Key to Lecture Quiz #1

1. **Define bioenergetics** and then explain how bioenergetics relates to metabolism. Make certain your answer included **four technical terms**, two relating to **energy** and two relating to **metabolism**.

   Bioenergetics can be defined as energy transfer mechanisms occurring within living organisms. Energy transfers are essential because living organisms cannot make energy; they are dependent on external energy sources (light or chemicals). Metabolic processes involve both **catabolic** (breakdown) and **anabolic** (building or synthesis) reactions. Anabolic reactions require energy (are **endergonic**) while catabolic reactions release more energy than was required to initiate them (are **exergonic**). Some energy is lost to entropy during energy transfers, so external energy is always in demand. Cells can use either chemical or light energy to make ATP (a high energy compound) and then use ATP to drive various activities within their cytoplasm (including, but not limited to anabolic reactions).

2. **Define coenzyme**, give two examples of coenzymes introduced during lecture and explain their relationship to oxidation and reduction reactions (how they are impacted by oxidation and reduction).

   Coenzymes are non-protein organic compounds that can interact with **apoenzymes** (inactive forms of conjugated enzymes) to form **holoenzymes** (active forms of conjugated enzymes). Some important coenzymes described in lecture are **NAD**, **FAD** and **NADP**; NAD and NADP are derived from the B-complex vitamin **niacin** and FAD is derived from **riboflavin**. Coenzymes can pick up electrons and hydrogen protons (NAD can be reduced to NADH + H^+ and FAD can be reduced to $FADH_2$) and **when in their reduced state have higher energy potentials**. Reduced coenzymes can also transfer electrons and hydrogen protons to other molecules, so can play important roles in electron transport chains or systems.

3. **Define fermentation**, explain the difference between **homofermentative** and **heterofermentative** organisms and give one specific **example** (genus and specific epithet) of each.

   Fermentation can be defined as the **anaerobic decomposition** (catabolism) of organic compounds (most often carbohydrates) that involves an **organic compound** (often pyruvate) as the **final electron acceptor**. **Homofermentative** organisms are those able to form only one product, **lactic acid**, through fermentation and a good example is *Lactococcus lactis* (a type of homofermentative or lactic acid bacteria). **Heterofermentative** organisms are those able to form **a variety of different products** through fermentation (mixed acids, alcohols, gasses, etc.). Saccharomyces cerevisiae is one example of a heterofermentative organism type because they form ethanol and carbon dioxide as fermentation products. All of the PUNK1-A organisms are heterofermentative.

4. Adenosine triphosphate (ATP)/ phosphorylation – Phosphorylation reactions are anabolic reactions, but anabolic reactions are not described as being categorized as substrate level, oxidative and photo. Make sure you read the entire question before filling in blanks.

5. Exoenzyme (active outside the cell)/ ribozyme – if you answered enzyme in the first blank your score was 0.5 rather than 1.0 (be specific).

6. According to the "lock and key" model each different type of enzyme has a specific reactive site or active site that will interact with specific substrate or reactant molecules, much as specific locks will only fit with specific keys. This is why there are so many different types of enzymes active within cells. The "induced fit" model is similar in that it describes enzymes as having active or reactive sites, but these change when interacting with substrate molecules. The interaction causes the enzyme active site to change slightly to better "fit" the substrate.

7. Energy of activation or activation energy.

8. Allosteric/ competitive

9. Cytochromes

10. Constitutive

11. Glycolysis – Glycolysis requires the coenzyme NAD in the oxidized state, but during glycolysis NAD is reduced to NADH + H^+. If the cell cannot oxidize the coenzymes required to run the glycolysis pathway, glycolysis will stop. This is why glycolysis is connected to other metabolic pathways (either fermentation or cellular respiration). During fermentation, pyruvate can pick up the extra electrons and hydrogen protons needed to oxidize NADH + H^+ and form NAD. During cellular respiration NADH + H^+ passes electrons to the electron transport chain.

    Granted, other essentials to glycolysis are the enzymes involved, and ATP, but bringing these into the answer is distracting (not helpful to understanding the point of the question).

12. Kinase/ isomerase

13. Pyruvic acid or pyruvate (either answer is fine)/ acetaldehyde – Fermentative organisms do not use oxygen as a final electron acceptor (it is inorganic).

Extra credit – The etiological agents of bubonic plague are identified as *Yersinia pestis*.