4.6 Inheritance, Variation and Evolution

Higher

Name: __________________________
Class: __________________________
Date: __________________________

Time: 405 minutes
Marks: 402 marks
Comments:
Q1.
Different antibiotics destroy bacteria in different ways.

• Some antibiotics disrupt the bacterial cell membrane.
• Some antibiotics disrupt the bacterial cell wall.

(a) Antibiotics that disrupt the bacterial cell membrane often cause more side effects in humans compared with antibiotics that disrupt bacterial cell walls.
Suggest why.

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(b) Some antibiotics prevent ribosomes functioning.
Suggest how this damages the bacterium.

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(c) Drug manufacturers are spending less on research into new antibiotics.
One reason why is because new antibiotics are rarely prescribed.
Some people think that governments should pay drug manufacturers to develop new antibiotics.
Suggest why.

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(3) (Total 5 marks)

Q2.
The figure below shows a carp.
(a) A mutation causes a blue colour in some carp.

What is a mutation?

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(1)

(b) Suggest how a mutation could cause a different colour in carp.

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___________________________________________________________________
(1)

(c) Two alleles control the body colour of carp:

• brown (B)
• blue (b).

The brown allele is dominant to the blue allele.

Two carp that are heterozygous for colour are crossed and produce $2.6 \times 10^5$ offspring.

Approximately how many of the offspring are expected to be blue?

Draw a genetic diagram to explain your answer.

Give your answer in standard form.

Number of offspring expected to be blue = _____________ (5)

(d) A scientist wanted to find out whether a brown carp has the genotype BB or Bb.

Describe what genetic cross a scientist could do to determine this.
Q3.

Phenylketonuria (PKU) is an inherited condition. PKU makes people ill.

(a) PKU is caused by a recessive allele.

(i) What is an allele?

(ii) What is meant by recessive?

(b) The diagram below shows the inheritance of PKU in one family.

(i) Give one piece of evidence from the diagram that PKU is caused by a recessive allele.

(ii) Persons 6 and 7 are planning to have another child. Use a genetic diagram to find the probability that the new child will have PKU. Use the following symbols in your answer:

\[ N \] = the dominant allele for not having PKU

\[ n \] = the recessive allele for PKU.

Probability = _________________________

(c) Persons 6 and 7 wish to avoid having another child with PKU. A genetic counsellor advises that they could produce several embryos by IVF
treatment.

(i) During IVF treatment, each fertilised egg cell forms an embryo by cell division. Name this type of cell division.

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(ii) An embryo screening technique could be used to find the genotype of each embryo. An unaffected embryo could then be placed in person 7's uterus. The screening technique is carried out on a cell from an embryo after just three cell divisions of the fertilised egg. How many cells will there be in an embryo after the fertilised egg has divided three times?

☐

(iii) During embryo screening, a technician tests the genetic material of the embryo to find out which alleles are present. The genetic material is made up of large molecules of a chemical substance. Name this chemical substance.

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(d) Some people have ethical objections to embryo screening.

(i) Give one ethical objection to embryo screening.

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(ii) Give one reason in favour of embryo screening.

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(Total 12 marks)

Q4.

A certain allele increases the chance of women developing one type of breast cancer. A woman has this allele. She wants to be sure that she will not have daughters who also have the allele.

Doctors:

• collect several eggs from her ovaries
• fertilise the eggs with sperm, in dishes.
(a) The doctors expect half the embryos produced to be female. Explain why.

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(2)

(b) The embryos grow to around 100 cells.

Doctors:
- remove one cell from each embryo
- check the cell for the allele.

Complete the sentence.
This process is known as embryo ______________________________ .

(1)

(c) One of the female embryos did not have the allele. This female embryo was implanted into the woman’s uterus.

Evaluate the advantages and disadvantages of the whole procedure.

Use information from all parts of this question and your own knowledge.

Remember to give a conclusion to your evaluation.

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Q5.

The fruit fly, *Drosophila*, has either long wings or vestigial wings, as shown in the diagram.

Long-winged fly  Vestigial-winged fly

The size of the wings is determined by a pair of alleles: $A$ and $a$. Long-winged flies have one of two possible genotypes: $AA$ or $Aa$. Vestigial-winged flies have only one genotype: $aa$.

(a) (i) What is the genotype of a heterozygous fly?

(ii) Why can vestigial-winged flies only have the genotype $aa$?

(b) A male and a female long-winged fly were crossed. They produced 96 offspring. 72 of the offspring had long wings and 24 had vestigial wings. Use a genetic diagram to explain this.
Q6.
The black pigment in human skin and eyes is called melanin. Production of melanin is controlled by a single pair of genes. A person who is homozygous for a recessive allele of the gene has no melanin and is said to be albino.

(a) A man is albino. His wife is heterozygous for the melanin-producing allele.

(i) The fertilised egg cell produced by the couple divides to form two cells.

Name the process of cell division involved.

(ii) How many albino genes would there be in each of these two cells?

Explain you answer.

(b) Albino people are more likely than people with melanin to suffer mutations that cause cancer in their skin. Suggest why albino people have an increased chance of mutation in their skin cells.

(i) Sometimes, mutation in skin cells leads to cancers in other organs, such as the liver.

Explain how.

(Total 7 marks)

Q7.
The drawings show bolls on cotton plants. Cotton thread is made from these bolls.
The size of the bolls is controlled by a single gene. This gene has two alleles. The dominant allele $B$ is the allele for large bolls. The recessive allele $b$ is the allele for small bolls.

Use a genetic diagram to show how two cotton plants with large bolls may produce a cotton plant with small bolls.

(Total 4 marks)

Q8.

Modern humans belong to the species $Homo sapiens$. Many people think that modern humans evolved from more primitive species. Three of these primitive species were $Australopithecus$, $Homo habilis$ and $Homo erectus$. These three species are now extinct. The graph shows the brain size of several specimens from each of the species.
(a) Estimate the mean brain size of *Homo habilis*.

\[ \text{___________ cm}^3 \] (1)

(b) Suggest how we know about the brain size of *Australopithecus*.

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___________________________________________________________________ (2)

(c) Suggest an explanation, in terms of natural selection, for the change in brain size during the evolution of *Homo sapiens*.

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___________________________________________________________________ (3)  

(Total 6 marks)

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**Q9.**

The drawings show two forms of the peppered moth.
In an investigation, pale and dark moths were placed in different positions on trees in two woods. One wood was in an industrial area where the bark was blackened by pollution. The other wood was unpolluted, and the tree bark was covered in pale mosses and lichen. After three days, the surviving moths were counted. The results are shown in the table.

<table>
<thead>
<tr>
<th>WOOD</th>
<th>POSITION OF MOTH ON TREE</th>
<th>PERCENTAGE OF MOTHS EATEN BY BIRDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PALE</td>
</tr>
<tr>
<td>Polluted</td>
<td>On main trunk</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Underside of branch</td>
<td>50</td>
</tr>
<tr>
<td>Unpolluted</td>
<td>On main trunk</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Underside of branch</td>
<td>26</td>
</tr>
</tbody>
</table>

(a) What can you tell from these results about the survival of the two types of moth in polluted and unpolluted woods, and in different positions on the tree?

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(b) Explain how the results provide evidence for one theory of evolution.

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(3)

(Total 6 marks)
Q10.
The diagram shows one method of cloning sheep.

1
An embryonic cell is removed from the donor sheep and allowed to multiply. Initially all these cells are capable of reproducing the complete organism.

2
The nuclei are taken from the donor cells and imported into ‘foster eggs’ (nuclei-less ova from other sheep). They are allowed to develop.

3
The eggs are implanted into the wombs of foster sheep and allowed to ‘go full term’.

(a) Explain why the lambs produced by this technique are identical to each other.
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(b) Explain why the lambs are not genetically identical to the sheep which produced the ‘foster’ eggs.
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(2)
(c) Explain the drawback of widespread use of just a few clones of sheep.

Q11.

Wild turkeys have black feathers. Until about 30 years ago turkeys reared for meat also had black feathers like this.

![Image of a turkey with black feathers]

However, a recessive gene which produced entirely white feathers appeared, and turkey farmers changed to breeding white-feathered birds.

![Image of a turkey with white feathers]

Supermarkets preferred white-feathered birds, because small pieces of feather left in the skin after plucking were not visible as dark patches. Customers wanted unblemished oven-ready birds. Now, however, there is a demand again for birds with black feathers which can be marketed as 'traditional' farm-produced turkeys.
(a) Feather colour is controlled by one pair of genes.

(i) Suggest suitable symbols for each of the two alleles of this pair of genes.

Black feathers ____________ White feathers ________________

(ii) What alleles for feather colour would a white turkey have? ______________

(1)

(b) Explain carefully why ‘traditional’ black-feathered turkeys could not be bred from a flock of white-feathered birds.

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(2)

(Total 4 marks)

Q12.

Read the extract.

Super-bug may hit the price of coffee

The coffee bean borer, a pest of the coffee crop, can be controlled by the pesticide endosulphan. However, strains of the insect that are up to 100 times more resistant to the pesticide have emerged on the South Pacific island of New Caledonia.

For full resistance to be passed on to an offspring two copies of the new resistance allele should be inherited, one from each parent. There is much inbreeding with brother-sister matings happening in every generation, so it takes only a few generations before all the descendants of a single resistant female have inherited two copies of the resistance allele.

If this resistance spreads from New Caledonia, it will mean the loss of a major control method. This will present a serious threat to the international coffee industry.

(a) Suggest how the allele for resistance to endosulfan may have arisen.

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(1)

(b) (i) How would you expect the proportion of normal coffee bean borers on New Caledonia to change over the next few years?

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(ii) Explain why this change will take place.
Q13.

Giraffes feed on the leaves of trees and other plants in areas of Africa. They are adapted, through evolution, to survive in their environment.

(a) Use the information in the picture to give one way in which the giraffe is adapted to its environment.
(b) Explain how Jean-Baptiste Lamarck (1744–1829) accounted for the evolution of the long neck in giraffes.

(c) Another scientist, August Weismann (1834-1914) wanted to check Lamarck's explanation. To do this he cut off the tails of a number of generations of mice and looked at the offspring.

His results did not support Lamarck's theory. Explain why.

(d) Explain how Charles Darwin (1809–1882) accounted for the evolution of the long neck in giraffes.
genetically-engineered strains of cotton which resist the action of herbicides. This means that when the crop is sprayed with herbicide, only the weeds are killed. However, there are potential dangers with this procedure. Cotton plants can interbreed with some other species of plants.

Evaluate the possible advantages and disadvantages of developing genetically-engineered herbicide-resistant crops.

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(Total 5 marks)

Q15.

The drawings below show a mammoth, an extinct relation of the elephant which lived in arctic regions, and a modern elephant which lives in tropical areas.

Mammoth

Elephant

The mammoth, which was very hairy, and the elephant, are both thought to have evolved from a scantily-haired ancestor. Explain, as fully as you can, how the mammoth evolved from the common ancestor.

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(Total 5 marks)
Q16.
Meiosis and mitosis are different types of division in human cells. Compare the two processes by referring to where each takes place and the kind of products that are made.

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(Total 6 marks)

Q17.
The following passage is adapted from an article by Martin Kelly in The Independent newspaper.

Thanks to the test tube banana

_Specially bred resistant varieties may save African crops from disease_

A banana is a fruit, but it has no seeds. And if there are no seeds how do the plants reproduce? At one level the answer is easy; centuries of selective breeding have resulted in varieties with plenty of tasty flesh but few bitter inedible seeds, and propagation is carried out by means of root corms.

Most bananas we eat are thus actually ‘clones’ of a few successful plants, as is also the case with the potato. Banana clones are genetically identical to their parents, so growers can be completely sure their fruits will be big and tasty.

Genetic variability of these cloned plants is extremely low. Resistance to new diseases, therefore, is almost nil; witness the spread of potato blight through Ireland in the 1840s.

The issue goes well beyond our high streets and supermarkets. The banana has a larger relative called a plantain, which is starchy rather than sweet and is a staple food of more than 60 million Africans. Bananas and plantains are being ravaged by a new fungal
disease called Black Sigatoka. The commercial planters that produce the bananas we buy in supermarkets have little problem here; they can afford to buy chemicals to spray their crops. African subsistence farmers, forced to rely on 'organic' methods can only sit by and watch their plants die.

Several governments have turned to the International Institute for Tropical Agriculture (IATA) for help. IATA is in Africa, but is not of Africa. It is internationally funded with levels of staffing and equipment that enable advanced bio-technological techniques to be used. However, even with genetic engineering, to breed resistant varieties is a long-term project and Black Sigatoka is not going to wait. IATA scientists have had to divide their energies between two approaches: an interim solution and the development of resistant varieties.

The interim solution was easily found in a group of 'cooking bananas' which were resistant to Black Sigatoka disease and which could, to some extent, be substituted for plantain in the diet. These, however, were only found in localised areas and the first problem facing IATA was to obtain enough plants from the few available plants of resistant varieties to supply the needs of the affected farmers.

(a) Explain how selective breeding may have been used to produce bananas with tasty flesh.

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(2) (b) Explain, as fully as you can, why “Genetic variability of these cloned plants is extremely low” compared with natural populations.

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(4) (c) Explain, as fully as you can, how IATA scientists might be able to “obtain enough plants from the few available plants of resistant varieties to supply the needs of affected farmers”.

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___________________________________________________________________
(d) Explain, as fully as you can, how IATA scientists may use genetic engineering to produce varieties of banana resistant to Black Sigatoka disease.

Q18.

(a) The diagram shows a normal body cell which has six chromosomes.

(i) Complete the diagram below to show one cell produced from this cell by mitosis.

(ii) Complete the diagram below to show one cell produced from the original cell by meiosis.
Thalassaemia is a blood disease. It is determined by a single recessive allele. A person with one recessive allele does not get the disease but does act as a carrier. People with this pair of recessive alleles can become ill.

(i) Draw a genetic diagram to show the inheritance of this disease if both parents are heterozygous.

[Use the symbols T = dominant allele and t = recessive allele]

(ii) What are the chances of a baby inheriting the disease?

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(iii) What are the chances of a baby being a carrier if both parents are heterozygous?

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Q19.
Darwin suggested the theory of natural selection.

(a) Explain how natural selection occurs.

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(Total 10 marks)
Latitude is a measure of distance from the Earth’s equator.

Scientists investigated the effect of latitude on:

• the time taken for new species to evolve
• the number of living species.

The table shows the scientists’ results.

<table>
<thead>
<tr>
<th>Latitude in degrees North of equator</th>
<th>Time taken for new species to evolve in millions of years</th>
<th>Relative number of living species</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (at the equator)</td>
<td>3–4</td>
<td>100</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>75 (in the Arctic)</td>
<td>0.5</td>
<td>20</td>
</tr>
</tbody>
</table>

As latitude increases environmental conditions become more severe.

(i) Describe the patterns shown by the data.

(ii) Suggest explanations for the patterns you have described in part (b)(i).
Q20.

(a) Mice with black fur can have the genotype BB or Bb, whilst mice with brown fur have the genotype bb.

(i) Use a genetic diagram to show what fur colours you would predict in the F1 offspring produced by two mice who are both Bb.

(ii) Why might your prediction of fur colour in the F1 generation not be proved right?

(b) Using the example in part (a) to help:

(i) describe the difference between dominant and recessive alleles;

(ii) describe the difference between alleles and genes;

(iii) describe the difference between homozygous and heterozygous chromosomes.
Q21.

The map shows:

- the most densely populated industrial areas;
- the frequency of pale and dark forms of the peppered moth;
- the direction of the prevailing winds in the British Isles.

**Key**

- □ Densely populated industrial areas
- ○ All normal pale forms
- ● All mutant dark forms
- ◯ Combinations of both forms
Peppered moths usually rest on trees covered with lichen, and they are preyed upon by many birds. In areas of low air pollution the lichen on trees is usually pale in colour. In areas of high air pollution the lichen turns black.

(a) (i) State a pattern of the distribution of the mutant dark form shown on the map.

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____________________________________________________________________________

(1)

(ii) Suggest a reason for your pattern.

____________________________________________________________________________
____________________________________________________________________________

(1)

(b) The dark form of peppered moth developed after a mutation in the pale form. What is a mutation?
(c) Using the idea of Natural Selection explain why the dark form of the moth is restricted to the areas shown.

Q22.

The diagram shows how genetic engineering can be used to produce human insulin from bacteria. Ampicillin and tetracycline are two types of antibiotic. Study the diagram carefully and answer the questions.
In experiments like these, some bacteria take up the plasmid (ring of DNA) containing the insulin gene. Other bacteria fail to take up a plasmid, or they take up an unmodified plasmid (a ring of DNA which has not been cut open and which does not contain the insulin gene).

(a) Complete the table by putting a tick (✓) in the correct boxes to show which bacteria would be able to multiply in the presence of ampicillin and which bacteria would be able to multiply in the presence of tetracycline.

<table>
<thead>
<tr>
<th>Bacterium can multiply in the presence of</th>
<th>Ampicillin</th>
<th>Tetracycline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterium + plasmid with the insulin gene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacterium without a plasmid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacterium with an unmodified plasmid</td>
<td></td>
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</tbody>
</table>
The bacterium with the plasmid containing the insulin gene multiplies by cell division to form a clone of bacteria.

Will all the bacteria in this clone be able to produce insulin? Explain your answer.

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(3)
(Total 6 marks)

Q23.
Pathogenic bacteria and viruses may make us feel ill if they enter our bodies.

(a) Why do bacteria and viruses make us feel ill?
Bacteria

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___________________________________________________________________
___________________________________________________________________

Viruses

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___________________________________________________________________

(2)

(b) Most drugs that kill bacteria cannot be used to treat viral infections.

Explain why.

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(2)

(c) Antibiotic-resistant strains of bacteria are causing problems in most hospitals.

Explain, as fully as you can, why there has been a large increase in the number of antibiotic-resistant strains of bacteria.
Q24.

Diagram 1 shows the nucleus of a cell at the start of meiosis.

(a) Name structure A. 

(b) During meiosis, the nucleus shown in diagram 1 will divide twice to form four nuclei. Complete diagram 2 to show the appearance of one of these nuclei.
Q25.
The vole is a small, mouse-like animal. Voles found on some cold islands to the north of Scotland are much larger than voles found in warmer areas such as southern France. Explain how natural selection may have caused the northern voles to be larger in size.
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(Total 5 marks)

Q26.
The diagram shows two patterns of cell division. Cell division type A is used in gamete formation. Cell division type B is used in normal growth.
(a) Name the two types of cell division, A and B, shown in the diagram.

Type A ________________________________________________________________

Type B ________________________________________________________________  

(2)

(b) Name the process in which an egg and sperm join together.

________________________________________________________________________ 

(1)

(c) Cell 1 contains 46 chromosomes. How many chromosomes will there be in:

(i) cell 10; _____________________________________________________________  

(1)

(ii) cell 14? ____________________________________________________________  

(1)

(Total 5 marks)

Q27.

(a) What does the theory of evolution state?

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(b) *Daphnia* are microscopic water fleas. Midge larvae prey on *Daphnia*. The midge larvae release a hormone into the water. *Daphnia* respond to these hormones by growing larger protective ‘helmet’-like structures.

Scientists were surprised to observe that the offspring of *Daphnia* females who had been exposed to these hormones always had larger helmets than offspring whose mothers had never been exposed to the hormones. The offspring with the large helmets went on to produce offspring with large helmets.

Explain why the scientists’ observations seem to contradict the theory of natural selection.

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Q28. The drawings show two different species of butterfly.

![Amauris](image1) ![Hypolimnas](image2)

- Both species can be eaten by most birds.
- *Amauris* has a foul taste which birds do not like, so birds have learned not to prey on it.
- *Hypolimnas* does not have a foul taste but most birds do not prey on it.

(a) Suggest why most birds do not prey on *Hypolimnas*.

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(b) Suggest an explanation, in terms of natural selection, for the markings on the wings of Hypolimnas.

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(3)
(Total 5 marks)

Q29.
Chromosomes contain molecules of DNA. Genes are small sections of DNA.

(a) Each gene contains a code.
What does a cell use this code for?
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(2)

(b) DNA fingerprints can be used to identify people. One example of the use of DNA fingerprints is to find out which man is the father of a child.

The diagram shows the DNA fingerprints of a child, the child’s mother and two men who claim to be the child’s father.

The numbers refer to the bars on the DNA fingerprints.

<table>
<thead>
<tr>
<th>Man A</th>
<th>Man B</th>
<th>Child</th>
<th>Mother</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>9</td>
<td>17</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>18</td>
<td>26</td>
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<td>3</td>
<td>11</td>
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<td>27</td>
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<td>4</td>
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<td>5</td>
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<td>6</td>
<td>14</td>
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<td>7</td>
<td>15</td>
<td>23</td>
<td>31</td>
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<tr>
<td>8</td>
<td>16</td>
<td>24</td>
<td>32</td>
</tr>
</tbody>
</table>
Q30.
Scientists are investigating how to reduce methane emissions from cattle.

Most of this methane is emitted by the cows belching.
Scientists have found that less methane is belched if the cows eat high-sugar rye grass.

This rye grass has been produced by genetic engineering.

(i) Suggest how the high-sugar rye grass might have been produced by genetic engineering.

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(ii) Some people might object to the growing of genetically-engineered, high-sugar rye grass for feeding cattle.

Give two reasons why.

1. ______________________________________________________________________
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________________________________________________________________________

2. ______________________________________________________________________
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(Total 5 marks)

Q31.

The photograph shows a Crossbill.
A Crossbill feeds by using its bill (beak) to force apart the scales on conifer cones. It then uses its tongue to extract the seeds. If the bill is clipped it grows back again.

Scientists were interested in the evolution of the bill of the Crossbill.

In an investigation, they clipped the bills of several Crossbills so that their bills no longer crossed.

They observed that Crossbills with clipped bills took much longer to get seeds.

Use information from the investigation to suggest an explanation for the evolution of the bill in the Crossbill.

In your explanation, use the ideas of selection, competition and mutation.

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(Total 4 marks)
The dodo is an extinct bird. The drawing shows an artist’s impression of the bird.

The dodo lived on a small island in the middle of the Indian Ocean. Its ancestors were pigeon-like birds which flew to the island millions of years ago. There were no predators on the island. There was a lot of fruit on the ground. This fruit became the main diet of the birds. Gradually, the birds became much heavier, lost their ability to fly and evolved into the dodo.

(a) Suggest an explanation for the evolution of the pigeon-like ancestor into the flightless dodo.

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(b) The dodo became extinct about 80 years after Dutch sailors first discovered the island in the eighteenth century.

Scientists are uncertain about the reasons for the dodo’s extinction.

Suggest an explanation for this uncertainty.

___________________________________________________________________
Q33.
The diagram shows one method of producing herbicide-resistant crop plants.

(a) (i) The herbicide-resistance gene is obtained from a herbicide-resistant plant.

Which structure in a cell carries the genes?
(ii) How is the herbicide-resistance gene cut out of this structure?

______________________________________________________________

(1)

(b) Apart from having the herbicide-resistance gene, the herbicide-resistant plants are identical to the herbicide-susceptible plants.

Explain why.

______________________________________________________________

(1)

(c) Suggest one advantage to a farmer of growing herbicide-resistant crops.

______________________________________________________________

(2)

(d) Many people are opposed to the growing of herbicide-resistant crops produced in this way.

Suggest one reason why.

______________________________________________________________

(1)

(Total 6 marks)

Q34.

Soay sheep live wild on an island off the north coast of Scotland. No people live on the island.

By Owen Jones = Jonesor [CC-BY-SA-2.5], via Wikimedia Commons

Over the last 25 years, the average height and mass of the wild Soay sheep have decreased.
The scientists think that climate change might have affected the size of the sheep.

Suggest an explanation for the evolution of the wild Soay sheep over the last 25 years.

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(Total 4 marks)

Q35.
The photograph shows a snake eating a toad.

Cane toads were first introduced into Australia in 1935. The toads contain toxins and most species of Australian snake die after eating the toad.

The cane toad toxin does not affect all snakes the same way. Longer snakes are less affected by toad toxin.

Scientists investigated how red-bellied black snakes had changed in the 70 years since cane toads were introduced into their area. They found that red-bellied black snakes had become longer by around 3 – 5 %.

Suggest an explanation for the change in the body length of the red-bellied black snakes since the introduction of the cane toads.

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Q36.
The table shows the number of chromosomes found in each body cell of some different organisms.

<table>
<thead>
<tr>
<th></th>
<th>Number of chromosomes in each body cell</th>
<th></th>
<th>Number of chromosomes in each body cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animals</td>
<td></td>
<td>Plants</td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td></td>
<td>Species</td>
<td></td>
</tr>
<tr>
<td>Fruit fly</td>
<td>8</td>
<td>Tomato</td>
<td>24</td>
</tr>
<tr>
<td>Goat</td>
<td>60</td>
<td>Potato</td>
<td>44</td>
</tr>
<tr>
<td>Human</td>
<td>46</td>
<td>Rice</td>
<td>24</td>
</tr>
</tbody>
</table>

(a) Nearly every organism on earth has an even number of chromosomes in its body cells.
Suggest why.

(b) Chromosomes contain DNA molecules.
Describe the function of DNA.

(c) Gametes are made in the testes by meiosis.
(i) Look at the diagrams.
Which diagram, A, B, C or D, represents how cell division by meiosis produces gametes in the testes?  

(i) How many chromosomes will each goat gamete contain?  
______________________________________________________________  

(ii) When a body cell of a potato plant divides, how many chromosomes will each of the new cells contain?  
______________________________________________________________  

(Total 7 marks)
The diagram shows a family tree in which some individuals have an inherited disorder, which may cause serious long-term health problems.

(a) What proportion of the children of A and B have the disorder?

___________________________________________________________________

(1)

(b) Explain the evidence from the diagram which shows that the allele for the disorder is dominant.

Use the appropriate letters to identify individuals in your answer.

You may use genetic diagrams in your explanation. There is space for you to draw a genetic diagram at the top of the facing page.

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(3)

(c) (i) What is meant by ‘embryo screening’?

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(1)

(ii) A doctor suggests that couple C and D should have their embryos screened
but that couple G and H do not need this procedure.

Explain the reasons for the doctor’s suggestions.

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Q38.
(a) Explain, as fully as you can, how natural selection leads to evolution.

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(b) Most penguins live in cold climates. The modern penguin best adapted for cold conditions is the emperor penguin.

Scientists have found fossils of a ‘giant’ penguin which they have called *Icadyptes*.

The diagram shows how the size of modern penguins compares with *Icadyptes*.
The scientists were surprised to discover that *Icadyptes* lived in warm seas at a time when the Earth's climate was much warmer than it is now.

Explain why the scientists were surprised that *Icadyptes* lived in warm seas.

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(2)
(Total 5 marks)

Q39.

Cystic fibrosis and Huntington's disease are inherited disorders.

(a) Someone can be a carrier of cystic fibrosis.

Explain how.

You may include a genetic diagram in your answer.

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Why does only one parent need to have the Huntington’s disease allele for a child to inherit Huntington’s disease?

Q40.
(a) Mr and Mrs Smith both have a history of cystic fibrosis in their families. Neither of them has cystic fibrosis. Mr and Mrs Smith are concerned that they may have a child with cystic fibrosis.

Use a genetic diagram to show how they could have a child with cystic fibrosis.

Use the symbol A for the dominant allele and the symbol a for the recessive allele.

(b) Mr and Mrs Smith decided to visit a genetic counsellor who discusses embryo screening.

Read the information which they received from the counsellor.

- Under an anaesthetic five eggs will be removed from Mrs Smith’s ovary.
- The eggs will be fertilised in a dish using Mr Smith’s sperm cells.
- The embryos will be grown in the dish until each embryo
has about thirty cells.

- One cell will be removed from each embryo and tested for cystic fibrosis.
- A suitable embryo will be placed into Mrs. Smith’s uterus and she may become pregnant.
- Any unsuitable embryos will be killed.

(i) Suggest why it is helpful to take five eggs from the ovary, rather than just one.

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(1)

(ii) Evaluate the use of embryo screening in this case.

Remember to give a conclusion as part of your evaluation.

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(4)

(Total 8 marks)

Q41.

Scientists in Korea have discovered a method of producing rabbit–human embryos. Rabbit–human embryos could provide cells for research into human diseases such as motor neurone disease. Rabbits produce large numbers of eggs. Rabbit–human embryos could overcome a shortage of human embryo cells for research.

The diagram shows how rabbit–human embryos are produced.
(a) Which structures in the nucleus contain 99.5% of a cell’s genetic information?
___________________________________________________________________ 

(1)

(b) Use the above information and your own knowledge and understanding to evaluate how the production of rabbit–human embryos may help research into human diseases.

Remember to give a conclusion as part of your evaluation.
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(4) (Total 5 marks)
Q42.
In the 18th century a binomial system of grouping similar organisms was developed.
Before the binomial system was developed the common briar rose had the following names:
• *Rosa sylvestris inodora seu canina*
• *Rosa sylvestris alba cum rubore folio glabro*.
In the binomial system, the same rose is called *Rosa canina*.
(a) One advantage of the binomial system is that the name is shorter than the names used before this system.
Suggest two other advantages of the binomial system.
1. _________________________________________________________________
___________________________________________________________________
2. _________________________________________________________________
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(b) Classification systems have changed in the last 50 years.
Give one reason why we now have more information to classify organisms.
___________________________________________________________________
___________________________________________________________________
(c) ‘Archaea’ is one of the groups in the three-domain system of classification.
Give two features of the domain Archaea.
1. _________________________________________________________________
___________________________________________________________________
2. _________________________________________________________________
___________________________________________________________________
(Total 5 marks)

Q43.
Humans have evolved from ape-like ancestors by natural selection.
The drawing shows the pelvis of an ape-like ancestor and a modern human.
The skull and brain of the new born baby are also shown to the same scale.
Modern humans are much more intelligent than their ape-like ancestors.
Suggest an explanation for the evolution of the size and shape of the pelvis of modern humans.

Use information from the drawing to help you.

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(Total 4 marks)
Cats normally have four toes on each back paw.

The picture shows the back paw of a cat with an inherited condition called polydactyly.

The family tree shows the inheritance of polydactyly in three generations of cats.

(a) What combination of alleles did the original parents, A and B, have?

Explain how you work out your answer.

You may use a genetic diagram in your answer.

Use the symbol $H$ to represent the dominant allele.

Use the symbol $h$ to represent the recessive allele.

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A = ____________________________________________ B = ____________________________________________
(b) (i) Give **two** possible combinations of alleles for cat D.

1. _____________________________ 2. _____________________________

(ii) You cannot be sure which one of these two is the correct combination of alleles for cat D.

Why?

__________________________________________________________________________________

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(Total 6 marks)

Q45.

The picture shows a zebrafish.

Illustration © Emily S. Damstra

Zebrafish are small freshwater fish that usually have black and silver stripes. Zebrafish can tolerate a wide range of environmental conditions.

(a) Scientists have genetically modified zebrafish to act as pollution indicators. The genetically modified zebrafish have a gene transferred from a jellyfish. The gene allows the stripes of the zebrafish to change colour.

Describe how the scientists produced the genetically modified zebrafish.

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(Total 3 marks)

(b) Some scientists are worried about the production of genetically modified zebrafish. Suggest reasons why.
Q46.

Many strains of bacteria have developed resistance to antibiotics. The table shows the number of people infected with a resistant strain of one species of bacterium in the UK.

<table>
<thead>
<tr>
<th>Year</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of people infected with the resistant strain</td>
<td>3499</td>
<td>3553</td>
<td>3767</td>
<td>3809</td>
<td>4131</td>
</tr>
</tbody>
</table>

(a) Calculate the percentage increase in the number of people infected with the resistant strain between 2004 and 2008.

Show clearly how you work out your answer.

Percentage increase = ____________________________________________ (2)

(b) Explain, in terms of natural selection, why the number of people infected with the resistant strain of the bacterium is increasing.

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(3) (Total 5 marks)
Q47.
People with cystic fibrosis make large amounts of thick, sticky mucus in their lungs. Cystic fibrosis is caused by the inheritance of recessive alleles.

(a) What do each of the following mean?

(i) Alleles

(1)

(ii) Recessive

(1)

(b) Mr and Mrs Brown have a child with cystic fibrosis. They hope to have another child. They want to know the probability that their next child will have cystic fibrosis. They visit a genetic counsellor who explains, “You are both heterozygous for cystic fibrosis. There is a 1 in 4 (25%) chance that your next child will have cystic fibrosis.”

Use the following symbols in answering the questions.

N = allele for being unaffected by cystic fibrosis
n = allele for cystic fibrosis

(i) Mr and Mrs Brown both have the same genotype.

What is their genotype? ________________________________

(1)

(ii) There is a 1 in 4 chance that Mr and Mrs Brown’s next child will have cystic fibrosis.

Use a genetic diagram to explain why.

(3)

(c) Mr and Mrs Brown do not want to have another child with cystic fibrosis. The genetic counsellor explains two different methods for finding out whether an embryo has cystic fibrosis. The methods are:

• pre-implantation genetic diagnosis (PGD)
• chorionic villus sampling (CVS).

In PGD, eggs are fertilised in dishes and allowed to grow into embryos. A cell is
taken from each embryo when the embryo is 3 days old. The photograph shows how the cell is taken.

The DNA in the cell can then be tested. The possibility of a false positive result is about 1 in 6. An unaffected embryo can then be placed in the woman’s uterus. The procedure costs about £6000.

CVS can only be done after 9 weeks of pregnancy. A tiny piece of the placenta is taken out using a tube attached to a syringe. This is grown in tissue culture for about 7 days. The diagram below shows how CVS is done.

The DNA in the cells can then be tested. About 2 in every 100 women have a miscarriage because of CVS. The possibility of a false positive result is about 1%. The procedure costs about £600. Following a positive result, the parents must then decide whether to terminate the pregnancy.

The genetic counsellor thinks that PGD is a better method than CVS for detecting cystic fibrosis in an embryo.

Evaluate this opinion.
The Galapagos Islands are in the Pacific Ocean, 1400 km from South America. A type of bird called a ground finch lives on the islands. The picture shows a ground finch.

The size of the seeds the ground finch can eat depends upon the size of the beak. To eat large seeds, a large beak is needed. The bar charts show the sizes of the beaks of ground finches on one island, in 1976 and in 1978.
(a) The population of the ground finches and their beak sizes changed between 1976 and 1978.

Describe these changes.

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(b) In 1977 there was very little rain on the island. The lack of rain affected the seeds that the finches ate.
The table shows how the seeds were affected.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean number of seeds per m²</th>
<th>Mean mass of each seed in mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976</td>
<td>8.5</td>
<td>3.5</td>
</tr>
<tr>
<td>1978</td>
<td>2.8</td>
<td>4.2</td>
</tr>
</tbody>
</table>
Q49.
(a) Animal breeders use sexual reproduction to produce new strains of animals.

How does sexual reproduction produce variation?

___________________________________________________________________
___________________________________________________________________
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(b) A salmon is a type of fish.

Scientists have created a GM (genetically modified) ‘super’ salmon.

The scientists transferred a gene from a fish called a pout into a salmon. The gene increases the secretion of growth hormone in the salmon. The GM salmon grows much faster than an ordinary salmon, reaching market size up to one year earlier. Many more GM salmon will be grown in fish farms.

(i) Describe how a gene can be transferred from a pout into a salmon.

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(ii) The government might not allow the production of GM salmon.
Q50.
People may be immunised against diseases using vaccines.

(a) (i) Which part of the vaccine stimulates the body’s defence system?

(ii) A person has been vaccinated against measles. The person comes in contact with the measles pathogen. The person does not catch measles. Explain why.

(b) A man catches a disease. The man has not been immunised against this disease. A doctor gives the man a course of antibiotics.

The graph shows how the number of live disease bacteria in the body changes when the man is taking the antibiotics.
(i) Four days after starting the course of antibiotics the man feels well again. It is important that the man does not stop taking the antibiotics. Explain why.

Use information from the graph.

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(ii) Occasionally a new, resistant strain of a pathogen appears. The new strain may spread rapidly. Explain why.

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Q51.
The Blue-moon butterfly lives on a small island called Samoa, in the Pacific Ocean.

In 2006 Blue-moon butterflies almost became extinct.

Wolbachia bacteria killed males before they could hatch from eggs. Only females were resistant to the bacteria.

In 2006 the number of male Blue-moon butterflies had decreased to only 1 per cent of the population. Two years later, the number of males was equal to the number of females.

(a) Scientists believe that a change in a gene suddenly occurred to make some males resistant to the bacteria.

What scientific term describes a change in a gene?

(b) The numbers of male Blue-moon butterflies in the population increased quickly after the new form of the gene had appeared.

Suggest why.
Q52.

The diagram shows one method of producing herbicide-resistant crop plants.

(a) The herbicide-resistance gene is cut out of a chromosome of a herbicide-resistant plant.
How is the herbicide-resistance gene cut out of the chromosome?

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(1)

(b) Apart from having the herbicide-resistance gene, the herbicide-resistant plants are identical to the herbicide-susceptible plants.

Explain why.

___________________________________________________________________

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___________________________________________________________________

(2)

(c) Suggest one advantage to a farmer of growing herbicide-resistant crops.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(1)

(d) Many people are opposed to the growing of herbicide-resistant crops produced in this way.

Suggest one reason why.

___________________________________________________________________

___________________________________________________________________

(1)

(Total 5 marks)

Q53.

The photographs show the flowers of two closely-related species of plant.

Species A  Species B

Images: © iStock/Thinkstock
The drawings show chromosomes from one cell in the root of each plant during cell division.

Species A Species B

(a) The drawings show that each chromosome has two strands of genetic material.

(i) How does a chromosome become two strands?

_______________________________________________________________________________
_______________________________________________________________________________

(ii) Explain why each chromosome must become two strands before the cell divides.

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(b) For sexual reproduction, the plants produce gametes.

(i) Name the type of cell division that produces gametes. ___________________ 

(ii) How many chromosomes would there be in a gamete from each of these two plant species?

Species A Species B

(iii) It is possible for gametes from Species A to combine with gametes from Species B to produce healthy offspring plants. How many chromosomes would there be in each cell of one of the offspring plants? 

(c) (i) Look back at the information at the start of the question and the information from part (b).
What evidence from these two pieces of information supports the belief that **Species A** and **Species B** evolved from a common ancestor?

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(ii) For successful gamete production to take place, chromosomes that contain the same genes must pair up.

The drawings showing the chromosomes of **Species A** and of **Species B** are repeated below.

**Species A**  
![Species A chromosomes]

**Species B**  
![Species B chromosomes]

The offspring plants cannot reproduce sexually.

Suggest an explanation for this.

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(Total 10 marks)

**Q54.**

(a) Mr and Mrs Smith both have a history of cystic fibrosis in their families. Neither of them has cystic fibrosis. Mr and Mrs Smith are concerned that they may have a child with cystic fibrosis.

Use a genetic diagram to show how they could have a child with cystic fibrosis.

Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.
(b) Mr and Mrs Smith decided to visit a genetic counsellor who discussed embryo screening.

Read the information which they received from the genetic counsellor.

- Five eggs will be removed from Mrs Smith's ovary while she is under an anaesthetic.
- The eggs will be fertilised in a dish using Mr Smith's sperm cells.
- The embryos will be grown in the dish until each embryo has about thirty cells.
- One cell will be removed from each embryo and tested for cystic fibrosis.
- A suitable embryo will be placed into Mrs Smith's uterus and she may become pregnant.
- Any unsuitable embryos will be destroyed.

(i) Suggest why it is helpful to take five eggs from the ovary and not just one egg.

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(ii) Evaluate the use of embryo screening in this case.

Remember to give a conclusion to your evaluation.

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(c) In someone who has cystic fibrosis the person’s mucus becomes thick.

The diagram shows how, in a healthy person, cells at the lung surface move chloride ions into the mucus surrounding the air passages.

![Diagram showing movement of chloride ions](image)

The movement of chloride ions causes water to pass out of the cells into the mucus. Explain why.

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Q55.

The drawings show two different species of butterfly.

- Both species can be eaten by most birds.
Amauris has an unpleasant taste which birds do not like, so birds have learned not to prey on it.

Hypolimnas does not have an unpleasant taste but most birds do not prey on it.

(a) Suggest why most birds do not prey on Hypolimnas.
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(b) Suggest an explanation, in terms of natural selection, for the markings on the wings of Hypolimnas.
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Q56.
CADASIL is an inherited disorder caused by a dominant allele.

CADASIL leads to weakening of blood vessels in the brain.

The diagram shows the inheritance of CADASIL in one family.

(a) CADASIL is caused by a dominant allele.

(i) What is a dominant allele?
___________________________________________________________________

(Total 5 marks)
(ii) What is the evidence in the diagram that CADASIL is caused by a dominant allele?

________________________________________________________________________

(1)

(iii) Person 7 has CADASIL.

Is person 7 homozygous or heterozygous for the CADASIL allele?

Give evidence for your answer from the diagram.

________________________________________________________________________

(1)

(b) Persons 7 and 8 are planning to have another baby.

Use a genetic diagram to find the probability that the new baby will develop into a person with CADASIL.

Use the following symbols to represent alleles.

\[D = \text{allele for CADASIL}\]
\[d = \text{allele for not having CADASIL}\]

Probability = ______________________________________________________________________

(4)

(c) Scientists are trying to develop a treatment for CADASIL using stem cells.

Specially treated stem cells would be injected into the damaged part of the brain.

(i) Why do the scientists use stem cells?

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(2)

(ii) Embryonic stem cells can be obtained by removing a few cells from a human
embryo. In 2006, scientists in Japan discovered how to change adult skin cells into stem cells. Suggest one advantage of using stem cells from adult skin cells.

__________________________________________________________________________

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Q57.
Humans can use different methods to produce animals and plants with desired characteristics.

The figure below shows some different breeds of horse.

(a) All breeds of horse are of the same species.
Suggest what you could do to show this.

__________________________________________________________________________

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(2)
(b) Horse racing is an ancient sport.

Selective breeding has been used for centuries to produce racehorses.

Describe the steps involved in selective breeding to produce a racehorse.

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(3)

c) Another way of producing organisms with desired characteristics is genetic engineering.

Bt cotton is a variety of cotton that has been genetically engineered to produce a poison.

The poison kills several different species of insect that feed on cotton plants.

The poison is naturally produced by a soil bacterium called *Bacillus thuringiensis*.

Describe how cotton plants can be genetically engineered to produce the Bt poison.

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(3)

d) Describe the advantages and disadvantages of growing Bt cotton.

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Q58.
Read the information.

Insects can be both useful and harmful to crop plants. Insects such as bees pollinate the flowers of some crop plants. Pollination is needed for successful sexual reproduction of crop plants. Some insects eat crops and other insects eat the insects that eat crops.

Corn borers are insects that eat maize plants. A toxin produced by the bacterium *Bacillus thuringiensis* kills insects. Scientists grow *Bacillus thuringiensis* in large containers. The toxin is collected from the containers and is sprayed over maize crops to kill corn borers.

A company has developed genetically modified (GM) maize plants. GM maize plants contain a gene from *Bacillus thuringiensis*. This gene changes the GM maize plants so that they produce the toxin.

(a) Describe how scientists can transfer the gene from *Bacillus thuringiensis* to maize plants.

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(b) Would you advise farmers to grow GM maize plants?
Justify your answer by giving advantages and disadvantages of growing GM maize plants.

Use the information from the box and your own knowledge to help you.

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(Total 12 marks)
Q59.
Huntington’s disease is an inherited disorder that affects the nervous system.

It is caused by a dominant allele.

A man is heterozygous for Huntington’s disease.

His partner is healthy and does not have the allele that causes Huntington’s disease.

(a) What are the genotypes of the man and the woman?

Use:
- H for the allele that causes Huntington’s disease
- h for the healthy allele.

Man’s genotype __________________________

Woman’s genotype __________________________

(1)

(b) The couple want to have a child.

Use a Punnett square to determine the probability of the child having Huntington’s disease.

Circle the genotypes of any children that will have Huntington’s disease.

Probability of child having Huntington’s disease = _________________

(4)

(c) The couple visit a genetic counsellor, who gives them the following options.

1. Adopt a child.

2. Gamete donation – uses sperm from another man to fertilise the woman’s eggs by in vitro fertilisation (IVF).

3. Conceive naturally.
4. Use pre-implantation genetic diagnosis (PGD).
   • Many embryos are produced by IVF using gametes from the man and woman.
   • Embryos are tested for Huntington’s disease and a healthy embryo is implanted into the woman’s uterus.
   • The risk of implanting an embryo with the allele for Huntington’s disease is 0.2%.
   • Costs the NHS about £11 000.

5. Conceive naturally and use prenatal diagnosis (PND) once the woman becomes pregnant.
   • A sample of the placenta is taken at 10 weeks of pregnancy or a sample of fluid is taken from around the developing baby at 16 weeks of pregnancy.
   • The sample is tested for the Huntington’s allele.
   • A 0.5–1.0% risk of miscarriage.
   • About 1% of samples collected are unsuitable for testing.
   • Costs the NHS about £600.

The couple decide they want to have a healthy baby that is their own biological offspring.

Evaluate the options.

Suggest which option would be best for the couple.

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(6) (Total 11 marks)

Q60. (a) Evidence about extinct species of animals and plants comes from fossils.
Below is a photograph of a fossil of a bird-like animal called *Archaeopteryx*. *Archaeopteryx* lived about 150 million years ago.

(i) Suggest how the fossil of *Archaeopteryx* was formed.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(ii) Scientists have found other fossils of the ancestors of modern birds, but the fossil record is very incomplete.

Suggest two reasons why there are gaps in the fossil record.

1. ____________________________________________________________
   ____________________________________________________________

2. ____________________________________________________________
   ____________________________________________________________

(2)

(b) There are many different species of bird on the Earth today.

Describe how these different species may have evolved from an ancestor such as *Archaeopteryx*.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
Q1.
(a) human cells have cell membrane
   or
   human cells have no cell wall
   1
(b) can no longer synthesise proteins
   1
(c) antibiotics are being developed at a slower rate than emergence of new resistant strains
   resistant strains mean we cannot treat (common) infections
   reduce (future) cost of antibiotic resistant infections
   1
   1
   1
   1
   [5]

Q2.
(a) a change in the DNA / gene
   1
(b) produces a different protein / enzyme that is responsible for colour
   1
(c) parents genotype both Bb
   allow correctly derived gametes
   offspring genotypes correctly derived
   bb identified as blue
   allow ring around bb only
   1
   1
   1
   1
65 000
   allow ecf or 260 000 × 0.25
   1
6.5 × 10^4
   1
(d) cross with bb / blue carp
   allow annotated Punnett square diagram(s) of cross with bb carp
   if any offspring are blue, the parent was Bb / heterozygous
   allow converse
   allow cross with known Bb carp
   if any offspring are blue, other parent was Bb / heterozygous
   1
Q3.

(a) (i) one form of a / one gene
   *do not allow 'a type of gene'*
   allow a mutation of a gene

(ii) not expressed if dominant / other allele is present / if heterozygous
   or
   only expressed if dominant allele not present / or no other allele present
   *allow need two copies to be expressed / not expressed if only one copy / only expressed if homozygous*

(b) (i) two parents without PKU produce a child with PKU / 6 and 7 → 10
   *allow 'it skips a generation'*

(ii) genetic diagram including:
   *accept alternative symbols if defined*

Parental gametes:

6: N and n
and 7: N and n

derivation of offspring genotypes:

NN  Nn  Nn  nn
   *allow genotypes correctly derived from student’s parental gametes*

identification: **NN and Nn** as non-PKU
**OR nn** as PKU
   *allow correct identification of student’s offspring genotypes*

correct probability only: 0.25 / ¼ / 1 in 4 / 25% / 1 : 3
   *do not allow 3 : 1 / 1 : 4*
   *do not allow if extra incorrect probabilities given*

(c) (i) mitosis
   *correct spelling only*

(ii) 8

(iii) DNA
   *allow deoxyribonucleic acid*
   *do not allow RNA / ribonucleic acid*
(d) (i) may lead to damage to embryo / may destroy embryos / embryo cannot give consent
   allow avoid abortion
   allow emotive terms – eg murder religious argument must be qualified
   allow ref to miscarriage
   allow idea of avoiding prejudice against disabled people
   allow idea of not producing designer babies

(ii) any one from:
   • prevent having child with the disorder / prevent future suffering / reduce incidence of the disease
     ignore ref to having a healthy child
     ignore ref to selection of gender
   • embryo cells could be used in stem cell treatment
     allow ref to long term cost of treating a child (with a disorder)
     allow ref to time for parents to become prepared

Q4.
(a) half / 50% sperm have X (chromosome)
   or
   half / 50% sperm have Y (chromosome)
   penalise incorrect use of gene / allele once only

   all eggs have X (chromosome)
   annotated genetic diagram could gain 2 marks

(b) screening
   ignore selection

(c) any three from:
   max 2 if only advantages or only disadvantages discussed

advantages:(max 2)
   • (girl / children / women) don’t / less likely to get / inherit (breast) cancer / this / the disease
     do not accept reference to allele alone for this point
   • future generations get less cancer or less likely to have the allele
   • less expensive (for NHS) than treating cancer

disadvantages:(max 2)
   • (wrong / immoral to) reject / kill embryos
     ignore wrong / immoral / religious argument unqualified
• possible harm to embryo (that is implanted) / miscarriage
  *ignore reference to termination*

• possible harm to mother (due to operational procedure)
  *allow reference to needing hormone treatment*

argued conclusion

*must refer to both advantages and disadvantages and must be at end of answer*

Q5.

(a)  
(i)  Aa or aA

(ii) allele / gene for vestigial wings / a is recessive
  *or vestigial is recessive or A is dominant or*
  A would override the effect of a or A present gives long wings

(b) parental genotypes correct – both Aa
  *NB can pick up chain of logic at any point correctly derived from candidate’s previous point*

  gametes correctly derived from P genotypes

  offspring genotypes correctly derived from gametes

  3:1 ratio recognised
  *wrong cross and not 3:1 ratio = max 2*

Q6.

(a)  
(i)  mitosis
  *for 1 mark*

(ii) 1
  fertilised egg cell has 1 albino gene from father splits to produce identical cells / produced by mitosis
  *each for 1 mark*

(b)  
(i)  less protection from UV light / UV radiation
  *for 1 mark*

(ii) ideas of uncontrolled multiplication of mutated cells reject fast / rapid cell division cells invade of other parts / cells transported in blood
  *each for 1 mark*
Q7. parental genotypes both correct – both Bb
gamete genotypes all correct B and b B and b
genotype of bb offspring correctly related to gametes
bb offspring identified as small bolls
for 1 mark each

Q8. (a) 550 – 650
for one mark

(b) skulls
preserved as fossils / measure skull volume
for 1 mark each

(c) range of brain size / bigger brains arose by mutation
more with large brains more likely to survive
because more intelligent / survival advantage described
their genes passed to next generation / offspring inherited large brains
any three for 1 mark each

Q9. (a) greater proportion of dark moths survive in polluted woods
Greater proportion of pale moths survive in unpolluted woods
% survival on underside of branch is greater in both situations
each for 1 mark

(b) ideas that (please indicate in body of answer by √1, √2, √3)
1. different sorts of moths / pale and dark moths
2. ideal of differential survival in different habitats
3. this is evidence for natural selection / survival of the fittest
or idea that feature likely to be passed on
each for 1 mark

Q10. (a) contain the same genes, because they are formed by division
of identical nucleus
for 1 mark each

(b) genes located in nucleus, nucleus comes from donor cells
for 1 mark each
(c) number of alleles in population reduced, therefore less chance of successfully breeding, to cope with changed conditions

for 1 mark each

Q11.

(a) (i) e.g. B and b

for 1 mark

(ii) e.g. bb

for 1 mark

(b) no black genes in flock
all double recessive

for 1 mark each

Q12.

(a) mutation

for 1 mark

(b) fall,
idea that resistant beetles more likely to survive to breed,
∴ their offspring more likely to appear in the next generation

for 1 mark each

(c) inbreeding between resistant brothers and sister,
will produce some individuals with 2 copies of the resistance allele,
if 2 of these individuals breed all their offspring will be resistant

for 1 mark each

Q13.

(a) long neck or legs

(b) change in environment or reaching
for food or stretching led to more use
of neck (and legs) [1]

use led to increased size or
characteristic acquired during lifetime [1]

this characteristic was passed to
offspring [1]

(c) phenotypic changes do not affect genotype or genes [1]
acquired characteristics are not passed to offspring or the offspring were born with tails or inheritance has to be genetic [1]

(d) one mark awarded for each of the following general points:

variation exists in all populations or mutation occurred [1]

or if written specific to giraffes:
all giraffes are different or reference to short necked giraffes [1]

some individuals will have an advantage in certain areas or will be better adapted or there is survival of fittest [1]

taller giraffes or those with longer necks will have an advantage in being able to reach high vegetation or there is survival of fittest [1]

advantaged individuals breed more or are more successful [1]
these giraffes will breed more or will be more successful [1]

the genes or units of heredity or DNA of these individuals are passed on [1] (look for idea of genetic information being passed on)
the genes or units of heredity or DNA of these giraffes are passed on [1]

Q14.

advantages 2 of:
kills weeds but not cotton
higher yields of cotton
increased profits

any 2 for 1 mark each

disadvantages 2 of:
reduced genetic variability in ecosystem
other species of plants may become resistant to herbicide
possible devastating effect on future crop growth
effects on ecosystem on spread of herbicide resistant plants

any 2 for 1 mark each

evaluation anywhere = 1
for 1 mark

Q15.

natural variation in amount of body hair;
in cold environment, (having genes) which produce long hair is an advantage;
because hair insulates; OWTTE
such animals more likely to survive;
and pass these genes onto succeeding generations

*each for 1 mark*

**Q16.**

one mark for each of the following comparisons to a maximum of 6 candidates **must** make a clear comparison

<table>
<thead>
<tr>
<th>meiosis</th>
<th>mitosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>sexual</td>
<td>asexual</td>
</tr>
<tr>
<td>gametes</td>
<td>growth</td>
</tr>
<tr>
<td>ovary or testes or gonads</td>
<td>all other cells</td>
</tr>
<tr>
<td>half number of chromosomes</td>
<td>same number of chromosomes</td>
</tr>
<tr>
<td>haploid or 23 chromosomes</td>
<td>diploid or 46 chromosomes</td>
</tr>
<tr>
<td>reassortment or variation possible or not identical</td>
<td>no reassortment or no variation or identical</td>
</tr>
<tr>
<td>4 cells produced</td>
<td>2 cells produced</td>
</tr>
<tr>
<td>2 divisions</td>
<td>1 division</td>
</tr>
</tbody>
</table>

**Q17.**

(a) select for breeding; the plants with the sweetest taste

*each for 1 mark*

(b) natural population has a wide range of variations; because it has a large number of alleles; selective breeding reduces the number of alleles; cloning perpetuates this reduced number of alleles

*each for 1 mark*

(c) 3 of:
reference to cuttings;
reference to tissue culture;
reference to hormones;
cloning

*each for 1 mark*

(d) 4 of:
cut genes for disease resistance;
from chromosomes of ‘cooking banana’;
introduce into chromosomes of ‘ordinary banana’;
tissue culture to produce disease resistant plants/clone;
enzymes cut chromosomes

Q18.

(a) (i) 

if two nuclei drawn then maximum two marks

6 chromosomes

same 3 homologous pairs

nuclear membrane drawn

(ii) 3 chromosomes

1 from each homologous pair

(b) (i) 

parent line must be separate

heterozygous parents Tt × Tt

maximum of 2 marks if parental genotype is wrong

gametes correct T  t  T t

genotypes TT  Tt  Tt  tt

(ii) correct analysis of chance i.e. 1 in 4

or 25%

(iii) 50% or 1 in 2

Q19.

(a) variation (between organisms within species)

allow described example

allow mutation – but not if caused by change in conditions

those most suited / fittest survive
genes / alleles passed on (to offspring / next generation)  
*allow mutation passed on*

(b)  
(i) any two from:  
*allow converse*  
- increase in latitude reduces number of (living) species  
  *ignore references to severity of conditions*  
- increase in latitude reduces time for evolution (of new species)  
- the less the time to evolve the fewer the number of (living) species

(ii) any two from:  
*do not accept intention or need to evolve*  
- (increase in latitude reduces number of (living) species because) less food / habitats / more competition at high latitude  
  *allow only extremophiles / well-adapted species can survive*  
- (increase in latitude reduces time for evolution (of new species) because) severe conditions act more quickly / to a greater extent on the weakest  
- (the less the time to evolve the fewer the number of (living) species because) species that evolve slowly don’t survive

Q20.  
(a)  
(i) gametes i.e. B b and B b  
  *correct combination of genotypes i.e. BB, Bb, Bb, bb*  
  *correct analysis of phenotypes i.e. 3 black fur 1 with brown fur*

(ii) award one mark for the recognition that it is down to chance (which two gametes fuse) and not simply ‘because it’s a prediction’  
*do not accept mutation*

(b)  
(i) B is dominant/ an allele is dominant if it is expressed in the heterozygous phenotype  
  *candidates are likely to use a variety of ways of expressing their ideas*  
  b is recessive/ a recessive allele is not expressed in the presence of its contrasting allele  
  *do not accept powerful*  
  *do not accept stronger*
(ii) alleles are different forms of a gene controlling a characteristic and occupying the same site on homologous chromosomes (e.g. B or b)

genes are the units of DNA/sites on chromosomes carrying the information that determines characteristics (e.g. bB)

(c) homozygous: BB / bb / possessing a pair of identical alleles for a character/true breeding

give credit to an explanation using a diagram

heterozygous: Bb / carrying a pair of contrasting/different alleles for a characteristic

**do not** accept references to xx, xy
**do not** accept gene by itself

Q21.

(a) (i) dark form lives in the industrialised/ densely populated areas

or

dark form lives to the East/downwind/North East of industrialised are

(ii) more pollution/discolouration in those areas

or

pollution blown by prevailing winds

(b) a **change** to the genetic material/DNA/chromosomes/genes in an organism

**do not** accept fault. error

(c) **survival in polluted areas:**

**one mark for each mark point to a maximum of 4**

(pollution) lichen/trees/buildings become(s) blackened

credit an answer given in terms of survival in polluted areas

or non-survival in other areas

(camouflage) black formed camouflaged / more difficult to see

(predation) not preyed upon eaten by thrushes

(survival) survive to breed

or non survival

(no pollution) lichen/trees/buildings remain(s)pale/non-blackened

(no camouflage) black formed not camouflaged / easier to see

(predation) preyed upon/eaten by thrushes

(survival) do not survive to breed
Q22.

(a) Ampicillin Tetracycline

<table>
<thead>
<tr>
<th></th>
<th>Ampicillin</th>
<th>Tetracycline</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

*accept blank or cross or –*

1st: mark by rows to maximum 3 marks

2nd: if no marks by rows, mark by columns to maximum 1 mark

table completely blank = 0 marks

(b) 1st: Yes (no mark)

if ‘no’ - read on for logical argument e.g. loss of plasmid or gene mutation

2nd: all formed from same original cell

*must be one cell i.e. bacterium*

by asexual reproduction / no fusion / not sexual

*allow reference to ‘mitosis’*

offspring cells are genetically identical or all have a copy of the insulin gene / of the plasmid

Q23.

(a) (bacteria) produce toxins / poisons

(viruses) damage / kills cells or toxins released from cell

(b) any two from:

• viruses live inside cells
• viruses inaccessible to drug
• drug would damage body cells / tissue

(c) any four from:

• overuse of antibiotics
• bacteria mutate

*do not allow antibiotic causes mutation*
• antibiotics kill non-resistant strains or idea of selection
• reduced competition
• resistant bacteria reproduce

Q24.
(a) chromosome
   accept chromosomes

(b) drawing shows:
   just 2 chromosomes
   one long + one short

Q25.
any five from:
• genetic variation exists in a population or
  variation caused by mutation / change in gene / in DNA
  S.A.\[\frac{\text{Vol.}}{\text{Vol.}}\]
• larger voles have smaller or have more fat
  ‘they’ accept as larger voles
• larger voles lose less heat / are better insulated or more energy stored
• larger voles survive
• larger voles breed
• larger voles pass on (beneficial) gene / allele / mutation / DNA
  ignore characteristic

Q26.
(a) A = meiosis
    accept ‘mieosis’
    do not accept ‘miosis’

B = mitosis
    do not accept ‘meitosis’ etc

(b) fertilisation allow conception
Q27.
(a) present day organisms have evolved from simpler organisms
    ignore answers in terms of natural selection
    over long periods of time
    or
    millions / billions of years

(b) (natural selection operates on successful)
    characteristics produced by chance / (random) mutation
    in this experiment caused by hormones / environment
    allow this example indicates
    inheritance of acquired
    characteristics for 2 marks
    allow this is Lamarckism only for 1 mark

Q28.
(a) wing pattern similar to *Amauris*
    birds assume it will have foul taste

(b) mutation / variation produced wing pattern similar to *Amauris*
    *do not* accept breeds with *Amauris*
    *do not* accept idea of intentional adaptation
    these butterflies survived
    breed / genes passed to next generation

Q29.
(a) any two from:
    • to combine / use amino acids
      *do not* allow to make amino acids
    • in specific / particular / correct / right order
• to manufacture protein / enzymes / hormones
  *allow examples of proteins / enzymes / hormones*

(b) (i) (man) B

_**no mark for this but max 2 marks if A given**_

**any three** from:

• child gets DNA / bars / lines from mother and father / parents
  *ignore genes / chromosomes*

• (child has) mother’s 25 / 28 / 30 / 31
  *or* child gets 17 / 19 / 22 / 24 from mother

• (child has) man B’s 10 / 12 / 13 / 14
  *or* child gets 18 / 20 / 21 / 23 from B

<table>
<thead>
<tr>
<th>Man B</th>
<th>Child</th>
<th>Mother</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>18</td>
<td>25</td>
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<td>30</td>
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<tr>
<td>24</td>
<td>23</td>
<td>31</td>
</tr>
</tbody>
</table>

*contradictions disqualify 2nd and / or 3rd marking points*

*ignore genes / chromosomes*

• no bars / DNA / lines from man A correspond to child

(ii) **any two** from:

• gametes / eggs / sperm

• contain only half of (mother’s / father’s) DNA / chromosomes / genes / genetic information

• due to meiosis

(ii) **any two** from:

• gametes / eggs / sperm

• contain only half of (mother’s / father’s) DNA / chromosomes / genes / genetic information

• due to meiosis

Q30.

(i) **any three** from:

*ignore references to other methods eg tissue culture and embryo transplantation*

• remove gene

• use of enzymes

• from plant with high sugar production

allow from bacteria

• insert gene into rye grass
(ii) any two from eg

- concern about effect on (health) of cow
- concern about effects on human (health)
- concern about food chain effects or effects on ecosystem
- effect on gene pool
  
  ignore not natural or cost
  ignore ethical / religious arguments
  if no other marks awarded
  'we don’t know the long term effects’ = 1 mark

\[2\]

Q31.

any four from:

\textit{max two marks for a Lamarck explanation}

- mutation produced a bird whose bill was crossed
  do not allow birds decide to mutate
- birds compete for food / seeds
- mutant crossbill able to obtain food faster / easier / more successfully
- selected for or more likely to survive
- reproduce / mate / breed / produce offspring

\[4\]

Q32.

(a) any four from:

- mutation / variation
- produces smaller wings / fatter body
  must be linked to mutation / variation
- wings no longer an advantage since no predators
  allow wings / flight not needed as no predators
- wings no longer an advantage since food on ground
  allow wings / flight not needed as food on ground
- fatter body can store more energy when fruit scarce
- successful birds breed / pass on genes

\[4\]

(b) any one from:

- evidence has all gone
- no scientists on island at time to record evidence
Q33.

(a) (i) chromosomes
   allow DNA
   ignore nucleus

(ii) enzymes

(b) asexual reproduction / no gametes / no fusion / only one parent
   ignore clones

   cells all contain same genetic information / same genes (as parent) / same DNA

(c) can spray crop with herbicide – only weeds killed
   crop survives herbicide insufficient

(d) any one from:
   • fears / lack of knowledge about effects of GM food on health
     allow ‘think that GM food is bad for health’
     ignore not natural or against religion
   • crop plants may pass on gene to wild plants
   • encourages use of herbicides

Q34.

mutation or variation or range of sizes
   do not accept deliberate mutation or factor caused mutation

warm(er) / dry(er) now
   allow global warming

if warmer more smaller lambs / sheep survive winter
   award ‘survival’ point only if linked to warmer / dryer conditions

or if warmer sheep do not need fat / wool / fur to keep warm
or if warmer smaller sheep can lose heat more readily / do not overheat / keep cool
(survive)
   do not accept smaller sheep retain more heat

or if warmer smaller sheep have larger SA / V ratio (survive)
   do not accept smaller sheep have smaller SA / V ratio
or if dryer smaller lambs / sheep need less grass (to survive)

ignore small sheep feed easier on grass

small sheep breed / pass genes / mutations / characteristics to next generation

do not accept if Lamarckian

ignore competition / predation / human influence

Q35.

any four from

• mutation
do not accept ‘had to mutate / decided to mutate’

• produces longer snake or there is variation in snake length
do not accept ‘had to adapt and became longer’

• longer snake less susceptible to toxin or longer snake survives

• survivors reproduce

• gene passed to next generation

allow characteristic passed to next generation

[4]

Q36.

(a) any one from

• chromosomes in pairs

• inherited one of each pair from each parent

• one of each pair in egg and one of each pair in sperm

• so sex cells / gametes can have half the number

allow need to pair during cell division / meiosis

[4]

(b) any two from:

• code

• combination / sequence of amino acids

• forming specific / particular proteins / examples

If no other mark gained allow reference to controlling characteristics / appearance for 1 mark

[2]

(c) (i) C

1

(ii) 30

1

(d) (i) for growth / repair / replacement / asexual reproduction
do not accept incorrect qualification, eg growth of cells or repair of cells
they equals cells therefore do not accept they grow etc

(ii) 44 or 22 pairs

Q37.
(a) 1 in 4 / 1/4 / 1:3 / 25% / 0.25
do not accept 3:1 / 1:4 / 2:6

(b) either from C and D
accept synonyms for dominant / recessive eg Normal / faulty
accept genetic diagram if clearly referring to correct individuals or genotypes on family tree
allow ‘gene’ for ‘allele’

any three from:
• C and D have disorder
  ignore ‘C & D are carriers’
• I/J don’t have disorder
• C and D have dominant and recessive alleles
• recessive alleles from C and D passed to I/J
  or I/J have two recessive alleles
  NB if allele was recessive then all offspring of C and D would have the disorder = 3 marks
or from A and B
assume response refers to A + B unless contradicted
• A is homozygous recessive / rr, and B is heterozygous / Rr can be shown in words or symbols
  allow any symbol
• offspring can be rr or Rr described
  allow without key

(c) (i) (embryos) checked for inherited / genetic disorders / conditions
accept diseases for disorders

(ii) any three from:
• C/D have disorder / have dominant allele
accept disease / condition
accept ‘gene’ for ‘allele’
ignore reference to ‘carriers’

• chance of embryo / foetus / child having disorder
  or may pass on alleles for disorder to their offspring

• C/D might want to decide on termination or prepare
  for child with disorder

• G and H don’t have disorder / both homozygous
  recessive / have no dominant alleles (for this disorder)

• so offspring (of G and H) cannot / don’t have disorder

Q38.
(a) variation / mutation

  individuals with characteristics most suited to environment
  survive

  allow survival of the fittest

  genes passed to next generation or these individuals reproduce

(b) any two from:
  • similar in size to Emperor penguin or bigger than all
    penguins
  • large size is adaptation to cold climate
  • since less heat loss per unit of body volume or smaller
    surface area / volume ratio

Q39.
(a) cystic fibrosis (allele / gene) recessive

  allow an annotated genetic diagram

  carrier has only one cystic fibrosis allele / gene

  accept carrier is heterozygous

  accept any symbol with key or

  accept conventional use of symbols

  penalise use of chromosome once only

(b) any one from:
  • Huntington’s (allele / gene) dominant
  • (to have Huntington’s) need only one Huntington’s allele / gene
Q40.

(a) both parents Aa
   
   accept other upper and lower case letters without key or symbols with a key
   
   allow shown as gametes in punnet square

   aa in offspring correctly derived from parents / aa correctly derived from the parents given
   
   ignore other offspring / gametes for this mark parents do not have to be correct

   offspring aa identified as having cystic fibrosis
   
   may be the only offspring shown or circled / highlighted / described

(b) (i) any one from:
   
   accept converse if clear eg if you (only) took one it might have cystic fibrosis / might not be fertilised
   
   • sure / greater chance of healthy / non-cystic fibrosis egg / embryo / child
     accept some may have the allele
     reference to suitable embryo is insufficient
   
   • greater chance of fertilisation

(ii) to gain 3 marks both advantages and disadvantages must be given

   advantages
   any two from
   
   ignore references to abortion unless qualified by later screening
   
   • greater / certain chance of having child / embryo without cystic fibrosis / healthy
   
   • child with cystic fibrosis difficult / expensive to bring up
   
   • cystic fibrosis (gene / allele) not passed on through generations

   disadvantages
   any two from:
   
   • operation dangers eg infection
     ignore risk unqualified
   
   • ethical or religious issues linked to killing embryos
     accept wrong / cruel to kill embryos accept right to life
   
   • (high) cost
possible damage to embryo (during testing for cystic fibrosis / during operation)

plus

conclusion

a statement that implies a valued, qualified judgement

eg it is right because the risk of infection is small

or

eg it is wrong because embryos are killed

Note: the conclusion mark cannot be given unless a reasonable attempt to give both an advantage and a disadvantage has (already) been made

do not award the mark if the conclusion only states that advantages outweigh disadvantages

Q41.

(a) chromosomes

ignore gene / DNA

(b) to obtain 3 marks candidates must give one reasonable pro and one reasonable con

pros eg

any two from:

• overcomes shortage of human eggs / rabbits produce lots of eggs
  ignore all embryos identical

• ethical / religious issues with using human embryos

• reduces tests on (adult) humans

• may provide cure for / cause of disease

• embryo not allowed to develop beyond 14 days

• no harm to rabbit

• 99.5 % human genetic information so very similar to human or will react in the same way

max 2

cons eg

any two from:

• ethical / religious objections to mixture of human and rabbit genes

• ethical issues with experimenting with rabbits
  allow some people object to using rabbits / cruel to rabbits
• ethical / religious objections to killing embryos
• 0.5% of rabbit genetic information might affect results
• 14 days too short a time to get results

plus

conclusion eg
• possibility of cure does / does not outweigh ethical / religious objections
  Note: the conclusion mark cannot be given unless both an advantage and a disadvantage have (already) been given
• cure does not justify mixing human and animal genes / killing embryos
do not award the mark if the conclusion only states that advantages outweigh disadvantages

Q42.
(a) same name to everyone
  (genus) part gives information on ancestry

(b) any one from:
  • DNA / RNA analysis
  • improvements to (electron) microscopes
  • improved understanding of biochemical processes
  • evidence of internal structures being more developed

(c) primitive bacteria / prokaryotes
  (often) from extreme environments / extremophiles

Q43.
  a mutation occurs or variation in size / shape of pelvis
    allow idea that walking upright needs larger pelvis to bear weight
  large / wide birth canal / pelvis allowed passage of wide skull / brain
do not allow pelvis became larger to enable birth of larger-skulled babies
  link between brain size and intelligence
  those with larger pelvis / brain more likely to survive / reproduce
Q44.

(a) \( A = Hh \) \( B = Hh \)

may not be in answer space
accept heterozygous or description

(allele for) polydactyly is dominant or polydactyly is \( H \),

for marking points 1, 2 and 3 accept evidence in clearly labelled / annotated genetic diagram

cats with polydactyly have \( H \)

accept if polydactyly was recessive all offspring would have polydactyly

E or (some) offspring of \( A \) and \( B \), does not have polydactyly,
so \( A \) and \( B \) must both have \( h \)

(b) (i) \( HH \) and \( Hh \) or

homozygous dominant and heterozygous

both required, in either order

allow description

(ii) any one from:

accept annotated genetic diagram to explain answer

• polydactyly is dominant

• parents are both \( Hh \)

• if \( D \) is \( Hh \) all offspring could inherit \( H \)

Q45.

(a) (jellyfish) gene(s) cut out

ref to enzymes (at any stage)

(gene) transferred to zebra fish at early stage of development / embryo / egg

ignore removal of zebra fish genes

(b) any two from:

ignore unethical / religious / unnatural

• could transfer gene to other (fish) species

• effects on food chains
accept effects on other species / humans who eat them

- effects on zebra fish themselves, eg may out compete non GM zebra fish

Q46.
(a) 18.06 / 18 / 18.1

Correct answer gains 2 marks
If answer incorrect evidence of
\[(4131 - 3499) \div 3499 \times 100\]
or \[632 \div 3499 \times 100\]
or \[((4131 \div 3499) \times 100) - 100\]
or 0.18
Gains 1 mark

(b) Antibiotics kill non-resistant strain
Or resistant strain bacteria survive
Accept resistant strain the successful competitor
Do not accept intentional adaptation
Ignore strongest / fittest survive
Ignore mutation
Ignore people do not finish antibiotic course

Resistant strain bacteria reproduce
Or resistant strain bacteria pass on genes

Population of resistant strain increases or proportion of resistant bacteria increases
Allow high numbers of resistant bacteria
Or
People more likely to be infected by resistant strain (than non-resistant strain)

Q47.
(a) (i) (alternative) forms / types of the same gene

(ii) only expressed if 2 copies inherited
Or not expressed if other allele present
Allow over ruled / over powered by the other allele

(b) (i) Nn
Ignore heterozygous

(ii) Genetic diagram including:
Accept alternative symbols, if defined
Gametes: N and n from both parents
accept alternative symbols if correct for answer to (b)(i)

correct derivation of offspring genotypes:

\[ NN \quad Nn \quad Nn \quad nn \]

allow if correct for candidate’s parental genotypes / gametes

identification of nn as having cystic fibrosis

(c) **Argued evaluation**

any four from:

- PGD **higher** financial cost
  
  accept **CVS only costs £600**

- PGD occurs before pregnancy / implantation
  
  accept detected at **earlier stage so less unethical / less trauma**

- PGD does not involve abortion so less trauma / less pain / ethical