

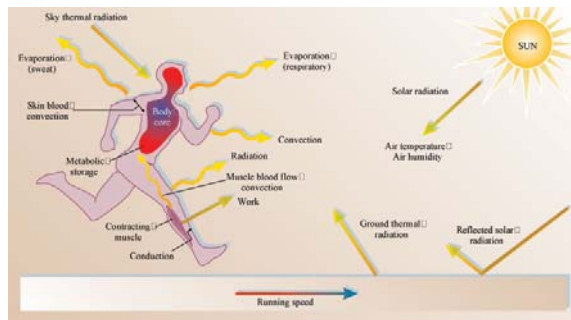
Temperature Regulation During Exercise

Chapter 4

Temperature Regulation

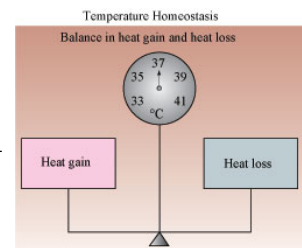
- Human body range must stay within a narrow range of temperatures.
 - _____ (normal is about 37° C or 98.6° F)
- Muscle contraction has an efficiency of about 30-33%.
 - Which means a lot of energy is released as heat.
- Endurance performance is affected by
 - The ability to get rid of excess heat in a hot environment.
 - The ability to retain heat in a cold environment.

Heat Exchange During Exercise



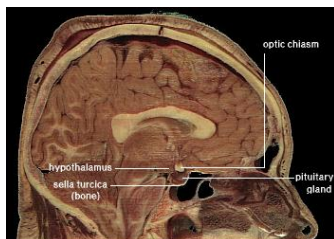
Heat Balance

- The goal of temperature regulation is to maintain a constant core-body temperature (_____).
 - Heat loss must match heat gain.
- A function of the _____ is to transport heat.
 - During exercise where heat must be lost, blood flow is increased to the skin.
 - Promotes heat loss to the environment.
 - During exercise where heat must be retained, blood flow is directed away from the skin.



Temperature Regulation

- Controlled by the _____
 - Works like a thermostat



Heat Transfer

- Energy can be transformed from one form to another.
- Terms like "_____ " and "Heat Loss" are descriptors of
 - Transformation of energy from one form to another.
 - Chemical to heat
 - Transfer of energy from one object to another.
 - Heat gradient: Heat will flow from objects with high temperature to objects with low temperature.

Heat Production

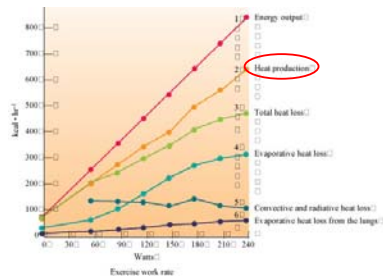
- The body produces heat through
 - Normal _____ processes
 - Not very large production of heat
 - Voluntary _____ (exercise)
 - Heat results from contraction
 - Involuntary muscle contraction (e.g., shivering)
 - Shivering can increase heat production as much as _____ resting.

Heat Loss (usually)

- Mechanisms of heat loss from the body:
 - _____
 - Heat loss to the environment in the form of infrared rays.
 - No physical contact.
 - Conduction
 - Heat flow from cooler object to hotter object where objects are in contact.
 - _____
 - A form of conductive heat loss.
 - Heat is transmitted to air or water molecules and moved away from heat source (e.g., fan).
 - Evaporation
 - Change from liquid form to vapor.
 - Heat is transferred to the skin via water. When water has reached sufficient heat, it is converted to a gas (water vapor).

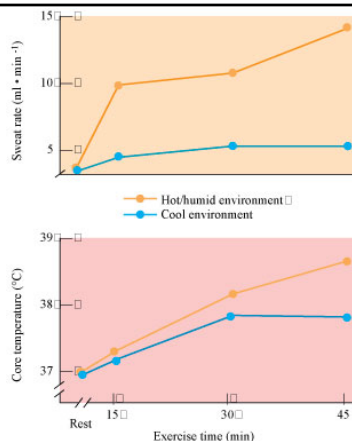
Factors that Affect Heat Balance

- Exercise intensity



Factors that Affect Heat Balance

- Wind
 - Heat loss by _____
 - Must consider relative wind speed
 - Head wind vs. tail wind
- High temperatures
 - If exercise is in an environment equal to or greater than body temperature, heat cannot be lost via _____.
 - Heat can be gained by the body in this type of environment.
 - _____ is an important mechanism of heat loss in hot environments.
 - If humidity is high, sweat does not vaporize but drips off body without producing a cooling effect.



Factors that Affect Heat Balance

- Low temperatures
 - The concern in low temperature environments is when the rate of heat loss exceeds the rate of heat production.
 - _____
 - Low body temperature
 - The body is better designed to lose heat energy vs. retain heat energy.
 - Clothing is important

Factors that Affect Heat Balance

- Cloud cover
 - The amount of _____ which the athlete is exposed to is greatest when there is no cloud cover.
- Clothing
 - As an _____
 - Traps a layer of air between skin and clothing.
 - Air is a poor conductor of heat (i.e., insulator).
 - Wear sufficient clothing to keep warm but not so much that you start to sweat.
 - Insulating properties of clothing are generally lost when they become wet.
 - To promote heat loss
 - Should not interfere with evaporation
 - Mesh singlet, breathable fabric for shorts and shirts

Factors that Affect Heat Balance

- Heat _____
 - Performance can be impaired if the athlete is not acclimatized to heat.
 - Heat acclimatization begins after the first exposure and is fully developed in _____.
 - The optimum acclimatization program is to exercise daily at intensities greater than _____.
 - Individual variability
 - Stimulus for acclimatization is raising the core temperature.
 - Characterized by earlier onset of sweating, increase in sweat capacity, reduced losses of sodium and chloride.
 - Heat acclimatization is retained for a few days up until about a week after returning to cooler climates
 - Complete loss of acclimatization _____.

Factors that Affect Heat Balance

- Dehydration
 - Loss of fluid from body due to:
- Ingestion of water during exercise enhances the ability to sustain the same exercise intensity for longer duration.
 - Including carbohydrate in the drink is better than water alone (prevents hypoglycemia; possible placebo effect).
- Fluid ingestion decreases the perception of effort.
- Fluid ingestion ad libitum is as beneficial as higher rates of forced ingestion.

Dehydration

- Is dehydration a cause of fatigue?
- Noakes reviews some of the early work on dehydration during exercise in the heat.
 - Even when given free access to adequate fluids, subjects drank less than they lost in sweat or urine.
 - Progressive dehydration was associated with premature fatigue.
 - Subjects stopped exercise when they lost about 7-10% body weight.
 - Dehydration did not reduce sweat or urine rate during exercise.
 - Rectal temperature and heart rate rose linearly with level of dehydration.
 - There were no immediate health risks associated with levels of dehydration (7-10%). Only at high levels of dehydration (15-20%) was there a risk of serious organ failure (e.g., kidney).
- Ingestion of fluid prolonged exercise (preventing dehydration).
- The impact of dehydration: stopping exercise.

Dehydration

- Several studies (Adolph, 1947; Pugh et al., 1967; Wyndham and Strydom, 1969) demonstrated that:
 - Endurance athletes _____ during competition.
 - Voluntary dehydration
 - Top finishers were _____ and had high rectal temperature.
 - But there were no dangers to athletes who were dehydrated.
- Two interpretations:
 - Fluid intake should be promoted.
 - Prevent heatstroke (failure of the heat-regulating mechanisms in the body)
 - To be a top endurance athlete you need to be able to tolerate levels of dehydration.

Dehydration

- There is no empirical evidence that endurance performance will be optimized if fluid is ingested at the same rate that it is lost during exercise.
 - McConnel et al. (1979) reported that replacing 100% sweat lost during exercise did not improve performance more than did replacing only 50% of that loss.
- Exercise in the heat is limited by _____.
 - Ingesting fluid is an important mechanism to keep body temperature controlled.
 - There may be a trade off to ingesting too much fluid (e.g., hyponatremia, excess weight, gastrointestinal problems).