

## 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.	A (63 %)	21.	A (66 %)
2.	C (85 %)	22.	C (28 %)
3.	C (71 %)	23.	B (64 %)
4.	A (64 %)	24.	B (63 %)
5.	B (73 %)	25.	A (57 %)
6.	B (70 %)	26.	D (49 %)
7.	D (41 %)	27.	C (61 %)
8.	D (78 %)	28.	B (84 %)
9.	D (45 %)	29.	C (70 %)
10.	B (86 %)	30.	C (65 %)
11.	C (80 %)	31.	D (81 %)
12.	D (59 %)	32.	B (92 %)
13.	A (82 %)	33.	D (43 %)
14.	B (53 %)	34.	D (57 %)
15.	B (91 %)	35.	A (38 %)
16.	A (56 %)	36.	C (41 %)
17.	D (58 %)		
18.	C (74 %)		
19.	A (52 %)		
20.	A (34 %)		

*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, and 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.
7. Where applicable, markers should put a tick (✓) against the answer which counts for a point of merit and the aggregated mark awarded for each question should be entered into the mark box of the OSM system in the right-hand side. If no marks are to be given, a cross (X) should be inserted there instead.

**Paper 1 Section B**

		<u>Marks</u>
1.	(a) B and C (1)	(1)
	(b) ATP and NADPH / NADPH <sup>+</sup> / NADPH <sub>2</sub> / reduced NAD (1)	(1)
	(c) Phase II Phase I Phase III (Deduct 1 mark for each mistake)	(2)
		<hr/> 4 marks
2.	(a) biomass of organisms at lower trophic levels is not 100% available to organisms at higher trophic levels because: (any <i>two</i> of the following)	
	• not all body parts are consumed (1)	(2)
	• indigestible parts are egested (1)	
	• energy loss at each trophic level through respiration / excretion / heat (1)	
	(b) • if sharks become extinct, the population of the secondary consumers will not be kept under control and thus will increase (1)	
	• these secondary consumers will prey on the primary consumers, leading to a great drop in the population of the primary consumers (1)	(3)
	• as a result, the producers will become too numerous because the number of primary consumers has decreased (1)	
		<hr/> 5 marks
3.	(a) (i) • rod cells and cone cells (1)	(1)
	(ii) • motor neuron(e) OR motor (1)	(1)
	(b) • circular muscles of iris contract while radial muscles of iris relax (1)	
	• leading to the constriction of the pupil (1)	
	• to reduce the amount of light entering the eyes (1)	(4)
	• this prevents overstimulation of rod cells and cone cells (1)	
	(c) • it is an involuntary action / a reflex / stereotyped response / inborn action / does not involve cerebrum for making decision (1) (any <i>one</i> )	(1)
		<hr/> 7 marks
4.	(a) A: protein * (1)	
	B: phospholipid * (1)	(2)
	(b) (i) • glycerol / fatty acid (any <i>one</i> ) (1)	(1)
	(ii) • glucose / simple sugar / amino acid (any <i>one</i> ) (1)	(1)

Marks

- (iii) lumen of small intestine  
 ↓  
 lacteal (1) (1)  
 ↓  
 lymph vessel (1) (1)  
 ↓  
 subclavian vein / vena cava (1) (1)  
 ↓  
 heart

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7 marks

5. (a) (i) amount of water lost by the leaf (1) (1)
- (ii) • the water vapour is lost from the leaf surface through transpiration (1)  
 • the mass of chemical X increases after absorbing water vapour (1) (2)  
 indicating the mass of water lost from the epidermis
- (b) Any **two** of the following:  
 • type of plant or leaf (same potted plant / same leaf being investigated) (1)  
 • surface area of the epidermis (covered by the identical flasks) (1) (2)  
 • wind speed (enclosed system) (1)  
 • volume of air containing the water vapour (confined by the identical flasks) (1)
- (c) (i) • the increase in the mass of chemical X in bell jar N is greater than that in bell jar M (1)  
 • this shows that the rate of water lost from the lower epidermis is higher than that of the upper epidermis (1) (2)
- (ii) this is probably due to: (any **one** of the following)  
 • different number of stomata in the upper and lower epidermises (1)  
 • different stomatal density of the upper and lower epidermises (1) (1)  
 • different stomatal structures of the upper and lower epidermises (1)  
 • different thicknesses of the cuticles of the upper and lower epidermises (1)
- (iii) number of stomata / stomatal density: (any **one** set)  
 • microscopic examination of epidermal peel (1), count the number of stomata per unit area in the upper and lower epidermis (1)  
 • use nail polish to obtain a mold of the epidermis for microscopic examination (1), count the number of stomata per unit area in the upper and lower epidermis (1)  
 • immersion of the leaf in hot water (1), count the number of bubbles appearing on each surface per unit area of the upper and lower epidermis (1) (2)
- OR
- different stomatal structure / thickness of cuticle:  
 • cut a section of the leaf for microscopic examination (1), compare the appearance of the stomata / the thickness of the cuticles of the upper and lower epidermises (1)

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10 marks

6. (a) (i) nitrifying bacteria \* (1) (1)
- (ii) • nitrates are absorbed by roots through diffusion and active transport (1) and transported to the xylem  
 • by transpiration pull, nitrates are transported upward along the xylem vessels (1) to the leaf cells (3)  
 • in the leaf cells, nitrates combine with intermediate products from photosynthesis to form amino acids, which are used in protein synthesis (1)
- (b) Any *two* of the following:  
 • to ensure there is sufficient oxygen for the respiration of organisms in the system (fish / plant roots / nitrifying bacteria) (1)  
 • to provide oxygen for decomposition / degradation / breaking down of organic waste in fish excreta into inorganic waste (1)  
 • to provide oxygen for nitrification (1) (2)
- (c) • the ammonia produced by fish increases as the amount of food is doubled (1)  
 • the bacteria fail to convert all ammonia to nitrates (1)  
 • as a result, the ammonia will accumulate in the water (1)  
 • to a certain level which is lethal to the fish / will kill the fish (1)
- OR
- the fish cannot consume all of the food / excess food is left in the water / organic waste produced by fish increases as the amount of food is doubled (1) (4)  
 • putrefying bacteria / decomposers decompose the excess food / organic waste to form ammonia (1)  
 • as a result, the ammonia will accumulate in the water (1)  
 • to a certain level which is lethal to the fish / will kill the fish (1)
- 
- 10 marks
7. (a) dengue fever / malaria / japanese encephalitis / zika / yellow fever (any *one*, accept other possible answers) (1)
- (b) parasitism (1) (1)
- (c) (i)
- |                            | Without fungal infection | Infected with normal fungus | Infected with GM fungus |
|----------------------------|--------------------------|-----------------------------|-------------------------|
| Survival rate on Day 6 (%) | 90                       | 85                          | 50                      |
- (1)
- (ii) • on Day 6, only about 50% of mosquitoes infected with GM fungus survived to reproduce while 85% of adult mosquitoes infected with normal fungus survived to do so (1)  
 • as a result, the former will have a lower population size than the latter in the next generation (1) (3)  
 • and the difference would be amplified after several generations (1)
- 
- 6 marks
8. (a) (i) anti-X can bind to protein X to form clumps / agglutination (1) (1)
- (ii) anti-X in the food debris left in the mouth cavity of the cats will not be digested (1), as a result, it can reduce the amount of free protein X in their saliva (1)

Marks

- (b) (i) • A: as the data show a decreasing trend/drop in the amount of protein X found (1)  
 • B: as the data show fluctuations of comparable levels (1) from week 5 to week 10 (2)
- (ii) • conduct the research for a longer time (1)  
 • to check if the decreasing trend will continue / if the fluctuations will continue (1)
- OR
- conduct the research with a higher dose of anti-X in cat food (1)  
 • to check if there will be a greater decrease in the amount of free protein X on cats' hair (1)
- OR
- conduct statistical analysis of the data (1)  
 • to check if the difference shown is significant or not (1)
- OR
- conduct the research with a greater sample size (1) (1+1)  
 • to check if similar trends / patterns in the change of the amount of protein X can be observed (1)
- OR
- set up a control with normal food / boiled anti-X in cat food (1)  
 • to check if there is still a decrease in the amount of free protein X on hair / to compare the result with the experimental group (1)
- OR
- conduct the research with groups of different types of cats (1)  
 • to check if there will be a greater decrease in the amount of free protein X on cats' hair for certain type of cats (1)
- (c) • can only reduce the amount of protein X in saliva but not that produced by sebaceous glands (1)  
 • protein X can accumulate in the environment, its amount can finally reach a critical level for eliciting unwanted immune responses (1) (2)

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8 marks

9. (a) AUG GUC GUA UAC GCU ACC (1)
- (b) Met- Val- Val - Tyr - Ala - Thr (2) (deduct 1 mark for each mistake)
- If candidates have chosen wrong answer in (a), accept: (2)  
 Tyr - Gln - His - Met - Arg - Trp
- (c) (i) gene mutation (1) (1)

Marks

- (ii) • the mutation results in a stop codon instead of tyr (1)  
• as result, the protein chain produced will be much shorter than the original one / the sequence after the new stop codon will not be translated / the protein chain produced will have a different amino acid sequence from that of the original one (1)  
• therefore, the protein formed will have a different shape (1)

(3)

If candidates have chosen wrong answer in (a), accept:

- the mutation results in a different amino acid (1)
- as result, the protein chain produced will have a different amino acid sequence from that of the original one (1)
- Therefore, the protein formed will have a different shape (1)

- (iii) • allele 1 is the recessive allele (1)  
• individuals with green body contain only allele 1, this shows that allele 1 codes for green colour (1)  
• some individuals with brown body colour contain both alleles (1 and 2), showing that the effect of allele 1 is masked by allele 2 (1)

OR

- the phenotype shown in the heterozygous condition is the dominant phenotype (1)
- therefore brown body colour is dominant over green body colour/ green body colour is recessive (1)
- therefore, allele 1 carried by individuals with green body is recessive (1)

(3)

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10 marks

10. (a) in the oviduct (1)
- (b) organelle Q supplies energy for the sperm to swim (1)
- (c) (i) • chromosome number is haploid (1) in all gametes  
• after fertilisation, the chromosome number is restored to diploid / constant chromosome number from generation to generation is maintained (1)
- (ii) • the zygote grows by mitotic cell division into the embryo (1), resulting in cells which are genetically identical  
• the embryo is split into two embryos with identical genetic composition at a certain stage (1)

(2)

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6 marks

Marks

11. Cellular level:

- red blood cells are biconcave disc in shape (1), which increases surface area to volume ratio for faster gas exchange (1)
- red blood cells are equipped with haemoglobin (1), which is specialised for binding with oxygen (1)
- in red blood cells nucleus is absent / membrane-bounded organelles are absent (1), leaving more space for haemoglobin (1)

max. 4

Tissue level:

- blood is a fluid or liquid tissue carrying the red blood cells / low viscosity allow flowing of the blood (1)

Organ / system level:

- heart is made up of cardiac muscles (1), which give driving force to maintain blood flow (1)
- septum or wall divides the heart into two halves (1), with one half for carrying deoxygenated blood to the lungs (1), and the other half for carrying oxygenated blood to other organs / body parts (1), increasing the efficiency of the oxygen transport
- blood vessels with lumina act as channels for distribution of blood to various organs (1)

max. 4

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



Paper 2 Section A

		<u>Marks</u>
1. (a) (i)	<ul style="list-style-type: none"> <li>When plasma sodium concentration was below <math>140 \pm 2</math> (a.u.), plasma ADH level remained very low / stable in both groups of subjects (1)</li> <li>With further increase in plasma sodium concentration, plasma ADH level increased dramatically in healthy subjects (1)</li> <li>but remained relatively stable / slightly increased in patients with pituitary disorders (1)</li> </ul>	(3)
(ii)	<ul style="list-style-type: none"> <li>high plasma ADH level increases the permeability of the collecting duct to water / low plasma ADH level decreases the permeability of the collecting duct to water (1)</li> <li>as a result, there is more reabsorption of water into the blood from the collecting duct in the healthy subjects / there is less reabsorption of water from blood from the collecting duct of the subjects with pituitary disorders (1)</li> <li>and produces a smaller volume of highly concentrated urine in healthy individuals than that of subjects with pituitary disorders / produces a large volume of less concentrated urine in patients with pituitary disorders than that of healthy subjects (1)</li> </ul>	(3)
(iii)	<ul style="list-style-type: none"> <li>the increase in plasma sodium concentration leads to decrease in water potential in blood (1)</li> <li>this is detected by the hypothalamus / osmoreceptor (1)</li> <li>which in turn stimulates the pituitary gland to release more ADH into the blood (1)</li> </ul>	(3)
(iv)	<ul style="list-style-type: none"> <li>the pituitary glands may secrete no / less FSH for stimulating the development of follicles (1)</li> <li>without developing follicles, the oestrogen secretion remains low (1)</li> <li>and the uterine lining will not thicken (1), therefore there is no menses</li> </ul>	(3)
(b) (i)	<ul style="list-style-type: none"> <li>with carbon dioxide concentrations at or below 2.7 / 3.5 %, the increase in ventilation rate is mainly driven by the increase in breathing depth (1)</li> <li>with carbon dioxide concentrations at or above 3.5 / 4.3 %, the increase in ventilation rate is mainly driven by the increase in the breathing rate (1)</li> </ul>	(2)
(ii)	<ul style="list-style-type: none"> <li>the inflation of lungs has reached its limit in volume / reached its maximum capacity (1)</li> </ul>	(1)
(iii)	<ul style="list-style-type: none"> <li>the ventilation rate increased with the increase in carbon dioxide concentration in inspired air (1)</li> </ul>	(1)
(iv)	<ul style="list-style-type: none"> <li>the increase in blood carbon dioxide concentration / decrease in blood pH (1)</li> <li>is detected by the respiratory centre / medulla oblongata (1)</li> <li>more nerve impulses will be sent from the respiratory centre to the intercostal muscles and diaphragm muscles (1)</li> <li>to contract faster and more powerfully to increase the ventilation rate (1)</li> </ul>	(4)

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20 marks

Paper 2 Section B

		<u>Marks</u>
2. (a) (i)	<ul style="list-style-type: none"> <li>since no clam harvesting occurred at Beach A, there was nearly no change / slight drop in the clam density (1)</li> <li>at Beach B, the clam density decreased following clam harvesting (1)</li> </ul>	(2)
(ii)	<ul style="list-style-type: none"> <li>the relative abundance of different species remained more or less the same at Beach A (1)</li> <li>the number of individuals of each species at Beach B decreased as compared to Beach A except for species 3 which increased greatly (1)</li> <li>these show that the species diversity of the animal community at Beach A remained unchanged while that at Beach B decreased (1)</li> <li>Conclusion:</li> <li>as clams were harvested at Beach B but not at Beach A, this shows harvesting clams at Beach B resulted in a decrease in species diversity (1)</li> </ul>	(4)
(iii)	<ul style="list-style-type: none"> <li>avoid harvesting small young clam so that they have a chance to grow (1)</li> <li>and carry out reproduction to produce offspring (1)</li> <li>keep a stable / sustainable population of clams (1)</li> </ul>	(3)
(b) (i) (1)	<ul style="list-style-type: none"> <li>when the lichen was sprayed with rainwater samples lower than pH 5.6, its photosynthetic rate decreased (1)</li> <li>the drop in photosynthetic rate was greater when the pH was lower (1)</li> <li>the photosynthetic rate of the lichen sprayed with rainwater sample of pH 3.5 recovered to normal on day 5 (1)</li> <li>the photosynthetic rate of the lichen sprayed with rainwater sample of pH 2.5 failed to recover by day 5 (1)</li> </ul>	(4)
(2)	<ul style="list-style-type: none"> <li>the pH of rainwater in industrial areas is likely to be very low / below 2.5, which will lead to a great drop in the photosynthetic rate of the lichen (1)</li> <li>the frequent rains prevent the lichen's photosynthetic rate from recovering (1)</li> <li>as a result, the lichen cannot produce enough food (1) and fails to survive</li> </ul>	(3)
(ii)	<ul style="list-style-type: none"> <li>sulphur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) (1)</li> <li>they are emitted into the atmosphere and react with water / dissolve in water to form acidic solutions (1)</li> </ul>	(2)
(iii)	<ul style="list-style-type: none"> <li>poisonous metals (such as cadmium, aluminium, mercury) will be soluble in acid rain and released to soils (1)</li> <li>acid rain leaches / dissolves and carries away many of the existing soil nutrients from the soil (1)</li> </ul>	(2)

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20 marks

Paper 2 Section C

		<u>Marks</u>
3.	(a) (i) • below 14, the number of cases drops / decreases as the age group increases / a rapid drop / decrease in number of cases from age 0-4 to 10-14 (1) • after that, the number of cases decreases slowly (1)	(2)
	(ii) Any <i>two</i> of the following: • more awareness of personal hygiene as the children grow older (1) • the immunity system is stronger as the children grow older (1) • older children might have been exposed to the virus previously and acquired immunity (1)	(2)
	(iii) • no (1) • because antibiotics can only kill / inhibit the growth of bacteria, not that of viruses (1)	(2)
	(iv) • once inside the human body, the virus will attach to its host cell's cell membrane (1), the epithelial cells of the affected areas in this case • the viral nucleic acid / genetic material will enter the host cell (1) • the viral nucleic acid / genetic material will control the host cells' metabolic process to synthesise large amounts of viral proteins & nucleic acid (1) • the viral proteins and nucleic acid will assemble into new viruses and be released, the host cells will burst / lyse (1)	(4)
	(b) (i) B and D (1)	(1)
	(ii) it only indicates the amount of micro-organisms in general but cannot distinguish if they are pathogenic (1)	(1)
	(iii) sushi was stored at a temperature higher than 4°C / chefs did not wash their hands properly before handling the sushi / contamination from the environment / raw fish meat itself contained a large amount of bacteria (any <i>one</i> ) (1)	(1)
	(iv) (1) • 10 <sup>-3</sup> plate (1) • plates with lower dilution power: too many colonies / overlapped with others (1) resulting in more errors in counting • 10 <sup>-4</sup> plate: only a few colonies, not statistically valid / high percentage error / not reliable (1)	(3)
	(2) • 37 (1) • $37 \div 10^{-3} \div 50 \times 500 = 370,000$ (1)	(2)
	(3) Any <i>one set</i> : • dip the inoculating spreader in alcohol & flame the spreader until red hot before & after use (1) to ensure that the spreader is sterilised (1) • the mouth of the culture tube should be passed quickly through a Bunsen flame each time the tube is opened or closed (1) to reduce the chance of microorganisms in the air from falling into the culture medium (1) • the opened culture tube should be held at an angle (1) to reduce the chance of microorganisms in the air from falling into the culture medium (1) • the whole process should be carried out near a Bunsen flame (1) to reduce the chance of microorganisms in the air from falling into the culture medium (1)	(2)

20 marks

**Paper 2 Section D**

Marks

4. (a) (i) • EcoRI (1)  
 • because EcoRI can create cut ends on both the DNA segment and plasmid for insertion / its restriction site is present at both ends of the DNA segment and plasmid (1) (3)  
 • EcoRI does not interrupt / cut the antibiotic P resistance gene / using PstI will interrupt the antibiotic P resistance gene (1)
- (ii) • DNA ligase (1) (1)
- (iii) (1) • Band B (1)  
 • the plasmid which has successfully picked up the inserted gene has a size of about 5000 bp (1) (3)  
 • Band B has a position similar to the marker of size 5000 bp (1)
- (2) • the insertion of target gene into the plasmid is a random process (1)  
 • some plasmids have the target genes inserted while some plasmids re-join without taking up the target gene (1) (3)  
 • as a result, these plasmids have a smaller size than those which experience successful insertion (1)
- (b) (i) • B (1)  
 • it is the structure where exchange of material between foetal blood and maternal blood takes place (1); it is likely that foetal cells from B breakdown and release DNA fragments into maternal blood (2)
- (ii) • polymerase chain reaction (1)  
 • this technique can amplify the quantity of the DNA sample (1) (2)
- (iii) (1) • people with Down Syndrome have an extra copy of chromosome 21 / 3 copies of chromosome 21 in each body cell (1)  
 • therefore, it is expected that the genes from chromosome 21 will occur more frequently than genes from the reference chromosome / other autosome (1) for a foetus with Down Syndrome (2)
- (2) Any *two* of the following:  
 • sex identification (1), check for the presence of a DNA sequence which is unique to the Y chromosome (1) / check for the frequency of occurrence of genes from X chromosomes as this is higher in females  
 • screen for genetic diseases resulting from gene mutation / due to the presence of certain alleles (1), check for DNA sequences related to genetic diseases (1) (4)  
 • personalised medicine (1), check for the possession of genes related to health risks for preventive measures (1)  
 • detection of cancer (1), check for the presence of mutated genes which lead to cancer (1)

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20 marks