

Notes: Other Senses

PDF

Hearing

Sound

a wave of air pressure

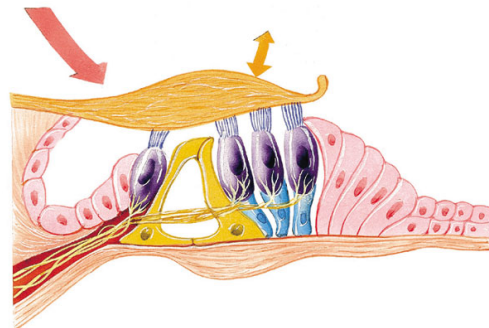
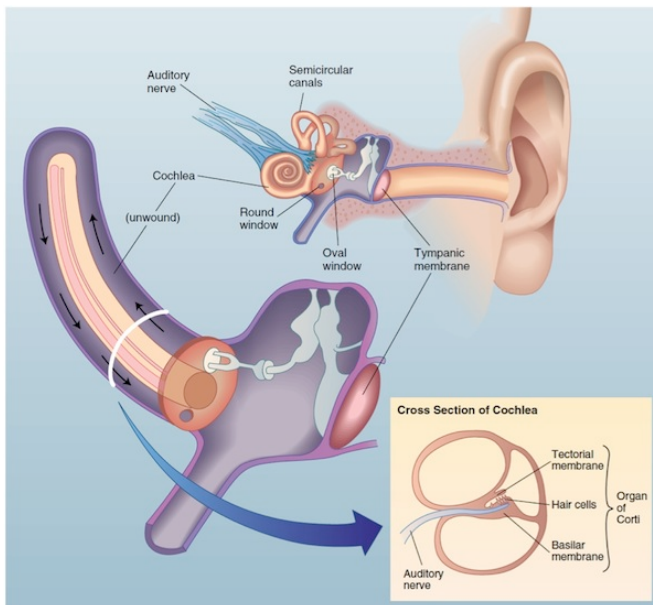
amplitude of the wave - _____

frequency of the wave - _____ (with some caveats)

complexity (how many frequencies) - _____

natural sounds are made up of many different frequencies

Ear



Source: <http://www.oup.co.uk/oxed/children/oise/pictures/light/earhaircells/>

cross section of inside of cochlea

tympanic membrane (ear drum) - _____

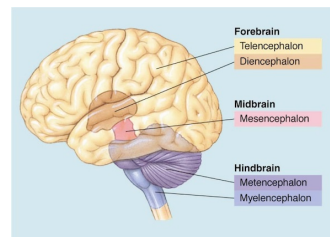
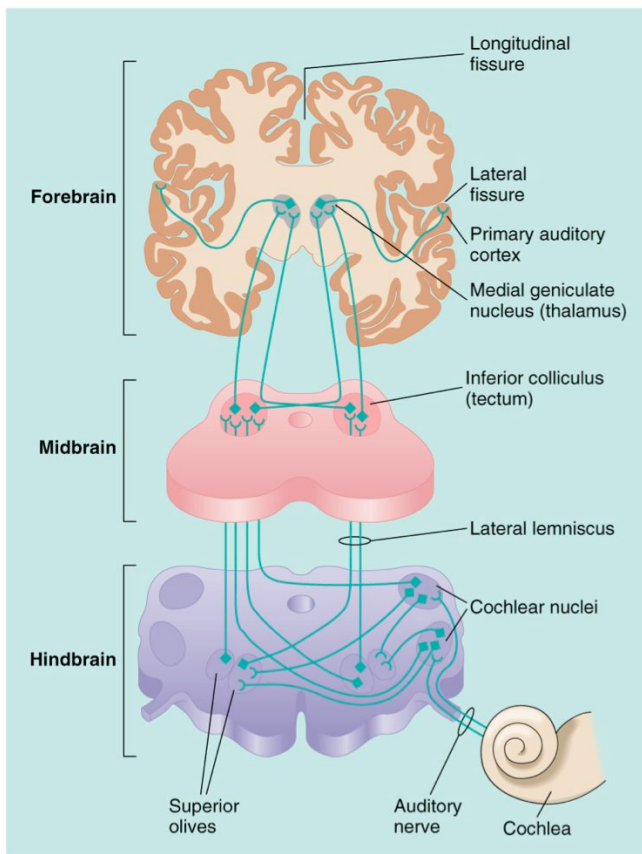
cochlea - _____

semicircular canals (vestibular system)
contain fluid and hair cells to detect movement
direction & intensity of head movements

two different membranes have hair stretched
between them
sound vibrations cause shearing force on hairs
mechanical disruption from shearing force allows
ions to flow through membrane
increased firing in auditory nerve

tonotopic organization - by _____

Auditory pathways



cochlea ->

auditory nerve ->

hindbrain ->

cochlear nuclear - input from only one ear

(From here on input from one/both ears)

superior olives - sound localization

thalamus

medial geniculate nucleus

primary auditory cortex

Auditory Cortex

primary auditory cortex - inside (medial) temporal lobe
functional columns organized by frequency

stimulation leads to perception of _____

secondary auditory cortex - outside (lateral) temporal lobe

stimulation leads to perception of _____

pathways leaving the auditory cortex

anterior auditory pathway - towards prefrontal cortex - _____ a sound is

posterior auditory pathway - towards parietal lobe - _____ a sound is

posterior parietal cortex

neurons in monkeys that respond to both vision and sound

integrating vision and hearing

Audition is not as extensively mapped out as vision

Damage

Lesions to auditory cortex = only temporary deafness

Long term problems with sound localization and pitch differentiation

damage to cochlea or auditory nerve = _____ deafness

loss of hair receptors

characteristic of age-related hearing loss

perception of ringing ("ringing in the ears") = _____

cutting auditory nerve from ringing ear doesn't eliminate ringing

may originate in the central nervous system

Somatosensory system

somatosensory - sensations of the body

stereognosis - identifying objects by touch

Cutaneous Receptors

principle

fast versus slow adaptation

fast are necessary for quick responses but, without adaptation, would be overwhelmed by continuous stimuli

slow are necessary for background information about continuous stimuli

Mechanoreceptors

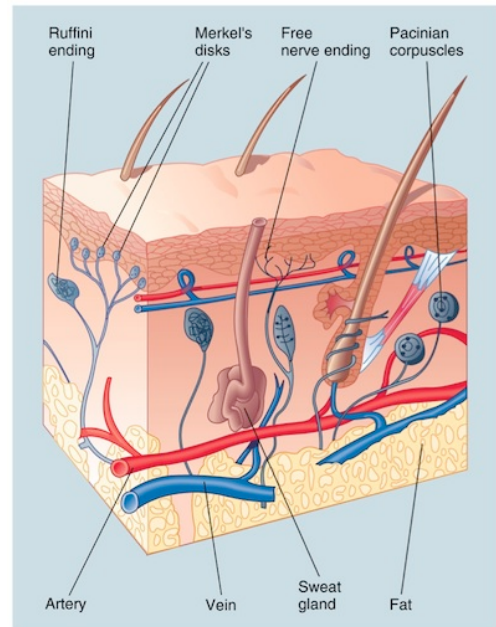
Perceive pressure, vibration (texture), stretch

Thermoreceptors

detect changes in _____
typically free nerve endings (not specialized structures)
different receptors for detecting heat and coolness

Nociceptors

noci = _____
detect stimuli that could be damaging to tissue
receptors for: extreme temperature, skin deformation, skin incision,
chemicals (capsaicin)
fast & slow conducting channels - immediate and chronic pain



Somatosensory Pathways

dermatomes

nerves from cutaneous receptors enter the dorsal route of the spinal cord
areas of the body that carry information to the same segment of the spinal cord are called dermatomes

1. dorsal-column medial-lemniscus system

information about _____
spinal cord -> ventral posterior nucleus (thalamus) ->
primary/secondary somatosensory cortex or posterior parietal cortex
3 neurons from toe to cortex

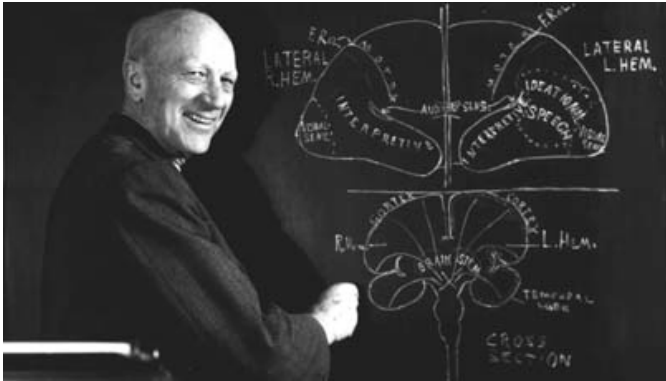
2. anterolateral system

information about _____
3 different tracts to different areas of the brain

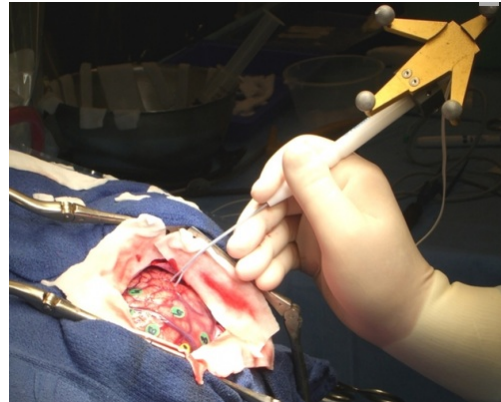
lesions of spinothalamic tract reduce sensitivity to _____

lesions of spinoreticular tract relieves _____

Somatosensory Cortex



Source: <http://www.mcgill.ca/about/history/more-history/firsts/1950>



Source: <http://www.isis-robotics.com/en/references.html>

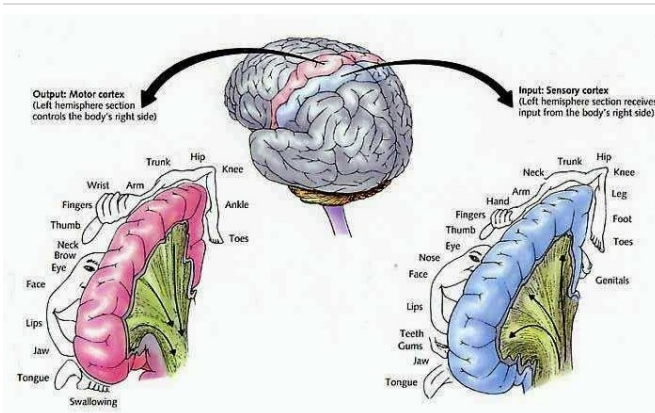
1937 - Dr. Wilder Penfield electrically stimulates the cortex of patients
finds an area that produces sensations through out the body
somatosensory cortex

_____ organization

areas of the body that are close together are represented close together in the brain
like retinotopic and tonotopic

somatosensory _____

a "little man", or representation of the body in the somatosensory cortex
larger areas of cortex dedicated to areas of the body with greater sensitivity



Source: <http://daphne.palomar.edu/rmorrissette/physio/studentwebpages/>

contralateral input to primary somatosensory cortex

the _____ side of the brain receives input from only the _____ side of the body (and vice versa)

secondary somatosensory cortex

just ventral to primary somatosensory cortex

receives input from both sides of the body

receptive fields

excited by stimulus to a given area on the body

inhibited by stimulus to the surrounding areas

cortical organization

columns (moving down from the surface) - all neurons tend to respond to same area of body

strips (moving across the surface) - different stimulus types: touch, temperature, pain

posterior parietal cortex

receives information from both primary and secondary cortex

we already learned: also receives input from visual and auditory cortex

contains _____ neurons that response to two senses, like vision/touch

for a given neuron, the visual field "moves" to stay with corresponding part of the body

case study: W.M. - using your hand to improve visual attention

this area of the brain _____ information for different senses

Chemical sense

the "oldest sense"

even single cell bacteria can sense chemicals in their environment

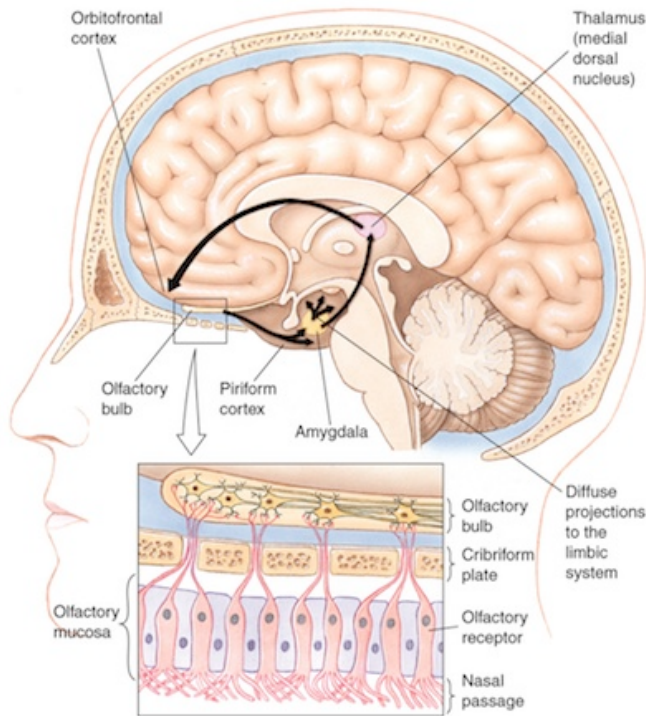
_____ - smell, detecting chemicals in the air

_____ - taste, detecting chemicals in the oral cavity

_____ - the combination of smell and taste

_____ - chemical signals to other members of the species

Olfactory System



chemicals are detected by receptors on the membrane of dendrites in the nose

humans have _____ distinct receptor proteins
neurons typically have a single receptor type
odors activate multiple receptors

olfactory pathway

receptors ->

olfactory bulb ->

inputs are grouped by similar receptor type

piriform cortex / amygdala ->

~primary olfactory cortex

retinotopic, tonotopic, somatotopic -> smellotopic?

no known principle for how odors are organized across

olfactory bulbs (no such thing as "smellotopic")

_____ - the birth of new neurons

olfactory receptors are replaced every few weeks

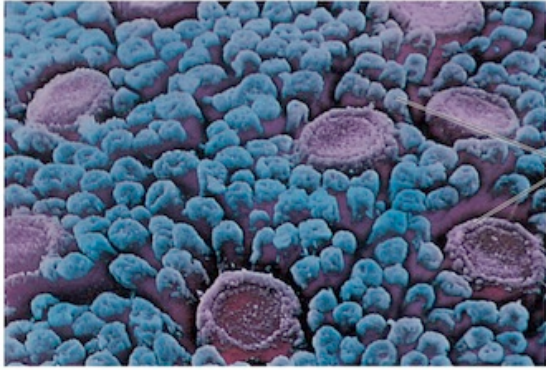
grow axons to the correct place in olfactory bulb

one of the few brain areas with noticeable

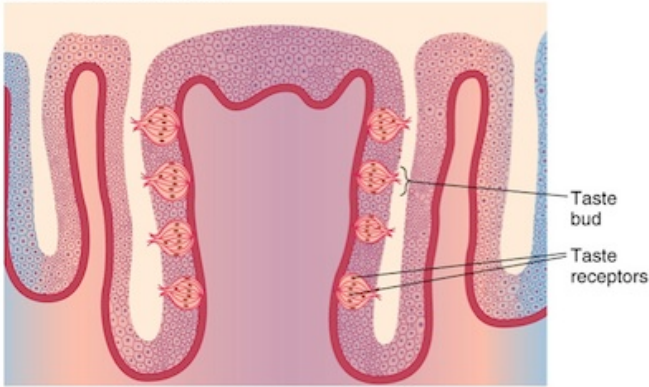
neurogenesis

Gustatory System

Surface of Tongue



Cross Section of a Papilla



_____ - clusters of approximately 50 taste receptors

taste receptors

do not have axons

many taste receptors pool to an output neuron

33 receptor proteins identified

conventional tastes

1. sweet - _____, 2 known receptors

2. sour - _____, influence ion channels directly

3. bitter - 30 known receptors

4. salty - _____, influence ion channels directly

5. unami - _____, 1 known receptor

pathway

leave tongue along 4 different nerves ->

(thalamus) ventral posterior nucleus ->

primary gustatory cortex (near somatosensory cortex)

&

secondary gustatory cortex (inside lateral fissure)