Light in medicine

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

1. The speed of light change when it goes from one material into another. (The ratio of 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, diffraction, which are of minor importance in medicine As particle it can be absorbed by a single molecule .when alight photon is absorbed its energy in various ways.

3. When light is absorbed, its energy generally appears as a heat .this property is the basis for the use in medicine of IR light to heat tissues. This property is known as fluorescence.

4. Sometimes when a light photon is absorbed, a lower energy light photon is emitted.

5. Light is reflected to some extent from all surfaces (endoscope).

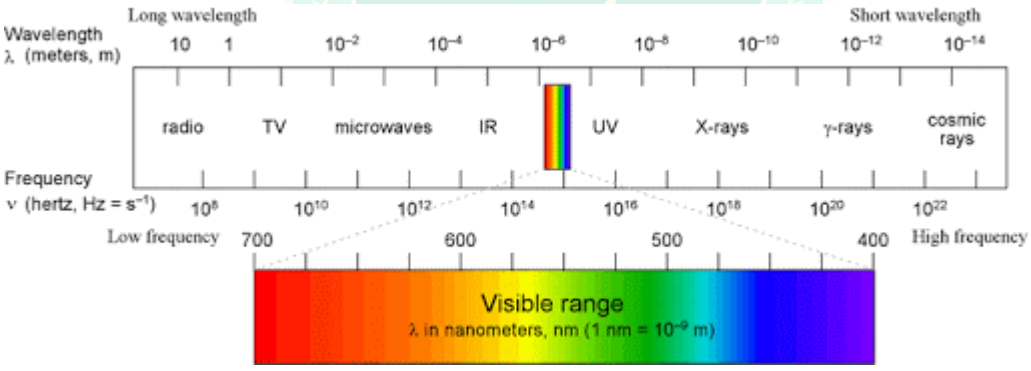


Figure: The relationship of light wavelengths to the entire spectrum of E.M.R.

Light Amplification by Stimulated Emission of Radiation (Laser)

In (1917) ,Einstein postulated that: **The incident photons of energies equal exactly to the energy that an excited atom must eject if it falls to its lower energy state**. These incident photons stimulate the excited

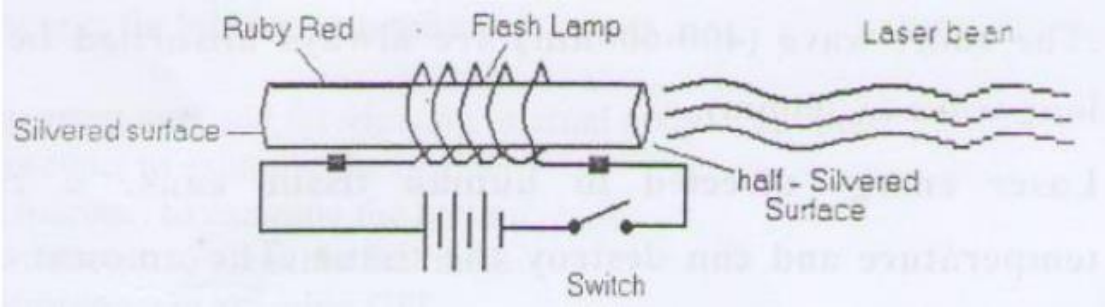
atom to fall to the lower state and the photon ejected by the atom is in phase with the incident photon that stimulates it to make the transition

Kinds of Laser:

1. **Pulse Laser: i.e.**
   (i) Ruby laser (λ =694 nm).
   (ii) Semiconductor (λ is dependent on the applied current).
   (iii) Glass laser.
   2. continuous wave laser (cw)e.g. ,gas filled tubes laser
   (i) Neon-helium laser (λ =632.8 nm)
   (ii) Argon laser (λ =488-514nm)

Ruby laser

In (1960) T.H. Maiman produced a laser beam from ruby crystal.
* The rod is aluminum oxide crystal with some chromium atoms throughout it (AL2O3 : Cr2O3).
* The active material (Medium) in the ruby is the chromium ions Cr+3 .
* The color of the ruby crystal depends on the contents of Cr+3 on it.
* One end of the rods are covered completely with silver and the other ends are coated partially with silver to allow light to escape.



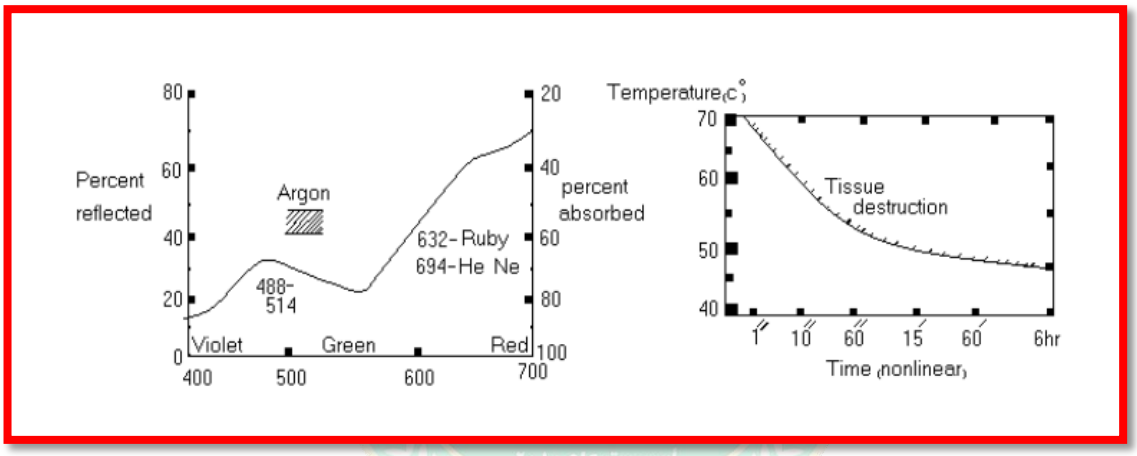
The bright flash causes electrons in the chromium atoms of the rod to gain energy, which is released inside the rod as red light
The red light is reflected back and forth between the mirrored surfaces at the ends of the rod.
The light causes the chromium atoms to release more light. The intensity of the red light beam increase and leaves the end of the half – coated end of the rod as a laser beam.
*A laser beam remains narrow over long distance and can be focused to a spot only a few microns in diameter.

* When all of the energy of laser is concentrated in such small area , the power density energy (power per unit area) become very large

Laser in Medicine:

In medicine laser are used primarily to deliver energy to tissue.

- The laser wave length used should be strongly absorbed by tissue .The short wave (400-600nm) are 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 time the tissue is exposed to increased temperature



A The absorbance and reflectance of skin as a function of wavelength.

B Effects of time and temperature on tissue destruction

1. It is used by surgeons for the painless removed of eye tumors

2. It is used as a (bloodless knife) in surgery.

3. Repairing retinal tears or holes that develop prior to retinal detachment. (Photo coagulation).

4. Treatment of the diabetic ethnography i.e. the complications of diabetes that affect the retina, (photocoagulation)

5. In medical research it is used for special three-dimensional imaging called (holography).

Application of visible light in Medicine:

1.Curved surfaces : e.g.:

Curved lenses : convex, concave and cylindrical.

Curved mirrors : which are used in:

a. Ophthalmoscope: for looking into the eyes.

b. Otoscope: for looking into the ear.

2.Endoscopes : are used for viewing internal body cavities.

i. Cystoscope: to examine the bladder.

ii. Proctoscope: to examine the rectum.

iii. Bronoscope: to examine the lungs.

iv. Gastroscope: to examine GIT

* Endoscopes are based on the "Total internal reflection rule". When the angle of incidence is greater than the critical angle where the critical angle is the angle of incidence. Which the refractive angle = 90°.

Glass fiber (rigid endoscope):	**Plastic fiber (flexible endoscope)**
it gives clear image, because it is transparence. It is difficult to bent and easily broken.	**it gives low quality images. It can be bent easily inside the body to reach the far or narrow location. i.e. (not easily broken)**

* Endoscopes are supplied with IR absorbing filters to minimize tissue heating i.e Cold light endoscope.

3.Tran illumination:

It is the transmission of light through the tissues of the body. It is used clinically in the detection of:-

i. Hydro cephalous (water-head) in infants.
ii. Pheumothorax (collapsed lung) in infant.
iii. The sinuses.

iv. The breasts
v. The gums
vi. The testes.

4.**Phototherapy**: Premature infants recover from Jaundice when they exposed to visible light.

5. **Microscopy**: The smallest objects that can be resolved is about l μm in diameter since the wavelengths of visible light from 0.4 to 0.7μm. light microscopes: are adequate for resolving ceils (diameters 5 to 50 μm).

Application of Ultra violet (UV)& Infra red (IR) light in Medicine

UV: photon have energy > than visible photon

IR: Photon are energy < than visible photon (1nm = 10-9 m).

$$\mathbf{E = h\,\upsilon = h\,c/\lambda}$$

where h = Plan's constant = 6.6*10-34 (joule/sec)

υ = frequency of radiation

c = velocity of light.

UV: wave length 100 – 400 nm

Visible: wave length 400-700 nm,.

IR: Wave length 700-10000 nm

Because of their higher energies: UV photons are most useful than IR photon

* UV with λ = 290 nm it can kill germs and also produce more reactions in the skin than visible light.

* UV. Light from the sun affects the melanin in the skin to cause tanning, solar UV is also the major cause of skin cancer in humans ⇒ because it is very well absorbed by the DNA. In the cell's.

* UV light can not be seen by the eye ⇒ because it is absorbed before it reaches the retina.

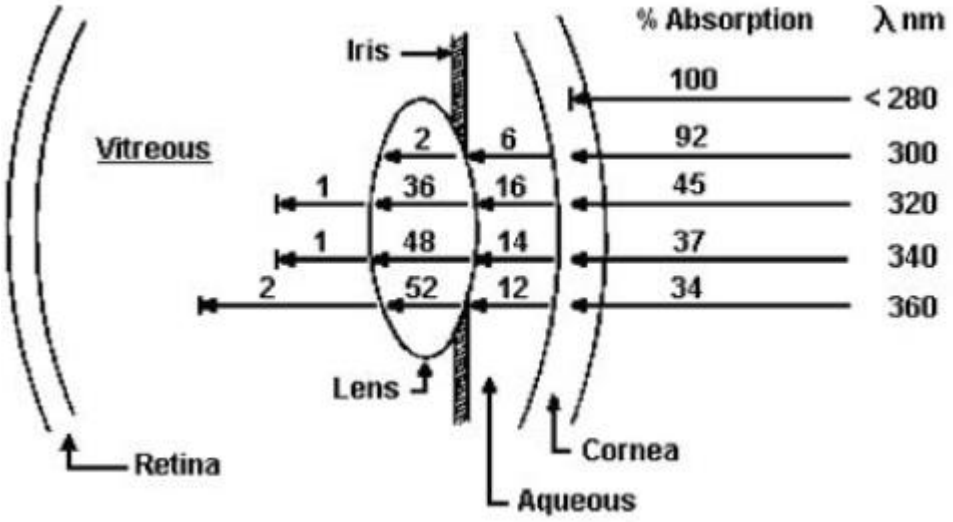


Fig. Showing the percentage of light transmittance through ocular media

About half of energy from the sun is in IR. Region

The warmth we feel from the sun is mainly due to the IR.

- The IR rays are not usually hazardous even though they are focused by the cornea and lens of the eye onto the retina.

- IR. Light penetrates further into the tissues than visible light and thus is better able to heat deep tissues.