Surname	Centre Number	Candidate Number
Other Names		2

GCE A level

1075/01

BIOLOGY/HUMAN BIOLOGY – BY5

A.M. FRIDAY, 20 June 2014

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**6**	
3.	**8**	
4.	**11**	
5.	**12**	
6.	**12**	
7.	**13**	
8.	**10**	
Total	**80**	

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INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the necessity for good English and orderly presentation in your answers.
The quality of written communication will affect the awarding of marks.

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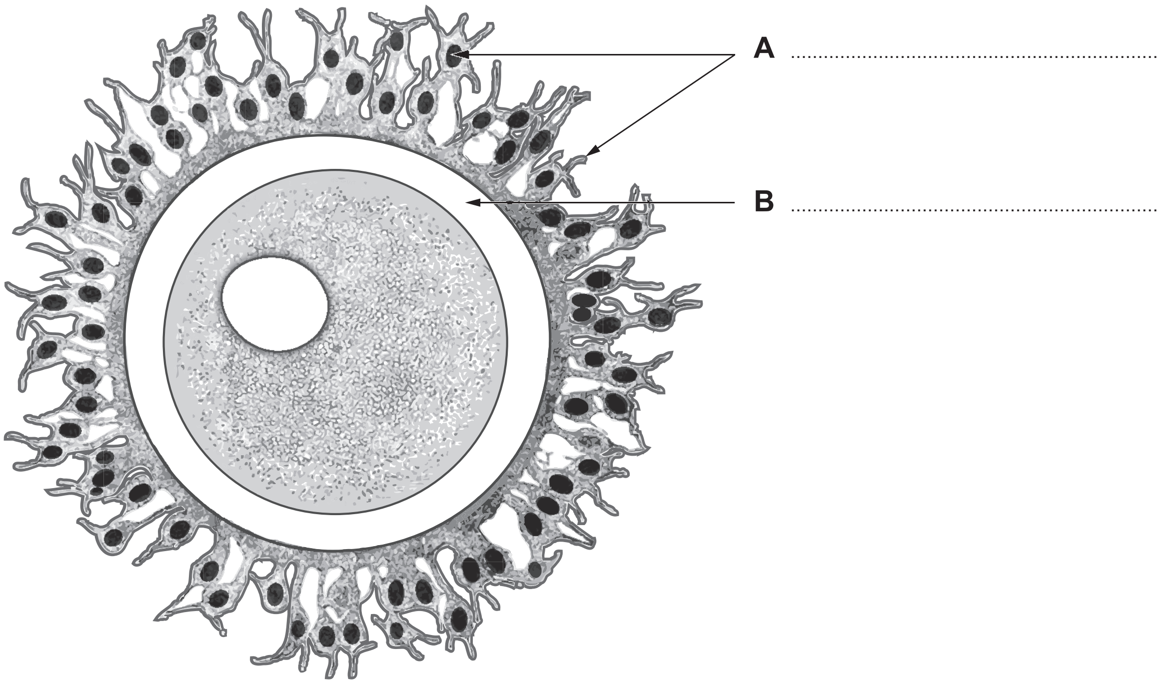
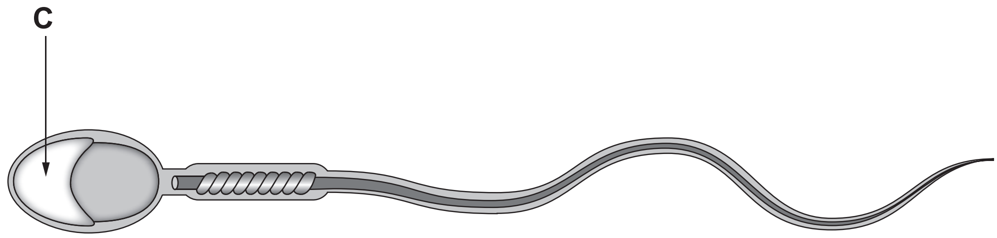
Answer **all** *questions.*

1. The illustration below shows a secondary oocyte.



(a) Label parts **A** and **B**. [2]

(b) The diagram below shows a sperm cell.



(i) Name the structure labelled **C**. [1]

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(ii) Describe the role that structure **C** plays in fertilisation of the ovum. [2]

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(c) Explain each of the following. [3]

(i) cell cleavage

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(ii) blastocyst

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(iii) implantation

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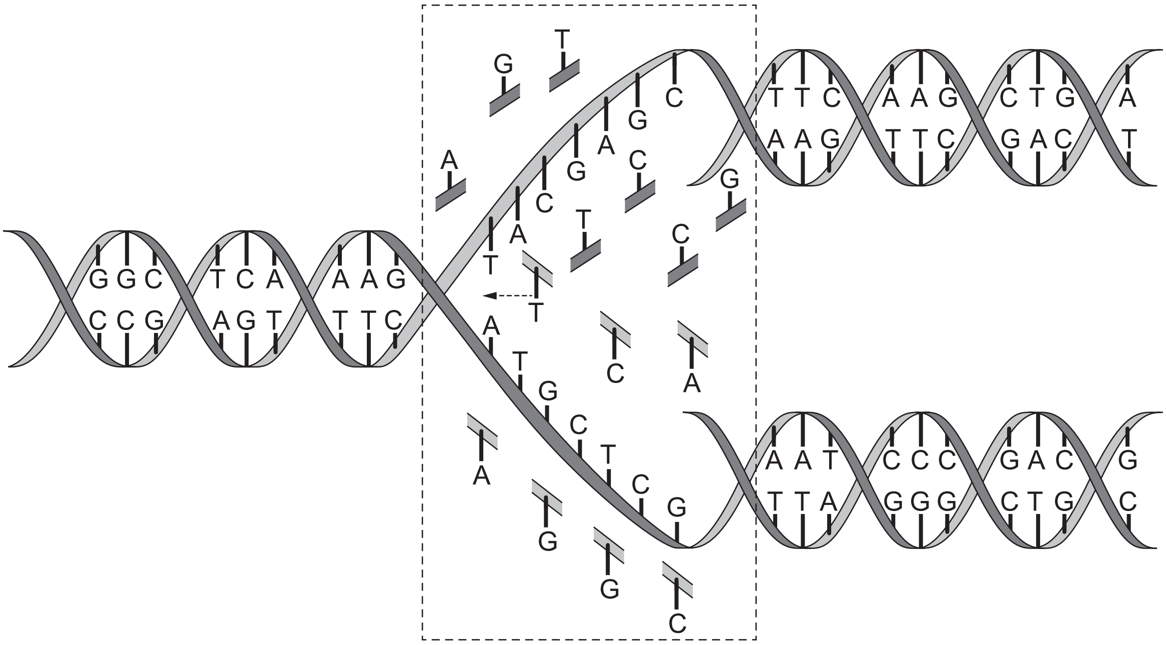
2. The diagram below illustrates replication of DNA in cells.



(a) (i) Describe the sequence of events shown within the dotted rectangle in the diagram above. [3]

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(ii) What is the role of DNA polymerase in the process? [1]

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(b) Explain why the process is referred to as ‘semi conservative’. [2]

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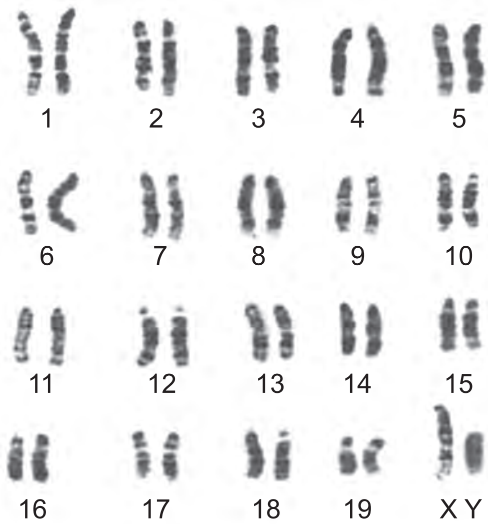
3. The photograph below shows the pairs of chromosomes found in a body cell of a mouse.



(a) What is the diploid number of the mouse? [1]

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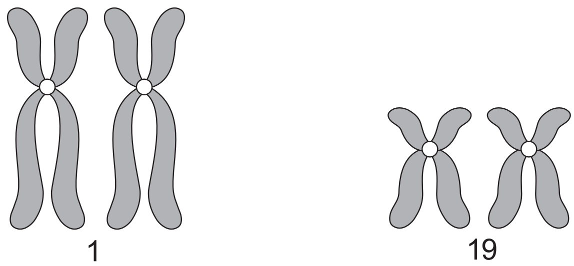
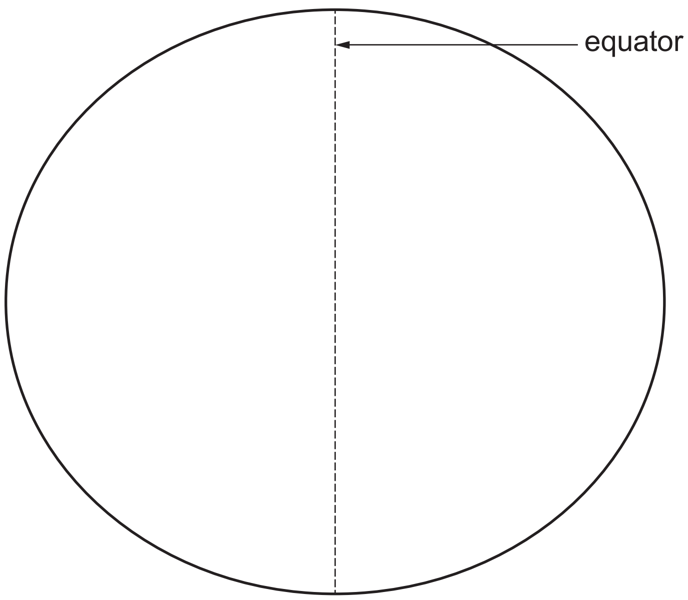
(b) The chromosomes in pairs 1 and 19 are commonly represented diagrammatically as:



(i) Using the cell outline below draw diagrams to show how these pairs of chromosomes are arranged in **metaphase I** of meiosis. [1]



(ii) On your drawing label; chromatid, centromere, centriole, spindle fibres. [2]

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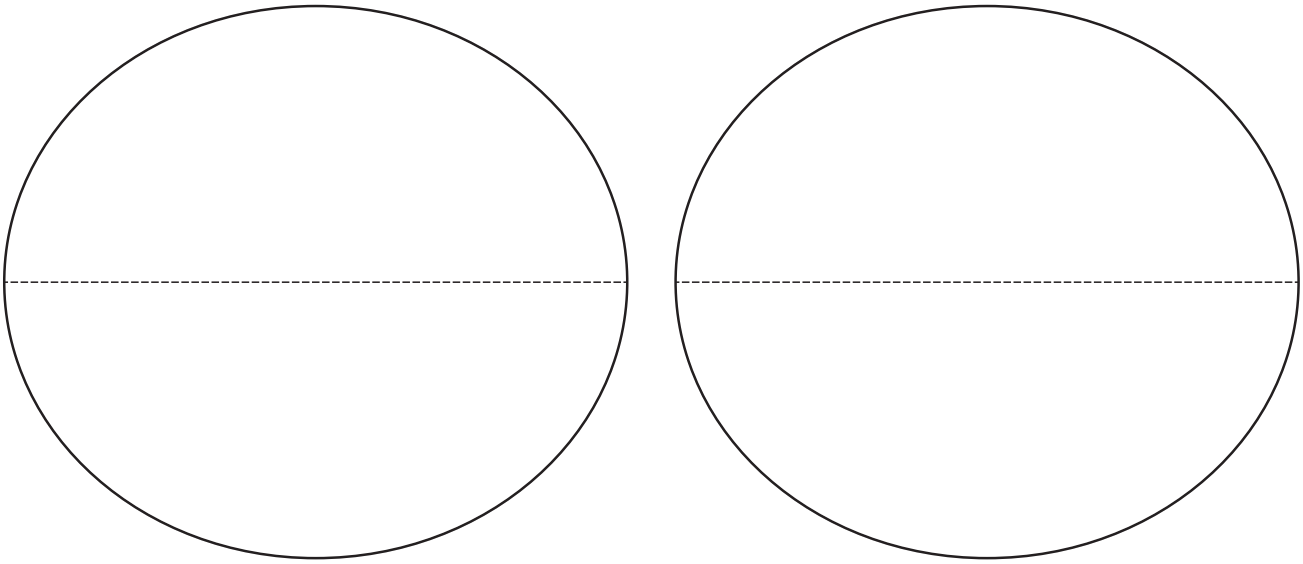
(iii) Using the cell outlines below draw diagrams to show how the chromosomes would subsequently be arranged in **metaphase II** of meiosis. [1]



(iv) State **three** ways in which meiosis contributes to variation in mouse offspring. [3]

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4. The fruit fly *Drosophila melanogaster* is extensively used to study genetics because it is relatively easy to cause mutations in the flies.
Some mutant flies have very small (vestigial) wings:


normal wings


vestigial wings

Other mutants have very dark (ebony) bodies instead of the normal grey body.


grey body


ebony body

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In a **dihybrid** cross, when flies with normal wings and grey bodies were crossed with flies with vestigial wings and ebony bodies all the offspring had normal wings and grey bodies.

(a) The F_1 hybrid flies (heterozygous for both traits) were allowed to interbreed freely. The F_2 flies were sorted and counted. The results are shown below.

Phenotype		**Number of flies**
Wings	**Body**	
Normal	Grey	75
Normal	Ebony	23
Vestigial	Grey	21
Vestigial	Ebony	9

Turn over.

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(i) Draw a genetic diagram, in the space provided below, to show the expected F_2 phenotype ratio. [5]
Use the letters given

Allele for normal wings = N   Allele for vestigial wings = n

Allele for grey body = G   Allele for ebony body = g

F_1 phenotypes	Normal wing, grey body	X	Normal wing, grey body
F_1 genotypes	....	X	....
Gametes	....	X	....

F_2 phenotype **ratio** ....

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(ii) Using the F_2 phenotype ratio from part (i) calculate the **expected** number of each phenotype in the F_2 generation from a total of 128 offspring, and enter the values in the table below. [1]

Phenotype		Observed number (O)	Expected number (E)	(O – E)	$(O - E)^2$	$\frac{(O - E)^2}{E}$
Normal wings	Grey body	75				
Normal wings	Ebony body	23				
Vestigial wings	Grey body	21				
Vestigial wings	Ebony body	9				

(b) Complete the other columns in the table and carry out a Chi square test, testing the Null Hypothesis – that there is no significant difference between the observed and expected results.

(i) Use the last column in the table to calculate χ^2. [1]

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

χ^2 = ...

(ii) Use the 5% probability level and the correct number of degrees of freedom to **circle** the critical value of χ^2 in the table below. [1]

Degrees of freedom	Probability								
	0.9	0.8	0.7	0.5	0.2	0.1	0.05	0.02	0.01
1	0.016	0.064	0.15	0.46	1.64	2.71	3.84	5.41	6.64
2	0.21	0.45	0.71	1.39	3.22	4.60	5.99	7.82	9.21
3	0.58	1.00	1.42	2.37	4.64	6.25	7.82	9.84	11.34
4	1.06	1.65	2.20	3.36	5.99	7.78	9.49	11.67	13.28

(iii) State whether you would accept or reject the Null Hypothesis, for this cross and explain why. [1]

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(c) In another cross, flies with ebony bodies and scarlet eyes were crossed with flies homozygous for grey body and red eyes. All the F_1 flies had grey bodies and red eyes. When the F_1 hybrid flies were crossed the following results were obtained:

Phenotype		Number of flies
Eyes	**Body**	
Red	Grey	91
Red	Ebony	3
Scarlet	Grey	2
Scarlet	Ebony	32

The table shows that some of the offspring were far more common than expected and some phenotypes were very rare. Explain both of these observations. [2]

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5. The techniques of recombinant DNA technology and micro-propagation are used to produce Genetically Modified Crops. The following summary is adapted from an account given on the Food Standards Agency's web site [www.food.gov.uk]

1. A plant with the desired characteristic is identified – e.g. resistance to the herbicide 'Roundup'.

2. The specific gene that produces this characteristic is found in the plant's DNA and cut out.

3. To get the gene into the cells of the plant being modified, the gene needs to be attached to a carrier. A piece of bacterial DNA called a plasmid is joined to the gene to act as the carrier.

4. Once the gene is attached to the plasmid, a marker gene is also added to identify which plant cells take up the new gene.

5. The 'gene package' is put in a bacterium, which multiplies, to create many copies of the 'gene package'.

6. A copy of the 'gene package' is dried onto a gold or tungsten particle – and fired into a piece of tissue from the plant being modified. The particle carries the 'gene package' into the plant's cells.

7. The plant tissue is put into a selective growth medium so that only modified tissue develops into plants.

(a) Explain how different types of enzymes are used in stages 2 and 3 to produce the 'gene package'. [4]

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(b) Describe the steps involved in the culture of a large number of genetically identical plants from the plant tissue produced in stage 7. [3]

(c) (i) Explain the advantage to farmers of having crops resistant to 'Roundup'. [3]

(ii) Explain why environmentalists might have legitimate objections to using GM crops resistant to 'Roundup'. [2]

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6. A species of mouse *Peromyscus polionotus* found in Florida, USA, has a number of different coat colours. Coat colour in mice is controlled by several genes. Dark fur is produced when the hair producing cells secrete a pigment called eumelanin. A high level of eumelanin is produced when a transmembrane protein called MC1R is stimulated by a hormone.

(a) The diagram below shows part of the amino acid sequence of MC1R, part of the sequence of nucleotides in the gene for MC1R and how it might change to produce light fur:

Original

Amino acid sequence	Ile	Thr	Lys	Asn	Arg	Asn	Leu	His	Ser

Nucleotide sequence (allele R) ATCACCAAAAACCGCAACCTGCACTCG

Changed to produce light fur

Amino acid sequence	Ile	Thr	Lys	Asn	Cys	Asn	Leu	His	Ser

Nucleotide sequence (allele C) ATCACCAAAAACTGCAACCTGCACTCG

(i) Describe the change in the gene and the subsequent change in the MC1R molecule. [2]

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(ii) Using the information provided, explain how this change results in mice with light fur. [2]

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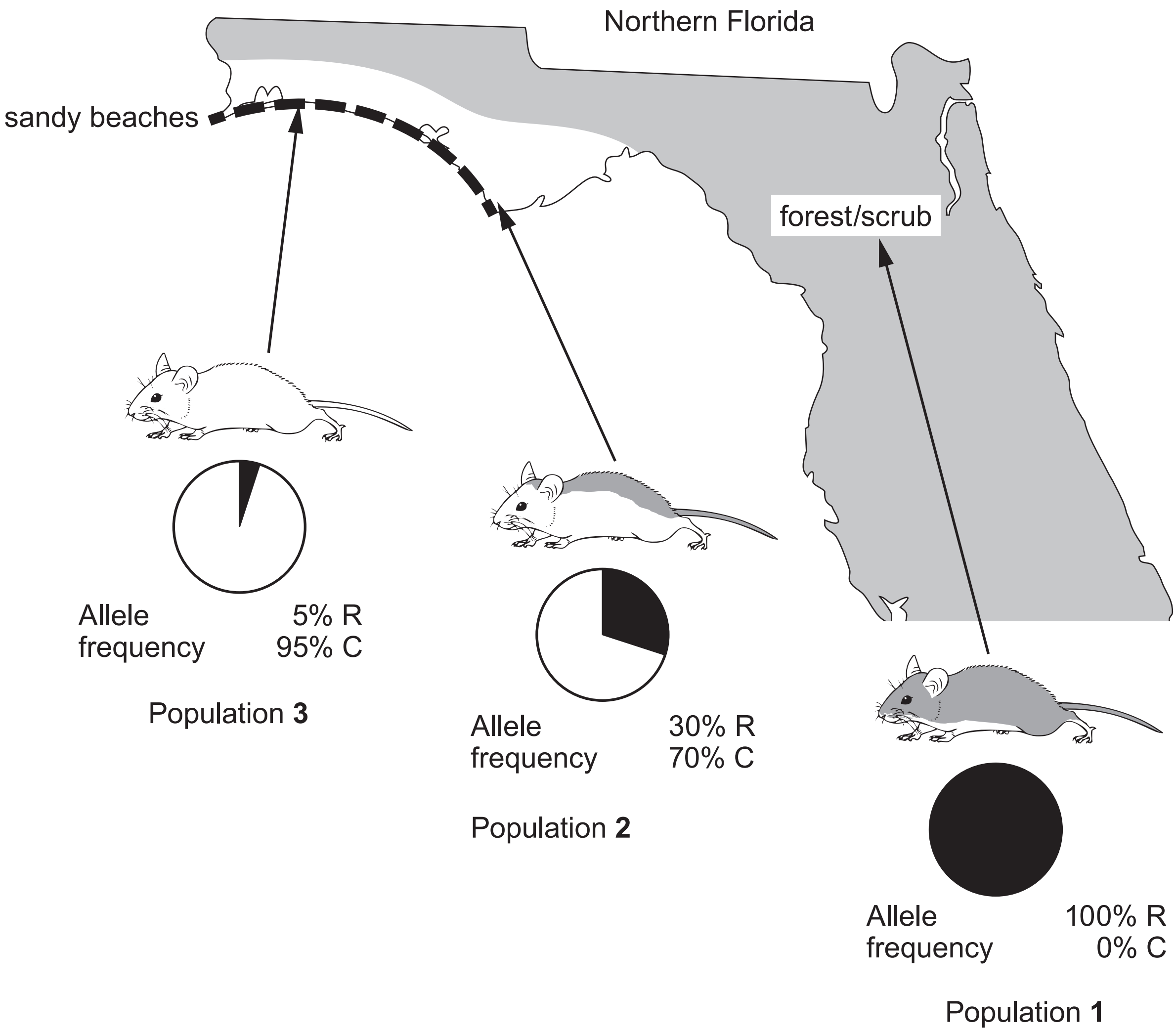
(b) This change in the MC1R gene means that there are two alleles, R and C. The map below shows the distribution of the different coloured mice and the relative frequencies of the alleles R and C in each population.



(i) Use the diagram to suggest how fur colour is related to environmental conditions. [2]

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(ii) Under what circumstance could the difference between the allele frequencies in populations **2** and **3** be explained by **genetic drift**, despite both living on beaches? [1]

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(iii) Explain how **Natural Selection** could have caused the relative allele frequency shown in population **3**. [4]

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(iv) Under what circumstances would the mouse population become a separate species? [1]

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7. The following is a quotation from an ecological investigation.

"Lowland heaths are high-profile ecosystems for conservation action in England, but they are under threat from invasion by *Betula spp*., *Pinus sylvestris*, and *Ulex europaeus*."

[R.J. Mitchel et al. *Journal of Applied Ecology*, 1997, 37, 1426-1444]

(a) Distinguish between primary succession and secondary succession. [2]

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The authors studied a number of heathland sites in Dorset including Arne, Blackhill, and Higher Hyde, where succession to one or another of the three species had taken place. The data below are based on the paper but have been simplified and modified for illustrative purposes.
The successional stages in the study were named according to the dominant invasive species; **plus B**, where *Betula spp*, was the invader, **plus PS**, where *Pinus sylvestris* was the invader and **plus U**, where *Ulex europaeus*, was the invader.

(*b*) The group examined changes in soil chemistry from the original heath stage. Some of their results are summarised in the table below:

soil chemical property	value by succession stage			
	original heath	**plus B**	**plus PS**	**plus U**
pH				
Arne	3.63	4.01	3.60	3.63
Blackhill	3.52	3.66	3.48	3.54
Higher Hyde	3.53	5.06	3.51	3.47
mean	**3.56**	**4.24**	**3.53**	**3.55**
phosphorus μgPg^{-1}				
Arne	2.41	3.85	2.69	3.16
Blackhill	4.15	4.91	3.79	4.55
Higher Hyde	5.08	5.35	3.55	4.76
mean	**3.88**	**4.70**	**3.34**	**4.16**
nitrate/nitrite μgNg^{-1}				
Arne	0.51	0.65	0.59	1.16
Blackhill	0.84	0.88	0.97	2.31
Higher Hyde	0.69	0.98	1.17	3.64
mean	**0.68**	**0.84**	**0.91**	**2.37**

(i) What do the pH values tell us about the soil in all stages in all sites? [1]

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(ii) Use **mean** values from the table above to compare **three** changes to soil chemistry following invasion by *Betula spp*. with the changes following invasion by *Ulex europaeus*. [3]

pH ....

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phosphorus ....

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nitrate/nitrite ....

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(c) The table below shows changes to the vegetation in the successional stages:

Species (by successional stage)	% cover of species (by site)		
	Arne	Blackhill	Higher Hyde
original heath			
Calluna vulgaris	62.0	66.1	88.2
Erica cinerea	22.4	25.7	2.6
Erica tetralix	9.9	2.6	9.9
Cladonia portentosa	8.5	0	0.5
plus B			
Betula spp.	18.9	11.7	16.5
Agrostis curtisii	0.0	53.6	0.0
Pteridium aquilinum	25.2	7.5	1.6
Calluna vulgaris	0.0	0.0	0.4
plus PS			
Pinus sylvestris	36.2	38.2	
Pteridium aquilinum	0.3	24.7	
Erica cinerea	0.0	0.0	
Calluna vulgaris	0.0	0.0	
plus U			
Ulex europaeus	87.0	75.3	79.0
Calluna vulgaris	14.7	5.8	7.2
Erica cinerea	1.5	11.3	4.3
Erica tetralix	0.1	0.3	0.3

(i) Which invading species has least impact on the vegetation on the original heathland? [1]

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(ii) With reference to the data for **plus B** in both tables suggest a mechanism by which changes to vegetation occur during succession. [2]

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(d) Sixteen years later some of these successions have reached their natural conclusions.

(i) What name is given to the group of organisms that inhabit the ecosystem at the end of successional change? [1]

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(ii) What usually happens to species diversity as succession proceeds? [1]

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(iii) Using **named** species from the table in part *(c)* explain why conservationists in Dorset are taking steps to prevent **plus B** and **plus PS** succession in heathland, but are less worried about type **plus U** succession. [2]

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8. Answer **one** of the following questions.
Any diagrams included in your answer must be fully annotated.

Either, *(a)* Describe how the structure of a typical flower is adapted for insect pollination and subsequent fertilisation. [10]

Or *(b)* Describe energy transfer in an ecosystem. Briefly explain the agricultural practice of keeping animals in heated sheds with little room to move about. [10]

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