TANJONG KATONG GIRLS' SCHOOL
PRELIMINARY EXAMINATION
SECONDARY FOUR EXPRESS

CANDIDATE NAME					
CLASS	4			INDEX NUMBER	

BIOLOGY
Paper 2

6093/02
13 August 2024
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

The use of an approved scientific calculator is expected, where appropriate.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
Section B	
Total	**/ 80**

This document consists of **22** printed pages.

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Section A

Answer **all** questions.

1 Fig. 1.1 and Fig. 1.2 show the sections of alveoli and a villus respectively.

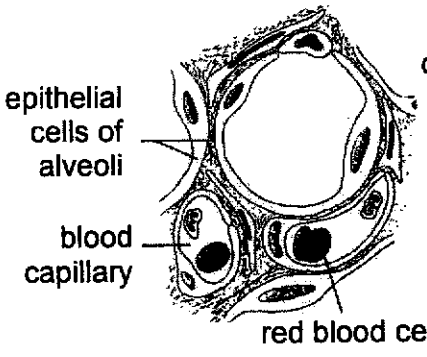


Fig. 1.1

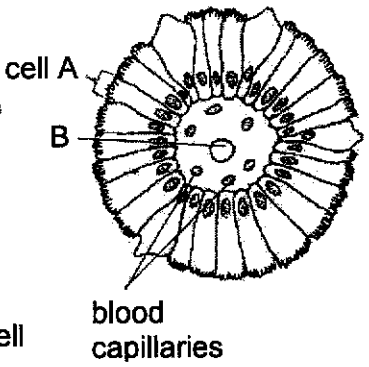


Fig. 1.2

(a) With reference to Fig. 1.1, describe one adaptation of an alveolus with respect to its function.

.....

.....[1]

(b) Cell A contains numerous small finger-like projections from the cell membrane.

Name these projections.

.....[1]

(c) Structure B absorbs nutrients from the lumen of the small intestine.

Name structure B.

.....[1]

(d) Name the substances that are absorbed into the blood capillaries of the alveoli and the villi.

blood capillaries of the alveoli: .....

blood capillaries of the villi: .....[2]

[Total: 5]

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2 Fig. 2.1 shows a section of a mammalian heart.

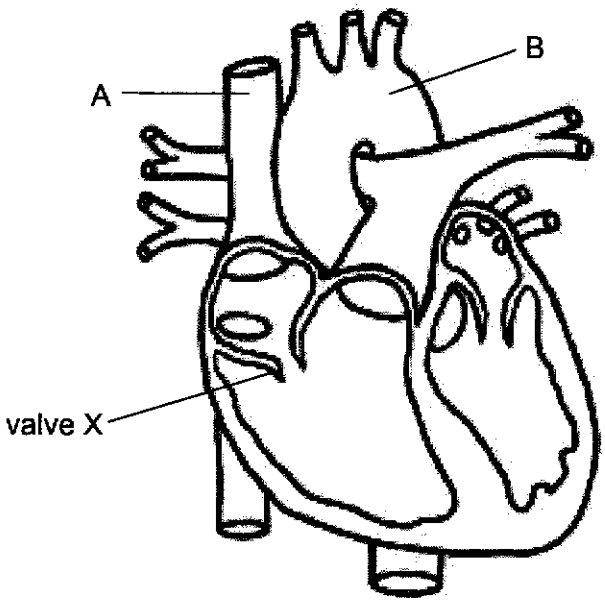


Fig. 2.1

(a) Describe one structural difference in the walls of vessels A and B.

.....

.....[1]

(b) On Fig. 2.1, draw arrows to show the flow of blood inside the heart. [1]

(c) Name valve X and explain its significance during ventricular systole.

.....

.....

.....[2]

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(d) Table 2.1 shows the cardiac cycle of a healthy man at rest.

Table 2.1

time / s	at rest		during exercise	
	atrium	ventricle	atrium	ventricle
0.0 – 0.1	■			
0.1 – 0.2		■		
0.2 – 0.3		■		
0.3 – 0.4		■		
0.4 – 0.5				
0.5 – 0.6				
0.6 – 0.7				
0.7 – 0.8				
0.8 – 0.9	■			
0.9 – 1.0		■		
1.0 – 1.1		■		
1.1 – 1.2		■		

legend:
■ contraction
□ relaxation

(i) Calculate the heart rate of the man at rest. Show your workings clearly.

heart rate: ..... beats / minute [1]

(ii) In Table 2.1, shade the relevant boxes to suggest how the cardiac cycle of the man will be like during vigorous exercise. [1]

[Total: 6]

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3 **(a)** Fig. 3.1 shows a nephron and the blood capillary surrounding it.

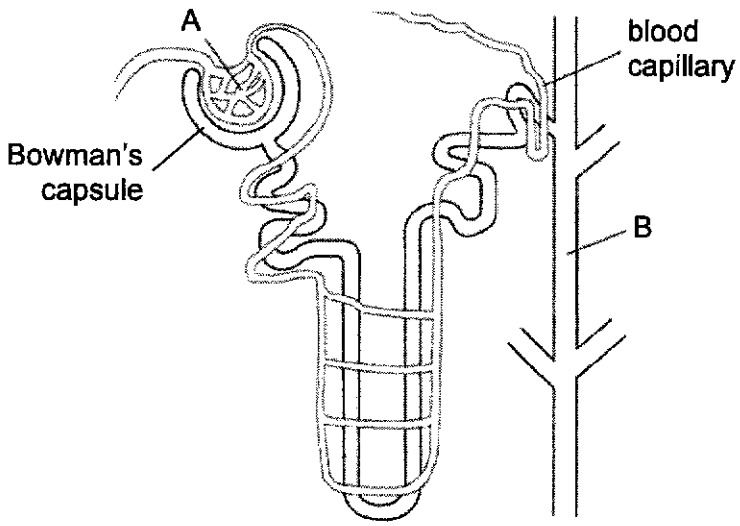


Fig. 3.1

(i) Name structures A and B.

A: .....

B: ..... [2]

(ii) Some substances in A are forced out into the Bowman's capsule of the nephron.

Explain how these substances are forced into the Bowman's capsule.

.....

.....

.....[2]

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(b) Fig. 3.2 shows a type of dialysis where the dialysis fluid enters the abdominal cavity. Exchange of materials will take place across the membrane that surrounds the abdominal cavity. This removes the waste products from the blood. After a few hours, the used fluid is drained out of the cavity, and fresh fluid will re-enter the abdominal cavity.

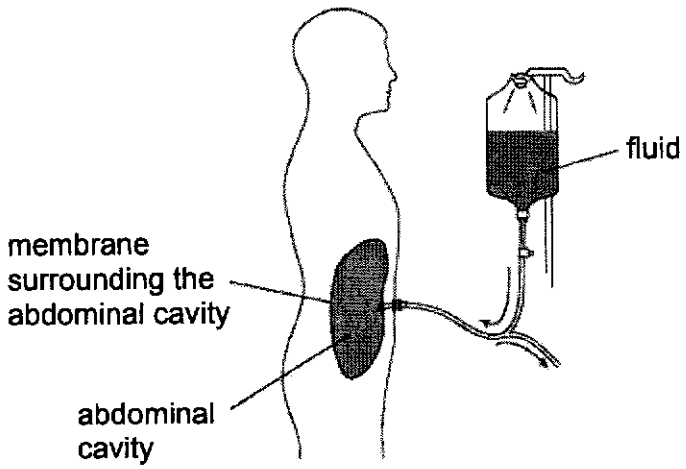


Fig. 3.2

Suggest why the fluid must be changed after a few hours.

.....

.....

.....[2]

[Total: 6]

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4 Fig. 4.1 shows a submerged aquatic plant known as bladderwort. Bladderworts thrive in aquatic environments that are poor in nutrients. To ensure their optimal development, they have evolved to be carnivorous in nature. The outer cells around the entrances of the bladders of the plant secrete a sticky mucus, which traps and then digests small water animals such as water fleas.

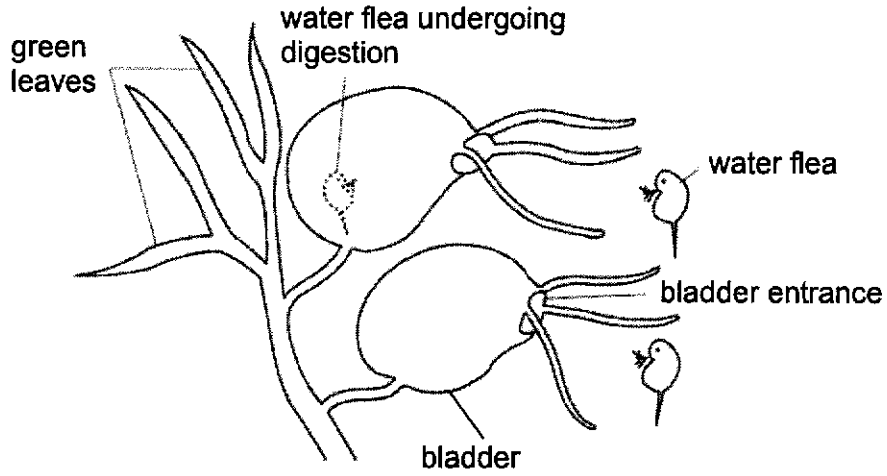


Fig. 4.1

(a) Write the chemical equation of the process that allows bladderworts to obtain carbohydrates.

[2]

(b) Name the elements of the carbohydrates formed in **(a)**.

.....[1]

(c) The nutrients obtain from the digestion of the water fleas enable bladderworts to develop optimally in the aquatic environment.

Suggest how the digestion of water fleas ensures the optimal development of bladderworts.

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.....[2]

[Total: 5]

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5 Fig. 5.1 shows a setup to investigate transpiration of a plant.

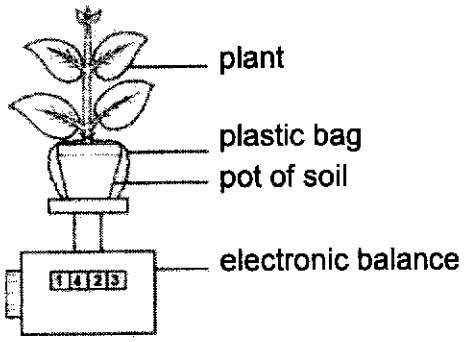


Fig. 5.1

The setup was placed under different environmental conditions. Table 5.1 shows the data collected.

Table 5.1

environment condition	air movement	temperature / °C	humidity / %	rate of transpiration / gh^{-1}
A	still air	30.0	65.0	9.8
B	still air	30.0	80.0	4.7

(a) Account for the difference in transpiration rates between environment conditions A and B.

.....

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.....

.....[3]

(b) Suggest a limitation to the setup in measuring the rate of transpiration.

.....[1]

(c) Suggest the significance of the plastic bag in the setup.

.....[1]

[Total: 5]

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6 Fig. 6.1 shows how a molecule of mRNA is formed from a molecule of DNA.

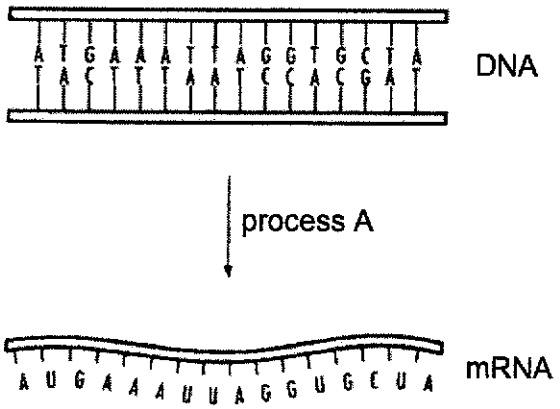


Fig. 6.1

(a) Describe the structure of a DNA molecule.

.....

.....

.....

.....

.....

.....[3]

(b) On Fig. 6.1, circle the DNA template. [1]

(c) Name process A and state the location of the cell that process A is occurring in.

Process A: .....

Cell location: .....[2]

[Total: 6]

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7 Fig. 7.1 shows the interactions of organisms in a pond habitat.

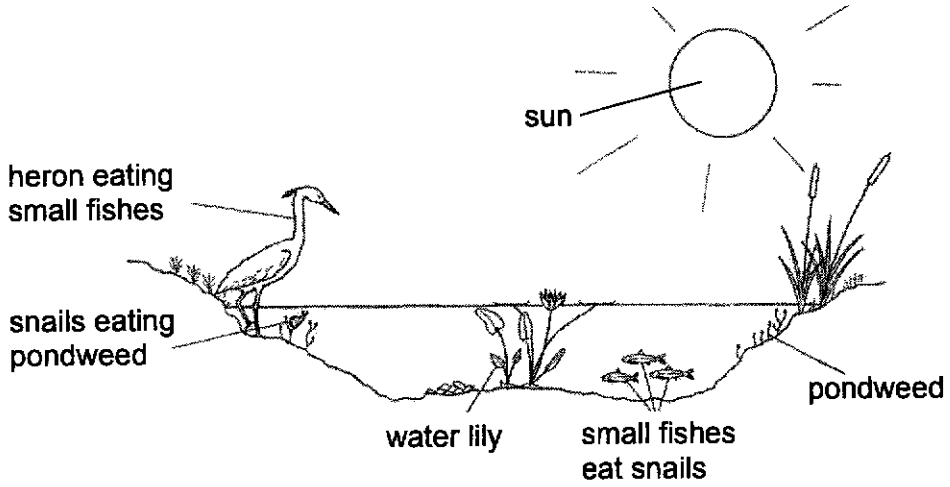


Fig. 7.1

(a) Using information from Fig. 7.1, construct a pyramid of biomass comprising of three trophic levels.

[2]

(b) Explain why food chains rarely go beyond 5 trophic levels.

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.....[3]

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(c) Due to excessive leaching of fertilisers into the pond from a farm nearby, a thick layer of algae was formed on the surface of the pond. Within days, after the formation of the algal layer, dead fishes were seen floating on the surface of the pond.

(i) State the process that results in the condition of the pond.

.....[1]

(ii) Explain how the appearance of the layer of algae results in the death of the fishes.

.....

.....

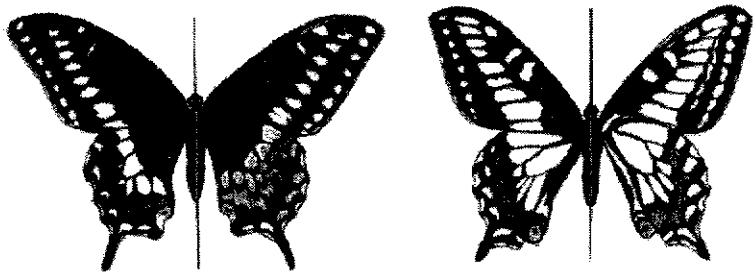
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.....[2]

[Total: 8]

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8 A species of butterfly displays two variations of wing pattern phenotypes. Fig. 8.1 shows the two different phenotypes displayed by this species.



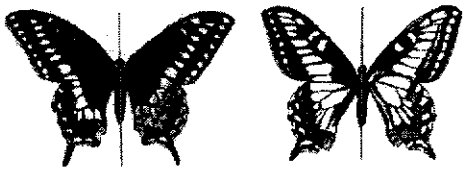
type A type B

Fig. 8.1

When the two types of butterflies are crossed, they produced different outcomes of offspring.

Table 8.1 shows the different outcomes of offspring from two types of crosses, C1 and C2.

Table 8.1

cross	parent butterflies	offspring number	
		type A	type B
C1	 type A type B	68	82
C2	 type A type B	0	150

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(a) With reference to Table 8.1, determine which type, A or B, is the dominant phenotype. Explain your answer.

.....

.....[2]

(b) Explain how cross C1 can produce the results shown in Table 8.1.

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.....[3]

(c) State the type of variation shown in this species of butterfly.

.....[1]

(d) Suggest how the variation in wing pattern phenotype might have been developed in this species of butterfly.

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.....[3]

[Total: 9]

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9 **(a)** Fig. 9.1 shows the emissions of carbon dioxide worldwide from 2005 to 2023.

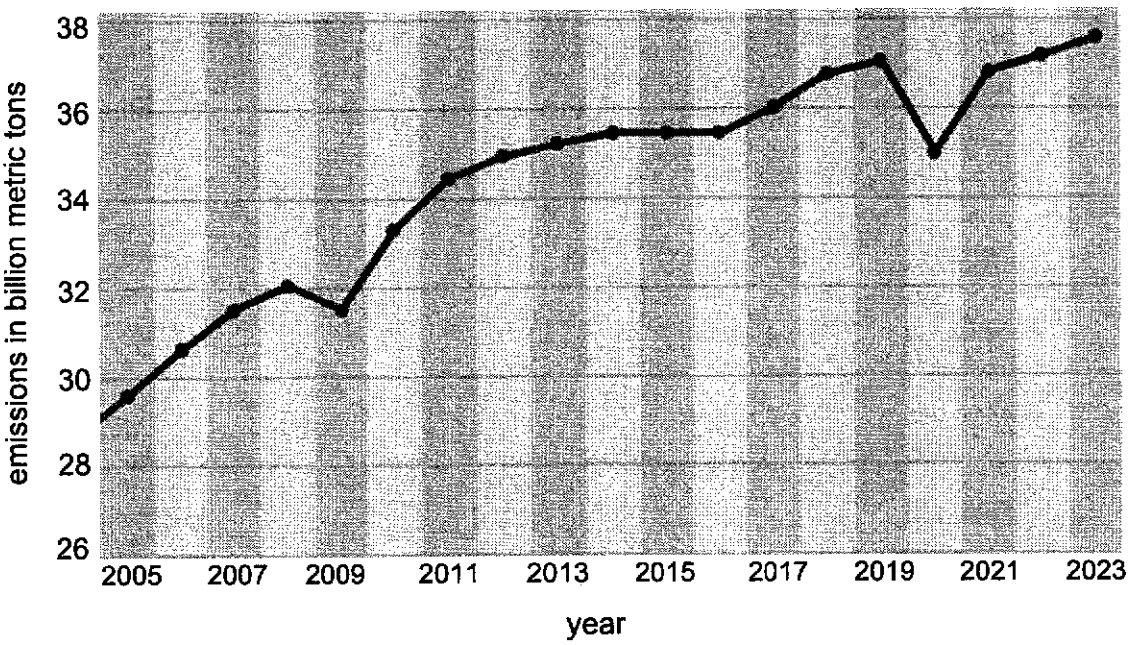


Fig. 9.1

(i) Describe the change in carbon dioxide emission from 2005 to 2023.

.....

.....

.....

.....[2]

(ii) State two human practices that contribute to the change in carbon dioxide emission shown in Fig. 9.1.

1. .....

2. .....[2]

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(iii) Using your knowledge of recent world events, suggest what would have caused the change in the carbon dioxide emission from 2019 to 2020.

.....

.....[1]

(b) Pollution is the process by which harmful substances, or pollutants, are added into the environment, making it undesirable or unfit for life.

Although carbon dioxide is not considered as an air pollutant, the concentration of carbon dioxide in the atmosphere has significantly increased due to human activity.

Explain the effects of carbon dioxide pollution on the environment.

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.....[5]

[Total: 10]

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10 In commercial production of apple juice, after the apples are chopped and grinded to a pulp, the enzyme pectinase is added to speed up the process of extracting the juice. Pectinase breaks down pectin, a polysaccharide component found in the cell walls of plant cells, to result in a higher yield of apple juice.

Fig. 10.1 shows how the final product is obtained. The apple pulp is added to a gel containing pectinase. The extracted apple juice will flow through the gel and is collected at the bottom.

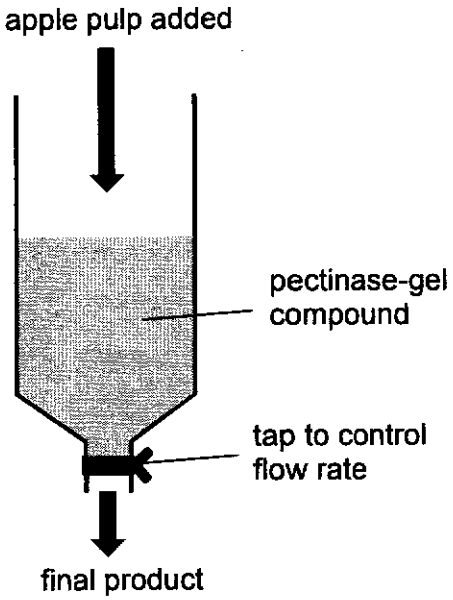


Fig. 10.1

(a) Suggest why reducing the flow rate of apple pulp through the tap would result in an increase in the yield of the final product.

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.....[1]

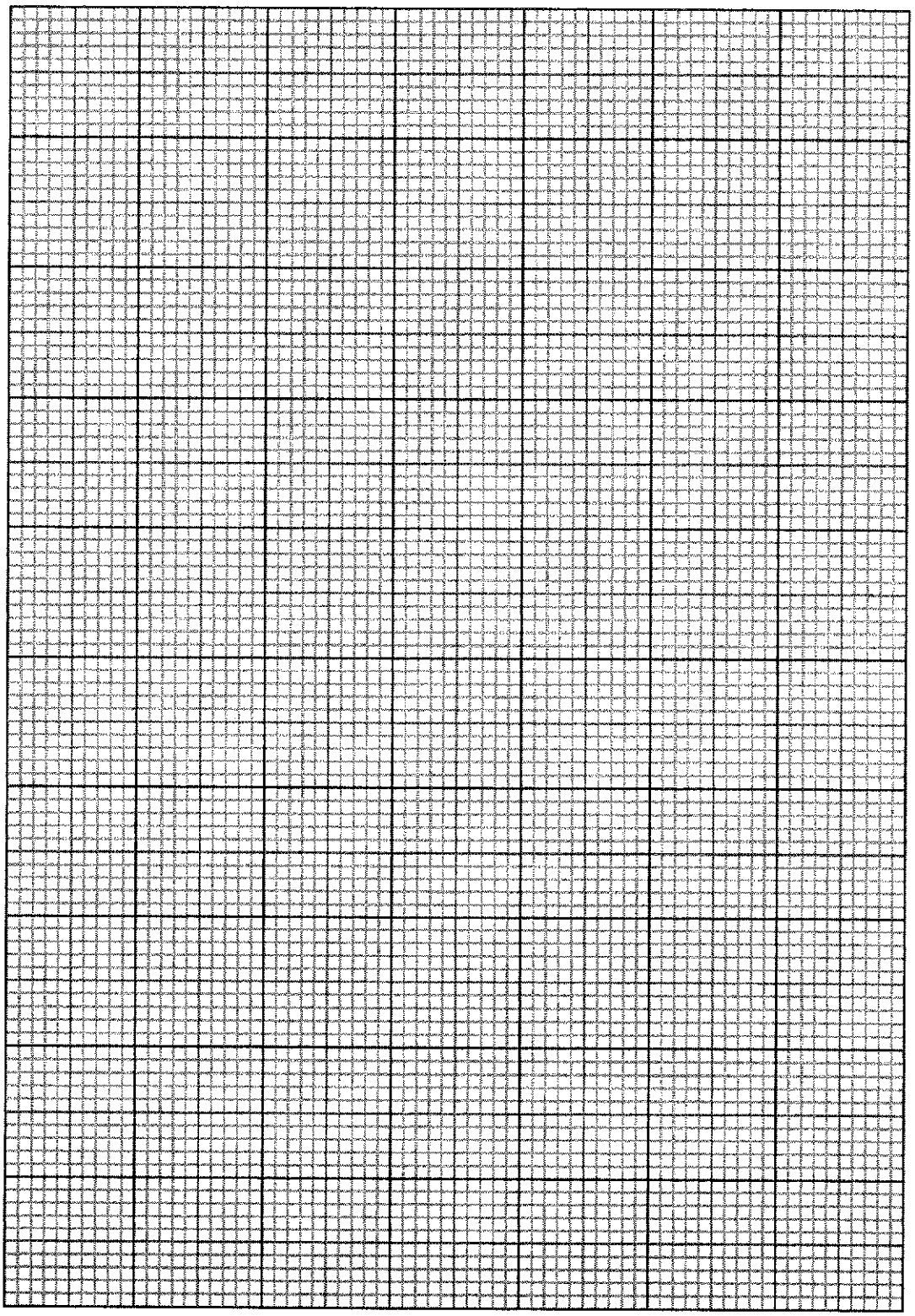
Table 10.1 shows the yield of apple juice over a range of reaction temperatures for pectinase.

Table 10.1

temperature / °C	apple juice yield / cm^3
20	28
30	50
40	64
50	88
60	22

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(b) Draw a graph to show the relationship between temperature and apple juice yield. [4]



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(c) Explain the change in apple juice yield between 20 °C and 50 °C.

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.....[3]

(d) Define *enzyme*.

.....

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.....

.....[2]

[Total: 10]

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Section B

Answer **one** question from this section.

11 Infectious diseases can be caused by organisms such as bacteria, viruses, fungi or parasites.

(a) Discuss on how infectious diseases can be transmitted.

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.....[4]

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(b) The World Health Organisation reported that in 2022, the global number of people living with HIV was 39.0 million, compared to 26.6 million in 2000.

Explain the effect of HIV on human body and suggest why it is difficult to control the spread of HIV.

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.....[6]

[Total: 10]

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12 Flowering plants reproduce sexually through a process called pollination.

(a) Discuss on the advantages and disadvantages of self-pollination over cross-pollination.

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.....[6]

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(b) Successful pollination will often lead to fertilisation.

Outline the events that occur after pollination that will lead to fertilisation.

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.....[4]

[Total: 10]

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	(c)	Prevent evaporation of water from the soil;	1m
6	**(a)**	Double helix structure; 2 strands of polynucleotides that are anti-parallel; 2 strands / each base pair held together by hydrogen bonds; Sugar-phosphate backbone of each strand; Each nucleotide consists of sugar, phosphate group and nitrogen-containing base; 4 types of bases adenine, thymine, cytosine, guanine; Each base pair is either adenine to thymine, or cytosine to guanine;	Max 3m
	(b)	(*circle correctly the lower strand including the bases*);	1m
	(c)	A – transcription; Nucleus;	2m
7	**(a)**	(*pondweed → snails → small fishes + "stable shape"*); (*labels + same width*);	2m
	(b)	90% of energy is lost from one trophic level to the next; (*must write properly*) Only 10% is successfully transferred into the organism; Energy is lost by heat energy from respiration / uneaten body parts e.g. _____ / undigested body parts e.g _____; Energy availability at the 5th trophic level is too small to ensure organism to survive;	Max 3m
	(c)(i)	Eutrophication;	1m
	(c)(ii)	Algae blocks sunlight from penetrating into the depths of the pond; Producers deeper in pond unable to photosynthesise; No photosynthesis + no oxygen production; OR Respiration of all organisms depletes oxygen concentration;	Max 2m
8	**(a)**	Type B; Cross C2 creates only offspring of type B + allele of type A is recessive / allele of type B is dominant;	2m
	(b)	Type A parent is homozygous recessive; Type B parent is heterozygous; Offspring inherit 1 allele from type A and 1 allele from type B; 50% chance to create a heterozygous offspring OR ratio of getting type A to type B is 1:1;	Max 3m
	(c)	Discontinuous variation;	1m
	(d)	Mutation creates variation in wing patterns; Variations enables the butterfly to adapt to environment + escape from predators / camouflage into the surroundings; Grow to maturity + reproduce successfully; Pass the genes in wing pattern to the next generation;	Max 3m

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9	**(a)(i)**	Increase from 29 billion metric tons to (approx.) 35 billion metric tons; OR Increase in 6 billion metric tons; From 2008 to 2009 + decrease by 1 billion metric tons; From 2019 to 2020 + decrease by 2 billion metric tons; (capped at 2m)	2m
	(a)(ii)	Deforestation; Burning of fossil fuels;	2m
	(a)(iii)	COVID pandemic + less human activity e.g. public transport;	1m
	(b)	Carbon dioxide is a greenhouse gas + traps heat; Higher temperature, melting of ice in polar regions + raise sea levels / release trapped pathogens; Higher temperature, bleaching of corals + decrease biodiversity; Higher concentration of carbon dioxide in water + decrease pH; Dissolves calcium compounds of shell fishes; Climate change + erratic weather conditions; Climate change + vulnerabilities in some animals e.g. polar bears (temperature) and bees (reproduction cycles of plants);	Max 5m
10	**(a)**	Allows more time for pectinase to break down pectin and release the apple juice;	1m
	(b)	*Axes + units;* *Appropriate scale + origin;* *Plots;* *Best-fit line;*	4m
	(c)	Increase temperature + increase kinetic energy of enzyme and substrate molecules; Increase collision rate of enzyme and substrate molecules; Increase formation of enzyme-substrate complex; Increase formation of product molecules;	Max 3m
	(d)	Biological/organic catalyst + protein; Speed up chemical reactions without itself chemically altered after the reaction;	2m
11	**(a)**	Through droplets in the air / airborne transmission + when individual talks / sneezes / coughs; The droplets inhaled by another individual; Exchange of body fluids during sexual intercourse; Baby receiving milk from mother through breastfeeding; Direct contact through mucous membranes e.g. conjunctivitis / HFMD / chicken pox; Transmitted through ingestion of contaminated food / water e.g. cholera, typhoid;	Max 4m

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	(b)	HIV destroys/lowers a person's immune system by destroying white blood cells; Hence the body is unable to produce antibodies to protect the person from foreign pathogens; Person infected might not display signs and symptoms for a long time and may unknowingly transmit the virus during this period of time; Social stigma and discrimination against people who are affected will deter affected individuals from seeking medical treatment; Lack of awareness and education about HIV transmission / HIV prevention / misconceptions about viral infections; High-risk behaviours from affected individuals through sharing of unsterilised needles / sharp instruments due to lack of resources, education, awareness, etc; Limited access to healthcare in low-income / remote areas; Virus is able to mutate rapidly which slows down the research on a vaccine against HIV infection; Hard to track movement of people on a global scale, which can spread the infection; (any four)	Max 6m
12	**(a)**	<u>Advantage</u> Only 1 parent is required; High chance that beneficial qualities is passed down to offspring; Does not require external pollinators e.g. wind / insect; High chance of pollination due to close proximity of male and female parts; Less energy is used to produce lesser pollen grains; (any three) <u>Disadvantage</u> Less genetic variation due to only 1 parent; Less adapted to changes in environment; Long-term, offspring becomes weaker and more susceptible to diseases; (any three)	Max 6m
	(b)	Germination of pollen grain + growth of pollen tube containing male gamete; Pollen tube penetrates through the style by secreting digestive enzyme; Pollen tube enters micropyle of ovule; Pollen tube absorbs sap in ovule and burst + release male gamete into the ovule; Male gamete fuses with female gamete to form zygote; (capped at 4m)	Max 4m

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