern of fluctuating population of the lynx follows that of the hare.

(3)

d. The population of the lynx is always lower than the population of the hare. Explain why.

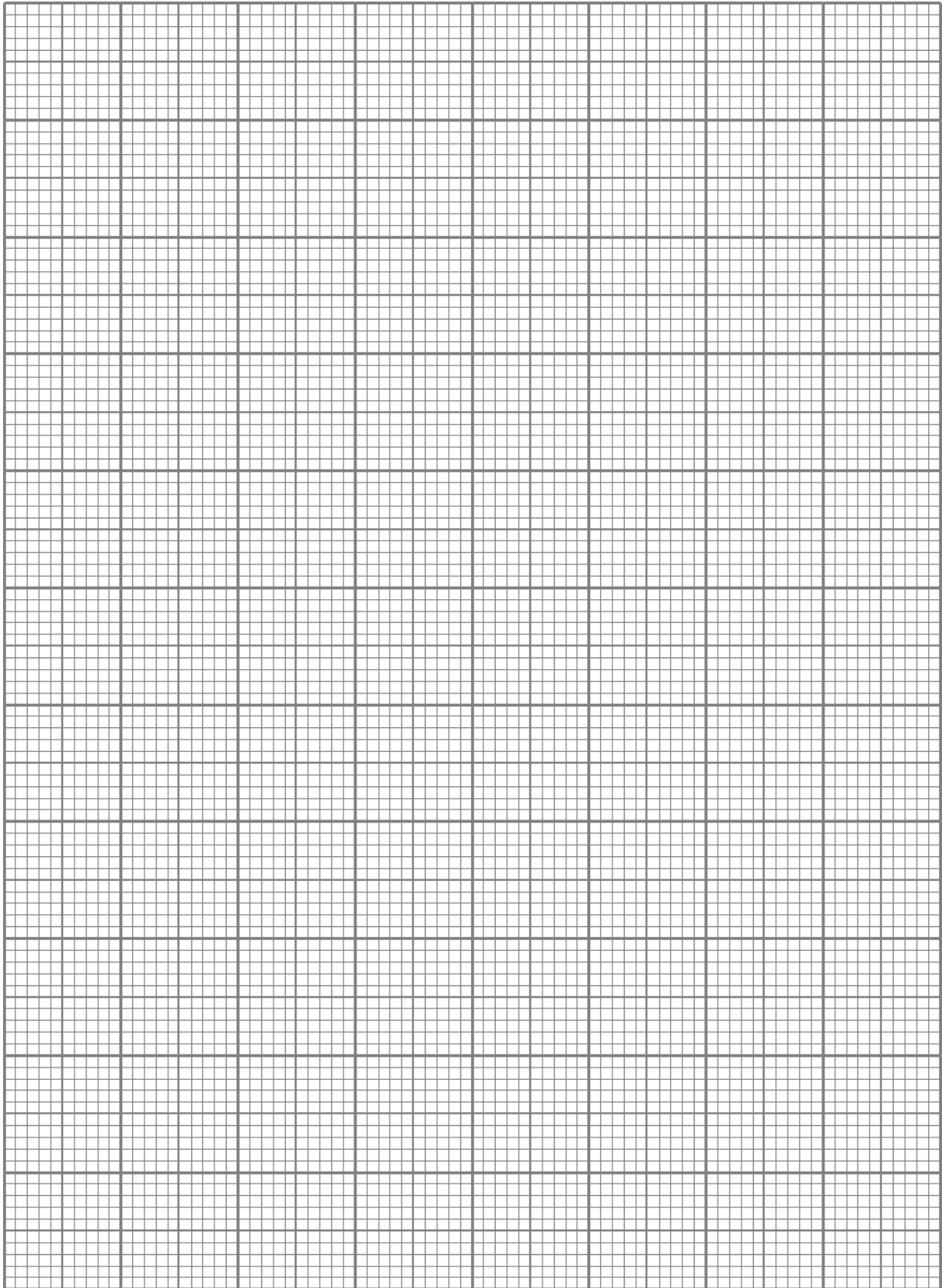
(2)

(Total: 8 marks)

7. The table below shows the results of an experiment to investigate the relationship between the concentration of glucose in the small intestine and the rate of uptake of glucose into the blood.

% concentration of glucose	Rate of uptake (units/min)
1	30
2	38
3	41
4	45
5	50
6	54
7	60
8	66
9	71
10	77

a. Use the graph paper provided to draw a line graph to show the relationship between rate of uptake (on the y-axis) against the % concentration of glucose (on the x-axis). Draw the line of best fit. (5)



This question continues on next page.

b. What would be a more appropriate word for uptake?

_____ (1)

c. From the graph, determine rate of uptake of glucose at 6.5% glucose concentration.

_____ (1)

d. If a 4% solution of glucose contains 60 milligrams of glucose, calculate the mass of glucose in a 6% glucose solution. Show your working.

_____ (2)

e. Name an enzyme involved in the digestion of carbohydrates.

_____ (1)

(Total: 10 marks)

8. Figure 8.1 shows the skull of a sheep and of a dog.

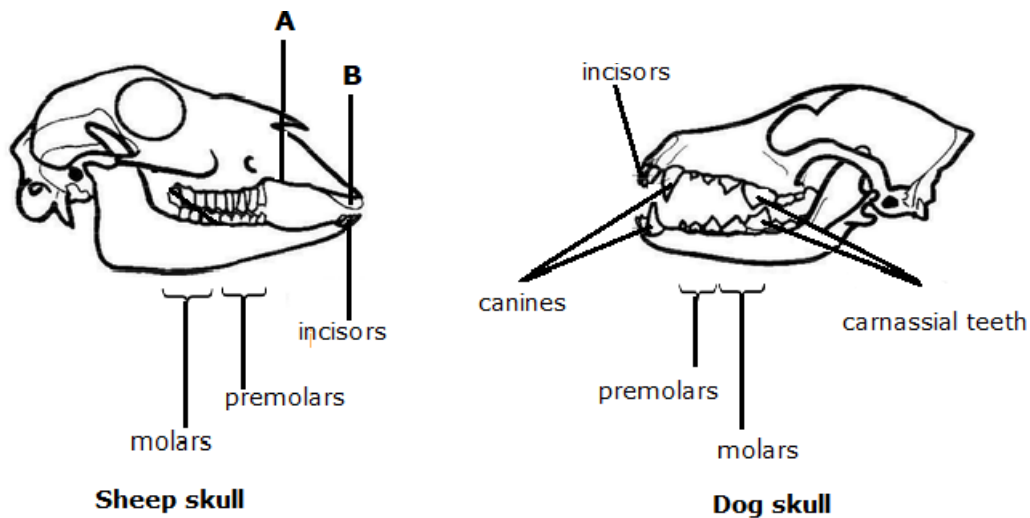


Figure 8.1 The skull of a sheep and the skull of a dog
 Source: <https://dryuc24b85zbr.cloudfront.net/tes/resources/6408784>

a. i) Name the structures labelled A and B in the skull of the sheep.

A: _____ (1)

B: _____ (1)

ii) Give the function of structure B.

(1)

b. In the table below write down the type of teeth shown in Figure 8.1 used to perform the function indicated. (3)

Function	Type of teeth
Used to cut and bite food	
Used to pierce and kill prey	
Used to crush and grind	

c. Figure 8.2 shows the skull of the dinosaur *Triceratops*.



Figure 8.2: Skull of the dinosaur *Triceratops*
Source: https://www.seekpng.com/ipng/u2e6y3o0y3i1e6t4_a-triceratops-skull-skull/

Is a *Triceratops*, a herbivore or a carnivore? Give **TWO** reasons for your answer.

Herbivore or carnivore: _____

Reason 1: _____ (1)

_____ (1)

Reason 2: _____

_____ (1)

(Total: 9 marks)

Please turn the page.

9. The process of photosynthesis is an essential process for all living organisms.
 a. Write a chemical or word equation to summarise the process of photosynthesis.

(2)

- b. Students investigated the effect of temperature on the rate of photosynthesis in the aquatic plant *Hydrilla*.
 They set up the experiment as shown in Figure 9.1 and repeated the experiment in different water baths set at different temperatures. They determined the rate of photosynthesis by counting the number of air bubbles released in 1 minute.

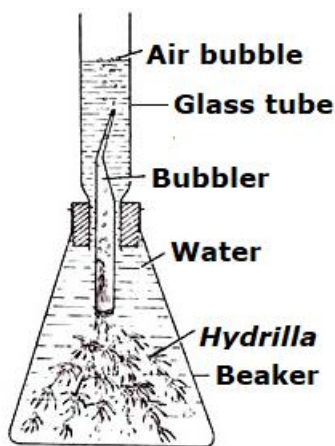


Figure 9.1 Set-up to investigate the effect of temperature on the rate of photosynthesis in *Hydrilla*
 Source: <http://cdn.biologydiscussion.com/>

The table below shows the results obtained.

Temperature/°C	Number of bubbles in 1 minute
15	21
20	25
25	30
30	33
35	35
40	40

Source: <http://www.biologydiscussion.com/experiments/photosynthesis-experiments>

- b. i) State **TWO** variables that need to be kept constant in this experiment.

(2)

- ii) Explain why the number of bubbles produced in 1 minute increases with increasing temperature.

_____ (2)

- iii) When the experiment was repeated at 80 °C, no bubbles were released. Give **ONE** reason for this observation.

_____ (2)

- c. A group of scientists in India studied the effect of pollution on the concentration of chlorophyll in leaves of different species of plants. They compared the concentration of chlorophyll in polluted and unpolluted areas and determined the percentage difference in concentration.

The table below summarises their results:

Plant species	Concentration of chlorophyll in leaves in unpolluted areas /mg g ⁻¹	Concentration of chlorophyll in leaves in polluted areas /mg g ⁻¹	% difference in concentration of chlorophyll
<i>Azadirachta indica</i>	2.19	1.04	52.40
<i>Mangifera indica</i>	2.75	2.02	26.55
<i>Nerium oleander</i>	2.14	1.25	41.71
<i>Dalbergia sissoo</i>	3.64	2.25	38.32

Adapted from <http://www.shorturl.at/fMOY1>

- i) Describe the overall effect of pollution on the concentration of chlorophyll in leaves.

_____ (1)

- ii) Explain how this change will effect the rate of photosynthesis. Give a reason for your answer.

_____ (2)

(Total: 11 marks)
Please turn the page.

10. The following diagram shows part of a wind pollinated flower.

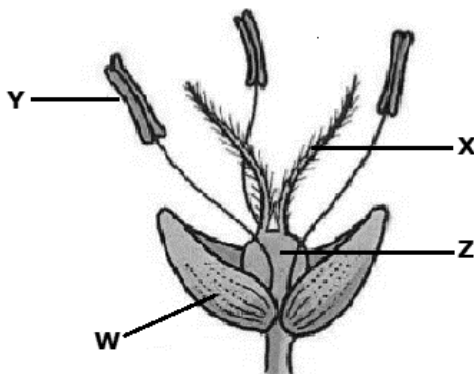


Figure 10.1: A wind pollinated flower

Source: <https://slideplayer.com/slide/5661384/>

a. i) Which **TWO** of the following statements **incorrectly** state the function of each part?

- W** Is colourful and produces scent to attract insects for pollination.
- X** Small and sticky to receive pollen grains.
- Y** Large amount of small, dry and smooth pollen grains are produced here.
- Z** Develops into fruit.

Incorrect statements _____ (2)

ii) Rewrite your answers to part ai) in the correct form.

_____ (2)

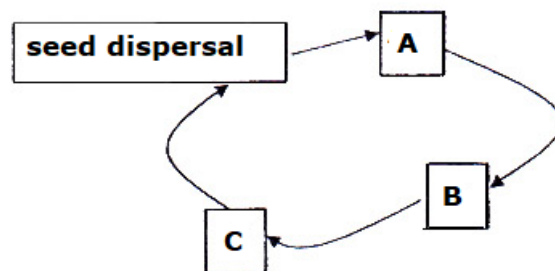
b. A botanist removed different parts of a brightly coloured flower of the same plant as tabulated below:

Flower	Petals	Ovary	Ovule
i)	Removed after pollination	Present	Present
ii)	Removed before pollination	Present	Present
iii)	Left intact	Absent	Absent

Which flower is most likely to form fruit and seeds? Give **ONE** reason for your answer.

(3)

c. The diagram below shows four processes in the life of a flowering plant.



i) Which **ONE** of the following represents the missing processes A, B and C?

	A	B	C
I	Pollination	Germination	Fertilisation
II	Germination	Fertilisation	Pollination
III	Germination	Pollination	Fertilisation
IV	Fertilisation	Germination	Pollination

(1)

ii) Explain why dispersal of seeds is very important for the survival of plant species.

(2)

(Total: 10 marks)

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SUBJECT:	Biology
PAPER NUMBER:	IIA
DATE:	11 th September 2020
TIME:	4:00 p.m. to 6:05 p.m.

Write your answers on the booklet provided. Write down the number of the questions you answer on the front page of your answer booklet.

Please note that for question 2 of this paper you need the graph paper in the booklet.

SECTION A: Answer ALL questions in this section. This section carries 25 marks.

1. Read the following passage and then answer the questions that follow.

Plants keep track of time

Circadian clocks are behavioural changes that follow a daily cycle. They respond primarily to light and darkness in an organism's environment.

The circadian clock controls almost all aspects of plant biology, including growth, flowering, photosynthesis and the opening and closing of leaf stomata. In most plants, the stomata open just before dawn and use their internal clocks to 'measure' day length, which determines the plant's flowering time. For example, some short-day plants (e.g. rice, chrysanthemums), only flower when the daylight is shorter than a critical length. Chrysanthemums, for instance, will start to flower if the day is shorter than their critical day length of 15 hours, so tend to flower in the spring or autumn. Long-day plants (e.g. lettuce, spinach) have the opposite response, so will only flower when the day exceeds a critical length during the summer.

Short-day and long-day plants with a faulty circadian clock flower earlier or later than they would do normally, as they are unable to determine the day length. Non-functional clocks can even affect plants' defence mechanisms, preventing them from synthesising defence compounds at the right time of day, making them more prone to attack by insects. Circadian clocks thus have important implications for agricultural productivity. Experiments using the model plant *Arabidopsis* demonstrate that, in controlled laboratory conditions, plants with a non-functioning circadian clock grow less well than plants with a functioning clock.

As the clock controls the flowering time, it also dictates harvest time for plant species. For example, the barley that is grown in southern Europe is sensitive to day length, so it flowers early in the spring and is harvested in early summer before it gets too hot. In northern Europe, however, the climate is much cooler; the barley grown there has a natural mutation that affects the way that the clock regulates genes controlling flowering time, making the plant less sensitive to day length. This mutation allows the plant to take advantage of the longer summer days so it can be harvested in the autumn. As a result, there is increasing interest in the circadian clock from biotechnology companies hoping to increase crop yields by manipulating the circadian clock.

Source: <https://www.scienceinschool.org/content/how-plants-beat-jet-lag>

- a. From the text, identify the importance circadian clocks have on plant biology. (2)
- b. Why do stomata open just before dawn? (1)
- c. Draw labelled diagrams to show how guard cells control the size of a stoma:
 - i) in the light; and
 - ii) in the dark. (3)
- d. Explain how biological clocks enable different plants to flower in different seasons. (2)
- e. Barley grown in northern Europe has a natural mutation that affects the way that the clock regulates genes controlling flowering time.
 - i) What is a mutation? (1)
 - ii) Explain how mutations in genes controlling flowering time affect crop yield. (1)
 - iii) Give a reason why there is increasing interest in the circadian clock from biotechnology companies. (2)

(Total: 12 marks)

2. A group of students investigated the effect of chloride ions on the rate of breakdown of starch by salivary amylase.

The data in the table below shows how the rate of breakdown of starch by salivary amylase varies in the absence and in the presence of chloride ions.

Concentration of starch/ mg cm ⁻³	Rate of breakdown of starch in absence of chloride ions/ arbitrary units	Rate of breakdown of starch in presence of chloride ions/ arbitrary units
0	0	0
25	1	3
50	3	8
75	6	12
100	10	14
125	12	18
150	18	21

- a. On the graph paper provided (use the 2 mm grid scale), draw a graph to show the variation in the rate of breakdown of starch in the absence of chloride ions with increasing concentration of starch. Join the points of the graph using a ruler. Plot concentration of starch on the x-axis. Using the same pair of axes plot a graph to show how the rate of breakdown of starch in the presence of chloride ions varies with increasing concentration of starch. Join the points of this graph using a ruler. (6)
- b. State the effect of chloride ions on the rate of breakdown of starch by salivary amylase. (2)
- c. List **TWO** variables that need to be kept constant during this experiment. (2)
- d. The students performing this experiment used Iodine solution to determine when starch was completely broken.
- i) Name the compound formed when starch is broken by salivary amylase. (1)
 - ii) Describe how Iodine solution may be used to determine when starch is completely broken. (2)

(Total: 13 marks)

Please turn the page.

SECTION B: Answer any THREE questions from this section.

3. In 2015, a new virus CpV-BQ2 from the group giant viruses (Megavirales) was found in protists in Lake Ontario, Canada.

- a. Describe the structure of a virus. (2)
- b. An article about this discovery states that some giant viruses have genes for replication. A gene forms a section of DNA.
 - i) Describe the function of a gene. (2)
 - ii) Briefly describe the structure of DNA (deoxyribonucleic acid). (4)
- c. Protists infected by CpV-BQ2 are usually either photosynthetic organisms or amoeboid organisms (*Amoeba*).
 - i) Are protists prokaryotic or eukaryotic cells? Give **ONE** reason for your answer. (2)
 - ii) List **ONE** organelle inside the photosynthetic protists that is **not** present in the amoeboid protists. (1)
- d. Fresh water protists have a contractile vacuole. State the function of this structure and describe how it works in relation to the surrounding fresh water environment. (3)
- e. Protists live in different environments. Some protists such as *Trichonympha collaris* reside in the guts of termites.
 - i) A termite is an insect. State **ONE** characteristic feature of insects. (1)
 - ii) Give **TWO** features of the phylum of the class insects. (2)
 - iii) Termites are wood eaters. A scientist described the protists inside the guts of termites as getting the insects to digest the indigestible. Explain. (3)
- f. Other protists reside in leaf litter or the bark of dicotyledonous trees.
 - i) List **THREE** characteristics of dicotyledonous plants. (3)
 - ii) Explain how leaf litter increases soil fertility. (2)

(Total: 25 marks)

4. a. Vaping is the inhalation of vapour produced by e-cigarettes. The vapour contains nicotine, a substance also found in cigarettes, and is produced to resemble cigarette smoke.

Excessive vaping has been linked to a condition called 'popcorn lung'. When a human develops this condition, the smallest airways to the air sacs become scarred and rigid while the air sacs become constricted.

- i) Name the 'smallest airways leading to the air sacs' of the lungs. (1)
- ii) Describe the role of the air sacs (alveoli) of the lungs. (2)
- iii) List **THREE** characteristics of surfaces such as the alveoli. (3)
- iv) People suffering from 'popcorn lung' become breathless when they are slightly active. Identify **TWO** structural abnormalities from the initial statement and, for each, state a reason for breathlessness. (4)

b. Cigarette smoke contains other toxic and harmful gases. Emphysema is a condition caused by long-term smoking.

- i) Describe the lungs of a person suffering from emphysema. (2)
- ii) Explain what causes this change in the lung structure. (2)

- c. Carbon monoxide is found in cigarette smoke but is also a gas produced from the burning of fossil fuels. This gas binds permanently to haemoglobin instead of oxygen. Describe the effect of carbon monoxide on:
- i) the muscles (attached to the skeleton); (1)
 - ii) the heart. (1)
- d. Surfactant dysfunction is a genetic lung condition caused when the tissues surrounding the air sacs fail to produce enough lubricant fluid for inhalation and exhalation to occur properly.
- i) Describe the mechanism of ventilation in a human. (4)
 - ii) Surfactant dysfunction is caused by an autosomal recessive allele. Use genetic diagrams to explain the probability that two carrier parents of surfactant dysfunction have an affected child. (5)

(Total: 25 marks)

5. a. Mongolia has large areas of grasslands where sheep are reared for their cashmere wool. These grasslands are threatened by overgrazing and climate change.
- i) Explain the effect of overgrazing on the vegetation and soil. (2, 2)
 - ii) In the last 60 years, the overall temperature in Mongolia has increased by 2.07 °C while the rainfall has decreased. Explain the effects of this climate change on the vegetation. (2)
 - iii) Explain how and why these changes will affect other herbivorous wildlife populations. (2)
 - iv) Explain **ONE** method used to decrease the effect of overgrazing in an area of the grasslands. (2)
- b. The Food and Agriculture Organisation (FAO) of the United Nations issued the following statement:
 'Ending hunger and all forms of malnutrition by 2030 is an immense challenge.'
 Figures from the FAO 2019 report show that 10.8% of the world population is suffering from malnutrition with Eastern Africa having the highest percentage of 30.8% and Northern America and Europe having the lowest rate of less than 2.5% in 2018.
- i) Give **TWO** reasons for malnutrition in Eastern Africa. (2)
 - ii) On the other hand, in 2019, Italy passed a law to send unsold food to charities. Explain the environmental benefit of this law. (2)
- c. Almost 10,000 km² of the Amazon rainforest was destroyed between August 2018 and July 2019.
- i) The Amazon rainforest is described as a carbon store. Explain. (4)
 - ii) Give **TWO** reasons why trees are cut down in the Amazon. (2)
 - iii) State **TWO** effects of deforestation. (2)
 - iv) An article about the Amazon rain forest included the following statement:
 'The Amazon rainforest takes in more carbon dioxide than it breathes out'.
 Discuss this statement with respect to global warming. (3)

(Total: 25 marks)

Please turn the page.

6. The following diagram shows a simplified view of the human heart and some of the blood vessels in the blood circulatory system. Some of the structures are labelled with letters A to K. Arrows show the direction of blood flow. Use letters on the diagram to answer the following questions:

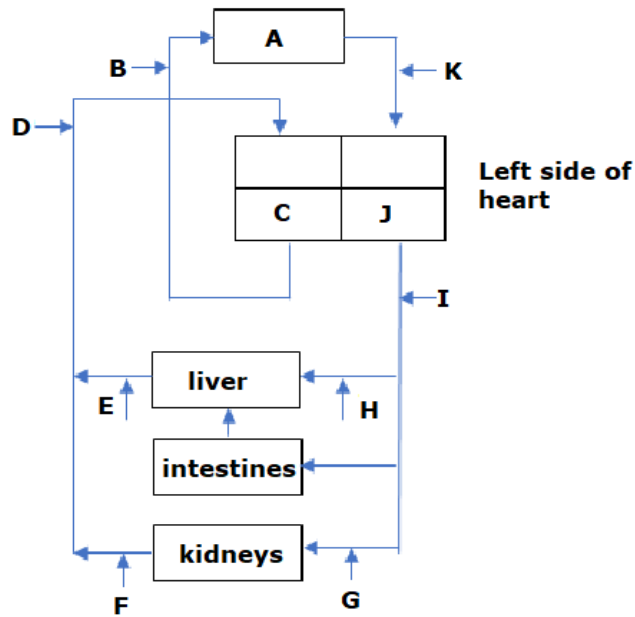


Figure 6.1: The human circulatory system

- a. Name the structure represented by A. (1)
- b. i) Name the part of the heart shown by letter C. (1)
 ii) Explain why the walls of part C and part J are of different thickness. (2)
- c. Explain why the hepatic portal vein carries high concentrations of glucose and amino acids. (1)
- d. i) Give the letter of the blood vessel with the highest blood pressure. (1)
 ii) Give **ONE** characteristic of this blood vessel that allows it to withstand high blood pressure. (1)
 iii) Give the letter of the vein that carries oxygenated blood. (1)
- e. Describe how a sluggish flow of blood influences gaseous exchange at the lungs. (2)
- f. 'Arteries carry oxygenated blood while veins carry deoxygenated blood'. State whether this is a correct statement. Explain. (2)
- g. Why are cells in tissues unable to survive without a capillary network? (3)
- h. State **THREE** structural differences between arteries and veins. Give your answer in table form. (3)
- i. Discuss how air pollution affects the circulatory system if several pollutants damage the inside walls of blood vessels making them narrower and less flexible. (2)

- j. The relative amounts of plasma and cellular components of blood remain constant regardless of age. The bone marrow always retains enough power to supply as many blood cells and platelets as needed.
- i) Distinguish between the cellular components of blood. (2)
 - ii) The number of platelets circulating in the blood remains unchanged throughout one's life. Why is this important? (1)
 - iii) Age changes in white blood cells include decreases in the number and rate of release of stored cells, rate of movement, ability to be chemically attracted to areas, and proportion of cells capable of performing phagocytosis. Explain how these changes will affect the human body. (2)

(Total: 25 marks)

7. Figure 7.1 shows a photo of a koala bear with its young. Koala bears are mammals that live in Australia.



Figure 7.1 A koala bear with its young

(<http://www.chinadaily.com.cn/sunday/img>)

- a. i) Name the kingdom and phylum that koala bears belong to. (2)
- ii) With reference to Figure 7.1, give **TWO** visible features to support the statement that koala bears are mammals. (2)

This question continues on next page.

- b. Populations of koalas in Australia are decreasing due to climate change, loss of habitat and disease. If unchecked, this may eventually lead to extinction of koala bears. The disease that is threatening the survival of koala bears is caused by chlamydia, bacteria that cause a common sexually transmitted infection in humans. There are two strains of chlamydia that affect koala bears *Chlamydia pecorum* and *Chlamydia pneumoniae*.
- i) List **THREE** differences between a cell taken from a koala and a chlamydia cell. Present your answer in table form. (3)
 - ii) The two strains of chlamydia belong to the same genus but are different species. Use evidence in paragraph b, to explain this statement. (2)
 - iii) Define the terms population, habitat and extinction. (3)
 - iv) Give **TWO** ways how loss of habitat can be controlled to ensure the survival of koala bears. (2)
- c. Treating the koalas with antibiotics (medicines that destroy bacteria) to kill chlamydia could create further problems as it affects the bacteria in their intestines making it difficult for them to digest eucalyptus leaves, which make most of their diet.
- i) What is the role of bacteria in the intestines of koala bears? (2)
 - ii) How might a decrease in digestion of eucalyptus leaves affect koalas? (1)
 - iii) Explain why, compared to carnivores of a similar size, koalas have a longer alimentary canal. (2)
 - iv) Koala bears can regurgitate the food contents from their stomach and rechew them. Why is this process important? (2)
 - v) Compared to ruminant herbivores, koala bears have a simple one-chambered stomach. Name the enzyme that is released in the stomach of mammals and give its function. (2)
- d. Adult koalas catch chlamydia through sexual transmission but young koalas can also become infected by eating pap, a nutritious type of faeces, when it is excreted by infected mothers. Suggest why pap is different from the faeces that animals normally produce. (2)

(Total: 25 marks)



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TIME:	4:00 p.m. to 6:05 p.m.

Write your answers on the booklet provided. Write down the number of the questions you answer on the front page of your answer booklet.

Please note that for question 2 of this paper you need the graph paper in the booklet.

Answer any FOUR questions.

1. In 2015, a new virus CpV-BQ2 from the group giant viruses (Megavirales) was found in protists in Lake Ontario, Canada.
 - a. i) Draw the structure of a virus. Include the following labels: genetic material and protein coat (capsid). (4)
 - ii) Describe how a virus normally reproduces. (4)
 - b. Protists infected by CpV-BQ2 are usually either photosynthetic organisms or amoeboid organisms (*Amoeba*).
 - i) Are protists prokaryotic or eukaryotic cells? Give **ONE** reason to your answer. (2)
 - ii) Give **ONE** other structural feature of the kingdom protists. (2)
 - iii) List **ONE** organelle inside the photosynthetic protists that is **not** present in the amoeboid protists. (1)
 - iv) Give the function of the structure mentioned in part biii). (2)
 - v) State **ONE** organelle found in both photosynthetic and amoeboid protists. (1)
 - c. Fresh water protists have a contractile vacuole that expels water. Explain why:
 - i) water enters the protist; (2)
 - ii) water is expelled. (1)
 - d. Protists live in different environments. Some protists such as *Trichonympha collaris* reside in the guts of termites.
 - i) A termite is an insect. State **ONE** characteristic feature of insects. (1)
 - ii) Name the phylum insects belong to. (1)
 - iii) Give **TWO** features of the phylum of the class insects. (2)
 - iv) Termites eat wood. List **ONE** component of the cell walls of plant cells. (1)
 - v) Other protists reside in leaf litter or in the bark of dicotyledonous trees. List **ONE** characteristic of dicotyledonous plants. (1)

(Total: 25 marks)

Please turn the page.

2. A group of students investigated the rate of breakdown of starch by salivary amylase. The results are shown in the table below.

Concentration of starch/ mg cm ⁻³	Rate of breakdown of starch/ arbitrary units
0	0
25	1
50	3
75	6
100	10
125	12
150	18

- a. On the graph paper provided (use the 2 mm grid scale), draw a graph to show how the rate of breakdown of starch varies with increasing concentration of starch. Join the points of the graph with a ruler. Plot concentration of starch on the x-axis. (6)
- b. The students performing this experiment used Iodine solution to determine when starch was completely broken.
- Name the compound formed when starch is broken by salivary amylase. (1)
 - Describe how iodine solution may be used to determine when starch is completely broken. (2)
- c. The students repeated the experiment and added chloride ions to salivary amylase before adding the starch. The following table shows the results obtained.

Concentration of starch/ mg cm ⁻³	Rate of breakdown of starch when chloride ions were added/ arbitrary units
0	0
25	3
50	8
75	12
100	14
125	18
150	21

Compare these results to the first experiment when no chloride was added to salivary amylase and describe the effect of chloride ions on the rate of breakdown of starch. (2)

- d. i) The students then performed the experiment at different temperatures. Sketch a graph to show how the rate of breakdown of starch varies with increasing temperatures. Label the axes clearly. (2)
- Explain the shape of the graph drawn. (4)
 - Describe how students may create different temperatures to carry out this experiment. (2)

- e. Biological washing powders include enzymes that help in the removal of stains. The enzymes included are generally proteinases (peptidases) and lipases.
- i) Explain why the enzymes included in biological washing powders are generally proteinases and lipases. (2)
 - ii) Give **ONE** advantage of using biological washing powders instead of non-biological washing powders and explain the importance of this advantage. (2)
 - iii) Give **ONE** disadvantage of using biological washing powders instead of non-biological washing powders and state why this is a disadvantage. (2)

(Total: 25 marks)

3. a. Mongolia has large areas of grasslands where sheep are reared for their cashmere wool. These grasslands are threatened by overgrazing and climate change.
- i) Explain overgrazing. (2)
 - ii) Overgrazing results in large areas without vegetation (grass). Describe the impact of this on soil. (4)
 - iii) In the last 60 years, the overall temperature in Mongolia has increased by 2.07 °C while the rainfall has decreased. Explain the effects of this climate change on the vegetation. (2)
 - iv) Explain how and why these changes will affect other populations of herbivores in the wild. (2)
 - v) Propose **ONE** method used to decrease the effect of overgrazing in an area of the grasslands. (2)
- b. The Food and Agriculture Organisation of the United Nations issued the following statement:
 'Ending hunger and all forms of malnutrition by 2030 is an immense challenge.'
 Values from the FAO 2019 report show that 10.8% of the world population is suffering from malnutrition with Eastern Africa having the highest percentage of 30.8% and Northern America and Europe having the lowest rate of less than 2.5% in 2018.
- i) Give **TWO** reasons for malnutrition in Eastern Africa. (2)
 - ii) On the other hand, in 2019, Italy passed a law to send unsold food to charities. Give **ONE** environmental benefit of this law. (2)
- c. Almost 10,000 km² of the Amazon rain forest was destroyed between August 2018 and July 2019.
- i) The Amazon rain forest is described as a carbon store. Explain. (4)
 - ii) Give **ONE** reason why trees are cut down in the Amazon. (1)
 - iii) State **TWO** effects of deforestation. (2)
 - iv) Explain why the Amazon rain forest as a whole, takes in more carbon dioxide than it releases. (2)

(Total: 25 marks)

Please turn the page.

4. a. The circadian clock responds mainly to light and darkness in an organism's environment. It controls almost all aspects of plant biology, including growth, flowering, photosynthesis and the opening and closing of leaf stomata. In most plants, the stomata open just before dawn and use their internal clocks to 'measure' day length, which determines the plant's flowering time. For example, some short-day plants (e.g. rice), only flower when the daylight is shorter than a critical length so tend to flower in the spring or autumn. Long-day plants (e.g. lettuce) have the opposite response, so will only flower when the day exceeds a critical length during the summer.

Adapted from: <https://www.scienceinschool.org/content/how-plants-beat-jet-lag>

- i) From the text, identify the importance circadian clocks have on plant biology. (2)
- ii) State why stomata open just before dawn. (1)
- iii) Discuss the importance of the opening and closing of stomata. (4)
- iv) Draw labelled diagrams to show how guard cells control the size of a stoma:
 - in the light; and
 - in the dark. (3)
- v) Explain the relationship between the opening and closing of leaf stomata and photosynthesis. (4)

- b. Short-day and long-day plants with a faulty circadian clock flower earlier or later than they would do normally, as they are unable to determine the day length. Non-functional clocks can even affect plants' defence mechanisms, preventing them from synthesising defence compounds at the right time of day, making them more prone to attack by insects. As the clock controls the flowering time, it also dictates harvest time for plant species. For example, in northern Europe where the climate is cool, the barley grown there has a natural mutation that affects the way that the clock regulates genes controlling flowering time, making the plant less sensitive to day length. This mutation allows the plant to take advantage of the longer summer days so it can be harvested in the autumn.

Adapted from: <https://www.scienceinschool.org/content/how-plants-beat-jet-lag>

- i) Explain how flowering early or late in season affects plant reproduction. (2)
 - ii) How will lack of defence compounds affect crop yield? (1)
 - ii) Why do different plants flower in different seasons? (2)
- c. Barley grown in northern Europe has a natural mutation that affects the way that the clock regulates genes controlling flowering time.
- i) Describe a mutation. (2)
 - ii) How do mutations in genes controlling flowering time affect crop yield? Give **ONE** explanation to this change. (2)
 - ii) Why do you think that biotechnology companies are interested in the circadian clock? (2)

(Total: 25 marks)

5. a. Vaping is the inhalation of vapour produced by e-cigarettes. The vapour contains nicotine, a substance also found in cigarettes, and is produced to resemble cigarette smoke. Excessive vaping has been linked to a condition called 'popcorn lung'. When a human develops this condition, the smallest airways to the air sacs become scarred and rigid while the air sacs become constricted.
- i) Describe the path air takes during inhalation from the nose to the air sacs (alveoli). (4)
 - ii) Describe the role of the air sacs (alveoli) of the lungs. (2)
 - iii) List **THREE** characteristics of surfaces such as the alveoli. (3)
 - iv) People suffering from 'popcorn lung' become breathless when they are slightly active. Explain why breathlessness is caused by:
 - constricted air sacs; (2)
 - rigid bronchioles. (2)
- b. Cigarette smoke contains other toxic and harmful gases. Emphysema is a condition caused by long-term smoking.
- i) Describe the change in the alveoli when a person suffers from emphysema. (2)
 - ii) Why does this change in the structure of alveoli alter the efficiency of gaseous exchange of the alveoli? (2)
 - iii) Emphysema is caused by persistent coughing. Describe a 'smoker's cough' and explain why smokers cough frequently. (1, 3)
- c. Carbon dioxide is a main air pollutant. Explain the role of carbon dioxide in global warming. (4)

(Total: 25 marks)

6. a. Distinguish between the following terms:
- i) osmosis and active transport; (6)
 - ii) aerobic respiration and fermentation; (4)
 - iii) angiosperms and gymnosperms; (4)
 - iv) motor and sensory neurone. (6)
- b. i) Define the term ecosystem. (1)
- ii) Distinguish between a pyramid of biomass and a pyramid of numbers. (4)

(Total: 25 marks)

Please turn the page.

7. The following diagram shows a simplified view of the human heart and some of the blood vessels in the blood circulatory system. Some of the structures are labelled with letters A to K. Arrows show the direction of blood flow. Use letters on the diagram to answer the questions.

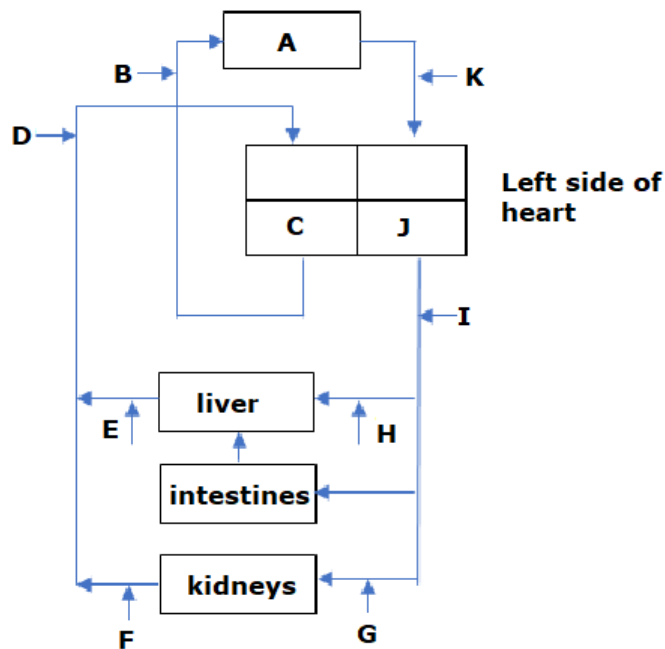


Figure 7.1: The circulatory system

- a. Name the organ represented by A and blood vessels represented by D and K. (3)
- b. i) Name the part of the heart shown by letter C. (1)
 ii) Explain why the walls of part C and part J are of different thickness. (2)
- c. Explain why the hepatic portal vein carries high concentrations of glucose and amino acids. (1)
- d. i) Give the letter of the blood vessel with the highest blood pressure. (1)
 ii) Give **ONE** characteristic of this blood vessel that allows it to withstand high blood pressure. (1)
- e. 'Arteries carry oxygenated blood while veins carry deoxygenated blood'.
 i) Is this statement true or false? (1)
 ii) Give **TWO** reasons for your answer. (2)
- f. Why is a capillary network essential for tissues? (3)
- g. State **THREE** structural differences between arteries and veins. Give your answer in table form. (3)
- h. Pollution affects the circulatory system because it damages the inside walls of the blood vessels making them narrow and less flexible. Explain. (2)

- i. The relative amounts of plasma and cellular components remain constant regardless of age. The bone marrow always retains enough power to supply as many blood cells and platelets as needed.
 - i) Give **ONE** structural difference between red blood cells and white blood cells. (2)
 - ii) Describe the role of phagocytes. (2)
 - iii) The number of platelets circulating in the blood remains essentially unchanged. Why is this important? (1)

(Total: 25 marks)

8. Figure 8.1 shows a photo of a koala bear with its young. Koala bears are mammals that live in Australia.



Source: <http://www.chinadaily.com.cn/sunday/img>

Figure 8.1 A koala bear with its young

- a.
 - i) Name the kingdom and phylum that koala bears belong to. (2)
 - ii) With reference to Figure 8.1, give **TWO** visible features to support the statement that koala bears are mammals. (2)
 - iii) List **TWO** other classes of the phylum referred to in part ai). (2)
- b. Populations of koalas in Australia are decreasing due to loss of habitat and disease. If unchecked, this may eventually lead to extinction of koala bears. The disease that is threatening the survival of koala bears is caused by chlamydia, bacteria that cause a common sexually transmitted infection in humans.
 - i) List **TWO** differences between a cell taken from a koala and a chlamydia cell. Present your answer in table form. (2)
 - ii) Define the terms population and extinction. (2)
 - iii) Give **ONE** way how loss of habitat can be controlled to ensure the survival of koala bears. (1)

This question continues on next page.

- c. Treating the koalas with antibiotics to kill chlamydia could create further problems as it affects the cellulose-digesting bacteria in their intestines making it difficult for them to digest eucalyptus leaves, which make most of their diet.
- i) Why is it important for koala bears to have cellulose-digesting bacteria in their intestines? (2)
 - ii) Explain why, compared to carnivores of a similar size, koalas have a longer alimentary canal. (2)
 - iii) Koala bears can regurgitate the food contents from their stomach and rechew them. Why is this process important? (2)
 - iv) Compared to ruminant herbivores, koala bears have a simple one-chambered stomach. Name the enzyme that is released in the stomach of mammals and give its function. (3)
- d. The eucalyptus tree is an angiosperm plant. Give **TWO** characteristics of angiosperms. (2)
- e. Ferns, gymnosperm and angiosperm plants can grow to different sizes while species of mosses remain small. Explain. (3)

(Total: 25 marks)