Objectives for Test Four: Chapter 7, 32.1, 34
Cellular Respiration Plus Respiratory Systems to Transport Oxygen

You should be able to:

1. In an ecosystem, draw the relationship between light energy, photosynthesis, food, cellular respiration,
2. Discuss the relationships between oxidation, reduction, electrons gained, electrons lost, energy lost, energy gained. Explain how the combustion of methane (CH_4) can be an oxidation/reduction reaction even though no atom totally loses or gains electrons.
3. For respiration, identify which compounds are oxidized and which are reduced.
4. Write the overall balanced equation for cellular respiration.
5. Distinguish between substrate level phosophorylation and chemiosmosis.
6. Identify the redox reaction in cellular respiration, that is, identify where electrons and hydrogen ions are lost and where they are gained.
7. Describe the general structure of the mitochondria and associate aspects of aerobic respiration with various parts of the mitochondria.
8. Describe Glycolysis: what is its purpose, where does it occur, what are the inputs, and what are the outputs.
9. Given a detailed diagram of glycolysis or the Krebs Cycle, identify occurances of oxidation and reduction, ATP production, formation of NADH and $FADH_2$
10. Describe the Krebs cycle (Citric Acid Cycle): what is its purpose, where does it occur, what are the inputs, what are the outputs? (Include the preparation step here)
11. Describe oxidative phosphorylation (the electron transport chain and chemiosmosis) (where & why).
    a. What goes into oxidative phosphorylation and what comes out of it?
    b. What happens during the electron transport chain? Why does the cell set up this electrochemical gradient?
    c. What happens during chemiosmosis?
12. Given labeled diagrams of various stages of cellular respiration, identify where various events occur.
13. Compare the yield of ATP from NADH to that from $FADH_2$.
14. Explain the function of oxygen (O_2) at the end of the electron transport chain.
15. Compare anaerobic cellular respiration and aerobic cellular respiration.
    a. Why do cells need to perform anaerobic respiration (why can't cells just perform glycolysis)?
    b. What is the end result of lactate (lactic acid) fermentation and where does it take place?
    c. What is the end result of alcohol fermentation and where does it take place?
    d. Give examples of organisms that do alcohol fermentation and lactic acid fermentation.
    e. Give a thorough example of how humans have put fermentation to use for food or products.
16. Design an experiment to test the effect of a variable such as pH, sugar type, temperature, amount of sucrose, amount of yeast, and the like on the rate of fermentation in yeast.
17. LAB: Rate of Cellular Respiration in Germinating and Non-germinating Seeds
    a. What could one measure to determine the rate of seed or small animal respiration rate?
    b. If using gas volume as the dependent variable in this experiment, explain what factors in addition to seed respiration can affect the volume of the gas.
    c. Explain why a CO_2 absorber, like KOH, is needed when using gas volume as the dependent variable. Why is this CO_2 absorber not needed when using a CO_2 probe?
    d. Imagine that you are given 25 germinating pea seeds that have been placed in boiling water for 5 minutes. You place these seeds in a respirometer and collect data. Predict the rate of oxygen consumption (i.e., cellular respiration) for these seeds, and explain your reasons.
    e. Imagine that you are asked to measure the rate of respiration for a 25 g reptile and a 25 g mammal at 10°C. Predict how the results would compare and justify your prediction.
    f. Imagine that you are asked to repeat the reptile/mammal comparison of oxygen consumption, but at a temperature of 22°C. Predict how these results would differ from the measurements made at 10°C, and explain your prediction in terms of metabolism
18. Describe characteristics of an efficient respiratory surface.
19. Explain the relationship between the partial pressure of a gas like oxygen and the amount of the gas dissolved in blood
20. Compare the respiratory process of several invertebrates and minor vertebrates such as *Paramecia*, hydra, planaria, earthworms, grasshoppers and fish.
21. Describe how gills are adapted for gas exchange. Explain how a countercurrent exchange system increases the concentration of oxygen in blood.
22. Describe how the tracheal system of a grasshopper is different from a vertebrate respiratory system.
23. Label a diagram of the human respiratory system; tell the main function of each anatomical part; and trace the path of oxygen from the air to the capillaries in the lungs.

24. ~~Identify the path of carbon dioxide from the capillaries in the lungs to the outside air.~~
25. Explain the changes in pressure and volume that occur during inhalation and exhalation. Explain the role the diaphragm and muscles of the rib cage play in these changes.
26. Explain how breathing in humans is regulated including carbon dioxide, blood pH, chemoreceptors, and the medulla. (We may not have time to discuss this topic; read about it on page 737)
27. Explain with detail how oxygen ~~and carbon dioxide~~ are transported in blood. Why do animals need pigments like hemoglobin and hemocyanin to help transport oxygen?
28. Describe the characteristics of hemoglobin that make it an effective molecule for transporting oxygen.
29. Explain why it is hard to breathe at high altitudes; tell adaptations a human can make when living at high altitude for long periods of time.
30. Explain why diving mammals like the Weddell seal can remain underwater for unusually long periods of time even though they are air breathers. (We may not have time to discuss this topic; read about it on page 740).
31. LAB: Human Lung Capacities and Breathing Rates
    a. Describe the various lung volumes that can be measured (tidal volume, vital volume, inspiratory reserve volume, expiratory reserve volume) and how they are measured.
    b. Interpret a spirogram (graph of various lung volumes).
    c. Design a controlled experiment to test the effect of exercise, hyperventilation, holding breath or other variable on the rate of human breathing.
32. Distinguish between ectotherms and endotherms.
33. Summarize a negative feedback loop for temperature regulation in endotherms.
34. Explain how animals can respond to changes in external environmental temperature with changes in their behavior.
35. Explain how animals can respond to changes in external environmental temperature with changes in their physiology.
    a. sweating/panting
    b. shivering
    c. goosebumps (How do these support common ancestry?)
    d. hair/fur/feathers
    e. vasoconstriction/vasodilation
    f. countercurrent exchange
    g. ~~brown fat~~
    h. structures with large surface area (eg. ears)
36. LAB: Design an experiment to evaluate the effect of alcohol, caffeine, or nicotine on the heart rate of Daphnia.
37. LAB: Design an experiment to evaluate the effect of some variable (temperature, pH, concentration of nicotine, caffeine, etc.) on the heart of an invertebrate such as *Daphnia*. Calculate the Q10 for this experiment and explain it's meaning. Given a graph of data, calculate the rate of heart rate increase as temperature increases.
38. Each chapter has some multiple choice questions and a few other additional questions at its end. Give these a try. You might see them again!

Some Examples of Short Free Response Questions: (2-3 sentences): These might be the actual questions.

1. Remember, ANY objective above could be turned into a short free response question.
2. Given the ΔG for the complete combustion of glucose and for the formation of ATP, **calculate** the efficiency of aerobic respiration and of anaerobic respiration.
3. ~~3.~~ Describe the role of membranes in the synthesis of ATP in either cellular respiration ~~or photosynthesis.~~
4. Identify two times during the biochemical pathways of cellular respiration when an oxidation/reduction reaction occurs.
5. Explain why a muscle cell would use lactic acid fermentation and how ATP production would compare to aerobic respiration.
6. **Explain** how chemiosmosis produces ATP.
7. **Explain** how the structure of the mitochondria is important to the production of ATP by the organelle you choose.
8. Given atmospheric pressure or other air pressure reading, **calculate** the partial pressure of oxygen gas.
9. Explain why it is difficult to obtain sufficient oxygen at high altitudes even though the percent of oxygen gas in the atmosphere is the same as at sea level.
10. Many organisms require a continuing source of oxygen for respiration. **Discuss** important structural and physiological adaptations for oxygen uptake in ONE of the following: a paramecium, a tree, a fish or a mammal

11. **Describe** the respiratory specialized structures that facilitate the movement of oxygen into the circulatory system of mammals.
12. **Explain** how oxygen is transported within the circulatory system of mammals.
13. In biological systems, structure and function are related. **Describe** the structure of an alveolus and **explain** how that structure is responsible for the function of the alveolus..
14. .

Essay for the Test (#238) – From 2015

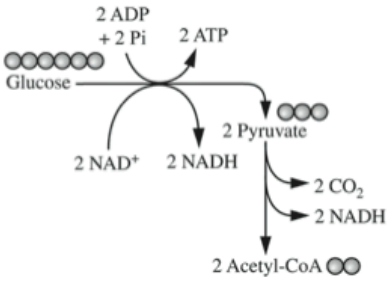

Figure 1. Glycolysis and pyruvate oxidation

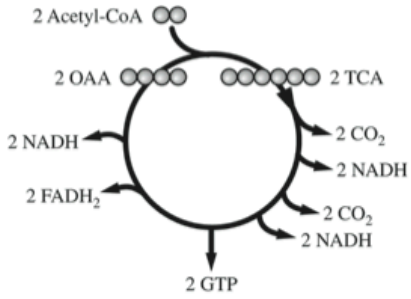

Figure 2. Krebs cycle

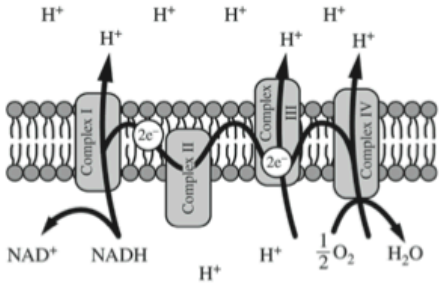

Figure 3. Electron transport chain

238. (Long) Cellular respiration includes the metabolic pathways of glycolysis, the Krebs cycle, and the electron transport chain, as represented in the figures. In cellular respiration, carbohydrates and other metabolites are oxidized, and the resulting energy-transfer reactions support the synthesis of ATP.
    a. Using the information above, **describe** ONE contribution of each of the following in ATP synthesis.
        - Catabolism of glucose in glycolysis and pyruvate oxidation
        - Oxidation of intermediates in the Krebs cycle
        - Formation of a proton gradient by the electron transport chain
    b. Use each of the following observations to **justify** the claim that glycolysis first occurred in a common ancestor of all living organisms.
        - Nearly all existing organisms perform glycolysis.
        - Glycolysis occurs under anaerobic conditions.
        - Glycolysis occurs only in the cytosol
    c. A researcher estimates that, in a certain organism, the complete metabolism of glucose produces 30 molecules of ATP for each molecule of glucose. The energy released from the total oxidation of glucose under standard conditions is 686 kcal/mol. The energy released from the hydrolysis of ATP to ADP and inorganic phosphate under standard conditions is 7.3 kcal/mol. **Calculate** the amount of energy available from the hydrolysis of 30 moles of ATP. **Calculate** the efficiency of total ATP production from 1 mole of glucose in the organism. **Describe** what happens to the excess energy that is released from the metabolism of glucose.
    d. The enzymes of the Krebs cycle function in the cytosol of bacteria, but among eukaryotes the enzymes function mostly in the mitochondria. **Pose** a scientific question that connects the subcellular location of the enzymes in the Krebs cycle to the evolution of eukaryotes.