



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



Name of subject : Medical physics 3

Number stage : fourth

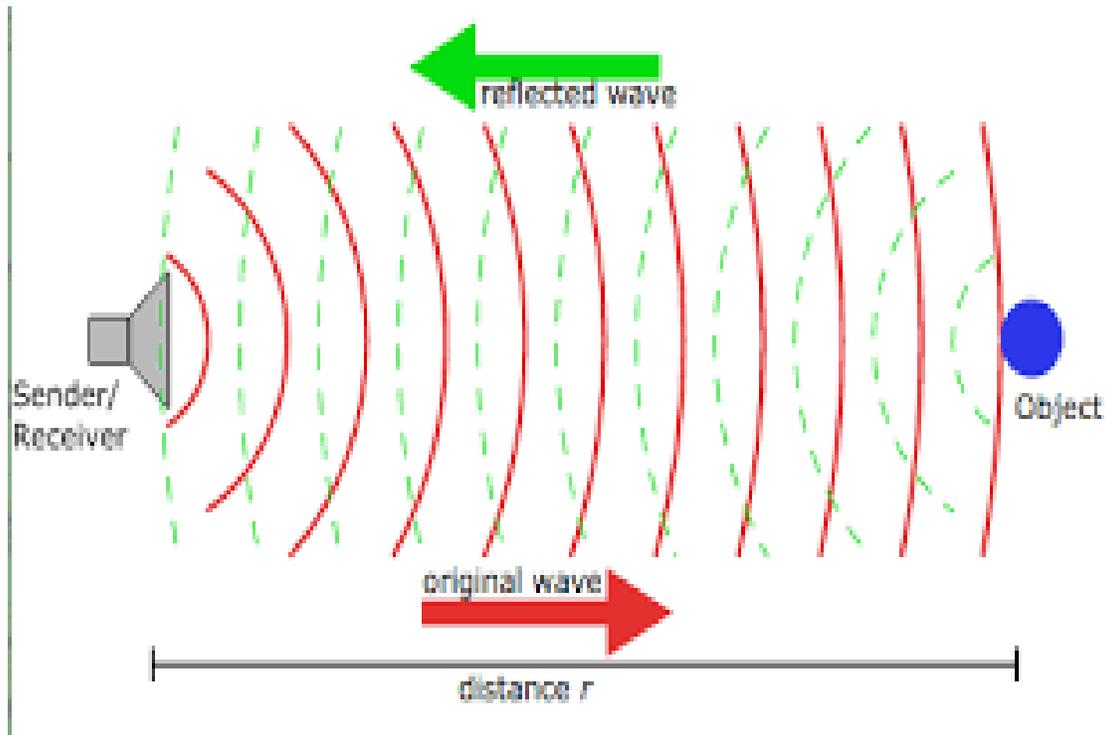
Lecture name : Ultrasound physics

Lecture number : 6

Name of lecturer : M.Sc Murtadha Kadhim Salman

Ultrasound physics

Ultrasound physics describes how high-frequency sound waves are used to create images by interacting with tissues in the body. A transducer sends sound pulses into the body, and these waves are reflected back as echoes at interfaces between different tissues. The strength of these echoes (echogenicity) determines the brightness of structures on the ultrasound image, with differences in tissue density creating stronger echoes. The waves also undergo absorption, scattering, and refraction, which reduces their intensity and contributes to image artifacts.





How it Works

1. Sound Wave Generation:

The transducer uses piezoelectric crystals to convert electrical energy into high-frequency sound waves (ultrasound).

2. Transmission:

These sound waves are directed into the patient's body as focused beams.

3. Interaction with Tissues:

As the sound travels, it encounters different tissues and interfaces, causing several interactions:

- Reflection: Sound waves bounce back to the transducer from tissue boundaries.
- Absorption: Sound energy is converted into heat as it travels through tissue.
- Scattering: Sound waves are dispersed in various directions when they hit small structures like red blood cells.
- Refraction: Sound waves change direction as they pass through different media.

4. Echo Detection:

The piezoelectric crystals in the transducer also act as receivers, converting the returning echoes back into electrical signals.

5. Image Formation:

The ultrasound machine interprets the strength, frequency, and timing of these returning echoes to create a real-time image, with stronger echoes appearing brighter.



Key Concepts

- Frequency and Resolution:

Higher frequencies produce images with better resolution but penetrate less deeply into the body. Lower frequencies provide deeper penetration but with lower resolution.

- Attenuation:

The reduction in the intensity of the sound beam as it travels through tissue is known as attenuation, which occurs through reflection, scattering, absorption, and other processes.

- Echogenicity:

The reflectivity of a structure, which is determined by the difference in acoustic impedance between tissues. Higher impedance differences result in stronger reflections and a brighter image.

- Time-Gain Compensation (TGC):

The machine amplifies weaker echo signals from deeper structures to compensate for attenuation and create a more uniform image.

- Artifacts:

Processes like scattering, absorption, and reflection can create distortions or artifacts in the ultrasound image, affecting its clarity and interpretation.