

4.4 Genetic Information, Variation and Relationship – Species and Taxonomy– Mark schemes

Q1.

- (a) 1. Species = (A group of) organisms that are able to produce fertile offspring;
 2. Species richness = the number of (different) species in a community;
 2. *Accept in a habitat / ecosystem / area*
 2. *Reject in a population*
 2. *Ignore 'types' unqualified* 2
- (b) 5; 1
- (c) 1. Number of individuals of each species not known;
 2. **Almost** all (of sample A / the 68%) could be of the same species;
 3. Two / other samples have a higher number of species / higher species richness but a lower number of individuals / fish;
 4. Other samples may have more individuals of each species;
 2. *If not stated otherwise, assume MP2 relates to sample A / 68%* 3 max

[6]

Q2.

- (a) 1. (Without genetic analysis / **X**) *mackloti and olivaceus* have a more recent common ancestor with each other (than with *papuana*);
 2. (Genetic analysis indicates / **Y**) *papuana and mackloti* have a more recent common ancestor with one another (than with *olivaceus*);
 Accept 'more closely related to' for 'more recent common ancestor' 2

(b)

Domain	Eukaryote
Kingdom	Animal
Phylum	Chordata
Class	Reptilia
Order	Squamata
Family	Python

All 5 correct = 1 mark
 Any errors = 0 marks

- (c) Genus / genera;
 If the response has two answers no mark is awarded. 1
- (d) 1. The (base) sequence of DNA;
 Accept 'DNA hybridisation' 1

2. The (base) sequence of mRNA;
3. The amino acid sequence (of proteins);

3

[7]

Q3.

- (a) Phylum; 1
- (b) **M** placed correctly between zygote and zygospore; 1
- (c) Any valid reasons, e.g.

Asexual

Fewer stages so quicker

OR

Only one parent involved so can colonise new environment

OR

Produces clone so successful (geno / pheno)type maintained;

Sexual

increases genetic diversity so greater chance of survival / success.

2

- (d) Spores spread / dispersed further; 1
- (e)
 1. Measure diameter of large number of spores;
 2. Divide measured values by 700 (to find true diameter);
 3. Reference to using volume of sphere.3

3

[8]

Q4.

- (a)
 1. Same genus;
 2. Same evolutionary origin / common ancestor.2

2

- (b)

Taxon	Name of Taxon
Domain	Eukarya
Kingdom	Animalia
Phylum	Chordata
Class	Mammalia
Order	Rodentia

Family	Muridae
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3 correct = 2 marks
 2 correct = 1 mark
 1 or 0 correct = 0 marks

2

- (c) 1. (No) SDs of means of body sizes / sizes of parts of bodies overlap;
 2. Calculation of correct head and body: tail ratios;
 3. Almost identical, so same body shape / proportions;

3

- (d) 1. Breed the two mice together;
 2. (Same species) produce fertile offspring.

2

[9]

Q5.

- (a) PKNJ.

1

- (b) *Lutra lutra*.

1

- (c) Bone / skin / preserved remains / museums.

1

- (d) 1. (Hunting) reduced population size(s), so (much) only few alleles left;
Accept bottleneck
 2. Otters today from one / few surviving population(s);
Accept founder effect
 3. Inbreeding.
Allow any two

2 max

- (e) 1. Population might have been very small / genetic bottleneck;
 2. Population might have started with small number of individuals / by one pregnant female / founder effect;
 3. Inbreeding.
Allow any two

2 max

[7]

Q6.

- (a) 1. Kingdom, Phylum, Class, Order, Family;
 2. *Luscinia svecica*.

1 mark for each correct column
*Allow Genus and Species if both placed in box for species
 but not if both placed in genus box*

2

- (b) Number of different alleles of each gene.

Accept number of different base sequences (found) in each gene

1

- (c) 1. Has greater proportion of genes / percentage of genes showing diversity;
2. Percentage is 35% compared with 28% / proportion is 0.35 compared with 0.28.

Allow correct figures that are not rounded up, i.e., 34.9% / 0.349 and 27.8% / 0.278

2

[5]

Q7.

- (a) 1. (So) age not a factor in female choice;
2. (So) will attract a mate;
3. (So similar) sexual maturity;
4. (So) have the correct feathers;
4. Accept 'have blue feathers'

2 max

- (b) Number the birds, then numbers out of hat / random number generator;

Both aspects needed for mark

1

- (c) 1. That movement was not related to some other factor (than the male);
2. That movement (towards the male) indicated mating behaviour;
3. (Females) only respond to throat feathers (of the male) / do not respond to other visual display / sounds / calls (by the male);

2 max

- (d) 1. Change in sequence of bases / nucleotides;
2. (As a result of a) deletion / substitution;
3. Change in amino acid sequence / primary structure;
4. Change in tertiary structure of protein;
*1. Do not accept 'change in the DNA sequence'
2. Accept e.g. addition / inversion / duplication / translocation*

3

- (e) **Yes**

1. (From resource A) birds can detect UV light;
2. (From resource B) difference between UVR and NR significant / not due to chance;
3. As error bars do not overlap;
*3 max if only **No** marks awarded*

2. Reject idea that 'results' in resource B are significant / not due to chance, must include idea of 'difference'

3. Reject 'as standard deviations do not overlap'

No

4. UV light may not be involved in mating / other factors may be involved in mating;

5. Some birds in UVR group were attractive to females;

6. (Experiment in resource B) carried out in artificial conditions / only 40 birds used / small sample size;

6. *Neutral: idea that this is only one study / that there are no repeats*

4 max

[12]

Q8.

- (a) (i) (Grouped according to) evolutionary links/history/relationships / common ancestry;
Ignore: closely related, factors, characteristics
Ignore: genetically similar

1

- (ii) 1. Able to reproduce;
Accept: smallest taxonomic group/groups of organisms with same genes/ chromosomes/same number of chromosomes
Accept: breed for 'reproduce'
Ignore: mate
Reject: genetically identical
Ignore: similar genes/chromosomes

2. To produce fertile offspring;
Ignore: that are 'viable'

2

- (b) Phylum
Class
Family
Genus;

Accept: plural answers phyla / genera / families

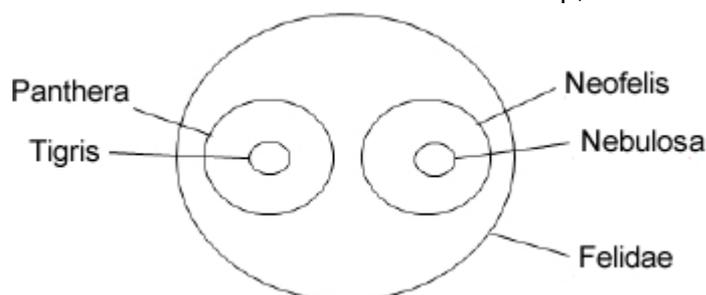
Accept phonetic answers

phyllem/phylem/fylum/fyla/phylae/phyli/jenus/ jenera/familys

All 4 in correct order for 1 mark

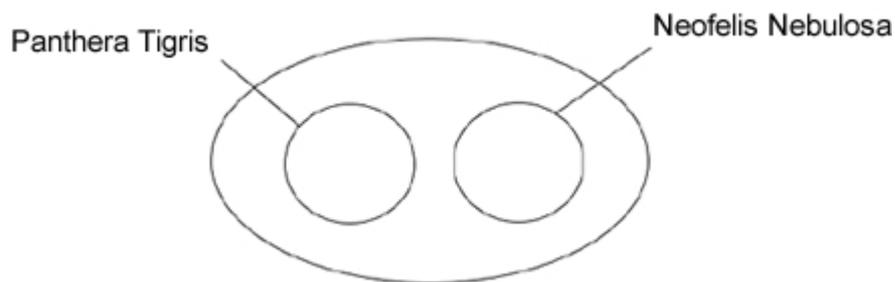
1

- (c) 1. Two circles/with two inner circles with no overlap;



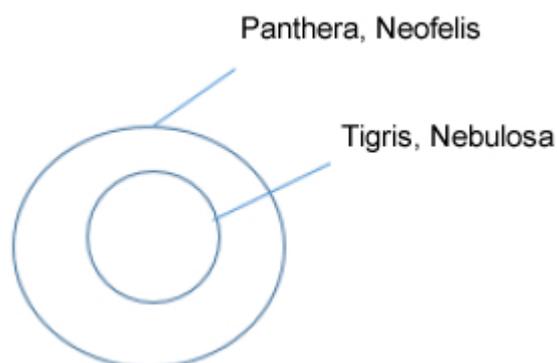
= 2 marks

OR



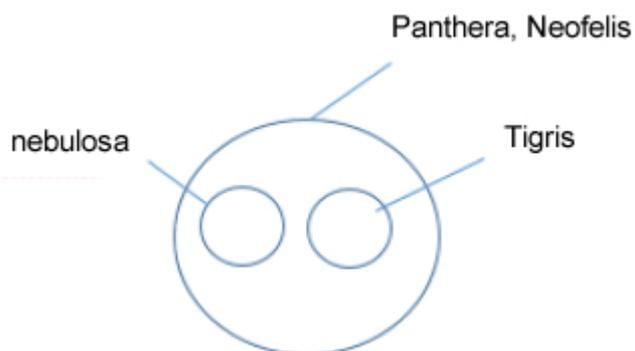
= 2 marks

OR



= 1 mark

OR



= 1 mark

2. Labels correct;

Ignore underlining / capitals

Accept: P tigris/ N nebulosa

Accept phonetic spelling

2

- (d) 1. South China and Sumatran tigers share a more recent common ancestor;
Accept: more closely related (statement must be comparative)
Accept: a labelled hierarchy
2. (because) identical/same/matching (nucleotide) sequences;
Accept: converse for Siberian tiger eg Siberian is less closely related to South China AND Sumatran tigers



2

[8]

Q9.

- (a)
1. Recognise / identify / attract same species;
Ignore: references to letting them produce fertile offspring
 2. Stimulates / synchronises mating / production / release of gametes;
 3. Recognition / attraction of mate / opposite sex;
Accept finding a mate
Accept: gender
 4. Indication of (sexual) maturity / fertility / receptivity / readiness to mate;
 5. Formation of a pair bond / bond between two organisms (to have / raise young).

3 max

- (b)
1. Use a (real) male (with intact wings / no wing removed);
Mark ignoring reference to birds / or other types of animals
Accept: use a real cricket, since only males sing
 2. Determine (percentage) response (of females compared with L).
Accept: compare results with L

2

- (c)
1. Lowest / only 30% courtship with no song / K / (or) courtship still occurred when no song played / K;
Note: throughout, for courtship accept response / stimulation / reaction
Neutral: references to methodology
Answer must make clear there is no song / version K
 2. Reduced courtship when no ticks / M / there is some courtship when no ticks / M;
 3. Reduced courtship when no chirps / N / there is some courtship when no chirps / N;
Accept: use of figures from the table in an explanation
 4. (So) courtship must involve a visual stimulus / other factor involved;
 5. Chirps more important as lowest courtship when none / N / ticks less important as similar courtship when changed / M;
Must make comparison to gain mark
 6. Data only show presence and absence of chirps / 0 and 7 chirps.
Note: 'courtship still occurred when no sound played so a visual stimulus / other factor / something else (e.g. pheromone?) must be involved'

= 2 marks

4 max

[9]

Q10.

(a) Aves;

1

(b) Gallicolumba kubaryi;

Must have both words and in this order

Must be capital G

If starts with k, award mark as impossible to recognise difference

Ignore: underlining

Accept: phonetic spelling

Accept: G kubaryi (must be a capital / upper case G)

1

(c) No overlap.

1

[3]

Q11.

(a) 1. Group of similar organisms / organisms with similar features / organisms with same genes / chromosomes;

1. Accept: same number of chromosomes

1. Accept: smallest taxonomic group

1. Reject: genetically identical. Only allow 1 max if mentioned

1. Q Neutral: similar genes / chromosomes

2. Reproduce / produce offspring;

2. Accept: breed / mate

3. That are fertile;

3. Neutral: that are 'viable'

'Produce fertile offspring' = 2 marks

2 max

(b) (i) Correct answer of 6.97 to 7 = 2 marks;

One mark for 6320 as numerator or 906 as denominator;

2

(ii) 1. Decrease in variety of plants / fewer plant species;

1. Accept: reference to monoculture or description

1. Neutral: fewer plants

2. Fewer habitats / niches;

2. Neutral: fewer homes / less shelter

3. Decrease in variety of food / fewer food sources;

3. Neutral: less food

3. Accept: less variety of prey

Q12.

- (a) (i) 1. Groups within groups;
Accept: idea of larger groups at the top or smaller groups at the bottom
2. No overlap (between groups); 2
- (ii) 3; 1
- (iii) Chordata;
Accept: if phonetically correct eg 'Cordata' 1
- (b) (i) 1. (To provide) genetic variation;
Genetic variation must be directly stated and not implied
2. (Allows) different combinations of maternal and paternal chromosomes / alleles;
Accept: any allele of one gene can combine with any allele of another gene 2
- (ii) 1. (Zedonk has) 47 / odd / uneven number of chromosomes;
Accept: diploid number would be odd
Reject: if wrong number of chromosomes is given
2. Chromosomes cannot pair / are not homologous / chromosome number cannot be halved / meiosis cannot occur / sex cells / haploid cells are not produced;
Accept: cannot have half a chromosome
*Q Reject: meiosis cannot occur **in** sex cells* 2

Q13.

- (a) 1. No interbreeding / gene pools are separate / geographic(al) isolation;
Accept: all marks if answer written in context of producing increased diversity of plants
1 Do not award this mark in context of new species being formed and then not interbreeding
1 Accept reproductive isolation as an alternative to no interbreeding
2. Mutation;
2 Accept: genetic variation
3. Different selection pressures / different foods / niches / habitats;
3 Accept: different environment / biotic / abiotic conditions or named condition
3 Neutral: different climates

4. Adapted organisms survive and breed / differential reproductive success;
5. Change / increase in allele frequency / frequencies; 5
- (b) Similar / same environmental / abiotic / biotic factors / similar / same selection pressures / no isolation / gene flow can occur (within a species);
Accept: same environment 1
- [6]**

Q14.

- (a) (i) Kingdom / phylum / class;
Accept Animalia / animal kingdom / Chordata / Chordates / Aves
Allow phonetic spelling 1
- (ii) Family; 1
- (b) 1. Shows the spread of the data / how data varies;
 1. *Reject range.*
Accept varies from the mean
2. Overlap = no difference / due to chance / not significant;
 2. *Allow converse* 2
- (c) 1. Different species would have different amino acid sequences;
Accept more closely related = more similar sequence
2. Amino acid sequence is the result of DNA / alleles / base sequence;
References to incorrect statements about coding negates second mark 2
- [6]**

Q15.

- (a) (i) *Synodontis batensoda* / *S. batensoda*;
Ignore spellings 1
- (ii) *Mochokus niloticus*;
Ignore spellings 1
- (b) 5; 1
- (c) (i) Fertile offspring produced;
Allow suitable description of offspring being fertile. 1
- (ii) 1. Attracts / recognises same species;
Attracts mate of the same species = two marks.

2. Attracts / recognises mate / opposite sex;
3. Indication of sexual maturity / fertility / synchronises mating;
Allow 'ready to mate'.
4. Stimulates release of gametes;
5. Form pair bond;

2 max

[6]

Q16.

- (a) Banding pattern changes as cheetah gets older / difficult to judge as tail is short / fluffy; 1
- (b) (i) Mean not (always) a whole number;
Standard deviation not (always) zero; 2
- (ii) Movement of tail / angle of sight / confused it with another band / subjective estimation;
*Accept reference to **Figure 1***
E.g. Bands 2 and 3 have same thickness but look different 1
- (c) Band width not the same on both sides of tail; 1
- (d) Offspring of the same family will be more similar genetically;
As have same mother (and father) / parent;
Expect to see more differences in randomly chosen cheetahs; 3

[8]

Q17.

- (a) (i) Phylum, Class, Order, Genus;
Mantophasma (M) / (Mantophasma) zephyra; 2
- (ii) Groups within (larger) groups;
No overlap; 2
- (b) Comparison of / look for similar features / structures / appearance; 1

[5]

Q18.

- (a) Kingdom / phylum / class; 1
- (b) (i) 6; 1

- (ii) Family; 1
- (iii) The two species of *Mirounga* shared a common ancestor more recently than they did with *Monarchus tropicalis*; 1
- (c) Difference in DNA / base sequence / alleles / genes; 1

[5]

Q19.

- (a) group of organisms with similar features;
can (interbreed to) produce fertile offspring; 2
- (b) directional selection;
any TWO from
selection against one extreme / for one extreme;
against broadest beaks in B and narrowest beaks
in **A** / for narrowest in **B** and broadest in **A**;
whole distribution / range / mean / mode / median is
shifted towards favoured extreme;

3 max

[5]

Q20.

- (i) Taxon **A** - there is more than one level / taxon below it / genus only has species / only has one level / taxon above it;
- (ii) Taxon **C** - there is more than one level / taxon above it / phylum only has kingdom / only has one level taxon above it;

[2]

Q21.

- (a) (i) 1. Groups within groups;
1. accept idea of larger groups at the top / smaller groups at the bottom
2. No overlap (between groups); 2
- (ii) (Grouped according to) evolutionary links / history / relationships / common ancestry;
Neutral: closely related
Neutral: genetically similar 1
- (b) (i) 1. (Only) one amino acid different / least differences / similar amino acid sequence / similar primary structure;
2. (So) similar DNA sequence / base sequence; 2
- (ii) 1. Compared with humans / not compared with each other;
Accept: degenerate code / more than one triplet (codes) for

an amino acid

2. Differences may be at different positions / different amino acids affected / does not show where the differences are (in the sequence);

1 max

- (iii) 1. All organisms respire / have cytochrome c;
Accept: converse arguments for haemoglobin
1. *Accept 'more' instead of 'all'*
1. *Accept 'animals' instead of organisms?*
2. (Cytochrome c structure) is more conserved / less varied (between organisms);
2. *Neutral: cytochrome c is conserved*

1 max

[7]

Q22.

- (a) (i) there are no fertile hybrids found in the overlapping regions;
- (ii) even if mating took place, there would be no fertile hybrids / different chromosome number / gene pool / evolutionary history / many morphological / biochemical / serological differences;

1

1

- (b) (i)

Kingdom	Animalia / Animals
Phylum	Chordata
Class	Mammalia
Order	Xenarthra
Family	Dasypodidae
Genus	<i>Dasypus</i>
Species	<i>(D.) novemcinctus</i>
1 mark per correct column	

2

- (ii) Family, as all three belong to different genera;

1

[5]

Q23.

- (a) phylum, class, order;
species, *Acinonyx jubatus*;
- (b) larger groups containing smaller groups;

2

1

- (c) (i) do not interbreed to produce fertile offspring / different DNA / different niches; 1
- (ii) fossil record; evolutionary history / phylogeny; biochemical differences e.g. DNA / proteins / cytochromes; homologous features / named feature; karyotype / number and form of chromosomes; *(discount any example credited in (i))* 2

[6]

Q24.

- (a) colder / below 0°C (January) areas, cyanogenic plants die in this cold / acyanogenic survive; non-cyanogenic allele / gene passed on more often / its frequency increases; warmer (January) areas cyanogenic plants at advantage, because of less herbivore selection pressure / feeding; so cyanogenic survive more often to pass on cyanogenic allele / gene. 4 max
- (b) large (and equal) number of quadrats in each area; *(reject several)* random sampling method, described; *(accept described 'systematic' method)* percentage cover / point hits per quadrat / count plants; mean / average value for each area; statistics test to see if differences significant. 4 max

[8]

Q25.

- (a) large groups are divided into smaller groups; *(not just 'hierarchical')* members of a group have features in common based on anatomy / fossils / embryology / DNA / specific aspect of cell biology / homologous structures; reflects evolutionary history; 3
- (b) fungi and animals; 1
- (c) (insects and fungi) have common ancestor; they diverged a long time ago / before others referred to in phylogenetic tree; 2
- (d) those with similar sequences put in same groups / are more closely related; the greater difference in amino acid sequence the longer ago the groups diverged; 2
- (e) A - present in all (eukaryotic) species or organisms / quantifiable; D - extinct species not considered / no timing of events available / only limited number of amino acid sequences / can't include prokaryotic species 2

[10]

- (a) (i) Order, Family, Genus.
(*all correct = 2 marks; 2 correct = 1 mark*) 2
- (ii) 3 concentric circles in Carnivora, labelled Felidae, Panthera and L; 1
- (b) (i) large groups split into smaller groups (which do not overlap); 1
- (ii) (phylogenetic) based on evolutionary history;
shows ancestry of groups / points of divergence / example,
e.g. reptiles and birds separated after mammals / reptiles
and birds more closely related than mammals;
(hierarchical) based on shared characteristics (seen today); 3

[7]

Q28.

- (a) phylum, class, family, genus; 1
- (b) (i) more recent common ancestor / DNA in common; 1
- (ii) mutation causes variation;
genes (coding) for protein / cytochrome c with different structures;
EITHER
individuals with a modified cytochrome c have a selective
advantage / are selected for / these individuals are more likely to survive
to have offspring / have more offspring;
(*must link a comparison of survival to reproduction*)

gene / allele frequency changes over generations / time;
OR
changed structure does not affect protein function;
these structural differences accumulate over time; 4

[6]

Q29.

- (a) principle of sequential multiplication ($0.9 \times 0.6 \times 0.75 \times 0.67$);
0.27;
(*correct answer 2 marks*) 2
- (b) (i) similar sequence / actions / sign stimuli; 1
- (ii) additional action in sequence (species A) / scissor wings blocks
sequence in B; 1
- (c) (acts as) sign stimulus;
responds only to species-specific sound; 2

[6]

Q30.

(a) breed together;
if fertile offspring, then same species; 2

(b) isolation of two populations;
variation already present due to mutations;

different environmental conditions / selection pressures leading to
selection of different features and hence different alleles;
different frequency of alleles;
separate gene pools / no interbreeding; 4

(c) selection of mate dependent on colour pattern;
prevents interbreeding / keeps gene pools separate; 2

[8]

