



2003

**Biology GA 3: Written examination**

**SPECIFIC INFORMATION**

**Section A – Multiple choice**

This table indicates the approximate percentage of students choosing each distractor. The correct answer is the shaded alternative.

Question	A	B	C	D	
1	7	70	20	3	
2	11	74	7	8	
3	16	24	16	44	<p>The difference between the phenotypes of the male and female offspring in the cross is an indication the gene will be on a sex chromosome. This makes alternative A incorrect.</p> <p>Given that the gene is sex-linked the female parent with a straight tail cannot be heterozygous. The male offspring would have to display both bent and straight tails for this to be true. This makes alternative B incorrect.</p> <p>The F<sub>1</sub> females are heterozygous therefore bent tails is the dominant phenotype. Therefore C is incorrect.</p> <p>The F<sub>1</sub> female is heterozygous receiving an allele that codes for a bent tail from the father and an allele that codes for a straight tail from the mother. This makes alternative D correct.</p>
4	1	40	45	14	<p>Many students incorrectly choose alternative C. A cross between a person with type O blood and a person with type AB blood may give two different phenotypes. A cross between a person with type A blood and a person with type B blood may give four different phenotypes.</p>
5	16	3	78	3	
6	30	53	13	4	<p>Parents III-1 and III-2 are both heterozygous. The chance that a child of these parents is male is <math>\frac{1}{2}</math>. The chance that the child will have Tay Sachs disease is <math>\frac{1}{4}</math>. The chance the child is a male with Tay Sachs disease is <math>\frac{1}{2} \times \frac{1}{4} = \frac{1}{8}</math>.</p> <p>Many students incorrectly choose alternative B forgetting to consider the chance of the child being male.</p>
7	16	55	22	7	<p>IV-2 does not have Tay Sachs. Parents III-1 and III-2 are both heterozygous. Considering only the children who do not have Tay Sachs, the chance that the child is heterozygous is <math>\frac{2}{3}</math>.</p>
8	70	9	18	3	
9	20	6	7	67	
10	8	5	79	8	
11	32	17	35	16	<p>The results of a test cross of a heterozygote determine whether the two genes are linked. If there are four groups of offspring in equal proportions the two genes are not linked and have been assorted independently. The results of the test cross show four groups in unequal proportion; therefore, alternative B incorrect.</p> <p>The percentage of recombinant offspring corresponds to the number of map units separating the two genes. The results show a total of 10% recombinant offspring making alternative C correct. Agouti, non-frizzy offspring have inherited AF from the heterozygous parent, a non-recombinant arrangement, making alternative D incorrect.</p>

Alternative A is incorrect as the genotype of the  $F_1$  of the cross must be  $\frac{AF}{af}$ .

12	3	21	62	14	
13	18	10	12	60	
14	68	16	10	6	
15	14	23	6	57	
16	14	11	70	5	
17	20	61	8	11	Divergent evolution occurs when isolated populations of the one ancestral species change over time. The stem of this question indicated the snakes and legless lizards evolved separately from ancestors with legs, not a common ancestor with legs, making B an incorrect response.
					This is an example of analogy as both species have produced a similar solution (lack of legs) to a particular selective pressure in their own habitats.
18	7	8	84	1	
19	7	61	21	11	
20	9	66	12	13	
21	70	4	10	16	
22	14	20	43	23	Individuals who are genetically identical must have the same alleles for a particular gene. The only possible explanation must be the influence of the environment.
23	8	43	12	37	Each snapdragon plant will have two copies of the gene that determines the colour of the snapdragon flower. This gives a total allele pool of 200 in the population of 100 snapdragon plants. This means that alternative D is incorrect.
					Each red plant has two copies of the $C^R$ allele, 40 plants have a total of 80 copies of the $C^R$ allele. Each pink plant has one copy of the $C^R$ allele. In 40 pink plants there are 40 copies of the $C^R$ allele. This makes a total of 120 copies of the $C^R$ allele in the population.
24	1	75	5	19	
25	21	11	24	44	Genetic drift is the result of chance events that cause allele frequencies in a population to change randomly over time. While it occurs in all populations it is more likely that an allele can be lost or fixed in a small population. This makes alternative D correct.

## Section B – Short answer

For each question an outline answer (or answers) is provided. In some cases the answer given is not the only answer that could have been awarded marks. Comments on student performance on the question follow the answers for each part of the question.

### Question 1

ai–ii

Marks	0	1	2	Average
%	2	65	33	1.30

ai

The patterned phenotype is dominant.

aii

Two patterned parents produce non-patterned offspring OR 2 heterozygous patterned parents produce a ratio of three patterned to one non-patterned offspring OR a 3 patterned to 1 non-patterned ratio indicates the parents are heterozygous (or carriers) AND because they have the patterned phenotype it is dominant OR production of offspring with a different phenotype from the parent indicates heterozygous parents with dominant phenotype OR if patterned phenotype is recessive then no non-patterned offspring would be produced.

Students who stated, without further explanation, that patterned phenotype occurs in a higher frequency, were not awarded a mark.

b

Marks	0	1	2	3	Average
%	21	20	37	22	1.59

Allelic symbols P = patterned, p = non-patterned  
 Parents genotypes Pp X Pp  
 Parents phenotypes patterned X patterned

Offspring genotypes 1/4 PP; 1/2Pp; 1/4 pp  
 Offspring phenotype patterned patterned non-patterned

One mark was awarded for the parent's genotypes and phenotypes; 1 mark was awarded for offspring genotypes and phenotypes; 1 mark was awarded for the allelic symbols.

Many students simply completed a punnett square and made no reference to parents or offspring. These students could not be awarded full marks.

c

Marks	0	1	2	Average
%	38	11	51	1.13

Patterned frogs can be homozygous (pure-breeding) or heterozygous. In cross A the patterned frog is homozygous PP (so all offspring are patterned) and in cross B the patterned frog is heterozygous (see both patterned and non-patterned offspring).

### Question 2

a

Marks	0	1	2	Average
%	41	41	18	0.77

The presence of four phenotypes in the F<sub>2</sub> generation indicates that two genes are involved. One of the genes determines coat colour. One allele for coat colour codes for black coats, the alternative allele codes for white coats. The gene for coat texture has two alleles; one coding for rough texture, the other allele codes for smooth texture.

OR there are four phenotypes in the F<sub>2</sub> generation with a ratio of 9:3:3:1 indicating the parents are heterozygous for two gene loci each with two alleles.

Many students could discuss the results in the terms of the presence of two genes. Fewer went on to discuss evidence in terms of the two alleles for each gene.

bi-iii

Marks	0	1	2	3	4	Average
%	31	6	8	9	46	2.33

bi

RR BB rough, black rr bb smooth, white

bii

Bb Rr

biii

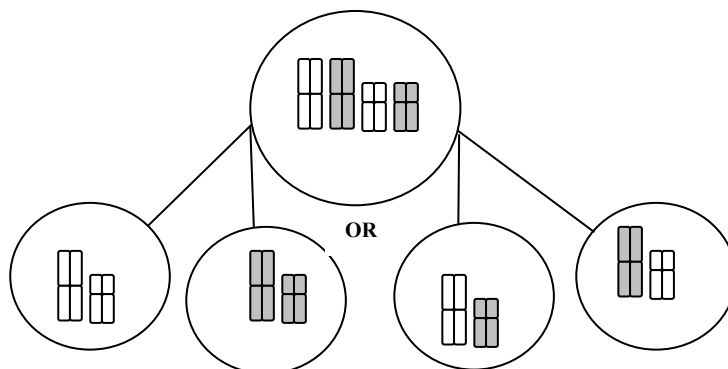
BBrr or Bbrr

c

Marks	0	1	2	3	Average
%	76	14	7	3	0.35

One mark was awarded for a written definition and 2 marks for the diagram.

During anaphase one the behaviour of one pair of homologous chromosomes is not influenced by the behaviour of the other pair of homologous chromosomes.



In the written description many students reiterated the words in the stem. Using the word ‘assort’ or ‘independently’ in their description does not explain what assort independently means.

In the diagram, 1 mark was awarded for showing two pairs of double stranded chromosomes. Students were not required to show the position of alleles on the two chromosomes. However, if they did, they were penalised for any contradiction in their answer; for example, if they had R on one chromosome and B on the homologue; a common mistake.

### Question 3

a

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>Average</b> <b>0.80</b>
<b>%</b>	55	9	36	

C, E, D, B, F, A

b

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>Average</b> <b>0.56</b>
<b>%</b>	56	32	12	

Any two of

- increases variation in the gametes or offspring
- the recombining of maternal and paternal alleles
- exchange of alleles or genetic material between homologous chromosomes or between non-sister chromatids resulting in new combinations of alleles.

Some students incorrectly stated that the homologous chromosomes exchanged genes. Homologous chromosomes have the same genes; they may have different forms of a gene. Therefore, they may exchange different forms of a gene. The different forms of a gene are called alleles.

ci–ii

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>Average</b> <b>1.02</b>
<b>%</b>	26	46	28	

ci

E

cii

In anaphase one chromosomes are double stranded. The chromosomes shown moving to the poles in E are double stranded.

### Question 4

a

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b> <b>0.49</b>
<b>%</b>	51	49	

vector or recombinant plasmid

b

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b> <b>0.70</b>
<b>%</b>	30	70	

restriction enzyme or endonuclease

c

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b> <b>0.54</b>
<b>%</b>	46	54	

DNA ligase

d

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b> <b>0.09</b>
<b>%</b>	91	9	

The importance of including a gene for antibiotic resistance in the plasmid is in identification of bacteria that have taken up the plasmid. After the new plasmids are incubated with bacteria, the bacteria is grown on media containing antibiotics. Only those bacteria that have taken up the plasmid will be able to grow on the media.

Many students simply stated to make the bacteria resistant to antibiotics and therefore were not awarded a mark.

e

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b> <b>0.52</b>
<b>%</b>	48	52	

Any one of the following responses would have been awarded a mark:

- Insecticide may be harmful to humans and other living things.
- Insecticide may kill useful insects.
- GM crop may be cheaper to grow and manage.
- Genetically engineered resistance may be more specific for a harmful insect.

f

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b>
<b>%</b>	66	34	<b>0.34</b>

One advantage for a farmer to spray his crops with herbicide would be that there would be less competition for resources from other plants so a greater yield from his crop. Another correct response would be that the farmer may reduce the time spent weeding.

g

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b>
<b>%</b>	89	11	<b>0.11</b>

Farmer Y may be concerned that he may lose some of his markets if he cannot state that his crops are GM free. Other correct responses included ethical issues raised by Farmer Y.

h

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>Average</b>
<b>%</b>	44	36	16	4	<b>0.80</b>

Conclusions that can be drawn from the experiments are:

- When the crops are adjacent to each other there is cross-pollination.
  - Cross-pollination can be reduced by moving crops 5 m apart.
  - the difference between separating 5 m or 7 m does not influence cross pollination at the edge, only 10m into crop.
- Many students restated the figures in the table without making conclusions from the data. An example of a response that could not be awarded a mark included 'there was 2 per cent cross-pollination when there was no gap between the crops and 0.3 per cent when the gap was 7 metres'.

### Question 5

a

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b>
<b>%</b>	54	46	<b>0.46</b>

Mutation

bi-ii

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Average</b>
<b>%</b>	41	17	15	15	12	<b>1.40</b>

bi

Sensitive and resistant bacteria existed in the population prior to the use of antibiotics. When antibiotics were introduced more sensitive bacteria were killed than resistant bacteria. Resistant bacteria are able to pass on the allele for resistance to the next generation or resistance is genetic and resistant bacteria reproduce and pass resistance on to next generation. Over several generations the frequency of the resistant bacteria increases.

bii

Antibiotics

### Question 6

a

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b>
<b>%</b>	31	69	<b>0.69</b>

Human 1

b

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>Average</b>
<b>%</b>	99	1	<b>0.01</b>

Mutations are reversible and some substitutions may reverse an earlier change making 77 nucleotides the minimum number of base substitutions.

ci-iii

<b>Marks</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>Average</b>
<b>%</b>	21	35	29	15	<b>1.37</b>

ci

Skeletal structure/morphology may be used to assist in determining the evolutionary relationship of Neanderthals with humans and chimpanzees.

cii

Carbon dating can be used because the fossil is approximately 25 000 years old.

ciii

To determine the relative age of the fossil, an index fossil may be used. Stratigraphy which states that the oldest stratum is at the bottom and younger layers lie above can also be used.

### Question 7

ai-ii

Marks	0	1	2	Average
%	11	27	62	1.51

ai

The trilobite had a hard tough exoskeleton or tough outer covering that improved its chances of being fossilised.

aii

Trilobite fossils may be abundant for any one of the following reasons:

- were widely distributed geographically
- able to survive in a wide range of habitats
- existed for 300 million years
- lived in an environment where fossilisation can occur readily.

b

Marks	0	1	2	Average
%	9	7	84	1.75

Order: trilobites, (helmetids, tegopeltids – in any order), naraoids.

c

Marks	0	1	Average
%	93	7	0.07

A global climate change must have occurred to make all species of trilobites extinct.

Some students mentioned a climate change without any indication of the global nature of the change and therefore were not awarded a mark.

### Question 8

ai-ii

Marks	0	1	2	Average
%	20	23	57	1.37

ai

Skull one

aii

Skull one has a more rounded jaw line or large jaw relative to overall skull size, or skull one has more prominent eyebrow ridges or skull one has a smaller brain case.

Students need to be reminded that when a question asks for one characteristic, they should only give one characteristic. If they include more and one is an incorrect response they may be penalised.

b

Marks	0	1	Average
%	90	10	0.10

The genera may have become extinct before the migration out of Africa could have occurred OR there were no selection pressures placed on the genera forcing them to move, so they remained in Africa until extinct.

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