Psychoacoustics

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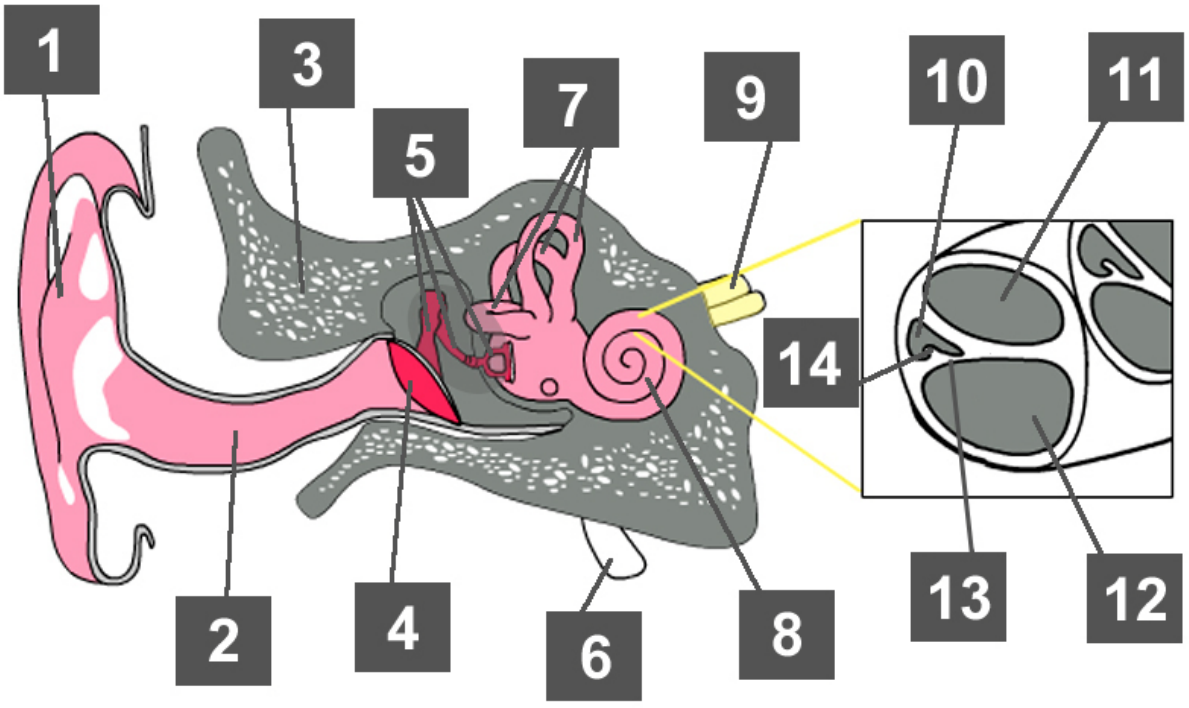
Module 3a Homework (Hearing A)

Student Name: _____

1) (*45pts*) **In the following (highly abstracted) schematic diagram of the ear, name the numbered sections and indicate their principle function(s) (no need to explain here how these functions are accomplished).**



(1) *3pts* Name:

Function:

(2) *4pts* Name:

Function:

(3) *2pts* Name:

Function:

(4) *3pts* Name:

Function:

(5) *4pts* Name:

Function:

(6) *2pts* Name:

Function:

(7) *2pts* Name:

Function:

(8) *3pts* Name:

Function:

(9) *3pts* Name:

Function:

(10) *5pts* Name:

Function:

(11) *2pts* Name:

Function:

(12) *3pts* Name:

Function:

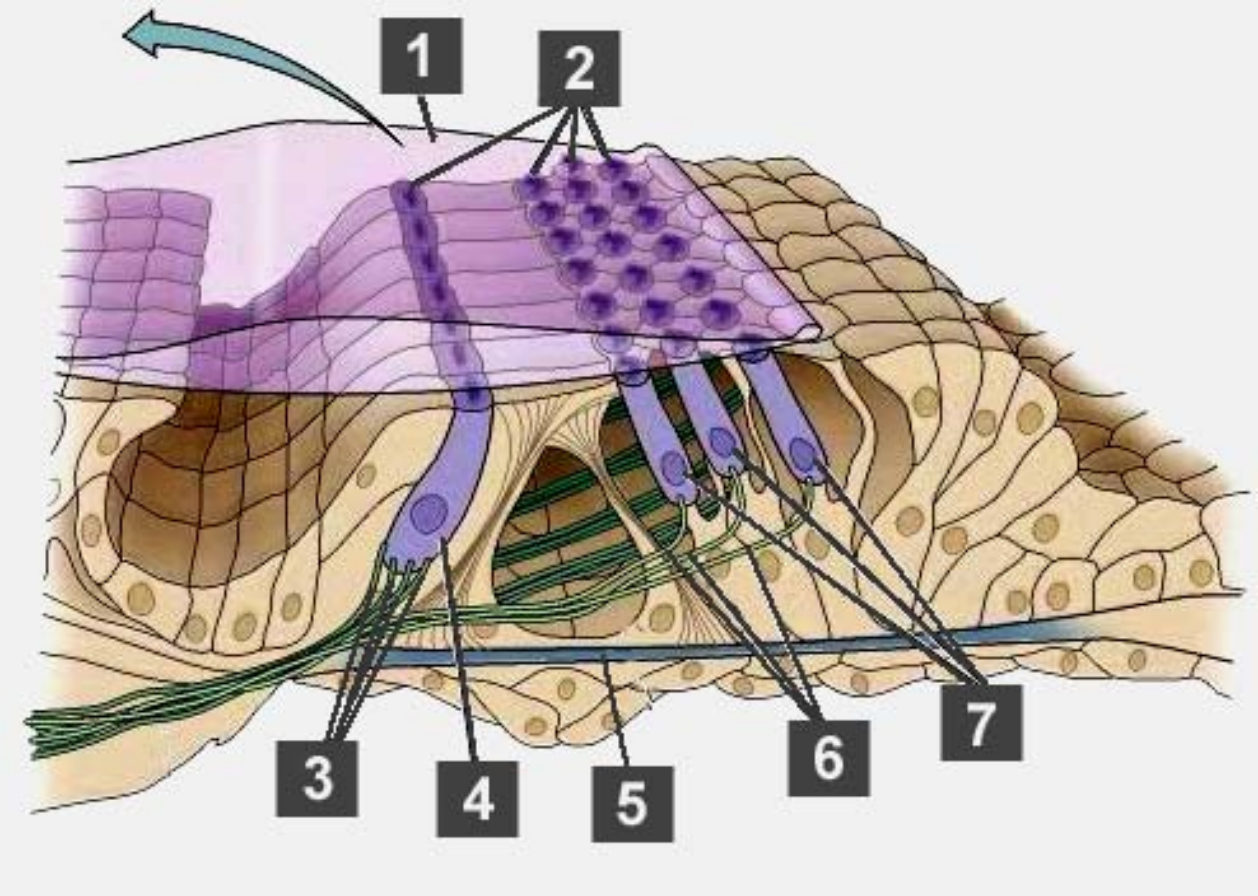
(13) *5pts* Name:

Function:

(14) *4pts* Name:

Function:

2) (*20pts*) **In the following schematic diagram of the organ of Corti, name the numbered sections and indicate their principle function(s) (no need to explain here how these functions are accomplished).**



(1) *4pts* Name:

Function:

(2) *3pts* Name:

Function:

(3) *1pt* Name:

Function:

(4) *4pts* Name:

Function:

(5) *3pts* Name:

Function:

(6) *1pt* Name:

Function:

(7) *4pts* Name:

Function:

3) (*9pts*) **Fill-in the blanks**

a) *4pts* The middle ear accomplishes its main function of decreasing the _____ difference between the outer and inner ears in three ways:

i)_____

_____

ii)_____

_____

iii) _____

_____[*tip*: (iii) is related to the eardrum's 'buckling' motion – see your textbook]

b) *3pts* Vibrations enter the cochlea through the _____ and into scala _____. Whatever energy is not absorbed by the vibrations of the _____ _____ moves through a little opening at the _____ end of the cochlea, called _____ and into the scala _____, exiting the cochlea through the vibrations of a membrane called _____.

c) *2pts* The organ of Corti contains a) 1 row of _____ hair cells and b) up to 5 rows of _____ hair cells. (a) hair cells are innervated by _____ nerve fibers and their stereocilia are _____ [*embedded* or *not embedded*] to the tectorial membrane, while (b) hair cells are innervated by _____ _____ nerve fibers and their stereocilia are _____ [*embedded* or *not embedded*] to the tectorial membrane.

4) (*9pts*) **Fill in the blanks (re. inner hair cell action)**

- (*3pts*) Basilar membrane motion pushes up against the _____ _____ _____, resulting in shearing forces that bend the inner hair cell stereocilia against the _____ membrane.
- (*1pts*) Stereocilia tip links (protein filaments) stretch during bending, opening up ____ _____ in neighboring stereocilia
- (*1pts*) (Positively/Negatively) _____ charged Potassium (K) ions enter the cells, attracted by the (positively/negatively) _____ charged (at rest) cells
- (*1pts*) The resulting signal to the brain is a rectified version of the stimulus signal because the cells fire only when the stereocilia bend towards the scala media and at the _____ portions of the signal
- (*3pts*) The ensuing (polarization/depolarization) -_____ of the cells (*not increase in action potential; this applies to all cells except for IHCs&OHCs*), result in the release of _____ and the creation of neural activity corresponding to a series of _____ _____

5) (*9pts*) **Fill in the blanks (re: outer hair cell action)**

- (*3pts*) OHC (Depolarization/Hyperpolarization) _____,[when the ion channels are open] and (depolarization/hyperpolarization) _____ [when the ion channels are closed] releases neurotransmitters that change the shape of prestin protein molecules inside the OHCs, and therefore the OHC (tension/length) _____.
- (*3pts*) OHCs (compress/expand) _____ the ear's dynamic response.
  At low levels, OHCs change periodically 90^0 out of phase with the TM, pulling on the BM, increasing stereocilia bending, and (amplifying/attenuating) _____ the signal.
  At high levels, OHC change periodically in phase with the TM, pushing against the BM, decreasing stereocilia bending, and (amplifying/attenuating) _____ the signal. Whether there will be amplification / attenuation depends on the (amount/phase) _____ of OHC changes.
- (*3pts*) In the short term, OHCs change in response to (the bending of their own stereocilia / messages from the brain) _____.
  In long-term stimulation, OHCs may change in response to (the bending of their own stereocilia / messages from the brain) _____.

6) (*4pts*) **What perceptions can arise if the frequency difference between two simultaneous sine tones of equal amplitude is smaller than the ear's filter (or critical) bandwidth?**

7) (*4pts*) **What is the average a) frequency range and b) intensity range of normal hearing? How do signals sound below and above this range for a) frequency and b) intensity?**