



## 7: Genetics, population genetics and evolutionary processes – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
7	2017	May/June	41
7	2017	May/June	42
3	2015	May/June	41

The mark scheme for each question is provided at the end of the document.

7 (a) The stems of raspberry plants have spines.

Fig. 7.1 shows part of a raspberry plant.

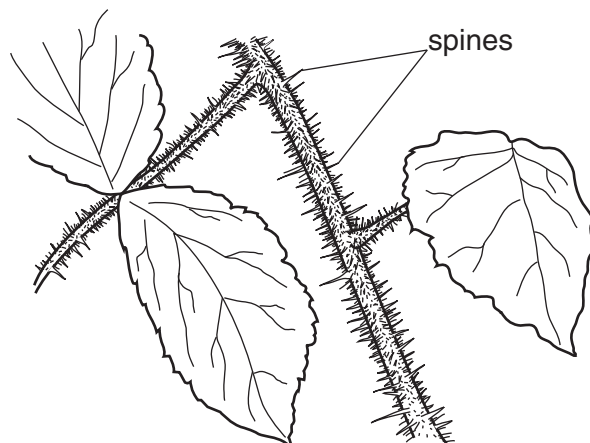


Fig. 7.1

The colour of the spines is controlled by two genes, **A/a** and **B/b**. The two genes are on different pairs of chromosomes.

- Allele **A** produces a pink anthocyanin pigment in the spines.
- Allele **B** has no effect by itself, but increases the colour produced by allele **A** to give red spines.
- Alleles **a** and **b** have no effect on colour.
- In the absence of anthocyanin, the spines are green.

State the colour of the spines of raspberry plants with the genotypes **Aabb** and **aaBB**.

**Aabb** .....

**aaBB** ..... [2]

- (b) Plants with the genotype **AaBb** were crossed with plants with the genotype **aabb**. The resulting seeds were sown and the seedlings grown until their stems developed spines.

Use a genetic diagram to show the outcome of this cross, including the ratio of offspring phenotypes.

[5]

- (c) Suggest why the ratio you have given in your genetic diagram would be different if the genes **A/a** and **B/b** were on the same homologous pair of chromosomes.

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..... [2]

[Total: 9]

- 7 (a) Cats with either black fur or white fur are common in Europe, whereas cats with brown fur are less common.

A gene, coding for an enzyme involved in pigment production, has two alleles.

- The dominant allele, **B**, results in black fur.
- The recessive allele, **b**, results in brown fur.

A second gene can affect fur colour.

- The dominant allele, **A**, prevents pigment production, resulting in a cat with white fur.
- The recessive allele, **a**, has no effect on fur colour.

The two genes are on different pairs of autosomes.

Use a genetic diagram to show how a cross between two cats, heterozygous at both loci, can produce offspring with three different colours: white, black and brown.

State the expected ratio of the different coloured offspring.

**(b)** Suggest how the presence of allele **A** prevents pigment production.

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..... [3]

[Total: 9]

- 3** The monkey flower, *Mimulus guttatus*, is cross-pollinated by bumblebees. It does not normally self-pollinate.

Since the number of bumblebees in many parts of the world is falling, an experiment was carried out in Kansas to investigate the effects on these plants of the loss of pollinators.

- 1600 *Mimulus* plants were grown in a field.
- 1600 *Mimulus* plants were grown in a glasshouse which bumblebees could not enter.

Seeds were repeatedly collected and sown for several generations at each site.

At first, the plants in the glasshouse produced few seeds, but after five generations the plants were able to self-pollinate and the number of seeds produced was almost the same as that of the plants in the field.

After five generations, the flowers of the plants in the glasshouse were significantly smaller than those of the plants in the field.

- (a)** Explain why offspring produced by cross-pollination and self-pollination differ in their genetic variation.

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- (b)** Suggest how smaller flowers could lead to an increase in self-pollination.

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- (c) Explain how natural selection produced the smaller flower size of the plants grown for five generations in the glasshouse.

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..... [5]

[Total: 9]


## Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
<u>underline</u>	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

### Paper 41

Question		Answer	Marks
7(a)	<b>Aabb</b> – pink ; <b>aaBB</b> – green ;		<b>2</b>



Question	Answer	Marks
7(b)	<p>1 parents phenotypes                      red                      green ;</p> <p>2 gametes                      AB                      Ab    aB                      ab    x                      ab ;</p> <p>3 offspring genotypes                      AaBb                      Aabb                      aaBb                      aabb ;</p> <p>4 offspring phenotypes                      red spines                      pink spines                      green spines    green spines ;  <i>(must be linked)</i>                      </p> <p>5 ratio                      1                      :                      1                      :                      2</p> <p><b>ecf</b>    mp 3 derived from incorrect 2                  mp 4 matching incorrect 3                  mp 5 matching incorrect 4</p>	5
7(c)	<p><i>max 2 of:</i></p> <p>1 genes would be, linked / inherited together ;</p> <p>2 no independent assortment ;</p> <p>3 ratio 1:1 / only two classes (of phenotypes) ; <b>A</b> red and green <b>or</b> pink and green</p> <p>4 rare cross-over events / recombination (gives small numbers of third phenotype) ;</p>	2
<b>Total: 9</b>		

Question	Answer	Marks																									
7(a)	<p>parental genotypes <b>AaBb</b> x <b>AaBb</b> ;</p> <p>gametes <b>AB Ab aB ab</b> x <b>AB Ab aB ab</b> ;</p> <p>offspring</p> <table><tr><td></td><td><b>AB</b></td><td><b>Ab</b></td><td><b>aB</b></td><td><b>ab</b></td></tr><tr><td><b>AB</b></td><td><b>AABB</b> white</td><td><b>AABb</b> white</td><td><b>AaBB</b> white</td><td><b>AaBb</b> white</td></tr><tr><td><b>Ab</b></td><td><b>AABb</b> white</td><td><b>AAbb</b> white</td><td><b>AaBb</b> white</td><td><b>Aabb</b> white</td></tr><tr><td><b>aB</b></td><td><b>AaBB</b> white</td><td><b>AaBb</b> white</td><td><b>aaBB</b> black</td><td><b>aaBb</b> black</td></tr><tr><td><b>ab</b></td><td><b>AaBb</b> white</td><td><b>Aabb</b> white</td><td><b>aaBb</b> black</td><td><b>aabb</b> brown</td></tr></table> <p><i>m</i> max 2 for all offspring correct max 1 if one error max 0 if more than one error</p> <p>offspring phenotype correctly linked to genotype ;</p> <p>ratio 12 white : 3 black : 1 brown ;</p>		<b>AB</b>	<b>Ab</b>	<b>aB</b>	<b>ab</b>	<b>AB</b>	<b>AABB</b> white	<b>AABb</b> white	<b>AaBB</b> white	<b>AaBb</b> white	<b>Ab</b>	<b>AABb</b> white	<b>AAbb</b> white	<b>AaBb</b> white	<b>Aabb</b> white	<b>aB</b>	<b>AaBB</b> white	<b>AaBb</b> white	<b>aaBB</b> black	<b>aaBb</b> black	<b>ab</b>	<b>AaBb</b> white	<b>Aabb</b> white	<b>aaBb</b> black	<b>aabb</b> brown	<p>6</p> <p>;;</p>
	<b>AB</b>	<b>Ab</b>	<b>aB</b>	<b>ab</b>																							
<b>AB</b>	<b>AABB</b> white	<b>AABb</b> white	<b>AaBB</b> white	<b>AaBb</b> white																							
<b>Ab</b>	<b>AABb</b> white	<b>AAbb</b> white	<b>AaBb</b> white	<b>Aabb</b> white																							
<b>aB</b>	<b>AaBB</b> white	<b>AaBb</b> white	<b>aaBB</b> black	<b>aaBb</b> black																							
<b>ab</b>	<b>AaBb</b> white	<b>Aabb</b> white	<b>aaBb</b> black	<b>aabb</b> brown																							

Question	Answer	Marks
7(b)	<ol style="list-style-type: none"> <li>example of, gene interaction / epistasis ;</li> <li><i>ref. to</i> blocking (one step in) pathway to pigment production ;</li> <li>(allele <b>A</b>) product / protein, inhibits enzyme (producing pigment) ;</li> <li>(allele <b>A</b>) product / protein, is a repressor ;      <b>A</b> allele codes for a repressor</li> <li>(which) blocks transcription / RNA polymerase cannot bind / switches off allele (coding for pigment) ;</li> <li>(by), binding to / blocking, operator / promoter ;</li> <li>(allele <b>A</b>) product / protein, prevents transcription factor complex formation / AW ;</li> </ol>	max 3
		Total: 9

Question	Answer	Marks
3(a)	<p><i>self-pollination</i> <b>ora</b> for cross-pollination</p> <ol style="list-style-type: none"> <li>gametes / alleles / genes / DNA, come(s) from one parent ;</li> <li>gives, less genetic variation / more genetic uniformity ;</li> <li>results in inbreeding ;</li> <li>increases homozygosity / decreases heterozygosity ;</li> </ol>	[max 3]

Question	Answer	Marks
3(b)	anthers and stigma/stamens and carpels, closer together ;	1
3(c)	<ol style="list-style-type: none"> <li>1 range of flower size in original population ;</li> <li>2 genetic variation (affecting flower size) in original population ; <b>I</b> mutation</li> <li>3 change in environment/selection pressure, is absence of, bees/insect pollination (in greenhouse) ;</li> <li>4 plants with small, flowers/petals, are, selected for/reproduce/at a selective advantage ; <b>ora</b></li> <li>5 <u>alleles</u> for small size passed to offspring ; <b>ora I</b> gene</li> <li>6 frequency of, advantageous/smallness, allele increases ; <b>ora</b></li> <li>7 directional selection ;</li> <li>8 temperature/irrigation/space/competition, different in field and glasshouse ;</li> <li>9 small size explanation linked to factor in mp8 ;</li> </ol>	[max 5]
		<b>Total: 9</b>