

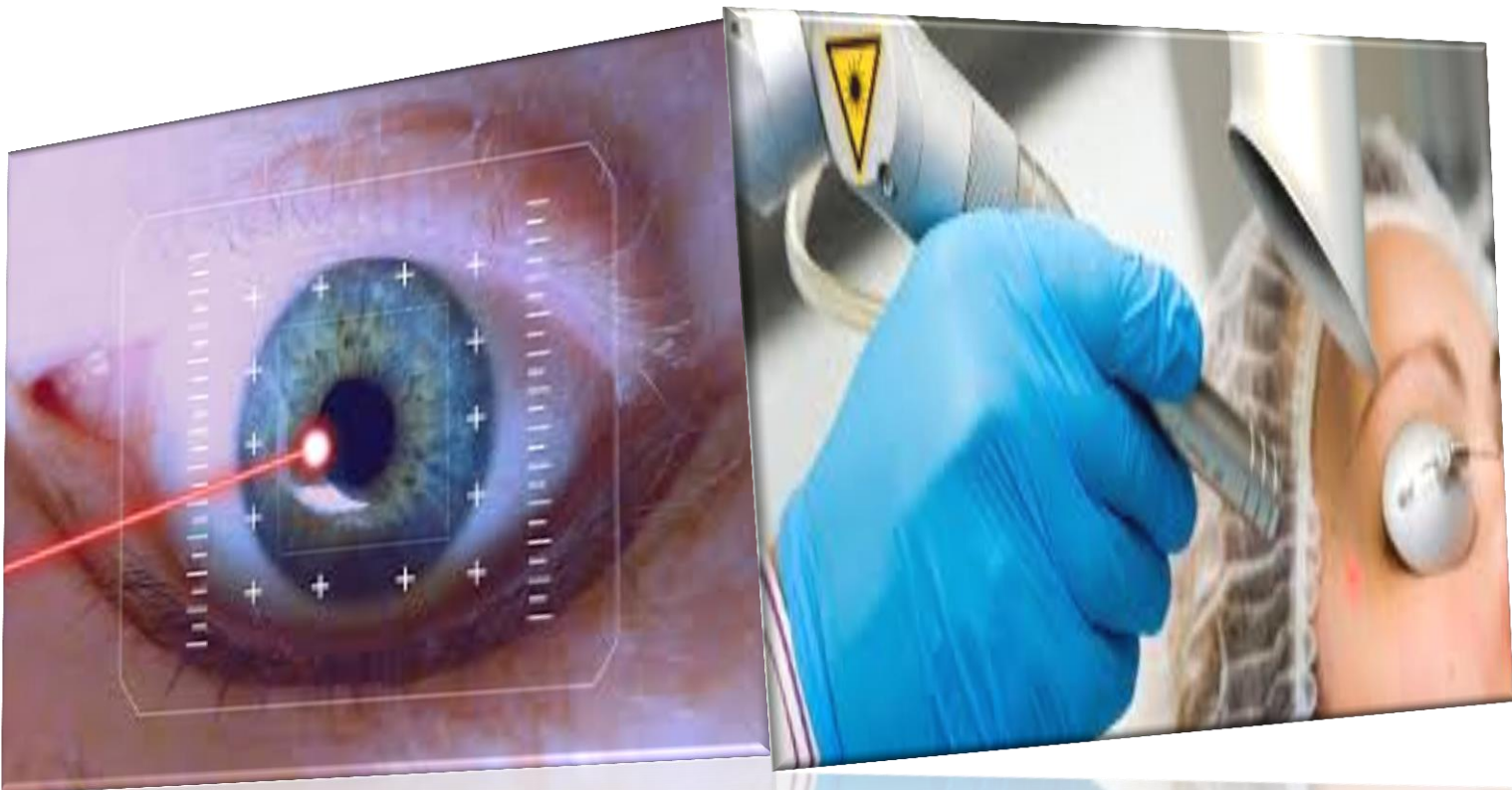
AL MUSTAQBAL UNIVERCITY

Department of Medical Physics



جامعة المستقبل
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Medical Laser Applications



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LASER

is defined as **l**ight **a**mplification **s**timulated **e**mission of **r**adiation.

Laser properties:

1- Coherence: that mean, there is a relation between the amplitude and pulse of the wave at different points in time and space.

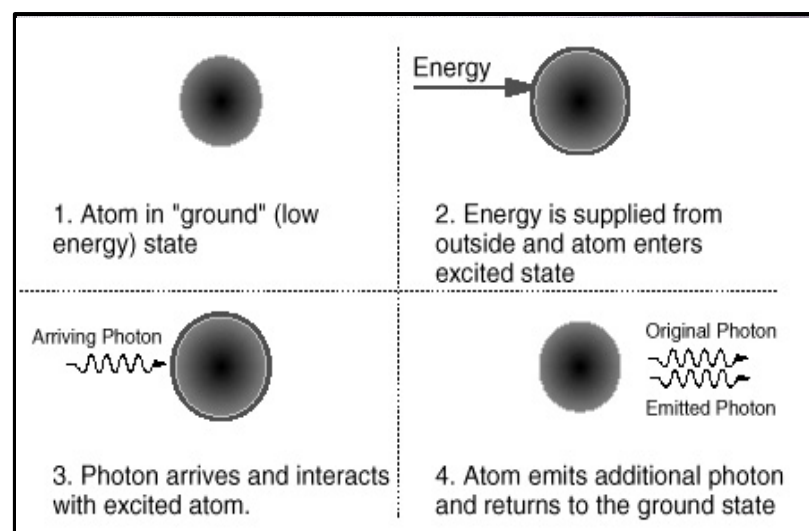
2-monochromaticity:all of the laser radiation is emitted at discrete narrow band wave lengths.

3- collimation: the laser beam is highly collimated, there is very little beam divergence. In laser surgery, the collimated beam is focused by a lens or mirror down small spot.

4-brightness.

5-high energy.

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.



Laser types in medical:

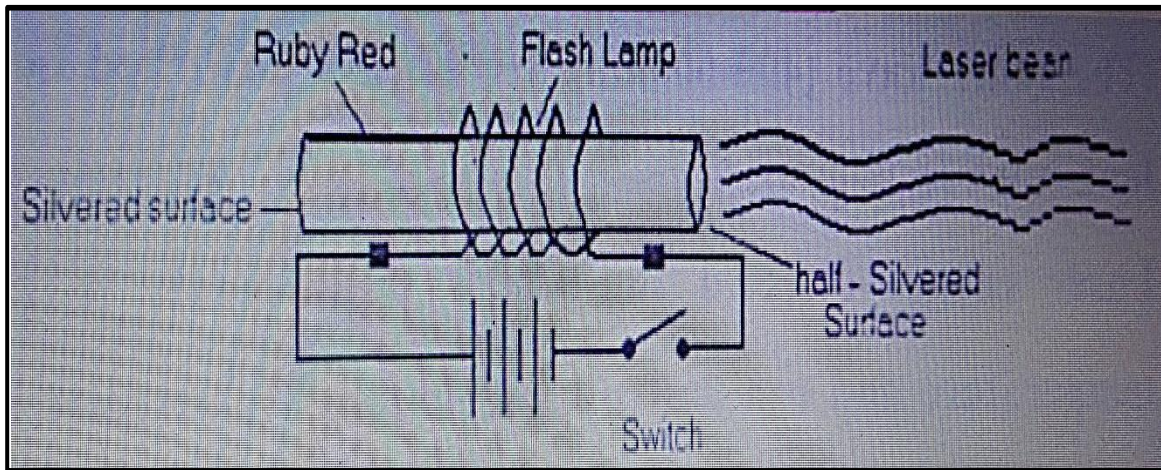
(1) Ruby Laser

1. The lasing medium is synthetic ruby; i.e. (Al_2O_3) doped with 0.05% Cr_2O_3 . 2. Pumping energy \Rightarrow Optically. (Flash light tube at a fast repetition rate).

3. A population inversion is achieved between the metastable states (E_1) and the Ground State (E_0).

4. The laser beam emitted as a series of very short pulses.

5. Output wavelength is 690 nm (Red) light - (Visible). At this wavelength is selectively absorbed by pigments in tissues, such as Hemoglobin or melanine.



(2) Carbon Dioxide Laser (CO_2)

1. It's a molecular gas laser operating in the infrared range.

2. In addition to electron energy level, there are (sub energy levels) (Vibrational and rotational energy sub-levels).

3. A population inversion is produced between metastable state and two lower energy vibrational states and gives rise to two lasers at 10600 nm and 9600 nm (Invisible) {Infrared region}.

4. Pumping energy: is by electrical discharge.

5. Specific absorption of 10600 nm - light in tissues is by water. (i.e., it is independent of tissue color).

6. Its surgical precision; i.e.; "High degree of absorption in soft tissue with limited lateral damage (Normal tissue), so that it is used for vaporizing.

(3) Argon Laser:

1. it's a gas laser (ionized argon atoms).

2. Pumping —→by continuous DC-current discharge.

3. Output wavelength = (488 and 515 nm) {Blue-green}.

4. Its easily transmitted through clear aqueous tissue.

5. Its depend on selective absorption principle (i.e; it absorbed by pigments such as hemoglobine and melanine). So that it used for photo coagulation.

(4) Nd: YAG Laser:

1. Solid Laser: (Yttrium Aluminum Garnet) doped with neodymium (Nd^{+3}).

2. Pumping —→optical energy.

3. Output wavelength : 1064 nm.

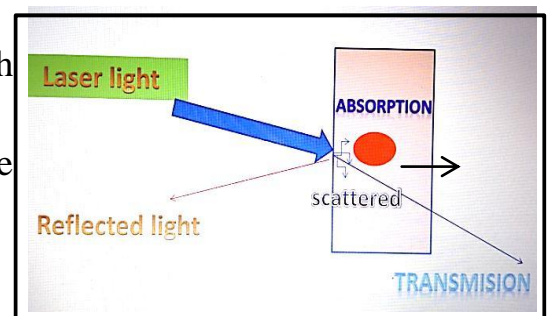
4. Its high degree of scattering upon impact tissue. The zone of damage is not limited as in the CO_2 -laser. i.e. (Precise control is not possible).

5. The beam is absorption by tissue is not as color dependent as argon laser. (It is absorbed by any tissue that is not clear (Dark).

Laser Interaction with Biological Tissue:

The nature of interaction of all lasers light with biological tissue can be described in terms of:

1. Reflection: A laser beam is reflected from the surface of tissue and has →No EFFECT.



2. Transmission: A laser beam is transmitted through tissue, and has no, or only very minimal, effect.

3. Scattering: A laser beam is scattered by a tissue, and absorbed over a large area. Its effect are diffuse and weakened.

4. Absorption: A laser beam is absorbed by small volume of tissue, and exerts its effects within this volume.

Biological Effects:

Laser absorbed by tissue may causes;(Thermal effects).

1.Homeostasis:Any procedure that stop bleeding.

2. Photocoagulation: Heating a blood vessel to point where the blood coagulates and blocks the vessel.

3. Photo Vaporization: To make incisions and vaporize tissue.

4. Sonic: Membrane disruption.

* The effects of Laser on any biological tissue are determined by:

1. Power density: Its defined us $\frac{power}{area} = \frac{watt}{cm^2}$.

2. Radiation exposure time.

3. Coefficient of absorption.

Advantages of Laser Surgery:

1. No—touch technique.

2. Dry surgical field.

3. Reduced blood loss.

4.Reduced edema.

5. Limited fibrosis and stenosis.

6. Precision.

7. Reduced post-operative pain.

8. It is effective, fast, safe.

9. Painless during its use especially when it is used in eye and dental treatment. 10. Anaesthesia is not indicated in eye or dental or some other treatments.

Medical applications

1. Ophthalmology:

a. In ophthalmology lasers are primarily used for photocoagulation of the retina.

b. The amount of laser energy needed for photocoagulation depends on the spot size used. In general;

The minimum amount of laser energy that will do observable damage to the retina is called the Minimal Reactive Dose(MRD).

- a. Photocoagulation is useful for;
- Repairing retinal tears or holes.
 - Diabetic retinopathy. (Complication of diabetes that effects the retina)

2.Dermatology:

a. Skin tumor therapy has been attempted by using high energy Focused laser beam.

b. Tatoos removal.

3. Surgery:

a. Its used continuous lasers of high power.

Example: In Vascular organs such as the liver normal surgery produces a large amount of bleeding. The focused beam of light from laser tends to seal of the vessels and very much less bleeding occurs.

b. Lasers may be combined with fiber optics for some kinds of internal treatment.

Example: Lasers are used through gastroscopy in treating stomach ulcers and bleeding.

4. Dentistry:

a. Repairing the teeth decays. b. Bleeding of gums. c. Ulcers of the gums