



# Biology

## General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil

### Section I Pages 3 – 20 Total marks (75)

This section has two parts, Part A and Part B

#### Part A Total marks (15)

- Attempt questions 1 – 15
- Allow about 30 minutes for this part

#### Part B Total marks (60)

- Attempt questions 16 – 27
- Allow about 1 hour and 45 minutes for this part.

### Section II Pages 21 – 25 Total marks (25)

1. Attempt all parts of this question
  - Allow about 45 minutes for this section.

1

## Section I Total marks (75)

### Part A Total marks (15) Attempt questions 1 – 15 Allow about 30 minutes for this part

Use the multiple-choice answer sheet.  
Select the alternative A, B, C or D that best answers the question. Fill in the response oval 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:

A ☒ B ☒ C ☐ D ☐  
correct

1. The graph below shows how the activity of three enzymes varies with pH.

The table below lists the pH of various parts of the alimentary canal.

Body Part	pH
mouth	6.0
stomach	2.0
duodenum	11.0
large intestine	9.0

Which enzyme is likely to be active in the duodenum?

- A. salivary amylase
- B. pepsin
- C. arginase
- D. none of the above

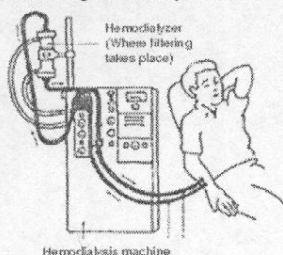
2. Which of the following was NOT a part of Gregor Mendel's successful experimental design?

- A. the choice of non sex linked traits for study
- B. using self pollinating plants
- C. repeating experiments on large numbers of plant crosses
- D. limited phenotypic ranges for each trait



3. Which of the following is the best definition of a pathogen?
- a micro-organism living on or in the human body
  - a protein on the surface of an invading microbe
  - a micro-organism which can be transmitted between people
  - an infecting agent which impairs the functioning of an organism

4. Which of the following substances/materials are removed from the blood of patients using a haemodialysis machine?



- red blood cells, blood proteins
  - urea, uric acid
  - glucose, amino acids
  - ammonia, fatty acids
5. The "Cambrian Explosion" of invertebrate life in the oceans of the Paleozoic is an example of
- gradual evolution
  - punctuated equilibrium
  - convergent evolution
  - special creation
6. Which of the following would be classified as a barrier to prevent entry of pathogens into humans?
- phagocytosis
  - salty surface to the skin
  - inflammation
  - vaccination

5

10. The picture below is a light micrograph of red blood cells. A scale bar is provided.



Which of the following would be the best estimate of the diameter of the red blood cells?

- 15mm
  - 18um
  - $2 \times 10^{-6}$  m
  - 8 mm
11. *Macropus robustus*, the euro, is a desert dwelling native mammal.
- Which of the following characteristics of the euro would be considered an adaptation to mitigate against water loss in a dry environment
- They pant to induce evaporative cooling.
  - They excavate a hole near or under rocks and stunted trees. In the hole, they lie in a upright position, very alert and difficult to approach.
  - Euros can survive on minimal nutrients and do not need to forage great distances or at great speeds for nutrient rich plants.
  - Euros have a very efficient excretory system that recycles nitrogen and urea to make a very concentrated urine.

7

7. Which of the following is the most significant change in chemical composition of the blood as it passes through the lungs?

- Reduction in plasma urea concentration
- Reduction in % saturation of haemoglobin with oxygen
- Increase in carbon dioxide levels carried on red blood cells
- Increase in suspended lipid molecules.

8. The photograph below depicts Kopy Cat (the first cloned cat) and her surrogate mother.



Which of the following techniques would have been used to produce Kopy Cat?

- artificial insemination
  - nuclear transplantation
  - artificial pollination
  - genetic engineering
9. Which of the following would be described as a non-infectious disease?
- A condition caused by a toxin released by a bacterium dispersed in droplets.
  - Rabies virus can be passed from dogs to humans in a dog bite
  - Liver flukes pass out of the body in the faeces and in through the skin in contaminated water.
  - A nutritional deficiency associated

6

The next two questions refer to the data below concerning plants in saline estuarine environments.

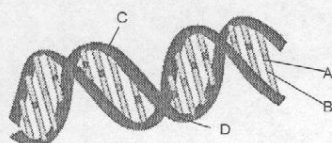
Most plants cannot tolerate high salt concentrations in the root zone as it leads to water stress. Once in the plant, salt can accumulate in the leaves and is toxic. Enzymes are inhibited by  $\text{Na}^+$  ions.

The grey mangrove, *Avicennia marina*, has special salt glands in its leaves that excrete salt. Other mangroves exclude salts at their roots through ultra-filtration, and a third mechanism is to allow salt to accumulate in leaves and then drop the leaves.

12. "Water stress" in this context is probably the result of
- active transport
  - osmosis
  - capillarity
  - enantiostasis
13. Which of the following is the best reason that species like the grey mangrove are naturally selected in estuarine environments?
- Salt concentrations within the grey mangrove vary with the fluctuations in salt in the environment.
  - Grey mangroves do not find salt toxic.
  - Some species of mangrove can get rid of salt from their tissues.
  - The salt concentration of the grey mangrove is independent from the salt concentration of the environment.

8

The next two questions refer to the sketch of DNA below.



14. Which of the following is the correct label for a nitrogenous base?

A. A  
B. B  
C. C  
D. D

15. If the above DNA fragment coded for a polypeptide, how many large would that polypeptide be?

A. 15 amino acids long  
B. 15 bases long  
C. 5 amino acids long  
D. 5 phosphates long

9

17. Identify ONE response of a plant to a defined temperature change. 2

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18. Describe how the story of the discovery of the structure of DNA demonstrates the need for communication between and collaboration of scientists from different disciplines. 3

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11

## Section I

### Part B

Total marks (60)

Attempt questions 16 – 28

Allow about 1 hour and 45 minutes for this part

Show all relevant working in questions involving calculations.

16. The following light micrograph of a pathogen was taken using a monocular light microscope on low power.



- (a) Identify the group of pathogens into which this organism would be classified. 1

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- (b) Name one disease caused by this type of pathogen. 1

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- (c) Label and name a characteristic feature of this type of pathogen on the micrograph above. 1

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10

19. (a) Draw a labelled and scaled diagram of a plant structure that you have studied which assists in the conservation of water for the organism. 3

- (b) Explain the water conserving role of the drawn structure. 2

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12



20. A science fiction novel depicts some futuristic experiments in which the brown haired and brown eyed heroine, Xena, is involved in reproduction.

In experiment 1, two ovum from Xena are made to fuse into a zygote in vitro, and offspring develop after implantation within Xena.

In experiment 2, Xena is cloned using one of her somatic cells and an ovum from a donor. The resulting zygote is implanted into Xena for gestation.

Use this fictional context and predictions of phenotypes of the progeny produced by these two reproductive methods, to explain the role of gamete formation and fertilisation in the variability of a species. 6

13

22. An internet home page contained this statement from a parent of a child who had undergone a liver transplant.

*"My daughter Brittany is now 5 years old. When she was six months she was put on a liver transplant list. In September she received a liver from a one year old who had passed away. After the operation she was put on immuno-suppressant drugs and all staff attending to her had to wear sterile face masks and gloves. We waited to her for weeks behind a glass window.....visitors were not allowed. By Christmas, Brittany had returned home without need of medication and able to mix freely with our family."*

- (a) Outline the medical reasons for prescribing immuno-suppressant drugs in such cases. 2

- (b) Justify the effective quarantine of Brittany after the operation. 2

- (c) Assess the reliability of this information on the risks of liver transplant surgery. 2

15

21. The following information was extracted from an online medical textbook after a search using *adosterone* and *deficiency* as key words.

Hypoadosteronism is a condition where people fail to secrete aldosterone. Addison's disease is the name of a disease with these symptoms which include high urine output with a resulting low blood volume. Eventually, as blood pressure falls, this can result in heart failure. A replacement hormone, fludrocortisone (Florinef), is used to treat this condition but a careful monitoring must be maintained to avoid fluid retention and high blood pressure.

Most cases of Addison's disease are caused by the gradual destruction of the adrenal cortex, the outer layer of the adrenal glands, by the body's own immune system. About 70 percent of reported cases of Addison's disease are due to auto-immune disorders, in which the immune system makes antibodies that attack the body's own tissues or organs and slowly destroy them.

- (a) Recall the effect of aldosterone on the kidney tubule. 1

- (b) Explain the high urine production in people suffering the condition hypoaldosteronism. 2

- (c) Describe the mechanism by which the cells of the adrenal cortex usually avoid the ravages of the immune system. 2

14

23. Draw a flow chart to represent one specific mechanism involved in thermo-regulation in mammals, including named processes that would be categorised as

- (i) detecting changes from the stable environment
- (ii) counteracting changes from the stable state

Include in your flow chart how the mechanism responds to reductions in body temperature and increases in body temperature. 4

1

16

24. You have designed an experiment to model natural selection.

- (a) Describe your experimental design.

3

- (b) Outline how you had to refine your experimental plan to address issues in relation to the validity of data collected.

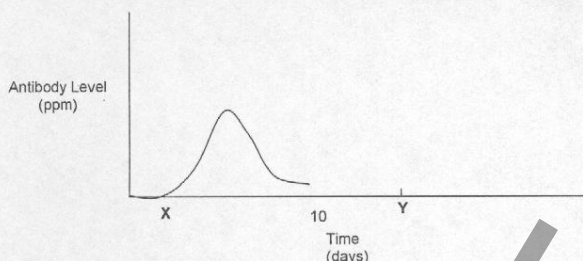
2

- (c) Discuss the limitations of models in science using this experiment as an example.

2

17

26. The graph below summarises the changes in blood concentration of antibody in laboratory rats after exposure to a subunit vaccine at X.



- a) Identify the type of lymphocyte involved in the production of antibodies.

1

- (b) Describe the interaction between a named B cell and a named T cell which occurs between X and day 10.

3

The rats are injected with the live pathogen at Y.

- (c) Complete the above graph for the antibody levels of the humans until day 18.

1

- (d) Account for the shape of the graph that you drew in (c).

2

19

25. The following passage is taken from a brochure advertising an instrument which measures blood gases.

Pulse oximetry is a simple non-invasive method of monitoring the percentage of haemoglobin (Hb) which is saturated with oxygen. The pulse oximeter consists of a probe attached to the patient's finger or ear lobe which is linked to a computerised unit. The unit displays the percentage of Hb saturated with oxygen together with an audible signal for each pulse beat.

A source of light originates from the probe at two wavelengths (650nm and 805nm). The light is partly absorbed by haemoglobin, by amounts which differ depending on whether it is saturated or unsaturated with oxygen. By calculating the absorption at the two wavelengths the processor can compute the proportion of haemoglobin which is oxygenated. The oximeter is dependant on a pulsatile flow and produces a graph of the quality of flow. Where flow is sluggish (eg blood vessel constriction,) the pulse oximeter may be unable to function.

- (a) Outline what is meant by % saturation of haemoglobin.

2

- (b) Analyse why this technology make not work on patients in intensely cold conditions.

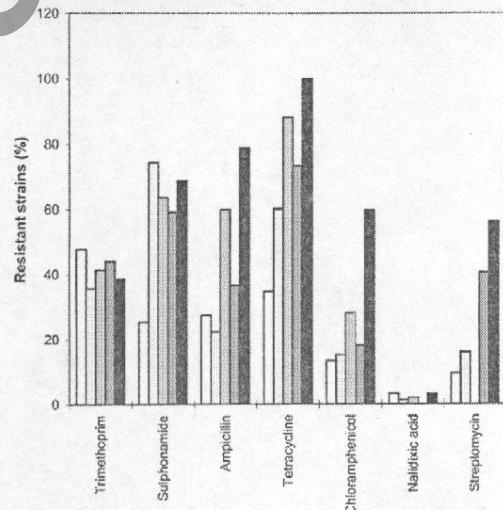
2

- (d) Classify this mode of testing as destructive or non-destructive. Justify your answer.

2

18

27. A student is required to collect data in order to evaluate the effectiveness of antibiotics since their development in World War II. She finds the following graph in a science journal.



Key:

1986

1988

1994

1996

1998

The graph shows percentage of resistant organisms in populations of bacteria at five sampling times after widespread use of named pharmaceuticals in the community.

20



(a) Identify the role of antibiotics in the management of infectious disease. 2

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(b) Assess the relevance of the information in the graph to the area of investigation. 2

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(c) For which antibiotic has there been the most evolution of resistant strains? Justify your answer. 2

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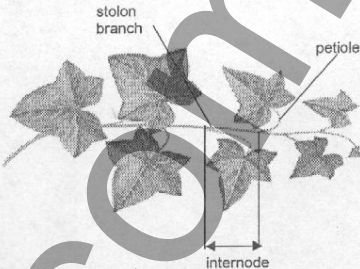
28. To investigate the effect of environment on phenotype, it is possible to grow ivy plants from cuttings of the same parent plant, and subject the resulting ivy plants to different light levels and soil nutrient availabilities.

Data presented below was found from secondary sources and was collected from experiments similar to that described above.

Ground Ivy. Data from Hutchins and Slade; "Plants Today" Jan-Feb, 1988.		
Treatment	Stolon Branches	Internode length (cm)
hi light/hi nutrients	37	6.4
hi light/low nutrients	22	7.0
low light/hi nutrients	5	10

Glechoma hederacea. Data from Tooley - Journal of Biological Education 23: 263 (1989)			
Light intensity (lux)	Petiole Length (% initial)	leaf number (% initial)	Leaf surface area (% initial)
400	28	30	7.8
2000	132	219	122.7

Examine the labelled diagram below of an ivy plant



(a) Assess the experimental design and the data collected in Figure 1 in terms relevance to the objectives of the investigation. 3

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(b) Assess whether the data collected for Figures 1 and 2 came out of the same experiment. Justify your answer. 3

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(c) If you wanted to accurately repeat the data collection for either Figure 1 or Figure 2 to ensure the reliability of the published results, which set of data would you choose to emulate? Justify your answer. 3

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29. The theory of evolution was not developed in a flash of inspiration winning instant global acclamation. Rather, it was reluctantly articulated and slow in receiving recognition and validation.

Discuss the social and political influences on the development of the theory of evolution. 6

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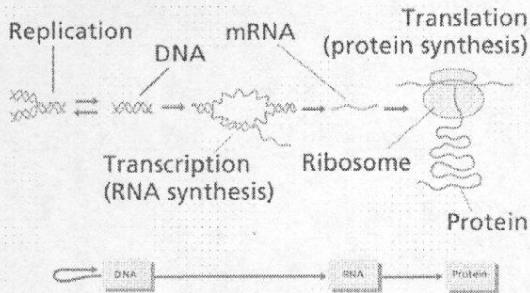
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OPTION 9.5: Genetics : The Code Broken?

Total marks (25)  
Attempt questions 1- 7  
Allow about 45 minutes for this part  
Write your answer in the booklet provided.

1. Examine the diagram below which summarises the current understanding of gene expression.



- (a) Compare transcription to translation. 4  
(b) Explain how a specific and identified error in DNA replication can lead to different outcomes in gene expression. 2

25

3. Two plants heterozygous for two traits are crossed. The genotypes of the two parent plants are AaBb. There is a co-dominant relationship between the genes A and a, and a dominant/recessive between the genes B and b.

Examine the table below which summarises the trait phenotype each gene codes for.

A	red flowers
a	white flowers
B	long stamens
b	short stamens

- (a) Identify the possible genotypes for the gametes of the parents if  
(i) the genes are inherited independently and no crossing over occurs  
(ii) the genes are inherited independently and crossing over occurs  
(iii) gene A is linked to gene B, and gene a is linked to gene b 3  
(b) Identify the ratio of phenotypes in the progeny of a cross produced in (a) (i). 2  
(c) Draw a punnett square for the cross in (a) (iii) and predict the ratio of phenotypes of the progeny. 2

27

2. A classroom of twenty biology students collected data about their variation in phenotype in reference to two traits. A table of results contains the data collected below.

Trait 1 : Blood Type				
A	B	A	AB	O
O	AB	O	A	A
A	A	B	A	B
AB	A	A	B	AB

Trait 2 : Height (cm)				
158	175	160	174	170
170	161	161	163	165
162	167	166	160	164
165	159	165	168	171

- (a) Plot data for each trait on separate and appropriate graphs on the graph paper provided. 4  
(b) Identify the polygenic trait in this question. Justify your answer from the data given. 3  
(c) Explain why some traits are polygenic and other traits are not. 3  
4.  
(a) Define gene cloning. 1  
(b) Identify one way in which scientists could verify that an animal was a clone of another animal. 1

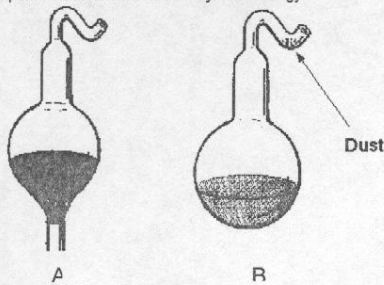
26

- 3 The role of enzymes in living systems would be best described as  
A. to speed up the reactions of the metabolism  
B. to control the pH of the cell  
C. to control the temperature of the cell  
D. both B and C  
9. If a relationship between two genes is classified as co-dominant, which of the following categories would you place an individual with an intermediate phenotype?  
A. homozygous  
B. heterozygous  
C. haploid  
D. diploid  
18. Active transport is necessary for kidney function.  
Explain this statement using ONE named substance involved in active transport in the kidney, citing the place in the kidney where this transport takes place. 3  
20. Identify a nitrogenous waste excreted by a named vertebrate. Explain the adaptive value for this animal of producing and excreting this particular form of nitrogenous waste. 3

28



24. The diagrams below illustrate a the set up of Louis Pasteur's classic experiment of nineteenth century microbiology.

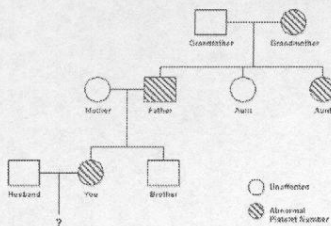


(a) Justify the design of the neck of the flasks in the set up. 2

(d) Assess the significance of the results of the experiment to the development of understanding of infectious disease. 2

29

31. The following pedigree was drawn up for a patient to show the incidence of a blood disease called thrombocytopenia in her family.



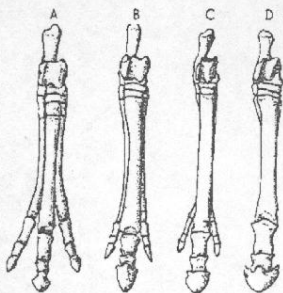
Medical scientists claim that this platelet abnormality appears to be inherited in an autosomal dominant manner.

(a) Define "autosomal dominant". 1

(b) Outline evidence in the pedigree which proves that thrombocytopenia is autosomal dominant. Explain. 2

31

30. The following diagrams A,B,C and D depict fossilised forelimbs of the horse like vertebrates.



The table below lists the estimate age of each fossil.

Fossil	A	B	C	D
Age (millions of years)	55	24	17	5

(a) Label the diagram of fossil A identifying features common to all vertebrate forelimbs. 2

(b) Explain how the above data can be considered as evidence for evolution. 3

30

28. One important component of homeostasis is the regulation of water concentration in the body.

Explain the need for maintenance of a constant water concentration in the body using your knowledge of the effect of substrate concentration on enzyme activity. 4

32