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.	B	(83%)	21.	D	(54%)
2.	D	(44%)	22.	D	(39%)
3.	B	(61%)	23.	C	(45%)
4.	B	(49%)	24.	C	(41%)
5.	D	(45%)	25.	C	(68%)
6.	A	(77%)	26.	A	(80%)
7.	C	(31%)	27.	C	(50%)
8.	A	(73%)	28.	B	(45%)
9.	B	(72%)	29.	A	(68%)
10.	A	(22%)	30.	C	(18%)
11.	B	(23%)	31.	C	(45%)
12.	D	(87%)	32.	D	(50%)
13.	D	(45%)	33.	B	(70%)
14.	D	(63%)	34.	C	(81%)
15.	A	(35%)	35.	A	(48%)
16.	D	(56%)	36.	C	(66%)
17.	C	(59%)			
18.	A	(61%)			
19.	D	(84%)			
20.	B	(65%)			

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 a candidate gives three answers, 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 calculating 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

				Marks
1.	(a)	(i)	A, D (1)	(2)
		(ii)	B, E (1)	
	(b)	•	P represents antibodies which attach to the antigens on the surface of the pathogens (1)	(3)
		•	as a result, P binds several pathogens together as a big mass / clump (1)	
		•	to enhance / facilitate the phagocytosis by Q (1)	
				5 marks
2.	(a)	•	P (1)	(2)
		•	because two molecules of P are joined together to form one molecule of Q (1)	
	(b)	•	R (1)	(2)
		•	it has a specific site / active site for binding with P or Q (1)	
				4 marks
3.	(a)	•	anther / ovary (1)	(1)
	(b)	(i)	• crossing over* (1)	(1)
		(ii)	• exchange of genetic materials between non-sister chromatids of the homologous pair of chromosomes (1)	(2)
			• this is an important source of genetic variation (1)	
	(c)	(i)	• Photomicrograph Y belongs to the first meiotic cell division (1)	(2)
			• because pairing or separation of homologous chromosomes is shown (1), which is the characteristic feature in first meiotic cell division	
		(ii)	• first meiotic cell division separates the two sets of homologous chromosomes (1)	(2)
			• while second meiotic cell division separates the sister chromatids (1)	
				8 marks
4.	(a)	•	Q and S (1)	(1)
	(b)	Any ***two*** of the following:		(2)
		•	insufficient number of vesicles at the synaptic knob / insufficient number of mitochondria to provide energy for vesicles to synthesize neurotransmitters (1)	
		•	insufficient numbers of neurotransmitters are released at the neuromuscular junction to stimulate R (1)	
		•	neurotransmitters degraded too rapidly (1)	
		•	insufficient number of receptors to bind with neurotransmitters (1)	
				3 marks
5.	(a)	•	A contains more oxygen than B / B contains less oxygen than A (1) because gas exchange takes place at air sacs where oxygen is taken up by blood through diffusion (1), so blood leaving air sac should have more oxygen	(4)
		•	A contains less glucose than B / B contains more glucose than A, (1) because the cells in air sacs / lung tissues have taken up glucose from the blood for respiration (1), so blood leaving air sac should have less glucose	

				Marks
5.	(b)	Any *two* sets: • dust deposits form a barrier (1), which increases the diffusion distance (1) • the inner surface of the air sacs was covered by dust (1), thus the area available for diffusion was reduced (1) • the hardened layer of dust deposit reduces the elasticity of the lung (1), hence there is a smaller lung volume when the lung inflates (1)		(4)
				8 marks
6.	(a)	• 0.3 M sucrose solution (1) • there was no change of mass at this concentration (1) • this shows that there was no net movement of water in or out of the cells (1) i.e. the bathing solution had the same water potential as the potato cells		(3)
	(b)	• the curve would shift downward / to the left (1)		(1)
	(c)	• this can increase the reliability of the results by minimizing the individual differences of the cylinders (1)		(1)
	(d)	• X: starch granule / starch grain * (1) • Y: cell wall* (1)		(2)
	(e)	• offspring produced will have the same genetic make-up as their parents (1) • this provides limited raw materials for the selection of a resistant strain / if parent genotype is susceptible to the pathogen attack, the whole population will be susceptible (1)		(2)
				9 marks
7.	(a)	• secondary succession (1) • because succession occurred in pre-existing soil / pre-existing plants (1)		(2)
	(b)	(i)	• after the landslide, the original vegetation / top soil was removed, so the soil nitrogen content fell / after the landslide, rapid growth of herbaceous plants absorbed nitrogen from the soil, so the soil nitrogen content fell (1) • some plant species have symbiotic nitrogen fixing bacteria in their root nodules, which enrich the soil nitrogen content by fixing atmospheric nitrogen (1) • as time went by, the dead mass of the new vegetation was decomposed by soil bacteria (1) • hence releasing nitrogen compounds back into the soil (1), and so soil nitrogen content increased with time	(max. 3)
		(ii)	• in the early stage / 2 years after the landslide, there were many more herbaceous plant species than woody plant species (1) • since the nutrient requirements of herbaceous plant species are lower than those of woody plant species (1), low soil nitrogen content favours the growth of herbaceous plants / does not favour the growth of woody plants • subsequently, the number of woody plants species increased as the soil nitrogen content continued to increase (1)	(3)
				8 marks

Marks

8. (a) (i) • sight is not the sense used by bats when they avoid obstacles (1) (1)

(ii) Any *two*:

Nature of Science	Elaboration
Science is based on evidence from experiment	Spallanzani and Jurine could not provide sufficient evidence to show how bats navigated / scientists did not accept that bats use hearing for navigation until Griffin showed that bats could emit ultrasounds (1)
Scientists build on the work of other scientists	Griffin used Pierce's apparatus to show bats emitted ultrasounds / Griffin built on Spallanzani and Jurine's work, and showed that bats emitted ultrasounds, providing important evidence for the navigation (1)
Technology has impact on the development of science	Griffin could not have proved that bats emitted ultrasounds without Pierce's apparatus (1)

(2)

(accept other reasonable answers)

(b) (i) • the procedures of cutting & gluing back the wing tail itself did not affect the rate of successful escape (1)
• this shows that the results of C / D were related to the length of the wing tail and not related to the manipulation procedures (1) (2)

(ii)

Pair of treatments	Conclusion
A & C	• Removing / shortening the wing tail reduced the rate of successful escape (1)
A & D	• Elongating the wing tail enhanced the rate of successful escape (1)

(2)

(iii) • the data show that the longer the wing tail, the higher the rate of successful escape (1) (1)

(c) • within the moth population, there were genetic variations with some individuals having long wing tails and others having short wing tails (1)
• individuals with long wing tails had a higher chance of escape from the attacks of bats than individuals with short wing tails (1)
• therefore, individuals with long wing tails had a higher chance of survival and reproduced more offspring (1)
• after many generations, offspring which inherited the allele for long wing tails became the majority in the population (1) (4)

12 marks

9. (a) • both apple snails and snail K showed a lower growth rate when they were raised together (1)
• this shows that there was competition between apple snails and snail K for habitat and / or food (1)
• the growth rate of snail K would be slower and some of them would fail to reach maturity for reproduction / death rate of snail K would be higher (1)
• so the population of snail K would fall / decline (1) (4)

OR

• apple snails had a higher growth rate when raised separately from snail K (1),
• the growth rate of snail K fell significantly when raised together with apple snails (1)
• this shows that apple snails were more competitive than snail K (1)
• hence the population of snail K would fall / decline (1)

			Marks
9.	(b)	• in the long term, plants would fail to reach maturity for reproduction (1) • it reduce the size of the plant community in the habitat (1), • this would reduce food availability / shelter for other animals (1) OR • in the short term, plants would grow more slowly (1) • the biomass of producers would decrease (1) • this would reduce food availability for other herbivores / animals (1)	(3)
	(c)	• lack of natural predators in the local habitat / a high rate of reproduction (1)	(1)
	(d)	any reasonable answers such as: • release of imported pets to the natural environment once owners cannot / do not want to keep them anymore (1) • release of imported organisms to the natural environment for religious purposes (1) • bringing in non-local seeds / plants which then reproduce and spread to the wild habitat through seed dispersal (1)	(1)
			9 marks
10.	(a)	• the diameter of the stem decreases as the rate of transpiration increases / the diameter of the stem increases as the rate of transpiration decreases (1)	(1)
	(b)	• water is transported up the stem by transpiration pull / pulling force / suction force / negative pressure (1) • this force increases with transpiration rate and pulls the xylem vessel's walls inwards (1) thus reducing the diameter of the xylem as well as that of the stem	(2)
	(c)	• hollow tube (1) to allow the passage of water with low resistance (1) • thickened / lignified wall (1) to withstand the negative pressure of the transpiration pull / to prevent the collapse of xylem vessels (1)	(4)
			7 marks

Marks

11. **Concept on genetic diseases (max. 3 marks)**

spontaneous mutations may give rise to dominant or recessive alleles, some of these mutations may be beneficial to the individuals, some may be disadvantageous,

- if genetic diseases are encoded in the form of dominant alleles, the diseases will be expressed in both homozygous and heterozygous forms (1), therefore they will be removed by natural selection more readily (1), so the chance of passing such dominant alleles to the next generation is lower (1)
- if genetic diseases are encoded in the form of recessive alleles, the diseases will be expressed only in homozygous recessive condition (1), therefore the chance of removal by natural selection is lower (1), the recessive allele will be passed to the next generation by carriers in heterozygous condition (1)

(max. 3)

Effect of breeding methods on genetic compositions (max. 5 marks)

- the parents of pure-bred pets are from among close relatives, i.e. they share the same gene pool / have similar genetic composition (1), as a result, the genetic composition of their offspring will be very similar to each other (1)
- on the other hand, parents of hybrid pets are from different gene pools / have very different genetic compositions (1), as a result, the genetic composition of their offspring will be different from each other (1)
- after several generations, the pure-bred offspring have a higher chance of being homozygous in various loci (1), whereas the hybrid offspring have a higher chance of being heterozygous in various loci (1)
- therefore, it is more likely for pure-bred pets to develop genetic diseases, which are only expressed in homozygous recessive or double recessive conditions (1)
- and it is less likely for hybrid pets to develop genetic diseases, as recessive alleles for genetic diseases are masked by their dominant counterparts in heterozygous condition (1), i.e. no genetic diseases are expressed

(max. 5)

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	• 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 this does not mar the overall answer.	• Answers are organised, but there is some repetition of ideas.
1	• Markers have to spend 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 and systematic. Candidates show no attempt to organise their thoughts.

Paper 2 Section A

					Marks
1.	(a)	(i)	(1)	• the corpus luteum / yellow body in ovaries degenerates (1) • leading to a decrease in the production of oestrogen (1)	(2)
			(2)	• oestrogen is secreted by the developing follicle in ovaries (1) • resulting in an increased oestrogen level during this period (1)	(2)
		(ii)	(1)	• in Graph 1, the level of FSH increased as the level of oestrogen decreased in the later period in the first cycle (1), i.e. the corresponding period of oestrogen injection • in Graph 2, FSH level remained low as long as the women received oestrogen injections (1) • FSH level started to rise again after the oestrogen treatment was stopped / discontinued (1) • this shows that oestrogen has a negative feedback on FSH level / inhibits the production / release of FSH (1)	(4)
			(2)	• oestrogen in contraceptive pills inhibits FSH production, as a result, there will be no follicle development (1) • therefore, there will be no mature eggs for ovulation / no ovulation (1)	(2)
	(b)	(i)		• cardiac output remained more or less the same / slightly increased in the hydrated group over the course of the experiment, but dropped continually in the dehydrated group (1) • cardiac output indicates the amounts of nutrients and oxygen supply skeletal muscles (1) • for respiration to release energy (1) • to support the muscle contractions (1) • the constant supply of energy to muscles in the hydrated group allowed them to maintain their cycling speed while the decreased energy supply to muscles in the dehydrated group resulted in their failure to maintain their cycling speed (1)	(5)
		(ii)	(1)	• stroke volume (1)	(1)
			(2)	• without replenishment, there was a net water loss in the dehydrated group because of continuous sweating / breathing during the course of the experiment (1) • this led to a drop in their total blood volume (1), hence a decrease stroke volume	(2)
		(iii)		• the stroke volume of the dehydrated group was lower than that of the hydrated group (1) • thus, the heart rate of the dehydrated group increased to compensate for the decrease in stroke volume / the heart rate of the dehydrated group increased to keep a high cardiac output to support the exercise (1)	(2)

Paper 2 Section B

Marks

2. (a) (i)
- large solid wastes are removed by passing through screens / filters (1)
- suspended solid wastes in sewage settle in the form of sedimentation and are then removed (1) (2)

(ii) (1)
- the effluent of the sewage treatment plant had a lower organic nitrogen content than that of the artificial wetland (1)
- because the sewage was aerated in the sewage treatment plant (1)
- to enhance the activities / growth of micro-organisms (1)
- the conversion / decomposition of organic nitrogen to ammonium compounds in sewage treatment plants is faster (1) (4)

(2) Any ***one*** of the following sets:
- presence of phosphate (1), as a raw material for the synthesis of DNA / RNA / ATP / NAD / NADP / phospholipids (1)
- presence of magnesium (1), as a raw material for the synthesis of chlorophyll (1) (2)

(iii) Any ***two*** of the following:
- lower cost of construction / equipment than that of sewage treatment plant (1)
- the artificial wetland is self-sustaining / no extra manpower needed / lower running cost (1)
- the artificial wetland is effective enough for small village with limited sewage (1) (2)

(b) (i) Any ***two*** of the following:
- soil erosion / soil degradation / desertification (1)
- loss of habitats / less shelter (1)
- decrease in biodiversity / decrease in the plant community (1) (2)

(ii) (1)
- the dry mass of Species B increased more significantly than that of Species A with the addition of fertilizer (1)
- the concentration of heavy metal X was higher in the root of species B (1)
- with the addition of fertilizer, the concentration of heavy metal X in the root was increased (1)
- this resulted in a much larger accumulated amount of heavy metal X in the root (1) (4)

(2)
- species B (1)
- a lower concentration of heavy metal X in shoots may cause fewer health problems for herbivores that consume shoots / consumers along the food chain (1)

OR (2)
- species C (1)
- the shoots can be harvested to remove heavy metal X from the site (1)

(3) Any ***two*** of the following:
- growing native plant species can develop a community which is similar to the original community / will not affect the structure of the native community / non-native plant species may outcompete the native plant species which can affect the structure of the original community / minimise the disturbance to local ecosystem (1) (2)
- native plant species are well adapted to the local environment (1)
- native plant species provide food / habitats for local animals (1)

Paper 2 Section C

					Marks
3.	(a)	(i)	•	A: 2 hrs (1); B: 20 hrs (1)	(2)
		(ii)	•	C (1)	(4)
			•	because it has the shortest doubling time (1)	
			•	in pH 4 at 37°C (1)	
			•	which are the conditions in the stomach (1)	
		(iii)	•	food poisoning (1)	(3)
			•	because B has a shorter doubling time at 4°C (1)	
			•	its growth under refrigeration may have resulted may result in toxin accumulation in the food (1), which may have caused food poisoning even though the bacteria had been killed during cooking	
			OR		
			•	its doubling time at 37°C is more than that at 4°C (1)	
			•	showing that B is heat-sensitive / probably killed by thorough cooking (1)	
			•	therefore, illness is not caused by the bacteria but by the toxins produced during refrigeration, causing food poisoning (1)	
	(b)	(i)	•	X: hyphae (1) Y: spores / spore-forming bodies / sporangium (1)	(2)
		(ii)	•	the fungus secretes the enzyme externally (1)	(4)
			•	to digest the layers of dead cells (1)	
			•	the digested products are absorbed by the fungus for growth (1)	
			•	the hyphae / structure X continue to penetrate the skin / grow deeper / longer to reach the sensory nerve endings (1) thereby stimulating the sensory nerve endings to give the sensation of itching	
		(iii)	(1) •	the shower room was warm / hot / wet / humid / with skin debris (food) for the growth of fungus (1)	(1)
			(2) •	hyphae / structure X had been lysed / destroyed by the antifungal cream (1), so there was no more itchiness	(4)
			•	however, there might have been some spores / structure Y left in the skin (1)	
			•	which were / was resistant to the cream / not affected / killed by the cream (1)	
			•	these spores germinated and re-infected the skin (1) when he stopped applying the cream	

Paper 2 Section D

Marks

4. (a) (i)
- suspect 2, whose DNA fingerprint shared the same pattern as that of the body fluids (1) (1)

(ii)
- as the number of times the sequence repeats is highly variable / polymorphic / different among individuals (1)
- and a different number of repeats results in different lengths of DNA fragments after cutting with suitable enzymes (1)
- since different lengths of DNA fragments migrate with different speeds in gel electrophoresis (1)

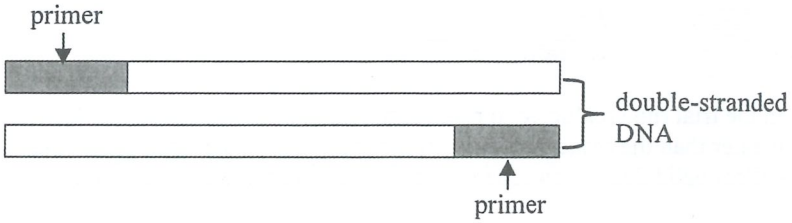
therefore, different bands of DNA fingerprinting, which is unique to individuals, can be shown (3)

(iii) (1)
- Ryan's idea is right (1)
- because blood stains contain white blood cells, which have nucleus / other nucleated cells (1) (2)

(2)
- Ryan's idea is wrong (1)
- although one sperm cell only contains one set of chromosomes (1)
- there are many sperm cells in semen, and each receives chromosomes randomly through meiosis from their diploid mother cells (1)
- thus the sperm cells lysate formed a collection of chromosomes containing both sets of chromosomes from the diploid mother cells (1) (4)

(b) (i)
- primer annealing (1) (1)

(ii)
- diagram showing double stranded DNA (1) and the position of primers (1) (2)



(iii)
- shorter primers have fewer combinations of base sequences (1)
- there is a high chance of annealing primers to wrong positions of the DNA strand (1) (2)

so DNA strands of different sizes are amplified

(iv)
- the *Agrobacterium* contains plasmids for target genes to be inserted (1)
- the *Agrobacterium* can infect crop cells (1) and transfer the genes of the plasmid to the genome of the crop cells (2)

(v)
- with the presence of gene K, and hence its toxic proteins, the root systems of transgenic crops is less likely to be attacked / damaged by insects (1)
- therefore their root systems can:
  - absorb more nutrients / water from the soil
  - provide better anchorage / support

  } any one (1) (3)

  than their non-transgenic counterparts,
- which means the crops can grow to a bigger size / grow better / support more fruit formation / store more food (1)