

SPHSC 461, Intro to Hearing Science
 Winter 2000
 Exam 1

Define the following terms (5 pt each):

1. Adaptation

The reduction in firing rate observed in auditory nerve fibers, over time, during stimulation.

2. Transduction

A change in energy from one form to another (In the auditory system, the change from acoustic to electrochemical energy.)

3. Otoacoustic emissions

Sounds produced in the inner ear and recorded in the ear canal.

4. The Dynamic Range Problem

People can hear intensity changes over a range of more than 100 dB, but individual auditory nerve fibers change their response over a range of only 30-50 dB.

True or false (2 pt each):

F 5. Outer hair cells receive 95% of the afferent innervation of the cochlea.
 Inner hair cells...

F 6. The primary function of the external ear is to protect the inner ear from overstimulation.
 Conduct sound to middle ear
 + produce cue for localization

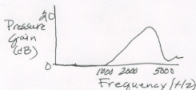
F 7. Phase locking makes it difficult for the auditory system to use firing rate as a code for intensity. *firing rate can change without changing*

F 8. The acoustic reflex refers to the action of the outer hair cells on basilar membrane motion. *Phase locking*
contraction of stapedius muscle
in middle ear

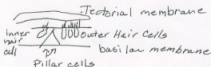
F 9. The shape of the traveling wave envelope is dependent of sound intensity. *At high intensities, [] leads out.*

Draw (10 pt ea)

10. Draw the transfer function of the external ear.



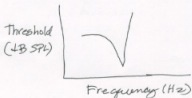
11. Draw a cross-sectional representation of the organ of Corti and indicate the inner hair cells, outer hair cells, basilar membrane, tectorial membrane and pillar cells.



12. Draw the traveling wave envelope on the basilar membrane that would be expected in response to a complex tone containing 500, 1000, and 6000 Hz.



13. Draw the tuning curve of a high-best-frequency auditory nerve fiber.



Short answers (5 pt each):

13. Why is the stria vascularis important to the process of auditory transduction?

The stria vascularis produces endolymph, which has a high concentration of potassium ions. Because hair cells have a negative intracellular potential, when ion channels to the hair cell open, positive ions flow into the cell, causing depolarization + neurotransmitter release.

14. What is the primary function of the middle ear? What is the major way that the middle ear accomplishes this function?

The primary function of the middle ear is to match the impedance of the air in the ear canal to that of the inner ear fluids. The major way it accomplishes this function is the areal ratio of the tympanic membrane to the ^{stapes} footplate.

15. What does the poststimulus time histogram tell us about the coding of the temporal characteristics of sound in the auditory nerve?

The PST histogram shows that an AN fiber's response varies when the stimulus does not vary. That means that the AN fiber's coding of the temporal characteristics of sound is imprecise.

A little bit longer answer, 15 pt:

16. The auditory nerve carries two representations of frequency to the brain. What are they? What mechanisms in the cochlea are responsible for forming these representations?

The two representations are

"neural amplitude spectrum" (or place code)

"time waveform" (or phase locking)

Mechanisms for neural amplitude spectrum

- stiffness gradient of basilar membrane results in biggest traveling wave amplitude at a different place for each frequency
- active mechanism sharpens the mechanical response of the basilar membrane

Mechanisms for time waveform

- phase locking results from fact that basilar membrane motion, + more importantly electrical changes in the inner hair cells, occurs at the frequency (rate) of stimulation.

A 15-pt answer had all of these ideas

A 10-pt answer usually had the codes, but not the mechanisms.

(Basically 5 pt for each code, 3 pt for place code mechanism, 2 pt for phase locking mechanism)