Exercise in Hot & Cold Env'ts: Thermoregulation

Objectives
Temperature Conversions

To Maintain a Steady-State Core Temperature, the Body Must Balance Heat Gain w/ Heat Loss

[Diagram showing a balance scale with inputs and outputs for Metabolic heat, Environmental heat (conduction, convection, radiation), Radiation, Conduction, Convection, Evaporation, Heat gain, Heat loss]
Modes of Heat Transfer

Removal of Heat From the Skin
Thermograms of the Body Showing Variations in Radiant Heat

From Department of Health & Human Performance, Auburn University, Alabama. Courtesy of John Eric Smith, Joe Molloy, & David D. Pascoe. By permission of David Pascoe.

Evaporation
Heat Balance Equation

Humidity
The Complex Interaction b/n the Body’s Mechanisms for Heat Balance & Env’tal Conditions


Heat Balance
Internal Body Temperature

A Simplified Overview of the Role of the Hypothalamus in Controlling Body Temperature During Hyperthemia
A Simplified Overview of the Role of the Hypothalamus in Controlling Body Temperature During Hypothermia

Thermoregulatory Control of Heat Exchange
Thermoregulatory Control of Heat Exchange

Thermoregulatory Effector Organs
Cardiovascular Function in the Heat

What Limits Exercise in the Heat?
Rectal Temperature & Cardiovascular Responses in Thermoneutral & Hot Env’ts

Body Fluid Balance: Sweating

Anatomy of an eccrine sweat gland that is innervated by a sympathetic cholinergic nerve

Exercise in the Heat

TABLE 11.1  Example of Sodium, Chloride, and Potassium Concentrations in the Sweat of Trained and Untrained Subjects During Exercise

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Sweat Na⁺ (mmol/L)</th>
<th>Sweat Cl⁻ (mmol/L)</th>
<th>Sweat K⁺ (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untrained men</td>
<td>90</td>
<td>60</td>
<td>4</td>
</tr>
<tr>
<td>Trained men</td>
<td>35</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>Untrained women</td>
<td>105</td>
<td>98</td>
<td>4</td>
</tr>
<tr>
<td>Trained women</td>
<td>62</td>
<td>47</td>
<td>4</td>
</tr>
</tbody>
</table>

Individual sweat electrolyte concentrations are highly variable, but training and heat acclimation decrease sodium losses in the sweat. Data from the Human Performance Laboratory, Ball State University.
Variables of Env'tal Heat Load

Heat-Related Disorders
Warning Signs & Symptoms of Heat Cramps, Heat Exhaustion, & Heatstroke

Adapted by permission of All Sport, Inc.

Heat Cramps
Heat Exhaustion

Heat Stroke
Preventing Hyperthermia

Effects of Fluid Intake on Core Body Temperature

Heat Stress

Heat Acclimation
Effects of Heat Acclimation

Effects of Heat Acclimation on Body Core Temperature & HR During a 90 Minute Run

Δs in Rectal Temperature, HR & Sweat Loss During Heat Acclimation

Achieving Heat Acclimation
Heat Acclimation

Exercise in the Cold:
Body Heat Conservation
Summary of Human Thermoregulatory Mechanisms

Factors That Affect Body Heat Loss
TABLE 11.2  Body Weight, Height, Surface Area, and Surface Area/Mass Ratios for an Average-Sized Adult and Child

<table>
<thead>
<tr>
<th>Person</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
<th>Surface area (cm²)</th>
<th>Area/mass ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult</td>
<td>85</td>
<td>183</td>
<td>21,000</td>
<td>247</td>
</tr>
<tr>
<td>Child</td>
<td>25</td>
<td>100</td>
<td>7,900</td>
<td>316</td>
</tr>
</tbody>
</table>

Windchill Equivalent Temperature Chart

![Windchill Chart Image]
Heat Loss in Cold Water

Exercise in the Cold
Physiological Responses to Exercise in the Cold

Hypothermia
The Warming of Inspired Air as it Moves Through the Respiratory Tract

Frostbite
Health Risks During Exercise in the Cold