

Ch40 Thermoregulation

Animal Form and Function

- Organisms use free energy to maintain organization, grow, and reproduce
- Physical laws shape evolution and animal's body shape and size
 - The larger the animal, the more metabolism is required to keep it alive

- However, the metabolic rate per body mass has an inverse relationship
 - The smaller the organism, the higher the metabolic rate
 - One idea is that heat is lost at a greater rate in smaller organisms due to a higher surface area to volume ratio
 - Also as body size becomes smaller, each gram of tissue increases in energy cost

Levels of Organization

Atom → Molecule →
Organelle → Cell → Tissue →
Organ → Organ system →
Organism

Homeostasis: Feedback control loops

- Homeostasis = stable internal environment
- Control systems operate around a set point – sensors can detect a stimulus above or below the set point

- Negative feedback = response is to reduce the stimulus
 - Ex: body temperature regulation
- Positive feedback = response is to increase the stimulus
 - Ex: blood clotting and child birth

Homeostasis: Thermoregulation

- Thermoregulation = how animals maintain an internal temperature within a tolerable range
- Source of Heat
 - Endotherms = maintenance of body temperature is mostly by heat generated by metabolism
 - Ex: mammals

- Source of Heat

- Ectotherms = maintenance of body temperature is by heat from external sources because of relatively little heat generated by metabolism

- Ex: invertebrates, fish, amphibians, and reptiles

Homeostasis: Thermoregulation

- Stability of Body Temperature
 - Poikilotherms = maintaining a body temperature that is the same as the surrounding environment
 - Varies body temperature
 - Ex: most aquatic animals (excluding sea mammals)
 - Homeotherm = relatively constant body temperature

Heat Gain and Loss

- Integumentary system = thermoregulation through the skin
- Insulation – reduces the flow of heat between an animal and its environment

Heat Gain and Loss

- Circulatory system = adaptations to aid in heat retention and loss
 - Vasoconstriction and vasodilation
 - Countercurrent exchange = antiparallel arrangement of blood vessels that aids in heat transfer; flow of adjacent fluids in opposite directions
 - Ex: birds, some mammals, and fish
 - Fish – also helps with oxygen intake

Heat Gain and Loss

- Behavior – birds seeking warm places in winter, bees huddling in a hive to retain heat, invertebrates orienting themselves to receive maximum sunlight to become active, preflight warm-up in moths
- Nervous system = thermoregulation center in the brain is the hypothalamus