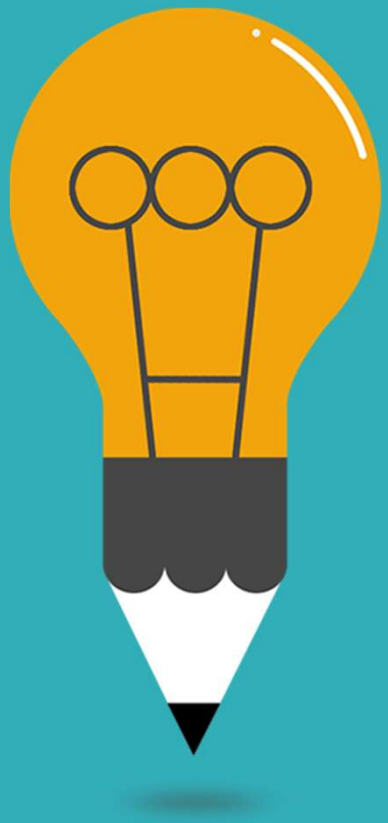
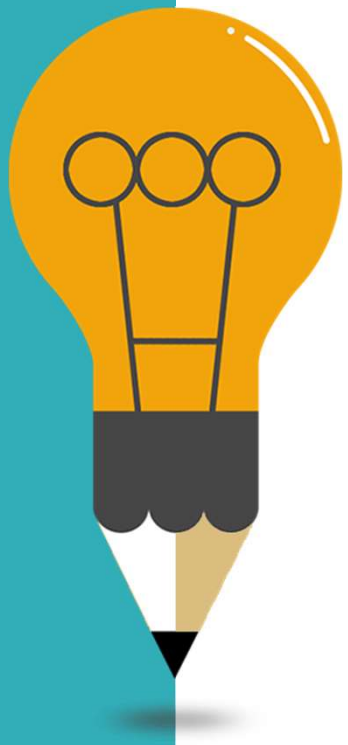


Introduction
Laser and Light therapy

Mohammed TA Omar Ph.D. PT,CLT

Outlines



01 Define laser and explain its physical principle of laser

02 Describe the classifications of laser.

03 Understanding the physiological effects of LASER

04 Describe the indications, precautions and contraindications for low power laser

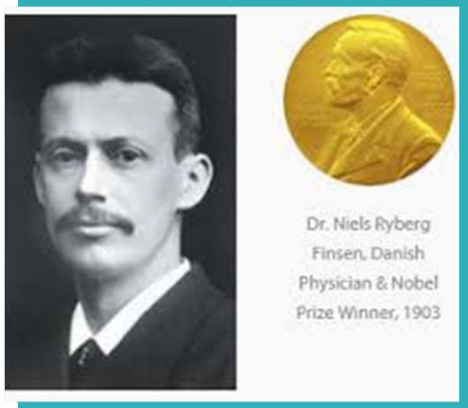
05 Demonstrate the application techniques of low power laser.

What Is Laser Therapy?

"The term Laser is the acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation."

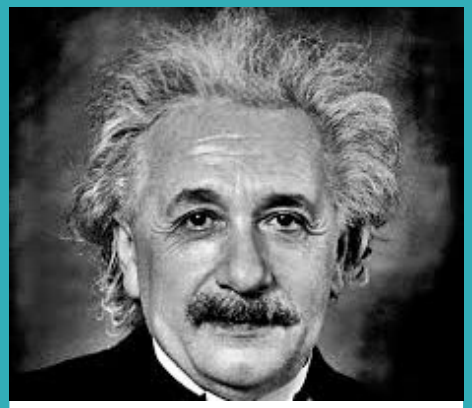
LLLT is a non-invasive light therapy

Characteristics of Laser Radiation

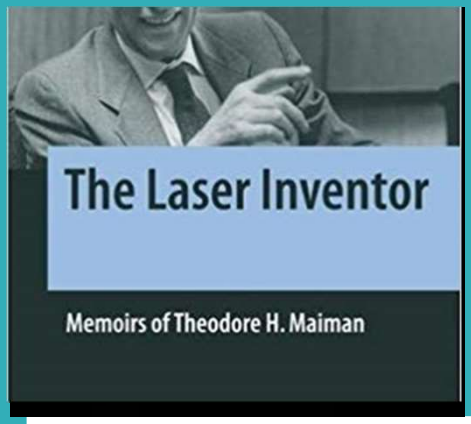


1903
Dr. Nils Finsen

lupus vulgaris

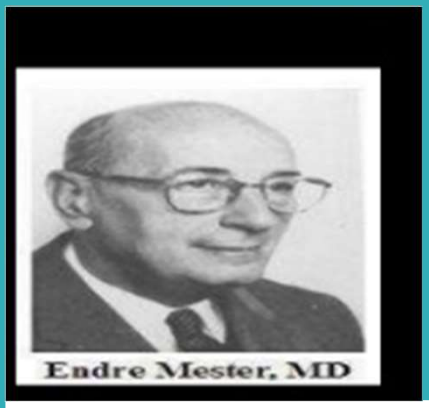


1917
Principle of emission radiation



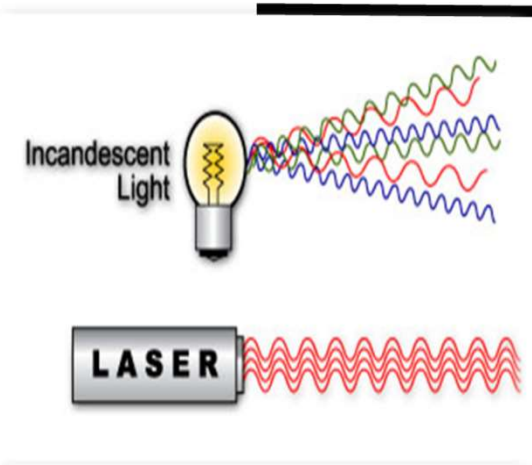
1960; Maiman TH

red ruby laser



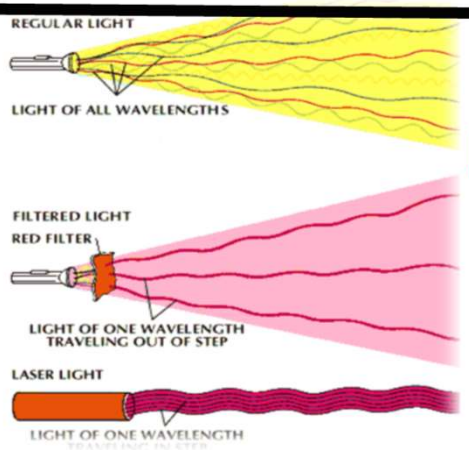
1967
henomenon of "laser bio stimulation"

Characteristics of Laser Radiation



Coherence

Wavelengths are in-phase (synchronizing)

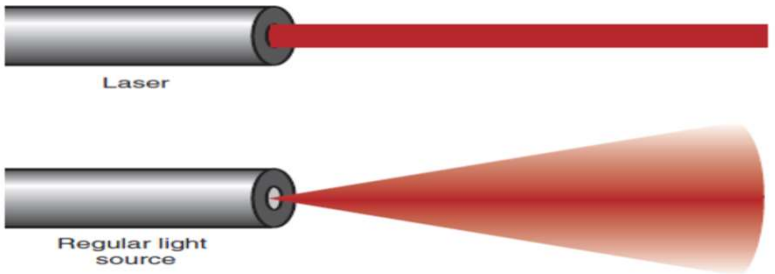


Monochromaticity

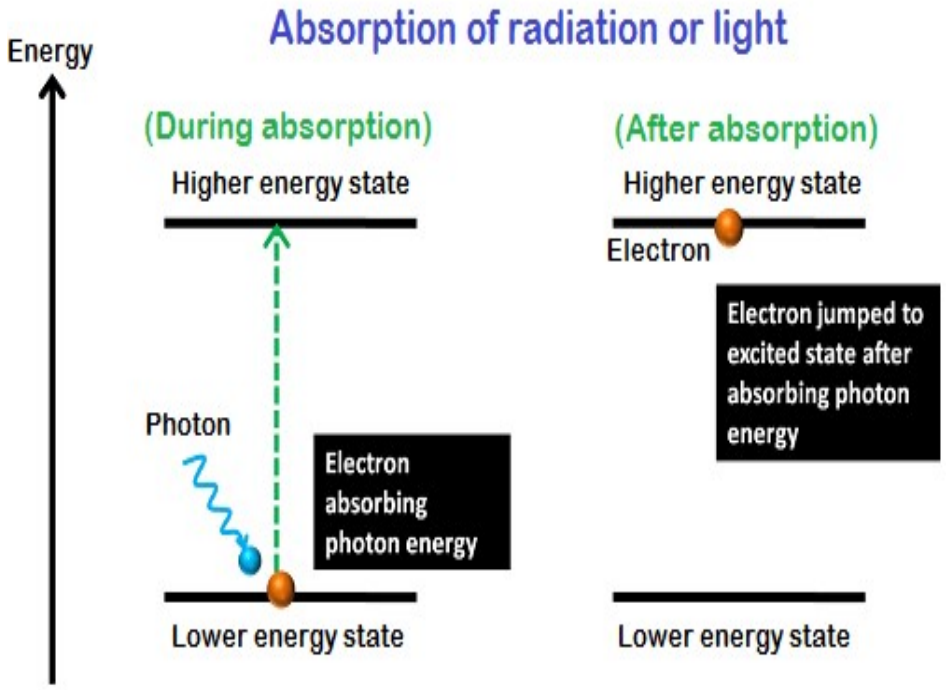
Single wavelength, color, & frequency

Collimation (directional):

All laser lights have minimal degree of diver gence over distance. (380)



Principle of laser production



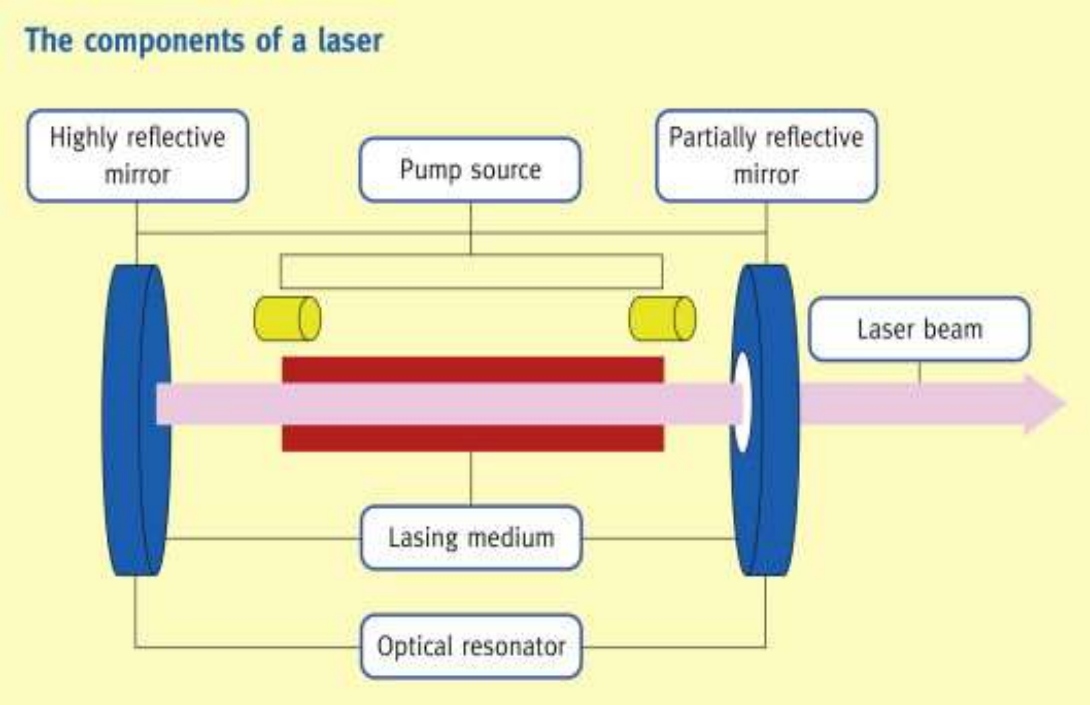
Physics and Radio-Electronics

Light as electromagnetic waves, emitting radiant energy in tiny package called ‘quanta’/photon.

Three basic ways for photons and atoms to interact:

- Absorption
- Spontaneous Emission
- Stimulated Emission

LASER LIGHT PRODUCTION



There are 4 main components to a laser

LASER Classification (Safety)

LASERs - classified by the FDA's Center for Devices & Radiological Health based on the Accessible Emission Limit (AEL).

Class	Power	Example	Effect
1	< 0.5mW	Laser printer, CD players Supermarket reader	Eye-safe under all operating conditions
2	< 1mW	Laser pointer	Safe to skin Safe for momentary viewing(blink reflex)
3A	<5mW	Laser pointer, low LLLT	Safe to skin Eye hazard for prolonged exposure
3B	5-500 mW	Low level laser High intensity laser	Used for therapy Can cause permanent eye injury with brief exposure Can cause minor skin burns with prolonged exposure
4	>500 mW	Surgical and industrial cutti ng lasers	Can cause permanent eye injury before you can react Can cause serious skin burns Can burn clothing Use with extreme caution.

LASER Classification :(lasing media)

Laser type	Lasing Media	Wavelength (nm)	Safety
Gas	He-Ne	633	3a-3b
	CO_2	10.600	3b-IV
	Argon	488-514	IV
Diode/ semiconductors	AlGaAs GaAs GaAl	600-1000	3b
Excimer	Dimer	351	IV
Solid –state	Ruby Nd :YAG	694 1060	IV IV

High vs. Low Level Lasers

- **High**
  - Surgical Lasers
  - Hard Lasers
  - Thermal
  - Energy 3000-10000mW

Used for

-Ophthalmology

-Dermatology

-Oncology

-Vascular specialties

Low

- Medical Lasers
- Soft/ cold Lasers
- Sub-thermal
- Energy 1-500mW

Used for;

- **Pain relieve**
- **Wound healing**
- **Anti/ or pro-inflammatory**

Cold laser

Maximum output of (90mW or less)
Wavelength (600-1000nm)
Penetration of (3-4mm).

Characteristics of LASER, LED, & SLDs

	LLLT	SLD	LED
Power	High	Medium	Low
Focus of light beam	Very focus (Small area)	Moderately focus	Scattered (wider area)
Penetration	deep Up to 5cm	intermediate	superficial
Characteristics	Monochromatic Coherence Collimated	Monochromatic Non-Coherence Less Divergent	Monochromatic Non-Coherence Divergent
Uses	Small area/deep area	Intermediate moderately deep	Larger area//superficial

LLLT Tissues Interaction

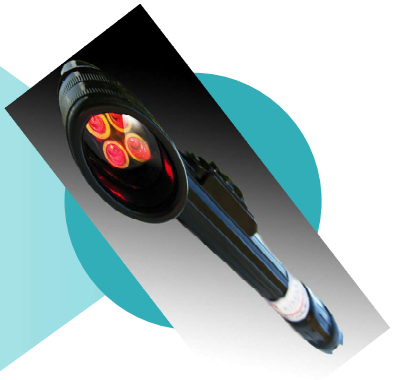
01 photovaporization

02 Photocoagulation

03 Photodisruptione

04 Photoablation

05 Photoradiation

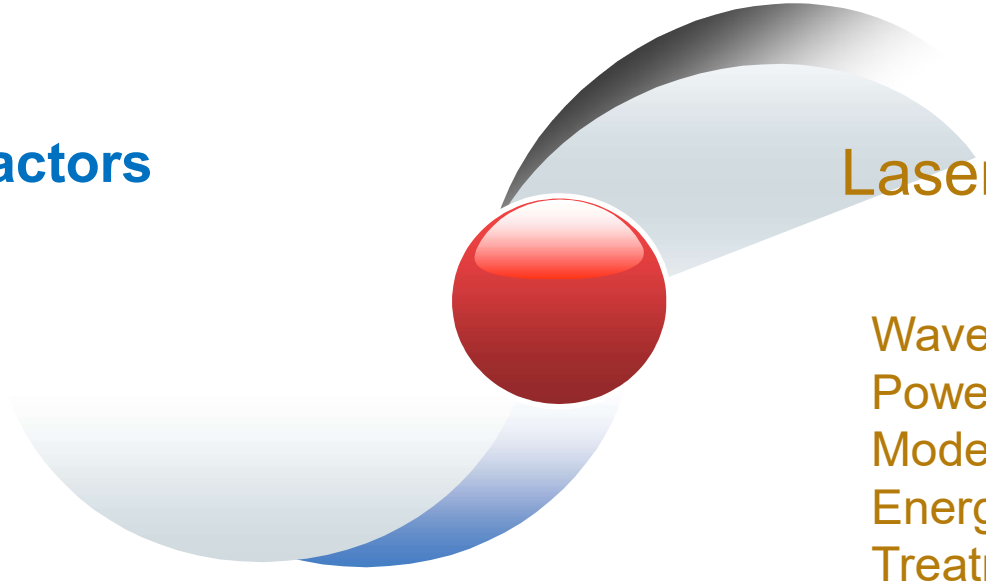


Thermal Effects=1+2+3

Photochemical= 4+5

LLLT Tissues Interaction

Patients factors



Laser factors

Wavelength (nm)
Power (mw)
Mode of laser
Energy
Treatment duration
Treatment frequency

Patients factors: Laser therapy

Need medical history & proper diagnosis

- Diabetes – may alter clinical efficacy

Medications

- Photosensitivity (antibiotics)

Pigmentation

- Dark skin absorbs light energy better

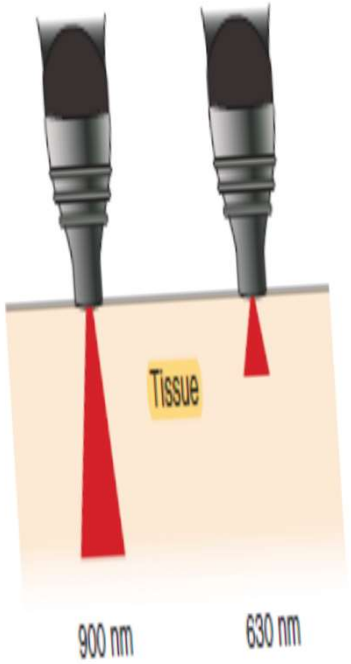
Clean skin surface

Wearing goggles

Laser factors: Wavelength

Longer wavelength penetrates deeper than shorter wavelength

Near IR Laser (700-2200nm):
Deep conditions (3-4cm)
Ga-As (wavelength=904nm)
(Ga-Al-As (wavelength =780-890nm)
Use for
Deep wound, edema (acute &chronic
Deep trigger point, & scar tissue



Red visible laser (600-700nm):
Superficial conditions < 2cm
He-Ne (wavelength=632nm)
Used for
Superficial wound, ulcer
Superficial trigger point

Laser factors : Power and Power density

Laser light applicator power is measured in mill watts (1mW=1/1000 watt).

Power is rate of energy production and measured in watts (mW)

Lasers used for therapy are generally power class 3B,with the power (5mW -500mW)

Power Density (PD) is the amount of power per unit area of the beam (spot size), and measured by W/cm^2 or mW/cm^2.

$$PD = \frac{Power\ output\ (mW)}{Spot\ size\ (cm^2)} = \text{mW/cm}^2$$

Laser factors : Energy& energy density

Energy (joules): Energy is the power multiplied by the treatment time, and is measured by J oule (J or mJ)

Energy (J) =Power output (W) X Treatment Time (s)

Energy Density is the amount of energy per unit of area, and is measured in Joules/cm^2) .
Also known as “fluency or dosage ”

$$ED = \frac{Energy\ (J)}{Spot\ size\ (cm^2)} = \text{J/cm}^2$$

Laser factors : Energy& energy density

Recommended Dosage Range

Therapeutic response = 0.01-20 J/cm^2 (average 6J/cm^2)

Too much – suppressive effect >20 J/cm^2

Conditions	Suggested Energy dosage J/cm^2
Soft tissue/ fracture healing	5-16
Arthritic acute	2-4
Arthritic chronic	4-8
Lymphedema	1.5-2.5
Acute soft tissue inflammation	2-8
Chronic soft tissue inflammation	10-20
Neuropathy	10-12

LLLT: Exercises

Example1: therapist is using a 50mW LLLT device and treated for (80sec) what is the total energy (J) delivered

Answer:
Step 1. 50mW need to be converted to 0.05W
Step2. 0,05W x80sec=4J

mW:	sec	Energy (J)
50	80	4
100	40	4
500	8	4

Example2: therapist is using a 10mW LLLT device and treated for (50sec), with beam area (spot size) (0.125cm^2
Calculate
Power density
Energy density

Laser factors : Mode

The power on most LLLT devices can be periodically interrupted for a very brief period on time. This is called “pulsing”.

When pulsed mode is used the average power delivered will decrease proportional to the pulse frequency that is selected.

In continuous mode: Average power= Peak power
In pulsed mode the Average power calculated as:

Average power = Pulse rate X Peak power X Pulse width
=100Hz X 2WX ($2x10^{-7}$ seconds)=0.04mW

Laser factors : Treatment frequency

Evidence Recommended the followings;

- Treatment should be individualized
- Daily treatment for 2 weeks
- Every other day for 3-4 weeks
- Multiple repetitive low dosage is recommended and more effective than higher dose for one time per week
- Acute conditions should be treated more frequently than chronic
- Reduce dosage by 30% when inflammation is under control
- Laser therapy has accumulative effect

Helium Neon Lasers versus Gallium Arsenide

Parameters	Helium Neon Lasers	Gallium Arsenide
Laser type	Gas	Semiconductor
Emitting radiation	Red (visible) light	IR (invisible) laser
Wavelength	632.8 nm	904- 910 nm
Pulse rate (frequency)	continuous	1-1000Hz
Pulse width	continuous	200nsec
Peak power	1-2mW (25mW)	1-5mW
Average power	1.0 mW	0.04-0.4mW
Beam area	0.01cm	0.07cm
Depth of penetration	0.5-1 cm	2cm up to 5 cm
Used	Superficial wound	Deeper tissue

Physiological effects of LASER

Low level laser-tissue interaction is essentially **ATHERMIC.**
The main type of reaction with tissue during laser therapy would appear to be **PHOTOCHEMICAL**.
So, Laser light absorbed by irradiated tissue produce chemical reaction ra ther than thermal reaction and energy.

Chromophores is a light absorbing part of the molecules that gives it color and stimulated by light energy and produce chemical reaction
These chromophores may be:

- Enzymes
- Membrane molecule
- Cellular or extracellular substances,

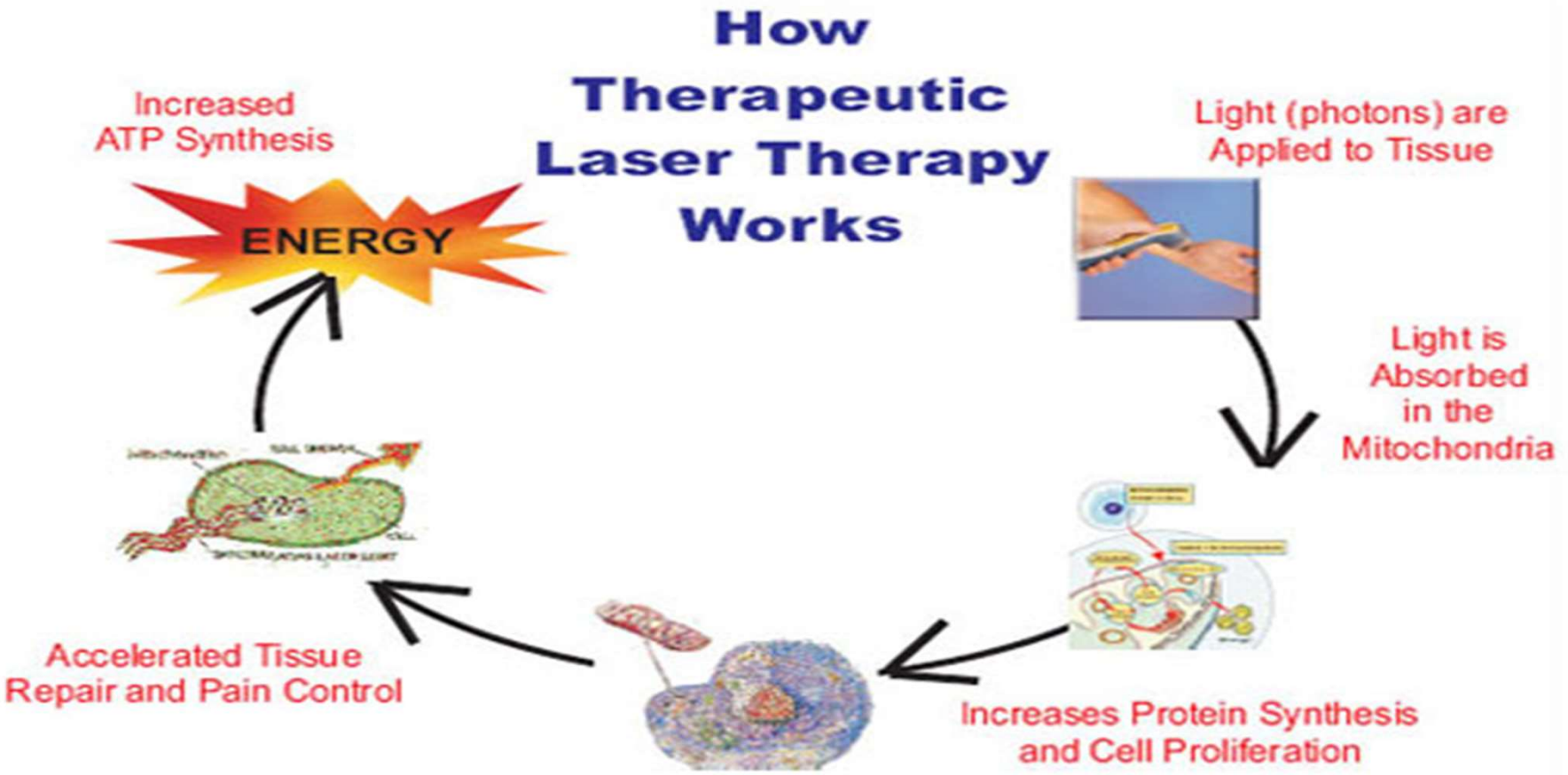
Physiological effects of LASER

01 Reduction of **inflammation**

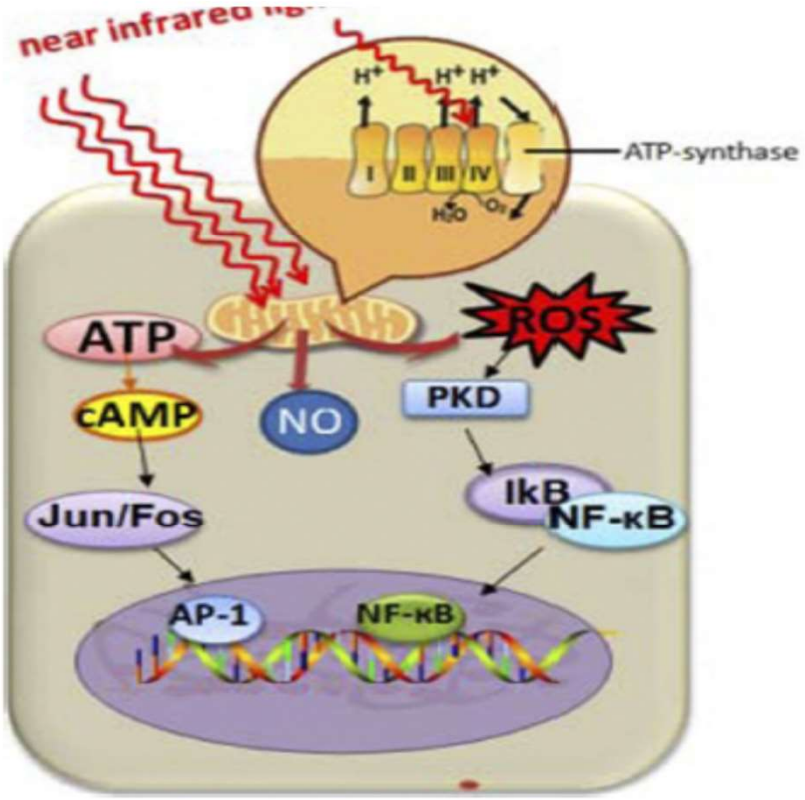
02 **Pain** relief

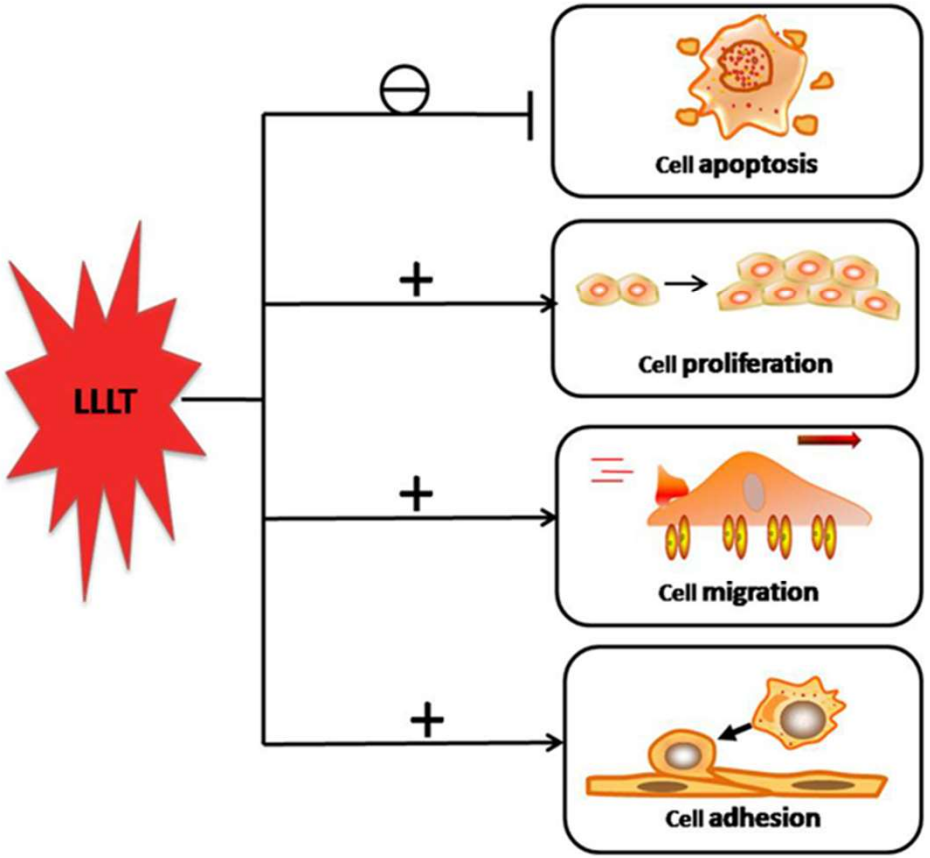
03 Accelerated tissue **regeneration**:

Physiological effects of LASER



Physiological effects of LASER





Inflammation and Tissue Regeneration

Stimulate ATP and RNA production within cells.
Stimulate production of DNA and mRNA
Enhance collagen/ procollagen production , so increase tensile strength
Increases in vascular endothelial growth factor (VEGF)
Increase fibroblast growth factor (FGF-2)
Stimulate release of Nos, so enhance angiogenesis
Stimulate multiple cell proliferation (e.g.fibroblast, endothelial cells, & keratinocytes cells)
Activates T and B lymphocytes, enhancing their ability to bind bacteria
Enhance Mast cell degranulation
Inhabit bacterial growth
Modulate inflammation through

- **Increase $PGF_2\alpha$, interleukin-Iα ($IL\text{-}1_\alpha$)/interleukin-8 (IL-8)**
- **Decrease level of PGE_2 and tumors necrosis factors-alpha (TNF-α)**

LASER for Pain Reduction

Increase nerve conduction velocity
Decrease latency of sensory nerve
Decrease activity of C-fibers , blocking pain gate
Increase in beta-Endorphins
Increase frequency of nerve action potential/increase acetylcholine
Axonal sprouting and nerve cell regeneration
Increase level of serotine (5-HT)
Decrease level of bradykinin

Indications for LASER therapy

Pain reduction

- Pain secondary to soft tissue injuries (sprain. Strain, bursitis)
- Osteoarthritis, Rheumatoid Arthritis, & low back pain
- Neurogenic Pain (trigeminal , post-herpetic, neuralgia)

Wound Healing

- Pressure Ulcers, Diabetic foot
- Burn wound, Postoperative wound care.
- Fracture healing ?????

Inflammation

- Post traumatic, peripheral nerve injury.
- Edema /lymphedema reduction

Contraindications

C

- Application over eyes
- Over or around Cancer
- Over pregnant uterus
- Over & around thyroid gland & endocrine glands
- Within 4 to 6 months after radiotherapy
- Direct irradiation of the eyes

Precautions

P

Over cardiac region
Vogues nerve
Growth plates in children
Confused/disoriented patients
Photosensitive area
Lower back/abdomen in pregnancy

Application Techniques: Indirect contact

This technique is used in treatment of open wounds.

The distance between the laser probe an d wound bed should be 0.5-1 cm.

The probe also should be held perpendicular to the site of radiation

Application Techniques: Direct contact

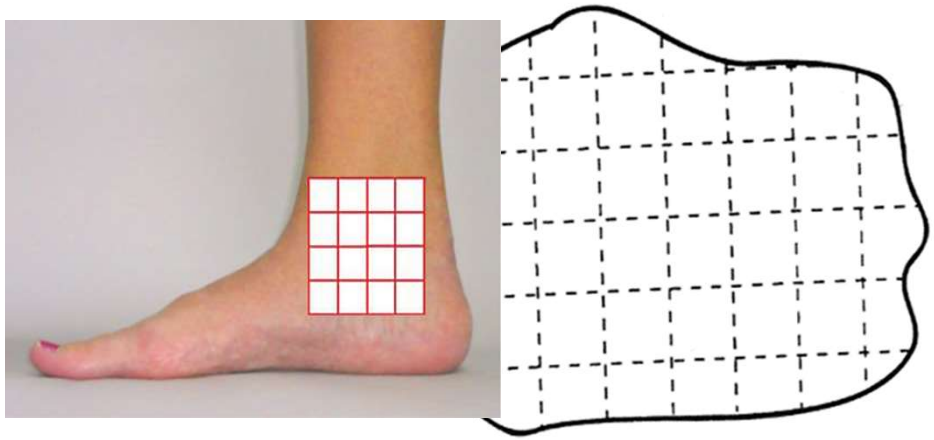
Clean area prior to treatment

The tip of the probe is held perpendicular in contact with skin.

Allow deeper penetration and maximize the power density on the target ti ssues as reflection is minimized

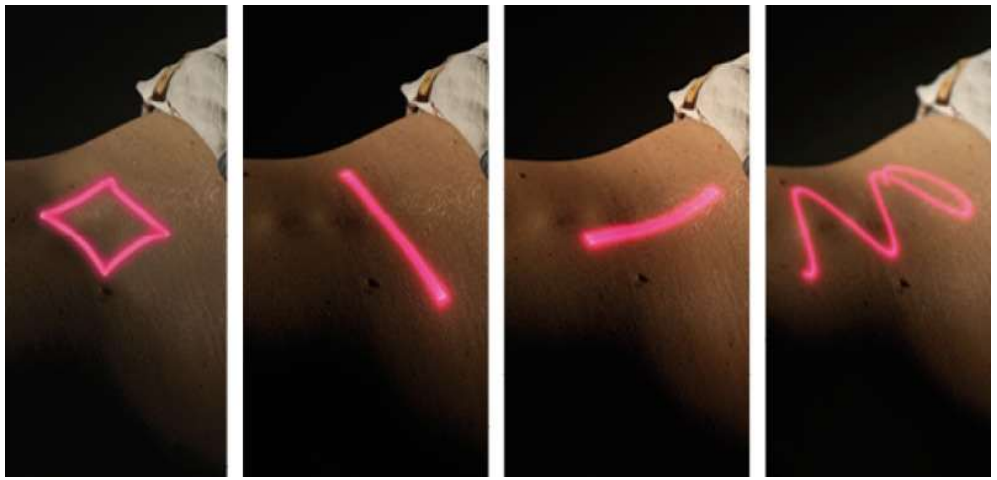
Application Techniques: Gridding

- Divide treatment areas into grids of square centimeters
- Hand held applicator in light contact with treatment area.
- Each square is stimulated for specific period of time (60-90seconds)



Application Techniques: Scanning

- Scanning or back and forth movement for the duration of the treatment time
- No contact between laser tip and skin.
- Tip is held at variable distance 10-50 cm from treatment area
- As distance from target increases amount of energy decreases



Application Techniques: Acupoint

It is used to irradiate localized painful spot.

Using hand held probe, one can use contact and non-contact technique.

It is commonly used in treatment of localized painful site, trigger points, and acupuncture points.

Treatment consideration

- Better to underexpose than to overexpose
- Begin treatment with minimal and gradually increase
- Avoid direct exposure into eyes (If lasing for extended periods of time, safety glasses are recommended)
- If icing – use BEFORE phototherapy • Enhances light penetration
- If heating – use AFTER phototherapy • Decreases light penetration
- Not recommended to combined US and LASER in the same sessions
- Medication should be considered e.g. photosensitizers

Thank you