NSW Education Standards Authority

2018 **HIGHER SCHOOL CERTIFICATE EXAMINATION**

Biology

General Instructions

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

Total marks: 100

Section I – 75 marks (pages 2–28)

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 21–30
- Allow about 1 hour and 40 minutes for this part

Section II – 25 marks (pages 29–42)

- Attempt ONE question from Questions 31–35
- 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 Why do some ectotherms bask in the sun?

A. To absorb vitamin D

B. To increase their activity

C. To decrease their metabolic rate

D. To constrict blood vessels close to the skin

2 Which substance in the table is correctly matched to the main form in which it is carried in mammalian blood?

	Substance	*Main form in which it is carried in blood*
A.	Oxygen	Dissolved gas
B.	Salts	Dissolved ions
C.	Glucose	Starch
D.	Nitrogenous waste	Uric acid

3 Which defence adaptation in the table is correctly matched with one of its features?

	Defence adaptation	*Feature*
A.	Inflammation	Constriction of blood vessels
B.	Phagocytosis	Production of antibodies by white blood cells
C.	Lymph system	Transportation of blood to help fight pathogens
D.	Cell death	Formation of a barrier around the pathogen

4 Which of the following describes the daughter cells produced as a result of mitosis?

A. Two genetically different cells

B. Two genetically identical cells

C. Four genetically different cells

D. Four genetically identical cells

5 Darwin and Wallace proposed the theory of evolution by natural selection.

Punctuated equilibrium differs from this theory in that punctuated equilibrium

A. occurs in relatively short bursts of rapid change.

B. requires genetic variation to exist in a population.

C. is driven by selection pressures in the environment.

D. discounts the idea that living organisms share a common ancestor.

6 The work of which of the following scientists demonstrated the mutagenic nature of radiation?

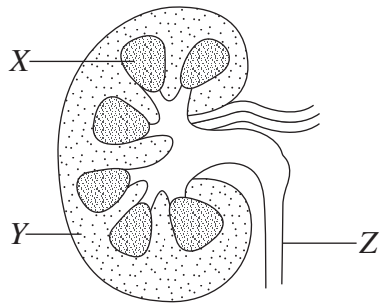
A. Mendel

B. Sutton

C. Tatum

D. Watson

7 Students dissected a mammalian kidney and drew the following diagram.



Which row in the table shows the correct labels for *X*, *Y* and *Z*?

	X	*Y*	*Z*
A.	Cortex	Medulla	Ureter
B.	Renal pyramid	Bowman's capsule	Renal artery
C.	Medulla	Cortex	Ureter
D.	Bowman's capsule	Cortex	Renal artery

8 An organism suspected of causing a disease is described as being unicellular, having a cell wall and lacking a nucleus.

How is this organism classified?

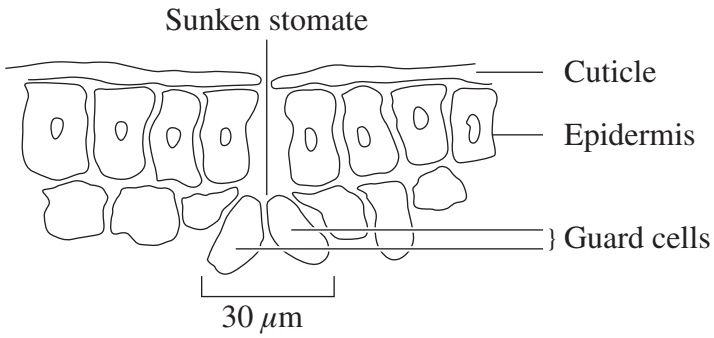
A. A bacterium

B. A fungus

C. A protozoan

D. A virus

9 Sunken stomata can be found in the leaves of some Australian plants. A section of such a leaf is shown.



How do sunken stomata assist the plant to conserve water in a dry environment?

A. They trap moist air, reducing humidity.

B. They prevent entry of gases into the leaf.

C. They accumulate moist air, reducing transpiration.

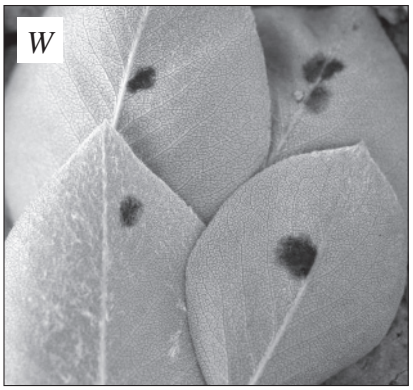
D. They increase the surface area available for transpiration.

10 Both artificial insemination and cloning are reproductive techniques that can decrease the genetic diversity of a population.

Which row of the table provides a correct reason for each technique's contribution to this decrease?

	Artificial insemination	*Cloning*
A.	Random fertilisation takes place	Large numbers of individuals are produced
B.	One male has many offspring	All gametes are genetically identical
C.	All male gametes are identical	All individuals have the same phenotype
D.	Fewer males are used to reproduce	All individuals have the same genotype

11 The following plants were presented to a quarantine office in Australia as part of a shipment of plants entering Australia for the plant nursery trade.



A photograph, 'Spots observed on the underside of a cultivar Bartlett', photo by Jay Pscheidt, Oregon State University, 2013 – taken from https://pnwhandbooks.org/plantdisease/host-disease/pear-pyrus-spp-scab

https://orchardpeople.com/wp-content/uploads/2017/09/IMG_3168-2.jpg

'Oak leaf blister (Taphrina Caerulescens)', Joseph Obrien, USDA Forest Service, Bugwood.org

This material cannot be displayed, due to copyright issues.

Which of the following is a decision that the quarantine office is likely to make?

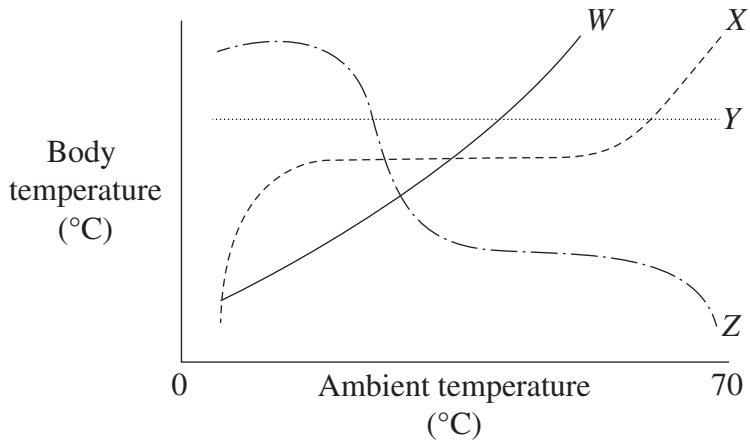
A. Plant *W* can enter Australia as it looks like it has 'black spot' which already occurs in Australia.

B. Plant *X* can enter Australia as it is unlikely the disease it has will transfer to Australian species.

C. Plant *Y* cannot enter Australia as it has a disease caused by shortage of soil magnesium.

D. Plant *Z* cannot enter Australia because its appearance suggests it may be carrying live insects.

12 The graph shows four possible relationships between ambient temperature and body temperature.



Which line on the graph represents the relationship between ambient temperature and body temperature for an endotherm in a terrestrial environment?

A. *W*

B. *X*

C. *Y*

D. *Z*

13 Red-bellied Black Snakes are a natural predator of frogs in Australia. With the introduction of Cane Toads into northern Australia, those snakes with jaws large enough to eat the large poisonous toads have died and those with smaller jaws have survived. Today, Red-bellied Black Snakes in northern Australia have, on average, smaller jaws than those in southern Australia.

Based on this information, which of the following statements is true?

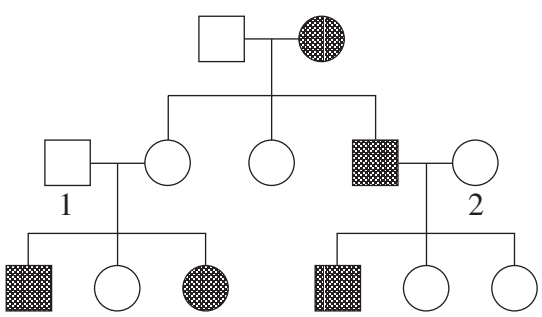
A. Divergent evolution has occurred in the snake populations.

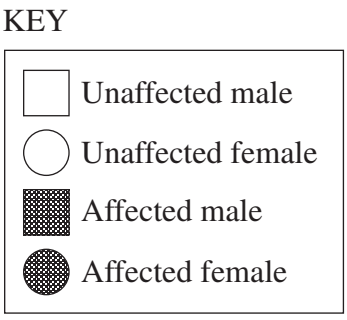
B. Convergent evolution has occurred in the snake populations.

C. Evolution has not occurred as the snakes are still all one species.

D. Evolution has occurred because snakes have developed resistance to the toxin.

14 The following pedigree shows the inheritance of a disorder.





Which row of the table shows the genotypes of individuals 1 and 2?

	Individual 1	*Individual 2*
A.	Aa	Aa
B.	AA	Aa
C.	X^AY	X^AX^a
D.	X^aY	X^AX^a

15 Which row of the table is correct with respect to the substances that pass through the nephron?

	Bowman's capsule	*Proximal convoluted tubule*	*Collecting duct*
A.	Chloride ions are at the same concentration as in plasma	All chloride ions are reabsorbed	Water is reabsorbed in the presence of aldosterone
B.	Plasma proteins are at the same concentration as in plasma	Water is reabsorbed by osmosis	Water is reabsorbed in the presence of ADH
C.	Glucose is at the same concentration as in plasma	All glucose is reabsorbed	Water is reabsorbed in the presence of aldosterone
D.	Sodium ions are at the same concentration as in plasma	Sodium ions are reabsorbed	Water is reabsorbed in the presence of ADH

16 How do helper T cells assist in raising a specific immune response to a pathogen?

A. They mass produce specific antibodies.

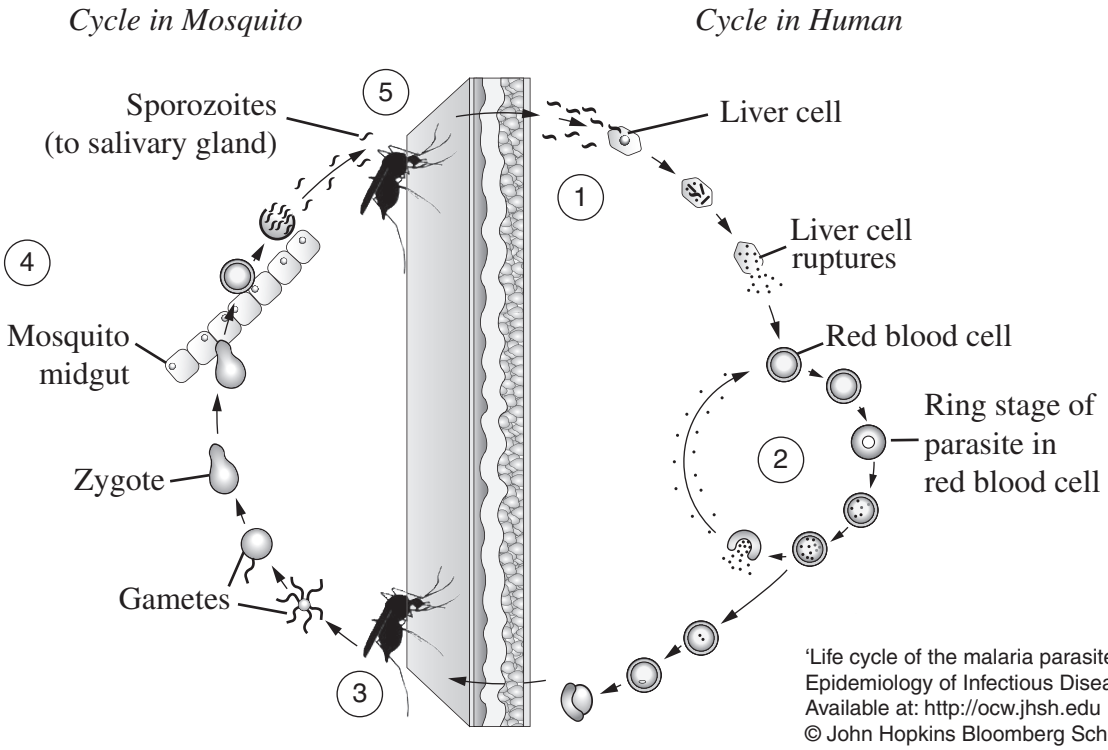
B. They stimulate the cloning of specific T cells.

C. They are cloned and differentiate to become specific cytotoxic T cells.

D. They produce cytokines that stimulate the cloning of specific phagocytes.

Please turn over

17 The diagram shows the life cycle of the malaria parasite, *Plasmodium* sp. Five stages in this life cycle are numbered on the diagram.



'Life cycle of the malaria parasite' from Epidemiology of Infectious Diseases. Available at: http://ocw.jhsh.edu

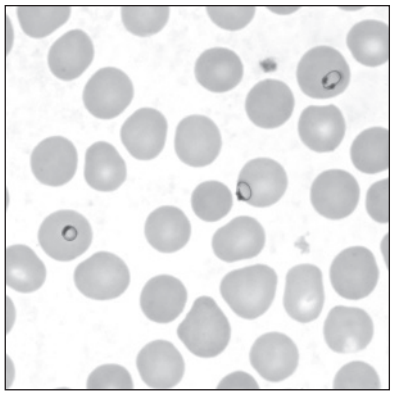
To prevent malaria, the following four strategies have been used:

- taking anti-malarial drugs
- spraying swamps with insecticides
- using mosquito nets over beds
- administering a malaria vaccine.

Which row in the table shows the stage in the life cycle in which each of these strategies would be most effective?

	Taking anti-malarial drugs	*Spraying swamps with insecticides*	*Using mosquito nets over beds*	*Administering a malaria vaccine*
A.	5	1	3	2
B.	2	5	1	3
C.	1	4	2	5
D.	2	3	5	1

18 The micrograph shows normal-sized human red blood cells, three of which are infected with the ring stage of *Plasmodium falciparum*.



Rings of P. falciparum in a thin blood smear.
© Division of Parasitic Diseases and Malaria, Centers for Disease Control and Prevention (2017)

Which of the following is the best estimate of the diameter of the *Plasmodium*?

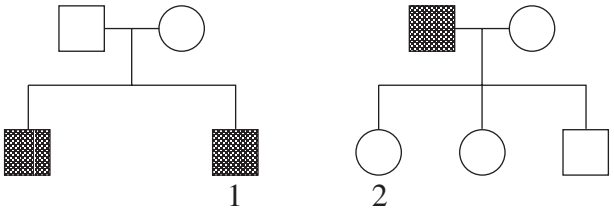
A. 0.002 mm

B. 0.8 μm

C. 2 mm

D. 8 μm

19 Colour blindness in humans is determined by a sex-linked gene. Two family trees are shown.



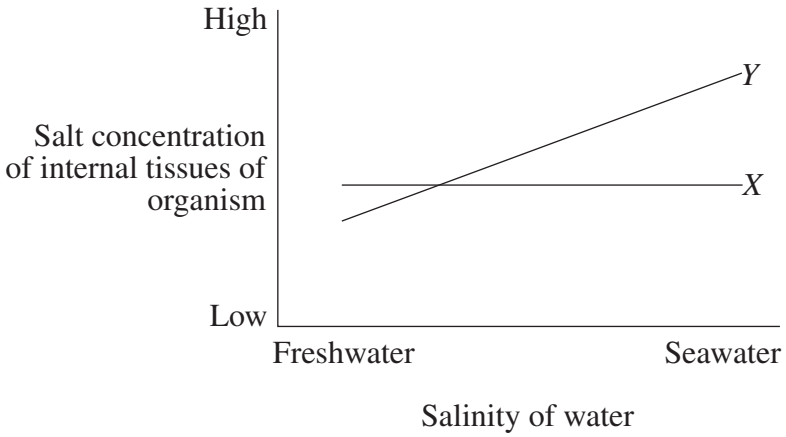
KEY

- Normal vision male
- Normal vision female
- Colour-blind male
- Colour-blind female

Which row of the table shows the probability of colour-blind offspring of each sex if individuals 1 and 2 were to have children together?

	Male offspring	*Female offspring*
A.	0%	0%
B.	50%	0%
C.	50%	50%
D.	0%	50%

20 Two organisms (*X* and *Y*) live in an estuary and maintain physiological function from the freshwater end to the seawater end of the estuary. The graph shows the salt concentration of the internal tissues of each organism at different locations along the estuary.



Based on this information, which of the following is true?

A. *X* exhibits enantiostasis and homeostasis.

B. *Y* exhibits enantiostasis and homeostasis.

C. *X* exhibits homeostasis but not enantiostasis.

D. *Y* exhibits homeostasis but not enantiostasis.

2018 HIGHER SCHOOL CERTIFICATE EXAMINATION

Centre Number

Student Number

Biology

Section I Part B
Answer Booklet

55 marks
Attempt Questions 21–30
Allow about 1 hour and 40 minutes for this part

Instructions

- Write your Centre Number and Student Number at the top of this page.
- 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 at the back of this booklet. If you use this space, clearly indicate which question you are answering.

Please turn over

Question 21 (4 marks)

(a) Identify TWO responses of a named endotherm to a decrease in body temperature. **2**

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(b) Outline the role of the nervous system of an endotherm in maintaining homeostasis when its body temperature changes. **2**

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Question 22 (5 marks)

(a) Pasteur performed an experiment to identify the role of microbes in decay. **2**

Justify a conclusion that can be drawn from his results.

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(b) Describe the contribution of Robert Koch to our understanding of disease. **3**

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Question 23 (5 marks)

(a) A student plans to investigate the effect of light intensity on transpiration in plants. **3**

Complete the table, identifying features that this student should include to ensure valid experimental design.

Dependent variable	•
Control	•
Variables to be kept constant	• •

(b) Explain ONE mechanism for the movement of materials in xylem vessels. **2**

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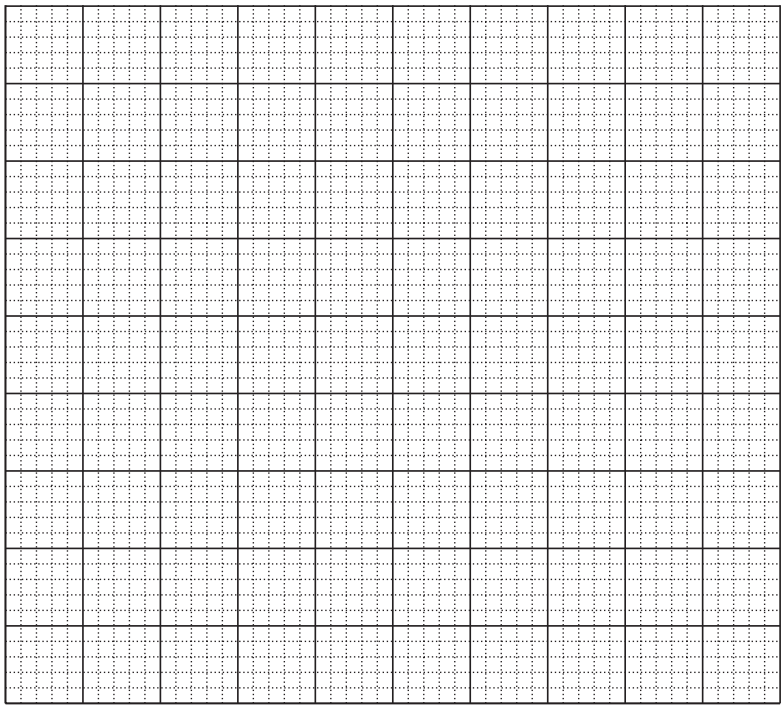
Question 24 (6 marks)

A new flu vaccine is prepared each year to protect the population against the current strains of influenza virus. The effectiveness of flu vaccines varies from year to year and can be measured using the overall vaccination effectiveness (VE) index. A VE of 60% means that a vaccinated individual's chance of getting the flu is reduced by 60%.

The following data show the VE over a 10-year period.

Influenza season	*VE (%)*
2006–2007	52
2008–2009	41
2010–2011	60
2012–2013	49
2014–2015	19

(a) Draw an appropriate graph to represent the data on the following grid. **3**



Question 24 continues on page 17

Question 24 (continued)

(b) Provide a possible explanation for the vaccination effectiveness (VE) index in 2014–2015. **3**

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End of Question 24

Please turn over

Question 25 (4 marks)

The table shows information on blood composition obtained from a patient admitted to hospital.

Blood test	*Patient's results*	*Normal range*
pH	7.49	7.35–7.45
*pCO_2	30 mm Hg	35–45 mm Hg
*pO_2	95 mm Hg	80–100 mm Hg

*(pCO_2 and pO_2 indicate the amount of carbon dioxide and oxygen, respectively, in the blood.)

(a) Identify the technology used to collect these results. **1**

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(b) Analyse the patient's results. **3**

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Question 26 (6 marks)

(a) Compare proteins and polypeptides. **2**

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(b) Antidiuretic hormone (ADH) is a protein produced by cells in the hypothalamus. The AVP gene codes for the production of ADH.

(i) Outline the steps to show how a mutation in the AVP gene could result in changes in the ADH protein. **3**

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(ii) Identify ONE possible effect of the AVP mutation on kidney function. **1**

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Question 27 (4 marks)

With the breakdown of proteins, animals produce ammonia, a nitrogenous waste product that must be removed. Direct removal of ammonia requires the excretion of large amounts of water. **4**

Explain how both terrestrial mammals and insects conserve water while excreting nitrogenous wastes.

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Question 28 (6 marks)

(a) Define the terms *genotype* and *phenotype*. **2**

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(b) A population of mammals living in a very cold climate have long, thick fur which assists their survival. At times, a widespread infestation of mites causes their fur to become thin, and bald patches appear in their coats. In this population some individuals are resistant to the mites. This is due to the presence of a co-dominant allele (M^R). Individuals that are homozygous for this allele (M^RM^R) are infertile. **4**

Explain how both genotype and phenotype influence the inheritance of genes and natural selection in this population.

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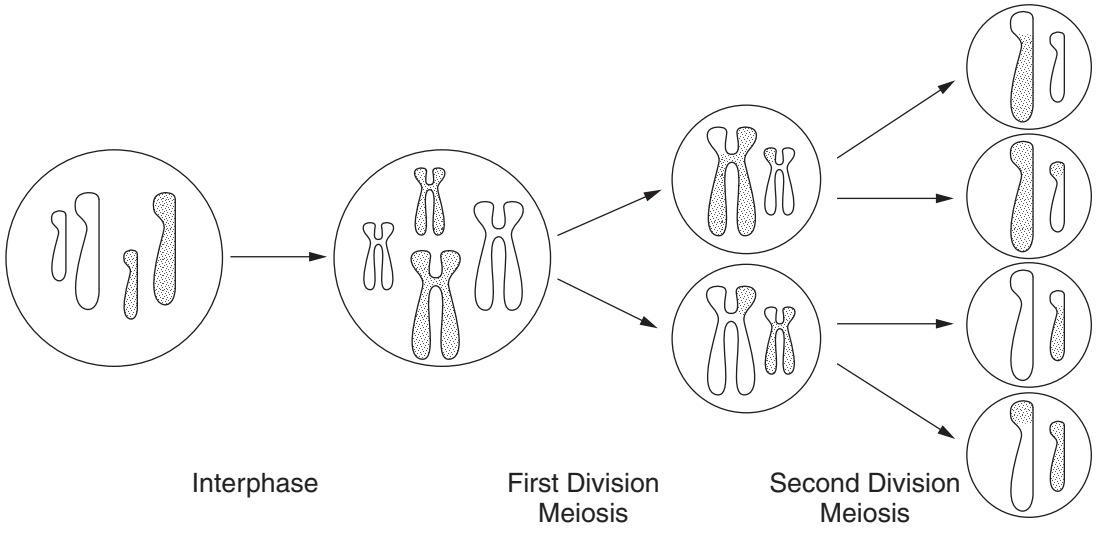
Question 29 (7 marks)

The diagram models the process of meiosis.



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(a) Describe the process that accounts for the changes shown in the model during interphase. **2**

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Question 29 continues on page 23

Question 29 (continued)

(b) Explain the structure and behaviour of chromosomes in the first division of meiosis. Include detailed reference to the model. **5**

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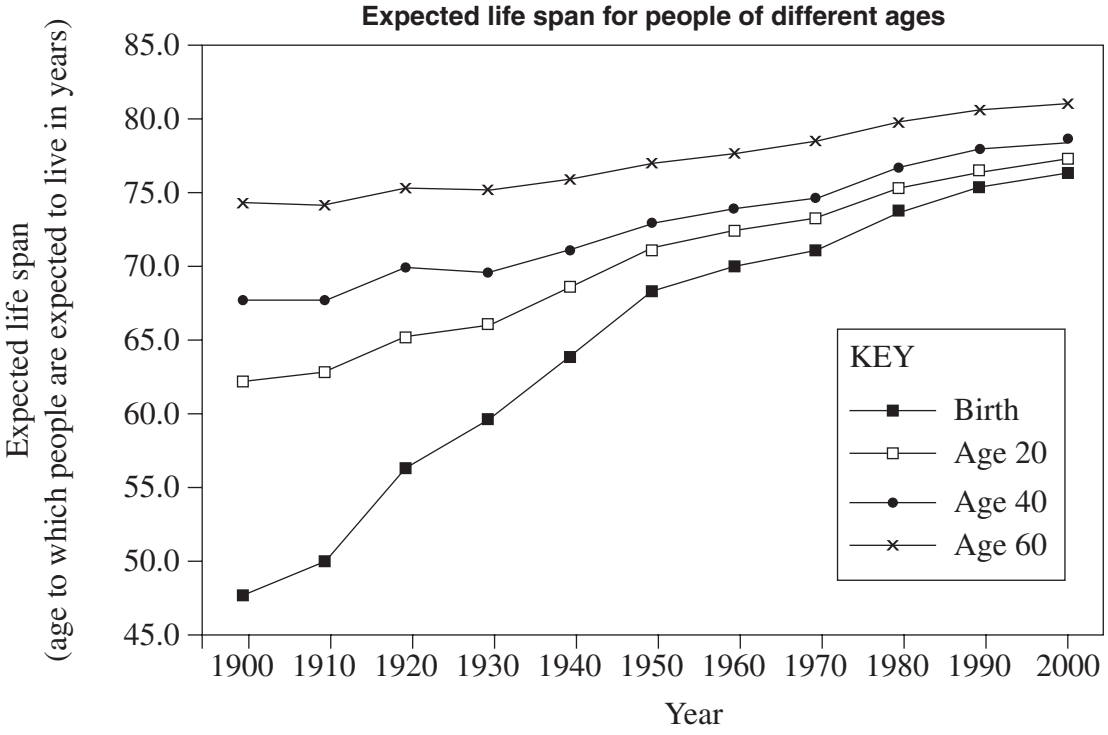
End of Question 29

Question 30 (8 marks)

The graph shows the expected life span (the age to which people are expected to live in years) for people of different ages during the 20th century in one country. **8**



Historical Statistics of the United States – Colonial Times to 1970 Part 1; Bureau of the Census, pp12, 56; Vital Statistics of the United States 1980, 1990, 1992; Statistical Abstract of the United States 2001, 121st edition, Issued November 2001, p4

There have been many biological developments that have contributed to our understanding of the identification, treatment and prevention of disease.

Evaluate the impact of these developments on the expected life span. In your answer, include reference to trends in the data provided.

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Question 30 continues on page 25

Question 30 (continued)

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End of Question 30

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Section I Part B extra writing space

If you use this space, clearly indicate which question you are answering.

Section I Part B extra writing space

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Section I Part B extra writing space

If you use this space, clearly indicate which question you are answering.

Biology

Section II

25 marks
Attempt ONE question from Questions 31–35
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.

Question 31 — 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) (i) Identify TWO structures that refract light as it passes through the eye. **2**

(ii) The diagram shows the human eye. The two lines labelled *A* and *B* represent two beams of light passing through the eye and stimulating different areas of the retina. **2**

The visual perception will be different at the two stimulated areas.

Identify TWO of these differences.

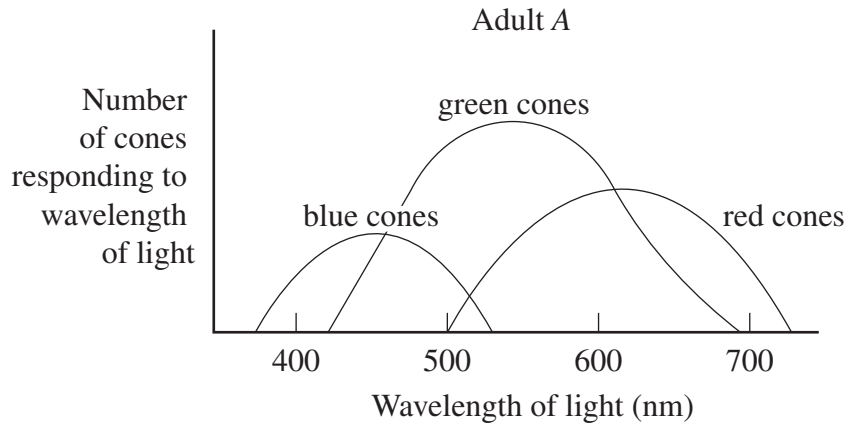
(b) Explain how the human larynx produces sounds of different pitch. **4**

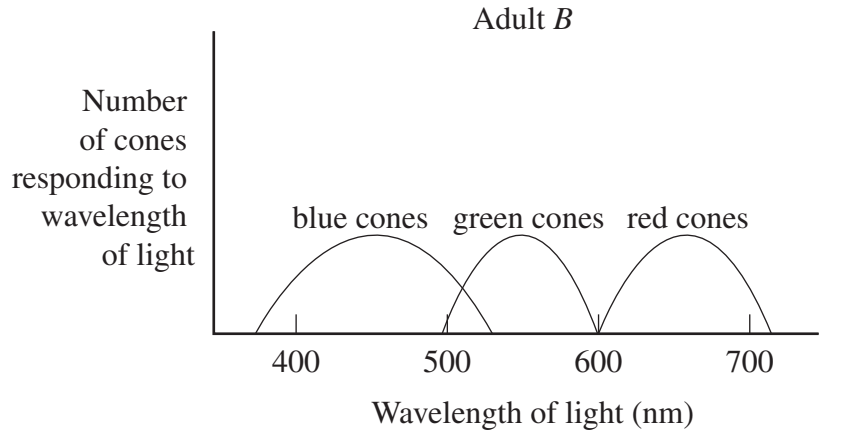
Question 31 continues on page 31

Question 31 (continued)

(c) The human eye contains cone cells carrying one of three pigments, with each pigment being particularly sensitive to light around a particular wavelength. They are commonly referred to as blue, green and red cones.

The numbers of each type of cone were counted in two adults, *A* and *B*. The results are graphed below.





(i) Outline TWO differences in the data between adults *A* and *B*. **2**

(ii) Explain how colour vision in adults *A* and *B* might differ. **3**

Question 31 continues on page 32

Question 31 (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) A person with normal vision and a person with myopia are both looking at an object in the distance. **5**

Construct THREE labelled diagrams of an eye to show the light path through the eye of the person with:

- normal vision
- myopia
- myopia corrected with a suitable lens.

(e) **7**

> Extensive studies of how humans detect both visual and auditory stimuli led to models that shaped our understanding of vision and hearing. These models have needed to be modified when other animals were studied.

Justify this statement.

End of Question 31

Question 32 — 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) (i) Identify TWO changes that have occurred in ONE species as a result of artificial selection for agricultural purposes. **2**

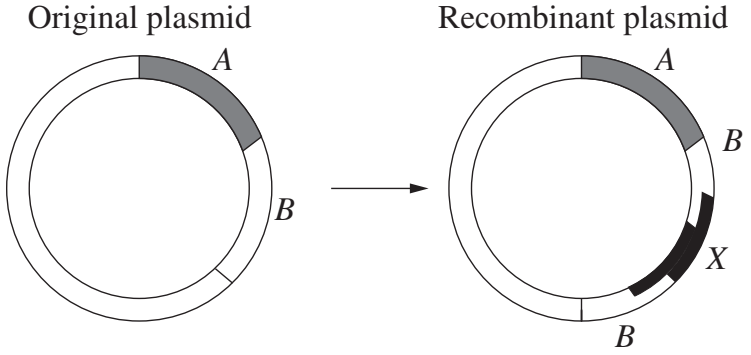
(ii) Outline the use of ONE biotechnology by Australian Aboriginal peoples in ancient times. **2**

(b) Explain an advantage and a disadvantage of EITHER the product OR process of a specific animal biotechnology. **4**

(c) (i) Outline how the polymerase chain reaction can be used to amplify DNA sequences. **2**

(ii) DNA can be inserted into bacterial plasmids to produce recombinant DNA. **3**

The diagrams below show a bacterial plasmid in its original form and the recombinant plasmid after a desired gene, *X*, has been spliced into a particular position. Plasmids are incorporated into bacterial hosts.



KEY
Gene *A*: codes for resistance to the antibiotic Ampicillin
Gene *B*: codes for the production of a yellow substance
Gene *X*: codes for the production of a human hormone

Explain how gene *A* and gene *B* could be monitored to determine which bacterial hosts have successfully incorporated the desired recombinant DNA.

Question 32 continues on page 34

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) For a specific strain isolation method, construct a flow chart to summarise the main steps and products. **5**

(e) Explain the relationship between advances in scientific knowledge of cell chemistry and modern uses of biotechnology. **7**

End of Question 32

Question 33 — 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) (i) Identify TWO differences in the chromosomes of haploid and diploid cells. **2**

(ii) Contrast the inheritance patterns that occur in a dihybrid cross when genes are linked, with when genes are unlinked. **2**

(b) The coding strand of some DNA is shown. It is part of a sequence that codes for a polypeptide. **4**

Contrast the effect of a frameshift mutation with the effect of a base substitution mutation on the polypeptide produced from this sequence.

Question 33 continues on page 36

(c) Lynch syndrome is a condition that is the result of a mutation.

(i) The graph shows data comparing the lifetime risk of cancer in people with Lynch syndrome to that in the general population. **2**

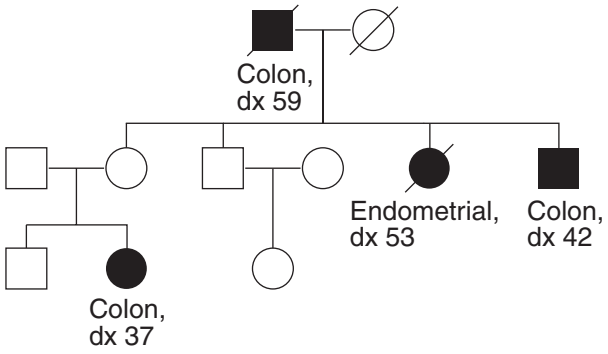
Outline TWO trends shown in the graph for people with Lynch syndrome.

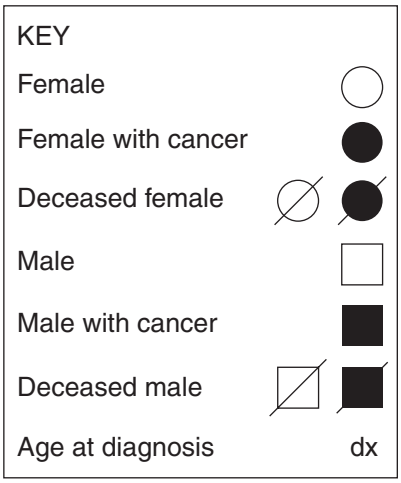
Question 33 continues on page 37

(ii) Lynch syndrome is an autosomal dominant condition that is the result of a mutation of a DNA repair gene. This mutation interferes with the ability of DNA to repair itself. **3**

The incidence of cancer in a family with Lynch syndrome is shown in the pedigree.

Incidence of cancer in a family with Lynch syndrome





'Lynch Syndrome Pedigree', 14 November 2014, from Genetics of Colorectal Cancers, 14 June 2018. Available at https://www.ncbi.nlm.nih.gov/books/NBK126744/figure/CDR0000062863_2756/

Analyse the disease pattern shown in the pedigree.

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) Construct a flow chart to show how an animal with a diploid number of 32 chromosomes can be cloned and how the clone can be verified. Include reference to chromosome number in each step. **5**

(e) **7**

Transgenic mice can be used as models to study human diseases such as muscular dystrophy, a condition caused by sex-linked mutation. These mice have been genetically modified and cloned, resulting in a population with the disease.

Explain how developments in our understanding of genes and gene technologies have led to the use of such models to study human disease.

End of Question 33

Question 34 — 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) (i) Identify ONE absolute and ONE relative dating method used in the study of human evolution. **2**

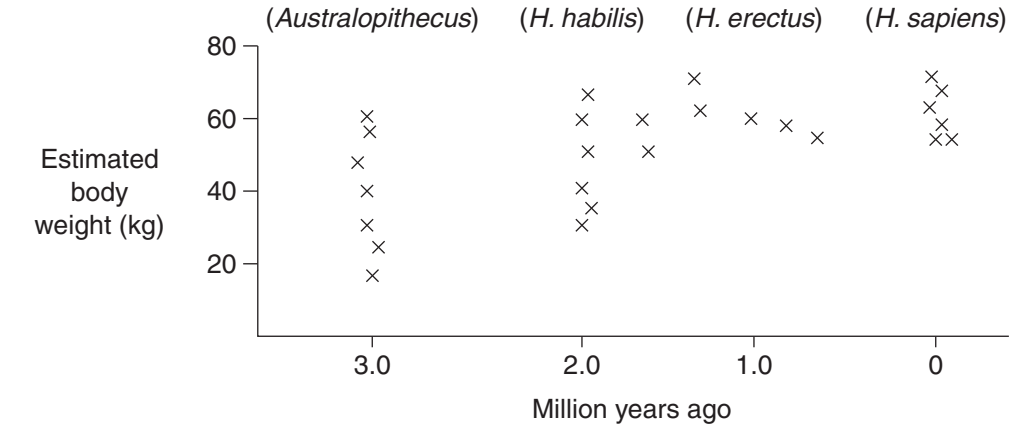
(ii) Using an example, outline a limitation of only using the fossil record to interpret the past. **2**

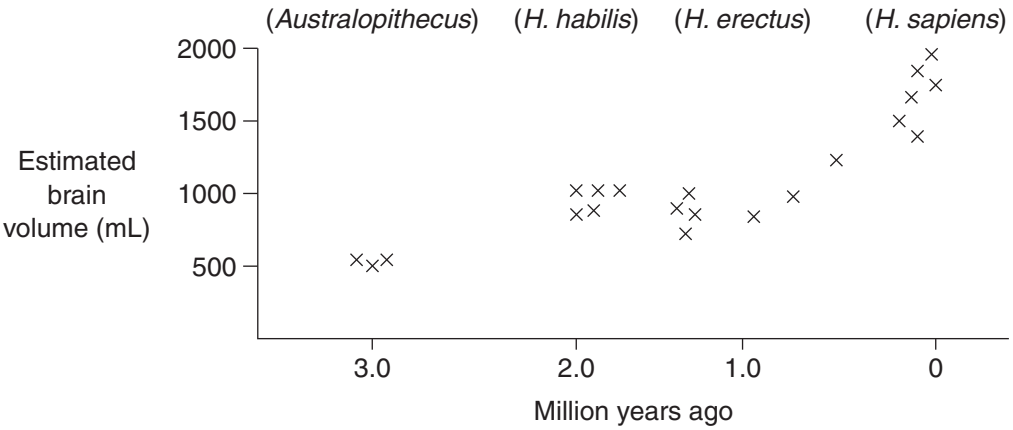
(b) Explain, using TWO examples, the evolutionary significance of polymorphism. **4**

Question 34 continues on page 39

Question 34 (continued)

(c) The following graphs show data from a scientific study on changes in body weight and brain volume in some hominid species over the last three million years.





(i) Describe ONE trend from each graph. **2**

(ii) Discuss the validity of a conclusion that can be drawn from the graphs about the relationships between body weight and brain volume. **3**

Question 34 continues on page 40

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) Construct a dichotomous key to classify primates into four groups: prosimians, new world monkeys, old world monkeys, apes. **5**

(e) **7**

Models of human evolution continue to change as a result of work done by individual scientists and advances in technology.

Justify this statement.

End of Question 34

Question 35 — 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.

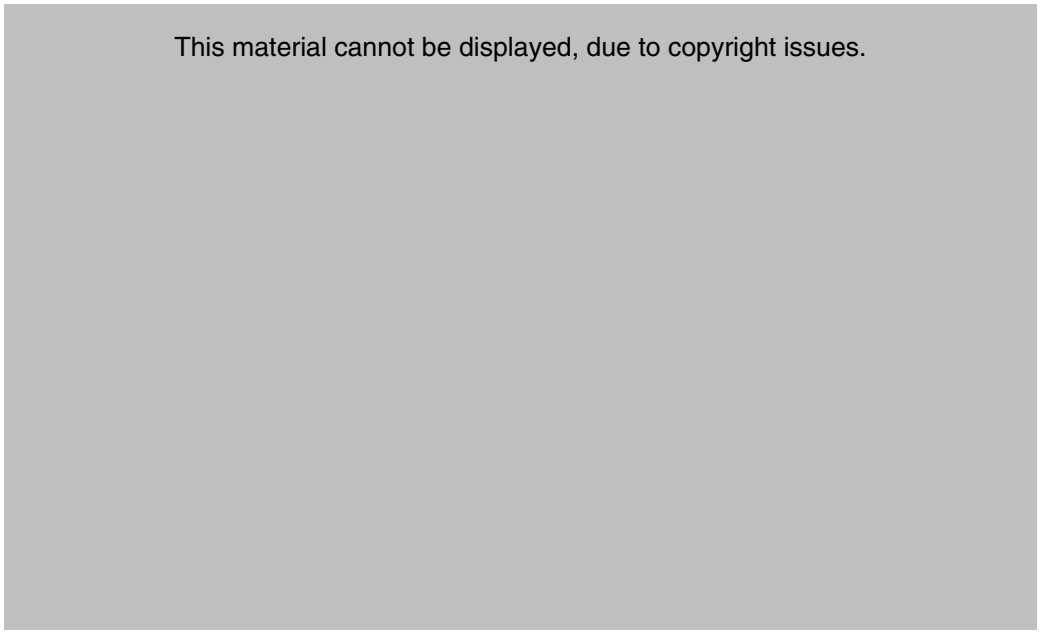
(a) (i) Identify TWO isotopes that have been useful in studying photosynthesis. **2**

(ii) Describe the location and structure of thylakoids. **2**

(b) Photosystems I and II have different functions in photosynthesis. **4**

Explain the significance of this difference.

(c) The graph shows results of investigations into the relationship between light intensity and the rate of photosynthesis under different conditions.



(i) Outline ONE way in which the rate of photosynthesis could have been measured. **2**

(ii) Justify conclusions that can be drawn from the data shown in the graph. **3**

Question 35 continues on page 42

Question 35 (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) Construct a flow chart to summarise the main steps and products of the light-independent reactions of photosynthesis. **5**

(e) **7**

> Biological theories are always provisional in nature and change in the light of new evidence.

Justify this statement with reference to the historical progression of our understanding of photosynthesis. Use specific examples, including the work of Engelmann, to support your answer.

End of paper

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