

Marking Schemes

This document was prepared for markers' reference. It should not be regarded as a set of model answers. Candidates and teachers who were not involved in the marking process are advised to interpret its contents with care.

Paper 1

SECTION A

Question No.	Key	Question No.	Key
1.	D (60%)	21.	C (71%)
2.	D (63%)	22.	D (67%)
3.	C (57%)	23.	B (48%)
4.	D (85%)	24.	D (66%)
5.	B (42%)	25.	D (65%)
6.	A (62%)	26.	B (35%)
7.	C (65%)	27.	B (75%)
8.	B (38%)	28.	A (12%)
9.	A (57%)	29.	C (60%)
10.	B (52%)	30.	B (44%)
11.	C (63%)	31.	B (30%)
12.	C (58%)	32.	A (54%)
13.	A (53%)	33.	B (80%)
14.	A (73%)	34.	C (61%)
15.	D (75%)	35.	A (47%)
16.	D (40%)	36.	C (54%)
17.	C (38%)		
18.	A (68%)		
19.	C (73%)		
20.	D (70%)		

Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

General Marking Instructions

1. In order to maintain a uniform standard in marking, markers should adhere to the marking scheme agreed at the markers' meeting.
2. The marking scheme may not exhaust all possible answers for each question. Markers should exercise their professional discretion and judgment in accepting alternative answers that are not in the marking scheme but are correct and well-reasoned.
3. The following symbols are used:

/ A single slash indicates an acceptable alternative within an answer.

* Correct spelling required

4. In questions asking for a specified number of reasons or examples etc. and a candidate gives more than the required number, the extra answers should not be marked. For instance, in a question asking candidates to provide two examples, if a candidate gives three, only the first two should be marked.
5. In cases where a candidate answers more questions than required, the answers to all questions should be marked. However, the excess answer(s) receiving the lowest score(s) will be disregarded in the calculation of the final mark.
6. Award zero marks for answers which are contradictory.

Paper 1 Section B

Marks

1. (a) pancreas* (1) (1)

- (b) Concept for mark award:
 • identification of the components in the secretion of duct B which are related to fat digestion (1) and how digestion of fat is affected by the process related to the components (1) x2 (4)

e.g.

blockage of duct B by gallstones will result in: (any *two* of the following sets)

- decrease in the secretion of bile salts (1), which in turn decreases the emulsification of fat in the small intestine (1)
- decrease in the secretion of lipase (1), which in turn decreases the chemical digestion of fat in the small intestine (1)
- decrease in the secretion of sodium hydrogen carbonate (1) such that the pH in the small intestine is no longer optimum for the digestion of fat (1)

5 marks

2. (a) • synapse* (1) (1)

- (b) (i) • terminal X (1) (1)

- (ii) • neurotransmitter W at location 1 diffuses to the membrane of terminal Y (1)
 • neurotransmitter W stimulates the membrane at terminal Y / binds to the receptor on the membrane of terminal Y to initiate a nerve impulse (1) (2)

- (c) • this ensures that the neurotransmission takes place in one direction only (1) (1)

5 marks

3. (a) (i) • the greater the total cross-sectional area, the slower the blood flow /
 the smaller the total cross-sectional area, the faster the blood flow (1) (1)

- (ii) • the blood flow in the capillaries is the slowest / very slow (1)
 • this allows more / enough / sufficient time for the exchange of materials in the capillaries (1) (2)

- (b)
- | <i>Features illustrated in the diagram</i> | <i>Importance to material exchange</i> |
|--|--|
| the capillaries are highly branched / form a dense network (1) | to increase the surface area for the exchange of materials (1) |
| the capillaries penetrate tissues / reach most of the cells in the tissues (1) | to shorten the diffusion distance (1) |
- (4)

7 marks

4. (a)
- | Solution injected | Mean flight time (s) |
|---|----------------------|
| inhibitor of trehalose-digesting enzyme | 85.2 |
| inhibitor of glycogen-digesting enzyme | 163.2 |
- (1)

Marks

- (b) Concept for mark award:
• comparison of the results of the experimental set-up and control set-up to draw conclusions (1+1) x2 (4)

e.g.

- the flight time of insect species A was decreased markedly by the inhibitor of the trehalose-digesting enzyme as compared to the saline control (1), which shows that the energy supply was halted once the digestion of trehalose was inhibited; therefore, trehalose is the energy reserve for flight in insect species A (1)
- the flight time of insect species A treated with the inhibitor of the glycogen-digesting enzyme was comparable to the saline control (1), which shows that the energy supply was not affected even though the digestion of glycogen was inhibited; therefore, glycogen is not the energy reserve for flight in insect species A (1)

- (c) • the amount of trehalose storage / size of the wings / size or mass of the individuals / age of the individuals / sex (1) (accept other reasonable answers) (1)

6 marks

5. (a) • mitotic cell division (1) (2)
• root tip is the vegetative part of the plant / is not the reproductive part of the plant / is the region for growth (1)

- (b) • use a stain to stain the chromosomes / staining / any named stain (1) (1)

- (c) (i) $W \rightarrow Y \rightarrow X \rightarrow Z \rightarrow V$ (1 or 0) (1)

(ii)

Stage	Number of chromosomes	Number of chromatids
Y	16	32
Z	32	0

6 marks

6. (a) Concept for mark award:
• recognition of antigen Y as a foreign antigen (1)
• production of memory cells for antigen Y (1)
• 2nd encounter of antigen Y on pathogen X (1)
• elicitation of secondary immune response (point out the characteristics of the secondary immune response) (1) (4)

e.g.

- after injection of antigen Y into the human body, B-lymphocytes will recognise antigen Y as a foreign antigen (1)
- the B-lymphocytes will produce memory cells for antigen Y (1)
- when pathogen X bearing antigen Y invades the body in the future, these memory cells can recognise the same antigen (1)
- and elicit a secondary immune response that produces a large number of antibodies in a short time (1) to eliminate the invading pathogen X

- (b) • vaccine derived from the weakened pathogen (1) (1)

- (c) (i) • Met Ala Ile Asn Cys Cys (2 marks, deduct 1 mark for each mistake) (2)

- (ii) Concept for mark award:
- correct choice of strain (1)
 - the effect of the stop codon on the polypeptide produced (1)
 - the effect on the antigen produced (1)
 - the failure to recognise the pathogen (1)
- (4)

e.g.

- strain Q (1)
- TGA becomes the stop codon and so the polypeptide produced is much shorter (1)
- therefore, no antigen Y will be produced / the antigen produced will have a different shape (1)
- the memory cells for antigen Y can no longer recognise the pathogen (1)

11 marks

7. (a) Concept for mark award:
- consequence of flowering (1)
 - explanation of how the chance of survival can be increased (any one of the following approaches):
 - dispersal of fruits / seeds (1) + description of how dispersal increases survival (1)
 - seeds can stay inactive (1) + description of how this increases survival (1)
 - dispersal of fruits / seeds (1) + seed can stay inactive (1)
- (3)

e.g.

- flowering results in the formation of fruits and seeds (1)
- (any **one** of the following sets)
- fruits / seeds are the dispersal units which allow the progeny / offspring to be dispersed away from the mother plants (1); thus the progeny / offspring can escape from the adverse conditions (1) and have a higher survival rate
- the seeds can survive / remain inactive throughout the period with adverse conditions (1) and germinate when the conditions become favourable again (1)
- fruits / seeds are the dispersal units which allow the progeny / offspring to be dispersed away (1) from the mother plants while the seeds can survive / remain inactive throughout the period of adverse conditions (1)

- (b) (i) • both bee damage and mechanical damage would shorten the flowering time to a similar extent (1) (1)

- (ii) Concept for mark award:
- comparison of effects of different treatments with the control (1) to draw valid conclusions (1) x2
- (4)

e.g.

- the time taken to flower in the plants with mechanical damage was shorter than in plants without damage (1), showing that mechanical damage can induce flowering (1)
- however, bee damage advanced the flowering time a lot more than pure mechanical damage (1), which shows that there were factors other than mechanical damage which induced the flowering (1)

Marks

- (c) • It can ensure that there is a match between the timing of flower production and colony establishment / the bees can induce flowering when they are establishing their colonies / it can ensure that there is a sufficient food supply for the colony (1)

9 marks

8. (a) • leaves taken from the lower region have a larger leaf area than those from the upper region (1)
• a larger surface area increases the chance of capturing light (1) (2)
- (b) (i) • leaves taken from the upper region have a thicker palisade mesophyll than those taken from the lower region (1) (1)
- (ii) • longer palisade cells / additional layers of palisade cells (1) (1)
- (iii) • observe a cut section of the leaf under the microscope (1)
• measure the length or size of the palisade mesophyll cell / count the number of layers of palisade mesophyll cells (1) (2)
- (c) (i) • respiration is faster than photosynthesis (1), resulting in a net release of carbon dioxide (1)
- (ii) • line with a higher starting point (1) (data interpretation: the amount of respiring tissue is smaller, so the amount of carbon dioxide produced is smaller when light intensity is zero)
• line indicates that a lower net CO₂ uptake can be reached (1) (data interpretation: the amount of photosynthetic tissue is smaller, therefore the amount of carbon dioxide uptake is smaller) (2)

9 marks

9. (a) • they were each other's competitor (1) because their percent coverage / growth rate when grown together is lower than when grown alone (1)
• Species 1 was more competitive than Species 2 (1) as the drop in coverage / growth rate for Species 2 was much higher than that for Species 1 (1) (4)
- (b) • larger leaves enabled Species 1 to be more successful in overtopping / shading Species 2 (1)
• and so increased its competitiveness for light / surface space (1) (2)

(c)

<i>Method</i>	<i>Feasibility</i>	<i>Reason</i>
Fresh weight	Feasible	plenty of water supply, fresh weight will not be affected / the experiment can be continued without killing the plants (1)
Number of leaves	Not feasible	leaf can grow in size without an increase in number / difficult to count / uncountable (1)

8 marks

Marks

10. (a) (i) • Step 1 simulates / mimics the pH condition / acidic condition / the presence of gastric juice in the stomach (1)
• while Step 4 simulates / mimics the pH condition / alkaline condition / the presence of pancreatic juice / intestinal juice / bile juice / neutralisation of the gastric juice in the small intestine (1) (3)
• and thus provides optimal / proper / suitable pH conditions for enzymatic digestion (1)
- (ii) • to stop the activity of the enzymes / the enzymatic reaction / denature the enzymes (1) (1)
- (iii) • this shows that the short RNA fragments were not digested into nucleotides (1)
• the RNA fragments are too large to pass through the wall of the small intestine / the small intestine cannot absorb the short RNA fragments as they are too large (1) to pass through effectively (2)
- (b) any *one* of the following:
• check whether the cells can pick up these short RNA fragments (1)
• check if these short RNA fragments in the milk vesicles can be detected in the infants, other than in the digestive tract in vivo, e.g. other organs / in the blood (1) (1)
• check if the presence of these short RNA fragments will affect gene expression (1)
(accept other reasonable answers)

7 marks

11. Concept for mark award:

Source of variation (max. 5):

- sexual reproduction produces offspring with a mix of genetic materials from parents (1)
 - production of gametes by meiosis (1)
 - different combinations of chromosomes due to independent assortment (1)
 - new combinations of alleles in chromosomes due to crossing over (1)
 - zygote has different combinations of genetic materials due to random fertilisation (1)
 - mutation resulting in new alleles (1)
 - environmental factors, with suitable example for illustration (1)
- max. 5

Importance of variations (max 3):

- how variations cope with different environmental conditions, e.g.
 - variations lead to different niches (1), allowing the exploration of different resources / reduced competition (1)
 - how variations cope with environmental changes over time, i.e. concept of natural selection, e.g.
 - provide a range of variants within the same species for natural selection; when there are environmental changes, organisms with better adapted traits are selected and survive (1) whereas less adapted ones are eliminated (1)
- max. 3

Effective communication (0-3)

max.3
11 marks

Mark award for communication:

Mark	Clarity of expression and relevance to the question	Logical and systematic presentation
3	<ul style="list-style-type: none"> Answers are easy to understand. They are fluent, showing good command of language. There is no or little irrelevant material. 	<ul style="list-style-type: none"> Answers are well structured, showing coherence of thought and organisation of ideas.
2	<ul style="list-style-type: none"> Language used is understandable but there is some inappropriate use of words. A little irrelevant material is included but does not mar the overall answer. 	<ul style="list-style-type: none"> Answers are organised, but there is some repetition of ideas.
1	<ul style="list-style-type: none"> Markers have to use some time and effort in understanding the answer(s). Irrelevant material obscures some minor ideas. 	<ul style="list-style-type: none"> Answers are a bit disorganised, but paragraphing is evident. Repetition is noticeable.
0	<ul style="list-style-type: none"> Language used is incomprehensible. Irrelevant material buries the major ideas required by the question. 	<ul style="list-style-type: none"> Ideas are not coherent or systematic. Candidates show no attempt to organise thoughts.

Paper 2 Section A

Marks

1. (a) (i) • both the heart rate and the blood lactate concentration increased (1) as the intensity level of exercise increased (1)
- (ii)

<p>Concept for mark award:</p> <ul style="list-style-type: none"> • energy required for exercise > energy produced by aerobic respiration (1) • additional energy supply from anaerobic respiration (1) • lactic acid as a product which accumulates (1)
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 (3)
- e.g.
- the energy consumed exceeded energy produced aerobically by the muscle due to insufficient oxygen supply (1)
 - the muscle underwent anaerobic respiration at the same time to produce extra / additional energy (1)
 - as anaerobic respiration produced lactic acid which accumulated in the blood / the production of lactic acid from anaerobic respiration is faster than its break down (1)
- so the blood lactate level increased during exercise
- (iii)

<p>Concept for mark award:</p> <ul style="list-style-type: none"> • correction stimulus + detection (1) • action of cardiovascular centre + destination (1) • generation of electrical signals (1) • correction response (1)
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 (4)
- e.g.
- increase in blood lactate level results in a drop in blood pH, which is detected by chemoreceptors in medulla oblongata (1)
 - the cardiovascular centre in the medulla oblongata sends more nerve impulses to the pacemaker / sinoatrial node along the sympathetic nerve (1)
 - the pacemaker / sinoatrial node generates more electrical impulses that spread through the cardiac muscles / heart muscles (1)
 - this causes the cardiac muscles / heart muscles to contract faster (1), which increases the heart rate
- (iv) Any *two* of the following:
- Alice's resting heart rate / heart rate at each fixed speed was lower than Billy's throughout (1)
 - Alice's heart rate increased less than Billy's (1)
 - Alice's had a lower blood lactate concentration at each fixed speed (1)
 - Alice's blood lactate concentration rose more slowly than Billy's (1)
- (2)
- (b) (i) • receptor: thermoreceptors in hypothalamus (1)
- effectors: sweat glands (1) (2)
- (ii)

<p>Concept for mark award:</p> <ul style="list-style-type: none"> • there is a normal value to be maintained (1) • the deviation in the value triggers a response, sweating in this case (1) • describe how the response, i.e. sweating, brings about a correction (2)

 (4)
- e.g.
- there was a normal value for body temperature which was 37°C for the isotonic group (1)
 - once the body temperature rose above this value, it triggered the sweating process (1)
 - evaporation of sweat absorbed heat energy from the body (1)
 - trying to lower the body temperature until it returns to normal range (1)

Marks

- (iii) • the curve of the hypertonic group showed a shift to the right / delayed / higher threshold for the onset of sweating (1)
 • this shows that the set-point of the negative feedback mechanism shifted to 37.5°C (1) (2)
- (iv) • the water potential was lower in the body fluid of the hypertonic group, and so the delay in the onset of sweating reduced water loss through sweating (1)
 • thus conserving more water at the expense of thermoregulation (1) (2)

20 marks

Paper 2 Section B

2. (a) (i)

Concept for mark award: • comparison of the correct sets of data (1) • implication of the difference between the data sets (1) • how the removal of weeds can increase the crop yield (1)
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 (3)
- e.g.
 • there were fewer plant species in the conventional farm than in the organic farm (1)
 • this shows that the use of herbicides was effective in removing weeds / plant species other than crops (1)
 • this reduces the competition for resources from weeds (1), increasing the crop yield
- (ii)

Concept for mark award: • comparison of the correct sets of data (1) • implication of the difference between the data sets (1) • use of the correct sets of data to explain why the population of pest A was suppressed (2)
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 (4)
- e.g.
 • there were fewer pest A in the organic farm than in the conventional farm (1)
 • this shows that organic farming / biological control was more effective in controlling pests than conventional farming / chemical control (1)
- Either *one* of the following sets:
 • the use of insecticides also killed some predators of A in conventional farming (1); with fewer predators, the population of pest A increased (1)
 • organic farming maintained a higher number of predators of A (1); with more natural predators, the population of pest A was suppressed (1)
- (iii)

Concept for mark award: • comparison of the correct sets of data (1) • relate the data to the sustainability of plant species (1) • explain how the abundance of plants species is beneficial to the sustainable development of animal species (1)

 (3)
- e.g.
 • higher species diversity / species richness of both plants and pollinators was noted in areas around the organic farm (1)
 • the large number of species of pollinators enhanced the reproduction of flowering plants (1), the sustainability of plant species was maintained
 • the large number of plant species provided a variety of food sources to support the growth of animal species (1)

			Marks
(b) (i)	<ul style="list-style-type: none"> phosphate is an essential nutrient for the growth of phytoplankton (1) therefore the addition of phosphates to lakes results in an increase in the population size of phytoplankton (1) 		(2)
(ii)	<ul style="list-style-type: none"> the results showed that the population of zooplanktons in Lake A remained more or less the same (1) while the population of zooplanktons in Lake B increased (1) a large population of zooplanktons helped remove / fed on phytoplankton in Lake B, keeping the population of phytoplankton under control (1) therefore, there was a lower chance of algal bloom in Lake B than Lake A 		(3)
(iii)	<ul style="list-style-type: none"> Fish Species 2 consumed Fish Species 1 (1) so the predation pressure on zooplankton decreased / there were fewer predators / Fish Species 1 to feed on zooplankton (1) when phosphate was added to Lake B, an increase in phytoplankton biomass provided more food to zooplankton (1) which resulted in an increase in their population 		(3)
(iv)	<ul style="list-style-type: none"> at night the dissolved oxygen content in water decreases because the large population of algae stops photosynthesizing (1) but continues to consume oxygen in respiration (1) 		(2)
			20 marks

Paper 2 Section C

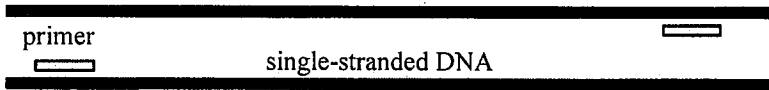
3. (a) (i)	<div>Concept for mark award:</div> <ul style="list-style-type: none"> relate the data / practice to the growth of the bacterium (1+1) x2 		(4)
	e.g.		
	Any <i>two</i> of the following sets:		
	<ul style="list-style-type: none"> the bacterium can grow in a refrigerator (1) because the lower temperature limit for its growth is below 4°C (1) these food products will be consumed without cooking (1), so if the bacterium is present in the food, it will not be killed (1) 		
(ii) (1)	<div>Concept for mark award:</div> <ul style="list-style-type: none"> idea of temperature shock: exposure to a high temperature for a brief period (1) followed by rapid cooling down (1) 		(2)
	e.g.		
	<ul style="list-style-type: none"> during pasteurisation, milk is heated to 75°C for a short period of time (1) and then cooled down rapidly to 10°C (1) 		
(2)	<ul style="list-style-type: none"> the sudden change in the temperature during the treatment kills <i>Listeria monocytogenes</i> / 75°C is higher than the maximum temperature for the survival of <i>Listeria monocytogenes</i> (1) 		(1)
(iii) (1)	<ul style="list-style-type: none"> 22 (1) 		(1)
(2)	<ul style="list-style-type: none"> the plates should be autoclaved (1) 		(1)
(b) (i)	<ul style="list-style-type: none"> the virus attaches to its host cell / injects viral DNA / RNA into the host cell / recognises host cells (1) 		(1)

- (ii) Concept for mark award:
- different shapes of membrane proteins (1)
 - the viral membrane proteins / receptors can only recognise the membrane proteins on the cells of the upper respiratory tract (1)
- (2)
- e.g.
- membrane proteins of the cells of the upper respiratory tract and lower respiratory tract are different shapes (1)
 - the virus can only infect cells of the upper respiratory tract because the protein on the virus surface fits / recognises / complements the shape of the membrane protein on upper respiratory tract cells (1)
- (iii) • pig viruses (1)
- Concept for mark award:
- pigs and humans have a closer phylogenetic relationship (1)
 - similar membrane proteins (1)
- (3)
- e.g.
- pigs have a closer phylogenetic relationship to humans / pigs and humans are both mammals / warm-blooded animals (1)
 - therefore the chance that pig viruses will acquire the ability to infect humans through mutation is higher than for fish viruses / the membrane protein of pig cells may be similar to that of humans (1)
- (iv) (1) • the viral nucleic acids take over the metabolic activities of the bacterial pathogens (1)
- to produce a large number of new bacteriophages (1)
 - after that the bacteriophages will burst and kill the bacterial pathogens (1)
 - the newly released bacteriophages can infect other bacterial pathogens in the food (1)
- (4)
- (2) • host-specificity ensures that only the targeted bacteria are eliminated / will not infect other normal microbes / the bacteriophages will not infect humans (1) (any other reasonable answers)
- (1)

20 marks

Paper 2 Section D

4. (a) (i) • should select stem cells / capable of producing cells continuously (1)
- the correct version of the gene will be expressed in the cells produced from these stem cells / the products of the corrected gene will be produced in the cells produced (1)
- (2)
- (ii) Any **one** set of the following:
- viral vector (1), advantage: can deliver the gene to specific host cells (1); disadvantage: safety concerns regarding viral residue / induces immune response (1)
 - gene gun (1), advantage: can deliver the gene to the any cells without limitation (1); disadvantage: random process, not sure if the insertion is successful / the gene can be expressed / cause mechanical damage to the cell (1)
 - micro-injection (1), advantage: precise delivery to the target cell (1); disadvantage: injection can cause damage / only one cell is targeted per injection (1)
- (3)
- Accept other reasonable answers

- (iii) • the gene therapy does not change the genetic composition of the sex cells / only changes the somatic cells of the patient (1), so the corrected version of the gene is not heritable (3)
- he will pass his X-chromosome carrying the defective gene to his daughter (1)
- he will pass his Y-chromosome, i.e. free of the defective gene to his son (1)
- (iv) Any *two* of the following:
- the gene used in the therapy comes from humans / is not from other species, therefore, this method does not break the normal species barrier nature has set (1)
- the trait is not heritable and thus it will not change the genetic composition permanently (1) (2)
- the corrected gene is already present in the genome (1)
- transgenic animals may upset the ecological balance if they are released into the natural environment (1)
- (b) (i) (1) • stage O (1)
- the temperature at stage N is high (1)
- which would lead to the denaturation of double-stranded DNA / separate double-stranded DNA to two single strands (1) for the binding of primers to the single-stranded DNA (3)
- (2) showing 2 single-stranded DNA (1), correct positions of primers (1) (2)
- 
- (ii) • primer II (1) and primer IV (1) (2)
- (iii) Concept for mark award:
- how DNA fragments can move along the gel (1)
 - the relationship between size and the speed the DNA fragments travel (1)
 - the use of DNA markers to confirm the size of the DNA bands (1)
- e.g.
- as DNA fragments are negatively charged, they will move along the gel and migrate to the positive pole (1)
 - shorter DNA fragments will migrate at a faster speed than longer DNA fragments (1) (3)
 - the sizes of the PCR products can be determined by comparing their relative positions on the gel against a set of DNA markers with known lengths (1)

20 marks