CHAPTER 9 Review

1. In respiration, is glucose oxidized or reduced? Oxidized
2. Explain why electrons lose energy when they are transferred to a more electronegative atom. They end up in a more stable state (lower potential energy)
3. What coenzyme is reduced during glycolysis? NAD+
4. Where does glycolysis occur in the cell? Cytosol
5. Substrate-level phosphorylation occurs during which two processes? glycolysis + Krebs
6. Oxidative phosphorylation occurs during this process: ETC + chemiosmosis
7. Is NADH an oxidizing agent or a reducing agent? reducing agent
8. Why is glycolysis an anaerobic process? does not directly use O_2
9. How many ATPs are produced during glycolysis by substrate-level phosphorylation? 4 total
10. How many molecules of pyruvate are produced from every molecule of glucose during glycolysis? 2
11. What would occur if one of the enzymes of the Krebs cycle was inhibited? Cycle would eventually stop, no more ETC either
12. In what part of the cell is pyruvate converted to acetyl Co A? matrix
13. What does Coenzyme A carry to the Krebs cycle? acetyl group
14. Pyruvate has 3 carbons, while the acetyl group on acetyl CoA has 2 carbons. What happened to the other carbon? lost as CO_2
15. What does it mean to say that the ET chain and chemiosmosis are "coupled?" What does an "uncoupler" do?
"Coupled" = ETC creates proton gradient that drives chemiosmosis
uncoupler = gets rid of proton gradient (see p. 177 book)
16. How many turns of the Krebs cycle occur for each glucose molecule? 2
17. For each turn of the Krebs cycle, two carbons enter in the form of Acetyl CoA and two carbons exit in the form of CO_2.
18. For each turn of the Krebs cycle, 3 molecules of NAD+ are reduced, 1 molecules of FAD+ is reduced, and 1 ATP is produced by substrate-level phosphorylation.
19. By the end of the Krebs cycle, what has happened to the six carbons of glucose? all lost as CO_2
20. By the end of the Krebs cycle, in what form is most of the extracted energy from glucose? NADH (high energy electrons)
21. How does the form of the cristae fit its function? more surface area for ETCs

22. The flow of electrons down the electron transport chain is an (exergonic/endergonic) exergonic pathway.

23. What is the function of prosthetic groups in the electron transport chain?
to accept + pass off e^-

24. Why does $FADH_2$ provide 2/3 the energy for ATP synthesis as NADH? passes off e^- lower in the ETC (is worth only 2 ATP instead of 3)

25. O_2 is the final electron acceptor at the end of the ET chain and it forms H_2O.

26. Where in the mitochondria is there a build-up of a H+ concentration gradient?
inner membranes

27. How is the H+ gradient created? by the ETC, shuttles H^+ from matrix to inner mem space

28. At what places is the inner mitochondrial membrane permeable to H+ leaking down its gradient? ATP synthase

29. Would yeast consume more glucose under anaerobic or aerobic conditions?
anaerobic b/c to make same amt of ATP, more glucose is required

30. The ATP synthase complex looks like a lollipop in the inner membrane. Are the heads of the lollipops pointing toward the matrix or the inner membrane compartment? matrix

31. Each molecule of glucose upon combustion releases 686 Kcal/mol of energy. Each ATP contains 7.3 Kcal/mol of energy. How efficient is aerobic respiration (percent)
~ 41 %

32. What happens to the energy that is not used to make ATP?
body heat

33. Why do eukaryotes produce less ATP per glucose (36) than prokaryotes (38)?
their NADH from glycolysis always have to cross a mit. membrane

34. Why is champagne bubbly and why does bread rise? CO_2 byproduct of fermentation

35. Why is it essential to oxidize NADH during fermentation?
to regenerate NAD+ for glycolysis

36. Lactate may accumulate in muscle cells because of an "oxygen debt." What later happens to lactate, and how is the oxygen debt paid?
must go back to blood stream, liver converts it to pyruvate + goes through cell respiration

37. Explain why are muscle cells behave as facultative anaerobes.
can switch from aerobic resp to fermentation

38. Why is the allosteric enzyme phosphofructokinase called the "pacemaker of respiration?"
Sensitive to levels of citrate, ATP, ADP - can adjust rate of glycolysis

INTERACTIVE QUESTION 9.2

Fill in the appropriate terms in the following equation.

becomes a. Oxidized

$Xe^- + Y \longrightarrow X + Ye^-$

becomes b. reduced

Xe^- is the reducing agent; it c. donates electrons.
Y is the d. OX agent; it e. accepts electrons.

INTERACTIVE QUESTION 9.3

a. In the conversion of glucose and O_2 to CO_2 and H_2O, which molecule becomes reduced?
O_2
b. Which molecule becomes oxidized?
glucose
c. What happens to the energy that is released in this redox reaction?
transformed into ATP + heat

INTERACTIVE QUESTION 9.4

a. NAD^+ is called an electron carrier (coenzym

b. Its reduced form is NADH.

INTERACTIVE QUESTION 9.6

Fill in the blanks in the following summary diagram of glycolysis.

Glucose

2 ADP + 2 Ⓟ ← a. 2 ATP

b. 2 G3P

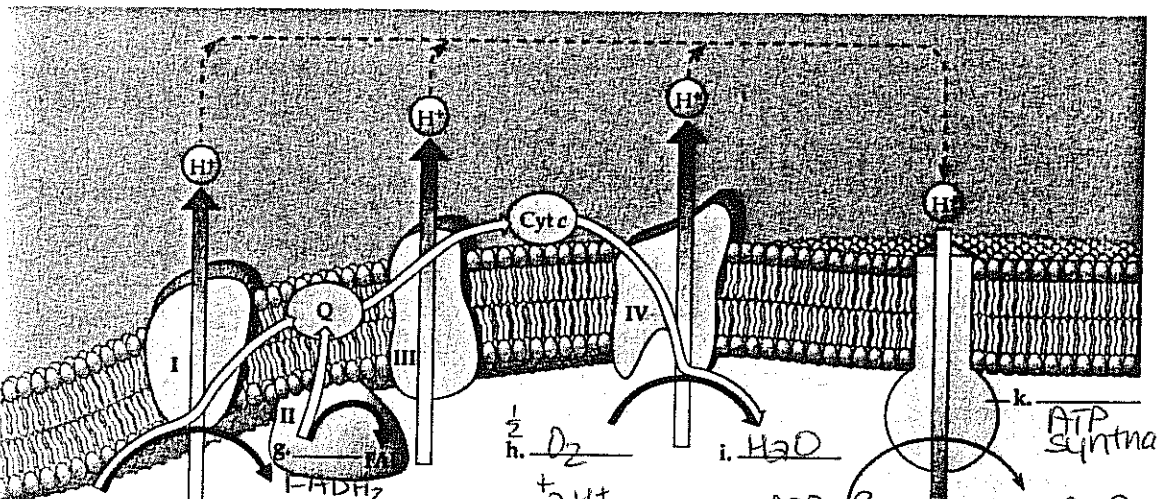
2 c. NAD^+ → d. 2 NADH

4 ADP + 4 Ⓟ → e. 4 ATP

f. 2 pyruvates

INTERACTIVE QUESTION 9.8

Label the following diagram of oxidative phosphorylation in a mitochondrial membrane.



a. matrix
b. inner membrane
c. space
d. ETC
e. NADH
f. NAD^+
g. FADH2
h. $\frac{1}{2}$ O_2 + $2H^+$
i. H_2O
j. chemiosmosis
k. ATP synthase
l. ADP + P_i
m. ATP

Oxidative phosphorylation

Process	Main Function	Inputs	Outputs
Glycolysis	Starts cell respiration	Glucose	Pyruvate (ATP NADH)
Pyruvate to acetyl CoA	prepares for Krebs	Pyruvate	Acetyl CoA (CO_2 NADH)
Citric acid cycle	completes breakdown of glucose	Acetyl CoA	CO_2, NADH ATP $FADH_2$
Oxidative phosphorylation	extracts energy from e^-	e^- from NADH, $FADH_2$ O_2	ATP H_2O
Fermentation	regenerates NAD+ so glycolysis can continue	pyruvate	NAD+, lactate or alcohol + CO_2

Test Your Knowledge

MULTIPLE CHOICE: *Choose the one best answer.*

1. When electrons move closer to a more electronegative atom,
   a. energy is released.
   b. energy is consumed.
   c. a proton gradient is established.
   d. water is produced.
   e. ATP is synthesized.

2. In the reaction $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$,
   a. glucose becomes reduced.
   b. oxygen becomes reduced.
   c. oxygen becomes oxidized.
   d. water is a reducing agent.
   e. oxygen is a reducing agent.

4. Which of the following reactions is *incorrectly* paired with its location?
   a. ATP synthesis—inner membrane of the mitochondrion, mitochondrial matrix, and cytosol
   b. fermentation—cell cytosol
   c. glycolysis—cell cytosol
   d. substrate-level phosphorylation—cytosol and mitochondrial matrix
   e. citric acid cycle—cristae of mitochondrion (matrix)

7. When pyruvate is converted to acetyl CoA,
   a. CO_2 and ATP are released.
   b. a multienzyme complex removes a carboxyl group, transfers electrons to NAD^+, and attaches a coenzyme.
   c. one turn of the citric acid cycle is completed.
   d. NAD^+ is regenerated so that glycolysis can continue to produce ATP by substrate-level phosphorylation.
   e. phosphofructokinase is activated and glycolysis continues.

8. How many molecules of CO_2 are generated for each molecule of acetyl CoA introduced into the citric acid cycle?
   a. 1 c. 3 e. 6
   b. 2 d. 4

9. Which of the following statements correctly describes the role of oxygen in cellular respiration?
   a. It is reduced in glycolysis as glucose is oxidized.
   b. It combines with H^+ diffusing through ATP synthase to produce H_2O.
   c. It provides the activation energy needed for oxidation to occur.
   d. It is the final electron acceptor for the electron transport chain.
   e. It combines with the carbon removed during the citric acid cycle to form CO_2.

10. In the chemiosmotic mechanism,
    a. ATP production is linked to the proton gradient established by the electron transport chain.
    b. the difference in pH between the intermembrane space and the cytosol drives the formation of ATP.
    c. the flow of H^+ through ATP synthases rotates a rotor and rod, driving the hydrolysis of ADP.
    d. the energy released by the reduction and subsequent oxidation of electron carriers transfers a phosphate to ADP.
    e. the production of water in the mitochondrial matrix by the reduction of oxygen leads to a net flow of water out of a mitochondrion.

15. Fermentation produces less ATP than cellular respiration because
    a. NAD^+ is regenerated by alcohol or lactate production, without the electrons of NADH passing through the electron transport chain.
    b. pyruvate still contains most of the "hilltop" electrons that were present in glucose.
    c. its starting reactant is pyruvate and not glucose.
    d. a and b are correct.
    e. a, b, and c are correct.

17. Muscle cells in oxygen deprivation gain which of the following from the reduction of pyruvate?
    a. ATP
    b. ATP and NAD^+
    c. CO_2 and NAD^+
    d. ATP, alcohol, and NAD^+
    e. ATP and CO_2