

BIOLOGICAL MOLECULES

Inorganic Ions EXAM Q&A

Q1.

The table below shows information about two types of medicine.

Name of medicine	Mass of medicine in one tablet / mg	Maximum dose of medicine an adult is allowed	Mass of sodium in one tablet / g
Aspirin	300	0.6 g every 4 hours	0.15
Paracetamol	500	1.0 g every 6 hours	0.43

(a) A journalist studied the data in the above table. She made the following suggestion.

'If an adult takes the maximum number of tablets allowed for **either** of the medicines, then the person would have more than the RDA of sodium.'

The RDA (recommended daily allowance) of sodium for an adult human is 2.4 g per day.

Is the journalist's statement true for **both** of the medicines in the above table?

Use suitable calculations to support your answer.

Show your working.

(2)

Doctors investigated the link between high sodium concentrations in medicines and hypertension (high blood pressure).

They analysed medical records of patients. 1 292 337 of these patients had taken

medicines containing high sodium concentrations. Each of these patients was paired with a patient from a control group.

- (b) Give **two** factors that should have been the same for each pair of patients and **one** factor that should have been different.

Same factor 1 _____

Same factor 2 _____

Different factor _____

(2)

- (c) Doctors found:

- 4.73% of the patients who had taken medicines containing high sodium concentrations suffered from hypertension
- there were 7.18 times fewer control patients with hypertension.

Calculate how many of the control patients had hypertension.

Show your working.

Answer _____ patients

(2)

- (d) A high concentration of sodium in the blood can affect blood volume and cause hypertension.

Use your knowledge of water potential to suggest how high sodium concentrations in the medicines taken could affect blood volume.

(3)
(Total 9 marks)

Q2.

- (a) Describe the roles of iron ions, sodium ions, and phosphate ions in cells.

(5)

- (b) The movement of substances across cell membranes is affected by membrane structure. Describe how.

(5)
(Total 10 marks)

Q3.

Write an essay on the importance of diffusion in organisms.

(Total 25 marks)

Q4.

Water and inorganic ions have important biological functions within cells.

- (a) Give **two** properties of water that are important in the cytoplasm of cells. For each property of water, explain its importance in the cytoplasm.

Property 1 _____

Biological importance within cells _____

Property 2 _____

Biological importance within cells _____

(4)

- (b) Other than sodium, name **one** inorganic ion and give **one** example of its biological importance in a cell.

Name of inorganic ion _____

Biological importance _____

(2)

- (c) Compare and contrast the processes by which water and inorganic ions enter cells.

(3)
(Total 9 marks)

Q5.

Write an essay on the importance of ions in biology.

(Total 25 marks)

Q6.

(a) Discs of carrot were placed in a solution containing potassium ions (K^+). The concentration of oxygen in air bubbled through the solution was changed and the rates of respiration and uptake of potassium ions were measured. The results are shown in the table.

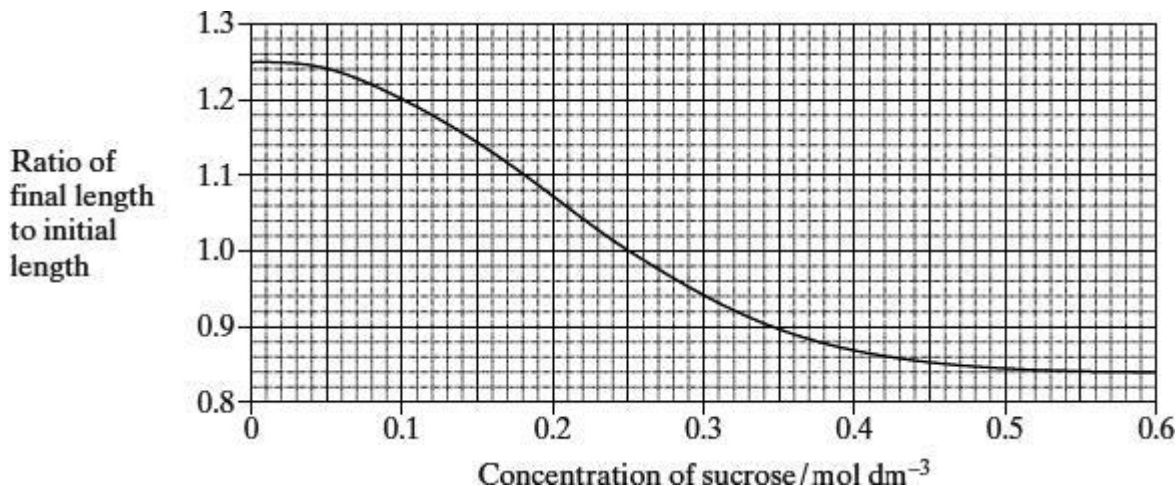
Concentration of oxygen / %	Rate of respiration / arbitrary units	Rate of uptake of potassium ions / arbitrary units
2.7	31	29
12.2	69	72
20.8	90	80

Describe and explain the link between oxygen concentration, rate of respiration and rate of uptake of potassium ions.

(4)

(b) Cylinders of potato were cut using a cork borer. Their initial lengths were measured. Each cylinder was then put in a different concentration of sucrose

solution for 12 hours. The graph shows the changes in length of the potato cylinders in the different sugar solutions.



- (i) In what concentration of sucrose did the length of the potato cylinder remain the same?

(1)

- (ii) The initial length of the potato cylinder in the solution of concentration 0.1 mol dm⁻³ was 90 mm. Calculate its final length. Show your working.

Final length = _____ mm

(2)

- (iii) Explain the change in length which occurs in a sucrose solution of concentration 0.5 mol dm⁻³.

(2)

(Total 9 marks)

Q7.

Inorganic ions include those of sodium, phosphorus and hydrogen. Write an essay to describe how these and other inorganic ions are used in living organisms.

(Total 25 marks)

Mark schemes

Q1.

- (a) 1. (No for aspirin) 1.8 g;
Accept for one mark evidence of 1.8 and 3.44 but no/wrong stated units
Accept maximum dose of aspirin has 0.6 g less than RDA
2. (Yes for paracetamol) 3.44 g;
Accept maximum dose of paracetamol has 1.04 g more than RDA

2

(b) **Same**

Accept any **two** of the following for **one** mark

1. BMI, age, sex/gender, other/previous medications, ethnicity, diet, exercise, health (issues)
Ignore weight

Different

2. No sodium in the (same) medicine;
Ignore placebo
Ignore 'salt' for sodium
Accept concentration of sodium in medicine

2

(c) Correct answer of 8513/8514 for **2 marks**;;

Allow 1 mark for 61 127(.5401) in answer

Incorrect answer but shows sequence of 8513(6) with decimal point in any position = 1 mark

2

- (d) 1. (Sodium ions) lower the water potential (of blood);
Accept make the blood water potential more negative
Accept decrease the blood water potential
2. Water would move into the blood by osmosis (from cells/tissue fluid);
3. Increasing the blood volume;

3

[9]

Q2.

(a)

Must have MP1 for 5 max
3 max for sodium and 3 max for phosphate

Iron ions

1. Haemoglobin binds/associates with oxygen
OR
Haemoglobin transports/loads oxygen;
Ignore reference to 2⁺ or 3⁺ in Fe²⁺ or Fe³⁺

Sodium ions

2. Co-transport of glucose/amino acids (into cells);
3. (Because) sodium moved out by active transport/Na – K pump;
4. Creates a sodium concentration/diffusion gradient;
5. Affects osmosis/water potential;

Phosphate ions

6. Affects osmosis/water potential;
Accept 5. OR 6. – not both
7. Joins nucleotides/in phosphodiester bond/in backbone of DNA/RNA/in nucleotides;
8. Used in/to produce ATP;
Reject 'energy produced'
9. Phosphorylates other compounds (usually) making them more reactive;
10. Hydrophilic/water soluble part of phospholipid bilayer/membrane;
Accept for 1 mark,
Sodium ions cause water reabsorption in kidneys
OR
Sodium ions establish resting potential (in neurones)
OR
Sodium ion diffusion creates action potential

5 max

- (b)
1. Phospholipid (bilayer) allows movement/diffusion of non-polar/lipid-soluble substances;
1. and 2. Accept correct named examples
1. and 2. Ignore water
Accept phospholipid (bilayer) allows movement/diffusion of O₂/CO₂
Accept water-insoluble
 2. Phospholipid (bilayer) prevents movement/diffusion of polar/charged/lipid-insoluble substances
OR
(Membrane) proteins allow polar/charged substances to cross the membrane/bilayer;
Accept water-soluble
 3. Carrier proteins allow active transport;
 4. Channel/carrier proteins allow facilitated diffusion/co-transport;

Accept aquaporins allow osmosis

5. Shape/charge of channel / carrier determines which substances move;
6. Number of channels/carriers determines how much movement;
7. Membrane surface area determines how much diffusion/movement;
6. and 7. Accept correct reference to faster/slower/rate for 'how much movement'
Accept microvilli / Golgi (apparatus) / ER / rER
Accept surface area to volume for 'surface area'
8. Cholesterol affects fluidity/rigidity/permeability;
Accept cholesterol affects vesicle formation/ endocytosis/exocytosis/phagocytosis;

5 max

[10]

Q3.

21 – 25	<p>Extended abstract</p> <p>Generalised beyond specific context</p>	<p>Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question.</p> <p>Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.</p> <p>No significant errors or irrelevant material.</p> <p>For top marks in the band, the answer shows evidence of reading beyond specification requirements.</p>
16 – 20	<p>Relational</p> <p>Integrated into a whole</p>	<p>Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained.</p> <p>Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology.</p> <p>Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.</p>
11 – 15	<p>Multistructural</p> <p>Several aspects covered but they are unrelated</p>	<p>Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.</p> <p>Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology.</p>

		Some significant errors and, or, more than one irrelevant topic.
6 – 10	Unistructural Only one or few aspects covered	Response predominantly deals with only one or two topics that relate to the question. Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or, irrelevant topics.
1 – 5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. 'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the

and always clearly explained.	specification. Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at <u>A-level standard</u> .

Please note that to obtain full credit, students must use information to show **the importance of diffusion in organisms**.

Specification Reference	Topic Area
3.1.7 and 3.1.8	water and inorganic ions
3.2.3	transport across membranes
3.3.2	gas exchange
3.3.3	digestion and absorption
3.3.4.1	mass transport in animals
3.3.4.2	mass transport in plants
3.4.2	DNA and protein synthesis
3.5.1	photosynthesis
3.5.2	respiration
3.5.4	nutrient cycles

3.6.1.1	plant responses to stimuli
3.6.1.2	receptors
3.6.2.1	nerve impulses
3.6.2.2	synaptic transmission
3.6.3	muscle contraction
3.6.4.1 and 4.2	control of blood glucose concentration
3.6.4.3	control of blood water potential

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q4.

- (a) 1. Polar molecule;
2. Acts as a (universal) solvent;

OR

3. (Universal) solvent;
4. (Metabolic) reactions occur faster in solution;

OR

5. Reactive;
6. Takes place in hydrolysis / condensation / named reaction;
Polar molecule so acts as (universal) solvent so (metabolic reactions are faster = 3 marks

4

- (b) Name of ion;

Correct function within cell;

Ions other than sodium in specification are H^+ , Fe^{2+} and PO_4^{3-} but accept any correct ion (other than sodium) plus relevant function = 2.

Allow ion to be named in words but not as element, e.g, iron ion but not iron.

2

- (c) 1. Comparison: both move down concentration gradient;
2. Comparison: both move through (protein) channels in membrane;
Accept aquaporins (for water) and ion channels
3. Contrast: ions can move against a concentration gradient by active transport

3

[9]

Q5.

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11 – 15	<p>Multistructural</p> <p>Several aspects covered but they are unrelated</p>	<p>Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.</p> <p>Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology.</p> <p>Some significant errors and, or, more than one irrelevant topic.</p>
6 – 10	<p>Unistructural</p> <p>Only one or few aspects covered</p>	<p>Response predominantly deals with only one or two topics that relate to the question.</p> <p>Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology.</p>

		May contain a number of significant errors and, or, irrelevant topics.
1 – 5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
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The importance of ions in biology.

Topics

P	3.1.3. and 3.2.2.	Phosphate in structure of phospholipids, structure of membranes, nucleotides, DNA and RNA
T	3.1.3 3.1.3	Water potentials and osmosis, chloride ions and cholera Co-transport involving sodium ions
H	3.2.4.	Haemoglobin and iron
Tr	3.2.7.	Passage of water through plants, symplast and root pressure
Tr	3.4.1. 3.4.3.	ATP and ADP Protons in photosynthesis, including reduced NADP and phosphorylated intermediates
R	3.4.4. 3.4.4.	Protons in respiration, reduced NADS and FAD and phosphorylated intermediates Glycolysis and lactate
F	3.4.5. 3.4.6.	Use of (NPK) fertilisers Nitrogen cycle
N	3.5.1. 3.5.2.	Chemoreceptors, heart rate and Pacinian function Nerve impulses and synapses
M	3.5.3.	Calcium ions and muscle contraction, and phosphate from ATP
G	3.5.8.	Genetic fingerprinting, electrophoresis

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[25]

Q6.

- (a) greater rate of oxygen consumption / leads to greater rate of respiration and greater rate of uptake;

(allow this mark even if spread through account but cause and effect must be within the correct context)

oxygen required for respiration;
 respiration produces ATP / releases energy;
(ignore ref to producing or making energy)
 potassium ions taken up by active transport / against concentration gradient;

4

- (b) (i) 0.25 (mol dm⁻³);

1

- (ii) 1 mark Incorrect answer but derived from ratio of 1.2 and initial length of 90 mm
 2 marks Correct answer of 108 mm;

2

- (iii) water potential inside potato higher / less negative than in solution;
 water moves out by osmosis;

2

[9]

Q7.

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Inorganic ions include those of sodium, phosphorus and hydrogen.

Please note that to obtain full credit, students must use information to **describe how these and other inorganic ions are used in living organisms**.

Topics

3.1.3	Lipids
3.1.5	Nucleic acids are important information-carrying molecules
3.1.6	ATP
3.2.3	Transport across cell membranes
3.5.1	Photosynthesis
3.5.2	Respiration
3.5.4	Nutrient cycles
3.6.2	Nervous coordination

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[25]