

CHAPTER 2

SENSES & PERCEPTION



VISION

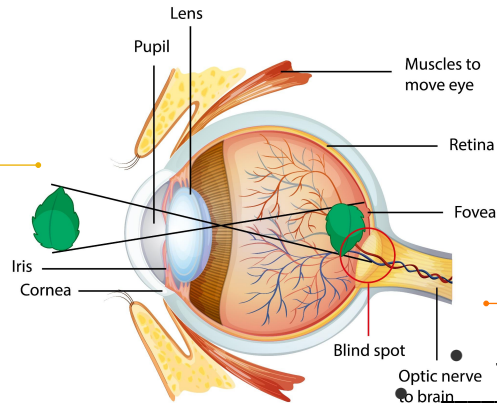
EYE

30%

Of cerebral cortex is occupied by _____

FRUIT FLIES & MICE

Knowledge of how light energy is converted into electrical signals comes primarily from studies of _____ (*Drosophila*) and _____



INVERTED IMAGES

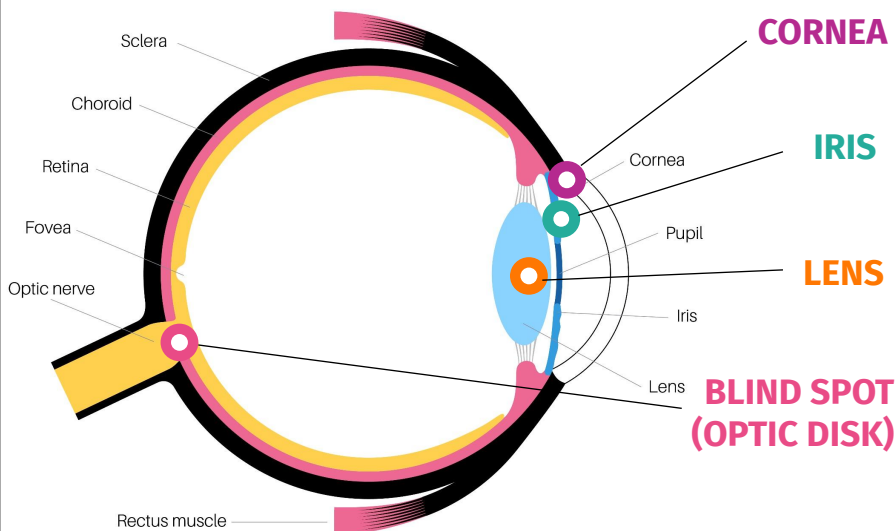
Visual input is mapped directly onto retina as two-dimensional _____ image

3-LAYERED RETINA

Made of:

- _____ (_____)
- _____ cells

EYE ANATOMY



Does about _____ (____) of _____

Regulates _____ light enters by _____ of _____

_____ focus

_____ light so that it focuses on retina

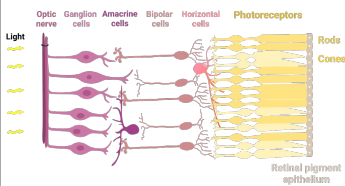
_____ of _____

Contains _____ photoreceptors

PHOTORECEPTORS

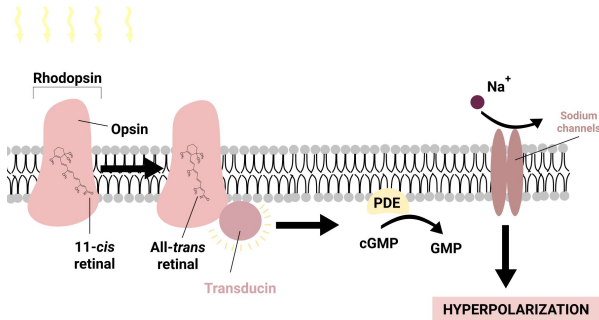
125 Million

PHOTORECEPTORS
in each human _____



PHOTOTRANSDUCTION

Process of converting _____ into another form of _____

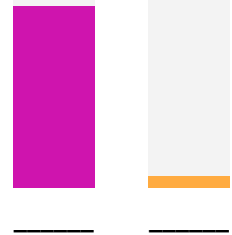


_____ turn light into electrical signals

RODS VS CONES

95%

5%



RODS

SENSITIVE

Extremely _____ to light

DARKNESS

Allow us to see in _____

ACHROMATIC VISION

_____ photopigment

LOW RESOLUTION

Many rods contact one _____ cell



CONES

NOT SENSITIVE

_____ than _____

LIGHT

Work under most _____ conditions

FUNCTIONS

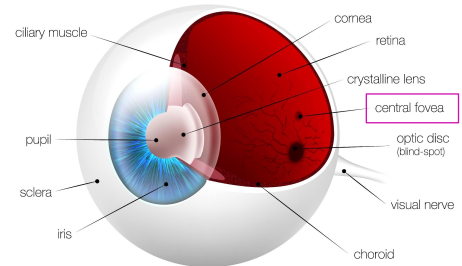
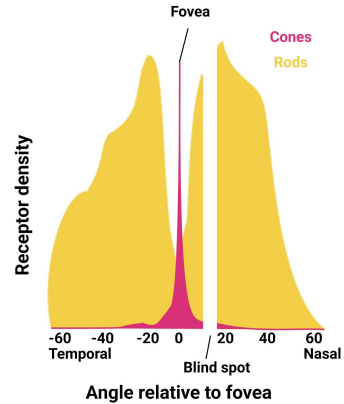
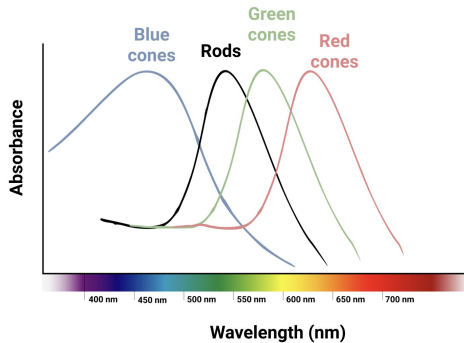
Responsible for _____ & _____
One cone contacts one bipolar cell
Ensure visual acuity

TYPES

_____, _____ & _____

FOVEA

- Located in _____
- Here _____ are most _____
- Fovea contains only _____ and _____ cones
- Can resolve very _____



MACULA

MACULAR DEGENERATION

_____ of photoreceptors in macula, which is leading cause of _____ in people older than _____

MACULA

_____ area of retina surrounding _____

FUNCTIONS

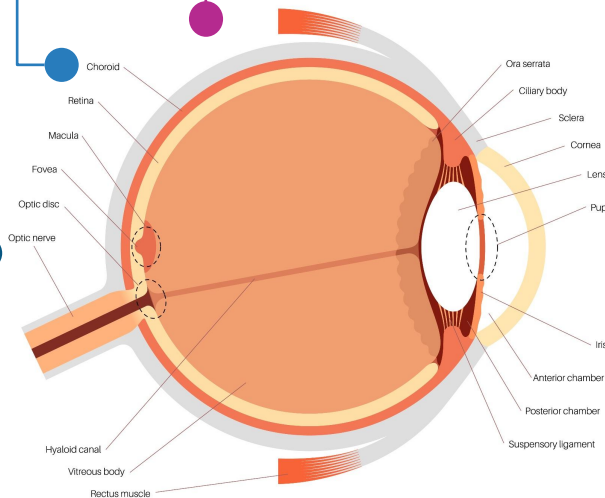
Responsible for sharp, focused vision, particularly for tasks such as _____, _____ & _____

STRUCTURE

Each ganglion cell receives input (via one or more interneurons) from just _____ or very _____, allowing to resolve very _____

VISUAL ACUITY

In macular region _____ is _____

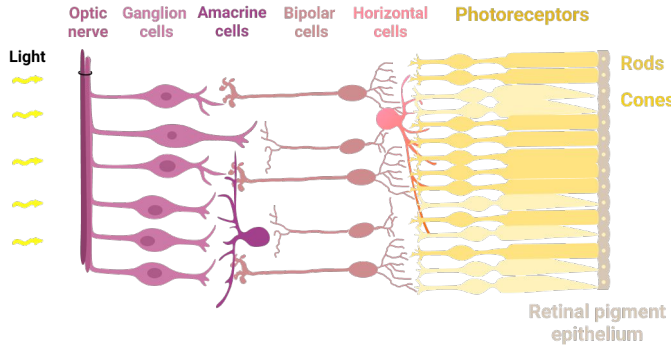
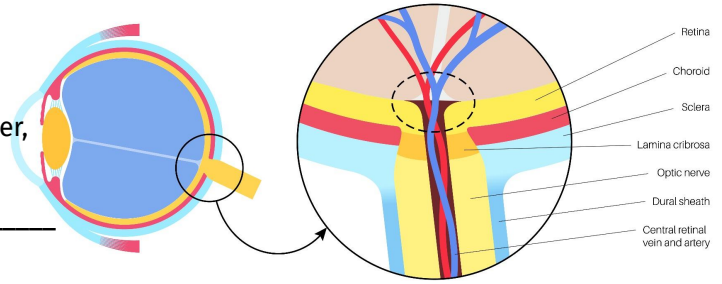


OPTIC NERVE

OPTIC NERVE (CN II)

_____ of _____ cells exit retina together,
forming _____

Responsible for transmitting _____
from retina to brain



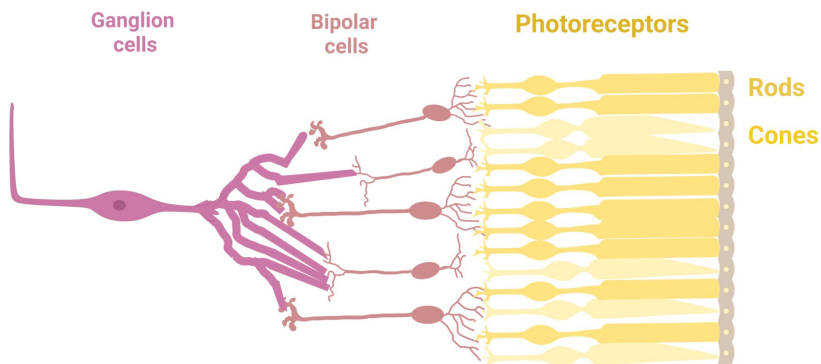
VISUAL IMPAIRMENTS

Damage to optic nerve can result in _____ or _____

Disorders affecting optic nerve include _____, _____ & _____

RECEPTIVE FIELD

Portion of visual space providing input to _____ ganglion cell is called its _____



VISUAL PATHWAY

OPTIC CHIASM

Signals travel along nerve fibers from _____ which first converge at _____

BINOCULAR VISION

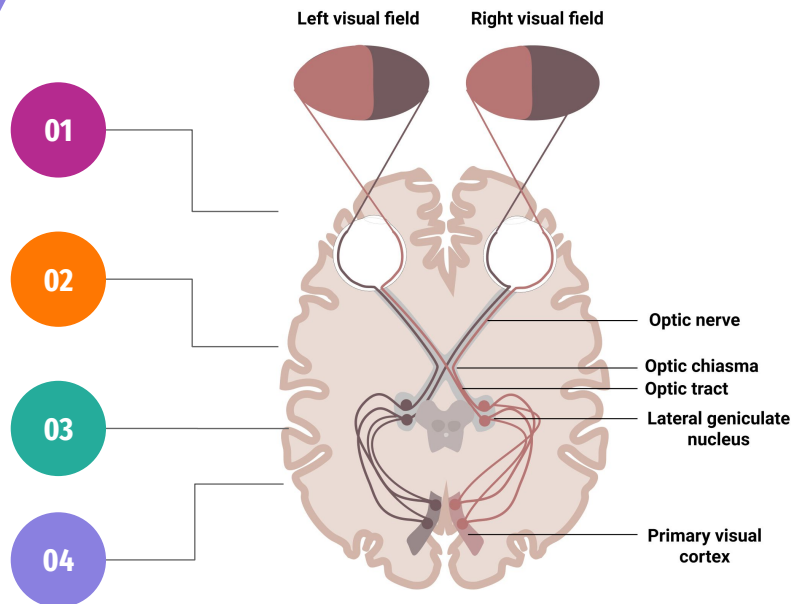
Allows to perceive _____ or _____

CONTRALATERAL CONTROL

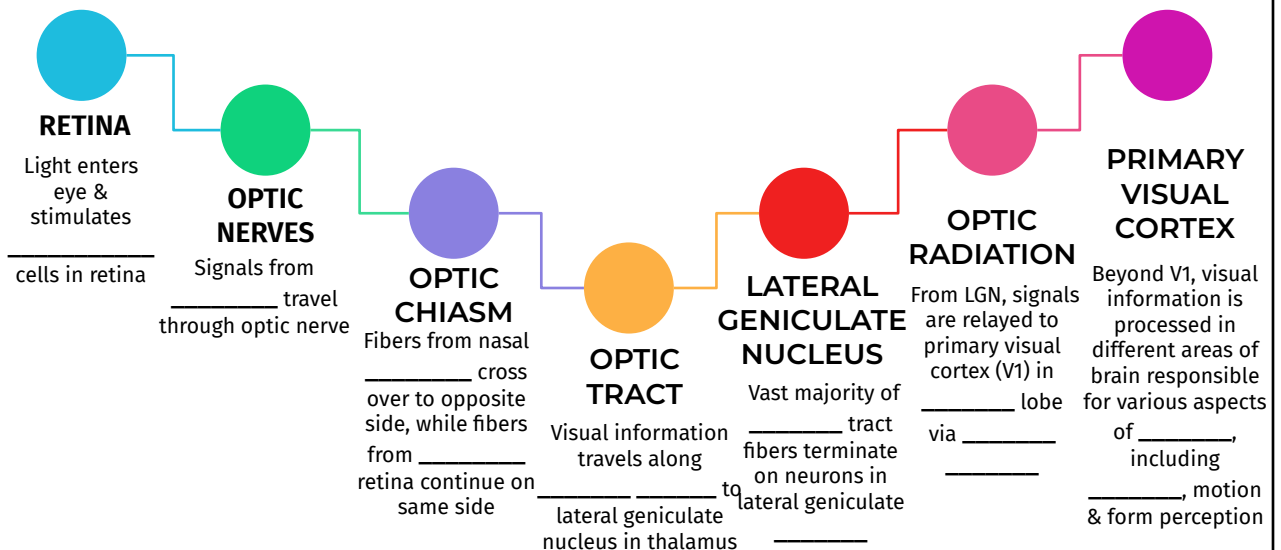
Signals from _____ field end up on the _____ side of _____ and vice versa

Action potential

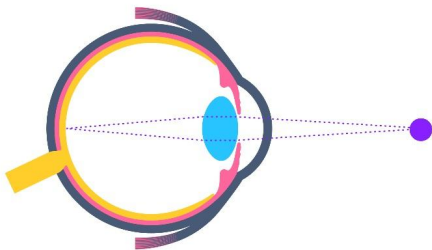
Electrical impulse which moves down _____ towards next neuron in circuit



VISUAL PATHWAY

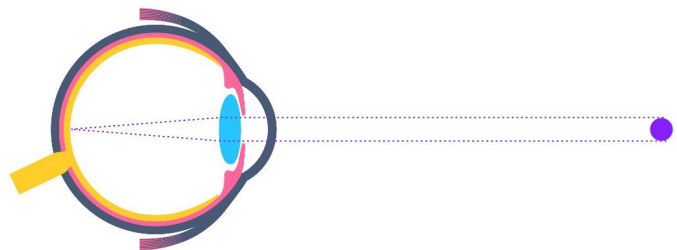


EYE ACCOMMODATION



CLOSE VISION

The ciliary muscles contract, the supporting ligaments relax, the lens of the eye becomes thicker



DISTANT VISION

The ciliary muscles relax, the ligaments become tensed, the lens becomes thinner

VISUAL IMPAIRMENTS

Known as "_____ " or "_____ "

Characterized by _____ of _____, where they point in different directions

People with crossed eyes miss out on much _____

Beyond _____ of _____ or so, blindness becomes _____



Also known as "_____ "

If strabismus is left untreated, brain will eventually _____ or _____ image of weaker eye

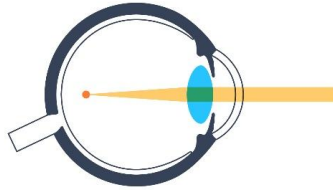
One eye has significantly reduced vision compared to other, despite having no obvious structural abnormalities

Eye is _____ to _____ on _____

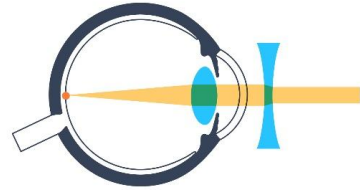


NEARSIGHTEDNESS AND FARSIGHTEDNESS

MYOPIA

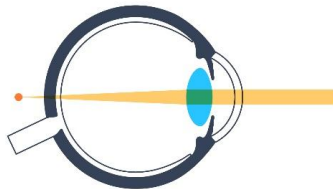


Distant objects appear blurry while
close objects appear normal

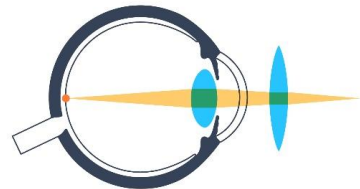


With lens correction

HYPERMETROPIA

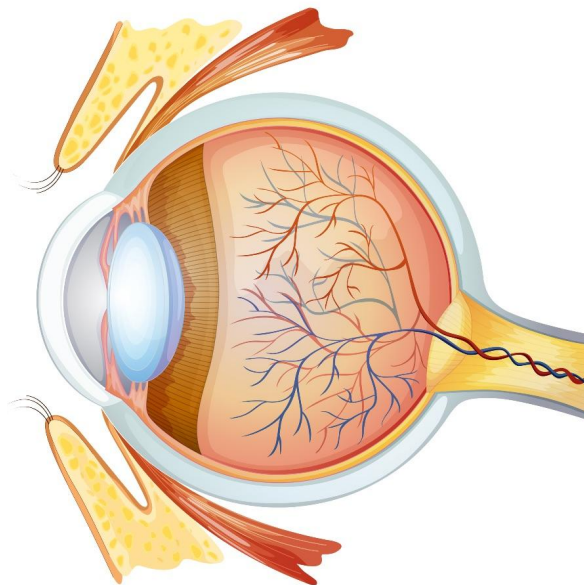


Close objects appear blurry while dis-
tant objects appear normal



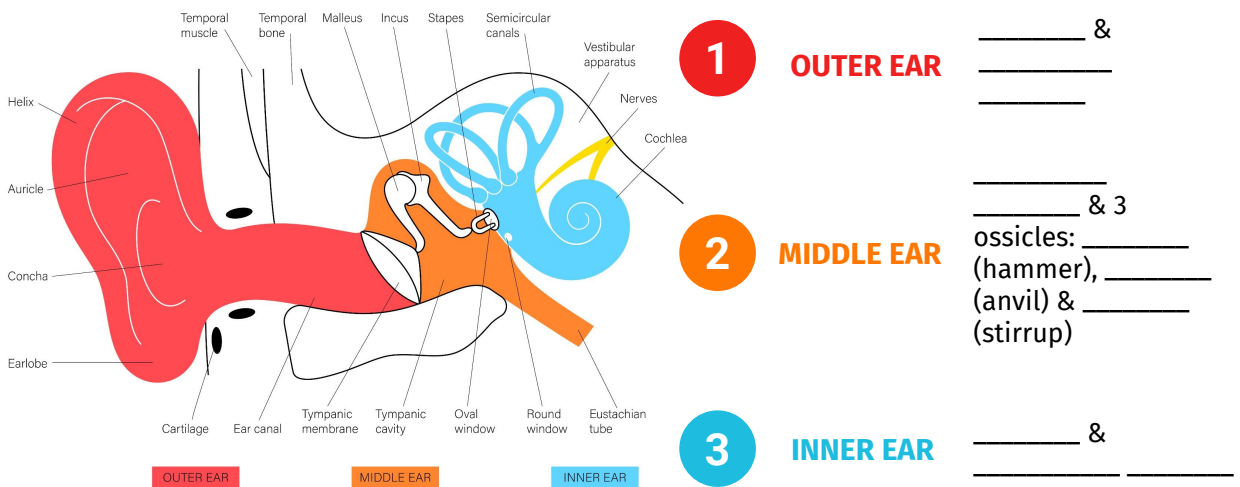
With lens correction

EYE ANATOMY QUIZ



HEARING

PARTS OF THE EAR



TRANSDUCTION

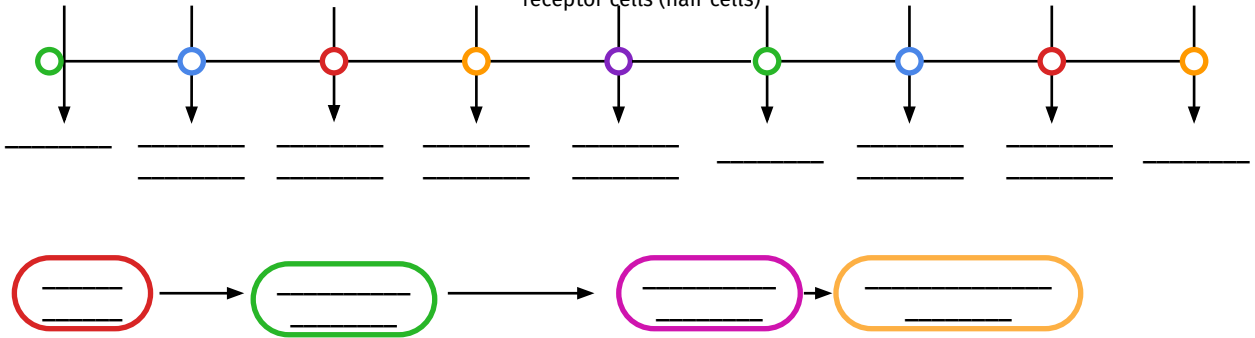
Sound waves are collected by pinna and travel down auditory canal to tympanic membrane, which vibrates at same frequency as sound

First ossicle is attached to tympanic membrane, which begins to vibrate, amplifying vibrations and passing them on to other ossicles

converts mechanical vibrations into pressure waves of fluid-filled cochlea, where they are transduced into electrical signals by specialized receptor cells (hair cells)

Hair cells of organ of Corti detect vibrations and pass messages to brain via auditory nerve

Different sounds move hair cells in different ways, allowing brain to distinguish various sounds



COCHLEA

OVAL WINDOW

Membrane-covered opening between middle ear & inner ear

Transmits sound vibrations from _____ to fluid-filled _____

Receives vibrations from _____

ROUND WINDOW

Membrane-covered opening located below oval window in _____

Acts as _____

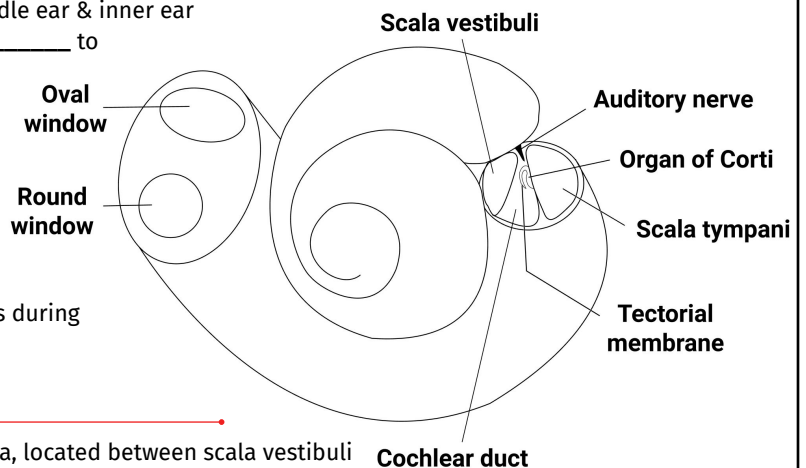
Helps _____ of cochlear fluids during transmission of sound waves

COCHLEAR DUCT

_____ fluid-filled chamber within cochlea, located between scala vestibuli & scala tympani

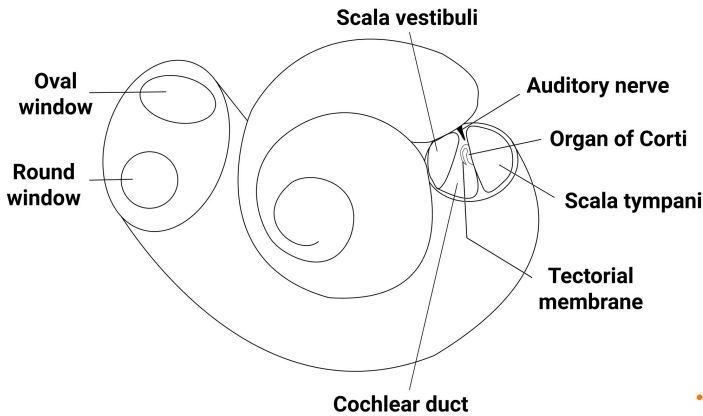
Contains _____, fluid high in _____ ions

Houses the _____ with sensory hair cells



COCHLEA

SCALA VESTIBULI & SCALA TYMPANI



Two fluid-filled chambers within cochlea that run _____ to each other

_____: Located _____ cochlear duct and is filled with _____

_____: Located _____ cochlear duct and is filled with _____

These chambers contain _____ that helps transmit vibrations from _____ to _____, facilitating movement of sound through cochlea

TECTORIAL MEMBRANE

_____ - _____ structure that extends over hair cells in _____ on one end & _____ - _____ on other

When sound vibrations cause basilar membrane to move, tectorial membrane bends hair cells, initiating process of _____

COCHLEA

HAIR CELLS
Specialized _____ in cochlea
Responsible for converting _____ into _____ signals

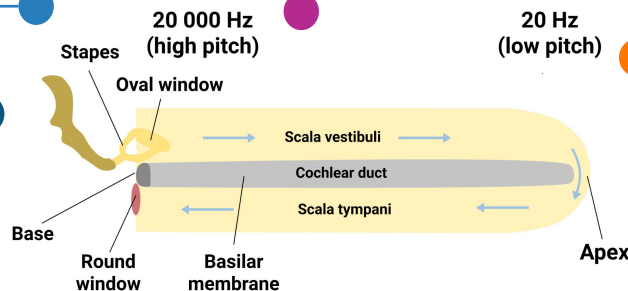
AUDITORY TRANSDUCTION

Initiated by movement of hair cells in response to sound vibrations

TONOTOPIC MAP

_____ varies in _____ & _____ along its length, creating tonotopic map of _____ along cochlea

BASILAR MEMBRANE
"Tuned" along its length to different frequencies (_____)



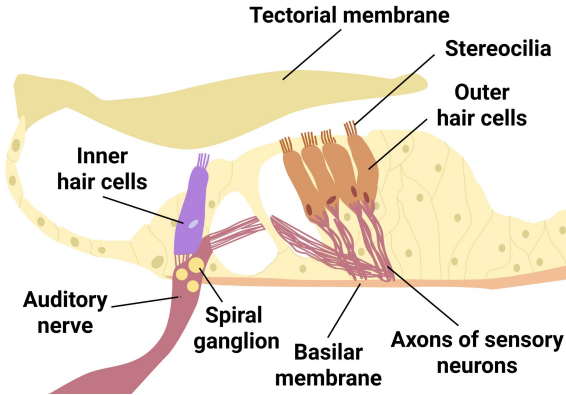
20 000 Hz (high pitch)

20 Hz (low pitch)

FREQUENCY SENSITIVITY

_____ - _____ sounds
→ near _____
_____ - _____ sounds
→ near _____

ORGAN OF CORTI



01. ORGAN OF CORTI

Crucial for _____ of _____ & _____ of auditory information to _____

02. INNER HAIR CELLS

_____ for auditory information

Each inner hair cell is innervated by _____ spiral ganglion neurons

Critical for _____ of _____ (_____ & _____)

03. OUTER HAIR CELLS

Involved in _____ & _____ of sound vibrations

Each outer hair cell is innervated by _____ spiral ganglion neurons

04. SPIRAL GANGLION

Collection of nerve _____

Receive input from _____ of organ of Corti

Serve as first _____ in transmission of auditory information from cochlea to brain
_____ of spiral ganglion neurons form _____ fibers

AUDITORY PATHWAY



_____ carries signals to brain stem, where they are relayed to _____



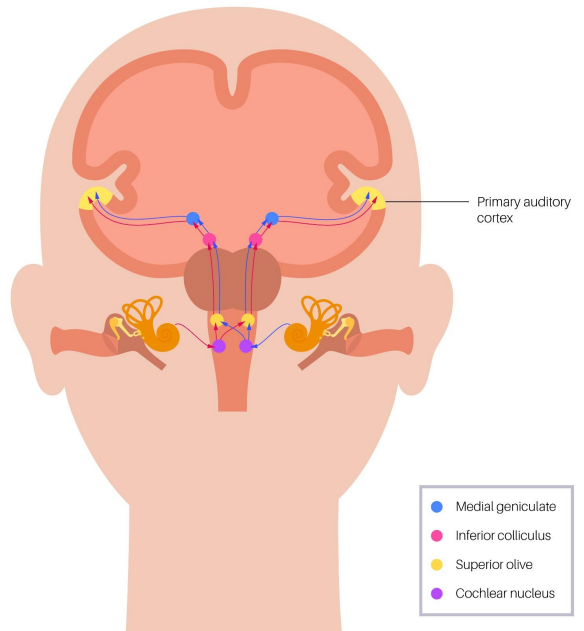
From cochlear nuclei, auditory signals ascend to _____, then to _____ & _____ (MGN) of thalamus



_____ is brain's _____ for incoming _____ information



From MGN, auditory signals are transmitted to _____ in _____ for processing & interpretation



LANGUAGE PROCESSING

LATERALIZATION

_____ side of brain is responsible for _____ & _____ speech

BROCA'S AREA

Involved in _____

MOTOR CORTEX

Broca

Wernicke

AUDITORY CORTEX

WERNICKE'S AREA

Involved in _____

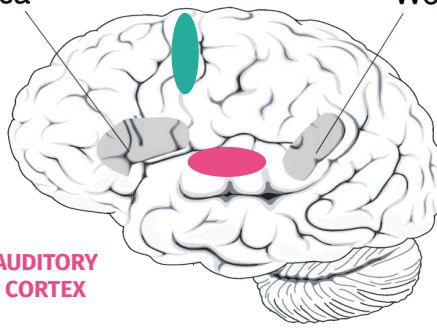
LEFT AUDITORY CORTEX

Someone with damage to left auditory cortex is able to _____ person speak but _____ longer _____ what is being said

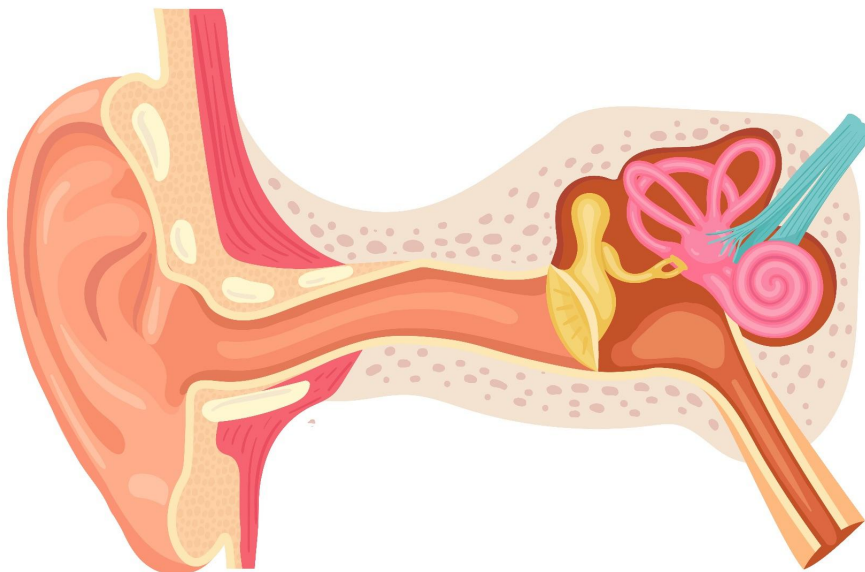
Front

Left Side View

Back



EAR ANATOMY QUIZ



SMELL

OLFACTORY SYSTEM



OLFACTION

Sense of _____



OLFACTORY BULB

Structure in _____
responsible for processing
_____ information



OLFACTORY NEURONS

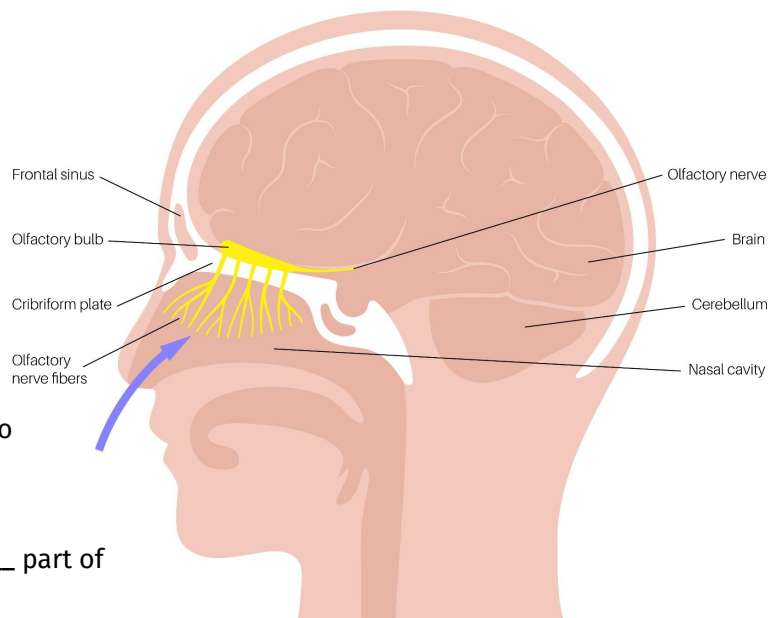
Only sensory neurons that are

Detect & transduce odorants into
neural signals

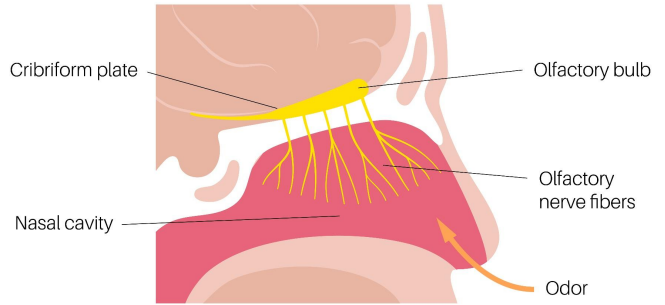
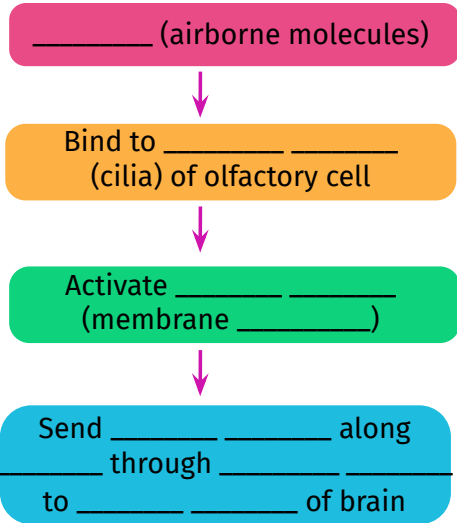


OLFACTORY EPITHELIUM

Specialized tissue lining _____ part of



TRANSDUCTION



1,000 **20,000**

OLFACTORY CELLS **SMELLS**

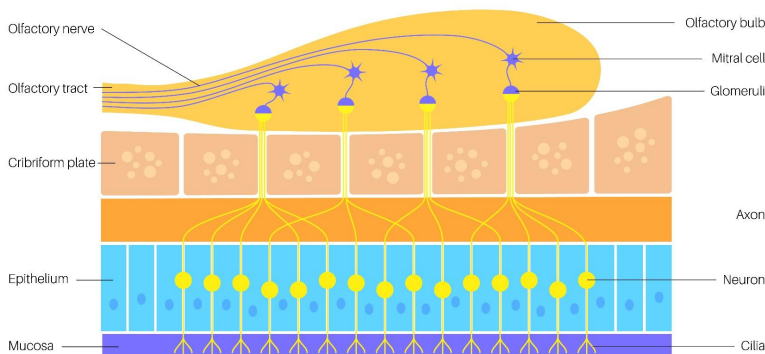
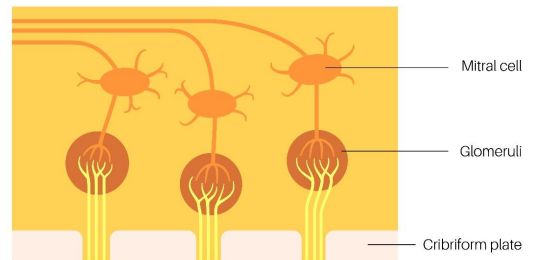
Found in _____ Can be detected

OLFACTORY CELLS

OLFACTORY NEURONS

Specialized sensory cells located in _____ of _____

Initiate _____ of _____



GLOMERULI

Spherical structures where _____ synapse onto _____

Contribute to _____

MITRAL CELLS

_____ of _____

Transmit olfactory information to higher brain regions (e.g., _____)

Play role in _____, _____ & _____

OLFACTORY NEURONS

FUNCTIONS

01

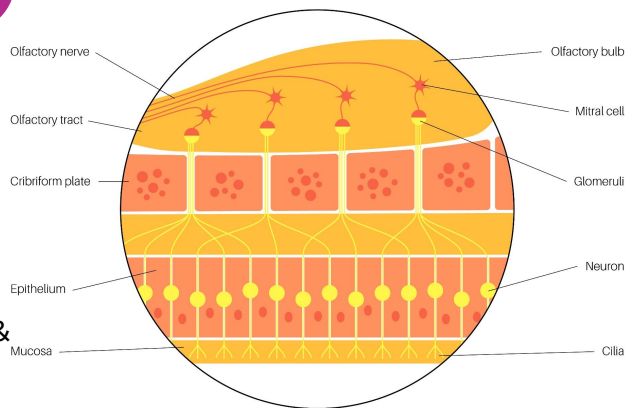
Responsible for _____ odorant molecules in air
Contain _____

ANOSMIA

04

_____ to _____, which can impact quality of life & safety

Caused by _____ or _____ of _____



02

PROJECTIONS

Axons of olfactory neurons project through _____ into _____

03

RECEPTORS

Each sensory neuron expresses only _____ of many similar _____ (ORs)

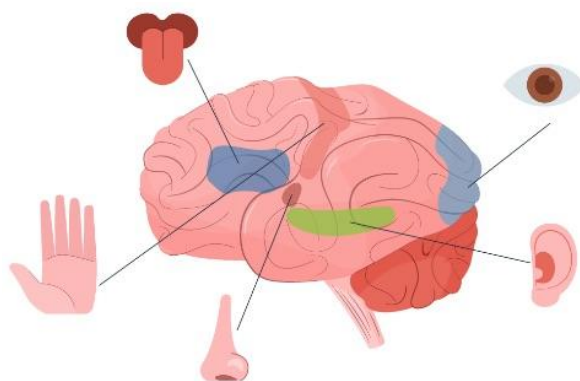
OLFACTORY PROCESSING

1 _____ is only sensory system that sends sensory information _____ to cerebral cortex _____ first passing through _____

2 _____ located on anterior surface of _____

3 _____ are one of few brain regions able to generate new neurons (_____) throughout life

4 From olfactory bulb, olfactory signals are relayed to higher brain regions, including _____, _____ & _____



OLFACTORY CORTEX

CENTRAL PROCESSING OF SMELL

OLFACTORY BULB

First _____
_____ for
olfactory information

Receives _____
from _____
_____ neurons

OLFACTORY CORTEX

Consists of several
interconnected
brain regions
involved in further
_____ and
_____ of
olfactory
information
_____ of

AMYGDALA

Involved in _____
processing & _____
formation
Receives direct input
from _____
_____ & _____
Contribute to formation
of _____
associated with

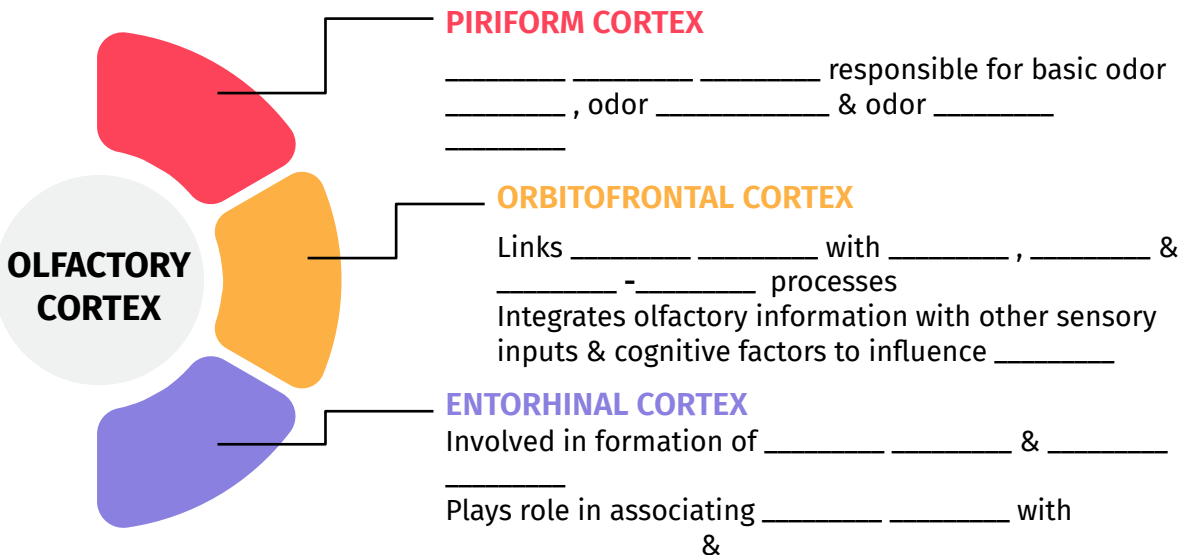
HIPPOCAMPUS

Essential for
_____ &

Encodes &
retrieves _____
_____ &

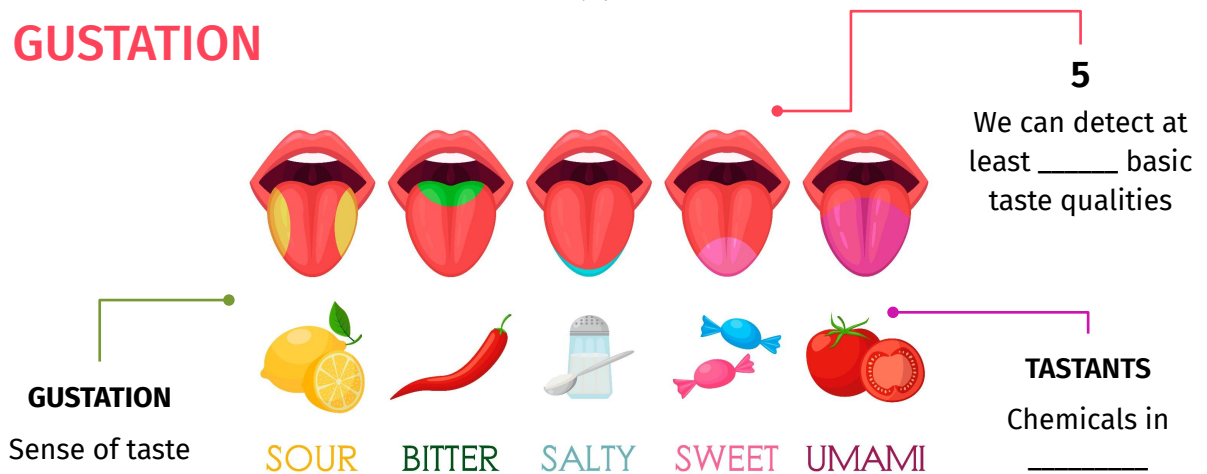
Olfactory information bypasses thalamus en route to cortex

OLFACTORY CORTEX



TASTE

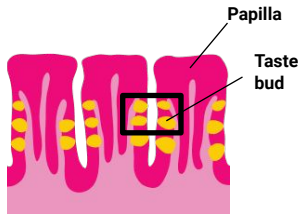
GUSTATION



TASTE MAPS ARE INCORRECT

All tastes are detected _____ tongue and are _____ limited to specific regions

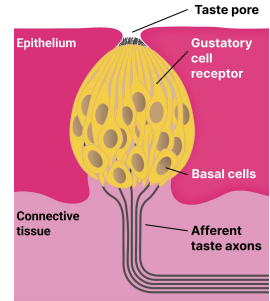
GUSTATION



5 000-
10 000



50



50-100



TASTE BUDS

Found in _____ on



YEARS OF AGE

Start to _____ taste buds

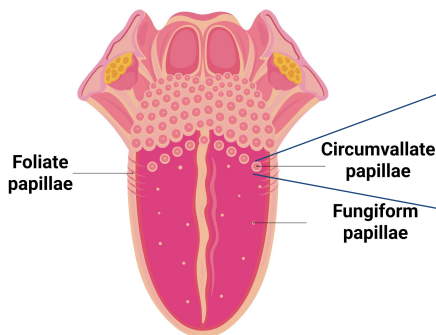


SENSORY CELLS

Found in each _____

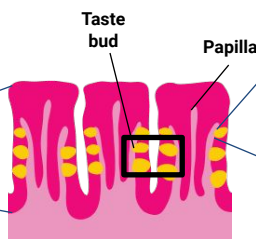
TASTE BUDS

TONGUE



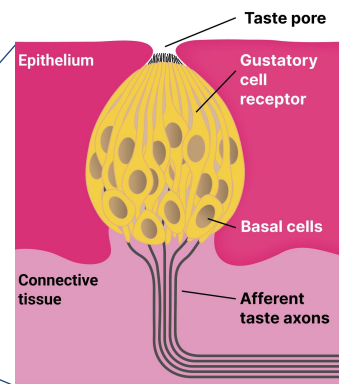
1 _____

PAPILLAE



1-100

TASTE BUD



50-100

GUSTATORY NERVES

When _____ cells are stimulated, they send signals through _____ cranial nerves:

FACIAL NERVE
Collects information from _____ $\frac{2}{3}$ of _____

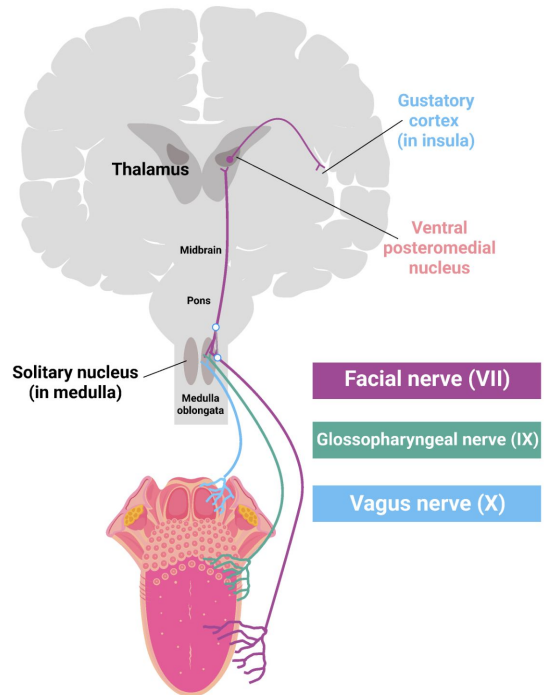
GLOSSOPHARYNGEAL NERVE
Collects information from _____ $\frac{1}{3}$ of _____

VAGUS NERVE
Collects information from _____, _____ & _____

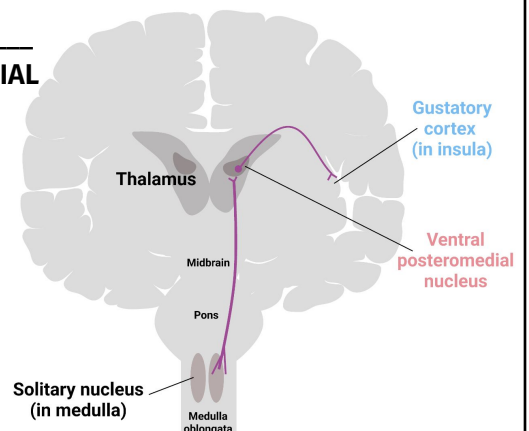
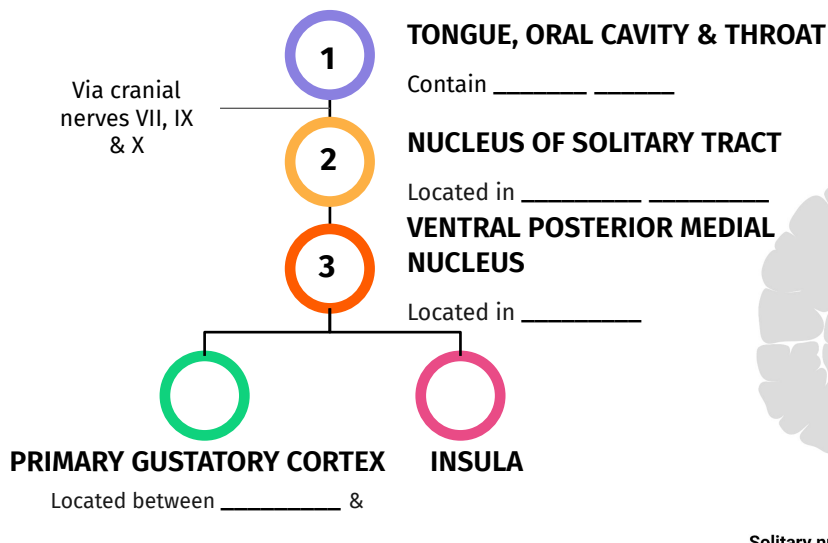
01.

02.

03.



GUSTATORY PATHWAY



SOMATOSENSATION

SOMATOSENSATION

SOMATOSENSORY SYSTEM

Responsible for _____
sensations



Free nerve endings

Pain sensitivity
receptors



Merkel disks

Pressure
receptors



Krause end bulbs

Cold
receptors



Meissner corpuscle

Touch
receptor



Ruffini endings

Heat
receptors



Pacinian
Corpuscle

High-frequency
receptor

INPUTS

Include light _____ , _____ ,
_____, _____ , _____ ,
_____ & _____



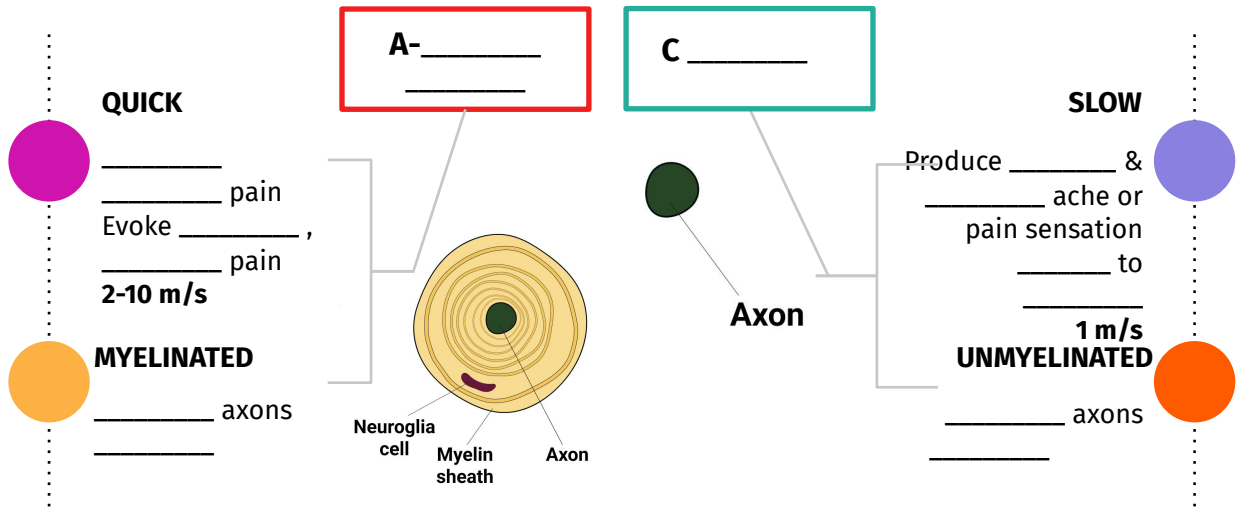
SKIN

Body's main sense
organ for touch



TOUCH

Touch information travels via:



SENSITIVITY

SENSITIVITY

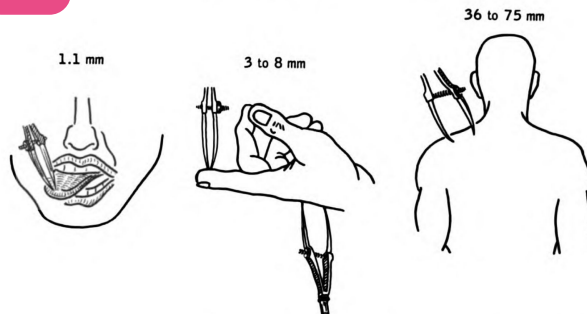


Depends on _____ of _____ per unit area & _____ between them

TWO-POINT DISCRIMINATION



_____ distance between two points on _____ that person can identify as _____



RECEPTIVE FIELDS

LARGE RECEPTIVE FIELD

OVERLAP

Receptive fields of primary neurons _____ to form large secondary receptive field

SUMMATION

_____ of primary neurons stimulate _____ at secondary sensory neurons, initiating _____ action potential

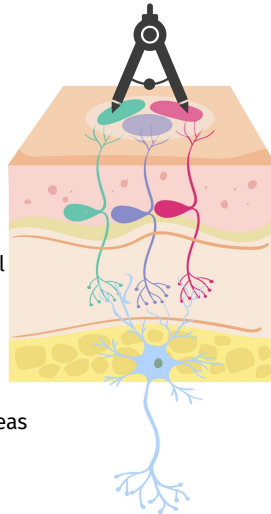
FUNCTIONS

2 stimuli are perceived as single point as _____ signal travels to brain

Found in _____ areas

CLINICAL SIGNIFICANCE

_____ receptor density



SMALL RECEPTIVE FIELD

NO OVERLAP

Primary neuron receptive fields do _____ overlap

NO SUMMATION

_____ convergence occurs at secondary sensory neurons
Stimuli activate _____ pathways to brain

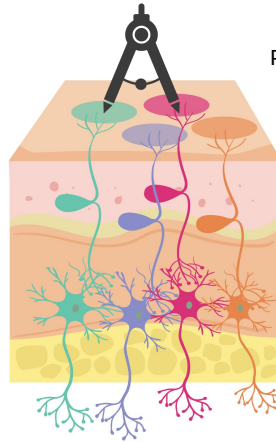
FUNCTIONS

Two stimuli are perceived as _____ points

Found in _____ areas

CLINICAL SIGNIFICANCE

_____ receptor density



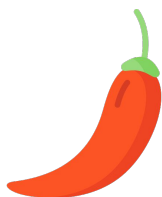
NOCICEPTION



NOCICEPTORS

Respond to stimuli that can cause _____

CHEMICALS



CAPSAICIN

Found in _____

Produce _____ pain



HISTAMINE

Cause _____
Plays role in _____
_____, _____
_____ & _____



PROTAGLANDINS

_____ sensitivity of
receptors to _____
Make feel _____ more
intensely

ABNORMAL PAIN RESPONSES

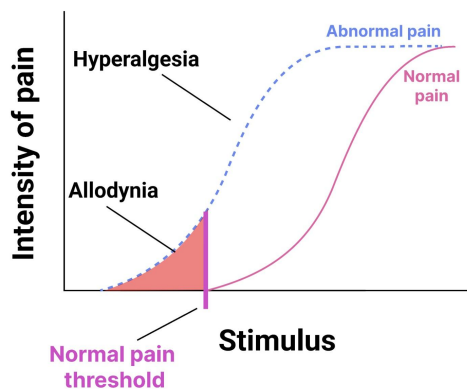
Caused by _____ or _____ of _____, leading to _____ processing of sensory signals & perception of pain in response to normally innocuous stimuli

ALLODYNIA

Type of _____

_____ - _____ stimuli, such as light touch or gentle pressure, elicit _____

Innocuous provoke significant pain.



HYPERALGESIA

_____ sensitivity to
_____ stimuli

Occur in response to _____
_____, _____ or

_____ pain perception in
response to _____

Increased _____ or
_____ of _____

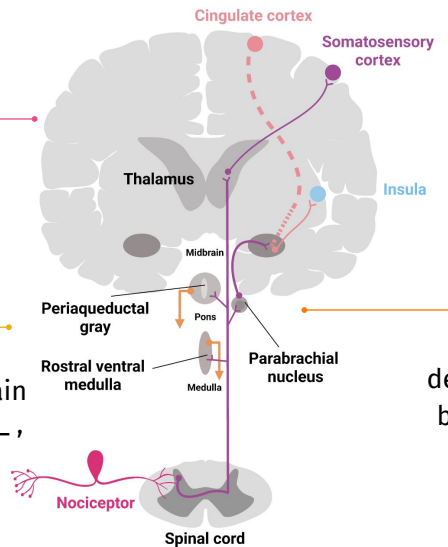
CENTRAL PAIN PROCESSING

PERIAQUEDUCTAL GRAY MATTER (PAG)

Cortex sends pain messages to this region of _____

ENDORPHINS

PAG activates _____ pathways that modulate pain
Trigger release of _____, opioids that act like _____ morphine



ADRENALINE

Produced in _____
_____ situations
_____ without
loss of consciousness

SPINAL CORD

_____ can be
delivered to _____
before, during & after surgery to
