

# Sound

June 11, 2021

## Contents

1	Applications of Sound	i
2	Hearing	i
3	Vocalisation	i
4	Hearing	i
5	Doppler Effect	i
6	Ultrasonic sound	ii
7	Noise	vi

## 1. Applications of Sound

Some of the application of sound in medical field are :

- Stethoscope
- Hearing aids
- Symbalophone
- Audiometry
- Ultrasound scanning

## 2. Hearing

- Hearing is the perception of sound.
- Normal human hearing encompasses frequencies from 20 to 20,000 Hz,.
- Sounds below 20 Hz are called infrasound, whereas those above 20,000 Hz are ultrasound. Neither is perceived by the ear, although infrasound can sometimes be felt as vibrations.
- Other animals have hearing ranges different from that of humans. Dogs can hear sounds as high as 30,000 Hz, whereas bats and dolphins can hear up to 100,000-Hz sounds.

## 3. Vocalisation

- In normal breathing, the vocal cords are relaxed and air can pass easily through the larynx.
- A voiced sound is produced when the cords close off the larynx.
- As air is exhaled, pressure builds up behind the cords and escapes through them. This reduces the pressure in the back of the cords.
- When the pressure is reduced, the cords again close, the pressure again increases and the action is repeated.
- The character of the voice is influenced by the tension, thickness and size of the cords as well as the size and shape of the throat, thorax and para nasal sinuses.
- This explains why the frequency of sounds is higher in women and change of voice happens in adolescence

## 4. Hearing

## 5. Doppler Effect

### Definition

“The apparent change in frequency of sound due to relative motion between the source of sound and the listener is known as Doppler effect.”

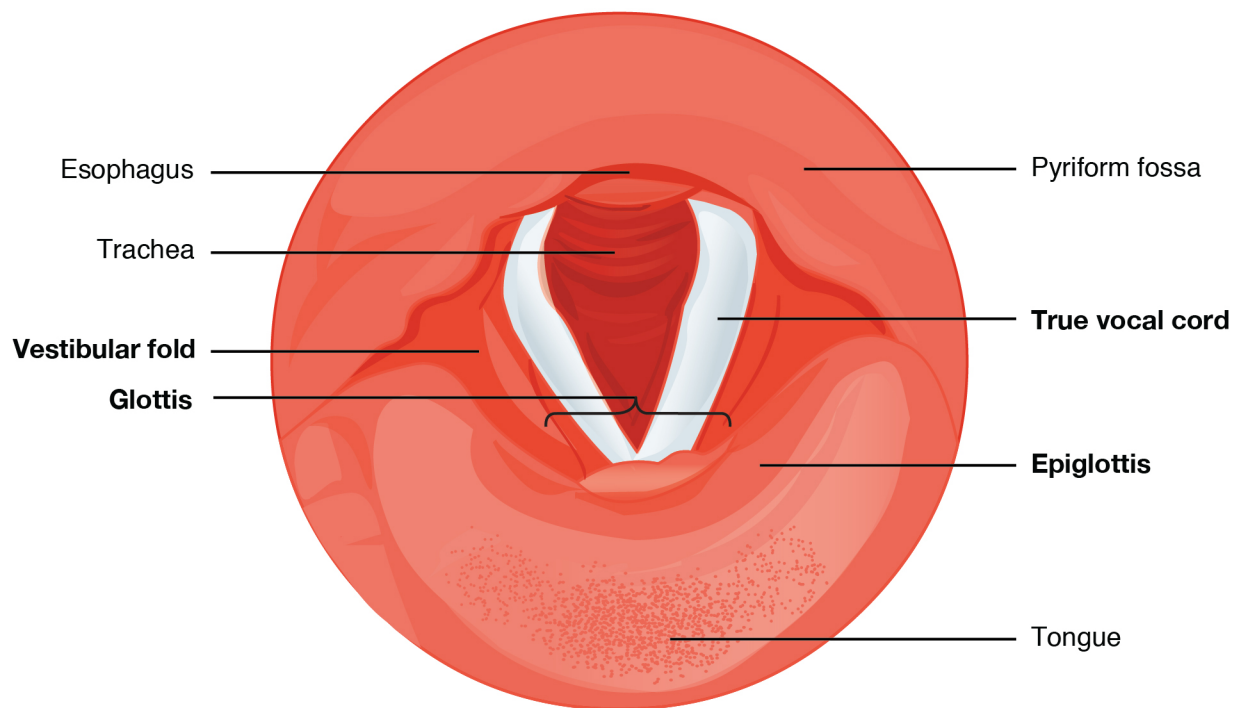


Figure 3.1: vocal cords

## Doppler effect in daily life

- Change in sound of a train or ambulance
- Speed guns used by police
- Doppler effect in light used by astronomers
- Doppler scans in hospitals

## 6. Ultrasonic sound

### Definition

Ultrasonic sound is sound of a frequency beyond the highest value in the range of human audibility  
Carries energy that can be absorbed by the medium

### Applications

- Provide diagnostic images that complement those made with x-rays, nuclear medicine, and magnetic resonance.
- Heat tissue (diathermy).

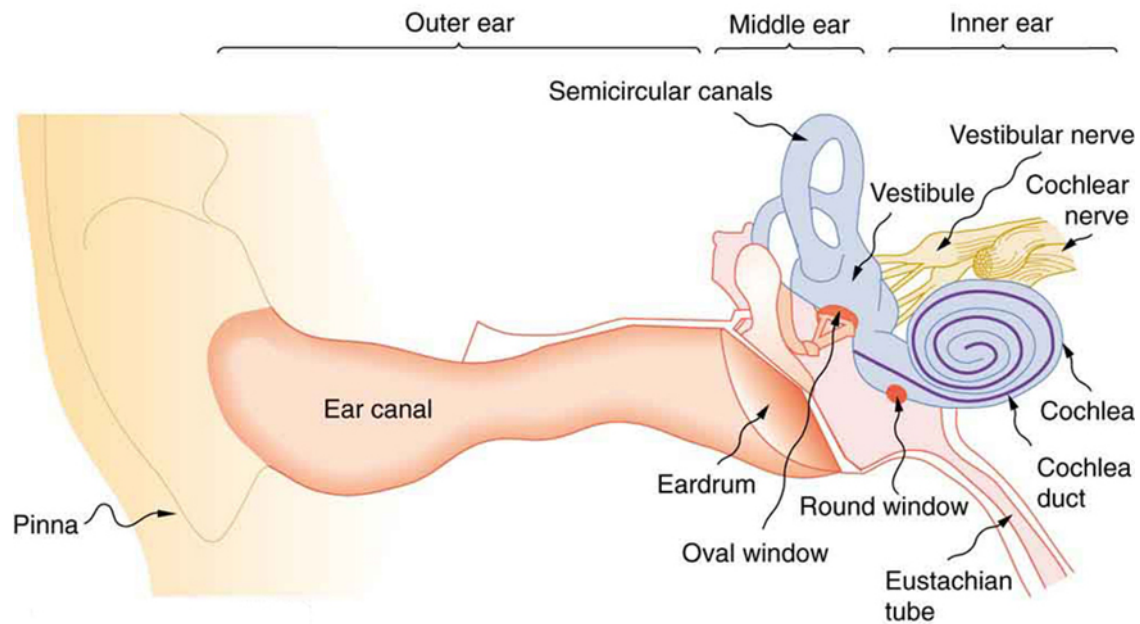


Figure 4.1: anatomy of the ear

- It is also used to break up gall stones and kidney stones (lithotripsy)
- Pulverize cancerous tissues in surgical procedure
- Detect motion and determine velocity through the Doppler shift of an echo, known as Doppler-shifted ultrasound.

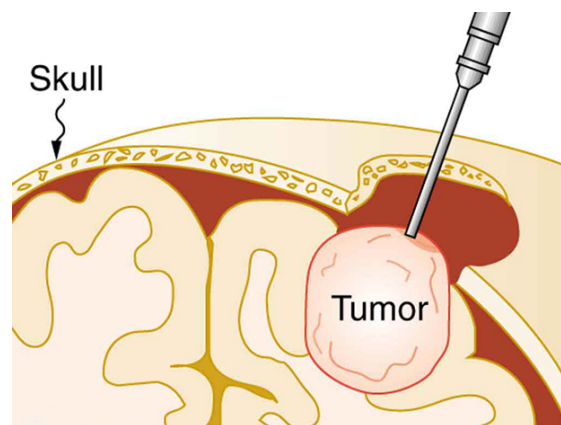


Figure 6.1: Pulverizing cancerous tissues

## Ultrasound Diathermy

- Intensities of  $10^3$  to  $10^4$  W/m<sup>2</sup>
- Applied to injured or overworked muscles to relieve pain and improve flexibility. “bone burns” and other tissue damage caused by overheating and cavitation,

## Ultrasound in medical diagnostics

### Working

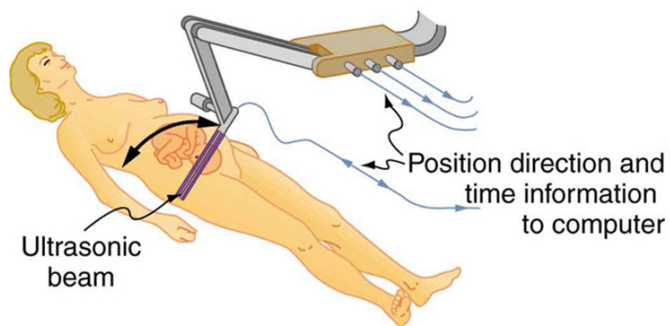
- When used for imaging, ultrasonic waves are emitted from a transducer, a crystal exhibiting the piezoelectric effect (the expansion and contraction of a substance when a voltage is applied across it, causing a vibration of the crystal).
- These high-frequency vibrations are transmitted into any tissue in contact with the transducer.
- Similarly, if a pressure is applied to the crystal (in the form of a wave reflected off tissue layers), a voltage is produced which can be recorded. The crystal therefore acts as both a transmitter and a receiver of sound.
- Ultrasound is also partially absorbed by tissue on its path, both on its journey away from the transducer and on its return journey.
- From the time between when the original signal is sent and when the reflections from various boundaries between media are received, (as well as a measure of the intensity loss of the signal), the nature and position of each boundary between tissues and organs may be deduced.

### Use

- Ultrasound today is commonly used in prenatal care. Such imaging can be used to see if the fetus is developing at a normal rate, and help in the determination of serious problems early in the pregnancy.
- Ultrasound is also in wide use to image the chambers of the heart and the flow of blood within the beating heart, using the Doppler effect (echocardiology).
- Many more..

## Benefits

- In addition to shape information, ultrasonic scans can produce density information superior to that found in X-rays, because the intensity of a reflected sound is related to changes in density.
- The applications of ultrasound in medical diagnostics have produced untold benefits with no known risks.



(a)



(b)

- Diagnostic intensities are too low (about  $10^{-2}\text{W/m}^2$ ) to cause thermal damage.
- More significantly, ultrasound has been in use for several decades and detailed follow-up studies do not show evidence of ill effects, quite unlike the case for x-rays.

#### Additional Information

**Ultrasound** - The frequency(or wavelength) of any wave used for imaging is what limits our resolution for that particular technique This is the reason why light microscopes have a limit of approximately 500nm and hence are unable to view viruses that are too small. In that case we need electron microscopes. This is also the reason why we do not use audible sound (7cm) but instead make use of ultrasonic sound (1.4-0.1mm).

## 7. Noise

### Definition

The common definition of noise is that noise is any unwanted sound. A better definition of noise is “wrong sound in the wrong place, at the wrong time”. The word noise comes from the Latin word nausea meaning seasickness.

### Human health effects of noise pollution

- Noise pollution can cause annoyance and aggression, hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful effects.
- Chronic exposure to noise may cause noise-induced hearing loss. Older males exposed to significant occupational noise demonstrate significantly reduced hearing sensitivity than their non-exposed peers, though differences in hearing sensitivity decrease with time and the two groups are indistinguishable by age 79.
- High noise levels can contribute to cardiovascular effects and exposure to moderately high levels during a single eight hour period causes a statistical rise in blood pressure of five to ten points and an increase in stress and vasoconstriction leading to the increased blood pressure noted above as well as to increased incidence of coronary artery disease.

## References

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