



2016

HIGHER SCHOOL CERTIFICATE
TRIAL EXAMINATION

BIOLOGY

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- *Write your name and class at the top of the Part A Answer Sheet, the Part B Written Answer Booklet and the Section II Answer Booklet*

Total marks - 100

Section I

77 marks

This section has two parts, Part A and Part B

Part A – 20 marks

- Attempt Questions 1- 20
- Allow about 35 minutes for this part

Part B – 57 marks

- Attempt Questions 21 - 39
- Allow about 1 hour and 40 minutes for this part

Section II

23 marks

- Attempt all parts of this question (Question 40)
- Allow about 45 minutes for this section

Part A – 20 marks

Attempt Questions 1 – 20

Allow about 35 minutes for this part

Use the multiple choice answer sheet- Part A Answer Sheet.

Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

Sample $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

correct
A B C D

1. The relative levels of two dissolved substances found in arterial and venule blood samples for an organ are given in the table.

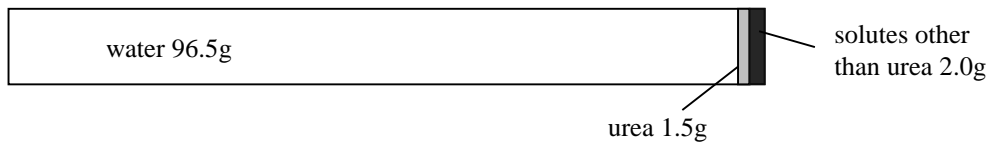
What organ would these blood sample results come from?

	Artery	Vein
Bicarbonate ions	<i>normal</i>	<i>high</i>
Glucose	<i>normal</i>	<i>high</i>

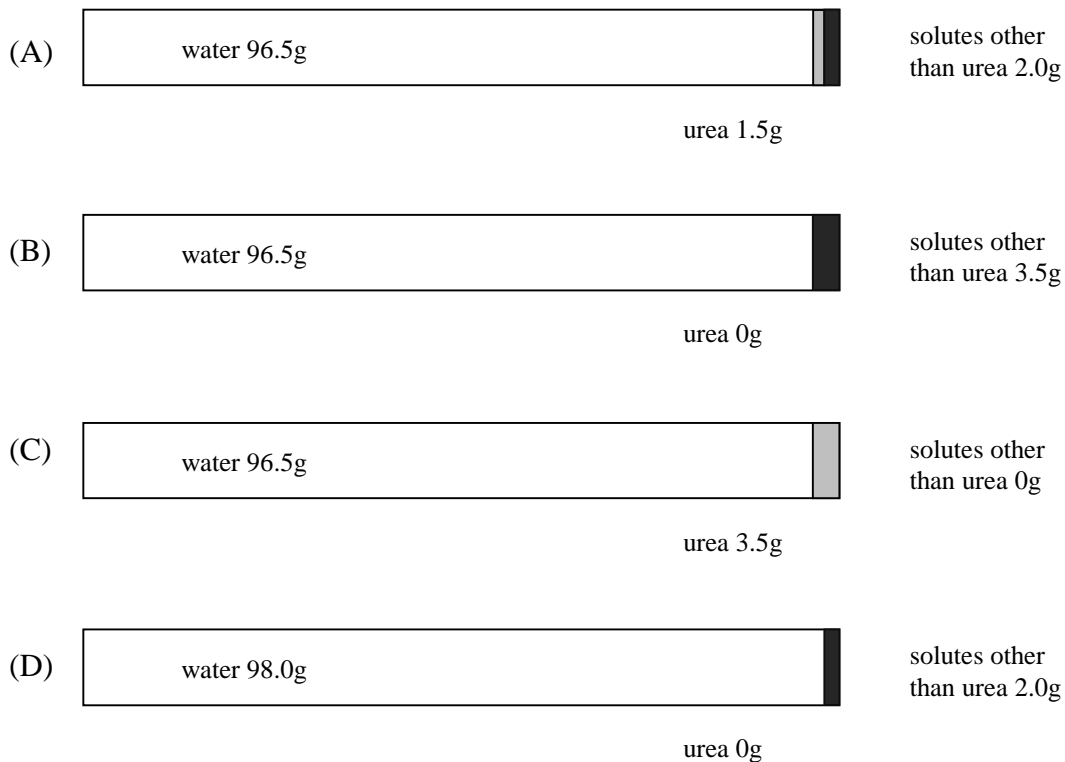
- (A) Brain
(B) Heart
(C) Lungs
(D) Small intestine
2. Which of the following defence adaptations relies upon the release of histamine to stimulate blood flow to the area and encourage the flow of fluid from capillaries into tissues?
- (A) Cell death to seal off pathogen
(B) Inflammation response
(C) Lymph system
(D) Phagocytosis

3. Sharks are osmoconformers. They maintain an internal concentration of body fluids which is similar to their external environment, thus minimising loss or gain of water by osmosis. Sharks do this by controlling the reabsorption of chemicals such as urea from the nephron into the blood and then body tissues.

The divided bar graph below shows the approximate amounts by mass of water, urea and other solutes in the body tissues of a bull shark swimming in the open sea.



Which graph below represents the masses of these substances in the body tissues of a bull shark which has moved up a freshwater river?



4. What are the responses of an ectotherm and an endotherm when the ambient temperature decreases significantly leading to cold conditions?

	endotherm	ectotherm
(A)	changing skin colour to a darker shade	shivering
(B)	basking in the sun	changing skin colour to a lighter shade
(C)	shivering	vasodilation
(D)	vasoconstriction	basking in the sun

5. What is the structure or function of arteries, veins and capillaries?

	Artery	Vein	Capillary
(A)	Always carries oxygenated blood	Always carries deoxygenated blood	Always carries waste products
(B)	Carries blood under high pressure	Carries blood under variable pressure	Thin walls with valves
(C)	Takes blood to the heart	Thick muscular walls	Takes blood to and from the heart
(D)	Thick muscular walls	Thin walls with valves	Walls one cell thick

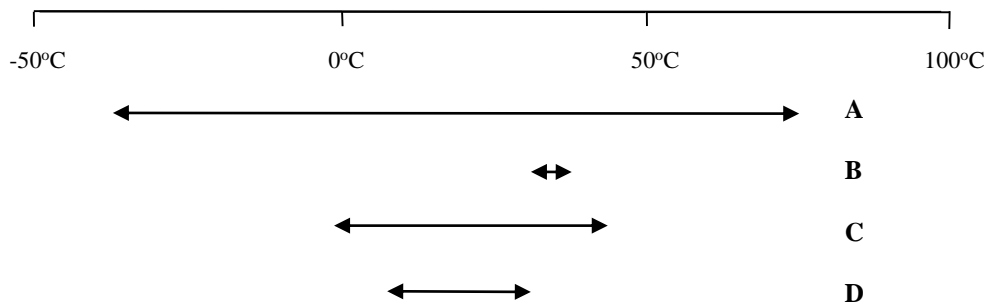
6. Which option matches the products of donated blood and their uses?

	Plasma	Red blood cells	Platelets
(A)	To increase the clotting ability of the blood.	To increase the immune response against pathogens.	To restore blood volume after injury.
(B)	To boost oxygen carrying capacity of the blood.	To restore blood volume after injury.	To increase the clotting ability of the blood.
(C)	To restore blood volume after injury.	To boost oxygen carrying capacity of the blood.	To increase the clotting ability of the blood.
(D)	To increase the immune response against pathogens.	To increase the clotting ability of the blood.	To restore blood volume after injury.

7. Why is the removal of carbon dioxide essential for continued metabolic activity?

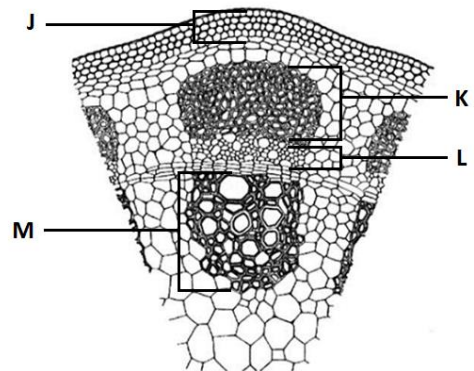
- (A) If carbon dioxide is allowed to accumulate in the body, it can bind to haemoglobin and prevent oxygen from doing so, starving the cells of oxygen.
- (B) The build-up of carbon dioxide in the body can cause carbon dioxide to move against a concentration gradient and start to move back into cells.
- (C) The accumulation of carbon dioxide can lower the pH of the cytoplasm causing a decrease in the acidity of the cell.
- (D) The accumulation of carbon dioxide can lower the pH of the cytoplasm, increasing the acidity of the cell.

8. The diagram below shows the ambient temperature ranges that various species on Earth can exist in.



What ambient temperature range can humans survive in?

- (A) A
 - (B) B
 - (C) C
 - (D) D
9. A cross section through a flowering plant stem is shown in the diagram.



In which cells does translocation occur?

- (A) J
 - (B) K
 - (C) L
 - (D) M
10. After contact with the mumps virus, a child developed mumps but recovered. Twelve months later the child came in contact with the mumps virus again but did not show any symptoms of the disease.

Why did the child not get mumps after the second exposure?

- (A) Shortly after the first infection, the child developed T cells that consumed the new mumps pathogen.
- (B) Shortly after the first infection, the child developed memory B cells that could respond to any virus.
- (C) Shortly after the first infection, the child developed memory T cells specific to mumps.
- (D) Shortly after the first infection, the child developed memory B cells and T cells that could respond to any virus.

11. Two grey flies were mated and this resulted in 156 grey and 48 black offspring flies. What is the black phenotype likely to be?
- (A) Autosomal recessive
 - (B) Autosomal dominant
 - (C) Sex linked dominant
 - (D) Co-dominant

12. Cytochrome C is a protein involved in the process of cellular respiration in eucaryotic cells. The cytochrome C found in chickens and turkeys is the same. However, the cytochrome C in ducks differs by two different amino acids compared to that found in chickens.

Which one of the following is a correct interpretation of these findings?

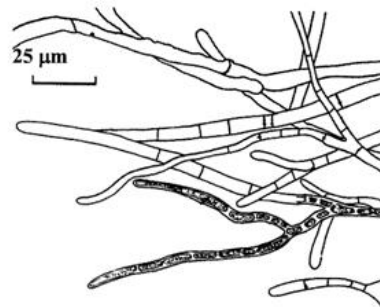
- (A) Chickens and turkeys belong to the same species.
 - (B) Chickens and turkeys evolved at different rates compared to ducks.
 - (C) Chickens and turkeys have a more recent common ancestor than chickens and ducks.
 - (D) Chickens and turkeys evolved at the same time while ducks evolved later.
13. Therapsid fossils have been observed to have features that resemble small mammals yet had scales and leg-like structures similar to reptiles. They also have a jawbone similar to the jawbones found in reptiles and birds. What is the evolutionary significance of these findings?
- (A) Therapsids were homologous forms of reptiles, birds and mammals.
 - (B) Therapsids represent a transitional form between birds and mammals.
 - (C) Therapsids represent a transitional form between reptiles and mammals.
 - (D) Therapsids were the ancestors of reptiles and mammals.
14. The coding strand for part of a gene is shown below.

CCG TTT ACA GCA ATC

What would be the complimentary DNA strand and the messenger RNA that results from transcription of the coding strand?

	Complementary DNA strand	Messenger RNA strand
(A)	GGC AAA TGT GCT TAG	CCG TTT ACA CGA ATC
(B)	CCG TTT ACA CGA ATC	CCG UUU ACA CGA AUC
(C)	GGC AAA TGT CGT TAG	GGC AAA UGU CGU UAG
(D)	CCG TTT ACA CGA ATC	GGC AAA UGU CGU UAG

15. Researchers were investigating the effect of periodic doses of intense radiation on the formation of point mutations in bacterial genes. These mutations would result in a non-functional bacterial enzyme. Which scientists used a method that would enable this investigation to prove that radiation is mutagenic?
- (A) Darwin and Wallace
(B) Boveri and Sutton
(C) Beadle and Tatum
(D) Watson and Crick
16. Which combination of genetic processes would result in the formation of gametes with the greatest possible variation?
- (A) Replication of chromosomes, spindle formation, formation of homologous pairs of chromosomes
(B) Independent assortment of homologous chromosomes, random fusion of gametes, mutations
(C) Crossing over, mutations, independent assortment of homologous chromosomes
(D) Crossing over, mutations, replication of chromosomes
17. The diagram shows part of a pathogen that causes disease in a potato plant.



What type of pathogen is represented?

- (A) Bacteria
(B) Fungus
(C) Prion
(D) Protozoan

18. Which option correctly represents a preventative measure and cause of malaria?

	Cause	Prevention
(A)	Mosquitoes are vectors of a protozoan that has life cycle stages in the mosquito and humans	Ensure drainage of water near homes and killing adult mosquitoes
(B)	The bad air in swamps contains the malarial parasite	Build homes away from the edges of waterways
(C)	Mosquitoes are vectors of a bacterium that has life cycle stages in the mosquito and humans	Use antibiotics and avoid blood transfusion
(D)	The malarial parasite is transmitted from mosquito into human by contaminated water	Do not use water contaminated with mosquito larvae

19. What is the role of helper T cells in clonal selection theory?

- (A) They activate B cells only.
- (B) They activate T cells only.
- (C) They activate both B and T cells.
- (D) They are an antigen presenting cell.

20. In his experiment, Louis Pasteur used specially designed flasks and broth. What steps would he need to do in order to make his experiment valid?

- (A) Pour equal amounts of broth into two different types of flasks. Boil both flasks for the same time.
- (B) Pour equal amounts of broth into two identical flasks. Boil both flasks for the same time.
- (C) Pour different amounts of broth into two identical flasks. Observe both flasks for mould growth.
- (D) Pour different amounts of broth into two different types of flasks. Observe both flasks for mould growth.

Girraween High School



Student Name	
Class (circle)	Teacher: Nguyen, Singh, Iverach
Mark /	

2016

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BIOLOGY

PART A ANSWER SHEET

Write your Name and Class at the top of this Part A Answer Sheet

1. A ○ B ○ C ○ D ○
2. A ○ B ○ C ○ D ○
3. A ○ B ○ C ○ D ○
4. A ○ B ○ C ○ D ○
5. A ○ B ○ C ○ D ○
6. A ○ B ○ C ○ D ○
7. A ○ B ○ C ○ D ○
8. A ○ B ○ C ○ D ○
9. A ○ B ○ C ○ D ○
10. A ○ B ○ C ○ D ○
11. A ○ B ○ C ○ D ○
12. A ○ B ○ C ○ D ○
13. A ○ B ○ C ○ D ○
14. A ○ B ○ C ○ D ○
15. A ○ B ○ C ○ D ○
16. A ○ B ○ C ○ D ○
17. A ○ B ○ C ○ D ○
18. A ○ B ○ C ○ D ○
19. A ○ B ○ C ○ D ○
20. A ○ B ○ C ○ D ○

Student Name	
Class (circle)	Teacher: Nguyen, Singh, Iverach
Mark /	

Write your Name and Class at the top of this Part B Answer Booklet.

Section I (continued)

Part B – 57 marks

Attempt Questions 21 - 39

Allow about 1 hour and 40 minutes for this part

Answer the questions in the spaces provided

Question 21 (3 marks)

A group of university students went camping attended a conference and some became ill. These people also were bitten by ticks. They were suspected of suffering from a disease called Rocky Mountain spotted fever which is caused by a bacterium for which the tick is a vector. Explain how the cause of the disease can be verified.

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Question 23 (2 marks)

Justify the role of gene expression in the maintenance and repair of body tissues.

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Question 24 (1 mark)

Outline how an identified personal hygiene practice assists in the control of disease.

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Question 25 (2 marks)

The table below shows seven turtle species, the types of habitat each occupies and the nitrogenous wastes produced.

Turtle species	Habitat	Urine component		
		Uric acid (g/L)	Ammonia (g/L)	Urea (g/L)
<i>Kinosternon subrubrum</i>	Almost wholly aquatic	0.7	24.0	22.9
<i>Pelusios derbianus</i>	Almost wholly aquatic	4.5	18.5	24.4
<i>Emys orbicularis</i>	Semi-aquatic; feeds on land in marshes	2.5	14.4	47.1
<i>Kinixys erosa</i>	Damp places; frequently enters water	4.2	6.1	61.0
<i>Testudo denticulata</i>	Damp, swampy ground	6.7	6.0	29.1
<i>Testudo graeca</i>	Very dry, almost desert conditions	51.9	4.1	22.3
<i>Testudo elegans</i>	Very dry, almost desert conditions	56.1	6.2	8.5

Explain the relationship between the type of nitrogenous waste produced and the habitat of the turtle species.

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Question 26 (4 marks)

There are many homeostatic mechanisms operating within the body. One of these controls blood glucose levels. The normal blood glucose level is 90 mg of glucose/100 mL of blood. Receptors in the pancreas detect deviations from this level and stimulate the release of two hormones.

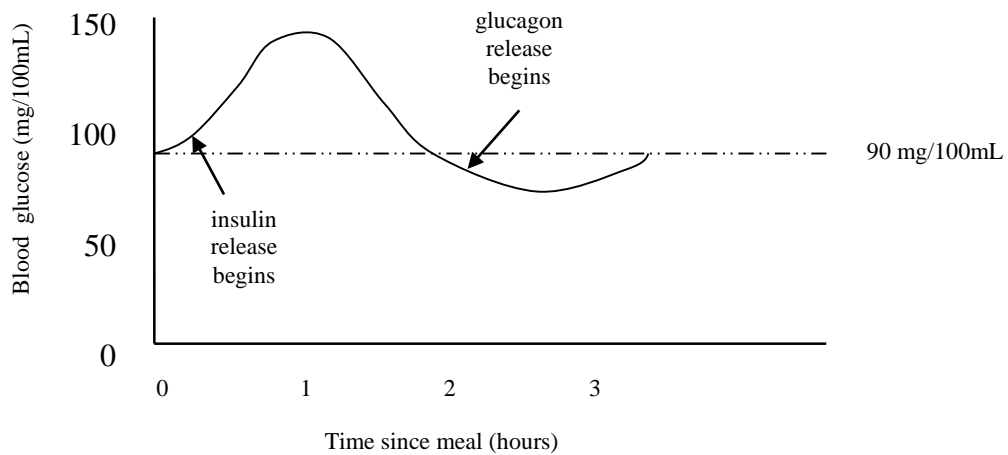
Insulin is secreted by β cells in the pancreas. It moves glucose out of the blood and into the tissues, where it can be used in respiration or stored as glycogen.

Insulin lowers blood glucose levels.

Glucagon is secreted by α cells in the pancreas. It stimulates the breakdown of glycogen in the liver to make glucose, and the release of this glucose into the blood.

Glucagon raises blood glucose levels.

The graph below shows how blood glucose levels can vary after eating a meal.



(a) Define homeostasis. (1 mark)

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(b) Identify the specific stimulus for the release of glucagon. (1 mark)

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Question 26 *Continued*

- (c) Use the information provided above to explain how the control of blood levels is an example of negative feedback. (2 marks)

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Question 27 (2 marks)

Outline the role of the nervous system in maintaining homeostasis in a mammal.

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Question 28 (3 marks)

Type I diabetes is an example of an autoimmune disease. In this type of disease the immune system attacks some of the islet cells of the pancreas, preventing insulin production.

- (a) Why is an autoimmune disease considered a malfunction of the body? (1 mark)

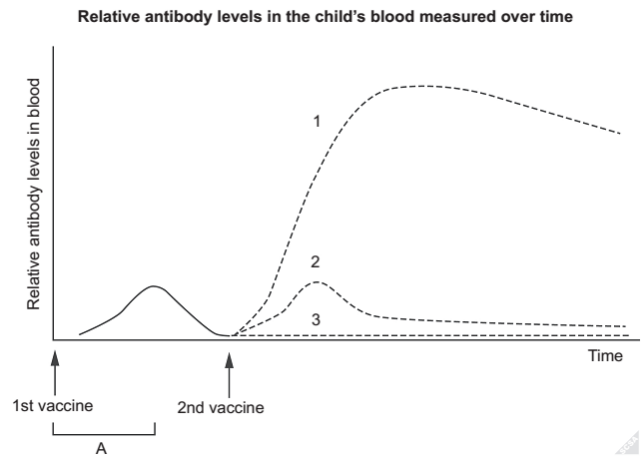
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- (b) Describe the immune response that occurs during Type I diabetes, identifying the specific type of cells involved. (2 marks)

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Question 29 (2 marks)

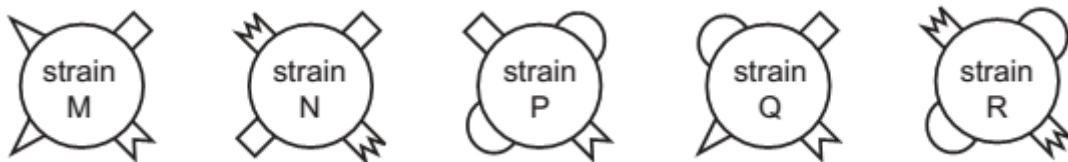
A young child was given a vaccine containing antigens for a viral disease. Several months later, the child was given the vaccine a second time, in what is known as a booster injection. The antibody levels in the child's blood were measured over this period and are shown in the graph.



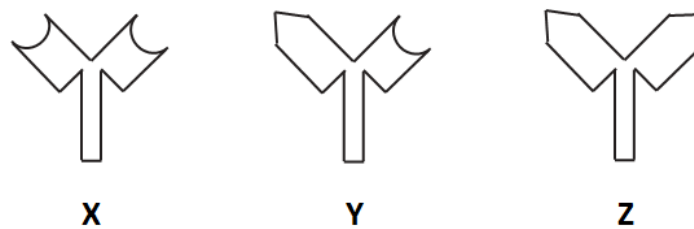
(a) Identify the cells responsible for the period labelled A on the graph. (1 mark)

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The diagram below shows the different forms of antigens and their relative distribution on the surface of different strains of weakened viruses contained in the vaccine.



The possible types of antibody that would be effective against the viral pathogen are shown below.

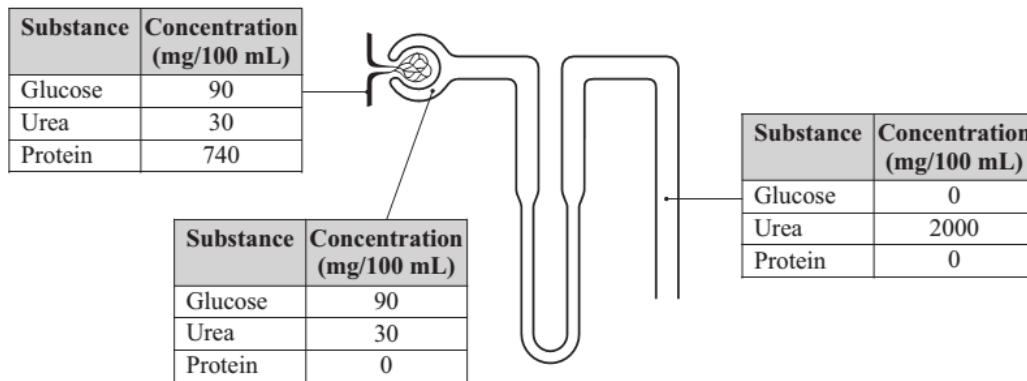


(b) Identify the antibody type that would be most effective against the strain P virus. (1 mark)

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Question 30 (5 marks)

- (a) The diagram shows a simplified representation of the human nephron. Concentrations of three substances in various regions of the nephron are shown in the tables.



Identify and explain the processes that change the concentrations of each of these substances. Use the terms renal artery, glomerulus, Bowman’s capsule, proximal convoluted tubule and collection tubule in your explanation. (3 marks)

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- (b) Explain why the processes of diffusion and osmosis are inadequate in removing dissolved nitrogenous wastes in some organisms. (2 marks)

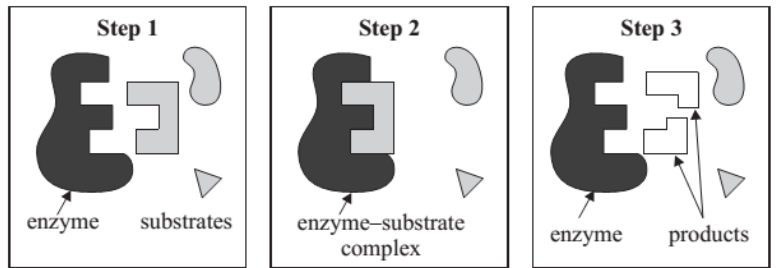
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Question 31 (7 marks)

The diagram represents a chemical reaction catalysed by an enzyme.



(a) Describe how this model explains the theory of enzyme specificity. (1 mark)

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(b) Describe the chemical composition of enzymes and their role in metabolism. (2 marks)

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(c) Amylase, an enzyme found in saliva, promotes the breakdown of starch into maltose. If saliva is mixed with starch, eventually all the starch will be broken down regardless of the amount of saliva added. Explain why this occurs. (2 marks)

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Question 31 *Continued*

- (d) Explain why the maintenance of a constant internal environment is important for optimal metabolic efficiency. (2 marks)

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Question 32 (2 marks)

Identify one similarity and one difference between Darwin's and Wallace's theory of evolution and punctuated equilibrium.

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Question 33 (3 marks)

Describe a method that could be used to clone an organism.

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Question 34 (3 marks)

(a) Using an example, define the term *mutagen*. (1 mark)

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(b) Discuss one example of evidence which supports the mutagenic nature of radiation. (2 marks)

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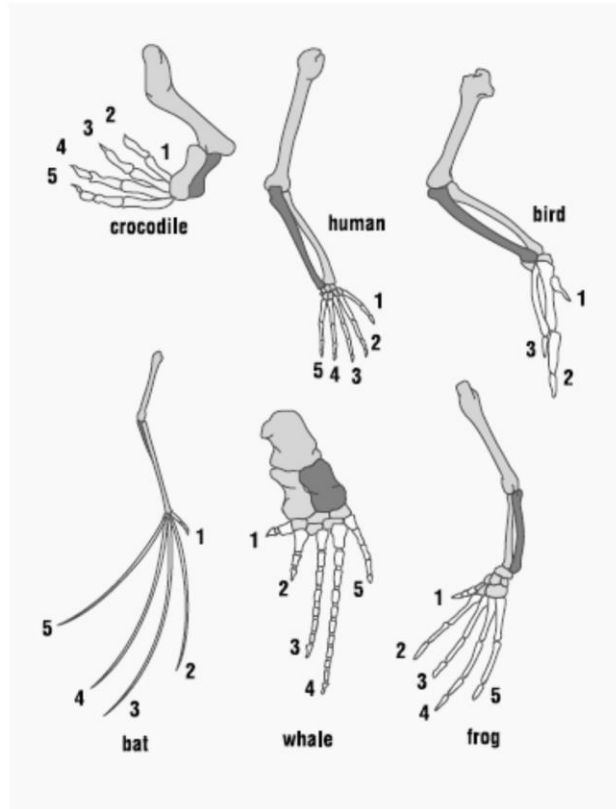
Question 35 (2 marks)

Outline one ethical issue arising from the development and use of a named transgenic organism you have studied.

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Question 36 (3 marks)

The diagram shows the structure of forelimbs of various vertebrates.



- (a) Identify the type of evolution that led to the development of changes in the anatomy of the forelimbs of these organisms. (1 mark)

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- (b) Justify the differences between bird and whale forelimbs. (2 marks)

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Question 37 (5 marks)

(a) Outline the cause and symptoms of one named infectious disease. (3 marks)

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(b) Some of the diseases caused by viruses show similar symptoms to those caused by some bacteria. A wrong diagnosis can lead to the unnecessary prescription of antibiotics. Explain why the inappropriate use of antibiotics is a problem. (2 marks)

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Question 38 (2 marks)

Outline the main steps used to produce a transgenic species.

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Question 39 (3 marks)

The following information was provided to a genetic counsellor about the inheritance of a trait in a family.

A man who does not have the trait marries a female who has the trait. Of their children, both sons have the trait and the daughter does not. The daughter marries a man without the trait and they have three children. One of their sons has the trait while his brother does not. Their sister does not have the trait.

The genetic counsellor has some other information about the trait and suspects the trait is sex-linked.

(a) Construct a pedigree for this family based on the above information. (2 marks)

(b) Determine the type of sex-linked inheritance exhibited by this trait. Show your working using Punnett squares. (1 mark)

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End of Section I

Section II

23 marks

Attempt ALL parts of Question 40 Biotechnology - Parts (a) – (f)

Allow about 45 minutes for this part

Answer the question parts in the Section II answer booklet. Write your Name and Class at the top of the Section II Answer Booklet.

Extra writing booklets are available.

Question 40 Biotechnology

- (a) Biotechnology practices have had a large impact on the evolution of animals and plants for use in agriculture. Present evidence for this judgement with respect to the impact of biotechnology practices upon the evolution of one group of animals and one group of plants that are used for agricultural stock. (4 marks)

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- (b) Explain the biotechnology practices required for the creation of alcoholic beverages and yoghurt. (4 marks)

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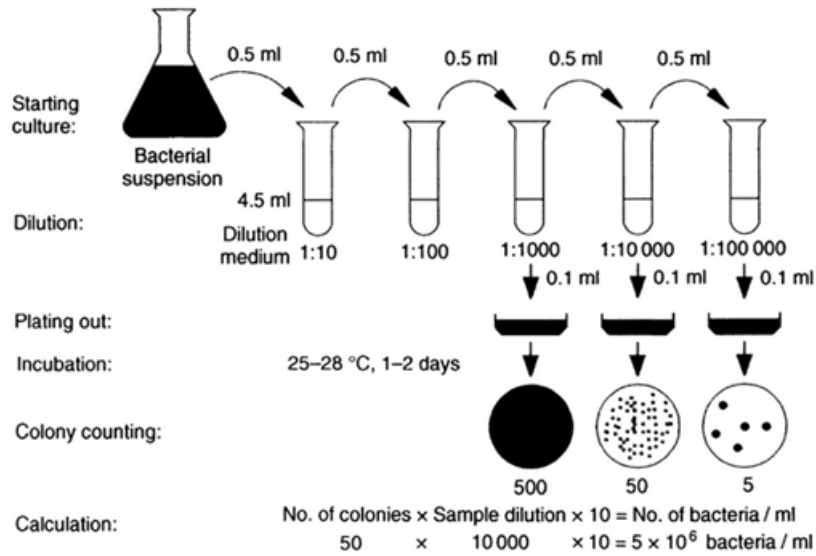
(c) Describe how traditional fermentation has been modified to form glycerol and citric acid. (4 marks)

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- (d) Construct a flow chart to outline the steps in the formation of a functional enzyme.
(3 marks)

(e) A process used in biotechnology since the 1950s is represented in Figure 1.

Figure 1. A process used in biotechnology



(i) Compare this process with another strain isolation method. (1 mark)

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(ii) Justify the use of strain isolation methods in biotransformation technologies. (2 marks)

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correct
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1. The relative levels of two dissolved substances found in arterial and venule blood samples for an organ are given in the table below.

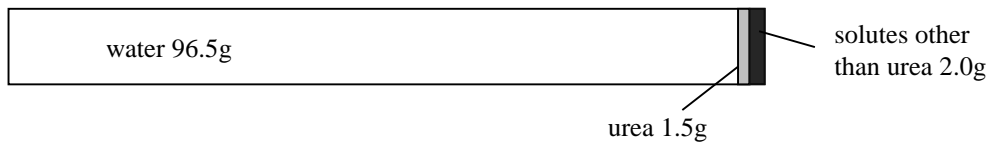
What organ would these blood sample results come from?

	Artery	Vein
Bicarbonate ions	<i>normal</i>	<i>high</i>
Glucose	<i>normal</i>	<i>high</i>

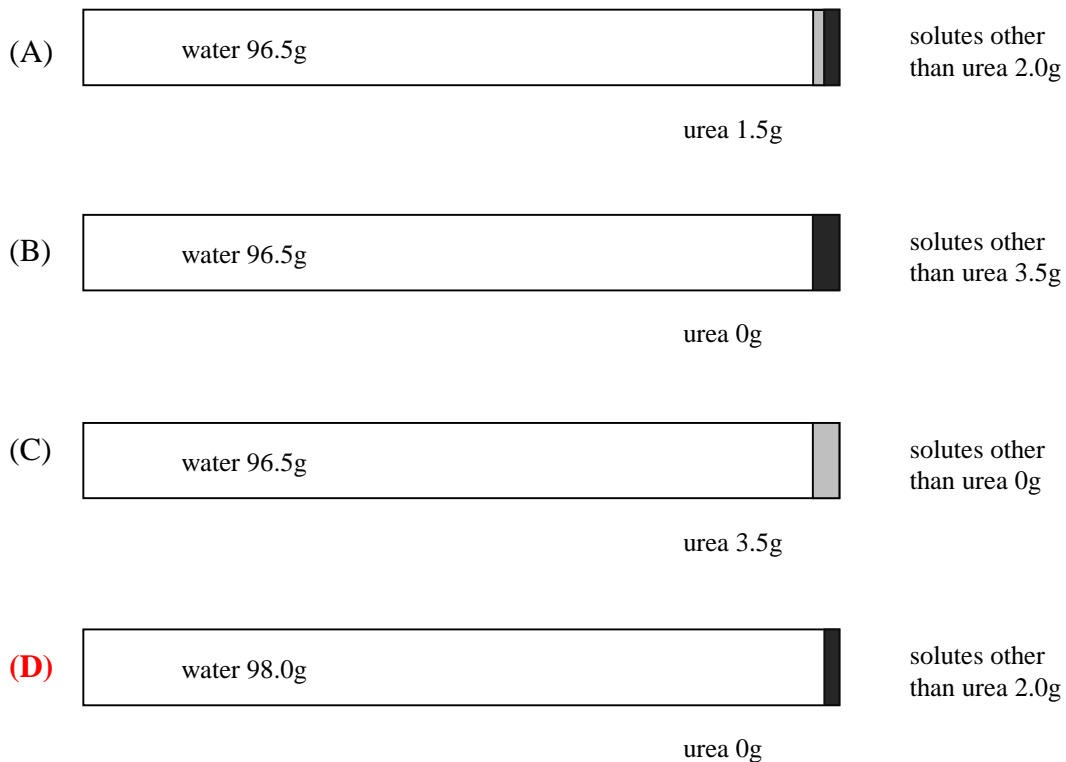
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(B) Heart
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(B) Inflammation response
(C) Lymph system
(D) Phagocytosis

3. Sharks are osmoconformers. They maintain an internal concentration of body fluids which is similar to their external environment, thus minimising loss or gain of water by osmosis. Sharks do this by controlling the reabsorption of chemicals such as urea from the nephron into the blood and then body tissues.

The divided bar graph below shows the approximate amounts by mass of water, urea and other solutes in the body tissues of a bull shark swimming in the open sea.



Which graph below represents the masses of these substances in the body tissues of a bull shark which has moved up a freshwater river?



4. What are the responses of an ectotherm and an endotherm when the ambient temperature decreases significantly leading to cold conditions??

	endotherm	ectotherm
(A)	changing skin colour to a darker shade	shivering
(B)	basking in the sun	changing skin colour to a lighter shade
(C)	shivering	vasodilation
(D)	vasoconstriction	basking in the sun

5. What is the structure or function of arteries, veins and capillaries?

	Artery	Vein	Capillary
(A)	Always carries oxygenated blood	Always carries deoxygenated blood	Always carries waste products
(B)	Carries blood under high pressure	Carries blood under variable pressure	Thin walls with valves
(C)	Takes blood to the heart	Thick muscular walls	Takes blood to and from the heart
(D)	Thick muscular walls	Thin walls with valves	Walls one cell thick

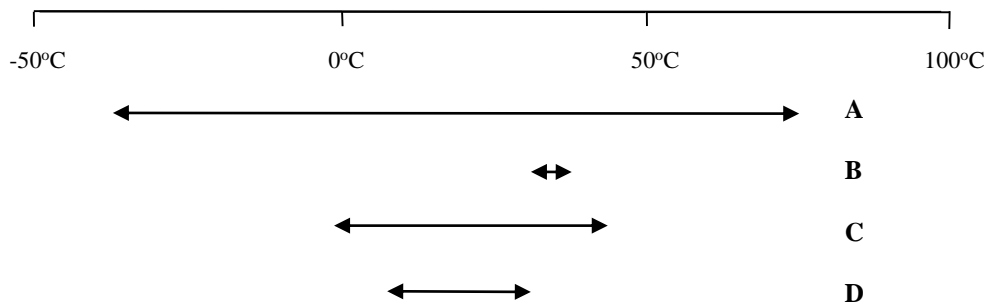
6. Which option matches the products of donated blood and their uses?

	Plasma	Red blood cells	Platelets
(A)	To increase the clotting ability of the blood.	To increase the immune response against pathogens.	To restore blood volume after injury.
(B)	To boost oxygen carrying capacity of the blood.	To restore blood volume after injury.	To increase the clotting ability of the blood.
(C)	To restore blood volume after injury.	To boost oxygen carrying capacity of the blood.	To increase the clotting ability of the blood.
(D)	To increase the immune response against pathogens.	To increase the clotting ability of the blood.	To restore blood volume after injury.

7. Why is the removal of carbon dioxide essential for continued metabolic activity?

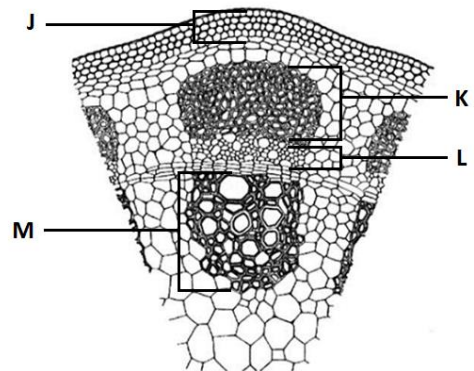
- (A) If carbon dioxide is allowed to accumulate in the body, it can bind to haemoglobin and prevent oxygen from doing so, starving the cells of oxygen.
- (B) The build-up of carbon dioxide in the body can cause carbon dioxide to move against a concentration gradient and start to move back into cells.
- (C) The accumulation of carbon dioxide can lower the pH of the cytoplasm causing a decrease in the acidity of the cell.
- (D) The accumulation of carbon dioxide can lower the pH of the cytoplasm, increasing the acidity of the cell.**

8. The diagram below shows the ambient temperature ranges that various species on Earth can exist in.



What ambient temperature range can humans survive in?

- (A) A
 - (B) B
 - (C) C**
 - (D) D
9. A cross section through a flowering plant stem is shown in the diagram.



In which cells does translocation occur?

- (A) J
 - (B) K**
 - (C) L
 - (D) M
10. After contact with the mumps virus, a child developed mumps but recovered. Twelve months later the child came in contact with the mumps virus again but did not show any symptoms of the disease.

What is the best explanation for this?

- (A) Shortly after the first infection, the child developed T cells that consumed the new mumps pathogen.
- (B) Shortly after the first infection, the child developed memory B cells that could respond to any virus.
- (C) Shortly after the first infection, the child developed memory T cells specific to mumps.**
- (D) Shortly after the first infection, the child developed memory B cells and T cells that could respond to any virus.

11. Two grey flies were mated and this resulted in 156 grey and 48 black offspring flies. What is the black phenotype likely to be?
- (A) **Autosomal recessive**
- (B) Autosomal dominant
- (C) Sex linked dominant
- (D) Co-dominant

12. Cytochrome C is a protein involved in the process of cellular respiration in eucaryotic cells. The cytochrome C found in chickens and turkeys is the same. However, the cytochrome C in ducks differs by two different amino acids compared to that found in chickens.

Which one of the following is a correct interpretation of these findings?

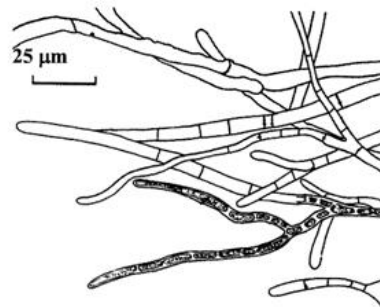
- (A) Chickens and turkeys belong to the same species.
- (B) Chickens and turkeys evolved at different rates compared to ducks.
- (C) **Chickens and turkeys have a more recent common ancestor than chickens and ducks.**
- (D) Chickens and turkeys evolved at the same time while ducks evolved later.
13. Therapsid fossils have been observed to have features that resemble small mammals yet had scales and leg-like structures similar to reptiles. They also have a jawbone similar to the jawbones found in reptiles and birds. What is the evolutionary significance of these findings?
- (A) Therapsids were homologous forms of reptiles, birds and mammals.
- (B) Therapsids represent a transitional form between birds and mammals.
- (C) **Therapsids represent a transitional form between reptiles and mammals.**
- (D) Therapsids were the ancestors of reptiles and mammals.
14. The coding strand for part of a gene is shown below.

CCG TTT ACA GCA ATC

What would be the complimentary DNA strand and the messenger RNA that results from transcription of the coding strand?

	Complementary DNA strand	Messenger RNA strand
(A)	GGC AAA TGT GCT TAG	CCG TTT ACA CGA ATC
(B)	CCG TTT ACA CGA ATC	CCG UUU ACA CGA AUC
(C)	GGC AAA TGT CGT TAG	GGC AAA UGU CGU UAG
(D)	CCG TTT ACA CGA ATC	GGC AAA UGU CGU UAG

15. Researchers were investigating the effect of periodic doses of intense radiation on the formation of point mutations in bacterial genes. These mutations would result in a non-functional bacterial enzyme. Which scientists used a method that would enable this investigation to prove that radiation is mutagenic?
- (A) Darwin and Wallace
(B) Boveri and Sutton
(C) **Beadle and Tatum**
(D) Watson and Crick
16. Which combination of genetic processes would result in the formation of gametes with the greatest possible variation?
- (A) Replication of chromosomes, spindle formation, formation of homologous pairs of chromosomes
(B) Independent assortment of homologous chromosomes, random fusion of gametes, mutations
(C) **Crossing over, mutations, independent assortment of homologous chromosomes**
(D) Crossing over, mutations, replication of chromosomes
17. The diagram shows part of a pathogen that causes disease in a potato plant.



What type of pathogen is represented?

- (A) Bacteria
(B) **Fungus**
(C) Prion
(D) Protozoan

18. Which option correctly represents a preventative measure and cause of malaria?

	Cause	Prevention
(A)	The parasite has life cycle stages in the mosquito and in humans	Drainage of water near homes and killing adult mosquitoes
(B)	The bad air in swamps causes mosquitoes	Build homes away from the edges of waterways
(C)	Malaria is caused by a bacteria in the blood	Use antibiotics and avoid blood transfusion
(D)	The malarial parasite is transmitted from mosquito into human by contaminated water	Do not use water contaminated with mosquito larvae

19. MacFarlane Burnet developed the theory of clonal selection. What are the key points of this theory?

- (A) A large number of lymphocytes pre-exist and the binding of an antigen to any of these causes the cloning of cells that will act specifically against that antigen.
- (B) A clone of lymphocytes pre-exist that the antigen can bind to and make chemicals that kill the antigen.
- (C) When an antigen binds to a lymphocyte it causes the lymphocyte to clone chemicals that kill the antigen.
- (D) The binding of an antigen to a particular lymphocyte causes the cloning of cells that will act specifically against that antigen.**

20. In his experiment, Louis Pasteur used specially designed flasks and broth. What steps would he need to do in order to make his experiment valid?

- (A) Pour equal amounts of broth into two different types of flasks. Boil both flasks for the same time.**
- (B) Pour equal amounts of broth into two identical flasks. Boil both flasks for the same time.**
- (C) Pour different amounts of broth into two identical flasks. Observe both flasks for mould growth.
- (D) Pour different amounts of broth into two different types of flasks. Observe both flasks for mould growth.

Girraween High School



Student Name	
Class (circle)	Teacher: Nguyen, Singh, Iverach
Mark /	

2016

HIGHER SCHOOL CERTIFICATE

TRIAL EXAMINATION

BIOLOGY

PART A ANSWER SHEET

Write your Name and Class at the top of this Part A Answer Sheet

1. A ○ B ○ C ○ D ○
2. A ○ B ○ C ○ D ○
3. A ○ B ○ C ○ D ○
4. A ○ B ○ C ○ D ○
5. A ○ B ○ C ○ D ○
6. A ○ B ○ C ○ D ○
7. A ○ B ○ C ○ D ○
8. A ○ B ○ C ○ D ○
9. A ○ B ○ C ○ D ○
10. A ○ B ○ C ○ D ○
11. A ○ B ○ C ○ D ○
12. A ○ B ○ C ○ D ○
13. A ○ B ○ C ○ D ○
14. A ○ B ○ C ○ D ○
15. A ○ B ○ C ○ D ○
16. A ○ B ○ C ○ D ○
17. A ○ B ○ C ○ D ○
18. A ○ B ○ C ○ D ○
19. A ○ B ○ C ○ D ○
20. A ○ B ○ C ○ D ○

Student Name	
Class (circle)	Teacher: Nguyen, Singh, Iverach
Mark /	

Write your Name and Class at the top of this Part B Answer Booklet.

Section I (continued)

Part B – 55 marks

Attempt Questions 21 - 36

Allow about 1 hour and 40 minutes for this part

Answer the questions in the spaces provided

Question 21 (3 marks)

A group of university students went camping attended a conference and some became ill. These people also were bitten by ticks. They were suspected of suffering from a disease called Rocky Mountain spotted fever which is caused by a bacterium for which the tick is a vector. Explain how the cause of the disease can be verified.

Use Koch's postulates:

The suspected microbe is present in all cases of diseased hosts. (S1)

The microbe can be isolated from the diseased host and grown in pure culture. (S2)

The microbes obtained from the pure culture produce the same disease when infecting a healthy susceptible host. (S3)

The microbe isolated from the experimentally infected host when grown in pure culture is identified as the same microbe obtained from the original culture. (S4)

Criteria	Marks
Describes the four steps associated with Koch's postulates	3
Describes three steps associated with Koch's postulates	2
Describes two steps associated with Koch's postulates	1

Note: humans, patients NOT accepted as "healthy hosts" !

Question 22 (3 marks)

Puritabs are used by hikers to purify creek water and make it fit for human consumption. A new type of Puritab has been developed. Design an experiment to test the effectiveness of the new form of Puritab.

Obtain some creek water and streak this onto sterile agar plates using a **sterile inoculating loop**. Incubate and observe for the presence of bacteria after one day. Use a control plate, with no creek water plated, to verify that the bacteria come from the creek water.

Obtain some of the creek water from above and sort into 10 samples, each the same volume. To 5 water samples, add puritabs. The other 5 water samples will not contain puritabs. Allow the samples to sit for 2 hours. Using the sterile inoculating loop, streak samples of water from each water sample onto individual agar plates; have on agar plate with no water sample added-this is a control. Incubate and observe for the presence of bacteria in the plates. If bacteria only shows up in the water samples with no puritabs then the puritabs would be deemed effective in purifying the creek water. However, if there is bacterial growth in both types (and none in the control) then the puritabs are not effective.

Criteria	Marks
Describes an experiment that incorporates controlling variables e.g., same creek water and a control condition; identifies independent and dependent variables; explains how to judge the effectiveness of the puritabs. Must state sterile inoculating loop	3
As above but missing one feature	2
Presents an attempt at experimental design, identifying the IV and DV but does not incorporate a control plate	1

Note: needle NOT accepted for loop (may rip the surface of the agar; may not get enough sample); many students did not include repeat trials in their design (do not say repeat experiment because that will occur under different environmental conditions)

M = measures (compare the size of growth on plates)

V = control variables; has a control plate (i.e., no puritab water)

R = repeats

E = experiment in general (2 steps given: incubates; seals plate; uses sterile inoculating loop)

Question 23 (2 marks)

Justify the role of gene expression in the maintenance and repair of body tissues.

When skin is cut or broken, genes are switched on in stem cells to trigger their development (differentiate) into epidermal cells or blood vessel smooth muscle cells etc, so that more of all types of skin cells are available to bridge the lesion and repair the hole in the skin. In this way, the barrier of the skin is restored intact, and the entry of pathogens into the body, and thus infectious disease, is prevented.

Criteria	Marks
Describes how gene expression is responsible for formation of specific cells that have roles in repairing and maintaining tissues and relates this to reforming a barrier or cell replacement	2
One of the above	1

Note: need to include TWO things

Must link gene expression to:

Mitosis = maintenance and repair tissue via cell growth; cell reproduction; genetic stability

Must link gene specifically to how they affect mitosis, tissue repair

Proto-oncogenes code for proteins that stimulate cell growth and mitosis

DNA repair genes stop cell cycle so DNA can be repaired and cells are maintained

Tumour suppressor genes code for proteins that slow down or stop mitosis (hence cell division continues)

Max (1) for just describing mitosis OR cancer cells cannot differentiate into normal functioning cells OR cell differentiation

Question 24 (1 mark)

Outline how an identified personal hygiene practice assists in the control of disease.

Washing hands before serving food or after going to toilet removes **pathogens** and thus these are not transferred to other people or objects. Hence infectious diseases are controlled.

Criteria	Marks
Identifies a personal hygiene practice and relates it to reducing the transmission of pathogens	1

Note: many students did not address the control of disease (i.e., stop the spread of the pathogen)

Question 25 (2 marks)

The table below shows seven turtle species, the types of habitat each occupies and the nitrogenous wastes produced.

Turtle species	Habitat	Urine component		
		Uric acid (g/L)	Ammonia (g/L)	Urea (g/L)
<i>Kinosternon subrubrum</i>	Almost wholly aquatic	0.7	24.0	22.9
<i>Pelusios derbianus</i>	Almost wholly aquatic	4.5	18.5	24.4
<i>Emys orbicularis</i>	Semi-aquatic; feeds on land in marshes	2.5	14.4	47.1
<i>Kinixys erosa</i>	Damp places; frequently enters water	4.2	6.1	61.0
<i>Testudo denticulata</i>	Damp, swampy ground	6.7	6.0	29.1
<i>Testudo graeca</i>	Very dry, almost desert conditions	51.9	4.1	22.3
<i>Testudo elegans</i>	Very dry, almost desert conditions	56.1	6.2	8.5

Explain the relationship between the type of nitrogenous waste produced and the habitat of the turtle species.

Marking Guidelines	Marks
<ul style="list-style-type: none"> ▪ Link the type of nitrogenous waste to the amounts of water required for its removal. ▪ Provide an explanation to account for the difference in water requirements in different nitrogenous wastes. E.g. If nitrogenous waste is not removed immediately it needs to be converted into the less toxic form (uric acid) so that it can be stored the body until enough water is available for its removal, thus the amount of water available dictates the type of nitrogenous waste produced. Note: the toxicity or the solubility of the nitrogenous wastes must be mentioned. 	2
<ul style="list-style-type: none"> ▪ 1 of the above 	1
<ul style="list-style-type: none"> ▪ 0 of the above 	0

Water is required to remove nitrogenous waste. Ammonia requires the most water for its removal and uric acid is the least with urea in between. If water availability was high, the organism will excrete nitrogenous wastes predominantly in the form of ammonia because although it is the most toxic form, it requires the least amount of energy to be produced. This is observable in the turtles that live in habitats that are almost wholly aquatic such as the *Kinosternon subrubrum* and *Pelusios derbianus* of which high levels of ammonia are produced and because water availability is high, the nitrogenous waste can be removed immediately.

Whereas in organisms that live in very dry conditions such as the *Testudo elegans* the opposite can be observed where nitrogenous wastes are produced predominantly as uric acid. Although requiring large amounts of energy to be produced, uric acid is more stable, less toxic and is insoluble in water. This means that it requires very minimal amounts of water to be excreted and thus allowing the organism to store the nitrogenous waste in the body until enough water is available for its removal, allowing the organism to conserve water for metabolic reactions.

Explain the relationship between the type of nitrogenous waste produced and the habitat of the turtle species.

The types of nitrogenous waste differs in terms of toxicity, energy required to produce it and level of dilution required to safely dispose of it. Uric acid requires the most energy to produce, however its toxicity is low and requires very little water dilution. Ammonia requires the least energy to produce, however its toxicity is high and thus requires a lot of water to dilute it to safe amounts. Lastly, urea is relatively in the middle for all the categories. Thus, animals with easy access to water, animals try and produce nitrogenous waste with the least energy required. However, animals with limited amounts of water don't have the option of producing NH_3 . Using this relationship, it is observed that turtles that have a unlimited amounts of water, i.e. the Galapagos and Red-footed have the capability of producing large amounts of NH_3 safely due to living in 'almost totally aquatic' habitats.

As the trend of the turtles' habitats going down the table is decrease in available water, ~~they~~ prefer urea as the nitrogenous waste, and at the other extreme where water is available, uric acid is produced to save water.

Explain the relationship between the type of nitrogenous waste produced and the habitat of the turtle species.

Turtle species such as *Kinosternon submarginatum* & *Pelusio deburianus* that...
live in almost wholly aquatic environments produce higher amounts of
ammonia compared to other species. ^{This is because ammonia requires the most amount of water to excrete which is not a problem as they live with water easily available.} turtles living in damp or semi-aquatic environments produce more urea than other types of nitrogenous waste. Therefore there is less water availability leading them to produce urea, a less toxic form which requires less water to excrete. Urea can be stored for longer due to its lower toxicity & released when water is available. Turtles living in very dry conditions produce predominantly uric acid, the nitrogenous waste which requires the least amount of water to excrete and is least toxic however requires most energy to create. This is due to their lack of water availability therefore water needs to be conserved. The type of nitrogenous waste produced correlates with water availability in environment.

2

Explain the relationship between the type of nitrogenous waste produced and the habitat of the turtle species.

... The more aquatic the habitat of the turtle, the greater
... Amount of ammonia ^{and lower the amount uric acid} is produced. Similarly, the drier
... the habitat, the ^{lower the} less amount of ammonia and greater
... amount of uric acid produced. This is due to
... the water requirements for excretion of the 3
... types of nitrogenous waste. Ammonia being highly 2
... toxic requires large amounts of water to be excreted
... hence found in highest amounts (24.0 g/L) in turtles
... living in almost wholly aquatic environments where water
... is readily available. On the other hand turtles
... in dry, desert conditions need to conserve water, thus
... producing uric acid which is the least toxic form, ^{in greatest}
... requiring least amount of water to excrete and ^{amounts (g/L)}
... is able to be stored in the body for long periods
... time due to low toxicity. Turtles living between
... the two extremes secrete urea which requires
... moderate amounts of water available in their moderately ¹³
... damp environments.

Girraween High School 2016 HSC Biology Trial Examination

Question 26 (4 marks)

There are many homeostatic mechanisms operating within the body. One of these controls blood glucose levels. The normal blood glucose level is 90 mg of glucose/100 mL of blood. Receptors in the pancreas detect deviations from this level and stimulate the release of two hormones.

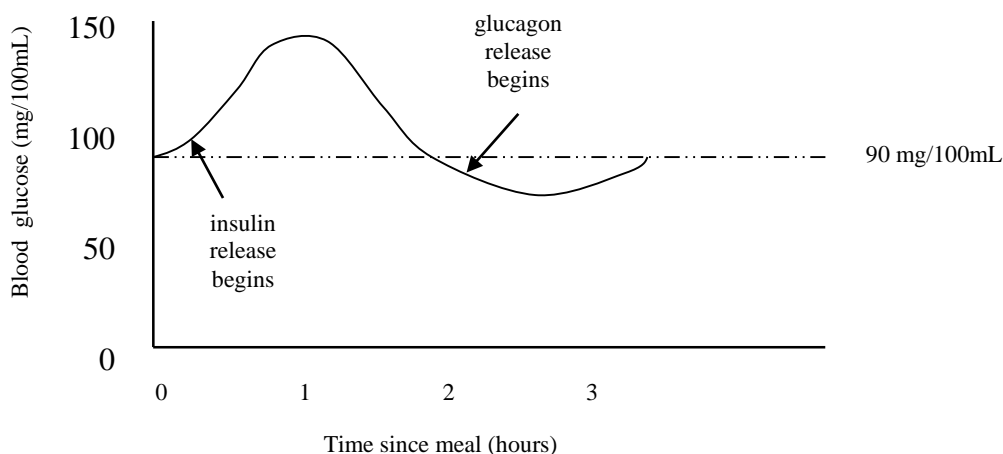
Insulin is secreted by β cells in the pancreas. It moves glucose out of the blood and into the tissues, where it can be used in respiration or stored as glycogen.

Insulin lowers blood glucose levels.

Glucagon is secreted by α cells in the pancreas. It stimulates the breakdown of glycogen in the liver to make glucose, and the release of this glucose into the blood.

Glucagon raises blood glucose levels.

The graph below shows how blood glucose levels can vary after eating a meal.



(a) Define homeostasis. (1 mark)

.....

.....

Marking Guidelines	Marks
<ul style="list-style-type: none"> ▪ Identify homeostasis as the process by which organisms maintain a relatively stable internal environment 	1

(b) Identify the specific stimulus for the release of glucagon. (1 mark)

.....

Marking Guidelines	Marks
<ul style="list-style-type: none"> ▪ Specifically identify 90 mg of glucose/100 mL of blood. 	1

(c) Use the information provided above to explain how the control of blood levels is an example of negative feedback. (2 marks)

.....

.....

.....

Marking Guidelines	Marks
<ul style="list-style-type: none"> ▪ Define negative feedback as a mechanism where the stimulus provokes a response which has the effect of changing the stimulus so that it no longer provokes the response. <p>AND</p> <ul style="list-style-type: none"> ▪ Identify the rise in blood glucose level is the stimulus which provokes the response of releasing insulin. Explain “Insulin reduces blood glucose level thus removing the original stimulus”. <p>OR</p> <ul style="list-style-type: none"> ▪ Identify the drop in blood glucose level is the stimulus which provokes the response of releasing glucagon. Explain “glucagon increases blood glucose level thus removing the original stimulus”. 	2
<ul style="list-style-type: none"> ▪ Define negative feedback as a mechanism where the stimulus provokes a response which has the effect of changing the stimulus so that it no longer provokes the response. <p>OR</p> <ul style="list-style-type: none"> ▪ Identify the rise in blood glucose level is the stimulus which provokes the response of releasing insulin. Explain “Insulin reduces blood glucose level thus removing the original stimulus”. <p>OR</p> <ul style="list-style-type: none"> ▪ Identify the drop in blood glucose level is the stimulus which provokes the response of releasing glucagon. Explain “glucagon increases blood glucose level thus removing the original stimulus”. 	1
<ul style="list-style-type: none"> ▪ 0 of the above 	0

Question 27 (2 marks)

Outline the role of the nervous system in maintaining homeostasis in a mammal.

Marking Guidelines	Marks
<ul style="list-style-type: none">▪ Identify the nervous system as the system in which the body uses to allow immediate communication within itself via CNS and PNS or identify at least the 2 structures of the nervous system e.g., receptors, sensory, inter and motor neurones.▪ Outline the components of the nervous system as containing receptors to allow the body to communicate with external surrounding and detect any changes that has occurred, the afferent and efferent pathways to allow communication within the body to carry out functions that can maintain homeostasis. <p>Note: You must explicitly state that the nervous system provides a mean for detecting changes to homeostasis via receptors such as sensory neurons & thermoreceptors and provides a mechanism to allow communication within the organism to carry out activities that will counteract the change in homeostasis.</p>	2
<ul style="list-style-type: none">▪ 1 of the above	1
<ul style="list-style-type: none">▪ 0 of the above	0

Question 27 (2 marks)

Outline the role of the nervous system in maintaining homeostasis in a mammal.

The nervous system consists of a network of specialised cells called neurons. There are millions of neurons in the body which co-ordinate different parts of the body to perform a specialised function of a circuit's homeostasis. Nervous system consists of peripheral nervous system and central nervous system which are used in the negative feedback mechanism to achieve homeostasis for mammals. A stimulus is detected ^{by} ~~then~~ receptors which cause sensory neurons (part of the peripheral nervous system) to send messages to the hypothalamus (central nervous system) and then ~~through~~ motor neurons (peripheral nervous system) they cause the ^{effectors} effector muscles to respond to the change and thus achieve homeostasis of a system. ~~has~~ contracted the change and achieved a steady state.

Question 28 (3 marks)

Type I diabetes is an example of an autoimmune disease. In this type of disease the immune system attacks some of the islet cells of the pancreas, preventing insulin production.

(a) Why is an autoimmune disease considered a malfunction of the body? (1 mark)

Marking Guidelines	Marks
<ul style="list-style-type: none">▪ Explain that the disease stem from the person's own immune system attacking cells that are 'self' instead of 'non-self', thus interfering with the 'normal' functions of the body or relevant cells.▪ This is a malfunction because the immune system should distinguish between self and non-self as the β islet cells of the pancreas contains chemicals that should not trigger an immune response.	1

(b) Describe the immune response that occurs during Type I diabetes, identifying the specific type of cells involved. (2 marks)

Marking Guidelines	Marks
<ul style="list-style-type: none">▪ A description of the immune response is provided.<ul style="list-style-type: none">- In diabetes, the cytotoxic T cells recognise the antigen on the islet cells of the pancreas as foreign and thus produces granzymes and perforins to attack the islet cells rendering them ineffective in the production of insulin. Memory B cells also differentiate to become plasma cells and produce antibodies that forms antibody-antigen complexes that also prevent the normal functioning of the islet cells.▪ The description of the immune response is specific to diabetes mellitus.<ul style="list-style-type: none">- Mentioning the words, islet cells, insulin production etc.	2
<ul style="list-style-type: none">▪ 1 of the above	1
<ul style="list-style-type: none">▪ 0 of the above	0

Question 28 (3 marks)

Type I diabetes is an example of an autoimmune disease. In this type of disease the immune system attacks some of the islet cells of the pancreas, preventing insulin production.

- (a) Why is an autoimmune disease considered a malfunction of the body? (1 mark)

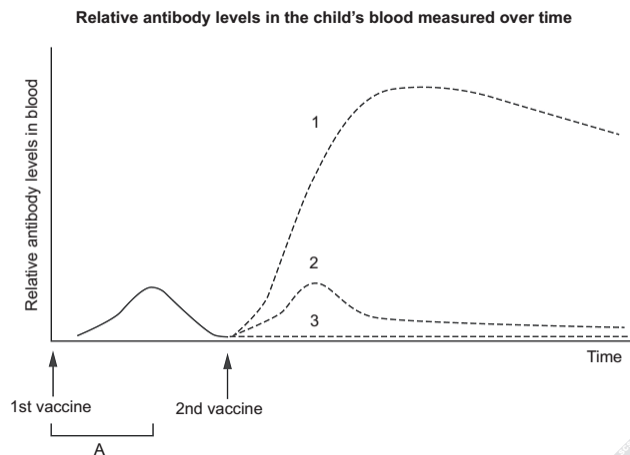
An autoimmune disease causes the body to attack ~~set~~ cells belonging to itself by recognising them as foreign, thus being considered a mal function of the body.

- (b) Describe the immune response that occurs during Type I diabetes, identifying the specific type of cells involved. (2 marks)

Antigens on the islet cells of the pancreas are identified by macrophages and helper T cells as being foreign. This causes macrophages to release cytokines and chemokines such as interleukin to the lymph nodes where they, along with helper T cells, activate B and T cells. ~~Plasma cells~~ the Cytotoxic T cells then go to the pancreas and attack the islet cells.

Question 29 (2 marks)

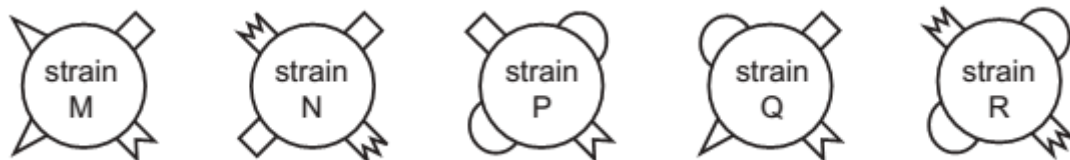
A young child was given a vaccine containing antigens for a viral disease. Several months later, the child was given the vaccine a second time, in what is known as a booster injection. The antibody levels in the child's blood were measured over this period and are shown in the graph below.



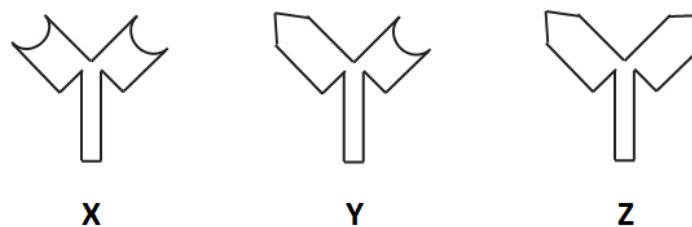
(a) Identify the cells responsible for the period labelled A on the graph (1 mark)

Marking Guidelines		Marks
▪ B lymphocytes		1

The diagram below shows the different forms of antigens and their relative distribution on the surface of different strains of weakened viruses contained in the vaccine.



The possible types of antibody that would be effective against the viral pathogen are shown below.

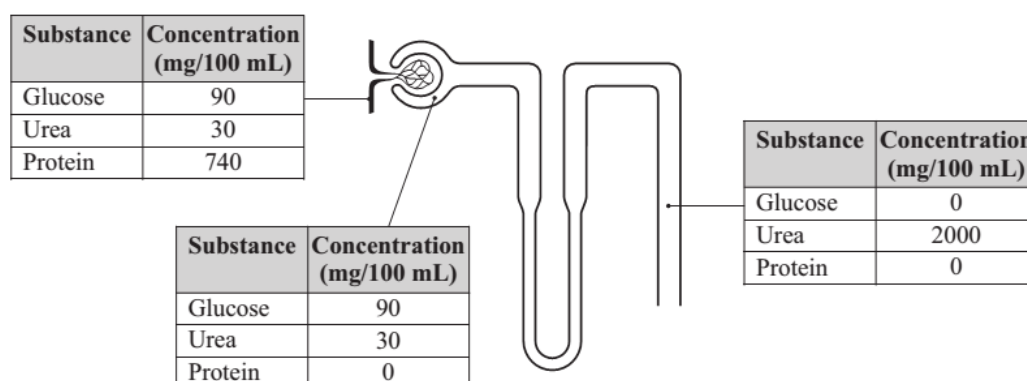


(b) Identify the antibody type would be most effective against the strain P virus. (1 mark)

Marking Guidelines		Marks
▪ Antibody type Y		1

Question 30 (5 marks)

- (a) The diagram below shows a simplified representation of the human nephron. Concentrations of three substances in various regions of the nephron are shown in the tables.



Identify and explain the processes that change the concentrations of each of these substances. Use the terms renal artery, glomerulus, Bowman's capsule, proximal convoluted tubule and collection tubule in your explanation. (3 marks)

As the blood from the renal artery is pushed through the Bowman's capsule, the filtrate which consist of plasma, water, urea and glucose are pushed through the glomerulus which acts like a filtration membrane. Protein are too large to cross the glomerulus and therefore remains in the renal artery. Thus the concentration of protein is 0mg/100 mL – **P**

Identify that as the filtrate continues along the path of the nephron: all of glucose is reabsorbed at the proximal convoluted tubule and the accumulation of urea occurs at the collection tubule. The increase in concentration of urea is due to the reabsorption of the water at the collecting duct and thus the concentration of urea is high at 2000mg/mL and glucose is 0mg/100 mL – **U and G**

Marking Guidelines	Marks
<ul style="list-style-type: none"> ▪ Correct identification of the process and site that created the change in the concentration of: protein – P ▪ Correct identification of the process and site that created the change in the concentration of: glucose – G ▪ Correct identification of the process and site that created the change in the concentration of: Urea – U 	3
<ul style="list-style-type: none"> ▪ 2 of the above 	2
<ul style="list-style-type: none"> ▪ 1 of the above 	1

Identify and explain the processes that change the concentrations of each of these substances. Use the terms renal artery, glomerulus, Bowman's capsule, proximal convoluted tubule and collection tubule in your explanation. (3 marks)

... In the glomerulus, molecules such as glucose and urea enter the nephron due to high pressure but protein cells are too big to pass through the glomerulus, hence why the conc. is 240 (high) for proteins at glomerulus. At the Bowman's capsule, ~~and this~~ the protein conc. is 0 because proteins have not entered but glucose and urea are the same as nothing ~~to~~ has been reabsorbed yet. At the proximal tubule, glucose is actively reabsorbed because it is an important nutrient and water and ~~solute~~ is also reabsorbed. At the collecting duct, all glucose has already been reabsorbed so the conc. is 0 and protein conc. is 0 as none entered the glomerulus and urea conc. is the highest at 2000 because ~~adrenaline~~ water has been reabsorbed and urea has been allowed to accumulate. Then, it is excreted by the kidney in urine.

(b) Explain why the processes of diffusion and osmosis are inadequate in removing dissolved nitrogenous wastes in some organisms. (2 marks)

- Diffusion and osmosis are passive processes so they are too slow to maintain optimal ~~metabolism~~ waste removal ~~the concentration difference~~ and also, they cannot actively secrete poisons and harmful drugs. Also, diffusion and osmosis move against a conc. gradient so if the conc. were equal on both sides of the gradient, then the processes would stop and waste removal would stop. This is ~~very~~ dangerous because ¹⁹ wastes remain in the body for long periods of time, they can disrupt homeostasis.

For e.g. CO₂ accumulated in lower the pH. and CO₂ results in enzyme and cell death.

(b) Explain why the processes of diffusion and osmosis are inadequate in removing dissolved nitrogenous wastes in some organisms. (2 marks)

Marking Guidelines	Marks
<ul style="list-style-type: none"> Identify the processes of osmosis and diffusion are both passive forms of transport and thus rely on the difference in the concentration gradient between two solutions to allow the flow of solutes to occur. – C 	2
<ul style="list-style-type: none"> Explain that when the concentrations of the two solutions reach equilibrium, no movement of wastes can occur and thus not all wastes can be removed. – E 	1

(b) Explain why the processes of diffusion and osmosis are inadequate in removing dissolved nitrogenous wastes in some organisms. (2 marks)

excrete by the kidney using urine

- Diffusion and osmosis are passive processes so they are

For O_2 and CO_2 around the cell, O_2 enters the cell and CO_2 leaves the cell.

too slow to maintain optimal ~~metabolism~~ waste removal ~~with osmosis & diffusion~~ and also, they cannot actively secrete poisons and harmful drugs.

- Also, diffusion and osmosis move against a conc. gradient so if the conc. were equal on both sides of the gradient, then the processes would stop and waste removal

would stop. This is ~~very~~ dangerous because if wastes remain in the body for long periods of time, they can disrupt homeostasis.

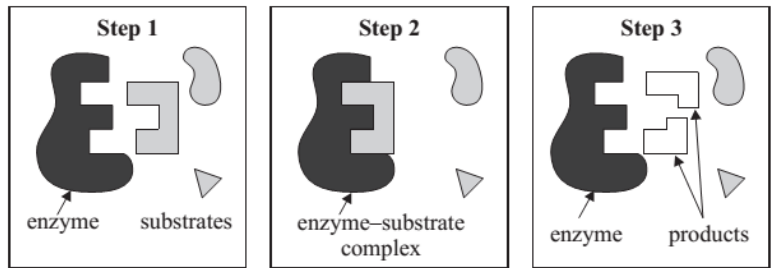
Girraween High School 2016 HSC Biology Trial Examination

2

5

Question 31 (7 marks)

The diagram represents a chemical reaction catalysed by an enzyme.



(a) Describe how this model explains the theory of enzyme specificity. (1 mark)

Marking Guidelines	Marks
<ul style="list-style-type: none"> Describe the enzymes as containing active sites that are specific to substrates that have matching or similar structure this means that each enzyme will only catalyse a specific type of substrate or chemical reaction. 	1

(b) Describe the chemical composition of enzymes and their role in metabolism. (2 marks)

Marking Guidelines	Marks
<ul style="list-style-type: none"> Enzymes are quaternary structure proteins which means that they are made up of amino acids. – C Enzymes are biocatalysts, this means that they are there to increase the rate of chemical reactions by decreasing the activation energy required to start the reaction. – E 	2
<ul style="list-style-type: none"> Provide a vague answer. 	1

(a) Describe how this model explains the theory of enzyme specificity. (1 mark)

... This model is the lock and key model. It illustrates how enzymes have a rigid shape with an active site that is specific for one substrate only. Hence, it catalyses the rate of reaction of one reaction only. After the enzyme does not change its shape and can be re-used as it is not used up. It is restored at the end of the reaction.

(b) Describe the chemical composition of enzymes and their role in metabolism. (2 marks)

Enzymes are biological proteins that catalyse reactions and are made up of amino acids and transition metals. Hence, they contain an amino acid chain. ^{They can also be aided with coenzyme & cofactors.} They are folded in a specific way to make it an enzyme. They reduce the activation energy required for a biological reaction. Thus, they increase the rate of reaction & metabolism for improved efficiency. It can be re-used in these metabolic reactions as they do not get used up. eg. Amylase in saliva

(c) Amylase, an enzyme found in saliva, promotes the breakdown of starch into maltose. If saliva is mixed with starch, eventually all the starch will be broken down regardless of the amount of added. Explain why this occurs. (2 marks)

(b) Describe the chemical composition of enzymes and their role in metabolism. (2 marks)

Enzymes are typically proteins which are hence made up of amino acids. These biological catalysts have a role in metabolism by speeding up ^{specific} reactions in the body where a specific enzyme will catalyse a specific reaction in the body depending on how its active site fits the substrate. Thus, they are responsible for breaking down substrates into products that our body can use for metabolic reactions. (2)

(c) Amylase, an enzyme found in saliva, promotes the breakdown of starch into maltose. If saliva is mixed with starch, eventually all the starch will be broken down regardless of the amount of saliva added. Explain why this occurs. (2 marks)

An enzyme is not used up in the reaction and thus, after producing, breaking down starch into maltose, the amylase enzyme will continue to do the same with other starch molecules. Since the enzyme is not used up at all during the reaction, it would not matter how much saliva (or amylase) is added. (2)

(c) Amylase, an enzyme found in saliva, promotes the breakdown of starch into maltose. If saliva is mixed with starch, eventually all the starch will be broken down regardless of the amount of saliva added. Explain why this occurs. (2 marks)

Marking Guidelines	Marks
<ul style="list-style-type: none"> Explain that enzymes are there to catalyse the chemical reactions and they are not used up in the reaction. Thus it can be recycled and reuse over and over again. – C 	2
<ul style="list-style-type: none"> Link the answer to the data given: That is why regardless of the amount of saliva is added, the amount of starch will get broken down eventually. – E 	1

(d) Explain why the maintenance of a constant internal environment is important for optimal metabolic efficiency. (2 marks)

Marking Guidelines	Marks
<ul style="list-style-type: none"> Identify that enzymes are heat and pH sensitive. Thus they will only function efficiently within the optimal range. – C 	2
<ul style="list-style-type: none"> Link the answer to the data given: If the internal environment is outside of the optimal range, it can cause enzymes to denature and thus will not be functioning efficiently and thus chemical reactions will be halted or slows down. This can cause disease or death in the organism. – E 	1

Question 31 Continued

(d) Explain why the maintenance of a constant internal environment is important for optimal metabolic efficiency. (2 marks)

optimal environment eq. temp. pH is needed to ensure enzymes operate in their optimum range and are efficient. Deviation from these eg. increase CO_2 accumulation can result in increase acidity. As the CO_2 builds up & produces acids H_2CO_3 , when produced acetic H_7CO_3 ... $\text{CO}_2(\text{aq}) + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3(\text{aq})$... Thus the optimum pH is lowered, leading to the denaturing of the enzyme... the enzymes then cannot carry out metabolic reactions, leading to inefficiency & accumulation of waste which can poison the cell & result in cell death.

Question 32 (2 marks)

Identify one similarity and one difference between Darwin's and Wallace's theories of punctuated equilibrium

Question 32 (2 marks)

Identify one similarity and one difference between Darwin's and Wallace's theory of evolution and punctuated equilibrium.

One similarity and one difference between two theories is clearly stated (2 marks)

Similarity: Both theories advocate the use of natural selection/selection pressure to select individuals with favourable variations.

Darwin's theory states that the change occurs gradually and continuously while punctuated equilibrium states that change occurs in short bursts/suddenly followed by a period of stability

Question 33 (3 marks)

Describe a method that could be used to clone an organism.

1 A somatic cell is removed from the animal A.

2 An egg cell is removed from the ovary of animal B and its nucleus is removed/enucleated.

3 Egg cell and somatic cell or nucleus of somatic cell are fused such that egg cell now have the genetic material from animal A.

4 Egg cell is induced to divide in a suitable medium using electric zapping to produce embryo.

5 Embryo is then implanted into the womb of animal C which act as surrogate mother.

6 An offspring is developed and is given birth.

Criteria	marks
Presents in the correct sequence of steps a method to clone an identified organism	3
one features missing from above	2
One step presented for cloning an organism	1

Question 34 (3 marks)

(a) Using an example, define the term *mutagen*. (1 mark)

A chemical or a type of radiation that can cause mutation by changing the genetic makeup of an organism. Example uv, gamma, x ray radiations, dioxin etc.

(b) Discuss one example of evidence which supports the mutagenic nature of radiation. (2 marks)

Cause and effect (refer to Chernobyl disaster, Hiroshima, Nagasaki etc)

State the cause and effect of one evidence (1+1 marks)

Question 35 (2 marks)

Outline one ethical issue arising from the development and use of a named transgenic organism you have studied.

Criteria	marks
Has chosen an example Given one positive or a negative issue related	2
Have given only the name of transgenic organism. No mark if only positive or negative issue is stated	1

Criteria include economic issue where benefit only goes to companies which have patents.

Third world countries cannot afford the technology.

Ethical issue in terms of manipulation of genetic makeup of organisms for personal gain.

Question 36 (3 marks)

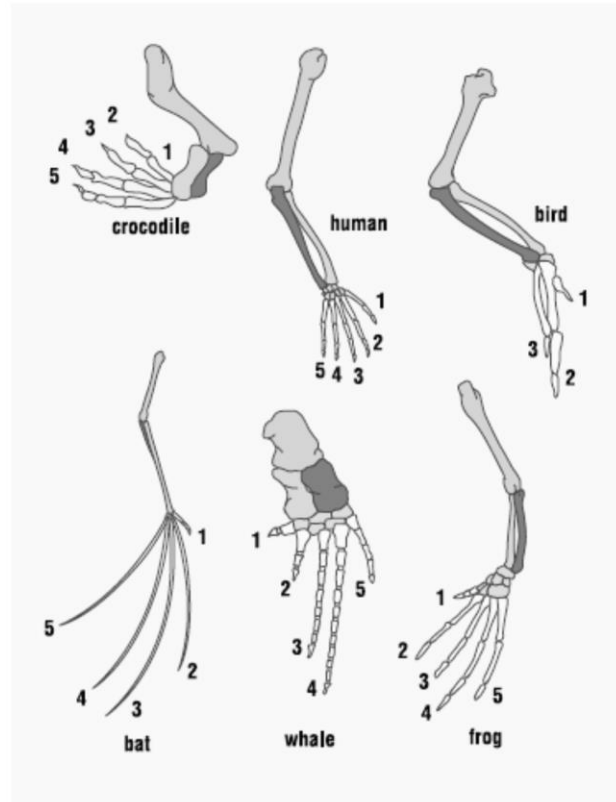
The diagram shows the structure of forelimbs of various vertebrates.

- (a) Identify the type of evolution that led to the development of changes in the anatomy of forelimbs of organisms shown. (1 mark)

divergent evolution

- (b) Justify the differences between bird and whale forelimbs. (2 marks)

Clearly states how each of these modifications has produced an adaptation that helped organism to live in the environment.



Criteria	marks
Identifies clearly by stating the type of bones where the modifications has occurred. Clearly states how each of these modifications has produced an adaptation that helped organism to live in the environment.	2
Any 1 of above	1

Question 37 (5 marks)

- (a) Outline the cause and symptoms of one named infectious disease. (3 marks)

Criteria	marks
Correctly identifies an infectious disease	3
Identifies clearly the cause and at least two distinct symptoms of the disease	
Only name of disease and/or cause and/or symptoms are given	1-2
No marks if name of disease is not given	

- (b) Some of the diseases caused by viruses show similar symptoms to those caused by some bacteria. A wrong diagnosis can lead to the unnecessary prescription of antibiotics. Explain why the inappropriate use of antibiotics is a problem. (2 marks)

States clearly those antibiotics only act on bacteria.

How wrong prescription of antibiotics for a viral type of disease can lead to unnecessary destruction of useful microbes causing imbalance or how this can increase the process of natural selection

(2 marks for two distinct statements given)

Question 38 (2 marks)

Outline the main steps used to produce a transgenic species.

Genetic material such gene for a useful characteristic is removed using a restriction enzyme

Multiple copies of gene is made or it is inserted into the plasmid of a bacterium WHICH IS CUT BY THE SAME RESTRICTION ENZYME.

It is then transferred into egg cell of another organism or plasmid is inserted into a bacterium and allowed reproduce. Must state clearly the technique used to transfer gene.

(all relevant steps given 2 marks. Less one step (1 mark) two steps missing zero mark.

Question 39 (3 marks)

The following information was provided to a genetic counsellor about the inheritance of a trait in a family.

A man who does not have the trait marries a female who has the trait. Of their children, both sons have the trait and the daughter does not. The daughter marries a man without the trait and they have three children. One of their sons has the trait while his brother does not. Their sister does not have the trait.

The genetic counsellor has some other information about the trait and suspects the trait is sex-linked.

- (a) Construct a pedigree for this family based on the above information. (2 marks)

Criteria	marks
Correct pedigree is constructed A complete key has been given	2
Correct pedigree is constructed OR A complete key has been given	1

- (b) Determine the type of sex-linked inheritance exhibited by this trait. Show your working using Punnett squares. (1 mark)

The student provides a clearly identified Punnett square and correct conclusion was drawn (sex linked recessive).

End of Section I

Section II

23 marks

Attempt ALL parts of Question 40 Biotechnology - Parts (a) – (f)

Allow about 45 minutes for this part

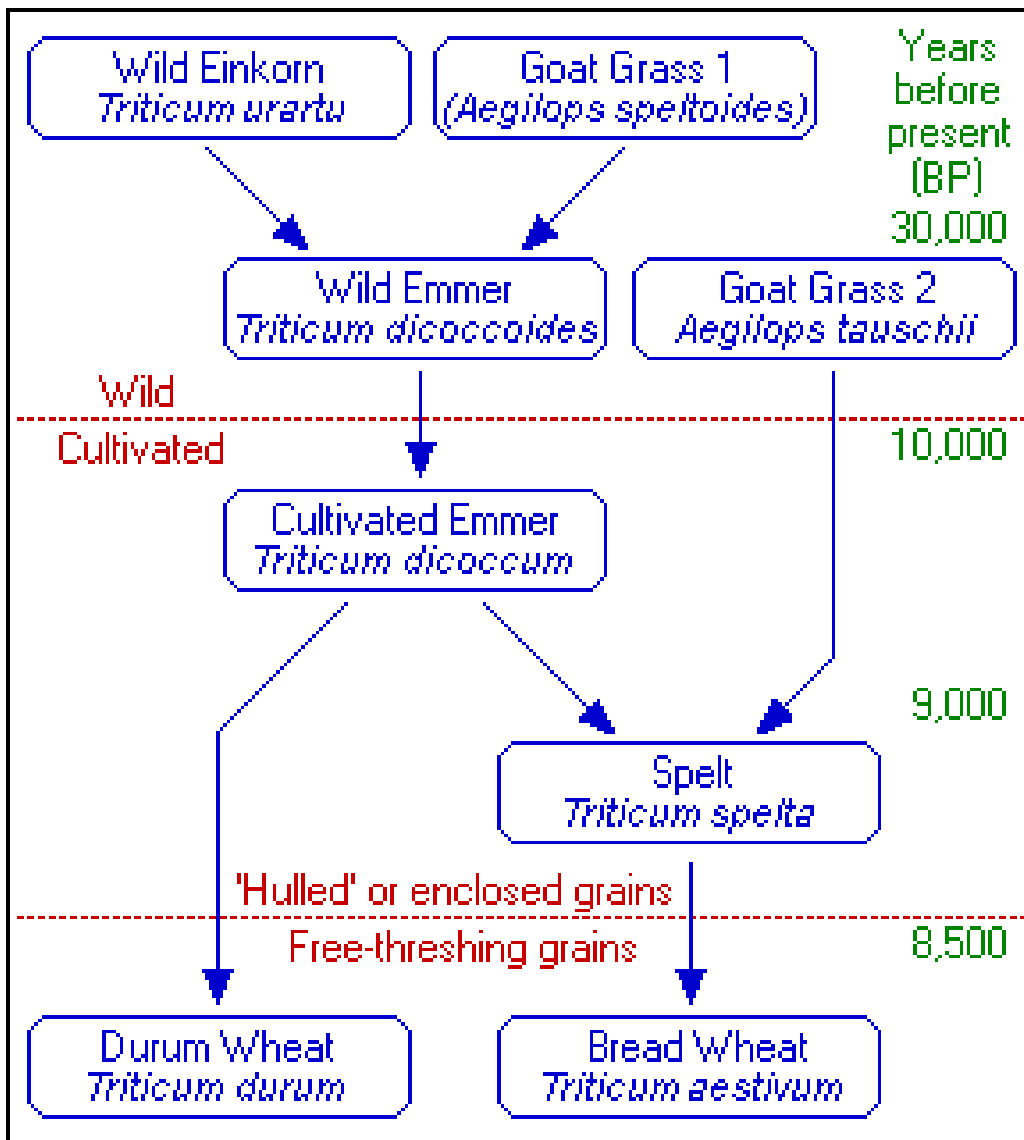
Answer the question parts in the Section II answer booklet. Write your Name and Class at the top of the Section II Answer Booklet.

Extra writing booklets are available.

Question 40 Biotechnology

- (a) Biotechnology practices have had a large impact on the evolution of animals and plants for use in agriculture. Present evidence for this judgement with respect to the impact of biotechnology practices upon the evolution of one group of animals and one group of plants that are used for agricultural stock. (4 marks)

Sheep have been domesticated over long period of time. Early sheep had course, rough fur with large horns. Domestic sheep (*O. aries*) may have arisen from the domestication of more than one *Ovis* species, the mouflon (*O. orientalis*) contributing to domestic sheep in Europe and the argali (*O. ammon*) to Asiatic breeds. Ancient sheep like the mouflon had horns and uneven textured coats with thick, course wool; e.g., extra long hairs. These features have been bred out via artificial selection of sheep that had finer wool and evenly textured coats. Woolly modern sheep do not have the extra long hairs in their fleece at the extreme. They have a very even textured coat e.g., merino sheep.



Wild Emmer (*Triticum dicoccoides*) is a tetraploid hybrid created when a Goat Grass was pollinated by pollen from Wild Einkorn at least 30,000 years ago. Hybridisation probably occurred many times over several millennia in areas of the Fertile Crescent where the two parent plants grew together.

10,000 BP, some of the Neolithic Age tribes began to cultivate Wild Emmer, instead of relying on the wild supplies. Initially the plants would have had ears with a brittle stalk or rachis, similar to the wild form, each fragmenting into separate spikelets when ripe. The tribes-people, probably the women, would have naturally selected the **larger intact ears** when they harvested the grain. This subconscious selection led to the rachis gradually **evolving from the brittle wild form into a non-brittle form**. By about 9,500 BP a new Cultivated Emmer had been created, no longer fragmenting into individual spikelets when ripe but dependant upon man for continued propagation.

About 8,500 BP, a fortuitous natural mutation changed the structure of the Spelt spike or ear. The ear became roughly square in section, with more grains and a tougher rachis. More importantly, the hard hull enclosing the grain mutated to a softer shell that would break away when threshed, thus releasing the grains. This free-threshing hexaploid hybrid evolved further to become the source of our modern Bread Wheat, *Triticum aestivum*.

Criteria	Marks
Describes in detail the changes one identified (specifies the names of the organisms involved in the crosses) group of animals (2 sequential changes to phenotype) and plants (specifies the names of the organisms involved in the crosses) have undergone (2 sequential changes to phenotype) over time as a result of domestication.	4
Describes in detail the changes one identified group of animals and plants have undergone over time as a result of domestication. 2 sequential changes to phenotype to one group; one change for the other group	3
Describes the changes one identified group of animals (1 change to phenotype) and plants have undergone (1 change to phenotype) over time as a result of domestication.	2
Describes the changes one identified group of animals (1 change to phenotype) OR plants have undergone (1 change to phenotype) over time as a result of domestication.	1

Note: A1, A2 = animal changes; P1, P2 = plant changes

“more yield” too vague-need to be specific about the phenotypic changes

Chromosomal number change in plants accepted as change

- (b) Explain the biotechnology practices required for the creation of alcoholic beverages and yoghurt. (4 marks)

Alcohol beverages: require yeast (microbe) and barley (source of sugar); The germinated grain (malt) is soaked in warm water to yield an extract called malt wort which contains the sugars and other nutrients needed by the yeast cells. The malt wort is then boiled before yeast is added to partly destroy the grain enzymes and microbes, and to concentrate the flavour. Hops are added to give taste and destroy bacteria (otherwise beer too acidic). Beer is then cooled so that the yeast can be removed (scooped) and allowed to settle for about 1 week to 3 months. After this period, the beer is filtered to remove any yeast and solid material.

Yoghurt is formed from mixing a culture of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* with pasteurized milk and incubating (constant heating) at 40°C until the lactose sugar in the milk is fermented. The flavour of yoghurt is due to the production of lactic acid and acetaldehyde by the bacteria. The texture of yoghurt is due to the lactic acid lowering the pH of milk, resulting in coagulation of the milk proteins.

Criteria	Marks
Identifies the microbe, chemicals and conditions for the formation of an alcohol beverage and yoghurt. Explains the processes associated with each product formation.	4
Identifies the microbe, chemicals and conditions for the formation of an alcohol beverage and yoghurt. Explains the processes associated with one product formation. Outlines the processes for the other product.	3
Identifies the microbe, chemicals and conditions for the formation of an alcohol beverage and yoghurt. Outlines the processes associated with one product formation. Outlines the processes for the other product.	2
Identifies the microbe, chemicals and conditions for the formation of an alcohol beverage OR yoghurt OR Outlines the processes associated with one product formation.	1

Note:

A1 = alcohol beverages - microbe and chemicals (type of sugar used) used

A2 = alcohol beverages - processes and conditions (e.g., use of hops in beer making; filtering)

Y1 = yoghurt - microbe and chemicals (type of sugar used) used

Y2 = yoghurt - processes and conditions (e.g., temperatures)

F = knows fermentation

-1 for incorrect information

Molasses not used for beer making (25-40% unfermentable, very strong aroma flavor)

- (c) Describe how traditional fermentation has been modified to form glycerol and citric acid. (4 marks)

More systematic (scientific) approaches applied to fermentation.

By altering the conditions, including manipulating the types of nutrients available, scientists could alter microbial chemical reactions (i.e., metabolism), leading to a range of different products.

Glycerol:

Glycerol production by yeast fermentation has been known since the investigations of Pasteur (1858). In *Saccharomyces cerevisiae*, glycerol is a by-product of the fermentation of sugar to ethanol. Substantial overproduction of glycerol from sugars such as glucose can be obtained by yeast in 3 ways:

- (1) forming a complex of acetaldehyde with the bisulfite ion that limits ethanol production and that promotes reoxidation of glycolytically formed NADH by glycerol synthesis;
- (2) growing at pH values around 7 or above; and
- (3) by using osmotolerant yeasts.

Hence, adding bisulfite will lead to glycerol synthesis.

Citric acid:

Fermentation continues to be the predominant way of producing citric acid and accounts for over 90% of the world production.

Fermentation is obviously a complex process because several reactions are sandwiched into one single bio-reaction, for which operating conditions have to be tailored precisely and controlled severely. The surface fermentation process is employed most commonly. *Aspergillus niger* is most commonly used for citric acid production. This organism (a fungus) has the capacity to utilize a variety of starchy substrates – mainly molasses. In this production technique, which is still the major industrial route to citric acid used today, cultures of *Aspergillus niger* are fed on a sucrose or glucose-containing medium to produce citric acid. The source of sugar is corn steep liquor, molasses, hydrolyzed corn starch or other inexpensive sugary solutions.

After the mould is filtered out of the resulting solution, citric acid is isolated by precipitating it with lime (calcium hydroxide) to yield calcium citrate salt, from which citric acid is regenerated by treatment with sulfuric acid.

Criteria	Marks
Describes in detail how glycerol and citric acid are formed using modified fermentation processes.	4
Describes in some detail how glycerol and citric acid are formed using modified fermentation processes.	3
Outlines how glycerol and citric acid are formed using modified fermentation processes.	2
Outlines how glycerol OR citric acid are formed using modified fermentation processes.	1

Note:

G1 = glycerol – sugar and organism used

G2 = glycerol – bisulfite added

C1 = citric acid – fungus and sugar used

C2 = citric acid – conditions required (e.g., precipitation of citric acid using calcium hydroxide)

(d) Construct a flow chart to outline the steps in the formation of a functional enzyme. (3 marks)

Transcription: **Gene sequence** (coding strand) is read by RNA polymerase and mRNA is formed.

Translation: mRNA attached to a ribosome and its base sequence dictates the binding of tRNA molecules which each bring an amino acid to be linked to each other via a peptide bond. This continues until the polypeptide is formed.

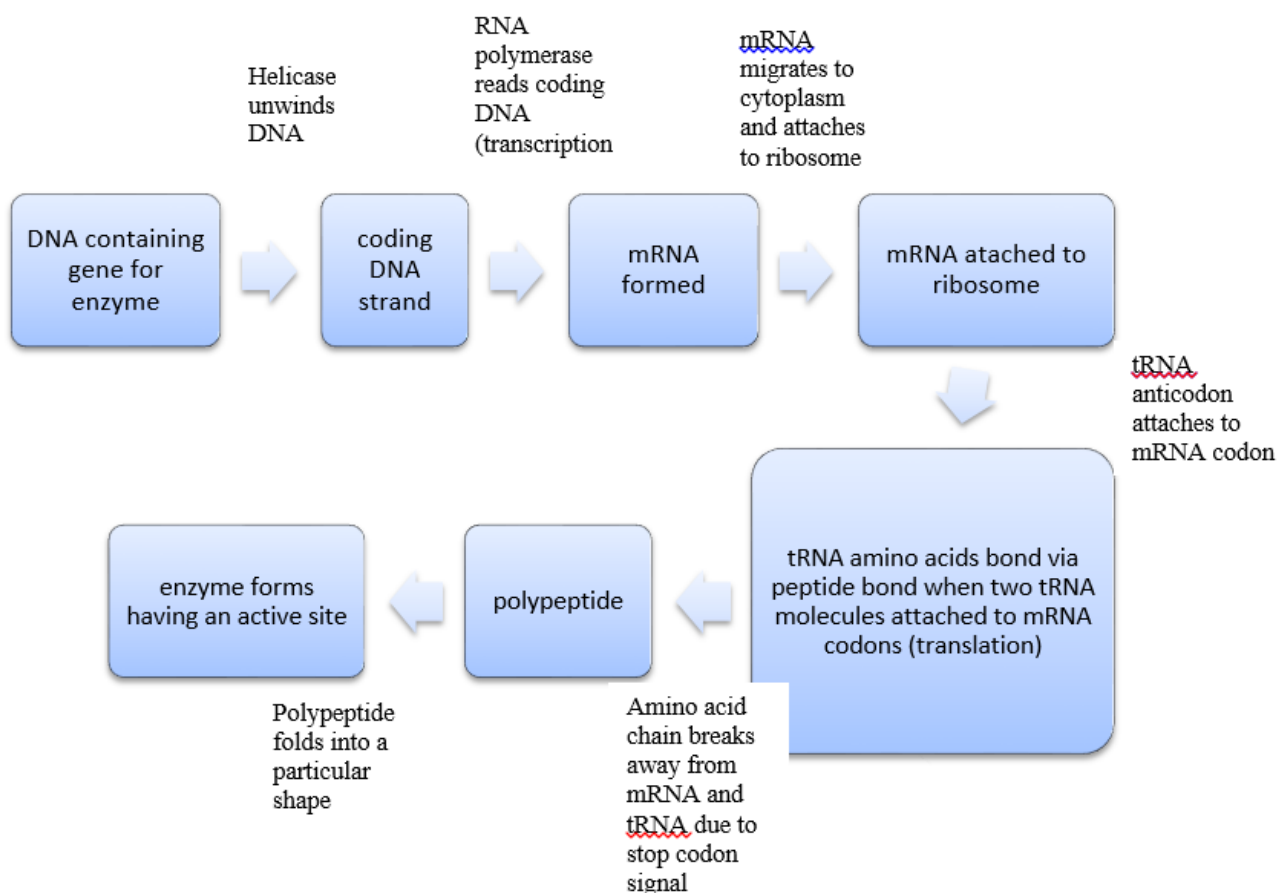
The polypeptide folds into specific shape that provides an active site for catalysing a chemical reaction.

Criteria	Marks
Uses a flowchart to outline the steps in forming an enzyme; includes transcription and translation. Shows processes and products	3
As above but missing one point	2
As above but missing two points	1
Provides part of a flow chart and two sequential steps associated with polypeptide synthesis	1

Note: G = gene for enzyme identified; S = distinct steps; F = polypeptide folds

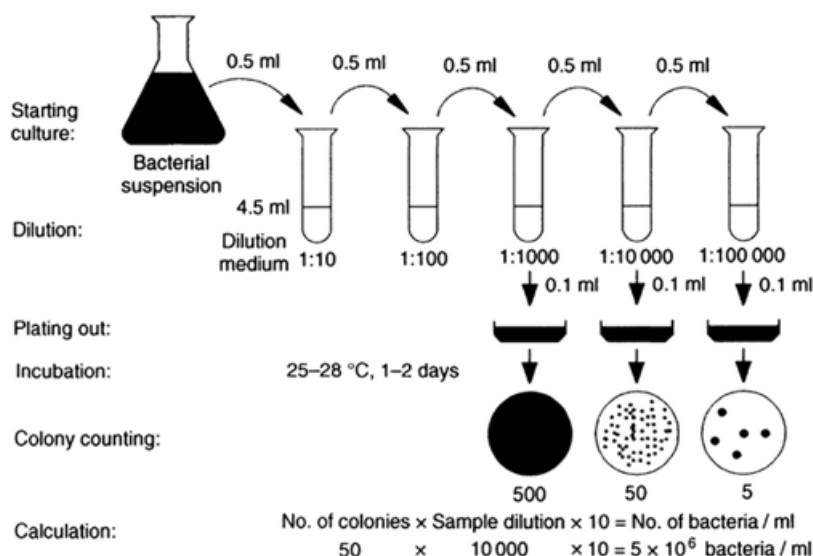
Many students do not know how to construct a flow chart.

Many students did not commence with the enzyme's gene.



(e) A process used in biotechnology since the 1950s is represented in Figure 1.

Figure 1. A process used in biotechnology



(i) Compare this process with another strain isolation method. (1 mark)

Streak plate method: Stain isolation involved streaking an agar plate with mixed culture and allow it to grow under certain conditions. Then streaking it at 90° to the original observe their growth. The above method does not involve streaking the agar plate. Both methods require incubation of the agar medium.

Criteria	Marks
Compares serial dilution with streak plate technique for isolating and identifying a strain: identifies two differences or one similarity and one difference	1

Note:

Many students did not compare and instead described the streak plate method. Must use “different in that...”; “both use...”; “both are similar in that...”.

Differences could include: various types of nutrient agar used in order to influence the type of microbe that grows on the medium; no dilution used in streaking method; streak method requires the use of inoculating loop to streak (spread) the microbes on the agar; may expose the agar plate to antibiotics to filter certain microbes

Similarities: sequential agar plates required for both; both require incubation; both use agar plates

Note: not testing the effectiveness of a “substance” on preventing bacterial growth-this is strain identification rather than isolation

- (ii) Justify the use of strain isolation methods in biotransformation technologies. (2 marks)

Strain isolation is important since it enables the identification of microbes suitable for efficient and effective biotransformation processes. E.g., a fungus that will convert a chemical from feedstock into another chemical for a specific chemical reaction in the synthesis sequence which is then used in a series of other chemical reactions in the laboratory to form cortisone.

Criteria	Marks
Explains how strain isolation is used to identify suitable microbes for chemical conversions in biotransformation technology using a suitable organic compound.	2
Outlines one use of strain isolation is used to identify suitable microbes for chemical conversions using a suitable organic compound.	1

Note: ID = identification of microbe; R = reason given for why microbe is used in biotransformation

Penicillin production is not accepted as this is strain isolation to produce a microbe that gives a greater yield of the chemical (antibiotic).

- (f) Hard cheeses are an example of the use of genetically modified organisms in food production. Chymosin, the primary component of rennin, is the milk-clotting enzyme used to make cheese and other dairy products. Traditionally, this substance was derived from the stomachs of calves. Most rennin used today is commercially produced by genetically modified microorganisms fungi or bacteria.

Describe the sequence of gene manipulation events that result in a GM bacterium that will produce rennin. (5 marks)

- cutting and joining DNA
- monitoring the cutting and joining
- transforming hosts, such as bacteria, with the recombinant DNA

Cutting and joining DNA:

Cut DNA containing the chymosin gene with same restriction enzyme as that used to cut the bacterial plasmid (obtained from salting out the bacterial cells)

Join recombinant DNA using DNA ligase

Monitoring the cutting and joining:

Plasmid contains two genes, one gene confers resistance to an antibiotic, ampicillin while the other gene expresses an enzyme, lacZ. The foreign DNA is inserted in the middle of the lacZ gene thus disrupting its expression. Hence **bacteria** that have been transformed will have resistance to the ampicillin antibiotic and will not show a reaction (colour change) when a substance that reacts with lacZ is added.

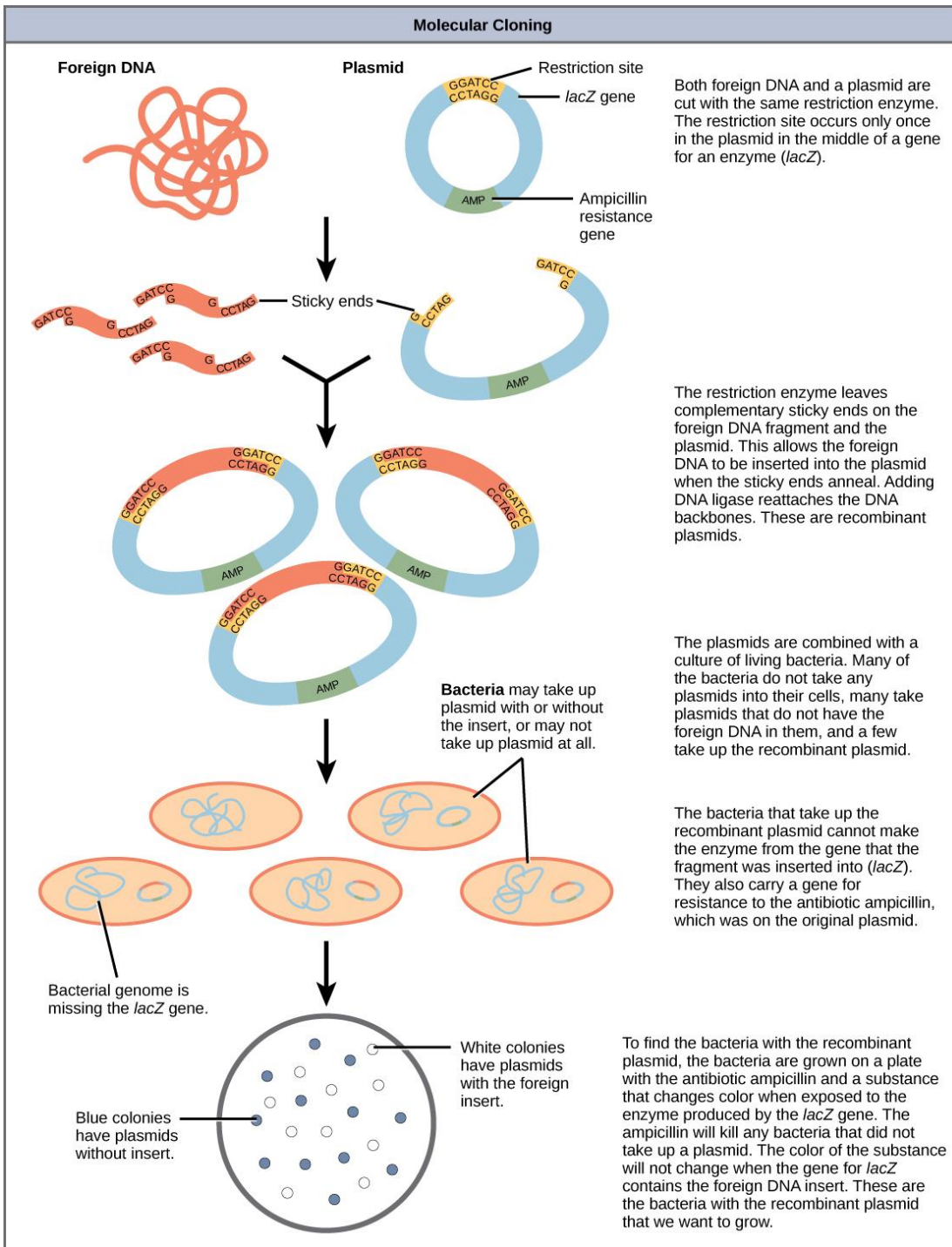
Transforming hosts

Using calcium chloride to salt the bacteria enables them to move plasmid across cell membrane. The bacterial cell is made competent either by electroporation or by using a cold liquid, such as CaCl₂ (calcium chloride) to temporarily induce a more permeable cell membrane. The recombinant plasmids and the bacterial cells are then mixed together. Plasmids enter the bacteria in a process called transformation.

Identify the recombinant bacteria: the **bacteria** that have been successfully transformed will have resistance to the ampicillin antibiotic and will not show a reaction (colour change) when a substance that reacts with lacZ is added.

Criteria	Marks
Explains the three distinct steps in sequence for producing a recombinant bacteria: cutting and joining DNA, monitoring the cutting and joining, transforming hosts	5
As above but outlines one step instead of explaining	4
Explains two distinct steps in sequence for producing a recombinant bacteria: cutting and joining DNA, monitoring the cutting and joining, transforming hosts	3
As above but outlines one step instead of explaining	2
Explains one distinct step in sequence for producing a recombinant bacteria: cutting and joining DNA, monitoring the cutting and joining, transforming hosts OR identifies the 3 steps	1

Note: G = gene identified; RE = SAME restriction enzyme used; L = DNA ligase used to anneal; M = monitoring; T = transformation process



End of Section II

