



National  
Qualifications  
2024

**X807/77/02**

**Biology**  
**Section 1 — Questions**

WEDNESDAY, 15 MAY  
9:00 AM – 12:00 NOON

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Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X807/77/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

Before leaving the examination room you must give your question and answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.



**SECTION 1 — 20 marks**

**Attempt ALL questions**

1. Which technique could be used to quantify the concentration of a pigmented compound extracted from plant tissue?

A Centrifugation  
B Colorimetry  
C Electrophoresis  
D Immunoassay

2. Following digestion, the sugar fructose is absorbed from inside the intestine into the cells that line the intestine. Fructose moves from a high concentration to a low concentration into the intestinal cells via a transmembrane protein. Fructose binds directly to the protein causing a conformational change that moves the fructose molecule through the membrane and releases it inside the cell.

Which of the following matches the mechanism of fructose transport described?

A Facilitated diffusion via a channel  
B Active transport via a transporter  
C Facilitated diffusion via a transporter  
D Facilitated diffusion via a symporter

3. The statements refer to steps in signalling pathways.

1. The hormone binds to a receptor protein in the cell membrane.
2. The hormone binds to a receptor protein in the nucleus or cytoplasm of the cell.
3. The hormone-receptor complex binds to DNA.
4. The activated receptor results in a G-protein relaying the signal to a target protein.

Which of these statements would refer to a signalling pathway for a steroid hormone?

A 1 and 3 only  
B 2 and 3 only  
C 1 and 4 only  
D 2 and 4 only

4. An investigation was carried out into the effect of changing light intensity on the growth of tomato plants. Plants were placed under different intensities of light, and their growth was determined by measuring the length and dry mass of the plants.

Which row in the table describes features of this investigation?

	Independent variable	Investigation is multi-factorial
A	discrete	yes
B	continuous	no
C	discrete	no
D	continuous	yes

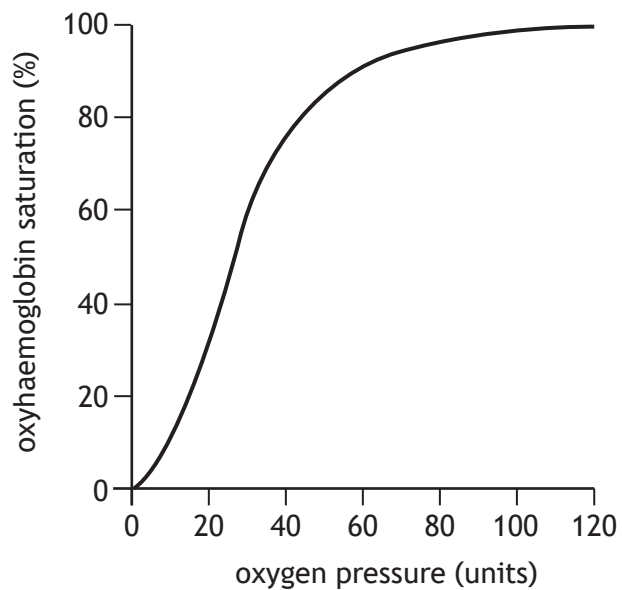
5. A researcher studying a protein with an isoelectric point of pH 8.2 wanted to separate it from a mixture of proteins and determine its molecular mass (size). A solution containing the mixture of proteins was adjusted to pH 8.2 then centrifuged.

The most appropriate next steps would be to

- A collect the protein from the pellet and carry out SDS-polyacrylamide electrophoresis (SDS-PAGE)
- B collect the protein from the supernatant and carry out SDS-polyacrylamide electrophoresis (SDS-PAGE)
- C collect the protein from the pellet and carry out native gel electrophoresis
- D collect the protein from the supernatant and carry out native gel electrophoresis.

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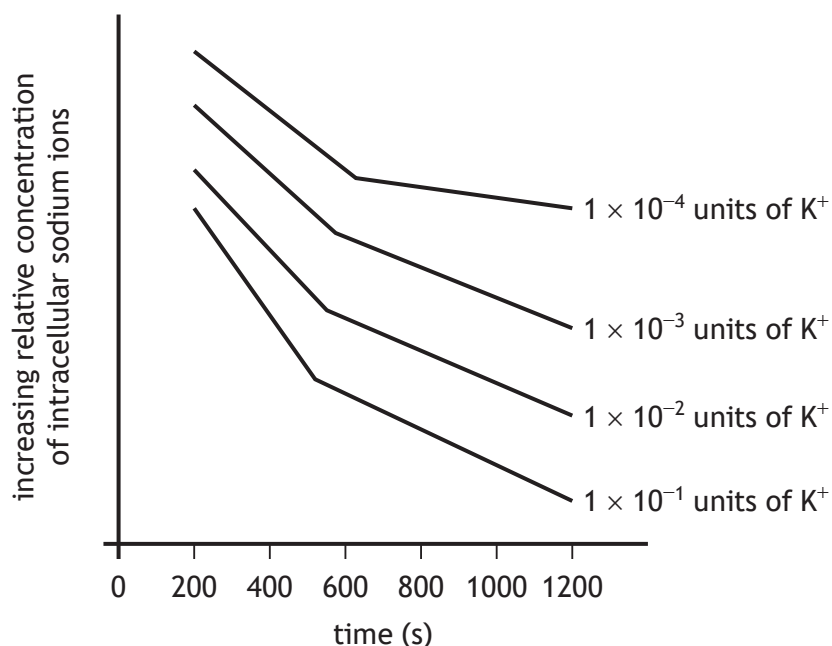
6. The figure shows the normal oxygen dissociation curve for haemoglobin.



Which row in the table shows the direction of shift in the oxygen dissociation curve as a result of changes in pH and temperature?

	Shift of curve	Change in pH	Change in temperature
A	left	decrease	increase
B	right	increase	increase
C	left	increase	decrease
D	right	decrease	decrease

7. The figure shows how the concentration of potassium ions ( $K^+$ ) in the extracellular environment affects the relative concentration of sodium ions inside a mammalian cell over time.



The following statements refer to the data in the figure.

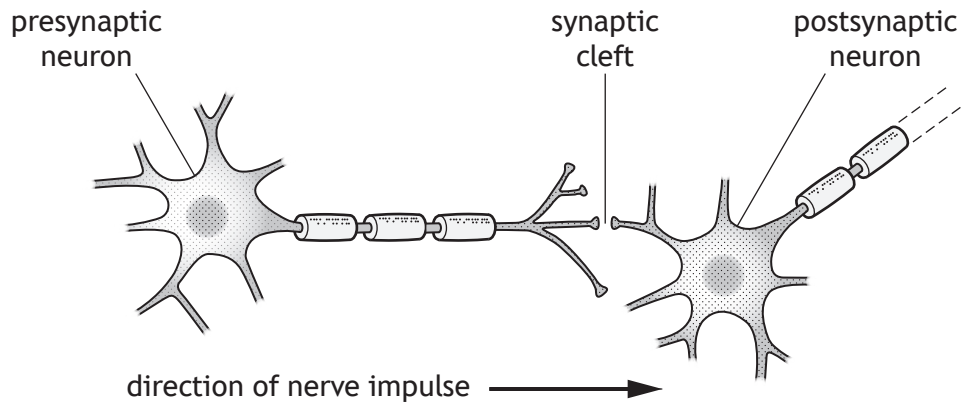
1. As the concentration of extracellular potassium ions decreases the relative concentration of intracellular sodium ions decreases.
2. The effect of changing the concentration of extracellular potassium ions decreases with time.
3. As the time in extracellular potassium ions increases the relative concentration of intracellular sodium ions decreases.
4. The relative concentration of intracellular sodium ions decreases more at higher concentrations of extracellular potassium ions.

Which of these statements are valid conclusions supported by the data shown?

- A 1 and 3 only  
B 2 and 3 only  
C 2 and 4 only  
D 3 and 4 only

[Turn over

8. The diagram shows two neurons and a synapse.



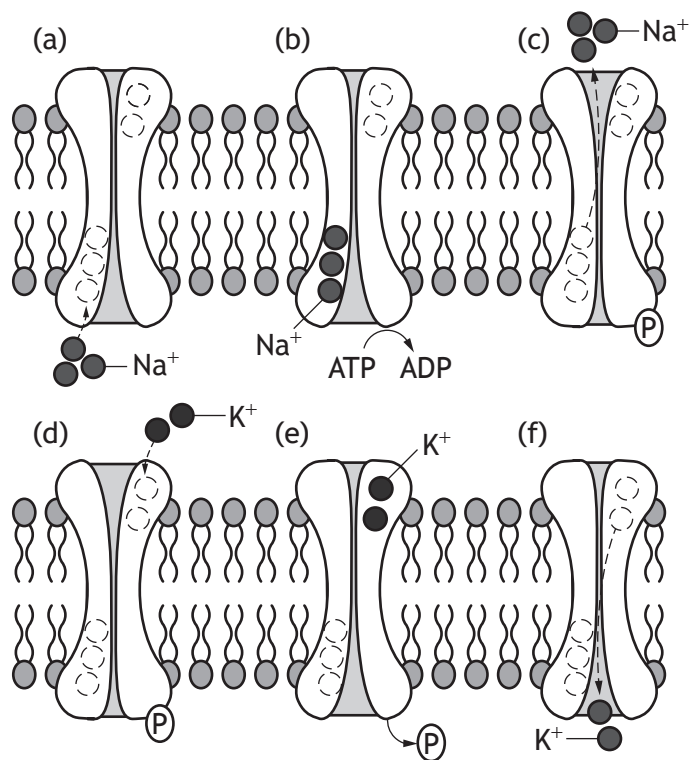
The following events occur during the transmission of a nerve impulse from one neuron to the next:

1. The neurotransmitter binds to its receptor.
2. Voltage-gated sodium channels open and sodium ions diffuse into the cell causing local depolarisation.
3. Vesicles containing the neurotransmitter fuse with the membrane.
4. Ligand-gated ion channels open.
5. The neurotransmitter diffuses across the synaptic cleft.

The correct order of events is

- A 5, 3, 4, 1, 2
- B 3, 5, 1, 4, 2
- C 3, 5, 1, 2, 4
- D 5, 3, 1, 4, 2

9. The diagram represents the stages in the operation of the sodium potassium pump.



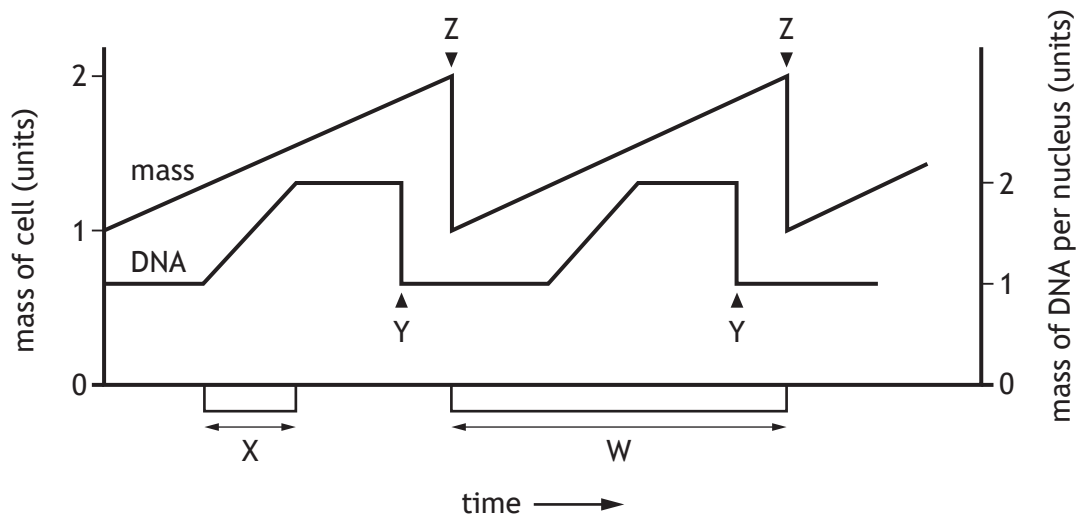
The pump is able to complete 150 cycles per second and each human red blood cell has around 200 sodium potassium pump proteins in its cell membrane.

Calculate the number of sodium ions that a red blood cell would be able to transport across the membrane in one minute.

- A  $2.7 \times 10^4$
- B  $9.0 \times 10^4$
- C  $1.8 \times 10^6$
- D  $5.4 \times 10^6$

[Turn over

10. The diagram shows the changes in cell mass and DNA content in a cell during two mitotic cell divisions.



Which row in the table identifies the cellular events labelled W, X, Y or Z in the diagram?

	Telophase	Cytokinesis	DNA replication
A	X	Y	W
B	Y	Z	W
C	Y	Z	X
D	Z	W	X

11. The ship rat (*Rattus rattus*) is an invasive species in New Zealand and threatens critically endangered bird life.

An elimination programme has been developed to reduce the size of the ship rat population on the islands. Scientists estimated the population size of the rats throughout the programme by using mark and recapture techniques.

Which of the following is **not** an assumption of the mark and recapture technique?

- A The ship rat population will increase due to their rapid reproduction rate.
- B The marked and released rats can mix fully with the total ship rat population.
- C None of the ship rats have left the survey area.
- D Every ship rat in the population has an equal chance of being captured during the sample.



12. Some stages of Meiosis I are described in the statements:

1. Sections of DNA are exchanged between non-sister chromatids.
2. Homologous chromosomes pair.
3. Chiasmata formation occurs.
4. Independent assortment of chromosomes occurs.
5. The chromosomes of each homologous pair separate.

The correct sequence of these stages in Meiosis I is

- A 2, 3, 1, 4, 5
- B 2, 5, 1, 3, 4
- C 3, 1, 2, 4, 5
- D 3, 1, 2, 5, 4

13. Which of the following is a correct statement about X chromosome inactivation?

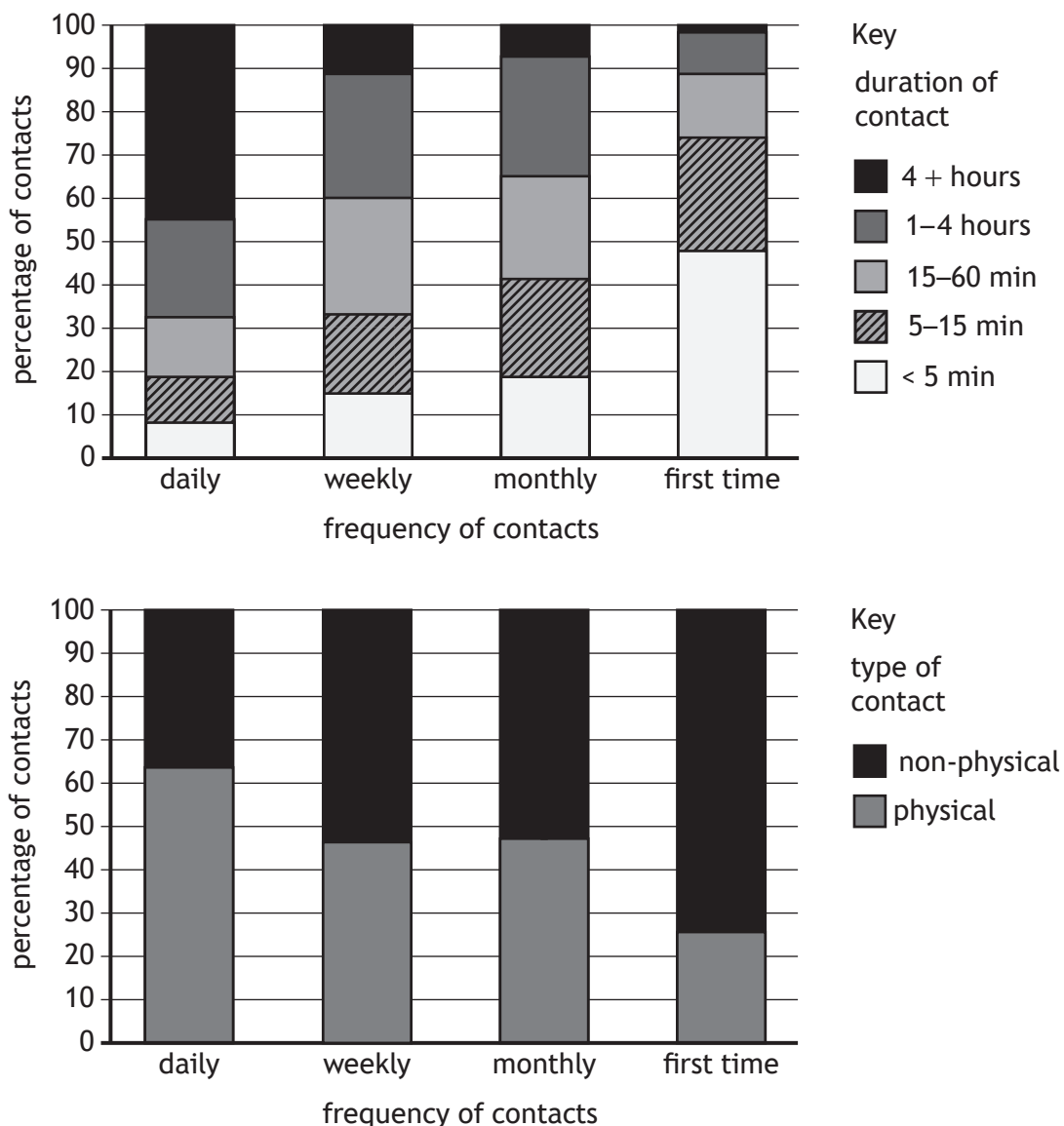
- A It is the cause of the Y chromosome being genetically inactive.
- B In females, it prevents the expression of harmful alleles present on the X chromosome.
- C The X chromosome inherited from the mother is active in all female cells.
- D It ensures the amount of protein encoded by X chromosomes in females is approximately equal to that of males.

[Turn over

14. A survey was conducted to predict the susceptibility of people to airborne infectious diseases during a pandemic. The survey examined the daily patterns of social contacts between 7000 individuals.

The frequency and duration of the interactions between an individual and each of their contacts, and whether it involved a physical or non-physical interaction, were recorded.

The results are shown in the graphs.



Which of the following observations is supported by these data?

- A Daily contacts are likely to be the longest but least likely to be physical.
- B First time contacts are the least likely to be physical and also likely to be the briefest.
- C Daily contacts are likely to be the shortest but more likely to be physical than less frequent contacts.
- D Weekly contacts are more likely to be physical than monthly contacts and likely to last longer.

15. A population of beetles was sampled by four different researchers. Each calculated the mean and variation in length of 85% of the sample. The whole population contained 362 beetles, with a combined body length of 6.878 m and a range in length of 1.1 cm for 85% of the population.

Which researcher has the most representative sample?

Researcher	Sample size	Mean body length (cm)	Variation in length of 85% of sample (cm)
A	105	1.9	1.6–2.0
B	84	1.7	1.2–2.3
C	128	1.8	1.4–2.5
D	273	1.9	1.3–2.4

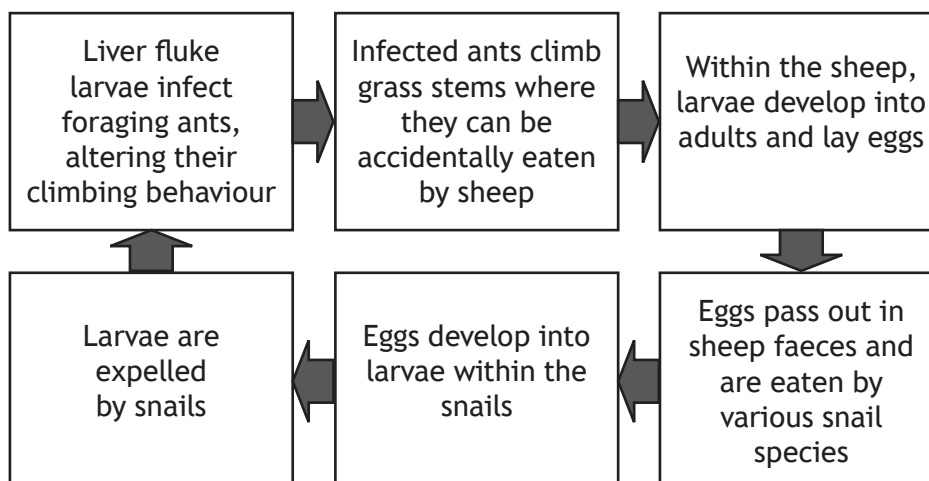
16. The table shows monthly samples of four species of copepods (small crustaceans) found in the surface layers of the North Atlantic Ocean.

Which species shows the lowest percentage change between March and July?

Species	Number caught per sample				
	March	April	May	June	July
A	95	100	110	20	100
B	95	70	80	30	80
C	120	140	180	150	110
D	105	100	110	100	120

[Turn over

17. The chart outlines the life cycle of a parasitic liver fluke.



Which of the following statements is correct for this life cycle?

- A Larvae are vectors
  - B Sheep are intermediate hosts
  - C Ants are intermediate hosts
  - D Snails are definitive hosts
18. A drug, used for the emergency treatment of a life-threatening condition, moderately increased survival in the short term but could also cause severe and life changing side effects.

To determine if the use of the drug should be discontinued, a study was proposed in which healthcare staff responding to medical emergencies for this condition would administer either an injection of the drug or a placebo. Healthcare staff would be unaware which injection had been administered, and patients would be assigned numbers designated on the injections given. After recovery from the immediate medical emergency, patients would be told about the study and its purpose and would be given the option to withdraw their data.

Why might this study be considered unethical?

- A The study had not been justified in terms of the benefits of its outcomes.
- B Informed consent was not obtained.
- C The drug causes severe and life changing side effects.
- D Confidentiality was not maintained.

19. Which of the following is the same for a **secondary** immune response?

- A Speed of antibody production
- B Antibody concentration in blood
- C Antigen triggering response
- D Duration of response

20. *Bent-tail* is an inherited condition in mice that causes them to have short, crooked tails. The gene responsible is sex-linked, and the allele for bent-tail ( $X^B$ ) is dominant to the allele for normal tail ( $X^b$ ).

If a male mouse with bent-tail is crossed with a heterozygous female mouse, the expected proportion of female mice with normal tails would be

- A 0.0
- B 0.25
- C 0.5
- D 0.75

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2  
OF YOUR QUESTION AND ANSWER BOOKLET.]

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