# L13
# Thermoregulation &Heat in Medicine

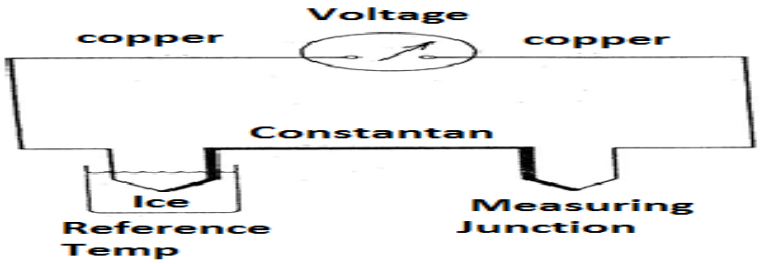
## Types of thermometers

### 3.Thermocouple

**Thermocouples are sensors that measure temperature. The core of a common thermoelement probe thermocouple consists of two dissimilar metals(two junctions) brought together at a point. When this point is subjected to a change in temperature (ΔT), a thermal gradient is created across the two dissimilar metals within the point. Due to the thermoelectric effect, electric potential V forms across this thermal gradient. Calibration between this electric potential and known temperatures allows for determination of unknown temperatures at the tip of the thermocouple.**

**Usually one of junction is kept at a reference temperature such as in ice-water bath. The copper-constantan thermocouple can be used to temperatures from -190 to 300°C.**

**For 100 ° C, temperatures difference, the voltage produced is only about 0.004V. Thermocouple can be made small enough to measure the temperature of individual cell.**




**Types of thermocouple**

**1. A medical-grade thermocouple is a device based on thermo-electric operations composed of bifilar and multi-filar wires made from traditional thermocouple alloys. They are used for measuring tissue temperature during therapeutic procedures. Thermocouples are commonly used to treat tachycardia and atrial fibrillation, as well as measuring the tissue temperature during radiofrequency ablation of cardiac arrhythmias. They are also used in ventilators.**

## 2.Thermography-mapping the body's Temperature

**Measurements of body surface temperature indicate that the surface temperature varies from point to point depending upon**

1. **External physical factors**
2. **Internal metabolic**
3. **Circulatory processes near the skin blood flow.**

**Near the skin is dominant factor, since the variations in these condition, many researchers have attempted to accurately measure the surface temperature of the body and relate it to pathologic conditions.**

**The simple method of obtaining a surface temperature map (thermogram). It was found that most breast cancer could be characterized by an elevated skin temperature in the region the cancer, The surface temperature above tumor was typically about 1c° higher than that above nearby normal tissue.**

**One very appealing method of obtaining a thermogram is to measure the radiation emitted from the body in the infrared (IR) region.**

**The basic equation describing the radiation emitted by a body was given by Max Plank .**

**For our purposes the Stefan-Boltizman law is more useful .**

**The Stefan–Boltzmann law states that (the total energy radiated per unit surface area of a black body in unit time (known as the black-body irradiance, ), $E_r$ is directly proportional to the fourth power of the black body's thermodynamic temperature T (also called absolute temperature)**

$$E_r = e\,\sigma T^4$$

**The irradiance $E_r$ has dimensions of energy flux (energy per time per area), and the SI units of measure are joules per second per square meter, or equivalently, watts per square meter.**

**T; is absolute temperature**

**e; is the emissivity =1 for radiation from the body**

**σ; is the Stefan Boltizman constant= 5.7x10-12W/cm2.K4**

**The power radiated** $P = e\,\sigma A T^4$

**Example:**

**a. what is the power radiated per square centimeters from skin at a temp. of 306°K.?**

$$E_r = e\,\sigma T^4 = (5.7\times10\text{-}12)(306)^4 = 0.05\,W/cm2$$

**b. what is the power radiated from a nude body 1.75m2(1.75×104 cm2) in area?**

$$P = (0.05)\,(1.75\times104\ cm2) = 875\ W$$

**Thermography is a test that uses an infrared camera to detect heat patterns and blood flow in body tissues.**

- **Digital infrared thermal imaging (DITI) is the type of thermography that is used to diagnose breast cancer. DITI reveals temperature differences on the surface of the breasts to diagnose breast cancer.**

- **The idea behind this test is that, as cancer cells multiply, they need more oxygen-rich blood to grow. When blood flow to the tumor increases, the temperature around it rises.**

- **X-ray mammography has shown much more successful results to detect breast tumor of less than 1cm in diameter, but they present a radiation hazard to the body.**
- **Thermograph has been most commonly used as an aid in detecting breast cancer. It is customary to compare the patterns from two breast. The cancer becomes warmer than the whole.**
- **It was found that one third of thousands women, have abnormal thermogram of the breast and less than 1% has shown cancer.**

**A basic thermographic unit used to measure the radiation emitted from a part of the body. (IR) radiation from a small area of patient is passed by mirror through a chopper to a detector. The chopper changes the continuous radiation to an alternating signal. That it can be more easily amplified. The IR transparent filter removes visible light, and detector converts IR to electrical signal that is proportional to the temperature of the body. The position and magnitude of radiation from the patient, displayed on the cathode tube (CRT).**

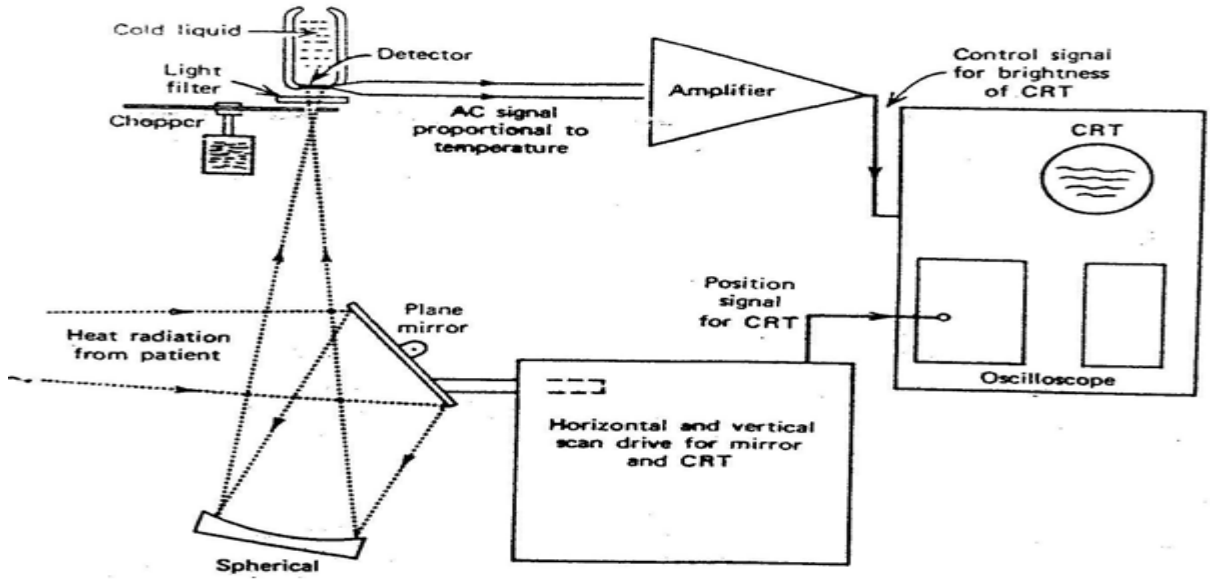



**Diagram of a typical thermo graphic unit.**

## What Is Medical Thermography?

**Thermal imaging is a type of imaging that uses infrared radiation. The thermal imaging machine detects light in the infrared range of the electromagnetic spectrum and produces images of that light. Since infrared radiation emits all objects according to their temperature, therefore the use of this system allows for visibility without any visible light.**

**Medical Thermography uses an infrared camera that creates an image by converting heat energy that radiates from the body into a signal which can then be viewed on a monitor and printed.**

**Using no radiation and no contact, it's ideal for disease prevention because of the high level of sensitivity and specificity.**

**What can cause an abnormal scan?**

**Cancer, inflammation, toxins, hormonal imbalance, nerve damage, and lack of circulation can cause abnormal heat**

**More red means more heat, which comes from more blood flow and metabolic activity.**

**That is why your head typically appears more red that your elbow, because your brain should have more activity than your elbow.**