Materials
For this paper you must have:
• Ruler
• Pencil, Rubber, Protractor and Compass
• Scientific calculator, which you are expected to use when appropriate

Instructions
• Answer all questions
• Answer questions in the space provided
• All working must be shown
• Do all rough work in this book. Cross out any rough work you don’t want to be marked

Information
• The marks for the questions are shown in brackets
All living organisms are classified into groups.

**Table 1** shows the classification of one species of wheat.

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Angiosperms</td>
</tr>
<tr>
<td>Class</td>
<td>Monocotyledons</td>
</tr>
<tr>
<td>Order</td>
<td>Commelinids</td>
</tr>
<tr>
<td>Family</td>
<td>Poaceae</td>
</tr>
<tr>
<td>Genus</td>
<td>Triticum</td>
</tr>
<tr>
<td>Species</td>
<td>spelta</td>
</tr>
</tbody>
</table>

(a) What is the binomial name for the wheat in **Table 1**?

Tick **one** box.

- Angiosperm monocotyledons  
- Poaceae triticum  
- Species spelta  
- Triticum spelta  

(1)
Modern classification systems compare the similarity between the DNA of organisms.
The more similar the DNA code, the more closely the organisms are related.

Table 2 shows DNA codes in five different organisms.

<table>
<thead>
<tr>
<th></th>
<th>DNA Codes</th>
<th>Number of differences in DNA code compared with the human sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>A B C D E F G H I</td>
<td></td>
</tr>
<tr>
<td>Pig</td>
<td>J F C D E F G H I</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>C I K D M F G H I</td>
<td></td>
</tr>
<tr>
<td>Yeast</td>
<td>C I K D L M G H I</td>
<td>5</td>
</tr>
<tr>
<td>Chicken</td>
<td>J F C D M F G H I</td>
<td>3</td>
</tr>
</tbody>
</table>

(b) Complete the final column of Table 2 for Pig and for Wheat.

(c) Which organism in Table 2 appears to be most closely related to humans?

___________________________________________________________________

(d) Give one reason why conclusions about the similarities between organisms should not be made using only the DNA codes in Table 2.

___________________________________________________________________

___________________________________________________________________

(1)
Chickens can be bred either for meat or for laying eggs.

The diagram below gives some information about different types of chicken.

<table>
<thead>
<tr>
<th>Chicken bred for meat</th>
<th>Chicken bred for laying eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average weight in kg</td>
<td>1.8</td>
</tr>
<tr>
<td>Average number of eggs laid per week</td>
<td>2</td>
</tr>
</tbody>
</table>

(e) Describe how selective breeding has been used to produce chickens bred for meat.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(f) Give one advantage of selective breeding to the farmer.

___________________________________________________________________
___________________________________________________________________

(1)
Selective breeding can lead to disadvantages for the chickens.

What is a possible disadvantage of selective breeding for the chickens bred for meat in the diagram above?

Tick one box.

- The chickens will be genetically identical
- There will be less food to feed people
- The chickens may weigh too much to be able to stand
- The chickens will be kept in better conditions

Pompe disorder is an inherited condition that affects thousands of people.

Pompe disorder is caused by the GAA gene.

(a) What is a gene made of?

___________________________________________________________________

(Total 9 marks)

Figure 1 shows the inheritance of Pompe disorder in one family.

Pompe disorder is caused by a recessive allele.

r is the allele for Pompe disorder

R is the allele for no Pompe disorder
(b) Person 2 has Pompe disorder.
What is the genotype of person 2?
_________________________________________

(1)

(c) Look at Figure 1.
Explain how we can tell Pompe disorder is caused by a recessive allele.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(d) Persons 6 and 7 decide to have another child.
Complete the genetic diagram in Figure 2.

Figure 2

![Genetic Diagram]

(e) Draw a ring around any offspring in Figure 2 who will have Pompe disorder.

(1)

(f) What is the probability of persons 6 and 7 having another child with Pompe disorder?
_________________________________________

(1)
A new drug to treat Pompe disorder has been successfully trialled on mice.
The drug now has approval for the next stage of clinical testing.
Describe the next steps in testing the new drug before it can be approved for use.

Figure 1 shows a photograph of a fossil of a trilobite.

Figure 1
(a) When were trilobites alive?

Tick one box.

Between 20 and 50 years ago. [ ]
Between 20 and 50 thousand years ago. [ ]
Between 200 and 500 thousand years ago. [ ]
Between 200 and 500 million years ago. [ ]

(b) Suggest how the fossil in Figure 1 was formed.

Tick one box.

The organism left a footprint behind. [ ]
The organism was buried by rocks. [ ]
The organism was frozen in ice. [ ]
The organism was replaced by minerals. [ ]

(c) Trilobites are extinct.

What does extinct mean?

Tick one box.

The species evolved into another species. [ ]
The species does not have any soft tissue parts. [ ]
There are no organisms of that species alive today. [ ]
There are not enough of the species alive to reproduce. [ ]

(1)
(d) Hyoliths are another type of fossil. Hyoliths were discovered in the 1800s and thought to be a type of snail.

In 2017 scientists used modern techniques to place hyoliths into a different group.

Suggest a modern technique that the scientists may have used.

Tick one box.

- DNA analysis
- Genetic modification
- Light microscopy
- Selective breeding

(1)

(e) Which scientist developed the traditional classification system for all living organisms?

____________________

(1)

The fossil record is used to draw evolutionary trees.

**Figure 2** shows an evolutionary tree for a group of dinosaurs.

![Figure 2]

(f) Suggest which two of these dinosaurs are most closely related.

____________________ and ____________________

(1)
(g) Name a common ancestor of Triceratops and Leptoceratops.

___________________________________________________________________

(h) How does the fossil record provide evidence for Darwin’s theory of evolution?

Tick one box.

- Dinosaurs became extinct 65 million years ago.
- Fossils have been found in most countries of the world.
- Older fossils have a simpler structure.
- Trilobites belong to the arthropod group of animals.

(Total 8 marks)

This question is about reproduction.

(a) Complete the sentences.

Choose answers from the box.

<table>
<thead>
<tr>
<th>asexual</th>
<th>clones</th>
<th>eggs</th>
<th>gametes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Identical offspring are produced by ________________ reproduction.

These offspring are called ________________ .

In another form of reproduction male and female ________________ join at fertilisation.

This leads to ________________ in the offspring.

The embryo grows by a type of cell division called ________________ .

(5)
(b) The body cells of a kangaroo have 16 chromosomes.

How many chromosomes will an egg cell of a kangaroo have?

Tick one box.

4  8  16  32

(c) Which sex chromosomes will be in the body cells of a male kangaroo?

Tick one box.

XX  XZ  XY  YZ

Different species of animal have different numbers of chromosomes in their body cells.

The table shows the chromosome number of some species.

<table>
<thead>
<tr>
<th>Species of animal</th>
<th>Number of chromosomes in each body cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giraffe</td>
<td>62</td>
</tr>
<tr>
<td>Human</td>
<td>46</td>
</tr>
<tr>
<td>Kangaroo</td>
<td>16</td>
</tr>
<tr>
<td>Snail</td>
<td>24</td>
</tr>
<tr>
<td>Zebra fish</td>
<td>50</td>
</tr>
</tbody>
</table>
(d) Plot the data from the table for the snail and for the zebra fish on the graph.

(e) Look at the graph.

How many more chromosomes are there in the body cells of giraffes than in the body cells of animal X?

Number of chromosomes = ____________________

(f) A student concluded:

‘the bigger an animal, the more chromosomes it has in each body cell.’

This is **not** a valid conclusion.

Give **one** reason why.

___________________________________________________________________

___________________________________________________________________

(Total 11 marks)
Figure 1 shows photographs of fossils of extinct organisms.

(a) What is a fossil?
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(b) What does extinct mean?
___________________________________________________________________
___________________________________________________________________
(c) **Fossil A** is a trilobite which had a shell, eyes and limbs.

**Fossil B** is a stromatolite formed by layers of microorganisms.

Which two statements suggest that the microorganisms lived at an earlier time than the trilobites?

Tick two boxes.

- Microorganisms have a more simple structure than a trilobite.
- Stromatolites are found in older rock than trilobites.
- Stromatolites are layers of minerals left behind by millions of microorganisms.
- Stromatolites structures are larger than trilobite fossils.
- Trilobites lived in the sediment on the sea floor.

(2) **Figure 2** shows an evolutionary tree drawn from the fossil record in the 1970s.

The evolutionary tree is for a group of dinosaurs.

![Figure 2](image)

(d) Scientists in the 1970s did radiocarbon dating on all the fossils.

Which fossil gave the earliest radiocarbon date?

___________________________________________________________________
The Arabian oryx (Oryx leucoryx) is a mammal that was once extinct in the wild.

The image shows an Arabian oryx.

(a) What is the genus of the Arabian oryx?

Tick one box.

leucoryx  
Oryx  
Oryx leucoryx  

(1)
(b) Give two adaptations of the Arabian oryx to living in hot desert environments. 
Use information from the image.
1. _________________________________________________________________
   _____________________________________________________________________
2. _________________________________________________________________
   _____________________________________________________________________

(c) The Arabian oryx uses its long horns to fight for territory and mates.
Describe how the long horns could have evolved.
   _____________________________________________________________________
   _____________________________________________________________________
   _____________________________________________________________________
   _____________________________________________________________________
   _____________________________________________________________________
   _____________________________________________________________________

Arabian oryx from many different zoos were interbred so that they could be reintroduced to the wild.

(d) What is the name of this method of increasing the population of endangered animals?
Tick one box.

Breeding programme

Genetic modification

Natural selection

Selective breeding
(e) Explain why it was important to use Arabian oryx from many different zoos instead of one zoo.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(Total 8 marks)

The figure below shows a carp.

(a) A mutation causes a blue colour in some carp.

What is a mutation?
___________________________________________________________________
___________________________________________________________________

___________________________________________________________________

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

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(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.

___________________________________________________________________
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(Fall armyworms are native to America.

Fall armyworms eat corn plants.

(a) The binomial name for fall armyworms is *Spodoptera frugiperda*.

Fall armyworms belong to an order of insects called Lepidoptera.

The table shows a classification table for the fall armyworm.

Complete the table.

<table>
<thead>
<tr>
<th>Classification group</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingdom</td>
<td>Arthropoda</td>
</tr>
<tr>
<td></td>
<td>Insecta</td>
</tr>
<tr>
<td>Order</td>
<td>Lepidoptera</td>
</tr>
<tr>
<td>Family</td>
<td>Noctuidae</td>
</tr>
<tr>
<td></td>
<td><em>frugiperda</em></td>
</tr>
</tbody>
</table>
Fall armyworms have been found in Africa.

By 2016 they had spread rapidly destroying corn crops.

(b) Suggest one reason why the fall armyworms are spreading so rapidly in Africa.

___________________________________________________________________
___________________________________________________________________

(1)

(c) Fall armyworms:
• are not worms (annelids)
• are the caterpillars of moths (arthropods).

Describe one way scientists could tell if a new ‘worm’ they found should be classified as an annelid or as an arthropod.

___________________________________________________________________
___________________________________________________________________

(1)

(d) In parts of Africa, aeroplanes have been used to spray insecticide on crops, to kill the worms.

Explain the advantages and disadvantages of spraying insecticide on the corn crops.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(4)
(Total 8 marks)
There are several species of owl alive today.
The image shows where two species of owl breed in North America.

(a) What is the genus name of the snowy owl?

______________________________________________________________________________

(b) The snowy owl and the great horned owl are different species.

Define the term 'species'.

______________________________________________________________________________

______________________________________________________________________________

(1)
(c) Explain how the owls in the image may have evolved from a common ancestor to become different species.

Use information from the image.

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___________________________________________________________________
___________________________________________________________________
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(6)
(Total 8 marks)

In 2012 scientists genetically modified goats to produce a specific protein in their milk.

The protein is found in the malarial parasite and can be used as a vaccine against malaria.

In the process:

• cells of goats are modified to produce the malarial protein
• the goats are milked
• the protein is removed from the milk
• the protein is purified.
(a) Describe how goat cells are modified so that they can produce the malarial protein.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
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___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(b) The scientists have only modified female goat cells.

Suggest one reason why.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(c) Scientists can clone the genetically modified goats.

Suggest two reasons why the scientists clone the goats instead of producing offspring by sexual reproduction.

1. ___________________________________________________________________
2. ___________________________________________________________________
(d) The protein in the milk has to be extracted and purified before it can be used as a vaccine.

Scientists are improving the process so the protein will work as a vaccine **without** needing to be extracted and purified.

Give **two** possible advantages of producing goat’s milk that contains an effective malaria vaccine.

1. _________________________________________________________________

   ___________________________________________________________________

2. _________________________________________________________________

   ___________________________________________________________________

(2)

(e) Malaria affects many people across the world.

Describe how the white blood cells might respond to an infection of the malaria pathogen.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

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___________________________________________________________________

(3)

(Total 12 marks)