

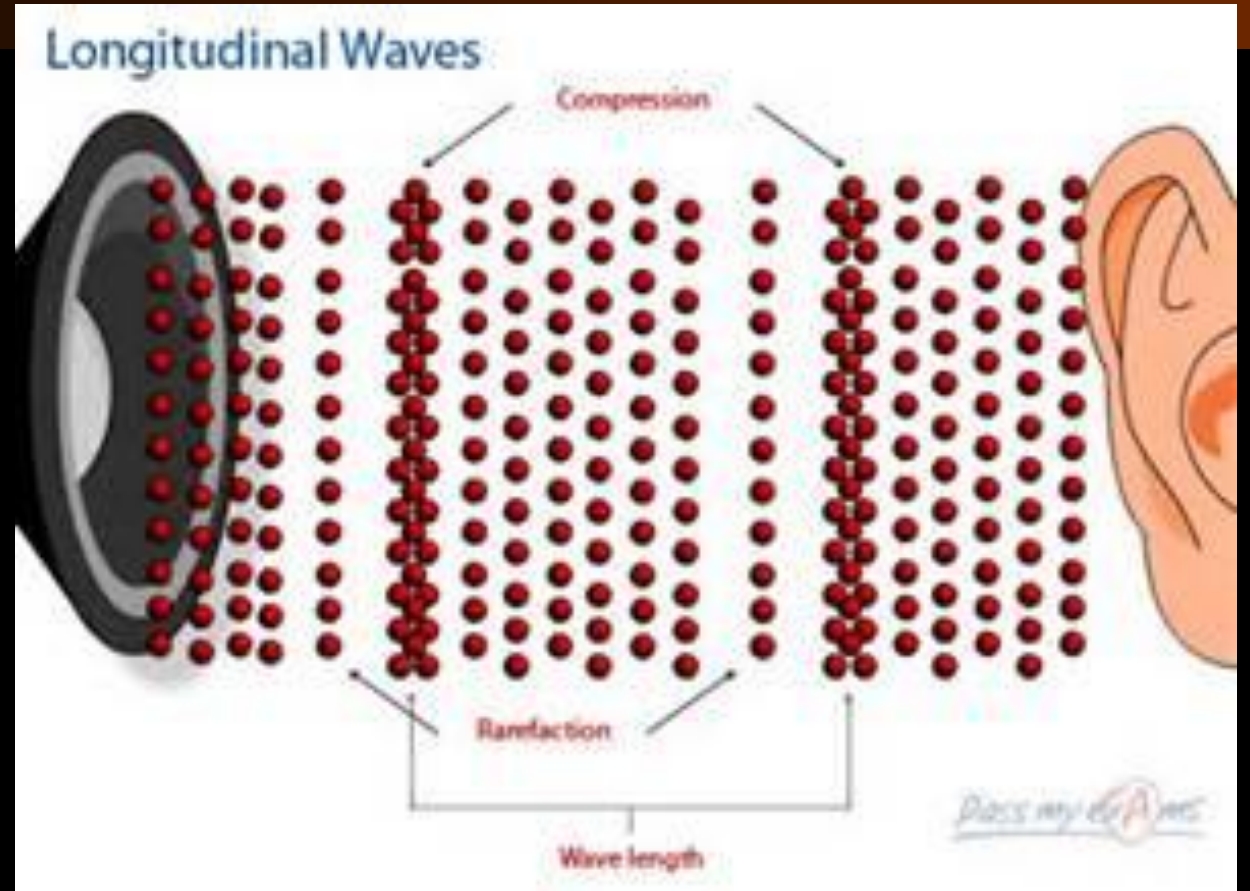


SOUND

CHAPTER 16

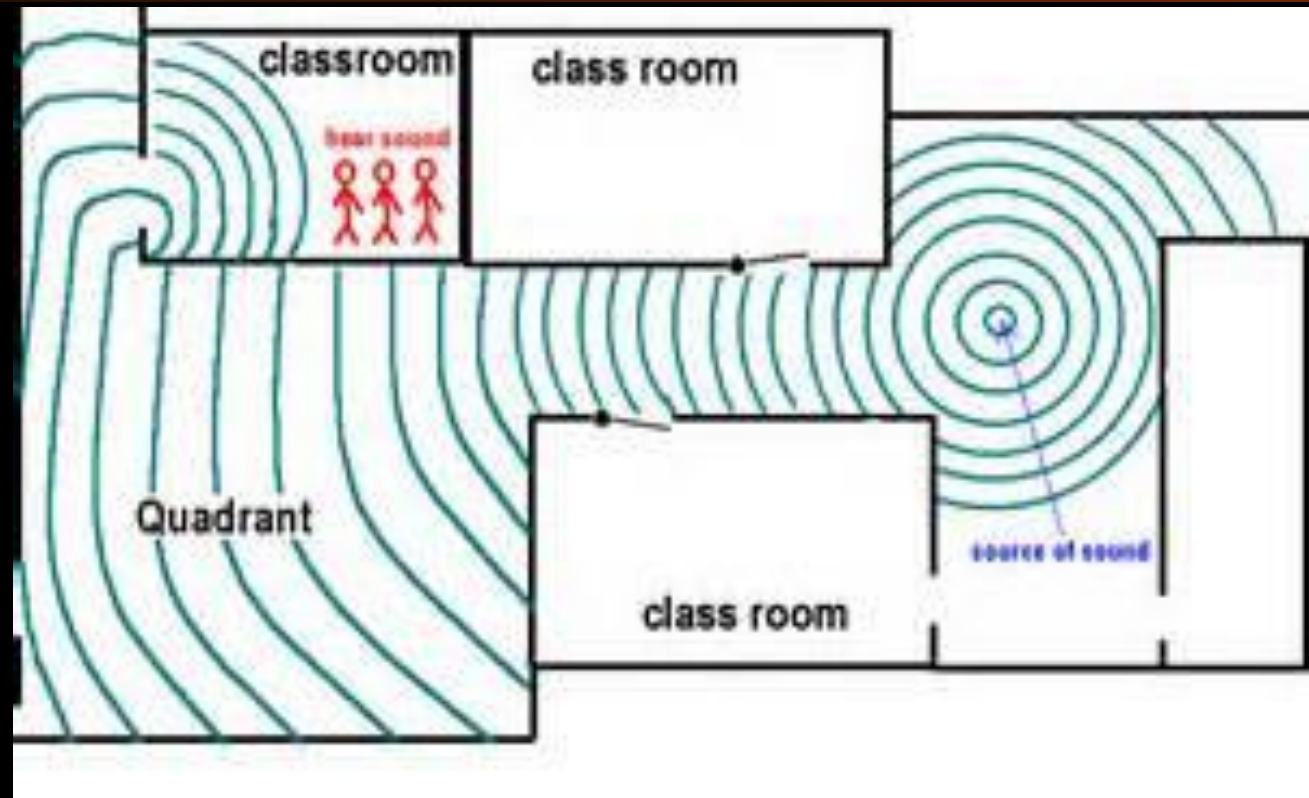
16.1 The Nature of Sound

- Sound is a disturbance that travels through a medium as a longitudinal wave



16.1 The Nature of Sound

- Sound waves reflect off objects, diffract through narrow openings and around barriers, and interfere with each other.



16.1 The Nature of Sound

- The speed of sound depends on the elasticity, density, and temperature of the medium the sound travels through.



echo

- A reflected sound wave.



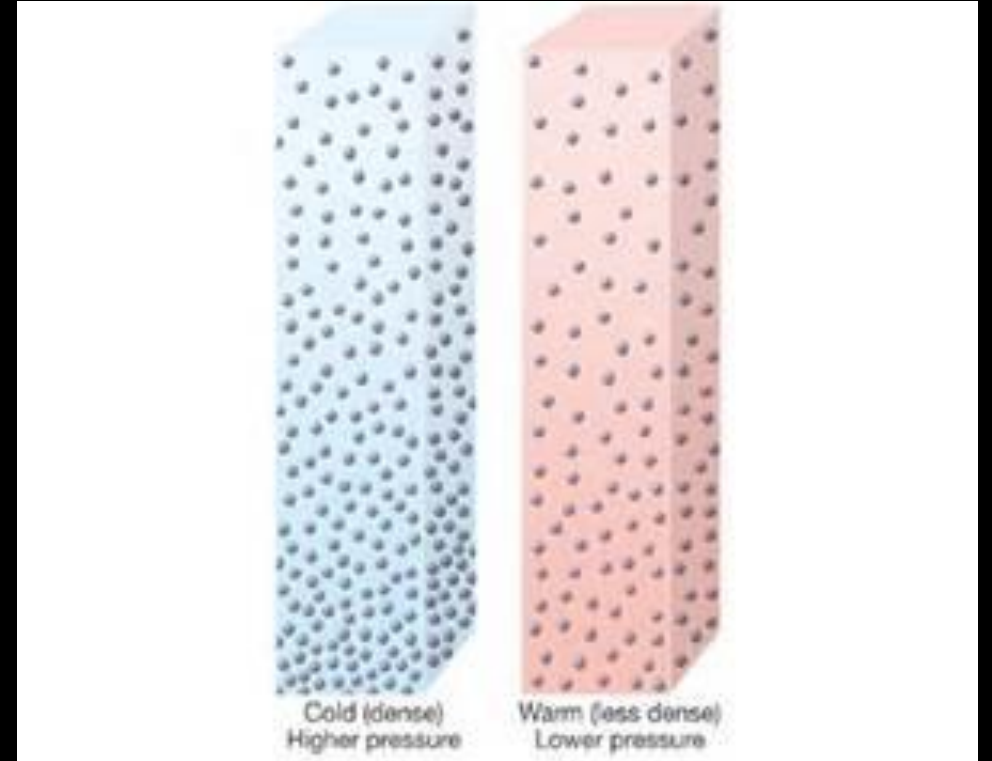
elasticity

- The ability of a material to bounce back after being disturbed.



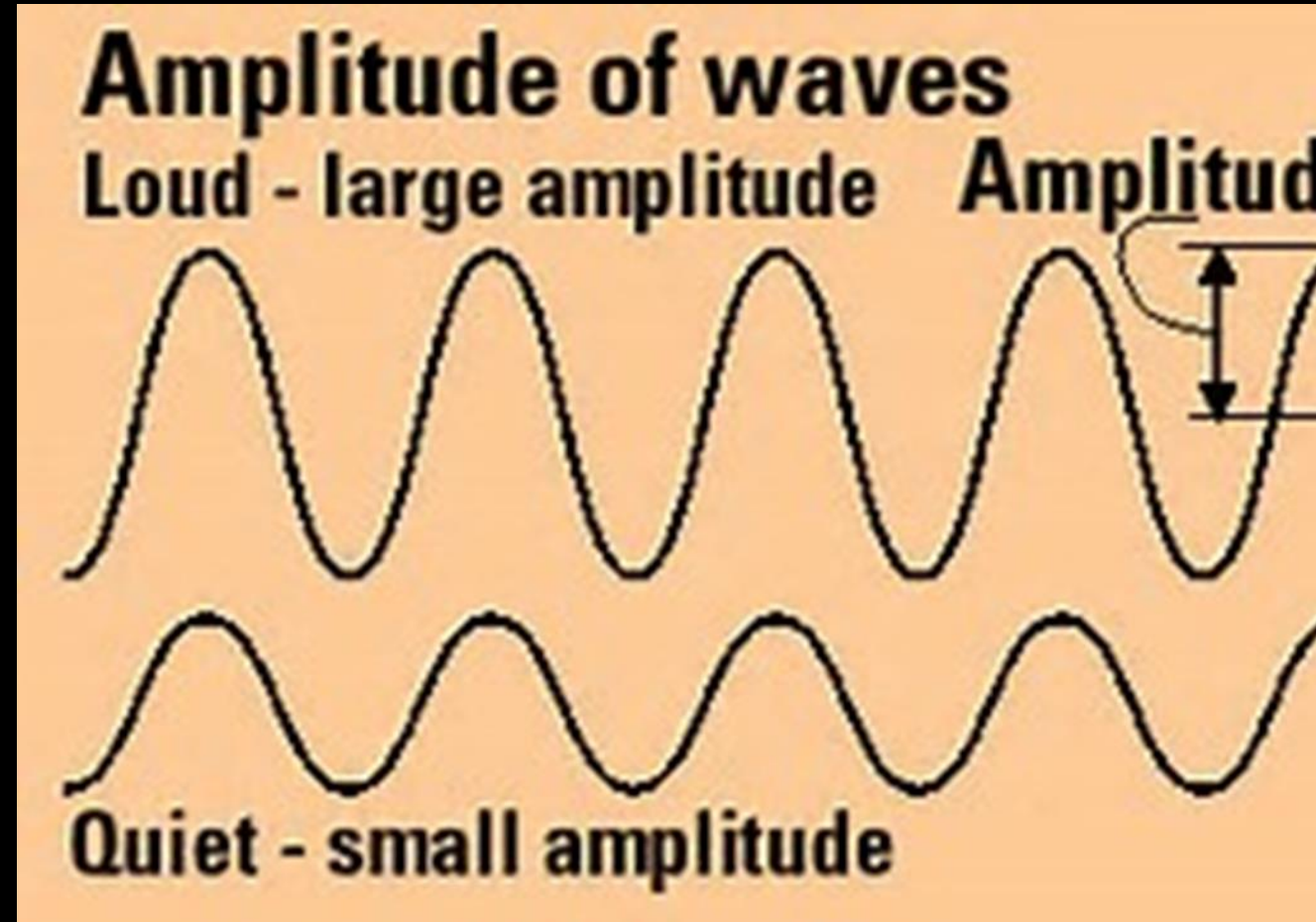
density

- The ratio of the mass of a substance to its volume.



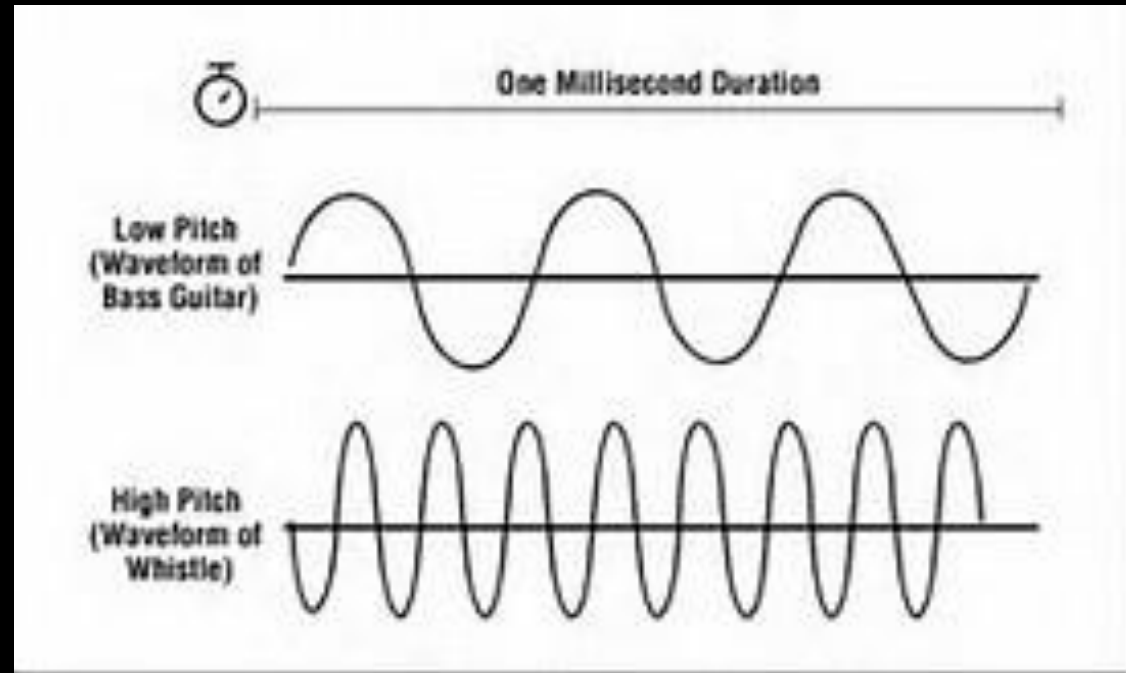
16.2 Properties of Sound

The loudness of a sound depends on two factors: the amount of energy it takes to make the sound and the distance from the source of the sound.



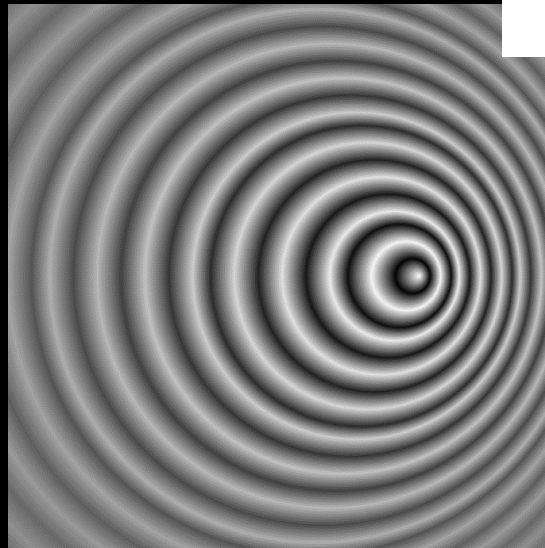
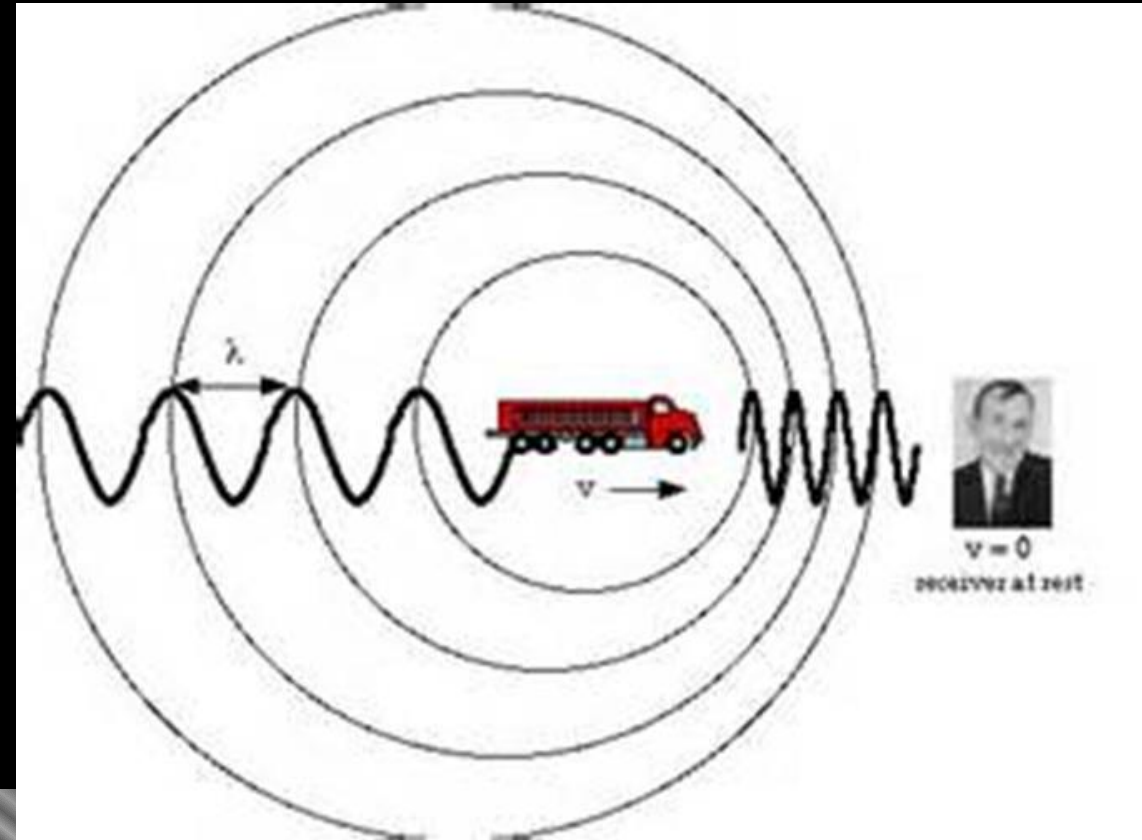
16.2 Properties of Sound

The pitch of a sound that you hear depends on the frequency of the sound wave



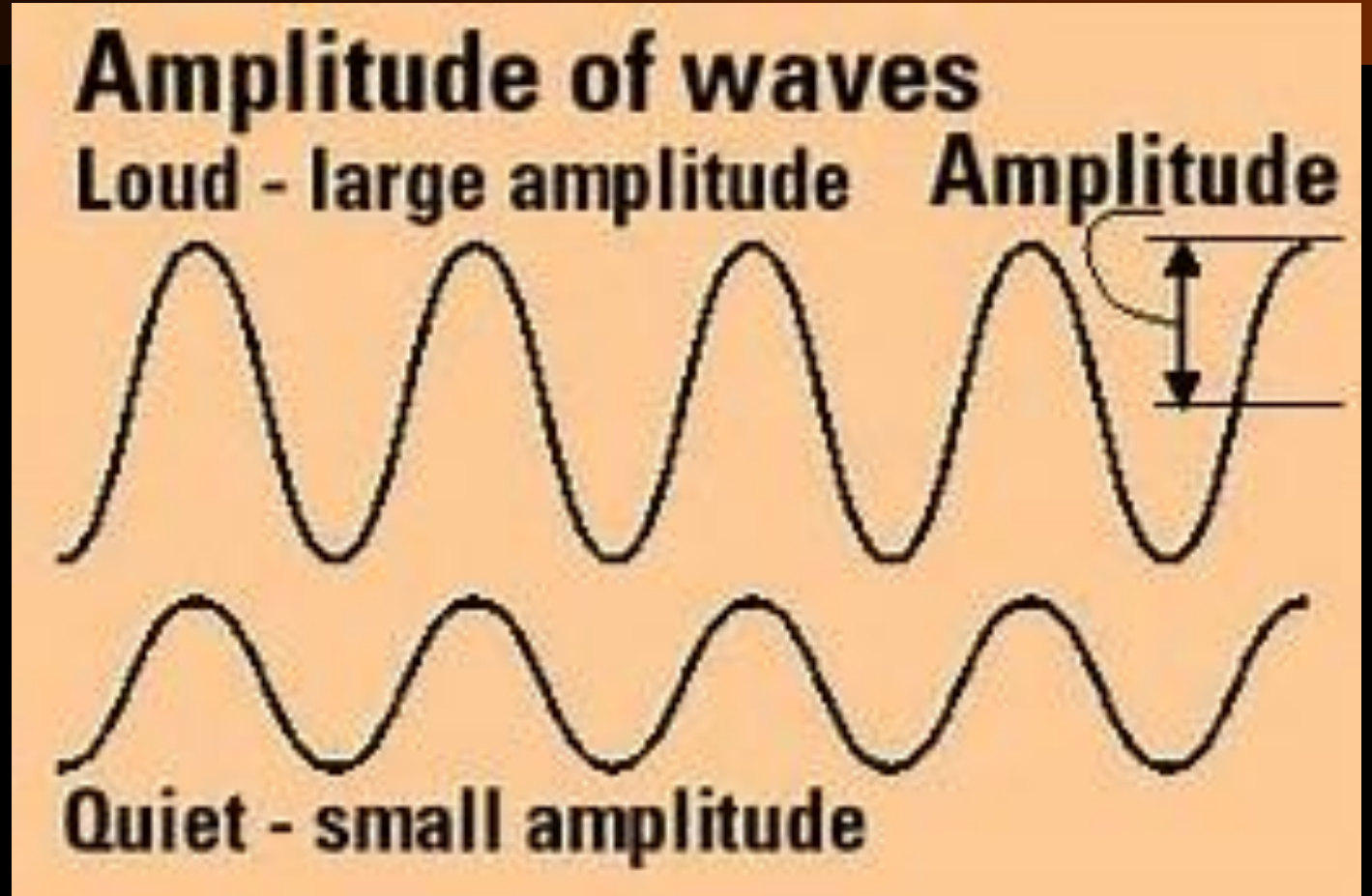
16.2 Properties of Sound

When a sound source moves, the frequency of the waves changes because the motion of the source adds to the motion of the waves



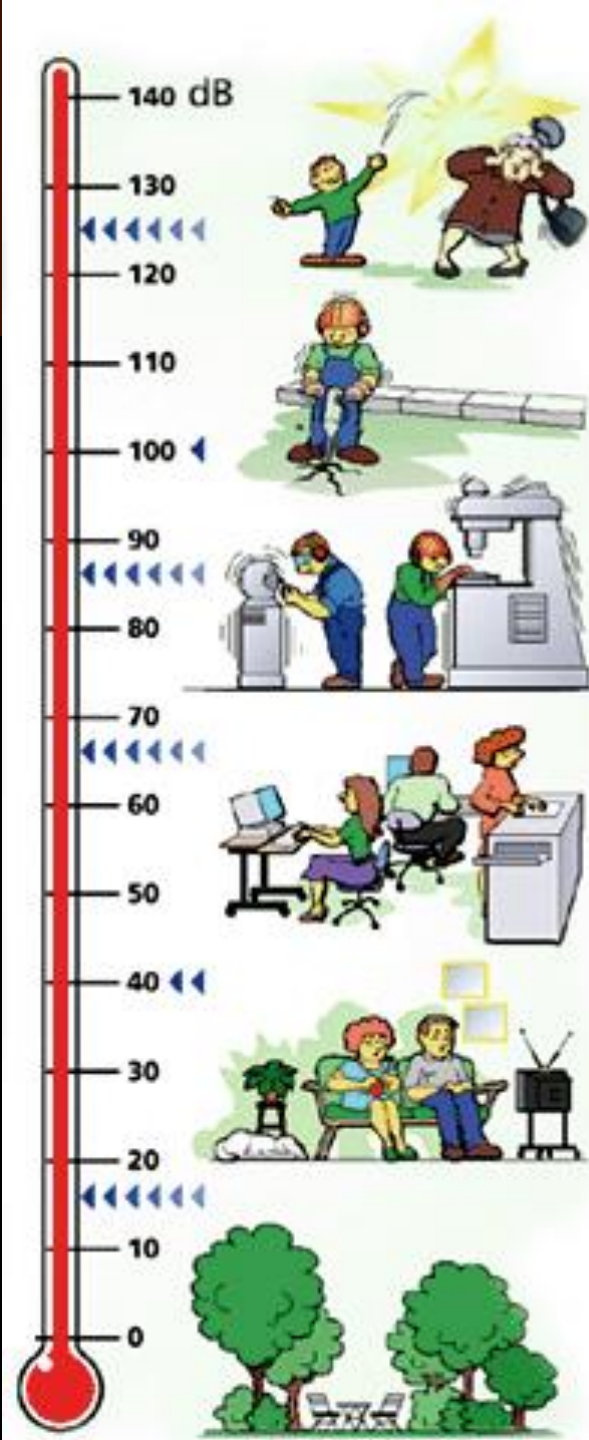
intensity

The amount of energy per second carried through a unit area by a wave.



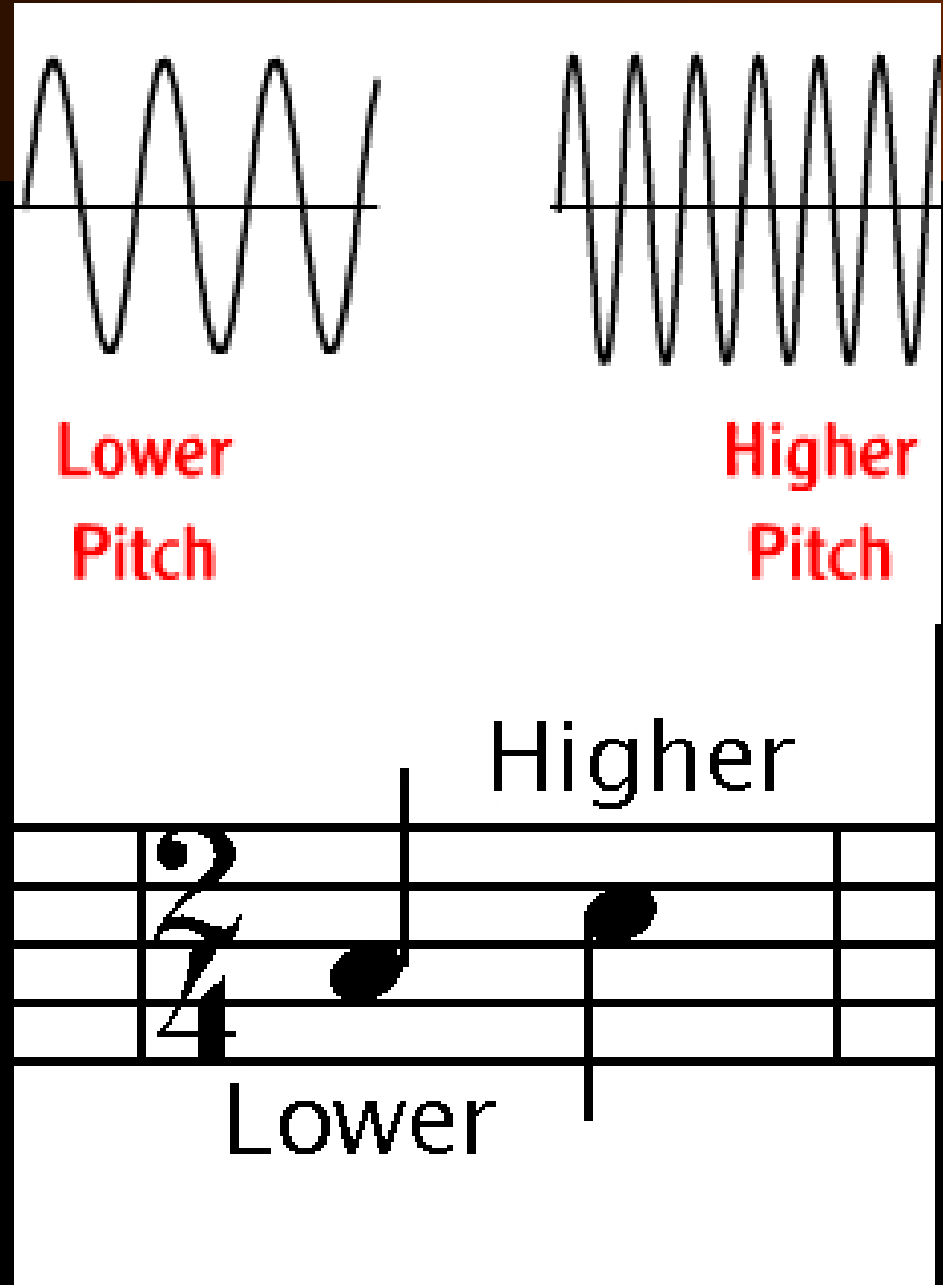
decibel (dB)

A unit used to compare the loudness of different sounds.



pitch

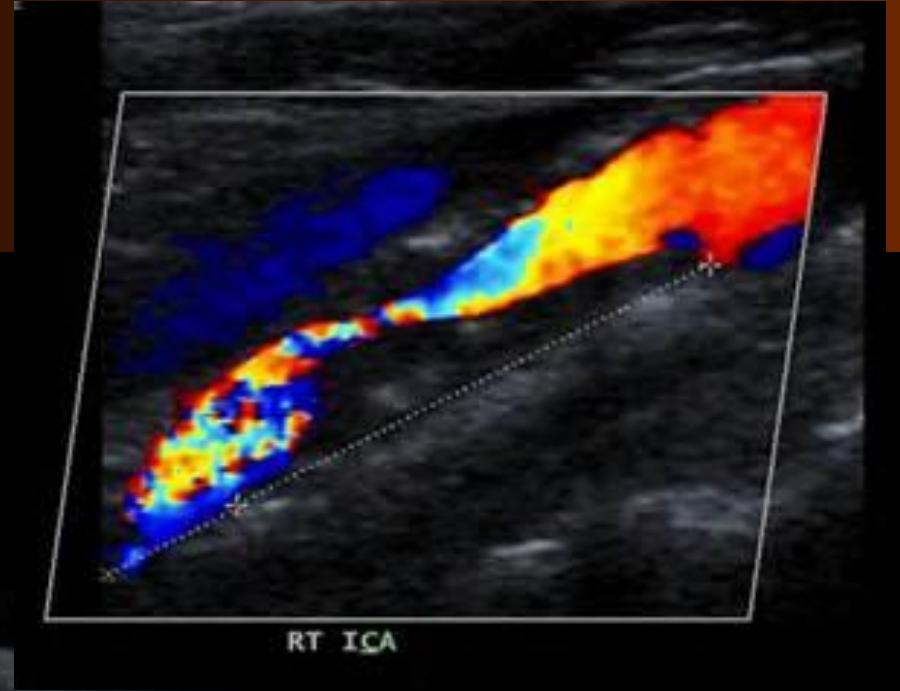
Perception of the frequency of a sound.



ultrasound

Sound waves with frequencies above 20,000 Hz.

Artery →

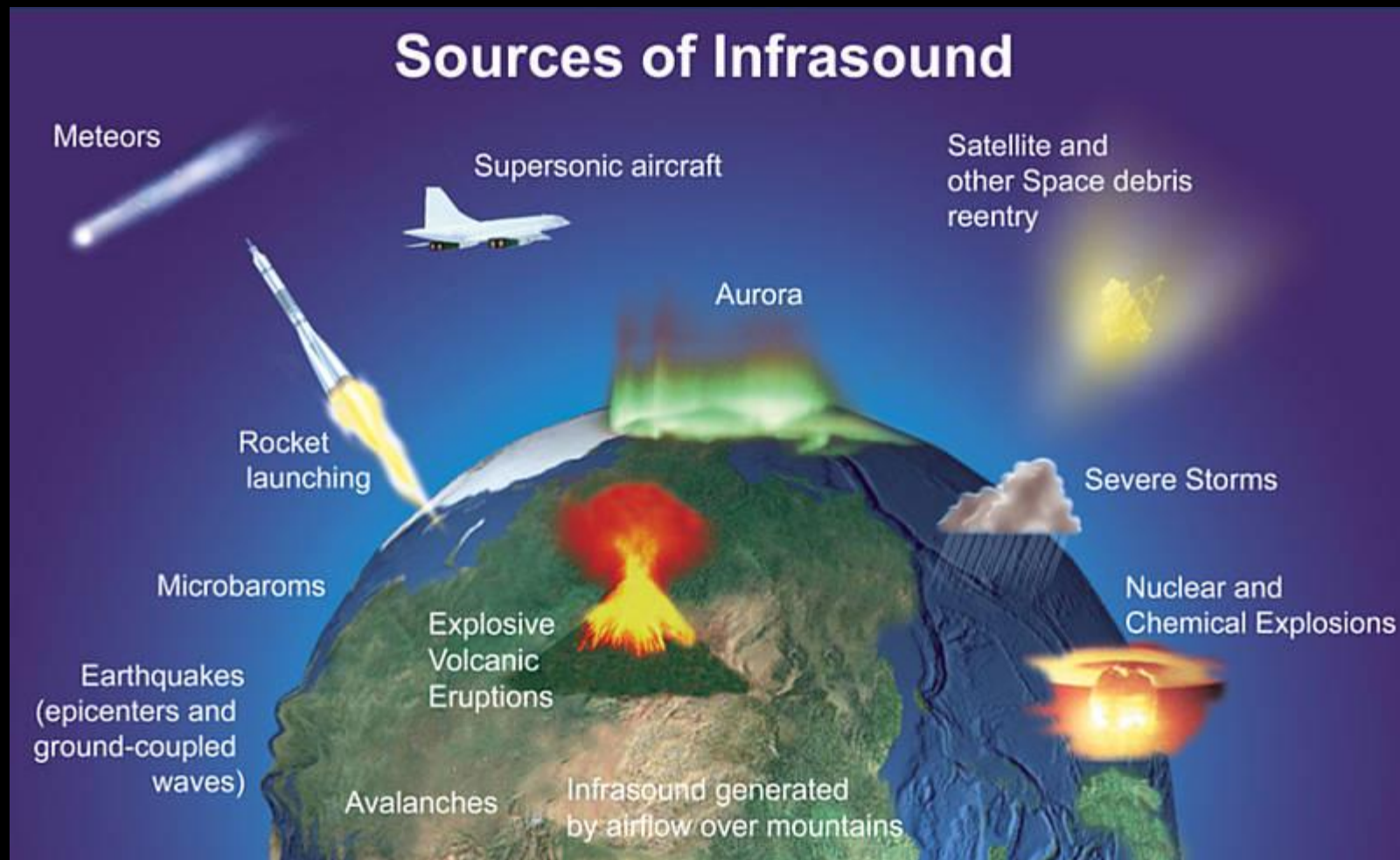


Kidney stone →



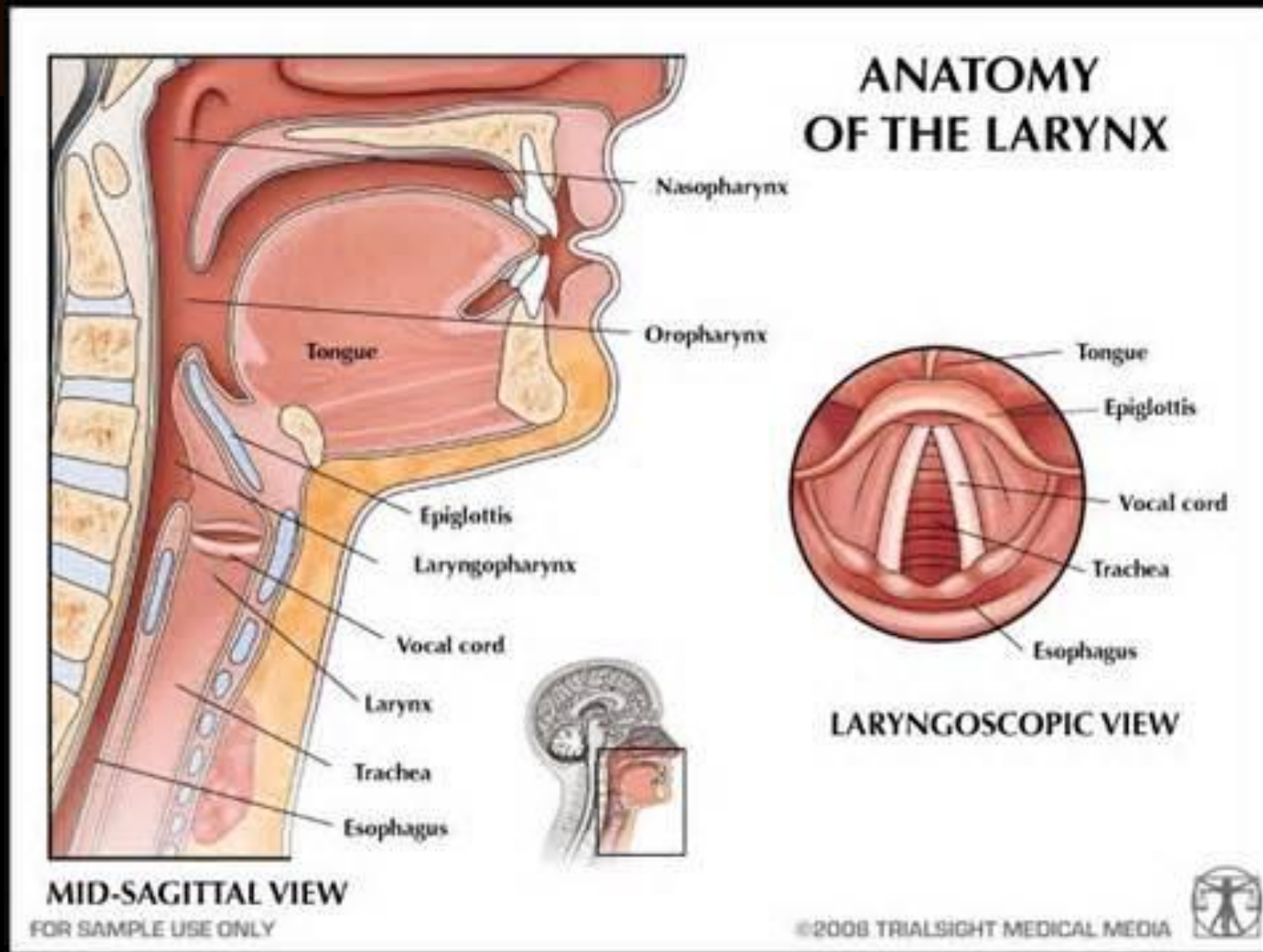
infrasound

Sound waves with frequencies below 20 Hz.



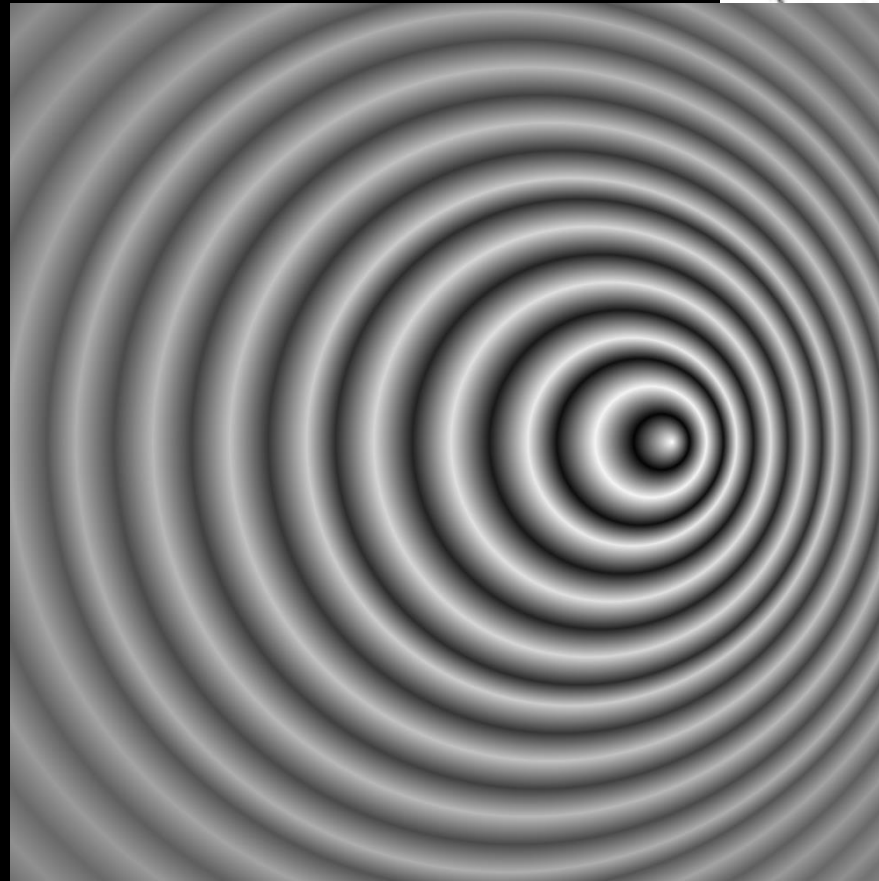
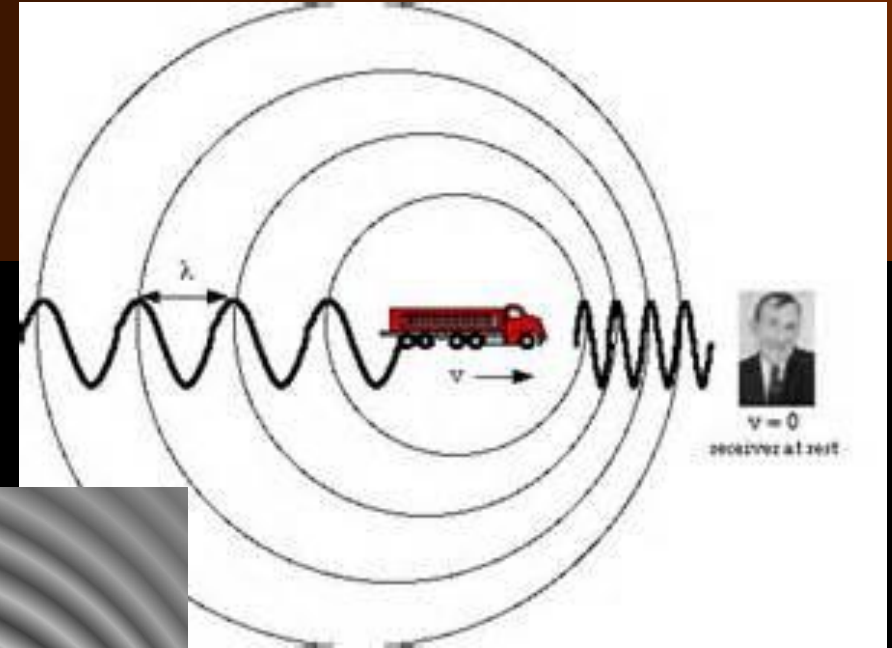
larynx

Two folds of tissue that make up the human voice box.



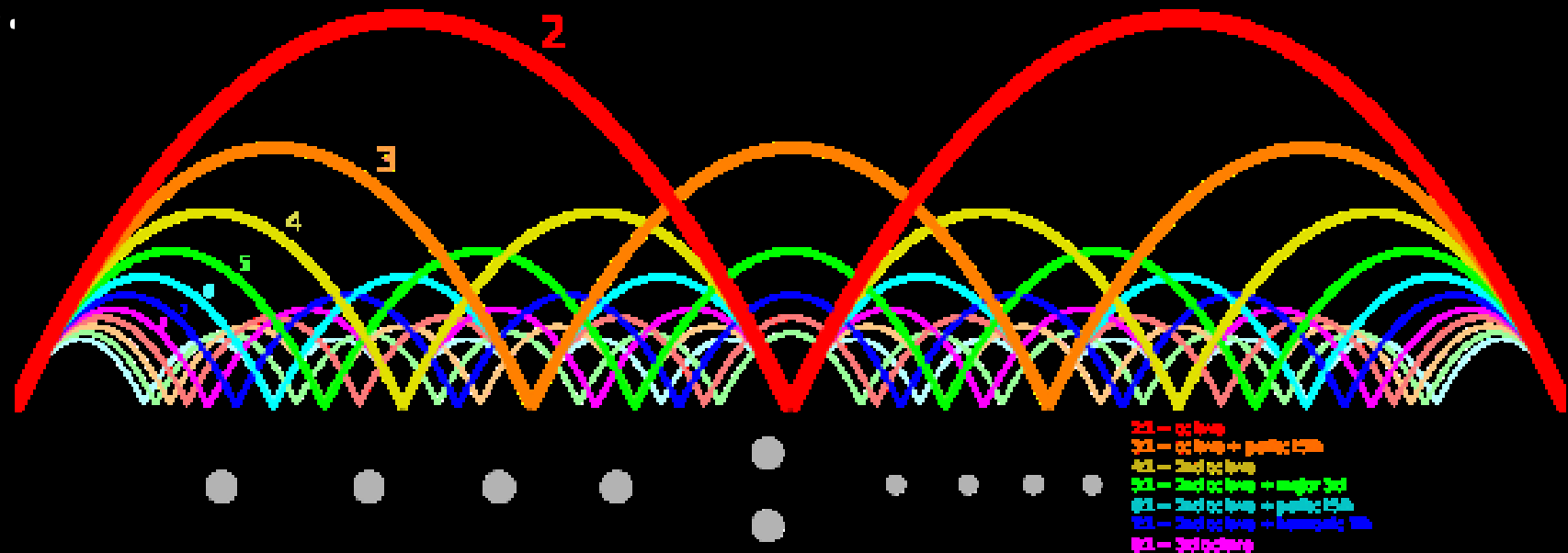
Doppler effect

The change in the frequency of a wave as its source moves in relation to an observer.



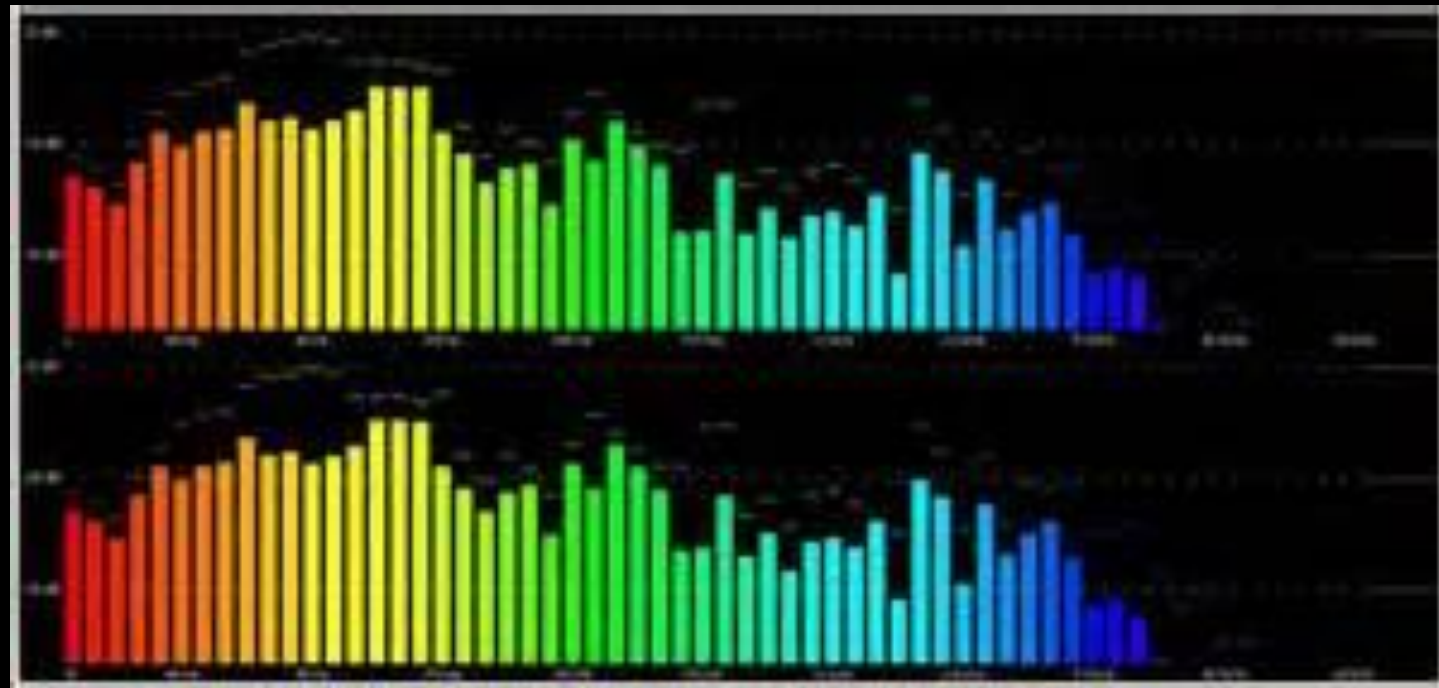
16.3 MUSIC

Sound quality results from the blending of a fundamental tone with its overtones.



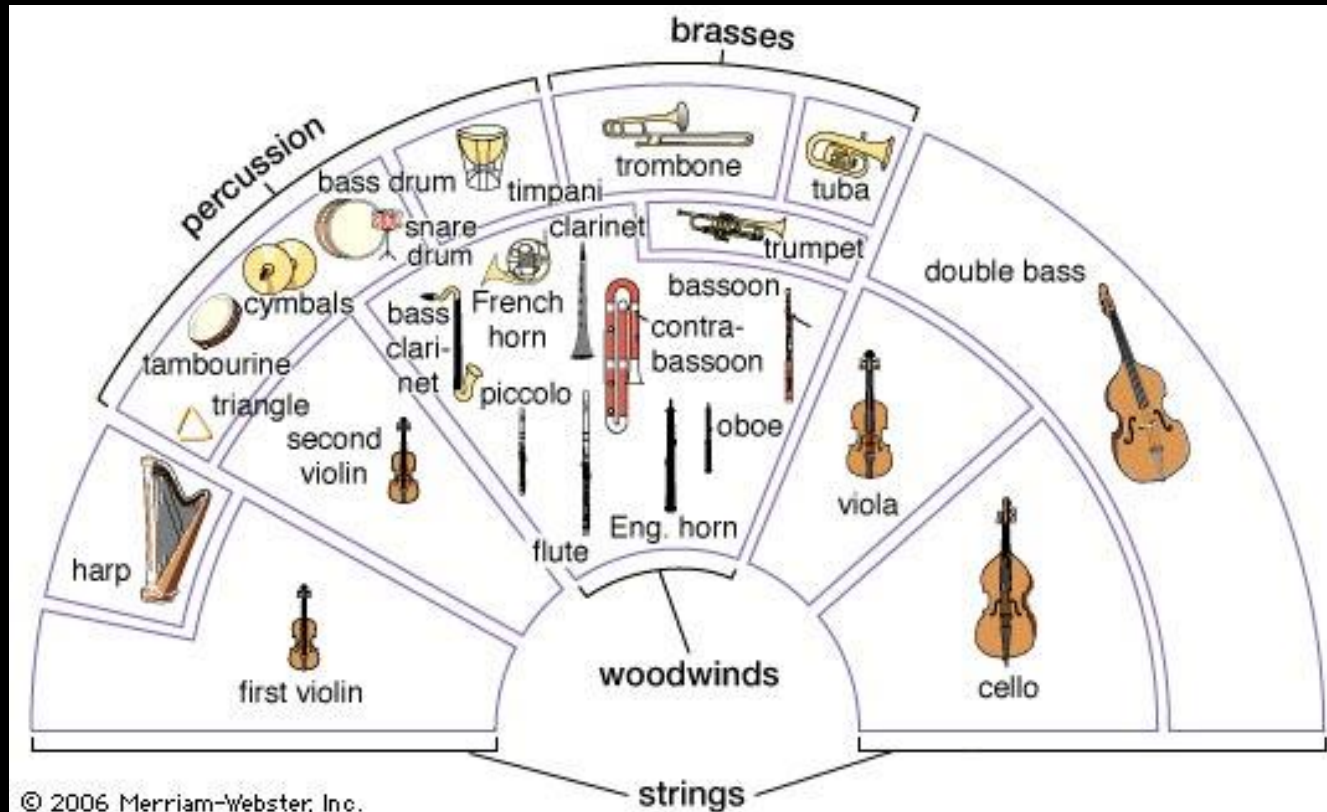
16.3 MUSIC

Resonance also plays a role in sound quality.



16.3 MUSIC

- There are three basic groups of musical instruments: stringed instruments, wind instruments, and percussion instruments.



16.3 MUSIC

Acoustics is used in the design of concert halls to control reverberation and interference.



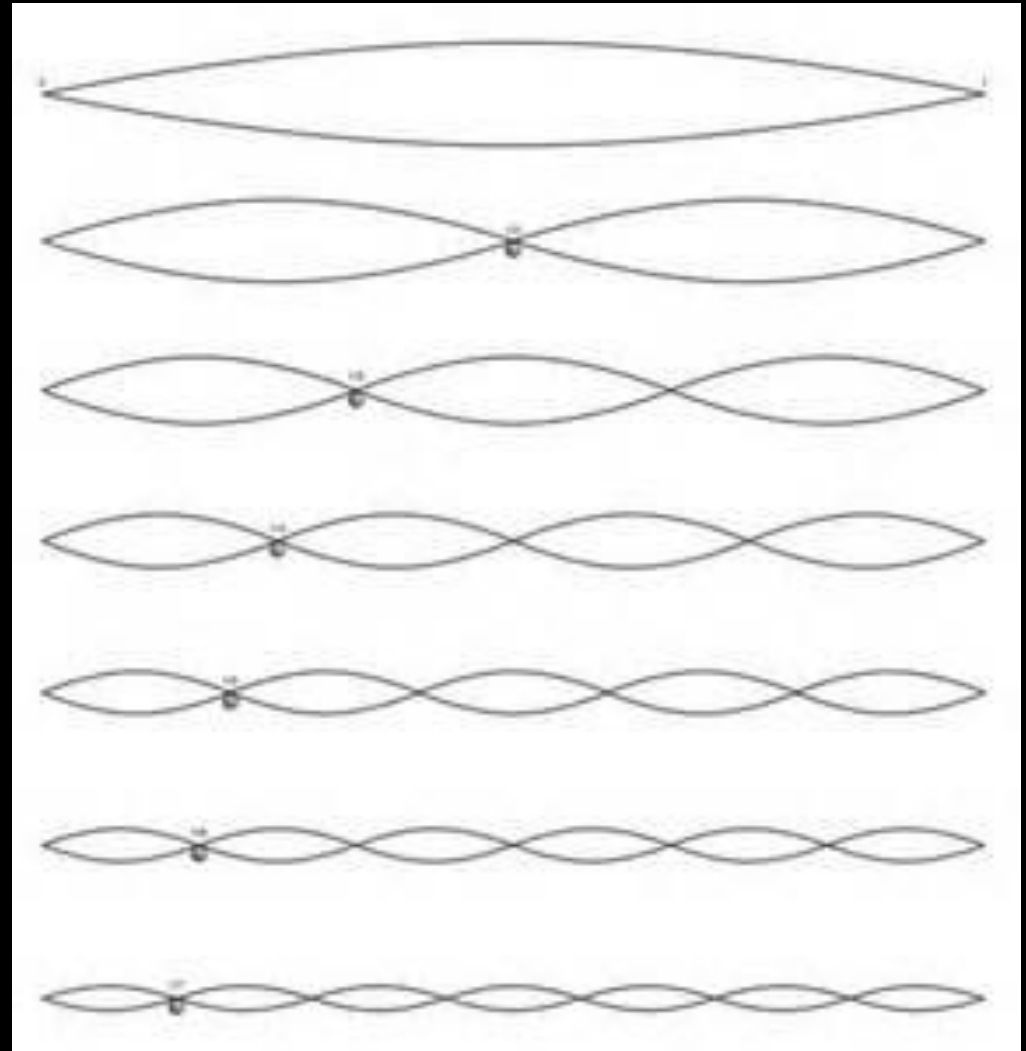
MUSIC

A set of tones and overtones combined in ways that are pleasing.



fundamental tone

The lowest natural frequency of an object.





overtone

A natural frequency that is a multiple of the fundamental tone's frequency

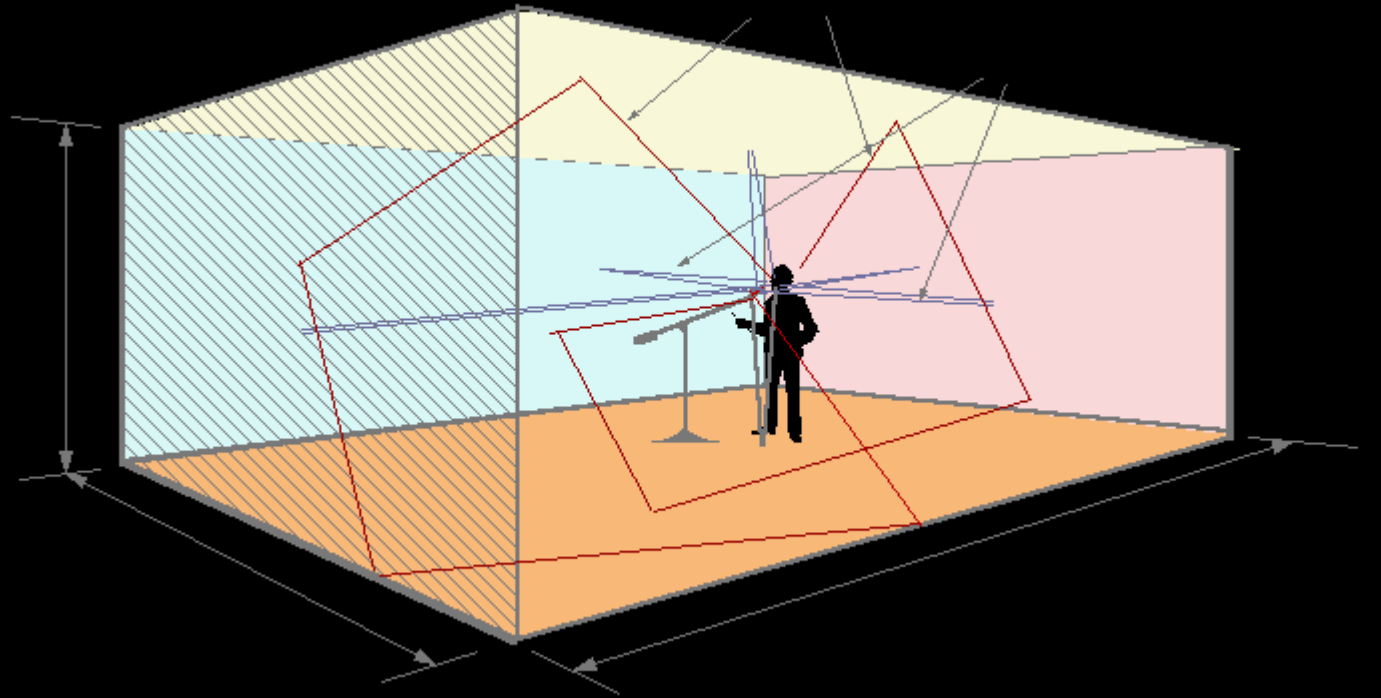
The Overtone Series (Harmonics)

Frequency	Multiple	Name	Pitch
65 Hz	1x	Fundamental	C1 (Base pitch)
130 Hz	2x	First Harmonic	C2 (1 octave higher)
195 Hz	3x	Second Harmonic	G2 (octave + fifth higher)
260 Hz	4x	Third Harmonic	C3 (2 octaves higher)
325 Hz	5x	Fourth Harmonic	E3 (2 octaves + maj 3rd higher)
390 Hz	6x	Fifth Harmonic	G3 (2 octaves + fifth higher)
455 Hz	7x	Sixth Harmonic	Bb3 (2 octaves + minor seventh higher... though it will be slightly out of tune)
520 Hz	8x	Seventh Harmonic	C4 (3 octaves higher)
585 Hz	9x	Eighth Harmonic	D4 (3 octaves + major 2nd)

And so on...

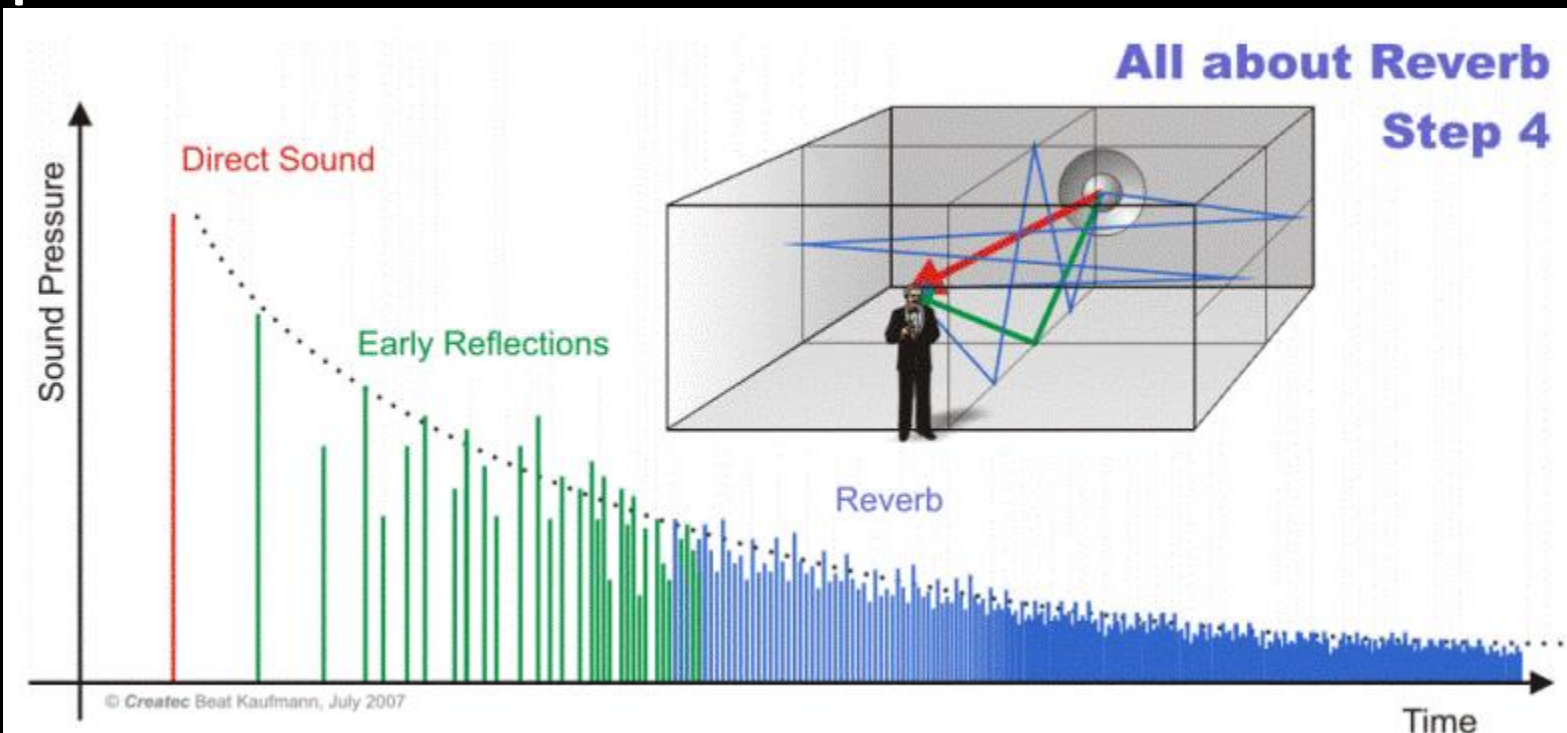
acoustics

The study of how sounds interact with each other and the environment.



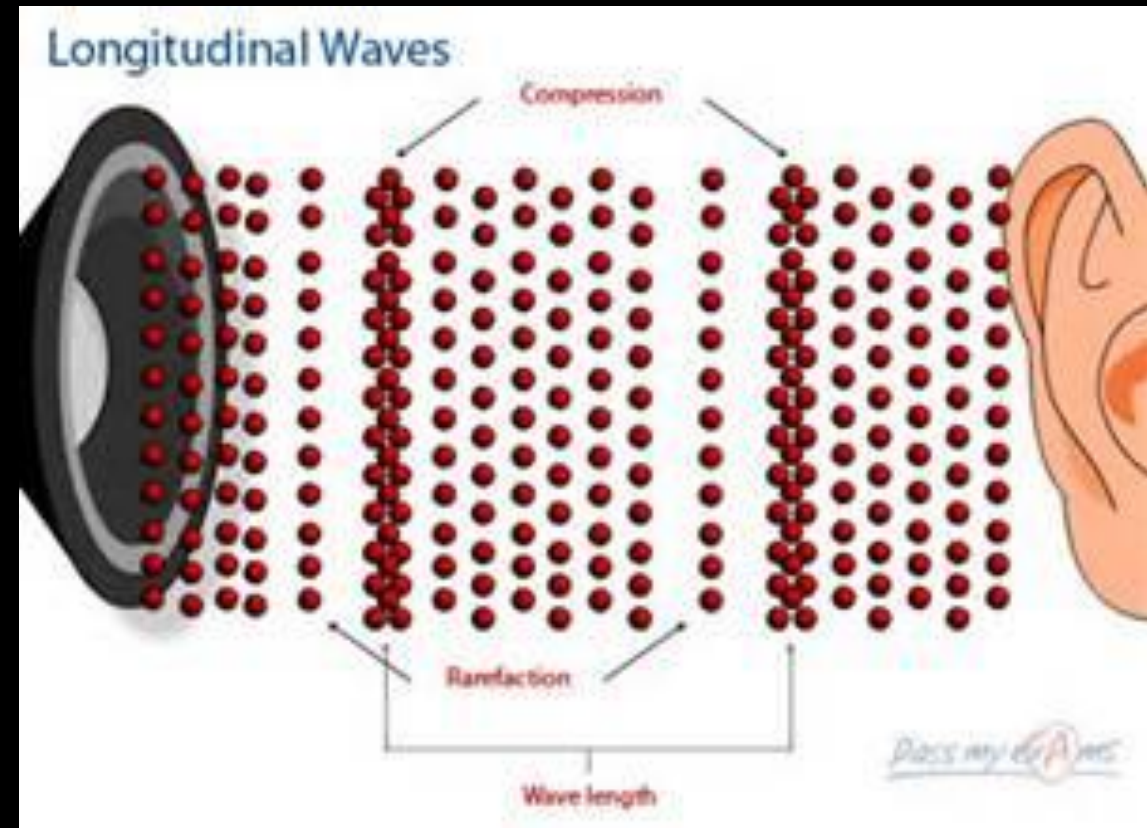
reverberation

The echoes of a sound that are heard after a sound source stops producing sound waves.



16.4 How You Hear Sound

- The outer ear funnels sound waves, the middle ear transmits the waves inward, and the inner ear converts sound waves into a form that travels to your brain.



16.4 How You Hear Sound

- There are many causes of hearing loss, including injury, infection, exposure to loud sounds, and aging.

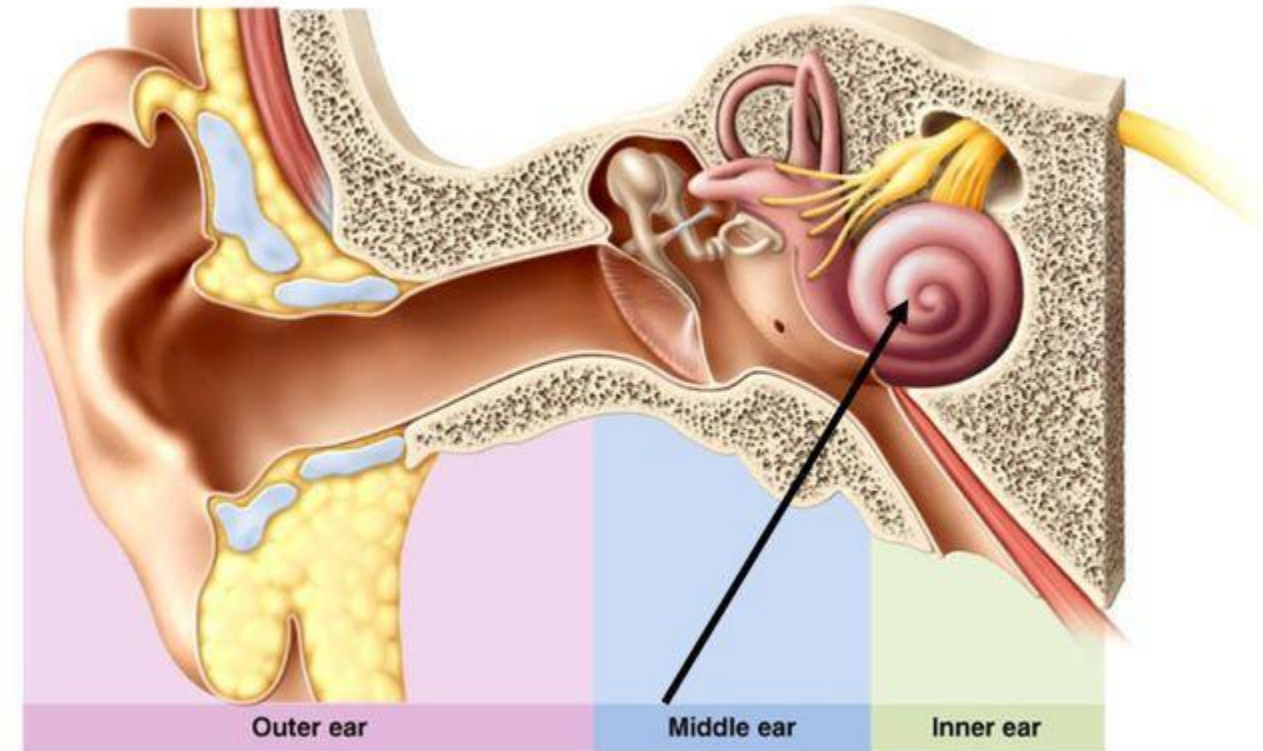


ear canal

A narrow region leading from the outside of the human ear to the eardrum.

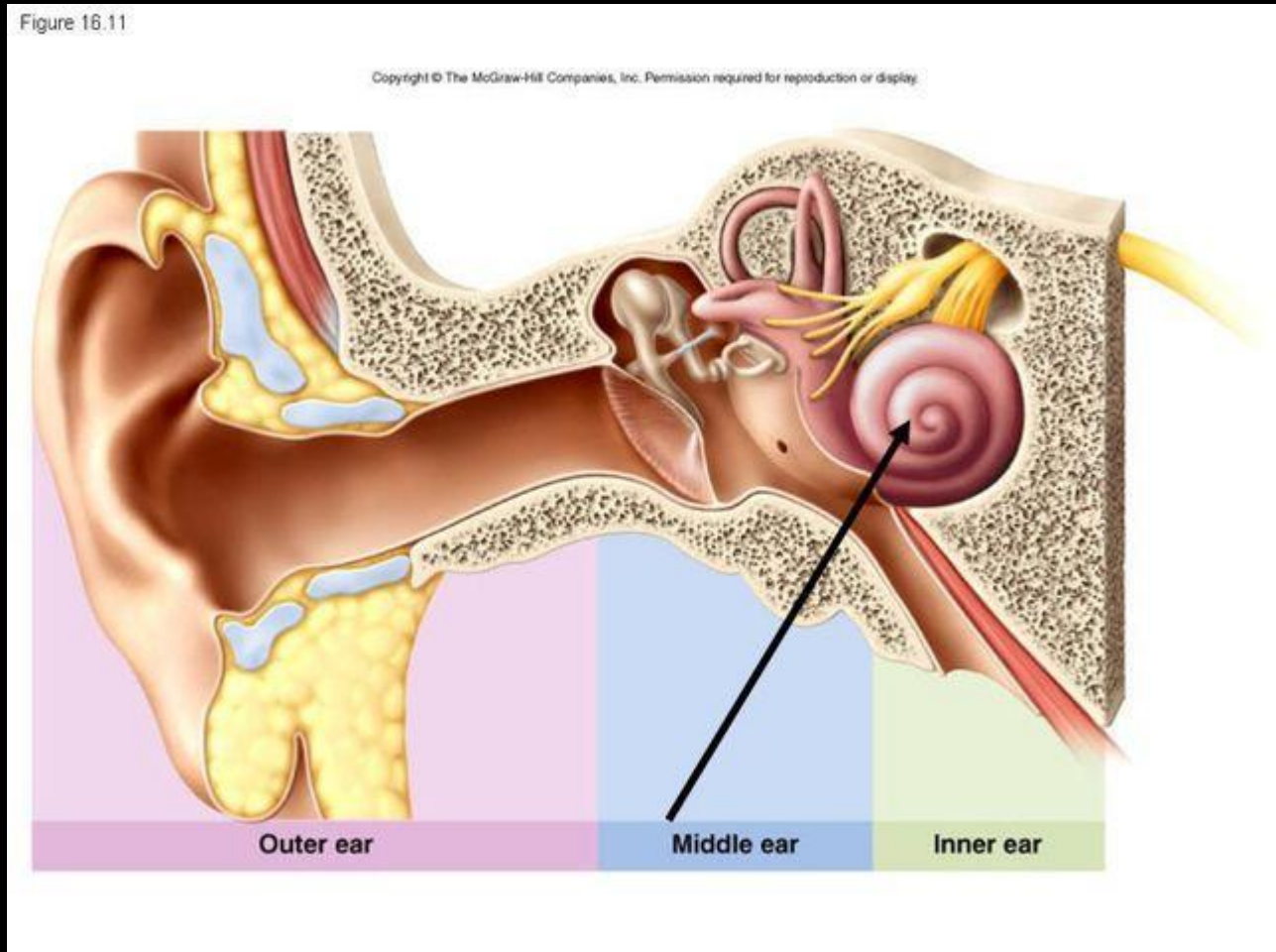
Figure 16.11

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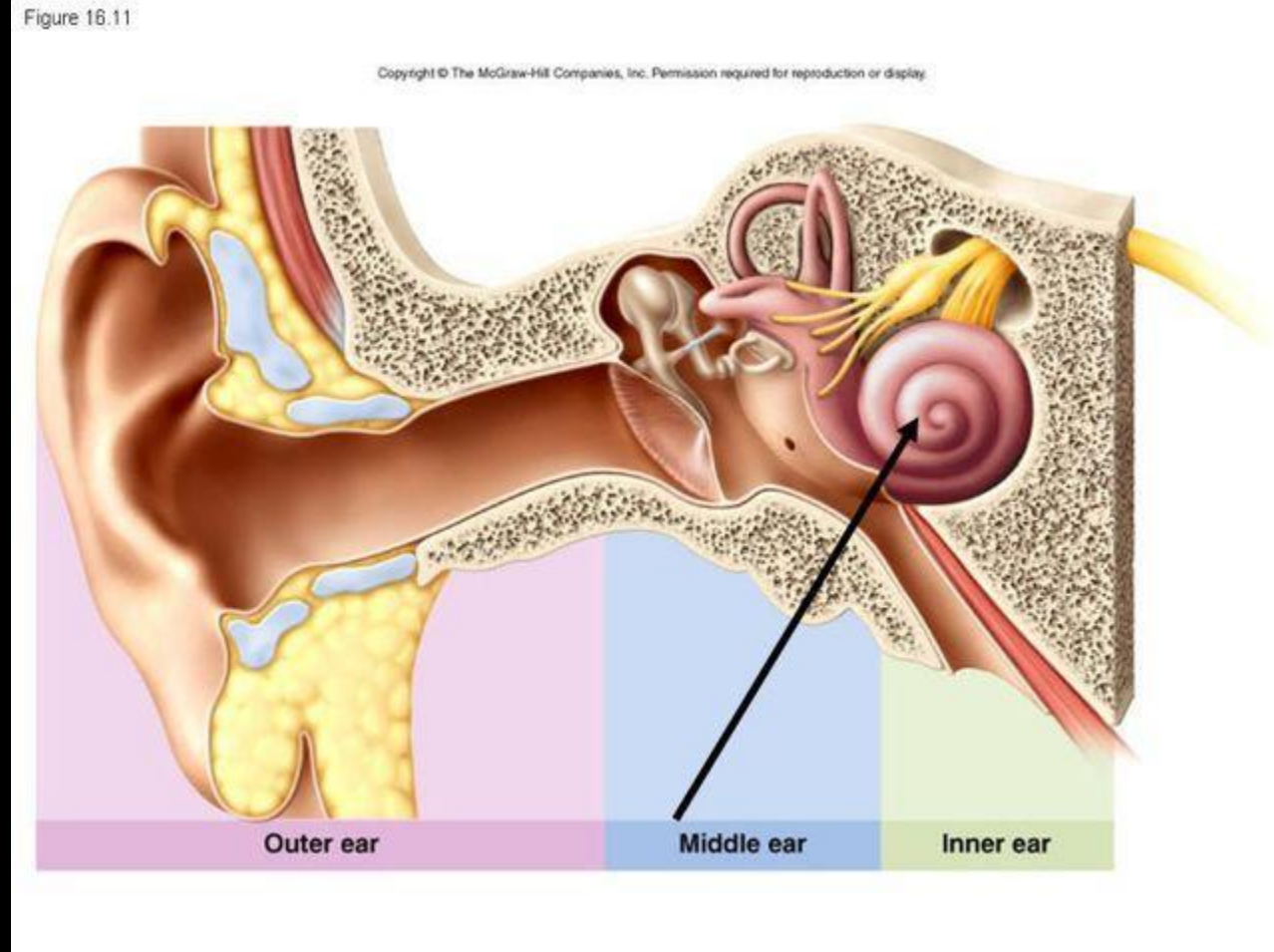
eardrum

A small, tightly stretched drum-like membrane in the ear.



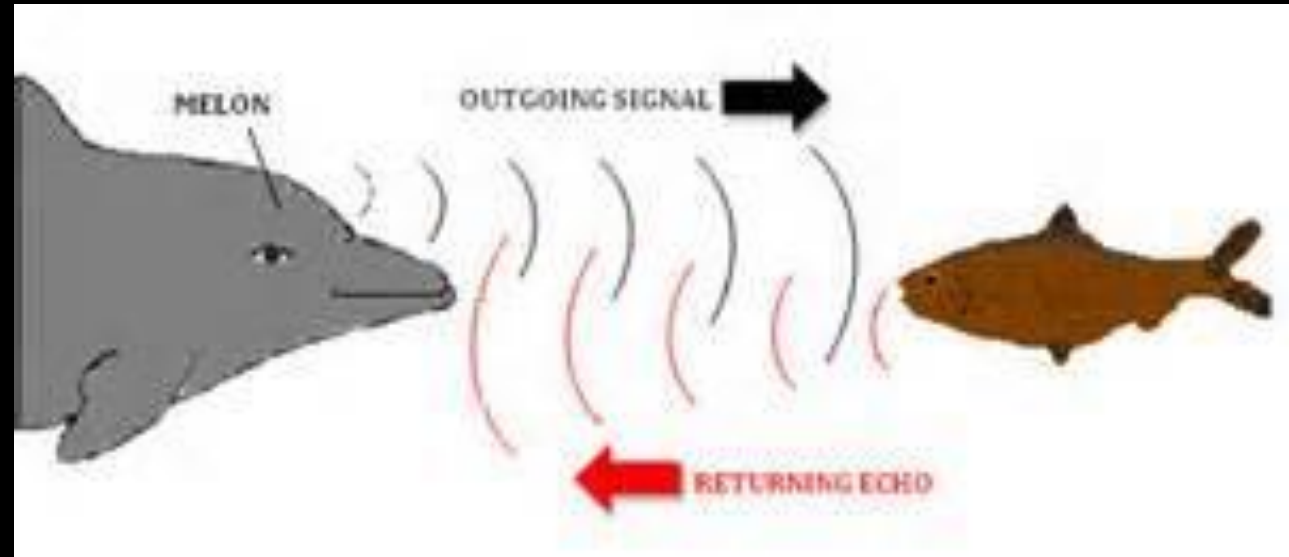
cochlea

A fluid-filled cavity in the inner ear that is shaped like a snail shell.



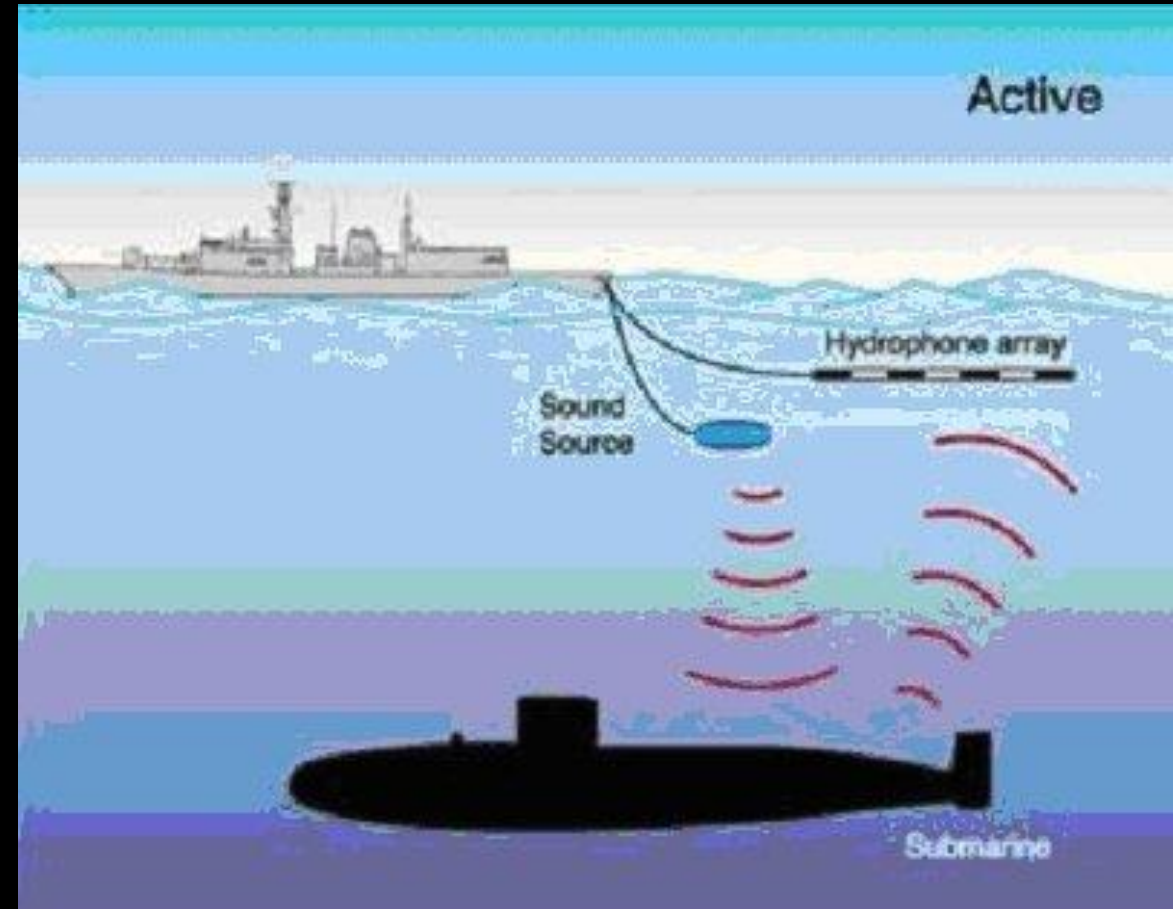
16.5 USING SOUND

- Some animals, including bats and dolphins, use echolocation to navigate and to find food.



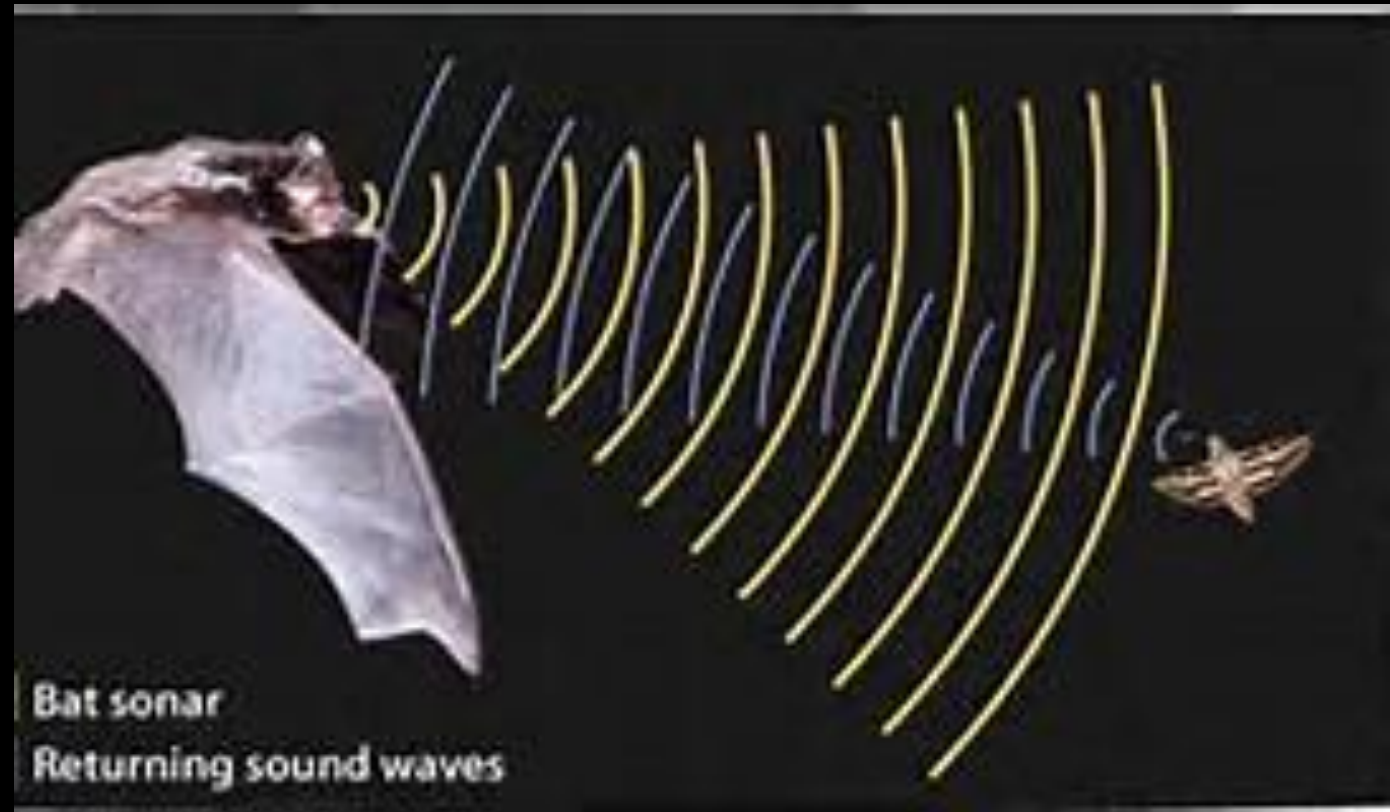
16.3 USING SOUND

- Ultrasound technologies such as sonar and ultrasound imaging are used to observe things that cannot be seen directly.



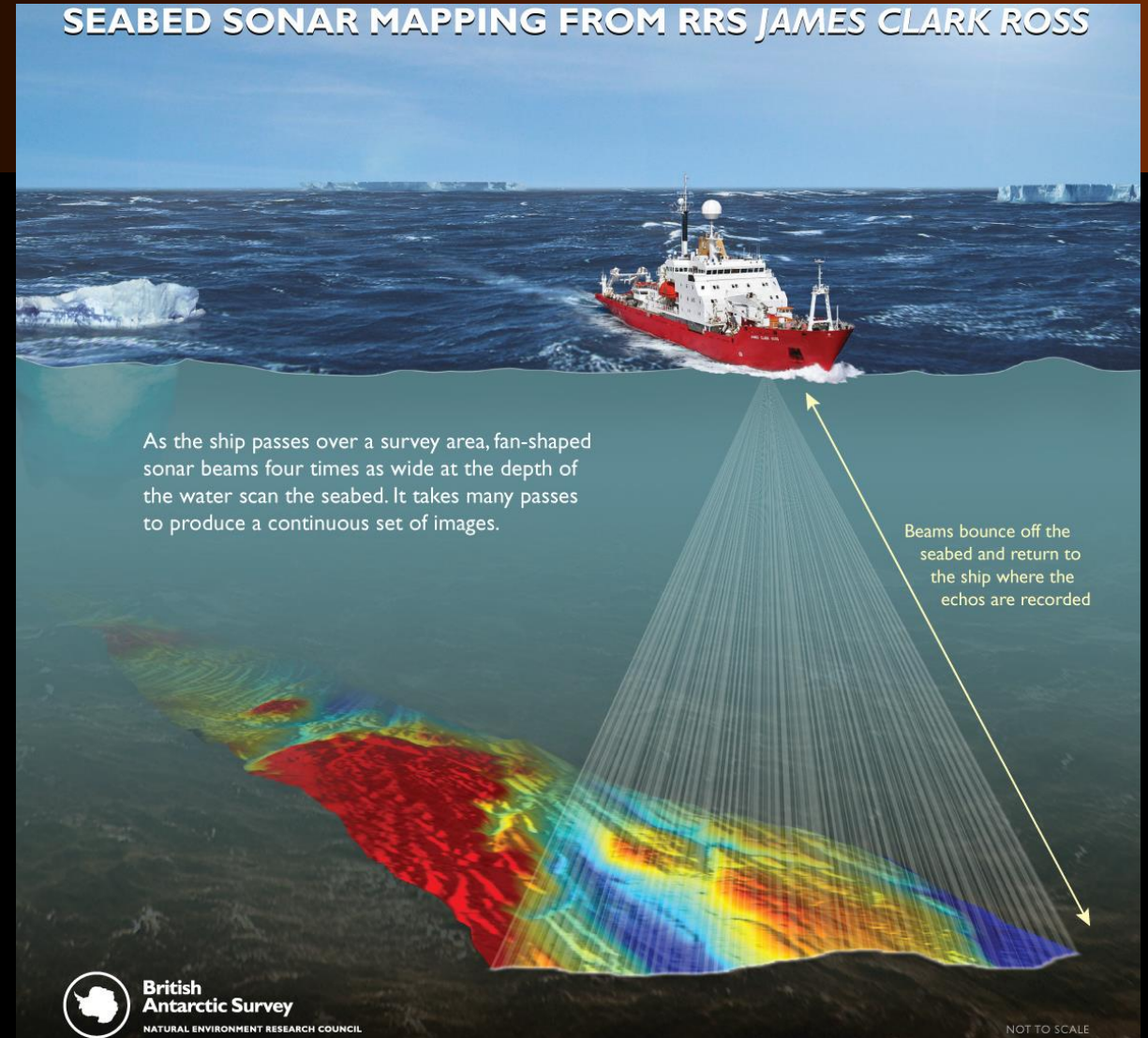
echolocation

The use of reflected sound waves to determine distances or to locate objects.



sonar

A system that uses reflected sound waves to detect and locate objects underwater.



sonogram

An image formed using reflected ultrasound waves.



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