At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]
For this paper you must have:
• a ruler
• a scientific calculator.

INSTRUCTIONS

• Use black ink or black ball-point pen.

• Answer ALL questions in the spaces provided.

• Do all rough work in this book. Cross through any work you do not want to be marked.

• In all calculations, show clearly how you work out your answer.
INFORMATION

- There are 100 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

DO NOT TURN OVER UNTIL TOLD TO DO SO
FIGURE 1 shows a food chain in a river.

FIGURE 1

Algae → Invertebrate animals → Small fish → Large fish
01.1 Draw ONE line from each scientific term to the correct organism in the food chain. [3 marks]

<table>
<thead>
<tr>
<th>Scientific term</th>
<th>Organism in the food chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apex predator</td>
<td>Algae</td>
</tr>
<tr>
<td>Primary consumer</td>
<td>Invertebrate animals</td>
</tr>
<tr>
<td>Producer</td>
<td>Large fish</td>
</tr>
<tr>
<td></td>
<td>Small fish</td>
</tr>
</tbody>
</table>

[Turn over]
TABLE 1 shows the biomass of the organisms at each stage in the food chain.

<table>
<thead>
<tr>
<th>Organism</th>
<th>Biomass in arbitrary units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algae</td>
<td>840</td>
</tr>
<tr>
<td>Invertebrate animals</td>
<td>200</td>
</tr>
<tr>
<td>Small fish</td>
<td>40</td>
</tr>
<tr>
<td>Large fish</td>
<td>10</td>
</tr>
</tbody>
</table>
7

Calculate the percentage of the biomass of the invertebrate animals that is transferred to the large fish. [2 marks]

Use the equation:

\[
\text{percentage} = \frac{\text{biomass of large fish}}{\text{biomass of invertebrate animals}} \times 100
\]

Percentage = ________________________

[Turn over]
A large amount of biomass is lost from the food chain.

Complete the sentences.

Choose answers from the list. [3 marks]

- coordination
- digestion
- excretion
- filtration
- ingestion
- respiration
When the small fish eat the invertebrate animals, not all of this material is broken down during _____________.

Materials absorbed from the gut may enter the body cells of the small fish. These materials are broken down into carbon dioxide and water by ________________.

The carbon dioxide and other waste materials from the body cells are removed from the small fish by _________________.

[Turn over]
A disease kills many of the small fish.

Why does the number of invertebrate animals increase? [1 mark]
FIGURE 2 shows some changes that occur during the menstrual cycle.

FIGURE 2

- Menstruation
- Egg release
- Thickness of lining of uterus

Time in days

1 3 5 7 9 11 13 15 17 19 21 23 25 27
FIGURE 2 shows that the lining of the uterus thickens between days 7 and 27.

What is the purpose of thickening the lining of the uterus? [1 mark]

Tick ONE box.

- To allow implantation of the embryo
- To break down waste
- To prevent sperm reaching the egg

[Turn over]
Which hormone causes thickening of the lining of the uterus? [1 mark]

Tick ONE box.

- Auxin
- Oestrogen
- Testosterone

On which day is fertilisation most likely to occur?

Use information from FIGURE 2, on page 12. [1 mark]
Contraception can be used to lower the chance of pregnancy.

Draw ONE line from each method of contraception to how the method works. [3 marks]

<table>
<thead>
<tr>
<th>Method of contraception</th>
<th>How the method works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contraceptive pill</td>
<td>Barrier to prevent sperm reaching the egg</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>Contains hormones to stop eggs maturing</td>
</tr>
<tr>
<td>Spermicidal cream</td>
<td>Kills sperm</td>
</tr>
<tr>
<td></td>
<td>Slows down sperm production</td>
</tr>
</tbody>
</table>

[Turn over]
TABLE 2 gives information about some different methods of contraception.

TABLE 2

<table>
<thead>
<tr>
<th>METHOD</th>
<th>NUMBER OF PREGNANCIES PER 100 WOMEN IN ONE YEAR</th>
<th>POSSIBLE SIDE EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diaphragm and spermicidal cream</td>
<td>8</td>
<td>Usually none, but can cause bladder infection in some women</td>
</tr>
<tr>
<td>Condom</td>
<td>2</td>
<td>None</td>
</tr>
<tr>
<td>Contraceptive pill</td>
<td>1</td>
<td>Mood swings, headaches, high blood pressure, blood clots, breast cancer</td>
</tr>
</tbody>
</table>
A man and a woman decide to use the condom as their method of contraception.

Suggest THREE reasons for this decision.

Use information from TABLE 2 and your own knowledge.

[3 marks]

1

2

3

[Turn over]
Fossils give evidence about organisms that lived a long time ago.

Scientists have found very few fossils of the earliest life forms. Give ONE reason why. [1 mark]

FIGURE 3 is a photograph of a fossilised fish.

FIGURE 3
03.2 Suggest how the fossil in FIGURE 3, on page 18, was formed. [2 marks]

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

03.3 The species of fish shown in FIGURE 3 is now extinct.

Give TWO possible causes of extinction. [2 marks]

1 ________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2 ________________________________________________________________
________________________________________________________________________

[Turn over]
Modern fish species have evolved from fish that lived a long time ago.

Evolution is caused by mutation and natural selection.

**03.4** What is a mutation? [1 mark]

Tick ONE box.

- A change in a gene
- Accidental damage to an organism
- An organism with a new characteristic
- The loss of a species
Describe the process of natural selection. [3 marks]
In the mid-19th century, a scientist studied inheritance in pea plants. The scientist’s work was the beginning of our modern understanding of genetics.

What is the name of this scientist? [1 mark]

Tick ONE box.

- Alfred Russel Wallace
- Charles Darwin
- Gregor Mendel
- Jean-Baptiste Lamarck
In the mid-20th century, other scientists identified the chemical substance that makes up genetic material.

What is the name of the chemical substance that makes up genetic material? [1 mark]

Tick ONE box.

- Carbohydrate
- DNA
- Lipid
- Protein

[Turn over]
A gene often has two alleles. One allele is dominant and the other allele is recessive.

When is a recessive allele expressed as a characteristic? [1 mark]

Tick ONE box.

- When the dominant allele is not present
- When the recessive allele is inherited from the female parent
- When the recessive allele is inherited from the male parent
- When the recessive allele is present on only one of the chromosomes
A scientist investigated the inheritance of height in pea plants.

The scientist crossed tall pea plants with short pea plants.

FIGURE 4 shows the scientist’s results.

FIGURE 4
In Questions 04.4 and 04.5, use the following symbols to represent alleles:

\[ T = \text{the dominant allele for tall.} \]
\[ t = \text{the recessive allele for short.} \]

In FIGURE 4, the genotype of plant 1 is TT.

Give the genotype of plant 2.

[1 mark]

[Turn over]
The scientist crossed plant 3 with plant 4.

Complete FIGURE 5 to show the offspring produced from this cross. [2 marks]

FIGURE 5

<table>
<thead>
<tr>
<th>Female gametes</th>
<th>Male gametes</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>t</td>
</tr>
<tr>
<td>T</td>
<td>TT</td>
</tr>
<tr>
<td>t</td>
<td></td>
</tr>
</tbody>
</table>
04.6 Draw a circle around ONE of the homozygous offspring in FIGURE 5, on page 28. [1 mark]

04.7 What is the ratio of tall plants : short plants in the offspring in FIGURE 5? [1 mark]

Ratio of tall plants : short plants = ______________________ : ____________________

[Turn over]
A person with Type 1 diabetes cannot make enough insulin.

Which organ makes insulin? [1 mark]

Tick ONE box.

- Adrenal gland
- Pancreas
- Pituitary gland
- Thyroid

A person with Type 1 diabetes can control the concentration of glucose in the blood by injecting insulin.

Complete the sentences.

Choose answers from the list on page 31. [2 marks]
Insulin acts on an organ called the ____________________.

This organ then takes in excess glucose from the blood and changes the glucose into ________________.

[Turn over]
Insulin cannot be taken as a tablet. This is because insulin is a type of protein.

What would happen to the insulin in the tablet if it reached the stomach? [1 mark]

Two people each drank the same volume of a glucose drink.

Person A has Type 1 diabetes. Person B does NOT have diabetes.

FIGURE 6, on page 33, shows how the concentration of glucose in their blood changed.
FIGURE 6
Blood glucose concentration in mmol/dm$^3$

Time in minutes

Glucose consumed
How much higher was the HIGHEST concentration of glucose in the blood of person A than the HIGHEST concentration in person B?

Use information from FIGURE 6 on page 33. [2 marks]

Answer = __________________ mmol/dm$^3$
5.5 Describe ONE other way that the results for person A were different from the results for person B.

Use information from FIGURE 6 on page 33. [1 mark]

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

[Turn over]
Type 2 diabetes is another form of diabetes. Type 2 diabetes is common in obese people.

People with Type 2 diabetes make enough insulin, but still cannot control their blood glucose concentration. This is because the body cells are not sensitive to the insulin.

FIGURE 7, on page 37, shows information about abdominal fat and insulin sensitivity in body cells.

What type of relationship is shown in FIGURE 7? [1 mark]

Tick ONE box.

☐ A negative correlation

☐ No correlation

☐ A positive correlation
FIGURE 7

Insulin sensitivity of body cells in arbitrary units

[Turn over]
A person is at risk of developing Type 2 diabetes.

Suggest TWO ways the person could lower the chance of developing Type 2 diabetes.

[2 marks]

1. ________________________
   ________________________
   ________________________

2. ________________________
   ________________________
   ________________________

[Turn over]
Some weed killers are selective. Selective weed killers kill broad-leaved weed plants, but do NOT kill narrow-leaved grass plants.

FIGURE 8 shows some weeds growing on a grassy lawn.

FIGURE 8

Some students investigated the effect of a selective weed killer on the weeds growing in a lawn. They used 0.5 m × 0.5 m quadrats.

The lawn was 20 metres long and 10 metres wide.

The method used is on page 41.
1. Divide the lawn into two halves, side A and side B.

2. Place 5 quadrats in different positions on side A.

3. Place 5 more quadrats in different positions on side B.

4. Count the number of weed plants in each quadrat.

5. Spray side A with weed killer solution.

6. Spray side B with the same volume of water.

7. Repeat steps 2-4 after 2 weeks.

Suggest a method the students should have used to place each quadrat. [1 mark]

[Turn over]
06.2 Give the reason for the method you suggested in Question 06.1. [1 mark]

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

06.3 Explain why the students used water on one side of the lawn instead of weed killer. [2 marks]

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________


[Turn over]
TABLE 3 shows the students’ results.

**TABLE 3**

<table>
<thead>
<tr>
<th>Number of weeds per quadrat</th>
<th>At start</th>
<th>After 2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Side A (Weed killer)</td>
<td>Side B (Water)</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

Calculate the mean value, X, in TABLE 3. [1 mark]

Mean value, X = _______________
Calculate the percentage decrease in the number of weeds on side A after 2 weeks.

[2 marks]

Use the following equation:

\[
\text{Percentage decrease} = \left( \frac{\text{mean at start} - \text{mean after 2 weeks}}{\text{mean at start}} \right) \times 100
\]

[Turn over]
One student thought the results were NOT valid.

Suggest ONE improvement the students could have made to the method to make the results more valid.

Give the reason for your answer. [2 marks]

Improvement ____________________

________________________________________________________________________

________________________________________________________________________

Reason _______________________

________________________________________________________________________

________________________________________________________________________

[Turn over]
Mycoprotein is a protein-rich food.

Mycoprotein is made from the fungus Fusarium.

FIGURE 9, on page 49, shows a fermenter used for growing Fusarium.

Explain why the fermenter is sterilised before use. [2 marks]

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
FIGURE 9

[Diagram of a process involving glucose and minerals, cooling coil, carbon dioxide, air, fusarium, warm and cold water, X]

[Turn over]
Cold water is pumped through the cooling coil at point X.
This maintains a constant temperature inside the fermenter.

Suggest the temperature at which Fusarium grows fastest.
[1 mark]

Tick ONE box.

- 5 °C
- 20 °C
- 30 °C
- 85 °C
Glucose and bubbles of air enter the fermenter.

The bubbles of air supply oxygen.

Explain why Fusarium needs glucose and oxygen. [2 marks]

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

[Turn over]
The bubbles of air also move materials around the fermenter.

Suggest why it is useful for bubbles of air and materials to move around inside the fermenter. [2 marks]
100 grams of chicken meat contains 22 grams of protein.

100 grams of mycoprotein contains 11 grams of protein.

A man ate 100 grams of chicken in one meal.

How many grams of mycoprotein would the man need to eat to get the same mass of protein as in 100 grams of chicken? [1 mark]

Tick ONE box.

- 100 grams
- 110 grams
- 200 grams
- 220 grams
Some students investigated phototropism in plant seedlings.

This is the method used.

1. Measure the lengths of the shoots of 20 seedlings.

2. Set up four groups of seedlings as follows:
   - A – bottom of shoot covered in aluminium foil
   - B – tip covered in aluminium foil
   - C – tip removed
   - D – no changes.

3. Put the seedlings in a cardboard box.

4. Use a lamp to shine a light into the box through a hole in one side.

5. After one day, re-measure the lengths of the shoots.
6. Make a drawing of the appearance of one seedling from each group.

FIGURE 10, below, shows the appearance of one seedling in each group at the start of the investigation.
Which TWO conditions should the students have kept constant for each group of seedlings? [2 marks]

Tick TWO boxes.

- The length of the roots
- The number of seedlings in each group
- The temperature
- The thickness of the aluminium foil
- The volume of water added to the soil
What is the purpose of the aluminium foil? [1 mark]

Tick ONE box.

☐ To hold the shoot straight

☐ To keep the shoot warm

☐ To remove the effect of gravity

☐ To stop light reaching the shoot

FIGURE 11, below and on page 59, shows the students’ results.

FIGURE 11
<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean length of shoot</td>
<td>23</td>
<td>24</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>at start in mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean length of shoot</td>
<td>28</td>
<td>30</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>after 1 day in mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean change</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>in length of shoot</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Suggest how the students measured the lengths of the curved shoots of seedlings A and D at the end of the investigation. [2 marks]

[Turn over]
The students concluded that the TIP of the shoot is needed for the plant to respond to light.

Give evidence for this conclusion from FIGURE 11 on pages 58 and 59. [2 marks]
A hormone stimulates growth in shoots.

Which distribution of the hormone would cause the results seen in shoot D?
[1 mark]

Tick ONE box.

Key:

\[
\times \times = \text{Molecules of hormone}
\]

[Turn over]
Many human actions are reflexes.

Which TWO of the following are examples of reflex actions? [2 marks]

Tick TWO boxes.

- Jumping in the air to catch a ball
- Raising a hand to protect the eyes in bright light
- Releasing saliva when food enters the mouth
- Running away from danger
- Withdrawing the hand from a sharp object
FIGURE 12 shows how the size of the pupil of the human eye can change by reflex action.

**FIGURE 12**

Name ONE stimulus that would cause the pupil to change in size from A to B, as shown in FIGURE 12. [1 mark]

Structure Q causes the change in size of the pupil.

Name structure Q. [1 mark]

[Turn over]
Describe how structure Q causes the change in the size of the pupil from A to B. [1 mark]
FIGURE 13 shows some structures involved in the coordination of a reflex action.

Describe how the structures shown in FIGURE 13 help to coordinate a reflex action. [6 marks]

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
Many scientists think that global air temperature is related to the concentration of carbon dioxide in the atmosphere.

FIGURE 14 shows changes in global air temperature and changes in the concentration of carbon dioxide in the atmosphere.
FIGURE 14

Change in global air temperature since 1955 in °C

Concentration of carbon dioxide in the atmosphere in ppm

Air Temperature

Carbon dioxide

Year


1.4 1.2 1.0 0.8 0.6 0.4 0.2 0.0 -0.2 -0.4

370 350 330 310 290 270 430 410 390 370
Complete TABLE 4, on page 71.

[2 marks]

Use information from FIGURE 14, on page 69.

Choose answers from the list below.

You may use each answer once, more than once or not at all.

constant, decreasing, increasing
<table>
<thead>
<tr>
<th>Year Period</th>
<th>Trend in Carbon Dioxide Concentration</th>
<th>Trend in Air Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960 – 1977</td>
<td>Increasing</td>
<td></td>
</tr>
<tr>
<td>1977 – 2003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003 – 2015</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 4
Many scientists think that an increase in carbon dioxide concentration in the atmosphere causes an increase in air temperature.

How would an increase in the concentration of carbon dioxide in the atmosphere cause an increase in air temperature? [1 mark]

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
Evaluate evidence for and against the theory that an increase in the concentration of carbon dioxide in the atmosphere causes an increase in air temperature.

Use data from FIGURE 14, on page 69, and your own knowledge. [4 marks]
In each year, the concentration of carbon dioxide in the atmosphere is higher in the winter than in the summer.

**10.4**  Give ONE human activity that could cause the higher concentration of carbon dioxide in the winter. [1 mark]

----------------------------------------

----------------------------------------

**10.5**  Give ONE biological process that could cause the lower concentration of carbon dioxide in the summer. [1 mark]

----------------------------------------

----------------------------------------
Give TWO possible effects of an increase in global air temperature on living organisms. [2 marks]

1

2

It is important to maintain water balance in the body.

FIGURE 15, on pages 78 and 79, shows how much water a person gained and lost by different methods in one day.

[Turn over]
FIGURE 15

Water gained by the body

Volume in cm³

1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

F  D  M
Method

KEY
F = Food  D = Drink  M = Metabolism
Water lost from the body
Volume in cm$^3$

<table>
<thead>
<tr>
<th>Method</th>
<th>U</th>
<th>F</th>
<th>S</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>KEY</td>
<td>U = Urine</td>
<td>F = Faeces</td>
<td>S = Skin</td>
<td>B = Breathing</td>
</tr>
</tbody>
</table>

[Turn over]
When water is balanced, the volume of water taken in by the body is equal to the volume of water lost from the body.

Calculate the volume of water the person lost in one day in faeces.

Use information from FIGURE 15 on pages 78 and 79. [2 marks]

Volume lost in faeces = _________________ cm³

[Turn over]
FIGURE 15, on pages 78 and 79, shows that one method of gaining water is by metabolism.

Which metabolic process produces water? [1 mark]

Tick ONE box.

- Breakdown of protein to amino acids
- Changing glycogen into glucose
- Digestion of fat
- Respiration of glucose
The next day, the person ran a 10-kilometre race.

The volume of water lost from the body through the skin and by breathing increased.

11.3 Explain why more water was lost through the skin during the race. [2 marks]

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

[Turn over]
11.4 Explain why more water was lost by breathing during the race. [3 marks]

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

END OF QUESTIONS
There are no questions printed on this page
There are no questions printed on this page

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