

Auditory System and Noise Pollution In The Course Of Study Related To the Biological Science at Various Levels

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Abstract

Auditory system relates the sense of hearing. The external ear, the middle ear, and the cochlea of the inner ear are concerned with hearing. The receptors for hearing and equilibrium are hair cells. The sound received by ears and it passes inside of the ears upto the central nervous system with the sound the noise pollutants also pass in the same direction. The harmful sound is the noise pollutant. This noise pollutant create the noise pollution. Different kinds of disease are created by noise pollution.

Key Words

Auditory system, Path of Hearing, Sound waves, Sense of Hearing, Noise pollutant.

Introduction

The sound waves, which are transmitted by the tympanic membrane malleus and incus, cause the movement of stapes. This leads to the origin of vibrations in the fluids of cochlea. The vibrations now, stimulate the hair cells in the organ of cortie This is turn causes the generation of action potential (auditory impulses) in the auditory nerves fibres, when the auditory impulses reach the cerebral cortex, the perception of hearing occurs.

Receptors for two sensory modalities, hearing and equilibrium are housed in the ear. The external ear, the middle ear, and the cochlea of the inner ear are concerned with hearing. The semicircular canals, the utricle, and the saccule of the inner ear are concerned with equilibrium, Receptors in the semicircular canals detect rotational acceleration, receptors in the utricle detect linear acceleration in the vertical direction. The receptors for hearing and equilibrium are hair cells, and there are six groups of hair cells in each internal one in each of the three semicircular canals one in the utricle, one in the saccule, and one in the cochlea.

Sound is a special kind of wave action which is usually transmitted through air in the form of pressure waves. These waves are received by hearing apparatus of animals, including man, on impulses electrical the ear into transformed and carried to the brain which enable us to hear. Sound waves are generated in a number of ways, such as explosive expansion of gases, turbulent movement of liquids, vibrations of solid objects etc. which start a series of pressure waves in all directions. The intensity of these waves diminished as the distance from

the object producing them increases. Sound waves are reflected and deflected by objects which happen to come in their way. Porous materials, such as perforated board, absorb these waves. When Porous materials, such two of more than two such waves superimpose they reinforce each other and in opposite phase they may cancel each other out.

The Organ of Hearing

The organ of hearing is ear and it consists of three parts namely, middle ear external ear, and inner ear.

The external ear is formed by two parts called – (i) Auricle or Pinna and (ii) External auditory to meatus.

The auricle or pinna of the external ear consists of fibrocartilagenous plate covered by Connective tissue and skin. The plate is : charactristically folded and ridged. The skin covering the plate is thin and contains many fine hairs and sebaceous glands. On the posterior surface of the auricles, many sweat glands are present.

The external auditory meatus is a slightly curved canal with a length of about 55mm. The meatus consists of two parts viz :-

- (i) The outer cartilagenous part,
- (ii) The inner bony part

The middle ear consists of the tympanie cavity with auditory ossicles, two small muscles and the auditory tube.

Tympanic cavity or tympanum is a small, narrow, laterally compressed chamber, situated within the temporal bone. The tympanie cavity is Seperated from external auditory meatus by tympanic membrane. The tympanic cavity contains the auditory ossicles.

Tympanic membrane is a semitransparent structure seperating middle ear from the external auditory side meat meatus. The periphery of the membrane is fixed to the tympanic sulcus in the surrounding bony ring by means of the fibro cartilage.

The auditory ossicles are the three miniature bones, which are arranged in a chain extending across the middle ear from the tympanic membrane to oval window. Malieus, incus and stapes are the three auditore osicles.

Tonsor tympanic and stapedius are the skeletal muscles attached to the ossicles.

Auditory tube or Eustachain tube is the flattened canal leading from the anterior wall of the middle ear to the nasopharynx. Its upper part is surrounded by bony wall and the lower part is surrounded by fibrocartilagenous plate. This tube connects the middle ear with posterior part of nose and forms the passage of air between middle ear and atmosphere. Thus, the pressure on both sides of tympanic membranes is equalized.

The Internal ear or labyrinth contains the sense organs of hearing and equilibrium. The sense organ for hearing is the cochlea. The sense organ for equilibrium is the vestibular apparatus which includes the semicircular canal and otolith organ. The labyrinth is a membranous structure, enclosed by a bony labyrinth in bony part of temporal bone.

Cochlea is a content coiled structure like a small snail's shell and it consists of two structures viz .

- (i) central conical axis formed by spongy bone called modiolus and
- (ii) Bony canal or tube which winds around this modiolus.

The sensory part of organ of hearing of the receptor organ for hearing is the spiral organ of Corti which is also the neuroepithelium of cochlea. It rests upon the lip of osseous spiral lamina and the basilar membrane. It extends throughout the cochlear duct, except for a short distance on either end. The organ of Corti is made up of the sensory elements, called the hair cells and various supporting cells. All the cells of organ of Corti are arranged in order from center towards periphery of the cochlea as follows :-

- (i) Border cells,
- (ii) Inner hair cells.
- (iii) Inner phalangeal cells.
- (iv) Inner pillar cells.
- (v) Outer pillar cells.
- (vi) Outer phalangeal cells,
- (vii) outer hair cells.
- (viii) cells of Hensen.
- (ix) cells of Claudius,
- (x) Tectorial membrane and lamina reticularis

Sound waves : Sound is the sensation produced when longitudinal vibrations of the molecules in the external environment i.e. alternate phase of condensation and rarefaction of the molecules, strike the tympanic membrane. A plot of these movements as changes in pressure on the tympanic membrane per unit of time is a series of waves and these movements in the environment are generally called sound waves. The waves travel through air at a speed of approximately 344 m/s (770 miles/h) at 20^o C at sea level. The speed of sound increases with temperature and with altitude.

Generally speaking the loudness of a sound is correlated with the amplitude of a sound wave and its pitch with the frequency. The greater the amplitude, the louder the sound and the greater the frequency, the higher the pitch. However, pitch is determined by other

poorly understood factors in addition to frequency and frequency affects loudness, since the auditory threshold is lower at some frequencies than others. Sound waves that have repeating patterns, even though the individual waves are complex, are perceived as musical sounds, a periodic nonrepeating vibrations causes a sensation of noise. Most musical sounds are made up of a wave with a primary frequency that determines the pitch of the sound plus a number of harmonic vibrations that give the sound its characteristic timbre (quality) variation in timber permit us to identify the sounds of the various musical instruments even though they are playing notes of the same pitch.

The amplitude of a sound wave can be expressed in terms of the maximum pressure change at the eardrum, but a relative scale is more convenient. The decibel scale is such a scale. The intensity of a sound in bels is the logarithm of the ratio of the intensity of that sound and a standard sound. A desibel (dB) is 0.1 bel. Therefore.

$$\text{Number of dB} = 10 \log \frac{\text{Intensity of sound}}{\text{Intensity of standard sound}}$$

Sound intensity is proportionate to the square of sound pressure. Therefore,

$$\text{Number of dB} = 20 \log \frac{\text{Pressure of sound}}{\text{Pressure of standard sound}}$$

The standard sound reference level adopted by the Acoustical Society of America corresponds to 0 decibels at a pressure level of $0.000204 \text{ dyne/cm}^2$, a value that is just at the auditory threshold for the average human.

The sound frequencies audible to humans range from about 20 to a maximum of 20,000 cycles per second (cps, Hz). The threshold of the human ear varies with the pitch of the sound, the greatest sensitivity being in the 1000- to 4000- Hz range. The pitch of the average male voice in conversation is about 120 Hz and that of the average female voice about 250 Hz. The number of pitches that can be distinguished by an average individual is about 2000, but trained musicians can improve on this figure considerably. Pitch discrimination is best in the 1000- to 3000- Hz range and is poor at high and low pitches.

Deafness :- Deafness is usually divided into two types (i) that caused by impairment of the cochlea, the auditory nerve, or the central nervous system circuits from the ear, which is usually deafness as "nerve deafness" and (ii) that caused by impairment of the physical structures that conduct of the ear sound itself to the cochlea, which is usually called "conduction deafness"

If either the cochlea or the auditory nerve is destroyed, the person becomes permanently deaf. However, if the cochlea and the nerve are still intact but the tympanum ossicular system has been destroyed or ankylosed, sound waves can still be conducted into the cochlea by means of bone conduction from a sound generator applied to the skull over the ear.

Noise Pollution : Sound is a special kind of wave action which is usually transmitted through air in the form of pressure waves, These waves are received by hearing apparatus of animals, including human, transformed into electrical impulses in the ear and carried to the brain which enables us to hear. Sound waves are generated in a number of ways, such as explosive expansion of gases, turbulent movement of liquids, vibrations of solid objects etc., which start a series of pressure waves in all directions. The intensity of these waves diminishes as the distance from the object producing them increases. Sound waves are happens reflected and deflected by objects which to come materials, such as in their way, Porous perforated board, absorb these waves. When two or more than two such waves superimpose other they reinforce each other and in opposite phase they may cancel each other out.

Noise is defined as unwanted or unpleasant sound that causes discomfort. It is also defined as "wrong sound, in the wrong place at the wrong time." : Noise pollution means" the unwanted sound dumped into the atmosphere leading to health hazards. Formerly noise was limited to the industry. This too was not use much as there were must only few industries. These days there has been rapid industrial growth growth. Moreover, there has been population explosion, due to which there is heavy traffic, urban crowd and electric equipments (luxury items and entertainment). All these have added to the noise nuisance in environment.

The main contribution to noise are Industries, transportations and communities. The chief man-made sources are automobiles, factories, industries, trains and airopenes. Noise makers are horns, sirens, lawn mover, musical instruments, TV, radio, and loudspeakers, etc. Ever since the industrial revolution, there has been doubling every 10 years of environmental noise.

Effects of Noise pollution :

I. Auditory Effect : These include auditory fatigue, and deafness. Auditory fatigue appears with in the 90 dB, and may be associated with side effects as whisling and buzzing in ears. Deafness can be caused due to continuous noise exposure. Temporary deafness occurs at 4000- 6000 hz. Permanent loss of hearing occurs at 100 dB.

2. Non - Auditory Effects :

(i) Interference with speech communication : A noise of 50-60 dB commonly interferes with speech, sound of warning (signal) may be understood

(ii) Annoyance : Balanced persons express great annoyance at even low levels of noise as crowded, highway radio etc. The effects are ill temper, bricking etc.

(iii) Loss in working efficiency - There develop tiredness and those doing mental work may put to deterioration in their efficiency or even complete loss of ability to work.

(iv) Physiological Disorders -

These are neurosis anxiety, insomnia, hypertension, hepatic diseases, behavioural and emotional stress, increase in sweating, giddiness, nausea, Jaque etc. Noise also causes visual disturbance, and reduce depth and quality of sleep that affecting overall mental and physical health. Other effects are undesirable changes in respiration circulation of blood in skin and gastrointestinal activity. Noise pollution also causes incidence of peptic ulcers.

Continuous noise causes an increase in cholesterol level resulting in the constriction of blood vessels making you prone to heart attack and strokes. There may be still births and usually low weight children born to mothers living near airports,

Discussion, Conclusion and Recommendations

The sound waves, which are transmitted by the tympanic membrane, malleus, and incus, cause the movement of stapes. This leads to the origin of vibrations in the fluids of cochlea. The vibrations now, stimulate the hair cells in the organ of Corti. This in turn causes the generation of action potential auditory impulses in the auditory nerve fibers. When the auditory impulses reach the cerebral cortex, the perception of hearing occurs. Thus, during the process of hearing ear converts the sound waves into action potentials in the auditory nerve fibers.

External ear directs the sound waves towards the tympanic membrane. The sound waves produce the pressure changes over the surface of tympanic membrane. Accumulation of wax prevents conduction of sound.

Due to the pressure changes produced by sound waves the tympanic membrane vibrates i.e. it moves in and out of middle ear this the tympanic membrane acts as a resonator that reproduces the vibration of sound.

The movement of foot plate of stapes against oval window causes movement of perilymph in scala vestibuli. The fluid will not move all the way from oval window toward round window through the helicotrema. So, the immediate effect is on the basilar membrane near oval window. The movement of fluid in scala vestibuli causes displacement of fluid in

scala media, as the vestibular membrane is flexible. This causes bulging of basal portion of basilar membrane towards round window. This in turn moves the fluid in scala tympanica towards round window and bulging of round window into middle ear.

The elastic tension developed in the basilar fibres in the bulged portion of basilar membrane initiates a wave which travels along basilar membrane towards the helicotrema like that of arterial pulse wave. This is called traveling wave.

During origin, each wave is weak, while traveling through basilar membrane from base to apex, the wave becomes stronger and, at one portion of basilar membrane immediately vibrates back and forth. The wave ceases here, and does not travel further. This point in the basilar membrane is called the resonance point.

The distance between the steps and resonance point is inversely proportional to the frequency of sound waves reaching the ear. The high pitched sound generates wave, which dies near the base of the cochlea. The medium frequency sound wave reaches half of the way, travels the entire distance of basilar membrane.

The electrical events, which take place during the process of hearing are the following:-

- (i) Receptor potential or cochlear microphonic potential
- (ii) Endocochlear Potential or endolymphatic Potential
- (iii) Action Potential in the auditory nerve fiber.

The two qualities of sound are : (i) The pitch sound and (ii) The loudness or intensity. The pitch of the sound depends upon the frequency of sound waves, and the loudness depends upon the amplitude of sound waves.

The frequency of sound audible to human ear lies between 20 and 20,000 hertz or cycles/second. The range of greatest sensitivity lies between 2000 and 3000 Hz (cycles/second).

The intensity of loudness of sound correlated with the rate of discharge from individual fibers of auditory nerve and with the total number of nerve fibers discharging. The threshold intensity of sound waves is not constant. It varies in accordance to the frequency of the sound.

The ability to detect the source from where the sound is produced or the direction through which the sound wave is coming is called sound localization. The cerebral cortex and also the medial geniculate body play an important role in localization of sound.

The sound and noise pollutants enter in the auditory system. The noise pollution created by the noise pollutants (harmful sounds) influence the following organs of auditory system :-

1. Auricle or Pinna. External Ear.
2. External Auditory meatus }
3. Middle Ear (Tympanic cavity, Tympanic membrane Auditory ossicles, Muscles Attached to Auditory ossicles and Auditory Tube).
4. Internal Ear (cochlea, compartments of spiral canal of Cochlea and organ of corn)
5. Auditory Pathway (hair cells, bipolar cells, neurons)

Since the life sciences along with the physical sciences have received much attention to revise and refresh courses there is an urgent need now to lay emphasis on the protection of environment all over the world and to provide a better life to the living beings of this planet in order to maintain an environment a proper balance between the environment and human survival it becomes imperative to incorporate concepts of immediate concern that have direct complications not only to theory but practical work and their subsequent application for environmental protection and human survival maintain the ecological and biochemical and then the ecological balance.

The study of such concepts as auditory system and noise pollution in the course of study related to the biological science at various level should be specifically introduced the course of study related to the biological science at various level.

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