James Ruse Agricultural High School

2010 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

BIOLOGY MARKING GUIDELINES

PART A

Multiple Choice: Questions 1-20 (1 mark each)

1.	A ●	B ○	C ○	D ○
2.	A ○	B ○	C ○	D ●
3.	A ○	B ○	C ●	D ○
4.	A ○	B ●	C ○	D ○
5.	A ○	B ●	C ○	D ○
6.	A ○	B ○	C ○	D ●
7.	A ○	B ○	C ●	D ○
8.	A ○	B ●	C ○	D ○
9.	A ○	B ○	C ○	D ●
10.	A ○	B ○	C ●	D ○
11.	A ○	B ●	C ○	D ○
12.	A ○	B ○	C ○	D ●
13.	A ○	B ○	C ●	D ○
14.	A ○	B ○	C ○	D ●
15.	A ○	B ●	C ○	D ○
16.	A ○	B ○	C ●	D ○
17.	A ○	B ○	C ○	D ●
18.	A ○	B ●	C ○	D ○
19.	A ●	B ○	C ○	D ○
20.	A ○	B ○	C ●	D ○

PART B

Total marks: 55 marks

Question 21 (3 marks)

Criteria	Marks
• Evaporation (transpiration)-cohesion-tension theory accounts for the movement of water, and thus ions, in the xylem. Water molecules attract each other and are also attracted to the walls of the xylem. As water evaporates from the leaf, each molecule of water drags another upwards. This stream carries ions as well. (1): Evaporation (transpiration)-cohesion-tension theory (1): water attracts water; water movement occurs a result of the evaporation of water from the leaf or other thus tugging the solution to other parts of the plant. (1): labelled diagram of xylem	
• Only two of the above points given.	2
• Only one of the above points given.	1

Evaporation (transpiration)-cohesion-tension theory (1) (E)
water attracts water; water movement occurs a result of the evaporation of water from the leaf or other thus tugging the solution to other parts of the plant. (1) (T)
Labelled diagram: micro-diagram option = water molecules + cohesive nature of water molecules + xylem

Macro-diagram: continuous stream of water through labelled xylem to leaves (evaporation)

Note: transpiration is not a theory but a process

Question 22 (3 marks)

• salt water fish: drink copious amounts of water; chloride-secreting cells in gills excrete salt; urine is concentrated.

• fresh water fish: drink small amounts of water; cells absorb salt in gills; urine is dilute.

(1): for each difference.

Note: must compare salt (s), urine concentration (u) and other (o)

Question 23 (6 marks)

(a) Bilby: endotherm (homeostasis)
Locus: ectotherm (temperature depends on environment)

• Only one of the above points given. 1

(b) Bilby: urea (some water) Locus: uric acid paste (virtually no water)

The insect excretes its nitrogenous waste in the form of uric acid since this is not soluble in water. Thus, the insect can reabsorb water. The Bilby excretes its nitrogenous waste in the form of urea which is moderately soluble in water thus enabling the Bilby to conserve a moderate amount of water.

Insects have malpighian tubules that collect water and uric acid from the insect's blood and deposit into the lumen of the gut. Water and other substances are reabsorbed through the walls of the tubules and the nitrogenous waste in the form of uric acid leaves via the anus.

Bilbies reabsorb water in the nephrons of their kidneys. Urea is filtered into the nephron from the blood of the Bilby.

Criteria	Marks
• Stating the differences between insects and Bilbys with regards to the processes associated with water reabsorption. • Stating the differences between insects and Bilbys with regards to the processes associated with the excretion of nitrogenous wastes. (1): Insects' malpighian tubules with respect to water (WI) (1): Bilbys' nephrons with respect to water (WB) (1): Insects' malpighian tubules with respect to nitrogenous waste (uric acid) (NI) (1): Bilbys' nephrons with respect to nitrogenous waste (urea) (NB)	
Only three of the above points given.	3
• Only two of the above points given.	2
• Only one of the above points given.	1

Note: must state insects excrete nitrogenous wastes in form of uric acid whereas mammals excrete urea to get full marks.

Bilby excretes urea; locust excretes uric acid (U) = max (1)

Bilby uses kidney; locust uses malpighian tubules (S) = max (1)

Question 24 (4 marks)

Banksia: thick, waxy cuticle on leaf surface prevents the evaporation of water from the leaves of the plant, sunken stomates, hairy stomates act as micro-barriers inhibiting the evaporation of water from the stomates. This ensures the water stays in the plant longer thus conserving water.

Outcome criteria	Marks
A second water regulation structural feature stated + explanation of water conservation given + (E2, S2)	4
Water regulation structural feature stated + explanation of water conservation given + (E1)	3
Water regulation structural feature stated + (S1)	2

Australian plant stated (P)	1

Question 25 (2 marks)

Aldosterone is a hormone that acts in the distal tubule cells of the nephron and causes them to increase their reabsorption of sodium.

Hormone replacement therapy involves replacing, or substituting, the hormones that the adrenal glands are not making. Cortisol is replaced orally with hydrocortisone tablets, a synthetic glucocorticoid, taken once or twice a day. If aldosterone is also deficient it is replaced with oral doses of mineralocorticoid, called fludrocortisone acetate (Florinef), which is taken once or twice a day.

Outcome criteria	Marks
In depth description of HRT	2
description of hormone replacement therapy (e.g., aldosterone replacement to enable reabsorption of Na^+)	1

Note: must state the hormone replacement (Florinef) and the administration of the drug (e.g., daily) to get full marks.

Question 26 (4 marks)

Wastes such as urea are removed via diffusion from blood into the dialysis solution. This occurs via the blood passing through dialysis tubing which has a semipermeable membrane. This membrane only filters smaller particles such as salts, water and urea from the blood; blood cells and proteins are too large to pass through.

In the kidney, wastes such as urea are removed via filtration (diffusion)

Similarities: filtration under pressure (passive transport); use of a semipermeable membrane; remove wastes such as urea and salts. (S)

Differences: dialysis: filtration of blood occurs outside of body; pump needed; anticoagulant required; supplements like glucose and other nutrients may be added; nephron uses active transport; no hormones like aldosterone and ADH are used in dialysis. (D)

Criteria	Marks
2 similarities (S) + 2 differences (D)	
• Only three of the above points given.	3
• Only two of the above points given.	2
• Only one of the above points given.	1

Question 27 (6 marks)

(a)

Early kangaroos: lived in a cool, heavily forested environment; being small enabled the kangaroos (such as the Musky-rat kangaroo) to move around easily to obtain food; teeth would have been adapted for browsing (chewing leaves and stems).
About 10-12 million years ago, Australia was much drier (due to the drift northwards) and the kangaroos that survived the drier environment were those that could hop (fossil record) and had teeth for either browsing or grazing (eating grass). These adaptations would become more important as the conditions got drier (end of the Pliocene).
It is thought that an early tertiary ancestor of the Kangaroo family browsed on leaves and shoots of shrubs. As the continent became drier, the grazing lifestyle may have developed. Studies of the teeth of kangaroos of different genera show that kangaroos (e.g. swamp wallaby) whose food contains little abrasive material such as tough grass have a different tooth and jaw structure compared to those kangaroos that graze (e.g. grey kangaroo)

(1): one change described for a species (C)
(1): change is linked to environmental selection pressures (E) e.g., predators like birds
(1): demonstration of an understanding of natural selection in the context of the case study (N)

(b) Various strains of corn.
- Improves certain qualities of the plant such as increased resistance to diseases; ability to grow in poor soils; desired colours, better growth, etc.
- The corn strains crossed are heterozygous for many of the genes responsible for growth etc. This leads to an increase in the desirable combination of alleles for various traits.

Outcome criteria	Marks
description of hybridisation + one in depth description of how hybridisation affects evolution e.g., changes phenotype thereby increases chances of surviving. (O)	3
description of hybridisation + one outline of how hybridisation affects evolution (O)	2
description of hybridisation (H)	1

Note: flow on error applies.

Question 28 (6 marks)

(a) Protozoan: Plasmodium species (1)

(b) Via a vector, the Phenophole species of moisquito (1)

(c) Periodic fever: alternating bouts of shivering and high temperatures every 48 -72 hours, depending the type of malaria. (1)

(d)
An early experiment to test the hypothesis that malaria is caused by drinking marsh water involved some Italian volunteers to consume the marsh water, or have it sprayed into their noses. These volunteers did not develop malaria

In 1880, Laveran, using a microscope slides preparations, observed certain forms of the protozoan, *Plasmodium*, in blood samples of malaria patients. Further work proved that malaria was caused by *Plasmodium*. Or, in the 1890s, Ronald Ross analysed the Anopheles species of mosquito via

dissection and discovered that *Plasmodium* is taken into the mosquito when it sucks the blood of people containing *Plasmodium*, that is, malaria sufferers.

Outcome criteria	Marks
Two scientists associated with important historical development + at least one approximate date (not "ancient").	3
One scientist + historical development + date	2
One scientist + historical development	1

Question 29 (2 marks)

(a) Taeniasis (tapeworm disease) (1)

(b) Tapeworm (1)

Question 30 (5 marks)

(a) Macro-filter water to remove undissolved solids and cells using sand/gravel beds; add a flocculating agent to trap small particles and bacteria, filter this away; add chlorine to water in order to destroy bacteria and any other organism (1).

Boil water. (1)

Micro-filter using cross flow membrane technology.

Any two of the above.

(b) Aseptically apply an inoculating loop of the water sample to a sterile agar plate. Incubate the plate and observe for colonies of microbes. Compare with control (no water) agar plate - record texture, colour, shape etc.

(1): compare with control agar plate (since lid would be removed in both cases) (C)
(1): sterile agar used as growth medium (A)
(1): observe for growth of colonies on agar after incubation – record texture, colour, shape etc. (G)

Question 31 (7 marks)

(a) Lock-and–key model of enzyme activity (or "Induced Fit"). Increasing concentrations of substrate would result in an increase in the enzyme activity until a certain level is reached from which thereafter there would no increase in enzyme activity with increasing substrate concentration. This is a result of collision theory: as the enzyme collides with the substrate at the active sites there is an increase n the enzyme activity. However, when all of the sites of the enzyme are occupied with the substrate the enzyme activity reaches a limit.

Outcome criteria	Marks

Explanation for the hyperbolic behaviour for substrate concentration with enzyme activity + (E)	3
Description of the hyperbolic behaviour for substrate concentration with enzyme activity + (D)	2
Enzyme model stated (M)	1

(b)
Same total volume of solution should be used. E.g., use total of 10 mL in each test tube.

Diluted the milk to different concentrations e.g., 10 ml milk in one test tube, 8 mL milk + 2 mL water in test tube 2, 6 mL milk + 4 mL water in test tube 3, 3 mL milk + 7 mL water in test tube 4.

Control condition: each milk concentration experimental condition had the same set up except water was substituted for the rennin (to same volume).

Same volume of enzyme (rennin) was used for each experimental condition. E.g., put 5 drops in each test tube.

Recorded the time taken for the milk to clump (test tube tilted, observing for no liquid motion).

Repeat the procedure to confirm results – use averages of results obtained.

Temperature/lighting must be kept constant and the same mixing procedure was applied to all the solutions.

Outcome criteria	Marks
Replicates (R)	4
Procedure (includes changing substrate concentration and how to measure the rate of enzyme activity) (P)	3
Control condition (C)	2
Control variables (V)	1

Note: if none above correct, max (1) for description of rennin + milk was investigated.

Question 32 (7 marks)

Animals:
This method involves the direct microinjection of a chosen gene construct (a single gene or a combination of genes) from another member of the same species or from a different species, into the pronucleus of a fertilized ovum. (m)

The DNA construct (usually about 100 to 200 copies in 2 pl of buffer) is introduced by microinjection through a fine glass needle into the male pronucleus - the nucleus provided by the sperm before fusion with the nucleus of the egg.

The insertion of DNA is, however, a random process, and there is a high probability that the introduced gene will not insert itself into a site on the host DNA that will permit its expression. The

manipulated fertilized ovum is transferred into the oviduct of a recipient female, or foster mother that has been induced to act as a recipient by mating with a vasectomized male.

This method has been successful in producing organisms such as transgenic sheep that produce blood clotting proteins in their milk.

(1): microinjection (M)
(1): pronucleus of fertilised ovum (P)
(1): ovum placed into recipient female (O)
(1): judgement with respect to the use of transgenic animals (evaluate) (J)

Plants:
Use of a bacterium such as Bacillus thuringiensis (Bt) that has a foreign gene inserted into a plasmid. The bacterium then inserts plasmids into the root cells of a plant.

Many plants have been successfully genetically modified using this method. For example, cotton has been inserted with a gene that produces a Bt toxin that is an insecticide against moths, which is a pest of cotton crops.

(1): use of a bacterium (b)
(1): plasmids inserted into plant roots (R)

(1):judgement with respect to the use of transgenic plants (evaluate) (J)

Note:

J J = correct success rate given (higher in plants than animals) + examples used to supplement answer.

J = only correct success rate given (higher in plants than animals).

Question 33 Genetics – The Code is Broken? (25 marks)

(a) Selective breeding: the purposeful selection of two organisms for breeding in order to produce offspring that have desirable characteristics.

(1): selective breeding result e.g., "finer wool" (not just "better wool") (R)
(1): one specific agricultural example (E)
(1): detailed reason for selective breeding; why the breeding improved the organism for human use (d)

(-1 if not used for agricultural purposes)

(b) (i) Use DNA fingerprinting for establishing the pedigree of the animal. This requires taking cell samples from the stock animal and the prized animal. By analysing the DNA of the stock animal and the prized animals, specifically the minisatellites or VNTRs, via the use of gel electrophoresis and Southern Blotting techniques, a comparison can be made in terms of the number of similar minisatellites or VNTRs and the pattern formed on the gel. The more similar the gel patterns of the DNA samples the more likely the animals are related. This form of analysis occurs at the molecular level and is therefore a more sensitive technique than comparing alleles.

(1): DNA fingerprinting (D)
(1): outline of method (M)
(1): description of how the results reveal the heredity relationship. (R)

Note: pedigree is incorrect since we have to prove that the animal belongs to the pedigree line anyway.

(ii) DNA fingerprinting would be the most accurate method since DNA fingerprinting involves the analysis of minisatellites or Variable Number Tandem Repeats (VNTRs) of DNA. These regions of DNA are short, highly repeated sequences of base pairs that are found throughout a person's chromosomes. Because they are unique to a person, minisatellites or VNTRs can be used to identify if two pieces of DNA *are linked via heredity or are from the same person.* This form of analysis is also more sensitive than other methods, requiring only small amounts of tissue samples from the organisms. In addition, the test can repeated many times to confirm the results.

(1): identifying the use of minisatellites
(1): giving a reason why DNA fingerprinting is more sensitive and more accurate than other methods.

Note: must mention role of minisatellites

(c)

Examples of chromosomal mutations: Translocation Down syndrome; cri-du-chat syndrome
Effects of chromosomal mutations: potentially more deleterious than gene mutations if the germ line cells are affected. The offspring will inherit the mutation and this may result in sterile offspring. E.g., Down syndrome suffers have a trisomy at pair 21 and are non-fertile. Thus the species would not be able to evolve due to the lack of fertile offspring.

Translocation Down syndrome: part of chromosome 21attaches to chromosome 14.

Cri-du-chat syndrome: missing part of chromosome 5.

Examples of gene mutations: Cystic fibrosis; sickle cell anaemia
Effects of gene mutations: less deleterious than chromosomal since they are confined to one protein and the associated characteristic. However, some gene mutations may affect the survival of an organism. E.g., cystic fibrosis suffers may not live to reproduce.

Cystic fibrosis: excessive secretions of mucous that block airways and inhibit pancreas secretions; these may lead to lung infections.

Sickle-cell anaemia: fatigue, breathlessness upon physical exertion.

Effects on evolution: detrimental mutations will not enable the organism to survive and reproduce thereby affecting the evolution of the species since genes are not passed on.

(1): examples of chromosomal mutations (C)
(1): Effects of chromosomal mutations on evolution (CE)
(1): Examples of gene mutations (G)
(1): Effects of gene mutations on evolution (GE)
(1): recognising role of somatic vs gamete inheritance of mutations (S)

(d) (i) Multiple allele traits are those that have three or more alleles for a gene. E.g. Eye colour in Drosophila (12 alleles). Wing size in Drosophila (normal wings, vestigial wings and antlered wings). Skin (coat) colour in mice (5 alleles).

(ii) More than two alleles are responsible for the phenotype. Thus a variety of combinations of alleles can yield a variety of phenotypes. E.g., in the fruit fly (Drosophila), The colour of Drosophila eyes is governed by a series of alleles which cause the hue to vary from red or wild type (w^+ or W) through coral (w^{co}),, blood (w^{bl}), eosin (w^o), cherry (w^{ch}), apricot (w^a) , honey (w^h), buff (w^{bf}), tinged (w^t), pearl (w^p) and ivory (w^1) to white (w). The wild type allele (w^+) is completely dominant and w is completely recessive to all other alleles in the series. The heterozygotes which contain unlike members of allelic series are called compounds. The compounds of this multiple allelic series which involve alleles other than w^+ tend to be phenotypically intermediate between the eye colours of the parentral homozygotes.

Multiple alleles: 3 or more alleles for a gene responsible for a trait.. Polygenic: more than one gene responsible for the trait. (1)

Genotype: polygenic yields greater variety than multiple alleles (1)

Phenotype: MA is discontinuous variation (1); PG is continuous variation. (1)

(e)

Gene cascades also play a role in the development of the embryo. If one of the transcription factor proteins switches on another gene that also is a transcription factor, the latter may switch on another gene(s), which may also be responsible for transcription. (1) In this fashion a cascade of gene expression is built up (a type of amplification), producing proteins along the way that may influence what the embryonic cells differentiate into. (1)

- Embryonic development in many organisms depends on several types of genes, or genes that have similar roles: maternal effect genes, segmentation genes and pattern formation genes.
- Maternal effect genes cause the egg to have concentration gradients of proteins that may act as gene regulatory proteins (transcription factors). The amount of these proteins received by embryonic cells influences what genes are switched on or off. Gene expression in, and the developmental fate of, cells in the early embryo are influenced by these local differences in the distribution of cytoplasmic determinants.
- Pattern formation genes mainly depend on the expression of the homeotic genes that contain the homeobox sequence of DNA (found in many types of organisms).
- The proteins expressed by these genes are transcription factors that turn on or off other genes in the embryo cells. For example, mutations occurring in the homeobox genes are responsible for many limb defects in vertebrates. (2)
- Gene cascades also play a role in the development of the embryo. If one of the transcription factor proteins switches on another gene that also is a transcription factor, the latter may switch on another gene(s), which may also be responsible for transcription. In this fashion a cascade of gene expression is built up (a type of amplification), producing proteins along the way that may influence what the embryonic cells differentiate into. (2)
- The spatial location of the limb formation cells also influences the orientation of the cells and thus determines features such as left and right, front and back. Pattern formation is controlled by positional information, which is a set of molecular cues that indicate a cell's location relative to other cells in an embryonic structure and that help to determine how the cell and its descendants respond to future molecular signals. Gradients in the concentration of these signaling factors along the three orientation axis provide cells with positional information

Timing comments (2)

Genes: maternal effect genes description; pattern formation genes (homeobox) description; segmentation genes description

Timing: gene cascades description; positional patterns described.

Judgement: must give reason for the value-laden statement ("important because…")

Note:
Must have maternal, pattern formation (homeobox), gene cascades or other and judgement to get (7).