Enzymes Worksheet

Use the following as a guideline in writing a summary note to study from.

1. How do enzymes speed up chemical reactions? Why do you think this is important in biological systems?
   - By lowering the activation energy ($E_A$) of the reaction
   - This is important so chemical reactions can keep up with the needs of the organisms

2. Sketch and label a potential energy diagram that outlines the effect of an enzyme on a reaction.

![Potential Energy Diagram]

3. What is the **induced fit model** (enzyme substrate complex)? Why is this important for enzyme function?
   - This states that the presence of the substrate causes (or “induces”) a change in the shape of the enzyme
   - This is important so that the enzyme is able to bind the substrate more precisely to better catalyze the reaction

4. Describe three different factors that affect enzyme activity. **Clearly explain** why each has an impact on the rate of enzyme activity.
   - pH: the presence of hydrogen ions ($H^+$) or hydroxide ions ($OH^-$) disrupts the relatively weak hydrogen bonds ($\delta^- \delta^+$) which hold the tertiary structure of the enzyme together
   - Salinity: the presence of ions (i.e. $Mg^{2+}$ or $Cl^-$) from the dissociation of the salt disrupt the hydrogen bonds. This is similar to the effect of pH.

5. What is the difference between co-factors and co-enzymes? Give examples for each.
   - Cofactors are inorganic ions (i.e. $Zn^{2+}$) which actually interact with the substrate during catalysis, therefore they are used up. They are essential dietary minerals.
6. What is the difference between competitive inhibitors and non-competitive inhibitors? Draw a quick sketch to support your answer.

- Competitive inhibitors actually bind the active site of the enzyme, preventing the binding of the substrate (i.e. they compete with the substrate)
- Non-competitive inhibitors do not bind the active site. Instead, they bind a separate allosteric site which induces a change in the shape of the active site, effectively preventing the binding of the substrate.

7. What is the difference between an allosteric activator and an allosteric inhibitor?

- An allosteric activator binds the enzymes allosteric site and causes a change in the shape of the active site which makes substrate binding easier
- An allosteric inhibitor binds the enzymes allosteric site and causes a change in the active site which makes substrate binding more difficult.

8. Draw a diagram that demonstrates how allosteric regulation could be used in feedback inhibition.

- See diagram in notes (feedback inhibition of threonine metabolism)

9. Use a graphic organizer to illustrate the relationship between different enzyme cofactors.

- See graphic organizer at end of cofactor note. Keep in mind you can supplement this graphic organizer with additional information.

10. Explain the role of NAD+ and dehydrogenase in enzyme catalyzed reactions.

- They have a complementary role. Dehydrogenases are enzymes that removes hydrogen from the substrate (oxidizes the substrate). The 2 e\(^{-}\) removed in the process are used to reduce NAD+ to NADH. In other words, NAD+ is acting as the oxidizing agent.
11. What is the most important energy-carrying coenzyme? How is its energy released?
   - ATP is the most important energy carrying coenzyme
   - Its energy is released by the hydrolysis of one of its three inorganic phosphates (Pi)

12. What distinguishes the structure of:
   a. a nucleotide from a nucleoside? Give an example of each.
      - Nucleoside (i.e. adenosine)
        - Nitrogenous base (i.e. adenine)
        - Ribose
        - Phosphate group
      - Nucleotide (i.e. AMP)
        - Nitrogenous base (i.e. adenine)
        - Ribose
        - Phosphate group

   b. ADP from ATP?
      - ADP
        - Nucleoside (adenosine)
        - Two phosphates (Pi)
      - ATP
        - Nucleoside (adenosine)
        - Three phosphates (Pi)

   c. guanosine and adenosine? What do they have in common?
      - Guanosine differ according to their nitrogenous bases (guanosine has guanine while adenosine has adenine)
      - They are both nucleosides which contain ribose

   d. NADH from FADH₂?
      - They are both dinucleotides (made of two nucleotides)
      - Both have one AMP
      - For NADH, the other nucleotide is NMP
      - For FADH₂ the other nucleotide is FMP

   e. NADH from NADPH?
      - They are identical except NADPH has an additional phosphate bonded to the AMP nucleotide

13. Which nucleotide do all of the coenzymes we discussed have in common?
• They all contain two nucleotides, one of which is always AMP

14. Which part of NADPH binds the enzyme? Which part is reduced/oxidized?
   • AMP binds the enzyme (this is true for all of the electron carrying cofactors)
   • The other side (NMP) is reduced/oxidized

15. How many electrons can each coenzyme we discussed carry?
   • 2 e-

16. Which vitamin is a precursor for FADH$_2$? NADH?
   • FADH$_2$ is derived from riboflavin while NADH (and NADPH) are derived from niacin