Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

**Pearson Edexcel Level 3 GCE**

Centre Number | Candidate Number

# Thursday 13 June 2019

Morning (Time: 2 hours) | Paper Reference **9BN0/02**

# Biology A (Salters Nuffield)

## Advanced

## Paper 2: Energy, Exercise and Coordination

**You must have:**
Calculator, HB pencil, ruler

Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

### Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

### Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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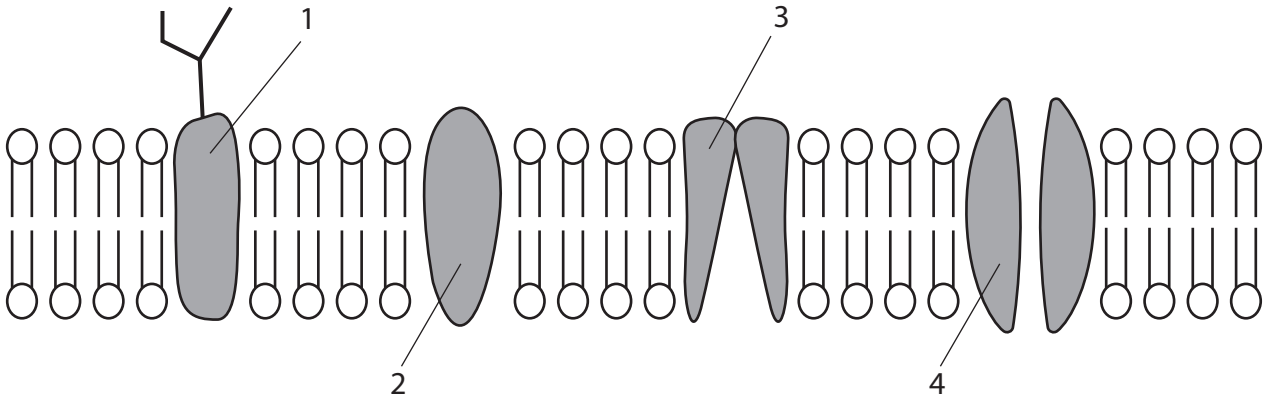
**Answer ALL questions.**

**Write your answers in the spaces provided.**

**Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

**1** The structure of the cell surface membrane can be described by the fluid mosaic model.

(a) The diagram shows the fluid mosaic model of the cell surface membrane.




(i) Which of the shaded structures transport charged molecules or ions across the membrane?

**(1)**

☒ **A** 1 and 2 only

☒ **B** 3 and 4 only

☒ **C** 1, 2 and 3 only

☒ **D** 1, 2, 3 and 4

(ii) Which of the shaded structures contain both hydrophilic regions and hydrophobic regions?

**(1)**

☒ **A** 1 and 2 only

☒ **B** 3 and 4 only

☒ **C** 1, 2 and 3 only

☒ **D** 1, 2, 3 and 4

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(iii) A student measured the width of the phospholipid bilayer shown on the diagram as 2.5 cm. The actual size of this bilayer is 5 nm.

What is the approximate magnification of the diagram?

**(1)**

- ☒ **A** × 5000
- ☒ **B** × 50 000
- ☒ **C** × 500 000
- ☒ **D** × 5 000 000

(b) Explain why the phospholipids are arranged in two layers in a cell surface membrane.

**(3)**

**(Total for Question 1 = 6 marks)**

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**2** There are various ways to scan the brain.

(a) (i) Brain tumours are dense masses of cells. The presence of brain tumours can be detected using several types of scanning method.

The table shows two types of scan. Place a tick [✓] in the box if the scan can identify the size and location of a large brain tumour or a cross [✗] in the box if the scan cannot identify the size and location of a large brain tumour.

**(2)**

| Type of scan | Can be used to identify the tumour |
|---|---|
| CT | |
| MRI | |

(ii) Functional MRI (fMRI) measures brain activity by detecting changes in

**(1)**

☒ **A** blood flow

☒ **B** bone density

☒ **C** dopamine release

☒ **D** lactic acid production

(iii) Which of the following types of scanner uses X-rays?

**(1)**

☒ **A** CT

☒ **B** fMRI

☒ **C** MRI

☒ **D** PET

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(b) Describe how positron emission tomography (PET) scans can be used to investigate brain structure.

**(2)**

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**(Total for Question 2 = 6 marks)**

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**3** Cystic fibrosis is a genetically inherited condition.

A couple who are both carriers for the condition have a 25% chance of having a baby with cystic fibrosis. In the UK, 1 in 2500 babies born have cystic fibrosis.

(a) Use the Hardy-Weinberg equation to calculate the probability of babies born in the UK being carriers for cystic fibrosis.

**(3)**

Answer.....

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(b) Cystic fibrosis can be caused by a number of different mutations in the CFTR gene.

(i) A gene contains a number of base pairs. Of the base pairs in this gene, 50% are adenine and thymine.

Q = the number of base pairs in this gene.

Which of the following shows the total number of hydrogen bonds (H bonds) present in this gene?

**(1)**

- ☒ **A** $2.0 \times Q$
- ☒ **B** $2.5 \times Q$
- ☒ **C** $4.0 \times Q$
- ☒ **D** $5.0 \times Q$

(ii) Explain why different mutations in the CFTR gene can lead to differences in the severity of the symptoms of cystic fibrosis.

**(2)**

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**(Total for Question 3 = 6 marks)**

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**4** A moderate amount of exercise is considered good for the human body.

(a) A student carried out 20 minutes of physical exercise. During this time, her heart rate and level of sweating increased.

Shortly after completing the exercise, the student noted that her heart rate and level of sweating decreased.

(i) Explain the role of the brain in reducing the student's heart rate after the exercise.

**(2)**

(ii) Describe how the brain reduces the activity of the sweat glands after the exercise.

**(2)**

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(b) Explain why too much exercise could be harmful to the human body.

**(3)**

**(Total for Question 4 = 7 marks)**

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**5** Muscle fibres contain a number of proteins, including actin, myosin and collagen.

(a) The myosin binding site is found on

**(1)**

☒ **A** actin

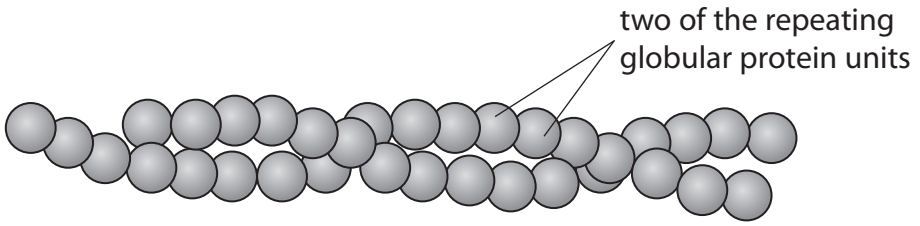
☒ **B** sarcoplasmic reticulum

☒ **C** tropomyosin

☒ **D** troponin

(b) Actin and collagen are both proteins.

The diagram shows two filaments of actin from a muscle fibre. Each filament is a polymer of repeating globular protein units.

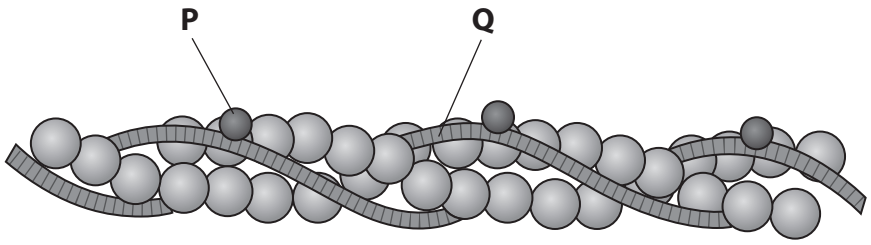



Compare and contrast the structures of an actin filament and collagen.

**(3)**

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(c) The diagram shows actin and other components (P and Q) of a thin filament in a myofibril.




(i) Describe the interaction between P and Q that allows muscle contraction.

**(2)**

(ii) The thick filament in a myofibril contains myosin. The myosin head contains the enzyme ATPase.

Explain the importance of the primary structure for the functioning of this enzyme.

**(3)**

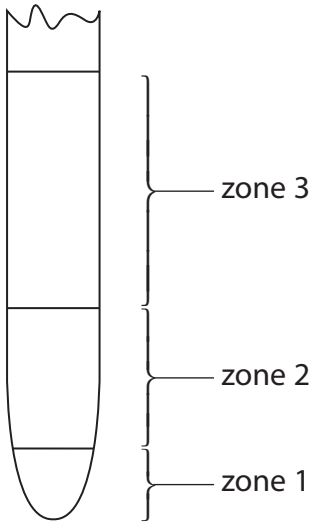
**(Total for Question 5 = 9 marks)**

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**6** The diagram shows three different zones found in a plant root.




(a) Cells in zone 1 carry out interphase, mitosis and cytokinesis.

A student stated the hypothesis that:

*In zone 1, the percentage of cells carrying out mitosis decreases from the tip to the start of zone 2.*

(i) Which one of the following would be the correct null hypothesis?

**(1)**

☒ **A** the percentage of cells carrying out mitosis increases from the tip to the start of zone 2

☒ **B** the percentage of cells in interphase decreases from the tip to the start of zone 2

☒ **C** there is no change in the percentage of cells carrying out mitosis from the tip to the start of zone 2

☒ **D** there is no change in the percentage of cells in interphase from the tip to the start of zone 2

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(ii) Devise an investigation to test this hypothesis.

**(5)**

(b) In zone 2, the plant cells elongate due to a change in their cellulose cell walls.

(i) Cellulose and amylopectin are polymers of hexose sugars.

State one difference between the hexose in cellulose and the hexose in amylopectin.

**(1)**

(ii) The cellulose molecules form microfibrils.

Name the bond between adjacent cellulose molecules in a cellulose microfibril.

**(1)**

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(c) In zone 3, some of the cells differentiate to give rise to phloem sieve tube elements and others differentiate into phloem companion cells.

(i) Explain how genetically identical cells in zone 3 can differentiate to give rise to different tissues.

**(3)**

(ii) The student also hypothesised that the cells in zone 1 would be smaller in size than the cells that had differentiated into xylem vessels in zone 3.

The student prepared microscope slides of sections from zones 1 and 3.

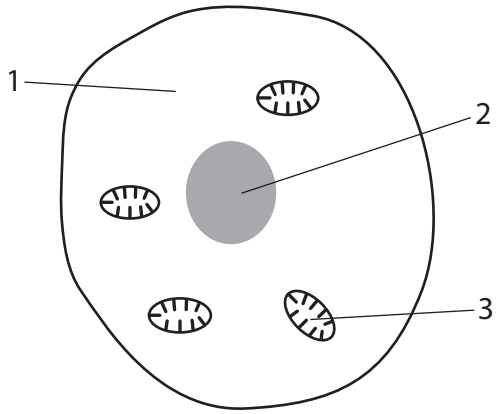
Explain how the student could compare the sizes of cells in zone 1 with the sizes of xylem vessels in zone 3.

**(3)**

**(Total for Question 6 = 14 marks)**

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**7** (a) The diagram shows some of the features of a human liver cell.




(i) Which of the labelled features in the liver cell contain RNA?

**(1)**

☒ **A** 1 only

☒ **B** 1 and 3 only

☒ **C** 2 and 3 only

☒ **D** 1, 2 and 3

(ii) Cells produce lactate during anaerobic respiration. Lactate travels in the blood to the liver.

Liver cells can absorb lactate from the blood.

Deduce what happens to the lactate in these cells.

**(2)**

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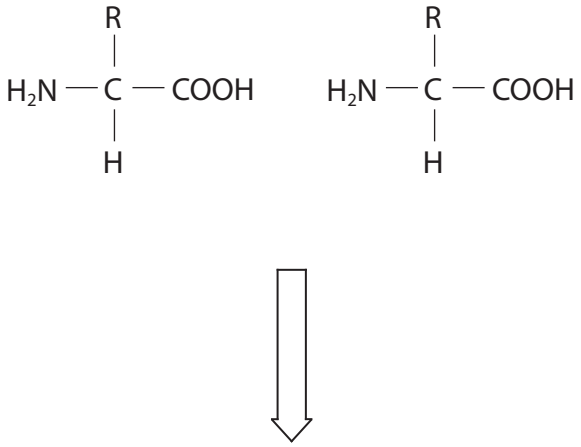
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(iii) During protein synthesis, two amino acids are joined together to form a dipeptide.

The diagram shows two identical amino acids.

Complete the diagram to show how the dipeptide is formed from these two amino acids.

**(2)**




(b) Explain why the liver is an organ and not a tissue.

**(2)**

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(c) Each liver cell carries out respiration.

During respiration, ATP is formed and broken down.

(i) During which of the following processes is ATP formed?

**(1)**

☒ **A** glycolysis and the electron transport chain only

☒ **B** glycolysis and the Krebs cycle only

☒ **C** glycolysis, the Krebs cycle and the electron transport chain only

☒ **D** glycolysis, the link reaction, the Krebs cycle and the electron transport chain

(ii) Explain why some ATP is broken down during glycolysis.

**(2)**

(iii) The electron transport chain occurs in the cristae of mitochondria. The electron transport chain involves a number of carrier molecules.

Explain the role of these carrier molecules in the electron transport chain.

**(3)**

**(Total for Question 7 = 13 marks)**

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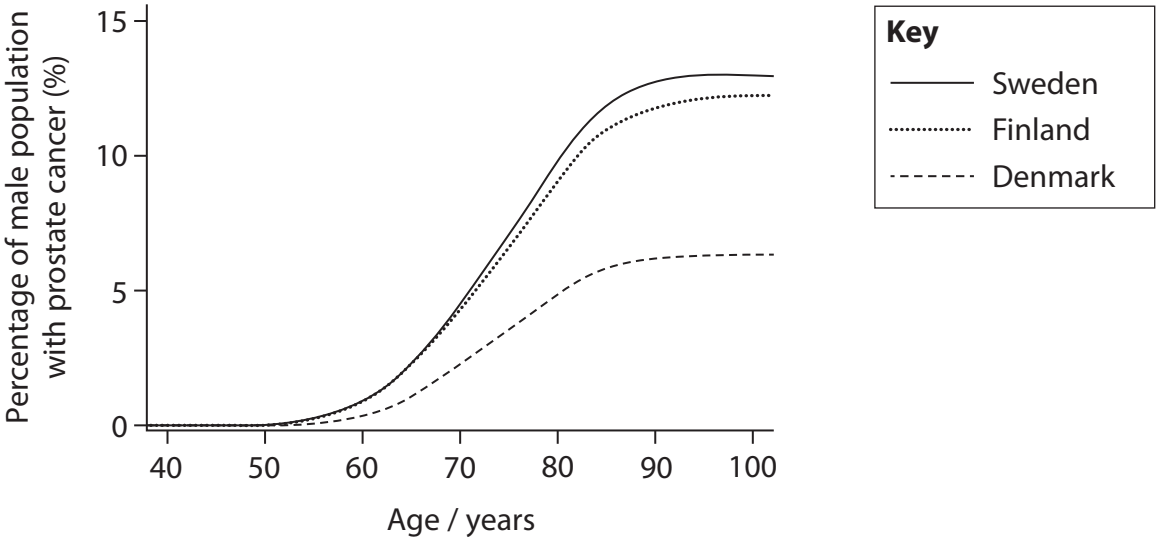
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**8** Prostate cancer is one of the most common forms of cancer in adult men.

A number of investigations have been carried out to study prostate cancer in a large number of men in Denmark, Finland and Sweden.

(a) In one of these investigations, the effect of age on developing prostate cancer was studied.

The graph shows the results.




Comment on the effect of age on the development of prostate cancer.

**(3)**

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(b) In another investigation, the effect of diet on the development of prostate cancer was studied.

Data were collected on prostate cancer death rates and the intake of sugar. Some of the data are shown in the table.

| Daily sugar intake per person / kJ | Prostate cancer death rate / 100 000 of the male population |
|---|---|
| 420 | 5.0 |
| 840 | 8.5 |
| 1260 | 12.0 |
| 1680 | 16.0 |
| 2100 | 20.0 |

The male population size of Denmark is 2.86 million.

Calculate the number of men likely to die from prostate cancer if their daily sugar intake was 1260 kJ.

**(2)**

Answer.....

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(c) In a third investigation, prostate cancer in identical and non-identical male twins was studied.

Data were collected on the probability of one male twin developing prostate cancer if his twin brother had prostate cancer.

(i) Explain why identical twins were included in this investigation.

**(2)**

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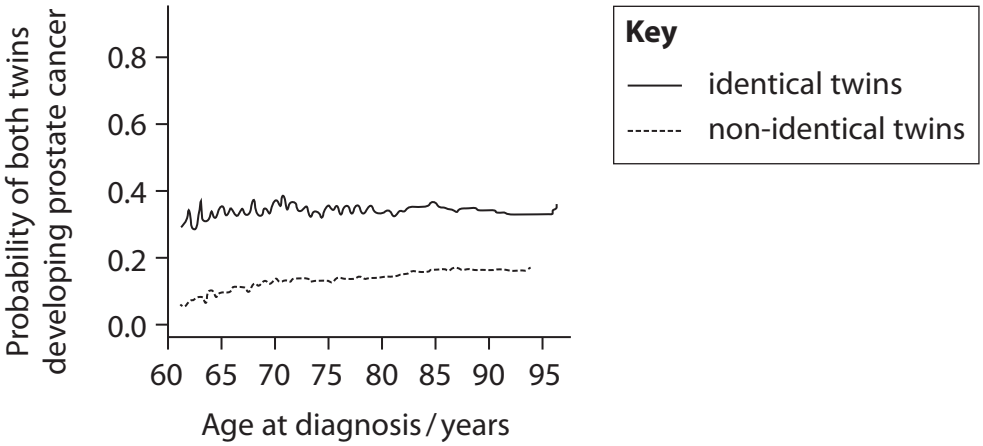
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*(ii) The graph shows the results of this investigation.




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Analyse the data from these three investigations to evaluate the likely causes of prostate cancer.

**(6)**

**(Total for Question 8 = 13 marks)**

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**9** Changes in diet are affecting the health of people in the UK.

(a) The table shows mean data for adult males in the UK in 1967 and 50 years later in 2017.

| Year | Mean mass / kg | Mean height / cm | Mean BMI |
|---|---|---|---|
| 1967 | 73 | 172 | 24.7 |
| 2017 | 84 | 178 | |

The National Health Service (NHS) states that BMI can be used to assess the weight category of an adult male. The table shows these categories.

| Category | BMI range |
|---|---|
| Underweight | $\leqslant$18.4 |
| Healthy weight | 18.5 – 24.9 |
| Overweight | 25.0 – 29.9 |
| Obese | $\geqslant$30.0 |

The mean BMI for adult males in 1967 indicates that they were in the healthy weight category.

Use the BMI formula to determine the mean weight category for adult males in 2017.

$$\text{BMI} = \frac{\text{mass in kilograms}}{(\text{height in metres})^2}$$

**(2)**

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(b) The effect of being shown a cheeseburger on saliva production in a child was studied.

The mass of saliva produced by this child was measured.

The child was then shown a cheeseburger and the new mass of saliva produced was measured. The change in the mass of saliva produced was recorded.

This was repeated with the child being shown a cheeseburger on eight occasions, at five minute intervals.

The results in the table show the change in mass of saliva produced compared with the mass of saliva produced before the child being shown a cheeseburger.

| Occasion | Change in mass of saliva produced / g |
|---|---|
| 1 | + 0.30 |
| 2 | + 0.18 |
| 3 | + 0.05 |
| 4 | + 0.02 |
| 5 | + 0.02 |
| 6 | – 0.08 |
| 7 | – 0.18 |
| 8 | – 0.19 |

(i) Describe the effect on saliva production shown by these results.

**(2)**

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(ii) Name the type of learning behaviour shown by the child as they were repeatedly shown a cheeseburger.

**(1)**

(iii) Explain what happens at the synapse to cause a decrease in saliva production when the child was shown a cheeseburger on more than six occasions.

**(4)**

(c) When the child was shown the cheeseburger, information would have been sent from the eye to the brain.

Describe the role of sodium ions in the functioning of a mammalian rod cell.

**(3)**

**(Total for Question 9 = 12 marks)**

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**10** Nandrolone is an anabolic steroid, it is a molecule with a similar shape to testosterone. Nandrolone has been used as a performance-enhancing substance by athletes in the past.

(a) A number of investigations with mice have been carried out to study the effect of nandrolone on the structure and function of the aorta.

In these investigations, all the mice were of one type and were all supplied with the same amount of food and water. These mice were placed into four groups.

Each group was treated differently for eight weeks. The treatments are shown in the table.

| Group | Treatment | |
|---|---|---|
| | Allowed to exercise | Given nandrolone |
| P | No | No |
| Q | No | Yes |
| R | Yes | No |
| S | Yes | Yes |

After eight weeks, the aorta of each mouse was studied.

(i) In investigation 1, samples of aorta were put under tension to test elastic recoil. The tension was removed and the mean maximum percentage recoil for each group was found.

The results are shown in the table.

| Group | Mean maximum percentage recoil (%) |
|---|---|
| P | 57 |
| Q | 38 |
| R | 80 |
| S | 53 |

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The use of nandrolone has been linked to a variety of cardiovascular conditions.

Explain how the use of nandrolone could lead to atherosclerosis.

**(3)**

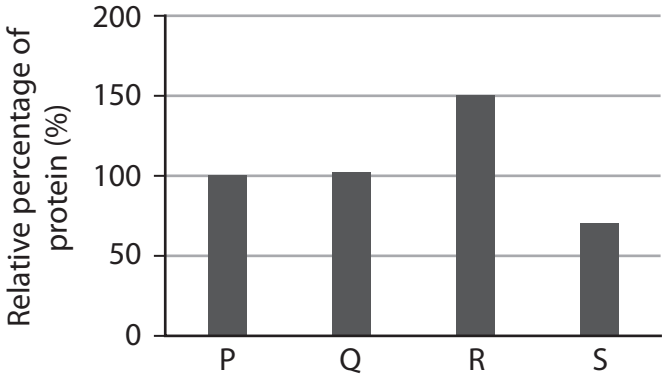
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(ii) In investigation 2, some of the cells from the middle layer of the aortas of the mice were removed.

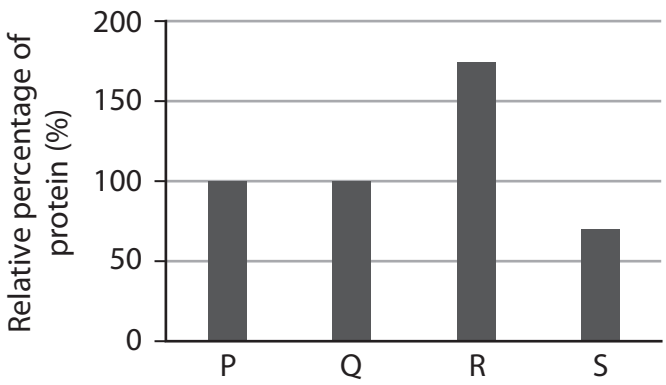
Two protein complexes, A and B, are found in the cells of the middle layer. These protein complexes are involved in the electron transport chain.

The graphs show the relative percentage of these two protein complexes in each group of mice.

Complex A




Complex B




Comment on the effects of nandrolone on the production of ATP.

**(3)**

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(iii) The transcription factor Tfam is involved in the production of mitochondria.

In investigation 3, some of the cells from the middle layer of the aortas of the mice were removed. The quantity of mRNA per cell coding for Tfam was measured.

The results are shown in the table.

| Group | Quantity of mRNA per cell coding for Tfam / a.u. |
|---|---|
| P | 100 ± 20 |
| Q | 75 ± 10 |
| R | 170 ± 25 |
| S | 85 ± 15 |

A student concluded that nandrolone affects the quantity of mRNA per cell coding for Tfam.

Explain why this conclusion is not valid for all the mice.

**(2)**

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*(b) Analyse the data from these three investigations to discuss the advantages of an exercise programme without nandrolone.

**(6)**

**(Total for Question 10 = 14 marks)**

**TOTAL FOR PAPER = 100 MARKS**

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