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Special Senses: Hearing and Equilibrium

Anatomy of the Ear

1. Select the terms from column B that apply to the column A descriptions. Some terms are used more than once.

Column A

_d_, _i_, _m_ 1. structures composing the outer or external ear

_b_, _k_, _n_ 2. structures composing the inner ear

_e_, _f_, _l_ 3. collectively called the ossicles

_i_, _k_ 4. ear structures not involved with audition

_a_ 5. involved in equalizing the pressure in the middle ear with atmospheric pressure

_m_ 6. vibrates at the same frequency as sound waves hitting it; transmits the vibrations to the ossicles

_k_, _n_ 7. contain receptors for the sense of balance

_g_ 8. transmits the vibratory motion of the stirrup to the fluid in the scala vestibuli of the inner ear

_j_ 9. acts as a pressure relief valve for the increased fluid pressure in the scala tympani; bulges into the tympanic cavity

_a_ 10. passage between the throat and the tympanic cavity

_c_ 11. fluid contained within the membranous labyrinth

_h_ 12. fluid contained within the osseous labyrinth and bathing the membranous labyrinth

Column B

a. auditory (pharyngotympanic) tube

b. cochlea

c. endolymph

d. external auditory canal

e. incus (anvil)

f. malleus (hammer)

g. oval window

h. perilymph

i. pinna

j. round window

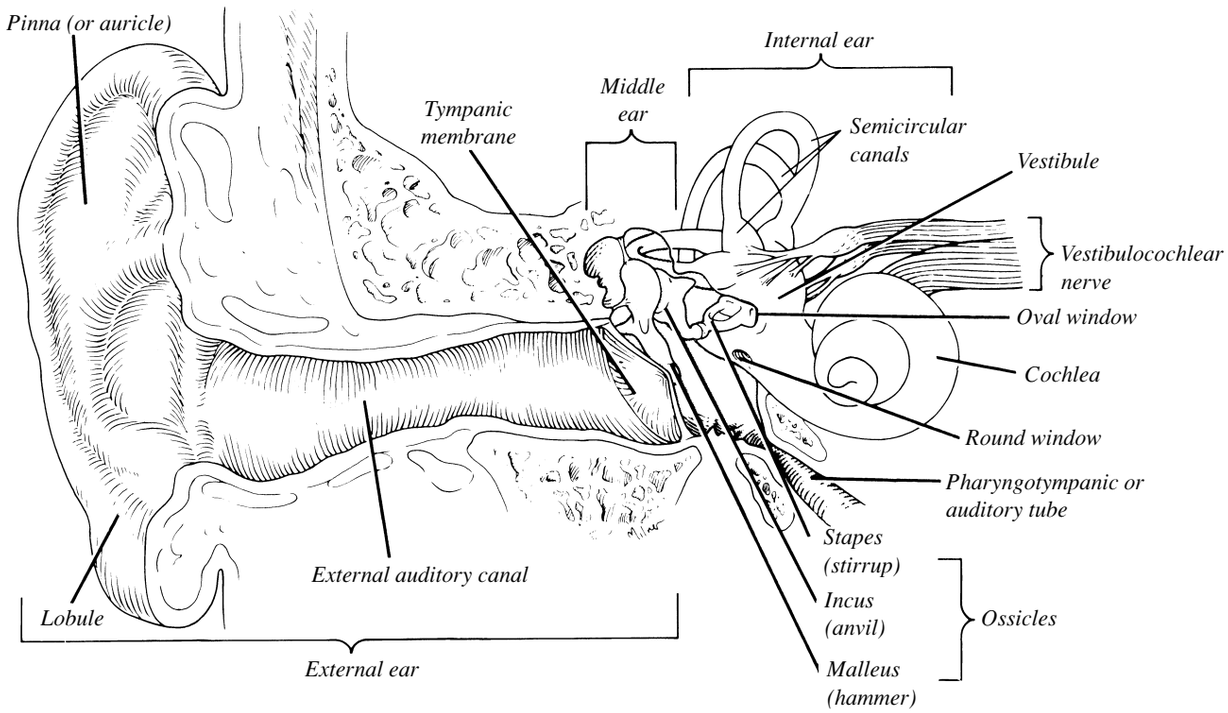
k. semicircular canals

l. stapes (stirrup)

m. tympanic membrane

n. vestibule

2. Identify all indicated structures and ear regions in the following diagram.



3. Match the membranous labyrinth structures listed in column B with the descriptive statements in column A:

Column A	Column B
g, j 1. sacs found within the vestibule	a. ampulla
c 2. contains the organ of Corti	b. basilar membrane
g, j 3. sites of the maculae	c. cochlear duct
h 4. positioned in all spatial planes	d. cochlear nerve
b 5. hair cells of organ of Corti rest on this membrane	e. cupula
i 6. gelatinous membrane overlying the hair cells of the organ of Corti	f. otoliths
a 7. contains the crista ampullaris	g. saccule
f, g, j, k 8. function in static equilibrium	h. semicircular ducts
a, e, h, k 9. function in dynamic equilibrium	i. tectorial membrane
d 10. carries auditory information to the brain	j. utricle
e 11. gelatinous cap overlying hair cells of the crista ampullaris	k. vestibular nerve
f 12. grains of calcium carbonate in the maculae	

4. Sound waves hitting the eardrum initiate its vibratory motion. Trace the pathway through which vibrations and fluid currents are transmitted to finally stimulate the hair cells in the organ of Corti. (Name the appropriate ear structures in their correct sequence.) Eardrum → *malleus → incus → stapes → oval window → perilymph → cochlear duct → endolymph → basilar membrane with hair cells*

5. Describe how sounds of different frequency (pitch) are differentiated in the cochlea. *It is believed that high-frequency (high-pitched) sounds peak close to the oval window while low-frequency (low-pitched) sounds peak near the cochlear apex, disturbing hair cells there (the "Place Principle").*

6. Explain the role of the endolymph of the semicircular canals in activating the receptors during angular motion.

When angular motion occurs in one direction, the endolymph in a semicircular canal lags behind, pushing the cupula in a direction opposite to that of the angular motion. Depending on the ear, this depolarizes or hyperpolarizes the hair cells, resulting in enhanced or reduced impulses to the brain.

7. Explain the role of the otoliths in perception of static equilibrium (head position). *When the head position changes, the otoliths "roll" in gelatinous material (responding to gravitational pull). This triggers hyperpolarization or depolarization of the hair cells and modifies the rate of impulse transmission along the vestibular nerve.*

Laboratory Tests

8. Was the auditory acuity measurement made during the experiment on page 282 the same or different for both ears? *(student response)* What factors might account for a difference in the acuity of the two ears?

Ear wax, middle/outer ear infection, cochlear nerve damage, etc. Anything that affects sound conduction or nervous system structures associated with hearing.

9. During the sound localization experiment on page 282, in which position(s) was the sound least easily located?

When the sound was exactly in midline of the head and out of vision.

How can this phenomenon be explained? *The usual cues which allow sound to be localized (slight differences in loudness in the two ears and in the time the sound reaches each ear) are missing.*

10. In the frequency experiment on page 282, which tuning fork was the most difficult to hear? *(stu obs)* Hz

What conclusion can you draw? *High-frequency sounds are heard less well at low intensity.*

11. When the tuning fork handle was pressed to your forehead during the Weber test, where did the sound seem to originate?

From the ears.

Where did it seem to originate when one ear was plugged with cotton? *From the plugged ear.*

How do sound waves reach the cochlea when conduction deafness is present? *By vibration through bones of the skull.*

12. Indicate whether the following conditions relate to conduction deafness (C) or sensorineural deafness (S):

c 1. can result from the fusion of the ossicles

s 2. can result from a lesion on the cochlear nerve

s 3. sound heard in one ear but not in the other during bone and air conduction

c, s 4. can result from otitis media

c 5. can result from impacted cerumen or a perforated eardrum

s 6. can result from a blood clot in the auditory cortex

13. The Rinne test evaluates an individual's ability to hear sounds conducted by air or bone. Which is more indicative of normal hearing? *Air-conducted sound*

14. Define *nystagmus*: *Involuntary rolling or trailing of the eyes in one direction and then rapid movement in the opposite direction.*

Define *vertigo*: *Sensation of dizziness and rotational movement when such movement is not occurring.*

15. The Barany test investigated the effect that rotatory acceleration had on the semicircular canals. Explain *why* the subject still had the sensation of rotation immediately after being stopped. *The fluids of the inner ear had not yet stopped moving.*

16. What is the usual reason for conducting the Romberg test? *To determine if proprioceptive impulses are being transmitted up the spinal cord to the brain properly.*

Was the degree of sway greater with the eyes open or closed? Why? *Closed. Visual cues (input) were lacking.*

17. Normal balance, or equilibrium, depends on input from a number of sensory receptors. Name them.

Proprioceptors of the muscles and tendons, vestibular apparatus of the ears, retina of the eye (photoreceptors).

18. What effect does alcohol consumption have on balance and equilibrium? Explain. *Alcohol depresses the nervous system and enhances inhibition of reflex and coordination centers, causing a loss of balance and equilibrium.*

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Special Senses: Olfaction and Taste

Localization and Anatomy of Taste Buds

1. Name five sites where receptors for taste are found, and circle the predominant site:

tongue papillae, *epiglottis*, *pharynx*, *soft palate*, and *cheek mucosa*

2. Describe the cellular makeup and arrangement of a taste bud. (Use a diagram, if helpful.) *A structure consisting of centrally located gustatory (receptor) cells surrounded by supporting cells.*

Localization and Anatomy of the Olfactory Receptors

3. Describe the cellular composition and the location of the olfactory epithelium. *1″ square area on roof of nasal cavity on each side of nasal septum. Receptor cells (bipolar neurons) surrounded by supporting cells.*

4. How and why does sniffing improve your sense of smell? *Draws air superiorly into contact with the olfactory mucosa. (Most air entering the nasal passages passes inferior to the receptors.)*

Laboratory Experiments

5. Taste and smell receptors are both classified as *chemoreceptors*, because they both respond to *chemicals in aqueous solution.*

6. Why is it impossible to taste substances with a dry tongue? *Substances must be in aqueous solution.*

7. State the most important sites of your taste-specific receptors, as determined during the plotting exercise in the laboratory:

salt *student data* sour *student data*

bitter *student data* sweet *student data*

8. The basic taste sensations are mediated by specific chemical substances or groups. Name them:

salt *influx of Na^+* sour *H^+ (hydrogen ions) and blockage of K^+ (or Na^+) channels*

bitter *G protein gustducin causing increased intracellular Ca^{2+}* sweet *G protein gustducin causing K^+ channels to close*

9. Name three factors that influence our appreciation of foods. Substantiate each choice with an example from the laboratory experience.

1. *smell* Substantiation

2. *texture* Substantiation

3. *temperature* Substantiation

Which of the factors chosen is most important? *Smell*

Substantiate your choice with an example from everyday life.

Expand on your explanation and choices by explaining why a cold, greasy hamburger is unappetizing to most people.

When hot, a hamburger is "juicy" and has an enticing aroma. When cold, the fat congeals, giving the hamburger a greasy taste and texture.

10. Babies tend to favor bland foods, whereas adults tend to like highly seasoned foods. What is the basis for this phenomenon?

Taste buds (and olfactory receptors) are less acute and are replaced more slowly as we age. Thus, more highly seasoned foods are necessary if the food is to be palatable (to most adults).

11. How palatable is food when you have a cold? *It's not.*

Explain. *Smell is half of taste. When you have clogged nasal passages, you lack this added sensory input.*

12. What is the mechanism of olfactory adaptation? *Receptors stop responding to a continuous unchanging stimulus. (However, if the stimulus or intensity is changed, the receptors will again begin to respond.)*

In your opinion, is olfactory adaptation desirable? *Yes.* Explain your answer.

Continuous nonimportant (unchanging) olfactory stimuli would be distracting and (probably) irritating.