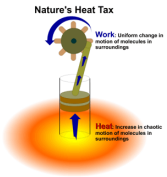
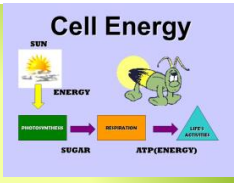
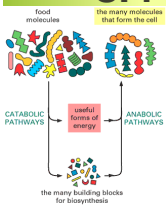
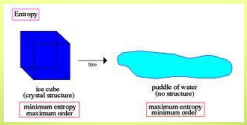
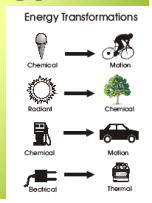




3.4 Cellular Energy

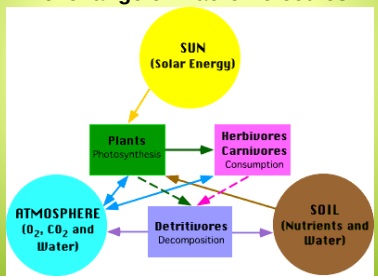






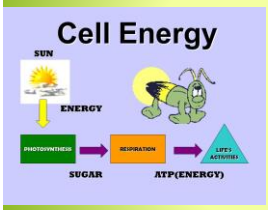
ENDURING UNDERSTANDING

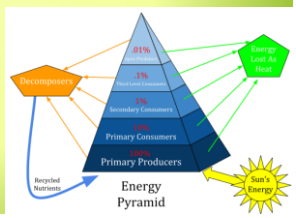
ENE-1 The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules



ENE-1.H Describe the role of energy in living organisms

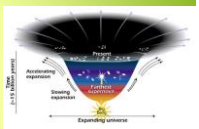
- All living systems require constant input of energy.

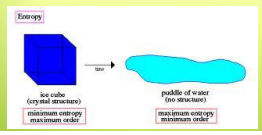


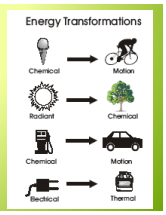


ENE-1.H Describe the role of energy in living organisms

- Life requires a highly ordered system and does not violate the second law of thermodynamics
  - **First Law of Thermodynamics**: Energy cannot be created or destroyed; it can be changed from one form to another
  - **Second Law of Thermodynamics:** Every energy transformation increases the entropy of the universe.

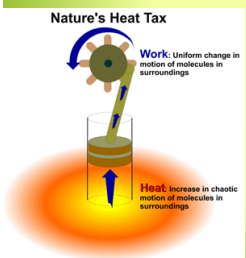


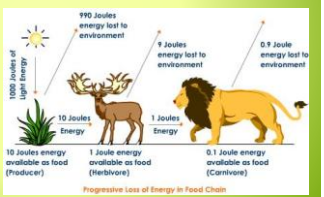




ENE-1.H Describe the role of energy in living organisms

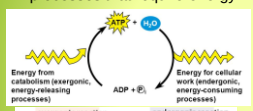
- Energy input must exceed energy loss to maintain order and power cellular processes.

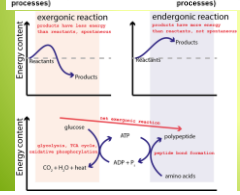


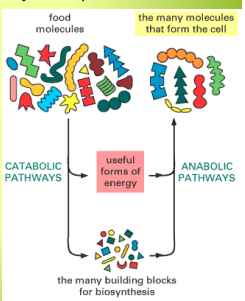


ENE-1.H Describe the role of energy in living organisms

- Cellular processes that release energy may be coupled with cellular processes that require energy.

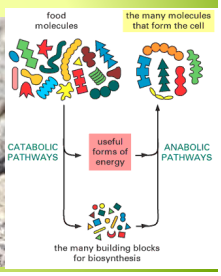






ENE-1.H Describe the role of energy in living organisms

- Loss of order or energy flow results in death.
- Increased disorder (entropy) are offset by biological processes that maintain or increase order (enthalpy).



ENE-1.H Describe the role of energy in living organisms

- Energy-related pathways in biological systems are sequential to allow for a more controlled and efficient transfer of energy. A product of a reaction in a metabolic pathway is generally the reactant for the subsequent step in the pathway.