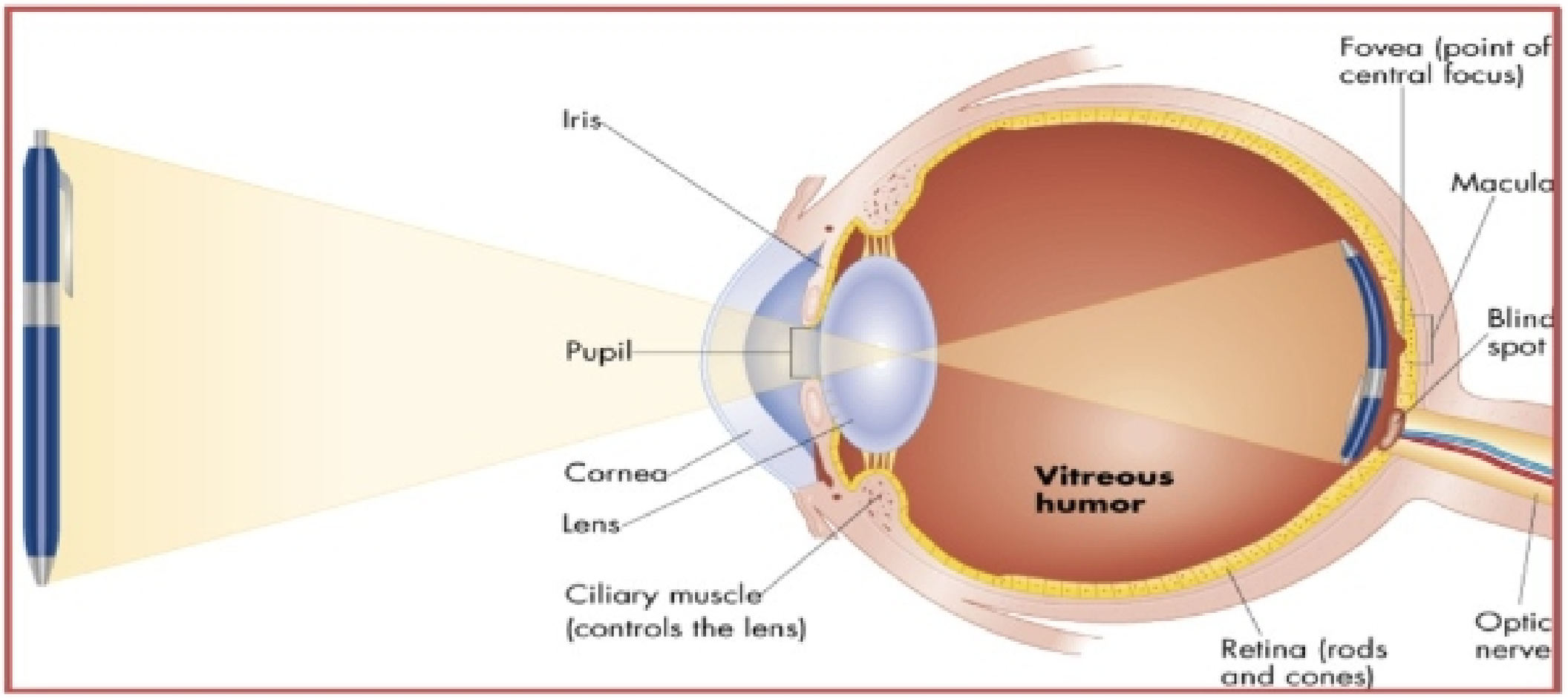
Study Guide for PSB2000-06 Exam 2 – Vision, Audition, Mechanical Senses, Chemical Senses

Vision

What is the law of specific nerve energies?

- Which neurons respond, the amount of response, and the timing of response influence what we perceive.
- Activity by a particular nerve always conveys the same type of information to the brain.
    - Ex. Impulses in one neuron indicate light; impulses in another indicate sound.
- The brain does not duplicate what we see.

Know the anatomy of the eye. What are the functions of the labeled parts in the image included here?



- Pupil: the hole in the center if the eye where light passes through. Size (dilated or constricted) determines how much light can pass.
- Iris: the circular band of muscles that controls the size of the pupil therefore controls light entry. Dilates with dilator and constricts with sphincter.
- Lens: bends light (to focus image on the retina) passing through the eye. It does this by bending itself using ciliary muscles. The cornea also focuses light.
- Fovea (point of central focus): most detailed vision happens here.
- Retina (rods and cones): Tissue with nerve cells and photoceptors. Like an outgrowth of the brain (same embryonic tissue)
- Blind Spot: Hole in retina where the optic nerve exits the eye. No photoreceptors here.
- Optic Nerve: Cranial Nerve (CN) II. Sends sensory info from photoreceptors to the brain.
- Macula: the area that holds to fovea and acts as a sun blocker from harmful light.

When light enters through the pupil and strikes the retinal neurons in what order? In other words, know the retinal circuitry (pictured below) and **how photons stimulate action potentials**.

Receptors → Bipolar Cells → Ganglion Cells

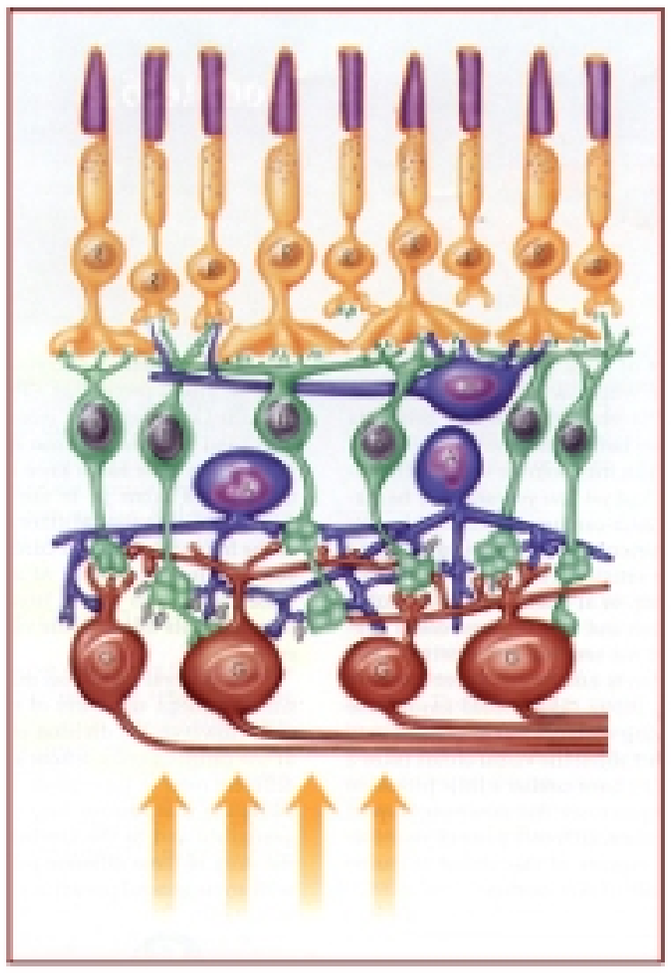
- First to visual receptrors in the back of the eye.
- Those sent messages to neurons called bipolar cells, located closer to the center of the eye.
- Bipolar cells send messages to ganglion cells that are even closer to the center of the eye.
    - The axons of ganglion cells join one another to form the optic nerve that travels to the brain.

Receptors: rods and cones

Horizontal cells

Amacrine cells

Ganglion Cells



Outer Segment

Inner Segment

Bipolar Cells

Optic Nerve Fibers

How protons stimulate action potentials:

- Without light, receptors inhibit bipolar cells.
- Light hyperpolarizes receptors.
- Receptors stop NT release.
- Bipolar cells are disinhibited.
- Bipolar cells stimulate ganglion cells.
    - By releasing an excitory NT.
- AP down optic nerve.

We talked a lot about rods and cones and their difference in foveal and peripheral vision (table 6.1). Also understand the Acuity-Sensitivity Tradeoff.

Rods are abundant in the periphery of the retina, and respond to faint light but are not useful in daylight because bright light bleaches them. See black/white. (bad detail but good sensitivity)

Cones are abundant in and near the fovea, are less active in dim light, more useful in bright light, and essential for color vision. (good detail but bad sensitivity)

In the fovea, each cone has its own line to the brain. In the periphery (mostly rods), each receptor shares a line with tens or hundreds of others.

TABLE 6.1 Human Foveal and Peripheral Vision

Characteristic	Foveal Vision	Peripheral Vision
Receptors	Cones	Proportion of rods increases toward periphery
Convergence of input	Each ganglion cell excited by a single cone	Each ganglion cell excited by many receptors
Brightness sensitivity	Distinguishes among bright lights; responds poorly to dim light	Responds well to dim light; poor for distinguishing among bright lights
Sensitivity to detail	Good detail vision because each cone's own ganglion cell sends a message to the brain	Poor detail vision because many receptors converge their input onto a given ganglion cell
Color vision	Good (many cones)	Poor (few cones)

Color Vision

You should know that there are photopigments (comprised of retinal and opsins) in rods and cones that respond to different wavelengths. The exact structure of opsin molecule determines maximal sensitivity to wavelengths of light. Long wavelength: red light, medium wavelength: green light, short wavelength: blue light.

Photopigments: chemicals contained by rods and cones that release energy when struck by light. Consist of 11-cis-retinal bound to proteins called opsins.

What is the Trichromatic Theory of color vision? What is the Retinex Theory? Opponent-Process Theory?

Trichromatic Theory: We perceive color through the relative rates of response by three kinds of cones, each one maximally sensitive to a different set of wavelengths. Determined by the particular opsin within a photoreceptor. Retina contains equal red and green but smaller number of blue.

Retinex Theory: The cortex compares information from various parts of the retina to determine the brightness and color for each area. Better explains color constancy.

The Opponent Process Theory: We perceive color in terms of paired opposites. The brain has a mechanism that perceives color on a continuum from red to green, another yellow to blue, and another from white to black. A possible mechanism is that bipolar cells are excited by one set of wavelengths, and inhibited by another.

Understand color and contrast constancy (lateral inhibition).