

Body Temperature Regulation

For Pharmacy & Nursing students

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Introduction

Animals are classified according to body temperature regulation into:

1. **Cold blooded:** which have no mechanisms for regulation of their body temperature. Which \uparrow or \downarrow according to atmospheric temperature e.g. **frogs and fishes.**
2. **Warm blooded:** they can keep their body temperature constant inspite of changes of atmospheric temperature e.g. **mammals and man.**

Core and skin temperatures

Core temperature

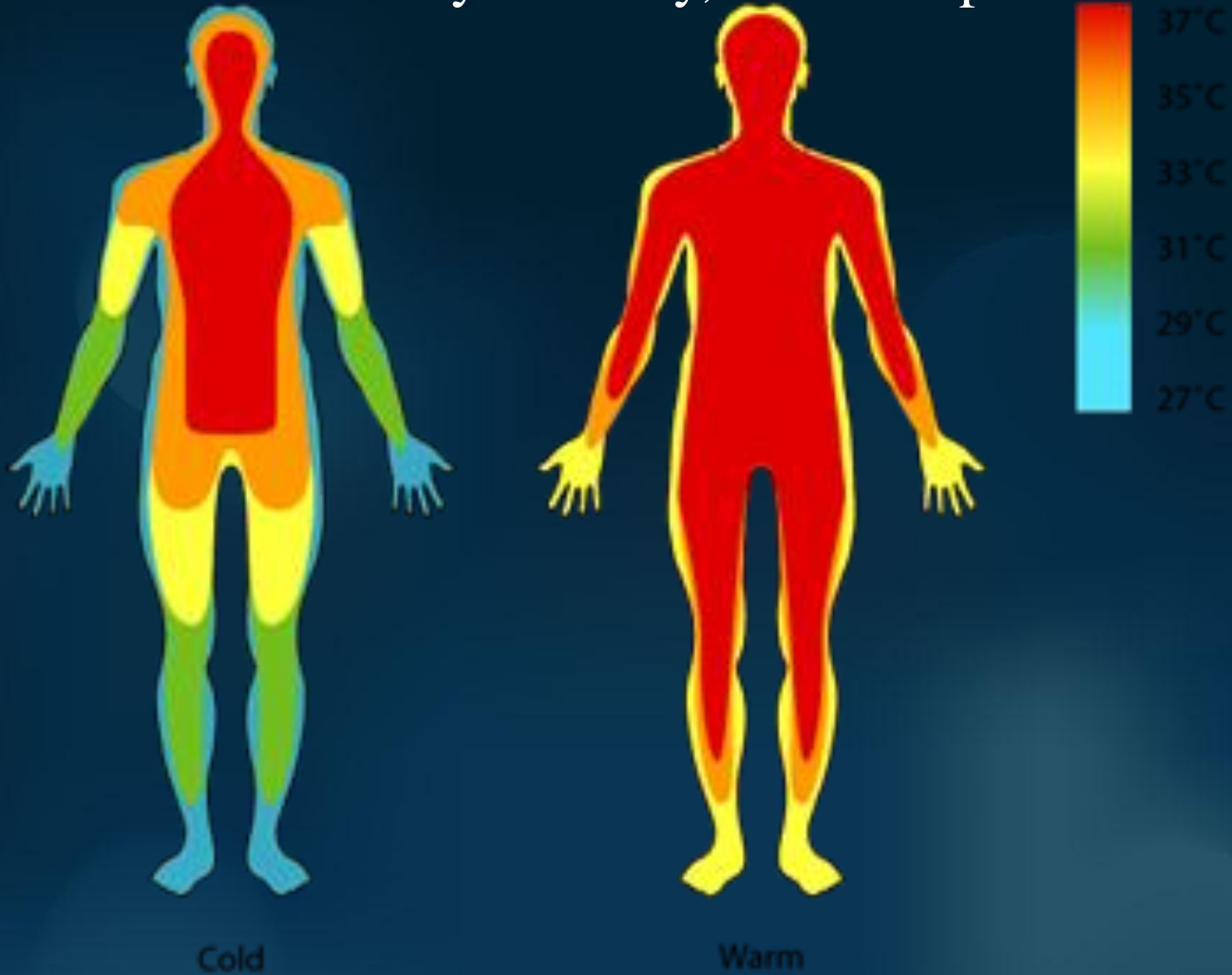
It is the temperature of the deep tissues of the body and blood which remains almost constant

Skin (shell) temperature

It rises and falls according to the temperature of the surrounding
It is usually lower than the core temperature

On a warm day, skin temperature may be just 1°C lower than the core temperature

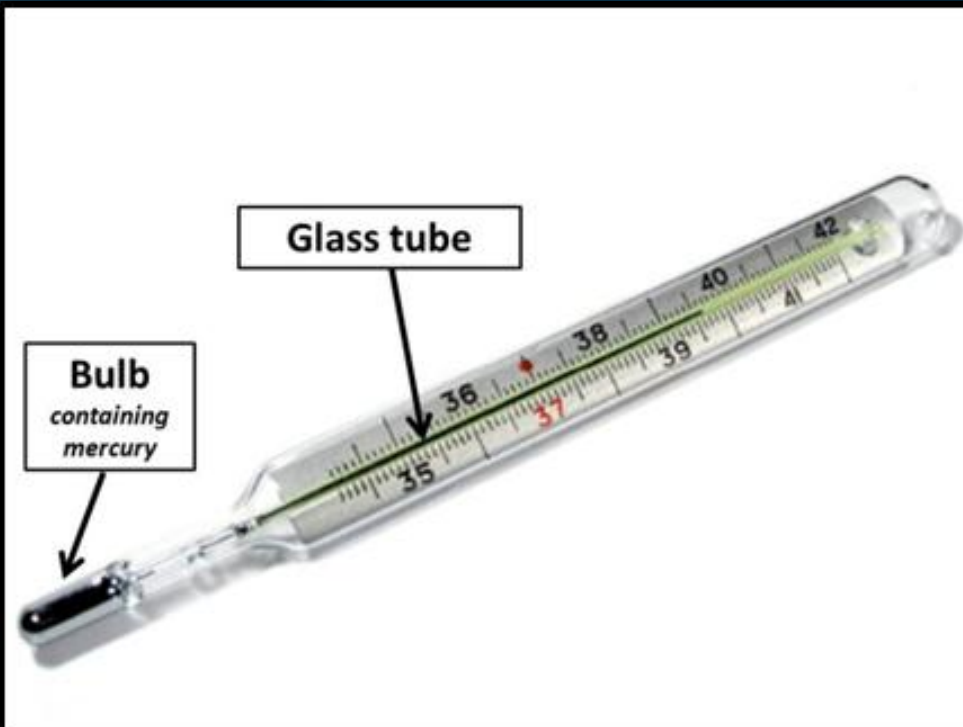
But On a very cold day, it could up to 9°C lower



Measurement of body temperature

By medical mercury thermometer

Normal body temperature ranges **36.5-37.2**.



Sites of measurements

- 1. Oral:** the bulb of the thermometer is placed underneath the tongue for 2 or 3 minutes until there are 2 successive equal readings.
- 2. Axillary:** it is 0.5°C *lower* than oral temp.
- 3. Rectal:** it is 0.5°C *higher* than oral temp.

Indication of axillary or rectal measurement

Infants

Uncooperative Children

Convulsion

Coma

Anaesthesia

Oral breathing

Variations in body temperature

1. *Diurnal variation:*

- The lowest is early in the morning before getting out of bed (*basal body temperature*). & the Highest in the late afternoon.

2. *Exercise.*

3. *Eating (Food ingestion.)*

4. *Exposure to Cold or hot bath.*

5. *Emotions.*

6. *Effect of Clothing.*

7. *In women at time of ovulation*, basal body Temperature rises by 0.5°C and remains elevated until the menses occurs by the effect of **progesterone**.

8. *Newly born infant* may show fluctuation in body temperature of 1°C or 2°C . Due to immaturity of heat regulating center.

Body temperature regulation

Body temperature is kept constant by balance between heat gain and heat loss

Heat gain

1. Basal metabolic rate.
2. Exercise.
3. Eating.
4. Exposure to sun rays.

=

Heat loss

1. Skin 85%.
2. Respiratory system 14%.
3. Body excreta 1%.

Ways of heat loss

***Skin:* (85%)**

1. Conduction, convection and radiation.

- ***Conduction:*** loss of heat from warm object to relatively cold one in contact with it.
- ***Convection:*** loss of heat through air current or water current.
- ***Radiation:*** loss of heat from warm object to relatively cold one not in contact with it. Radiant heat rays need no conducting medium.

- ## ***2. Evaporation*** → sweat secretion → Insensible water loss

Lungs: (14%)

Through **warming** of the inspired air & **H₂O**
vapor loss in expiration

Each 1 gm of water **H₂O vapor lost** leads to loss
of **0.58 Calorie**

Body excreta: (1%)

in urine and stool

- Within the comfortable zone of temperature (*28°C -31°C when the person is naked or 20-25 when dressed*) the rate of heat gain = rate of heat loss without the use of any heat regulation mechanism.

- Sweating starts if the external temperature rises above the comfortable zone.

Temperature regulation

Body temperature is detected by thermoreceptors

Central thermoreceptors

Detect **blood** temperature

Present in the **hypothalamus**

anterior hypothalamus contains the **heat** sensitive neurons.

Posterior hypothalamus contains the **cold** sensitive neurons.

Peripheral thermoreceptors

Detect the **skin** temperature

Present in the **skin**

Gives the **sensation** of coldness or hotness of objects

Hypothalamic heat regulating centers

Regulation of body temperature is achieved by the hypothalamus through 2 centers

a) Heat loss center

In **anterior** hypothalamus

Stimulated when blood temperature exceeds 37°C \rightarrow \uparrow heat loss to \downarrow body temperature to normal

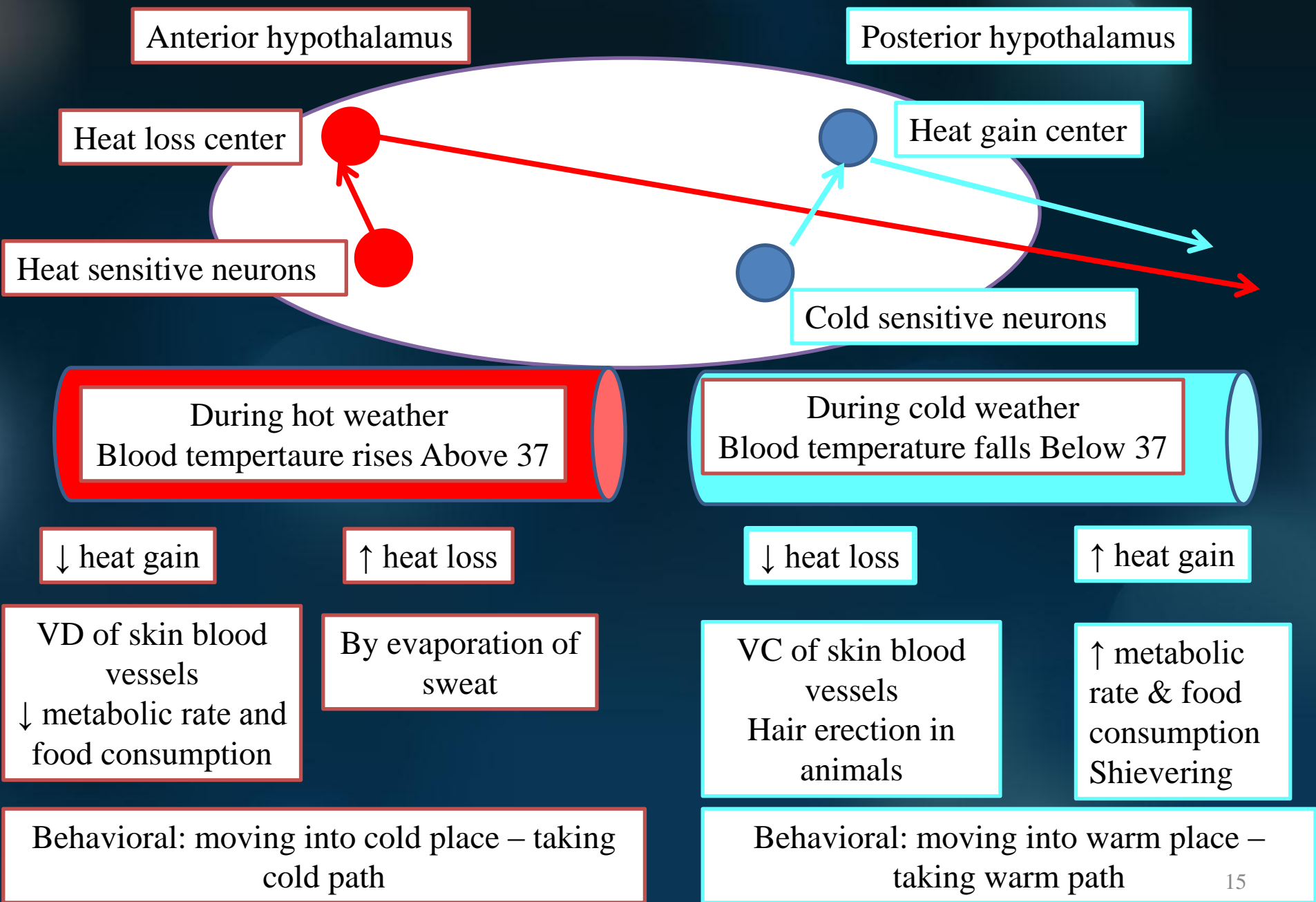
Its Injury doesn't stop the response to cold weather but stops the increase heat loss occurring in hot weather \rightarrow hyperthermia.

b) Heat gain center

in **posterior** hypothalamus

Stimulated when blood temperature falls below 37°C \rightarrow \uparrow heat gain to \uparrow body temperature to normal.

Its Injury stops the response to hot and cold atmosphere because the descending fibers from anterior nuclei pass through the posterior hypothalamus



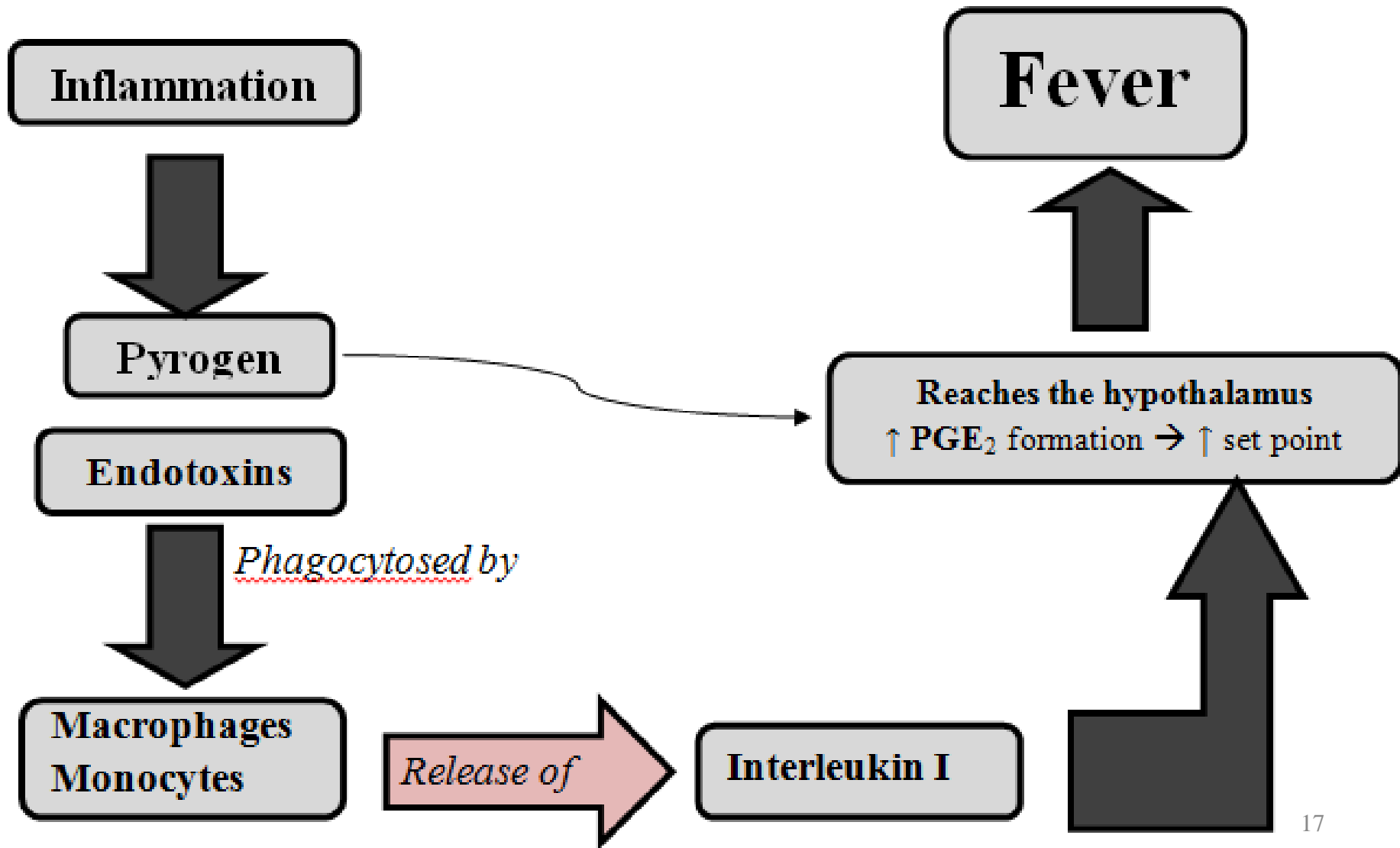
Fever



Definition: rise of body temperature above normal due to rise in hypothalamic setpoint above 37°C .

Causes: increase pyrogen levels in blood after bacterial or viral infection or tissue damage

Mechanism of fever



Aspirin and other antipyretic drugs block PGs formation so improve or relieve fever but don't decrease the temperature of a normal person

Significance of fever

- Inhibits the growth of micro-organism.
- ↑ Antibody formation.
- Inhibits the growth of some tumors.

Before the advent of antibiotics, fevers were artificially induced for the treatment of neurosyphilis and proved to be beneficial

Characteristics of febrile conditions

- **Chills:**

- Changing the set point of hypothalamus from 37- 40 → start mechanism of heat gain (vasoconstriction and shivering) , thus the person chills and feels cold.
- This continues until the temperature reaches the new set point.

- **Crises or flush:**

- When the cause of fever is removed, the set point returns to the normal level and body starts to ↑ heat loss → sweating , vasodilatation → hot skin (flush).

Heat stroke

(hyperthermia or Miner's disease)

It is a condition in which the rate of heat gain becomes more than the rate of heat loss

Causes:

- Exposure to hot humid atmosphere → stops the heat loss by all ways → ↑ in body temperature inspite of sweating.
- Hyperthyroidism.
- Dehydration.
- Malignant hyperthermia.

If the body temperature reaches 41-43°C, heat stroke develops

Effects of heat stroke

1. Dehydration (due to loss of water in sweat) → hypovolemic shock.
2. NaCl loss (electrolyte disturbance).
3. Permanent damage of body tissues by denaturation and coagulation of cell protoplasm and enzymes.
4. Permanent CNS damage → loss of consciousness and may end fatally.

Management of heat stroke

- Placing the person in cold water bath or spraying the body by alcohol.
- Workers in desert are advised to wear white light clothes especially for the head
- Taking enough water and NaCl.
- Avoid severe continuous muscular work in hot weather especially at noon.

Sun stroke

It is the damage of nervous system by the direct local effect of sun rays when fall directly on the skull and the back of head

Hypothermia

- **Definition:** Fall of body temperature below normal levels.
- **Causes:** (*Factors helping its occurrence*)
 1. Exposure to cold air current (heat loss $>$ heat gain)
 2. Cold bath.
 3. General Anesthesia.
 4. Artificial hypothermia: as during open heart surgery.
 5. Removal of clothes.
 6. Newly born infants.
- **Effects:**
 - ↓ Metabolic rate, heart rate & cardiac output.
 - It does not produce permanent damage of the tissue and normal body functions can return back to normal by warmth.

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