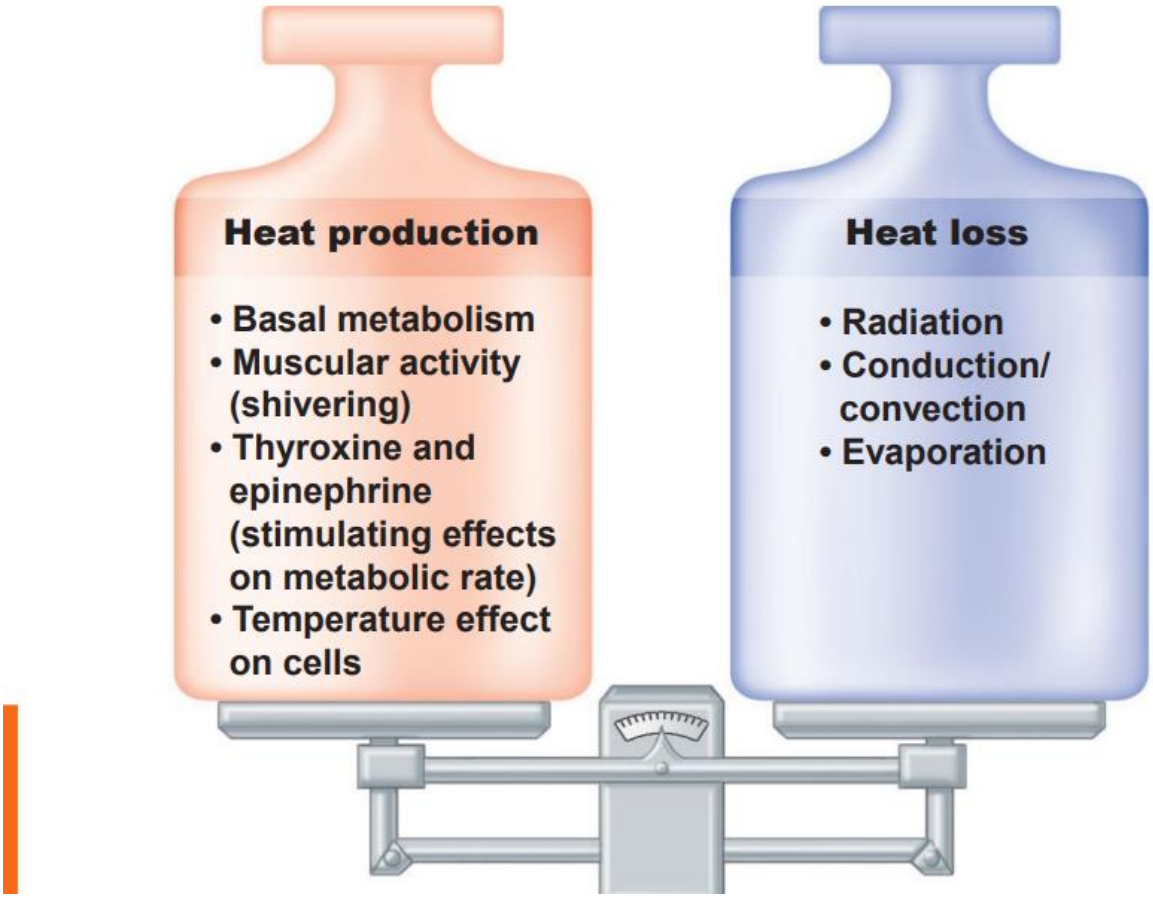
Body Temperature and its Regulation

Body temperature is tightly controlled to maintain normal metabolic processes also reflects the balance between heat production and heat loss at rest, the liver, heart, brain, kidneys, and endocrine organs generate most heat During exercise, heat production from skeletal muscles increases dramatically.

Regulation of Body Temperature

Normal body temperature = 37°C ± 5°C (98.6°F) Optimal enzyme activity occurs at this temperature Increased temperature denatures proteins and depresses neurons.



Mechanisms of Heat Exchange

• Insensible heat loss accompanies insensible water loss from lungs, oral mucosa, and skin.

• Evaporative heat loss becomes sensible (active) when body temperature rises and sweating increases water vaporization.

Role of The Hypothalamus

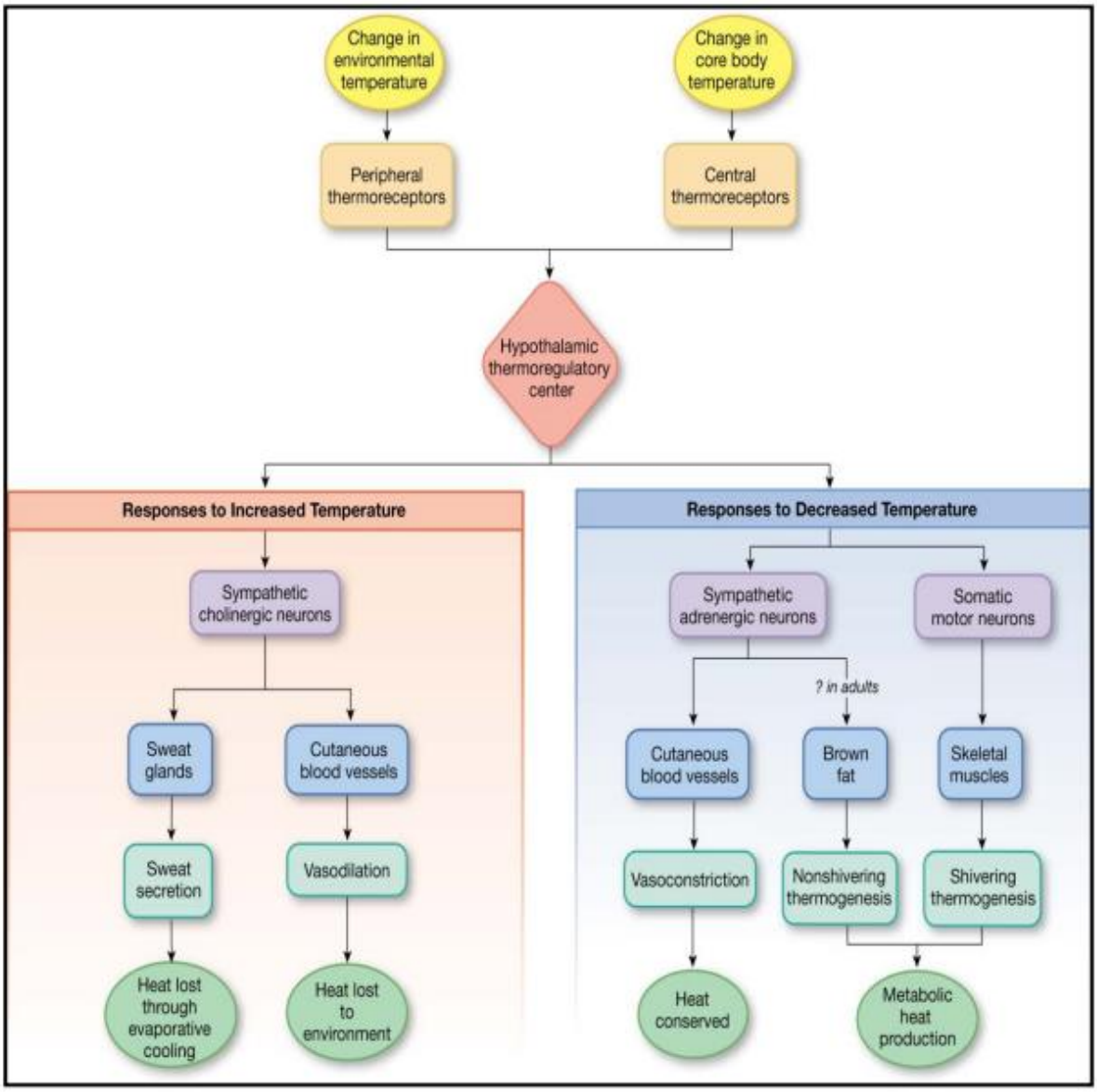
The temperature of the body is regulated almost entirely by nervous feedback mechanisms, and almost all these mechanisms operate through temperature regulating centers located in the hypothalamus. For these feedback mechanisms to operate, there must also be temperature detectors to determine when the body temperature becomes either too high or too low. The set point under normal physiological conditions is 37°C

Hypothalamus contains the two thermoregulatory centers

♣Anterior Hypothalamus : activates the mechanism that promote Heat-loss .
♣Posterior Hypothalamus : activates the mechanism that increase Heat-production and promote heat gain.

The normal body temperature in human is 37°C (98.6°F) when measured by placing the clinical thermometer in the mouth (oral temperature). It varies between 35.8°C and 37.3°C (96.4° and 99.1°F).

Figure: Response of hypothalamic thermoregulatory center to temperature change (Sympathetic cholinergic &adrenergic neurons)



the heat loss center brings the temperature back to normal by promotion of heat loss and prevention of heat production through theses mechanisms:

1) Heat loss center promotes heat loss from the body by:

A- Vasodilation of skin blood vessels

B- Increasing the secretion of sweat gland.

2) Decrease in heat production- The mechanisms that cause excess heat production, such as shivering and chemical thermogenesis, is strongly inhibited

Temperature-increasing mechanisms when body temperature decreases

When the body is too cold, the temperature controls system institutes exactly opposite procedures, it is brought back to normal by prevention of heat loss and promotion of heat production through theses mechanisms:

Prevention of heat loss by Skin vasoconstriction throughout the body- This vasoconstriction is caused by stimulation of the posterior hypothalamic sympathetic centers, The blood flow to skin decreases, and so the heat loss is prevented.

2. Increase in thermogenesis (heat production) by two ways:

A- **Shivering**: The primary motor center for shivering is situated in posterior hypothalamus. When body temperature is low, this center is activated by heat gain center and, shivering occurs. Enormous heat is produced during shivering due to severe muscular activities.

B- **Increased metabolic reactions**: The sympathetic centers, which are activated by heat gain center, stimulate secretion of adrenaline and noradrenaline. These hormones, particularly adrenaline increase heat production by accelerating cellular metabolic activities. At the same time, hypothalamus secretes thyrotropic releasing hormone (TRH). It causes release of thyroid stimulating hormone (TSH) from

pituitary. It in turn increases release of thyroxin (T4) from thyroid. T4 accelerates the metabolic activities in the body and increases heat production.

Sympathetic "Chemical" Excitation of heat production An increase in either sympathetic stimulation or circulating adrenaline and noradrenaline in the blood can rapidly increase the rate of cellular metabolism**. This effect is called chemical thermogenesis, or non-shivering thermogenesis**.

Chemical thermogenesis: It is the process in which heat is produced in the body by metabolic activities induced by hormones.

Suppression of thermoregulatory defense mechanisms during **general anesthesia** is dose dependent and mostly results in perioperative hypothermia. Several adverse effects of hypothermia have been identified, including an increase in postoperative wound infection, perioperative coagulopathy and an increase of postoperative morbid cardiac events. Perioperative hypothermia can be avoided by warming patients actively during general anesthesia. Fever is a controlled increase of core body temperature.

The incidence of fever varies **with type and duration of surgery, patient's age, surgical site and preoperative inflammation.**

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.

Materials and instruments:

1- Medical or clinical thermometer (figure 1-1).
2- Antiseptic substance.
3- Cotton.
4- Container.

Procedure:

1- Before inserting thermometer in the mouth, wash it by antiseptic solution.
2- Hold the thermometer by fingers and watch the level of mercury, if it is higher than 35C˚, shake it down to bring mercury below this level.
3- Put it in the mouth under the tongue for 2 minutes. 4
4- Mouth should be firmly closed, breathing is taken through nose.
5- Prior to reading, no hot or cold substance is placed in mouth and no gum chewing. *Fever (pyrexia): is a temporary increase in body temperature.*

ϖ Fever is present if the oral temperature is >37.7°C, or tympanic temperature >37.5°C.

A


B

Figure 1-1 shows different types of thermometers(a- mercurial, b-electronic & c- tympanic)

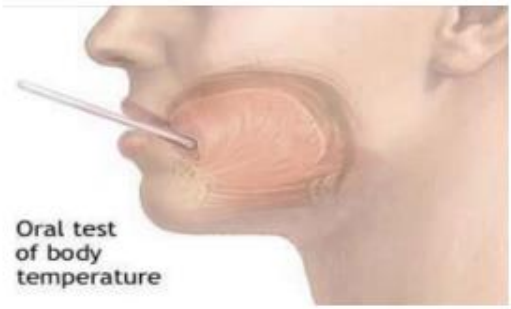


Figure 1-2: demonstrate oral temperature measurement

Ear thermometers

The forehead thermometer