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 (56%)	21.	D (47%)
2.	C (60%)	22.	D (27%)
3.	A (35%)	23.	B (51%)
4.	B (66%)	24.	A (52%)
5.	B (44%)	25.	C (56%)
6.	D (51%)	26.	C (44%)
7.	C (64%)	27.	D (62%)
8.	D (62%)	28.	A (85%)
9.	C (73%)	29.	A (61%)
10.	D (80%)	30.	C (91%)
11.	B (51%)	31.	D (33%)
12.	B (74%)	32.	D (64%)
13.	B (69%)	33.	C (33%)
14.	A (55%)	34.	C (63%)
15.	D (70%)	35.	B (59%)
16.	B (48%)	36.	A (63%)
17.	C (69%)		
18.	A (61%)		
19.	D (51%)		
20.	B (46%)		

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) D = C – (any combination) (1) — (1)

(b) Concept for mark award:
- vegetarian diets contain a large amount of dietary fibre which is indigestible (1)
- the indigestible materials will be egested as faeces (1)
- impact on D/C ratio (1)

(3)

e.g.
- vegetarians feed on plant materials, a large proportion of which is indigestible / contains dietary fibre / cellulose which is indigestible (1)
- these indigestible materials cannot be absorbed and will be egested as faeces (1)
- as a result, the vegetarians have a greater energy loss through faeces / excretion than non-vegetarians (1), leading to a lower D/C ratio

4 marks

2. (a) • C (1) — (1)

(b) • A: produces seminal fluid which nourishes the sperms (1)
• B: stores or protects sperm / allows the sperm to mature (1) — (2)

(c) (i) • E (1) — (1)

(ii) • sperm are no longer present in the semen / ejaculated semen does not contain sperm (1)
• there is no fertilisation (1) — (2)

6 marks

3. (a) • M: cell wall* (1) — (1)

(b) • 19 (±1) μm (1)
no mark if no unit is given — (1)

(c) • rotate the fine adjustment knob until the image is in focus (1) — (1)

(d) • granum / thylakoid membrane / inner membrane / outer membrane (1) — (1)

(e) • electron microscope (1) — (1)

5 marks

4. (a) • male (1)

Concept for mark award:
- relating the features of sex chromosomes (i.e. shorter Y chromosome) to sex determination (1)

(2)

e.g.
- because chromosomes in the 23rd pair are of different lengths or sizes, showing that the pair is composed of an X chromosome and a Y chromosome / the shorter chromosome in the 23rd pair or the last pair is a Y chromosome (1), therefore, the patient is a male

(b) (i) • an extra copy of chromosome 15 (1) — (1)

Marks

(ii) • chromosomal mutation (1) (1)

(iii) • level of expression of mRNA of the genes located on the 15th set of chromosomes is increased (1) as there are three chromosomes (1)

(c)

Concept for mark award:
• a description of an activity which is related to balance or coordination of movement (1)

(1)

e.g.

- activities related to balance : the patient may trip easily while walking / may experience difficulty in walking / cannot maintain body balance (1)

OR

- activities related to coordination of movement: the patient may not be able to walk along a straight line / perform fine movement / perform movement smoothly (1)

6 marks

5. (a)
- independent variable: types / combinations of enzyme(s) used (1)
- dependent variable: volume / amount of apple juice produced (1)

(2)

(b) Any ***one*** of the followings:
- increased reliability to ensure the results are reproducible (1)
- averaging the three data to work out a value closer to the true value / to minimise the effect of error of experiment / individual variations (1)
- to collect data for statistical analysis (1)

(1)

(c)

Beaker	Cost of enzyme(s) for producing 1 mL apple juice
A	---
B	$ 0.42
C	$ 1.75
D	$ 0.29

(2)

(deduct 1 mark for each wrong answer)

(d) • using a mixture of 0.25 mL pectinase and 0.25 mL cellulase / D (1) (1)

(e) • the enzymes break down the insoluble components of the cell wall to soluble ones (1) (1)

7 marks

6. (a) • cell type Q (1) (1)

Concept for mark award:
• observable features related to cell type Q (1)
• deduction from the feature in relation to hormone secretion (1)

(2)

e.g.

- there are several blood capillaries in close proximity to cell type Q (1)
- where hormones will be released into the blood (1)

OR

- there is no duct connected to cell type Q (1)
- therefore, the hormonal secretion should be released into the blood (1)

Marks

(b)
- during jogging, muscles continue to take up glucose from blood (1) to release energy via respiration to support muscle contraction
- the blood glucose level will drop and stimulate the pancreas to secrete more glucagon and less insulin (1)
- this hormone combination stimulates the liver cells to convert stored glycogen to glucose (1)
- and release into the blood, thereby increase the blood glucose level back to normal / maintain the normal blood glucose level (1)

(4)

7 marks

7. (a)
- E (1)
- the tumour cells can spread through the blood to other parts of the body (1) / the tumour cells have grown out of the boundary / break through the connective tissue (1)

(2)

(b) (i)

Concept for mark award:
- chance of mutation in relation to time (1)
- ability to repair in relation to age (1)

(2)

e.g.
- they have been living for a longer time period for the accumulation of mutations / they have been exposed to cancer-causing agents / carcinogens / mutagens for a longer period, therefore the chance for genetic mutation to occur is higher (1)
- the cells in old people have a lower ability to repair / old people have a weaker immune system / there is a lower level of expression of tumour suppressor genes / more active of oncogenes (1)

(ii)
- the development of the outgrowth to malignant tumour / the stage of spreading of cancer cells takes many years in colorectal cancer (1)

(1)

(iii) any ***two*** of the following:
- insufficient dietary fibre in their diet (1)
- consumption of a lot of processed meat / processed food (1), which contains carcinogenic substances
- consumption of a lot of deep-fried food (1), which contains carcinogenic substances produced during deep-frying

(2)

7 marks

8. (a) (i)
- water supply is the selection force which drives the evolution of root depth / water supply in the grassland is limited (1)
- a greater root depth has a selective advantage, enabling the grasses to obtain more water from underground (1)

(2)

(ii)
- more energy can be allocated to the development of the shoot / less energy is needed for the development of the root (1)
- a better developed shoot will have a higher photosynthetic rate / support better development of seeds and fruits / a higher yield will be obtained (1) with the same amount of energy input

(2)

Marks

(b) (i)

	Observable feature	Function
X	large empty lumen / hollow (1)	offers less resistance to water transport (1)
	thick cell wall (1)	prevent collapse of the vessel (1)
Y	slender / elongated (1)	penetrates the space between soil particles / increases surface area for water / mineral absorption (1)

(4)

(ii)
- transpiration pull continues to draw water from cells adjacent to X (1), lowering the water potential of neighbouring cells (1)
- absorption of water at Y maintains a high water potential there (1)
- water moves from Y to X along the water potential gradient across the root (1)

(max. 3)

11 marks

9. (a) any ***three*** of the following:
- prevent formation of bacterial cell wall thereby inhibiting the growth (1)
- break down the bacterial cell membrane, causing lysisto kill the cell (1)
- interfere with the metabolism / protein synthesis thereby inhibiting the bacterial growth (1)
- interfere with the DNA synthesis of the bacteria and stop them from reproduction (1)

(3)

(b) (i)
- UCA CUG AGC CAG UCG (1)

(1)

(ii)

Concept for mark award:
- role of mRNA (1)
- role of tRNA / ribosome (1)
- failure of translation (1)

(3)

e.g.
- after binding, the single-stranded template is no longer available / the binding region becomes double stranded (1)
- the tRNA cannot bind to the template to transfer the corresponding amino acid / ribosome cannot bind to the template (1)
- translation cannot proceed (1) at the binding region

(iii) any ***one*** of the followings:
- can design a new synthetic polynucleotide any time once we know the sequence of antibiotic resistance gene (1)
- the action is very specific (1) as it targets the resistance gene

(1)

8 marks

10. (a)
- 1a→2a→3b (1), group S

(1)

Marks

(b) Concept for mark award:
- different pollinating agents → no cross breeding (1)
- concept of isolation (1)
- concept of speciation (1)

(3)

e.g.
- in ancestral species of *Habenaria,* there was no cross pollination / cross breeding between individuals with dull-coloured flowers and those with reddish flowers because of the different insect pollinators (1)
- hence, the two populations were isolated and evolved independently / there was no gene flow between the two populations (1)
- after many generations, mutations / genetic variations accumulated in the two populations such that individuals of the two groups were no longer able to interbreed to produce fertile offspring (1),
  i.e. becoming two distinct species, the one pollinated by species A is *H. rhodocheila*

(c) (i) to make sure data collected were not affected by the positions of the two set-ups / the preference of A was regardless of the positions of the set-ups / to cancel the effect of different physical factors (accepted named examples) of the two positions / to minimize the effect of behavioural inertia or habit of the pollinators (1) (1)

(ii) Concept for mark award:
- correct comparison of the results + conclusion (1+1) x 2

(4)

e.g.
- in Treatment 1, the number of visits to the visual set-up was significantly greater than that of the control set-up (1), this shows that A was attracted by the appearance of the flower (1)
- in Treatment 2, the number of visits to the smell set-up was more or less the same as that of the control set-up (1), this shows that A was not attracted by the smell of the flower (1)

(iii) conditions of the two control set-ups:
- with plant, transparent container without holes (1)
- with plant, non-transparent container with holes (1)

(2)

11 marks

11. Concept for mark award:
Managing the blood glucose level in diabetics (max. 3):
- as compare with normal diets, the consumption of ketogenic diets will not lead to a sharp rise in blood glucose level / result in a relatively stable blood glucose / (1) because
  - the ketogenic diet is low in carbohydrates, this will end up with a smaller amount of glucose after digestion and absorption (1)
  - after metabolism, only a small amount of glucose will be obtained from the fat of the ketogenic diet (1)
- diabetics cannot adequately regulate the blood glucose level on their own / cannot produce sufficient insulin to lower the blood glucose level after meal / cannot adequately respond to insulin (1), after consumption of ketogenic diet, the blood glucose level is still manageable to the diabetics / glucose will not appear in the urine of the diabetics (1)

max. 3

Marks

Concept of energy balance for weight management (max. 4):

- to lose weight, the daily energy intake should be lower than the daily energy expenditure / energy deficit (1), when energy intake is lower than energy expenditure, the body will mobilise / use the energy reserve, such as glycogen stored in liver and muscles as energy source (1)
- ketogenic diet is low in carbohydrates, the body is forced to use stored glycogen as energy source (1), if glycogen is insufficient / depleted, the body will use the stored fat instead (1)
- as the ketogenic diet has a high fat content, the energy intake may be higher than the normal diet (1) because fat stores more energy than the same mass of proteins and carbohydrates (1)

max. 4

Other health concerns (max. 2): (Any ***two***, accept other reasonable answers)

- the high-fat content may result in obesity or blockage of blood vessels due to high fat / triglyceride / cholesterol levels in blood which may result in cardiovascular diseases / stroke (1)
- brain cells use mainly glucose as the energy source , a low carbohydrate intake may result in a low blood glucose supply, leading to dizzness (1)
- consuming a ketongenic diet will deplete the glycogen store, people may feel tired easily (1)

max. 2

Effective communication (0-3) max.3

12 marks

Mark award for communication:

Mark	Clarity of expression and relevance to the question	Logical and systematic presentation
3	• Answers are easy to understand. They are fluent, showing good command of language. • There is no or little irrelevant material.	• Answers are well structured, showing coherence of thought and organisation of ideas.
2	• 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.	• Answers are organised, but there is some repetition of ideas.
1	• Markers have to use some time and effort in understanding the answer(s). • Irrelevant material obscures some minor ideas.	• Answers are a bit disorganised, but paragraphing is evident. Repetition is noticeable.
0	• Language used is incomprehensible. • Irrelevant material buries the major ideas required by the question.	• Ideas are not coherent or systematic. Candidates show no attempt to organise thoughts.

Paper 2 Section A

Marks

1. (a) (i)
- high blood / hydrostatic pressure in glomerulus squeezes blood plasma out through the walls of the glomerulus and the Bowman's capsule (1)
- the fluid, except protein and blood cells, is filtered into the Bowman's capsule and forms the glomerular filtrate (1)

(2)

(ii)
- region A (1)

(1)

(iii)
- 180 x 71% (± 1) = 127.8 L (accept 126 – 129.6) (1)
if no unit is given, no mark

(1)

(iv)

Concept for mark award:
- active reabsorption of useful substances along region A (1)
- absorption of soluble substances into the blood creates a water potential gradient (1)
- net movement of water along the water potential gradient into the blood by osmosis (1)

(3)

e.g.
- along region A, most of the useful substances in the glomerular filtrate are reabsorbed into the blood by active transport (1)
- as a result, the water potential of the blood is much lower than that in the remaining filtrate in region A (1)
- there is a net movement of water from the filtrate in region A to the blood by osmosis (1)

(v)

Concept for mark award:
- correctly state the difference in the relative volume of the glomerular filtrate at the end of region C under the two conditions (1)
- the detection of water potential in blood (detector + stimulus) (1)
- the corresponding response elicited (hormone + response) (1)
- effect on the reabsorption of water (1)

(4)

e.g.
- the percentage of the glomerular filtrate remaining within region C in the case of dehydration is much less than that under normal condition (1)
- the osmoreceptors of the hypothalamus detects a lower water potential in the blood of the dehydrated group (1)
- more ADH is secreted from the hypothalamus / released from the pituitary to increase the permeability of the wall of region C to water (1)
- as a result, a larger proportion of water is reabsorbed from the tubular fluid (1), leading to the lower volume of glomerular filtrate of the dehydrated group

(b) (i)
- the breathing depth of the patients was lower than that of the healthy persons at any time (1)
- the breathing depth of the patients reached a maximum earlier than the heathy persons (1)

(2)

(ii)
- hardening of lung tissues reduced its elasticity / the lung tissues were less elastic / became inelastic, therefore, the lung could not expand fully (1)
- the amount of air taken in during inhalation was limited (1)

(2)

Marks

(iii) • plasma oxygen level (1)

Concept for mark award:
- similar trends with in group (breathing rate and plasma oxygen level in patients) as evidence to support the choice (1)
- similar trends across groups (plasma carbon dioxide level in healthy persons and patients) as evidence to rule out carbon dioxide (1)

(3)

e.g.
- plasma oxygen level gradually decreased in the patients while it remained stable in the healthy group (1)
- plasma carbon dioxide level remained relatively stable and was similar in both groups (1)

(iv)
- the plasma oxygen level of the patients kept decreasing (1)
- the patients might not have enough oxygen supply to the brain (1), therefore they would feel dizzy (2)

20 marks

Paper 2 Section B

Marks

2. (a) (i) (1) • converting the rainforest to a grassland reduces both the average plant height and the number of plant species / species richness (1) (1)

(2)

Concept for mark award: (any ***one***)
- concept about measurement of growth: number vs biomass (1)
- concept about measurement of productivity (1)

(1)

e.g. (any ***one*** of the following)
- plants in grassland are much smaller in size / mass / biomass than plants in the primary rainforest / the sizes of plants in grassland and in primary rainforest are different (1), therefore, using the number of individuals for comparison is not fair
- the percent coverage reflects the productivity of the plant species in the plant community (1) which is a more meaningful comparison than the number of individuals in this case

(3)
- deforestation results in the dominance of the community by a single species (i.e., Species H) in the grassland / near 100% of or almost the whole grassland is covered by a single species (i.e., Species H) (1)
- as compared with a more homogeneous community with a similar percent coverage of different species / similar abundance in the primary forest (1)
- the compositions of species in the two plant communities are also different (1)

(3)

(ii) (1) • deforestation reduces the porosity of the soil (1), this implies a lower oxygen level in the soil (1) (2)

(2) (I) this will reduce the rate of decomposition / conversion of organic nitrogen to ammonium compounds as it is an aerobic process (1), and hence the amount of ammonium compounds in the soil of grassland is lower than that in the primary forest / less ammonium compounds are formed in the soil of grassland (1) (2)

Marks

(II) this will reduce the rate of nitrification as it is an aerobic process / this will favour denitrification as it is an anaerobic process (1), as a result, the amount of inorganic nitrogen in the soil of grassland is lower than that in the primary forest (1) (2)

(b) (i)
- the root systems of the trees of the secondary forest hold the soil together / prevent soil erosion / running off of soil / land slide (1) in areas around the reservoirs / canopy of the trees increases interception that prevents soil erosion / protects top soil
- this prevents the reservoirs from silting up / this maintains the storage capacity of the reservoirs (1) (2)

(ii) (1)
- the forest has been disrupted and redeveloped naturally (1) (1)

(2)
- forests provide food / shelter / hiding place from predators / breeding ground for bird species / habitat (any two) (1) (1)

(3) any one of the following:
- birds help the pollination / dispersal of seed of the trees (1)
- birds help removing insect pests from the trees (1)
- faeces / wastes / dead bodies from birds enrich the nutrient content of soil (1) (1)

(4)
- native tree species (1)
- because the secondary forest has a higher proportion of forest-dependent bird species / has a lower proportion of migrating bird species / (1)
- also, there is a higher number of species nested in the secondary forest (1)
- this implies that more local bird species are found in the secondary forest (1), showing that the environment there is more favourable to the local bird species (4)

20 marks

Paper 2 Section C

Marks

3. (a) (i)
- during incubation, the bacteria grew / reproduce on the surface of agar, the region covered by bacterial colonies appeared cloudy (1)
- the clear zone indicates that the hand sanitiser samples has killed / inhibited the growth of bacteria (1) (2)

(ii)
- the diameter of the clear zone indicates the antibacterial effectiveness of the hand sanitiser, the larger the clear zone, the greater was the antibacterial effect (1)
- $Y < X < Z$ (1) (2)

(iii)
- no (1)
- this round of pandemic (COVID-19) is caused by a virus, this test can only indicate the inhibitory effect of those products on bacteria / no anti-viral effect can be demonstrated in this test (1) (2)

Marks

(iv) any ***two sets*** of the following:
- conduct the spreading near a Bunsen flame (1) which create an upward air current to prevent other micro-organisms in the air from reaching the agar plate (1)
- do not open the lid fully / only open the lid slightly while spreading (1) to reduce the chance of other micro-organisms in the air from reaching the agar plate (1)
- do not speak or talk during spreading / wear mask (1) to prevent contamination by bacteria coming from our body during speaking / breathing (1)

(4)

(b) (i) Glucose → ethanol + carbon dioxide
[correct raw material (1); correct products (1)] (2)

(ii) (1)
- the growth rate of yeast cells is reduced with the increase in concentration of biofuel (1)
- the percentage of dead cells increases with the increase in concentration of biofuel (1)

(2)

(2)
- correct counting of dead cells (1), correct calculation & answer (1)
(for cells that fall on the boundaries, only count those on one pair of adjacent side, e.g. top and left boundaries)

(2)

(3) Number of yeast cells in the sample = number of yeast cells / volume of sample × 1000 × dilution factor
[correct method (1); correct answer with unit (1)] (2)

(iii) any ***two*** of the following:
- it can use non-edible part of the crop / non-crop grasses / wood instead of edible part of the crop (1) / the remains of the sugar cane after sugar / juice extraction can be used to produce biofuel (1)
- will not reduce the food production. (1)
- the yield of the biofuel production can be increased as the non-edible part is also used for production (1)

(2)

20 marks

Paper 2 Section D

Marks

4. (a) (i) GTG (1) (1)

(ii) 421 (1) base pairs (1) (2)

(iii) (1)

Concept for mark award:
• carrier being heterozygous (1)
• effect of restriction enzyme on normal allele (1)
• effect of restriction enzyme on mutated allele (1)

(3)

e.g.
- carrier of sickle cell anaemia has both the normal allele and mutated allele in their body cells / is a heterozygote (1)
- the PCR product from the normal allele will be digested by restriction enzyme X, resulting in two DNA fragments with shorter lengths / two DNA bands (1)
- while that from the mutated allele will be not be digested, giving rise to one DNA fragment with longer length / one DNA band (1)

Marks

(2)

Concept for mark award:
- correctly identify the band corresponding to the mutated allele (1)
- logical deduction based on the length of the DNA fragment and their relative positions / travelling speed along the gel (2)

OR
- correctly identify the band corresponding to the mutated allele (1)
- logical deduction using the undigested PCR products as a reference to look for the band occupying the same position in the gel (2)

(3)

e.g.
- band A corresponds to the mutated allele (1)
- as the recognition site of restriction enzyme X is destroyed in the mutated allele, the PCR products of the DNA fragment carrying the mutated allele should be the longest / longer than the DNA fragments from restriction cutting of the normal allele (1)
- band A is the closest to the well / moves (to the positive pole) at the lowest speed (1), indicating that it contains the longest DNA fragment

OR
- band A corresponds to the mutated allele (1)
- as the recognition site of restriction enzyme X is destroyed in the mutated allele, the PCR products of the DNA fragment carrying the mutated allele will not be digested (1)
- band A has the same position as that from the undigested PCR products (1)

(iv) • African (1) (1)

(b) (i) any ***two*** of the following:
- insertion is a random process, so it may affect the expression of the gene in the host cell / multiple insertion of target gene in a host cell may occur (1)
- the target gene may not be expressed in the infected plant cells (1)
- only a small proportion of host cells can be infected by Agrobacterium / the efficiency of transformation / success rate is low (1)
- may have restriction to infect certain hosts only (1)

(2)

(ii) (1)
- when the adoption rate of *Bt* corn increased, the use of pesticides decreased (1)
- as the *Bt* gene confers pest resistance to the corn / the product from the *Bt* gene can kill pests, these corns have resistance to pests (1),
- therefore, there is less application of / no need to apply pesticides to these crops (1)

(3)

(2) advantages: (any ***one***)
- increases yield (1) by reducing the loss due to damage by pests
- reduces cost / time / labour (1) by reducing the amount of pesticides used
- less pesticides would remain in the farmland, which decreases the health risk of the farmers (1)

(1)

(iii) (1)
- the survival rate of the caterpillars which consumed leaves with *Bt* pollen deposit was lower than those which consumed leaves with pollen from untransformed corns and without any pollen (1)
- this was probably because the *Bt* pollen contained the toxic protein which killed the caterpillars (1)

(2)

Marks

(2) Any ***two*** of the followings: (accept other reasonable answers)

- the dispersal of pollen might vary with the distance / the amount of pollen present in the field might not be high enough to kill the caterpillars (1)
- rain would wash away / wind would blow away the pollen deposit (1)
- there were other food sources available (1)
- there were competitors in the fields that also feed on the leaves with pollen (1)

(2)

20 marks