BOSTES | BOARD OF STUDIES TEACHING & EDUCATIONAL STANDARDS NSW

2016 HIGHER SCHOOL CERTIFICATE EXAMINATION

IMPORTANT: This resource was developed to support a previous version of the syllabus. It may contain content that differs from the current syllabus.

Biology

General Instructions

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

Total marks – 100

Section I Pages 2–24

75 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 – 55 marks

- Attempt Questions 21–31
- Allow about 1 hour and 40 minutes for this part

Section II Pages 25–35

25 marks

- Attempt ONE question from Questions 32–36
- Allow about 45 minutes for this section

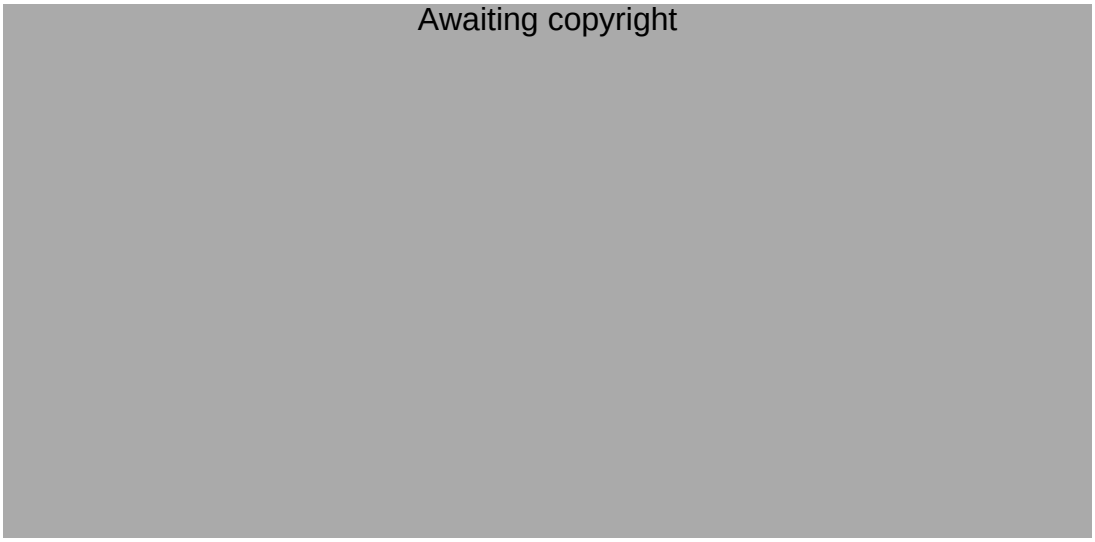
Section I
75 marks

Part A – 20 marks
Attempt Questions 1–20
Allow about 35 minutes for this part

Use the multiple-choice answer sheet for Questions 1–20.

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1 The diagram shows the shape of an enzyme and its substrate, before and after heating.



As a result of the temperature increase, enzyme activity will

(A) cease.

(B) increase.

(C) slow down.

(D) stay the same.

2 Normal microflora are considered to be pathogenic when they

(A) increase in size.

(B) are resistant to antibiotics.

(C) cause symptoms in a person.

(D) are transferred to another person.

3 Which of the following scientists proposed the chromosomal theory of inheritance?

(A) Walter Sutton

(B) Gregor Mendel

(C) Macfarlane Burnet

(D) Thomas Hunt Morgan

4 Beadle and Tatum's 'one-gene-one-protein' hypothesis was modified to the 'one-gene-one-polypeptide' hypothesis.

What does this modification tell us about their work?

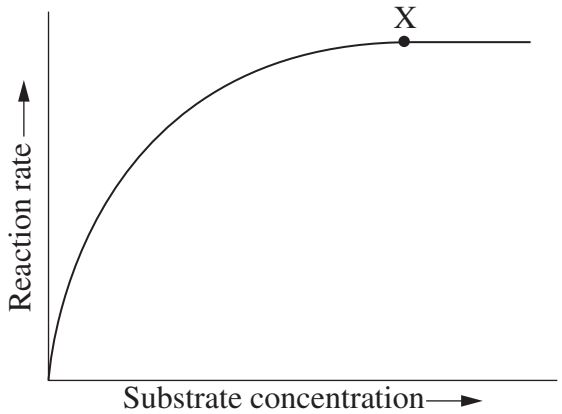
(A) Their results were inaccurate.

(B) Their experiments were poorly designed.

(C) Their results were not analysed properly.

(D) Their conclusions were provisional in nature.

5 The graph shows the relationship between substrate concentration and reaction rate in an enzyme-catalysed reaction.



Why does the reaction rate NOT continue to increase after point X?

(A) The enzyme has been denatured.

(B) The substrate has been denatured.

(C) The enzyme is no longer acting as a catalyst.

(D) All the enzyme active sites are being occupied.

6 Which of the following best describes *metabolism*?

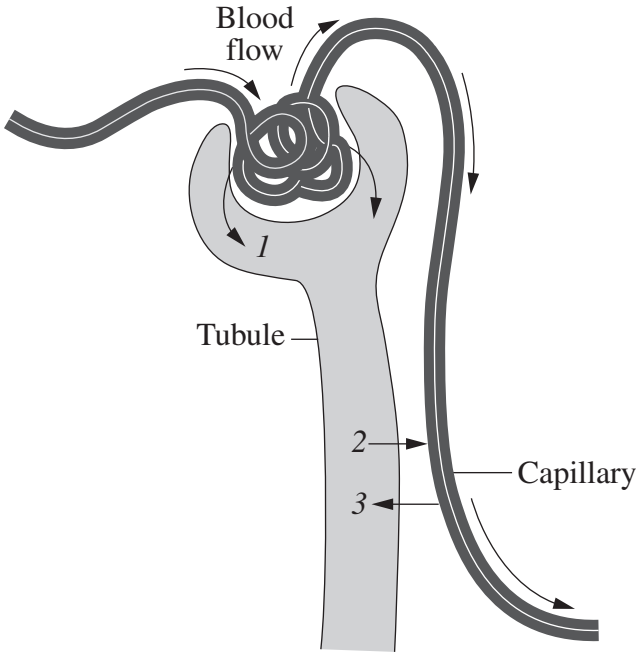
(A) The optimum activity of an organism

(B) All of the enzymes in a living organism

(C) An enzyme-catalysed reaction in an organism

(D) All the chemical reactions inside cells of an organism

7 The diagram shows a simplified model of a mammalian nephron and three processes labelled *1*, *2* and *3*.

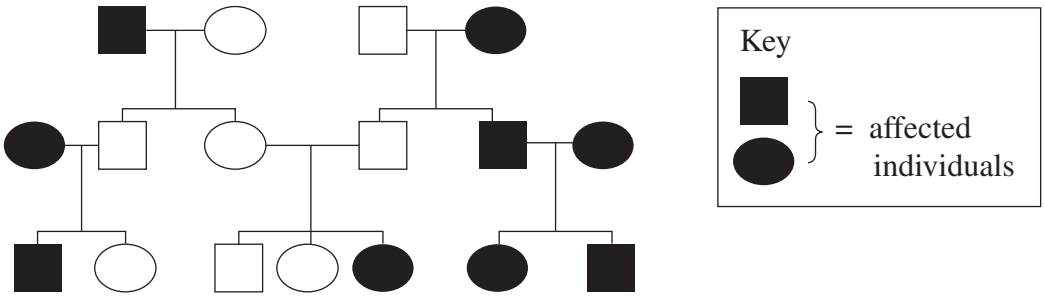


McGraw-Hill Education

Which row of the table correctly identifies each of the processes?

	1	*2*	*3*
(A)	Reabsorption	Filtration	Secretion
(B)	Filtration	Reabsorption	Secretion
(C)	Secretion	Reabsorption	Filtration
(D)	Filtration	Secretion	Reabsorption

8 The pedigree shows the inheritance of a characteristic.



What pattern of inheritance is shown?

(A) Dominant and sex-linked

(B) Recessive and sex-linked

(C) Dominant and not sex-linked

(D) Recessive and not sex-linked

9 Why is passive transport alone inadequate for the production of urine that is high in nitrogenous wastes?

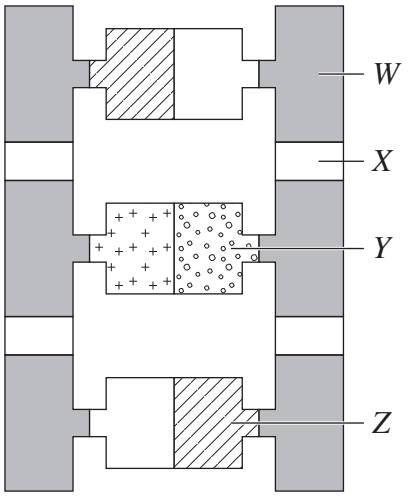
(A) Osmosis cannot target specific solutes.

(B) Solutes cannot move against a concentration gradient.

(C) Solute transport increases at low concentration gradients.

(D) Osmosis moves water from a low concentration to a high concentration.

10 A model of DNA is shown.



Which row of the table correctly identifies the different components of the model?

	W	*X*	*Y*	*Z*
(A)	Sugar	Phosphate	Adenine	Guanine
(B)	Phosphate	Sugar	Guanine	Cytosine
(C)	Sugar	Phosphate	Adenine	Thymine
(D)	Phosphate	Sugar	Guanine	Thymine

11 Antibodies are molecules released by

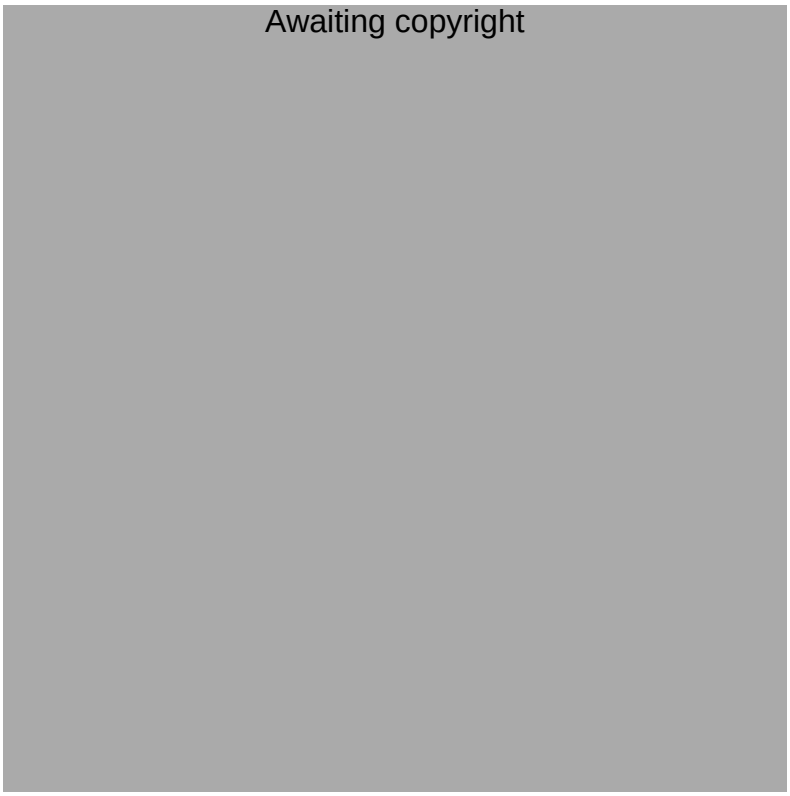
(A) memory B cells.

(B) memory T cells.

(C) specialised B cells.

(D) specialised T cells.

12 Some students investigated the response of a plant cutting to an increase in ambient air temperature. They used the apparatus shown.



Their data are shown below.

Air temperature (°C)	*Water lost in 60 minutes* (mL)
10	1
18	3
21	4
25	5
30	6

The benefit for the plant of this response would be a decrease in the

(A) rate of transpiration.

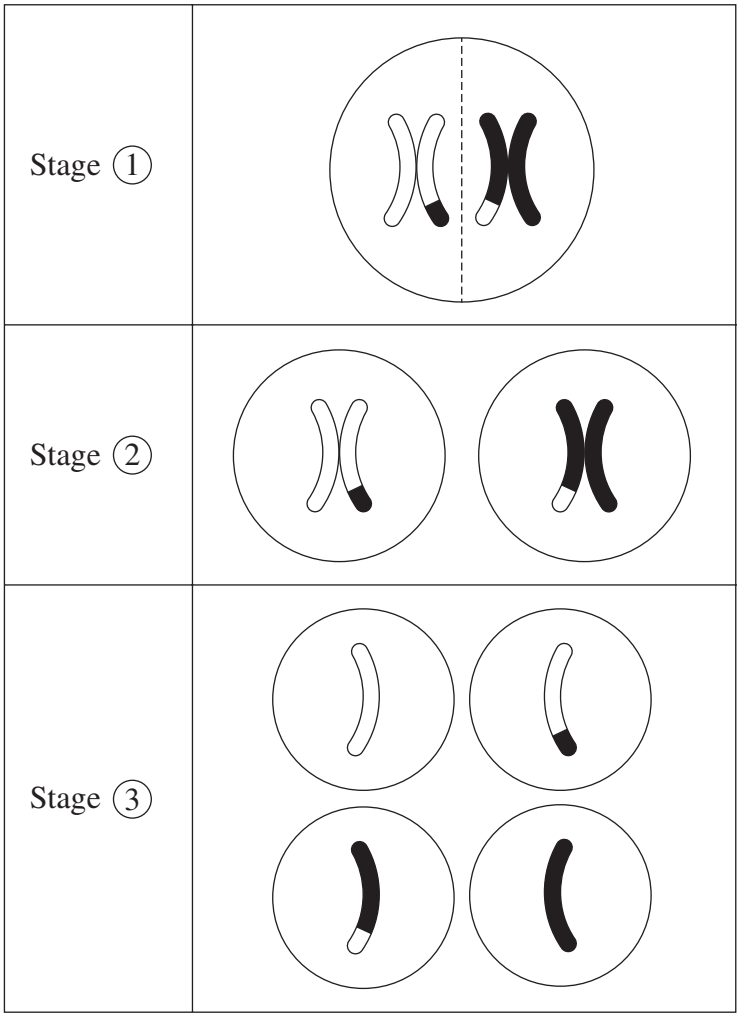
(B) rate of photosynthesis.

(C) temperature of the plant.

(D) amount of water in the plant.

Refer to the following information to answer Questions 13 and 14.

The diagram shows some chromosomes during some stages of meiosis.



13 When does the segregation of homologous chromosomes occur?

(A) Before stage ①

(B) Between stages ① and ②

(C) Between stages ② and ③

(D) Between stages ① and ② and again between stages ② and ③

14 The chromosomes shown carry

(A) different genes and different alleles.

(B) different genes and the same alleles.

(C) the same genes and different alleles.

(D) the same genes and the same alleles.

15 The table shows four features that can be used to distinguish between types of pathogens.

Which row of the table is correct?

	Feature	*Prion*	*Protozoan*
(A)	Contains DNA	✓	✗
(B)	Cellular	✗	✓
(C)	Can reproduce	✓	✗
(D)	Composed of protein	✗	✓

16 Ringbarking is the removal of a thin strip of bark from the entire circumference of a tree.

The tree will initially survive, but the roots will eventually die because ringbarking stops

(A) photosynthesis.

(B) the transport of water.

(C) the transport of oxygen.

(D) the transport of dissolved nutrients.

17 Capillaries have thin walls that help them perform their main function.

The best explanation for this is that

(A) capillaries are the smallest vessels in the body.

(B) thin walls are an adaptation that help diffusion.

(C) blood flow in capillaries is under very low pressure.

(D) thin walls maximise the surface area available for gas exchange.

18 How does the production of a new transgenic species have the potential to alter the path of evolution?

(A) The creation of new genes increases biodiversity.

(B) The removal of genes from a species decreases biodiversity.

(C) The transfer of genes within a species increases biodiversity.

(D) The transfer of genes between two species increases biodiversity.

Refer to the following information to answer Questions 19 and 20.

> Melanomas are characterised by uncontrolled cell division caused by mutations that continue to occur once the tumour has developed. Scientists have discovered that vaccines produced using antigens extracted from the patient's own melanoma cells can be useful in treating melanoma. When injected, the vaccines stimulate an immune response.

19 What can be inferred from the scientists' discovery?

(A) Cancer cells carry unique antigens.

(B) Self-antigens are not present on cancer cells.

(C) The melanoma patient has a dysfunctional immune system.

(D) The body cannot mount an immune response against cancer cells.

20 The effect of the melanoma vaccine is to stimulate

(A) T cells which produce antibodies.

(B) cytotoxic T cells which activate B cells.

(C) cell division to produce more lymphocytes.

(D) production of B cells which destroy melanoma cells.

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Biology

Centre Number

Student Number

Section I (continued)

Part B – 55 marks
Attempt Questions 21–31
Allow about 1 hour and 40 minutes for this part

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Extra writing space is provided on pages 23 and 24. If you use this space, clearly indicate which question you are answering.

Write your Centre Number and Student Number at the top of this page.

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Question 21 (2 marks)

Give TWO potential benefits of artificial blood. **2**

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Question 22 (2 marks)

Name an Australian ectotherm and describe its response to a decrease in ambient temperature. **2**

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Question 23 (5 marks)

(a) Explain ONE reason why the concentration of water in cells should be maintained within a narrow range for optimal cell function. **2**

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(b) A person has consumed large amounts of water. Complete the table to show the effect on each of the variables listed. **3**

Variable	*Effect*
Urine volume	
ADH secretion	
Salt concentration in blood	

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Question 24 (3 marks)

Name an infectious disease and explain how ONE host response is a defence adaptation. **3**

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Question 25 (6 marks)

Rabies is a disease caused by a virus that affects mammals.

In 1880 Louis Pasteur investigated dogs that were suffering from rabies in order to find the cause. He believed rabies was caused by a microorganism but could not culture it in broth nor observe it under the light microscope. However, he could cause the disease in healthy dogs by injecting them with saliva from infected dogs. He was able to repeat the disease cycle in this way.

(a) Why was Pasteur NOT able to observe the rabies virus? **2**

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(b) Explain why Pasteur needed to identify and culture the microorganism in order to meet the scientific standards for establishing the cause of rabies. **4**

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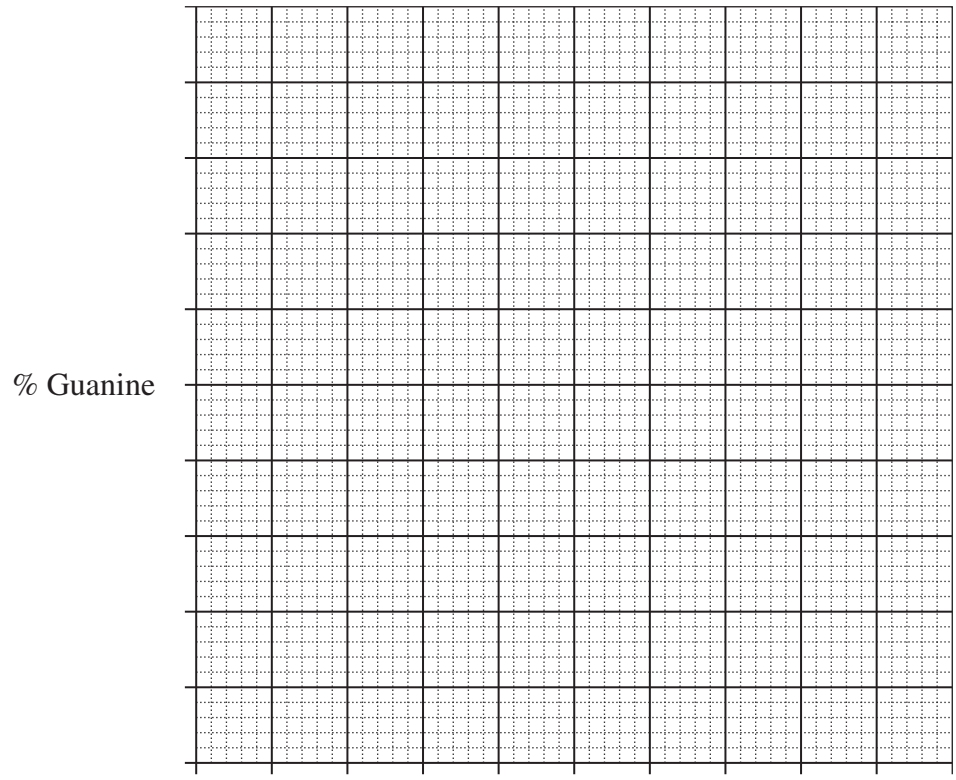
Question 26 (7 marks)

Students conducted preliminary experiments across different species to analyse their DNA base composition.

The table shows the experimental data collected.

Species	*% Adenine*	*% Guanine*
A	38	12
B	26	22
C	8	40
D	20	32
E	33	18

(a) On the grid below, plot the % Adenine vs % Guanine of the species analysed AND draw a suitable line of best fit. **3**



Question 26 continues on page 17

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Question 26 (continued)

(b) Identify the relationship shown by the data. **1**

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(c) Explain the relationship shown by the data. **3**

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End of Question 26

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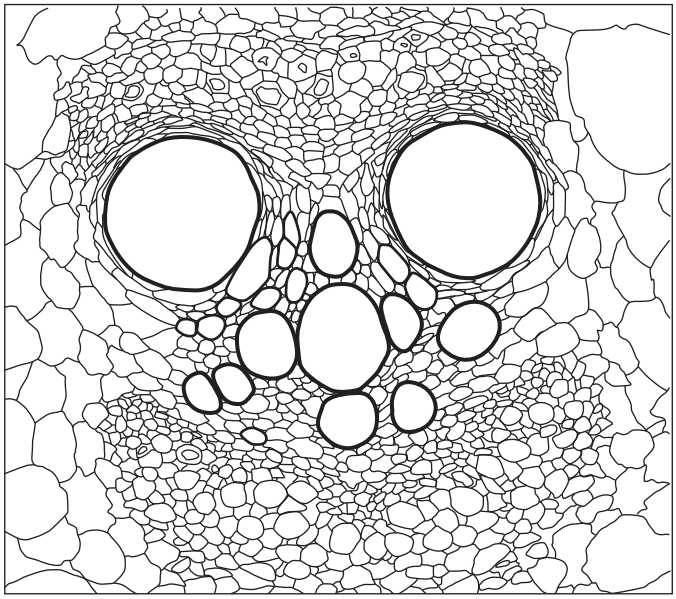
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Question 27 (4 marks)

The diagram shows a vascular bundle from a flowering plant.



Adapted from © Claudiodivizia | Dreamstime.com

(a) On the diagram, clearly label a xylem vessel. **1**

(b) A mutation in this species causes the walls of the xylem vessels to be significantly reduced in thickness. **3**

Explain why the leaves of these mutant strains will wilt more easily.

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Question 28 (6 marks)

Bacteriophages are viruses that use bacteria as host cells. One type of bacteriophage infects only one species of bacterial cell. The infected cells are destroyed as the bacteriophage particles burst out of them, completing their life cycle.

Bacteriophages can be used to fight bacterial infections. As bacteria evolve, bacteriophages also evolve.

(a) Explain TWO advantages of using bacteriophage treatment compared to antibiotic treatment for bacterial infections. **4**

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(b) Describe a possible disadvantage of using bacteriophage treatment. **2**

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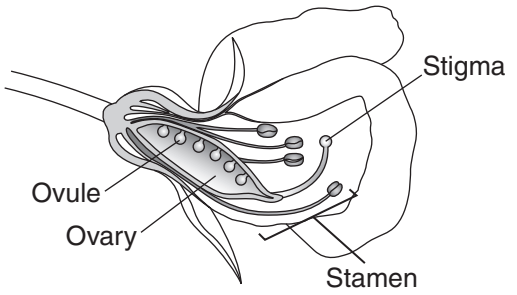
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Question 29 (7 marks)

The diagram shows the parts of a pea plant flower, similar to those used by Mendel in his experiments to investigate the inheritance of characteristics.



http://biology-forums.com/index.php?action=gallery

(a) Describe TWO ways in which Mendel's use of flower parts contributed to the success of his experiments. **3**

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(b) How did Mendel's experimental results advance our knowledge of the inheritance of characteristics? **4**

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Question 30 (5 marks)

Explain why the combined use of quarantine and vaccination programs is a more effective way of controlling disease than using only one of these strategies. **5**

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Question 31 (8 marks)

As altitude increases, the partial pressure of oxygen (pO_2) in air decreases. **8**

Species A and B are closely related endotherms that live in different habitats in Asia. The minimum pO_2 required for 100% blood oxygen saturation differs in these species because of differences in their haemoglobin structure. Data related to these two species are shown below.

Endotherm species	*Habitat altitude*	*Minimum pO_2 for 100% Hb saturation*
A	High	54
B	Low	80

Explain how the differences in these species could have arisen, using the Darwin/ Wallace theory of evolution and your understanding of the adaptive advantage of haemoglobin.

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Question 31 continues on page 22

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Question 31 (continued)

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End of Question 31

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Section I Part B extra writing space

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Section I Part B extra writing space

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Biology

Section II

25 marks
Attempt ONE question from Questions 32–36
Allow about 45 minutes for this section

Answer parts (a)–(e) of one question in the Section II Writing Booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Pages

Question 32 Communication 26–27

Question 33 Biotechnology 28–29

Question 34 Genetics: The Code Broken? 30–31

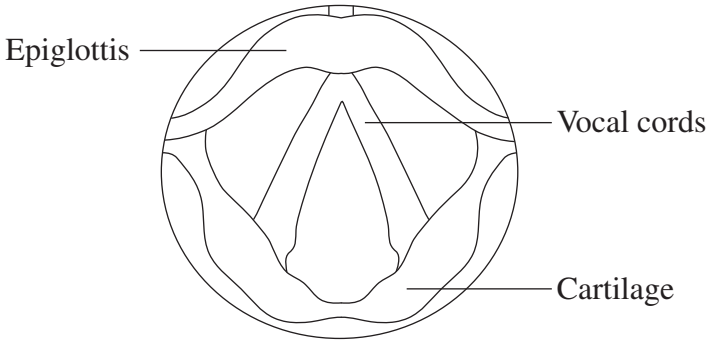
Question 35 The Human Story 32–33

Question 36 Biochemistry 34–35

Question 32 — Communication (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

(a) The diagram shows a cross-section of the part of the human body responsible for voice production.



© 2008 Trialsight Medical Media

(i) Name the part of the human body shown. **1**

(ii) Describe how vocal cords produce sounds of different frequencies. **2**

(b) A student conducted an experiment to model the process of accommodation. **5**

Describe the experiment and how the first-hand data collected could contribute to an understanding of how accommodation works in human vision.

(c) (i) Describe how electrochemical changes in the membrane of a neurone allow information to be transferred. **2**

(ii) The brain includes the cerebrum, cerebellum and brain stem. Draw an outline diagram of the human brain, and shade and label the area of the cerebrum involved in the perception of sound. **2**

Question 32 continues on page 27

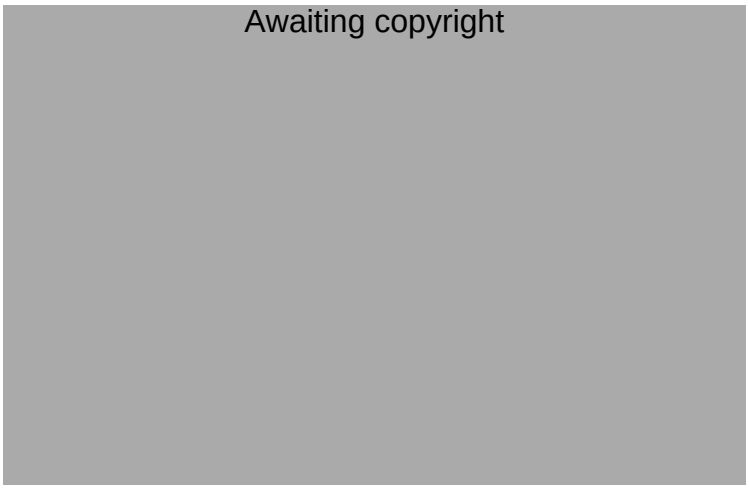
Question 32 (continued)

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

(d) Total colour blindness is a condition that causes people to see only black, white or grey. Colours all appear as grey.

An eyeborg is a new technology that can be worn externally on the head to help these people perceive differences in colour.

The diagram shows an eyeborg. It has a receiver which points to an object. Light reflected from the object causes an electronic message to be sent along a wire to a speaker which produces a sound of a specific frequency that is detected by the ear. Different colours produce sounds of different frequencies.



(i) Describe the energy transformations occurring at locations 1, 2 and 3 in the diagram. **2**

(ii) Other technologies also improve human communication. Name ONE such technology and compare it to an eyeborg in terms of the impact it has on the user. **4**

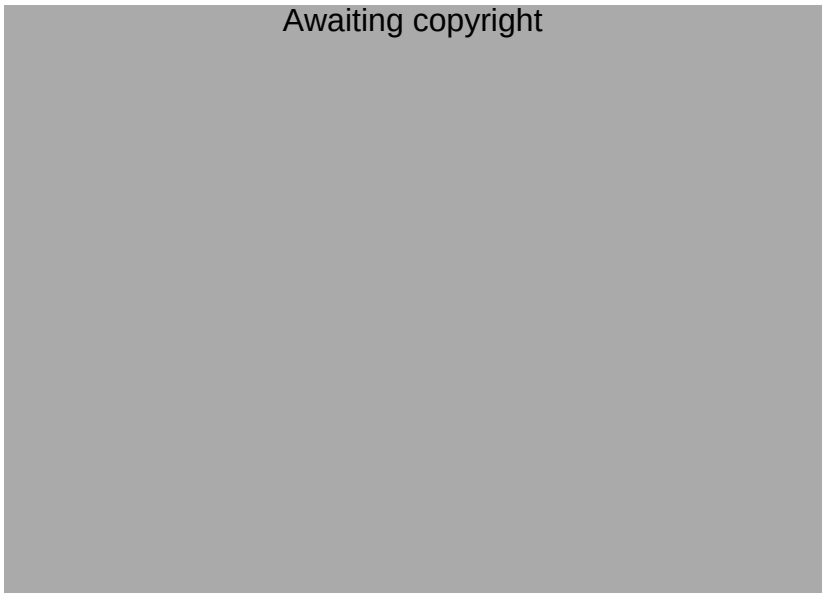
(e) Compare mechanisms in the human body for detection and perception of a range of frequencies in visual and auditory communication. **7**

End of Question 32

Question 33 — Biotechnology (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

(a) The diagram shows a step in protein synthesis.



(i) Name the process by which mRNA is produced. **1**

(ii) Explain why the mRNA moves in the direction shown. **2**

(b) A student conducted an experiment to investigate the rate of enzyme activity. **5**

Relate the understanding gained from performing this experiment to an application of biotechnology.

(c) (i) Explain why the Polymerase Chain Reaction (PCR) is used in biotechnology. **2**

(ii) Draw a flow chart to show the sequence of events that results in the formation of recombinant DNA. **2**

Question 33 continues on page 29

Question 33 (continued)

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

(d) (i) Explain a benefit of strain isolation in biotechnology. **2**

(ii) Assess the impact of our understanding of restriction enzymes on developments in biotechnology. **4**

(e) 'Artificial selection and animal cloning are similar biotechnologies, used to create organisms with improved characteristics.' **7**

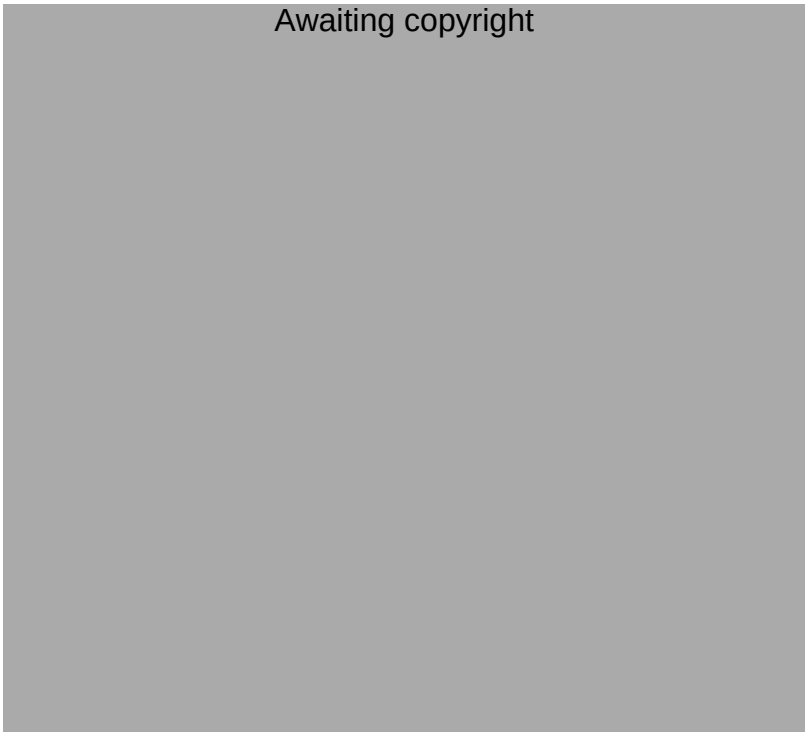
Evaluate this statement. In your response, include reference to the processes involved in the two biotechnologies.

End of Question 33

Question 34 — Genetics: The Code Broken? (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

(a) The diagram shows a process used in agriculture.



(i) Name the process shown. **1**

(ii) Give TWO reasons for what occurs in the shaded area. **2**

(b) Explain how selective breeding has resulted in a series of changes in an agricultural species. **5**

(c) (i) Provide a human and a non-human example of multiple allelism controlling a trait. **2**

(ii) Sketch a graph that shows the variation of a named polygenic trait within a population. **2**

Question 34 continues on page 31

Question 34 (continued)

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

(d) (i) Using an example, describe what is meant by *gene cloning*. **2**

(ii) Assess the impact of advances in our understanding of mutations on the development of technologies. **4**

(e) 'Genes influence proteins and proteins influence genes.' **7**

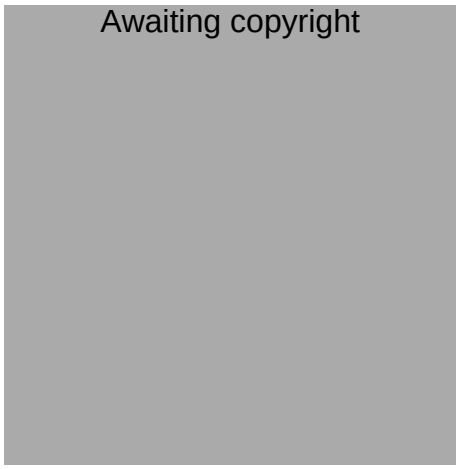
Evaluate this statement with reference to the structure and function of genes and proteins.

End of Question 34

Question 35 — The Human Story (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

(a) The diagram shows rock layers containing a number of fossils. A dating technique was used on this data alone to determine that the youngest fossil was in layer *D*.



(i) Name the dating technique used. **1**

(ii) Name a different dating technique and describe how it could be used to verify this finding. **2**

(b) The table compares some of the amino acids present in a particular protein in different primates. **5**

Human	PRO	GLY	GLY	ALA	ASN	ALA	THR	ARG
Ape (chimpanzee)	PRO	GLY	GLY	ALA	ASN	ALA	THR	ARG
Ape (gorilla)	PRO	GLY	GLY	ALA	ASN	ALA	THR	LYS
New world monkey	PRO	GLY	GLY	ASN	ASN	ALA	GLN	LYS
Prosimian	PRO	GLY	SER	HIS	ASN	ALA	GLN	LYS

Using these data and your knowledge of the characteristics of primate groups, explain why using different types of data improves the reliability of estimated evolutionary relationships.

Question 35 continues on page 33

Question 35 (continued)

(c) (i) What are TWO features of chromosomes used in karotype analysis? **2**

(ii) Sketch a graph that depicts changes in human population over the last 10 000 years. Identify a point on the graph that shows the effect of a technological advance on world population. **2**

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

(d) A new fossil form was recently found in South Africa. This fossil shares characteristics with both the genus Australopithecus and the genus Homo.

There has been debate as to whether this new fossil form should be classified in the genus Australopithecus or in the genus Homo.

(i) Describe a key difference between fossils classified as the genus Australopithecus and those classified as the genus Homo. **2**

(ii) Explain how DNA sequencing technology could be used to determine which genus the new fossil belongs to. In your answer, refer to relevant hominid species. **4**

(e) 'Biological evolution influences cultural development and cultural development influences biological evolution.' **7**

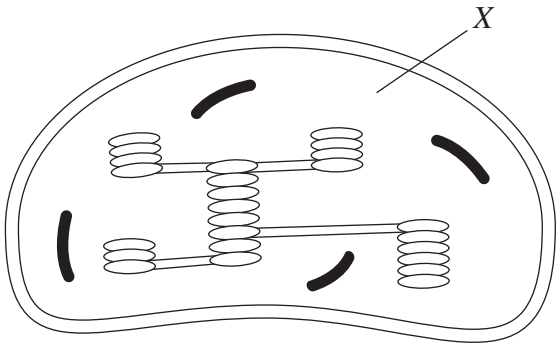
Evaluate this statement with reference to examples in hominid evolution.

End of Question 35

Question 36 — Biochemistry (25 marks)

Answer parts (a), (b) and (c) of the question on pages 2–4 of the Section II Writing Booklet. Start each part of the question on a new page.

(a) The diagram shows a plant cell organelle.



(i) Name the organelle shown. **1**

(ii) Give TWO reasons that explain why the Calvin cycle happens at *X*. **2**

(b) Explain how the energy liberated in the light-dependent reaction is stored and used in cells. **5**

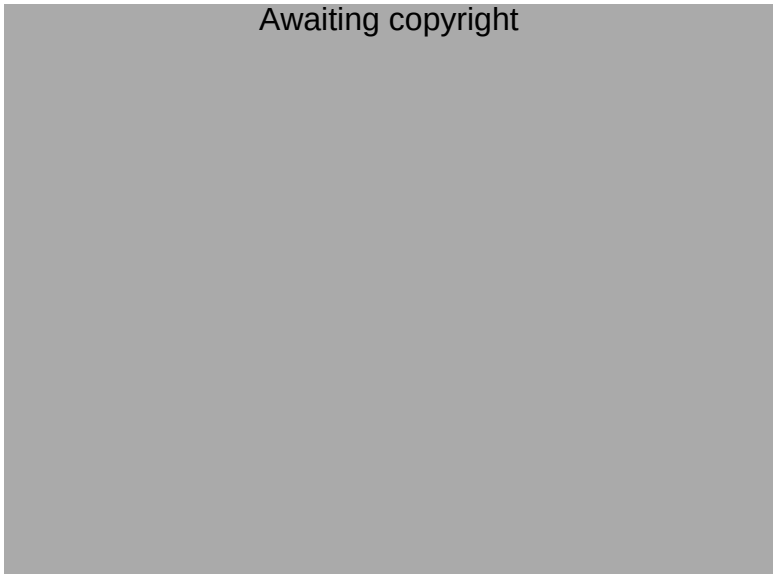
(c) Draw a labelled diagram showing the results of Engelmann's experiment which led to the description of the action spectrum of photosynthesis. Include wave lengths on your diagram. **4**

Question 36 continues on page 35

Question 36 (continued)

Answer parts (d) and (e) of the question on pages 6–8 of the Section II Writing Booklet. Start each part of the question on a new page.

(d) (i) An 'artificial leaf' uses a solar cell to convert sunlight into electricity. The electricity drives chemical reactions to split water into hydrogen and oxygen. Hydrogen can be collected and used as a fuel. **4**



Compare the artificial leaf to a plant leaf in terms of processes and products.

(ii) Why is research into artificial photosynthesis important? **2**

(e) 'Over the past 400 years, the development of our knowledge of the chemical transformations occurring both inside and outside plants has led to our current understanding of photosynthesis.' **7**

Evaluate this statement with reference to the experiments of TWO named scientists.

End of paper

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