KINESIOL 1Y03

20: Olfaction & Taste

Sense Classification

general: receptors are distributed over large parts of the body

- ***somatic***: *skin, muscles, and joints (touch, pressure, proprioception, temperature, pain)*
- ***visceral***: *internal organs (pain, pressure)*

special: receptors are located within specific organs (smell, taste, sight, hearing, balance)

sensory receptors: interpret environmental stimuli to create electrical signals

- ***mechanoreceptors***: *compressing, bending, and stretching of cells; typically mechanically gated ion channels; touch, pressure, proprioception, hearing, balance*
- ***chemoreceptors***: *chemicals attach to receptors on the membrane; can bind to ligand gated ion channels or set off signaling cascade; smell, taste*
- ***thermoreceptors***: *respond to changes in temperature; proteins embedded within plasma membrane change shape with temperature, which opens gates*
- ***photoreceptors***: *respond to light; vision*
- ***nociceptors***: *respond to extreme mechanical, chemical, or thermal stimuli; pain*

Nose Anatomy

nasal cavity: in facial region of the skull; made of bones and cartilage

- ***hard palate***: *inferior; separates nasal and oral cavities*
- ***frontal bone***: *covers forehead and frontal region of brain*
- ***ethmoid bone***: *roof of nasal cavity*
- ***nasal conchae***: *ridges along the sides*

cribriform plate: thin region of ethmoid bone with foramina, which allows nervous signals to move from nasal to cranial cavity

nostrils: also known as nares; separated by the septum

Olfactory Region

olfactory nerve fibers: run through cribriform plate

olfactory bulb: olfactory nerve fibers synapse with the second neuron

olfactory tract: axons exiting olfactory bulb bundle together (yes, it's still called a tract, but it's PNS); runs to the brain

olfactory epithelium: layer of epithelial cells with specialized receptor cells embedded within

Olfactory Epithelium

olfactory neuron: specialized bipolar receptor cells, whose dendrites extend towards the nasal cavity

- ***olfactory vesicle***: *enlarged region of olfactory neuron dendrite*
- ***olfactory hairs***: *cilia on the end of the olfactory vesicles: where the chemoreceptors are located*
- ***mucus layer***: *covers vesicles and hairs; odorants dissolve into this layer so that they can bind to the receptors; mucus producing glands are found in the connective tissue layer*

epithelial cells: supporting cells; help hold neurons in place

basal cells: involved in regenerating the epithelium and neurons; all cells are replaced about every 2 months

Olfactory Function

pathway: odorant > air > nostrils > nasal cavity > nasal conchae (swirl air to get rid of debris and move air to receptors) > mucus > hairs > chemoreceptors > open gates > produce GP > produce AP on bipolar neuron > through cribriform > kind of bundle > olfactory bulb > olfactory tract > brain (primary and secondary olfactory areas)

primary olfactory area: olfactory cortex; conscious perception of cell; frontal and temporal lobes

secondary olfactory area: deep region near corpus callosum; visceral and emotional reactions to smell; connected to the habenula

thalamus: it does NOT go here (smell is the only sense that bypasses the thalamus)

odor classes: based on chemicals with similar shapes and structures, which therefore activate a specific pattern of receptors; up to 50 classes

- ***camphoraceous***: *mothball (camphor tree)*
- ***musky***: *animal mating (colognes)*
- ***floral***: *...flowers*
- ***pepperminty***: *...peppermint (candy canes !)*
- ***ethereal***: *fruity (sweet)*
- ***pungent***: *strong stink*
- ***putrid***: *rotting smell*

receptors: there are ~1000 types of olfactory chemoreceptors; the pattern of activated chemoreceptors is what makes a certain scent

adaptation: when there are lots of odorants, the receptors are fully saturated, and the brain can signal for synaptic inhibition if it doesn't want to hear about the stink anymore

Oral Anatomy

gustatory receptors: located mostly on tongue, but also the roof of the mouth, throat, and the lips

epiglottis: posterior portion of tongue, deep within throat; structure that covers the windpipe when swallowing

papillae: small epithelial projections covering the tongue

- ***vallate***: *largest; 8-12 big bumps forming a V shape at the posterior of the anterior tongue; 100-300 taste buds in each*
- ***foliate***: *leaf-shaped; side of the tongue; smaller than vallate but more in number; degenerate with age (maybe all gone by adulthood); most sensitive taste buds*
- ***fungiform***: *resemble mushrooms; surface of tongue; most taste buds are here; ~5 taste buds in each*
- ***filiform***: *flame-shaped; surface of tongue; no taste buds, but creates a rough surface to manipulate food*

taste buds: receptors; found inside the pocket formed by papillae; about 10,000 in total

oral cavity: covered in stratified squamous epithelium, with taste buds embedded within

Taste Buds

gustatory cells: create nervous system signal

- ***gustatory hairs***: *microvilli which extend through an opening in the epithelium, towards the oral cavity; about 50 per taste bud*
- ***cell body***: *there is NO AXON; they're so short they don't need it, since the GP reaches right to the end of the cell and releases NT through the synaptic vesicles*

supporting cells: help hold in place

basal cells: help regenerate; taste cells are regenerated about every 10 days

Gustatory Function

pathway: tastant > saliva > receptors > depolarization > NT > EPSP created > CN VII (anterior tongue), IX (posterior tongue), and X (throat and epiglottis) > medulla oblongata > thalamus > taste area of insula

5 tastes: salt, sour, bitter, sweet, and umami; each has its own receptor type

- ***ion channels***: *salt has sodium and sour has hydrogen; these ions go through channels and cause depolarization*
- ***G-protein signaling pathways***: *for bitter, sweet, and umami; activating these pathways opens relevant ion channels*

variety: each taste cell has one type of chemoreceptor, but each taste bud can have multiple types (usually with one favorite)

summary sheet by Jasmine Ah Yong for KINESIOL 1Y03 (2022)

KINESIOL 1Y03

21: Vision

Accessory Structures

eyebrows and eyelashes: protect from foreign objects and perspiration; shade from sun
palpebra: eyelid; there is one superior and one inferior per eye
palpebral fissure: opening of the eye
canthus: where the palpebrae meet
- ***medial***: *contains the lacrimal caruncle (pink mound), which contains modified oil and sweat glands that produce eye poop*
- ***lateral***: *...the other one*

conjunctiva: mucus membrane forming the inner lining of the eyelid; folds back on itself; attaches at the palpebral fissure; prevents objects from entering eye
- ***palpebral conjunctiva***: *covers eyelid*
- ***bulbar conjunctiva***: *covers white of eye*
- ***conjunctivitis***: *inflammation; response to irritants (bloodshot eyes) or bacterial infection (pink eye)*

lacrimal apparatus: collection of structures involved in tear production
- ***pathway***: *lacrimal gland (production) > lacrimal ducts (distribution) > mostly evaporates but also moves medially and laterally > medial commissure > puncta (opening on upper and lower eyelids) > lacrimal canaliculi (superior and inferior pathways) > lacrimal sac (tears are drained...) > nasolacrimal duct (...into the nasal cavity)*

Extrinsic Muscles

rectus muscles: attached to anterior portion of sclera, and extend to the posterior of the socket (orbit) where they attach to the bone
- ***superior rectus***: *superior and medial*
- ***inferior rectus***: *inferior and medial*
- ***lateral rectus***: *lateral*
- ***medial rectus***: *medial*

oblique muscles: involved in the rotation of the eye
- ***superior oblique***: *inferior and lateral*
- ***inferior oblique***: *superior and lateral*

Fibrous Tunic

fibrous tunic: white of the eye
sclera: posterior region; tough, thick connective tissue which helps maintain shape and provide point of attachment for extrinsic muscles; provides protection
cornea: anterior region; transparent curved structure for focusing light; avascular; covers anterior 1/6 of eye

Vascular Tunic

vascular tunic: contains lots of blood vessels and melanin
melanin: pigment which makes the inside of the eye appear black; stops light from reflecting around the eye and improves visual acuity
choroid: posterior region; rich blood and melanin supply
ciliary body: smooth muscles; change shape of lens
- ***ciliary ring***: *formed by the ciliary muscles, wrapping all the way around the lens*
- ***ciliary processes***: *attach via zonular fibers (suspensory ligaments) to the lens; also produces fluid for the posterior chamber*
- ***at rest***: *large diameter; lens is flattened by tension on zonular fibers*
- ***contracted circular***: *small diameter; lens bounces back to spherical shape*

iris: colored portion of eye; smooth muscles anterior to ciliary processes; change pupil diameter (partially covers lens based on contraction state of iris and dilation of pupil)
- ***sphincter pupillae***: *circular muscle; contracts as a parasympathetic response to bright light*
- ***dilator pupillae***: *radial muscle; contracts as a sympathetic response to dim light*

smooth muscle: (for both ciliary and iris): outer muscles are oriented radially, and inner muscles are oriented circularly

Nervous Tunic

retina: posterior portion up to the level of the ciliary body; contains photoreceptors (rods and cones) and vasculature
cones: color vision and visual acuity; about 6-7 million cones
rods: black and white vision, and low light conditions; about 120 million rods (mostly peripheral)
macula lutea: dark central region of retina; contains mostly cones; great visual acuity, so we want to focus light here (why we see most clearly when looking directly)
- ***fovea centralis***: *small depression in the middle; contains only cones*

optic disc: blind spot; hole in retina for the optic nerve and retinal blood supply to enter the eye; your brain normally fills in the image (binocular vision)
pigmented layer: cells with melanin form a black matrix, decreasing light scattering and increasing visual acuity; adheres closely to choroid; more superficial
neural layer: deeper layer
- ***photoreceptor layer***: *rods and cones*
- ***bipolar layer***: *neuron cells; synapses here*
- ***ganglionic layer***: *synapse with optic nerve (~1 million cells)*

Specialized Structures

lens: biconvex; solid but transparent tissue; just deep to the pupil
- ***clarity***: *has no internal structures, because it develops organelles but then triggers self-destruct, yet manages to stop killing itself right before it actually dies; ergo, it is clear and there is no scattering of light rays*
- ***current research***: *attempting to apply prevented cell death to diseases of programmed cell death (Alzheimer's, Parkinson's, etc.)*

pupil: opening; looks black due to the melanin in the choroid layer behind it

Chambers

anterior chamber: between cornea and iris
posterior chamber: between iris, lens, and suspensory ligaments
aqueous humor: fluid produced by ciliary processes which fills the anterior and posterior chambers; maintains interocular pressure and shape of eye, provides nutrients for cornea and lens, and helps with refraction of light as it enters
- ***turnover rate***: *~90 minutes (high)*
- ***glaucoma***: *build up of aqueous humor due to sinus blockage; increase in interocular pressure can cause blindness if untreated*
- ***flow***: *ciliary processes > posterior chamber > pupil > anterior chamber > sinus*

vitreous chamber: at the back of the eye
vitreous humor (body): jelly-like substance; helps keep shape of eye and holds the retina flat against the choroid to produce clear images
- ***turnover rate***: *slow*
- ***"floaters"***: *debris in visual field; cells die, and normally phagocytes deal with them, but they become less efficient as you age*

Focus and Acuity

refraction: bending of light at the junction of two transparent substances of different densities
- ***pathway***: *cornea > anterior chamber > lens > vitreous body > retina (where it's hopefully very focused for the photoreceptors)*
- ***function***: *light rays need to focus on macula*
- ***focal point***: *convergence of light information from top and bottom, to focus on the macula*
- ***retinal image***: *inverted, but our brain un-inverts it (in the 1800s, they used inversion glasses, and after 4 days, the brain overcame that)*

distant vision: rays enter in an almost parallel fashion; ciliary muscles are relaxed and lens is wide
- ***far point of vision***: *~20 ft.*

near vision: rays are really divergent, so they have to bend a lot; circular ciliary muscles contract to make a round lens that refracts light more
- ***near point of vision***: *4-6" (farther as you age)*

Focal Adjustments

accommodation: ciliary muscles contract > spherical lens > refraction > focus
pupil constriction: impacts depth of focus (smaller pupil = deeper field)
- ***squinting***; *helps focus by decreasing light information*
- ***low light***: *pupil dilates to let more light in, causing some loss of focus*

convergence: there are regions on the left and right retina that the brain detects as the same location on the visual field
- ***far vision***: *naturally hits correctly*
- ***near vision***: *need to rotate eyes medially; otherwise, the image is blurry*

Photoreceptors

photoreceptors: bipolar neurons with modified dendrite ends to detect light
rods: uses rhodopsin (photosensitive pigment)
- ***opsin***: *protein*
- ***retinal***: *pigment (made of Vitamin A. carrots are good for your eyes.)*

cones: uses iodopsin (also known as photopsin)
- ***opsin***: *have specialized proteins for red, blue, or green light detection*
- ***retinal***: *pigment (made of Vitamin A. carrots are good for your eyes.)*

plasma membrane: contains photosensitive molecules; folds on itself near the pigmented retina to form discs and maximise area

Neuron Function

sodium gated channels: linked to photoreceptors; can create electrical signal
unstimulated condition: gates held open (depolarized) by cGMP; retinal molecule is bent (inactive); opsin is in dark condition
stimulated condition: retinal is straightened (active); opsin is in light condition; phosphodiesterase is activated, converted cGMP to GMP; channels are closed and hyperpolarized
return to rest: active retinal detaches from opsin protein; phosphodiesterase inactivates; cGMP reforms; channels open; inactive retinal reattaches to opsin
glutamate: neurotransmitter constantly released at rest; causes an IPSP in the bipolar cell

Visual Fields

temporal field: lateral regions (closer to ear)
nasal field: medial regions (closer to nose)
retina: receives crossed-over information from temporal and nasal fields
optic nerve: formed by convergence of neurons in retina
optic chiasm: formed by convergence of optic nerves
optic tract: sides of each visual field go to the opposite side of the brain (e.g., right temporal and left nasal go to the left)
destination: superior colliculi (midbrain) or lateral geniculate nuclei (thalamus) > occipital lobe > primary visual cortex

Pathways

bending pathway: cornea > aqueous humor > lens > vitreous body > retina
light pathway: back of eye > photoreceptors > AP generated > reverses back to optic nerve
neuronal pathway: optic chiasm > around brainstem > lateral geniculate nuclei > optic radiations > primary visual cortex

KINESIOL 1Y03

22: Hearing & Balance

Acoustics

sound: interpretation of vibrations through air, based on bands of compressed and non-compressed air
peak of soundwave: most compressed air
amplitude: volume (bigger amplitude = louder)
frequency: pitch (higher frequency = higher pitch)

External Ear

auricle (pinna): flap collecting soundwaves and directing them towards the middle ear
external auditory canal: channel leading to the middle ear; starts as a soft tissue with cartilage embedded; becomes a canal in the temporal bone

***cerumen**: ear wax; prevents dust and foreign objects from entering, and prevents water damage*

tympanic membrane (eardrum): separates external and middle ear; thin, delicate membrane which vibrates when soundwaves reach it

Middle Ear

cavity: filled with air; equal pressure allows tympanic membrane to vibrate

***auditory (eustachian) tube**; opening in tissue which connects to the back of throat; allows measure in middle ear to be equal to external ear*
***balance**: unequal pressure would tighten the membrane, preventing vibrations*
***ear popping**: occurs when this tube becomes blocked, so pressure is unequal; can be fixed by increasing pressure in the oral cavity*
***problems**: fluid build up, infection, etc. can interfere with ossicle function*

auditory ossicles: small bones connected to each other with small synovial joints; amplify the soundwave from the tympanic membrane

***malleus**: shaped like a mallet with handle connected to tympanic membrane and head connected to the incus*
***incus**: shaped like an anvil*
***stapes**: looks like a stirrup; the footplate covers the oval window*

Inner Ear

cavity: fluid filled
cochlea: long tube that rolls in on itself (like a conch shell); portion of the ear involved in hearing; deep within temporal bone

***helicotrema**: end of the tube*

oval window: opening from middle ear; connects to cochlea; has a membrane to prevent movement of fluid and air between middle and inner
round window: membrane-covered opening that serves as an exit point for vibrations (to avoid echo)
vestibule: trunk structure involved in static balance
semi-circular canals: three loops, one in each plane (x, y, z); involved in dynamic balance
vestibulocochlear nerve: branches out to cochlea (cochlear branch) and vestibule and semi-circular canals (vestibular branch)
bony membrane: cored out region of the temporal bone
membranous labyrinth: membranes divide the cored out region to make chambers for different types of fluids (with different ion concentrations) and functions

***dynamic (kinetic) labyrinth**: another name for th membranous labyrinth in the semi-circular canals*
***cochlea**: divided into 3 chambers*

Cochlear Structure

endolymph: fluid inside labyrinth; high [K+] and low [Na+]
perilymph: fluid between the bony and membranous labyrinth; high [Na+] and low [K+]
scala vestibuli: top chamber; filled with perilymph; attached to oval window
scala tympani: lower chamber; filled with perilymph; attached to round window
helicotrema: connects scala vestibuli and tympani
cochlear duct: inner chamber; filled with endolymph

***vestibular membrane**: thin membrane separating cochlear duct and scala vestibuli*
***basilar membrane**: thicker membrane where specialized cells are located*

spiral organ (organ of Corti): where the epithelium and receptors are located
hair cells: receptors; organized in rows

***3 outer rows**: monitor tension on the basilar membrane; bottom of cell moves and activates mechanoreceptors*
***inner row**: detects sounds*

Hair Cells

cochlear nerve: connected to hair cells; hair cells are short enough to not require an axon
stereocilia: MICROVILLI located at top of hair cell; bundled in order of height; when the basilar layer moves, the microvilli lean towards the taller ones
tip-links (gating springs): physical connection between stereocilia and its neighboring taller one; this is attached to a K+ ion channel (endolymph has very high [K+]) and leads to depolarization
tectorial membrane: gelatinous membrane that holds the hair cells (does not cover entire epithelium)

Aural Perception

pitch: based on which hair cells are activated; basilar membrane is tighter at the oval window and looser at the helicotrema

***high pitch**: closer to oval window (think of this like flute tubes or guitar strings)*
***low pitch**: closer to helicotrema*

volume: based on how many hair cells are stimulated

Aural Pathways

hearing escape: soundwave > auricle > canal > tympanic membrane > ossicles > oval window > ***scala vestibuli > cochlear duct > helicotrima > scala tympani > round window > gone***
hearing sense: soundwave > auricle > canal > tympanic membrane > ossicles > oval window > ***vestibular membrane > endolymph > basilar membrane > stereocilia > [K+] gated channels open; K+ rushes out of endolymph > depolarization***
neuronal; depolarization > releases NT > cochlear nerve > cochlear nuclei (medulla oblongata) for pitch perception > may send back to basilar membrane to dampen loud sounds > ***superior olivary nucleus (medulla oblongata)***
neuronal 2: depolarization > releases NT > cochlear nerve > cochlear nuclei > may send back to basilar membrane for dampening > ***inferior colliculus (midbrain) for auditory reflexes > medial geniculate nucleus (thalamus) > primary auditory cortex (temporal lobe)***

Static Equilibrium

static equilibrium: position of head relative to the ground (upright, tilted, etc.)
vestibule: between cochlea and semi-circular canals
utricle: typically horizontal plane
saccule: typically vertical plane
maculae: from both utricle and saccule; contains specialized hair cells surrounded by supporting cells
- ***otolithic membrane***: *gelatinous membrane for these hair cells*
- ***otoliths***: *crystalized structures which add mass to the membrane so it moves with gravity*
- ***pathway***: *depolarization > synapse with vestibular branches > brain (subconscious perception for subtle back and neck adjustments)*
- ***stereocilia***: *make up the hair cells (same tip-links as hearing)*
- ***kinocilium***: *ACTUAL cilia; tall structure at tip of stereocilia*

Dynamic Equilibrium

dynamic equilibrium: concerns where we are moving; acceleration and direction
semi-circular canals: filled with membranous labyrinth (endolymph)
ampullae: enlarged regions at the base of each canal
semi-circular ducts: contain endolymph inside ampullae
cristae ampullaris: specialized curved epithelial layer (comprises hair and surrounding cells); hairs join to vestibular nerve fibers
- ***cupula***: *structure floating in the labyrinth; as it moves, it tilts the hair bundles and opens the tip links*
- ***acceleration***: *cupula moves in opposite direction of actual movement*
- ***deceleration***: *cupula moves in same direction as previous movement*
- ***equilibrium***: *cupula returns to resting position*

motion sickness: caused by looking at something stationary while actually moving; vestibular and visual systems are in conflict
pathway: vestibular nerve > vestibular nuclei (medulla oblongata) > cerebellum, motor nuclei (control eye muscles), and thalamus (> vestibular area of cortex in post-central gyrus)

KINESIOL 1Y03

III: Cranial & Senses

CN Assessments

I: olfactory nerve: not generally clinically assessed; if suspected, try to identify familiar scents

taste: *olfactory receptors are much more sensitive than taste receptors, so much of "taste" comes from smell*

II: optic nerve: sensory (vision); optic disc (optic nerve head) can be seen with an ophthalmoscope (magnifier with light); retina and vitreous humor can be viewed by using drops which dilate the pupil

III: oculomotor nerve: motor; somatic extraocular muscles and parasympathetic innervation of papillary sphincter (constriction of pupil)

vision test: *shine a penlight into the eye; watch the pupil constrict*

blind spot identification: *uses two points; cover one eye, and move the paper closer/farther until one point disappears*

presbyopia: *condition of lens elasticity loss (>9" near point of accommodation); corrected with reading glasses*

visual acuity: *tested with eye chart; <1 is myopic, >1 is better than normal; (20/15 = you can see at 20ft clearly something the average person can see at 15ft)*

astigmatism: *bend in the cornea or lens*

color blindness: *caused by deficiency in a certain cone*

depth perception: *product of binocular vision*

lazy eye: *amblyopia; lack of syncing between eye and brain as a developmental problem; corrected with an eyepatch to force the lazy eye to work*

IV: trochlear nerve: tested by visually tracking an H shape

V: trigeminal nerve: motor and sensory functions keep food in the bite zone when chewing

jaw contraction: *if you touch your jaw and clench your teeth, you can feel the contraction*

skin pressure: *should be able to determine where you are being poked in the face*

VI: abducens nerve: controls lateral rectus

VII: facial nerve: facial expression and taste in anterior 2/3 of tongue

Bell's palsy: *drooping in half the face*

VIII: vestibulocochlear nerve: equilibrium and audition

balance test: *hinge at the waist to pick up two pennies from the ground*

tuning fork: *determine where sound is coming from around you*

otoscope: *can be used to see tympanic membrane*

Hearing Loss

conductive: failure in the outer ear, tympanic membrane, or middle ear

sensorineural: failure in CN VIII, inner ear, or central processing centers of the brain

Weber test: sound from vibrations on top of the head localizes to normal ear for sensorineural, but localizes to affected ear for conductive

hypothetical reason 1: *there is decreased ambient noise if there is a blockage*

hypothetical reason 2: *due to the blockage, sound can't escape, amplifying it*

More CN Assessments

IX: glossopharyngeal nerve: pharyngeal muscles and salivary glands; taste in back of tongue; tested with CN X

X: vagus nerve: parasympathetic innervation of heart and abdominal organs

gag reflex test: *touch a cotton swab to the back of the throat or uvula*

nausea: *vagus provides sensory innervation to auditory canal; links nausea to foreign objects in ear*

XI: accessory nerve: sternocleidomastoid (neck rotation) and trapezius (shoulder raising) muscles

XII: hypoglossal nerve: tongue muscles; stick out tongue, move it around, shape it weirdly, speak clearly

Cow Eyes

aqueous humor: comes out from an incision between sclera and cornea; more liquid

optic nerve: on the posterior side, it enters the eye from the inferior lateral side

lens: clear ball; magnifies vision

vitreous humor: gelatinous

retina: white membrane overlying choroid layer; milky and thin

choroid: appears iridescent in many animals (tapetum lucidum); light focusing adaptation for night vision

optic disk: region on posterior of eye; where optic nerve is

Reflexes

reflex arc (SS[L]IME): sensory receptor > sensory neuron > interneuron (only for polysynaptic) > motor neuron > effector organ

somatic reflex: controls skeletal muscles (e.g., moving away from stimuli)

autonomic reflex: controls smooth and cardiac muscle (e.g., maintains homeostasis)

monosynaptic reflex: input > synapse 1 > output

polysynaptic reflex: input > synapse 1 > interneuron > synapse 2 > output

patellar reflex: monosynaptic stretch reflex; can test L2-4 and femoral nerve by tapping on patella

conduction rate: *strength of tap, temperature, etc. impact reflex strength*

fatigue: *physical exhaustion and motor neuron damage may also weaken reflex strength*

mental distraction: *no impact on reflexes*

withdrawal reflex: polysynaptic reflex; pain receptors > sensory neurons > interneuron > motor neuron > remove limb from painful stimulus

Equilibrium

static equilibrium: head position vs. gravity; determined by the macula of the utricle and saccule

gelatinous (otolithic) membrane: *jelly mass which moves with gravity; moves the macula as well*

dynamic equilibrium: movements of the head; determined by the cupula inside the ampulla

seasickness: caused by a loss of equilibrium, since vestibular and visual information is out of sync

intoxication: drunkenness can be assessed by walking in a straight line; alcohol inhibits integration of somatic, sensory, and visual information, which is not great for posture and balance