CHRIST CHURCH SECONDARY SCHOOL
2024 PRELIMINARY EXAMINATION
SECONDARY FOUR EXPRESS

CANDIDATE NAME						CLASS		
CENTRE NUMBER	S					INDEX NUMBER		

Biology

Paper 2

6093/02
22 August 2024
1 hour 45 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

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

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

At the end of the examination, fasten all your work securely together.
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	

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Section A

Answer **all** questions in the spaces provided.

1 Fig. 1.1 shows the reproductive organs of a man who has had part **X** cut and tied in a surgery known as vasectomy.

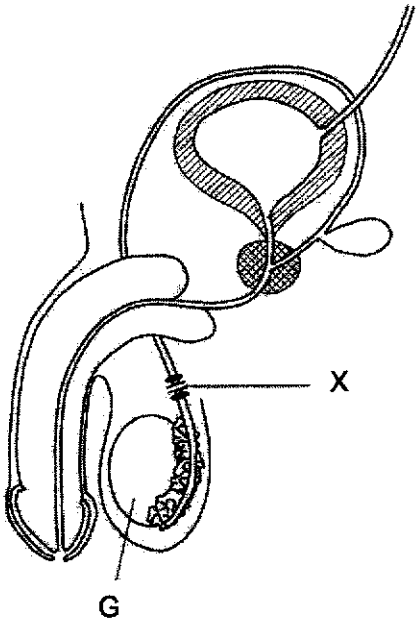


Fig. 1.1

(a) State two products of organ G.

1 .....

2 ..... [2]

(b) Name part X and explain how cutting and tying of part X means for the fertility of this man.

X ..... [1]

explanation .....

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..... [2]

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(c) A patient was diagnosed with varicocele, a condition characterised by the enlargement of veins within the scrotum due to malfunctioning valves inside the testicular veins.

Suggest and explain how varicocele might affect the sperm production and quality.

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

[Total: 9]

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2 **(a)** Explain how the human gas exchange system is protected against pathogens.

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..... [3]

(b) Tuberculosis (TB) is an infectious disease caused by a bacterial pathogen. The spread of this disease can be controlled by vaccination.

Explain how vaccination provides a defence against infectious diseases.

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..... [3]

(c) TB is a disease that can be treated with antibiotics.

Explain why viral diseases cannot be treated with antibiotics.

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..... [2]

[Total: 8]

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3 The blood flow through the skin of some volunteers was measured with a flow-meter when their skin was exposed to different temperatures.

Capsaicin is a compound that gives people the sensation of feeling hot when it is put on the skin similar to how the skin would feel warm after touching something hot like a warm cup of tea because it activates the same nerves that detect heat. Researchers applied capsaicin to the skin of the volunteers and again measured the blood flow through their skin at different temperatures.

Fig. 3.1 shows the results.

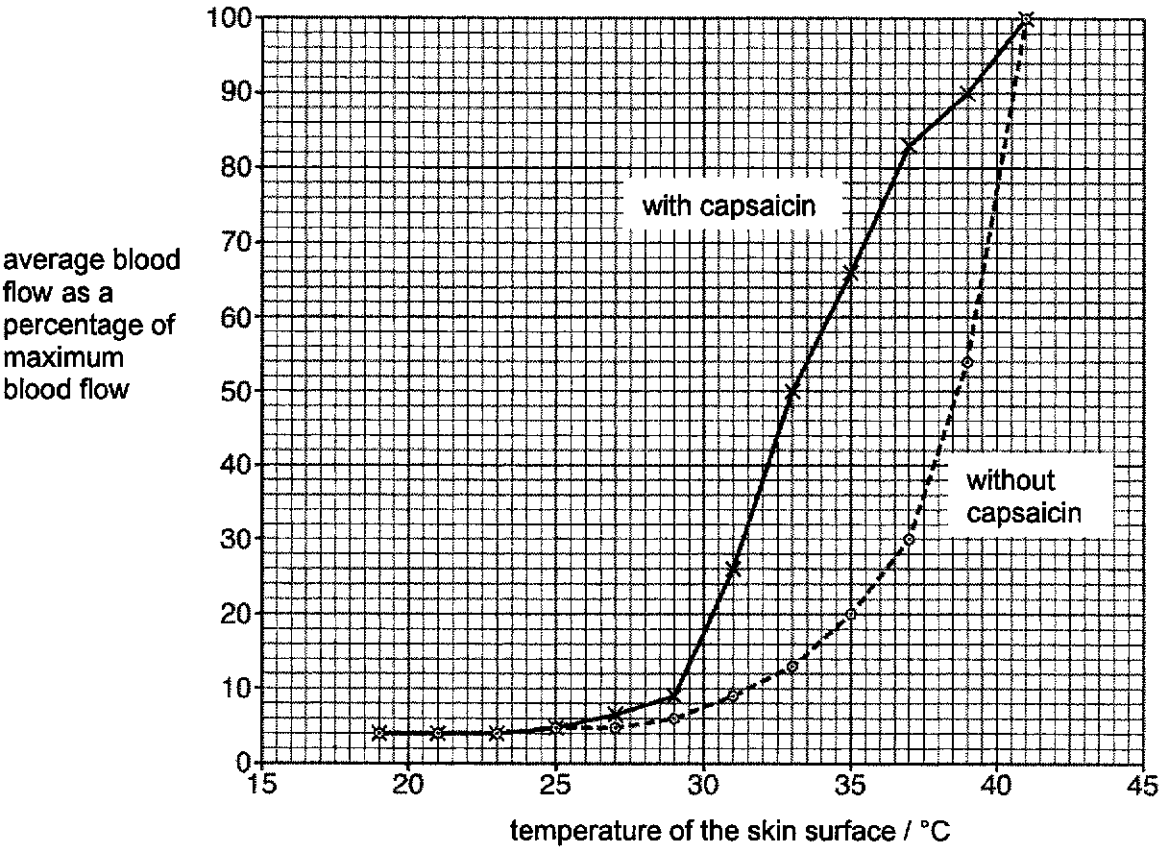


Fig. 3.1

(a) Use the information in Fig. 3.1 to describe the effect of increasing the temperature of the skin surface on blood flow to the skin **without** capsaicin.

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..... [3]

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(b) Explain the mechanism that increases blood flow through the skin.

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..... [3]

(c) State the difference between the average blood flow for the treatments (with and without capsaicin) at 35°C.

..... % [1]

(d) The researchers thought that capsaicin stimulated cells in the skin.

Explain the process by which capsaicin could reach these cells.

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..... [3]

(e) Body temperature is controlled by both hormones and nerves.

Explain how co-ordination by hormones differs from co-ordination by nerves.

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..... [2]

[Total: 12]

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4 Maple syrup urine disease (MSUD) is a rare inherited human condition caused by mutation. MSUD is caused by a recessive allele.

MSUD is usually diagnosed in early childhood and can be controlled by having a low protein diet.

Fig. 4.1 shows the inheritance of MSUD in one family.

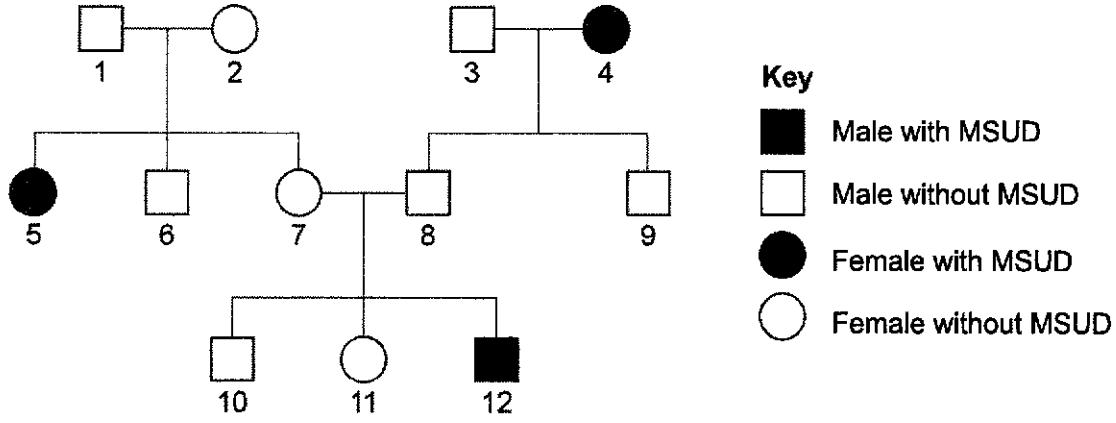


Fig. 4.1

(a) (i) Describe what is meant by mutation.

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..... [1]

(ii) State the name of one factor which increases the rate of mutation.

..... [1]

(iii) State one piece of evidence from Fig. 4.1 which shows that MSUD is a recessive condition.

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..... [1]

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(iv) Persons 7 and 8 in Fig. 4.1 are expecting a fourth child.

Determine the probability that the child will have MSUD by completing the genetic diagram.

Use the symbol **N** for the dominant allele and **n** for the recessive allele.

	father		x		mother	
genotypes of parents	.....				.....	
gametes	.....	.....		.....	.....	
genotypes of offspring	.....	.....	.....	.....		
phenotypes of offspring	.....	.....	.....	.....		

Probability that the child will have MSUD: .....% [4]

(b) Fig. 4.2 shows chemical reactions involved in the normal breakdown of some types of amino acid inside body cells.

A person with MSUD **cannot** make Enzyme 2. This leads to the accumulation of amino acids in the blood and urine, giving the urine a characteristic sweet smell.

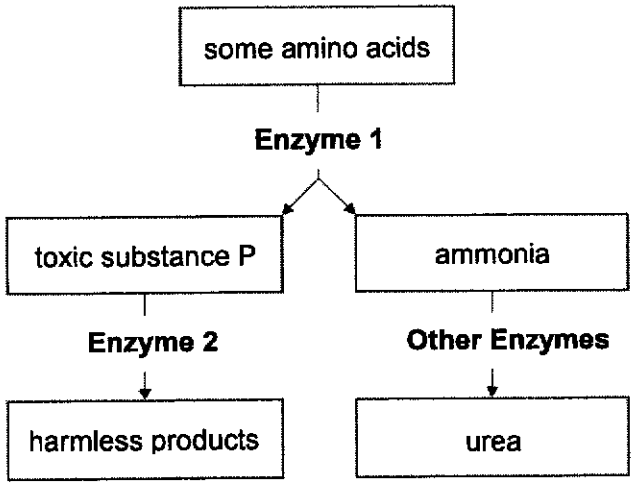


Fig. 4.2

(i) One of the final products shown in Fig. 4.2 is urea.

Which part of the human body are the reactions shown in Fig. 4.2 is most likely to occur?

..... [1]

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(ii) Scientists can analyse urine samples to see if a person has MSUD.

Explain why the urine of a person with MSUD will have high concentration of toxic substance **P**.

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..... [2]

(iii) Explain why a person with MSUD must have a low-protein diet.

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..... [3]

[Total: 13]

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5 Fig 5.1 shows the codon chart.

First Base	Second Base: U	Second Base: C	Second Base: A	Second Base: G	Third Base
U	Phenylalanine	Serine	Tyrosine	Cysteine	U
	Phenylalanine	Serine	Tyrosine	Cysteine	C
	Leucine	Serine	STOP	STOP	A
	Leucine	Serine	STOP	Tryptophan	G
C	Leucine	Proline	Histidine	Arginine	U
	Leucine	Proline	Histidine	Arginine	C
	Leucine	Proline	Glutamine	Arginine	A
	Leucine	Proline	Glutamine	Arginine	G
A	Isoleucine	Threonine	Asparagine	Serine	U
	Isoleucine	Threonine	Asparagine	Serine	C
	Isoleucine	Threonine	Lysine	Arginine	A
	Methionine	Threonine	Lysine	Arginine	G
G	Valine	Alanine	Aspartic Acid	Glycine	U
	Valine	Alanine	Aspartic Acid	Glycine	C
	Valine	Alanine	Glutamic Acid	Glycine	A
	Valine	Alanine	Glutamic Acid	Glycine	G

Fig. 5.1

The sequence of bases on the transcribed strand of a DNA molecule is shown:

TTGTGCAGGAGTC

(a) **(i)** Write the sequence of bases on the corresponding strand of the mRNA molecule.

..... [1]

(ii) With reference to the codon table, write down the corresponding amino acid sequence of the polypeptide based on the mRNA sequence in **(a)(i).**

..... [1]

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(b) Fig. 5.2 shows a section through a villus in the small intestine.

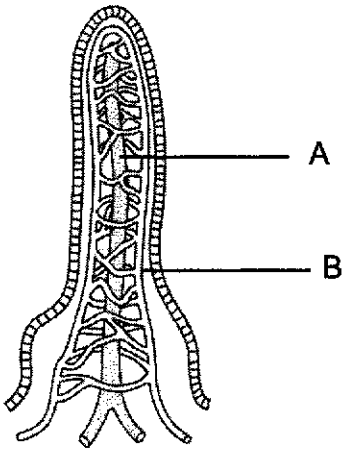


Fig. 5.2

A change in the amino acid sequence due to a single nucleotide change in the mRNA sequence affects the production of a transporter protein responsible for the absorption of amino acids from the small intestine.

(i) With reference to Fig. 5.2, predict and explain which part of the villi would be affected by the transporter protein.

part .....

explanation .....

..... [2]

(ii) A three-year-old patient was recently diagnosed with a deficiency in pancreatic enzymes, specifically those responsible for the digestion of dietary proteins in the small intestine. As a result, the patient suffers from poor absorption of amino acids, leading to stunted growth and poor muscle development.

Using the lock and key hypothesis of enzyme action, explain why the patient has low levels of amino acids and how this deficiency contributes to the symptoms of stunted growth and poor muscle development.

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..... [4]

[Total: 8]

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6 Fig. 6.1 shows part of a cross-section of the stem of a young sunflower plant.

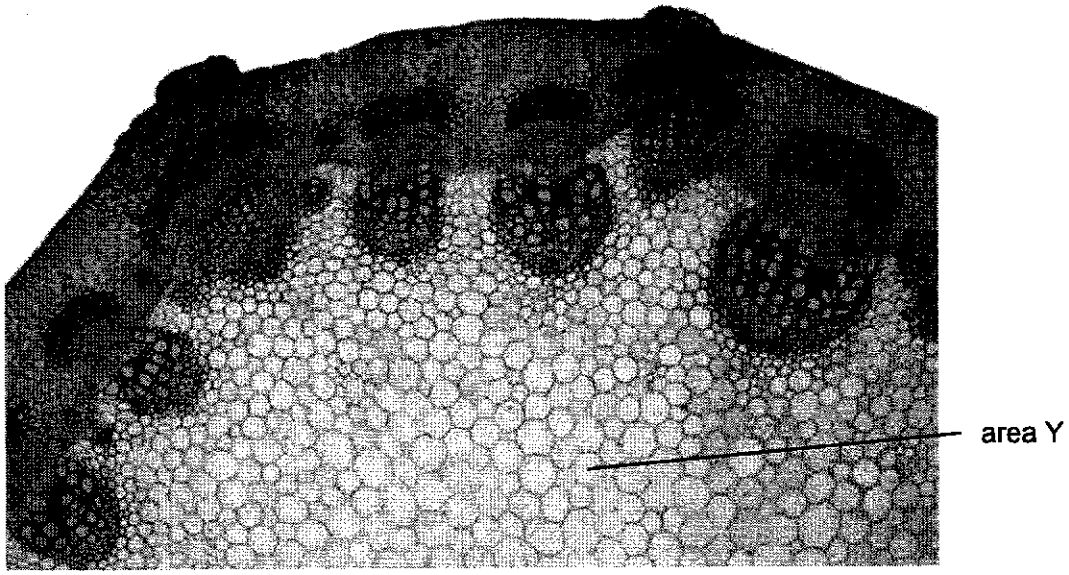


Fig. 6.1

(a) Draw a circle around one vascular bundle on Fig. 6.1

Label the **xylem** in the vascular bundle with the letter **X**. [2]

(b) Explain how the cells in area Y are able to support the stem so that it stays upright.

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..... [3]

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(c) Researchers used carbon dioxide that contained a traceable source of carbon (^{13}C) to investigate translocation of sucrose from the leaves of bean plants, *Phaseolus vulgaris.*

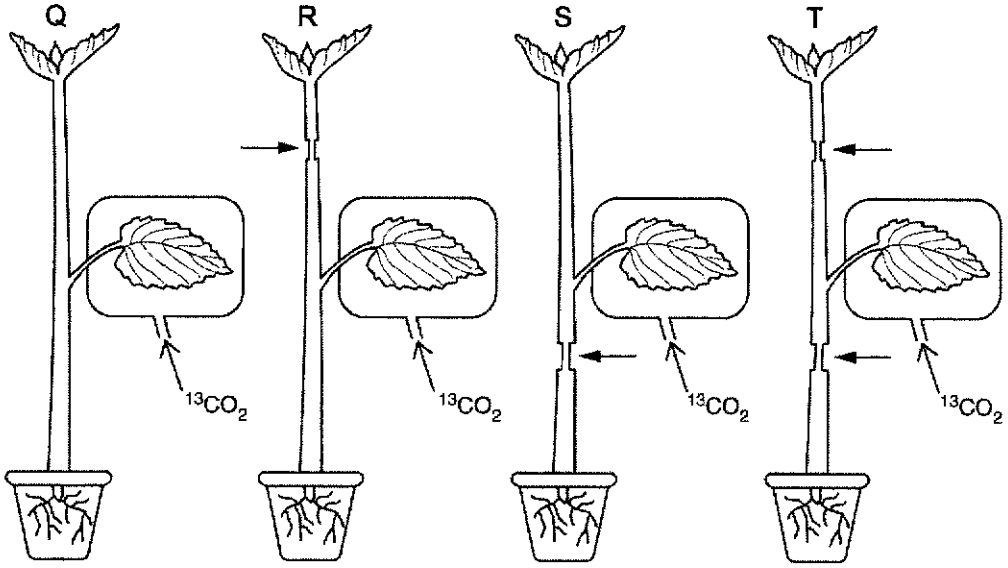
Fig. 6.2 shows that glucose produced in photosynthesis is converted to sucrose for translocation.

carbon dioxide ⟶ glucose ⟶ sucrose

Fig. 6.2

Researchers selected four plants, Q, R, S and T, which had leaves that were of similar sizes. The leaves on the four plants were supplied with $^{13}CO_2$.

After the leaves had started to make sucrose, the researchers cut away a ring of tissue in different places as shown in Fig. 6.3. The rings of tissue that were removed from plants R, S and T contained phloem.



Key: ⟶ the positions on the stems where rings of tissues containing phloem were removed.

Fig. 6.3

The quantities of sucrose containing ^{13}C in the shoot tips and in the roots were determined. The results are shown in Table 6.1.

Table 6.1

plant	quantity of sucrose containing ^{13}C/arbitrary units	
	shoot tip	root
Q	3.24	0.94
R	0.00	0.44
S	4.14	0.00
T	0.00	0.00

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Describe and explain the effect of removing the phloem on the translocation of sucrose in plants Q, R, S and T.

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..... [5]

[Total: 10]

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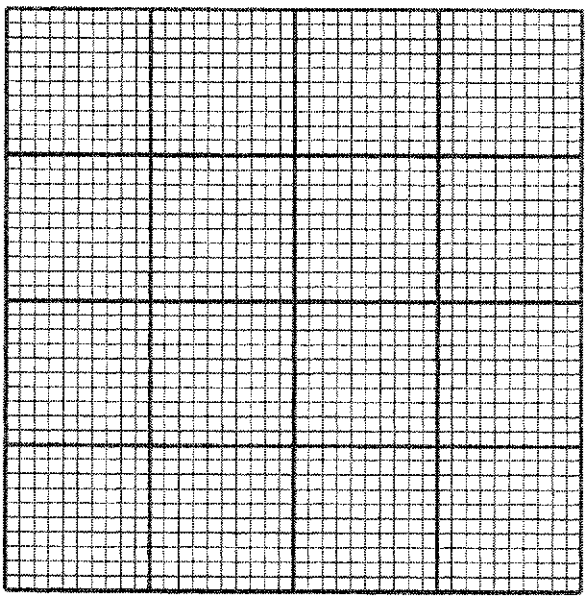
7 Pulmonary edema is a condition where fluid accumulates in the lungs, making it difficult to breathe. In recent years, doctors have seen increasing cases of pulmonary edema especially in young adults.

Table 7.1 shows the partial pressure of oxygen levels in patients with pulmonary edema.

Table 7.1

time (hours)	0	6	12	24	48
Partial pressure of oxygen levels (mmHg)	75	70	65	60	55

(a) (i) Plot a graph of these data.



[4]

(ii) Describe the trend shown by the data in your graph.

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..... [2]

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(b) Accumulation of fluid in the alveoli occurs in patients suffering from pulmonary edema.

Explain how the structure of the alveolus is adapted for efficient gas exchange.

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..... [4]

[Total: 10]

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Section B

Answer **one** question from this section.

8 A scientist studied communities in different parts of a desert and estimated the biomass of the organisms in each area.

He divided the organisms into four groups according to their roles in the food web as shown in Table 8.1.

Detritivores are animals that eat dead organisms or parts of organisms.

Table 8.1

groups of organisms in the food web	biomass / g per m^2
producers	480
herbivores	220
detritivores	120
carnivores	40

Some of these results are shown as a pyramid of biomass in Fig. 8.1.

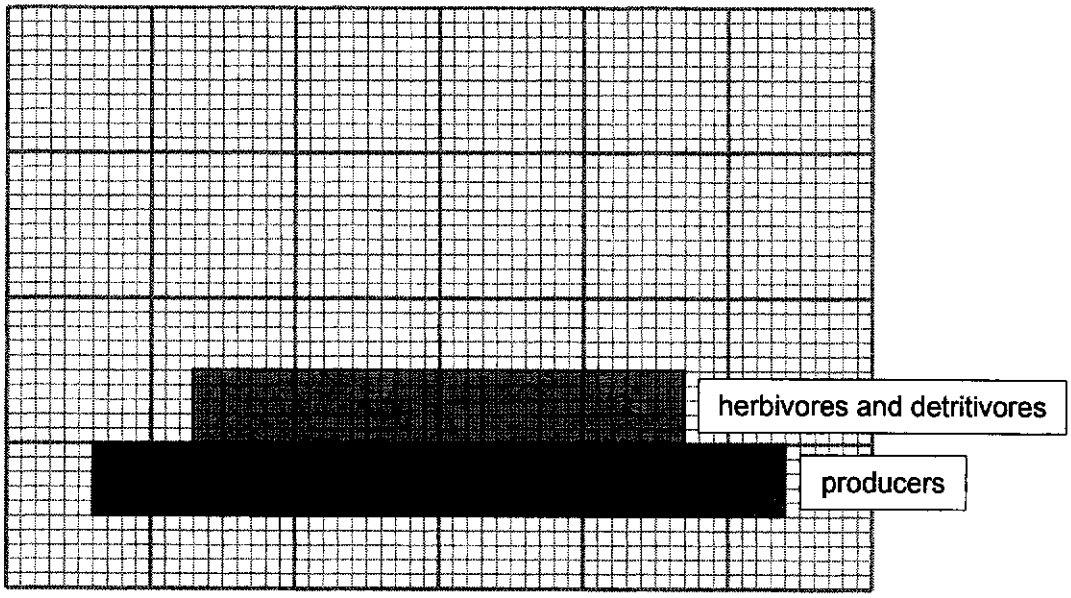


Fig. 8.1

(a) Use the information in Table 8.1 to complete the pyramid of biomass in Fig. 8.1. [2]

(b) The scientist observed the detritivores and decided to include them with herbivores in this pyramid of biomass.

Suggest what the scientist discovered about the detritivores that made him make this decision.

.....

..... [1]

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(c) Calculate the percentage of biomass lost between producers and herbivores.

Give your answer to the nearest whole number.

Show your working.

answer .....% [2]

(d) Explain why there are rarely more than four or five trophic levels in ecosystems.

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..... [2]

(e) Explain the advantages of presenting information about food webs as a pyramid of biomass and **not** as a pyramid of numbers.

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..... [3]

[Total: 10]

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9 A congenital heart defect (CHD) is a structural abnormality of the heart that is present at birth. These defects can involve the heart's walls affecting the normal flow of blood through the heart and to the rest of the body.

Fig. 9.1 shows a fetal heart with an opening in the septum between the ventricles.

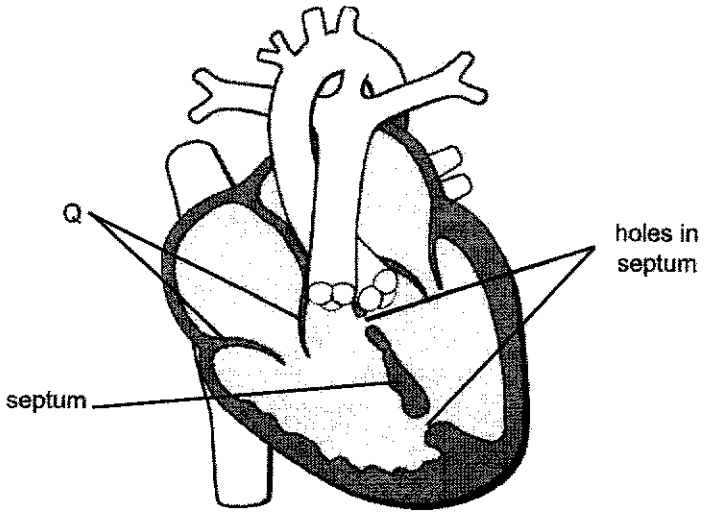


Fig. 9.1

(a) Name structure Q.

..... [1]

(b) The holes in the fetal heart naturally close at birth. However, in a small percentage of babies, the holes do not close. These babies may have faster breathing rates and get tired out during attempts to feed.

With reference to blood pressure and direction of blood flow in the ventricles, explain why the holes in the heart of these babies lead to these symptoms.

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..... [3]

(c) Suggest why these holes do not affect a fetus developing in the uterus.

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..... [1]

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(d) Table 9.1 presents the survival rates over a period of five years for children with CHD comparing to those who receive no treatment to those undergoing surgical intervention.

The year indicates the time in years since the initial diagnosis or intervention.

Table 9.1

year	untreated CHD survival rate (%)	surgical intervention survival rate (%)
1	95	99
2	90	98
3	85	97
4	82	96
5	80	95

Using Table 9.1, describe the differences in children with CHD between those who receive no treatment to those undergoing surgical intervention.

Suggest a reason for the differences.

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..... [3]

(e) In severe cases where CHD cannot be corrected by other means, a heart transplant may be carried out. However, the success rate for heart transplants is relatively low. Explain why a heart transplant may not be successful.

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..... [2]

End of Paper

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		Answer	Remarks	Marks
3	(a)	[1] Blood flow remains constant <u>and</u> then increases. [2] Blood flow remains at 4/5 %. [3] Increase in blood flow from 25-27°C [4] to a maximum / 100% at 41°C.	AW Any three points	3
	(b)	[1] Rise in <u>temperature detected by receptor in skin and generate nerve impulses.</u> [2] Nerve impulses generated travelled to the <u>brain</u> via the <u>sensory neurone</u>. [3] Impulses from the brain travelled to the <u>muscles</u> in the arterioles / shunt vessels via <u>motor neurone</u>. [4] <u>Arterioles dilate</u> / vasodilation OR <u>shunt vessels constrict</u> to <u>increase more blood flow</u> into capillaries / near the surface of the skin	Any three points	3
	(c)	46%		1
	(d)	[1] Higher concentration of capsaicin on the skin surface (than in the cells) [2] Capsaicin diffuse through the cells / passes through / across cell membranes to the cells by [3] diffusion.	A down a concentration gradient A from high to low concentration	3
	(e)	[1] Hormones is by chemical means while nerve co-ordination involves nerve impulses. [2] Hormones are transported in the blood / circulatory system while nerve co-ordination are transported by the neurones. [3] The (effects) by hormones are slower than nerves. [4] The (effects) by hormones are longer-lasting than nerves.	Any two points	2
Total				12

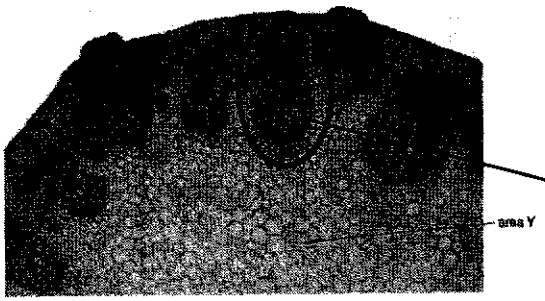
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		Answer	Remarks	Marks
4	(a)(i)	Mutation is spontaneous / random change in the structure of the gene or the number of chromosome.		1
	(a)(ii)	formaldehyde; radiation; x-ray; tar		1
	(a)(iii)	Parent without MSUD has a child who has MSUD; Parent 1 and 2 without MSUD have child 5 with MSUD; Parent 7 and 8 without MSUD have child 12 with MSUD.		1
	(a)(iv)	Correct genotype of parents and gametes: N + n and N + n Correct genotypes of offspring: NN / Nn / Nn / nn Correct phenotypes of offspring. Probability that the child will have MSUD: 0.25 / ¼ / 25%	R ratio	4
	(b)(i)	liver		1
	(b)(ii)	[1] Toxic substance P passes through the (glomerulus) in the **kidney**. [2] Not all of the toxic substance P is reabsorbed back into the blood capillaries and end up in the urine. [3] Only some of the toxic substance P is reabsorbed into the blood capillaries.	Any two points	2
	b(iii)	[1] proteins are broken down into amino acids / proteins are made up of / contain amino acids. [2] must keep amino acids in low amount / amino acids do not build up / less amino acids produced. [3] so that toxic substance P does not build up in the body <u>and</u> cause damage to cells / tissues / organs.	 AW AW	3
Total				13

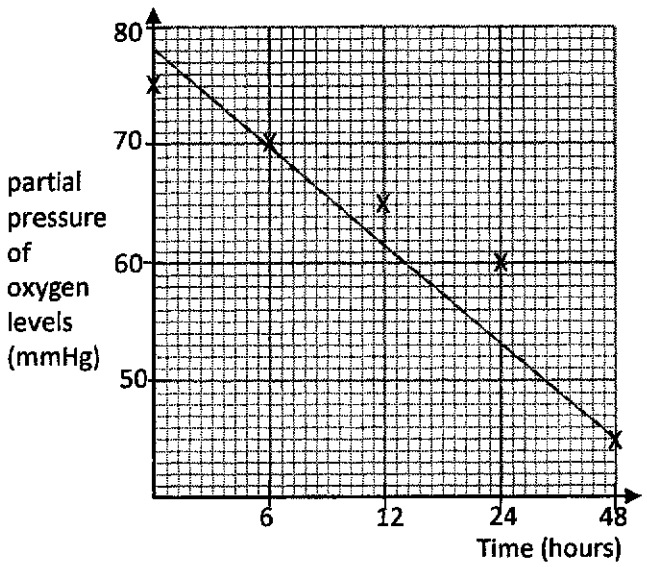
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		Answer	Remarks	Marks
5	(a)(i)	AAC-ACG-UCC-CAG		1
	(a)(ii)	asparagine – threonine – serine – glutamine		1
	(b)(i)	B		1
		Explanation: Amino acids is absorbed by the blood capillaries in the villi.		1
	b(ii)	[1] (Pancreatic enzymes) Protease active site is <u>complementary</u> to the shape of the proteins. [2] Only proteins can bind / fit to the protease (enzyme) / other molecules cannot bind / fit to the enzyme active site. [3] Lesser proteins is broken down (digested) into amino acids <u>and</u> lesser <u>absorption of amino acids into the blood stream.</u> [4] lesser amino acids results in stunted growth and poor muscle development. [5] amino acids are building blocks needed for muscle and tissue repairs / growth of new cells.	Any four points	4
Total				8

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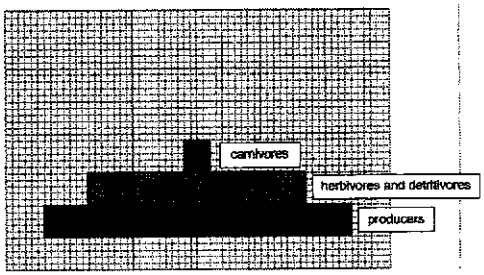
		Answer	Remarks	Marks
6	(a)	 xylem	Circle any one of the vascular bundles. Label xylem.	2
	(b)	[1] cell vacuoles / cells have a higher water potential [2] cells absorbed water by <u>osmosis</u> / down a water potential gradient [3] causes cells to become <u>turgid</u> / have turgor pressure. [4] presence of cell wall which is inelastic and prevent the cells from bursting.	Any three points	3
	(c)	Describe: [1] Q has sucrose / ^{13}C in shoot <u>and</u> root [2] T has no sucrose / ^{13}C in shoot <u>and</u> root [3] R has sucrose / ^{13}C in root but not in shoot [4] S has sucrose / ^{13}C in shoot but not in root	Any two points	5
		Explain: [5] there is no transport of sucrose / ^{13}C where phloem is removed. [6] phloem transport sucrose / ^{13}C in both directions; upwards and downwards. [7] leaf carry out photosynthesis and produce glucose and convert to sucrose for transport. [8] sucrose is then transported to the roots and shoots.	Any three points	
Total				10

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		Answer	Remarks	Marks
7	(a)(i)	Scale; Best-Fit line; Axis Titles; Plotting points  		4
	(a)(ii)	[1] As the time increases, the partial pressure of oxygen levels decreases from 75 mmHg to 55 mmHg / by 20 mmHg. [2] Every 6 hours, the partial pressure of oxygen levels decreases by 5 mmHg.	AW	2
	(b)	[1a] walls of alveolus has a thin film of moisture [1b] to allow gases to dissolve to diffuse into the blood capillary [2a] walls of alveolus is made up of one cell thick [2b] to allow faster diffusion of gases [3a] alveolus is surrounded by a dense network of blood capillaries. [3b] to transport gases quickly to maintain a steep concentration gradient of gases.	Any four points	4
Total				10

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Paper 2 Section B [10 marks]

		Answer	Remarks	Marks
8	(a)		4 units; Correct size Label carnivores	2
	(b)	[1] eat mainly plants [2] feed at second trophic level as primary consumers [3] eaten by third trophic level / secondary consumers	(any 1 point)	1
	(c)	(480 – 220)/480 * 100% = 54%	Working 1 m Final 1 m	2
	(d)	[1] 90% of energy is lost from one trophic level to the next. [2] Only 10% of the energy is passed down from one trophic level to the next. [3] Not all of the organisms are eaten / digested / absorbed. [4] Energy is lost mainly as heat through respiration' [5] Insufficient energy to support more than four/five trophic levels.	Any two points	2
	(e)	[1] in a pyramid of numbers, one large individual is shown in the same way as one very tiny individual. [2] biomass indicates how much food there is / available / left [3] biomass is an indicator of the energy available [4] pyramid of biomass is pyramid shaped but a pyramid of numbers is not always. [5] a pyramid of numbers can be misleading because it only counts the number of organisms without considering their size or energy content.	Any three points	3
Total				10

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		Answer	Remarks	Marks
9	(a)	Tricuspid valve		1
	(b)	[1] Deoxygenated blood from the right side of the heart will mix with the oxygenated blood from the left side of the heart or vice versa. [2] This reduced the (overall) pressure of the blood. [3] which results in lesser oxygenated blood flowing to the rest of the body. [4] Breathing rate and heart rate increases to pump more oxygenated blood to the rest of the body. [5] Cells receive lesser oxygen and nutrients resulting in reduced respiration rates and lesser energy released.	Any three points	3
	(c)	In the fetus, the main source of oxygen is from the mother through the placenta.		1
	(d)	Describe differences: [1] The survival rate for untreated CHD decreases progressively from 95% at 1 year to 80% at 5 years. [2] The survival rate for children who undergo surgical intervention remains higher throughout the period, starting at 99% at 1 year and slightly decreasing to 95% at 5 years. [3] Surgical intervention significantly improves the long-term survival rates for children with CHD compared to those who remain untreated. [4] Survival rate for untreated CHD decreases the most by 5% between the first and the third year / for the first 3 years.	Any two points	3
		Reason: [1] by repairing the defect, the blood flow will improve resulting in adequate oxygen supply and good nutrient absorption. [2] children will be able to engage in normal physical activities and have a better overall quality of life. [3] children will have better growth and development.	Any one point	
	(e)	[1] body / immune system will recognise the heart transplanted as foreign object. [2] white blood cells will attack the foreign object leading to rejection of the heart.		2
Total				10

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