7.1 Genetics, populations, evolution, ecosystems (A-Level Only) - Inheritance and genetic crosses 1 - Mark schemes

Q1.

(a) (i) Only expressed / shown (in the phenotype) when homozygous / two (alleles) are present / when no dominant allele / is not expressed when heterozygous;

1

(ii) Both alleles are expressed / shown (in the phenotype);

Allow both alleles contribute (to the phenotype).

1

(b) (i) Evidence (not a mark)

3 and 4 / two Rhesus positives produce Rhesus negative child / children / 7 / 9;

Explanation (not a mark)

Both Rhesus positives / 3 and 4 carry recessive (allele) / are heterozygous / if Rhesus positive was recessive, all children (of 3 and 4) would be Rhesus positive / recessive;

Do not negate mark if candidate refers to gene rather than allele.

Answers including correct and incorrect evidence = zero marks evidence and explanation.

2

(ii) Evidence (not a mark)

3 would not be / is Rhesus positive / would be Rhesus negative;

Explanation (not a mark)

3 would receive Rhesus negative (allele) on X (chromosome) from mother / 3 could not receive Rhesus positive (allele) from mother / 3 would not receive Rhesus positive (allele) / X (chromosome) from father / 1 / 3 will receive Y (chromosome) from father / 1;

OR

Evidence (not a mark)

9 would be Rhesus positive / would not be / is Rhesus negative / 8 and 9 / all daughters of 3 and 4 would be Rhesus positive;

Explanation (not a mark)

As 9 would receive X chromosome / dominant allele from father / 3;

Do not negate mark if candidate refers to gene rather than allele.

One mark for evidence and one mark for explanation linked to this evidence.

Any reference to allele being on Y chromosome negates mark for explanation.

2

(c) Correct answer of 48(%) = 3 marks;;;

q^2 / p^2= 16% / 0.16 / p / q = 0.4;

Shows that 2pq = heterozygotes / carriers;

Final answer of 0.48 = 2 marks

Allow mark for identifying heterozygotes if candidate multiplies incorrect p and q values by 2.

3

[9]

Q2.

(a) 1. (Expression / appearance / characteristic due to) genetic constitution / genotype / allele(s);
2. (Expression / appearance / characteristic due to) environment;

1. Accept: named characteristic.

1. Accept: homozygous / heterozygous / genes / DNA.

1. Ignore: chromosomes.

2

(b) Epistasis
OR
Epistatic (interaction / control);

Accept: phonetic spellings.

Ignore: preceding word e.g. (recessive / dominant) epistasis.

1

(c) **AAbb** – white
aaBB – yellow;

Both correct for one mark.

1

(d) 1. AaBb, Aabb, aaBb, aabb;
2. White, (white), yellow, green;
3. 2 : 1 : 1;

Note: If genotypes are incorrect = zero marks.

1. Accept: equivalent genotypes e.g. ABab for AaBb.

Accept: sequence of phenotypes does not need to mirror genotypes but must be correct.

*3. Accept: ratios of 2:1:1 or 1:2:1 or 1:1:2 even if sequence of phenotypes do not match if mark points 1 **and** 2 have been awarded.*

3. Accept: alternative ratios in correct proportions e.g. 4:2:2

3. Ignore: percentages / fractions.

3

(e) 1. Correct answer of 32% = **2 marks**;
2. Incorrect answer but shows understanding that 2pq = heterozygous / carriers = 1 mark;

Accept: understanding of 2pq by using a calculation involving 2 × two different numbers.

2

[9]

Q3.

(a) 1. Bb / suitable equivalent;

Reject sex linkage or superscripts

2. Both parents have bar eyes, but have some offspring with round eyes, so parents must be carriers of recessive allele for round eyes;

2

(b) 3:1;

1

(c) Fertilisation is random
OR
Fusion of gametes is random;

2. Small / not large population / sample;

3. Selection advantage / disadvantage / lethal alleles;

2 max

(d) χ^2 / chi squared;

1

(e) Both alleles expressed in the phenotype (if both are present);

1

(f) 0.25;

1

(g) 304;

Award 1 mark for answers which show understanding that 2pq represents heterozygous

2

[10]

Q4.

(a) (Genes / loci) on same chromosome.

1

(b) 1. GN and gn linked;
2. GgNn individual produces mainly GN and gn gametes;
3. Crossing over produces some / few Gn and gN gametes;
4. So few(er) Ggnn and ggNn individuals.

4

(c) (Grey long:grey short:black long:black short) =1:1:1:1

1

(d) 1. Chi squared test;
2. Categorical data.

2

[8]

Q5.

(a) 1. Reduction in ATP production by aerobic respiration;
2. Less force generated because fewer actin and myosin interactions in muscle;
3. Fatigue caused by lactate from anaerobic respiration.

3

(b) Couple **A**,

1. Mutation in mitochondrial DNA / DNA of mitochondrion affected;
2. All children got affected mitochondria from mother;
3. (Probably mutation) during formation of mother's ovary / eggs;

Couple **B**,

4. Mutation in nuclear gene / DNA in nucleus affected;
5. Parents heterozygous;
6. Expect 1 in 4 homozygous affected.

4 max

(c)
1. Change to tRNA leads to wrong amino acid being incorporated into protein;
2. Tertiary structure (of protein) changed;
3. Protein required for oxidative phosphorylation / the Krebs cycle, so less / no ATP made.

3

(d)
1. Mitochondria / aerobic respiration not producing much / any ATP;
2. (With MD) increased use of ATP supplied by increase in anaerobic respiration;
3. More lactate produced and leaves muscle by (facilitated) diffusion.

3

(e)
1. Enough DNA using PCR;
2. Compare DNA sequence with 'normal' DNA.

2

[15]

Q6.

(a)
1. (Expression/appearance/characteristic due to) genetic constitution/genotype/allele(s);

   Accept: named characteristic.

   Accept: homozygous/ heterozygous/genes/DNA.

   Ignore: chromosomes.
2. (Expression/appearance/characteristic due to) environment;

2

(b) (i)
1. (Individual) 2 has colour vision but 4 is colour blind / 10 has colour vision but 12 is colour blind
   OR
   4/12 is colour blind but parents have colour vision;
2. So 2/10 must be heterozygous/carriers;

   Accept: (1), 2 and 4 ***or*** *10, (11) and 12.*

   Accept: any suitable description and explanation equivalent to points 1 and 2.

   Reject: (both) parents heterozygous/carriers.

   Accept: correct genotypes for 2 and 10.

   Accept: for 2 marks, if it was dominant the daughters (8 and 10) of individual 4 would be colour blind.

2

(ii) X^BX^b **or** X^bX^B;

Reject: Bb / bB

Accept: XBXb or XbXB;

Accept: use of other letter than B

e.g. X^RX^r, X^HX^h.

1

(c) (i) 2 marks for the correct answer of 0.0625 / 6.25% / 1/16;;
1 mark for incorrect answer but shows 0.03125 / 3.125% / 1/32;

Accept: 0.063 / 0.06 / 6.3% / 6% for 2 marks.

Accept: incorrect answer but shows / 0.0313 / 0.031 / 0.03 / 3.13% / 3.1% / 3% / ¼ × ¼ / 0.25 × 0.25 for 1 mark.

Note: if probability is calculated as a percentage but no % shown in the answer then deduct one mark. For example 6.25 = one mark, 3.125 = zero.

2

(ii) 2 marks for the correct answer of 48(%);;
1 mark for an incorrect answer but shows understanding that 2pq = heterozygous or attempts to calculate 2pq;

1 mark maximum for the answer of 0.48.

2

[9]

Q7.

(a) 1. (Reaction with ATP) breaks/allows binding of myosin to actin/ actinomyosin bridge;
2. Provides energy to move myosin head;

1. Credit 'breaks' or 'allows' binding to actin (because cyclical)

2. Allow in context of 'power stroke' or 're-cocking' (because cyclical)

2. Ignore contraction on its own

2

(b) (i) Any value between 68.5 and 69.49 (%);;

If get difference of 0.9 but calculation of percentage incorrect, then award 1 mark;

2

(ii) (Mutant mice)

1. Unable to make phosphocreatine/ less phosphate available to make/recycle ATP;
2. So less energy/so less ATP available for contraction/fast muscle fibres;

1 and 2. Reject production/creation of energy once

2. Accept less energy for grip

2. Accept no energy/no ATP for contraction/fast muscle fibres

2

(c) 1. (Heterozygous) have one dominant/normal allele (for creatine production);
2. (This) leads to production of enough/normal amount of creatine;

1. Accept has one allele/one copy of the gene for/that is

making creatine

2

[8]

Q8.

(a) Both alleles are expressed / shown (in the phenotype).

Accept: both alleles contribute (to the phenotype)

Neutral: both alleles are dominant

1

(b) Only possess one allele / Y chromosome does not carry allele / gene / can't be heterozygous.

Accept: only possess one gene (for condition)

Neutral: only 1 X chromosome (unqualified)

1

(c) 1. X^GX^B, X^BX^B, X^GY, X^BY;

Accept: equivalent genotypes where the Y chromosome is shown as a dash e.g. X^G-, or is omitted e.g. X^G

Reject: GB, BB, GY, BY as this contravenes the rubric

2. Tortoiseshell female, black female, ginger male, black male;

3. (Ratio) 1:1:1:1

2 and 3. Award one mark for following phenotypes tortoiseshell, black, (black) ginger in any order <u>with</u> ratio of 1:2:1 in any order.

*Allow one mark for answers in which mark points 1, 2 and 3 are not awarded but show parents with correct genotypes i.e. X^GX^B and X^BY **or gametes as** X^G, X^B and X^B, Y*

3. Neutral: percentages and fractions

3. Accept: equivalent ratios e.g. for 1:1:1:1 allow 0.25 : 0.25 : 0.25 : 0.25

3

(d) (i) Correct answer of 0.9 = 2 marks;

Incorrect answer but shows $q^2 = 0.81$ = one mark.

Note: 0.9% = one mark

2

(ii) Homozygous dominant increases and homozygous recessive decreases.

1

[8]

Q9.

(a) (Recessive) allele is always expressed in females / females have one (recessive) allele / males need two recessive alleles / males need to be homozygous recessive / males could have dominant and recessive alleles / be heterozygous / carriers;

Accept: Y chromosome does not carry a dominant allele. Other answers must be in context of allele not chromosome or gene.

1

(b) (i) 1. 1, (2) and 5;

Accept: for 1 mark that 1 and 2 have slow (feather production) but produce one offspring with rapid (feather production).

Neutral: any reference to 3 being offspring of 1.

2. 1 must possess / pass on the recessive allele / 1 must be a carrier / heterozygous / if slow (feather production) is recessive all offspring of (1 and 2) would be slow (feather production) / if rapid (feather production) was dominant 1 would have rapid (feather production);

Reject: both parents must be carriers / possess the recessive allele.

Reject: one of the parents (i.e. not specified) must be a carrier / heterozygous.

2

(ii) 5 = X^fY / X^fY^- / f / f- / fY ;

7 = X^FX^f **and** X^FX^F (either way round) /

or X^fX^F **and** X^FX^F (either way round) /

or X^FX^f, X^fX^F **and** X^FX^F(in any order);

Note: allow 5 = X^fY, X^fY.

Accept: for both 5 and 7 a different letter than F. However, lower case and capital letter must correspond to that shown in the answer. For example accept 7 = X^RX^r and X^RX^R.

2

(iii) X^FX^f **and** X^fY **or** X^fX^F **and** X^fY

or X^FX^f **and** X^fY^- or X^fX^F **and** X^fY^- /

or Ff **and** fY /

or Ff **and** fY^- /

or Ff **and** f- /

or Ff **and** f;

Accept: a different letter than F. However, lower case and capital letter must correspond to that shown in the answer.

Accept: each alternative either way round.

1

(c) Correct answer of 32 (%) = 3 marks;;;

Accept: 0.32 = 2 marks

If incorrect answer, allow following points

1. p^2 / q^2 = 4% / 0.04 / or p / q = 0.2;

2. Shows understanding that 2pq = heterozygotes / carriers;

Accept: answer provided attempts to calculate 2pq. This can be shown mathematically i.e. 2 x two different numbers.

3

[9]

Q10.

(a) 1. Expression / appearance / characteristic due to genetic constitution / genotype / allele(s);

1. Accept: named characteristic

1. Accept: homozygous / heterozygous / genes / DNA

1. Neutral: chromosomes

2. (Expression / appearance / characteristic) due to environment;

2

(b) (i) 1. 3 and 4 and 9 / 11 / affected offspring;

1. Accept: 9 / 11 and their parents

1. Accept: unaffected parents have affected children

2. Both 3 and 4 are carriers / heterozygous;

2. Accept: if 3 and 4 are unaffected all their children will be unaffected

OR

If dominant at least one of 3 and 4 would be affected;

2

(ii) 1. 11 is affected, 3 is not;

1 Accept: 3 / unaffected father / parents produce an affected daughter

1. Accept: 3 and 4 would only produce unaffected females

2. 3 / father of 11 does not have a recessive allele on his X chromosome / X^t;

2. Answers must be in context of alleles

OR

(If on X) 11 / affected female would not receive the recessive allele on X chromosome / X^t from 3 / father;

Reject: recessive / dominant chromosomes

OR

(If on X) 3 / father (of 11) would pass on the dominant allele on his X chromosome / X^T;

2

(c) (i) Answer in range of 5.8 − 6.2% = 3 marks;;;

Answers in range of 0.058 - 0.062 = 2 marks

If incorrect answer, then 2 max of following points

1. q^2 / p^2 / tt = 0.001 or 1 divided by 1000;

2. p / q / T = 0.968 − 0.97;

3. Understanding that heterozygous = 2pq;

3. This can be shown mathematically ie 2 × two different numbers

3. Accept: answer provided attempts to calculate 2pq

3 max

(ii) Affected individuals (usually) do not reproduce / die during childhood / do not pass on allele / genetic screening;

1

[10]

Q11.

(a) 2.84:1;

Accept '2.84 to 1' or (just) 2.84

Do not accept 1:2.84 or 142:50

1

(b) 1. Some embarrassed / some not willing to show tongue / cannot tell;

2. Could not decide whether thumb was straight or not / thumb bending is judgemental / subjective;

2

(c) 1. (No) - should be 92.9% / should be calculated from 182 out of 196 / should not be calculated from 182 out of 200;

Allow either no or yes approach but no mark awarded for no or yes on its own

2. (Yes) – assumes 4 out of 200 use either hand;

Accept ambidextrous

3. (But) sample may not be representative;

This could be expressed in other ways e.g. only based on one part of the country / might not be the same in different parts of the UK / might not be representative of UK

4. Small sample size / only sampled 200;

2 max

[5]

Q12.

(a) (i) 1. No overall pattern / pattern (of right or left most common) is not the same for all islands;

Allow expression in other ways e.g. three islands show left on top is more common

2. For **(B) C** and **E** there is little difference;

3. Large differences on **A** *and* **D** *and* opposite ways (to each other);

Need both aspects but allow other expressions of 'opposite ways'

2 max

(ii) 1. Can record all individuals on (small) islands;

2. (So) no / less sampling error;

3. (Maybe) different rates of mutation / different selection pressures / different environmental conditions;

4. Inbreeding / breeding with close relatives (more likely);

5. (Little) gene flow / (more chance of) genetic drift;
Accept reference to either of these ideas for this point

2 max

(b) 1. If R is recessive, R × R parents cannot produce L offspring;
Accept use of genetic diagrams to illustrate points 1 and 2

2. If L is recessive, L × L parents cannot produce R offspring;
Accept right arm on top as R etc.

3. R × R **and** L × L parents produce both types of offspring;
Need reference to two parent crosses for this mark

3

(c) Both L and R in a set of twins / (some) twins show different arm-folding;

1

[8]

Q13.

(a) 1. Large number of eggs / offspring / flies (therefore) improves reliability / can use statistical tests / are representative / large sample (size) / reduces sampling error;
Each mark point requires a feature linked in mark scheme (by therefore) to an explanation
Do not accept a large number of eggs produces a large number of flies unless the term sample is used
Ignore references to accuracy or precision

2. Small size / (breed) in small flasks / simple nutrient medium (therefore) reduces costs / easily kept / stored;
Accept small size so can be kept in small flasks

3. Size / markings / phenotypes (therefore) males / females easy to identify;
Answers must relate to size, markings or use the term phenotype

4. Short generation time / 7 - 14 days / develop quickly / reproduce quickly (therefore) results obtained quickly / saves times / many generations;

2 max

(b) (i) 1. X^RX^R and X^rY;
All marking points are completely independent. Allow crosses from the following parents for a possible three marks:
X^RX^R and X^r-
X^RX^R and X^rY;
RR and rY / rY^-
RR and r− or RR and r

2. X^R and X^R plus X^r and Y;

3. X^RX^r and X^RY;

OR

1. X^RX^r and X^rY;

OR

X^RX^r and X^r-

X^RX^r and X^rY;

2. X^R and X^r plus X^r and Y;

Rr and rY / rY^-

Rr and r^- or Rr and r

Accept different symbols e.g. W and w

2. Accept gametes in a punnet square

3. X^RX^r and X^RY;

3

(ii) Fertilisation is random / fusion of gametes is random / small / not large population / sample / selection advantage / disadvantage / lethal alleles;

Mutation = neutral

Random mating = neutral

Accept fertilisation / fusion of gametes is due to chance

1

(c) 1. Males have one <u>allele</u>;

Answers should be in context of alleles rather than chromosomes

2. Females need two recessive alleles / must be homozygous recessive / could have dominant and recessive alleles / could be heterozygous / carriers;

2

[8]

Q14.

(a) Is always expressed / shown (in the phenotype);

Reject 'is always present' without further qualification

1

(b) C^BC^B, C^BC^P and C^BC^Y;

All three are required for the mark

<u>Or</u>

C^BC^B, C^PC^B and C^YC^B;

Accept C^BC^B, C^BC^P, C^BC^Y,

C^YC^B and C^PC^B

Accept BB, BP and BY <u>or</u>

BB, BP, BY, YB and PB

1

(c) 1. Two genotypes (as parents) shown as C^P C^Y

*Award **one mark maximum** for candidates who have misread the question and complete a correct genetic cross between a pink snail, C^PC^Y and a yellow snail, C^YC^Y to give pink and yellow offspring*

<u>Or</u>

Two sets of gametes shown as C^P and C^Y;

2. Genotypes of offspring shown as $C^P C^Y$, $C^P C^P$ and $C^Y C^Y$;

3. Above genotypes of offspring correctly linked to phenotypes i.e. pink and yellow;

Accept ratio (or equivalent) of 3 pink: 1 yellow for mark point 3

3

(d) 1. Correct answer of 42% = 3 marks

Answer of 0.42 = 2 marks

*Award **one mark maximum** for answer of 49.9 / 49.98 / 50% or 0.49 / 0.5*

2. q^2 = 0.49 / 49% ***OR*** q = 0.7 / 70%

*Award **one mark maximum** for answer of 40.8 / 41% or 0.41*

3. Shows understanding that 2pq = heterozygotes / carriers / shows answer is derived from 2pq;

Accept: b^2 = 0.49 / 49% or b = 0.7 / 70% for mark point 2

3

[8]

Q15.

(a) (i) 1. Animal 2 / 5 has hair but offspring do not;

Accept parents as alternative to animals 2 and 5

2. So 2 / 5 parents must be heterozygous / carriers;

1 + 3: Allow reference to children / offspring for animals 7 + 8

OR

3. 4 / 7 / 8 are hairless but parents have hair;

Ignore reference to individuals 1 and 6

4. So 2 / 5 must be heterozygous / carriers;

2

(ii) Hairless males have fathers with hair / 4 is hairless but 1 is hairy / 7 and / or 8 are hairless but 6 is hairy / only males are hairless;

Ignore references to other individuals

Ignore reference to genotypes

Allow credit for candidate who states that evidence is not conclusive / pedigree possible with autosomal character;

1

(b) 1. Parental genotypes
$X^H X^h$ and $X^H Y$
Gametes
X^H X^h X^H Y;

Accept any letter for gene but capital letter must represent dominant allele.

Both parental genotypes and gametes must be correct

2. Genotypes of offspring

X^HX^H, X^HY, X^HX^h, X^hY;

Allow for offspring genotypes correctly derived from gametes given by candidate;

3. Phenotypes of offspring
female with hair
male with hair
male hairless;

Allow phenotypes correctly derived from offspring genotype
Allow H ≡ X^H, h ≡ X^h

4. 0.25 / ¼ / 1 in 4 / 25 %

Ignore 1:3 in context of correct probability
Reject 1:4

4

[7]

Q16.

(a) (i) 1. Parents are heterozygous;

Accept carriers / carries white allele

2. Kittens receive white allele from parents / black cat;

1 max

(ii) 1:1;

Answer must be expressed as a ratio that could be reduced to 1 : 1

1

(b) (i) Black,
Chocolate,
Black;

All three correct for the mark

1

(ii) Parental phenotypes Chocolate male Black female

1. Parental genotypes bb^i Bb^i;

Both genotypes needed for the mark.

1

2. Parental gametes $b\ b^i$ $B\ b^i$;

Allow credit if gametes are correctly derived from candidate's incorrect parental genotypes.

1

3. Offspring genotypes Bb, Bb^i bb^i b^ib^i;

Genotype(s) must be with correct phenotype.
Allow credit if symbols other than B / b / b^i have been used correctly.
Ignore genetic diagrams unless clearly annotated.

1

Offspring phenotypes Black Chocolate cinnamon;

(iii) 1. Offspring ratios are a probability / not fixed / arise by chance /

2. gametes may not be produced in equal numbers /

3. fertilisation / fusion of gametes is random /

4. small sample;

1

(iv) 1. Possible if parents homozygous / bb;

2. Don't know genotype of chocolate cat / chocolate cat could be homo- or heterozygous / chocolate cat could be bb or bb[i];

3. Two chocolate cats could give cinnamon kittens;

2 max

[9]

Q17.

(a) Cannot make (active) enzyme A (which converts precursor to linamarin) / cannot make linamarin;

1

(b) (i) **AL** + **Al** + **aL** + **al** ;

1

(ii) Meiosis separates alleles / homologous chromosomes / pairs of chromosomes;
Independent assortment / means either of **A** / **a** can go with either of **L** / **l**;

Accept "random segregation" but cancel if reference to crossing-over

2

(c) From parental genotypes: **AaLl** × **AaLl** (no mark)
Note: If wrong parental genotypes / wrong gametes: ALLOW correct derivation of offspring genotypes = 1 max

Correct derivation of offspring genotypes; max 2 marks if error in Punnett square

	AL	**Al**	**aL**	**al**
AL	AALL	AALl	AaLL	AaLl
Al	AALl	AAll	AaLl	Aall
aL	AaLL	AaLl	aaLL	aaLl
al	AaLl	Aall	aaLl	aall

Correct identification of offspring genotypes with at least one **A** and two **l** alleles (= grey cells in above table);
Correct proportion: 3 / 16 / 3:13 / 18.75% ;

3

(d) (i) There was no (significant) difference in damage between cyanogenic and acyanogenic / being cyanogenic has no effect;

1

(ii) The difference (from expected / from chance variation) is significant / difference / results not just due to chance;
Reject null hypothesis;
Being cyanogenic does help protect from slug damage;

3

(e) High slug population:
1. Find only cyanogenic plants / only cyanogenic plants survive;
2. (Cyanide release) limits / stops feeding by slugs / slugs killed;

Accept: converse argument re. acyanogenic plants

Low slug population:
3. Find both types of plant;
4. Less selection pressure on plants from slugs / no selective advantage / no selection / described;

4

[15]

Q18.

(a)
1. Homologous chromosomes pair up / bivalents form;
2. Crossing over / chiasmata form;
3. Produces new combination of **alleles;**
4. Chromosomes separate;
5. At random;
6. Produces varying combinations of chromosomes / genes / alleles (*not twice*) ;
7. Chromatids separated at meiosis II / later;

Independent assortment / random segregation = marking points 4 and 5

6 max

(b) (i)

Parental phenotypes	Agouti	White	
Parental genotypes	BbAa	bbaa	;
Gamete genotypes	BA Ba bA ba	ba	;
Offspring genotypes	BbAa Bbaa	bbAa bbaa	;
Offspring phenotype	Agouti Black	White White	;

Phenotypes must match genotypes

Allow marking points 2 and 3 if correctly derived from wrong parental genotypes

4

(ii)

Colour of offspring	***Observed (O)***	***Expected (E)***	***(O-E)***	***$(O-E)^2$***	***$\frac{(O-E)^2}{E}$***
Agouti	34	30	4	16	0.53

Black	35	30	5	25	0.83
White	51	60	9	81	1.35
			$\frac{(O-E)^2}{E}$ **= 2.71 or 2.72**		

;; 2

(χ^2 correct = 2 marks)
($(O-E)^2$ all correct = 1 mark)

p = 0.05;
2 degrees of freedom;
Differences due to chance / no significant difference as χ^2 less than / to left of critical value OR Not due to chance / difference is significant as χ^2 greater than to right of critical value;

(as appropriate for candidates χ^2)

3

[15]

Q19.

(a) Table completed as below:

Kingdom	Animalia / Animals
Phylum	Chordata
Class	Mammalia
Order	Rodentia
Family	Caviidae
Genus	*Cavia*
Species	*porcellus*

Column 1 correct;

Column 2 correct;

2

(b) Mutation occurs;

Correct e.g. of isolating mechanism
e.g.
temporal − different breeding seasons / feeding times /
ecological / behavioural − different courtship displays / different niches / habitats / feeding areas /
mechanical − mismatch of reproductive parts /
gamete incompatibility − sperm killed in female's reproductive tract /
hybrid inviability / hybrid infertility;
Ignore references to "genetic isolation" or "reproductive isolation"

Different selection pressures operate / changes in allele frequency / divergence of gene pools;

3

(c) Using candidate's symbols for alleles −
e.g. B = black, b = brown, S = short, s = long:

Parental genotypes <u>correct</u>: Male **A** SSBb Female **B** SsBB;

Gametes correctly <u>derived</u> from candidate's parental genotypes: SB Sb SB sB;

offspring genotypes correctly <u>derived</u> from candidate's suggested gametes − accept Punnett square or line diagram;

offspring genotypes <u>correct</u>: SSBB SsBB SSBb SsBb;

If monohybrid:cross ⇨ 0 marks

4

(d) There is no (significant) difference between observed and expected results / any difference is due to chance;

1

[10]

Q20.

parental genotypes correct: $\mathbf{X^RX^r}$ AND $\mathbf{X^RY}$;
gametes correct for candidate's parental genotypes;
offspring genotypes correct and colourblind male identified as $\mathbf{X^rY}$ /
correct genotypes derived from cand's gametes <u>and</u> identify $\mathbf{X^rY}$;
<u>correct</u> probability = ¼ / 0.25 / 25% / 1 in 4 / 1:3 ;

[4]

Q21.

(a) (i) Two, as white blood cells are diploid cells / alleles are present on each chromosome of an homologous pair / one maternal and one paternal;

1

(ii) A **and** B

(reject I^A and I^B)

1

(b) 1 in 8 / 1 / 8 / 12.5% / 1:7 / 0.125;
(*Reject 1:8*) parents I^AI^O and I^BI^O ;
give 1:3 / ¼ / 1 in 4 / 25% probability of blood group A and half will be male;

(accept 2nd and 3rd points from a suitable genetic diagram)

3

[5]

Q22.

Parental genotypes: Gg nn gg Nn ;
Gamete genotypes Gn gn gN gn ;

	gN	gn
Gn	Gg Nn Grey, normal	Gg nn Grey, vestigial

gn	gg Nn Ebony, normal	gg nn Ebony, vestigial

All offspring genotypes correct;

All offspring genotypes correctly derived;

[4]

Q23.

(a) (i) Only seen in males / not in females;

1

(ii) Unaffected parents / mother → child with M.D. /
(1 ×)2 → 5 / (3 ×) 4 → 11 / 8 (× 9) → 13;

1

(b) 5 = X^dY

6 = X^DY

7 = X^DX^d AND X^DX^D

8 = X^DX^d;;

All 4 correct = 2 marks

2 or 3 correct = 1 mark

max 2

(c) ¼ / 0.25 / 25% / 1:3 / 1 in 4; (*NOT* '1:4')

1

[5]

Q24.

(a) Cannot make (active) enzyme A (which converts precursor to linamarin) / cannot make linamarin;

1

(b) (i) **AL** + **Al** + **aL** + **al** ;

1

(ii) Meiosis separates alleles / homologous chromosomes / pairs of chromosomes;
Independent assortment / means either of **A** / **a** can go with either of **L** / **l**;

[Accept: 'random segregation'] [Cancel: if reference to crossing-over]

2

(c) From parental genotypes: **AaLl** × **AaLl** (no mark)

[Note: If wrong parental genotypes / wrong gametes: ALLOW correct derivation of offspring genotypes] (= max 1)

Correct derivation of offspring genotypes:

	AL	**Al**	**aL**	**al**

AL	AALL	AALl	AaLL	AaLl
Al	AALl	AAll	AaLl	Aall
aL	AaLL	AaLl	aaLL	aaLl
al	AaLl	Aall	aaLl	aall

;

Correct identification of offspring genotypes with at least one **A** and two **l** alleles (= grey cells in above table);
Correct proportion: 3 / 16 / 3:13 / 18.75% ;

3

(d) (i) There was no (significant) difference in damage between cyanogenic and acyanogenic / being cyanogenic has no effect;

1

(ii) The difference (from expected / from chance variation) is significant / difference / results not just due to chance;
Reject null hypothesis;
Being cyanogenic does help protect from slug damage;

3

(e) High slug population:
1. Find <u>only</u> cyanogenic plants / only cyanogenic plants survive;
2. (Cyanide release) limits / stops feeding by slugs / slugs killed;

[Accept: converse argument re. acyanogenic plants]

Low slug population:
3. Find both types of plant;
4. Less selection pressure from slugs / no selective advantage / no selection / described;

4

[15]