

## BIOLOGICAL FRAMEWORKS FOR ENGINEERS

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### Session #15 [Cellular Energetics]

#### General Objectives:

- ✓ Discuss the importance of energy to the body and metabolism
- ✓ Discuss cellular respiration in detail and compare with known systems

#### Central Framework:

- ✓ Cellular energetics involves the complex transformation of chemical bonds into free energy for the cell to utilize; nature's storage and handling of energy may provide insight into our engineering of energy solutions

#### Interactive Activity:

- ✓ Discussions on cellular processes to produce energy efficiently.

#### Session Outline:

##### A. Basics of Energy

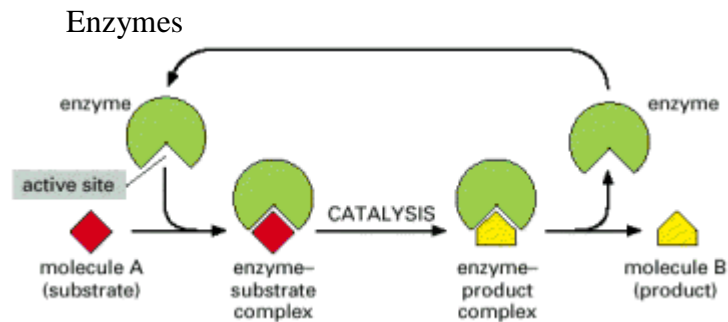
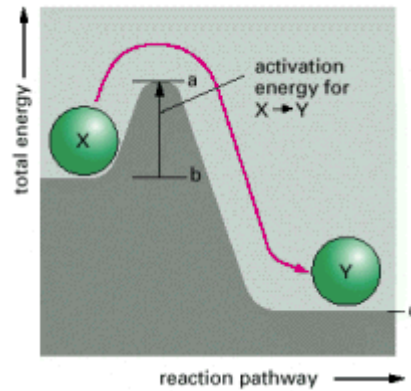
1. Thermodynamics – the science of energy transformations (Including within a single cell and an entire ecosystem)

2. Energy Conversion

Fuels (such as hydrocarbons – gasoline, wood, etc.)

Burned to release heat (chemical energy is converted to heat)

Heat is then converted into useful energy (e.g. electricity)



## B. Energy in Biologic Systems

### 1. Cellular Activity Requiring Energy (Why do we need energy?)

- a. Mechanical work – cells can change their physical location or shape and move structures within.
- b. Transport work – cells need to pump substances across the membrane
- c. Chemical work – endergonic process of polymerization (making proteins)
- d. Organization –

2. Metabolism –a collection of chemical reactions by which cells convert what they have (food, raw materials) into what they need (energy - ATP).

Fuel (carbohydrates, fats, etc.) “burned,” but energy is recaptured in the form of other high-energy chemical compounds (e.g., ATP). These compounds then donate their energy to endothermic processes

3. ATP (adenosine triphosphate) – “energy currency” of the cell

4. Cellular Respiration (breakdown of food and synthesis of ATP)

| <u>Fuel</u>            | <u>Pathways used to break it down</u>                             |
|------------------------|---|
| Carbohydrate (glucose) | glycolysis / Citric Acid (Krebs) cycle / e <sup>-</sup> transport |
| Fat (fatty acid)       | oxidation / Citric Acid (Krebs) cycle / e <sup>-</sup> transport  |

