5.1 Respiration, glycolysis to oxidative phosphorylation

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS glycolysis • Krebs cycle • oxidative phosphorylation • lactate • respiratory quotient

Objective

Practise statements 7.1-7.8 with Core Practicals 15-16: the four stages of respiration, where each happens and what each yields, anaerobic lactate metabolism, and the respiratory quotient.

1 Key knowledge and worked examples

The four stages in one table

Stage	Where	Carbon products	Hydrogen carriers	ATP
Glycolysis	cytoplasm	none (pyruvate made)	2 reduced NAD	2 (substrate-level)
Link reaction	matrix	1 CO2 per pyruvate	1 reduced NAD	0
Krebs cycle	matrix	2 CO2 per acetyl	3 reduced NAD + 1 reduced FAD	1
Oxidative phosphorylation	cristae	none	carriers reoxidised	most (chemiosmosis)

Electrons from reduced NAD and FAD pass down the transport chain; released energy pumps H+ into the intermembrane space; H+ flows back through ATP synthase; oxygen accepts the electrons and forms water.

Anaerobic and after

No oxygen, no chain: reduced NAD cannot be reoxidised, so pyruvate accepts its hydrogen and becomes lactate. After exercise the lactate travels to the liver and is rebuilt to glucose – that reconstruction costs oxygen (the oxygen debt).

Respiratory quotient (RQ)

RQ = CO2 produced / O2 consumed: carbohydrate 1.0, protein 0.9, lipid about 0.7.

Worked example: RQ from a respirometer

Germinating seeds release 42 cm3 CO2 and consume 60 cm3 O2 per hour. RQ = 42/60 = 0.70 - lipid is the substrate. An RQ above 1.0 means some anaerobic respiration is present, since CO2 is released without matching O2 use.

2 Practice

2.1 Name the stage of respiration that occurs in the cytoplasm and state its carbon-containing product. [2]

2.2 State the final electron acceptor of the electron transport chain and the molecule formed. [2]

2.3 Explain why the rate of respiration of a mammal falls sharply above 45 degrees Celsius. [2]

3 Exam-style questions

3.1 A student uses a respirometer with hydrogencarbonate indicator to follow respiration of three organisms. The table shows gas exchange per hour.

Organism	CO2 produced / mm3	O2 consumed / mm3
A	60	60
B	36	60
C	72	60

Calculate the RQ of each organism, identify the likely substrate in each case, and suggest what organism C's value above 1.0 indicates. [6]

3.2 Cyanide blocks the final electron carrier of the transport chain. Explain why cyanide poisoning stops ATP production by oxidative phosphorylation AND stops the Krebs cycle soon afterwards. [5]

3.3 During intense exercise a muscle cell's ATP demand rises tenfold while its oxygen supply rises only threefold. Explain how the cell keeps respiring, what accumulates, and why the muscle aches and recovers hours later. [6]