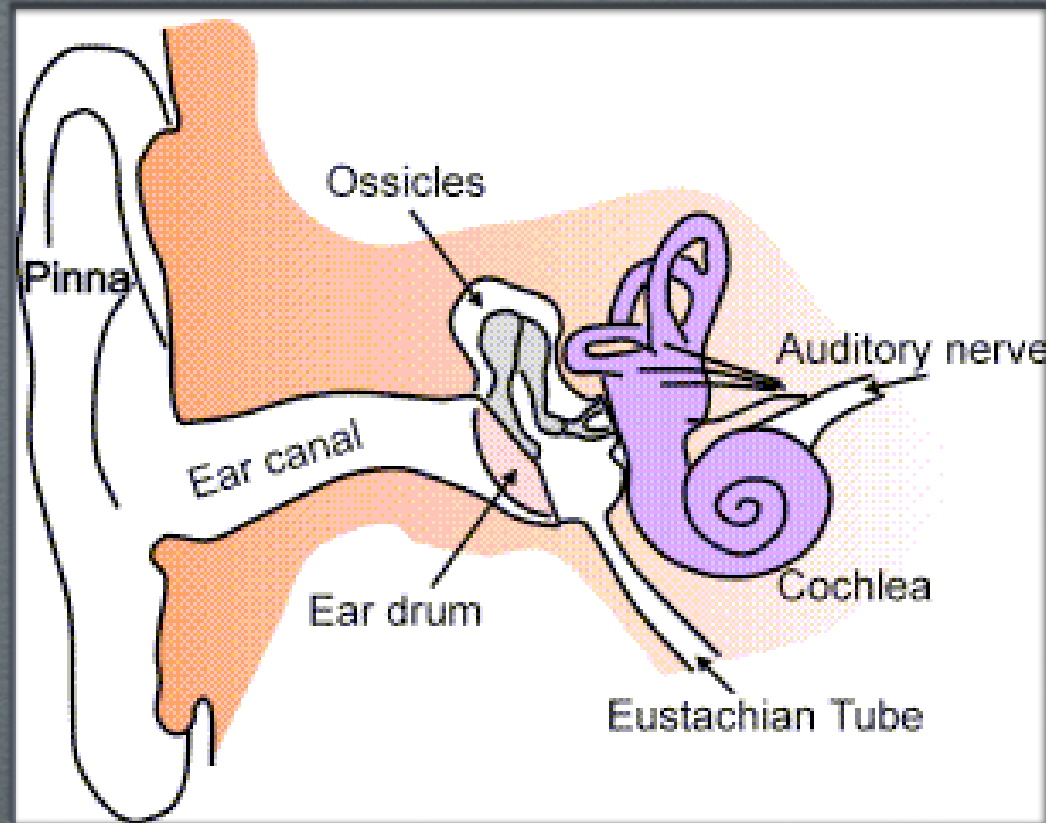


I HEAR YOU

...THE FUNCTION OF THE EAR

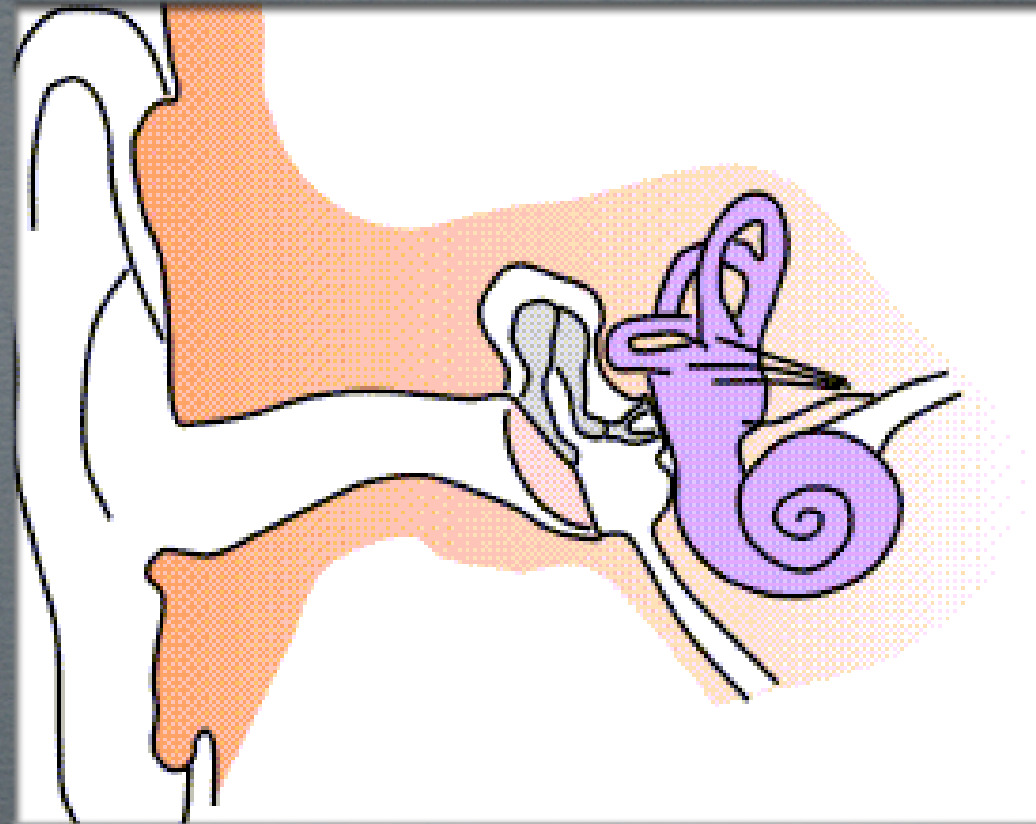
EAR STRUCTURE

- ✻ The Outer Ear - “Pinna”
- ✻ Auditory Canal - “Meatus”
- ✻ Eardrum - “Tympanic Membrane”
- ✻ Middle Ear - “Malleus, Incus, Stapes”
- ✻ Inner Ear - “Cochlea”
- ✻ Auditory Nerves



EAR STRUCTURE

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The Outer Ear - "Pinna"

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Eardrum - "Tympanic Membrane"

Middle Ear - "Malleus, Incus, Stapes"

Inner Ear - "Cochlea"

Auditory Nerves



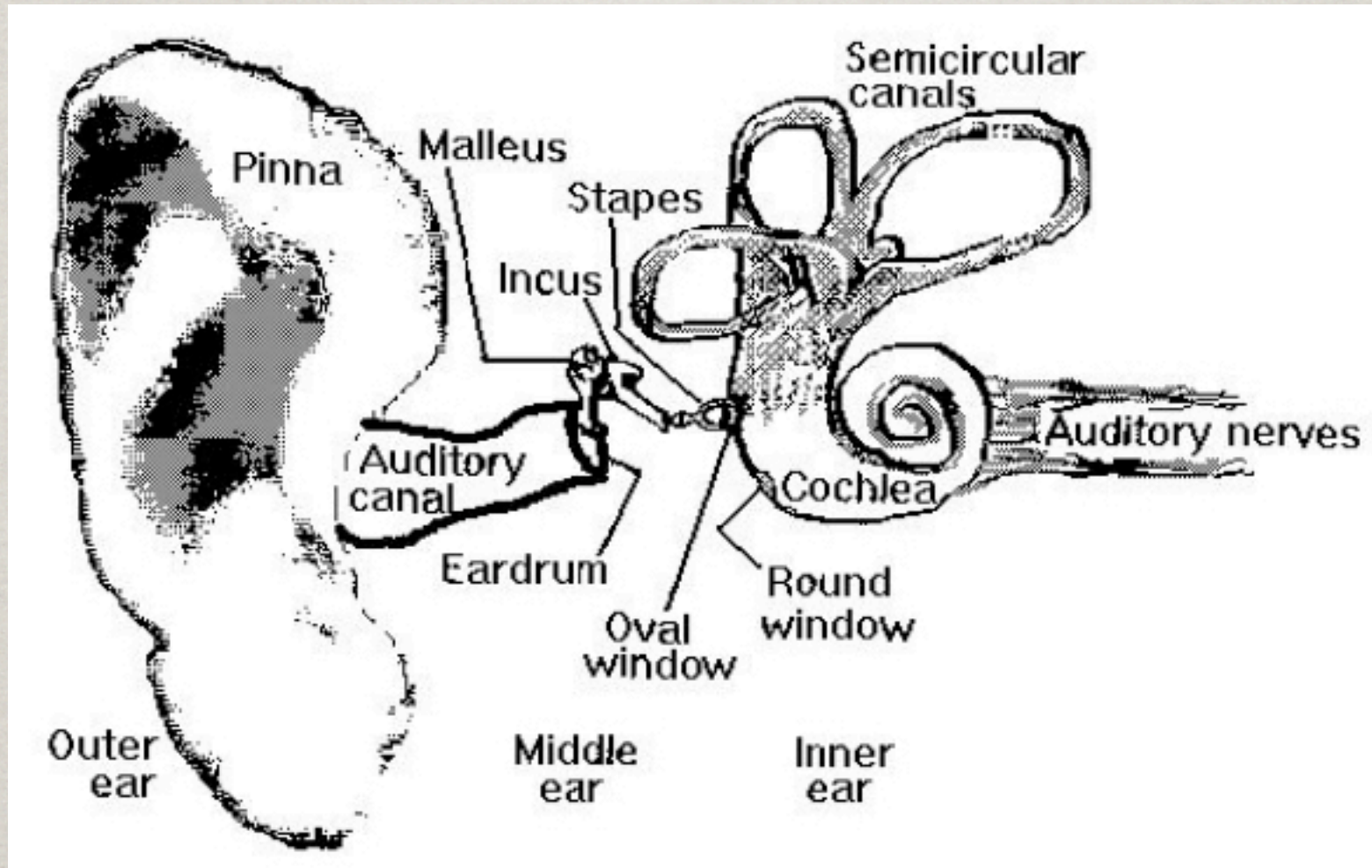
“HOW THE EAR
WORKS”

(1940)

SIGNAL PATH

1. Air
2. Outer Ear
3. Ear Canal
4. Eardrum
5. Inner Ear (bones)
6. Cochlea
7. Auditory Nerve

COCHLEA



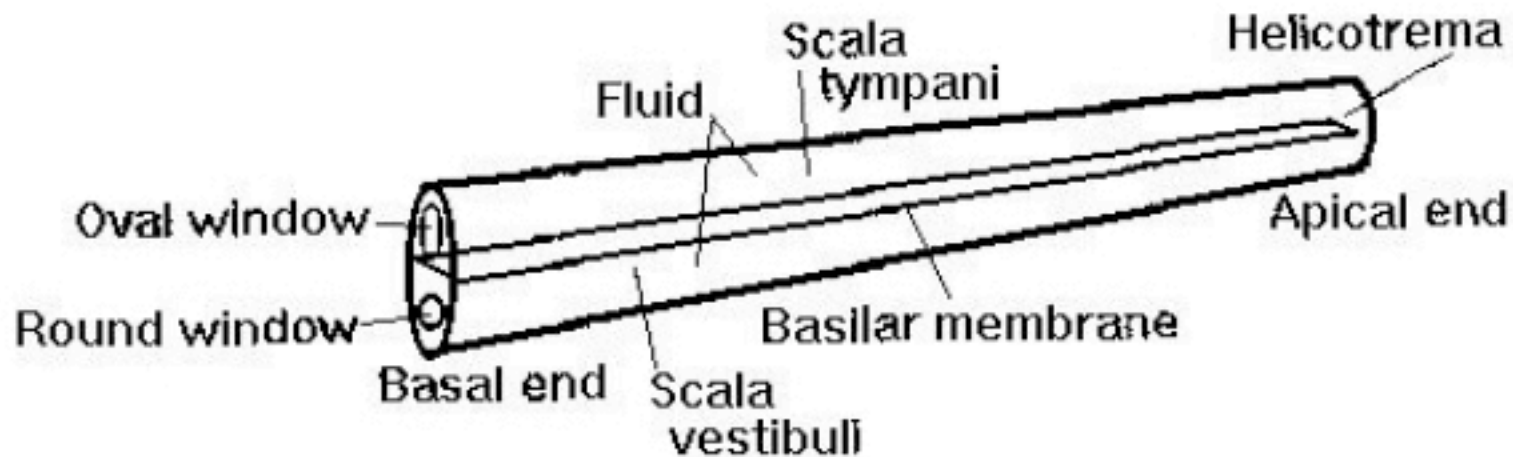
A Closed System: oval window, round window

COCHLEA



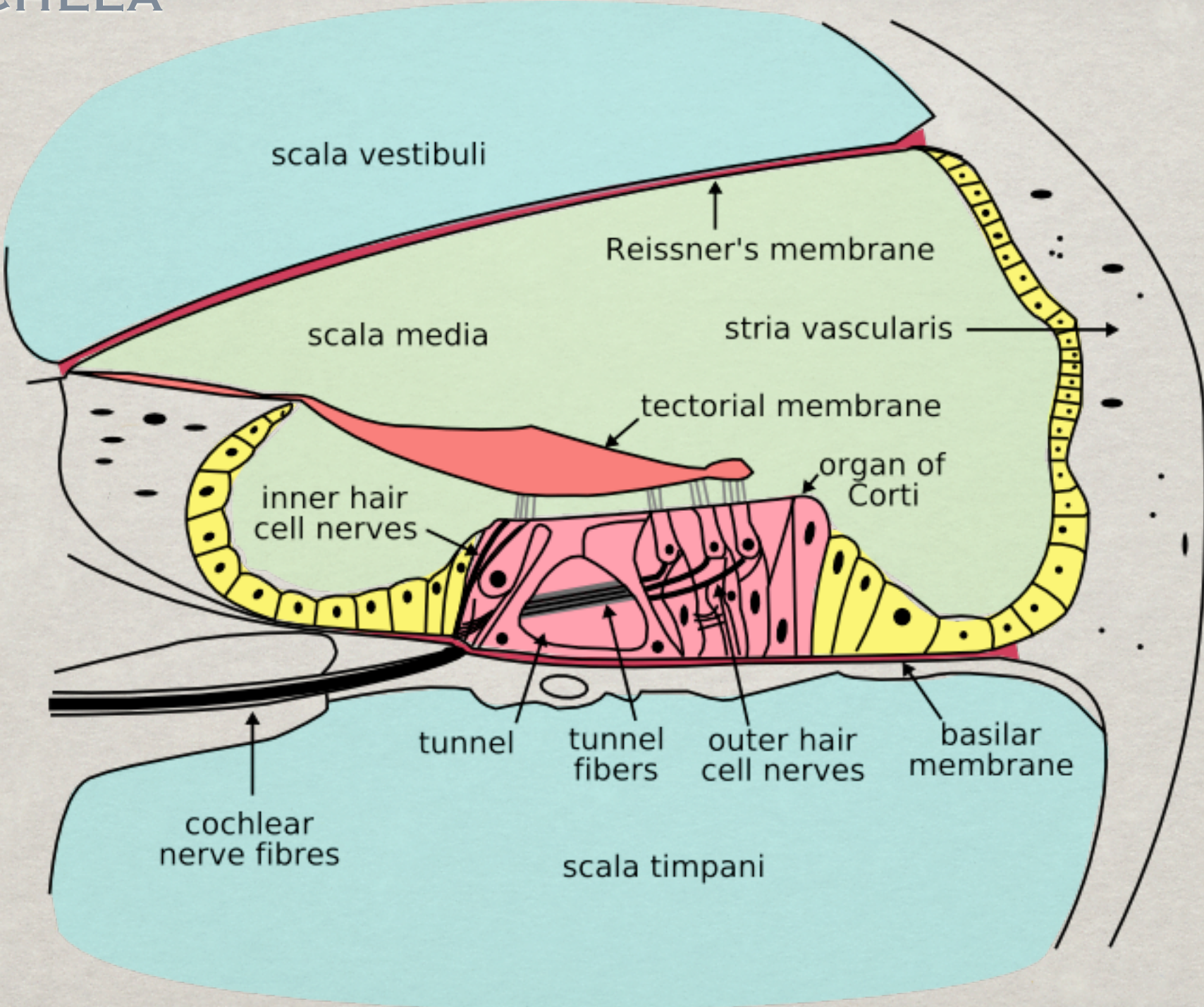
A Closed System: transmission of vibration through stapes/oval window, round window equalizes pressure.

COCHLEA



An unrolled view of the cochlea. Fluid volume is constant. If the stapes pushes the oval window in, the fluid pushes the round window out.

COCHLEA



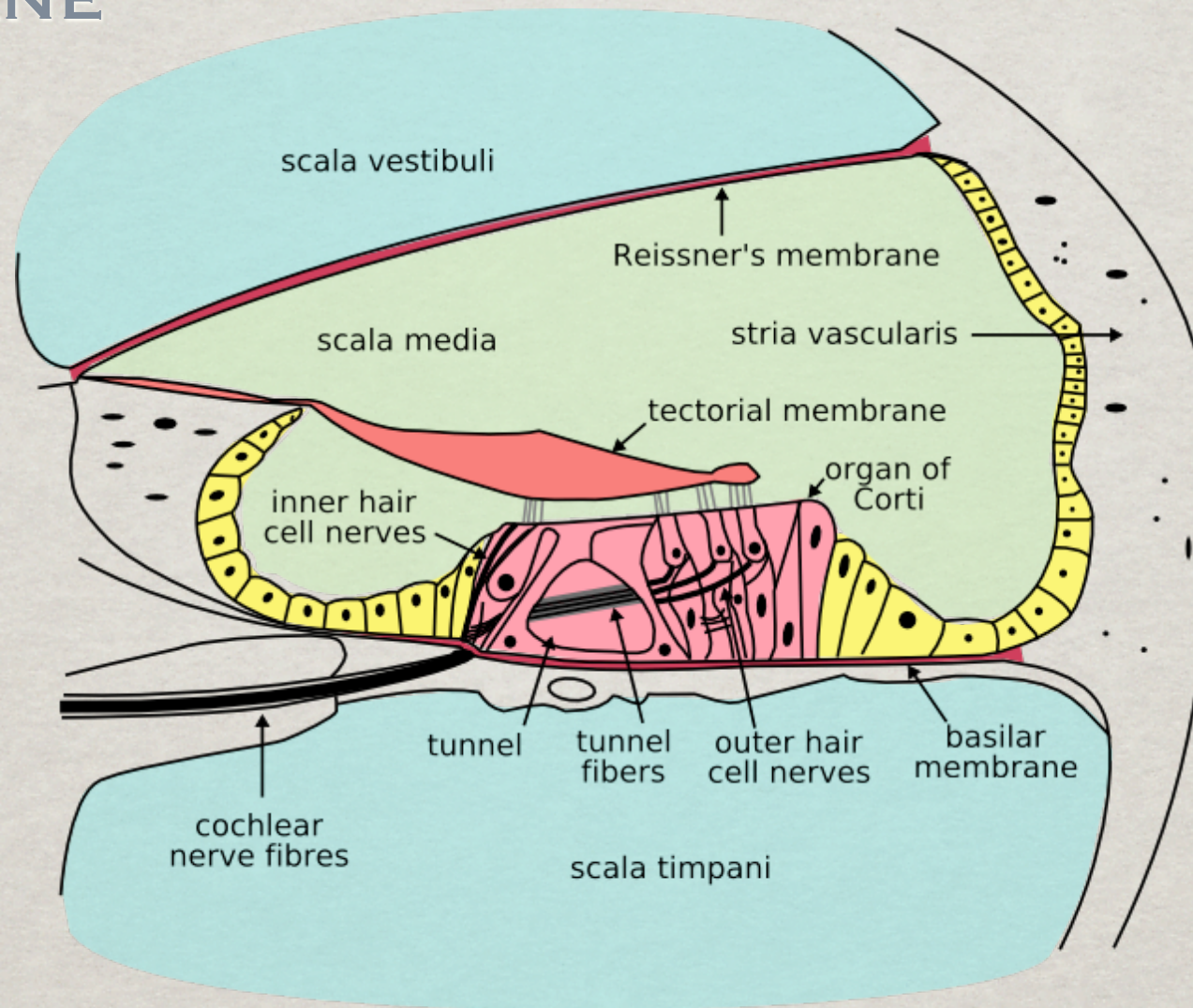
WHY DO I CARE?

...IT'S ALL ABOUT "EXPERIENCE"

...IT'S A MECHANICAL THING

...BECAUSE I CARE ABOUT YOUR EARS

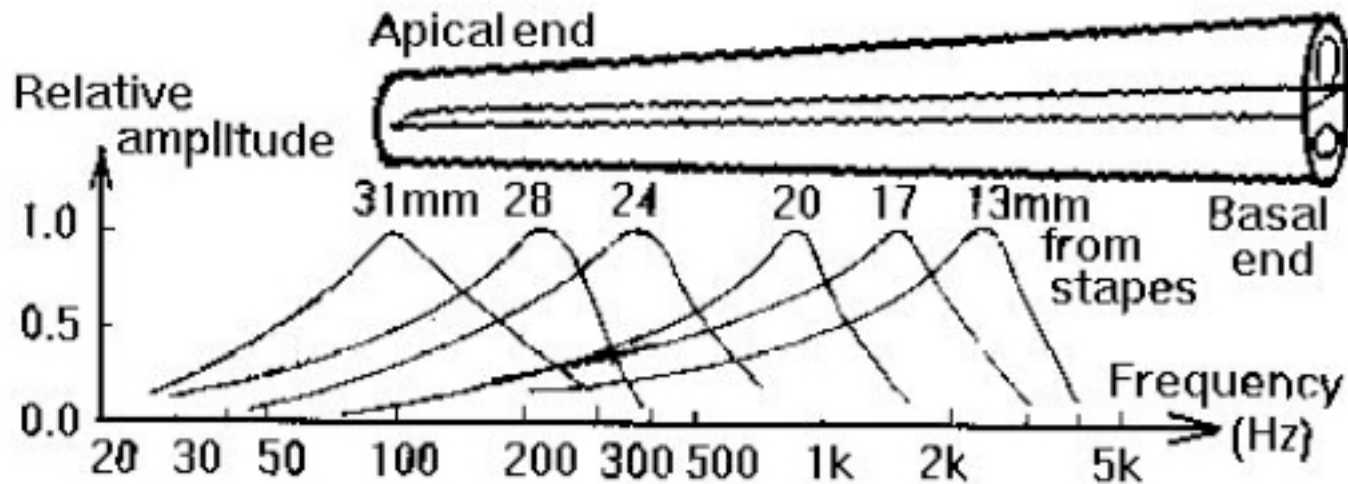
BASCILAR MEMBRANE



Inner Hairs:
Detect Waves

Outer Hairs:
Controlled by the Brain

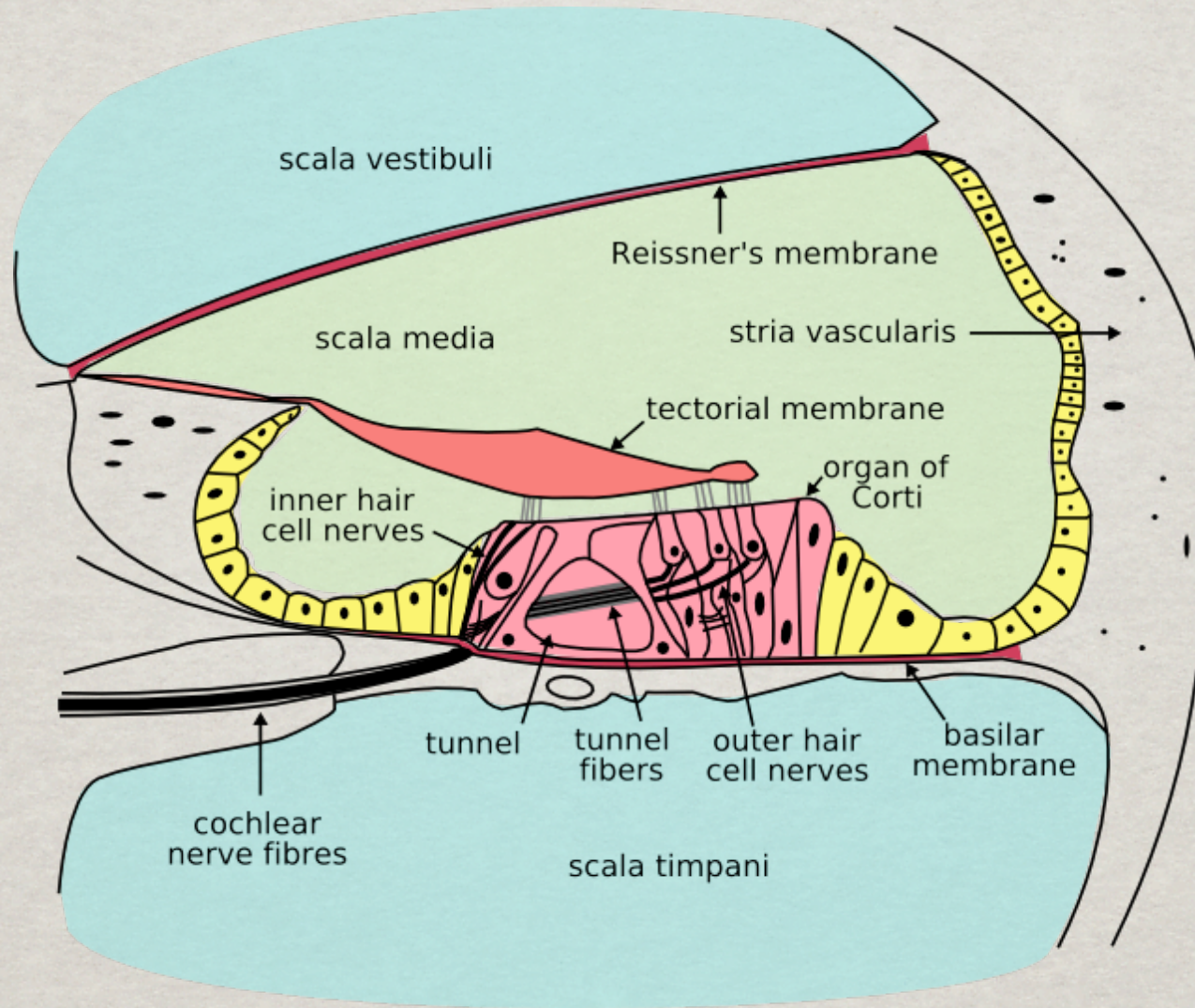
HZ ALONG THE COCHLEA



The envelope or maximum deflection as a function of distance along the basilar membrane for sinusoidal excitation at the oval window of various frequencies. (Modified from G. von Békésy, *Experiments in Hearing*. New York: Wiley, 1960, fig. 11-49.)

Location of displacement along the basilar membrane is transmitted to brain, which interprets information as pitch.

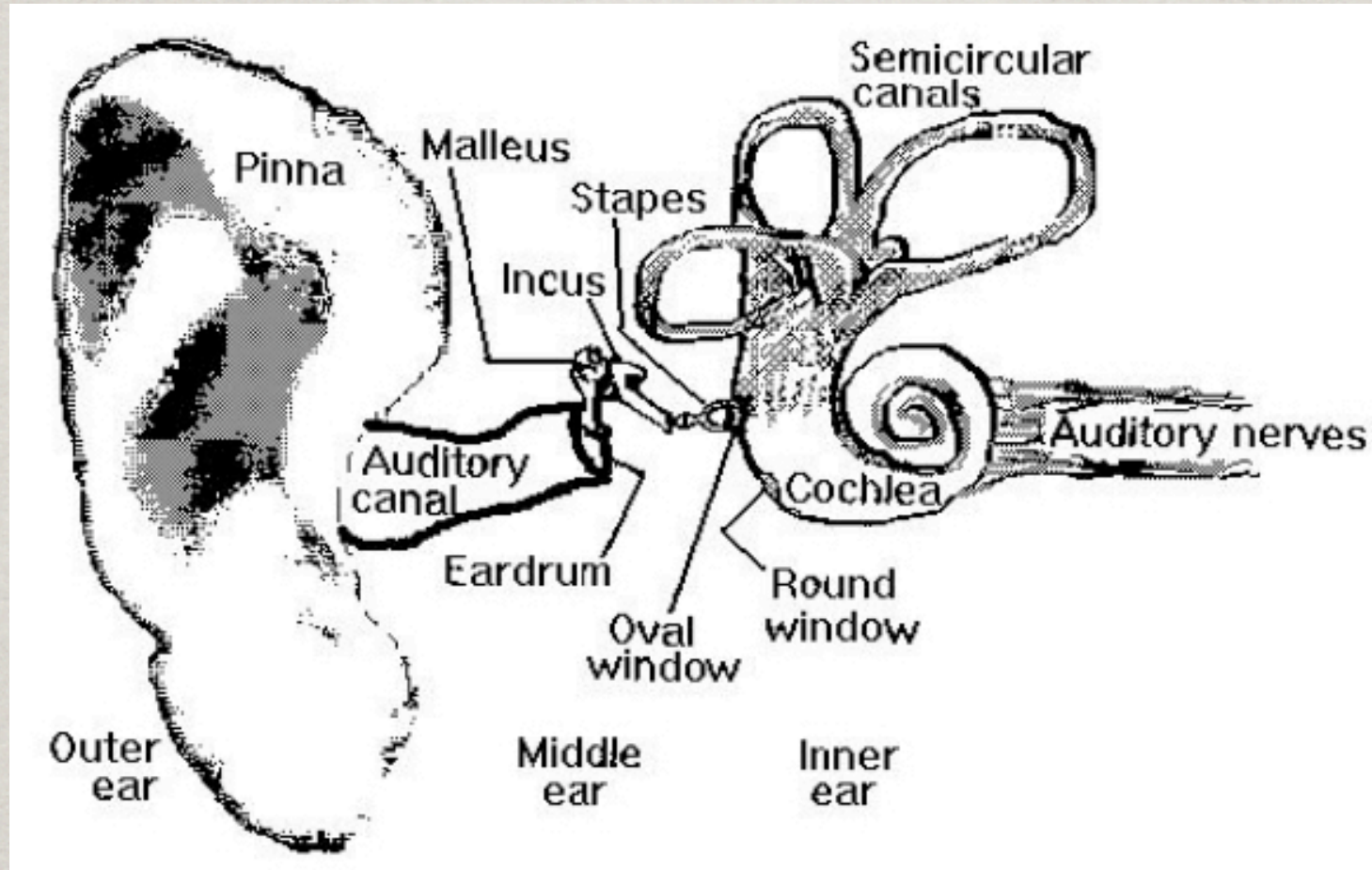
TINNITUS



Inner Hairs are damaged -->> **Outer Hairs** compensate.

(A Balanced System)

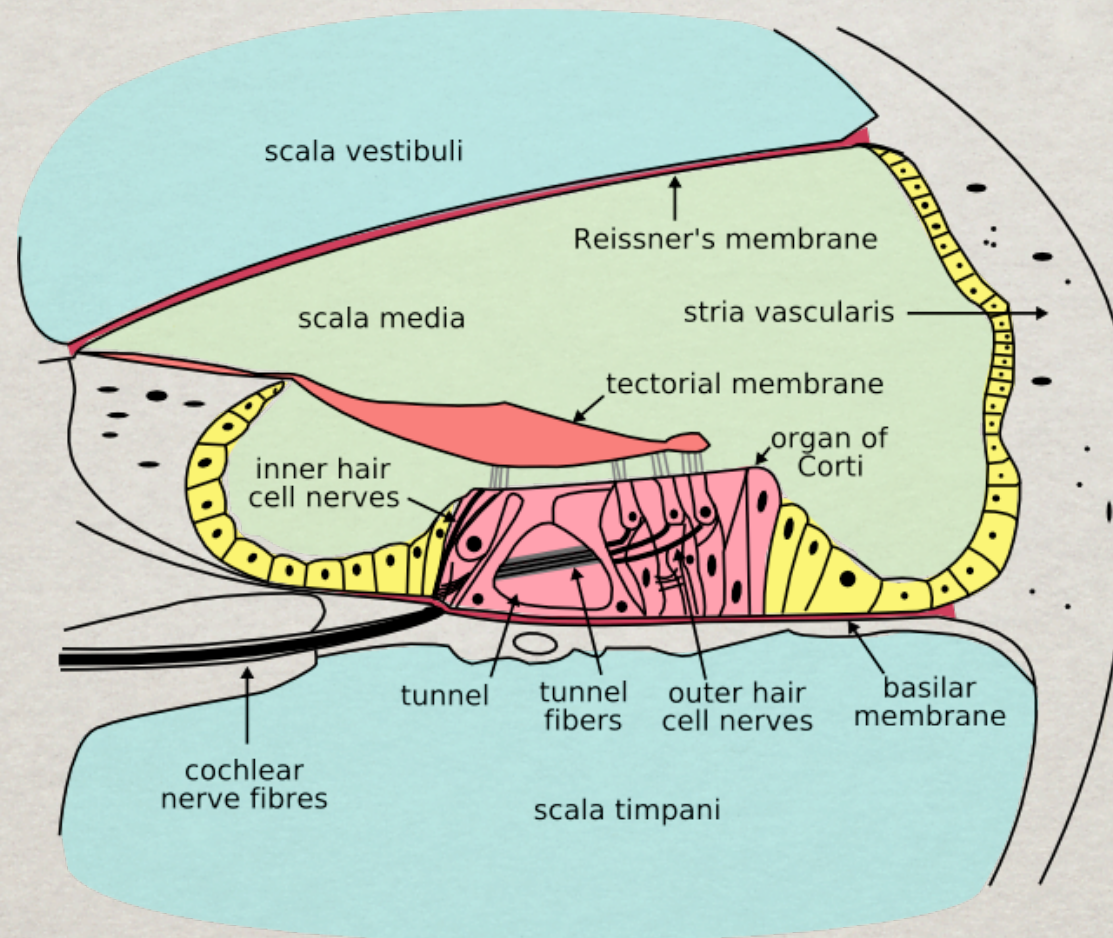
GAIN CONTROL



☼ Stapedius Muscle

- ☼ between the stapes and the oval window of the cochlea

GAIN CONTROL



☼ Outer Hair Cells - Organ of Corti

☼ counter act the movement of inner hair cells

GAIN CONTROL

☼ Stapedius Muscle

- ☼ between the stapes and the oval window of the cochlea

☼ Outer Hair Cells - Organ of Corti

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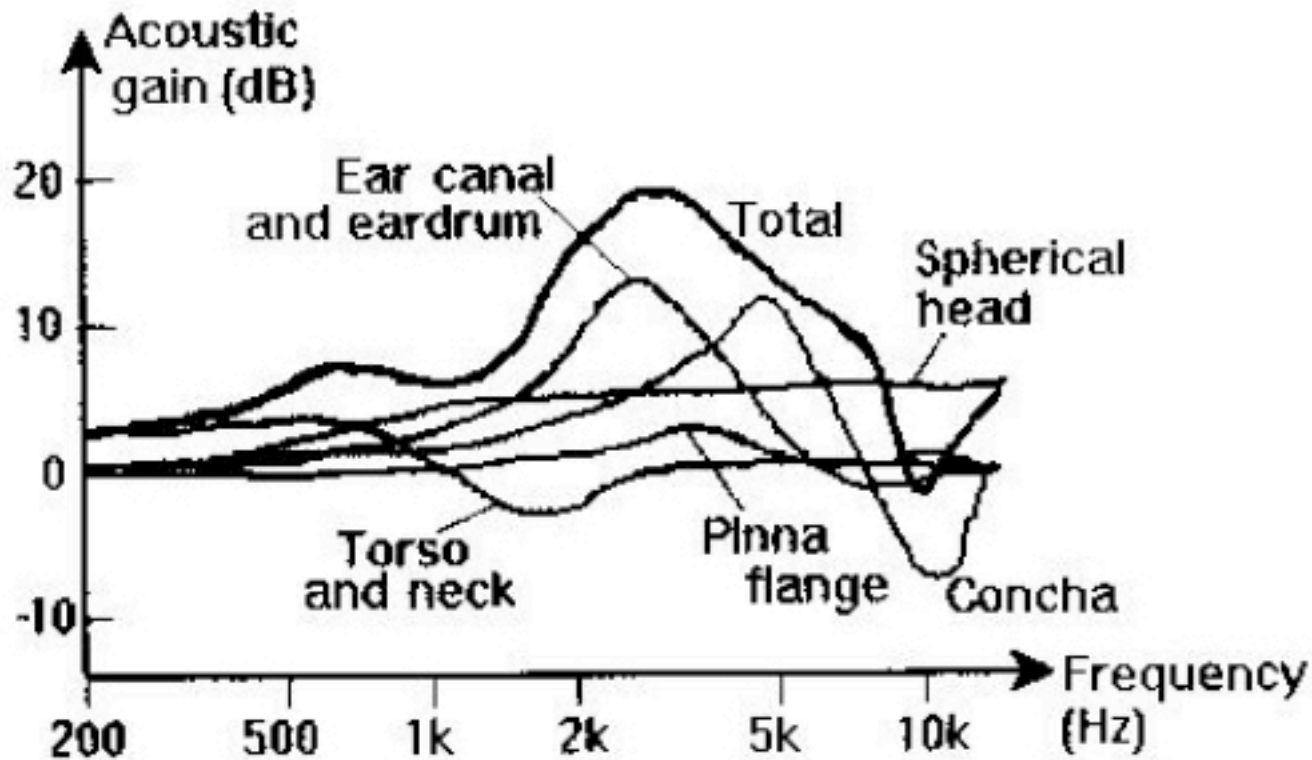
ACOUSTIC SHADOWS

(REFLECTED BY)

- ☼ Torso and Neck (6 inches)
- ☼ Head (8 inches)
- ☼ Pinna (Outer Ear) (2 inches)
- ☼ Ear Canal/Ear Drum (6 inches)

ACOUSTIC SHADOWS

(REFLECTED BY)

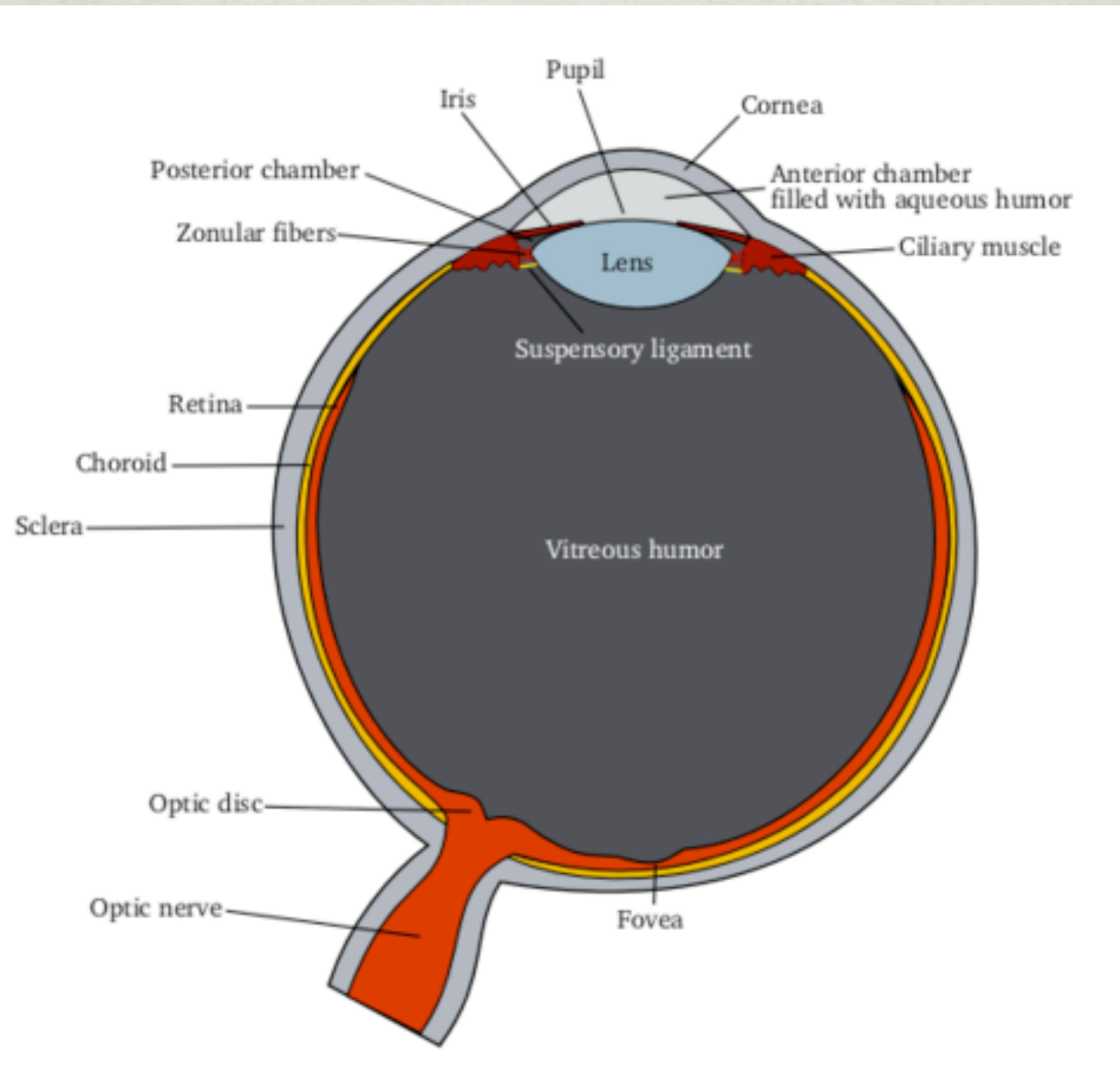


The acoustic effects of various body structures as a function of frequency. Sound is from 45 degrees off center in front of listener. (Modified from E. H. G. Shaw, 1974, *Handbook of Sensory Physiology*, vol. 5/1. Berlin: Springer, fig. 11.)

AYE!!

... I MEAN "EYE"

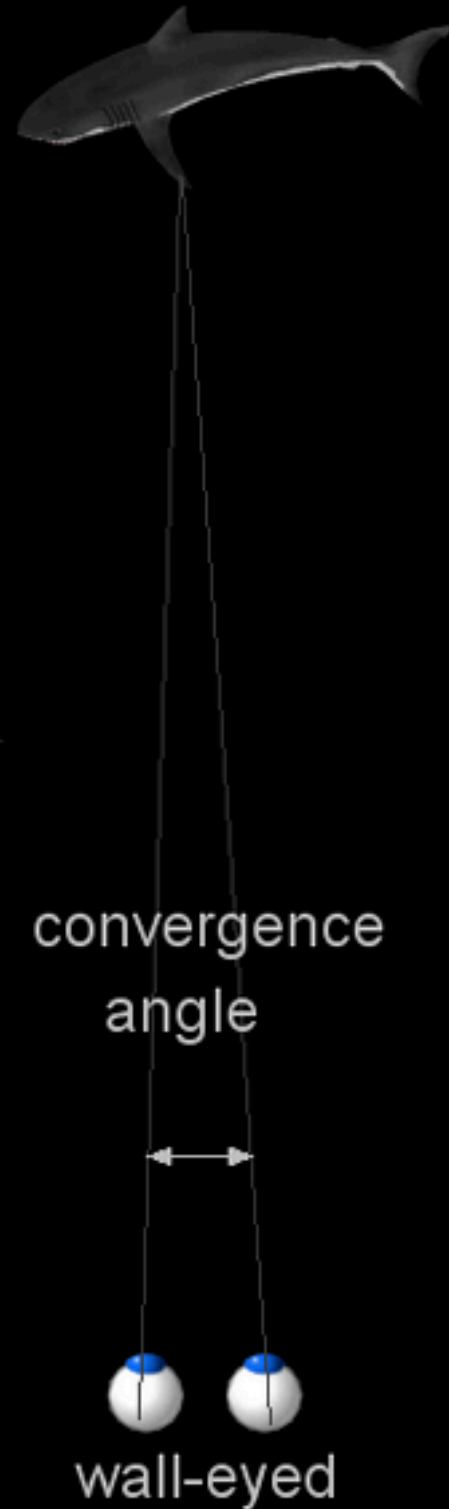
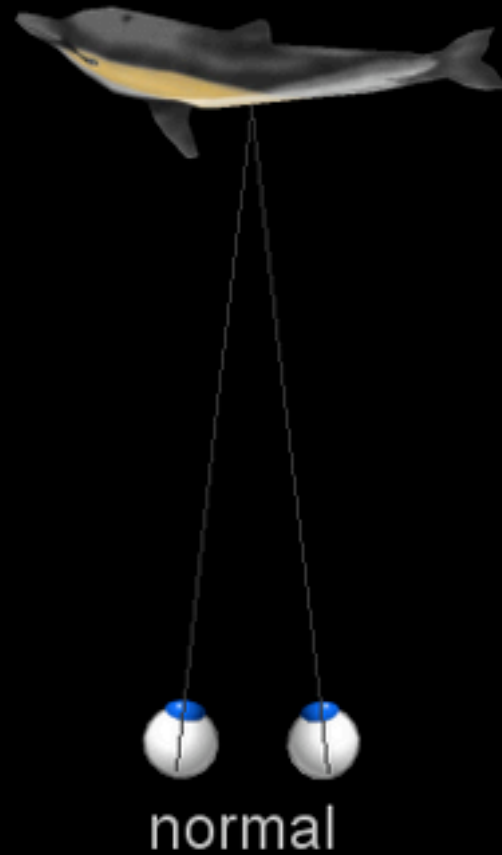
VISION



Sense of Direction and Position

VISION

Sense of
Distance



AURAL SENSE OF DIRECTION AND POSITION

- ☼ Acoustic Shadows
- ☼ Disparity - Time Arrival
- ☼ Folds of the Pinna

AURAL SENSE OF DISTANCE AND MOVEMENT


DISTANCE

(DETERMINED BY)

- ☼ Sound quality (Hz spectrum)
- ☼ Reverberation

MOVEMENT

(DETERMINED BY)

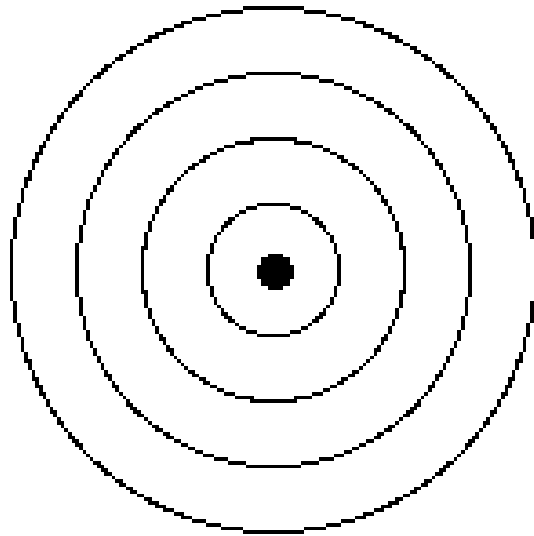
 Doppler Effect

DOPPLER EFFECT

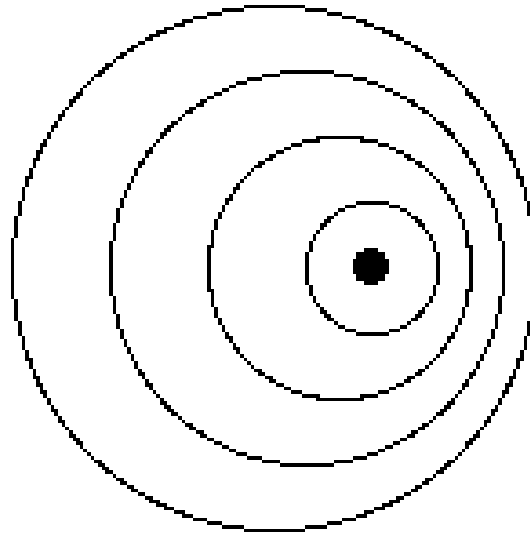
- ☼ **Doppler Effect** is the shift in frequency and wavelength of waves which results from a source moving with respect to the medium, a receiver moving with respect to the medium, or even a moving medium.

DOPPLER EFFECT

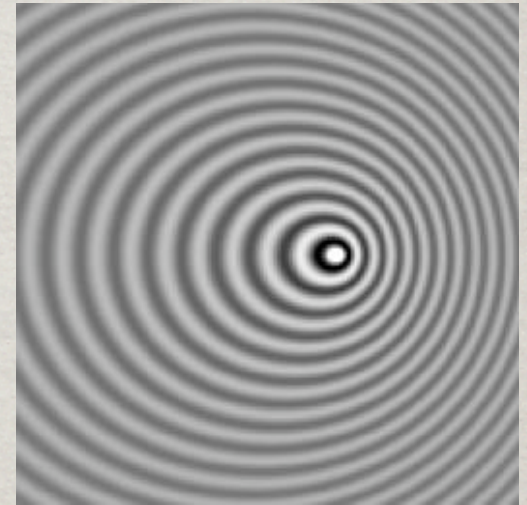
Doppler Effect



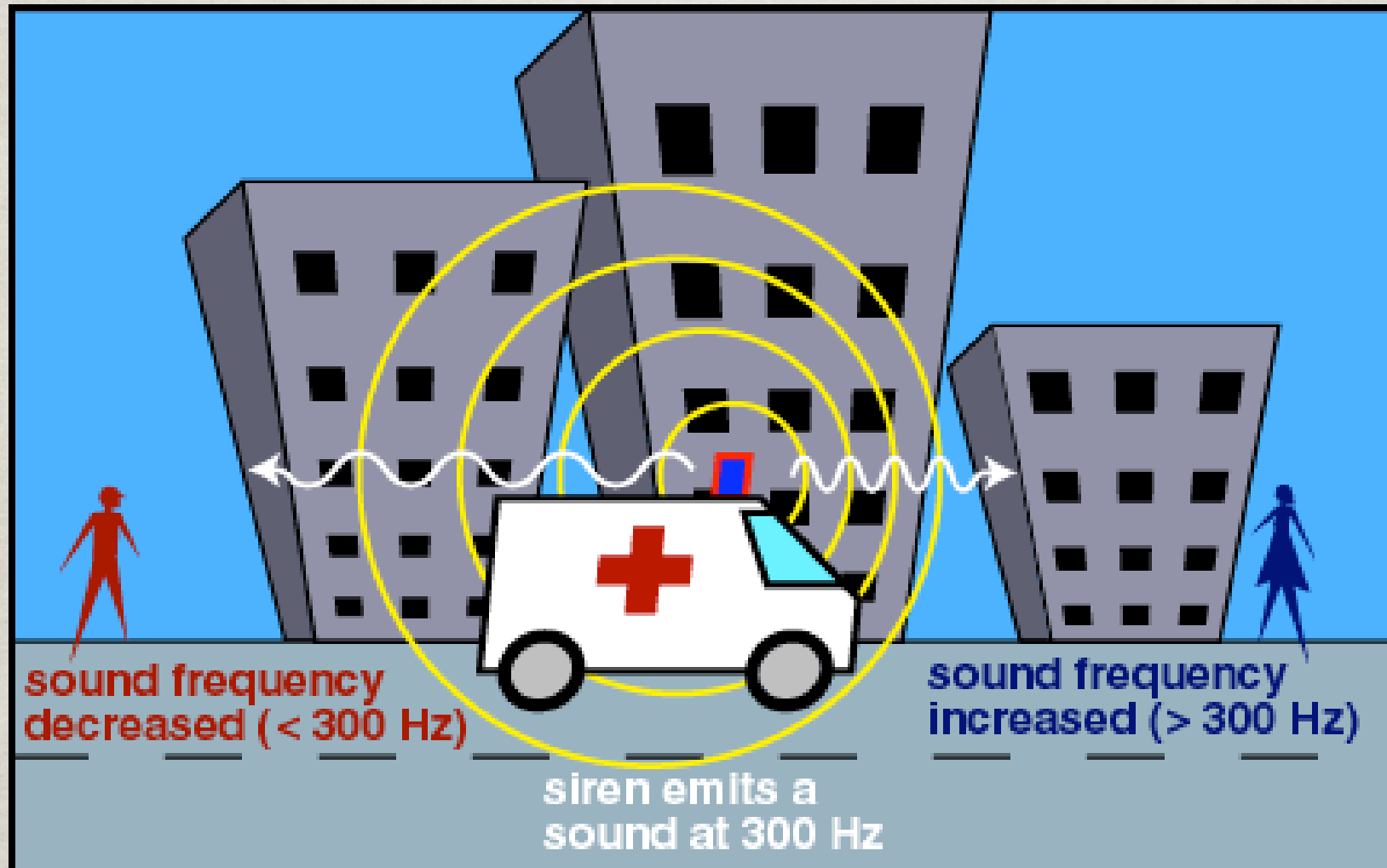
(a) stationary source



(b) moving source



DOPPLER EFFECT



REVIEW

- ✻ Signal Path of the Ear
- ✻ Structure of the Cochlea
- ✻ Hz Perception
- ✻ Inner/Outer Hair Cells
- ✻ Tinnitus
- ✻ Gain Control (two types)
- ✻ Acoustic Shadows
- ✻ Aural Sense of Position
- ✻ Doppler Effect

QUESTIONS?

