



كلية المستقبل الجامعة  
قسم الفيزياء الطبية  
المرحلة الثالثة

# Medical Physics

## Lecture 7

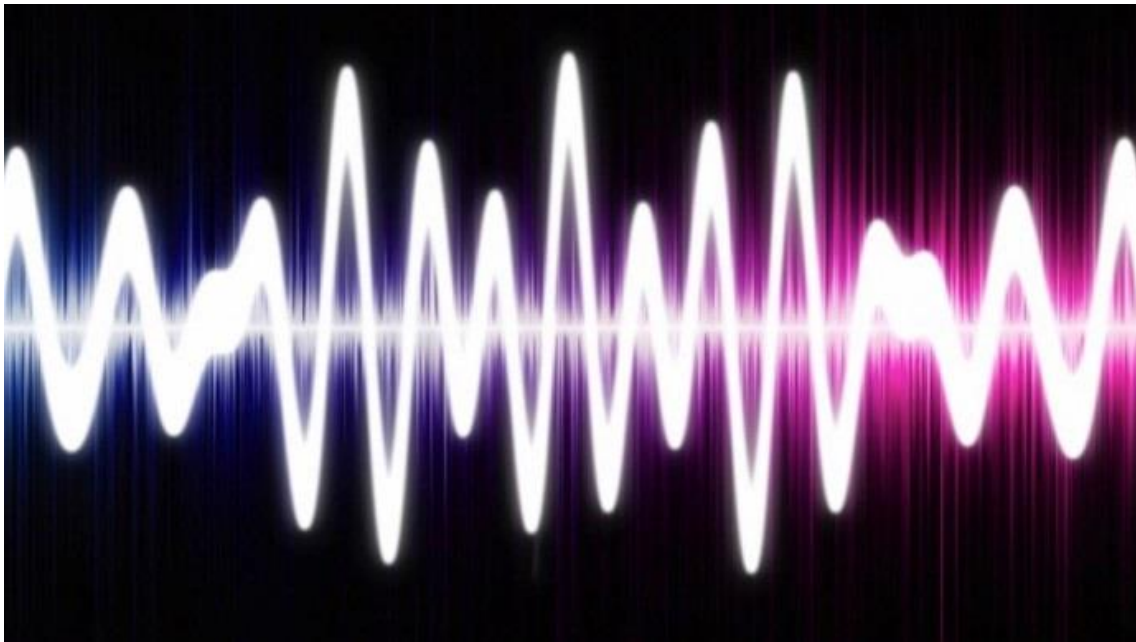
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## **General properties of sound :**

### **Sound :**

Sound is a vibration that travels through the medium in the form of longitudinal waves. This means that sound waves are waves in which the particles of the medium vibrate parallel to the direction of wave propagation.

Sound waves are called mechanical waves since they require a medium to propagate. The medium can be solids, liquids or gases .



Sound waves above 20 kHz are known as ultrasound and are not audible to humans. Sound waves below 20 Hz are known as infrasound .

Sound is transmitted through gases, plasma, and liquids as longitudinal waves, also called compression waves.

It requires a medium to propagate. Through solids, however, it can be transmitted as both longitudinal waves and transverse waves.

- **Longitudinal sound waves** : are waves of alternating pressure deviations from the equilibrium pressure, causing local regions of compression and rarefaction.
- **Transverse waves (in solids)** : are waves of alternating shear stress at right angle to the direction of propagation .

## **Properties of Sound :**

**1- Frequency** : is the number of periodic compression and rarefaction cycles that occurs each second as the wave propagates through the medium . The higher the frequency of the sound the higher is its pitch and a lower frequency means a lower pitch .

**2- Amplitude** : The amplitude of the sound waves determines its loudness. The amplitude of the sound is a measure of the magnitude of the maximum disturbance of sound. The amplitude is also a measure of the energy of vibration. More energetic vibration causes a larger amplitude .

**3- Speed** : The speed at which the sound waves travel through the medium is called the speed of sound. The speed of sound is different for different mediums. Sound travels fastest in solids since the atoms in a solid are closely packed .

**4- Reflection of sound** : When sound waves hit the surface of a solid or liquid, it bounces back to the same medium. This is called the reflection of sound. Sound waves, like light waves, follow the laws of reflection .

**5- Timbre** : is the property used to differentiate sounds of the same frequency .

## Sound and Medicine :

### Diagnostic Ultrasound Instrumentation and Operation :

Principal reasons for its wide application are its ease of use, the relatively low cost of the instrumentation, and the lack of ionizing radiation .

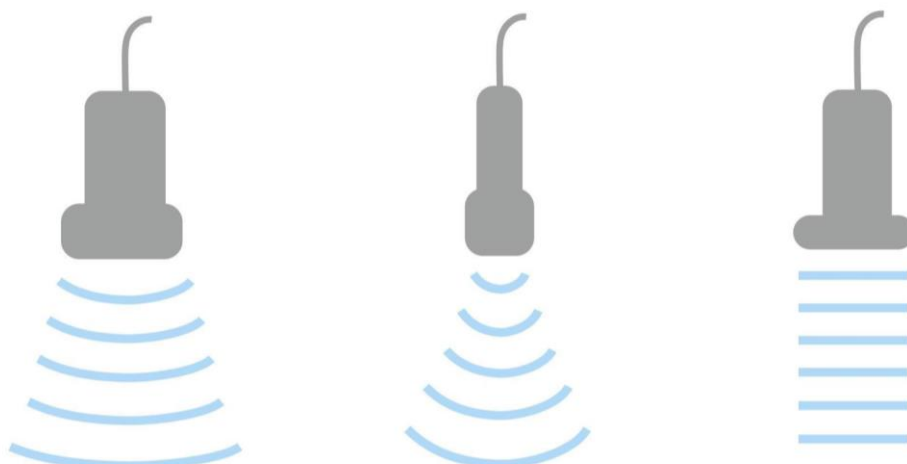
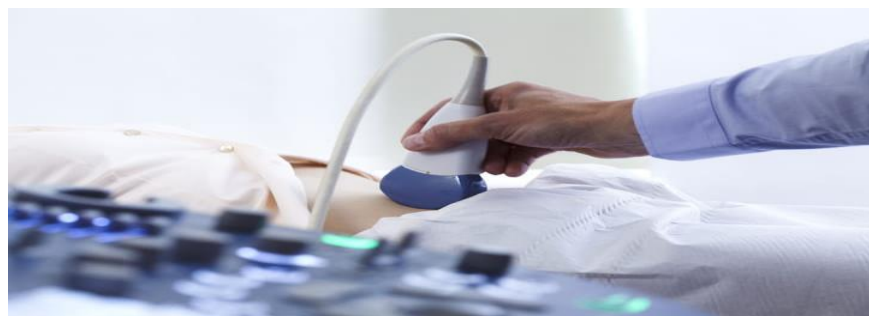
The heart of diagnostic ultrasound is the **Transducer** .

### Ultrasound Transducer :

A transducer is any device that converts energy from one form to another. An ultrasound transducer converts electric energy into ultrasound energy and ultrasound energy back into electric energy .

The physical phenomenon of an ultrasound transducer is the piezoelectric effect phenomenon .

**Piezoelectric Effect** is the ability of certain materials to generate an electric charge in response to applied mechanical stress .



## Diagnostic Methods of Ultrasound :

Diagnostic medical sonography, is an imaging method that uses sound waves to produce images of structures within your body. The images can provide valuable information for diagnosing and directing treatment for a variety of diseases and conditions :

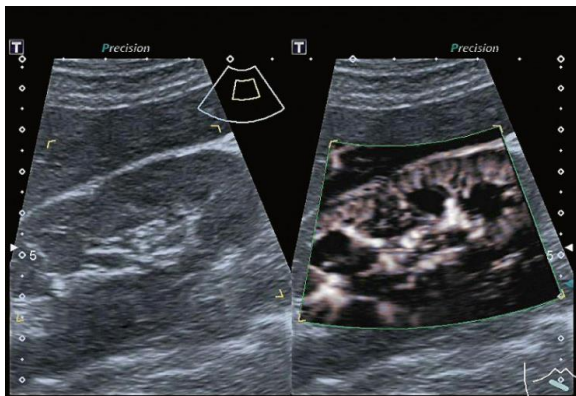
**1- A-mode** : is particularly useful for measuring midline shifts of the brain .

**2- B-mode** : is perhaps the one most widely employed, and it is used primarily for abdominal imaging .

**3- M-mode** : finds its principal application in dynamic imaging of internal structures .

**4- Real-time** : ultrasound allows for observation of structures in motion .

**5- Doppler ultrasound** : is used for depth and flow measurements and moving surfaces. It finds principal application in fetal investigations of heart monitoring and peripheral blood flow measurement .



## Uses of Ultrasound :

Ultrasound is used for many reasons, including to :

- 1- View the uterus and ovaries during pregnancy and monitor the developing baby's health .
- 2- Diagnose gallbladder disease and Evaluate blood flow .
- 3- Guide a needle for biopsy or tumor treatment .
- 4- Check the thyroid gland and genital and prostate problems .
- 5- Assess joint inflammation (synovitis) and Evaluate metabolic bone disease .

