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L12
Thermoregulation &Heat in Medicine

Heat and low temperature

Heat is thermal energy transferred from system to another.

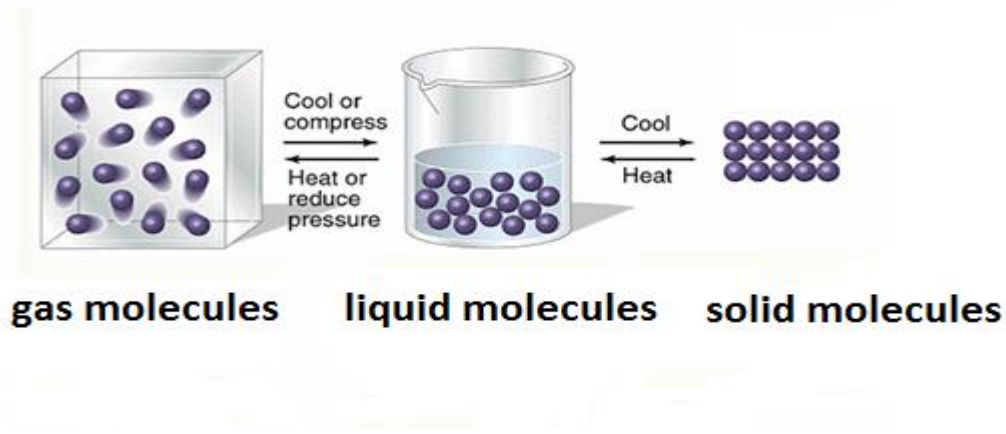
The direction of energy flow is from the substance of higher temperature to the substance of lower temperature. Heat measured in units of energy, usually calories or joules.

Temperature is the measure of hotness or coldness of matter., or is the average kinetic energy per molecule of a substance. Temperature is measured in degrees on the Celsius (C) or Fahrenheit (F) scale, or in kelvins (K).

The amount of heat required to raise one gram of water 1° Celsius is one calorie. When heat energy flows into a substance, the temperature of the substance usually rises.

Therefore, as molecules of all materials are moving so they have kinetic energy. The average kinetic energy (K.E) α temperature (of an ideal gas, liquids and solids)

i.e K.E α T



Heat can be remove from a substance to lower the temperature. Low temperature referred to as the cryogenic region (absolute zero,-273.15°c).

Thermometry and temperature scales

Temperature is difficult to measure directly, so we usually measure it indirectly by measuring one of many physical properties that change with temperature, such as volume (density) increases with temperature for most substances, electrical resistance and color and the emission of infrared radiation.

Temperature scales

1. **1-Fahrenheit scale (°F): in this scale, the freezing temperature is 32°F and boiling point is 212°F, and normal body temperature is about 98.6°F.**
2. **The Celsius (°C): the freezing point is 0°C and the boiling point is 100°C, in between is divide into 100 division.**

3. **The Kalvin scale(°K):or the absolute scale this scale has the same divisions as the Celsius but takes the 0° K at the absolute zero which is=-273.15°C.**

What is thermoregulation?

Thermoregulation is a process that allows your body to maintain its core internal temperature. All thermoregulation mechanisms are designed to return your body to homeostasis. This is a state of equilibrium.

A healthy internal body temperature falls within a narrow window. The average person has a baseline temperature between 98°F (37°C) and 100°F (37.8°C). Your body has some flexibility with temperature. However, if you get to the extremes of body temperature, it can affect your body's ability to function. For example, if your body temperature falls to 95°F (35°C) or lower, you have "hypothermia." This condition can potentially lead to cardiac arrest, brain damage, or even death. If your body temperature rises as high as 107.6°F (42 °C), you can suffer brain damage or even death.

Many factors can affect your body's temperature, such as spending time in cold or hot weather conditions.

Factors that can raise your internal temperature include:

- **fever**
- **exercise**
- **digestion**

Factors that can lower your internal temperature include:

- **drug use**
- **alcohol use**
- **metabolic conditions, such as an under-functioning thyroid gland**

Your hypothalamus is a section of your brain that controls thermoregulation. When it senses your internal temperature becoming too low or high, it sends signals to your muscles, organs, glands, and nervous system. They respond in a variety of ways to help return your temperature to normal.

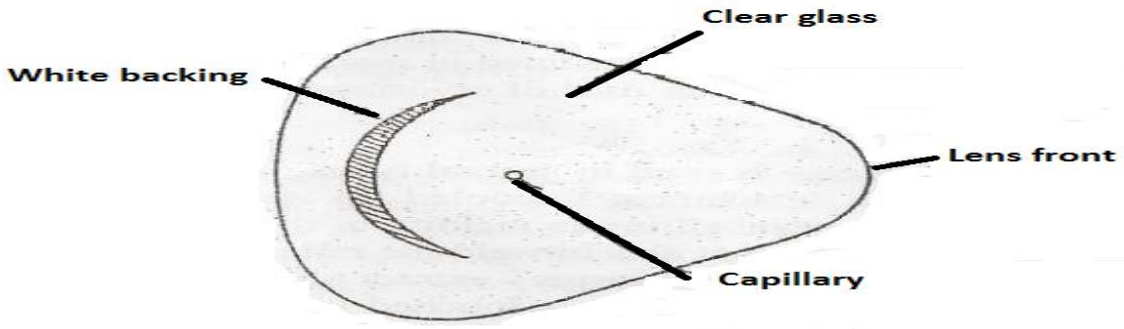
Types of thermometers

1. **Glass-liquid thermometer**

- **In the thermometer, a temperature increase causes the mercury to expand more than the glass causing the liquid to rise in the capillary, for mercury it expand 1.8%from (0-100°C).**
- **As the fever temperature is need to be precise, it has a thin capillary less than 0.1mm in diameter, which makes the mercury to rise higher per degree.**
- **In addition to that, the fever thermometer has a restriction above the bulb making the mercury not to return if the thermometer is expose to low**

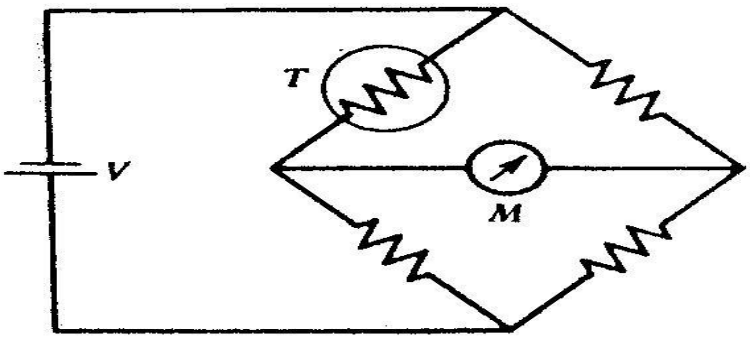
temperature unless the thermometer is move rapidly with proper snap of the wrist.

- **In the fever thermometer, because the mercury is raising in a very thin capillary a better vision is made by making the front glass tube convex to act like a magnifying lens and the back of the tube is opaque, white colored. The temperature usually taken underneath the tongue or in the rectum.**



2. Thermistor

- **Initially the four resistors are equal, that is, the bridge is balance by symmetry, and the voltages at each end of the meter are equal and no current flows through the meter.**
- **A temperature change causes the thermistor resistance to change. The voltage at each end become unequal, causing current to flow and the meter deflection can be calibrate for temperature.**
- **The resistance of a thermistor T can be measure with a simple bridge circuit to determine the temperature.**



Application of thermistor in medicine

Thermistors are used quit often in medicine because of their sensitivity and responds rapidly to temperature change (with a thermistor it is easy to measure temperature change of (0.01 °C))
Thermistors are occasionally place in nose to monitor the breathing rate of patients by showing the temperature change between inspired cool air and expired warm air. This instrument called penumograph.
Pneumograph: is a device for recording velocity and force of chest movements during respiration.