Sensory receptors

The cells that detect a sense stimulus (light, sound, taste, smell, touch, etc.) and then change the stimulus into a nerve signal

• The sensory receptor sends its nerve signal to the brain

• In some sense organs the sensory receptors are sensory neurons. The neuron detects the stimulus and carries the nerve signal

√ In other sense organs, the sensory receptor is two cells: A specialized epithelial cell (detects the stimulus) and a sensory neuron (carriers the nerve signal)

• There are many types of sensory receptors. Each sensory receptor specializes in detecting just one specific type of sense stimulus

Cutaneous receptors

The sense receptors in the skin for the sense of touch

• There are several types of cutaneous receptors

√ Pressure receptors (sense touch and texture)

√ Temperature receptors (different ones for sensing hot and sensing cold)

√ Nociceptors/pain receptors (sense tissue damage)

Fig 5.2; Table 14.1

Proprioreceptors

Sensory neurons in muscles and joints that sense the body part's position

Table 14.1

Eyes (eyeballs)

The two ball-shaped visual organs

• Each eye has six extrinsic skeletal muscles that control its movement

• Iris = The colorful structure (made of smooth muscle) that controls the amount of light entering the eye by changing the size of the pupil

√ Pupil = The tiny opening in the iris where light enters the eye

• Tunics = The three layers that make up the wall of the eye

√ Outer tunic = The sclera (white, fibrous tissue) and the cornea (a clear region in front of the pupil)

√ Middle tunic = The choroid coat (a layer rich in blood vessels)

√ Inner tunic = The retina (the light-sensing layer)

• Lens = The structure that focuses light onto the retina

√ The lens is attached to a round group of smooth muscles called the ciliary body

• The optic nerve conducts visual signals from the retina to the brain

√ The optic nerve exits at the medial posterior area of the eye

• Humors = The clear fluids that fill the eye

√ Aqueous humor = The fluid between the cornea and the lens

√ Vitreous humor = The fluid between the lens and the retina

Figs 14.14 and 14.15, Fig 12.5 for poor optice nerve

Retina

The innermost tunic of the eye. The retina contains nervous tissue that converts light into nerve signals.

- The lens focuses light onto the retina

- The retina has three layers of nervous tissue

  √ Ganglion cell layer (the anterior layer)

  √ Bipolar cell layer (the middle layer)

  √ Photoreceptor cell layer (the posterior layer)

- Only the photoreceptor layer detects light and converts it into nerve signals

  √ Rods = Black and white detecting photoreceptor cells

  √ Cones = Color detecting photoreceptor cells

- The nerve signals from the photoreceptors synapse *anteriorly* to the bipolar cells

- The bipolar cells synapse *anteriorly* to the ganglion cells

- The axons of all the ganglion cells bundle together, then pass posteriorly through the wall of the eye then connect to the brain

  √ The optic nerve = The bundled axons of the ganglion cells

  √ The blind spot (also called the optic disc) = Where the optic nerve passes through the retina

    - There are no photoreceptors so no vision at this spot

Fig 14.16

Color vision

There are only three cone types: Red-detecting, blue-detecting, green detecting

- All other colors that we see (yellow, orange, purple, etc.) are produced by combinations of red, blue, and green signals

- Color blindness = Lack of one or more cone types

  √ Much more common in males than females

Fig 14.18

Detection of light by photoreceptors

Photoreceptors contain visual pigments (light-absorbing molecules)

- The pigments are at the posterior end of the photoreceptors

- Pigments split apart when struck by light

  √ The pigment splitting generates the nerve signal

  √ The split pigment quickly joins together again so that the photoreceptor can detect light again

Fig 14.17

Locations of the rods and the cones:

- Rods are mostly at the sides of the retina; there are few rods in the posterior region

- Cones are mostly at the posterior of the retina; there are few cones at the sides

  √ Fovea centralis = A cones-only area at the center of the retina

Rules of eye focusing:

- The lens' relaxed shape focuses far objects exactly on retina
- Close objects focus further back (behind the retina)
  - √ Close objects are therefore out of focus when the lens is relaxed
- Accommodation = When the ciliary body muscles contract to change the lens shape to move the focal points forward
  - √ This moves the close object focal point to the retina, which brings close objects into focus

Farsighted (hyperopia)

A vision disorder where far objects can be focused but near objects cannot

- Cause: The lens is focusing focal points too posteriorly (behind the retina)

Nearsighted (myopia)

A vision disorder where near objects can be focused but far objects cannot

- Cause: The lens is focusing focal points too anteriorly (in front of the retina)
- Corrected by glasses/contact lenses that move focal points backward

Ear structures

- The outer ear = The pinna (the folded skin and cartilage visible as the "ear" on the side of the head) and the auditory canal (the tube leading inward to the middle ear)

- The middle ear = The tympanic membrane (ear drum) and the ossicles (three tiny bones)

- The inner ear = A group of three chambers inside the temporal bone for the senses of hearing and equilibrium. The three cavities are:

    1) The semicircular canals = 3 curved tubes at the top of the inner ear that are involved in equilibrium

    2) The vestibule = The central chamber of the inner ear; it is involved in equilibrium

    3) The cochlea = A snail shell shaped tube below the vestibule; It is for the sense of hearing

    All three inner ear cavities contain hair cells (cells that generate nerve signals when their hairs bend) and fluids called endolymph and perilymph

Fig 14.5

Sound

Vibrations in air

- Pitch (highness or lowness of sound) = The number of vibrations per second (the frequency)

Fig 14.6

Hearing

Detection of sound vibrations in the air

• Vibrations travelling through the air are channeled by the outer ear into the auditory canal.

• The vibrations then pass through the tympanic membrane (ear drum) and through the ossicles of the middle ear

• The vibrations then enter the inner ear at the vestibule and become vibrations in the endolymph of the cochlea

√ The vibrations in the cochlea generate nerve signals which travel through the cochlear nerve to the brain

√ The brain interprets these sensory signals as sounds

Figs 14.6 and 14.7

Organ of Corti

The hearing structure inside the cochlea

• The organ of Corti contains hair cells (neurons with hair-like cilia) that sit on the flexible basilar membrane but their cilia are attached to the inflexible tectorial membrane

• The vibrations in the cochlea cause the basilar membrane to vibrate

• The vibrations in the basilar membrane bend the hair cell hairs, which generates sound sensory nerve signals.

• Hair cells are tuned to detect different pitches

√ Deeper in cochlea = Detects lower sounds

Figs 14.8 and 14.9

Equilibrium

The sense of movement and balance

- Equilibrium is sensed by the otolith organs in the vestibule and by the semicircular canals

The otolith organs (the utricle and the saccule)

Organs in the vestibule that sense linear movement (straight line movement, such as up/down, left/right, backward/forward) and that provide the ability to stand with balance

- Inside each otolith organ are structures called macula. Each macula contains hair cells encapsulated in a gel that contains otoliths (dense granules of calcium)
  - √ Linear motion causes movement of the otoliths, which bends the gel and the hair cell cilia, which generates a sensory nerve signal
  - √ Leaning and tilting of the head also causes the otoliths to move, providing a sense of balance

Fig 14.11

The semicircular canals

Three half-circle structures that sense rotational movement (movement in circular directions, such as spinning, turning, rotating)

- √ The canals are filled with endolymph
- √ Hair cells enclosed in a gelatinous cap (the cupula) are located at the enlarged entrance each canal (the ampulla)
- √ Rotation makes the endolymph flow, which bends the cupula, which bends the hair cell cilia, which generates a nerve signal

Fig 14.12

Taste and smell senses

Both senses use chemoreceptors (neurons that detect specific molecules)

- Each chemoreceptor specializes in sensing one type of molecule
  - √ Many types of chemoreceptors are present in the nose and the mouth so many types of molecules can be smelled/tasted

Olfactory sense

The sense of smell

- The roof of the nasal cavity is lined with olfactory receptors (chemoreceptors that detect molecules in the air)
  - √ There are about 380 different kinds of olfactory receptors in the nasal epithelium, each specializing in a different molecule

Fig 14.4

Gustatory (taste) sense

- Taste buds = Clusters of taste receptors (chemoreceptors that detect molecules dissolved in saliva) on the tongue

- There are five kinds taste receptors
  - √ Salty = Detects Na^+ ions
  - √ Sweet = Detects sugars (monosaccharides and disaccharides)
  - √ Sour = Detects acids (H^+ ions)
  - √ Bitter = Detects alkaloid plant molecules (some of which are poisonous) and bases
  - √ Umami = Detects meaty tastes (amino acids of proteins)

- Much of our "taste" sensation is actually smelling of food as we eat

Fig 14.3