Sweating
Hypothalamus --> SNS output -->
SNS releases acetylcholine (ACH) on
sweat glands --> stimulates Na+ active
(with ATP) transport out of sweat gland
--> Cl- follows passively --> water
follows movement of ions

In profuse, long-term sweating:
As the Na+, Cl- and water continue
up the duct toward the skin
surface, K+ exchanged for Na+,
HCO3- exchanged for Cl- with
expenditure of ATP.
Sweating, continued….
When the ionic mixture reaches the skin surface, water is evaporated, leaving the ions on the skin.

\[ \text{Na}^+, \text{Cl}^-, \text{K}^+, \text{HCO}_3^- \]

Sweating is a highly effective way (600 kcal/L) of losing heat

A given amount of sweat causes much more heat loss than it cost to produce it.

The effectiveness of sweat varies with relative humidity

Regulation of body temperature

Body temperature is the only homeostatically regulated variable that is not allowed to change before the regulator takes action.

The regulator takes action in response to a potential change in body temperature, not an actual one.
\[ \uparrow \text{Tb} \rightarrow \text{sensors} \rightarrow \text{hypothalamus} \rightarrow \text{SNS} \rightarrow \text{sweating (\( \uparrow \) heat loss)} \]
\[ \text{vasodilation (\( \uparrow \) heat loss)} \]
\[ \downarrow \text{Tb} \rightarrow \text{sensors} \rightarrow \text{hypothalamus} \rightarrow \text{motor} \rightarrow \text{shivering (\( \uparrow \) heat prod.)} \]
\[ \text{SNS} \rightarrow \text{vasoconstriction and piloerection (\( \downarrow \) heat loss)} \]

\[ \rightarrow \uparrow \text{Tb} \]
Hypothermia
If heat loss > heat production, Tb ↓
If negative feedback cannot bring Tb ↑, then positive feedback can occur
Tb ↓ --> heat production ↓ --> Tb ↓ --> heat production ↓ --> Tb ↓, etc.

Body temperature

Log
Metabolic rate

Hypothermia
98 --> 95 F extreme shivering, change in mental ability, lack of coordination, slurred speech, aggression
94 F --> greatly impaired mental and physical below 85 F lose ability to shiver
below 78 F heart stops

Frostbite
To protect the core body temperature, the brain may shunt warm blood away from the areas with highest heat loss (fingers, toes, nose, ears) to the core.
As area cools, skin red --> skin white --> pain --> numb --> freeze --> cells killed
Hyperthermia

A. fever—a regulated rise in Tb

“Pyrogens” are small proteins released by white blood cells that detect pathogens. Pyrogens then cause the production of a fever.
Benefits of fever

1. White blood cells more mobile at higher Tb
2. WBC’s more able to kill pathogen at higher body temperature
3. Some pathogens killed directly by higher Tb

Antipyrogens (aspirin, acetaminophen) decrease set point.

2. Exercise induced hyperthermia
   (also a regulated rise in body temperature)
Hyperthermia
C. heat stroke (unregulated rise in body temp)
If heat loss < heat production + heat gain from environment, Tb ↑
If negative feedback cannot bring Tb ↓, then positive feedback can occur

\[
\begin{align*}
Tb & \uparrow \rightarrow \text{heat production} \uparrow \rightarrow Tb \uparrow \rightarrow \\
& \text{heat production} \uparrow \rightarrow Tb \uparrow, \text{etc.}
\end{align*}
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