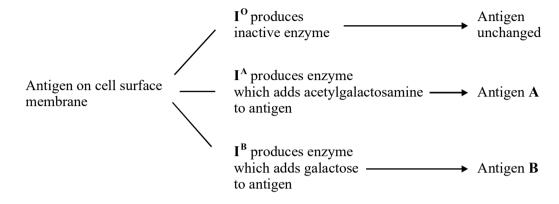
**(2)** 

1. The inheritance of the ABO blood groups is an example of multiple allele inheritance and is controlled by three alleles of a single gene,  $I^O$ ,  $I^A$  and  $I^B$ 

These three alleles determine the activity of an enzyme which modifies the structure of an antigen on the cell surface membrane of the red blood cells. This is summarised below.

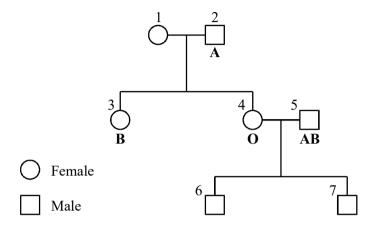


- (a) In terms of mutation, explain each of the following statements.
  - (i) The alleles  $I^A$  and  $I^B$  differ at several nucleotide positions but produce enzymes which are very similar in their structure.
  - (ii) The  ${\bf I^O}$  allele has a single base deletion and gives rise to an inactive enzyme. (3)
- (b) Briefly explain how a DNA (gene) probe could be used to identify the presence of the 1° allele in a sample of DNA,

  (3)

(c) The allele  $I^O$  is recessive to both alleles  $I^A$  and  $I^B$ . Alleles  $I^A$  and  $I^B$  are codominant, that is, they are both expressed in the phenotype.

The diagram shows the inheritance of ABO blood groups in one family.



- (i) Give the blood group genotype or genotypes of the sperm cells produced by individual 2.
  - (1)
- (ii) Give the blood group phenotype of individual 1.

(1)

(iii) Calculate the probability that the next child produced by individuals 4 and 5 will be a boy with blood group **A**. Show your working.

**(2)** 

- (d) Explain why a person with blood group **O**:
  - (i) can safely give blood to someone with blood of any ABO type;

(2)

(ii) can only safely receive blood from someone with blood group  ${\bf O}$ 

**(2)** 

- (e) (i) In a study of people living in India, the frequency of the  $\mathbf{I}^{\mathbf{O}}$  allele was found to be 0.55 and that of the  $\mathbf{I}^{\mathbf{A}}$  allele, 0.18. What was the frequency of the  $\mathbf{I}^{\mathbf{B}}$  allele in this population?
  - (ii) Smallpox was an extremely severe disease which was particularly common among the people of the Indian sub-continent. It has been suggested that the smallpox virus had proteins on its surface which were very similar to the **A** antigen. Use this information to suggest why people with blood groups **B** and **O** were less likely to develop smallpox than those with blood groups **A** and **AB**.

(3) (Total 20 marks)

**(1)** 

2. New Zealand beech trees do not produce seeds every year. A study was carried out on the mice living in an isolated New Zealand beech forest. Because of the location of this forest, biologists could only visit it at monthly intervals and stay approximately 12 hours on each visit.

At the beginning of each visit, they set all the traps they had available. This number varied. At the end of the visit, they collected the traps and released any mice they had captured.

**Figure 1** shows the population density of the mice at different times during a New Zealand beech seed year and a non-seed year.

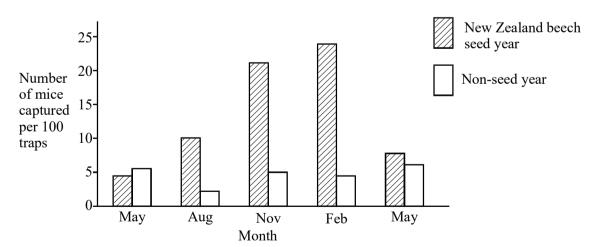


Figure 1

(a)	Use t	he information in the question to suggest	
	(i)	why the mark-release-recapture method would have given unreliable results;	
			(2)
	(ii)	the advantage of giving the number of mice captured per 100 traps rather than just the number of mice captured.	
			(2)
(b)	(i)	A statistical test was carried out on the August figures. The population density of mice in the seed year was found to be significantly different at the $p=0.05$ level from the population density in the non-seed year. Explain the meaning of this statement.	
			(2)

		(2)
	ent survey, mice were trapped at various sites in the UK. <b>Figure 2</b> shows the mean and the standard deviation of the adult males that were among the trapped mice.	
Refrigerate	ed cold stores ⊢ <del>• • • • • • • • • • • • • • • • • • </del>	
Farms in S	cotland — •	
Farms in V	Vales — — —	
Farms in N	Northern England	
	12 14 16 18 20 22 24 26 Mass / g	
	Figure 2	
(c) (i)	Explain why the data for only the male mice were plotted in Figure 2.	
		(1)
		(1)
<i>(</i> ::)		
(ii)	In collecting the raw data in this survey, the investigators also measured the amount of tooth wear shown by the mice. Suggest why.	
		(2)

Suggest why the population density increases in a seed year.

(ii)

(d)	(i)	Explain the advantage of a large body mass to mice living in a refrigerated cold store.	
			(2)
	(ii)	Use the information in <b>Figure 2</b> to explain what is meant by directional selection.	
			(3)
(e)		colour of wild mice is grey but in some island populations there are black mice. difference in colour is caused by a single pair of alleles.	
	(i)	Describe how you could use genetic crosses to show that the allele for black is the recessive allele.	
			(2)

(2)

neie in a population of	e frequency of the reces	g on an island.		(ii)
(Total 20 mar				
7A 7B 1		hlood groups is go	tance of AR	The inherit
came gene I'l I' and	ntrolled by three alleles			THE IIIICIN
same gene, $I^{A}I^{B}$ and he allele $I^{O}$ .	ntrolled by three alleles oth I <sup>A</sup> and I <sup>B</sup> are domina	are codominant. Bo	eles I <sup>A</sup> and I	I <sup>O</sup> . The alle
same gene, I <sup>A</sup> I <sup>B</sup> and he allele I <sup>O</sup> .	ntrolled by three alleles oth I <sup>A</sup> and I <sup>B</sup> are domina	are codominant. Boneant by an allele.	leles I <sup>A</sup> and I	I <sup>O</sup> . The alle
same gene, I <sup>A</sup> I <sup>B</sup> and he allele I <sup>O</sup> .	ntrolled by three alleles oth I <sup>A</sup> and I <sup>B</sup> are domina	are codominant. Bo	leles I <sup>A</sup> and I	I <sup>O</sup> . The alle
he allele I <sup>O</sup> .	ntrolled by three alleles oth I <sup>A</sup> and I <sup>B</sup> are domina	are codominant. Bo	leles I <sup>A</sup> and I	I <sup>O</sup> . The alle
he allele I <sup>O</sup> .	ntrolled by three alleles oth I <sup>A</sup> and I <sup>B</sup> are domina	are codominant. Bo	leles I <sup>A</sup> and I	I <sup>O</sup> . The alle
same gene, I <sup>A</sup> I <sup>B</sup> and he allele I <sup>O</sup> .	ntrolled by three alleles oth I <sup>A</sup> and I <sup>B</sup> are domina	are codominant. Bo	leles I <sup>A</sup> and I	I <sup>O</sup> . The alle
he allele I <sup>O</sup> .	ntrolled by three alleles oth I <sup>A</sup> and I <sup>B</sup> are dominated and I <sup>B</sup> are dominated at the state of	are codominant. Bo	leles I <sup>A</sup> and I <sup>d</sup>	I <sup>O</sup> . The alle
he allele I <sup>O</sup> .	oth I <sup>A</sup> and I <sup>B</sup> are domina	are codominant. Bo	leles I <sup>A</sup> and I <sup>d</sup>	I <sup>O</sup> . The allo (a) Expl 
he allele I <sup>O</sup> .	e missing genotypes.  Possible	he table to show the	leles I <sup>A</sup> and I <sup>d</sup>	I <sup>O</sup> . The allo (a) Expl 

AB

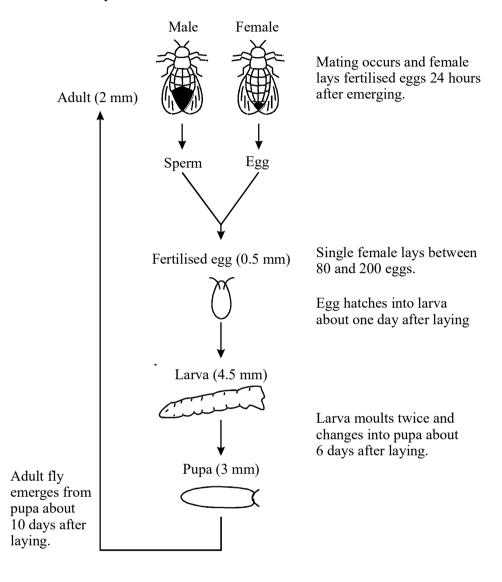
O

Parental phenotypes	Blood group A	Blood group B	
Parental genotypes			
Genotypes of gametes			
Genotypes of children			
Phenotypes of children			(3)
		(Total 6 mar	

Children of blood groups A and O were born to parents of blood groups A and B. Complete the genetic diagram to show the possible ABO blood group phenotypes of the children which could be produced from these parents.

(ii)

**4.** The fruit fly is a useful animal for studying genetic crosses. The diagram shows the life cycle of the fruit fly.



(a) Using information from the diagram explain **three** ways in which the fruit fly is a useful animal for studying genetic crosses.

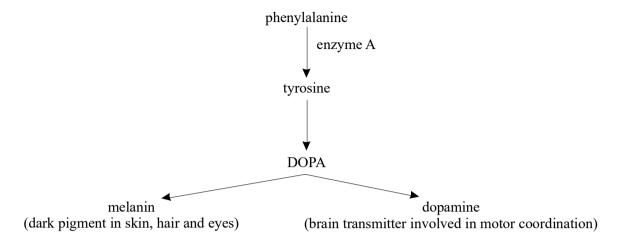
1	
	•••••
2	
	•••••
3	

In fruit flies the allele for grey body colour, G, is dominant to the allele for black body, g, and the allele for normal wings, N, is dominant to the allele for vestigial wings, n. A cross between a grey-bodied, normal-winged fly and a black-bodied, vestigial-winged fly resulted in the following offspring.

25 grey-bodied, normal-winged 26 grey-bodied, vestigial-winged 24 black-bodied, normal-winged

27 b	lack-bo	odied, vestigial-winged	
(b)	(i)	Give the genotype of the grey-bodied, normal-winged parent.	
			(1)
	(ii)	Give the genotypes of the gametes which could be produced by one of the grey-bodied, vestigial-winged offspring.	
			(1)
(c)		t ratio would you expect in the offspring produced if the grey-bodied, normal-winged nt had been crossed with a fly of the same genotype?	
	•••••	(Total 6 ma	(1) arks)

5. The diagram shows the pathway by which phenylalanine is normally metabolised.



Phenylketonuria (PKU) is a condition which results from the absence of enzyme A. People with PKU are homozygous for a recessive allele which fails to produce this enzyme.

(a)	Use the information shown in the diagram to give <b>one</b> symptom you might expect to be visible in a person who inherits PKU.	
		(1)
(b)	Explain how gene mutation may result in an allele which fails to produce a functional enzyme.	
		(3)

(c) (i)	A child with PKU was born to two unaffected parents. Complete the genetic diagram to show how this is possible.	ic
	Parental phenotypes	
	Parental genotypes	
	Genotypes of gametes	
	Genotypes of children	
	Phenotypes of children	
		(2)
(ii)	i) What is the probability that a second child born to these parents will have I	<b>PK</b> U?
		 (1) (Total 7 marks)

6. Tongue-rolling and red-green colour blindness are two genetically controlled conditions which occur in humans. Tongue-rolling is controlled by the dominant allele, **T**, while non-rolling is controlled by the recessive allele, **t**.

Red-green colour blindness is controlled by a sex-linked gene on the X chromosome. Normal colour vision is controlled by the dominant allele, **B**, while red-green colour blindness is controlled by the recessive allele, **b**.

	(a)	Complete the genetic diagram to show to could be produced from the following p	the possible genotypes and phenotypes which parents.	
		Female Colour blind and heterozy for tongue-rolling.	Male /gous Normal colour vision and non-roller	
		Parental genotypes		
		Genotypes of gametes		
		Genotypes of children		
		Sex and phenotypes of children		(4)
	(b)	Explain why a higher percentage of mal colour blind.	les than females in a population is red-green	
	(c)		e have been found in humans and other animal of evidence which would support the presence of	
				(1)
			(Total 6 ma	arks)
7.	tissu		roduce poisonous hydrogen cyanide when their gen cyanide takes place in two steps, each of a different gene.	
		Dominant	Dominant	
		allele A	allele B	
		<b>∀</b> Enzyme A	<b>♥</b> Enzyme B	
	Subs	strate	oside → Hydrogen cyanide	

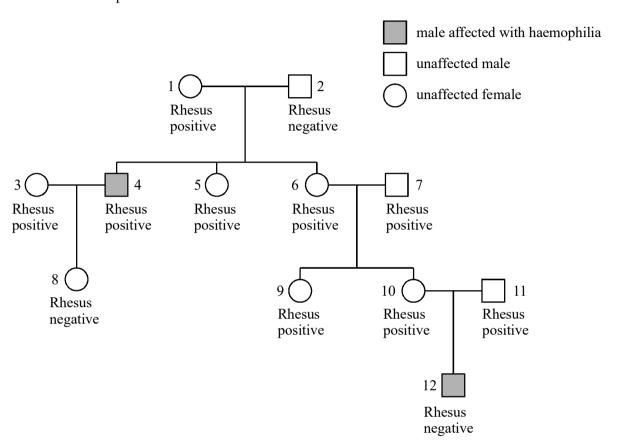
(3)
(3)

Use the information given to explain how the different allele frequencies might be

(ii)

tn	e result of natural selection.
•••	
•••	
•••	
•••	
•••	
•••	
•••	
•••	(Tot

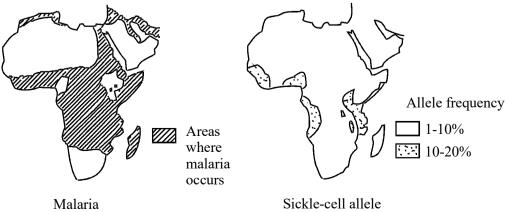
8. The allele for Rhesus positive, **R**, is dominant to that for Rhesus negative, **r**. Haemophilia is a sex-linked condition. The allele for haemophilia, **h**, is recessive to the allele for normal blood clotting, **H**, and is carried on the X–chromosome. The diagram shows the Rhesus blood group phenotypes in a family tree where some individuals have haemophilia.



(a)	(i)	Use the information in the diagram to give <b>one</b> piece of evidence that the allele for the Rhesus negative condition is recessive.		
			(1)	
	(ii)	Explain the evidence from the cross between individuals 3 and 4 that the gene controlling Rhesus blood group is <b>not</b> sex-linked.		

(b)	Give	e the full genotype of	
	(i)	individual 6;	
			(1)
	(ii)	individual 12.	( )
			. (1)
(c)	Wha	at is the probability that the next child of couple 10 and 11 will have the same otype as the first child? Show your working.	
	•••••		
	•••••		
	•••••		(3) Total 8 marks)

9. The maps show the present distribution of malaria and the sickle-cell allele in Africa.

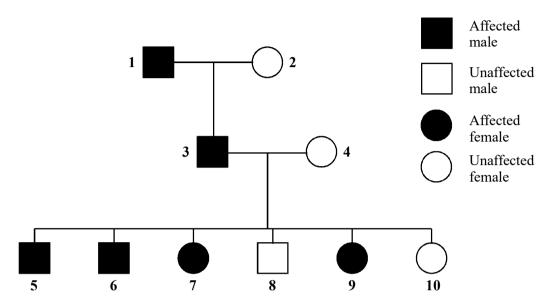


(a)	Draw a genetic diagram to show how sickle-cell anaemia can be inherited from parents who do not have the condition.				
	Key to symbols for alleles	Hb <sup>A</sup> HbS	Normal adult haemoglobin Sickle–cell haemoglobin		
	Parental genotypes				
	Gamete genotypes				
	Children's genotypes				
	Children's phenotypes				
(b)		vere heter	ere were 8 people who were homozygous for the ozygous. Calculate the frequency of the Hb <sup>S</sup> .		
			Answer	(2)	

(c)	One hypothesis to account for the high frequency of the sickle-cell allele in parts of Africa concerns resistance to malaria.		
	(i)	Explain the link between sickle cell anaemia, resistance to malaria and the frequency of the Hb <sup>S</sup> allele.	
			(3)
	(ii)	Select and evaluate the evidence from the maps which supports this hypothesis.	
			(2)

	(d)	Chloroquine is a drug which has been used very successfully to treat malaria. The use of chloroquine to treat malaria has produced changes in the frequency of the Hb <sup>S</sup> allele. Explain how.	
		(Total 12 mark	(2) (s)
10.	(a)	Explain what is meant by	
		a recessive allele;	
		a sex-linked gene.	
			(2)

(b) Nail-patella syndrome is an inherited condition caused by a single gene. Sufferers have abnormal nail growth and underdeveloped kneecaps. The pedigree shows how members of one family were affected by the syndrome.



Explain one piece of evidence from the pedigree which indicates that

the allele for the nail-patella syndrome is dominant;

(i)

(2)
(2) otal 6 marks)

1.	inner devel	Familial polyposis is a hereditary disease. In this disease small wart-like growths appear on the inner surface of the large intestine during childhood. The risk that one of these warts will develop into a malignant tumour in teenage years is so high that affected children are often treated by having that part of the large intestine surgically removed.					
	(a)	Suggest <b>one</b> diagnostic technique that could be used to detect familial polyposis in children from a family with a history of this disease.					
			(1)				
	(b)	Explain what is meant by a malignant tumour.					
			(2)				
	(c)	Familial polyposis is caused by a dominant allele, <b>A</b> . The allele is <b>not</b> located on a sex chromosome.  In a couple, the male is heterozygous for familial polyposis and the female is unaffected. What is the probability that a child born to this couple would have familial polyposis? Use a genetic diagram to explain your answer.					

11.

	(d)	Serious diseases caused by dominant alleles are relatively uncommon compared with diseases caused by recessive alleles.  Suggest an explanation for this.	
		(Total 8	(2) marks)
12.	Indiv when	ler-Najjar (C-N) syndrome is a rare genetic disorder controlled by a recessive allele. Viduals with the disorder are unable to break down bilirubin, a toxic waste product formed in the liver destroys old red blood cells. Children with this syndrome must sleep under ital blue lights which destroy bilirubin. If this treatment fails a liver transplant is required.	
		ough rare in the general population, C-N syndrome is common in one particular munity. This community is described as closed as marriage occurs only between its abers.	
	(a)	Explain what is meant by an allele.	
			(1)
	(b)	(i) Use a genetic diagram to show how two people, neither of whom shows the disorder, can have a child with C-N syndrome.	

	(ii)	Suggest how C-N syndrome could become common in a closed community.	
			(4)
			(4)
(c)	cells in thi	nt studies have shown that it may be possible to repair the defective gene in the liver of affected individuals. Successful gene therapy of all individuals with this disorder is community might increase the frequency of C-N syndrome in future generations.	
	•••••	(Total 7 m	(2) arks)

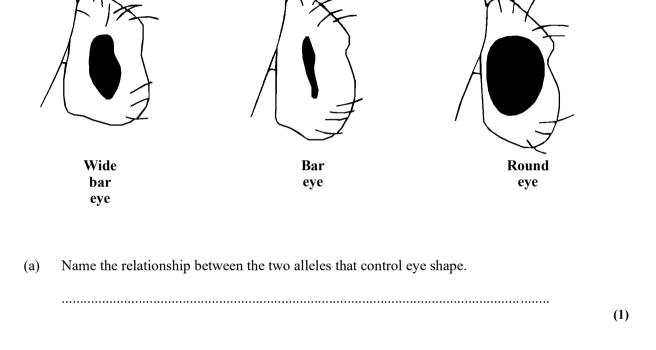
**13.** In a species of fruitfly, females have two X chromosomes, and males have an X and a Y chromosome.

A gene controlling eye shape in fruitflies is sex-linked, and found only on the X chromosome. This gene has two alleles,  $\mathbf{R}$  for round eyes and  $\mathbf{B}$  for bar eyes.

**(1)** 

A homozygous, round-eyed female  $(X^R \, X^R)$  was crossed with a bar-eyed male. In the offspring (Offspring 1), all the female offspring had wide bar eyes (intermediate in size) and all the males had round eyes.

## The figure shows the head of three fruitflies



(b)

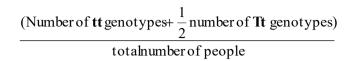
Give the genotype of the male parent.

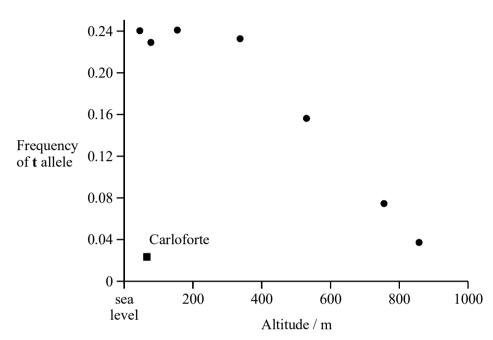
Parental phenotypes	Round-eyed female	Bar-eyed male
Parental genotypes	$X^R X^R$	
Offspring 1 phenotypes	Wide bar-eyed female	Round-eyed male
Offspring 1 genotypes		
Gametes		
Offspring 2 genotypes		
Offspring 2 phenotypes and ratio		
		(Total 5 ma

14. Thalassemia is a disease in which people homozygous for the recessive allele, t, show a severe anaemia. Before suitable medical treatment was available, they did not usually survive childhood. Heterozygotes are only mildly affected, but are more resistant to malaria than people who are homozygous dominant, TT.

The graph shows the relationship between altitude and the frequency of the thalassemia allele,  $\mathbf{t}$ , for a group of villages on the Italian island of Sardinia. The information relates to the early 20th century.

The frequency of the allele t in a population can be calculated from the formula





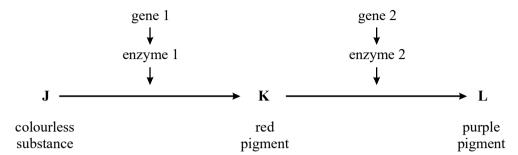
(a)	Ignoring the information for the village of Carloforte, describe the relationship between
	the frequency of the <b>t</b> allele and altitude.


**(2)** 

Until the late 19th century, malaria was commonly found among people living at low altitudes in Sardinia. It is a serious blood disease caused by a parasite which is carried in the salivary glands of certain species of mosquito. These mosquitoes, which thrive in warm conditions near to sources of still or slow-moving water, infect humans with malaria by biting them.

reasons for the unusually low frequency of the <b>t</b> allele found at Carloforte.  1
1
1
1
Information for the village of Carloforte is shown on the graph as a square. This village was founded more recently, by families from mainland Italy. Suggest two possible

15. A species of flowering plant can have white, red or purple flowers. The colour of the flowers is controlled by two genes. Each gene is found on a different chromosome, and is responsible for one step in a biosynthetic pathway. The biosynthetic pathway is



Gene 1 has the dominant allele **A** and the recessive allele **a**. Gene 2 has the dominant allele **B** and the recessive allele **b**. In both cases, the dominant allele needs to be present for the production of the associated enzyme.

(a)

Explain how the two genes are involved in producing white, red or purple flowers.

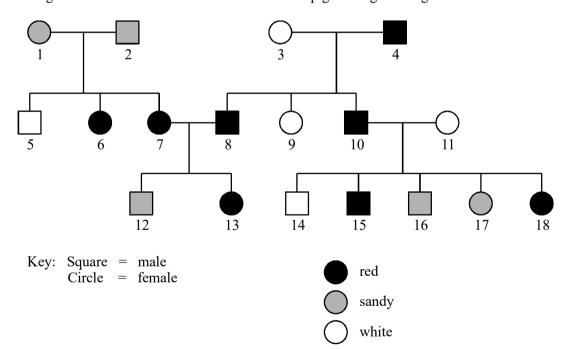
(b)	(i)	A homozygous red-flowered plant was crossed with a homozygous white-flowered plant. All the flowers of the offspring were purple. What was the genotype of the red-flowered parent;		
		the white-flowered parent?	(2)	
	(ii)	The purple-flowered offspring were crossed. What phenotypic ratio would you expect in the next generation? Use a genetic diagram to explain your answer.	(2)	
			(4)	
(c)	(i)	Genetically, there are different types of white-flowered plants of this species. Give their different genotypes.		
			(1)	

**(2)** 

(Total 15 marks)

(ii) You have samples of fresh petals from the two homozygous types of white flowers, and a pure sample of the red pigment, **K**. Explain, in outline, how you might distinguish the two types of petal from each other.

16. The diagram shows the inheritance of coat colour in pigs through three generations.



controlled by one g	gene with two codominant alleles	S.
••••		
	t forward to explain the results, e	each based on the action of two
hypotheses were puess.	t forward to explain the results, e  Hypothesis 1	Hypothesis 2
s.	Hypothesis 1	Hypothesis 2
Phenotype	Hypothesis 1 Genotype	Hypothesis 2 Genotype
Red Sandy White	Hypothesis 1  Genotype  A_B_  A_bb or aaB_  aabb	Hypothesis 2  Genotype  A_B_ or A_bb  aaB_  aabb
Phenotype Red Sandy White  (_ represent	Hypothesis 1  Genotype  A_B_  A_bb or aaB_  aabb  abb  se either a dominant or a recessive pothesis 1 is correct, give one pothesis in the diagram.	Hypothesis 2  Genotype  A_B_ or A_bb  aaB_  aabb  e allele of the gene)
Red Sandy White  (_ represent	Hypothesis 1  Genotype  A_B_  A_bb or aaB_  aabb  abb  se either a dominant or a recessive pothesis 1 is correct, give one pothesis in the diagram.	Hypothesis 2  Genotype  A_B_ or A_bb  aaB_ aabb  e allele of the gene)

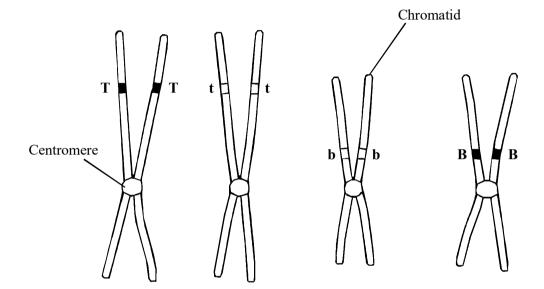
(2)

(c)	Explain <b>one</b> piece of evidence from the diagram which shows that Hypothesis 2 should be rejected.	
		(2)

(d)	Individual 18 was crossed with a pig of genotype <b>Aabb</b> .  Use Hypothesis 1 to predict the genotypes and the ratio of phenotypes expected in the offspring of this cross.				
		Individual 18	Other parent		
	ental				
geno	otypes		Aabb		
Pare	ental				
gam	etes				
Offs	pring				
	otypes				
Offs	pring				
	notypes				
Frn	ected ratio				
of of	fspring				
pher	notypes				

- 17. The diagram shows the chromosomes from a plant cell in which 2n = 4. The plant is heterozygous for two characteristics:
  - height (the alleles T = tall and t = dwarf);
  - flower colour (the alleles  $\mathbf{B} =$ blue and  $\mathbf{b} =$ white);

Allele T is dominant to allele t and allele B is dominant to allele b.

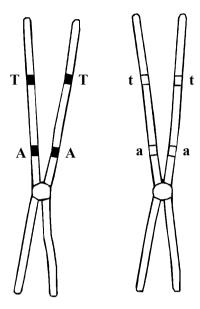


(a) (i) In the space below, draw a diagram to show the appearance of these chromosomes just as they are beginning to separate in the first stage of meiosis.

(2)

(ii)	Give all the different genotypes of the gametes produced at the end of meiosis in this plant.		
		(1)	

The plant is also heterozygous for another characteristic, the colour of its stem. The alleles responsible (A = purple stem, a = green stem) are carried on the same pair of chromosomes as the alleles for height. Allele A is dominant to allele a. The pair of chromosomes is shown in the diagram.



The plant was crossed with a dwarf, green-stemmed plant and produced a large number of offspring. The table shows the results.

Phenotype	Tall, purple- stemmed	Tall, green- stemmed	Dwarf, purple- stemmed	Dwarf, green-stemme d
Number of offspring	91	9	11	89

(b)	(i)	Explain how crossing over accounts for the fact that the offspring include some individuals which are tall and green-stemmed and some which are dwarf and purple-stemmed.					
			(2)				

(ii)	Suggest why there are fewer offspring with these phenotypes.	
		(1)

(iii)	When observing dividing cells under a microscope, how would you recognise that crossing over had taken place?	
		(1)

(c)	Give <b>two</b> factors, other than crossing over, which result in genetic variation in the offspring produced by a sexually reproducing organism. In each case, explain how the factor brings about genetic variation.	
		(4)
	(Total 11 may	rke

18.	(a)	Expl	ain what is meant by
		(i)	a recessive allele;

(ii)	codominant alleles.	
		(2)

(b) Chickens homozygous for black feathers were crossed with chickens homozygous for white feathers. These colours are determined by alleles of a single gene. All the F<sub>1</sub> offspring had blue feathers.

When the blue-feathered  $F_1$  chickens were crossed with each other, there were black-feathered, white-feathered and blue-feathered chickens in the  $F_2$  offspring.

(i) Complete the genetic diagram to explain. how the F<sub>1</sub>, and F<sub>2</sub> phenotypes were produced.

Parental phenotypes Black-feathered White-feathered Parental genotypes  $F^BF^B$   $F^WF^W$ 

PMT

 $F_1$  genotype

 $F_1$ , gametes

F<sub>2</sub> genotypes

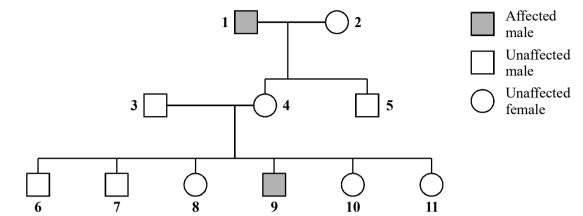
 $F_2$  phenotypes Black-feathered White-feathered Blue-feathered

**(4)** 

(ii)	The number of black-feathered, white-feathered and blue-feathered chick	ens in the
	F <sub>2</sub> offspring was counted. The observed ratio of black: white: blue was s	imilar to
	the ratio expected from theory but not the same. Explain why observed ratios often not the same as the expected ratios.	tios are
		••••
		(2)
		(Total 8 marks)

19.	(a)	Expl	in what is meant by			
		(i)	an allele;			
		(ii)	a sex-linked gene.			
				(2)		
				(4)		

(b) Becker muscular dystrophy is an inherited condition caused by an allele of a gene. Sufferers experience some loss of muscle strength. The diagram shows how members of one family were affected by the condition.



(i)	Explain <b>one</b> piece of evidence from the diagram which shows that the allele for Becker muscular dystrophy is recessive.	
	Becker muscular dyshophly is recessive.	
		(2)

(ii)	The allele for Becker muscular dystrophy is sex-linked. Explain how individual 9 inherited the condition from his grandfather.
	(Total 6 marks)

Number of	91	9	11	89
offspring				

(b)	(i)	Explain how crossing over accounts for the fact that the offspring include some individuals which are tall and green-stemmed and some which are dwarf and purple-stemmed.

		(2
(ii)	Suggest why there are fewer offspring with these phenotypes.	
		(1)
(iii)	When observing dividing cells under a microscope, how would you recognise that crossing over had taken place?	
		(1)
		(1)
offspi	ring produced by a sexually reproducing organism. In each case, explain how the	
	offspi	(iii) When observing dividing cells under a microscope, how would you recognise that crossing over had taken place?

**21.** (a) A protein found on red blood cells, called antigen G, is coded for by a dominant allele of a gene found on the X chromosome. There is no corresponding gene on the Y chromosome.

The members of one family were tested for the presence of antigen G in the blood. The antigen was found in the daughter, her father and her father's mother, as shown in the genetic diagram below. No other members had the antigen.

		Grandmother (has antigen G)	Grandfather	Grandmo	ther	Grandfather
Geno	otypes	or				••••
Gam geno		or				
			nther ntigen G)		Mother	r
Geno	types					
Game						
				Daughter		
			(has	s antigen G)		
Geno	type					
(i)	diagram, us	grandmothers has $X$ ing the symbol $X$ mosome, and $X^g$	<b>K</b> <sup>G</sup> to show the p			_
	(1					
(ii)	Complete the	he rest of the dia	gram.			
						(3)
(iii)	The mother and father have a son. What is the probability of this son inheriting antigen G? Explain your answer.					inheriting
	Probability					
						(2)
		when the X and Y er chromosomes		oair up, they do n	ot form a	ı typical

(b)

		(Total 8 mai	(2)
		(Total o mai	KSj
	colour nosom	in mice is controlled by two genes, each with two alleles. The genes are on different es.	
bandi	ng pat	ontrols the pigment colour. The presence of allele <b>A</b> results in a yellow and black tern on individual hairs, producing an overall grey appearance called agouti. he genotype <b>aa</b> do not make the yellow pigment and are, therefore, black.	
	opmen	ene determines whether any pigment is produced. The allele <b>D</b> is required for at of coat colour. Mice with the genotype <b>dd</b> produce no pigment and are called	
(a)	What	type of gene interaction is occurring between the two genes? Explain your answer.	
	•••••		
	•••••		(2)
(b)	Give	all the possible genotypes for a black mouse.	
			(1)
(c)		gouti mouse of unknown genotype was crossed with an albino mouse of unknown type. Their offspring included albino, agouti and black mice.	
	(i)	What was the genotype of the agouti parent?	
			(1)
	(ii)	Give <b>two</b> possible genotypes for the albino parent.	
			(1)

22.

(iii)	Suggest how the actual genotype of the albino parent could be determined.		
	(2)		
	(2) (Total 7 marks)		

23.	Answers should be written in continuous prose. Credit will be given for biological accuracy, the
	organisation and presentation of the information and the way in which the answer is expressed.

Read the following passage

Bt is a toxin made by the soil bacterium, *Bacillus thuringiensis*. It is very toxic to insects so it is an effective insecticide. Unfortunately, resistant strains have developed in the diamond-back moth, whose caterpillars are important pests of crops of the cabbage family.

To try to overcome some of the problems of resistance, a programme of crop management was developed. Studies showed that the allele which confers resistance on diamond-back moths was recessive. Farmers were encouraged to leave a few untreated fields in which moths that were susceptible to Bt would survive. If the rest of the fields were then sprayed with Bt, a few resistant individuals would remain. However, because they were likely to mate with susceptible individuals from the untreated fields, the number of resistant moths in the population would not increase.

(a)		y populations of insect pest have become resistant to insecticides. Explain how tion can result in an insect population which is resistant to a particular insecticide.	
			(5)
(b)	(i)	Explain how the programme of crop management described in the second paragraph prevents the number of resistant moths from increasing.	

		dominant.
		(6) (Total 11 marks)
24.	color labor	e flour beetle, the allele for red body colour ( <b>R</b> ) is dominant to the allele for black body at ( <b>r</b> ). A mixed culture of red beetles and black beetles was kept in a container in the atory under optimal breeding conditions. After one year, there were 149 red beetles and 84 beetles in the container.
	(a)	Use the Hardy-Weinberg equation to calculate the expected percentage of heterozygous red beetles in this population.
		Answer:(3)
	(b)	Several assumptions are made when using the Hardy-Weinberg equation. Give <b>two</b> of these.
		1
		2(2)
		(Total 5 marks)

Explain why this programme would not work if the resistance allele were

(ii)

(1	(4) Fotal 11 marks)

## **25.** Read the following passage.

15

In the living world, success may be measured by reproductive capacity. But this brings its own problems: the more individuals there are, the greater the competition and struggle for survival.

In the early 1830s, Charles Darwin visited the Galapagos Islands, some 1000 km off the coast of Ecuador, where he discovered several different species of small birds, called ground finches. They all seemed to be related to similar birds found on the South American mainland and Darwin suggested that they might therefore have originated from a common ancestor and changed over the years to their present form. More recently, measurements have shown that there are variations, not only between, but also within each species. For instance, on one of the larger islands, called Albemarle, two species of ground finch share the same habitat. The beaks of one species, *Geospiza fortis*, range in depth from 11 to 16 mm, while the other, *Geospiza fuliginosa*, possesses beaks varying from 7 to 10 mm. On another island, *G. fuliginosa* is absent and here *G. fortis* has a range of beak depths from 9 to 12mm.

What causes this divergence when living together? Perhaps competition is the answer. The two species specialised by feeding on different-sized seeds. As beak depths diverged, competition was reduced.

Use information from the passage and your own knowledge to answer the following question.
Explain how the process of natural selection on the two islands might have led to the different ranges of beak depth in <i>G. fortis</i> .
(Total 7 marks)

26. New Zealand beech trees do not produce seeds every year. A study was carried out on the mice living in an isolated New Zealand beech forest. Because of the location of this forest, biologists could only visit it at monthly intervals and stay approximately 12 hours on each visit.

At the beginning of each visit, they set all the traps they had available. This number varied. At the end of the visit, they collected the traps and released any mice they had captured.

**Figure 1** shows the population density of the mice at different times during a New Zealand beech seed year and a non-seed year.

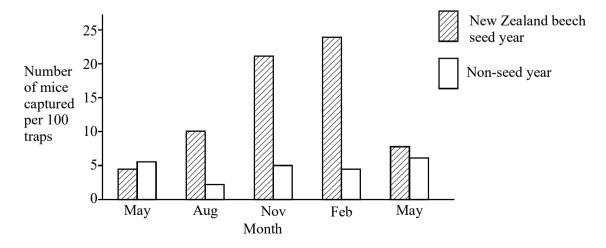
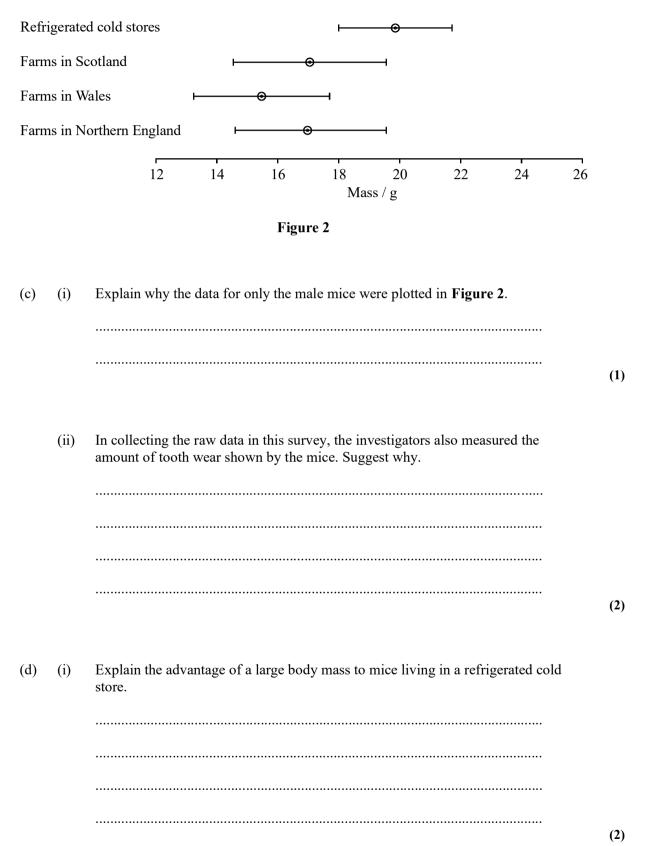


Figure 1

(a)	Use	the information in the question to suggest	
	(i)	why the mark-release-recapture method would have given unreliable results;	
			(2)
	(ii)	the advantage of giving the number of mice captured per 100 traps rather than just the number of mice captured.	
			(2)
(b)	(i)	A statistical test was carried out on the August figures. The population density of mice in the seed year was found to be significantly different at the $p=0.05$ level from the population density in the non-seed year. Explain the meaning of this statement.	
			(2)
	(ii)	Suggest why the population density increases in a seed year.	
			(2)

In a different survey, mice were trapped at various sites in the UK. Figure 2 shows the mean body mass and the standard deviation of the adult males that were among the trapped mice.



	(ii)	Use the information in <b>Figure 2</b> to explain what is meant by directional selection.	
			(3)
			(0)
(e)		colour of wild mice is grey but in some island populations there are black mice. difference in colour is caused by a single pair of alleles.	
	(i)	Describe how you could use genetic crosses to show that the allele for black is the recessive allele.	
			(2)
			(-)
	(ii)	Explain how you could find the frequency of the recessive allele in a population of mice living on an island.	
		(Total 20 m	(2)

27.	(a)	What is meant by reproductive isolation?	
			(1)
	(b)	Explain how geographical isolation can lead to the formation of new species.	
		(T:4-15	(4)
		(Total 5 n	narks)
28.	(a)	Explain what is meant by a gene pool.	
			(2)

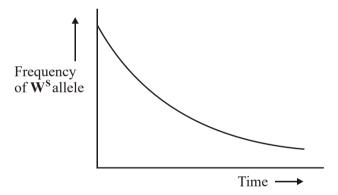
	(b)	Greater willow herb is a common plant found in damp places. It usually has red flowers controlled by the allele <b>R</b> . Plants with the genotype <b>rr</b> , however, have white flowers. In a sample of plants growing beside a ditch, 17 had white flowers and 327 had red flowers.				
		(i)	Calculate the frequency of the ${\bf r}$ allele in this sample. Show your working.			
			Frequency of <b>r</b> allele =	(2)		
		(ii)	The Hardy-Weinberg equation could be used to find the frequencies of the different genotypes in the population from which this sample was taken. Give <b>one</b> assumption that must be made if the equation is to be applied.			
			(Total 5 ma	(1) arks)		
29.	inter	nal blee	a substance which inhibits blood clotting. Rats which eat warfarin are killed due to ding. Some rats are resistant to warfarin as they have the allele $\mathbf{W}^{\mathbf{R}}$ . ree possible genotypes:			
		W <sup>R</sup> W W <sup>R</sup> W W <sup>S</sup> W	resistant to warfarin			
			rats with the genotype $W^RW^R$ require very large amounts of vitamin K in their do not receive this they will die within a few days due to internal bleeding.			
	(a)		can resistance suddenly appear in an isolated population of rats which has never e been exposed to warfarin?			

(b)	cont	A population of 240 rats was reared in a laboratory. They were all fed on a diet containing an adequate amount of vitamin K. In this population, 8 rats had the genotype $\mathbf{W^SW^S}$ , 176 had the genotype $\mathbf{W^RW^S}$ and 56 had the genotype $\mathbf{W^RW^R}$ .				
	(i)	Use these figures to calculate the actual frequency of the allele $\mathbf{W}^{\mathbf{R}}$ in this population. Show your working.				
		A mayyan				
		Answer	(2)			
	(ii)	The diet of the rats was then changed to include only a small amount of vitamin K. The rats were also given warfarin. How many rats out of the population of 240 would be likely to die within a few days?				
			(1)			
(c)	In a	population of wild rats, 51% were resistant to warfarin.				
	(i)	Use the Hardy-Weinberg equation to estimate the percentage of rats in this population which would be heterozygous for warfarin resistance. Show your working.				
		Answer %	(3)			

(ii) If all the susceptible rats in this population were killed by warfarin, more susceptible rats would appear in the next generation. Use a genetic diagram to explain how.

(2)

(iii) The graph shows the change in the frequency of the  $\mathbf{W}^{\mathbf{S}}$  allele in an area in which warfarin was regularly used. Describe and explain the shape of the curve.



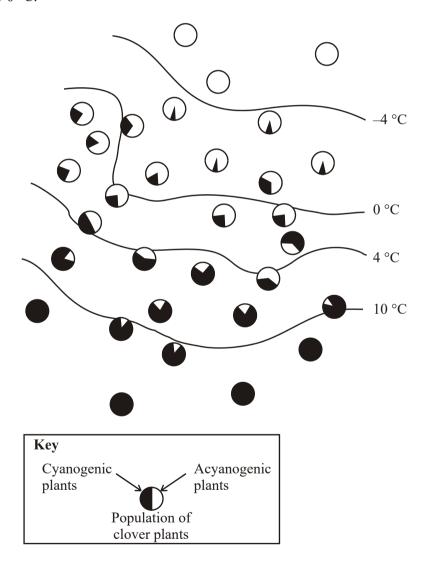
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•••••	• • • • • • • • • • • • • • • • • • • •		• • • • • • • • • • • • • • • • • • • •	• • • • • • • • • • • • • • • • • • • •
•••••	• • • • • • • • • • • • • • • • • • • •		•••••	•••••

(iv)	Give <b>two</b> assumptions that must be made when using the Hardy-Weinberg equation.	
	1	
	2	
	(F. ) 145	(2)
	(Total 15	marks)
•••••		
		(5)
	Exp	equation.  1

(b) Some European clover plants can produce cyanide. Those plants that can produce cyanide are called cyanogenic; those that cannot produce cyanide are called acyanogenic. Cyanide is toxic to the cells of animals and plants.

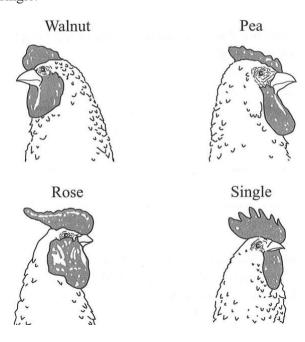
When the leaves of cyanogenic plants are damaged by slugs, or exposed to low temperatures, membranes within the cells are broken. This causes the release of the enzymes that control the reactions which produce cyanide.

The proportions of cyanogenic and acyanogenic plants in clover populations were determined in different parts of Europe. These are shown in the diagram below, together with the mean minimum winter temperatures. Slugs are not usually active at temperatures below  $0\,^{\circ}\mathrm{C}$ .



explain the proportions of cyanogenic and acyanogenic plants in clover populations rowing in the area where the mean minimum winter temperature is below –4°C and in the area where it is above 10 °C.
(5) (Total 10 marks)

**31.** Chickens have a structure on their heads called a comb. The diagram shows four types of comb: walnut, pea, rose and single.



Two genes control the type of comb; each gene has a dominant and a recessive allele. The two genes are inherited independently, but interact to produce the four types of comb.

Genotype	Phenotype
A- B-	Walnut
A- bb	Pea
aa B-	Rose
aa bb	Single

A male with a pea comb, heterozygous for gene A, was crossed with a rose-combed

The symbol - indicates that either the dominant allele or recessive allele could be present

female, heterozygous for go expected from this cross.	ene B. Complete the geneti	c diagram to show the offspring
Phenotypes of parents	Pea comb	Rose comb
Genotypes of parents		
Gametes formed		

(a)

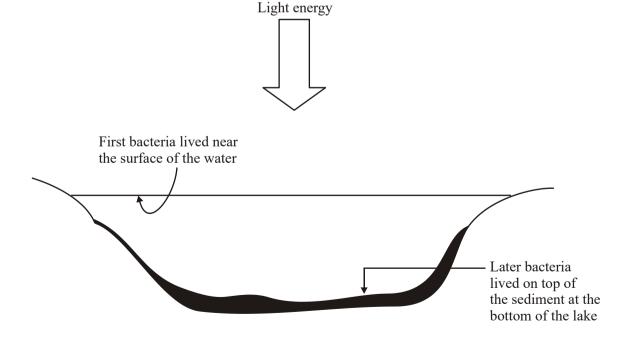
Offspring genotypes	
Ratio of offspring phenotypes	

**(3)** 

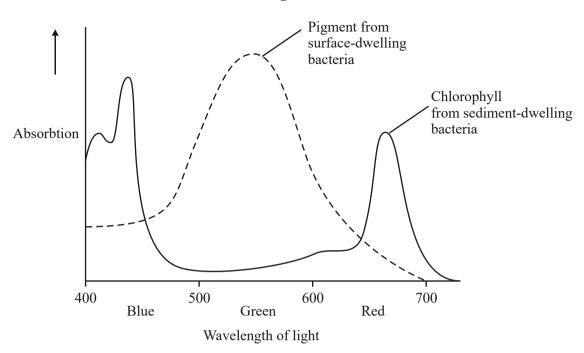
(b) Chickens with rose or single combs made up 36% of one population. Assuming the conditions of the Hardy-Weinberg equilibrium apply, calculate the frequency of allele **a** in this population. Show how you arrived at your answer.

32. There is evidence that the first photosynthetic organisms were primitive water-dwelling bacteria. The very first of these lived near the surface of the water in lakes and contained a purple pigment that absorbed light most strongly in the green region of the spectrum. Later, other bacteria evolved that lived on the top of sediment at the bottom of the lakes (Figure 1). Gene mutations had enabled these bacteria to synthesise chlorophyll instead of the purple pigment present in the bacteria living near to the surface. Chlorophyll absorbs light most strongly in the blue and red regions of the spectrum (Figure 2).

Figure 1







(a)

Describe how light energy absorbed by chlorophyll molecules is used to synthesise ATP.

(b)	Use <b>Figure 2</b> to explain how natural selection would favour the evolution of sediment-dwelling bacteria containing a different photosynthetic pigment from those living near the surface of the water.					
	(6)					
	(Total 11 marks)					

## **33.** Read the following passage.

## Madagascar

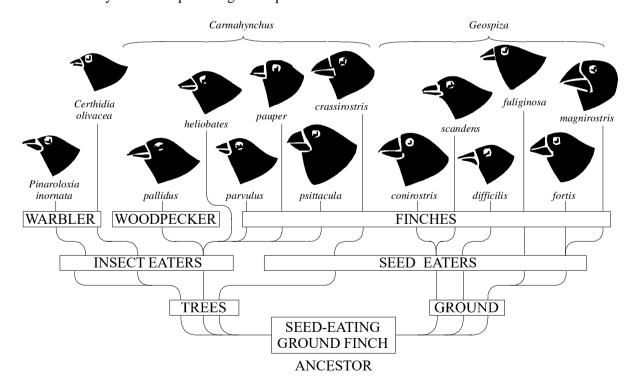
The island of Madagascar has been described as the laboratory of evolution. It broke away from mainland Africa at least 120 million years ago and, following this, many new species developed. Estimates of the number of plant species on the island vary from 7 370 to 12 000, making it botanically one of the richest areas in the world. Of 400 flowering plant families found worldwide, 200 grow only in Madagascar. Among animals, true lemurs are found nowhere else, and 95 per cent of the country's 235 known species of reptiles evolved on the island. Over the past 25 years the human population has doubled. Land shortage is leading to clearing of the forest, and Madagascar is now facing deforestation on a massive scale. Scientists have estimated that even if the forest could recover, regeneration could take up to a hundred years.

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		(
(i)	Explain the processes which might have led to the evolution of new species on the island.	
(ii)	Suggest and explain how the number of animal species on the island may have	
	changed as it became ,botanically one of the richest areas in the world".	

(c)	Describe the processes by which forest is able to regenerate after being cleared.
	(4)
	(Total 12 marks)

**34.** Fourteen different species of finch live on the isolated Galapagos Islands. The finches are believed to have all evolved from a single common ancestor. The diagram shows the suggested evolutionary relationships amongst the species.



(a)	Sugg	gest why these fourteen types of finch ar	e considered to be different species.	
				(1)
(b)	Use	the information in the diagram to identif	y	
	(i)	the species of ground finch which eats	the largest seeds;	
	(ii)	the number of genera which are presen	at on the islands.	
				(2)
(c)		gest how two distinct species, one insect- ved from a common ancestor.	eating and the other seed-eating, may have	
			(T. 1.17	(4)
			(Total 7	marks
tissu	es are	ns of clover are cyanogenic. They production of hydrogen catalysed by an enzyme produced by a dif		
		Dominant allele A	Dominant allele B	
		<b>▼</b> Enzyme A	♥ Enzyme B	
Sub	strate	→ Cyanogenic glucoside	→ Hydrogen cyanide	

35.

(a)		are the phenotypes (cyanogenic or non-cyanogenic) of the following genotypes? ain your answer.	
	(i)	AABb	
	(ii)	aaBB	
			(3)
(b)	Two	clover plants, each with the genotype AaBb were crossed.	
	(i)	Use a genetic diagram to show the genotypes of the offspring.	
	(ii)	What is the expected ratio of cyanogenic to non-cyanogenic plants in the offspring?	
			(3)

(c)	high freez The	altitude where the climate is colder. When the cells of cyanogenic clover plants are, the hydrogen cyanide that is released kills the cells and as a result the plant dies. frequencies of the alleles for cyanogenesis are different in clover plants growing at and at high altitudes.
	(i)	How would you expect the allele frequencies to differ?
	(ii)	Use the information given to explain how the different allele frequencies might be the result of natural selection.
		(6) (Total 12 marks)

- **36.** The purple saxifrage is a flowering plant found in the Arctic. It has two distinct forms, one growing on dry ridges, the other in the valleys.
  - On dry ridges, where the temperature is higher and the growing season longer, the plants grow in upright tufts. These plants are drought tolerant and store carbohydrate which they use in times of stress.
  - In the valleys, where it is colder and the growing season is shorter, the plants grow very close to the ground. These plants have a higher rate of photosynthesis and grow more rapidly.

Both forms usually complete their life cycle in the short Arctic summer. In unfavourable years, plants in the valleys may produce pollen but are unable to form seeds. Some pollen from the valley plants fertilises plants on the ridges. The seeds may then be washed down to the valleys. Those that develop and complete their life cycles are all low-growing plants. When plants from the ridges and the valleys are grown under identical conditions in the laboratory, they have the same growth form as they did when in their original environment.

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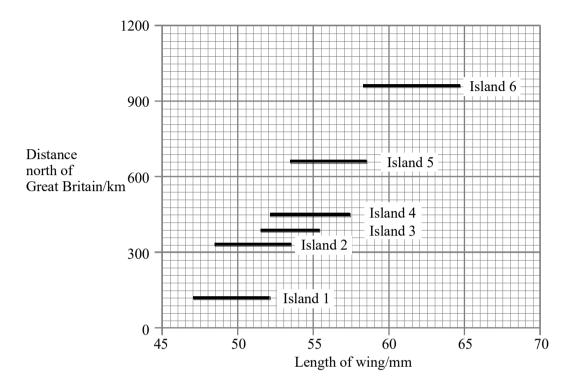
(a)	Wha	t is the evidence in the passage that the two forms of the purple saxifrage	
	(i)	are genetically different;	
			(1)
	(ii)	belong to the same species?	
			(1)

(b)	When cross pollination between the low-growing and upright forms occurs, both forms of plant develop when the seeds produced are grown in the laboratory. Explain why only low-growing plants develop from the seeds which are washed from the ridges into the valleys.	
		(2)
(c)	Under the conditions described, the two forms of the purple saxifrage are unlikely to evolve into separate species. Explain why.	
		(2)
(d)	The effect of global warming on the environment of the Arctic is uncertain. Suggest why species such as the purple saxifrage are likely to survive even if changes in climate do occur.	
		(0)
	(Total 8 m	(2) arks)

7.	North Ame	apple maggot fly ( <i>Rhagoletis pomonella</i> ) was found originally only on hawthorn tree a America. In the 19th century, it spread as a pest to apple trees introduced into Norrica by farmers. The flies attacking the apple trees are now genetically different frow that attack hawthorn trees. It is thought that a new species of fly may be evolving.	th
	(a)	Suggest how the flies that feed on apple trees could evolve from those that fed on hawthorn trees.	
			(3)
	(b)	Suggest <b>one</b> way in which scientists could find out whether the flies from apple to were a different species from those found on hawthorn trees.	rees
			 (2) (Total 5 marks)

37.

**38.** The diagram shows the range in wing length of a species of small bird on different islands to the north of Great Britain.



(a)	(i)	On which islands might a bird with wings 55mm long live?

(1)

(ii) What would be the mid-point of the range of wing length expected on an island that is 750km north of Great Britain?

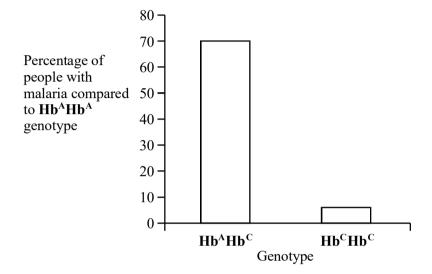
(1)

(b)	In this species wing length increases with body size. Suggest how this trend in body size
	might help the birds to survive.

.....

	Explain how selection may have resulted in an increase in body size.	(c)	
(3) Total 7 marks)			
,	·		
	Explain how natural selection produces changes within a species.	. (a)	39.
(4)			

(b) Malaria is caused by a parasite that attacks red blood cells, producing repeated bouts of serious illness and often causing death. The allete for normal haemoglobin in red cells is  $\mathbf{Hb^A}$ . In the West African country of Burkina Faso, twenty percent of people are heterozygous for a different allele,  $\mathbf{Hb^C}$ , which has no effect on their health. People homozygous for  $\mathbf{Hb^C}$  suffer a very mild anaemia. The bar chart shows how the  $\mathbf{Hb^C}$  allele affects the chance of getting malaria.



(1)	Use the bar chart to describe how the <b>Hb</b> ° allele affects the chance of getting malaria.

**(2)** 

		(ii)	Malaria is very common in Burkina Faso. The <b>Hb</b> <sup>C</sup> allele is increasing in frequency in this part of Africa. Suggest an explanation for this.	
			(Total 8 ma	(2) arks)
40.	spray per b	yed on oillion.	pt to control the huge numbers of an insect pest, low doses of a pesticide were a lake. After spraying, the concentration of pesticide in the lake water was 14 parts After spraying, diving birds which fed on small fish in the lake were found to be concentration of the pesticide in these birds was more than 1 part per thousand.	
40.	spray per b	yed on oillion. g. The	a lake. After spraying, the concentration of pesticide in the lake water was 14 parts After spraying, diving birds which fed on small fish in the lake were found to be	
40.	spray per b dyin	yed on oillion. g. The	a lake. After spraying, the concentration of pesticide in the lake water was 14 parts After spraying, diving birds which fed on small fish in the lake were found to be concentration of the pesticide in these birds was more than 1 part per thousand.	
40.	spray per b dyin	yed on oillion. g. The	a lake. After spraying, the concentration of pesticide in the lake water was 14 parts After spraying, diving birds which fed on small fish in the lake were found to be concentration of the pesticide in these birds was more than 1 part per thousand.	
40.	spray per b dyin	yed on oillion. g. The	a lake. After spraying, the concentration of pesticide in the lake water was 14 parts After spraying, diving birds which fed on small fish in the lake were found to be concentration of the pesticide in these birds was more than 1 part per thousand.	
40.	spray per b dyin	yed on oillion. g. The	a lake. After spraying, the concentration of pesticide in the lake water was 14 parts After spraying, diving birds which fed on small fish in the lake were found to be concentration of the pesticide in these birds was more than 1 part per thousand.	
440.	spray per b dyin	yed on oillion. g. The	a lake. After spraying, the concentration of pesticide in the lake water was 14 parts After spraying, diving birds which fed on small fish in the lake were found to be concentration of the pesticide in these birds was more than 1 part per thousand.	

S	(b)	The lake was sprayed three times. The first spraying killed almost all of the insects, as did a second application five years later. When the lake was treated for a third time it was found that some insects were resistant to the pesticide.	
		Explain how resistance to the pesticide evolved in the insect population.	
			(3)
S	(c)	This pesticide is able to pass easily through cell membranes. Suggest why.	
			(2)
		(Total 8 ma	ırks)
41.		e Malawi in East Africa contains around 400 different species of cichlids which are small, atly coloured fish. All these species have evolved from a common ancestor.	
	(a)	Describe <b>one</b> way in which scientists could find out whether cichlids from two different populations belong to the same species.	
			(2)

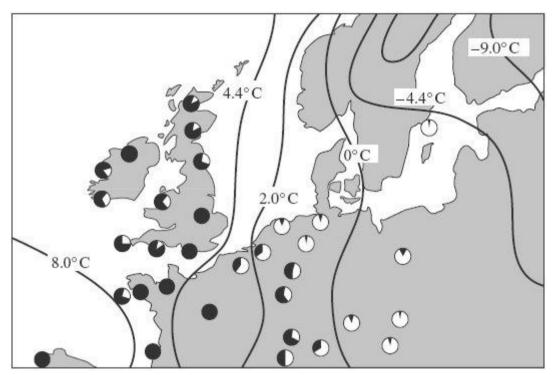
(b)	During the last 700 000 years there have been long periods when the water level was much lower and Lake Malawi split up into many smaller lakes. Explain how speciation of the cichlids may have occurred following the formation of separate, smaller lakes.	
		(4)
(c)	Many species of cichlids are similar in size and, apart from their colour, in appearance. Suggest how the variety of colour patterns displayed by these cichlids may help to maintain the fish as separate species.	
	(Total 8 ma	(2) arks)

42. S Clover plants have leaves all through the year. Some clover plants have leaves that produce poisonous hydrogen cyanide gas when damaged. These cyanogenic plants are less likely to be eaten by snails. However, the leaves of these plants can be damaged by frost, resulting in the production of enough hydrogen cyanide to kill the plants. Acyanogenic plants do not produce hydrogen cyanide. This characteristic is genetically controlled.

The map shows the proportions of the two types of plant in populations of clover from different areas in Europe. It also shows isotherms, lines joining places with the same mean January temperature.

## Key





(a)	Explain how different proportions of cyanogenic plants may have evolved in populations in different parts of Europe.	
		(4)
(b)	Differences in cyanide production may affect the total number of clover plants growing in different areas. Describe how you would use quadrats in an investigation to determine whether or not there is a difference in the number of clover plants in two large areas of equal size.	
	(Total 8 n	(4) narks)

43. The polecat, shown in the drawing, is a wild British mammal. At one time it was very rare. It is now more common and its range is increasing. Scientists carried out a survey of the distribution and status of polecats in Britain during the 1990s.



The first problem that the scientists had was that they needed to distinguish between wild polecats and escaped ferrets. Ferrets are domesticated polecats. They investigated skulls from polecats and ferrets.

They used dial callipers to take skull measurements. They took each measurement six times on six different skulls. They used their measurements to calculate a percentage measurement error using the formula:

Percentage measurement error = 
$$\frac{100(1+0.25n)\sigma}{x}$$

where n = number of measurements

 $\sigma$  = standard deviation

x = mean

(a)	(i)	Use the information from this question to explain the difference between accuracy and reliability.
	(ii)	Unreliable measurements will produce a large percentage measurement error. Use the formula to explain why.

**(2)** 

Table 1 shows some of the skull measurements obtained by the scientists.

Table 1

Animal	Sex	Number of	Mean skull breadth/mm		Cranial volume/cm <sup>3</sup>	
		skulls measured	mean	standard deviation	mean	standard deviation
Polecat	Male	90	16.38	1.34	10.15	0.92
Ferret	Male	114	15.56	0.84	8.96	0.93
Polecat	Female	44	15.52	1.04	8.34	0.68
Ferret	Female	47	14.42	0.78	7.03	0.55

(b)	(i)	Describe <b>one</b> way in which you could show whether there was a correlation between mean skull breadth and mean cranial volume.	
			(2)
	(ii)	The scientists found that there was an advantage in taking measurements of skull breadth rather than cranial volume when measuring skull size. Suggest this advantage.	
			(1)

	(111)	a polecat of from a ferret? Explain the evidence from <b>Table 1</b> that supports your answer.	
			(3)
(c)	"Som and to Desc	e report that the scientists wrote, they referred to an earlier scientific paper about the characteristics of the skulls and skins of the European polecat, the Asiatic polecat the domestic ferret" ribe <b>two</b> ways in which this earlier paper might have helped the scientists to carry their work and produce a reliable report.	
			(2)

In this survey, the scientists collected the bodies of the dead polecats from roads where they had been killed by passing vehicles. They analysed the stomachs to see what the polecats had eaten. **Table 2** shows the results.

Table 2

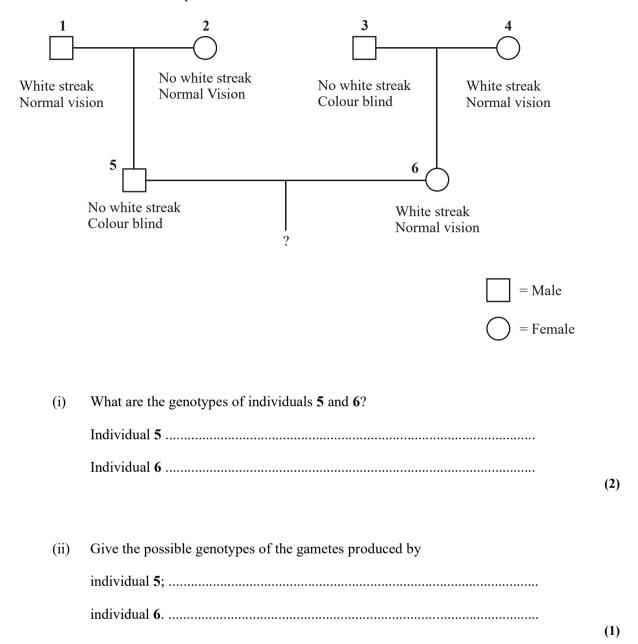
		Total number of	polecats examined	l = 83
Prey	Mass/g	Mass as percentage of all prey	Number of stomachs in which prey item found	Percentage of all stomachs in which prey item found
Rabbit	1063.80	85.4	60	72.3
Rat	22.18	1.8	2	2.4
Other mammals	43.54	3.5	9	10.8
Pigeons	29.45	2.4	3	3.6
Other birds	7.68	0.6	5	5.6
Frogs and toads	56.98	4.6	7	8.4
Fish	0.12	0.01	1	1.2
Earthworms	21.97	1.8	2	2.4
Total	1245.72		89	

(d)	The table shows that a total of 83 stomachs were analysed. Explain why the total for the number of stomachs in which the prey item was found was more than 83.

(1)

	(e)	Use the data to suggest how you would explain to these farmers that they should tolerate polecats on their land.	
		(Total 15 marl	(2) ks)
			ĺ
44.	<b>X</b> <sup>b</sup> , i a wh	our blindness is controlled by a gene on the $X$ chromosome. The allele for colour blindness, is recessive to the allele for normal colour vision, $X^B$ . The gene controlling the presence of ite streak in the hair is not sex linked, with the allele for the presence of a white streak, $H$ , is dominant to the allele for the absence of a white streak, $H$ .	
	(a)	Explain why colour blindness is more common in men than in women.	
			(2)

(b) The diagram shows a family tree in which some of the individuals have colour blindness or have a white streak present in the hair.



		(iii) What is the probability that the first child of individuals <b>5</b> and <b>6</b> will be a colour blind boy with a white streak in his hair? Show your working.	
		Answer	
			(2) ks)
45.	The	production of pigment in rabbit fur is controlled by two genes.	
	the pigminact	gene controls whether any pigment is made. This gene has three alleles. Allele <b>A</b> codes for production of one form of the enzyme tyrosinase, which converts tyrosine into a black ment. Allele <b>A</b> <sup>h</sup> codes for the production of a second form of the enzyme, which becomes tive at temperatures close to a rabbit's core body temperature, so only the face, ears, legs tail are pigmented. A third allele, <b>a</b> , fails to code for a functional tyrosinase.	
	dom	other gene controls the density of pigment in the fur. This gene has two alleles. Allele <b>B</b> is inant and results in the production of large amounts of pigment, making the fur black. le <b>b</b> results in less pigment, so the fur appears brown.	
	(a)	How do multiple alleles of a gene arise?	
			(2)

(b) The table shows some genotypes and phenotypes.

Genotype	Phenotype
A-B-	all fur black
aaB–	all fur white (albino)
a <sup>h</sup> abb	white body fur with brown face, ears, legs and tail (Himalayan)

(i)	What do the dashes represent in the genotype of the black rabbit?	
		(1)
(ii)	Give all the possible genotypes for a Himalayan rabbit with black face, ears, legs and tail.	
		(2)
(iii)	Suggest an explanation for the pigment being present only in the tail, ears, face and legs of a Himalayan rabbit.	
		(2)

(c)	Using the information given, explain why the phenotypes of rabbits with <b>AABB</b> and <b>Aa<sup>h</sup>BB</b> genotypes are the same.
	(2) (Total 9 marks)

**46.** Coat colour in Labrador dogs is controlled by two different genes. Each gene has a dominant and a recessive allele. The two genes are inherited independently but the effects of the alleles interact to produce three different coat colours. The table gives four genotypes and the phenotypes they produce.

Genotype	Phenotype
BbEe	black
bbEe	chocolate
Bbee	yellow
bbee	yellow

(a)	What colour coat would you expect each of the following genotypes to give?			
	(i)	BBEe		
	(ii)	bbEE		

**(2)** 

(b) A **BbEe** male was crossed with a **bbee** female. Complete the genetic diagram to show the ratio of offspring you would expect.

Parental phenotypes Black male × Yellow female

Parental genotypes BbEe bbee

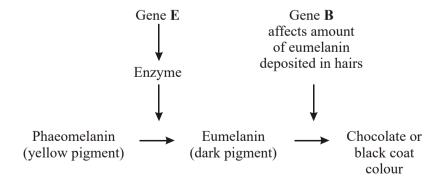
Gametes

Offspring genotypes

Offspring phenotypes

Ratio of offspring phenotypes

(c) The yellow coat colour of Labrador dogs is due to the presence of the pigment phaeomelanin in the hairs. The black and chocolate coat colours are due to different amounts of another pigment, eumelanin, deposited in these hairs. The more eumelanin there is, the darker the hair. The diagram shows the action of genes **E** and **B** in producing the different coat colours.



(3)

(1)

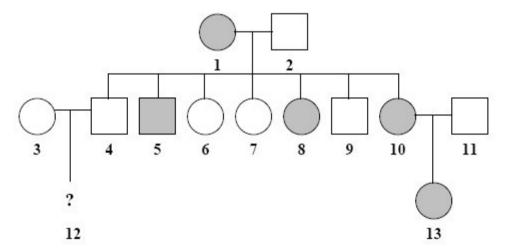
		Use t	this information to explain how	
		(i)	the genotype bbee produces a yellow coat colour;	
				(2)
		(ii)	the genotype <b>BbEe</b> produces a black coat colour.	
			(Total 9	(2) marks
<b>1</b> 7.	horn coat	ed conc	of cattle the <b>H</b> allele for the hornless condition is dominant to the <b>h</b> allele for the adition. In the same breed of cattle the two alleles $C^R$ (red) and $C^W$ (white) control $C^R$ . When red cattle were crossed with white cattle all the offspring were roan. Roan a mixture of red and white hairs.	
	(a)		lain what is meant by a <i>dominant</i> allele.	
				(1)
				(1)
	(b)	Nam	ne the relationship between the two alleles that control coat colour.	

(c)	Horned, roan cattle were crossed with white cattle heterozygous for the hornless condition. Compete the genetic diagram to show the ratio of offspring phenotypes you would expect.					
	Parer	ntal phenotypes	Horned, roan	×	hornless, white	
	Paren	ntal genotypes				
	Game	etes				
	Offsp	ring genotypes				
	Offsp	ring phenotypes				
		of offspring otypes				(4)
(d)	The semen of prize dairy bulls may be collected for in vitro fertilisation. The sperms in the semen can be separated so that all the calves produced are of the same sex. The two kinds of sperms differ by about 3% in DNA content.					
	(i)	Explain what causes the other kind.	the sperms of or	ne kind t	o have 3% more DNA than sperms of	
				••••••		(2)

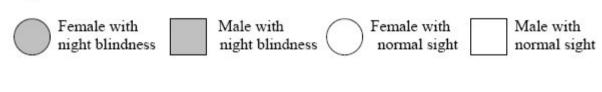
(ii)	Suggest <b>one</b> reason why farmers would want the calves to be all of the same sex.
	(1)
	(1) (Total 9 marks)
	(10tal 7 marks)

**48.** People with night blindness have difficulty seeing in dim light. The allele for night blindness, **N**, is dominant to the allele for normal vision, **n**. These alleles are *not* carried on the sex chromosomes.

The diagram shows part of a family tree showing the inheritance of night blindness



Key

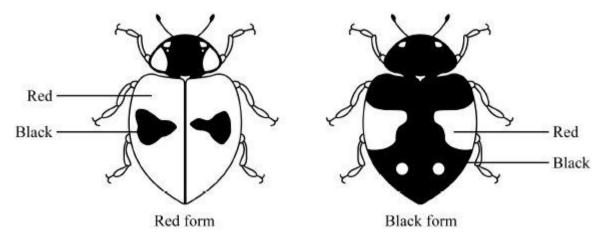


(a) Individual 12 is a boy. What is his phenotype?

**(1)** 

(b)	What is the genotype of individual 1? Explain the evidence for your answer.	
	Genotype	
	Evidence	
		(2)
(c)	What is the probability that the next child born to individuals 10 and 11 will be a girl with night blindness? Show your working.	
	Answer(Total 5 mar	(2) :ks)

**49.** The two-spot ladybird is a small beetle. It has a red form and a black form. These two forms are shown in the diagram.



Colour is controlled by a single gene with two alleles. The allele for black,  ${\bf B}$ , is dominant to the allele for red,  ${\bf b}$ .

Scientists working in Germany compared the number of red and black ladybirds over a ten-year period. They collected random samples of ladybirds from birch trees.

(a)	(i)	It was important that ladybirds in the samples were collected at random. Explain why.	
			(1)
	(ii)	Suggest <b>one</b> method by which the scientists could collect a random sample of ladybirds from the trees.	
			(1)

Some of the results from the investigation are shown in the table.

Year	Season	Frequency of b allele
1933	Autumn	0.70
1934	Spring	0.82
1934	Autumn	0.59
1935	Spring	0.76
1935	Autumn	0.57
1936	Spring	0.78

(b) Use the Hardy-Weinberg expression to estimate the percentages of red ladybirds and black lady birds in the Autumn 1933 ladybird population. Show your working.

Answer	red ladybirds
	black ladybirds

(c)	(i)	The evidence from the table shows that the black ladybirds were at a disadvantage and survived less well over winter. Explain this evidence.	
			(2)
	(ii)	The scientists found that black ladybirds heated up more quickly and became active at lower temperatures than red ladybirds. How might this explain the poorer survival of black ladybirds over winter?	
		(Total 8 ma	(2) arks)

**50.** Answers should be written in continuous prose. Credit will be given for biological accuracy, the organisation and presentation of the information and the way in which the answer is expressed.

Read the following passage

Bt is a toxin made by the soil bacterium, *Bacillus thuringiensis*. It is very toxic to insects so it is an effective insecticide. Unfortunately, resistant strains have developed in the diamond-back moth, whose caterpillars are important pests of crops of the cabbage family.

To try to overcome some of the problems of resistance, a programme of crop management was developed. Studies showed that the allele which confers resistance on diamond-back moths was recessive. Farmers were encouraged to leave a few untreated fields in which moths that were susceptible to Bt would survive. If the rest of the fields were then sprayed with Bt, a few resistant individuals would remain. However, because they were likely to mate with susceptible individuals from the untreated fields, the number of resistant moths in the population would not increase.

(i)	Explain how the programme of crop management described in the second paragraph prevents the number of resistant moths from increasing.	
(ii)	Explain why this programme would not work if the resistance allele were dominant.	

51.	1. In the flour beetle, the allele for red body colour (R) is dominant to the allele for black body colour (r). A mixed culture of red beetles and black beetles was kept in a container in the laboratory under optimal breeding conditions. After one year, there were 149 red beetles and black beetles in the container.				
	(a)	Use the Hardy-Weinberg equation to calculate the expected percentage of heterozygous red beetles in this population.			
		Answer:			
	(b)	Several assumptions are made when using the Hardy-Weinberg equation. Give <b>two</b> of these.	(3)		
		1	(2) arks)		

**52.** Read the following passage.

5

10

15

In the living world, success may be measured by reproductive capacity. But this brings its own problems: the more individuals there are, the greater the competition and struggle for survival.

In the early 1830s, Charles Darwin visited the Galapagos Islands, some 1000 km off the coast of Ecuador, where he discovered several different species of small birds, called ground finches. They all seemed to be related to similar birds found on the South American mainland and Darwin suggested that they might therefore have originated from a common ancestor and changed over the years to their present form. More recently, measurements have shown that there are variations, not only between, but also within each species. For instance, on one of the larger islands, called Albemarle, two species of ground finch share the same habitat. The beaks of one species, *Geospiza fortis*, range in depth from 11 to 16 mm, while the other, *Geospiza fuliginosa*, possesses beaks varying from 7 to 10 mm. On another island,

What causes this divergence when living together? Perhaps competition is the answer. The two species specialised by feeding on different-sized seeds. As beak depths diverged, competition was reduced.

G. fuliginosa is absent and here G. fortis has a range of beak depths from 9 to 12mm.

(Total 7 marks)

Use information from the passage and your own knowledge to answer the following question.
Explain how the process of natural selection on the two islands might have led to the different ranges of beak depth in <i>G. fortis</i> .

53. New Zealand beech trees do not produce seeds every year. A study was carried out on the mice living in an isolated New Zealand beech forest. Because of the location of this forest, biologists could only visit it at monthly intervals and stay approximately 12 hours on each visit.

At the beginning of each visit, they set all the traps they had available. This number varied. At the end of the visit, they collected the traps and released any mice they had captured.

**Figure 1** shows the population density of the mice at different times during a New Zealand beech seed year and a non-seed year.

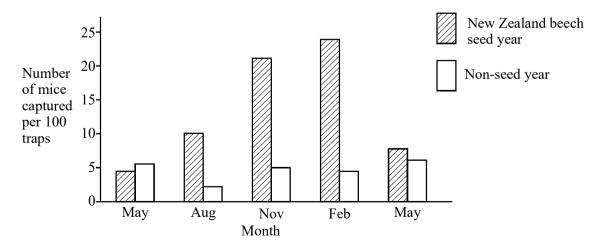


Figure 1

(a) Use the information in the question to suggest

	(1)	why the mark-release-recapture method would have given unreliable results;	
			(2)
	(ii)	the advantage of giving the number of mice captured per 100 traps rather than just the number of mice captured.	
			(2)
(b)	(i)	A statistical test was carried out on the August figures. The population density of mice in the seed year was found to be significantly different at the $p=0.05$ level from the population density in the non-seed year. Explain the meaning of this statement.	
			(2)
	(ii)	Suggest why the population density increases in a seed year.	
			<b></b>
			(2)

In a different survey, mice were trapped at various sites in the UK. Figure 2 shows the mean body mass and the standard deviation of the adult males that were among the trapped mice.

Refrige	erated	d cold stores ⊢ ⊕	
Farms i	in Sc	otland — •	
Farms i	in Wa	ales ⊢ → ·	
Farms i	in No	orthern England — — — — — — — — — — — — — — — — — — —	
		12 14 16 18 20 22 24 26 Mass / g	
		Figure 2	
(c) (a	(i)	Explain why the data for only the male mice were plotted in <b>Figure 2</b> .	
			(1)
(	(ii)	In collecting the raw data in this survey, the investigators also measured the amount of tooth wear shown by the mice. Suggest why.	
			(2)
(d) (s	(i)	Explain the advantage of a large body mass to mice living in a refrigerated cold store.	
			(2)
(	(ii)	Use the information in <b>Figure 2</b> to explain what is meant by directional selection.	

			(2)
			(3)
(e)		colour of wild mice is grey but in some island populations there are black mice. difference in colour is caused by a single pair of alleles.	
	(i)	Describe how you could use genetic crosses to show that the allele for black is the recessive allele.	
			(2)
			(2)
	(ii)	Explain how you could find the frequency of the recessive allele in a population of mice living on an island.	
			(2)
		(Total 20 ma	

54.	(a)	What is meant by reproductive isolation?	
			(1)
	(b)	Explain how geographical isolation can lead to the formation of new species.	
		(Total 5 n	(4) narks)
55.	(a)	Explain what is meant by a gene pool.	
			(2)

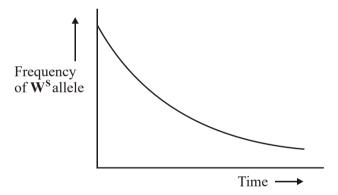
	(b)	Greater willow herb is a common plant found in damp places. It usually has red flowers controlled by the allele <b>R</b> . Plants with the genotype <b>rr</b> , however, have white flowers. In a sample of plants growing beside a ditch, 17 had white flowers and 327 had red flowers.				
		(i)	Calculate the frequency of the ${\bf r}$ allele in this sample. Show your working.			
			Frequency of <b>r</b> allele =	(2)		
		(ii)	The Hardy-Weinberg equation could be used to find the frequencies of the different genotypes in the population from which this sample was taken. Give <b>one</b> assumption that must be made if the equation is to be applied.			
			(Total 5 ma	(1) arks)		
56.	inter	nal blee	a substance which inhibits blood clotting. Rats which eat warfarin are killed due to eding. Some rats are resistant to warfarin as they have the allele $\mathbf{W}^{\mathbf{R}}$ . aree possible genotypes:			
		W <sup>R</sup> W W <sup>R</sup> W W <sup>S</sup> W	resistant to warfarin			
			rats with the genotype $\mathbf{W}^{\mathbf{R}}\mathbf{W}^{\mathbf{R}}$ require very large amounts of vitamin K in their do not receive this they will die within a few days due to internal bleeding.			
	(a)		can resistance suddenly appear in an isolated population of rats which has never e been exposed to warfarin?			

(b)	cont	epulation of 240 rats was reared in a laboratory. They were all fed on a diet aining an adequate amount of vitamin K. In this population, 8 rats had the genotype $\mathbf{V}^{\mathbf{S}}$ , 176 had the genotype $\mathbf{W}^{\mathbf{R}}\mathbf{W}^{\mathbf{S}}$ and 56 had the genotype $\mathbf{W}^{\mathbf{R}}\mathbf{W}^{\mathbf{R}}$ .	
	(i)	Use these figures to calculate the actual frequency of the allele $\mathbf{W}^{\mathbf{R}}$ in this population. Show your working.	
		Answer	(2)
	(ii)	The diet of the rats was then changed to include only a small amount of vitamin K. The rats were also given warfarin. How many rats out of the population of 240 would be likely to die within a few days?	
			(1)
(c)	In a	population of wild rats, 51% were resistant to warfarin.	
	(i)	Use the Hardy-Weinberg equation to estimate the percentage of rats in this population which would be heterozygous for warfarin resistance. Show your working.	
		Answer %	(3)

(ii) If all the susceptible rats in this population were killed by warfarin, more susceptible rats would appear in the next generation. Use a genetic diagram to explain how.

(2)

(iii) The graph shows the change in the frequency of the  $\mathbf{W}^{\mathbf{S}}$  allele in an area in which warfarin was regularly used. Describe and explain the shape of the curve.



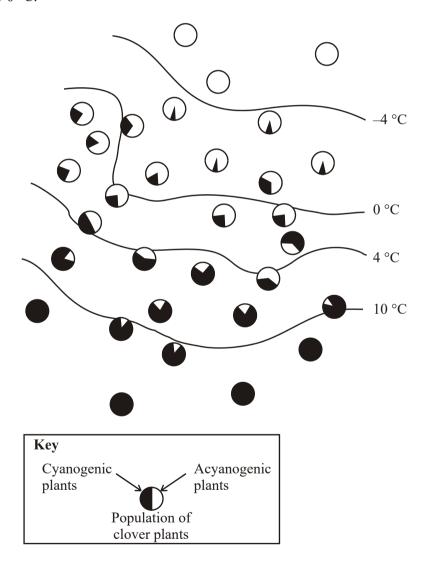
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•••••	• • • • • • • • • • • • • • • • • • • •		•••••	•••••

		(iv)	Give <b>two</b> assumptions that must be made when using the Hardy-Weinberg equation.	
			1	
			2	
			(Total 1	(2) 5 marks)
57.	(a)		ain what is meant by stabilising selection and describe the circumstances under the hit takes place.	
		•••••		
		•••••		
		•••••		(5)

(b) Some European clover plants can produce cyanide. Those plants that can produce cyanide are called cyanogenic; those that cannot produce cyanide are called acyanogenic. Cyanide is toxic to the cells of animals and plants.

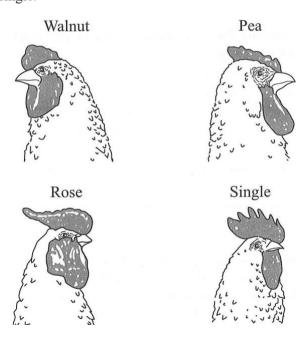
When the leaves of cyanogenic plants are damaged by slugs, or exposed to low temperatures, membranes within the cells are broken. This causes the release of the enzymes that control the reactions which produce cyanide.

The proportions of cyanogenic and acyanogenic plants in clover populations were determined in different parts of Europe. These are shown in the diagram below, together with the mean minimum winter temperatures. Slugs are not usually active at temperatures below  $0\,^{\circ}\mathrm{C}$ .



	(Total 10 marks)
	(5)
Explain the proportions of cyanogenic and acyanogenic plants in clogrowing in the area where the mean minimum winter temperature is the area where it is above 10 °C.	
Explain the proportions of evanogenic and acvanogenic plants in clo	ver populations

**58.** Chickens have a structure on their heads called a comb. The diagram shows four types of comb: walnut, pea, rose and single.



Two genes control the type of comb; each gene has a dominant and a recessive allele. The two genes are inherited independently, but interact to produce the four types of comb.

Genotype	Phenotype
A- B-	Walnut
A- bb	Pea
aa B-	Rose
aa bb	Single

A male with a pea comb, heterozygous for gene A, was crossed with a rose-combed

The symbol - indicates that either the dominant allele or recessive allele could be present

female, heterozygous for go expected from this cross.	female, heterozygous for gene B. Complete the genetic diagram to show the offspring expected from this cross.			
Phenotypes of parents	Pea comb	Rose comb		
Genotypes of parents				
Gametes formed				

(a)

Offspring genotypes	
Ratio of offspring phenotypes	

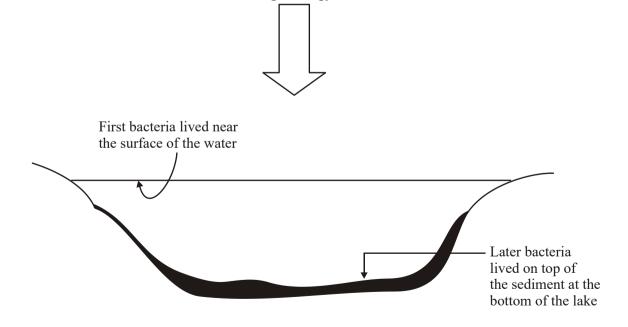
**(3)** 

(b) Chickens with rose or single combs made up 36% of one population. Assuming the conditions of the Hardy-Weinberg equilibrium apply, calculate the frequency of allele **a** in this population. Show how you arrived at your answer.

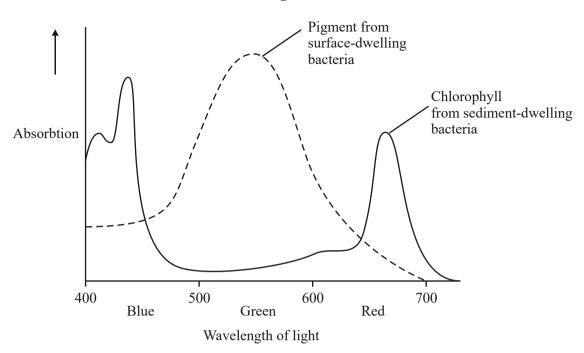
59. There is evidence that the first photosynthetic organisms were primitive water-dwelling bacteria. The very first of these lived near the surface of the water in lakes and contained a purple pigment that absorbed light most strongly in the green region of the spectrum. Later, other bacteria evolved that lived on the top of sediment at the bottom of the lakes (Figure 1). Gene mutations had enabled these bacteria to synthesise chlorophyll instead of the purple pigment present in the bacteria living near to the surface. Chlorophyll absorbs light most strongly in the blue and red regions of the spectrum (Figure 2).

Figure 1

Light energy







(a)

Describe how light energy absorbed by chlorophyll molecules is used to synthesise ATP.

(b)	Use <b>Figure 2</b> to explain how natural selection would favour the evolution of sediment-dwelling bacteria containing a different photosynthetic pigment from those living near the surface of the water.
	nving hear the surface of the water.
	(6)
	(Total 11 marks)

**60.** Read the following passage.

## Madagascar

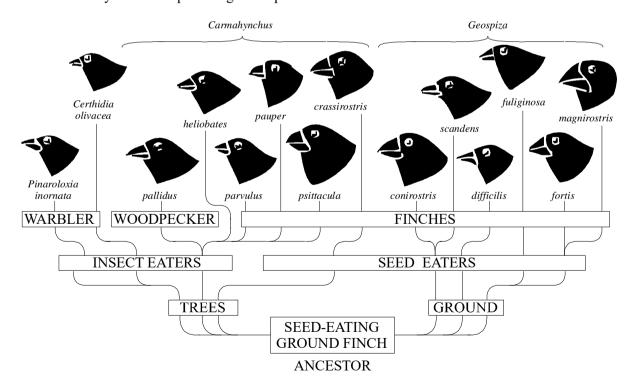
The island of Madagascar has been described as the laboratory of evolution. It broke away from mainland Africa at least 120 million years ago and, following this, many new species developed. Estimates of the number of plant species on the island vary from 7 370 to 12 000, making it botanically one of the richest areas in the world. Of 400 flowering plant families found worldwide, 200 grow only in Madagascar. Among animals, true lemurs are found nowhere else, and 95 per cent of the country's 235 known species of reptiles evolved on the island. Over the past 25 years the human population has doubled. Land shortage is leading to clearing of the forest, and Madagascar is now facing deforestation on a massive scale. Scientists have estimated that even if the forest could recover, regeneration could take up to a hundred years.

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(i)	Explain the processes which might have led to the evolution of new species on the island.	
('')		
(ii)	Suggest and explain how the number of animal species on the island may have changed as it became "botanically one of the richest areas in the world".	

(c)	Describe the processes by which forest is able to regenerate after being cleared.
	(4)
	(Total 12 marks)

**61.** Fourteen different species of finch live on the isolated Galapagos Islands. The finches are believed to have all evolved from a single common ancestor. The diagram shows the suggested evolutionary relationships amongst the species.



(a) Su	ggest why these fourteen ty	ypes of finch are considered to be different species.	
(b) Us	e the information in the dia	agram to identify	
(i)	the species of ground f	finch which eats the largest seeds;	
(ii)	the number of genera v	which are present on the islands.	
	ggest how two distinct speolved from a common ance	ecies, one insect-eating and the other seed-eating, may lestor.	have
••••			
		Т)	otal 7 mar
tissues ar	e damaged. The production	nic. They produce poisonous hydrogen cyanide when the n of hydrogen cyanide takes place in two steps, each or coduced by a different gene.	
	Dominant allele A	Dominant allele B	
	<b>▼</b> Enzyme A	<b>∀</b> Enzyme B	
Substrate	e — Cyanog	genic glucoside → Hydrogen cyanide	

62.

(a)		are the phenotypes (cyanogenic or non-cyanogenic) of the following genotypes? ain your answer.	
	(i)	AABb	
	(ii)	aaBB	
			(3)
(b)	Two	clover plants, each with the genotype AaBb were crossed.	
	(i)	Use a genetic diagram to show the genotypes of the offspring.	
	(ii)	What is the expected ratio of cyanogenic to non-cyanogenic plants in the offspring?	
			(3)

(c)	high freez The	altitude where the climate is colder. When the cells of cyanogenic clover plants are, the hydrogen cyanide that is released kills the cells and as a result the plant dies. frequencies of the alleles for cyanogenesis are different in clover plants growing at and at high altitudes.
	(i)	How would you expect the allele frequencies to differ?
	(ii)	Use the information given to explain how the different allele frequencies might be the result of natural selection.
		(6) (Total 12 marks)

**(1)** 

- 63. The purple saxifrage is a flowering plant found in the Arctic. It has two distinct forms, one growing on dry ridges, the other in the valleys.
  - On dry ridges, where the temperature is higher and the growing season longer, the plants grow in upright tufts. These plants are drought tolerant and store carbohydrate which they use in times of stress.
  - In the valleys, where it is colder and the growing season is shorter, the plants grow very close to the ground. These plants have a higher rate of photosynthesis and grow more rapidly.

Both forms usually complete their life cycle in the short Arctic summer. In unfavourable years, plants in the valleys may produce pollen but are unable to form seeds. Some pollen from the valley plants fertilises plants on the ridges. The seeds may then be washed down to the valleys. Those that develop and complete their life cycles are all low-growing plants. When plants from the ridges and the valleys are grown under identical conditions in the laboratory, they have the same growth form as they did when in their original environment.

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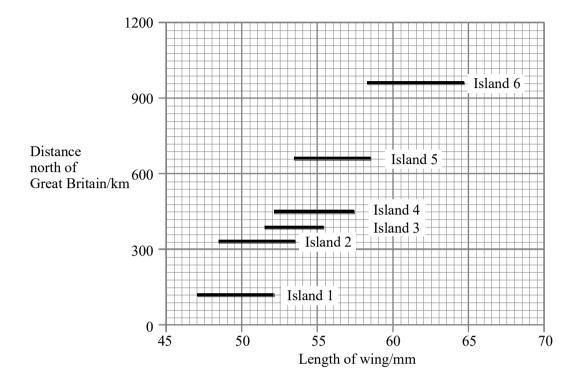
(a)	What	is the evidence in the passage that the two forms of the purple saxifrage	
	(i)	are genetically different;	
			(1)
	(ii)	belong to the same species?	

(b)	When cross pollination between the low-growing and upright forms occurs, both forms of plant develop when the seeds produced are grown in the laboratory. Explain why only low-growing plants develop from the seeds which are washed from the ridges into the valleys.	
		(2)
(c)	Under the conditions described, the two forms of the purple saxifrage are unlikely to	
	evolve into separate species. Explain why.	
		(2)
(d)	The effect of global warming on the environment of the Arctic is uncertain. Suggest why species such as the purple saxifrage are likely to survive even if changes in climate do occur.	
	(Total 8 ma	(2) rks)

ı)	Suggest how the flies that feed on apple trees could evolve from those that fed on hawthorn trees.
b)	Suggest <b>one</b> way in which scientists could find out whether the flies from apple trees were a different species from those found on hawthorn trees.
b)	
(b)	
(b)	
b)	
b)	

**64.** 

**65.** The diagram shows the range in wing length of a species of small bird on different islands to the north of Great Britain.



(a)	(i)	On which islands might a bird with wings 55mm long live?	
(a)	(1)	On which islands might a bird with whigs 35mm long live.	

(1)

(ii) What would be the mid-point of the range of wing length expected on an island that is 750km north of Great Britain?

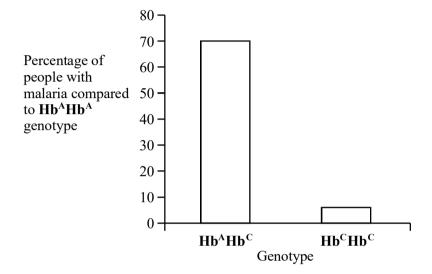
(b) In this species wing length increases with body size. Suggest how this trend in body size might help the birds to survive.

.....

**(1)** 

	(c)	Explain how selection may have resulted in an increase in body size.	
		Γ)	(3) Total 7 marks)
66.	(a)	Explain how natural selection produces changes within a species.	
			(4)

(b) Malaria is caused by a parasite that attacks red blood cells, producing repeated bouts of serious illness and often causing death. The allete for normal haemoglobin in red cells is  $\mathbf{Hb^A}$ . In the West African country of Burkina Faso, twenty percent of people are heterozygous for a different allele,  $\mathbf{Hb^C}$ , which has no effect on their health. People homozygous for  $\mathbf{Hb^C}$  suffer a very mild anaemia. The bar chart shows how the  $\mathbf{Hb^C}$  allele affects the chance of getting malaria.



(1)	Use the bar chart to describe how the <b>Hb</b> ° allele affects the chance of getting malaria.

**(2)** 

	(ii)	Malaria is very common in Burkina Faso. The <b>Hb</b> <sup>C</sup> allele is increasing in frequency in this part of Africa. Suggest an explanation for this.
		(Total 8 marl
_	т "	
7.	sprayed of per billio dying. The	mpt to control the huge numbers of an insect pest, low doses of a pesticide were on a lake. After spraying, the concentration of pesticide in the lake water was 14 parts n. After spraying, diving birds which fed on small fish in the lake were found to be ne concentration of the pesticide in these birds was more than 1 part per thousand.
	sprayed of per billio dying. The	on a lake. After spraying, the concentration of pesticide in the lake water was 14 parts n. After spraying, diving birds which fed on small fish in the lake were found to be
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	sprayed of per billio dying. The	on a lake. After spraying, the concentration of pesticide in the lake water was 14 parts in. After spraying, diving birds which fed on small fish in the lake were found to be ne concentration of the pesticide in these birds was more than 1 part per thousand.

S	(b)	The lake was sprayed three times. The first spraying killed almost all of the insects, as did a second application five years later. When the lake was treated for a third time it was found that some insects were resistant to the pesticide.	
		Explain how resistance to the pesticide evolved in the insect population.	
			(3)
S	(c)	This pesticide is able to pass easily through cell membranes. Suggest why.	
			(2)
		(Total 8 ma	(2) arks)
68.		e Malawi in East Africa contains around 400 different species of cichlids which are small, atly coloured fish. All these species have evolved from a common ancestor.	
	(a)	Describe <b>one</b> way in which scientists could find out whether cichlids from two different populations belong to the same species.	
			(2)

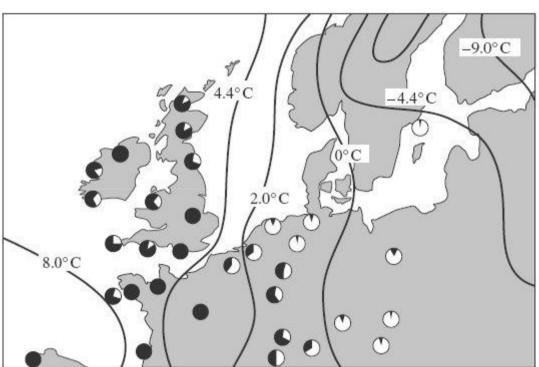
(b)	During the last 700 000 years there have been long periods when the water level was much lower and Lake Malawi split up into many smaller lakes. Explain how speciation of the cichlids may have occurred following the formation of separate, smaller lakes.	
		(4)
(c)	Many species of cichlids are similar in size and, apart from their colour, in appearance. Suggest how the variety of colour patterns displayed by these cichlids may help to maintain the fish as separate species.	
	(Total 8 m	(2) arks)

69. S Clover plants have leaves all through the year. Some clover plants have leaves that produce poisonous hydrogen cyanide gas when damaged. These cyanogenic plants are less likely to be eaten by snails. However, the leaves of these plants can be damaged by frost, resulting in the production of enough hydrogen cyanide to kill the plants. Acyanogenic plants do not produce hydrogen cyanide. This characteristic is genetically controlled.

The map shows the proportions of the two types of plant in populations of clover from different areas in Europe. It also shows isotherms, lines joining places with the same mean January temperature.

## Key





(a)	Explain how different proportions of cyanogenic plants may have evolved in populations in different parts of Europe.	
		(4)
(b)	Differences in cyanide production may affect the total number of clover plants growing in different areas. Describe how you would use quadrats in an investigation to determine whether or not there is a difference in the number of clover plants in two large areas of equal size.	
	(Total 8 n	(4) narks)

**(2)** 

**70.** The polecat, shown in the drawing, is a wild British mammal. At one time it was very rare. It is now more common and its range is increasing. Scientists carried out a survey of the distribution and status of polecats in Britain during the 1990s.



The first problem that the scientists had was that they needed to distinguish between wild polecats and escaped ferrets. Ferrets are domesticated polecats. They investigated skulls from polecats and ferrets.

They used dial callipers to take skull measurements. They took each measurement six times on six different skulls. They used their measurements to calculate a percentage measurement error using the formula:

Percentage measurement error = 
$$\frac{100(1+0.25n)\sigma}{x}$$

where n = number of measurements  $\sigma =$  standard deviation

x = mean

(a)	(i)	Use the information from this question to explain the difference between accuracy and reliability.	
			(2)
	(ii)	Unreliable measurements will produce a large percentage measurement error. Use the formula to explain why.	

**Table 1** shows some of the skull measurements obtained by the scientists.

Table 1

Animal	Sex	Number of	Mean skull breadth/mm		Cranial volume/cm <sup>3</sup>	
		skulls measured	mean	standard deviation	mean	standard deviation
Polecat	Male	90	16.38	1.34	10.15	0.92
Ferret	Male	114	15.56	0.84	8.96	0.93
Polecat	Female	44	15.52	1.04	8.34	0.68
Ferret	Female	47	14.42	0.78	7.03	0.55

(b)	(1)	Describe <b>one</b> way in which you could show whether there was a correlation between mean skull breadth and mean cranial volume.	
			(2)
	(ii)	The scientists found that there was an advantage in taking measurements of skull breadth rather than cranial volume when measuring skull size. Suggest this advantage.	
			(1)

	(111)	a polecat of from a ferret? Explain the evidence from <b>Table 1</b> that supports your answer.				
			(3)			
(c)	"Son and t Desc	e report that the scientists wrote, they referred to an earlier scientific paper about ne characteristics of the skulls and skins of the European polecat, the Asiatic polecat he domestic ferret" ribe <b>two</b> ways in which this earlier paper might have helped the scientists to carry neir work and produce a reliable report.				
	•••••					
			(2)			

In this survey, the scientists collected the bodies of the dead polecats from roads where they had been killed by passing vehicles. They analysed the stomachs to see what the polecats had eaten. **Table 2** shows the results.

Table 2

	Total number of polecats examined = 83					
Prey	Mass/g	Mass as percentage of all prey	Number of stomachs in which prey item found	Percentage of all stomachs in which prey item found		
Rabbit	1063.80	85.4	60	72.3		
Rat	22.18	1.8	2	2.4		
Other mammals	43.54	3.5	9	10.8		
Pigeons	29.45	2.4	3	3.6		
Other birds	7.68	0.6	5	5.6		
Frogs and toads	56.98	4.6	7	8.4		
Fish	0.12	0.01	1	1.2		
Earthworms	21.97	1.8	2	2.4		
Total	1245.72		89			

(d)	The table shows that a total of 83 stomachs were analysed. Explain why the total for the number of stomachs in which the prey item was found was more than 83.

(1)

(e)	Some farmers regard polecats as pests and claim that they kill poultry and game birds. Use the data to suggest how you would explain to these farmers that they should tolerate polecats on their land.							
	(2)							
	(Total 15 marks)							