

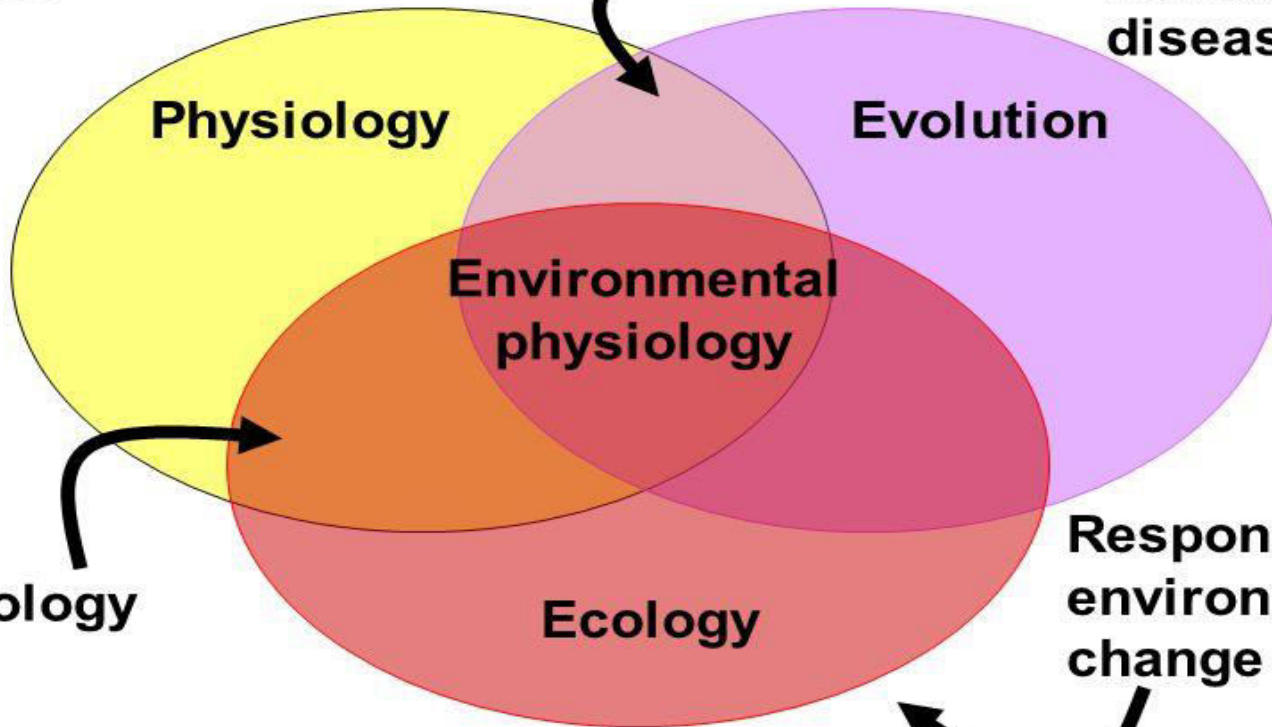
MSC II YEAR- 3rd Semester- I unit

Environmental Physiology

Why study environmental physiology?

Medicine

Evolution of health and disease



Physiology

Evolution

Environmental
physiology

Toxicology

Ecology

Response to
environmental
change

Definition of Homeostasis

1. A property of cells, tissues, and organisms that allows the maintenance and regulation of the stability and constancy needed to function properly.

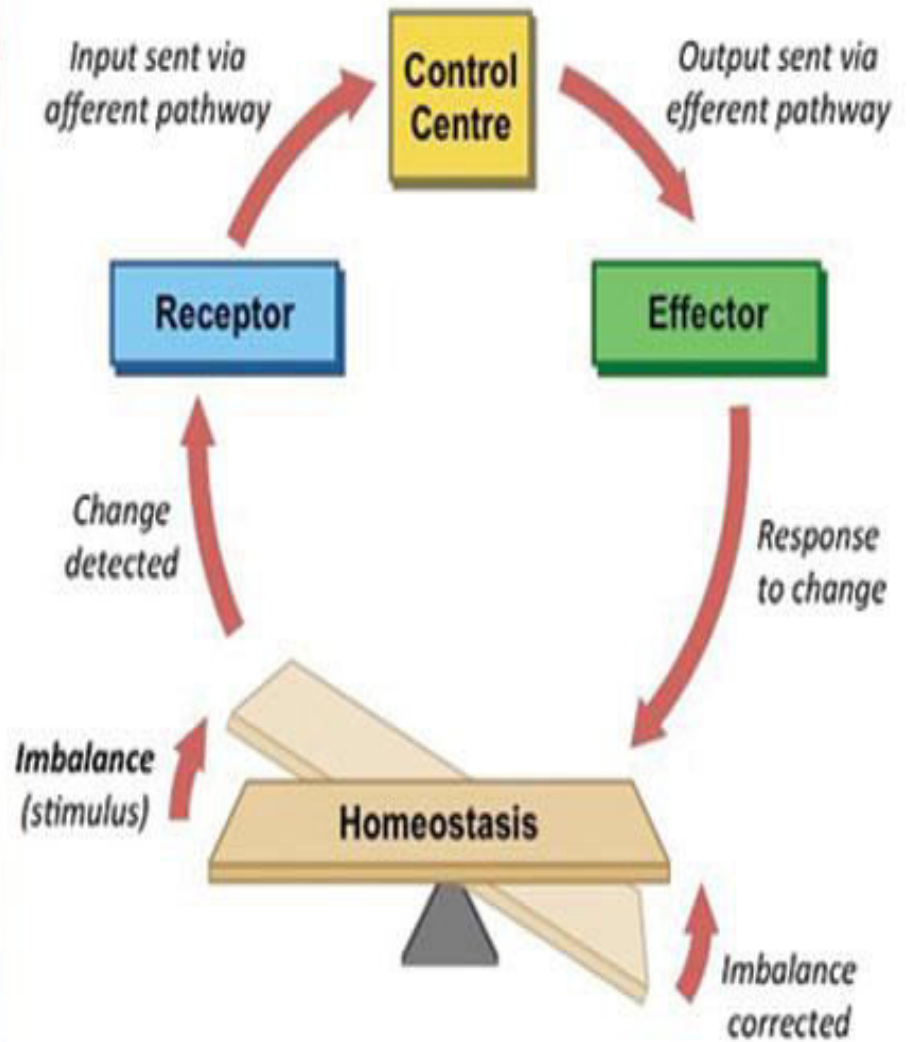
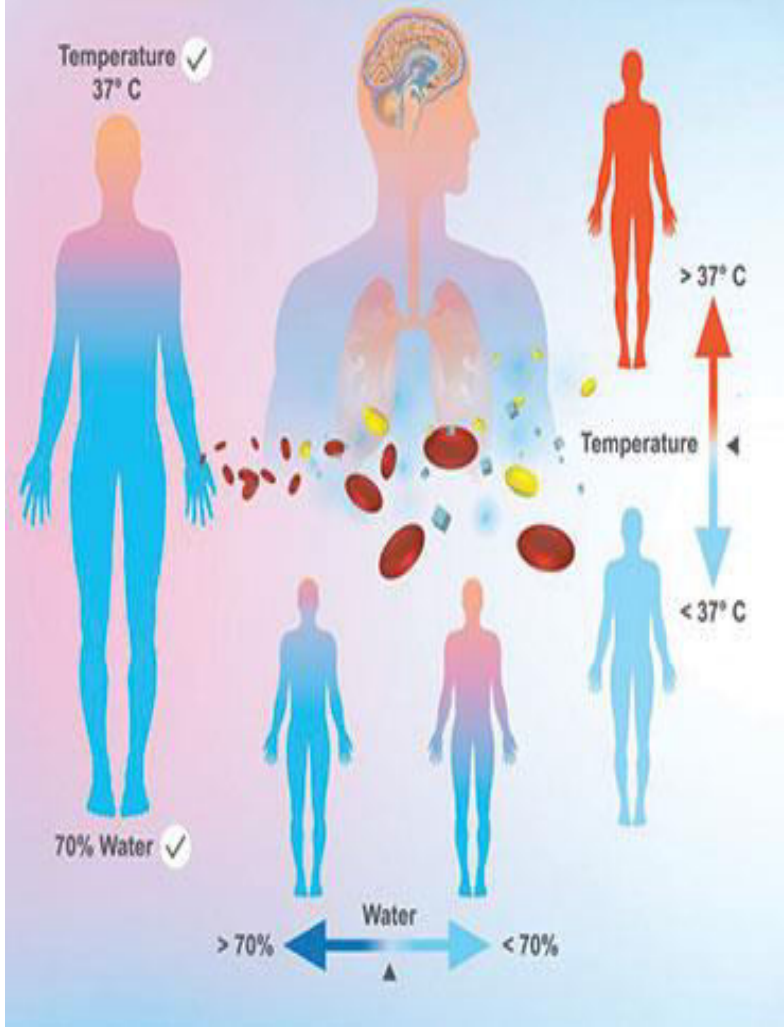
Homeostasis is a healthy state that is maintained by the constant adjustment of biochemical and **physiological** pathways.

- **2. Physiological homeostasis** is the tendency of the body to maintain critical **physiological** parameters (e.g., blood glucose level, blood salinity, blood pressure, core body temperature) of its internal environment within specific ranges of values.
- **Humans** rely on **homeostasis** to keep their core temperature hovering around 98.6 degrees Fahrenheit, so that their **bodies** can maintain proper function. ... **Homeostasis** is the ability to maintain a relatively stable internal state that persists despite changes in the world outside.

Examples of homeostasis

- in humans include the regulation of blood sugar via insulin, the regulation of body temperature by the hypothalamus, the constant surveillance and functioning of the immune system, regulation of blood pressure via sensors in the walls of arteries, the pH balance maintained by the lungs.

Homeostasis



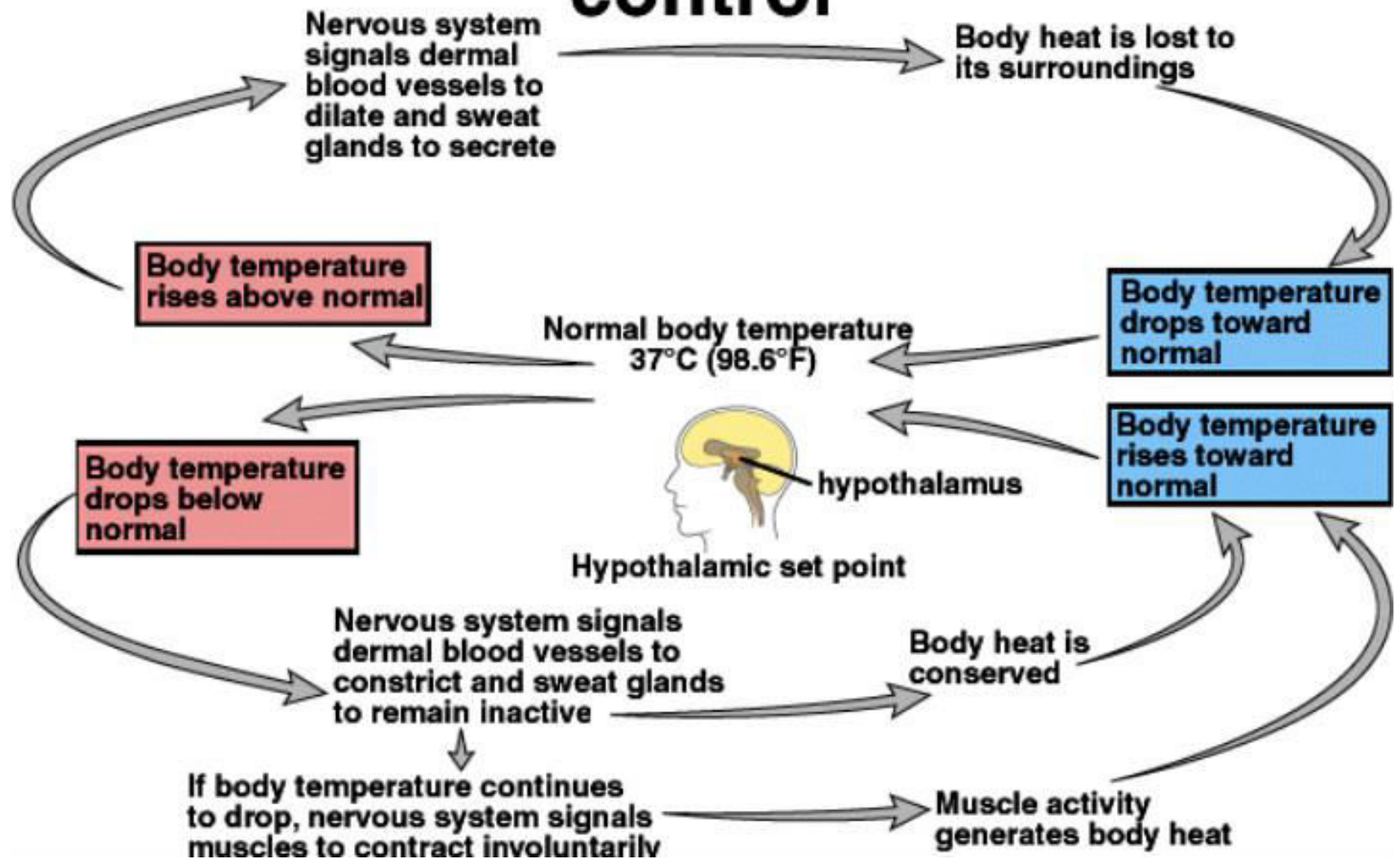
12 FUNCTIONS OF HOMEOSTASIS

- Transport, absorb, distribute, and circulate material,
- Respiration, release of energy from food or **nutrients**,
- Reproduction- production of new organisms,
- Regulation - control and coordination of internal levels, processes,
- Synthesis,
- **Excretion**,
- Nutrition,
- Growth.

thermoregulation

- **Thermoregulation** is the process that allows our body to maintain a safe internal temperature.

Homeostasis and temperature control



Goal of Thermoregulation

Maintain correct body temperature range in order to:

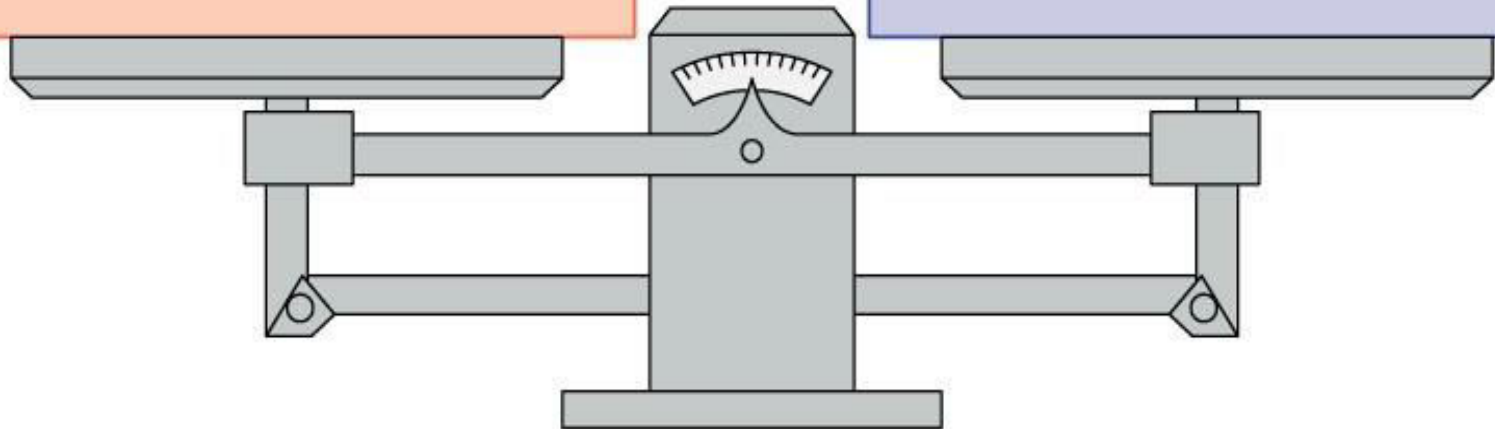
- maximize metabolic efficiency
- reduce oxygen use
- protect enzyme function
- reduce calorie expenditure

Heat production

- Basal metabolism
- Muscular activity (shivering)
- Thyroxine and epinephrine (stimulating effects on metabolic rate)
- Temperature effect on cells

Heat loss

- Radiation
- Conduction/convection
- Evaporation



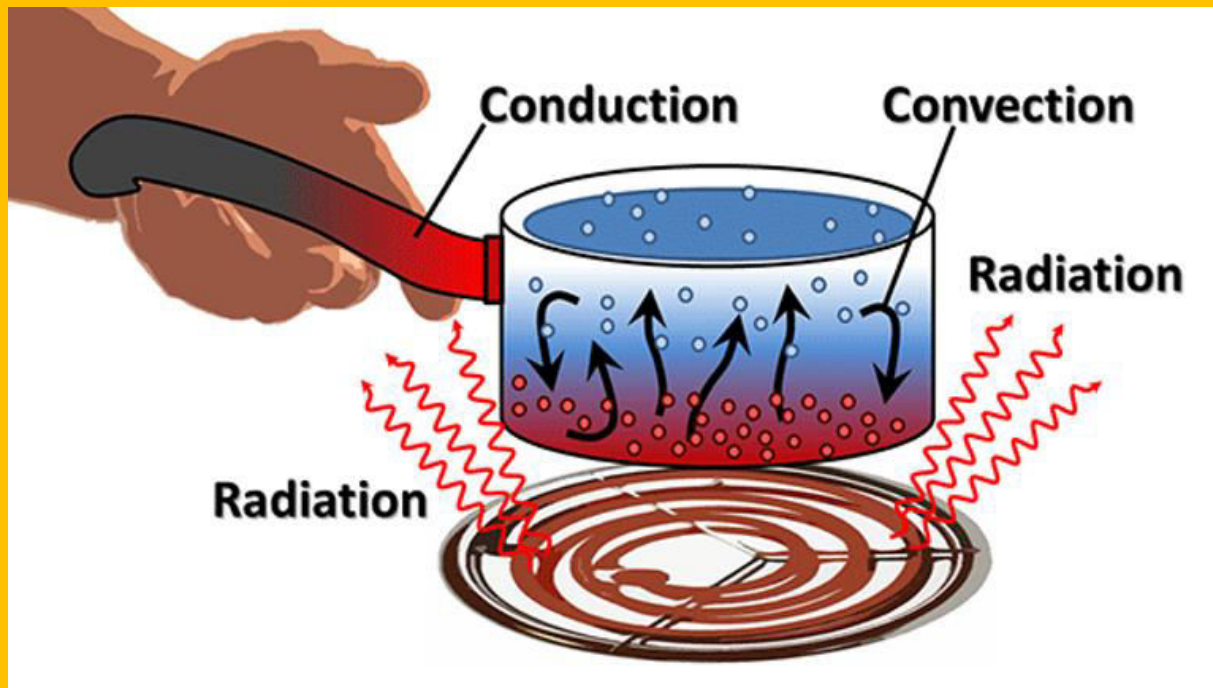
- **Metabolism** is a term that is used to describe all chemical reactions involved in maintaining the living state of the cells and the organism. **Metabolism** can be divided into two categories: Catabolism - the breakdown of molecules to obtain energy. Anabolism - building up of molecules to obtain energy.

- **Heat stress** occurs when the body's means of controlling its internal temperature starts to fail. As well as air temperature, factors such as work rate, humidity and clothing worn while working may lead to **heat stress**.

signs

- Cool, moist skin with goose bumps when in the heat.
- Heavy sweating.
- Faintness.
- **Dizziness.**
- **Fatigue.**
- Weak, rapid pulse.
- Low blood pressure upon standing.
- **Muscle cramps.**

Fundamental principles involved in thermoregulation



- **Conduction** – the process by which heat or electricity is directly transmitted through the material of a substance when there is a difference of temperature or of electrical potential between adjoining regions, without movement of the material.
- **Convection** - the movement caused within a fluid by the tendency of hotter and therefore less dense material to rise, and colder, denser material to sink under the influence of gravity, which consequently results in transfer of heat.
- **Radiation – Heat** transfer from a body with a high temperature to a body with a lower temperature, when bodies are not in direct physical contact with each other.
- **Radiation** is energy that comes from a source and travels through space at the speed of light. This energy has an electric field and a magnetic field associated with it, and has wave-like properties.
- **Evaporation** - the process of turning from liquid into vapour.

Hypothalamus and heat losing mechanism

- Our internal body **temperature is** regulated by a part of our brain called the **hypothalamus**. The **hypothalamus** checks our current **temperature** and compares it with the normal **temperature** of about 37°C. If our **temperature is** too low, the **hypothalamus** makes sure that the body generates and maintains heat.
- How does the hypothalamus regulate body temp?
- When our **hypothalamus** senses that we are too hot, it sends signals to our sweat glands to make the sweat and cool . When the **hypothalamus** senses that we're too cold, it sends signals to our muscles that make us shiver and create warmth.

How is temperature controlled?

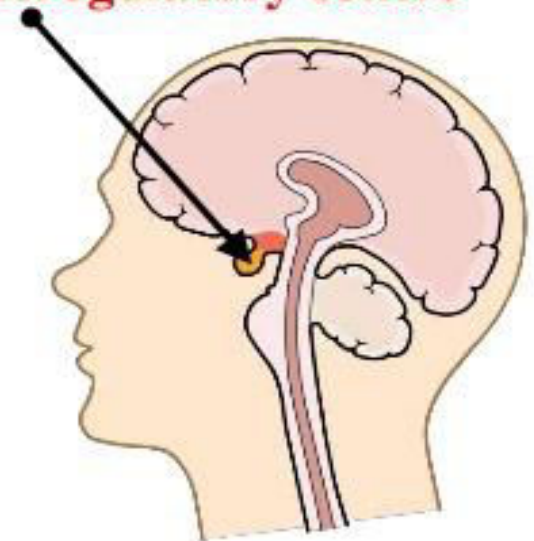
Body temperature is monitored and controlled by temperature receptors in the skin and brain (thermoregulatory centre)

Thermoregulatory centre is situated in the hypothalamus – in the brain.

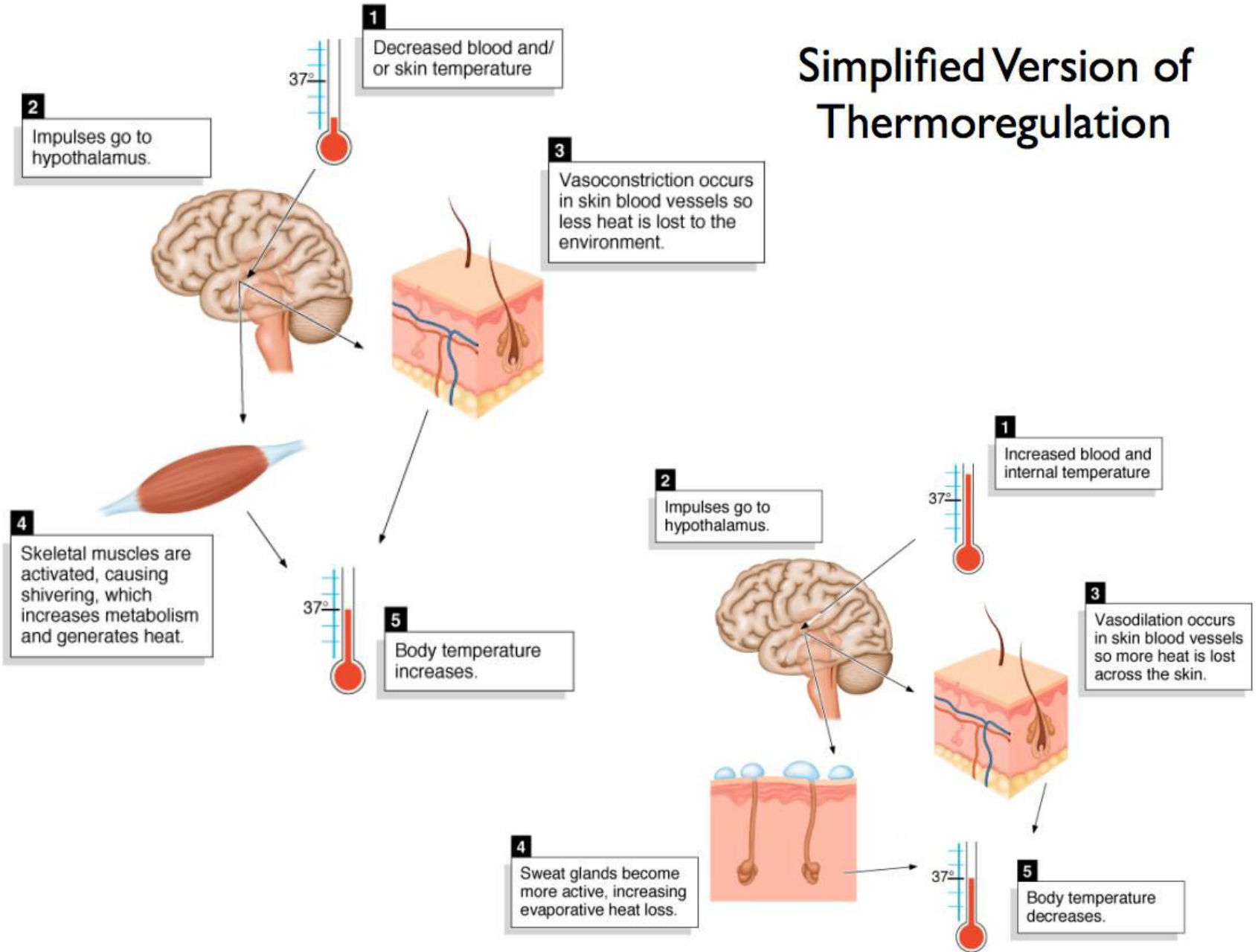
These receptors detect changes in the temperature of blood flowing through those areas.

If body temperature deviates from $37\text{ }^{\circ}\text{C}$, these receptors send out electrical signals to the thermoregulatory centre that trigger actions that increase or decrease heat loss.

Thermoregulatory centre



Simplified Version of Thermoregulation

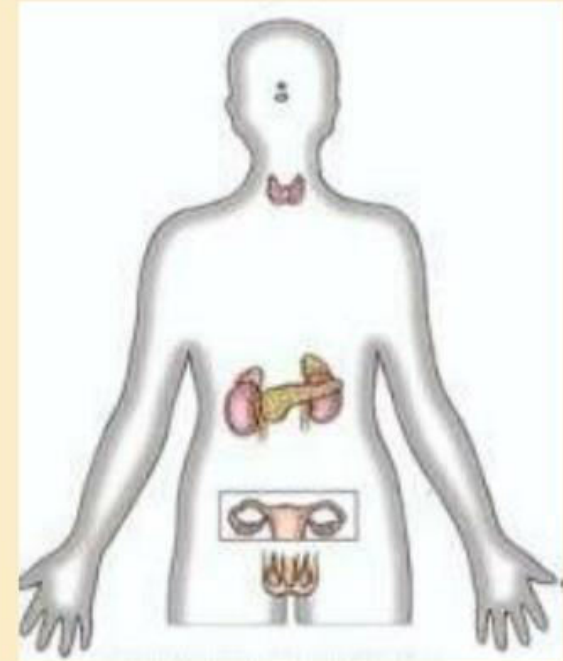


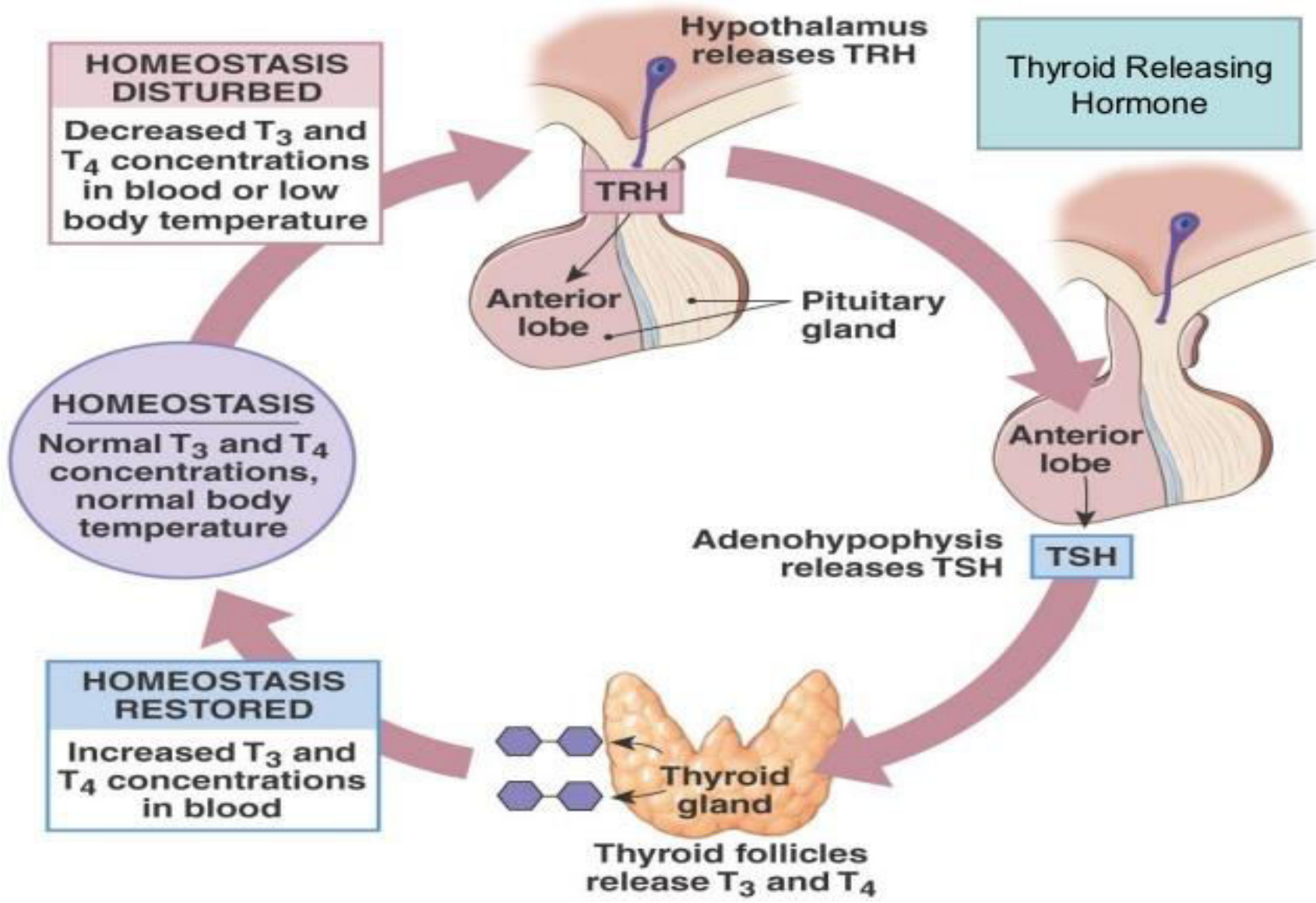
- role of endocrine glands in regulating body temperature

- The hypothalamus plays a significant **role** in the **endocrine system**. It is responsible for maintaining our **body's** internal balance, which is known as homeostasis. To do this, the hypothalamus helps stimulate or inhibit many of our **body's** key processes, including **Body temperature**.

Endocrine System

- **Functions**
 - Sends messages to control and coordinate the body's environment such as:
 - body temperature
 - metabolism
 - development
 - reproduction
 - Maintains homeostasis and regulates other organ systems
 - Hormones : chemical signals that travel through blood
 - Gland : organ that manufactures and secretes hormones
- **Major Structures**
 - Hypothalamus
 - Pituitary gland
 - Many other endocrine glands



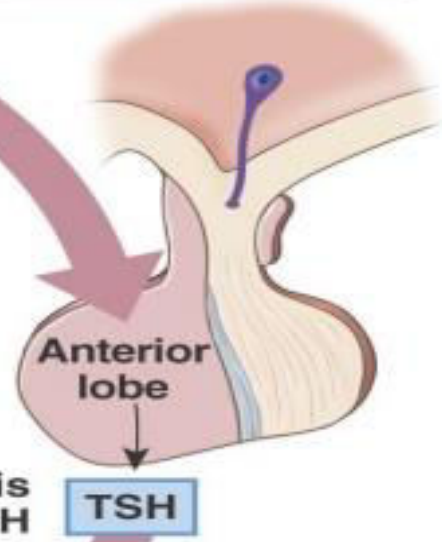
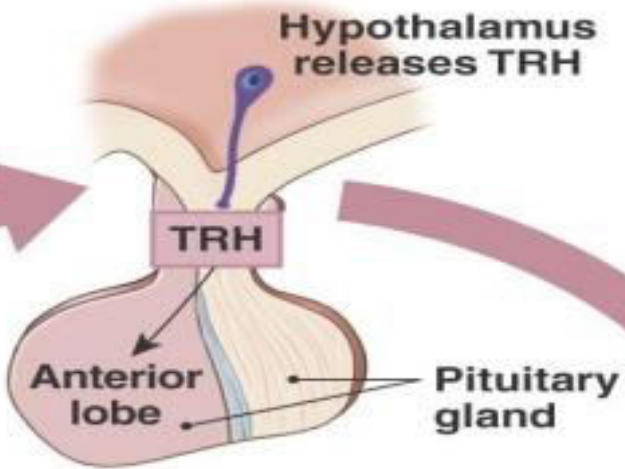


HOMEOSTASIS DISTURBED
Decreased T₃ and T₄ concentrations in blood or low body temperature

HOMEOSTASIS
Normal T₃ and T₄ concentrations, normal body temperature

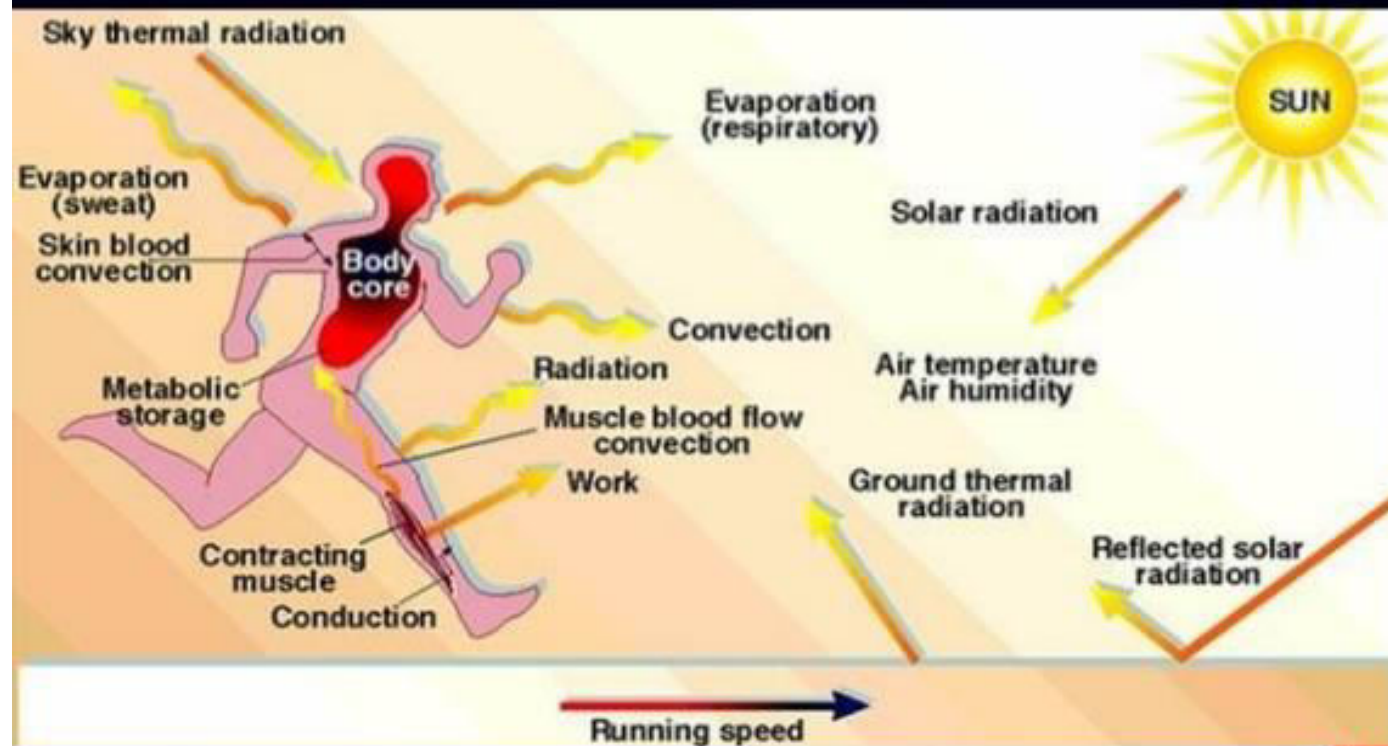
HOMEOSTASIS RESTORED
Increased T₃ and T₄ concentrations in blood

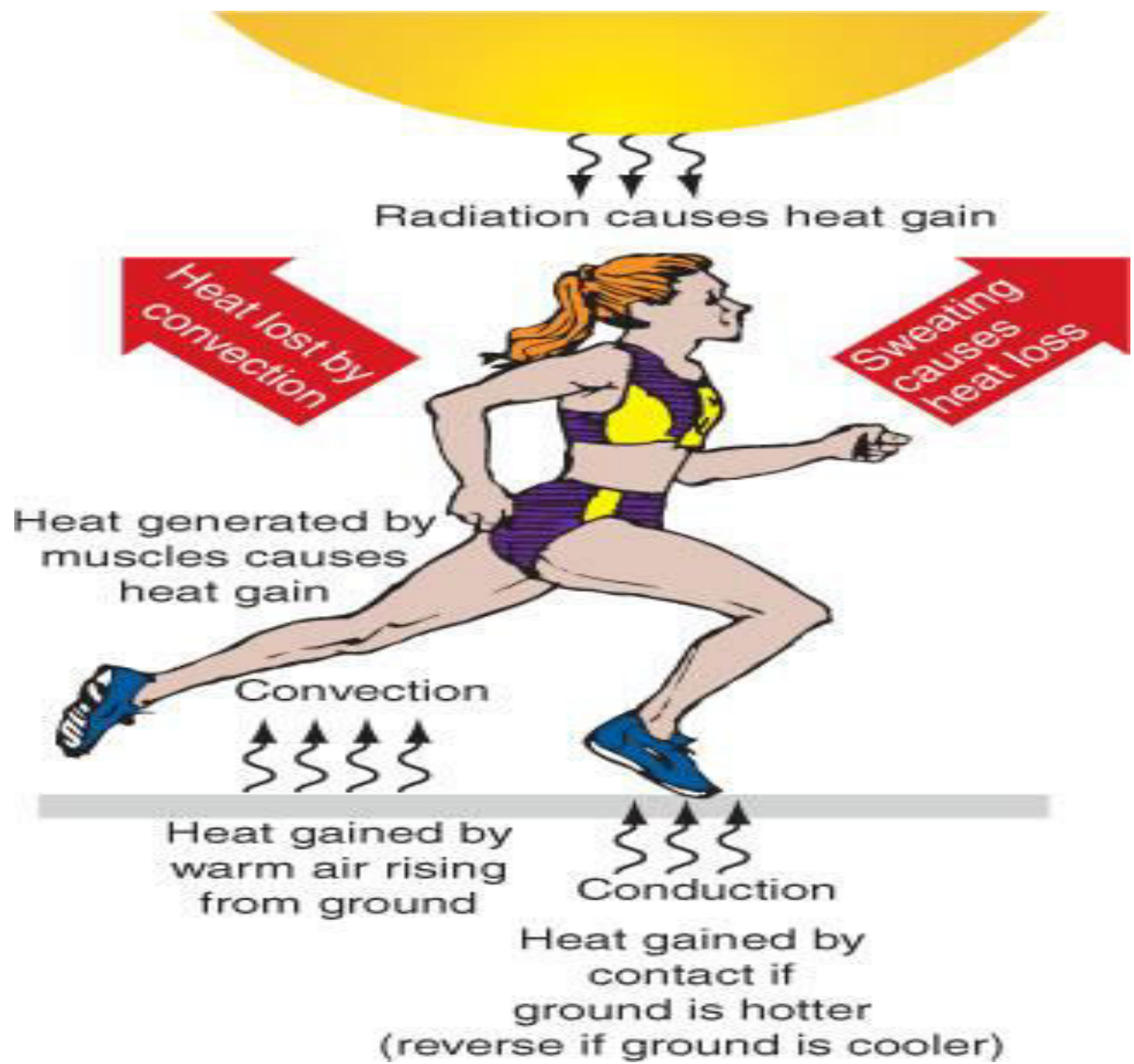
Thyroid Releasing Hormone



temperature regulation during exercise

Heat Exchange During Exercise





Radiation causes heat gain

Heat lost by convection

Sweating causes heat loss

Heat generated by muscles causes heat gain

Convection

Heat gained by warm air rising from ground

Conduction

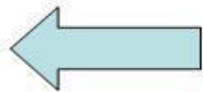
Heat gained by contact if ground is hotter (reverse if ground is cooler)

Thermal Events During Exercise

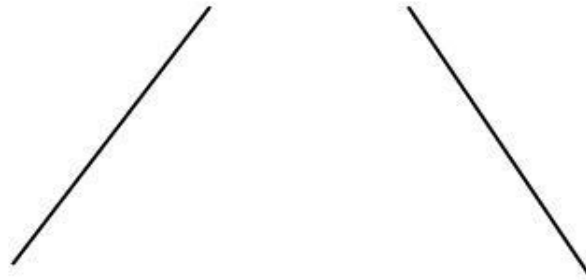
- Increase in body temperature is directly related to exercise intensity
 - Body heat load increases with intensity
- Mechanisms of heat loss during exercise
 - Evaporation
 - Most important means of heat loss
 - Convection
 - Small contribution
 - Radiation
 - Small role in total heat loss

Thermoregulation During Exercise

1. Competitive Demands



Metabolic heat must be transported by the blood from the deep tissues to the periphery



Muscles that require oxygen

2. During exercise, evaporation becomes the predominant avenue of heat loss.
3. Excessive sweating leads to fluid loss and a reduction in plasma volume. This may cause circulatory failure and increase the rate of elevation in body temperature.

- How does the body regulate temperature during exercise?
- In general, **body core temperature** is increased **during** whole-**body** continuous work and **exercise**. That is because energy produced in contracting muscles is used for muscle contraction by about 20 %, and the other 80 % is converted to heat energy and therefore increases muscle **temperature**.