

# How does light therapy work?

## Is all light therapy the same?

By Dr. Gerry Graham, III

These are complex questions with literally thousands of research papers documenting the answers. There are many known functions, many additional theories and still much to discover about this amazing and powerful therapy. Due to the complexity of these questions much confusion surrounds Low Level Light Therapy (LLLT). This white paper will attempt to resolve much of this confusion.

To understand **Light Therapy** you must understand that all light therapy is not the same; in fact, there are several different light therapy devices that produce totally different effects on the body – utilizing many different actions. All of these different actions are created by different properties of light, power, and frequency. This document discusses each of these factors.

As we discuss light therapy, many terms and their abbreviations will be utilized. If you are not fully aware of the common terminology related to light therapy please review the glossary of terms to the right.

**Light** therapy can include everything from standing in the sun, to using full spectrum lighting, to utilization of complex medical light therapy units. For this conversation we will limit our discussion to the common medical light therapy units available on the market today.

There are several different properties that determine the effect of light on living tissue. These are the **wavelength** of the light used, the power density or mW of power, the light source that is used, and if that light source is continuous or pulsed and if it is pulsed, at what frequency.

Surgical lasers are not considered therapeutic because they are not designed to heal tissue but to burn and cut tissue during surgical procedures. Even RK surgery on the eyes uses a burning procedure to scar the surface of the eye to change the way it focuses.

**Ultraviolet** light devices are also not designed to be therapeutic. They are promoted to kill bacteria. It is often used for acne therapy to kill bacteria that causes acne and you can even purchase a tooth brush holder that utilizes ultraviolet radiation to sanitize your tooth brush.

There are two basic concepts currently utilized for

**Light:** Light is a small spectrum of electromagnetic energy with wavelengths between 380nm and 760nm in length. This spectrum of energy is visible to the naked eye.

**Wavelength:** The property that differentiates different spectrums of energy within the electromagnetic spectrum of energy is wavelength. Each photon contains energy and just as energy of the ocean comes to shore in waves of high and low energy, the same is true of photons. Only with photons, the energy is not measured by the height of the wave but the number of waves the photon carries. These waves are measured in two ways; the number of waves that will pass a given point in one second, or wavelength, the distance between one wave and the next.

**Ultraviolet:** Ultraviolet is electromagnetic energy with a wavelength shorter than 380nm. It is not truly light because it is not visible to the eye but it is still commonly called light therapy.

therapeutic light instruments. The first is higher power infrared light devices and the second is low power visible red lasers that are pulsed. We will discuss each of these in detail.

### **Infrared light therapy devices:**

**Infrared** lamps, LEDs and LASERS are intended to emit energy in the infrared spectrum to provide topical and deep heating for the purpose of elevating tissue temperature. This heating is promoted to relieve pain, increase joint mobility and relax muscles. The mechanism of action for infrared lasers and light units is thermal and mechanical, and healing comes about as a byproduct of the stimulation, not as a direct mechanism of the therapy.

If the infrared therapy contains infrared lasers they are seldom **collimated** because collimation will cause heat to focus on a small area and burning may occur.

Many devices will only use **LEDs** or **SLDs** as their light source because the properties of the laser light are not required for thermal actions and LEDs are less expensive than lasers.

The **infrared** light devices are very effective at killing pain. Pain relief is so consistent and predictable that it is obviously a **pharmacological dose** of therapy. As described in the glossary, this means that the patient's body has little to do with the response. The therapy is mechanically and/or thermally killing the pain. This is usually accomplished by thermally damaging the fine sensory nerve endings to stop the sensation of pain. When used properly, this damage is not permanent and the nervous system heals in two or three weeks. This factor is also why the therapy requires another dose at or about the two to three week timeframe to keep the pain away. This is certainly safer, more effective, and lower in cost than using narcotics and other pain killing drugs, but the operator needs to understand that they have not corrected the cause of the pain; they have only stopped the pain. When utilized on athletes, caution must be advised or the athlete - without having the pain sensation - may push an injured area to the point of severely injuring himself or herself.

There is a suggested mechanism of healing with infrared therapy, which states that the stimulation of the

Ultraviolet rays are damaging to all organic material. It is the ultraviolet (UV) protection that we look for in sunscreens and sun glasses to prevent us from being burned by the sun. There are no known healing effects of UV radiation that this author knows of. UV burns tissue with energy but produces no heat in the process.

**Infrared:** Wavelengths above 760 *nm* have fewer waves per second than red and termed infrared wavelengths. They carry or transfer heat from one object to another. They have been utilized for thermal applications for many years in the medical field as infrared lamps.

**Collimation:** A property of light commonly associated with lasers and accomplished with focusing lenses where all the photons are traveling in the same direction.

**LED: Light Emitting Diode:** There are thousands of different types of diodes that can emit light ranging in power density and bandwidths of wavelength. All semiconductor lasers produce light from a diode, however, LED's are NOT Lasers. LEDs do not produce coherent or polarized light.

**SLD: Super Luminescent Diode;** is a specific type of LED that has a higher emission of energy than typical LEDs. All other aspects are the same as LEDs.

**Pharmacological Dose:** A pharmacological dose of any therapy is the dose necessary to produce and maintain a desired effect. The goal is to have a drug or therapy to stay above or at the threshold level for effective therapeutic action but below the toxic level.

Therefore;

- A **pharmacological dose** always contains risk and **WILL DO HARM.**
- A **pharmacological dose**

infrared wavelengths stresses the local tissue and stimulates the body to mobilize resources to that area of the body to increase the healing of that tissue. This is quite sound and emphasizes the fact that infrared is more of an irritant than a healing stimulation to the body but **can** stimulate the healing process.

Other therapeutic effects of infrared lasers appear to be present but are not understood or defined. Further research may discover other mechanisms of action that are not understood today.

**Infrared** devices can be recognized by the following characteristics:

1. In the product description the wavelength of the light will be in the infrared range, greater than 760nm, usually in the 800nm and 900nm wavelengths.
2. In the product description the total power output will be 100mW or higher. It can be much higher even up to 100,000 mW. The greater **power density** is needed to produce the heat required to create the desired thermal effect on the tissue.
3. If the unit contains **laser** diodes the unit will be classified as a Class IIIb or Class IV laser.
4. They require that the wand that contains the lasers be in direct contact with the skin. This is confusing since the FDA states that you should avoid direct exposure to the radiation from Class IIIb and Class IV lasers.
5. Eye protection is mandatory for both operator and patient.
6. The proper treatment will be based on the **Irradiation dose** or the Joules of energy delivered. This is an equation of the amount of optical energy or heat that is delivered to the area of tissue.
7. They will advertise greater **penetration** of energy into the body. However, penetration is related to physical and thermal actions, not healing actions.
8. Infrared devices frequently claim that the higher the mW, the faster the therapy. **Example:** If it takes 10 minutes to produce 'x' amount of Joules of energy at 100 mW, then you could perform the same therapy in 1 minute if you had a unit that produced 1,000mW of energy. If this example were

seldom improves health on its own merit.

•A **pharmacological dose** will generally be predictable and consistent for symptomatic response because it is measuring a response to a concentration, exposure, etc. mostly independent of the body – overriding the normal physiology of the patient.

**Nanometer (nm):** One nanometer is one billionth of a meter.  $10^{-9}$  meters or .000000001 meter = 1 nm. It is the unit of measurement that is commonly used to measure the wavelength of energy commonly used in light therapy.

**Power Density (mW):** Power density is synonymous with the Watts of power produced by the light source.  $P = mW$

**LASER:** *Light Amplification by Stimulated Emission of Radiation*; refers to the specific qualities and methods by which lasers produce light. Originally theorized and defined by Albert Einstein in 1917, it was not produced until the 1950s. Laser light is *Coherent, has a Monochromatic wavelength, is Collimated, and Polarized*. These four characteristics differentiate Laser's from LED & SLD light sources.

**Irradiation Dose ( $J/cm^2$ ):** Irradiation dose is defined by the product of the power density (mW); exposure time divided by area irradiated and is reported as Joules of energy per square centimeter ( $J/cm^2$ ).

**ID ( $J/cm^2$ ) = P (mW) X T (sec) / A ( $cm^2/sec$ )**

**Penetration:** Propagation of light through tissue is regulated by three properties, Reflection, Penetration,

accurate, it would also mean that if you needed to bake a cake for 30 minutes at 300 degrees, if you had a better oven you could bake the same cake for 3 minutes at 3,000 degrees and have the same outcome. Obviously, even though the math is the same the results will be different in people and cakes. So just because it sounds logical does not mean that it is.

9. Infrared energy is not visible so most units will contain a visible red laser for the purpose of aiming and knowing when the laser is turned on. These are not considered part of the therapy.

10. The infrared units will have a pulse duration setting. This setting is not for the pulse frequency but for the **duty cycle** of the light. By varying the duty cycles you can change the amount of energy delivered during the treatment.

#### **Low Level visible red Laser Therapy devices: (LazrPulsr 4X)**

Unlike the infrared devices that are only concerned about the heat that is delivered, these lasers are very complex in their actions because they are designed to **stimulate the physiology** of the body through a mechanism called **biomodulation** or **photobiomodulation**. These principles of light or energy medicine originated in the quantum physics of Einstein himself. He first introduced the concept of the LASER "**Light Amplification by Stimulated Emission Radiation**". He also stated that every living cell emits radiation called the "**photon emission of living cells**", or what we commonly refer to as the aura. Albert Einstein, in 1917, proposed all living and nonliving matter represented dynamic electromagnetic fields, which exist in an electromagnetic environment – the universe! It took nearly 60 years for fellow physicists to begin to comprehend Einstein's holistic worldview of quantum mechanics, and the relationship between matter, energy and health.

Due to the low power density and the properties of the wavelength used, the true low level therapy lasers are only capable of delivering a **physiological dose** of therapy. Some consider this limited because it is dependent on the ability of the patient to respond to care which creates less consistent and predictable outcomes. However, when you consider that this therapy actually gives the body a greater ability to

and Absorption. Penetration refers to the distance an energy wave travels into the tissue before it is absorbed and dissipated as heat or molecular vibration. Penetration is a physical and thermal phenomenon, not a therapeutic phenomenon.

**Duty Cycle:** Duty cycle relates to the amount of time the light source is active, usually from 10% to 100%. If the setting was a 10% duty cycle then out of every second the light source would be on 1/10 of a second and be off 9/10 of a second. This cycle can be at various pulse intervals depending on the manufacture.

**Biomodulation:** Biomodulation is the process of changing the natural biochemical response of a cell or tissue within the normal range of its function, stimulating the cell's innate metabolic capacity to respond to a stimulus. A cell can heal itself by this basis.

**Photobiomodulation:** When biomodulation occurs from a photon transferring its energy to a chromophore it is referred to as photobiomodulation.

**Physiological Dose of therapy:** A Physiological Dose of any therapy is designed to stimulate production of, or provide to the body what it needs to normalize and heal itself through

respond you can see that it has expanded the limits of what can be accomplish.

One of the most important aspects of a **physiological dose** of therapy is that it is safe. It is safe no matter what the condition or pathology is, no matter what medications the patient is on, no matter what the patient may be allergic to, no matter what, a true LLLT unit will

“...**DO NO HARM!**”

One of the most profound physiological effects of low level therapeutic lasers is the effect of Neuroplasticity. Neuroplasticity represents the brain's ability to reorganize itself by forming new neural connections throughout life. Neuroplasticity provides a way for nerve cells (neurons) in the brain to respond and compensate for injury and disease and adjust neuronal activity in response to a new situation or to changes in the environment.

Reorganizing the brain occurs by the mechanism of “axonal sprouting” where damaged axons grow new nerve endings to reconnect neurons whose links were injured or severed. Undamaged axons can also contribute new nerve endings and connect with other undamaged nerve cells, forming new neural pathways to accomplish a needed function. In order for neurons to reconnect or form new connections, the neurons need active stimulation. LLLT provides one of the most powerful stimulants for Neuroplasticity known today and it provides that stimulation in a safe, therapeutically correct, organized manner.

Neuroplasticity represents unlimited potential to retrain the brain after injury. However, neuroplasticity can also contribute to impairment. For example, deaf individuals may suffer from continual ringing in the ears (tinnitus), which results from faulty rewiring of the brain cells starved for sound. For beneficial neural connections to form, neurons must be stimulated correctly.

Neuroplasticity represents a new rapidly evolving approach to healing. *Given any trauma, realizing all traumas involve the central nervous system recognizing the trauma (consciously or subconsciously), quick response with active neuronal stimulation, could theoretically maintain, repair, retain most CNS functions (learning, memory, speech, emotional distress, movement, balance etc.).* In simpler terms, theoretically the proper immediate use of LLLT therapy

biomodulation. The symptomatic response to a physiological dose of therapy is dependent of the capacity of the patient's body to respond to the therapy. The physiological dose of any treatment has specific advantages.

- A **physiological dose** represents the body's own response to a stimulus (e. g., adrenaline in response to a “fight or flight” challenge) and is generally safe and will **DO NO HARM**.

- A **physiological dose** generally improves the patient's health.

- A **physiological dose** will always be less predictable and consistent than a pharmacological dose for symptomatic response because it depends upon an interaction with the individual patient's entire body system.

post trauma, especially brain trauma, could eliminate much of the neurological disabilities common in head trauma today.

Even the simplest memory stimulates complex neural networks at several different sites in the brain. The content (what happened) and meaning (how it felt) of an event are laid down in separate parts of the brain. The goal of neuroplastic therapy is to connect these sites to resolve the damaged, disjointed, dysfunctional nervous systems.

**“...The effect of LLLT on the brain is not magic, it’s malleable”**

As with the infrared lasers, the wavelength and power density selected for an LLLT laser is very important, but for very different reasons. There are also a third and fourth component that is critically important for the LLLT laser use. One is the light source and the properties of the light itself and the other is frequency. It is not only important for the light to be pulsed but the frequency it is pulsed is specific to the therapeutic response desired.

Following is a close look at the four separate therapeutic properties of the LazrPulsr 4X unit.

### **The mechanism of action for 635nm light:**

Biological light receptors in living tissue, termed **chromophores**, have peak activation at wavelengths between 600nm and 720nm. The most commonly used wavelengths to activate these chromophores are from 630nm to 635nm. This is because even though different chromophores have peak activation somewhere between 600nm and 720nm, each chromophore can still be activated within a wider wavelength spectrum. 635nm falls within the wavelength spectrum of all biological chromophores in man and animals. This means there is no need to utilize multiple colors of lasers to activate the different chromophores in the body. One wavelength – 635nm – has the potential to activate every biological photo-sensitive receptor in the body. For this reason, the **LazrPulsr System** has selected only 635nm lasers for the therapy lasers.

There are three specific and unique methods the 635nm wavelength lasers of the **LazrPulsr 4X**

**Chromophores:** Chromophore literally means, “Color lover” (**L. chromo** = color; **L. Phore** = to seek out, to have an affinity for, to love). Chromophores are generally pigmented molecules that accept **photons** within living tissue. When the chromophore accepts a photon, it causes a **biochemical** change within an atom, molecule, cell or tissue. If this change increases cellular function, it is said to have activated the tissue. If this change decrease cellular function it is said to have inhibited the tissue. Biomodulation occurs in both cases.

modulates tissues:

1. Within the cell, the signal is transduced and amplified by a photon acceptor (chromophore). When a chromophore first absorbs light, *electronically excited states* are stimulated, primary molecular processes are initiated which lead to measurable biological effects. These photobiological effects are mediated through a secondary biochemical reaction, photosignal transduction cascade, or intracellular signaling which amplifies the biological response.

2. The *ionizing* effects of LLLT allow photon acceptors to accept an electron. This turns on the oxidation-reduction cycle of the stimulated chromophores such as Cytochrome oxidase, hemoglobin, melanin, and serotonin. Changing the redox state of the chromophore changes the biological activity of that chromophore e.g., hemoglobin changes its oxygen carrying capacity. This has the potential to triple the oxygen carrying capacity of blood instantly.

3. When photon energy *breaks a chemical bond*, changes occur in the allosteric proteins in cell membranes (cell, mitochondrial, nuclear) and monovalent and divalent fluxes activate cell metabolism and intracellular enzymes directly. Direct activation of cell membranes alters ion fluxes, particularly calcium, across that membrane. Changes in intracellular calcium alter the concentrations of cyclic nucleotides, causing an increase in DNA, RNA, and protein synthesis, which stimulate mitosis and cellular proliferation.

When any of the above occurs, the initial biological reaction rapidly catalyzes thousands of other chemicals similar to the calcium regulated, 2<sup>nd</sup> messenger cAMP cascade. This **biological amplification** process produces systemic effects – which means that as you are treating a wound on the left hand, the wound on your right hand and the injury to your liver and kidney are also being treated equally as well. So while the infrared manufacturers brag about a 2 inch penetration of their energy, true therapeutic lasers are profoundly more advanced, producing systemic therapeutic results.

These three actions produce four separate and distinct functions that are clearly understood in the body.

1. *Growth factor production* occurs within cells

**Biological Amplification:** When photobiomodulation occurs, the photon activates a chromophore, amino acid, nucleic acid, or molecule. Activation of a single enzyme molecule rapidly catalyzes thousands of other chemical reactions amplifying the signal to the cell. This is similar to the, calcium regulated, 2<sup>nd</sup> messenger cAMP cascade. **Biological amplification** explains how systemic, cellular, and clinical effects can occur almost instantaneously after exposure to light therapies.

and tissue in response to increased ATP and protein synthesis. This initiates mitosis and cell proliferation by changing the cell, mitochondrial, or nuclear membranes permeability to monovalent (Na<sup>+</sup>, K<sup>+</sup>) and divalent (Ca<sup>+</sup>, Mg<sup>++</sup>) ions (Karu 1987, 1998, 2002).

2. *Pain relief* results from suppression of the nociceptor response mediated by increased serotonin and endorphin release (Sumano et al., 1987a, 1987b).

3. *Immune-modulation and mitigation of the inflammatory response* occur because the mononuclear phagocytic cells, mast cells, and leukocytes are stabilized preventing the release of harmful inflammatory mediators (Amano 1994). In addition, vasodilatation and increased microcirculation allows a rapid return to homeostasis and promotes first intention healing (Sumano 1987a, 1987b; Fiszerman and Rozenbom 1995).

4. *Direct trigger point stimulation* allows direct release of endorphins and other endogenous pain mediators such as serotonin, VIP, substance P, prostaglandins, etc. (Kaada, B and Eielson O, 1983, Kaada, Olsen and Eielson, 1985).

#### **The common effects of 635nm light:**

For those research scientists that read this paper the above section is very clear, however, for the rest of us, The common effects are easier to understand.

The above mechanisms of action produce three basic functions in the body. It provides **pain relief**. It reduces or **manages inflammation** around injuries thereby controlling pain, swelling, redness, and heat. Finally it **stimulates the growth** of new cells to improve healing time. One other factor that is not covered in this paper but has been well researched is that 635 nm laser light also **inhibits** the growth of almost all known infection causing **bacteria**.

**Therefore 635nm light will control the pain and swelling related to acute and chronic pain such as:**

- Shoulder pain    - Carpal tunnel    - Back pain
- Tennis elbow    - Arthritic pain    - Fibromyalgia
- Dental pain    - Headaches    - Stomach pain

Controlling pain also reduces the need for pain medications.

**Because LLLT reduces pain, manages inflammation, reduces bacteria related to infection, and stimulates new human cell growth, it is ideal for Wound Management therapy including:**

- Skin ulcers
- Diabetic ulcers

**Effects of 630-, 660-, 810-, and 905-nm laser irradiation delivering radiant exposure of 1-50 J/cm<sup>2</sup> on three species of bacteria in vitro.**

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Results:

**A wavelength of 630 nm appeared to be most commonly associated**



- Wounds, deep and superficial
- Bruises, deep and superficial
- Burns, all types and levels
- Pre and Postoperative wound and surgical care
- Fractures
- Open wounds
- Skin abrasions

**Based on the above, Low-Level Laser Therapy should also support a number of other conditions including:**

- Osteochondriosis
- Intervertebral disk
- Radiculitis
- Arthrosis
- Calcaneal spurs
- Sunburn
- Tennis/golfer elbow
- Migranes
- Ankle strain/sprain
- Muscle cramps
- Allergies
- reorganization of collagen to reduce scar tissue
- Scoliosis
- Post-traumatic pain
- Arthritis
- Contractures
- Myositis.
- Tendonitis
- Carpal tunnel syndrome
- Tinnitus
- Common colds
- Over exertion
- Brain Injury

### The mechanism of action for LASER:

There are different properties of light. Most light that we are exposed to is **reflected** off our bodies. This is a natural *in vivo* protection mechanism. If we absorbed all photon energy that struck our skin, we would explode in a few minutes of standing in the sun. So the first requirement is understanding how to achieve the proper penetration through the skin. This includes all the skin layers – not only our outer skin but the skin of the cell, the skin of the nucleus of the cell, the skin of the mitochondria and so on. All tissues have optical windows and guards to let only specific forms of light penetrate and activate the chromophores and other light sensitive properties of the tissue. This requires the properties that **only LASER light** possesses.

Collimated light is essential for penetrating the outer surface of the skin. Coherent light and polarized light is required to pass through the optical windows of different tissues. The monochromatic property of laser light is the ability to activate only the chromophores desired. Many assertions have been made claiming that LEDs – which do not have coherent, polarized, or collimated properties – work as well as LASER light does. If one reviews the scientific papers, one quickly will find that these studies were performed on tissue cells *in vitro*, or in a test tissue sample. When the test is run on living animals and people, *in vivo*, LED light is not nearly as effective as the LASER light source due the above mentioned properties of the LASER.

**with bacterial inhibition.** The findings of this study might be useful as a basis for selecting LLLT for infected wounds. J Clin Laser Med Surg. 2000 Oct;18(5):235-40.

**Reflection:** Propagation of light though tissue is regulated by three properties, **Reflection**, Penetration, Absorption. When energy waves strike the skin of any tissue, they will either pass through or reflect off the tissue. The energy's ability to pass through a surface tissue is dependent on the collimation, coherency, wavelength and polarization of the light. Reflected energy has no therapeutic effect to the internal tissue.

**LASER:** *Light Amplification by Stimulated Emission of Radiation*; refers to the specific qualities and methods by which lasers produce light. Laser light is *Coherent* (having all waves in phase), *Monochromatic* (having a very narrow band of wavelength), *Collimated* (all photons traveling in the same direction), and *Polarized* (all waves are in the same plane). These four characteristic differentiate Laser's form LED & SLD, light sources.

### The different mechanisms of power density:

Power density or mW of power of the light source is every important. As identified earlier, the power density of the infrared radiation needs to be high to quickly produce the heat desired. However, in the low-level therapeutic lasers, heat is the enemy. **Heating tissue is not conducive to healing.** Chromophores are very sensitive to the power density. For example, the easiest way to understand the action of the chromophore is to think about your vision. The cones on the retina of the eye contain three different chromophores. Each is sensitive to different wavelengths of light, allowing us to see in colors. But it is not just the wavelength; it is also the power density of the light. If it is too dark, you cannot see because the power density is too low to activate the chromophore. However, if the light is too bright, it over stimulates the chromophore into a sedated state and you still can't see. The chromophore has to be stimulated not only by the right wavelength but also with the correct power density. This is one more reason why a fully collimated laser light source is needed for LLLT. To get the correct penetration of the outer skin with very low power density, you must use a fully collimated laser light source.

### The different mechanisms of frequency:

**Frequency** addresses the very fundamental properties of your life and the world we live in. Each atom, element, molecule, cell, organism, or substance has its own ideal electrical wavelength and **resonance frequency of vibration** that coordinates its activities (Lakovsky, 1970). At the resonance frequency, energy is maximized and harmonious. The further a substance deviates from its resonance frequency, the more dissonance and disease occurs (Pauling, Wilson 1963; Vithoulkas, 1980)

The body itself uses frequency to alter its functions and control its physiology. Using brainwave entrainment (specific frequency stimulation), it is possible to coax the brainwaves to a certain frequency and achieve the mental state associated with that frequency. This is the basis of the much accepted Biofeedback modulation used to treat Post Traumatic Stress patients.

Brainwave Frequencies are frequencies associated with different mental states. A familiar example is the five brain wave ranges recorded by the EEG;

**Dose:** The term **dose** is an estimate of a **therapy**, traditionally a drug, which produces a desired therapeutic action without harmful side effects. The **therapeutic dose** (safe and effective) range is defined by clinical evaluation of the response of a sufficient number of patients, generally 50 percent who improve without toxicity.

Drugs are evaluated at doses to which 20%, 70% or any percentage to which a subject responds.

It is customary to calculate:

**Median Effective Doses** or ED<sub>50</sub>, the dose that gives rise to a response in 50 % of the subject

**Median Toxic Dose** or TD<sub>50</sub> is the dose that manifests toxic side effects in 50 % of the subjects

**Median Lethal Dose** or LD<sub>50</sub> is the dose that gives rise to the death of 50% of the subjects

In general, a therapy (traditionally a drug) is considered safe when the harmful LDR region of the side effects is much greater than the therapeutic dose range, expressed as: **Therapeutic Index: TI = TD 50/ED50** [Medical Principles of Pharmacology, 1990](#)

**Frequency Biomodulation:** Biomodulation caused by specific frequencies produced by therapeutic light devices is called frequency biomodulation.

*Delta Range* 0.5 to 4 Hz - associated with deep sleep.

*Theta Range* 4 to 8 Hz - associated with dreaming sleep and other mental states where the mind is wandering, daydreaming, or imaging.

*Alpha Range* 8 to 13 Hz – associated with a relaxed but awake state.

*Beta Range* 13 to 30 Hz – associated with the normal awake/aware state and speech.

*Gamma Range* 30 to 60 Hz -associated with higher mental activity including perception and consciousness. General anesthesia eliminates gamma waves.

Just as the brain can be stimulated to change function by introducing and changing resonant frequencies, frequency stimulation can alter all functions of the body by altering the frequency of the tissue. When you consider that frequency pollution from EMFs, florescent lights, cell phones, all the other radio waves and telecommunication transmissions etc. are devastating to your health, frequency therapy becomes mandatory to just correct these pollutants in our environment.

**Low Level Therapeutic Lasers (LLLT)** can be recognized by the following properties:

1. In the product description the wavelength of the light will be in the visible red range, 630nm (for HeNe tube lasers) and 635nm (for semiconductor laser diodes).
2. In the product description the total power output will be less than 5mW per laser.
3. It will always have fully collimated true lasers and the unit will be classified as a class IIIa laser.
4. The housing that contains the lasers can be held at a comfortable distance from the wound or tissue being treated.
5. The therapy can be administered through natural fiber clothes so that the patient seldom has to disrobe.
6. Eye protection is not necessary for the patient or the doctor; although directing any LLLT unit at the eyes can be dangerous.
7. The proper treatment will be based on the frequency utilized and the Joules of energy are never mentioned.

### **Properties of The *LazrPulsr 4X***

Multiple **635nm** wavelength semiconductor laser diodes of visible red light.

Less than **5mW** each laser.

Each laser is a Class IIIa, fully collimated laser.

Designed to be held a comfortable distance from the wound.

Works equally well through natural fiber clothing.

Eye protection is not required by the FDA.

Each different therapy protocol is

8. Photobiomodulation and biological amplification is promoted, the word "penetration" will never be found.

9. Low power and no heat will be promoted; High power of **any** kind should not be seen.

10. 635nm energy is visible so you always know if the unit is on and where it is pointed.

11. The laser will have pulsed frequency settings and they will be documented as accurate and with a broad range.

### **The *LazrPulsr 4X***

The LazrPulsr 4X possesses all the properties of a true Low Level Therapeutic Laser. It is also designed to be the most user friendly LLLT unit on the market with easy to use controls, lightweight, one hand operation, fully portable and the most accurate and broad range of frequency therapy in any LLLT unit on the market.

based on specific unique frequencies, the light source and power density never changes

The ***LazrPulsr 4X*** is low power and not designed for penetration but for maximum systemic physiological actions through **biological amplification** producing no significant rise in tissue temperature.

Up to 1,000,000Hz of therapeutically accurate frequencies.

10 programs that can be user edited and stored for instant recall and use.

Up to 45 proprietary frequency programs in the laser for instant recall and use.