• Sensory receptors – detect environmental changes
  – Stimulate neurons to send impulses to brain

• Receptors – each sensitive to distinct type of change
  – Selective response
4 Types of Sensory Receptors

• 1) nociceptors – pain
• 2) thermo – temperature change
• 3) mechano – change in pressure or movement
• 4) chemo – respond to chemical change
Sensation

- Feeling that occurs when brain interprets impulse
- Brain concurrently uses projection to send info to origin to stimulated area can be pinpointed
  - Why eyes “see” and ears “hear” and etc.
Sensory Adaptation

• Impulse sending rate decreases until receptors send no more
  – Desensitization occurs
  • Ex: strong odor of pigs, cows, bio labs, etc.
2 Major Categories of Sensory Receptors

1) Somatic – associated w/ skin, muscles, joints, viscera
   - Touch and pressure
   - Temperature
   - Pain

2) Special – associated w/ large complex organs of head
   - A) Sight
   - B) Smell
   - C) Taste
   - D) Hearing, equilibrium
A) Sense of Sight

- Visual Accessory Organs – aid eye’s function
- 1) Eyelid – protects
  - 4 layers:
    - Skin – thinnest of entire body
    - Muscle
    - Connective tissue
    - Conjunctiva
Visual Accessory Organs

- 2) Lacrimal apparatus – lacrimal gland and ducts
  - **Gland** secretes tears
    - Antibacterial enzyme (lysozyme); cleansing
    - Keeps eyes moist; lubricating
  - **Ducts** carry tears to nasal cavity
    - Pathway = superior and inferior canaliculi to lacrimal sac to nasalacralimal duct into nasal cavity
Visual Accessory Organs

• 3) Extrinsic muscles – move eyes
  • attach to sclera
  – A) superior rectus – up and toward midline
  – B) inferior rectus – down and toward midline
  – C) medial rectus – toward midline
  – D) lateral rectus – away from midline
  – E) superior oblique – down and away from midline
  – F) inferior oblique – up and away from midline
Right Eye
Structure of Eye

- Hollow
- Spherical
- Fluid filled
- ~2.5cm in diameter
- ~ 8 g
- 3 layers:
  - Fibrous tunic
  - Vascular tunic
  - Neural tunic
1) Fibrous Tunic

- Outer
- Forms cornea – “window” on front
  - Focuses light
  - Transparent
  - Connective tissue w/ layer of epithelium
  - Few cells in regular pattern
Cornea

• Can do transplants between unrelated individuals
  – No blood supply
    • Tears supply oxygen and nutrients
• Lasik 6 min
1) Fibrous Tunic

- Forms **sclera** – white part of eye
  - Opaque
  - Large, disorganized fibers
  - Protects
  - Attachment for extrinsic muscles
  - Optic nerve and blood vessels pierce posteriorly
2) Vascular Tunic

- Middle
- Contains choroid coat – loosely joined to sclera
  - Lots of blood vessels
  - Nourishes eye
  - Keeps inside of eye dark
    - Contains melanocytes – produce pigments
      » Melanin absorbs excess light
2) Vascular Tunic

- Contains **ciliary body** –
  - forms ring around front of eye
  - Ciliary muscles and suspensory ligaments hold lens in position and change its shape (Focus)
  - **Accommodation** ability of lens to adjust shape and focus
    - Thick lens = see close
    - Thin lens = see far; lens less convex
2) Vascular Tunic

- **Iris** – thin, smooth muscle that adjusts the amount of light that enters the pupil (hole)
  - Colored
  - Bw cornea and lens
Iris

- Smooth muscles control pupil size
  - **Circular (pupillary)** – contracts and pupil gets smaller
    - Less light enters
    - Like a sphincter
  - **Radial** – contracts and pupil gets larger
    - More light enters
Iris

• **Anterior Cavity**
  – Contains aqueous humor – watery fluid that nourishes eye
  – Divided by iris into 2 parts:

• 1) **anterior chamber** – bw cornea and iris

• 2) **posterior chamber** – bw iris and vitreous body (contains lens)
  – Aqueous humor circulates bw chambers thru the pupil and drains via the canal of Schlemm
Eye Conditions

• **Diploplia** – double vision caused by muscle imbalance
  – One eye deviates
Eye Conditions

• **Cataracts**
  – Lens becomes cloudy and opaque
  – Causes blindness
  – Can treat:
    • using laser
    • Replace lens

• **Cataract Surgery**
  7:50
Eye Conditions

• **Presbyopia** – loss of accommodation
  – Need reading glasses

• **Night blindness** – poor vision in dim light
  – Lack of vitamin A
  – Take vitamin A to treat
Eye Conditions

- **Glaucoma** – accumulation of aqueous humor
  - Formation exceeds removal
  - Increase in pressure on blood vessels or retina
    - Leads to permanent damage or blindness
  - Cannot detect on own
  - Can treat:
    - laser, surgery, or drugs
3) Neural Tunic

• Inner

• Retina – contains photoreceptors
  – Continuous w optic nerve
  – Nearly transparent
  – Inner lining of eyeball
  – Thin, fragile, complex
  – **Macula lutea** – central region of retina
    • **Fovea centralis** – depression in center of macula
      – Sharpest vision
3) Neural Tunic

• **Optic disc** – where nerve fibers leave retina and join optic nerve
  – Lacks receptors; called “blind spot”
3) Neural Tunic

- **Posterior cavity** – largest compartment of eye
  - Filled w **vitreous humor** – jellylike, transparent
- **Vitreous body** – collagenous fibers and vitreous humor
  - Supports internal eye
  - Gives shape
Dissected Eyeball
Light Refraction

• Bending of light waves
  – Pass from medium of one density into different density
Convex lens

- Causes rays to converge
- Like our lens and cornea
- Farsighted people wear glasses w these lenses
- Thick in middle, thin at edges
Light Refraction

• Waves focus sharply on retina
  – Image upside down and reversed left to right
  – Visual cortex interprets image correctly
Visual Receptors

• Modified neurons
• **Rods** – long, thin
  – Colorless vision
  – Provide vision in dim light
  – General outlines, not shape
  – 100x more sensitive than cones
  – Not in fovea centralis

• **Cones** - short, blunt
  – Sharp images
  – Detect color
Visual Pigments

• **Rhodopsin** – in rods
  – Break down in presence of light and activate enzyme
    • Changes rod cell membrane
    • Generate nerve impulse
    • Interpreted as vision

• **Isodopsins** – in cones (not in book)
  – 3 sets of cones contain 1 of 3 pigments
  – Wavelength of light determines color
  – All stimulated = white
  – None = black
  – Lack of certain pigments = color blindness
Nerve Pathways of Eyes

• Axons of retinal neurons leave and form optic nerves
• Medial (nasal) fibers cross over in optic chiasm
  – Lateral (temporal) fibers do not cross
• Form L and R optic tracts
• Impulses transmitted to thalamus and then to visual cortex (in occipital lobe)
• Bionic Eye 1:30
B) Olfaction – The Sense of Smell

- Provided by olfactory organs
  - On sides of nasal septum
  - Contain olfactory receptor cells
  - Secrete mucus
Olfactory Receptor Cells

• Highly modified neurons
  – Have cilia on receptors to help absorb chemicals
  – 10-20 million cells packed into area of 5cm²!
    • Including cilia = more than surface area of body!!
    • Drug dogs are 72x more sensitive than us
Olfactory Organs
Sniffing

• Draws air across olfactory organs
• Repeated action intensifies stimulation
• Mucus prevents dangerous buildup of chemicals
• Cancer detecting dogs 3:39
Olfactory Stimuli

- Only type of sensory info that goes to cerebral cortex without synapsing in thalamus

- Extensive limbic and hypothalamic connections
  - Causes intense emotional connections
C) Gustation – Sense of Taste

- Most receptors are on the tongue
- Ones on larynx and pharynx decreased in # by adulthood
Taste Sensations

• Four primary:
  – Sweet
  – Salty
  – Bitter
  – Sour

• Two additional:
  – Umami (oo-MAH-me)
    ● Savory
    ● Ex: Beef/chicken broth, parmesan cheese
  – Water
Taste Buds

- All 4 primary taste sensations on every bud
- Difference in sensitivity on long axis of tongue
- More sensitive to acids (sour) and biological toxins (bitter)
  - Life preserving
- Different Tasters 3:12
D) Hearing and Equilibrium

- Performed by ear
- hearing test
Hearing and Equilibrium

• Equilibrium
  – Tells us position of body
  – Monitors gravity, acceleration, and rotation

• Hearing
  – Allows detection and interpretation of sound waves

• Hair cells – mechanoreceptors
  – Respond to stimuli
External Ear Includes:

• **Auricle** (pinna) – the big, fleshy part

• **External acoustic meatus** (ear canal)
  - Contains ceruminous glands
    • Secrete cerumen – waxy
      - Prevents entry of foreign objects/critters
      - Kills microorganisms

• **Tympanic membrane** (eardrum)
  - Thin sheet
  - Separates external and middle ear
Middle Ear (Tympanic Cavity):

- Air filled
- Communicates w/ nasopharynx using the Eustachian tube
  - Allows pressure to equalize
  - Also allows microorganisms in!
- Leads to otitis media (middle ear infection)
Middle Ear Contains:

• **Auditory Ossicles**
  – 1) Malleus (hammer)
    • Attaches to eardrum
  – 2) Incus (anvil)
    • Connects the other two bones
  – 3) Stapes (stirrup)
    • Fills most of the oval window
The Middle Ear:

- Vibrations from ear drum cause bones to move and create sound
- 2 muscles reduce movement to protect hearing:
  - **Stapedius** – smallest skeletal muscle in body
  - **Tensor tympani**
The Middle Ear

- Auditory Ossicles – three bones
  - Malleus (hammer) – attaches to tympanum
  - Incus (anvil) – middle bone
  - Stapes (stirrup) – meets with the oval window – connects to inner ear
The Inner Ear

• Provides hearing and equilibrium

• **Hair cells** - receptors that provide hearing and equilibrium
  – Have long microvilli (stereocilia)

• Contains bony labyrinth
  – [The ear 5:28](#)
Bony Labryinth

- Protects receptor cells
  - Made mostly of dense bone
- Made of three parts:
  - a) Vestibule
  - b) Semicircular canals
  - c) Cochlea
a) Vestibule

- Includes 2 membranous sacs:
  - Saccule
  - Utricle
- Detects gravity and acceleration
b) Semicircular Canals

- Encloses semicircular ducts
- Contain fluid
- Receptors here are stimulated by rotation of head
c) Cochlea

- Spiral shaped
- Contains cochlear duct
- Receptors here provide hearing
Equilibrium

• 1) **Dynamic** – helps maintain balance
• 2) **Static** – maintains posture and stability when still
Auditory Pathways

• Afferent axons form vestibulocochlear nerve
  – Enter medulla oblongata
  – Eventually reach the thalamus and then the cerebral cortex – where we become conscious of them
Aging and the senses

- Smell decreases
- Taste decreases
- Vision decreases
- Hearing decreases – but affected less
  - High pitches hardest to hear