Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 27 October 2025

Afternoon (Time: 1 hour 45 minutes)

Paper reference **WBI15/01**

Biology

International Advanced Level
UNIT 5: Respiration, Internal Environment, Coordination and Gene Technology

You must have:
Scientific article (enclosed), scientific calculator, ruler, HB pencil

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.
- Answer the questions in the spaces provided – *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In the question labelled 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.

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Answer ALL questions.

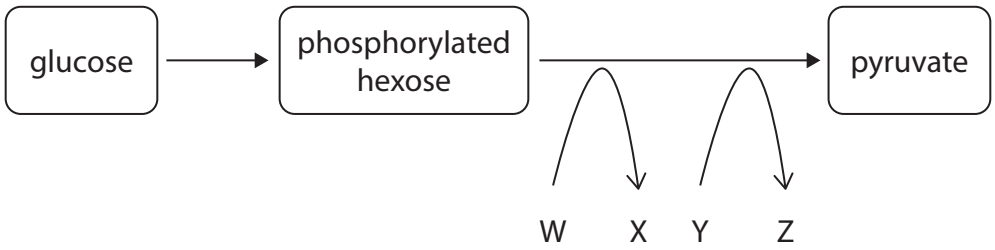
Write your answers in the spaces provided.

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 Cells release energy from respiratory substrates by anaerobic and aerobic respiration.

(a) Glycolysis takes place in both anaerobic and aerobic respiration.

The diagram shows some steps in glycolysis.



(i) Which is the site of glycolysis?

(1)

☒ **A** cytoplasm

☒ **B** inner membrane of mitochondria

☒ **C** mitochondrial matrix

☒ **D** nucleus

(ii) Which row in the table identifies molecules W, X, Y and Z?

(1)

		Molecule W	Molecule X	Molecule Y	Molecule Z
☒	**A**	ADP	ATP	NAD	reduced NAD
☒	**B**	ADP	ATP	reduced NAD	NAD
☒	**C**	ATP	ADP	NAD	reduced NAD
☒	**D**	ATP	ADP	reduced NAD	NAD

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(b) During a prolonged period of exercise, muscle fibres can switch from aerobic respiration to anaerobic respiration.

(i) Describe what happens to the pyruvate produced during **aerobic** respiration.

(3)

(ii) Describe what happens to the pyruvate produced during a period of **anaerobic** respiration.

(3)

(Total for Question 1 = 8 marks)

2 Thale cress plants produce seeds.

The germination of these seeds occurs when phytochromes are exposed to light.

(a) In an investigation, three groups of thale cress seeds were incubated in the dark at 25 °C for 24 hours.

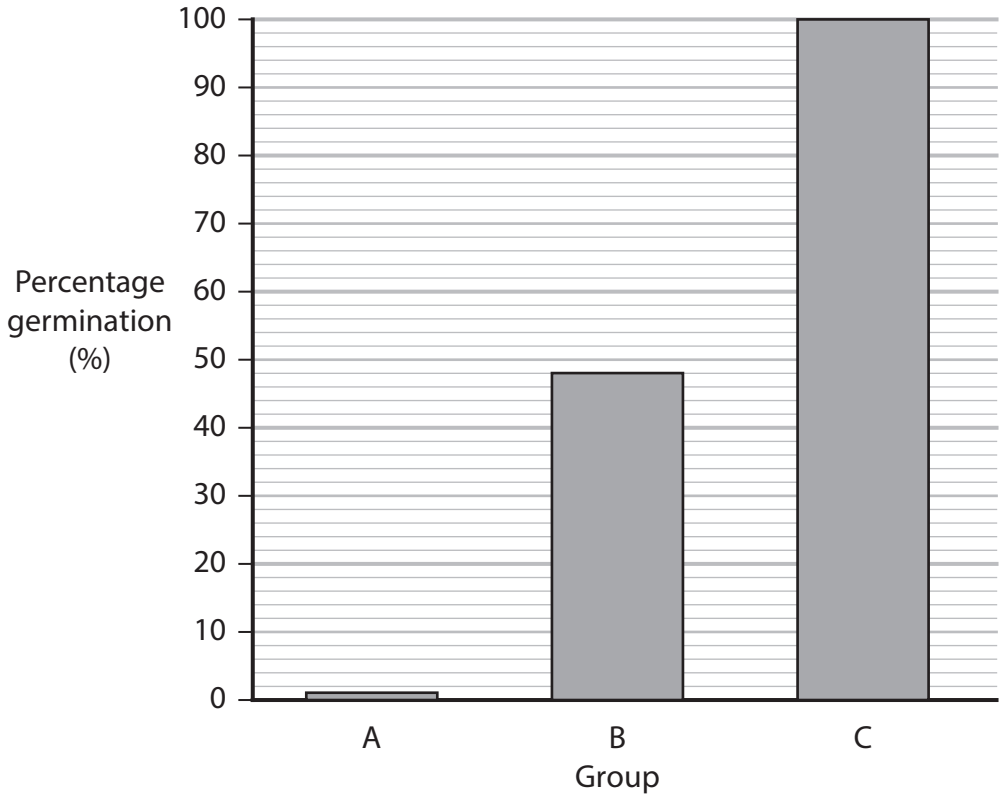
The groups of seeds were then given different treatments and kept in the dark for a further four days.

The table shows the treatments.

Group	Treatment
A	none
B	treated with a flash of red light followed by a flash of far-red light
C	treated with a flash of red light

Four days after the treatment the percentage germination was determined.

The graph shows the results of the investigation.



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(i) The total number of seeds in group B was 250.

Which is the number of seeds germinating in group B?

(1)

- ☒ **A** 48
- ☒ **B** 52
- ☒ **C** 120
- ☒ **D** 130

(ii) Explain the role of phytochromes in the germination of thale cress seeds.

Use the results of this investigation to help you.

(4)

(b) The enzyme amylase is produced during the germination of thale cress seeds.

Explain why amylase is required for germination.

(3)

(Total for Question 2 = 8 marks)

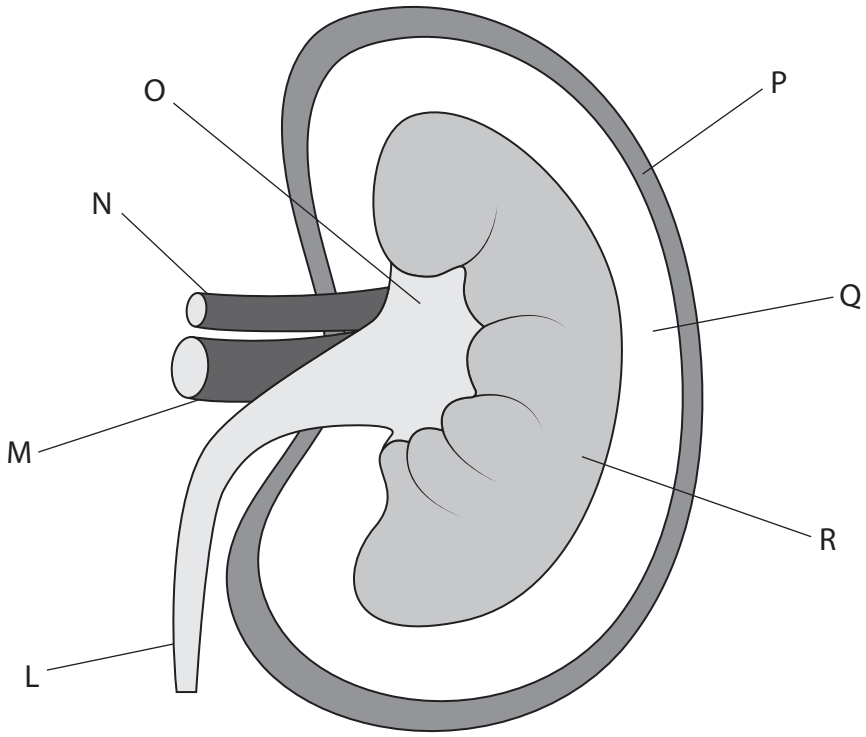
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3 The mammalian kidney is involved in removing toxins from the blood and maintaining blood plasma concentration.

(a) The diagram shows a transverse section through a kidney.



(i) Which row identifies the cortex and the medulla of the kidney?

(1)

		Cortex	Medulla
☒	**A**	P	Q
☒	**B**	Q	P
☒	**C**	Q	R
☒	**D**	R	Q

(ii) Which label identifies the pelvis of the kidney?

(1)

☒ **A** L

☒ **B** M

☒ **C** N

☒ **D** O

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(iii) Which label identifies the location of the structures responsible for ultrafiltration?

(1)

- ☒ **A** O
- ☒ **B** P
- ☒ **C** Q
- ☒ **D** R

(b) The table shows some information about the urine concentration of six mammals.

Mammal	Size of mammal	Habitat	Urine concentration / a.u.
water vole	small	very wet	1200
rat	small	moderately wet	2900
kangaroo rat	small	dry	5500
beaver	large	very wet	520
gorilla	large	moderately wet	1400
addax	large	dry	1880

(i) Describe **two** conclusions that can be made about the urine concentration of mammals living in these habitats.

(2)

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(ii) Explain how the **structure of a nephron** (kidney tubule) in the kangaroo rat is adapted to produce a high urine concentration.

(3)

(Total for Question 3 = 8 marks)

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4 The photograph shows two harbour seals swimming.



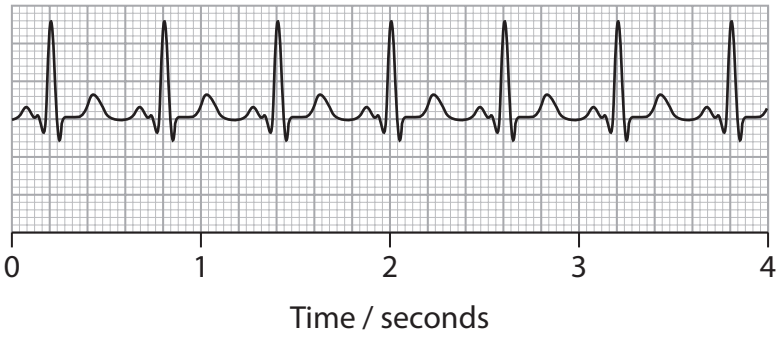
(Source: © Dirk Rueter / Alamy Stock Photo)

Seals are mammals that breathe air.

Seals dive under water to catch fish.

Each dive can last for more than 15 minutes.

(a) The diagram shows an ECG trace for a seal before a dive.



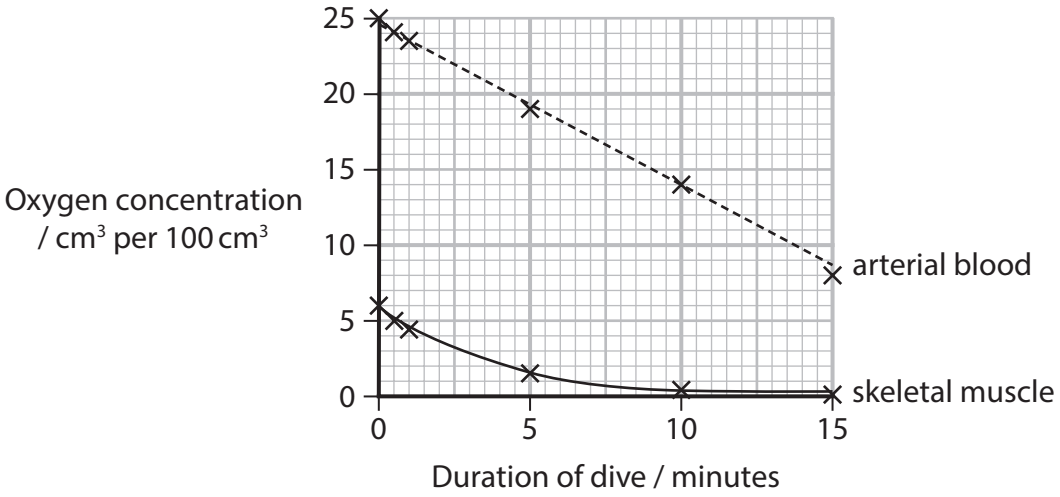
The heart rate of the seal during a dive was 13 beats per minute (bpm).

Calculate the change in heart rate when the seal dives.

(2)

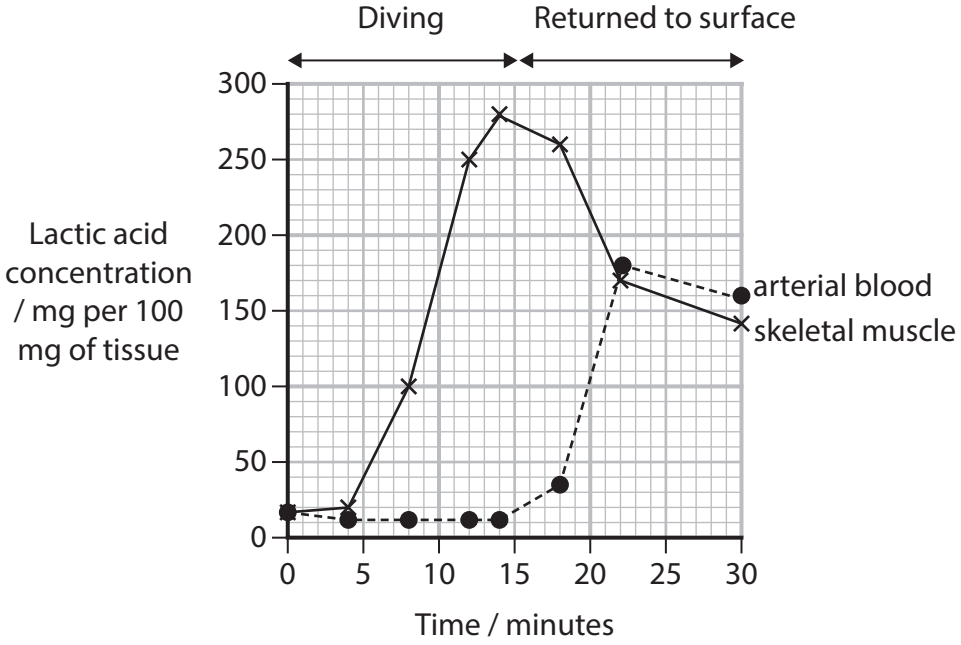
Answer ..... bpm

*(b) Graph 1 shows the oxygen concentration in arterial blood and skeletal muscle in a diving seal.



Graph 1

Graph 2 shows the lactic acid concentration in blood and skeletal muscle in a diving seal and after it has returned to the surface.



Graph 2

When seals dive the proportion of blood flowing to different tissues changes.

The table shows the change in blood flow to some tissues when a seal is diving.

Tissue	Change in proportion of blood flowing to tissues when diving
brain (cortex)	increases by 20%
cardiac muscle	decreases by 90%
skeletal muscle	decreases by 99%

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Assess the role of aerobic and anaerobic respiration when seals dive.

(6)

(Total for Question 4 = 8 marks)

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5 The eye is a sensory organ.

(a) Rod cells are a type of sensory cell found in the eye.

(i) Which is the name of the light-sensitive pigment found in rod cells?

(1)

☒ **A** auxin

☒ **B** L-DOPA

☒ **C** phytochrome

☒ **D** rhodopsin

(ii) Which row in the table describes the effects of light being absorbed by the light-sensitive pigment in a rod cell?

(1)

		Sodium ion channels	Rod cell membrane becomes
☒	**A**	closed	depolarised
☒	**B**	closed	hyperpolarised
☒	**C**	open	depolarised
☒	**D**	open	hyperpolarised

(iii) Name the process that uses ATP to change the polarisation of rod cell membranes.

(1)

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(b) Pupil dilation can be used as a measure of the difficulty of a learning task.

The effect of a learning task on pupil dilation was studied.

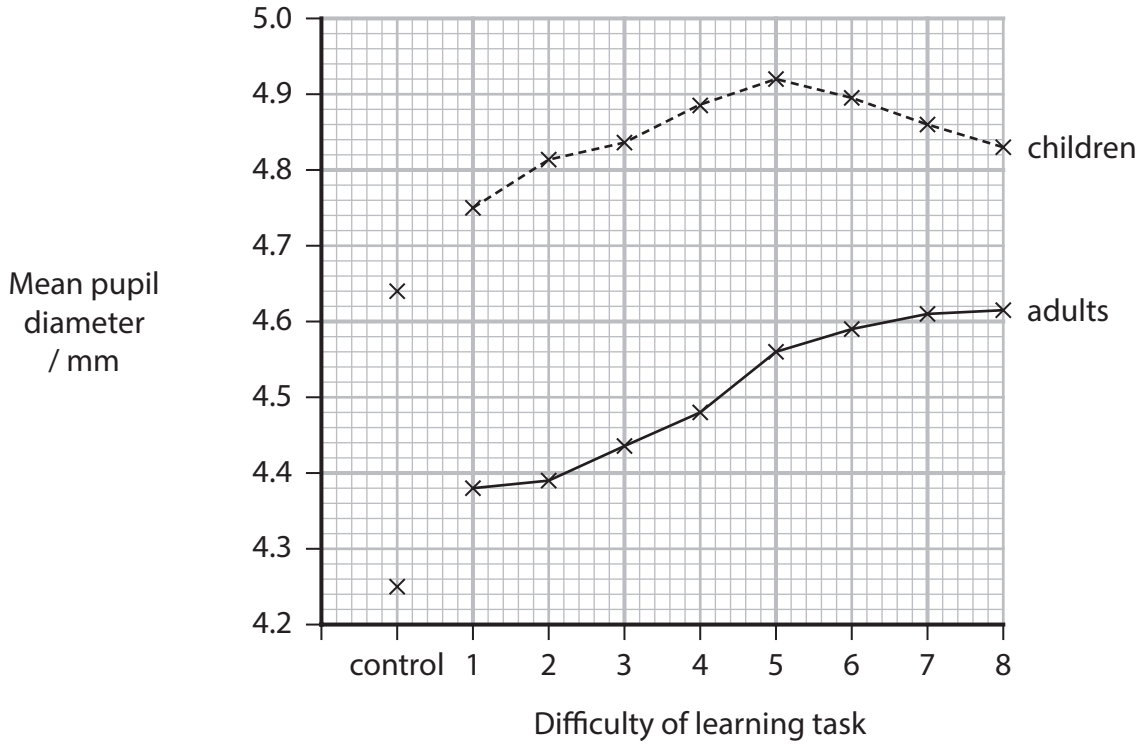
The pupil diameter was measured in a control group of adults.

The adults were then given a learning task and the increase in pupil diameter was measured.

The procedure was repeated with learning tasks of increasing difficulty.

The study was then repeated with a group of children.

The graph shows the results of this study.



(i) Describe how muscles dilate the pupil.

(2)

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(ii) The mean area of the pupil for the control group of children was 16.9 mm^2.

Calculate the maximum increase in mean area of the pupil for the children.

Give your answer to an appropriate number of significant figures.

(3)

Answer ..... mm^2

(iii) Describe **three** conclusions that can be made from the results shown in the graph.

(3)

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(iv) Which part of the brain has learning and memory as one of its main functions?

(1)

- ☒ **A** cerebral hemispheres
- ☒ **B** hypothalamus
- ☒ **C** medulla oblongata
- ☒ **D** pituitary gland

(v) Suggest **one** reason for the difference in response of children and adults.

(1)

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(Total for Question 5 = 13 marks)

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6 The nervous system is involved in coordination and learning.

(a) Many axons are surrounded by myelin.

Myelin is involved in saltatory conduction.

(i) Name the type of cell that produces myelin.

(1)

(ii) State what is meant by the term **saltatory conduction**.

(1)

(iii) Give the property of myelin that contributes to saltatory conduction.

(1)

(b) Describe how a nerve impulse is transmitted across a synapse.

(3)

(c) In an investigation, two groups of children were studied.

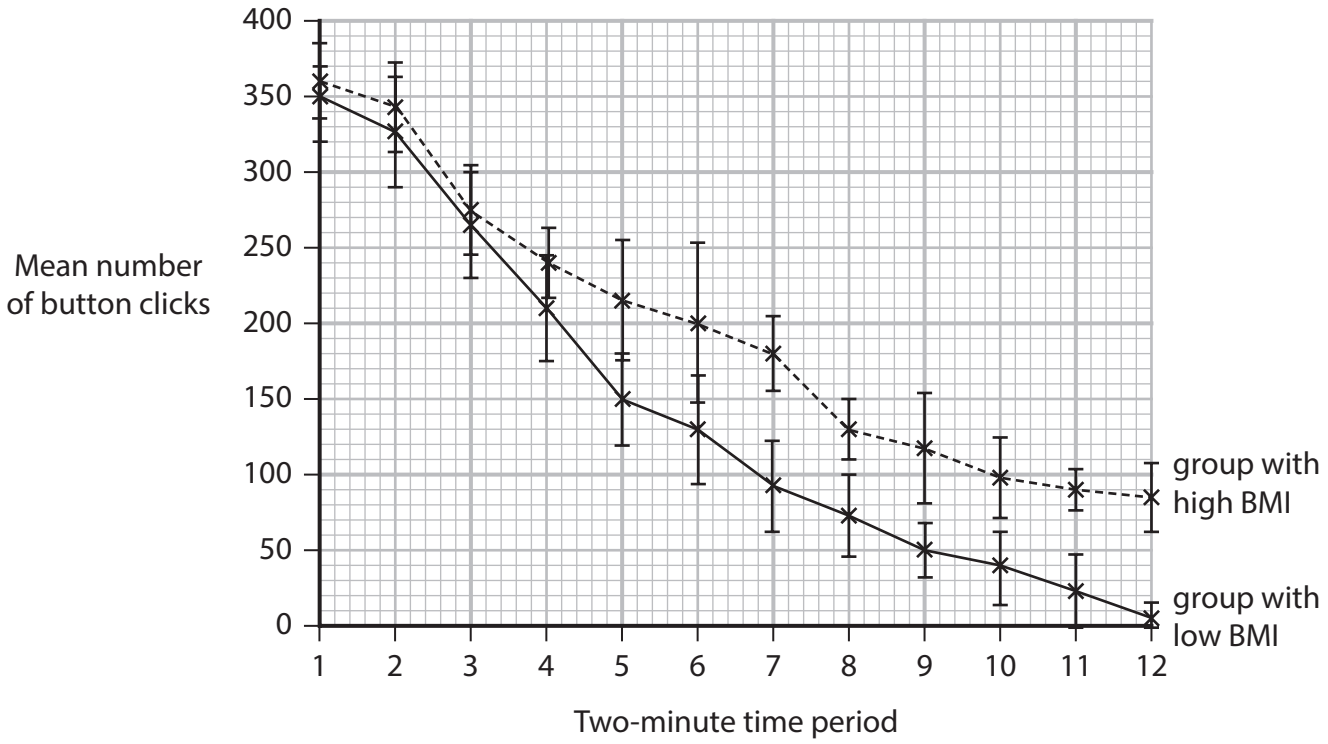
One group of children had a low body mass index (BMI) and another group had a high BMI.

Every two-minute period, each child was shown a picture of some food and allowed to request the food by clicking a button.

The children were not given the food.

For 24 minutes, the number of button clicks in each two-minute period was recorded.

The graph shows the results of this investigation.



(i) It was suggested that these results can be explained by habituation.

Explain why these results might be due to **habituation**.

(2)

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(ii) Calculate the percentage difference in button clicks for the sixth two-minute period.

Use the equation:

$$\text{percentage difference} = \left(\frac{\text{difference for two values}}{\text{mean of the two values}} \right) \times 100$$

Give your answer to two significant figures.

(2)

Answer ..... %

(iii) Comment on the difference between the two BMI groups shown in the graph.

(3)

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(Total for Question 6 = 13 marks)

7 Tissues of the skeletal system are required for movement.

(a) Muscle tissues are formed from different types of fibres.

(i) Describe how the structure of fast-twitch fibres is adapted for stronger and more rapid contraction than slow-twitch fibres.

(3)

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(ii) Myocytes are pluripotent stem cells that can differentiate into different muscle tissues.

The cells in slow-twitch and fast-twitch muscle tissues contain different myosin proteins.

Muscle tissues are made of different types of fibre. Each type of fibre has a different form of myosin.

The table shows information about these muscle tissues.

Muscle tissue	Types of fibre	Forms of myosin
slow-twitch	type I	M7
fast-twitch	type 2a	M2
	type 2x	M1
	type 2b	M4

Explain how a myocyte can differentiate into muscle cells that contain different forms of myosin protein.

Use the information in the table to support your answer.

(3)

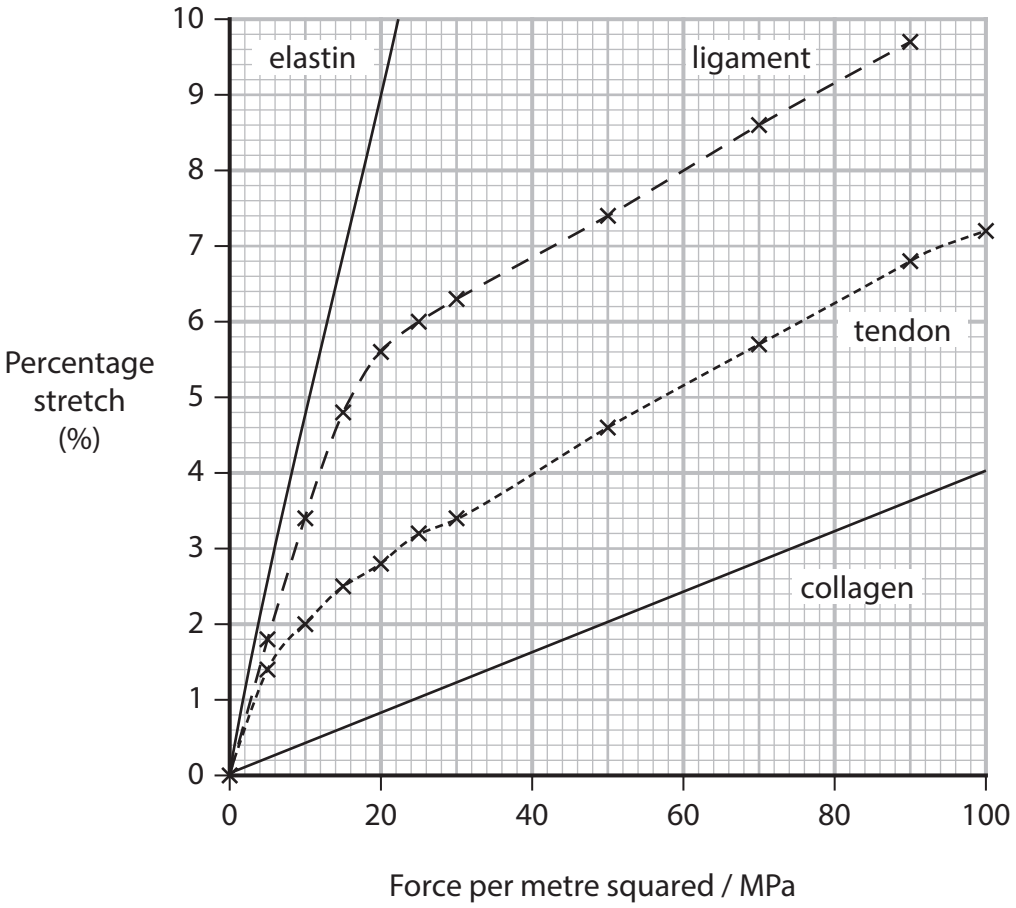
(b) The main components of ligaments and tendons are collagen and elastin.

In an investigation, the elastic properties of a ligament and a tendon were compared with those of pure collagen and pure elastin.

The table shows the collagen and elastin composition of ligaments and tendons.

Structure	Percentage composition (%)	
	Collagen	Elastin
ligament	70 to 80	10 to 15
tendon	75 to 85	< 3

The graph shows the force required to stretch each material.



(i) Calculate the ratio of the slopes for elastin and collagen.

(2)

Answer .....: 1

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(ii) Explain how the composition of ligaments and tendons contributes to their function.

Use the information in the table and the graph to support your answer.

(4)

(Total for Question 7 = 12 marks)

8 The scientific document you have studied is adapted from articles in Popular Science: *Why fruit bats can eat tons of sugar without getting diabetes* and *How do bats stay cancer-free? The answer could be lifesaving for humans.*

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

(a) While fruit bats eat a lot of sugar, 'genetic adaptations have helped keep their sugary diets from becoming harmful' (paragraph 1).

State what is meant by the term **genetic adaptations**.

(2)

(b) Explain why the pancreas can be described as an organ that controls blood sugar (paragraph 4).

(3)

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(c) Describe how the kidneys 'trap scarce salts and electrolytes' (paragraph 6).

(2)

(d) 'The organisation of the DNA around the insulin and glucagon genes was very clearly different between the two bat species.'

This is an example of epigenetic modification.

Explain how the organisation of DNA around these genes could affect gene transcription (paragraph 8).

(3)

(e) Suggest how some bats are able to suck blood without the blood coagulating (paragraph 13).

(2)

(f) 'Mammalian immune systems evolve fast as species are always challenged with new pathogens' (paragraph 15).

Explain why constant challenge with new pathogens could cause the rapid evolution of the mammalian immune system.

(3)

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(g) Describe how interferons help resist viral infections (paragraphs 19 and 20).

(2)

(h) Explain how scientists could 'learn which genes drive bats' 20- to 30-year lifespans' (paragraph 22).

(3)

(Total for Question 8 = 20 marks)

TOTAL FOR PAPER = 90 MARKS

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Biology

International Advanced Level

UNIT 5: Respiration, Internal Environment, Coordination and Gene Technology

Scientific article for use with Question 8

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Scientific document for use with Question 8

Article 1



(Source: © Eyepix Group / Contributor (Ed))

Fruit bats hanging on tree branches in daylight in Bangladesh on November 6, 2023.

1. Some fruit bats eat up to twice their body weight in sugary mangoes, bananas, or figs every day to not only survive, but thrive. Unlike humans, these flying mammals can have an essentially permanent sweet tooth and do not develop some of the negative health consequences such as diabetes. A study published January 9 in the journal Nature Communications found that genetic adaptations have helped keep their sugary diets from becoming harmful.

2. The study could have future implications for treating diabetes, which affects an estimated 38 million Americans, according to the Centers for Disease Control and Prevention (CDC). It is the eighth leading cause of death in the United States and the leading cause of kidney failure, lower-limb amputations, and adult blindness.

3. "With diabetes, the human body can't produce or detect insulin, leading to problems controlling blood sugar," study co-author and University of California, San Francisco geneticist Nadav Ahituv said in a statement. "But fruit bats have a genetic system that controls blood sugar without fail. We'd like to learn from that system to make better insulin- or sugar-sensing therapies for people."

Fruit bats vs. insect bats

4. Every day, fruit bats wake up after about 20 hours of sleep and feast on fruit before returning back to their caves, trees, or human-built structures to roost. To figure out how they can eat so much sugar and thrive, the team in this study focused on how the bat pancreas and kidneys evolved. The pancreas is an abdominal organ that controls blood sugar.

5. Researchers compared the Jamaican fruit bat with an insect-eating bat called the big brown bat. They analyzed the gene expression–which genes were switched on or off–and regulatory DNA that controls gene expression.

To do this, the team measured both the gene expression and regulatory DNA present in individual cells. These measurements show which types of cells primarily make up the bat's organs and also how these cells regulate the gene expression that manages their diet.

6. They found that the compositions of the pancreas and kidneys in fruit bats evolved to accommodate their sugary diet. The pancreas had more cells to produce insulin, an essential hormone that tells the body to lower blood sugar. It also had more cells that produce another sugar-regulating hormone called glucagon. The fruit bat kidneys had more cells to trap scarce salts and electrolytes as they filter blood.

Changes in DNA

7. Taking a closer look at the genetics behind this, the team saw that the regulatory DNA in those cells had evolved to switch the appropriate genes for fruit metabolism on or off. The insect-eating big brown bats had more cells that break down protein and conserve water and the gene expression in these cells was calibrated to handle a diet of bugs.

8. "The organization of the DNA around the insulin and glucagon genes was very clearly different between the two bat species," study co-author and Menlo College biologist Wei Gordon said in a statement. "The DNA around genes used to be considered 'junk,' but our data shows that this regulatory DNA likely helps fruit bats react to sudden increases or decreases in blood sugar."

9. While some of the fruit bat's biology resembled what is found in humans with diabetes, the bats are not known to have the same health effects.

10. "Even small changes, to single letters of DNA, make this diet viable for fruit bats," said Gordon. "We need to understand high-sugar metabolism like this to make progress helping the one in three Americans who are prediabetic."

Studying bats for human health

11. Bats are one of the most diverse families of mammals and everything from their immune systems to very particular diets are considered by some scientists to be examples of evolutionary triumph. This study is one of recent examples of how studying bats could have implications for human health, including in cancer research and virus prevention.

12. For this study, Gordon and Ahituv travelled to Belize to participate in an annual Bat-a-Thon, where they took a census of wild bats and field samples. One of the Jamaican fruit bats that they captured at the Bat-a-Thon was used to study sugar metabolism.

13. "For me, bats are like superheroes, each one with an amazing super power, whether it is echolocation, flying, blood sucking without coagulation, or eating fruit and not getting diabetes," Ahituv said. "This kind of work is just the beginning."

Article 2



(Source: © YASSER AL-ZAYYAT / Contributor (Ed))

Egyptian fruit bats on a fruit feeder at a zoo

14. After getting bit by a bat bug at a recent conference, Armin Scheben had a literal and figurative itch to study bats. The blood-sucking insect is one of many disease-causing parasites that latch themselves onto the flying mammals—yet, bats rarely get sick in the same way humans do.

15. Mammalian immune systems evolve fast as species are always challenged with new pathogens in their environment. "You need to constantly keep pace with new bad guys that are trying to infect and hurt you," says Scheben, who is a postdoctoral fellow in population genomics at Cold Spring Harbor Laboratory (and has since recovered from the bite). And while he has studied the genetic adaptations of several mammals, they pale in comparison to the ones that have given bats the ability to fight off infections so effectively.

16. In a new study published today in the journal Genome Biology and Evolution, Scheben and his team have identified the genes that have contributed to bats' rapidly evolving immune system and their unique ability to evade deadly viruses and even cancer. Understanding how bats survive diseases could inspire new immune treatments for humans and potentially help prevent another pandemic.

17. The authors analyzed the DNA of 15 different bat species to get a clearer picture of how their genes evolved over time. They fully sequenced the genomes of two bat species, the Jamaican fruit bat and the Mesoamerican mustached bat, and gathered the other species from preexisting datasets.

18. They then compared the bat genomes to that of humans, mice, and other cancer-susceptible mammals, focusing their attention on the sequences that encode proteins responsible for causing or preventing diseases.

To start, they lined up the homologous genes, or shared genes among different species inherited from a shared evolutionary ancestor. (It's like comparing apples with apples, explains Scheben.) With each homologous gene, they hypothesized two scenarios: if bats lost it or if it mutated. If the flying mammals completely lost the gene, it suggests that the omission is important in fighting disease. But if it remained with subtle changes in the DNA sequence that are only found in bats, it could show a change in gene function that somehow helps the group stay healthy.

19. In the end, the most striking changes the team detected were in type one interferon (IFN) genes, which are important for controlling inflammatory responses to infections. Specifically, they observed a shift in the number of antiviral IFN-α and IFN-ω genes. For instance, three bat species seemed to have lost all of their IFN-α while increasing the number of IFN-ω genes.

20. According to Scheben, the most surprising finding was observing the loss of IFN-α and addition of more IFN-ω genes, "which hadn't been reported at all before." The results suggest the new IFN-ω and missing IFN-α genes are important in bats for resisting viral infections while preventing overactive inflammatory responses—a feature that has made inflammation a double-edged sword in humans.

21. But while the findings have put geneticists one step closer to understanding how bats evolved their unique ability to resist cancer and viruses, it doesn't paint a complete picture. The study focuses only on the genetics of innate immunity (the immediate immune response to infected cells), says Tony Schountz, a professor at the Center for Vector-Borne Infectious Diseases at Colorado State University, who was not involved in the study. It does not include information about bats' adaptive immunity, which consists of the antibody and T-cell responses that many mammals use to fight diseases. "These are two very different but complementary components of immunity," Schountz explains. "Nearly all of the focus on bat immunity to date has been on innate immunity, principally because the study of adaptive immunity requires live animals, which few groups have and is much more complicated."

22. Even without a full set of information, understanding the changes in the bats' innate immune system could help scientists develop genetic treatments for humans that decrease susceptibility to certain illnesses. We can also learn which genes drive bats' 20- to 30-year lifespans, or how their bodies have adapted to process sugar-rich foods without developing the negative consequences seen in people with diabetes.

23. And though bats have gained a notorious reputation for their purported role in spreading COVID, Scheben hopes that these new findings could point researchers in the right direction in understanding how the animals host such potent viruses and parasites without getting very sick. One day, he says, that information could be used to prevent our species from suffering major symptoms when infected. "It's absolutely not misplaced to believe that studying bats could help us prevent another pandemic."

GradeMax

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Sources:

Article 1
Magazine: Popular Science
Article: Why fruit bats can eat tons of sugar without getting diabetes by Laura Baisas
09/01/2024

Article 2
Magazine: Popular Science
Article: How do bats stay cancer-free? The answer could be lifesaving for humans. By Jocelyn SoliaMoreira
21/09/2023