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9.01 Introduction to Neuroscience Fall 2007

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RECITATION #4: Tuesday, October 16th

Review of Lecture: 9, 10 Reading: Chapter 9 and 10 of *Neuroscience: Exploring the Brain (3rd edition)*

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Outline of Recitation:

- I. Questions on the Exam?
- II. Review of Material: VISION
 - a. The Eye and Retina
 - Structure of the eye
 - Anatomy of Retina
 - Phototranduction
- III. Practice Exam Questions
- Receptive Fields
- Color Perception
- Visual Pathway

THE EYE AND THE RETINA:

Structure of the eye: (p283)

Diagram removed due to copyright restrictions.

- <u>pupil</u>: opening that allows light to enter the eye
- <u>iris</u>: surrounds pupil; pigmented
- <u>sclera</u>: "white of the eye"
- <u>extraocular muscles</u>: moves eyeball
- <u>conjunctiva</u>: membrane that covers extraocular muscles
- <u>aqueous humor</u>: nourishing fluid behind cornea
- lens: transparent; adjusts focus
- <u>cilliary muscles</u>: controls shape of lens
- <u>zonule fibers</u>: ligaments that suspend lens
- <u>vitreous humor:</u> lies between lens and retina; keeps eyeball spherical

View of the Retina (ophthalmoscope):

- <u>optic disk</u>: where optic nerve fibers exit retina and retinal blood vessels enter. No photo receptors (blind spot).
- <u>macula</u>: part of the retina for central vision; absence of blood vessels
- fovea: marks the center of retina

Photo removed due to copyright restrictions.

Focusing light onto the retina: (p283-288)

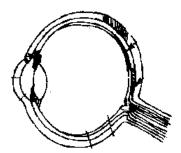
Refraction by cornea:

Accommodation by lens:

- Near point:
- Far point:

Pupillary light reflex:

Anatomy of retina: (p288-292)



Two important points:

- (1) *Photoreceptors* are the only light-sensitive cells in the retina.
- (2) *Ganglion cells* are the source of output from the retina to the brain via the optic nerve. Only cells fire AP.

Two different types of photoreceptors: (1) Rods:

Found mainly in the: *Outnumber cones 20:1

(2) Cones:

Found mainly in the:

Phototransduction: (p292-298)

Photoreceptors convert or transducer light energy into changes in membrane potential.

Dark: depolarize

Light: hyperpolarize w/ light stimulus (only OFF response)

Vm

time

Receptive Fields and Retinal Processing: (p298-306)

Receptive Field:

- the region of visual space that, when stimulated, causes a retinal neuron to respond
- the region of a sensory surface (retina) that, when stimulated, changes the membrane potential of a neuron
- point-to-point mapping
- locality of receptive fields a result of structure of cells in retina...
 - short dendrites (doesn't spread across retina)
 - center-surround receptive fields

Bipolar Cell Receptive Fields: ON bipolar cells:

OFF bipolar cells:

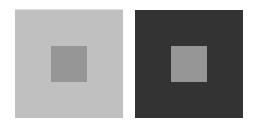
Center-surround receptive fields:

Ganglion Cell Receptive Fields:

- ON and OFF ganglion cells like bipolar cells
- Center-surround receptive fields

Ganglion cells are mainly responsive to differences in illumination that occur within their receptive fields.

- Light vs. reality (examples: illusions)
 - visual system detects reflection, not luminance
 - incident light x reflectance
 - based on context



Adaptation: (box 4.6)

Vm

time

Color perception: (p296, 304)

Young-Helmholtz trichromacy theory

Color after-effect: (example: pink/green dot illusion)

Color-opponent ganglion cells:

Center-surround receptive fields

Pathway for "conscious" visual perception: (Chapter 10) Retinofugal projection:

-----> Via the ----->

Cortical cell receptive fields:

- elongated ON and OFF sub regions
- orientation selectivity
 - preferred orientation
 - null orientation

PRACTICE EXAM QUESTIONS:

17. A strange disease, Lentifical Pancakium, results in a permanent flattening of the lenses of your eyes. This results in which of the following while you are looking at a picture in your Neuro 1 textbook?

a) Images of very close objects would be focused in front of the retina.

b) Images of very close objects would be focused behind the retina.

c) Light entering your eye would not be refracted

d) More than one of the above are correct.

18. Which of the following would cause the lens of the eye to become more round?

a) focusing on your pencil while bringing it from your nose to one arm-length away.

b) zonule fiber tightening

c) ciliary muscle contraction

- d) more than one of the above
- e) none of the above

19. In general, which of the following are true about the retina and its organization:

a) light passes through ganglion cells before photoreceptors b) only photoreceptors and horizontal cells are sensitive to light (contain photopigment)

c) only ganglion and amicrine cells project out of the eye

d) there are no cones in the peripheral retina

e) more than one of the above

20. Dark Current

a) refers to a resting membrane potential that is more hyperpolarized than that of a typical neuron

b) is due to the inward flow of Na+ caused by PDE binding to the Na+ channels

c) is due to the inward flow of Na+ caused by transducin binding to the Na+ channels

d) is a result of the activation of a Rhodopsin molecule

e) none of the above

21. Phosphodiesterase activation in a photoreceptor leads to (directly and indirectly):a) the activation of transducinb) a break down of cGMP into GMP

c) Na+ channel closing

d) Na+ channel opening

- e) B and C
- f) B and D

22. Some snakes can see infrared electromagnetic radiation (wavelengths above 700nm), why can't we?a) This energy is not present in our environment.

b) Our photopigments are not sensitive to these

wavelengths.

c) We do not have a cortical area that can process this information.

d) It would turn us red and drive us insane.

23. Under prolonged scotopic light conditions:

a) your rods saturate and can't hyperpolarize anymore

b) your cones saturate and can't depolarize anymore

- c) rod hyperpolarization correlates with the light intensity
- d) you will be forced to tear up this exam and eat it

Answers: b, c, a, e, e, b, c