Level 3 Certificate/Extended Certificate
APPLIED SCIENCE
Unit 4 The Human Body

Thursday 17 January 2019 Afternoon Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
• a calculator.

Instructions
• Use black ink or black ball-point pen.
• Answer all questions.
• You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
• If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
• Do all rough work in this book. Cross through any work you do not want to be marked.

Information
• The marks for questions are shown in brackets.
• The maximum mark for this paper is 60.

Advice
Read each question carefully.
Sports scientists study the musculoskeletal system and its movement.

**Figure 1** shows the human skeleton.
01.1 Name the type of joint labelled X in Figure 1. [1 mark]

01.2 On Figure 1, label one of the bones of the axial skeleton with a letter Y. [1 mark]

01.3 Which type of joint can only move in one plane? [1 mark]

01.4 The skeleton allows us to move. What are two other functions of the skeleton? Tick (✓) two boxes. [2 marks]

Absorption of glucose
Blood cell production
Control of breathing rate
Creatine phosphate production
Protection

Question 1 continues on the next page
**Figure 2** shows how the average mass of calcium in bones changes with age.

Figure 2

![Graph showing the average mass of calcium in bones over age]

- **Male**
- **Female**

The average mass of calcium in the bones of males decreases between the ages of 30 and 100 years.

Calculate the percentage decrease. 

**[3 marks]**

Percentage decrease in mass of calcium =

**01.5**

Name the process that breaks down old bone.

**[1 mark]**

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04

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Figure 2 shows patterns of bone growth.

Describe the patterns in the changes in the average mass of calcium in bones of males and females.

[3 marks]

Explain why females over the age of 60 may be more likely to break their bones than males over the age of 60.

Use information from Figure 2.

[2 marks]
The percentage of fast-twitch muscle fibres and slow-twitch muscle fibres in the human body changes over time.

Exercising can affect the percentages of the different muscle fibres.

The percentage of fast-twitch muscle fibres in a sprinter is higher than the percentage in a marathon runner.

Give two features of fast-twitch muscle fibres.

[2 marks]

1

2
**Figure 3** shows how the total number of muscle fibres changes with age. Each point represents one person’s data.

**Figure 3**

![Graph showing the total number of muscle fibres changing with age.](image)

02.2 Give **two conclusions** you can make using the information in **Figure 3**. [2 marks]

1. 

2. 

02.3 The percentage of fast-twitch muscle fibres decreases as a person gets older.

Suggest a reason why. [1 mark]

02.4 Slow-twitch muscle fibres have an oxygen-binding protein that is similar to haemoglobin.

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

Turn over ➤
Nutritionists can help people improve their diet to avoid deficiency diseases.

**Table 1** shows some daily recommended allowances.

<table>
<thead>
<tr>
<th></th>
<th>Energy / kJ</th>
<th>Protein / g per kg of body weight</th>
<th>Iron / mg</th>
<th>Vitamin D / µg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girl aged 1–3 years</td>
<td>5 500</td>
<td>1.10</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Girl aged 14–18 years</td>
<td>11 500</td>
<td>0.85</td>
<td>8.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Woman</td>
<td>10 000</td>
<td>0.80</td>
<td>18.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Pregnant woman</td>
<td>10 400</td>
<td>1.20</td>
<td>27.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

A pregnant woman eats a chicken sandwich.

**Figure 4** shows the nutritional information for the chicken sandwich.

**Figure 4**

<table>
<thead>
<tr>
<th>Nutritional Information</th>
<th>Amount Per Serving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy/kJ</td>
<td>1715</td>
</tr>
<tr>
<td>Total Fat (g)</td>
<td>12</td>
</tr>
<tr>
<td>Saturated Fat (g)</td>
<td>5</td>
</tr>
<tr>
<td>Trans Fat (g)</td>
<td>-</td>
</tr>
<tr>
<td>Cholesterol (mg)</td>
<td>80</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>1350</td>
</tr>
<tr>
<td>Total Carbohydrate (g)</td>
<td>37</td>
</tr>
<tr>
<td>Dietary fibre (g)</td>
<td>3</td>
</tr>
<tr>
<td>Sugars (g)</td>
<td>9</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>37</td>
</tr>
</tbody>
</table>

Calculate what percentage of the pregnant woman’s daily energy allowance is provided by the chicken sandwich.

Use information from **Table 1** and **Figure 4**.

Percentage = ________________________________
Explain why girls aged 14–18 years need a different mass of protein than girls aged 1–3 years.

Use information from Table 1.

[2 marks]

Which disease is caused by a lack of vitamin D?

Tick (✓) one box.

[1 mark]

1. Anaemia
2. Hyponatraemia
3. Rickets
4. Scurvy

Name two foods that have a high vitamin D content.

[2 marks]

The pregnant woman is deficient in vitamin D.

1. [ ] 2. [ ]

1. [ ] 2. [ ]

Question 3 continues on the next page
03.5 The pregnant woman is told to reduce her salt intake because she has high blood pressure.

Give **two** symptoms of high blood pressure. [2 marks]

1

2

03.6 The nutritional information label in **Figure 4** shows how much carbohydrate the chicken sandwich contains.

Give **one** use of carbohydrate in the human body. [1 mark]
The nutrients from digestion are absorbed into the bloodstream in the small intestine.

Figure 5 shows a section of the small intestine seen through a microscope.

Figure 5

Give two adaptations of the small intestine that help to speed up the rate of absorption into the blood.

[2 marks]

1

2

Turn over for the next question
The nervous system coordinates many activities in the human body. The nervous system is organised into different areas with different functions.

**Figure 6** shows the organisation of the nervous system.

Complete **Figure 6**.

Write your answers on lines 1, 2 and 3.

**Figure 6**

1 nervous system

2 nervous system

3 nervous system

What is the role of the somatic nervous system?

Give two effects of stimulating the sympathetic nervous system.
**Figure 7** shows a synapse between two neurones.

Name parts A, B, and C.

[3 marks]

A ____________________________________________

B ____________________________________________

C ____________________________________________

When a nerve impulse reaches the end of neurone X, a neurotransmitter is released. Describe how the neurotransmitter causes a nerve impulse to start in neurone Y.

[2 marks]

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

Describe what happens to the neurotransmitter after a new impulse starts in neurone Y.

[3 marks]

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________

Question 4 continues on the next page
Figure 8 shows changes in the membrane potential of neurone Y during one action potential.

During section D on Figure 8 the neurone depolarises.

Calculate the overall change in membrane potential during depolarisation.

\[
\text{Change in membrane potential} = \square mV
\]

During depolarisation of the neurone, ion channels open and close.

Which ion channels are open during depolarisation?

Tick (✓) one box.

- Potassium only
- Sodium and potassium
- Sodium only
Haemoglobin is made of protein. **Figure 9** shows the structure of haemoglobin.

**Figure 9**

![Diagram of haemoglobin structure](image)

**5.1** Which ion is found in A?

Tick (√) one box. [1 mark]

- Ca$^{2+}$
- Fe$^{2+}$
- K$^+$
- Na$^+$

**5.2** How many molecules of oxygen (O$_2$) can be carried by one molecule of haemoglobin?

Tick (√) one box. [1 mark]

- 1
- 2
- 4
- 16

Question 5 continues on the next page
A man goes to hospital. The man is dizzy, vomiting and short of breath.

At the hospital his oxygen saturation level and blood pressure are measured.

0 5. 3 Name **one** non-invasive way of measuring oxygen saturation. [1 mark]

0 5. 4 Name **one** piece of equipment used to measure blood pressure. [1 mark]

0 5. 5 The man’s oxygen saturation level is 92%.

What can you conclude from this value? [1 mark]
A doctor thinks the man may have carbon monoxide poisoning.

Carbon monoxide binds to haemoglobin to form carboxyhaemoglobin.

People who smoke often suffer from symptoms of carbon monoxide poisoning.

The man has a blood test to measure the concentration of carboxyhaemoglobin in his blood.

**Table 2** shows the concentration of carboxyhaemoglobin in different people.

<table>
<thead>
<tr>
<th></th>
<th>Concentration of carboxyhaemoglobin / arbitrary units</th>
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<tbody>
<tr>
<td>Normal level in a non-smoker</td>
<td>1</td>
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<tr>
<td>Level when symptoms of poisoning begin</td>
<td>10</td>
</tr>
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<td>Level in a heavy smoker</td>
<td>15</td>
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<tr>
<td>Level when coma and death are likely</td>
<td>&gt;40</td>
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Suggest what you would expect the level of carboxyhaemoglobin concentration to be for a non-smoker who lives with a smoker.

Give a reason for your answer.

Use information in **Table 2**.

[2 marks]

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Question 5 continues on the next page
Figure 10 shows a normal oxygen dissociation curve for haemoglobin at rest.

Figure 10

Explain how the difference in pH in an active muscle compared with the pH in the lungs increases the efficiency of oxygen transport.

[3 marks]
Some athletes train at high altitude.

Explain how training at high altitude affects oxygen transportation. [3 marks]
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