260-2017-11-13-audition

Rick Gilmore

2017-11-13 07:11:26

Prelude

sound of silence

Today's Topics

- Auditory processing

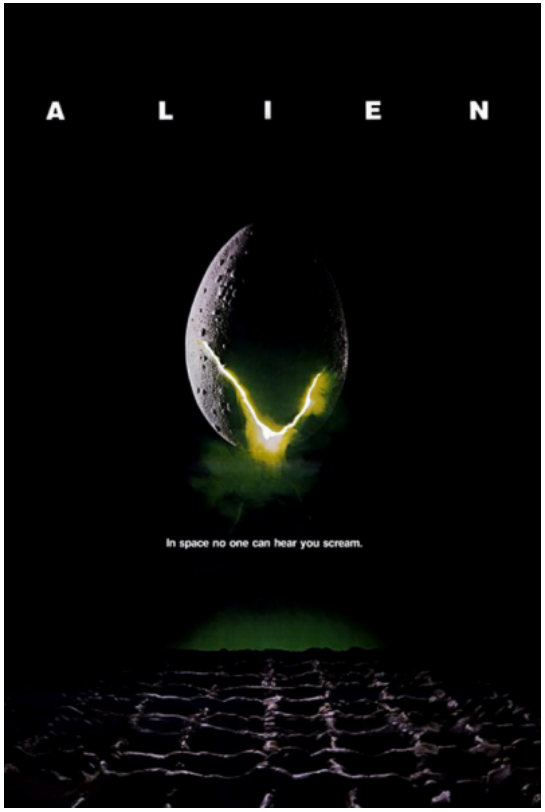
Auditory processing

- Goals
  - What's out there
  - Where is it?
- Sound
  - What is it?
- How the brain processes sound

What is sound?

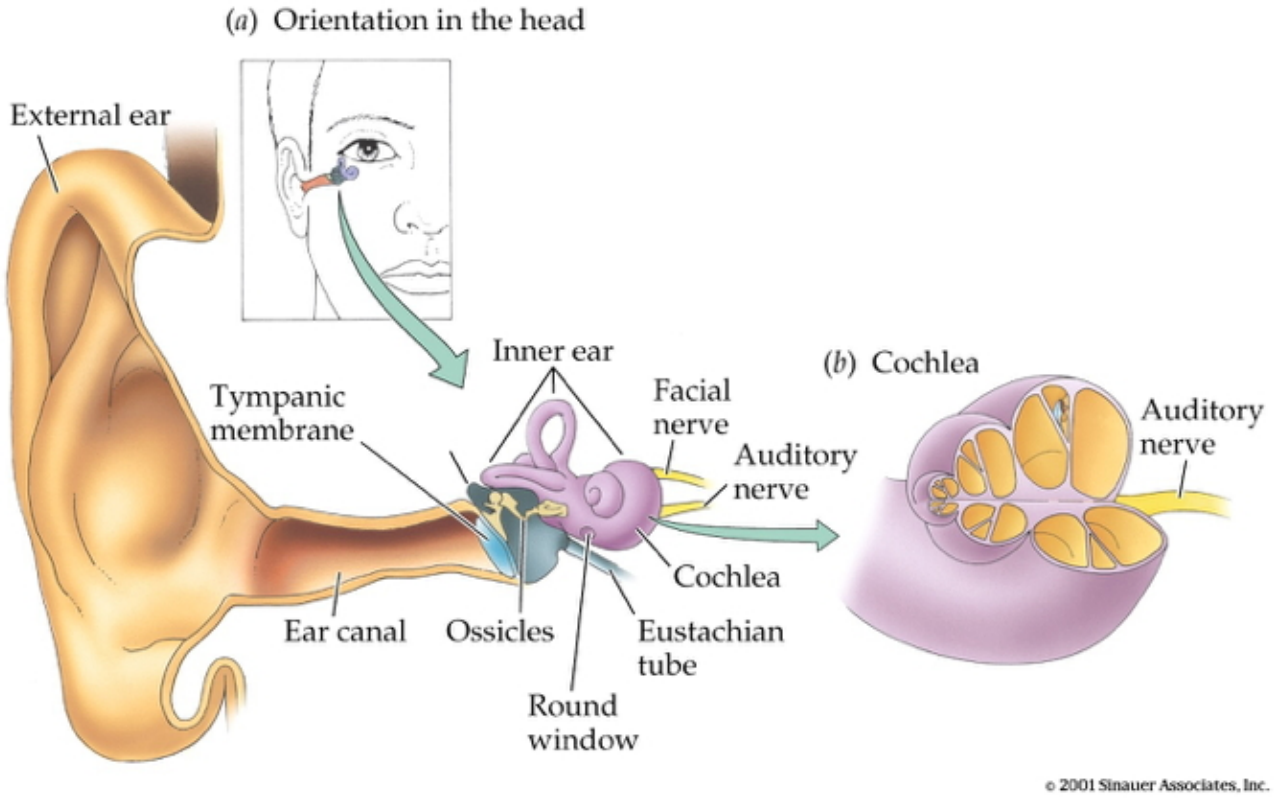
- Sound = pressure waves
- Vary in frequency, amplitude
- Requires a physical medium
- Works in the dark, over long distances, out of sight lines

Alien



http://www.imamuseum.org/blog/wp-content/uploads/2012/07/movieposter-400x599.png

Detecting sound

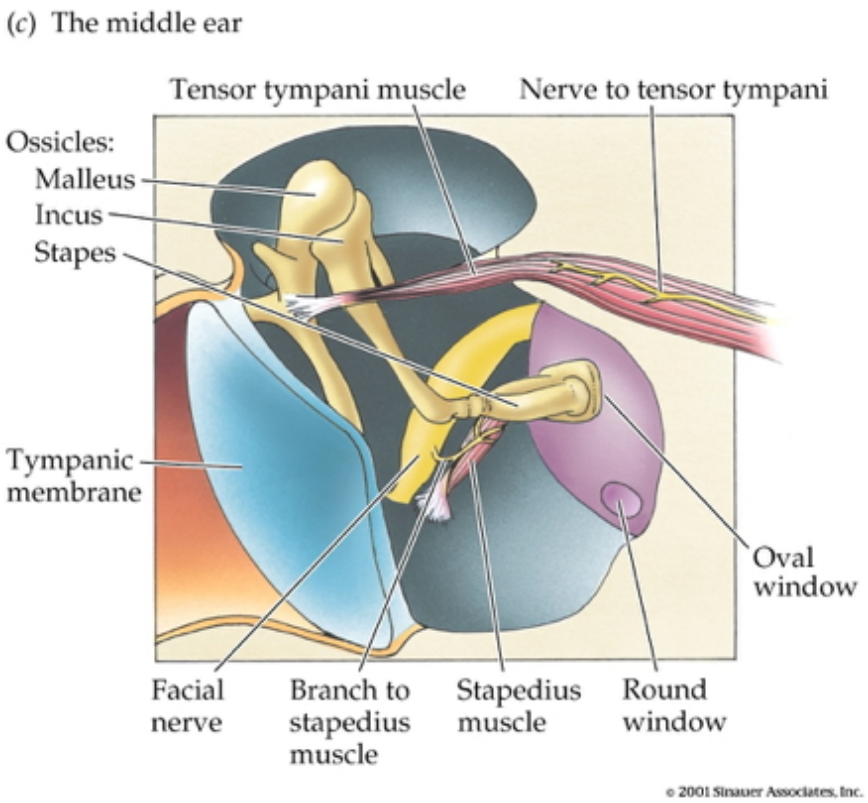


Outer ear

-
  - Filter sound
  - Channel sound
-
  - Resonates to frequencies in speech

Length, diameter determine resonant frequency

Middle ear


(c) The middle ear
Tensor tympani muscle
Nerve to tensor tympani
Ossicles:
Malleus
Incus
Stapes
Tympanic membrane
Oval window
Facial nerve
Branch to stapedius muscle
Stapedius muscle
Round window
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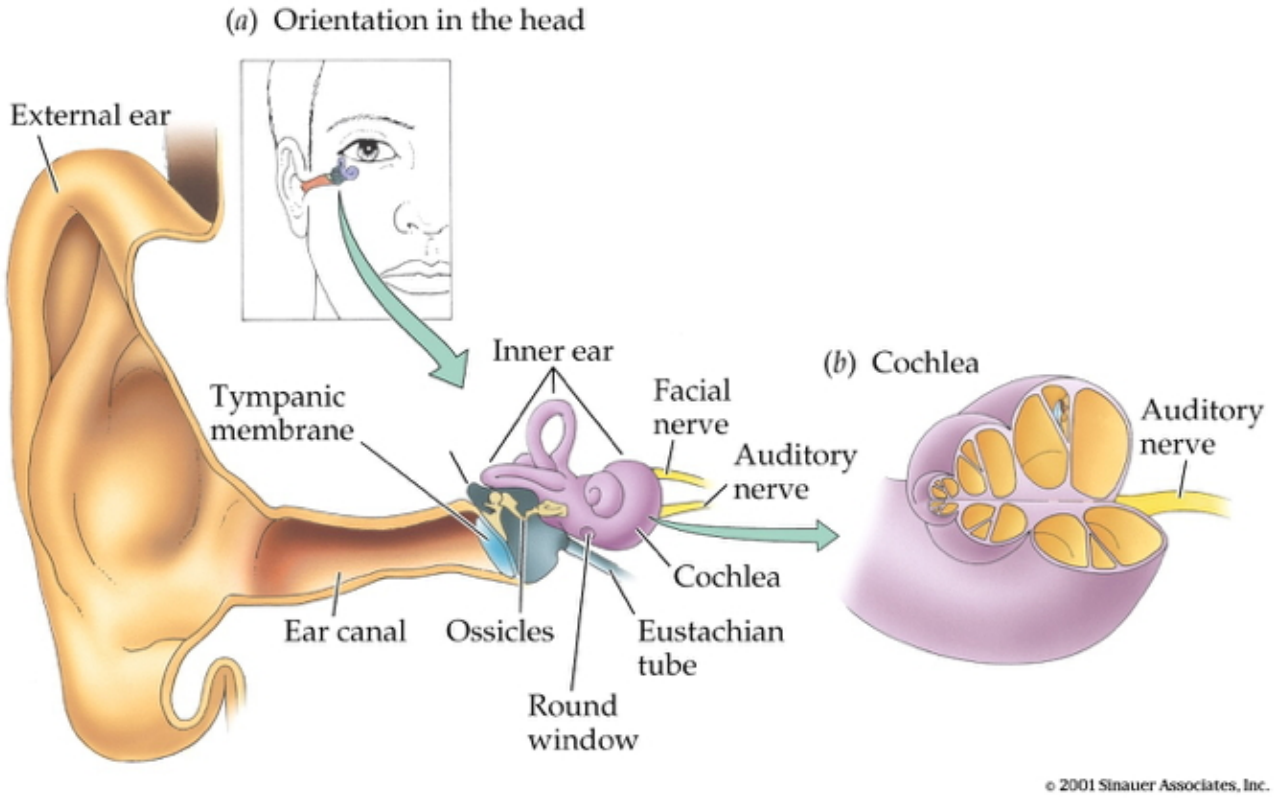
Middle ear

-
-
    - Malleus ('hammer')
    - Incus ('anvil')
    - Stapes ('stirrup')
-
    - Stapedius & tensor tympani

Where are we


(a) Orientation in the head
External ear
Inner ear
Tympanic membrane
Facial nerve
Auditory nerve
(b) Cochlea
Auditory nerve
Cochlea
Ear canal
Ossicles
Eustachian tube
Round window
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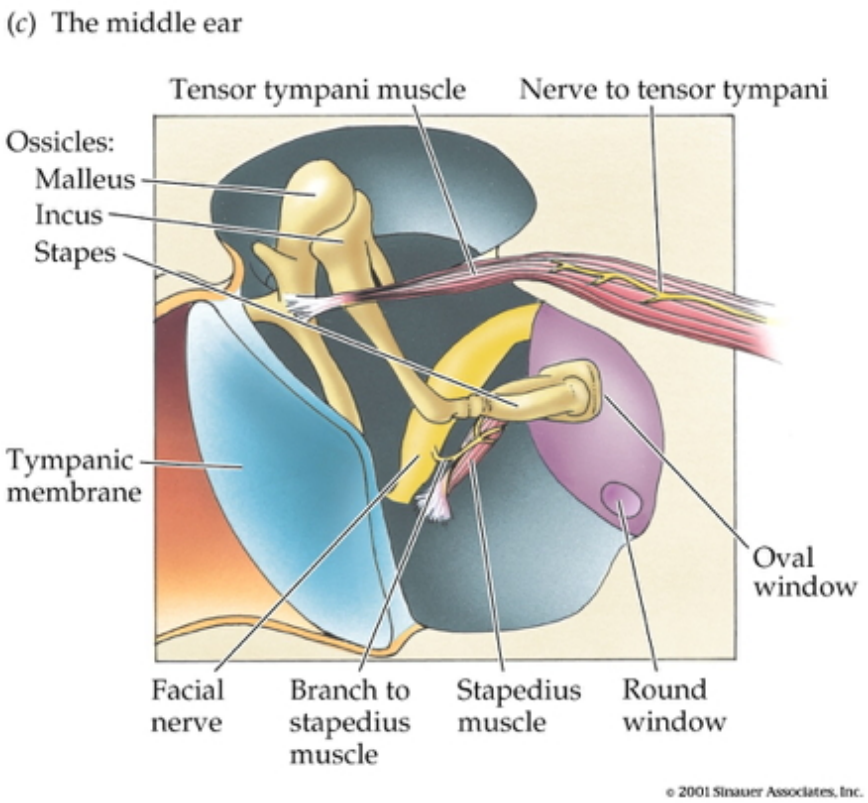
Function of ossicles, stapedius

- Ossicles amplify
  - Air thinner than cochlear fluid
- Muscles dampen
  - when sound intense or speaker vocalizes

Inner ear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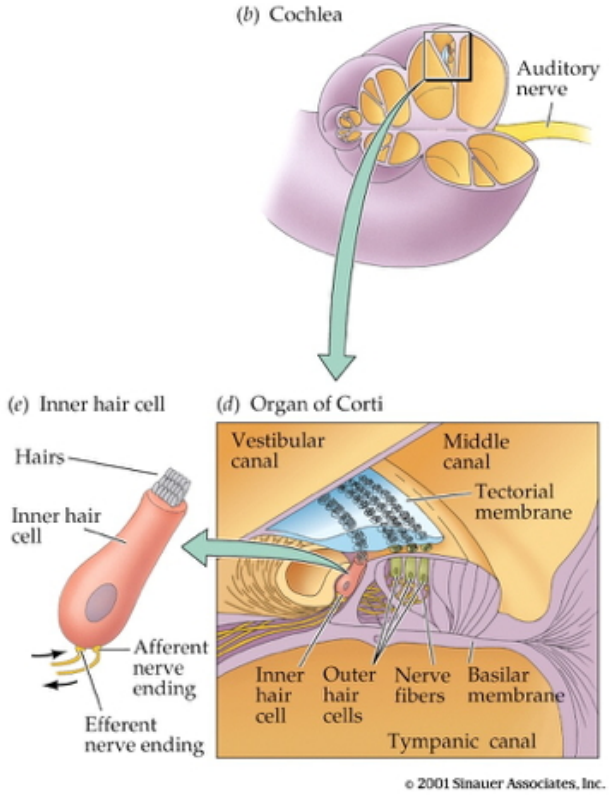
Inner ear

- Oval window
-
    -
- Round window

Organ of Corti



Organ of Corti

-
-
-
- Cochlear fluid/endolymph

Hair cells

-
  - Transduce pressure waves
-
  - “Fine tune” transduction
  - Alter stiffness of basilar/tectorial membranes

Otoacoustic emissions (OAE)

- Sounds made by the ear
  - Reflect integrity of hair cells
- Age of detection critical for early therapy

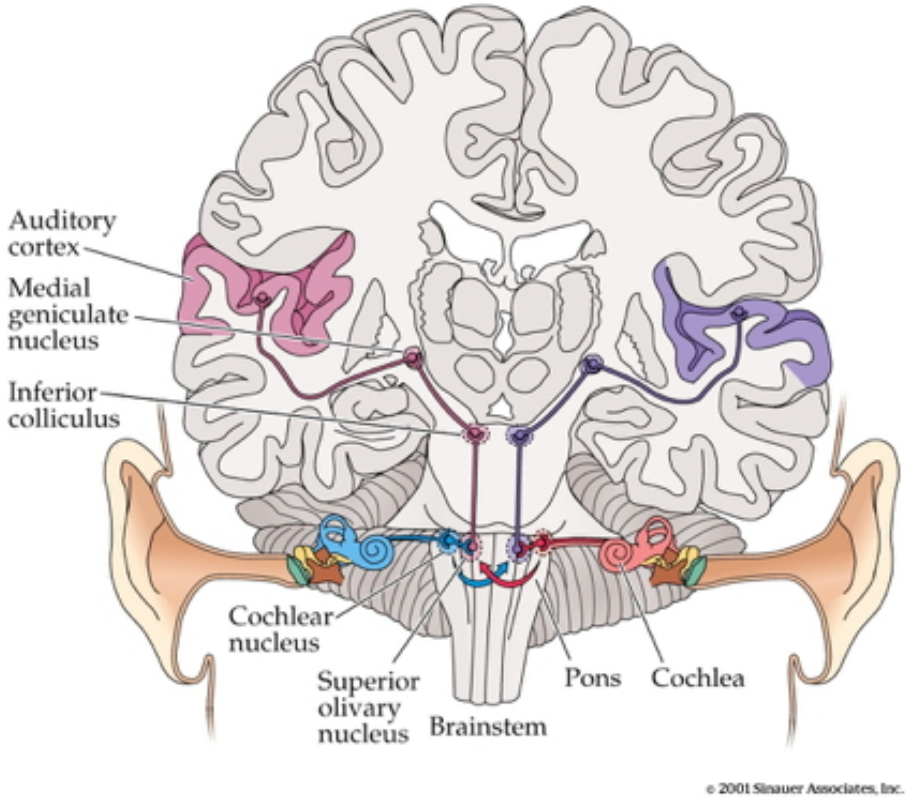
Standing waves

AP Physics 1: Waves 10: Resonance and Standing Waves on a String

Cochlear movement

Basilar Membrane

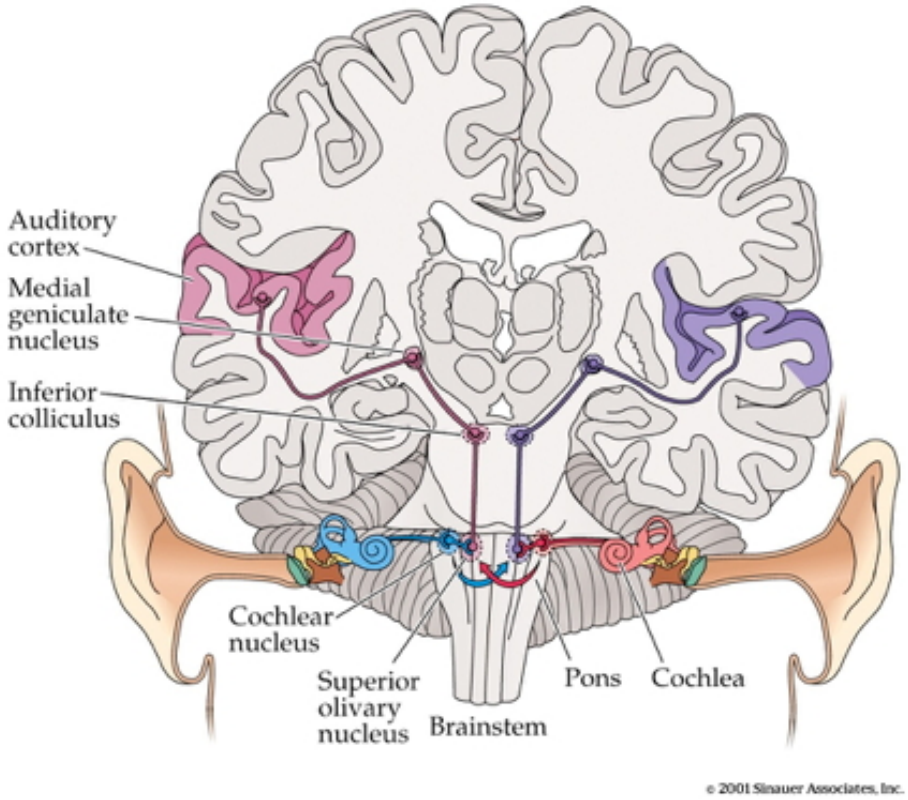
CNS projections



CNS projections

-
- Cochlear nuclei
- Superior olivary nucleus
    - L & R ear inputs mix
-

CNS projections



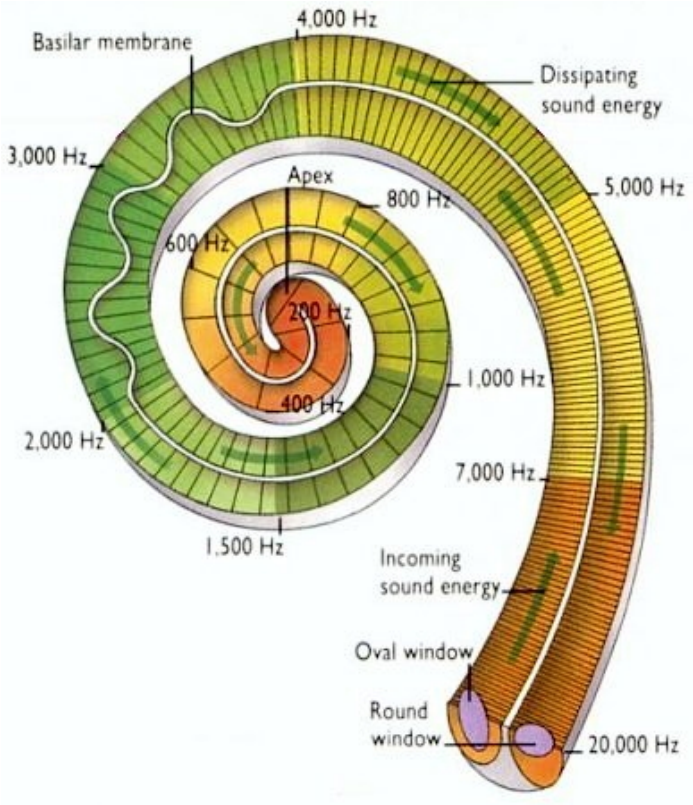
CNS projections

- Thalamus
  -
- Temporal lobe
  -

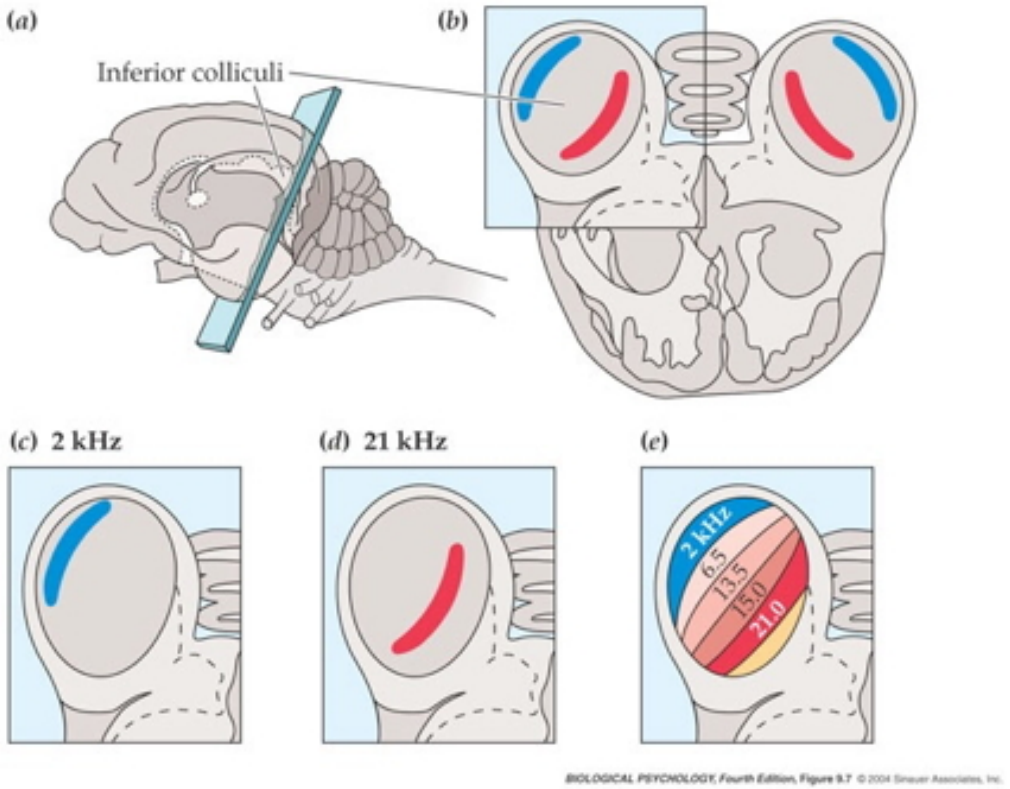
Coding frequency

- Frequency ~ pitch
- Mixture of frequencies ~ timbre (TAHMber)
-
    - Place on basilar membrane that vibrates most strongly

Place code


4,000 Hz
Basilar membrane
Dissipating
sound energy
3,000 Hz
Apex
800 Hz
5,000 Hz
600 Hz
200 Hz
1,000 Hz
400 Hz
2,000 Hz
7,000 Hz
1,500 Hz
Incoming
sound energy
Oval window
Round
window
20,000 Hz

Place code ~ xylophone



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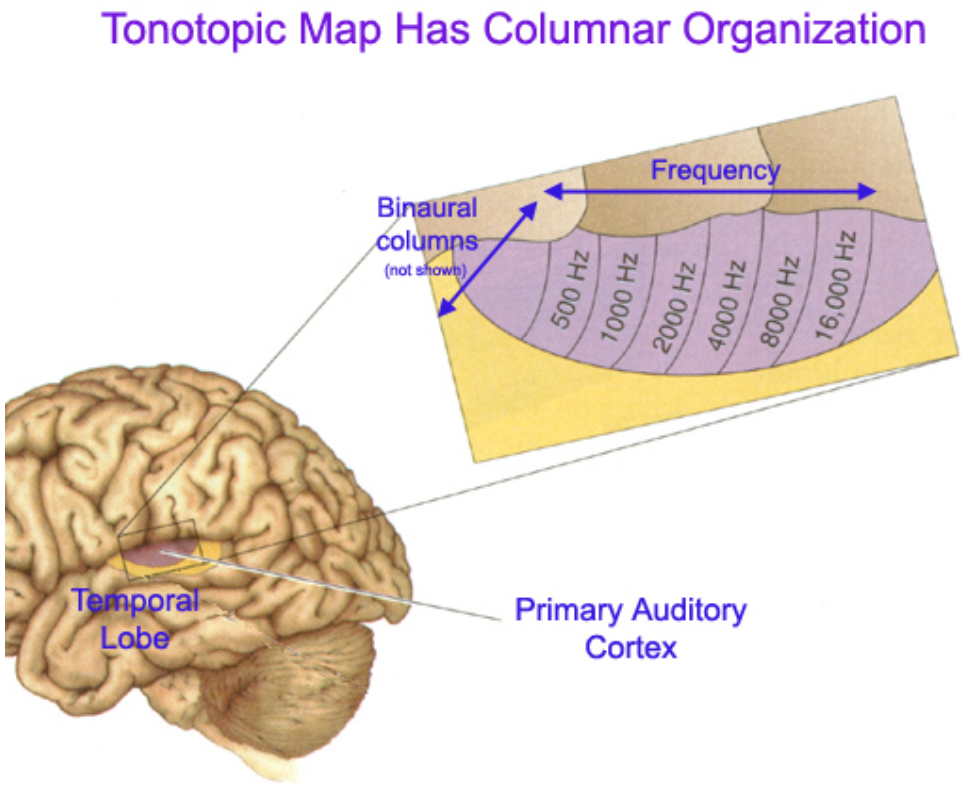
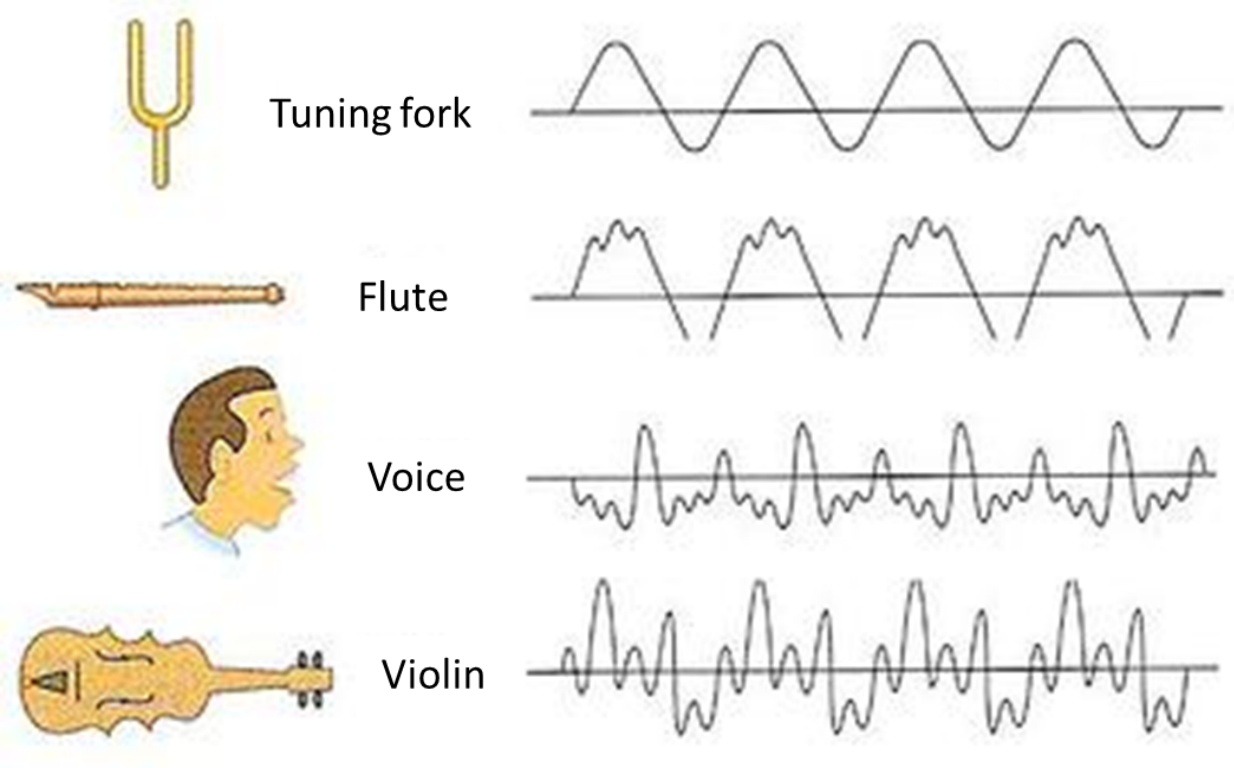
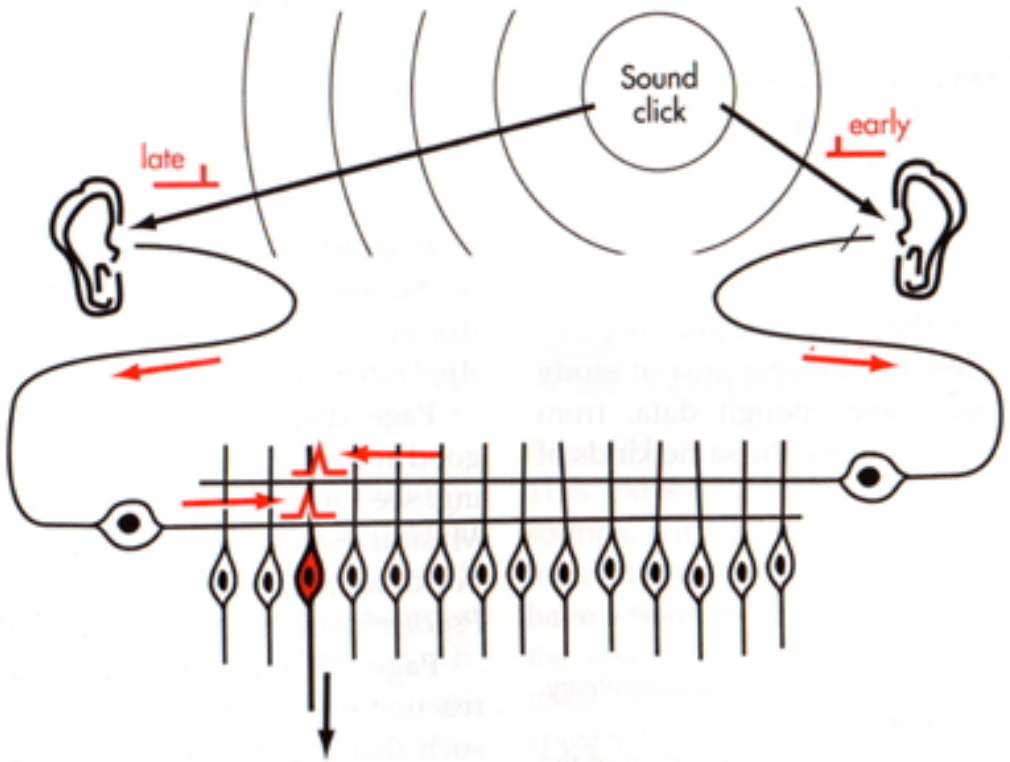
Tonotopy in auditory cortex



Timbre



Perceiving location



Perceiving location

- Interaural (between the ears) time/phase differences
  - Low frequencies
- Interaural intensity differences
  - High frequencies

How do we perceive sound elevation?

Next time…

- Vision