



كلية المستقبل الجامعة

قسم الفيزياء الطبية

المرحلة الثالثة

Laser in Medicine

Lecture One

Absorption of light by Tissue

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Absorption of light by Tissue :

The term tissue is used to describe a group of cells that are similar in structure and perform a specific function .

The four primary tissue types :

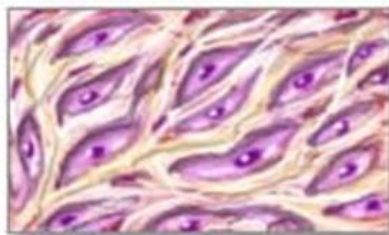
1- Epithelial tissue : Refers to groups of cells that cover the exterior surfaces of the body, line internal cavities and passageways, and form certain glands .

2- Connective tissue : As its name implies, binds the cells and organs of the body together.

3- Muscle tissue : Contracts forcefully when excited, providing movement.

4- Nervous tissue : Is also excitable, allowing for the generation and propagation of electrochemical signals in the form of nerve impulses that communicate between different regions of the body .

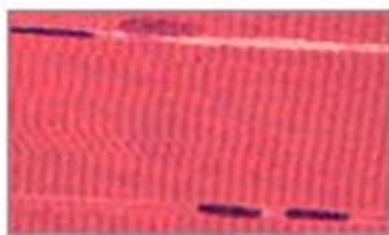
Four types of tissue



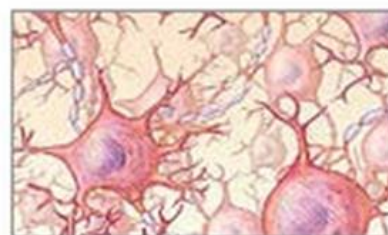
Connective tissue



Epithelial tissue



Muscle tissue

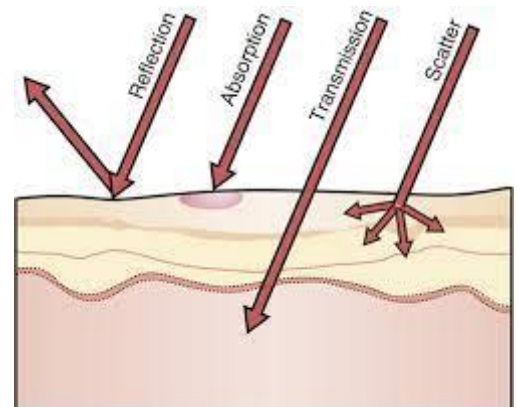
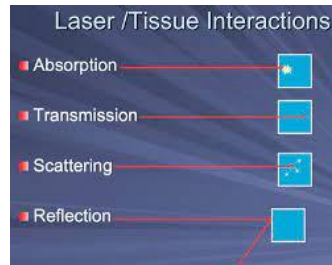


Nervous tissue

Laser-Tissue Interactions :

Light can interact with tissue in four key ways :

- 1- Transmission .
- 2- Reflection .
- 3- Scattering .
- 4- Absorption .



Transmission refers to the passage of light through a tissue without having any effect on that tissue or on the properties of the light. Reflection refers to the repelling of light off the surface of the tissue without an entry into the tissue. Approximately 4% to 7% of light is reflected off skin. The amount of light reflected increases with increasing angle of incidence .

Surface Cooling :

When the chromophore contained in the target for ablation, such as melanin in a hair follicle, is located deeper in the skin than unintended targets such as epidermal melanin, the selectivity of the laser for its intended target can also be improved by surface cooling There are three principal delivery methods for surface cooling :

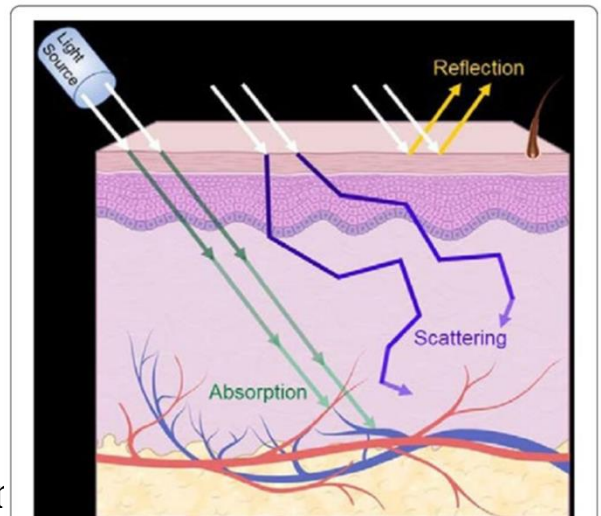
- 1- Precooling .
- 2- Parallel cooling .
- 3- Postcooling .



Main Absorbing Components Chromophores by Tissue :

Each type of tissue has specific absorption characteristics depending on its

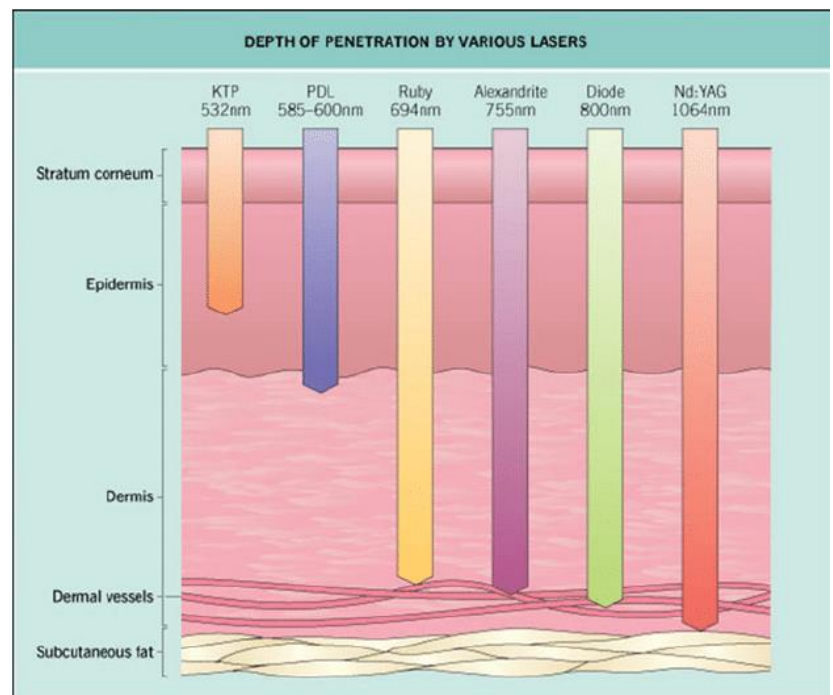
- Specific components
- Hemoglobin - in blood .
- Melanin -skin, hair .
- Water – all biological tissue .



Factors Affecting on Absorption

The following factors will each and collectively affect the absorption of laser light by a target tissue :

- 1- Laser wavelength .
- 2- Tissue (composition) .
- 3- Tissue thickness .
- 4- Surface wetness .
- 5- Incident angle of beam .
- 6- Exposure time .



Benefits of Laser-Tissue Interaction :

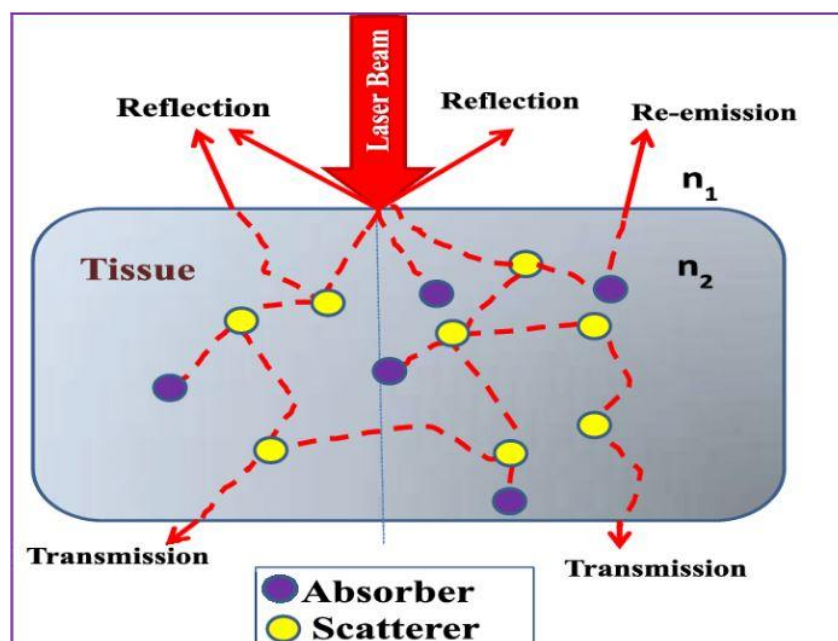
From the above, a number of benefits of laser use in the treatment of soft and hard tissue can be listed as follows:

Soft Tissue :

- 1- Ability to cut, coagulate, ablate or vaporise target tissue elements .
- 2- Sealing of small blood vessels (dry field of surgery) .
- 3- Sealing of small lymphatic vessels (reduced post-operative oedema) .
- 4- Sterilising of tissue .
- 5- Decreased post-operative tissue shrinkage (decreased amount of scarring).

Hard Tissue :

- 1- Ability to selectively ablate carious dental tissue (faster ablation due to higher water content) .
- 2- Reduced peri-operative cracking compared to rotary instrumentation .
- 3- Reduced pulpal temperature rise .
- 4- Cavity sterilisation.



Thermal Properties of Tissues :

The transport of thermal energy in living tissue is a complex process involving multiple phenomenological mechanisms including conduction, convection, radiation, metabolism, evaporation, and phase change .

Thermal probe techniques are used frequently to determine the thermal conductivity and the thermal diffusivity of biomaterials.

Type of tissue	Thermal conductivity [$\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$]	Thickness [mm]
Skull	0.32	7
Skin	0.37	1.5
Fat	0.21	4.5
Muscle	0.49	7.5
Blood	0.52	-
Cartilage	0.49	-