Physiology 3

## Thermoregulation

Human body temperature
- In young adult
- oral temperature ⇒ 37.1
- rectal ⇒ higher by 0.5 → 37.6
- axillary ⇒ lower by 0.5 → 36.6
- skin (shell) ⇒ lower than the central (core) temperature.

## Specific dynamic action (SDA)

⇓

It is the power of food to stimulate the MR above the BMR.

* SDA starts 1 hour after food intake, reach maximum in 3-4 hours, & disapear after 12 hours.

Causes ⇒ • Due to metabolic process taking place in Liver not due to digestion & absorption of ingested food.

Fate ⇒ It is lost as a waste heat.
However, it is useful in exposure to cold to maintain body temperature..

## Factors affecting body temperature

**Age** → In the premature baby, the temperature is lower than in mature man
↳ born before the 40th weeks of pregnancy.
kids > adults > old age (why → because of deficiency in their metabolism & thermogenesis.
→ old age have slight decrease in temperature
(why → a. Sedentary life b. ↓ in metabolic rate (toward catabolism)
c. ↓ tissue activity e. ↓ muscle tone (due to ↓ movement → atrophy)

**Sex** → Basal temp. in ♀ ↑ by 0.5°C in 2nd half of menstrual cycle.
→ pregnancy → ↑ temp. (due to progesterone) thermogenic

**Diurnal variation** → it is lowest during sleep & early morning.
→ slightly higher during awake state of afternoon (+0.5°C)

**Diseases** → Hyperthyrodism → ↑ temp ; ↑ thyroxin hormone ; ↑ metabolic rate
→ Febrile diseases → Fever ; (it's when you have fever but the cause is unknown).

**Exercise** → ↑ body temp.

**Emotions** → ↑ body temp. (↑ muscle tone & hormones)

**Environmental temp.** → Ths ↑ → ↑ body temp.

**Food intake** → ↑ body temp.

# Heat balance

## Heat production

① **Basal metabolic rate** ⇒ the ~~rate~~ loss of energy expenditure per unit time (hour) devided by body surface area ($m^2$)

under the following conditions ⇩

a. complete physical & mental rest but not sleeping.
b. Post absorptive state 12 hours after the last meal (to avoid SDA)
c. comfortable external temperature 20-25°C
to avoid sweating ↓ heat loss & shivering ↓ heat gain.

# Normal value of BMR = 40 kcal/hour/$m^2$ ±15%
it represents the unavoidable cost of life i.e metabolic activity of → heart, liver, respiratory muscle, intestine, muscle tone

② **Extra metabolic rate.**

Endocrinal activity.
- Thyroxin ⇒ ↑ heat production slowly but for long time.
- Catecholamines ⇒ ↑ heat production rapidly but for short time.

Muscular activity
↳ Shivering ⇒ heat production.

③ **Fat (brown fat)** → thermogenic.
↳ present in children ⇒ high rate of metabolism.
- # brown fat ↓ with age → white fat → stored energy
* only used in cases as starvation.

④ **Food intake.**
especially proteins → ↑ SDA → ↑ heat production.

⑤ **Sun radiation.**

## Heat loss

① **Non-evaporative heat loss**

**Radiation** 60% of heat loss — hot object → cold object — not in contact to each other.

**Conduction** 5% of heat loss — hot object → surrounding objects — in direct contact (limited)

**Convention** 15% of heat loss — Heat must be conducted to air or water & then carried away by convention current as wind.

② **Evaporative heat loss** 20% of heat loss.
- Insensible perspiration ↳ water vapor (heat) while speaking (only small amount)
- sweat secretion.

③ **Heat loss via urine & stool.** less than 1% of heat loss

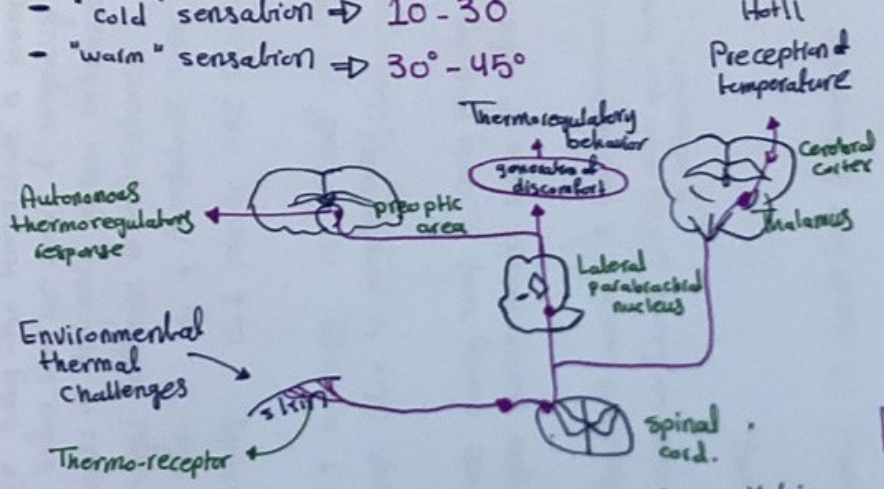
# Control of body temperature

The thermoregulatory system is composed of

## Thermoreceptors

### Peripheral thermoreceptors

- skin contains both cold & warm receptors with more cold receptors.
  - "cold" sensation ⇒ 10°-30°
  - "warm" sensation ⇒ 30°-45°




#Pathway ⇒ discharge impulses via the lateral spinothalamic tract to the thalamus & somatosensory cortex with collateral from the thalamus pass to active the heat regulatory center in hypothalamus.

### Central thermoreceptors

The anterior hypothalamus & the preoptic area contain large number of heat sensitive neurons & cold sensitive neurons.

- These receptors are sensitive to core temp. (brain & blood temp.)

## Thermoregulatory center

### Thermostat

- It is present in the hypothalamus.
- It receives impulses from the thermo receptors & compares it with specific standard reference temperature (set-point) = 37.1°C body core temp.

↓

If body temp < set point
↳ stimulation of posterior hypothalamus
↓ heat loss ↑ heat production

If body temp. > set point
↳ stimulation of anterior hypothalamus
↑ heat loss ↓ heat production.

## The effectors organs

- skin (BV & sweat glands)
- skeletal muscle
- Endocrine glands