



Exampro A-level Biology

Inheritance

Name:

Class:

Author:

Date:

Time: 158

Marks: 137

Comments:

- M1.** (a) (i) Avoid bias/can only apply statistical test/Hardy-Weinberg expression to randomly collected data; 1
- (ii) Give credit for any method which would ensure collection of a random sample from trees e.g. beating tray;
Q Note that specification does not require specific knowledge therefore the use of specific terminology such as "beating tray" is not required here. 1
- (b) Two marks for correct answer of 49% red and 51% black;
 One mark for incorrect answer in which p/frequency of black allele/B is Identified as 0.3 and q/frequency of black allele/B as 0.7; 2
- (c) (i) Increase in the frequency of the red/b allele from autumn to spring/in all years;
 Therefore frequency of black/B allele decreased and fewer black ladybirds in spring;
Q The terms allele and gene must be used correctly but penalise only once 2
- (ii) Black ladybirds would become more active so respiration rate increases;
 Deplete food reserves; 2

[8]

- M2.** (a) (i) Accurate means without error/free from mistakes when callipers used;
 Reliable means that figure can be reproduced when measurement Repeated/show little variation about true value; 2
- (ii) If data unreliable, there will be a wide range of values;
 Large standard deviation;
 The higher the figure on the top line of the equation, the greater The percentage measurement error; 2 max
- (b) (i) Plot graph of mean skull breadth against mean cranial volume/ scatter diagram;
 Draw line of best fit / calculate coefficient of correlation;
 Look for figures close to +1 or -1; 2
- (ii) Skull breadth is a linear measurements/can be measured with a single measurement/less prone to error/Cranial volume more difficult to measure because...; 1

- (iii) Could distinguish between large male polecats and small female ferrets;
Little overlap in standard deviations;
Mean measurements for female polecats and male ferrets are very similar; 3
- (c) Scientists could use method suggested/protocol established in earlier paper (thus saving time);
Findings more likely to be reliable if they replicate the findings of others; 2
- (d) Some stomachs may contain more than one type of prey item; 1
- (e) Unidentified bird remains small percentage of total prey/found in few stomachs;
Significant numbers of rabbits/rats eaten and these are pests; 2

[15]

- M3.**
- (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); 1
Allow both alleles contribute (to the phenotype).
 - (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]

M4. (a) Normal sight;

1

(b) **Nn**;

Must have at least one **N** allele as she has the condition and must pass on an **n** allele to her normal sighted children;

2

(c) Two marks for correct answer of $\frac{1}{4}$ / 0.25 / 25%;
One mark for incorrect answer that determines probability of next child having night blindness as $\frac{1}{2}$ / 0.5 / 50%;

2 max

[5]

M5. (a) Excitation of chlorophyll molecule/electrons/ energy of (pairs of) electrons raised to higher energy level;

Electron(s) emitted from chlorophyll molecule;

Electron(s) to electron transport chain;

Loss of energy by electron(s) along electron transport chain;

Energy lost by electron(s) is used to synthesise ATP;

From ADP + Pi;

“By electrons” need not be stated in each marking point if it can be reasonably inferred that the candidate is referring to electrons

max 5

(b) Little green light reaches bottom as absorbed by surface dwellers / water;
Red and blue not absorbed and so penetrate;
Variation in pigments of sediment dwellers;
Bacteria with chlorophyll at an advantage;
As chlorophyll absorbs red and blue;
(Survive to) reproduce in greater numbers;
Pass on advantageous alleles/genes in greater numbers / increase in frequency of advantageous alleles in subsequent generations;
Increase in frequency/numbers of bacteria with chlorophyll;

max. 6

[11]

M6. (a) males are XY and females XX / males have one X chromosome and females two X chromosomes;
males only have one allele (of the gene) present / recessive allele always expressed;
colour blindness is masked in heterozygote / female needs 2 recessive alleles to be colour blind;

2 max

(b) (i) 5 - hh X^b Y;
6 - Hh X^B X^b;

2

(ii) h X^b , h Y, and H X^B, h X^B, H X^b, hX^b;

1

(iii) $1/8$ or 12.5% or 0.125;;

either

genetic diagram to show genotypes $Hh X^b X^b$, $Hh X^{bY}$, $hh X^B X^b$,
 $hh X^{bY}$, HHX^bX^b , $Hh X^{bY}$, $hh X^b X^b$; $hh X^{bY}$;

$1/8$;

or

$P(\text{boy}) = 0.5$, $P(\text{colour blind}) = 0.5$, $P(\text{white streak}) = 0.5$;
 $(0.5 \times 0.5 \times 0.5 =) 0.125$;

2

[7]

M7. (a) Mutation/(spontaneous) change in a gene/change in DNA;

1

(b) (i) Correct answer: $0/6$;; 2 marks
OR

Use of 56 and $\frac{176}{2}$ or $88 / 56 \times 2$ or 112 and 176 ; 1 mark

max 2

(ii) 64;

1

(c) (i) Correct answer = 42%;;; (only if $q^2 = 0.49$) 3 marks
OR 0.42;;; 2 marks
OR

$p + q = 1 / p^2 + 2pq + q^2 = 1 / p = 1 - 0.7 / q^2 = 0.49 / q = 0.7$;

Answer = $2pq$ / use of appropriate numbers; 2 marks

max 3

(ii) 1. Parental genotypes correct: both $W^R W^S$
(ACCEPT 'RS')

AND

W^S (ACCEPT 'S') /gamete from each parent;

2. $W^S W^S$ (ACCEPT 'SS') / offspring formed and identified
as susceptible;

If different symbols:

– defined : max 2 marks

– not defined max 1 mark (= pt.2)

2

- (iii) 1. Description: decrease + rate of decrease slows with time;

Explanation: Any **three** from:

2. Resistant rats/rats with W^R allele survive
OR susceptible / $W^S W^S$ rats killed
3. (more likely) to pass on W^R allele to offspring/less likely to pass on W^S /
higher proportion of next generation has W^R allele/lower proportion has W^S ;
4. Chance of mating with $W^S W^S$ is reduced / $W^S W^S$ becomes rare;
5. Rate of selection against W^S slows because W^S allele is in heterozygotes;

max 4

- (iv) No selective advantage / All genotypes equally fertile;
Large population;
Random mating; (IGNORE 'random fertilisation')
No mutation;
No emigration/immigration;

max 2

[15]

- M8.** (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
1. Do not accept a large number of eggs produces a large number of flies unless the term sample is used
1. Ignore references to accuracy or precision
2. Small size / (breed) in small flasks / simple nutrient medium (therefore) reduces costs / easily kept / stored;
2. Accept small size so can be kept in small flasks
 3. Size / markings / phenotypes (therefore) males / females easy to identify;
3. 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. $X^R X^R$ and $X^r Y$;
All marking points are completely independent. Allow crosses from the following parents for a possible three marks:
 $X^R X^R$ and $X^r -$
 $X^R X^R$ and $X^r Y$;
 RR and rY / rY
 RR and $r-$ or RR and r

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

3. $X^R X^r$ and $X^R Y$;

OR

1. $X^R X^r$ and $X^r Y$;

OR

$X^R X^r$ and $X^r -$

$X^R X^r$ and $X^r Y$;

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. $X^R X^r$ and $X^R Y$;

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 allele;
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]

- M9.** (a) (i) 1. Parents are heterozygous;
2. Kittens receive white allele from parents /black cat;
 1. *Accept carriers/carries white allele*

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 ; | 1 |
| 2. Parental gametes | $b\ b^i$ | | $B\ b^i$; | 1 |
| 3. Offspring genotypes | Bb, Bb^i | bb^i | $b^i b^i$; | 1 |
| Offspring phenotypes | Black | Chocolate | cinnamon; | |

1. Both genotypes needed for the mark.
 2. Allow credit if gametes are correctly derived from candidate's incorrect parental genotypes.
 3. 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.*

(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]

- M10.** (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) *Accept any letter for gene but capital letter must represent dominant allele.*

1. Parental genotypes
 $X^H X^h$ and $X^H Y$
Gametes
 $X^H X^h X^H Y$;
1. *Both parental genotypes and gametes must be correct*
2. Genotypes of offspring
 $X^H X^H, X^H Y, X^H X^h, X^h Y$;
2. *Allow for offspring genotypes correctly derived from gametes given by candidate;*
3. Phenotypes of offspring
female with hair
male with hair
male hairless;
3. *Allow phenotypes correctly derived from offspring genotype*
Allow $H \equiv X^H, h \equiv X^h$
4. 0.25 / $\frac{1}{4}$ / 1 in 4 / 25 %
4. *Ignore 1:3 in context of correct probability*
Reject 1:4

4

[7]

- M11.** (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 = $X^F X^f$ **and** $X^F X^F$ (either way round) /

or $X^f X^F$ **and** $X^F X^F$ (either way round) /

or $X^F X^f$, $X^f X^F$ **and** $X^F X^F$ (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 = $X^R X^r$ and $X^R X^R$.

2

- (iii) $X^F X^f$ **and** $X^f Y$ **or** $X^f X^F$ **and** $X^f Y$

or $X^F X^f$ **and** $X^f Y^-$ **or** $X^f X^F$ **and** $X^f Y^-$ /

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]

M12.

(a) (i) Reliable / representative / for statistical tests;

Accept: identify anomalies

Neutral: accurate/valid/bias

1

(ii) 1. Find coordinates (on a grid) / split area into squares / number the sites;

1. Ignore references to tape measures, metre rulers etc

2. Method of generating / finding random numbers eg calculator / computer / random number generator / random numbers table;

2. Accept: numbers out of a hat / use of dice

2

(iii) 1. Breeding (of lizards);

Neutral: weather / climate / hurricanes / hibernation / migration / emigration / immigration

2. Food source / prey;

3. Predator;

4. Variation in malarial infection;

5. Temperature variation;

6. Availability of water eg drought/'rainy season'

2 max

(b) 1. Number in sample varies;

2. Allow a (valid) comparison;

2

(c) 1. (Overall) positive correlation (for either / both species);

Neutral: only one study / no repeats

2. Reference to (site) 5 / 300 metres;

3. Limited results for *A. wattsi* / small sample / number / percentage infected for *A. wattsi*.

2 max

- (d) (i) 1. Fewer *A.wattsi* infected / more *A. gingivinus* infected;
 2. Higher number of *A.wattsi* present when higher percentage / number of *A.gingivinus* infected;
 3. No *A.wattsi* present when *A.gingivinus* has zero infection;

2 max

- (ii) 1. Reduced immunity / increased susceptibility to disease;
 1. *Accept: idea that energy / resources are used to combat malaria*
 2. Reduced oxygen transport / uptake / respiration / reduced activity / movement;

2

- (iii) 1. There is a probability of less than 1% / 0.01;
 1. *Reject: probability is / equal to 1% / 0.01;*
 1. *Reject 0.01% / 5% / 0.05 / 0.05%*
 2. That result(s) / correlation / it is due to chance;
 2. *Allow correct interpretation using above (incorrect) figures eg there is a probability of less than 5% that the results are due to chance =1 mark*

OR

3. There is a probability of more than 99% / 0.99;
 4. That result(s) / correlation / it is not due to chance;
Note: there is a probability of more than 5% that the results are due to chance =0 marks
 3. *Reject: probability is / equal to 99%/0.99;*
 3. *Reject 0.99% / 95% / 0.95 / 0.95%*
 4. *Allow correct interpretation of above figures ie 0.99% / 95% / 0.95 / 0.95% but reject if less than*

2

[15]

- M13.** (a) 1. 21 or 21.4;
Correct answer = 2 marks outright
 2. One mark for the principle of difference / initial;
Ignore number of decimal places

2

- (b) (i) Water intake linked to sweating / panting;
Neutral: ref. to urine
Neutral: dehydration

1

- (ii) 1. Food intake linked to (increased) respiration;
 1. *Not 'increased metabolism'*
Reject: decreases respiration
Neutral: references to environmental temperature increasing
2. Food intake linked to heat / energy release / maintaining body temperature;
 2. *This mark is independent of 1*
- 2
- (c) 1. Increased sweating so less water available (for milk production);
2. Less food so less energy / nutrients available (for milk production);
 2. *Not just 'less energy available (for milk production)'*
3. Enzymes not working at optimum temperature;
 3. *Reject: references to enzyme denaturation*
- 1 max
- (d) (Skin temperature)
Accept: converse arguments for rectal temperature
1. Varies / fluctuates more / more heat lost / gained / (can be) further from core;
2. (As) more affected by environment / sweating / conduction / convection / radiation;
 2. *Accept: 'not affected by' in relation to rectal temperature*
Accept: named environmental factors
Accept: idea that skin is more exposed to the environment
Accept refs. to vasoconstriction / vasodilation
- 2
- (e) Select a bull whose mother / offspring produced a high milk yield;
- 1
- (f) 1. Allows comparison;
2. (As) different countries have different population / sample sizes;
- 2

- (g) 1. (Selective) advantage producing lactase / being lactose tolerant / able to digest milk / able to eat dairy foods;
Accept: converse arguments for people who are lactose intolerant
2. People (producing lactase) reproduce;
3. (And) pass on gene / allele;
*If mark point 2 has **not** already been given, then mark point 3 automatically gains 2 marks as reproduction must have occurred*
4. Allele frequency increases;
*4. Neutral: gene frequency increases / allele frequency changes
 Must be clearly stated and not implied*

4

[15]

M14. (i) increased use of insecticides/greater selection pressure;

1

- (ii) mutations;
 producing alleles/genes giving resistance;
 natural selection/described;
 leads to increased frequency of alleles/genes in population/insect;

3 max

[4]

