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Laser Technology and Its Applications in Medicine

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Abstract **Review Article**

This study examines the laser and its uses in medicine. It refers to light amplification by stimulated emission of radiation (SEER). This is electromagnetic radiation whose photons are equal in frequency and phase, and whose wavelengths interfere constructively, transforming into a light pulse. The history of laser development, which began in the mid-nineteenth century, is also studied. Lasers have evolved and their use in many fields has expanded. The components of the laser, including the active medium, the excited source, and the resonator, are also studied. The conditions for lasing are defined by three points: the presence of the active medium, the achievement of inverse rehabilitation. The laser's operating principle is also studied, which is based on three types of interactions: absorption, stimulated emission, and spontaneous emission. The characteristics of the laser are also studied, as its beam has four characteristics: monochromaticity, coherence, directivity, and brightness. The types of lasers, including solid-state lasers (such as ruby lasers), liquid lasers, chemical lasers, and others, are explained in detail in this research. Lasers have a wide range of practical applications. They are used in medicine, industry, mining, communications, and for measuring distances with extreme precision, among many other fields. In general, lasers are highly advanced and play a significant role in human life because they are linked to human health and medicine. Doctors will be able to use them more widely in the future to treat diseases using lasers.

Keywords: Laser Technology, Medicine, Electromagnetic Radiation.

INTRODUCTION

Light is a scattered electromagnetic wave of varying frequencies, which makes it a variety of colors carrying weak energy. This light is used in many areas of daily life, such as lighting homes and streets. However, lasers are a type of this light, but they differ from it in many characteristics, giving them many capabilities that transform them into a powerful beam carrying tremendous energy compared to ordinary light. Therefore, humans have used this beam in many areas of life, allowing them to simplify and facilitate many complex tasks, revolutionizing all other sciences and applications. The word "laser" refers to the method of forming laser light. It means light amplification by stimulated emission of radiation. It is a beam of light with the same frequency and identical waves, causing constructive interference between their waves, transforming them into a high-energy light pulse that differs from light in some properties. Ordinary light is composed of scattered light waves, so it does not possess the energy and properties that laser light possesses [1]. So, how is this formed? Ray? Why does it carry this high energy that distinguishes it from light? Also, how have humans been able to harness this energy?

A laser is a source for generating visible and invisible light, characterized by unique properties not found in the light emitted by other natural and artificial light sources. Lasers generate a unique type of light whose properties differ from the natural light emitted by the sun and stars and the artificial light emitted by various types of light bulbs. Laser light has several characteristics, the most important of which is that all of the light energy is concentrated in a beam with an extremely small cross-section, which in some types may not exceed a few square micrometers. Therefore, it travels long distances, retaining its energy within this precise beam. Since all of the light energy generated by a laser is concentrated within this small cross-section of the beam, it is possible to achieve a light intensity that may be millions of times greater than the intensity of the light emitted by the sun or light bulbs. The second characteristic is that laser light consists of a very narrow band of frequencies, unlike other types of light, which consist of a wide spectrum of frequencies. Therefore, it appears to the eye as white light containing all the colors of the visible spectrum, while laser light appears to the eye as a single, highly pure color, such as red, green, and blue [2].

The invention of the laser is considered one of the most exciting inventions of this era. No one imagined that this simple light source would open countless doors to applications of great importance to human life. After the first laser was created in 1960, scientists wondered among themselves what applications this amazing device would have. The impetus behind the intensive research that led to the invention of the laser was solely to satisfy scientists' curiosity, unlike many inventions, which were driven by necessity. However, after a few years, scientists in various disciplines embraced this amazing invention and used it in countless applications. It revolutionized human life no less than the revolution brought about by the diode and the transistor. For example, electrical communications engineers realized the importance of this great invention after they discovered that laser light could be used as an alternative to radio waves as an information carrier, due to its ability to carry an amount of information thousands of times greater than the capacity of the most powerful radio carriers due to the high frequencies of laser light.

Mechanical engineers, on the other hand, began Dreams haunted them after they realized the intense focus of laser light, which they used to cut and trim metal and non-metallic sheets with extreme precision and in the desired shape, meeting the needs of various industries, as well as its use in metal welding operations. Civil engineers found the visible laser beam, which travels long distances in the form of a fine thread, to be their desired goal in surveying and construction work of all kinds, to adjust the straightness and measure dimensions. Doctors had a large share of this invention, using it as a high-precision scalpel that leaves no bleeding behind and can reach areas of the human body that their metal scalpels cannot reach except after causing significant damage. They used it to correct vision, remove tumors, break up stones, drill teeth, remove pimples, acne, wrinkles, boils, and other skin diseases and defects [1].

The laser is a source for generating visible and invisible light, characterized by characteristics not found in the light emitted by other natural and artificial light sources. The invention of the laser is considered one of the most exciting inventions of this era, as no one would have imagined that this simple light source would open countless doors to applications of great importance to human life. In the field of medicine, it had a large share of this invention. They used it as a high-precision scalpel that leaves no trace behind and can reach places in the human body that their metal scalpels cannot reach except after causing great damage. They used it to correct vision, remove tumors, break up stones, drill teeth, remove pimples, acne, wrinkles, boils, and other skin diseases and defects. Thus, the study aims to provide a brief introduction to the topic of lasers, explain when they first appeared, and identify the scientists who discovered and developed them. It also aims to understand the concept of lasers and laser devices, as well as their characteristics, types, and operating principles. It also aims to identify the numerous applications of lasers, which are too numerous to be listed in this research. However, we will identify a small number of their applications in the field of medicine.

History of Laser Development

In the development of modern science and technology, the laser stands out as a transformative innovation with far-reaching implications. Lasers, coined as an acronym for (light amplification by stimulated emission of radiation) have evolved from theoretical speculation into indispensable tools in various disciplines [1]. The emergence of the laser can be traced back to Albert Einstein's optical work in the early 20th century, with its concrete realization by Theodore Meimann in 1960 [1, 2]. The fundamental principle of the laser is the controlled emission of coherent light through stimulated processes, a concept that has since sparked countless breakthroughs and innovations [3, 4]. From communications and manufacturing to medical procedures and defense systems, lasers have become ubiquitous, revolutionizing how we perceive and interact with the world [5].

It not only uncover the technological marvels made possible by lasers, but also the potential they hold to shape the future of scientific research and industrial progress [5]. Join us on this illuminating journey through the world of lasers, where light meets innovation and boundaries are redefined. The beginnings of laser technology can be traced back to Albert Einstein's theoretical musings in the early 20th century, particularly his work on the quantum theory of radiation [1]. However, the tangible breakthrough of the laser came in 1960 when Theodor Maiman developed the first functional laser, marking a pivotal moment in the history of scientific innovation [2]. Since then, lasers have evolved into a diverse and powerful set of tools with applications spanning multiple fields. [2].

Recent contributions by Arab researchers have greatly enriched the understanding and application of laser technology. Noteworthy works by Abdel-Majid *et al*., (2017) highlighted recent developments in laser technology and presented the ongoing evolution in this field [4]. In addition [7], provided valuable insights into the theoretical foundations of lasers, contributing to a broader understanding of their principles and potential applications [3]. The fundamental principle of lasers involves controlling the emission of coherent light through stimulated processes, a concept that has spurred numerous breakthroughs and innovations. Arab researchers, represented by [8], have made significant strides in exploring the applications of lasers in manufacturing, underscoring the impact of lasers on industrial processes [5].

This collaborative global effort has propelled lasers to become ubiquitous tools, revolutionizing industries and scientific disciplines alike. It becomes clear that recent research by [9], has highlighted innovations in laser research, further underscoring the dynamic nature of this field [10]. By building on the work of Founded by pioneers such as Einstein and Maiman, contemporary researchers continue to uncover the full potential of the laser, shaping the landscape of scientific research and industrial progress [11].

Laser Operating Principle

A- Absorption: The atoms of a material absorb the photons of radiation directed at them. The energy of the absorbed radiation raises electrons from low-energy orbits to high-energy orbits, placing the atoms in an excited state. Photons are only absorbed by a material if their energy exceeds the energy difference between the electron orbits of the atoms of that material. Therefore, materials are transparent to all radiation with frequencies below specific values determined by the atomic structure of those materials, such as glass [12].

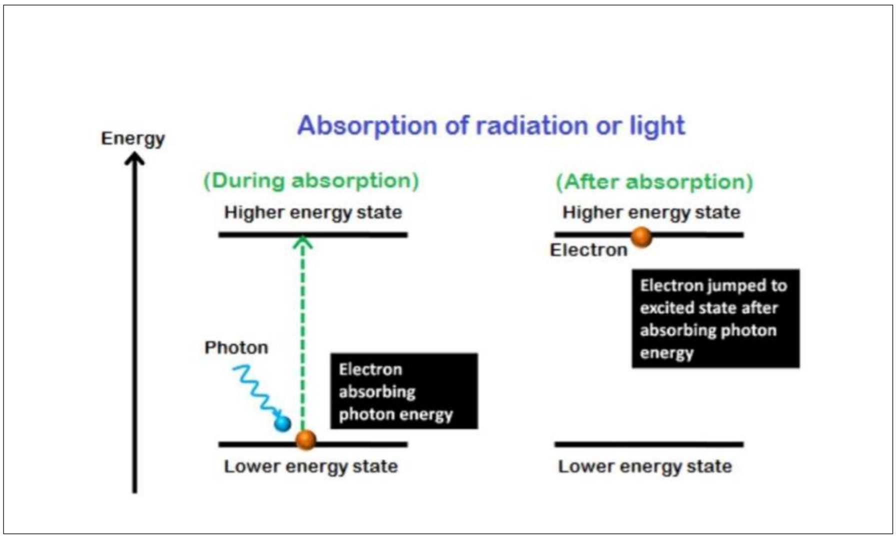

Figure 1: Transfer an electron from one energy level to a higher energy level [12**]**

B- Spontaneous Emission: Excited atoms emit electromagnetic waves as electrons descend from high-energy orbits to lower-energy orbits. The spontaneous radiation emitted by an excited material is called incoherent radiation because the electrons descend spontaneously and randomly between the atom's different orbits. Therefore, this radiation contains a very large number of frequencies [Ordinary light sources rely on the phenomenon of spontaneous emission in their operation] [13].

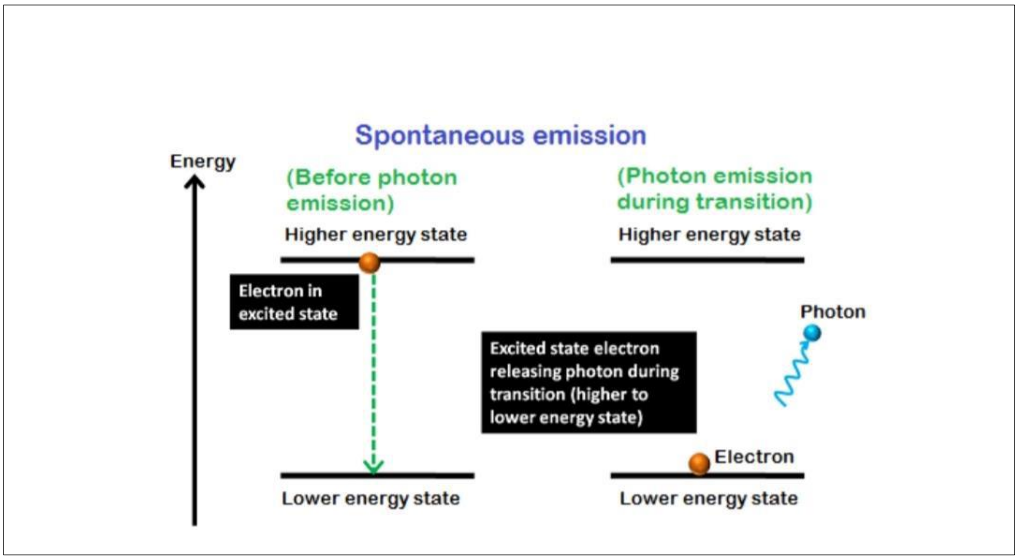

Figure 2: How a photon is emitted when an electron moves from a higher energy level to a lower energy level

C- Stimulated Emission: In this, excited atoms emit electromagnetic waves as a result of electrons descending from high-energy orbits to lower-energy orbits. However, this does not occur spontaneously and randomly, as in spontaneous emission, but rather as a result of being stimulated by radiation of a specific frequency. The stimulated radiation emitted by an excited material is called coherent radiation because the electromagnetic waves resulting from the descending electrons have a frequency and phase that are exactly equal to the frequency and phase of the waves that stimulated the electrons to emit radiation. Therefore, this radiation theoretically has a single frequency. The frequency of the radiation emitted by the material can be calculated by dividing the energy difference between the two orbits between which the electron moved by Planck's constant [14].

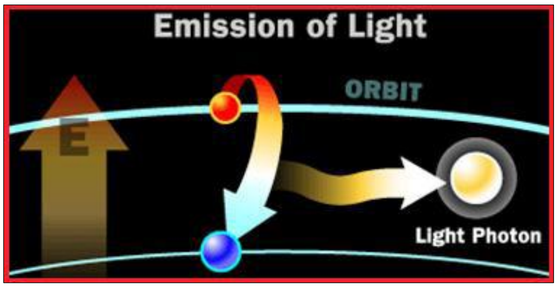

Figure 3: The frequency of the radiation emitted by the material through the energy difference between the two orbits between which the electron moved

The stages of this phenomenon can be summarized as follows:

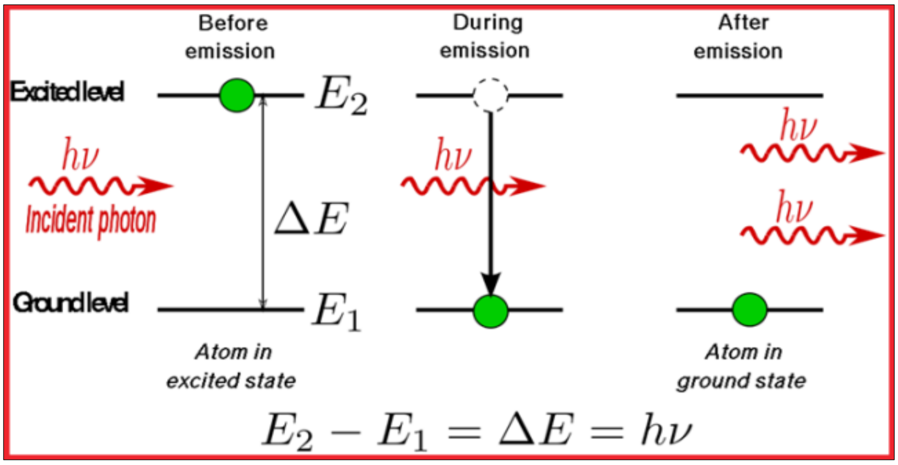

Figure 4: The phenomenon of stimulated emission

Conditions for Laser Beam Generation

The main principle underlying laser operation is the phenomenon of stimulated emission, which we explained earlier. There are three basic conditions for a laser to generate light. The first is the presence of what is called an inverted population distribution of electrons in the atoms of the material that will generate light. This means that the number of electrons in the excited state must be greater than in the unexcited state [15]. This condition is only met in certain materials called active mediums, which have three or more orbitals in their conduction band, and where a metastable orbit exists between the low-energy orbit and the high-energy orbit. There are certain conditions for stimulated emission to occur, which are parallel to what Einstein predicted. N atom with two energy levels, N1 and E1, in the ground state, and 2N and 2E, in the excited state, the stimulated emission is proportional to the number of atoms in the upper level. To achieve significant stimulated emission, N1 must be greater than N2, meaning the population distribution must be inverted. In the case of external excitation, this is called pumping [16].

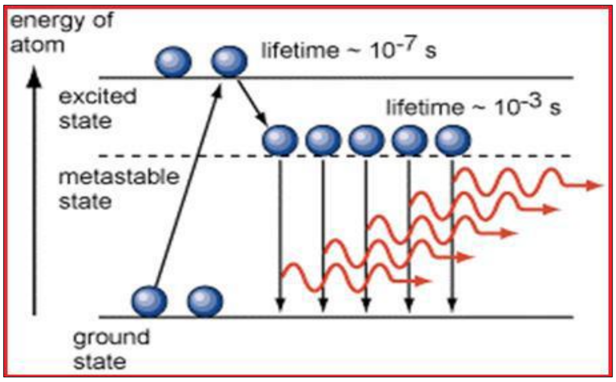

Figure 5 :**The inverted electron population distribution**

The second condition is the availability of a source that pumps electrons from low-energy (non-excited) orbitals to high-energy (excited) orbitals to achieve the inverted electron distribution. The third condition is the presence of a positive feedback system for the laser to act as an oscillator that generates the desired light frequency. Mirrors are often used to achieve this feedback [17].

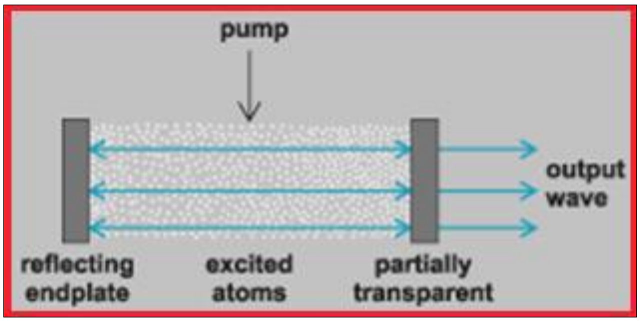

Figure 5 :**The positive back system**

Thus, the laser works by pumping electrons using an external pumping source, such as light or an electric current, from a lower orbit to a higher orbit. The excited electrons then descend through spontaneous emission from the higher orbit to the metastable orbit, which lies between the lower and higher orbits. The electrons begin to accumulate in this orbit, producing the desired inverted population distribution. If a light photon of a specific frequency passes through the material in the inverted population distribution, it will induce some of the electrons in the metastable orbit to descend to the lower orbit, producing a number of light photons with the same frequency, phase, and direction as the photon that excited them. This means that the generated light will have a single frequency, i.e., theoretically monochromatic. Mirrors are used to reflect some of the generated photons so that they pass through the atoms of the active material, generating more photons with the same properties.

One mirror typically has a reflection coefficient close to one, reflecting all incident light, while the second mirror has a reflection coefficient less than one, allowing some of the generated light to escape for use in various applications. Since the stimulated photons have the same frequency as the photons that stimulated them and travel in the same direction, the resulting laser light is nearly monochromatic and travels in one direction, unlike the nature of light from other sources. The light generated by a laser is usually emitted either in pulses or as a continuous wave. This is determined by the atomic composition of the active material, the type and amount of pumping used, and the method of constructing the laser [18].

Structure of a Laser Device

Every laser device, regardless of its type, contains three basic components:

1. Active Medium: The active medium includes materials such as gases (such as helium and neon), liquids (such as dyes), semiconductors (such as gallium arsenide), or solid-state materials (such as sapphire or doped neodymium crystals). It undergoes stimulated emission to emit photons [9].

2. Pump source: A pump source, such as a flash lamp, an electric discharge, an optical microscope, or any other laser, provides the energy needed to excite atoms or molecules within the active medium, triggering the lasing process [10].

3. Optical cavity: The optical cavity consists of two mirrors located at either end of the laser device. These mirrors reflect the photons generated within the active medium, facilitating amplification through multiple passes. One mirror is partially reflective, allowing a portion of the laser light to exit as the output beam [11].

Characteristics of the Laser Beam

Laser radiation possesses several unique properties that distinguish it from conventional light sources and make it highly valuable for various applications. These properties include coherence, monochromaticity, directionality, and high intensity.

1. Coherence: Laser light is coherent, meaning that the waves emitted by the laser are in phase with each other. This coherence results in a well-defined wavefront, enabling laser beams to maintain their spatial and temporal properties over long distances. Coherence allows lasers to produce interference patterns and achieve high-resolution imaging in applications such as holography and interferometry [12].

2. Monochromaticity: Laser radiation is monochromatic, consisting of light waves of a single wavelength or a narrow band of wavelengths. This narrow bandwidth enables lasers to produce light of specific colors with high purity, facilitating accurate spectroscopy and color-based applications in fields such as medical diagnostics and communications [13].

3. Directivity: Laser beams exhibit high directivity, meaning they propagate in a focused, parallel manner with minimal divergence. This directional propagation enables lasers to deliver concentrated energy to specific targets with high precision, making them ideal for applications such as laser cutting, welding, and materials processing [14].

4. High Intensity: Laser radiation is characterized by its high intensity, with energy densities far exceeding those of conventional light sources. This high laser intensity allows the laser to generate extreme temperatures and pressures in localized areas, enabling applications such as laser surgery, laser ablation, and laser-induced plasma generation [15].

Types of lasers

1. Gas Laser: Gas lasers use a gas mixture as the active medium to generate laser light. Examples include helium-neon (HeNe) lasers, carbon dioxide (CO_2) lasers, argon-ion lasers, and excimer lasers. Gas lasers are known for their high power output and wide wavelength range, making them suitable for applications such as laser cutting, welding, and medical surgery [16].

2. Solid-State Lasers: Solid-state lasers use a solid crystalline or glassy medium doped with ions as the active medium. Examples include neodymium-doped yttrium aluminum garnet (Nd:YAG) lasers, ruby lasers, and semiconductor diode lasers. Solid-state lasers offer high efficiency, compactness, and reliability, making them prevalent in many applications, including laser marking, engraving, and medical procedures [11].

3. Semiconductor Lasers: Semiconductor lasers, also known as diode lasers, use a semiconductor material as the active medium. They are small, energy-efficient, and cost-effective, making them ideal for laser applications. They are widely used in telecommunications, optical storage devices, and laser pointers. Semiconductor lasers are also important components in fiber optic communications systems and laser printing technologies [71].

4. Fiber Laser: Fiber lasers use optical fibers as the active medium to generate laser light. They offer high beam quality, stability, and efficiency, making them suitable for industrial cutting, welding, and material processing applications. Fiber lasers are also used in communications, sensing, and medical diagnostics due to their small size and versatility [18].

5. Dye Laser: Dye lasers use organic dye molecules dissolved in a solvent as the active medium. They offer a wide range of tunable wavelengths and high pulse energies, making them valuable for scientific research, spectroscopy, and medical applications such as dermatology and ophthalmology [19].

6. Excimer Laser: Excimer lasers use rare-earth halide gas mixtures as the active medium to produce short-wavelength ultraviolet light. They are used in photolithography for semiconductor manufacturing, as well as in eye surgery for procedures such as laser-assisted in situ (LASIK) and photorefractive keratectomy (PRK) [19].

Medical Applications of Lasers

With the advancement of science and technology, humanity has become able to find many solutions and overcome difficulties that were previously considered impossible. With the arrival of the twenty-first century, humanity has been exposed to a modern technology that has revolutionized various fields, most notably the medical field: laser technology. Lasers have been used in many medical fields since their invention in 1960. Since then, they have been widely used in the medical field, with the use of automated technology in modern medicine developing dramatically.

One of the most famous applications of this technology is the introduction of lasers into surgery, cosmetic surgery, ophthalmology, and the treatment of skin diseases, among other ailments. This has added more magic and ingenuity to treatment methods thanks to these amazing rays, and has brought about a major, unprecedented scientific revolution in the field of therapeutic medicine and surgery. It took a long time for lasers to become a staple in therapeutic tools. The operation of lasers was based on Albert Einstein's theory in the early twentieth century (1917), but scientists were not able to apply his theory until the early 1960s (1964). After that, the actual application of lasers to the human body did not occur until another decade later. Lasers have been used in many types of treatment, from vision correction to smoothing the skin's surface to eliminate wrinkles and remove moles and scars. [20]. Laser medicine includes laser diagnosis, laser treatment, and treatment, such as phototherapy [20]. Among the medical applications of lasers are:

1. Laser-Tissue Interaction

The interaction of laser light with soft tissue provides a unique surgical method. A highly focused laser beam vaporizes tissue containing a high degree of water. The laser can create very small incisions when the beam is focused on tissue (the focal spot can be reduced to 0.1 mm), but the most widely used area in practice is 0.4 mm. When the beam is defocused, the intensity of the laser light on the tissue decreases. In this case, it can be used to cauterize small blood vessels and lymphatic vessels, thus reducing post-operative swelling. The laser beam also has a natural sterilizing effect, vaporizing bacteria, viruses, and fungi, leading to a reduction in local infections. Perhaps most importantly, the laser reduces post-operative pain by blocking nerve endings [21].

Figure 6: Laser tissue surgery device

2. Using Lasers in Cancer Treatment

The absorption of laser light in photochemical effects results from vibrational or electronic excitation of cellular molecules or the secondary optical structure of the naturally occurring biocompatible tissue, or at the outer edges of cells. Biostimulation and photodynamic therapy for cancer are important examples of this type of interaction. Photodynamic therapy can be used after bone fracture treatment, wound healing, pain relief, nerve stimulation, etc. Photodynamic therapy for cancer treatment involves injecting the photosensitizer into the human body. Approximately 24-48 hours after injection, the highest contrast in the photosensitizer concentration occurs. The cancerous tissue bearing the pigment is then irradiated with a gold-plated laser, which radiates at 630 nm, a wavelength close to 624 nm. Finally, the photosensitizer selects the photochemical substructure that generates monooxygen, which then causes cancer cell toxicity due to membrane separation [21].

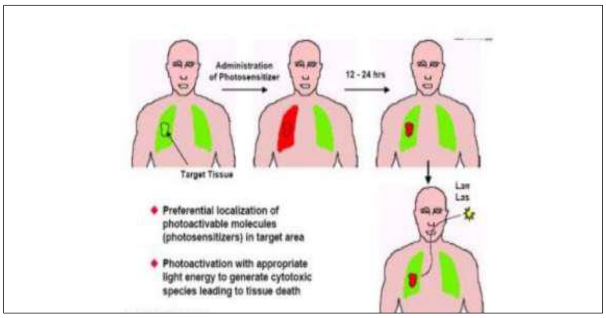

Figure 7: Represents photodynamic therapy

3. Use of Lasers in Dental Treatment

The use of lasers in dentistry is relatively new and not widespread. However, the science of using lasers in dentistry is constantly evolving, and many dental clinics have begun to introduce and use advanced laser dental treatment devices. The laser-treated dentist directs light energy at the teeth or gums he wishes to treat. The laser acts as a cutting or dissolving tool for the tissues it passes through [22].

Important indications for lasers in dentistry include the following:

1. Tooth decay: The laser is used to remove tooth decay and prepare teeth for fillings.
2. Gum disease: The laser can be used as a cutting tool to remove and modify the appearance of the gums.
3. Teeth whitening: The laser saves time in the teeth whitening process. 4- Tumor removal: Lasers can be used to remove benign and malignant tumors within the mouth.
4. Sterilization of root canals (nerve treatments)
5. Minor surgeries, as some types of lasers are capable of making a surgical incision and coagulating bleeding blood vessels.

As for the disadvantages of using lasers in dentistry today, they are [22]:

- Lasers cannot be used on teeth with old fillings.
- Lasers cannot be used on completely decayed teeth.
- Lasers cannot be used to prepare teeth for crowns or bridges.
- Laser treatment does not completely replace anesthesia.
- The cost of laser treatment is often higher.

The most important indications for lasers in oral and gum surgery and dentistry are: [22]

1. Treatment of Abscesses: Despite local anesthesia for acute infections and abscesses, the patient feels pain when the abscess is opened. However, using the Diodone laser reduces this feeling, with impressive results and less bleeding than with traditional treatment.

2. Removal of Salivary Stones in the Salivary Glands: These stones block the saliva flow, causing saliva to pool and causing severe pain and dry mouth. Therefore, the stone must be removed before the gland becomes chronically inflamed, causing a pathological morphological change in its tissue or membrane. Using the laser, the membrane can be released, exposing the duct, and removing the stone without any bleeding that would obstruct vision. Another benefit is that the sutured salivary duct does not form a scar, which can lead to its narrowing and subsequent saliva retention, as with conventional surgery.

3. Pre-Denture Surgery: There may be fibrous protrusions and tumors that cause pain and trauma to the mucous membrane. These can be removed without any side effects or bleeding. There is no need to close the wound; it heals spontaneously, and a new mucous membrane forms shortly thereafter.

4. Soft Tissue Tumors: Tumors that are located extensively on the mucous membrane of the cheek or adjacent to the corner of the mouth or the opening of the parotid duct make their removal difficult using conventional methods due to the bleeding that obscures the view. However, with a laser, they can be easily removed without the need for stitches. Salivary cysts are also removed superficially.

5. Orthodontic Surgery: For migrated and impacted teeth, such as canines, the tooth must be freed from the soft tissue covering it, and the work area must be kept clean and free of blood and fluids so that the orthodontist can adhere the orthodontic appliance to the tooth. This is done using a Diodone laser.

6. Dental Implants: The laser helps perform the procedure with clear vision in a sterile, bloodless area.

7. Gum Surgery: The laser treats deep gum pockets and sterilizes them down to the roots [22].

4. Using Low-Energy Lasers in Eye Surgery

The cases in which burning laser treatment is used are diabetic retinopathy, which is of two types:

1. Partial Treatment, In Which Abnormal Blood Vessels Are Closed: This results in the secretion of proteins that accumulate in parts of the retina, potentially affecting visual acuity. In some cases, prior to performing this laser treatment, a retinal dye scan must be performed to identify weak areas in the blood vessels, facilitating precise cauterization [23].

2. Complete Treatment of all Parts of the Retina: This treatment is required when there is additional and abnormal blood vessel growth on the surface of the retina, often accompanied by retinal hemorrhage and contractions on the surface of the retina or between the retina and the vitreous humor [23].

5. Use of Lasers in Cosmetic Surgery

a. Use of Low-Energy Lasers in the Treatment of Obesity

Obesity and overweight are the cause of decreased mobility, joint and back pain, inability to wear nice clothes, and a low self-esteem for the obese person. Low-energy laser treatment for obesity also uses the same concept as the use of Chinese acupuncture points in the ear, specifically the appetite, stomach, and lung points. This is the same point used in treating addiction. In traditional Chinese medicine, obesity is described as a case of food addiction. A point in the ear, called the "gateway of the soul" in Chinese medicine, is also treated to calm the psychological state of the obese patient, who may become stressed while following a weight-loss regimen.

In this case, a sedative is placed on the ear. Semi-permanent needles are inserted into specific points in the ear, then exposed to a low-energy laser beam for 5 seconds. These are then left in place for a week, during which the treatment is repeated. Various points on the patient's body can be stimulated using the laser beam alone, as an alternative to traditional metal needles. With the use of lasers for obesity treatment, the patient is prescribed a special diet that ensures they receive all the nutrients their body needs. This diet also serves the goal of losing excess weight, while ensuring that obese patients change their eating and exercise habits to prevent relapse. Regular exercise is also encouraged during and after the obesity treatment program [23].

b. Using Lasers in Body Contouring (Laser Diet)

The new Zerona device generates low-energy laser beams that leave no scars in body tissue. Instead, it helps the body dissolve fat and stimulate its biological functions to eliminate it without surgery, negative complications, or even downtime, as is the case with liposuction. The Zerona device is ideal for people seeking to lose weight using the easiest, most laboratory-proven methods, hence the nickname "laser diet." This leads to the formation of massive fatty tissues, which leads to the accumulation of subcutaneous fat. Because subcutaneous fat is close to the surface of the skin, laser technology can achieve extremely positive results. Experiments have shown that accumulated fat melts and shrinks in size after medical laser treatment, contributing to body slimming and toning. This treatment allows the user to perform daily activities normally. The Arkon laser is used for liposuction, and it is considered the safest and most studied type in the world experiments to date have shown extremely positive results [23].

Lasers are also used to alleviate the symptoms of some types of cancer, Reducing bleeding and blockages, Shrinking or destroying tumors that block the patient's windpipe or esophagus, (colon polyps) to eliminate colon polyps, Eliminating tumors that block the colon or stomach and break up urinary tract stones without the need for surgery [24].

The use of lasers is no longer limited to vision correction and hair removal procedures, but has extended to surgical procedures as a cutting tool. Lasers are a hot topic in medicine these days. Scientific statistics have proven the benefits of lasers in reducing pain during and after surgery and reducing bleeding. They are also used in dental clinics, treating skin diseases such as acne and eczema, removing scars and warts, treating burns, and more. They have even recently been used in hearing restoration. Scientific studies are ongoing in all medical fields to explore other areas where lasers can be used [24].

Although scientific research is still underway to develop the use of lasers in various medical fields, the following advantages have been observed in laser technology over other medical technologies:

- Laser treatment is often painless or minimally invasive, thus reducing the need for anesthesia.
- Laser treatment does not produce noises like other traditional medical technologies, thus reducing patient stress.
- Lasers reduce bleeding associated with surgical procedures.
- Laser use in medical procedures is limited to the area to be treated, thus reducing the side effects resulting from various surgical procedures [24].

Advantages of Using Lasers in Medicine

Lasers in medicine enable high precision by focusing on a small area and minimizing subsequent damage to surrounding areas of the body. Pain, swelling, and tissue damage are less common than with traditional surgical procedures. Lasers are also used to shrink and destroy precancerous tumors or small tumors before they develop into cancerous tumors [24].

Another benefit of using lasers in medicine, and particularly in surgical operations, is the sterilization of the surgical area. Lasers offer precision and selectivity in their interaction with diseased tissue. Using lasers can reduce the amount of germs and other pathogenic organisms in the surgical field, as well as reduce bleeding and pain. Laser surgery has been shown to be less painful than traditional surgery, such as during and after surgery, and to reduce the use of local anesthesia. It also reduces the surgeon's effort due to the absence of bleeding and the time required to close and suture the wound, as there is no need for sutures when using lasers in surgery [24].

Disadvantages of Using Lasers in Medicine

Currently, the use of lasers is widespread and noticeable across a wide range of fields. Despite the benefits that result from their use, they may cause some damage to the areas exposed to the radiation. The following are the damages resulting from the use of lasers [24].

Skin Damage: Skin pigmentation; Skin pigmentation refers to the appearance of white spots. These spots appear on the skin due to the inability of melanin to reach the skin due to exposure to the laser. The pigmentation may be dark spots and appear due to an increase in melanin secretion in the area exposed to the laser. Skin irritation, swelling, and itching may occur in the area exposed to the radiation. These side effects are temporary and disappear after a period of use. Some local pain and tingling sensations may occur in the exposed area. Eye damage: The eye is one of the body's sensitive organs and can be severely damaged by laser treatment. Therefore, care and caution must be taken when treating it with radiation. Some errors in laser use can cause severe eye damage, including: Pressure on the eye fluids.

General Body Damage: During laser treatment, the treated area becomes very sensitive and irritated, making it more susceptible to infection. Therefore, it must be cleaned regularly.

Burns: Laser beams are characterized by their extremely high temperature, so sensitive skin may suffer burns during radiation therapy. The burns and the severity of burns vary depending on the skin type and nature, as well as the skin type.

Laser Treatment May Be Expensive and Requires Multiple Treatment Sessions.

The disadvantages of using the laser beam scalpel are as follows:

1. The high cost and complexity of this surgical technique.
2. The speed of this scalpel is slower than that of a conventional scalpel.
3. The problems resulting from its use as a surgical instrument and the safety issues associated with its use.

CONCLUSIONS

The study concludes that lasers are electromagnetic radiation whose photons are equal in frequency and in phase, constructively interfering with each other, transforming into a high-energy light pulse. Over the past ten years, the topic of lasers has occupied a prominent place in the conversation in various aspects of science and technology. For example, traditional lamps, both spectral and thermal, have been replaced by laser sources. Laser technology is here to stay and will evolve at a measured pace, increasing the efficiency of older devices (such as ruby and others) and developing new ones (such as copper lasers and others). They have a bright and amazing future in applied sciences, especially when combined with fiber optic technology.

Despite the advancements in the use of lasers, they face many challenges, as concerns remain about the impact of their use and the need to regulate their operating techniques. The applications of lasers are numerous and cannot be listed in this research. These include scientific, industrial, and medical fields, which have begun to spread widely and are receiving widespread acceptance due to their quality and accuracy.

The most important applications of lasers are medical, given their direct connection to human life and health. Lasers are used in many medical applications related to accurate diagnosis and treatment, as well as in many applications in the field of healthcare.

REFERENCES

1. Steiner, R., 2006. New laser technology and future applications. Medical Laser Application, 21(2), pp.131-140.
2. Goldman, L. ed., 2013. The biomedical laser: technology and clinical applications. Springer Science & Business Media.
3. Legres, L.G., Chamot, C., Varna, M. and Janin, A., 2014. The laser technology: new trends in biology and medicine. Journal of Modern Physics, 5(5), pp.267-279.
4. Berlien, H.P., 2003. Applied laser medicine. Springer Science & Business Media.
5. Jelínková, H. ed., 2013. Lasers for medical applications: diagnostics, therapy and surgery. Elsevier.
6. Slusher, R.E., 1999. Laser technology. Reviews of modern physics, 71(2), p.S471.
7. Nafisah, S., Tukiran, Z., Sheng, L.W., Rohim, S.N., Teck, V.S.I., Razali, N.L. and Morsin, M., 2021. Laser technology applications in critical sectors: Military and medical. Journal of Electronic Voltage and Application, 2(1), pp.38-48.
8. Senz, R. and Müller, G., 1989. Laser in medicine. Berichte der Bunsengesellschaft für physikalische Chemie, 93(3), pp.269-277.
9. Anthony E. Siegman, "Lasers," University Science Books, 1986
10. Peter W. Milonni and Joseph H. Eberly, "Lasers," John Wiley & Sons, 2010[10]
11. Orazio Svelto, "Principles of Lasers," Springer, 2010[11]
12. Joseph W. Goodman, "Introduction to Fourier Optics," Roberts and Company Publishers, 2005 [12]
13. Milo Wolff, "Exploring the Physics of the Unknown Universe: An Adventurous Journey into the World of Particles, Fields, and Waves," Taylor & Francis Group, 2019.
14. Mark Csele, "Fundamentals of Light Sources and Lasers," John Wiley & Sons, 2004[14]
15. Dieter Meschede, "Optics, Light and Lasers: The Practical Approach to Modern of Photonics and Laser Physics," Wiley-VCH, 2008 Mark Csele, "Fundamentals of Light Sources and Lasers," John Wiley & Sons, 2004
16. Sons, 2012& Govind P. Agrawal, "Fiber-Optic Communication Systems," John Wiley
17. Johan Nilsson, "High-Power Fiber Lasers: A Review," IEEE Journal of Selected Topics in Quantum Electronics, 2013.
18. F.J. Duarte, "Dye Laser Principles," Academic Press
19. Hillman, L.W. (1990). Dye Laser Principles, with Applications. Boston:Academic Press. ISBN 0-12-222700-X.
20. Azadgoli, B. and Baker, R.Y., 2016. Laser applications in surgery. Annals of translational medicine, 4(23), p.452.
21. Niemz, M.H. and Niemz, M.H., 2019. Medical applications of lasers. Laser-tissue interactions: fundamentals and applications, pp.153-249.
22. Deckelbaum, L.I., 1994. Cardiovascular applications of laser technology. Lasers in surgery and medicine, 15(4), pp.315-341.
23. Khalkhal, E., Rezaei-Tavirani, M., Zali, M.R. and Akbari, Z., 2019. The evaluation of laser application in surgery: a review article. Journal of lasers in medical sciences, 10(Suppl 1), p.S104.