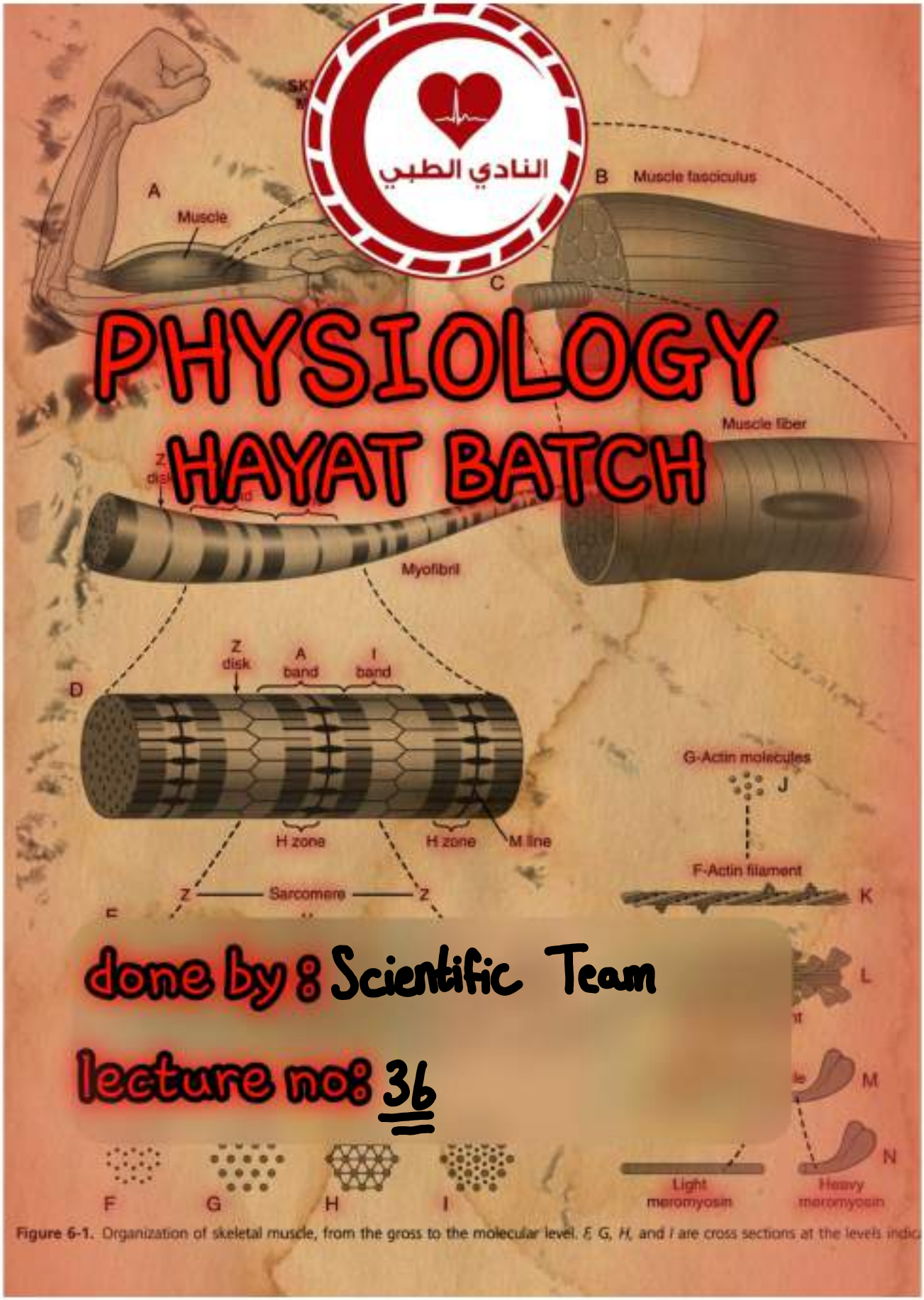

Figure 6-1. Organization of skeletal muscle, from the gross to the molecular level. *E*, *G*, *H*, and *I* are cross sections at the levels indic

General Physiology_
Temperature regulation

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Reference: COSTANZO Physiology Textbook

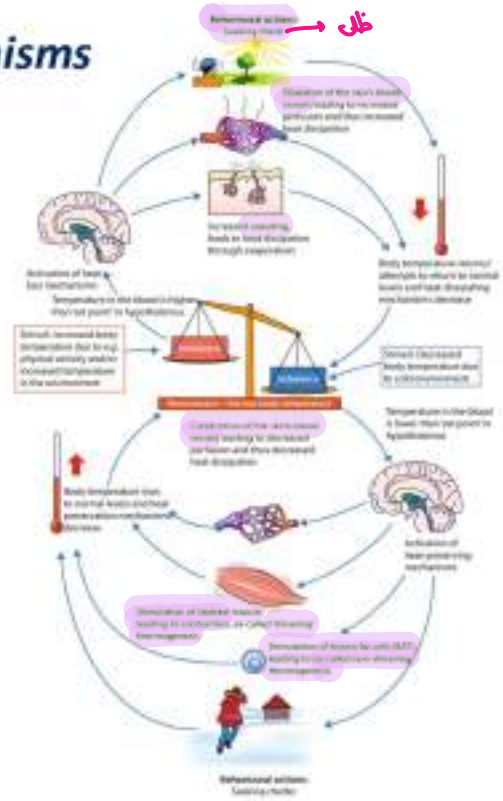
Temperature Regulation: Objectives

- ✓ *Introduction*
- ✓ *Temperature Regulation: Mechanisms*
- ✓ *Mechanisms for Generating Heat*
- ✓ *Mechanisms for Dissipating Heat*
- ✓ **Why Does Fever Occur?**
- ✓ **Heat stroke**

Temperature Regulation: Introduction

- Humans maintain a normal body temperature at a set point of 37°C (98.6°F).
- Because environmental temperatures vary greatly, the body has mechanisms coordinated in the anterior hypothalamus for heat generation and loss to keep body temperature constant.
- When the environmental temperature decreases, the body generates and conserves heat. When the environmental temperature increases, the body reduces heat production and dissipates heat.
- The anterior hypothalamus is the primary temperature-regulating center of the body.
- Thermoreceptors in the skin and the anterior hypothalamus relay information about environmental and core temperatures, respectively.
- Depending on the received information, the anterior hypothalamus orchestrates suitable responses to regulate body temperature.
- If core temperature drops below the set-point (37°C/98.6°F), heat-generating and heat-retaining mechanisms are activated.
- If core temperature rises above the set-point, heat-dissipating mechanisms are activated.

Temperature Regulation: Mechanisms



1. *Thyroid Hormones*
2. *Sympathetic Nervous System*
3. *Shivering*
4. *Behavioral changes*

Mechanisms for Dissipating Heat:

1. *Radiation and convection.*
2. *Sweating*
3. *Behavioral changes*

Mechanisms for Generating Heat:

1. Thyroid Hormones:

- Thyroid hormones are thermogenic, meaning they contribute to heat production in the body.
- Major functions of thyroid hormones include stimulating Na+-K+ ATPase, increasing O2 consumption, increasing metabolic rate, and thus, increasing heat production.
- Exposure to cold temperatures triggers an increase in the activity of thyroid hormones.
- An excess or deficit of thyroid hormones can disrupt normal body temperature regulation.
- Hyperthyroidism: increased heat production.
- Hypothyroidism: decreased heat production and heightened sensitivity to cold.

2. Sympathetic Nervous System:

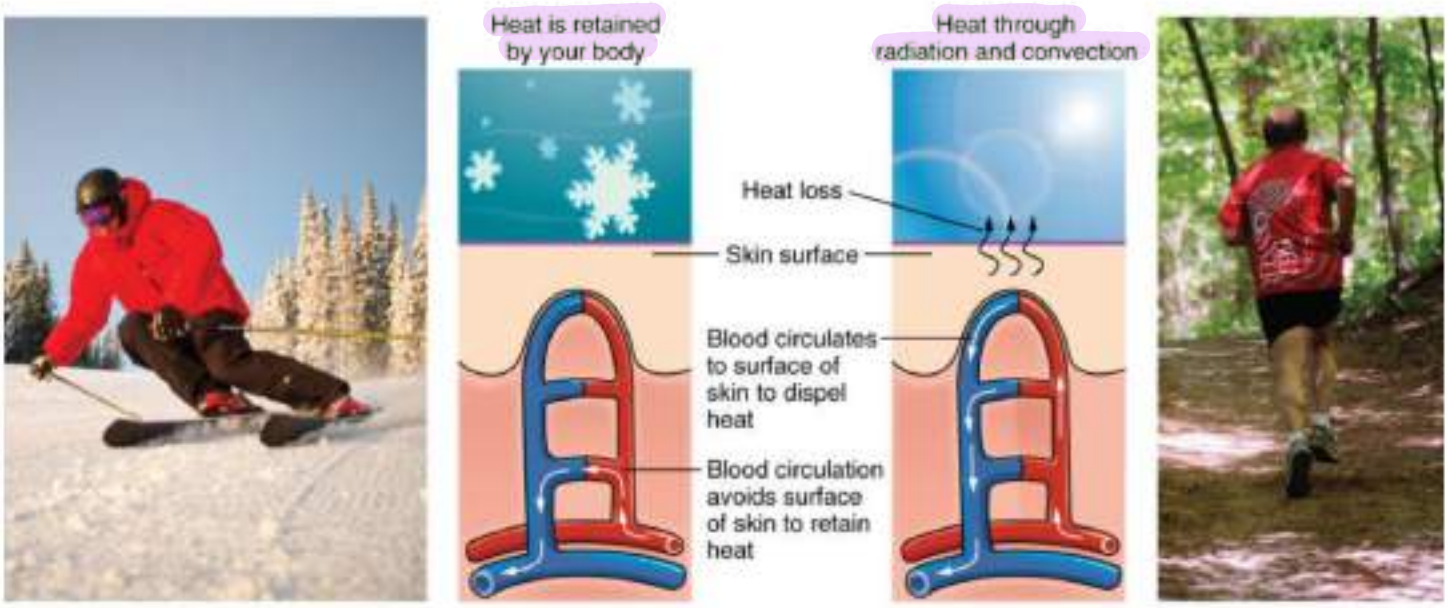
- Cold environmental temperatures activate the sympathetic nervous system.
- This activation leads to the stimulation of β receptors in brown fat, increasing metabolic rate and heat production.
- A second consequence of the sympathetic nervous system's activation is the stimulation of α1 receptors in the vascular smooth muscle of skin blood vessels.
- This receptor stimulation results in vasoconstriction, reducing blood flow to the skin surface and thereby minimising heat loss.

3. Shivering :

- Shivering involves the rhythmic contraction of skeletal muscles.
- It is a powerful mechanism for increasing heat production in the body.
- These activated centres in Hypothalamus in turn, stimulate motor neurons that innervate skeletal muscles.
- The stimulated skeletal muscles contract rhythmically, generating heat and consequently raising the body's core temperature.

Mechanisms for Dissipating Heat:

1. Radiation and convection.



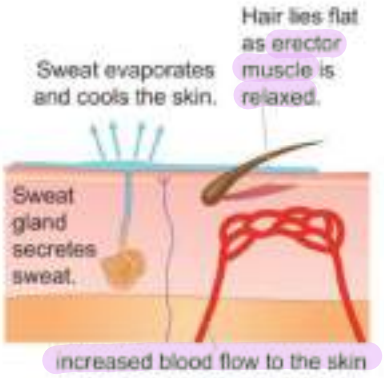
1. Radiation and convection:

- The process of heat dissipation (تبدّد) is essential for maintaining the body's set temperature point.
- Increased body temperature leads to decreased sympathetic activity in skin blood vessels.
- This reduced sympathetic tone causes increased blood flow through skin arterioles and more arteriovenous shunting (تحويل) of blood to venous plexuses (شبكة) near the skin surface.
- As a result, warm blood from the body core is directed to the skin surface, allowing heat to be lost through radiation and convection.
- This shift of blood to the skin surface can be observed as skin redness and warmth.

Mechanisms for Dissipating Heat:

2. *Sweating (evaporative cooling):* → نظام التبريد

- The activity of sympathetic cholinergic fibers to sweat glands increases, resulting in more sweating, a cooling mechanism.
- The amount that someone sweats depends on how active they are, the temperature of their environment, and their emotional state.

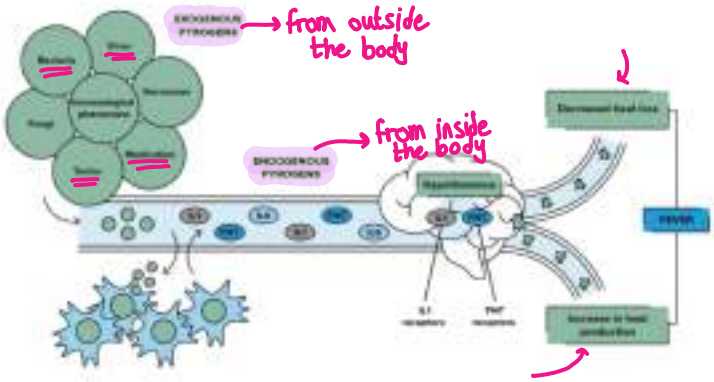


2. *Sweating (evaporative cooling):*

- As the sweat evaporates, it absorbs heat from the skin, which then cools down.
- The cooled skin, in turn, cools the blood circulating just beneath it.
- The cooled blood then circulates throughout the body, reducing the overall body temperature.
- Behavioural changes to facilitate heat dissipation can include actions like removing clothing or fanning to increase skin exposure to the air.

Why Does Fever Occur?

- An abnormal elevation of body temperature characterises fever.
- Pyrogens: increase the hypothalamic set-point temperature. This leads the hypothalamus to perceive a normal core temperature as too low relative to the new set point.
- In response, the anterior hypothalamus activates heat-generating mechanisms, such as shivering, to raise the body temperature to the new set point.



- Pyrogens are substances that induce fever and can be either exogenous (originating outside the body) or endogenous (produced within the body).
- Exogenous pyrogens are typically foreign substances like toxins, bacteria, or viruses that stimulate the immune response.
- Endogenous pyrogens are primarily cytokines, including interleukin-1 (IL-1), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-alpha). They are released by immune cells in response to infection or inflammation.
- Pyrogens act on the hypothalamus, the part of the brain responsible for temperature regulation. They raise the body's "set point" temperature, leading to fever.
- Fever is a defense mechanism of the body, creating a less favorable environment for pathogen growth and reproduction.

Not every fever needs or should be treated with ceftriaxone (antibiotic).

Fever is not a disease by itself it is a sign of disease.

Disturbances of Temperature Regulation: Heat stroke ضربة الشمس

- ✓ **Cause**: Heat stroke typically occurs when an individual is exposed to high temperatures for a prolonged period and the body's mechanisms for dealing with heat, such as sweating and blood vessel dilation, are overwhelmed. تغلبة
- ✓ **Symptoms**: high body temperature (above 104°F or 40°C), altered متغير mental state or behavior, alteration in sweating, nausea and vomiting, flushed skin جلد ملتهب, rapid breathing, racing سريع heart rate, and headache.
- ✓ **Risk Factors**: age (the very young and elderly are more at risk), certain health conditions (like heart, lung, or kidney disease), and certain medications that affect the body's ability to stay hydrated and respond properly to heat.

- ✓ **Complications:** If not treated immediately, heat stroke can cause serious damage to vital organs and can even be fatal. Complications can include damage to the brain, heart, kidneys, and muscles. The longer treatment is delayed, the more severe the damage, increasing the risk of serious complications or death.
- ✓ **Prevention and Treatment:** Prevention involves avoiding prolonged exposure to high temperatures, staying hydrated, and taking breaks in cool places when necessary. Treatment usually requires rapid cooling of the body to get the body temperature back to normal as quickly as possible. This may be accomplished through methods such as immersing the person in a bath of cold or ice water, applying cooling blankets بطانيات, or using evaporative cooling techniques.
- ✓ **Remember, heat stroke is a medical emergency.**