Key to Lecture Quiz #2

1. **Define Cellular respiration**, name the three metabolic pathways involved and explain why this is a more energy efficient form of metabolism than is fermentation.

   Cellular respiration is a metabolic pathway allowing organisms to completely catabolize glucose and form 6 molecules of carbon dioxide. If oxygen serves as the final electron acceptor, water is also formed. The three pathways involved are **glycolysis**, the **Krebs cycle** and the **electron transport chain or respiratory chain**. Cellular respiration is more energy efficient than is fermentation because more covalent bonds are broken. Fermentation typically yields only 2 ATP per glucose catabolized while cellular respiration yields 36 to 38 ATP depending on the cell type involved.

2. **Define proton motive force** and then explain how this force is associated with ATP synthesis during oxidative and photophosphorylation.

   The **proton motive force** is a concentration and electrical gradient (**electrochemical gradient**) formed when hydrogen protons are pumped or transported (moved against their gradient) **across a membrane** out of the cytoplasm and into the periplasmic space or intermembrane space of mitochondria or into the thylakoid spaces of chloroplasts. The transport of the hydrogen protons can be accomplished by electron transport chain proteins (cytochromes, flavoproteins, etc.) or by bacteriorhodopsin (using energy provided by an electron flow or by light respectively). The proton motive force drives the passage of protons (**down their electrochemical gradient**) back into the cytoplasm through **ATP-synthase enzymes**. These enzymes use the energy provided by the proton flow to **bind ADP and Pi and form ATP** (one for every three H^+ ions passing through).

3. **Define symbiosis** and then explain why respiratory chemoheterotrophs are dependent upon oxygenic photoautotrophs for their survival on this planet.

   Symbiosis can be defined as a **close association** between two or more different types of organisms and often involves **mutualistic** relationships (where both organism types benefit from the relationship). Respiratory chemoheterotrophs such as humans and other animals are dependent upon oxygenic photoautotrophs because **we require oxygen as a final electron acceptor** (our metabolic processes would stop without it) and they make it by splitting water. We are also dependent on autotrophs because **we cannot "fix" carbon** and they can. Everything we eat and catabolize to provide us with the energy we need to function comes from organic compounds made by autotrophs or something that ate autotrophs.

4. Pyruvate dehydrogenase (if you answered pyruvate decarboxylase you were given 0.5/1 for this answer).
   Acetyl coenzyme-A or acetyl co-A

5. The molecular source of carbon dioxide is organic acids (pyruvic acid, isocitric acid and α-ketoglutaric acid). When these molecules are decarboxylated just prior to or during the Krebs cycle, one carboxyl group ($COOH^-$) is released from each. The coenzyme NAD picks up the hydrogen and two electrons (is reduced) forming NADH + H^+ and carbon dioxide is released as a waste gas (COO).

6. Reduced coenzymes – NADH + H^+ and $FADH_2$ / Niacin and riboflavin (respectively)

7. Cytochromes/ cristae of mitochondria or thylakoids of chloroplasts

8. Respiratory organisms use molecular oxygen (O_2) as a final electron acceptor and it allows ETC components to transport electrons from reduced coenzymes (NADH + H^+ and $FADH_2$). Without oxygen, the coenzymes could not be oxidized and NAD and FAD would not be available for use (glycolysis and the Krebs cycle would stop). By using O_2 as a final electron acceptor, respiratory organisms can form water. This eliminates the potentially toxic O_2 (and its derivatives) and provides cells with metabolic water needed for a variety of processes.

9. Bacteriorhodopsin

10. Bacteriochlorophylls

11. Plastoquinone/ The pigments of PSII pull electrons and H^+ away from water molecules (split water) and molecular oxygen (O_2) is formed.

12. Ferredoxin/ NADPH + H^+ / reduction

13. Calvin or Calvin-Benson or Calvin-Benson-Bassham / RuBisCO (Ribulose bisphosphate carboxylase oxygenase)

14. *Treponema pallidum* (yes, these are spirochetes but if you added that to your answer Canvas marked it as incorrect).