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## GCE AS / A LEVEL – BIOLOGY UNIT 2 QUESTION PACK

1072-01 (Legacy BY2) · New spec Unit 2 Topic 9 · AS unit, first sat 2016, 80 marks, 1h 30min paper

# REVISE

.wales

## BIOLOGY – UNIT 2 · TRANSPORT IN ANIMALS & BLOOD, HAEMOGLOBIN & DISSOCIATION

### *BY2.2.5 Adaptations for transport in animals – blood vessels, haemoglobin and the oxygen dissociation curve*

*Structure and function of arteries, veins and capillaries, blood pressure profile along the circulation, the oxygen dissociation curve and the Bohr shift, plus comparative haemoglobins (e.g. foetal, llama).*

#### LEGACY 2008 SPECIFICATION

#### Estimated time for entire question pack: ~51 min

*Derived from the legacy BY2 paper's pace of ~1.1 min/mark, padded for long-prose answers (32 marks over 3 questions).*

*You are advised to **not** attempt to complete all of this in one sitting.*

#### ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC BY2 papers (2008 modular spec, 2011–2017) that maps onto new-spec AS Unit 2 Topic 9 (2.5).

Questions are ordered by source paper date.

#### INSTRUCTIONS

Use black ink or black ball-point pen. Show all working – quality of written communication will affect marks. A calculator is allowed. Diagrams included in answers must be fully annotated.

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Q	Source	Max	Mark
1	Jan 12 Q4	10	
2	Jan 13 Q5	10	
Total		32	

# Transport in Animals – Blood, Haemoglobin & Dissociation – what the new spec asks

WJEC GCE AS / A Level Biology (from 2015) · Unit 2: Biodiversity & Physiology of Body Systems · Topic 2.5.

## Blood vessels

- Arteries: thick muscular wall, narrow lumen, no valves.
- Veins: thin wall, wide lumen, valves prevent backflow.
- Capillaries: single endothelial cell layer, narrow lumen, no muscle.

## Blood pressure profile

- High and pulsatile in arteries → smoothed in arterioles.
- Falls along capillary bed; low and steady in veins.
- Venous return aided by skeletal muscle pump & valves.

## Haemoglobin

- Quaternary protein: 4 polypeptides, 4 haem groups ( $\text{Fe}^{2+}$ ).
- Cooperative binding gives sigmoidal  $\text{O}_2$  dissociation curve.
- Partial pressure (kPa) on x-axis; % saturation on y-axis.

## Bohr effect & variants

- $\uparrow \text{CO}_2$  /  $\downarrow \text{pH}$   $\Rightarrow$  curve shifts right  $\Rightarrow$  more  $\text{O}_2$  unloaded at tissues.
- Foetal Hb has higher  $\text{O}_2$  affinity than maternal  $\Rightarrow$  placental transfer.
- Llama, lugworm and high-altitude mammals show variant Hb curves.

# Transport in Animals – Blood, Haemoglobin & Dissociation in one page

Quick-reference notes – revisit before each question.

## Vessel structure

Artery: thick muscle + elastic; narrow lumen.

Vein: thin wall; wide lumen; valves.

Capillary: 1-cell endothelium; lumen ~RBC width.

## Blood pressure

Pulsatile in arteries (systolic / diastolic).

Smoothed in arterioles; lowest in venules / veins.

Aided by skeletal muscle pump & valves.

## Haemoglobin structure

4 polypeptide chains:  $2\alpha + 2\beta$ .

Each has a haem with  $\text{Fe}^{2+}$  binding one  $\text{O}_2$ .

Maximum 4  $\text{O}_2$  per Hb molecule.

## $\text{O}_2$ dissociation curve

Sigmoidal due to cooperative binding.

Plateau at high  $\text{pO}_2$  (lungs) – near saturation.

Steep at intermediate  $\text{pO}_2$  – large  $\text{O}_2$  release at tissues.

## Bohr shift

$\uparrow \text{CO}_2, \downarrow \text{pH} \Rightarrow$  curve shifts right.

Hb releases more  $\text{O}_2$  in actively respiring tissues.

Mechanism:  $\text{H}^+$  binds Hb, lowers  $\text{O}_2$  affinity.

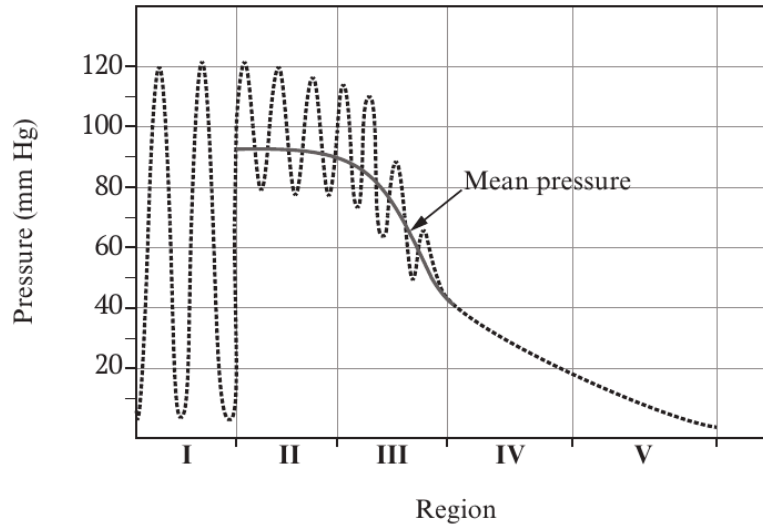
## Foetal & variant Hb

Foetal Hb:  $2\alpha + 2\gamma$  chains; higher  $\text{O}_2$  affinity.

Curve shifts left of maternal – allows placental  $\text{O}_2$  transfer.

Llama / high-altitude mammals: left-shifted curve.

4. (a) The graph below shows how the blood pressure changes as the blood is transported through the human circulatory system.



- (i) Region I of the graph shows the blood pressure in the left ventricle and region II shows the blood pressure in the aorta.

Explain fully the reasons for the differences in the maximum and minimum blood pressure in the left ventricle and the aorta.

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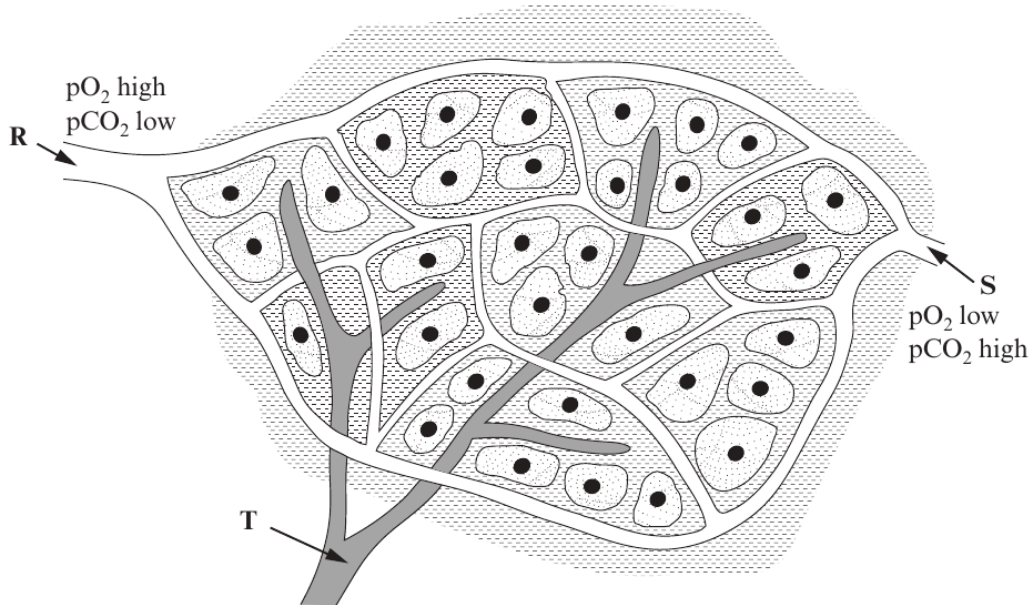
- (ii) Why does the blood pressure decrease so rapidly in region III?

[1]

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- (b) The diagram below shows the blood supply to the cells of the body tissues. The relative amounts of oxygen and carbon dioxide in the blood vessels are given.



- (i) Which of vessels **R** and **S** represents the arterial end of the blood supply to the tissues? Give a reason for your answer. [2]

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- (ii) Explain how differences in the hydrostatic and osmotic pressures between the arterial and venous ends of the blood supply results in the formation of tissue fluid. [3]

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- (iii) What is the function of the vessel labelled **T** in the diagram? [1]

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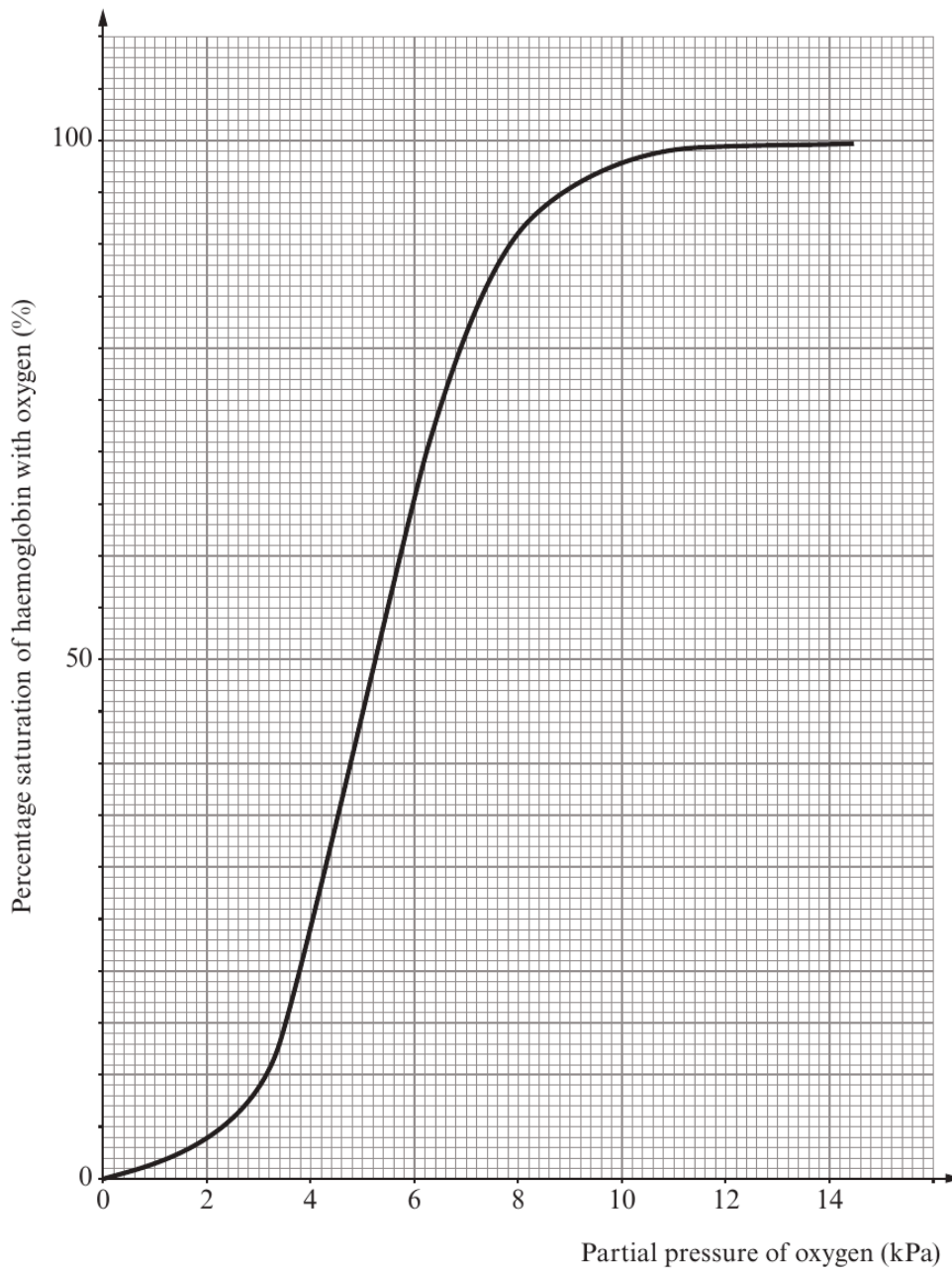
(Total 10 marks)

5. The graph below shows the relationship between partial pressure of oxygen and the percentage saturation of haemoglobin in the blood of a human **adult**.

(a) (i) State the name given to the curve shown on the graph below. [1]

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(ii) Draw another curve on the axes below showing the relationship for **human foetal** haemoglobin. [1]



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(iii) Explain the advantage of the position of the curve for **human foetal** haemoglobin. [2]

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(b) (i) What would happen to the curve for adult haemoglobin if the partial pressure of carbon dioxide increased? [1]

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(ii) What is the name of this effect? [1]

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(iii) Explain the mechanism and the significance of this effect during exercise. [4]

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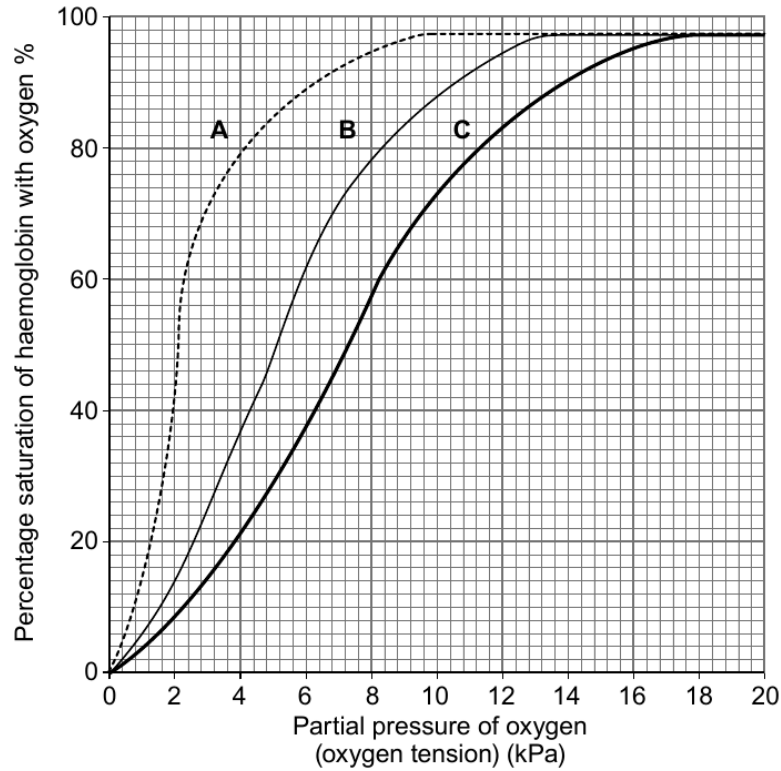
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3. (a) The graph below shows the oxygen dissociation curve for three mammals.

Graph **A** is the curve for a llama which is a mammal that lives at high altitudes. Graph **B** is the curve for a domestic cat and graph **C** is the curve for a mouse which is a small mammal with a high metabolic rate.



**Key:**

- A = llama
- B = domestic cat
- C = mouse

(i) What is the percentage saturation of the cat's haemoglobin with oxygen when the partial pressure of oxygen in the muscle tissue of a cat is 3.0kPa? [1]

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(ii) Explain the circumstances under which the partial pressure of oxygen may fall to 3.0kPa in muscle tissues. [2]

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(b) State which of the three curves represents the haemoglobin with the lowest affinity for oxygen at 3.0kPa. [1]

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(c) If the pH of the blood became more acidic, the position of curve **C** for the mouse would change.

(i) Draw on the graph opposite the new position of curve **C** when the blood becomes more acidic. [1]

(ii) Explain the benefits to the mouse of this change in position of curve **C**. [3]

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(d) Explain how curve **A** for the llama shows that its haemoglobin is well adapted for its environment. [3]

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(e) State which of the three curves could represent the oxygen dissociation curve of a lugworm. [1]

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**END OF QUESTION PACK**

3 questions · 32 marks · ~51 min

Source: WJEC BY2 (2008 modular spec, 2011–2017)

Curated for WJEC Biology 2015 spec AS Unit 2 – Topic 9 (2.5)

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