BOARD OF STUDIES
NEW SOUTH WALES

2013

HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

General Instructions

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

Total marks – 100

Section I Pages 2–19

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

Section II Pages 21–31

25 marks

- 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 Infectious diseases can be spread when microbial experiments are conducted.

Which of the following would be an effective barrier to stop this from happening?

(A) Using chlorinated water during the experiment

(B) Washing hands before performing the experiment

(C) Wearing plastic or latex gloves during the experiment

(D) Disposing carefully and safely of waste materials produced during the experiment

2 Antibodies are proteins that

(A) break down pathogens.

(B) bind with a specific antigen.

(C) catalyse biochemical reactions.

(D) are produced by T cells to kill disease-causing viruses.

3 Which of the following can cause an imbalance of microflora in humans?

(A) Overuse of antibiotics

(B) Excessive use of antiviral drugs

(C) Consumption of genetically modified foods

(D) Immunisation against different diseases

4 Which of the following prevents the entry of pathogens into the human body?

(A) Cell death to seal off a pathogen

(B) Mucus lining the respiratory tract

(C) Phagocytosis performed by B cells

(D) Destruction of pathogens by the lymphatic system

5 What is the genotype of pure breeding plants?

(A) Heterozygous

(B) Homologous

(C) Homozygous

(D) Monohybrid

6 What are the main components of the immune response involved in organ rejection?

(A) Antibodies, T cells and B cells

(B) Antibiotics and white blood cells

(C) T cells, B cells and red blood cells

(D) Red blood cells, white blood cells and antigens

7 Vaccination can control the spread of

(A) a genetic disorder.

(B) an infectious disease.

(C) a nutritional deficiency.

(D) an environmental disease.

8 Sutton and Boveri contributed to our understanding of the importance of chromosomes.

What was one of their findings?

(A) Chromosomes carry hereditary factors.

(B) Sex is genetically determined by chromosomes.

(C) Radiation can cause mutations in chromosomes.

(D) The structure of chromosomes is a double helix.

9 What is a feature of an estuarine organism (eg mangroves) that allows it to survive?

(A) High rate of salt excretion

(B) Low rate of osmosis into its cells

(C) High uptake of salt from its environment

(D) Low uptake of oxygen from its environment

10 What does the structure of arteries allow them to do?

(A) Transport oxygen rich blood

(B) Withstand high blood pressure

(C) Release carbon dioxide to the lungs

(D) Remove nitrogenous waste via the kidneys

11 Why are quarantine measures needed when there is an outbreak of an infectious disease in Australian farm animals?

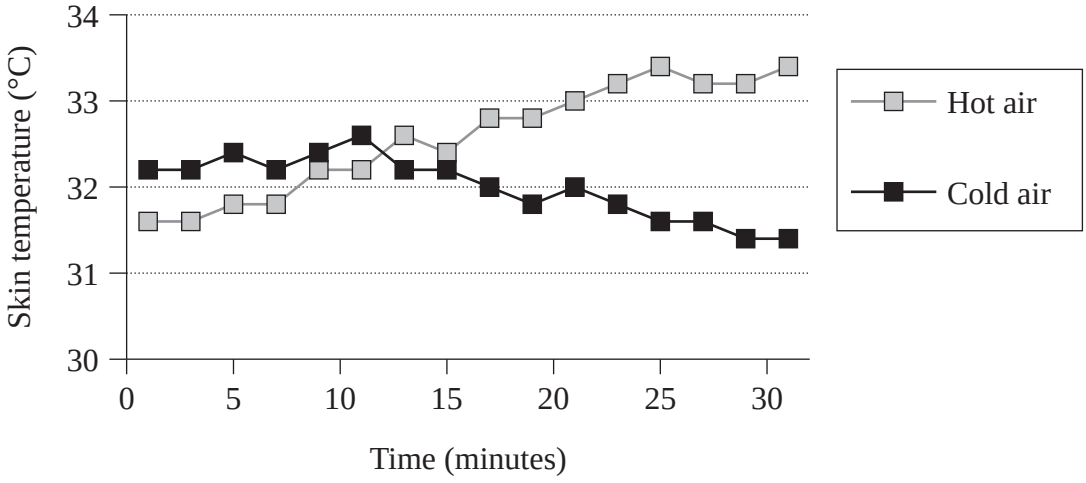
(A) To prevent the spread of the disease to food imported into Australia

(B) To prevent Australian farm animals from becoming immune to the disease

(C) To prevent introduced plants threatening the survival of Australian farm animals

(D) To prevent the disease from spreading to farm animals in different regions of Australia

12 Two experiments were conducted where either cold air or hot air was blown continuously onto a student's legs while the skin temperature on the student's arm was being measured. The graph shows the change in skin temperature on the arm of the student for each experiment.



Which process best accounts for the trends shown in the graph?

(A) Diffusion

(B) Enantiostasis

(C) Homeostasis

(D) Inflammation

13 Why is carbon dioxide removed from cells?

(A) To decrease osmosis

(B) To allow oxygen to replace it

(C) To prevent an increase in blood pH

(D) To prevent cells from becoming acidic

14 Hormone replacement therapy was used to treat a patient who had low salt levels in their blood.

Which hormone was used for the treatment?

(A) Aldosterone

(B) Anti-diuretic hormone

(C) Insulin

(D) Oestrogen

15 Which is the correct sequence of a feedback mechanism for the control of blood pressure?

(A) blood pressure → blood vessels → brain → receptors → blood pressure

(B) blood pressure → blood vessels → receptors → brain → blood pressure

(C) blood pressure → receptors → blood vessels → brain → blood pressure

(D) blood pressure → receptors → brain → blood vessels → blood pressure

16 The theory of evolution has been supported by studying the structures of vertebrate forelimbs from the fossil record.

This type of study is best described as

(A) biogeography.

(B) comparative biochemistry.

(C) comparative embryology.

(D) palaeontology.

17 The photo shows insect mounds (nests) in hot northern Australia. The mounds are built with a narrow side facing the midday sun and the wide sides facing towards the morning and late afternoon sun.



The structure of these nests helps the insects in them to

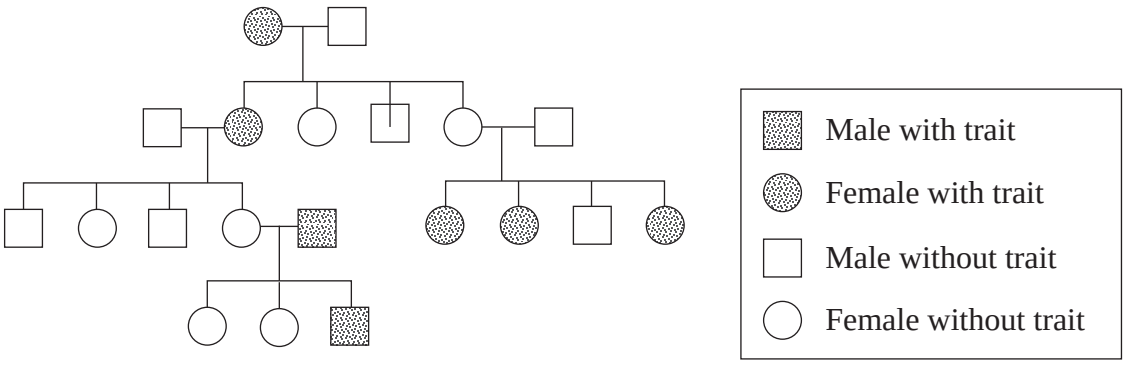
(A) become endothermic.

(B) cool down quickly in the afternoon.

(C) maintain a constant body temperature.

(D) develop enzymes that operate at a high temperature.

18 A family tree is shown.



What is represented by this family tree?

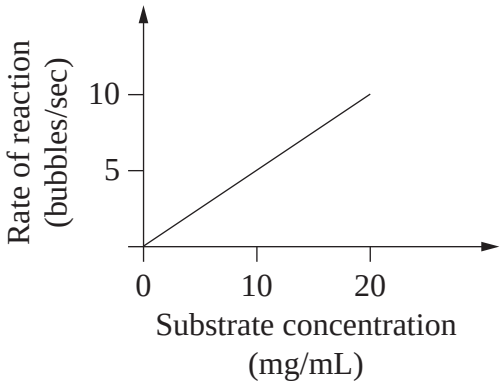
(A) Sex-linked inheritance

(B) Co-dominant inheritance

(C) Inheritance of a recessive trait

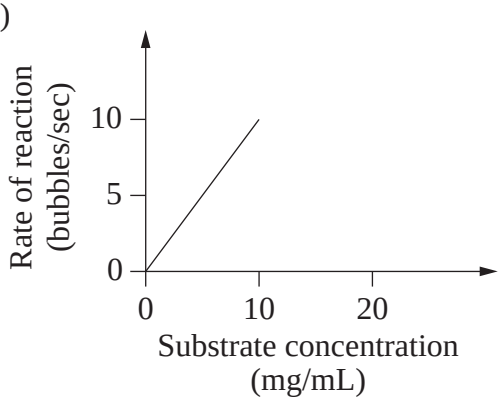
(D) Inheritance of a dominant trait

19 An enzyme was extracted from a mammal. The graph shows the rate at which bubbles are produced in a reaction at 36ºC using the extracted enzyme.

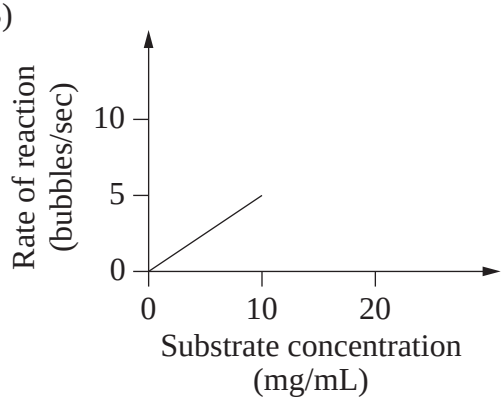


Which of the following graphs would show the results if the enzyme reaction were carried out at 18°C?

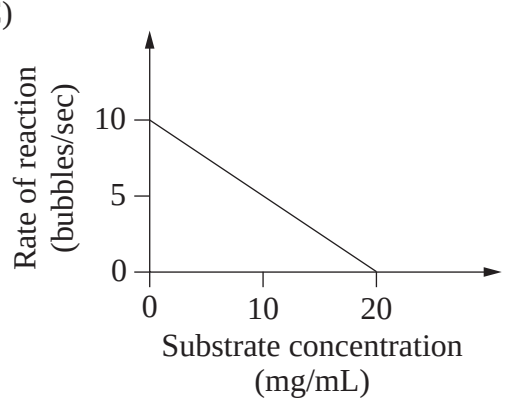
(A)



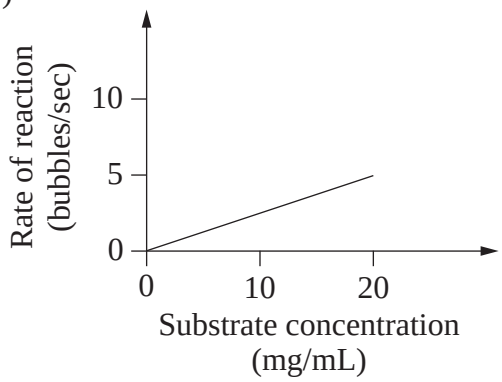
(B)



(C)



(D)



20 Which of the following statements about DNA provides support for Darwin's theory of evolution?

(A) Genes are inherited from both parents.

(B) Mutation of DNA may lead to new alleles.

(C) DNA contains the code for proteins and polypeptides.

(D) The sequence of bases in DNA differs between species.

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Biology

Centre Number

Student Number

Section I (continued)

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

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

Extra writing space is provided on pages 18 and 19. 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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Please turn over

Office Use Only – Do NOT write anything, or make any marks below this line.

Question 21 (4 marks)

Describe the difference between the roles of TWO named types of T cells in the immune response in humans. **4**

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Question 22 (3 marks)

Outline the work done by Morgan that has led to our understanding of sex linkage. **3**

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Question 23 (4 marks)

Spinifex is a grass common across central Australia where soils are nutrient deficient. It frequently grows as a circular clump of stems and the diameter of the clump increases slowly each year. Initially the leaves are flat and the roots are shallow. As the plant matures, the leaves curl inwards to form long thin tubes with the stomates on the inside, while the roots grow deep into the soil to obtain nutrients and water. Silicon granules make the stems tough. **4**

Explain how TWO of the adaptations outlined above allow Spinifex to survive in hot, dry conditions.

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Question 24 (7 marks)

(a) Draw a flowchart showing the steps you could take to model Pasteur's experiment to identify the role of microbes in decay. **4**

(b) Explain the importance of using controls in microbial experiments. **3**

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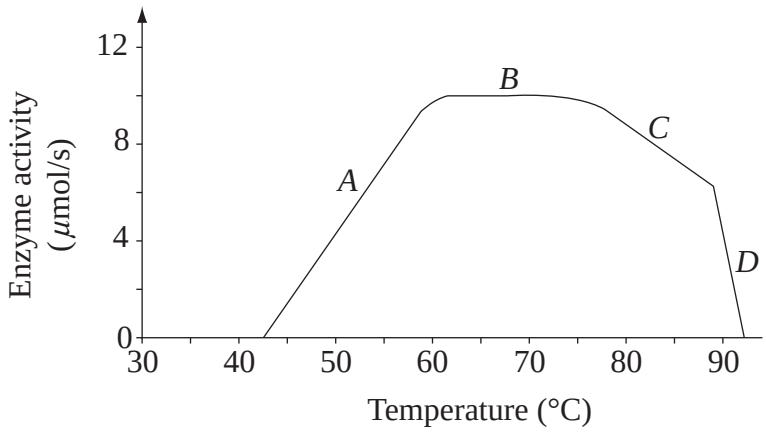
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Question 25 (7 marks)

The graph below shows the results obtained from testing the activity of a bacterial enzyme.



(a) Name ONE variable, other than temperature, that would have been controlled in the experiment. **1**

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(b) For what temperature range does the enzyme display the maximum rate of change in activity? **1**

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(c) Account for the activity of the enzyme at the parts of the graph labelled *A*, *B*, *C* and *D*. **4**

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(d) Based on the information in the graph, suggest the type of environment in which these bacteria might survive. **1**

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Question 26 (3 marks)

A virus was used to kill rabbits in Australia. After first release of the virus nearly all rabbits were killed, but over time the numbers recovered. **3**

Outline how Darwin/Wallace's theory of evolution could be used to explain the recovery of rabbit numbers.

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Question 27 (4 marks)

Explain how ONE advance in technology has provided support for the theory of evolution. **4**

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Question 28 (7 marks)

(a) As part of your Biology course you were required to examine plant shoots and leaves for evidence of pathogens and insect pests. **2**

List TWO observations that indicated the presence of pathogens on plant shoots and/or leaves.

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(b) Describe how TWO named methods have changed the way we manage disease and/or insect pests. **5**

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Question 29 (8 marks)

(a) What chemicals are filtered out of the blood by the kidney? **2**

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(b) What chemicals are reabsorbed into the blood by the kidney? **2**

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(c) Explain the steps involved in the formation of urine. **4**

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Question 30 (8 marks)

Explain how our knowledge of chromosome structure has led to reproductive technologies that have the potential to alter the path of evolution. **8**

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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 31–35
Allow about 45 minutes for this section

Answer the question in the Section II Writing Booklet. Extra writing booklets are available.

Pages

Question 31 Communication 22

Question 32 Biotechnology 23

Question 33 Genetics: The Code Broken? 24–26

Question 34 The Human Story 27–29

Question 35 Biochemistry 30–31

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) Outline how the larynx produces sounds of different frequencies. **3**

(b) Outline how sound is transmitted to the brain in humans. **4**

(c) (i) Describe the process of accommodation. You may include diagrams in your answer. **4**

(ii) Outline how ONE technology is used to treat hyperopia. **1**

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) Describe the sequence of events that occurs when photoreceptors in different regions of the retina are stimulated by red light. **6**

(e) (i) Outline ONE essential step that must occur for the photoreceptor signal to be transmitted along the optic nerve to the brain. **1**

(ii) Microelectronic chips containing light sensitive detectors have been implanted in the retinas of blind volunteer patients. These implants do not give normal vision but allow these patients to see only areas of light and dark. **6**

Relate your understanding of the use of hearing aids and cochlear implants to possible advantages and limitations of microelectronic chips to vision.

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) Outline the function of RNA. **3**

(b) Using a named example, outline how greater knowledge of science has led to a change in traditional methods of fermentation. **4**

(c) (i) Outline the steps in the extraction process of DNA from a named source. **2**

(ii) How could the final product be identified as DNA? **1**

(iii) Describe how a specific gene from extracted DNA could be amplified. **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) Analyse the contribution that ONE of the following applications has made to medicine. **6**

- tissue engineering
- gene delivery by nasal sprays
- production of a synthetic hormone

(e) The domestication of seeds produced the most cultural change in human history, transforming most human societies from hunter gatherers to permanent settlements anchored by agriculture.

(i) Outline how the collection of seeds could be seen as an early example of biotechnology. **1**

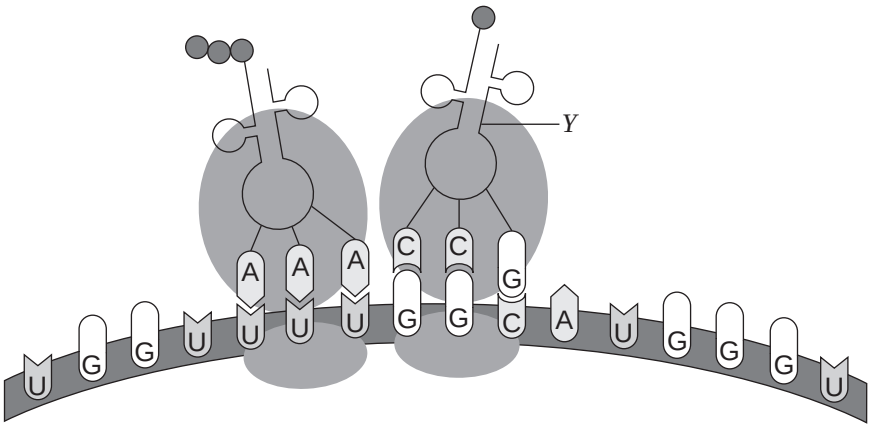
(ii) Using your knowledge of the domestication of one plant or animal species, evaluate relevant ethical issues raised by the use of current biotechnology. **6**

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) Outline *polygenic inheritance*. Include an example in your answer. **3**

(b) The diagram shows part of the process of protein synthesis. **4**



Acknowledgement: © Maryland State Department of Education (MSDE)

Outline how the structure *Y* enables information from DNA to be translated into a specific polypeptide.

Question 33 continues on page 25

(c) (i) In the early 1900s, Bateson and Punnett studied inheritance in the sweet pea plant. They studied the inheritance of two genes: **2**

- flower colour (*P*, purple, and *p*, red)
- shape of pollen grain (*L*, long, and *l*, round).

They crossed pure lines *PPLL* (purple, long) × *ppll* (red, round). In the F1 generation all offspring had purple flowers and long pollen grains. These offspring were then crossed with the expectation that the Mendelian ratios would occur.

Construct a Punnett square to show the phenotypic ratios that would have been obtained if these genes showed typical Mendelian dihybrid inheritance.

(ii) The table shows the actual results that Bateson and Punnett obtained. **3**

Phenotype	*Number of offspring*
Purple, long	4831
Purple, round	390
Red, long	393
Red, round	1338
Total number of offspring	6952

Acknowledgement: Reprinted by permission from Macmillan Publishers Ltd : Nature Reviews Genetics 13, 2012

Explain how the results of cross-breeding experiments could be used to identify the relative positions of genes.

Question 33 continues on page 26

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) Analyse how the understanding of mechanisms of genetic change has influenced the use of genetic technology in society. **6**

(e)

DNA kits can bring unwanted surprises

'For the price of a night out, individuals can learn key elements of their genetic composition and take treatment, or protect their children from hereditary health risks …

To take the test, a client spits into a test tube or swabs the inside of their cheek, then sends the sample for analysis …

Mrs X took the test to determine the cause of some minor health problems … She learnt that she was at risk of breast cancer but also that the man she has called 'Dad' for 50 years was not her father. She tracked down her biological father and a half-sister, who had breast cancer. A biopsy found Mrs X had cancer.'

The Sydney Morning Herald, 7 January 2013 (adapted)

Acknowledgement: Telegraph Media Group Limited 2013

(i) Outline a method used to gain this genetic profile. **1**

(ii) Using your knowledge of the Human Genome Project, discuss the effects that gene therapy may have on society. **6**

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) Outline the features used to identify humans as the species *Homo sapiens*. **3**

(b) ^{14}C can be used for dating fossils. Its half life is approximately 5750 years. **4**

Compare this method for dating with another dating technique.

Question 34 continues on page 28

Question 34 (continued)

(c) This table outlines human population growth.

Human Population (billions)	*Year*	*Time Span* (years)
1	1830	50 000
2	1930	100
3	1960	30
4	1975	15
5	1989	14
6	1999	10
7	2011	12
8 (predicted)	2025	14
9 (predicted)	2045	20

(i) What trends in human population growth do the data illustrate? **2**

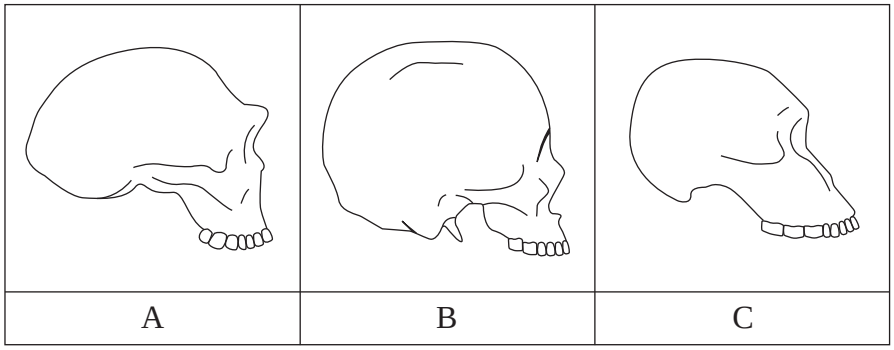
(ii) Outline specific examples of technology that could explain the growth rate of the human population before and after 1999. **3**

Question 34 continues on page 29

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) Analyse the impact of cultural development on human evolution. **6**

(e) Different hominid skulls are illustrated.



Acknowledgement: Reprinted by permission from Macmillan Publishers Ltd: Pontzer, H (2012) Overview of Huminin Evolution. Nature Education Knowledge 3(10):8, www.nature.com, copyright © 2012

(i) Place the hominid skulls in order from the oldest to the youngest. **1**

(ii) Explain how molecular analysis has changed scientists' opinions about primate classification. In your answer, include specific examples. **6**

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.

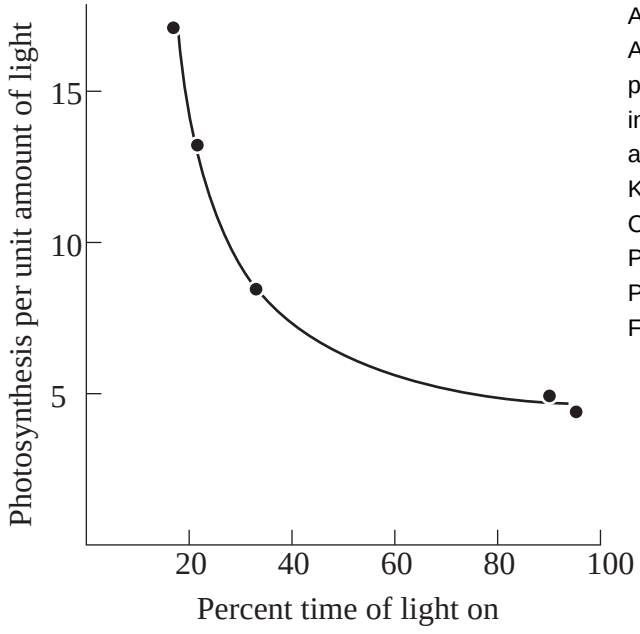
(a) Outline the roles of the coenzymes in the light reactions. **3**

(b) Describe an experiment to identify the pigments in leaves. **4**

(c) Emerson and Arnold (1932) measured the amount of photosynthesis caused by a flashing light rather than by a continuous light. They kept the temperature constant, the levels of CO_2 high, and the intensity of the flashing light constant.

They measured the effect on photosynthesis if they changed the percentage of time for each light flash but still kept the light flashing at 50 times per second.

The curve shows the relationship between percent time of illumination and yield of photosynthesis per unit amount of light.



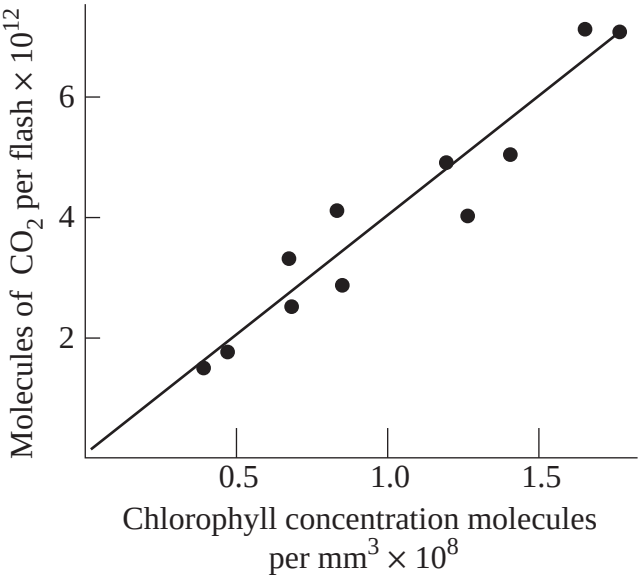
Acknowledgement :
A separation of the reactions in photosynthesis by means of intermittent light by Robert Emerson and William Arnold. From the Kerckhoff Laboratories of Biology, California Institute of Technology, Pasadena, The Journal of General Physiology, March 14, 1931, Figure 2, page 195

(i) What would you predict would happen to photosynthesis per unit of light if continuous light rather than flashing light were used in this experiment? **1**

Question 35 continues on page 31

Question 35 (continued)

(ii) The following data were obtained by Emerson and Arnold. **4**



Acknowledgement :
A separation of the reactions in photosynthesis by means of intermittent light by Robert Emerson and William Arnold, From the Kerckhoff Laboratories of Biology, California Institute of Technology, Pasadena, The Journal of General Physiology, March 14, 1931, Figure 2, page 195

The figure shows the concentrations of chlorophyll in molecules per mm^3 of cells plotted against molecules of carbon dioxide used per flash of light at saturation, at 25ºC.

Outline how the experiments of Emerson and Arnold led to Gaffron and Wohl concluding the presence of a photosynthetic unit.

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) Analyse how the use of isotopes has contributed to tracing biochemical pathways. **6**

(e) (i) Identify the products of photosynthesis. **1**

(ii) Explain how photosynthesis could be used to help solve THREE named environmental issues. **6**

End of paper

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