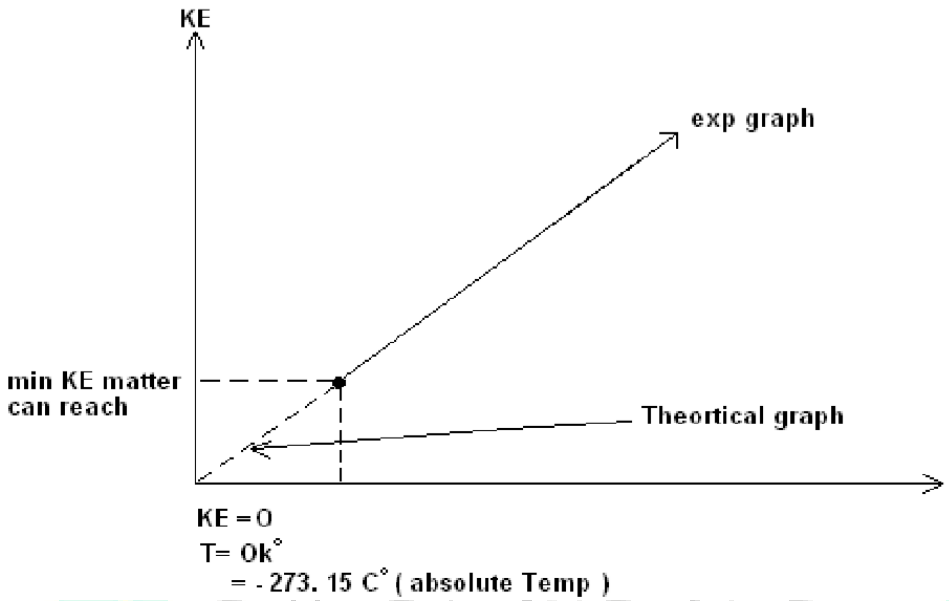
Heat & Cold In Medicine

Matter is composed of molecules that are in motion

(This means have KE, it related to Temp : KE α Temp) .



Heat : It is the energy transferred from the hot subject to the cold subject causing to rise the temp of cold subject.

Solid heat , Liquid heat, Gas heat → ion

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 temp. .

1- Fahrenheit scale(°F):in this scale the freezing temp. is 32°F and boiling point is 212°F ,and normal body temp. is about 98.6°F.

2- The Celsius(°C):the freezing point is 0°C and the boiling point is °100C ,in between is divided 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.

Temperature Measurement Devices:

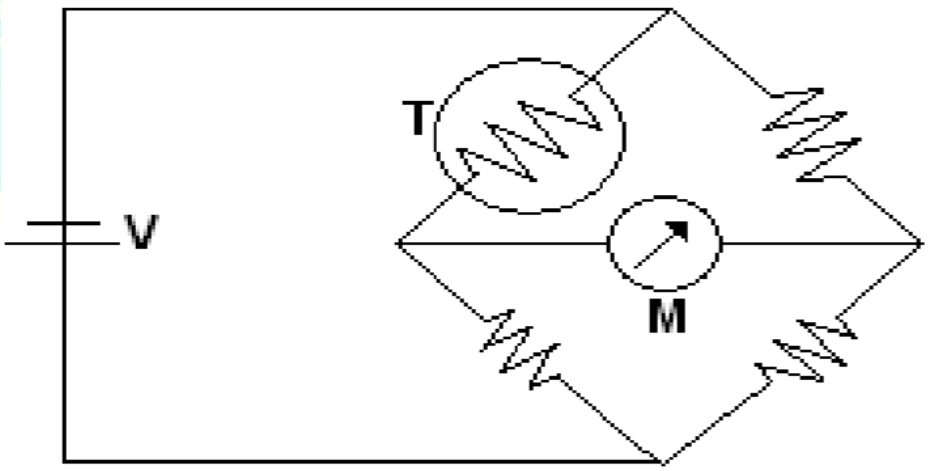
1-**Glass Fever Thermometer** → It used to know the temp of the body

* The most common way to measure a temperature is with in the glass fever thermometer containing mercury or alcohol.

* Input fever thermometer ,a temperature increase causes the alcohol or mercury to expand more than the glass and thus produces an increase in the level of the liquid.

2 -**Thermistor** →It's a special resistor that changes it's resistance rapidly with temp ($\approx 5\% C^o$).

* The principle behind this thermistor is that a temperature change causes the thermistor resistance to change.



Because it is very sensitive and very fast for measuring temp change ,it has been used to monitor the breathing rate of the patient → This is called "pneumograph"

3-**Thermocouple** → measuring the temp from "-190 to 300 C^0 ".

* A thermocouple consists of two junctions of two different metals . If the two junctions are at different temperature, a voltage is produce that depend on the temperature difference.

Because it has a sharp end then it can measure the temp of "individual cell"

Thermograph:

It is a simple method for obtaining a surface temp "mapping".

1- It has been used to detect other type of cancer not only breast cancer.
2- It used to study the circulation of the blood in the head.
3- It used to study the blood in the diabetics leg.

Thermogram:

Is done by measuring the radiation emitted from the body .At the body temp emitted radiation is in the far infrared (IR) reigon at wavelength greater than (4000-7000)Aº.The total radiative power per surface area (w) is given by Stefan – Bultzman Low :

$$W = e\sigma T^4 \qquad (\frac{w}{cm^2})$$

σ: $S.B\ constant = 5.7 \times 10^{-12}\ \mathrm{W}cm^2.K^4$

e : emissivity depends upon the emitter material and its temp.

(e=1 for the body).

k : Kelvin or absolute, scale=273kº.

0 kº = absolute zero= -273 Cº

normal body temp =(T Cº+273) k º (this temperature scale is not used in medicine).

Example:

A person of skin temp. of 36Co and body surface area 1.75m2 .find

1. net total power if he receives radioactive power from the surrounding walls 20Co would be about 735w walls 20Co would be about 735w (σ = 5.7 * 10^{-12}w/cm^2)
2. The emissivity of surrounding walls.

Solution:

1- T=36C°+273=309 °K

$$T^4 \sigma w = e$$

=1*(5.7*10^{-12})*$(309)^4$

0.052 w / cm^2

Total power (w)={Total radiative power per surface area}*surface area

= 0.052 (w/cm^2) * 1.75*10^4 (cm^2)

= 910w

∴ net power =910-735=175w

2- T= 20 + 273 = 293k

Heat from the wall = 735= [e* 5.7*10^{-12} *$(293)^4$] * (1.75× 10^4)

∴e = 735 / (735.163) = 0.998

For the Breast Cancer Detection:

1- Thermography to detect the elevated temp. area
2- To detect the area by smooth touching (palpation or feeling).
3- Use of low voltage X-ray (mammography).
4- To be sure of the type of Breast tissue of the specific area ,biopsy examination for histopathology is done.

Physical Methods of Producing Heat in the Body:

1- Conductive heating.
2- Infrared radiant heating (IR).
3- Radio wave heating (Electro magnetic Wave).
4- Micro wave diathermy .
5- Ultrasonic wave heating.

1. **Conductive Heating** : → used to treatment the superficial area.

* Conductive Heating is used in treating conditions such as :-

1- Arthritis.

2-Neuritis.

3- Sprains.
4- Strains.
5- Contusions.
6- Sinusitis.
7- Back Pain

2-**IR. Heating:** The heat can be transferred to the body by radiation. It is used for surface heating of the body .This is the same heat. We feel from the sun and flame.

- The IR wave length used are between (800- 4000nm).
- These wave penetrate the skin about (3mm)& increase the surface temp.
- This type of heating is used to treat the same conditions of conductive heating.

3. Electro magnetic Wave (diathermy).

They are very useful for internal heating because E.M.R. have energy depend on their frequency E=hɣ , (ɣ: is the frequency).

A. Short wave diathermy(Wavelength (λ) = 10nm & F=30 MHz) :

Heat from diathermy is useful for internal heating because it penetrates deeper than radiant & conductive heat.

- It used in treatment of :

A. In flammation of the skeleton , bursitis , neuralgia .

B. Muscle spasm, pain from protruded intervertebral discs , degenerative joint disease .

- The treatment is done by two method to get energy to the part of The body :
  1- Capacitance method.

  Heat = Constant X $(current)^2$

  2- Magnetic induction.

B. Long Wave Diathermy : The frequency = 10 kHz .

Some patients were sensitive to get electricity in this frequency than they were under electrical shock hazards.

EM Diathermy has limitations when it used on muscle tissue surrounded by fatty layer. In infrared waves most of the energy is deposited in the surface of fatty layers. So, we use microwaves diathermy for deep area covered with fatty layers.

4. **Microwave Diathermy** : F= 2460 MHz
   It is penetrate deep into the tissue → causing temp . rise & deep heating .

* Microwave therapy is used in the treatment of :

1. Fractures.
2. Sprains.
3. Strains .
4. Bursitis.
5. Arthritis.
6. Injuries to tendons.

The absorption for homogeneous tissue can be described by this equation:

$I = I_o e^{-\frac{x}{D}}$

I : radiation intensity at the depth X in the tissue.

Io : radiation intensity at the surface .

X : depth in the tissue.

D : Tissue thickness at which 63% of the beam is absorbed

Example:- If the radiation intensity of the surface is 10^4 & tissue for treatment half of intensity absorbed at depth 3cm. Calculate the intensity under 2cm in tissue

Solution:

At the half value thickness ($X_{1/2}$) The beam absorbed Is

I = $I_0/2$ → ie I/I_0 = 1/2 at x = $x_{1/2}$

Since I = $I_0 e^{-x/D}$ → ie I/I_0 = $e^{-x/D}$

∴ 1/2 = $e^{-x_{1/2}}/D$ → Ln 1/2 = – $X_{1/2}$/D

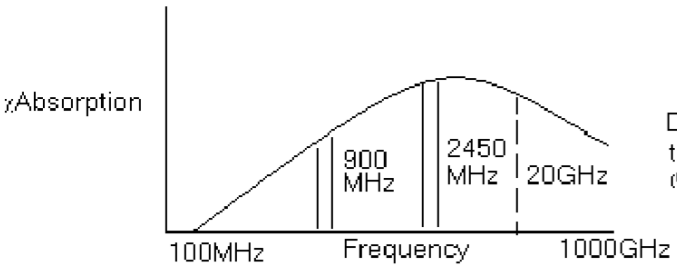
Ln2 = $X_{1/2}$/ D ∴ D = $X_{1/2}$/ 0.693 = 3cm /0.693 = 4.32cm

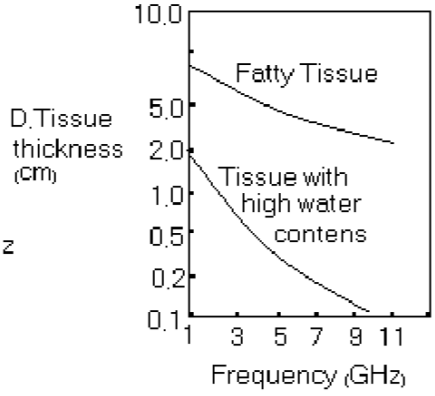
To calculate the intensity under 2 cm in tissue substitute the value of intensity Io and D in equation

∴ I = 10^4 e – 2 cm / 4.32 = 6.3× 10^3

Absorption of Microwave beam depend on :

1. The a mount of water in the tissue. Because the energy is deposited more effectively in tissue with high water content, microwave energy is absorbed better in muscle tissue rather than in fatty tissue which have less water
2. The frequency of microwaves: The energy is absorbed % is very high at frequency ~ 20 GHz (GHz = 110^9Hz). It's poorly absorbed at lower frequency nearly 100 MHz & at very high frequency >1000 GHz





* 2450 MHz for kitchen uses but best frequency for medical treatment uses is 900 MHz.
* Tissue for treatment half of beam absorbed at depth = 3cm.

Use of Cold in Medicine:

Cryogenics:

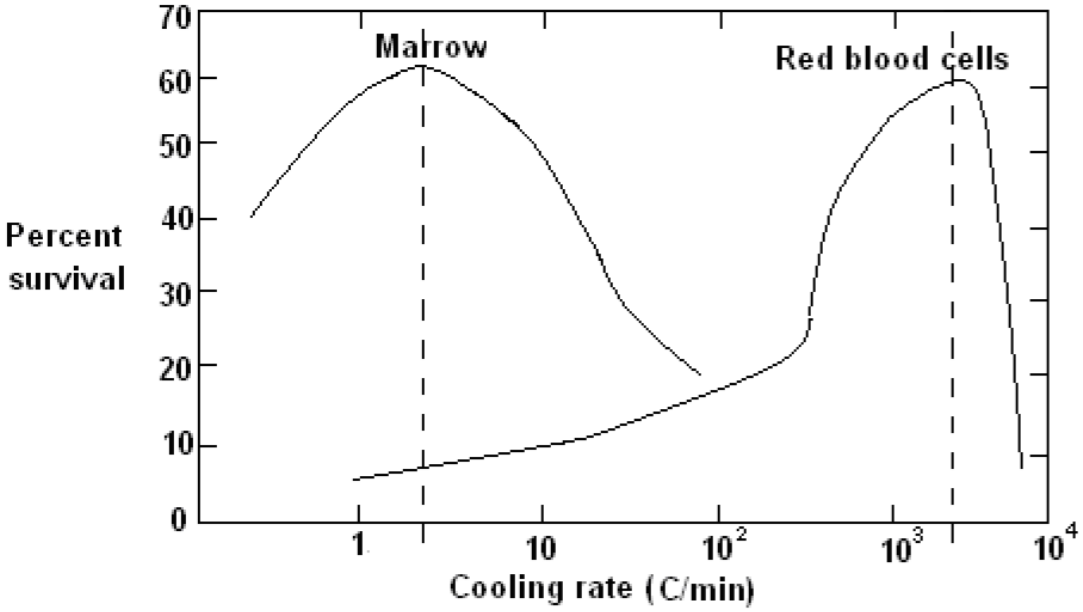
is the science and technology of producing and using very low temp. in medicine to preserve blood, sperm, bone marrow and soft tissue.

Cells & Tissues which is sorted for long term should be :

1. Stored at a very low temp. (-196 C^0) since biochemical & physical processes are temp. dependents → then lowing temp. will reduce the rate of these two processes .
2. Cooled at the optium cooling rate of the tissue to be stored and the % of survival is more dependent on the cooling rate than on the warming rate.
3. Stored with adding protective agent (glycerol or dimethyle solfoxide) before cooling.

*Survival behavior as a function of colling Rate for blood RBCs and Bone marrow :

Cooling rate = ΔT / time interval = (T2 -T1) / time interval (Cº/min)



cooling rate of Bone marrow = 3 (Cº/min)

colling rate of RBCs = 3000 (Cº/min)

Blood Storage

1. Convential Method: It is non - cryogenics method & it is done by mixing the whole blood with anticoagulant then stored at 4C° at this method about 1% of the RBCs hemolyzed or breaked , then the maximum expired is 21 days because at this period 20% of RBCs are break.

2. Long term storage : It is cryogenics method .It divides into two ways:

a. Thin - walled containers : The container is filled with blood then is quickly inserted into a liquid Nitrogen bath .

The frozen blood can be stored at - 196 Co

b. Blood sand Method : The blood is sprayed into a liquid Nitrogen surface which freezes into small droplets grains of sand .The droplets are collected & stored in special containers at - 196 C^0 .

Cryosurgery:

It is the application of using cryogenics methods to destroy cells.

*** The advantages:**

1. There is little bleeding in the destroyed area.

2. The volume of tissue destroyed can be controlled by the temp. of cryosurgical prob.

3. There is little pain sensation because low temp. tend to desensitize the nerves.

*** Uses of Cryosurgery** : In treatment of " Parkinson

a. Disease or Shaking Palsy . It is a disease that associated with the basal ganglion of the brain which causes un controlled tremor in the arms and legs.

- Treatment is done by destroying the part of the thalamus in the brain that controls the transmission of nerve impulses to other parts of nervous system .

b. Treatment of tumors by cutting it.

c. In several of types of eye surgery :

1. Repair of detached retina.

2. Cataract surgery removal of a darkened lens.r