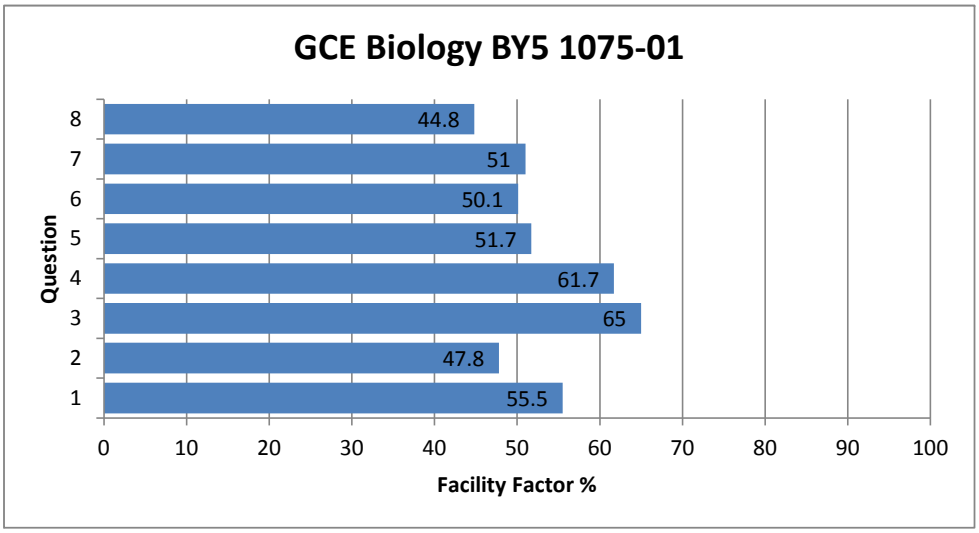
WJEC 2014 Online Exam Review

GCE Biology BY5 1075-01

All Candidates' performance across questions

Question Title	N	Mean	S D	Max Mark	F F	Attempt %
1	5207	4.4	1.9	8	55.5	99.9
2	5207	2.9	1.5	6	47.8	99.9
3	5211	5.2	1.6	8	65	100
4	5210	6.8	2.5	11	61.7	99.9
5	5192	6.2	3.1	12	51.7	99.6
6	5207	6	2	12	50.1	99.9
7	5202	6.6	2.8	13	51	99.8
8	5194	4.5	2.1	10	44.8	99.6

5
6
7



Examiner only

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]

.....

.....

.....

.....

.....

.....

.....

.....

Examiner only

(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]

.....

.....

.....

.....

12

Turn over.

Examiner only

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]

restriction endonuclease cuts the DNA into staggered small sections were sticky ends are formed. DNA ligase wraps the DNA into a liposome which is taken up by the bacterial by a virus. virus DNA injects DNA into plasmid. Bacteria

Examiner only

(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]

Micropropagation, a sterile loop takes meristems, at the tip of the plant. Meristems are grown on a ~~medium containing required nutrients~~ agar jelly and DNA is inserted into plants. This makes an explant, goes into a callus where many plantlets grow in tubes

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

~~Roundup can apply~~ herbicide doesn't kill crops, crops can grow so farmers can apply herbicide making a higher yield as doesn't effect crop.

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

More farmers spray pesticides therefore contaminating near by rivers / when lakes, washed down. This deoxygenates water, therefore contaminates fish and birds that feed from rivers causing death.

12

Examiner only

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]

restriction endonuclease cuts the DNA into staggered small sections were sticky ends are formed. DNA ligase wraps the DNA into a liposome which is taken up by the bacterial by a virus. virus DNA injects DNA into plasmid. Bacteria

Examiner only

(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]

Micropropagation, ~~a~~ a sterile loop takes meristems, at the tip of the plant. Meristems ~~are grown on a medium containing required nutrients and~~ DNA is inserted into plants. This makes an explant, goes into a callus where many plantlets grow in tubes

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

~~Roundup can apply~~ herbicide doesnt kill crops, crops can grow so farmers can apply herbicide making a higher yield as doesnt effect crop.

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

More farmers spray pesticides therefore contaminating near by rivers / when lakes, washed down. This deoxygenates water, therefore contaminates fish and birds that feed from rivers causing death

12

Examiner only

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]

Restriction endonuclease enzymes are used to cut out the DNA fragment holding the required resistant gene of the donor plant. Restriction endonuclease will cut between specific base pairs, leaving 'sticky ends', which are ~~nus~~ on the edge of the DNA fragment with unpaired bases. The same restriction endonuclease cuts the plasmid, which will produce complimentary sticky ends to the DNA fragment's. The DNA fragment's sticky ends aligns with the plasmid's sticky ends and DNA ligase anneals the 2 sticky ends together producing recombinant DNA. ~~Alternatively~~

Examiner only

(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]

* meristems are totipotent cells.

micropropagation ~~is~~ is completed. So meristems from the tip of the shoot / plant tissue is removed from the plant tissue produced. with a sterile scalpel. The explant is then subdivided into many pieces and each piece is placed on a sterile, aerated nutrient medium such as agar jelly. A callus will grow, which is a mass of undifferentiated cells. The callus is subdivided and each piece placed on a growth medium, and will grow into a plantlet

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

Farmers can spray 'roundup' onto their crops, so killing off any weeds, while the crops will remain alive. This is economically beneficial to the farmers as they will produce a larger crop yield due to more crops surviving due to the decreased interspecific competition for food and space that would have been present if the weeds were still present.

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

The resistant gene to roundup may pass onto closely related species of plants or weeds. This may mean that 'super weeds' are produced which will be herbicide resistant. The GM crops may have an effect on the ~~number of~~ organic farm as the crops may become undifferentiable.

12

Examiner only

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]

Restriction endonuclease enzymes are used to cut out the DNA fragment holding the required resistant gene of the donor plant. Restriction endonuclease will cut between specific base pairs, leaving 'sticky ends', which are ~~nus~~ on the edge of the DNA fragment with unpaired bases. The same restriction endonuclease cuts the plasmid, which will produce complimentary sticky ends to the DNA fragment's. The DNA fragment's sticky ends aligns with the plasmid's sticky ends and DNA ligase anneals the 2 sticky ends together producing recombinant DNA. ~~ternarily~~

Examiner only

(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]

* meristems are totipotent cells

micropropagation ~~is~~ is completed. So meristems from the tip of the shoot / plant tissue is removed from the plant tissue produced. with a sterile scalpel. The explant is then subdivided into many pieces and each piece is placed on a sterile, aerated nutrient medium such as agar jelly. A callus will grow which is a mass of undifferentiated cells. The callus is subdivided and each piece placed on a growth medium, and will grow into a plantlet

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

Farmers can spray 'roundup' onto their crops, so killing off any weeds, while the crops will remain alive. This is economically beneficial to the farmers as they will produce a larger crop yield due to more crops surviving due to the decreased interspecific competition for food and space that would have been present if the weeds were still present.

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

The resistant gene to roundup may pass onto closely related species of plants or weeds. This may mean that 'super weeds' are produced which will be herbicide resistant. The GM crops may have an effect on the ~~number of~~ organic farm as the crops may become undifferentiable.

12

Examiner only

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]

The enzyme restriction endonuclease is used to 'cut out' the desired gene. It does this by cutting up the DNA into fragments, a gene probe is then used to obtain the desired gene. The same restriction endonuclease enzyme is used to cut open the plasmid, so the two DNA fragments have complementary sticky ends. The second enzyme used in stage 3 is DNA ligase. This splices the DNA fragment containing the gene into the plasmid. It anneals the two by their complementary sticky ends.

Examiner only

(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]

Small cuttings of totipotentent cells are placed in a sterile nutrient medium They are called explants. There explants then divide to form a large mass of undifferentiate cells called a callus. This callus is split up and grown with certain growth factors which cause the cells to differentiate into plantlets. Once of a sufficient size, these are placed in sterile soil and are allowed to grow. (continued)

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

Farmers ~~do not need to~~ can apply herbicide the herbicide 'Roundup' onto the crops. The crops will be unharmed, but weeds and other undesirable sources of interspecific competition will be killed. The crops therefore compete have to compete less with other species, so can ✓ easily have more available nutrients, water and light grow healthier and stronger, producing a greater crop yield for the farmer.

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

The pollen from the plant ✓ with the resistant gene may be transferred and cross-pollinate with undesirable weed species, causing them to be resistant to the herbicide too. ✓ increasing inter specific competition

Also, it is unknown whether this foreign DNA could be toxic or dangerous to the consumer, and if the plants are used near organic farms, the organic status of the farm may be compromised by cross-pollination between the two groups/batches of crops.

12

5.	(d) A selective growth medium is used, which only allows those plant cells that have taken up the recombinant plasmid to divide. This medium could contain the herbicide Round-up and then only the plant cells with the newly resistant gene would survive.

Examiner only

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]

The enzyme restriction endonuclease is used to 'cut out' the desired gene. It does this by cutting up the DNA into fragments, a gene probe is then used to obtain the desired gene. The name restriction endonuclease enzyme is used to cut open the plasmid so the two DNA fragments have complementary sticky ends. The seen enzyme used in stage 3 is DNA ligase. This splices the DNA fragment containing the gene into the plasmid. It anneals the two by their complementary sticky ends.

Examiner only

(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]

Small cuttings of totipotent cells are placed in a sterile nutrient medium. They are called explants. These explants then divide to form a large mass of undifferentiate cells called a callus. This callus is split up and grown with certain growth factors which cause the cells to differentiate into plantlets. Once of a sufficient size, these are placed in sterile soil and are allowed to grow. (continued)

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

Farmers ~~do not need to~~ can apply herbicide the herbicide 'Roundup' onto the crops. The crops will be unharmed, but weeds and other undesirable sources of interspecific competition will be killed. The crops therefore ~~compete~~ have to compete less with other species so can grow healthier and stronger (as they have more available nutrients, water and light), producing a greater crop yield for the farmer.

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

The pollen from the plant (with the resistant gene) may be transferred and cross-pollinate with undesirable weed species, causing them to be resistant to the herbicide too, increasing inter specific competition.

Also, it is unknown whether this foreign DNA could be toxic or dangerous to the consumer, and if the plants are used near organic farms, the organic status of the farm may be compromised by cross-pollination between the two groups/batches of crops.

12

5. (d) A selective growth medium is used, which only allows those plant cells that have taken up the recombinant plasmid to divide. This medium could contain the herbicide Round-up and then only the plant cells with the newly resistant gene would survive.

Examiner only

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]

.....

.....

.....

.....

.....

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

.....

.....

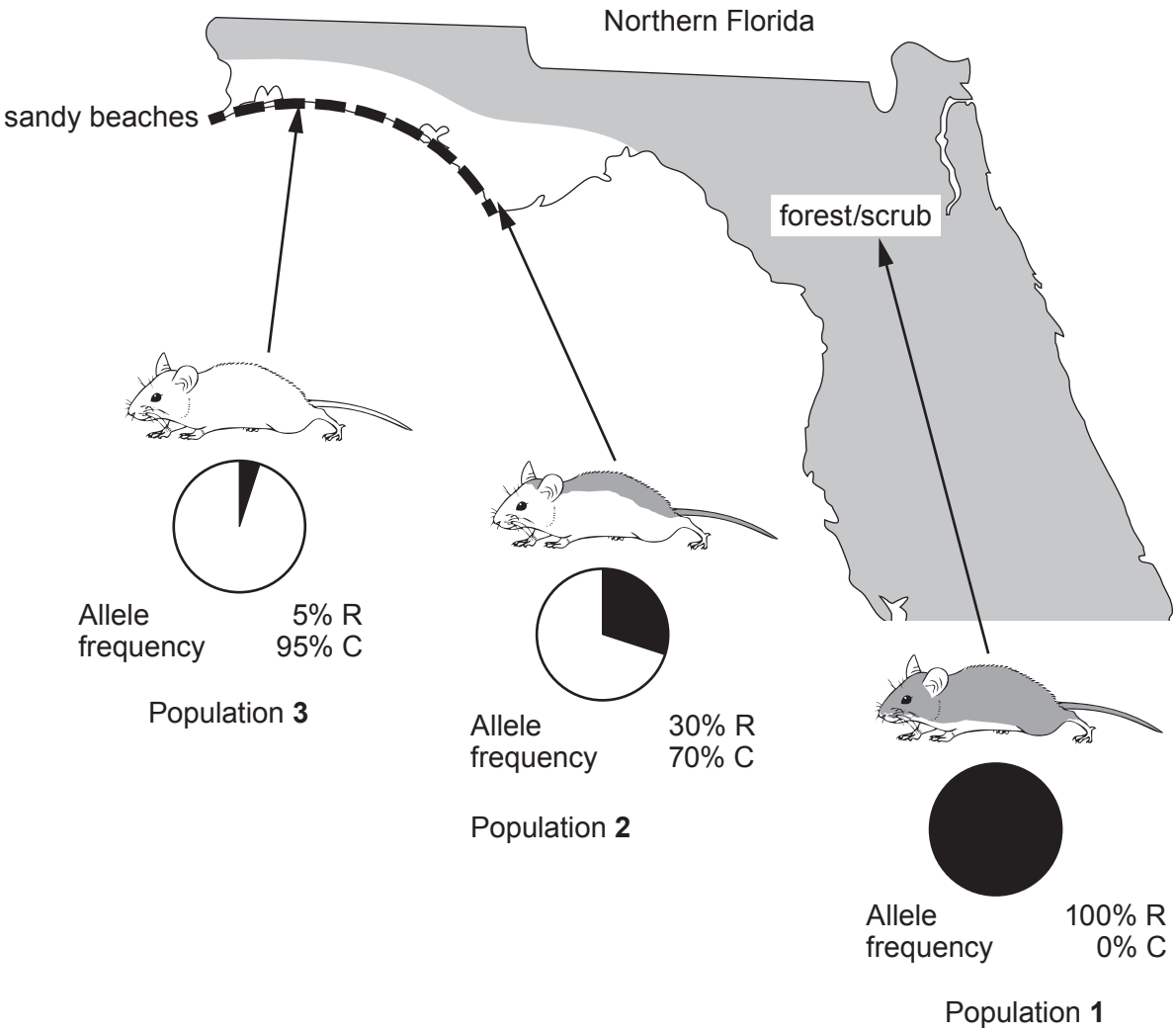
.....

.....

.....

Examiner only

(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]

.....

.....

.....

.....

(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]

.....

.....

Examiner only

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

.....

.....

.....

.....

.....

.....

.....

.....

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

.....

.....

12

Turn over.

Examiner only

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): ATCACCAAAAACGCGAACCTGCACTCG

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]

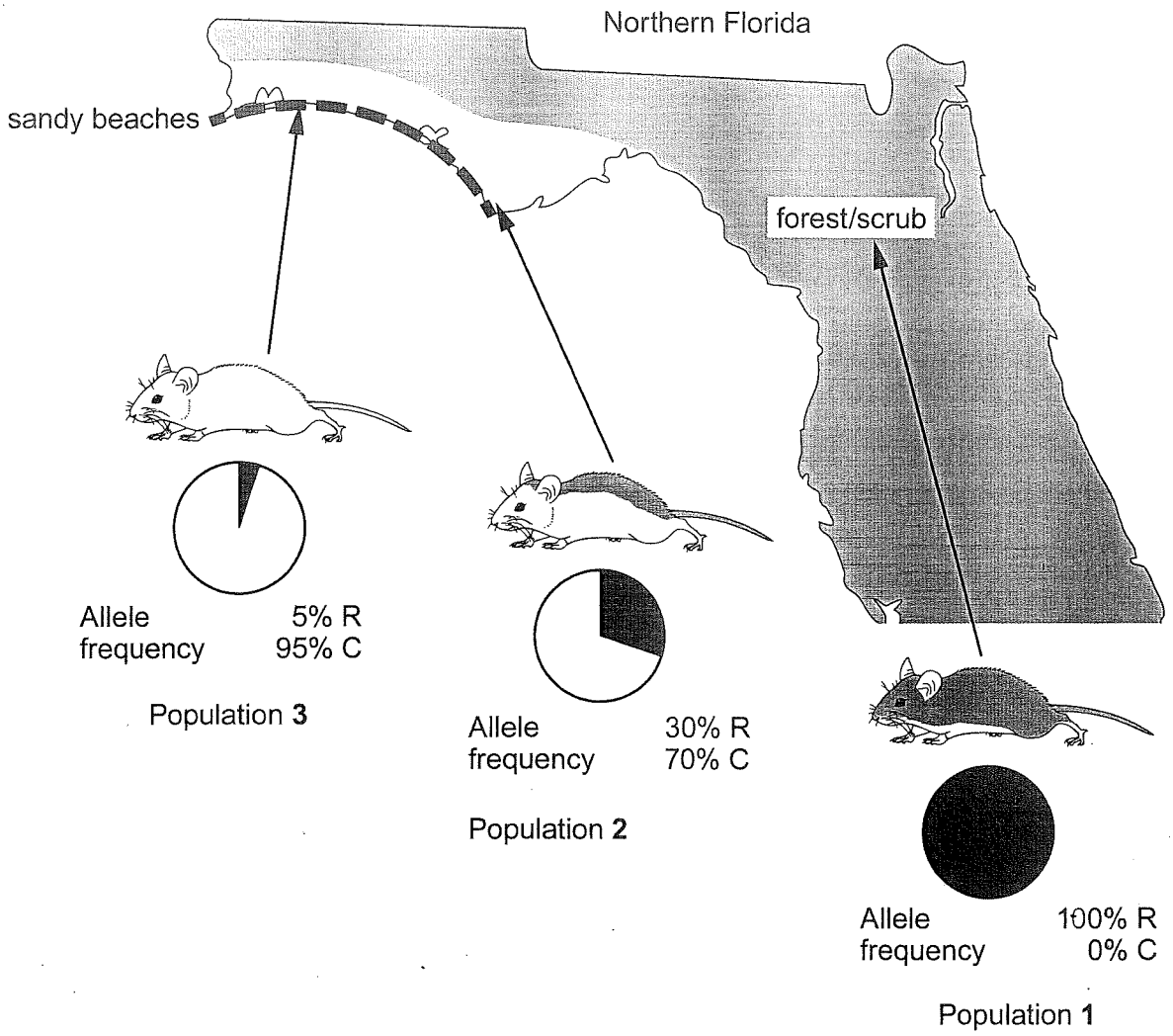
Cytosine in original nucleotide sequence changes to thymine. ~~to~~ There this changes the code meaning a different amino acid. Therefore amino acid sequence will make a different Protein.

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

~~with~~ The new/changed protein doesn't secrete the eumelanin pigment due to the transmembrane Protein, MC1R not stimulated by hormone

Examiner only

(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]

A lighter coat colour is more likely to survive on a sandy beach than a dark coat as it is less likely to be seen. Lighter coats in forest is more obvious so dye out as killed by predators.

(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]

Population 2 could have bred with heritable variation

Examiner only

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

Dark coated mice are more likely to survive in forests as they are harder to see by predators. Therefore increased dark coat population as they reproduce offspring, passing on R allele. any mice with C allele are spotted easily so killed. This is selection pressure.

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

Isolation

12

Examiner only

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): ATCACCAAAAACGCGAACCTGCACTCG

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]

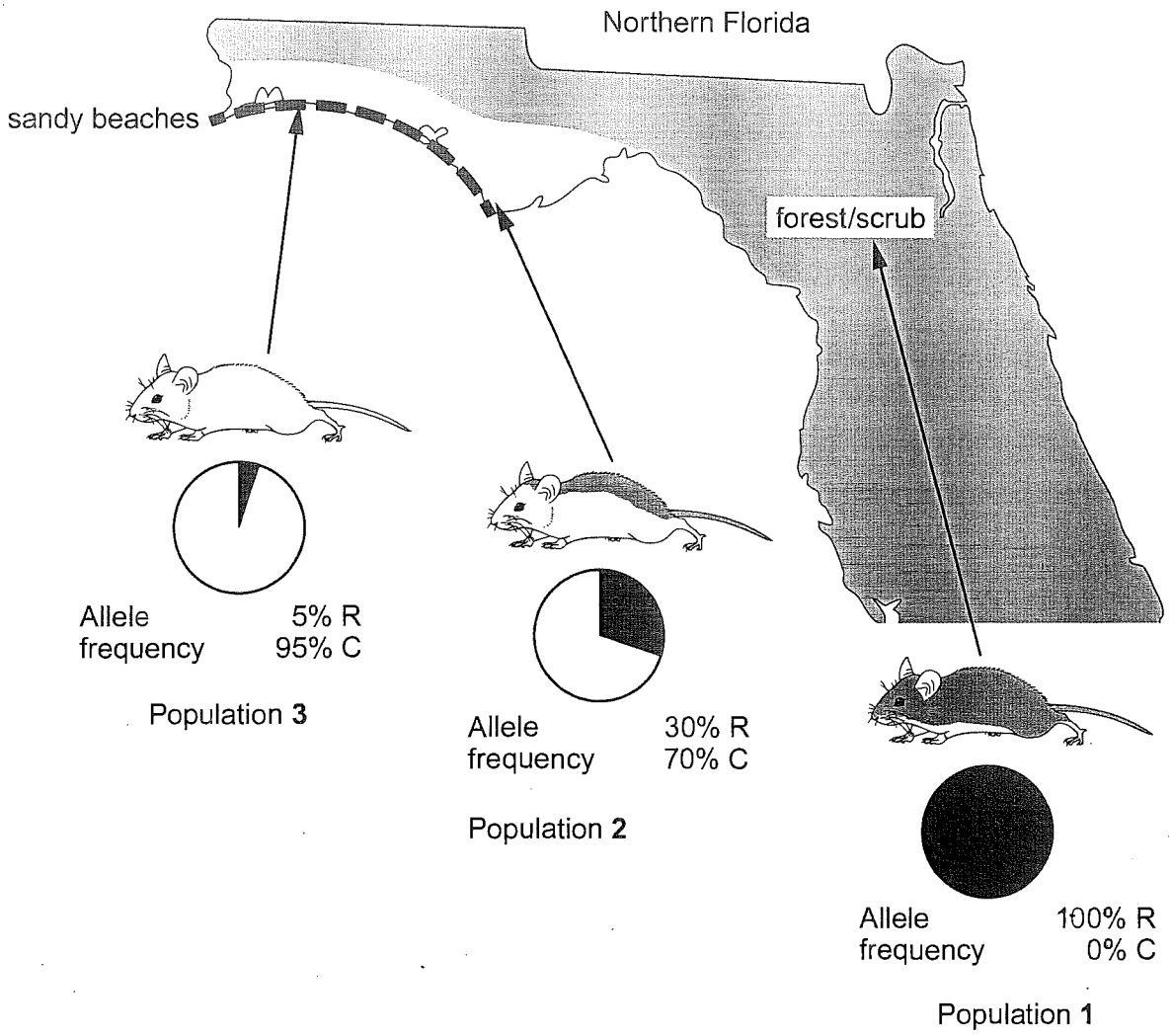
Cytosine in original nucleotide sequence changes to thymine. ~~to~~ There this changes the code meaning a different aminoacid. Therefore amino acid sequence will make a different Protein.

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

~~with~~ The new/changed protein doesn't secrete the eumelanin pigment due to the transmembrane Protein, MC1R not stimulated by hormone

Examiner only

(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]

A lighter coat colour is more likely to survive on a sandy beach than a dark coat as it is less likely to be seen. Lighter coats in forest is more obvious so dye out as killed by predators.

(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]

Population 2 could have bred with heritable variation

Examiner only

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

Dark coated mice are more likely to survive in forests as they are harder to see by predators. Therefore increased dark coat population as they reproduce offspring, passing on R allele. any mice with C allele are spotted easily so killed. This is selection pressure.

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

Isolation

12

Examiner only

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): ATC|ACC|AAA|AAC|CGC|AAC|CTG|CAC|TCG

Changed to produce light fur

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

Nucleotide sequence (allele C): ATC|ACC|AAA|AAC|TGC|AAC|CTG|CAC|TCG

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

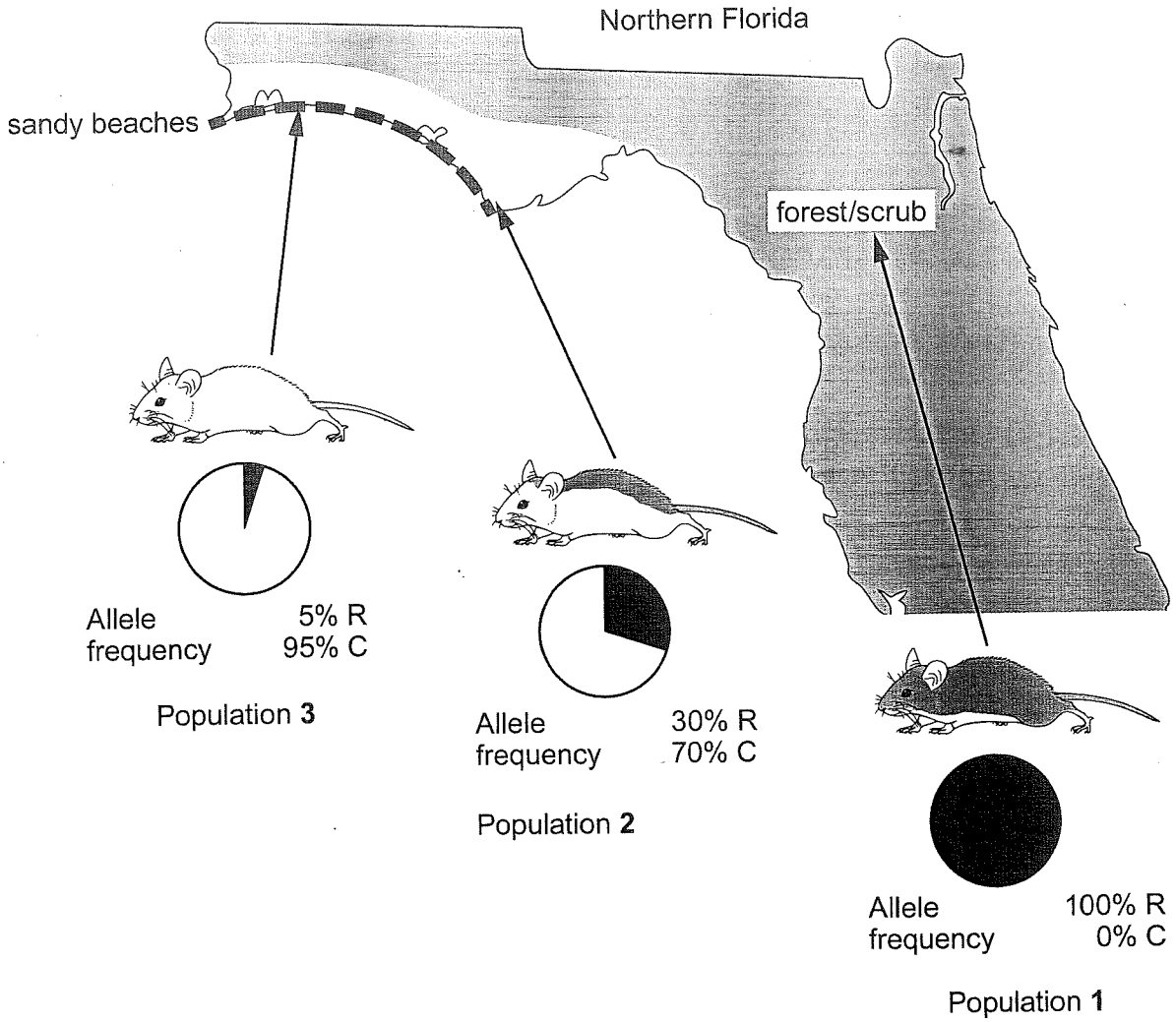
The fifth triplet code in sequence has changed from 'CGC' to 'TGC' and so the amino acid in sequence has changed from 'Arg' to 'Cys'. This means the polypeptide chain has changed and so the MC1R molecule is a new protein. molecule is no longer stimulated by a hormone so hair

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

The change has resulted in the function of MC1R not operating properly. The MC1R no longer is stimulated by a hormone and so a low/none level of eumelanin is produced, resulting in the mice having lighter.

Examiner only

(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]

Fur colour is related to the habitat they occupy. In population 3, 95% have light fur as they live in sandy beaches and in population 1, 100% have dark fur as they live in forest. This is because they have an advantage by camouflaging in with the surroundings.

(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]

Separate population selection pressure

Examiner only

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

in population 3, mice with light fur had a desirable characteristic as they blended in with their environment making them less likely to be eaten by predators. This meant those mice with light fur were more likely to survive and reproduce, passing on their alleles for light fur to their offspring. Over several generations, the allele for light fur increased until the frequency reached 95% in the current gene pool.

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

If they could no longer interbreed and produce fertile offspring.

12

Examiner only

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): ATC|ACC|AAA|AAC|CGC|AAC|CTG|CAC|TCG

Changed to produce light fur

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

Nucleotide sequence (allele C): ATC|ACC|AAA|AAC|TGC|AAC|CTG|CAC|TCG

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

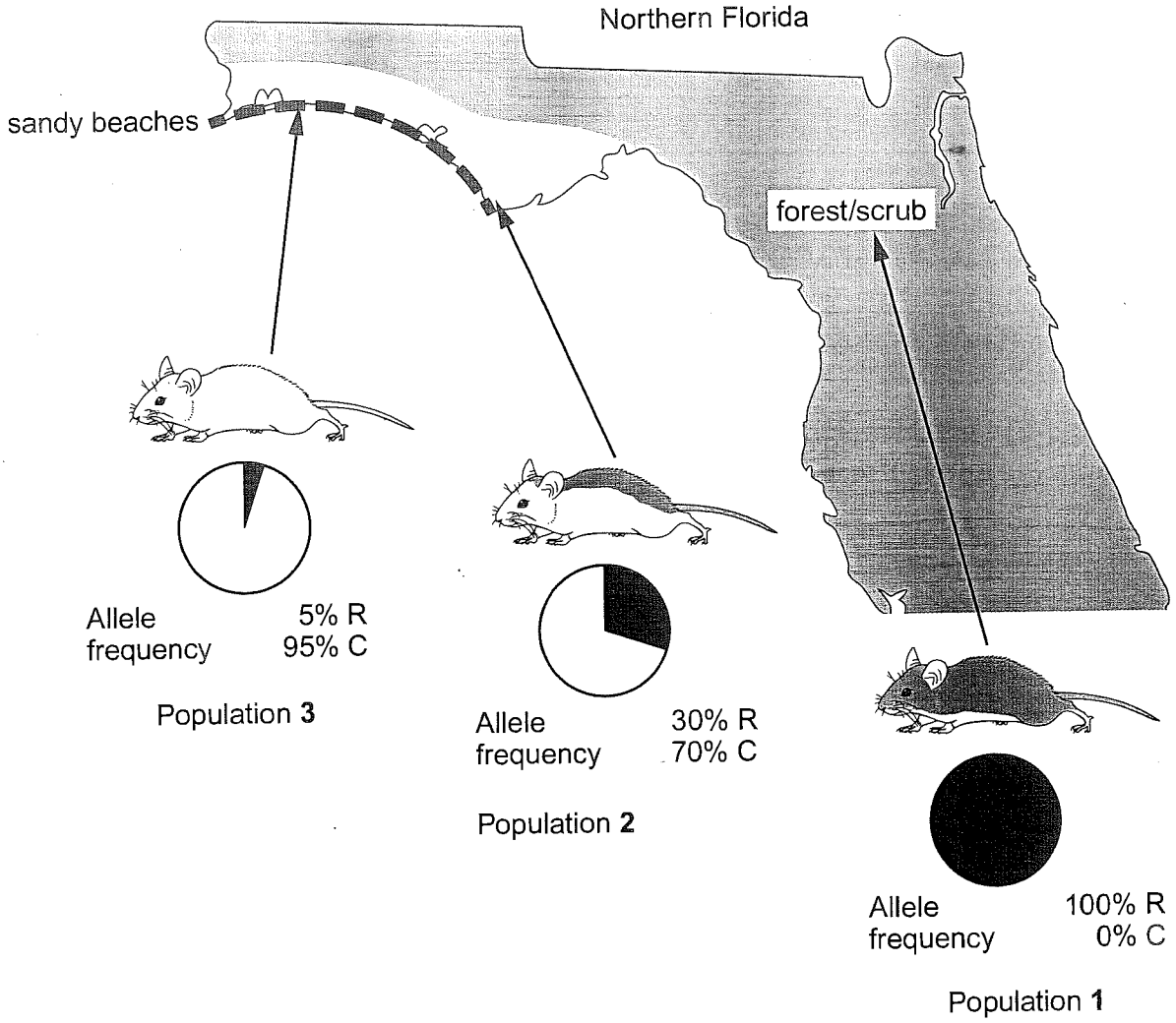
The fifth triplet codein sequence has changed from 'CGC' to 'TGC' and so the amino acid in sequence has changed from 'Arg' to 'Cys'. This means the polypeptide chain has changed and so the MC1R molecule is a new protein. molecule is no longer stimulated by a hormone so hair

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

The change has resulted in the function of MC1R not operating properly. The MC1R no longer is stimulated by a hormone and so a low level (none) of eumelanin is produced resulting in the mice having lighter.

Examiner only

(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]

Fur colour is related to the habitat they occupy. In population 3, 95% have light fur as they live in sandy beaches and in population 1, 100% have dark fur as they live in forest. This is because they have an advantage by camouflaging in with the surroundings.

(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]

Sympatric speciation. selection pressure

Examiner only

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

in population 3, mice with light fur had a desirable characteristic as they blended in with their environment making them less likely to be eaten by predators. This meant those mice with light fur were more likely to survive and reproduce, passing on their alleles for light fur to their offspring. Over several generations, the allele for light fur increased until the frequency reached 95% in the current gene pool.

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

If they could no longer interbreed and produce fertile offspring.

12

Examiner only

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): ATC ACC AAA AAC CGC AAC CTG CAC TCG

Changed to produce light fur

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

Nucleotide sequence (allele C): ATC ACC AAA AAC TGC AAC CTG CAC TCG

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

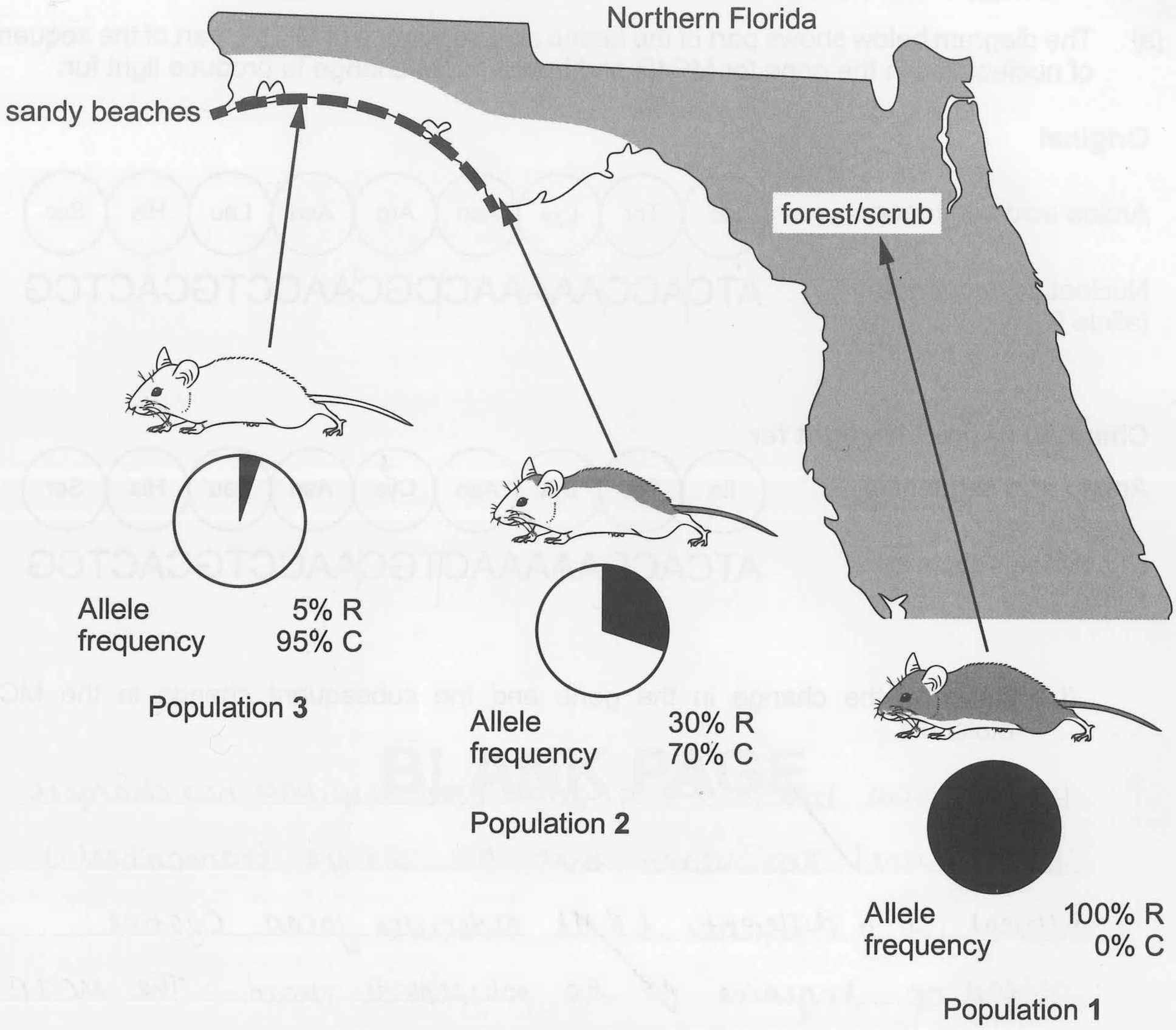
A Cytosine base in the orignal base sequence has changed to thymine. This means that the mRNA transcribed is different, so a different tRNA molecules joins Cystine instead of Argenine to the polypeptide chain. The MC1R molecule is therefore also different, as its amino acid sequence is different.

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

Since the amino acid sequence making up the polypeptide is different, the resulting polypeptide is different, so the complex 3D protein is a different shape, the transmembrane protein therefore cannot secrete high levels of eumelanin, and so the dark pigment is not expressed, leaving the mice with lighter brown fur.

Examiner only

(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]

In sandy beaches, the lighter mice have a selective advantage as they are more camouflageed, than their predators (from) then darker mice as they blend in with the light sand. However in forest/scrub, it is a selective advantage to have the allele for dark fur, as this is (continued)

(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]

The populations (sized) are small, so by chance, the allele for dark fur could have been passed on by (en) mice (to their offspring) in population 3 then population 2.

Examiner only

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

The mice show variation, with some having alleles for light fur, and others dark fur. There is a selection pressure of predation on the mice. Those with lighter fur have a selective advantage so are less likely to be killed by predators as they are more camouflaged. They therefore survive to maturity, reproduce and pass on their favourable alleles for light fur to the next generation. Over time, the allele frequencies change, as a greater proportion of mice with light fur alleles survive, so the allelic frequency of light fur increases, and that for dark fur decreases.

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

When the different demes became so phenotypically different, that they no longer reproduced with each other demes. This is reproductive isolation. They (continued)

12

6. (b) (iv) They are separate species when the offspring produced by them interbreeding are infertile. They cannot interbreed to produce fertile offspring.

Examiner only

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): ATC|ACC|AAA|ACC|GCA|ACC|TGC|ACT|CG

Changed to produce light fur

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

Nucleotide sequence (allele C): ATCACCAAAAAC|TGC|AACCTGCACTCG

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

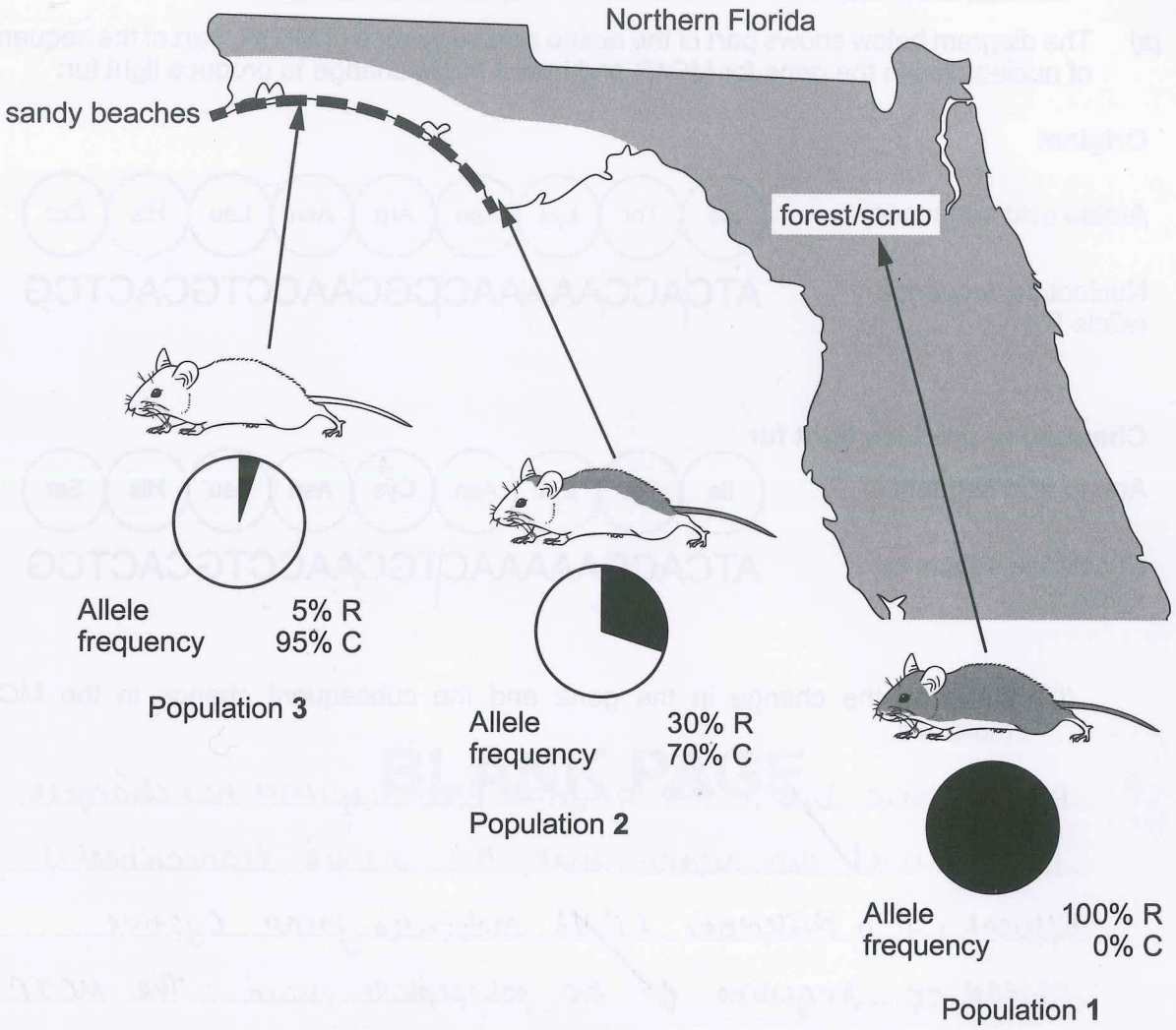
A Cytosine base in the orignal base sequence has changed to thymine. This means that the mRNA transcribed is different, so a different tRNA molecules joins Cystine instead of Arginine to the polypeptide chain. The MC1R molecule is therefore also different, as its amino acid sequence is different.

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

Since the amino acid sequence making up the polypeptide is different, the resulting polypeptide is different, so the complex 3D protein is a different shape, the transmembrane protein therefore cannot secrete high levels of eumelanin, and so the dark pigment is not expressed, leaving the mice with lighter brown fur.

Examiner only

(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]

In sandy beaches, the lighter mice have a selective advantage as they are more camouflaged than their predators from the darker mice as they blend in with the light sand. However in forest/scrub, it is a selective advantage to have the allele for dark fur, as this is (continued)

(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]

The populations size are small, so by chance, the allele for dark fur could have been passed on by ten mice to their offspring in population 3 than population 2.

Examiner only

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

The mice show variation, with some having alleles for light fur, and others dark fur. There is a selection pressure of predation on the mice. Those with lighter fur have a selective advantage so are less likely to be killed by predators as they are more camouflaged. They therefore survive to maturity, reproduce and pass on their favourable alleles for light fur to the next generation. Over time, the allele frequencies change, as a greater proportion of mice with light fur alleles survive, so the allelic frequency of light fur increases, and that for dark fur decreases.

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

When the different demes became so phenotypically different, that they no longer reproduced with other demes. This is reproductive isolation. (continued)

11

12

6. (b) (iv) They are separate species when the offspring produced by them interbreeding are infertile. They cannot interbreed to produce fertile offspring.

Examiner only

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]

.....

.....

.....

.....

Examiner only

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]

.....

(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 .....

.....

phosphorus .....

.....

nitrate/nitrite .....

.....

Examiner only

(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]

.....

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

.....

.....

.....

.....

Examiner only

(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]

.....

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

.....

(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]

.....

.....

.....

.....

13

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]

primary succession is bare rock that has no passed life. Secondary succession is re-introducing organism back after a previous forest fire or deforestation

Examiner only

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]

it was high acidity

(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 more acidic

phosphorus lowered phosphorus

nitrate/nitrite increased nitrate/nitrite levels.

Examiner only

(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]

plus U

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

depletion of nutrients and build up of excretion

Examiner only

(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]

Oak trees

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

increases

(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]

Percentage of species drop dramatically when plus B and plus PS successes by plus U has less impact.

13

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]

Primary succession is bare rock that has no passed life. Secondary succession is re-introducing organism back after a previous forest fire or deforestation

Examiner only

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]

it was high acidity

(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 more acidic

phosphorus lowered phosphorus

nitrate/nitrite increased nitrate/nitrite levels.

Examiner only

(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]

plus U

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

depletion of nutrients and build up of excretion

Examiner only

(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]

Oak trees

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

increases

(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]

Percentage of species drop dramatically when plus B and plus PS successes by plus U has less impact.

13

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]

Primary succession is the colonisation of land that has never been inhabited like a bare rock. Secondary succession is the colonisation of land which has previously been inhabited by but life has been stopped ~~because~~ for example by a fire.

Examiner only

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]

tell us how much nitrogen is aviable in the soil.

(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 the invasion of Betula spp made the soil more alkaline from the original heath, whereas Ulex the reactivity stayed the same

phosphorus The phosphorus concentration in the soil increased with Betula spp and increased with Ulex. However it increased more with Betula spp.

nitrate/nitrite The nitrate concentration decreased with the invasion of plus B but increased with the invasion of plus U.

Examiner only

(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]

~~Pinus sylvestris~~ PLUS PS

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

first the Betula spp would invade the area, making the soil more alkaline, then peteridium aquilinum would grow, then agrostis curtisii then calluna vulgaris would start to colinise the area.

Examiner only

(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]

climax community

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

species diversity increases

(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]

Because plus U has already colonised the area & and has had little effect on the % cover of species so far however plus B and plus PS are still in the early stages of colonisation and if their numbers grow then plus B calluna vulgaris would be in direct competition with the original site calluna vulgaris.

13

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]

Primary succession is the colonisation of land that has never been inhabited like a bare rock. Secondary succession is the colonisation of land which has previously been inhabited by but life has been stopped ~~the~~ for example by a fire.

Examiner only

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]

tell us how much nitrogen is avaible in the soil.

(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 the invasion of Betula spp made the soil more alkaline from the original heath, whereas Ulex stayed the same the reactivity

phosphorus The phosphorus concentration in the soil increased with Betula spp and increased with Ulex. However it increased more with Betula spp.

nitrate/nitrite The nitrate concentration decreased with the invasion of plus B but increased with the invasion of plus U.

Examiner only

(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]

PLUS PS

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

first the Betula spp would invade the area, making the soil more alkaline, then peteridium aquilinum would grow, then agrostis curtisii then calluna vulgaris would start to colinise the area.

Examiner only

(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]

climax community

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

species diversity increases

(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]

Because plus U has already colonised the area & and has had little effect on the % cover of species so far however plus B and plus PS are still in the early stages of colonisation and if their numbers grow then plus B calluna vulgaris would be in direct competition with the original site calluna vulgaris.

13

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]

Primary succession occurs when a habitat is initially colonised by species, starting with pioneers, and where the habitat is considered bare ground in that it has never previously supported an ecosystem. Secondary succession occurs when species re-inhabit an area after they were

+ see additional answer booklet

Examiner only

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]

All soils are acidic

(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 plus B is able to increase the pH of the soil, making the soil less acidic ~~than before its invasion~~ than plus U, which makes the soil more acidic

phosphorus plus B is able to abe to increase the phosphorus concentration of the soil more than plus U

nitrate/nitrite plus B increase the nitrate/nitrite concentration of the soil less so than plus U, which increases this concentration by a greater amount than plus B

Examiner only

(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]

Ulex europaeus - plus U has the least impact, as most of the original species are still present.

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

Plus B is able to increase both the pH levels and phosphorus concentration of the soil to such levels that the ~~plants~~ species Erica cinerea, Erica tetralix and Cladonia portentosa are able to survive, causing the death of these species and the subsequent

* see additional answer booklet

Examiner only

(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]

Climax Community

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

Species diversity starts to increase as succession proceeds

(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]

Plus U succession only removes Cladonia portentosa via plus U succession, maintaining Erica cinerea and Erica tetralix along with Calluna ~~vulgaris~~ vulgaris in the ecosystem, whereas plus B and plus PS remove more species, including Erica tetralix in both, causing a greater change

* see additional answer booklet

13

7.(a) Continued	wiped out due to natural disaster or human impacts. This takes the form of seeds that survived germinating to form new plants and animal migration back into the ecosystem.
7.(c)(ii) Continued.	introduction of new species which are able to survive in the less acidic and more concentrated phosphorus soils, causing the vegitational change during succession seer
7.(d)(iii) Continued	in the species make-up in the community, prompting conservationists to prevent plus B and plus BS succession more than plus U succession due to the ~~can~~ greater change in species in Plus B and Plus BS succession than plus U succession. seen

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]

Primary succession occurs when a habitat is initially colonised by species, starting with pioneers, and where the habitat is considered bare ground in that it has never previously supported an ecosystem. Secondary succession occurs when species re-inhabit an area after they were

+ see additional answer booklet

+1

Examiner only

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]

All soils are acidic

(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 plus B is able to increase the pH of the soil, making the soil less acidic than plus U, which makes the soil more acidic ~~than before its invasion~~.

phosphorus plus B is able to abe to increase the phosphorus concentration of the soil more than plus U

nitrate/nitrite plus B increase the nitrate/nitrite concentration of the soil less so than plus U, which increases this concentration by a greater amount than plus B

Examiner only

(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]

Ulex europaeus plus U has the least impact, as most of the original species are still present.

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

Plus B is able to increase both the pH levels and phosphate concentration of the soil to such levels that the ~~plant~~ species Erica cinerea, Erica tetralix and Cladonia portentosa are able to survive, causing the death of these species and the subsequent

* see additional answer booklet

Examiner only

(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]

Climax Community

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

Species diversity starts to increase as succession proceeds.

(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]

Plus U succession only removes Cladonia portentosa via plus U succession, maintaining Erica cinerea and Erica tetralix along with Calluna ~~vu~~ vulgaris in the ecosystem, whereas plus B and plus PS remove more species, including Erica tetralix in both, causing a greater change

* see additional answer booklet

12

13

7.(c) Continued	wiped out due to natural disaster or human impacts. This takes the form of seeds that survived germinating to form new plants and animal migration back into the ecosystem.
7.(c)(ii) Continued.	introduction of new species which are able to survive in the less acidic and more concentrated phosphorus soils, causing the vegitational change during succession seer
7.(c)(iii) Continued	in the species make-up in the community, prompting conservationists to prevent plus B and plus PS succession more than plus U succession due to the ~~can~~ greater change in species in Plus B and Plus PS succession than plus U succession. seen