Candidate Name:	Class:	Index No.:

FUHUA SECONDARY SCHOOL
Secondary Four Express
PRELIMINARY EXAMINATION 2024

4E

BIOLOGY **6093/02**

Paper 2

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

DATE	**22 August 2024**
TIME	**1115 – 1300**
DURATION	**1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an 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			PARENT'S SIGNATURE
Section A	**Section B**	**Total**	
/70	**/10**	**/80**	

This document consists of 18 printed pages, including this page.

Section A

Answer **all** questions.

1 Pectin, a type of carbohydrate, is one of the components of cell walls which are essential to maintaining the structure of plant cells. Tomatoes are firm when unripe but soften when ripening due to the hydrolysis of these cell wall components by enzymes, including polygalacturonase. The activity of polygalacturonase can be described as follows:

$$\text{pectin} \xrightarrow{\text{polygalacturonase}} \text{mono-galacturonate}$$

(a) Using the 'lock and key' hypothesis, describe the action of polygalacturonase.

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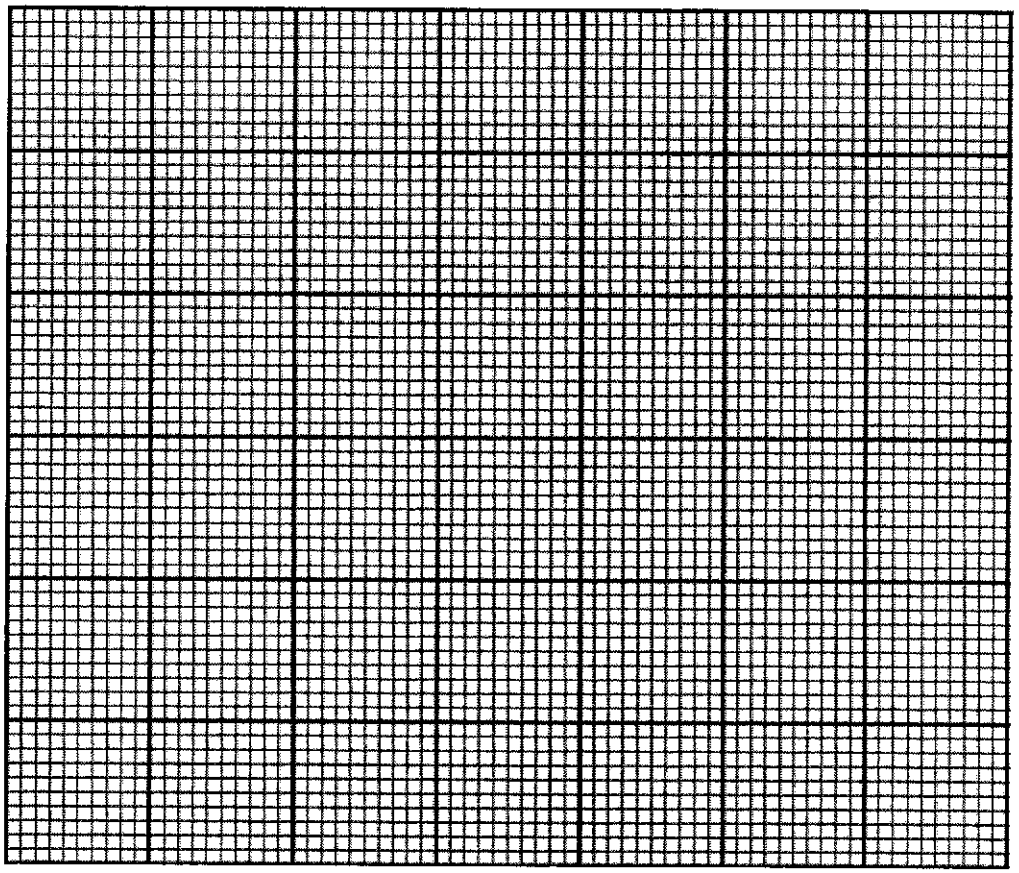
..... [4]

The activity of polygalacturonase can be triggered by ethylene, which is released as a gas by some ripening fruits. An experiment was carried out to investigate the effect of spraying a liquid form of ethylene on the ripening of tomatoes. Table 1.1 records the concentration of ethylene used and the corresponding average number of days the tomatoes took to completely ripen.

Table 1.1

concentration of ethylene / %	average number of days tomatoes took to completely ripen
0	20
5	16
10	13
15	11
20	10
25	10
30	10

(b) Plot a graph of the results in Table 1.1.



[4]

(c) With reference to the graph in **(b)**, describe and explain how polygalacturonase concentration affected the number of days the tomatoes took to completely ripen.

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(d) It is often advised that ripening bananas should not be placed together with other ripe fruits. Using the information provided in the question, suggest why this is so.

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..... [2]

[Total: 13]

2 Fig. 2.1 shows the human alimentary canal.

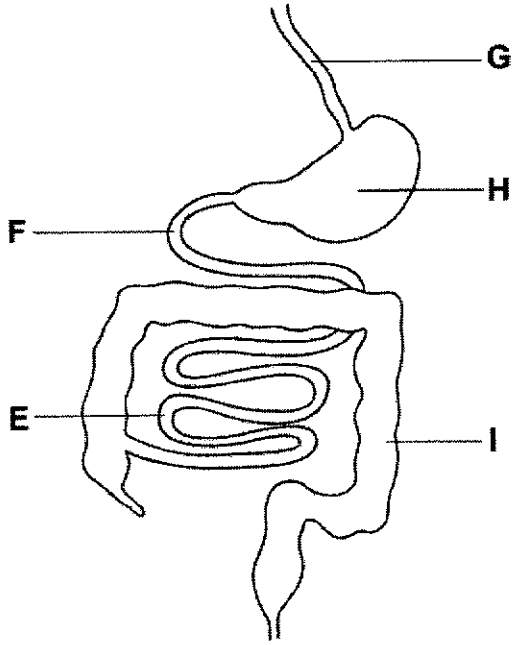

Fig. 2.1

(a) Name parts **G** and **H**.

G .....

H .....

[2]

(b) In which lettered part does most of the absorption of substances occur?

..... [1]

(c) Auto-brewery syndrome (ABS) is a condition characterised by the conversion of carbohydrates into alcohol in the digestive tract by fungi or bacteria. This process, known as fermentation, can occur in anaerobic conditions. Individuals with severe ABS suffer from elevated blood alcohol levels, as well as symptoms usually associated with alcohol intoxication. Over time, these patients often experience liver failure.

(i) Patients with ABS are advised not to drive. Explain why.

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..... [2]

(ii) Suggest how patients with ABS can manage their blood alcohol levels to reduce the likelihood of liver failure.

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..... [1]

[Total: 6]

3 Individuals with a condition known as autosomal dominant compelling helio-ophthalmic outburst (ACHOO) syndrome experience uncontrollable sneezing episodes whenever they are suddenly exposed to bright light.

Various muscles contract during sneezing, including the diaphragm muscle, abdominal muscles, and muscles at the back of the throat.

(a) Explain the nervous pathway when an individual with ACHOO syndrome is exposed to bright light and sneezes.

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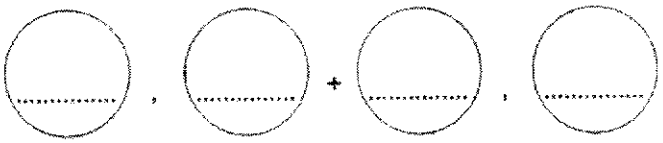
..... [5]

(b) (i) A couple, both with ACHOO syndrome decided to have a child. The child was born without ACHOO syndrome.

Use a genetic diagram to show how that is possible. Include a legend stating the letters representing each allele.

parental phenotypes ..... × .....

parental genotypes ..... × .....

gametes  , + ,

offspring genotypes ....

offspring phenotypes ....

ratio ..... : .....

[4]

(ii) The couple decided to have another child. Calculate the probability that they will have a baby girl with ACHOO syndrome.

probability ..... [2]

[Total: 11]

4 A study investigated the probability of pregnancy resulting from sexual intercourse on specific days of the menstrual cycle.

Fig. 4.1 shows the results of this study.

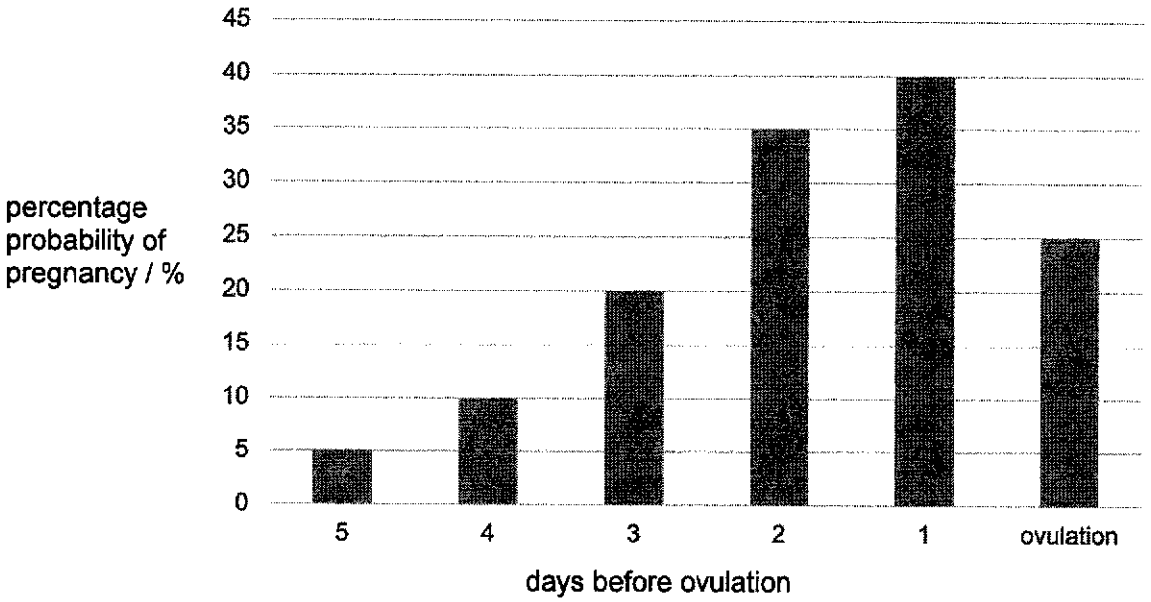


Fig. 4.1

(a) (i) The study shows a probability of 20% that sexual intercourse three days before ovulation will result in pregnancy.

State how many times more likely pregnancy is if sexual intercourse takes place two days later?

..... [1]

(ii) Explain the role of a **named** hormone in the menstrual cycle during the days investigated by this study.

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..... [2]

(b) A woman smoked while she was pregnant. Explain how this will affect oxygen transport to the fetus.

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..... [3]

(c) Describe the transport of glucose from when it was first absorbed in a pregnant woman's small intestine to when it reaches the fetus, including **named** organs and blood vessels.

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[Total: 11]

5 Young grass plants were grown with their roots in a mineral solution that contained nitrate ions. The plants were divided into two batches, **N** and **P**. Cyanide, which inhibits aerobic respiration, was added to the mineral solution given to the plants in batch **P**.

The mean quantity of nitrate ions in each plant was determined at regular time intervals for 70 hours. After 60 hours, the mineral solution was replaced by distilled water. The results are shown in Fig. 5.1.

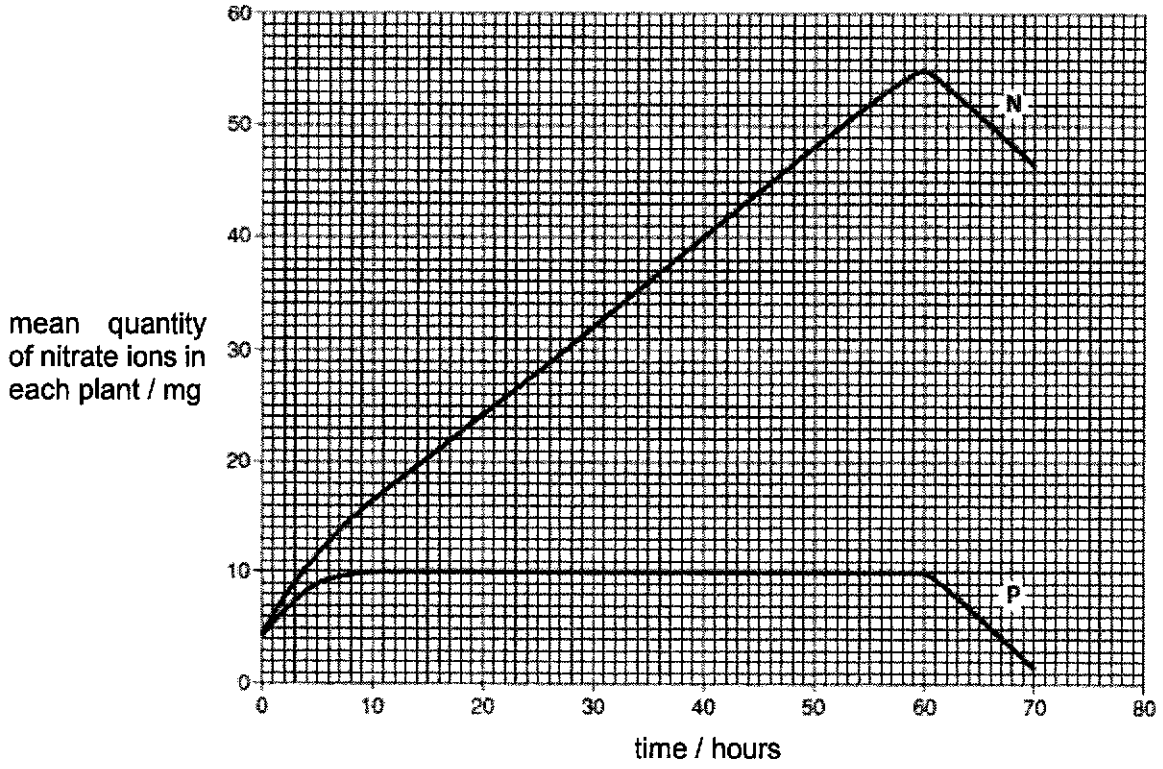

Fig. 5.1

(a) Using the data in Fig. 5.1, calculate the rate of absorption of nitrate ions in batch **N** at time = 40 hours. Show your working.

rate of absorption of nitrate ions ..... mg/h [2]

(b) Explain why the absorption of nitrate ions by the plants in batch **N** differs from that in batch **P**.

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..... [4]

(c) The mean quantity of nitrate ions in both batches of plants decreased after 60 hours.

(i) State the process responsible for this decrease.

..... [1]

(ii) Explain how the process stated in **(c)(i)** resulted in the decrease.

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..... [2]

[Total: 9]

6 Our eyes require photoreceptors to be able to detect light. Rod cells and cone cells are two types of photoreceptors. Rod cells detect light of low intensity and provide night vision in shades of grey. Cone cells detect light of high intensity and provide colour vision, allowing us to see sharply.

The number of rod cells and cone cells at places across the retina were recorded.

The diagram of an eye in Fig. 6.1 shows the angles from the fovea where the recordings were made.

The graph in Fig. 6.1 shows the number of rod cells and cone cells across the retina.

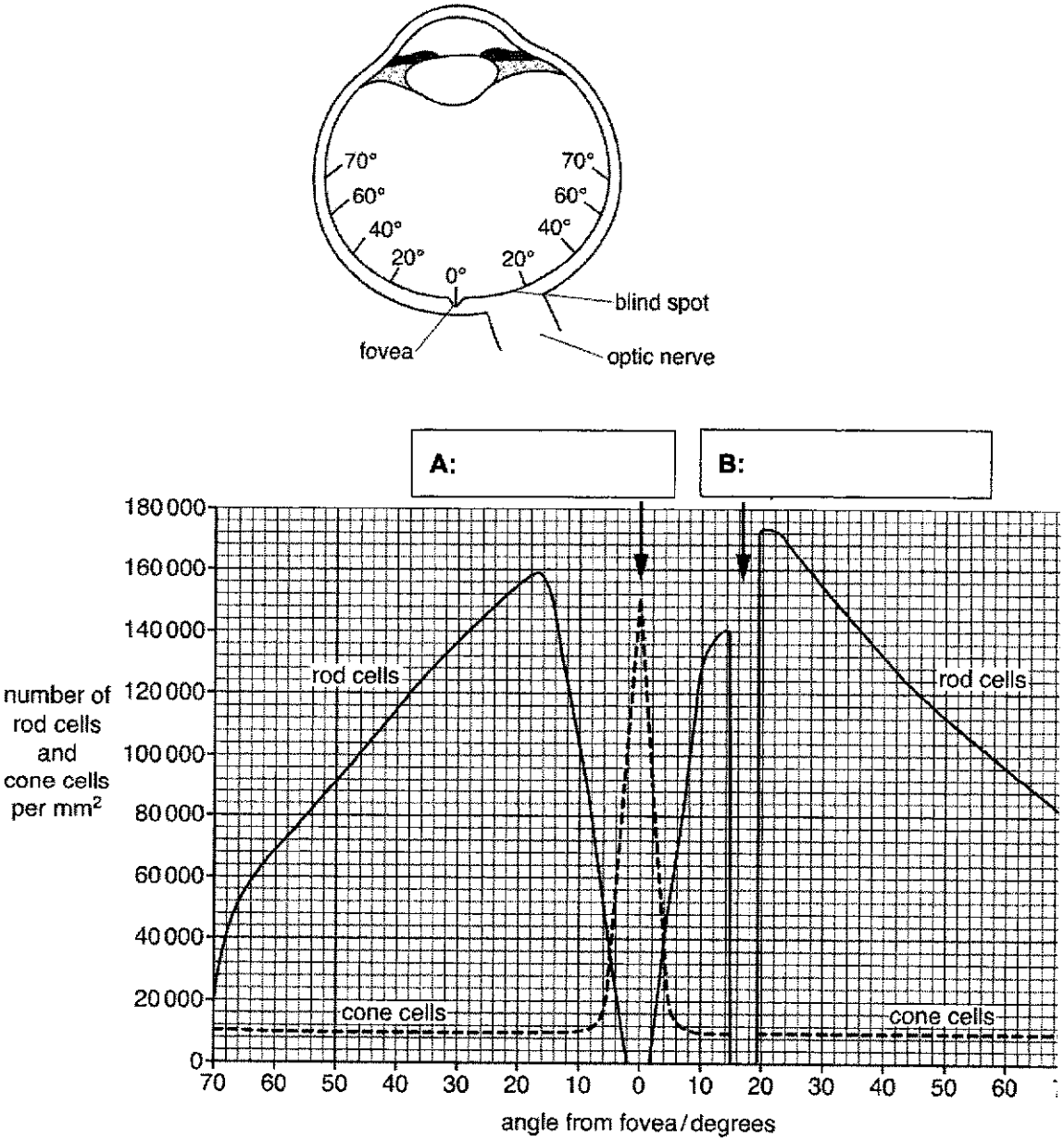

Fig. 6.1

(a) State the part of the eye that refracts light the most.

..... [1]

(b) **(i)** Identify the parts of the eye **A** and **B** represent in Fig. 6.1 by filling in the boxes. [2]

(ii) Use Fig. 6.1 to describe the distribution of rod cells and cone cells across the retina.

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(c) **(i)** State the type of neurone found in the optic nerve.

..... [1]

(ii) Explain the function of the neurone stated in **(c)(i)**.

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..... [2]

[Total: 10]

7 **(a)** Fig. 7.1. shows a pathogen.

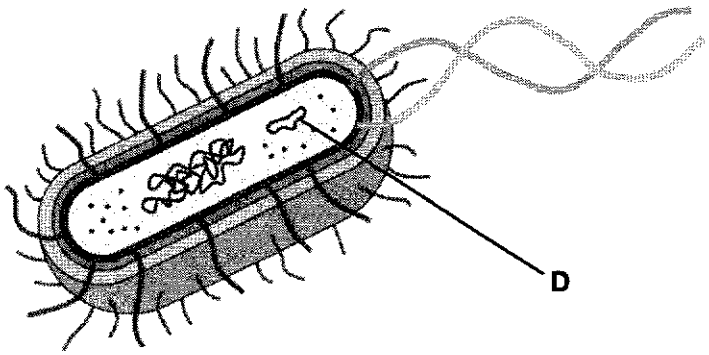

Fig. 7.1

(i) Identify the type of pathogen shown in Fig. 7.1.

..... [1]

(ii) Name structure **D**.

..... [1]

(b) "Viruses are able to evolve faster than humans, hence humans will eventually succumb to the ever-evolving viruses and go extinct." Discuss the validity of this statement.

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(c) Viruses are unable to replicate by themselves and require a host cell for replication. Describe how the virus makes use of named human cell components to synthesise viral proteins needed for the virus' assembly.

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..... [4]

[Total: 10]

Section B

Answer **one** question from this section.

8 Rice, maize and wheat plants are the main carbohydrate source for more than 60% of the human population.

(a) Fig. 8.1 shows the nutritional information of rice.

Nutrition Facts

Serving Size: 150 g

Amount Per 100 g	
Calories 121	
	% Daily Values*
Total Fat 0.38g	**1%**
Saturated Fat 0.09g	**0%**
Polyunsaturated Fat 0.122g	
Monounsaturated Fat 0.128g	
Cholesterol 0mg	**0%**
Sodium 126mg	**5%**
Potassium 32mg	
Total Carbohydrate 25.22g	**8%**
Dietary Fiber 0.4g	**2%**
Sugars 0.05g	
Protein 3.54g	

Fig. 8.1

Calculate the mass of carbohydrate in grams per serving of rice. Leave your answer to 2 decimal places.

mass of carbohydrate ..... g [1]

(b) State and describe the process plants like these carry out to produce carbohydrates using materials from the environment.

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(c) Besides carrying out the process stated in **8(b)**, discuss the roles these plants play in the carbon cycle in terms of the removal and release of carbon dioxide into the atmosphere.

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..... [4]

[Total: 10]

9 Globally, deforestation still outpaces reforestation, causing a net loss of five million hectares of forests every year.

(a) Describe the consequences of deforestation on animals that live in the forests.

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..... **[4]**

(b) Fig. 9.1 shows shorter plants called shrubs that are often found in dark and humid environments near the forest floor of tropical rainforests.

Fig. 9.1

Deforestation removes the top canopy of rainforests, exposing the shrubs. Explain how deforestation will affect the rate of transpiration in these shrubs.

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..... **[6]**

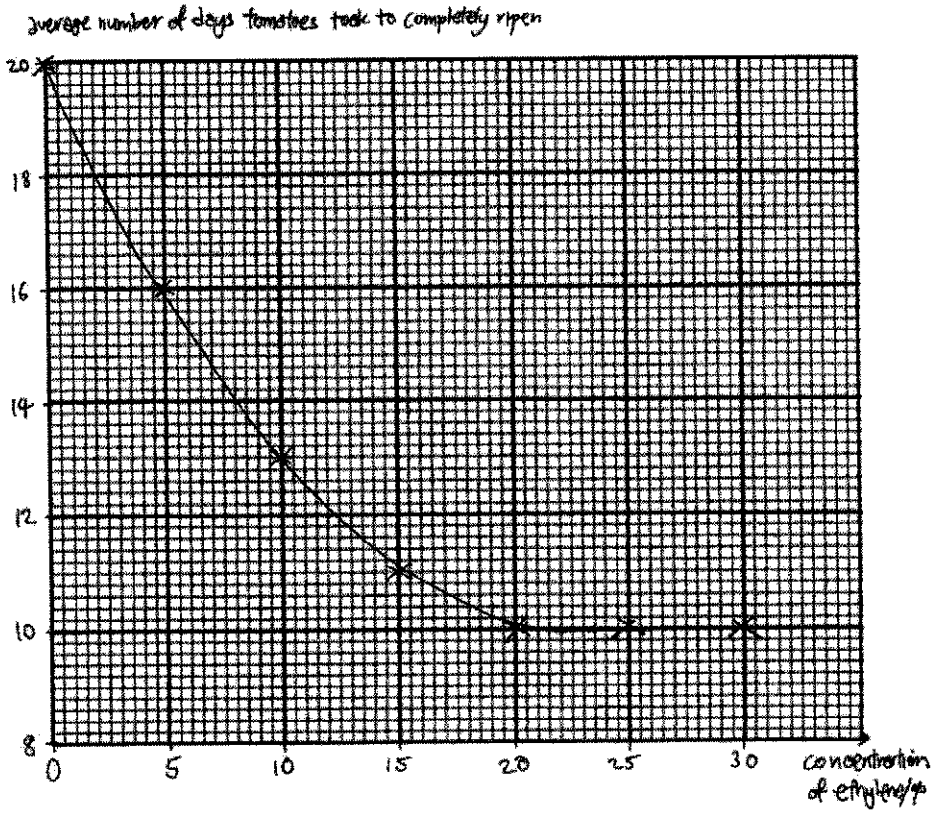
[Total: 10]

End of Paper

2024 FHSS 6093 Pure Biology Prelim Paper 2 Mark Scheme

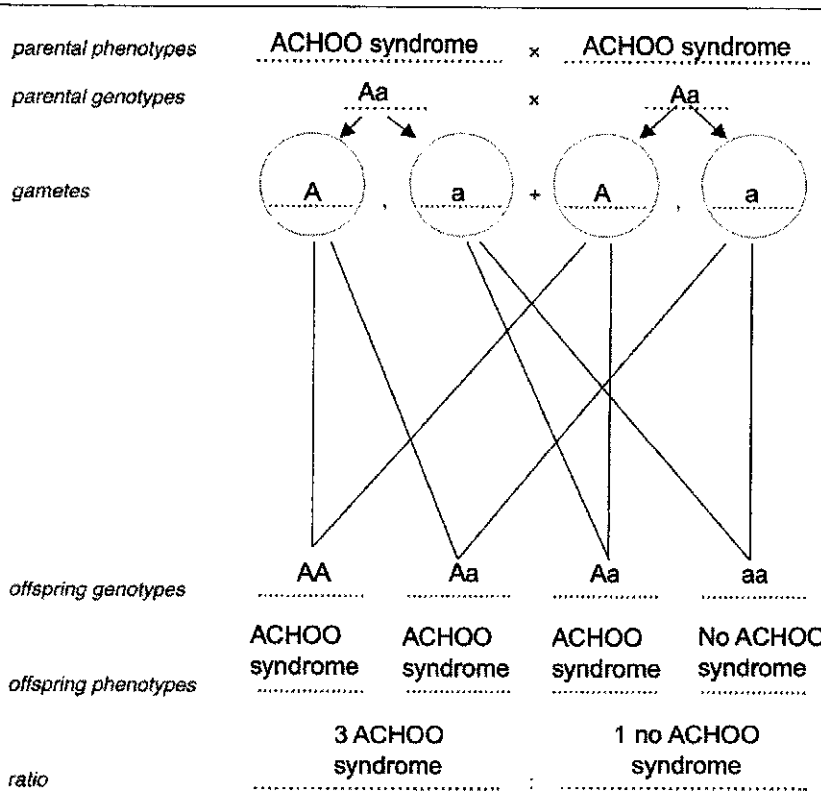
Section A

Qn		Mark Scheme	Marks	Examiner's Comment
1	a	Any 4 • polygalacturonase acts as the lock, pectin acts as the key (active site of polygalacturonase is the keyhole) • The specific 3D shape of the active site of polygalacturonase is complementary to the shape of pectin • Pectin fits and binds to the active site of polygalacturonase to form the enzyme-substrate complex • Activation energy of the reaction is lowered • reaction takes place at the active site to form mono-galacturonate, which leave the active site, which is available to bind with the next substrate molecule	4	Many did not mention fit and bind. Many did not mention that the activation energy is lowered
	b	• Plots accurate; • Axes correct with units; • Best-fit curve • Appropriate Scales Note: if odd scale, penalise 2m for plot + scale;	4	Graph was generally well plotted. A number of candidates use a scale of 10 boxes to 5 days for the y-axis, which caused their graphs to occupy less than half the space.

				
	c	Describe: • As concentration of ethylene increased from 0% to 20%, (polygalacturonase concentration increased), average number of days tomatoes took to completely ripen decreased from 20 days to 10 days, (by 10 days). Reject: as concentration of polygalacturonase increased from 0% to 20%...) BOD: if did not calculate difference in number of days decreased	3	Many quoted data for ethylene but referred to concentration of polygalacturonase increasing by those amounts instead, which is not correct.

		Explain: • As polygalacturonase concentration increases, there is a higher frequency of effective collision between enzyme and substrate molecules • Higher rate of formation of enzyme-substrate complex and thus products Describe: • As concentration of ethylene increased from 20% to 30%, (polygalacturonase concentration increased), average number of days tomatoes took to completely ripen remained constant at 10 days. BOD: if mistake of describing the % changes as concentration of polygalacturonase changing is made again Explain: • Enzyme concentration is no longer the limiting factor BOD: concentration of ethylene is no longer the limiting factor • Idea of all pectin (substrates) being bound to polygalacturonase (enzymes), so any further increase in enzyme concentration does not increase rate of reaction/ decrease number of days taken.		(e.g. when concentration of polygalacturonase increased from 0% to 20%...) Many did not gain credit for the explanation as candidates simply stated that more enzymes breaks down more substrate.
	d	• Ripening bananas release ethylene + ethylene triggers the activity of polygalacturonase • Idea of causing other ripe fruits to overripe, which may spoil/soften the fruits	2	Well done
2	**a**	• G: oesophagus • H: stomach	2	Well done
	b	• E	1	Many candidates indicated F instead.
	ci	• Poor muscular coordination / slower reaction time (reject: decreased reaction time)/ blurred vision when intoxicated • Increased risk of traffic accidents/ result in dangerous driving	2	Well done
	ii	• Consume less carbohydrates Reject: dialysis, as alcohol when absorbed first makes its way the liver before it can reach the veins for dialysis to remove excess alcohol, so the alcohol would have already exerted its effects on the liver	1	Well done

3	a	• Increase in light intensity detected by photoreceptors on the retina, which generate nerve impulse • Nerve impulse transmitted along sensory neurone in optic nerve • Across synapse, with help of neurotransmitter • To relay neurone in brain • Nerve impulse transmitted to motor neurone, then to effector, which are the diaphragm muscle, abdominal muscles and muscles at the back of the throat Reject: if it is stated that nerve impulses are transmitted from motor neurone to effector across synapse. • These muscles contract to cause sneezing	5	Many forgot to mention that the photoreceptors generate nerve impulse after detecting the stimulus. Some candidates did not specify the location of the sensory neurones. Many candidates thought the relay neurone receiving this nerve impulse is in the spinal cord. Some wrote that the brain generates a nerve impulse that leads to the sneezing reflex. This is a reflex action, not voluntary action, so this should not happen Some candidates did not use the term "effector".
	bi	Let A represent the allele for having ACHOO syndrome Let a represent the allele for not having ACHOO syndrome	1 mark for legend	Generally well done. Most common mistake was candidates not specifying which

		 BOD: for no arrow from parental genotypes to gametes	1 mark for parental phenotype and genotype 1 mark for gametes and offspring genotype (cross lines must be present) 1 mark for offspring phenotype and ratio	phenotypes the ratio 3:1 is referring to.
	ii	Probability of child having ACHOO syndrome = ¾ Probability of child having ACHOO syndrome and being a girl = ¾ * ½ = 3/8 or 0.375 Ecf allowed from bi if student mistakenly thought that ACHOO is a recessive trait	1 1	
4	ai	40%/20% = 2 times	1	

	ii	• Estrogen stimulates repair and thickening of uterine lining Reject: Estrogen repairs/thickens the uterine lining • High concentration of estrogen triggers ovulation	2	Some students described the role of progesterone instead, failing to notice that the study had a focus on ovulation, which is not regulated by progesterone.
	b	• Carbon monoxide from cigarette **smoke** binds irreversibly with haemoglobin in maternal blood to form carboxyhaemoglobin • Reduced oxygen carrying capacity of mother's red blood cell • Lesser oxygen transported to placenta and diffused to fetus/ Lesser oxygen transported to the fetus via the umbilical cord REJECT: carbon monoxide diffused to fetus OR • Carbon monoxide from cigarette **smoke** increases rate of fatty deposits in inner arterial wall • Lumen of arteries narrowed • Rate of oxygen transported to placenta and fetus decreases /Lesser oxygen transported to the fetus via the umbilical cord OR • Nicotine from cigarette **smoke** increases risk of blood clots in arteries • Lumen of arteries narrowed • Rate of oxygen transported to placenta and fetus decreases /Lesser oxygen transported to the fetus via the umbilical cord	3	Most chose to explain the effect of carbon monoxide on oxygen carrying capacity. Students did not mention that oxygen is first transported to the placenta before diffusing to the fetus.
	c	• Glucose is carried in the blood plasma • Small intestine → hepatic portal vein → liver • → hepatic vein → vena cava → heart	5	Many jumped directly from small intestine to the umbilical cord, thus missing the

		• → pulmonary artery → lungs → pulmonary vein • → heart → aorta → placenta • → umbilical vein → fetus		entire marking point of this question.
5	a	• Gradient plots to be shown on graph at time = 40 hours • Gradient calculation + correct calculation of final answer (0.8 mg/h) ECF: if gradient plot read wrongly but gradient calculation is done correctly	1 1	Many candidates calculated the rate over 40 hours, instead of the instantaneous rate at 40 hours.
	b	• Aerobic respiration inhibited in batch P, no/less energy released, • only/mainly diffusion happening • Quantity of nitrate ions absorbed in batch P plateaus after 10 hours as equilibrium has been reached (no more net intake of nitrate ions) • Aerobic respiration able to occur in batch N, energy released • Active transport (and diffusion) able to take place • to absorb nitrate ions at a higher rate against the concentration gradient	4	Many did not mention the process that is happening for P (only stating that active transport is not occurring)
	ci	Diffusion	1	Many did not read the question on what happens after 60 hours, and gave their guesses based on all possibilities (E.g. transpiration, photosynthesis, etc.)
	ii	2 points for 1 mark • Concentration of nitrate ion in cell sap of root hair cells higher than that of distilled water • Net movement of nitrate ions out of root hair cells into distilled water • Down concentration gradient • through partially permeable cell surface membrane	2	
6	a	• cornea	1	Common mistake: lens
	bi	• A: fovea • B: blindspot	2	Well answered
	ii	• more rod cells than cone cells in the retina ; • ref. to uneven distribution of rod cells either side of fovea ; • no rod cells and no cone cells at blind spot ; • optic nerve enters /leaves retina at blind spot ; • only cone cells at the fovea / no rod cells at the fovea ;	5	No ecf from 6bi

		• maximum number of cone cells are at the, fovea / 0 degrees ; • maximum number of rod cells at 20–21 degrees ; • data quote include units ;		
	ci	• Sensory neurone	1	
	ii	• They transmit nerve impulses generated • from the photoreceptors to the brain If any other neurone is stated in ci), max 1m given for "transmit nerve impulses"	2	
7	ai	Bacteria	1	
	ii	Plasmid	1	
	b	**Invalid (max 3m)** • Humans overcome viruses using their adaptive immune system/active immunity/antibodies, not by evolving • Immune system able to adapt to new strains of viruses within a very short time period/operate on a shorter timeframe than evolution • Quick production of vaccines can provide protection before any infection • Weakened virus injected, where its antigens stimulate antibody production by lymphocytes • Memory cells produced for immunological memory/long-term immunity • Memory cells recognise virus' antigens during reinfection, triggering a rapid immune response • Use of antiviral drugs to defeat the viruses **Valid (max 3m)** • Some viruses are mutation-prone • develop new antigens, avoiding detection by memory cells/antibodies • Unable to stimulate immune response in humans, humans fall ill and may die • Viruses can evolve faster than vaccines can be produced/ time needed for production of safe vaccines • Viruses can evolve mechanisms to evade/shut down the immune system and its ability to adapt (e.g. HIV)	4	

	c	• Viral DNA used as template to synthesis mRNA (reject: DNA converted to mRNA) via transcription in the nucleus • Ribosome uses mRNA/viral RNA to synthesise specific sequence of amino acids / polypeptide chain via translation in the cytoplasm • Polypeptide chain folds up to form viral protein • Viral protein may be further processed, packaged and modified in the Golgi apparatus.	4	Many students jump straight into stating that ribosomes synthesise proteins, without elaborating on transcription and translation. Candidates should also be aware that Golgi is spelled with a capital G.

Section B

Question 8 was the more popular choice. However, candidates who chose question 9 generally did much better. Candidates are advised to choose their question more carefully in Section B.

For candidates who did both questions, only Q8 will be considered.

8	**a**	25.22 *150/100 = 37.83 g	1	
	b	Any five: • Photosynthesis ; • in leaves / green parts of plants / in mesophyll / chloroplasts / using chlorophyll ; • using light energy ; • water + soil through the roots/ root hair cells / irrigation from roots ; • carbon dioxide + air through stomata ; • produce glucose / $C_6H_{12}O_6$; • converted to starch ;	5	
	c	Any four (note: all explanations must link back to carbon): • These plants are food source to/ fed on by other organisms, transferring carbon compounds from one trophic level to another • These plants may eventually be buried underground and subjected to high pressure over time to form fossil fuels, trapping carbon underground • Combustion of biofuel/these plants (reject coal/natural gas/ fossil fuels) to release carbon dioxide • These plants are decomposed by microorganisms to release carbon dioxide • These plants carry out respiration, breaking down nutrients to release carbon dioxide into the atmosphere Reject: dissolution of carbon dioxide into/out of ocean (not related to rice, maize and wheat)	4	

9	**a**	• loss of habitat ; • population decrease /migration ; • extinction /endangerment, of species ;	4	

		• loss of biodiversity ; • less food ; • idea of food chains /food webs disrupted ;		

	b	• Light intensity increases
		  o Stomata open wider → rate of transpiration increases
		• Temperature increases
		  o Rate of evaporation increases → rate of transpiration increases
		• Humidity decreases
		  o <u>Steeper concentration gradient</u> of water vapour between atmosphere and intercellular air spaces → rate of transpiration increases
		• Wind speed increases
		  o Water vapour quickly carried away by wind, <u>steeper concentration gradient</u> of water vapour between atmosphere and intercellular air spaces → rate of transpiration increases
		
		Marks only awarded if explanations are tagged to the correct factor
			6	