

Nature's Heat Tax

Work: Uniform change in motion of molecules in surroundings

Heat: Increase in chaotic motion of molecules in surroundings

Cell Energy

3.4 Cellular Energy

food molecules → the many molecules that form the cell

CATABOLIC PATHWAYS → useful forms of energy → ANABOLIC PATHWAYS → the many building blocks for biosynthesis

Energy Transformations

- Chemical → Motion
- Radiant → Chemical
- Chemical → Motion
- Biological → Thermal

Ice cube (crystal structure) → puddle of water (no structure)

minimum entropy / maximum order → maximum entropy / minimum order

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.

Cell Energy

Energy Pyramid

- 81% Energy lost as Heat
- 3% Energy lost as Heat
- 9% Energy lost as Heat
- 10% Primary Consumers
- 10% Primary Producers

Recycled Nutrients

Energy Transformations

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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.

Energy Transformations

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

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

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Progressive Loss of Energy in Food Chains

- 1000 Joules of Light Energy → 10 Joules Energy (Producers)
- 1000 Joules of Light Energy → 990 Joules energy lost to environment
- 10 Joules energy available as food (Herbivores)
- 10 Joules energy lost to environment
- 1 Joule energy available as food (Carnivores)
- 1 Joule energy lost to environment
- 0.1 Joule energy lost to environment

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.

Energy from catabolism (exergonic, energy-releasing) → Energy for cellular work (endergonic, energy-consuming processes)

ATP + H₂O → ADP + H₂O

glucose → pyruvate → amino acids

CO₂ + H₂O + heat

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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.

