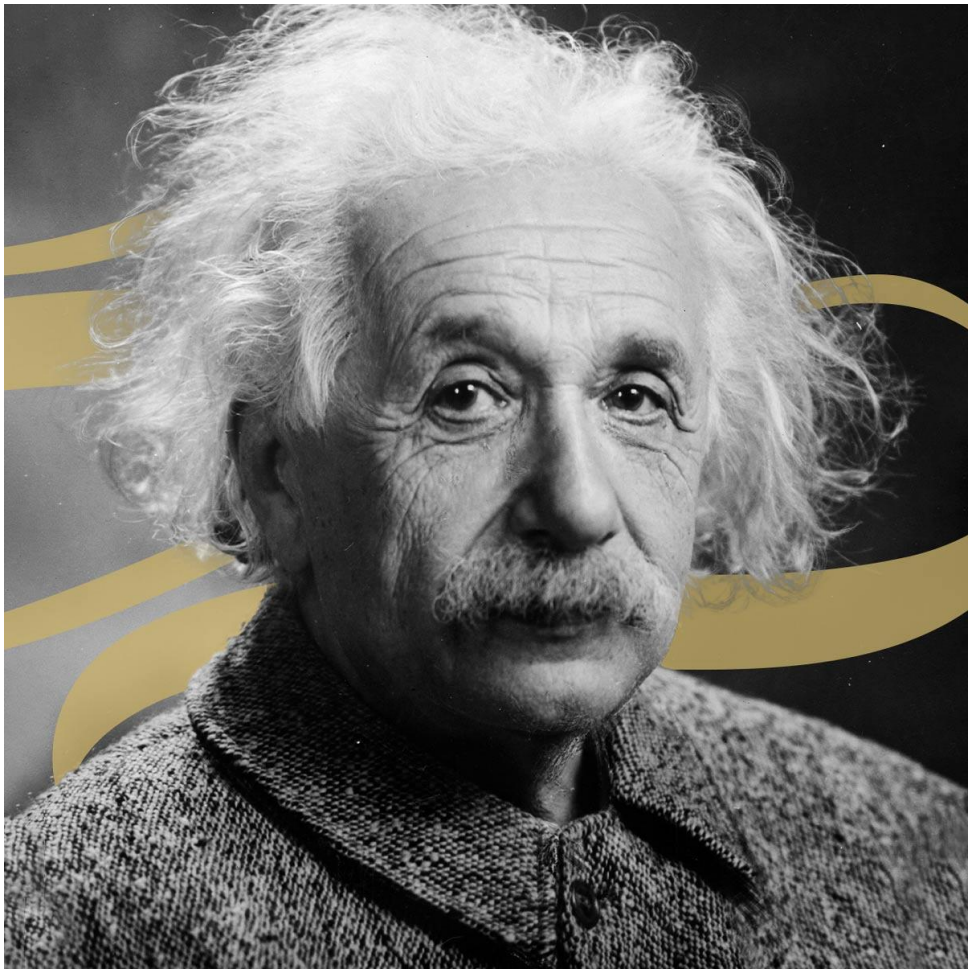
TURNING LIGHT INTO LIFE WITH PHOTOMEDICINE™

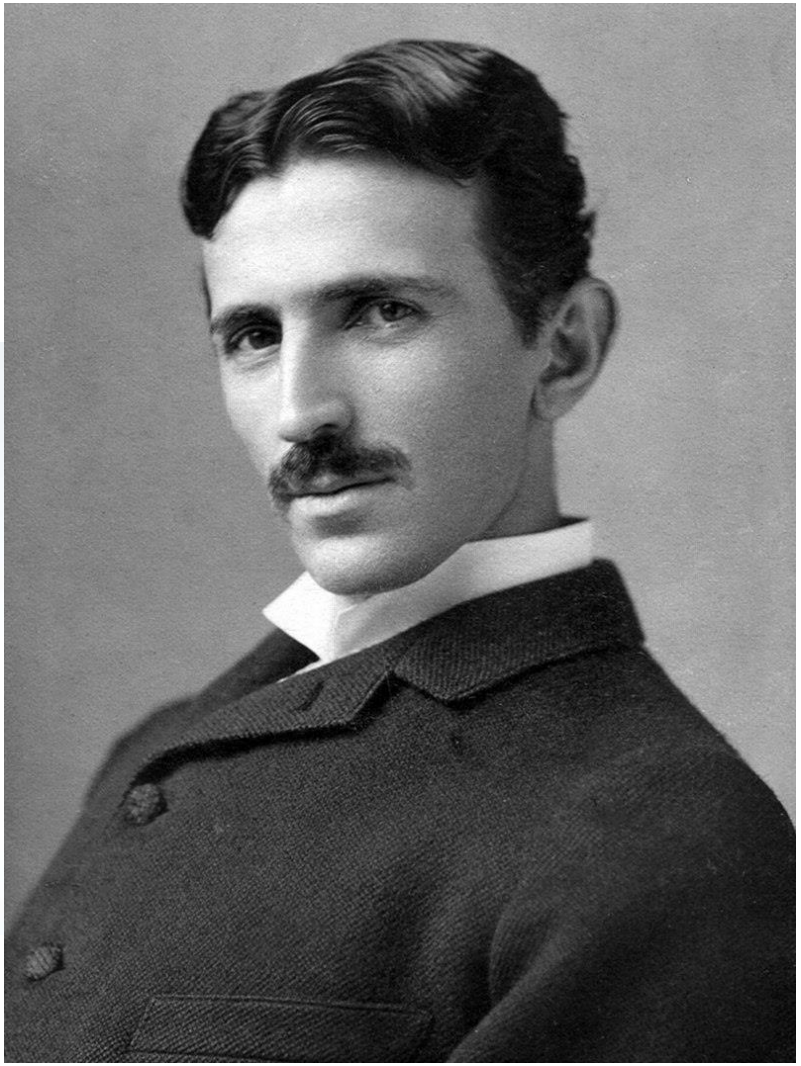
"Future Medicine Will Be the Medicine of Frequencies"

~Albert Einstein~



“If you want to find the secrets of the universe, think in terms of energy, frequency, and vibration”

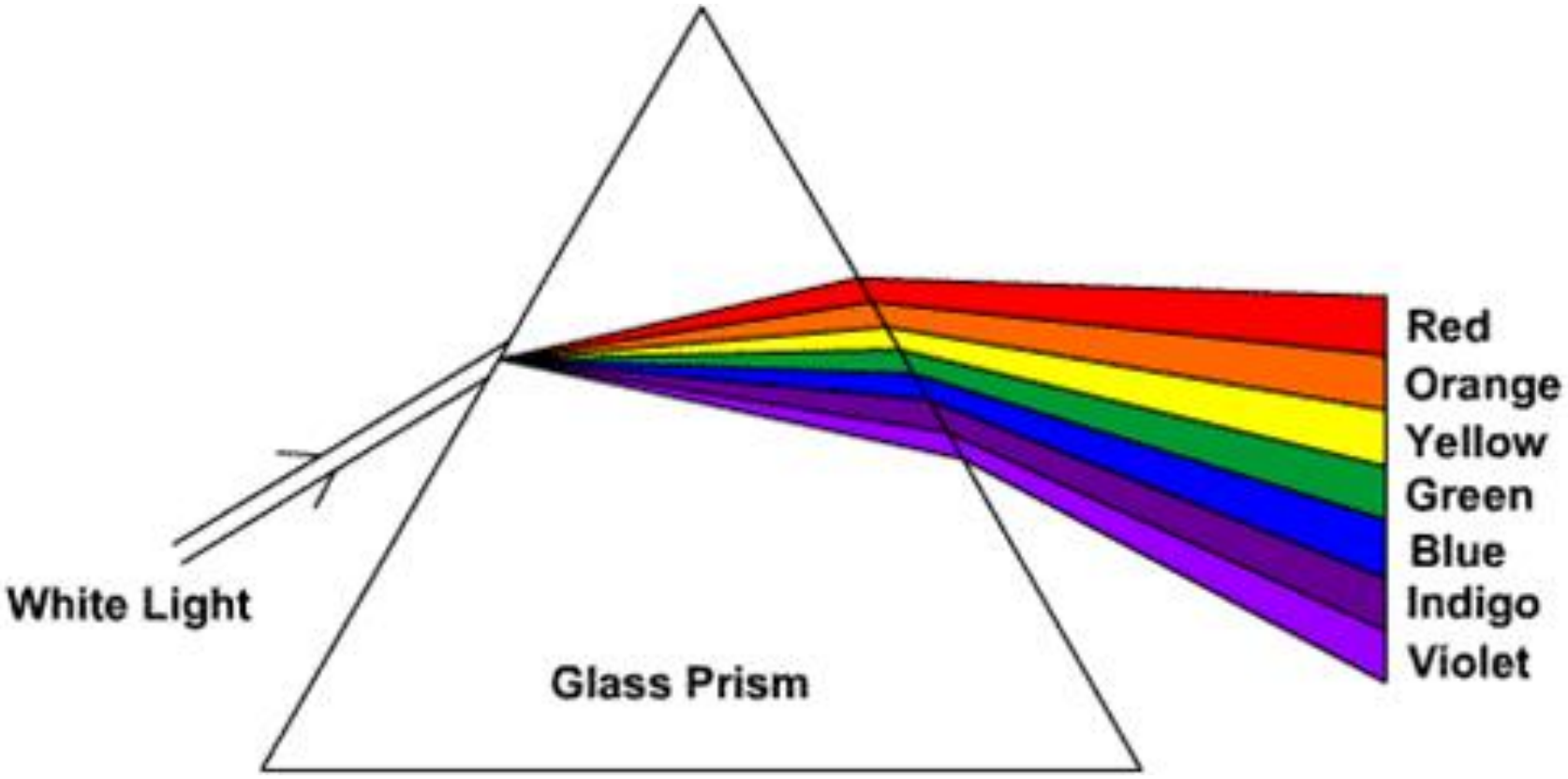
~Nikola Tesla~



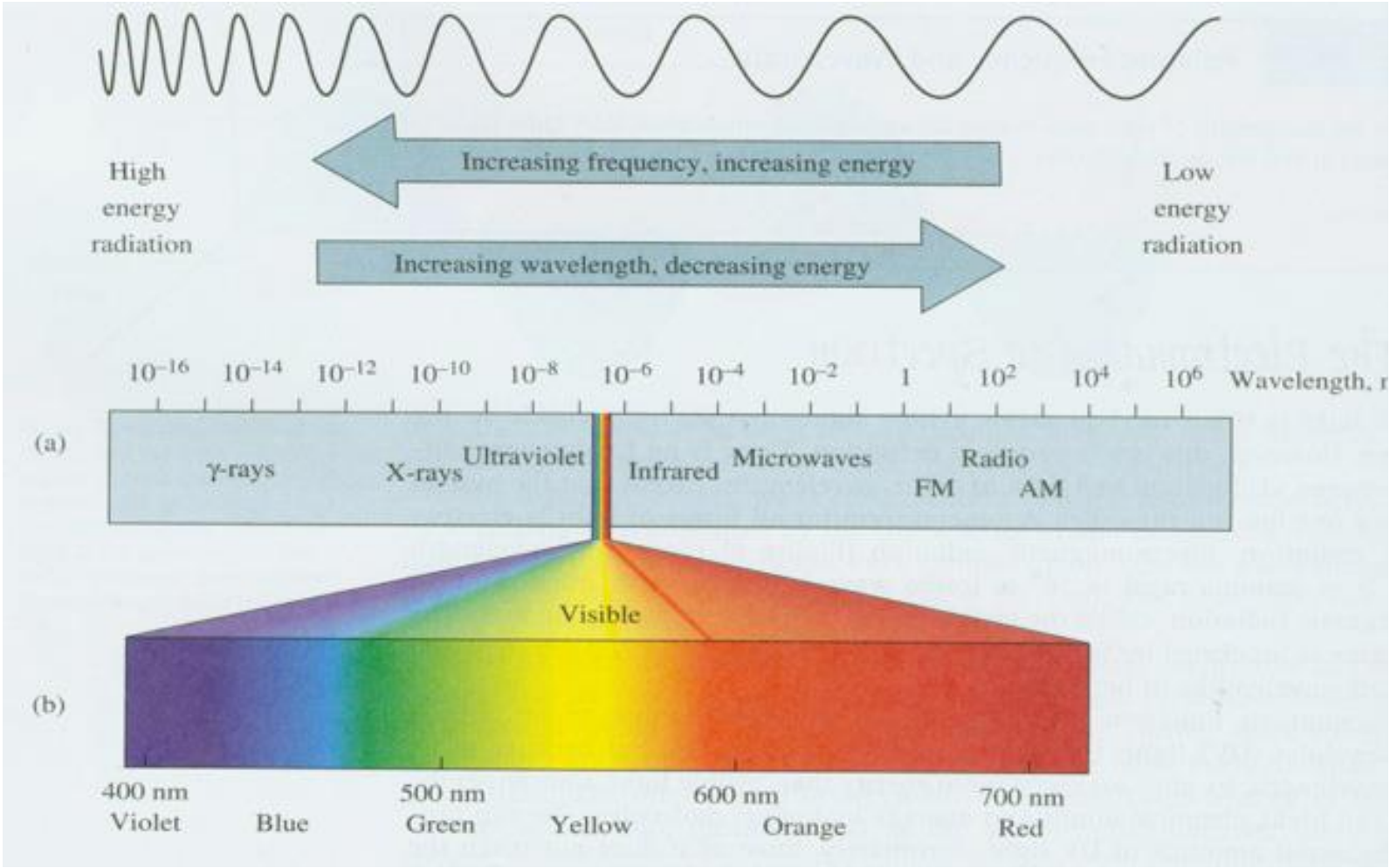
Light has been recognized as a source of energy and healing since the early days of recorded time. Ancient Greeks, Romans and Egyptians practiced heliotherapy, or healing by sunlight to treat various ailments.

EARLY BEGINNINGS

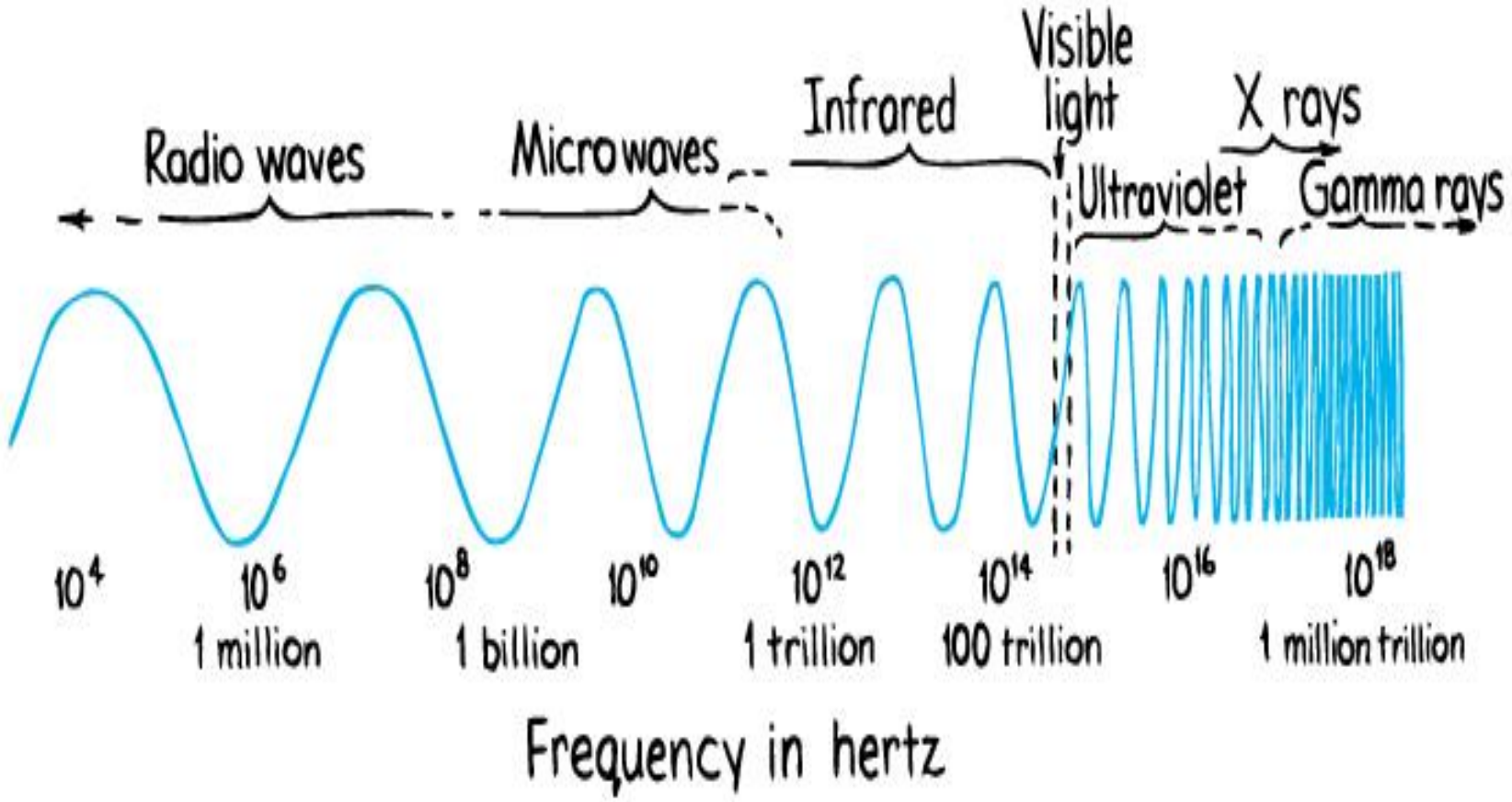
In the 17th century, Sir Isaac Newton identified the visible spectrum of light when he separated light with a prism.



ELECTRO-MAGNETIC SPECTRUM



ELECTRO-MAGNETIC SPECTRUM – Different Perspective



Hewitt, *Conceptual Physics*, Ninth Edition.

LASER

- **L**ight
- **A**mplification by
- **S**timulated
- **E**mission of
- **R**adiation

FREQUENTLY USED TERMINOLOGY

Terminology

- LLLT: Low-level Laser Therapy
- LILT: Low-intensity Laser Therapy
- Cold Laser Therapy
- Soft Laser Therapy
- Low Reactive Laser Therapy
- Low Power Laser Therapy
- Light Emitting Diode Therapy
- Low Energy Photon Therapy
- Biostimulation Laser
- Therapeutic Laser
- Bio-regulating Laser
- Medical Laser
- Phototherapy
- Class III Laser Therapy
- Class IV Laser Therapy
- HPLT: High Power Laser Therapy
- DTL: Deep Tissue Laser
- Photobiomodulation Therapy

WHAT DO WE CALL IT?

- Laser Therapy is the application of a very narrow ***spectral width of light*** over injuries or lesions to stimulate healing within those tissues.

- It used to be referred to as low level laser therapy (LLLT); today more appropriately referred to as Photomedicine.

We generally should not use the term **cold laser, or even laser therapy.**

The proper terms are: PHOTOMEDICINE, OR PHOTOMEDICINE THERAPY

FREQUENTLY USED TERMINOLOGY

- Accessible Exposure Limit (AEL)
- American National Standards Institute
- Aperture
- Aversion Response
- Biological Amplification
- Biomodulation
- Chromophores
- Coherence
- Collimation
- Continuous Wave (CW)
- Diffuse Reflection
- Dose
- Duty Cycle
- Energy Density
- Frequency
- Infrared Radiation (IR)
- Intrabeam Viewing
- Irradiance

FREQUENTLY USED TERMINOLOGY

- Laser Diode
- Laser Safety Officer (LSO)
- Light Amplification By Stimulated Emission of Radiation
- Light
- Maximum Permissible Exposure (MPE)
- Monochromatic.
- Nominal Hazard Zone (NHZ)
- Optical Density (OD)
- Penetration
- Photobiomodulation
- Physiological Dose of Therapy
- Power Density
- Pulsed
- Radiant Exposure
- Specular Reflection
- Ultraviolet Radiation (UV)
- Visible Radiation
- Wavelength

KEY LASER TERMINOLOGY

- **Aperture:** Hole where the laser comes out
- **Diode:** The semiconductor component where the laser beam is generated from (like a light bulb, but not really)
- **Watt:** Unit for measuring power of diode
- **mW:** 1/1000th of a Watt
- **Joules:** The amount of energy delivered to patient
- **nm:** The measurement of length of laser waves (“color”)
- **cm^2:** Area of body treated with laser

KEY LASER TERMINOLOGY CONTINUED…

- **Average Power**: Refers to the average power that a laser emits during the treatment, measured in watts (W).
- **Duty Cycle:** Ratio of “on” duration compared to “off” during one period. A period is the time it takes to complete an on-and-off cycle.
- **Effective Dose:** Is the does or amount that produces a therapeutic response or desired effect.
- **Energy:** Commonly used to characterize laser output, measured in joules (J).
- **Energy Density/Fluence:** The energy density expresses the total amount of energy delivered per unit area, in Joules per square centimeter (J/cm^2).
- **Hertz (Hz)**: Unit of frequency, i. e. “pulses per second”, listed in Hz.
- **Joule (J)**: A unit of energy describing the work required to produce one watt of power for one second (one watt-second).
- **Joule cm^2 ($J\ cm^2$)**: A unit of radiant exposure used in measuring the amount of energy per unit area of absorbing surface or per unit area of a laser beam. Also called the dose.

KEY LASER TERMINOLOGY CONTINUED…

- **Peak Power:** The maximum pulse power output of a laser and it is fixed by the laser manufacturer.
- **Power**: The time rate at which energy is transferred. Usually expressed in watts (joules per second); also termed radiant flux.
- **Power Density**: The intensity of the laser beam; average power divided by size of beam (“spot size”); relates to the dose.
- **Pulse Mode:** The pulse energy is simply the total optical energy content of a pulse. Pulse mode is operation of a laser when the beam is intermittently on in fractions of a second.
- **Watt (W):** The unit of power; equivalent to one joule per second.
- **Watt cm^2 (W cm^2):** A unit of irradiance used in measuring the amount of power per area of absorbing surface, or per cross-sectional area of a laser beam. Also called power density.

COMMON LASER TYPES

- **Solid State:**
  - Nd:YAG 1064 nm, 532 nm (KTP)
  - Alexandrite 755 nm, HoYAG (2100 nm)
  - Sapphire 700 to 1000nm
- **Diode Lasers:** 650nm, 810nm, 915nm, 980nm, 1064nm
- **Fiber Lasers:** 1000nm and 1700 nm
- **Dye Lasers:** visible range
- **Gas Lasers:**
  - CO^2 10,000nm
  - Excimer 193nm, 248nm

GALLIUM-ALUMINUM-ARSENIDE LASERS

GaAlAs Lasers:

- Semiconductor lasers
- Wavelength in 635-1064nm range (typically)
- **Continuous wave** (CW); can be chopped to simulate pulsing
- Average power is the same as peak power on continuous wave
- Average power typically in 0.5W – 45W

CHARACTERISTICS OF LASER LIGHT

A laser generates a beam of very intense light, in either OR both visible and non-visible light.

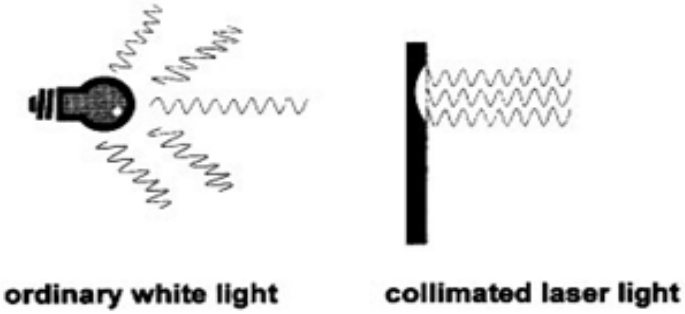
Laser light has three distinct characteristics that distinguish it from ordinary light:

Laser light is:

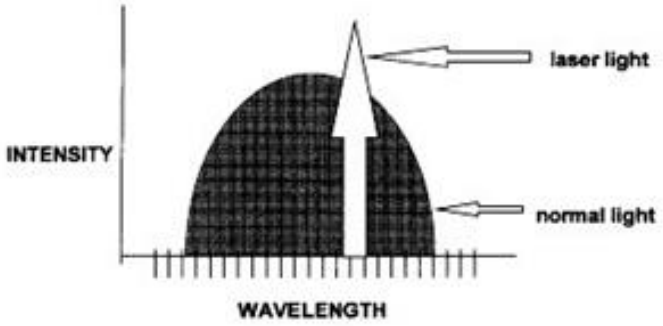
1. **- Collimated**
2. **- Monochromatic**
3. **- Coherent**

COLLIMATION/NON-DIVERGENCE

A **laser beam** is collimated, meaning it consists of waves traveling parallel to each other in a single direction with very little divergence. This allows laser light to be focused to very high intensity.



Ordinary light waves spread and lose intensity quickly.

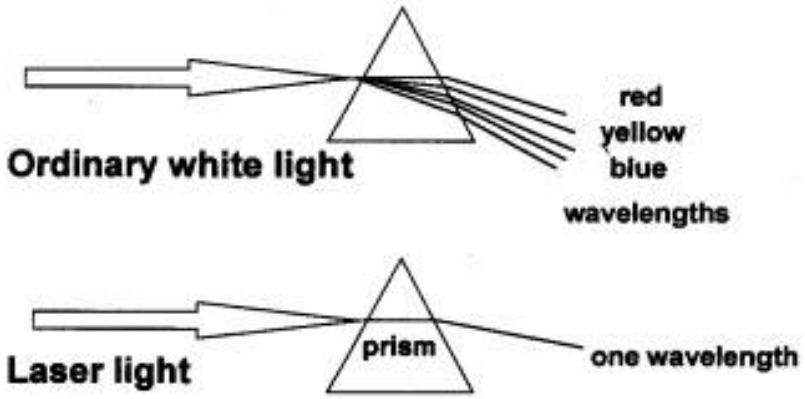


MONOCHROMATIC

Monochromatic refers to the **single (wavelength) color** of a laser beam.

Ordinary white light is a **mixture of colors**, as you can demonstrate by shining sunlight through a prism.

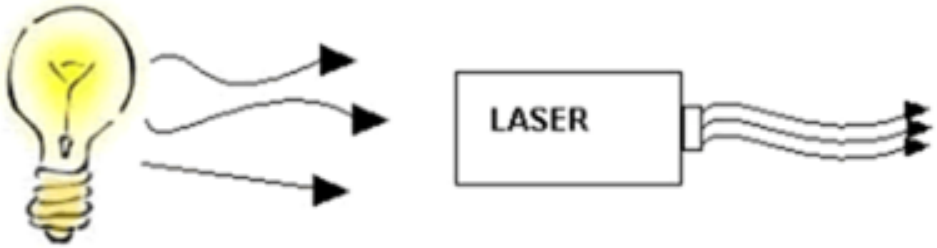
Because the wavelength of laser light determines its effect on tissue, the monochromatic property of laser light allows energy to be delivered to specific tissues in specific ways.



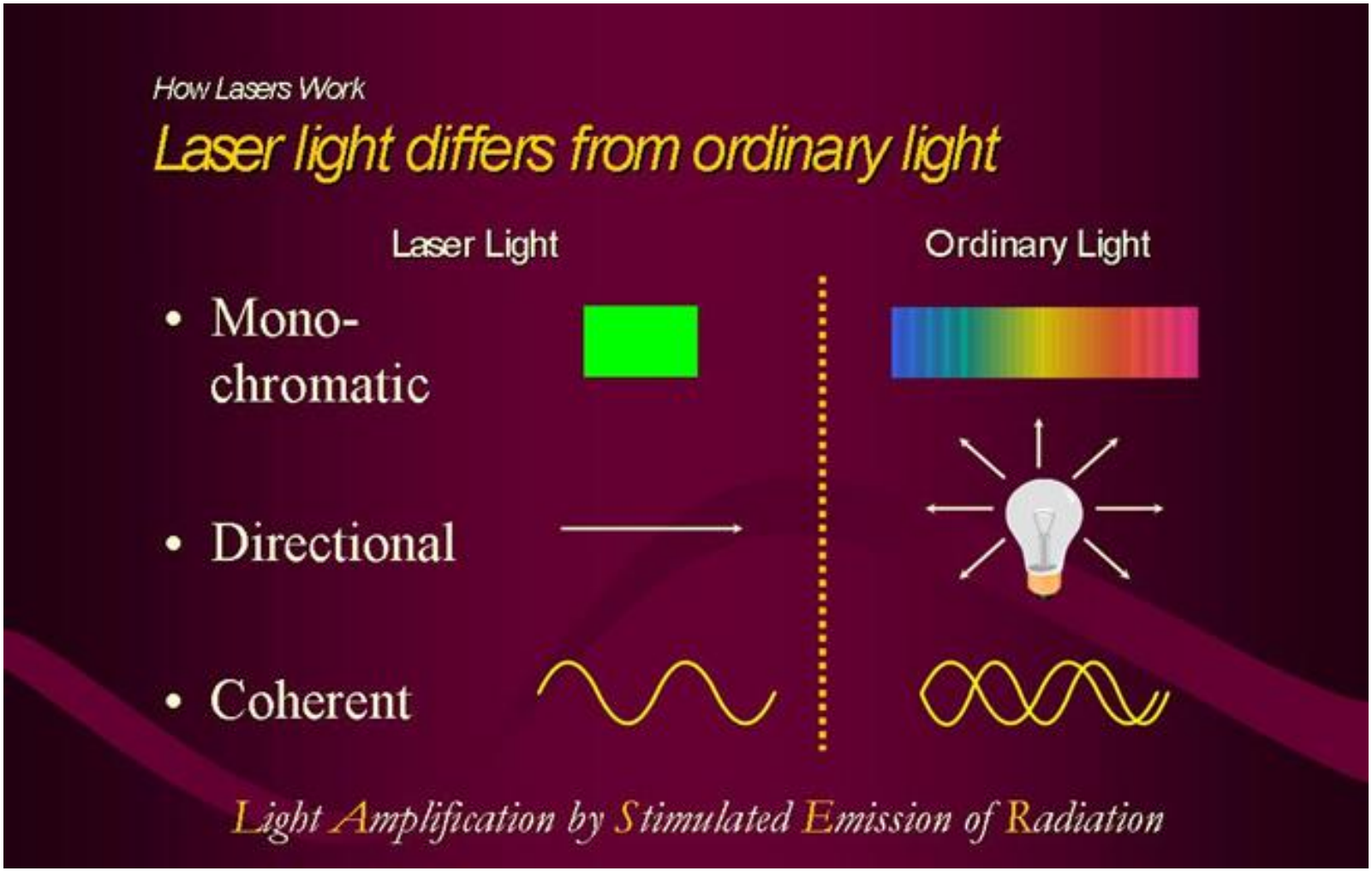
COHERENCE

Laser light is coherent, which means **all the light waves move in phase together** in both time and space. A laser has a very tight beam that is strong and concentrated.

A **light bulb**, by comparison, **releases light in many directions**; the light is weak and diffuse.



LASER (PHOTONS) VERSUS WHITE LIGHT

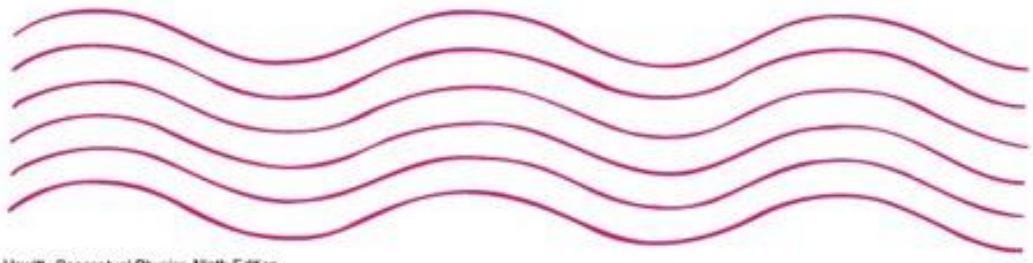


LASER (PHOTONS) VS WHITE LIGHT

White Light:

Monochromatic Light: (e.g., LED)

Laser Light:

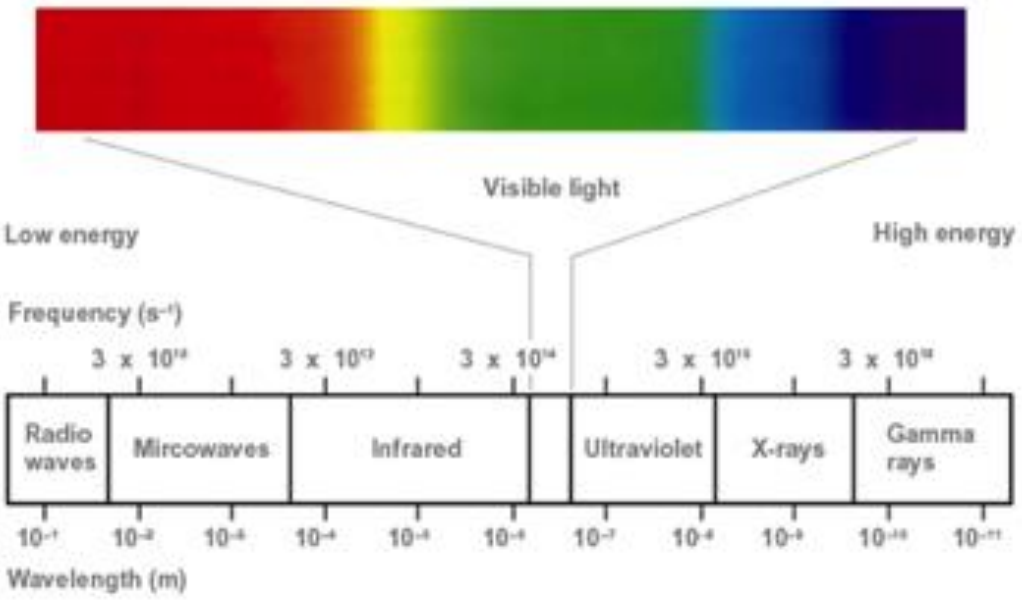


LASER WAVELENGTHS

- **Electromagnetic Spectrum and Wavelengths**

A commonly accepted definition laser is “limited to electromagnetic radiation-emitting devices using light amplification by stimulated emission of radiation at wavelengths from 180 nanometers to 1 millimeter.”

- **The electromagnetic spectrum includes energy ranging from gamma rays to electricity.** The Figure below illustrates the total electromagnetic spectrum and wavelengths of the various regions.



MEASURING WAVELENGTHS: NANOMETERS (NM)

The biological effects of laser therapy are related to the wavelengths of light emitted by the laser, and the volume of energy transferred to the targeted tissues.

- **Different wavelengths target different tissues** e.g. blood, melanin, water, etc.
- These targets are known as **Chromophores**
- **Ultraviolet radiation** consists of wavelengths between **180nm and 400nm**
- The **visible light region** is radiation with wavelengths between **400nm and 700nm. Some people can see slightly higher.**
- The **infrared light region (not visible)** of the spectrum consists of radiation with wavelengths between **700nm and 1mm.**

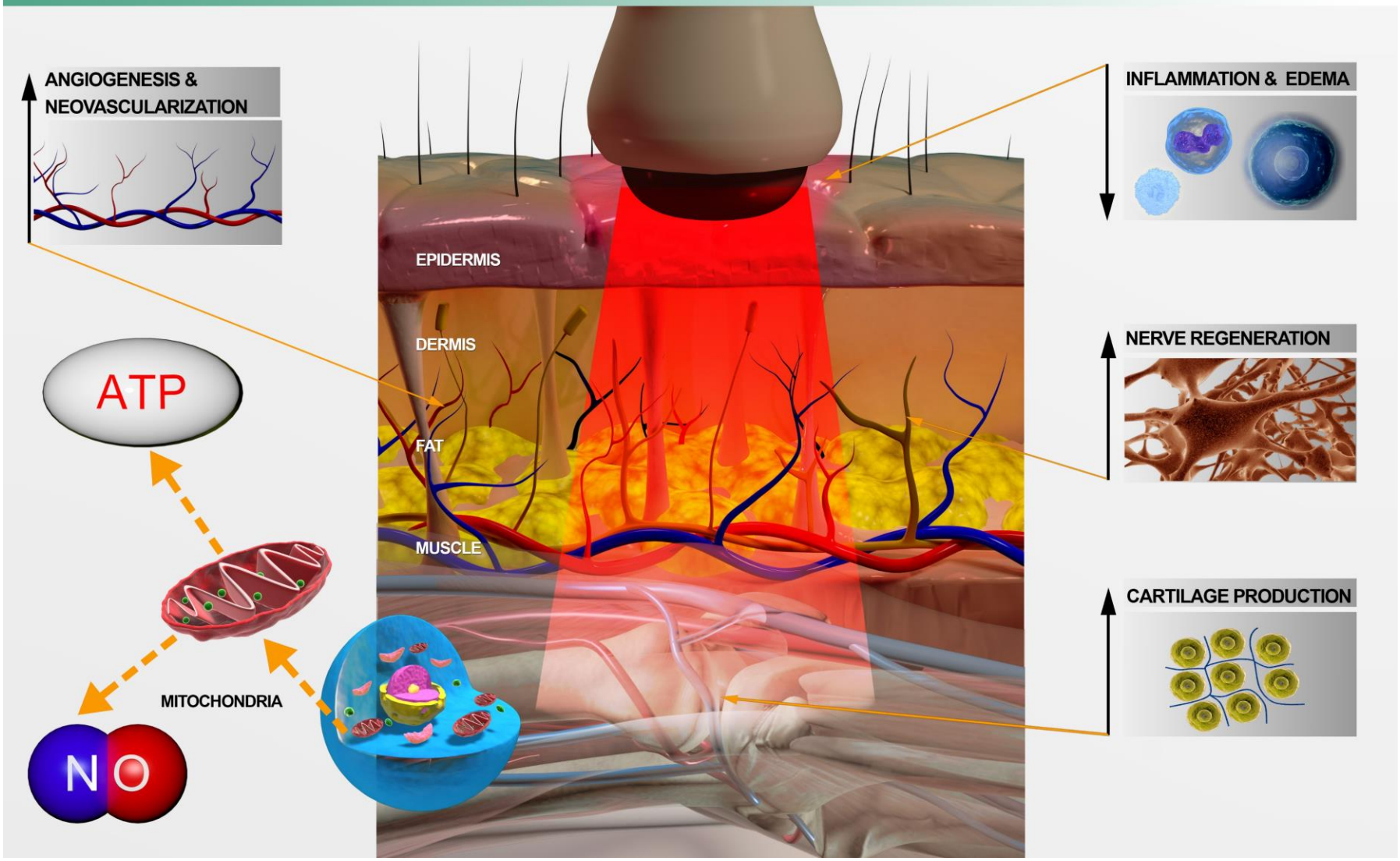
Primary Tissue Variability Factors

Biological effects of Photomedicine (laser therapy) are dependent on the following Primary Tissue Variability Factors:

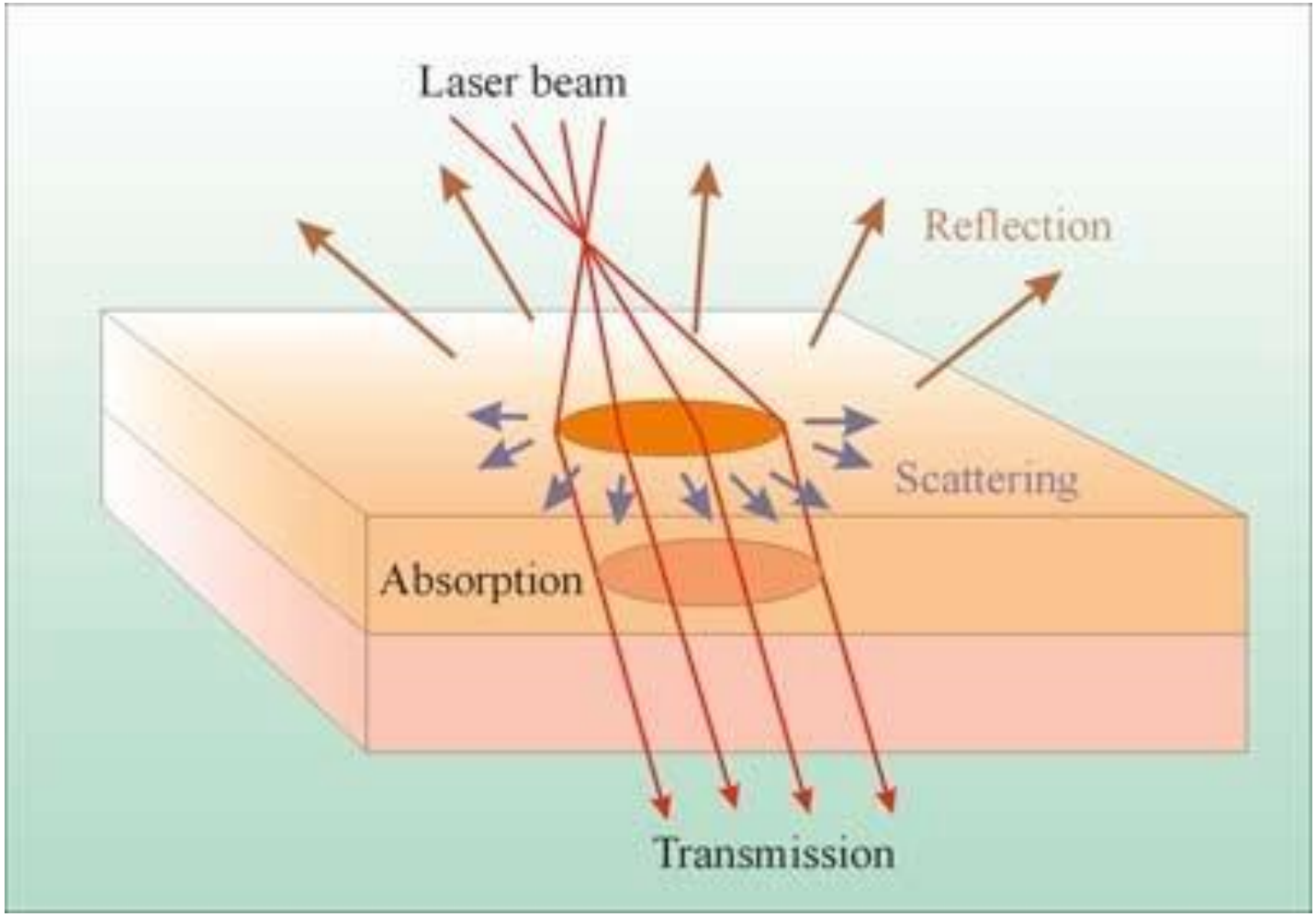
- **P.T.V.F. - Primary Tissue Variability Factors™**
- The following Primary Tissue Variability Factors™ have been established for setting and adjusting optimal laser therapy treatment dosages:
-

1. **Tissue Type**: blood, fat, nerve, muscle, skin, tendon, cartilage, bone
2. **Tissue Structure**: Simple, stratified, pseudostratified, transitional
3. **Tissue Density**: adiposity index or BMI (Body Mass Index)
4. **Tissue Permeability** (ability of wave energy to pass through, or be absorbed by tissue structures)
5. **Tissue Proximity**: (depth of tissue (shallow vs. deep)
6. **Tissue Pigmentation**: six levels, from white to black (Fitzpatrick Scale)
7. **Tissue Hydration**: hydrated or dehydrated (typical = Min. 54.8% to Max. 78.1%)
8. **Tissue Stress**: bio-behavioral factors that can induce cell damage (cortisol levels, etc.)
9. **Tissue Age**: from atrophic to neoplastic
10. **Tissue Function/malfunction:** Equilibrium, Entropy, & Homeostasis

Clinical Effects of Photomedicine



LIGHT - TISSUE INTERACTIONS



LIGHT - TISSUE INTERACTIONS

Photo – Thermal Lasers

Photothermal converts light energy into heat energy. This causes the tissue to heat up and vaporize. These lasers are “long pulsed”.

Examples:

- Most surgical lasers
- Hair removal lasers

Photo –Mechanical (or Photo-Acoustic) Lasers

Photoablative causes photodissociation or breaking of the molecular bonds in tissue. These lasers are “short pulsed”.

Examples:

- Q-switched lasers
- Tattoo removal lasers

Photo-Chemical Lasers

Photochemical causes target cells to start light-induced chemical reactions.

Examples:

- Therapy lasers - treating pain in a joint or the deep tissues
- Photo-dynamic lasers (PDT) - cancer treatment, ophthalmic treatments

WAVELENGTHS AND ABSORPTION

Laser light's monchromaticity is responsible for its selective effect on biologic tissue. Whenever light hits tissue, it can be transmitted, scattered, reflected, or absorbed, depending on the type of tissue and the wavelength (color) of the light.

However, light absorption must take place for there to be any biologic effect, and a given wavelength of light may be strongly absorbed by one type of tissue, and be transmitted or scattered by another.

Infrared light is absorbed primarily by water, while visible and ultraviolet light are absorbed mainly by hemoglobin and melanin, respectively. As the wavelength decreases toward the blue-violet, and ultraviolet, scatter, which limits the depth that light may penetrate into tissue, becomes more significant.

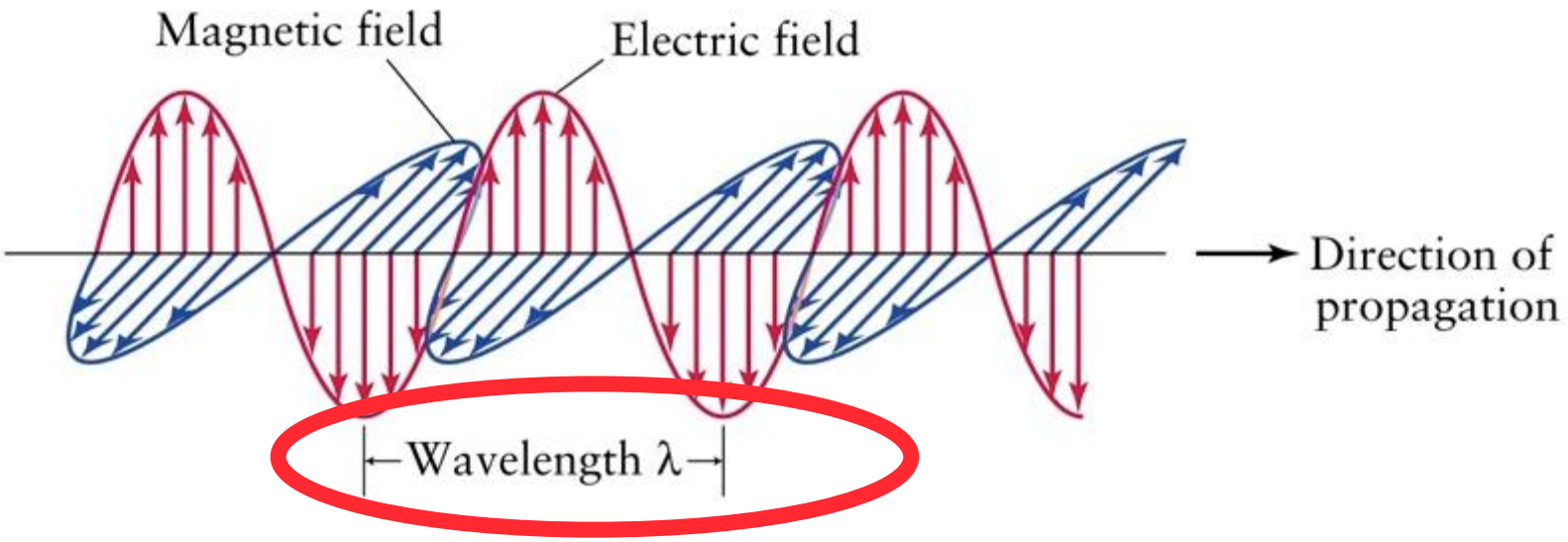
When light is absorbed, it delivers energy to tissue, and the tissue's reaction depends on the intensity and exposure time of the light.

Each type of tissue has its **specific absorption characteristics** depending on its specific components (i.e., skin is composed of cells, hair follicles, pigment, blood vessels, sweat glands, etc.)

The main absorbing components, or Chromophores, of tissue are:

- **Hemoglobin** in blood
- **Melanin** in skin, hair, moles, etc.
- **Water** (present in all biologic tissue)
- **Protein** or “Scatter" (covalent bonds present in tissue)

PHOTON: ELECTROMAGNETIC WAVE



A photon is a discrete bundle (or quantum) of electromagnetic (or light) energy

FIRST LAW OF PHOTOCHEMISTRY (Photophysics)

The First law of photochemistry, **the Grotthuss-Draper law*:***

"light must be absorbed by a compound in order for a photochemical reaction to take place."

Since photobiological and phototherapeutic effects are initiated by photochemistry (or photophysics), unless light of a particular wavelength ***reaches*** and it is ***absorbed*** by a chromophore, no photochemistry (or photophysics) will occur, and no photobiological effects will be observed, no matter how long one irradiates with that wavelength and power of light.

THE RECIPROCITY RULE IN PHOTOMEDICINE

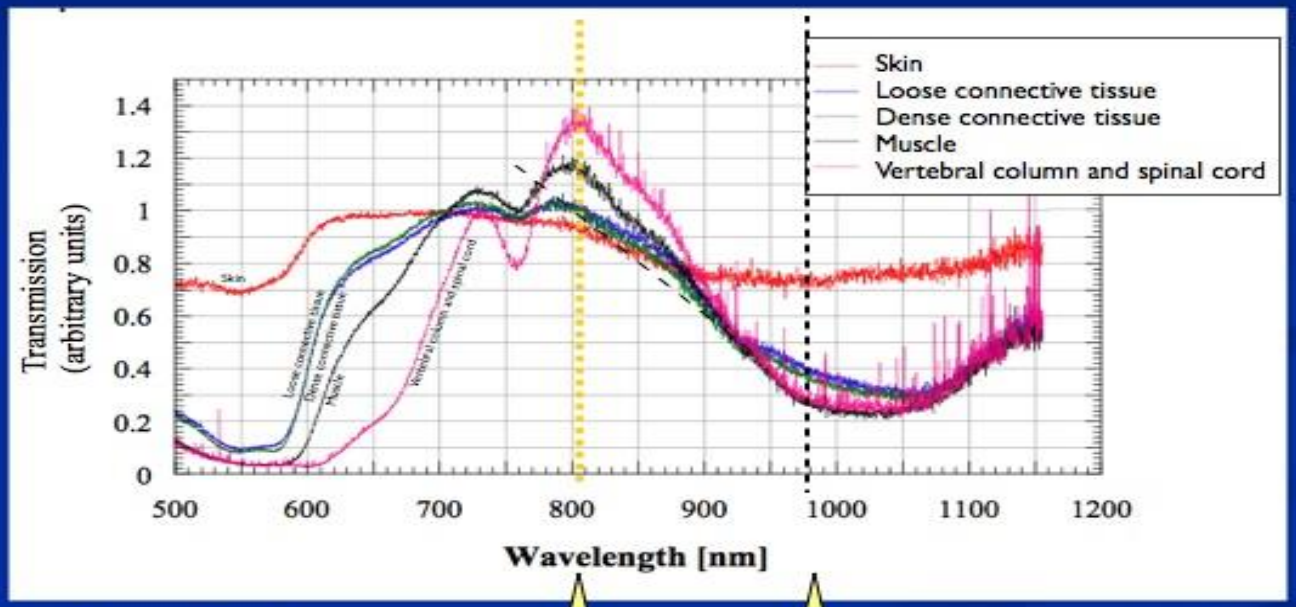
The Reciprocity Rule in Photomedicine, Bunsen Roscoe Law The Reciprocity Rule states that specific biochemical and energy field interactions that occur in the body are directly proportional to the total energy dose received and governed by specific tissue variability factors; in this document, we define those factors and identify appropriate energy dosages required to effectively stimulate the desired tissue interactions.

THE STARK-EINSTEIN LAW

Stark–Einstein Law “Number of activated molecules = number of quanta of radiation absorbed.” The Stark–Einstein law is known as the Photochemical Equivalence Law. It says that every photon that is absorbed will cause a (primary) chemical or physical reaction; the photon = one unit of radiation; therefore, this is a single unit of EM radiation that is equal to Planck's constant (h) times the frequency of light.

EFFECTIVENESS OF THE 810NM, 915NM, 980NM, & 1064NM WAVELENGTHS

Laser Penetration



Light Promotes Regeneration and Functional Recovery and Alters the Immune Response After Spinal Cord Injury
Byrnes et al
Lasers Surg Med. 2005 Mar;36(3):171-85

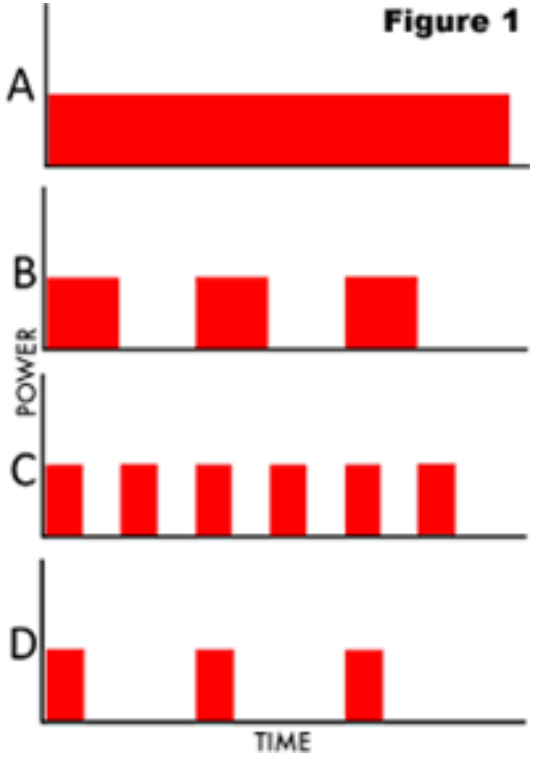
810nm 980nm

MODES: CONTINUOUS WAVE AND PULSING

Laser Modes of Operation

A laser can be classified as operating in either continuous or pulsed mode, depending on whether the power output is essentially continuous over time or whether its output takes the form of pulses of light on one or another time scale.

- **Continuous Wave**
- **Modulated Continuous Wave**
- **Q Switched (nanosecond pulses)**
- **Long pulsed (micro or millisecond pulses)**

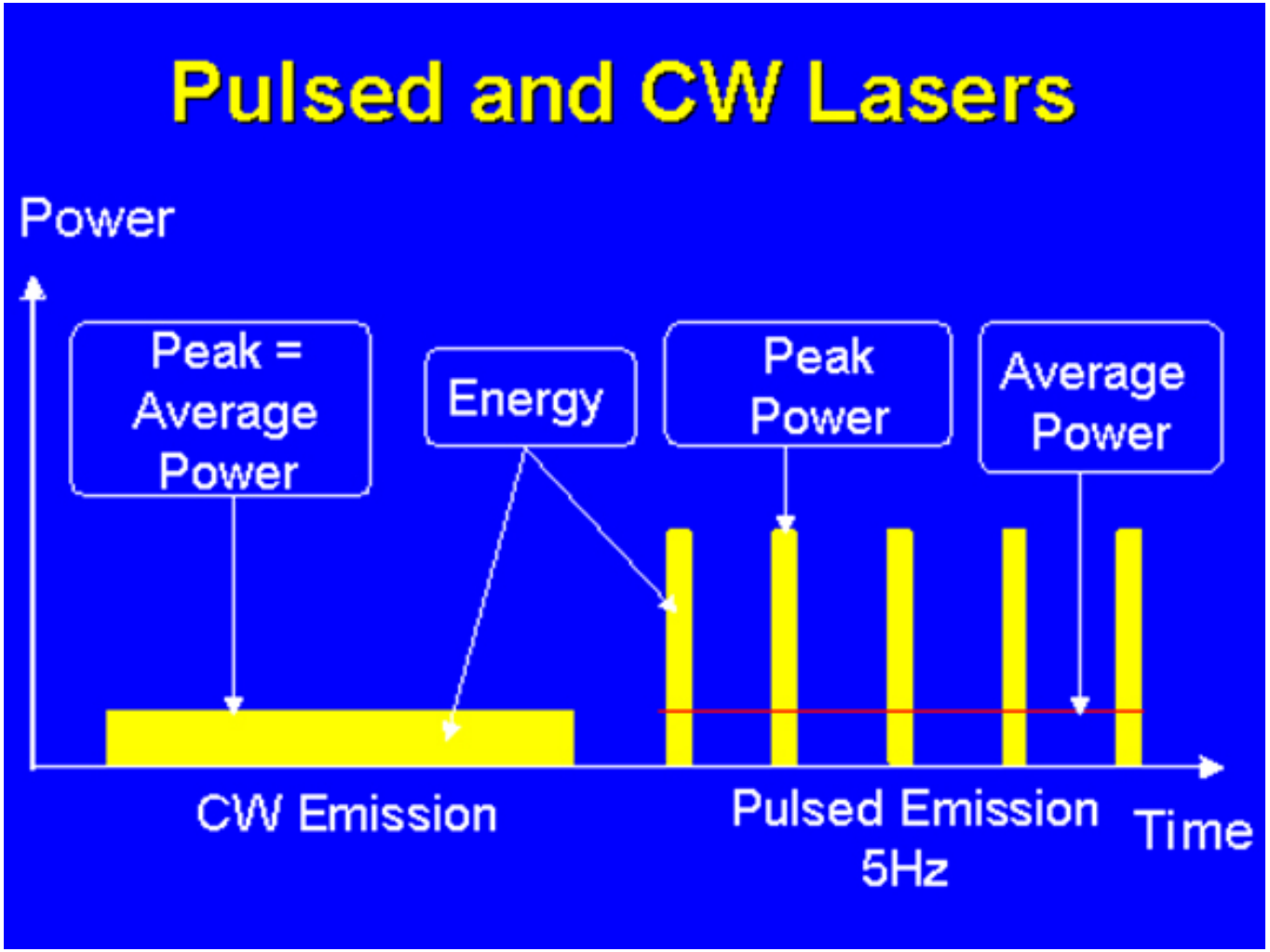


Graph A: Continuous wave (CW) is like a light that is constantly "on," **Continuous wave emission lasers have no interruption during the delivery of their energy**

Graph B and C: Modulated lasers produce light that is "on" half the time and "off" half the time. The duty cycle is simply 50 percent, because the light is "on" half the time and "off" half the time. An advanced definition of duty cycle is the duration of the pulse divided by the period, or the time from the beginning of one pulse to the beginning of the next.

Graph D: The laser represented has a duty cycle of 25 percent; it is "on" one-fourth of the time and "off" three-fourths of the time.

CONTINUOUS WAVE AND PULSING



Why do the CW and Pulsed have same Average Power?

BEAM TYPES

Continuous Wave (CW and Modulated or "Pulsed")

- **Power output (watts) is constant** over time
- Average power is about the same level or lower than peak
- Can be chopped, modulated, turned on-off to simulate pulses
- Peak power is about the same as maximum average power

Pulsed Wave (Pulsed and Superpulsed)

- Power output is emitted in impulses over time at regular intervals (frequency)
- **High peak power output** – "Flash Bulb"
- Pulsed in nanoseconds (10^{-9} or billionths of a second)
- Peak power level (50-250W); much higher than average power

PULSING AND FREQUENCY

The words pulsing and frequency are used interchangeably to describe the same concept. The interruption of energy flow on a predetermined basis.

There are principally two types of pulsing in laser phototherapy

- **1 - chopped (switched)**
- **2 - superpulsed**

A chopped beam is a continuous beam that is electronically (or mechanically) switched between on and off. During the moments when it is on it has typically the same output power as in continuous mode, but as it is not on all the time, the average output power is less than when it is continuous mode.

The average power is a function of the continuous wave power and the duty cycle (the ratio of the “on” time of the beam to the total emission (“on” + “off”) time, usually expressed as a percentage).

POWER DENSITY

Power

Power and energy are closely related. Power is the rate at which energy is delivered, not an amount of energy itself.

Formula:

Power = Energy / Time **1 Watt = 1 Joule / Second**

Therapeutic Energy = Power (Watts) or Joules/sec x Time (sec).

Power Density

Power density or Irradiance refers to the amount of power delivered per unit area. Power density indicates the degree of concentration of the laser output. It is expressed in Watts per square centimeter W/cm^2), or miliWatts per square centimeter (mW/cm^2). Some studies have concluded that the power density may be of even greater significance than the dose.

Example: A laser's output is 4 Watts, and it is illuminating a circle of 3 centimeter diameter.

First find the area of the circle, 3.14 x 1.5 x 1.5 = 7 cm^2.

Then divide the power by the area, 4W / 7cm^2 = 0.6 W/cm^2.

Formula:

Irradiance (Power Density PD) = W/cm^2

THE MOST IMPORTANT PARAMETERS

- **Power Density = "Intensity"**
- **Power Density = Average Power ÷ Size of Beam ("spot size")**
  - **Power Density = W / cm^2**
- **Energy Density = J / cm^2 (dose)**

ENERGY DENSITY(ED) / (FLUENCE)

Energy Density
The energy density expresses the total amount of energy delivered per unit area, in **Joules per square centimeter (J/cm^2).**

The energy is measured in Joules, and is calculated by multiplying the power output of the laser times the amount of time elapsed during the laser treatment.

Example: A 4 Watt continuous wave laser would deliver 240 Joules in one minute. (4 Watts x 60 seconds = 240 Joules). Then simply divide the total energy by the area to arrive at the energy density in Joules per centimeter squared.

Formula:
Fluence (ED) = Power x Exposure Time, measured in Joules/cm^2 (Watts x Seconds)

The amount of energy delivered,
determines the magnitude of the laser interaction
within the tissues and the individual cells.

EXPRESSIONS OF LASER POWER (Strength)

Output Power: Peak and Mean: Photons per second
Power is measured in Watts = Joules per second

Energy is expressed in Joules
Energy (Dose) (Joules) = Ave. Power (Watts) x Time (s)

1 Joule = 1 W x 1 sec = 1 Watt flowing for 1 second

Power Density = Intensity = Concentration
Power Density: W/cm^2 = Power ÷ size of beam (circle area)

Energy Density (treatment dose): $(W \times s)/cm^2 = J/cm^2$

Power density in 60 seconds = dose per minute

The key to successful treatment is getting the correct amount of laser energy to the target tissue

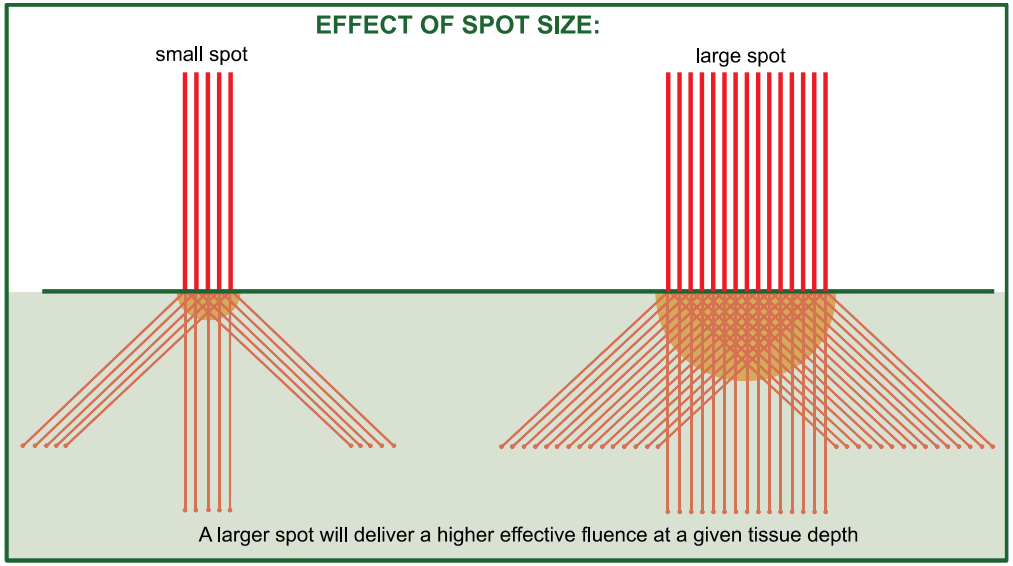
EFFECT OF LASER SPOT SIZE

A beam of light on tissue may be:

- **1 – Reflected**
- **2 – Absorbed**
- **3 – Scattered**
- **4 – Transmitted**

Scattering in tissue broadens the incident beam, decreasing the effective fluence in the intended target area.

For effective penetration, light needs to avoid scattering and surface absorption by irrelevant targets



CLASS III VS. CLASS IV THERAPY LASERS

Trends in Photomedicine (Laser) Therapy

"The authors of **Laser Therapy- Clinical Practice and Scientific Background**, Dr. Jan Tuner and Lars Hode, have performed an analysis of a number of frequently cited studies on the effects of low-power-laser therapy.

Selected Quotes:
“In many of these studies, analysis uncovered one or more **reasons for the negative findings** reported, the most common being the use of **extremely low doses**.”

"The trend in laser therapy for the past 10 years has been to **increase power density and dose,** since this has been shown to **improve therapeutic outcomes considerably**.”

“There is no point in increasing the dose if the wavelength has a low penetration factor; the penetration of the particular wavelength must be taken into account."

CLASS III VS. CLASS IV THERAPY LASERS

“For the moment, we must rely on our own clinical experience. That experience, however, is so encouraging that it cannot be ignored, and scientific support is growing. It would appear that “high powered” therapeutic lasers will be able to further expand the scope of laser therapy.”

“I can see two alternatives for myself: to speak up and start a conflict within the laser community, maybe discrediting the therapy itself in the eyes of the general public or to keep quiet and let US practitioners pay a lot of money for very low-powered lasers, leaving us with dissatisfied customers and discredit from those who are supposed to use laser therapy in medicine.”

CLASS III VS. CLASS IV THERAPY LASERS

Insurance Determination: Class III Therapy Lasers Are Not Effective

"While the FDA has approved the marketing of the device, many payers have declined to recognize LLLT as effective treatment. Results of treatment have not been consistent so that it is difficult to state that such treatment would be necessary. Last, given the reported number of visits required to be nine to 12 visits, the cost of such treatment would be approximately $1000 to $1500. These costs appear to be somewhat unreasonable for a treatment that has not been demonstrated in the medical literature to be effective."

Source: Position Paper on Low Level Laser Therapy (LLLT) 12 pages
Ohio Bureau of Workers' Compensation

"Aetna considers cold laser therapy experimental and investigational because there is inadequate evidence of the effectiveness of low-energy (cold) lasers in wound healing, pain relief, or for other indications such as musculoskeletal dysfunction, arthritis, and neurological dysfunctions."

Source: Aetna: Clinical Policy Bulletins, Number 0363,
Subject: Cold Laser Therapy

CHARACTERISTICS OF CLASS IV THERAPY LASERS

Class IV lasers offer better therapeutic outcomes, based on six characteristics of the technology:

1 – Larger dosages of therapeutic energy. Class IV lasers can deliver up to 1,500 times more energy than Class III and consequently reduces treatment time.

2 – Deeper penetration into the body. Leading Class III lasers only penetrate
0.5-2.0 cm^2. Class IV can penetrate up to 5 cm^2.

3 – Larger treatment surface area. Class III cover a treatment area of 0.3-5.0 cm^2, depending on the model and manufacturer. Class IV cover up to 77 cm^2. This is important when treating large regions, such as the lumbar spine, quadriceps or hips.

4 – Greater power density. Power density indicates the degree of concentration of the power output. This property has been shown to play a major role in therapeutic outcomes.

CHARACTERISTICS OF CLASS IV THERAPY LASERS

- **Continuous power supply.** In Class III lasers, the power is pulsed or modulated approximately 50 percent of the time. In other words, light is permitted to pass through the probe for only 50 percent of the total operating time. In most cases, Class IV lasers deliver a consistent amount of energy over a given time. Their power can be adjusted for acute and chronic conditions.

- **Superior fiber optic cables.** Fiber optic cables transmit laser energy from the laser to the treatment probe (wand) at the end of the cable. Several studies reveal that as much as 50 percent of the light energy generated by a Class III laser may be lost by the time it reaches the end of the probe.

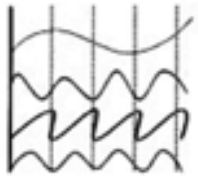
LED DEVICES

Light Emitting Diode (LED): LED is a device that emits incoherent low intensity light.

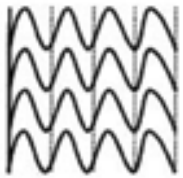
LED Clusters: Deliver energy superficially over broader regions.

Whereas Laser Energy delivers photonic energy deeply and specifically

Primary Difference:
The main difference is coherency. Laser light is coherent ("coherent waveform"), which means all the light waves move in phase together in both time and space. A laser has a very tight beam that is strong and concentrated. An LED ("incoherent waveform") releases light in many directions; with the result that the light is weak and diffuse.



incoherent waveforms



coherent waveforms

- LED Devices Are Not Lasers – Light Therapy is not Laser Therapy
- LED Distributors Incorrectly Promote Laser Clinical Studies
- Significant Difference in Biostimulation Effects
- Insurance Determination: LED Not Effective

Conclusion: Laser Energy far surpasses LED Therapy for clinical effectiveness and results.

POSITIVE DOUBLE BLIND LLLT STUDIES

Allergic rhinitis:	1
Arthritis:	16
Epicondylitis:	5
Fibrositis:	1
Herpes simplex:	1
Hypersensitive dentine:	3
Microcirculation:	1
Mucositis:	1
Nerve functions:	6
Pain:	33
Paresthesia:	2
Post herpetic neuralgia:	2
Tendinitis:	3
Trigger points:	4
Sinusitis:	1
Sjoegren's Syndrome:	1
Wound healing:	8

PubMed has thousands of laser studies!

PEER REVIEWED RESEARCH

For hundreds of additional peer-reviewed studies, please go to https://www.medlasers.org

A Meta-analysis of The Efficacy of Laser Phototherapy on Pain Relief
CONCLUSION: Laser phototherapy effectively relieves pain of various etiologies; making it a valuable addition to contemporary pain management armamentarium.
http://www.ncbi.nlm.nih.gov/pubmed/20842007

Low Level Laser Treatment of Tendinopathy: A Systematic Review With Meta-analysis
Conclusion: LLLT can potentially be effective in treating tendinopathy when recommended dosages are used. The 12 positive studies provide strong evidence that positive outcomes are associated with the use of current dosage recommendations for the treatment of tendinopathy.
http://www.ncbi.nlm.nih.gov/pubmed/19708800itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDoSum&ordinalpos=90

Photobiomodulation of Pain In Carpal Tunnel Syndrome: Review of Seven Laser Therapy Studies
Photoradiation is a promising new, conservative treatment for mild/moderate CTS cases (motor latency < 7 msec; needle EMG, normal). It is cost-effective compared to current treatments.
http://www.ncbi.nlm.nih.gov/pubmed/16706688ordinalpos=1&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pbmed_DiscoveryPanel.Pubmed_Discovery_RA linkpos=5&log$=relatedreviews&logdbfrom=pubmed

Efficacy of Different Therapy Regimes of Low-power Laser in Painful Osteoarthritis of The Knee: A Double-blind and Randomized-Controlled Trial
CONCLUSIONS: Our study demonstrated that applications of LPLT in different dose and duration have not affected results and both therapy regimes were a safe and effective method in treatment of knee OA. Copyright 2003 Wiley-Liss, Inc.
http://www.ncbi.nlm.nih.gov/entrezquery.fcgicmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14677160&query_hl=18&it ol=pubmed_DocSum

CLASS IV LASER THERAPY (PHOTOMEDICINE)STUDY

CLASS IV LASER THERAPY; EFFECTIVE FOR BACK AND NECK/SHOULDER PAIN

(Retrospective, Practice Based Clinical Preliminary Investigation)

Author: L.D. Morries, DC, CCSP®

Background: Class IV laser therapy is a recent modality that is used to treat pain and promote healing of muscular tissue. The procedure is minimally invasive and easily performed. Laser therapy was added to conventional chiropractic treatment of spinal manipulation and an exercise program for treating patients with back pain. The objective of this investigation was to assess efficacy and safety of the combination and generate preliminary results for a randomized controlled trial.

Conclusions: These results indicate that both treatments successfully reduced the VAS by the fourth week of treatment, and that a higher reduction in VAS occurred in the group treated by manipulation + laser at week four.

In summary, Class IV laser therapy is a safe and effective modality for treating low back pain when added to conventional treatment of manipulation and exercise. Further study is indicated to support these initial findings.

AMERICAN CHIROPRACTIC BOARD OF SPORTS PHYSICIANS™

2010 CHIROPRACTIC SPORTS SCIENCES SYMPOSIUM CHICAGO, ILLINOIS
APRIL 30-MAY 2, 2010

CLASS IV LASER THERAPY STUDY

Effects of Photomedicine [Class IV Laser Therapy] on Disease Impact and Function in Women with Fibromyalgia

Author(s): Kristen Williams, Reed Mathis, J. Derek Kingsley, Emily Simonavice, Francesca Charles, Chris Mojock, Jeong-Su Kim, Victor McMillan, Lynn Panton, FACSM. Florida State University, Tallahassee, FL.

Abstract: It has been shown that 91% of individuals with Fibromyalgia (FM) use some form of alternative medicine compared to 42% of the general population. One modality that may show promise in helping to reduce the pain and impact of FM is laser therapy (LT).

PURPOSE: The purpose of the present study was to evaluate the effects of Class IV Infrared LT on pain, FM impact, and function in women diagnosed with FM.

RESULTS: There was a significant interaction effect for upper body flexibility (UBF) measured by the CS-PFP. LT significantly improved UBF (70.6±16.8 to 78.4±12.5 units) compared to SHT (77.3±11.8 to 76.7±10.7 units). There were no other differences in functionality or pain between LT and SHT. Although there was no interaction effect for the measure of FM impact measured by the FIQ, there was a time effect. FM impact significantly improved from pre to post treatment in LT (63.1±20.4 to 56.7±17.8 units) while there was no change in the SHT (56.9±10.6 to 55.1±11.5 units).

CONCLUSION: This study provides evidence that LT may be a modality to help women with FM improve their upper body range of motion which may ultimately decrease the impact of FM.

American College of Sports Medicine
Location: 331 Presentation. Time: Saturday, Jun 05, 2010, 10:00 AM -10:15 AM
Session: G-29-Neuromuscular Disorders; +1108 musculoskeletal or neuromuscular interventions

CLASS IV LASER THERAPY STUDY

A Randomized Controlled Trial for the Efficacy of Photomedicine [Therapeutic Class IV Laser Treatment] for Tendinosis

Author(s): Delia Roberts, FACSM[1], Roger Kruse, FACSM[2], Matthew Petznick[2], Jacklyn Kiefer[2], Peter Alaskym[2], Stephen Stoll[2]. [1]Selkirk College, Castlegar, BC, Canada. [2]ProMedica, Toledo, OH.

PURPOSE: To determine the efficacy of a class IV laser for the treatment of chronic epicondylitis.

RESULTS: No differences were noted between the two groups for any parameter before treatment. The mean duration of symptoms was 14.5±12 months, all subjects displayed pain and loss of strength and range of motion on the afflicted side, as well as ultrasonic evidence consistent with chronic tendinosis. There was a trend for increased strength (control change = -0.4±5.3 kg; LLLT change +0.8±3.7 kg; $p<0.07$) and decreased pain rating (change control = +0.6±3.3 units, 1/5 decreased pain; change LLLT= -2.6±3.3 units, 4/5 decreased pain; $p<0.06$) in the treatment group compared to the placebo group at the first post treatment exam.

CONCLUSION: Preliminary results suggest that LLLT is efficacious for the treatment of chronic epicondylitis. However, it remains to be seen whether statistical significance will be achieved with a larger group and whether the ultrasonographic evidence will indicate improved tendon health at 3 months.

American College of Sports Medicine
Location: Hall C, Poster Board: 217 Wednesday, Jun 02, 2010, 2:00-3:30 PM
Session: B-34-Musculoskeletal Evaluation and Care +1108 neuromuscular interventions

COMMENTARY ON WAVELENGTHS

Soliton Waves

Solitons are solitary waves that maintain their shape and speed while propagating with constant velocity. They are ubiquitous in nature and have many applications in nonlinear dynamics.

Some therapy laser manufacturers in the USA claims that their lasers produce “soliton waves” by “piggybacking one wavelength upon another”, and that these “penetrate deeper into the body than is possible with any other type of laser”. Either no therapy laser produces solitons, or ALL therapy lasers produce solitons. **There is no evidence to support this manufacturer’s claim that their laser alone produces solitons. This is psychobabble.**

Scalar Waves (more psychobabble)

The self-described “inventors” of the Scalar Wave (actually discovered by Heinrich Hertz) Laser claim to have developed the “most advanced low level laser technology with state-of-the-art quantum scalar waves” that supposedly employs a “unique approach to accessing the quantum neutral unified field state” to “dissolve cellular memory, normalize body systems, optimize anti-aging capabilities, and activate the glands and higher dimensional subtle body that yogis and mystics have tapped into throughout the ages” (this is known as psychobabble).

Some people would say anything to sell a laser.

COMMENTARY ON WAVELENGTHS

Penetration through clothing or "patented" wavelengths (Unique to Erchonia Laser)

For many indications, some degree of light penetration through tissue is an advantage. The penetration of laser light into different types of tissue is surprisingly poorly investigated, but enough is certainly known to refute the claims of Erchonia Laser. There are two extremes found in their marketing claims:

1) one that photons can penetrate clothes and even the entire body at very low powers,

2) the other that only "patented" wavelengths can reach very deep-lying targets

Both claims are characterized by gross exaggeration, demonstrating either complete ignorance or deliberate misapplication of the science of optics.

Again, some people would say anything to sell a laser.

SUPERPULSING

Typical peak power is in the order of many watts. However, when an electric current is conducted through a material heat is generated, and with the necessary high current in this laser the crystal will burn up immediately unless the time of current conduction is extremely short, i.e., superpulsed GaAs lasers cannot work continuously.

The maximal pulse time for this laser is in the order of 100 to 200 nanoseconds and, after each such pulse, a long cooling time is needed, usually about a thousand times longer than said pulse time.

This form of pulsing is called superpulsing and, although the peak power is very high, the average output of superpulsed lasers is comparatively low. Even though the peak power of the superpulsed GaAs laser may be very high, it lasts for an extremely short time compared to the pulse cycle, resulting in an average output power that is usually one hundred to one thousand times lower than the peak power. **For clinical use, it is the average power that counts.**

The energy (dose) delivered from pulsed lasers is always the average output power multiplied by the exposure time. The average power is the important output of the laser.

Some manufacturers prefer to label these lasers as “very strong” and state only the peak power which then can be in the order of 25, 50 and even 100+ watts.

This sounds impressive, but typically **these lasers emit 10-500 mW average power**, and this is what counts for a therapeutic benefit.

Again, some people would say anything to sell a laser.

SUPERPULSING CHALLENGES

To calculate the average power one must only know the Peak Power, the Pulse Frequency and the Pulse Duration. The pulse duration (i.e., the 'width' of each pulse of energy) of most GaAs devices is 100-200 nanoseconds (0.0000001-0.0000002 sec).

If we use one laser manufacturer's 'highest' power option (50,000 mW), and select their 5 Hz program, and assume the longest possible pulse duration (0.0000002 sec) for our calculation, we arrive at an Average Output Power of only 0.050 mW, or fifty millionths of one Watt**. With this very low average power it will take twenty thousand seconds (5.6 hours) for this manufacturer's laser to deliver one Joule**. No wonder they will not disclose their average power!

Many **"recommended" frequencies** employed in therapeutic lasers are, in fact, carried over from other fields and modalities, especially electrical stimulation. **Nogier's frequencies,** for example, are often incorporated into laser therapy protocols for both humans and animals; yet their original application was in humans only, specifically auricular therapy delivered by electrical stimulation. **There have been no studies undertaken to compare or confirm the efficacy of the original or higher-harmonic laser-delivered frequencies in humans or animals.**

KEYS FOR SUCCESSFUL TREATMENT

Get the correct amount of **laser energy** to target **tissue or organ**

- Correct amount is driven by **average power**
- Tissue penetration is driven by **peak power and wavelength**

OVERVIEW

– Laser Standards and Regulations

– Overview of Laser Classifications

– The Center for Devices and Radiological Health (CDRH)

– The International Electrotechnical Commission (IEC)

– The American National Standards Institute (ANSI)

LASER STANDARDS AND REGULATIONS

Regulatory Agencies include:

CDRH The Center for Devices and Radiological Health

IEC The International Electrotechnical Commission

ANSI The American National Standards Institute

State Regulations

Some states currently require registration of medical lasers. The regulations cover use of Class IIIB and Class IV medical lasers and require following specific guidelines for usage.

Federal Regulations

The Federal Food and Drug Administration (FDA) Center for Devices and Radiological Health (CDRH) has responsibility for implementing and enforcing the laws and regulations which apply to radiation-producing electronic products and medical devices.

510K Clearance

Medical devices, including laser systems for medical applications, require **clearance** by the FDA in order to be introduced commercially in the US. The clearance can follow the review of a premarket notification under section 510(k) of the Federal Food, Drug and Cosmetic Act (FFDCA) for a device that is substantially equivalent to a device that was in commercial distribution in the US prior to May 1976 or to previously cleared devices. Clearances are device specific and for indications claimed in the cleared labeling. **Note: Laser devices are cleared but not approved and should not be marketed as such.**

LASER CLASSIFICATIONS

The Food and Drug Administration (FDA) recognizes the following classifications:

Major hazard classes (I to IV) of lasers:

- Class 1
- Class 2
- Class 3
- Class 4

Subclasses of lasers:

- Class 2A
- Class 3A
- Class 3B

The higher the class, the more powerful the laser and the potential to pose serious danger if used improperly.

The labeling for Classes II-IV must include a warning symbol that states the class and the output power of the product.

LASER & LED SAFETY CLASSIFICATION

Class I	Safe under reasonable operation (Barcode Reader)
Class 1M	Generally Safe-Some Precaution Required
Class II	Visible light low power-Blink response limits risk-laser pointers and LED
Class IIM	UV or IR light at low power, generally safe LED systems
Class 3R(A)	Safe for viewing with unaided eye (laser printer)
Class IIIa	< 5mW
Class IIIb	5-500mW, viewing beam is hazardous, diffuse reflections are safe
Class IV	501mW to Industrial MegaWatts; hazardous under all conditions to eyes and skin

BASED ON SAFETY NOT CLINICAL PERFORMANCE

CLASS 1 LASERS: EXEMPT LASERS

These lasers are exempt from the requirements of most corporate Laser Safety Programs.

- Class 1 laser cannot, under normal operating conditions, produce damaging radiation levels
- All Class 1 lasers must be labeled

Examples:

Laser Printers

CD/ DVD players

CLASS II LASERS: LOW POWER VISIBLE LASERS

Output: 1 milliwatt (mW) of continuous wave
Low Power
Diffuse output
Wavelength: 400–700 nanometers (nm) (visible)

Class 2 lasers are low power lasers or laser system in the visible range (400 - 700 nm wavelength) that may be viewed directly under carefully controlled exposure conditions.

Eye protection is usually afforded by aversion response and blink reflex (0.25 seconds). However, a class 2 laser beam could be hazardous if one were to intentionally expose the eye for longer than 0.25 seconds.

Class 2 lasers must be labeled.

The laser beam should not be purposefully directed toward the eye of any person. Alignment of the laser optical systems (mirrors, lenses, beam deflectors, etc.) should be performed in such a manner that the primary beam, or specular reflection of the primary beam, does not expose the eye to a level above the Maximum Permitted Exposure (MPE) for direct irradiation of the eye.

Examples: barcode scanner shown

CLASS 3A LASERS: MEDIUM POWER

Output: 1–5 mW of continuous wave
Wavelength: Infrared spectrum (non-visible)

Class 3A denotes lasers or laser systems that normally would not produce a hazard if viewed for only momentary periods with the unaided eye. They may present a hazard if viewed using collecting optics. Do not view the direct or reflected beam.

Class 3A lasers must be labeled accordingly. The work area should be posted with a warning label or sign cautioning users to avoid staring into the beam or directing the beam toward the eye of individuals.

Removable parts of the housing and service access panels should have interlocks to prevent accidental exposure.

A permanent beam stop or attenuator may also be used. If the MPE is exceeded, design viewing portals and/or display screens to reduce exposure to acceptable levels. Alignment procedures should be designed to ensure the MPE is not exceeded.

Examples: OfficeMax Laser Pointer shown,
Terraquant Therapy Laser shown

CLASS 3B LASERS “MEDIUM POWER”

Output: 5 - 500mW of continuous wave
Wavelength: Infrared spectrum (non-visible)

Class 3B denotes lasers or laser systems that can produce a hazard if viewed directly. This includes intrabeam viewing or specular reflections. Except for the higher power Class 3b lasers, this class laser will not produce diffuse reflections.

Class 3B lasers and laser systems must be labeled accordingly.

These lasers are used in areas where entry by unauthorized individuals can be controlled. If an individual who has not been trained in laser safety must enter the area, the laser operator or supervisor should first instruct the individual as to safety requirements and must provide protective eyewear, if required.

An alarm, warning light or verbal countdown should be used during use or startup of the laser. The controlled area should:

- have limited access to spectators,
- have beam stops to terminate potentially dangerous laser beams,
- be designed to reduce diffuse and specular reflections,
- have eye protection for all personnel,
- not have a laser beam at eye level,
- have restrictions on windows and doorways to reduce exposure to levels below the MPE, and
- require storage or disabling of the laser when it is not being used.

If the MPE is exceeded, design viewing portals and/or display screens to reduce exposure to acceptable levels. Alignment procedures and collecting optics should be designed to ensure the MPE is not exceeded. Only authorized, trained individuals should service the laser. Approved, written standard operating, maintenance and service procedures should be developed and followed.

Examples: *THOR LX2* Therapy Laser shown

CLASS 4 LASERS: “HIGH POWER”

Output: 500mW and greater, continuous wave
Wavelength: Infrared spectrum (non-visible)

Class 4 Lasers are high power lasers or laser systems that can produce a hazard not only from direct or specular reflections, but also from a diffuse reflection. In addition, such lasers may produce fire and skin hazards. All lasers in excess of Class 3 imitations are included.

In addition to the control measures described for Class 3b, Class 4 lasers should be operated by trained individuals in areas dedicated to their use. Failsafe interlocks should be used to prevent unexpected entry into the controlled area, and access should be limited by the laser operator to persons who have been instructed as to the safety procedures and who are wearing proper laser protection eyewear when the laser is capable of emission.

Laser operators are responsible for providing information and safety protection to untrained personnel who may enter the laser controlled areas as visitors.

The laser area should be:

- restricted to authorized personnel only
- designed to allow for rapid emergency egress
- equipped with a device that allows for deactivation of the laser or reduction of the output to below the MPE
- designed to fulfill Class 3b controlled area requirements
- designed with entry safe controls
- designed such that the laser may be monitored and fired from a remote location
- have interlocks designed to turn off the power supply or interrupt the beam by means of shutters

The beam path must be free of specularly reflective surfaces and combustible objects and the beam terminated in a non-combustible, non-reflective barrier or beam stop.

CLASS 4 LASERS: “HIGH POWER”

Surgical Lasers:

- Used to cut, coagulate and evaporate tissues: (CO^2 Lasers shown)

Therapeutic Lasers:

- The biological effect is photochemical not thermal, unlike surgical lasers
- Used for the stimulation of cell function
- Provides effective dosage levels in the deep tissues (Medray Supermax™ Laser shown)

BIOLOGICAL EFFECTS OF LASER THERAPY

- Anti-Inflammatory
- Anti-Pain (Analgesia)
- Increased Metabolic Activity
- Immunoregulation
- Accelerated Tissue Repair and Cell Growth
- Improved Nerve Function
- Improved Vascular Activity
- Trigger Point Resolution
- Acupuncture Point Stimulation

BIOLOGICAL EFFECTS OF LASER THERAPY

Clinical studies and research using laser therapy technology indicate the following beneficial effects of laser therapy on tissues and cells:

Anti-Inflammation

Laser therapy has an anti-edemic effect as it causes vasodilation, but also because it activates the lymphatic drainage system (drains swollen areas). As a result, there is a reduction in swelling caused by bruising or inflammation.

Anti-Pain (Analgesic)

Laser therapy has a high beneficial effect on nerve cells which block pain transmitted by these cells to the brain and which decreases nerve sensitivity. Also, due to less inflammation, there is less edema and less pain. Another pain blocking mechanism involves the production of high levels of pain killing chemicals such as endorphins and enkephalins from the brain and adrenal gland.

Accelerated Tissue Repair and Cell Growth

Photons of light from lasers penetrate deeply into tissue and accelerate cellular reproduction and growth. The laser light increases the energy available to the cell so that the cell can take on nutrients faster and get rid of waste products. As a result of exposure to laser light, the cells of tendons, ligaments and muscles are repaired faster.

BIOLOGICAL EFFECTS OF LASER THERAPY

Improved Vascular Activity

Laser light will significantly increase the formation of new capillaries in damaged tissue that speeds up the healing process, closes wounds quickly and reduces scar tissue. Additional benefits include acceleration of angiogenesis, which causes temporary vasodilatation, an increase in the diameter of blood vessels.

Increased Metabolic Activity

Laser therapy creates higher outputs of specific enzymes, greater oxygen and food particle loads for blood cells.

Trigger Points and Acupuncture Points

Laser therapy stimulates muscle trigger points and acupuncture points on a non-invasive basis providing musculoskeletal pain relief.

Reduced Fibrous Tissue Formation

Laser therapy reduces the formation of scar tissue following tissue damage from cuts, scratches, bums or surgery.

BIOLOGICAL EFFECTS OF LASER THERAPY

Improved Nerve Function

Slow recovery of nerve functions in damaged tissue can result in numbness and impaired limbs. Laser light will speed up the process of nerve cell reconnection and increase the amplitude of action potentials to optimize muscle action.

Immunoregulation

Laser light has a direct effect on immunity status by stimulation of immunoglobines and lymphocytes. Laser Therapy is absorbed by chromophones (molecule enzymes) that react to laser light. The enzyme flavomono-nucleotide is activated and starts the production of ATP (adenosine-tri-phosphate), which is the major carrier of cell energy and the energy source for all chemical reactions in the cells.

Faster Wound Healing

Laser light stimulates fibroblast development (fibroblasts are the building blocks of collagen, which is predominant in wound healing) in damaged tissue. Collagen is the essential protein required to replace old tissue or to repair tissue injuries. As a result, Laser Therapy is effective on open wounds and burns.

PRIMARY TISSUE VARIABILITY FACTORS

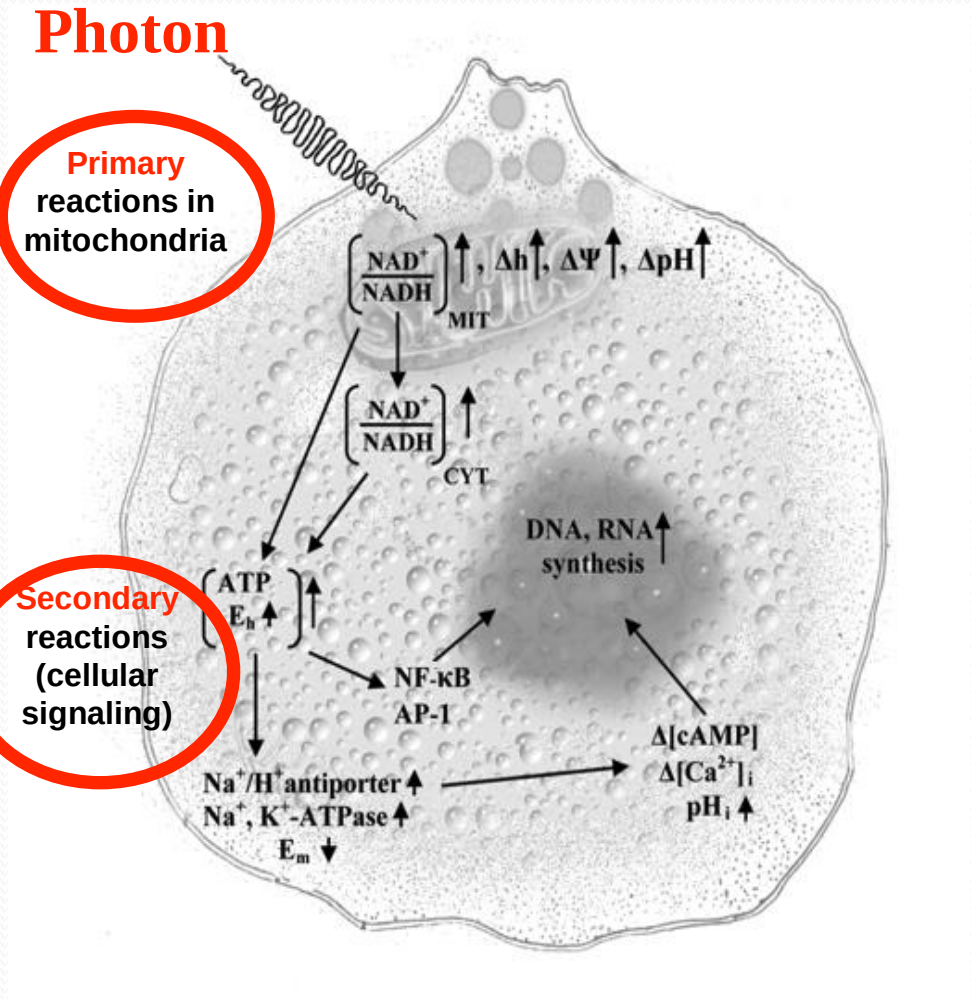
Photons must reach the target tissue; anatomical and histological factors determined by Primary Tissue Variability Factors MUST BE CONSIDERED:

- Tissue Type: blood, fat, nerve, muscle, skin, tendon, cartilage, bone
- Tissue Structure: Simple, stratified, pseudostratified, transitional
- Tissue Density: adiposity index or BMI (Body Mass Index)
- Tissue Permeability (ability of wave energy to pass through, or be absorbed by tissue structures)
- Tissue Proximity: (depth of tissue (shallow vs. deep)¬¬¬
- Tissue Pigmentation: six levels, from white to black (Fitzpatrick Scale)
- Tissue Hydration: hydrated or dehydrated (typical = Min. 54.8% to Max. 78.1%)
- Tissue Stress: bio-behavioral factors that can induce cell damage (cortisol levels, etc.)
- Tissue Age: from atrophic to neoplastic
- Tissue Function/malfunction: Equilibrium, Entropy, & Homeostasis

WAVELENGTH AND ENERGY BOTH MATTER

The biophysical process of laser absorption into cells of the soft or hard tissue is identical, except that with a suitable selection of wavelength and pulse energies, virtually all laser energy can be converted into bioelectronic and biochemical energy, thus avoiding tissue damage by heating.

- Laser photons must reach the injured tissue **(high peak power necessary)**
- Laser photons must be absorbed by cytochrome c protein **(proper wavelength necessary)**



PHOTONS

All light is composed of photons.

Photons are small packets of light energy — in the form of waves — with a defined wavelength and frequency.

Photon energy is able to more effectively penetrate the skin and underlying structures, therefore accelerating the healing process.

Laser light holds its intensity until it is absorbed by a medium (the body).

When applied to an organism, Laser light, tuned to specific wavelengths and frequencies, stimulates metabolic processes at the cellular level.

PHOTOCHEMICAL ACTION

Studies have shown that when tissue cultures are irradiated by Lasers, enzymes within cells absorb energy from laser light.

Visible (red) light and Near Infrared (NIR) are absorbed within the **mitochondria** and the **cell membrane**.

This **produces higher ATP levels and boosts DNA production**, leading to an **increase in cellular health and energy.**

When applied as treatment, therefore, Lasers have been shown to reduce pain and inflammation as well as stimulate nerve regeneration, muscle relaxation and immune system response.

Lasers have no effect on normal tissues, as photons of light are only absorbed and utilized by the cells that need them.

CHROMOPHORES

Role of Chromophores

Chromophores are components of various cells and sub-cellular organelles which absorb light.

The stimulation of Chromophores on mitochondrial membranes incites the production of ATP.

This results in:

- Increases cellular energy levels
- Allows pain relief
- Accelerates cellular healing

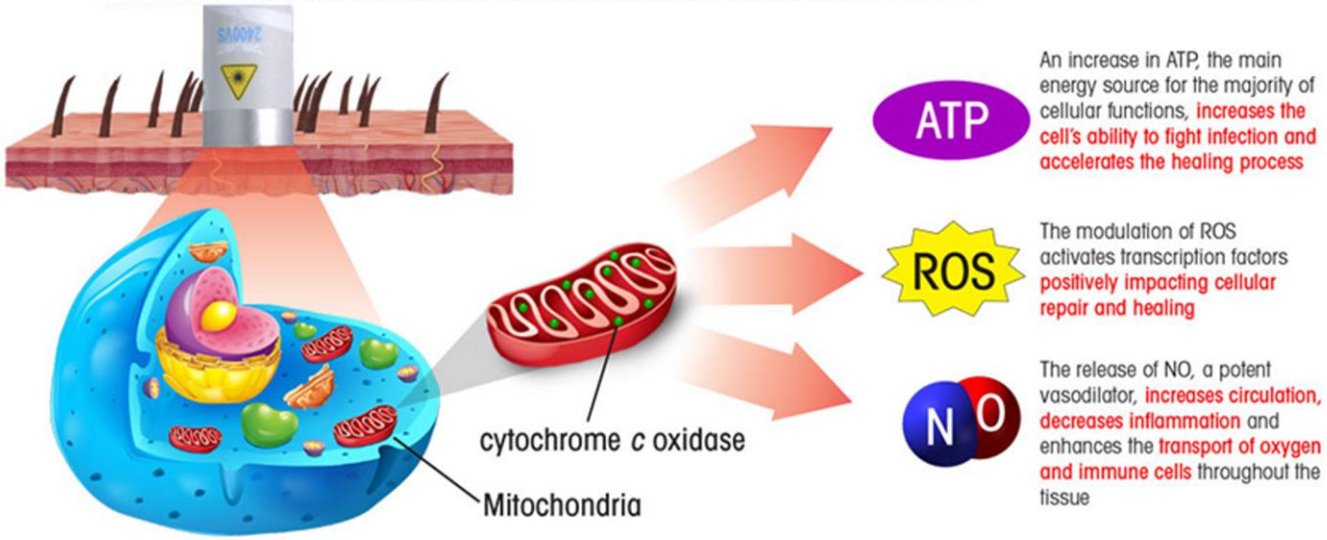
PHOTOCHEMICAL EFFECT

High Intensity Energy + Human Tissue

Gene Expression

=

The Photochemical Effect



PHOTOCHEMICAL PROCESS

LIGHT ENERGY

↓

LOCALIZED MECHANICAL EXPANSION & CONTRACTIONS

↓

LOW INTENSITY PHOTOACOUSTIC U/S EFFECT

↓

INCRESE OF CELL STRESS SIGNALING
CYTOKINE ACTIVATION

↓

INCREASE IN **GENE EXPRESSION**, PROTEIN SYNTHESIS
& PROPRIOCEPTIVE/NEUROLOGIC FIRING

PHOTOCHEMICAL PROCESS

Summary of the Photochemical Process:

1 – Photons >

2 – Absorbed in Mitochondria and Cell Membrane within cytochromes and Porphyry's >

3 – Singlet Oxygen is Produced >

4 – Changes in Membrane Permeability >

5 – ATP Synthesized and DNA Produced >

6 – Increase in Cell Metabolism from a Depressed Rate to a Normal Level >

7 – Selective Bio-Stimulatory Effect on Impaired Cells > (cells and tissues functioning normally are not affected)

ACUTE INFLAMMATION REDUCTION

How does Laser Therapy reduce inflammation?

Summary of Light Induced, Anti Inflammatory Responses

1. Stabilization of the cellular membrane
2. Enhancement of ATP production and synthesis
3. Stimulation of vasodilation
4. Acceleration of leukocytic activity
5. Increased prostaglandin synthesis
6. Reduction in interleukin 1
7. Enhanced lymphocyte response
8. Increased angiogenesis
9. Temperature modulation
10. Enhanced superoxide dismutase (SOD) levels
11. Decreased C-reactive protein and neopterin levels

ANALGESIA

How does Laser Therapy reduce pain?

Summary of Light Induced, Analgesic Responses

1. Increase in beta endorphins
2. Increased nitric oxide production
3. Decreased bradykinin levels
4. Ion channel normalization
5. Blocked depolarization of C-fiber afferent nerves
6. Increased nerve cell action potentials
7. Increased release of acetylcholine
8. Axonal sprouting and nerve cell regeneration

INDUCIBLE & CELL SPECIFIC FUNCTIONS OF MITOCHONDRIA

- **ATP Synthesis (aerobic)**
  ATP Consumption (anaerobic or aerobic with uncoupling)
  Redox Poise Homeostasis
- Platelet Aggregation and Activation
  Neutrophil Chemotaxis
- Late Neutrophil Oxidative Burst
- Macrophage Activation
- **T-Cell Activation**
- Sperm cell motility/fertilization
- **Angiogenesis**
- **Lymphedema**
- **Nitric Oxide Synthesis**
- Apoptosis/Caspase Activation
- Prostaglandin Inactivation
- Cholesterol Synthesis
- **Cortisol Synthesis**
- Mineralocorticoid Synthesis
- Sex Steroid Synthesis
- Vitamin D Metabolism
- Cytoskeleton Architecture/ Mechanotransduction
- Calcium Storage and Release
- Iron Storage and Metabolism
- **DNA and RNA–*De Novo* Pyrimidine Synthesis (DHO-QO)**
- Lipids–Fatty Acid Oxidation
- Proteins–Amino Acid Metabolism
- **Sugars–Carbohydrate Metabolism (Krebs Cycle)**
- Urea Cycle and NH_3 Metabolism
- Peripheral Benzodiazapine Receptor

PHOTON TISSUE INTERACTION

Primary Responses

- Photons absorbed by cytochromes
- Singlet oxygen (free radicals) are generated affecting ATP synthesis and so increasing the energy available to cells
- Nitric oxide produced
- Reversible increase in cell (plasma) membrane permeability to calcium and other ions
- The above triggers cell activity (i.e., secondary responses)

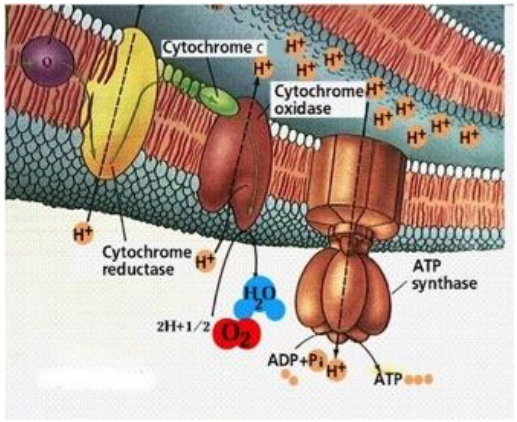
PHOTON TISSUE INTERACTION

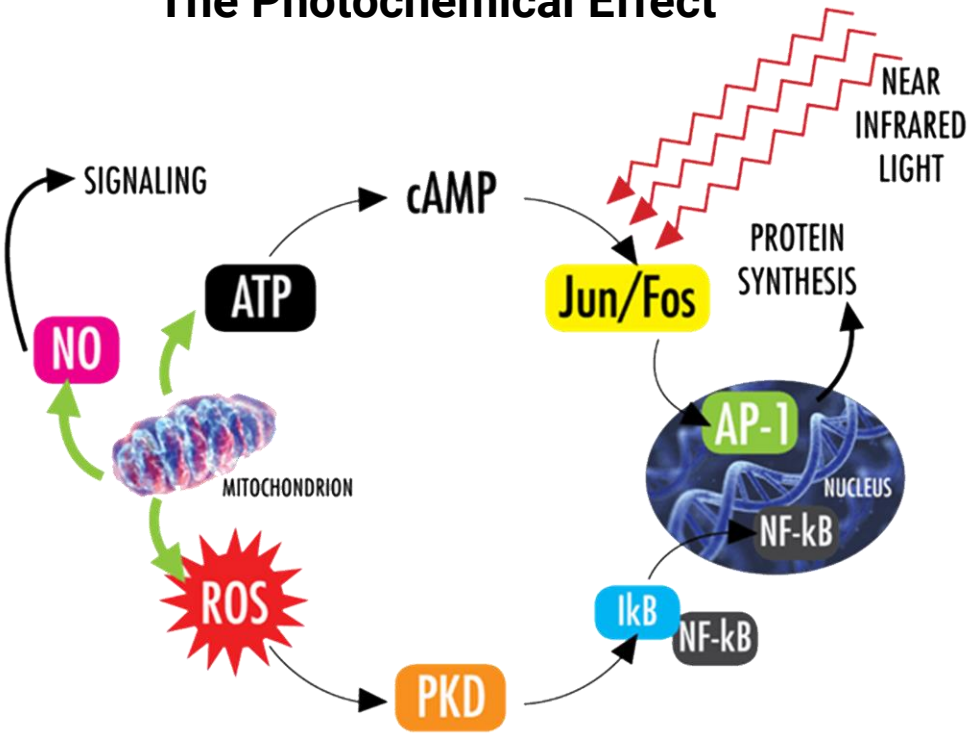
Secondary Responses

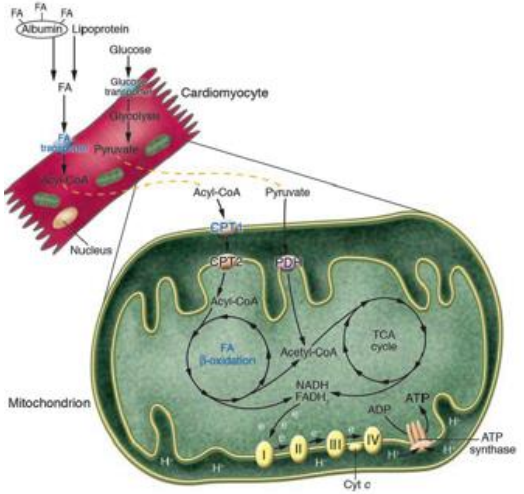
- More cell division
- DNA & RNA synthesis increase
- Growth factor release
- Collagen synthesis by fibroblasts
- Myofibroblast contraction
- Blood vessel formation (angiogenesis)
- Immune system changes
- Action potential changes in neurons, etc.

ATP IS THE KEY

- Cytochrome C protein is the main **photon absorber** in the cellular mitochondria
- Cytochrome C drive the **production of ATP**
- **Photo + Cytochrome C = ATP**
  The Photochemical Effect

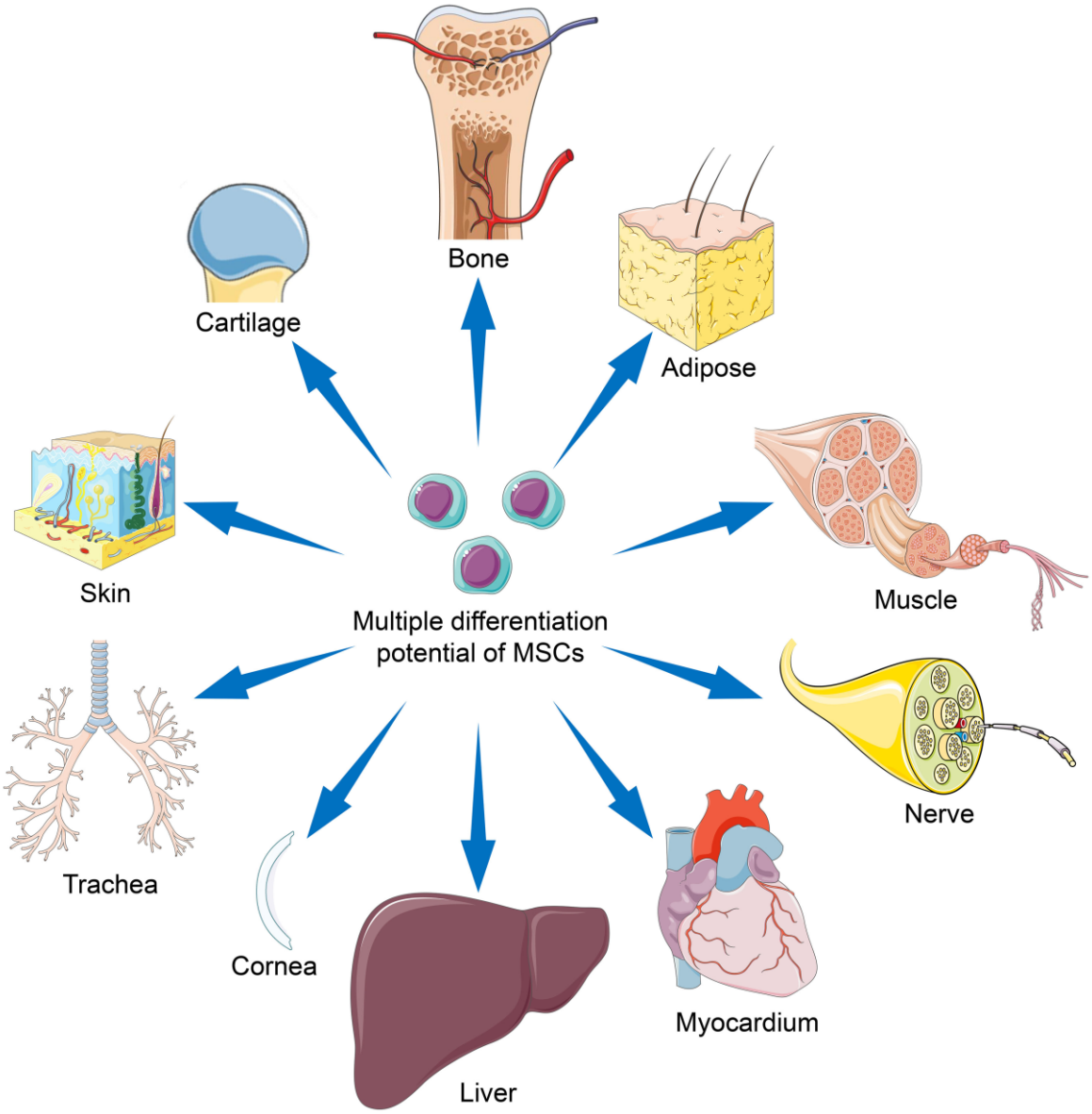






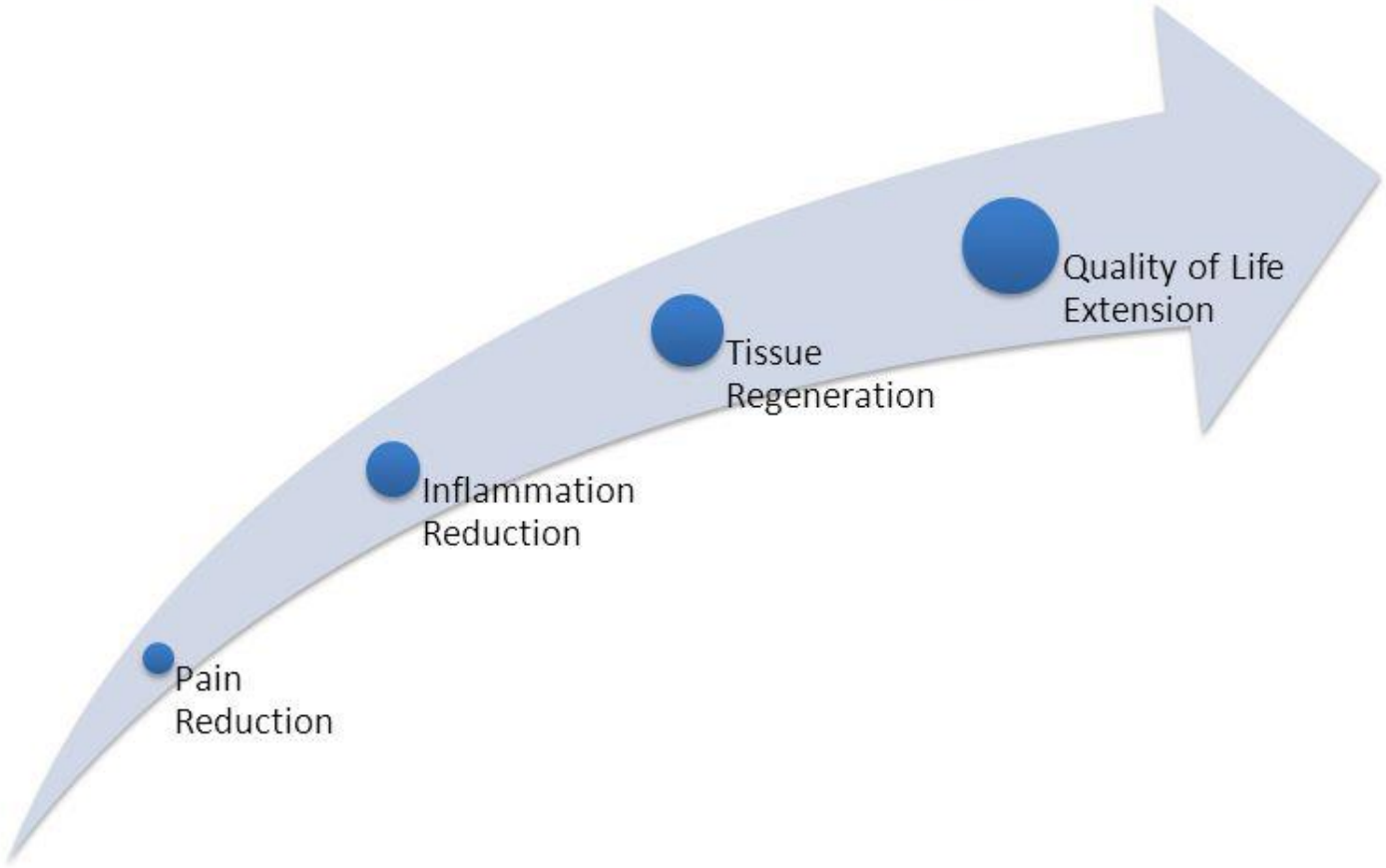
STEM CELLS TO THE RESCUE

Adult stem cells are transformed into the needed types of cells to help repair or replace damaged cells. Osteogenesis for bone, Myogenesis for muscular tissue and Chondrogenesis for cartilage, and so on. Photomedicine can enhance this process and play a vital part in regenerative medicine.



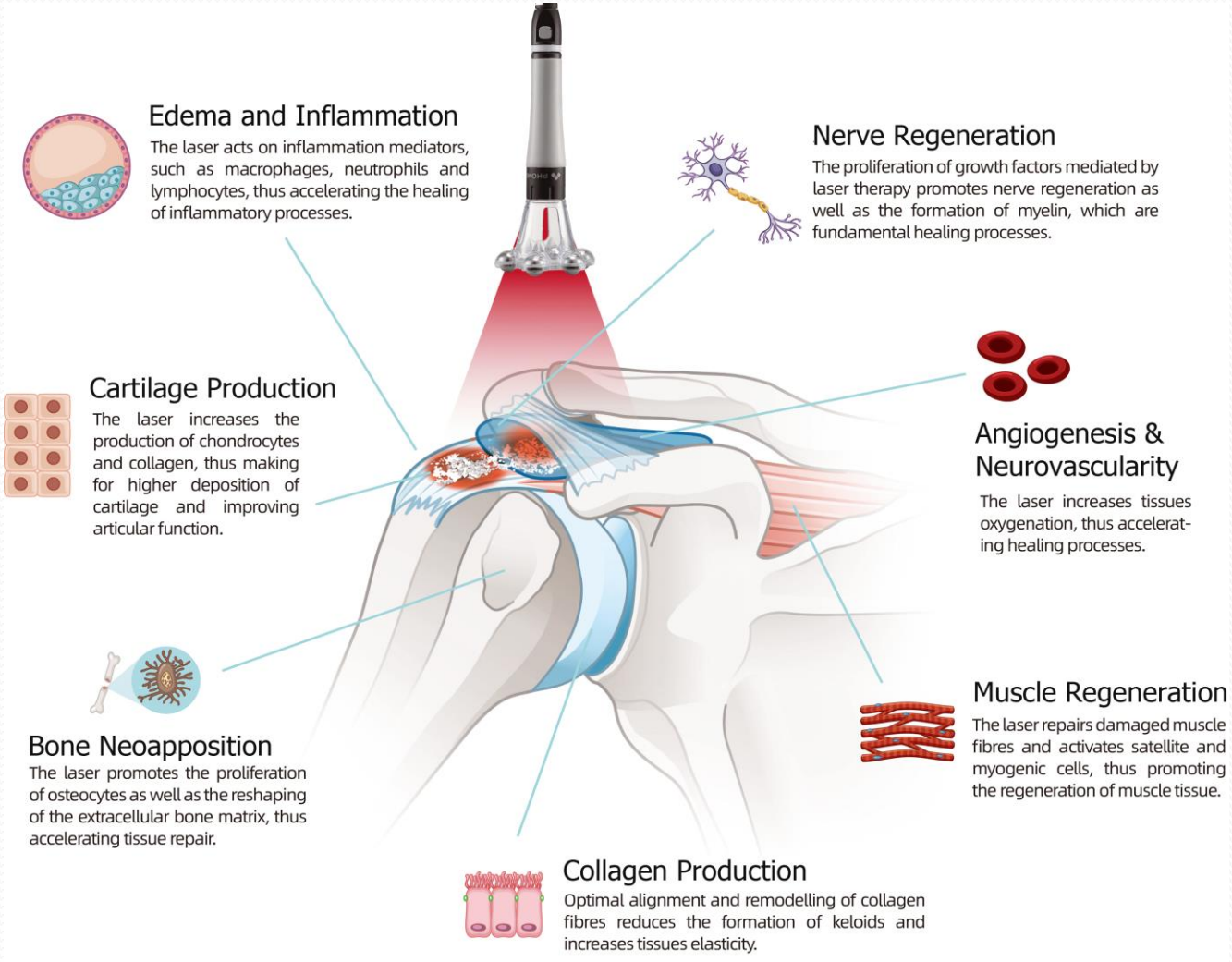
Regenerative Medicine

The New Paradigm



SUMMARY

- **INCREASED SYNTHESIS OF ATP, RNA AND DNA**
- **INCREASED TISSUE OXYGENATION AND NUTRITION**
- **INCREASED RATE OF TISSUE REGENERATION**



ABSOLUTE CONTRAINDICATIONS

Absolute **Contraindications in Laser Therapy include:**

- Eye exposure
- Over cancer or tumor
- Over thyroid
- Over gravid uterus

RELATIVE CONTRAINDICATIONS

Relative **Contraindications in Laser Therapy include:**

- Over tattoos
- Patients using IR photosensitizing
- medications
- Patients using steroids
- Autoimmune disorders
- Renal failure (severe)
- Lupus (severe)
- Encephalopathy
- Meningitis
- Neuronopathy
- Hypersensitivity to laser

UNPROVEN CONTRAINDICATIONS

Unproven Contraindications in Laser Therapy include:

- Ununited fontanelles
- Ununited epiphyseal plate
- Systemic infections
- Multiple sclerosis
- Epilepsy (mild)
- Patients with Pacemaker

Additional Precautions

Additional Precautions in Photomedicine Therapy include:

- Hairline sensitivity
- Patients using anticoagulants
- Through dark clothing
- Iodine treated wounds
- Steroid therapy
- Dark skin

SAFETY PROGRAM (https://medlasers.org/training)

PHOTOMEDICINE THERAPY IS VERY SAFE when basic protocols are followed by the laser operator and support staff.

As with all therapeutic procedures, some element of risk is present through negligence or accident. These hazards are easily prevented or reduced with safety protocols for each application.

Every clinic using a laser should have an individual trained in safe operation of laser therapy and regularly use a safety checklist. This individual (often the doctor), is the **Laser Safety Officer (LSO)**.

EYE PROTECTION

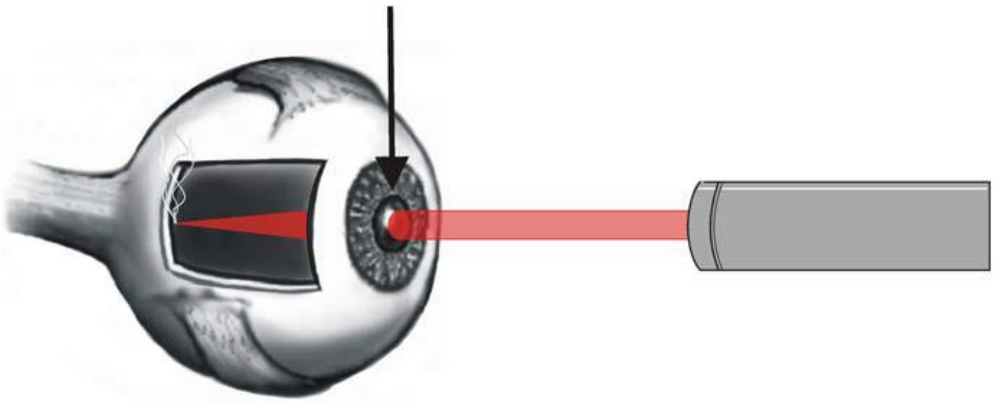
Class IV Therapy Lasers emit both visible and invisible radiation.

Protective eyewear is necessary for both Class III and Class IV lasers where irradiation of the eye is possible.

Required Users:

1 - Administrator of the laser therapy treatment
2 - Patient
3 - Other individuals in the room

Laser beam focused by the lens on the retina or fovea



An incident laser beam striking directly inline with the lens is very dangerous. The beam is magnified over 100,000 times by the lens of the eye. The more divergence of the beam the less light strikes the eye. The more the beam is focused or collimated the greater the fluence of the beam and potential for injury.

SAFETY GOGGLES

Not all Safety Goggles are the same. The protective eyewear that came with your Laser is manufactured specifically for the wavelengths emitted by the laser. Do not order protective eyewear online just because it is less expensive, it may not provide the appropriate level of protection.

Technical Specifications for proper usage include:

- Wavelength Specific
- Blocks 980nm and 810nm
- Meets ANSI Safety Standards

USING SAFETY GOGGLES CORRECTLY

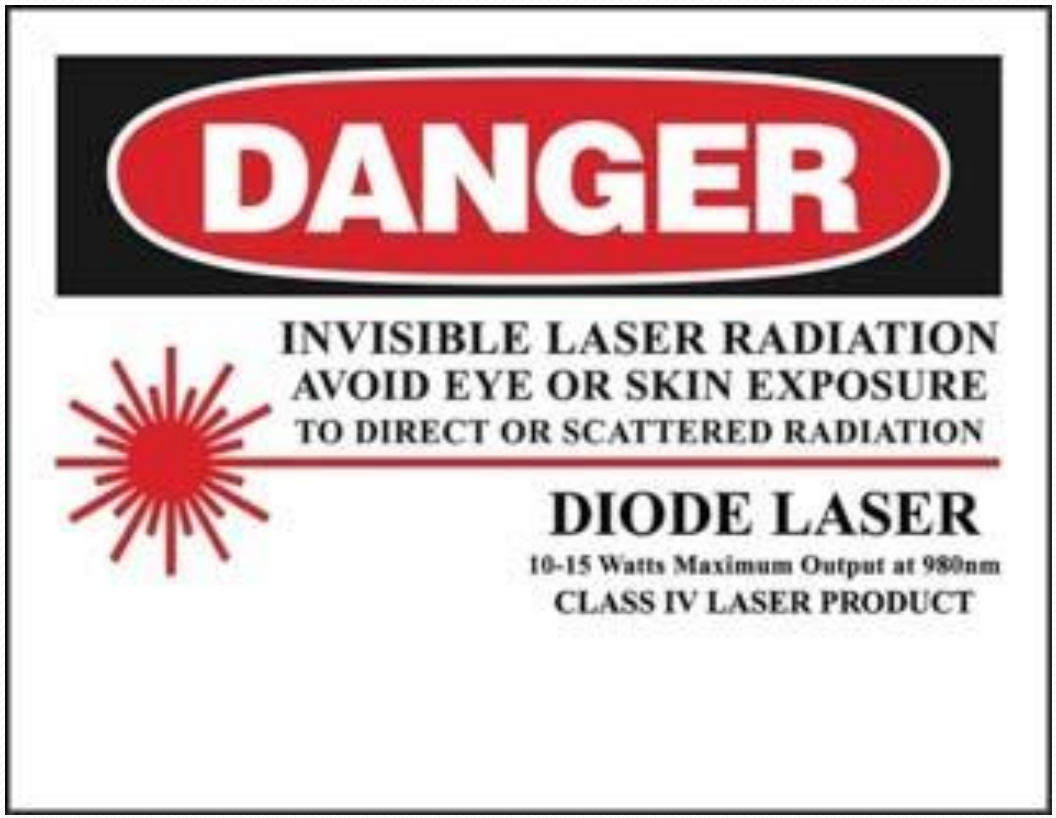
Laser safety glasses are vital for eye protection in the presence of laser radiation. Since accidental laser radiation exposure can cause irreversible damage to the human eye, protective measures must not be taken lightly.

- Ensure that the eyewear has appropriate optical density for the wavelengths.
- **Remove all reflective objects** (such as rings, metal watchbands, and jewelry) prior to treatment with the laser. Indirect or direct eye contact with the laser beam or with scattered laser light from any reflective surfaces will cause serious damage, irreparable corneal and/or retinal damage, and possible blindness.
- Do not allow any reflective object to fall into or obstruct the path of the laser beam.
- Always wear protective eyewear. Any person present during the laser operation must wear protective eyewear.
- **Never look directly into the end of any therapy hand piece.**
- **Never direct the laser light toward the eyes** or direct the laser beam at anything other than the area to be treated with or without the correct Safety Goggles.
- Do not remove the Safety Goggles until the administrator of the laser has turned off the laser or notified the patient that it is safe to remove them.

LASER WARNING SIGNS

Lasers require the use of **specific Warning Signs** for the safe operations of each laser system

- Warning signs must be in view outside and inside the room where the laser treatment is being performed
- Warning signs must meet ANSI recommendations



LASER SAFETY CHECKLIST

Check List For The Laser Operator And Laser Safety Officer

- Appropriate warning signs posted
- Access to Laser and treatment area is secure and controlled
- Visually inspect and clean all optical connectors for dirt, debris, etc.
- Inspect laser for proper function
- Visually inspect and clean all safety goggles
- Goggles available for all persons in Nominal Hazard Zone
- Extra goggles placed outside treatment room if necessary
- Sources of potential laser beam reflection and scatter controlled
- Treatment protocol established for patient
- Laser injury management protocol in place for accidental injury
- Document laser treatment and post-treatment outcome

PHOTOMEDICINE THERAPY PROTOCOLS

GENERAL THERAPY PROTOCOLS

- PLACEMENT OF THE HANDPIECE
- POWER, VOLUME, OTHER SETTINGS
- PATIENT RECORDS

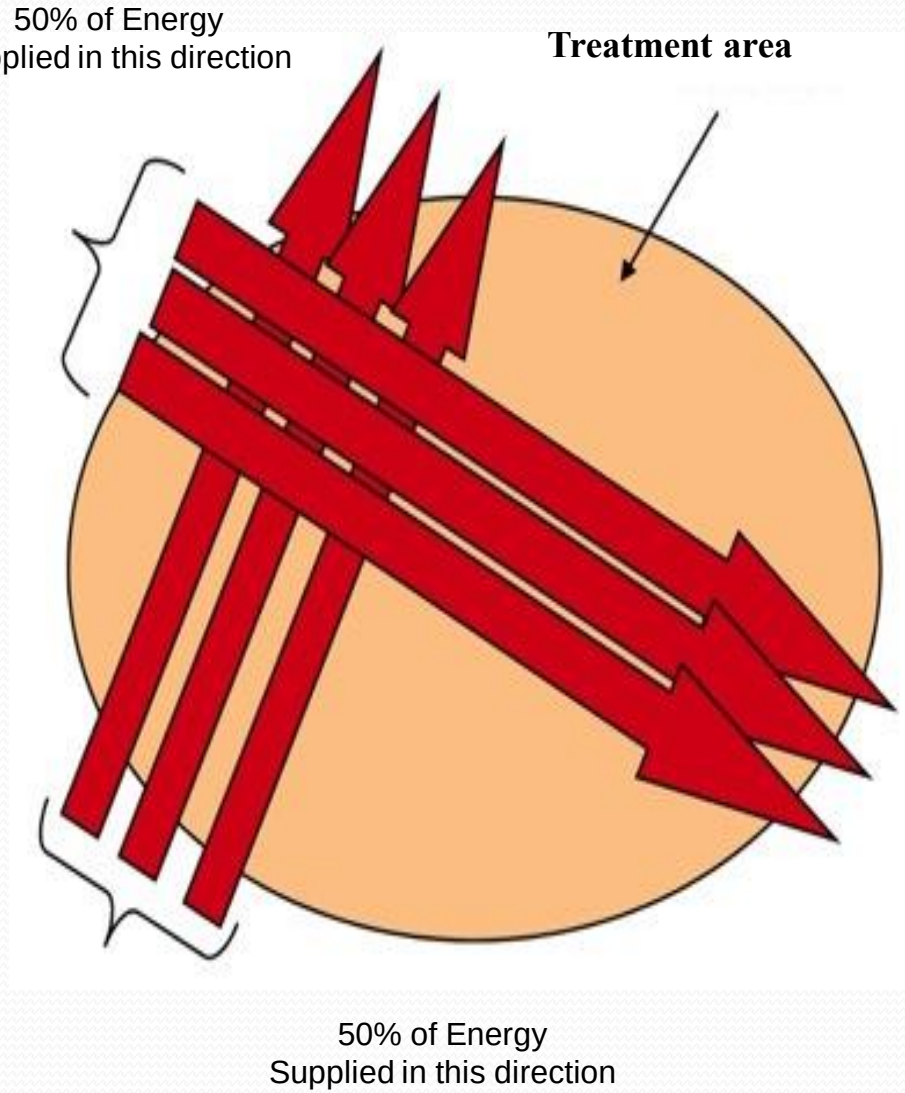
THERAPY PROTOCOLS

PHOTOMEDICINE GENERAL THERAPY PROTOCOLS

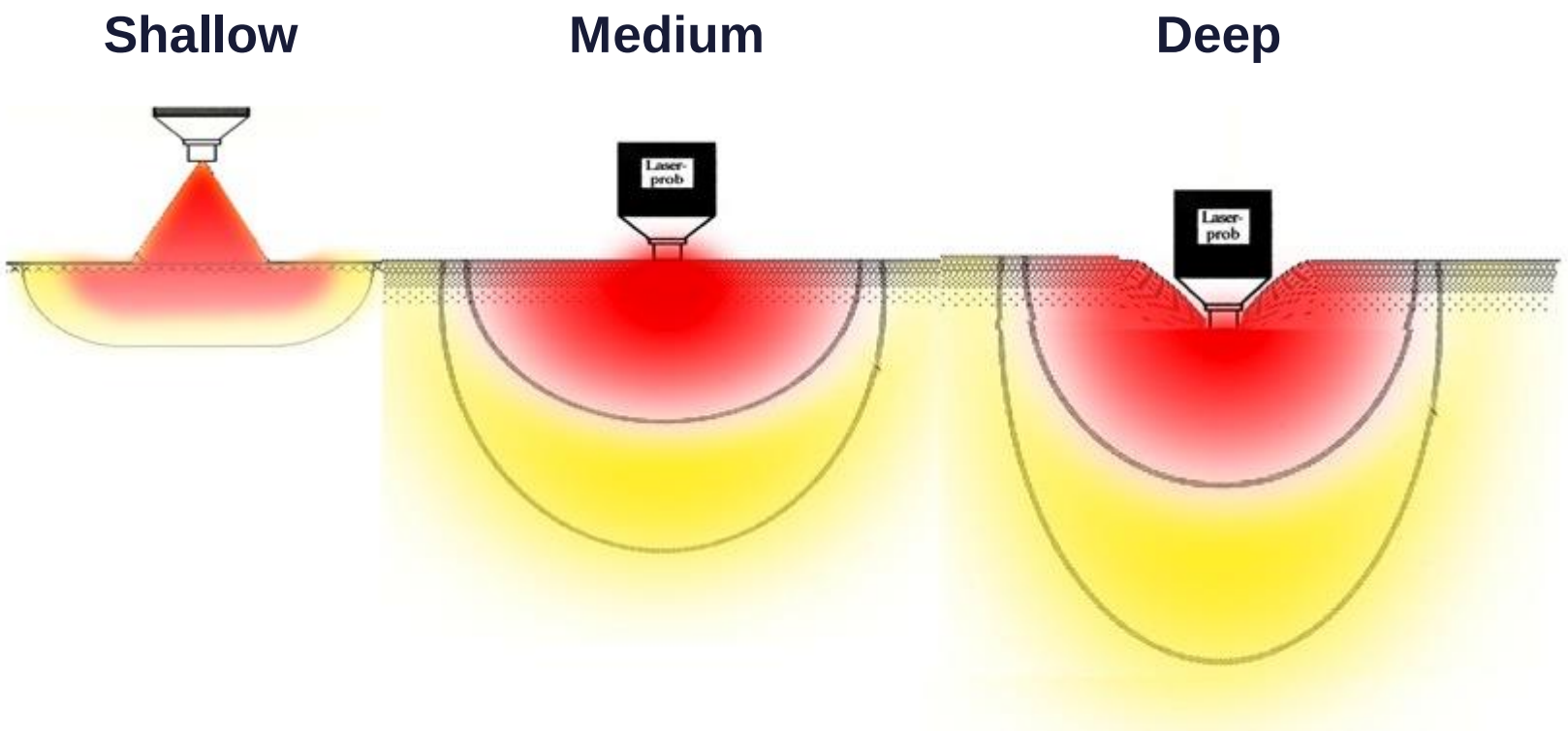
- DUE TO ENERGY VOLUME, POWER OUTPUT, and PENETRATION, THERAPY TIMES ARE BOTH EFFICIENT AND EFFECTIVE
- WHENEVER POSSIBLE, TREAT ENTIRE TARGET AREA IN EACH TREATMENT
- THERAPY IS MEASURED IN JOULES ADMINISTERED TO IMPACTED BODY PARTS

ADMINISTRATION of PHOTOTHERAPY

- Keep a good grip on the handpiece
- Keep the handpiece perpendicular to the dermis whenever possible.
- Whenever possible, keep the end of the handpiece directly on the skin
- Utilize a slow “erasure” type movement when administering therapy.
- Administer the therapy in a 50% / 50% technique.



THREE MODES OF PHOTOMEDICINE TREATMENT



The first picture is a technique that would be beneficial for dermatitis. The following is typical for extremities, and the last is for spinal structures or deep muscle tissue.

TIME TO DELIVER ONE JOULE OF ENERGY

- **Dependent on the Output Power of Laser:**
- 1 ÷ power (watts) = time to deliver 1 joule
- 7.5mW takes 133 seconds to emit 1 joule
- 10mW takes 100 seconds to emit 1 joule
- 30mW takes 33 second to emit 1 joule
- 40mW takes 25 seconds to emit 1 joule
- 100mW takes 10 seconds to emit 1 joule
- 200mW takes 5 seconds to emit 1 joule
- 250mW takes 4 seconds to emit 1 joule

EFFECTIVE DOSAGE

Dosage is expressed in Joules

1 J = 1W x 1 second
= 1,000mW x 1 second
= 100mW x 10 seconds
= 10 mW x 100 seconds
= 1 mW x 1,000 seconds

Typical dosage may vary greatly, from 0.5 to 100 joules/cm² at the **targeted tissue** **(most often quoted is 30 to 80 joules/cm² at the target)**

Dosage at **skin level** depends on location of targeted tissue (i.e., 0.5 to 120 joules/cm² per point/location)

SPREAD IT AROUND

A playing card is about 6.5cm X 9cm - about 60cm². If you deliver 1200 joules to a body region that size, the dosage would be 1200J/60cm² = 20J/cm², a reasonable anti-inflammatory or biostimulative dosage for a 2 to 3 cm deep condition.

12W=100secs. 10W=120secs. 2W=600seconds
500mW= 40mins 200mW=100minutes

CONDITIONS RESPONSIVE TO PHOTOMEDICINE THERAPY

HEADACHES

- CERVICOGENIC
- CEPHALGIA

FACIAL AND NECK PAIN

- TMJ DYSFUNCTION
- CERVICAL RADICULOPATHY
- CERVICAL SPONDYLOSIS
- FACET SYNDROME
- HERNIATED CERVICAL DISC
- ACUTE CERVICAL SPRAIN
- CHRONIC CERVICAL SPRAIN

SHOULDER INJURIES

- A/D JOINT OSTEOARTHRITIS
- A/C JOINT SPRAIN
- ROTATOR CUFF TEAR
- BICEP TENDON INJURY
- SHOULDER TENDINITIS/BURSITIS

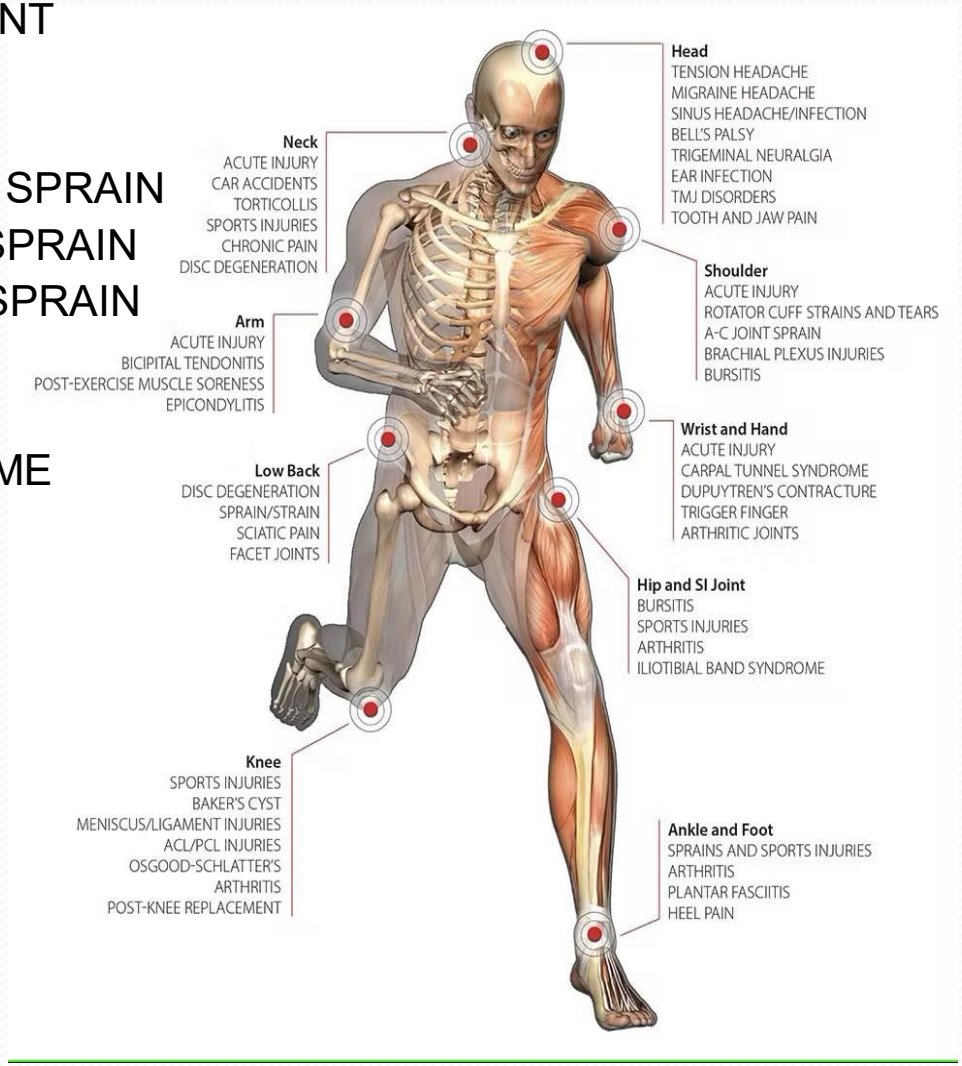
THORACIC REGION PAIN

- ACUTE THORACIC STRAIN
- ACUTE THORACIC SPRAIN

CONDITIONS RESPONSIVE TO PHOTOMEDICINE THERAPY

LOWER EXTREMITY INJURIES

- OSTEOARTHRITIS OF THE HIP JOINT
- HIP BURSITIS
- GROIN STRAINS
- LATERAL COLLATERAL LIGAMENT SPRAIN
- MEDIAL COLLATERAL LIGAMENT SPRAIN
- ANTERIOR CRUCIATE LIGAMENT SPRAIN
- MEDIAL MENISCAL INJURY
- LATERAL MENISCAL INJURY
- PATELLOFEMORAL PAIN SYNDROME
- SHIN SPLINTS
- COMPARTMENT SYNDROME
- HAMSTRING STRAIN
- QUADRICEP STRAIN
- HIP CONTUSION
- QUADRICEPS CONTUSION
- PIRIFORMIS SYNDROME
- ILIOTIBIAL BAND SYNDROME



CONDITIONS RESPONSIVE TO PHOTOMEDICINE THERAPY

FOOT AND ANKLE INJURIES

- ANKLE SPRAINS
- ACHILLES TENDINITIS
- BUNIONS
- DIABETIC NEUROPATHY
- MORTON'S NEUROMA
- PLANTAR FASCIITIS
- STRESS FRACTURES
- TARSAL TUNNEL SYNDROME
- TURF TOE
- PAIN ASSOCIATED WITH FRACTURES
- FIBROMYALGIA
- IMMEDIATE POST SURGICAL PAIN
- MYOFASCIAL TRIGGER POINTS
- REFLEX SYMPATHETIC DYSTROPHY

A PHOTOMEDICINE THERAPY STUDY

CLASS IV LASER THERAPY; EFFECTIVE FOR BACK AND NECK/SHOULDER PAIN
(Retrospective, Practice Based Clinical Preliminary Investigation)
Author: L.D. Morries, DC, CCSP®

Background: Photomedicine therapy is a modality that is used to treat pain and promote healing of muscular tissue. The procedure is minimally invasive and easily performed. Laser therapy was added to conventional chiropractic treatment of spinal manipulation and an exercise program for treating patients with back pain. The objective of this investigation was to assess efficacy and safety of the combination and generate preliminary results for a randomized controlled trial.

Conclusions: These results indicate that both treatments successfully reduced the VAS by the fourth week of treatment, and that a higher reduction in VAS occurred in the group treated by manipulation + laser at week four.

In summary, Class IV laser therapy is a safe and effective modality for treating low back pain when added to conventional treatment of manipulation and exercise. Further study is indicated to support these initial findings.

AMERICAN CHIROPRACTIC BOARD OF SPORTS PHYSICIANS™
2010 CHIROPRACTIC SPORTS SCIENCES SYMPOSIUM CHICAGO, ILLINOIS
APRIL 30-MAY 2, 2010

A PHOTOMEDICINE THERAPY STUDY

EFFECTS OF CLASS IV LASER THERAPY ON DISEASE IMPACT AND FUNCTION IN WOMEN WITH FIBROMYALGIA

Author(s): Kristen Williams, Reed Mathis, J. Derek Kingsley, Emily Simonavice, Francesca Charles, Chris Mojock, Jeong-Su Kim, Victor McMillan, Lynn Panton, FACSM. Florida State University, Tallahassee, FL.

Abstract: It has been shown that 91% of individuals with Fibromyalgia (FM) use some form of alternative medicine compared to 42% of the general population. One modality that may show promise in helping to reduce the pain and impact of FM is laser therapy (LT).

PURPOSE: The purpose of the present study was to evaluate the effects of Class IV Infrared LT on pain, FM impact, and function in women diagnosed with FM.

RESULTS: There was a significant interaction effect for upper body flexibility (UBF) measured by the CS-PFP. LT significantly improved UBF (70.6±16.8 to 78.4±12.5 units) compared to SHT (77.3±11.8 to 76.7±10.7 units). There were no other differences in functionality or pain between LT and SHT. Although there was no interaction effect for the measure of FM impact measured by the FIQ, there was a time effect. FM impact significantly improved from pre to post treatment in LT (63.1±20.4 to 56.7±17.8 units) while there was no change in the SHT (56.9±10.6 to 55.1±11.5 units).

CONCLUSION: This study provides evidence that LT may be a modality to help women with FM improve their upper body range of motion which may ultimately decrease the impact of FM.

American College of Sports Medicine
Location: 331 Presentation. Time: Saturday, Jun 05, 2010, 10:00 AM -10:15 AM
Session: G-29-Neuromuscular Disorders; +1108 musculoskeletal or neuromuscular interventions

A PHOTOMEDICINE THERAPY STUDY

A RANDOMIZED CONTROLLED TRIAL FOR THE EFFICACY OF THERAPEUTIC CLASS IV LASER TREATMENT FOR TENDINOSIS

Author(s): Delia Roberts, FACSM[1], Roger Kruse, FACSM[2], Matthew Petznick[2], Jacklyn Kiefer[2], Peter Alaskym[2], Stephen Stoll[2]. [1]Selkirk College, Castlegar, BC, Canada. [2]ProMedica, Toledo, OH.

PURPOSE: To determine the efficacy of a class IV laser for the treatment of chronic epicondylitis.

RESULTS: No differences were noted between the two groups for any parameter before treatment. The mean duration of symptoms was 14.5±12 months, all subjects displayed pain and loss of strength and range of motion on the afflicted side, as well as ultrasonic evidence consistent with chronic tendinosis. There was a trend for increased strength (control change = -0.4±5.3 kg; LLLT change +0.8±3.7 kg; $p<0.07$) and decreased pain rating (change control = +0.6±3.3 units, 1/5 decreased pain; change LLLT= -2.6±3.3 units, 4/5 decreased pain; $p<0.06$) in the treatment group compared to the placebo group at the first post treatment exam.

CONCLUSION: Preliminary results suggest that LLLT is efficacious for the treatment of chronic epicondylitis. However, it remains to be seen whether statistical significance will be achieved with a larger group and whether the ultrasonographic evidence will indicate improved tendon health at 3 months.

American College of Sports Medicine
Location: Hall C, Poster Board: 217 Wednesday, Jun 02, 2010, 2:00-3:30 PM
Session: B-34-Musculoskeletal Evaluation and Care +1108 neuromuscular interventions

PHOTOMEDICINE THERAPY w/MEDRAY LASERS

THE MOST EFFECTIVE THERAPEUTIC MODALITY

- IDEAL WAVELENGTHS: 650nm, 810nm, 915nm, 1064nm
- IDEAL POWER: 15Watts per wavelength, up to 45.3Watts total on CW
- IDEAL PENETRATION (Deepest penetration of any therapy laser)

SAFE AND EFFECTIVE

- EXCELLENT ADDITION TO ANY PRACTICE (THE BEST DOLLAR VALUE)
- ADDING STATE OF THE ART MEDICAL TECHNOLOGY (THE LATEST)
- INCREASING THE VALUE OF STAFF MEMBERS (TECHNICIANS TREAT)

PROVIDES:

- PAIN RELIEF (LOCAL and SYSTEMIC)
- REDUCTION OF INFLAMATION (SCIENTIFICALLY PROVEN)
- FASTER TISSUE HEALING AND RECOVERY (SCIENTIFICALLY PROVEN)

THERAPY DELIVERY TECHNIQUES

The essential considerations for laser therapy parameters are the patient's individual physical conditions: differences in anatomy, skin pigmentation, overall physical health, and their comfort/tolerance level.

WARNING: The Class IV Therapy laser is a high-powered instrument: be mindful of the photothermal reaction of energy transformed into heat. This phenomenon could cause pain or damage to the skin or deeper layers of tissue. This is relevant in the case of highly pigmented skin dark complexion, birthmarks, moles, etc.) or tattoos – laser light conversion to heat could cause pain or damage.

There are two basic ways to deliver the laser therapy treatment: pushing and sweeping.

Pushing is the technique of holding the laser handpiece on one spot with skin contact and with gentle to moderate pressure.

Be sure to hold the handpiece perpendicular to the surface you are treating. This ensures the maximum tissue penetration of the laser energy.

Sweeping is moving the handpiece in a pattern over the treatment area. All conditions benefit from treating the surrounding healthy tissues beyond the tissues needing the laser energy. Healthy tissues can absorb the laser energy without negative side effects.

When using the sweeping technique, it is best to follow the direction of the muscle, tendon or ligament fibers.

ACHILLES TENDINITIS/TENDINOSIS

PARAMETERS

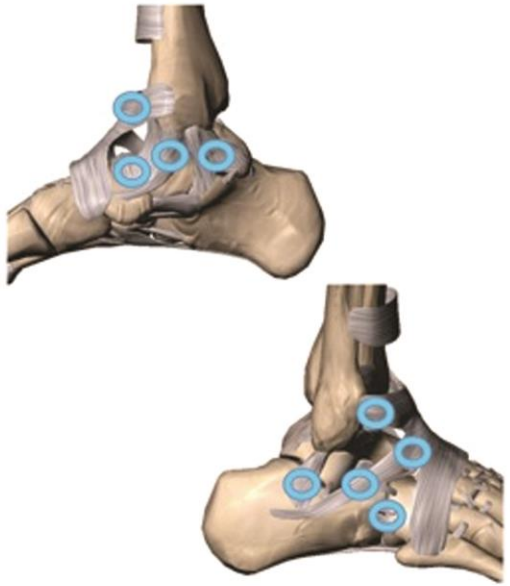
Pulsing (Hz)	Acute: CW; chronic: 250
Power (W)	8 to 30
Time (minutes)	3 to 8
Frequency	2X weekly sessions until resolution

Application: Cover the entire tendon length. Sweep along the marks over the tendon. Ensure the treatment of the tendon insertion point into the calcaneus (blue square in image).

Area: Along the Achilles tendon.

Clinical Notes: Ensure that the origin and insertion points of the gastrocnemius and the musculotendinous junction are completely irradiated. If collapsed plantar arch (flat foot), then treat plantar muscles.

ANKLE PAIN



PARAMETERS

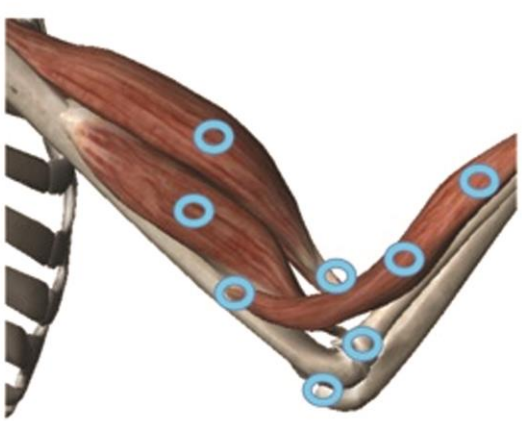
Pulsing (Hz)	Acute: CW; chronic: 250
Power (W)	12 to 30
Time (minutes)	3 to 8
Frequency	3X weekly sessions until resolution

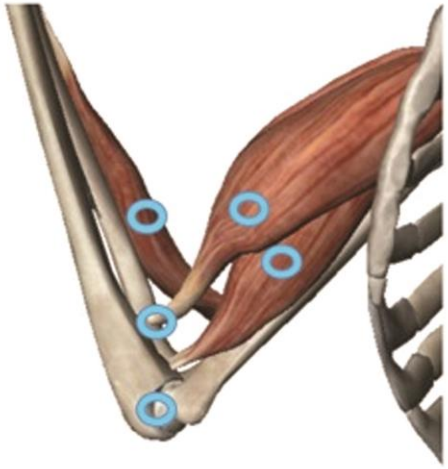
Application: Cover the entire mortise joint in all angles. Sweep along the marks following the muscle and tendon fibers.

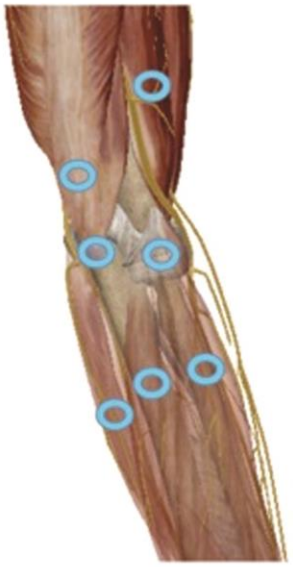
Area: All ankle joints – talo-tibial, talo-calcaneal and tarsals plus the bellies of the gastrocnemius and soleus muscles.

Clinical Notes: Ensure that the origin and insertion points of the gastrocnemius and the musculotendinous junction are completely irradiated. If collapsed plantar arch (flat foot), then treat plantar muscles.

ELBOW PAIN







PARAMETERS

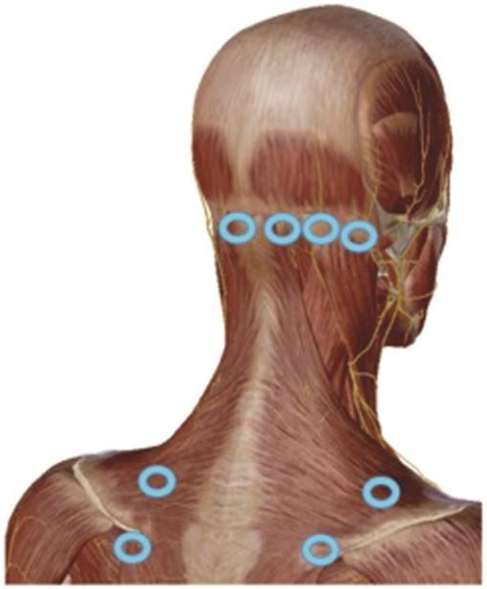
Pulsing (Hz)	Acute: CW; chronic: 250
Power (W)	10 to 30
Time (minutes)	4 to 8
Frequency	3X weekly sessions until resolution

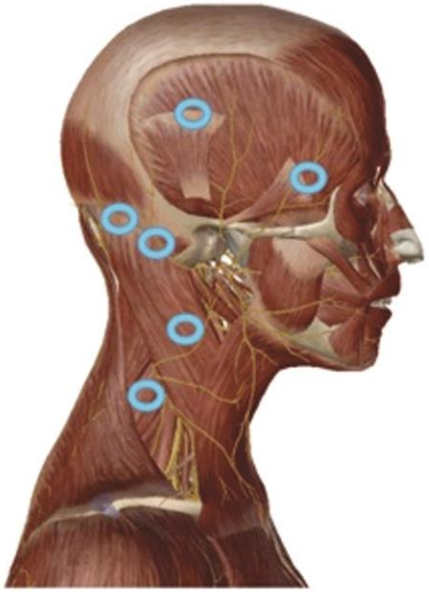
Application: Cover the entire elbow joint in all angles Sweep along the marks following the muscle and tendon fibers.

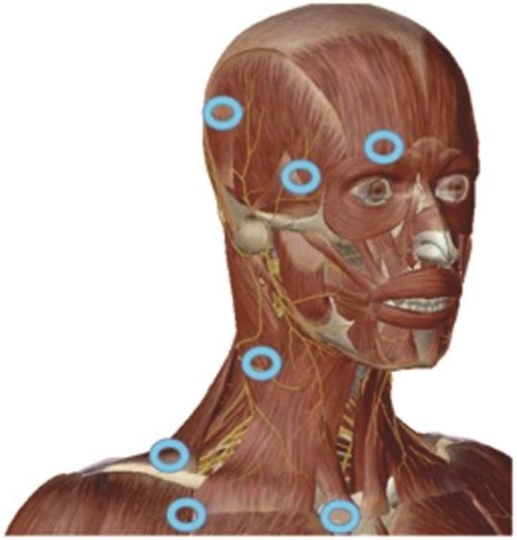
Area: Elbow joints between the humerus, radius and ulna plus the musculotendinous junctions of the muscles connecting in the elbow.

Clinical Notes: Additional benefits are obtained by gently having the elbow joint in motion while using the laser on joints and muscles.

HEADACHES







PARAMETERS

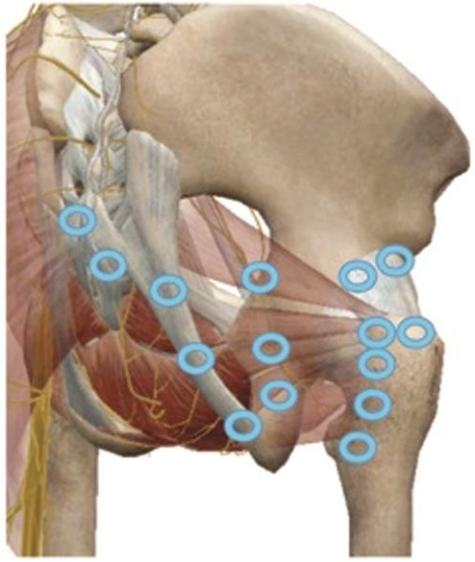
Pulsing (Hz)	CW
Power (W)	18
Time (minutes)	4 to 6
Frequency	3X weekly sessions until resolution

Application: Sweep along the marks following the muscle and tendon fibers.

Area: Occipital ridge and all muscle insertions into skull, scapula and clavicle.

Clinical Notes: Ensure that occipital ridge is completely treated plus the origin and insertions of the trapezius, SCM, levator, and scalene muscles. Areas covered with hair could get uncomfortably hot. If so, increase sweep rate and/or move handpiece about 1" away from skin surface.

HIP PAIN



PARAMETERS

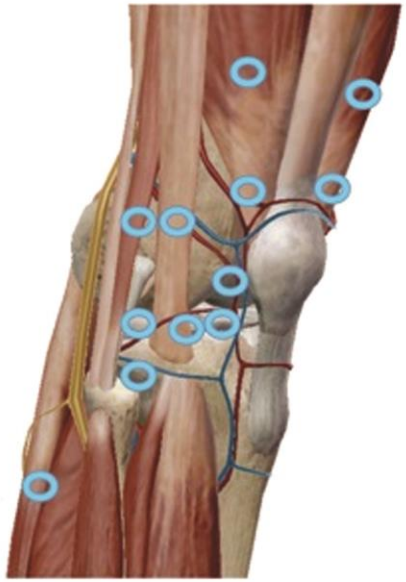
Pulsing (Hz)	Acute: CW; chronic: 250
Power (W)	12 to 30
Time (minutes)	5 to 10
Frequency	3X weekly sessions until resolution

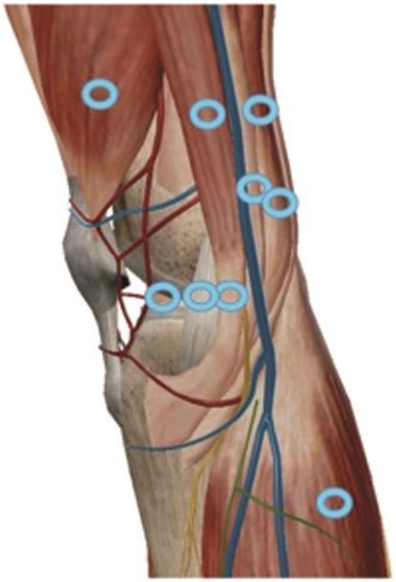
Application: Sweep along the marks following the muscle and tendon fibers. Increase treatment time to 1.5X for "deep" muscles.

Area: Around the hip joint including the medial aspect plus the bellies of muscles affecting the hip joint.

Clinical Notes: Ensure that the bellies of the piriformis, psoas, and gluteus maximus, medius and minimus are irradiated. Place the handpiece on the skin with light pressure.

KNEE PAIN





PARAMETERS

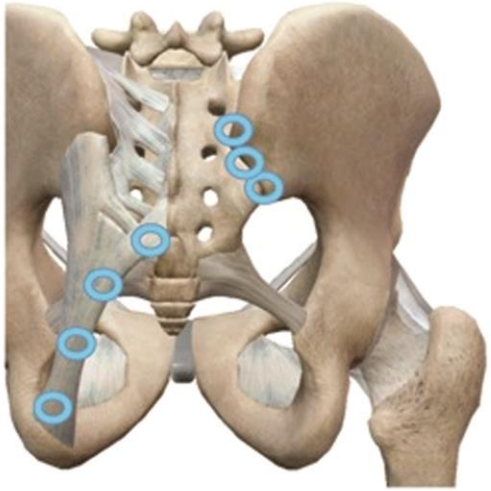
Pulsing (Hz)	Acute: CW; chronic: 250
Power (W)	12 to 30
Time (minutes)	5 to 10
Frequency	Acute: 1X daily sessions for 1 week. Chronic: 3X weekly sessions for 2 weeks.

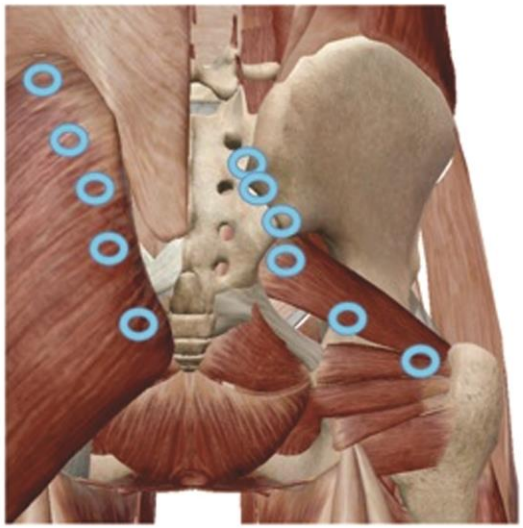
Application: Sweep along the marks following the muscle and tendon fibers. Increase time to 2X for "deep" muscles.

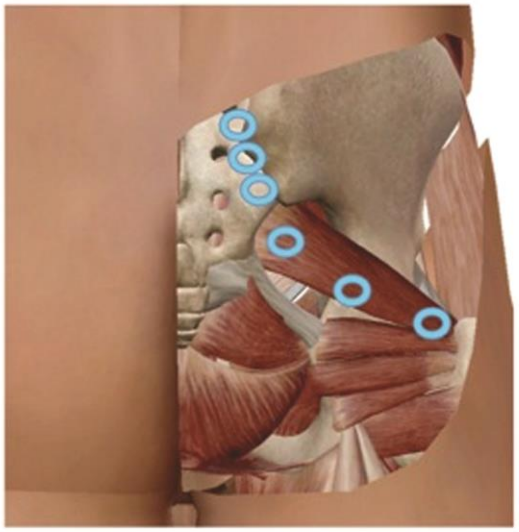
Area: Around the knee joint including the bellies of some muscles acting on the knee joint - the quads, hamstring, sartorius, and gastrocnemius plus the entire ITB, which is mostly tendon.

Clinical Notes: Ensure that the bellies of the quads, hamstrings, sartorius, ITB, and gastrocnemius are irradiated.

SACROILIAC PAIN







PARAMETERS

Pulsing (Hz)	Acute: CW; chronic: 250
Power (W)	12 to 30
Time (minutes)	4 to 8
Frequency	3X weekly sessions for 2 weeks.

Application: Sweep along the marks following muscle and ligament fibers. Apply moderate pressure against the skin with the laser handpiece especially over the piriformis muscle (deep muscle).

Area: Sacroiliac (SI) joint, gluteal and piriformis muscles plus sacrotuberous ligament.

Clinical Notes: There are no muscles crossing the SI joint. Need to treat the gluteal and piriformis muscles plus the sacrotuberous ligament (for SI joint support).