Unit 2: Biochemistry

Content Outline: Metabolism and Enzymes (2.5) – Part 1

1. **Metabolism**
   1. The *sum* *of all the chemical reactions* occurring in an organism.
   2. The collective process has two separate phases.
      1. **Catabolism** – This refers to the *breaking down of a molecule*.
         1. This process *releases* “potential” E found in the chemical bond between monomers.
         2. This is an **exergonic** reaction because it *releases heat to the environment*
         3. Think **Cata**strophe; breaking up things.
      2. **Anabolism** –This is the *assembly of molecules*.
         1. This process *requires* “Kinetic” E to *position molecules* in away so as to create a chemical bond between monomers.
         2. This is an **endergonic** reaction because it *absorbs energy from the environment*.
         3. Think **Anabol**ic steroids; these *build* muscle.
2. **Energy** (represented by “E”)
   1. Has the ability to *facilitate* transformation.
   2. There are two types of E mainly, as living organisms are concerned.
      1. **Kinetic E** (represented as “KE”) - This is the energy of *movement*. (Usually refers to the movement of electrons or protons in Biology.)
      2. **Potential E** (represented as “PE”) – This is the energy of *position*. (Usually referring to the chemical bonds associated with those electrons and protons.)
   3. For living organisms, the chemical E of life is found in chemical bonds.
      1. The processes of Cellular Respiration and Digestion *release* the E for use by cells.
      2. Source of all E for Earth? (It is the sun) The process of photosynthesis allows plants to *store* this solar energy in the form of chemical energy (sugar).
3. **Thermodynamics**
   1. The study of Heat E (Thermo) and its properties (dynamics).
   2. **First Law of Thermodynamics** (Also called the **Principle of the Conservation of E**)
      1. E cannot be created nor destroyed only transformed or transferred.
   3. **Second Law of Thermodynamics**
      1. Every E transfer *increases the entropy* of the universe.
         1. **Entropy**- means disorder; unable to do work because it is in a *low* state of order.
      2. Sunlight(high quality E) going in and heat (low quality E)coming out; it can’t do work.
4. **Gibbs Free E** (represented as “G”)
   1. It is referred to as *“free”* because E is *available* to perform work. (Mainly making ATP or GTP in a cell.)
   2. Notall E is available. (Some is lost as waste…like when we defecate…same goes for cells too.)
      1. Most E is *lost* as Heat as a byproduct of the bonds being *broken*.
5. *Types of work* performed by living cells: (Most are achieved by using *proteins and enzymes*.)
   1. *Mechanical* – work outside of the cell
   2. *Transport* across the membrane
   3. *Metabolic* processes – Catabolism and Anabolism
6. **ATP** (Adenosine Tri-Phosphate)
   1. Made from *Ribose sugar (RNA sugar)* and the nitrogen base Adenine.
   2. Has 3 *negative* phosphates linked together which makes it highly unstable like a “compressed spring”. *Unstable*, means it has the *capacity do perform work* remember.
   3. ATP converting to ADP gives off energy; ADP being converted to ATP requires energy.(The energy needed to make this bond comes from the “free” e in our food as it is broken down.)(ADP is recycled back to ATP.)

D**. Phosphorylation**

* + 1. The *attaching of an unstable phosphorus* ion to another molecule to make it unstable and thereby able to perform work. (Take the phosphorus off and it quits working.)

**Metabolism and Enzymes – Part 2**

1. **Enzymes** 
   1. These molecules are *Biological Catalysts*.
      * 1. Proteins that *speed up and control* the rate of a chemical reaction.

## *They are recycled*; *they are not consumed* *by the reaction*.

## Enzymes are *selective* in what they will work with. We used to say they had a “lock and key fit” (old term); we now say it “fits like a glove or has an induced fit”. (new term)

* + - 1. This is like putting on a latex glove… it stretches *to conform* to the shape of your hand.

## Enzyme names usually end with “ase”.

1. **Free E of Activation**

## This refers to *the Free E used to start* a chemical reaction in motion. (Essentially is the energy for getting the molecules moving and positioned so that it is possible to combine or be torn apart.)

## The energy of activation is lowered by the action of enzymes. (Enzymes reduce by *grabbing* the molecule and positioning it correctly… we don’t have to *wait* for nature to do it.)

* + - 1. Enzymes also *replace* the need for heat in most chemical reactions (remember heat can make molecules move faster) so that organisms don’t burn up during metabolism.

1. **Substrate**

## This refers to the molecule that is being *affected* by the enzyme. (What the enzyme is *grabbing and working on.)*

1. **Active Site**

## This refers to the *location* where the chemical reaction(s) is taking place between the enzyme and substrate.

## It is an Induced Fit , which creates the Enzyme-Substrate Complex. (Complex meaning “more than one piece in the unit”.)

## The two parts are mainly held together by *weak Hydrogen bonds*

## By *orienting* the substrate molecules, the reaction rate speeds up.

1. *Environmental factors* that can affect enzymes ability to work **optimally**. (“optimal” means “best” or “Fastest”)

## *Temperature* – freeze/cold (cold things don’t move quickly) or Heat causing it to Denature (“unfold”).

## *pH* of the environment

## *Salt* concentrations

## The Optimal Conditions for most human enzymes:

* + 1. 98.6˚F (35 - 40⁰C)
    2. pH usually between 7.2 and 7.6 (The human body’s pH of blood is an average of 7.4.)
    3. Remember, this is an unstable (dynamic) environment. There is an upper limit and a lower limit for enzymes. Beyond the limits, bad things begin to happen. So it is basically, trying to stay between the limits. The limits of “life”.

1. **Inhibitors**

## The name implies that these molecules *negatively affec*t an enzymes ability to work *optimally*. These *slow* *down or stop* the rate of the chemical reaction.

## Two *types of Inhibitors* exist, based on the location of the enzyme that is affected:

* + 1. **Competitive**- These molecules compete for the active site. (This is because of *similar shape*.)
       1. These molecules *slow down* the reaction rate. (These molecules will be removed.)
    2. **Non-competitive** –These molecules attach *somewhere other than the active site* causing the shape of the active site to *change s*o the substrate can’t fit into it.

a. These molecules cause the reaction to stop completely

1. **Feedback** Inhibition
   1. A **product** *in excess* shuts down the reaction that is taking place at *an earlier point in the pathway*.
   2. Prevents “waste” of precious materials and energy by not making more of what is not needed at that time.