1 # Enzymes

Mark Mayo
Cypress College

2 ## What are enzymes?

- Enzymes are proteins
- They usually break down molecules or join molecules together
- Enzymes can be used over and over

3 ## What are enzymes?

- Even though they are not used up in their reactions they must be replaced often
- Our genes code for all proteins so they code for our enzymes
- Enzymes work on other molecules called substrates *

4 ## What are enzymes?

5 ## Four Features of Enzymes

- They do not make anything happen that would not have happened without them
- They are not altered or permanently used up in the reaction they facilitate
- The same enzyme works in the forward or reverse directions
- Enzymes are highly selective in their choice of substrates

6 ## Enzymes are highly selective in their choice of substrates *

7 ## Enzyme-Substrate Interactions

- Enzymes have reaction sites where the substrates attach
- Enzymes reduce the energy needed to get the substrates in close proximity
- Enzymes only allow certain substrates to fit in their reactive sites
- There may be a close fit that is induced to exactly match upon binding

8 ## An Induced Fit of an Enzyme

9 ## Four ways enzymes help reactions

- assist in getting substrates in the same area (10,000x to 1,000,000,000,000x faster)
- orient molecules with their reactive sites facing each other
- promote acid base exchanges of H^+ ions
- exclude water molecules that might get in the way

10 ## Enzyme Optima

- Enzymes require certain conditions for them to function correctly
- Temperature is important to enzyme function because it changes the SHAPE of the enzyme
  - too low and the enzyme does not function correctly
  - too high and the enzyme also does not function correctly

- ► pH is important to enzyme activity because it changes the SHAPE of the enzyme

11 ☐ Temperature is important to enzyme function*

12 ☐ Fevers are a measure of enzyme function

- ►The fever makes us weak, but are more effective against bacteria
- ►Fevers do not allow bacterial cell division because their enzymes for cell division do not work correctly or at all at the higher temperature
- ►At elevated body temperatures, cell division do not work or makes "leaky" cell walls

13 ☐

pH is also important to enzyme activity

14 ☐ Control of Enzyme Function

- ►Allosteric control – a change in enzyme shape
  - brought about by other chemicals
  - can activate or inhibit depending of shape change
  - without the control agent the enzyme's shape might not fit the substrate

15 ☐ Feedback inhibition

- ► Using tryptophan synthesis in bacteria as an example
  - bacteria are synthesizing tryptophan and other amino acids
  - bacterium makes an excess of tryptophan
  - tryptophan binds to enzyme used in tryptophan production
  - this binding changes the shape of the enzyme and this inactivates the enzyme
  - no more tryptophan is produced
  - if there is too little tryptophan the enzyme is free to make more tryptophan

16 ☐ Cofactors – substances needed by enzymes for proper functionality

- ►Can be ions, small proteins, etc.
- ►FAD (flavin adenine dinucleotide) – accept H^+
- ►NADP – (nicotinamide adenine dinucleotide phosphate) – a molecule that accepts H^+

17 ☐ Coenzymes

- ►Metals that help enzymes function (a form of cofactor)
  - Zinc (Zn)
  - Copper (Cu)