

AL- Mustaqpal University
Science College
Dep. Medical physics



Medical physics
Third Stage

Lec 5

Laser process

م . م علي سلمان حمادي

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.

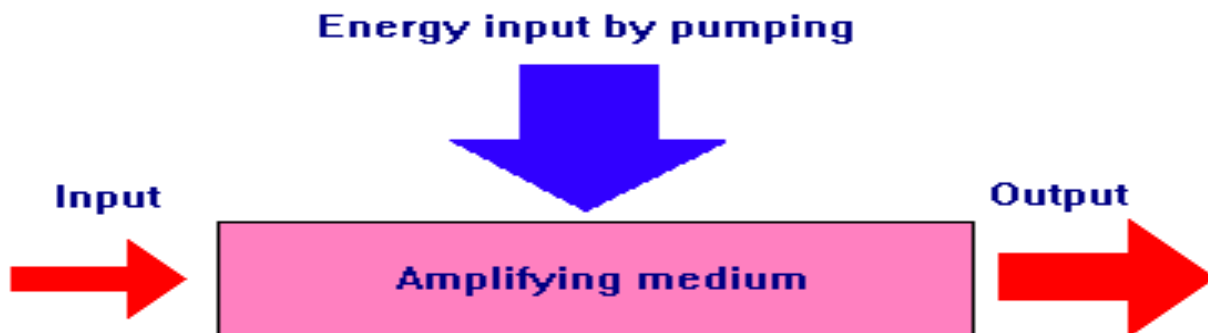
Amplifying medium is characterized by **GAIN**

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

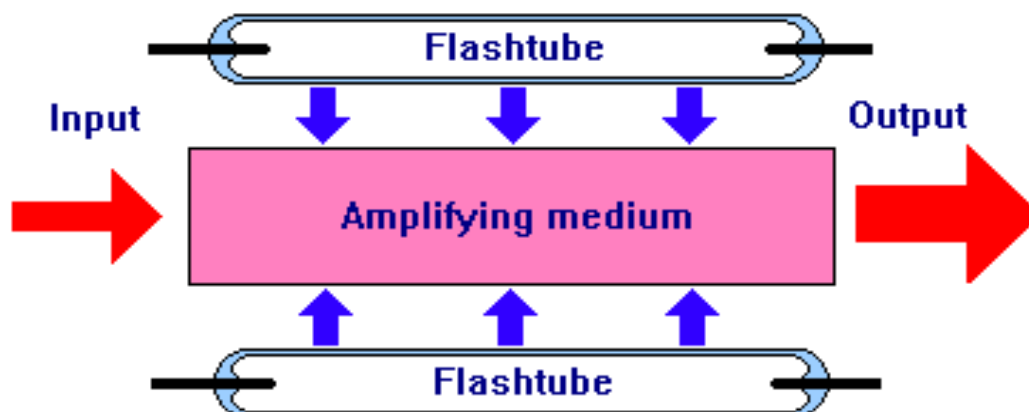
the amplifying medium must have energy fed into it to provide this energy.

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

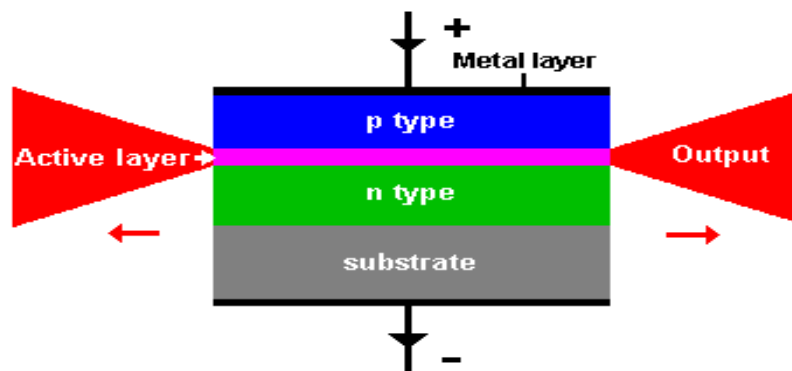
* Xenon-filled flashtubes around a solid state amplifying medium.

* High voltage causes electric discharge through the flash tube

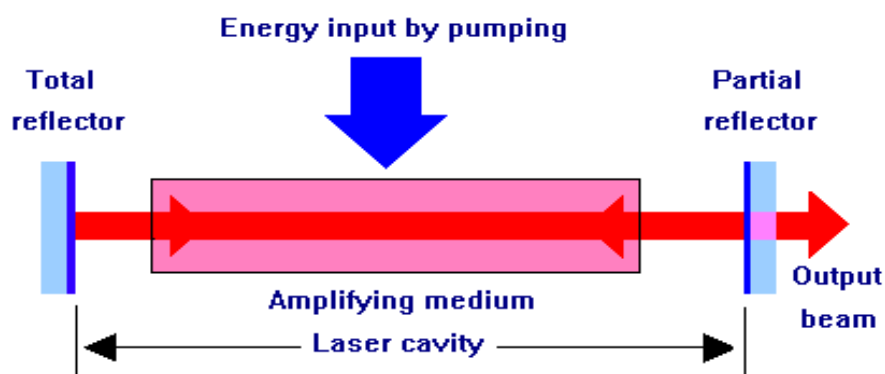


- **Electrical pumping**

electric current passes across the junction of the diode



3- Laser Oscillator



The pumped amplifying medium is positioned between

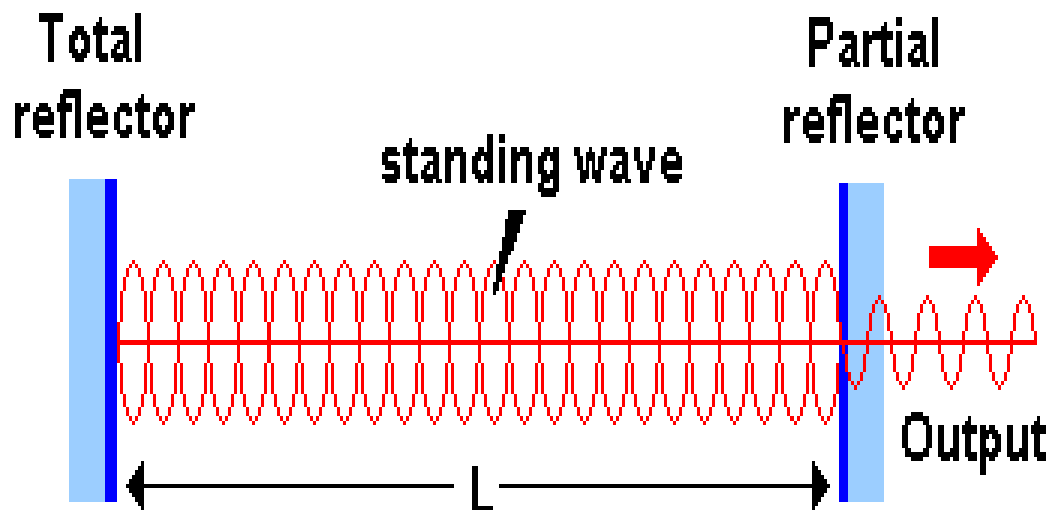
two mirrors



'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 .
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- ❖ 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

Question 1

What is the function of the amplifying medium in a laser?

- A) To reduce the intensity of light
- B) To increase the intensity of light.
- C) To change the wavelength of light
- D) To reflect light
- E) None of the above

Question 2

What is the term used to describe the process of feeding energy into the amplifying medium?

- A) Pumping.
- B) Amplifying
- C) Oscillating
- D) Reflecting
- E) None of the above

Question 3

What is the purpose of the two mirrors in a laser oscillator?

- A) To absorb light
- B) To reflect light back into the amplifying medium.
- C) To change the direction of light
- D) To reduce the intensity of light
- E) None of the above

Question 4

What is the term used to describe the space between the two mirrors in a laser oscillator?

- A) Laser cavity.
- B) Amplifying medium
- C) Light amplifier
- D) Optical pump
- E) None of the above

Question 5

What happens to the light that emerges from the amplifying medium in a laser oscillator?

- A) It is absorbed by the mirrors
- B) It is reflected back into the amplifying medium.
- C) It is transmitted out of the cavity
- D) It is converted into heat
- E) None of the above

Question 6

What is the advantage of using a laser cavity in terms of beam divergence?

- A) It increases the divergence of the beam
- B) It has no effect on the divergence of the beam
- C) It ensures that the divergence of the beam is small.
- D) It changes the direction of the beam
- E) None of the above

Question 7

What is the result of spontaneous emission by excited atoms in a laser oscillator?

- A) Stimulated emission.
- B) Absorption of light
- C) Reflection of light
- D) Transmission of light
- E) None of the above

Question 8

What is the term used to describe the factor by which the intensity of light is increased by the amplifying medium?

- A) Gain.
- B) Pumping
- C) Amplification
- D) Reflection
- E) None of the above

Question 9

What determines the spectral purity of the laser beam in a laser oscillator?

- A) The amplifying medium
- B) The laser cavity.
- C) The mirrors
- D) The pumping process
- E) None of the above

Question 10

What is the characteristic of the light that undergoes multiple reflections in a laser oscillator?

- A) It has a wide range of wavelengths
- B) It has a narrow range of wavelengths.
- C) It travels in all directions
- D) It is absorbed by the mirrors
- E) None of the above