

# ***Biothermal physics***

***Second lecture***

## ***Body temperature and heat***

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***Third Stage***

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## **Introduction: -**

- Body temperature is tightly controlled to maintain normal **metabolic** processes. This control is achieved by the **hypothalamus**.
- Body temperature depends upon **the balance between heat generation and loss, and the ambient environment**.
- The normal range of the body temperature is **36.6-37.2 C°**.

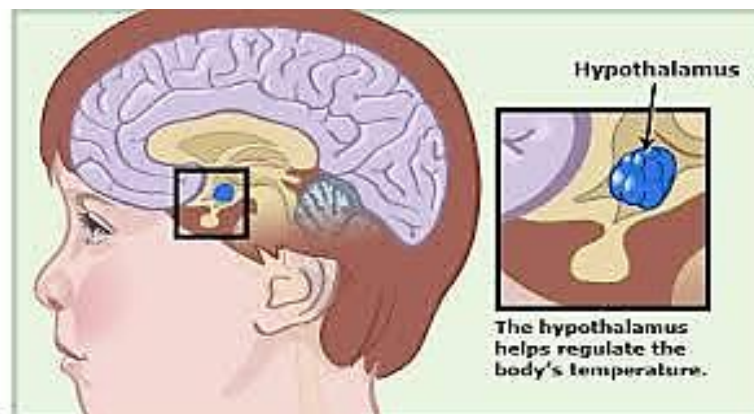
## **Heat is produced by: -**

- 1- Metabolic process.
- 2- Food intake (dynamic action).
- 3- Exercise (contraction of skeletal muscles).
- 4- Hot environment such as sun, heater.

## **Heat is lost through:**

- 1- Skin 97 % (radiation, conduction, convection and evaporation)
- 2- Expired air 2%.
- 3- Urine and feces 1%.

- ✚ The body temperature is regulated by **temperature center in hypothalamus**.



✚ When body temperature raises too high, temperature center in anterior hypothalamus is activated and following mechanisms take place:

**I- The mechanisms activated by heat are: -**

**A- Increase heat loss: -**

- 1- Skin blood vessels dilate to transfer internal heat to skin.
- 2- Sweating through sympathetic nervous system (SNS).
- 3- Increases respiratory rate.

**B- Decrease heat production: -**

- 1- Anorexia.
- 2- Apathy and inertia.

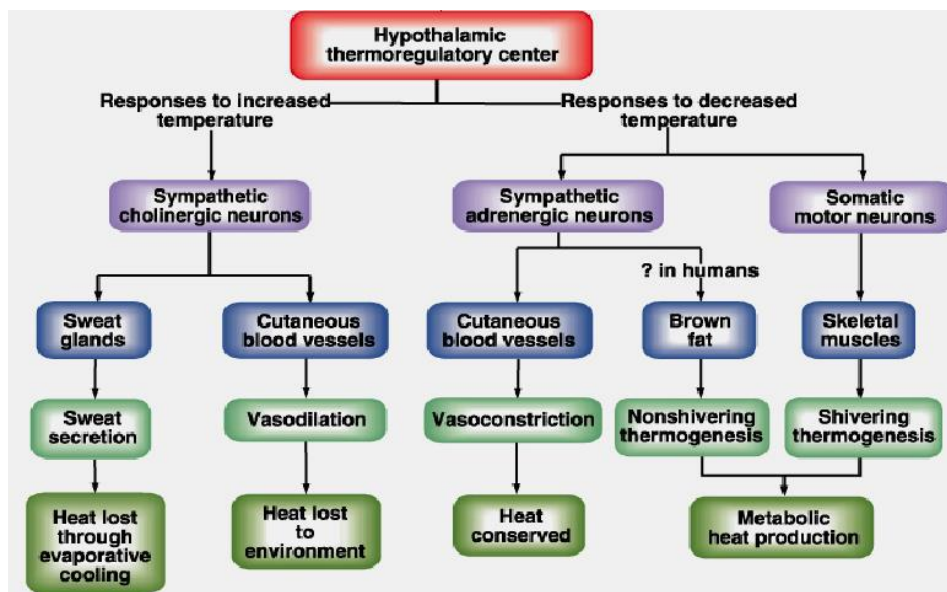
**II- The mechanisms activated by cold are: -**

**A- Decrease heat loss: -**

- 1- Skin blood vessels constrict.
- 2- Curling up.

**B- Increase heat production: -**

- 1- Shivering.
- 2- Hunger.
- 3- Increase secretion of norepinephrine and epinephrine through (SNS).



### **Physiological variation: -**

- 1- In women, the temperature may be one Celsius degree higher during ovulation.
- 2- The temperature of people who live in hot area  $0.5\text{ C}^\circ$  more than those live in cold area.
- 3- The temperature at evening  $0.5\text{ C}^\circ$  more than morning due to increase metabolism.
- 4- The temperature in groin and axilla is low  $0.5\text{ C}^\circ$  than that in the mouth while in the rectum its  $0.5\text{ C}^\circ$  higher.

### **Routs of temperature measurement: -**

- 1- Mouth route, the most commonly used route and used in a conscious adult and in children older than 5 years.
- 2- Axilla route is used in unconscious adult and children.
- 3- Groin route is used in infant and smaller children.
- 4- Rectal route is now rarely taken.

### **Types of Thermometers**

Common types of thermometers are

1. Medical thermometers
  - ✓ Infrared thermometers
  - ✓ Mercury thermometers
  - ✓ electronic thermometer
  - ✓ tympanic thermometer
4. Thermocouple thermometers
5. Laboratory thermometers
6. Bimetallic strip thermometers



***mercurial thermometer***



***Infrared thermometers***



*tympanic thermometer*



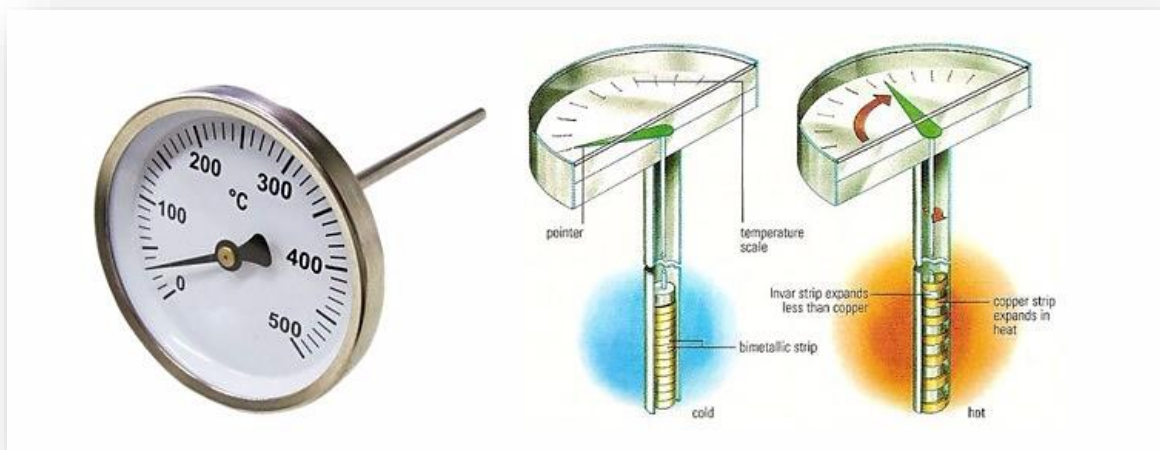
*electronic thermometer*



*Digital Scientific  
Thermocouple Thermometer*



*Laboratory thermometer*



*Bimetallic strip thermometers*

## ***Physical effect of heat***

**1. Expansion:** it is result of increased kinetic energy producing a greater vibration of molecules which move further a part.

**2. Change of State:** one form of state (solid) to the other form of state (liquid).

**3. Acceleration of Chemical Action:** (Van't Hoff's law)

State that "*any chemical action capable of being accelerated by a rise in temperature*".

**4. Thermocouple Principle:** if the junction of two dissimilar metals is heated a potential difference is produced between their free ends.

**5. Production of Electromagnetic Waves:** if energy is added to an atom by heat, this can cause electron to move out to a higher-energy electron shell. It is then said to be in an excited state. When the electron returns to its normal level energy is released as a pulse of electromagnetic energy (a photon).

**6. Thermionic Emission:** the heating of molecules of some materials (e. g.) Tungsten may cause such molecular agitation that some electrons leave their atoms.

**7. Reduced viscosity of fluids:** the molecules in viscous fluids are fairly strongly attracted to one another. Heating increases the kinetic movement of these molecules and reduces their cohesive mutual attraction this makes the fluid less viscous.