Respiration in Plants

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer 8 × 1 = 8 marks

1. Glycolysis takes place in the:
(a) inner mitochondrial membrane **(b)** chloroplast
(c) mitochondrial matrix **(d)** cytoplasm

2. The net ATP gained from 4 molecules of glucose by fermentation is:
(a) 8 **(b)** 152 **(c)** 144 **(d)** 16

3. Where does the build-up of protons pumped by the electron transport system take place?
(a) The cytoplasm
(b) The mitochondrial matrix
(c) The inner mitochondrial membrane
(d) The inter-membrane space of the mitochondrion

4. The respiratory quotient of sucrose ($C_{12}H_{22}O_{11}$) is:
(a) 1.33 **(b)** 0.7 **(c)** 1 **(d)** 4

5. How many molecules of NADH are produced in glycolysis from 6 molecules of glucose?
(a) 12 **(b)** 6 **(c)** 18 **(d)** 24

6. A tissue gives out 72 mL of CO_2 while taking in 80 mL of O_2. Its respiratory quotient is:
(a) 1 **(b)** 1.11 **(c)** 1.1 **(d)** 0.9

7. Which enzyme catalyses acetyl CoA + oxaloacetic acid → citric acid?
(a) Citrate synthase **(b)** Lactate dehydrogenase
(c) NADH dehydrogenase (complex I) **(d)** Alcohol dehydrogenase

8. Assertion (A): The respiratory quotient of glucose is equal to 1.
Reason (R): The respiratory quotient is 1 for every substrate.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Section B — Short answer 8 × 2 = 16 marks

9. What is the difference between aerobic respiration and fermentation?

10. How many ATP are made in the electron transport system from 13 NADH and 8 $FADH_2$?

11. A germinating seed gives out 90 mL of CO_2 while using 100 mL of O_2. Find its RQ and the likely respiratory substrate.

12. Where does the link reaction (pyruvate to acetyl CoA) take place in the cell?

13. For 10 molecules of glucose respired aerobically, how many NADH, $FADH_2$ and CO_2 molecules are produced in all?

14. Write the balanced equation for the complete oxidation of tartaric acid and find its RQ.

15. 2 molecules of glucose are fermented by muscle cells short of oxygen. What are the products, and how many ATP are gained?

16. What reaction does ATP synthase (complex V) catalyse?

Section C — Word problems — 4 × 4 = 16 marks

17. Describe glycolysis.

18. 10 molecules of glucose are respired aerobically. Find, for each stage (glycolysis, link reaction, Krebs cycle), the NADH, $FADH_2$ and ATP made directly, and then the total ATP.

19. Write the balanced equations for the complete oxidation of oxalic acid and malic acid. Find the RQ of each and explain why they differ.

20. Compare aerobic respiration and fermentation for 18 molecules of glucose: the ATP gained, the end products, and where in the cell each happens. How many times more ATP does aerobic respiration give?

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Answer key

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Q	Answer	Working
1	**(d) cytoplasm**	—
2	**(a) 8**	2 per glucose, from glycolysis only
3	**(d) The inter-membrane space of the mitochondrion**	—
4	**(c) 1**	$C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O$; RQ = $CO_2 \div O_2$
5	**(a) 12**	per glucose: 2 NADH, 0 $FADH_2$, 0 CO_2
6	**(d) 0.9**	72 ÷ 80
7	**(a) Citrate synthase**	—
8	**(c) A is true, but R is false.**	A is true: RQ = 1. R is false.
9	**Aerobic respiration needs oxygen and breaks glucose completely to CO_2 and water, giving about 38 ATP. Fermentation happens without oxygen and breaks glucose only partly, to ethanol and CO_2 or lactic acid, giving only 2 ATP.**	—
10	**55**	13 × 3 + 8 × 2
11	**RQ 0.9; protein (or a mixture)**	90 ÷ 100; carbohydrate 1, protein about 0.9, fat about 0.7, organic acids above 1
12	**The mitochondrial matrix**	—
13	**100 NADH; 20 $FADH_2$; 60 CO_2**	per glucose: NADH 2 + 2 + 6, $FADH_2$ 2, CO_2 2 + 4
14	**$2C_4H_6O_6 + 5O_2 \rightarrow 8CO_2 + 6H_2O$; RQ = 1.6**	RQ = moles of CO_2 ÷ moles of O_2
15	**Lactic acid; 4 ATP (2 per glucose, from glycolysis)**	—
16	**Making ATP from ADP and phosphate as protons flow back**	—
17	**In the cytoplasm, glucose is phosphorylated using 2 ATP to fructose 1,6-bisphosphate, which splits into two triose phosphates (PGAL). Each is oxidised to 1,3-bisphosphoglycerate, reducing NAD^+ to NADH; then ATP is made directly (substrate-level phosphorylation) twice per triose as it becomes pyruvic acid. Per glucose: 4 ATP made, 2 used, net 2 ATP, 2 NADH and 2 pyruvic acid.**	—

Q	Answer	Working
18	**Glycolysis: 20 NADH, 20 ATP; link: 20 NADH; Krebs: 60 NADH, 20 $FADH_2$, 20 ATP. Total ATP = 40 + 100 × 3 + 20 × 2 = 380**	3 ATP per NADH, 2 per $FADH_2$ (NCERT)
19	**$2C_2H_2O_4 + O_2 \rightarrow 4CO_2 + 2H_2O$: RQ 4. $C_4H_6O_5 + 3O_2 \rightarrow 4CO_2 + 3H_2O$: RQ 1.33. The substrate with less oxygen of its own needs more O_2, so its RQ is lower.**	RQ = $CO_2 \div O_2$ from the balanced equation
20	**Aerobic: 684 ATP; CO_2 and water; cytoplasm and mitochondria. Fermentation: 36 ATP; ethanol and CO_2 (yeast) or lactic acid (muscle); cytoplasm. 19 times as much.**	—

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