Module 08

Sensation

Sensation

- The process by which our sensory systems (eyes, ears, and other sensory organs) and nervous system receive stimuli from the environment
- A person's awareness of the world

Bottom-Up Processing

- Information processing that focuses on the raw stimuli entering through the many sensory systems
- *Gathering* environmental *information* through the senses

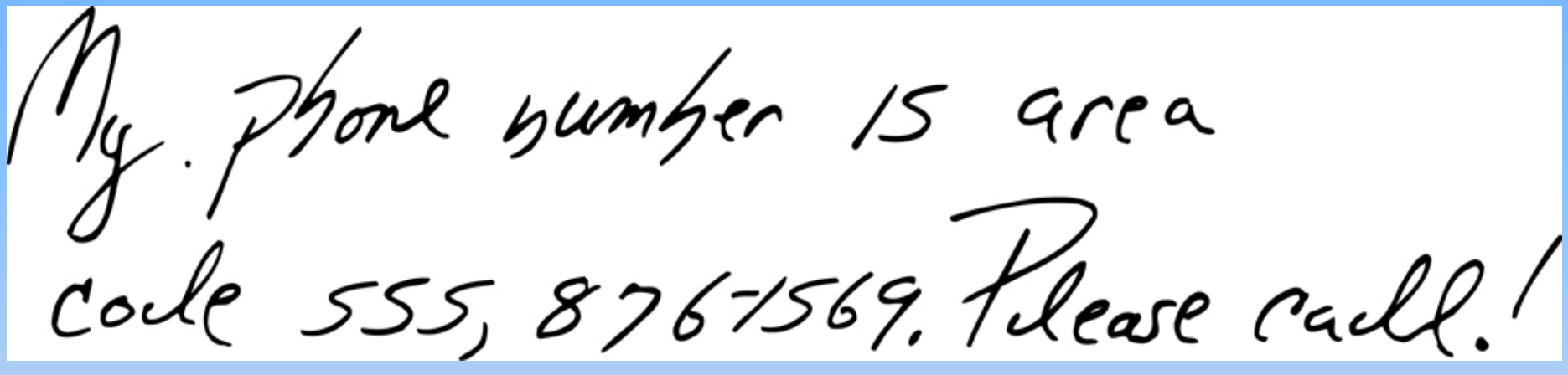
Perception

- The process of *organizing* and *interpreting* incoming sensory information

Top-Down Processing

- Information processing that draws on *expectations* and experiences to *interpret* incoming sensory information

Top-Down Processing



- Relies on your experiences with, and expectations about, language

IF YOU CAN READ THIS YOU HAVE A STRONG MIND!

7H15 M3554G3
53RV35 7O PR0V3
H0W 0UR M1ND5 C4N
D0 4M4Z1NG 7H1NG5!
1MPR3551V3 7H1NG5!
1N 7H3 B3G1NN1NG
17 WA5 H4RD BU7
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Y0UR M1ND 1S
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4U70M471C4LLY
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B3 PROUD! 0NLY
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Module 8: Sensation

Basic Principles: Thresholds, Signal Detection, Sensory Adaptation, and Selective Attention

Threshold

- An edge or a boundary

Absolute Threshold

- The minimum amount of a stimulation needed to detect a particular stimulus
- Amount of a stimulus needed for a person to detect it 50% of the time
- For example, the dimmest star in the sky would be right at the absolute threshold for vision because it is just barely bright enough for you to see
- The least amount of basil you can taste in the spaghetti sauce would be the absolute threshold for taste
- (clock demo)

Difference Threshold

- The minimum amount of *difference* needed to detect that two stimuli are not the same
- Also called just noticeable difference (JND)
- For example, how much do you have to increase the volume before you can tell the music is louder?
- How many degrees do you need to turn the heat up before you notice a change in the temperature?
- (Envelopes, pennies and shoes)

Weber's Law

- States that the *intensity* of the just-noticeable difference depends on *how large the stimulus is to begin with*.
- For example, if someone is bench pressing 250 pounds, they may not notice an additional 10 pounds being added. However, if they are only bench pressing 40 pounds, then an additional 10 pounds will be much more noticeable

Signal Detection Theory

- A theory that predicts how and when we detect the presence of a faint stimulus (signal) amid background stimulation (noise)
- Developed out of the Cold War as a way to detect incoming nuclear bombs in time to respond appropriately (99 Red Balloons)

Signal Detection Theory

- Three kinds of variables
  - *Stimulus variables* – how bright is the blip on the radar screen?
  - *Environmental variables* – how much distracting noise is there in the room with the radar equipment?
  - *Organismic variables* – is the operator properly trained, or motivated?

Sensory Adaptation

- Diminished sensitivity to constant and unchanging stimulation
- If a stimulus is constant and unchanging, eventually a person may fail to respond to it (you “get used to it”)
- For example, a pool may be freezing cold when you first jump in, but you no longer notice after a couple of minutes

Selective Attention

- Focusing conscious awareness on a particular stimulus to the exclusion of others
- The ability to focus on one stimulus at a time
- Allows a person to function in a world filled with many stimuli

Selective Attention

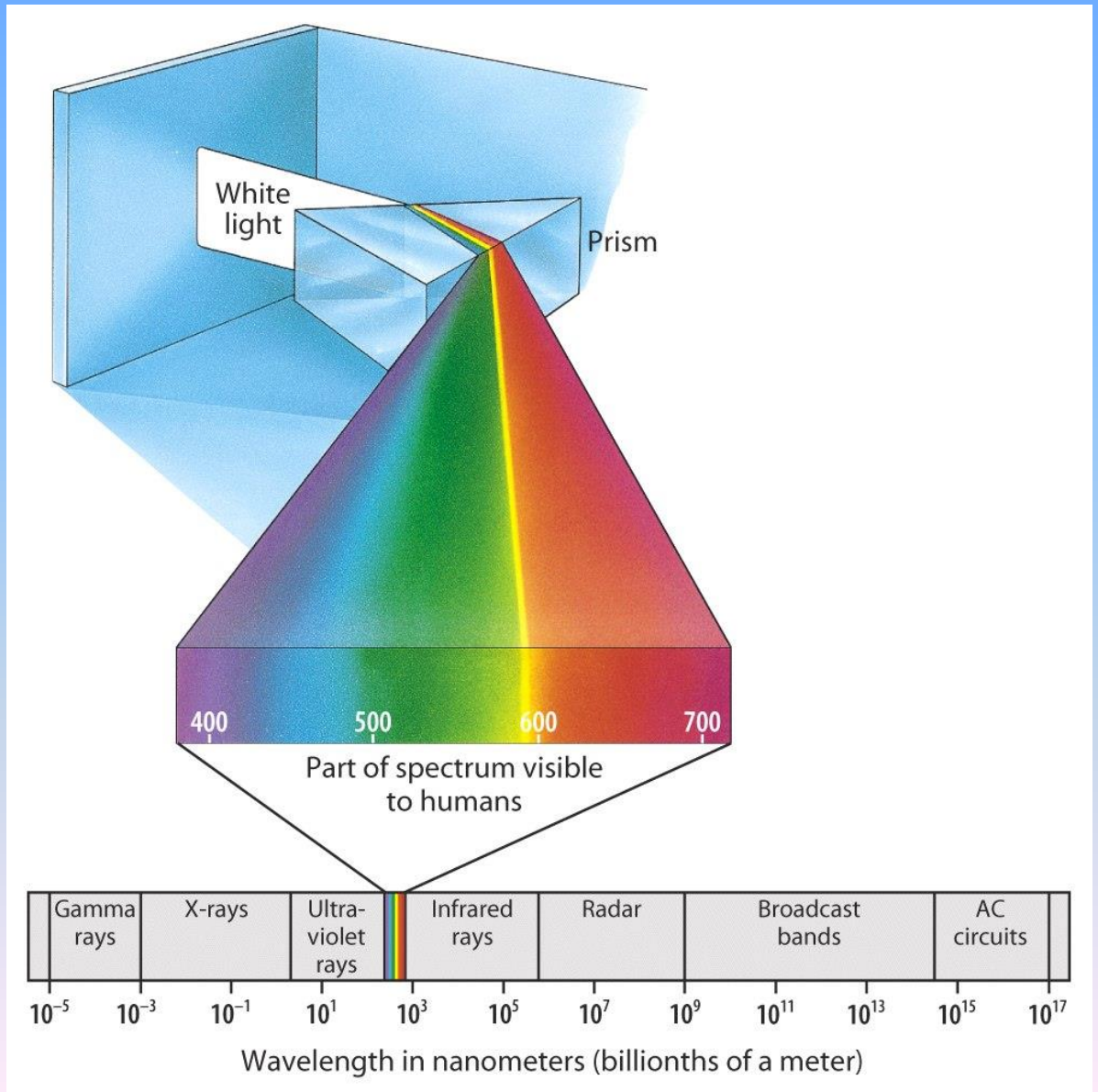
Module 8: Sensation

The Visual System: The Nature of Light

Electromagnetic Energy

- An energy spectrum that includes X-rays, radar, and radio waves
- A small portion of the spectrum includes light visible to the human eye

The Electromagnetic Spectrum



Hue

- The *color* of light as determined by the wavelength of the light energy
- Includes: red, orange, yellow, green, blue, indigo and violet (ROY G BIV)
- The eye can detect 7 million separate hues

Wavelength

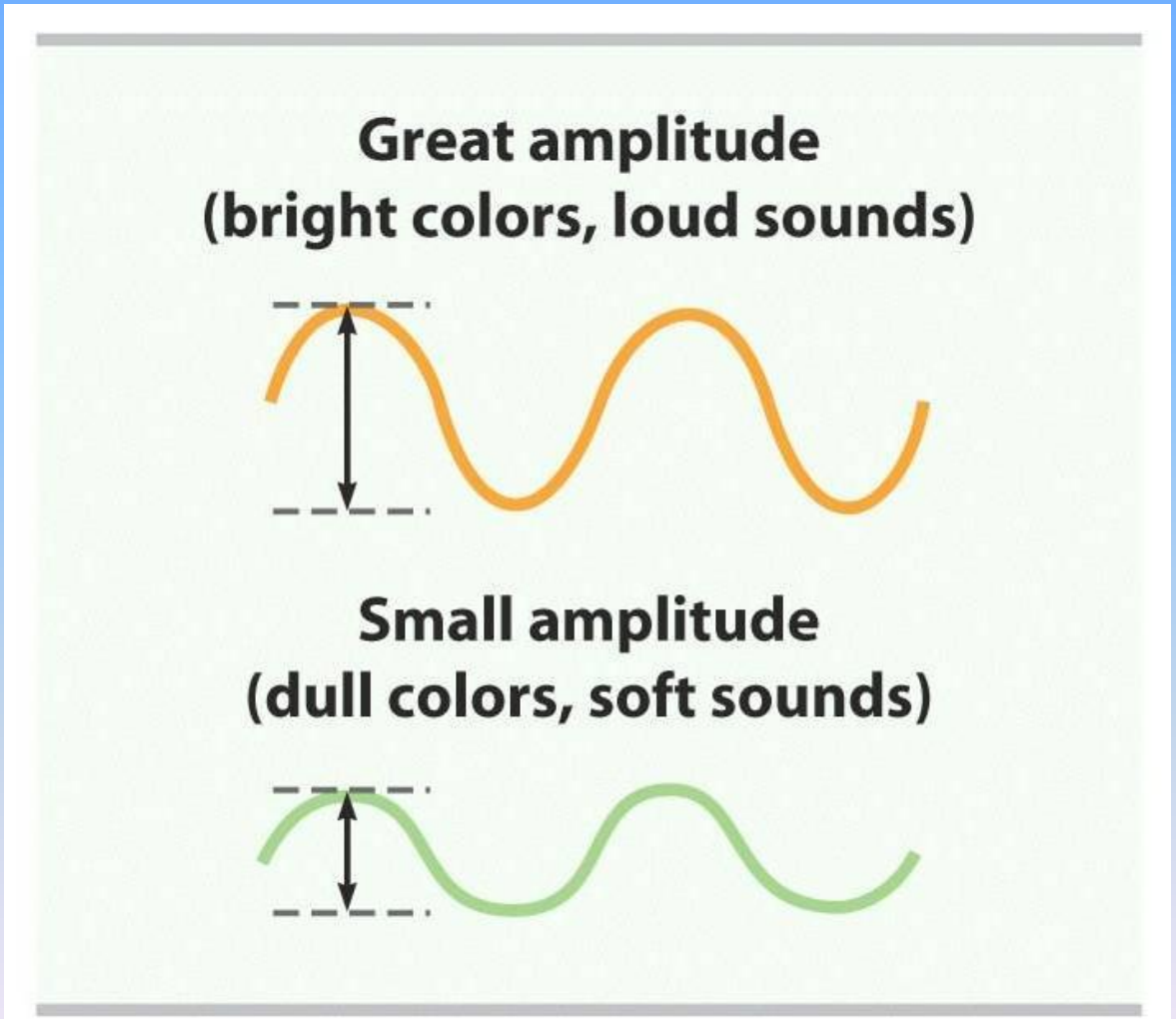
Short wavelength = high frequency
(bluish colors, high-pitched sounds)

Long wavelength = low frequency
(reddish colors, low-pitched sounds)

Amplitude

- The *brightness* of light as determined by height of the wave
- The *taller* the wave, the *brighter* the color

Amplitude


Great amplitude
(bright colors, loud sounds)
Small amplitude
(dull colors, soft sounds)

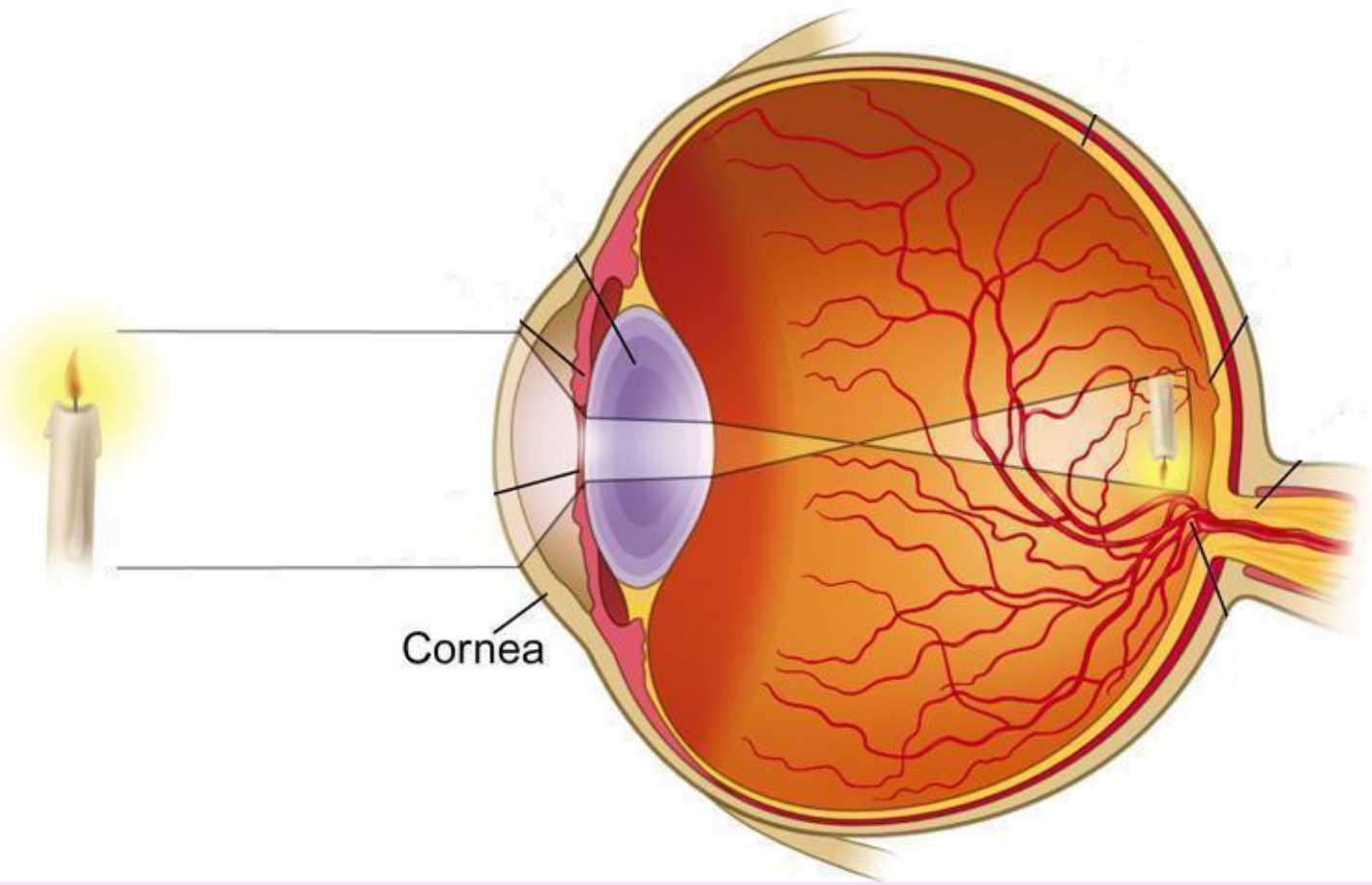
Module 8: Sensation

The Visual System: The Structure of the Visual System

Cornea

- The clear, curved bulge on the *front of the eyeball*
- Begins to focus the light by bending it toward a central focal point
- Protects the eye

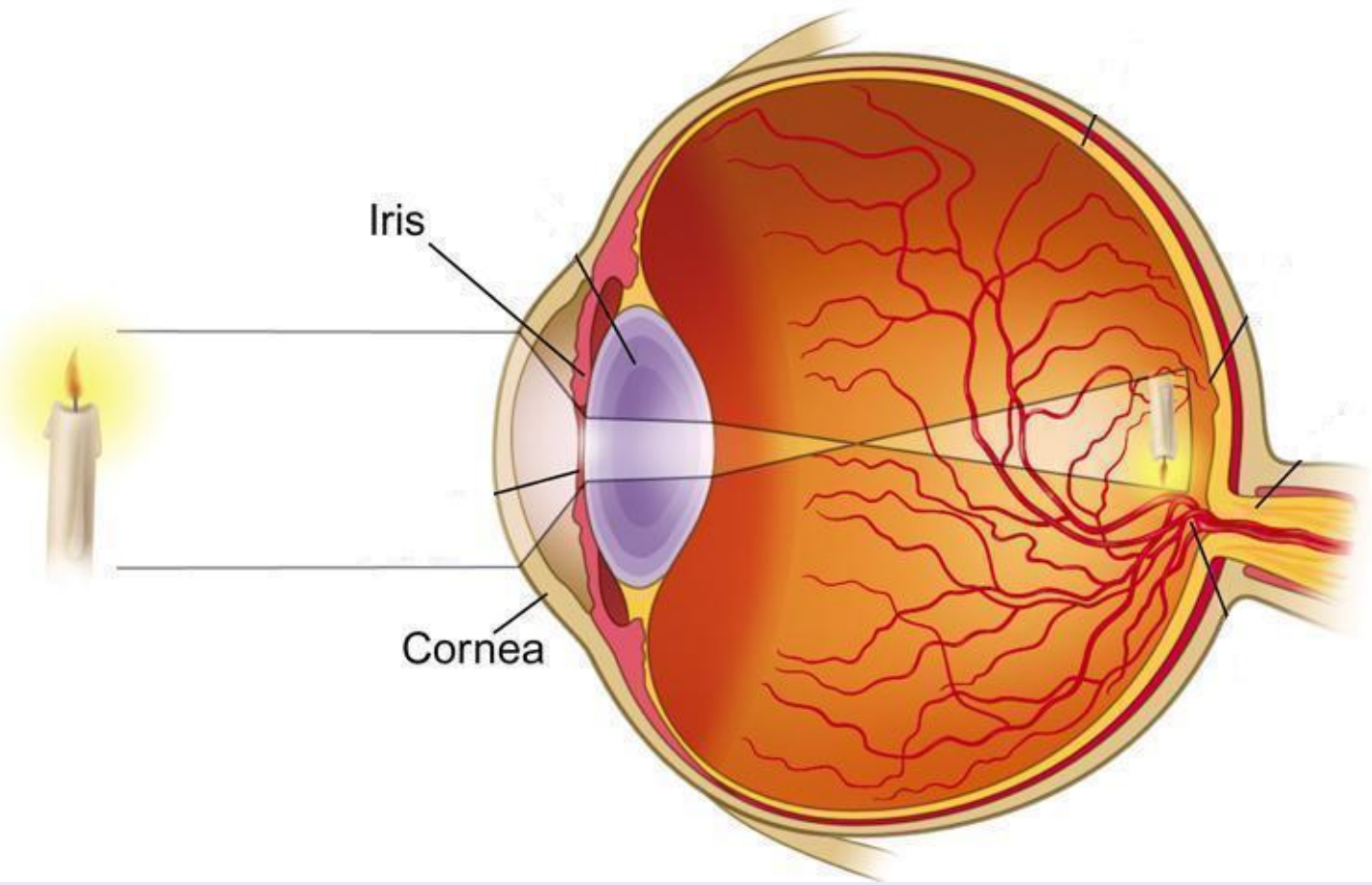
Parts of the Eye – Cornea



Iris

- A ring of muscle tissue that forms the *colored portion of the eye*; creates a hole in the center of the iris (pupil)
- Regulates the size of the pupil by changing its size--allowing more or less light to enter the eye

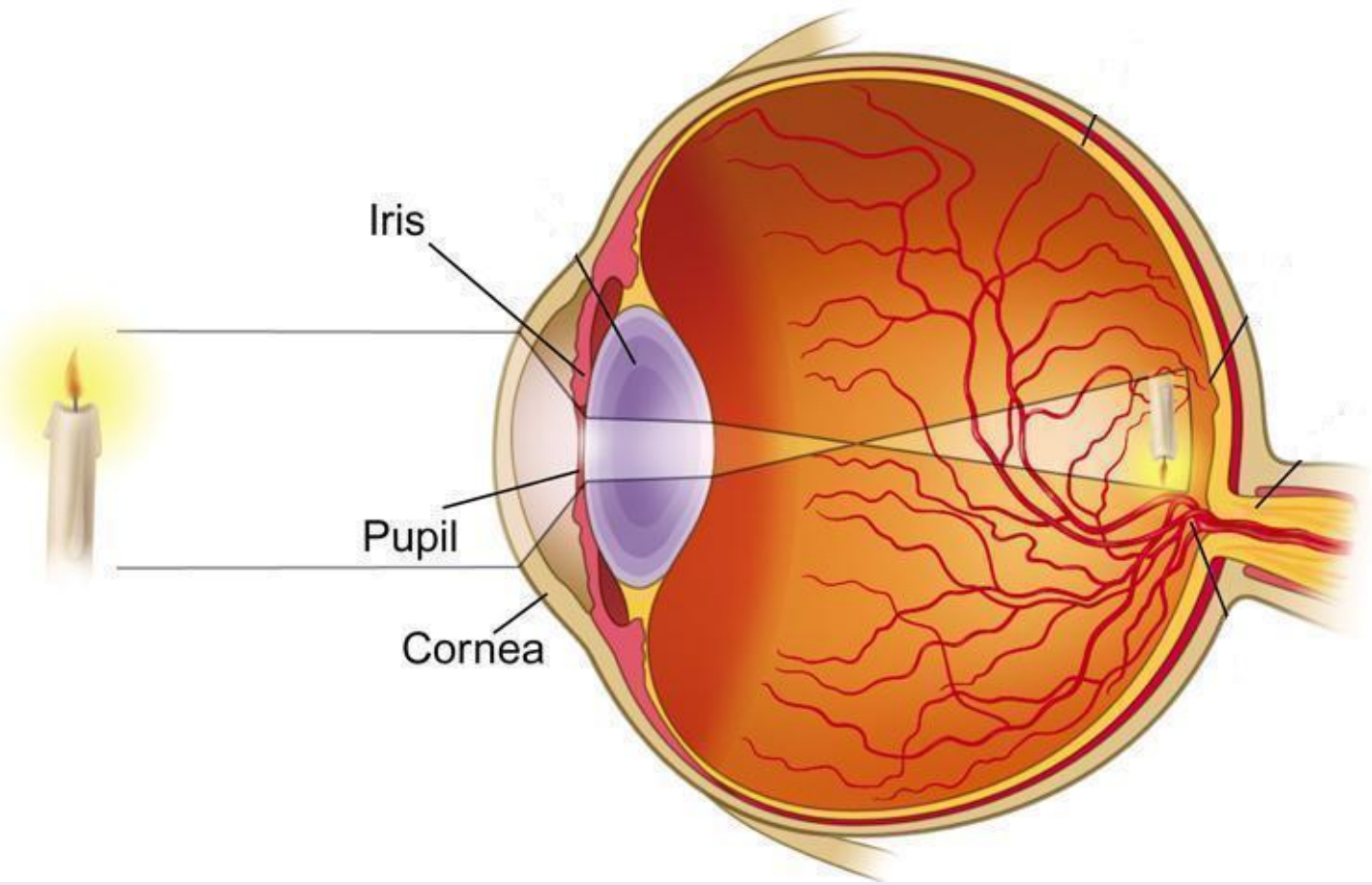
Parts of the Eye - Iris



Pupil

- The adjustable opening in the center of the eye; which *controls the amount of light entering the eye* (surrounded by the iris)
- Appears black because no light is emitted *from* the eye (like looking into opening of a dark cave)
- In bright conditions the iris expands, making the pupil smaller and letting in less light.
- In dark conditions the iris contracts, making the pupil larger and letting in more light.
- (lights on and off)

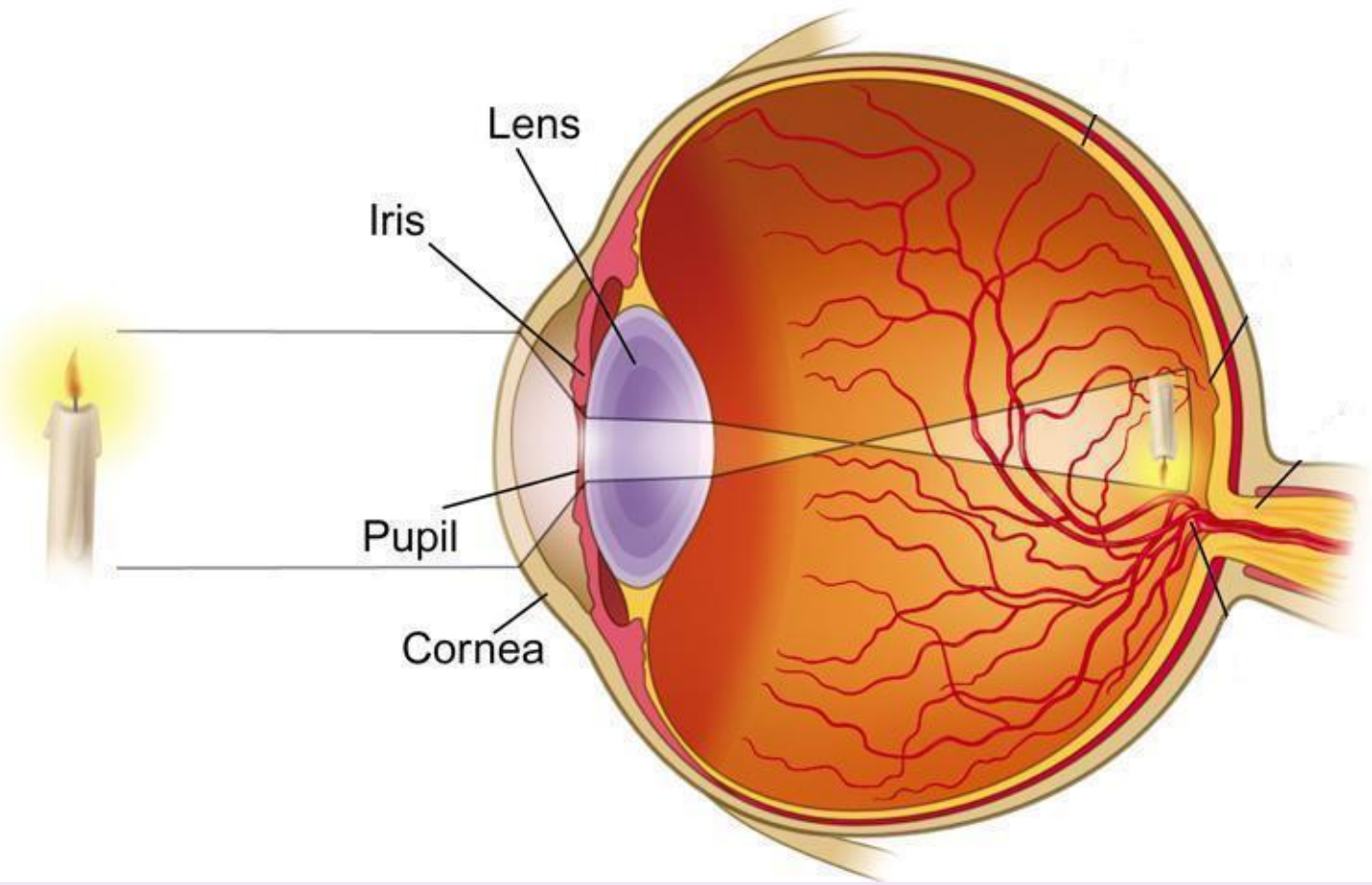
Parts of the Eye - Pupil



Lens

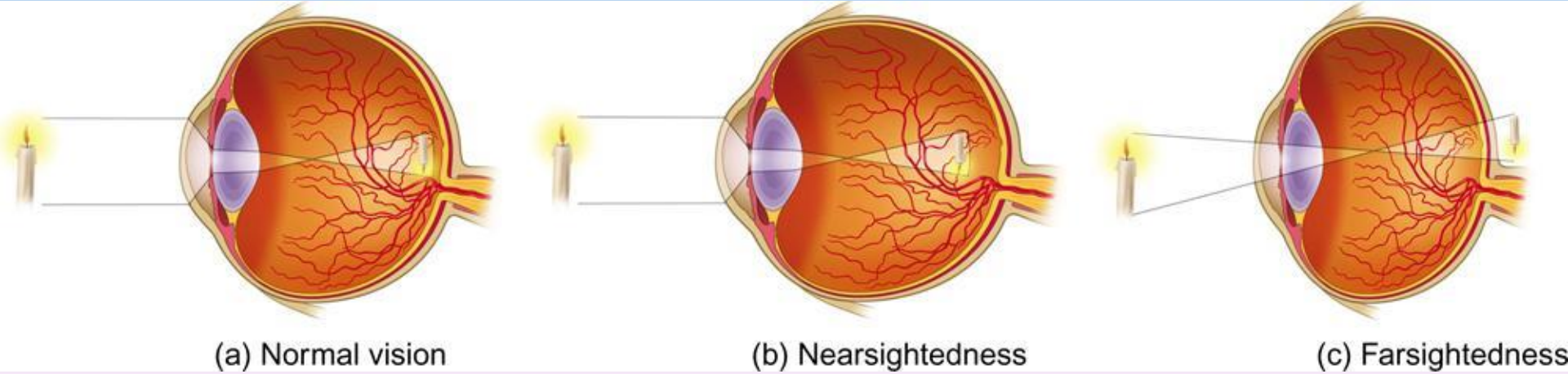
- A transparent structure behind the pupil in the eye that changes shape to *focus images on the retina*
- Muscles that change the thickness of the lens change how the light is bent thereby focusing the image
- Glasses or contacts correct problems in the lens' ability to focus.

Parts of the Eye - Lens



Nearsightedness and Farsightedness

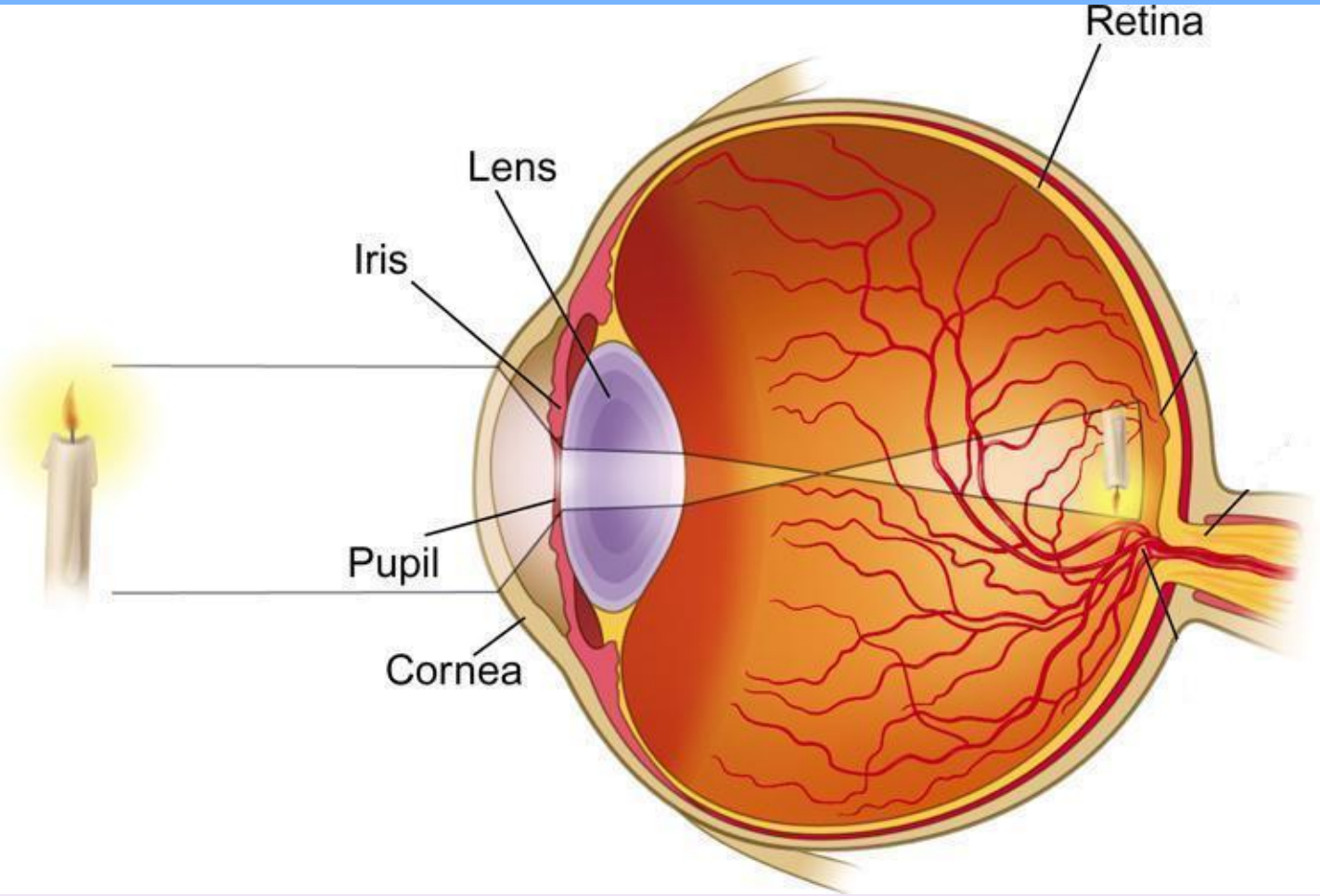
- *Normal vision* – lens focuses the light rays into an image *on* the retina – clear focused image
- *Near-sighted* – lens causes light rays from *distant* objects to converge in *front* of the retina
- *Far-sighted* – lens causes light rays from *close* objects to converge *behind* the retina



Retina

- Light-sensitive surface at the back of the eyeball
- Contains cells that *convert light energy to nerve impulses (*process called *transduction)*
- Made up of three layers of cells
  - Receptor cells
  - Bipolar cells
  - Ganglion cells

Parts of the Eye - Retina



Receptor Cells

- Specialized cells in every sensory system of the body that can *turn other different kinds of energy into action potentials* (neural impulses) that the brain can process
- These cells are present in every sensory system to change (*transduce*) some other form of energy into neural impulses.
- *In sight they change light into neural impulses the brain can understand.*
- Visual system has two types of receptor cells – rods and cones

Rods

- Visual receptor cells located in the retina
- Can only detect *black, white and gray*
- In dim light conditions, only rods respond and you see the world in shades of gray
- *Respond to less light* than do cones (they have a *lower absolute threshold* than cones)

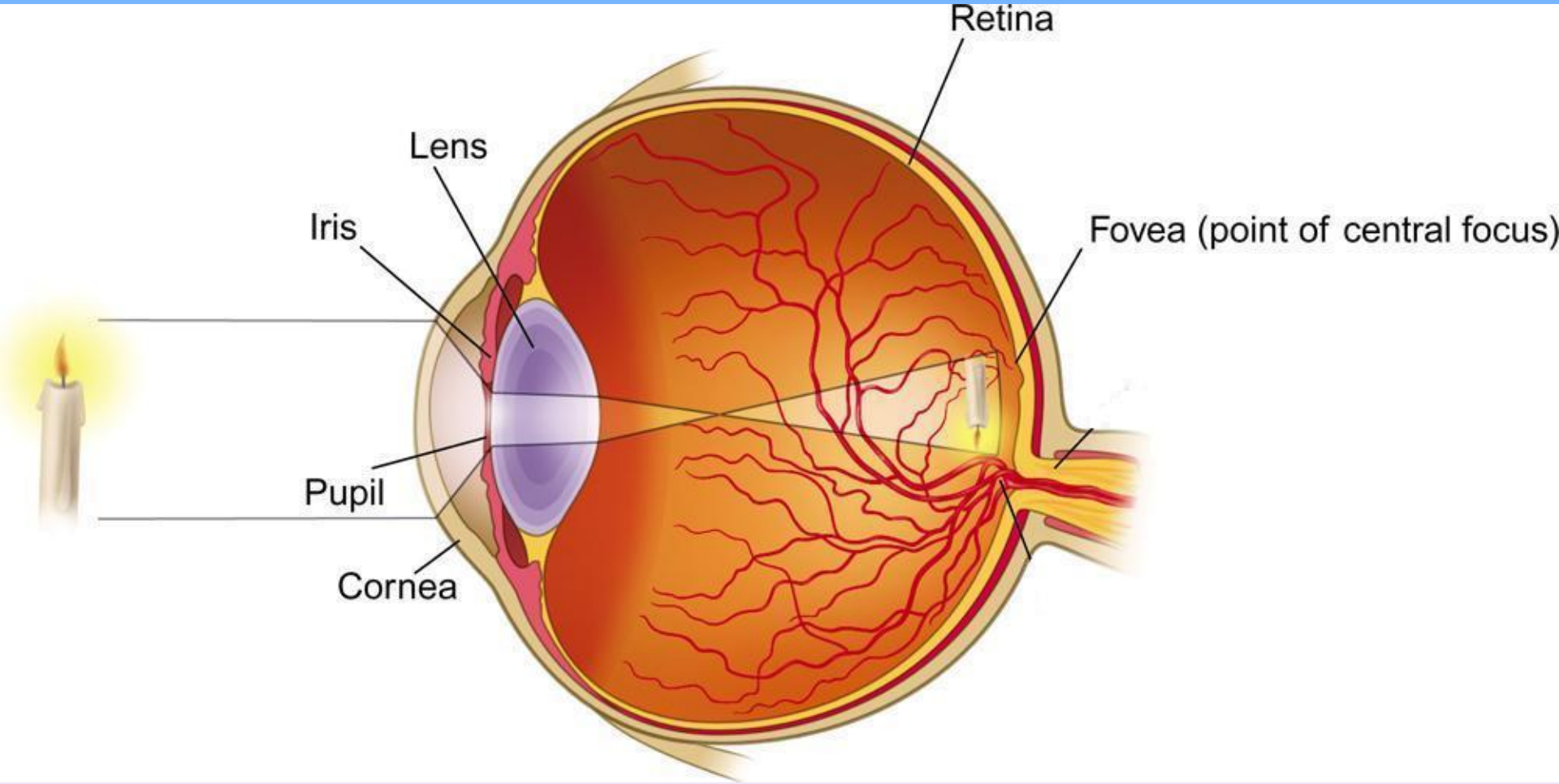
Cones

- Visual receptor cells located in the retina
- Can detect sharp details and *color*
- Need more light than the rods
- Many cones are clustered in the *fovea*

Fovea

- The central focal point of the retina
- The spot where vision is best (most detailed)

Parts of the Eye - Fovea



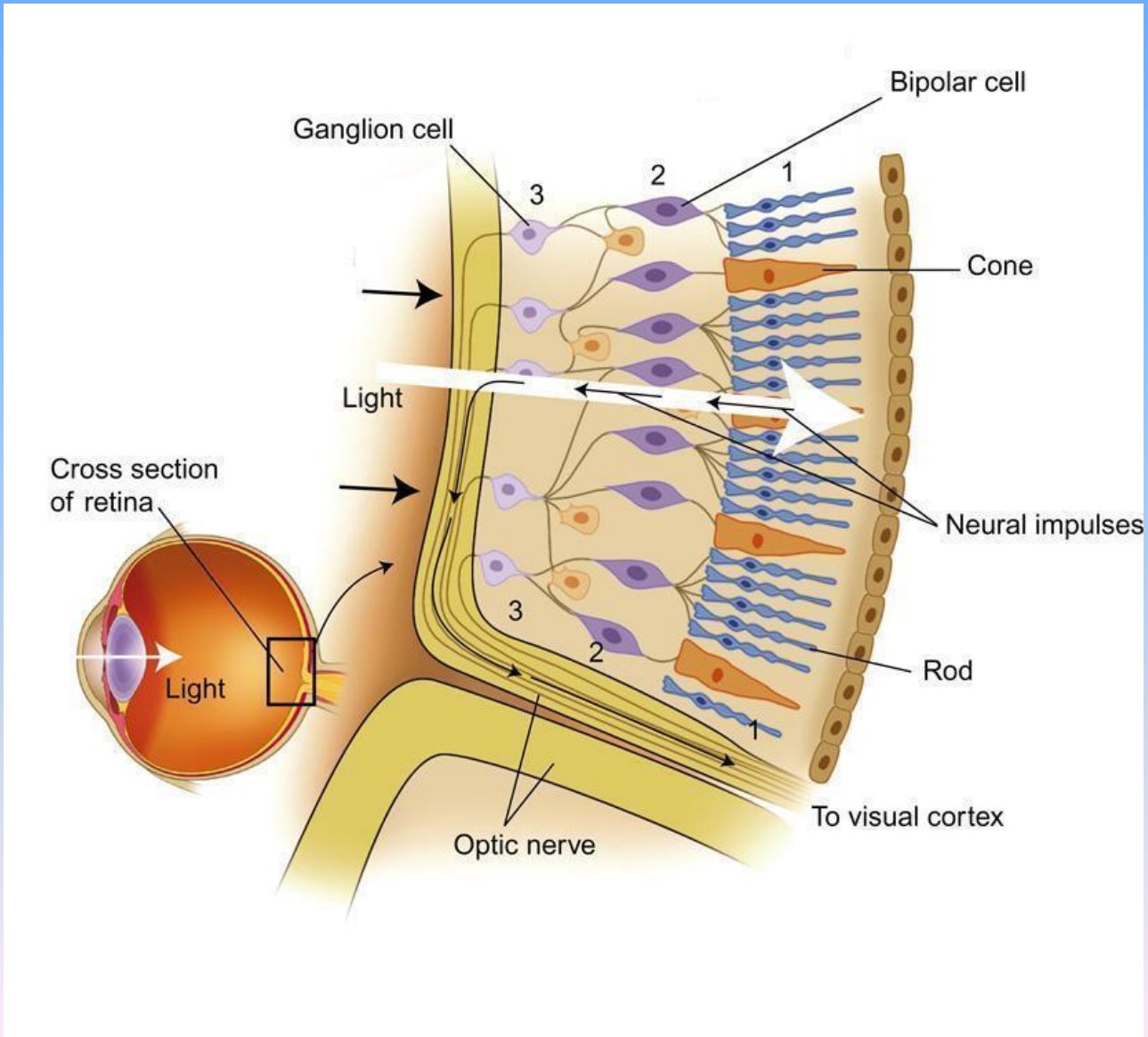
Bipolar Cells

- Gather information from the rods and cones and *pass it on to the ganglion cells*
- Cells that form the *middle layer* in the *retina*

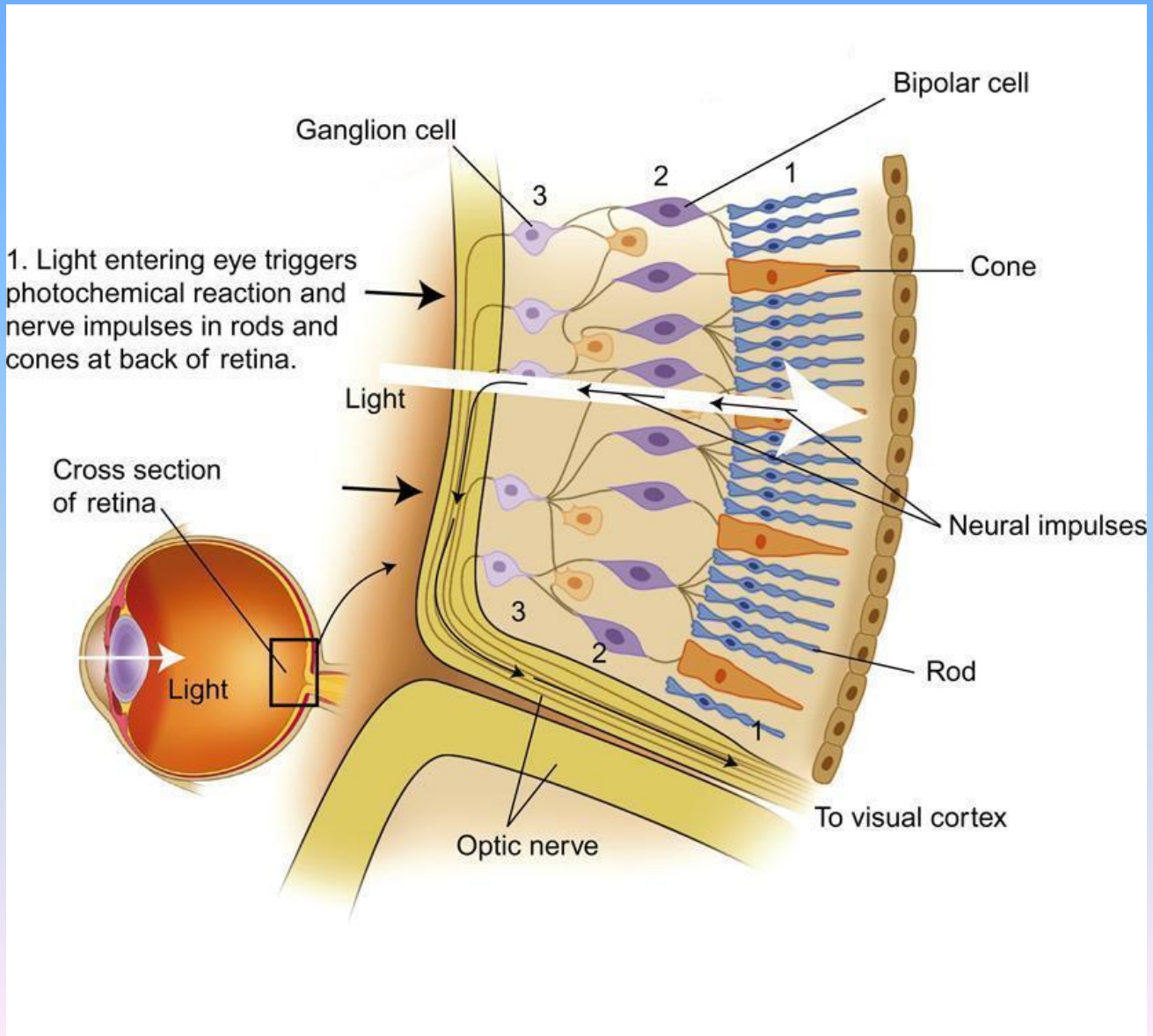
Ganglion Cells

- Pass the information from the bipolar cells through their axons
- The axons of the ganglion cells form the optic nerve.
- The top layer of the cells in the retina

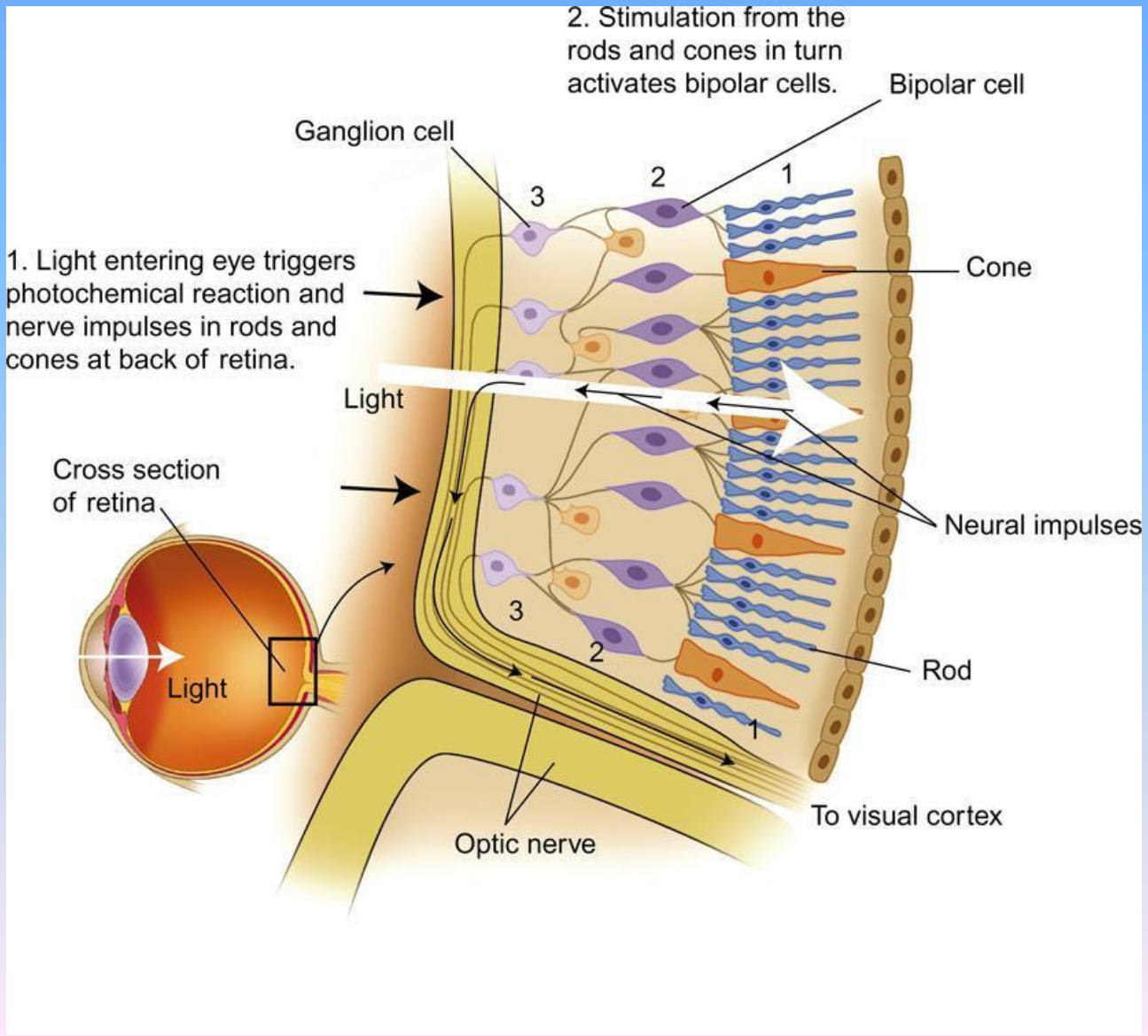
Visual Processing in the Retina



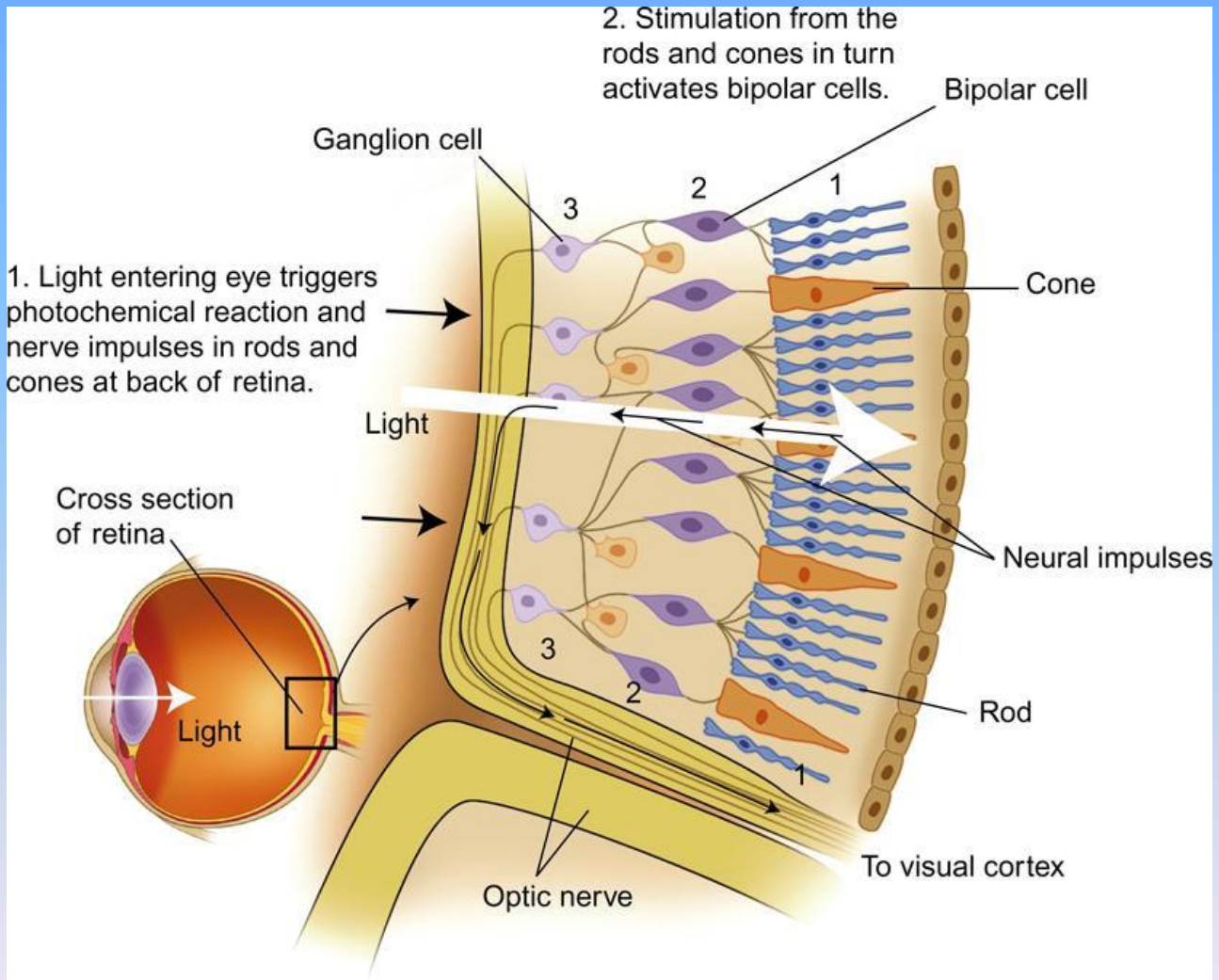
Visual Processing in the Retina



Visual Processing in the Retina



Visual Processing in the Retina

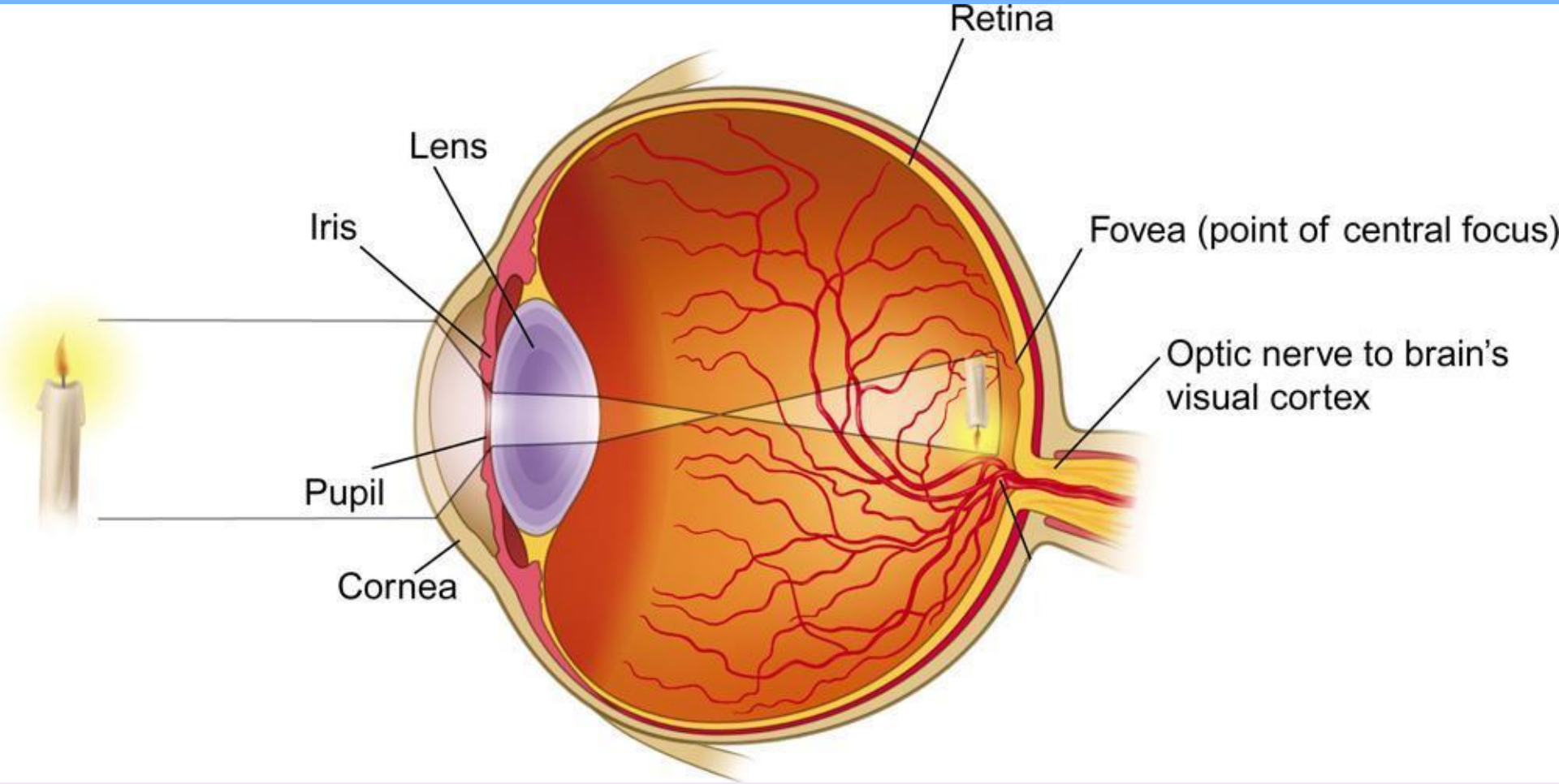


3. Bipolar cells then activate the ganglion cells, the axons of which converge to form the optic nerve. This nerve transmits information to the visual cortex in the brain's occipital lobe.

Optic Nerve

- The nerve that *carries* visual information from the eye *to the occipital lobes* of the brain

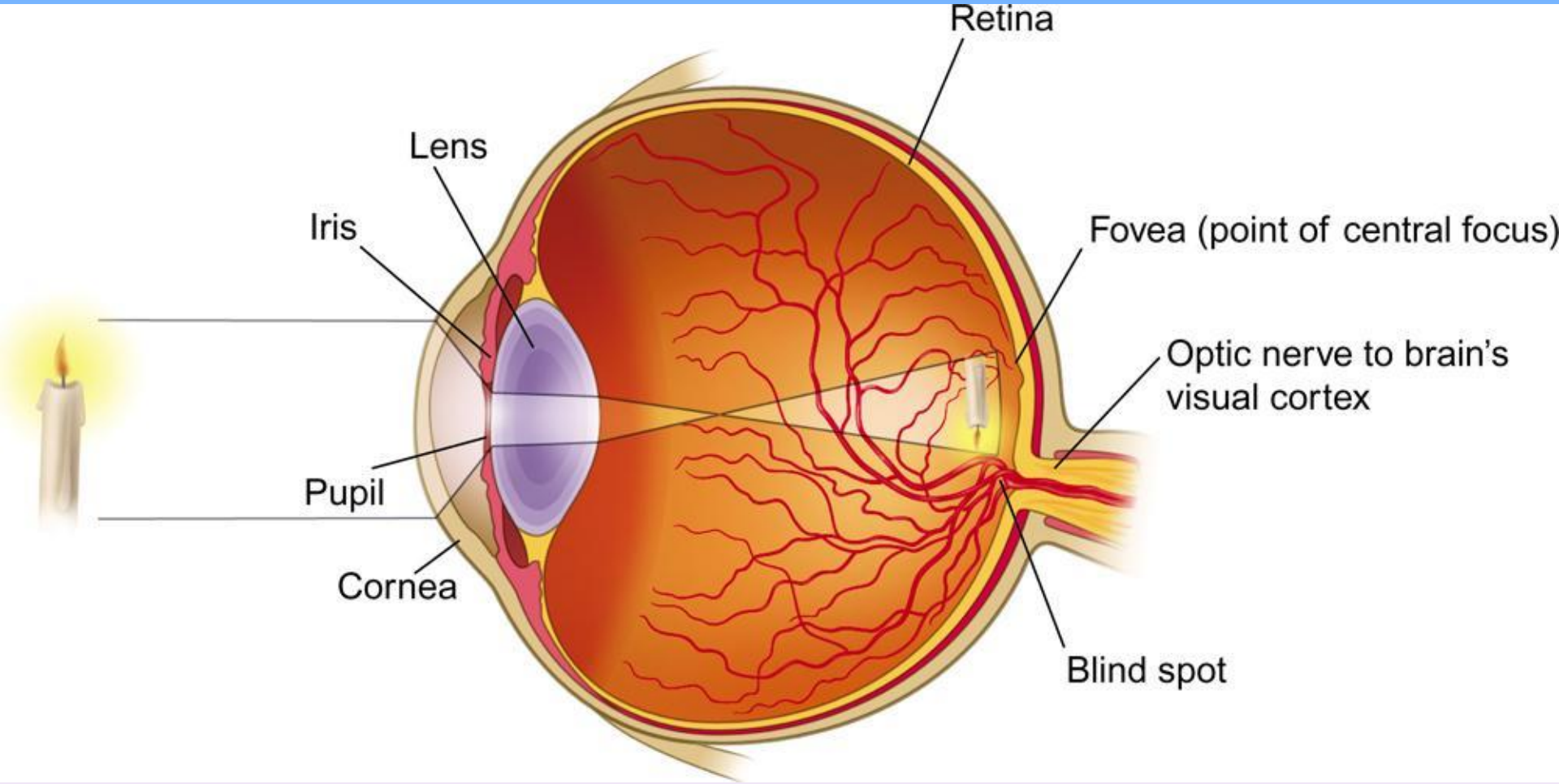
Parts of the Eye – Optic Nerve



Blind Spot

- The point at which the optic nerve travels through the retina to exit the eye
- There are *no rods and cones at this point*, so there is a small blind spot in vision.

Parts of the Eye – Blind Spot



Module 8: Sensation

The Visual System: Color Vision

Trichromatic (three-color) Theory

- Theory of color vision that says *cones are sensitive to red, green and blue light*
- All the colors we see are a combination of these three colors (additive process)
- Based on work of Helmholtz and Young
- Similar to the design of a color TV

Subtractive Color Mixing

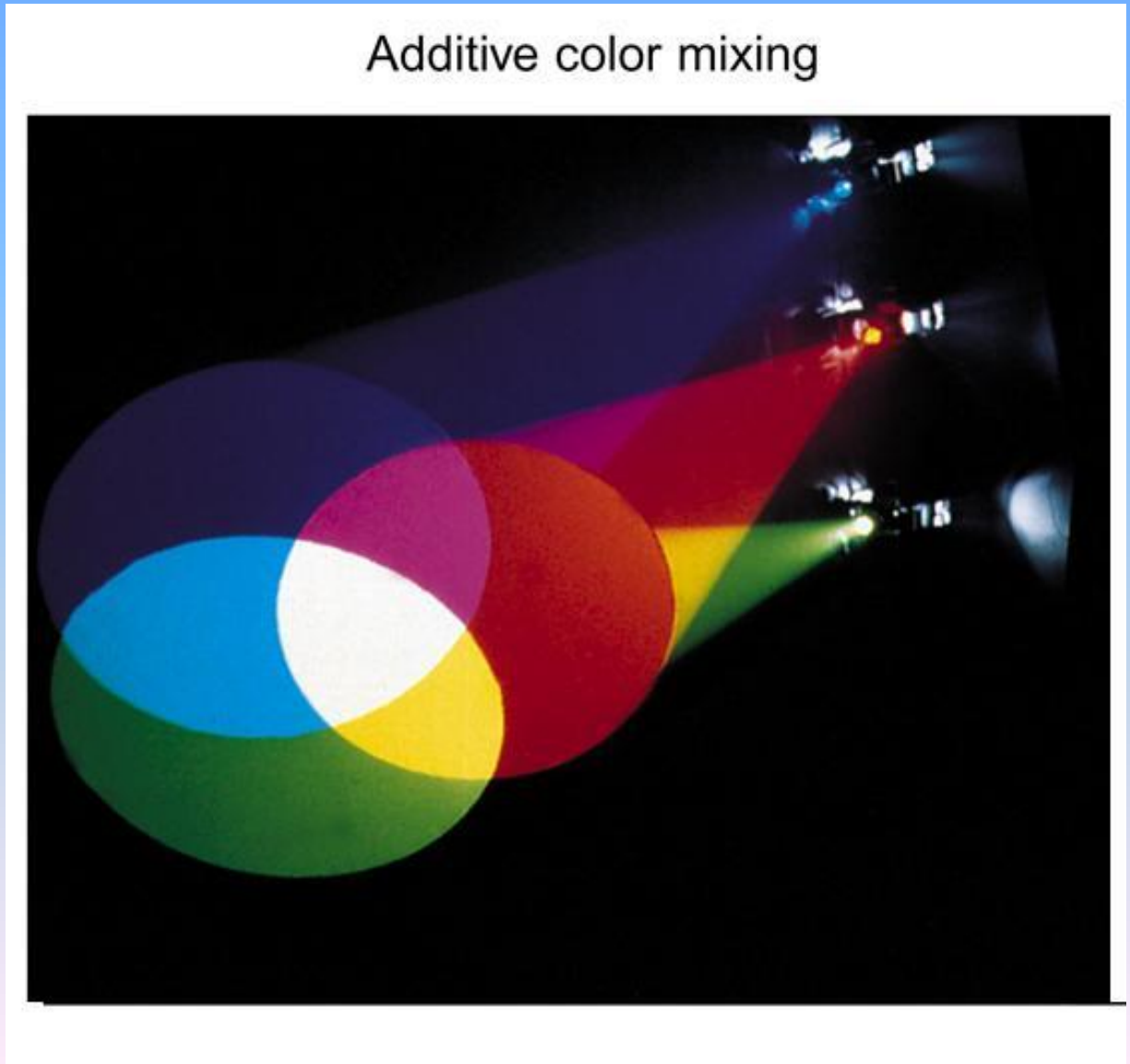
- When mixing colored paints, each new color SUBTRACTS (absorbs or soaks up) another wavelength.
- Red, blue, and yellow combine to make black paint (these 3 pigments subtract all wavelengths of light).

Subtractive color mixing

Additive Color Mixing

- Vision operates on an additive process, with each wavelength of light *adding* a new color to the mix.
- Red, green, and blue combine to make white (not black) light, which combines all wavelengths of light.

Additive Color Mixing



Color Deficient Vision

- People who *lack* one of the three types of *cones*
- *Usually* the *red* or *green* receptors are missing
- Usually inaccurately referred to as “color blindness”
- Inherited and found more in males

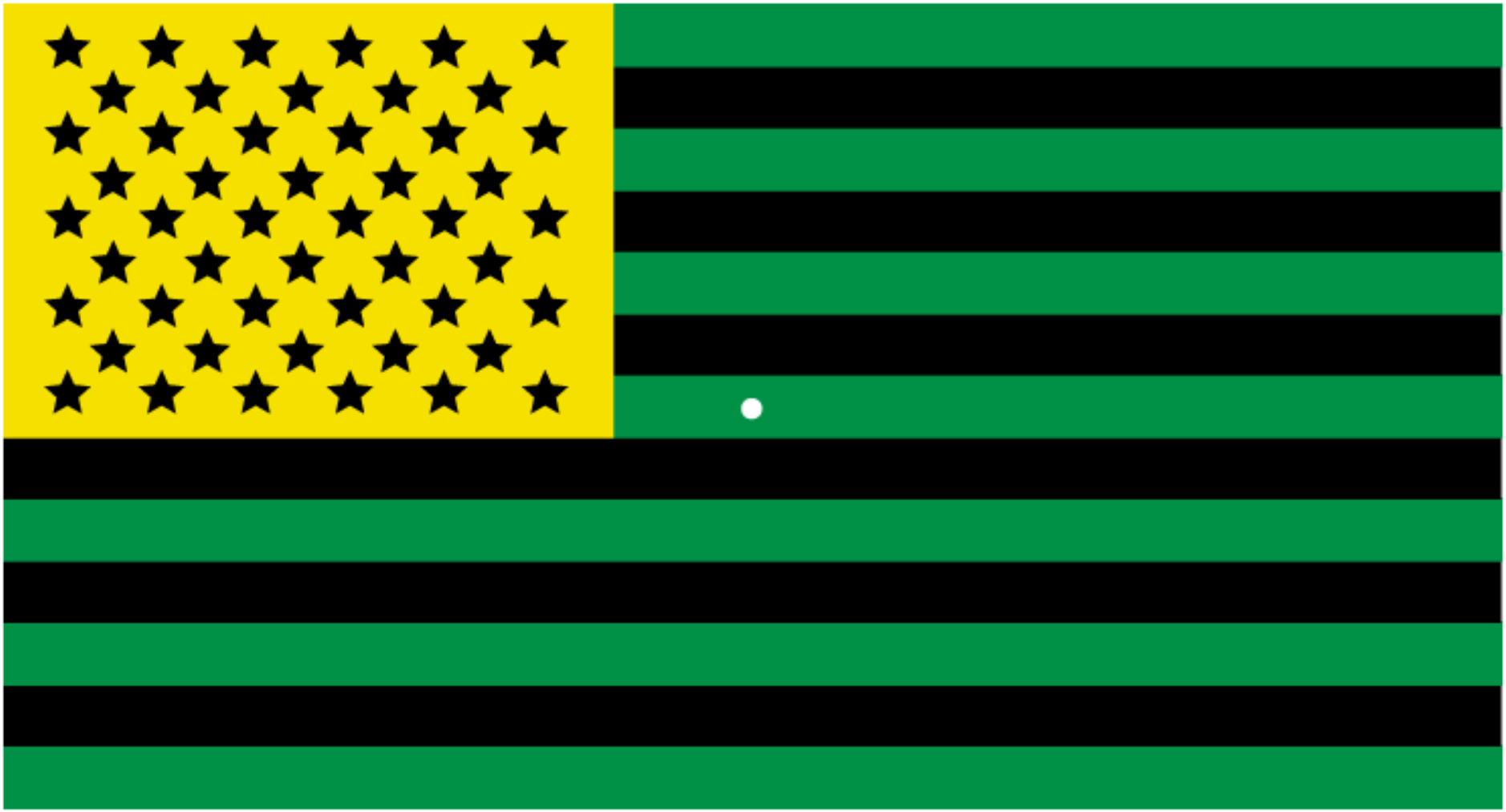
Opponent-Process Theory of Color

- Theory of color vision that says color is processed by cones organized in opponent pairs
- Red-green, yellow-blue, black-white
- *Light that stimulated one half of the pair inhibits or blocks the other half*
- When green is *on*, red is *off* so you can see one or the other, but there is no greenish-red color
- Explains the afterimage effect

Afterimage effect

- When staring at the green, yellow, and black United States flag long enough, you *fatigue* your green, yellow, and black-detection *neurons.* Then, when you look away at a white space, your red, blue, and white-detection neurons, which *were not tired*, produce an *aftereffect* that lasts until the green cells recover.

Afterimage Effect



Module 8: Sensation

Hearing:
The Nature of Sound

Sound

- Sound, like light, comes in waves
- Sound is vibration
- Features of sound include:
  - Pitch
  - Hertz
  - decibels

Pitch

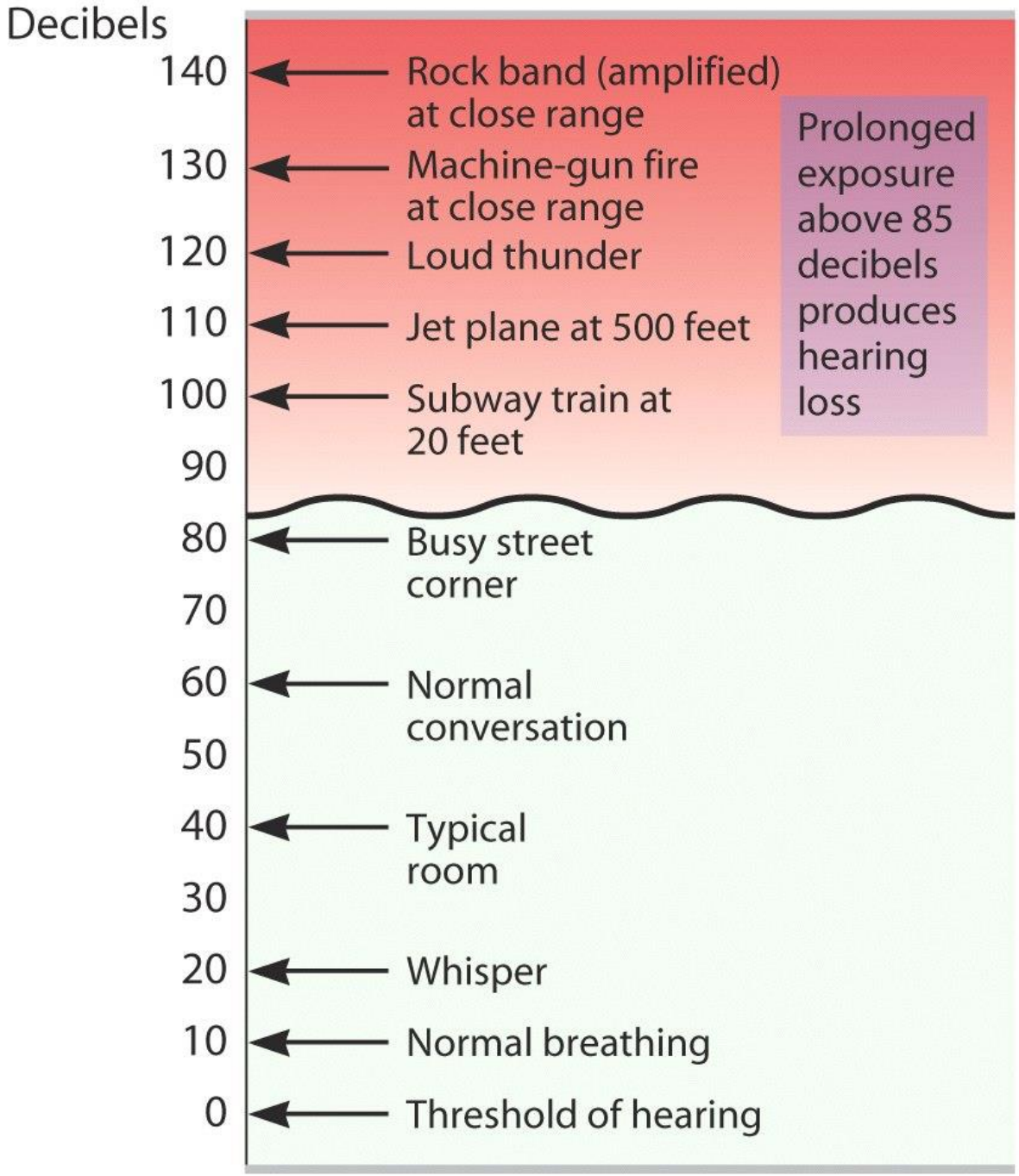
- A sound’s highness or lowness
- Dependent on the frequency of the sound wave
- Is measured as hertz (Hz)

Hertz (Hz)

- A measure of the number of sound wave peaks per second; measures “frequency”
- Determines the pitch of the sound
- Human hearing goes from 20 Hz to 20,000 Hz

Decibel (dB)

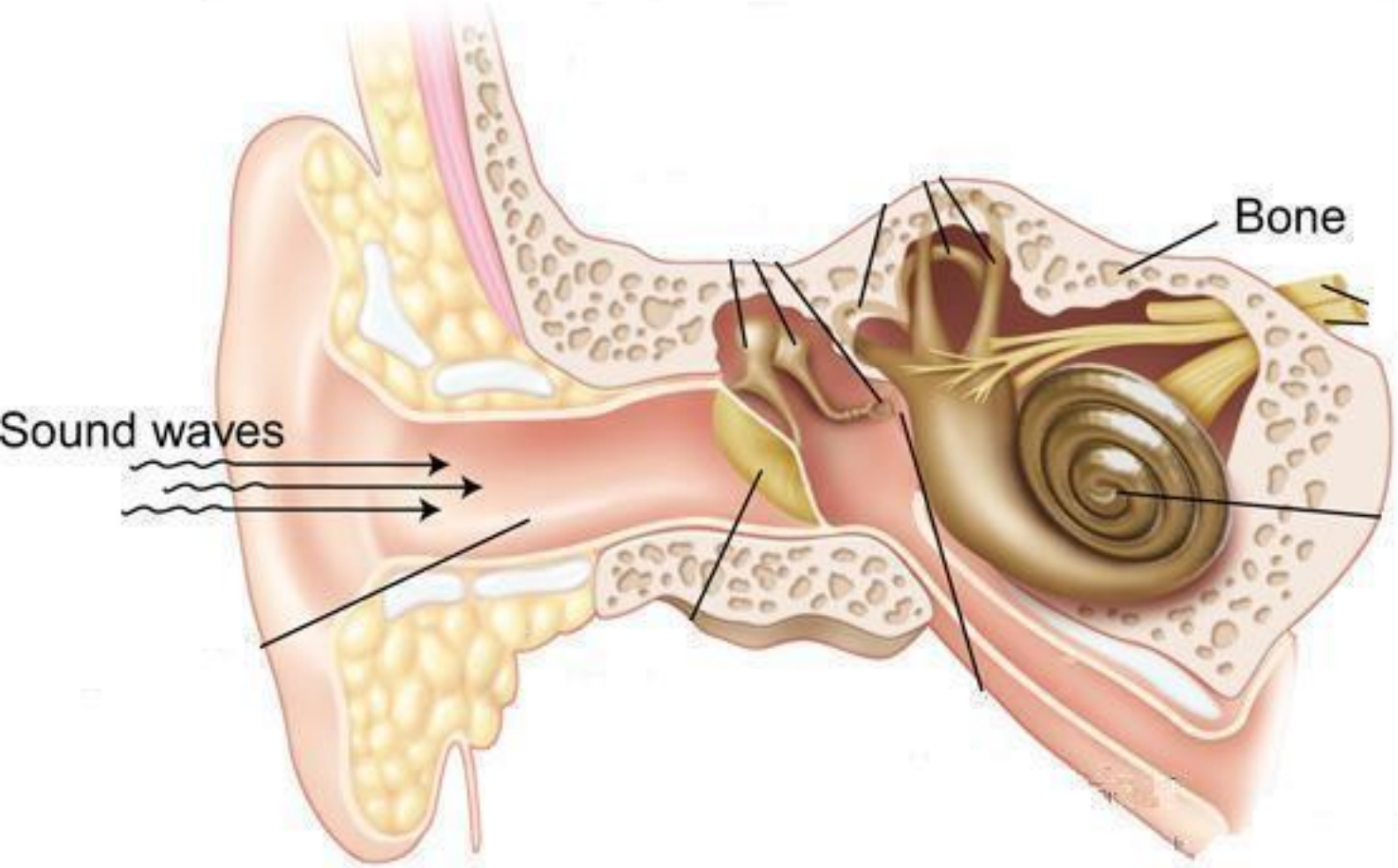
- A measure of the height of the sound wave
- Determines the loudness of the sound
- Sometimes called amplitude


Decibels
140
Rock band (amplified) at close range
130
Machine-gun fire at close range
120
Loud thunder
110
Jet plane at 500 feet
100
Subway train at 20 feet
90
80
Busy street corner
70
60
Normal conversation
50
40
Typical room
30
20
Whisper
10
Normal breathing
0
Threshold of hearing
Prolonged exposure above 85 decibels produces hearing loss

Module 8: Sensation

Hearing: The Structure of the Auditory System

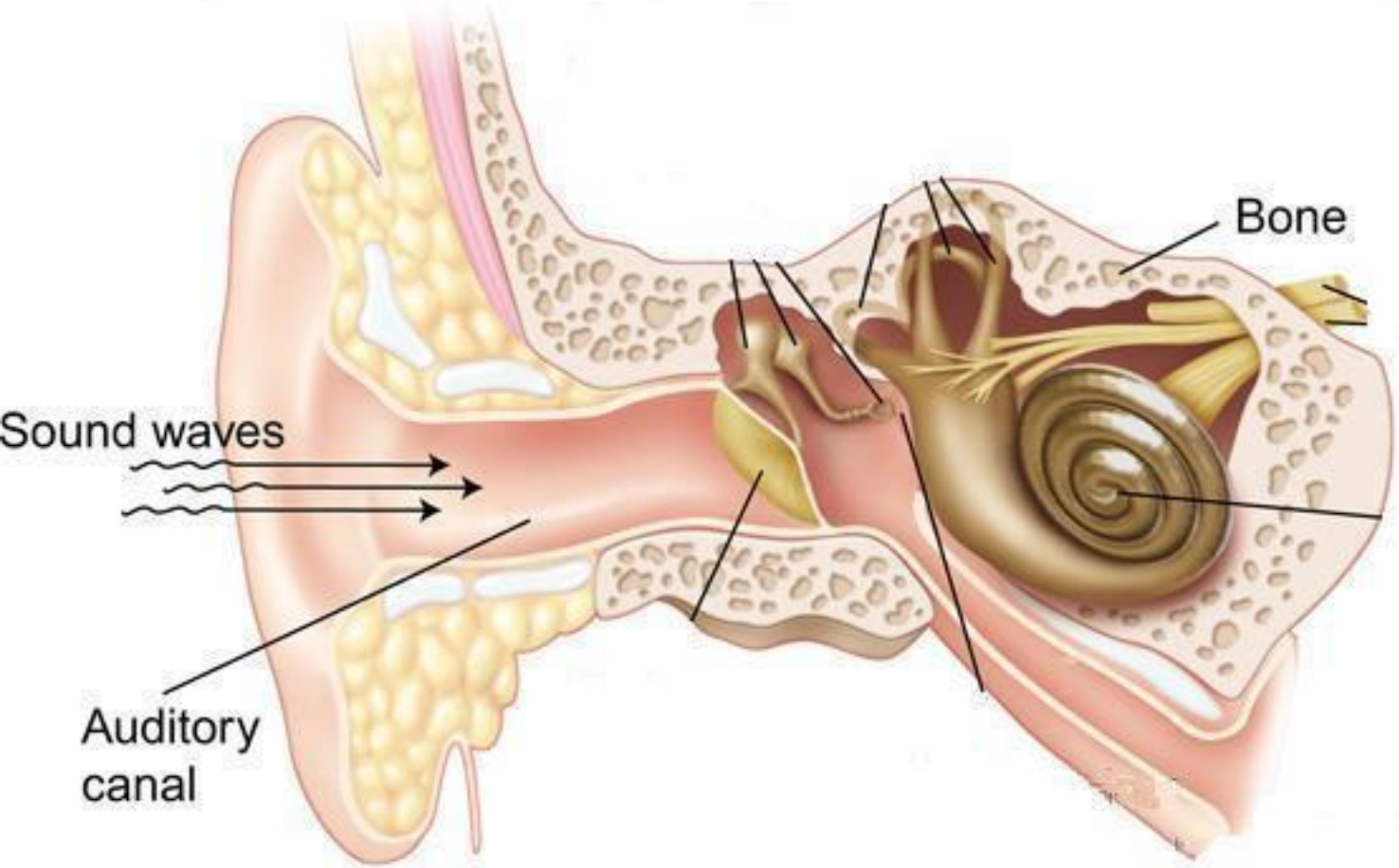
Parts of the Ear – Sound Waves



Auditory Canal

- The opening through which sound waves travel as they move into the ear for processing
- Ends at the tympanic membrane (eardrum)

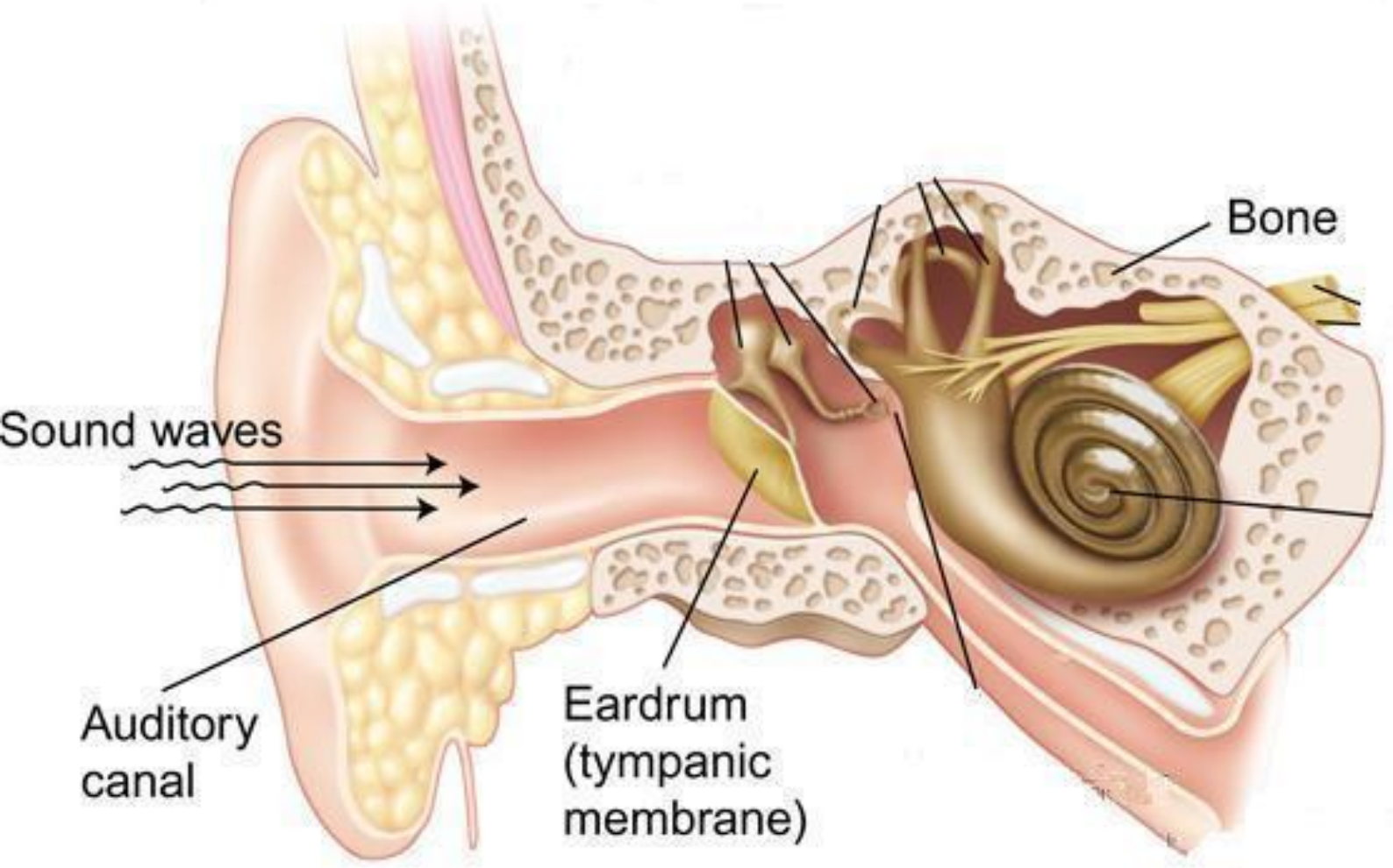
Parts of the Ear – Auditory Canal



Tympanic Membrane (eardrum)

- The tissue barrier that transfers sound vibration from the air to the tine bones of the middle ear
- Can be damaged by objects in the ear or exceptionally loud noises

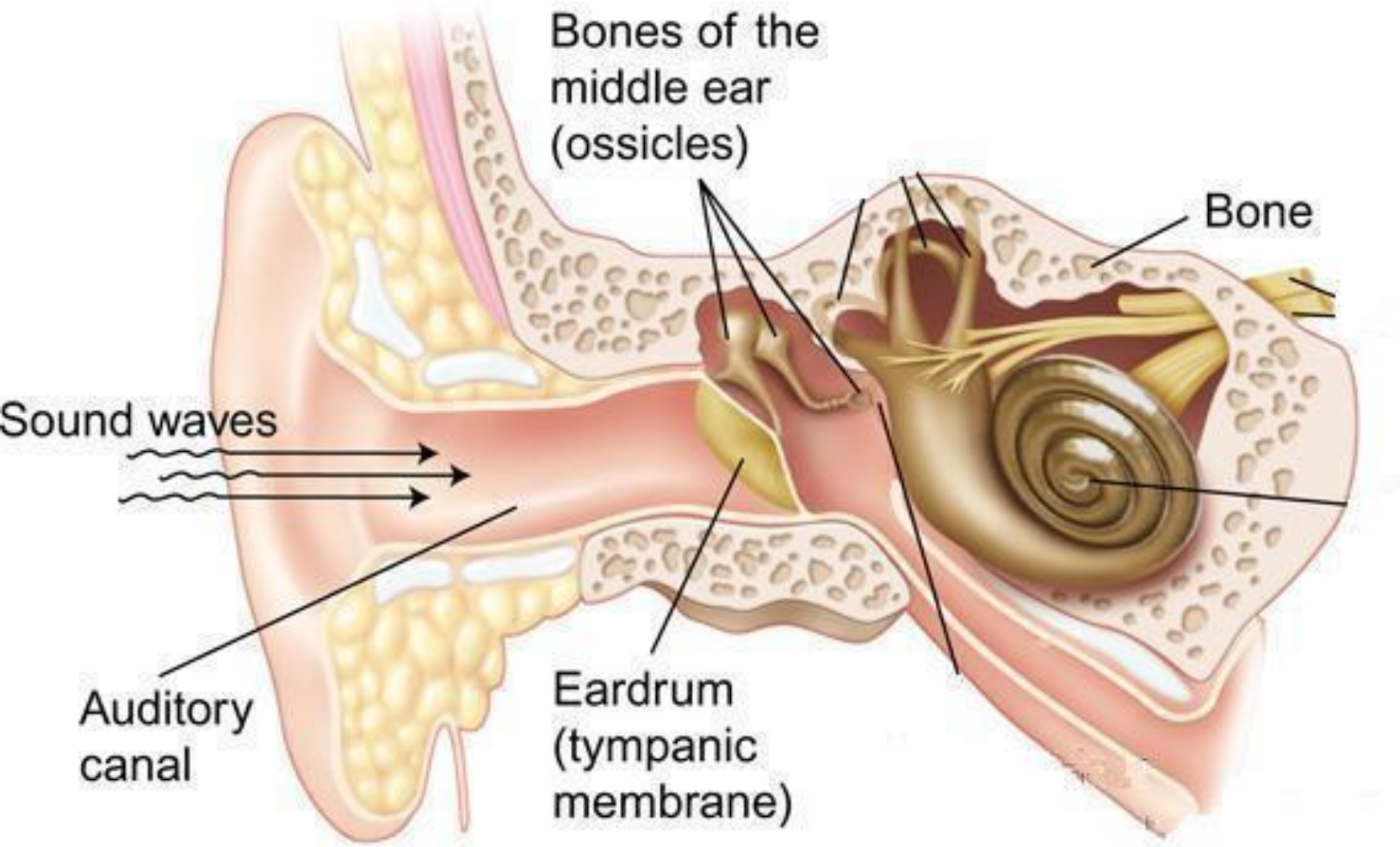
Parts of the Ear – Tympanic Membrane



Ossicles

- Three tiny bones that transfer sound waves from the eardrum to the cochlea
- Hammer, anvil and stirrup

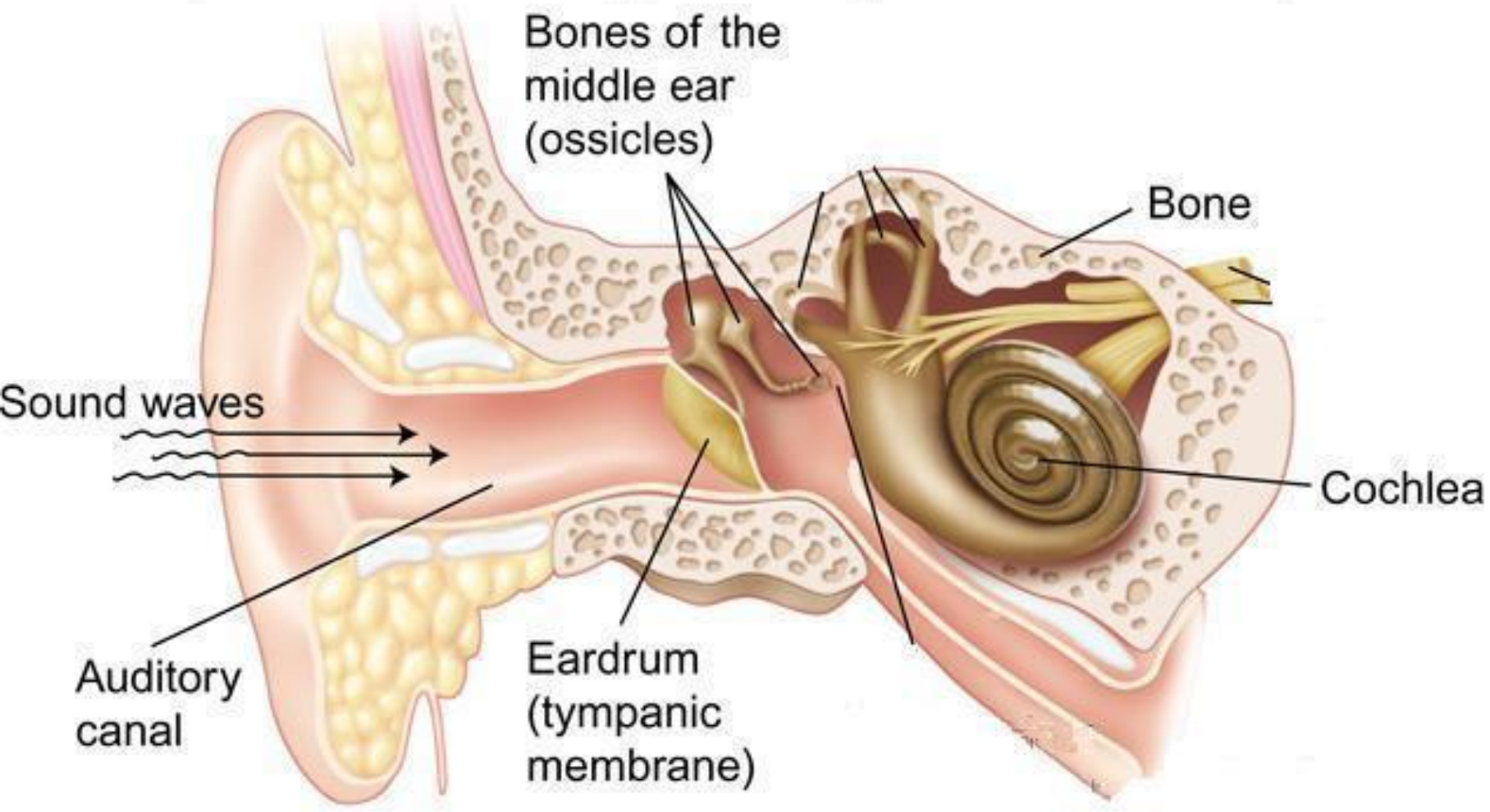
Parts of the Ear - Occicles



Cochlea

- The major organ of hearing
- A snail shaped bony body tube fluid-filled in the inner ear
- Sound waves are changed to neural impulses

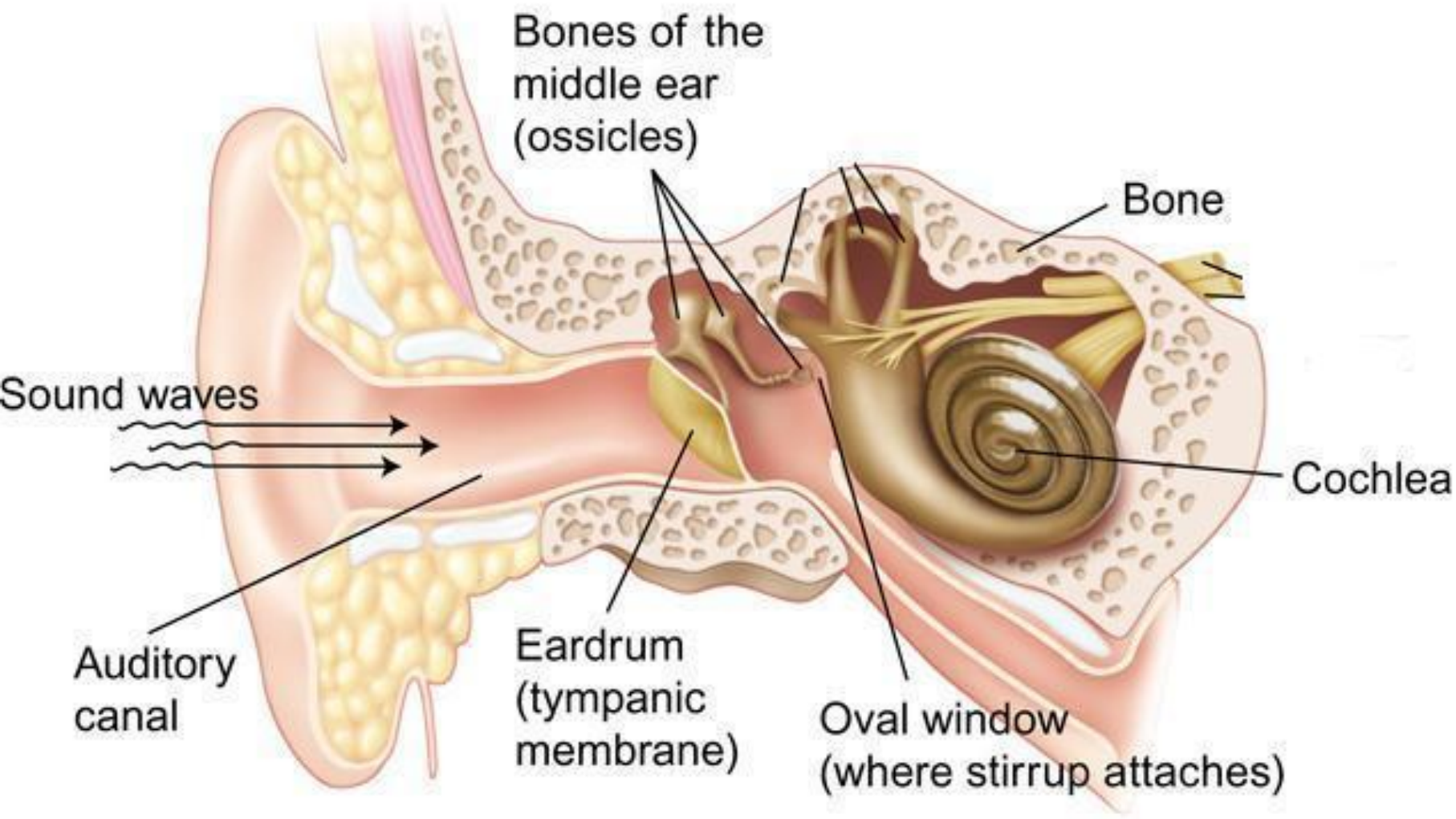
Parts of the Ear - Cochlea



Oval Window

- The point on the surface of the cochlea which receives the sound vibration from the ossicles
- As the oval window vibrates, the fluid in the cochlea vibrates.

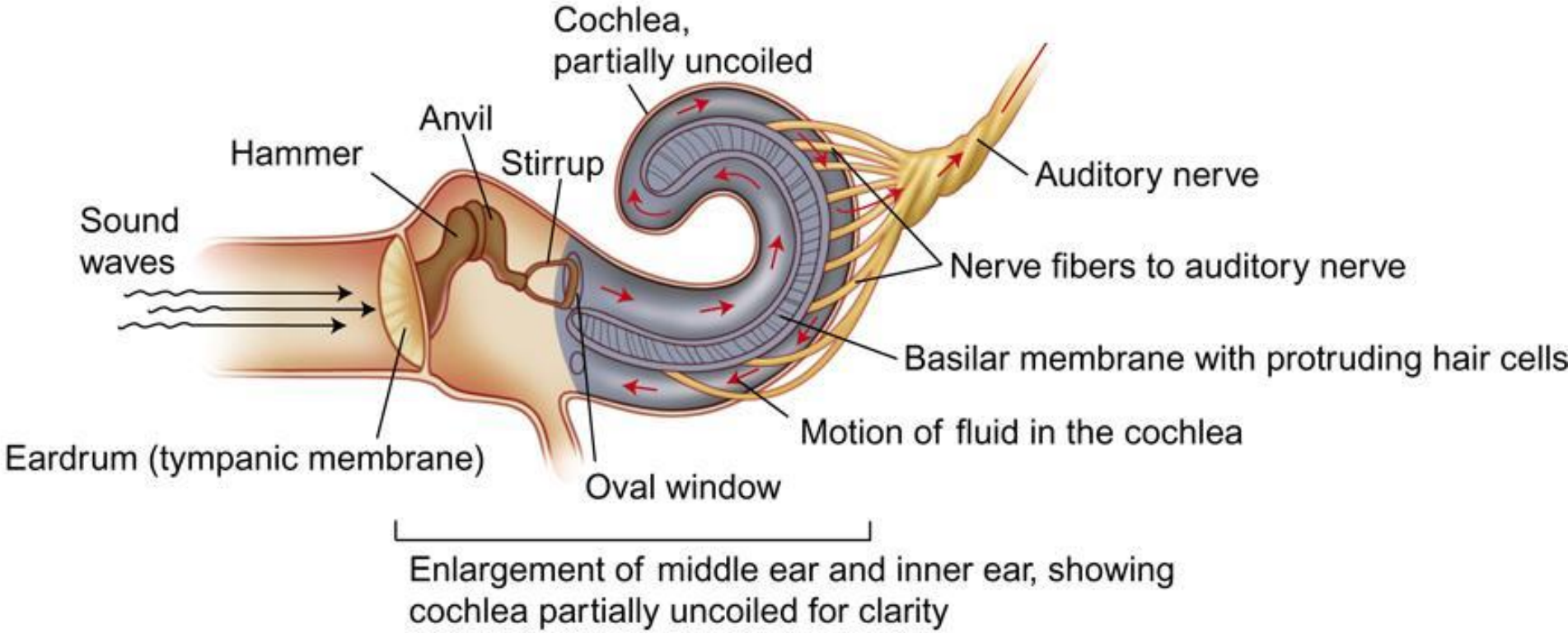
Parts of the Ear – Oval Window



Hair Cells

- The receptor cells for hearing
- Located in the cochlea
- Responsibly for changing sound vibrations into neural impulses
- Similar to the rods and cones within the eye

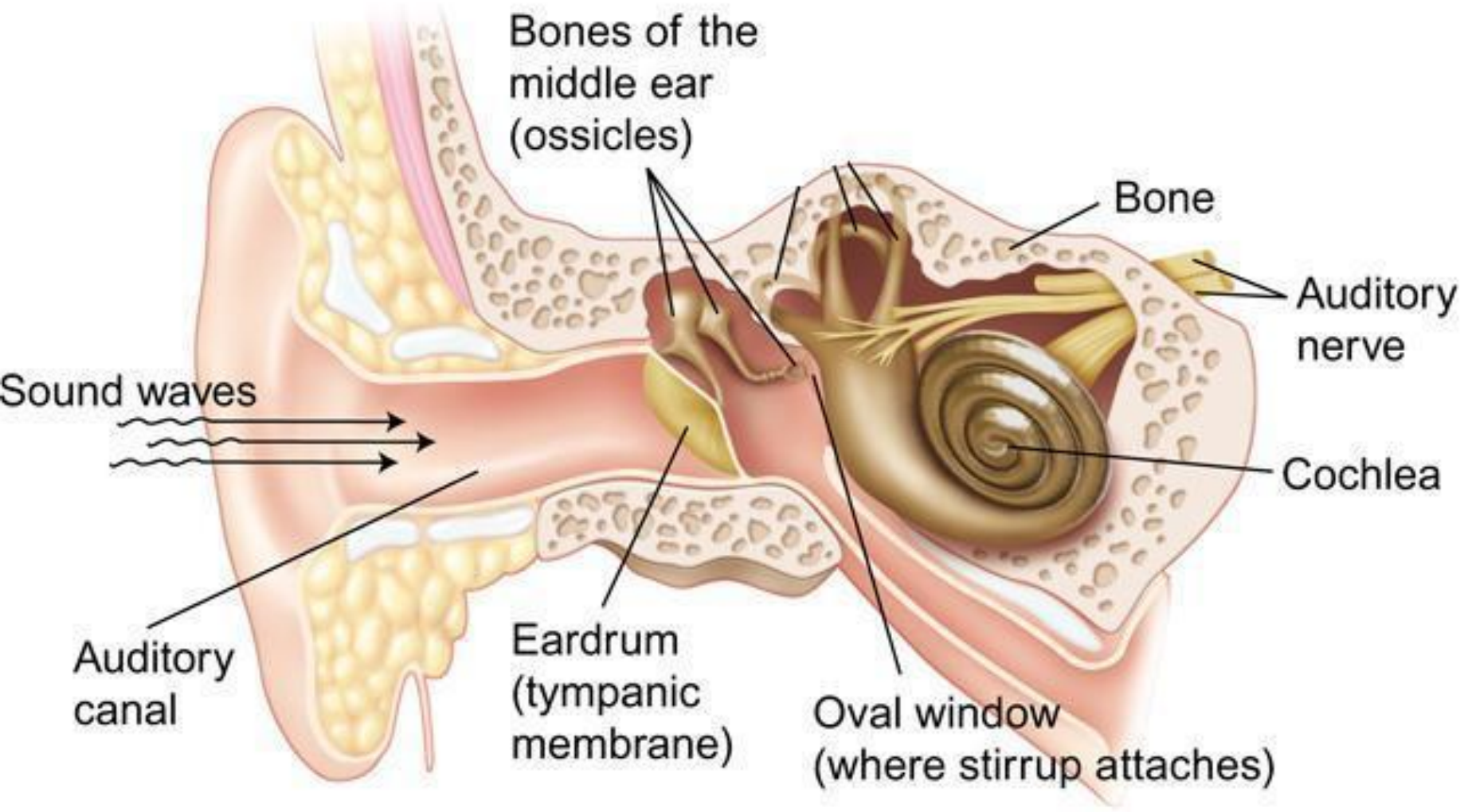
Parts of the Ear - Hair Cells



Auditory Nerve

- The nerve that carries sound information from the ears to the temporal lobes of the brain

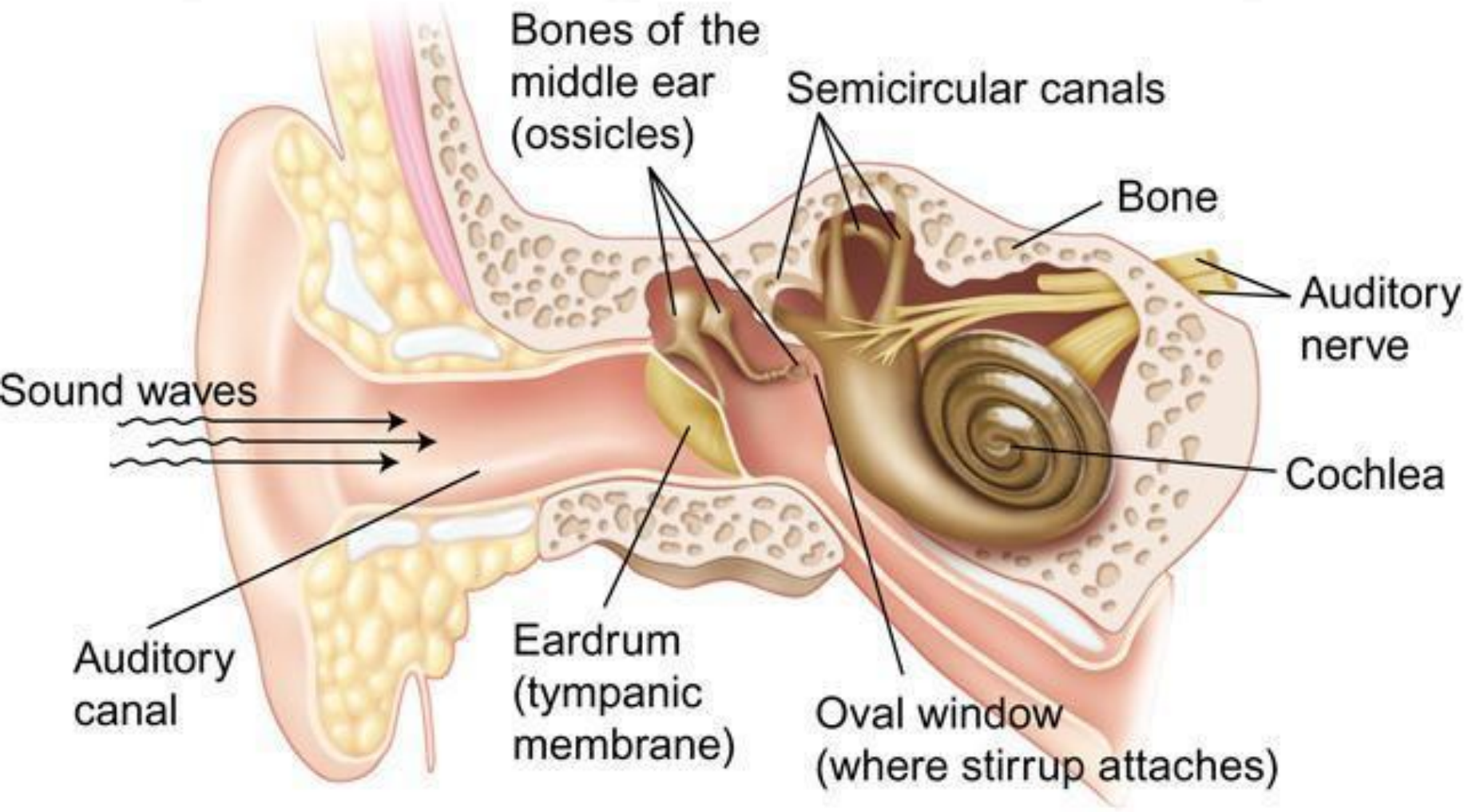
Parts of the Ear – Auditory Nerve



Semicircular Canals

- Organs in the inner ear used in sensing body orientation and balance (vestibular sense)
- Relies on fluid in the canals
- Spinning in circles disrupts the fluid.

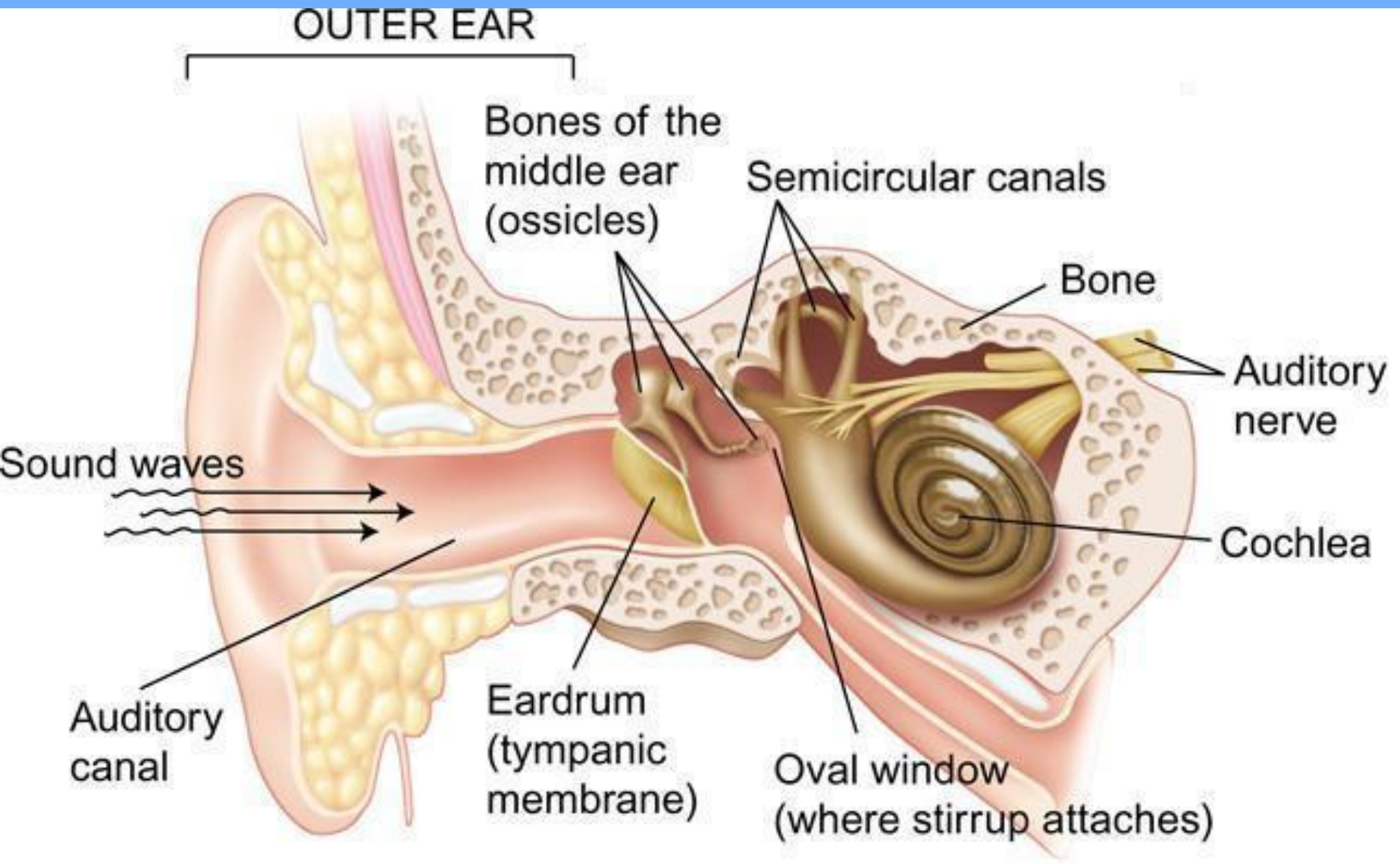
Parts of the Ear – Semicircular Canals



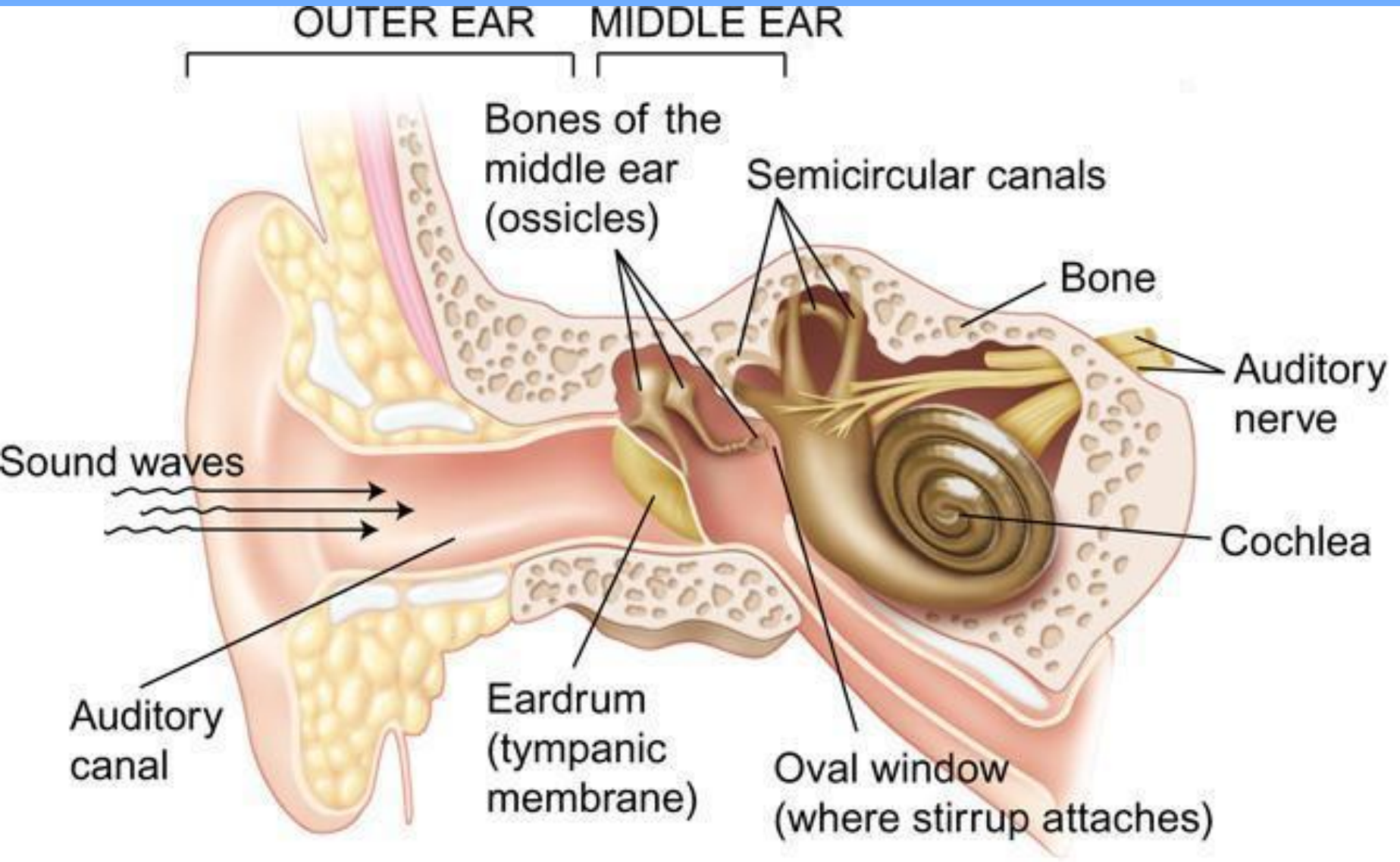
Divisions of the Ear

- Ear's structure can be divided into:
  - The outer ear
  - The middle ear
  - The inner ear

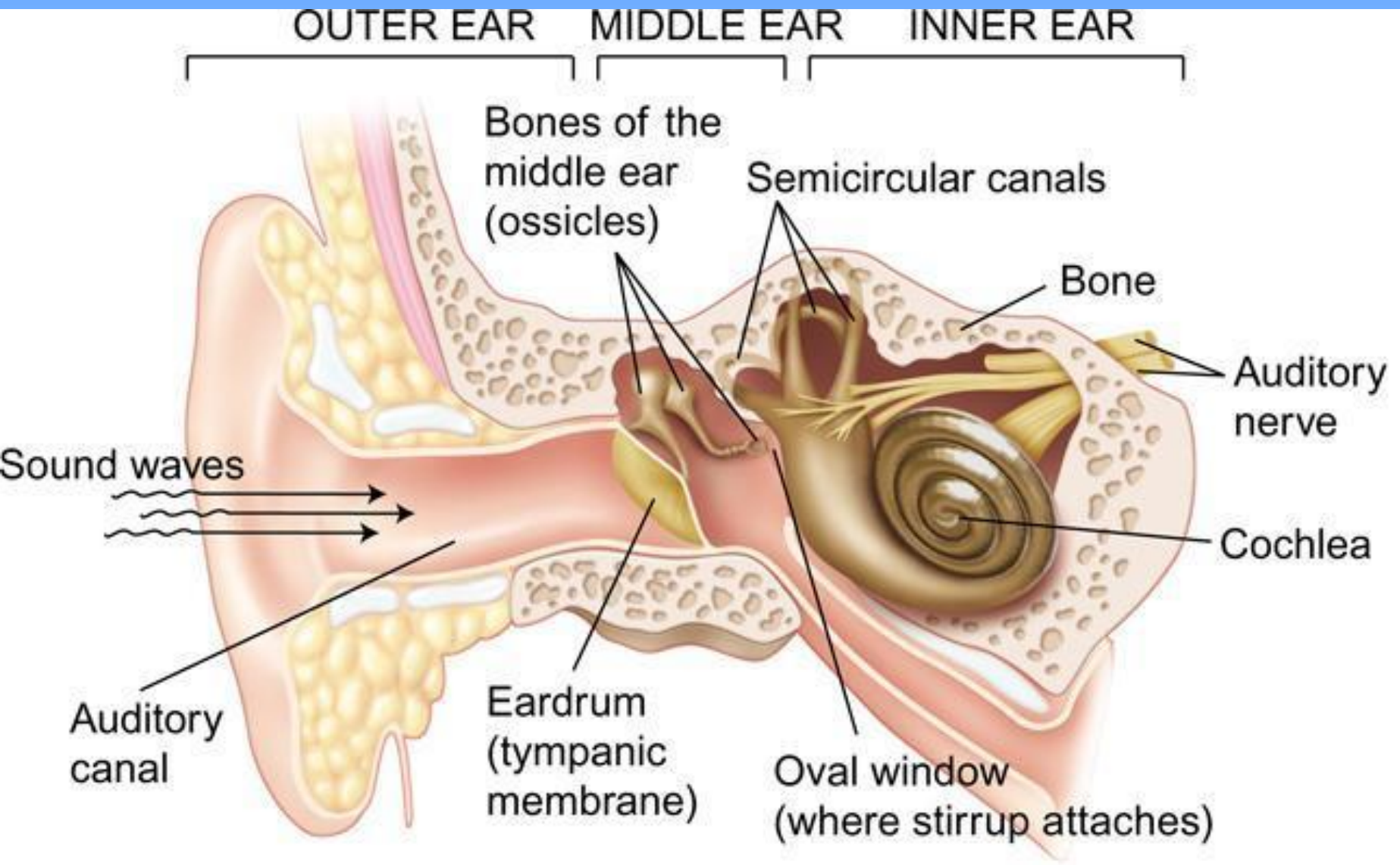
Divisions of the Ear



Divisions of the Ear



Divisions of the Ear



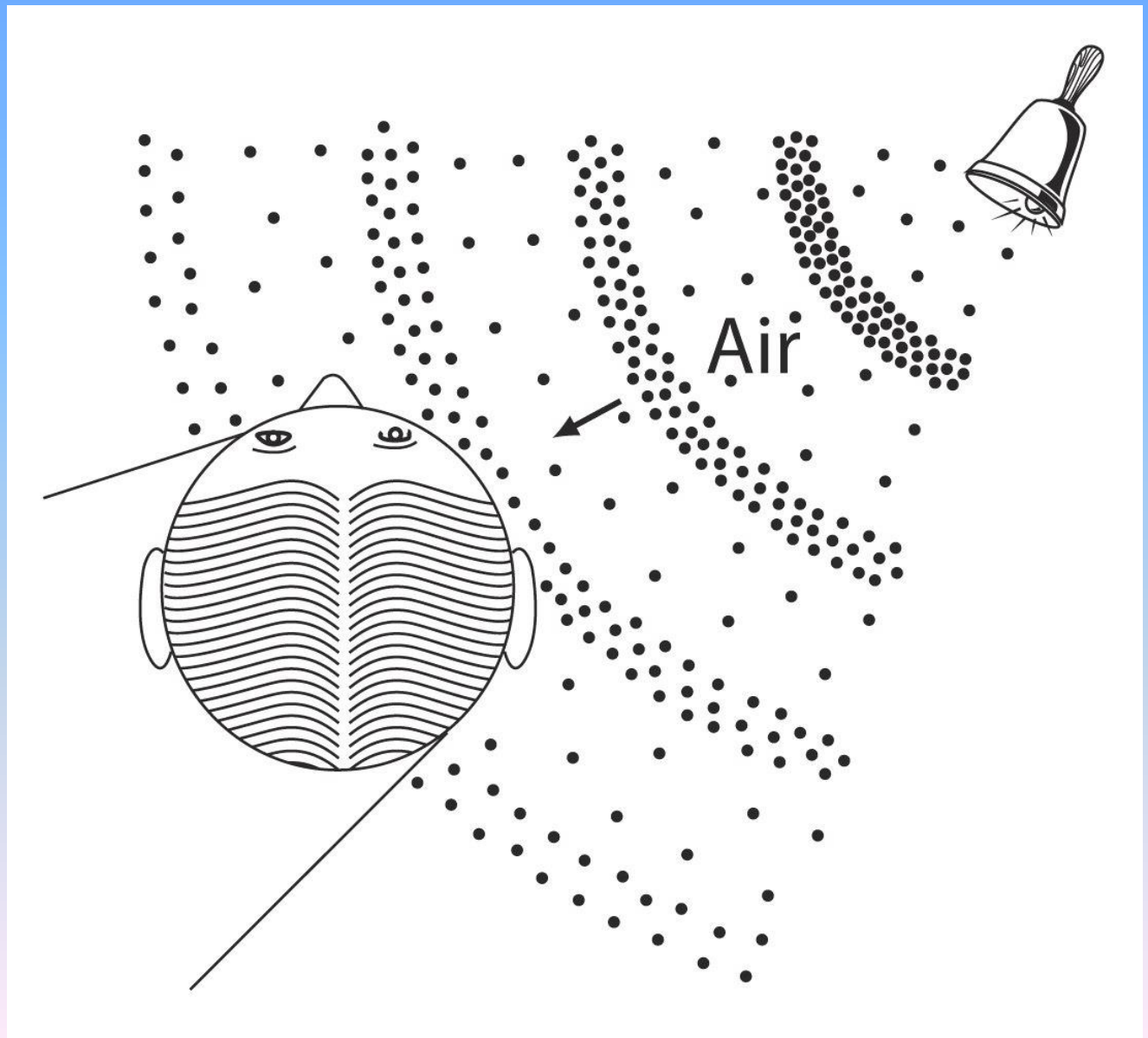
Module 8: Sensation

Hearing: Sound Localization

Localization of Sound

- Locating where sound is originating from
- Done through two cues:
  - Which ear hears the sound first?
  - Which ear hears the louder sound?

Localization of Sound



Other Senses: Taste

Taste

- Taste is a chemical sense.
- Receptor cells are located primarily on the tongue and in the mouth.
- Four different tastes:
  - Salty, sweet, sour and bitter
- Damaged taste receptor cells are replaced within a few days.

Supertasters

- People with an abundance of taste receptors
- Approximately 25% of the population

Nontasters

- People with a minimum of taste receptors
- Taste with less intensity than the rest of the population
- Approximately 25% of the population

Other Senses: Smell

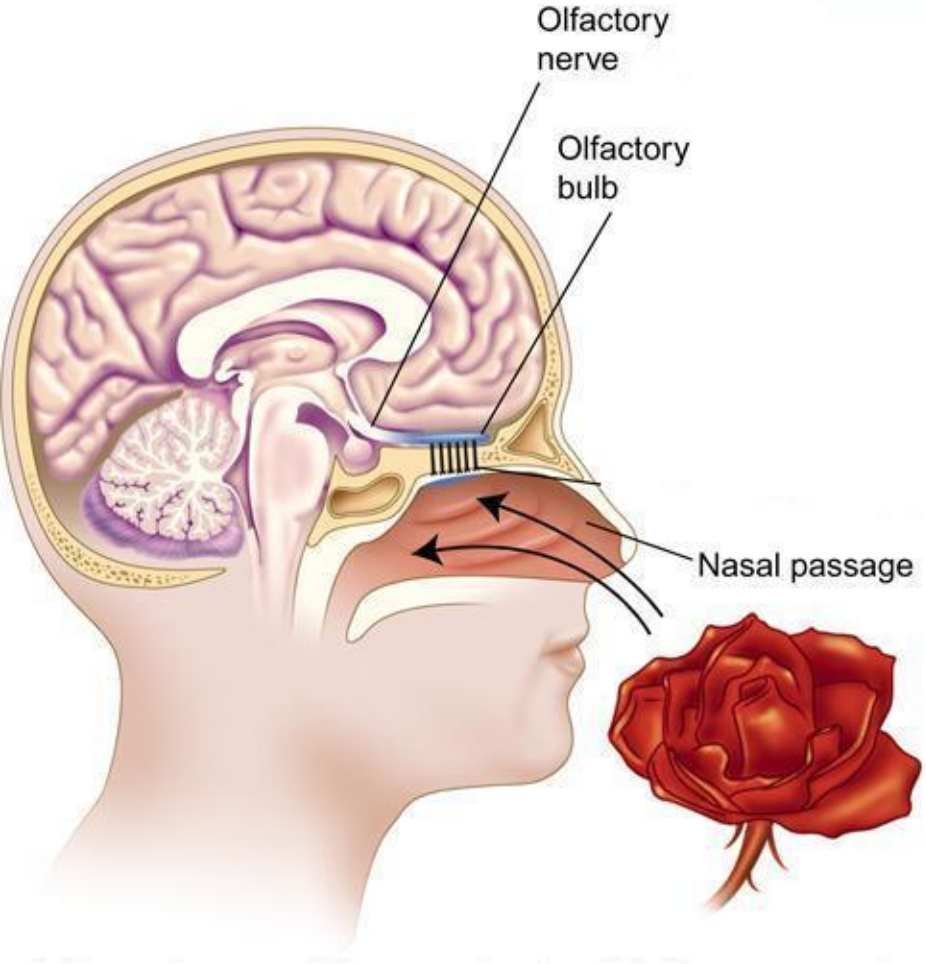
Smell

- Smell is a chemical sense.
- Olfactory cells in the upper nasal passages detect molecules in the air.
- Taste and smell interact to produce flavor.

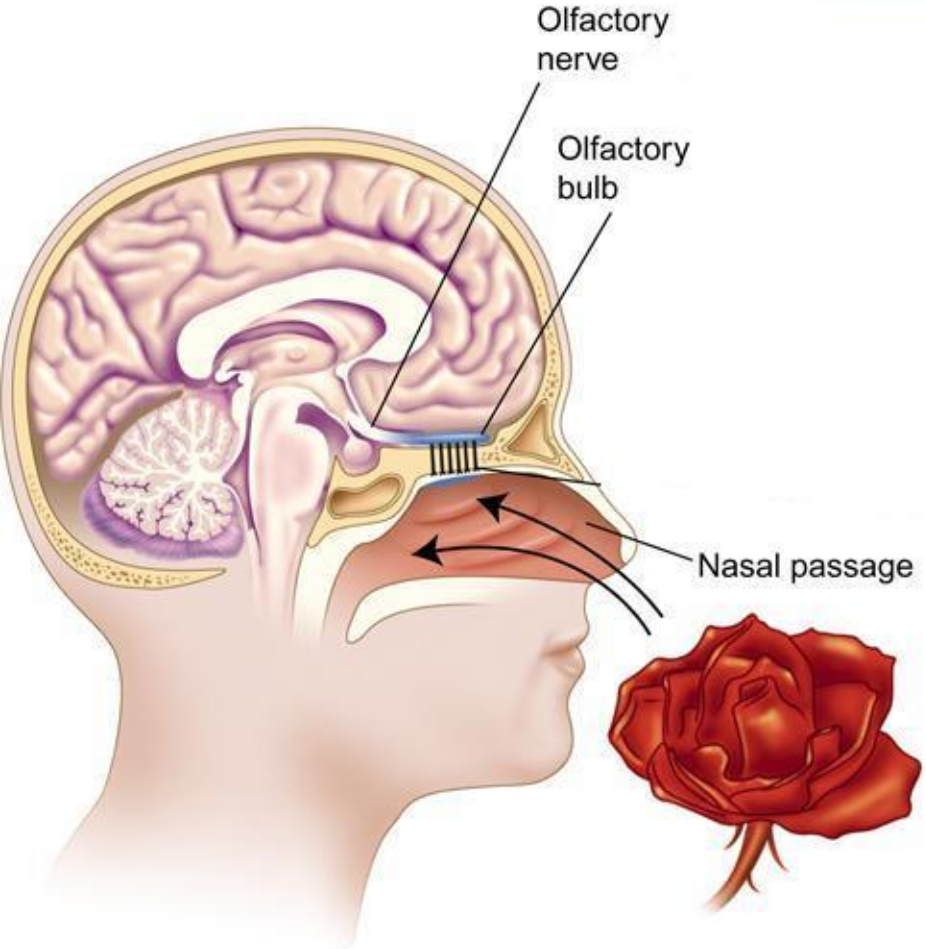
Olfactory Cells

- The chemical receptor cells for smell
- Located in the nasal passages

Smell

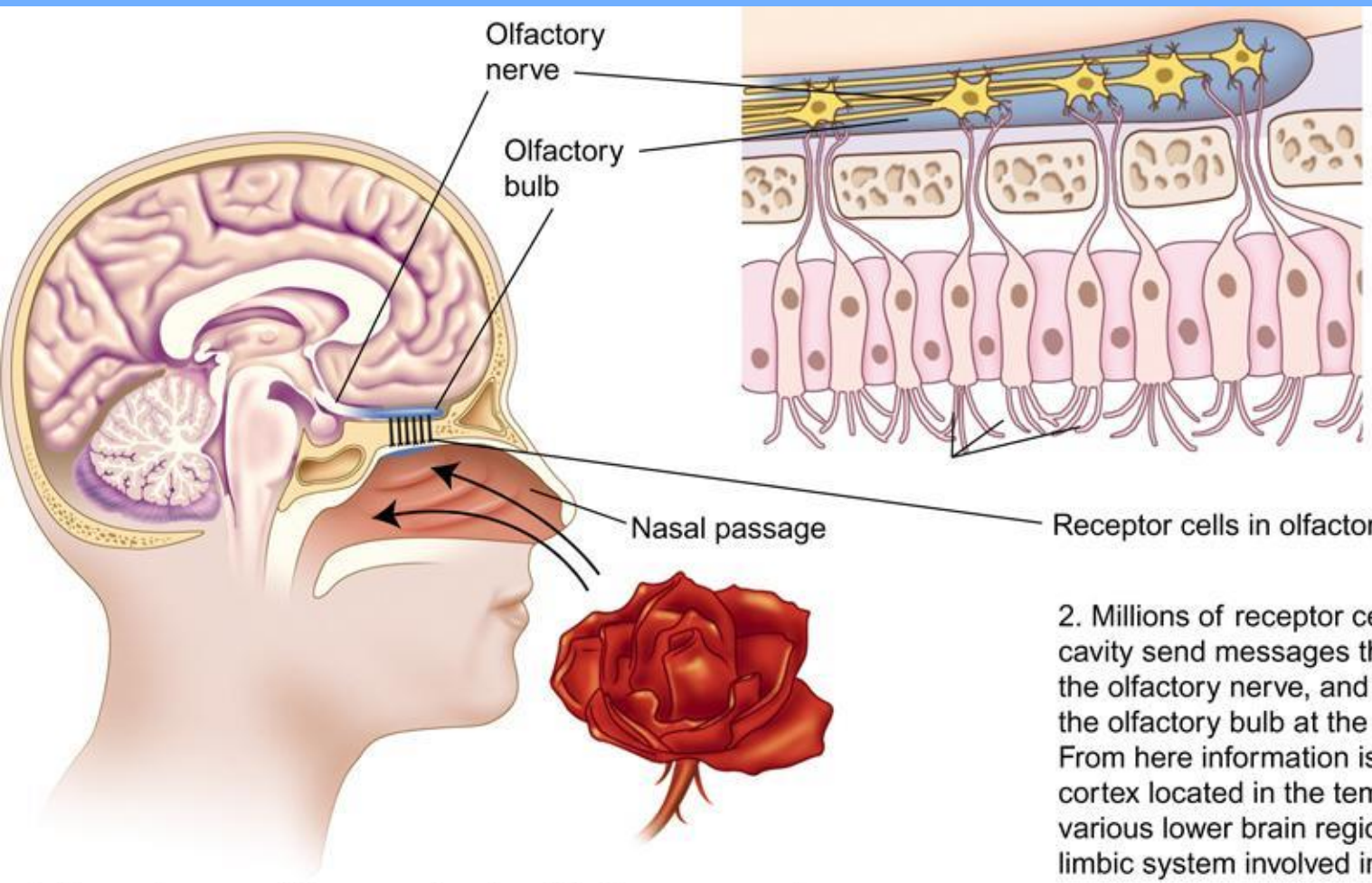


Smell



1. To smell a rose, airborne molecules of its fragrance must reach receptors at the top of the nose. Sniffing swirls air up to the receptors, enhancing the aroma.

Smell



1. To smell a rose, airborne molecules of its fragrance must reach receptors at the top of the nose. Sniffing swirls air up to the receptors, enhancing the aroma.

2. Millions of receptor cells at the top of each nasal cavity send messages through axon fibers that form the olfactory nerve, and route those messages to the olfactory bulb at the forward base of the brain. From here information is sent to the primary smell cortex located in the temporal lobe, as well as to various lower brain regions, especially parts of the limbic system involved in memory and emotion.

Other Senses: Touch

Touch

- Touch receptors are on the skin
- Four basic skin senses are
  - Pain, warmth, cold, and pressure
- All skin sensations are a combination of these four basic senses

Gate-control Theory of Pain

- Pain messages travel on one set of nerve fibers containing pain gates.
- The gates are open when pain is felt.
- Other sensory messages go through another set of fibers.
- The nonpain fibers can close the pain gates to stop the sense of pain.

Other Senses: Body Senses

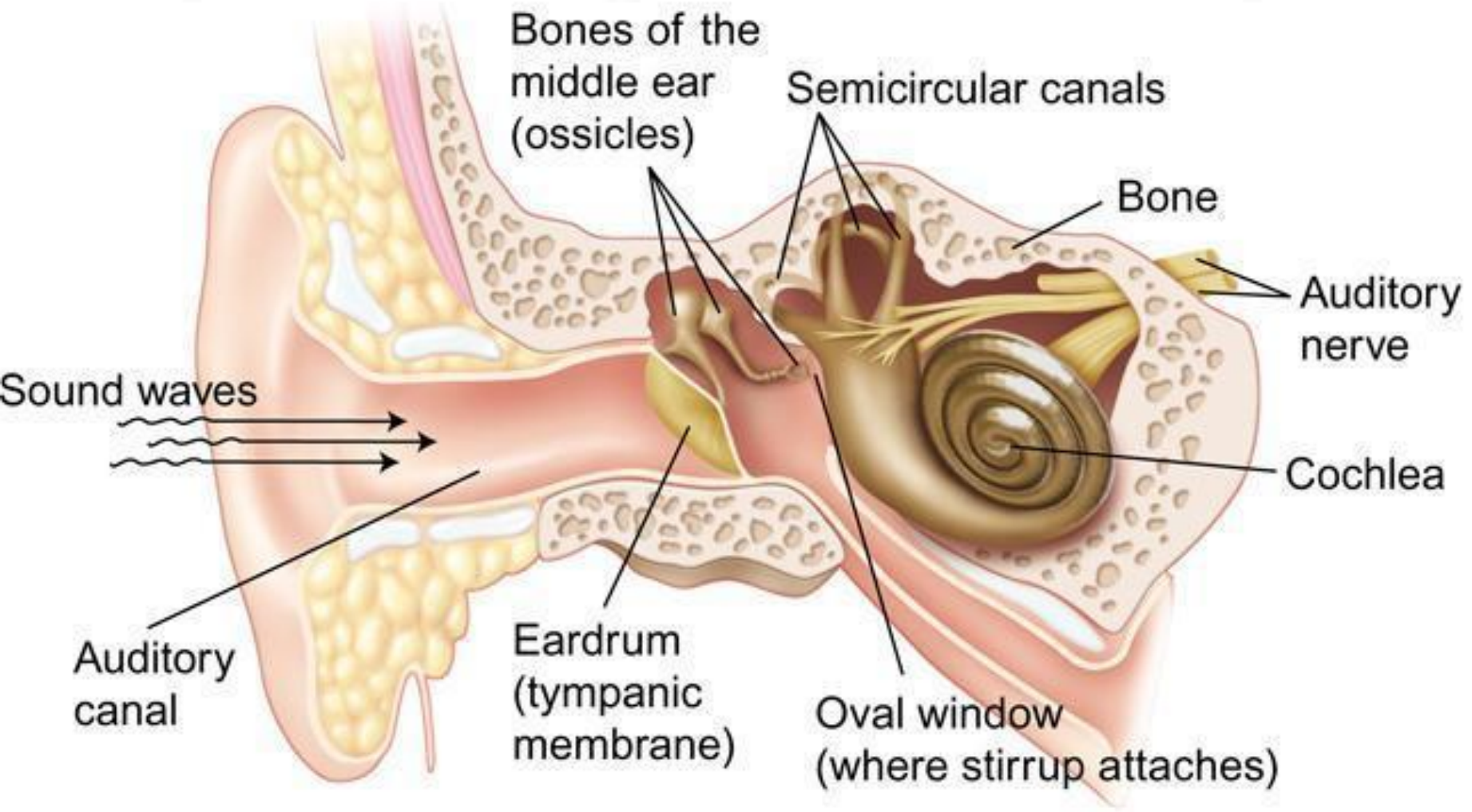
Kinesthetic Sense

- The system for sensing the position and movement of individual body parts
- Relies on receptor cells from the muscles and joints
- One's leg "falling asleep" is a disruption of the kinesthetic sense

Vestibular Sense

- The system for sensing body orientation and balance
- Located in the semicircular canals in the inner ear
- Relies on fluid in the canals
- Spinning in circles disrupts the fluid.

Parts of the Ear – Semicircular Canals



The End