Hearing

Sound

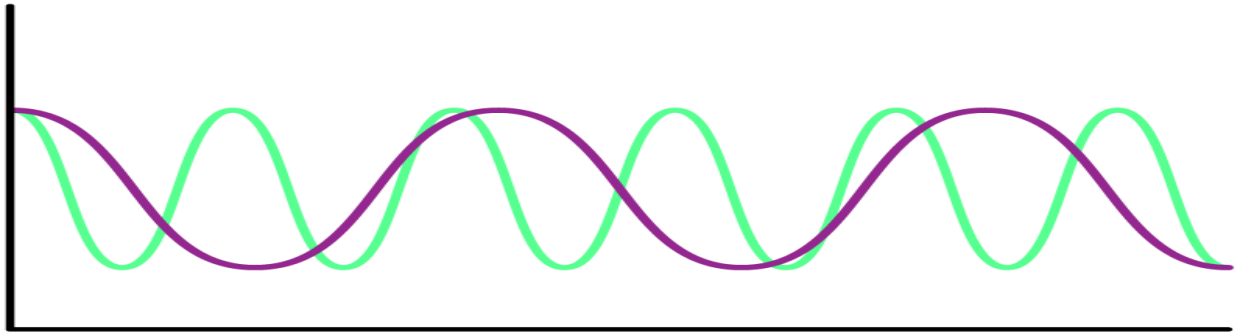
Sound is best thought of as a wave ‘sound-wave’

Waves come from a vibrating source

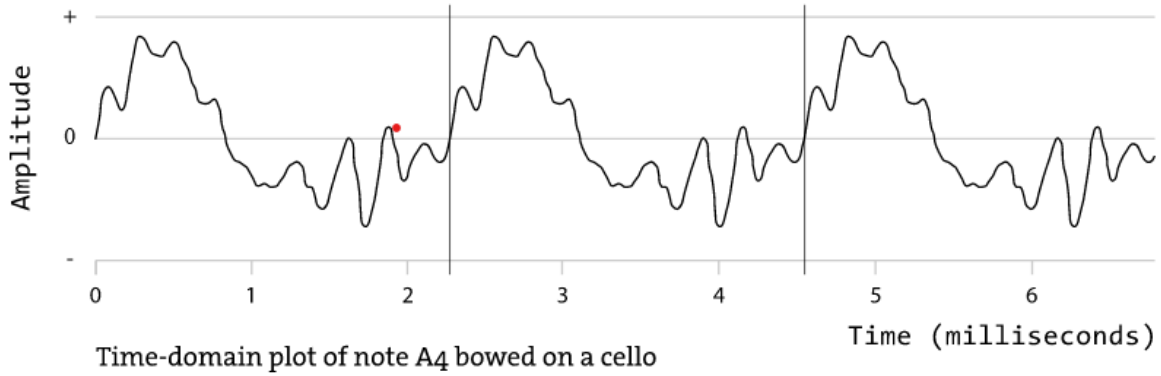
- The vibrations change pressure of the air as they move, a bit like waves in water
- The vibrations can be slow or fast (differences in frequency)
  - An instrument like a bass produces slow vibrations, so the waves are far apart. We hear this as a low pitched sound
  - An instrument like a violin produces faster vibrations, so the waves are closer. We hear this as a higher pitched sound
- The extent to which the air is compressed can also differ (i.e., differences in amplitude)
  - We perceive air that is highly compressed as loud sound

Sound

Almost sounds, apart from those from a tuning fork produce more than a single simple vibration

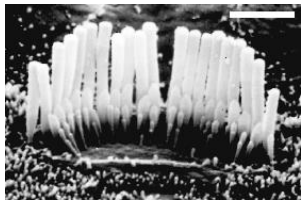


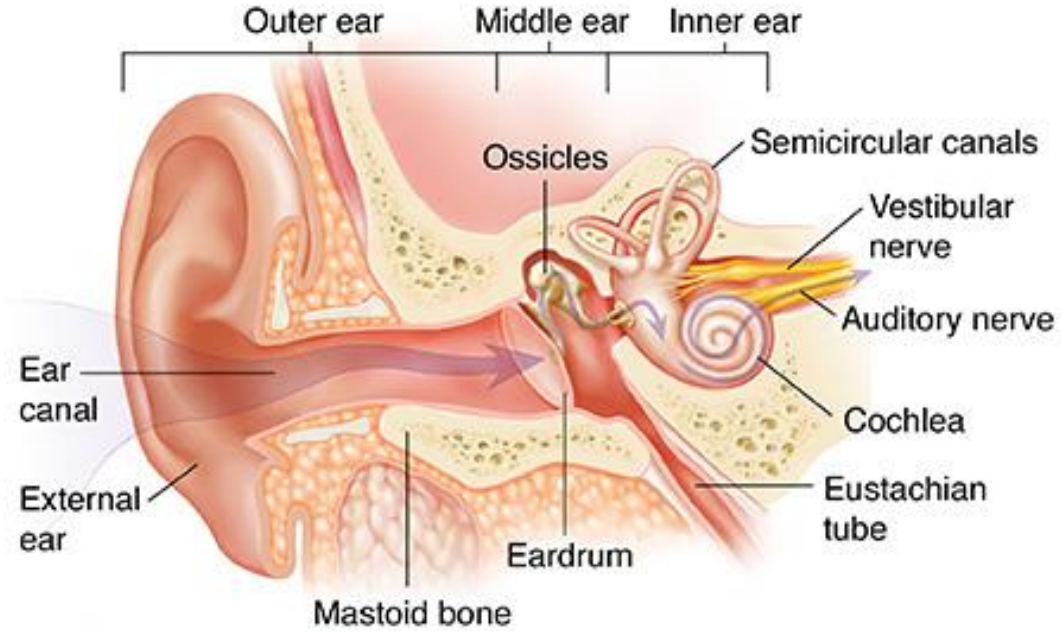
But these frequencies interact with each other (superposition) and form a new wave – the same air at a given point can't be at two different pressures.

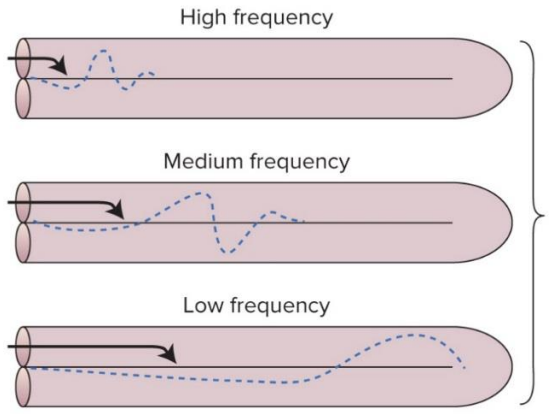


Time-domain plot of note A4 bowed on a cello

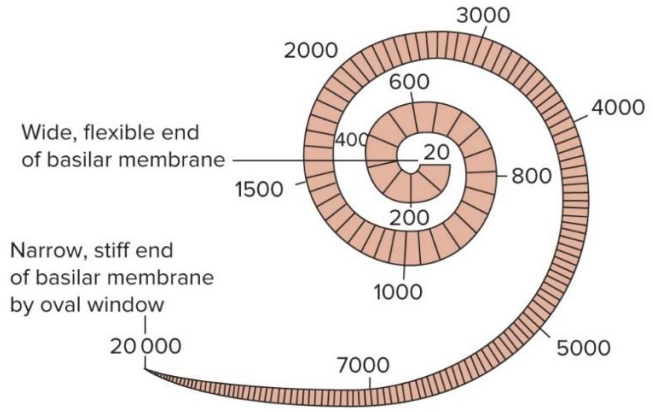
Anatomy of your ear







(c)



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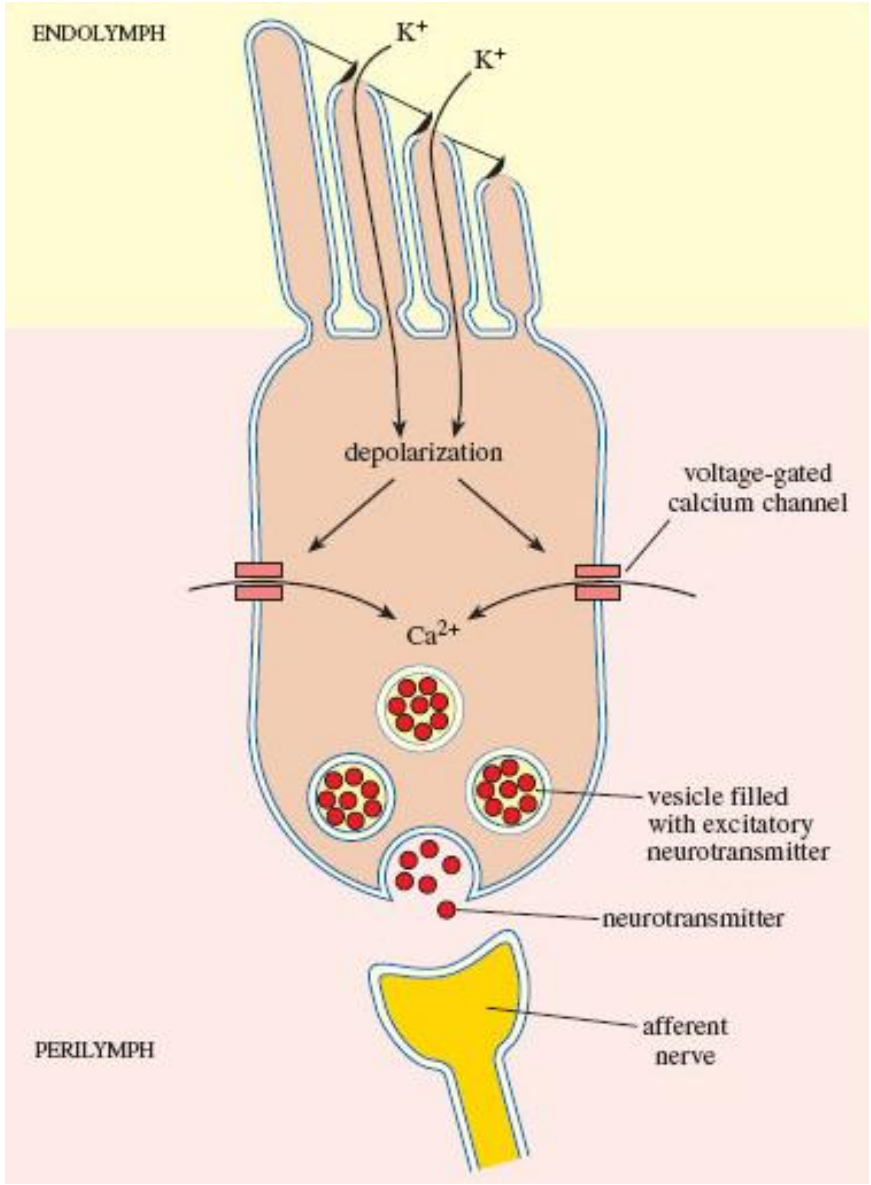
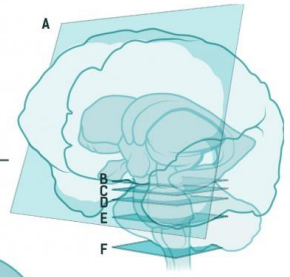
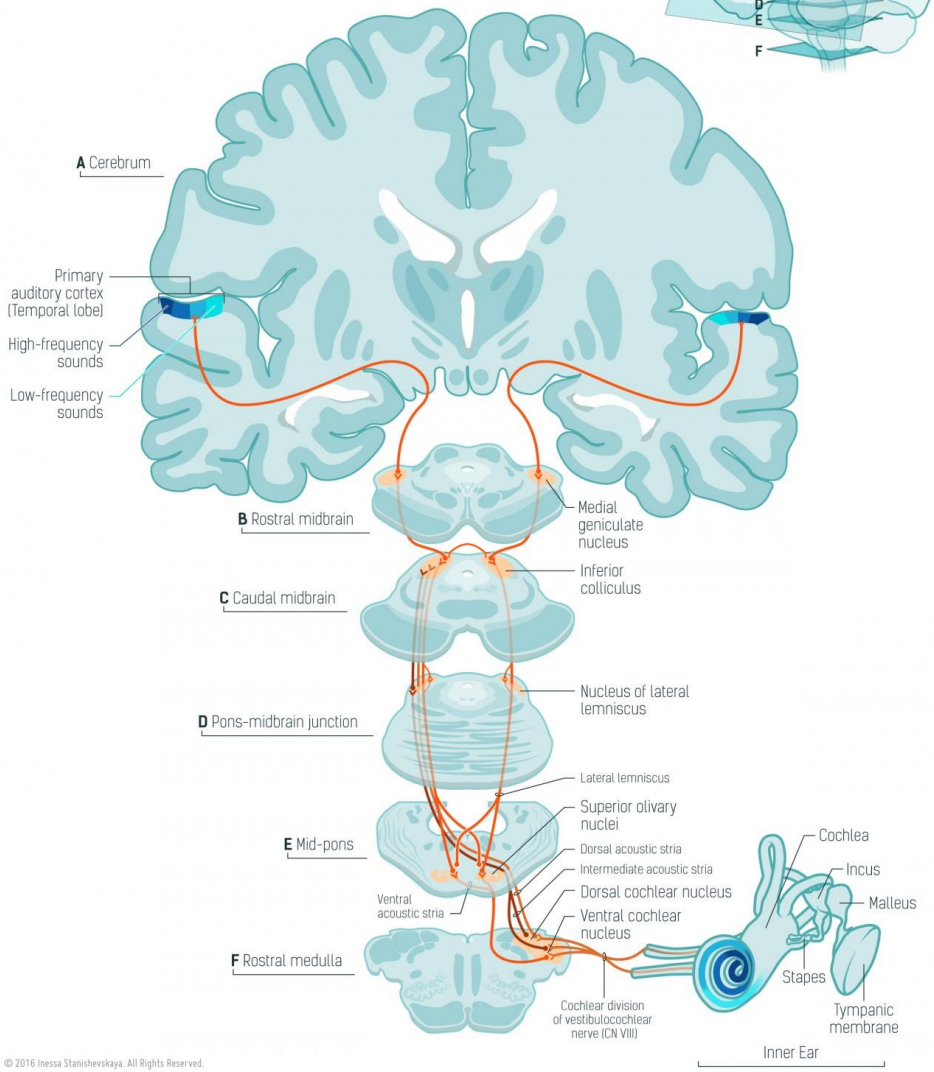


THE AUDITORY PATHWAY

of the human brain





Learning:
I don’t expect you to learn any terminology in this picture

Pitch

Highness or lowness of sound

Humans hearing range from 20-20000Hz

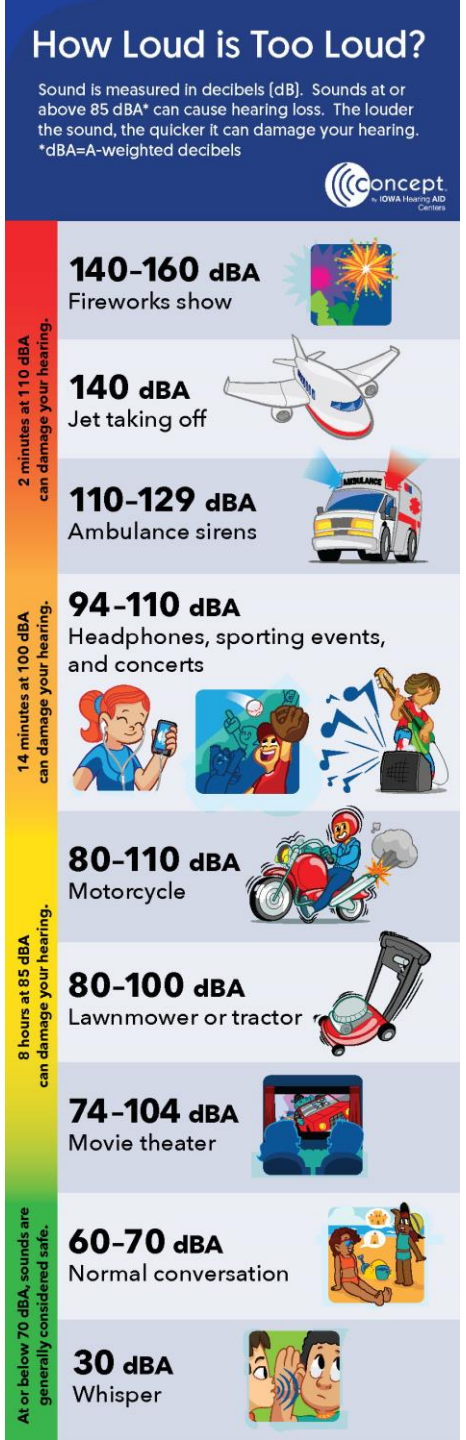
- Sensitivity is best between 1000-4000hz
- Most people have hearing loss which starts at about 30
- Worse for high than low frequencies

Loudness

Intensity of sound

Amplitude of the sound waves

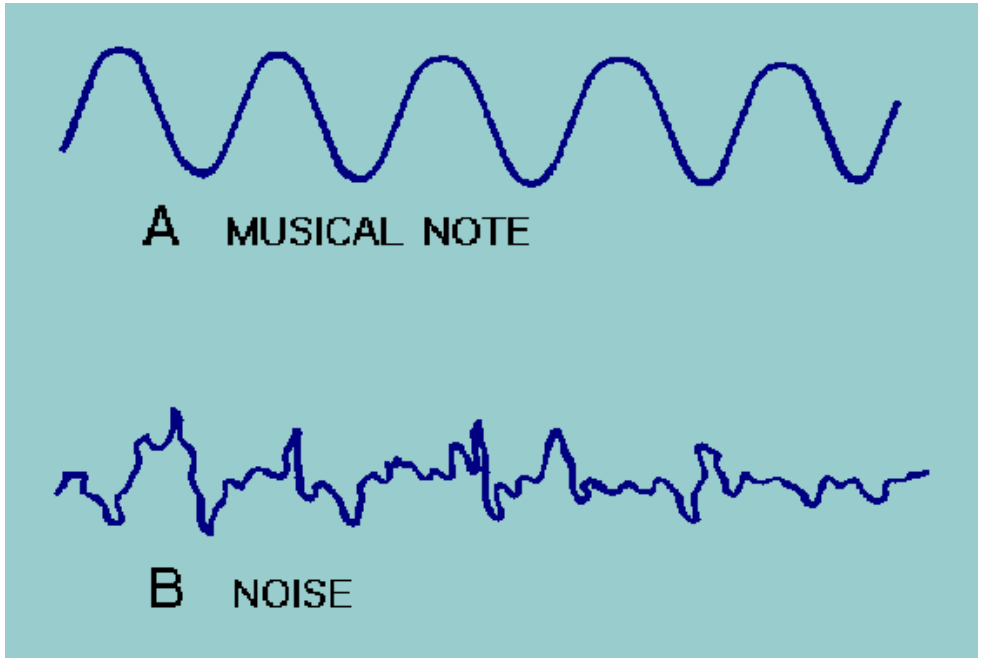
We use decibels to measure it (DB)



Timbre

The complexity of the sound

Noise sounds is represented by deformations of the wave form that are not predictable to the listener



Interesting stuff

Lots of animals have evolved ears that can move and be directed at a sound (humans lost this ability)

- An ear pointed at a sound can increase the acoustic pressure 25 times compared to one pointed away
- Some animals can move their ears independently so get a full 360 degrees of sound improvement

Humans have tried to invent things even before modern times to help with hearing that is similar to this – Beethoven used to use an ear-trumpet when he was going deaf

Interesting stuff 2

Some types of bats use echo location to fly in the dark and catch insects

- They emit a sound, and listen for the distortion when it bounces back off objects
- Because sound is absorbed easily, they need to emit really loud to sounds so they can hear the sound bouncing back.
  - The emitted sound can be 140db 10cms from their mouth, but fortunately it is at too high a pitch for human hearing!
  - The have also evolved so when they emit the sound their ears are covered by skin so they don’t go deaf, and the sound is produced essentially free using energy created in their normal flying motion