**AP Biology** **Name:** **P:**

# Chapter 7 Reading Guide: Cellular Respiration and Fermentation

How to use this reading guide: Look over the entire reading guide—read each question to prepare yourself for reading the chapter. Read the chapter carefully and thoroughly. Make sure to look at all of the figures and pictures and read their captions. Then…answer the questions posed below.

## Life is Work

1. Cells need a constant infusion of_____in order to carry out their everyday functions, such as (describe the functions):

    a. Describe how this relates to relate to the law of entropy and the increasing order of life (from atoms -> molecules -> cells).

2. Compare and contrast the paths that energy and chemical elements follow in an ecosystem.

3. Give a brief description of how photosynthesis and cellular respiration are related. Use figure 7.2 in your explanation.

## Catabolic Pathways yield energy by oxidizing organic fuels

4. How do cells get energy from complex organic molecules like glucose?

    a. Is this endergonic or exergonic?
    b. Which have more “free energy” the products or the reactants?

5. Briefly compare fermentation with cellular respiration.

    a. Where does cellular respiration take place within a eukaryotic cell?

6. Write a summary equation for the process of cellular respiration.

    a. What “fuels” can be used in the process of cellular respiration?

7. If glucose (sugar) is the fuel, what would the overall equation for the process be?

    a. Is this process endergonic or exergonic? How much?

8. How is catabolism linked to work? How is ATP involved in the work?

9. In redox reactions (or oxidation-reduction reactions), electrons are transferred from one molecule to another.
    a. What happens in oxidation?

    b. What happens in reduction?

10. What does a “reducing agent” do? What does an “oxidizing agent” do?

11. Why is oxygen considered a “powerful” oxidizing agent?

12. A reaction that transfers an electron from a less electronegative element to a more electronegative element will be exergonic. Explain why.

13. Why are organic molecules such excellent “fuels”?

    a. Compare carbohydrates and lipids in terms of hydrogen saturation. Why are lipids a more “energetic fuel’?

14. What is the equation for the oxidation of glucose?
    a. What is being oxidized? What does that mean?
    b. What is being reduced? What does that mean?

**15.** If the electrons from glucose were transferred directly to the oxygen----BOOOM!!!!!----there’d be an explosion! So...the electrons are transferred to _____. That makes this molecule a(n)_____agent.

16. How does NAD+ trap electrons from glucose (and other molecules)? (Include the enzymes involved).

17. How do electrons that are extracted from food and stored by NADH finally reach oxygen?

18. Summarize the electron pathway in cellular respiration.

19. What are the three stages of cellular respiration?
    a. Where does each stage take place?

**Glycolysis harvests chemical energy by oxidizing glucose to pyruvate**

20. What does glycolysis mean?
21. There are 10 steps in glycolysis divided into two phases: energy investment and energy yield.
    **a.** Describe what happens in the first 5 steps (the energy investment phase).

    b. Describe what happens in the second 5 steps (the energy yield phase).

22. Read p. 140-141 "A closer look at glycolysis". DON'T MEMORIZE THIS!!!---BUT….make sure you understand what happens at each step.
    **a.** How many ATP go into glycolysis?_____
        i. Why do you have to put ATP in? (explain how related to Ea and enzymes!)

    b. How many total ATP are yielded by one glucose molecule?
    c. What is the net gain of ATP?
    d. How many NAD+ go in? How many NADH come out?
        i. What are these carrying? Where are they going?

    e. How many enzymes are used in this process? How many are "kinases"?
        i. Look carefully at the "kinase" enzyme steps. What does a kinase do?

    f. How much oxygen is used?
    g. How much $CO_2$ is produced?

**The citric acid cycle completes the energy-yielding oxidation of organic molecules**

23. Once inside the mitochondrion, what happens to Pyruvate? Why must this series of reactions take place before the citric acid cycle (Krebs Cycle)?

24. Summarize the Krebs cycle. Where does it take place?

    a. What goes in to the cycle?
    b. How many CO2 come out? What do you ultimately do with that CO2? Why can't it stay in the body?

    c. How many ATP per cycle?
    d. How many NADH per cycle?
    e. How many FADH2 per cycle?

    f. How many times does the cycle turn for each glucose molecule put into the system?

25. What is FAD? How is it similar to NAD?

26. Why is the Krebs Cycle a cycle?

**During oxidative phosphorylation, chemiosmosis couples electron transport to ATP synthesis**

27. Summarize where the energy stored in the glucose has gone by the time glycolysis and the Krebs Cycle have been completed.

    a. What accounts for most of the energy extracted? How will you recovery this energy?

28. Explain the structure of the electron transport chain. What is it made of? Where is it located?

29. An NADH brings its electrons to the ETC and drops them off with what molecule?
    a. Is this molecule oxidized or reduced?
    b. Does this release energy or store it? Why?

30. When this molecule passes its electrons on to FeS, why will the electrons move?
    a. Is FeS oxidized or reduced?
    b. Is FMN oxidized or reduced?
    c. Does this release energy or store it? Why?

31. Name the molecules, in order, that make up the electron transport chain. Why do the electrons move from one to the next?

32. Where do the electrons from the ETC end up? What does this form?
    a. Where did the electrons come from at the beginning of cellular respiration?

33. $FADH_2$ yields less energy than NADH in the electron transport chain. Why?

34. The electron transport chain doesn't directly make any ATP. It only "eases" the free energy drop from food to oxygen. What actually makes ATP?

35. What enzyme actually makes ATP from ADP? Where is it located?

36. Study Figure 7.13. How does the enzyme work to make ATP? (Chemiosmosis!)

37. To explain how the ETC is related to (coupled with) chemiosmosis, draw a picture showing a segment of the inner membrane of a mitochondrion. Place the ETC molecules in the membrane in order and place the ATP Synthase molecule in an appropriate place.
    a. Label the inner membrane, the intermembrane space, the mitochondrial matrix.
    b. Show where NADH and FADH2 drop off the electrons
    c. Show where and how many H+ will be pumped across.

38. Chemiosmosis, in general, is…

    a. Where else does chemiosmosis occur?

39. How do prokaryotes (bacteria) make ATP if they don't have any mitochondria?

40. The number of ATP generated for each glucose molecule that enters cellular respiration is between 36 and 38. Why isn't this an exact number?

41. KNOW FIGURE 7.15!!! COUNT IT OUT!!!—how many ATP, NADH, $FADH_2$ are made at each of these steps.
    a. Glycolysis –

    b. Pyruvate Oxidation –

c. Krebs cycle –

d. ETC/Chemiosmosis

**Fermentation enables some cells to produce ATP without the use of oxygen**

43. How can food be oxidized without the use of oxygen?

44. What is fermentation? How are NADH and $FADH_2$ "recycled" in fermentation?

45. Explain what happens in alcohol fermentation. Which organisms can do this?
    a. What are the end products of this type of fermentation?

46. Explain what happens in lactic acid fermentation.

47. What happens to the lactic acid that builds up in your muscle cells? How do you "get rid" of the lactic acid?

48. Compare cellular respiration with fermentation. List their similarities.

49. Contrast cellular respiration with fermentation. List their differences.

50. Why is fermentation considered a much less efficient way to produce ATP?

51. What is a facultative anaerobe? How are fermentation and cellular respiration significant to them?

52. Explain the evolutionary significance of glycolysis.
    a. If the early earth had very little oxygen, how did cells make ATP?
    b. What evidence is there that suggest that glycolysis evolved very early in the history of life?

**Glycolysis and the citric acid cycle connect to many other metabolic pathways**

53. Describe how molecules such as proteins and fats can be utilized in cellular respiration to produce ATP.

54. How does cellular respiration also help you build other organic molecules?

55. Cellular processes have to be controlled. Regulation often occurs due to positive and negative feedback mechanisms. Phosphofructokinase is an example of negative feedback. Explain how this feedback mechanism works.