

Chapter 3:

Sensation and Perception



Sensation

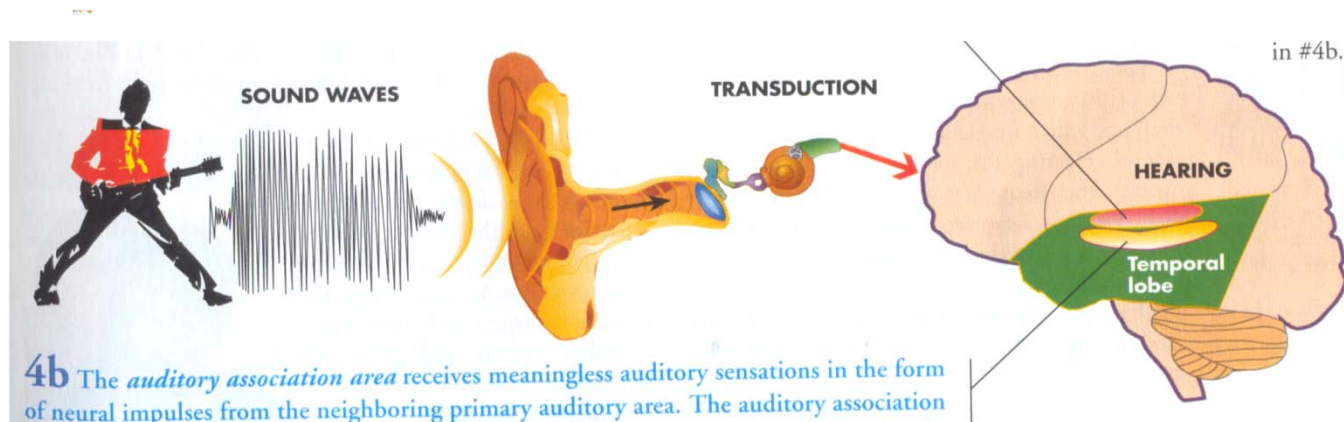
Sensation - the activation of special receptors in the various sense organs allowing outside stimuli to become neural signals to the brain:

Eyes, Nose, Ears, Skin, Tongue/Taste Buds, each gather information about your environment

A *stimulus* is an energy pattern (such as light, sound, pressure, temperature) which is registered by the sense organs

Sensation

Sensation and **Perception** are linked to form the entire process through which we gain sensory input, convert it to electrochemical energy, and interpret the info so it makes sense...organization, form, and meaning



Sensation

Gathering info about the world takes 2 steps

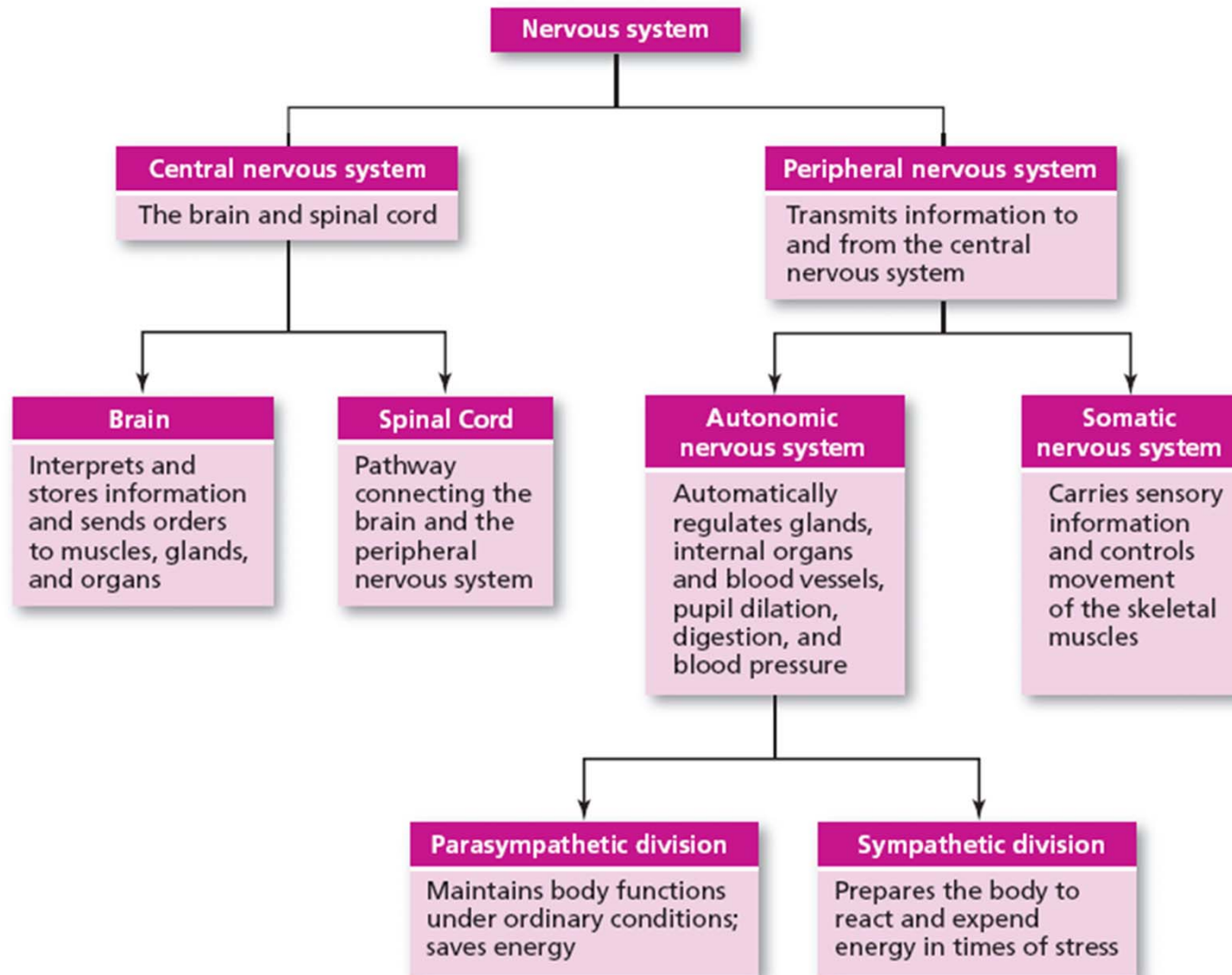
1. Electrical signals reach the brain where they are turned into **Sensations**



into sensations.

Sensations are relatively meaningless bits of information (left figure) that result when the brain processes electrical signals that come from the sense organs.

An over view of the Nervous System



Neurons and Nerves

Neurons - the basic cell that makes up the nervous system and which receives and sends messages within that system.

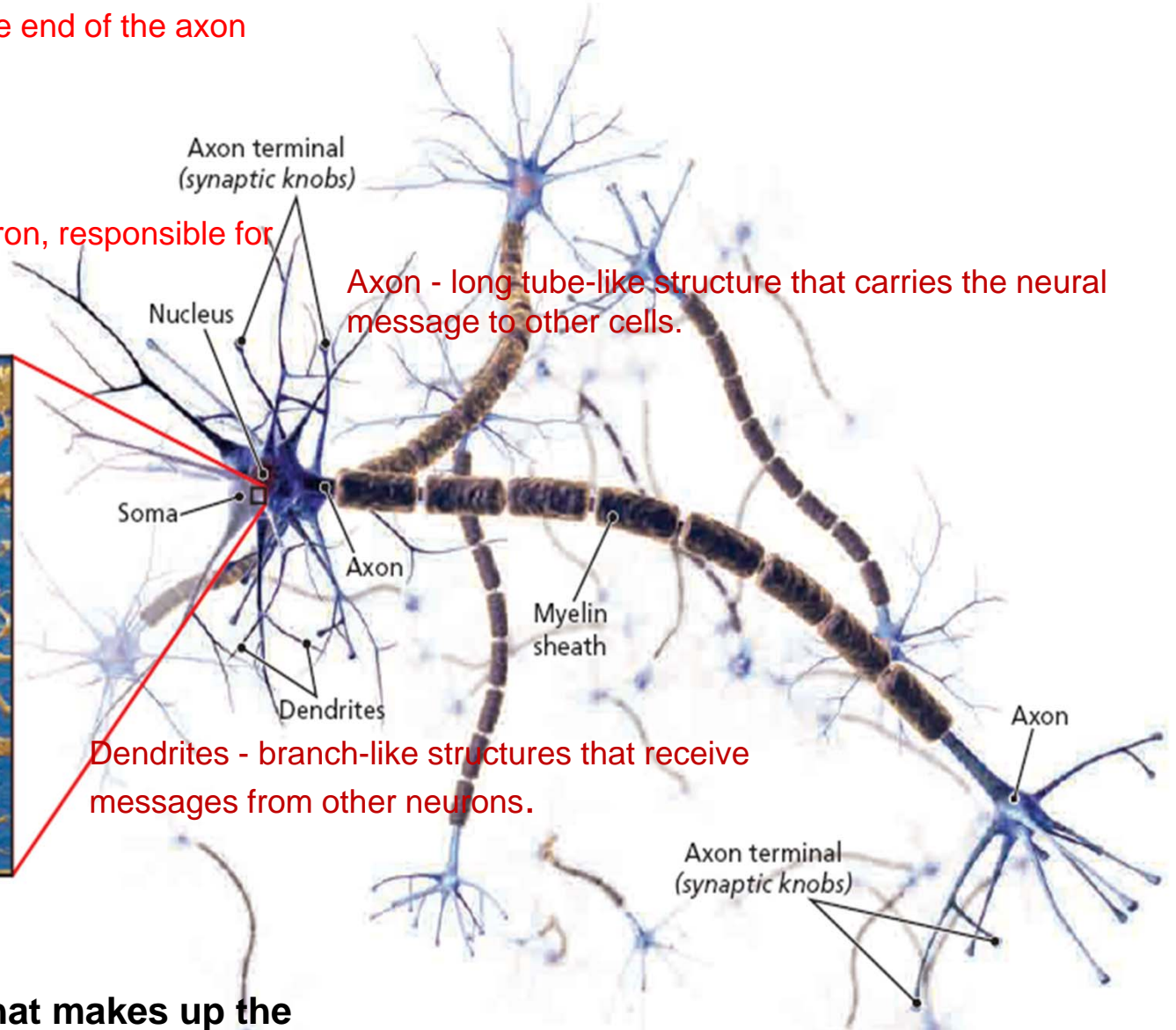
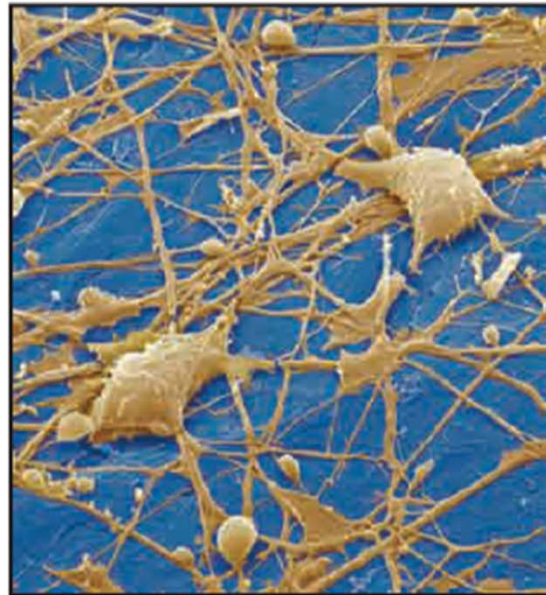
Nerves – bundles of axons in the body that travel together through the body.

The Structure of a Neuron

Axon terminals - branches at the end of the axon

Soma - the cell body of the neuron, responsible for maintaining the life of the cell.

Axon - long tube-like structure that carries the neural message to other cells.

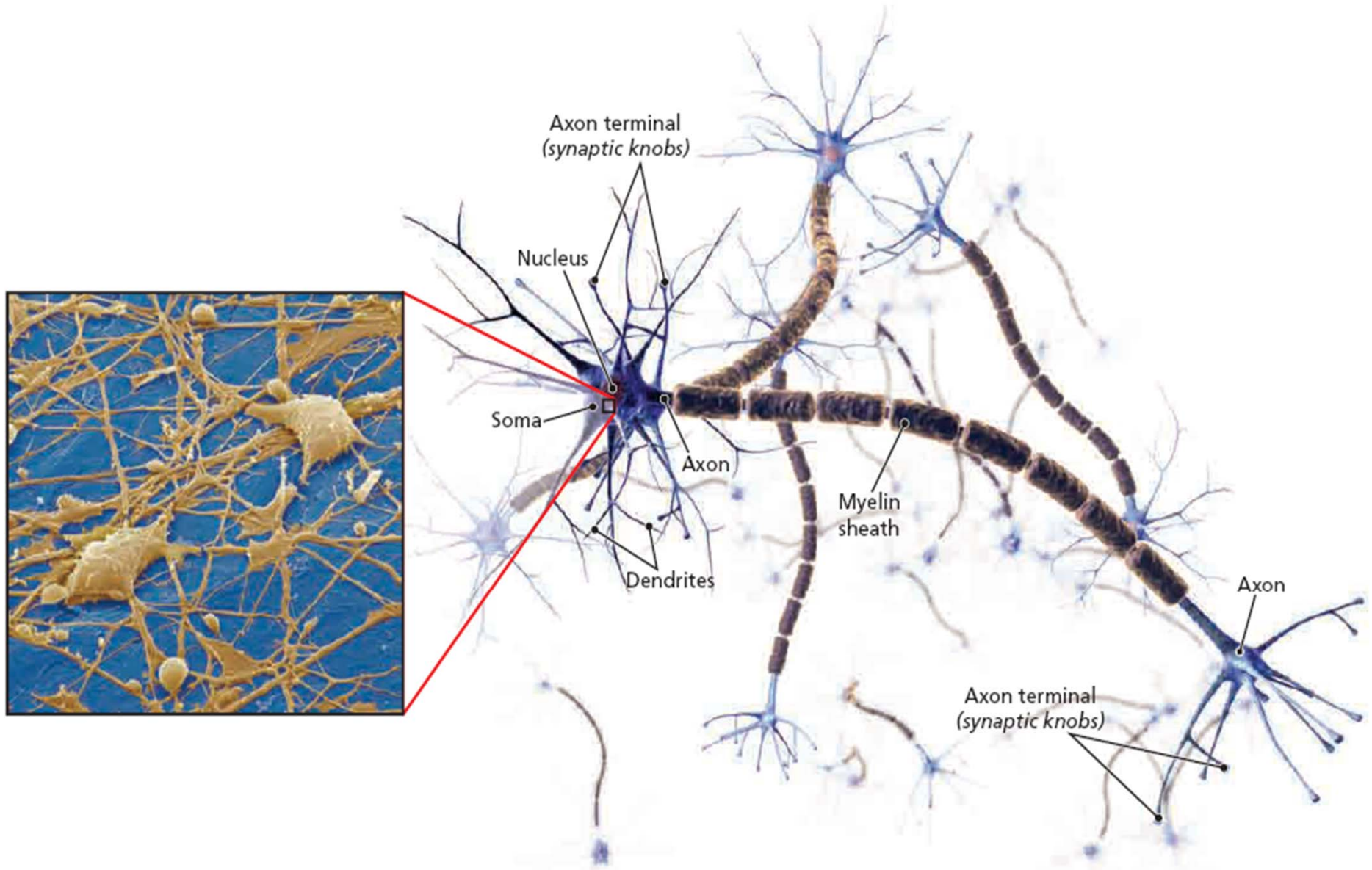


Dendrites - branch-like structures that receive messages from other neurons.

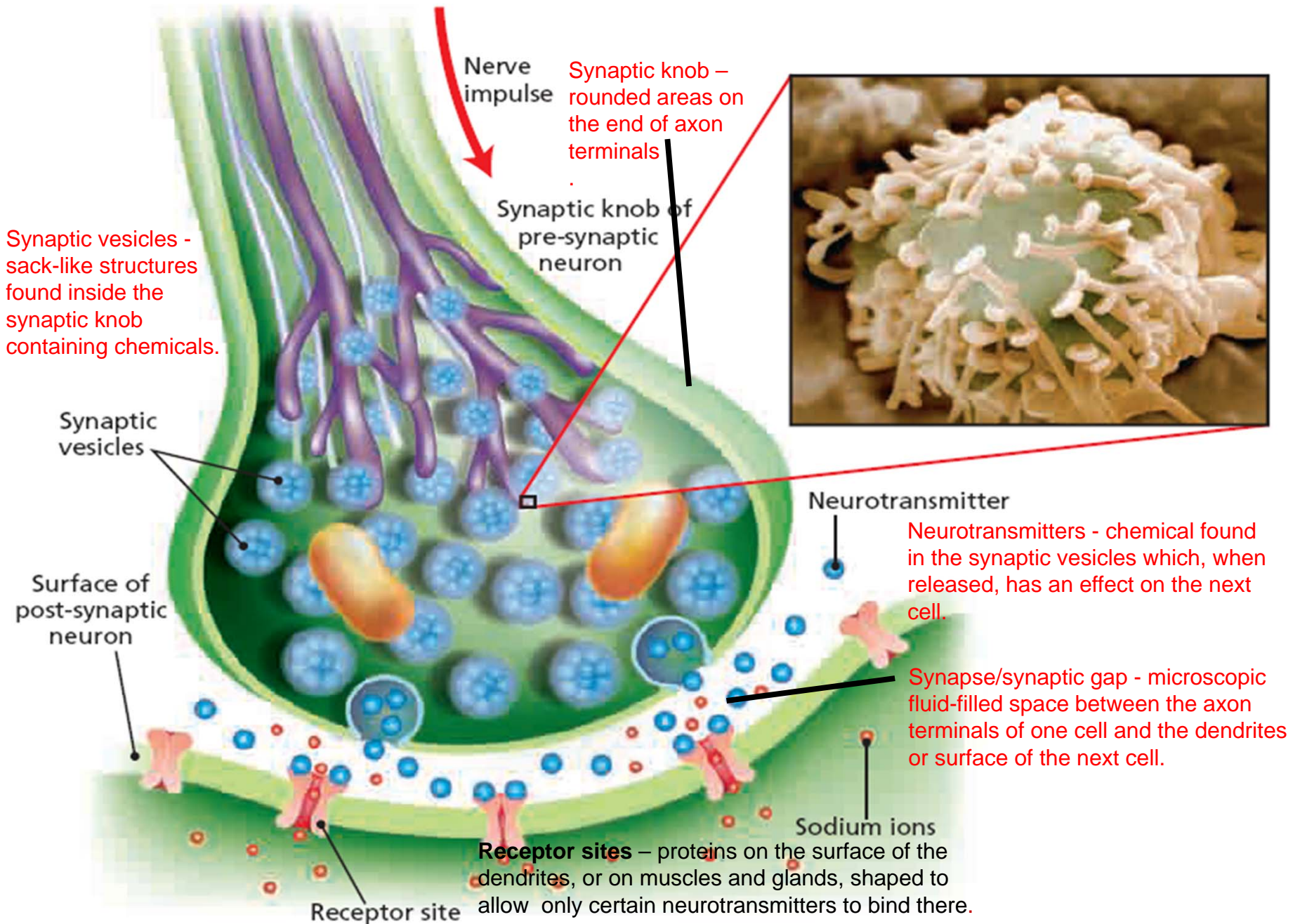
Neurons - the basic cell that makes up the nervous system and which receives and sends messages within that system.

Synaptic knob – rounded areas on the end of axon terminals

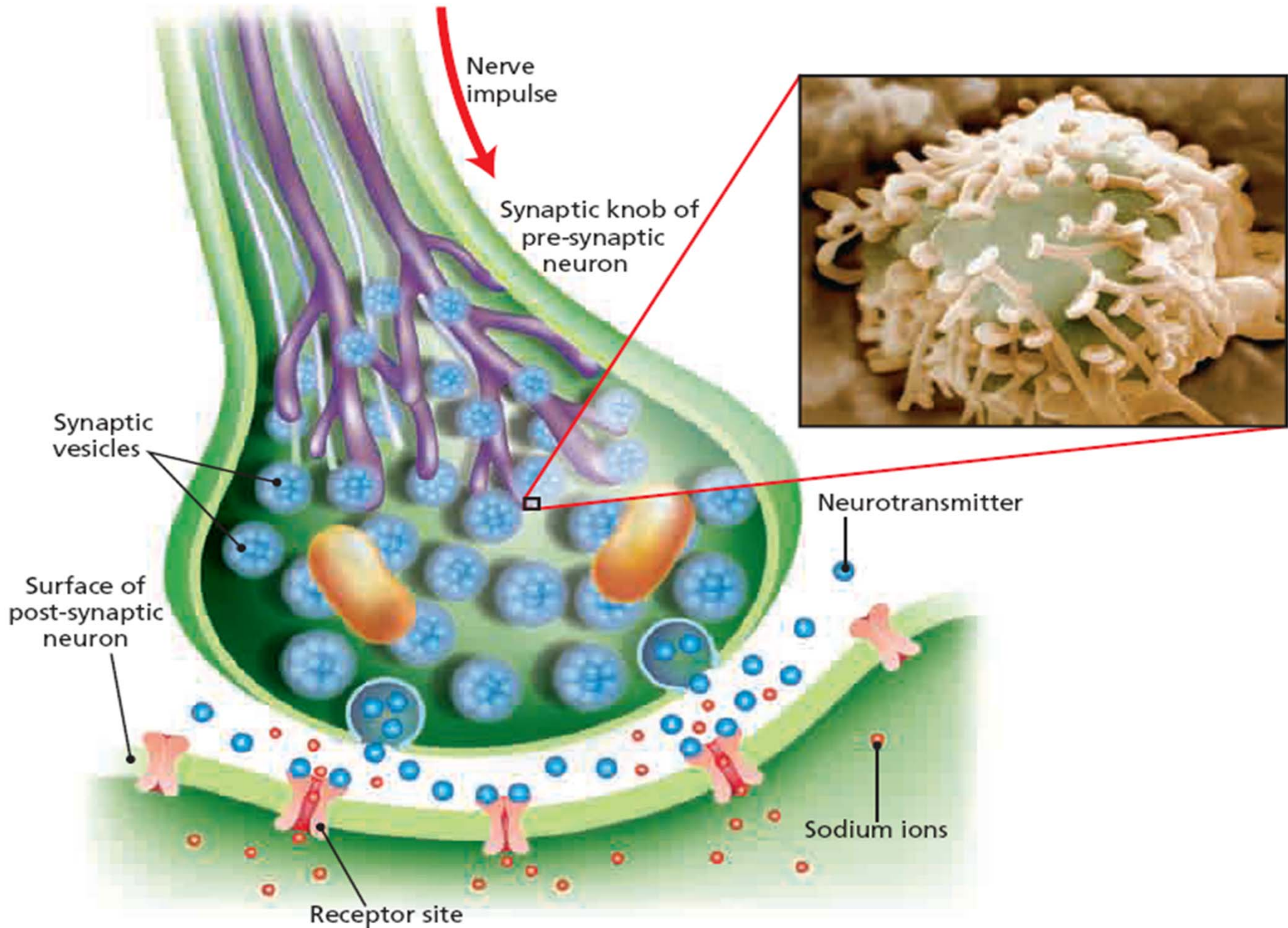
The Structure of a Neuron



The Synapse



The Synapse



Sensory Receptors

Sensory Receptors - specialized forms of neurons- cells that make up the nervous system; instead of receiving Neurotransmitters from other cells, they are stimulated by different kinds of energy (**stimuli/stimulus**):

The receptors in your eyes (Sight) are triggered by **light**

The receptors in your ears (Sound) are triggered by **vibrations**.

The receptors in your skin (Touch) are triggered by **pressure or temperature**

The receptors in your Nose and Mouth (Smell + Taste) are triggered by **chemical substances**

Sensory Thresholds

Weber's Law of Just Noticeable Difference (jnd) a.k.a. Difference Threshold:

Minimum amount of stimulation required to tell the difference between two **stimuli**.

Weber's Law of **jnd** can be applied to different senses: the **brightness of light**, the **weight of objects**, the **length of lines**

Our sensory systems are good at detecting changes in our surroundings, but we do better when the initial value of the **stimulus** is weak rather than strong

Sensory Thresholds

Links to test Weber's Law of *just noticeable difference (jnd)*:

http://highered.mcgraw-hill.com/sites/007312387x/student_view0/perception5/weber_s_law_/

http://media.pearsoncmg.com/ph/hss/shared_hss_assets/psychology/livepsych_experiments/weberexperiment.html

Absolute Thresholds

Absolute threshold - the smallest amount or lowest level of energy needed for a person to consciously *detect* a *stimulus* 50 percent of the time it is present. (Remember that *jnd* is detecting a *difference between two stimuli*)

Table 3.1 Examples of Absolute Thresholds

SENSE	THRESHOLD
Sight	A candle flame at 30 miles on a clear, dark night
Hearing	The tick of a watch 20 feet away in a quiet room
Smell	One drop of perfume diffused throughout a three-room apartment
Taste	1 teaspoon of sugar in 2 gallons of water
Touch	A bee's wing falling on the cheek from 1 centimeter above

Absolute Thresholds

Another example:

How much salt must be added to a glass of water before a change in taste can be detected in at least half of the taste tests?

Subliminal Sensation

Subliminal Stimuli - stimuli that are below the level of conscious awareness.

- Just strong enough to activate the sensory receptors but not strong enough for people to be consciously aware of them. Limin - “threshold” Sublimin - “below the threshold.”

Subliminal Perception – process by which subliminal stimuli act upon the unconscious mind, influencing behavior.

There is no evidence that subliminal stimuli in advertisements influence people’s behavior

Habituation and Sensory Adaptation

Habituation - Tendency of the brain to stop attending to constant, unchanging information.

Our brains are only really interested in changes in information and our brains “ignore” *conscious attention* to stimuli that does not change.

Example: Not “hearing” the air conditioner until the sound changes (stops, increases, decreases)

This is how our brains deal with unchanging information in our environments

Habituation and Sensory Adaptation

Sensory Adaptation - Tendency of sensory receptor cells to become less responsive to a stimulus that is unchanging.

Example: Walking into someone's house you get a certain smell, but after awhile, the smell "goes away"

The difference between **Habituation** and **Sensory Adaptation**:

Habituation: Your sensory receptors are still responding to the stimulation but the lower centers of your brain are not sending signals from those sensory receptors to the brain's cortex for interpretation.

Sensory Adaptation: *The receptor cells themselves* become less responsive to an unchanging stimulus and no longer send signals to the brain for interpretation .

Habituation and Sensory Adaptation

So if Sensory Adaptation, The tendency of sensory receptor cells to become less responsive to a stimulus that is unchanging, is “true” then explain why unchanging things we stare at for long periods of time do not disappear?

If I put tape on your arm after awhile you would not feel it; you don't constantly feel your clothes because your skin (touch) adapts. So do your ears (sound), nose (smell), and mouth (taste)- so why not your eyes(vision)?

Habituation and Sensory Adaptation

Unchanging things we stare at for long periods of time do not disappear because of *Microsaccades* - constant tiny movement of the eyes that prevents sensory adaptation to visual stimuli (we do not consciously notice this)

Sensory Adaptation

Some sense organs adapt quickly...some more slowly...depends on the intensity of the stimulation...

Will your senses eventually adapt to any stimulation despite intensity level?

Yes or No and Why???

Adaptation

Your sense organs **WILL NOT** adapt to intense forms of stimulation if the stimulation will cause physical damage...extreme heat or cold on your skin for example.



Transduction

When a sense organ changes or transforms physical energy into electrical signals...example:

A skunk's spray/molecules enters your nose, molecules get transformed into electrical signals/impulses. These signals get interpreted by your brain as unpleasant odor

transduction.

**Electrical
signal**



Transduction refers to the process in which a sense organ changes, or transforms, physical energy into electrical signals that become neural impulses, which may be sent to the brain for processing.

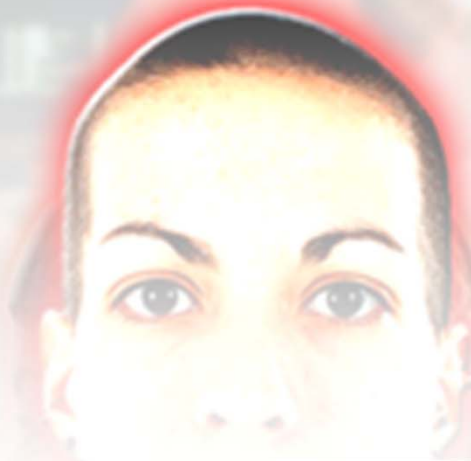
For example, trans-

Habituation & Sensory Adaptation



- Habituation – brain stops attending to constant, unchanging stimuli (cognitive)

- Sensory adaptation – sensory receptors less response to constant stimuli



◀ Does sensory adaptation mean that if I stare at something long enough, it will disappear?



Vision: Properties of Light

We experience light in 3 aspects:

1. **Brightness** (intensity of light) - determined by the **amplitude** (height) of the light wave

The higher the wave = the brighter the light. Low waves are dimmer.

All light travels in the form of waves at a speed of about **186,000 miles per second**; (almost eight times around the Earth in 1 second).

2. **Color/Hue** is determined by the **length** of the wave. **Length** determines the type of light.

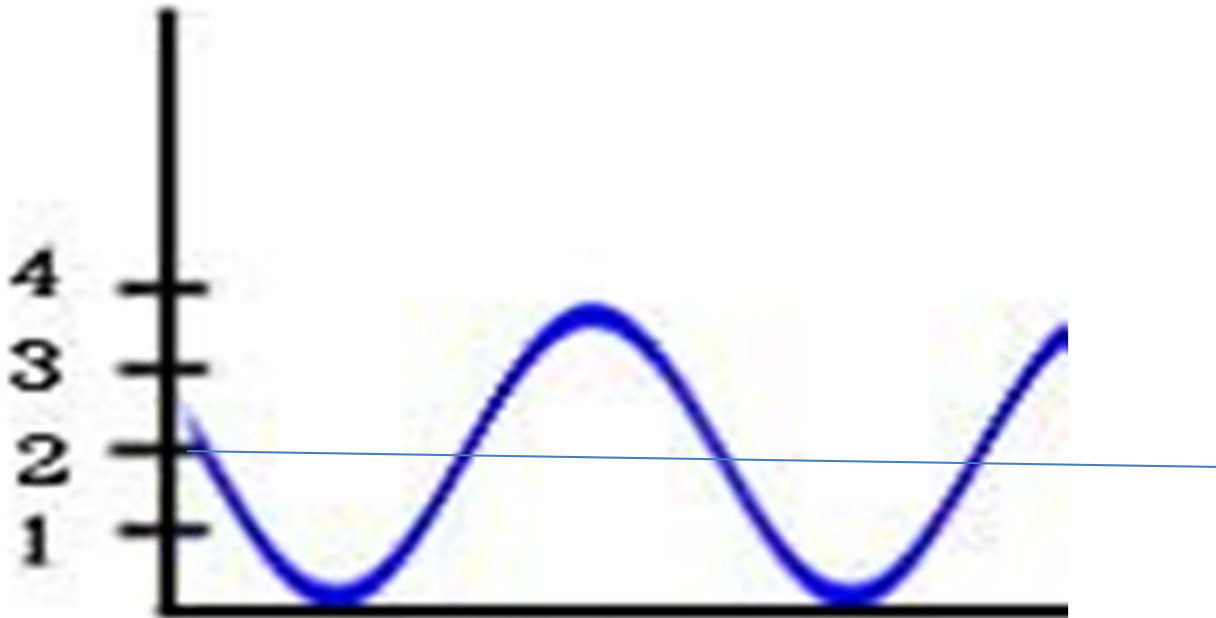
Long wavelengths are found at the red end of the **visible spectrum** (the portion of the whole spectrum of light that is visible to the human eye), whereas shorter wavelengths are found at the blue end. The entire range of different kinds of light including the ones the human eye cannot see is called the **electromagnetic spectrum**.

3. **Saturation** - refers to the purity of the color people see.

Highly saturated Red would contain only **Red wavelengths** while a less saturated red would contain a mixture of wavelengths

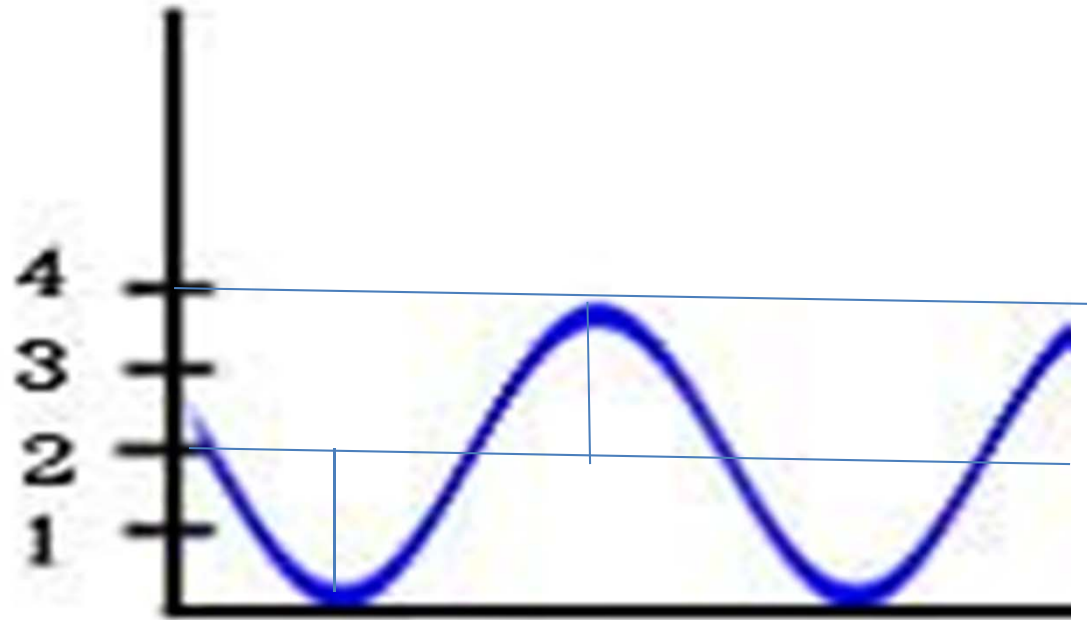
Vision: Properties of Light- **Amplitude**

Amplitude is a measurement of the top (or bottom) half of the wave. What is the **Amplitude** of this wave?



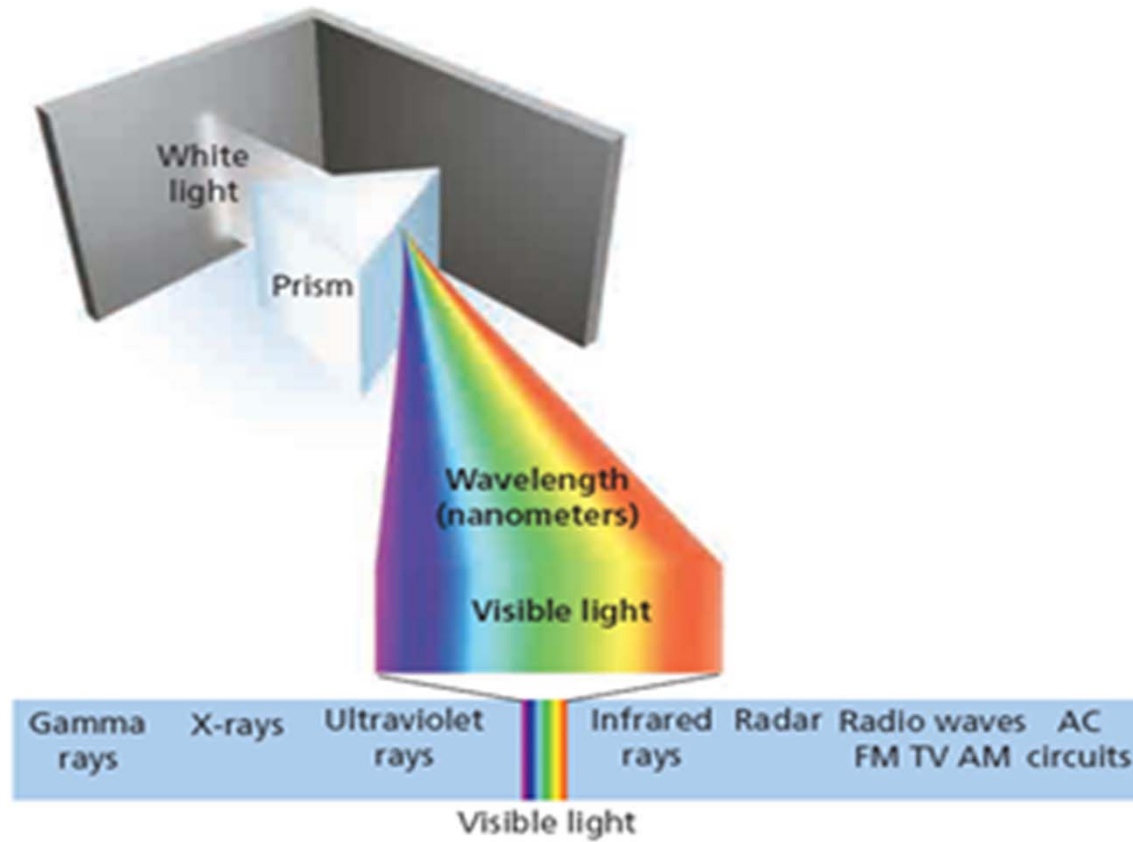
Vision: Properties of Light- Amplitude

The Amplitude of the wave = 2

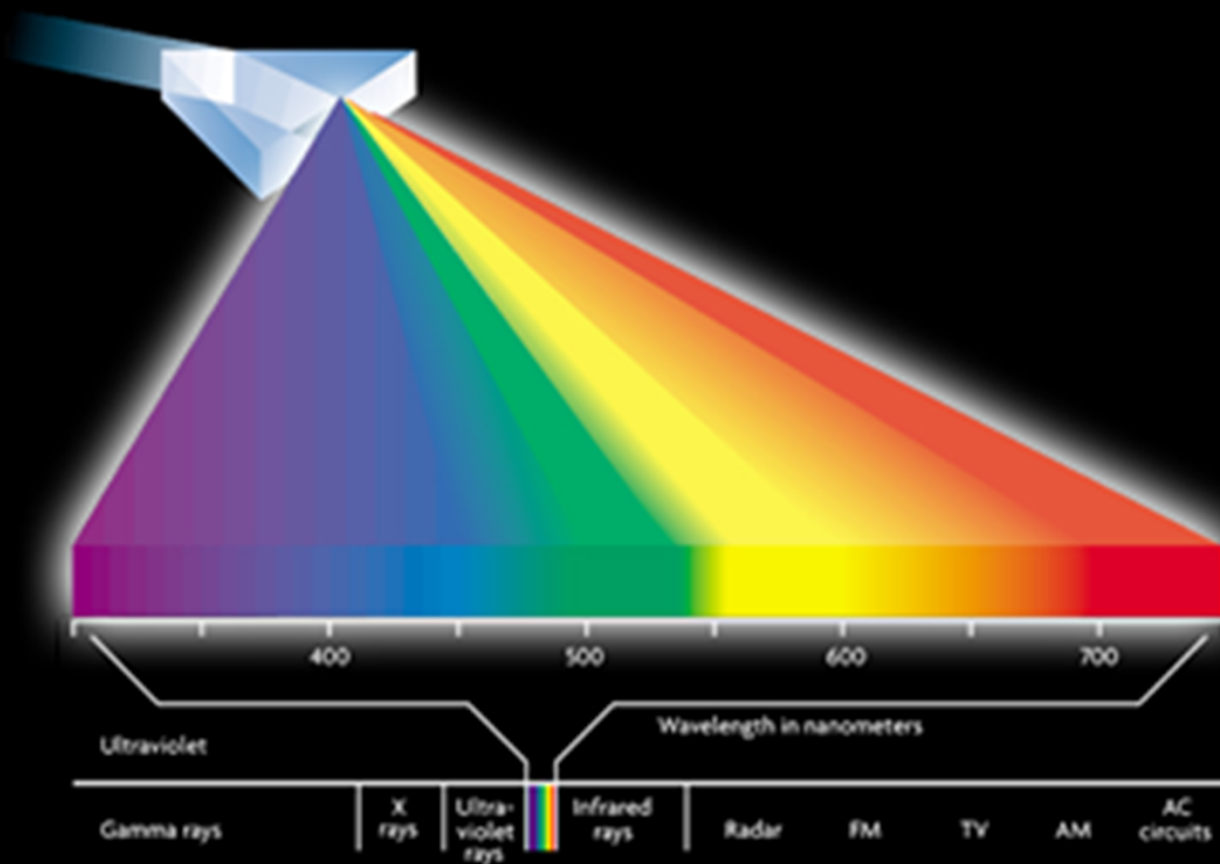


Vision: Properties of Light- Color/Hue

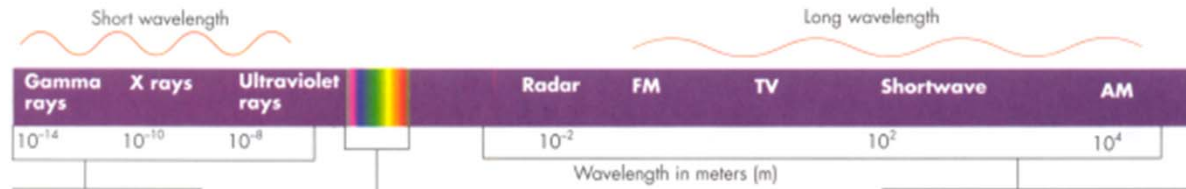
Figure 3.1 The Visible Spectrum



Spectrum of Visible Colors



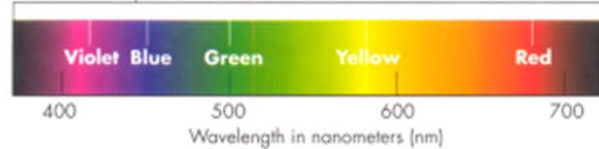
Vision: Properties of Light



Invisible—too short.

On this side of the electromagnetic energy spectrum are shorter wavelengths, including gamma rays, X rays, and ultraviolet rays. These waves are invisible to the human eye because their lengths are too short to stimulate our receptors.

However, some birds (such as hummingbirds) and insects can see ultraviolet rays to help them find food.



Visible—just right. Near the middle of the electromagnetic spectrum is a small range of waves that make up the visible spectrum.

The visible spectrum is one particular segment of electromagnetic energy that we can see because these waves are the right length to stimulate receptors in the eye.

The reason you can see a giraffe is that its body reflects light waves from the visible spectrum back to your eyes. One function of the eyes is to absorb light waves that are reflected back from all the objects in your environment.

Invisible—too long. On this side of the electromagnetic spectrum are longer wavelengths, such as radio and television waves. These waves are invisible to the human eye because their lengths are too long to stimulate the receptors in the eye.

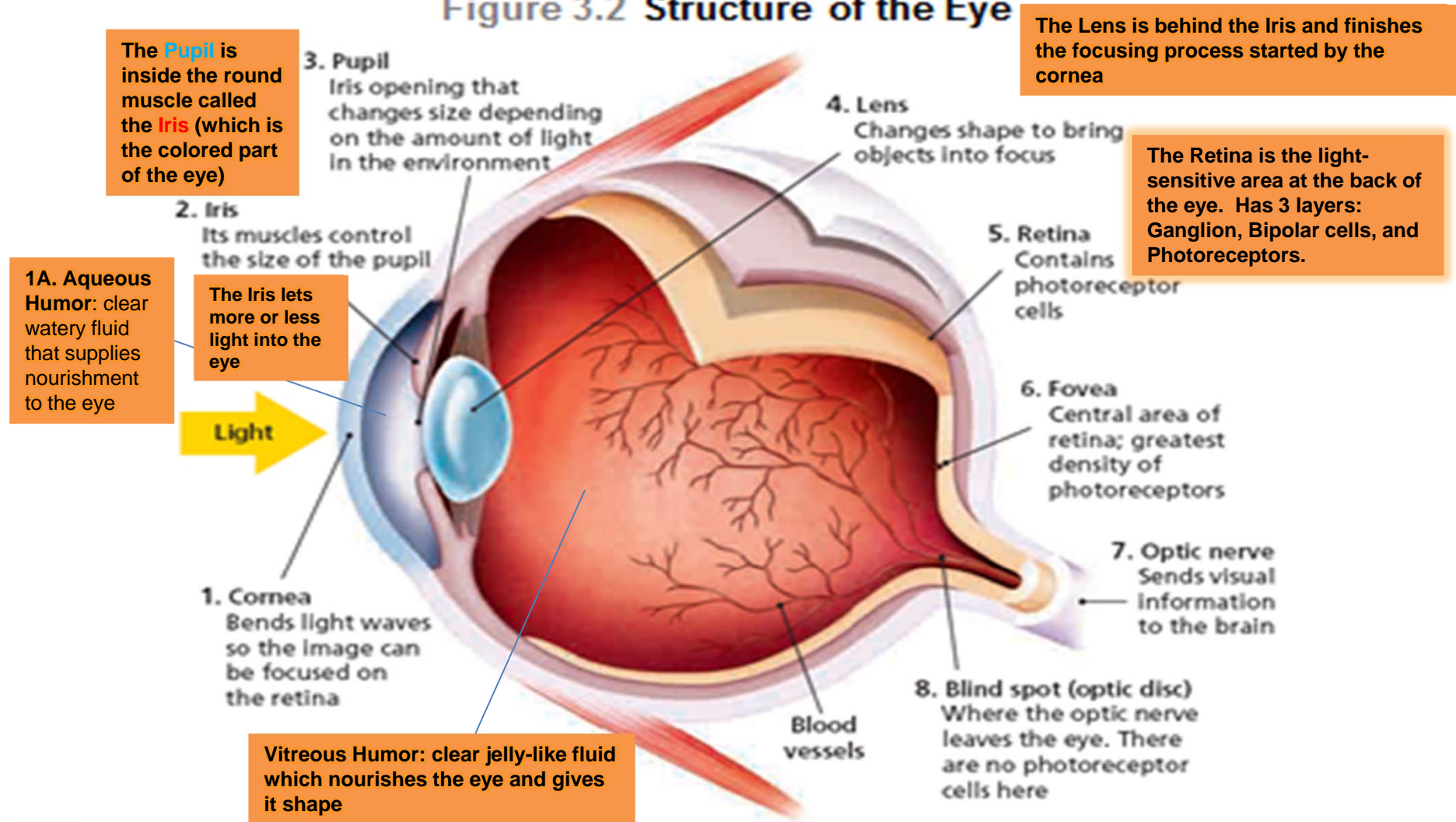
Imagine the awful distraction of seeing radio and television waves all day long!



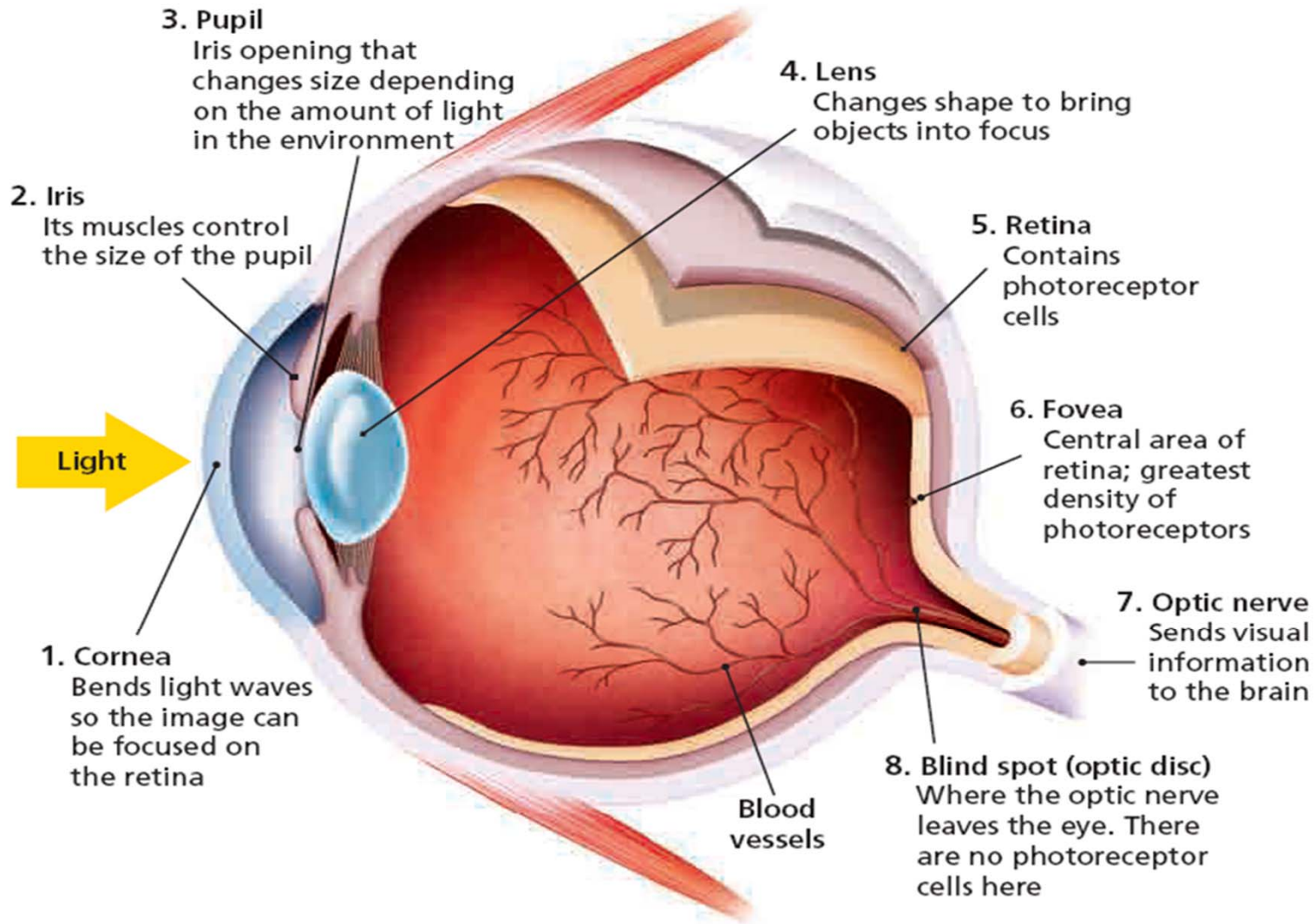
Stimulus. Thus, the most effective stimulus for vision is energy (light waves) from the visible spectrum. However, for you to see anything, reflected light waves must be gathered and changed into electrical signals, and for that process—transduction—we must look inside the eye itself.

Parts of the Eye

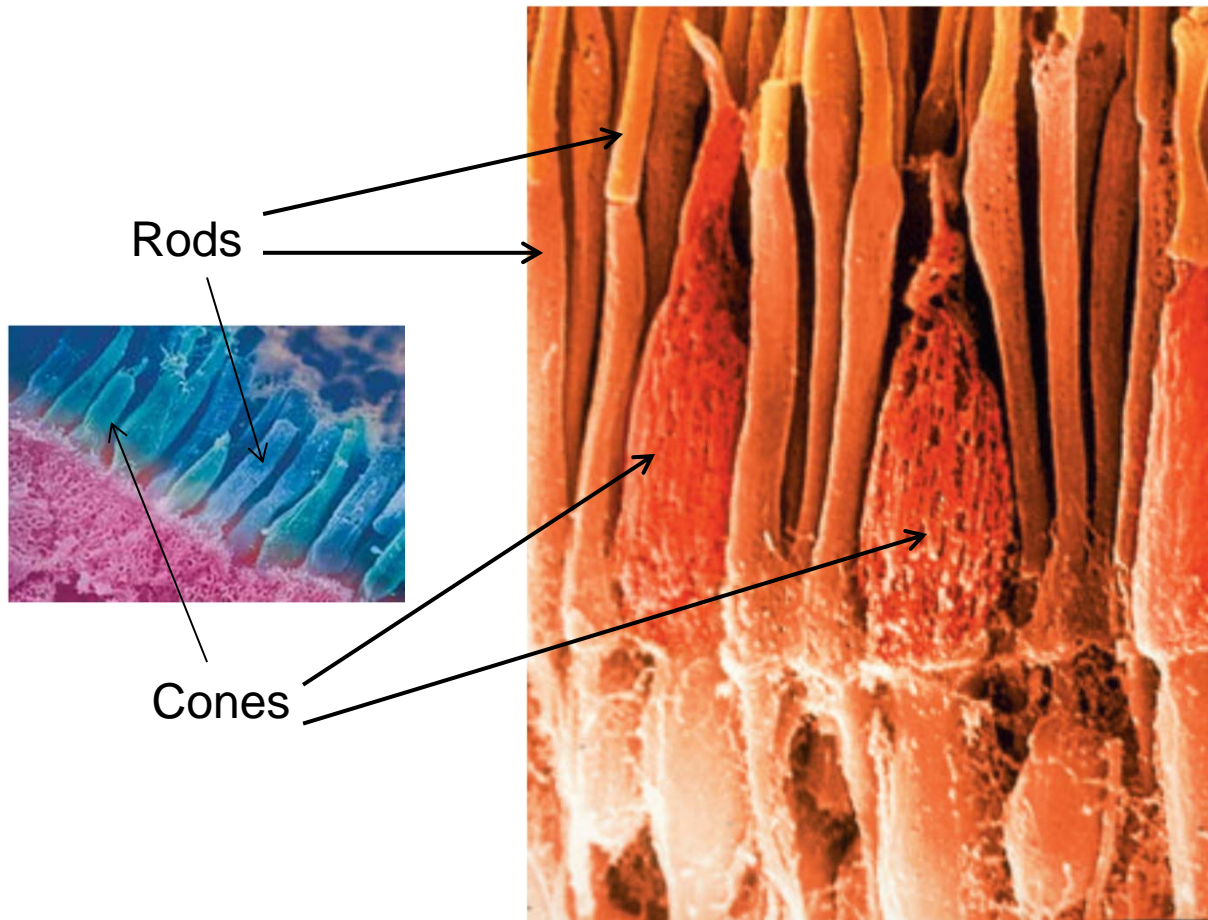
Figure 3.2 Structure of the Eye



Parts of the Eye



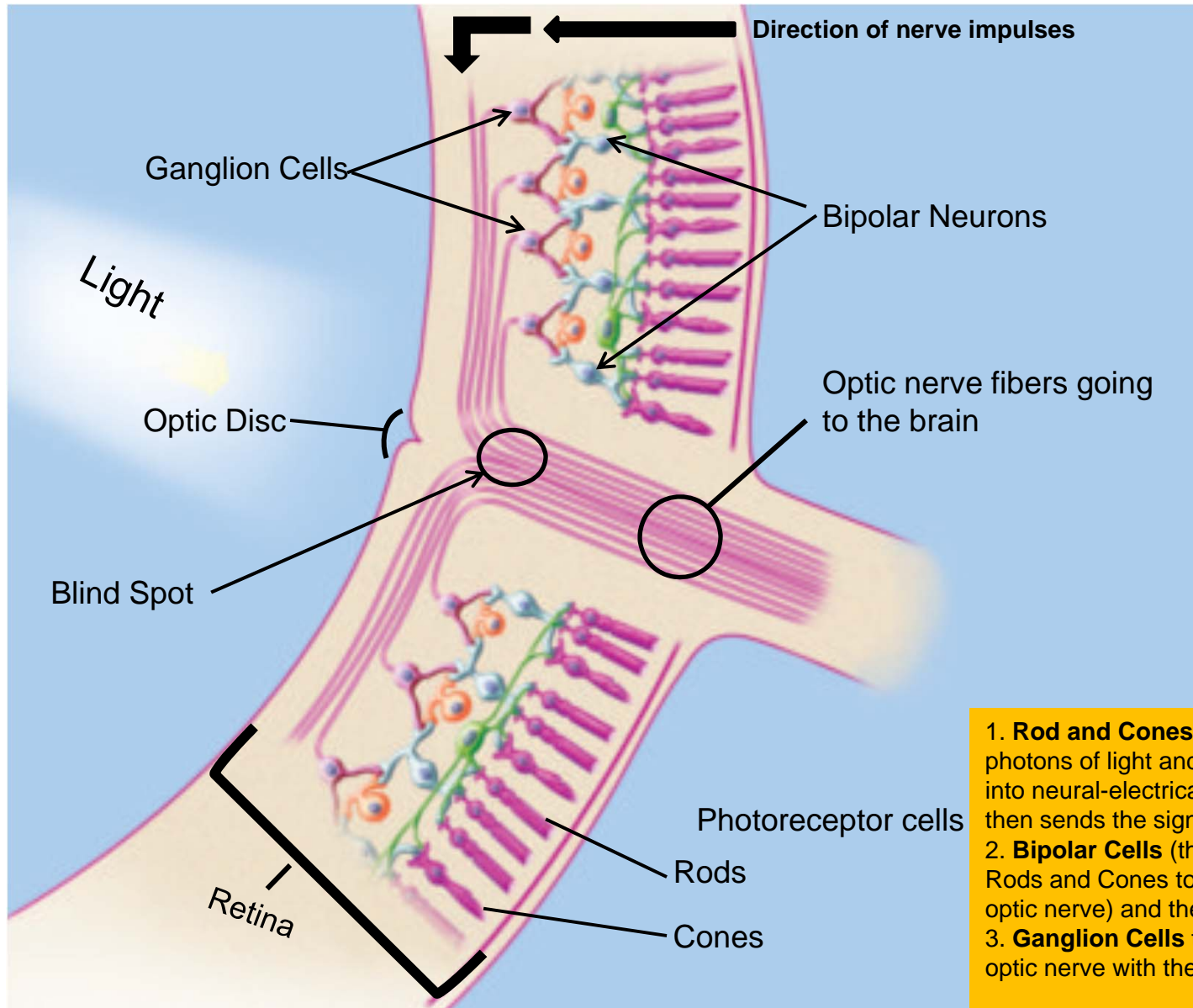
Rods and Cones



Rods are visual sensory receptors in the back of the retina that are responsible for non-color sensitivity to low levels of light.

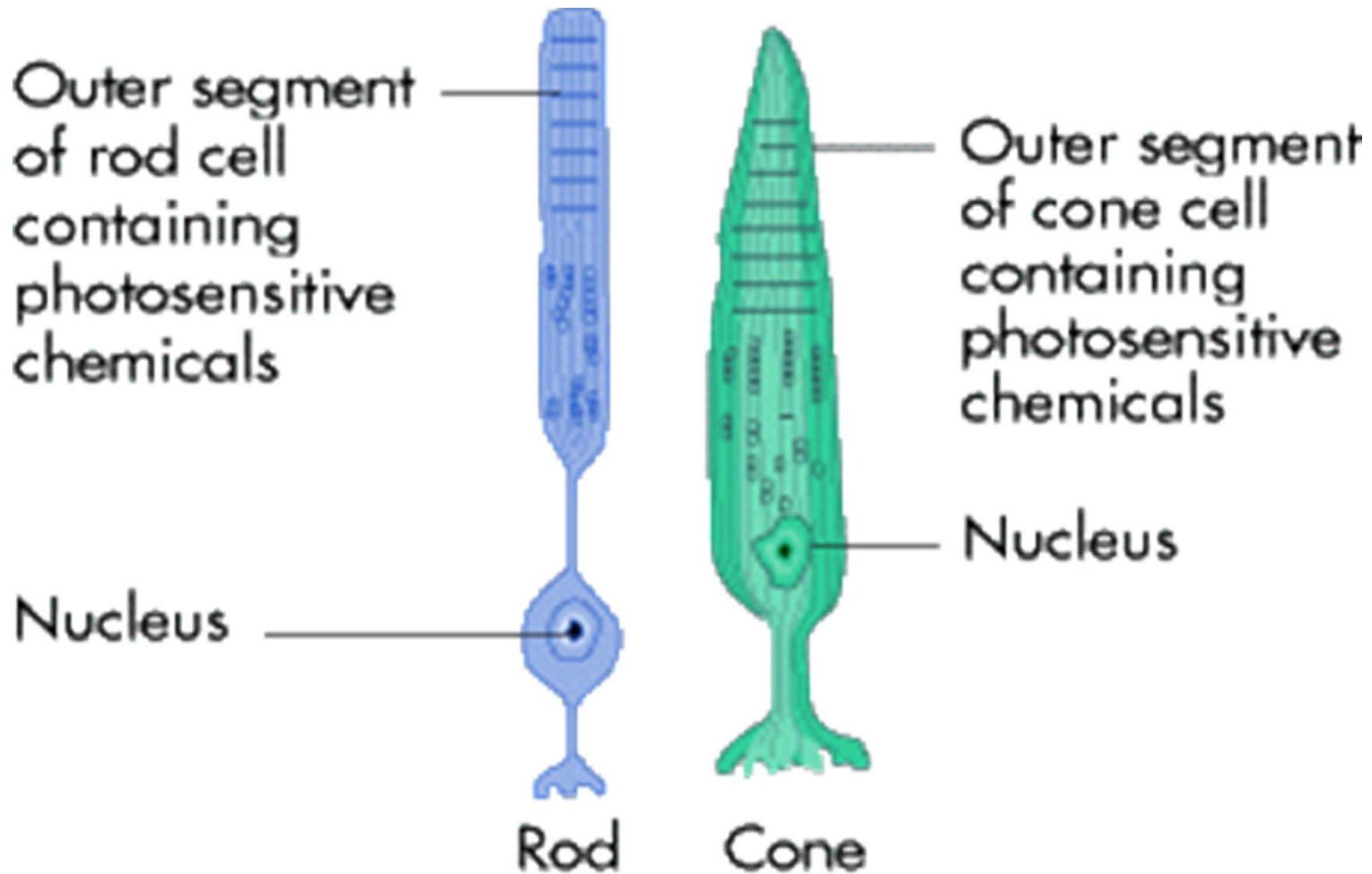
Cones are visual sensory receptors in the back of the retina that are responsible for color vision and sharpness of vision

Parts of the Retina



1. **Rod and Cones** receive the photons of light and turns them into neural-electrical signals and then sends the signal to the
2. **Bipolar Cells** (these connect the Rods and Cones to the cells in the optic nerve) and then to the
3. **Ganglion Cells** that form the optic nerve with their axons.

Rods and Cones



How The Eye Works



- **Cones**
located in
fovea
 - day vision
(color)
- **Rods** in
periphery
 - night vision
(black and
white)

Rods and Cones

- There are about 120 million **Rods** in each eye and are found all over the Retina except the very center (the **Fovea**), which only contains **Cones**. **Rods** are sensitive to changes in brightness but NOT color (wavelength), so they only see in black and white and shades of gray. * **Rods** are located on the periphery of the Retina and are also responsible for peripheral vision. Because **Rods** work well in low light, they allow your eye to adapt to low light situations and help us see movement.

Dark Adaption: The recovery of the eye's sensitivity to visual stimuli in darkness after exposure to bright lights. Occurs as your eyes recover their ability to see when going from a brightly lit state to dark state- the brighter the light was, the longer it takes the **Rods** to adapt to the new lower levels of light.

Light Adaptation: The recovery of the eye's sensitivity to visual stimuli in light after exposure to darkness. Occurs when going from a dark room to a brightly lit one- your **Cones** (6 million total found mostly near the middle of the **Retina**) have to adapt to the increased light level, and they do so much quicker (a few seconds) than **Rods** adapt to darkness because about 50,000 Cones have a direct line to the **Optic Nerve** and **Cones** need a lot more light to function as they are not as sensitive to light (**Rods** are sensitive to light but do not register color) so they work best in bright light.

Full Dark Adaption- Where you go from constant light to sudden darkness (turning the lights off in your bedroom) takes about 30 min for your **Rods** to adjust and as you get older the process takes longer (this is why some elderly people experience "night blindness" and have difficulty seeing well enough to drive at night or get around a dark room.

Rods work well in low light and allow us to adapt when going from light to low light/dark

Cones are responsible for color vision and they function best in bright light (Going from a dark movie theater to the bright outdoors, your eyes adapt quicker).

What will it be difficult to do in dim light and why?

When looking at stars at night, did you ever think you saw smaller stars around the larger brighter stars out of your peripheral vision when you are focusing on the larger ones? Then when you turn your head to see those small stars they disappear? What is up with that?

Here is what's up:

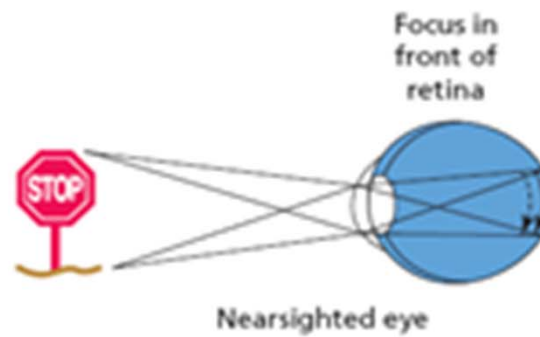
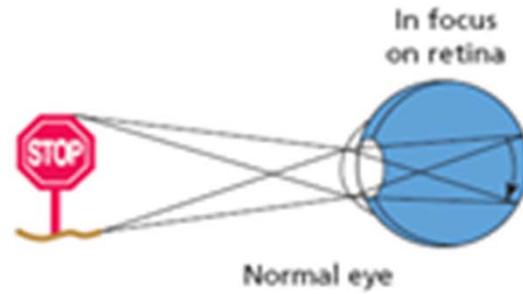
The **Fovea** (the central area of your **Retina**) has no **Rods**, but contains a high amount of **Cones**, which are responsible for color vision and *sharpness*.

Rods work well in low light are located on the periphery of the Retina and are responsible for peripheral vision.

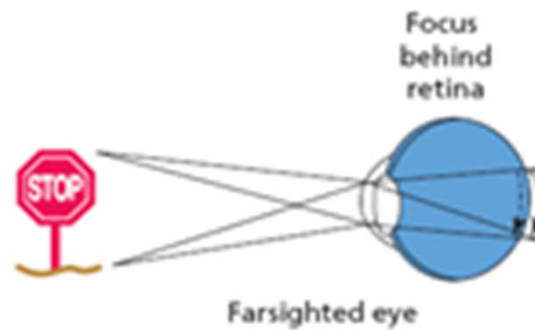
When focusing upon a star the Fovea is the central area and the Fovea's Cones make things sharp. If you look at a small dim object in the dark it cannot be seen if you look directly at it.

This is why when you look up at the stars at night you seem to see fainter stars next to the ones you are focusing on; to detect faint stars in the sky, you have to look just to one side of them so that their light falls on the area of the eye that contains the most rods.

Figure 3.3 Common Visual Problems: Nearsightedness and Farsightedness



The Eyeball is too long

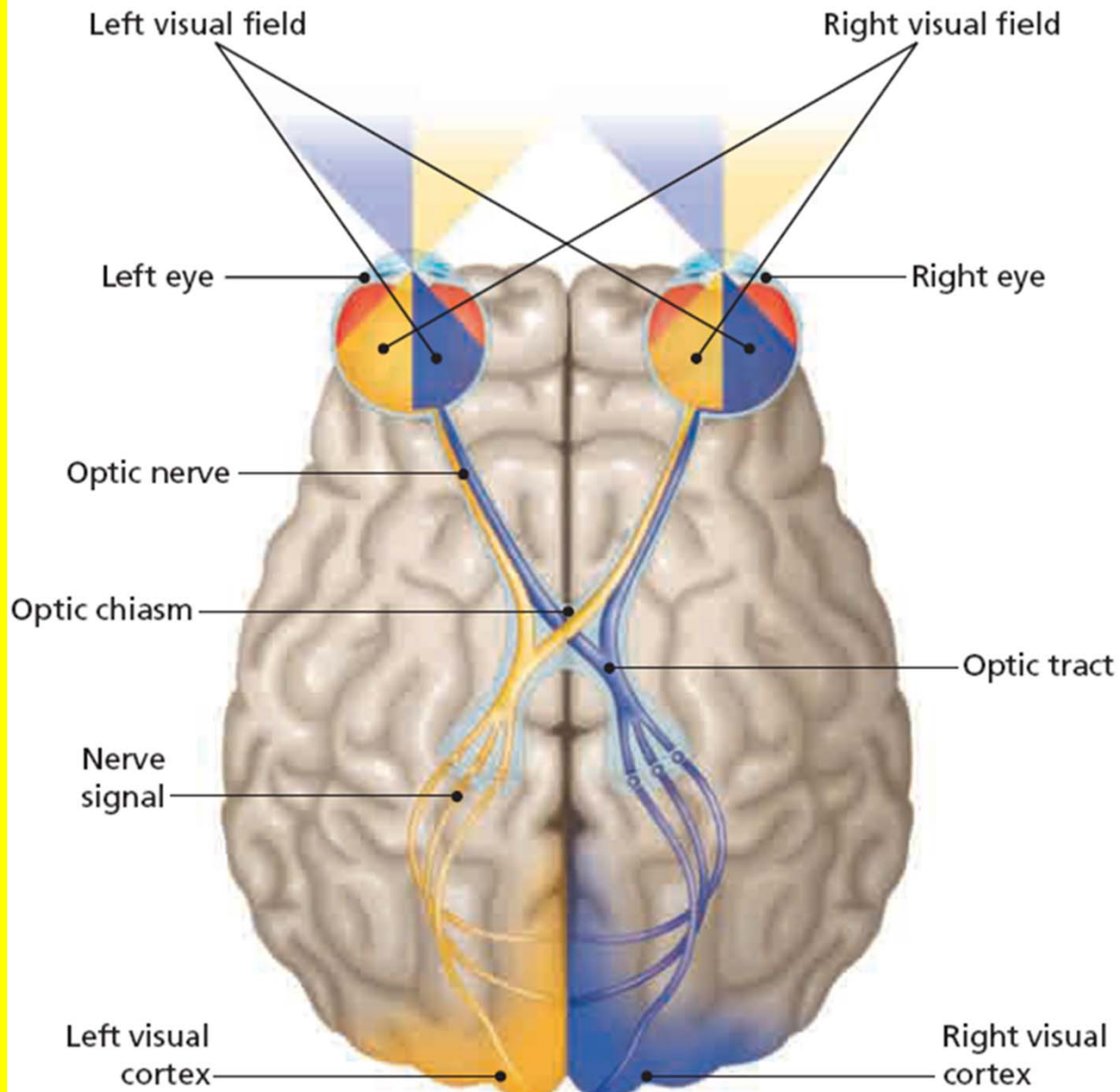


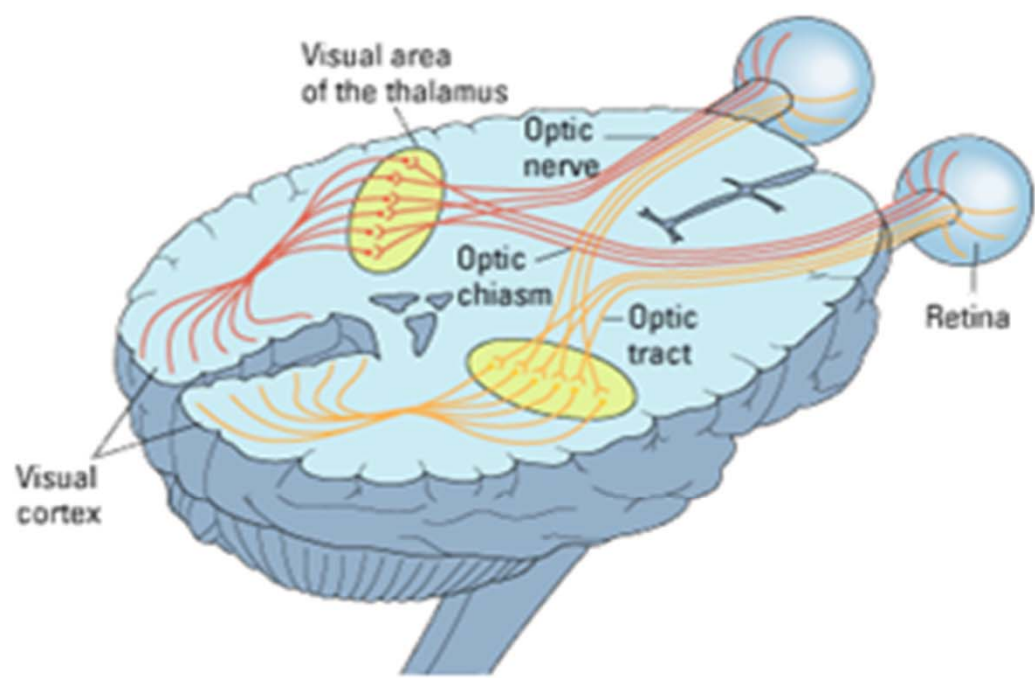
The Eyeball is too short

Crossing of the Optic Nerve

Crossing of the Optic Nerve

Light falling on the left side of each eye's retina (from the right visual field, shown in yellow) will stimulate a neural message that will travel along the optic nerve to the visual cortex in the occipital lobe of the left hemisphere. Notice that the message from the temporal half of the left retina goes directly to the left occipital lobe, while the message from the nasal half of the right retina crosses over to the left hemisphere (the optic chiasm is the point of crossover). The optic nerve tissue from both eyes joins together to form the left optic tract before going on to the left occipital lobe. For the left visual field (shown in blue), the messages from both right sides of the retinas will travel along the right optic tract to the right visual cortex in the same manner.





Color Vision

Color Vision Theories:

1. **Trichromatic: 3 types of Cones**: Red, Blue, and Green. These Cones “combine” to form different colors: If red Cones and green Cones are firing (faster than other Cones) in response to a stimulus then the person will see yellow. If red Cones and blue Cones are firing then the result is magenta.

2. **Opponent-Process**: Cones are arranged in pairs with **four primary colors** red, green, blue, and yellow: red Cones with green Cones and blue Cones with yellow Cones. If one **member** of the pair is stimulated, the other member of the pair cannot be working. Example: If a red Cone is stimulated, then the green Cone cannot be working. So...there are NO reddish-greens or bluish-yellows (hence *Opponent-Process*).

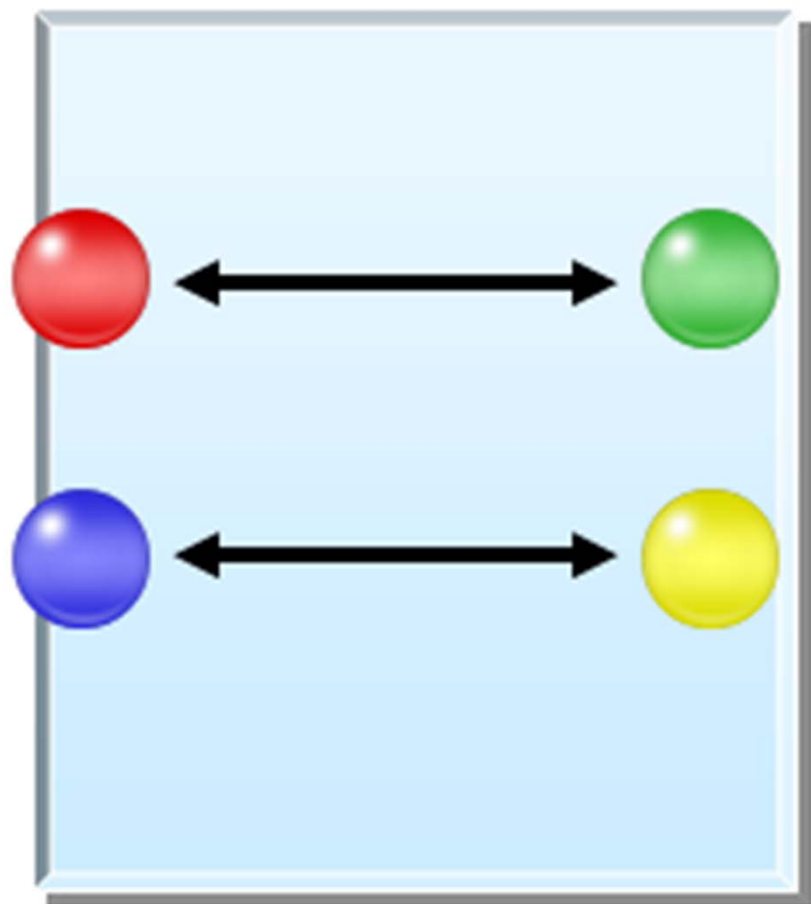
Both theories play a part in color vision

Trichromatic Theory

- Trichromatic theory - **three types of cones: red, blue, and green**
 - firing rate of cones and color



Opponent-Process Theory



Afterimages

- Opponent-process theory – four primary colors with cones arranged in pairs

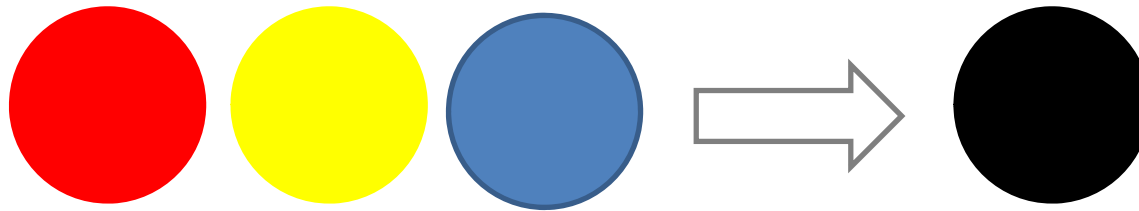


Opponent-Process Color Theory

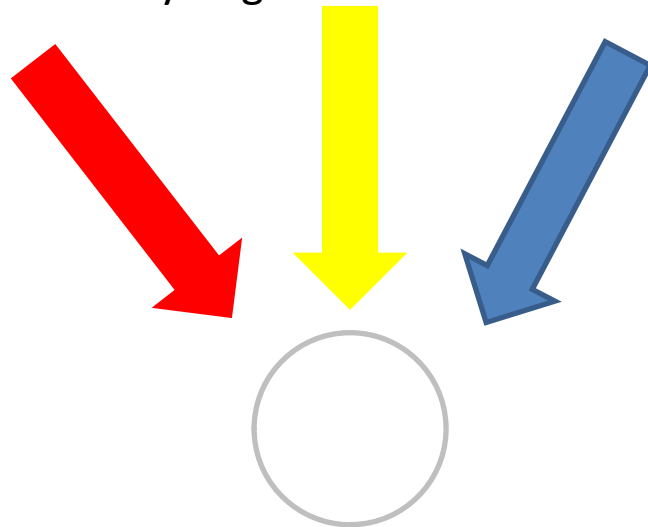
So you may be thinking “I thought the primary colors were Red, Yellow and Blue?”

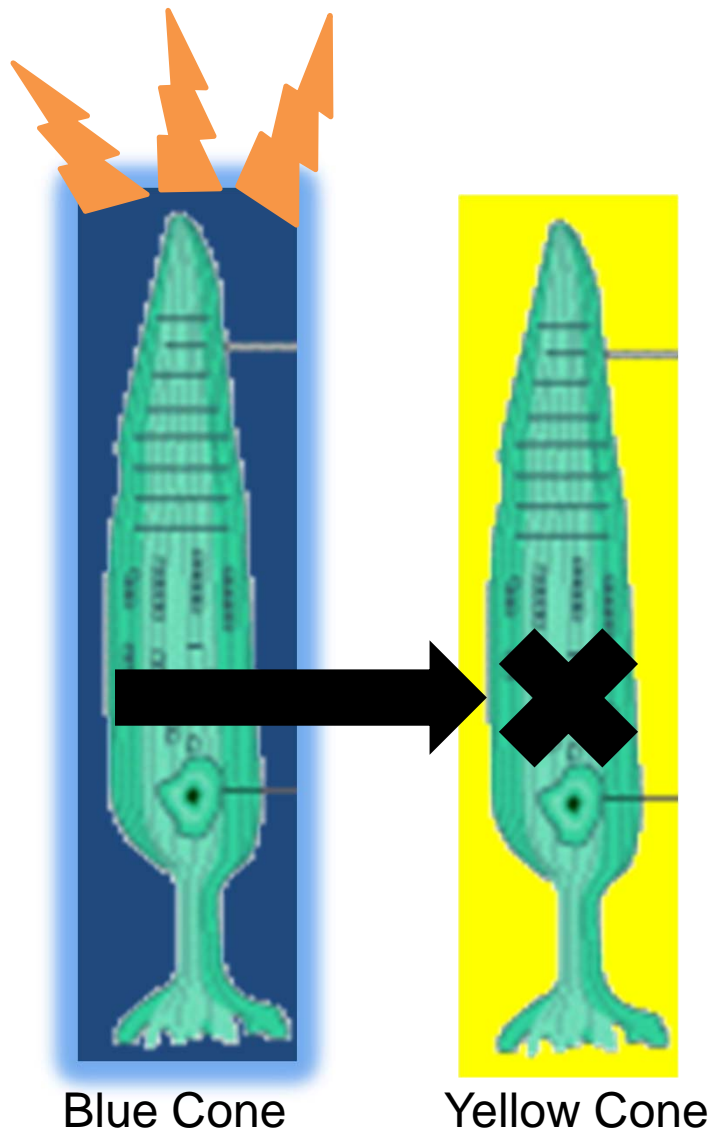
Correct if you are talking about *painting*, but not when talking about *light*: Paint reflects light. The way reflected light mixes is different from the way direct light mixes.

Blend Red, Yellow, and Blue paint together (Reflected light) and what color do you get?



Blend Red, Yellow, and Blue lights together (Direct light) by focusing them on the same spot and what color do you get?



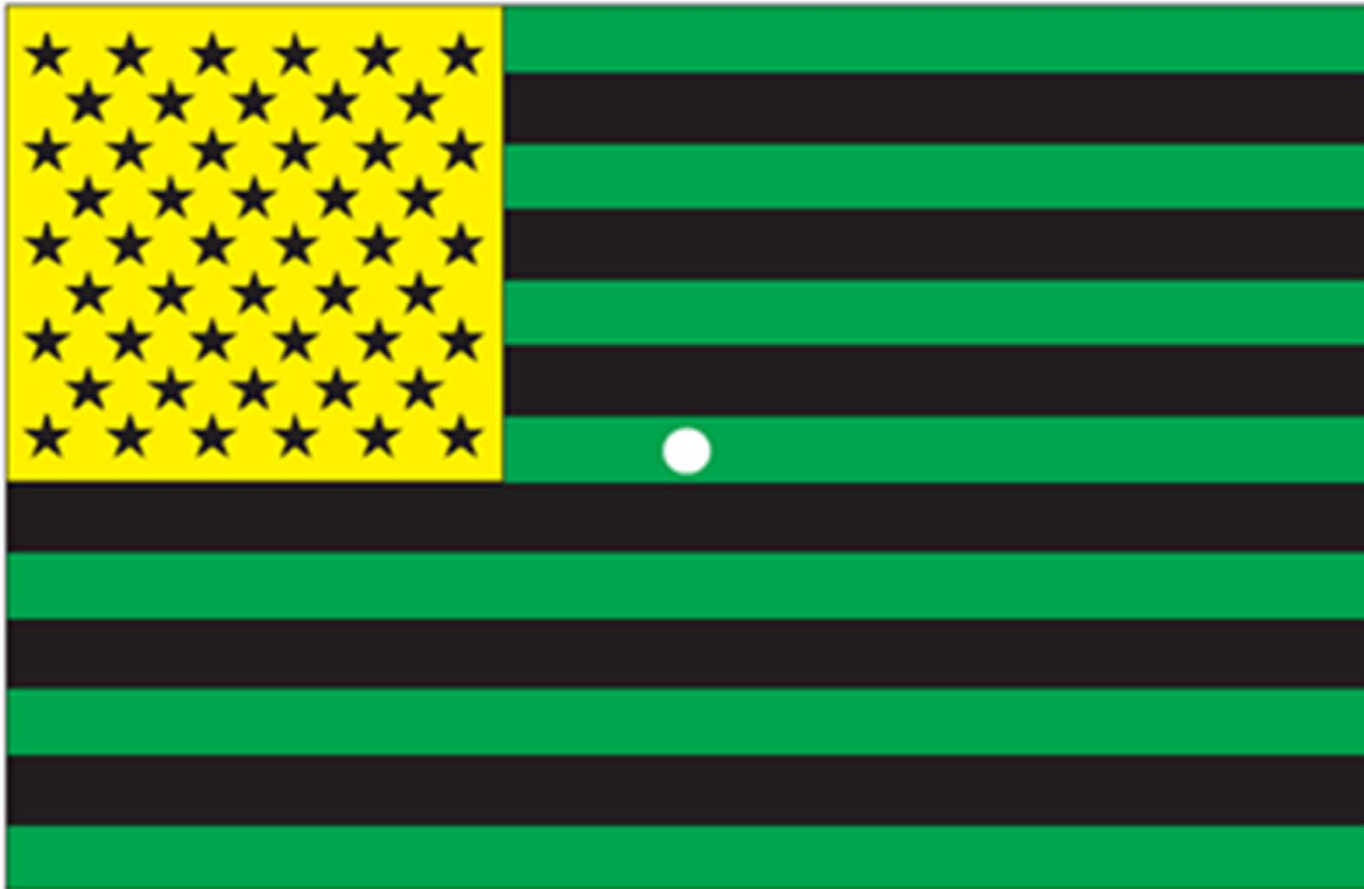


Here are a pair of Cones: Blue and Yellow. When one Cone within the pair is firing, it shuts off the ability of the other Cone to fire.

If you stare at a Blue image for a minute, the Blue Cone is firing and inhibiting (stopping) the Yellow Cone from firing, but, as you continue to stare, you are tiring out or weakening the Blue Cone's ability to stop the Yellow cone from firing.

When you look away from the blue image, the Yellow Cone is no longer inhibited and will begin to fire giving you a yellow **Afterimage**.

Figure 3.6 Color Afterimage

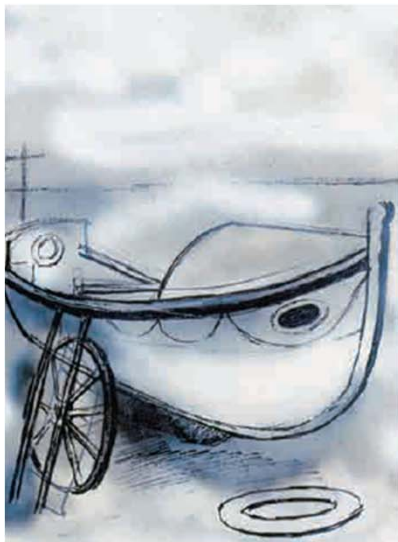


Stare at the white dot in the center of this oddly colored flag for about 30 seconds. Now look at a white piece of paper or a white wall. Notice that the colors are now the normal, expected colors of the American flag. They are also the primary colors that are opposites of the colors in the picture and provide evidence for the opponent-process theory of color vision.

Color Blindness

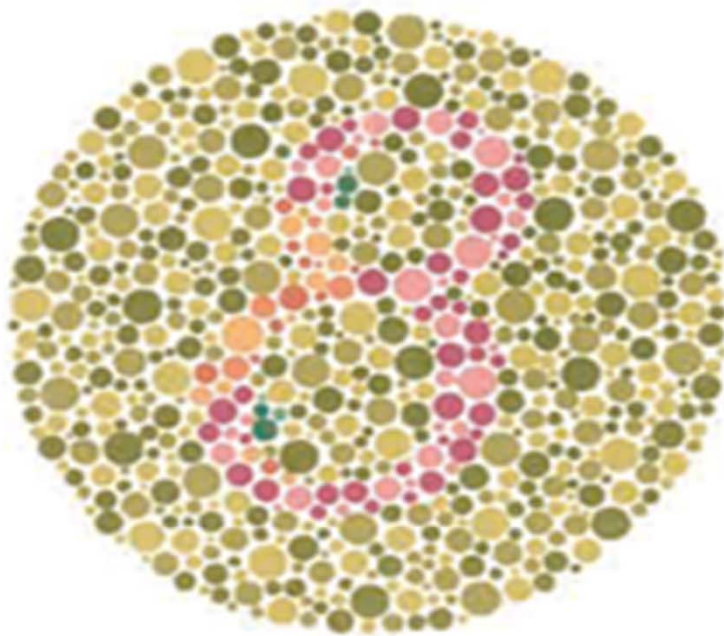
There are 3 main types of color blindness, (Monochromatic, Dichromatic and Tritanopia) though some people can have cones that are weaker and slightly alter the way they see color:

1. Monochromatic colorblindness – Very rare; person either have no cones or they have cones that are not working at all. If they do have cones they have only 1 type and therefore everything looks the same to the brain (shades of gray).
2. Dichromatic colorblindness – A. **Protanopia (Red-Green)**- the **red cone** does not function. B. **Deuteranopia (another Red-Green color deficiency)** results from the lack of functioning **green cones**. People with these forms would see in **blues, yellows**, and shades of gray.
3. Tritanopia colorblindness - (blue-yellow color deficiency). If the **blue cones** are not working then the person sees in **reds, greens**, and shades of gray. Blue yellow color blindness is quite uncommon; people who are **blue-yellow** color blind will confuse some shades of blue with green, and some shades of yellow with violet. Much like red green color blindness, those who are blue yellow color blind can be categorized in two ways. However, unlike red and green color blindness, blue yellow color blindness is not more prominent in males.



What numbers do you see?

Figure 3.7 The Ishihara Color Test

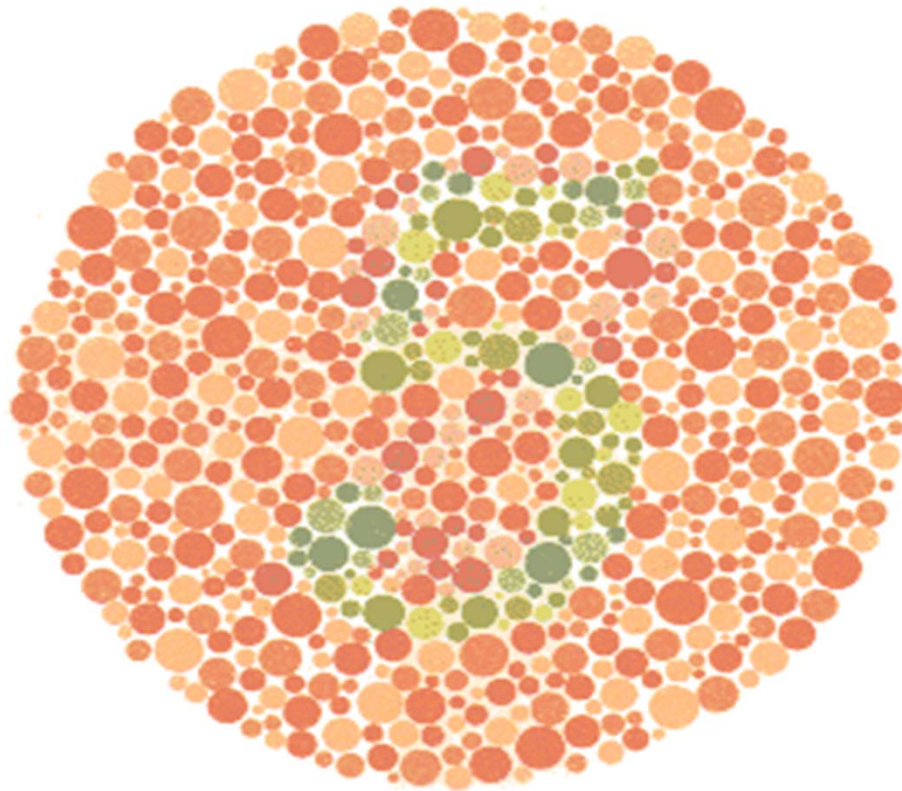


The number 8 is visible only to those with normal color vision.



The number 96 is visible to those with normal color vision, while those with red-green color blindness will see nothing but a circle of dots

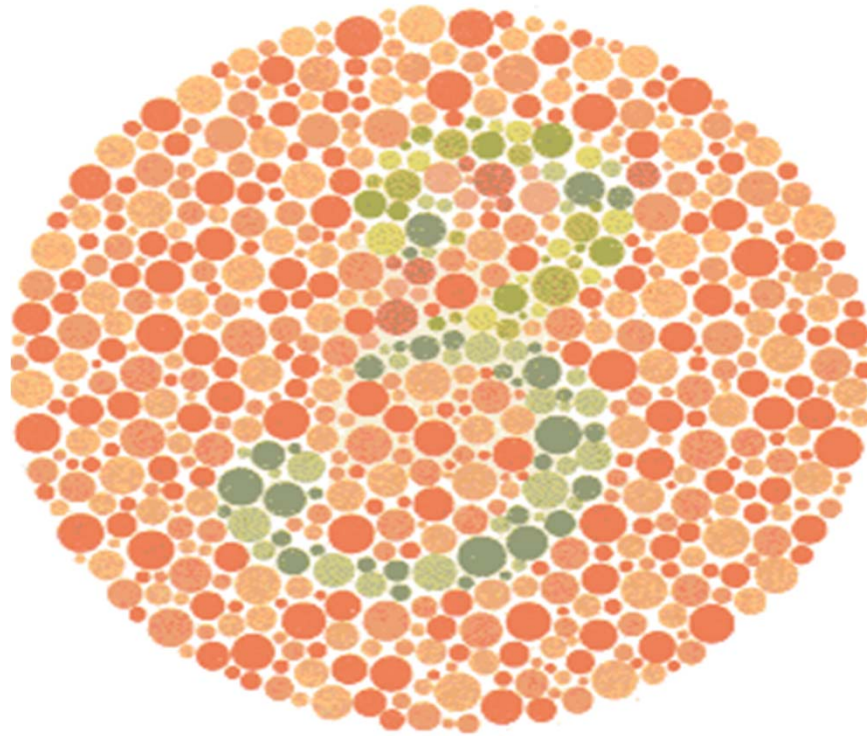
What number do you see?





Those with normal color vision see this 5.
People with red-green will see a 2.

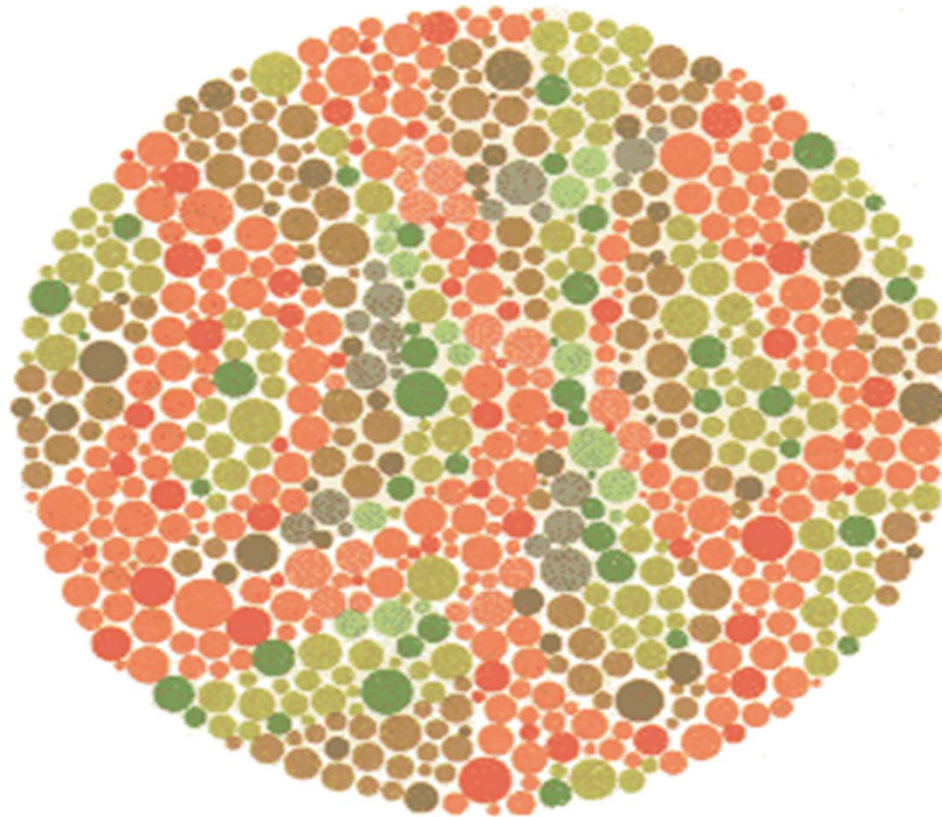
What number do you see?





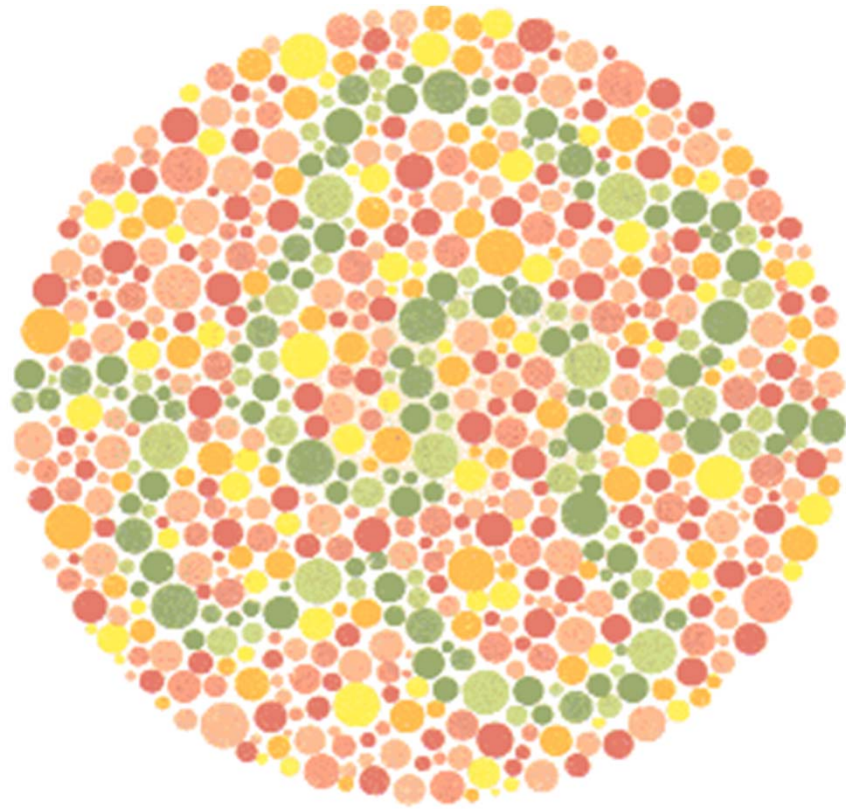
Those with normal color vision see this 3.
People with red-green will see a 5.

What number do you see?

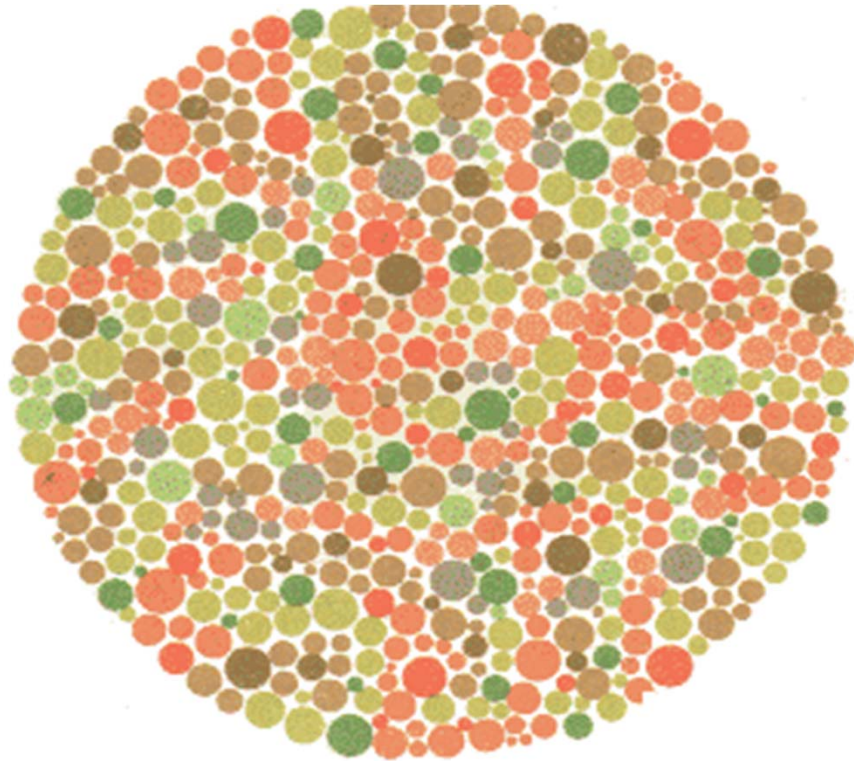


People with normal color vision will not see any number. Those with Red-Green color blindness will see a 5.

Can you trace the wiggly line?



Can you trace the wiggly line?



Ishihara Color Blindness Test

<http://www.colour-blindness.com/colour-blindness-tests/ishihara-colour-test-plates/>

Synesthesia

- Synesthesia –
**sensory
information
processed in
wrong cortical
areas**
 - information
interpreted as
more than one
sense

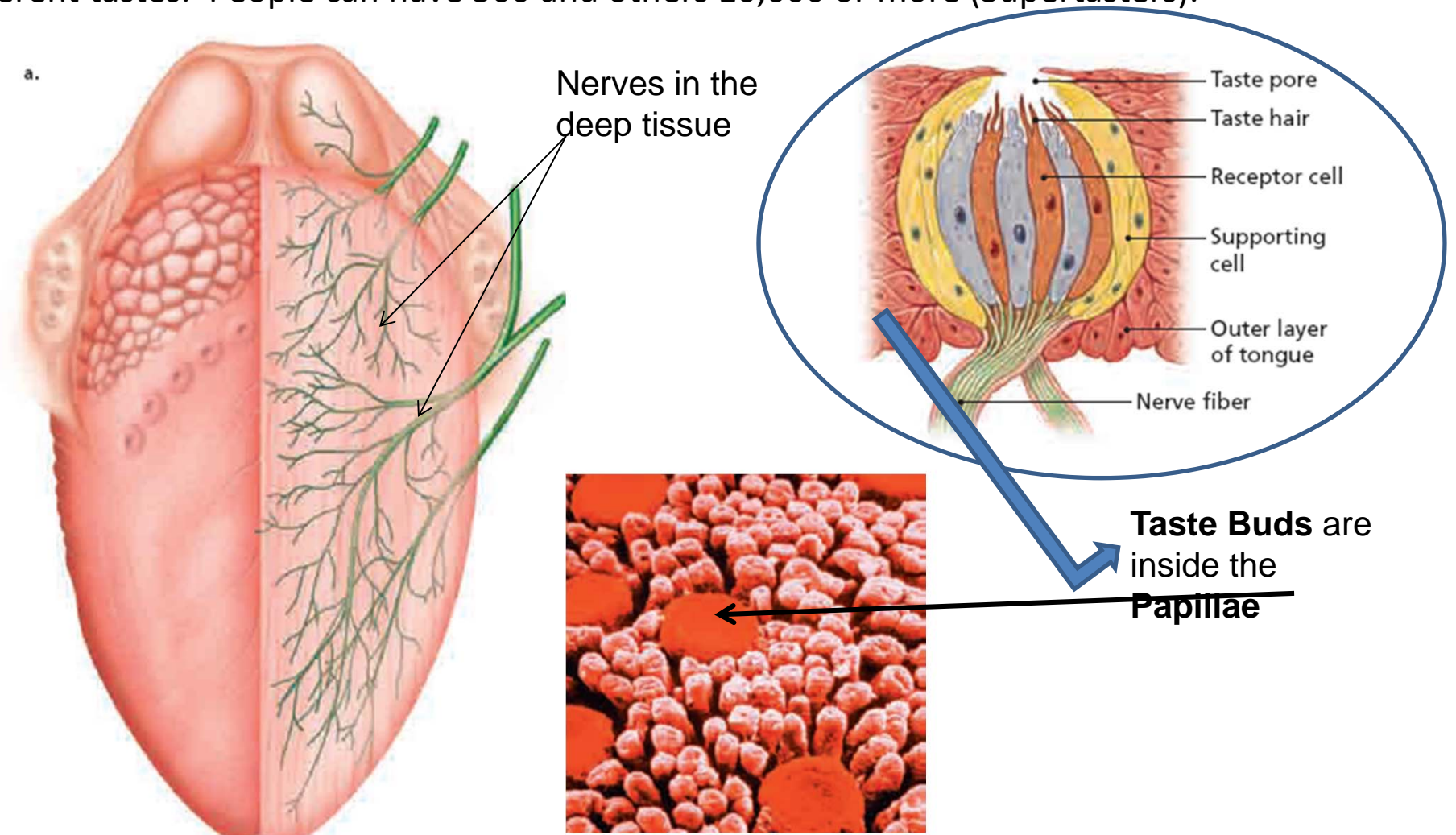


Synesthesia

- A *synesthete* is a person with **synesthesia**, which literally means “joined sensation.” People with this condition are rare—about 1 in 25,000. In the synesthete, the signals that come from the sensory organs, such as the eyes or the ears, go to places in the brain in which they weren’t originally meant to be, causing those signals to be interpreted as more than one sensation. A fusion of sound and sight is most common, but touch, taste, and even smell can enter into the mix.

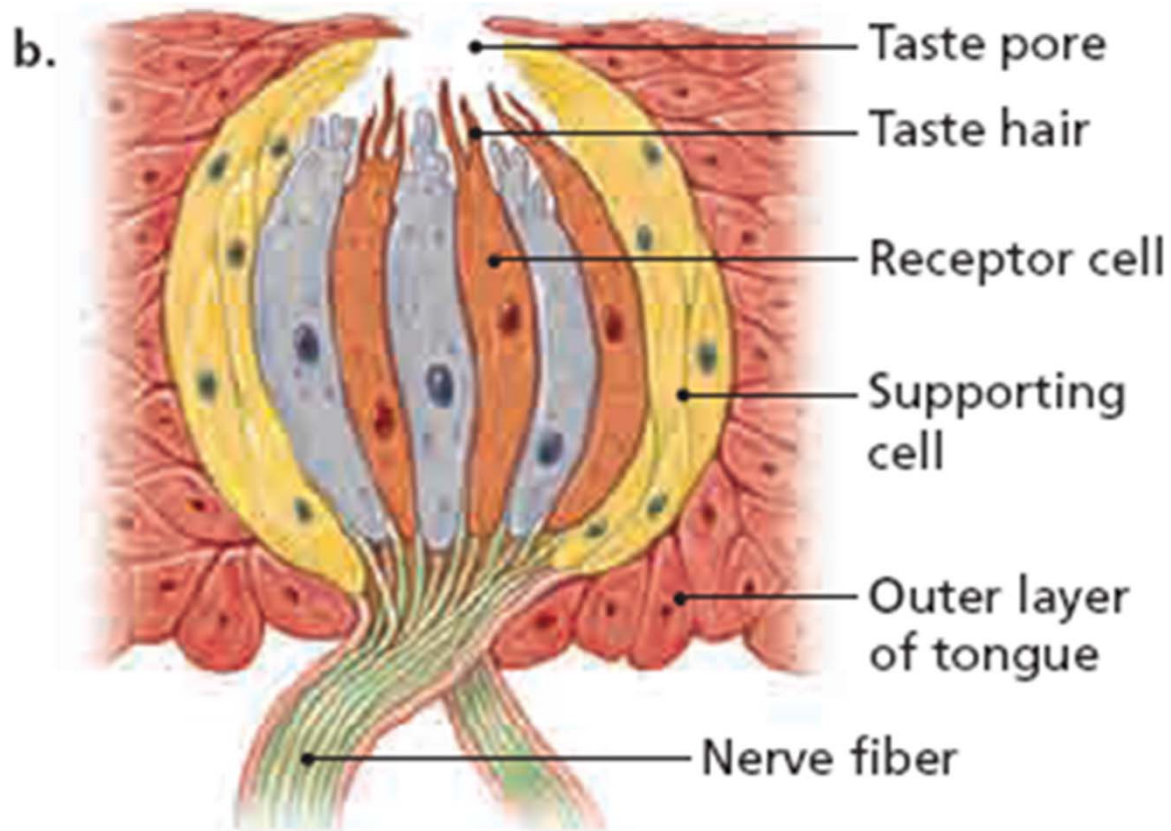
Ch. 3 Sensation: Taste

Taste Buds – Called taste receptor cells in mouth; responsible for sense of taste, which is called Gustation. Most Taste buds are located on the tongue but some are on the roof of your mouth and on cheeks. The more Taste Buds you have the more sensitive you are to different tastes. People can have 500 and others 10,000 or more (Supertasters).



Taste Buds are inside the **Papillae**

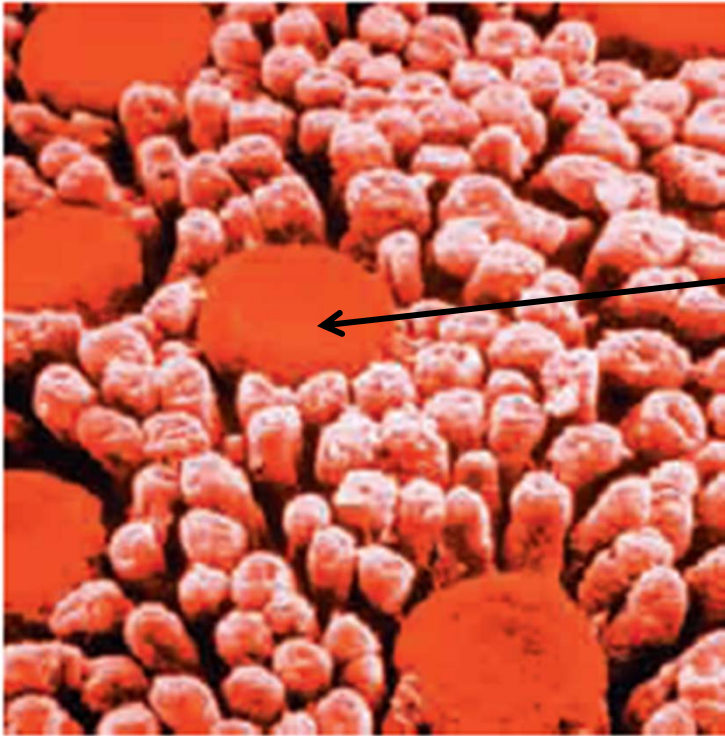
Taste Bud



The **Taste Buds** (which are really your **Taste Receptors**) are special neurons located inside the Papillae and are composed of small cells that send signals to the Brain when stimulated by molecules of food

Surface of the Tongue

c.



Surface of the Tongue showing two different sizes of Papillae; Taste Buds are located under the larger Papillae (refer back to slide two for the taste bud itself). The smaller Papillae form a tough-sensitive rough surface that assists in chewing and moving food around the mouth. Taste Buds are replaced every 10-14 days.

How We Taste

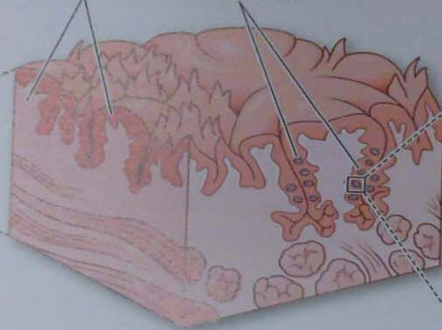
FIGURE 4.8 How We Taste

1 Stimuli

When you bite into something, molecules dissolve in fluid on your tongue and are received by...

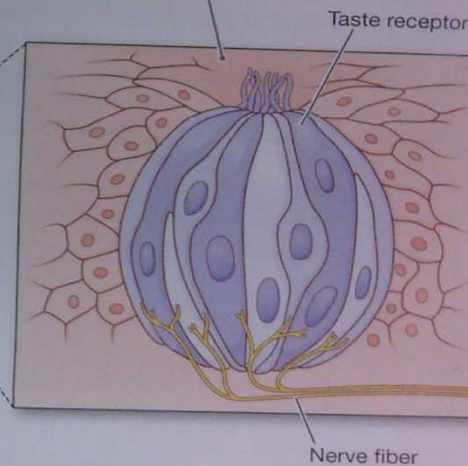


Papillae Taste buds



2 Receptors

taste receptors in taste buds (on your tongue and in your mouth and throat), which transmit that signal...



How We Taste

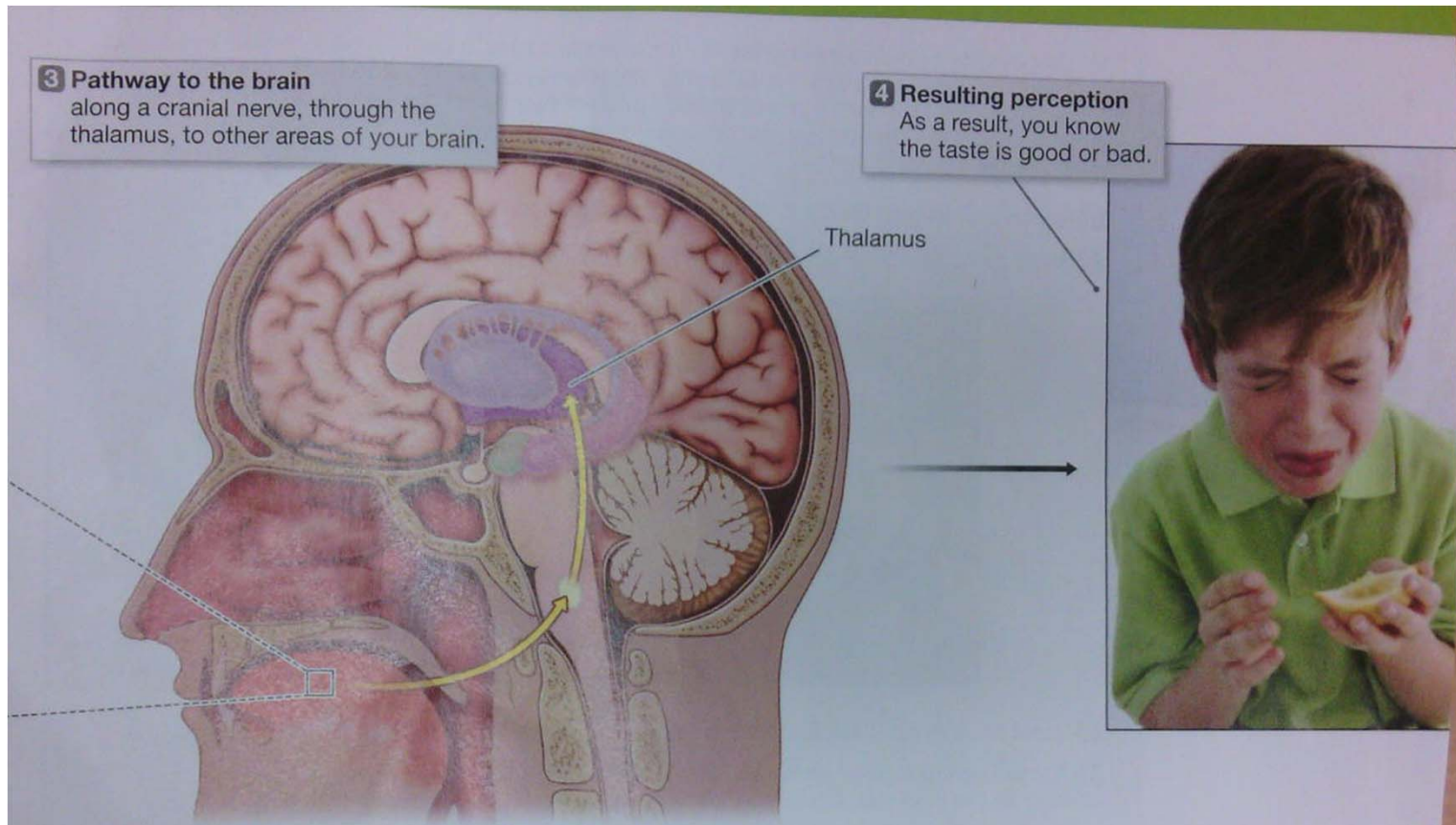
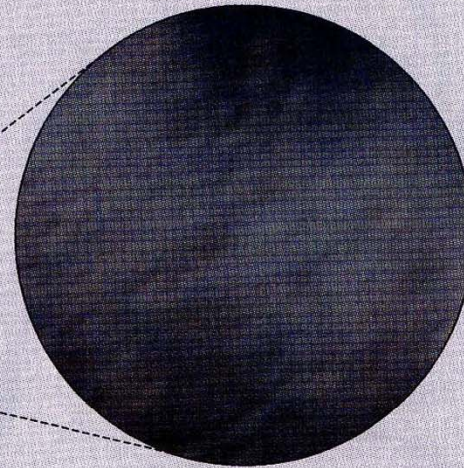
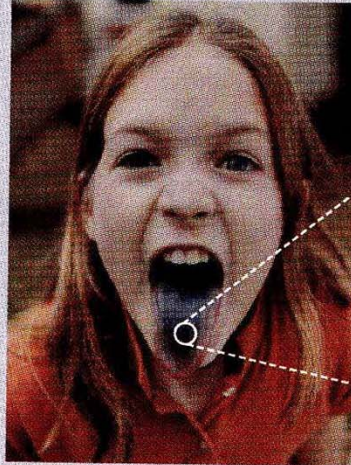


FIGURE 4.9 Try for Yourself: Are You a Supertaster?

Do you wonder if you are a supertaster? Supertasters tend to be thin and to dislike vegetables that can be bitter, such as broccoli. Women are more likely than men to be supertasters. Supertasters are born with more taste buds and are more likely to become professional chefs or wine tasters. To determine if you are a supertaster, the psychologist Linda Bartoshuk suggests the following test:

- 1 Punch a small hole (about 7 millimeters or .25 inches) into a small square of wax paper.
- 2 Swab some blue food coloring on the front of your tongue, then place the wax paper over it.



- 3 Use a magnifying glass to view the part of your tongue that shows through the small hole.
- 4 You will see pink dots, which are the papillae. They remain pink because they do not take up the blue dye. Count the number of pink dots you can see in the small hole.

Result: In general, fewer than 15 papillae means you have fewer taste buds than average, 15 to 35 is average, and above 35 means you are probably among the 25 percent of the population who are supertasters.

Super Tasters





- Extrasensory Perception (ESP) - claim of perception that occurs without the use of normal sensory channels such as sight, hearing, touch, taste, or smell.
 - Telepathy - claimed ability to read another person's thoughts or ideas (mind reading) by means other than the known senses.
 - Clairvoyance - supposed ability to "see" things that are not actually present; perceiving things or events in the future
 - Precognition - supposed ability to know something in advance of its occurrence or to predict a future event.
- Parapsychology - the study of ESP, ghosts, and other subjects that do not normally fall into the realm of ordinary psychology.

[Menu](#)



Figure 3.24 Zener Cards

These five shapes—star, circle, cross, wavy lines, and square—are used in a test for telepathy, a form of extrasensory perception. One person (the sender) looks at each card after pulling it from a randomly shuffled deck of these five cards and thinks about the image on the card. The person being tested for telepathy, who cannot see the card, is supposed to guess what the shape is. An accuracy rate greater than chance is taken as an indication of telepathic ability.