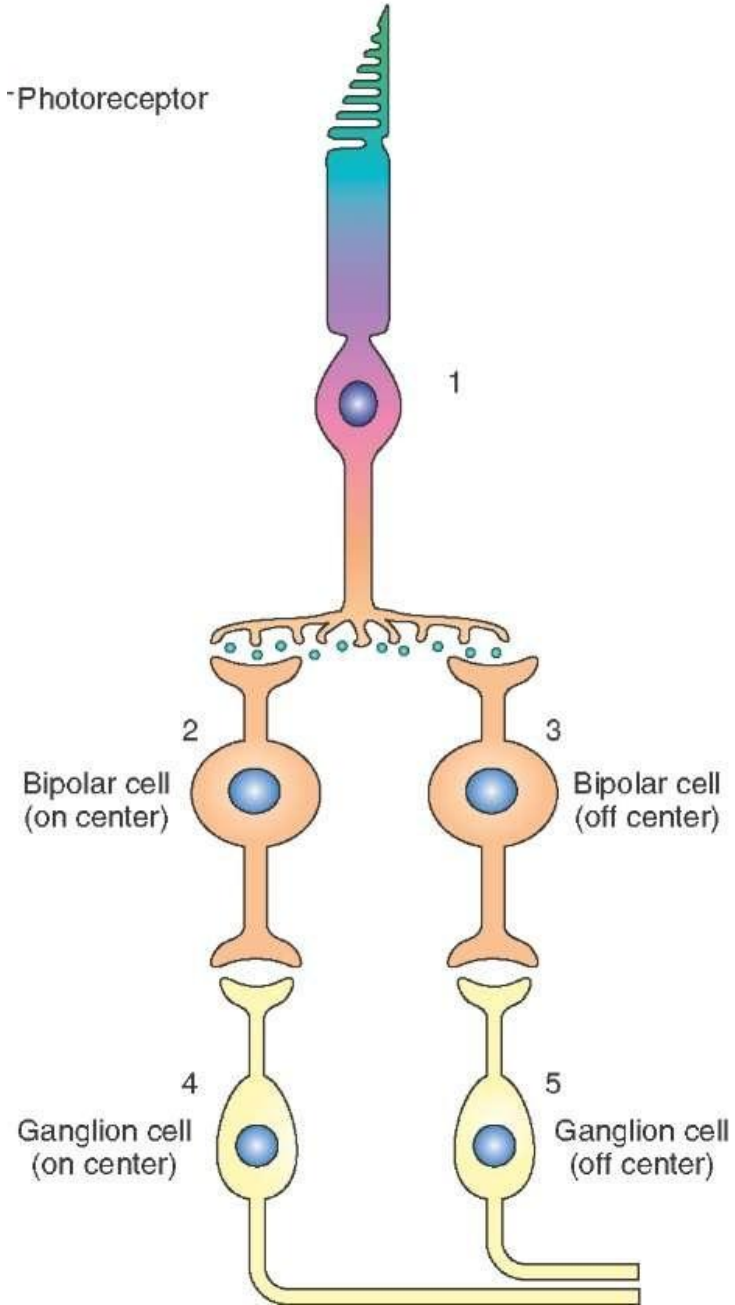
(more) vision

COGS17 - WEEK 4
7/22/19

“it doesn’t matter what one cell does, it matters HOW they are connected”

Review of the potential connectivity patterns of photoreceptors, bipolar cells, and retinal ganglion cells

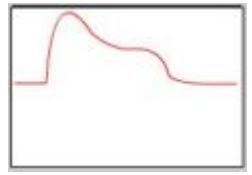


ON center vs OFF center bipolar cells

What happens when the photoreceptor is…

In the light:

ON → depolarizes

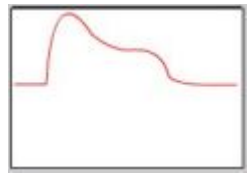


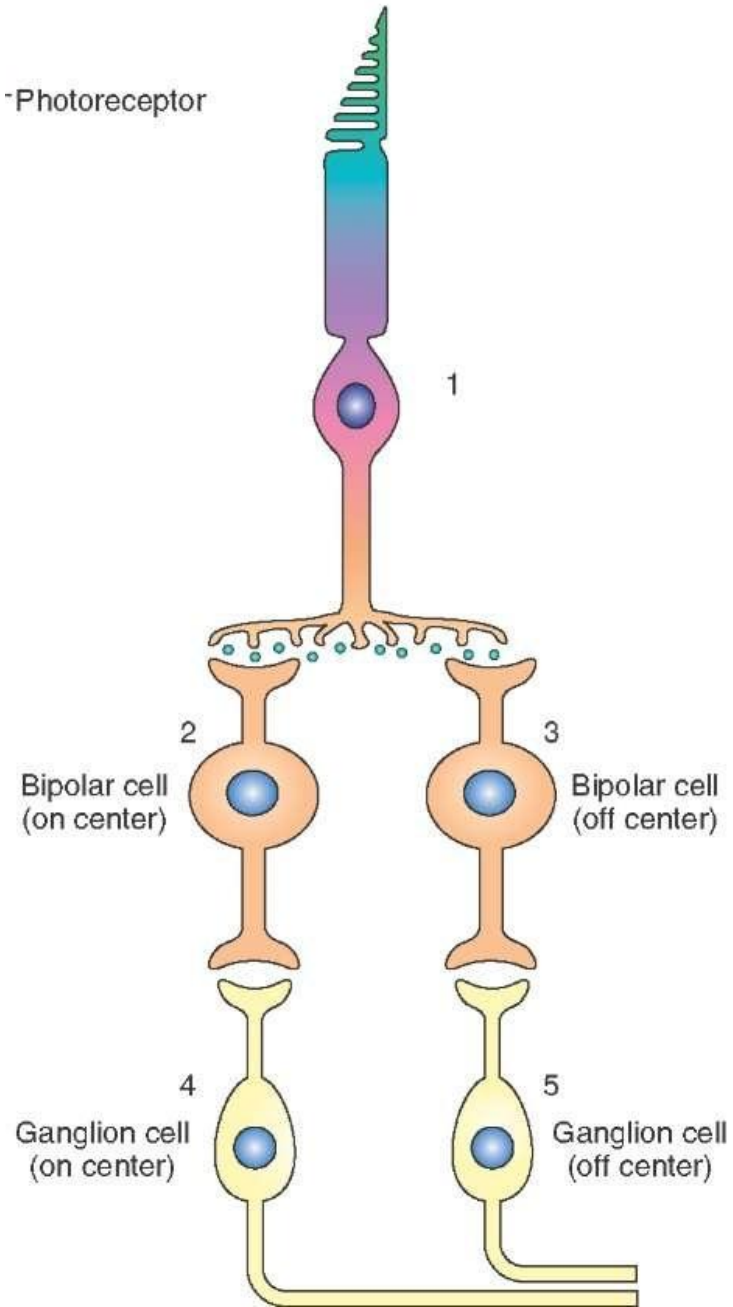
OFF → hyperpolarizes

In the dark:

ON → hyperpolarizes

OFF → depolarizes





why?

ON = metabotropic receptor (mGluR6, g-protein coupled!)

OFF = ionotropic receptor (AMPA)

glutamate has opposite effects on these receptors

In the light:

ON → less glutamate around, so voltage-gated Na+ channels are open

OFF → less glutamate around, so less Na+ enters via channels

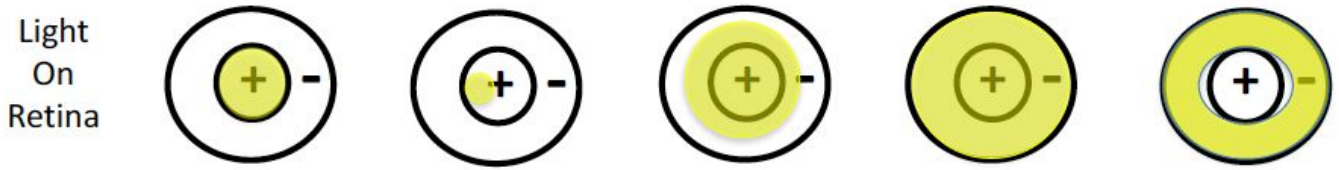
In the dark:

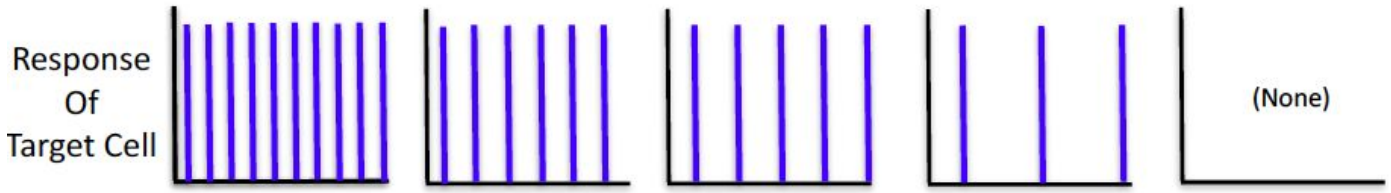
ON → more glutamate, so voltage-gated Na+ channels are closed

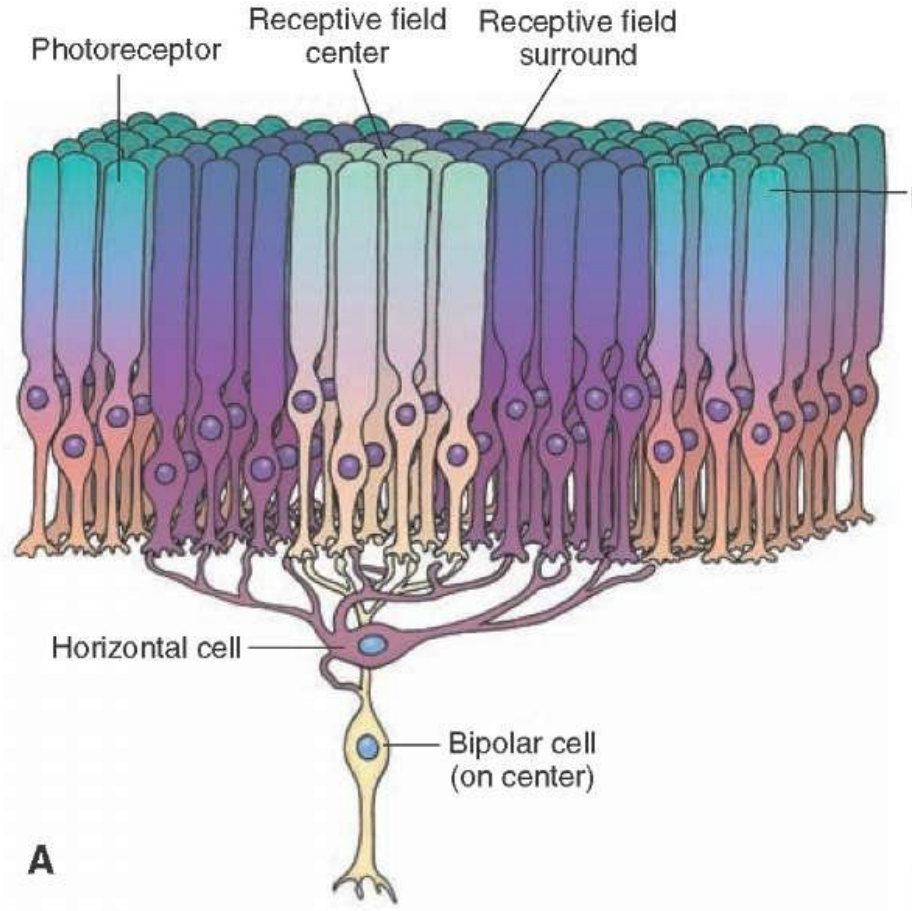
OFF → more glutamate, so more Na+ enters via channels

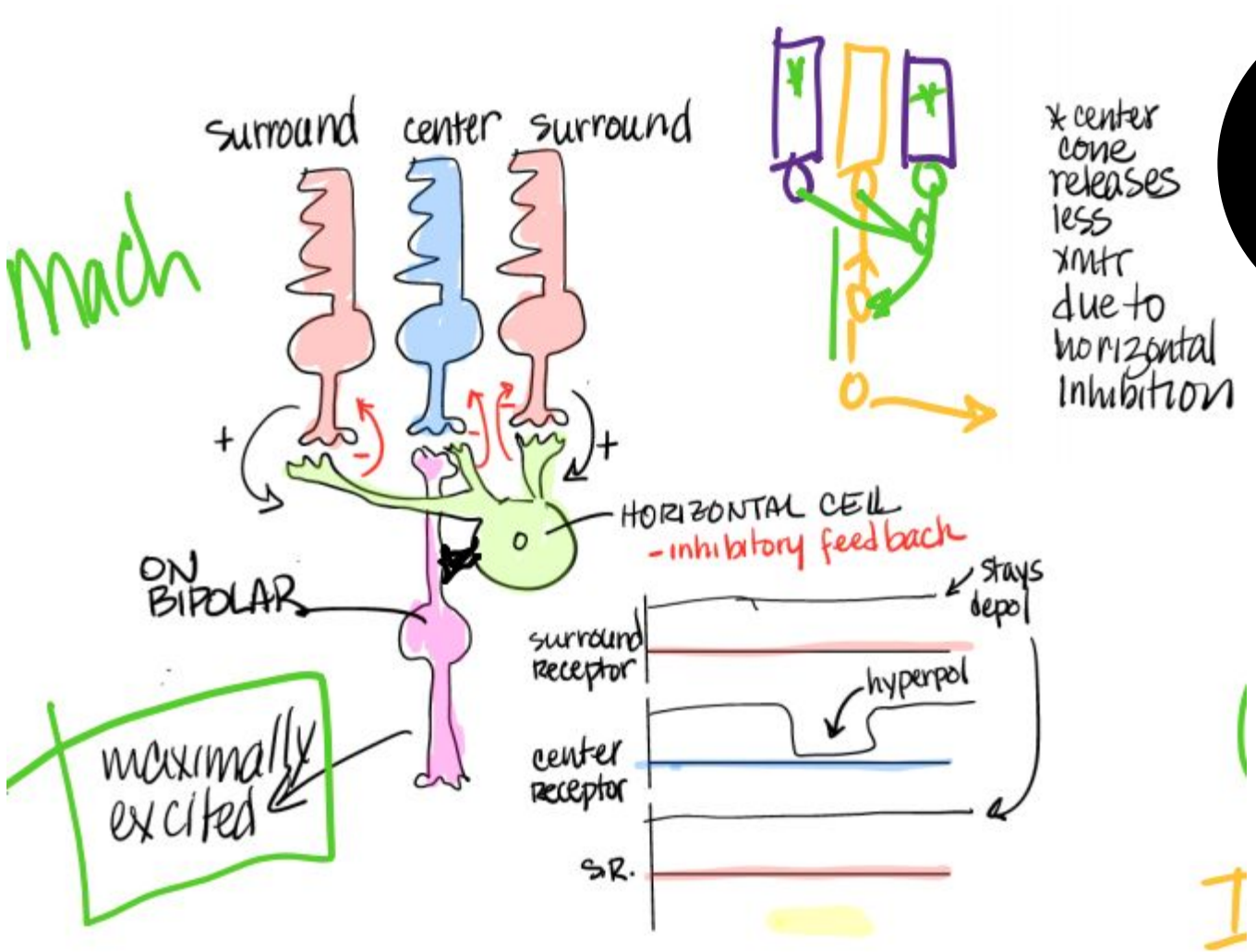
Center-Surround

- Excitatory center and inhibitory surround receptive fields
- Refers to receptive fields for cells in a place on the retina
- Plus and minus refer to what the target cell is doing
- Receptive fields are overlapping thus many receptor cells contribute to many receptive fields

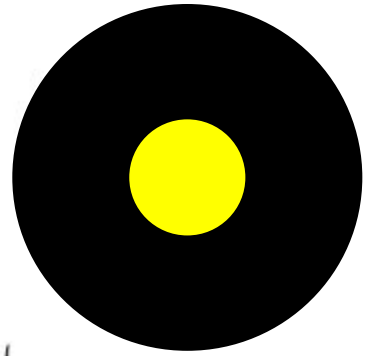


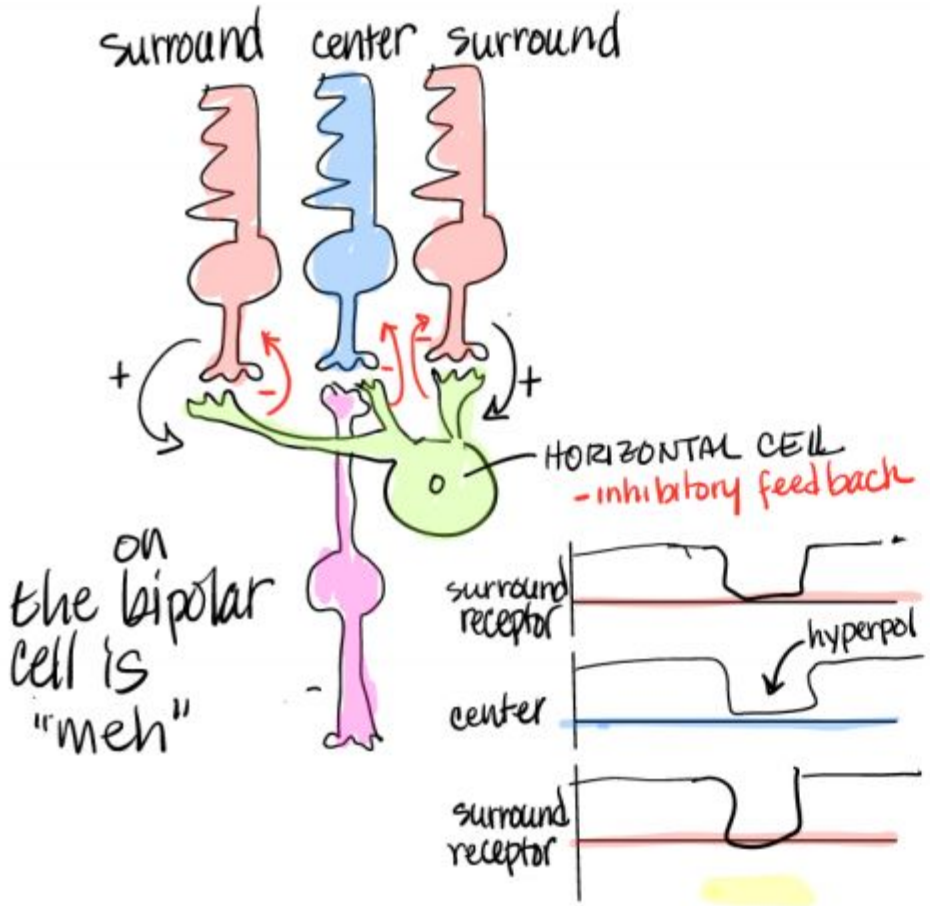




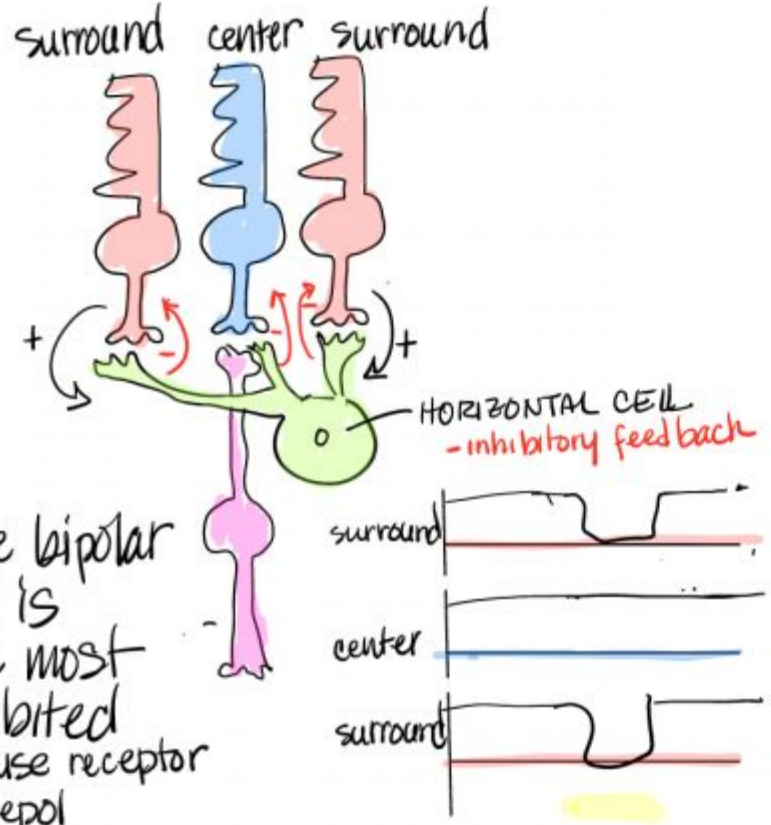


* center cone releases less xmtr due to horizontal inhibition

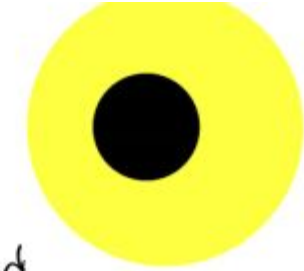




*horizontal cell is less excited
- inhibition to center receptor is reduced

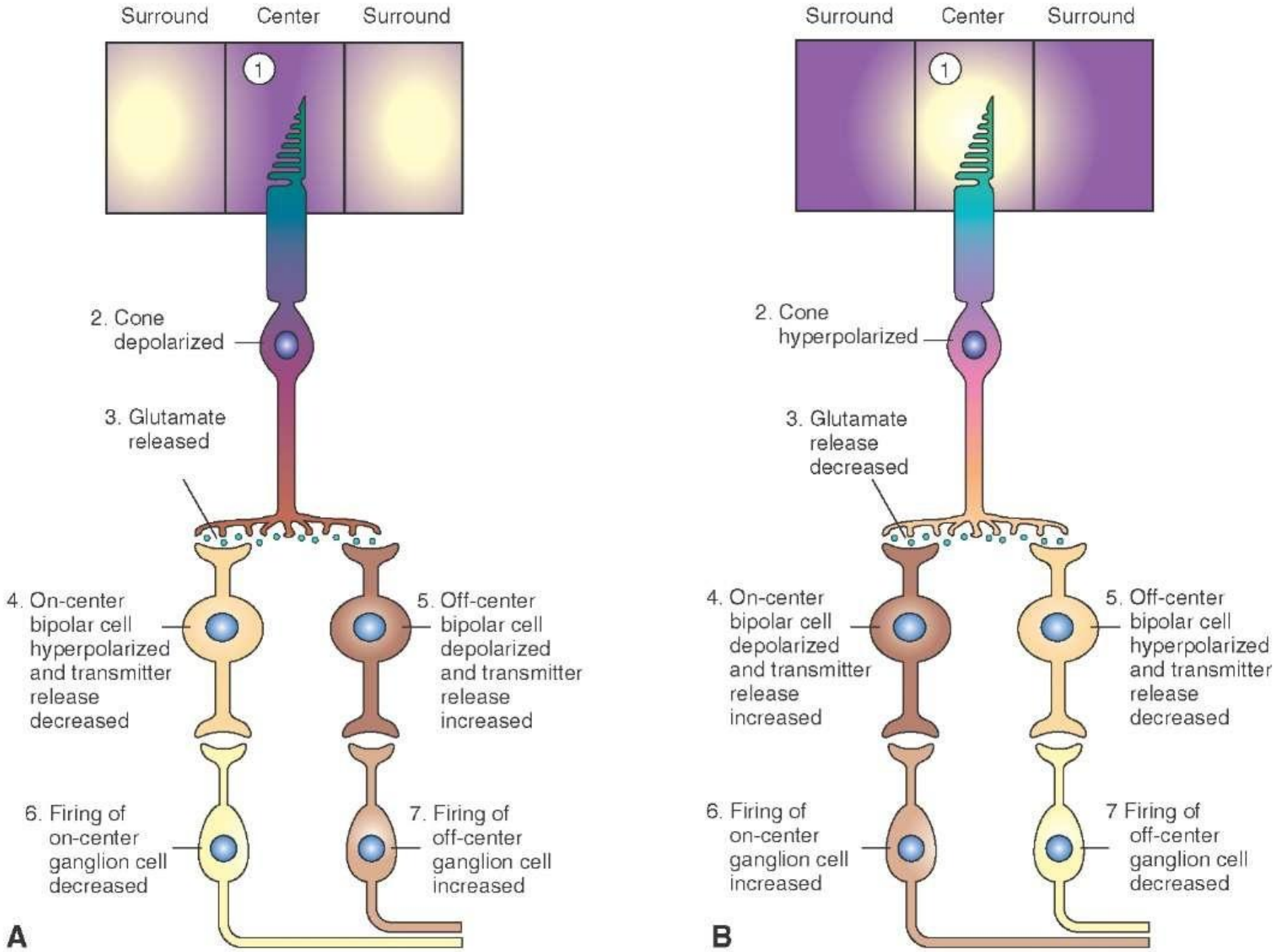


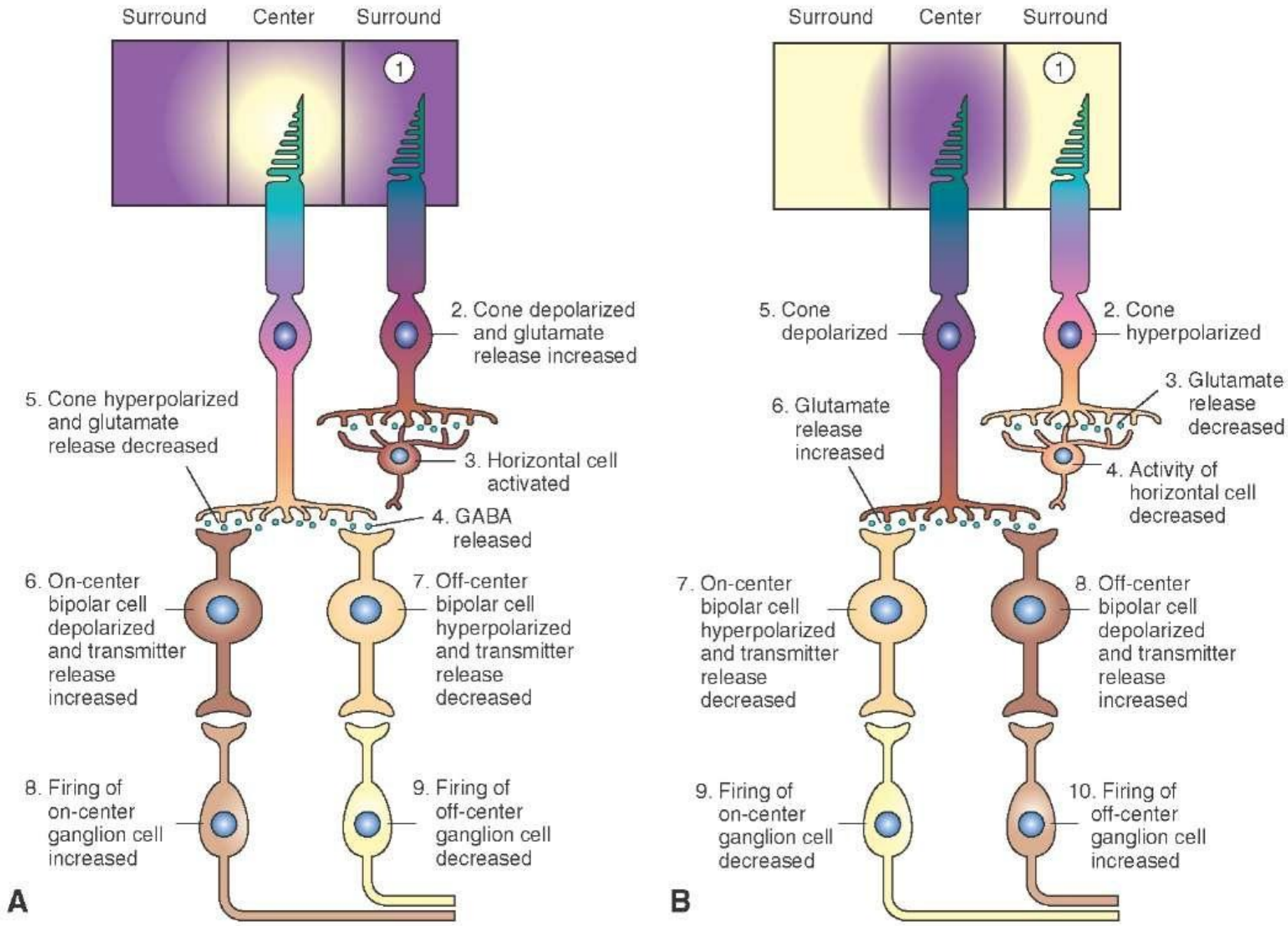
the bipolar cell is the most inhibited because receptor is depol & hc is not inhibiting



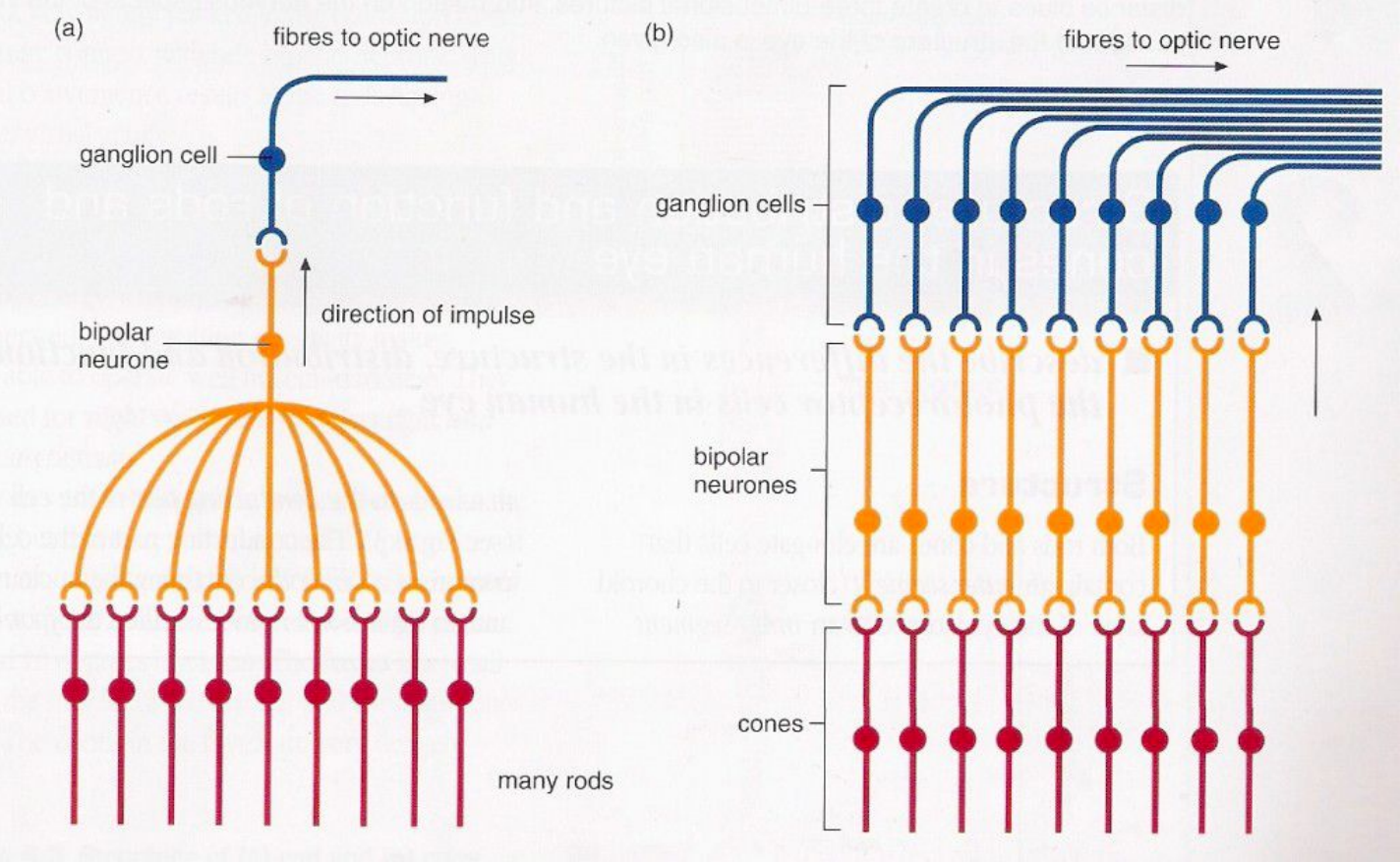
* surround receptors → hyperpol → horizontal cell minimally excited

∴ inhibitory signals are low

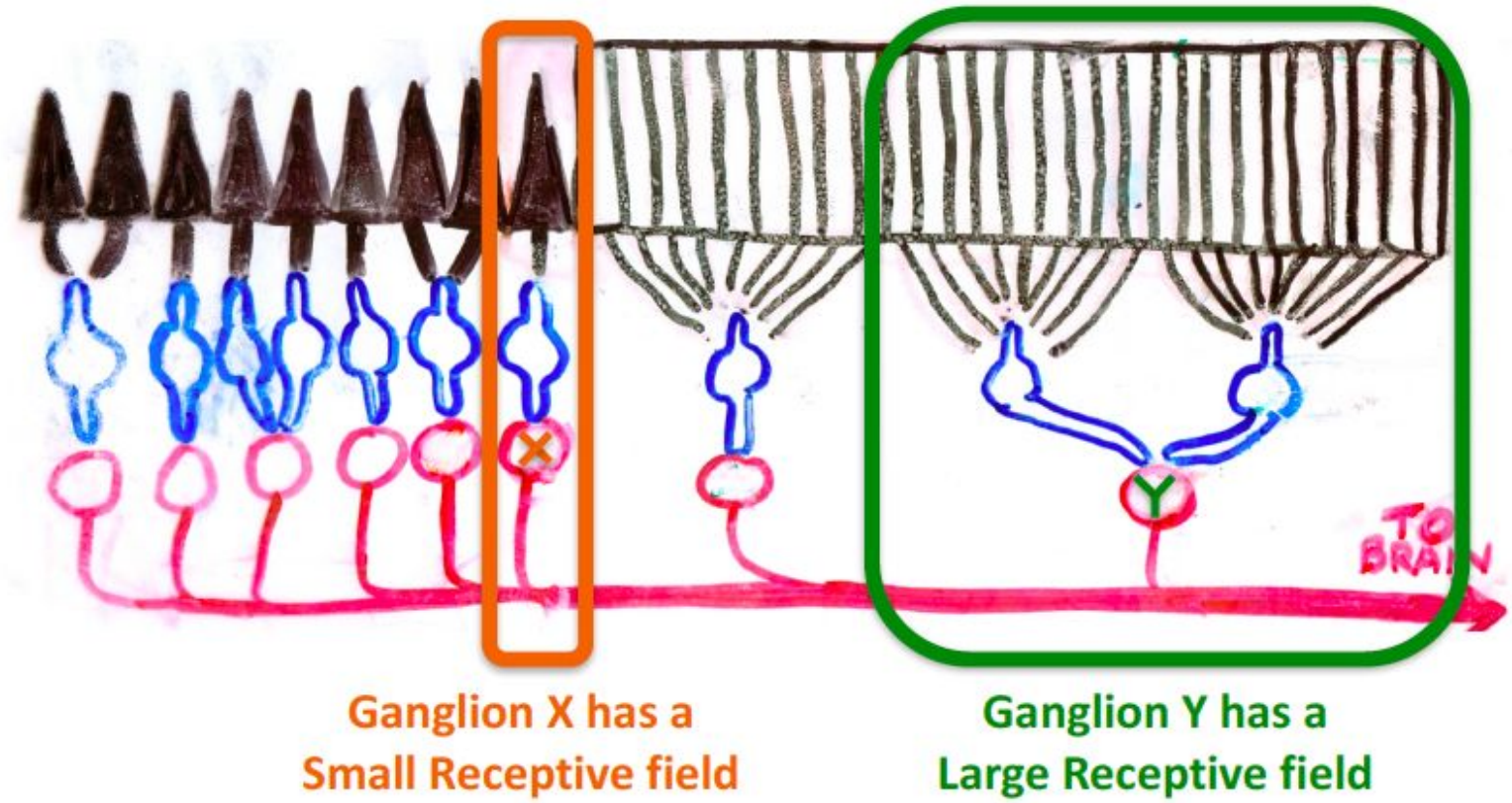

Surround
Center
Surround
1
2. Cone depolarized
3. Glutamate released
4. On-center bipolar cell hyperpolarized and transmitter release decreased
5. Off-center bipolar cell depolarized and transmitter release increased
6. Firing of on-center ganglion cell decreased
7. Firing of off-center ganglion cell increased
A
Surround
Center
Surround
1
2. Cone hyperpolarized
3. Glutamate release decreased
4. On-center bipolar cell depolarized and transmitter release increased
5. Off-center bipolar cell hyperpolarized and transmitter release decreased
6. Firing of on-center ganglion cell increased
7 Firing of off-center ganglion cell decreased
B


Surround
Center
Surround
1
2. Cone depolarized and glutamate release increased
5. Cone hyperpolarized and glutamate release decreased
3. Horizontal cell activated
4. GABA released
6. On-center bipolar cell depolarized and transmitter release increased
7. Off-center bipolar cell hyperpolarized and transmitter release decreased
8. Firing of on-center ganglion cell increased
9. Firing of off-center ganglion cell decreased
A
Surround
Center
Surround
1
5. Cone depolarized
2. Cone hyperpolarized
3. Glutamate release decreased
6. Glutamate release increased
4. Activity of horizontal cell decreased
7. On-center bipolar cell hyperpolarized and transmitter release decreased
8. Off-center bipolar cell depolarized and transmitter release increased
9. Firing of on-center ganglion cell decreased
10. Firing of off-center ganglion cell increased
B

- Cones
  - *Low convergence*
  - *1:1 or few : 1*
  - *High acuity*
  - *Information about details gets preserved*
- Rods
  - *High convergence*
  - *Many : 1*
  - *Poor acuity*
  - *Details can be lost*
- In dim light (cones)
  - *Each cone reacts slightly*
  - *Not enough activity for each bipolar cell to cross the threshold for ganglion cell to fire*
  - *Still too much inhibition coming from the rods*
- In dim light (rods)
  - *Little bit of excitation from each bipolar cell*
  - *Ganglion cell will have enough input to cross threshold and start to fire*



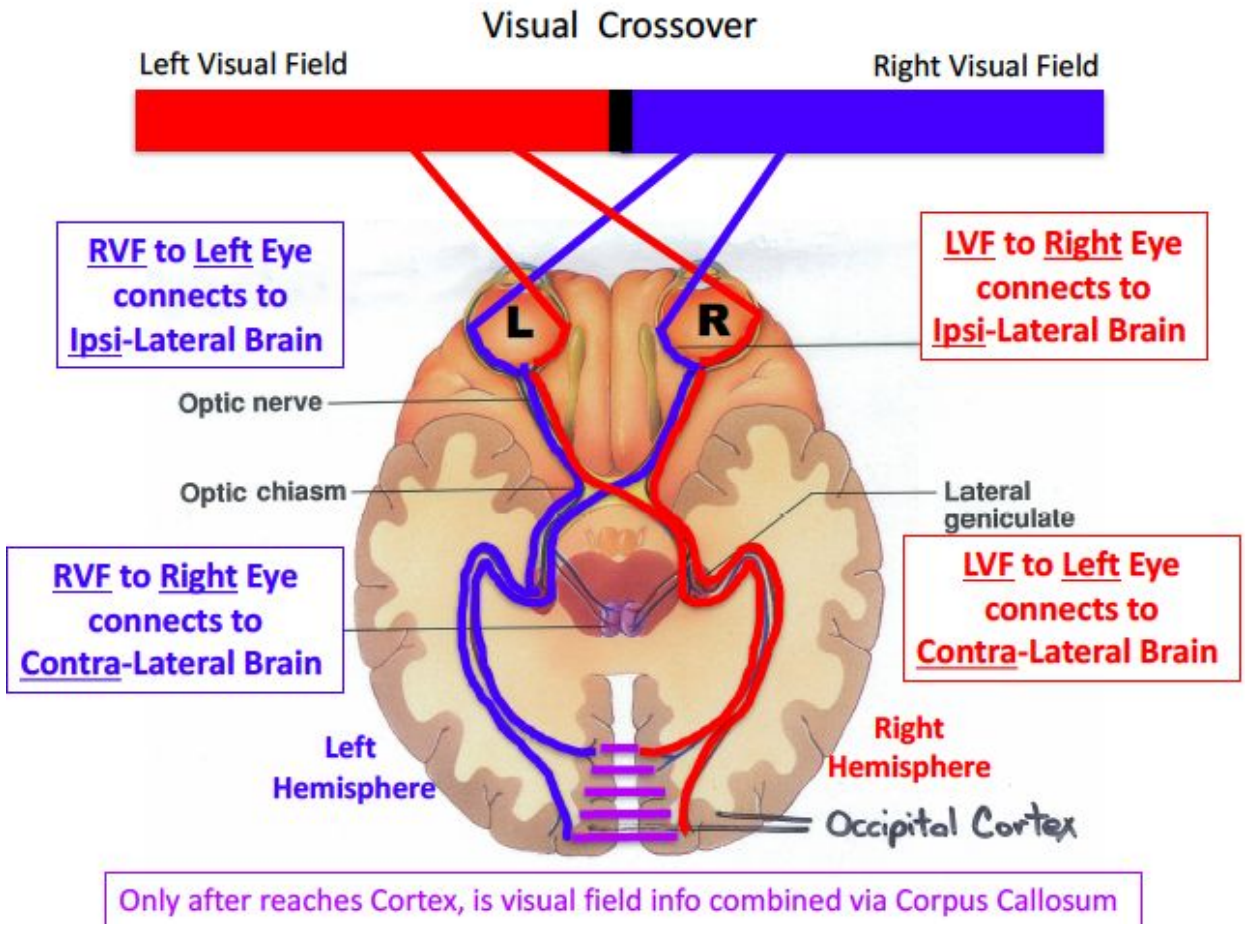
convergence



- Receptive field: set of receptors whose activity influences the activity of a “target” cell
- Better acuity when a cell has a smaller receptive field

visual crossover

- Information from the right visual field goes to the left side of the eye
- Information from the left visual field goes to the right side of the eye
- Right visual field information goes to left side of the brain and vice versa
- Each optic nerve divides and goes to both sides of the brain



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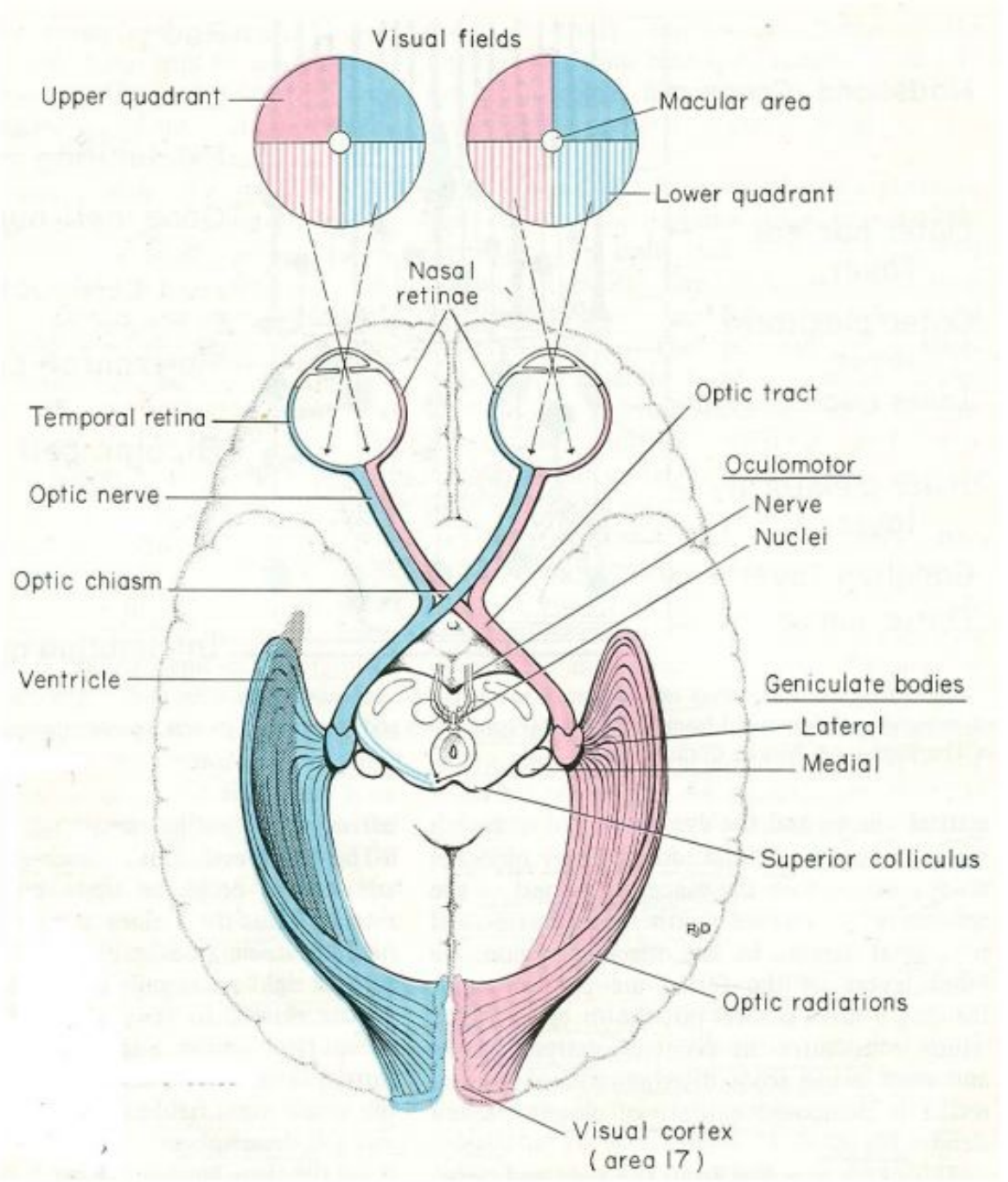
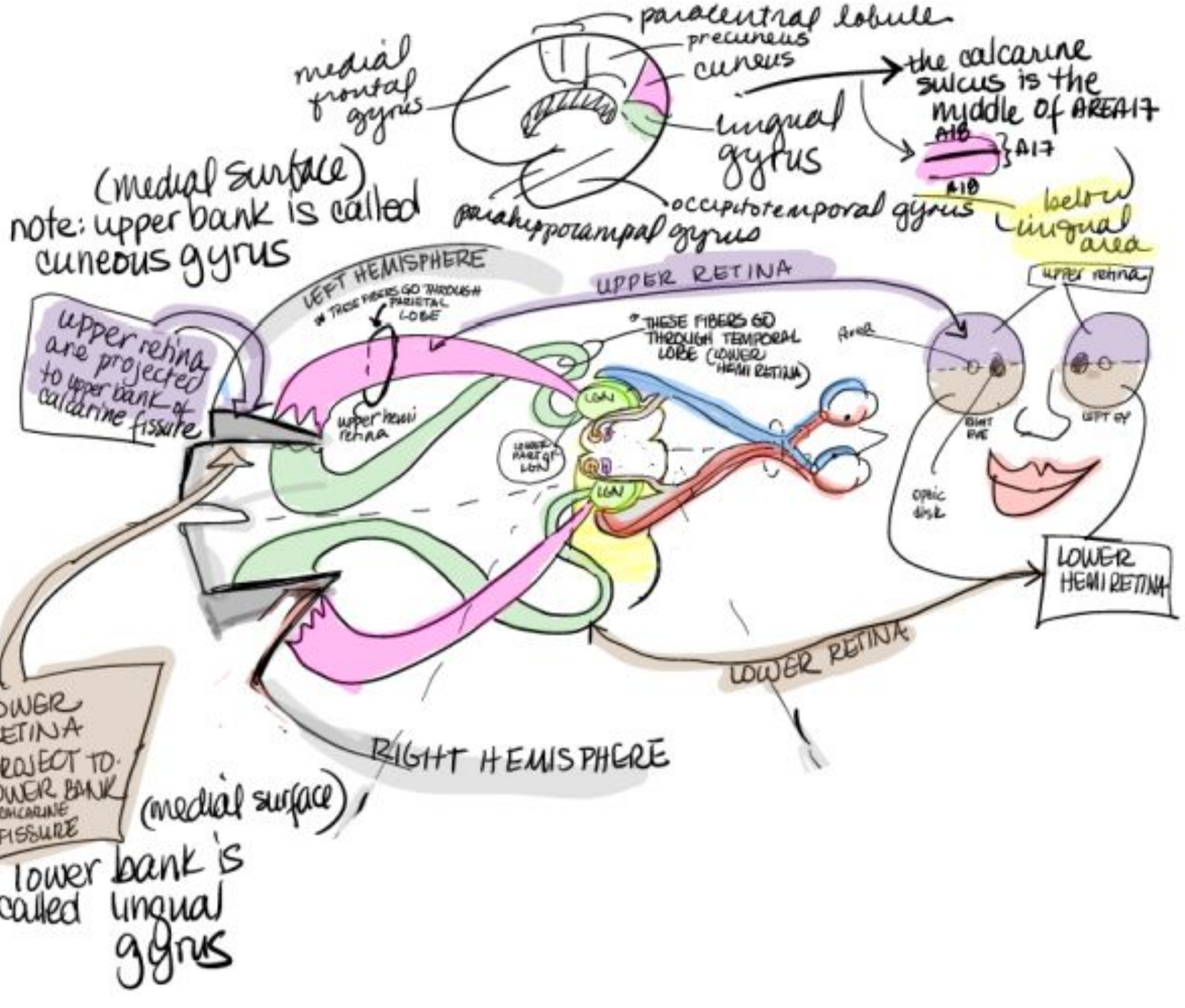
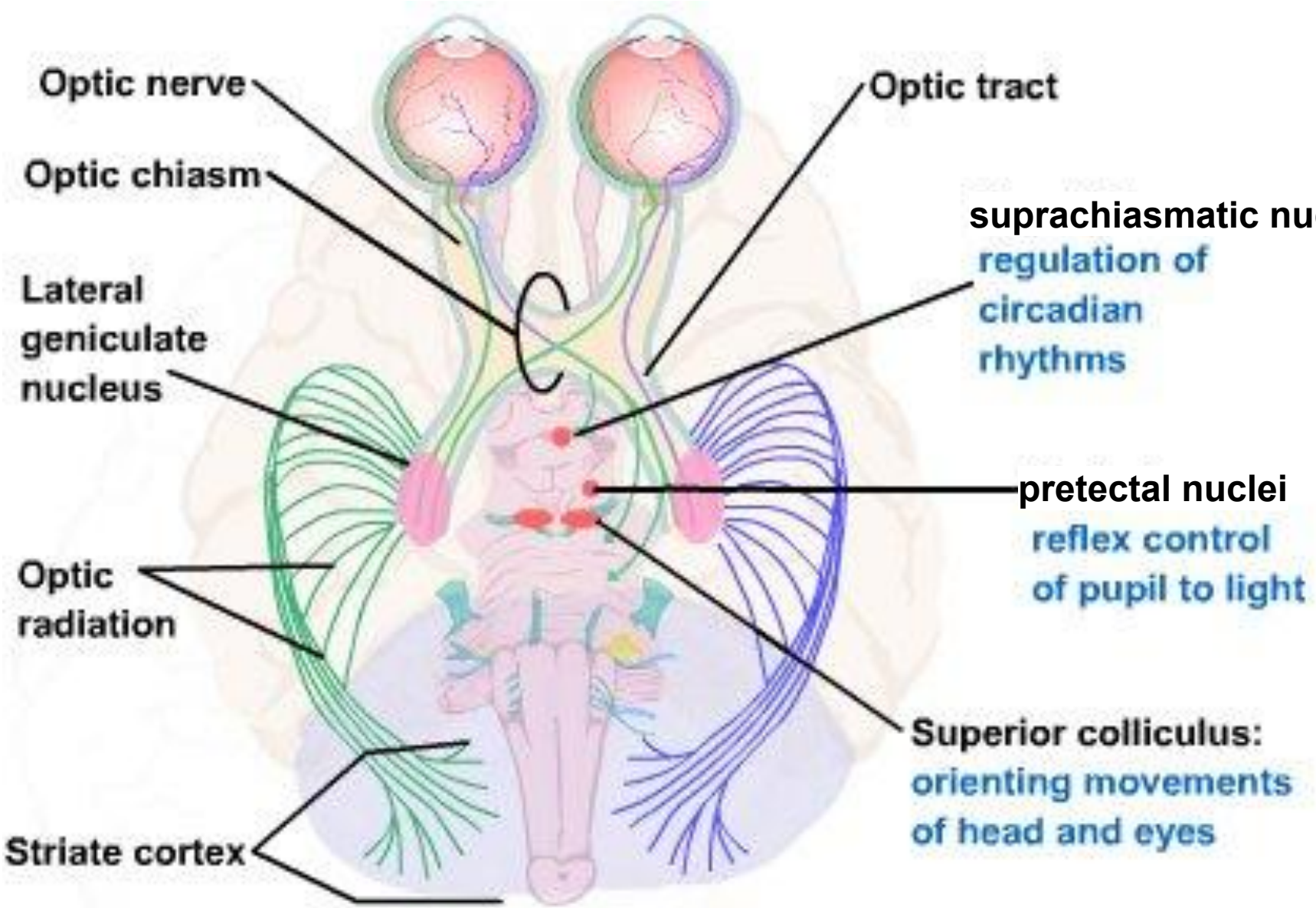
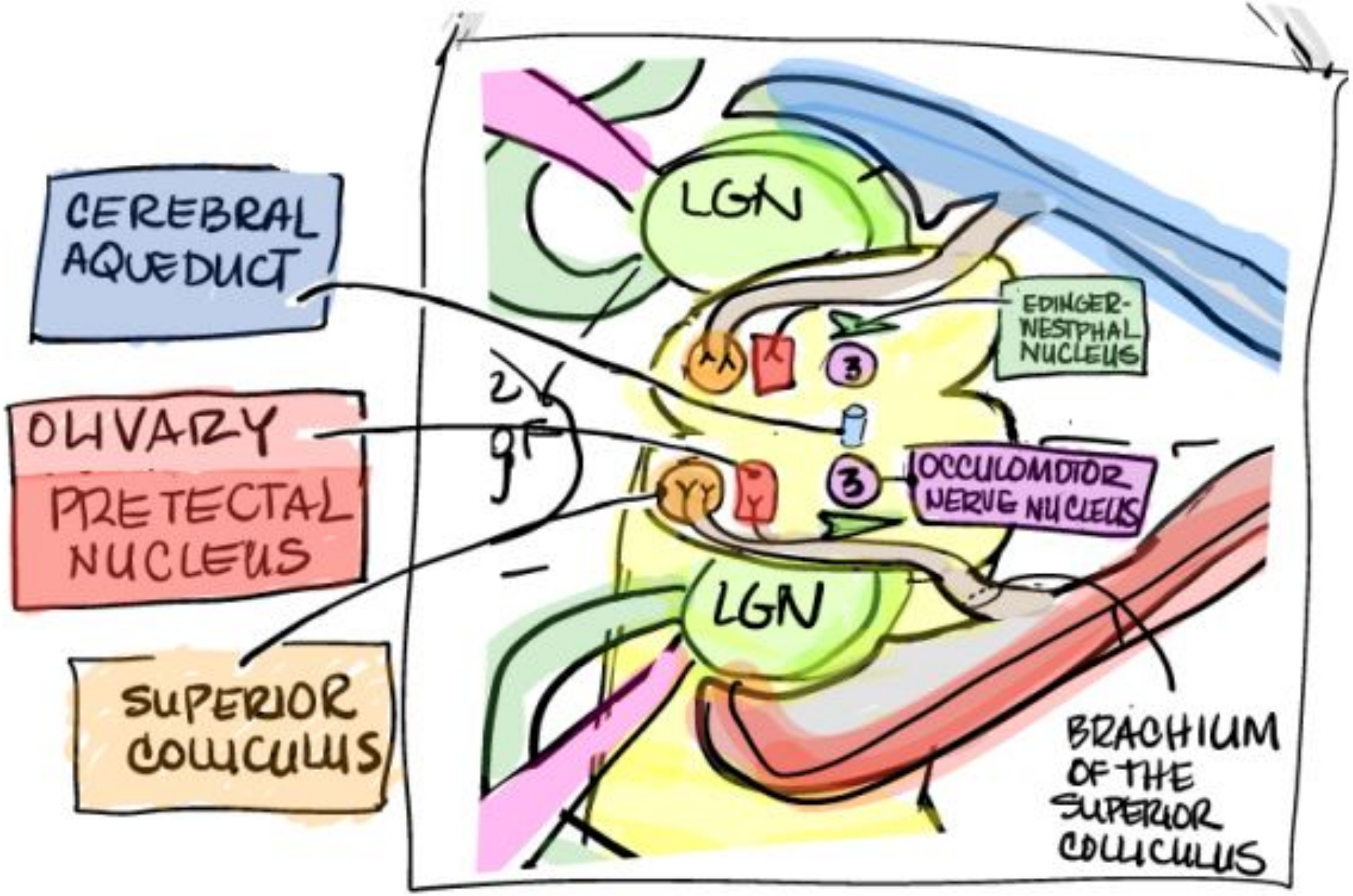
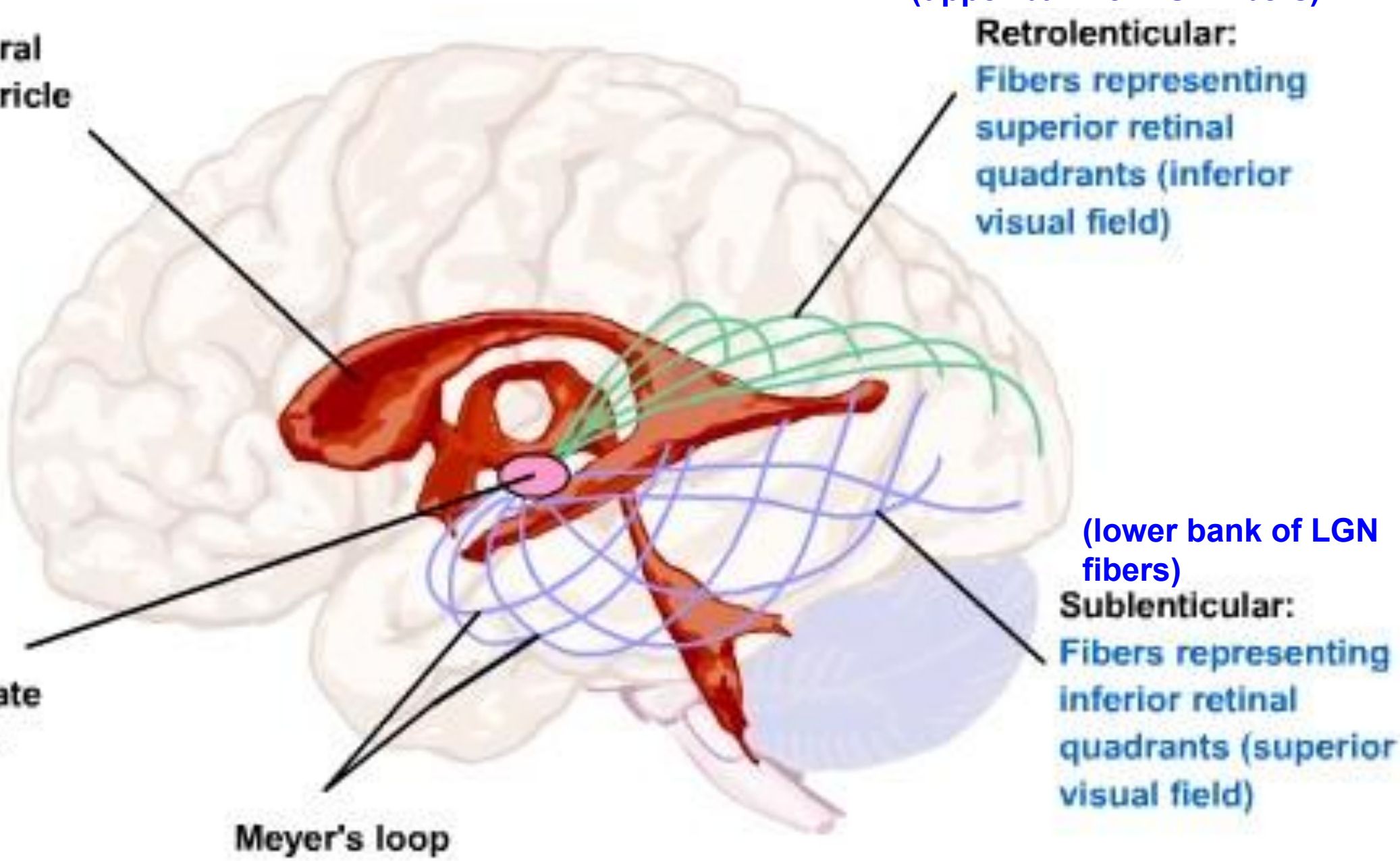



paracentral lobule
precuneus
cuneus
medial frontal gyrus
lingual gyrus
the calcarine sulcus is the middle of AREA17
A18
A17
A18
occipitotemporal gyrus
parahippocampal gyrus
below lingual area
(medial surface)
note: upper bank is called cuneous gyrus
LEFT HEMISPHERE
UPPER RETINA
upper retina are projected to upper bank of calcarine fissure
upper hemi retina
THESE FIBERS GO THROUGH TEMPORAL LOBE (LOWER HEMI RETINA)
LGN
LGN
upper retina
RIGHT EYE
LEFT EY
OPTIC disk
LOWER HEMI RETINA
LOWER RETINA
LOWER RETINA PROJECT TO LOWER BANK OF CALCARINE FISSURE
RIGHT HEMISPHERE
(medial surface)
lower bank is called lingual gyrus

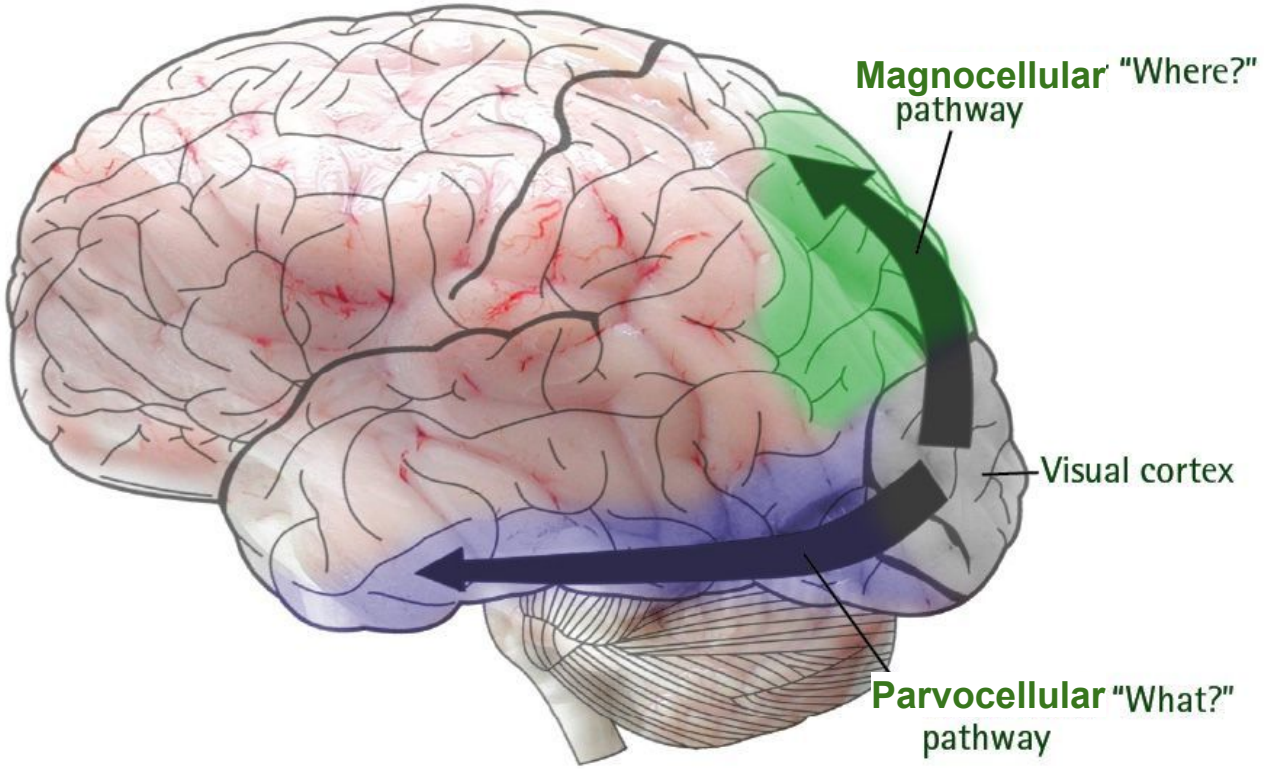

Optic nerve
Optic chiasm
Lateral geniculate nucleus
Optic radiation
Striate cortex
Optic tract
suprachiasmatic nucleus
regulation of circadian rhythms
pretectal nuclei
reflex control of pupil to light
Superior colliculus:
orienting movements of head and eyes

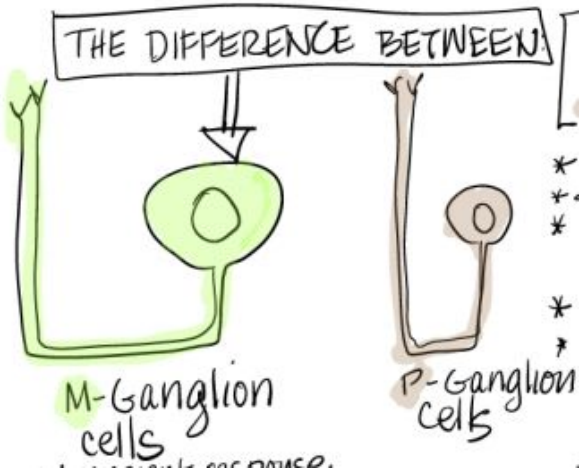

CEREBRAL AQUEDUCT
OLIVARY PRETECTAL NUCLEUS
SUPERIOR COLLICULUS
LGN
EDINGER-WESTPHAL NUCLEUS
OCCULOMOTOR NERVE NUCLEUS
LGN
BRACHIUM OF THE SUPERIOR COLLICULUS


(upper bank of LGN fibers)
Retrolenticular:
Fibers representing superior retinal quadrants (inferior visual field)
Lateral ventricle
(lower bank of LGN fibers)
Sublenticular:
Fibers representing inferior retinal quadrants (superior visual field)
Lateral geniculate nucleus
Meyer's loop

visual pathways

- Dorsal Pathway
  - “Where/how”
  - Motion and depth
  - Magnocellular pathway
  - Primarily rods
  - ‘Large’ ganglion cells
- Ventral Pathway
  - “Who/what”
  - Color and detail
  - Parvocellular pathway
  - Primarily cones
  - ‘Small’ ganglion cells





visual pathways

- Optic nerve goes to lateral geniculate nucleus (LGN) of the thalamus
- Optic chiasm: location where the axons cross (don't synapse)
- LGN
  - *6 layers*
  - *Magnocellular pathways project to layers 1 and 2*
  - *Parvocellular pathways projects to layers 3-6*
- Some axons from magnocellular pathway project to the super colliculus