Laser Therapy – a Systematic Review

BY: PAUL SCHWEN

Making the Case for Photomedicine

"I believe that when BASIC PHYSICAL LAWS are applied, PRIMARY TISSUE VARIABILITY FACTORS are considered, and PROPER MEDICAL EQUIPMENT is utilized, optimal clinical outcomes will be achieved and quantum energy treatment will become a primary modality for a wide range of medical conditions."
Paul Schwen, Executive Director, MedLaser Foundation

NOTE: The information below is based on randomized clinical double-blind research studies in addition to peer-reviewed papers found on https://www.ncbi.nlm.nih.gov/, the National Center for Biotechnology Information, which advances science and health by providing access to biomedical and genomic information.

The Reciprocity Rule in Photomedicine, Bunsen Roscoe Law (BRL0
http://www.photobiology.com/reviews/bunsen/index.htm
The Reciprocity Rule[01] 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.

Grotthuss–Draper Law
http://www.newworldencyclopedia.org/entry/Photochemistry
"Only radiation absorbed in a system can produce a chemical change."
The Grotthuss–Draper Law (also called the Principle of Photochemical Activation) states that only that light which is absorbed by a system can bring about a photochemical change. This law provides a basis for fluorescence and phosphorescence; the law was first proposed in 1817 by Theodor Grotthuss and in 1842, independently, by John William Draper.

Stark–Einstein Law
http://ccb.rutgers.edu/sites/default/files/coursefiles/courses_sp10/512/Handout_I_Photochemistry_I.pdf
"Number of activated molecules = number of quanta of radiation absorbed."
The Stark–Einstein law is named after German-born physicists Johannes Stark and Albert Einstein, who independently formulated the law between 1908 and 1913, and is also 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. This quantity is symbolized by γ, hν, or ħω.

Beer-Lambert Law

http://www.pci.tu-bs.de/aggericke/PC4/Kap_I/beerslaw.htm

The Beer-Lambert Law (or Beer's law) is the linear relationship between absorbance and concentration of an absorbing species. The general Beer-Lambert law is usually written as: A = a(lambda)*b*c
where A is the measured absorbance, a(lambda) is a wavelength-dependent absorptivity coefficient, b is the path length, and c is the analyte concentration. When working in concentration units of molarity, the Beer-Lambert law is written as: A = epsilon * b * c, where epsilon is the wavelength-dependent molar absorptivity coefficient with units of M -1 cm -1.

Electromagnetic Energy Spectrum (Herschel Scale)

The electromagnetic energy spectrum was first recognized by Sir William Herschel, of Hanover, Germany)[02]. The whole spectrum with wavelengths ranging from 1 micron to 1 mm is loosely called the 'infrared', but scientists tend to break this up into sub-regions: the 'near infrared' (from 1 to 5 microns); the 'mid infrared' (5 to 30 microns), the 'far infrared' (from 30 to 300 microns) and the 'submillimeter' (from 300 microns to 1 mm). The exact boundaries are somewhat arbitrary, and the exact definitions can vary. Therapeutic wavelengths absorbed by mitochondria and converted into cellular energy are 'NIR', (near infrared), or between 740nm and 1047nm, with ideal absorption coefficients at 808nm and 980nm.

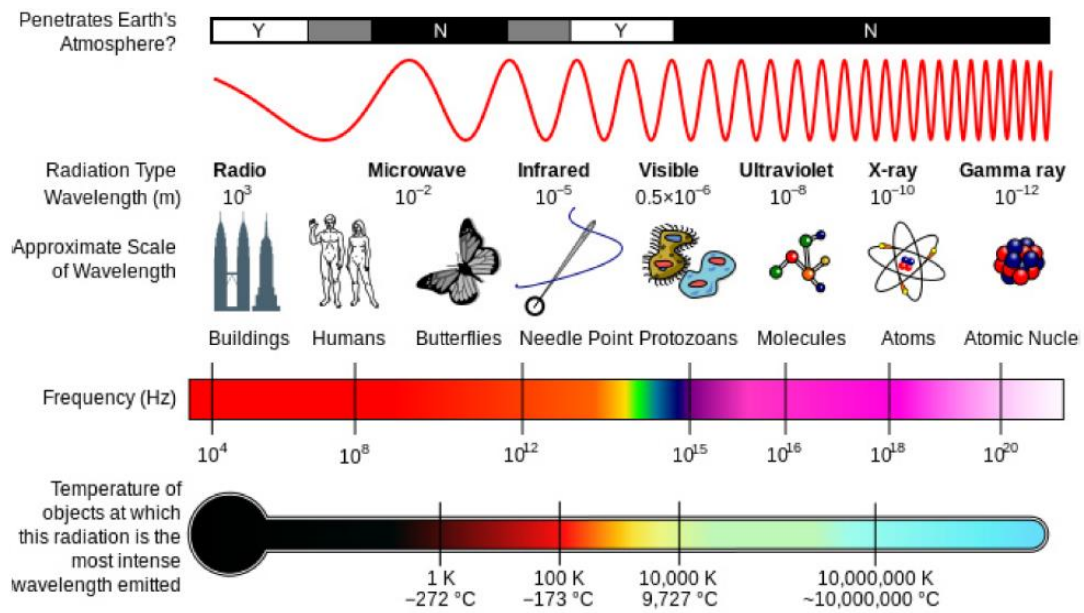
Near Infrared Energy

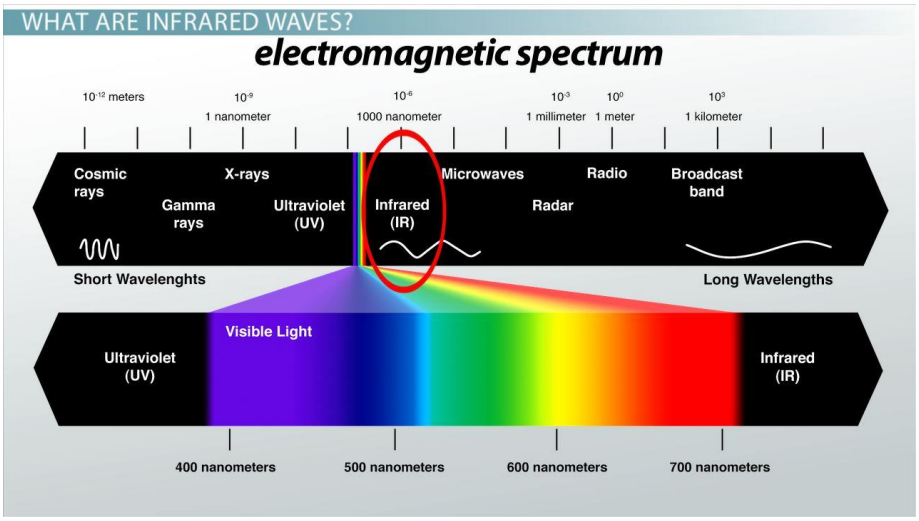
Near infrared energy therapy (laser therapy, biomedical photonic therapy, photobiostimulation) are alternate terms for Photomedicine which uses invisible, near infrared wavelengths between 700 and 1100 nm to deliver quantum energy to organic tissues, stimulating healing and relieving pain. Infrared energy therapy has been proven effective by hundreds of studies found on the National Center for Biotechnology Information website, which advances science and health by providing access to biomedical and genomic information (*https://www.ncbi.nlm.nih.gov/).*

Therapeutic wavelengths of NIR (near infrared) light therapy are from 700 nm to 1100 nm. The full range of NIR spectrum wavelengths have the same healing and therapeutic effects, but, the longer the wavelength, the deeper it penetrates into the body. So, for example, for applications affecting the surface of the skin, red light therapy (570nm-700nm) would be appropriate. For healing of deep wounds, resolution of systemic diseases, or relief of deep muscle and joint pain, the longer wavelengths of near infrared are more beneficial, with 808nm and 980nm being the most effective.

How Does it Work?

Near infrared light therapy works much like red light therapy on skin tissues. Visible red and invisible near infrared energy are absorbed by photoreceptors in each cell. Once absorbed, the light energy stimulates a wide range of metabolic events, stimulating the body's natural processes on the cellular level. Increase in blood flow occurs, allowing targeted parts of the body to receive the oxygen and nutrients they need in order to function more effectively.

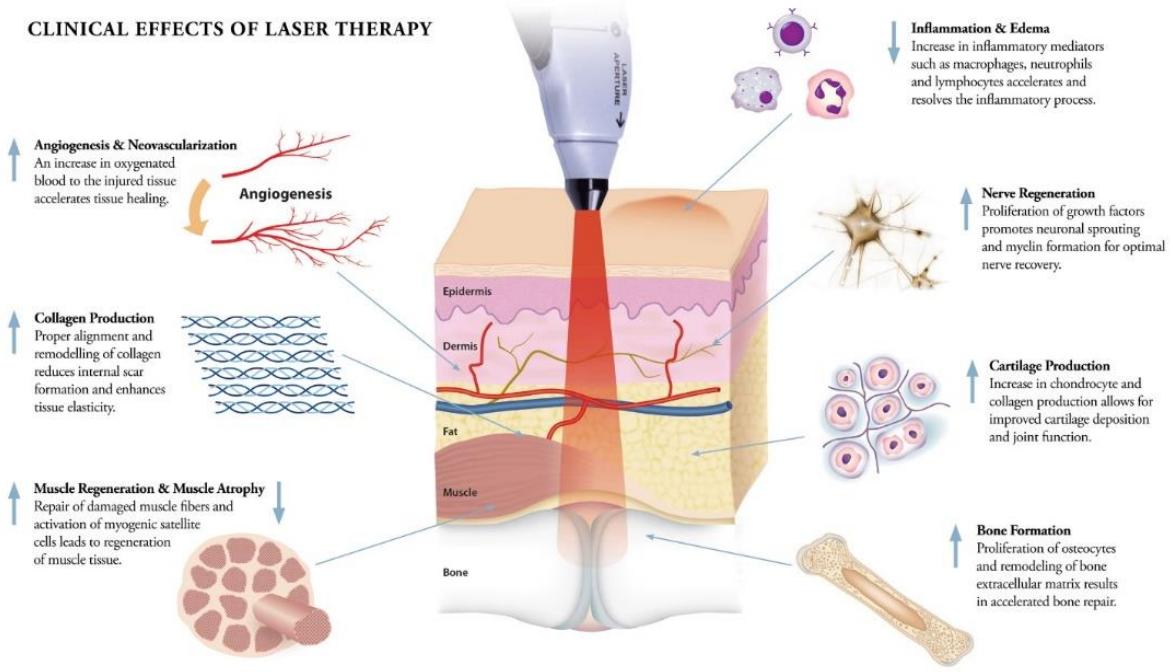




Photomedicine and Dose Effectiveness

Laser therapy dose effectiveness is dependent on a variety of patient tissue factors, all other variables being equal - i.e. wavelength(s), output power, etc.; for example, degenerative disc disease usually requires a large volume of high-output energy for effective tissue interactions, while oral cavity sores require only a small volume of low-output energy to successfully treat; effective treatment application for most other conditions lie somewhere in between. The reason for this is oral cavity sores exist in shallow, pigmented, moist, warm tissues with a plentiful blood supply, while injured discs are non-pigmented and protected by layers of densely complicated structural tissues and do not have an independent blood supply.

Laser light attenuates the further from the surface it penetrates, until it reaches a point at which the laser photon density is so low that no biological effect of the light can be measured; effective stimulatory depth of photonic energy is dependent on targeted tissues, and varies according to tissue variability factors listed below. Secondary and tertiary photobiomodulatory effects, as well as systemic effects, are additionally observed at greater tissue depths.



Benefits of Photomedicine - Primary, Secondary, Tertiary Effects

Primary Response

Primary response is elicited when photons emitted by the laser reach the mitochondria and cell membranes of underlying cells such as fibroblasts, where photonic energy is absorbed by chromophores and is converted to chemical kinetic energy within the cell. Chromophores absorb photons with wavelengths between 700 and 1100 nanometers (NIR, or near infra-red), with those in the 808nm and 980nm wavelengths being the deepest penetrating.

Secondary Response

Secondary reactions lead to the amplification of the primary actions. A cascade of metabolic effects results in various physiological changes at the cellular level—such as changes in cell membrane permeability. Calcium is released from the mitochondria resulting in changes of intracellular calcium levels. This stimulates cell metabolism and the regulation of signaling pathways responsible for significant events required for tissue repair such as cell migration, RNA and DNA synthesis, cell mitosis, protein secretion, and cell proliferation.

Tertiary Response

Tertiary effects are induced at a distance from the cells in which the secondary events occur. Energized (irradiated) cells communicate with each other and with nonirradiated cells through increased levels of cytokines or growth factors, along with correlating electromagnetic energy field interactions. This intercellular communication on the cellular biochemical and electromagnetic energy field levels results in an increase in (ATP) Adenosine Triphosphate production, enhanced immune response with the increased activation of T-lymphocytes, macrophages, and number of mast cells, an increase in the synthesis of endorphins, and a decrease in bradykinin results in pain relief, and a general increase in the energy levels of targeted tissues, as well as additional beneficial interactions. While tertiary effects can be least predictable because they rely on intercellular interactions and vary according to tissue factor variables, they can be most profound and have a major effect on beneficial targeted tissue interactions.

Chromophores Absorb Quantum Light Energy

Chromophores are substances present in living tissues that absorb quantum light energy (all energy from the sun is quantum energy, or energy in its purest and smallest particle form). Examples of endogenous (existing inside the body) chromophores that absorb NIR, or near infrared quantum energy are hemoglobin, oxyhemoglobin, de-oxyhemoglobin and methemoglobin (absorbed by 808nm energy), water, protein, peptide bonds (absorbed by 980nm energy), aromatic amino acids, nucleic acid, urocanic acid and bilirubin (absorbed by UV energy (10nm to 400nm). Melanin in the skin also absorbs quantum UV energy at different rates according to skin pigmentation; then acts as an 'umbrella' to protect underlying tissue substances from destructive UV rays. Exogenous (existing outside the body), compounds, like colors of tattoo ink, also act as chromophores.

Bilirubin as a Chromophore

For centuries, jaundiced infants have been placed near a window so sunlight can be employed to break down bilirubin in an infant's bloodstream. The yellow color in an infant's skin comes from a substance called bilirubin, a common material that comes from red blood cells when they age and die - this is also true for the elderly, and those suffering from liver failure. An average red blood cell lasts about 120 days, then most of it is recycled by the body except for bilirubin. Normally, the liver takes bilirubin out of the bloodstream and delivers it to the digestive system in the form of bile, which gets its greenish-yellow color from bilirubin. In the womb, the mother's liver and placenta process bilirubin in an infant's blood. When the child is born and the umbilical cord is cut, there's no more assistance from the mother's liver or the placenta – the infant's own liver suddenly has to start independently processing bilirubin. Sometimes, premature and infants who have a higher birth rate are prone to a build-up of bilirubin in the blood as the liver initially struggles to catch up with its new requirements. Mothers and doctors alike have known for centuries that bilirubin, as a chromophore, rapidly absorbs quantum UV energy from the sun due to its unique coloring. UV energy, unlike NIR energy, is destructive and rapidly breaks down the bilirubin so that it can be more easily absorbed and processed by the infant's liver.

Water as a Chromophore

The liquid component (water) of the human body is contained in the tissues, the blood, the bones, and elsewhere; this water makes up a significant portion of the human body, both by weight and by volume, and ranges from maximum 78.1% to minimum 54.8%. It is made up of primarily plasma; fatty tissues contain less water content than lean tissues. Ensuring the right amount of body fluids is an important aspect of homeostasis; proper hydration is also very important for successful photomedicine treatments. The 980nm wavelength is primarily absorbed by tissue fluids, as well as nerve tissues, ligamentous and bony (structural tissues), white adipose tissues fatty tissues, other connective and lymphatic tissues that are lightly pigmented.

Hemoglobin as a Chromophore

Red blood cells (Erythrocytes), white blood cells (Leukocytes), and platelets (thrombocytes), make up 45% of blood tissue by volume, with the remaining 55% of the volume composed of plasma, the liquid component of blood. The 808nm wavelength is primarily absorbed by hemoglobin, vascular tissues, endothelial tissues muscle tissues. There are three types of muscle tissue: striated muscles, such as those that move the skeleton (also called voluntary muscle), smooth muscles (involuntary muscle), such as the muscles contained in the stomach and other internal organs, and cardiac muscle, which makes up most of the heart wall (also an involuntary muscle).

Melanin as a Chromophore

Epithelial tissue covers the body surface and forms the lining for most internal cavities – melanin is found primarily in epithelial tissues, and in the skin presents a barrier to NIR energy absorption and penetration, and is readily absorbed by 1064nm as well as lower wavelengths in the UV range (10nm to 400nm). More than 60% of directed quantum energy from a therapy laser is attenuated by melanin in the skin.

DNA as A Chromophore

DNA contains molecules that absorb and transfer quantum energy via the F.R.E.T. (Fluorescent Resonance Energy Transfer) process. Substances in DNA (receptor chromophores) are excited by quantum energy to a higher vibrational, or energy state - they then resonate, or transfer the higher energy state to acceptor chromophores (targeted substances in DNA). This process is enhanced by high volumes of excited quantum particles to direct higher energy states where it is most needed; in addition, laser energy represents a control of photochemical reactions that mimics and greatly enhances the mitochondrial functional response to natural light, much like photosynthesis in plants, algae, and many types of bacteria except at a more highly accelerated rate.

Quantum Energy/Tissue Interactions

The Enteric Nervous System

The enteric nervous system is in the endothelial sheaths of tissues that line the esophagus, stomach, small intestine & colon; high levels of neurotransmitter (serotonin, dopamine, norepinephrine, etc. production occurs in the enteric nervous system. Stimulation of the tissues in this part of the body with quantum energy at higher power and pulse rates can be useful in treating a wide range of mood disorders as well as opioid withdrawal, and can be an integral part of chronic pain resolution, especially when treating CRPS Chronic (Regional Pain Syndrome).

Mitochondrial Respiration

Laser therapy not only enhances mitochondrial respiration, but also activates the redox-sensitive NFkB signaling via generation of ROS. Expression of anti-apoptosis and pro-survival genes responsive to NFkB could explain the beneficial clinical effects of Photomedicine.

Mitochondria are a principal intracellular target of near infrared light energy. Cytochrome C oxidase (unit IV of the mitochondrial respiratory chain) is a chromophore that absorbs light as far into the infrared as 1000 nm. Numerous clinical studies report increased cytochrome c oxidase activity after laser therapy treatments, and increased ATP synthesis after light delivery to isolated mitochondria. Additional evidence of the role of cytochrome c oxidase as a chromophore in photomedicine has been provided by action spectra studies from Karu's laboratory in Russia [1] and from Eells and Wong-Riley in Wisconsin [2].

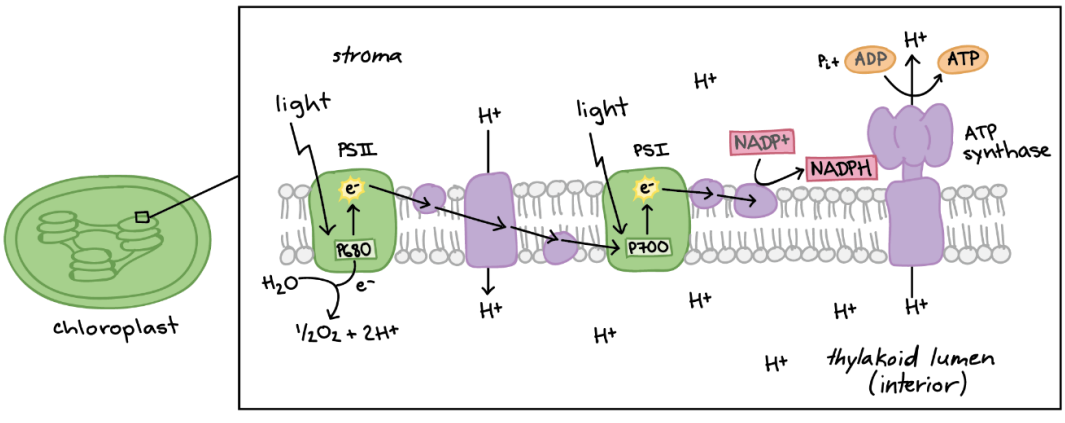
Many genes have their transcription upregulated (or down regulated) after illumination of cells with near infrared wavelengths of light energy; for example, illumination of human fibroblasts with 808nm light emitting diode led to altered expression of 111 genes (68 up, 43 down) that can be sub-categorized into 10 functional groups [3].

Nuclear factor kappa B (NF-kB) is a transcription factor regulating expression of multiple genes[4], and has been shown to govern various cellular functions, including inflammatory and stress-induced responses and survival [5]. NF-kB activation is regulated by negative feedback mediated by IkB, an inhibitor protein that binds to NF-kB, but can undergo ubiquitination and proteasomal degradation [6], thus freeing NF-kB to translocate to the nucleus and initiate transcription [7].

NF-kB is a redox-sensitive transcription factor [8], that has been proposed to be the sensor for oxidative stress [9]. Reactive oxygen species (ROS) can both activate NF-kB directly [10], and ROS are also involved in NF-kB activation by other stimuli such as tumor necrosis factor alpha (TNFα), phorbol ester, and interleukin (IL)-1 [11].

Several Clinical Studies have observed the formation of ROS in cells after NIR energy irradiation[12], [13], [14], [15], and it has been proposed that ROS are involved in the signaling pathways initiated after photons are absorbed by the mitochondria within cells [16].

At least four types of reactions can occur with the participation of a photo-acceptor molecule after its electronic excitation: changes in redox properties and the acceleration of electron transfer, one-electron autooxidation (0;- formation), photodynamic action (IO2 formation), and changes in biochemical activity induced by the local transient heating of the absorbing chromophores. It is unreasonable to believe that only one of these reactions occurs under irradiation. Recent studies indicate that changes in redox properties of absorbing chromophores in photo-acceptor molecules has a great importance.



Heightened ATP Synthase

ATP synthase is the process that creates the energy storage and transfer molecule *Adenosine Triphosphate* (ATP). ATP is the most generic form of energy production, storage, and transfer in the cells of most organisms; it is formed from adenosine diphosphate (ADP) and inorganic phosphate (Pi) and needs photonic energy for its formation. Laser therapy delivers high volumes of quantum energy for the ATP synthase process to be stimulated, thereby providing an enhanced pathway for more rapid and effective healing of aging, sick, injured, or malfunctioning tissues and body systems. ATP synthase occurs in the mitochondria, which are often found in brown adipose tissues that are made up mostly fat cells with fibrous strings as structure, primarily found under the skin and in deposits between muscles, intestines, heart, bone marrow (see below).

Reactive Oxygen Species (ROS) Modulation

Reactive oxygen species (ROS) are continuously produced as byproducts of aerobic metabolism. Depending on the nature of the ROS species, some are highly toxic and usually detoxified by various cellular enzymatic and nonenzymatic mechanisms. Whereas the human body contains mechanisms to combat increased ROS levels during abiotic stress conditions, in other circumstances the body purposefully generates ROS as signaling molecules to control various processes including pathogen defense, programmed cell death, and stomatal behavior. The reactive oxygen species can be primary contributors of oxidative stress at increased levels, which leads to many diseases and disorders such as cardiovascular disease, cancer, aging, and various neurodegenerative diseases. This occurs when the body produces higher levels of ROS in response to metabolic or external stimuli from environmental toxins, pathogens, increased stress, etc. Quantum energy loads from laser therapy can play an important role in reversing the damage caused by increased levels of oxidative stress.

Fluorescent Resonance (F.R.E.T.) Increase

Photons (quantum light energy) are an integral part of our lives and play a pivotal role in the function of our bodies on the molecular level – in fact, photons control everything that happens in the cells. Photonic energy exists in our DNA and is the means whereby molecular signaling occurs.

DNA contains molecules that absorb and transfer quantum energy via the F.R.E.T. process. Substances in DNA (receptor chromophores) are stimulated (excited) by quantum energy to a higher energy state (fluorescent Resonance); they then transfer that higher energy state to other substances in the DNA (acceptor chromophores). This process is called Fluorescent Resonance Energy Transfer, or F.R.E.T., and is used to direct stimulated energy to where it is most needed. In addition, the quantum energy in photomedicine exerts a control of photochemical reactions that mimics and enhances the function of natural light, like those processes of photosynthesis in plants, algae, and many types of bacteria.

Fluorescent Resonance Energy Transfer is a function of the ATP synthase process. ATP synthase is the process that creates the energy storage and transfer molecule *Adenosine Triphosphate* (ATP). ATP is the most common form of energy production, storage, and transfer in the cells of all organisms; it is formed from adenosine diphosphate (ADP) and inorganic phosphate (Pi), and needs quantum light energy for its formation. Photomedicine delivers additional sources of quantum energy for the ATP synthase process to be enhanced, boosting the process whereby F.R.E.T. can occur most efficiently, and providing a pathway for enhanced healing of aging, sick, injured, or malfunctioning tissues and body systems.

Enhanced Cytokine Modulation

Cytokine Modulation (Increased Production of Good Cytokines/Reduction of Bad Cytokines)

Cytokines play a broad role in helping the immune system respond to diseases. Cytokines may be 'good' when stimulating the immune system to fight a foreign pathogen or attack tumors. Other good cytokine effects include reduction of an immune response, for example interferon β reduction of neuron inflammation in patients with multiple sclerosis. Cytokines are 'bad' when the body is no longer able to manage the higher level of production due to environmental stress, injury, or pathogenic infection, and the 'overactive' cytokine response causes inflammatory diseases, i.e. the role of tumor necrosis factor α in rheumatoid arthritis or asthma and Crohn's disease. Quantum energy loads from laser therapy can help to modulate overactive cytokine responses, strengthening the immune system and reducing the inflammatory processes that occur in an overactive cytokine response (such as autoimmune disorders).

Enhanced Immunoregulatory Response

Quantum light energy has a direct effect on immunity status by stimulation of immunoglobulins and lymphocytes. Quantum light energy, when absorbed by chromophores and other molecule enzymes within the body, activate flavomononucleotides and enhance the production of ATP (adenosine triphosphate), a major component of cellular energy and the energy source for all chemical reactions in the cells.

Quantum NIR Energy as an Antimicrobial and Anti-biofilm Technology

Photomedicine therapy is antibacterial, antiviral, and antifungal (anti-microbial, anti-biofilm), and is extremely useful in wound healing and resolving a wide range of pathogenic conditions. Quantum NIR energy has strong antimicrobial effects and low toxicity to human cells - which means strong antibacterial, antiviral, and antifungal treatments for hygiene and medical applications.

Laser Therapy in the Treatment of Viral Infections

Herpes simplex virus (HSV) is one of the most common viral infections for humans. Although most of the seropositive persons do not manifest symptoms, infected individuals may present recurrent infections, often characterized by cold sores. HSV-1 infection can result in potentially harmful complications in some patients, especially in those with compromised immunity. Recently, an otherwise healthy nine-pound newborn infant died several days after being held and kissed by a close relative (Aunt) with a herpes simplex viral infection – the infant's immune system simply could not withstand the damaging effects of the virus. Recent clinical studies show that photomedicine treatments can resolve viral outbreaks of the herpes simplex virus typically within 3-4 days, and minimize symptoms from initial radiation. Additionally, laser

therapy treatments will significantly reduce frequency of outbreaks for extended periods. It is logical to theorize that the same response will be experienced with other viral infections, up to and including HIV.

P.T.V.F. - Primary Tissue Variability Factors™

The MedLaser Foundation® has developed the following tissue variability factors as a guide for setting and adjusting optimal laser therapy treatment dosages; *primary* variables affecting quantum energy depth of penetration, absorption, and attenuation are listed below:

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

Variability Factor™ Definitions

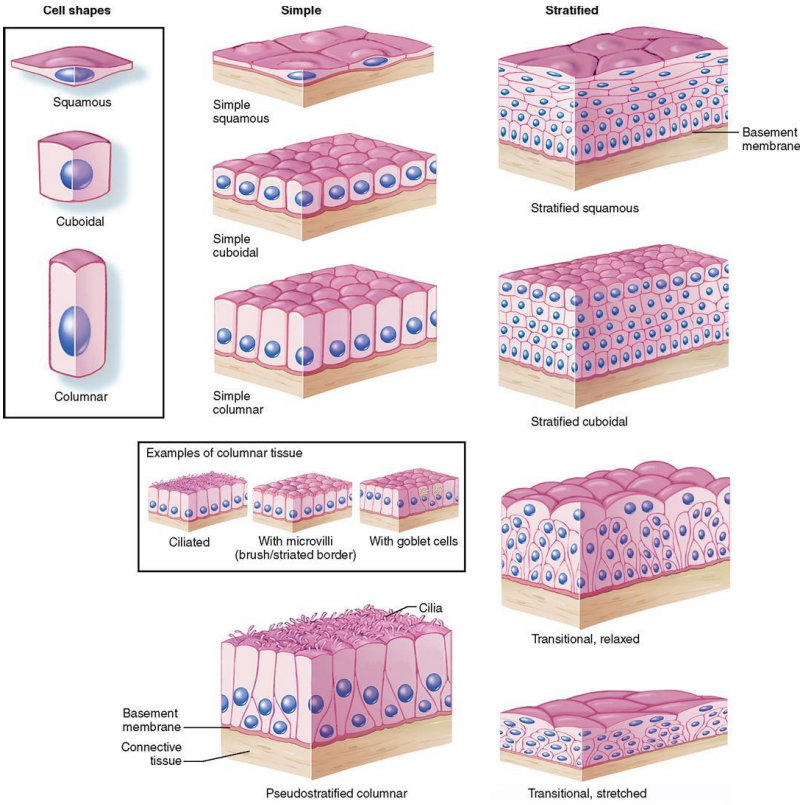
1. Tissue Type

listed in order of most to permeable to least permeable, or least dense to most dense:

1. blood cells
2. fat cells
3. nerve cells
4. muscle cells
5. skin cells
6. tendons cells
7. cartilage cells
8. bone cells

2. Tissue Structure

1. Simple: squamous (flat and scale-like), columnar (tall, column-shaped), cuboidal (equal width/height)
2. Stratified - squamous, columnar
3. Pseudostratified - columnar
4. Transitional



3. Tissue Density

Penetration through a medium (tissue types, including, connective, epithelial, endothelial, muscle, vascular, and nerve tissues) is inversely related to the density and directly related to the permeability of that medium, if pigmentation is not a factor.

Treatment settings related to tissue density and permeability factors: continuous wave (CW) vs. Pulse: Pulse mode is more absorbent in denser tissues because it allows for more intense micro absorption of energy with less possibility of damage from excess heat or other effects. The following statements are true when skin pigmentation is considered:

1. Continuous wave energy is absorbed more rapidly in the tissues, and therefore is considered to be most appropriate for more superficial conditions and more permeable tissues.
2. Pulsing is absorbed less rapidly with better progression through the tissues, and can therefore be more effective at greater depth and with denser tissue structures.

4. Tissue Permeability

Permeable tissues use lower dosage; denser tissues use higher dosage; Penetration through a medium (tissue types, including, connective, epithelial, endothelial, muscle, vascular, and nerve tissues) is inversely related to the density and directly related to the permeability of that medium, if pigmentation is not a factor.

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2. Pulsing is more rapidly absorbed with better progression through tissues, and can therefore be more effective at greater depth and with denser tissue structures.

5. Tissue Proximity

Tissue Proximity: proximity to skin surface (shallow adipose tissue, deep, underlying muscle, vascular, nerve, connective, structural red adipose tissue). Shallow tissues better absorb continuous wave (CW) energy output, tissues that are deeper in the body respond better to fractional, or pulsed energy; the deeper and denser the tissues, the higher the pulse (duty cycle, or ratio between beam emission and rest) for optimal clinical outcomes.

6. Tissue Pigmentation according to the Fitzpatrick Scale[1c]:

The Fitzpatrick Skin Type Test is a skin classification system first developed in 1975 by Thomas Fitzpatrick, MD, of Harvard Medical School. His skin classification system and its adaptations are familiar to dermatologists and aestheticians. To determine your Fitzpatrick Skin Type, our quiz measures two components (genetic disposition and reaction to sun exposure). Types range from very fair (Type I) to the very dark (Type VI).

1. White; very fair; red or blonde hair; blue eyes; freckles; always burns, never tans;
2. White; fair; red of blonde hair; blue, hazel, or green eyes, usually burns, tans with difficulty;
3. Cream white; fair with any eye or hair color; very common, sometimes mild sunburn, tans gradually;
4. Brown; typical Mediterranean or Caucasian skin, rarely burns, tans with ease;
5. Dark brown; Middle Eastern skin type, very rarely burns, tans very easily;
6. Black; African origin, never burns, tans easily

Your eye color is:
Light blue, light gray or light green = 0
Blue, gray or green = 1
Hazel or light brown = 2
Dark brown = 3
Brownish black = 4

Your natural hair color is:
Red or light blonde = 0
Blonde = 1
Dark blonde or light brown = 2
Dark brown = 3
Black = 4

Your natural skin color (before tanning) is:
Ivory white = 0
Fair or pale = 1
Fair to beige, with golden undertone = 2
Olive or light brown = 3
Dark brown or black = 4

How many freckles do you have on unexposed areas of your skin?
Many = 0
Several = 1
A few = 2
Very few = 3
None = 4

Total score for genetic disposition: _____

How does your skin respond to the sun?
Always burns, blisters and peels = 0
Often burns, blisters and peels = 1
Burns moderately = 2
Burns rarely, if at all = 3
Never burns = 4

Does your skin tan?
Never -- I always burn = 0
Seldom = 1
Sometimes = 2
Often = 3
Always = 4

How deeply do you tan?
Not at all or very little = 0
Lightly = 1
Moderately = 2
Deeply = 3
My skin is naturally dark = 4

How sensitive is your face to the sun?
Very sensitive = 0
Sensitive = 1
Normal = 2
Resistant = 3

Very resistant/Never had a problem = 4

Score for reaction to sun exposure: _____

Genetic Disposition: _____

Reaction to Sun Exposure: _____

Total Score: _____

Add up your genetic disposition and sun exposure totals to find your Fitzpatrick Skin Type:

Type #1. (0-6) – Increase Dosage)
You always burn and never tan in the sun. You are extremely susceptible to skin damage as well as cancers like basal cell carcinoma and squamous cell carcinoma. You are also at very high risk for melanoma, the deadliest type of skin cancer. Generally, follow The Skin Cancer Foundation's prevention tips but use a sunscreen with a SPF of 30+ and clothing with a UPF rating of 30 or higher. Seek the shade whenever you are out in the sun. Check your skin head-to-toe each month, paying careful attention to any suspicious growths, and make sure you have an annual professional skin checkup.

Type #2. (7-12) – Increase Dosage)
You almost always burn and rarely tan in the sun. You are highly susceptible to skin damage as well as cancers like basal cell carcinoma and squamous cell carcinoma. You are also at elevated risk for melanoma, the deadliest type of skin cancer. Generally, follow The Skin Cancer Foundation's prevention tips but also consider using a sunscreen with a SPF of 30+ and clothing with a UPF rating of 30 or higher. Seek the shade whenever you are out in the sun. Check your skin head-to-toe each month, paying careful attention to any suspicious growths, and make sure you have an annual professional skin checkup.

Type #3. (13-18) – Slightly Increase Dosage)
You sometimes burn and sometimes tan in the sun. You are susceptible to skin damage as well as cancers like basal cell carcinoma and squamous cell carcinoma. You are also at risk for melanoma, the deadliest type of skin cancer. Be sure to apply a sunscreen with an SPF of at least 15 every day, wear sun-protective clothing, and seek the shade between 10 AM and 4 PM, when the sun is strongest. Check your skin head-to-toe each month, paying careful attention to any suspicious growths, and make sure you have an annual professional skin checkup.

Type #4. (19-24) – dosage remains the same)
You tend to tan easily and are less likely to burn. However, you are still at risk; use sunscreen with an SPF of 15+ outside and seek the shade between 10 AM and 4 PM. Follow all other Prevention Tips from The Skin Cancer Foundation as well. Check your skin head-to-toe each month, paying careful attention to any suspicious growths, and make sure you have an annual professional skin checkup.

Type #5. (25-30) - Slightly Decrease Dosage)
You tan easily and rarely burn, but you are still at risk. Use sunscreen with an SPF of 15+ and seek the shade between 10 AM and 4 PM. Acral lentiginous melanoma, a very virulent form of the disease, is more common among darker-skinned people. These melanomas tend to appear on parts of the body not often exposed to the sun, and often remain undetected until after the cancer has spread. Check your skin head-to-toe each month, paying careful attention to any suspicious growths, and make sure you have an annual professional skin checkup. Keep an eye out for any suspicious growths, especially on the palms, soles of the feet and mucous membranes.

Type #6. (31+) - Decrease Dosage)
Although you do not burn, dark-skinned people are still at risk for skin cancers, and should wear sunscreen with a SPF of 15+ and seek the shade between 10 AM and 4 PM. Acral lentiginous melanoma, a very virulent form of the disease, is more common among darker-skinned people. These melanomas tend to appear on

parts of the body not often exposed to the sun, and often remain undetected until after the cancer has spread. Check your skin head-to-toe each month, paying careful attention to any suspicious growths, and make sure you have an annual professional skin checkup. Keep an eye out for any suspicious growths, especially on the palms, soles of the feet and mucous membranes.

7. Tissue Hydration

Tissue hydration level serves several distinct functions in the human body. Total body water comprises approximately 45–75% of a person's body weight. Muscle mass is 70–75% water, while water in fat tissue can vary between 10 and 40% (25); the brain and heart are composed of 73% water, and the lungs are about 83% water. Water acts as a transporter of nutrients, helps to regulate body temperature, lubricates joints and internal organs, provides structure to cells and tissues, and can help preserve cardiovascular function. Fluid deficits adversely impact physical and mental performance according to the degree of dehydration; thus, it is important to maintain adequate hydration levels. Research also indicates proper hydration levels play an important part on the effectiveness of therapeutic laser treatments - it is therefore important to consider hydration a primary factor in tissue response.

The recommended fluid intake while undergoing therapy laser treatments is around 1/2 a patient's body weight in fluid ounces of water intake daily - in other words, if the patient weighs 100 pounds, they should drink approximately 50 ounces of fluid per day, or approximately 6 ½ cups of water, with additional fluid intake needs being satisfied by food intake.

8. Tissue Stress Factors

Bio-behavioral stress factors can induce cell damage (increased cortisol levels, etc.)

- Allostasis: Capacity to Adapt to Stresses in order to achieve homeostasis;
- Minimal Stress: State of happiness (or denial);
- Acute Stress: Acute Stress: acute - most common type of stress;
- Episodic Stress: Episodic Stress: when acute stress occurs frequently;
- Chronic Stress: Chronic -most damaging for health.

Stress as a Disease

Acute, episodic, and chronic stress, or the body's instinctive response to external environmental cues, triggers a deregulation of several bodily systems including muscle tension, musculoskeletal disorders, nervous system and cardiovascular disorders including increased heart rate and blood pressure, adrenal, endocrine, and gastrointestinal system disorders including increase blood sugar levels, decreased immune system response, and bowel disorders. Other deregulatory responses included female and male reproductive system disorders.

Types of Stress that induce cell damage:

- Physical: intense exertion, manual labor, lack of sleep, travel;
- Chemical: drugs, alcohol, caffeine, nicotine and environmental pollutants such as cleaning chemicals or pesticides;
- Mental: perfectionism, worry, anxiety, long work hours;
- Emotional: anger, guilt, loneliness, sadness, fear;
- Nutritional: food allergies, vitamin and mineral deficiency;
- Traumatic: injuries or burns, surgery, illness, infections, extreme temperatures;
- Psycho-spiritual: troubled relationships, financial or career pressures, challenges with life goals, spiritual alignment and general state of happiness.

9.Tissue Age

Cells are the basic building blocks of tissues. All cells experience changes with aging. They become larger and are less able to divide and multiply. Among other changes, there is an increase in pigments and fatty substances inside the cell (lipids). Many cells lose their ability to function, or they begin to function abnormally. As aging continues, waste products build up in tissue. A fatty brown pigment called lipofuscin collects in many tissues, as do other fatty substances.

Connective tissues change as they age and becoming stiffer; this makes the organs, blood vessels, and airways more rigid. Cell membranes change, so many tissues have more trouble getting oxygen and nutrients, and removing carbon dioxide and wastes. Many tissues lose mass. This process is called atrophy. Some tissues become lumpy (nodular) or more rigid. Because of cell and tissue changes, your organs also change as you age. Aging organs slowly lose function. Most people do not notice this loss immediately, because you rarely need to use your organs to their fullest ability.

Organs have a reserve ability to function beyond the usual needs. For example, the heart of a 20-year-old is capable of pumping about 10 times the amount of blood that is needed to keep the body alive. After age 30, an average of 1% of this reserve is lost each year. The biggest changes in organ reserve occur in the heart, lungs, and kidneys. The amount of reserve lost varies between people and between different organs in a single person.

These changes appear slowly and over a long period. When an organ is worked harder than usual, it may not be able to increase function. Sudden heart failure or other problems can develop when the body is worked harder than usual. Things that produce an extra workload (body stressors) include the following:

- Illness;
- Medications;
- Significant life changes;
- Sudden increased physical demands on the body, such as a change in activity or exposure to a higher altitude;
- Loss of reserve also makes it harder to restore balance (equilibrium) in the body. Drugs are removed from the body at a slower rate. Lower doses of medications may be needed, and side effects become more common;
- Medication side effects can mimic the symptoms of many diseases, so it is easy to mistake a drug reaction for an illness. Some medications have entirely different side effects in the elderly than in younger people.

Cellular Changes

- Atrophy: Cells shrink - if enough cells decrease in size, the entire organ atrophies. This is often a normal aging change and can occur in any tissue. It is most common in skeletal muscle, the heart, the brain, and the sex organs (such as the breasts). The cause of atrophy is unknown, but may include reduced use, decreased workload, decreased blood supply or nutrition to the cells, and reduced stimulation by nerves or hormones;
- Hypertrophy: Cells enlarge - this is caused by an increase of proteins in the cell membrane and cell structures, not an increase in the cell's fluid; when some cells atrophy, others may hypertrophy to make up for the loss of cell mass;
- Hyperplasia: The number of cells increases - there is an increased rate of cell division. Hyperplasia usually occurs to compensate for a loss of cells. It allows some organs and tissues to regenerate, including the skin, lining of the intestines, liver, and bone marrow. The liver is especially good at regeneration. It can replace up to 70% of its structure within 2 weeks after an injury. Tissues that have limited ability to regenerate include bone, cartilage, and smooth muscle (such as the muscles around the intestines). Tissues that rarely or never regenerate include the nerves, skeletal muscle, heart muscle, and the lens of the eye. When injured, these tissues are replaced with scar tissue;

- Dysplasia: The size, shape, or organization of mature cells becomes abnormal - this is also called atypical hyperplasia. Dysplasia is fairly common in the cells of the cervix and the lining of the respiratory tract;

- Neoplasia: The formation of tumors, either cancerous (malignant) or noncancerous (benign) - neoplastic cells often reproduce quickly, and may have unusual shapes and abnormal function.

As you grow older, you will have changes throughout your body, including changes in:

- Hormone production
- Immunity
- The skin
- Sleep
- Bones, muscles, and joints
- The breasts
- The face
- Tissue Sensitivity (to light & heat)
- The female reproductive system
- The heart and blood vessels
- The kidneys
- The lungs
- The male reproductive system
- The nervous system
- Tissue Health

As one ages, fibroblasts slow their production of collagen, elastin and glycosaminoglycan; when these proteins are lacking in the body, the skin loses its ability to repair itself. A history of excessive exposure to UV rays causes visible signs of aging; photo-aged skin can also exhibit a reduction in elasticity and strength. Laser therapy has anti-aging properties that penetrate the skin's surface with targeted beams of quantum energy - this energy creates microscopic zones of cellular function enhancement, stimulating the body's natural healing process which then stimulates the production of collagen and elastin, thereby causing skin to act and feel younger. Patients see improvement in overall texture, clarity and radiance of their facial skin. As the body produces new collagen and elastin, the appearance of wrinkles and fine lines is greatly reduced, and the skin regains its youthful glow.

10. Tissue Function/malfunction: Equilibrium, Homeostasis, Allostasis, and Entropy

Homeostasis is conventionally thought of merely as a synchronic (same time) servo-mechanism that maintains the status quo for organismal physiology. However, when seen from the perspective of developmental physiology, homeostasis is a robust, dynamic, intergenerational, diachronic (across-time) mechanism for the maintenance, perpetuation and modification of physiologic structure and function. The integral relationships generated by cellular molecular signaling for the mechanisms of embryogenesis, physiology and repair provide describe the homeostatic principle, Starting with the inception of life itself, with the advent of reproduction during meiosis and mitosis, moving forward both ontogenetically and phylogenetically through the evolutionary steps involved in adaptation to an ever-changing environment, Homeostasis is far more complex than previously considered.

Homeostasis is defined as the property of a system in which variables are regulated so that internal conditions remain stable and relatively constant despite the constant change of external stimuli. Examples of homeostasis include the regulation of body temperature, and the balance between acidity and alkalinity. It is a process that maintains the stability of the organism's internal environment in response to fluctuations in external environmental conditions.

Homeostasis requires a sensor to detect changes in the condition to be regulated, an effector mechanism that can vary that condition, and a negative feedback connection between the two.

Every living organism depends on maintaining a complex set of interacting metabolic chemical reactions. From the simplest unicellular organisms, to the most complex plants and animals, internal processes operate to keep their conditions within tightly regulated and controlled limits to allow these reactions to proceed. Homeostatic processes act at the level of the cell, the tissue, and the organ, as well as at the level of the organism as a whole, referred to as allostasis.

Diseases Involve Disturbances in Homeostasis

Diseases involve disturbances in homeostasis; for example, as the organism ages, the efficiency in the control of systems becomes reduced due to the loss of receptors. The inefficiencies gradually result in an unstable internal environment that increases the risk of illness, leading to the physical changes associated with aging. Certain homeostatic imbalances, such as a high core body temperature, a high concentration of salt in the blood, or a low concentration of oxygen, can generate homeostatic reactions such as warmth, thirst, or breathlessness, which motivate behavior aimed at restoring homeostasis.

The life span of the organism as a continuous series of ligand-receptor interactions from morphogenesis to the maintenance of physiologic homeostasis, to the loss of homeostatic control mechanisms during aging, culminating in death has been formulated. Seen in this light, allostasis takes on a very different set of characteristics, stress having short-term effects that are physiologically beneficial for the reproductive strategy; but over the long haul, such adaptive responses can have deleterious effects that occur as unintended consequences of the optimization of the primary homeostatic mechanisms involved. In other words, acceleration of development would bring on precocious aging and death as a continuous mechanism selecting for the unicellular state.

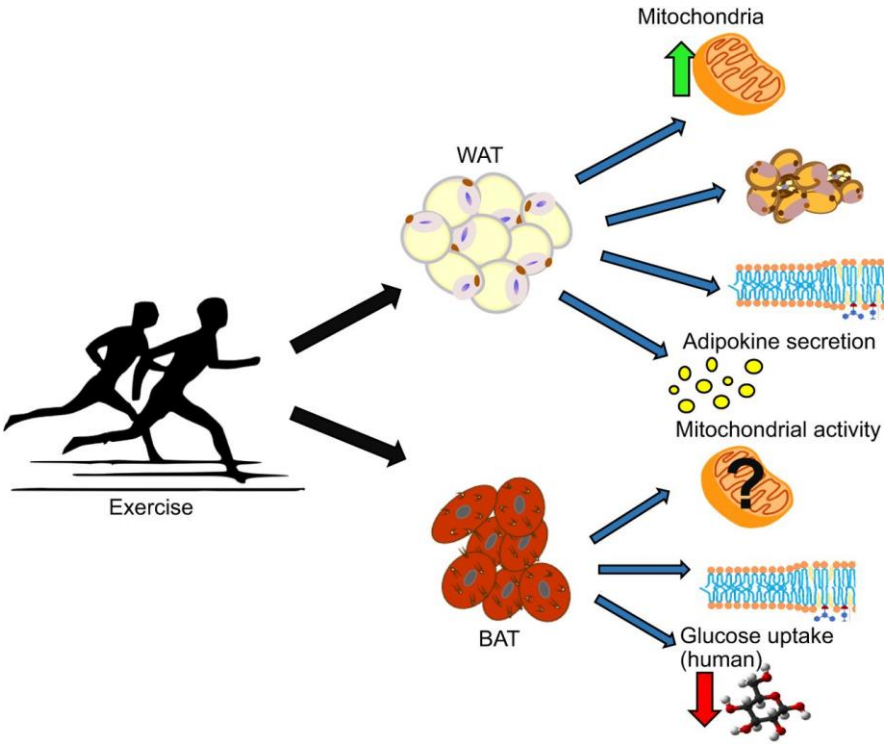
Quantum Energy Applications Enhance Tissue Regeneration (a Form of Regenerative Medicine)

Systemic applications of high volumes of quantum energy can assist in controlling and redirecting the mechanisms of homeostasis in enhancement of tissue regeneration, added vigor, robustness, and more dynamic interactions throughout the full range of metabolic processes.

Tissue Properties

Adipose Tissue (Found Throughout the Body in Shallow and Deep Tissues)[16]

Adipose tissue is mostly fat cells with fibrous strings as structure, primarily found under the skin in deposits between muscles, intestines, heart, bone marrow. There are 2 types of adipose tissue, WHITE, which makes up 20% of human body weight in men, and 25% in women (metabolism & endocrine function) and is used to store energy, aids in endocrine function and metabolism, and is considered a major endocrine organ; and BROWN, which derives its color from rich vascularization and densely packed mitochondria. Instead of serving as a substrate, the lipid in brown adipose tissue releases energy directly as heat, and for utilization of excess caloric intake via diet-induced-thermogenesis. The mechanism of heat generation is related to the metabolism of the mitochondria.



Brown Adipose Tissue

Brown adipose tissue is rich in mitochondrial cells, ranges from tan to red in color, and is primarily responsible for ATP production. Photobiostimulation of red blood cells (erythrocytes), enhances the following processes:

- Hemoglobin interaction, tissue oxygenation
- plasma and platelets interaction
- mitochondrial interaction
- vascular tissue interaction

White Adipose Tissue

For pain control, treating structural damage, laser energy is absorbed by fluid/plasma/platelets in white adipose tissues, in addition to stimulation of leukocytes, lymphocyte B&C, connective tissues, tendons, ligaments, bones and nerve tissues. White adipose tissue has the following properties:

- Injured white tissue heals more slowly;
- Composed of white blood cells (granulocytes, monocytes, lymphocytes, leukocytes);
- Found in spinal discs;
- Found in tendons, ligaments, and bones.

Relationships Between Adipose Tissues and the Brain

Over the last decades, more and more data supporting the importance of the relationships between the brain and adipose tissues (white and brown) in regards of body weight regulation and energy homeostasis have been published. The brain, via the autonomic nervous system, participates to the regulation of different parameters such as the metabolic (lipolysis, lipogenesis and thermogenesis), and secretory (leptin and other adipokines) activities but also plasticity (proliferation differentiation and apoptosis) of adipose tissues. In turn the various fat pads will send information via sensory innervation of white adipose tissue as well as metabolic and hormonal signals acting directly on some brain areas. Altogether, these results show the presence of a neural feedback loop between adipose tissues and the brain, which plays a major role in the regulation of energy homeostasis according to physiological and pathological states.

Epithelial Tissues

Properties of epithelial tissues include:

- One free surface open to outside or inside the body;
- Closely attached to other cells of the same type;
- Attached to underlying connective tissue;
- Has no blood vessels;
- innervated (lots of nerves in it);
- Regenerates rapidly;
- Stratified;
- Several shapes including squamous, cuboidal, columnar.

Connective Tissue

Most abundant and found everywhere in the body; dense regular connective tissue includes tendons and ligaments, collagen fibers in an orderly parallel fashion, giving a tensile strength…
Loose connective tissues are fibrous, elastic, lymphoid connective tissues vary in density and cellularity; most connective tissues are lightly pigmented, some connective tissues are darkly pigmented and include special connective tissue, reticular, cartilage, bones, ligaments, tendons and blood. Elastic and lymphoid connective tissues provide resistance to stretch forces and hold organs in place, and are also found in walls of large blood vessels and certain ligaments.

Muscle Tissue

- Smooth Muscle Tissue - organ and blood vessel walls
- Skeletal Muscle Tissue - large, striated muscles packed in bundles and attached to bones for movement
- Cardiac Muscle - heart wall, involuntary striated muscle with connecting cells for synchronized contractions during heartbeat cardiac, skeletal, smooth
- Dense irregular connective tissue

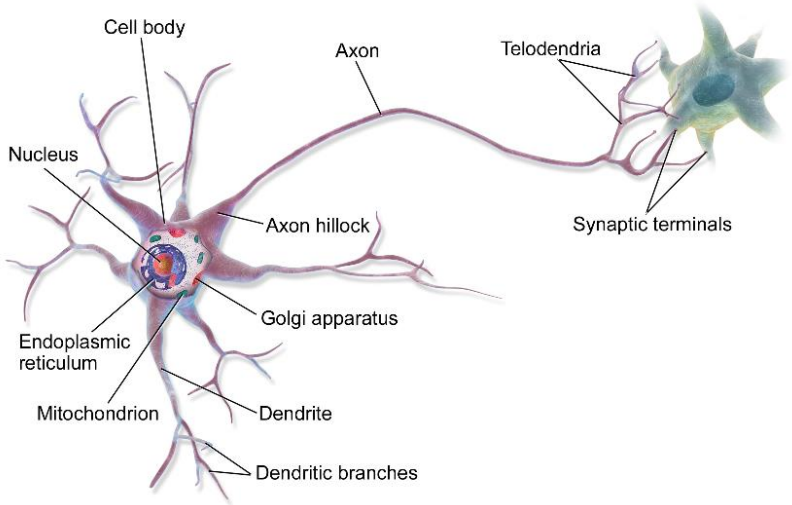
dermal tissues (skin)

Collagens

Collagen is found within the many types of connective tissue. Connective tissue is made up of a material called a matrix, with cells embedded within. The matrix can be a variety of substances, including fluid or a gel-like material.

Nerve Tissues

Within the spinal cord, there is gray and white matter holding nerves in place, as well as spinal fluid and other permeable tissues, despite their comparative lack of pigmentation; the brain is also made up of gray matter as well as white matter, with nerves embedded within.



Nerves, axons, ganglions, (neuroglial cells in the CNS include astrocytes, microglial cells, ependymal cells, and oligodendrocytes.) Two types of neuroglia found in the PNS are satellite cells and Schwann cells.

The Brain

The brain is composed primarily of 2 broad classes of cells: neurons and glial cells. Glial cells come in several types, and perform many critical functions, including structural support, metabolic support, installation, and guidance of development. In humans the cerebral cortex contains approximately 15–33 billion neurons, each connected by synapses to several thousand other neurons. Brain tissue in its natural state is very soft without any fixed structure. The brain and CNS has two kinds of tissue: grey matter and white matter - grey matter, which has a pinkish-grey color in the living brain, contains the cell bodies, dendrites and axon terminals of neurons, so it is where all synapses are. White matter is made of axons connecting different parts of grey matter to each other.

Neurons are considered to be the most important cells in the brain These neurons communicate with one another by means of long protoplasmic fibers called axons, which carry trains of signal pulses called action potentials to distant parts of the brain or body targeting specific recipient cells.

Axons transmit signals to other neurons by means of specialized junctions called synapses. The single axon may take as many as several thousand synaptic connections with other cells. When an action potential traveling along an axon arrives at a synapse, it causes a chemical called a neurotransmitter to be released. Neurotransmitter binds to receptor molecules in the membrane of the target cell.

Myelin is 80% lipid and 20% protein and formed by oligodendrocytes (type of neuroglia); (a nerve cell with a myelin sheath around its axon is called myelinated; autoimmune diseases attack myelin sheaths, degrading them and stripping axons of their myelination - these diseases are called inflammatory demyelinating.) The human brain consists of various major parts, each fulfilling highly complex functions.

Neuronal Frequencies

Groups of neurons generate oscillatory activity; Neural oscillations are observed throughout the central nervous system at all levels, and include spike trains, local field potentials and large-scale oscillations which can be measured by electroencephalography (EEG). In general, oscillations can be characterized by their frequency, amplitude and phase. Neural oscillations and synchronization in the brain have been linked to many cognitive functions such as information transfer, perception, motor control and memory. When treating upper motor neurons (the brain) and lower motor neurons (the spine), matching laser output frequencies as closely as possible to neural frequencies in targeted tissues will create RESONANCE, or harmonic field vibrations that will invariably improve energy-tissue interactions.

- Beta Waves: 15Hz to 40Hz: lower amplitude and higher frequency
- Alpha Waves: 8Hz to 15Hz: slower, and higher in amplitude
- Theta Waves: 4Hz to 8Hz: greater amplitude and slower frequency
- Delta Waves: 0.5 Hz to 2Hz; greatest amplitude and slowest
- Gamma Waves: 25Hz to 100Hz: (40Hz to 45Hz is typical) central to cognitive processing

Pulsed quantum wave energy at targeted rates will create RESONANCE – harmonic wave energy that penetrates more deeply and stimulates more effectively than out-of-phase wave energy.

Treating Blood Deficiency Syndrome

Intranasal light therapy to stimulate blood capillaries in nasal cavities is a very non-invasive method of introducing therapeutic light energy into the human body through the blood. This form of nonionizing radiation on biological systems offers health and medical benefits including effects on cognitive performance, fighting free radicals, combatting Alzheimer's symptoms and more. The FDA has approved infrared therapy for everything from eliminating viruses, bacteria, and fungi in the human body, to destruction of cancer cells.

Mitochondria are the key to photo-biomodulation. Mitochondria has a substance called cytochrome C oxidase that absorbs laser energy in the 808-980nm range, converting the photonic energy into a form of biological energy called adenosine triphosphate or ATP. Cytochrome C oxidase is commonly accepted as a photo-acceptor chromophore that catalyzes cellular level activity when therapeutic laser energy targets tissues.

Blood washing, back-transfusion therapy and intravascular laser irradiation therapy are costly dangerous medical procedures that can now be done easily, safely and inexpensively in one's own home. Compared to intravenous laser blood irradiation, nasal laser irradiation for 30 minutes will optimally improve up to 98% of the blood in the body.

The laser beam targets the nasal cavities, which is rich in blood capillaries. The device parameters have been derived from researching clinical studies on low level light therapy over the last several decades.

Why Treat the Blood

Chinese medicine's definition of Blood is different from Western medicine's definition. Yes, it's the red stuff in the veins that nourishes the organs, circulates, warms, heals and the like. However, in the eyes of Chinese medicine, Blood is enlivened with energy (Qi), which moves the blood through the body so it can nourish every aspect of our body from the skin and muscles to the brain and deep organs. It is the quality of blood circulating through our systems that helps give us vitality, focus and even rosy cheeks.

When blood is abundant, we feel alive, nourished, and well connected. Blood does more than run through our veins and oxygenate cells. It ensures we have nourishment and moisture for the entire body. Blood keeps our tendons, skin and hair healthy, strong and flexible. It lubricates joints and allows for smooth movement. Blood also nourishes the mind and is considered the material basis for mental activity. Strong Blood ensures good sleep and helps us wake feeling rested.

Modern Medicine and Laser Therapy

Laser energy at 808nm is arguably the most effective for irradiation of blood and the vascular walls. Photons at this wavelength are absorbed by hemoglobin and increase tissue oxygenation, improve microcirculation, and can change the viscosity of the blood and affect vascular endothelium.

More than 25 years of experience of using laser energy at 808nm-980nm nm has shown that these wavelengths directly influence the parameters of all cells in the blood, blood plasma, the coagulation process and all the structural components of the vascular wall.

The treatment, using photons of infrared wavelength improves the rheological characteristics of the blood and microcirculation; with normalization of parameters of hormonal, immune, reproductive and many other systems. Intranasal Laser Therapy (ILT) improves the viscosity of blood and profile of lipids thus the treatment is associated with improvements in cardiovascular and cerebrovascular diseases via improvements of the rheological properties of blood. Under laser blood irradiation, anti-inflammatory effects were observed that improved the immunologic activity of the blood.

With intravenous irradiation, medical scientists have reported that the tissue hypoxia is improved, leading to a normalization of the tissue metabolism and fibrinolysis activation. Apart from the elimination of hypoxia and the normalization of tissue metabolism, an increase of ATP-synthesis occurs with a normalization of cell membrane potential.

Laser Therapy has been investigated and used clinically for over 30 years, first in Russia, Eastern Europe and Asia, and later in North America. The ability of lasers to cut, cauterize, and destroy tissue is well known throughout the medical world; however, its role with a divergent-beam therapy handpiece is less well-known. The ability to non-thermally and non-destructively induce improvement of cellular function is known as photobiostimulation and is the basis for the current use of lasers in a number of medical fields.

The aggregating property of red blood cells was first described by John Hunter in 1786 and was long considered to be principally of pathophysiologic importance since aggregation is elevated in many disease states; hence the term “blood sledging” coined by M. H. Kinsley to describe the phenomenon.

“The apparent viscosity of blood depends on the existing shear forces (i.e., blood behaves as a non-Newtonian fluid) and is determined by hematocrit, plasma viscosity, Red Blood Cell RBC aggregation, and the mechanical properties of RBCs. RBCs are highly deformable, and this physical property significantly contributes to aiding blood flow both under bulk flow conditions and in the microcirculation,” write Drs. Baskurt and Meiselman.

One study showed transcranial and intranasal photobiomodulation (PBM) therapy in the near-infrared (NIR) 808nm wavelength improves cognition in dementia. Their protocol involved weekly, in-clinic use of a combined transcranial-plus-intranasal PBM device; and daily at-home intranasal-only PBM device. Participants reported better sleep, fewer angry outbursts, less anxiety and less wandering. After the 4-Week, No-Treatment follow-up, some declines were noted. No adverse events were related to the treatments. Results from this controlled study are the first to report significant cognitive improvement in dementia participants following PBM treatments.

Red blood cells (RBCs) exhibit a unique deformability, which enables them to change shape reversibly in response to an external force. The deformability of RBCs allows them to flow in micro-vessels while transporting oxygen and carbon dioxide. Low level laser therapy can affect the physical as well as chemical properties of blood cells which is not only helpful in preservation of blood but also in revitalizing the physically and chemically stressed erytherocytatory membranes. It was determined that the laser therapy decreases the viscosity of blood thus increasing the electrophoreticmobility of erythrocytes. The improvement in microcirculation is a result of all the above factors and dynamics.

Scientific bases and evidence support therapeutic energy irradiation of the blood for lowering high blood pressure.

Poor blood viscosity, RBC aggregation and poor rheology either independently or collectively, are linked to cardiovascular diseases. Neumann et al claim that, “Plasma viscosity and erythrocyte aggregation were more predictive of myocardial infarction (heart attack) than age, male gender, fibrinogen concentration, abnormal ECG readings, or coronary score.” Another study confirms that high blood viscosity has been associated with cardiovascular related diseases such as stroke, heart attacks and deep vein thrombosis.

There are numerous examples of light induced photochemical reactions in biological systems. Vitamin D synthesis in our skin is an example of a photochemical reaction. The power density of sunlight is only 105 mW/cm2 yet when ultraviolet B (UVB) rays strikes our skin, it converts a universally present form of cholesterol, 7-dehydrocholesterol to vitamin D3.

Cancer

The National Cancer Institute says that Lasers can be used to shrink or destroy tumors or precancerous growths. Lasers are most commonly used to treat superficial cancers (cancers on the surface of the body or the lining of internal organs) such as basal cell skin cancer and the very early stages of some cancers, such as cervical, penile, vaginal, vulvar, and non-small cell lung cancer.

The use of intravascular laser blood irradiation can be appropriate during conventional oncological treatments. Dr. Frank Andrä reported that, “Merely as a result of the sole application of intravascular laser therapy, the quantity of circulating tumor cells was reduced and the patient’s pathological immune response modulated in the direction of the standard. Intravascular laser blood irradiation changes mitochondria morphologically and activates metabolic energy processes.”

Medical researchers and oncologists around the world are using and experimenting with quantum light energy to cure cancer. There are many different techniques. Near Infrared (NIR) has been shown to induce DNA double-strand breaks and apoptosis of cancer cells. In one study, a 915nm laser was used to examine the effects of NIR on pancreatic cancer cells. Irradiation of pancreatic cancer cells using the 915nm laser significantly induced caspase-3 activation and apoptosis.

10.1 Laser Therapy Contraindications

Contraindications are generally based on prudence rather than empirical or anecdotal data and represent precautions for overall safe and effective laser therapy treatment and care.

Laser Therapy Contraindication Types:

1. ABSOLUTE
2. RELATIVE
3. ANECDOTAL/UNPROVEN
4. PRECAUTIOUS

1. Absolute Contraindications:

- Eye exposure
- Over cancer or tumor
- Over gravid uterus (see below: fact versus fiction)
- Over thyroid (see below: fact versus fiction)

2. Relative Contraindications:

- Encephalopathy
- Hypersensitivity to powerful light energy
- Over tattoos
- Patients using IR photosensitizing medications
- Patients using steroids

• Renal failure (severe)

3. Unproven Contraindications:

• Epilepsy - flashing lights at 5-10 Hz may induce seizure, when treating someone epilepsy always use pulse mode 30% duty cycle or less with frequency over 40 Hz
• Patients with Pacemaker - see below, Fact Versus Fiction
• Systemic infections - laser therapy has proven to be beneficial in dealing with systemic infections, as laser energy is inherently antimicrobial
• Un-united Epiphyseal Plate
• Un-united Fontanelles

4. Precautious Contraindications:

• Dark skin
• Hairline sensitivity
• Iodine treated wounds
• Patients using anticoagulants
• Steroid therapy
• Through dark clothing - laser energy is 'pigment oriented', darker clothing will absorb laser energy at a faster rate, leading to possible thermal hazards.

Contraindications are presented as precautions for overall safe and effective treatment and care;
An adequate history should be taken from the patient to determine if any contraindications to treatment are present. Following CORRECT treatment protocols for laser dosage will prevent some, if not all of the potential adverse responses to treatment; mild adverse reactions with normal treatment protocols may occur.

Some patients may report increased pain after the initial treatment or within 24 hours; mild bruising also may occur from pressure of the laser wand into cutaneous tissues using the laser tip in conjunction with deep tissue myofascial techniques. Mild temporary dizziness may rarely occur, most likely from the peripheral vasodilatory effect and a mild drop in blood pressure.

Laser therapy is commonly utilized for symptomatic treatment and is contraindicated when analgesia may mask progressive pathology. Laser therapy should not be employed in certain situations when the clinician would normally avoid the use of any other analgesia to retain the beneficial aspects of pain.

Class IV lasers are potentially harmful to the retina, though accidental retinal damage is highly unlikely. Both patient and practitioner must wear laser safety eyewear appropriate for the NIR wavelength.

Do not employ laser therapy over the pregnant uterus; it may be used elsewhere as indicated for conditions commonly treated by laser therapy (may be considered relative contraindication, see below)

Laser therapy should not be applied over the thyroid gland (may be considered relative contraindication, see below)

Laser-mediated vasodilatation may worsen an existing hemorrhage (may be considered relative contraindication, see below)

Laser Therapy and Big Pharma

I. Patients may suffer an increase of symptoms after treatment in conjunction with a recent steroid injection; consequently, laser therapy should not be employed within 7-days of a recent steroid injection at or near the injection site. In addition, research has suggested that it is a net zero gain for laser therapy and steroid use, because both suppress prostaglandin E-2. In addition, vasodilatation from laser

treatments may cause release of the steroid from the localized injection site. Laser therapy can also accelerate the inflammatory process in a chronic condition, which is counter-productive to the use of steroids.

II. Photosensitivity reactions from certain drugs (including many antibiotics), may be heightened by laser therapy treatments. It is recommended that patients with a history of such reactions be patch-tested for the minimum recommended treatment time.

III. Laser therapy can stimulate immune system function; immunosuppressant drugs may be counter-productive and may minimize the beneficial effects of laser therapy.

IV. Anti-inflammatory medications taken by mouth may potentially decrease the effectiveness of laser therapy; therefore, the reduction or discontinuation of anti-inflammatory medications may need to be considered to allow for the full benefits of laser treatment. In addition, patients using topical or systemic steroids or NSAIDS for pain or skin conditions may experience mild exacerbation of their symptoms; if such a reaction occurs, laser therapy should be discontinued, or applied at lower dosages.

V. Some clinical evidence suggests that certain holistic remedies, such as St. John's Wort, may elicit hypersensitivity to laser therapy; consequently, smaller laser doses should be initially applied, with a gradual increase in dosage over the next several treatments.

VI. Iodine based products may also make tissue more sensitive to light when treating wounds, requiring a lower dose.

Laser Therapy Contraindications, Fact vs. Fiction

While laser therapy has relatively few associated contraindications when compared with other therapeutic modalities, some cautions are worth noting; likewise, some contraindications are assumed when they are not—or are relative rather than absolute.

Laser Therapy and Pacemakers

The use of therapeutic laser over internal pacemakers is mistakenly considered to be contraindicated. Pacemakers are usually encased in aluminum and cannot be influenced by photonic energy, other than a slight risk of external warmth if directed laser energy is placed over the pacemaker site for at least several minutes.

Laser Therapy and Pregnancy

Pregnancy is an alleged contraindication largely because extreme caution has historically been exercised with any modality during pregnancy—especially during the first trimester. It would be prudent to avoid large doses over the pregnant uterus; however, no evidence exists to support the idea of risk in treating other regions of the body relative to the uterus. In fact, treatment of the pregnant uterus may likely yield the same benefits enjoyed by the treatment of other tissues throughout the body, although no clinical research studies have been done to either prove or disprove the theory.

While researchers observed cell damage in chicken embryos after irradiation with a HeNe laser through an opening in the egg, it is important to keep in mind that the dosage represented a very high dose of laser irradiation for the size and weight of the chicken egg compared with a human fetus inside a pregnant abdomen of an adult female. Nevertheless, it would be wise to note that if any complication occurred after using a therapeutic laser on a pregnant uterus, it would automatically be suspect and leave the clinician with the burden of proof in a lawsuit, or even worse, guilt over possibly injuring a fetus or pregnant mother.

Laser Therapy and Epilepsy

Pulsing visible red light in the 5–10 Hz range can trigger epileptic seizures. Many light therapy devices utilize flashing visible light, so it should be used with extreme caution in patients with epilepsy. There is little evidence in scientific literature about pulsing invisible (NIR) energy contraindicated in treating epileptics.

Laser Therapy and the Thyroid Gland

The thyroid gland is considered to be a delicate structure due to its relative closeness to the skin surface and its dark pigmentation, so it is prudent to avoid treating over the thyroid with therapeutic laser. Rat studies have demonstrated the development of thyroid disorders in rats treated with very large doses of NIR radiation; however, clinical studies have found that GaAs laser therapy reduced mRNA levels of thyroglobulin, changes in the cytoskeleton of thyroid cells and a reduction in thyroid hormone plasma levels. This was associated with an increase in thyroid-stimulating hormone (TSH).

Mikhailov performed an interesting study in which he utilized an 890 nm infrared laser in treating 42 patients with autoimmune thyroiditis. Each patient received 10 treatments at 2.4J/cm2. The thymus projection, vascular junction, and thyroid itself were irradiated. A control group of equivalent size was given 100mg of L-thyroxin. The clinical effect in all laser-treated patients was a decreased feeling of squeezing in the field of the thyroid, as well as a decrease in facial edema. The thyroid gland became palpably soft and decreased in size as observed on ultrasound. The number of winter colds decreased. The immunoregulatory index (Th/Ts) normalized decreasing from 7.5 to 4.2%. These effects were still observable in 78% of the patients after four months, indicating that laser therapy, at appropriate levels, was beneficial in treating patients with thyroiditis.

Children

There is concern over the treatment of children with therapeutic laser, especially over bone growth plates. Cheetham irradiated healthy growth plates in young rats. One knee of each animal in the experimental group was irradiated three times/week at 5J/cm2. The animals were examined histologically after 6 to 12 treatments. There were no observable differences between the treated group and the control group.

Renstrom successfully treated 30 children with Osgood Schlatter disease (aged 11 to 15). Their knees and lower legs were treated with a 60 mW GaAs laser at 30 Hz and 0.1J/cm2 dosage. Paolini also successfully treated 15 children with Osgood-Schlatter disease with 30 sessions of GaAs laser. These patients were compared with 15 patients who underwent conventional care including surgery. The laser group obtained the best results.

Laser Therapy and Cancer

Cancer should not be treated by anyone but an oncologist or other appropriate specialist for many reasons; U.S. regulations also forbid cancer treatment by anyone other than a cancer specialist or oncologist. Laser therapy is commonly considered to be contraindicated in patients undergoing radiation therapy, yet recent scientific research paints a more positive view. Tamachi studied the effect of therapeutic laser on cytoxin, 5-florouracil (5-FU) uptake in various experiments on rats. The rats received 6J/cm2 of HeNe laser. They demonstrated a greater uptake of cytoxin, 5-FU than a group that only received cytoxin, 5-FU. The laser irradiation caused blood vessel to dilate allowing more chemotherapy to accumulate in the lesion which allowed lower doses of anti-cancer drugs - mitochondrial tunneling may likely be responsible for this effect.

Podalskaya has used an HeNe laser on post-radiation reactions and injuries on lips and oral mucosa. This treatment has had better results than any previous treatment approaches. Soldo studied the effect of GaAs laser irradiation on murine sarcoma; there was an anti-tumor effect on small tumors probably due to

increased immune defense. Many subsequent clinical studies have shown quantum energy irradiation to be responsible for shrinking malignant tumors.

Funk investigated cytokine production after HeNe laser irradiation to cultures of human PMN cells, which were irradiated for various periods at selected intensities then stimulated with various mitogens. When these cells were stimulated after irradiation at 18.9J/cm2, significantly higher levels of all cytokines were observed. Cells that received 37.8J/cm2 of laser irradiation showed significantly decreased cytokine levels.

Laser Therapy and Diabetes

There has been debate about whether diabetes is a contraindication for therapeutic laser; almost all clinical studies have shown positive results in diabetic patients, especially in treating peripheral nerve damage. Radelli performed an experiment on rats utilizing a 904nm GaAs laser. There was no observable effect on insulin-glycemic balance.

Angiopathic Disorders

Schindl carried out thermographic studies on patients with macroangiopathic disorders. Blood flow began to improve within 15 minutes after the initiation of laser therapy and persisted for 45 minutes after ending the treatment session and a maximum temperature increase of 2.5 degrees was observed.

NOTE: The term 'LLLT' or 'Low-Level Laser Therapy' is archaic, outdated and no longer appropriate, and was randomly formulated before higher, more effective levels of photobiomodulation were discovered and utilized. Many so-called LLLT devices are actually not lasers at all, but simple LED light therapy devices. Most, if not all 'high-intensity' therapy lasers are converted or repurposed surgical, or dental lasers. In addition, the term 'Laser Therapy' itself is also misleading, as a laser is a device that generates quantum energy beams and not the energy beam itself.

Other quantum energy devices include so-called 'Super-Pulse Lasers' - manufacturers claim these devices have the power of a 'high-intensity' laser with the safety of a 'low-level' laser. There is no such thing in science as 'Super-Pulsing' – the correct terminology is 'Intense Pulsed Light'. These devices deliver energy in a short, nano-second pulse; the energy exchange of these pulses is closer to 50-70 milliWatts rather than the 25,000-50,000milliWatts claimed. Since effective energy/tissue exchanges are primarily dependent on tissue resonance, and since tissue resonance is not possible in a nano-second pulse, these devices are useless in a therapeutic environment. In addition, all of these largely-ineffective 'LLLT' and 'Super-Pulse' devices are ridiculously expensive – in many cases costing a few hundred dollars to manufacture and being sold for up to $30,000 or more, thanks to the dubious and outrageous claims made by manufacturers and resellers of these devices. The net result of so much misunderstanding and confusion in the laser therapy marketplace has led to intense frustration by clinicians and patients alike who, expecting effective therapeutic energy treatments are treated instead by a device with no more power than a classroom laser pointer. In addition, almost all 'high-intensity' lasers are highly overpriced (up to $50,000 or more). Diode lasers are fairly inexpensive to produce – and should be priced accordingly. If this were the case, many more health sufferers could have access to this wonderful therapeutic regimen that holds so much promise for the future of medicine.

Much of the misunderstanding and confusion related to laser therapy could be resolved by dropping all the pseudo-descriptive terminology and calling laser therapy for what it really is:

- Therapeutic Quantum Energy Treatment
- Photobiomodulation, or photobiostimulation Treatment
- Photomedicine Treatment
- Biomedical Photon Therapy Treatment

No matter what it is called, therapeutic laser/light energy dosage and efficacy should be determined by Primary Tissue Variability Factors (PTVF™) rather than by misleading labels such as 'low-level', 'high-intensity', and 'super-pulse'.
Paul Schwen, Executive Director, MedLaser Foundation

Randomized, Double-Blind Clinical Research Studies

Basics of the action of monochromatic visible and near IR (laser) radiation on cells
http://www.isbem.org/conf/1998/proceedi/125.pdf

A meta-analysis of the efficacy of laser phototherapy on pain relief
http://www.ncbi.nlm.nih.gov/pubmed/20842007
Objective:
Laser phototherapy has been widely used to relieve pain for more than 30 years, but its efficacy remains controversial. To ascertain the overall effect of phototherapy on pain, we aggregated the literature and subjected the studies to statistical meta-analysis.
Conclusion:
Laser phototherapy effectively relieves pain of various etiologies; making it a valuable addition to contemporary pain management armamentarium

The neurobiological basis of ADHD
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3016271/
Objective:
Attention-Deficit/Hyperactivity Disorder (ADHD) is a common, long-lasting, treatable childhood psychiatric disorder, characterized by a pattern of developmentally inappropriate inattention, motor restlessness, and impulsivity that affects approximately 5-10% of school-aged children and adults world-wide.

A meta-analysis of the efficacy of phototherapy in tissue repair
http://www.ncbi.nlm.nih.gov/pubmed/19698019
Objective:
The effect of phototherapy on tissue repair was determined by aggregating the literature and using statistical meta-analysis to analyze pertinent studies published between 2000 and 2007.
Conclusion:
These findings indicate that phototherapy is a highly effective form of treatment for tissue repair, with stronger supporting evidence resulting from experimental animal studies than human studies

Intricacies of dose in laser phototherapy for tissue repair and pain relief
https://www.ncbi.nlm.nih.gov/pubmed/19473073
Objective:
Inaccurate measurement and incorrect reporting of dosages are major shortcomings of phototherapy articles. As many as 30% of published reports in the field either lack relevant information needed to determine a dosage or report dosages that are altogether inaccurate. The high prevalence of dosage-related mistakes in published reports suggests that dosage determination errors are common among clinicians and other end-users. This special article is designed to advance understanding of the relevant parameters used in phototherapy for tissue repair and pain relief, particularly among clinicians and others who may not be completely familiar with the technology. I define and discuss five key parameters that influence dosage, including 1) radiant power, 2) radiant energy, 3) power density, 4) energy density, and 5) wavelength, and use hypothetical cases to demonstrate how factors such as beam spot size, size of lesion, mode of treatment (contact, noncontact, or scanning), frequency of treatment, dose per treatment, and cumulative dose affect dosages and treatment outcomes. The potential effects of patient-related factors,

such as etiology, pathology, tissue optical density, depth of target tissue, and skin pigmentation are discussed concurrently and strategies are suggested to improve dosage determination.
Conclusion: Pending

How to report low-level laser therapy (LLLT)/photomedicine dose and beam parameters in clinical and laboratory studies
https://www.ncbi.nlm.nih.gov/pubmed/22107486
Objective:
Dose and beam parameters are critical for successful laser, LED, and other light therapy treatments; however, in our experience, researchers frequently make critical errors and omissions when submitting papers for publication. Journals frequently publish studies with missing data, mathematical errors, and no reported verification of beam parameters. This makes reproducibility impossible, and further confounds an already complex subject.
The three commonly used dose parameters are time, energy, and energy density. In addition, more thorough reporting would include coherence, application technique (contact, projection, scanning, pressure), beam profile, and spectral width, as these may also be considered important.
Conclusion:
Reviewers should insist that the minimum eight most important beam parameters are included, and authors should take care to measure and record these accurately before, during, and after an experiment or clinical trial.

Therapeutic and Analgesic Efficacy of Laser in Conjunction With Pharmaceutical Therapy for Trigeminal Neuralgia
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5775958/
Objective:
Trigeminal neuralgia (TN) is the most common neuralgia in the head and neck region and a common cause of orofacial pain. It is routinely treated with carbamazepine. Laser, acupuncture and radiofrequency are among other treatment modalities for this condition. This study sought to assess the efficacy of laser therapy in conjunction with carbamazepine for treatment of TN.
Conclusion:
It is difficult to reach a conclusion regarding a specific dosage, wavelength or type of laser with the highest analgesic efficacy. In most cases, minimum dosage is not known and various doses have been reported for each type of laser. Selection of the most appropriate wavelength is also difficult because the conclusions have been drawn mainly based on clinical experiences of the operators, and a widely accepted protocol does not exist in this regard. For instance, it has been suggested that laser therapy activates the somatosensory receptors and decreases regional pain perception, causing relaxation at the trigger points. However, this theory does not apply to deeper trigger points. Thus, variability in the results of studies may be explained by differences in laser parameters. Further studies are required on different types, wavelengths and energy densities of laser for trigger points at different depths in patients with TN.

Potential for Transcranial Laser Therapy to Treat Stroke, Traumatic Brain Injury, and Neurodegenerative Disease
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3128319/
Objective:
Transcranial Laser Therapy has shown many benefits in the treatment of TIA, Stroke Neurodegenerative conditions, and other injuries or diseases of the brain.
Conclusion:
TLT may be thought to be just in its infancy, but we believe the stage is set for rapid growth, especially in view of the massive and continuing failure of clinical trials of pharmaceuticals for many brain disorders and neurodegenerative diseases. As the population continues to age, and the epidemic of degenerative diseases

of aging such as AD and other dementias continues to grow, TLT may make a real contribution to patient health. **Additional controlled studies with real and sham transcranial laser therapy are recommended.**

Laser therapy (810 nm) protects primary cortical neurons against excitotoxicity
https://www.ncbi.nlm.nih.gov/pubmed/24127337
Objective:
Excitotoxicity describes a pathogenic process whereby death of neurons releases large amounts of the excitatory neurotransmitter glutamate, which then proceeds to activate a set of glutamatergic receptors on neighboring neurons (glutamate, N-methyl-D-aspartate (NMDA), and kainate), opening ion channels leading to an influx of calcium ions producing mitochondrial dysfunction and cell death. Excitotoxicity contributes to brain damage after stroke, traumatic brain injury, and neurodegenerative diseases, and is also involved in spinal cord injury. We tested whether low level laser (light) therapy (LLLT) at 810 nm could protect primary murine cultured cortical neurons against excitotoxicity in vitro produced by addition of glutamate, NMDA or kainate. Although the prevention of cell death was modest but significant, LLLT (3 J/cm(2) delivered at 25 mW/cm(2) over 2 min) gave highly significant benefits in increasing ATP, raising mitochondrial membrane potential, reducing intracellular calcium concentrations, reducing oxidative stress and reducing nitric oxide. The action of LLLT in abrogating excitotoxicity may play a role in explaining its beneficial effects in diverse central nervous system pathologies.
Conclusion:
The present study has added further mechanistic insights to the scientific rationale for the use of laser therapy in brain disorders, and particularly its role after traumatic events such as stroke and TBI. The ability of laser therapy to reverse many of the adverse consequences of neuronal excitotoxicity, in combination with its known ability to lower inflammation, increase angiogenesis and act as a neuroprotective agent should encourage its much wider use in these applications.

NEUROSCIENCE/ LASER THERAPY: Laser therapy boosts cognitive function following brain injury
https://www.bioopticsworld.com/articles/2011/05/neuroscience-low-level-laser-therapy-led-therapy-boosts-cognitive-function-following-brain-injury.html
Objective:
Research newly published in Photomedicine and Laser Surgery (doi:10.1089/pho.2010.2814) details the first case reports documenting improved cognitive function in chronic traumatic brain injury (TBI) patients treated with transcranial light-emitting diodes (LEDs), and concludes that controlled studies are warranted. The study reports the application of red and near-infrared LEDs, applied transcranially to forehead and scalp areas of two patients. The studies used MedX Health's (Mississauga, ON, Canada) model 1100 LED console device, a cluster-head of 2.1 inches in diameter containing 52 near-infrared (870 nm) and nine red (633 nm) diodes for a total optical output power of 500 mW (±20%) continuous wave.
Conclusion:
Patient 1 began the low-level laser therapy (LLLT) seven years after closed-head TBI from a motor vehicle accident, at a time when her ability for sustained attention (computer work) was just 20 minutes. After eight weekly treatments (applied bilaterally for between 5 and 13 minutes), her sustained attention time increased to three hours. She has now performed nightly home treatments for five years. Patient 2 had a history of closed-head trauma (sports/military and recent fall), and magnetic resonance imaging showed frontoparietal atrophy. When she began the LED treatment, she had been on medical disability for five months. After four months of nightly LED treatments at home, she was able to discontinue medical disability and return to working full-time. Neuropsychological testing after nine months of LED treatment indicated significant improvement in executive function (inhibition, inhibition accuracy) and memory, as well as reduction in post-traumatic stress disorder. These patients' cognitive gains decreased if they stopped treatment for one to two weeks, and returned when treatment was restarted. The findings will provide a basis for future therapeutic use of phototherapy, according to Raymond J. Lanzafame, editor-in-chief of Photomedicine and Laser Surgery. "The development of novel therapies to restore function after neurologic

injury, stroke, or disease is an increasingly important goal in medical research as a result of an increase in non-fatal traumatic wounds and the increasing prevalence of dementias and other degenerative disorders in our aging population," he explains.

Treating cognitive impairment with transcranial laser therapy
https://www.ncbi.nlm.nih.gov/pubmed/28219828
Objective:
This report examines the potential of laser therapy (LLLT) to alter brain cell function and neurometabolic pathways using red or near infrared (NIR) wavelengths transcranially for the prevention and treatment of cognitive impairment. Although laser therapy on human tissue has been used for a number of medical conditions since the late 1960s, it is only recently that several clinical studies have shown its value in raising neurometabolic energy levels that can improve cerebral hemodynamics and cognitive abilities in humans. The rationale for this approach, as indicated in this report, is supported by growing evidence that neurodegenerative damage and cognitive impairment during advanced aging is accelerated or triggered by a neuronal energy crisis generated by brain hypoperfusion. We have previously proposed that chronic brain hypoperfusion in the elderly can worsen in the presence of one or more vascular risk factors, including hypertension, cardiac disease, atherosclerosis and diabetes type 2. Although many unanswered questions remain, boosting neurometabolic activity through non-invasive transcranial laser biostimulation of neuronal mitochondria may be a valuable tool in preventing or delaying age-related cognitive decline that can lead to dementia, including its two major subtypes, Alzheimer's and vascular dementia.
Conclusion:
The technology to achieve significant improvement of cognitive dysfunction using laser therapy or variations of this technique is moving fast and may signal a new chapter in the treatment and prevention of neurocognitive disorders.

Transcranial laser stimulation improves human cerebral oxygenation
https://www.ncbi.nlm.nih.gov/pubmed/26817446
Objective:
Transcranial laser stimulation of the brain with near-infrared light is a novel form of non-invasive photobiomodulation or low-level laser therapy (LLLT) that has shown therapeutic potential in a variety of neurological and psychological conditions. Understanding of its neurophysiological effects is essential for mechanistic study and treatment evaluation. This study investigated how transcranial laser stimulation influences cerebral hemodynamics and oxygenation in the human brain in vivo using functional near-infrared spectroscopy (fNIRS).
Results:
In both experiments, transcranial laser stimulation induced an increase of oxygenated hemoglobin concentration (Δ[HbO2]) and a decrease of deoxygenated hemoglobin concentration (Δ[Hb]) in both cerebral hemispheres. Improvements in cerebral oxygenation were indicated by a significant increase of differential hemoglobin concentration (Δ[HbD] = Δ[HbO2] - Δ[Hb]). These effects increased in a dose-dependent manner over time during laser stimulation (10 minutes) and persisted after laser stimulation (6 minutes). The total hemoglobin concentration (Δ[HbT] = Δ[HbO2] + Δ[Hb]) remained nearly unchanged in most cases.
Conclusion:
Near-infrared laser stimulation applied to the forehead can transcranially improve cerebral oxygenation in healthy humans.

Cerebral Perfusion Enhancing Interventions: A New Strategy for the Prevention of Alzheimer Dementia
https://www.ncbi.nlm.nih.gov/pubmed/27324946
Objective: Cardiovascular and cerebrovascular diseases are major risk factors in the development of cognitive impairment and Alzheimer's disease (AD). These cardio-cerebral disorders promote a variety of

vascular risk factors which in the presence of advancing age are prone to markedly reduce cerebral perfusion and create a neuronal energy crisis. Long-term hypoperfusion of the brain evolves mainly from cardiac structural pathology and brain vascular insufficiency. Brain hypoperfusion in the elderly is strongly associated with the development of mild cognitive impairment (MCI) and both conditions are presumed to be precursors of Alzheimer dementia. A therapeutic target to prevent or treat MCI and consequently reduce the incidence of AD aims to elevate cerebral perfusion using novel pharmacological agents. As reviewed here, the experimental pharmaca include the use of Rho kinase inhibitors, neurometabolic energy boosters, sirtuins and vascular growth factors. In addition, a compelling new technique in laser medicine called photobiomodulation is reviewed.

Conclusion:

Photobiomodulation is based on the use of low level laser therapy to stimulate mitochondrial energy production non-invasively in nerve cells. The use of novel pharmaca and photobiomodulation may become important tools in the treatment or prevention of cognitive decline that can lead to dementia.

See 'The Bowel and Beyond: the Enteric Nervous System in Neurological Disorders'

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5005185/

Objective:

The enteric nervous system (ENS) is large, complex and uniquely able to orchestrate gastrointestinal behavior independently of the central nervous system (CNS). An intact ENS is essential for life and ENS dysfunction is often linked to digestive disorders. The part the ENS plays in neurological disorders, as a portal or participant, has also become increasingly evident. ENS structure and neurochemistry resemble that of the CNS, therefore pathogenic mechanisms that give rise to CNS disorders might also lead to ENS dysfunction, and nerves that interconnect the ENS and CNS can be conduits for disease spread. We review evidence for ENS dysfunction in the atiopathogenesis of autism spectrum disorder, amyotrophic lateral sclerosis, transmissible spongiform encephalopathies, Parkinson disease and Alzheimer disease. In addition, the neurotropic pathogen, varicella zoster virus (VZV), unexpectedly establishes latency in enteric and other autonomic neurons that do not innervate skin. VZV reactivation in these neurons produces no rash and is therefore a clandestine cause of gastrointestinal disease, meningitis and strokes. The gut–brain alliance has raised consciousness as a contributor to health, but a gut–brain axis that contributes to disease merits equal attention.

Conclusions:

The major site of integrative neuronal activity is the brain; however, the functions of the bowel are so complex that evolution has provided the gut with an intrinsic nervous system that can uniquely provide the necessary regulation of enteric behavior and integration of multiple sensory inputs independently from the CNS. Details of the control of enteric behavior have been delegated to the ENS. This 'peripheralization' has freed the brain from providing space for the hundreds of millions of neurons that are housed in the bowel, and eliminated a need for vast numbers of nerve fibers to connect these neurons to the gut. Still, despite the potential independence of the ENS, the brain and gut are connected and, for better or worse, able to influence one another (FIG. 4). In health, this complex mutual inter-relationship works well, but disorders of the CNS might have enteric manifestations and could even be acquired from the gut. Many developmental mechanisms that operate in CNS formation are also operative in ENS ontogeny, and the two nervous systems share a considerable degree of cellular and molecular identity. Several conditions that are commonly thought to be CNS disorders, such as TSE, ASD, PD, AD and ALS have enteric consequences. Additionally, many gastrointestinal disorders, such as IBS, chronic intestinal pseudo-obstruction and gastroparesis, are idiopathic. One fairly common cause of occult gastrointestinal disease is infection with VZV, which has been diagnosed infrequently due to lack of previous consideration. Other such conditions probably exist. Further exploration of brain–gut disease with molecular tools and the application of genetic approaches, including reverse phenotyping, will probably shrink the current idiopathic category of gastrointestinal disease and enlarge that of disorders common to the CNS and the ENS.

Laser therapy (LLLT) reduces oxidative stress in primary cortical neurons
https://www.ncbi.nlm.nih.gov/pubmed/23281261
Objective:
Low-level laser (light) therapy (LLLT) involves absorption of photons being in the mitochondria of cells leading to improvement in electron transport, increased mitochondrial membrane potential (MMP), and greater ATP production. Low levels of reactive oxygen species (ROS) are produced by LLLT in normal cells that are beneficial. We exposed primary cultured murine cortical neurons to oxidative stressors: hydrogen peroxide, cobalt chloride and rotenone in the presence or absence of LLLT (3 J/cm², CW, 810 nm wavelength laser, 20 mW/cm²). Cell viability was determined by Prestoblue™ assay. ROS in mitochondria was detected using Mito-sox, while ROS in cytoplasm was detected with CellRox™. MMP was measured with tetramethylrhodamine. In normal neurons LLLT elevated MMP and increased ROS.
Conclusion:
In oxidatively-stressed cells LLLT increased MMP but reduced high ROS levels and protected cultured cortical neurons from death. Although LLLT increases ROS in normal neurons, it reduces ROS in oxidatively-stressed neurons. In both cases MMP is increased. These data may explain how LLLT can reduce clinical oxidative stress in various lesions while increasing ROS in cells in vitro.

Photobiomodulation of Pain in Carpal Tunnel Syndrome: Review of Seven Laser Therapy Studies
https://www.liebertpub.com/doi/10.1089/pho.2006.24.101
Objective:
In this review, seven studies using photoradiation to treat carpal tunnel syndrome (CTS) are discussed: two controlled studies that observed real laser to have a better effect than sham laser, to treat CTS; three open protocol studies that observed real laser to have a beneficial effect to treat CTS; and two studies that did not observe real laser to have a better effect than a control condition, to treat CTS. In the five studies that observed beneficial effect from real laser, higher laser dosages (9 Joules, 12–30 Joules, 32 J/cm2, 225 J/cm2) were used at the primary treatment sites (median nerve at the wrist, or cervical neck area), than dosages in the two studies where real laser was not observed to have a better effect than a control condition (1.8 Joules or 6 J/cm2). The average success rate across the first five studies was 84% (SD, 8.9; total hands = 171). The average pain duration prior to successful photoirradiation was 2 years.
Conclusion:
Photoirradiation is a promising new, conservative treatment for mild/moderate CTS cases; It is cost-effective compared to current treatments.

Low-level laser therapy for wound healing: mechanism and efficacy
https://www.ncbi.nlm.nih.gov/pubmed/15841638
Objective:
In examining the effects of LLLT on cell cultures in vitro, some articles report an increase in cell proliferation and collagen production using specific and somewhat arbitrary laser settings with the helium neon (HeNe) and gallium arsenide lasers, but none of the available studies address the mechanism, whether photothermal, photochemical, or photomechanical, whereby LLLT may be exerting its effect. Some studies, especially those using HeNe lasers, report improvements in surgical wound healing in a rodent model; however, these results have not been duplicated in animals such as pigs, which have skin that more closely resembles that of humans. In humans, beneficial effects on superficial wound healing found in small case series have not been replicated in larger studies.
Conclusion:
To better understand the utility of laser therapy in cutaneous wound healing, good clinical studies that correlate cellular effects and biologic processes are needed. Future studies should be well-controlled investigations with rational selection of lasers and treatment parameters. In the absence of such studies, the literature does not appear to support widespread use of LLLT in wound healing at this time. Although applications of high-energy (10-100 W) lasers are well established with significant supportive literature and

widespread use, conflicting studies in the literature have limited low-level laser therapy (LLLT) use in the United States to investigational use only. Yet LLLT is used clinically in many other areas, including Canada, Europe, and Asia, for the treatment of various neurologic, chiropractic, dental, and dermatologic disorders. To understand this discrepancy, it is useful to review the studies on LLLT that have, to date, precluded Food and Drug Administration approval of many such technologies in the United States. The fundamental question is whether there is sufficient evidence to support the use of LLLT. (LLLT, or Low Level Laser Therapy does not recognize Primary Tissue Variability Factors, and is therefore ineffective.

Quantum Energy Antimicrobial Effects

http://www.healinglightseminars.com/laser-research-library/antimicrobial-effects/

Objective:

UVC light has long been known to be highly germicidal but has not been much developed as a therapy for infections. This study investigated the potential of UVC light for the prophylaxis of infections developing in highly contaminated superficial cutaneous wounds. In vitro studies demonstrated that the pathogenic bacteria Pseudomonas aeruginosa and Staphylococcus aureus were inactivated at UVC light exposures much lower than those needed for a similar effect on mammalian keratinocytes. Mouse models of partial-thickness skin abrasions infected with bioluminescent P. aeruginosa and S. aureus were developed. Approximately 10(7) bacterial cells were inoculated onto wounds measuring 1.2 by 1.2 cm on the dorsal surfaces of mice. UVC light was delivered at 30 min after bacterial inoculation. It was found that for both bacterial infections, UVC light at a single radiant exposure of 2.59 J/cm(2) reduced the bacterial burden in the infected mouse wounds by approximately 10-fold in comparison to those in untreated mouse wounds ($P < 0.00001$). Furthermore, UVC light increased the survival rate of mice infected with P. aeruginosa by 58.3% ($P = 0.0023$) and increased the wound healing rate in mice infected with S. aureus by 31.2% ($P < 0.00001$). DNA lesions were observed in the UVC light-treated mouse wounds; however, the lesions were extensively repaired by 48 h after UVC light exposure. These results suggested that UVC light may be used for the prophylaxis of cutaneous wound infections.

Conclusion:

Chemical antibacterial agents are increasingly being used in prophylactic and therapeutic regimes for plaque-related diseases. As these agents can be rendered ineffective by the development of resistance in the target organisms there is a need to develop alternative antimicrobial approaches. Light from high-power lasers is known to be bactericidal and investigations have shown that it is effective against organisms implicated in caries and inflammatory periodontal diseases. However, the adverse effects of such light on dental hard tissues argue against its use solely as an antibacterial agent. Although light from low-power lasers has no adverse effect on bacterial viability, bacteria can be sensitized to killing by such light by prior treatment with a chemical photosensitizing agent. Lethal photosensitization of a wide range of cariogenic and periodontopathogenic bacteria has been demonstrated using light from a helium/neon or gallium aluminum arsenide laser in conjunction with a dye such as toluidine blue or aluminum disulphonated phthalocyanine as a photosensitizer. The advantages of the technique are that killing is achieved in very short periods of time (< 60 s), resistance development in the target bacteria would be unlikely and damage to adjacent host tissues can be avoided. This approach may be a useful alternative to antibiotics and antiseptics in eliminating cariogenic and periodontopathogenic bacteria from disease lesions.

Evaluation Of Laser Therapy In Reducing Diabetic Polyneuropathy Related Pain And Sensorimotor Disorders

http://acta.tums.ac.ir/index.php/acta/article/view/4395

Objective:

Over the past three decades physicians have used light level laser therapy (LLLT) for the management and the treatment of diabetic peripheral neuropathy and have obtained results that calls for further investigations. This study aimed to investigate the effectiveness of LLLT in treatment of pain symptoms in patients with diabetic polyneuropathy. In this study 60 patients with diabetic peripheral neuropathy were

matched based on their sex, age, BMI, type of diabetes, duration of diabetes, and duration of pain, and randomized to case and control groups based on their established scores on the visual analog scale (VAS) and the Toronto clinical scoring system (TCSS). Cases received laser therapy with wavelength of 78 nm and 2.5 j/cm2 two times a week, each time for 5 min, for one month. During the same period, controls received sham laser therapy. Comparing the differences between the two groups' VAS and TCSS mean scores before the intervention with that of the 2 weeks and 4 weeks after the intervention we were able to see a statistically significant difference between the two groups ($P<0.05$). On the other hand, when we compared their VAS and TCSS mean scores 4 weeks and 2 weeks after the intervention we did not find any statistically significant difference between the two groups. We achieved the same results when we examined cases' and controls' pre and post VAS and TCSS scores independent from each other; no improvement in the assessment based on their 2 and 4 weeks comparisons tests. Laser therapy resulted in improved neuropathy outcomes in diabetic patients who received it relative to the group that received sham therapy, evaluating before and after LLLT assessments.

Conclusion:

Further studies are needed to test types of lasers, as well as different dosage and exposure levels required in different phase of neuropathic care, so as to obtain reproducible results.

The molecular mechanisms of the antimicrobial properties of laser processed nano-particles

https://www.research.manchester.ac.uk/portal/files/68670907/FULL_TEXT.PDF

Objective:

Microbial resistance to the current available antibiotics is considered a global health problem, especially for the Multi-Drug Resistant pathogens (MDR) including methicillin resistant Staphylococcus aureus. Recently nanoparticles (NPs) have been involved in variety of antimicrobial applications due to their unique properties of antibacterial effects. However, the molecular mechanisms behind their antibacterial activity are still not fully understood.

Conclusion:

In this study, we produced silver Ag NPs (average size 27 nm) and silverTitanium Ag-TiO2 NPs (average size 47 nm) using picosecond laser ablation. Our results showed that both laser NPs had obvious size-dependent antibacterial activity. The laser Ag NPs with a size of 19 nm and Ag-TiO2 NPs with a size 20 nm presented the highest bactericidal effect. The laser generated Ag and Ag-TiO2 NPs with concentrations 20, 30, 40, and 50 µg/ml showed strong antibacterial effect against three bacterial strains: E. coli, P. aeruginosa, and S. aureus, and induced the generation of reactive oxygen species (ROS), lead to cell membrane interruption, lipid peroxidation, DNA damages, glutathione depletion and the eventual cell death. Both types of laser NPs at two concentrations (2.5 and 20 µg/ml) showed low cytotoxicity to the in vitro cultured five types of human cells originated from the lung (A549), kidney (HEK293), Liver (HepG2), skin (HDFc) and blood vessel cells (hCAECs). The antibacterial activity of the laser generated Ag and Ag-TiO2 NPs had lasted for over one year depending on the degree of air exposure and storage conditions. Frequent air exposure increased particle oxidation and reduced the antibacterial durability of the laser generated Ag NPs. The laser generated Ag NPs had lower antibacterial activity when stored in cold compared to that stored at room temperature. The antibacterial activity of laser generated Ag and Ag-TiO2 NPs were also compared with four types of commercial based-silver wound dressings (Acticoat TM, Aquacel® Ag, Contreet ® Foam, and Urgotul® SSD) against E. coli to inform future application in this area. In conclusion, laser generated Ag and Ag-TiO2 NPs have strong bactericidal effect and low toxicity to human cells which could be a type of promising antibacterial agents for future hygiene and medical applications.

The neurobiological basis of ADHD

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3016271/

Attention-Deficit/Hyperactivity Disorder is not a single pathophysiological entity and appears to have a complex etiology. There are multiple genetic and environmental risk factors with small individual effect that act in concert to create a spectrum of neurobiological liability. ADHD is not a single pathophysiological

entity and appears to have a complex etiology. Multiple genetic and environmental factors act together to create a spectrum of neurobiological liability. Convergent data from neuroimaging, neuropsychology, genetics and neurochemical studies consistently point to the involvement of the frontostriatal network as a likely contributor to the pathophysiology of ADHD. This network involves the lateral prefrontal cortex, the dorsal anterior cingulate cortex and the caudate nucleus and putamen [39]. Functional neuroimaging has provided new ways to examine the pathophysiology of ADHD, has shown widespread dysfunction in neural systems involving the prefrontal, striatal, and parietal brain regions, and has led to a brain model of deficits in multiple developmental pathways. Molecular genetic studies support dysregulation of neurotransmitter systems as the basis of genetic susceptibility to the disorder.

Lasers and photodynamic therapy in the treatment of onychomycosis: a review of the literature
https://escholarship.org/uc/item/0js6z1kw
Objective:
Onychomycosis is a widespread problem. Oral antifungal medications are currently the gold standard of care, but treatment failure is common and oral therapy is contraindicated in many cases. There is a need for effective treatment without the systemic complications posed by oral therapy. Laser and photodynamic therapy may have the potential to treat onychomycosis locally without adverse systemic effects; some small studies have even reported achieving clinical and mycologic cure. However, there is reason for restraint; these therapies are expensive and time-consuming. Furthermore, they may not be covered by insurance and have not been proven effective with randomized, controlled clinical trials.
Conclusion:
This paper will review current literature regarding the use of laser and photodynamic therapy as potential treatments for onychomycosis.

A Systematic Review With Procedural Assessments and Meta-analysis of Laser Therapy in Lateral Elbow Tendinopathy (Tennis Elbow)
https://www.medscape.org/viewarticle/579379
Objective:
Recent reviews have indicated that low level level laser therapy (LLLT) is ineffective in lateral elbow tendinopathy (LET) without assessing validity of treatment procedures and doses or the influence of prior steroid injections.
Conclusion:
LLLT administered with optimal doses of 904 nm and possibly 632 nm wavelengths directly to the lateral elbow tendon insertions, seem to offer short-term pain relief and less disability in LET, both alone and in conjunction with an exercise regimen. This finding contradicts the conclusions of previous reviews which failed to assess treatment procedures, wavelengths and optimal doses.

Effect of Laser Therapy on Bone Regeneration During Osseointegration and Bone Graft
https://www.ncbi.nlm.nih.gov/pubmed/28742438
Objective:
The effect of low-level laser therapy (LLLT) on bone regeneration during osseointegration and bone graft is very controversial. Despite many positive reports of in vitro and in vivo studies and more than 50 randomized clinical trials claiming a positive effect of photobiomodulation (PBM), many reports found no significant effect of lasers.
Conclusion:
A positive effect of low-level laser energy on bone regeneration within a certain relationship between dose and output power was found. LLLT stimulates cellular metabolism, increasing protein synthesis and subsequent bone regeneration. A high dose combined with low power or a low dose combined with high power appears to produce a positive effect.

Efficacy laser therapy in the treatment of Bell's palsy: a randomized double-blind placebo-controlled trial.

https://www.ncbi.nlm.nih.gov/pubmed/23709010

Objective:

The aim of the present study was to investigate and compare the effects of high intensity laser therapy (HILT) and low-level laser therapy (LLLT) on the treatment of patients with Bell's palsy. Forty-eight patients participated in and completed this study. The mean age was 43 ± 9.8 years. They were randomly assigned into three groups: HILT group, LLLT group, and exercise group. All patients were treated with facial massage and exercises, but the HILT and LLLT groups received the respective laser therapy. The grade of facial recovery was assessed by the facial disability scale (FDI) and the House-Brackmann scale (HBS). Evaluation was carried out 3 and 6 weeks after treatment for all patients. Laser treatments included eight points on the affected side of the face three times a week for 6 successive weeks. FDI and HBS were used to assess the grade of recovery. The scores of both FDI and HBS were taken before as well as 3 and 6 weeks after treatment. The Friedman test and Wilcoxon signed ranks test were used to compare the FDI and HBS scores within each group. The result showed that both HILT and LLLT significantly improved the recovery of patients with Bell's palsy. Moreover, HILT was the most effective treatment modality compared to LLLT and massage with exercises.

Conclusion:

Both HILT and LLLT can be effective physical therapy modalities for the recovery of patients with Bell's palsy, with HILT showing a greater improvement than LLLT.

Efficacy of high intensity laser therapy in the management of foot ulcers: a systematic review

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6181666/

Objective:

The aim of this systematic review was to assess the efficacy of high intensity laser therapy (HILT) on wound surface area in patients with foot ulcers. [Methods] Four databases including PubMed, MEDLINE, the Cochrane library, and the Physiotherapy Evidence Database (PEDro) were searched up to the end of April 2018 to identify relevant studies. Studies were included if they met the following criteria: randomized controlled trial (RCT), assessed the efficacy of HILT in patients with foot ulcers, evaluated wound surface area, and written in English language with available full text. The PEDro scale was used to evaluate the quality of studies. [Results] A total of three RCTs met the inclusion criteria, with two studies of the efficacy of HILT in adult patients with diabetic foot ulcers and one in spina bifida children with neuropathic foot ulce

rs. According to the PEDro scale assessment, all three studies were rated as a fair quality. All studies found that HILT provided significantly better outcomes compared to sham laser or standard medical therapy.

Conclusion:

This systematic review suggests that HILT is an effective modality for wound healing in patients with foot ulcers, but further large-scale studies are required to confirm its efficacy.

Effective Laser Therapy On Proliferation And Differentiation Of The Cells Contributing And Bone Regeneration

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4281990/

Objective:

Low level laser therapy (LLLT) also known as photobiomodulation, is a treatment that uses low-level lasers or light-emitting diodes (LEDs) to change cellular function and is a clinically well accepted tool in regenerative medicine and dentistry. Considering the variety of laser, exposure, cells and study types, the exact effects of low-level laser therapy seems to be unclear. The aim of this study was to review the data published in the field of the effects of low-level laser therapy on proliferation and differentiation of the cells contributing in bone regeneration

Conclusion:

Low level laser with low-energy density range appears to exert a biostimulatory effect on bone tissue, enhance osteoblastic proliferation and differentiation on cell lines used in in vitro studies. Despite the fact that many researches have been recently done on the effects of LLLT on different cell lines, without knowing the precise mechanism and effects, we are not able to offer a clinical treatment protocol. This paper is a beginning to help further progress and extend practical use of LLLT in future.

The effects of high intensity laser therapy on pain and function in patients with knee osteoarthritis
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5140828/
Objective:
The purpose of this study was to examine the effects of high intensity laser therapy (HILT) on pain and function in patients with knee osteoarthritis
Conclusion:
High intensity laser therapy is considered an effective non-surgical intervention for reducing pain in patients with knee osteoarthritis and helping them to perform daily activities.

Effects of high intensity laser therapy on pain and function of patients with chronic back pain
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5468204/
Objective:
This study examined the effects of High Intensity Laser Therapy on pain and function of patients with chronic back pain.
Conclusion:
In this study, VAS and ODI significantly decreased in a within-group comparison of CPTG and HLTG ($p<0.05$). In a between-group comparison after the treatment, VAS and ODI of HLTG were significantly lower than CPTG… This study has several limitations. First, the number of subjects was small. The sample only included patients who visited our hospital during one four-week period. Second, we could not perfectly control the daily routine of the subjects. Third, as the treatment duration was short, we could not check the long-term effects. We believe that many new studies on the effects of HILT will be required in order to complement the limitations of this study.

The efficacy of laser therapy in tissue repair and pain control: a meta-analysis study
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15345176&query_hl=10&itool=pubmed_DocSum
Objective:
We used statistical meta-analysis to determine the overall treatment effects of laser phototherapy on tissue repair and pain relief.
Conclusion:
These findings mandate the conclusion that laser phototherapy is a highly effective therapeutic modality for tissue repair and pain relief

The Effects of Photobiomodulation of 808 nm Diode Laser Therapy at Higher Fluence on the in Vitro Osteogenic Differentiation of Bone Marrow Stromal Cells
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5829029/
Objective:
The literature has supported the concept of mesenchymal stromal cells (MSCs) in bone regeneration as one of the most important applications in oro-maxillofacial reconstructions. However, the fate of the transplanted cells and their effects on the clinical outcome is still uncertain. Photobiomodulation (PBM) plays an important role in the acceleration of tissue regeneration and potential repair. The aim of this in vitro study is to evaluate the effectiveness of PBM with 808 nm diode laser therapy, using a flat-top hand-piece delivery system at a higher-fluence (64 J/cm2) irradiation (1 W, continuous-wave) on bone marrow stromal cells (BMSCs).

Conclusion:
The data prove for the first time that 808 nm diode laser irradiation, delivered by the flat-top hand-piece at the higher-fluence and -power of 64 J/cm2 and 1 W (CW) respectively, promotes BMSCs differentiation toward osteogenesis. Within the limits of our evaluation, our results suggest an additional possible laser effect based on its ability to increase TGFβ synthesis and to facilitate osteoblast differentiation by creating an anti-inflammatory effect on bone marrow stroma cells.

Efficacy of laser therapy in the management of neck pain: a systematic review and meta-analysis of randomized placebo or active-treatment controlled trials
http://www.ncbi.nlm.nih.gov/pubmed/19913903
Objective:
Neck pain is a common and costly condition for which pharmacological management has limited evidence of efficacy and side-effects. Low-level laser therapy (LLLT) is a relatively uncommon, non-invasive treatment for neck pain, in which non-thermal laser irradiation is applied to sites of pain. We did a systematic review and meta-analysis of randomized controlled trials to assess the efficacy of LLLT in neck pain.
Conclusion:
We show that LLLT reduces pain immediately after treatment in acute neck pain and up to 22 weeks after completion of treatment in patients with chronic neck pain.

Efficacy of 904 nm gallium arsenide laser therapy in the management of chronic myofascial pain in the neck: a double-blind and randomize-controlled trial
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15389743&query_hl=18&itool=pubmed_DocSum
Objective:
A prospective, double-blind, randomized, and controlled trial was conducted in patients with chronic myofascial pain syndrome (MPS) in the neck to evaluate the effects of infrared low level 904 nm Gallium-Arsenide (Ga-As) laser therapy (LLLT) on clinical and quality of life (QoL).
Conclusion:
This study revealed that short-period application of LLLT is effective in pain relief and in the improvement of functional ability and QoL in patients with MPS.

Efficacy laser therapy in the management of neck pain: a systematic review and meta-analysis of randomized placebo or active-treatment controlled trials
http://www.ncbi.nlm.nih.gov/pubmed/19913903?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=27
Objective:
Neck pain is a common and costly condition for which pharmacological management has limited evidence of efficacy and side-effects. Low-level laser therapy (LLLT) is a relatively uncommon, non-invasive treatment for neck pain, in which non-thermal laser irradiation is applied to sites of pain. We did a systematic review and meta-analysis of randomized controlled trials to assess the efficacy of LLLT in neck pain.
Conclusion:
We show that LLLT reduces pain immediately after treatment in acute neck pain and up to 22 weeks after completion of treatment in patients with chronic neck pain.

In chronic low back pain, laser therapy combined with exercise is more beneficial than exercise alone in the long term: a randomized trial
http://www.ncbi.nlm.nih.gov/pubmed/17725472?ordinalpos=2&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum

Objective:
Is laser therapy an effective adjuvant intervention for chronic low back pain?
Conclusion:
In chronic low back pain laser therapy combined with exercise is more beneficial than exercise alone in the long term

The effect of laser irradiation for nucleus pulposus: an experimental study.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15845216&query_hl=18&itool=pubmed_DocSum
Objective:
The radicular pain caused by disc herniation can be explained by two mechanisms: the compression of the nerve root by the herniated disc or the irritation of the nerve root due to chemical factors. Percutaneous laser disc decompression (PLDD) was introduced for the treatment of lumbar disc hernias in the 1980s. Decompression of the nerve root is assumed to be an effective therapeutic mechanism for PLDD. However, laser irradiation might reduce the chemical factors that cause nerve root irritation by altering intra-disc proteins. We used nerve conduction velocities (NCV) and levels of two chemical factors to evaluate the differences between the two groups in this in vivo study.
Conclusion:
One of the mechanisms thought to be responsible for PLDD's effectiveness is a decrease in the chemical factors through protein alteration in the intervertebral disc by laser irradiation.

The Effect of Laser Therapy on Trismus and Facial Swelling Following Surgical Extraction of a Lower Third Molar
http://www.ncbi.nlm.nih.gov/pubmed/19196113?ordinalpos=1&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
Objective:
The purpose of this study was to evaluate the effect of low-level laser therapy (LLLT) on postoperative trismus and edema after the removal of mandibular third molars.
Conclusion:
Within the limitations of this study it can be concluded that LLLT can be beneficial for the reduction of postoperative trismus and swelling after third molar surgery.

Laser technology in orthopedics: preliminary study on laser therapy to improve the bone-biomaterial interface
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=11831596&query_hl=10&itool=pubmed_DocSum
Objective:
Low Power Laser (LPL) seems to enhance the healing of bone defects and fractures. The effect of LPL in other orthopedic areas such as osteointegration of implanted prosthetic bone devices is still unclear. In the present study, 12 rabbits were used to evaluate whether Ga-Al-As (780 nm) LPL stimulation has positive effects on osteointegration. Hydroxyapatite (HA) cylindrical nails were drilled into both distal femurs of rabbits. From postoperative day 1 and for 5 consecutive days, the left femura of all rabbits were given LPL treatment (Laser Group-LG) with the following parameters: 300 Joule/cm2, 1 Watt, 300 Hertz, pulsating emission, 10 minutes. The right femura were sham-treated (Control Group-CG). At 4 and 8 weeks after implantation, histologic and histomorphometric investigations evaluated bone-biomaterial-contact. Histomorphometry showed a higher degree of osteointegration at the HA-bone interface in the LG Group at 4 ($p < 0.0005$) and 8 weeks ($p < 0.001$). These preliminary positive results seem to support the hypothesis that LPL treatment can be considered a good tool to enhance the bone-implant interface in orthopedic surgery.
Conclusion:

These preliminary positive results seem to support the hypothesis that LPL treatment can be considered a good tool to enhance the bone-implant interface in orthopedic surgery

Effect of laser therapy on attachment, proliferation and differentiation of human osteoblast-like cells cultured on titanium implant material

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15621240&query_hl=18&itool=pubmed_DocSum

Objective:

The aim of this in vitro study was to investigate the effect of low-level laser therapy (LLLT) on the attachment, proliferation, differentiation and production of transforming growth factor-ss(1) (TGF-beta(1)) by human osteoblast-like cells (HOB). Cells derived from human mandibular bone were exposed to GaAlAs diode laser at dosages of 1.5 or 3 J/cm(2) and then seeded onto titanium discs. Non-irradiated cultures served as controls. After 1, 3 and 24h, cells were stained and the attached cells were counted under a light microscope. In order to investigate the effect of LLLT on cell proliferation after 48, 72 and 96 h, cells were cultured on titanium specimens for 24h and then exposed to laser irradiation for three consecutive days. Specific alkaline phosphatase activity and the ability of the cells to synthesize osteocalcin after 10 days were investigated using p-nitrophenylphosphate as a substrate and the ELSA-OST-NAT immunoradiometric kit, respectively. Cellular production of TGF-beta(1) was measured by an enzyme-linked immunosorbent assay (ELISA), using commercially available kits. LLLT significantly enhanced cellular attachment ($P<0.05$). Greater cell proliferation in the irradiated groups was observed first after 96 h. Osteocalcin synthesis and TGF-beta(1) production were significantly greater ($P<0.05$) on the samples exposed to 3 J/cm(2). However, alkaline phosphatase activity did not differ significantly among the three groups. These results showed that in response to LLLT, HOB cultured on titanium implant material had a tendency towards increased cellular attachment, proliferation, differentiation and production of TGF-beta(1), indicating that in vitro LLLT can modulate the activity of cells and tissues surrounding implant material.

Conclusion:

These results showed that in response to LLLT, HOB cultured on titanium implant material had a tendency towards increased cellular attachment, proliferation, differentiation and production of TGF-beta(1), indicating that in vitro LLLT can modulate the activity of cells and tissues surrounding implant material.

Laser therapy accelerates initial attachment and subsequent behavior of human oral fibroblasts cultured on titanium implant material. A scanning electron microscope and histomorphometric analysis

http://www.ncbi.nlm.nih.gov/pubmed/15777326?ordinalpos=5&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum

Objective:

The aim of the study was to investigate the effect of low-level laser therapy (LLLT) on attachment and proliferation of human gingival fibroblasts (HGF) cultured on titanium implant material. HGF were exposed to gallium-aluminum-arsenide diode laser at dosages of 1.5 or 3 J/cm(2) and then cultured on commercially pure titanium discs. Cell profile areas were measured after 1, 3 and 24 h, using scanning electron microscopy and an automatic image analyzer. The results were expressed as percentage of attachment. In order to investigate the effect of LLLT on cellular growth after 8 and 10 days, HGF were cultured on titanium discs for 24 h and then exposed to laser irradiation on 3 consecutive days. Colony-forming efficiency (CFE) and clonal growth rates (CGR) were measured. Cell viability was determined by Hoechst and prodidium iodide staining. Non-lased cultures served as controls. Morphologically, the cells spread well on all titanium surfaces, indicating good attachment by both irradiated and non-irradiated cells. Fibroblasts exposed to laser irradiation had significantly higher percentages of cell attachment than the non-exposed cells ($P<0.05$). CFE and CGR were also enhanced for the irradiated cells ($P<0.05$). Cell viability was high (>90%) in the irradiated and control groups, without significant differences. It is

concluded that in vitro laser therapy enhances the attachment and proliferation of HGF on titanium implant material.

Conclusion:
It is concluded that in vitro LLLT enhances the attachment and proliferation of human gingival fibroblasts on titanium implant material.

The role of laser biostimulation in early post-surgery rehabilitation and its effect on wound healing
http://www.ncbi.nlm.nih.gov/pubmed/20203347
Objective:
Low energy infrared laser radiation had a beneficial effect on the covering of the scar with stratified squamous cornifying epithelium and intensified wound healing.
Conclusion:
The gross and microscopic findings indicated a beneficial effect of laser stimulation on wound healing. These results underscore the utility of biostimulation lasers in the early post-operative period. Physio-mechanical investigations did not reveal an effect of infrared laser biostimulation on the breaking strength of the cutaneous scar.

Effects of Low-Level Laser Therapy on Pain and Scar Formation after Inguinal Herniation Surgery: A Randomized Controlled Single-Blind Study
http://www.ncbi.nlm.nih.gov/pubmed/19821701?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=62
Objective:
The aim of this study was to investigate the efficacy of an infrared GaAlAs laser operating with a wavelength of 830 nm in the postsurgical scarring process after inguinal-hernia surgery.
Conclusion:
Infra-red LLLT (830 nm) applied after inguinal-hernia surgery was effective in preventing the formation of keloids. In addition, LLLT resulted in better scar appearance and quality 6-month post surgery.

Laser therapy for implants without initial stability
http://www.ncbi.nlm.nih.gov/pubmed/19860572?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=48
Objective:
This study evaluated the effect of low-level infrared laser on removal torque values of implants with poor initial stability inserted in rabbit tibias.
Conclusion:
In this study, low-level laser therapy promoted the osseointegration of implants with poor initial stability, particularly in the initial stages of bone healing

The efficacy of laser therapy in wound repair: a meta-analysis of the literature.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15315732&query_hl=10&itool=pubmed_DocSum
Objective:
We determined the overall effects of laser therapy on tissue healing by aggregating the literature and subjecting studies meeting the inclusion and exclusion criteria to statistical meta-analysis
Conclusion:
We conclude that laser therapy is an effective tool for promoting wound repair.

The effect of laser irradiation on implant-tissue interaction - In vivo and in vitro studies
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15906852&query_hl=10&itool=pubmed_docsum

Objective:
Laser Therapy is increasingly used in medicine and dentistry. It has been suggested that Laser Therapy may be beneficial in the management of many different medical conditions, including pain, wound healing and nerve injury. The present thesis is based on a series of in vivo and in vitro experimental studies investigating whether Laser Therapy has the potential to enhance titanium-implant interaction. Information about Laser Therapy's effect on bone healing is fundamental to understand whether Laser Therapy may improve implant-tissue interaction. In the initial study (I), the effect of LT on bone healing and growth in rat calvarial bone defects was investigated. It was found that LT may accelerate metabolism and/or mineralization during early bone healing. Based on these findings, study II explored the hypothesis that LT can enhance implant integration in the rabbit tibial bone. It was shown that Laser Therapy stimulated the mechanical strength of the interface between the implant and bone after a healing period of 8 weeks. Histomorphometrical and mineral analyses showed that the irradiated implants had greater bone-to-implant contact than the controls. In the in vitro experiments, cellular responses to Laser Therapy were studied in two cell types: primary cultures of human gingival fibroblasts and human osteoblast-like cells, with special reference to attachment, proliferation, differentiation and production of transforming growth factor beta1 (TGF-beta1). The objectives of studies III & IV were to develop a standardized, reproducible in vitro model for testing a GaAlAs diode laser device and to document the influence of single or multiple doses of Laser Therapy, as a guide to defining the optimal laser dose for enhancing cell activity. A further objective was to investigate the effect of Laser Therapy on initial attachment and subsequent behavior of human gingival fibroblasts cultured on titanium. While both multiple doses (1.5 and 3 J/cm2) and a single dose (3 J/cm2) enhanced cellular attachment, proliferation increased only after multiple doses (1.5 and 3 J/cm2). Study V concerned the response to Laser Therapy of osteoblast-like cells, derived from human alveolar bone cultured on titanium implant material. In this study Laser Therapy significantly enhanced cellular attachment. Greater cell proliferation in the irradiated groups was observed first after 96 h indicating that the cellular response is dose dependent. Osteocalcin synthesis and TGF-beta1 production were significantly stimulated on the samples exposed to 3 J/cm2. The following conclusions are drawn from the results of these five studies: Laser Therapy can promote bone healing and bone mineralization and thus may be clinically beneficial in promoting bone formation in skeletal defects. It may be also used as additional treatment for accelerating implant healing in bone. Laser Therapy can modulate the primary steps in cellular attachment and growth on titanium surfaces. Multiple doses of Laser Therapy can improve Laser Therapy efficacy, accelerate the initial attachment and alter the behavior of human gingival fibroblasts cultured on titanium surfaces. The use of Laser Therapy at the range of doses between 1.5 and 3 J/cm2 may modulate the activity of cells interacting with an implant, thereby enhancing tissue healing and ultimate implant success.
Conclusion:
Laser Therapy can promote bone healing and bone mineralization and thus may be clinically beneficial in promoting bone formation in skeletal defects. It may be also used as additional treatment for accelerating implant healing in bone. LASER THERAPY can modulate the primary steps in cellular attachment and growth on titanium surfaces. Multiple doses of Laser Therapy can improve efficacy, accelerate the initial attachment and alter the behavior of human gingival fibroblasts cultured on titanium surfaces.

The effects of laser therapy on both HIV-1 infected and uninfected TZM-bl cells
https://www.ncbi.nlm.nih.gov/pubmed/28128530
Objective:
Human immunodeficiency virus (HIV-1) infection remains a major health problem despite the use of highly active antiretroviral therapy (HAART), which has greatly reduced mortality rates. Due to the unavailability of an effective vaccine and treatment that would completely eradicate the virus in infected individuals, the quest for new therapies continues. Laser therapy involves the exposure of cells to low levels of red or infrared light. Laser Therapy has been widely used in different medical conditions, but not in HIV-1 infection.

This study aimed to determine the effects of LLLT on HIV-1 infected and uninfected TZM-bl cells. Both infected and uninfected cells were irradiated at a wavelength of 660 nm with different fluences from 2 J/cm2 to 10 J/cm2.

Conclusion:

Changes in cellular responses were assessed using cell morphology, viability, proliferation, cytotoxicity and luciferase activity assays. Upon data analysis, uninfected irradiated cells showed no changes in cell morphology, viability, proliferation and cytotoxicity, while the infected irradiated cells did. In addition, laser irradiation reduced luciferase activity in infected cells. Finally, laser irradiation had no inhibitory effect in uninfected cells, whereas it induced cell damage in a dose dependent manner in infected cells.

Dose response effects of 810 nm laser light on mouse primary cortical neurons

https://www.ncbi.nlm.nih.gov/pubmed/21956634

Objective:

In the past four decades numerous studies have reported the efficacy of low level light (laser) therapy (LLLT) as a treatment for diverse diseases and injuries. Recent studies have shown that LLLT can biomodulate processes in the central nervous system and has been extensively studied as a stroke treatment. However there is still a lack of knowledge on the effects of LLLT at the cellular level in neurons. The present study aimed to study the effect of 810 nm laser on several cellular processes in primary cortical neurons cultured from embryonic mouse brains.

Conclusion:

Light induced a significant increase in calcium, ATP and MMP at lower fluences and a decrease at higher fluences. ROS was significantly induced at low fluences, followed by a decrease and a second larger increase at 30 J/cm(2). Nitric oxide levels showed a similar pattern of a double peak but values were less significant compared to ROS. The results suggest that laser therapy at lower fluences is capable of inducing mediators of cell signaling processes which in turn may be responsible for the beneficial stimulatory effects of laser therapy.

A meta-analysis of the efficacy of laser phototherapy on pain relief

https://www.ncbi.nlm.nih.gov/pubmed/20842007

Objective:

Laser phototherapy has been widely used to relieve pain for more than 30 years, but its efficacy remains controversial. To ascertain the overall effect of phototherapy on pain, we aggregated the literature and subjected the studies to statistical meta-analysis.

Conclusion:

These findings warrant the conclusion that laser phototherapy effectively relieves pain of various etiologies; making it a valuable addition to contemporary pain management armamentarium.

Role of laser therapy in neurorehabilitation

https://www.ncbi.nlm.nih.gov/pubmed/21172691

Objective:

In recent years, LLLT has become an increasingly mainstream modality, especially in the areas of physical medicine and rehabilitation. At first used mainly for wound healing and pain relief, the medical applications of LLLT have broadened to include diseases such as stroke, myocardial infarction, and degenerative or traumatic brain disorders. This review will cover the mechanisms of LLLT that operate both on a cellular and a tissue level. Mitochondria are thought to be the principal photoreceptors, and increased adenosine triphosphate, reactive oxygen species, intracellular calcium, and release of nitric oxide are the initial events. Activation of transcription factors then leads to expression of many protective, anti-apoptotic, anti-oxidant, and pro-proliferation gene products. Animal studies and human clinical trials

of LLLT for indications with relevance to neurology, such as stroke, traumatic brain injury, degenerative brain disease, spinal cord injury, and peripheral nerve regeneration, will be covered.

Conclusion:

Laser Therapy is steadily moving into mainstream medical practice. As the Western populations continue to age, the incidence of the degenerative diseases of old age will only continue to increase and produce severe financial and societal burden. Moreover, despite the best efforts of "big pharma," distrust of pharmaceuticals is growing in general because of uncertain efficacy and troublesome adverse effects. Laser therapy has no reported adverse effects, and no reports of adverse events can be directly attributed to laser or light therapy. We believe that the high benefit-risk ratio of laser therapy should be better appreciated by medical professionals in the rehabilitation and physical medicine specialties. The introduction of safe and affordable therapy laser devices will lead to many home-use photomedical applications. The particular benefits of LLLT to both the central and peripheral nervous systems suggest that much wider use of quantum energy medicine could or should be made in cases of both brain diseases and injuries.

Low-Intensity Laser Therapy is an Effective Treatment for Recurrent Herpes Simplex Infection. Results from a Randomized Double-Blind Placebo-Controlled Study

https://www.sciencedirect.com/science/article/pii/S0022202X15405652

Objective:

Recurrent infection with herpes simplex virus is a common disease. Recently, alternative therapies have been introduced. Among those, low-intensity laser therapy mainly used for the acceleration of wound healing and in pain therapy has previously been shown to be of benefit in herpes zoster infections. In this study we evaluated the influence of low-intensity laser therapy (wavelength 690 nm, intensity: 80 mW per cm2, dose: 48 J per cm2) in 50 patients with recurrent perioral herpes simplex infection (at least once per month for more than 6 mo) in a randomized, double-blind placebo-controlled trial design. Patients in the laser group received daily irradiations for 2 wk, whereas patients in the placebo group were sham-irradiated.

Conclusion:

After completion of the laser/sham treatment, patients were asked to return to the Department of Dermatology, University of Vienna Medical School at the time of recurrence. All except two patients completed the study and were monitored for 52 wk. The median recurrence-free interval in the laser-treated group was 37.5 wk (range: 2–52 wk) and in the placebo group 3 wk (range: 1–20 wk). This difference was found to be statistically significant ($p < 0.0001$; Wilcoxon's Rank Sum Test). In conclusion, we demonstrated that a total of 10 irradiations with low-intensity laser therapy significantly lowers the incidence of local recurrence of herpes simplex infection. Since this athermic phototherapeutic modality represents a safe, noninvasive treatment, it might be considered as an alternative to established therapeutic regimens in this indication.

Low-level laser therapy (LLLT) efficacy in post-operative wounds

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15782037&query_hl=10&itool=pubmed_docsum

Objective:

The aim of this paper was to investigate the efficacy of low-level laser radiation (LLLR) with wavelength of 904 nm on the stimulation of the healing process of postoperative aseptic wounds (early scar).

Conclusion:

LLLR with wavelength of 904 nm to stimulate postoperative aseptic wounds (early scar) is efficient in both cases of cutting plague.

Low Level Laser Therapy (LLLT) as an Effective Therapeutic Modality for Delayed Wound Healing

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=16387711&query_hl=18&itool=pubmed_DocSum

Objective:
Low level laser therapy (LLLT) is a form of phototherapy that involves the application of low power monochromatic and coherent light to injuries and lesions. It has been used successfully to induce wound healing in nonhealing defects. Other wounds treated with lasers include burns, amputation injuries, skin grafts, infected wounds, and trapping injuries. The unique properties of lasers create an enormous potential for specific therapy of skin diseases.
Conclusion:
As with any new device, the most efficacious and appropriate use requires an understanding of the mechanisms of light interaction with tissue as well as the properties of the laser itself.

Efficacy of laser therapy in reducing postoperative pain after endodontic surgery-- a randomized double blind clinical study
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=14758818&query_hl=18&itool=pubmed_DocSum
Objective:
Conclusion:
Laser therapy can be beneficial for the reduction of postoperative pain

Effect of low-level laser treatment on neurosensory deficits subsequent to sagittal split ramus osteotomy
http://www.ncbi.nlm.nih.gov/pubmed/8863301?ordinalpos=5&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
Objective:
Conclusion:
In conclusion GaAlAs low-level laser treatment results in both a subjective and objective improvement in mechanical sensory perception in long-standing neurosensory deficit in the inferior alveolar nerve.

Increased fibroblast proliferation induced by light emitting diode and low power laser irradiation
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=12928819&query_hl=18&itool=pubmed_DocSum
Objective:
Conclusion:
LED and LLL irradiation resulted in an increased fibroblast proliferation in vitro; this study therefore postulates possible stimulatory effects on wound healing in vivo at the applied dosimetric parameters.

Wound healing of animal and human body sport and traffic accident injuries using low-level laser therapy treatment: a randomized clinical study of seventy-four patients with control group
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=11800105&query_hl=10&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
In addition to accelerated wound healing, the main advantages of LLLT for postoperative sport- and traffic-related injuries include prevention of side effects of drugs, significantly accelerated functional recovery, earlier return to work, training and sport competition compared to the control group of patients, and cost benefit.

A randomized, placebo-controlled trial of low level laser therapy for activated Achilles tendonitis with microdialysis measurement of peritendinous prostaglandin E2 concentrations

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=16371497&query_hl=29&itool=pubmed_docsum
OBJECTIVE:
CONCLUSION:
LLLT at a dose of 5.4 J per point can reduce inflammation and pain in activated Achilles tendonitis. LLLT may therefore have potential in the management of diseases with an inflammatory component.

Low Level Laser treatment of tendinopathy: A Systematic Review with Meta-analysis
http://www.ncbi.nlm.nih.gov/pubmed/19708800?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=90
OBJECTIVE:
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.

Low-Level Laser Therapy Facilitates Superficial Wound Healing in Humans: A Triple-Blind, Sham-Controlled Study
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15496990&query_hl=39&itool=pubmed_docsum
OBJECTIVE:
CONCLUSIONS:
The LLLT resulted in enhanced healing as measured by wound contraction. The untreated wounds in subjects treated with LLLT contracted more than the wounds in the sham group, so LLLT may produce an indirect healing effect on surrounding tissues. These data indicate that LLLT is an effective modality to facilitate wound contraction of partial-thickness wounds.

Effect of NASA light-emitting diode irradiation on wound healing
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=11776448&query_hl=7&itool=pubmed_docsum
OBJECTIVE:
CONCLUSION:
We believe that the use of NASA LED for light therapy alone, and in conjunction with hyperbaric oxygen, will greatly enhance the natural wound healing process, and more quickly return the patient to a preinjury/illness level of activity. This work is supported and managed through the NASA Marshall Space Flight Center-SBIR Program.

Carpal tunnel syndrome pain treated with low-level laser and microamperes transcutaneous electric nerve stimulation: A controlled study
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=12098159&query_hl=29&itool=pubmed_docsum
OBJECTIVE:
CONCLUSIONS:
This new, conservative treatment was effective in treating CTS pain; larger studies are recommended. Copyright 2002 by the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

Treatment of carpal tunnel syndrome by low-level laser versus open carpal tunnel release

http://www.ncbi.nlm.nih.gov/pubmed/17334675?ordinalpos=1&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_Discovery_RA&linkpos=2&log$=relatedarticles&logdbfrom=pubmed
OBJECTIVE:
CONCLUSION:
LLLT has proven to be an effective and noninvasive treatment modality for CTS especially for early and mild-to-moderate cases when pain is the main presenting symptom. However, surgery could be preserved for advanced and chronic cases. Refinement of laser tools and introduction of other wavelengths could make LLLT for CTS treatment a field for further investigations.

The effects of low level laser in clinical outcome and neurophysiological results of carpal tunnel syndrome
http://www.ncbi.nlm.nih.gov/pubmed/18754533?ordinalpos=8&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSIONS:
Laser therapy as a new conservative treatment is effective in treating CTS paresthesia and numbness and improves the subjects' power of hand grip and electrophysiological parameters.

Photobiomodulaion of pain in carpal tunnel syndrome: review of seven laser therapy studies
http://www.ncbi.nlm.nih.gov/pubmed/16706688?ordinalpos=1&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DiscoveryPanel.Pubmed_Discovery_RA&linkpos=5&log$=relatedreviews&logdbfrom=pubmed
OBJECTIVE:
CONCLUSIONS
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.

Efficacy of different therapy regimes of low-power laser in painful osteoarthritis of the knee: a double-blind and randomized-controlled trial
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=14677160&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
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.

The effect of low-level laser in knee osteoarthritis: a double-blind, randomized, placebo-controlled trial
http://www.ncbi.nlm.nih.gov/pubmed/19530911?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=145
OBJECTIVE:
CONCLUSION:
Our results show that LLLT reduces pain in KOA and improves microcirculation in the irradiated area.

Low level laser therapy (Classes I, II and III) for treating osteoarthritis
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15266461&query_hl=62&itool=pubmed_DocSum
OBJECTIVE:

CONCLUSIONS:
For OA, the results are conflicting in different studies and may depend on the method of application and other features of the LLLT application. Clinicians and researchers should consistently report the characteristics of the LLLT device and the application techniques used. New trials on LLLT should make use of standardized, validated outcomes. Despite some positive findings, this meta-analysis lacked data on how LLLT effectiveness is affected by four important factors: wavelength, treatment duration of LLLT, dosage and site of application over nerves instead of joints. There is clearly a need to investigate the effects of these factors on LLLT effectiveness for OA in randomized controlled clinical trials.

The effect of low-level laser in knee osteoarthritis: a double-blind, randomized, placebo-controlled trial
http://www.ncbi.nlm.nih.gov/pubmed/19530911
OBJECTIVE:
CONCLUSION:
Our results show that LLLT reduces pain in KOA and improves microcirculation in the irradiated area

Low-power laser treatment in patients with frozen shoulder: preliminary results
http://www.ncbi.nlm.nih.gov/pubmed/18341417?ordinalpos=34&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSIONS:
The results suggested that laser treatment was more effective in reducing pain and disability scores than placebo at the end of the treatment period, as well as at follow-up.

Low-level laser therapy is an important tool to treat disorders of the maxillofacial region
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=OBJECTIVEPlus&list_uids=9796491&query_hl=1&itool=pubmed_docsum
OBJECTIVE:
CONCLUSIONS:
These results confirm that LLLT is an effective tool and is beneficial for the treatment of many disorders of the maxillofacial region.

Low-level laser therapy in the management of disorders of the maxillofacial region
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=OBJECTIVEPlus&list_uids=9612167&query_hl=1&itool=pubmed_docsum
OBJECTIVE:
CONCLUSIONS:
These preliminary results indicate that LLLT is an important tool and brings many benefits for the treatment of many disorders of the maxillofacial region.

Laser application effects on the bite strength of the masseter muscle, as an orofacial pain treatment
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=*16144479&query_hl=18&itool=pubmed_DocSum*
OBJECTIVE:
CONCLUSIONS:
These results suggest that low-level laser application is an effective tool for the treatment of patients with oral facial pain

Effectiveness of low-level laser therapy in temporomandibular disorder
OBJECTIVE:

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=12737331&query_hl=18&itool=pubmed_DocSum
CONCLUSION:
Low-level laser therapy can be considered as an alternative physical modality in the management of temporomandibular disorder.

Effectiveness of low-level laser therapy in temporomandibular joint disorders: a placebo-controlled study
http://www.ncbi.nlm.nih.gov/pubmed/17803388?ordinalpos=164&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSION:
The results suggest that LLLT (application of 10 J/cm(2) and 15 J/cm(2)) can be considered as a useful method for the treatment of TMD-related pain, especially long lasting pain.

Low intensity laser application in temporomandibular disorders: a phase I double-blind study
http://www.ncbi.nlm.nih.gov/pubmed/17696035?ordinalpos=174&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSION:
Results show that low intensity laser is an effective therapy for the pain control of subjects with TMD.

Arthralgia of the temporomandibular joint and low-level laser therapy
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=OBJECTIVEPlus&list_uids=16942435&query_hl=1&itool=pubmed_docsum
OBJECTIVE:
CONCLUSION:
This study showed the effectiveness of complex non-invasive treatment in patients with arthralgia of the TMJ. The analgesic and anti-inflammatory effects of LLLT were confirmed by infrared thermography.

Low intensity laser therapy in temporomandibular disorder: a phase II double-blind study
OBJECTIVE:
CONCLUSION:

http://www.ncbi.nlm.nih.gov/pubmed/19004308?ordinalpos=12&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
Low intensity laser application is effective in reducing TMD symptoms, and has influence over masticatory efficiency [Ev2 (0.2423) and Ev3 (0.2043), observed in the interaction Evaluations x Probes for effective dosage].

Management of mouth opening in patients with temporomandibular disorders through low-level laser therapy and transcutaneous electrical neural stimulation
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=OBJECTIVEPlus&list_uids=16503788&query_hl=1&itool=pubmed_docsum
OBJECTIVE:
CONCLUSION:
A significant improvement in the range of motion for both therapies was observed immediately after treatment. Comparing the two methods, the values obtained after LLLT were significantly higher than

those obtained after TENS ($p < 0.01$). CONCLUSIONS: Both methods are effective to improve mouth opening. Comparing the two methods, LLLT was more effective than TENS applications.

Effectiveness of low-level laser therapy in temporomandibular disorder
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=pubmed&cmd=Retrieve&dopt=OBJECTIVEPlus&list_uids=12737331&query_hl=1&itool=pubmed_docsum
OBJECTIVE:
CONCLUSION:
Low-level laser therapy can be considered as an alternative physical modality in the management of temporomandibular disorder.

Measurements of jaw movements and temporomandibular joint pain intensity in patients treated with GaAlAs laser
http://www.ncbi.nlm.nih.gov/pubmed/20976388
OBJECTIVE:
CONCLUSION:
Laser application can be a supportive therapy in the treatment of TMD, since it resulted in the immediate decrease of painful symptoms and increased range of mandibular movements in the treated group. The same results were not observed in the placebo group.

A systematic review of laser therapy with location-specific doses for pain from chronic joint disorders
http://www.ncbi.nlm.nih.gov/pubmed/12775206?ordinalpos=20&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum

OBJECTIVE:
CONCLUSION:
Low level laser therapy with the suggested dose range significantly reduces pain and improves health status in chronic joint disorders, but the heterogeneity in patient samples, treatment procedures and trial design calls for cautious interpretation of the results.

Efficacy of low power laser therapy in fibromyalgia: a single-blind, placebo-controlled trial
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=11845369&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
Our study suggests that laser therapy is effective on pain, muscle spasm, morning stiffness, and total tender point number in fibromyalgia and suggests that this therapy method is a safe and effective way of treatment in the cases with fibromyalgia.

Low level laser therapy in primary Raynaud's phenomenon--results of a placebo controlled, double blind intervention study
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15570642&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
Low level laser therapy reduces frequency and severity of Raynaud attacks. The effect is most pronounced in patients with signs of decreased threshold for vasospasm and less effective in patients with delayed hyperemia.

Therapeutic Effects of Low-Level Laser on Lateral Epicondylitis from Differential Interventions of Chinese-Western Medicine: Systematic Review
http://www.ncbi.nlm.nih.gov/pubmed/19874256?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=22
OBJECTIVE:
CONCLUSION:
We suggest that using LLLT on tender points or MTrPs of LE could effectively improve therapeutic effects.

Effects of 904-nm low-level laser therapy in the management of lateral epicondylitis: a randomized controlled trial
http://www.ncbi.nlm.nih.gov/pubmed/17508839?ordinalpos=7&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSION:
This study revealed that LLLT in addition to exercise is effective in relieving pain, and in improving the grip strength and subjective rating of physical function of patients with lateral epicondylitis.

Treatment of medial and lateral epicondylitis--tennis and golfer's elbow--with low level laser therapy: a multicenter double blind, placebo-controlled clinical study on 324 patients
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=9743652&query_hl=18&itool=pubmed_DocSum

OBJECTIVE:
CONCLUSIONS:
This clinical study has demonstrated that the best results are obtained using combination treatment (i.e., TPs and scanner technique). Good results are obtained from adequate treatment technique correctly applied, individual energy doses, adequate medical education, clinical experience, and correct approach of laser therapists. We observed that under- and overirradiation dosage can result in the absence of positive therapy effects or even opposite, negative (e.g., inhibitory) effects. The current clinical study provides further evidence of the efficacy of LLLT in the management of lateral and medial epicondylitis.

A systematic review with procedural assessments and meta-analysis of low level laser therapy in lateral elbow tendinopathy (tennis elbow)
http://www.ncbi.nlm.nih.gov/pubmed/18510742?ordinalpos=7&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSION:
LLLT administered with optimal doses of 904 nm and possibly 632 nm wavelengths directly to the lateral elbow tendon insertions, seem to offer short-term pain relief and less disability in LET, both alone and in conjunction with an exercise regimen. This finding contradicts the conclusions of previous reviews which failed to assess treatment procedures, wavelengths and optimal doses.

Effects of low-level laser and plyometric exercises in the treatment of lateral epicondylitis
http://www.ncbi.nlm.nih.gov/pubmed/17603862?ordinalpos=20&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSION:
The results suggested that the combination of laser with plyometric exercises was more effective treatment than placebo laser with the same plyometric exercises at the end of the treatment as well as at

the follow-up. Future studies are needed to establish the relative and absolute effectiveness of the above protocol.

Low-level laser therapy with trigger points technique: a clinical study on 243 patients
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=9456632&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
Results measured according to VAS/VRS/PTM: in acute pain, diminished more than 70%; in chronic pain more than 60%. Clinical effectiveness (success or failure) depends on the correctly applied energy dose--over/underdosage produces opposite, negative effects on cellular metabolism. We did not observe any negative effects on the human body and the use of analgesic drugs could be reduced or completely excluded. LLLT suggests that the laser beam can be used as monotherapy or as a supplementary treatment to other therapeutic procedures for pain treatment.

Efficacy of laser therapy in myofascial pain syndrome: an algometric and thermographic evaluation
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=14677161&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSIONS:
LLLT seemed to be beneficial for pain in MPS by using algometry and thermography.

Laser phototherapy (780 nm), a new modality in treatment of long-term incomplete peripheral nerve injury: a randomized double-blind placebo-controlled study.
http://www.ncbi.nlm.nih.gov/pubmed/17975958?ordinalpos=44&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSION:
This pilot study suggests that in patients with long-term peripheral nerve injury noninvasive 780-nm laser phototherapy can progressively improve nerve function, which leads to significant functional recovery.

Efficacy of laser therapy on neurosensory recovery after injury to the inferior alveolar nerve
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=16480503&query_hl=18&itool=pubmed_docsum
OBJECTIVE:
CONCLUSION:
Low level laser therapy seemed to be conducive to the reduction of long-standing sensory nerve impairment following third molar surgery. Further studies are worthwhile regarding the clinical application of this treatment modality

Pain relief by single low-level laser irradiation in orthodontic patients undergoing fixed appliance therapy
http://www.ncbi.nlm.nih.gov/pubmed/16979496?ordinalpos=22&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_DefaultReportPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSIONS:
LLLT immediately after multi-banding reduced the prevalence of pain perception at 6 and 30 hours. LLLT might have positive effects in orthodontic patients not only immediately after multibanding, but also for preventing pain during treatment.

The effect of low-level Nd:YAG laser energy on adult articular cartilage in vitro
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=1550649&query_hl=10&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
These findings indicate that exposure to low-level noncontact Nd:YAG laser energy promotes a significant stimulation of cartilage matrix synthesis. However, a single exposure may not be sufficient to promote a sustained upregulation of cartilage metabolism.

Low level laser therapy (Classes I, II and III) for treating rheumatoid arthritis.
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=16235295&query_hl=62&itool=pubmed_docsum
OBJECTIVE:
CONCLUSION:
LLLT could be considered for short-term treatment for relief of pain and morning stiffness for RA patients, particularly since it has few side-effects. Clinicians and researchers should consistently report the characteristics of the LLLT device and the application techniques used. New trials on LLLT should make use of standardized, validated outcomes. Despite some positive findings, this meta-analysis lacked data on how LLLT effectiveness is affected by four important factors: wavelength, treatment duration of LLLT, dosage and site of application over nerves instead of joints. There is clearly a need to investigate the effects of these factors on LLLT effectiveness for RA in randomized controlled clinical trials.

The role of laser fluence in cell viability, proliferation, and membrane integrity of wounded human skin fibroblasts following helium-neon laser irradiation
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=16444694&query_hl=18&itool=pubmed_docsum
OBJECTIVE:
CONCLUSIONS: Results show that 5 J/cm(2) stimulates mitochondrial activity, which leads to normalization of cell function and ultimately stimulates cell proliferation and migration of wounded fibroblasts to accelerate wound closure. Laser irradiation can modify cellular processes in a dose or fluence (J/cm(2)) dependent manner.

Low-power laser treatment in patients with frozen shoulder: preliminary results
http://www.ncbi.nlm.nih.gov/pubmed/18341417?ordinalpos=44&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSIONS:
The results suggested that laser treatment was more effective in reducing pain and disability scores than placebo at the end of the treatment period, as well as at follow-up

Effects Of High Intensity Laser Therapy For Reduction Of Arthritis
OBJECTIVE:

Effects Of Laser Therapy On Neurovascular Function
OBJECTIVE:

Efficacy Of High Intensity Laser Therapy In The Treatment Of Males With Osteoporosi
OBJECTIVE:

The effects of low level laser therapy on both HIV-1 infected and uninfected TZM-bl cells
https://www.ncbi.nlm.nih.gov/pubmed/28128530?report=OBJECTIVE
OBJECTIVE:

Fibromyalgia Treatment: A New and Efficient Proposal of Technology and Methodological - A Case Report
https://www.omicsonline.org/open-access/fibromyalgia-treatment-a-new-and-efficient-proposal-of-technology-and-methodological--a-case-report-2165-7025-1000379-98191.html

Effectiveness of low-level laser therapy on pain intensity, pressure pain threshold, and SF-MPQ indexes of women with myofascial pain
https://www.ncbi.nlm.nih.gov/pubmed/28054261
OBJECTIVE:
CONCLUSION:

Low-level laser therapy to treat fibromyalgia
https://www.ncbi.nlm.nih.gov/pubmed/24801056
OBJECTIVE:
CONCLUSION:

Treatment of drug-resistant fibromyalgia symptoms using high-intensity laser therapy: a case-based review
https://www.ncbi.nlm.nih.gov/pubmed/29080932
OBJECTIVE:
CONCLUSION:

https://www.liebertpub.com/doi/abs/10.1089/acm.2011.0398#
OBJECTIVE: This study evaluated the effects of Class IV laser therapy on pain, Fibromyalgia (FM) impact, and physical function in women diagnosed with FM.
CONCLUSION:

Latest Science Shows Traumatic Brain Injury Can Be Targeted Effectively With Near-Infrared Laser
http://www.tbi.care/2015/07/latest-science-shows-traumatic-brain-injury-can-be-targeted-effectively-with-near-infrared-laser/

What happens when photons enter the body
https://www.youtube.com/watch?v=huX6G48f3kM

Particle Physics – What is a Photon?
https://www.youtube.com/watch?v=EVAKRL0mhZc

Effect of Laser Therapy On Neurovascular Function Of Diabetic Peripheral Neuropathy
https://ac.els-cdn.com/S2090123211000361/1-s2.0-S2090123211000361-main.pdf?_tid=7c55a66f-0199-4ebc-a6c8-d0b3a3f7ea1e&acdnat=1520308378_6ea0d1ae6bd231f8f9e4943aad845919
OBJECTIVE:
CONCLUSION:

Case Study: Use of Vibration Therapy In The Treatment Of Diabetic Peripheral Small Fiber Neuropathy

(NOTE: high-speed vibration therapy is indicated as an effective adjunct to HI LT)
https://ac.els-cdn.com/S1877593411000117/1-s2.0-S1877593411000117-main.pdf?_tid=d9ef0879-09cc-41ec-bf0f-b420c5773d2a&acdnat=1520308904_9b38385c4c28aa9c764ce68ac6b409c7
OBJECTIVE:
CONCLUSION:

Assessment of feasibility and efficacy of Class IV laser therapy
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4881709/
OBJECTIVE:
CONCLUSION:

Effects of High Intensity Laser Therapy on Pain and Function of Patients with Chronic Back Pain
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5468204/

Effects of Photobiomodulation Therapy in Patients with Chronic Non-Specific Low Back Pain: Protocol for A Randomized Placebo-Controlled Trial
http://bmjopen.bmj.com/content/bmjopen/7/10/e017202.full.pdf
OBJECTIVE:
CONCLUSION:

Efficacy of High Intensity Laser Therapy in Treatment of Patients with Lumbar Disc Protrusion: A Randomized Controlled Trial
https://www.ncbi.nlm.nih.gov/pubmed/28854500

Effect Of Diode Laser In The Treatment Of Patients With Nonspecific Chronic Low Back Pain: A Randomized Controlled Trial
in https://www.ncbi.nlm.nih.gov/pubmed/25141218

The Effects of Two Different Laser Therapies In The Treatment Of Patients With Chronic Low Back Pain: A Double-Blinded Randomized Clinical Trial
https://www.ncbi.nlm.nih.gov/pubmed/27472858

Is Laser Therapy Effective In Acute Or Chronic Low Back Pain?
https://www.ncbi.nlm.nih.gov/pubmed/20414695
CONCLUSION:
There were no differences between laser and placebo laser treatments on pain severity and functional capacity in patients with acute and chronic low back pain caused by LDH – LLLT is ineffective (more power is needed!)

Meta-Analysis of Pain Relief Effects by Laser Irradiation on Joint Areas
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3412059/pdf/pho.2012.3240.pdf
(suggesting HILT is a superior modality)

Increased Limb Blood Flow After Class 4 Laser Therapy
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3418129/

Efficacy Of High-Intensity Laser Therapy In The Treatment Of Chronic Neck Pain: A Randomized Double-Blind Placebo-Control Trial
https://www.ncbi.nlm.nih.gov/pubmed/26914684

Effects Of High Intensity Laser Therapy On Pain And Function Of Patients With Chronic Back Pain
https://www.ncbi.nlm.nih.gov/pubmed/28626329

High-Intensity Laser Therapy In The Management Of Myofascial Pain Syndrome Of The Trapezius: A Double-Blind, Placebo-Controlled Study
https://www.ncbi.nlm.nih.gov/pubmed/25274197

Surgical versus nonsurgical treatment of chronic low back pain: A meta-analysis based on current evidence
https://www.ncbi.nlm.nih.gov/pubmed/26406211

Joint Pain, Sports Medicine, Arthritis Clinical Trial for High Intensity Laser Therapy (HILT) for Elbow Epicondylitis (HILT)
https://clinicaltrials.gov/ct2/show/NCT01992627

Radial Pressure Waves vs High Intensity Laser Treatments in Acute Ankle Sprains
https://www.high-intensity-laser.com/study-4

Laser Therapy (Classes I, II And III) For Treating Osteoarthritis
https://www.ncbi.nlm.nih.gov/pubmed/12804422
OBJECTIVE:
CONCLUSION:
Despite some positive findings, this meta-analysis lacked data on how LLLT effectiveness is affected by four crucial factors: wavelength, treatment duration of LLLT, dosage and site of application over nerves instead of joints. There is clearly a need to investigate the effects of these factors on LLLT effectiveness for OA in randomized controlled clinical trials.

The Efficacy Of Laser Therapy For Shoulder Tendinopathy: A Systematic Review And Meta-Analysis Of Randomized Controlled Trials
https://www.ncbi.nlm.nih.gov/pubmed/25450903
OBJECTIVE:
CONCLUSION:

A systematic review with procedural assessments and meta-analysis of Laser Therapy in lateral elbow tendinopathy (tennis elbow)
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2442599/
OBJECTIVE:
CONCLUSION:

Investigation Of The Effect Of GaAs Laser Therapy On Lateral Epicondylitis
https://www.ncbi.nlm.nih.gov/pubmed/19877824
OBJECTIVE:
CONCLUSION:

Meta-Analysis of Pain Relief Effects by Laser Irradiation on Joint Areas
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3412059/pdf/pho.2012.3240.pdf
(suggesting HILT is a superior modality)
OBJECTIVE:

CONCLUSION:

Laser Therapy (Classes I, II And III) For Treating Osteoarthritis
https://www.ncbi.nlm.nih.gov/pubmed/12804422
OBJECTIVE:
CONCLUSION:
Despite some positive findings, this meta-analysis lacked data on how LLLT effectiveness is affected by four crucial factors: wavelength, treatment duration of LLLT, dosage and site of application over nerves instead of joints. There is clearly a need to investigate the effects of these factors on LLLT effectiveness for OA in randomized controlled clinical trials.

A Systematic Review of Laser Therapy with Location-Specific Doses for Pain From Chronic Joint Disorders
https://ac.els-cdn.com/S0004951414601276/1-s2.0-S0004951414601276-main.pdf?_tid=f5330ac5-3a13-4a7a-9e14-7ab2699aa940&acdnat=1520308167_424a8c842bafd2c0803bfd6a03ac532a
OBJECTIVE:
CONCLUSION:

High Intensity Laser Therapy (HILT): state of the art in sporting traumatology and pain therapy
https://pdfs.semanticscholar.org/b27b/7acb8a74c20e37e3e98b510ba96ac467ae8b.pdf?_ga=2.77412309.1972336951.1520312887-1354315015.1520312887
OBJECTIVE:
CONCLUSION:

Laser Therapy Efficacy Evaluation In Mice Subjected To Acute Arthritis Condition
https://www.ncbi.nlm.nih.gov/pubmed/28772237
OBJECTIVE:
CONCLUSION:

Comparison Of Effects Of Laser Therapy And LIPUS On Fracture Healing In Animal Models And Patients: A Systematic Review
https://www.ncbi.nlm.nih.gov/pubmed/28688752
OBJECTIVE:
CONCLUSION:

Treatment Of Drug-Resistant Fibromyalgia Symptoms Using High-Intensity Laser Therapy: A Case-based Review
https://www.ncbi.nlm.nih.gov/pubmed/29080932
OBJECTIVE:
CONCLUSION:

Laser Therapy to Treat Fibromyalgia
https://www.ncbi.nlm.nih.gov/pubmed/24801056
OBJECTIVE:
CONCLUSION:

Effect Of Laser Therapy On Pain, Quality Of Life And Sleep In Patients With Fibromyalgia: Study Protocol For A Double-Blinded Randomized Controlled Trial
https://www.ncbi.nlm.nih.gov/pubmed/23171567

OBJECTIVE:
CONCLUSION:

Effects of laser therapy and low dose amitriptyline therapy on clinical symptoms and quality of life in fibromyalgia: a single-blind, placebo-controlled trial
https://www.ncbi.nlm.nih.gov/pubmed/12215864
OBJECTIVE:
CONCLUSION:

Can NIR (Near Infra-Red Energy Reach the Brain in Treatment of TBI?
http://www.laser-therapy.us/research/index.cfm?researchinput=bestwavelength
https://www.youtube.com/watch?v=iZbP2IVekh0
OBJECTIVE:
CONCLUSION:

How Flashing Lights and Pink Noise Might Improve Alzheimer's, Improve memory and More…
https://www.nature.com/articles/d41586-018-02391-6
OBJECTIVE:
CONCLUSION:

The End of Alzheimer's?
https://www.bostonmagazine.com/health/2017/11/27/li-huei-tsai-alzheimers-treatment/
OBJECTIVE:
CONCLUSION:

Cognito Therapeutics Is Focused on Discovering and Developing New Treatments and Preventive Therapies for Neurodegenerative Diseases -
https://www.cognitotx.com/
OBJECTIVE:
CONCLUSION:

Shining Light on The Head: Photobiomodulation For Brain Disorders
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5066074/pdf/main.pdf
OBJECTIVE:
CONCLUSION:

Review of Transcranial Photobiomodulation For Major Depressive Disorder: Targeting Brain Metabolism, Inflammation, Oxidative Stress, And Neurogenesis
https://www.spiedigitallibrary.org/journals/Neurophotonics/volume-3/issue-03/031404/Review-of-transcranial-photobiomodulation-for-major-depressive-disorder--targeting/10.1117/1.NPh.3.3.031404.full?SSO=1
OBJECTIVE:
CONCLUSION:

Transcranial Laser Therapy (810 Nm) Temporarily Inhibits Peripheral Nociception: Photoneuromodulation Of Glutamate Receptors, Prostatic Acid Phophatase, And Adenosine Triphosphate
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4725212/
(Effects are more profound and long-lasting with HILT)

OBJECTIVE:
CONCLUSION:

Comparison of Therapeutic Effects between Pulsed and Continuous Wave 810-nm Wavelength Laser Irradiation for Traumatic Brain Injury in Mice
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3196530/
OBJECTIVE:
CONCLUSION:

Use of Electroanalgesia And Laser Therapies As Alternatives To Opioids For Acute And Chronic Pain Management
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5749131/
OBJECTIVE:
CONCLUSION:

Laser Therapy Facilitates Superficial Wound Healing in Humans: A Triple-Blind, Sham-Controlled Study
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC522143/

OBJECTIVE:
CONCLUSION:

Influence of Different Energy Densities of Laser Phototherapy on Oral Wound Healing
https://www.spiedigitallibrary.org/journals/Journal-of-Biomedical-Optics/volume-18/issue-12/128002/Influence-of-different-energy-densities-of-laser-phototherapy-on-oral/10.1117/1.JBO.18.12.128002.short?SSO=1
OBJECTIVE
The aim of the present prospective study was to evaluate the impact of laser phototherapy (LPT) on the healing of oral ulcers. Different power densities were used on oral wounds in Wistar rats (n=72) randomly divided into three groups: control (0 J/cm2), 4 J/cm2 laser and 20 J/cm2 laser. Ulcers (3 mm in diameter) were made on the dorsum of the tongue with a punch. Irradiation with an indium-gallium-aluminum-phosphide laser (660 nm; output power: 40 mW; spot size: 0.04 cm2) was performed once a day in close contact with the ulcer for 14 consecutive days. A statistically significant acceleration in healing time was found with wounds treated with 4 J/cm2 LPT. Moreover, striking differences were found in the ulcer area, healing percentage, degree of re-epithelialization, and collagen deposition. The most significant changes occurred after 5 days of irradiation. Based on the conditions employed in the present study, LPT is capable of accelerating the oral mucosa wound-healing process. Moreover, faster and more organized re-epithelialization and tissue healing of the oral mucosa were achieved with an energy density of 4 J/cm2 in comparison to 20 J/cm2.

'Influence of different energy densities of laser phototherapy on oral wound healing' Journal of Biomedical Optics 18(12), 128002 (10 December 2013)
https://doi.org/10.1117/1.JBO.18.12.128002

Insurance Studies
Aetna, Blue Cross, Blue Shield - Recent Well-Designed, Controlled Studies Have Found No Benefit from Low- Energy Lasers in Relieving Pain in Rheumatoid Arthritis or Other Musculoskeletal Conditions
http://www.aetna.com/cpb/medical/data/300_399/0363.html
OBJECTIVE:

CONCLUSION:

The Effect of Laser Radiation on Spermatogenesis in Men
https://www.ncbi.nlm.nih.gov/pubmed/2281618
OBJECTIVE:
CONCLUSION:

Laser Therapy for Male Infertility. Part 1. Etiology and Pathogenesis. Experimental Studies
https://www.ncbi.nlm.nih.gov/pubmed/29135155
OBJECTIVE:
CONCLUSION:

Efficacy of High Intensity Laser Therapy in The Treatment of Male with Osteopenia or Osteoporosis: A Randomized Placebo-Controlled Trial
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5599844/
OBJECTIVE:
CONCLUSION:

Laser Therapy (Photobiomodulation Therapy) For Breast Cancer-related Lymphedema
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5719569/pdf/12885_2017_Article_3852.pdf
OBJECTIVE:
CONCLUSION:

High-Intensity Laser Therapy Versus Pulsed Electromagnetic Field in The Treatment of Primary Dysmenorrhea (Painful Menstrual Cramps)
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5684002/
OBJECTIVE:
CONCLUSION:

Revolution in Blood Medicine – Intranasal Laser Therapy
http://drsircus.com/general/revolution-blood-medicine-intranasal-laser-therapy/
OBJECTIVE:
CONCLUSION:

Lasers for Thyroid Tissue Regeneration
https://thyroidpharmacist.com/articles/lasers-thyroid-tissue-regeneration/
OBJECTIVE:
CONCLUSION:

Lipogels Responsive To Near-Infrared Light For The Triggered Release Of Therapeutic Agents
https://www.ncbi.nlm.nih.gov/pubmed/28801266
OBJECTIVE:

Long-term effect of pulsed high-intensity laser therapy in the treatment of post-mastectomy pain syndrome: a double blind, placebo-control, randomized study.
https://www.ncbi.nlm.nih.gov/pubmed/26115690
CONCLUSION:
We assess the long-term effect of pulsed high-intensity laser therapy (HILT) in the treatment of the post-mastectomy pain syndrome (PMPS). A total of 61 women participated in this study (30 in the laser group

and 31 in the placebo laser group), with a mean age of 53.56 ± 1.11 years. Patients who were randomly assigned to the laser group received HILT three times per week for 4 weeks, plus a routine physical therapy program (RPTP). The placebo laser group received placebo HILT plus RPTP. The outcomes measured were pain level by visual analog scale (VAS), shoulder range of motion (ROM), and quality of life (QOL). Statistical analysis was performed by ANOVA with repeated measures to compare the differences between baseline and post-treatment measurements and after 12 weeks of follow-up for both groups. The level of statistical significance was set at $P < 0.05$. Shoulder ROM significantly increased in the laser group after 4 weeks of treatment and after 12 weeks of follow-up compared with the placebo group. VAS results showed a significant decrease post-treatment in the laser group relative to the placebo group, and QOL results showed a significant improvement in the laser group compared with the placebo group and still improved after 12 weeks of follow-up. HILT combined with an RPTP appears to be more effective in patients with PMPS than a placebo laser procedure with RPTP.

Adjunctive 830 nm light-emitting diode therapy can improve the results following aesthetic procedures
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4751092/pdf/islsm-24-277.pdf
OBJECTIVE:
CONCLUSION:

The effects of low level laser therapy on both HIV-1 infected and uninfected TZM-bl cells
https://www.ncbi.nlm.nih.gov/pubmed/28128530
OBJECTIVE
Human immunodeficiency virus (HIV-1) infection remains a major health problem despite the use of highly active antiretroviral therapy (HAART), which has greatly reduced mortality rates. Due to the unavailability of an effective vaccine and treatment that would completely eradicate the virus in infected individuals, the quest for new therapies continues. Low level laser therapy (LLLT) involves the exposure of cells to low levels of red or infrared light. LLLT has been widely used in different medical conditions, but not in HIV-1 infection. This study aimed to determine the effects of LLLT on HIV-1 infected and uninfected TZM-bl cells. Both infected and uninfected cells were irradiated at a wavelength of 660 nm with different fluences from 2 J/cm2 to 10 J/cm2 . Changes in cellular responses were assessed using cell morphology, viability, proliferation, cytotoxicity and luciferase activity assays. Upon data analysis, uninfected irradiated cells showed no changes in cell morphology, viability, proliferation and cytotoxicity, while the infected irradiated cells did. In addition, laser irradiation reduced luciferase activity in infected cells. Finally, laser irradiation had no inhibitory effect in uninfected cells, whereas it induced cell damage in a dose dependent manner in infected cells.

CONCLUSION:

Effect of Low Level Laser Therapy on Proliferation and Differentiation of the Cells Contributing in Bone Regeneration
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4281990/pdf/JLMS-5-163.pdf
OBJECTIVE:
CONCLUSION:

Effects of low-level laser therapy and eccentric exercises in the treatment of recreational athletes with chronic Achilles tendinopathy
http://www.ncbi.nlm.nih.gov/pubmed/18272794?ordinalpos=61&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSION:

Low-level laser therapy, with the parameters used in this study, accelerates clinical recovery from chronic Achilles tendinopathy when added to an EE regimen. For the LLLT group, the results at 4 weeks were similar to the placebo LLLT group results after 12 weeks.

Improved wound healing by low-level laser irradiation after gingivectomy operations: a controlled clinical pilot study
http://www.ncbi.nlm.nih.gov/pubmed/18269665?ordinalpos=63&itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum
OBJECTIVE:
CONCLUSION:
Within the limitations of this study, the results indicated that LLLT may enhance epithelization and improve wound healing after gingivectomy and gingivoplasty operations. T

Effect of low-level ErYAG laser irradiation on cultured human gingival fibroblasts
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15974841&query_hl=10&itool=pubmed_docsum
OBJECTIVE:
CONCLUSION:
Our results showed that the low-level Er:YAG laser irradiation stimulates the proliferation of cultured gingival fibroblasts. The optimal stimulative energy density was found to be 3.37 J/cm(2). This result suggests that Er:YAG laser irradiation may be of therapeutic benefit for wound healing.

Low-level laser irradiation promotes proliferation and differentiation of human osteoblasts in vitro
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15910179&query_hl=18&itool=pubmed_DocSum
OBECTIVE:
CONCLUSION:
We conclude that LLLT promotes proliferation and maturation of human osteoblasts in vitro. These results may have clinical implications.

Phototherapy promotes healing of chronic diabetic leg ulcers that failed to respond to other therapies
http://www.ncbi.nlm.nih.gov/pubmed/19588536?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=83
OBJECT:
CONCLUSION:
Combined 660 and 890 nm light promotes rapid granulation and healing of diabetic ulcers that failed to respond to other forms of treatment

A Randomized Clinical Trial on the Effect of Low-Level Laser Therapy on Chronic Diabetic Foot Wound Healing: A Preliminary Report
http://www.ncbi.nlm.nih.gov/pubmed/21214368
OBJECTIVE:
CONCLUSION:
The study provides evidence that LLLT can accelerate the healing process of chronic diabetic foot ulcers, and it can be presumed that LLLT may shorten the time period needed to achieve complete healing.

Does the use of low-level laser influence wound healing in chronic venous leg ulcers?
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=16178295&query_hl=10&itool=pubmed_docsum

CONCLUSION:
These study results suggest that low-level laser does not stimulate wound healing in venous leg ulcers. Further controlled studies are needed to clarify the efficacy of low-level laser treatment as a wound-healing stimulant.

Effect of low-level laser therapy on Candida albicans growth in patients with denture stomatitis A
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15954824&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
LLLT is effective in the treatment of denture stomatitis.

Low-level laser irradiation promotes proliferation and differentiation of human osteoblasts in vitro
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15910179&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
We conclude that LLLT promotes proliferation and maturation of human osteoblasts in vitro. These results may have clinical implications.

Evidence of changes in sural nerve conduction mediated by LED (light emitting diode) irradiation
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15895289&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
LED irradiation, applied to intact skin at the described irradiation parameters, produces an immediate and localized effect upon conduction characteristics in underlying nerves. Therefore, the outcome of this in vivo experiment yields a potential explanation for pain relief induced by LED.

Low-level laser for prevention and therapy of oral mucositis induced by chemotherapy or radiotherapy
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15818167&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
low-level laser therapy may be useful in decreasing the severity of chemotherapy-associated or radiotherapy-associated mucositis is substantial

Use of laser for rectal lesions in poor-risk patients
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15619488&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSIONS:
Outpatient laser therapy is safe, repeatable, and effective in the local control of rectal lesions.

Low-level laser irradiation stimulates mitochondrial membrane potential and disperses subnuclear promyelocytic leukemia protein
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15611960&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:

CONCLUSION:
These changes reflect a biostimulative boost that causes a shift of the cell from a quiescent to an activated stage in the cell cycle heralding proliferation and suppression of inflammation. Further characterization of MMP kinetics may provide a quantitative basis for assessment of the effect of LLLI in the clinical setting.

Low-level laser treatment can reduce edema in second-degree ankle sprains T5
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15165387&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSIONS:
LLLT combined with RICE can reduce edema in second-degree ankle sprains.

Laser biostimulation in the treatment of pleurisy
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=OBJECTIVE&list_uids=15080043&query_hl=18&itool=pubmed_DocSum
OBJECTIVE:
CONCLUSION:
Patients with pleurisy undergoing laser stimulation presented with faster resorption of effusion and remission of the subjective symptoms, as well as significant decrease of biochemical acute inflammation parameters in the peripheral blood and therefore with faster recovery.
In patients with pleurisy laser treatment increases regenerative mechanisms of the pleural surface, thus decreasing the quantity of formed adhesions and resulting in better mobility of the diaphragm.

Managing postmastectomy lymphedema with low-level laser therapy
http://www.ncbi.nlm.nih.gov/pubmed/19878027?itool=EntrezSystem2.PEntrez.Pubmed.Pubmed_ResultsPanel.Pubmed_RVDocSum&ordinalpos=44
OBJECTIVE:
CONCLUSION:
LLLT was effective in the management of PML, and the effects were maintained to the 4 wk follow-up.

Laser treatment for toenail fungus
Conclusion:
trial resulted in nail clearing in most subjects
http://www.patholase.com/sites/all/themes/patholase/downloads/Laser_Treatment_for_Toenail_Fungus_SPIE_090219.pdf

laser therapy in skin: stimulating, healing, restoring
https://www.science.gov/topicpages/l/laser+therapy+lllt.html

Fundamental Biological Processes in the Application of Picosecond Pulses Utilizing Vacuum Ultra-Violet Light
https://www.sciencedirect.com/science/article/pii/S0076695X08609035?via%3Dihub
Objective:
The applications of picosecond pulse techniques run a wide range of diversity. Chemists are studying photochemical reactions and energy relaxation processes in molecules. Biologists are investigating fundamental biological processes on a picosecond time scale, which provides new understanding in such areas as vision and photosynthesis. Physicists have opened an entirely new area of nonlinear optics: the study of matter with intense optical fields. Short optical pulses provide a unique means of supplying high-peak-intensity optical fields with the least energy to minimize catastrophic material failure. This chapter

covers the present state of the art in generation of short optical pulses and some techniques for their application to measurements of ultrafast phenomena. It deals with several methods of laser spectroscopy that allow an investigator to study material excitations with energies ≥ 50,000 cm–1, the low-energy cutoff for the vacuum ultraviolet (VUV) region of the spectrum. The chapter analyzes the question of multiphoton processes and resonant enhancement. Methods of generating VUV by optical sum mixing are discussed, followed by a description of the use of this generated VUV light for spectroscopic studies. The subject of multiphoton absorption and ionization spectroscopy, which access states ≥ 50,000 cm–1 above the ground state, is also discussed.

Conclusion:

Pending

Mechanisms of Laser-Tissue Interaction: Tissue Thermal Properties

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4295363/pdf/jlms-4-99.pdf

Objective:

Laser-tissue interaction is of great interest due to its significant application in biomedical optics in both diagnostic and treatment purposes. Major aspects of the laser-tissue interaction which has to be considered in biomedical studies are the thermal properties of the tissue and the thermal changes caused by the interaction of light and tissue. In this review paper the effects of light on the tissue at different temperatures are discussed. Then, due to the noticeable importance of studying the heat transfer quantitatively, the equations governing this phenomenon are presented. Finally, a method of medical diagnosis called thermography and some of its applications are explained.

Conclusion:

Infrared Thermography is a highly accurate and precise method of diagnosing Disease in the Human Body.

References:

1a. The Reciprocity Rule in Photobiology - a Review

Schindl, B. Rosado-Schlosser, F. Trautinger

http://www.photobiology.com/reviews/bunsen/index.htm

Summary

This survey of the available literature on dose-time relationships in photobiology strengthen the view that the Bunsen-Roscoe law seems to be restricted to rather narrow limits for most photobiological reactions. With this knowledge it is surprising that the available information on the influence of radiation intensity is poor and that in most experimental and clinical studies variations in radiation intensity are not included in the experimental setup (or simpler: are not studied). In photomedicine where endpoints such as therapeutic efficacy, carcinogenesis, immunosuppression and photoaging are of major importance, validity and failure of the BRL are either completely unknown or subject of speculation based on experience from animal models and comparison of historical data.

Beyond phototherapy, investigations into the molecular events underlying the differential effects of **equal doses** and **varying intensities** are necessary for a comprehensive understanding of the way living matter responds to electromagnetic radiation. In this regard to date most information comes from basic research into the effects of low level radiation and it can be expected that these data will influence phototherapy. Systematic exploration in carefully designed studies may thus result in optimized phototherapeutic regimens with an improved therapeutic index, i.e. a maximized therapeutic benefit with minimized adverse reactions.

1.a.1 Fukuyama, F (1996). Trust: the Social Virtues and Creation of Prosperity. London: Free Press.

1.a.b R., Smith, Eliot. Social psychology. Mackie, Diane M., Claypool, Heather M. (Fourth ed.). New York. ISBN 9781848728936. OCLC 878812937

1b. **Sir Frederick William Herschel**

Sir Frederick William Herschel (1738-1822) was born in Hanover, Germany, and became well known as both a musician and an astronomer. He moved to England in 1757 and, with his sister Caroline, constructed telescopes to

survey the night sky. Their work resulted in several catalogs of double stars and nebulae. Herschel is famous for his discovery of the planet Uranus in 1781, the first new planet found since antiquity.

Herschel made another dramatic discovery in 1800. He wanted to know how much heat was passed through the different colored filters he used to observe sunlight. He had noted that filters of different colors seemed to pass different amounts of heat. Herschel thought that the colors themselves might be of varying temperatures and so he devised a clever experiment to investigate his hypothesis.
Herschel then directed sunlight through a glass prism to create a spectrum—the rainbow created when light is divided into its colors—and then measured the temperature of each color. Herschel used three thermometers with blackened bulbs (to better absorb the heat) and, for each color of the spectrum, placed one bulb in a visible color while the other two were placed beyond the spectrum as control samples. As he measured the individual temperatures of the violet, blue, green, yellow, orange and red light, he noticed that all the colors had temperatures higher than the controls. Moreover, he found that the temperatures of the colors increased from the violet to the red part of the spectrum.

After noticing this pattern, Herschel decided to measure the temperature just beyond the red portion of the spectrum in a region apparently devoid of sunlight. To his surprise, he found that this region had the highest temperature of all. Herschel performed additional experiments on what he called calorific rays (derived from the Latin word for heat) beyond the red portion of the spectrum. He found that they were reflected, refracted, absorbed and transmitted in a manner similar to visible light. What Sir William had discovered was a form of light (or radiation) beyond red light, now known as infrared radiation. (The prefix infra means below.) Herschel's experiment was important because it marked the first time that someone demonstrated that there were types of light that we cannot see with our eyes.

1c. The Fitzpatrick Scale
The Fitzpatrick scale (also Fitzpatrick Skin Typing Test; or Fitzpatrick Phototyping Scale) is a numerical classification schema for human skin color. It was developed in 1975 by Thomas B. Fitzpatrick as a way to estimate the response of different types of skin to ultraviolet (UV) light.

1. Karu TI, Kolyakov SF (2005) Exact action spectra for cellular responses relevant to phototherapy. Photomed Laser Surg 23: 355–361.
2. Wong-Riley MT, Liang HL, Eells JT, Chance B, Henry MM, et al. (2005) Photobiomodulation directly benefits primary neurons functionally inactivated by toxins: role of cytochrome c oxidase. J Biol Chem 280: 4761–4771.
3. Zhang Y, Song S, Fong CC, Tsang CH, Yang Z, et al. (2003) cDNA microarray analysis of gene expression profiles in human fibroblast cells irradiated with red light. J Invest Dermatol 120: 849–857.
4. Wang T, Zhang X, Li JJ (2002) The role of NF-kappaB in the regulation of cell stress responses. Int Immunopharmacol 2: 1509–1520
5. Baichwal VR, Baeuerle PA (1997) Activate NF-kappa B or die? Curr Biol 7: R94–96.
6. Henkel T, Machleidt T, Alkalay I, Kronke M, Ben-Neriah Y, et al. (1993) Rapid proteolysis of I kappa B-alpha is necessary for activation of transcription factor NF-kappa B. Nature 365: 182–185.
7. Hoffmann A, Levchenko A, Scott ML, Baltimore D (2002) The IkappaB-NF-kappaB signaling module: temporal control and selective gene activation. Science 298: 1241–1245.
8. D'Angio CT, Finkelstein JN (2000) Oxygen regulation of gene expression: a study in opposites. Mol Genet Metab 71: 371–380.
9. Li N, Karin M (1999) Is NF-kappaB the sensor of oxidative stress? Faseb J 13: 1137–1143.
10. Schreck R, Rieber P, Baeuerle PA (1991) Reactive oxygen intermediates as apparently widely used messengers in the activation of the NF-kappa B transcription factor and HIV-1. Embo J 10: 2247–2258.
11. Schreck R, Grassmann R, Fleckenstein B, Baeuerle PA (1992) Antioxidants selectively suppress activation of NF-kappa B by human T-cell leukemia virus type I Tax protein. J Virol 66: 6288–6293.
12. .Eichler M, Lavi R, Friedmann H, Shainberg A, Lubart R (2007) Red light-induced redox reactions in cells observed with TEMPO. Photomed Laser Surg 25: 170–174.

13. Lubart R, Eichler M, Lavi R, Friedman H, Shainberg A (2005) Low-energy laser irradiation promotes cellular redox activity. Photomed Laser Surg 23: 3–9.
14. Alexandratou E, Yova D, Handris P, Kletsas D, Loukas S (2002) Human fibroblast alterations induced by low power laser irradiation at the single cell level using confocal microscopy. Photochem Photobiol Sci 1: 547–552.
15. Pal G, Dutta A, Mitra K, Grace MS, Romanczyk TB, et al. (2007) Effect of low intensity laser interaction with human skin fibroblast cells using fiber-optic nano-probes. J Photochem Photobiol B 86: 252–261.
16. Notes on Adiposity Index

The body's visceral adiposity index classification is different for men and women. This is important because adipose tissue, in addition to skin color, represents the largest barrier to absorption of beam energy (its fat cells are designed to cushion and insulate the body). At the same time, adipose tissue is the repository for a variety of immune cells, and acts as a major endocrine organ because it produces hormones such as leptin, estrogen, resisting, and most importantly, cytokines. Adipose tissue also stores energy in the form of lipids (the average woman with 20% body fat has about one month of energy stored as fat).

As the major form of energy storage, fat provides a buffer for energy imbalances when energy intake is not equal to energy output; it is an efficient way to store excess energy, because it is stored with very little water. Consequently, more energy can be derived per gram of fat (9 kcal.gm-1) than per gram of carbohydrate (4 kcal.gm-1) or protein (4 kcal.gm-1). In addition, if terrestrial animals stored their excess energy as carbohydrate, the increased mass would interfere with mobility.

In biology, adipose tissue, (body fat, or simply fat) is a loose connective tissue composed mostly of adipocytes. In addition, adipose tissue contains the stromal vascular fraction (SVF) of cells including preadipocytes, fibroblasts, vascular endothelial cells and a variety of immune cells such as adipose tissue macrophages. Adipose tissue is derived from preadipocytes; Its primary role is to store energy in the form of lipids, although it also cushions and insulates the body. Far from being hormonally inert, adipose tissue has, in recent years, been recognized as a major endocrine organ, as it produces hormones such as leptin, estrogen, resistin, and the cytokine TNFα. The two types of adipose tissue are white adipose tissue (WAT), which stores energy, and brown adipose tissue (BAT), which generates body heat.

White adipose tissue serves three functions: heat insulation, mechanical cushion, and most importantly, a source of energy. Subcutaneous adipose tissue, found directly below the skin, is an especially important heat insulator in the body, because it conducts heat only one third as readily as other tissues. The degree of insulation is dependent upon the thickness of this fat layer. For example, a person with a 2-mm layer of subcutaneous fat will feel as comfortable at 15°C as a person with a 1-mm layer at 16°C. Adipose tissue also surrounds internal organs and provides some protection for these organs from jarring.

Brown adipose tissue, which derives its color from rich vascularization and densely packed mitochondria, is found in various locations, depending upon the species and/or age of the animal. In the rat, brown adipose tissue is found primarily in the interscapular region and the axillae, minor amounts are found near the thymus and in the dorsal midline region of the thorax and abdomen. During maturation, in non-hibernating animals, brown adipose tissue is metabolically less active, although cold exposure can activate it. In hibernating animals and neonates, brown adipose tissue is important for regulating body temperature via non-shivering thermogenesis.

Instead of serving as a substrate, the lipid in brown adipose tissue releases energy directly as heat and is, therefore used in heat production for non-shivering thermogenesis and for utilization of excess caloric intake via diet-induced-thermogenesis. The mechanism of heat generation is related to the metabolism of the mitochondria. Mitochondria from brown adipose tissue have a specific carrier called uncoupling protein that transfers protons from outside to inside without subsequent production of ATP.