AL-Mustaqbal University College
Department of Medical Physics
Lasers in medicine
Class : Third Stage

كلية المستقبل الجامعة
قسم الفيزياء الطبية
المرحلة الثالثة
الليزر في الطب

الليزر في الطب

المحاضرة الثانية

م.م نور ضياء محمد تقي الربيعي

Effect of Light on Tissue

• When light is absorbed- it delivers energy to tissue- and the tissue's reaction depends on the intensity and exposure time of the light.

• Three major categories of interaction:

1. Photomechanical

2. Photo thermal

3. Photochemical

• all of these interactions coexist, although by selecting the proper wavelength, intensity, and pulse duration.

Photomechanical Reactions

• much intense- short pulse of laser light will usually cause an unstable expansion of tissue **photomechanical** reaction.

• High energy- ultra short pulses of laser light cause extremely rapid heating of the target- with formation of a rapidly expanding thermal plasma.

• As the plasma collapses- the shock wave causes mechanical disruption of the target.

•This photomechanical disruption is utilized to treat tattoos- disruption of stones and color skin.

Photo-thermal Reactions

• A less intense- longer pulse will cause a rapid heating- ***photothermal*** effect.

• When laser energy is absorbed by a chromophore - and transformed into heat which is dissipated in the target- leading to denaturation of proteins at 42-65 C.

• Depending on the exposure time, tissue vaporization, or coagulation, or both will take place.

Photo-thermal Reactions

• The best example of a photo thermal laser is the CO2 laser- used to cut and vaporize tissue - which mostly consists of water.

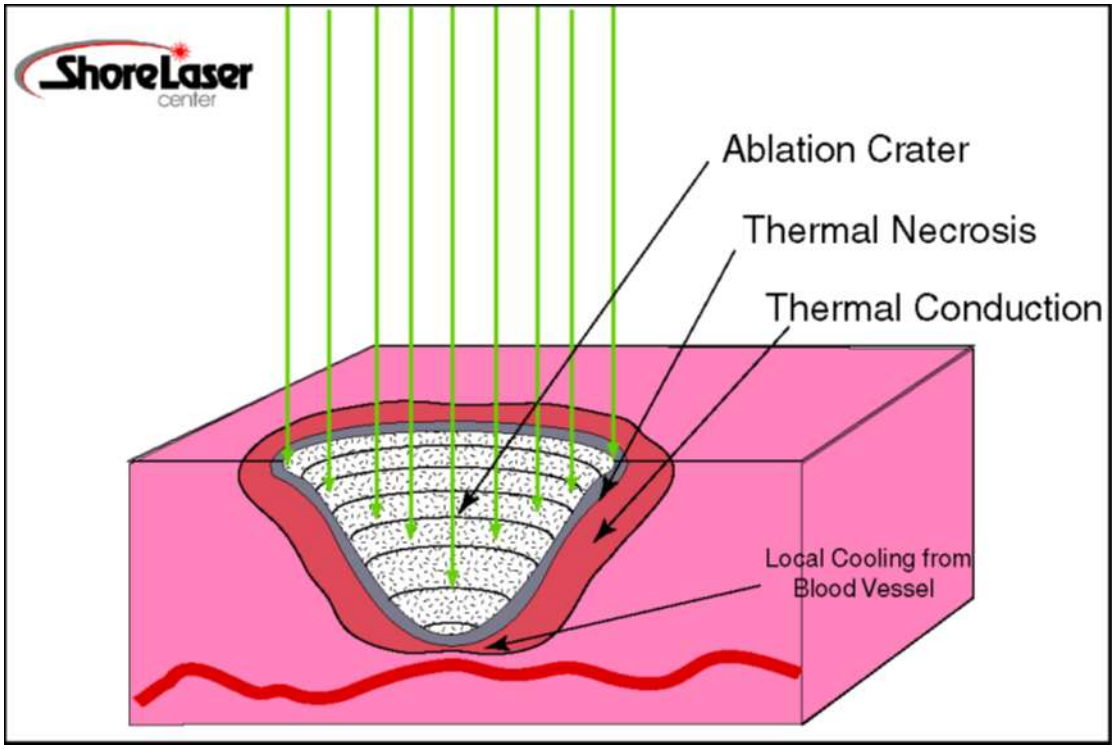
• Water- and thus soft tissue- vaporizes at 100 degrees C.

• When the laser hits soft tissue- rapid heating the water in the tissue to into steam- ablating the tissue

• To minimize thermal damage- maximize the ablation- a short exposure time is necessary.

• This can be done by ***pulsed*** laser beam in such a way that the time it dwells over the tissue is less than its ***thermal relaxation time***.

• This type of photo thermal reaction is utilized in surgical laser applications , laser hair removal, and treatment of vascular.



Photochemical Reactions

• Lower intensities applied for longer durations cause a ***photochemical*** change- either by a slow transfer of energy as heat or by a specific chemical reaction as used in photodynamic therapy **(PDT)** and in **LASIK** vision correction.

• Laser energy can react chemically with specific molecules within tissue.

• **Excimer** lasers for modifying the shape of the cornea in LASIK procedures is based on - (UV) lasers ability to break covalent bonds in protein.

Photodynamic Therapy (PDT):

• A photosensitizing drug **(prophyrin)** is administered which is selectively absorbed by tumor cells.

• When irradiated with the appropriate wavelength of laser light- a chemical reaction takes place- releasing a toxic substance (usually the highly reactive singlet oxygen) which selectively destroys the tumor.

• The use of PDT is limited by the lack of easily administered, sufficiently selective photosensitizing drugs

• PDT techniques are used for the treatment of some skin cancers, precancerous lesions, obstructing tumors in the esophagus and bronchi.

Selective Photothermolysis

Selective Photothermolysis:

• A process in which transfer of laser energy is restricted to a particular site because of the selective absorption of a chromophore at that site.

• In other words, **proper selection of the wavelength and exposure time damages only the desired target tissue**. This principal is what distinguishes lasers from many other tools in medicine

• Selective photothermolysis occurs with :

• The appropriate **Wavelength-** selectively absorbed by the target tissue

• The appropriate **Exposure time-** should be less than the thermal relaxation time of the target tissue

• The appropriate **Energy density**

Laser Spot Size on Tissue

Effect of Laser Spot Size on Tissue Distribution of Light energy:

• A beam of light incident on tissue may be reflected, absorbed, or ***scattered.***

• ***Scattering*** - broadens the incident beam - decreasing the effective fluency in the intended target area. Doubling the spot size will increase the effective volume by a factor of eight.

• A larger spot size usually enables faster and more effective treatment in dermatologic applications.

• It needs - more photons must be supplied by more complex and expensive power supplies, components, and delivery devices.