BIOLOGY 2020

Unit 2
Key Topic Test 5 – Pedigrees, genetic crosses and genetic decisions

Recommended writing time*: 45 minutes
Total number of marks available: 45 marks

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: D

Explanation: Option A is what the tool, a punnet square, predicts. Option B can help sort information to put in a punnet square and option D is the term that describes the characteristics the individual will exhibit.

Question 2

Answer: D

Explanation: A test cross is done to find out the genotype of an individual with a dominant phenotype, it could be heterozygous or homozygous dominant. To do this the unknown is crossed with a homozygous recessive. If the unknown is heterozygous, there will be 2 different phenotypes in the offspring. If the unknown is homozygous dominant, all the offspring will show a dominant phenotype.

Question 3

Answer: C

Explanation: Option A describes monohybrid inheritance and option B describes linked genes. Option C is correct.

Question 4

Answer: C

Explanation: Option C is the best definition of Linked Genes. Linked genes can code for completely different characteristics and so option A is incorrect. There are no genes found on all chromosomes and so option D is incorrect.

Question 5

Answer: A

Explanation: It is likely that most of the offspring will be of the parental type but some will be recombinants produced by crossing over in prophase 1 of meiosis, option A.

Question 6

Answer: A

Explanation: Only option A would give rise to blood group A. Option B would give rise to blood group AB and option C would give rise to blood group O.

Question 7

Answer: C

Explanation: If the father was option A, then the daughter could only be blood group A. If the father was option B, then the daughter could be blood group A, AB or B. If the father was option C, then the daughter could be blood group A or O and so option C is correct.

Question 8

Answer: B

Explanation: The only way the child could have a blood group AB would be to receive an I^A from one parent and a I^B from the other. As one of the parents has a blood group O (i,i) then it is impossible for the child to be blood group AB. Option B is correct.

Question 9

Answer: A

Explanation: Options B, C and D may be desirable (option D is debatable) but they do not warrant screening of all newborns. This testing can be done later. Widespread screening at birth must comply with option A.

Question 10

Answer: C

Explanation: Options A, B and D are all possible reasons to undergo genetic testing. Option C is the correct solution. Only genetic diseases that will benefit from swift diagnosis and early treatment are considered suitable for testing at birth. This would be termed genetic screening not genetic testing.

SECTION B: Short-answer questions

Question 1

a. A recessive allele will only show in the phenotype if there are two present as it can be masked by a dominant allele.

1 mark

b. Let N represent normal and n represent the cystic fibrosis allele.

- All carriers are Nn*.
- All affected are nn*.
- Normal individuals will be NN*.

3 marks

c. The female in the last generation is affected because both her parents are carriers*. They are not affected themselves but each carries the n allele to her so she is nn* and is affected.

2 marks

d. Any two of:

- A person may be considering having children and wants to know if there is a risk of passing an abnormality on.
- A person may not yet have symptoms but may want to make lifestyle changes to avoid or even prepare for symptoms developing in the future.
- A person may also seek preventive medical intervention if appropriate.
- Or any other reasonable response

2 marks

e. To ensure that the consequences/risk factors are fully understood OR
to be able to discuss possible treatments or alternatives.

1 mark

f. A genome is an organism's complete set of DNA, including all of its genes*.
Each genome contains all of the information needed to build and maintain that organism*.

2 marks

g. Any reasonable response is acceptable here but hopefully the student recognises that there should be some restriction to this information.

1 mark

Total 12 marks

Question 2

a. A dihybrid genetic cross is a cross between two organisms that are hybrid* for two traits*.

A hybrid organism is one that is heterozygous, which means that it carries two different alleles at a particular genetic position, or locus. A dihybrid is heterozygous at two loci eg. AaBb and a dihybrid cross is two of these crossed together AaBb x AaBb

2 marks

b. Let P represent purple, p represent white
Let T represent tall, t represent dwarf

Genotypes in a dihybrid cross

PpTt x PpTt

1 mark

c.

	PT	Pt	pT	pt
PT	PPTT	PPTt	PpTT	PpTt
Pt	PPTt	PPtt	PpTt	Pptt
pT	PpTT	PpTt	ppTT	ppTt
pt	PpTt	Pptt	ppTt	pptt

Two marks for correct parent genotypes and two marks for correct offspring genotypes

4 marks

d. Purple/Tall 9: Purple/Dwarf 3: White/Tall 3: White/Dwarf 1
Half a mark for correct phenotype and number for each category

2 marks

e. Indicates that the genes for colour and height are located on different chromosomes.

1 mark

f. If test crossed with pptt, then the ratios would be 1:1:1:1 of all the phenotypes in the previous solution.

1 mark

g. This would indicate that the two genes were located on the same chromosome and were linked.

1 mark

h. *Let S represent smooth and s represent wrinkled*
Let Y represent yellow and y represent green

Heterozygote genotype is SsYy or better shown as SY/sy as these two genes are linked*. As the genes are linked crossing over can occur during meiosis*.

Without linkage, the cross above would produce 3 smooth/yellow: 1 wrinkled green but if these two genes are on the same chromosome (linked) crossing over during prophase 1 of meiosis can take place.
The possible gametes would mostly be SY and sy but now with a few Sy and sY.
The presence of the few Sy and sY gametes means that there will be a few recombinants that are smooth/green and wrinkled/yellow unlike the original parents.

2 marks

Total 14 marks

Question 3

a. Autosomal dominant*. Several justifications are possible but individuals 1 and 2 must be heterozygous so they can produce offspring that have a dominant phenotype or a recessive phenotype. Affected parents can produce an unaffected offspring*.

2 marks

b. X-linked

2 marks

c. This is X-linked recessive and if females have two of the recessive alleles they will be colour blind*. It is more prevalent in males because they only have one X chromosome (from their mother) and so they only need one recessive allele whereas females need two*.

2 marks

d. Let $\mathbf{X^N}$ represent normal sight and $\mathbf{X^n}$ represent colour blindness.

Individual	Genotype
1	$\mathbf{X^n X^n}$
2	$\mathbf{X^N Y}$
3	$\mathbf{X^N Y}$
4	$\mathbf{X^N X^n}$
5	$\mathbf{X^n Y}$
6	$\mathbf{X^N X^n}$
7	$\mathbf{X^n Y}$
8	$\mathbf{X^n X^n}$
9	$\mathbf{X^n Y}$
10	$\mathbf{X^N X?}$
11	$\mathbf{X^N Y}$
12	$\mathbf{X^N X?}$
13	$\mathbf{X^n Y}$
14	$\mathbf{X^n X^n}$
15	$\mathbf{X^n Y}$

If 15 are correct award 3 marks, if 10 are correct award 2 marks, if 5 are correct award 1 mark

3 marks

Total 9 marks