BOARD OF STUDIES
NEW SOUTH WALES

2011

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
- Write your Centre Number and Student Number at the top of pages 9, 13, 15, 19, 21 and 23

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 25–36

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 DNA in plants and animals is composed of the same chemical components.

What is the biological significance of this statement?

(A) Plants and animals can interbreed.

(B) Plants and animals share common ancestry.

(C) Plants and animals are genetically identical.

(D) Plants and animals are composed of identical proteins.

2 Which substance is mainly bound to proteins when it is carried in mammalian blood?

(A) Nitrogenous waste

(B) Carbon dioxide

(C) Lipid

(D) Salt

3 In organisms, the maintenance of a constant internal environment is

(A) necessary because organisms must have a constant body temperature.

(B) necessary because enzyme activity is highest at specific temperatures.

(C) unnecessary because organisms are found in environments with a broad range of temperatures.

(D) unnecessary because the nervous system detects and responds to changes in ambient temperature.

4 Which of the following alternatives lists ALL of the chemical components of a chromosome?

(A) Sugar, phosphate and bases

(B) Lipids, DNA and protein

(C) DNA and protein

(D) Genes and DNA

5 The presence of freckles is a dominant characteristic. A child's mother has no freckles and its father is heterozygous for freckles.

What is the probability that this child will have freckles?

(A) 25%

(B) 50%

(C) 75%

(D) 100%

6 What was Macfarlane Burnet's contribution to our understanding of human disease?

(A) He determined that mosquitoes transmit malaria.

(B) He disproved the theory of spontaneous generation.

(C) He developed a method for establishing that a particular microbe causes a disease.

(D) He discovered how the body distinguishes between its own tissues and foreign cells.

7 How do cleanliness in food preparation and cleanliness in personal hygiene assist in the control of disease?

(A) They reduce the microflora.

(B) They reduce transmission of pathogens.

(C) They stop the transfer of dirt between people.

(D) They stop food that contains bacteria from being eaten.

8 Which type of cells destroy virally infected cells?

(A) B cells

(B) Killer T cells

(C) Helper T cells

(D) Cytotoxic T cells

9 Which list shows pathogens in order of increasing size?

(A) Bacterium, prion, virus, protozoan, macroparasite

(B) Macroparasite, prion, protozoan, bacterium, virus

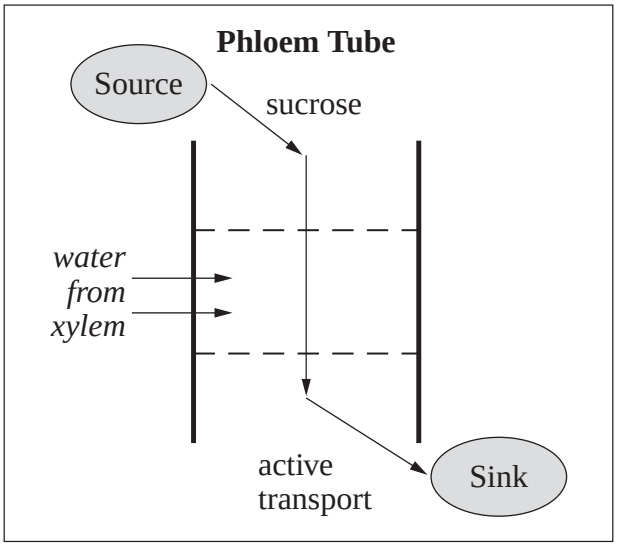
(C) Prion, virus, bacterium, protozoan, macroparasite

(D) Virus, prion, bacterium, macroparasite, protozoan

10 Which of the following correctly identifies a source of variation in both asexual and sexual reproduction?

	Asexual	*Sexual*
(A)	Cloning	Natural selection
(B)	Crossing over	Cell division
(C)	Spontaneous generation	Fertilisation
(D)	Mutation	Mutation

11 The diagram represents one current theory for the movement of materials in phloem.



In the process illustrated in the diagram, water from xylem

(A) causes a build up of pressure.

(B) allows adhesion for capillarity.

(C) provides water for photosynthesis.

(D) dilutes sucrose for active transport.

12 An Australian insect produces uric acid and no other form of nitrogenous waste.

What is the purpose of this adaptation?

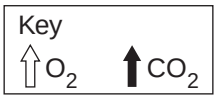
(A) To increase salt loss

(B) To reduce water loss

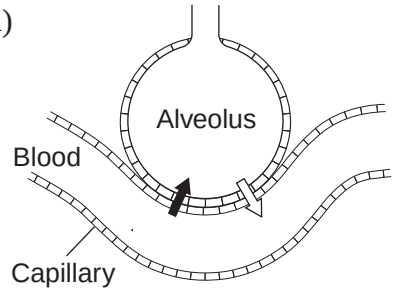
(C) To increase its toxicity to predators

(D) To reduce the chance of attracting predators

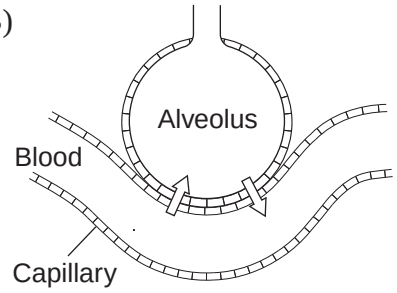
13 Which diagram best explains changes to the composition of blood in the lungs?



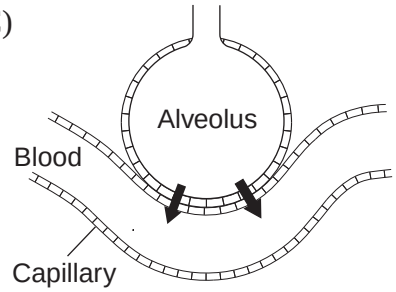
(A)



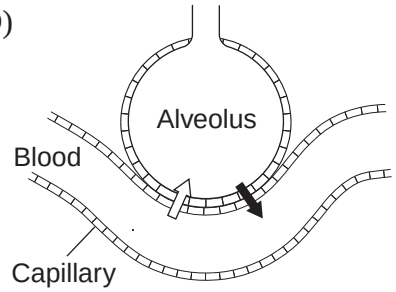
(B)



(C)



(D)



14 What role do mucous membranes and cilia play in the body's defence against pathogens?

(A) They cause cell death to seal off pathogens.

(B) They form part of a barrier preventing entry of pathogens.

(C) They remove pathogens as part of the inflammatory response.

(D) They recognise pathogens passing through the lymphatic system.

15 African ostriches, South American rheas and Australian emus are all large extant flightless birds. These observations provide evidence for the theory of evolution.

This evidence for evolution belongs to

(A) biochemistry.

(B) biogeography.

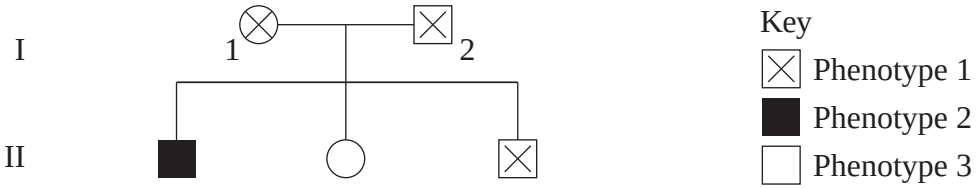
(C) paleontology.

(D) comparative embryology.

16 Which of the following shows the correct sequence of steps in the interaction between T cells (lymphocytes) and B cells (lymphocytes)?

	Step 1	*Step 2*	*Step 3*
(A)	T cells interact with antigens presented by macrophages	Activated T cells differentiate into helper T cells	Helper T cells produce chemicals that cause B cells to multiply
(B)	T cells interact with antigens presented by macrophages	Activated T cells differentiate into B cells	B cells produce chemicals that cause T suppressor cells to multiply
(C)	B cells interact with antigens presented by macrophages	Activated B cells differentiate into plasma cells	Plasma cells produce chemicals that cause T cells to multiply
(D)	B cells interact with antigens presented by macrophages	Activated B cells differentiate into B memory cells	B memory cells produce chemicals that cause macrophages to multiply

17 The pedigree shows the inheritance of a trait controlled by a pair of alleles.



Which Punnett square correctly represents the cross between the parents in generation I?

(A)

	B	b
A	AB	Ab
a	aB	ab

(B)

	B	B
A	AB	AB
A	AB	AB

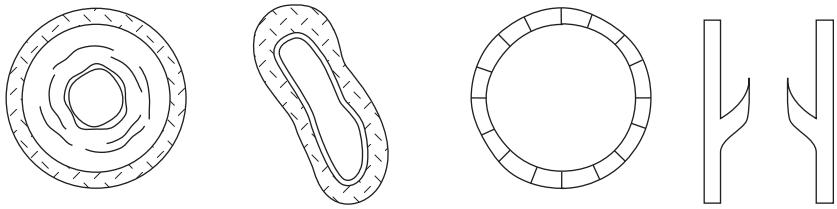
(C)

	B	b
B	BB	Bb
b	Bb	bb

(D)

	A	B
A	AA	AB
B	AB	BB

18 Diagrams of blood vessels are shown (not to scale).



1 *2* *3* *4*

Which of the following correctly lists the names of the blood vessels shown?

	1	*2*	*3*	*4*
(A)	Artery	Vein	Capillary	Vein
(B)	Capillary	Artery	Artery	Vein
(C)	Artery	Vein	Vein	Capillary
(D)	Vein	Artery	Capillary	Capillary

19 Why are antibiotics ineffective in treating malaria?

(A) Malaria is not caused by bacteria.

(B) Malaria is not an infectious disease.

(C) Malaria is transmitted by mosquitoes.

(D) Malaria is associated with wet environments.

20 How does the fossil record provide evidence to support the concept of punctuated equilibrium?

(A) The fossil record is incomplete.

(B) The fossil record shows that some organisms have become extinct.

(C) The fossil record shows that there are short periods of rapid change in fossil forms.

(D) The fossil record shows that some organisms change gradually over geologic time.

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2011 HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

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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.

Question 21 (4 marks)

(a) Identify TWO methods used to treat drinking water to reduce the risk of infection. **2**

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(b) Outline how the use of each of these methods reduces the risk of infection. **2**

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Question 22 (4 marks)

Six students performed a trial experiment on enzyme activity. The enzyme they were studying acts on a cloudy suspension, breaking it down into a soluble form. The lesson ended and students were asked to stop their experiment. They then recorded the time the experiment had run and their observations. These data are collated in the table.

Student	*Volume of enzyme solution* (mL)	*Temperature* (°C)	*pH*	*Volume of cloudy suspension* (mL)	*Time* (minutes)	*Observation at end of lesson*
1	5	37	2	10	9	Cloudy
2	5	37	2	10	20	Clear
3	5	37	4	10	35	Clear
4	5	37	4	10	20	Cloudy
5	5	37	6	10	8	Cloudy
6	5	37	6	10	40	Cloudy

(a) What is the purpose of this experiment? **1**

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(b) Describe TWO changes that would improve the validity of the data collected in the experiment. **2**

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Question 22 continues on page 11

Question 22 (continued)

(c) The experiment was repeated with all trials running for 40 minutes. Complete the table to predict the results. **1**

Student	*Volume of enzyme solution* (mL)	*Temperature* (°C)	*pH*	*Volume of cloudy suspension* (mL)	*Time* (minutes)	*Observation at end of trial*
1	5	37	2	10	40	
2	5	37	2	10	40	
3	5	37	4	10	40	
4	5	37	4	10	40	
5	5	37	6	10	40	
6	5	37	6	10	40	

End of Question 22

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Section I – Part B (continued)

Student Number

Question 23 (5 marks)

Several scientists were involved in determining the structure of DNA. **5**

To what extent did the quality of collaboration and communication between these scientists impact on their scientific research?

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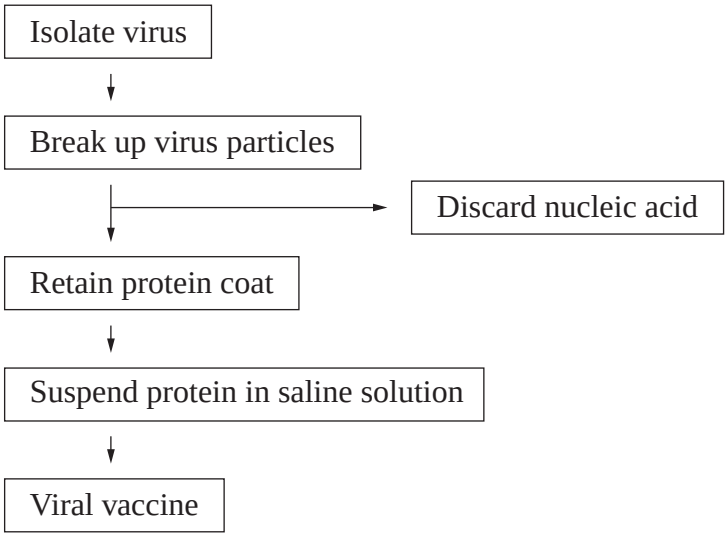
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Question 24 (5 marks)

(a) Name a viral disease that is controlled by the use of a vaccine. **1**

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(b) The flowchart shows the steps involved in the preparation of a vaccine to prevent a viral disease.



(i) Outline how a vaccine that is prepared in this way will produce immunity to a specific viral disease. **2**

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(ii) Explain ONE procedure in the flowchart that ensures the safety of the prepared vaccine. **2**

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Biology

Centre Number

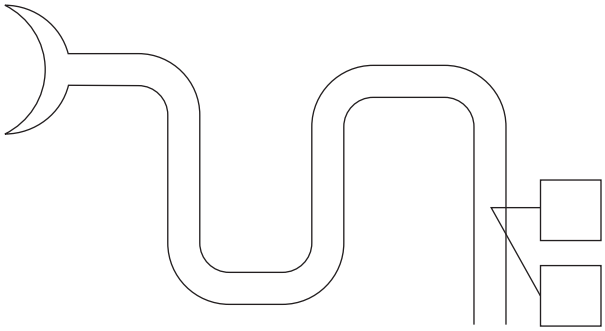
Section I – Part B (continued)

Student Number

Question 25 (5 marks)

A diagram of a nephron is shown.

Processes that occur in a nephron



Key:

A Filtration takes place
B Water reabsorption takes place
C Glucose reabsorption takes place
D Antidiuretic hormone (ADH) has its effect

(a) Label each of the two boxes on the diagram using A, B, C or D to identify the processes that take place at this location. **2**

(b) Which one of the above processes (A, B, C or D) occurs due to active transport? **1**

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(c) Outline the effect of aldosterone on the control of body fluids. **2**

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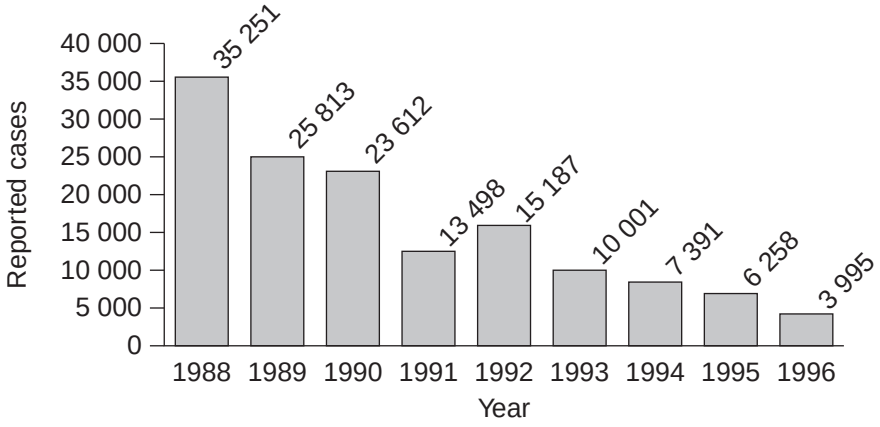
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Question 26 (6 marks)

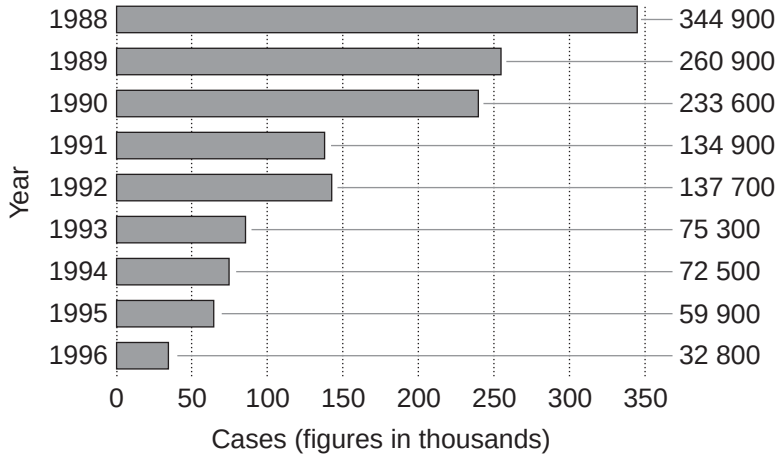
In assessing the effectiveness of the global polio vaccination program started in 1988, a student collected Graphs A and B from two reputable sources.

Graph A: Reported annual global polio cases from 1988–1996



Source: World Health Organization
http://www.who.int/en/
Date accessed: 10/6/201

Graph B: Estimated annual global polio cases from 1988–1996



Source: World Health Organization
http://www.who.int/en/
Date accessed: 10/6/2011

Question 26 continues on page 17

Question 26 (continued)

(a) Identify TWO similarities and TWO differences between the information contained in Graphs A and B. **4**

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(b) Recommend TWO additional types of data that could be used for evaluating the effectiveness of the global polio vaccination program. **2**

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End of Question 26

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2011 HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

Centre Number

Section I – Part B (continued)

Student Number

Question 27 (4 marks)

A new non-infectious disease has been discovered in people in some aged care homes. **4**

Outline at least FOUR features of an epidemiological study that could be used to identify the cause of this disease.

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Question 28 (5 marks)

Stem cells can develop into any type of body cell. When stimulated they can differentiate into specialised cells.

The skin contains stem cells as well as epidermal, blood vessel, fat and muscle cells.

New research suggests that stem cells obtained from the skin of a patient can be used to make red and white blood cells for that patient in the laboratory. Production of new improved artificial blood seems a likely outcome.

(a) Outline how gene expression in skin stem cells is linked to the maintenance of health after the skin is broken. **2**

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(b) Explain features of the new artificial blood made from skin stem cells that are likely to be an improvement over an existing form of artificial blood. **3**

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2011 HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

Centre Number

Section I – Part B (continued)

Student Number

Question 29 (5 marks)

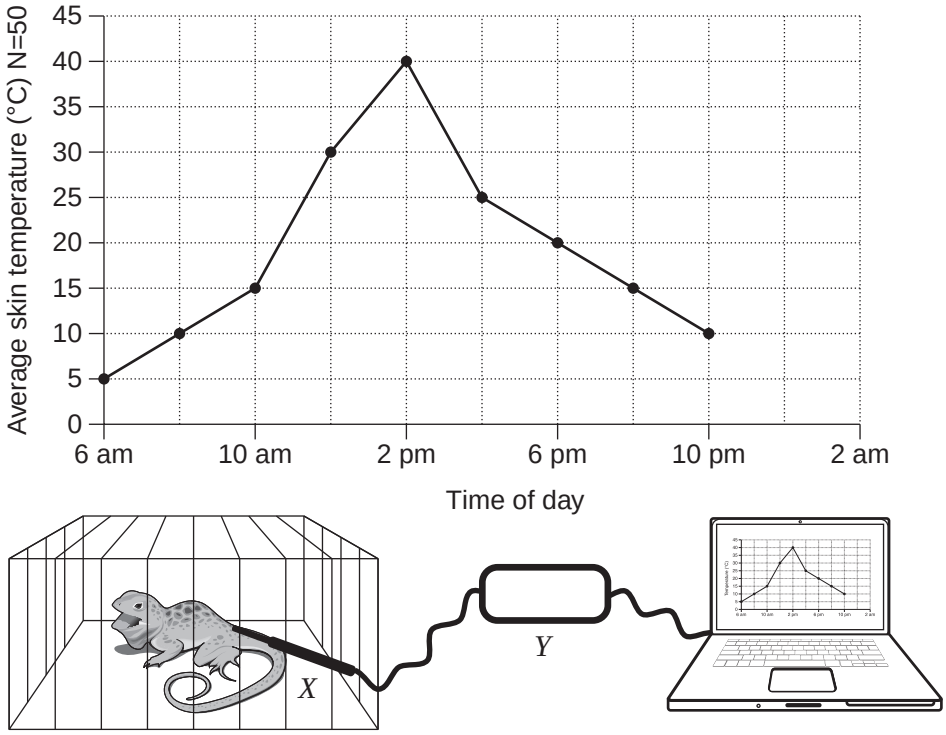
You are required to plan and perform a first-hand investigation to identify microbes in food or in water. **5**

Complete the following table for your investigation.

Dependent variable	
Independent variable	
Control	
Safe work practices to be followed	

Question 30 (5 marks)

Scientists recorded the body temperature of 50 reptiles of the same species on the same day. They were kept in small cages in the shade in a hot desert habitat. Technology *X* was used to measure skin temperature. This was linked to technology *Y* and then to a computer as shown in the diagram. The graph shows the averaged data generated by the computer from this experiment.



(a) Identify technology *X* and technology *Y*. **2**

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(b) The scientists concluded that the body temperature of this species of reptile is only controlled by the ambient temperature. **3**

Construct an argument against this conclusion, based on the information provided.

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2011 HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

Centre Number

Student Number

Section I – Part B (continued)

Question 31 (7 marks)

Fungi are a natural source of antibiotics. A scientist developed a new antibiotic by exposing a fungus to radiation. **7**

Information relevant to this antibiotic:

- It stops the activity of an enzyme in pathogenic bacteria.
- It has no effect on a similar enzyme in humans.
- The chemical composition of the enzyme in humans differs from the enzyme in the pathogenic bacteria by two amino acids.
- It is used to treat humans infected with the pathogenic bacteria.

Using this example and other relevant knowledge, describe how advances in our understanding of biology have implications for society.

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Question 31 continues on page 24

Question 31 (continued)

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Biology

Section II

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

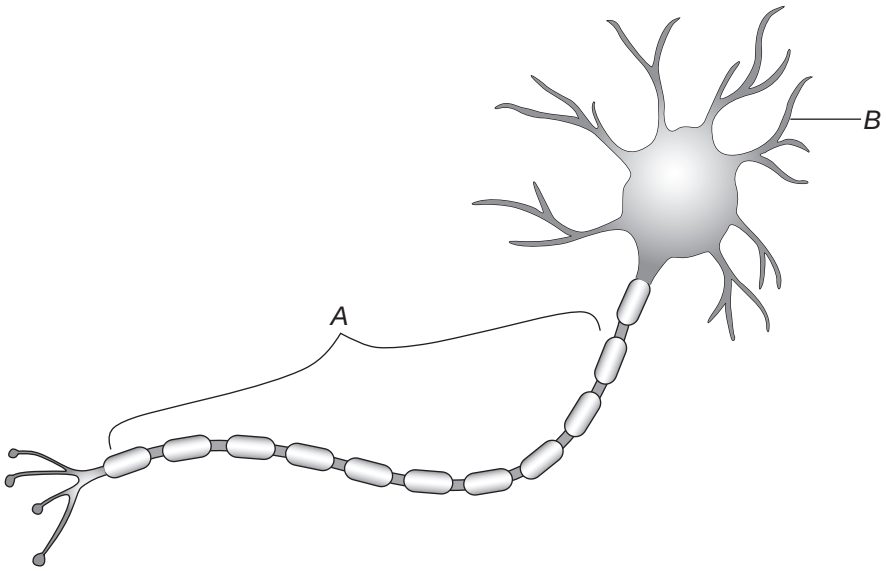
Answer parts (a)–(c) of the question in Section II Answer Booklet 1.
Answer parts (d)–(e) of the question in Section II Answer Booklet 2.
Extra writing booklets are available.

		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)–(c) in Section II Answer Booklet 1.

(a) The diagram below shows a microscopic view of a neuron.



(i) What are the structures labelled *A* and *B*? Clearly indicate in your answer which is *A* and which is *B*. **2**

(ii) Identify the role of structure *B*. **1**

(b) Explain why some stimuli do not result in an action potential. Use a graph to support your answer. **4**

(c) Laser Assisted In-Situ Keratomileusis (LASIK) is a procedure that uses a laser beam to cut into the cornea to change its shape in a precise manner.

(i) Identify the functions of the cornea. **2**

(ii) Explain how LASIK could be used to treat myopia so that glasses or contact lenses are no longer required. **3**

Question 32 continues on page 27

Question 32 (continued)

Answer parts (d)–(e) in Section II Answer Booklet 2.

(d) Compare the hearing of THREE mammals, including humans, giving possible reasons for their differences in hearing. **6**

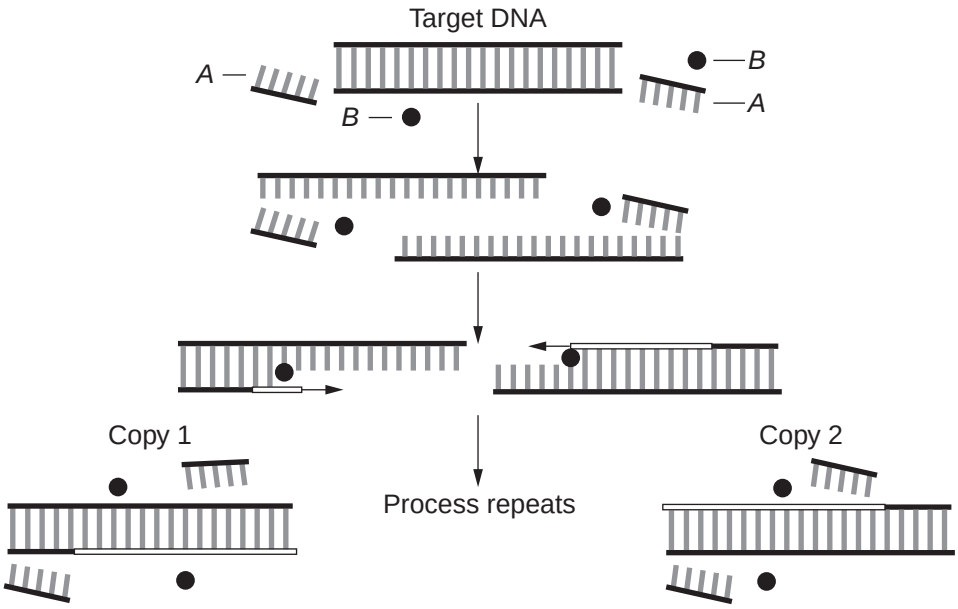
(e) Explain how the hearing aid and cochlear implant technologies assist hearing. Refer to the anatomy and function of the human ear and the role of the brain in coordinating responses to stimuli. **7**

End of Question 32

Question 33 — Biotechnology (25 marks)

Answer parts (a)–(c) in the Section II Answer Booklet 1.

(a) The diagram below shows a recombinant DNA technique.



(i) What are represented by the components labelled *A* and *B*? Clearly indicate in your answer which is *A* and which is *B*. **2**

(ii) Identify the process shown in the diagram. **1**

(b) Explain why transcription and translation result in different products. Use a diagram to support your answer. **4**

(c)

Ants cultivate grass for food

A species of ant has been observed to clear the surface of the ground for 5 metres around its colony and bury grass seeds there. The ants remove any other plants that may spring up among their crop. When the seeds are ripe, the ants harvest the seeds for food and retain some seeds for next year's crop. A ten-year study has shown that the average size of the grass seeds increased by 5%.

(i) Outline the difference between qualitative and quantitative observations, using examples from the text above. **2**

(ii) Explain why the ant activity could be interpreted as biotechnology. **3**

Question 33 continues on page 29

Question 33 (continued)

Answer parts (d)–(e) of the question in Section II Answer Booklet 2.

(d) Explain the risks and benefits to society of using recombinant DNA technologies. **6**

(e) Enzymes have been developed from bacteria that remove contaminating insecticides and herbicides from waterways. **7**

Explain how the technologies you have studied in this option could be applied to the development and production of such enzymes. Refer to techniques such as those used to extract enzymes, amplify genes and recombine DNA.

End of Question 33

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

Answer parts (a)–(c) in Section II Answer Booklet 1.

(a) The table shows parts of DNA sequences.

	DNA Sequence
Original DNA	AAC TCG GTC AAT ATG
Mutation 1	AAC TCC GTC AAT ATG
Mutation 2	AAC TCG GTA ATA TGC

(i) What types of mutations are *Mutation 1* and *Mutation 2*? Clearly indicate in your answer which is *Mutation 1* and which is *Mutation 2*. **2**

(ii) Using the information provided in the table, what is the effect of *Mutation 1* in part (i)? **1**

	T	**C**	**A**	**G**
T	TTT Phe (F) TTC Phe (F) TTA Leu (L) TTG Leu (L)	TCT Ser (S) TCC Ser (S) TCA Ser (S) TCG Ser (S)	TAT Tyr (Y) TAC Tyr (Y) TAA STOP TAG STOP	TGT Cys (C) TGC Cys (C) TGA STOP TGG Trp (W)
C	CTT Leu (L) CTC Leu (L) CTA Leu (L) CTG Leu (L)	CCT Pro (P) CCC Pro (P) CCA Pro (P) CCG Pro (P)	CAT His (H) CAC His (H) CAA Gin (Q) CAG Gin (Q)	CGT Arg (R) CGC Arg (R) CGA Arg (R) CGG Arg (R)
A	ATT Ile (I) ATC Ile (I) ATA Ile (I) ATG Met (M) START	ACT Thr (T) ACC Thr (T) ACA Thr (T) ACG Thr (T)	AAT Asn (N) AAC Asn (N) AAA Lys (K) AAG Lys (K)	AGT Ser (S) AGC Ser (S) AGA Arg (R) AGG Arg (R)
G	GTT Val (V) GTC Val (V) GTA Val (V) GTG Val (V)	GCT Ala (A) GCC Ala (A) GCA Ala (A) GCG Ala (A)	GAT Asp (D) GAC Asp (D) GAA Glu (E) GAG Glu (E)	GGT Gly (G) GGC Gly (G) GGA Gly (G) GGG Gly (G)

Question 34 continues on page 31

(b) Explain how children with different ABO and Rhesus blood groups could be the offspring of the same parents. Use diagrams to support your answer. **4**

(c) Generally, chickens raised for meat are fed intensively to achieve fast growth. However, this also leads to the generation of a lot of body heat.

It has been found that appetite is reduced when animals are hot. A scientist, using the technology of selective breeding, has developed a featherless chicken.

The scientist claims that 'these chickens are not genetically modified as they come from a natural breed and were not cloned'.

(i) Outline the difference between selective breeding and animal cloning. **2**

(ii) Discuss the scientist's claim using your knowledge of selective breeding. **3**

Answer parts (d)–(e) in Section II Answer Booklet 2.

(d) Discuss the use of the Human Genome Project and traditional inheritance studies as ways to identify the location of harmful genes. **6**

(e) The origin of the dingo (an Australian native dog) is uncertain. It has commonly been classified as *Canis familiaris dingo*, a subspecies of the domestic dog, *Canis familiaris*. **7**

It has recently been suggested that the dingo should be reclassified as *Canis lupus dingo* to reflect a closer relationship to the Asian wolf, *Canis lupus*.

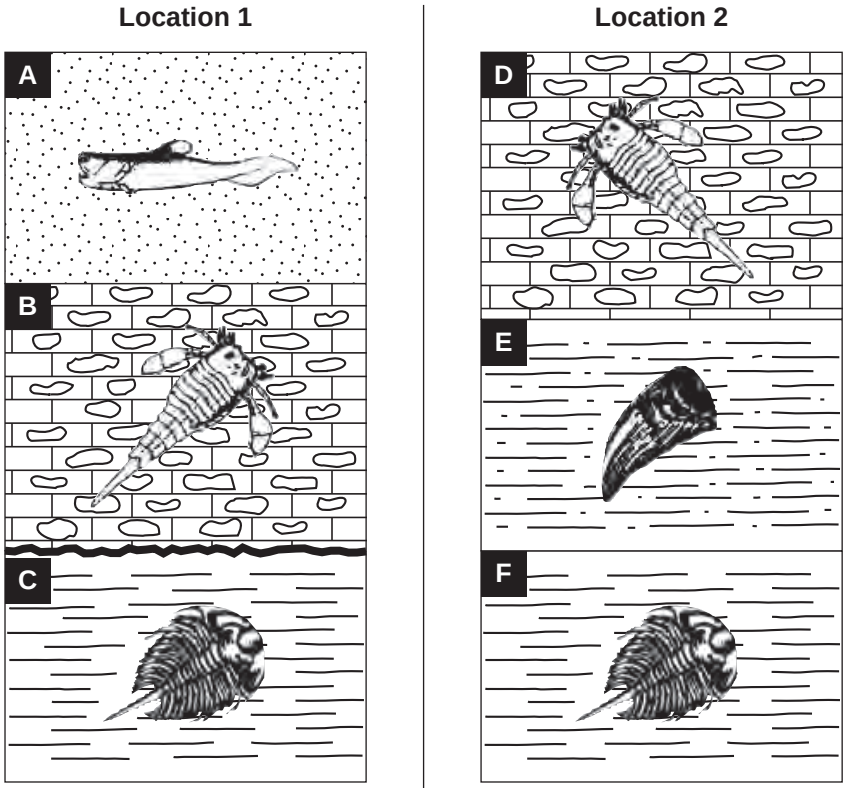
Explain how the technologies you have studied in this option could be applied to identifying the relationships between these species.

End of Question 34

Question 35 — The Human Story (25 marks)

Answer parts (a)–(c) in Section II Answer Booklet 1.

(a) The diagrams show labelled fossil strata that were found in different locations within a region.



(i) Which rock layer(s) is/are the oldest and which is/are the youngest in this region? **2**

(ii) Name the relative dating technique used in your answer to part (i). **1**

(b) Explain TWO alternative views of the evolutionary relationships between FOUR identified hominids of the same genus. Use diagrams to support your answer. **4**

Question 35 continues on page 33

(c) In 2004, a new species, Homo floresiensis, was identified from fossils found in a cave on an Indonesian island. Dated to 18 000 years ago, these fossils were found in sediment containing stone tools and cooking hearths.

The adult skull of this upright bi-pedal fossil organism has a volume of 380 cm^3. The size of each adult organism was approximately the same as a three-year-old modern human.

Their arm to leg ratio was slightly larger than modern humans. They had hard, thicker eyebrow ridges than us, a sharply sloping forehead, and no chin.

The cooking hearths contained charred bones of game species, each estimated to weigh more than 1 000 kilograms. Stone tools included blades, spear heads and cutting and chopping utensils.

(i) Outline the fossil evidence from this description that suggests the advanced cultural development of *Homo floresiensis*. **2**

(ii) Discuss the validity of the classification of *Homo floresiensis* as a species separate from other known fossil hominids. **3**

Answer parts (d)–(e) in Section II Answer Booklet 2.

(d) (i) By explaining the mechanisms of biological evolution, compare early and current *Homo sapiens*. **4**

(ii) Explain why there is a greater genetic diversity between human populations in Africa than between human populations in other continents. **2**

(e) Insectivorous microbats and fruit-eating megabats are classified as members of the order Chiroptera. Lemurs are fruit and leaf eaters and are classified as members of the order Primates. **7**

Scientists have recently hypothesised that megabats are closer in evolutionary terms to lemurs than to microbats.

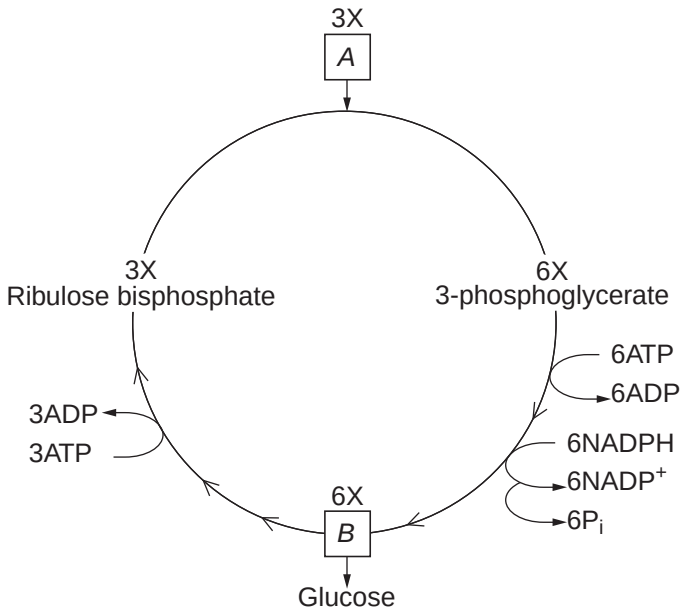
Explain how you could use technologies and the data they generate to test this hypothesis.

End of Question 35

Question 36 — Biochemistry (25 marks)

Answer parts (a)–(c) in Section II Answer Booklet 1.

The diagram outlines a biochemical pathway.



(a) (i) Name the pathway. **1**

(ii) What are molecules *A* and *B*? Clearly indicate in your answer which is *A* and which is *B*. **2**

(b) Describe the location of the site of light absorption during photosynthesis. Use a diagram to support your answer. **4**

Question 36 continues on page 35

Question 36 (continued)

(c) You wish to study the dark cycle of photosynthesis by using radioactive isotopes. A table of half-lives is provided. **5**

Element	Isotope	Half-life
Carbon	C-11 C-14	20.38 minutes 5730 years
Hydrogen	H-3	12.35 years
Nitrogen	N-13 N-16	9.97 minutes 7.13 seconds
Oxygen	O-15	122.24 seconds
Sulfur	S-35	87.44 days

Name the isotopes you would use for this study and account for your choice.

Answer parts (d)–(e) in Section II Answer Booklet 2.

(d) Describe how Mayer's conclusion about photosynthesis brought together the ideas from the work of earlier scientists. **6**

(e) A new chlorophyll, chlorophyll E, was recently discovered in cyanobacteria by Australian scientists. As a member of the scientific team, your role is to identify the subcellular location of the new chlorophyll, extract it, separate it from other chlorophylls and analyse its properties. **7**

Explain the technologies that you would use to carry out your role in the scientific team.

End of paper

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