A-LEVEL BIOLOGY • EXERCISE SHEET

8.2 Transport of oxygen and carbon dioxide

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

Objective

Build the skills to answer exam questions on the **transport of oxygen and carbon dioxide** —the **oxygen dissociation curve** 氧解离曲线, the **Bohr shift** 波尔位移, and how carbon dioxide is carried.

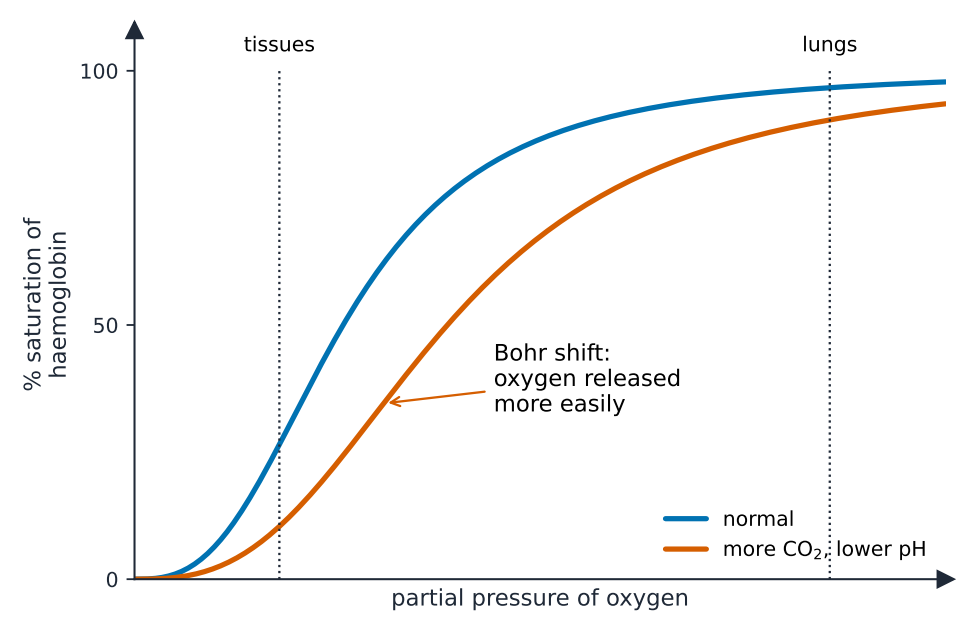
You must be able to:

- describe and explain the oxygen dissociation curve and its importance in the lungs and tissues
- describe and explain the Bohr shift
- describe carbon dioxide transport, including the **chloride shift** 氯转移

1 Worked examples

The oxygen dissociation curve

The S-shaped curve plots **saturation** 饱和度 of haemoglobin against the **partial pressure** 分压 of oxygen.



Haemoglobin loads O in the lungs (high pO) and unloads it in tissues (low pO); the Bohr shift moves the curve right

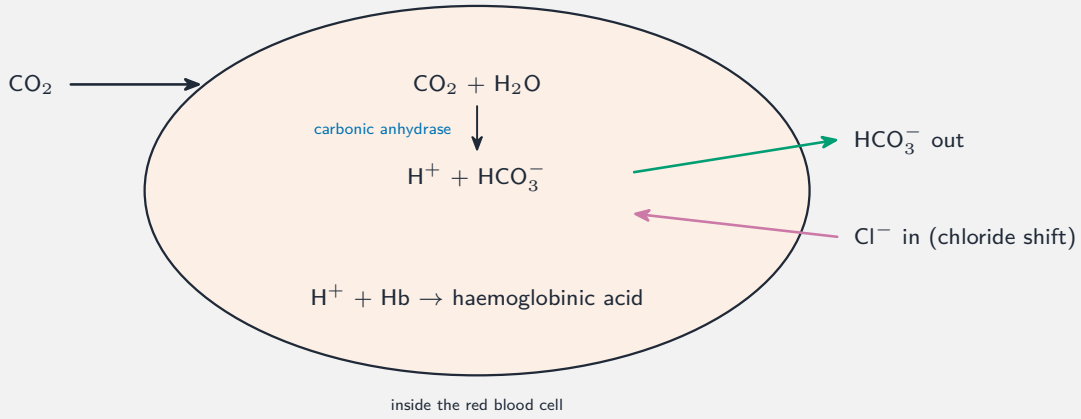
- in the lungs (high pO), haemoglobin becomes almost fully saturated (loads O).
- in respiring tissues (low pO), haemoglobin unloads O for the cells.

Reading the curve: O unloaded = saturation in lungs − saturation in tissues. E.g. 98% → 40% means 58% of the oxygen is released.

The Bohr shift

Active tissues make more **carbon dioxide** 二氧化碳, lowering pH; this makes haemoglobin release O more easily, so the curve shifts **right** —O is given up where it is most needed.

Carbon dioxide transport



Most CO travels as hydrogencarbonate ions; the chloride shift balances charge; haemoglobin mops up H

Most CO is carried as **hydrogencarbonate ions** 碳酸氢根离子: **carbonic anhydrase** 碳酸酐酶 catalyses CO + water → carbonic acid → H + HCO . HCO leaves the red cell and **chloride ions** move in (the chloride shift) to balance the charge; H binds haemoglobin (**haemoglobinic acid** 血红蛋白酸).

2 Practice

2.1 State where on the dissociation curve haemoglobin (a) loads oxygen and (b) unloads oxygen. [2]

2.2 Name the enzyme that catalyses the reaction of carbon dioxide with water. [1]

3 Exam-style questions

3.1 In which form is **most** carbon dioxide carried in the blood? [1]

- **A** dissolved in plasma
- **B** as hydrogencarbonate ions
- **C** as carbaminohaemoglobin
- **D** as carbonic anhydrase

3.2 The Bohr shift moves the oxygen dissociation curve to the right. This means that, at a given partial pressure of oxygen, haemoglobin: [1]

- **A** is more saturated with oxygen
- **B** releases oxygen more readily
- **C** carries more carbon dioxide directly
- **D** has a higher affinity for oxygen

3.3 Use the dissociation curve idea: in the lungs haemoglobin is 98% saturated; in an exercising muscle it falls to 25%.

(a) Calculate the percentage of oxygen unloaded to the muscle. [1]

(b) Explain how the Bohr shift increases the oxygen delivered to exercising muscle. [3]

3.4 Explain the importance of the chloride shift. [2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **8.2 Transport of oxygen and carbon dioxide** past-paper sheet in the Library, or try these in **Practice mode**:

- 9700/12 N25 —Q33 (oxygen dissociation)

- 9700/14 N25 —Q33 (carbon dioxide transport)
- 9700/21 N25 —Q2 (gas transport, calculation)
- 9700/22 N25 —Q6 (gas transport, calculation)

Solutions

2.1 (a) at high partial pressure of oxygen (in the lungs); (b) at low partial pressure of oxygen (in respiring tissues).

2.2 carbonic anhydrase.

3.1 B. Most CO is carried as hydrogencarbonate ions.

3.2 B. Shifting right means lower affinity, so haemoglobin releases oxygen more readily.

3.3 (a) $98 - 25 = 73\%$.
(b) exercising muscle releases more CO , lowering pH; this shifts the curve right, so at the same pO haemoglobin is less saturated and releases more oxygen; so more oxygen is delivered exactly where respiration is fastest.

3.4 as HCO leaves the red cell, chloride ions move in to keep the charge balanced inside the cell.