Index Number:_____ SEC04/1.21s

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2021 SUPPLEMENTARY SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	I
DATE:	11th October 2021
TIME:	4:00 p.m. to 6:05 p.m.

Answer ALL questions in this paper in the spaces provided.

1. The schematic diagram below shows a coronavirus, part of a family of viruses that cause the common cold and SARS.

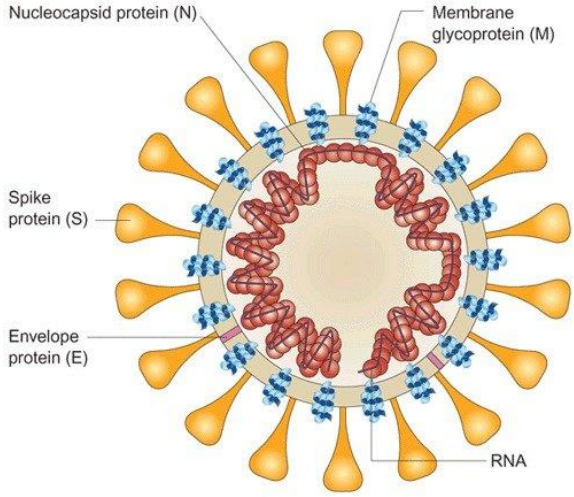


Figure 1.1: Image of a Coronavirus
(Source: https://www.researchgate.net/figure/Schematic-diagram-of-the-SARS-coronavirus-structure)

a. COVID-19 is a mutated virus of this family. It causes fever and respiratory illness. Explain why the virus is **not** given a binomial nomenclature.

_____

_____ (2)

b. The virus contains genetic material surrounded by a protein coat. Describe the role of the genetic material of viruses.

_____

_____ (2)

c. Pangolins, primitive mammals, were suspected of being a host to the COVID-19 coronavirus. Pangolins are the only mammals that have dry scales on skin.
   i) Describe briefly the common skin covering of mammals.

_____ (1)

This question continues on next page.

ii) Name the class of Vertebrates that have a characteristic skin similar to Pangolins.

_____ (1)

iii) State **ONE** other characteristic of mammals.

_____ (1)

Various organisms including bacteria and protists feed on pangolins.

d. i) Give **ONE** structural difference between bacteria and protists.

_____ (2)

ii) Some species of protists feed on the food material in the intestines of the pangolins. Are these protists animal-like or plant-like? Give **ONE** reason for your answer.

_____

_____ (2)

(Total: 11 marks)

2. *Strumigenys hirsuta* is one of three ant species of the genus *Strumigenys* discovered and classified in 2019.

a. State **ONE** reason why it is important to classify organisms.

_____

_____ (2)

b. This ant has a hairy body, is 2 mm to 4 mm long, has three pairs of legs and is a predator to other arthropods.

i) Give **ONE** structural characteristic of arthropods.

_____

_____ (1)

ii) Define a predator.

_____

_____ (2)

iii) Explain why the statement to part b states that the ant is a predator 'to other arthropods'.

_____

_____ (2)

c. These ants live in the leaf litter of the tropical forests of Hong Kong. Explain why leaf litter is considered as an important component of healthy soil.

_____

_____ (2)

(Total: 9 marks)

3. An experiment is carried out to determine the air content of a sample of soil.

A 200 cm^3 empty tin has very small holes punched in the bottom and is then pushed, open-end first, into the soil until its bottom is level with the soil surface. The tin is then dug out of the soil without disturbing its contents and the soil is removed until it is level with the open end of the tin.

All the soil is then emptied into a 1000 cm^3 measuring cylinder containing 500 cm^3 of water. After bubbles have stopped rising, the level of the water inside the measuring cylinder reads 660 cm^3.

a. Why is the reading taken after bubbles have stopped rising?

_____ (1)

b. Why is a measuring cylinder used instead of a glass jar?

_____ (1)

c. Showing your working, calculate:
   i) the volume of air in the soil sample;

_____

_____ (1)

   ii) the percentage of air in the soil sample.

_____

_____ (1)

This question continues on next page.

d. Do sand, loam and clay soil contain different amounts of air? Give a reason for your answer.

_____

_____

_____ (3)

e. Give **THREE** reasons why air is an important part of soil.

_____

_____

_____

_____ (3)

(Total: 10 marks)

4. Students were asked to investigate cellular respiration in germinating seeds. In the experiment, the students measured the volume of oxygen taken up by 25 germinating seeds. The apparatus was kept at 24 °C and results were recorded every five minutes. The following results were obtained.

Time (minutes)	0	5	10	15	20
Volume of oxygen consumed (ml)	0	0.095	0.200	0.310	0.415

a. On the graph paper on the opposite page, plot a graph of volume of oxygen consumed (y-axis) against time (x-axis). Draw the line of best fit. (5)

b. Determine the rate of cellular respiration in ml per minute. Show your working in the space provided below.

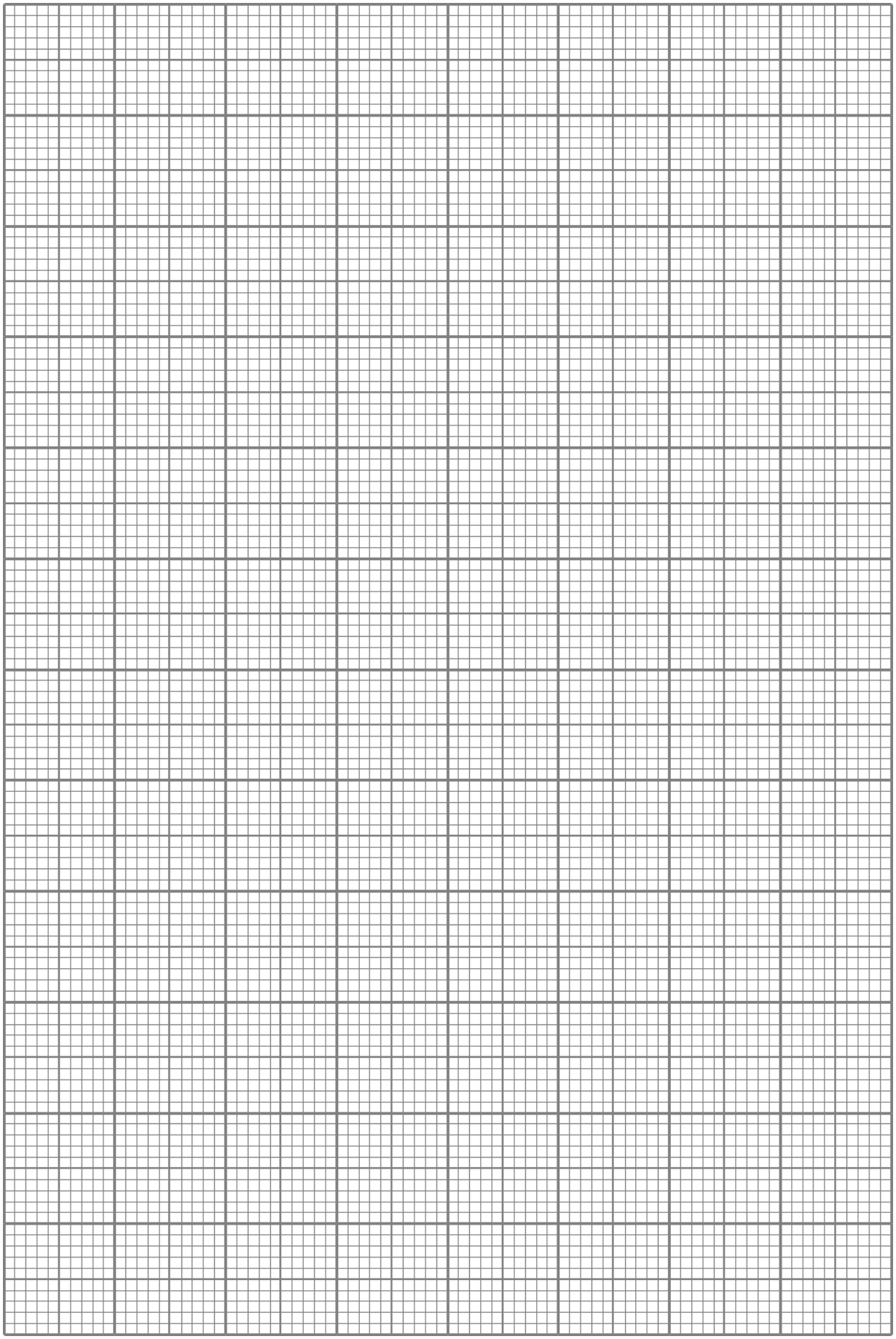
(3)

c. Give the word equation of aerobic cellular respiration.

_____

_____ (2)

(Total: 10 marks)



5. Parasitism involves a symbiotic relationship where the parasite gains all the benefits at the expense of another organism.

   a. i) Give the term used to describe the organism that is harmed by the presence of a parasite.

_____ (1)

   ii) State how mutualism differs from parasitism.

_____

_____ (2)

   b. Tapeworm is a parasite that lives in the intestine of humans. Here it absorbs the products of digestion.
   The tapeworm shows several characteristics that make it adapted to its mode of life. The table below lists some of these characteristics.

   i) In the space provided explain how **each** characteristic makes the tapeworm adapted to its parasitic mode of life.

Characteristic	Explanation
The 'head' region of the tapeworm has several hooks and suckers.	
The body of the tapeworm is very flat.	

(4)

   ii) When there are many tapeworms in the small intestine, the rate of reproduction of these organisms decrease. Explain why.

_____

_____ (2)

   c. *Rhizobium* is a root nodule bacterium that has a mutualistic relationship with legumes. How and why would plant growth be affected if the legume does not form a mutualistic relationship with the nitrogen-fixing bacteria?

_____

_____ (2)

(Total: 11 marks)

6. Lesch Nyhan syndrome is a sex-linked disorder characterised by neurological abnormalities and the overproduction of uric acid in the human body. The disease is inherited in an X-linked recessive manner.

   a. Give the number of pairs of chromosomes in a human nerve cell.

_____ (1)

   b. A female carrier who is heterozygous for the sex linked Lesch Nyhan disorder marries a normal male. What is the probability of having a son affected by Lesch Nyhan syndrome? Use the symbols $\mathbf{X^L}$ for the normal gene and $\mathbf{X^l}$ for the mutated gene that causes the disease.

	Mother	Father
Parent's Genotype	_____	_____
Gametes	◯ ◯	◯ ◯

Genetic diagram

Probability of son with Lesch Nyhan syndrome_____ (5)

   c. In a commentary on this disease, a person was heard saying that this inherited disease is more common in males that in females. Is this comment correct? Give a reason for your answer.

_____

_____

_____ (3)

(Total: 9 marks)

7. Figure 7.1 shows the effect of hormones on the blood sugar levels in a human. The optimal concentration of blood glucose is 90 mg/100 mls. Feedback mechanisms work to keep blood glucose constant at this value.

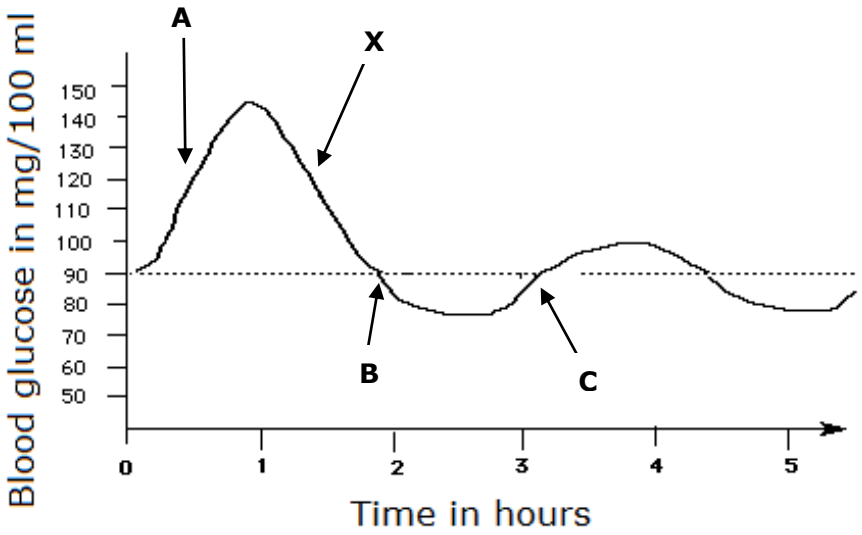


Figure 7.1: Graph of Blood glucose against time
(Source: http://science.halleyhosting.com/sci)

a. Name the process that keeps in control several chemical concentrations including glucose in the blood.

_____ (1)

b. i) Give **ONE** reason why the blood glucose levels increase at A.

_____ (1)

ii) Name the hormone X, produced by the body, that decreases the blood glucose levels.

_____ (1)

iii) State the gland that produces this hormone.

_____ (1)

iv) On the graph, draw the point where hormone X decreases. Label this point D. (1)

c. i) State what you observe from point B to point C.

_____

_____

_____ (2)

ii) Explain what is happening in the liver for your observations to occur.

_____

_____

_____ (3)

(Total: 10 marks)

8. The diagram below shows a vertical section through a villus.

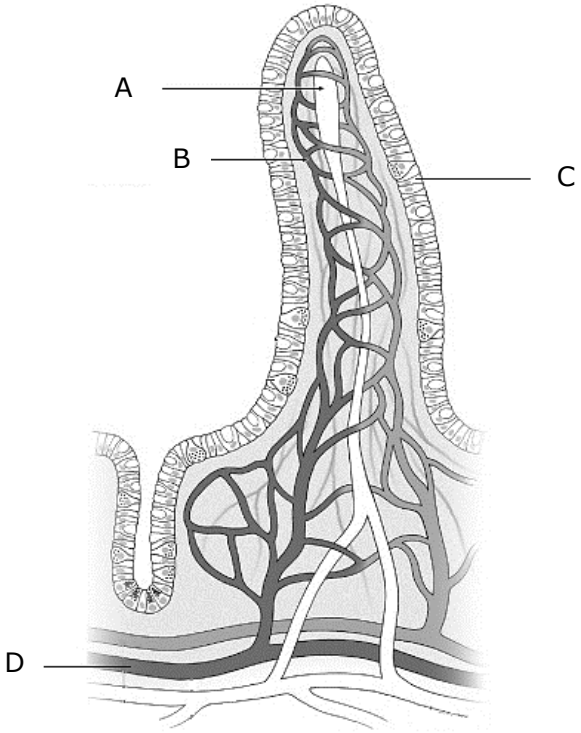


Figure 8.1: Diagram of a villus of the small intestine
(Source: https://www-sciencedirect-com.ru.idm.oclc.org)

a. Name the parts labelled A, B, C and D. (4)

A_____ B_____

C_____ D_____

b. List **THREE** structural features that make a villus absorb products of digestion more efficiently.

_____

_____

_____ (3)

This question continues on next page.

c. Name **TWO** products of digestion that move from the small intestine into the villi.

_____ (2)

(Total: 9 marks)

9. The food web in Figure 9.1 shows some feeding relationships for marine organisms living in polar regions. Phytoplankton consists of microscopic organisms that can carry out photosynthesis.

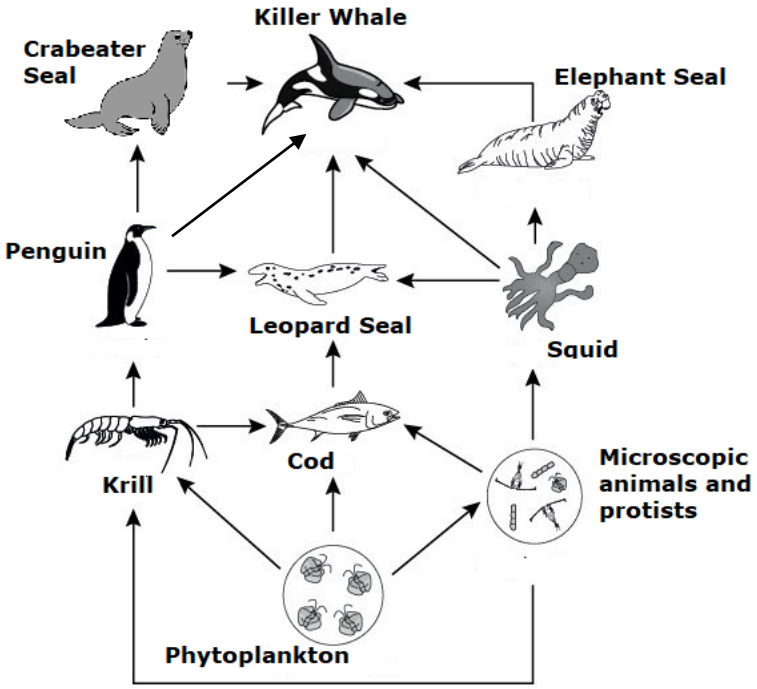


Figure 9.1: A marine food web
(Adapted from: https://brainly.com/)

a. Use the food web to name:
   i) **TWO** organisms that are tertiary consumers;

_____ (2)

   ii) **ONE** group of organisms that are producers;

_____ (1)

   iii) **TWO** organisms that are both primary and secondary consumers.

_____ (2)

b. Which group of organisms has the greatest biomass in this food web during the whole year?

_____ (1)

c. Some organisms in this food web, suffer from marine pesticide pollution which is not degradable. Analysis of samples of tissues from organisms in this food web showed the highest concentration in the killer whale. Give an explanation for this.

_____

_____

_____ (3)

d. Fishing of cod increased in this region until it became unsustainable. This means that the cod were removed at a faster rate than they could be replaced by natural reproduction. Should the cod become extinct as a result of overfishing, predict and explain **TWO** ways that this might affect the food web.

_____

_____ (2)

e. The gulf stream supplies mineral ions, carried in sea currents, to polar regions. Which group of organisms, in the food web benefits directly from this supply of mineral ions?

_____ (1)

(Total: 12 marks)

10. The following diagram shows a bag made from dialysis tubing tied at both ends and filled with solution A and the beaker filled with solution B.

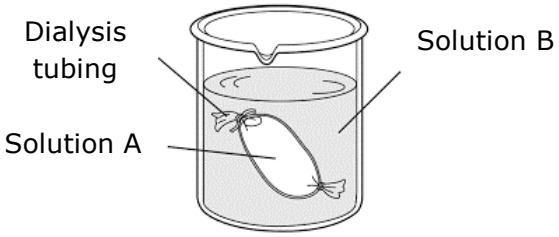


Figure 10.1: Beaker with dialysis tubing
(Source: shorturl.at/enK14)

a. Describe, giving **ONE** reason what would happen to the size of the bag when:
   i) Solution A is distilled water and solution B is 100 g/dm^3 sugar solution.

_____

_____ (2)

   ii) Solution A is 100 g/dm^3 sugar solution and solution B is 100 g/dm^3 sugar solution.

_____

_____ (2)

b. Name the processes by which the molecules of (i) water and (ii) sugar move across the dialysis tubing.

i)_____ ii)_____ (2)

c. The following figure shows the water balance of a marine (saltwater) fish. Use the information in the figure to answer the following questions:

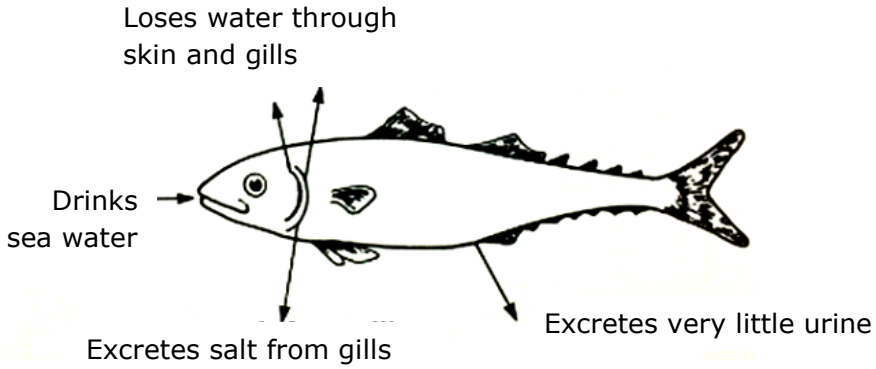


Figure 10.2: A saltwater fish
(Source: Revise Biology: Letts Study aides – Julian Ford – Robinson)

i) What can you conclude about the concentration of water in the blood of the fish compared with the concentration of water in seawater?

_____

_____ (1)

ii) Explain how the fish is able to drink sea water and survive whereas humans are unable to do so.

_____

_____ (2)

(Total: 9 marks)

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SECONDARY EDUCATION CERTIFICATE LEVEL
2021 SUPPLEMENTARY SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	IIB
DATE:	12th October 2021
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 1 of this paper you need the graph paper in the booklet.

Answer any FOUR questions.

1. Scientists determined the stomatal density (i.e. the number of stomata per unit area) in different types of plants. The results are shown in the table below:

Table 1.1: Stomatal density in different plants

Type of plant	Stomatal Density / mm^2
Shrub	21
Daisy	43
Squash	85
Zucchini	92
Agave sp.	3
Christmas cactus	5

(Adapted from Polireddy K. & Kejriwal A., The Analysis of Stomatal Density and leaf geometries in plant tissues. https://slideplayer.com/slide/13355730/)

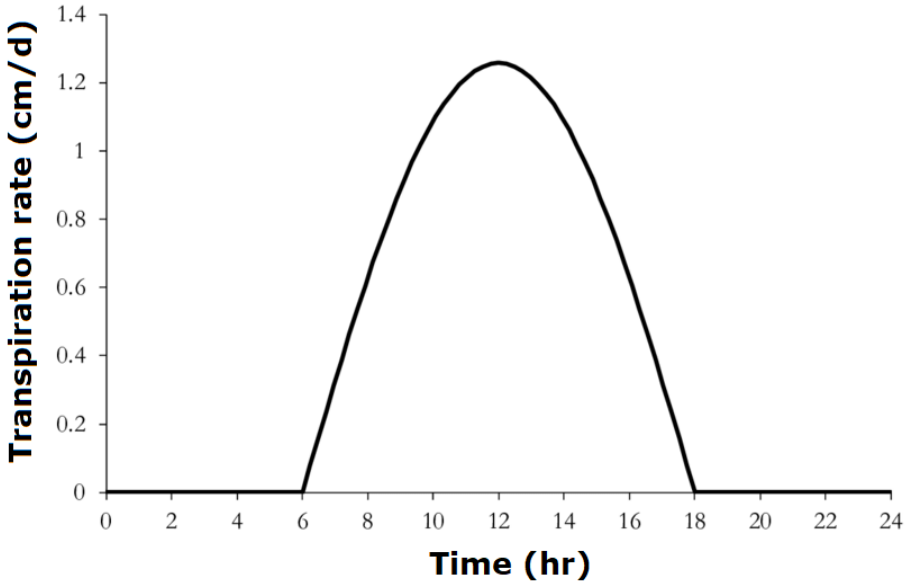
a. On the graph paper provided (use the 2 mm grid scale), draw a bar chart to show how the stomatal density varies in different types of plants. (6)

b. Use the information in the table to:
   i) Name the **TWO** plants that will have the highest rate of transpiration. Give a reason for your answer. (3)
   ii) List the **TWO** plants that are most adapted to survive in a hot and dry environment. Give a reason for your answer. (3)

c. i) State the **TWO** main functions of stomata. (2)
   ii) Some plant species open their stomata at night and keep them closed during the day. Give **ONE** advantage and **ONE** disadvantage associated with this pattern of activity in stomata. (4)

Please turn the page.

d. The graph below shows how the rate of transpiration in a plant varies over a period of 24 hours starting from midnight.



(Source: https://www.researchgate.net/profile/Mathieu_Javaux/publication/254832975/figure/fig5)

Figure 1.1: Variation of rate of transpiration over 24 hours

i) Describe how the rate of transpiration varies over a 24-hour period. (2)

ii) Explain why the rate of transpiration is 0 cm/d from 0 to 6 hours. (2)

iii) Give **TWO** reasons why the rate of transpiration reaches a maximum at 12 hours. (2)

iv) On another day the maximum rate of transpiration measured at 12 hours was 0.8 cm/d. Suggest a possible reason for this observation. (1)

(Total: 25 marks)

2. a. In 2019, scientists in UK discovered that the medicinal fungus, 'Zhuhongjun', known in China for more than 400 years, actually belongs to a new genus. The fungus has now been formally named *Rubroshiraia bambusae*.

The new genus is native to Yunnan in south-west China where it grows on a species of bamboo plant, forming pink ball-like fruiting bodies. The fungus is used as traditional medicine in the area to treat arthritis.

i) Name the kingdoms to which the medicinal fungus and bamboo belong. (2)

ii) Although the cells of the fungus and the cells of the bamboo plant are both surrounded by a cell wall, the two organisms are classified in two different kingdoms. Describe how the cell walls of the fungus differ from the cell walls of the bamboo. (2)

iii) The bamboo plant is autotrophic whilst the fungus is heterotrophic. Explain this statement. (4)

iv) Give **ONE** advantage for naming the fungus *Rubroshiraia bambusae* rather than continuing to use its popular name. (2)

b. The scientific name of the Common Bamboo Plant is *Bambusa vulgaris*. Bamboo is a monocot. It rarely produces flowers, which are wind pollinated.

i) List **TWO** characteristics of the leaf of the Common Bamboo plant. (2)
ii) Give **THREE** characteristics of the flower of the Common Bamboo Plant. (3)
iii) Write down the statement which indicates that the Common Bamboo Plant generally reproduces asexually. (2)

c. The Common Bamboo Plant was introduced in the Maltese Islands after year 1492 and now forms established populations. It is typically found growing in areas where water is abundant.

i) Define population. (1)
ii) Give **ONE** disadvantage that may be associated with the introduction of the Common Bamboo Plant in the Maltese islands. (2)
iii) The Common Bamboo Plant is found growing in regions where clay soil is abundant. Give a reason for this observation. (2)

d. The table lists the scientific name and the common name of different types of bamboo plants.

Table 2.1: Scientific names and common names of bamboo plants

Scientific Name	**Common Name**
Bambusa multiplex	Hedge bamboo
Bambusa oldhamii	Giant timber
Borinda fungosa	Chocolate bamboo
Chimonobambusa pachystachys	Thorny bamboo
Chimonobambusa tumidissinoda	Walking stick
Chimonobambusa yunnanensis	Black bamboo

i) How many different genera (plural of genus) of bamboo are listed in the table? (1)
ii) Write the common names of the **TWO** bamboo species that belong to the same genus as the Common Bamboo plant. (2)

(Total: 25 marks)

Please turn the page.

3. Figure 3.1 shows a diagrammatic representation of the human heart. The arrows show the direction of blood flow.

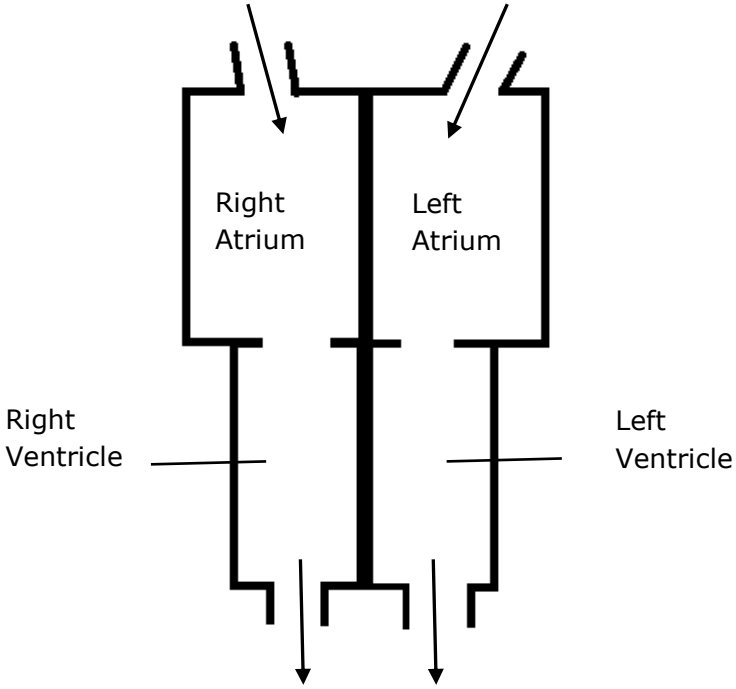


Figure 3.1 A diagrammatic representation of the human heart.

a. Copy the diagram on the answer booklet and then answer the following questions:
   i) Label the bicuspid and the tricuspid valves. (2)
   ii) Shade the heart chambers that carry oxygenated blood and keep empty those that carry deoxygenated blood. (2)
   iii) Label the four blood vessels that are attached to the heart using the following terms: aorta, pulmonary artery, pulmonary vein and vena cava. (4)
   iv) Complete the circuit to show how blood flows from the heart to the lungs and back. (2)
   v) Complete the circuit to show how blood flows from the heart to the body systems and back. (2)

b. Blood consists of red blood cells, white blood cells and platelets. These components float in plasma.
   i) Draw a simple diagram to show the shape of a red blood cell. (2)
   ii) Give the function of red blood cells and give **TWO** adaptations that they have to perform this function. (5)
   iii) Give the function of white blood cells. Give **TWO** differences between white blood cells and red blood cells. (5)
   iv) State the role of platelets in the body. (1)

(Total: 25 marks)

4. Photosynthesis is an important metabolic process observed in some bacteria, algae and plants. The process of photosynthesis is summarised in the following equation:

Carbon dioxide + Water $\longrightarrow$ Glucose + Oxygen

a. i) Name **TWO** other factors that are essential for photosynthesis to occur. (2)
ii) Where do terrestrial plants obtain carbon dioxide and water from, to perform photosynthesis? (2)
iii) Bacteria have infoldings on their plasma membrane to perform photosynthesis, but algae and plants have chloroplasts. Give a reason for this difference. (2)
iv) Name **TWO** type of plant cells which are adapted to perform photosynthesis. (2)
v) When the rate of photosynthesis is very high, plants produce much more glucose than needed. What do plants do with the extra glucose? Explain. (4)

b. Jellyfish belonging to the genus *Cassiopea* (upside-down jellyfish) have a symbiotic relationship with unicellular photosynthetic organisms. They must lay upside-down in areas where enough light is present for photosynthesis to proceed.

i) Name the kingdom and the phylum to which the upside-down jellyfish belong. (2)
ii) Give **TWO** characteristics of the organisms belonging to the phylum that the upside-down jellyfish belongs. (2)
iii) State **ONE** benefit gained by the upside-down jellyfish and **ONE** benefit gained by the unicellular organisms involved in this symbiotic relationship. (2)

c. Sacoglossans are a group of marine molluscs. They live by ingesting the cellular contents of algae. Some species of sacoglossans do not digest the living chloroplasts from the algae they eat, but keep them in their cells. Thus the sacoglossan may now photosynthesize.

i) List **TWO** characteristics of molluscs. (2)
ii) List **ONE** similarity between a mollusc and a cnidarian. (1)
iii) One may consider sacoglossans that keep chloroplasts in their cells to be better competitors than sacoglossans that digest the chloroplasts after eating algae. Give a reason for this answer. (2)
iv) From where would the sacoglossans that perform photosynthesis get the carbon dioxide needed for this process? (1)
v) Name the kingdom that algae belong to. (1)

(Total: 25 marks)

5. Give biological explanations to **each** of the following:

a. With the rapid increase in the World's population in recent years, the problem of sewage disposal is growing. A broken pump allowed raw sewage to flow into a river. The number of algae per cm^3 of water increased for the first 10 days after the sewage spillage. Contamination of the river with sewage led to many problems. (5)

This question continues on next page.

b. Natural resources are the stock of nature such as air, water, soil, animals and plants. Humans use natural resources to live. We need to manage natural resources in a sustainable way. (5)

c. A gardener adds earthworms to the soil in potted plants in the yard. (5)

d. Environmental Non-government organisations (NGOs) question the ecological viability of land reclamation on garrigue land. (5)

e. If plants are grown in greenhouses or polythene tunnels, they can be protected from unfavourable weather conditions. Increasing the availability of certain factors that are normally found in outdoor conditions will tend to increase growth. (5)

(Total 25 marks)

6. Glucose is the energy source which enables sperm fertilise ova extracted from mice. If the fertilising medium lacks glucose (present in the female reproductive tract) fertilisation fails to occur.

Before fertilisation, the sperm head loses its outer membrane releasing a store of enzymes that break down the egg's outer layers. In the absence of glucose, these enzymes are not released and so it cannot penetrate the egg. Secondly, there is no change in the way the sperms move in the early stages of their passage through the female reproductive system towards the egg. After some hours, in the female reproductive tract, the sperm tail waving becomes very vigorous to enable sperms to penetrate the egg membrane. Without glucose the sperms' tail waving is slow, and so has a smaller chance of fertilising the egg.

a. i) What **TWO** effects does glucose normally have on sperm cells? (2)
   ii) How might the effect of glucose on sperm cells improve the chances of fertilisation? (2)
   iii) Where does the glucose come from? (1)

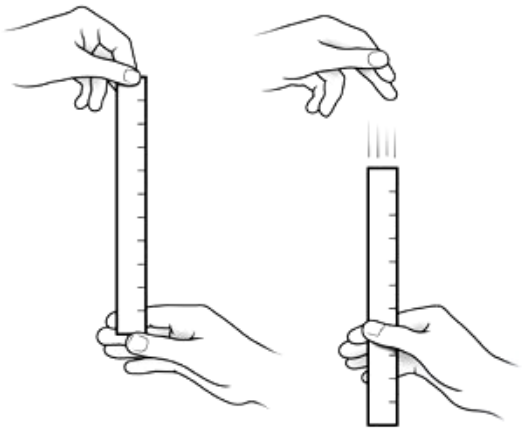
b. i) Draw a labelled diagram of the human female reproductive system. (6)
   ii) On your diagram show:
   - with a letter **A** the organ from where ova are released;
   - with a letter **B** where fertilisation occurs;
   - with a letter **C** where implantation takes place;
   - with a letter **D** where dilation occurs during labour;
   - with a letter **E** where the foetus develops. (5)

c. Couples can undergo in-vitro fertilisation (IVF).
   i) The first stage of in-vitro fertilisation involves giving the woman a course of reproductive hormones. Explain the effect of the reproductive hormones on the ovary and the uterus. (4)
   ii) Explain why more than one embryo must be placed in the uterus. (1)

d. In order to prevent pregnancy different methods of contraception can be used. Explain how the following methods of contraception prevent pregnancy:
   i) contraceptive pill;
   ii) condom. (4)

(Total: 25 marks)

7. a. A group of students were investigating their reaction time when a ruler is dropped. In this investigation one student releases a ruler while another student catches it. Figure 7.1 shows this investigation below.



(http://math.oxford.emory.edu/site/home/futurePages/excelProjectReactionTime/)
Figure 7.1: Ruler drop test

The drop distance was found by taking the reading at the top of the fingers holding the ruler. This test was repeated five times for each student.

i) The list below shows the action and co-ordination of the nervous system for this test, but not in correct order. Write the statements in the correct order. (2)

A	An impulse travels along the motor neurone to the effector muscles.
B	An impulse travels along the sensory neurone to the brain.
C	The hand catches the ruler.
D	Light from the moving ruler stimulate eye receptors.
E	The brain processes the information.

ii) Explain why this test was repeated five times. (2)

iii) In one test, as a student was releasing the ruler, a large noise was heard from the other side of the lab. Give the effect of this disturbance on the reaction time. (2)

b. The above-mentioned investigation does not show a reflex action.

i) Distinguish between a reflex action and the nervous action of the test. (2)

ii) State **ONE** property of a reflex action. (1)

iii) Explain the importance of reflex actions on the human body. (2)

iv) The knee-jerk response is a reflex action. Draw a labelled diagram to explain a reflex arc. (6)

c. Human co-ordination also involves hormonal control.

i) Hormonal control is slower than nervous control. Explain. (2)

ii) Hormonal control is of a longer duration than nervous control. Explain. (2)

This question continues on next page.

d. Guillain-Barré syndrome is a nerve disorder that occurs when the body's own defences (immune system) attack part of the peripheral nervous system. Initial symptoms are tingling of finger and toes and muscular weakness and paralysis of the arms and legs.
Give the type of neurone being affected when:
i) there is tingling of fingers and toes; (2)
ii) there is muscular weakness and paralysis. (2)

(Total: 25 marks)

8. a. The following statements regarding the Mediterranean Sea are found on an infographic on the EU Marine Strategy Framework directive.
- Around 40% of sharks, rays and skates are declining.
- 85% of the turtles assessed had ingested litter.
- 87% of the fish and shellfish species are overfished.

(Source: https://ec.europa.eu/environment/marine/images/infographic25062020.jpg)

i) The decline in sharks and similar species is the result of aggressive bottom trawling where fishing boats tow heavy-weighed nets along the seabed to catch bottom-living fish. Give **ONE** other negative impact of bottom trawling. (2)
ii) State **ONE** approach to reduce the declining numbers of sharks, rays and skates. (2)
iii) Single use plastics such as plastic bags is the type of litter usually ingested by turtles. Why do turtles ingest these plastic bags and describe how this litter may harm these organisms. (1, 2)

b. Coastal water quality is monitored regularly to identify harmful chemicals and/or microbes in the sea water.
i) *E.coli* is a harmful bacterium that may be found in contaminated waters. Describe the structure of a bacterium. (4)
ii) *E.coli* is found in the gut of humans and mammals. Give **ONE** explanation of how high amounts of this bacterium may end up in coastal waters. (2)
iii) High nitrate levels and low dissolved oxygen levels are also monitored especially in inlet waters such as is-Salini. Explain how **both** high nitrate levels and low oxygen levels affect the organisms living in enclosed inlet waters. (4, 2)

c. Monitoring of chemicals such as mercury occur by assessing bioaccumulation of the chemicals in bioindicators such as the seagrass *Posidonia*. Bioaccumulation is the build up of these chemicals along a food chain. Bioindicators are organisms used as an indicator of the quality of an ecosystem.
i) Explain why chemicals accumulate in organisms along a food chain. (2)
ii) Define the term ecosystem. (2)

d. *Posidonia oceanica* is an aquatic angiosperm. Give **TWO** characteristics of angiosperms. (2)

(Total: 25 marks)