PEARSON EDEXCEL A-LEVEL BIOLOGY A · 9BN0

BIOLOGY



EXAM QUESTION PACK

TOPIC 7: RUN FOR YOUR LIFE

SCORE	PERCENTAGE
/161	%

STEMUP

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Q1.

The scientific article you have studied is adapted from *Scientific American*.

Use the information from the scientific article and your own knowledge to answer the following question.

Explain how 'a cancer-causing mutation' could increase the rate of division in stem cells (paragraph 14).

(3)

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(Total for question = 3 marks)

Q2.

A person arrived at hospital having eaten some poisonous berries.

An electrocardiogram (ECG) was recorded for this person.

One of the poisons in the berries can bind to acetylcholine receptors on the surface membrane of cells in the SAN. This prevents acetylcholine binding to the receptors if it is in low concentration.

This person was treated with a drug that stopped acetylcholinesterase from being released into the synaptic gap.

Explain how this drug lowered the heart rate of this person.

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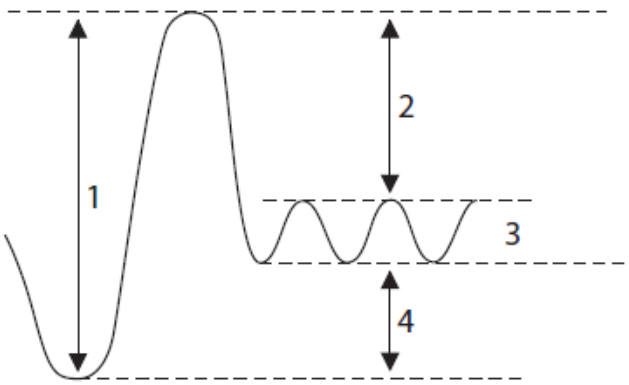
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(Total for question = 3 marks)

Q3.

A spirometer can be used to study aspects of the human respiratory system.

The diagram shows a trace produced using a spirometer.



Which of the following parts of the spirometer trace could be used to determine the maximum volume of air that can be exhaled?

(1)

☒ **A** 1 only

☒ **B** 2 and 3 combined

☒ **C** 3 only

☒ **D** 3 and 4 combined

(Total for question = 1 mark)

Q4.

As levels of activity increase, the heart can respond to the changing demand for oxygen.

Which term describes the ability of heart muscle to contract without external stimulation?

(1)

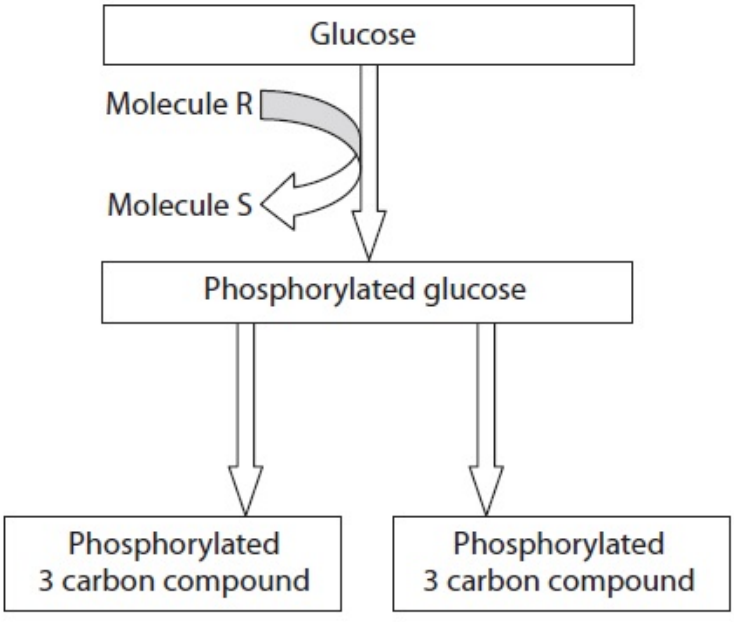
- ☒ **A** autonomic
- ☒ **B** cardiac
- ☒ **C** myogenic
- ☒ **D** systolic

(Total for question = 1 mark)

Q5.

Respiration is a vital process in living organisms. All organisms carry out glycolysis. The Krebs cycle also occurs in some organisms.

(a) The diagram below shows some of the stages in glycolysis, using the hexose sugar glucose.



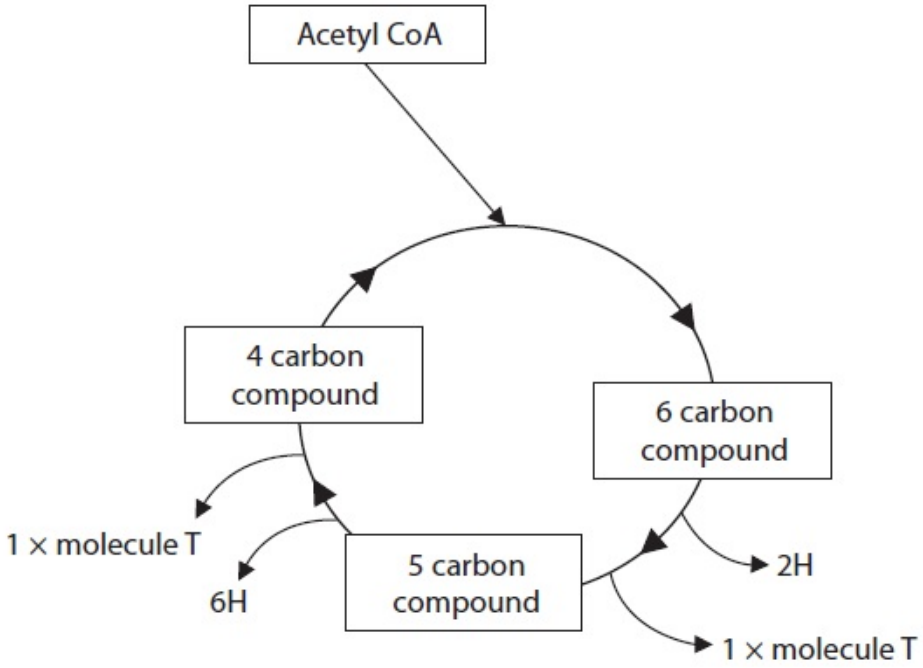
Name the molecules R and S shown in the diagram.

(2)

Molecule R .....

Molecule S .....

(b) The diagram below shows some of the stages in the Krebs cycle.



(i) Name molecule T and use the information in the Krebs cycle diagram to give a reason for your answer.

(2)

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(ii) Using information in the diagram, suggest what would happen in the Krebs cycle if acetyl CoA became unavailable.

(3)

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(b) The hydrogen (H) from the Krebs cycle enters the electron transport chain and oxidative phosphorylation occurs.

Explain what is meant by the term **oxidative phosphorylation**.

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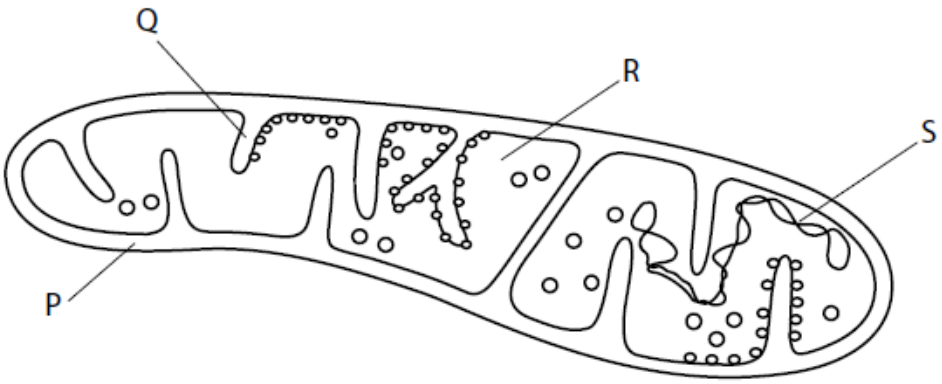
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(Total for question = 10 marks)

Q6.

Aerobic respiration is a series of reactions that occur in the cytoplasm and mitochondria of animal and plant cells.

(a) The diagram shows a mitochondrion.



Which row of the table shows where each process takes place in a mitochondrion?

(1)

	Diffusion of hydrogen ions / production of ATP in chemiosmosis	Production of reduced NAD
☒ **A**	P	Q
☒ **B**	Q	R
☒ **C**	R	S
☒ **D**	S	P

(b) The link reaction takes place in mitochondria.

Which row of the table shows the correct substances produced by the link reaction?

(1)

	Carbon dioxide	ATP	Reduced NAD
☒ **A**	no	no	no
☒ **B**	no	yes	no
☒ **C**	yes	yes	yes
☒ **D**	yes	no	yes

(c) The number of ATP molecules synthesised in mitochondria from one molecule of acetyl CoA is

(1)

☒ **A** 11

☒ **B** 12

☒ **C** 22

☒ **D** 24

(Total for question = 3 marks)

Q7.

Yeast is a single-celled organism that can respire aerobically.

Mitochondria are the sites of aerobic respiration in yeast cells.

(i) Name two molecules needed for aerobic respiration that can move into the mitochondria.

(2)

1 .....

2 .....

(ii) The outer mitochondrial membrane is not permeable to hydrogen ions (H^+).

Explain the importance of this feature of the membrane.

(4)

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(Total for question = 6 marks)

Q8.

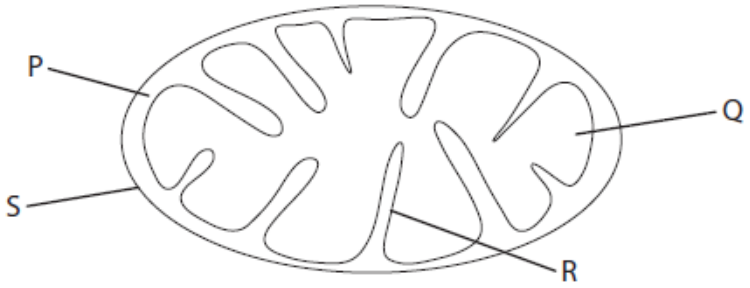
Answer the questions with a cross in the boxes you think are correct ☒. If you change

your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Yeast is a single-celled organism that can respire aerobically.

Mitochondria are the sites of aerobic respiration in yeast cells.

The diagram shows a mitochondrion.



(i) Which labelled component in the diagram is the site of the Krebs cycle?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(ii) Which labelled component in the diagram is the site of oxidative phosphorylation?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(iii) Yeast cells can have many small mitochondria.

Calculate the magnification of the diagram if the maximum length of the mitochondrion is 0.5 µm.

(2)

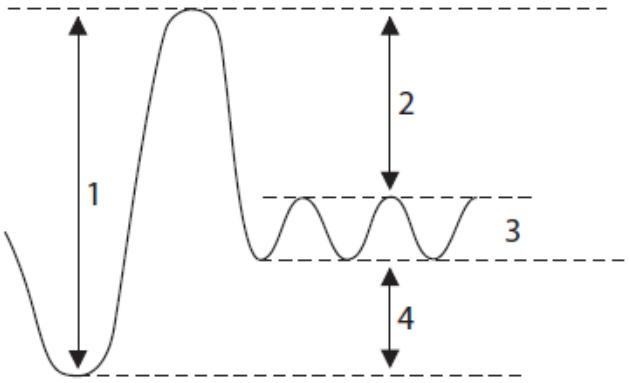
Answer .....

(Total for question = 4 marks)

Q9.

A spirometer can be used to study aspects of the human respiratory system.

The diagram shows a trace produced using a spirometer.



The availability of oxygen in the air is lower at high altitudes because of the lower air pressure.

Populations of humans that have lived at high altitude for many generations have adapted to these conditions.

One adaptation these people have is a larger thorax than people living at lower altitudes.

A student made the following hypothesis:

People with this adaptation will have a lower breathing rate as their tidal volume will be greater than those without the adaptation.

(i) Devise a valid investigation, using a spirometer, to test this hypothesis.

(4)

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(ii) Another adaptation to living at high altitude is to have more red blood cells circulating in their blood.

Explain how a bone marrow stem cell can give rise to red blood cells.

(4)

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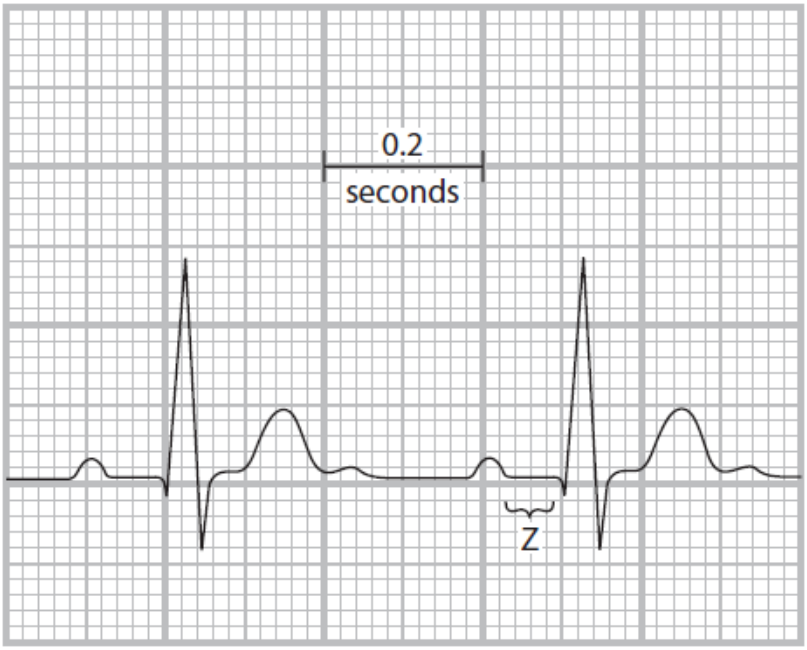
(Total for question = 8 marks)

Q10.

A person arrived at hospital having eaten some poisonous berries.

An electrocardiogram (ECG) was recorded for this person.

The diagram shows part of the ECG obtained.



(i) Tachycardia for an adult is defined as a heart rate above 100 beats per minute.

Calculate the percentage increase above 100 beats per minute for the heart rate of this person.

(2)

Answer ..... %

(ii) The length of time labelled Z on the ECG was shorter than for a person with a normal heart rate.

Which of the following is shown by label Z on the diagram?

(1)

☒ **A** the time that the atria are contracting

☒ **B** the time for the atrioventricular (AV) valves to open

☒ **C** the time that the atrioventricular node (AVN) delays depolarisation

☒ **D** the time that the ventricles are contracting

(Total for question = 3 marks)

Q11.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Moving a limb involves the interaction of muscles, tendons and ligaments.

Tendons and ligaments are important structures in elbow and knee joints.

(i) Which of the following identifies the structures that join bones to bones in an elbow joint?

(1)

☒ **A** ligaments only

☒ **B** ligaments and tendons

☒ **C** tendons only

☒ **D** neither ligaments nor tendons

(ii) One type of joint injury is a torn ligament. This may be treated by adding a piece of tendon to the ligament. This is because after a period of time, the tendon tissue changes and responds in the same way as a ligament.

Which of the rows in the table correctly describe the changes in this piece of tendon?

(1)

Row	Piece of tendon shows a change in its	The change is
1	genotype	an anatomical adaptation
2	genotype	a physiological adaptation
3	phenotype	an anatomical adaptation
4	phenotype	a physiological adaptation

☒ **A** row 1 only

☒ **B** row 3 only

☒ **C** rows 1 and 2

☒ **D** rows 3 and 4

*(iii) The photograph shows athletes competing in the modern triathlon.



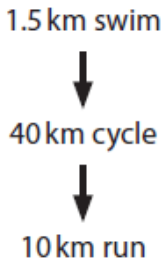
© Gonzalo Arroyo Moreno / Stringer

The modern triathlon involves three sports: swimming, cycling and running.

An investigation was carried out to compare the level of demand on the body of these three sports during a triathlon.

The investigation involved 12 athletes who were all males of the same age.

Each athlete carried out the triathlon as shown in the flow diagram. There was no rest period between each sport.



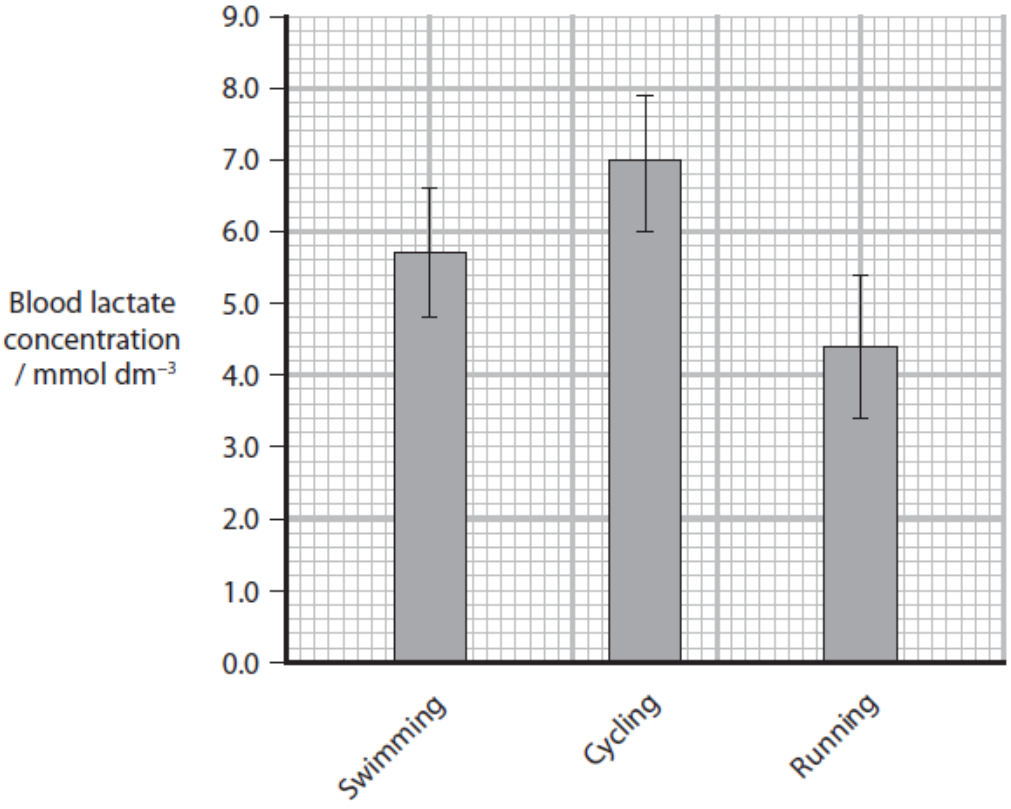
The heart rate for each athlete was measured as they completed each sport.

The mean heart rate for each sport was then calculated and is shown in the table.

Sport	Mean heart rate / bpm
Swimming	163
Cycling	165
Running	159

The blood lactate level for each athlete was also measured as they completed each sport. Means for lactate level after each sport were calculated.

The results are shown in the graph.



It was concluded that cycling was the most demanding of the three triathlon sports. This was followed by swimming and then running.

Evaluate the validity of this conclusion.

(6)

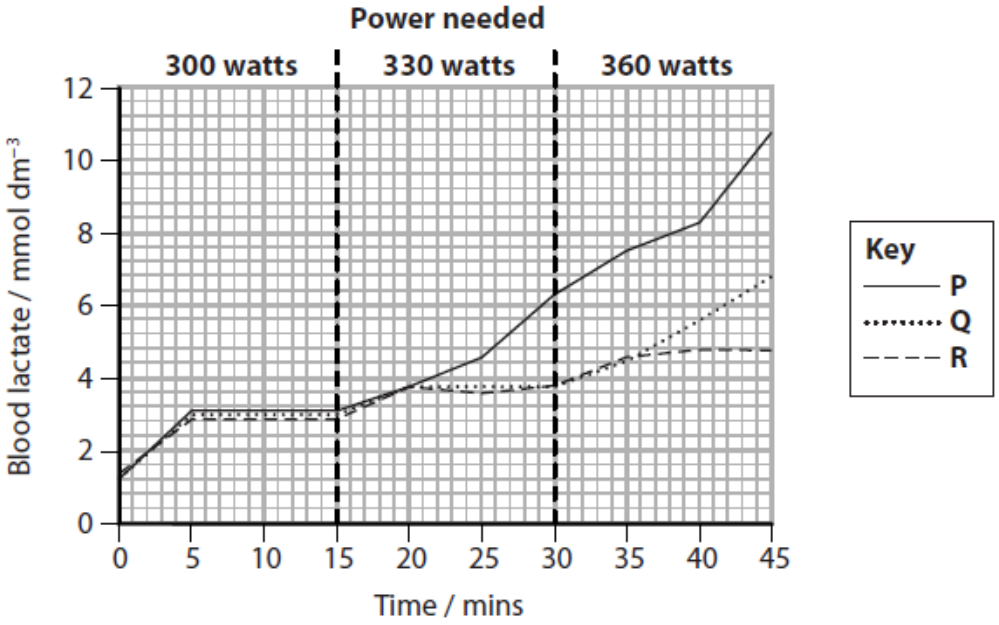
(Total for question = 8 marks)

Q12.

Athletes monitor the effect of different levels of exercise on their blood lactate concentration. This helps them to train effectively.

In a study, three athletes, **P**, **Q** and **R**, used an exercise bicycle for 45 minutes.
The power needed to maintain a constant speed was increased every 15 minutes.
Their blood lactate concentration was measured at 5-minute intervals.

The results are shown in the graph.



The most effective training involves the greatest power requirement over longer periods of time. Therefore, it is important to avoid high concentrations of blood lactate, which causes muscle fatigue, for as long as possible.

Analyse the data to deduce how each of these three athletes should plan their training.

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(Total for question = 4 marks)

Q13.

Anabolic steroids stimulate muscle development.

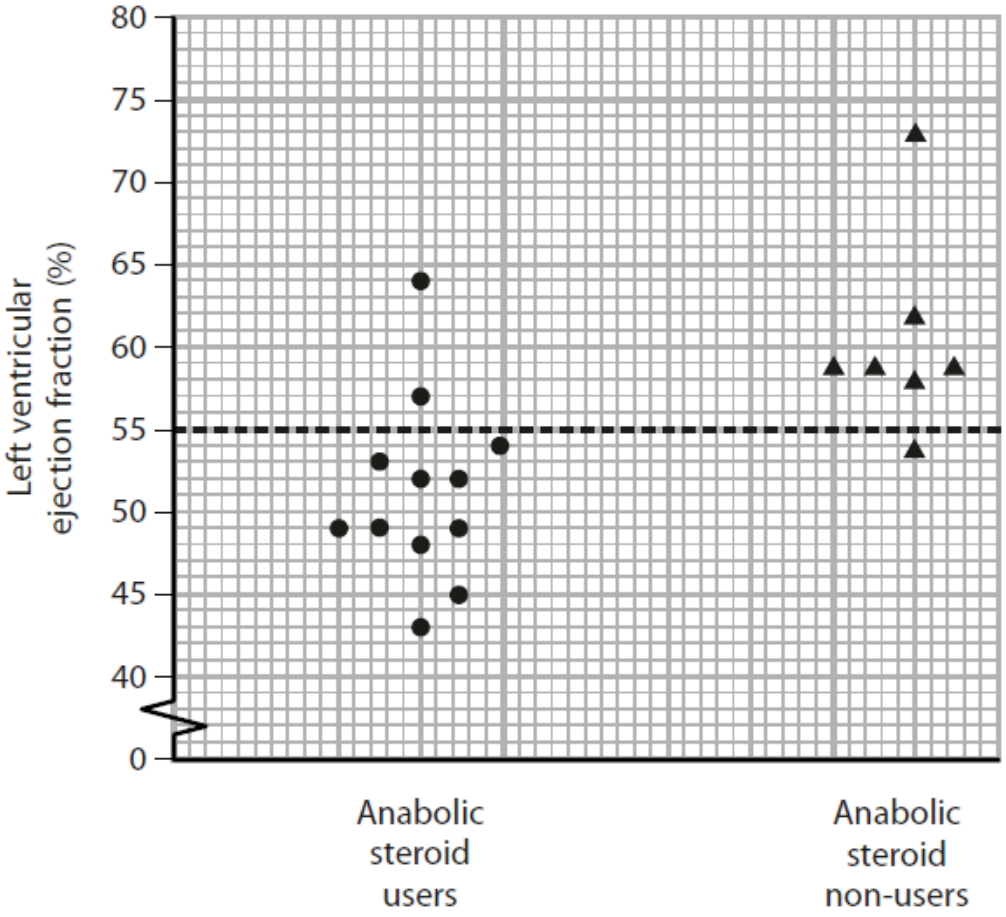
Some athletes use anabolic steroids in an attempt to improve their performance.

The effect of long-term anabolic steroid use on heart function has been investigated.

The left ventricular ejection fraction is the percentage of blood that leaves the left ventricle when it contracts.

The left ventricular ejection fraction for a healthy heart should be greater than 55%.

The results of a small study are shown in the graph.



(i) Analyse the data to determine the effect of anabolic steroid use on heart function.

(2)

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(ii) Some drugs used to treat cancer have also been shown to reduce the ventricular ejection fraction.

Describe how the safe dose of a cancer drug could be determined.

(3)

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(Total for question = 5 marks)

Q14.

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 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.

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.

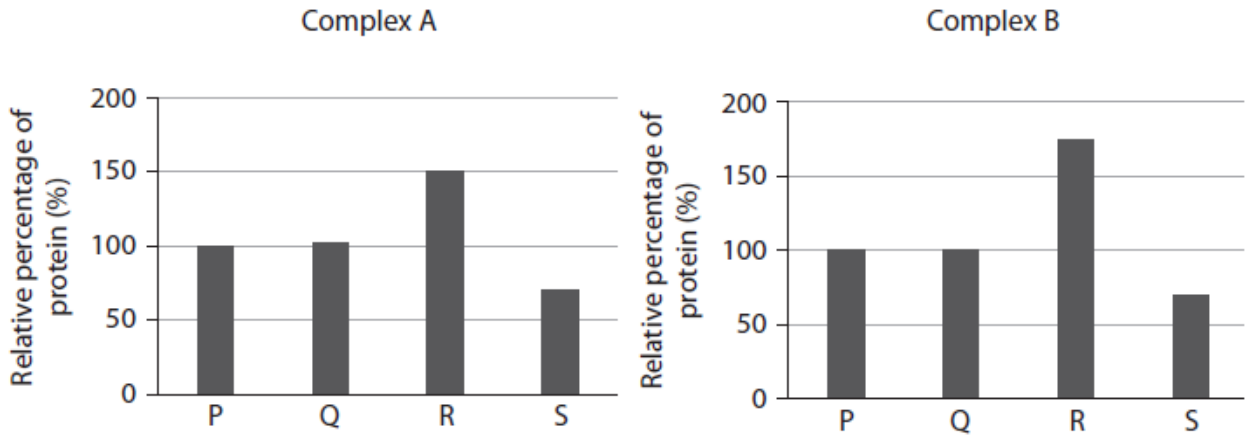
Group	Mean maximum percentage recoil (%)
P	57
Q	38
R	80
S	53

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.



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

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

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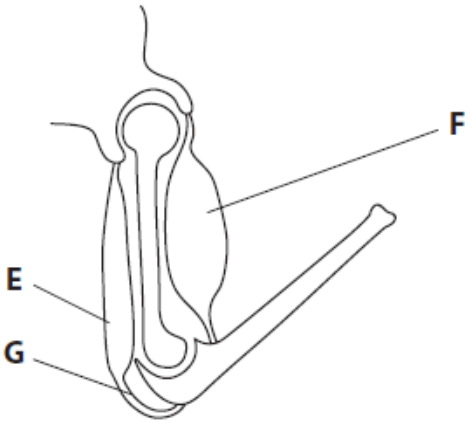
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(Total for question = 6 marks)

Q15.

Movement of the arm at the elbow joint results from the contraction of muscles.

The diagram shows some of the structures in a human arm.



(a) Give the term for a pair of muscles that brings about movement at a joint.

(1)

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(b) (i) Give a reason why **F** can be described as a flexor muscle.

(1)

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(ii) Describe how **G** interacts with **E** to enable movement at this joint.

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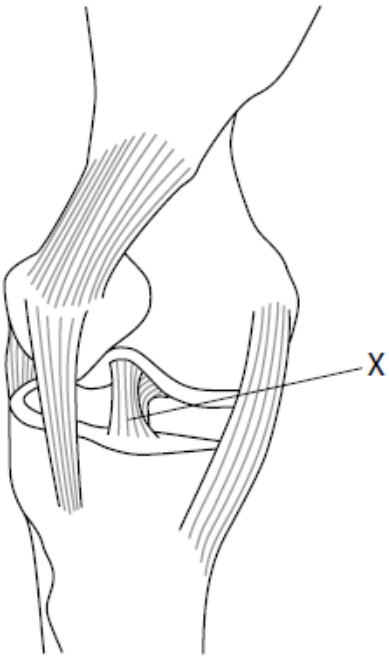
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Q16.

Movement at a joint is brought about by the contraction of antagonistic muscles which contain slow and fast twitch fibres.

The diagram shows a knee joint.



Lateral view of the knee

(a) Which tissue is used to repair structure X using keyhole surgery?

(1)

☒ **A** bone

☒ **B** cartilage

☒ **C** ligaments

☒ **D** tendon

(b) Explain why muscles occur in antagonistic pairs.

(2)

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(Total for question = 3 marks)

Q17.

Lipids and carbohydrates are found in both plants and animals.

The carbohydrate content of vegetables ranges from 3 to 35%. However, meat contains little to no carbohydrate. Milk is the only food source from animals that contains a significant amount of carbohydrate.

Although plant material contains a higher proportion of carbohydrate than animal tissues, it has been claimed that carbohydrates are more important to animals than they are to plants.

Assess the relative importance of carbohydrates to plants and animals.

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(Total for question = 9 marks)

Q18.

The scientific article you have studied is adapted from articles in New Scientist.

Use the information from the article and your own knowledge to answer the following questions.

(a) Suggest why 'incredibly efficient cellular mechanisms' can increase the chance of obesity (paragraphs 4 and 5).

(2)

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(b) A larger VO_2max means more oxygen can enter a mitochondrion and therefore more energy can be released from fuel (paragraph 8).

Name **two** substances, other than oxygen, that need to enter the mitochondrion to enable energy to be released from fuel.

(2)

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(c) Describe the structure of glycogen (paragraph 11).

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(d) Using the information in paragraphs 12 to 14, explain how lowered testosterone levels may help a cyclist to race harder on successive days.

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(e) Explain why Coyle suggests that greater muscle efficiency may be linked to an increase in the percentage of **slow twitch** muscle fibres (paragraph 20).

(2)

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*(f) Suggest how 'the development of a leak in a specific class of calcium channel in muscle cells' can lead to muscle fatigue (paragraph 23).

(4)

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(g) The ACE gene codes for the synthesis of angiotensin converting enzyme (ACE) (paragraph 25).

Complete the table by naming two nucleic acids involved in each of the processes described.

(2)

Process	Two nucleic acids involved in the process
Transcription of the ACE gene	1 ..... 2 .....
Synthesis of ACE at a ribosome	1 ..... 2 .....

(h) A variant of the APOE gene could put individuals at increased risk in contact sports. DNA profiling is a technique that can be used in genetic screening.

Suggest how DNA profiling could be carried out to identify this variant of the APOE gene (paragraph 27).

(4)

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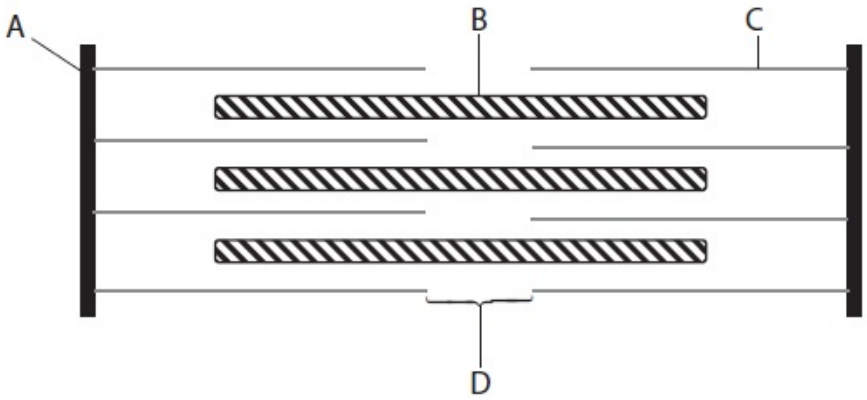
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(i) The titin gene produces a protein that attaches to myosin in a sarcomere (paragraph 30).



Place a cross (☒) in the box that identifies myosin shown in the diagram.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(j) The colder the water Japanese Ama divers swim in, the higher their resting metabolic rate (paragraph 50).

Suggest and explain why this might be an advantage to these divers.

(3)

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(k) Pugh noticed the effects of climate change (paragraph 53).

Name **two** greenhouse gases that contribute to climate change. Give **one** source of each of these gases.

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(l) Using the information in paragraph 55, calculate the percentage increase in Pugh's core body temperature due to his "anticipatory thermogenesis".

Show your working.

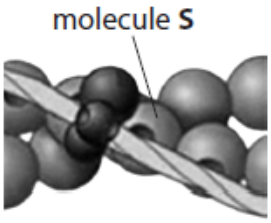
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Answer = ... %

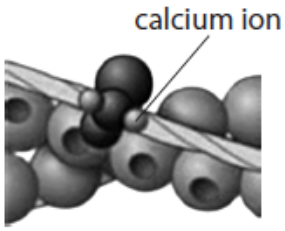
(Total for question = 30 marks)

Q19.

Muscle cells contain myofibrils. The diagrams show the arrangement of some of the molecules present in a myofibril when calcium ions are absent and when they are present.



calcium ions absent



calcium ions present

(i) Describe the changes caused when calcium ions bind to the molecules shown in the diagram.

(2)

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(ii) Explain how these changes cause muscles to contract.

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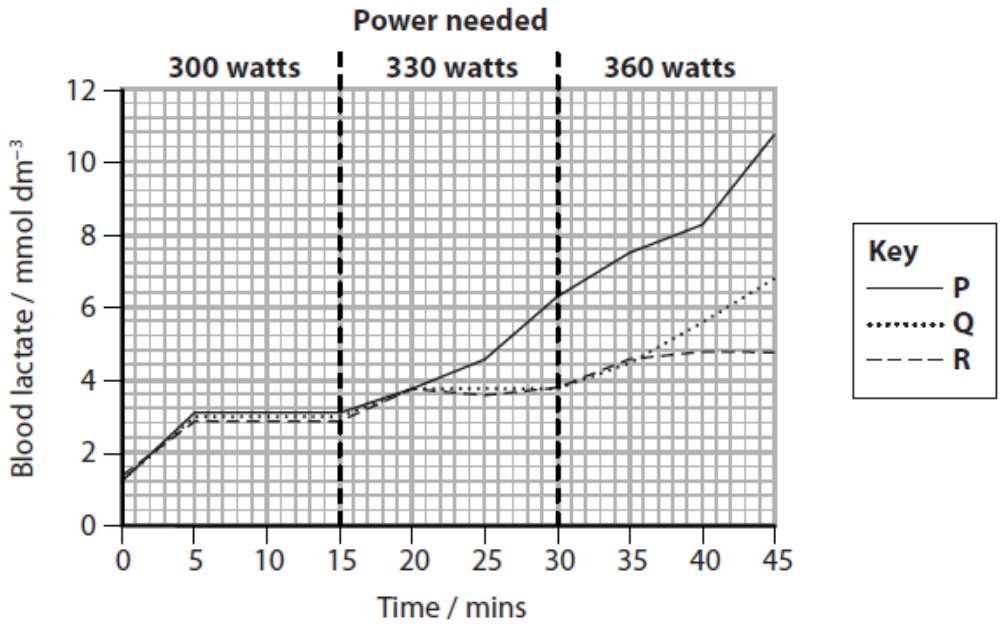
(Total for question = 6 marks)

Q20.

Athletes monitor the effect of different levels of exercise on their blood lactate concentration. This helps them to train effectively.

In a study, three athletes, **P**, **Q** and **R**, used an exercise bicycle for 45 minutes.
The power needed to maintain a constant speed was increased every 15 minutes.
Their blood lactate concentration was measured at 5-minute intervals.

The results are shown in the graph.



Explain the increase in blood lactate concentration observed between 0 and 5 minutes.

(2)

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(Total for question = 2 marks)

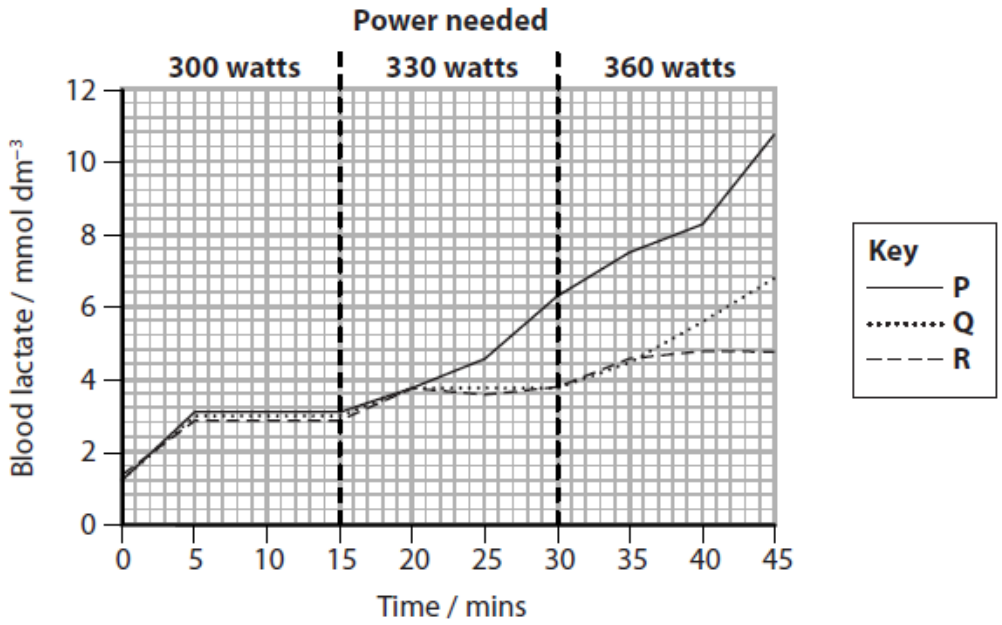
Q21.

Athletes monitor the effect of different levels of exercise on their blood lactate concentration. This helps them to train effectively.

In a study, three athletes, **P**, **Q** and **R**, used an exercise bicycle for 45 minutes.

The power needed to maintain a constant speed was increased every 15 minutes.
Their blood lactate concentration was measured at 5-minute intervals.

The results are shown in the graph.



Give reasons why blood lactate concentration remains constant between 5 and 15 minutes.

(3)

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(Total for question = 3 marks)

Q22.

Athletes compete in a range of environmental conditions.

An investigation studied the effects of environmental conditions on athletes.

A group of nine athletes ran for 50 minutes in two sets of environmental conditions:

- warm temperature and high humidity
- cool temperature and low humidity.

All other variables were kept constant including the level of exercise.

The core temperature of each athlete was recorded during the exercise and for 70 minutes following the exercise.

In another investigation, samples of blood were taken from athletes during exercise and after exercise.

The concentration and activity of neutrophils, a type of phagocyte, in the blood were measured.

The table shows the results.

Measurements	During exercise	Immediately after exercise
Mean concentration of neutrophils in blood / 10^6 cells cm^{-3}	3.57	3.42
Mean activity of neutrophils / a.u.	28.4	22.0

(i) The mean body mass of the athletes was 70 kg and the mean volume of blood per athlete was 5 dm^3.

Calculate how many fewer neutrophils there are in the blood per kilogram of body mass immediately after exercise.

(3)

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(ii) State how these results support the statement that exercise increases the risk of infection.

(1)

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(Total for question = 4 marks)

Q23.

The central nervous system (CNS) is made up of the brain and the spinal cord.

(a) The image below of a human head and neck shows part of the CNS.



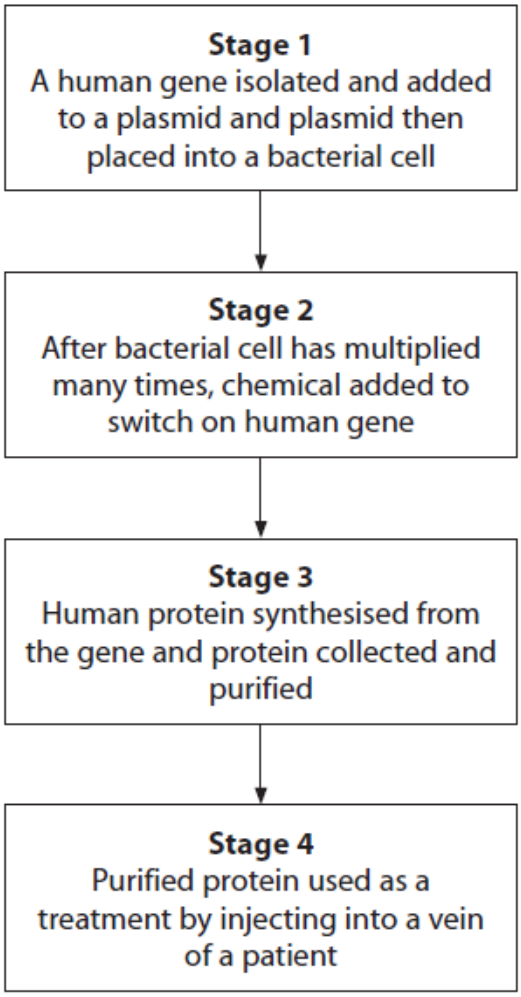
Using the image and your knowledge, complete the table below.

(4)

Labelled structure	Name of structure	One function
A		
		Feel emotions

(b) Some of the drugs used to treat human disorders are proteins. Some of these proteins can be synthesised by genetically modified bacteria.

The diagram below shows some stages in the production of one of these drugs.



(i) A restriction enzyme is used in Stage 1.

Explain why only one restriction enzyme is used in stage 1.

(2)

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(ii) Suggest how the addition of a chemical causes the human gene to be switched on in stage 2.

(3)

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(iii) Describe the structure of an organelle found in a bacterial cell that is involved in synthesising human protein in stage 3.

(1)

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(iv) Suggest **two** advantages of injecting the protein into a vein rather than an artery in stage 4.

(2)

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(Total for question = 12 marks)

Q24.

The photograph shows a female gymnast on a narrow beam.



(a) The table below refers to two regions of the brain.

Complete the table by describing **one** role of each region of the brain, while she is on the beam.

(2)

Region of the brain	One role while she is on the beam
Cerebellum	
Medulla oblongata	

(b) This gymnast will generate a lot of heat while she is on the beam.

Describe and explain how changes in blood flow in the skin will help her to control her body temperature.

(4)

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(c) Gymnasts can damage their cruciate ligaments. This is an injury that can be repaired using keyhole surgery.

(i) Explain what is meant by the term **cruciate ligament**.

(2)

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(ii) A gymnast was offered keyhole surgery to repair her damaged cruciate ligament.

Suggest and explain **two** reasons why she might choose this type of surgery.

(2)

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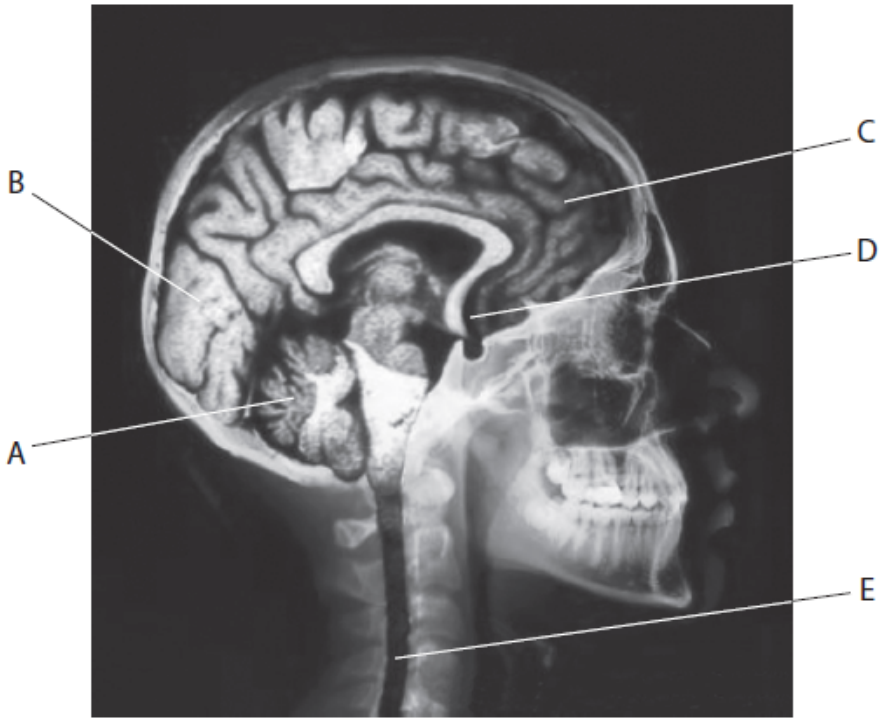
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(Total for question = 10 marks)

Q25.

The central nervous system (CNS) is made up of the brain and the spinal cord.

(a) The image below of a human head and neck shows part of the CNS.



Using the image and your knowledge, complete the table below.

(4)

Labelled structure	Name of structure	One function
A		
		Thermoregulation

(b) The structure involved in thermoregulation may cause sweat glands to release more sweat.

Explain how increased sweating is involved in the regulation of body temperature.

(3)

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(c) The photograph below shows a California sea lion (*Zalophus californianus*), a large marine mammal.



Magnification × 0.005

Domoic acid is a neurotoxin, produced by algae, that harms the brains of these mammals. This neurotoxin damages brain cells that release a neurotransmitter called glutamate.

(i) Describe how a neurotransmitter, such as glutamate, is released from a brain cell.

(4)

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(ii) Scientists have used magnetic resonance imaging (MRI) to provide evidence that domoic acid may damage the brains of California sea lions.

Suggest how MRI can provide this evidence.

(2)

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(Total for question = 13 marks)