



University of Al-Mustaqbal
College of Science
Department of Medical Physics



AL- Mustaqpal University

Science College

Dep. Medical physics

Medical Laser Applications

Third Stage

Lec 1

Introduction Of Laser In Medicine

Asst. lec. Ali Salman Hamadi

Introduction to Lasers in Medicine

Uses of Lasers in Medicine. Lasers have revolutionized medical science with their precision, versatility, and ability to uniquely interact with biological tissue. During this lecture, we will understand the basic principles of the laser, its unique properties, and its applications in various medical fields.

1. What is a Laser?

Laser is an acronym for **Light Amplification by Stimulated Emission of Radiation**. It is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation.

Key Properties of Laser Light:

- **Monochromatic:** The light emitted is of a single wavelength.
- **Coherent:** The light waves are in phase, both temporally and spatially.
- **Directivity:** The light is emitted as a narrow, focused beam.
- **High Intensity:** The light can be concentrated to a small area, delivering significant energy.

2. Basic Principles of Laser Operation:

To understand how lasers work, let's discuss the underlying physical principles:

- **Stimulated Emission:** An atom or molecule in an excited state emits a photon when triggered by another photon of the same energy.
- **Population Inversion:** A condition where more atoms are in an excited state than in the ground state, achieved by external energy sources (pumping).
- **Optical Resonance:** The emitted photons are amplified as they reflect back and forth in a cavity containing a gain medium.

3. Interaction of Laser Light with Biological Tissues

When laser light interacts with tissues, several phenomena can occur depending on the wavelength, intensity, and tissue type:

- **Absorption:** The tissue absorbs laser energy, often leading to heating or other effects.
- **Scattering:** The light is redirected in different directions.
- **Reflection:** Part of the laser light is reflected off the tissue surface.
- **Transmission:** Some of the laser light passes through the tissue without interaction.

The specific effects depend on the chromophores (light-absorbing molecules) present, such as water, hemoglobin, and melanin.

4. Applications of Lasers in Medicine

Lasers are used in a wide range of medical procedures due to their precision and ability to target specific tissues. Some major applications include:

a) Surgical Applications

- **Soft Tissue Surgery:** Carbon dioxide (CO₂) lasers are commonly used for precise cutting and coagulation.
- **Ophthalmology:** Excimer lasers are used in LASIK surgery to reshape the cornea and correct vision.

b) Dermatology

- **Laser Skin Resurfacing:** Fractional lasers improve skin texture and treat scars or wrinkles.

- **Hair Removal:** Diode and Nd:YAG lasers target hair follicles to prevent regrowth.

c) **Oncology**

- **Photodynamic Therapy (PDT):** Combines a photosensitizing agent with laser light to destroy cancerous cells.

d) **Dentistry**

- **Cavity Treatment:** Lasers can remove decayed tissue and sterilize the area without drilling.
- **Teeth Whitening:** Certain lasers activate bleaching agents for faster results.

e) **Diagnostic Applications**

- **Laser Doppler Flowmetry:** Measures blood flow in tissues.
- **Optical Coherence Tomography (OCT):** High-resolution imaging of tissues, particularly in ophthalmology.

f) **Therapeutic Applications**

- **Low-Level Laser Therapy (LLLT):** Promotes healing, reduces pain, and stimulates cellular repair.

5. Advantages of Using Lasers in Medicine

- a) **Precision:** Lasers can target specific tissues without damaging surrounding areas.
- b) **Minimally Invasive:** Many laser procedures require small incisions or none at all.
- c) **Reduced Recovery Time:** Less trauma to tissues leads to quicker healing.
- d) **Versatility:** Applicable across diverse medical specialties.

6. Safety Considerations

While lasers offer many benefits, safety is paramount. Protective measures include:

- Wearing appropriate laser safety goggles.
- Avoiding direct or reflected laser exposure.
- Proper training for operators.

7. The Future of Lasers in Medicine:

Advancements in laser technology continue to expand their medical applications.

Areas of active research include:

- **Nanomedicine:** Combining lasers with nanoparticles for targeted drug delivery.
- **Robotic Surgery:** Integration of laser systems with robotic platforms.
- **Regenerative Medicine:** Using lasers to stimulate stem cell growth and tissue repair.

Conclusion In summary, Lasers have revolutionized the medical field by providing precise, effective, and minimally invasive solutions. Their unique properties, such as monochromaticity and coherence, make them indispensable in various diagnostic and therapeutic applications. As medical physicists, understanding the principles and applications of lasers will enable you to contribute to innovations in this promising field.

Discussion

1. The term LASER stands for:

- A) Light Absorbing Radiation
- B) Light Amplification Radiation
- C) Light Reflection System
- D) Light Activated Emission
- E) Light Amplification by Stimulated Emission

✓ **Correct Answer: E**

2. Laser light has only one wavelength, meaning it is:

- A) Coherent
- B) Intense
- C) Divergent
- D) Monochromatic
- E) Reflected

✓ **Correct Answer: D**

3. In-phase laser waves are described as:

- A) Monochromatic
- B) Coherent
- C) Focused
- D) Polarized
- E) Scattered

✓ **Correct Answer: B**

4. Emission in a narrow beam indicates:

- A) Absorption
- B) Scattering
- C) Directivity
- D) Transmission
- E) Reflection

✓ **Correct Answer: C**

5. High laser intensity means:

- A) Low energy
- B) Wide beam
- C) Multiple wavelengths
- D) Concentrated energy
- E) Weak output

✓ **Correct Answer: D**

6. Stimulated emission occurs when:

- A) Photon triggers emission
- B) Atom loses electron
- C) Energy decreases
- D) Atom cools
- E) Photon absorbed

✓ **Correct Answer: A**

7. Population inversion means:

- A) More excited atoms
- B) Equal energy levels
- C) Fewer excited atoms
- D) No emission
- E) Energy loss

✓ **Correct Answer: A**

8. Population inversion is achieved by:

- A) Cooling
- B) Pumping
- C) Reflection
- D) Absorption
- E) Scattering

✓ **Correct Answer: B**

9. The optical cavity causes:

- A) Light loss
- B) Photon absorption
- C) Light amplification
- D) Beam divergence
- E) Energy reduction

✓ **Correct Answer: C**

10. Tissue heating mainly results from:

- A) Reflection
- B) Transmission
- C) Refraction
- D) Scattering
- E) Absorption

✓ **Correct Answer: E**

11. Scattering of laser light means:

- A) Light absorption
- B) Direction change
- C) Complete reflection
- D) Energy loss
- E) Beam focusing

✓ **Correct Answer: B**

12. Which is a biological chromophore?

- A) Bone
- B) Plastic
- C) Air
- D) Glass
- E) Water

✓ **Correct Answer: E**

13. CO₂ lasers are mainly used for:

- A) Imaging
- B) Soft tissue surgery
- C) Hair removal
- D) PDT
- E) Diagnosis

✓ **Correct Answer: B**

14. LASIK surgery uses:

- A) CO₂ laser
- B) Diode laser
- C) Nd:YAG laser
- D) Excimer laser
- E) Ruby laser

✓ **Correct Answer: D**

15. Fractional lasers are used in:

- A) Oncology
- B) Dentistry
- C) Dermatology
- D) Cardiology
- E) Neurology

✓ **Correct Answer: C**

16. Laser hair removal targets:

- A) Skin surface
- B) Hair follicles
- C) Blood vessels
- D) Nerves
- E) Bones

✓ **Correct Answer: B**

17. Photodynamic therapy combines:

- A) Laser only
- B) Drug only
- C) Laser and photosensitizer
- D) Heat and light
- E) Radiation only

✓ **Correct Answer: C**

18. Lasers in dentistry are used for:

- A) Tissue sterilization
- B) Imaging
- C) Mechanical drilling
- D) Cooling enamel
- E) Bone cutting

✓ **Correct Answer: A**

19. OCT provides:

- A) Therapy
- B) Surgery
- C) High-resolution imaging
- D) Hair removal
- E) Tissue cutting

✓ **Correct Answer: C**

20. Laser Doppler Flowmetry measures:

- A) Blood flow
- B) Temperature
- C) Pressure
- D) Oxygen level
- E) Cell growth

✓ **Correct Answer: A**

21. Low-Level Laser Therapy is used for:

- A) Cutting tissue
- B) Destroying cells
- C) Promoting healing
- D) Imaging
- E) Anesthesia

✓ **Correct Answer: C**

22. A major advantage of medical lasers is:

- A) Wide damage
- B) Long recovery
- C) Random energy
- D) High precision
- E) High invasiveness

✓ **Correct Answer: D**

23. Laser procedures are generally:

- A) Highly invasive
- B) Unsafe
- C) Minimally invasive
- D) Slow
- E) Conventional

✓ **Correct Answer: C**

24. Essential laser safety equipment:

- A) No protection
- B) Safety goggles
- C) Higher power
- D) Dark room
- E) Metal mirrors

✓ **Correct Answer: B**

25. Laser-nanoparticle research belongs to:

- A) Nanomedicine
- B) Surgery
- C) Imaging
- D) Dentistry
- E) Dermatology

✓ **Correct Answer: A**