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9.01 Introduction to Neuroscience
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9.01 Recitation
Section 1 (Mondays)

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medial v. lateral

lateral - structures farther from the midline

medial - structures closer to the midline

i.e. the eyes are more medial than the ears

ipsilateral v. contralateral

contralateral - two structures on different sides

ipsilateral - two structures on the same side

i.e. the right ear is ipsilateral to the right eye

Central Nervous System:

- cerebrum (cerebral hemispheres divided by sagittal fissure; right hemisphere controls left side of body, vice versa)
- cerebellum (as many neurons as the cerebrum; movement control center; extensive connections with cerebrum and spinal cord; left side of cerebellum controls left side of body, right controls right)
- brain stem (relays information from spinal cord to cerebrum and cerebellum; regulates vital functions; most primitive part of brain, most vital to life)
- spinal cord (encased in vertebrate column; communicates with body via spinal nerves, which attach to cord via dorsal root or ventral root)
 - dorsal root (sensory information)
 - ventral root (motor information)

Peripheral Nervous System

- somatic PNS (all spinal nerves that innervate skin, joints, muscles under voluntary control)
- visceral PNS (aka autonomic nervous system; neurons that innervate internal organs, blood vessels, glands)

afferent v. efferent

afferent means "carry to" a particular point

efferent means "carry from" a particular point

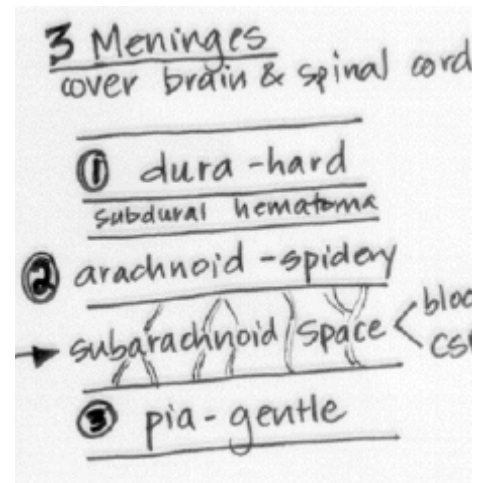
if the point is the CNS, then afferents are nerve cells that bring information from the PNS to the CNS, and efferents take information away from the CNS to the PNS

Cranial Nerves (12 nerves that arise from brain stem and innervate mostly the head; see page 233)

- mnemonic for nerve names: on old Olympus towering tops, a Finn and German viewed some hops
- mnemonic for function (sensory, motor, or both): some say money matters, but my brother says big brains matter more

The Meninges covers the brain and spinal cord

- dura mater
the outermost layer, "hard mother," tough inelastic bag
- arachnoid membrane
appearance and consistency of spider web; normally no space between dura and arachnoid - blood vessels rupture, and blood collects → subdural hematoma
- pia mater
"gentle mother," thin membrane covering the brain; separated from arachnoid by fluid filled space



Ventricular System fluid filled spaces in the brain

Cerebrospinal fluid is made in the choroids plexus → lateral ventricles → third ventricle → cerebral aqueduct → fourth ventricle → subarachnoid space where CSF is absorbed by blood vessels

Imaging (pages 175 to 176; CT, MRI, PET, fMRI)

CNS Development, Cerebral Cortex (pages 178 to 199)

Review Questions for Ch. 7:

- 1) You wish to disturb communication between the left and right cerebral hemispheres yet leave the hemispheres intact. To do this you would bisect the _____ using a _____ cut.
 - a) thalamus, coronal
 - b) internal capsule, midsagittal
 - c) corpus callosum, coronal
 - d) corpus callosum, midsagittal
- 2) During back surgery, a sloppy surgeon accidentally snips a bundle of nerves just as they exit the back side of the spinal cord (medial to the spinal nerve). Which is the most likely consequent of his mistake?
 - a) loss of sensation in the left leg
 - b) loss of movement in the right leg
 - c) loss of movement on the left side of the face
- 3) Visceral sensory axons of the PNS carry what type of information:
 - a) blood pressure information in the arteries
 - b) positional information of joints and limbs in space
 - c) motor commands to the skeletal muscles
 - d) contraction/relaxation commands to the artery walls

- 4) In a normal individual, which of the following spaces are filled with cerebrospinal fluid (CSF)?
- the subdural space
 - the 3rd ventricle
 - the subarachnoid space
 - All of the above are correct
 - Both a and b are correct
 - Both b and c are correct
- 5) The cerebellum is an area of the brain involved in, among other things, fine motor control. This tissue is derived from which primary vesicle of the neural tube?
- prosencephalon
 - mesencephalon
 - rhombencephalon
- 6) All nervous tissue develops from the walls of the neural tube. (True or false?)
- 7) The olfactory bulbs differentiate from the _____ encephalon, while the optic vesicles differentiate from the _____ encephalon.
- 8) CSF generated in the lateral ventricles flows through the remaining ventricles in what sequence:
- lateral → cerebral aqueduct → 3rd → 4th
 - lateral → 3rd → 4th → cerebral aqueduct
 - lateral → 2nd → cerebral aqueduct → 3rd
 - lateral → 3rd → cerebral aqueduct → 4th
 - None of the above
- 9) What area of the brain serves as a relay nucleus (a synapse stop) between the sensory axons and the cortex _____? What area of the brain is the relay nucleus between the cortex and the cerebellum _____?
- 10) Cell bodies of the nerves found in the ventral roots of the spinal nerves are located in the:
- PNS
 - CNS
 - In the ventral root ganglia
- 11) The medullary pyramids are made up of white matter. (True or false?)
- 12) The primary somatic sensory cortex is _____ to the primary motor cortex.
- rostral
 - caudal
 - anterior
 - posterior
 - a and c
 - b and d
- 13) The diencephalon develops into the:
- thalamus
 - retina
 - pons
 - hypothalamus
 - a, b, and d
 - a and d

Answers:

- | | | |
|------|---------------------------------|----------|
| 1) d | 6) false | 11) true |
| 2) a | 7) telencephalon / diencephalon | 12) f |
| 3) a | 8) d | 13) e |
| 4) f | 9) thalamus / pons | |
| 5) c | 10) b | |

Chapter 9 Review - VISION

The Big Picture

Visual stimuli → eye (photoreceptors → bipolar cells → ganglion cells) → optic nerve (chiasm, tract) → LGN (thalamus, a relay station for the sense) → primary visual cortex → parietal and temporal visual areas

Anatomy of the Eye

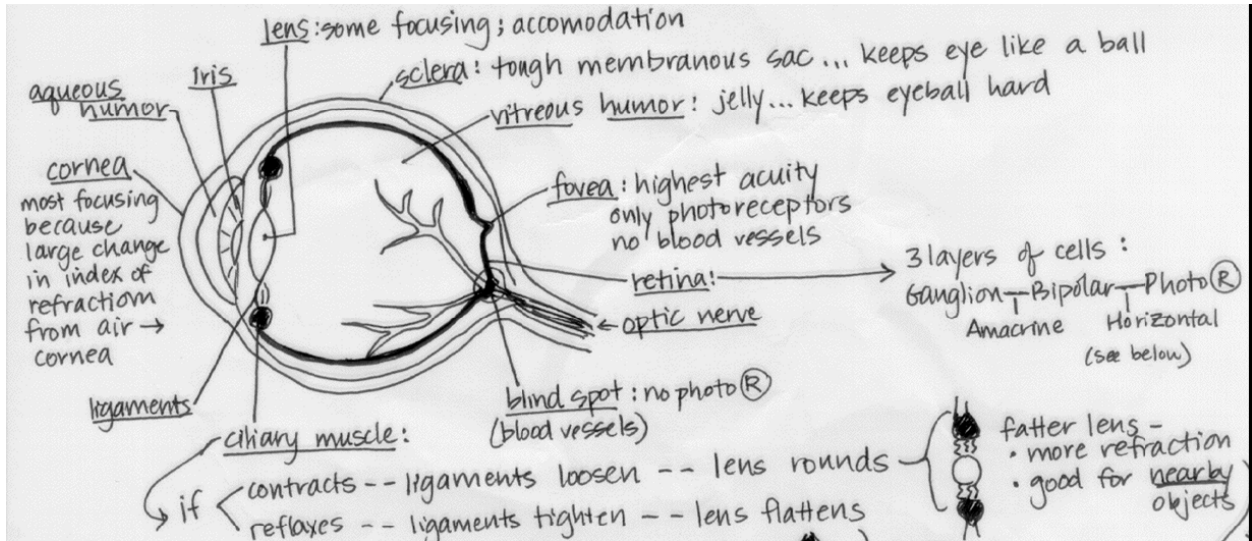


Image Formation by the Eye

Refraction by the Cornea

- Refraction is the bending of light rays that occur when light moves from one transparent medium to another; bends toward a line that makes it more perpendicular to the surface
- When parallel rays enter the eye, the curved surface of the cornea bends refracts and bends the light so that the image is focused on the retina
- Focal distance: from refractive surface to point where is converges

Accommodation by the Lens

- The cornea does most of the refraction
- The lens is important for objects closer than 9 meters
- For closer objects, light rays first diverge and require greater refractive power to bring into focus; additional power is given by change in lens
- Ciliary muscles contract (swell) → ligaments loosen → fatter lens (more refraction)
- Myopia v. hyperopia v. emmetropia

Pupillary Light Reflex

- Pupils adjust to different levels of light (more light, smaller pupil)
- Consensual - shining in light in only one eye will make both pupils constrict

Anatomy of the Retina

Pigmented cells

Rod
Cone

Retina is organized in layers - photoreceptors to bipolar cells to ganglion cells

Two types of photoreceptors: rods and cones; rods for night vision, cones for color

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Horizontal cell
Amacrine cell
Bipolar cell

The retina varies from the fovea to the periphery. Fovea: more cones, good visual acuity, low ratio of receptors to ganglion cells. Periphery: more rods; more sensitive to light; greater receptor to ganglion ratio

Ganglion cell

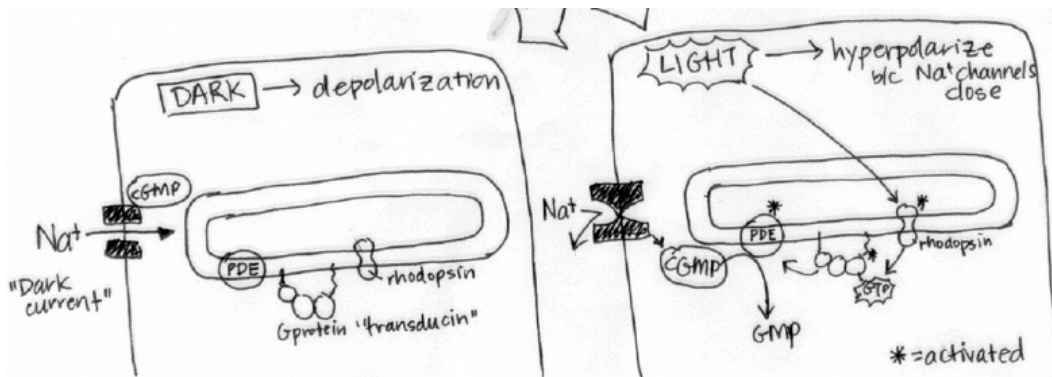
Central fovea: no rods at all

Light enters here

Phototransduction

Rods A typical neuron has a membrane potential of -65 mV. A rod has a membrane potential of -30 mV in complete darkness. There is a steady influx of sodium ions called "dark current." Sodium channels are gated by cGMP, which is produced by the enzyme guanylyl cyclase. cGMP keeps the channels open. Light reduces cGMP, causes sodium channels to close; the cell hyperpolarizes.

Mechanism: light activates the photopigment rhodopsin, which activates a G-protein, which activates phosphodiesterase, an enzyme that breaks down cGMP.



Cones cGMP levels fall in light \rightarrow when they can't fall any lower, the rods become "saturated." Phototransduction in cones is the same as in rods, except the opsins (photopigments) are different and have different sensitivities (three - long, medium, and short wavelengths - color).

Dark and Light Adaptation

Dark adaptation

- transition from day to night
- takes 20-25 minutes
- sensitivity to light increases
- pupil dilation
- rhodopsin is regenerated, begins to work again (no longer saturated)
- adjustment of circuitry - information from more rods available to each ganglion cell (higher photoreceptor to ganglion cell ratio)

Light adaptation

- transition from night to day
- takes 5-10 minutes
- when you walk into bright light, vision is temporarily saturated; rhodopsin stops working
- pupil constriction
- lower photoreceptor to ganglion cell ratio