

Directions: Create a concept map on a sheet of short bond paper summarizing and showing the connections between the key words and processes in this handout (due on Friday for Li and Sr and Monday for K).

THERMOREGULATION

Thermoregulation

- **definition:** maintenance of body temperature within a range that enables cells to function efficiently
- **importance:** enzymes responsible for metabolic processes function best at optimal temperatures (37°C in humans)

Heat exchange between animals and their environment occur through 4 processes

1. **Conduction** – direct transfer of heat between molecules of the environment and animal's body
2. **Convection** – transfer of heat by movement of a fluid past the surface of a body
3. **Radiation** – emission of electromagnetic waves (i.e. warmth from the sun) that transfer heat between objects that are not in direct contact
4. **Evaporation** – loss of heat involved when a liquid becomes gas

Animals classified according to the major source of body heat

1. **Ectotherms**
 - absorb heat from surroundings
 - examples: invertebrates, fishes, amphibians, reptiles
2. **Endotherms**
 - obtain heat from metabolism
 - maintain a relatively stable body temperature even if environmental temperatures fluctuate
 - examples: mammals, birds, insects, some fishes

Thermoregulation involves physiological and behavioral adjustments

- **Adjusting rate of heat exchange between the animal and its surroundings**
 - *Integumentary system:* body insulation (hair, feathers, fat) reduce heat loss
 - *Circulatory system:* alter amount of blood flowing to skin
 - **Vasodilation** (increased blood flow) cools the body by transferring heat to the environment
 - **Vasoconstriction** (reduced blood flow) conserves the body's heat by reducing blood flow to the skin
 - **Countercurrent heat exchange** – special parallel arrangement of arteries and veins in the extremities of the animal: warmer blood in the arteries can transfer heat to the blood in veins

- **Cooling by evaporative heat loss**
 - Terrestrial animals lose water by breathing, panting, and through their skin
 - Evaporation of water from the skin takes away heat from the skin, cooling the animal
 - May be increased by bathing or sweating
- **Behavioral responses**
 - Movement or migration to warmer or cooler environments
 - Example: reptiles bask in the sun to warm up and seek shade when it gets too hot
- **Generation of heat by muscle motion**
 - Flying insects generate heat by continuous movement of flight muscles
 - Endothermic fishes like tuna, swordfish, and sharks produce heat via movement of muscles during swimming
- **For endotherms (especially mammals/birds): changing the rate of metabolic heat production**
 - Increase in heat production may be accomplished through:
 - **Increased contraction of muscles** by moving or shivering
 - **Nonshivering thermogenesis (NST):** action of hormones that increases the metabolic rate and produces more heat.
 - Decrease in metabolism may be accomplished through **torpor**, a state where the body is functioning at minimum levels to conserve energy
 - **Hibernation** – long-term torpor in the winter
 - **Estivation** – summer torpor
 - **Daily torpor** – inactivity during a specific part of the day (day time for bats and shrews, night time for hummingbirds)

Feedback mechanisms in thermoregulation in humans and other terrestrial mammals

The hypothalamus contains a thermostat that regulates body temperature.

- High body temperature → vasodilation and activation of sweat glands
- Cool body temperature → vasoconstriction and activation of skeletal muscles