DSE
BIO
First Mock Exam

PAPER 1A

Methodist College

First Mock Examination 2022-2023

FORM 6 BIOLOGY PAPER 1

Date: 25th OCT 2022

Time: 8:30 – 11:00 (2 hours 30 minutes)

Class: F.6 _____ Name: _____ ( )

GENERAL INSTRUCTIONS

1. There are **TWO** sections, A and B in the paper. Section A carries 36 marks. Section B carries 84 marks. You are advised to finish Section A in about 40 minutes.
2. Section A consists of multiple-choice questions. Section B contains conventional questions.
3. Answer to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in Question-Answer Book B. **The Answer Sheet for Section A and Question-Answer Book for Section B must be handed in separately at the end of the examination.**

INSTRUCTIONS FOR SECTION A

1. All questions carry equal marks.
2. **ANSWER ALL QUESTIONS**. You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber.
3. You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.
4. No mark will be deducted for wrong answers.

INSTRUCTIONS FOR SECTION B

1. **ANSWER ALL QUESTIONS**.
2. Clearly state the question number.
3. Present your answers in paragraphs wherever appropriate.
4. Supplementary answer sheets will be provided on request.
5. The diagrams in this section are **NOT** necessarily drawn to scale.

Section A: Multiple-Choice Questions (36 marks)

1. Which of the following sub-cellular structures is present in all types of plant cells but not in animal cells?

   A. nucleus
   B. chloroplast
   C. vacuole
   D. cell wall

2. Which of the following compounds is/are involved in the photochemical reactions of photosynthesis?

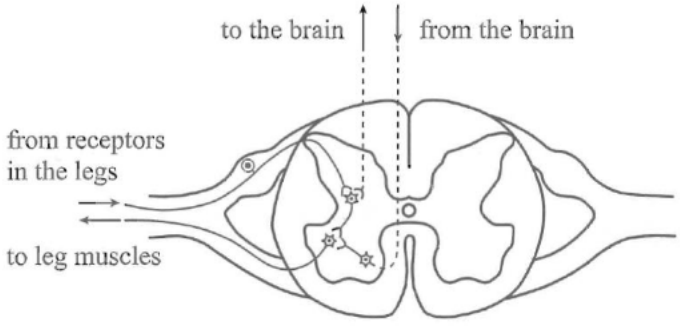
   (1) NAD
   (2) ADP
   (3) water

   A. (1) only
   B. (2) only
   C. (2) and (3) only
   D. (1), (2) and (3)

3. Which of the following correctly describe the functions/properties of the following plant cells?

	Sieve tubes	***Xylem vessels***
A.	for transporting starch	for transporting minerals
B.	no water can be found inside	water can be found inside
C.	have sieve plates	do not have end walls
D.	turgidity of cells provides support	rigidity of cells provides support

4. When a person's foot is pricked by a pin, the foot withdraws immediately. The diagram below shows the nervous pathway involved in this action:



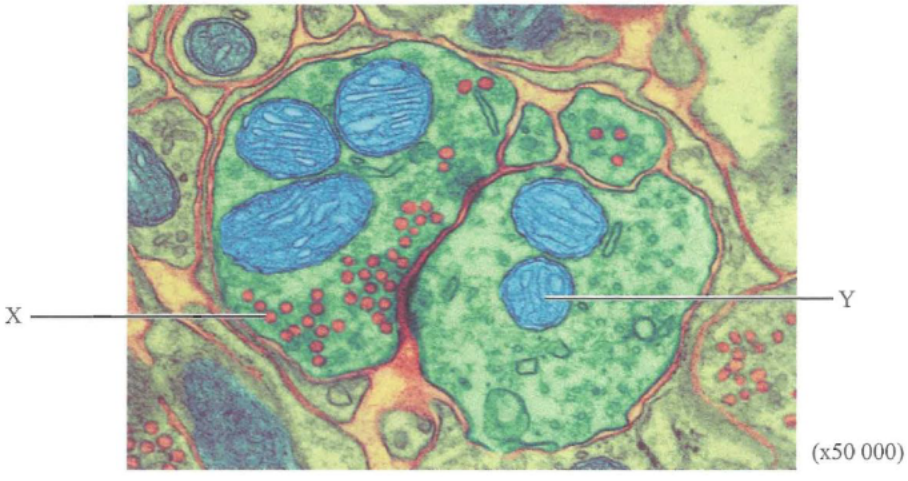
A boy was injured in an accident and his dorsal root was damaged. Which of the following will happen when a pin pricks his foot?

   A. The boy will withdraw his foot by reflex action, and then feel the pain.
   B. The boy will feel the pain and then withdraw his foot voluntarily.
   C. The boy will withdraw his foot by reflex action, although he cannot feel the pain.
   D. The boy can withdraw his foot voluntarily, although he cannot feel the pain.

5. Which of the following correctly describes coughing and the pupil reflex?

A. Unlike the pupil reflex, coughing is not a reflex action.
B. Coughing can be controlled voluntarily, while the pupil reflex cannot be controlled voluntarily.
C. Both involve the spinal cord.
D. Both can be acquired through learning.

6. The following electron micrograph shows a junction between two neurones:



(x50 000)

Which of the following statements concerning organelle Y is/are correct?

(1) It provides energy for the synthesis of neurotransmitters.
(2) It provides energy for the movement of neurotransmitters across the synaptic cleft.
(3) It provides energy for the movement of vesicle X.

A. (1) only
B. (3) only
C. (1) and (3) only
D. (1), (2) and (3)

7. The table below shows the results of DCPIP test on three different fruit juices.

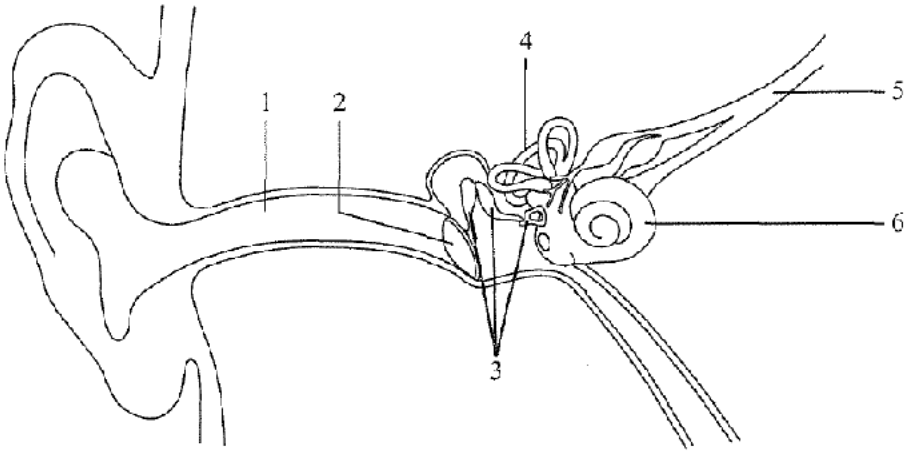
Fruit juice	*Number of drops used to decolourise 1 cm^3 of DCPIP solution*
Orange	1
Apple	1
Grape	5

Which of the following can be deduced from the results?

(1) Grape juice contains the lowest concentration of vitamins among the three fruit juices.
(2) Orange juice and apple juice contain the same concentration of vitamin C.
(3) If the orange juice is diluted ten times, the number of drops of diluted orange juice needed to decolorize 1 cm^3 of DCPIP solution would be 10.

A. (2) only
B. (1) and (2) only
C. (1) and (3) only
D. (2) and (3) only

Directions: Questions 8 and 9 refer to the diagram below, which shows part of the human ear:



8. What is/are the function(s) of structure 6?

(1) detecting the movement of the head
(2) converting sound waves to vibrations
(3) generating nerve impulses

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

9. Which of the following would not result in hearing loss?

A. Ear wax blocks structure 1.
B. Structure 2 is ruptured.
C. Structure 4 is damaged.
D. Structure 5 is cut.

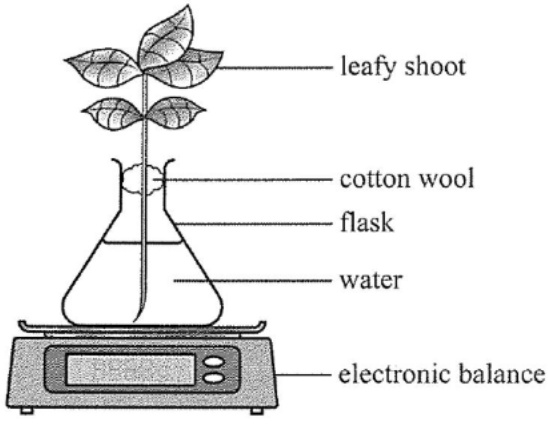
10. The table below shows the densities of stomata on the upper epidermis and lower epidermis of the leaves of two types of plants (X and Y):

Plant	Stomatal density (arbitrary unit)	
	Upper epidermis	Lower epidermis
X	9 000	0
Y	0	0

What are plant types X and Y likely to be?

	X	***Y***
A.	terrestrial plant	floating plant
B.	terrestrial plant	submerged plant
C.	floating plant	desert plant
D.	floating plant	submerged plant

Directions: Questions 11 and 12 refer to the set-up below, which is used to investigate the rate of transpiration of a leafy shoot.



The mass of the leafy shoot and the mass of the whole set-up were recorded at the beginning of the experiment and after two days. The table below shows the results.

	Mass at the beginning (g)	***Mass after two days (g)***
Whole set-up	281.3	275.7
Leafy shoot only	9.7	13.1

11. The rate of transpiration (g hr^{-1}) of the leafy shoot can be calculated by

    A. (281.3 g - 275.7 g) ÷48 hrs
    B. (13.1 g - 9.7 g) ÷48 hrs
    C. [(281.3 g - 275.7 g) + (13.1 g - 9.7 g)] ÷48 hrs
    D. [(281.3 g - 275.7 g) - (l3.1 g - 9.7 g)] ÷48 hrs

12. Which of the following can improve the accuracy of the experiment?

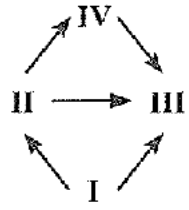
    (1) repeating the experiment twice
    (2) using an electronic balance that reads to two decimal places
    (3) covering the set-up with a black cloth

    A. (2) only
    B. (3) only
    C. (1) and (2) only
    D. (1), (2) and (3)

13. In humans, normal skin and hair colour is dominant to albinism. A man who is homozygous for normal skin and hair colour married a woman who is heterozygous for normal skin and hair colour. The expected phenotypic ratio (normal skin and hair colour: albinism) among their offspring should be

    A. 1 : 0
    B. 1 : 1
    C. 1 : 3
    D. 3 : 1

Directions: Questions 14 and 15 refer to the following food web involving four organisms:



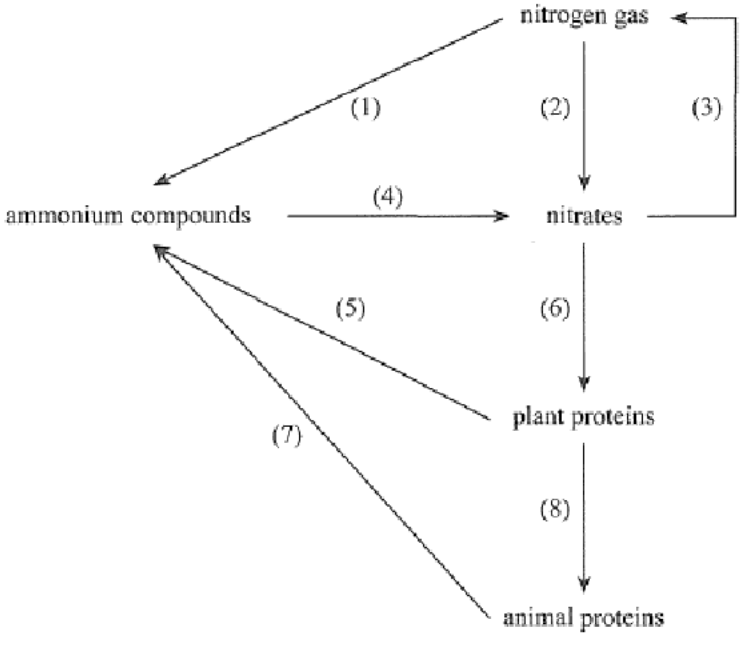
14. Which of the following concerning the above food web is correct?

A. Organism I is a herbivore.
B. Organism II occupies the second trophic level.
C. Organism III is eaten by organism IV.
D. Organism IV is the tertiary consumer in this food web.

15. Which of the following does not occur in the above organisms and their environment?

A. predation
B. competition
C. cycling of nutrients
D. cycling of energy

Directions: Questions 16 and 17 refer to the diagram below, which shows the transfer of nitrogen in an ecosystem:



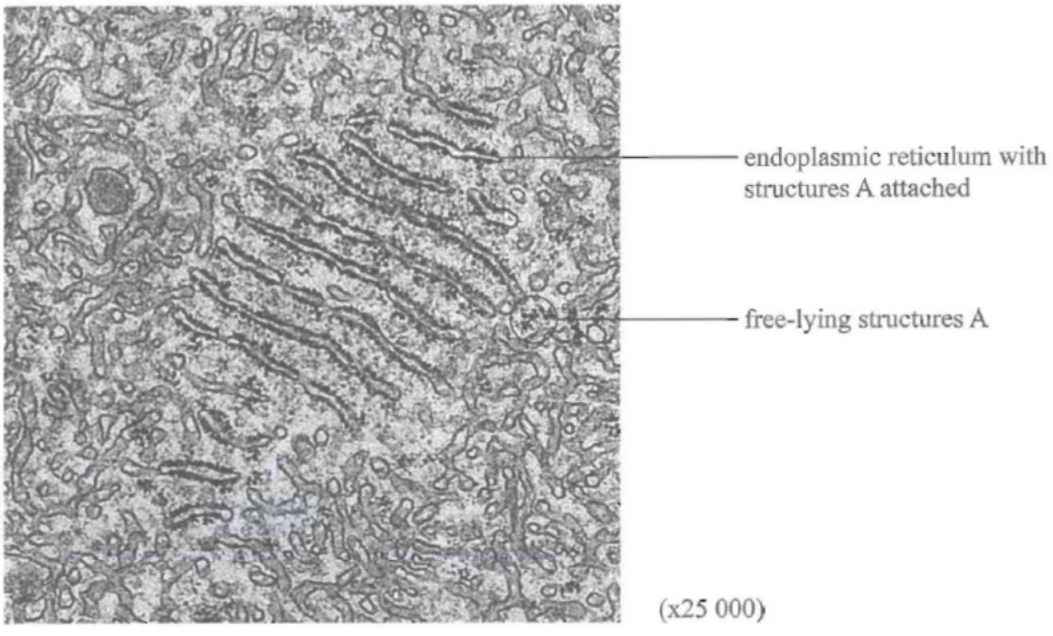
16. Which of the following combinations correctly identifies processes (2) and (4)?

	Process (2)	***Process (4)***
A.	nitrogen-fixation	ammonification
B.	lightning	nitrification
C.	nitrogen-fixation	nitrification
D.	lightning	ammonification

17. Which of the following processes do / does not involve microbial activities?

A. (1)
B. (3)
C. (5) and (7)
D. (6) and (8)

Directions: Questions 18 and 19 refer to the electron micrograph below, which shows the endoplasmic reticulum and structure A:



18. What is structure A?.

A. nucleic acid
B. ribosome
C. RNA polymerase
D. transfer RNA

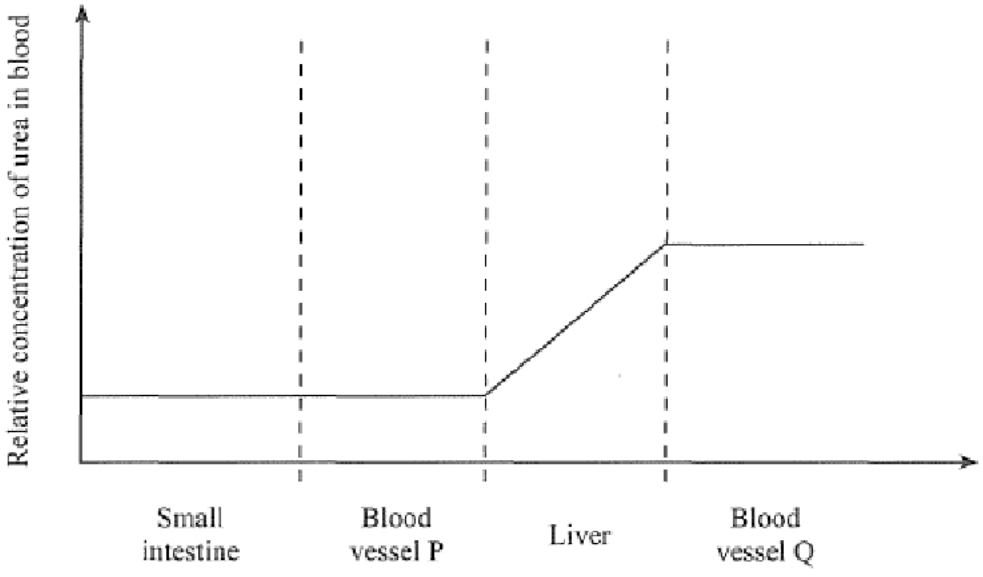
19. Which of the following is the role of the proteins synthesized at free-lying structures A?

A. antibodies
B. hormones
C. enzymes
D. receptors

20. Which of the following comparisons between salivary amylase and insulin is correct?

	Salivary amylase	***Insulin***
A.	It is produced by glands.	It is not produced by glands.
B.	It is made up of proteins.	It is not made up of proteins.
C.	It is transported via ducts.	It is transported by blood.
D.	It catalyses the breakdown of starch into maltose.	It catalyses the conversion of glucose into glycogen.

21. The graph below shows the change in urea concentration of blood flowing from the small intestine, through blood vessel P, to the liver, and then leaving the liver via blood vessel Q.

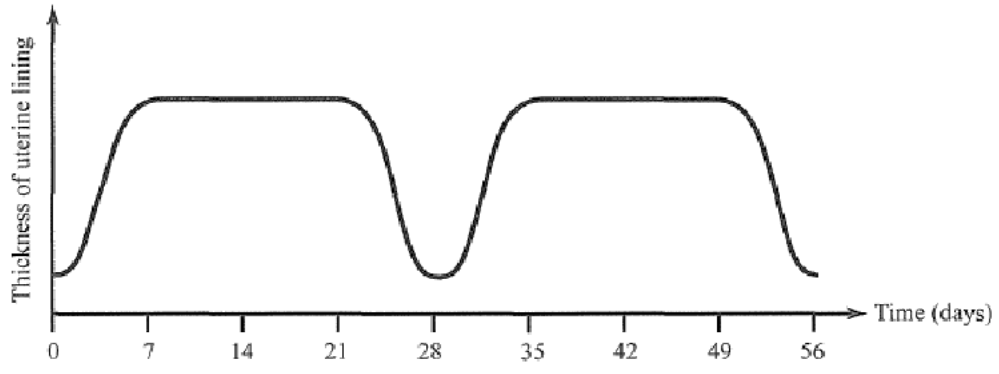


Which of the following can be deduced based on the graph above?

(1) Blood vessel P is the hepatic artery.
(2) Blood vessel Q is the hepatic vein.
(3) Urea is produced by the liver.

A. (1) only
B. (2) only
C. (1) and (2) only
D. (2) and (3) only

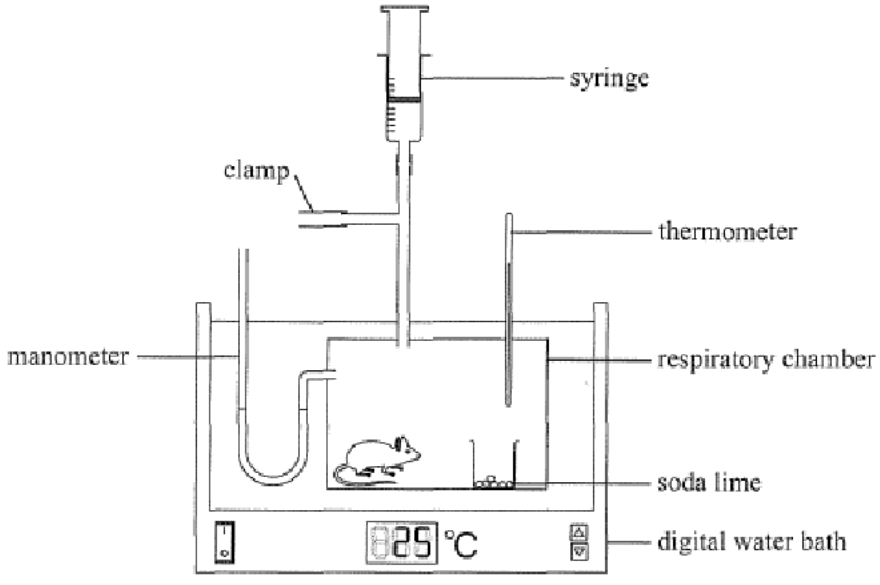
22. The graph below shows the changes in the thickness of the uterine lining of a woman during eight weeks:



In which of the following periods is ovulation and menstruation most likely occurring respectively?

	Ovulation	***Menstruation***
A.	day 6 to 8	day 21 to 28
B.	day 14 to 16	day 21 to 28
C.	day 36 to 38	day 28 to 35
D.	day 28 to 30	day 50 to 56

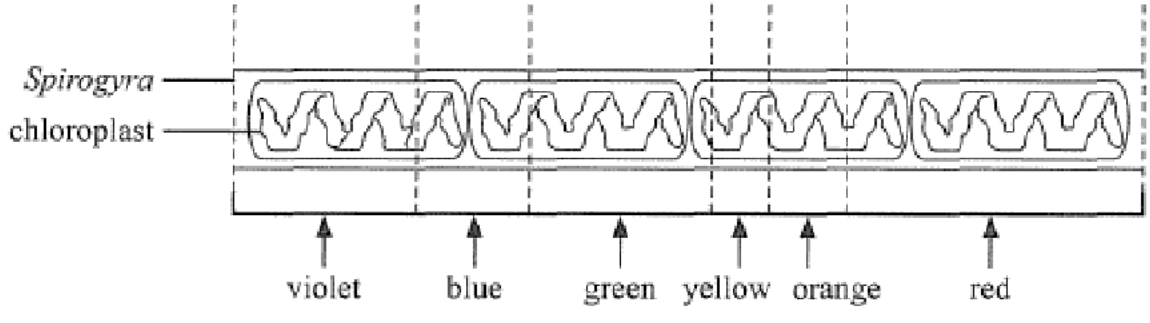
23. The diagram below shows a set-up used to measure the rate of oxygen consumption of a mouse:



Before the start of the experiment, the clamp was closed. 20 mL of air was injected into the respiratory chamber through the syringe so that the liquid level in the left arm of the manometer rose. After 1 hour, the liquid levels in the two arms of the manometer became the same. Which of the following descriptions about the experiment is incorrect?

A. The temperature of the air injected into the respiratory chamber at the beginning of the experiment should be of 25 C.
B. The mouse consumed oxygen and released carbon dioxide during the experiment.
C. The rate of oxygen consumption by the mouse is 20 mL x 21 % per hour.
D. The carbon dioxide content in the respiratory chamber was lower than 0.04% during the experiment.

24. A student carried out an experiment to study the effect of light on photosynthesis. The green algae Spirogyra, which has spiralling chloroplasts, and oxygen-seeking bacteria were added onto a slide. The slide was then illuminated with lights of different colours and observed with a microscope:

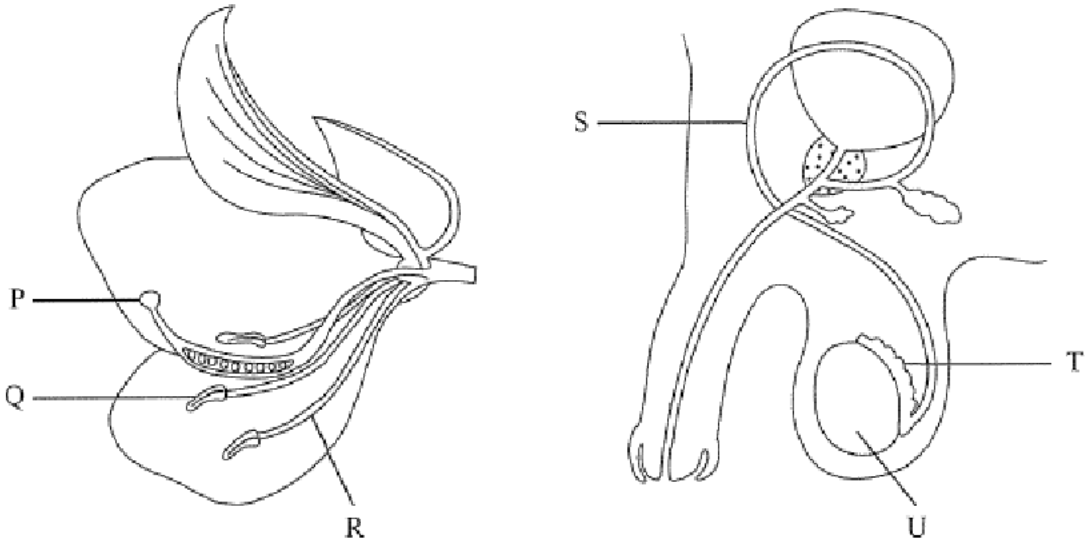


After one hour, most of the bacteria accumulated in the blue and red colour zones. The student concluded that blue and red lights are most effective for Spirogyra to carry out photosynthesis. For this conclusion to be valid, which of the following assumption(s) has/have to be made?

(1) Chlorophyll absorbs only red and blue lights.
(2) Oxygen is produced only in photosynthesis, but not in other metabolic processes of Spirogyra.
(3) The migration and accumulation of the bacteria is mainly affected by oxygen concentration only.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

25. The diagrams below show the structure of a flower and the human male reproductive system respectively.



Which of the following descriptions about the labelled structures is/are correct?

(1) Meiotic cell division takes place at P and T.
(2) Structures Q and U serve similar functions in reproduction.
(3) Structures Rand S are responsible for transferring male gametes.

A. (2) only
B. (3) only
C. (1) and (2) only
D. (1) and (3) only

26. Which of the following descriptions about the human male gamete is/are correct?

(1) It can undergo meiotic cell division.
(2) It must contain a Y chromosome.
(3) It is haploid.

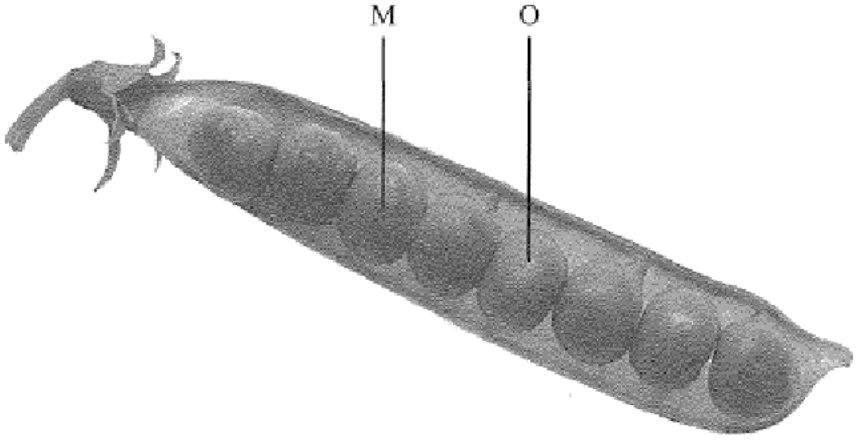
A. (1) only
B. (2) only
C. (3) only
D. (1) and (3) only

27. Vaccination helps us prevent COVID-19. However, some vaccinated people are still susceptible to the infection. Which of the following may be the possible reason(s) for this phenomenon?

(1) The human body quickly recognizes the antigens of the virus as foreign and eliminates them.
(2) The human body may not produce enough antibodies after vaccination.
(3) The antibodies produced by the body mutate and become ineffective against the virus.

A. (1) only
B. (2) only
C. (1) and (2) only
D. (2) and (3) only

28. The photograph below shows the longitudinal section of a pea pod:



Which of the following combinations correctly shows the floral part that develops into structure M, and correctly compares the genetic make-up of structure O?

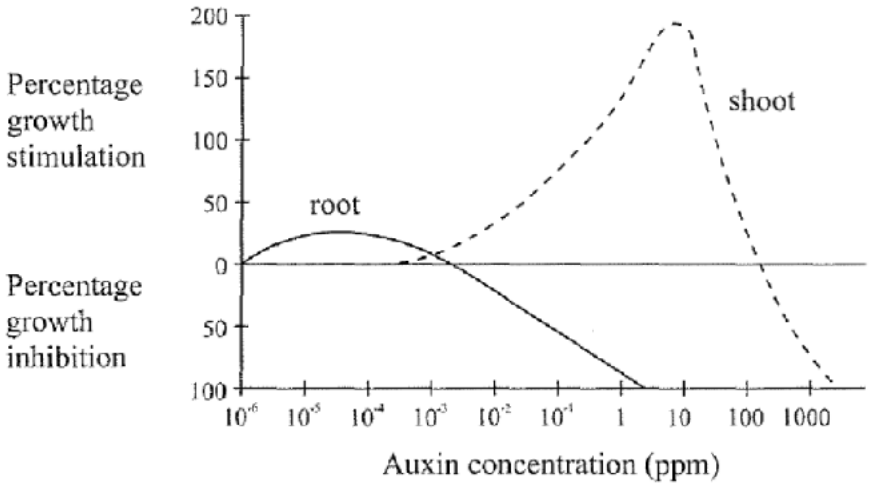
	Floral part that develops into Structure M	***Genetic make-up of structure O***
A.	ovule	different from M
B.	ovule	same as M
C.	stigma	different from the fruit wall
D.	stigma	same as the fruit wall

29. Which of the following descriptions about seed dispersal is/are correct?

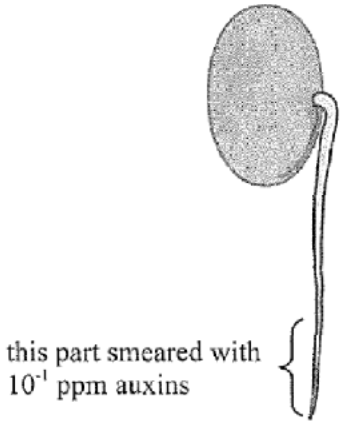
(1) Seed dispersal can only be achieved with the help of external agent.
(2) Seed dispersal can reduce overcrowding.
(3) Seed dispersal allows the offspring to escape from diseases associated with the parent plants.

A. (1) only
B. (3) only
C. (2) and (3) only
D. (1), (2) and (3)

30. The graph below shows the effect of auxin concentrations on the growth of shoots and roots of bean seedlings:



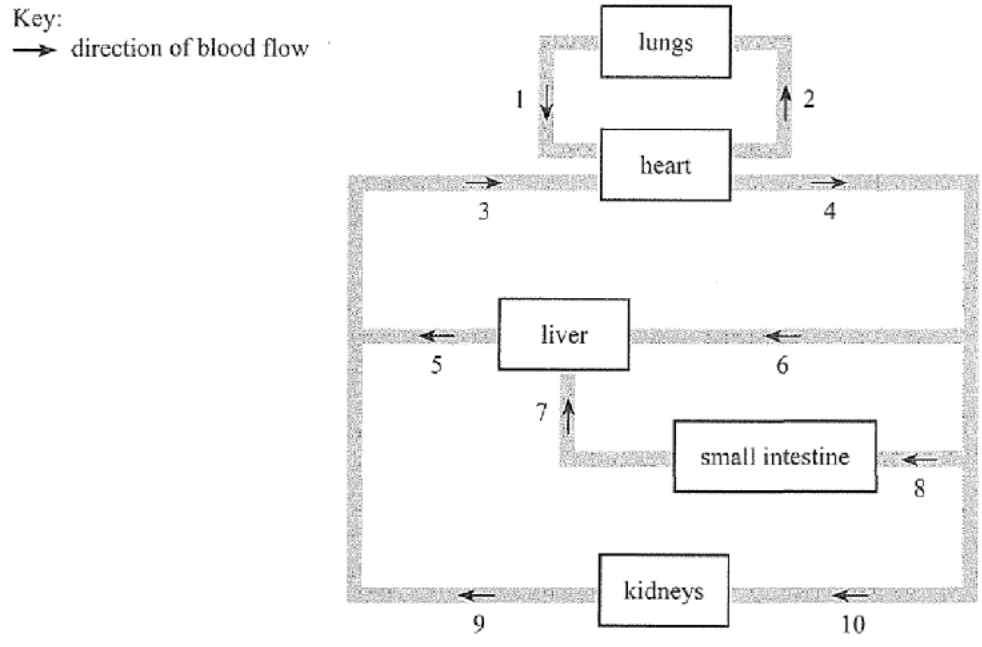
A bean seedling with its root tip removed was left hanging vertically in a moist and dark box. Auxins of concentration 10^{-1} ppm was smeared onto the left side of the decapitated seedling as shown in the diagram below:



What would happen to the root after two days?

A. The root will bend towards the left.
B. The root will bend towards the right.
C. The root will grow straight downwards.
D. The root will not grow.

Directions: Questions 31 and 32 refer to the schematic diagram below, which shows the blood vessels (1 to10) that connect the heart, lungs, liver, small intestine and kidneys in humans::



31. Which of the following descriptions about the composition of the blood in the labelled blood vessels is correct?

    A. The blood in vessel 1 contains no carbon dioxide.
    B. The blood in vessel 5 contains the highest concentration of urea among all the labelled blood vessels.
    C. The blood in vessel 8 contains no glucose after fasting for 2 days.
    D. The blood in vessel 9 contains no urea.

32. Which of the following descriptions about the blood flow or blood pressure in the labelled blood vessels is correct?

    A. The blood in vessel 1 has the slowest blood flow among all the blood vessels in the body.
    B. The blood in vessel 2 has the highest blood pressure among all the blood vessels in the body.
    C. The blood in vessel 3 has the slowest blood flow among all the blood vessels in the body.
    D. The blood in vessel 4 has the highest blood pressure among all the blood vessels in the body.

33. A species of grass grew on an abandoned field. When the field became polluted with heavy metals, most of the grasses died and only few remained. Several years later, a large proportion of grass became tolerant to the heavy metals. Which of the following is illustrated in this phenomenon?

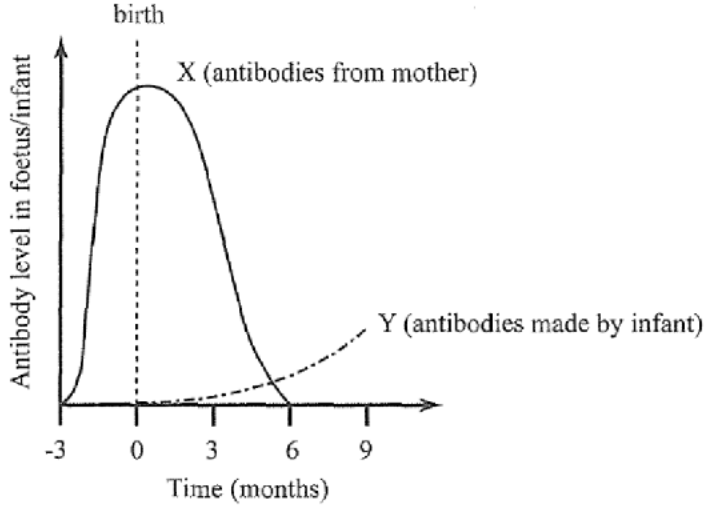
    A. The grasses mutated to tolerate heavy metals.
    B. There was no gene flow between the grasses in the field.
    C. The species of grass has evolved due to natural selection.
    D. A new species of grass which is tolerant to heavy metals formed.

34. Which of the following parts of the digestive system is/are able to produce enzymes that digest fat?

(1) gall bladder
(2) pancreas
(3) liver

A. (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

35. The graph below shows the changes in the antibody level in foetus/infant before and after birth:



Which of the following combinations correctly describes and explains the type of immunity acquired by the foetus/infant?

	Immunity represented by	***Type of immunity***	***Explanation***
A.	Curve X	active	antibodies in the maternal blood pass through the placenta and enter the foetal blood
B.	Curve X	passive	ready-made antibodies are injected into the mother
C.	Curve Y	active	the antibodies are resulted from vaccination of the infant
D.	Curve Y	passive	ready-made antibodies are injected into the infant

36. Which of the following statements concerning phagocytes is/are correct?

(1) Phagocytes can squeeze through the capillary walls and enter the tissue fluid.

(2) Each phagocyte has numerous mitochondria to provide energy for the synthesis of antibodies.

(3) Each phagocyte contains a large number of lysosomes to fuse with engulfed pathogens.

A. (1) only
B. (2) only
C. (1) and (3) only
D. (2) and (3) only

– END OF SECTION A –

Go on to Question-Answer Book B for questions in Section B.

DSE
BIO
First Mock Exam

PAPER 1B

B

Methodist College

First Mock Examination 2022-2023

NAME	
CLASS	
CLASS NO.	

FORM 6 BIOLOGY PAPER 1

SECTION B

Date: 25th OCT 2022

Time: 8:30 – 11:00 (2 hours 30 minutes)

	Marker's Use Only	
Question No.	Marks	
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total		

INSTRUCTIONS

(1) Write your Name, Class and Class Number in the space provided on Page 1.

(2) Refer to the general instructions on the cover of Question Book for Section A.

(3) The questions in this Question-Answer Book carry 84 marks. Answer ALL questions.

(4) Write your answers to Section B in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.

(5) Supplementary answer sheets will be provided on request. Write your Name, Class and Class Number, fill in the question number.

(6) Present your answers in paragraphs whatever appropriate.

(7) The diagrams in this section are NOT necessarily drawn to scale.

Section B: Conventional Questions (84 marks)
Answer ALL questions. Put your answers in the spaces provided.

1. For each of the events listed in Column 1, select from Column 2 the stage of meiotic cell division during which the event occurs. Put the letter in the space provided. (4 marks)

Column 1		*Column 2*	
Separation of sister chromatids	_____	A	Telophase I
Crossing over	_____	B	Prophase I
Formation of new nuclear membranes	_____	C	Interphase
DNA replication	_____	D	Anaphase I
		E	Anaphase II
		F	Metaphase I

2. The photomicrograph below shows the section of a blood vessel, P, in pancreatic tissue.

(×8000)

(a) Name the type of blood vessel that P belongs to. (1 mark)

(b) With reference to one feature shown in the photomicrograph, explain how cell Q is adapted to its function. (2 marks)

(c) By means of a flowchart, show the route through which cell Q is transported from the pancreas to the liver. Indicate only the major blood vessels and organs involved. (2 marks)

3. Helen designed an investigation to find out the water potential of the epidermal cells of an onion. The main steps of the investigation are shown below.

> Step 1: A strip of epidermis was peeled off from an onion.
> Step 2: The epidermis strip was cut into seven smaller pieces.
> Step 3: A piece of epidermis was placed into different salt solutions.
> Step 4: The pieces of epidermis were left in the solutions for 15 minutes.
> Step 5: The pieces of epidermis were observed under low-power magnification.

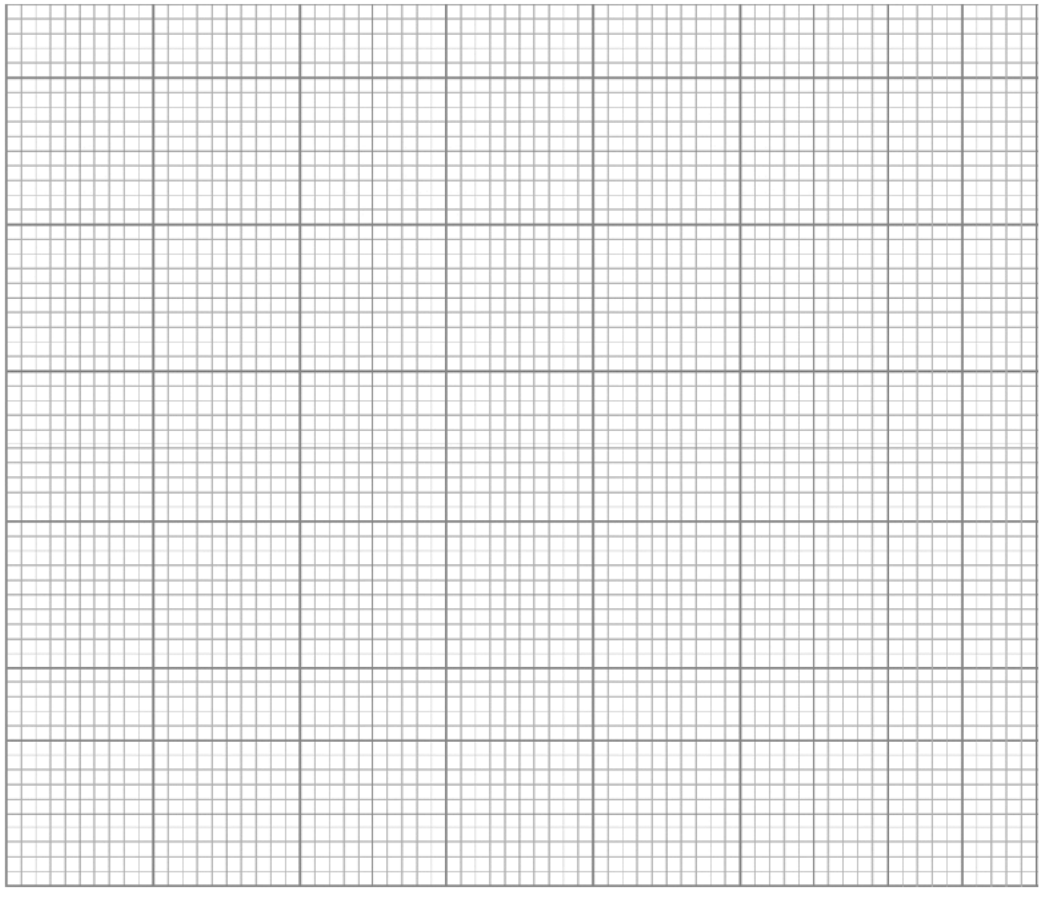
She counted 25 cells from each piece of epidermis and noted how many cells had become plasmolysed. The results of the experiment are shown in the table below.

Concentration of salt solution (mol/cm^3)	**Number of plasmolysed cells observed**
0	0
0.1	0
0.2	2
0.3	6
0.4	15
0.5	21
0.6	23

(a) Explain why the onion epidermal cells became plasmolysed in concentrated salt solutions. (4 marks)

(b) In concentrated salt solutions, most of the epidermal cells became plasmolysed but a small number of them showed no observable changes. Give a reason for this. (1 mark)

(c) (i) Plot a graph on the percentage of plasmolysed cells against concentration of salt solution. (4 marks)



(ii) It can be assumed that the water potential of the onion epidermal cells is the same as the water potential of a salt solution that causes half of the cells to become plasmolysed. Based on your graph, estimate the water potential of onion epidermal cells. (1 mark)

_____

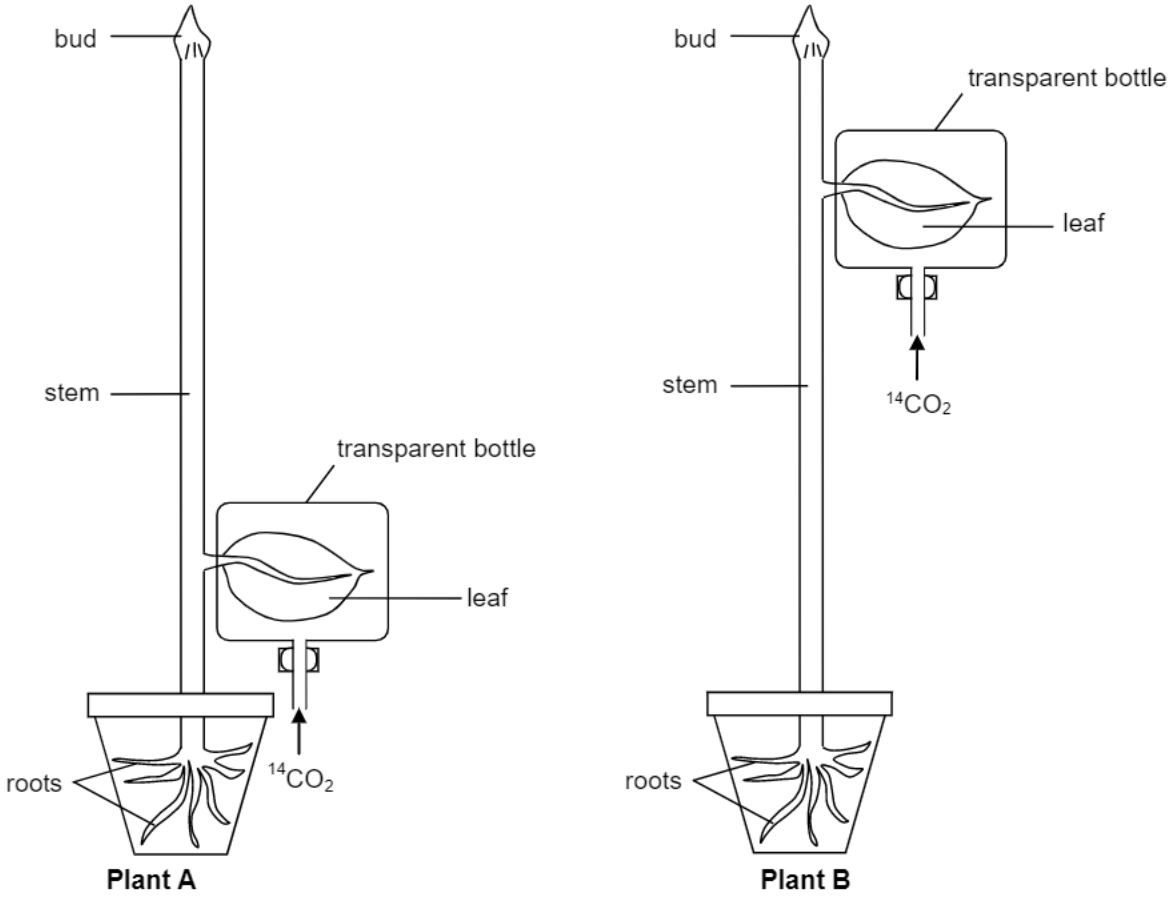
(d) Suggest one way by which Helen could improve the reliability of the results. Explain your answer. (2 marks)

_____

_____

_____

4. An experiment was carried out to investigate the transport of carbohydrates in a plant species. Two young plants of a similar size are selected. One leaf of each plant was supplied with carbon dioxide containing the radioactive isotope of carbon, 14C. The diagram below shows the set-ups (only the leaves supplied with $^{14}CO_2$ on the plants are drawn).



The plants were kept in bright light for 24 hours. The level of radioactivity was then measured at four positions on each plant. The table below shows the results.

Part of plant	**Radioactivity** (arbitrary units)	
	Plant A	**Plant B**
Bud	904	1204
Leaf supplied with $^{14}CO_2$	226	224
Stem (in the middle region)	232	162
Roots	540	240

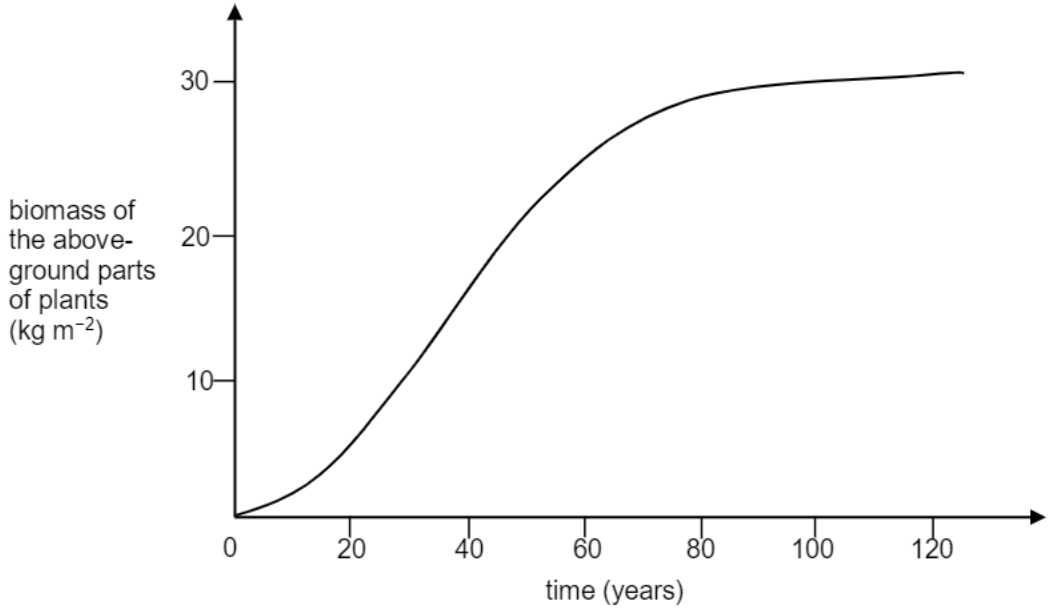
(a) Name the process by which carbohydrates are transported in the plant. (1 mark)

(b) Based on your biological knowledge, explain how the radioactive carbon supplied to the leaf can be detected in the roots. (3 marks)

(c) Suggest why the level of radioactivity in the bud was much higher than that in the stem in plant B. (2 marks)

(d) By comparing the results of plant A and plant B, what conclusion can be drawn? Give evidence from the results to support your answer. (2 marks)

5. The graph below shows how the biomass of plants in an area formed by glacial retreat (冰川後退) in Europe changed with time in the succession to woodland.



(a) Identify the type of ecological succession that occurred. (1 mark)

_____

(b) In the first 20 years, herbaceous plants and some shrubs made up the vegetation of the area.

(i) Briefly describe how the data present in the graph above can be determined in the first 20 years. (3 marks)

_____

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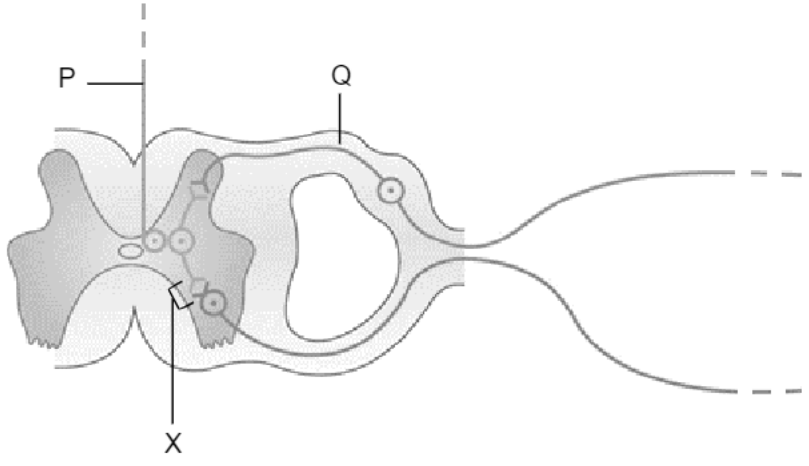
(ii) Using your knowledge on ecological succession, explain the difference in the rate of increase in plant biomass during the first 20 years and after 100 years. (3 marks)

6. The diagram below shows part of the spinal cord and the neurones involved in the withdrawal reflex when a person touches a hot object with his hand.



(a) In the diagram above, draw arrows to show the direction in which nerve impulses travel to bring about the withdrawal reflex. (1 mark)

(b) Describe how structure X helps ensure that nerve impulses travel in one direction only. (2 marks)

(c) What would be the effects on the response of the withdrawal reflex and the sensation of pain if the nerve fibre had been cut

(i) at position P? (2 marks)

(ii) at position Q? (2 marks)

(d) After the reflex action, the person decides to straighten his arm. Describe the series of events that lead to the straightening of the arm. (4 marks)

7. The table below shows the major events in the history of the treatment for diabetes mellitus.

Year	Events
1869	Paul Langerhans found clusters of cells with an unknown function within the pancreatic tissues when observing a pancreas under a light microscope. These cell clusters were later named islets of Langerhans, which were found to be responsible for blood glucose regulation.
1889	Oskar Minkowski and Joseph von Mering conducted experiments to show that if the pancreas is removed surgically from a dog, it will develop diabetes.
1921	Banting and Best first removed the pancreas from a dog (dog A) to make it diabetic. They then tied off the pancreatic duct of another dog (dog B). The pancreas of dog B soon partially degenerated, but the dog did not develop diabetes. They removed the pancreas and prepared an extract. The extract was injected into dog A, which then became healthy for some time.
1922	Banting and Best tested the pancreas extract on themselves. They felt dizzy and weak after the injection.

(a) In Banting and Best's experiment, tying off the pancreatic duct led to the partial degeneration of the pancreas of dog B. How would you account for this? (3 marks)

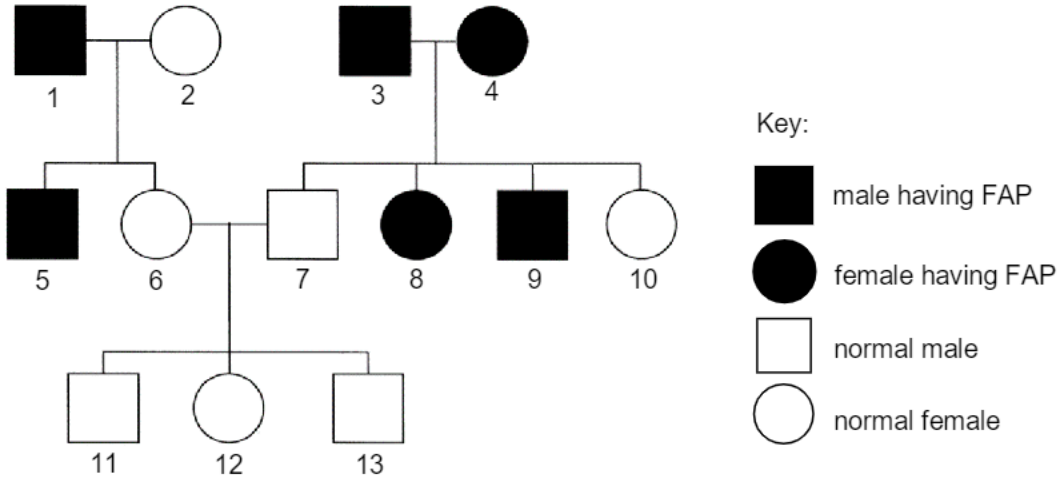
(b) Suggest why Banting and Best felt dizzy after they had the injection of the pancreas extract. (4 marks)

(c) The history of the treatment for diabetes mellitus demonstrates certain aspects on the nature of science. Complete the following table to show your understanding about the nature of science based on this history. (2 marks)

Nature of science	Elaboration
Science is affected by the technology and the types of equipment available at the time.	
	Banting and Best knew that the removal of pancreas from a dog can make it diabetic.

8. A gene in humans called APC is located on chromosome 5. This gene is found to be a tumour suppressor gene. A mutated APC gene can cause familial adenomatous polyposis (FAP) (家族性腺瘤性息肉症). Patients with FAP develop many polyps in the large intestine, some of which may become cancerous over time and result in colorectal cancer.

The following pedigree shows the inheritance of this disease in a family.



(a) Is FAP a sex-linked genetic disease? Explain your answer. (2 marks)

(b) Deduce whether the FAP-causing allele is dominant or recessive. Explain your deduction. (Marks will not be awarded for genetic diagrams.) (5 marks)

(c) Suggest one possible mechanism by which tumour suppressor genes like APC can prevent the formation of a tumour. (2 marks)

(d) Patients with FAP are suggested to have a colonoscopy every year. Explain how this can help prevent colorectal cancer in these patients. (2 marks)

9. Two types of tests are available for coronavirus disease 2019 (COVID-19): antigen test and antibody test. Four individuals, P, Q, R and S, took both tests to find out whether they have COVID-19 or not. The results are shown in the table below.

Individual	P	Q	R	S
Antigen test	Positive	Positive	Negative	Negative
Antibody test	Positive	Negative	Negative	Positive

(a) Which individual(s) may have been infected with COVID-19? (1 mark)

(b) Suggest a reason to explain the difference in the test results of individuals Q and S.

(2 marks)

(c) (i) Vaccines against COVID-19 have been developed by laboratories around the world. Would vaccination against COVID-19 be able to provide immunity against Middle East Respiratory Syndrome (MERS), which is also caused by coronavirus? Explain your answer. (2 marks)

(ii) Name another infectious disease that can be prevented by vaccination. (1 mark)

For the following question, candidates are required to present their answer in essay form. Criteria for marking will include relevant content, logical presentation and clarity of expression.

10. The lung is the organ of gas exchange in humans. However, the placenta serves as the foetus' organ of gas exchange. Briefly describe how gases are exchanged in the placenta. State the ways in which both placenta and the lung are adapted to the exchange of gases. (11 marks)

– END OF PAPER –

DSE
BIO
First Mock Exam

PAPER 2

Methodist College

First Mock Examination 2022-2023

FORM 6 BIOLOGY PAPER 2

Date: 25th OCT 2022

Time: 11:30 – 12:30 (1 hour)

Class: F.6 _____ Name: _____ ( )

INSTRUCTIONS

1. Attempt **ALL** questions.
2. Write your answers in the Answer Book. Start each question (not part of a question) on a new page.
3. Present your answers in paragraphs wherever appropriate.
4. Illustrate your answers with diagrams wherever appropriate.
5. The diagrams in this Paper are **NOT** necessarily drawn to scale.

Answer ALL questions

1. (a) Read the following passage and answer the questions that follow.

Gene Therapy Breakthrough Offers Hope to Cystic Fibrosis Patients

Cystic fibrosis (CF), an autosomal recessive genetic disease, is caused by mutations in the CFTR gene. People with cystic fibrosis produce sticky mucus which affects the lungs in particular. Patients have to receive treatments to clear their lungs every day. In some cases, a lung transplant is needed if the lungs become extensively damaged. There is currently no cure for cystic fibrosis and many patients do not survive beyond the age of 40.

Scientists have been working for decades to develop a gene therapy for the disease. Previous attempts using viruses to deliver the normal CFTR gene to the patients' lungs were proved unsuccessful, as the viruses were destroyed by the immune system of the patients.

A new trial involving 136 patients was conducted in the UK in 2015. Scientists wrapped the normal CFTR gene in liposome, a tiny sphere made of phospholipid bilayer, which was then delivered to the lungs via inhalation. The treatments were given once a month for a year and most of the patients showed improved lung function. The team said more research is needed before the therapy will be suitable for clinical use.

(i) Explain why people with cystic fibrosis are likely to have frequent lung infections. (2 marks)

(ii) The viral vectors delivered into patients' bodies caused immune responses with the formation of memory cells. Explain why the formation of memory cells prevents repeated gene therapy from working normally. (3 marks)

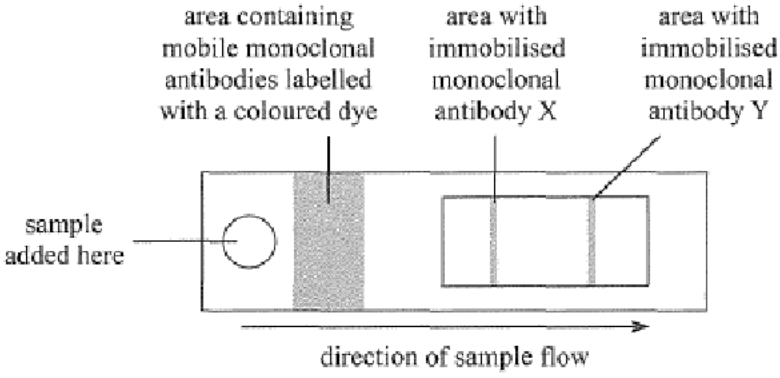
(iii) With reference to the trial on liposome-based gene therapy, explain the following:

(1) Watery mucus is produced in the lungs after the treatment. (3 marks)

(2) The patients need to receive the treatment once a month. (2 marks)

1. (b) Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The prevalence of asymptomatic carriers of SARS-CoV-2 makes it difficult to control the spread of the disease. To identify people carrying the virus, rapid antigen tests and polymerase chain reaction (PCR) can be used.

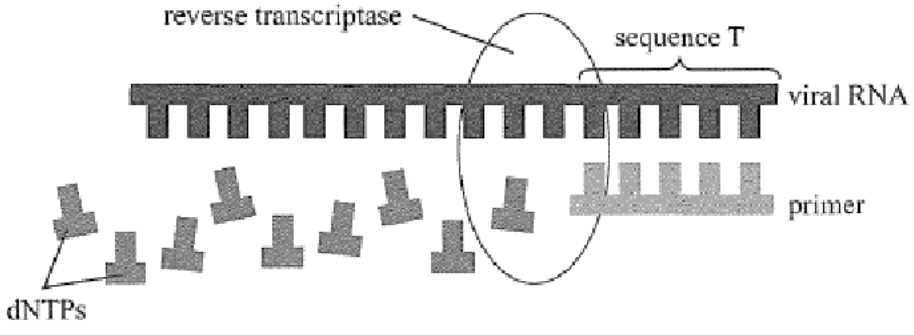
The diagram below shows the design of a rapid antigen test kit for SARS-CoV-2:



If the sample contains proteins specific to SARS-CoV-2, the mobile monoclonal antibodies bind to one part of the protein and flow to the right. → Immobilised monoclonal antibody X binds to the protein-antibody complex (with dye). A red line appears in the area with monoclonal antibody X, indicating the presence of viral proteins in the sample. → Immobilised monoclonal antibody Y binds to the antibody with dye. A red line appears in the area with monoclonal antibody Y, indicating that the test kit is working properly.

(i) Rapid antigen tests using monoclonal antibodies are highly specific. Why is each type of monoclonal antibody highly specific to a particular protein? (2 marks)

Unlike other DNA viruses, SARS-CoV-2 is an RNA virus that has RNA as genetic materials. To detect the presence of viral RNA, a complementary DNA (cDNA) strand should be synthesized using the enzyme reverse transcriptase (RTase). The cDNA is then amplified by PCR. The diagram below shows how the cDNA can be synthesized from viral RNA:



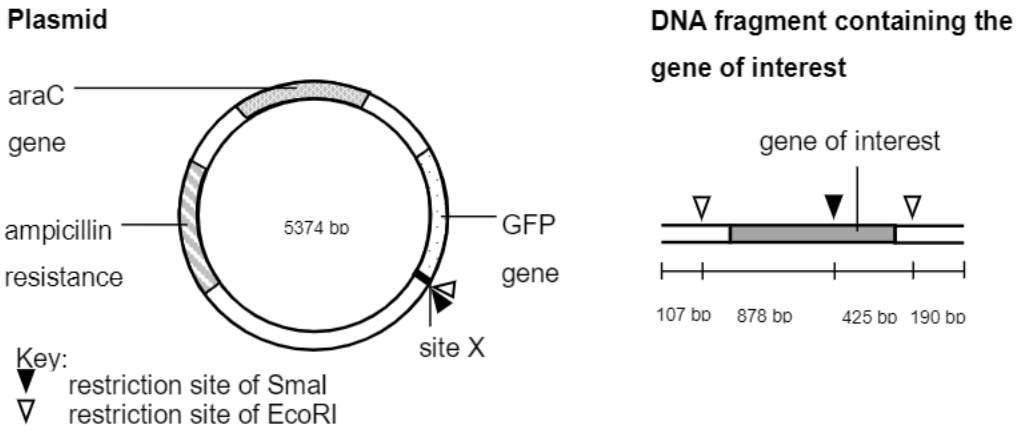
(ii) Given that sequence T on the viral RNA is UAAGCC, what is the base sequence of the primer? (1 mark)

(iii) With reference to the diagram, describe how the cDNA is formed. (2 marks)

(iv) Describe how the principle of gel electrophoresis can be used to determine whether a sample of PCR products contains viral specific sequence. (3 marks)

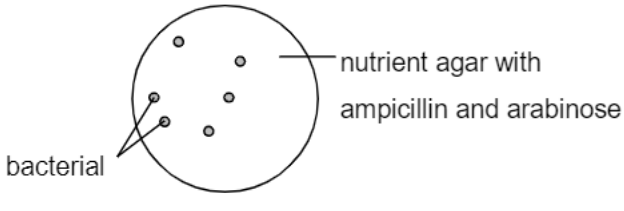
(v) Give ***one*** strength and ***one*** weakness of rapid antigen tests over PCR. (2 marks)

1 (c) A plasmid and a DNA fragment containing the gene of interest are shown below.



GFP gene codes for green fluorescent protein (GFP), which emits green light when it is exposed to ultraviolet light. araC gene codes for araC protein. araC protein normally prevents RNA polymerase from binding to GFP gene, but it promotes the binding in the presence of arabinose.

A student tried to insert the gene of interest into the plasmid at site X, so that the gene of interest can be expressed together with the GFP gene, and the protein produced will be linked to GFP. He cut the plasmid and the DNA fragment with a restriction enzyme and mixed them with a DNA ligase. After ligation, the student mixed the products with bacteria and cultured the bacteria on an agar plate. The diagram below shows the plate after incubation.



(i) Which restriction enzyme should the student use to cut the plasmid and the DNA fragment? Explain your answer. (3 marks)

(ii) Explain why only some of the bacteria grew on the agar plate. (2 marks)

(iii) To check whether the gene of interest was inserted into the plasmid, the student obtained plasmids from different colonies and found out their size. What would be the size of the plasmids if the gene of interest was inserted? (1 mark)

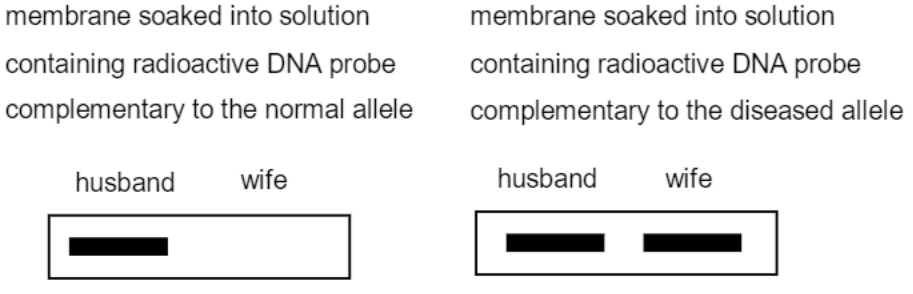
(iv) Explain why the colonies on the agar plate glow when the plate is exposed to ultraviolet light. (3 marks)

1. (d)

One form of β-thalassaemia caused by substitution of a base can be detected using a DNA test. The procedure of the test is shown below.

1. Obtain DNA sample from an individual and cut it using a restriction enzyme.
2. Separate the DNA fragments using gel electrophoresis.
3. Denature the DNA fragments in the gel and transfer them to two nylon membranes. Soak one membrane into a solution containing a radioactive DNA probe complementary to the normal allele, and another one into a solution containing a radioactive DNA probe complementary to the diseased allele.
4. Wash off the unbound DNA probes and visualize the DNA probes on the membranes.

A couple, both having no symptoms of the disease, underwent the test. The results are shown below.

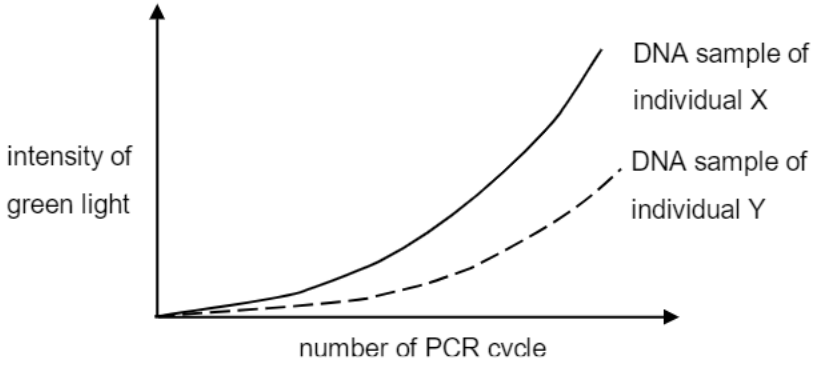


(i) In DNA tests for some other diseases, DNA fragments containing the normal and the diseased alleles can be differentiated by observing the positions of the DNA bands in the gel. Suggest why this is not possible in this test. (3 marks)

(ii) In the diseased allele, only one base is substituted. Explain why instead of using DNA probes containing one base, DNA probes containing about 20 base are used in the test. (2 marks)

(iii) Based on the results of the test, deduce the genotypes of the couple. (2 marks)

Scientists are developing another test for β-thalassaemia. In the test, same concentration of DNA samples are obtained from individuals and polymerase chain reaction (PCR) is carried out. A DNA probe complementary to the diseased allele and with a dye attached is added to the reaction mixture. The dye gives out green light only when the DNA probe binds to the target sequence. The graph below shows the intensity of green light detected when PCR is carrying out.



(iv) Explain the shape of the curve for the DNA sample of individual X. (2 marks)

(v) Suggest a reason to explain the difference in the intensities of green light detected when PCR is carried out on the two samples. (2 marks)

– END OF PAPER –