AL- Mustaqpal University
Science College
Dep. Medical physics

Medical physics
Third Stage

Lec 5

Laser process

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Laser process

Common Features of Lasers

1- Light amplifying media

¬All lasers contain an amplifying substance that works to increase the intensity of light passing through it

¬This substance is called the amplifying (or the gain) medium. ¬It can be a solid (solid state laser), a liquid (liquid laser) or a gas (gas laser).

¬It contains atoms, molecules or ions in a high proportion to: store energy which is subsequently released as light.

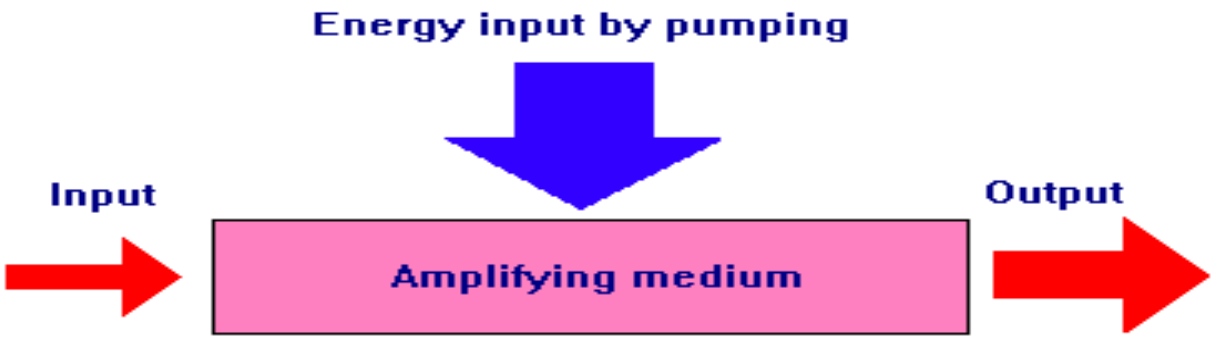
Amplifying medium is characterized by **GAIN**

GAIN : the factor by which the intensity of the light is increased by the amplifying medium

IT **DEPENDS ON** :

1- Wavelength of the incoming light.
2- Intensity of the incoming light.
3- Length of the amplifying medium (inverse proportionality).
4- Amount of energizing the amplifying medium (pumping).

2- Energizing Amplifying Medium (Pumping)



Amplifying a beam of light means putting additional energy into the beam.

THEREFORE

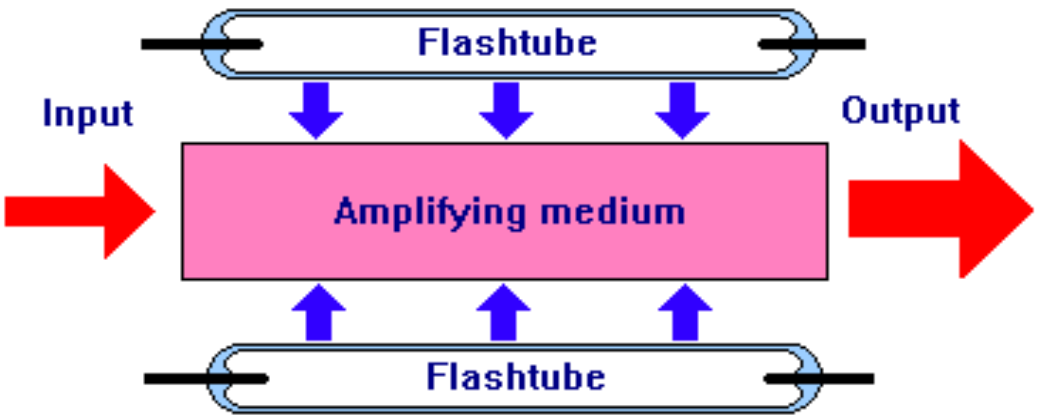
the amplifying medium must have energy fed into it to provide this energy.

The fed energy works to re-arranges the amplifying medium in some way to store the energy and then releases it as amplified light ,This process is known as **"pumping**

• Optical pumping

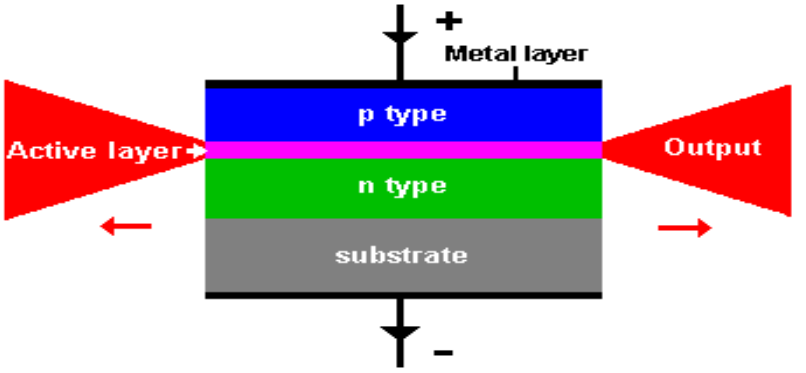
* Xenon-filled flashtubes around a solid state amplifying medium.

* High voltage causes electric discharge through the flash tube

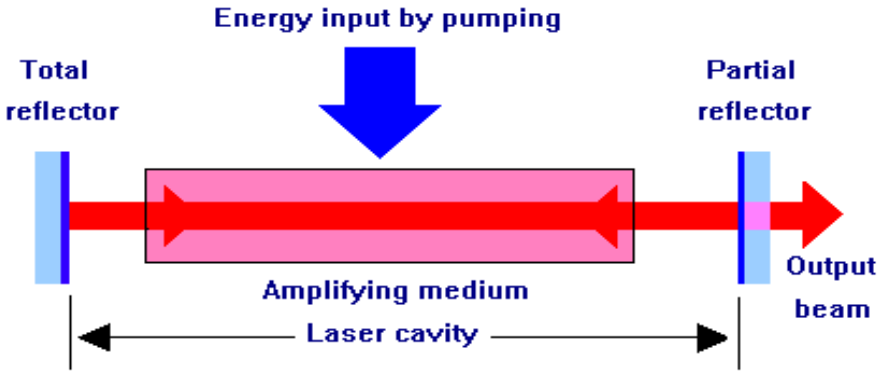


● **Electrical pumping**

electric current passes across the junction of the diode



3- Laser Oscillator



The pumped amplifying medium is positioned between

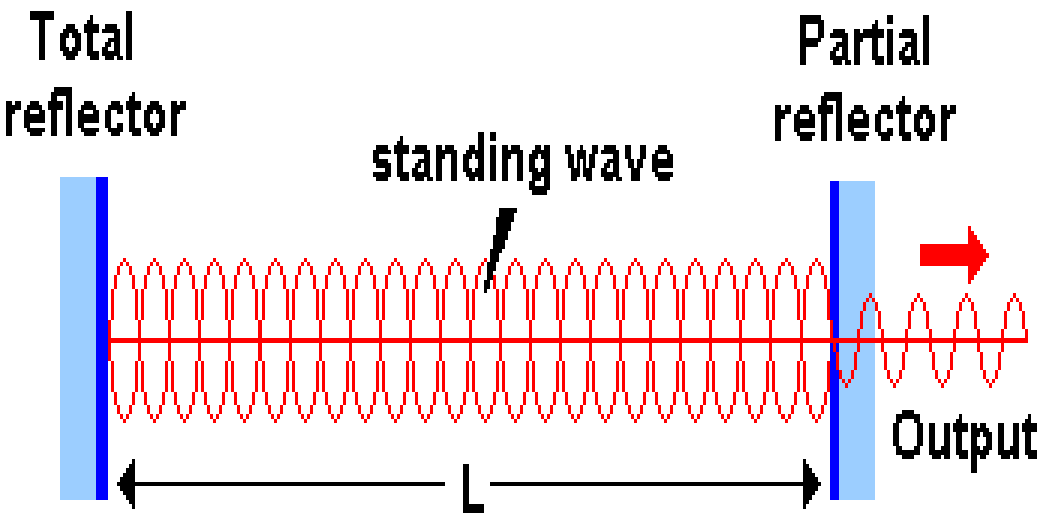
two mirrors

↓

'positive feedback'

some of the light that emerges from the amplifying medium is reflected back into it for further amplification.

An amplifier with positive feedback is known as an **oscillator**



- The space between the two mirrors is known as **the laser cavity** .
- Within the cavity, the beam undergoes multiple reflections and is amplified each time it passes through the amplifying medium .
- One of the mirrors reflects almost all of the light that falls upon it .
- The other mirror reflects between 20% and 98% of the incident light.
- This transmitted portion constitutes the output beam of the laser .

❖Light forms standing waves between the mirrors.

❖These waves correspond to longitudinal modes.

❖**Each mode:**

- has a characteristic wavelength
- propagates in a characteristic direction

Lasing process and advantages of employing the laser cavity

Following pumping, spontaneous emission occurs by excited atoms

ADVANTAGES OF THE CAVITY

- The cavity ensures that the divergence of the beam is small
- This emitted light initiates stimulated emission and then increases in intensity by multiple passes through the amplifying medium.
- Only light traveling in a direction parallel to the cavity axis can undergo multiple reflections and make multiple passes through the amplifying medium.
- More divergent rays wander out of the cavity.
- **The laser cavity also improves the spectral purity of the laser beam**
- The amplifying medium amplifies light within a narrow range of wavelengths.
- Within this narrow range, only cavity modes can undergo repeated reflection up and down the cavity
- Other modes are rapidly attenuated and will not be present in the output beam.

Discussion

1. What is the amplifying substance in a laser called?
   A) Source
   B) Medium
   C) Lens
   D) Mirror
   E) Filter
   Ans: B
2. The amplifying medium can be:
   A) Solid only
   B) Gas only
   C) Liquid only
   D) Solid, liquid, gas
   E) Plasma
   Ans: D
3. What does the amplifying medium store?
   A) Heat
   B) Sound
   C) Energy
   D) Vibration
   E) Pressure
   Ans: C
4. GAIN refers to:
   A) Energy loss
   B) Light speed
   C) Light intensity factor
   D) Wavelength shift
   E) Power loss
   Ans: C

5. Gain depends on:

   A) Mirror type

   B) Medium color

   C) Wavelength

   D) Beam angle

   E) Crystal size

   Ans: C

6. Which is NOT a gain factor?

   A) Wavelength

   B) Pumping

   C) Length

   D) Intensity

   E) Mirror type

   Ans: E

7. Longer amplifying medium means:

   A) More gain

   B) Less gain

   C) No effect

   D) Random gain

   E) Infinite gain

   Ans: B

8. Pumping provides:

   A) Cooling

   B) Energy

   C) Shielding

   D) Reflection

   E) Diffraction

   Ans: B

9. Optical pumping uses:

   A) Lasers

   B) LEDs

   C) Flash tube

   D) Magnet

   E) Prism

   Ans: C

10. Electrical pumping uses:

   A) Diode junction

   B) Flash tube

   C) Battery

   D) Capacitor

   E) Magnet coil

   Ans: A

11. Laser oscillator needs:

   A) One mirror

   B) Two mirrors

   C) Lens

   D) Crystal only

   E) No mirrors

   Ans: B

12. The laser cavity is:

   A) Medium itself

   B) Space between mirrors

   C) Source tube

   D) Cooling area

   E) Lens path

   Ans: B

13. Positive feedback is provided by:

A) Pumping

B) Mirrors

C) Prism

D) Lens

E) Diode

Ans: B

14. The highly reflective mirror reflects:

A) 10%

B) 50%

C) Almost all

D) 0%

E) 25%

Ans: C

15. Output beam comes from:

A) Lens

B) Medium

C) Partially reflecting mirror

D) Both mirrors

E) Flash tube

Ans: C

16. Standing waves inside cavity are:

A) Transverse modes

B) Longitudinal modes

C) Random modes

D) Lateral modes

E) No modes

Ans: B

17. Each cavity mode has:

A) One direction only

B) One frequency only

C) Wavelength & direction

D) Polarization only

E) No property

Ans: C

18. Divergence is reduced by:

A) Gain

B) Pumping

C) Laser cavity

D) Flash tube

E) Cooling

Ans: C

19. Stimulated emission is triggered by:

A) Spontaneous emission

B) Pumping

C) Cooling

D) Mirror

E) Flash tube

Ans: A

20. Only rays parallel to cavity axis:

A) Are lost

B) Are amplified

C) Are absorbed

D) Scatter away

E) Stop

Ans: B

21. Divergent rays in cavity:

A) Reflected

B) Amplified

C) Wander out

D) Focused

E) Stored

Ans: C

22. Spectral purity is improved by:

A) Pumping

B) Mirrors

C) Laser cavity

D) Cooling

E) Gain

Ans: C

23. Amplifying medium amplifies:

A) Wide wavelengths

B) Single color

C) Narrow range

D) Infrared only

E) UV only

Ans: C

24. Modes outside cavity range are:

A) Amplified

B) Attenuated

C) Reflected

D) Stored

E) Multiplied

Ans: B

25. The final laser output is:

A) Divergent, weak

B) Pure, collimated

C) Wide, incoherent

D) Random, strong

E) Unstable, weak

Ans: B