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4EX

BIOLOGY

6093/01

Paper 1 Multiple Choice [40 Marks]

PRELIMINARY EXAMINATION

September 2021

1 hour

Additional Materials:
Approved calculator
OTAS

Instruction to Candidates

Do not start reading the questions until you are told to do so.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class, and index number on the OTAS provided.

Information for Candidates

There are **forty** questions on this paper. Answer **all** questions.

For each question, there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the OTAS.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of 19 printed pages.

Setter: Mrs Marie Huang

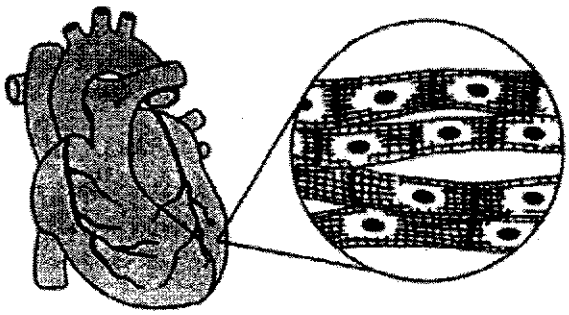
Vetter: Mr Nigel Ng / Mr Timothy Ng

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1 The diagram shows the magnified tissue of a human organ.



Which of the following organelles is found in large numbers in the cells of this tissue?

A 

B 

C 

D 

2 What is the correct order in which organelles function to make and secrete an enzyme?

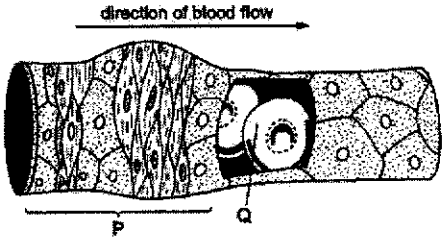
A nucleolus → ribosome → Golgi body → vesicle

B nucleolus → smooth endoplasmic reticulum → vesicle

C nucleus → rough endoplasmic reticulum → Golgi body → vesicle

D nucleus → smooth endoplasmic reticulum → vesicle

3 The diagram shows blood passing through an arteriole into a capillary. Part of the capillary wall has been cut away to show the blood.



What is the level of organisation of the structures labelled **P** and **Q**?

	P	Q
A	organ	cell
B	organ	tissue
C	tissue	cell
D	tissue	tissue

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4 Equal sized potato pieces were placed into test-tubes containing equal volumes of different concentrations of sucrose solution and left for 30 minutes. All other variables were controlled.

After 30 minutes, the potato piece in one of the concentrations of sucrose solution had not changed in size.

What can be concluded from this result?

1 There is no net movement of water into or out of the potato.
2 The water potential of the potato is the same as the water potential of the sucrose solution.
3 The concentration of sucrose in the potato is the same as the concentration of the sucrose solution.

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 1, 2 and 3

5 Which process can involve active transport?

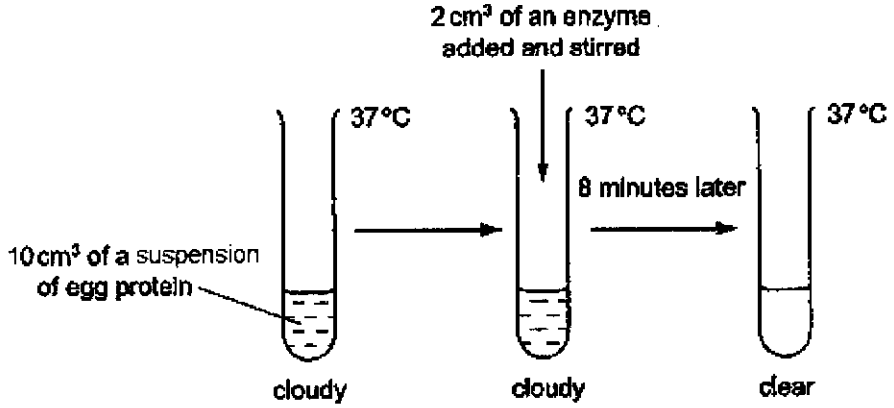
A carbon dioxide intake through stomata
B mineral ion intake through root hairs
C mineral ion transport through xylem vessels
D water leaving mesophyll cells

6 Which of the following is **not** a common feature among carbohydrates, proteins and fats?

A They are important for the normal functioning of the human body.
B They are made up of repeated units of one type of molecule.
C They can be broken down to release energy.
D They contain carbon, hydrogen and oxygen.

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7 The diagram shows an experiment using the enzyme pepsin.



Which of the following modifications to the experiment may cause the egg protein suspension to remain cloudy after 8 minutes?

A less egg protein is used

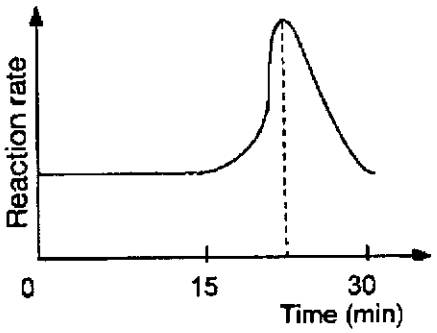
B the mixture is stirred

C pH of the mixture is increased

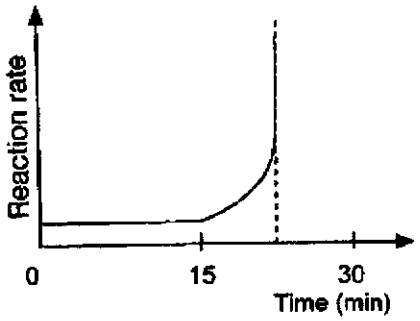
D temperature is decreased to 25°C

8 Which graph shows the rate of enzyme reaction when a hot mixture of starch and salivary amylase is cooled down from 100 °C to 0 °C over 30 minutes?

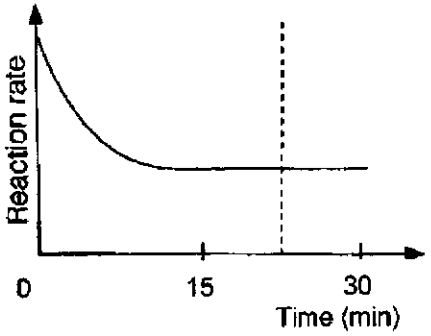
A



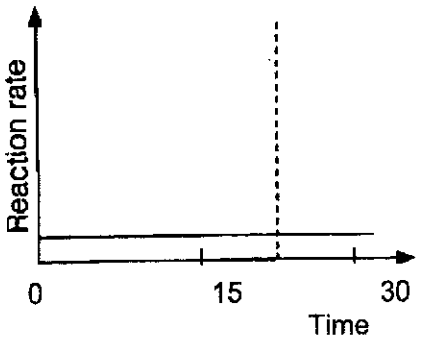
B



C



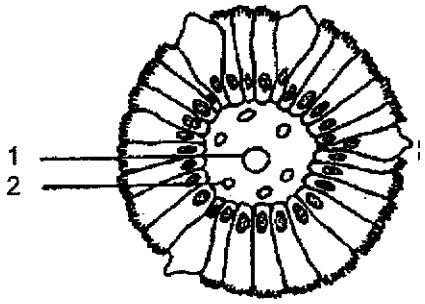
D



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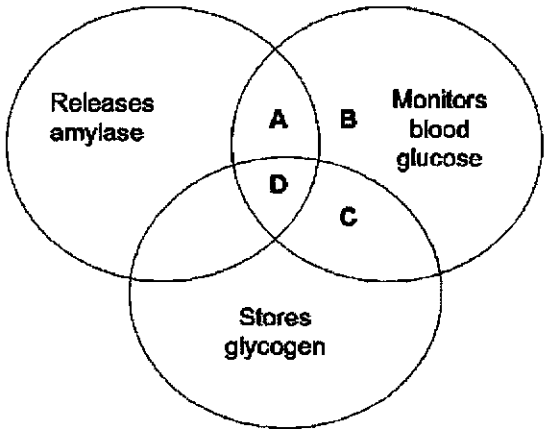
9 The diagram below shows the transverse section of a villus found in the small intestine.



What are the substances absorbed into structures 1 and 2?

	1	2
A	amino acid	glucose
B	starch	fats
C	fats	amino acid
D	glycerol	glucose

10 Which area best represents the function(s) of the pancreas?



11 A certain disease results in the reduction of the innermost layer of mucus in the stomach. Which would be a likely consequence of this disease?

A destruction of the stomach wall by acid

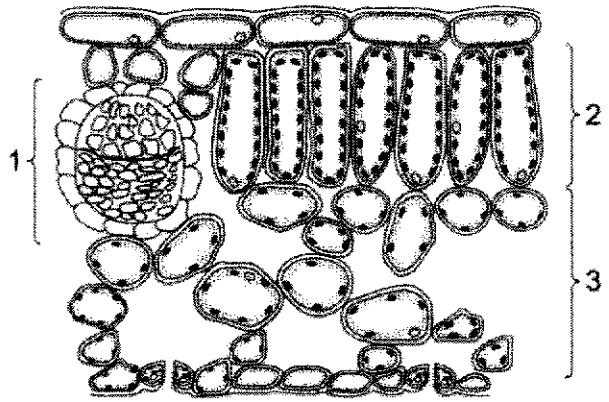
B greater production of gastric juice

C rapid emptying of the stomach contents into the small intestine

D reduced enzymatic action

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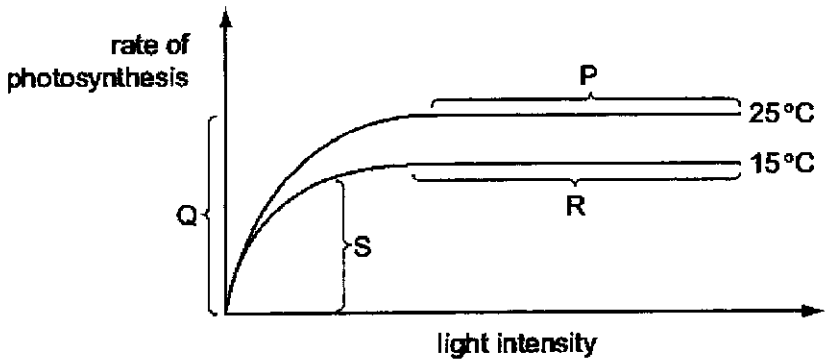
12 The diagram shows part of a leaf as seen in cross section under the microscope.



What are the names of regions **1**, **2** and **3**?

	regions		
	1	2	3
A	palisade mesophyll	vascular bundle	spongy mesophyll
B	spongy mesophyll	palisade mesophyll	vascular bundle
C	vascular bundle	palisade mesophyll	spongy mesophyll
D	vascular bundle	spongy mesophyll	palisade mesophyll

13 The graph shows how the rate of photosynthesis varies with light intensity at two different temperatures. Other variables are kept the same.



In which sections of the graph is light intensity limiting the rate of photosynthesis?

A P and R

B Q and S

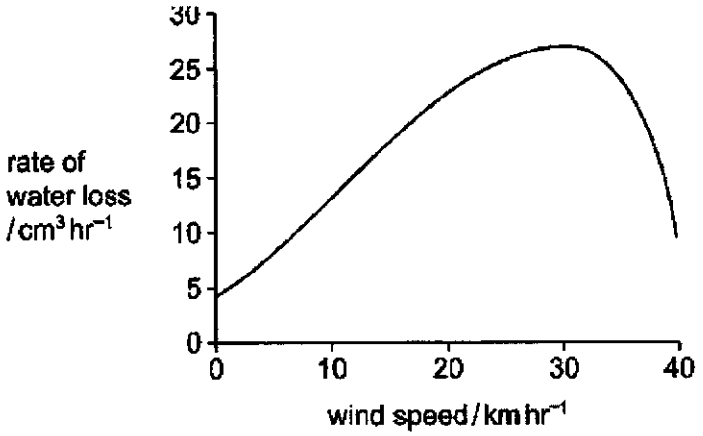
C R and Q

D S and P

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14 The graph shows the results of using a photometer to measure the effect of wind speed on the water loss in a plant.



Which statement explains the results obtained from the investigation?

A As wind speed increases, it becomes harder for the plant to obtain carbon dioxide. At high wind speeds, the stomata are fully open and rate of water loss is high.

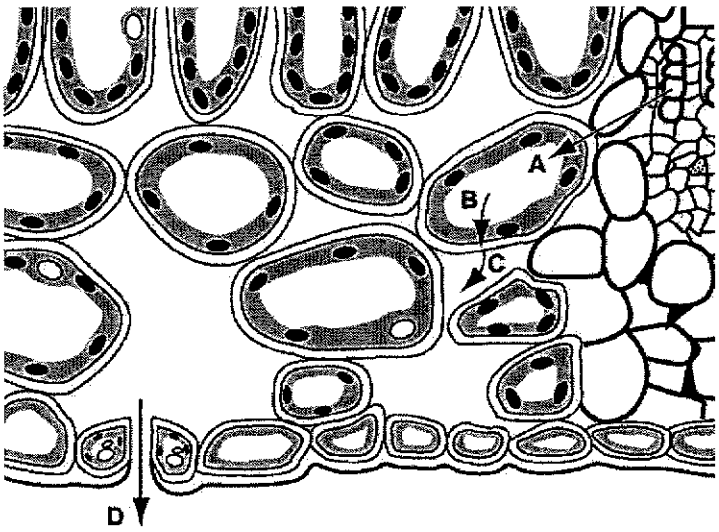
B As wind speed increases, moist air around the stomata is removed and replaced by dry air. At high wind speeds the transpiration rate is lower.

C As wind speed increases, the rate of water loss is lowered due to an increased diffusion gradient. At high wind speeds, stomata close.

D As wind speed increases, transpiration and photosynthesis rate increase. At high wind speeds, more water is used for photosynthesis.

15 The diagram shows the movement of water molecules in a leaf from the xylem to the atmosphere.

At which stage does evaporation occur?



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16 The table refers to blood vessels in the human body.

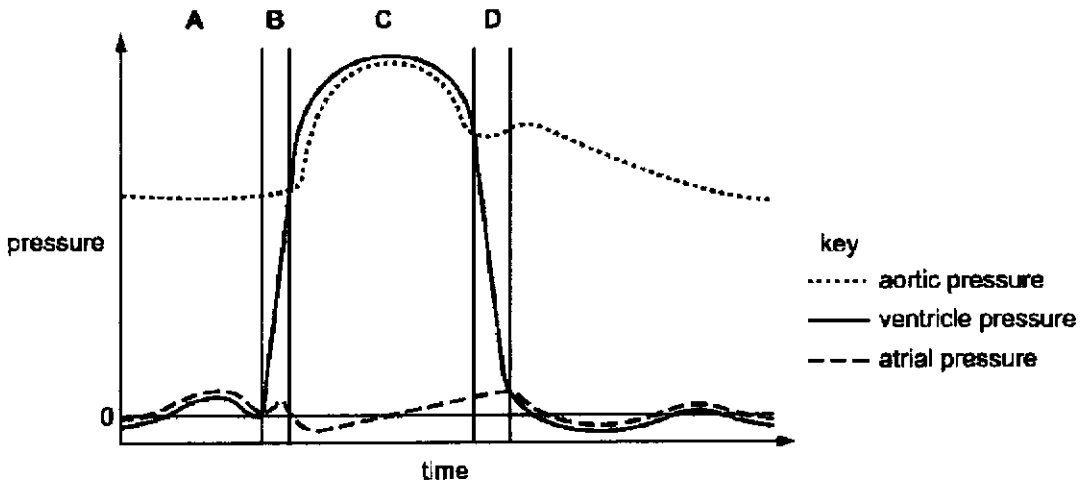
vessel	blood carried		oxygenated / deoxygenated
	from	to	
aorta	**P**	all organs except lungs	oxygenated
pulmonary vein	lungs	heart	**Q**
hepatic artery	aorta	**R**	oxygenated
hepatic portal vein	alimentary canal	liver	**S**

What are **P**, **Q**, **R** and **S**?

	P	Q	R	S
A	left ventricle	deoxygenated	lungs	deoxygenated
B	left ventricle	oxygenated	liver	deoxygenated
C	right ventricle	deoxygenated	lungs	oxygenated
D	right ventricle	oxygenated	liver	oxygenated

17 The diagram shows pressure changes in different parts of the heart during one cardiac cycle.

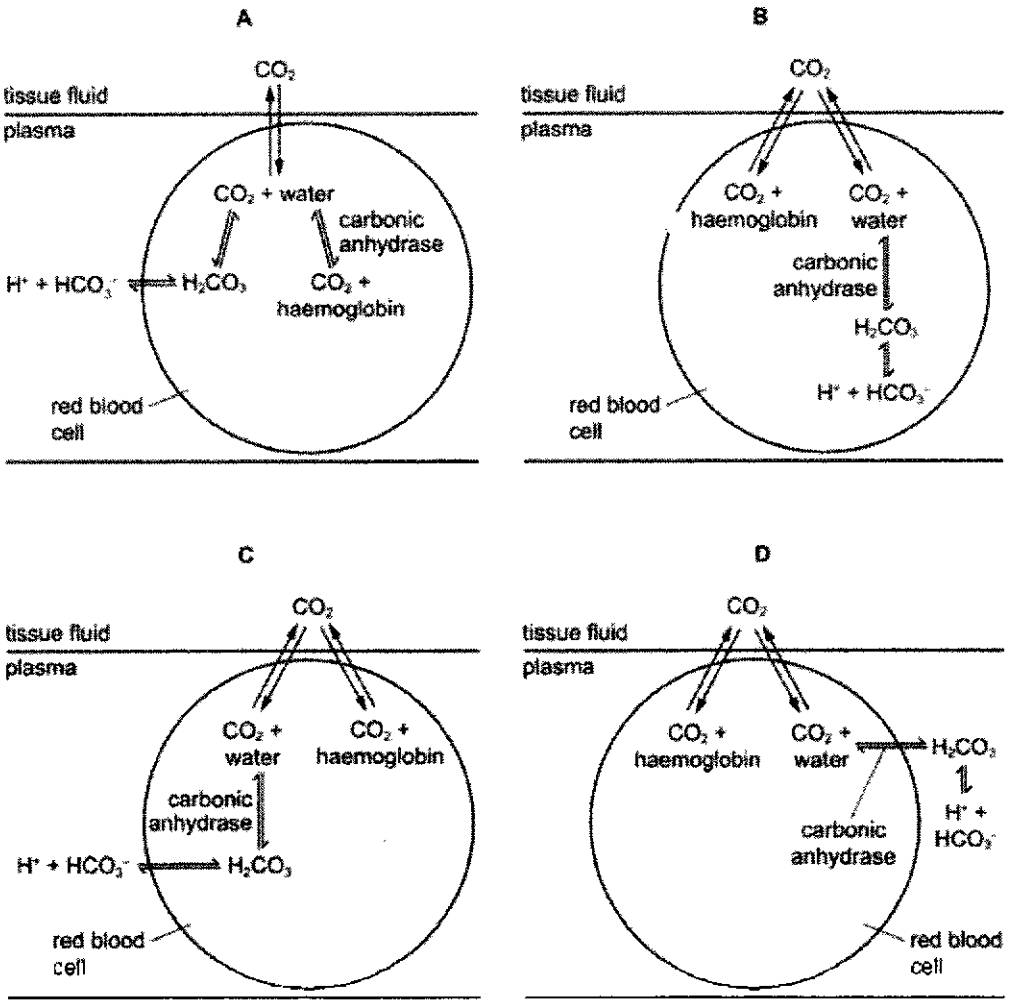
During which period are the semilunar valves open and the atrioventricular valves closed?



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18 Which diagram shows the events that occur during transport of carbon dioxide by the blood?



19 Carbon monoxide, nicotine and tar are components of tobacco smoke.

Which row correctly describes their effect on a smoker's body?

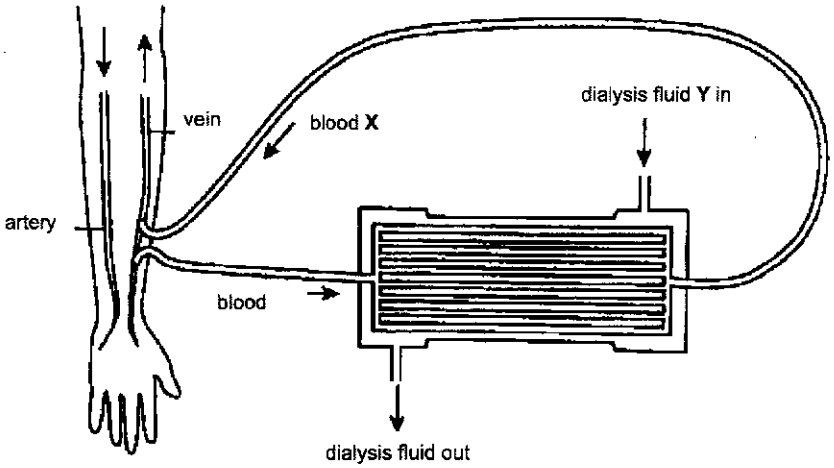
	carbon monoxide	nicotine	tar
A	causes loss of consciousness at very low concentrations	increases the diameter of blood vessels	destroys cilia on cells lining the airways
B	forms carbaminohaemoglobin	decreases the heart rate	settles on cells lining the airways
C	forms carboxyhaemoglobin	increases the diameter of the coronary artery	settles on cells lining the airways
D	forms a stable compound with haemoglobin	increases blood pressure	stimulates goblet cells to secrete mucus

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20 The diagram below shows the flow of blood and dialysis fluid through a kidney machine.



Which of the following statements about **X** and **Y** is true?

A Both **X** and **Y** do not contain urea.

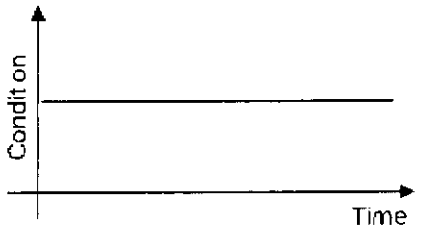
B **X** and **Y** have similar concentrations of glucose.

C **X** contains mineral salts but **Y** does not.

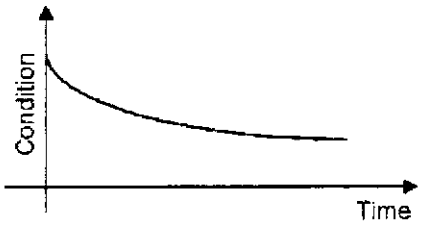
D **X** contains a higher concentration of amino acids than **Y**.

21 Which graph accurately shows the control of an internal condition by negative feedback?

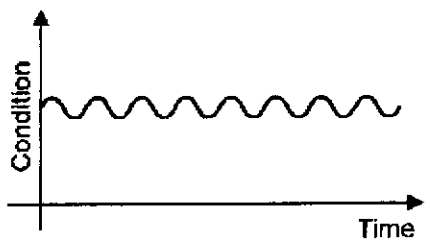
A



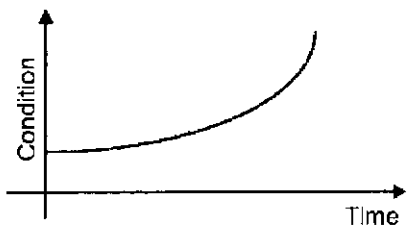
B



C



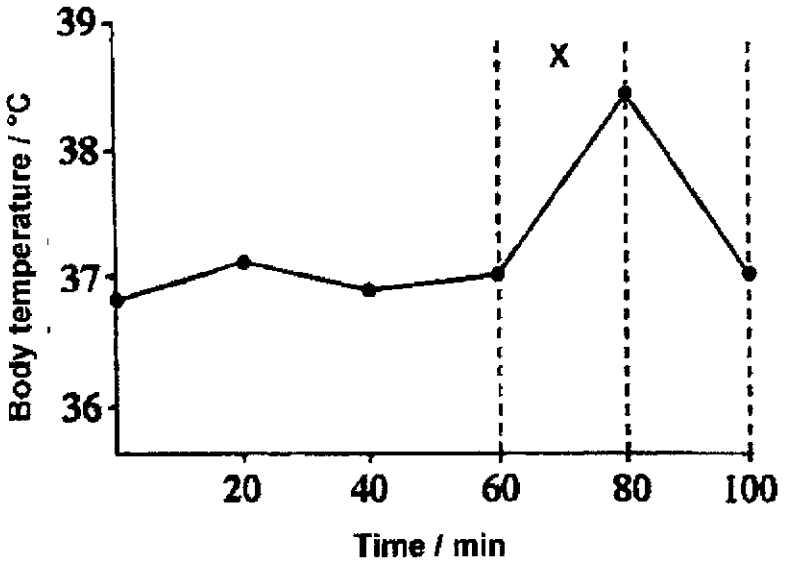
D



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22 The graph below shows the changes in body temperature of a person.



Due to a change in the external environment, the body temperature of the person changed during period **X**.

Which of the following could be occurring during this period to reverse that change?

I. decrease in metabolic rate
II. dilation of arterioles in the skin
III. contraction of hair erector muscles
IV. increased production of sweat
V. shivering

A I, II and IV
B I, III and V
C II, III and IV
D III, IV and V

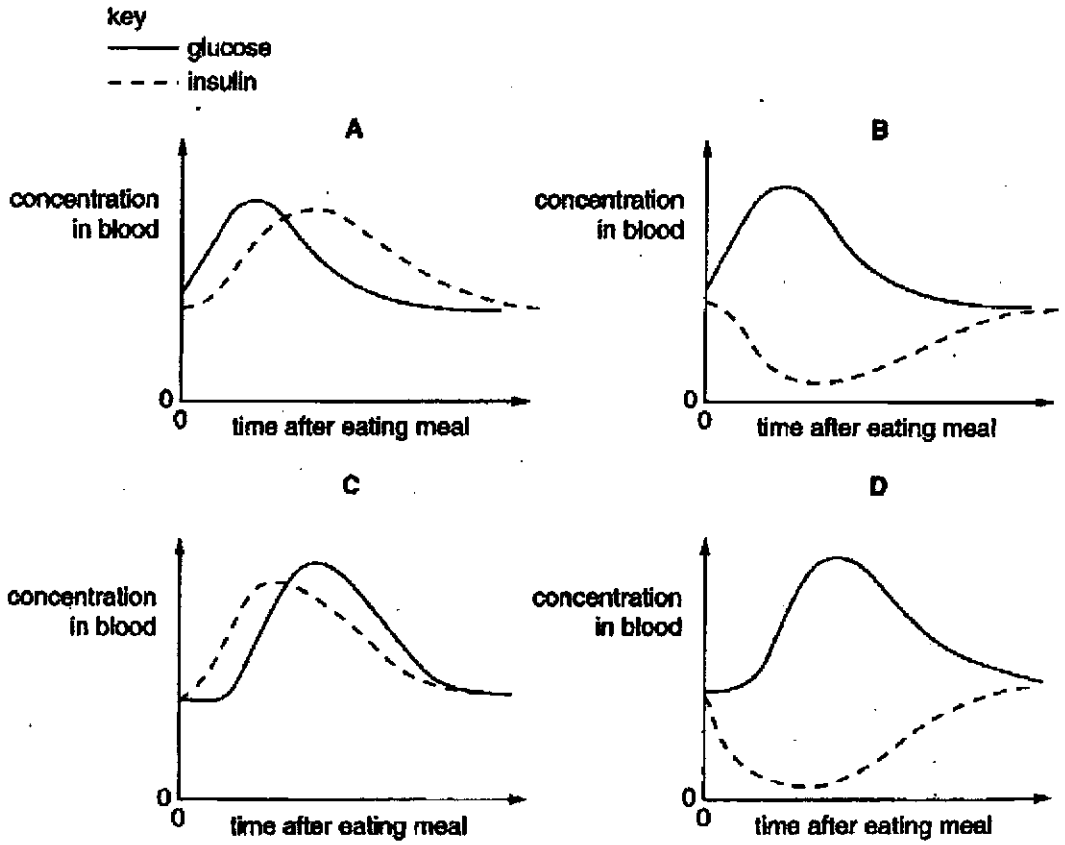
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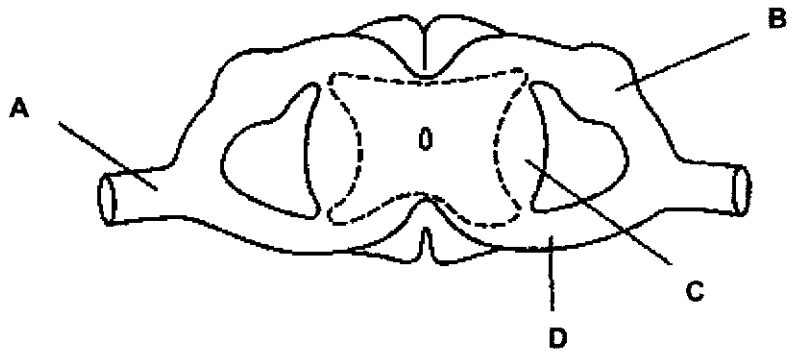
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23 The graphs show the concentration of glucose and insulin in the blood of a healthy person.

Which graph shows the changes expected after a meal containing starch?



24 The diagram shows a cross-section of the spinal cord of a mammal. Which region, **A**, **B**, **C** or **D**, contains the cell bodies of the sensory neurone?



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25 Our eyes feel strained when we read small prints for a long period of time.

Which of the following is the correct explanation for the incident described above?

A The suspensory ligaments become stretched.

B The retina will no longer record clear images.

C The optic nerve will no longer transmit impulses to the brain.

D The ciliary muscles become fatigued.

26 What is an advantage of sexual reproduction over asexual reproduction?

A It allows for growth of the species.

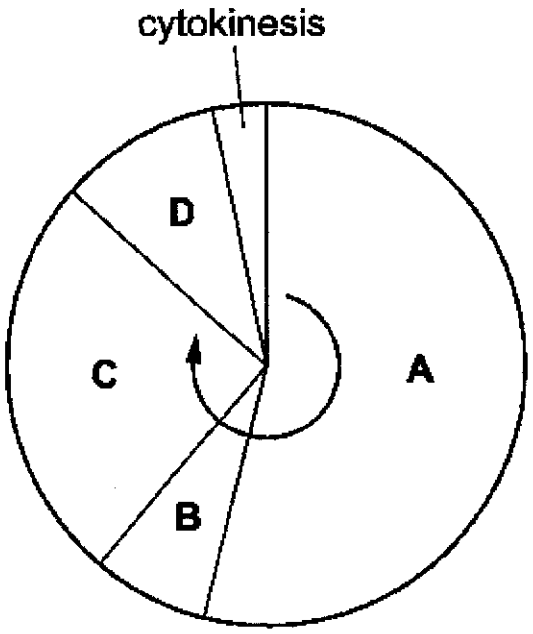
B It produces offspring more quickly.

C It produces offspring with different characteristics.

D It protects the offspring during its early stages of growth.

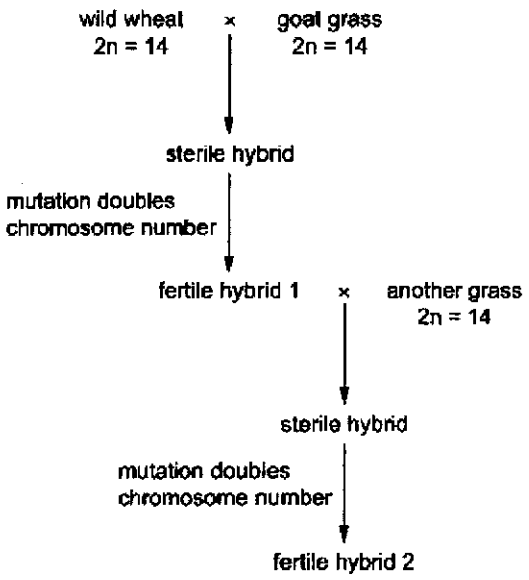
27 The diagram shows the cell cycle.

During which phase do chromosomes condense and become visible?



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28 The diagram shows crosses between wild wheat and two types of grass.



What is the chromosome number of the fertile hybrid 2?

A 28 **B** 42 **C** 56 **D** 140

29 An experiment was set up using four groups of insect-pollinated flowers in a field.

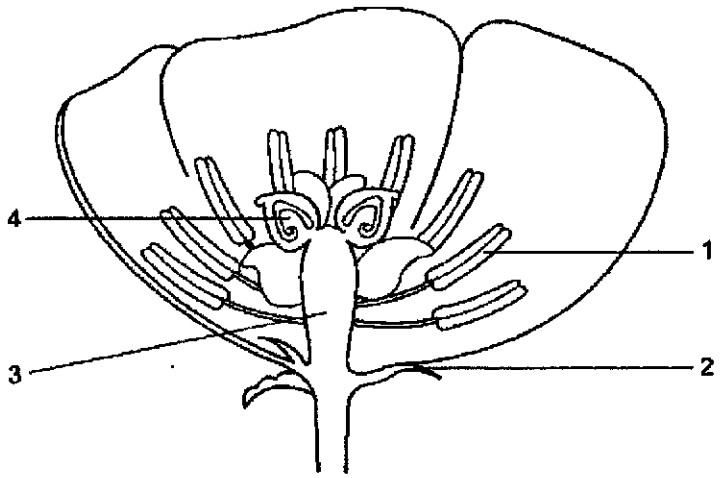
In each group, different parts of the flowers were removed, as shown in the table below, and insects were allowed to visit all the flowers freely.

Which group of flowers would be most successfully cross-pollinated?

	stigma	anther	petals
A	intact	removed	intact
B	intact	intact	removed
C	removed	intact	removed
D	removed	intact	intact

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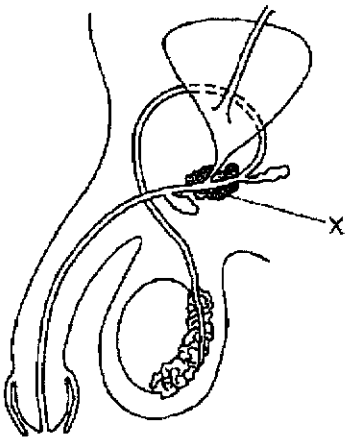
30 The diagram shows half a flower.



Where are the gametes produced?

A 1 and 3
B 1 and 4
C 2 and 3
D 2 and 4

31 The diagram shows a section through the male reproductive system



What will be the consequence of removing gland **X**?

A Fewer sperms are formed.
B Fewer sperms stored.
C Less testosterone is produced.
D Sperms are less active.

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32 The calendar shows the menstrual cycle of a woman in September 2020.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

key

= ovulation

= menstruation

Why would fertilisation not take place if sperms are deposited in the vagina on 8 September?

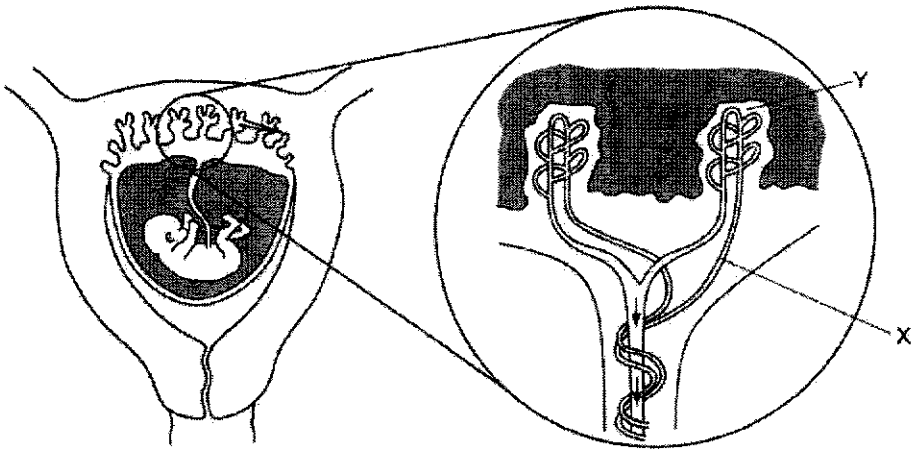
A Sperms are washed out of the female uterus by the menstrual flow.

B Sperms can survive in the female reproductive system only for 3 or 4 days

C Sperms must be released after ovulation for fertilisation to take place.

D The uterus lining is washed out of the female body during menstruation.

33 The diagram shows a fetus in the uterus.



Which substance will be at a lower concentration at **X** than at **Y**?

A carbon dioxide and glucose

B carbon dioxide and urea

C glucose and oxygen

D oxygen and urea

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34 In humans, the allele for achondroplasia dwarfism is dominant over the normal allele.

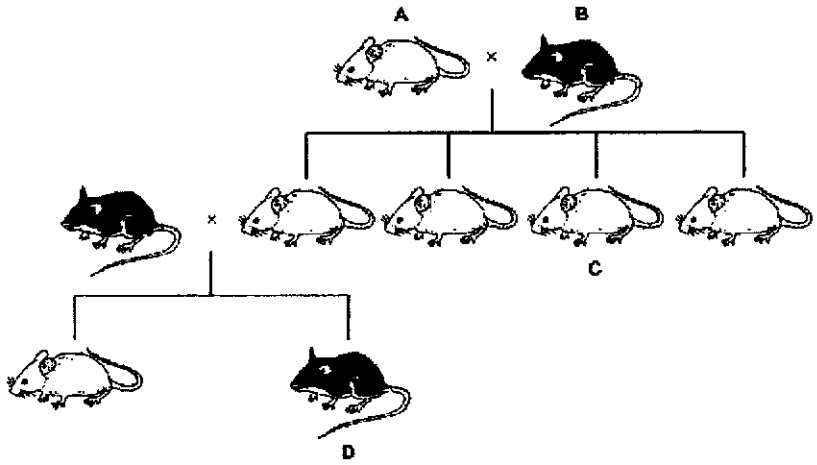
A homozygous recessive individual is normal; a heterozygous individual is dwarfed, while a homozygous dominant individual is always fatal before and shortly after birth due to severe developmental defects.

If a dwarf man marries a dwarf woman, what is the probability of them having a child with severe developmental defects?

A 0 **B** 0.25 **C** 0.33 **D** 0.5

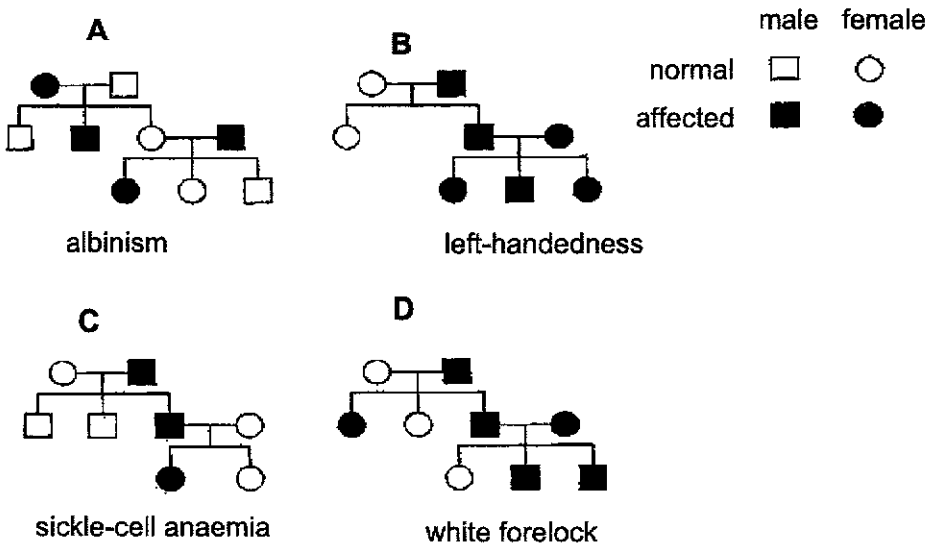
35 The chart shows the inheritance of fur colour in a small mammal.

If the allele for white fur is dominant, which animal must be heterozygous for the gene controlling fur colour?



36 The inheritance patterns of four conditions are shown.

Which inheritance pattern proves that the condition is **not** caused by a recessive allele?



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37 A short piece of DNA 15 base pairs long was analysed to find the number of nucleotide bases in each of the polynucleotide strands.

Some of the results are shown below.

	number of nucleotide bases			
	A	C	G	T
strand 1		6		3
strand 2				4

How many nucleotides containing guanine were present in strand 1?

A 2 **B** 3 **C** 4 **D** 6

38 The following list gives some features of the processes of artificial selection and genetic engineering.

I. The organism's genotype is altered.

II. The new variety can make a substance previously only made by a different species.

III. The process involves working with many generations of the organism over a long period.

IV. The gene for the useful characteristic is transferred from one species to another.

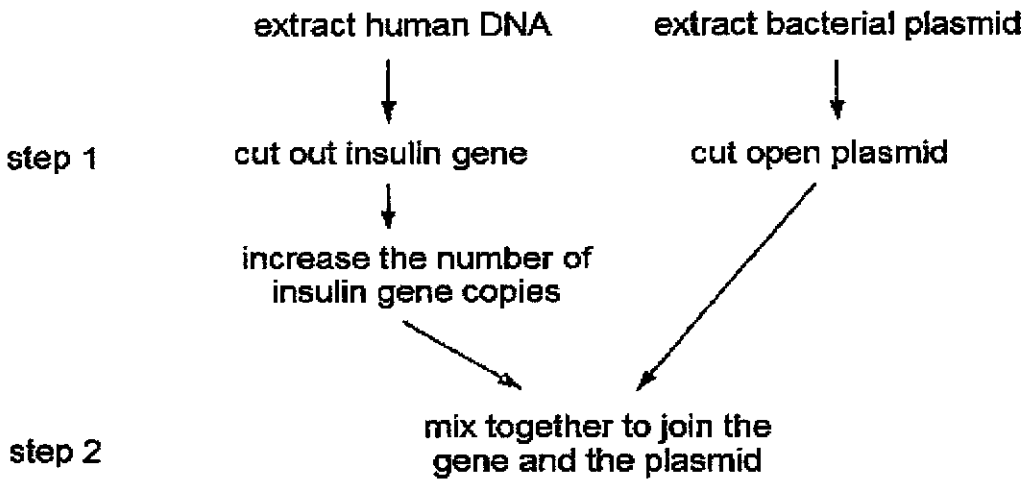
Which of the features listed above refer to genetic engineering and to artificial selection?

	genetic engineering	artificial selection
A	I, III and IV	I and II
B	I, II and IV	I and III
C	II and IV	II and III
D	I, II, III and IV	I, II and III

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39 The diagram outlines part of the process to produce recombinant DNA that will synthesise human insulin.



Which row correctly identifies the enzyme used in each of steps 1 and 2?

	step 1	step 2
A	peptidase	restriction
B	peptidase	ligase
C	restriction	peptidase
D	restriction	ligase

40 The table shows mRNA triplets and their corresponding amino acids.

mRNA triplet	GCA	GCG	GAA	GAG	AAA	AAG
amino acid	ala	ala	glu	glu	lys	lys

A tripeptide is glu-lys-ala.

Which sequence of bases in DNA could code for this tripeptide?

A CTCCGTTTT

B CTTTTCCGT

C TTCCGTCTT

D TTTCTCCGC

--- End of Paper 1 ---

[Turn Over

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Name	Reg. No	Class

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4EX

BIOLOGY

6093/02

Paper 2 Theory [80 Marks]

PRELIMINARY EXAMINATION

August 2021

Additional Materials:
Approved calculator

1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

Do not start reading the questions until you are told to do so.

Write your name, class, and index number on all the work you hand in.

Write in dark blue or black pen.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use paper clips, highlighters, glue or correction fluid.

This paper consists of **Section A** and **Section B**.

Answer **all** questions.

Write your answers in the spaces provided on the Question Paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

Candidates are reminded that **all** quantitative answers should include appropriate units.

Candidates are advised to show all their working in a clear and orderly manner.

The use of an approved scientific calculator is expected, where appropriate.

FOR EXAMINER'S USE		
Paper		**Marks**
Paper 1 (MCQ)		/ 40
Paper 2		
A		/ 50
B	**7**	/ 11
	8	/ 9
	9 E/O	/ 10
Total		**/ 120**

This question paper consists of **19** printed pages.

Setter: Mrs Marie Huang

Vetter: Mr Ng Tze How/Mr Timothy Ng

[Turn Over

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Section A [50 marks]

Answer **all** questions in this section.
Write your answers in the spaces provided.

1 Aphids are small insects, which feed directly on sap found in plant vascular tissue.

The salivary glands of aphids have secretory cells that make and release a variety of proteins that assist in feeding.

Fig. 1.1 is a transmission electron micrograph of a small area of a salivary gland cell of an aphid.

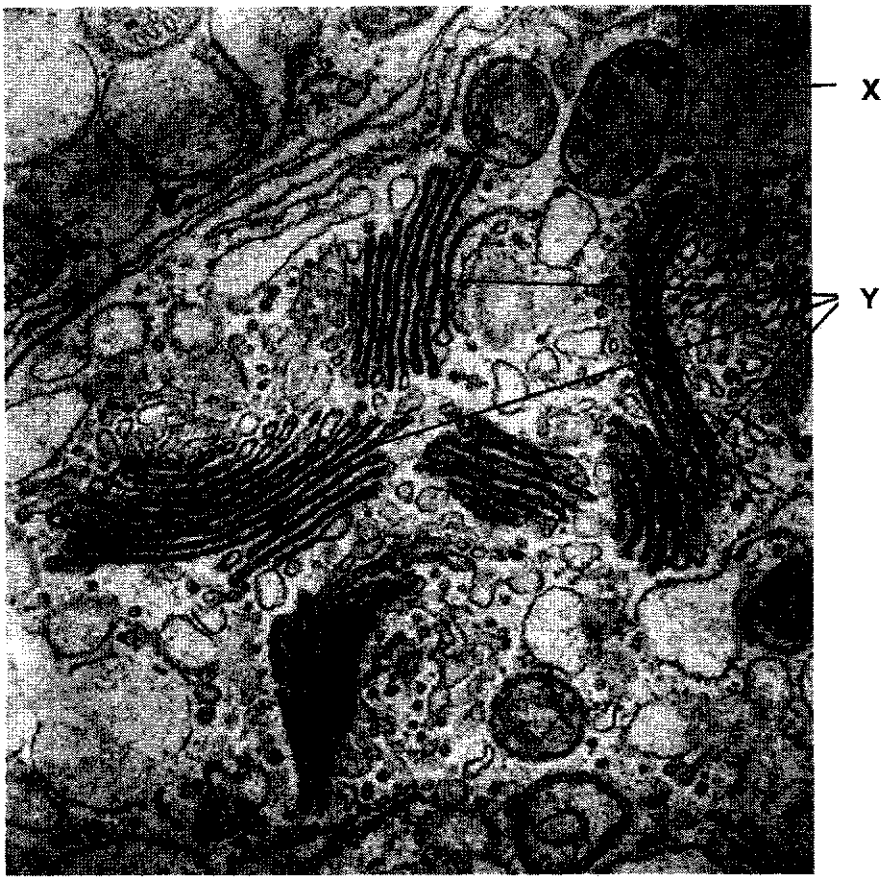


Fig 1.1

(a) Identify structures **X** and **Y**.

X .....

Y .....

[2]

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(b) Describe the role of **X** and **Y** in secretory cells such as the salivary gland cells of aphids.

(i) **X**

.....

.....[1]

(ii) **Y**

.....

.....

.....

.....[2]

(c) Fig 1.2 shows the transverse section of a stem.

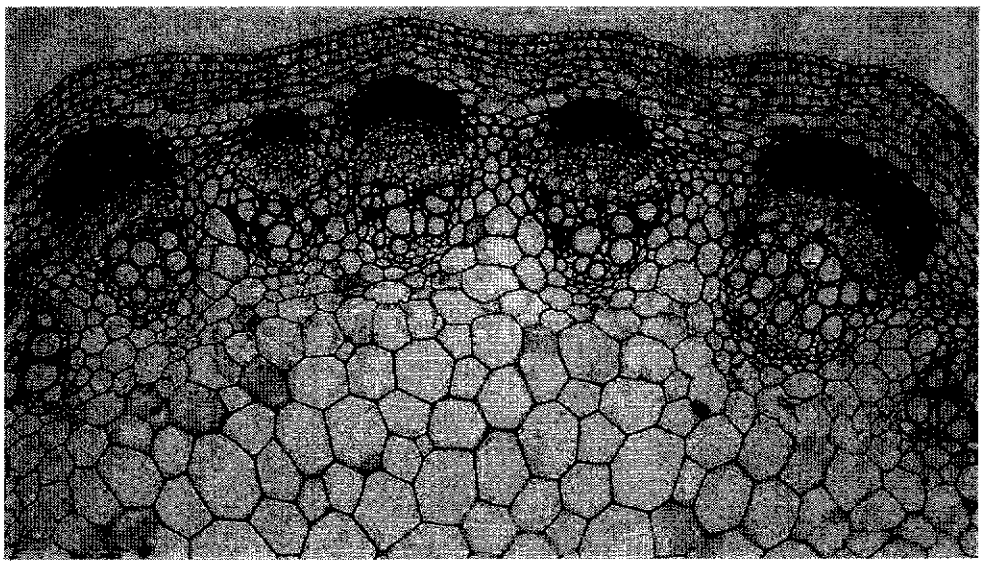


Fig 1.2

(i) Label on Fig 1.2 the name of the vessel(s) involved which the aphid obtain the sap from. [1]

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A soluble metabolic poison that prevents respiration was added to the soil. It was observed that the aphid could no longer absorb any more sap. The presence of the poison was detected in the stem and leaves.

(ii) Describe, in detail, how the poison entered the cells in the leaves from the soil.

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.....[3]

(iii) Explain why the aphid was no longer able to absorb any more sap from the vascular tissues in the stem.

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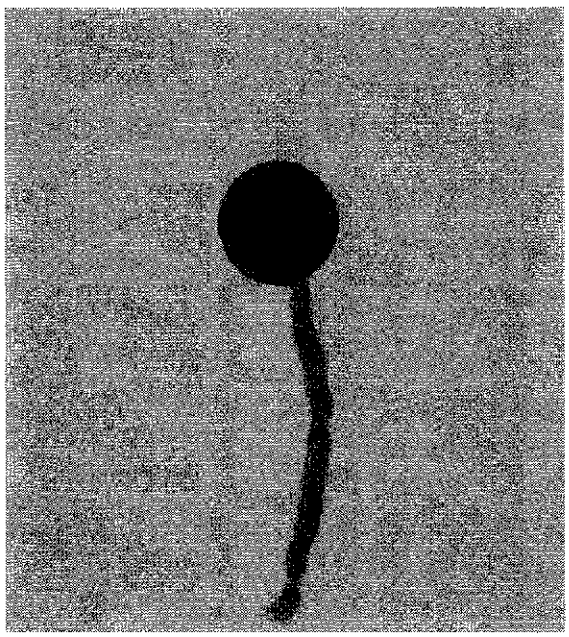
.....

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.....[2]

[Total = 11]

2 The diagram shows a pollen grain with a pollen tube growing from it.



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Pollen grains from the same type of plant were placed in sucrose solutions of different concentrations for a fixed amount of time. After this time, the pollen grains and tubes were examined using a microscope.

The following observations were made for each concentration of sucrose:
- the number of pollen grains that had germinated to produce a pollen tube
- the length of each pollen tube.

Table 2.1 shows the results of the investigation.

Table 2.1

% sucrose concentration	% of pollen grain germinated	mean pollen tube length/mm
1	6	0.005
2	13	0.008
4	25	0.015
8	56	0.040
10	31	0.030
20	25	0.018
40	13	0.006

(a) (i) 12 pollen grains were placed in the 20% sucrose solution. Use the information in the table to calculate the number of pollen grains that germinated to produce a pollen tube in the 20% sucrose solution.

.....[1]

(ii) Use the information in the table to suggest the optimum concentration of sucrose solution for pollen tube germination and growth.

Explain how the information in the table enabled you to reach this conclusion.

.....

.....

.....

.....[2]

[Turn Over

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(iii) The germination of a pollen grain to form a pollen tube requires the movement of water into the pollen grain from its surroundings.

Suggest why placing a pollen grain in a solution with a higher sucrose concentration than in your answer to **(a)(ii)** may result in a lower percentage of germination.

.....

.....

.....

.....

.....

.....[3]

(b) Describe the route taken by a growing pollen tube in a plant and explain its importance in plant reproduction.

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.....[3]

[Total = 9]

3 Fig 3.1 shows the variation in the concentration of dissolved carbon dioxide in the water of a pond over a period of 24 hours.

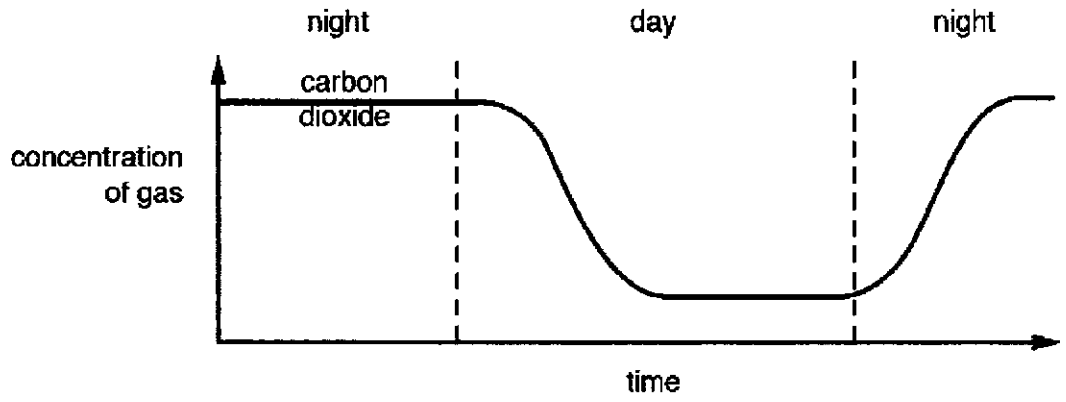


Fig 3.1

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(a) State the word equation of the processes that contribute to the change in concentration of dissolved carbon dioxide as shown in the graph.

.....

.....[2]

(b) Draw a line on Fig 3.1 to show the change in concentration of dissolved oxygen in the water of the same pond over the same period. [1]

Carbon dioxide dissolves in water to form an acidic solution.

Ammonia is a toxic chemical found in ponds that may harm fish. Fig 3.2 shows how the concentration of dissolved ammonia in the water of a pond changes as the pH changes.

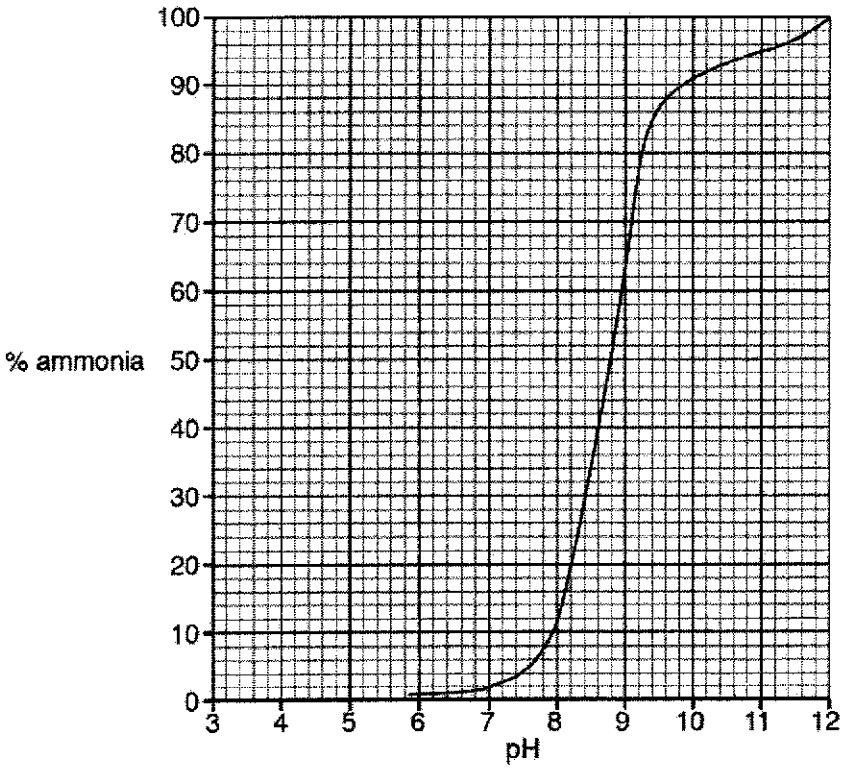


Fig 3.2

[Turn Over

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(c) With reference to Fig 3.1 and Fig 3.2, suggest and explain at which time of the day fish in the pond are most likely to be affected by the toxic effects of ammonia.

Circle the correct time of the day.

time of day: sunrise midday sunset

Explanation

.....

.....[2]

(d) Describe how carbon dioxide can be converted into other carbon containing compounds in the water plants.

.....

.....

.....

.....[2]

[Total = 7]

4 Fig 4.1 shows the distance between sister chromatids during mitosis.

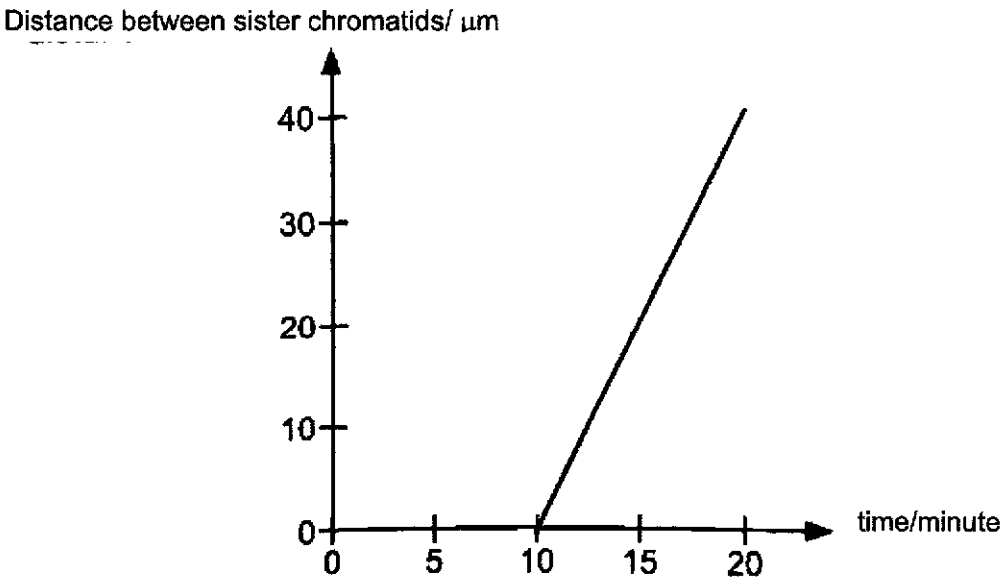
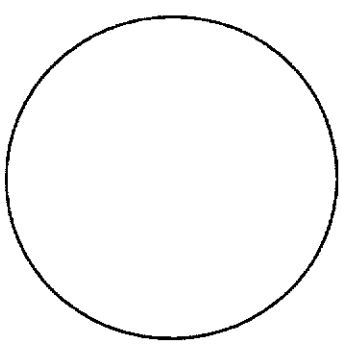


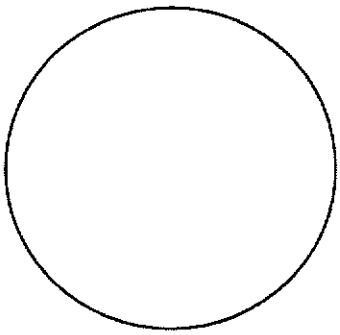
Fig 4.1

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(a) For a diploid cell containing four chromosomes, draw the arrangement of chromosomes at the 10th minute and at the 20th minute.



10th minute



20th minute

[2]

(b) Compare the arrangement of chromosomes of this cell at 10th minute going through mitosis and meiosis.

.....

.....

.....

.....[2]

(c) Explain how meiosis introduces genetic variation in the daughter cells produced.

.....

.....

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.....[2]

(d) Suggest why meiosis is necessary in sexual reproduction.

.....

.....[1]

[Total = 7]

[Turn Over

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5 Fig 5.1 shows a section through the human eye.

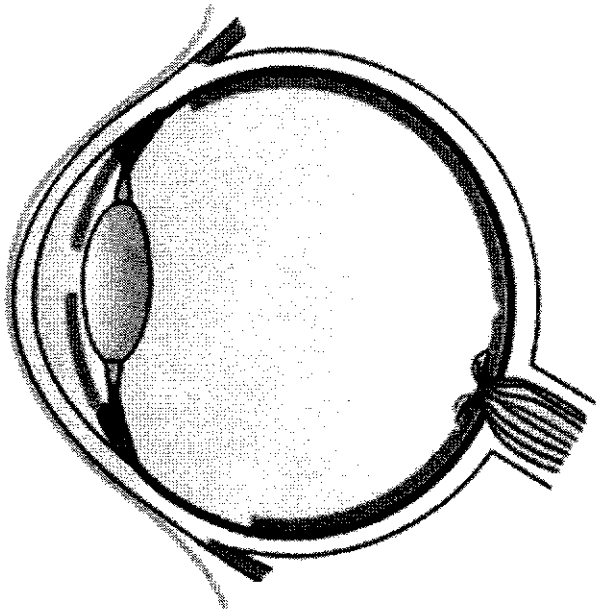


Fig 5.1

(a) On Fig 5.1, identify and label the structure that

(i) detects light stimuli

(ii) refracts the most light as it enters the eye

[2]

(b) Describe the changes in the eye when a person walks out from a dimly-lit cinema into bright light.

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.....[2]

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(c) The interpupillary distance (IPD) is the distance in millimetres between the centres of the pupils of the eyes.

Fig. 5.2 shows how IPD is measured.

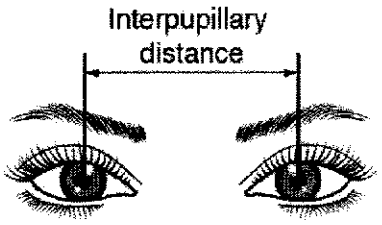


Fig 5.2

IPD is one example of a human phenotype that shows variation. Fig 5.3 shows the pattern of variation in IPD in a large sample of adults.

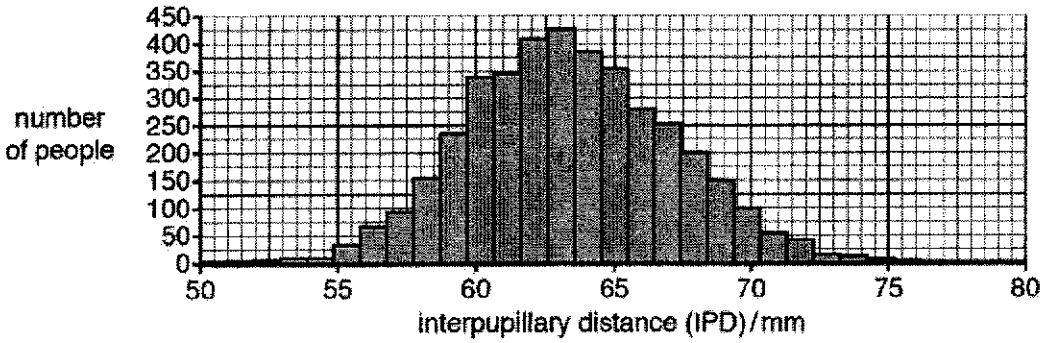


Fig 5.3

(i) Distinguish the terms genotype and phenotype.

.....

.....

.....

.....[2]

(ii) Identify the type of variation shown in Fig 5.3. Explain your choice.

.....

.....

.....

.....[2]

[Total =8]

[Turn Over

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6 Fig 6.1 shows a fetus developing in the body of its mother.

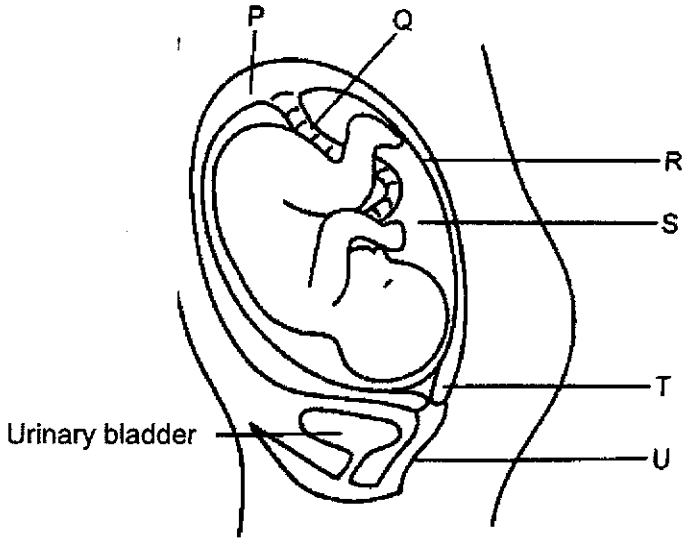


Fig 6.1

(a) Identify the structures labeled **P**, **Q**, **R** and **T**.

P .....

Q .....

R .....

T .....

[4]

(b) Mrs Tan suffers from diabetes mellitus and is pregnant. Explain how her medical condition puts her fetus at a greater risk of higher birth weight.

.....

.....

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.....[4]

[Total = 8]

---End of Section A ---

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Section B [30 marks)

Answer all **three** questions in this section.

7 Land animals secrete urea as the main metabolic waste product. In aquatic animals, ammonia is discharged as the main metabolic waste product instead of urea.

When a tadpole undergoes metamorphosis to become an adult frog, several structural changes as the tadpole changes from excreting ammonia to excreting urea, as it becomes a frog.

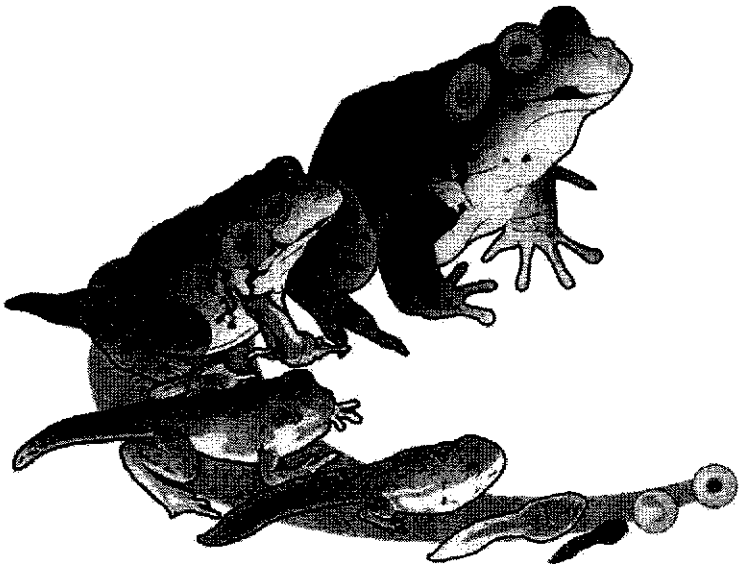


Table 7.1 shows the changes in ammonia secreted as a percentage of waste products of a tadpole as it metamorphosed into a frog.

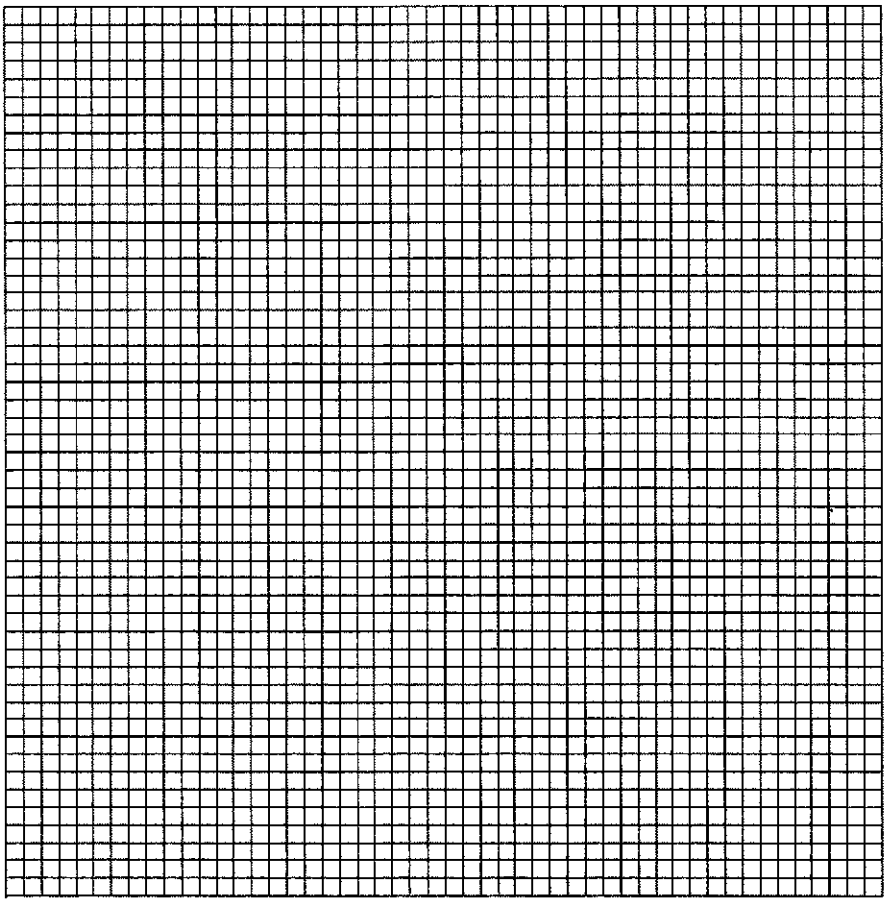
Table 7.1

Age of tadpole or frog (days)	Ammonia secreted as a percentage of waste products (%)
50	92
60	90
70	87
80	82
90	20
100	13
110	12

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(a) Plot a graph using the data given in Table 7.1.



[4]

(b) Using the graph drawn in **(a)**, predict the most likely period of time in which the frog first left the water to live on dry land. Explain your answer.

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.....

.....[2]

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(c) The process of removing waste products in the form of urea in a frog is similar to that of a human.

Describe the processes in which urea is formed and subsequently excreted from a human.

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.....[5]

[Total = 11]

8 The CCR5 protein is found on the cell membrane of white blood cells involved in phagocytosis.

Fig 8.1 shows the gene loci of the CCR5 protein on human chromosome 3.

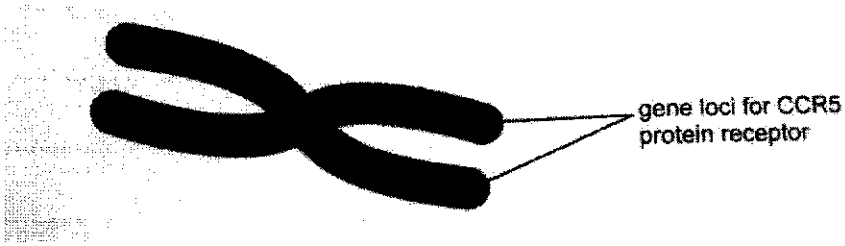


Fig 8.1

(a) Outline the relationship between a gene, chromosome and DNA.

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.....[2]

[Turn Over

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(b) Explain the presence of two copies of the CCR5 protein genes in the chromosome found in Fig. 8.1.

.....

.....[1]

(c) The CCR5 protein is known to enable the Human Immunodeficiency Virus (HIV) to attach onto the white blood cell and infect the cell. It is found that a mutation in the CCR5 gene confers some protection against HIV, raising the possibility of prevention or cure of HIV infection by genetically engineering a person's CCR5 gene.

(i) Define mutation.

.....

.....[1]

(ii) Describe why homozygous recessive individuals exhibit greater resistance to HIV compared to heterozygous individuals.

.....

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.....[2]

(iii) Suggest the possible social and health issues pertaining to the application of genetic engineering on humans to alter genetic information.

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.....[3]

[Total = 9]

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9 EITHER

Amyotrophic lateral sclerosis (ALS) is a form of neurological disease that is caused by the gradual degeneration of neurones. Early symptoms usually include muscle weakness and stiffness. Eventually, the brain loses its ability to initiate and control voluntary muscles.

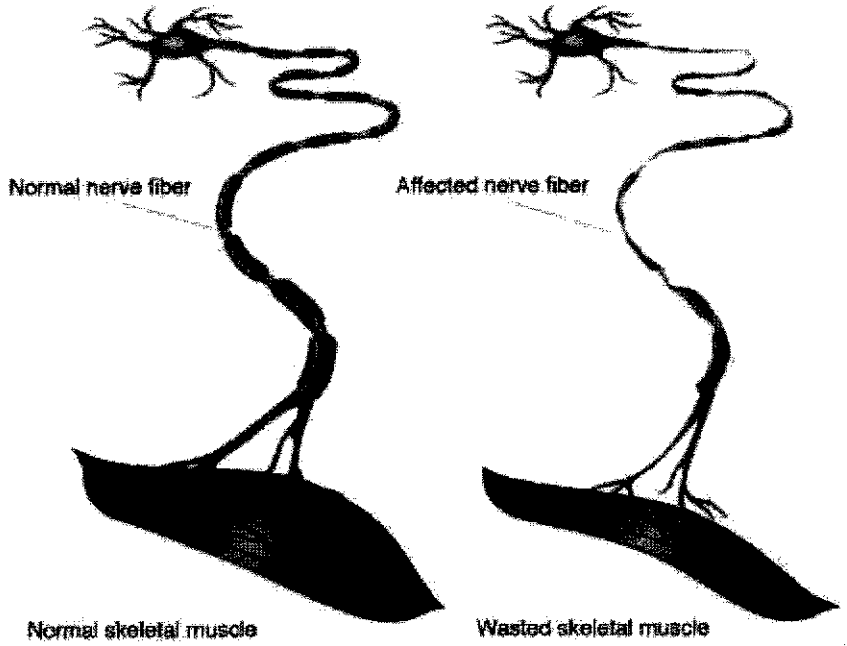


Fig. 9.1

(a) With reference to Fig 9.1, identify the type of neurones that are degenerated in individuals with ALS.

.....[1]

(b) Explain how individuals with ALS are unable to control voluntary movements over time.

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.....[3]

[Turn Over

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(c) Individuals with ALS eventually lose the ability to breathe on their own and must depend on a ventilator to breathe.

(i) Describe how a healthy individual inhales to take in air.

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.....[4]

(ii) Suggest why the use of a ventilator is necessary in individuals with late stage ALS.

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.....[2]

[Total =10]

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9 **OR**

A group of specialized muscle cells called the sinoatrial node (SA node) produces an electrical impulse, which then initiates a single heartbeat by triggering contraction of muscles in the chamber walls.

(a) **(i)** State, with a reason, if generating a heartbeat is a voluntary or involuntary response.

.....

.....[1]

(ii) Describe how the "lub dub" sound of a heartbeat is generated.

.....

.....

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.....[4]

(b) Adrenaline is a hormone, which is able to stimulate the SA node to further increase heart rate.

Describe how adrenaline is produced and subsequently transported to the heart muscle cells to increase heart rate.

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.....[5]

[Total = 10]

----End of Paper----

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2021 MFSS SECONDARY 4 BIOLOGY 6093 PRELIMINARY EXAMINATION
MARK SCHEME

Paper 1

1	2	3	4	5	6	7	8	9	10
A	C	C	A	B	B	C	D	C	A

11	12	13	14	15	16	17	18	19	20
A	C	B	B	C	B	C	C	D	B

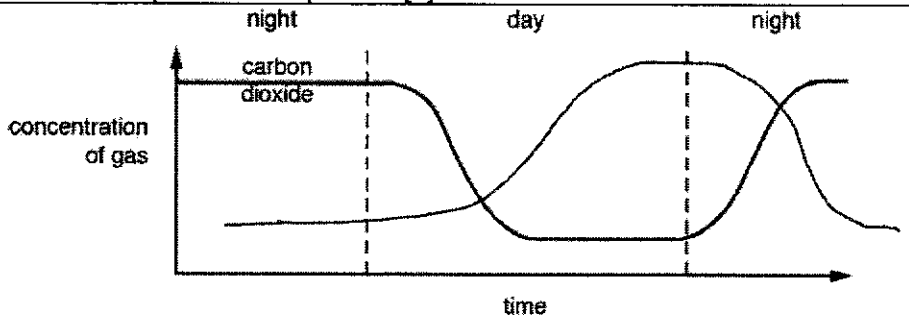
21	22	23	24	25	26	27	28	29	30
C	A	A	B	D	C	B	B	A	B

31	32	33	34	35	36	37	38	39	40
D	B	C	B	C	D	D	B	D	B

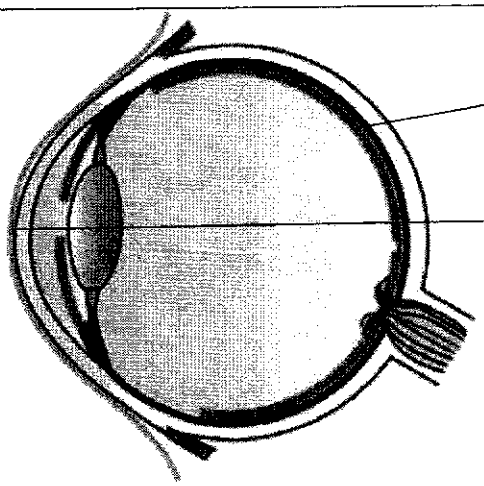
Paper 2
Section A

1a	**X** mitochondrion **Y** Golgi apparatus/body	2[1]
bi	**X** – release energy by aerobic respiration for the synthesis of proteins **or** export of proteins out of the cell. [1] **Y** – chemically modify the proteins synthesized in the ribosomes [1]; package the modified proteins into vesicles to be exported out of the cell [1] *ECF from (a) permitted.	3[1]
ci	Correct label on diagram of 1 phloem vessel. X Label line w/o name of vessel	[1]
cii	Any 3 of the following • The poison dissolved into the soil solution and diffused into the root hair cell down a concentration gradient. • The poison molecules then diffuse through the root cells and enter the xylem vessels into the roots by root pressure. • The poison molecules, together with water molecules, are drawn up the xylem vessels into the stem by capillary action and transpiration pull. • The poison molecules then diffuse from the xylem vessels in the leaves into the mesophyll cells and • into the mitochondria to inhibit aerobic respiration.	3[1]
ciii	• The mitochondria in the companion cells of the phloem are unable to release energy. • No translocation of sugars in the phloem vessels occurs.	2[1]
2ai	• 3 pollen grains	[1]

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aii	• 8% [1] • The <u>longest mean pollen tube length</u> of 0.040mm is produced as a result of being exposed to 8% sucrose concentration. [1] • <u>Most likely to be able to reach the micropyle</u> of the ovule for fertilisation.	2[1]
aiii	• When a pollen grain is placed in a sucrose solution of a higher concentration that 8%, <u>less water molecules enter the pollen grain</u> by osmosis. [1] • This is due to the <u>water potential gradient between the sucrose solution and cell sap of the pollen grain becoming less steep</u>. [1] • Some pollen grains might <u>not absorb sufficient water to germinate.</u> [1] X Reject: water molecules leaving the pollen grain – from data, germination still occurs at concentration above 8%. Hence, this is evidence that water molecules are still entering the pollen grains.	3[1]
b	• The tip of the pollen tube releases enzymes to <u>digest the tissues of the style as it grows down the style. [1]</u> • The pollen tube <u>reaches the micropyle of the ovule and releases the male gametes into the ovule.</u> [1] • This process is essential to plant reproduction <u>to allow the male gametes to meet and then fuse with the ovum to form a zygote. [1]</u>	3[1]
3a	• Word equation of photosynthesis [1] • Word equation of respiration [1]	2[1]
b		[1]
c	• Mid-day [1] • <u>Lowest carbon dioxide concentration results in the highest pH of waters</u> [1] and hence causing the concentration of dissolved ammonia to increase to toxic levels.	2[1]
d	<u>Any 2 of the following</u> • Carbon dioxide is first converted to glucose by photosynthesis. • The glucose is converted to sucrose to be translocated within the plant. • Excess glucose is converted to starch for storage within the cells. • Glucose, together with the nitrates absorbed from the soil, can be converted to amino acids and synthesized into proteins. • Glucose can also be converted to fats that is utilised for energy storage. • Glucose can be converted to cellulose that is used to synthesize cell walls.	2[1]
4a	<u>10th minute:</u> 4 chromosomes in double arm structure line up along 1 row on equator [1] <u>20th minute:</u>	2[1]

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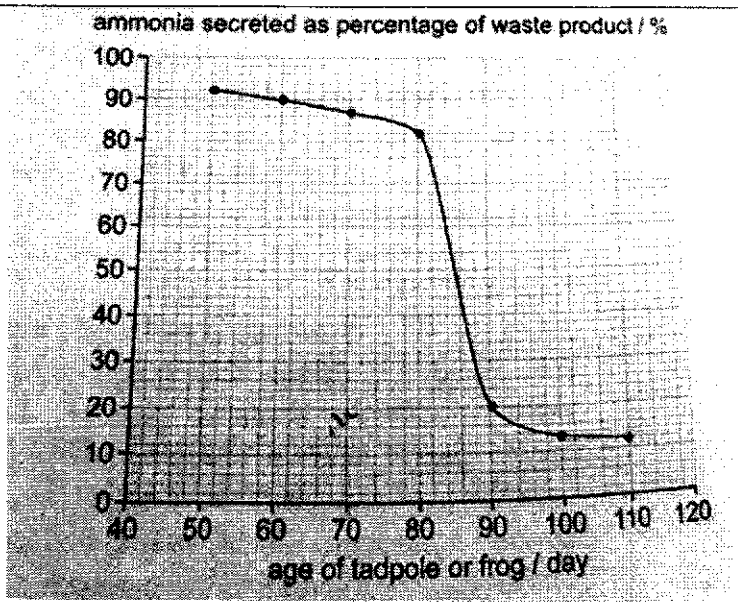
	4 chromatids being pulled to 1 side of the cell; 4 chromatids being pulled to the other side of the cell. [1] **(marks not awarded if chromatid is not shown to be pulled at the centromere)** Details of centrioles and spindle fibres not required.	
b	Comparison of Metaphase I and Metaphase Similarity – in both stages, chromosomes are aligned along the equator of the cell. [1] Difference • In metaphase I, homologous chromosomes line up in 2 rows along the equator of the cell but in metaphase, homologous chromosomes line up in 1 row. [1]	2[1]
c	• Crossing over at the chiasma between non-sister chromatids at Prophase I leads to new allele combinations/recombinant chromatids. • Independent assortment of homologous chromosomes at Metaphase I leads to varied gametes being formed.	2[1]
d	Any one of the following: • Reduction division produces haploid gametes that enable the restoration of diploid number when a zygote is formed during fertilisation. • In this way, the chromosome number is maintained within a species after every generation.	[1]
5a	 **(a)(i) retina** **(a)(ii) cornea**	2[1]
b	• The increase in light intensity is detected by the photoreceptors on the retina and this triggers the nerve impulses to be sent to the brain via the optic nerve. • The motor neurones then triggers the relaxation of the radial muscles and contraction of the circular muscles [1] • to constrict the pupil, allowing less light to enter the eye. [1]	2[1]

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ci	• Genotype is the allele combination/genetic make up of an individual [1] but phenotype is the outward appearance of an individual.[1]	2[1]
cii	• Continuous variation [1] • The range of values of IPD spans across a range from 53mm to 77mm. [1]	2[1]
6a	• P: placenta • Q: umbilical cord • R: amniotic sac • T: cervix	4[1]
b	• When the mother's blood glucose concentration rises above the norm, insulin is produced in an insufficient quantity/target cells are not responsive to insulin [1] • Excess glucose cannot be converted to glycogen [1] • The high amounts of glucose diffuses from the maternal blood into the fetal capillaries. [1] • Resulting in more glucose to be converted to glycogen/fats OR greater growth rate, leading to higher rate of fetal weight increase. [1]	4[1]

Paper 2
Section B

7a	 • Correct axes with units • Scale • Plotting • Best fit curve	**4[1]**
b	Between day 80 to 90. [1] In this period of time, the tadpole transitioned from secreting ammonia as the main waste product to a minor waste product as seen from the drastic drop in concentration. [1]	**2[1]**

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<table>
<tr><td>c</td><td>• Urea is synthesized from excess amino acids in the liver in the process called deamination. [1]

Any 4 of the following
• The urea is then transported in the blood via hepatic vein and vena cava back to the right atrium of the heart. [1]
• The blood containing urea then goes to the right ventricle and out of the heart via the pulmonary artery to the lungs. [1]
• The blood returns to the heart by the pulmonary vein into the left atrium and left ventricle, leaving the heart by the aorta. [1]
• Then, the aorta branches into various arteries, including the renal artery where the blood containing urea then goes into smaller arteries and arterioles. [1]
• The blood goes through ultrafiltration and the urea molecules pass through the basmement membrane of the glomerulus into the Bowman's Capsule. [1]
• Urea molecules then go through the entire nephron without being selectively reabsorbed and the glomerular filtrate containing urea will enter the renal pelvis. [1]
• Ultimately, the urine will leave the kidneys via the ureter and out of the body via the urethra. [1]</td><td>5[1]</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>8a</td><td>Any 2 of the following
• A gene is a segment/nucleotide sequence of the DNA molecule that codes for the synthesis of a polypeptide.
• A chromosome is a DNA molecule that is wrapped around histone proteins and further condensed.
• A chromosome can contain multiple genes and each gene has a specific gene locus on the chromosome.</td><td>2[1]</td></tr>
<tr><td>b</td><td>• One copy of the gene exist on each sister chromatid [1]
• which is the result of DNA replication [1]</td><td>2[1]</td></tr>
<tr><td>ci</td><td>• Mutation is defined as the sudden, random change in the gene structure or chromosome number</td><td>[1]</td></tr>
<tr><td>cii</td><td>• Homozygous individuals would contain 2 copies of the mutated gene, hence producing a defective/non functional CCR5 protein, preventing the entry of HIV into the cells.
• Heterozygous individuals would only contain 1 copy of the mutated gene, and the non-mutated gene would still be able to produce some amounts of CCR5 proteins to allow some entry of HIV into the cells.</td><td>2[1]</td></tr>
<tr><td>ciii</td><td>Any 3 of the following

<table><tr><th>Social issues</th><th>Health issues</th></tr><tr><td>Widenining of social inequality/rich poor divide as only those who have the resouces are able to afford to genetically engineer their children, giving rise to unfair advantages.</td><td>The impact of altering these genes is not well-understood, possibly leading to severe unexpected health issues.

The accumulation of beneficial alleles and the deletion of non-</td></tr></table></td><td>3[1]</td></tr>
</table>

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	Ability to select for characteristics and/or gender of babies would lead to social and gender imbalance in society. Discrimination and segregation of people based on the level of genetic manipulation.	beneficial alleles may reduce the gene pool and genetic variation of the human species.
9E		
a	Motor neurone	**[1]**
b	• Motor neurones' nerve fibres have reduced myelination/myelin sheath that affects the ability to transmit impulses towards the muscles. • Therefore, the impulses generated from the brain that are transmitted by the relay neurones are not able to be fully transmitted to the motor neurones. • Hence, the control from the brain is reduced as the muscles are no longer able to respond to the nerve impulses from the brain.	**3[1]**
ci	• During inhalation, the diaphragm contracts and flattens.[1] The external intercostal muscles contract and the internal intercostal muscles relax. [1] • Overall, the volume of the thoracic cavity increases, pressure decreases.[1] Air is then forced into the lungs down a pressure gradient. [1]	**4[1]**
cii	At late stage ALS, the individual will no longer be able to breathe on his own and hence have low oxygen concentration in blood. This would result in cells having lower respiratory rate, releasing low amounts of energy that is dangerous to the individual. The ventilator is then able to supply the individual with more oxygen that can bring the oxygen conentration to a more sustainable level, keeping the individual alive.	**[1]**
		3[1]
9O		
ai	Involuntary response It does not require conscious control to conduct the heart beat. [1]	**[1]**
aii	• During ventricular systole, the ventricle walls contract and the pressure of the ventricles is higher than that of the atria. • The biscupid and tricupid valves close to prevent backflow of blood, forming the "lub" sound. • During ventricular diastole, the ventricle walls relax and the pressure of the ventricles is lower than that of the pulmonary artery and aorta. • Hence, the semilunar valves close to prevent the backflow of blood, forming the "dub" sound.	**4[1]**
b	• Adrenaline is produced in the adrenal glands and enter the blood stream and travels to the heart by the vena cava. • The adrenaline in blood is then transported out of the heart via the aorta and it branches out into the coronary arteries.	**5[1]**

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	• The coronary arteries then further branch into capillaries that surround the heart muscle cells. • The adrenaline in blood then diffuse into the effector cardiac muscles, • increasing their rate of contractions and hence results in an increased heart rate.	

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