

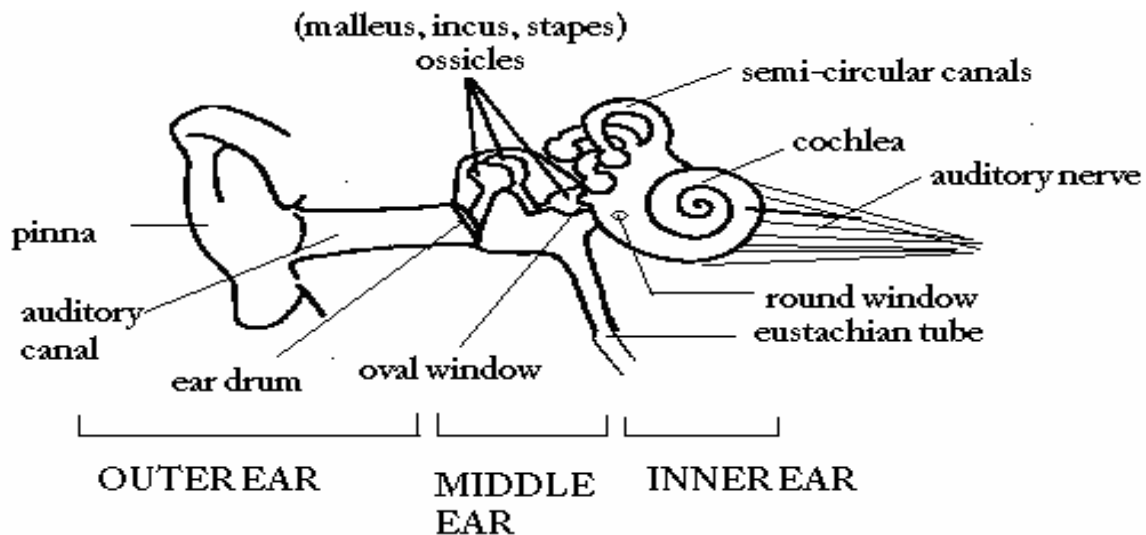
Biology Notes

Topic: Receptors 2 -The human ear

Objectives:

At the end of this topic, the students should be able to:

1. Describe the structure and functions of the human ear.
2. List the pathway of sound into the ears.
3. Describe the function of the cochlea
4. Describe the function of the semi-circular canals
5. Describe the function of the utricle and saccule.



OUTER EAR (air-filled)

pinna – collects sound waves

auditory canal – directs sound waves on to the ear drum

ear drum – separates the outer ear from the middle ear; vibrates when hit by sound waves

MIDDLE EAR (air-filled)

ossicles – three small bones which transmit and amplify vibrations of the ear drum

eustachian tube – equalizes air pressure on both sides of the ear drum

An air pressure difference especially at high altitudes causes discomfort in the ear and may even be painful. This can sometimes be alleviated by swallowing or by chewing and swallowing. This condition is very common when one flies in an aircraft.

oval window – the base the stapes fits into the oval window and transmit vibrations from the ossicles to the inner ear

INNER EAR (fluid-filled)

semi-circular canals – helps to maintain balance

cochlea – contains sensory cells which convert vibrations into impulses

auditory nerve – transmit impulses from the ear to the brain

round window – relieve pressure in the inner vibrations

The main functions of the ear are for hearing and to maintain balance.

Pathway of sound waves into the ear

auditory canal → ear drum → hammer → anvil → stirrup → oval window → cochlea
(sound waves) *(mechanical energy)* *(pressure changes to electrical energy)*
outer ear *middle ear* *inner ear*

The ear drum amplifies the sound waves received and passes them on to the ossicles which further amplifies the sound. The bones in the middle ear, being solid objects, ensures the rapid transmission of sound, since solids are better conductors of sound than air. In the inner ear, the pressure changes provide the stimulus to form the impulses which are sent to the brain to interpreted.

Function of the cochlea

The cochlea is the structure in the ear that is actually responsible for hearing. It is filled with a fluid and its inside membrane contains millions of **sensory cells** called **hair cells** (organ of Corti). When the **stirrup** vibrates in the oval window, the cochlea also vibrates and the fluid in the cochlea is stimulated. The sensory cells then are stimulated and impulses are formed.

Soft sounds cause slight vibrations of the cochlea while **louder sounds** cause greater vibrations. **High notes** are detected by fibers towards the base of the cochlea which are short and stiff, hence vibrating very rapidly. **Low notes**, on the other hand, are detected by fibers towards the apex of the cochlea which are long and flexible, hence vibrating more slowly.

The ear detects the direction of a sound by **comparing the strength of the sound waves** that reaches each ear and also by **which ear was first to receive the sound waves**. The ear which is closer to the sound will receive the sound waves a fraction of a second before they reach the other ear. From this the brain can detect the direction of the sound. Sounds directly in front of us will produce sound waves of equal strength.

The impulses that are formed as a result of soft sounds, loud sounds, high notes, low notes and the strength of the sound waves are sent along the **auditory nerve** to the brain to be interpreted.

Function of the semi-circular canals

The semi-circular canals are responsible for maintaining balance. Each semi-circular canal is at right angle to the other two so that whichever way the head is moved, at least one canal moves, causing the fluid within it to lag behind. When the head is moved, the fluid in the canals moves also, stimulating the **sensory cells**. The sensory cells in the canals are able to send impulses to the brain regarding the moving fluid and the position of the body. As a result of the information received, the brain then sends messages to the appropriate muscles to maintain the balance of the body.

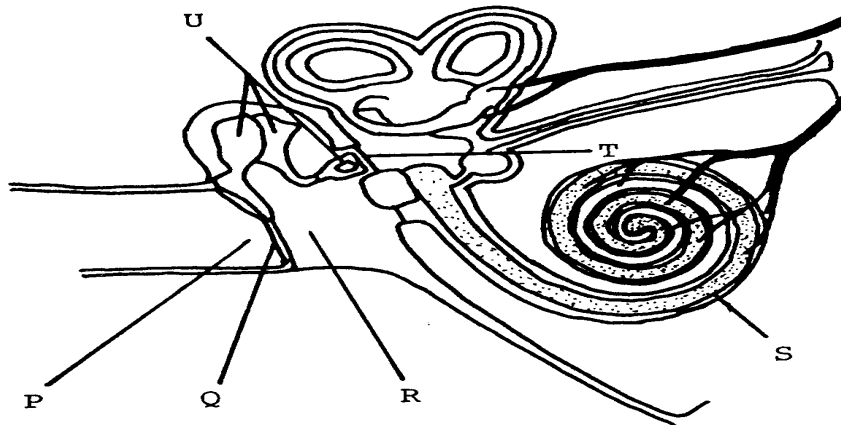
Function of the sacculus and utriculus

The **sacculus** and **utriculus** are located at the base of the semi-circular canals. **They are responsible for making the body aware of its position in relation to the pull of gravity.** They are lined with sensory cells which are connected to nerve fibers. Entangled in the sensory cells are tiny spheres of calcium carbonate. When gravity acts upon these spheres, they press against the sensory cells and generate impulses. These impulses are sent to the brain to let the body become aware of its position.

e.g. If we are lying down, the spheres press on certain of these sensory cells and the body is thus conscious of its position in space.

Questions

1. The diagram is that of the human ear.



- (a) Give the names of the structures labeled with the letters Q, S and U (3)
- (b) (i) Name the substance from which the structures labeled U are made. (1)
(ii) Describe the function of these structures.(2)
- (c) What is the name of the sensory cells, which are located in part S? (1)
- (d) How is air pressure at R made equal to that at P? (1)
- (e) How does the brain distinguish between:
(i) a high pitch and a low pitch sound (2)
(ii) a sound on the right side and one which is directly in front? (2)
- (f) Describe the role played by the cochlea in hearing (4)
2. (a) Describe the role played in maintaining balance by the semi-circular canals (4)
(b) Describe how the sacculus and utricle, in the ear detect a change in the body's position. (4)
(c) Trace the path of vibrations caused by a beat of a drum until they reach the brain. (8)
(d) Air is a poor conductor of sound. What features of the ear ensures that sound is heard? (4)