Medical Physics

Light in Medicine

Lecture Nine

Introduction:

Even though man is now very efficient at making artificial light, the sun is still the major source of light in the world. The sun is both beneficial and hazardous to our health. The light visible to the human eye and the eye is most efficient in the wavelengths corresponding to the maximum output from the sun.

Light has some interesting properties, many of which are used in medicine:

1. The speed of light changes when it goes from one material to another. The ratio of the speed of light in a vacuum to its speed in a given material is called the index of refraction.

2. Light behaves both as a wave and as a particle. As a wave, it produces interference and diffraction, which are of minor importance in medicine as particles can be absorbed by a single molecule. When light is absorbed, its energy generally appears, as heat .this property is the basis for the use in medicine of IR light to heat tissues. Sometimes when a light photon is absorbed, a lower energy light photon is emitted. This property is known as fluorescence.

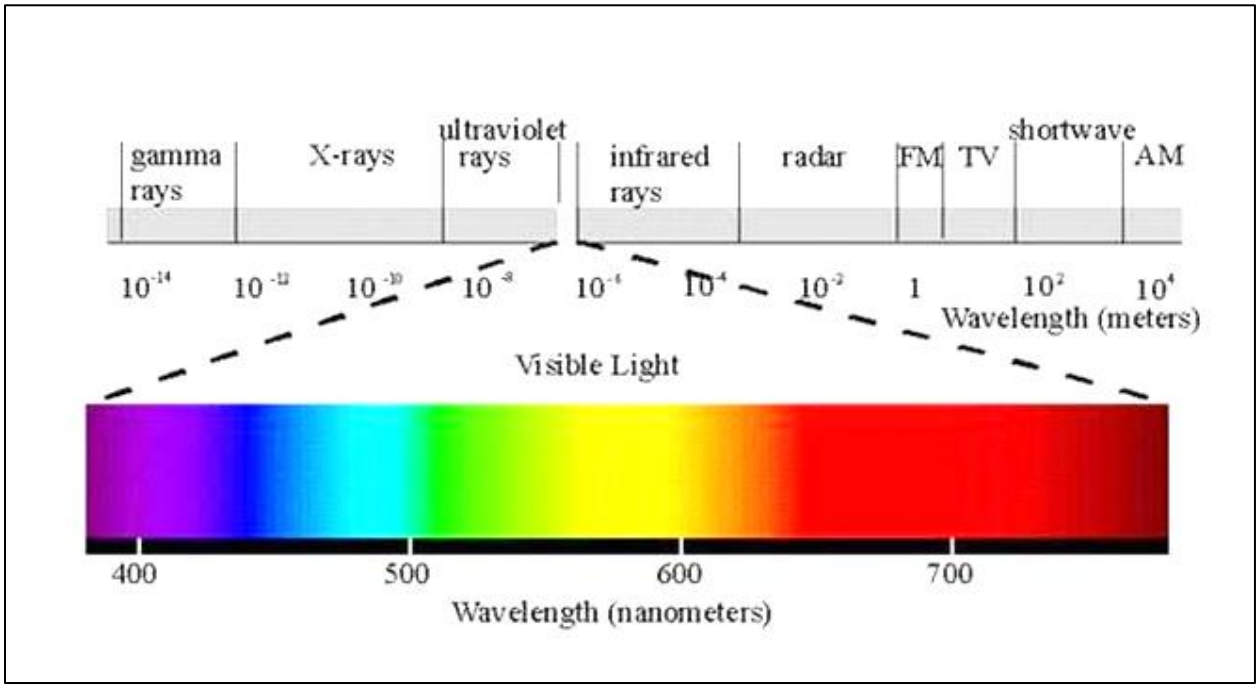
3. Light has reflected to some extent from all surfaces.

Measurement of light and its units

The three general categories of light are UV, Visible and IR.

The wavelength of light used to be measured in Microns 1 $\mu = 10^{-6}$ m or in Angstroms 1 A° = 10^{-10} m but at present the recommended Nanometer 1 nm = 10^{-9} m

Ultraviolet (UV) light has wavelengths from about 100 to 400 nm, Visible light extends from about 400 to 700 nm and Infrared (IR) light extends from about 700 to over 10^4 nm.



Application of visible light in Medicine:

Endoscopes: are used for viewing internal body cavities.

Special purpose endoscopes are often given names indicating their purpose. For example:

1. Cystoscopes: are used to examine the bladder.

2. Proctoscopes: are used for examining the rectum.

3. Bronchoscopes: are used for examining the air passages into the lungs.

Applications of ultraviolet light in medicine:

1- Ultraviolet photons have energies greater than visible photons, while IR photons have lower energies. Because of their higher energies, UV photons are more useful than IR photons.

2-UV light is used to kill germs and is sometimes used to sterilize medical instruments.

3-UV also produces more reactions in the skin than visible light. Some of these reactions are beneficial, and some are harmful.

a. One of the major beneficial effects of UV light from the sun is the conversion of molecular products in the skin into vitamin D.
b. Harmful effects of UV light can produce sunburn as well as tan skin.
c. Solar UV light also causes skin cancer in humans. The high incidence of skin cancer among people who have been exposed to

the sun a great deal, such as fishermen and agricultural workers, may be related to the fact that the UV wavelengths that produce sunburn are also very well absorbed by the DNA in the cells.

4- Ultraviolet cannot be seen by the eye because it is absorbed before it reaches the retina.

Applications of infrared light in medicine:

1-Heat lamps that produce a large percentage of IR light with wavelengths of 1000 to 2000nm are often used for physical therapy purposes.

2-Two types of IR photography are used in medicine:

a- Reflective IR photography, which uses wavelengths of 700 to 900nm to show patterns of veins just below the skin.

b- Emissive IR photography, which uses the long IR heat waves emitted by the body that gives an indication of the body temperature, is usually called thermography.

Laser in medicine

A Laser is a unique light source that emits a narrow beam of light of a single wavelength (monochromatic light) in which each wave is in phase with the others near it (coherent light).

Laser is an acronym for "Light Amplification by Stimulated Emission of Radiation".

In ophthalmology, a laser is used for photocoagulation of the retina, which is heating blood vessels to the point where the blood coagulates and blocks the vessel.

Lasers are also used in medical research for special in three-dimensional imaging called holography.

In medicine, lasers are used primarily to deliver energy to tissue.

The laser wavelength used should be strongly absorbed by the tissue. The short wave (400-600nm) is always absorbed better than the long wave (≈700nm).

Laser energy directed to human tissue cause a rapid rise in temperature and can destroy the tissue. The amount of damage to living tissue depends on the time the tissue is exposed to increased temperature.