Sense Organs
I. Introduction to the Senses.
   A. Scientists at Princeton studied solitary confinement and sensory deprivation.
      1. EXP - Volunteers were immobilized in dark soundproof rooms or chambers of water.
      2. RESULT - visual, auditory, and tactile hallucinations, incoherent thought patterns, deterioration of intellectual performance and sometimes morbid fear and panic.
      3. CONCLUSION - Sensory input is essential to the integrity of personality and intellectual function.
II. Classification of the senses.
   A. The Senses can be classified by their modality (form of the sensation) as either General (somatic and visceral) or Special.
      1. General
         a. Somatic - Type of sense: Touch, pressure, temperature, proprioception, pain
         b. Visceral - Type of sense: Pain, pressure
      2. Special senses - Type of sense: Smell, taste, sight, hearing, balance.
III. Sensation
   A. Sensation or perception is the conscious awareness of stimuli received by receptor.
   B. Our perceptions of the world are created by the brain from electrochemical nerve impulses delivered to it from sensory receptors.
      1. Receptors transduce (change) different forms of energy into nerve impulses
      2. Nerve impulses are conducted to the brain
         a. Stimulus must initiate an action potential in the cerebral cortex
      3. The brain interprets these impulses as sound or sight even though the impulses themselves are identical in nature.
      4. The cerebral cortex screens the information and ignores most of what it receives.
   C. Our senses act as energy filters that perceive a narrow range of energy.
      1. Eg. Vision is limited to electromagnetic waves of light in the visible spectrum
   D. Sensation requires:
      1. A stimulus,
      2. activation of a receptor,
      3. conduction of an action potential to a specific region of the CNS,
      4. translation or interpretation of the signal.
         a. Sensation or awareness of stimuli occurs in the cerebral cortex.
         b. The sensation is then projected to the site of origin (ie tip of the finger)
IV. Properties and Types of Sensory Receptors
   A. General Properties of Receptors
      1. A receptor is any structure specialized to detect a stimulus.
         a.

(1)
      2. All receptors are transducers, changing stimulus energy into nerve energy.
         a. A stimulus produces a receptor potential, or voltage change on the plasma membrane.
         b. If the potential reaches threshold, the stimulus triggers the firing of nerve impulses to the CNS.
         c. These impulses may or may not produce sensations that reach consciousness
      3. Sensory receptors transmit four kinds of information:
         a. Modality
         b. Location
            (1) Sensory projection is the ability of the brain to identify the site of stimulation.
         c. Intensity of stimulus
(1) Encoded by:
   (a) 
   (b) 
   (c) 

d. **Duration** is encoded in the way nerve fibers change their firing frequencies over time.
   (1) All receptors exhibit sensory **adaptation or accommodation**
   (2) **Phasic receptors:**

(3) **Tonic receptors:**

B. **Classification of Receptors** **three different ways:**
   1. Receptors can be **classified by stimulus modality**
      a. **Chemoreceptors**
      b. **Thermoreceptors**
      c. **Nociceptors**
      d. **Mechanoreceptors**
      e. **Photoreceptors**
   2. Sense receptors can be **classified according to the type sensory information** they deliver.
      a. **General senses** have receptors that are widely distributed throughout the body.
         (1) includes proprioceptors and cutaneous receptors.
         (2) **Location**:
         (3) Detect:
      b. **Special senses** include vision, hearing, taste, smell, and equilibrium.
   3. Receptors can be **classified according to the origins of their stimuli**.
      a. **Interoceptors (Visceroreceptors)** detect stimuli from internal organs
         (1) pain, nausea, stretch, pressure
         (2) **referred pain**.
         (a)
      b. **Proprioceptors** sense position and movement of the body or its parts.
         (1)
      c. **Exteroceptors** detect external changes.
         (1)

V. **Law of Specific Nerve Energies**
   A. Stimulation of a sensory nerve fiber produce only one sensation
   B. Regardless of how a sensory neuron is stimulated, only one sensory modality will be perceived.
   C. Allows brain to perceive stimulus accurately under normal conditions.

VI. **Generator (Receptor) Potentials**
   A. Sensory endings produce local graded changes in membrane potential
   B. The generator potential is proportional to the intensity of the stimulus.
      1. A greater stimulus produces an increase in the **frequency** of action potentials.

VII. **Sensory Nerve Endings.**
   A. There are at least 8 types of Sensory Nerve Endings
      1. **Classified as either encapsulated or unencapsulated.**
   B. Unencapsulated Nerve Endings
      1. **Unencapsulated nerve endings** are sensory dendrites that lack a cloak of connective tissue.
         a. **Free nerve endings**
         b. **Merkel (tactile) discs**
c. Hair follicle receptors (peritrichial endings)

2. Encapsulated Nerve Endings
   Encapsulated nerve endings are dendrites wrapped in glial cells or fibroconnective tissue. The connective tissue enhances the sensitivity or specificity of the receptor.
   a. Lamellated (pacinian) corpuscles
   b. Tactile (Meissner) corpuscles
   c. Ruffini corpuscles
   d. Golgi tendon organs
   e. Muscle spindles

VIII. Proprioceptors
   A. Located in and around joints within the skeletal system
      1. Kinesthetic sense by which body position is perceived.
      2. With kinesthetic sense the position and movement of the limbs can be determined without visual sensation. May reach the level of consciousness -
   B. Joint kinesthetic receptors
   C. Neuromuscular spindles
   D. Neurotendinous receptors

IX. Smell (Olfaction)
   A. Olfaction is the sense of smell
   B. Anatomy
      1. Olfactory mucosa contains 10-20 million olfactory neurons,
         a. bipolar with enlarged ends (olfactory vesicles) in the olfactory epithelium,
         b. Axons extend up through foramina of the cribiform plate to the olfactory bulb.
         c. Each of the enlarged ends has 10-20 cilia called olfactory hairs.
   C. Physiology
      1. Process of olfaction
         a. Airborne chemicals enter the nasal cavity and are dissolved the fluid covering the olfactory epithelium. (Chemicals must be volatile and water soluble.)
         b. Odor molecule binds with a specific receptor
         c. A second messenger is produced opening ion channels in the membrane.
         d. Sodium ions enter the cell and depolarize it, creating a receptor/axon potential.
      2. Olfactory discrimination
         a. Humans can discriminate between ~10,000 different odors.
b. 7-50 primary classes of odors - The brain integrates the signals from the several sensory neurons to form a characteristic fingerprint of the odor.

3. Olfactory receptors adapt quickly.
4. Some odors, such as the ammonia smell of smelling salts, stimulate nociceptors that trigger the trigeminal nerve.

D. Projection Pathways
1. Pathway
   a. Olfactory axons pass through the cribiform plate to the olfactory bulbs
   b. Synapse with mitral cells (bishop’s mitral hat) and tufted cells in the bulb.
   c. Mitral cells relay information to the brain via the olfactory tract.
   d. These tracts follow a complex pathway that involves the medial temporal lobes
      (1) Olfactory signals reach the cortex before the thalamus if the person is unaware of them (subconscious);
      (2) Olfaction is the only sensation that is relayed directly to the cerebral cortex without first going to the thalamus.
   e. Conscious awareness of smell travels through the thalamus to the olfactory cortex in the frontal lobes.

E. Clinical considerations
1. Anosmia -
2. Age-

X. Taste (Gustation)
A. Anatomy
1. Taste results from the action of chemicals on the taste buds located on the tongue. The sense of taste is strongly influenced by olfaction.
2. Taste buds
   a. Taste buds consist of specialized epithelial cells clustered together.
   b. Most taste buds are associated with structures on the tongue called papillae
3. Four types of lingual papillae
   a. Circumvallate (circled by a valley) papillae,
   b. Fungiform (mushroom shaped) papillae,
   c. Foliate (leaf shaped) papillae
   d. Filiform (filament shaped)

B. Histology
1. 10,000 tast buds on a person’s tongue
2. Two types of specialized epithelial cells within a taste bud.
   a. supporting cells
   b. Gustatory or taste cells
   c. Taste cells divide by mitosis and live for 7-10 days.

C. Physiology
1. Process of taste
   a. molecules are first dissolved in water/saliva.
   b. Substance enters taste pore and attaches to chemoreceptor molecule on cell membrane
   c. Causes depolarization of the taste cell.
d. Taste cells have no axons but release a neurotransmitter
e. Neurotransmitter stimulates action potential in cells associated with the gustatory cells.

2. Four primary taste sensations exist:
   a. salty
   b. sweet
   c. sour,
   d. bitter -

3. Large number of different tastes are combinations of these four primary tastes.

4. The flavor of food also involves smell, texture, and appearance.

D. Projection Pathways
1. Cranial nerves VII, IX, and X send taste sensations to the tractus solitarius of the medulla oblongata.
   a. VII (facial)
   b. IX (glossopharangeal)
   c. X (vagus)

2. From the medulla oblongata fibers extend to the thalamus and then to the taste area of the cortex on the extreme inferior end of the postcentral gyrus.

XI. Vision
A. Vision and Light
1. Vision is the perception of light.
   a. Light is electromagnetic radiation, measured in wavelengths.
   b. Most solar radiation reaching earth falls within 400-750 nm, the same range the eye is adapted to see.

2. Visual system includes eyes, accessory structures and optic nerves, tracts and pathways

B. Accessory Structures of the Orbit
1. Accessory structures of the eye include the eyebrows, eyelids, conjunctiva, lacrimal apparatus, and extrinsic eye muscles.
   a. Eyebrows:
      (1)
   b. Eyelids (palpebrae):
      (1)
      (2) tarsal glands- secrete oil to coat the eye and reduce tear evaporation.
   c. Palpebral fissure - space between eyelids
   d. Canthus (pl. canthi) - angles at medial and lateral borders of palpebral fissure
   e. Caruncle (mound)- small reddish-pink mound of tissue in medial canthus.
   f. Muscles that move the eyelid
      (1) Orbicularis oculi
      (2) Levator palpebrae superiorus
      (3) Tarsal plate with attached smooth muscle
   g. Eyelashes
      (1) Ciliary glands - modified sweat glands keep follicles lubricated
      (2) Meibomian glands are sebaceous glands near inner margin
         (a)
   h. Conjuctiva
      (1) Conjunctiva is the pink, vascular inner lining of the eyelid.
      (2) Palpebral conjunctiva - conjunctiva of eyelid
      (3) Bulbar conjunctiva - conjunctiva of eye
      (4) Conjunctival fornices - curve where palpebral and bulbar conjunctiva meet.
      (5) Conjunctivitis-
   i. Lacrimal apparatus consists of:
(1) *lacrimal gland* - superolateral to orbit,
   (a) enervated by the facial nerve (VII)
   (b) produces tears (water, salt, mucus and lysozyme)

(2) *lacrimal canaliculi* - in the medial canthus superior and inferior to the caruncle.
(3) *lacrimal sac* - collects tears
(4) *nasolacrimal duct* - opens into the nasal cavity.

j. **Six extrinsic eye muscles**
   (1) are responsible for movements of the eye.
   (2) *superior, inferior, medial and lateral rectus* muscles
      (a) lateral rectus in innervated by the abducens nerve (VI)
      (b) superior, inferior and medial are innervated by the *oculomotor nerve* (III).
   (3) *superior oblique* -
      (a) innervated by the trochlear nerve (IV)
      (b) superior oblique goes through a pulley or trochlea
   (4) *inferior oblique* muscles.
      (a) innervated by the *oculomotor nerve* (III).

C. **Anatomy of the Eye**

1. **The Tunics** - three layer of eye wall (Fibrous, vascular and nervous tunics)

2. **Fibrous Tunic**
   a. consists of
      (1) *sclera* (white portion of eye)
         (a)
      (2) *cornea* - transparent (small colagen fibers)
         (a)

3. **Vascular tunic**
   a. *choroid layer*
   b. A *ciliary body* forms a muscular ring around the lens
      (1) *ciliary ring, ciliary processes*
      (2) *supensory ligaments*
         (a) Fxn:
   c. *Iris* -
   d. *Pupil* -
      (1) *sphinter pupillae* - circular group of smooth muscles
      (2) *dilator pupillae* - radial group of smooth muscle
      (3) controlled by oculomotor nerve (III)

4. **The nervous tunic (Retina)**
   a. *Pigmented retina* - simple cuboidal epithelium
   b. *Sensory retina* -
      (1) rods and cones
   c. *Macula lutea* - small yellow spot on retina
   d. *Fovea centralis* - center of macula lutea
      (1)
   e. *Optic disc* - medial to macula

5. **Compartments of the eye**
   a. Anterior compartment
(1) **anterior chamber** - cornea to iris
(2) **posterior chamber** - iris and lens
(3) filled with **aqueous humor**:
   (a)
   (b)
   (c) Glaucoma - increase in pressure of anterior chamber
b. Posterior compartment
   (1) large compartment
   (2) contains **vitreous humor**
      (a)
      (b)

6. Lens

D. Functions of the Complete Eye
1. Eye functions much like a camera

2. Light
   a. Visible light is that portion of the electromagnetic spectrum that humans can see ~400 - 700 nm.

3. Light Refraction and Reflection
   a. When light travels from one medium to another, it can bend or refract.
      (1) A **concave** surface refracts light outward (divergence).
      (2) A **convex** surface refracts inward (convergence).
         (a) **focal point**
         (b) The more **spherical** the lens the **more the light is bent**.
         (c) The more **flattened** the lens the **less the light is bent**.
      (3) **Reflection** - light rays strike a non-transparent object some of the light rays bounce off the object.

4. The cornea, aqueous humor, an vitreous humor all refract light.
   a. The cornea is responsible for most of the convergence, whereas the lens can adjust the focal point by changing shape.
   b. Relaxation of the ciliary muscles causes the lens to flatten,
      (1) **emmetropic eye** - normal resting position of the lens.
      (2) **Far point of vision** - the point at which the lens does not need to change shape to focus on an object (approximately 20 feet).
   c. Contraction of the ciliary muscles causes the lens to become more spherical.
      (1) **accommodation**.

5. Three things must occur to bring an object closer than 20 feet into focus:
   a. **Accommodation** by the lens,
      (1) Process of accomodation:
      (2) As an object is brought closer to the eye accommodation becomes more difficult.
         (a) **Near point of vision** is the distance at which blurring occurs.
   b. **Constriction of the pupil**,
      (1) increases the **depth of focus**.
      (2) A small pupillary diameter increases the depth of focus.
(3) The pupil also regulates how much light passes into the eye.

c. convergence of the eyes
(1) Convergence is the medial rotation of the eyes during close vision.

E. Structure and Function of the Retina
1. Retina consists of a pigmented retina and a sensory retina.
   a. Pigmented retina (retinal pigmented epithelium)
      (1) single layer of cells that contain melanin pigment
         (a) with choroid makes a black matrix (backdrop) which enhances visual acuity.
      (2) The rods and cones that make vision possible lie next to this layer.
         (a) The outer layer of the rods and cones must be dissolved by the retinal pigment epithelium
             for normal vision to occur.
   b. Sensory retina
      (1) consists of three layers of neurons
         (a) (b) (c)
      (2) nuclear layers are separated by two plexiform layers (outer plexiform and inner plexiform
          layer)

2. Rods
   a. Involved in noncolor and low illumination (night) vision.
   b. The rod shaped portion of the rod cell contains about 700 double-layered membranous discs.
      (1) Discs contain the molecule rhodopsin which consists of:
         (a) opsin (protein)
         (b) retinal (pigment derived from Vitamin A).

3. Function of Rhodopsin
   a. Light causes a separation of rhodopsin into retinal and opsin
      (1) As light is absorbed retinal changes shape and detaches for opsin causing a change in the
          configuration of opsin
      (2) An active site on opsin is exposed causing the plasma membrane of the discs within the rod to
          become hyperpolarized (Not Depolarized).
   b. Photoreceptor cells when inactive constantly leak Na+
      (1) influx of Na+ cause the photoreceptor cell to release the neurotransmitter glutamate
         (a) glutamate is an inhibitory transmitter
         (b) glutamate binds to receptors on the bipolar cells causing them to hyperpolarize.
         (c) An inhibitory post synaptic potential (IPSP) is generated in the bipolar cell.
   c. Na+ channels in Photoreceptor cells exposed to light close.
      (1) fewer Na+ ions enter the cell therefore less glutamate is released to the postsynaptic cell.
      (2) IPSPs to hyperpolarized bipolar cell decrease
      (3) Bipolar cells become depolarized and an action potential is generated in the bipolar cell.
   d. Number of Na+ ion channels that close is proportional to the amount of light exposure.
   e. Final stage of light initiated reaction
      (1)
      (2)
   f. Light adaptation is a result of a decrease in rhodopsin; dark adaptation - increased rhodopsin
      production.

4. Cones
   a. Cones are responsible for color vision and visual acuity.
b. Color is a function of the wavelength of light
(1)

c. Structure
(1) Cones are bipolar neurons with a cone shaped light sensitive part that tapers from the base to the apex.

d. Cone cells use the visual pigment iodopsin (retinal + specialized ops in protein)
e. There are three types of color sensitive opsin each with a different photopigment.
(1)
(2) The red and green pigments are encoded by specific genes on the X chromosome.
   (a) One one gene is expressed in each cone.
(3) As light of a particular wavelength hits the retina only those cone with the specific opsin for that wavelength or color will be activated.

5. Distribution of rods and cones in the retina
   a. Most visual images are focused on the fovea centralis
      (1) fovea centralis has 35,000 cones and no rods.
   b. Rods are concentrate in the periphery of the retina.

6. Inner layers of the retina.
   a. two major types of neurons in the middle and inner layers of the retina:
      (1) bipolar cells
      (2) ganglion cells
   b. The rods an the cones synapse with bipolar cells that in turn synapse with ganglion cells.
      (1)
      (2)
   c. Axons from the ganglion cells pass over the inner surface of the retina except in the area of the fovea centralis.
   d. Association neurons of the retina:
      (1) - modify information sent to the brain.
         (a) horizontal cells-
         (b) amacrine cells -
         (c) interplexiform cells -

F. Neuronal Pathways for Vision
1. Ganglia cell axons extend out through the optic nerve
   a. Ganglion cells from the medial (nasal) retina cross through the Optic chiasm and project to the opposite side of the brain.
   b. Ganglion cells from the later portion of the (Temporal) retina project to the same side of the brain.
   c. Optic nerves continue on through the opirc tract
   d. Nerves terminate in the lateral geniculate nucleus of the thalamus or in the superior colliculi.

2. Visual fields from each eye can be divided into a temporal half (lateral) and a nasal half (medial)

3. Depth perception -
   a. Binocular vision

G. Clinical focus on the eye
1. Myopia - nearsightedness
2. Hyperopia - farsightedness
3. Presbyopia - degeneration of accommodation
4. Astigmatism
5. Strabismus -
6. Retinal Detachment
7. Color blindness
8. Night blindness
9. Glaucoma
10. Cataract - clouding of the lens from a buildup of proteins
11. Macular degeneration
12. Infections
   a. Trachoma - leading cause of blindness worldwide
   b. Neonatal gonorrheal ophthalmia

XII. Hearing and Balance (Anatomy)
A. The Nature of Sound
1. Hearing is a response to vibrating air molecules.
   a. A vibrating object sets up vibrations in nearby air molecules which travel to the eardrum and cause it to vibrate.
2. Pitch
   a. Pitch is determined by the frequency of vibration.
      (1) Human ears can hear frequencies from 20-20,000 Hz, but are most sensitive to frequencies ranging from 1,500 to 4,000 Hz.
3. Loudness
   a. Loudness is the perception of amplitude of frequency.
      (1) Loudness is expressed in decibels (dB),
         (a) with 120-140 dB causing pain in most people. Prolonged exposure to sounds greater than 90 dB can cause permanent hearing loss.

B. Organs of hearing and balance can be divided into three parts
1. External ear -
2. Middle ear -
3. Inner ear -

C. External ear anatomy
1. Auricle or pinna
2. External auditory meatus
   a. Hairs and ceruminous glands
3. Tympanic membrane

D. Middle Ear
1. Air filled
2. Two openings for air passage
   a. Mastoid air cells
   b. Auditory or eustachian tube
      (1) Fxn:
3. Contains auditory ossicles
   a. Malleus,
   b. incus
   c. stapes

E. Inner Ear
1. Made up of a bony labyrinth (maze) within the temporal bone
   a. Contains a membranous lining (periosteum) called the membranous labyrinth
      (1) Membranous labyrinth is filled with endolymph
b. Space between the membranous labyrinth (Cochlear duct) is filled with perilymph.
c. Bony labyrinth divided into three regions
   (1) vestibule, semicircular canals, cochlea

2. **Vestibule**
a. Makes up a static labyrinth
   (1) contains utricle and saccule that are involved in position of head relative to gravity

3. **Semicircular canals**
a. Makes up the kinetic labyrinth
b. 
c. 
d.

4. **Cochlea** spiral-shaped canal within the temporal bone- divided into three parts
   a. **Scala vestibuli,**
      (1) oval window at one end
      (2) extends to the helicotrema (hole) at apex of cochlea
   b. **scala tympani**
      (1) extends from helicotrema back to the round window.
   c. cochlear duct
      (1) **vestibular membrane** separates the scala vestibuli from the top of the cochlear duct.
      (2) **basilar membrane** separates the scala tympani form the bottom of the cochlear duct.
   (a) 
   (b) 

F. The spiral organ (Organ of Corti) consists of
   1. **Hair cells**
      a. Contain stereocilia at tip which touch the tectorial membrane
      b. Have no axons.
      c. Cochlear nerve has nerve endings that interact with the hair cells.
   2. **Tectorial membrane.**
      a. Made of a Gelatinous material.

G. Auditory Functions (Video) (Fig. 15.29)
   1. Sound waves are funneled by the auricle down the external auditory meatus, causing the tympanic membrane to vibrate.
   2. The tympanic membrane vibrations are passed along the ossicles to the oval window of the inner ear.
   3. Foot plate of the stapes causes the oval window to vibrate.
   4. Vibration of oval window causes the perilymph, vestibular membrane, and endolymph to vibrate.
   5. Vibration produces movement of the basilar membrane.
      a. 
      b. 
      c. Movement of the basilar membrane causes displacement of the hair cells in the spiral organ and the generation of action potentials, which travel along the vestibulocochlear nerve.
      d. Some vestibulocochlear nerve axons synapse in the superior olivary nucleus.
         (1) 

   6. Vibrations of in scala vestibuli are transferred through the cochlear duct (endolymph) and into the scala tympani.
   7. The round window protects the inner ear from pressure buildup and dissipates waves.

H. Neuronal Pathways for Hearing
1. Axons from the **vestibulocochlear** nerve synapse in the **medulla**.
   a. Neurons from the medulla project axons to the **inferior colliculi**, where they synapse. Neurons from this point project to the **thalamus**. Thalamic neurons extend to the **auditory cortex**.

2. Efferent neurons project to cranial nerve nuclei responsible for controlling muscles that dampen sound in the middle ear.
   a.

I. Balance
1. Organs of balance can be divided structurally and functionally into two parts (Static labyrinth and kinetic labyrinth).
   a. Static labyrinth
      (1) **Static balance** evaluates the position of the head relative to gravity and detects linear acceleration and deceleration.
      (2) The **utricule and saccule** within the vestibule of the inner ear are responsible for static balance.
         a) contain **maculae** - specialized simple cuboidal cells.
         b) The maculae consists of **supporting cells** and **hair cells**
            i) Microvilli are embedded in a **gelatinous matrix** that contains **otoliths**.
         c) The gelatinous mass moves in response to gravity.
         d) The maculae in the utricule are parallel to the base of the skull while the maculae in the saccule are perpendicular to the base of the skull.
      (3) The pattern of stimulation of hair cells as the gelatinous matrix moves over the microvilli can be translated in the brain into specific information about head position or acceleration.
   b. Kinetic labyrinth
      (1) **Kinetic balance** evaluates movements of the head.
         a) The kinetic labyrinth consists of **three semicircular canals** at right angles to one another in the inner ear.
            i) ii) iii) iv) v) Fluid movement bends the hairs and initiates action potentials.
         b) The ampulla of each semicircular canal contains the a specialized epithelium called the **crista ampullaris**.
            i) **crista ampullaris** ,
               a) Similar in structure to the maculae.
               b) c) d) e) Fluid movement bends the hairs and initiates action potentials.
         c) Displacement of of the cupula is most intense when the rate of head movement changes
            i)

J. Neuronal Pathways for Balance
1. Axons from the **maculae and the cristae ampullares** extend through the vestibulocochlear nerve to the **vestibular nucleus** in the **medulla**.
2. Fibers form the medulla run to the **spinal cord, cerebellum, cortex, and nuclei that control the extrinsic eye muscle**.
3. Balance also depends on proprioception and visual input.

K. Clinical notes:
1. Otosclerosis - immobility of stapes due to bone growth over the oval window.
2. Tinnitus -
3. Motion sickness - nausea and weakness caused by stimulation of the semicircular canals treated with Cyclizine, Dramamine or Benadryl.
4. Otitis media -
5. Earache - result of otitis media or externa or TMJ.