

2011 BIOLOGY

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**ATTACH SACE REGISTRATION NUMBER LABEL
TO THIS BOX**

**QUESTION
BOOKLET**

1

23 pages, 31 questions

Tuesday 8 November: 9 a.m.

Time: 3 hours

Section A and Part 1 of Section B

Examination material: Question Booklet 1 (23 pages)
Question Booklet 2 (10 pages)
Question Booklet 3 (8 pages)
one multiple-choice answer sheet
one SACE registration number label

Approved dictionaries and calculators may be used.

Instructions to Students

- You will have 10 minutes to read the paper. You must not write in your question booklets, or on your multiple-choice answer sheet, or use a calculator during this reading time but you may make notes on the scribbling paper provided.
- This paper is in three sections: Section A and Part 1 of Section B are in Question Booklet 1; Part 2 of Section B is in Question Booklet 2; and Section C is in Question Booklet 3.

Section A: Multiple-choice Questions (Questions 1 to 25)
Answer Section A on the separate multiple-choice answer sheet, using black or blue pen.
Answer *all* questions in Section A.

Section B: Short-answer Questions (Questions 26 to 35)
Answer Part 1 of Section B (Questions 26 to 31) in the spaces provided in Question Booklet 1.
Write on page 23 of Question Booklet 1 if you need more space.
Answer Part 2 of Section B (Questions 32 to 35) in the spaces provided in Question Booklet 2.
Write on page 10 of Question Booklet 2 if you need more space.

Section C: Extended-response Questions (Questions 36 and 37)
Answer *both* questions in Section C in Question Booklet 3.
Write on page 8 of Question Booklet 3 if you need more space.
- In Section B there is no need to fill all the space provided; clear, well-expressed answers are required. If you delete part or all of an answer you should clearly indicate your final answer and label it with the appropriate question number.
- The allocation of marks and suggested allotment of time are as follows:

Section A	50 marks	40 minutes
Section B	120 marks	110 minutes
Section C	30 marks	30 minutes
Total	200 marks	180 minutes
- Attach your SACE registration number label to the box at the top of this page. Copy the information from your SACE registration number label into the boxes on your multiple-choice answer sheet and on the front covers of Question Booklets 2 and 3.
- At the end of the examination, place Question Booklets 2 and 3, and your multiple-choice answer sheet, inside the back cover of Question Booklet 1.

**STUDENT'S DECLARATION ON THE USE OF
CALCULATORS**

By signing the examination attendance roll I declare that:

- my calculators have been cleared of all memory
- no external storage media are in use on these calculators.

I understand that if I do not comply with the above conditions for the use of calculators I will:

- be in breach of the rules
- have my results for the examination cancelled or amended
- be liable to such further penalty, whether by exclusion from future examinations or otherwise, as the SACE Board of South Australia determines.

SECTION A: MULTIPLE-CHOICE QUESTIONS (Questions 1 to 25)

(50 marks)

Answer **all** questions in this section.

Each of the twenty-five multiple-choice questions in Section A involves choosing from four alternative answers. Read each question carefully. Then indicate the **one** alternative that you consider best answers the question by shading the bubble by the appropriate letter alongside the question number on the multiple-choice answer sheet. Use black or blue pen. It is in your interest to give an answer to every question in this section of the paper, as no marks are deducted for incorrect answers. Each question is worth 2 marks. You should spend about 40 minutes on this section.

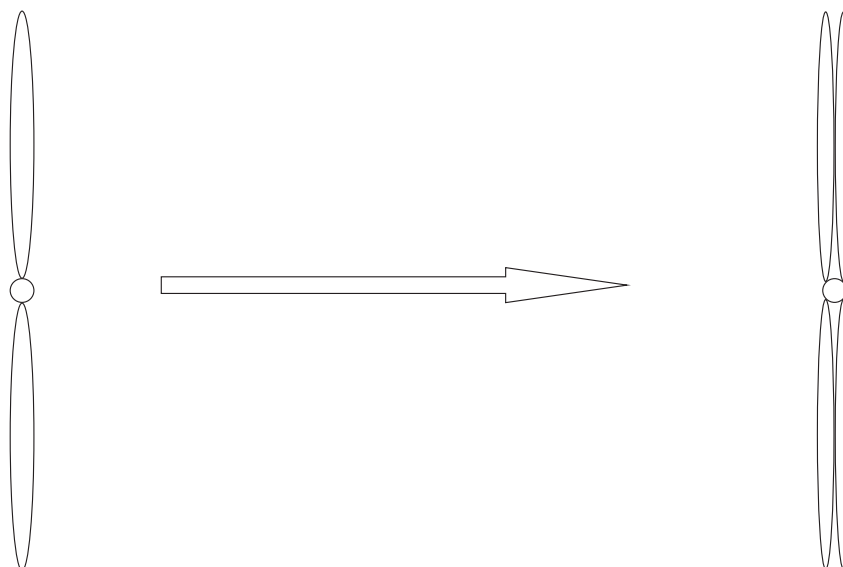
1. Refer to the following sequence of bases, which was transcribed from a nucleic acid:

... A U A G C C C U A G G C ...

Which one of the following sequences of bases is the template that was used for this transcription?

- J. ... U A U C G G G A U C C G ...
 - K. ... A T A G C C C T A G G C ...
 - L. ... T A T C G G G A T C C G ...
 - M. ... C G G A T C C C G A T A ...
2. Which one of the following statements about polysaccharides in cells is correct?
- J. Polysaccharides are the only energy reserve molecules in a cell.
 - K. Cellulose is an important component of plant cell membranes.
 - L. Glycogen and starch have structural roles in cells.
 - M. Polysaccharides may be a component of the cell wall.

3. Refer to the following diagram, which shows one essential process in the synthesis of new cells in an organism:



Which one of the following combinations identifies the result of the process shown in the diagram above and names this process?

	Result of process	Name of process
J.	identical sister chromatids	cell division
K.	production of complementary strands	transcription
L.	identical sister chromatids	semi-conservative replication
M.	production of complementary strands	binary fission

4. Refer to the following table, which shows amino acid sequences from a segment of a viral protein that is found in a number of different viruses. These viruses were isolated from patients suffering from either the common cold (caused by a rhinovirus) or influenza. Each letter represents a single amino acid.

Virus	Amino acid sequence																	
rhinovirus 1	P	E	F	P	Y	N	A	T	T	E	P	T	K	A	V	P	F	Q
rhinovirus 2	P	E	F	S	Y	S	A	V	D	D	P	I	G	E	E	P	F	K
rhinovirus 3	P	E	F	S	Y	S	A	G	D	D	P	A	G	E	E	P	F	N
influenza A	P	E	Y	H	T	P	V	M	E	P	L	D	P	F	T	M	D	K
influenza B	P	E	Y	H	T	P	K	M	E	P	L	D	A	F	A	M	D	N
influenza C	P	E	Y	H	T	P	V	M	E	P	L	D	V	F	D	M	D	K

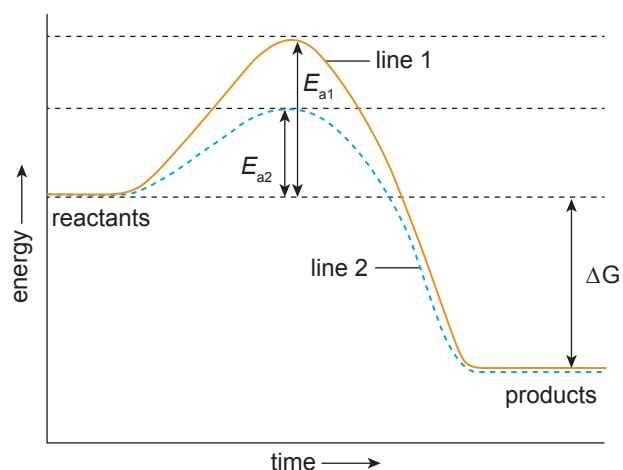
Which one of the following statements is consistent with the data in the table above?

- J. The rhinoviruses are more closely related to each other than the influenza viruses are to each other.
- K. Influenza virus A is more closely related to influenza virus B than influenza virus B is to influenza virus C.
- L. The influenza viruses are less closely related to each other than they are to the rhinoviruses.
- M. Rhinovirus 2 is more closely related to rhinovirus 3 than it is to rhinovirus 1.
5. For the Golgi body to transport proteins to the extracellular environment the proteins must first bind to receptors on the surface of the Golgi body. NDGA is a chemical that specifically blocks the transport of proteins to and from the Golgi body.

It is most likely that NDGA blocks the transport of proteins to and from the Golgi body by

- J. preventing the synthesis of proteins at ribosomes on the surface of the endoplasmic reticulum.
- K. having the same shape as receptors on the cell membrane.
- L. binding to the receptors on the surface of the Golgi body.
- M. preventing the formation of vesicles that are required for proteins to be secreted from the Golgi body.

6. Refer to the following graph, which shows the energy changes during a chemical reaction in a cell. Line 1 and line 2 represent the same reaction under different conditions.



Which one of the following statements is consistent with the information in the graph above?

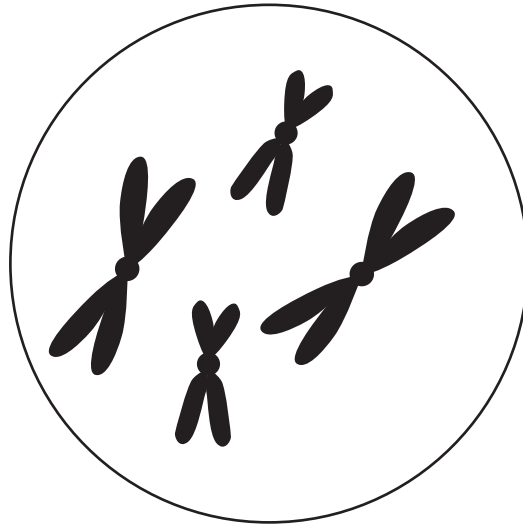
- J. The difference between E_{a1} and E_{a2} is called the 'activation energy'.
- K. Line 1 shows the energy changes during the chemical reaction in the absence of an enzyme.
- L. ΔG indicates that the reaction requires energy.
- M. In this reaction the energy required to break bonds is greater than the energy released when new bonds are formed.

7. A prokaryotic cell can be identified by the
- J. presence of a cell wall.
 - K. absence of a nucleus.
 - L. presence of ribosomes.
 - M. absence of ribosomes.
8. The cytoskeleton **does not**
- J. maintain the shape of a red blood cell.
 - K. help in the process of active transport.
 - L. move vesicles through the cytoplasm.
 - M. help in the process of endocytosis.
9. Penicillin is an antibiotic, a drug used to treat bacterial infection. Penicillin is toxic to some dividing bacterial cells as it prevents the formation of their cell walls, causing the cells to burst.
- This suggests that bacteria affected by penicillin burst as a result of having
- J. a reduced number of carrier proteins.
 - K. a reduced number of channel proteins.
 - L. an extracellular environment that is more concentrated than the intracellular environment.
 - M. an extracellular environment that is less concentrated than the intracellular environment.

10. The cell cycle is **regulated** by

- J. hormones in prokaryotic and eukaryotic cells.
- K. internal factors and external factors in cancer cells.
- L. gene products in plant cells.
- M. carcinogens in animal cells.

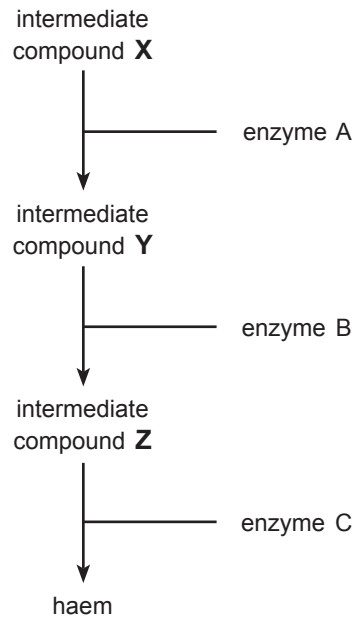
11. Refer to the following diagram, which shows four chromosomes in a cell during cell division:



The most likely stage and type of cell division shown in the diagram above is near the

- J. beginning of mitosis.
- K. beginning of meiosis.
- L. end of mitosis.
- M. end of meiosis.

12. Refer to the following metabolic pathway, which shows the intermediate compounds in the synthesis of the haem molecule that forms part of haemoglobin. The enzymes that catalyse the reactions at each step are also shown.



Porphyrias are diseases that result when a person has a defective gene that codes for an enzyme in the haem metabolic pathway.

The deficiency of a specific enzyme results in a particular disease, as shown in the table below:

Enzyme deficiency	Disease
A	hereditary coproporphyria
B	variegate porphyria
C	erythropoietic protoporphyria

Diagnosis is often made when abnormal amounts of one or more intermediate compounds are found in the patient's blood, urine, or faeces.

The urine samples of a person with **variegate porphyria** would be likely to contain an abnormally high amount of

- J. intermediate compound **Z** and an abnormally low amount of haem.
- K. intermediate compound **Z** and an abnormally low amount of intermediate compound **Y**.
- L. intermediate compound **Y** and an abnormally high amount of intermediate compound **X**.
- M. intermediate compound **Y** and an abnormally high amount of intermediate compound **Z**.

13. In plant cells, fermentation

- J. is an anaerobic alternative to aerobic respiration.
- K. results in the same products as fermentation in animal cells.
- L. occurs in mitochondria.
- M. releases more energy per molecule of glucose than is released by aerobic respiration.

14. Heterotrophic, but **not** autotrophic, organisms

- J. release carbon dioxide and water as products of respiration.
- K. manufacture their own organic molecules for their nutrition.
- L. rely on carbon dioxide and water for their nutrition.
- M. rely on existing organic molecules for their nutrition.

15. Blood capillaries and lymph capillaries

- J. provide a large surface area for carbon dioxide to be removed directly from the blood.
- K. provide a thin surface that increases the rate of osmosis.
- L. supply body cells with blood.
- M. supply body cells with oxygen.

16. Refer to the following table, which lists the concentrations (in g/100 cm³) of various substances in the blood plasma, the glomerular filtrate, and the urine of a hospital patient:

Substance	Blood plasma	Glomerular filtrate	Urine
water	92	99	96
urea	0.03	0.03	2.00
glucose	0.01	0.01	0.00
amino acids	0.05	0.05	0.00
proteins	8.00	2.00	2.00
chloride ions	0.50	0.49	0.01

Which one of the following statements is **not** consistent with the information in the table above?

- J. Glucose is filtered from the blood.
 - K. Proteins are not filtered from the blood.
 - L. Water is reabsorbed into the blood.
 - M. Proteins are not reabsorbed into the blood.
17. The concentration of CO₂ in a sample of air was found to be 330 parts per million (ppm). An experiment was designed to measure the concentration of CO₂ in this air after it had flowed over a green plant.

Measurements that were made at various light intensities are recorded in the table below:

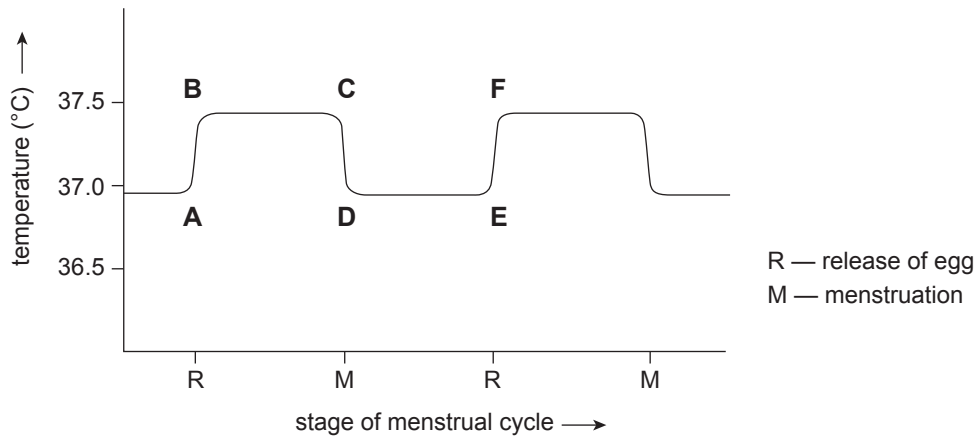
Light intensity (%)	Concentration of CO ₂ (ppm) in air after it flowed over the plant
75	303
50	303
25	304
10	330

Which one of the following statements is **incorrect** according to the information above?

- J. At light intensities between 10% and 25%, the rate of photosynthesis is dependent on light intensity.
- K. At light intensity of 10%, photosynthesis does not occur.
- L. If measurements were made in the dark the concentration of CO₂ would be at least 330 ppm.
- M. At light intensities between 50% and 75%, the rate of photosynthesis is independent of light intensity.

18. In human beings, body temperature changes during the menstrual cycle. The day after an egg is released from an ovary, the body temperature rises by approximately 0.5°C and remains at this temperature until the beginning of menstruation.

Refer to the following graph, which shows the variation in body temperature during two menstrual cycles:

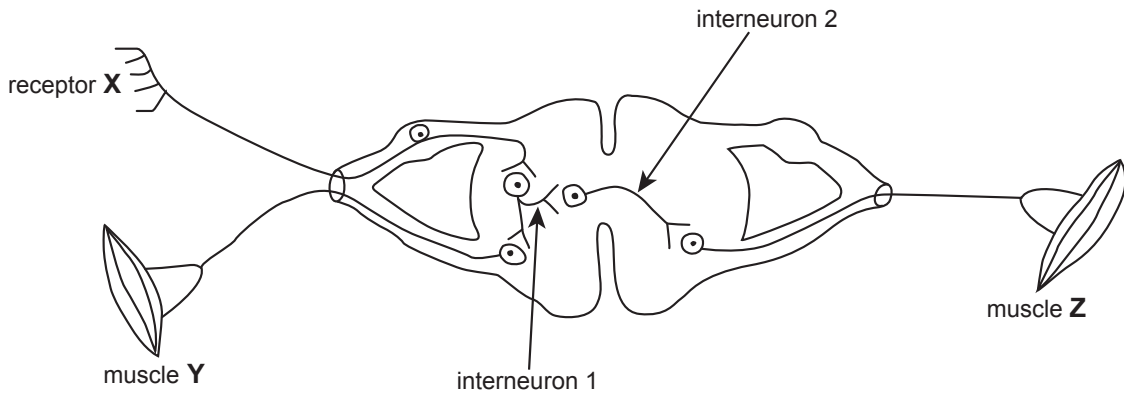


Which one of the following statements is consistent with the information in the graph above?

The temperature change between

- J. **A** and **B** could result from an increase in metabolic rate.
- K. **E** and **F** could result from an increase in sweating.
- L. **C** and **D** could result from a decrease in the flow of blood to the skin.
- M. **A** and **B** could result from a decrease in shivering.

19. Refer to the following diagram, which shows a cross-section of the spinal cord of a mammal:



Sensory neurons transmit impulses from the receptor, and motor neurons transmit impulses to the effector. Normally when receptor **X** is stimulated, muscles **Y** and **Z** contract.

Which one of the following circumstances will cause **only** muscle **Z** to contract when receptor **X** is stimulated?

- J. One interneuron is not functioning.
- K. Neither motor neuron is functioning.
- L. No reflex response is occurring.
- M. One motor neuron is not functioning.

20. The fat-leaved wattle (*Acacia pinguifolia*) is an endangered plant species known to exist only in small areas of South Australia.

The best way to ensure the survival of the fat-leaved wattle is to

- J. collect the seeds and store them in a seed bank.
- K. protect the remaining fat-leaved wattles from herbivores.
- L. cultivate as many seedlings as possible for replanting.
- M. ensure that the natural habitat of the fat-leaved wattle is preserved.

21. Refer to the following photographs, which show two species of bird commonly found nesting near each other in the same areas of the Australian bushland:



crimson rosella (*Platycercus elegans*)

Source: www.dreamstime.com



eastern rosella (*Platycercus eximius*)

Source: Adapted from www.istockphoto.com

The two birds shown above may belong to

- J. the same population but not the same community.
- K. the same population and the same ecosystem.
- L. different populations and different communities.
- M. different populations but the same ecosystem.

22. Skinks are smooth-scaled lizards that are found in a variety of habitats.

Which one of the following differences is **least likely** to prevent two species of skink from interbreeding?

- J. The two species have different-coloured skin.
- K. Males of different species have different mating rituals.
- L. The two species colonise different parts of a desert community.
- M. Females of different species are fertile in different months of the year.

23. Which one of the following combinations of characteristics would be most common in the species of plants growing in the first few months after a large bushfire?

	Reproductive effort	Length of life	Number of offspring
J.	high	short	many
K.	low	long	few
L.	high	long	many
M.	low	short	few

24. It has recently been found that some species of disease-causing bacteria that were previously killed by antibiotics are now resistant to these drugs.

Which one of the following statements is the best explanation for the **origin** of this resistance?

- J. Resistant bacteria survive as a result of natural selection.
 - K. Generations of bacteria adapt and become resistant to antibiotics.
 - L. Random changes in the sequence of bacterial DNA bases produce resistance to antibiotics.
 - M. Antibiotics cause mutations in bacterial proteins, resulting in resistance.
25. A student measured the rate of photosynthesis in water plants by collecting the oxygen gas that the plants produced in 1 hour, at three different temperatures.
- Five identical sets of equipment were used for each of the three temperatures. The average result for each of the three temperatures was calculated and used to form a conclusion.
- Repeating this experiment on a different occasion with five new identical sets of equipment would enable the student to
- J. identify a systematic error.
 - K. increase the precision of the experiment.
 - L. reduce the number of random errors.
 - M. increase the reliability of the results.

SECTION B: SHORT-ANSWER QUESTIONS (Questions 26 to 35)

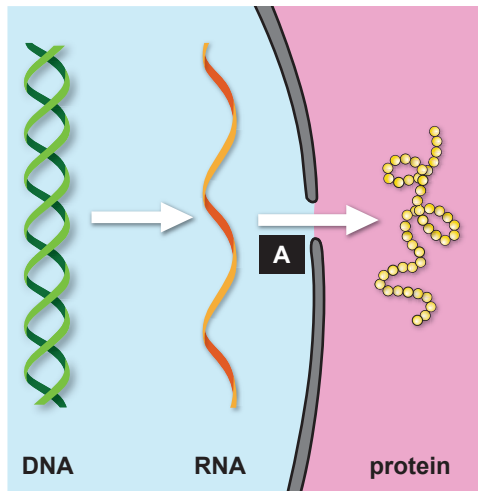
(120 marks)

You should spend about 110 minutes on this section. Answers may be in note form. The allocation of marks is shown in brackets at the end of each part of each question. Answer **all** questions in the spaces provided.

PART 1 (Questions 26 to 31)

(60 marks)

26. Refer to the following diagram, which shows cellular process **A**:



(a) State the name of cellular process **A** (RNA → protein).

_____ (2 marks)

(b) Describe the roles of mRNA and tRNA in the process of protein synthesis in eukaryotic cells.

mRNA: _____

tRNA: _____
_____ (4 marks)

27. In a colony of ants the queen ant is diploid and the male ants are haploid. The queen ant lays two different types of egg:

Type 1: Those that have been fertilised and give rise to females that become either worker ants or queen ants.

Type 2: Those that have not been fertilised and give rise to male ants.

(a) Compare the number of chromosomes in the body cells of worker ants and male ants.

_____ (2 marks)

(b) State the type of cell division that gives rise to the body cells of male ants.

_____ (2 marks)

(c) Describe how independent assortment results in new combinations of genes in male ants.

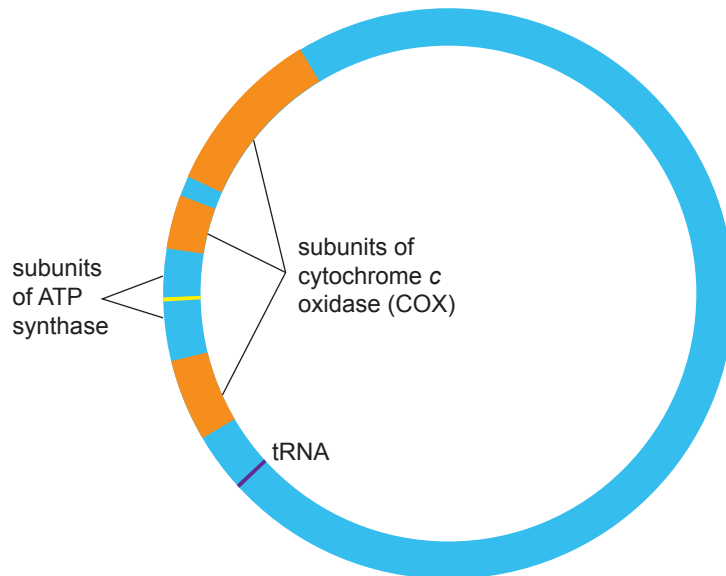
_____ (4 marks)

(d) Explain the advantage that genetic variation has for a species.

_____ (4 marks)

28. The mitochondrion contains DNA called mtDNA (mitochondrial DNA). In mammals, each circular mtDNA molecule consists of 15000 to 17000 base pairs, which encode the same thirty-seven genes.

Refer to the following diagram, which shows a simplified version of the human mtDNA genome:



The three sections of mtDNA that code for the subunits of cytochrome c oxidase (COX) are shown in the diagram above.

COX is an enzyme that is essential in the process of cellular respiration. It is present in almost every organism. Cyanide is a poison that can kill an organism quickly. The cyanide ion halts cellular respiration by inhibiting COX.

- (a) Explain how a chemical inhibitor can prevent an enzyme from functioning normally.

(4 marks)

- (b) Explain how the universal presence of the COX gene is strong evidence for the common ancestry of all living things.

(4 marks)

- (c) Choose one relevant piece of information from page 18 and explain how it provides evidence that the presence of mitochondria in eukaryotic cells may be the result of endosymbiotic events.

(4 marks)

- (d) Describe the structure of a mitochondrion. You may use a labelled diagram.

(4 marks)

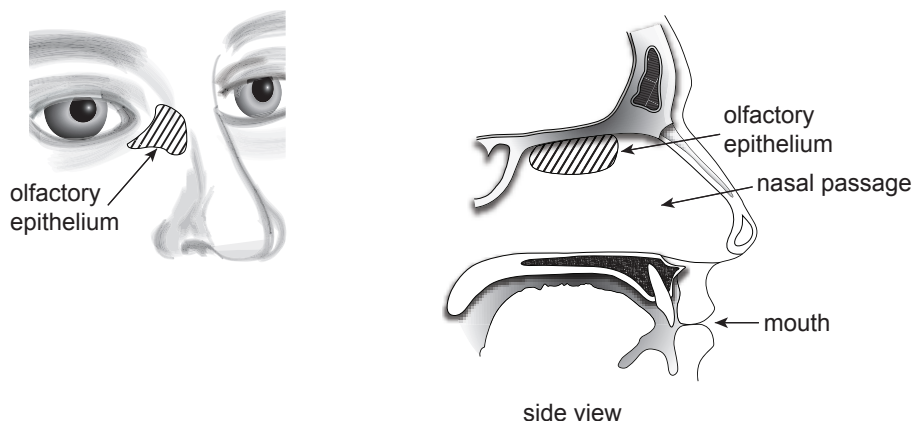
- (e) (i) Compare the **external** surface area-to-volume ratio of a mitochondrion with that of the cell in which it is found.

(2 marks)

- (ii) State a reason for your answer to part (i).

(2 marks)

29. Refer to the following diagram, which shows a patch of specialised tissue on the roof of the nasal cavity. This tissue is called the olfactory epithelium, and is responsible for a human being's sense of smell:



Olfactory cells are sensory receptors. When odour molecules bind to receptor molecules on the olfactory cells, an electrical message is transmitted to the brain.

(a) State the importance to human beings of sensory receptors such as olfactory cells.

_____ (2 marks)

(b) Olfactory cells are involved in nervous communication.

State *two* differences between nervous communication and hormonal communication.

Difference 1: _____

Difference 2: _____

_____ (4 marks)

(c) Write a balanced chemical equation for the reaction within the mitochondria of olfactory cells that produces water and releases energy.

_____ (2 marks)

30. Refer to the following photograph, which shows a common sea star, a marine organism that lives mainly in rock pools and shallow reefs:



Source: www.istockphoto.com

The body of a sea star is composed of epithelial, connective, muscle, and nervous tissues.

Sea stars can undergo a process called fragmentation, in which the body of an individual sea star breaks into smaller pieces, each of which becomes a new sea star.

- (a) Compare the genetic information that would be found in an epithelial cell and a muscle cell of the same sea star.

_____ (2 marks)

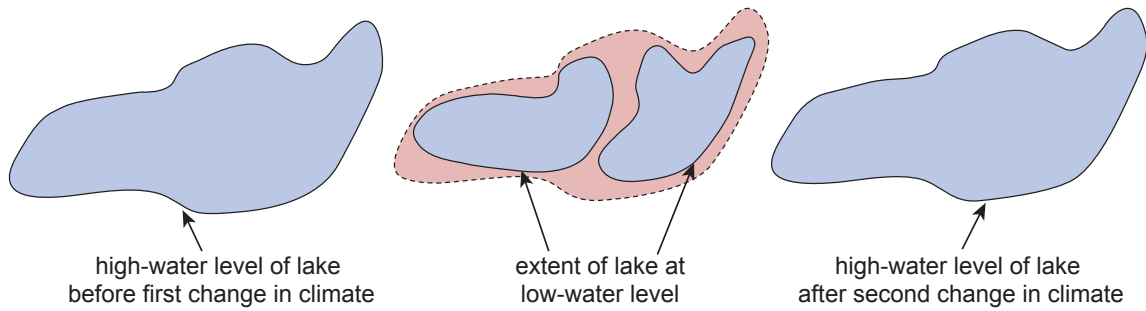
- (b) Name the type of reproduction that involves fragmentation.

_____ (2 marks)

- (c) State the only source of genetic difference between sea stars formed by fragmentation of an individual sea star.

_____ (2 marks)

31. Refer to the following diagram, which shows the shore-line of a large lake at high-water level and at low-water level:



After a change in the climate, the high-water level of the large lake dropped to a low-water level and the lake divided into two sections. One species of fish that had been living in the lake before it divided was separated into two populations that could no longer interact or exchange genes.

Several thousand generations of fish thrived in each section of the lake. After a second change in climate, the water in the lake again rose to the high level and the two sections became one large lake.

The two previously separated populations of fish were reunited and began to interbreed successfully.

(a) State the term that is used to describe the sum of all the genes of all the individuals in a population.

_____ (2 marks)

(b) State one biotic factor that could contribute to natural selection in a population of fish in a lake.

_____ (2 marks)

(c) Explain why, after several thousand generations of separation, the two populations of fish were able to interbreed and produce fertile offspring when the level of the water rose.

 _____ (4 marks)



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QUESTION BOOKLET
2
10 pages, 4 questions

Tuesday 8 November: 9 a.m.

Part 2 of Section B

Write your answers to Part 2 of Section B in this question booklet.

SECTION B: SHORT-ANSWER QUESTIONS

PART 2 (Questions 32 to 35)

(60 marks)

Answer **all** questions in the spaces provided.

32. Golden rice is genetically modified rice that is able to synthesise beta-carotene, which the human body uses to make vitamin A. For rice to synthesise beta-carotene, three new genes are required: two from daffodils and one from a species of bacterium. Beta-carotene gives daffodils their golden colour and is the reason why this genetically modified rice is golden.

- (a) Describe the main steps needed to incorporate in the DNA of rice one of the two genes that have been isolated from daffodils.

(4 marks)

- (b) State one advantage and one disadvantage of the production and use of genetically modified organisms by human beings.

Advantage: _____

Disadvantage: _____

(4 marks)

- (c) An attempt was made to produce golden rice. To determine whether or not DNA from the daffodils and the bacterium had been successfully incorporated in the DNA of the rice, scientists used PCR and gel electrophoresis to produce DNA profiles.

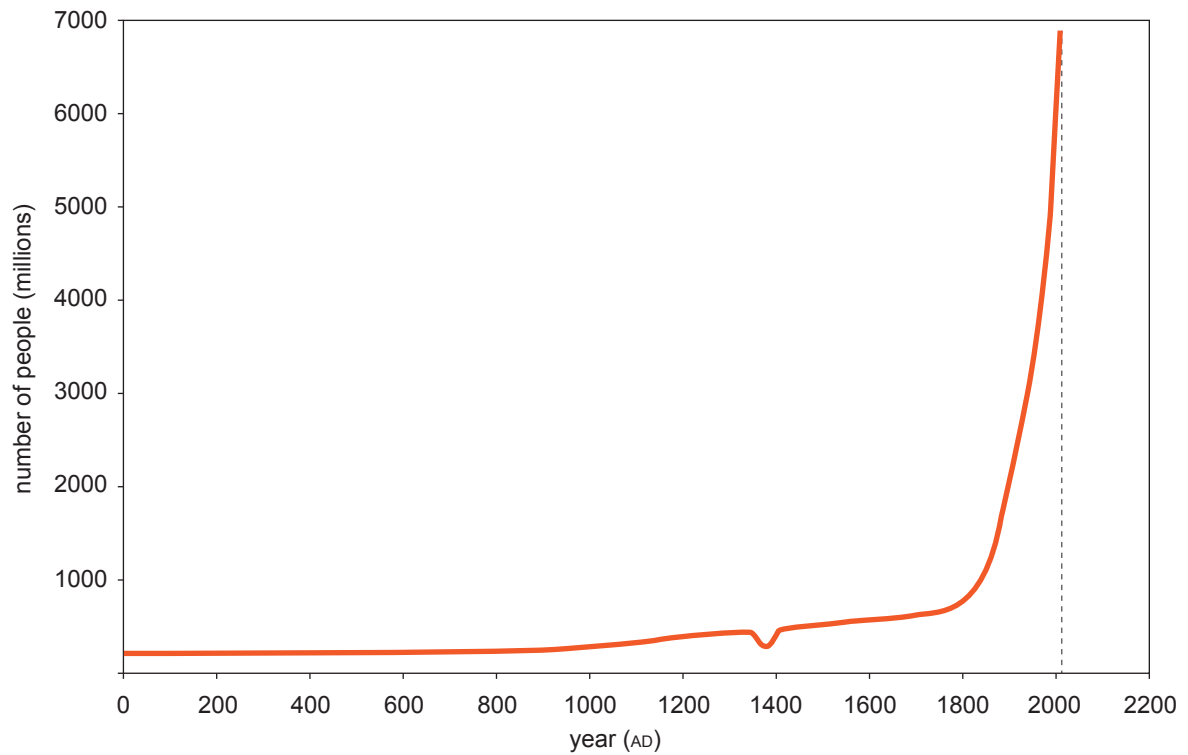
Refer to the following DNA profiles of the original strain of rice, three strains of genetically modified golden rice, and the species of daffodil and bacterium used to incorporate beta-carotene genes in the rice:

original strain of rice	strain 1 of golden rice	strain 2 of golden rice	strain 3 of golden rice	daffodil	bacterium

Identify and explain which one of the strains of golden rice has successfully incorporated DNA from both the daffodil and the bacterium.

(4 marks)

33. Refer to the following graph, which shows the growth in the human population during the past 2010 years:



In a long-term study, ecologists discovered a possible connection between the growth in the human population and the number of species that have become extinct in the same period.

The ecologists involved in the study estimated the following data for the period between 1800 and 2010:

Year	Estimated number of species extinctions per year between 1800 and 2010
1800	0
1830	1000
1860	1000
1890	2000
1920	5000
1950	7000
1980	15000
2010	55000

(a) On the grid below, graph the data from the table on page 4 for the estimated number of species extinctions per year for the period between 1800 and 2010.



(4 marks)

- (b) State **one** hypothesis that the ecologists could have been testing about the growth in the human population and the estimated number of species extinctions per year.

_____ (2 marks)

- (c) **Using the information in the graph and the table on page 4**, describe how the data support a connection between the growth in the human population and the estimated number of species extinctions per year.

_____ (4 marks)

- (d) Explain why the current growth pattern of the human population is unsustainable.

_____ (4 marks)

- (e) The extinction of species has the potential to cause instability in an ecological community. Explain how the extinction of a species can affect the stability of an ecological community.

_____ (4 marks)

34. It is estimated that at least 16% of the Amazon rainforest has been cleared for agricultural use. Typically, the forest plants are completely removed by 'slash-and-burn' methods.

In the first few growing seasons after an area has been cleared, the farmers can expect a good crop. However, as the soil nutrient levels drop, the crops fail, the farms are abandoned, and the forest plants slowly recolonise the areas.

(a) State the term that is used to describe the change in the mix of forest plant species that recolonise the abandoned farms.

_____ (2 marks)

(b) State which trophic level is the most important in returning resources to a community.

_____ (2 marks)

(c) The biodiversity of the community changes as the forest plants slowly recolonise the abandoned farms.

Describe the process that results in this change in biodiversity.

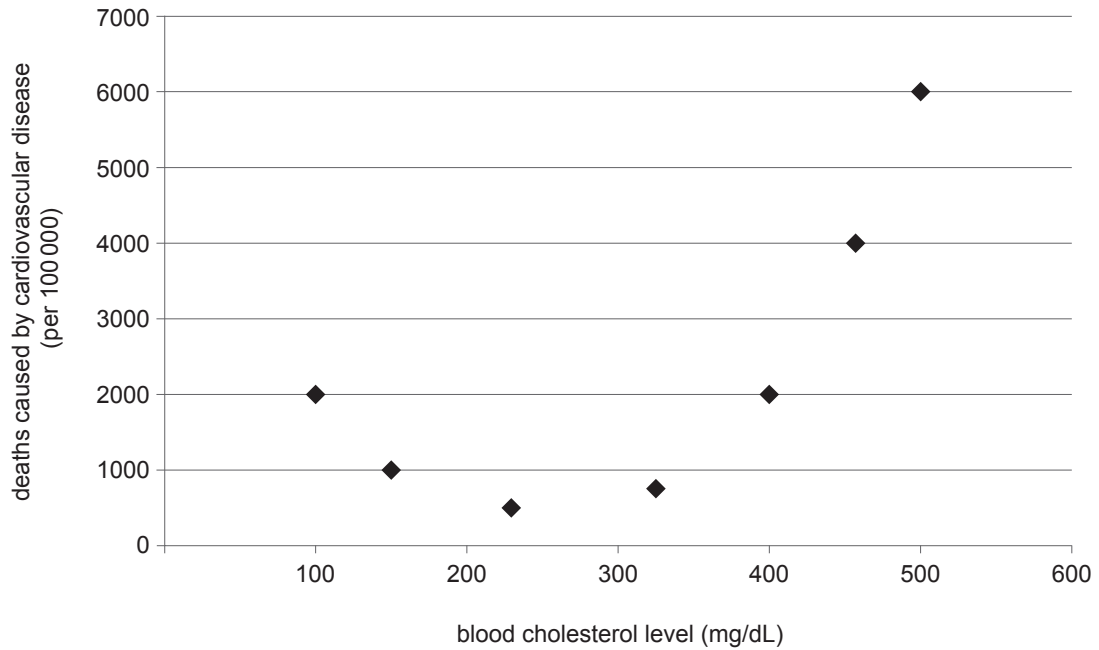
_____ (4 marks)

(d) Explain how the clearing of rainforest could result in an increase in levels of carbon dioxide in the atmosphere.

_____ (4 marks)

35. A major investigation involving more than 27 000 people from fifty-two countries was carried out to determine the relationship between blood cholesterol levels and deaths caused by cardiovascular disease.

Refer to the following graph, which shows the results of this investigation:



(a) Explain why 27 000 people were used in this investigation.

(4 marks)

(b) State the independent variable in this investigation.

(2 marks)

(c) Describe the pattern of results illustrated by the graph on page 8.

(4 marks)

(d) State one conclusion that is consistent with the results of this investigation.

(2 marks)

(e) **By referring only to the data points** on the graph on page 8, state the two blood cholesterol levels for which the number of deaths caused by cardiovascular disease (per 100 000) are the same.

(2 marks)

(f) State how increased exercise and a modified diet may affect the well-being of an individual.

Increased exercise: _____

Modified diet: _____

(4 marks)



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External Examination 2011

2011 BIOLOGY

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QUESTION BOOKLET
3
8 pages, 2 questions

Tuesday 8 November: 9 a.m.

Section C

Write your answers to Section C in this question booklet.

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SECTION C: EXTENDED-RESPONSE QUESTIONS (Questions 36 and 37)

(30 marks)

Answer **both** questions in this section.

Write your answers in this question booklet:

- Question 36, on pages 4 and 5, is worth 15 marks.
- Question 37, on pages 6 and 7, is worth 15 marks.

*You should spend about 30 minutes on this section,
5 to 10 minutes planning and 20 to 25 minutes writing.*

*Credit will be given for clear, well-expressed answers that are
well organised and relevant to the questions.*

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ACKNOWLEDGMENT

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