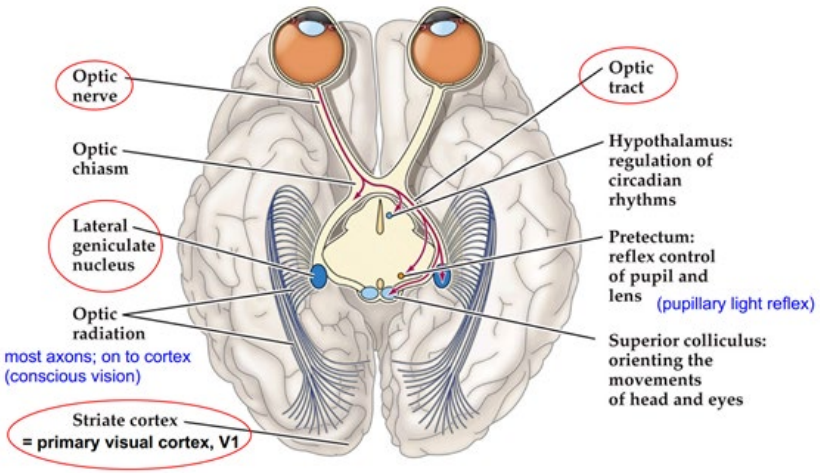
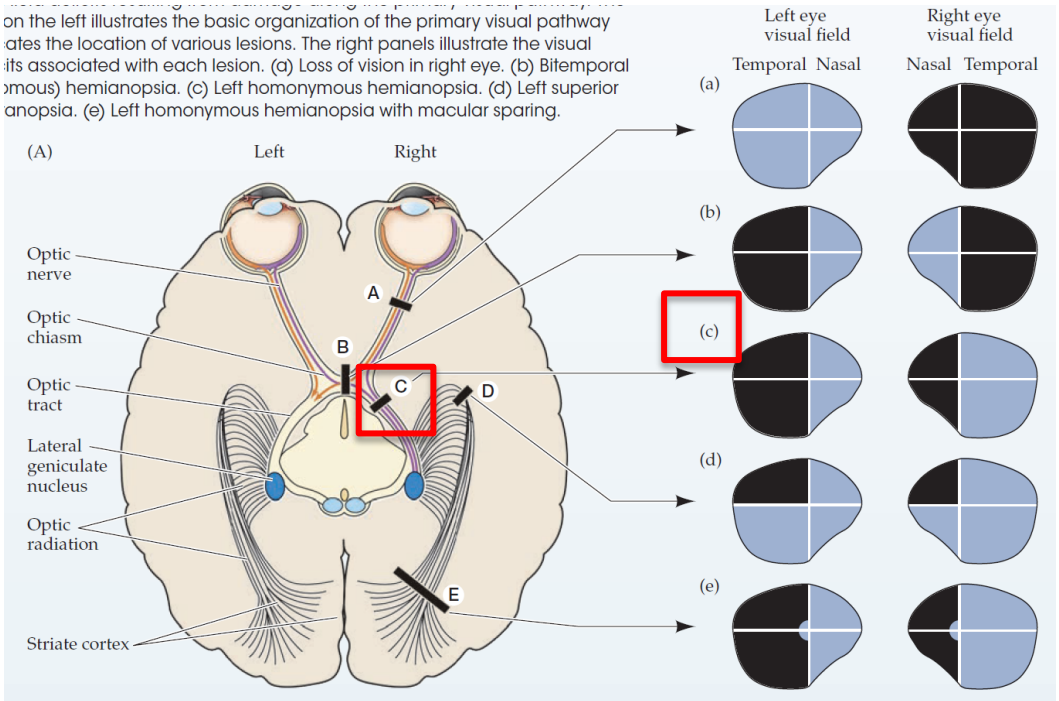
Neuroscience BIO-311 Ramdya
Exercises
Vision – System and Circuits

1) i) Recapitulate in a drawing the principle of binocular field in human vision?
   ii) Add to your drawing the pathways (i.e., main targets) carrying the information from the eye to the primary visual cortex V1
   iii) What part of the visual field of view would be impaired in the case of a total section of the right optic tract downstream of the optic chiasm?

Ans i and ii:



Ans iii:



2) i) Name the two main pathways in the Lateral Geniculate Nucleus (LGN).
ii) What is the principal difference between Optic tract and LGN axons?
iii) If a person has symptoms of not being able to detect rapidly changing location of object(s) but color vision is intact, where do you think the impairment is located in LGN layers?

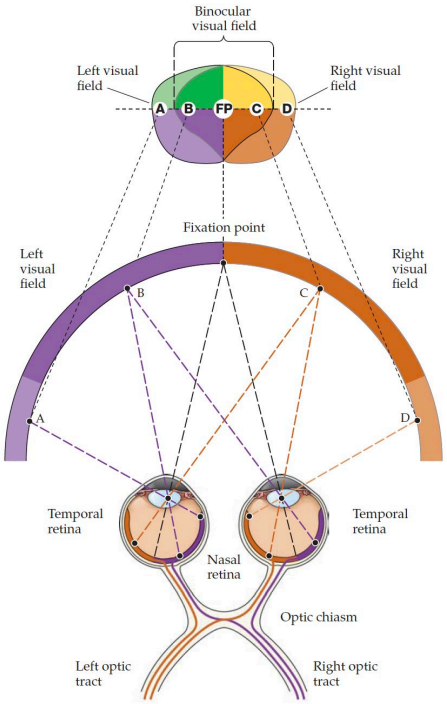
Ans i:

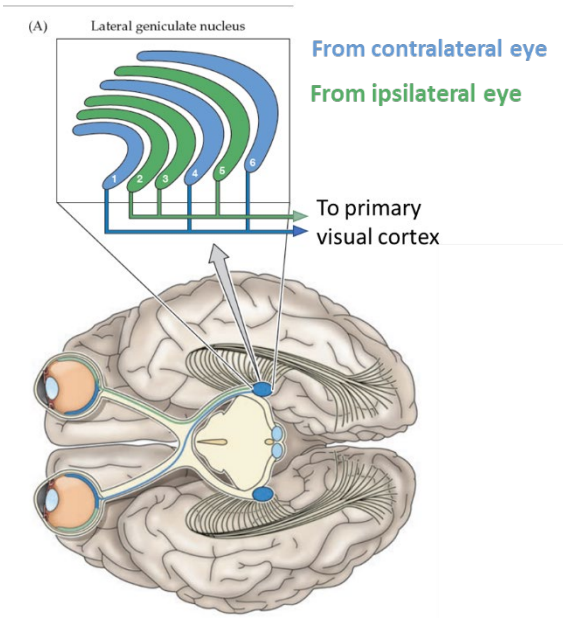
Pathway	**LGN layers**	**Size of cells and RF**	**Type of Information**	**Response**
Magnocellular pathway • M ganglion cells (RGC) • Magnocellular cells (LGN)	Layers 1 and 2	Large	Perception of **movement** and **location** Colorblind	Rapid and transient
Parvocellular pathway • P ganglion cells (RGC) • Parvocellular cells (LGN)	Layers 3, 4, 5 and 6	Small	Perception of **color** and **shape** in fine details	Slow and sustained

Ans ii:
Retinal ganglion cells (RGC) axons in the **optic tract** come from **both eyes** (carrying nerve fibers after crossing over in the optic chiasm)

But the input from each eye is segregated in different layers of the LGN with the input of the contralateral eye arriving in layers 1, 4 and 6 (blue) while the input of the ipsilateral eye arrives in layers 2,3 and 5.

So the neurons and the layers in the LGN are strictly monocular where RGC fibers are binocular.





RGC fibers (left and right optic tract) LGN layers are segregated

Ans iii:

The lesion/impairment will be located in the Magnocellular pathway (LGN layer 1 and 2) as those cells are involved in detecting movement and location of object(s).

3) i) Explain the principle of retinotopic map in the visual system.
ii) Is the distribution of photoreceptor cells along the retina uniform? If not, where is the location of area with highest photoreceptor distribution?
iii) If a visual stimulus is perceived by the right eye (providing the fact that left eye is closed) which primary visual cortex (which hemisphere(s)) will process that information?
iv) Explain what is the phenomenon of cortical magnification using the organization of the primary visual cortex and of the primary somatosensory cortex as examples

Ans i:

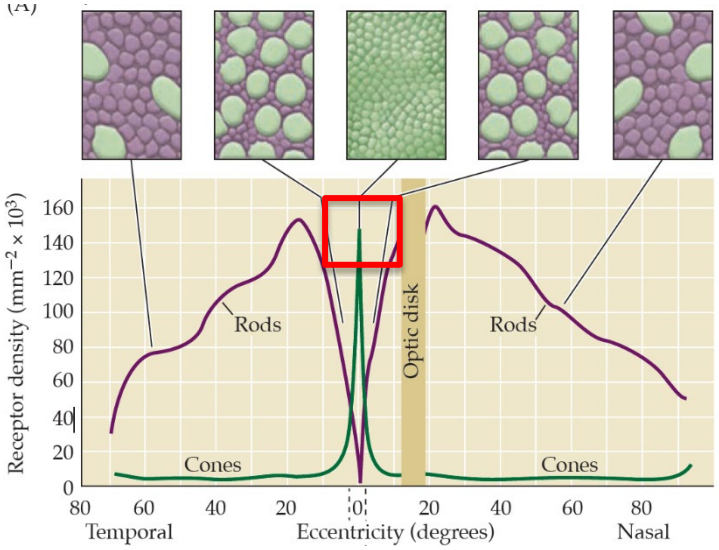
Neurons in the visual cortex are organized based on the spatial arrangement of the visual field

The organization of the visual field is reflected in the organization of the visual system: regions that are adjacent in the visual field travel together throughout the retinogeniculostriate pathway and finally are processed in adjacent regions in the visual cortex.

Preserving the organization of the visual field makes a lot of sense because it allows to extract critical visual information from a scene (e.g. preserving the shape of things to allow object recognition).

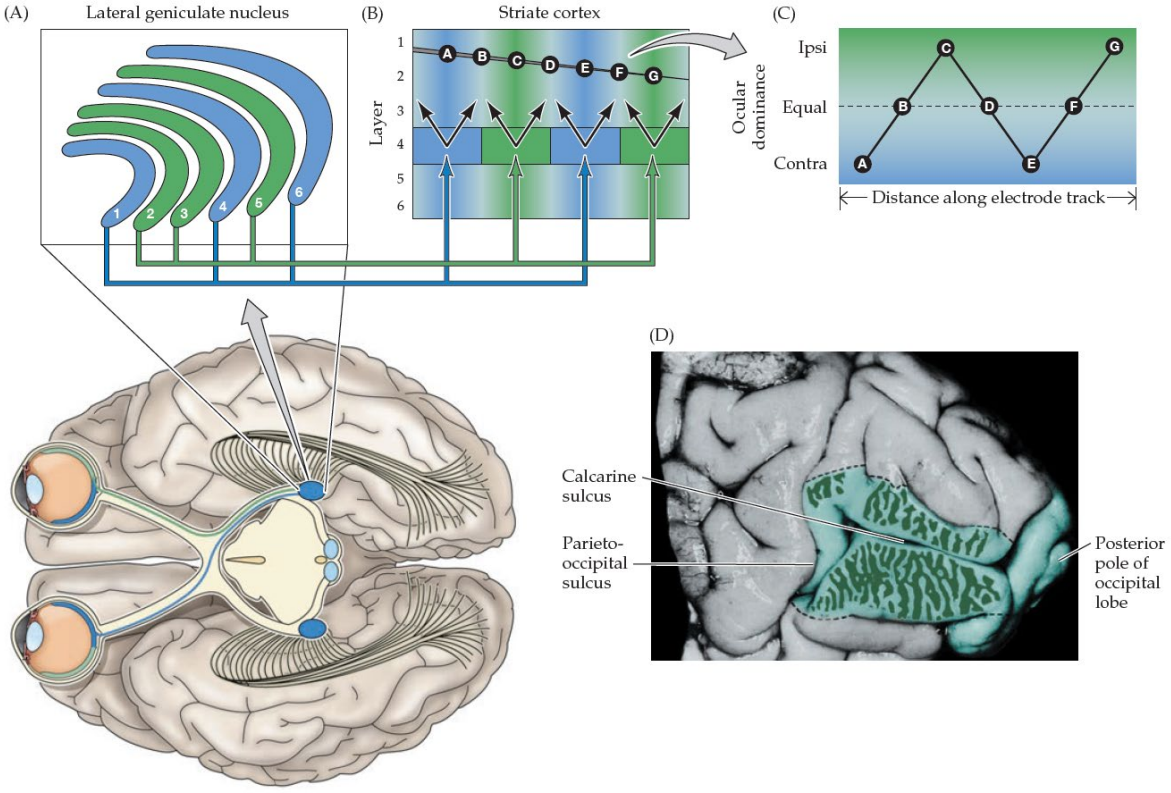
Ans ii :

The Fovea is the area where there is highest photoreceptor density (Cones, cones have high spatial resolution)



Ans iii)

Both right and left hemispheres (both visual cortex) will process the visual stimuli perceived by the right eye. As information traveling through optic tract crosses over and goes to both



LGNs where this information gets segregated in layers which then goes to primary visual cortex where this information is processed in distinct columns.

Ans iv:

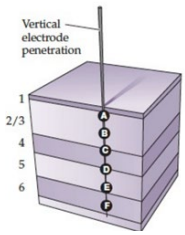
Density of photoreceptor is not uniform across the retina as there is a much higher concentration at the level of the fovea

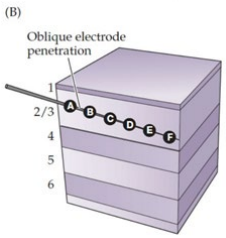
- As a consequence, the amount of cortical area devoted to the fovea is much larger than the cortical surface devoted to the periphery because there are much more axons and information coming from the fovea than from the periphery
- This phenomenon is referred to as cortical magnification (like in magnification glass), as a result in the right picture, the nose and eyes of the painted portrait seem inflated relatively to the rest of the face

Another example of cortical magnification in the course with the somatotopy. Remember the homonculus, the strange little human illustration with inflated hands and lips. This character was illustrating the ratio between the somatosensory cortex area dedicated to a body region and the actual size of that body region. The body regions that are big in the homonculus (lips and hands) have a high density of mechanosensors and thus require more brain surface area to process all that additional information.

4) There are different tools used to study the visual cortex. One of them consists in recording the brain activity using an electrode equipped with multiple electrode sites.
   i) Cite two orientations in which electrodes can be inserted?
   ii) Which insights do we get on visual processing using these two approaches?

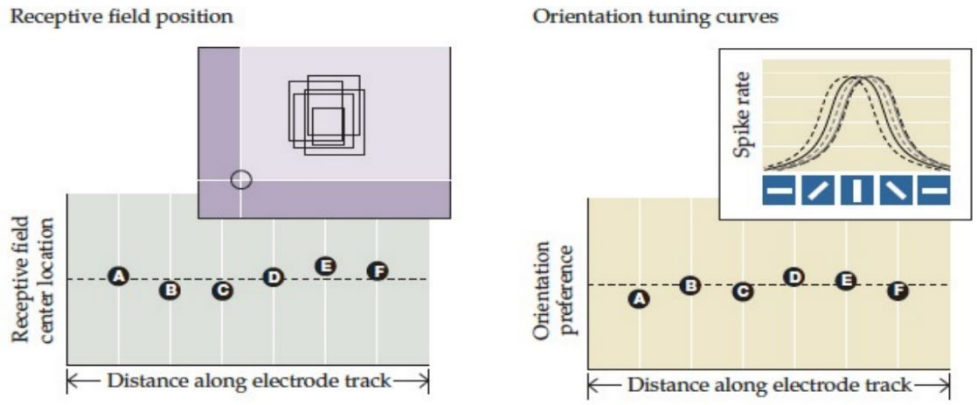
Ans i) Vertical and Oblique





Ans ii:

Neurons in the same column (along radial axis of the cortex) have receptive fields that are



centered on the same region (left panel) of visual space and exhibit similar orientation.

Neurons in the oblique case have receptive fields which center on a slightly larger spread of regions (left panel) and orientation preferences (right panel) that shift in a progressive fashion.