Name	Class	Register Number

6093/02 **24/4P/6093/02**

BIOLOGY
PAPER 2

Friday **23 August 2024** **1 hour 45 minutes**

VICTORIA SCHOOL

PRELIMINARY EXAMINATION
SECONDARY FOUR

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, class and register number in the spaces provided at the top of this page.
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	
Section	**Marks**
A	**/ 70**
B	**/ 10**
Total	**/ 80**

Setters: L. Ruiting and Nur'Shifa M.

This Question Paper consists of 23 printed pages (including this cover page).

[Turn Over

Section A
Answer **all** questions.

1 Scientists investigated how the diet of rabbits affected their digestion and absorption of protein. The scientists fed rabbits an identical mass of food but varied the percentage of protein in the food.

The scientists measured the mean mass of protein fed to the rabbits that was absorbed, which they then expressed as a percentage value.

The results are shown in Fig. 1.1.

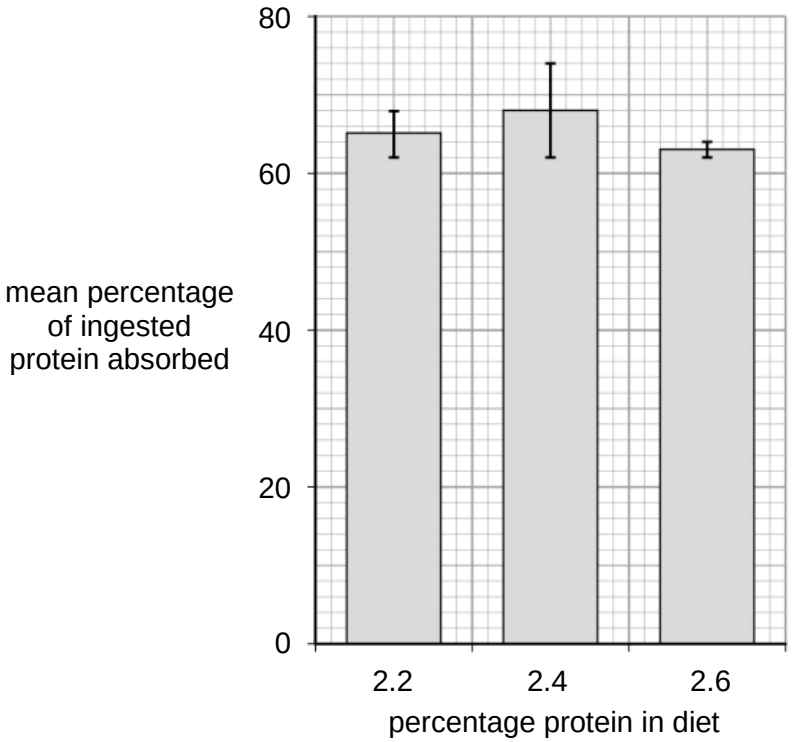

Fig. 1.1

(a) State and explain one conclusion that can be made about the absorption of the products of protein digestion as the percentage of protein increased in the rabbits' food.

……

……

……

……[2]

(b) The digestive system of a rabbit is shown in Fig. 1.2.

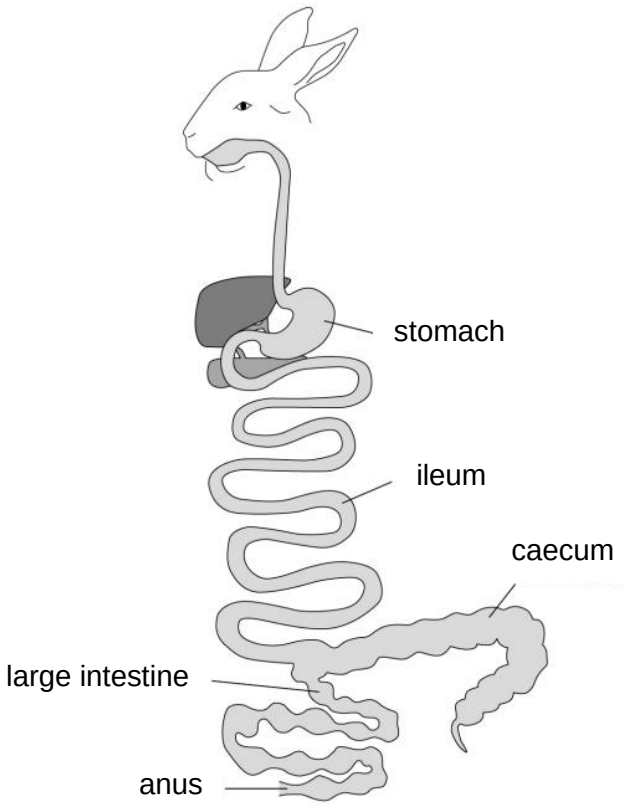

Fig. 1.2

The food eaten by a rabbit is digested mainly by microorganisms in its caecum. The caecum is a section of intestine attached between the ileum and the large intestine. The resulting semi-digested material leaves the anus of a rabbit as soft, caecal droppings. The rabbit then eats these caecal droppings.

Use this information and Fig. 1.2 to suggest how eating its own caecal droppings helps a rabbit's digestion and absorption of dietary protein.

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……

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……

……

……[3]

[Total: 5]

2 Fig. 2.1 shows the life cycle of the plant *Coffea arabica (C. arabica)*.

This plant produces seeds which are used to make coffee.

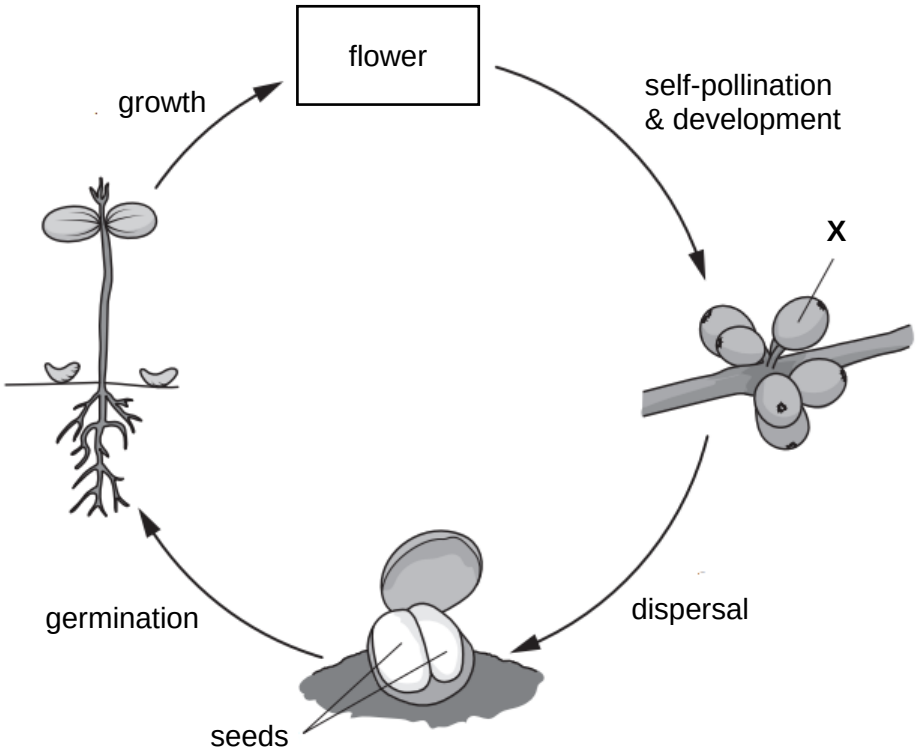

Fig. 2.1

(a) **(i)** Define *self-pollination*.

……...

……...

……..……..…….[2]

(ii) State two cellular processes that allow a seedling to grow into a mature flowering plant.

1……..…….……..……...

2…….[2]

(b) Fig. 2.2 shows a drawing of the *C. arabica* flower.

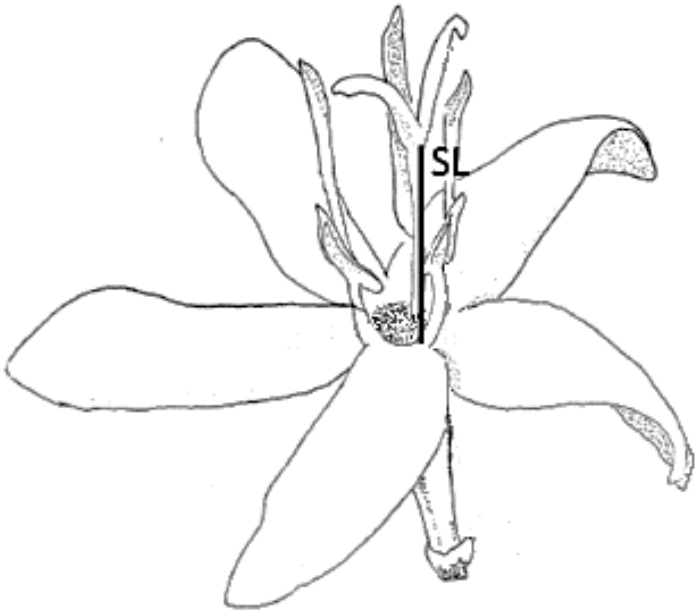

Fig. 2.2
(Source: Drawing by Mariam Marand)

(i) The line **SL** in Fig. 2.2 represents the length of the style of the flower.

On Fig. 2.2, label clearly the anther. [1]

(ii) A pollen tube grows out from each compatible pollen grain.

Describe the events thereafter which lead to the formation of structure **X** in Fig. 2.1 and its contents.

……

……

……

……

……

...[4]

(c) *C. arabica* plants produce a chemical called caffeine which in high concentrations is toxic to insects.

Suggest why it is important to the plant to have different concentrations of caffeine in different parts of the plant.

……..……..

……..……..……..[1]

[Total: 10]

3 (a) Fig. 3.1 shows the genitourinary system of a man.

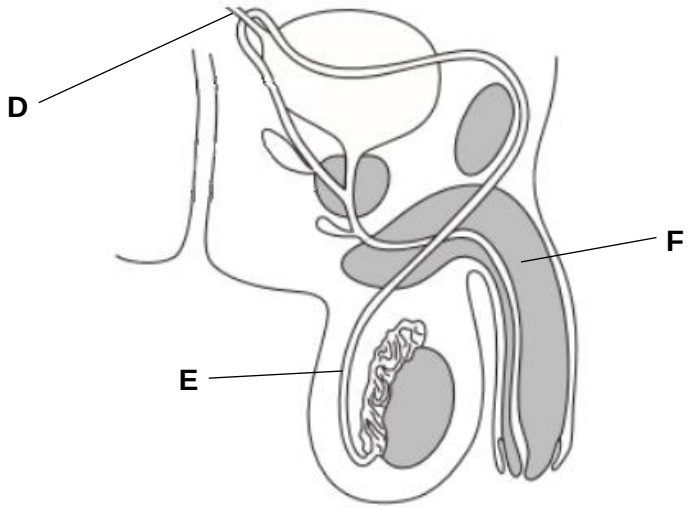

Fig. 3.1

(i) Name the parts labelled **D** and **E**.

D: ……

E: …… [2]

(ii) Explain the role of structure **F** in fertilisation.

……..……..…

……..……

……..

……..……

……..

……....……....[3]

(b) A couple could produce gametes but still could not produce children. A doctor advised them to undergo an in-vitro fertilisation (IVF) treatment.

Fig. 3.2 outlines the stages involved in the IVF treatment.

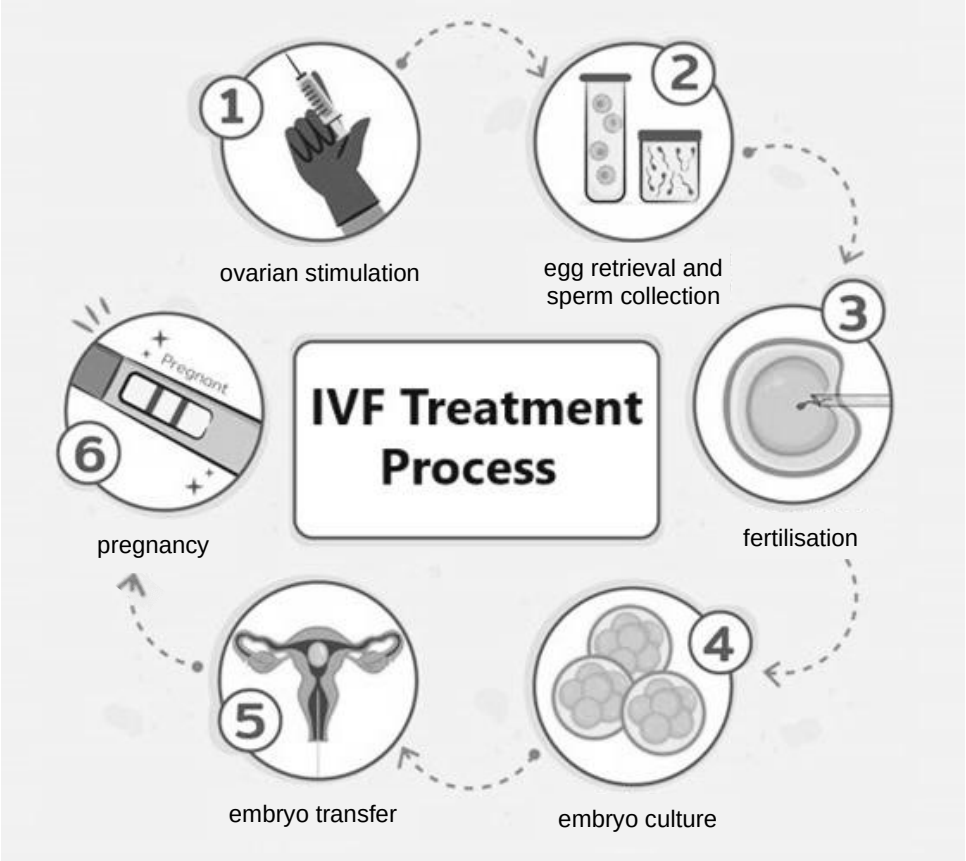

Fig. 3.2

(i) Suggest one possible cause of infertility for this couple.

the man..……

……

the woman…..……

……[2]

(ii) Of the six embryos placed into the uterus, only two embryos developed successfully.

Suggest why some embryos are not able to develop in the uterus.

……

……..……[1]

(iii) State if it is possible for the two embryos to be of different sexes.

Explain your answer.

……

……

...……[2]

(iv) Explain why it is important that the foetal blood system in the placenta is not continuous with the maternal blood system.

……

……

……

……

...……[3]

[Total: 13]

4 Table 4.1 shows some information of two genetic traits of a couple.

Table 4.1

	sickle cell	blood type
man	carrier – normal oxygen saturation in erythrocytes	blood type B – heterozygote
woman	affected – 80% oxygen saturation in erythrocytes	universal recipient

(a) Using the information in Table 4.1, explain why the woman often experiences episodes of lethargy.

……

……

……

……[2]

(b) Using the Punnett square below, find the probability of this couple having a son with blood group B.

Show your working clearly.

gametes	……	……
……	…… ……	…… ……
……	…… ……	…… ……

probability: ……[4]

(c) Sickle cell anaemia is an autosomal recessive disease caused by a gene mutation in the haemoglobin beta gene.

(i) Explain what is meant by *autosomal*.

……

……[1]

(ii) The couple has a child who has sickle cell anaemia.

Explain how this condition is inherited by the child.

……

……[1]

(iii) The sickling of red blood cells can cause blockages and subsequently inflammation in blood vessels. This can lead to further complications such as increased risk of blood clotting.

Describe how a clot is formed.

……

……

……

……

……

……[3]

[Total: 11]

5 Residents from Florida have been experiencing the consequences of “red tides” – excessive growth of the algae *Karenia brevis (K. brevis).* This species of algae releases brevetoxin, a dangerous, tasteless and odourless nerve toxin that can be fatal to animals.

Even though shellfish which can eat *K. brevis* are not affected by the algae, many fish and other marine organisms such as dolphins and manatees are paralysed by the toxin. This toxin prevents the organisms from carrying out the process of cellular respiration.

A variety of factors seem to be associated with their occurrence. These factors include warmer ocean temperatures, heavy rainfall, and pollution from fertilisers.

Fig. 5.1 shows an incomplete food web of the marine ecosystem in Florida.

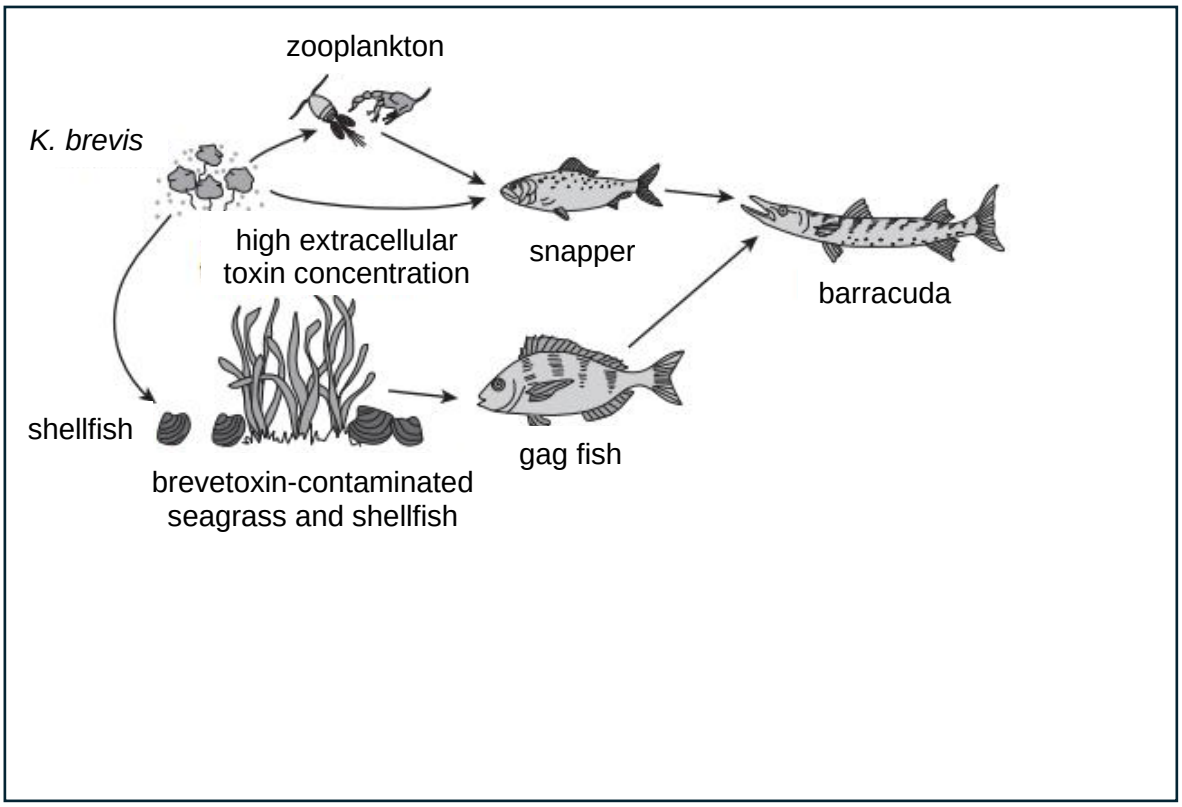

Fig. 5.1
(Source: Adapted from Toxicon, 2007 Oct 50(5): 707-72)

(a) Fig. 5.2 shows some facts about this marine ecosystem.

☑ sea manatees are herbivores ☑ barracudas are hunted by dolphins ☑ shellfish and snappers are often consumed by locals living there

Fig. 5.2

With reference to Fig. 5.2, complete the food web on Fig. 5.1.

Do not draw the organisms. Use only their names. [2]

(b) **(i)** Identify one abiotic factor mentioned above that could be causing the red tides in Florida.

……[1]

(ii) Describe how the factor in **(b)(i)** may lead to an increase in the algae population.

……

……

……

……[2]

(c) Public health officials have advised residents of the increased risk of brevetoxin poisoning if the whole fish is eaten. Instead, only fillets from these fish are preferred.

(i) Explain how the toxins are found in the fish.

……

……

……

……[2]

(ii) Explain why such guidelines were issued by the public health officials.

……

……

……

……[2]

(iii) Suggest a reason how the fact that *K. brevis* does not kill shellfish could be a factor in the damage caused by the red tide.

……

……

……

……[2]

[Total: 11]

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6 A student investigated the effect of surface area on osmosis in cubes of potato.

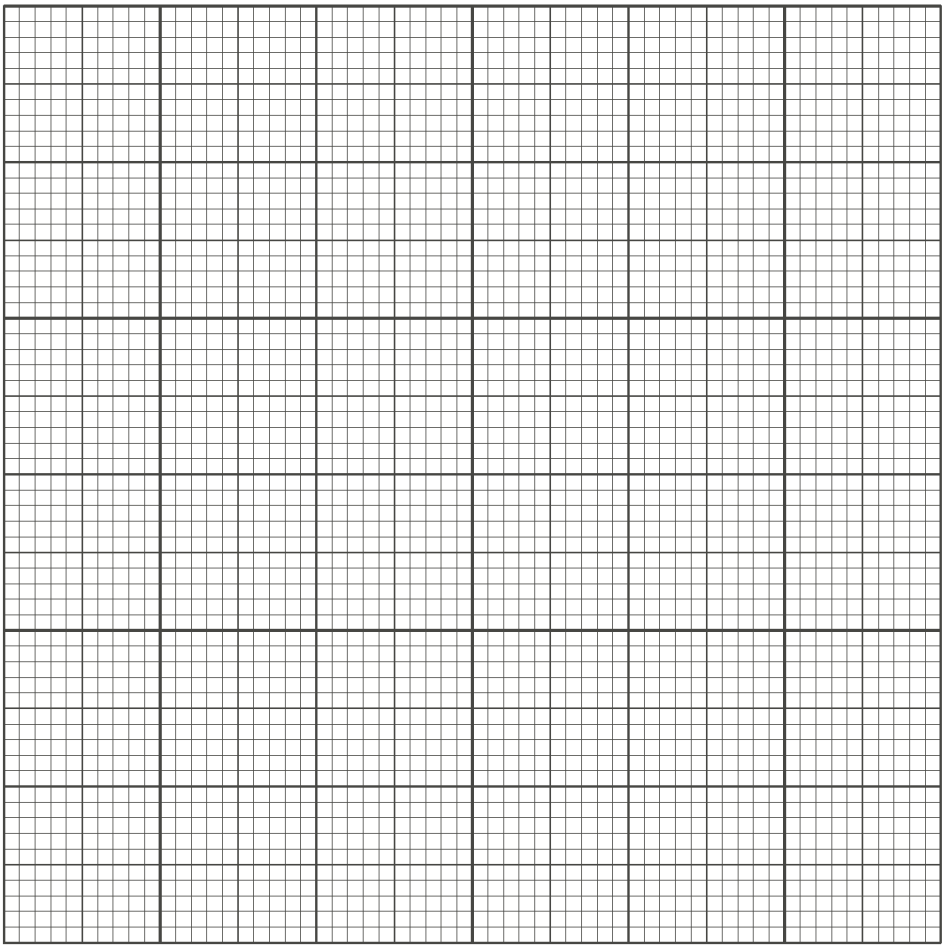
- He cut two cubes of potato tissue, each with sides of 35 mm in length.
- He put one cube into a concentrated sucrose solution.
- He cut the other cube into eight equal-sized smaller cubes and put them into a sucrose solution of the same concentration as the solution used for the large cube.
- He recorded the masses of the cubes at intervals.

His results are shown in Table. 6.1.

Table. 6.1

time / minutes	total mass / g	
	1 large cube	8 small cubes
0	62.0	62.0
40	57.0	53.0
80	54.5	50.0
120	53.5	48.0
160	52.0	47.0

(a) **(i)** Plot two point-to-point graphs to show the change in total mass of the potato cubes with time.



[4]

(ii) Using your graph, find the change in total mass for each type of potato sample at 100 minutes.

1 large cube……..……..

8 small cubes……..……..……[2]

(b) Describe and explain the results obtained at 40 minutes.

……..……..……..……..……

……..……..……..……..……

……..……..……..……..……

……..……..……..……..……

……..……..……..……..……

……..……..……..……[3]

[Total: 9]

7 **(a)** Fig. 7.1 shows the first three structures of the human respiratory system through which air from the external atmosphere passes during inhalation.

Complete Fig. 7.1 to show the pathway that air takes during inhalation.

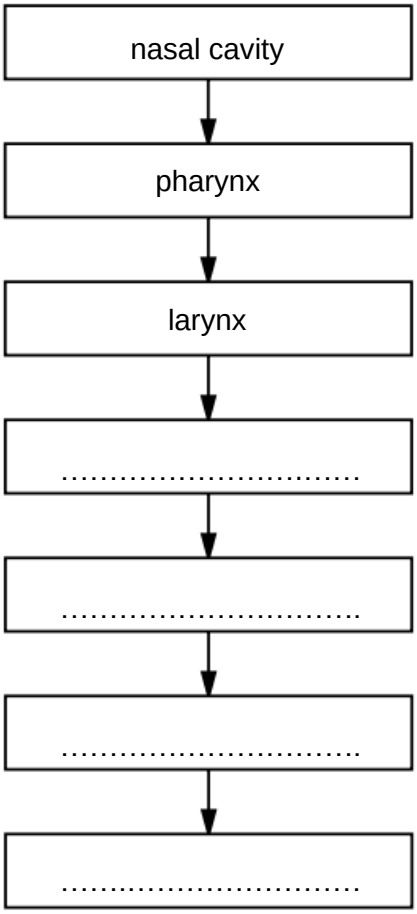


Fig. 7.1 [2]

(b) Pneumonia and chronic bronchitis are diseases that affect the respiratory system.

With reference to pneumonia and chronic bronchitis, explain how infectious diseases differ from non-infectious diseases.

……..……..……...……...……..

……..……...……...……..

……..……...……...……..

……..……..……..……..……..……...[2]

(c) Macrophages are large phagocytic cells that are found in many tissues including alveolar tissue in the lungs. They provide the main means of defence against pathogens in this tissue.

Fig. 7.2 shows part of a capillary and two alveoli, with a macrophage.

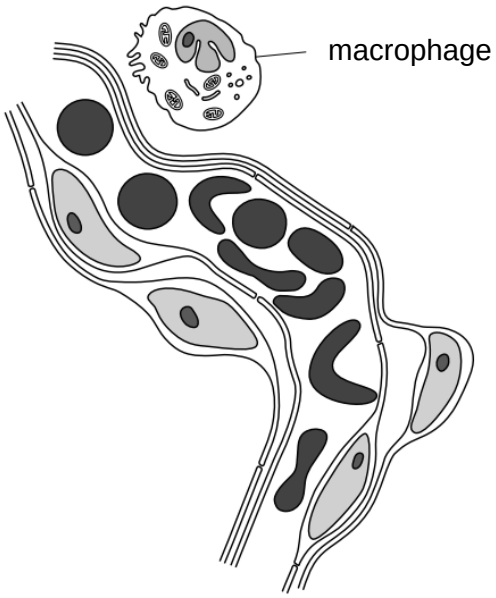


Fig. 7.2

With reference to Fig. 7.2, explain how:

(i) the alveoli are adapted for gaseous exchange

..……..……..……..……..……..…[2]

(ii) the macrophages function to protect the lungs from becoming infected.

……

……

……

……..……..……..……....[2]

(d) Phagocytes release enzymes that digest proteins. In smokers, this may lead to the large-scale destruction of alveolar walls.

Outline the effects of this destruction on the health of a person.

……..……..……..……..……..……

……..……..……..……..……..……

……..……..……..……..……..……

……..……..……

……..……..……

……..……..……...[3]

[Total: 11]

Section B
Answer **one** question from this section.

8 Fig. 8.1 shows the risk of coronary heart disease by age and gender.

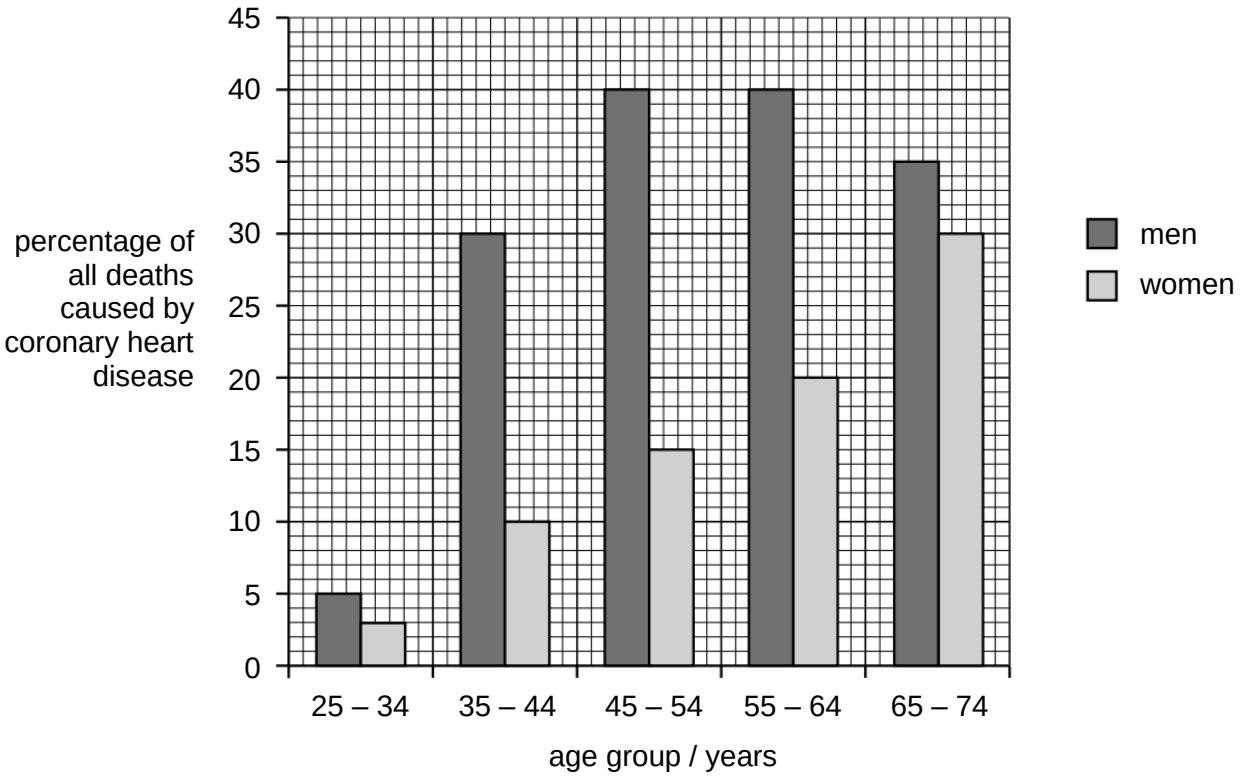


Fig. 8.1

(a) With reference to Fig. 8.1,

(i) state which age group has the lowest percentage deaths caused by coronary heart disease

……[1]

(ii) describe what happens to the risk of coronary heart disease as a man ages

……

……

……

……[2]

(iii) describe the difference in risk of coronary heart disease for a man and a woman between the ages of 55 and 64.

……

……

……

……[2]

(b) State two risk factors for coronary heart disease, other than age and gender.

1……

2……[2]

(c) Fig. 8.2 is an X-ray showing the coronary arteries of a man with coronary heart disease. The arrows indicate where there is narrowing of the blood vessels.

Fig. 8.2

(i) State the likely effect of narrowing of these blood vessels.

……[1]

(ii) Suggest two ways in which the condition shown in Fig. 8.2 may be treated.

1……

……

2……

……[2]

[Total: 10]

9 Measles is a highly contagious viral infection that affects the respiratory system and often results in a skin rash. The infection is more common among children and can be fatal. However, it can be contracted at any age.

As part of the Singapore National Childhood Immunisation Schedule (NCIS), all children should receive two doses from age 12 months onwards, at least 4 weeks apart. Immunisation against measles is compulsory by law. This vaccination is also required for enrolment into schools.

Fig. 9.1 shows the number of cases of measles in Singapore from 2019 to 2022.

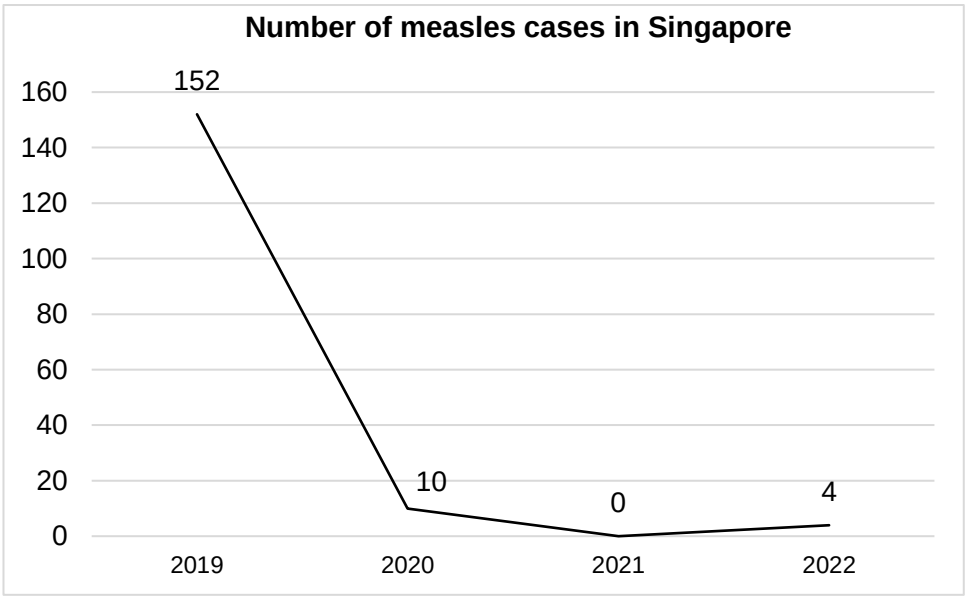


Fig. 9.1

(a) **(i)** Calculate the percentage change in measles cases from 2019 to 2020.

……% [1]

(ii) Suggest a reason for this change from 2019 to 2020.

……

..……[1]

(b) Compare and contrast measles and pneumococcal disease.

1……………………………………………………………………………………………

……………………………………………………………………………………...………....

2……………………………………………………………………………………………

……………………………………………………………………………………...………....

3...………………………………………………………………………………...………....

……………………………………………………………………………………..………...[3]

(c) **(i)** Some parents are reluctant for their children to get the measles vaccine because they may have certain misconceptions or doubts about the vaccines.

Table 9.1 shows some claims that are commonly made by these parents.

In Table 9.1, write a possible reason a healthcare professional could give to counter each of the claims made.

Table 9.1

claim	reason
"My child does not need the vaccine as measles has been eliminated from the population."	
"The vaccine contains the measles virus which is dangerous for my child."	
"My child will also be protected from common childhood diseases such as chicken pox from this vaccine."	

[3]

(ii) Suggest why a child who had received protection from an influenza vaccine may get reinfected by the same virus.

……

……

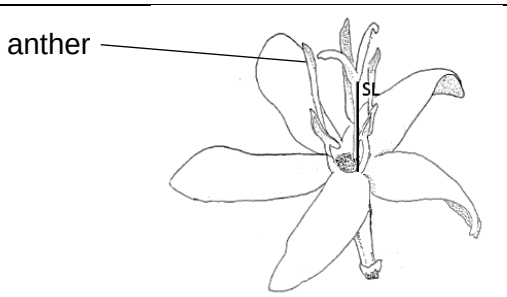
……

……[2]

[Total: 10]

End of Paper

Marking Scheme

Qn	Answer	Marks	Guidance
1(a)	**1** no significant difference in protein absorption → (mean) percentage absorbed not affected by amount of protein in diet ; **2** amount of protein in diet is not a limiting factor OR something else is limiting factor e.g. amount of protease ;	2	increase only / state only without explain – max 1m **A** max digestion / absorption
(b)	**1** protein/ food passes again through stomach/ ileum/ caecum ; **2** more/ remaining/ undigested (protein) broken down ; **3** (so more) amino acids absorbed ;	3	no mention of protein – max 2m
		[Total: 5]	
2(a)(i)	**1** transfer of pollen grains from anther to stigma of the same flower ; **2** or different flower of the same plant ;	2	
(a)(ii)	**1** mitosis ; **2** cell differentiation ;	2	
(b)(i)		1	
(b)(ii)	**any four from** **1** pollen tube secretes enzymes to digest the style tissues and moves towards the ovule; **2** pollen tube enters the ovule wall through the micropyle ; **3** pollen tube tip absorbs sap + burst + release male gamete into ovule ; **4** male nucleus/ gamete + fuses with female nucleus/ gamete/ egg cell/ ovum to form zygote / embryo develops ; **5** ovule becomes seed + ovary becomes fruit ;	4	
(c)	**any one from** **1** low conc. in flowers ensures that pollinators are unharmed ; **2** high conc. in other parts such as stem/roots ensures that the whole plant is not edible → able to survive ;	1	

	3 low conc. in fruit ensures fruit is tolerable for consumption for seed dispersal ;		
		[Total: 10]	
3(a)(i)	**D**: ureter ; **E**: sperm duct ;	2	
(a)(ii)	**1** F/urethra in penis transports semen containing sperm ; **2** ejaculates semen into vagina during intercourse/ copulation ; **3** sperm able to swim up vagina to uterus to fallopian tube to fuse (nucleus) with egg (nucleus) ; OR **1** F/erectile tissue)fills with blood during sexual arousal ; **2** causes penis to become hard/erect and ejaculates semen into vagina during intercourse/ copulation ; **3** sperm able to swim up vagina to uterus to fallopian tube to fuse (nucleus) with egg (nucleus) ;	3	
(b)(i)	**1** the man low sperm count/ low sperm mobility/ structural deformities in sperm/ blocked sperm duct/ damaged testes/ prostate cancer ; **2** the woman blocked oviduct (as a result of cyst/ tumour)/ no or few ovulation/ no implantation/ hormonal imbalances/ irregular menstrual cycle/ cyst in ovaries/ paralysed cilia ;	2	
(b)(ii)	**any one from** **1** fail to be implanted in the uterine lining ; **2** not viable due to chromosomal/ structural defects ; **3** insufficient nutrients obtained by embryo due to competition ; **4** failure to form placenta at site of implantation ;	1	
(b)(iii)	**1** yes, <u>sperm</u> carries two different sex chromosome, <u>X or Y</u> ; **2** two different sperm (one with X and the other with Y) could fertilise <u>two different ova</u> ;	2	
(b)(iv)	**1** mother's higher blood pressure would kill foetus ;	3	

<table>
<tr><td></td><td>2 mother and foetus may have incompatible blood groups ;
3 mixing of blood would cause maternal antibodies to agglutinate foetal RBCs, thus killing it ;
4 prevents potential harmful substance/pathogens from directly entering bloodstream ;</td><td></td><td></td></tr>
<tr><td></td><td></td><td>[Total: 13]</td><td></td></tr>
<tr><td>4(a)</td><td>1 less oxygen transported in haemoglobin of sickled cells/ less oxyhaemoglobin present in RBCs ;
2 less oxygen supplied to respiring cells → less energy released during aerobic respiration ;</td><td>2</td><td></td></tr>
<tr><td>4(b)</td><td>allelic notation:
I^B – allele for B antigen
I^A – allele for A antigen
I^O – allele for no antigen

<table><tr><td>gametes</td><td>I^B</td><td>I^O</td></tr><tr><td>I^A</td><td>I^AI^B
AB group</td><td>I^AI^O
A group</td></tr><tr><td>I^B</td><td>I^BI^B
B group</td><td>I^BI^O
B group</td></tr></table>
P(B group) = 0.5
P (son) = 0.5
therefore:
P(B and son) = 0.5 × 0.5
= 0.25 ;</td><td>1

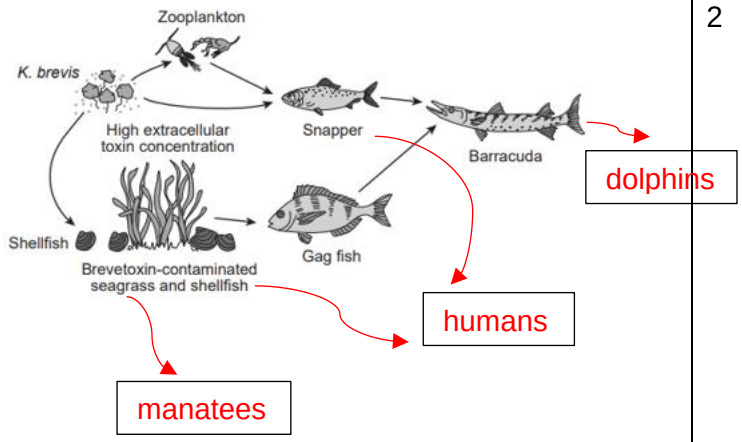
2

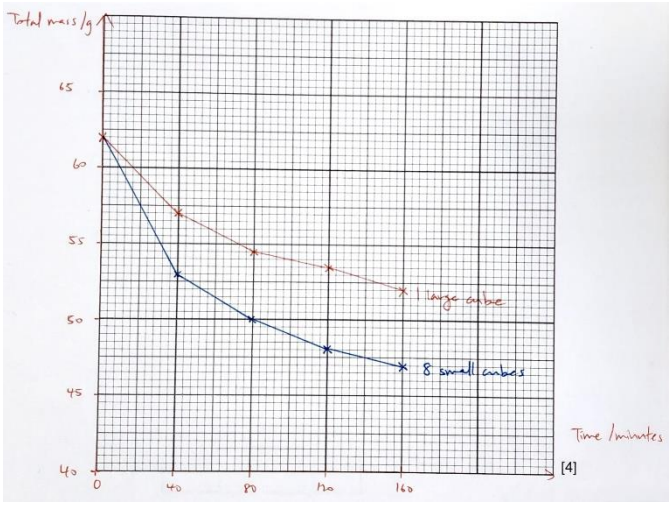
1</td><td>1m for correct parent genotypes and gametes

1m for correct offspring genotypes

1m for correct offspring phenotypes

1m for correct probability</td></tr>
<tr><td>(c)(i)</td><td>a gene that is located in a non-sex chromosome ;</td><td>1</td><td></td></tr>
<tr><td>(c)(ii)</td><td>child inherits a recessive allele from each parent, and expresses the condition ;</td><td>1</td><td></td></tr>
<tr><td>(c)(iii)</td><td>1 damaged tissue and platelets release thrombokinase ;
2 thrombokinase converts inactive thrombin to active thrombin;</td><td>3</td><td></td></tr>
</table>

	3 thrombin converts soluble fibrinogen to insoluble fibrin threads which entangle blood cells to form a mass ;		
		[Total: 11]	
5(a)		2	3 correct 2m 2 correct 1m 0/1 correct 0m **R** locals
5(b)(i)	**any one from** **1** warm temperature ; **2** increased fertilisers ; **3** heavy rainfall ;	1	**R** sewage
(b)(ii)	**any one from** *warm temperature* **1** encourages higher enzymatic activities of the algae ; increased metabolism/ processes that encourages growth ; **2** increased nutrient uptake/ diffusion ; increased substrates for metabolism/processes that encourages growth ; *increased fertilisers* **3** increased nitrates and phosphates enhances synthesis of proteins and nucleic acids ; increased growth/ production of new cells/ protoplasm ; *heavy rainfall* **4** encourages nutrient run-off ; increased nitrates and phosphates enhances synthesis of proteins and nucleic acids ;	2	
(c)(i)	**any two from** **1** fish took in the extracellular toxins from the sea directly ; **2** fish consumed seagrass/ zooplankton that have accumulated the toxins ; **3** toxins transferred from one trophic level to the next through feeding ;	2	

(c)(ii)	**1** toxins are insoluble/ non-biodegradable/ cannot be excreted/ stored in fatty tissues/ organs ; **2** eating flesh only reduces risk of bioamplification ;	2	
(c)(iii)	**any one from** **1** *lack of natural control* since K. brevis does not kill shellfish, there is no natural mechanism to reduce the number of contaminated shellfish ; high toxin levels persist, posing a continuous risk during red tide events ; **2** *continual intake of toxins by the shellfish* continuous feeding and toxin accumulation mean that shellfish can become highly contaminated during a red tide ; when people consume these shellfish, they ingest high levels of brevetoxin, increasing the risk of neurotoxic shellfish poisoning ; **3** *unnoticed contamination* shellfish appear healthy and normal even though they are highly contaminated with brevetoxin ; difficult to detect the risk before the shellfish are consumed, leading to potential human health hazards ;	2	
		[Total: 11]	
6(a)(i)	***axes:*** labelled with units ; ***scale:*** evenly scaled and plots occupying half of the grid in one direction ; ***plots:*** all correct ± half a small square ; ***line:*** two point-to-point graphs clearly labelled ;  [4]	4	**A** data plotted for change in mass rather than total mass (values need to be -ve since mass decreased)
(a)(ii)	1 large cube: (-) 8.0 g ; 8 small cubes: (-) 13.0 g ;	2	E.C.F. from graph in 6(a)(i)

(b)	**1** potato cell sap/ cytoplasm has higher water potential than sucrose solution ; **2** water moved out via osmosis + decrease in mass ; **3** 4g more water moved out in 8 small cubes due to higher SA:V ;	3	accept ORA
		[Total: 9]	
7(a)	**1** trachea **2** bronchus/ bronchi **3** bronchiole/ bronchioles **4** alveolus / alveoli	2	all correct 2m **R** windpipe **R** spelling error 1m: 1 structure incorrect/ missing, but others in correct order 1m: trachea and alveolus correct but bronchus and bronchiole wrong way round
(b)	**1** infectious disease is caused by pathogen which is transmissible → P is caused by pneumococcus bacteria ; **2** CB is caused by damage to/ irritation of lung tissue → not transmissible/ passed from one organism to another ;	2	**A** microorganism/ bacterium **R** virus allow detail of transmission e.g. droplet infection max 1 if no ref. to P and CB, or if correct definitions given and ref. to P/CB incorrect
(c)(i)	**any one from** **1** epithelium/wall is thin/ one-cell thick ; short diffusion distance/ only diffuse through two cells ; **2** surrounded by many/ network of capillaries ; maintain diffusion/ concentration/ gradient(s) ;	2	**R** alveoli are one-cell thick **R** an alveolus has a large surface area

(c)(ii)	**1** recognise foreign antigens (on pathogen) ; **2** engulf and digest (using enzymes) via phagocytosis → destroy pathogen ;	2	allow microorganism/ named pathogen
(d)	**1** less surface area for gas exchange/ diffusion ; **2** difficulty in breathing/ restriction in air flow/ shortness of breath wheezing/ rapid breathing ; **3** less oxygen reaches tissues → lethargy/ fatigue/ constraints on mobility or activity ;	3	
		[Total: 11]	
8(a)(i)	25 – 34 ;	1	
(a)(ii)	**any two from** **1** increases (with age) ; **2** plateaus between 45 – 64 ; **3** then falls (at/ after 65) ;	2	
(a)(iii)	**1** higher risk for men ; **2** men twice as high as women/ 40% for men and 20% for women/ difference is 20% ;	2	
(b)	**any two from** **1** diet high in fat / cholesterol ; **2** stress ; **3** smoking/ tobacco ; **4** genetic predisposition ; **5** obesity / sedentary lifestyle ;	2	**R** lifestyle / diet / unhealthy diet
(c)(i)	**any one from** **1** insufficient glucose/ oxygen (to cardiac/ heart muscle) ; **2** heart attack/ myocardial infarction/ cardiac arrest ; **3** description of anaerobic conditions in muscle ;	1	**R** reduced blood flow with no further elaboration **A** high blood pressure
(c)(ii)	**any two from** **1** coronary (artery) by-pass (graft) operation ; **2** angioplasty/ insertion of a (coronary) stent ; **3** heart transplant ;	2	**A** described
		[Total: 10]	
9(a)(i)	[(10-152)/152] × 100% = - 93.4 %	1	
(a)(ii)	decline was likely due to social distancing measures during COVID-19 pandemic ;	1	
(b)	*similarity* **1** affect respiratory system ; **2** transmitted through (respiratory) droplets ; **3** transmission can be reduced using vaccines ;	3	both similarities & differences required:

<table>
<tr><td></td><td>difference
1 measles caused by virus + pneumococcal disease caused by (pneumococcus) bacteria ;
2 measles cannot be treated using antibiotics + pneumococcal disease can ;</td><td></td><td>1S + 2D
OR
2S + 1D</td></tr>
<tr><td>(c)(i)</td><td>
<table>
<tr><th>claim</th><th>response</th></tr>
<tr><td>“My child does not need the vaccine as measles has been eliminated from the population.”</td><td><u>resurgence is possible</u> – increase from 0 cases in 2021 to 4 cases in 2022 ;

OR some cases may be <u>undetected/ unreported</u> due to common symptoms ;

OR can still be brought in through <u>international travel</u> ;</td></tr>
<tr><td>“The vaccine contains the measles virus which is dangerous for my child.”</td><td>vaccine contains part of the virus/ <u>weakened form</u> of the virus to trigger an immune response to cause a <u>harmless mild infection</u> ;</td></tr>
<tr><td>“My child will also be protected from common childhood diseases such as chicken pox from this vaccine.”</td><td>measles vaccine will only give immunity against measles virus as it is <u>specific in its action</u> → child will need to take a chicken pox vaccine to protect against chicken pox ;</td></tr>
</table>
</td><td>3</td><td>1m per row</td></tr>
<tr><td>(c)(ii)</td><td>1 virus is able to mutate quickly into a different strain ;
2 unrecognisable by immune system
→ incomplete immune response ;</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td>[Total: 10]</td><td></td></tr>
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