The roles of genes in determining the phenotype

Mark Scheme 1

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Inherited change
Sub Topic	The roles of genes in determining the phenotype
Booklet	Theory
Paper Type	Mark Scheme 1

Time Allowed : **81 minutes**

Score : **/ 67**

Percentage : **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a** random / spontaneous **;**

<u>mutation</u> **;**

base / nucleotide / triplet, change / substitution **; R** addition / deletion 2]

(b) (i) as altitude increases frequency of $\mathbf{A^0}$ increases **; ora** for $\mathbf{A^1}$

$\mathbf{A^0}$ more frequent at high altitudes / $\mathbf{A^1}$ more frequent at low altitudes / intermediate frequency of either allele at intermediate altitude **;** [2]

(ii) *idea of* (pre-existing) genetic variation in deer mouse population **;**

at high altitude mice with, glycine / $\mathbf{A^0}$, more likely to survive / have selective advantage **; ora**

mice (with $\mathbf{A^0}$) reproduce (at high altitude) **; ora**

and pass on the $\mathbf{A^0}$ allele **; ora**

partial pressure / concentration, of O_2 acts as a selection pressure **;**

ref. to disadvantage of haemoglobin with very high affinity at low altitude **;**

as less able to unload oxygen (in respiring tissues) **;** [max 4]

[Total:8]

2 **(a (i)** idea of sugars unable to pass through phospholipid bilayer **;**

hydrophilic / polar / not lipid-soluble / water soluble **;**

large **;** [max 2]

(ii) forms bonds with hydrophilic heads (of phospholipids) **;**

hydrophobic parts of SWEET **;**

bond with, fatty acid chains / hydrophobic tails, (of phospholipids) **;**

ref. hydrogen bonding / ionic bonds / hydrophobic interactions **;** [max 3]

(b) (i) (SWEET) <u>gene</u> cannot be switched on **;**

no SWEET (protein) produced **;**

no, glucose / sugar, secreted (into intercellular spaces) **;**

(so) Xoo / bacteria, do not multiply / numbers remain low **;**

(small numbers of Xoo / bacteria) so no disease **;** [max 3]

(ii) allele is recessive **;**

idea of not expressed when dominant allele present **;**

ref. promoter **;** e.g. normal promoter must be inactivated or removed / must transfer mutated promoter [max 2]

(iii) prevents <u>diffusion</u> of air (from leaves to roots) **;**

ref. aerenchyma **;**

roots respire anaerobically **;**

(so) less ATP produced (for growth) **;**

bacteria use of oxygen **;**

more ethanol produced may be beyond tolerance / **AW ;** [max 4]

[Total:14]

3 **(a** correct symbols ; e.g. X^A = (allele for) red-eye
X^a = (allele for) white-eye

parental genotypes $X^A X^a$ and X^aY ;

gametes X^A X^a X^a Y ;

offspring genotypes $X^A X^a$ $X^A Y$ $^a X^a$ X^aY ;

offspring phenotypes red-eyed female, red-eyed male, white-eyed female, white-eyed male ; [5]

(b) (i) passes **Y** chromosome onto son / passes **X** chromosome onto daughter ; [1]

(ii) heterozygous ; [1]

(iii) gene / allele, mutation ; [1]

[Total: 8]

4 **(a** 1 *idea of* genetic variation ;
2 increased heterozygosity / decreased homozygosity ;
3 hybrid vigour / decreased inbreeding depression ;
4 able to adapt to changing conditions ;
5 *idea of* some individuals surviving ;
6 AVP ; e.g. reduced risk of expression of harmful recessive alleles [3 max]

(b) (i) *most affected*
almond, because, 100% / all / only, pollinated by honey bee **;**
least affected
orange, because only 25% pollinated by honey bee / 75% pollinated by other methods [2]

(ii) *any three from*
1 parasites / mites / viruses / bacteria ;
A disease
2 detail of climate change ; e.g. temperature change
3 pollution qualified ; e.g. increased use of pesticides / increased sulfur dioxide concentration in air
4 inbreeding ;
5 competition for food / food shortage ;
6 increase in predator numbers ;
7 AVP ; e.g. ref. killer bees / plant monoculture provides limited nutrition [3 max]

[Total: 8]

5 **(a) (i)** 1. anthers, versatile / loosely attached /attached at one point (to filaments) ;
2. anthers / stamens / tassels / androecium, on long filaments / hang out (of, plant / flower) ;
3. anthers / stamens / tassels / androecium, above leaves / high up ;
4. stigmas / silks, hang out (of, plant / flower) ;
5. stigmas / silks, large surface area / hairy / feathery / long, (to catch pollen) ;
6. no / small, petals allow access to wind / AW ; *ignore references to pollen* [3 max]

(ii) 1. increased genetic variation / increased heterozygosity / more diverse gene pool / increased gene pool ;
2. reduced inbreeding / prevents inbreeding depression ;
3. less likely that harmful recessive alleles will be expressed ;
4. hybrid vigour ;
5. ability to respond to named change in conditions ; e.g. climate / disease / pests [2 max]

(b) (i) *must be comparative statements*
1. maize has greater rate of photosynthesis (at all temperatures) / ora ;
2. optimum for maize is at 23°C while optimum for wheat is at 17.5°C ;
or
highest rate for maize is 39 units while highest rate for wheat is 26 units ;
3. after 17.5°C increase for maize while decrease for wheat ; [2 max]

(ii) 1. maize is C4 ;
2. PEP carboxylase more efficient at higher temperatures (than rubisco) ;
3. photorespiration occurring in wheat ; **ora**
4. oxygen, instead of carbon dioxide, combines with RuBP ;
5. less fixation of carbon dioxide ;
6. Calvin cycle slows down ;
7. AVP ; e.g. detail of krantz anatomy **R** ref. denaturation [3 max]

(c) (i) 1. protein in aleurone layer ;
2. which is removed in white rice ; **A** outer layer(s) removed
3. ref. different species ; [2 max]

(ii) 1. wheat has more iron / comparative figs ;
2. ref. haemoglobin ;
3. low haemoglobin linked to anaemia ; [2 max]

[Total: 14]

6 **(a)** 1. (amino acid) code is three, bases / nucleotides ; **A** triplet code
2. (gene) mutation ; **R** chromosome mutation
3. base / nucleotide, substitution / addition / deletion
4. addition / deletion, has large effect (on amino acid sequence) ;
5. frame shift ;
6. completely new code after mutation / alters every 3 base sequence which follows ;
7. substitution may have little or no effect / silent mutation ;
8. different triplet but same amino acid / new amino acid in non-functional part of protein ;
9. substitution may have big effect (on amino acid sequence) ;
10. could produce 'stop' codon ;
11. sickle cell anaemia / PKU / cystic fibrosis ;
12. reference to transcription or translation in correct context ; **A** description [8 max]

(b) 13. (haemophilia) allele on X chromosome ; **A** gene
14. sex-linked ;
15. (haemophilia) allele recessive ;
16. man, homogametic / has one X chromosome ;
17. Y chromosome does not have blood clotting gene ;
18. only daughter(s) get his X chromosome ;
19. daughter(s) carrier(s) of (haemophilia) allele ;
20. grandson(s) 50% chance of having, (haemophilia) allele / haemophilia ;
21. granddaughter(s) 50% chance of carrying, (haemophilia) allele ;

allow following marks from diagram

22. correct symbols ; e.g. X^H and X^h explained
23. man's genotype ; e.g. X^hY *ignore partner's genotype*
24. F1 (daughter's) genotype ; e.g. X^HX^h *ignore her partner's genotype*
25. F2 (grandson's) genotypes ; e.g. X^hY X^HY *both required*
26. F2 (granddaughter's) genotypes ; e.g. X^HX^H X^HX^h *both required* **or** X^hX^h X^HX^h [7 max]

[Total: 15]