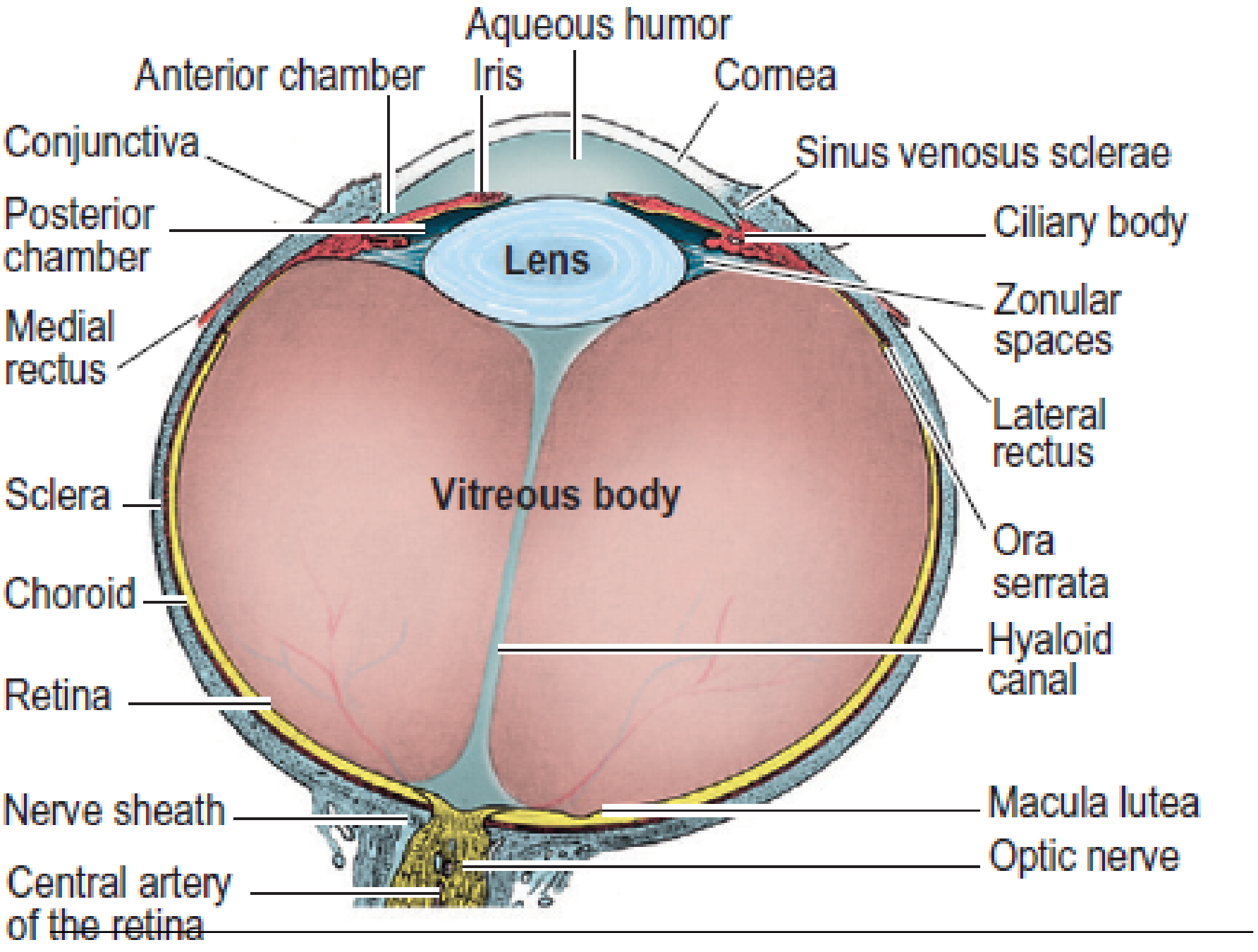
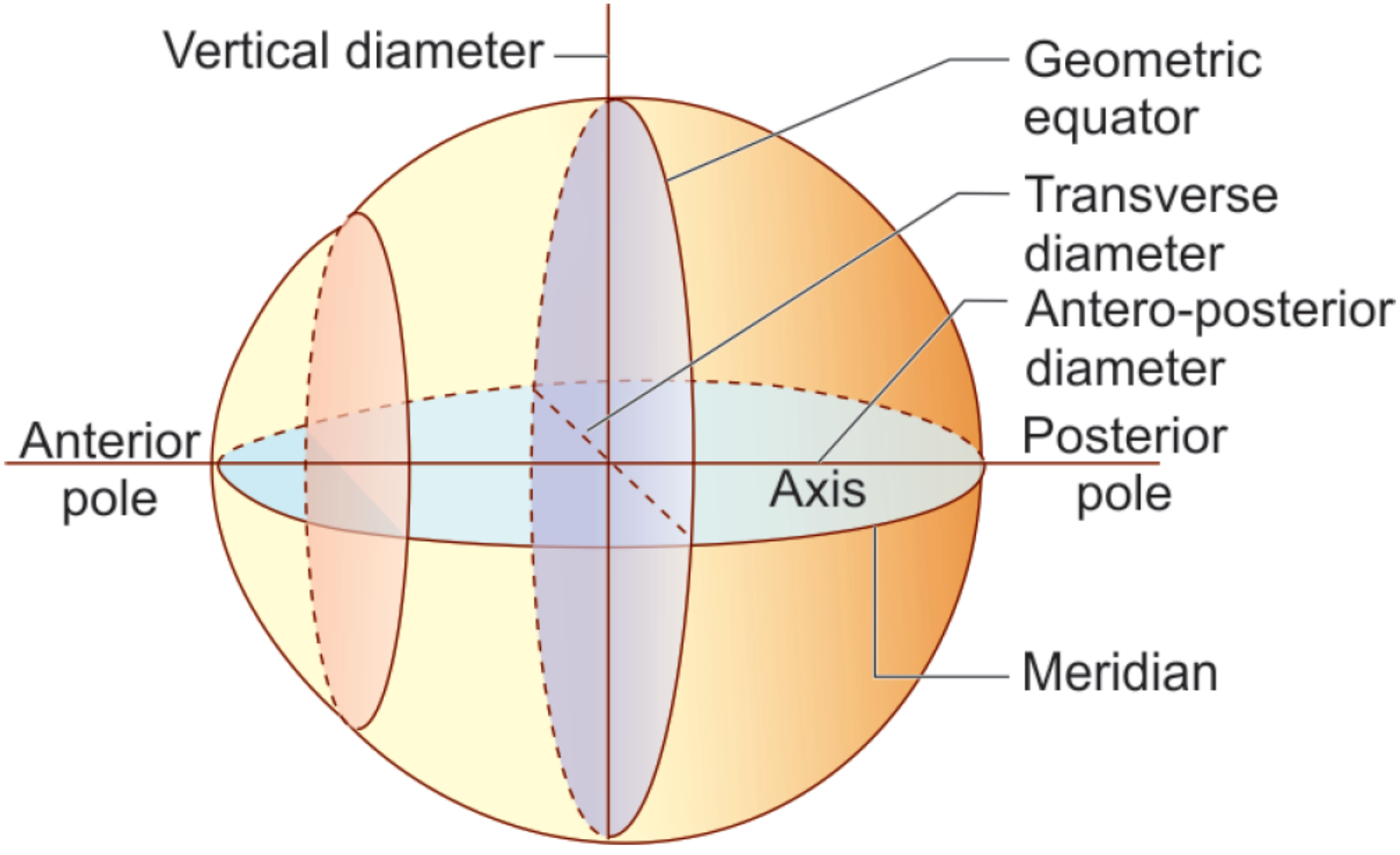
Structure of eyeball

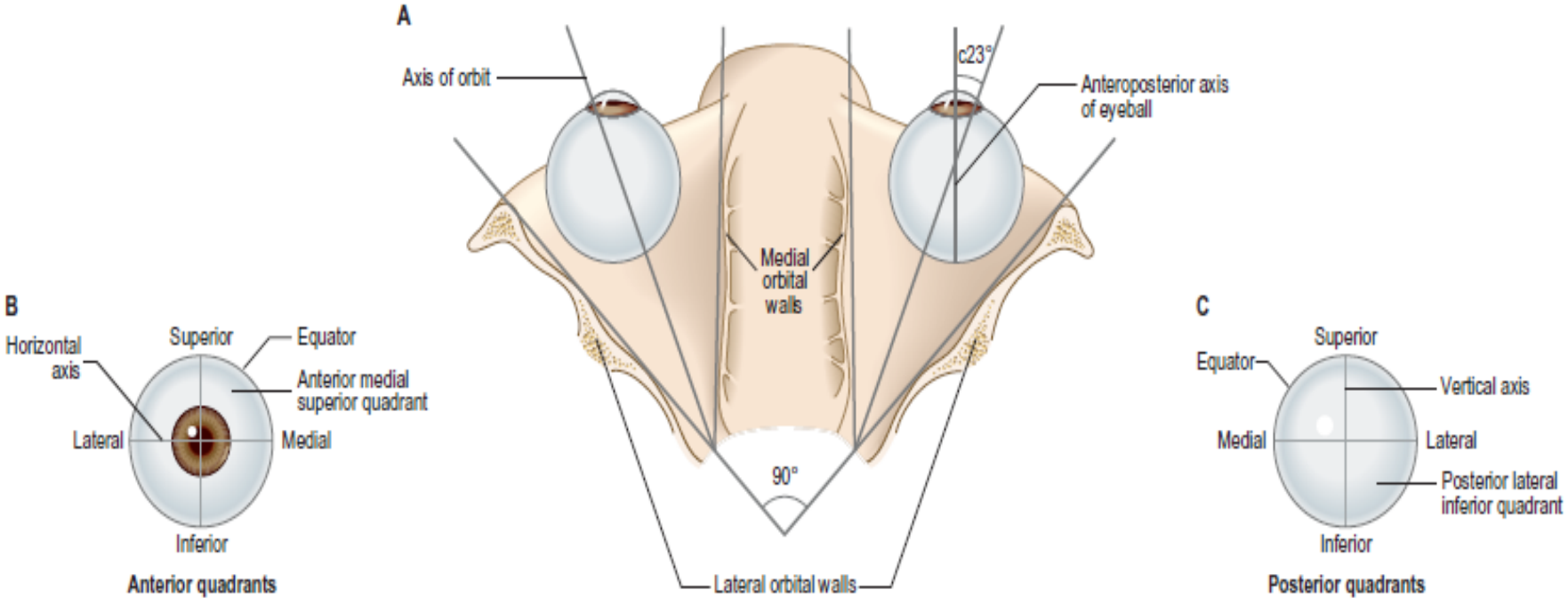
- 2 spheres connected into one
- 3 layers - fibrous , vascular and neural
- 3 chambers – anterior , posterior , vitreous
- 2 segments – anterior and posterior
- Aqueous humour provides metabolic support to the avascular lens and cornea.
- AP diameter - , transverse diameter - , vertical diameter –
- AP axis , anterior and posterior pole , equator
- Axis of eyeball and axis of orbit are not in same plane , orbital axis makes an angle of 23degree with visual axis in resting position of eye .
- The compromise between protection and ensuring a good field of view dictates that each eyeball is located anteriorly within the orbit.
- Retina terminates anteriorly at ora serrata; it also marks the junction between ciliary body and choroid.
- The vasculature of the choroid supplies nutrients to the avascular outer retina.
- The sole purpose of the eyes and their associated structures within the bony orbit is to form a good image on a healthy retina.
- The photoreceptors of retina transduce optical radiation into neurobiological activity .



Poles and equators of the eyeball



The geometrical basis of ocular movements. **A, The relationship between the orbital and ocular axes, with the eyes in the primary position,** where the visual axes are parallel. **B and C, The ocular globe in anterior and posterior views to show conventional geometry.**



Retina (neural layer of eye)

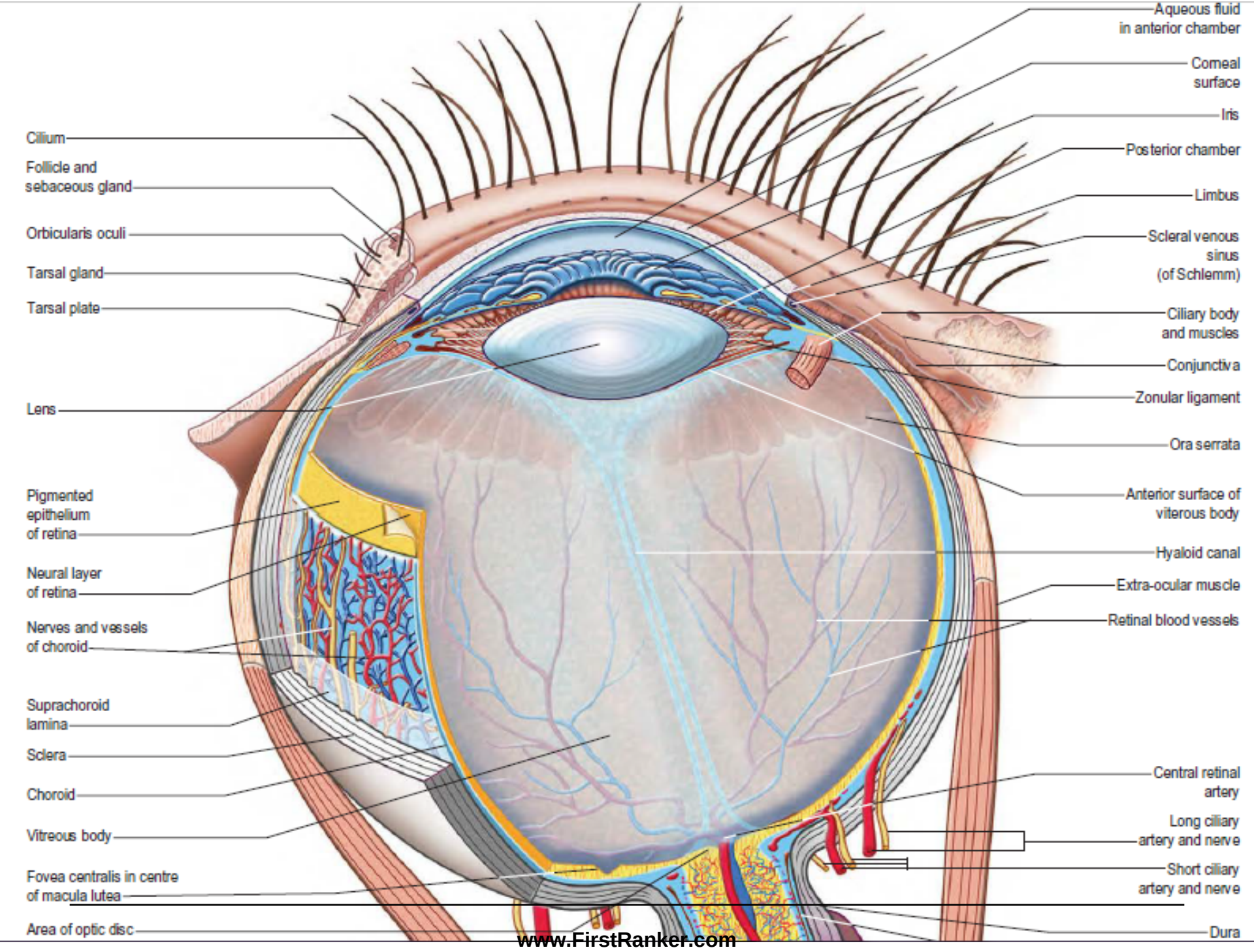
- Is a thin sheet of cells, ranging from less than 100 µm at its edge to a maximum of around 300 µm at the foveal rim.

- It lines the inner posterior surface of the eyeball, sandwiched between the choroid externally and vitreous body internally, and terminates anteriorly at **ora serrata** .

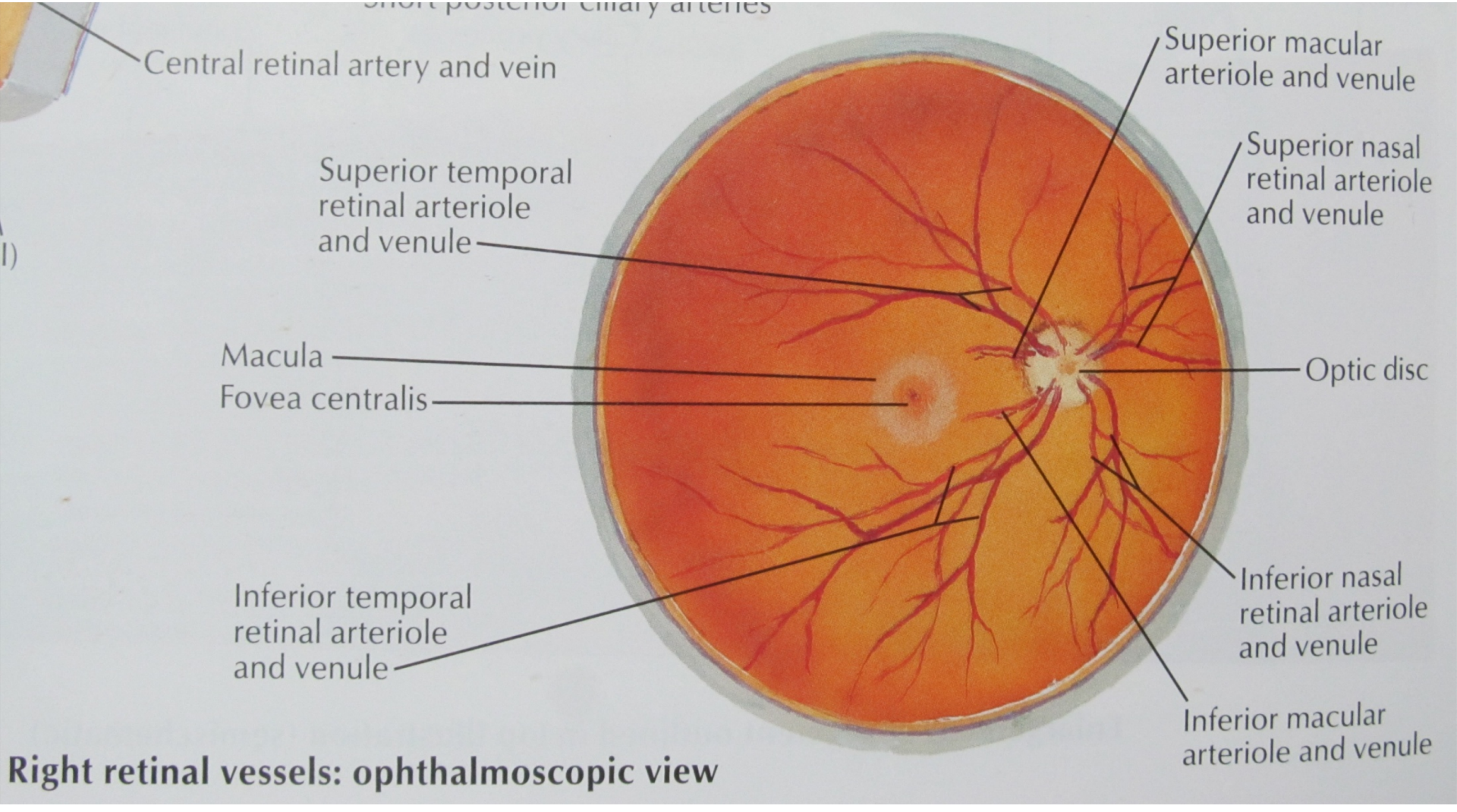
- When it is viewed with an ophthalmoscope to show the fundus oculi, the most prominent feature is the blood vessels emanating from and entering the optic disc .

- Centred temporal and inferior to the disc lies the '**central retina' or macula (diameter 5–6 mm**), the middle of which is composed of the fovea and foveola, and easily identified with an ophthalmoscope as an avascular area with a yellow tinge . The lack of blood vessels at the foveola is even more apparent in a fluorescein angiogram.

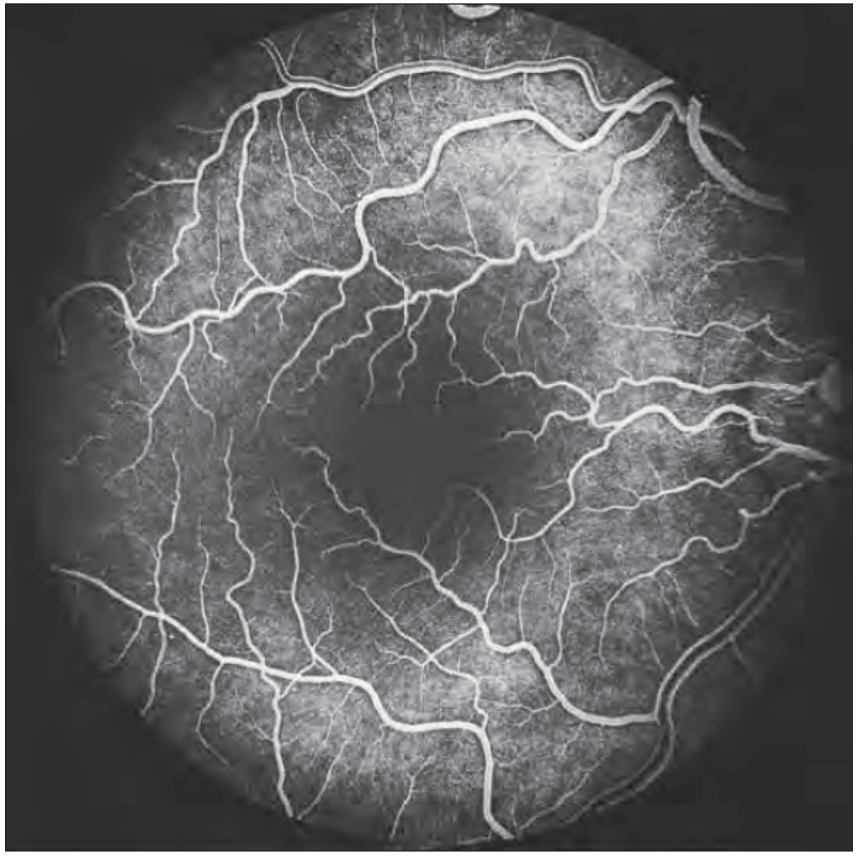
- The **peripheral retina** lies outside the central retina .



- A fundus photograph of the right eye of a 19-year-old .
- The central retinal vessels are seen emanating from the optic disc.
- Retinal arteries are narrower and lighter in colour, and generally are vitreal to the veins.
- The avascular centre of the macular region, with its associated macular pigment, can be seen temporal to the disc.



Right retinal vessels: ophthalmoscopic view



- Fluorescein angiogram showing the macular region of a right eye.
- The main macular vessels are approaching from the right.
- The subject was an elderly person with considerable macular pigmentation, which masks fluorescence from the choroidal circulation.

Modifications of the central retina

- The central retina, clinically referred to as the macula, is composed of four concentric areas, which, starting with the innermost, are:
  - > foveola (0.35 mm diameter),
  - > fovea (1.5 mm),
  - > parafovea (2.5 mm) and the vaguely defined
  - > perifovea (5–6 mm)
- The foveola, which contains no rods or S cones, is centred about 3 mm temporal and 1 mm inferior to the optic disc . In the foveola and surrounding fovea, all the inner layers of the neural retina beyond the outer nuclear layer have been displaced peripherally, resulting in a retinal thickness around half of that elsewhere in the retina **.**

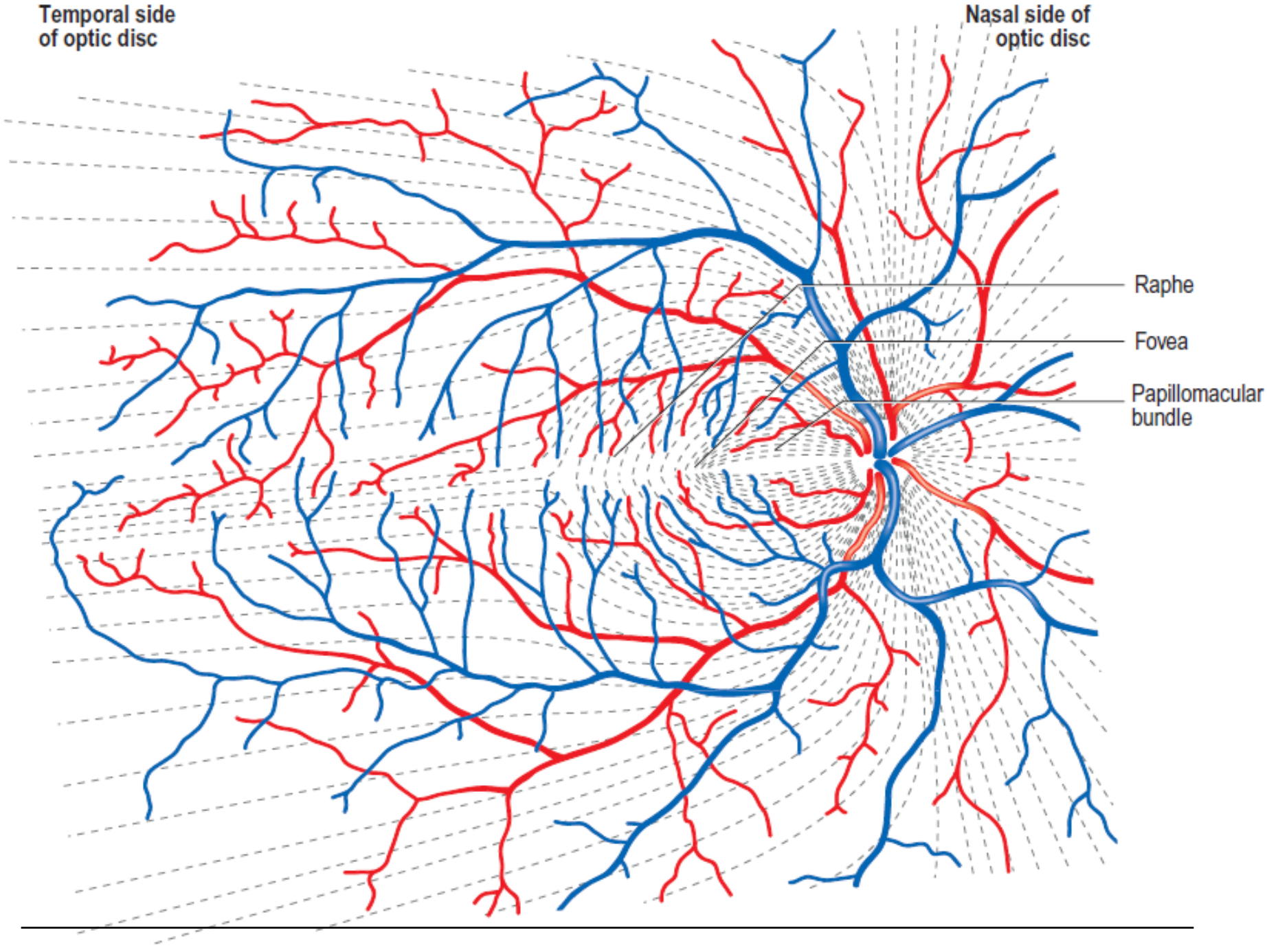
  This foveal pit is created by the cone 'axons', known here as Henle fibres, running almost parallel to the retinal surface before connecting to postreceptoral retinal neurones outside the fovea. The Henle fibres contain two xanthophyll carotenoid pigments (lutein and zeaxanthin), which create an elliptical yellowish area (approximately 2 mm horizontally and 1 mm vertically): the macula lutea.

- Macular pigment density varies by more than an order of magnitude between individuals, is influenced by several environmental factors, including diet, and is negligible in the central foveola.

- Low levels of macular pigment are likely to be associated with retinal pathologies such as age-related macular degeneration (Beatty et al 2008).

- The absence of the inner retinal layers, including blood vessels , reduces light scatter, which, along with the increased packing density of cones in the foveola and their lack of convergence with ganglion cells, ensures that visual resolution is highest in this part of the retina.

- Acuity may be further enhanced by the macular pigment, which, apart from having antioxidant properties and removing potentially harmful short-wave radiation, will absorb those wavelengths most prone to chromatic aberration and Rayleigh scatter.



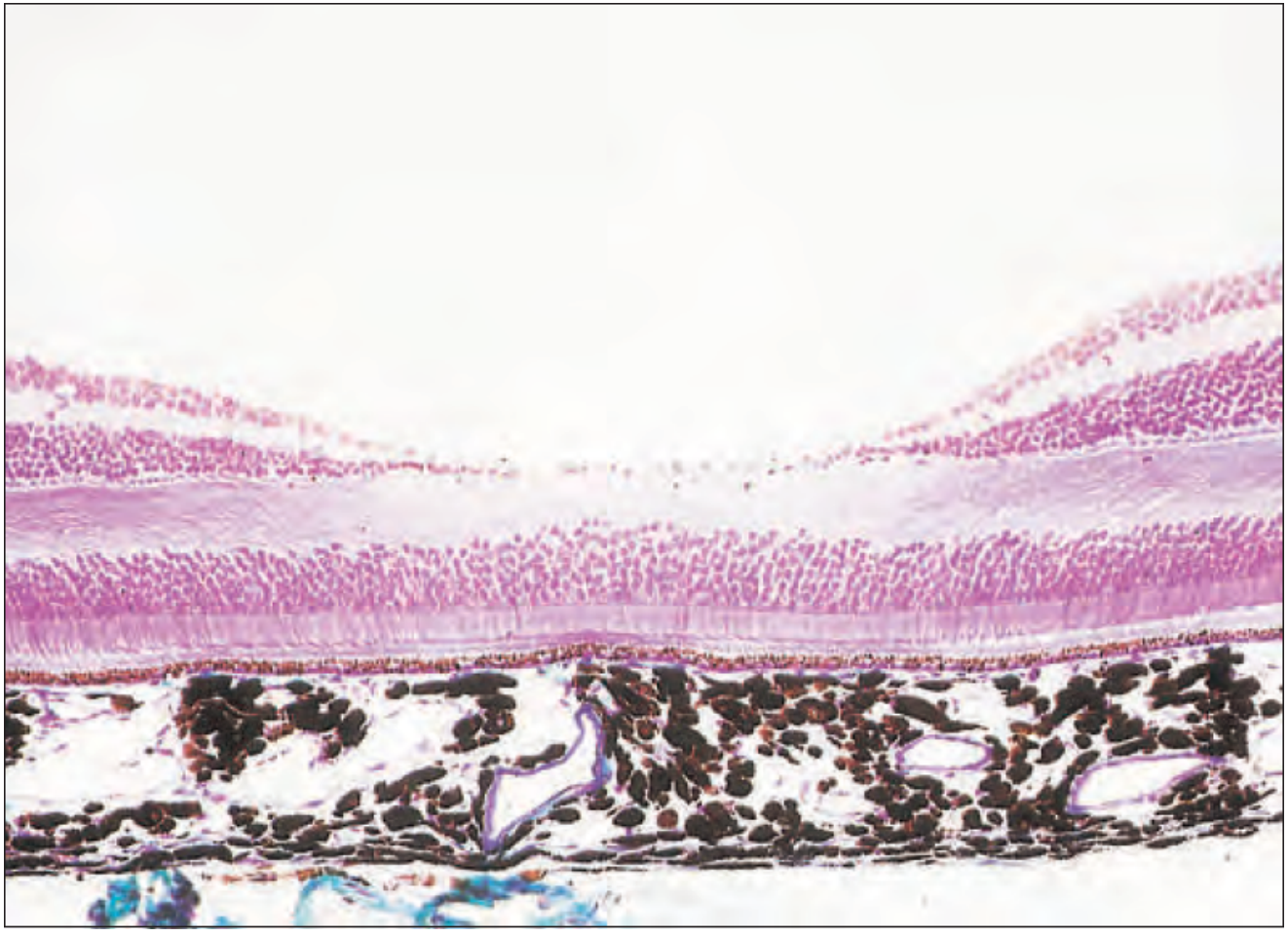
- Directions of axons (dashed lines) and blood vessels of the nerve fibre layer of the retina of the right eye. Axons pass radially on the nasal side of the optic disc, whereas fibres on the temporal side avoid crossing the fovea by arching around it. Some of the fibres from the fovea and central region pass straight to the optic disc and others arch above and below the horizontal; together, these form the papillomacular bundle.

- A raphe is formed by the central fibres temporal to the fovea.

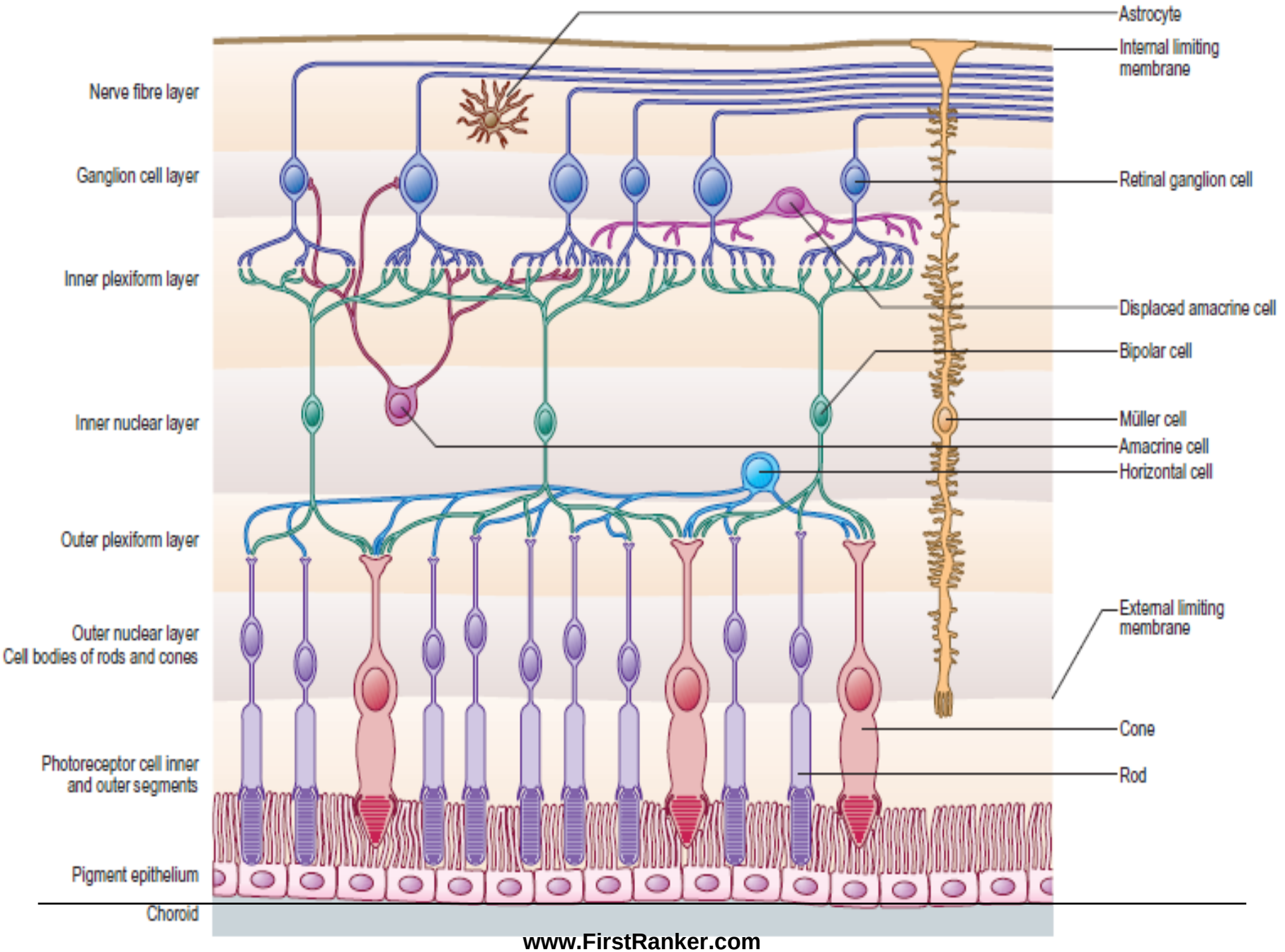
- Venules are shown crossing in front of arteries; the reverse relationship is probably the more common pattern. All vessels issue from the disc on the right of the figure; the larger temporal branches tend to arch around the central regionof the retina and do not approach the fovea.

- The peripheral retina and most of the nasal retina are not shown.

Foveal pit



Layers of retina



- Customarily 10 retinal layers are distinguished from outside inwards; they are as follows:

1. Pigment epithelium
2. Rods and cones (processes)
3. External limiting lamina
4. Outer nuclear layer (rod and cone cell bodies with their nuclei)
5. Outer plexiform layer
6. Inner nuclear layer (bipolar cells)
7. Inner plexiform layer
8. Ganglion cell layer
9. Nerve fibre layer (axons of ganglion cells which pass into the optic nerve at the disc)
10. Inner limiting lamina.

Visual pathway

- **Receptors** - Rods and Cones in the retina

- **1st order neuron** - Bipolar cells of retina

  bipolar cells synapse with rods and cones in outer plexiform layer of retina (1 cell for each cone,1 cell for 80 rods)

  they synapse with ganglion cells in inner plexiform layer of retina

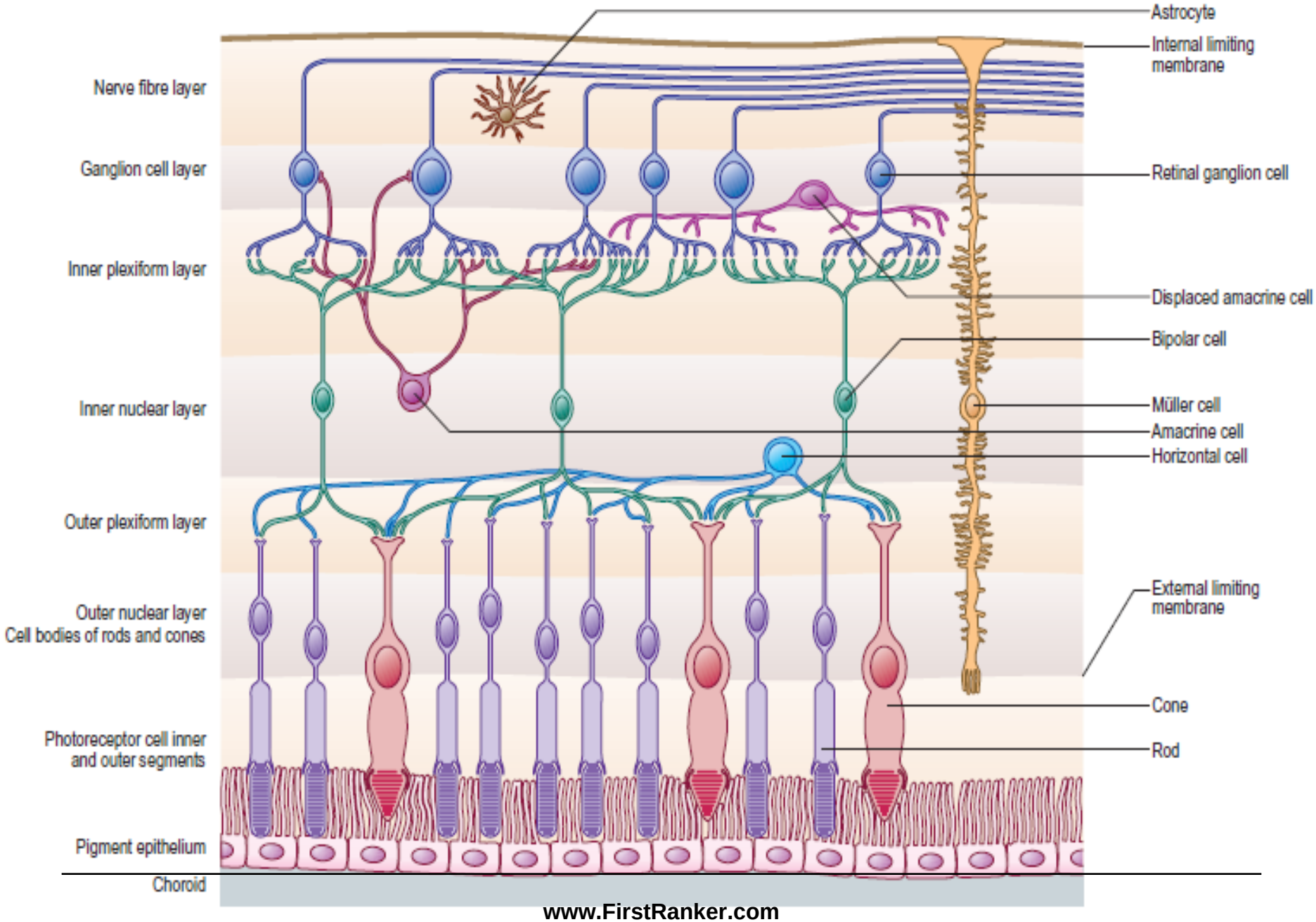
- **2nd order neuron** - Ganglion cells of retina

  Axons of ganglion cells form the nerve fiber layer of retina and leave the retina at optic disc to run backwards towards the optic canal as optic nerve .

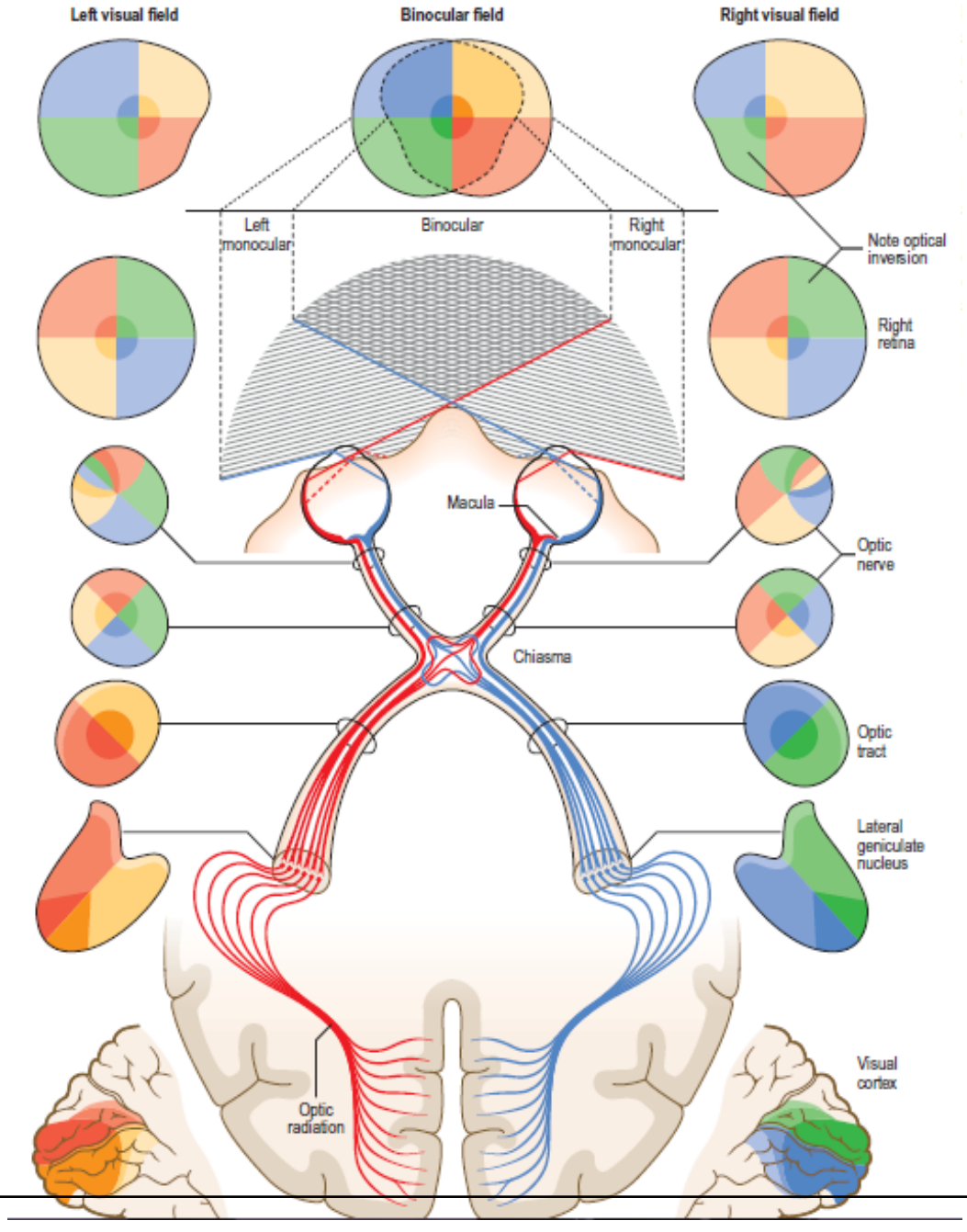
  In the orbit optic nerve is surrounded by a tube of dura mater and arachnoid, with CSF in the subarachnoid space.

  At the optic foramen the dura and arachnoid leave it and the nerve, still sheathed in pia mater, passes up to meet its fellow at the optic chiasma, which is attached to the anterior part of the floor of the third ventricle.

Layers of retina



12.5.2020



Visual field , retinal quadrants and retinal projection

- Visual field
  - > Right eye -
    - Right(temporal) half - superior temporal
      inferior temporal
    - Left(nasal) half - superior nasal
      inferior nasal
  - > Left eye -
    - Right (nasal) half - superior nasal
      inferior nasal
    - Left(temporal) half - superior temporal
      inferior temporal
- Retinal quadrants
  - > superior temporal
  - > inferior temporal
  - > superior nasal
  - > inferior nasal

- Retinal projection of visual field

> Right eye -

Superior temporal field - inferior nasal quadrant of retina
Inferior temporal field - superior nasal quadrant of retina
Superior nasal field - inferior temporal quadrant of retina
Inferior nasal field - superior temporal quadrant of retina

> Left eye -

Superior nasal field - inferior temporal quadrant
Inferior nasal field - superior temporal quadrant
Superior temporal field - inferior nasal quadrant
Inferior temporal field - superior nasal quadrant

- **Optic chiasma**

In the chiasma the nasal fibres of each optic nerve decussate and pass into the optic tract of the opposite side.

As they do so, some crossing fibres loop forwards slightly into the contralateral optic nerve before entering the optic tract, while some fibres loop backwards slightly into the ipsilateral optic tract before crossing the midline.

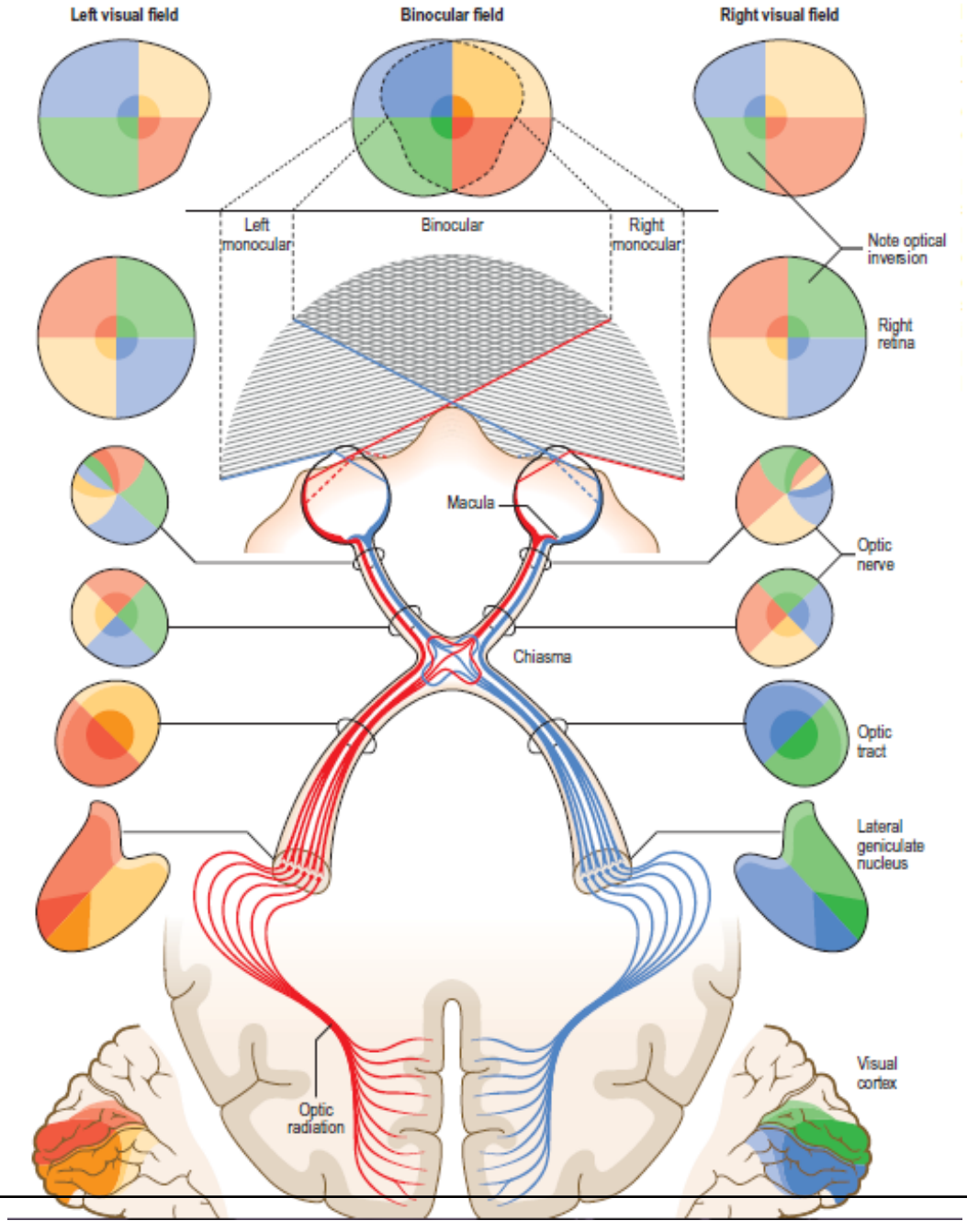
The temporal fibres from each retina pass directly to the optic tract of their own side . Thus the right optic tract contains fibres from the right half of each retina, i.e. it carries impressions from the nasal field of the right eye and the temporal field of the left eye.

Likewise, the left optic tract contains fibres which carry impressions from the right half of each visual field.

Cortical pathways for common sensation consist of three neurons. They reach the opposite hemisphere by a complete decussation of second order neurons.

The visual pathway by the half decussation of its second order neurons at chiasma achieves the same object.

One hemisphere registers common sensation from the opposite half of the body and also from the opposite half of the visible environment.



- **Optic tract**

The optic tract passes from the chiasma around the cerebral peduncle, high up against the temporal lobe, and, reaching the side of the thalamus, divides into two branches.

The larger (90%fibres) of these enters the lateral geniculate body, in which the fibres synapse. These are visual fibres.

The smaller branch (10%fibres,superior brachium) passes down medially, between the lateral and medial geniculate bodies, and synapses in the superior colliculus and the pretectal nuclei; these are fibres mediating light reflexes .

- **Lateral geniculate body** – 3rd order neuron

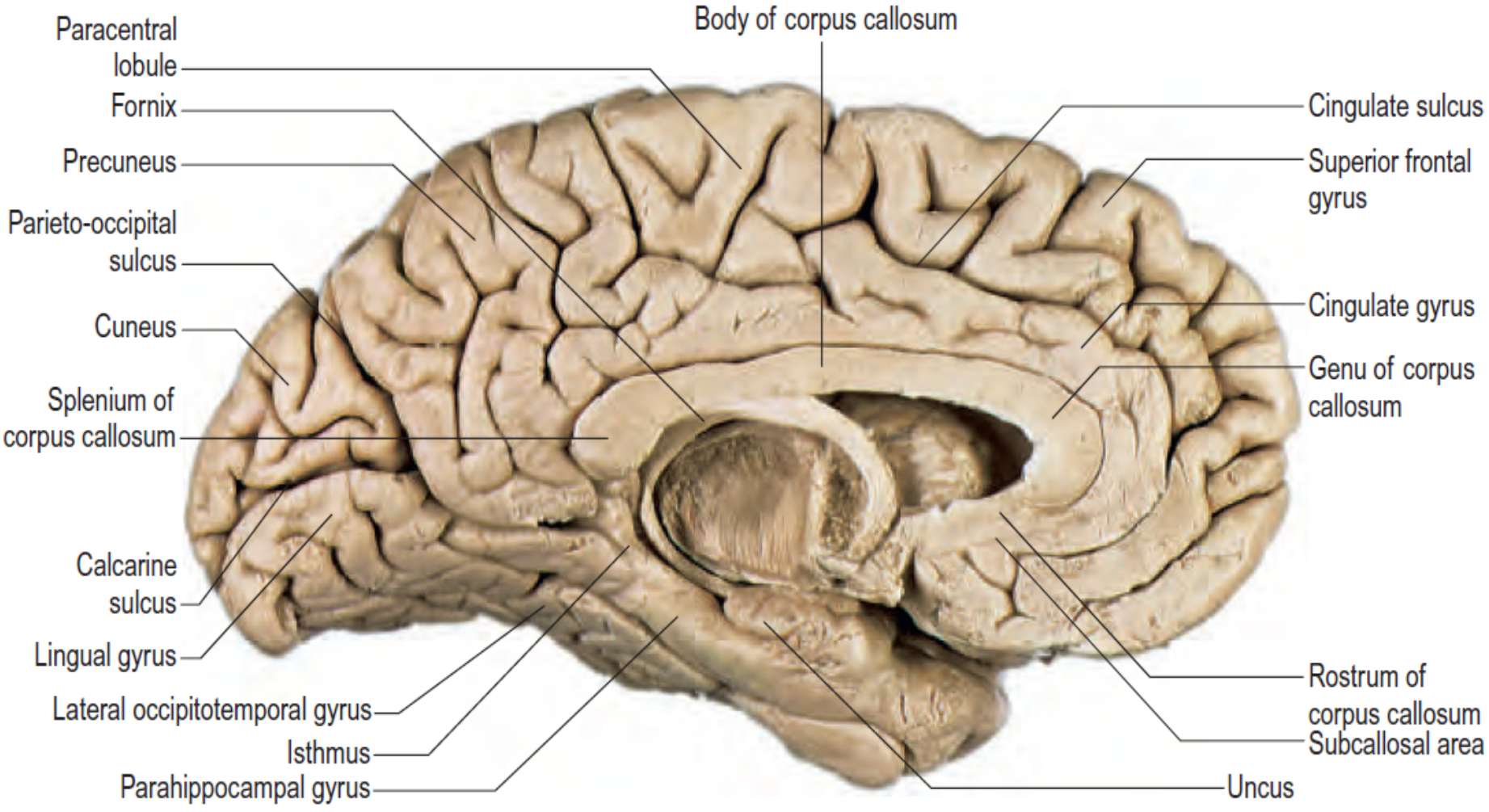
Is a small rounded elevation on the posterior surface of the thalamus .
It has six layers of neurons numbered 1–6 from the ventral to the dorsal surface.

Crossed optic tract fibres end in layers 1, 4 and 6 .
Uncrossed fibres end in layers 2, 3 and 5.

The neurons of geniculate body send their axons through the optic radiation to the occipital cortex .

The axons from lateral part of the geniculate body, carrying impressions from upper part of opposite side of visual fields(lower quadrants of retina), fan out laterally and inferiorly around anterior tip of inferior horn of lateral ventricle (**Meyer's loop**) before swinging posteriorly to reach inferior lip of the calcarine sulcus;

Axons from medial part, carrying impressions from corresponding inferior part of visual fields(upper quadrants of retina), pass directly backwards to superior lip of calcarine sulcus.



- **Primary visual area (Brodmann area 17)**

- Is situated in walls of posterior part of calcarine sulcus and occasionally extends around occipital pole onto lateral surface of hemisphere .

- Receives afferent fibers from lateral geniculate body.
- The fibers first pass forward in white matter of temporal lobe and then turn back to primary visual cortex in occipital lobe.

- Receives fibers from temporal half of ipsilateral retina and nasal half of contralateral retina. Right half of field of vision, therefore, is represented in visual cortex of left cerebral hemisphere and vice versa.

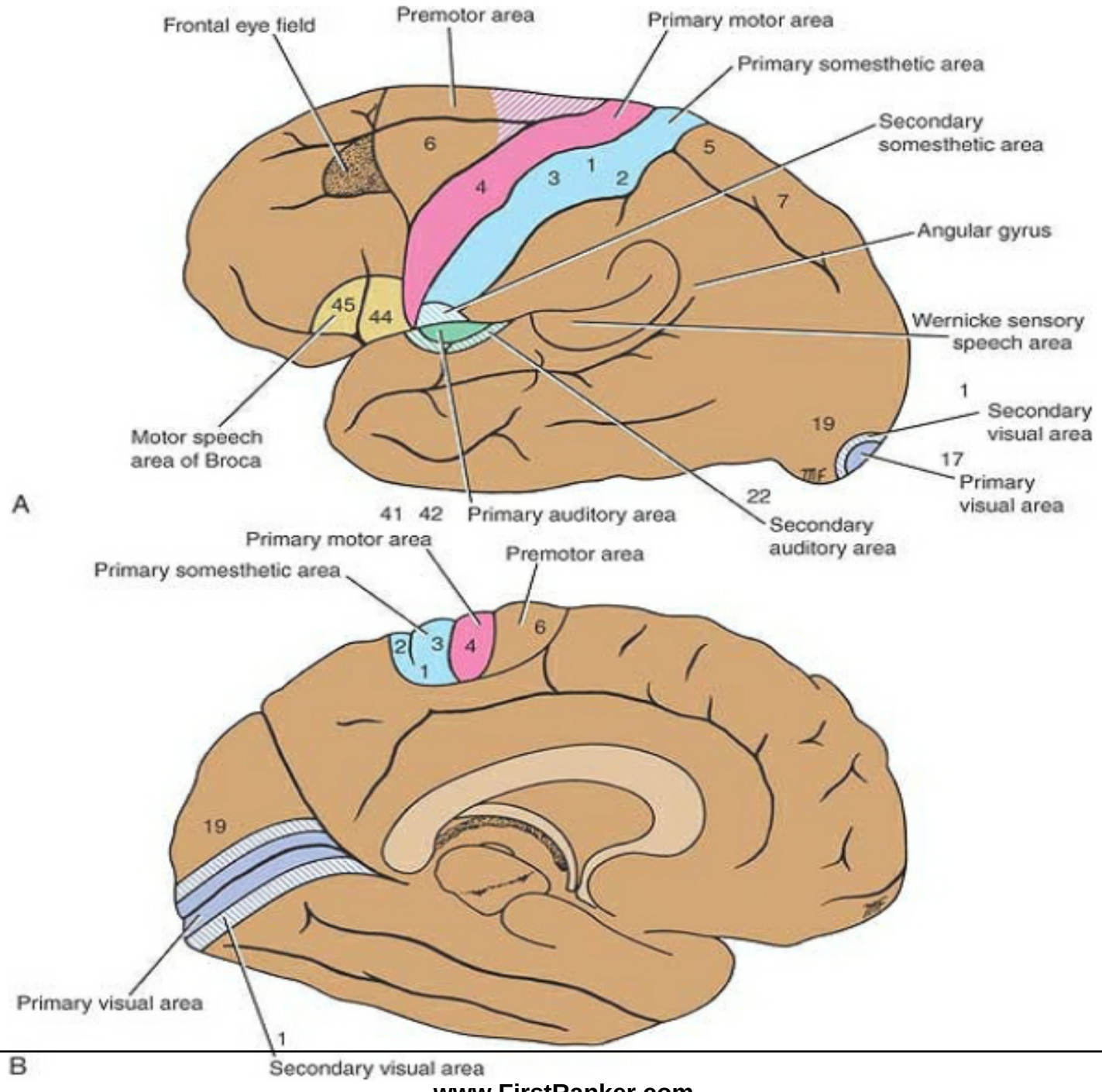
- It is also important to note that

  superior retinal quadrants (inferior field of vision) pass to superior lip of calcarine sulcus,

  inferior retinal quadrants (superior field of vision) pass to inferior lip of the calcarine sulcus.

- Macula lutea, which is central area of retina and area for most perfect vision, is represented on the cortex in posterior part of area 17 and accounts for one-third of visual cortex.

- The visual impulses from peripheral parts of retina terminate in concentric circles anterior to the occipital pole in the anterior part of area 17.



- **Secondary visual area (Brodmann areas 18 and 19)**

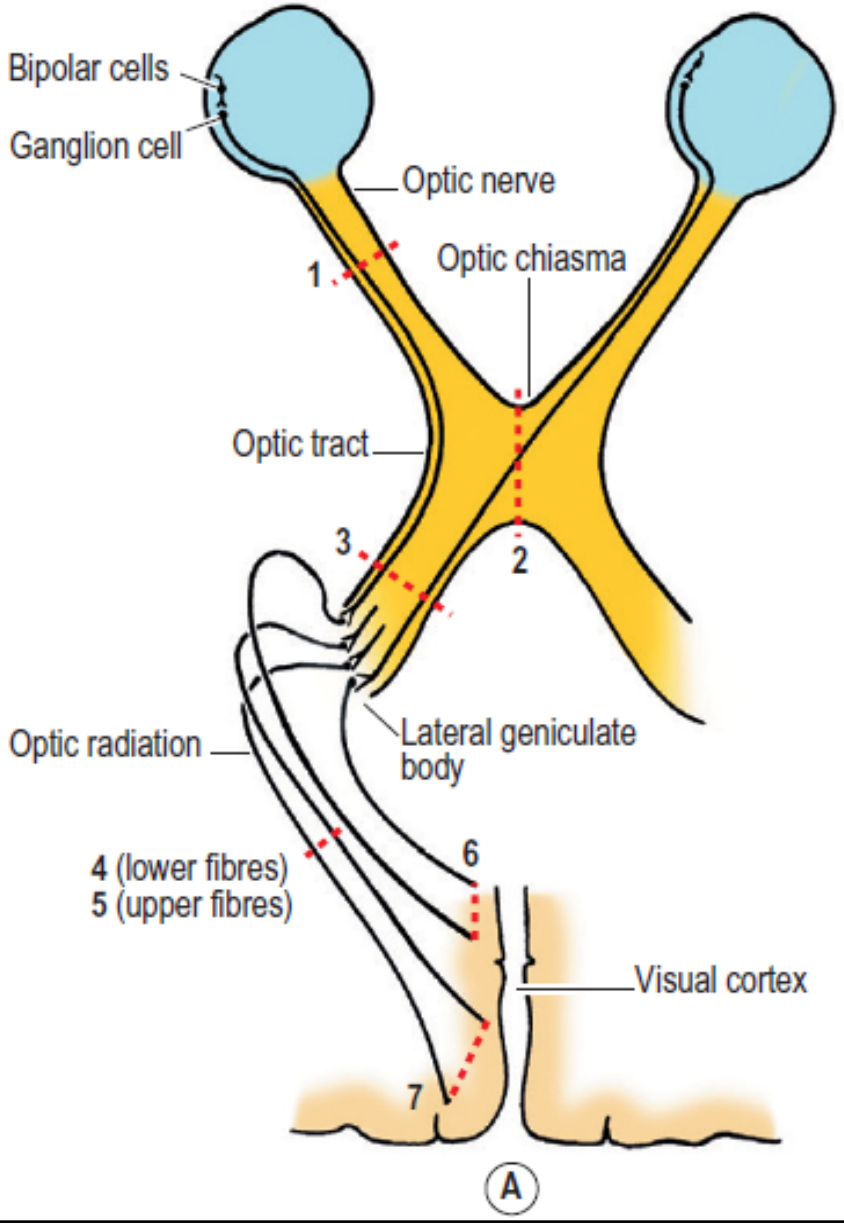
Surrounds primary visual area on medial and lateral surfaces of hemisphere .

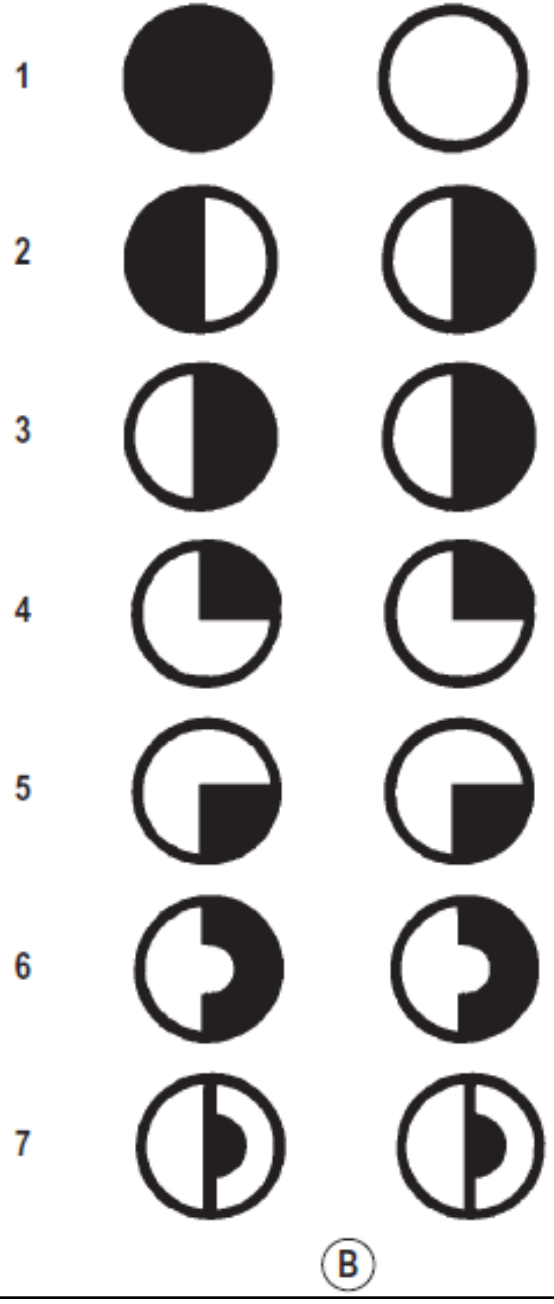
This area receives afferent fibers from area 17 and other cortical areas as well as from thalamus.

Function of secondary visual area is to relate visual information received by primary visual area to past visual experiences, thus enabling individual to recognize and appreciate what he or she is seeing.

Effect of injury to visual pathway

- Assessment of visual fields tests integrity of visual pathways from retina to cortex, and lesions at different points along the path give rise to characteristic defects.
- The defects are conventionally described with reference to the visual fields and not to the retina.
- Clinically most common lesions are at chiasma and in optic radiation .





1. A **complete lesion of optic nerve**

   gives rise to complete blindness in the eye concerned .

2. **Compression of optic chiasma**

   As by a pituitary tumour, causes bitemporal hemianopia (blindness in the temporal half of both visual fields) because nasal fibres from both retinas are interrupted. This effectively narrows outer part of each visual field, so that patient complains of bumping into sides of a doorway or into people on each side.

3. A lesion of **left optic tract**

   Gives a right homonymous hemianopia, due to interruption of fibres from the same (left) sides of both retinas (hence homonymous, meaning same-sided). The field defects are therefore right-sided.

   A lesion of right optic tract will produce left homonymous hemianopia .

4. A lesion of the **lower fibres in left optic radiation**
(as from an abscess in temporal lobe from infection spreading upwards from the middle ear) causes a right upper quadrantic homonymous hemianopia, because the lower fibres in optic radiation are from lower part of retina.

5. Similar to 4 , a **lesion of the upper fibres in the left optic radiation**
(as from a parietal lobe lesion, and in practice very rare) gives a right lower quadrantic homonymous hemianopia.

6. A **lesion of the anterior part of the left visual cortex**
   As from occlusion of the posterior cerebral artery gives a right homonymous hemianopia similar to the optic tract lesion in (3), but there may be sparing of the macular (central) vision when the most posterior part of the visual cortex at the very tip of the occipital lobe, where macular vision is represented, is (sometimes) supplied by the middle cerebral artery.

7. Traumatic **damage to the tip of the left occipital lobe**, i.e. to the macular area, gives a right homonymous macular defect.