Retinal Anatomy and Histology

What is the difference between the retina *and the* **neurosensory** retina*?*
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The neurosensory retina contains three classes of cells:

--**Neurons**

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----Photoreceptors (PRs)
----Bipolar cells
----Ganglion cells
----Amacrine cells
----Horizontal cells
--Glial

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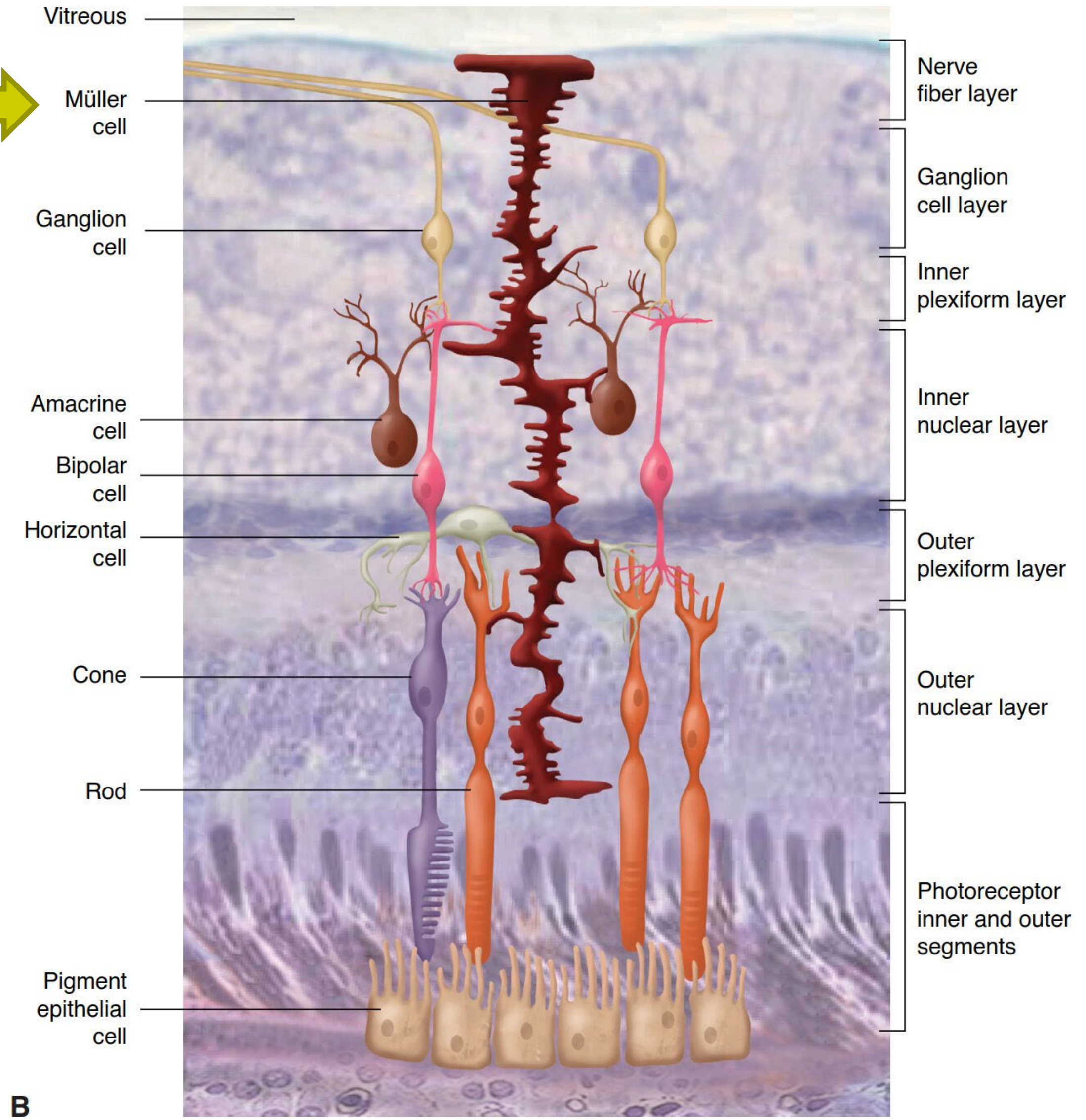
One of the glial cells is of particular note—**Müeller cells**. These large cells extend the breadth of the neurosensory retina, and their foot-processes form the **internal limiting membrane** of the retina.

Retinal Anatomy and Histology



Müeller cells

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The amacrine cells and horizontal cells are **interneurons** connecting other neural elements.

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The amacrine cells and horizontal cells are **interneurons** connecting other neural elements. The horizontal cells interconnect PRs with one another; the amacrine cells interconnect bipolar cells, and ganglion cells.

--Glial:
----Müeller cells
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Noting that amacrine and horizontal cells are interconnectors dovetails nicely with a fundamental way you should think about the neural elements of the neurosensory retina. Specifically, all of the neural elements can be conceptualized as belonging to one of two pathways:

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--The *vertical pathway* comprised of (in order) the PRs, bipolar cells, and ganglion cells; and
--the *horizontal pathway* comprised of amacrine and horizontal cells

And lastly, two vascular cell types:

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----Photoreceptors (PRs)
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Vertical pathway

Horizontal pathway

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***Vertical* pathway**

Horizontal pathway

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Vertical pathway

----Amacrine cells
----Horizontal cells

***Horizontal* pathway**

In contrast, the horizontal pathway conducts impulses from one area of the retina to another.

--Glial:
----Müeller cells
----Astrocytes
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Let's drill down on the PRs. Their fundamental role is to convert light energy into electrical (neural) impulses, ie, they are the site at which phototransduction occurs. There are two basic PR types: Rods and cones, each named for the shape of their outer segments (we'll explain what an outer seg is shortly). In the average human retina there are 100-125M rods, and 6-7M cones.

--Vascular
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Rods and cones differ in many ways, but the most fundamental is that cones provide color vision, whereas rods provide monochromatic vision. There are three types of cones; they differ in terms of the wavelength of light to which they are most responsive: Short wavelength (S cones), medium (M cones), and long (L cones).

----Endothelial cells
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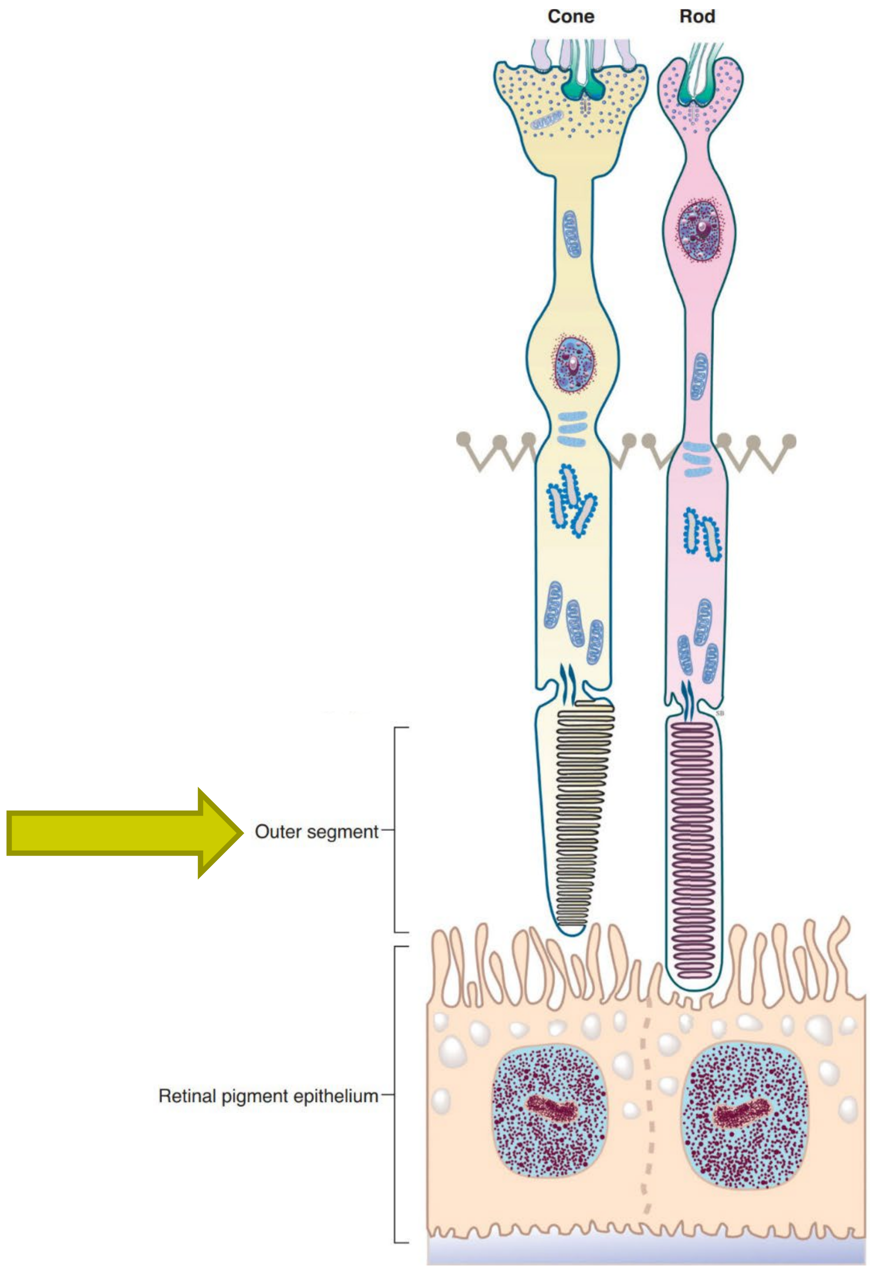
----Pericytes

Retinal Anatomy and Histology



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The dominant morphologic feature of a PR outer seg are its **discs**. The disc membranes contain the protein **rhodopsin**, which is the substance that reacts to the incoming light and kicks off the process of phototransduction. After a disc's phototransduction ability is spent, it is 'shed' by the PR, and gobbled up by adjacent RPE cells.

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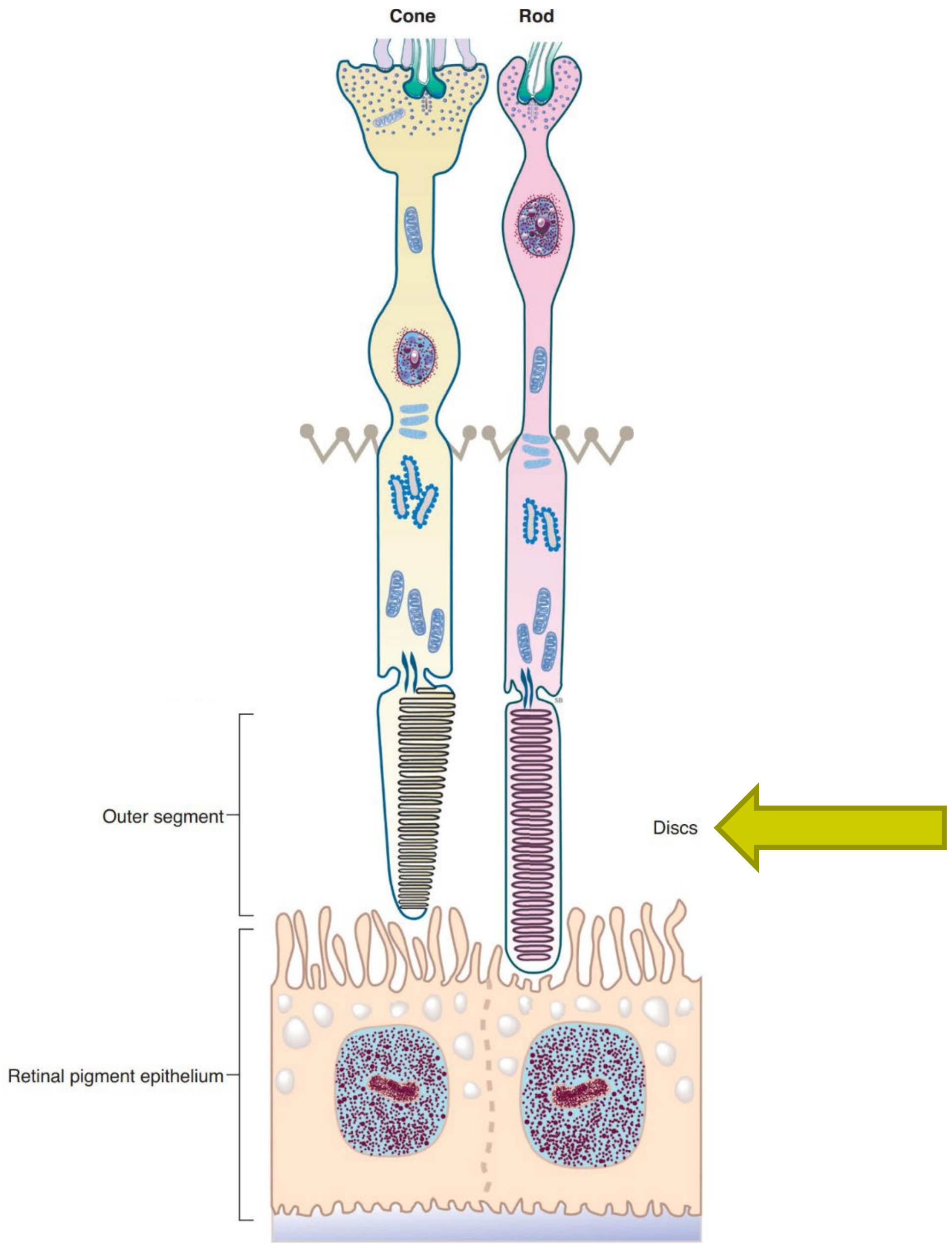

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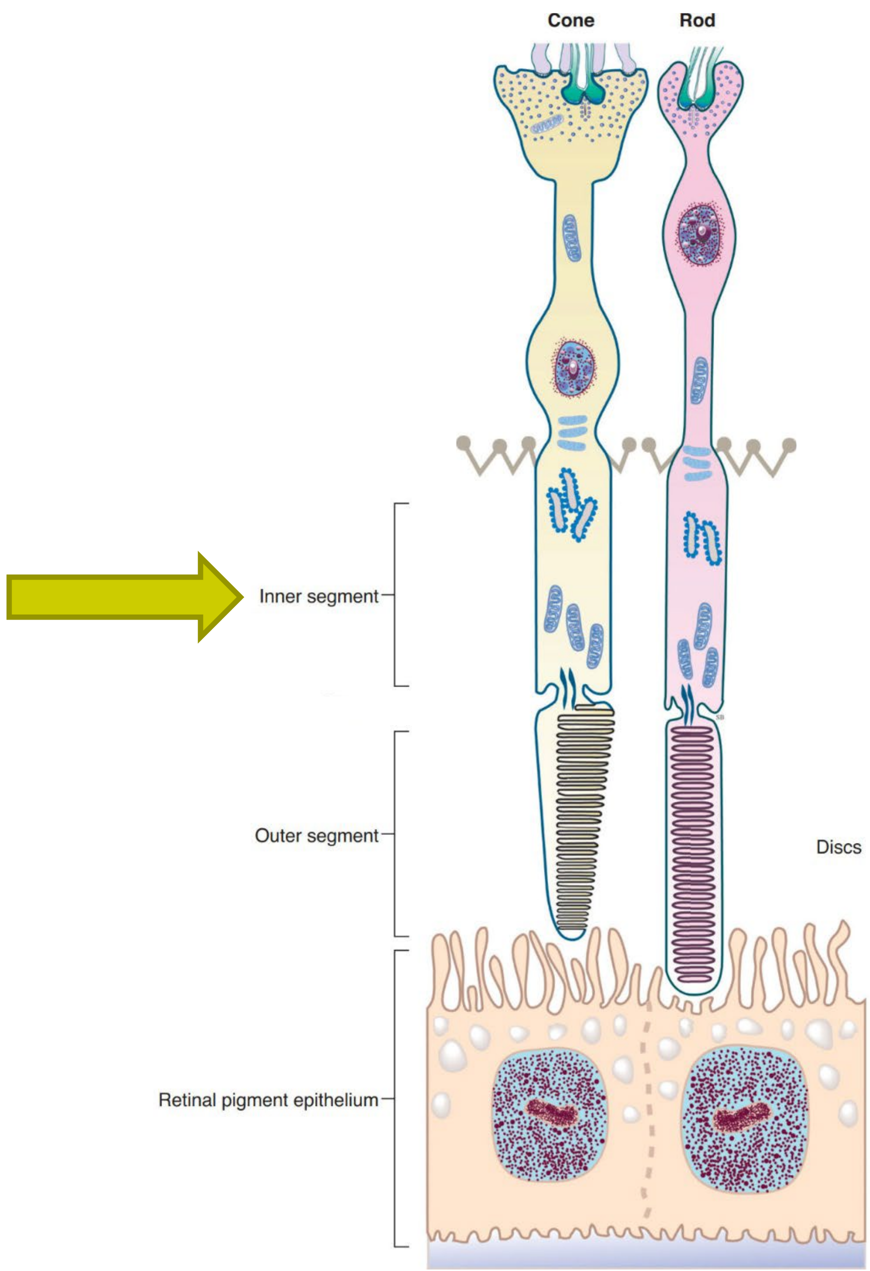
--**Vascular**:
----Endothelial cells
----Pericytes

Retinal Anatomy and Histology



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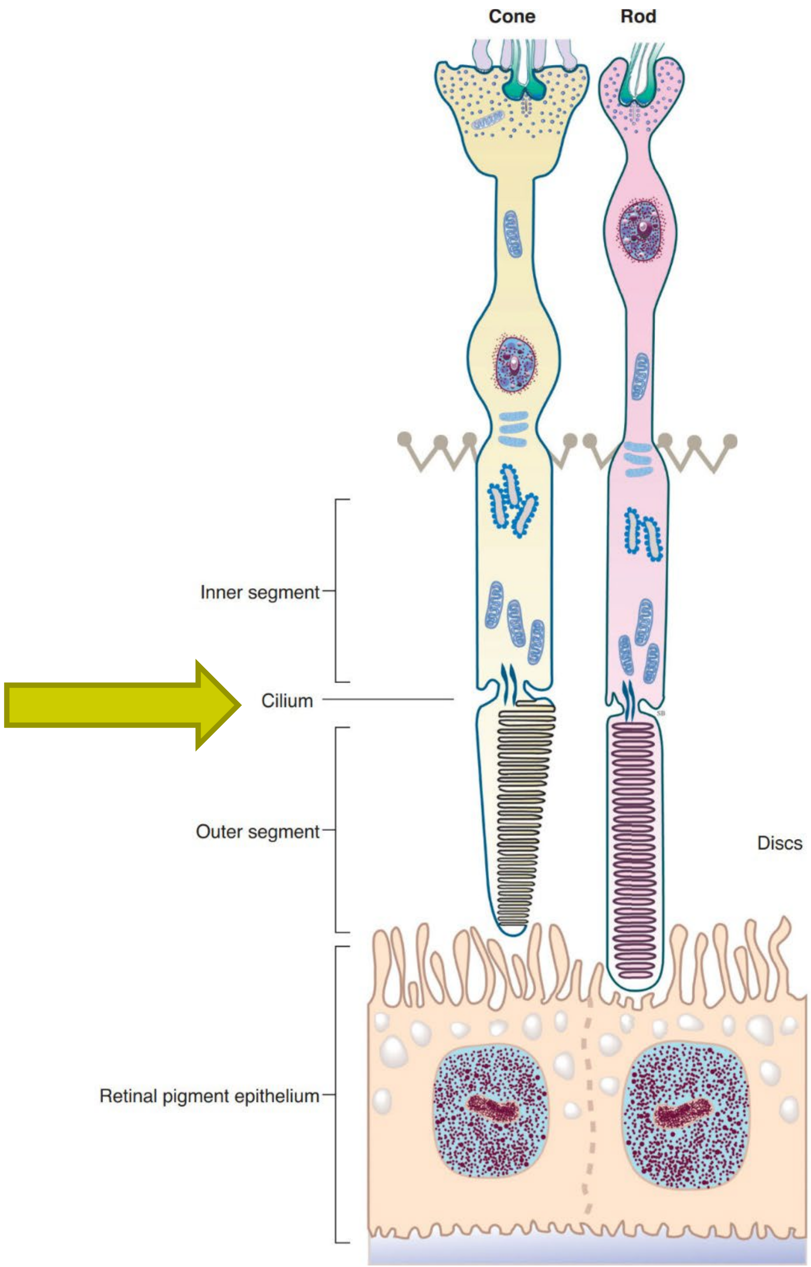

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The inner segment has two subsections—an **ellipsoid** immediately adjacent to the cilium, then a **myoid**. Each area is known for its contents, with the ellipsoid being chock full of mitochondria, and the myoid full of glycogen.

--**Vascular**:
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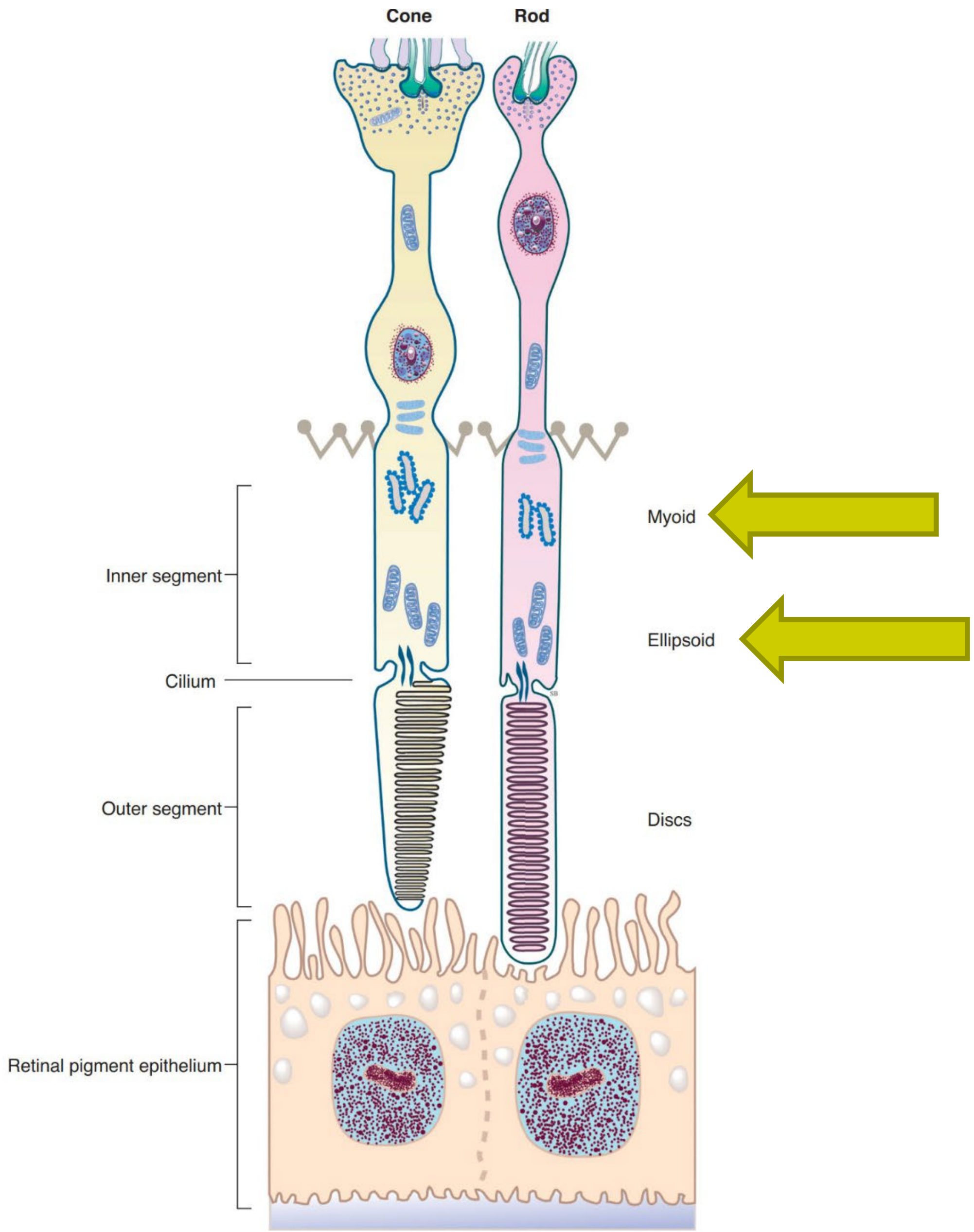
Retinal Anatomy and Histology



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----Pericytes

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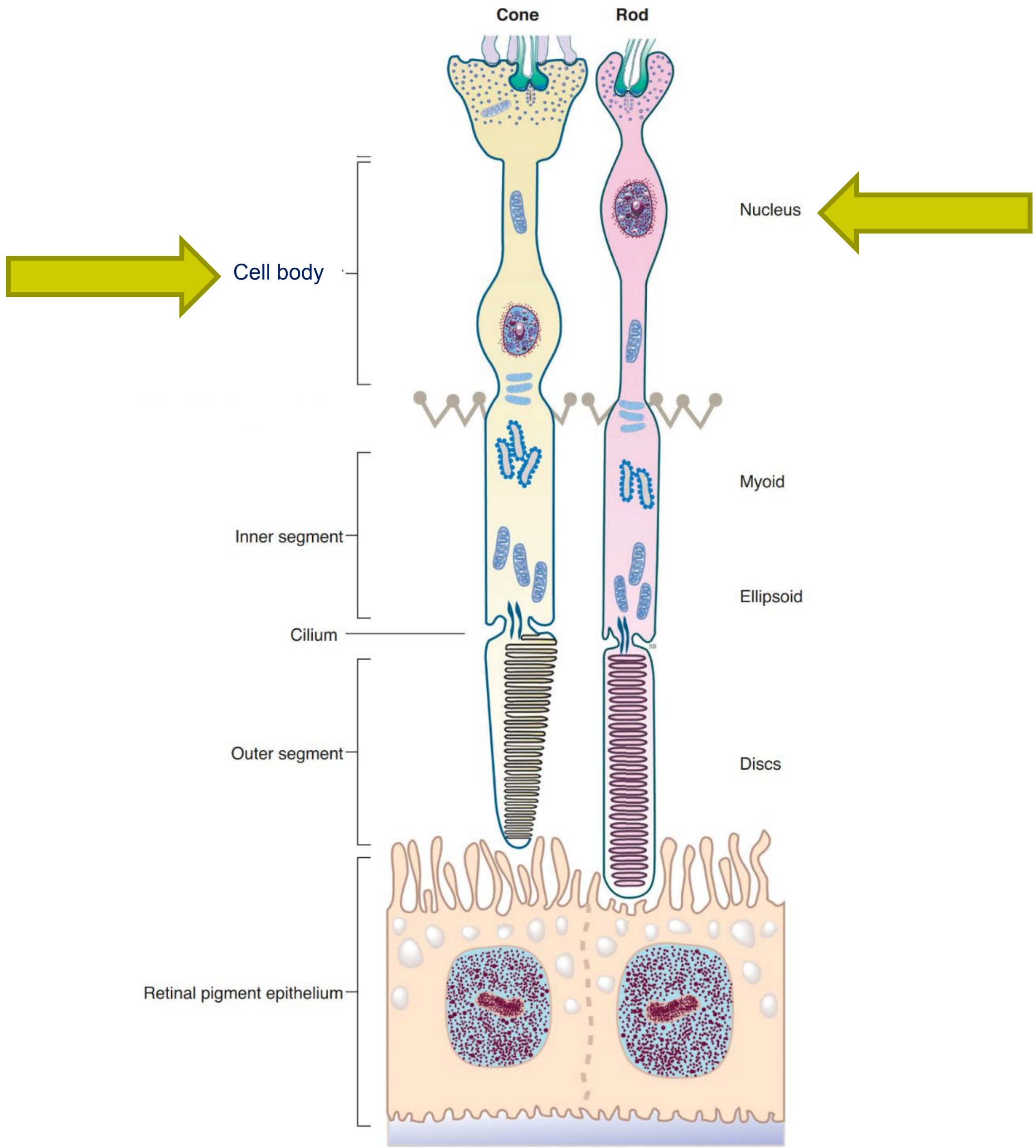

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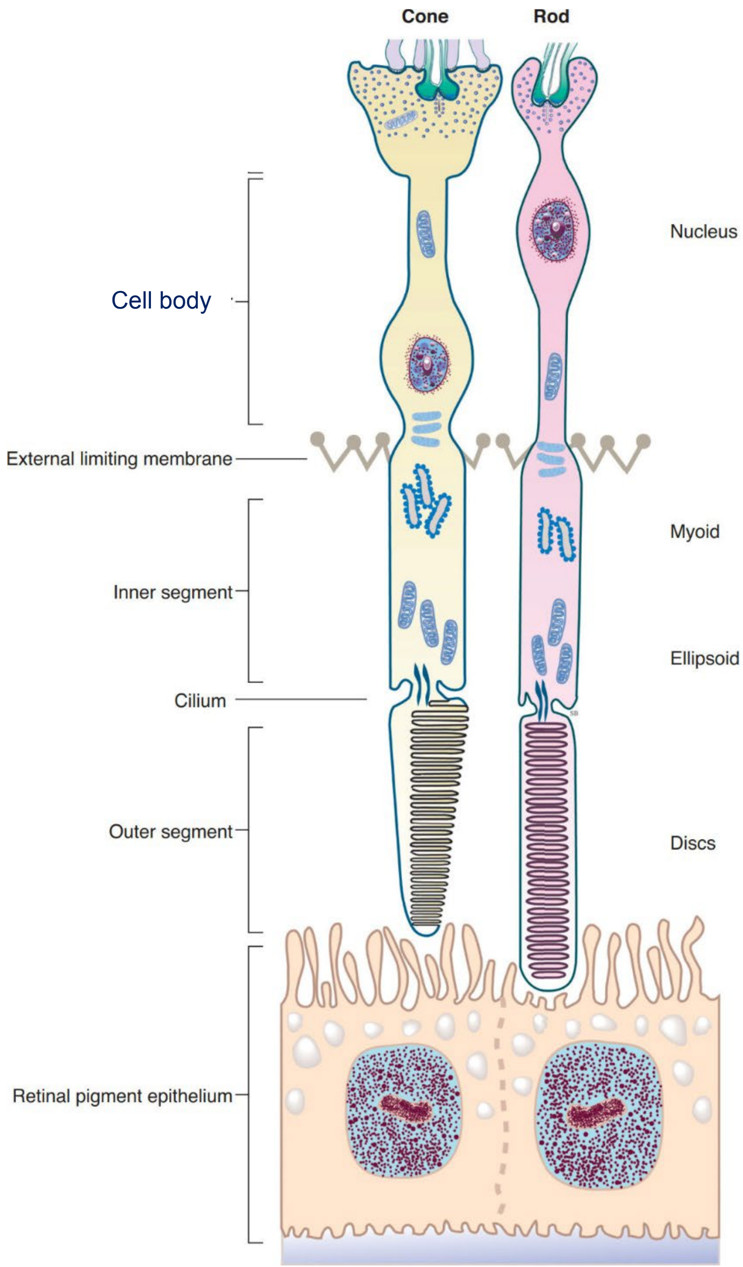
While not a part of the PRs per se, they (the PRs) contribute to an important retinal structure located at the juncture of the inner segment and cell body—the **external limiting membrane** (ELM). The ELM is not an actual membrane, rather, it is a barrier created by connections between Mueller cells and PRs.

----Pericytes

Retinal Anatomy and Histology



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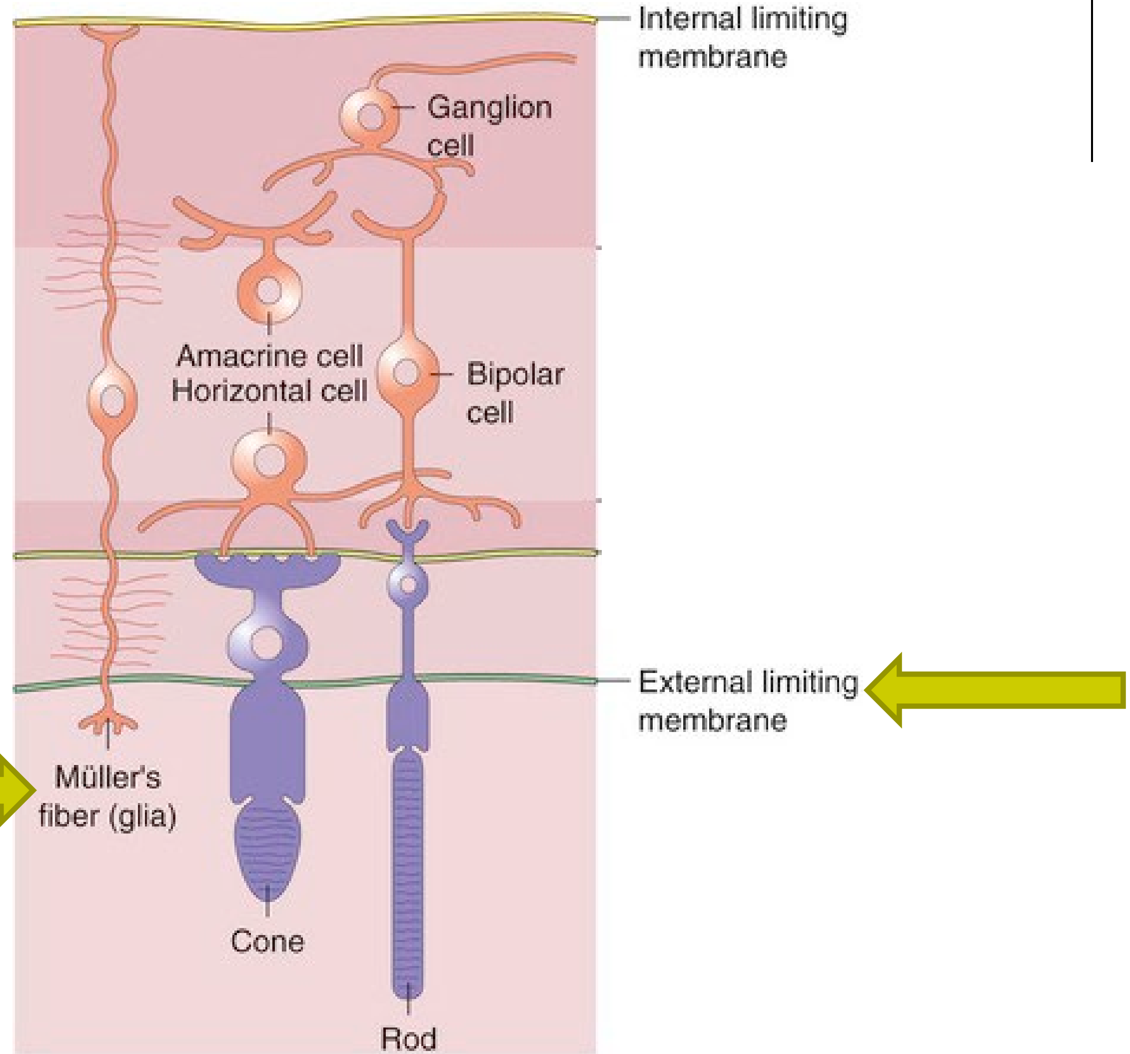

ELM, Müeller cells and PRs

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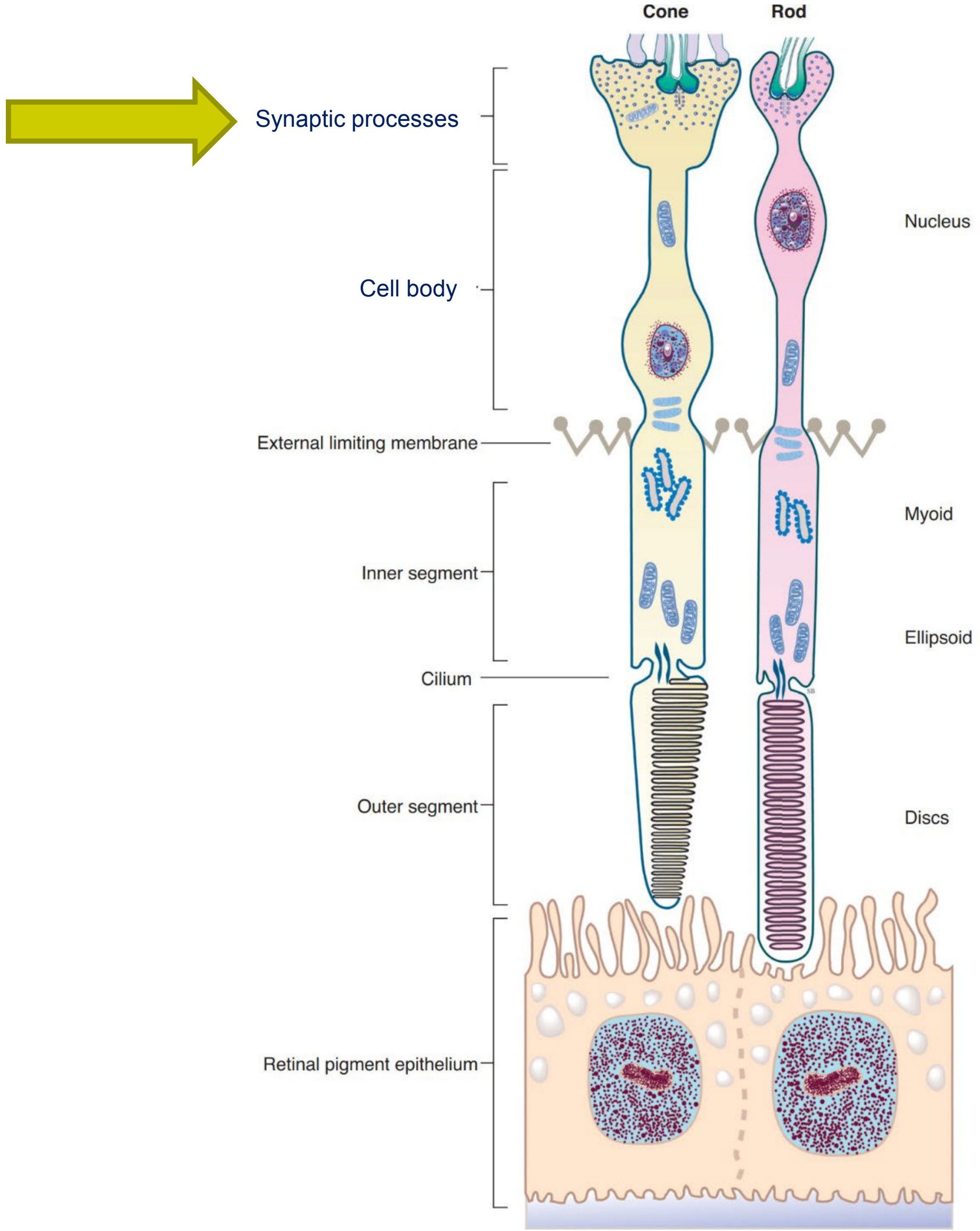
After the cell body, the final portion of the PR is an axon-like fiber terminating in the PR's synaptic processes.

----Endothelial cells
----Pericytes

Retinal Anatomy and Histology



Retinal Anatomy and Histology

Next we will look at the layers of the neurosensory retina. But before we do, let's make sure you're on fleek* regarding the critical aspects of retinal histology we've seen thus far.

So in "**so** cool" is bold, the rest of the line italic:

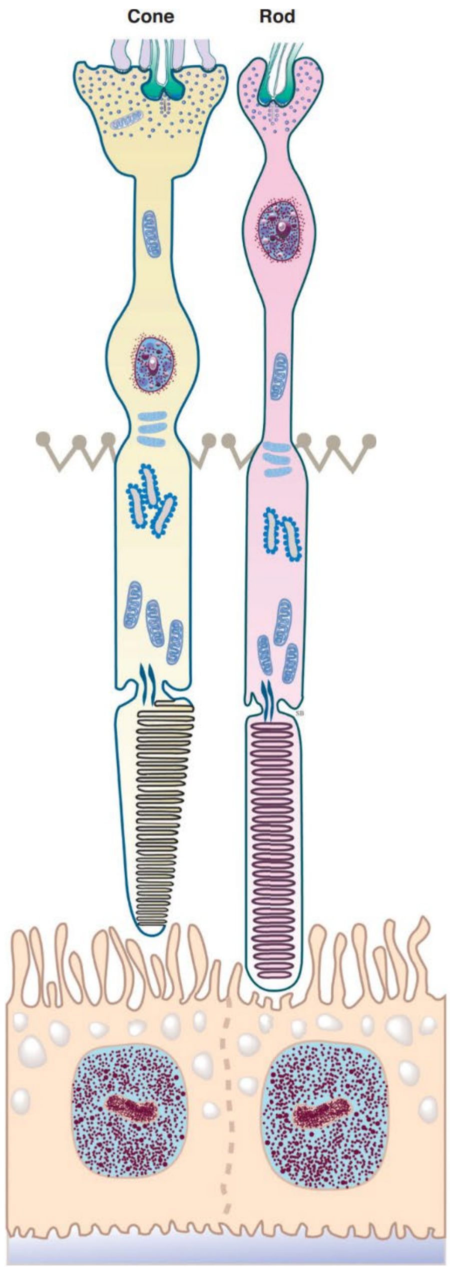
You're* **so *cool, Dr Flynn*

Retinal Anatomy and Histology

Next we will look at the layers of the neurosensory retina. But before we do, let's make sure you're on fleek* regarding the critical aspects of retinal histology we've seen thus far. Why? Because as we will see later in the slide-set, a firm grasp of this info is absolutely required to read OCTs. So go through the next section of slides over and over until they're burned into your brain. (You'll thank me later.)

You're* ***so* *cool, Dr Flynn*

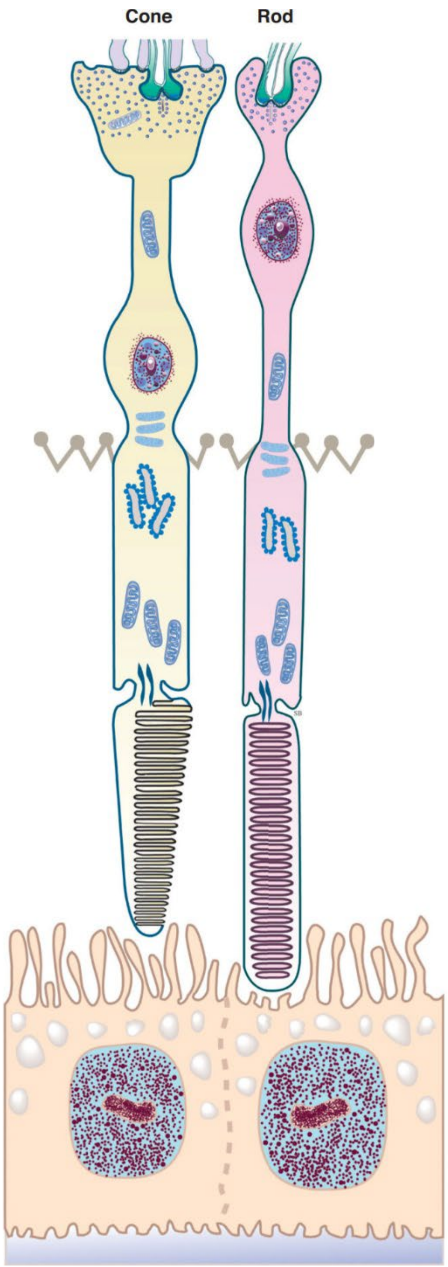
Retinal Anatomy and Histology



Working out→in: The first structure to be particularly aware of is…

RPE/Bruch's membrane complex

Retinal Anatomy and Histology

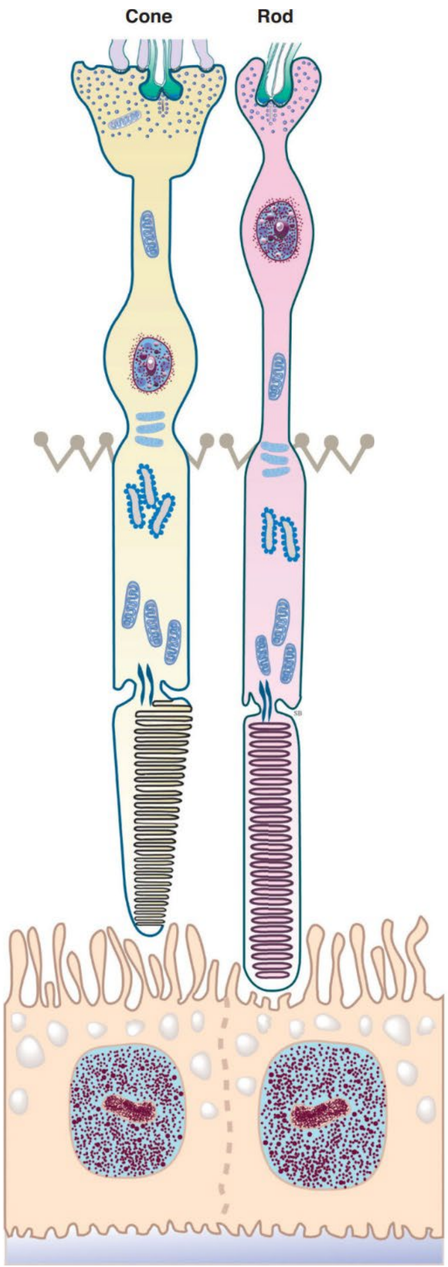


The next is…

The interdigitation zone

RPE/Bruch's membrane complex

Retinal Anatomy and Histology



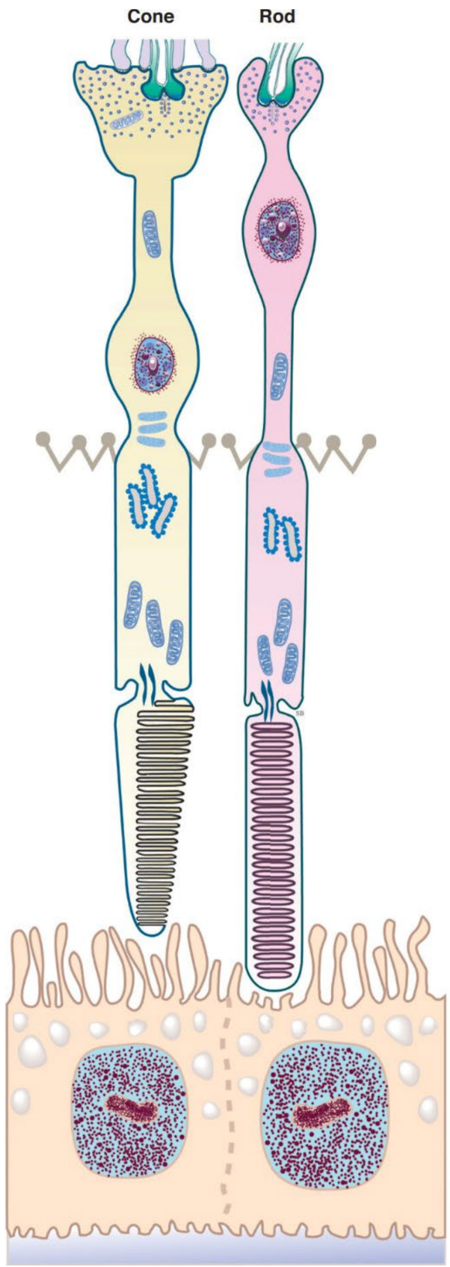
The next is…

PR outer segs

The interdigitation zone

RPE/Bruch's membrane complex

Retinal Anatomy and Histology



The next is…

The ellipsoid zone

PR outer segs

The interdigitation zone

RPE/Bruch’s membrane complex

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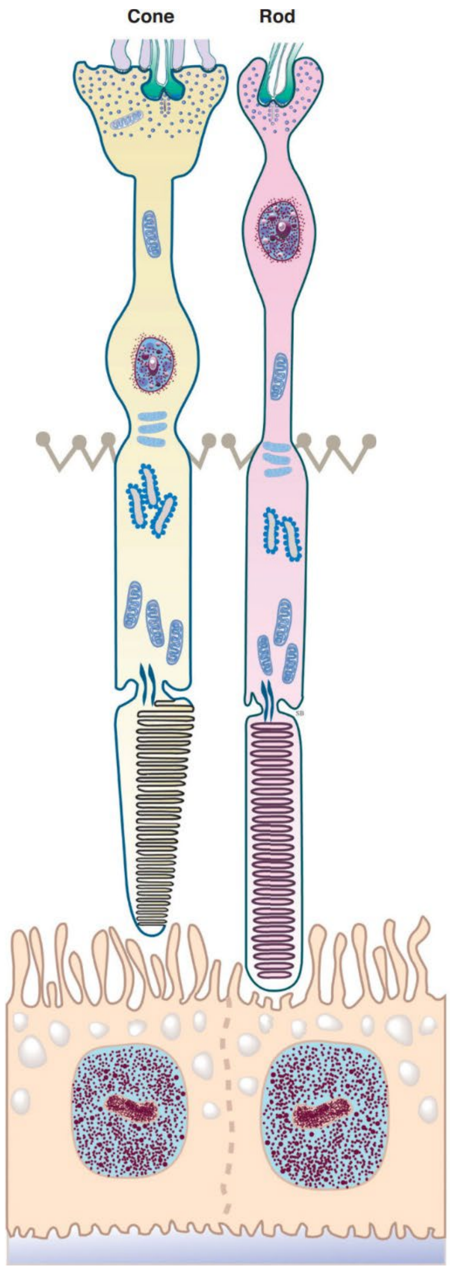

The next is…

- The myoid zone
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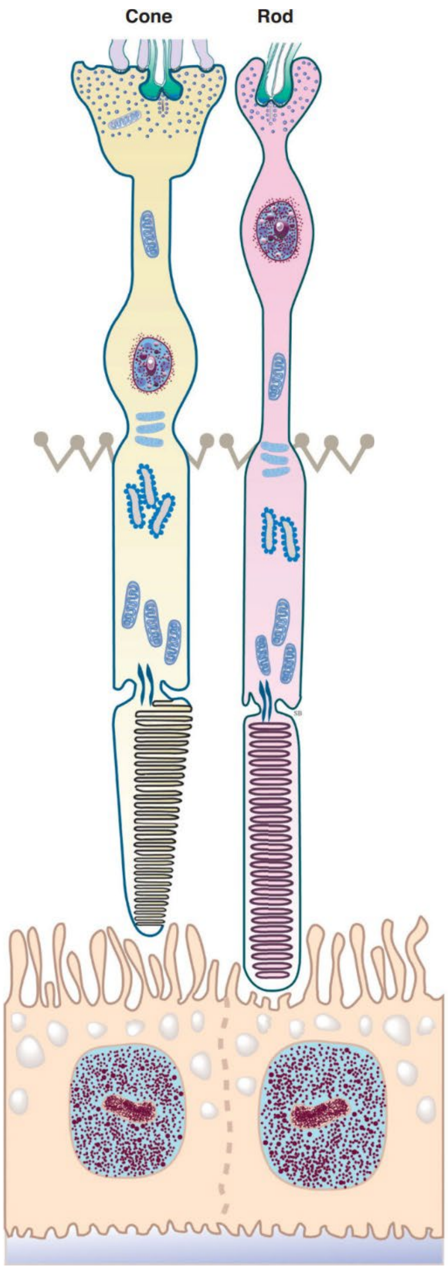

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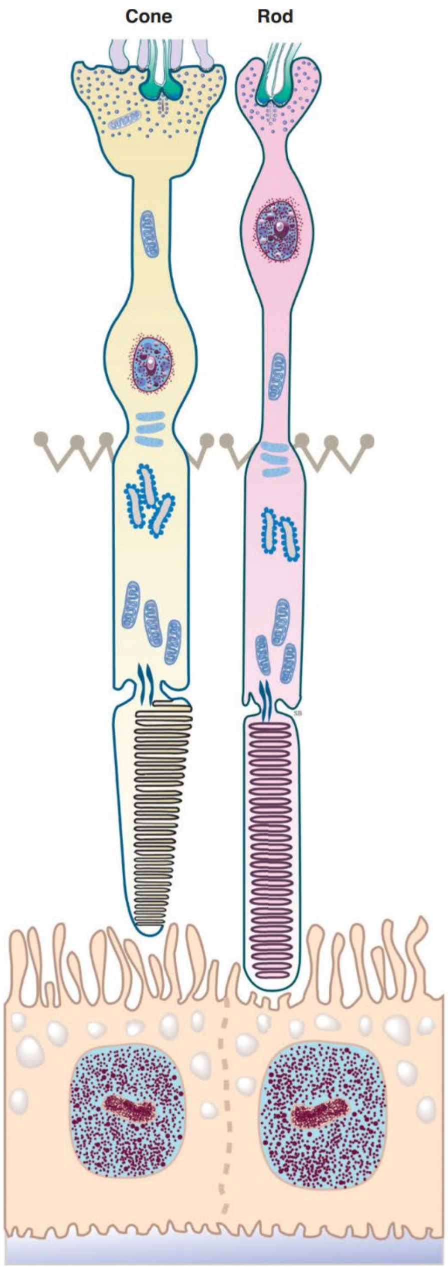
Retinal Anatomy and Histology



Re-rack those until you know them cold!

- The ELM
- The myoid zone
- The ellipsoid zone
- PR outer segs
- The interdigitation zone
- RPE/Bruch's membrane complex

Retinal Anatomy and Histology

Now we're ready to review the layers of the retina

Retinal Anatomy and Histology

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer
  - Ganglion cell layer
  - Inner plexiform layer
  - Inner nuclear layer
  - Outer plexiform layer
  - Outer nuclear layer
  - External limiting membrane
  - Rod & cone inner and outer segments
- **RPE**
- **Bruch's membrane**

Here they are, but don't try to memorize them at this point—instead, let's work through them.

Retinal Anatomy and Histology

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - **Nerve fiber layer**
  - Ganglion cell layer
  - **Inner plexiform layer**
  - Inner nuclear layer
  - **Outer plexiform layer**
  - Outer nuclear layer
  - External limiting membrane
  - Rod & cone inner and outer segments
- **RPE**
- **Bruch's membrane**

These three layers consist of **fibers**, ie, axons and/or dendrites. (A *plexus* is an interlaced group of fibers.)

Retinal Anatomy and Histology

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer
  - **Ganglion cell layer**
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  - Outer plexiform layer
  - **Outer nuclear layer**
  - External limiting membrane
  - Rod & cone inner and outer segments
- **RPE**
- **Bruch's membrane**

In contrast, these layers composed of the **cell bodies** that give rise to the axons and/or dendrites of the other layers.

Retinal Anatomy and Histology

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**
  - Outer plexiform layer ← **Processes**
  - Outer nuclear layer ← **Bodies**
  - External limiting membrane
  -
- **RPE**
- **Bruch's membrane**

Note that this section of the retina consists of alternating layers of cell **processes** and cell **bodies**. This pattern can help you remember which layer is next to which!

Retinal Anatomy and Histology

- **Neurosensory Retina Layers**
  - Internal limiting membrane
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  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**
  - Outer plexiform layer ← **Processes**
  - Outer nuclear layer ← **Bodies**
  - External limiting membrane
  - Rod & cone inner and outer
- **RPE**
- **Bruch's membrane**

Axons

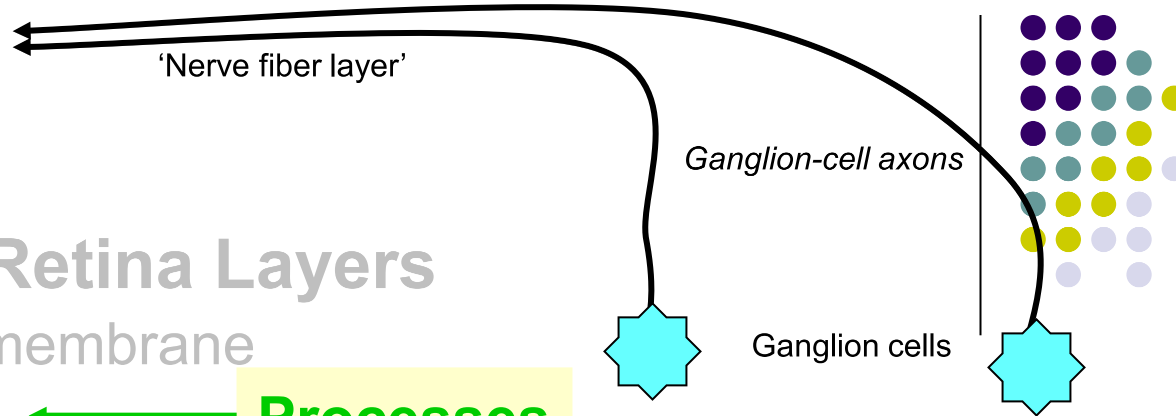
Dendrites

Axons

Dendrites

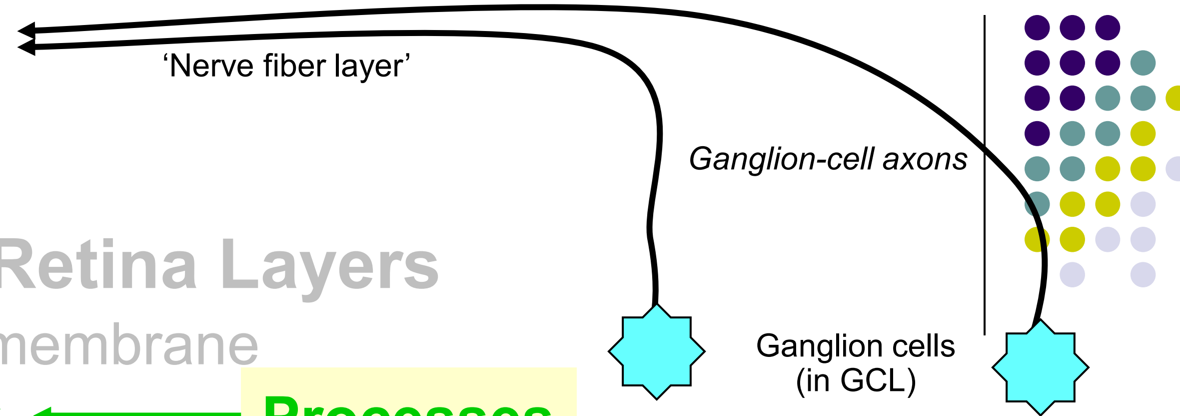
Axons

Further, we can see the origins of the fibers that comprise each fiber/plexiform layer



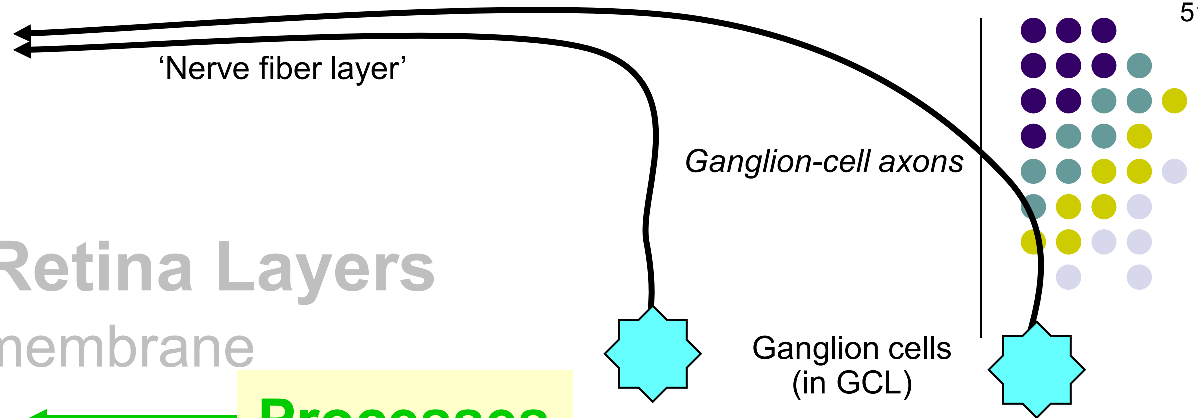
- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
- **RPE**
- **Bruch’s membrane**

The first layer after the ILM is the retinal **nerve fiber layer**. The NFL is composed of the axons of the ganglion cells.



- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
- RPE
- **Bruch's membrane**

The first layer after the ILM is the retinal **nerve fiber layer**. The NFL is composed of the axons of the ganglion cells. The cell bodies of the ganglion cells are located in the **ganglion cell layer.**

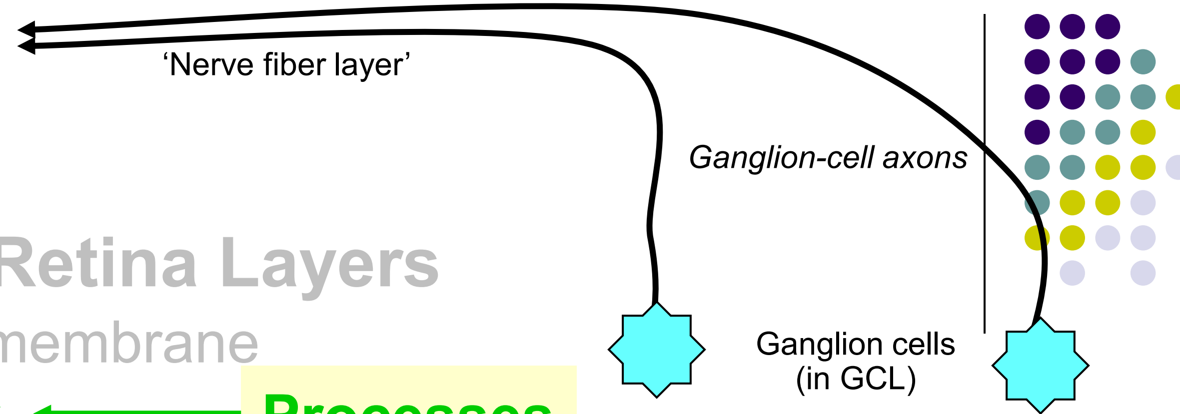


- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**

The first layer after the ILM is the retinal **nerve fiber layer**. The NFL is composed of the axons of the ganglion cells. The cell bodies of the ganglion cells are located in the **ganglion cell layer.**

The NFL fibers run toward the lamina cribrosa of the sclera where they exit the eye, in the process forming first the optic nerve head, and then the optic nerve.

- **RPE**
- **Bruch’s membrane**



- **Neurosensory Retina Layers**
  - Internal limiting membrane
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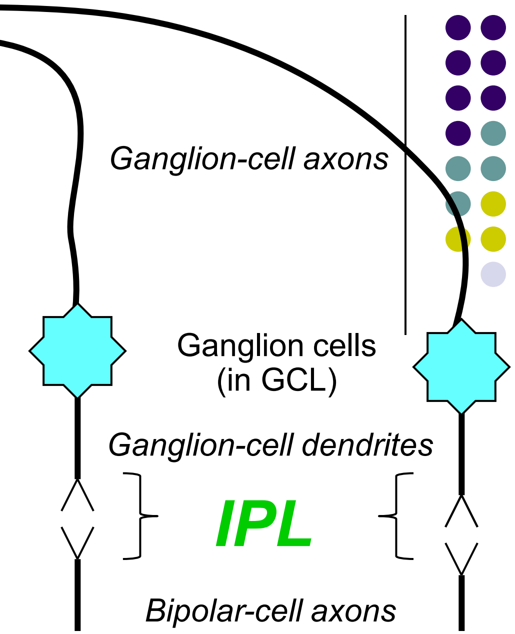
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**

The first layer after the ILM is the retinal **nerve fiber layer**. The NFL is composed of the axons of the ganglion cells. The cell bodies of the ganglion cells are located in the **ganglion cell layer.**
The NFL fibers run toward the lamina cribrosa of the sclera where they exit the eye, in the process forming first the optic nerve head, and then the optic nerve. Most of these fibers will synapse in the lateral geniculate nucleus (LGN); others will synapse elsewhere as part of the pupillary light reflex or circadian rhythm modulation.

- **RPE**
- **Bruch's membrane**

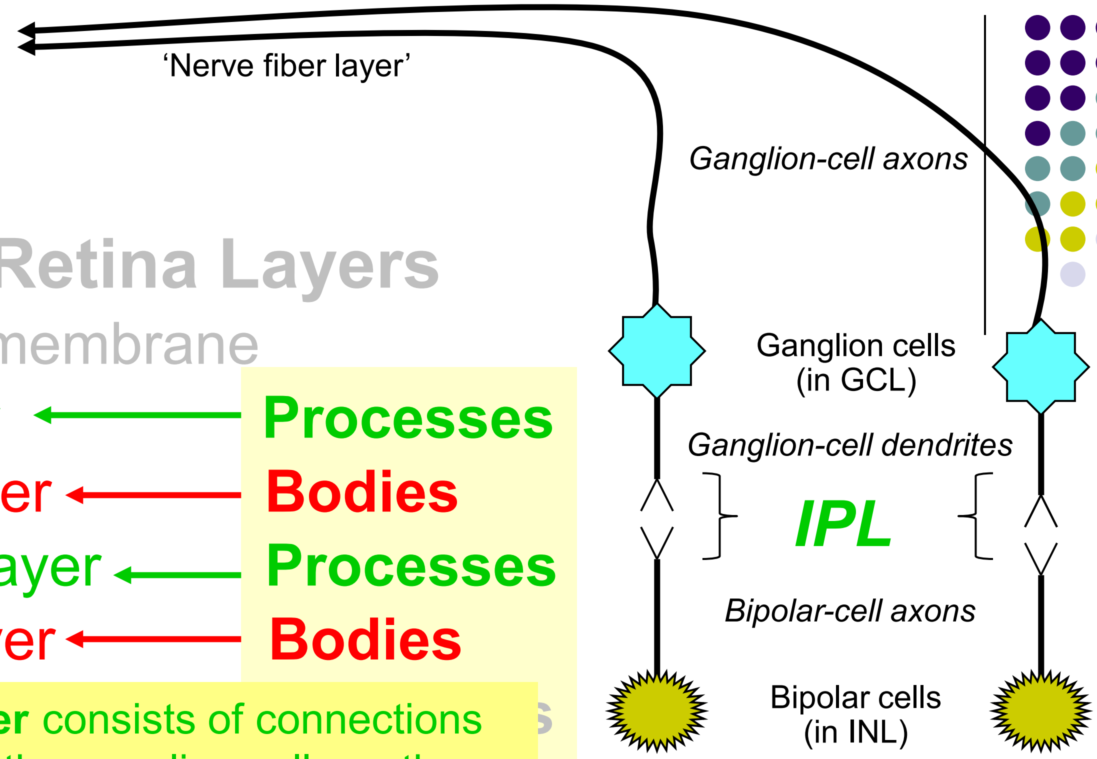


- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**

The **inner plexiform layer** consists of connections between the dendrites of the ganglion cells as they synapse with axons originating from bipolar cells.

- **RPE**
- **Bruch's membrane**

To CNS



- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**

The **inner plexiform layer** consists of connections between the dendrites of the ganglion cells as they synapse with axons originating from bipolar cells. The bodies of these bipolar cells reside in the **inner nuclear layer**.

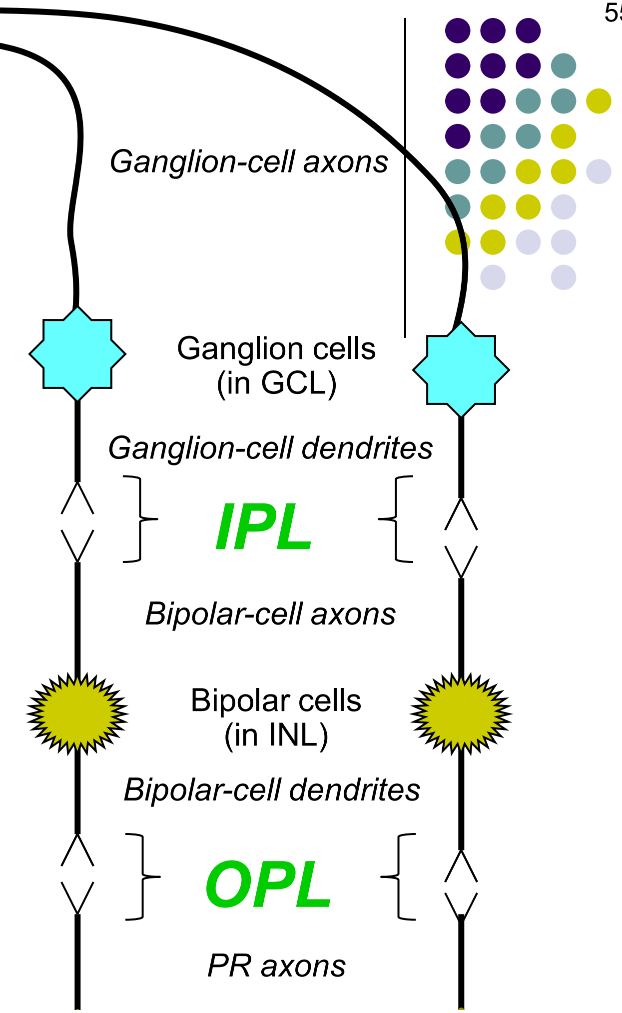
- **RPE**
- **Bruch's membrane**

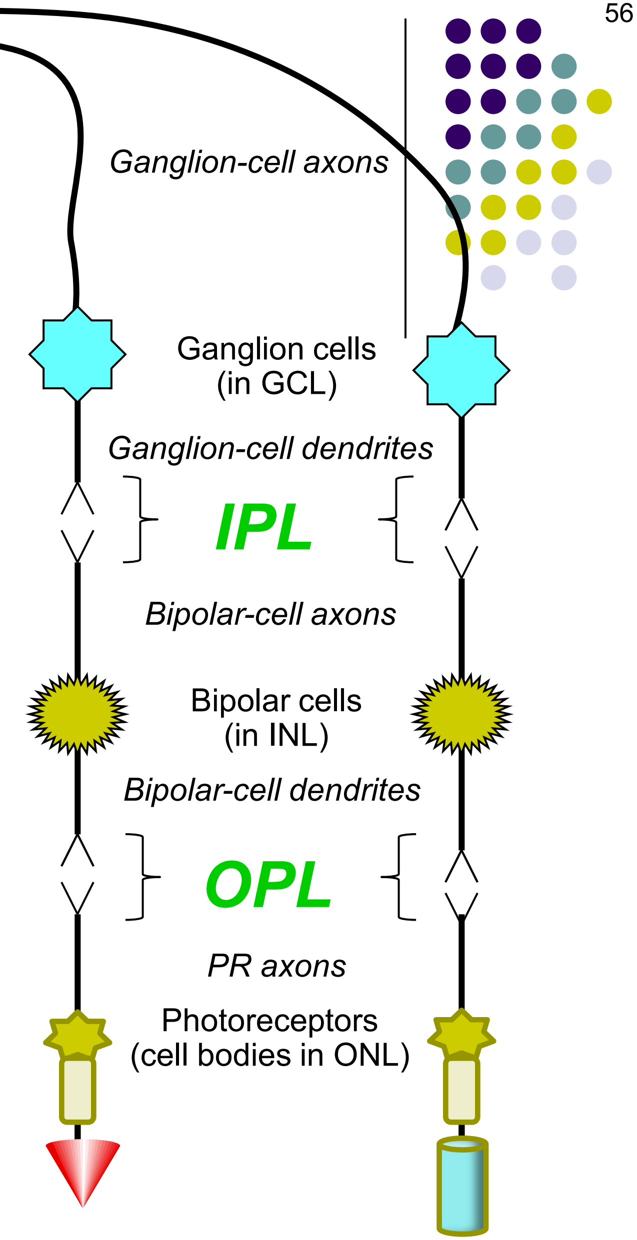
To CNS

'Nerve fiber layer'

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**
  - Outer plexiform layer ← **Processes**
  - Outer nuclear layer ← **Bodies**
  - External limiting membrane
  - ...ts
- ...
- Bruch's membrane

The **outer plexiform layer** consists of connections between the dendrites of the bipolar cells as they synapse with axons originating from the PRs.



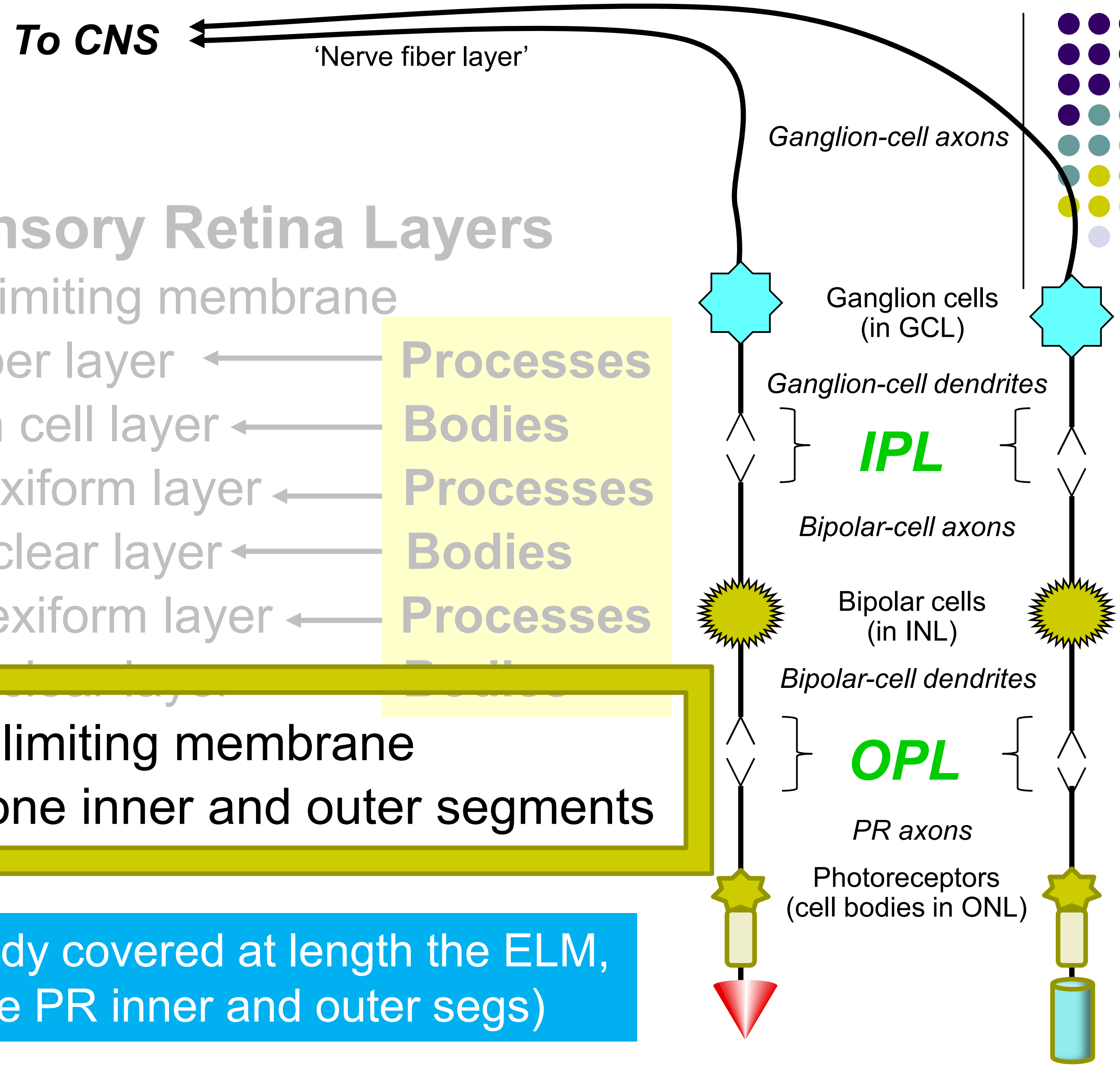


- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**
  - Outer plexiform layer ← **Processes**
  - Outer nuclear layer ← **Bodies**
  - External limiting membrane

The **outer plexiform layer** consists of connections between the dendrites of the bipolar cells as they synapse with axons originating from the PRs. The cell bodies of the PRs reside in the **outer nuclear layer**.

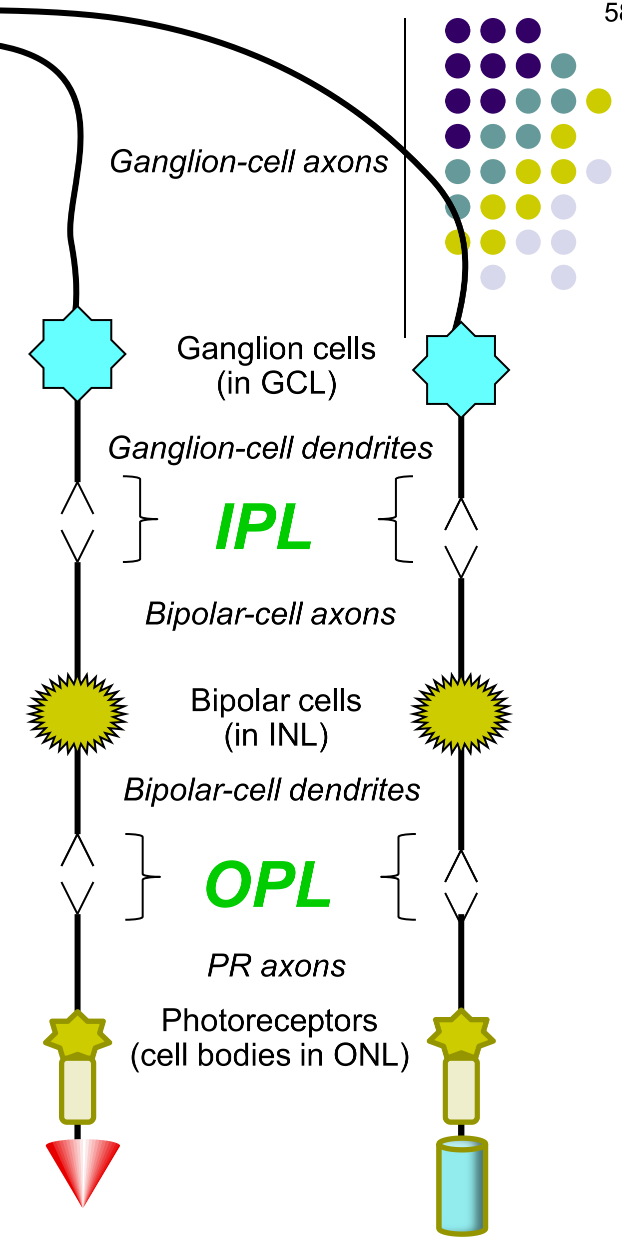
- Bruch's membrane

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**
  - Outer plexiform layer ← **Processes**
  - Outer nuclear layer **Bodies**
  - External limiting membrane
  - Rod & cone inner and outer segments
- RPE
- (We've already covered at length the ELM, as well as the PR inner and outer segs)



- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**
  - Outer plexiform layer ← **Processes**
  - Outer nuclear layer ← **Bodies**
  - External limiting membrane
  - segments

RPE
Bruch's membrane

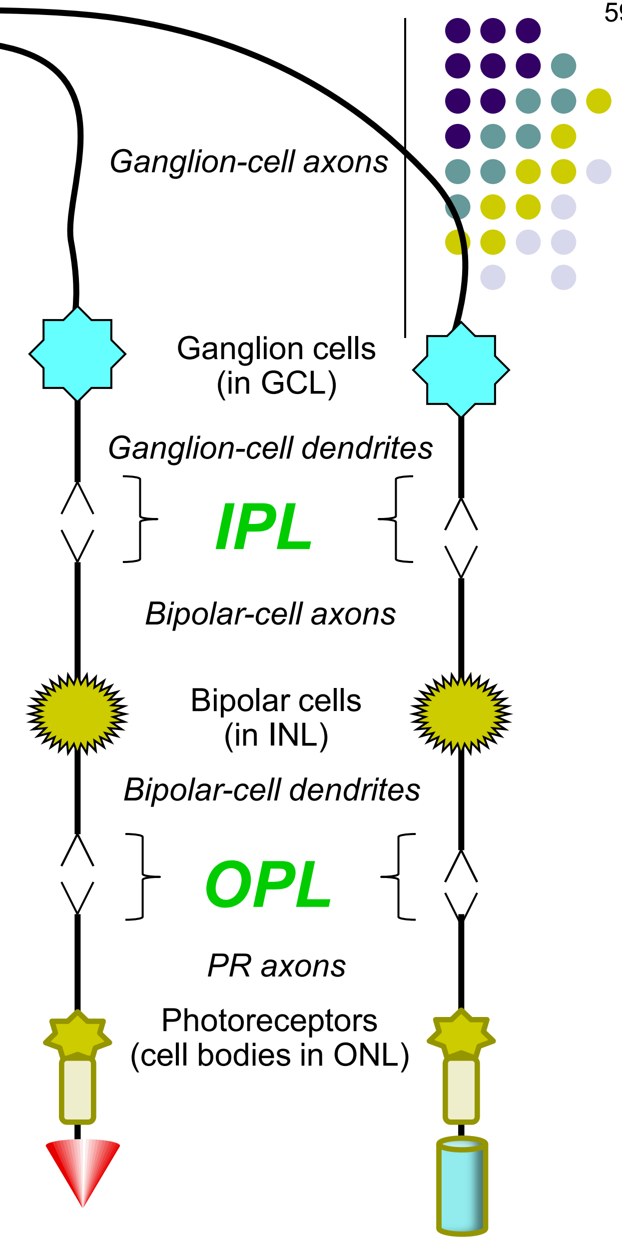


We'll look at the RPE and Bruch's in-depth shortly

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer ← **Processes**
  - Ganglion cell layer ← **Bodies**
  - Inner plexiform layer ← **Processes**
  - Inner nuclear layer ← **Bodies**
  - Outer plexiform layer ← **Processes**
  - Outer nuclear layer ← **Bodies**
  - External limiting membrane

Note that all we've done here is lay out in detail the ***vertical pathway*** discussed earlier

- **Bruch's membrane**



Retinal Anatomy and Histology

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer
  - Ganglion cell layer
  - Inner plexiform layer
  - Inner nuclear layer
  - **Outer plexiform layer = *Henle's layer***

Important aside: The outer plexiform layer is often referred to by an eponym: **Henle's layer**.

- **RPE**
- **Bruch's membrane**

Retinal Anatomy and Histology

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer
  - Ganglion cell layer
  - Inner plexiform layer
  - Inner nuclear layer
  - **Outer plexiform layer = *Henle's layer* *(sort of)***

Important aside: The outer plexiform layer is often referred to by an eponym: **Henle's layer**. However, as we will see when we correlate retinal anatomy with OCT imaging later in the slide-set, these terms are in fact **not** synonyms.

- **RPE**
- **Bruch's membrane**

Retinal Anatomy and Histology

- **Neurosensory Retina Layers**
  - Internal limiting membrane
  - Nerve fiber layer
  - Ganglion cell layer
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- **RPE**
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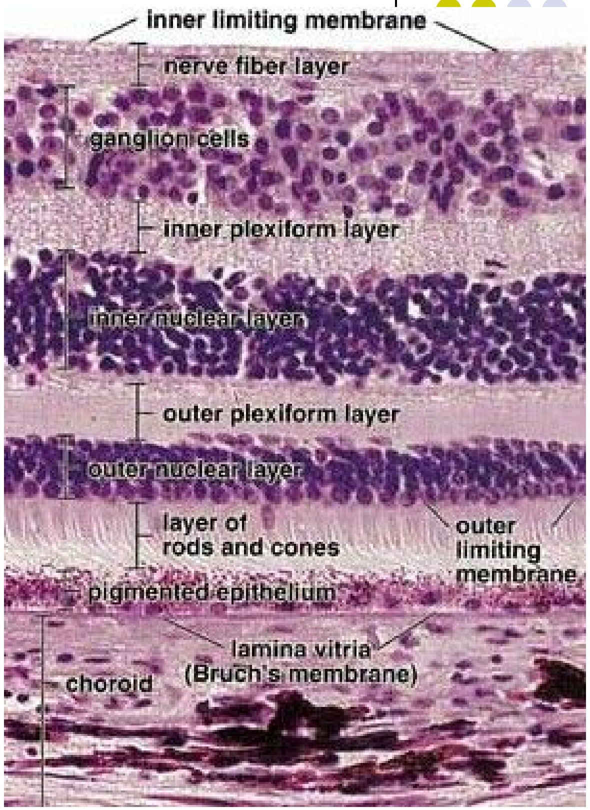


Review slide—no questions

Retinal Anatomy and Histology

macula

Retinal Anatomy and Histology

Now that we're familiar with the histology of the retina, we're ready to tackle the topography of the *macula*

Retinal Anatomy and Histology

- We define the term *macula*…
  - …**anatomically**

    as well as both

  - …**histologically**

    and of course

  - …**clinically**

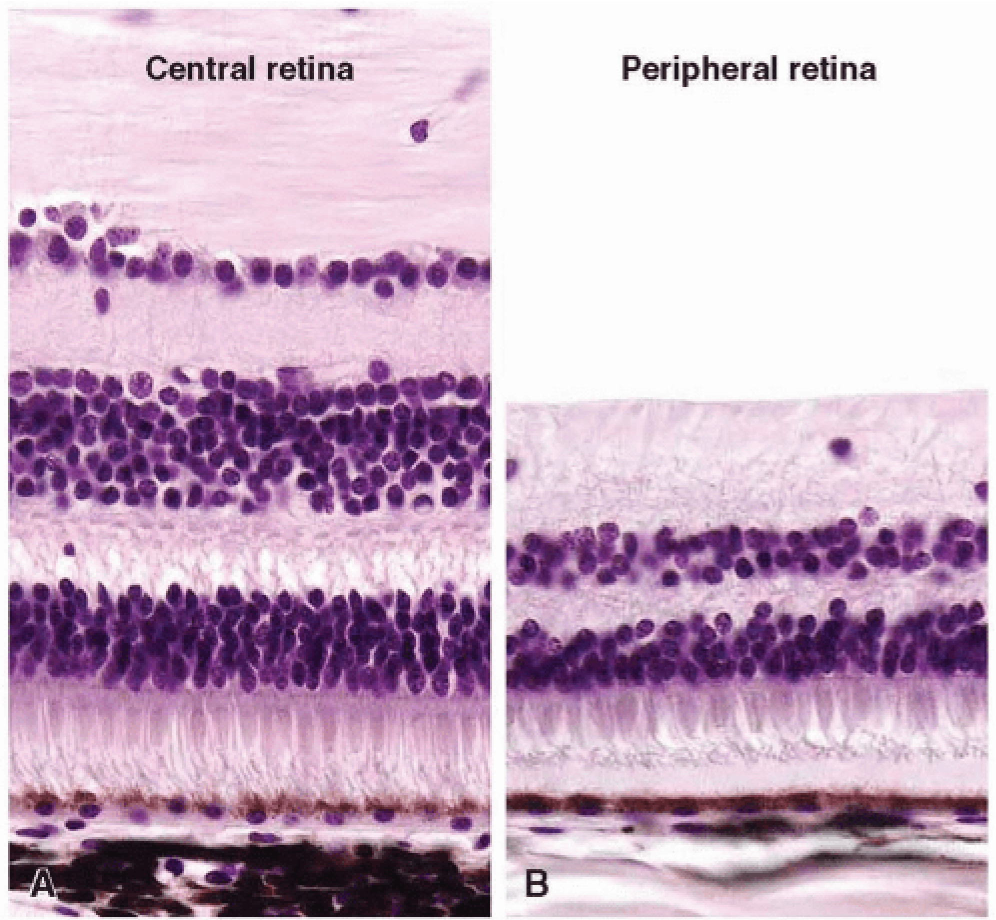
Retinal Anatomy and Histology

- We define the term *macula*…
  - …**anatomically**, it is the retinal area in which the ganglion-cell layer is ≥ 2 cells thick
  - …**histologically**
  - …**clinically**

The latest iteration of the *Retina* book refers to this pigment as "oxygenated carotenoids, in particular lutein and zeaxanthin"

Retinal Anatomy and Histology

GCL ≥2 cells thick



GCL <2 cells thick

Changes in retinal thickness. Two sections through the central (A) and peripheral (B) regions of the retina, aligned at the retinal pigment epithelium. The peripheral retina is thinner and has only rare cell nuclei in the ganglion cell layer (the uppermost layer of nuclei).

Retinal Anatomy and Histology

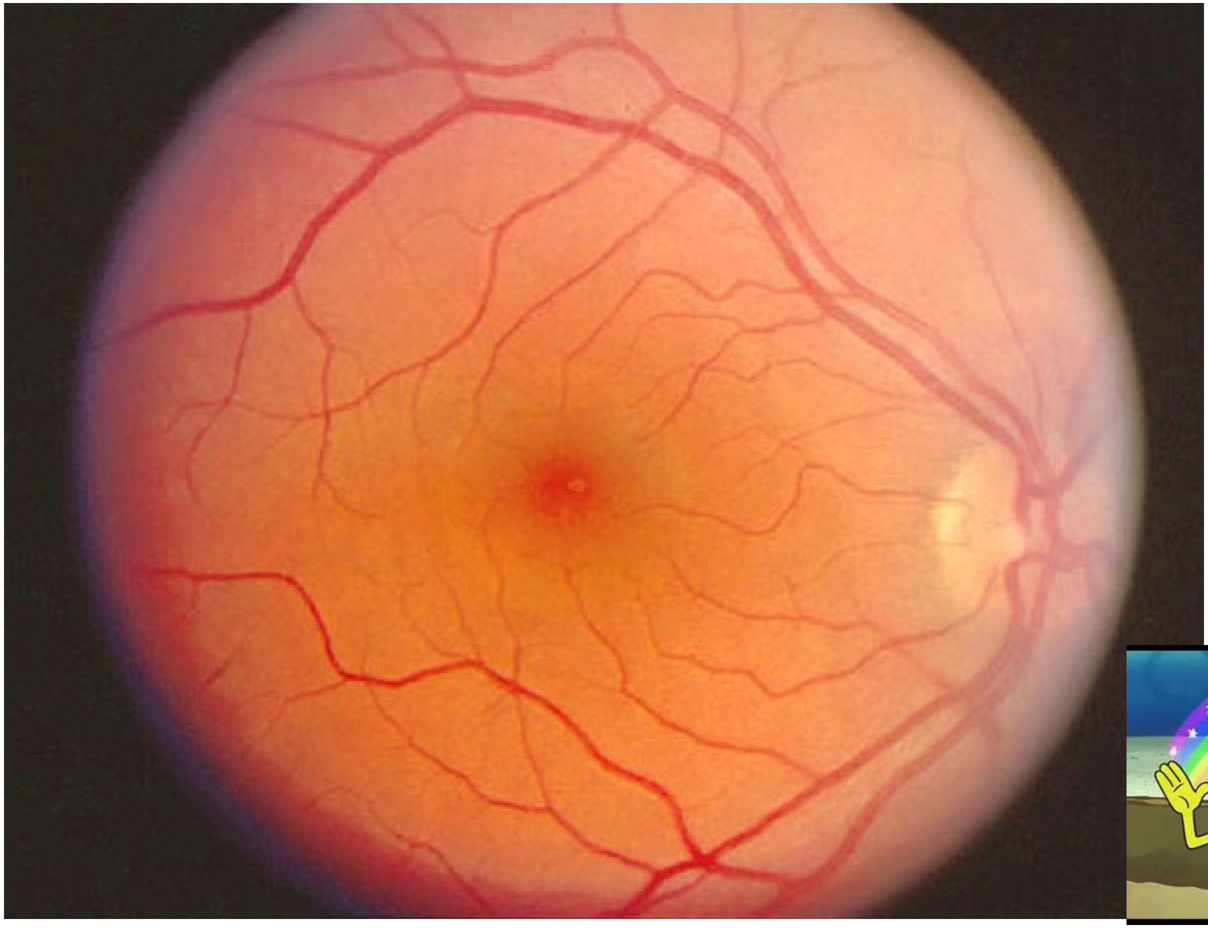
- We define the term *macula*…
  - …**anatomically**, it is the retinal area in which the ganglion-cell layer is ≥ 2 cells thick
  - …**histologically**, it is the retinal area containing xanthophyll pigment
  - …**clinically**

Retinal Anatomy and Histology

- We define the term *macula*…
  - …**anatomically**, it is the retinal area in which the ganglion-cell layer is ≥ 2 cells thick
  - …**histologically**, it is the retinal area containing xanthophyll pigment
  - …**clinically**

Xanthophyll gives the macula a slight yellowish hue (hence the ‘full’ name of the macula being the **macula lutea**)

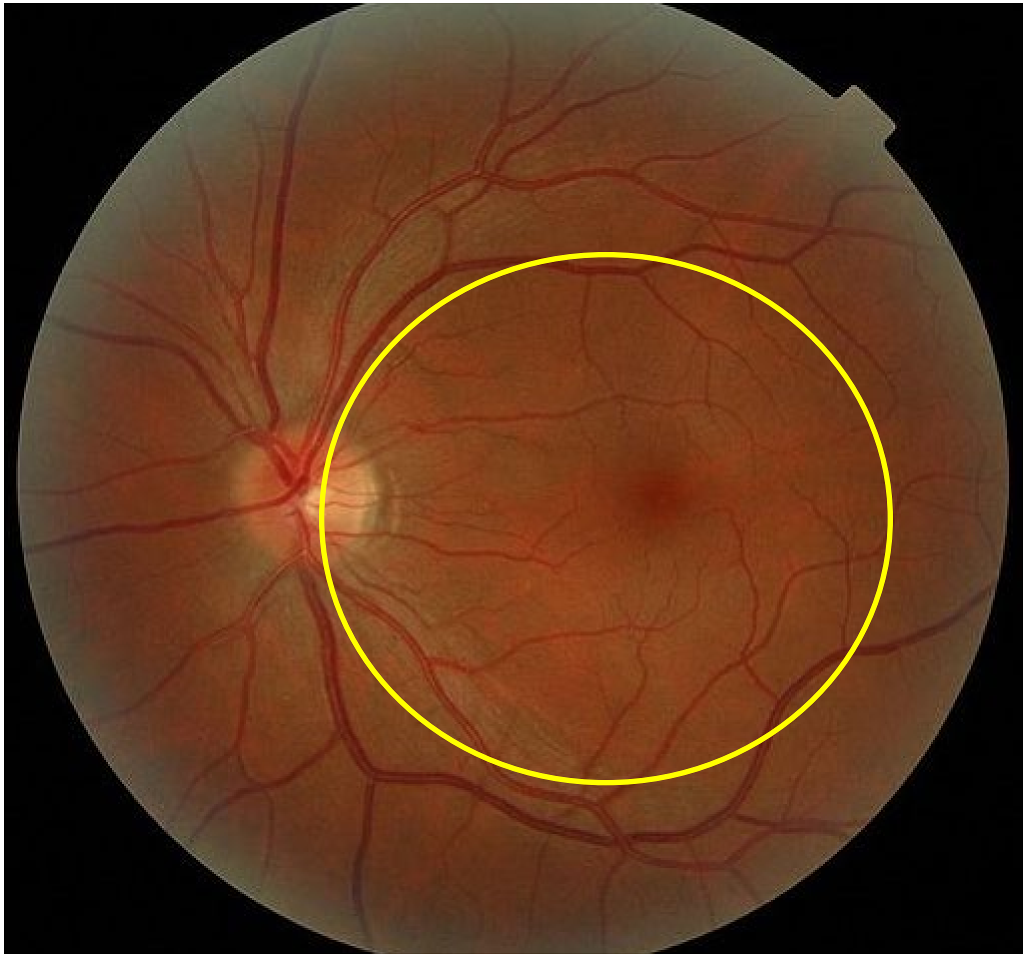
Retinal Anatomy and Histology



Macula lutea If you use your imagination, you can sort of see that the macula has a yellow tint

- We define the term *macula*…
  - …**anatomically**, it is the retinal area in which the ganglion-cell layer is ≥ 2 cells thick
  - …**histologically**, it is the retinal area containing xanthophyll pigment
  - …**clinically**, it is the retinal area bounded by the temporal vascular arcades

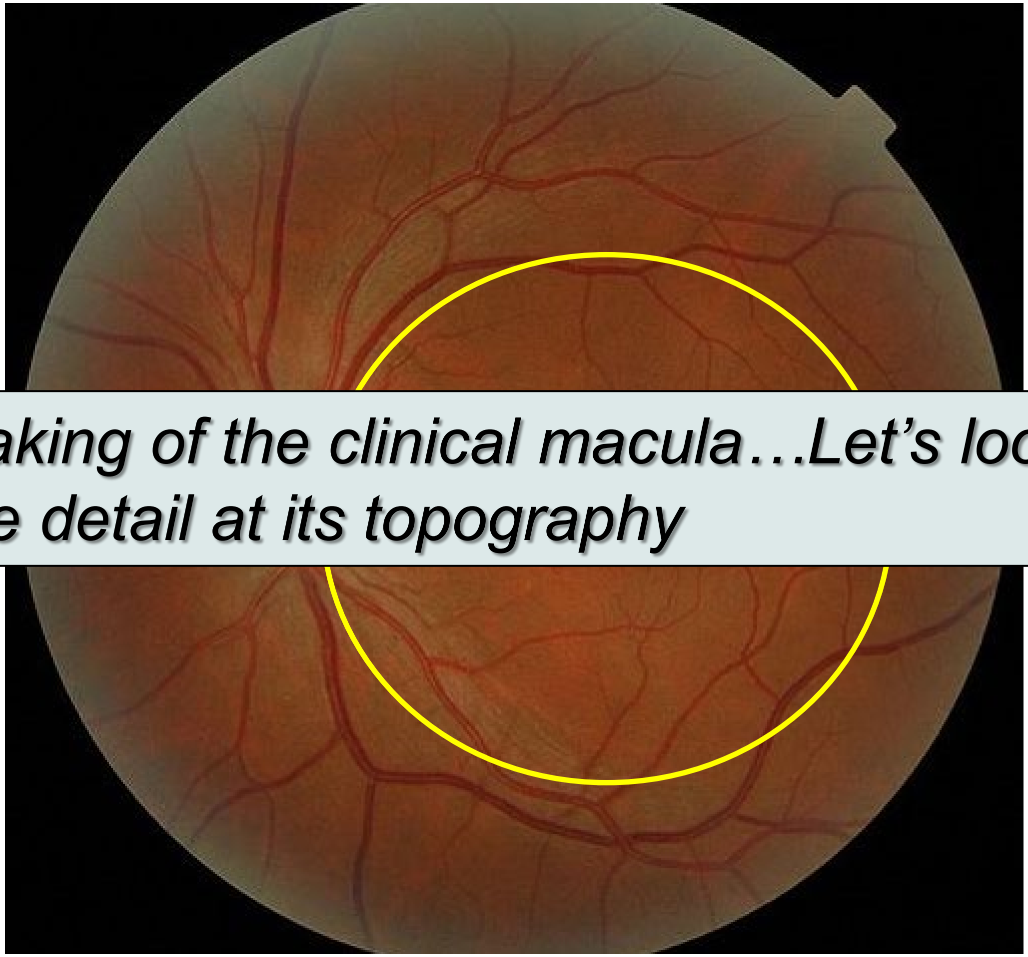
Retinal Anatomy and Histology



The clinical macula

Retinal Anatomy and Histology

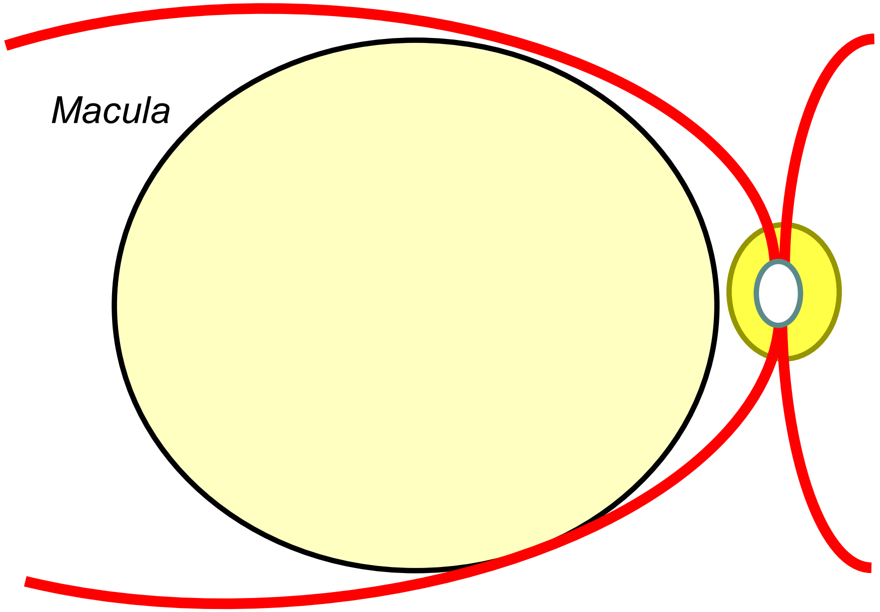
Speaking of the clinical macula…Let's look in some detail at its topography



The clinical macula

Retinal Anatomy and Histology

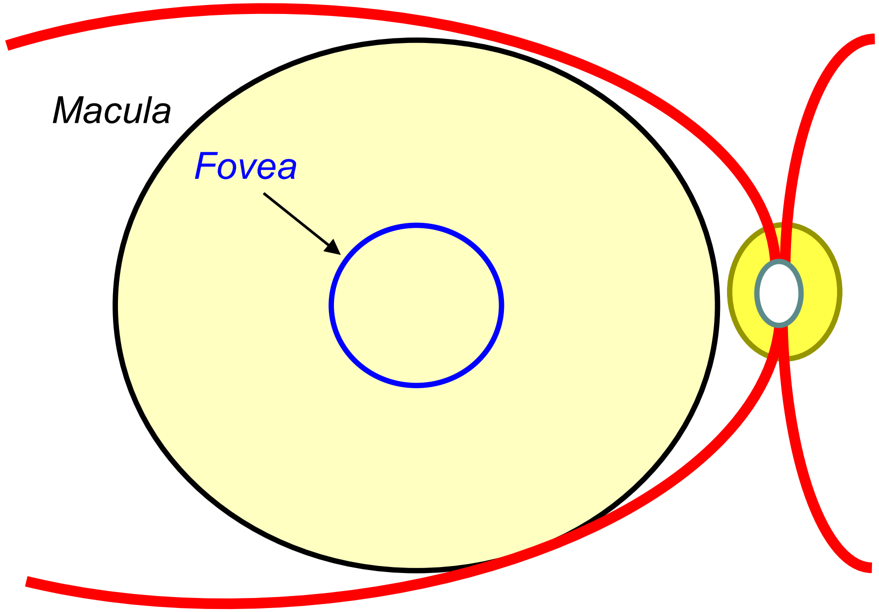
As said previously, the *macula* is defined clinically as the area bounded by the temporal arcades. It has a diameter of 5.5 to 6 mm or so.



Retinal Anatomy and Histology

As said previously, the *macula* is defined clinically as the area bounded by the temporal arcades. It has a diameter of 5.5 to 6 mm or so.

The macula is organized around the *fovea*. The fovea is the central ~1.5 mm of the macula—about the size of an ONH. Its outer edge is the location at which the foveal depression starts. It contains mostly (but not exclusively) cones.



Retinal Anatomy and Histology

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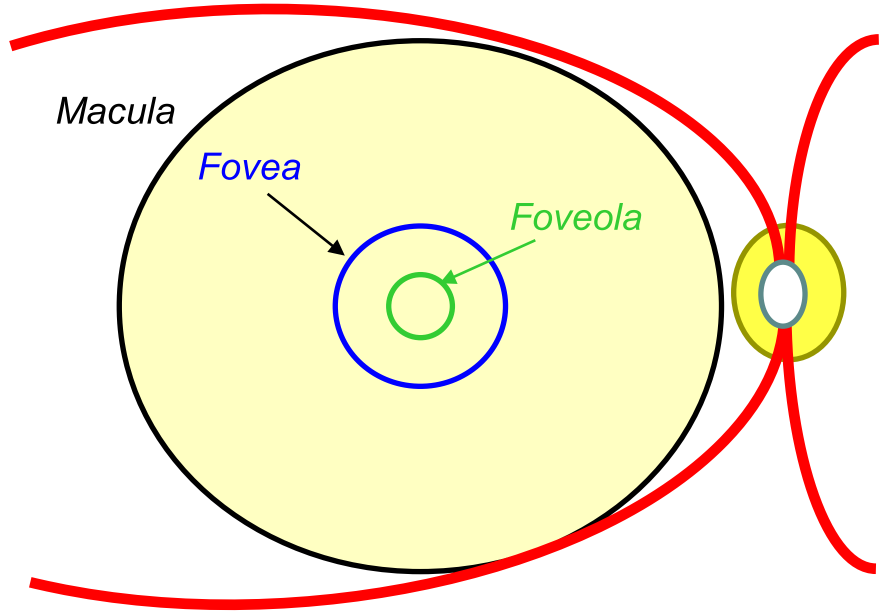
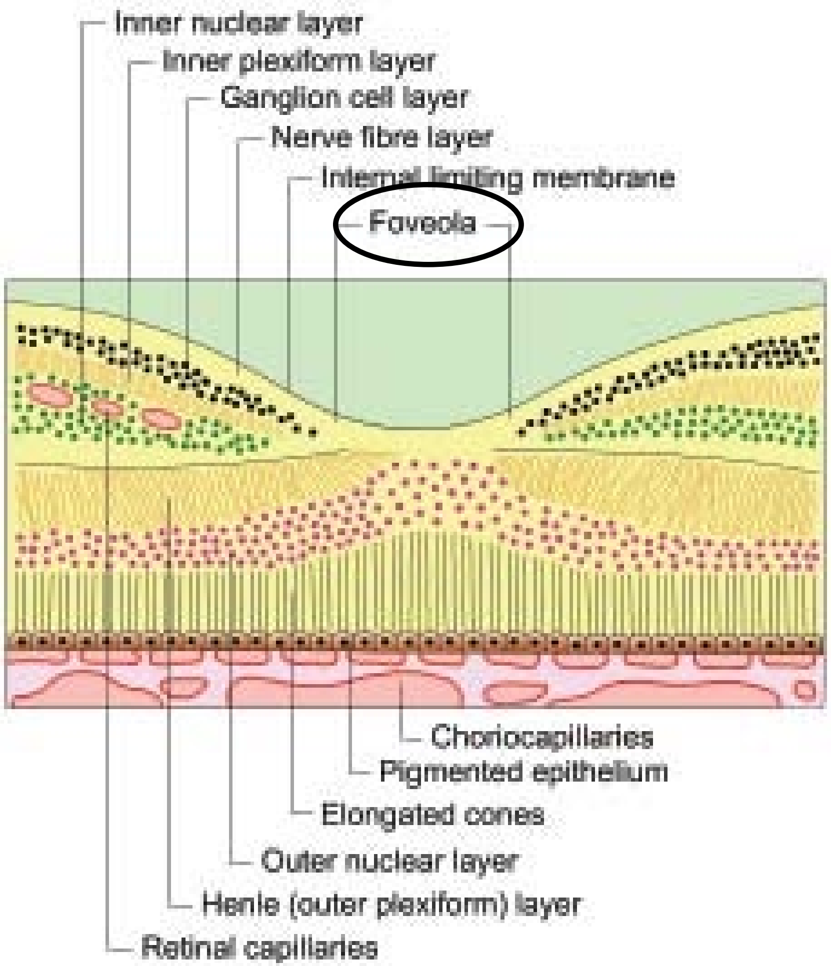


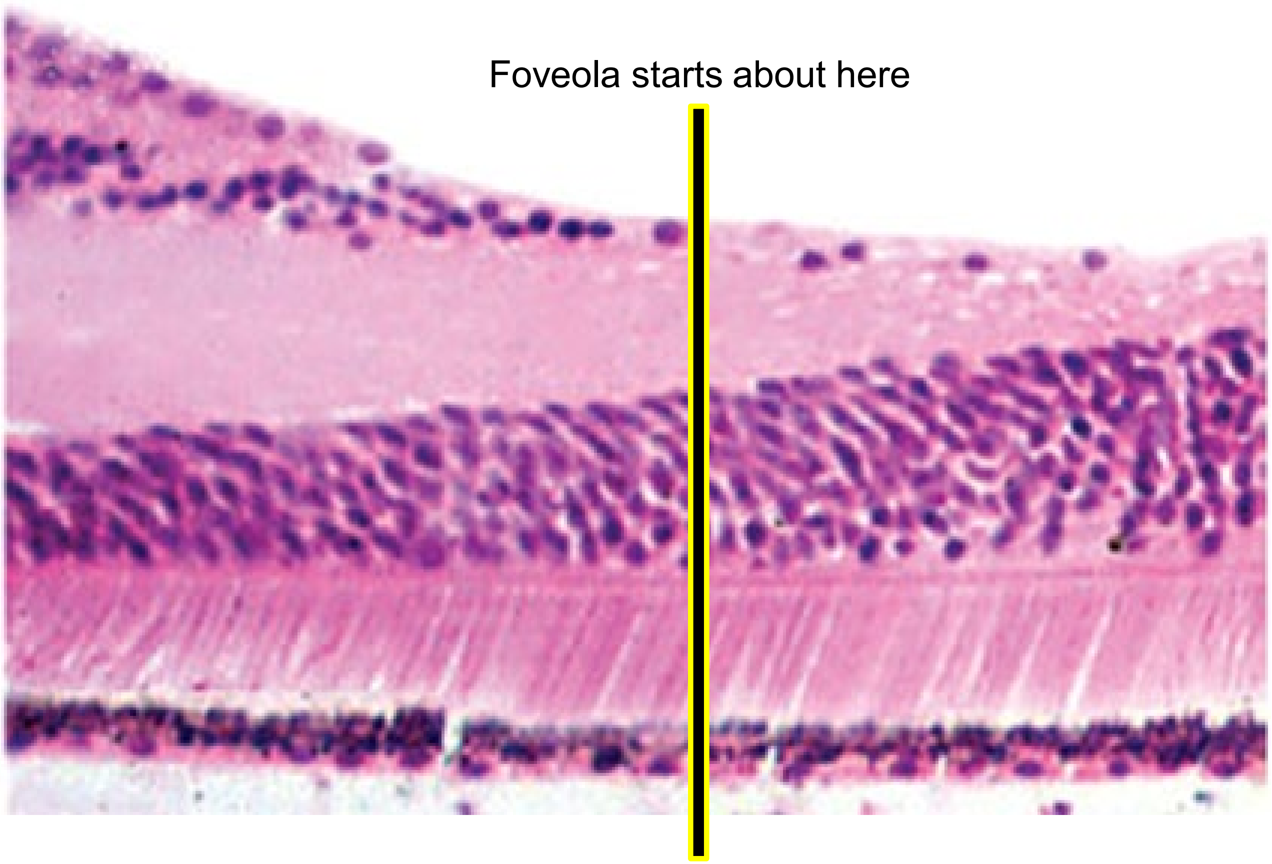
The ‘floor’ of the fovea is the *foveola*, an area ~0.35 mm in diameter—about the size of a small optic-disc cup. The foveola contains only cones and a few glial cells; the rest of the retinal layers were left behind along the walls of the fovea.

Retinal Anatomy and Histology



Foveola

Retinal Anatomy and Histology



Retinal Anatomy and Histology

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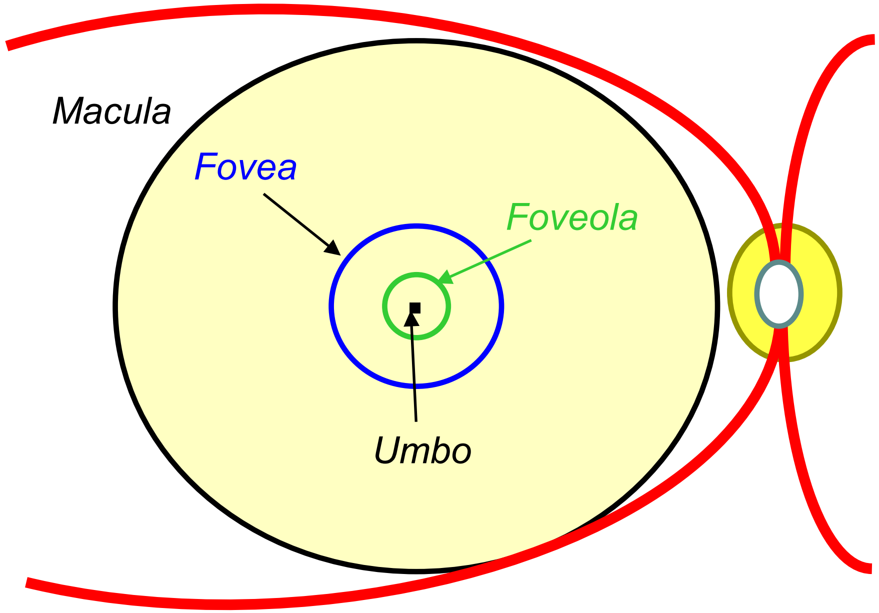

The 'floor' of the fovea is the *foveola*, an area ~0.35 mm in diameter—about the size of a small optic-disc cup. The foveola contains only cones and a few glial cells; the rest of the retinal layers were left behind along the walls of the fovea. Finally, at the very center of the foveola is a small depression called the *umbo*. The outer segs of cones within the umbo are especially tall.

Retinal Anatomy and Histology

As said previously, the *macula* is defined clinically as the area bounded by the temporal arcades. It has a diameter of 5.5 to 6 mm or so.
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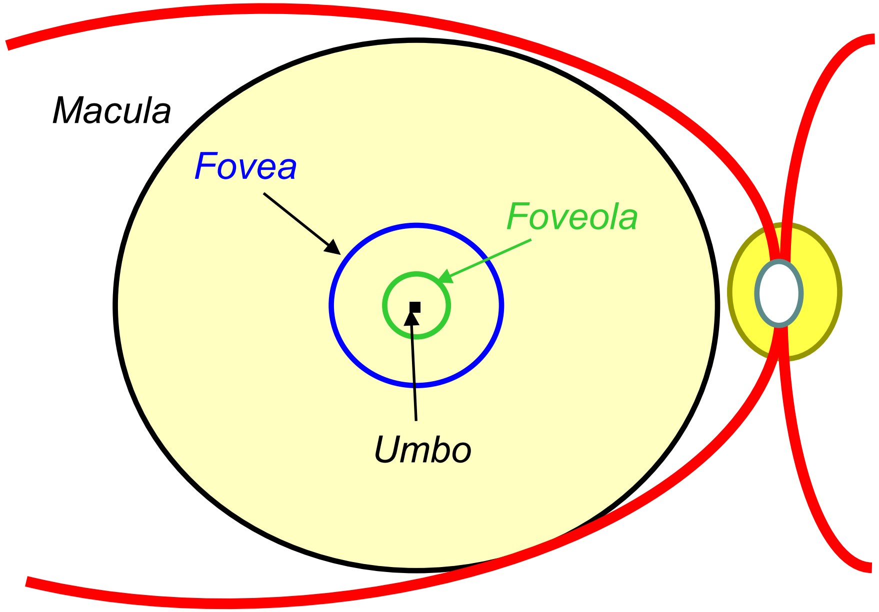
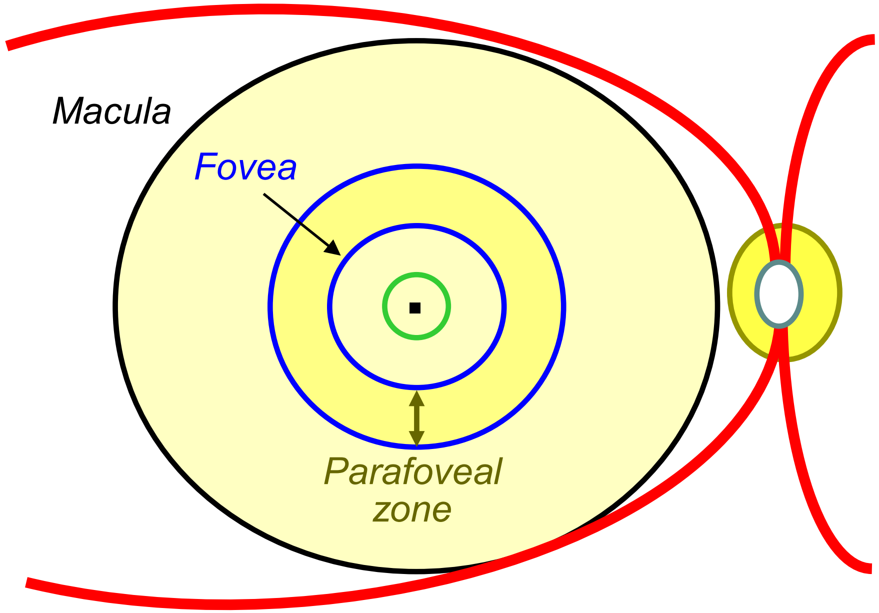


The 'floor' of the fovea is the *foveola*, an area ~0.35 mm in diameter—about the size of a small optic-disc cup. The foveola contains only cones and a few glial cells; the rest of the retinal layers were left behind along the walls of the fovea. Finally, at the very center of the foveola is a small depression called the *umbo*. The outer segs of cones within the umbo are especially tall.

***Next we'll describe the rest of the macula from the fovea* outward**

Retinal Anatomy and Histology

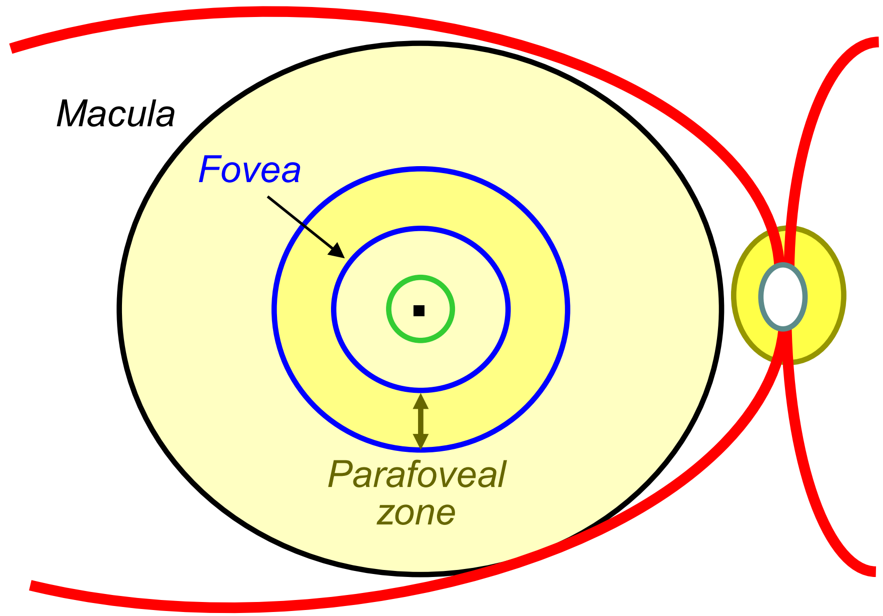


The *parafoveal zone* is the donut-shaped area about 0.5 mm in width that surrounds the fovea. (The inner edge of the donut = the outer edge of the fovea.).

Next we'll describe the rest of the macula from the fovea ***outward***

Retinal Anatomy and Histology

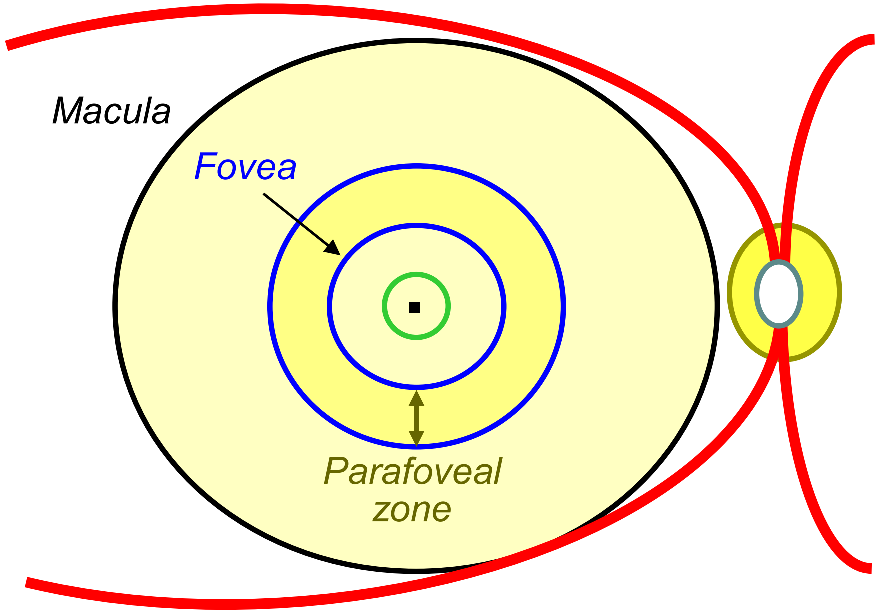
The *parafoveal zone* is the donut-shaped area about 0.5 mm in width that surrounds the fovea. (The inner edge of the donut = the outer edge of the fovea.).



Next we'll describe the rest of the macula from the fovea **outward**

Retinal Anatomy and Histology

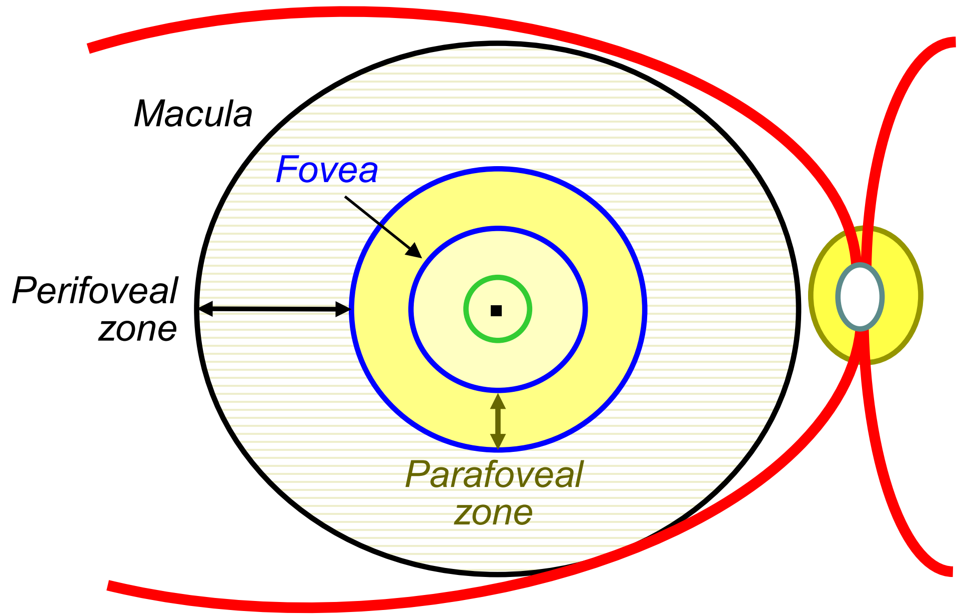
The *parafoveal zone* is the donut-shaped area about 0.5 mm in width that surrounds the fovea. (The inner edge of the donut = the outer edge of the fovea.). The parafoveal zone is where the GCL, INL and OPL are all at their thickest.



Next we'll describe the rest of the macula from the fovea ***outward***

Retinal Anatomy and Histology

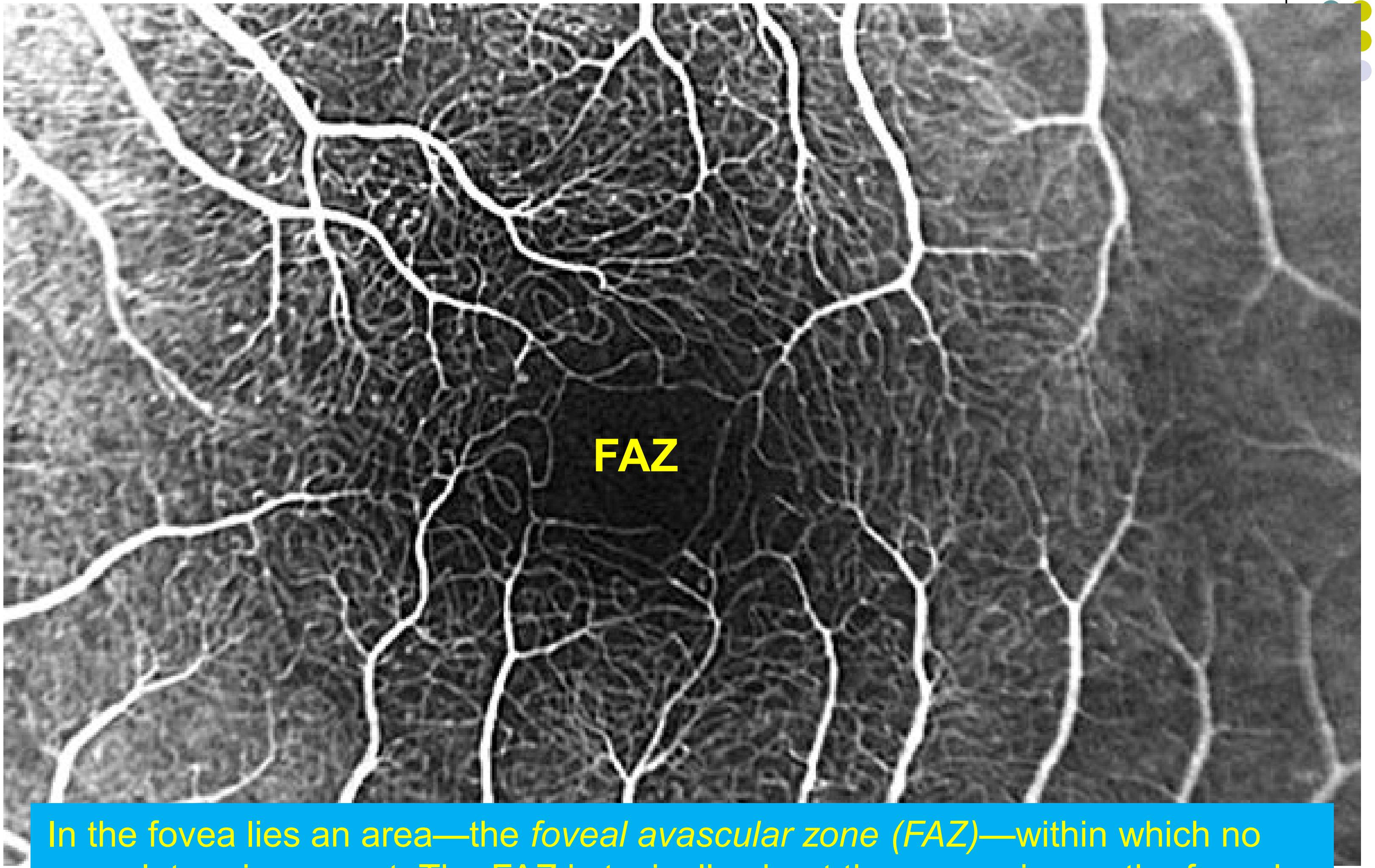
The *parafoveal zone* is the donut-shaped area about 0.5 mm in width that surrounds the fovea. (The inner edge of the donut = the outer edge of the fovea.). The parafoveal zone is where the GCL, INL and OPL are all at their thickest.



The remainder of the clinical macula—ie, the portion beyond the parafoveal zone—is the *perifoveal zone.* It is about 1.5 mm wide.

Next we'll describe the rest of the macula from the fovea ***outward***

Retinal Anatomy and Histology



In the fovea lies an area—the *foveal avascular zone (FAZ)*—within which no vasculature is present. The FAZ is typically about the same size as the foveola, but considerable variability exists among individuals.

Retinal Anatomy and Histology

Next let's look at the retina's blood supplies

Retinal Anatomy and Histology

Blood supply

Blood supply

Blood supply

Blood supply

Blood supply

Blood supply

How many blood supplies does the retina receive?

Blood supply

Blood supply

Blood supply

Blood supply

Blood supply

Blood supply

Blood supply

Retinal Anatomy and Histology

Blood supply

How many blood supplies does the retina receive? Two

Blood supply

Retinal Anatomy and Histology

Blood supply:

Central retinal artery

These are the sources of the retina's two blood supplies

Blood supply:

Choriocapillaris

Retinal Anatomy and Histology

- **Retinal Layers**
  - Internal limiting membrane
  - Nerve fiber layer
  - Ganglion cell layer
  - Inner plexiform layer
  - Inner nuclear layer
  - Outer plexiform layer
  - Outer nuclear layer
  - External limiting membrane
  - Rod & cone inner and outer segments
- **RPE**
- **Bruch's membrane**

Inner 2/3 of INL on in

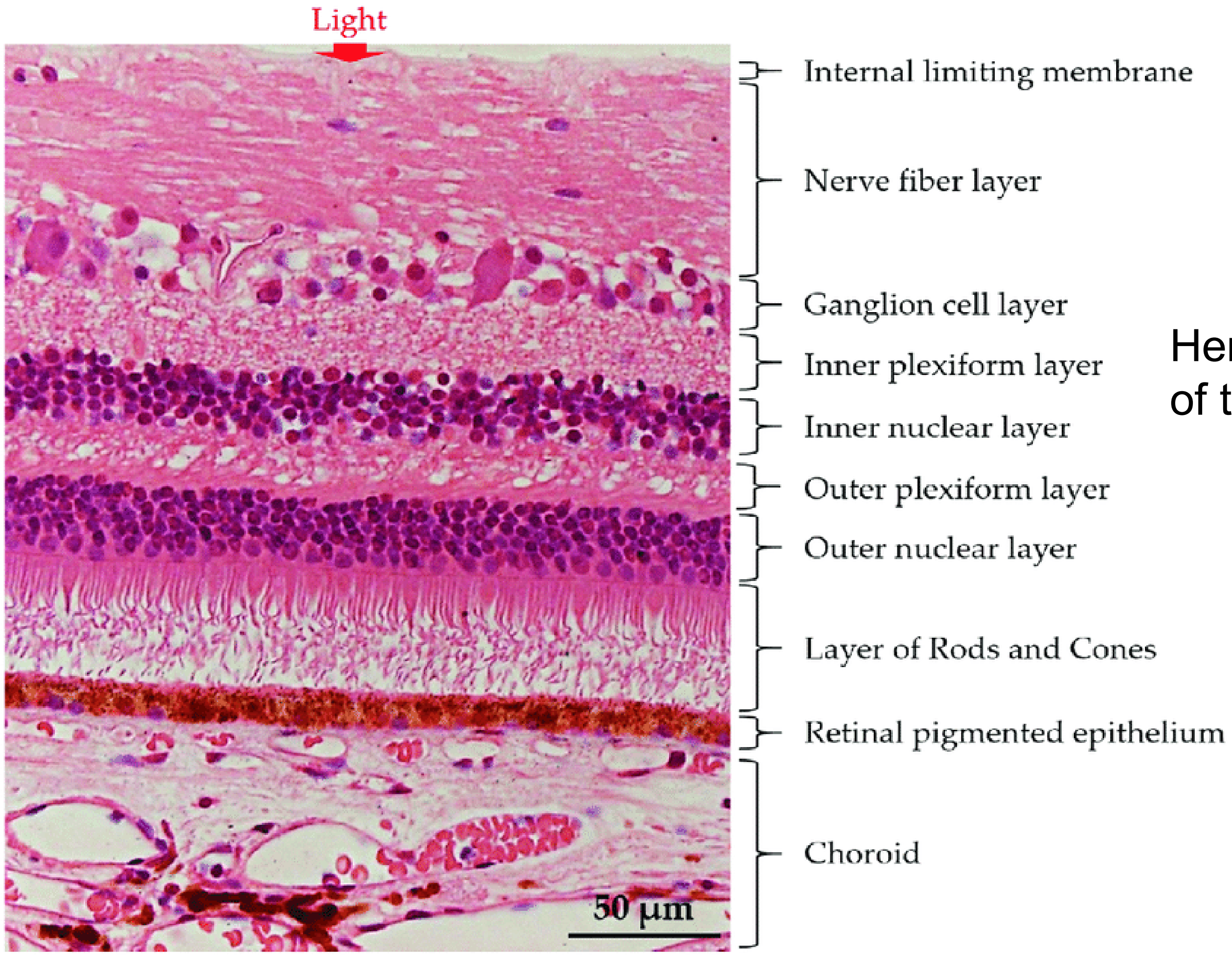
Outer 1/3 of INL on out

Blood supply:
Central retinal artery

These are the layers supplied by each source

Blood supply:
Choriocapillaris

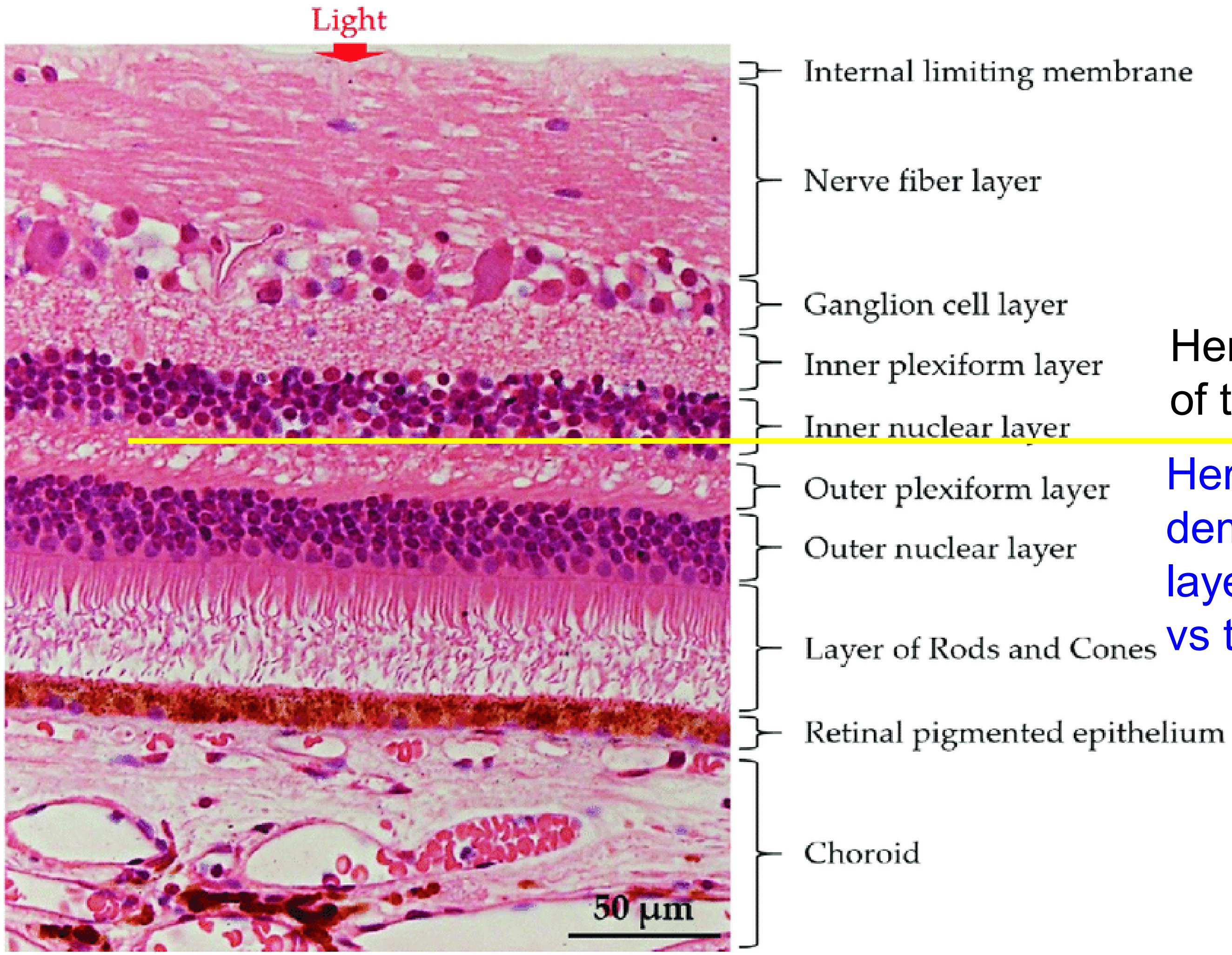
Retinal Anatomy and Histology



Here is a photomicrograph of the normal human retina

(No question—proceed when ready)

Retinal Anatomy and Histology

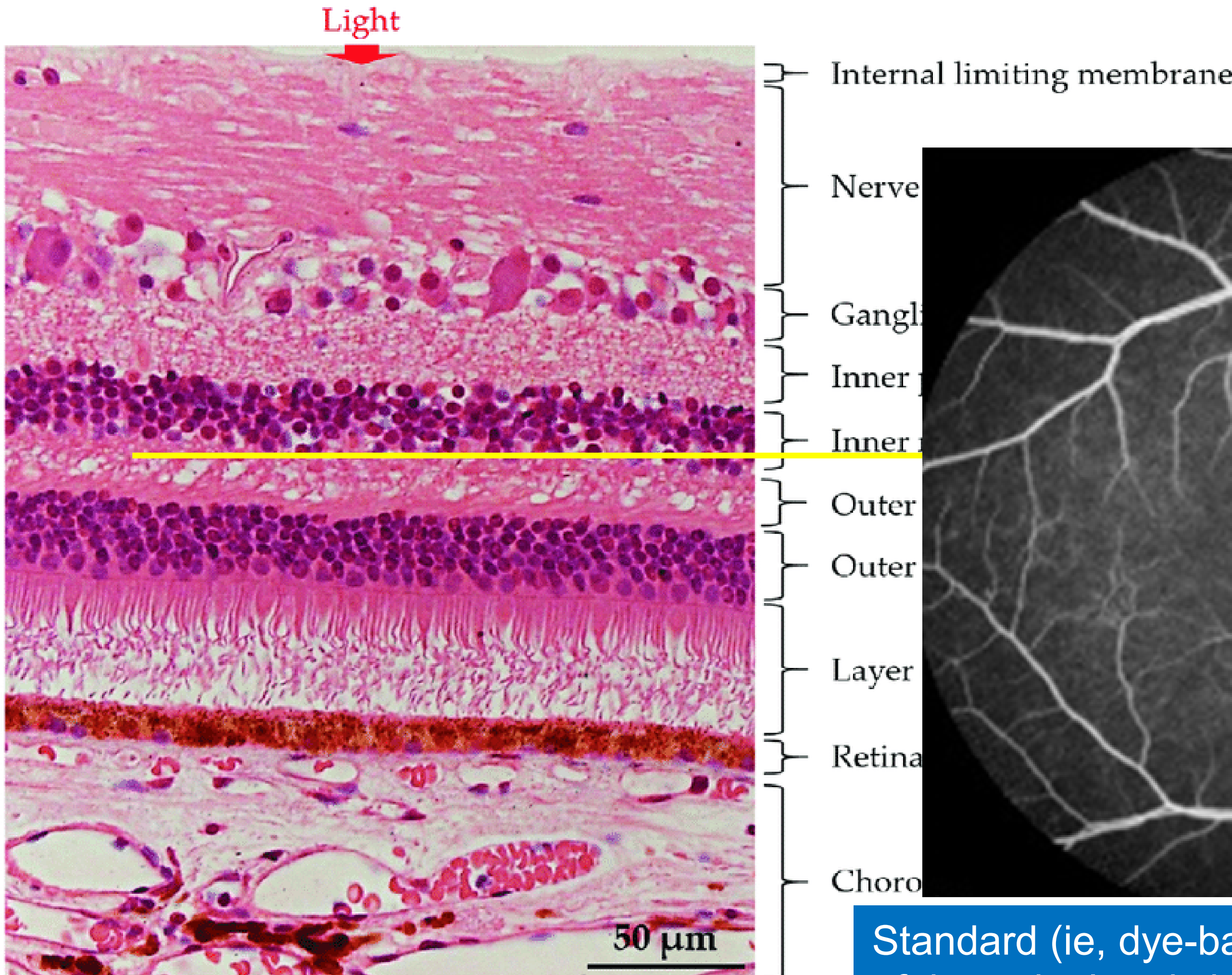


Here is a photomicrograph of the normal human retina

Here, approximately, is the demarcation between the layers perfused by the CRA vs the choriocapillaris

(No question—proceed when ready)

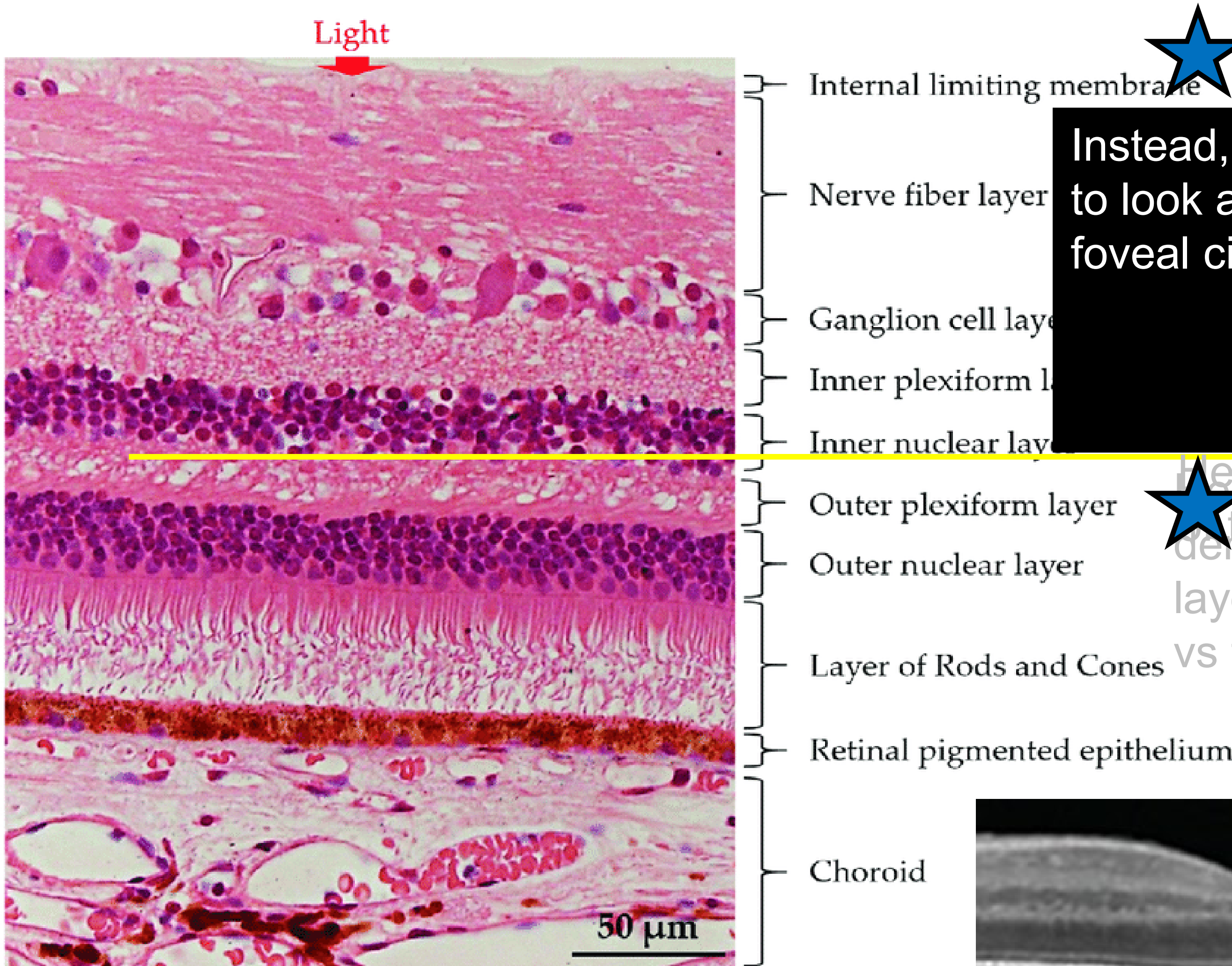
Retinal Anatomy and Histology



Standard (ie, dye-based) FA allows visualization of the retinal and choroidal vasculatures, but the layers are all superimposed upon one another, making it impossible to distinguish among them

(No question—proceed when ready)

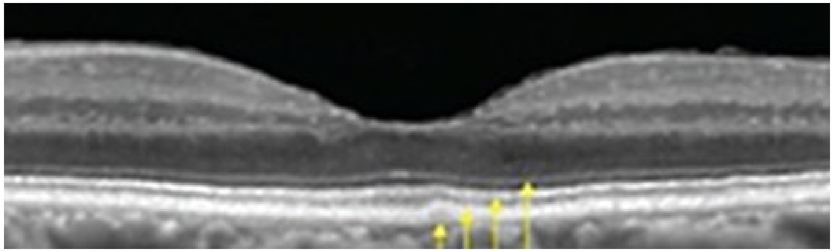
Retinal Anatomy and Histology



Instead, let's use *en face* OCTA to look at the ultrastructure of foveal circulation.

Here is a photomicrograph

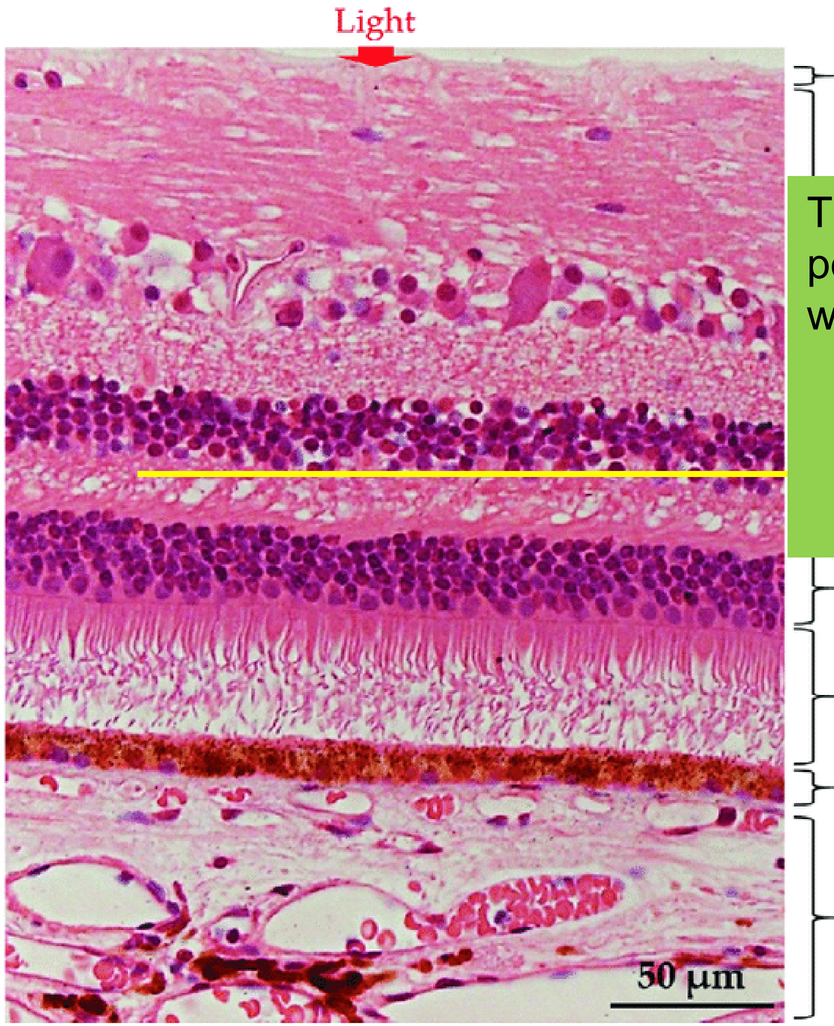
layers perfused by the CRA vs the choriocapillaris



Optical coherence tomography (OCT) through the fovea (cross-sectional, not *en face*)

(No question—proceed when ready)

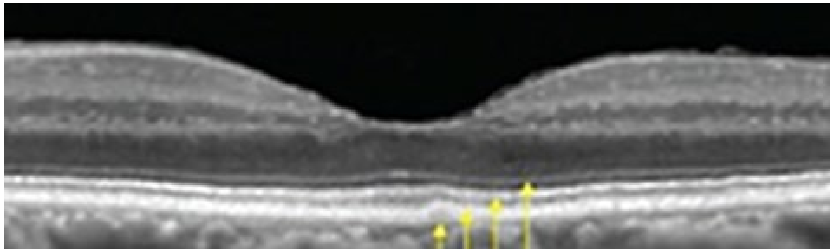
Retinal Anatomy and Histology



Instead, let's use *en face* OCTA

The **A** in OCTA stand for 'angiography.' OCTA makes possible the visualization of the retinal vasculature without the need for intravascular dye as in FA

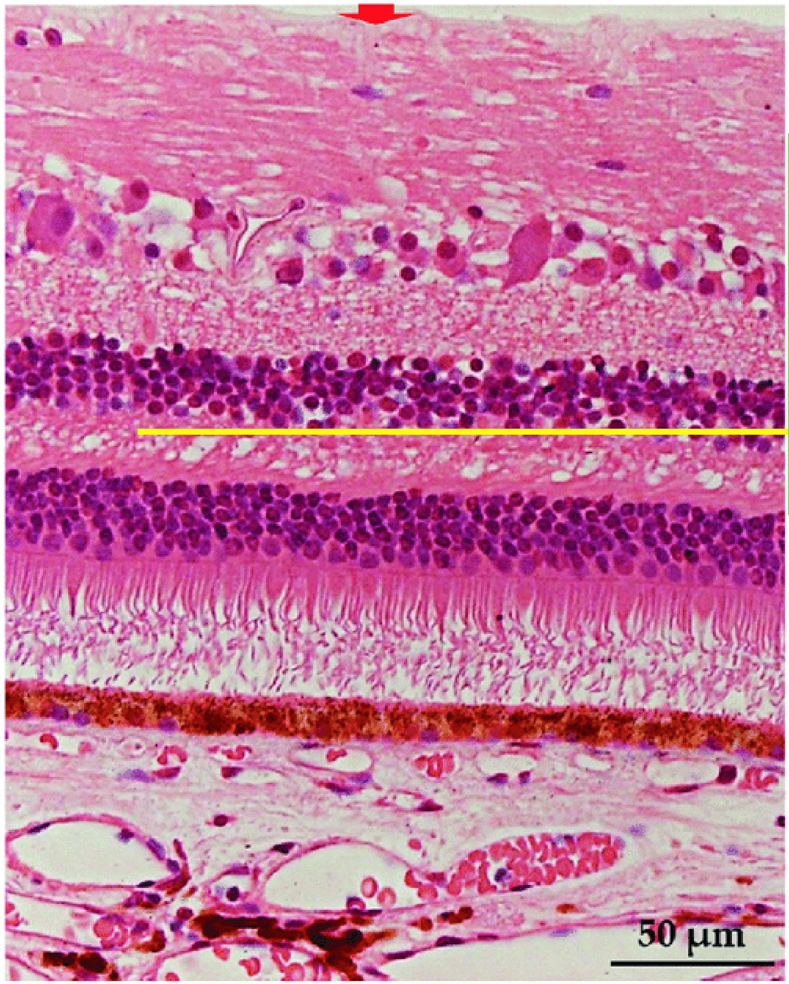
demarcation between the layers perfused by the CRA vs the choriocapillaris



Optical coherence tomography (OCT) through the fovea (cross-sectional, not *en face*)

(No question—proceed when ready)

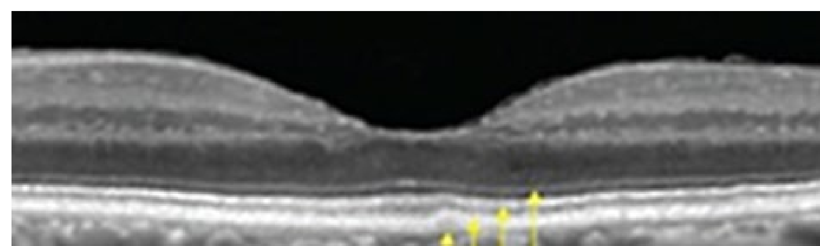
Retinal Anatomy and Histology



Instead, let's use *en face* OCTA

The **A** in OCTA stand for 'angiography.' OCTA makes possible the visualization of the retinal vasculature without the need for intravascular dye as in FA. Further, en face OCTA not only allows us to see the vasculature, it allows us to 'slice' and inspect it layer by layer—something that cannot be done via conventional FA.

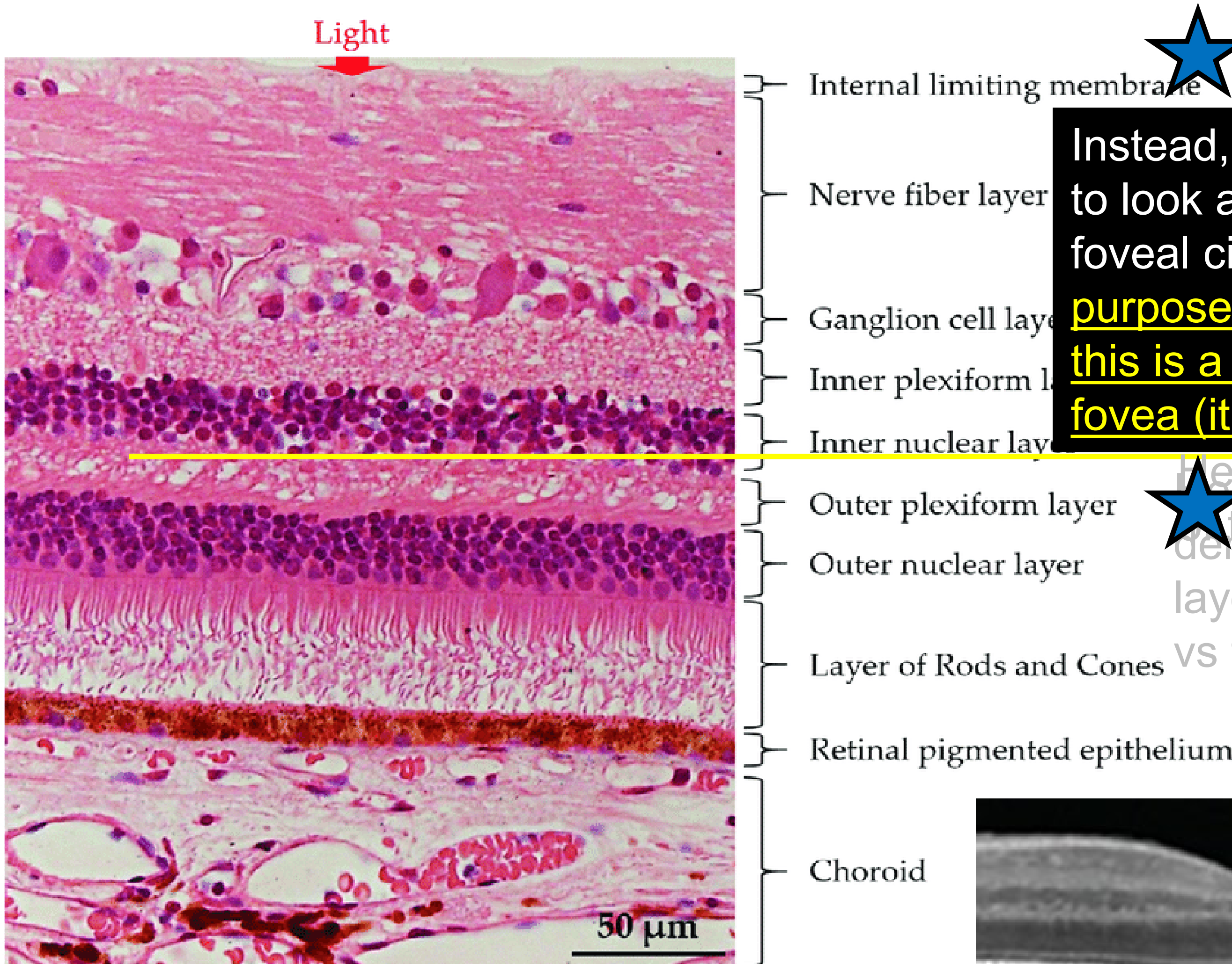
demarcation between the layers perfused by the CRA vs the choriocapillaris



Optical coherence tomography (OCT) through the fovea (cross-sectional, not *en face*)

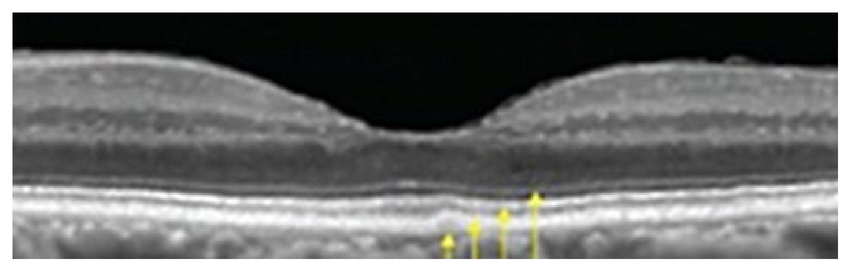
(No question—proceed when ready)

Retinal Anatomy and Histology



Instead, let's use *en face* OCTA to look at the ultrastructure of foveal circulation. For illustration purposes, we're gonna pretend this is a photomicrograph of the fovea (it's not).

Here is a photomicrograph ... of the normal human retina ... demarcation between the layers perfused by the CRA vs the choriocapillaris

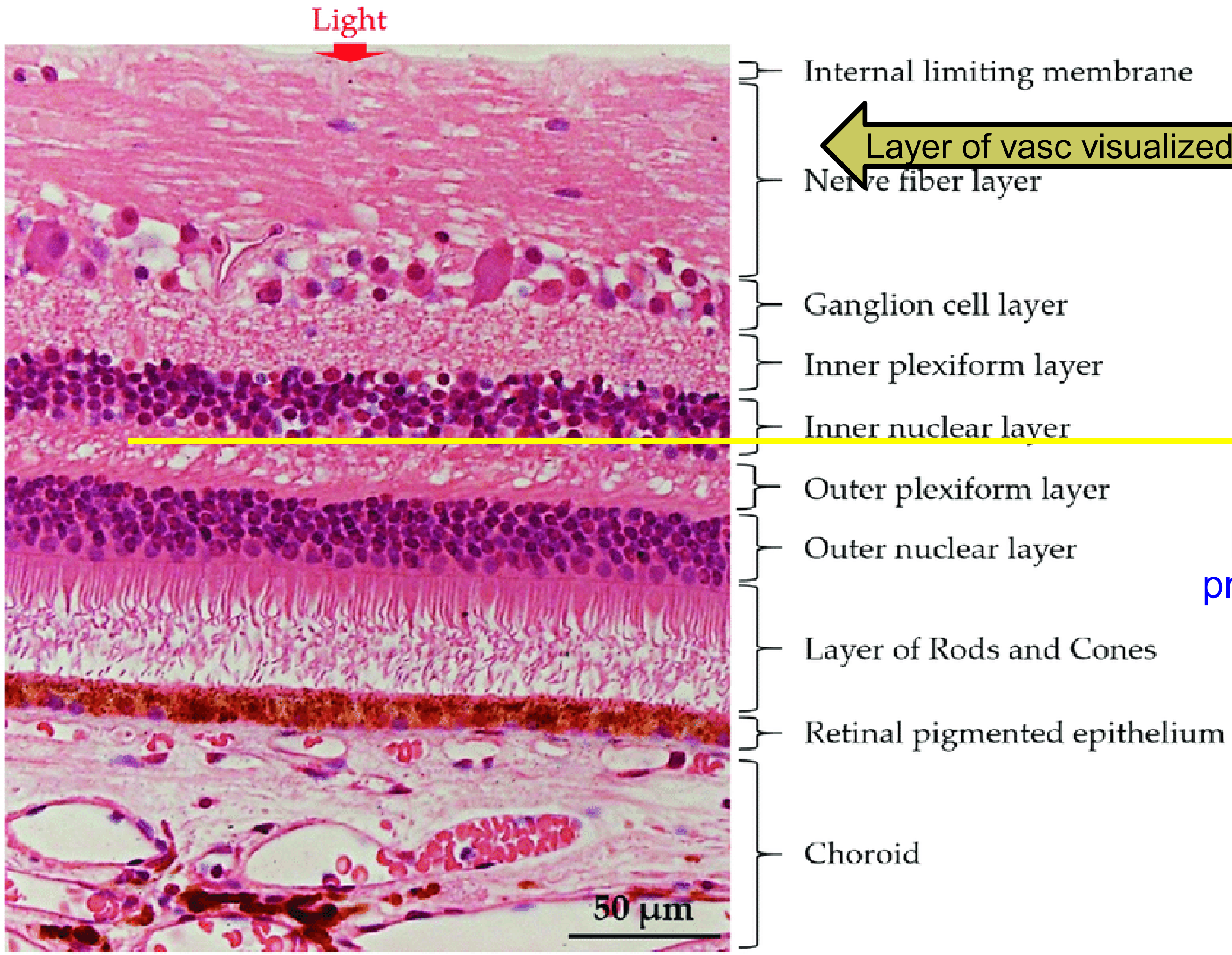


Optical coherence tomography (OCT) through the fovea (cross-sectional, not *en face*)

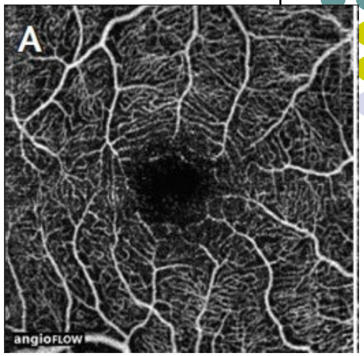
(No question—proceed when ready)

Retinal Anatomy and Histology

En face OCTA



Layer of vasc visualized

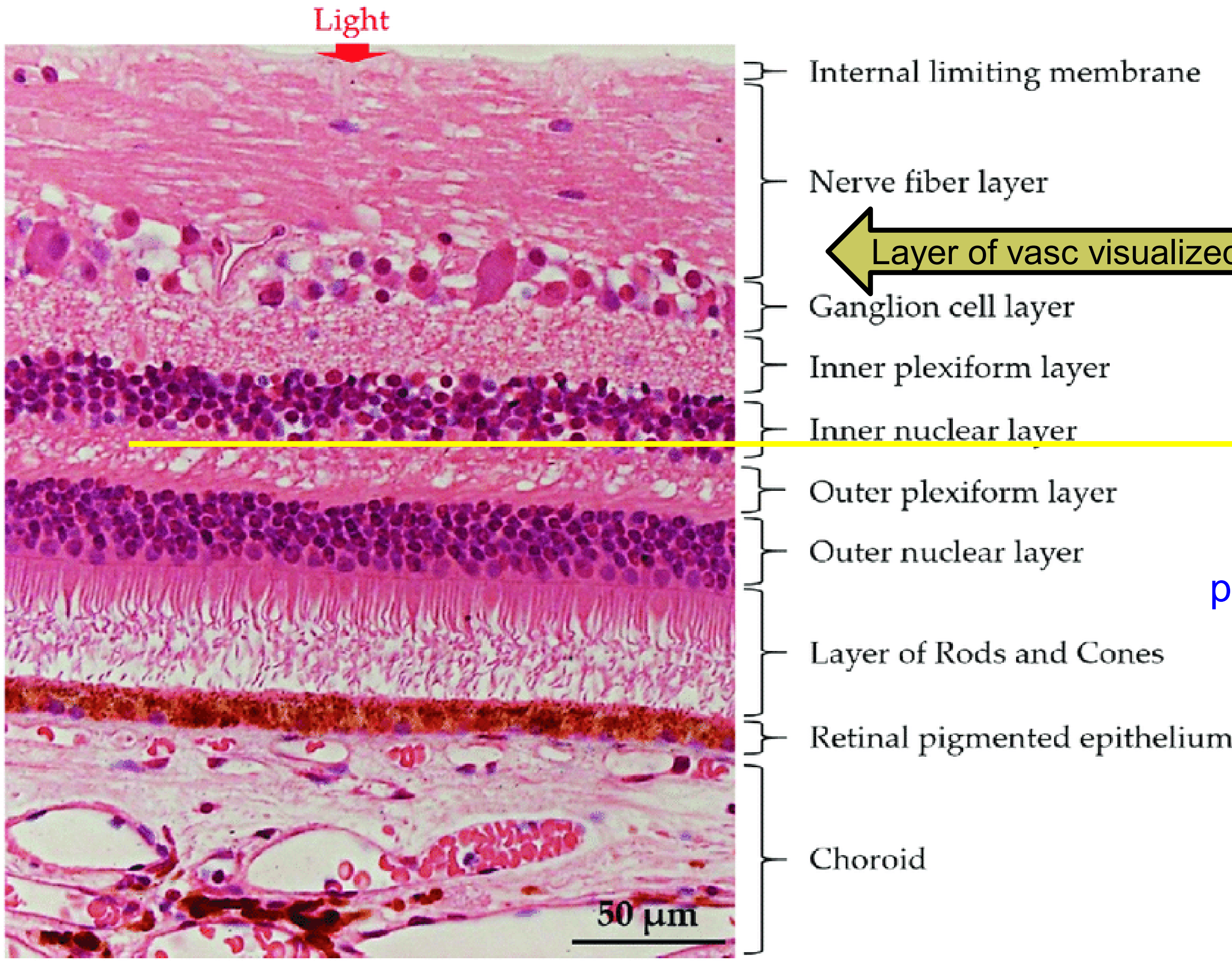


Pics ***A***, *B* and *C* depict the parafoveal vasculature as we progress deeper into the retina

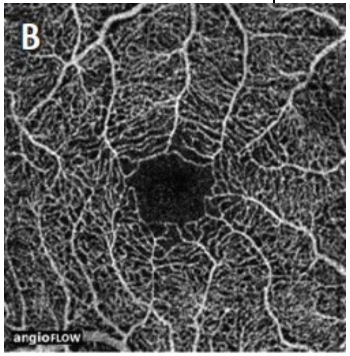
(No question—proceed when ready)

Retinal Anatomy and Histology

En face OCTA



Layer of vasc visualized

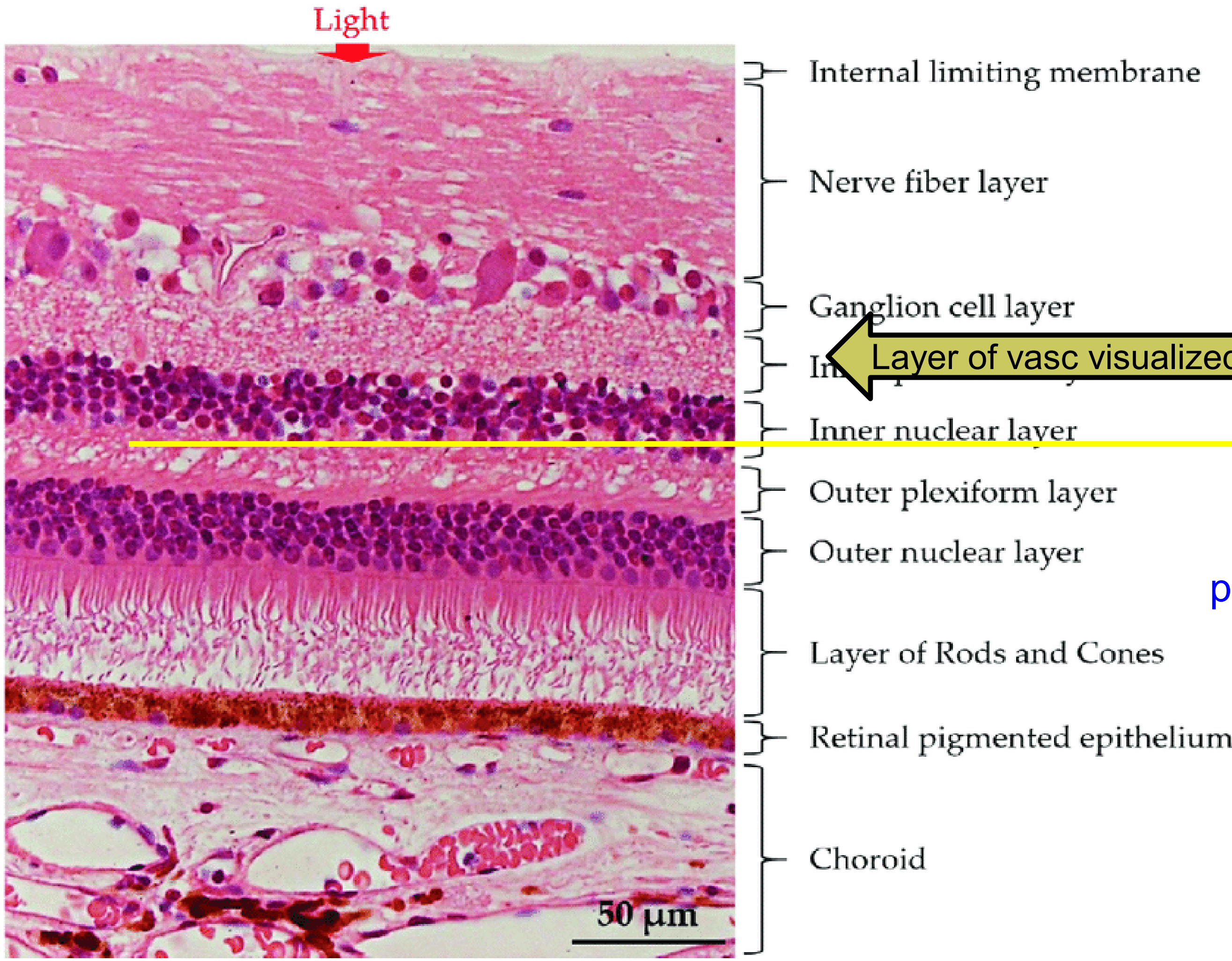


Pics *A*, ***B*** and *C* depict the parafoveal vasculature as we progress deeper into the retina

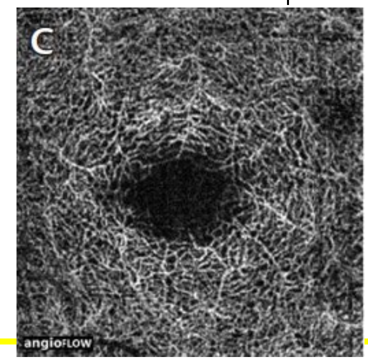
(No question—proceed when ready)

Retinal Anatomy and Histology

En face OCTA



Layer of vasc visualized

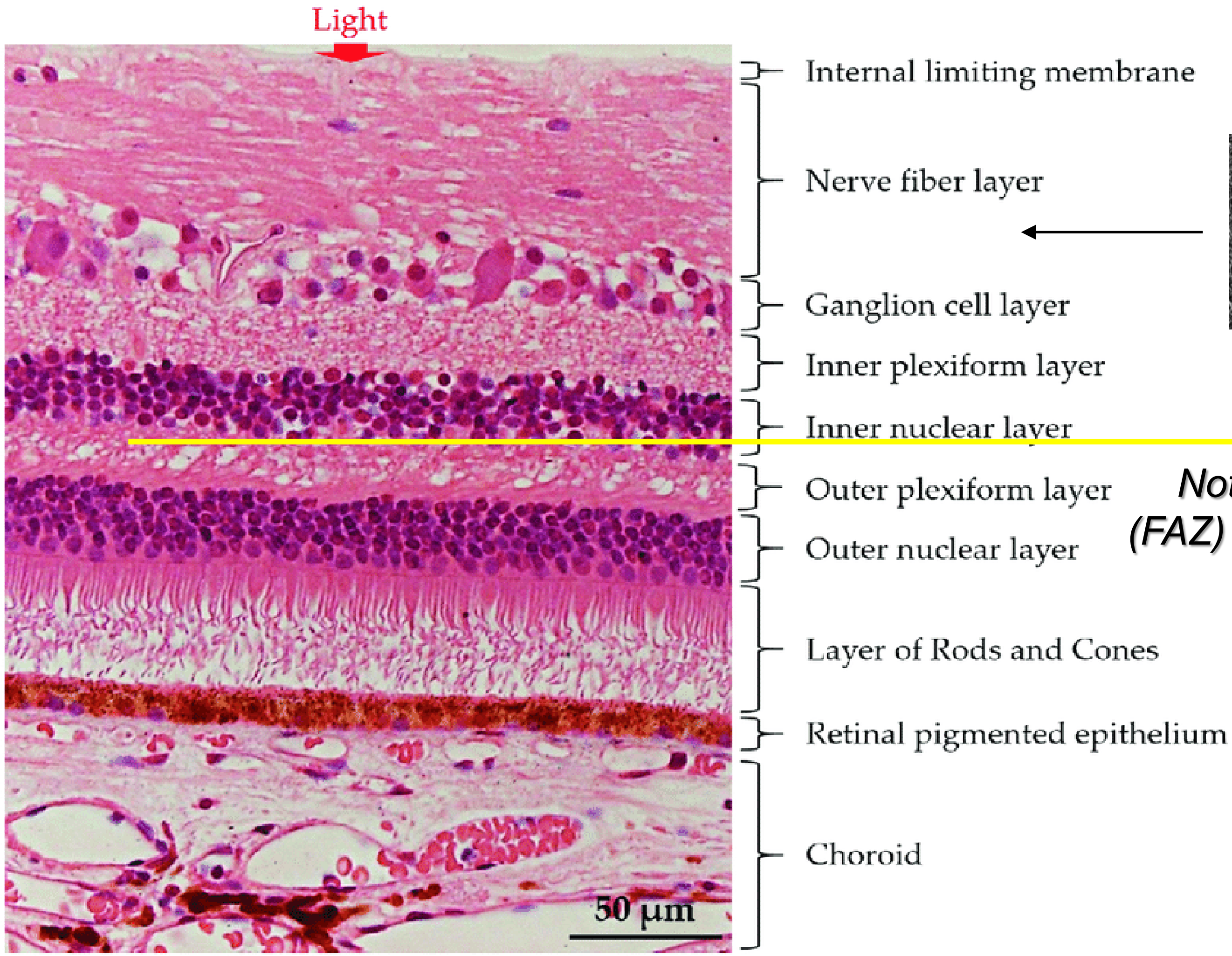


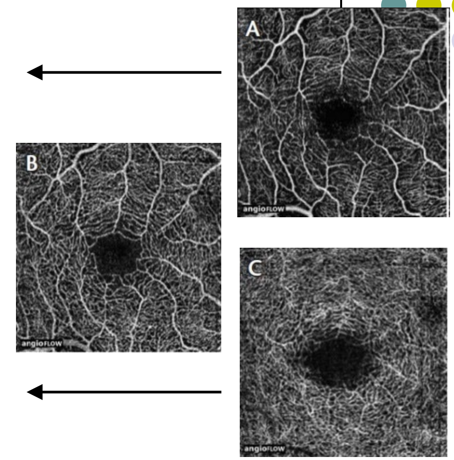
Pics *A*, *B* and ***C*** depict the parafoveal vasculature as we progress deeper into the retina

(No question—proceed when ready)

Retinal Anatomy and Histology

En face OCTA



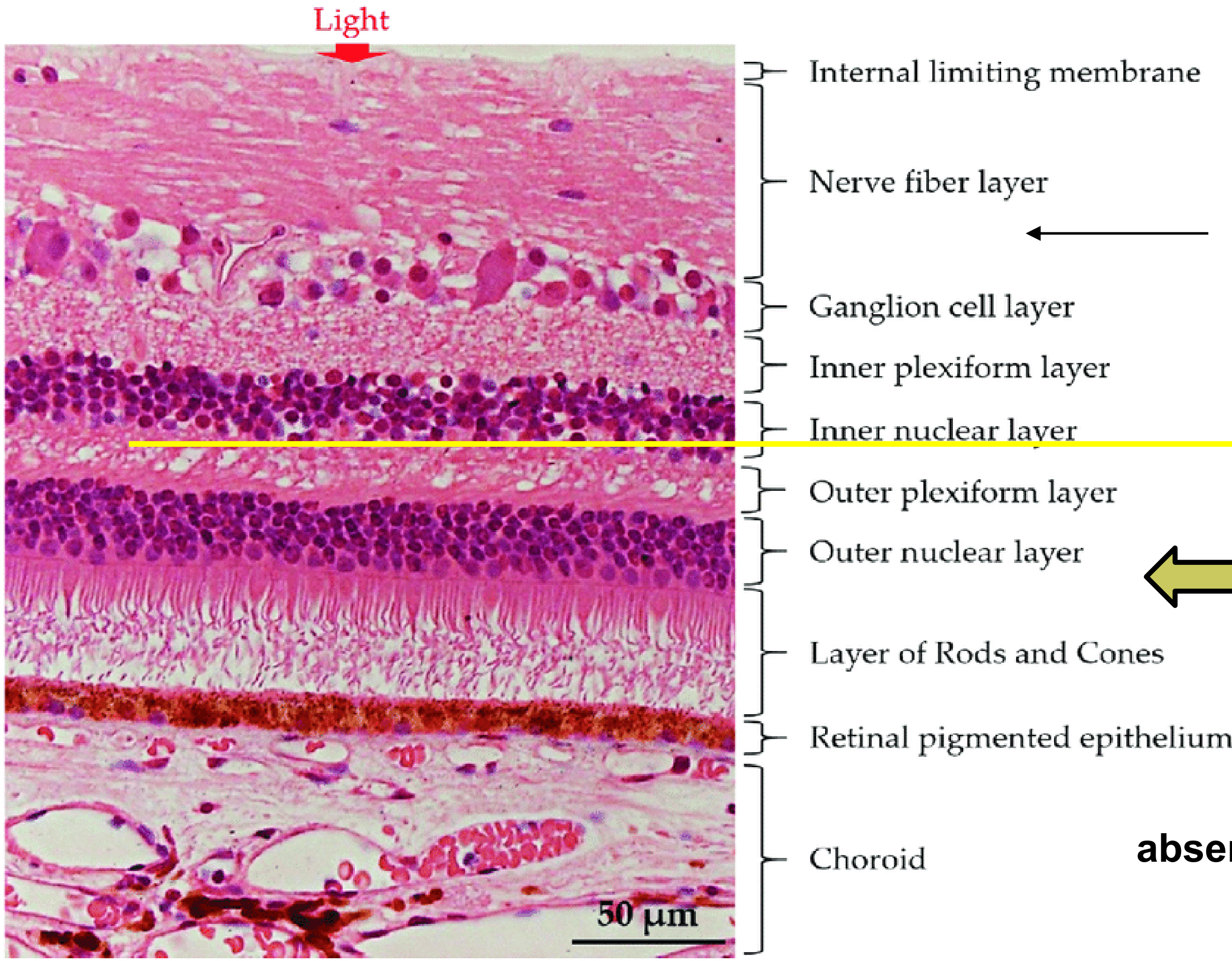


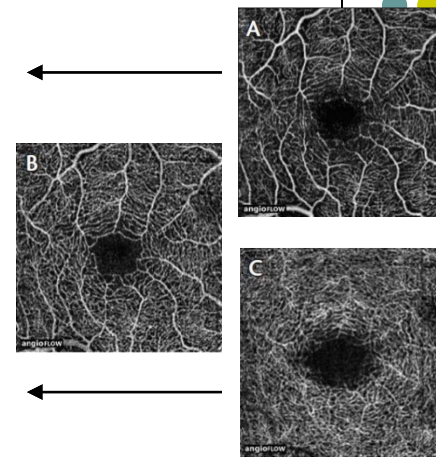
Note the foveal avascular zone (FAZ) is present in all three layers

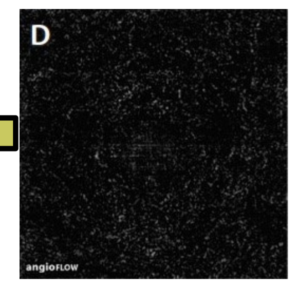
(No question—proceed when ready)

Retinal Anatomy and Histology

En face OCTA





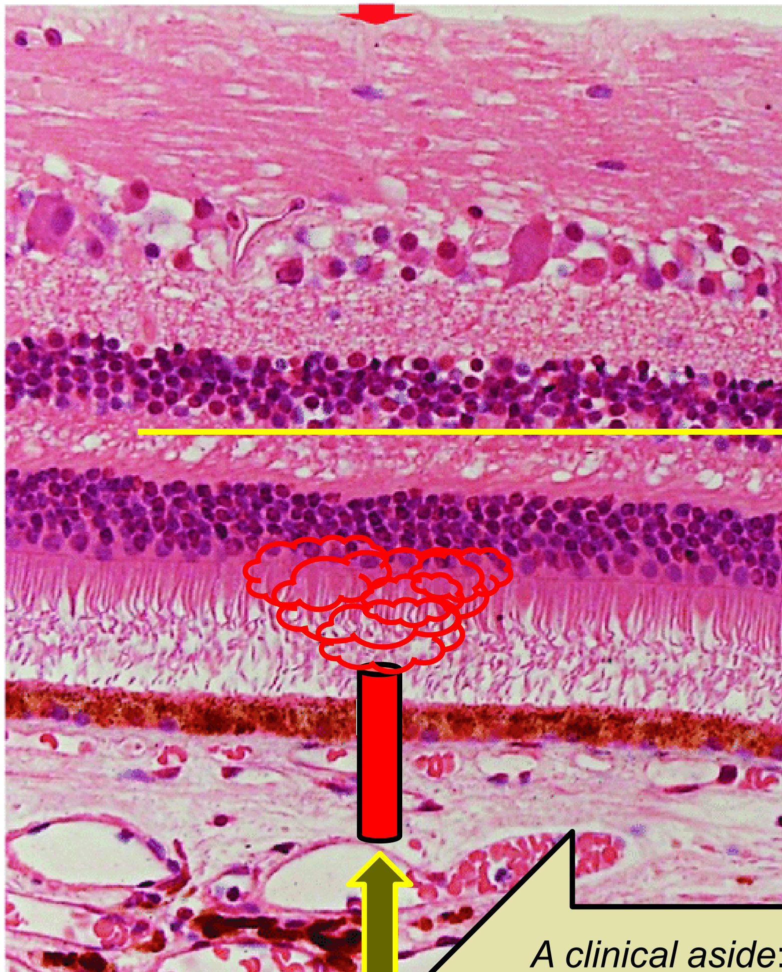


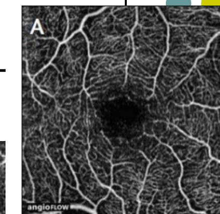
As expected, imaging of the deeper retina (*D*) reveals the **absence** of intraretinal vasculature

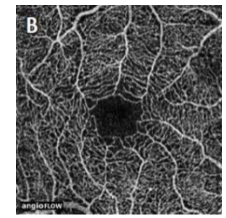
(No question—proceed when ready)

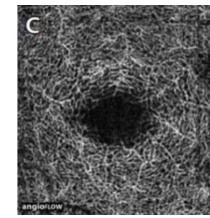
Retinal Anatomy and Histology

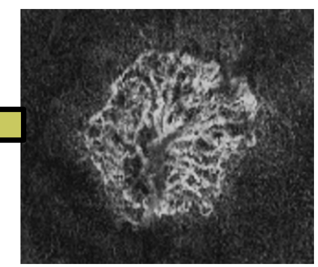
En face OCTA









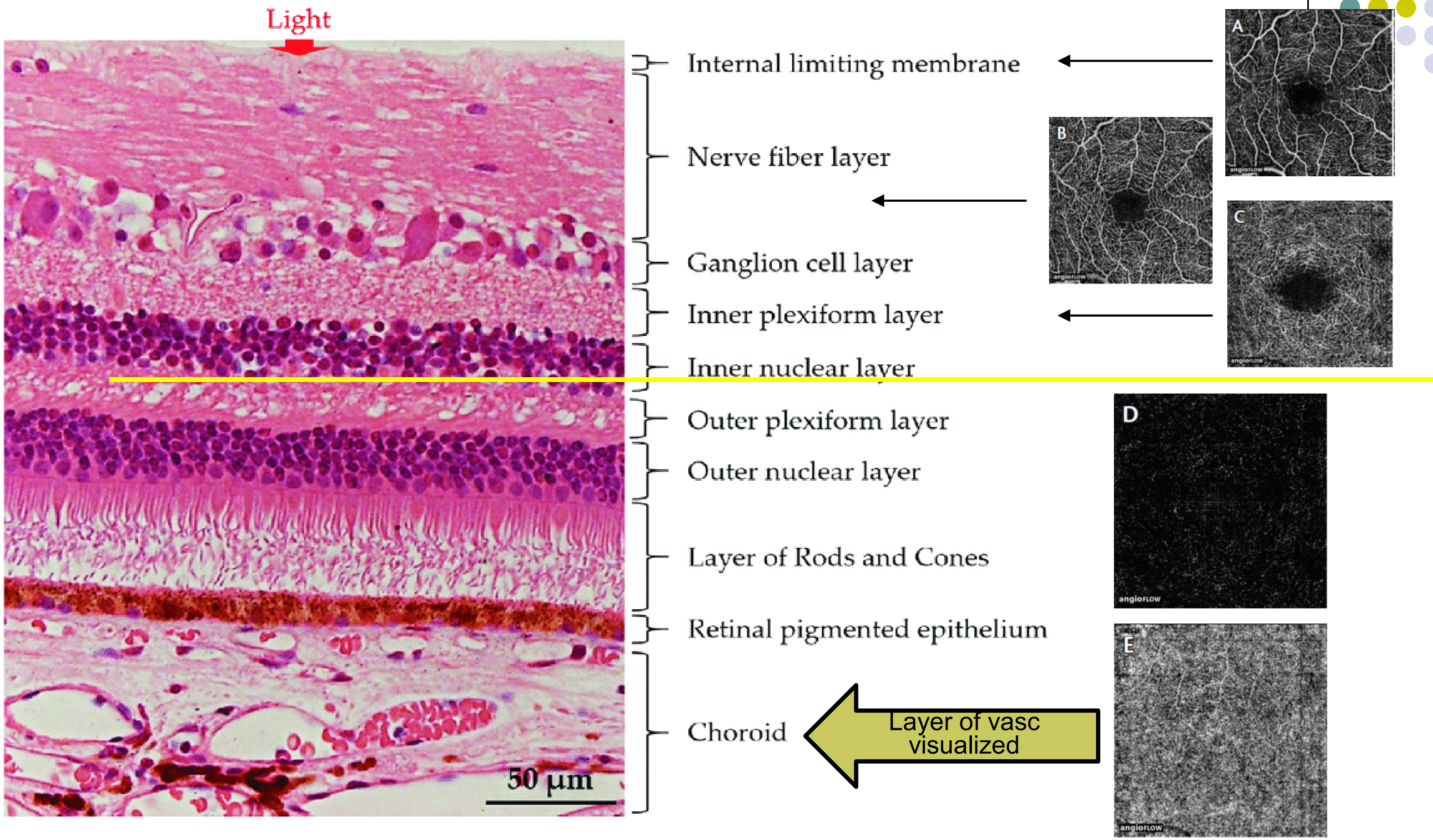


A clinical aside: Note that vessels in the deep retina, as seen here, often represent a CNVM such as is encountered in ARMD

***CNVM**: Choroidal neovascular membrane*
***ARMD**: Age-related macular degeneration*

Retinal Anatomy and Histology

En face OCTA

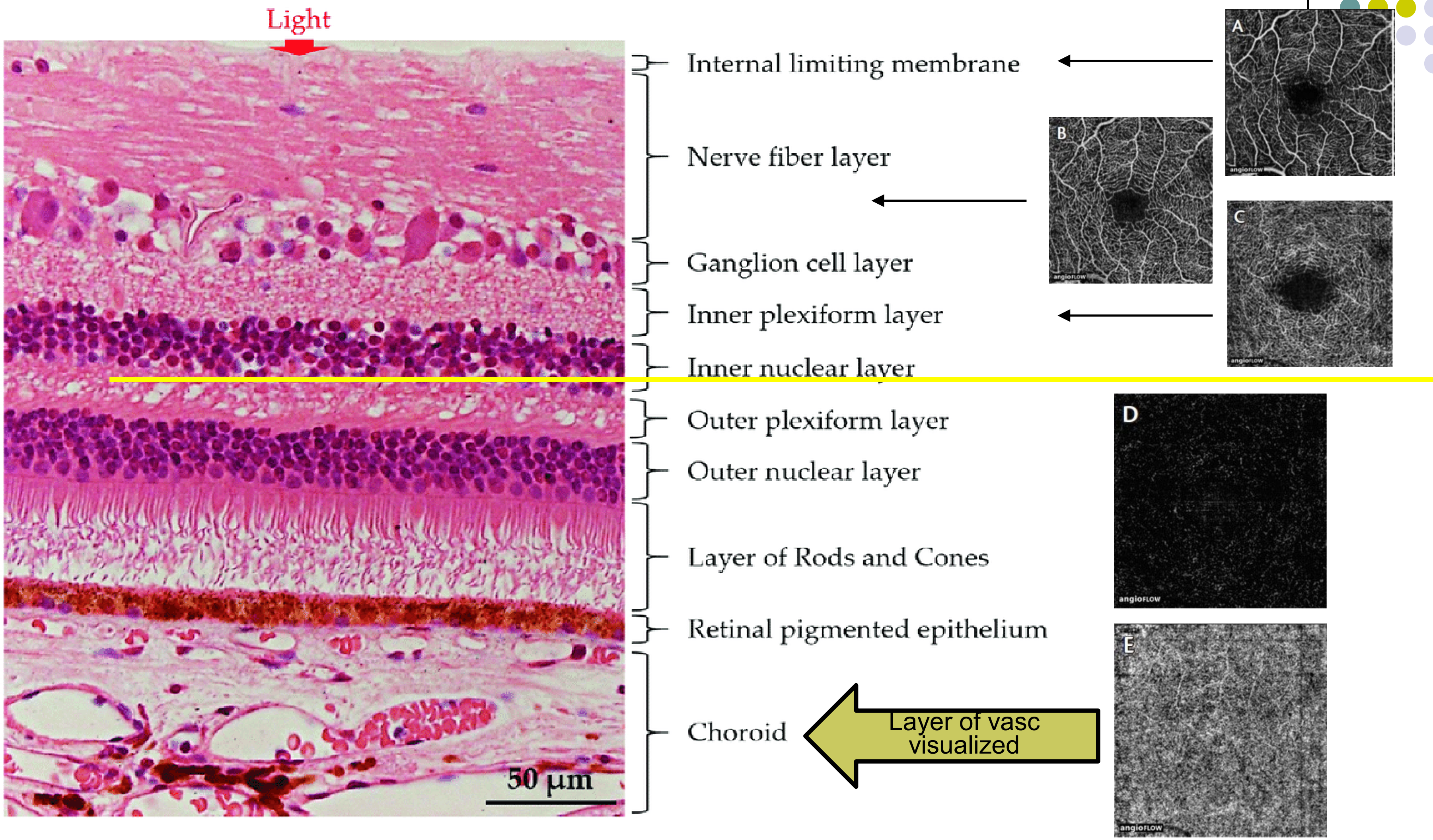


Imaging of the choriocapillaris (*E*) indicates it contains a dense, robust vasculature.

(No question—proceed when ready)

Retinal Anatomy and Histology

En face OCTA



Imaging of the choriocapillaris (*E*) indicates it contains a dense, robust vasculature. *As expected, note the* absence *of a void corresponding to the FAZ.*

(No question—proceed when ready)

- **RPE**

Next let's look in detail at the function and structure of the ***RPE***

- **RPE: Functions**

  1)

  2)

  3)

- **RPE: Functions**

  1) Outer blood-retinal barrier

  2)

  3)

- **RPE: Functions**

  1) Outer blood-retinal barrier

  - Formed by zonulae occludens near cell apices

  2)

  3)

- **RPE: Functions**
  1) *Outer blood-retinal barrier*
     - Formed by zonulae occludens near cell apices
  2)
  3)

As an aside, the *inner* blood-retinal barrier is formed by tight junctions between endothelial cells of the retinal vasculature

- **RPE: Functions**
  - *1) Outer blood-retinal barrier*
    - Formed by zonulae occludens near cell apices
  - *2) Phagocytosis of rod/cone outer segments*
  - *3)*

- **RPE: Functions**
  1) *Outer blood-retinal barrier*
     - Formed by zonulae occludens near cell apices
  2) *Phagocytosis of rod/cone outer segments*
  3) *Vitamin A metabolism*

- **RPE: Functions**
  - *1) Outer blood-retinal barrier*
    - Formed by zonulae occludens near cell apices
  - *2) Phagocytosis of rod/cone outer segments*
  - *3) Vitamin A metabolism*
    - Retinol acquired, stored and transported by RPE

The five layers of Bruch's membrane:

Bruch's membrane

1) Basement membrane of RPE
2)
3)
4)
5)

Innermost

Outermost

The five layers of Bruch's membrane:

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3)
4)
5)

Innermost

Outermost

The five layers of Bruch's membrane:

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4)
5)

Innermost

Outermost

The five layers of Bruch's membrane:

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5)

Innermost

Outermost

The five layers of Bruch's membrane:

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

Innermost

Outermost

The five layers of Bruch's membrane:

0) RPE cells

The RPE cells themselves go here

Bruch's membrane

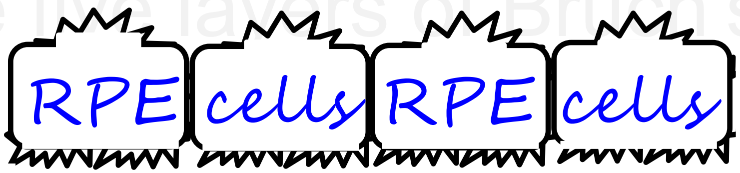
1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

Innermost

Outermost

Retinal Anatomy and Histology

The five layers of Bruch's membrane:

0) 

So, the plasma membranes of the RPE cells…

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

Innermost

Outermost

Retinal Anatomy and Histology

The five layers of Bruch's membrane:

0) RPE cells RPE cells

So, the plasma membranes of the RPE cells… ***sit directly on their BM***

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

Innermost

Outermost

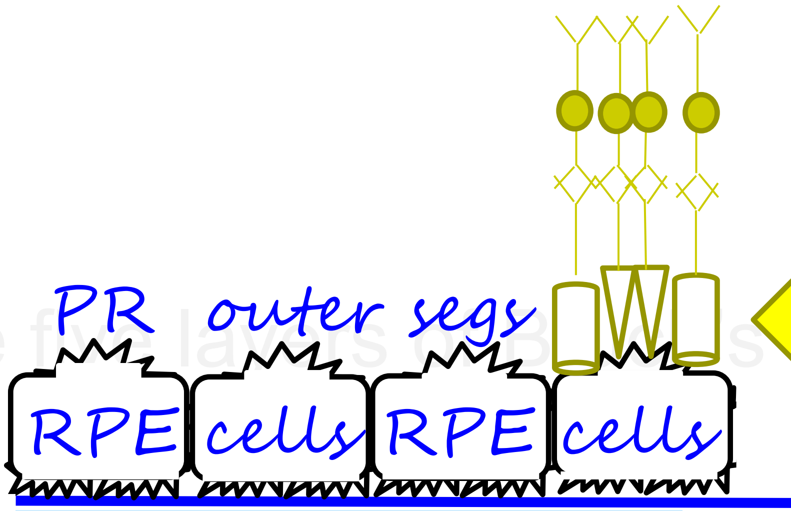
Retinal Anatomy and Histology

The five layers of Bruch's membrane.

-1) PR outer segs

PR outer segs are next

0)



Bruch's membrane

1) Basement membrane of RPE

2) Inner collagenous layer

3) Elastic layer

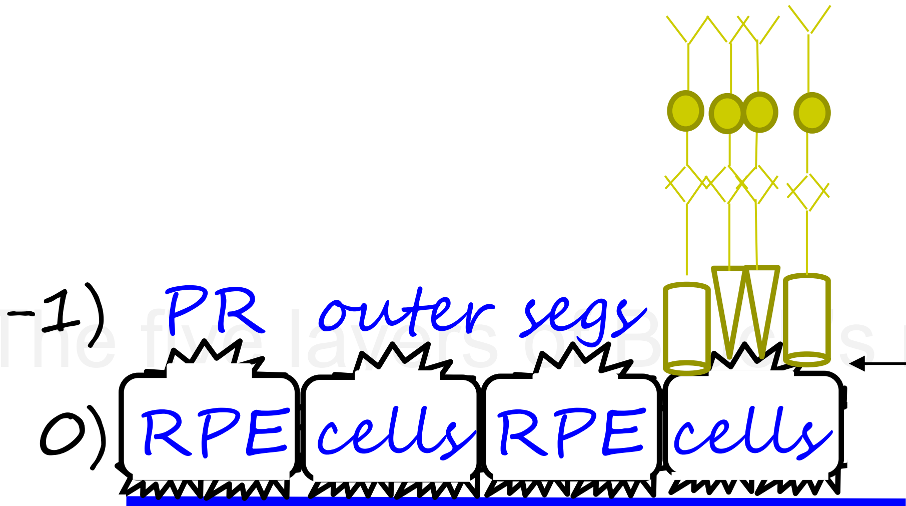
4) Outer collagenous layer

5) Basement membrane of choriocapillaris

Innermost

Outermost

Retinal Anatomy and Histology



Note that both the RPE apical membranes…

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

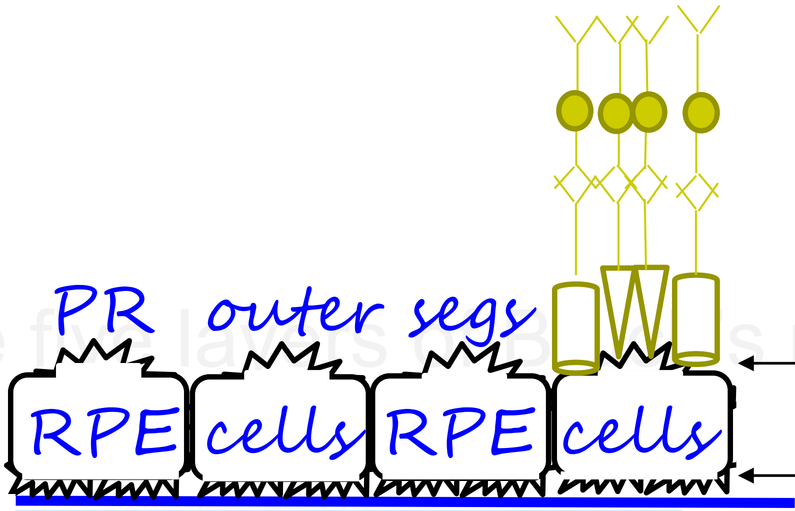
Innermost

Outermost

Retinal Anatomy and Histology

The five layers of Bruch's membrane:

-1)



0)

Note that both the RPE apical membranes…

and their basal membranes…

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

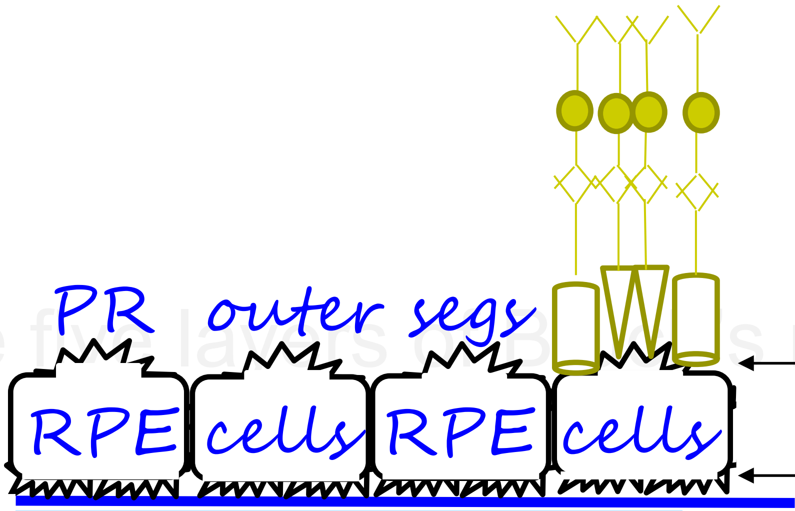
Innermost

Outermost

Retinal Anatomy and Histology

The five layers of Bruch's membrane:

-1) PR outer segs



0) RPE cells

Note that both the RPE apical membranes…

are highly infolded.

and *their basal membranes…*

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

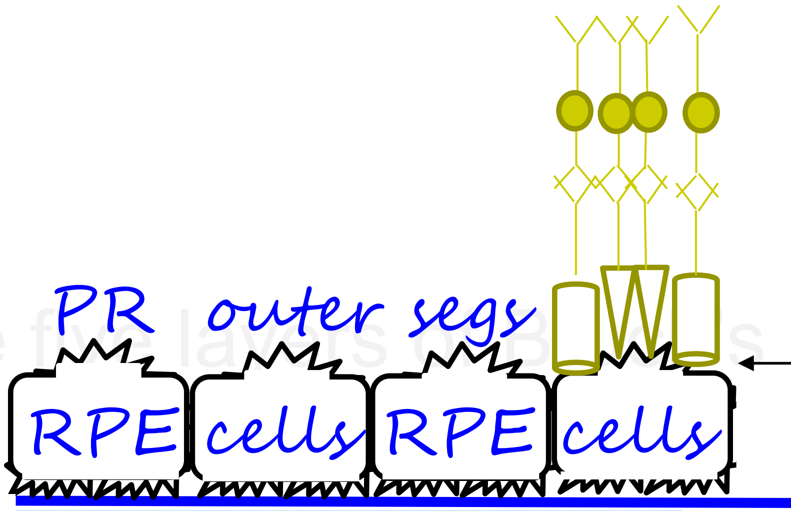
Innermost

Outermost

Retinal Anatomy and Histology

-1) PR outer segs

0) RPE cells RPE cells



But note further that, while the PRs closely interdigitate with these infoldings…

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

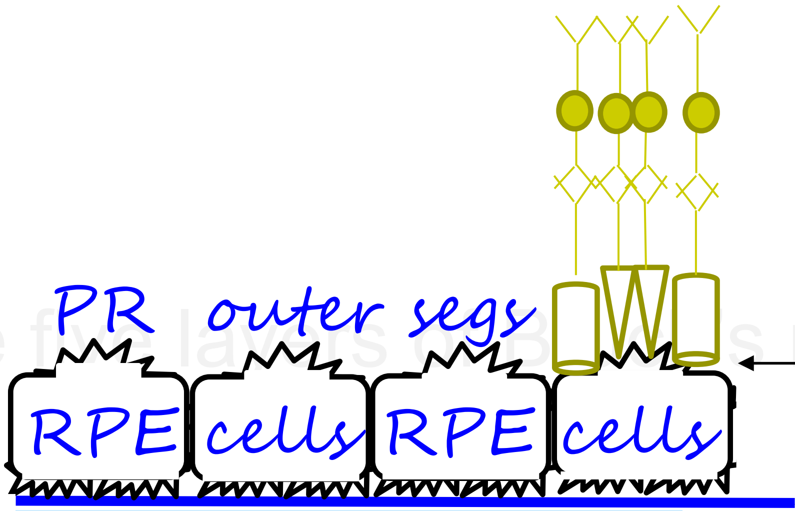
Innermost

Outermost

Retinal Anatomy and Histology

-1) PR outer segs

0) RPE cells RPE cells



But note further that, while the PRs closely interdigitate with these infoldings…

the BM does not.

Bruch's membrane

1) Basement membrane of RPE

2) Inner collagenous layer

3) Elastic layer

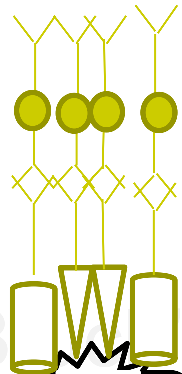
4) Outer collagenous layer

5) Basement membrane of choriocapillaris

Innermost

Outermost

Retinal Anatomy and Histology



-1) PR outer segs

0) RPE cells RPE cells

But note further that, while ***the PRs closely interdigitate with these infoldings****…*

Recall that a central function of the RPE is to provide metabolic support for the PRs. The interdigitations greatly increase the total surface area of PR-RPE contact, thereby facilitating these metabolic efforts.

Bruch's membrane

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris

Outermost

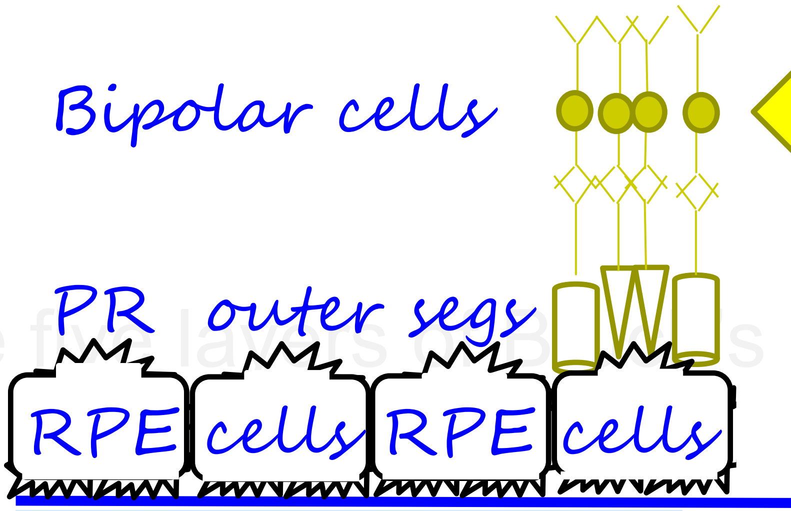
Retinal Anatomy and Histology

-2) Bipolar cells

Bipolar cells are next

-1) PR outer segs

0)



Bruch's membrane

1) Basement membrane of RPE

2) Inner collagenous layer

3) Elastic layer

4) Outer collagenous layer

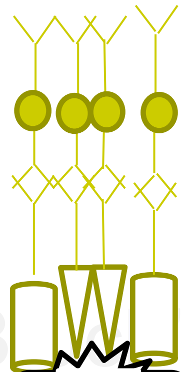
5) Basement membrane of choriocapillaris

Innermost

Outermost

Retinal Anatomy and Histology

-2) Bipolar cells



-1) PR outer segs

The five layers of Bruch's membrane:

0) RPE cells RPE cells

Bruch's membrane

1) Basement membrane of RPE

2) Inner collagenous layer

3) Elastic layer

4) Outer collagenous layer

5) Basement membrane of choriocapillaris

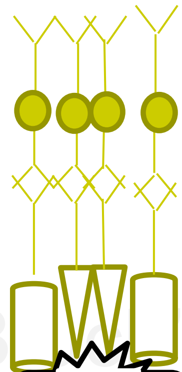
6) ?

Innermost

Outermost

Down here is…

Retinal Anatomy and Histology



-2) Bipolar cells

-1) PR outer segs

0) RPE cells RPE cells

Bruch's membrane

1) Basement membrane of RPE

2) Inner collagenous layer

3) Elastic layer

4) Outer collagenous layer

5) Basement membrane of choriocapillaris

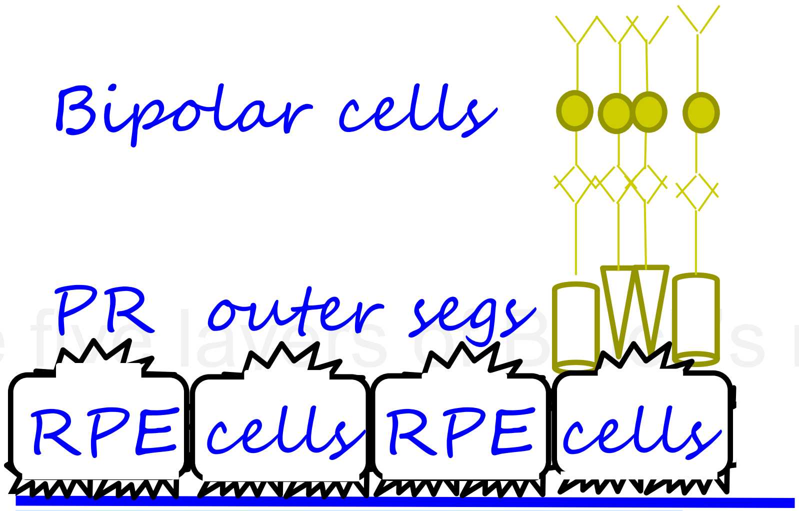
6) Choriocapillaris

Innermost

Outermost

Down here is…
The choriocapillaris

Retinal Anatomy and Histology



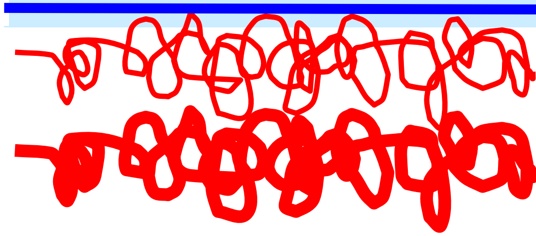
-2) Bipolar cells

-1) PR outer segs

0) RPE cells RPE cells

Bruch's membrane:

1) Basement membrane of RPE
2) Inner collagenous layer
3) Elastic layer
4) Outer collagenous layer
5) Basement membrane of choriocapillaris



6) Choriocapillaris

7) Choroid

Innermost

Outermost

And the **choroid**

Retinal Anatomy and Histology

Next we will look at macular OCT, and relate it to what we've learned about the anatomy of the retina

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OCT stand for *optical coherence tomography*. It allows cross-sectional imaging of ocular structures, including the retina (tomography means 'cross-sectional image').

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It works via **interferometry:** A beam of coherent light is directed toward the retina, and reflects when it encounters boundaries between tissue layers of differing optical properties. The device gathers the reflected light and compares it to a standardized beam of light reflected from a reference mirror.

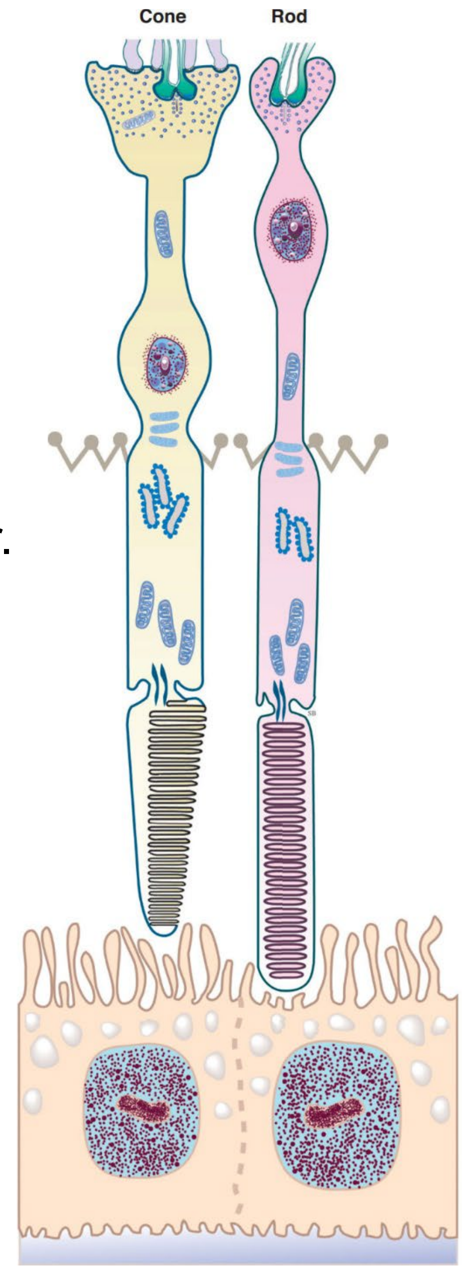
Next we will look at macular OCT, and relate it to what we've learned about the anatomy of the retina

OCT stand for *optical coherence tomography*. It allows cross-sectional imaging of ocular structures, including the retina (tomography means 'cross-sectional image').

It works via **interferometry:** A beam of coherent light is directed toward the retina, and reflects when it encounters boundaries between tissue layers of differing optical properties. The device gathers the reflected light and compares it to a standardized beam of light reflected from a reference mirror. In *spectral-domain OCT* (sdOCT), differences in the frequencies of the two reflected beams are used to infer the ultrastructure of the retina.

Retinal Anatomy and Histology

Recall this slide from earlier. The time/effort you spent committing it to memory is about to pay off.



The ELM

The myoid zone

The ellipsoid zone

PR outer segs

Interdigitation zone

RPE/Bruch’s membrane

Retinal Anatomy and Histology

The ELM

The myoid zone

The ellipsoid zone

PR outer segs

Interdigitation zone

RPE/Bruch's membrane

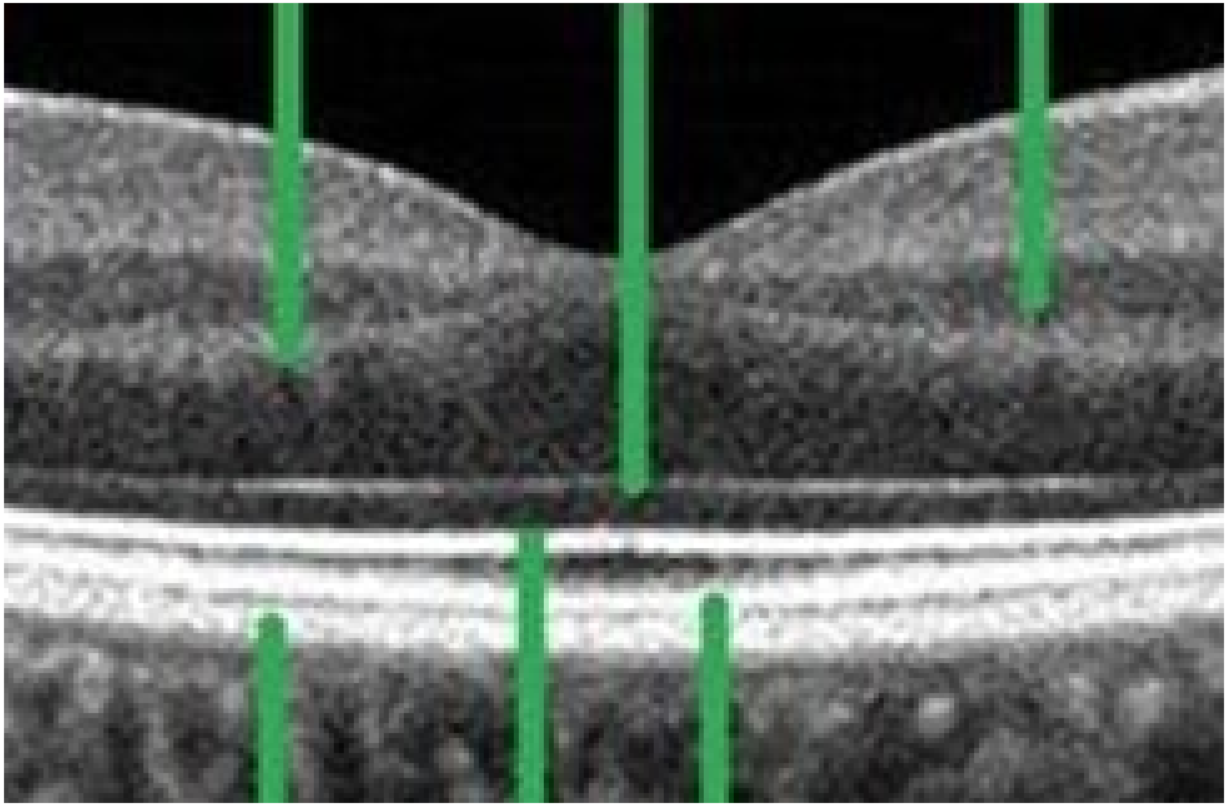
Recall this slide from earlier. The time/effort you spent committing it to memory is about to pay off. As we will see, these structures are visible on sdOCT, and it's vital you be able to recognize them.

Retinal Anatomy and Histology

Let's identify the RPE/Bruch's complex *first.*

(Ignore this line)

(And this one)



Look up here

The ELM

The myoid zone

The ellipsoid zone

PR outer segs

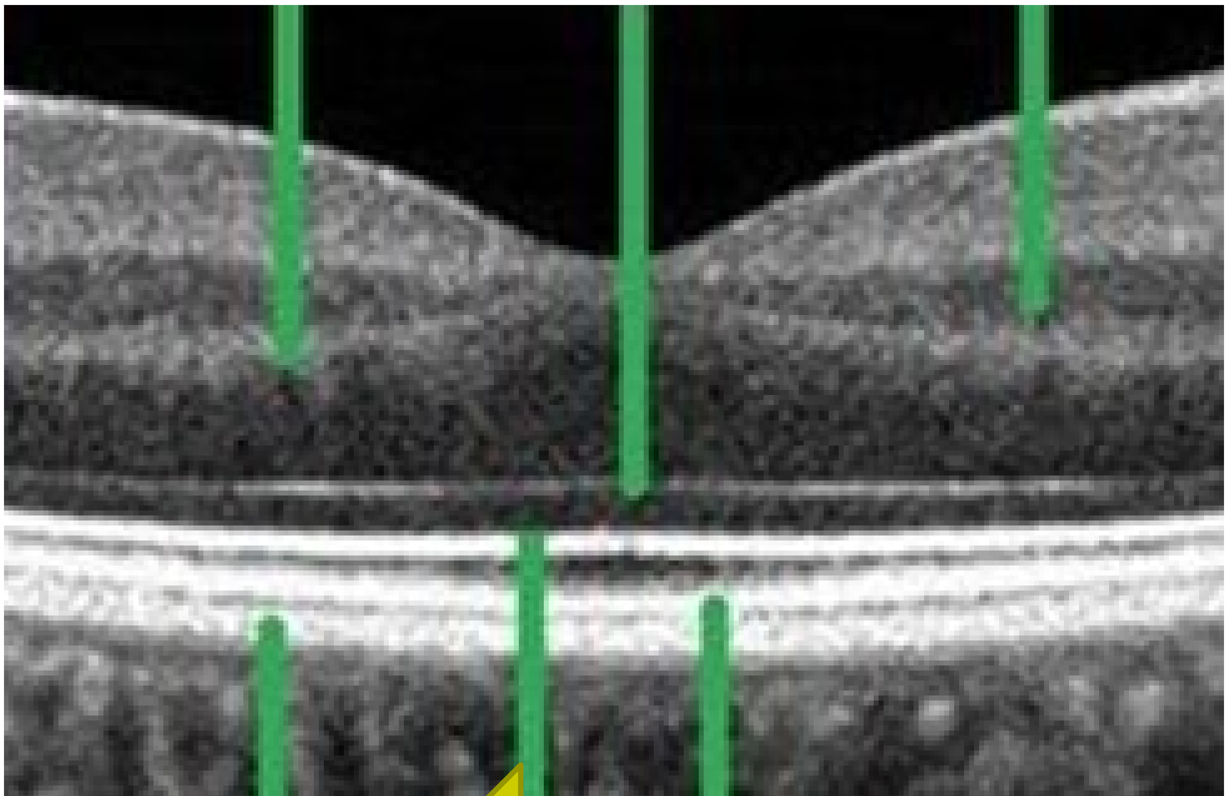
Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

Let's identify the RPE/Bruch's complex *first.*
The RPE/Bruch's complex is the outermost heavy white line

(Ignore this line) (And this one)



Now down here

RPE/Bruch's membrane

(The green line is pointing to it)

The ELM

The myoid zone

The ellipsoid zone

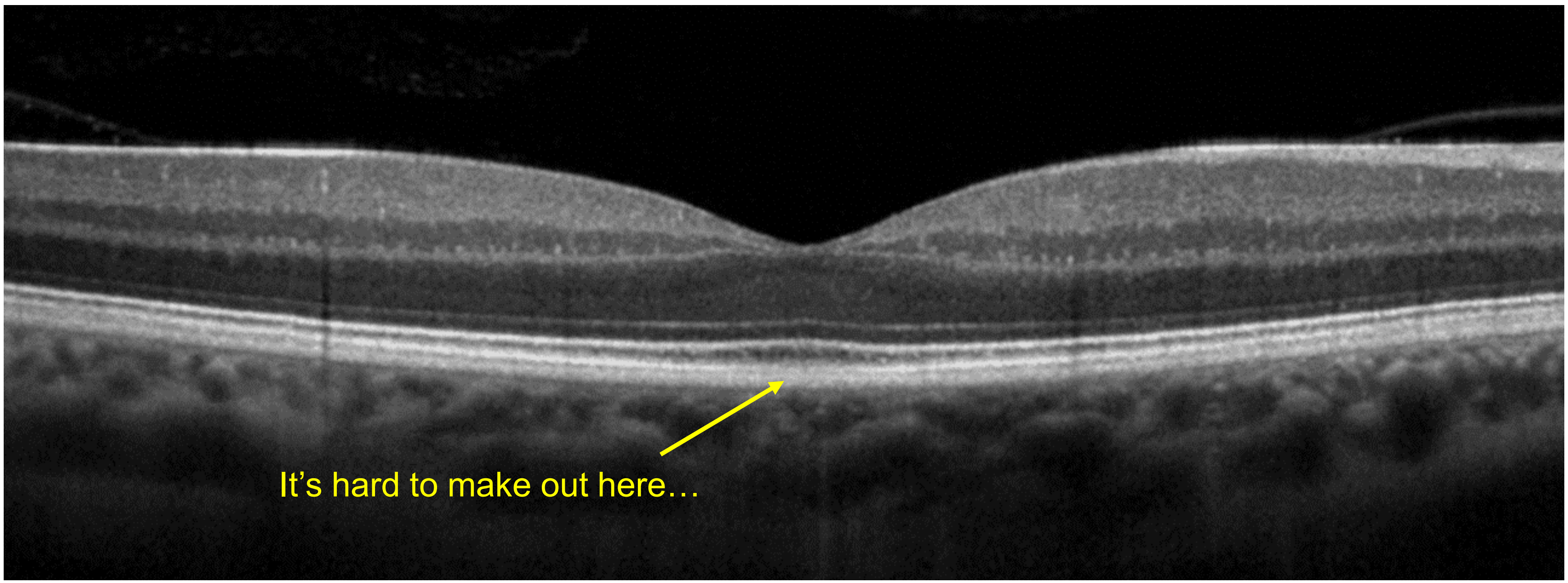
PR outer segs

Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

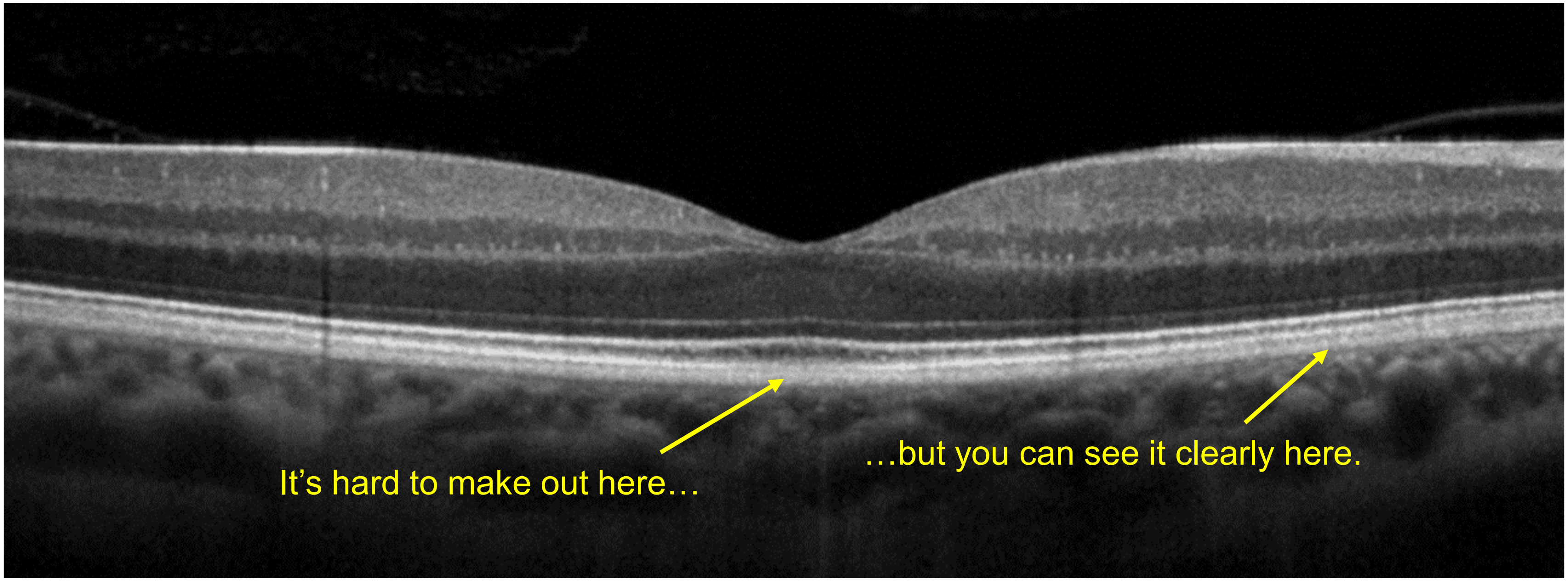
Let's identify the **RPE/Bruch's complex** *first.*
The RPE/Bruch's complex is the outermost heavy white line



(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

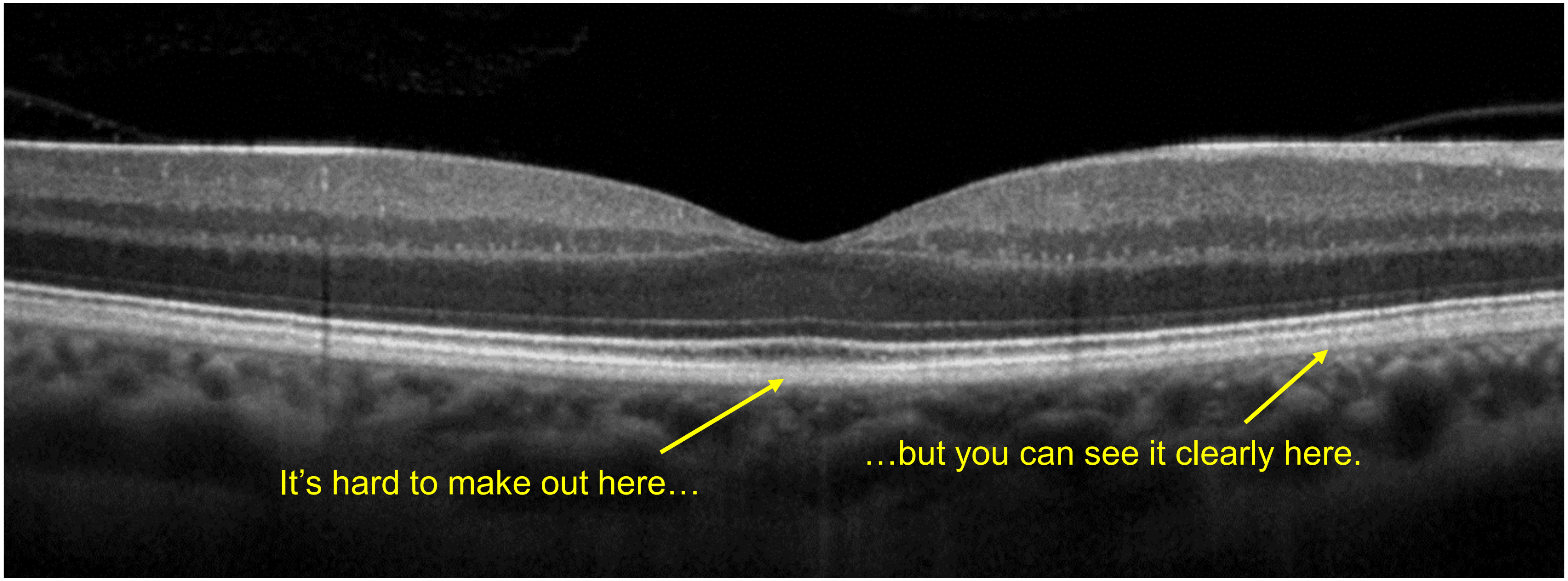
Let's identify the **RPE/Bruch's complex** *first.*
The RPE/Bruch's complex is the outermost heavy white line



(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

Let's identify the **RPE/Bruch's complex** *first.*
The RPE/Bruch's complex is the outermost heavy white line



You must identify ***and*** *assess the integrity of the RPE/Bruch's complex* *<u>on every OCT you read!</u>*

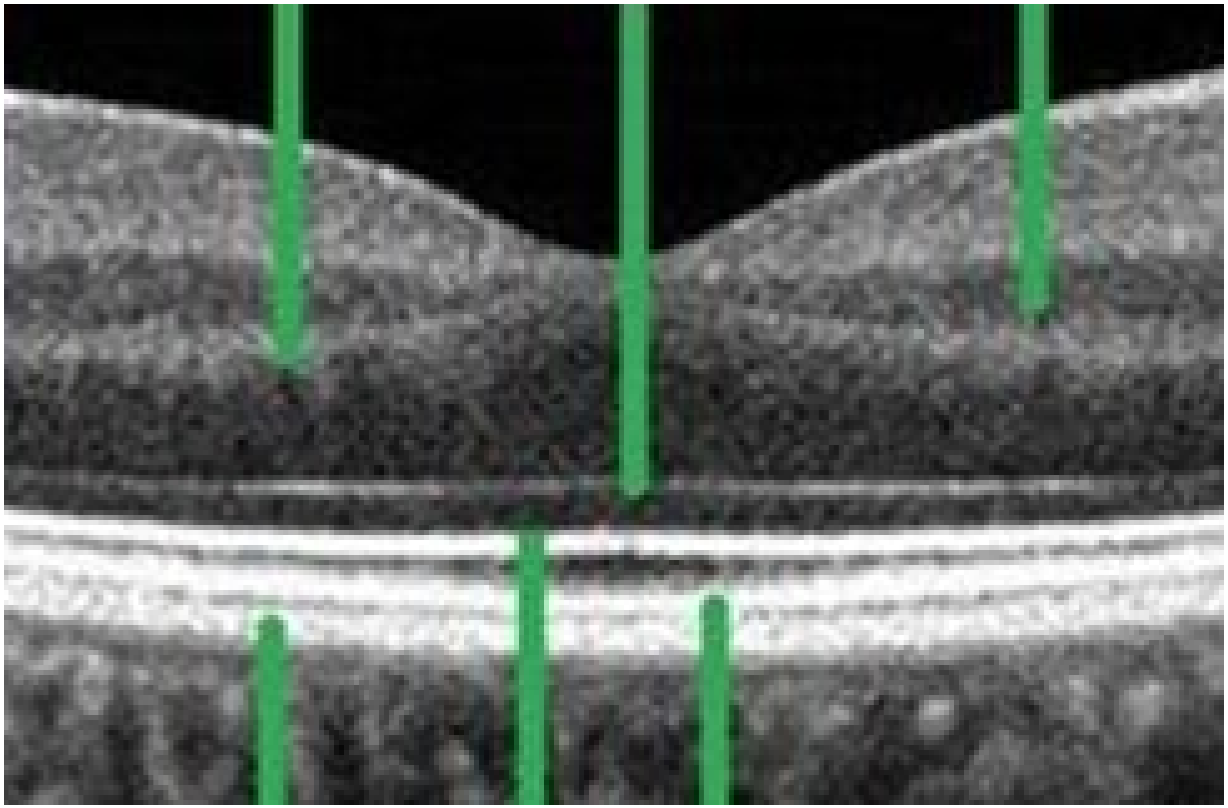
(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

Next is the interdigitation zone.

(Ignore this line)

(And this one)



RPE/Bruch's membrane

The ELM

The myoid zone

The ellipsoid zone

PR outer segs

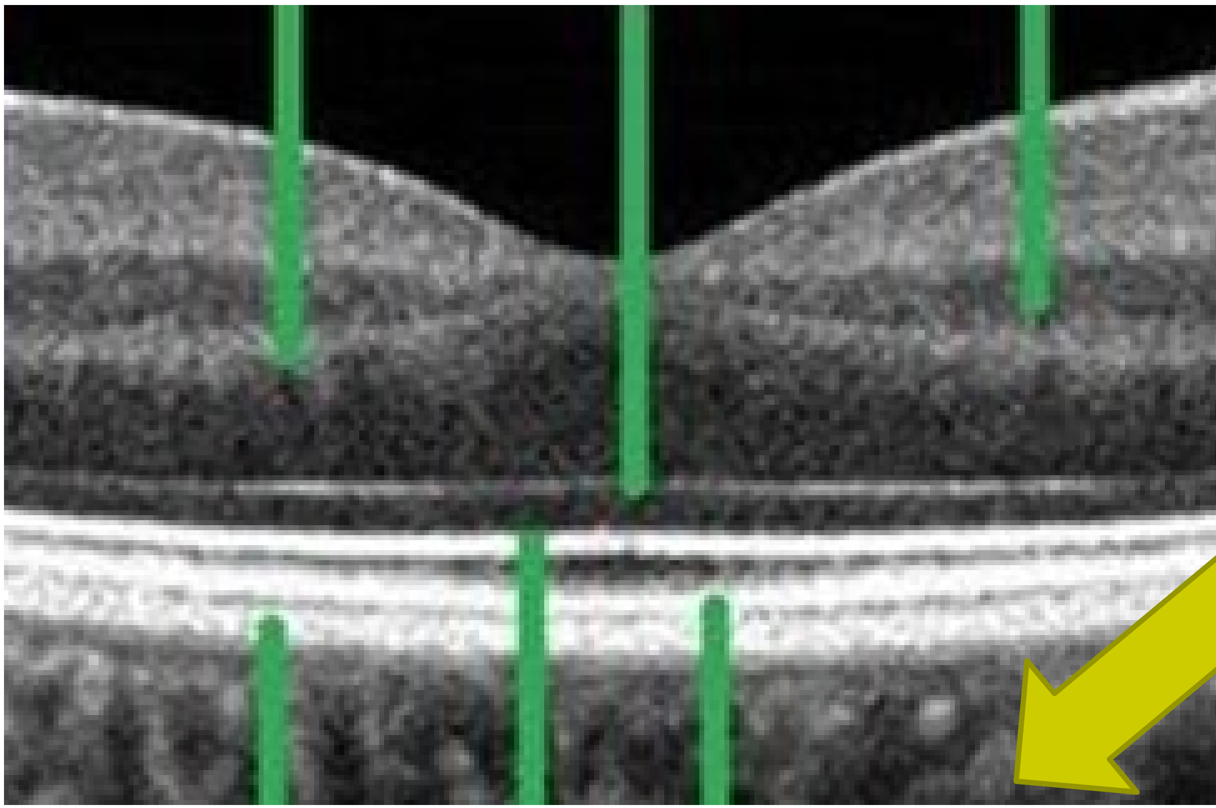
Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

Next is the interdigitation zone*.*
It is the next heavy white line

(Ignore this line) (And this one)



RPE/Bruch's membrane

Interdigitation zone
(Ditto)

The ELM

The myoid zone

The ellipsoid zone

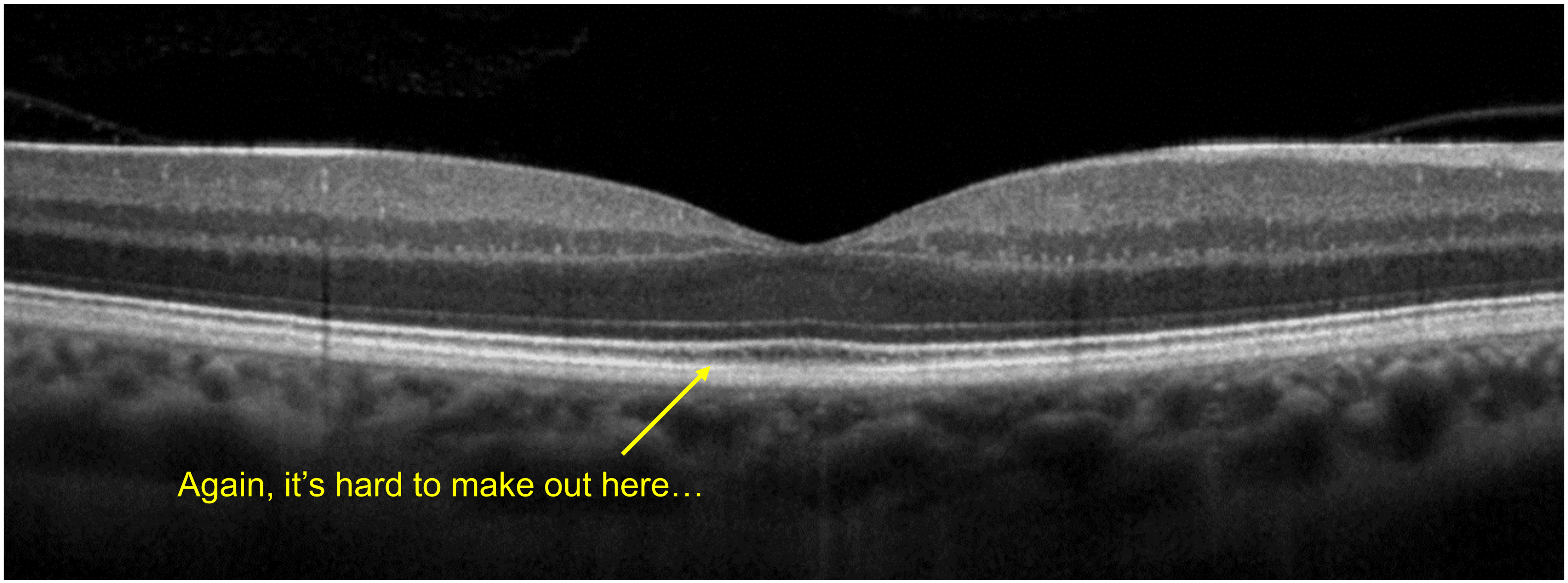
PR outer segs

Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

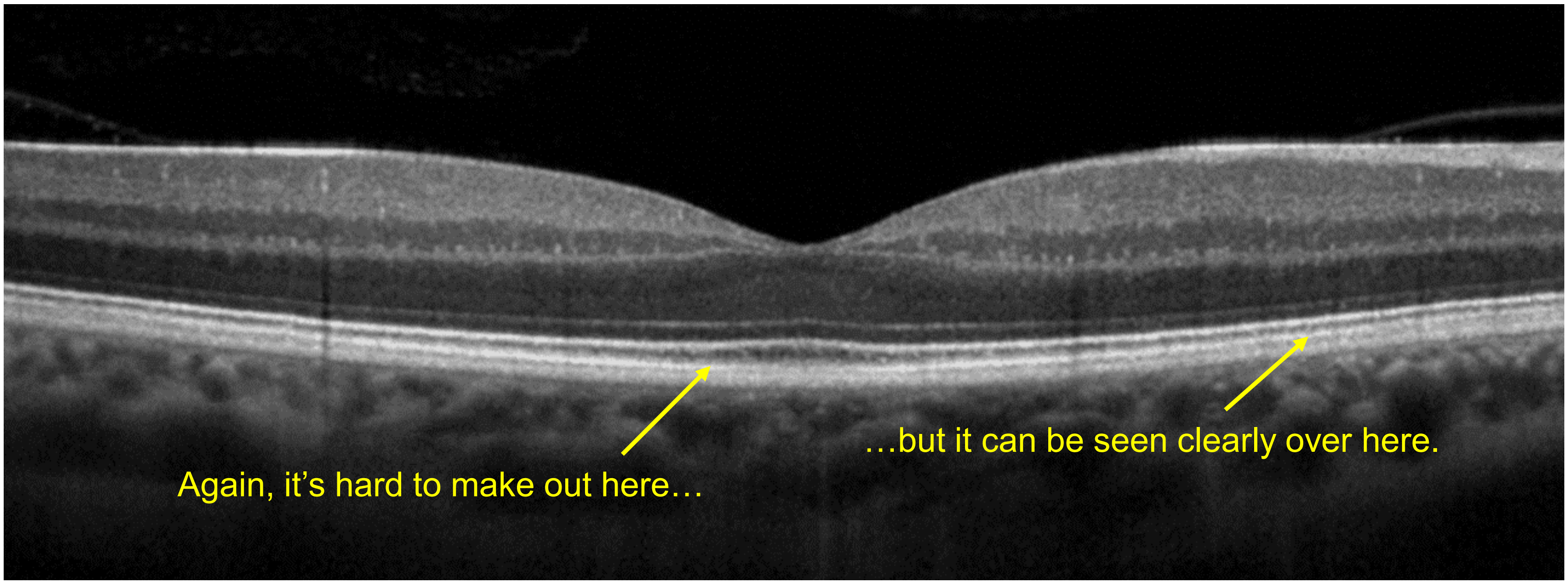
Next is the **interdigitation zone**.
It is the next heavy white line



(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

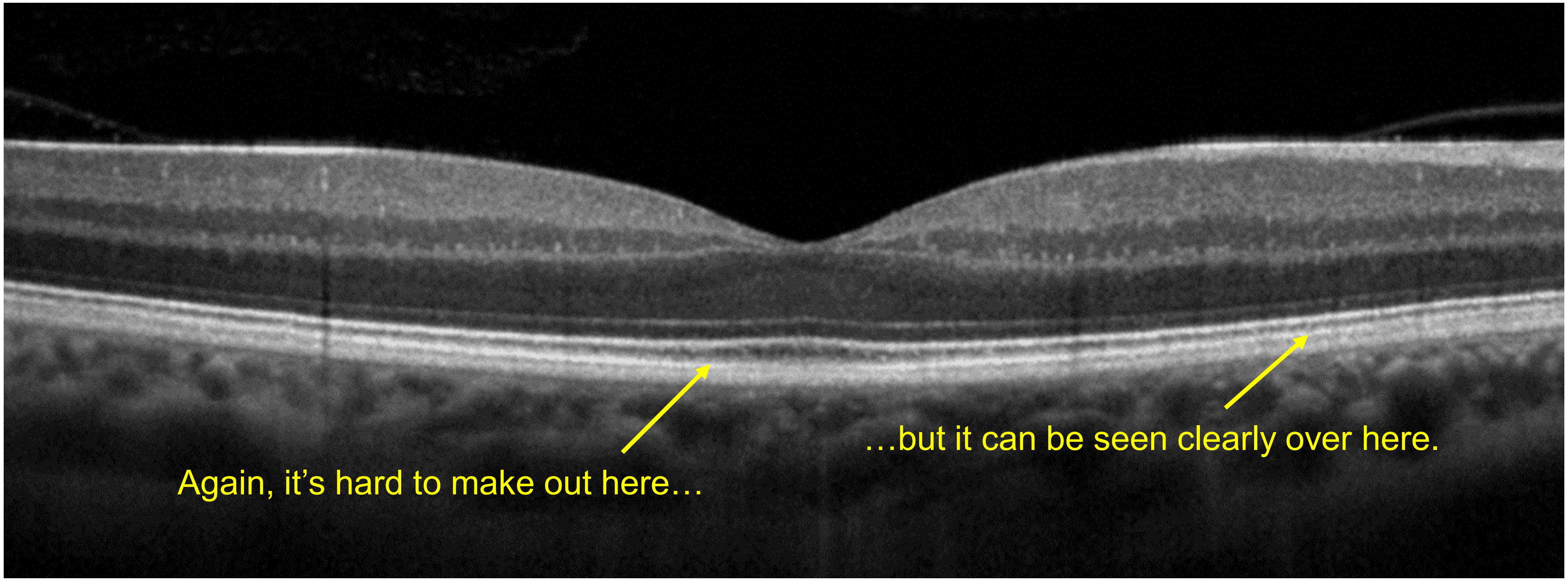
Next is the **interdigitation zone**.
It is the next heavy white line



(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

Next is the **interdigitation zone**.
It is the next heavy white line



The interdigitation zone is not always clearly visible on OCT

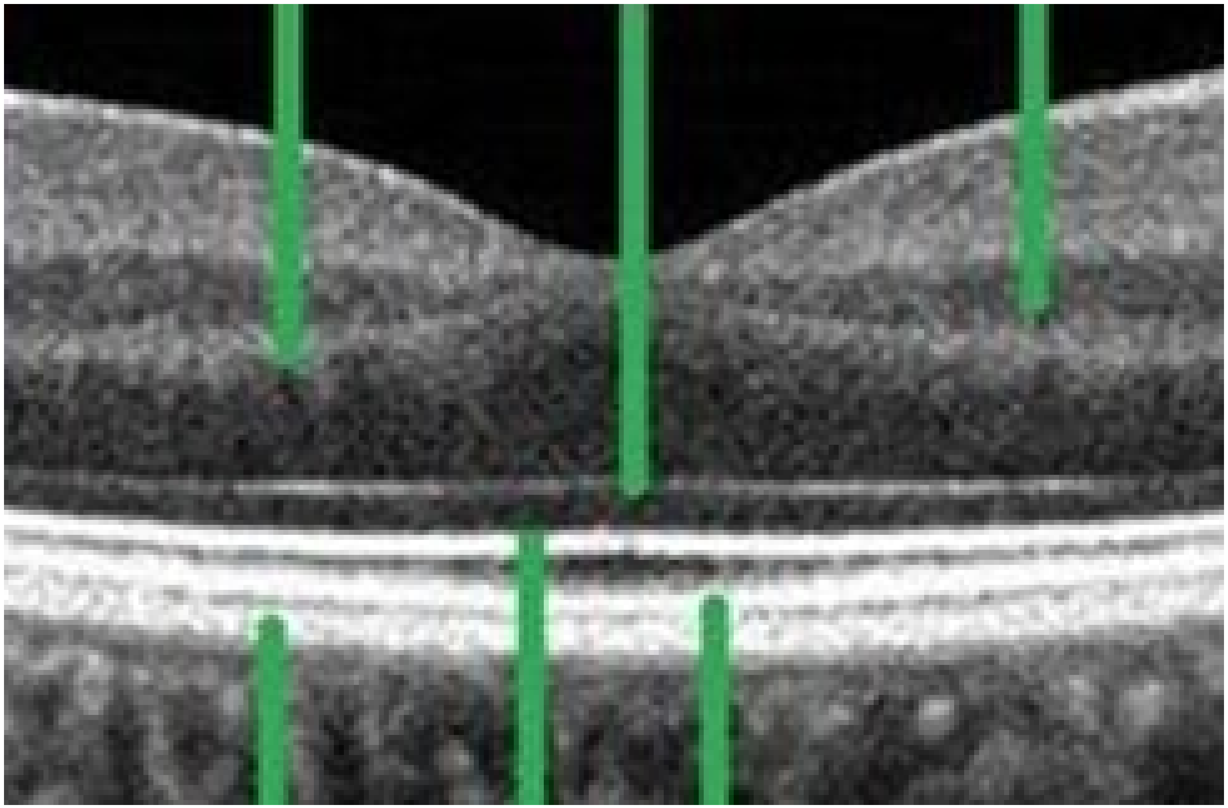
(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

Next is the PR outer segs*.*

(Ignore this line)

(And this one)



RPE/Bruch's membrane

Interdigitation zone

The ELM

The myoid zone

The ellipsoid zone

PR outer segs

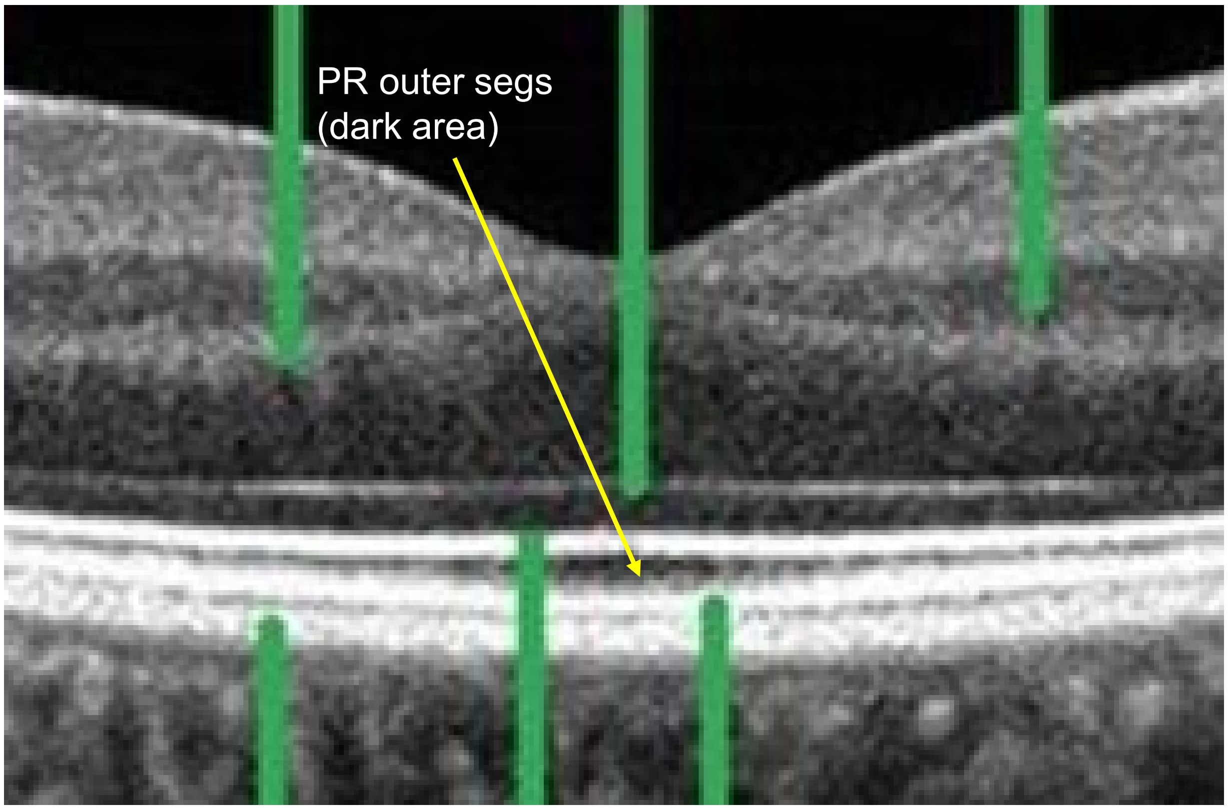
Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

Next is the PR outer segs*.*
In the dark band just inside the interdigitation zone

(Ignore this line) (And this one)



RPE/Bruch's membrane

Interdigitation zone

The ELM

The myoid zone

The ellipsoid zone

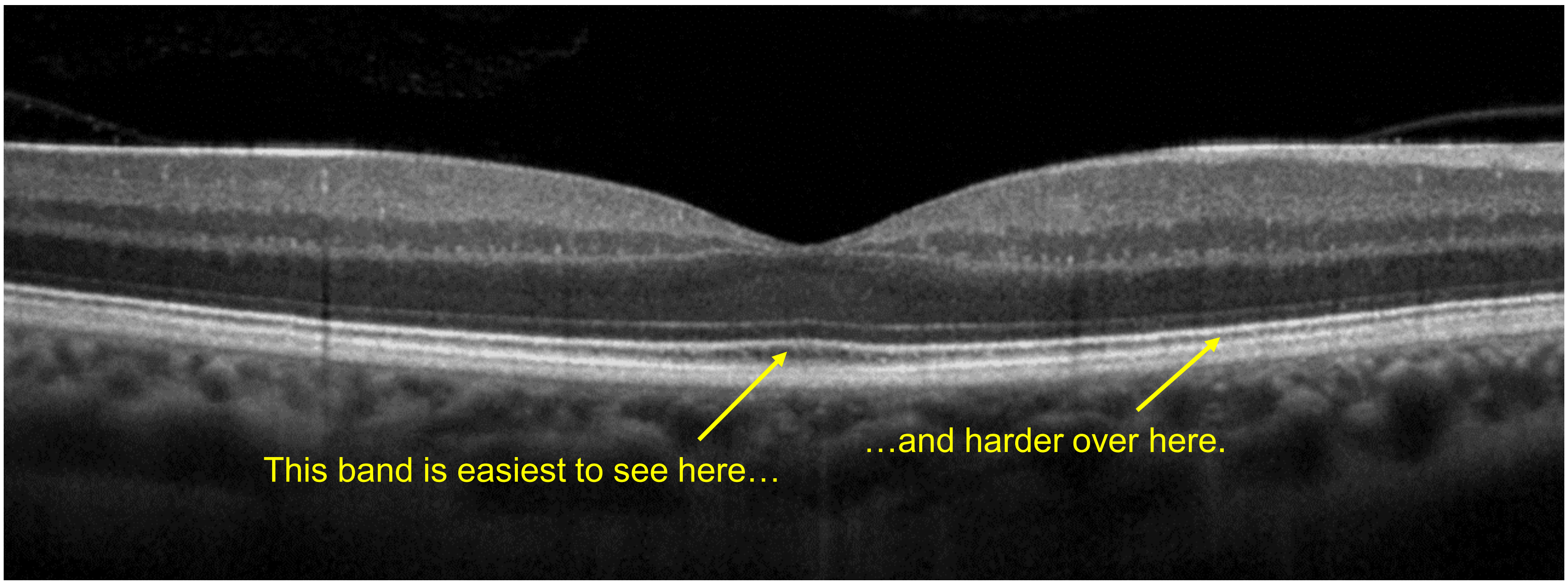
PR outer segs

Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

Next is the **PR outer segs**.
In the dark band just inside the interdigitation zone

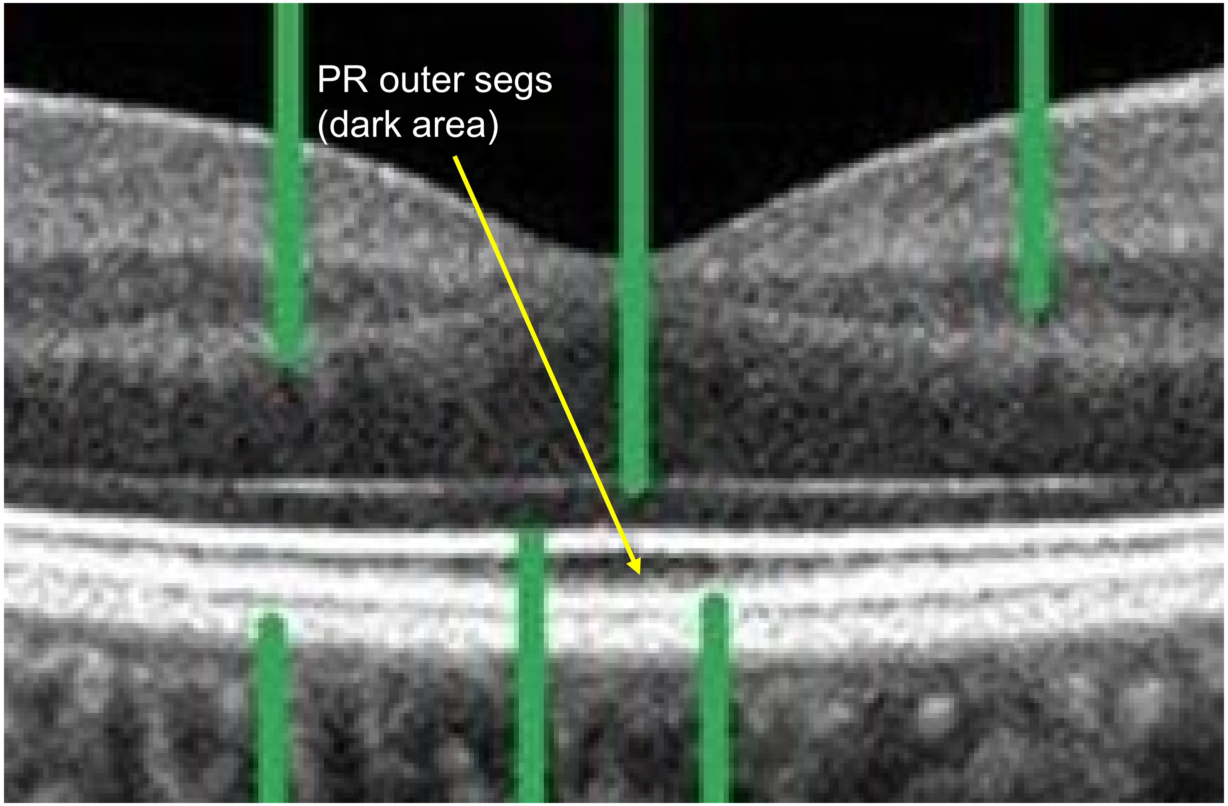


The PR outer segs band is taller at the fovea because the outer segs are longer here

(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

Next is the ellipsoid zone.



The ELM

The myoid zone

The ellipsoid zone

PR outer segs

Interdigitation zone

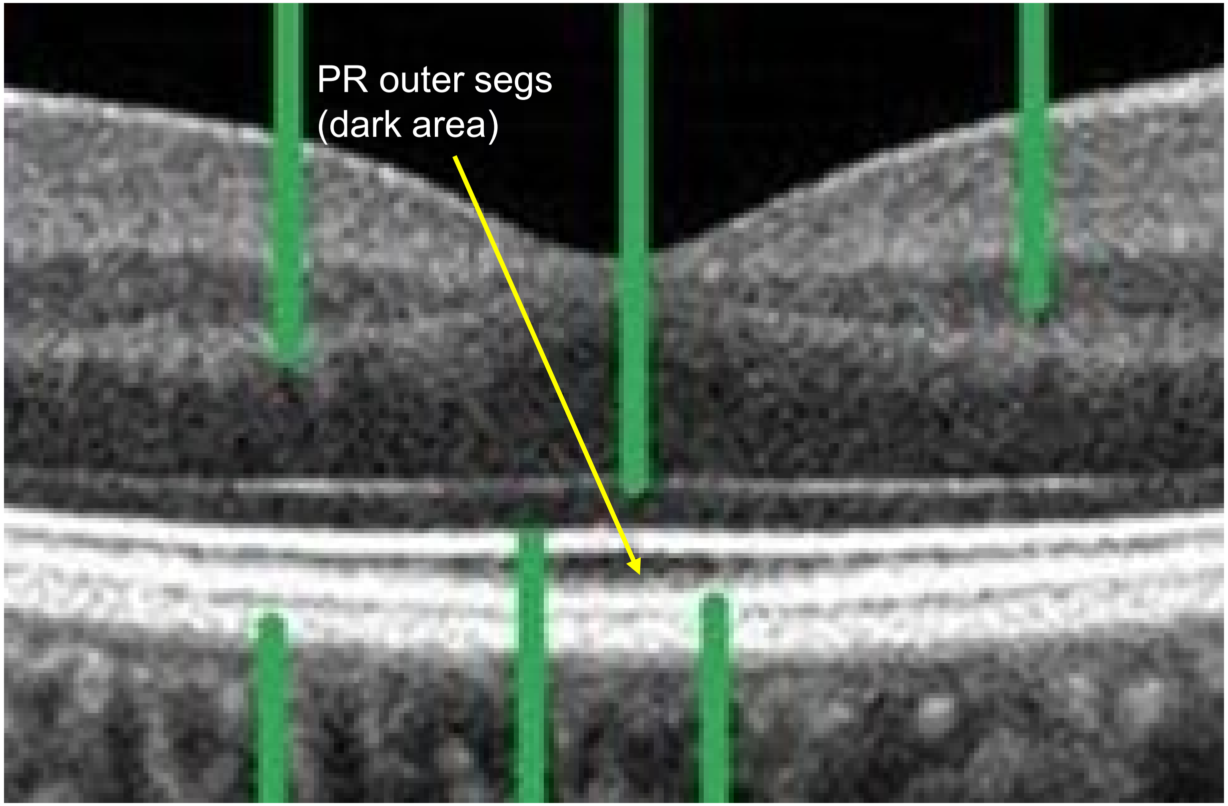
RPE/Bruch's membrane

Retinal Anatomy and Histology

Next is the ellipsoid zone*.*
It is the heavy white band inside the outer segs

(Ignore this line)

(And this one)



RPE/Bruch's membrane

Ellipsoid zone (the white line)

Interdigitation zone

The ELM

The myoid zone

The ellipsoid zone

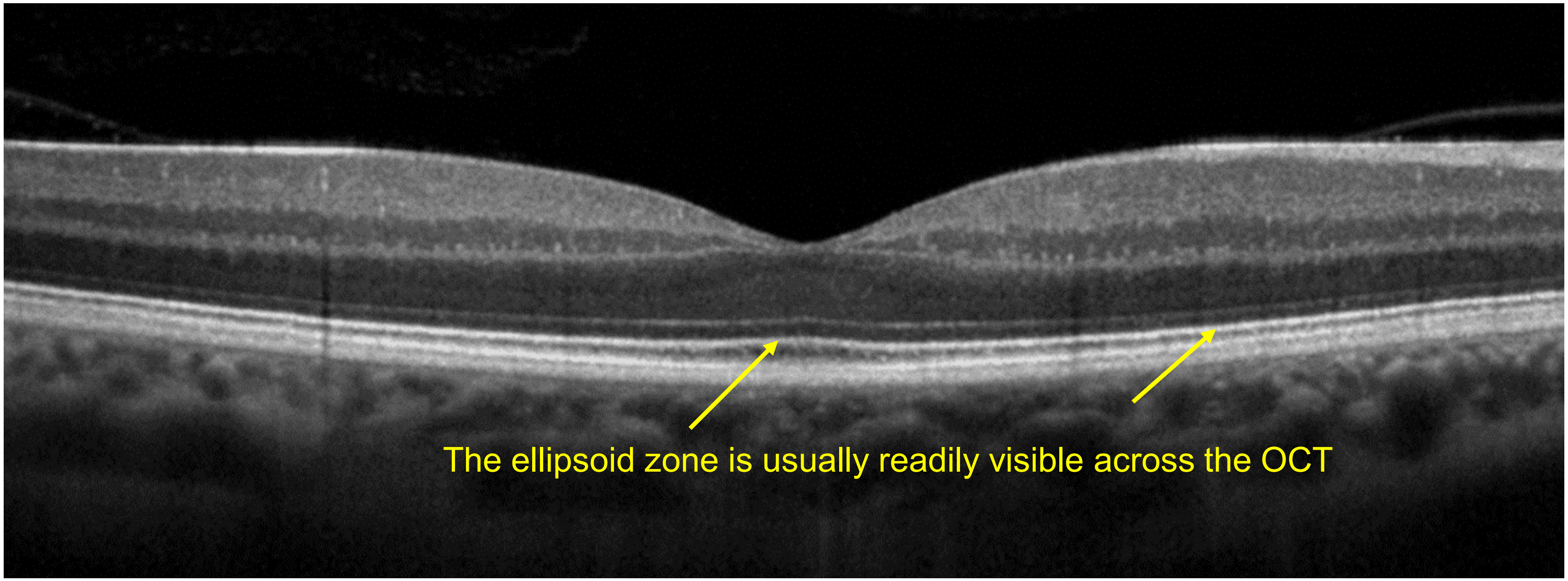
PR outer segs

Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

Next is the **ellipsoid zone**.
It is the heavy white band inside the outer segs

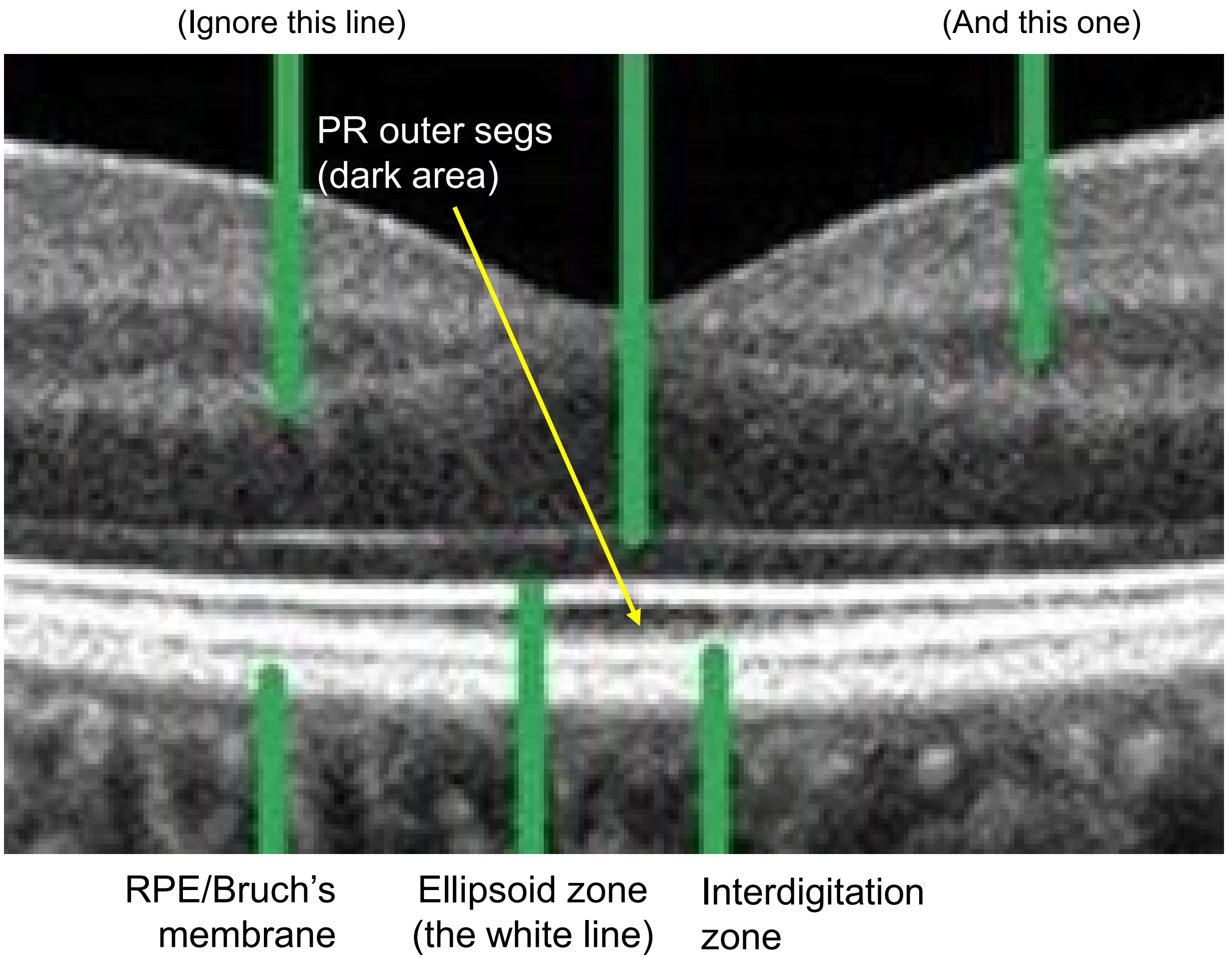


Many PR and other outer-retinal diseases manifest as changes to the EZ. Like the RPE/Bruch's complex, the EZ must be identified and assessed on every retinal OCT!

(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

Next is the myoid zone.



The ELM

The myoid zone

The ellipsoid zone

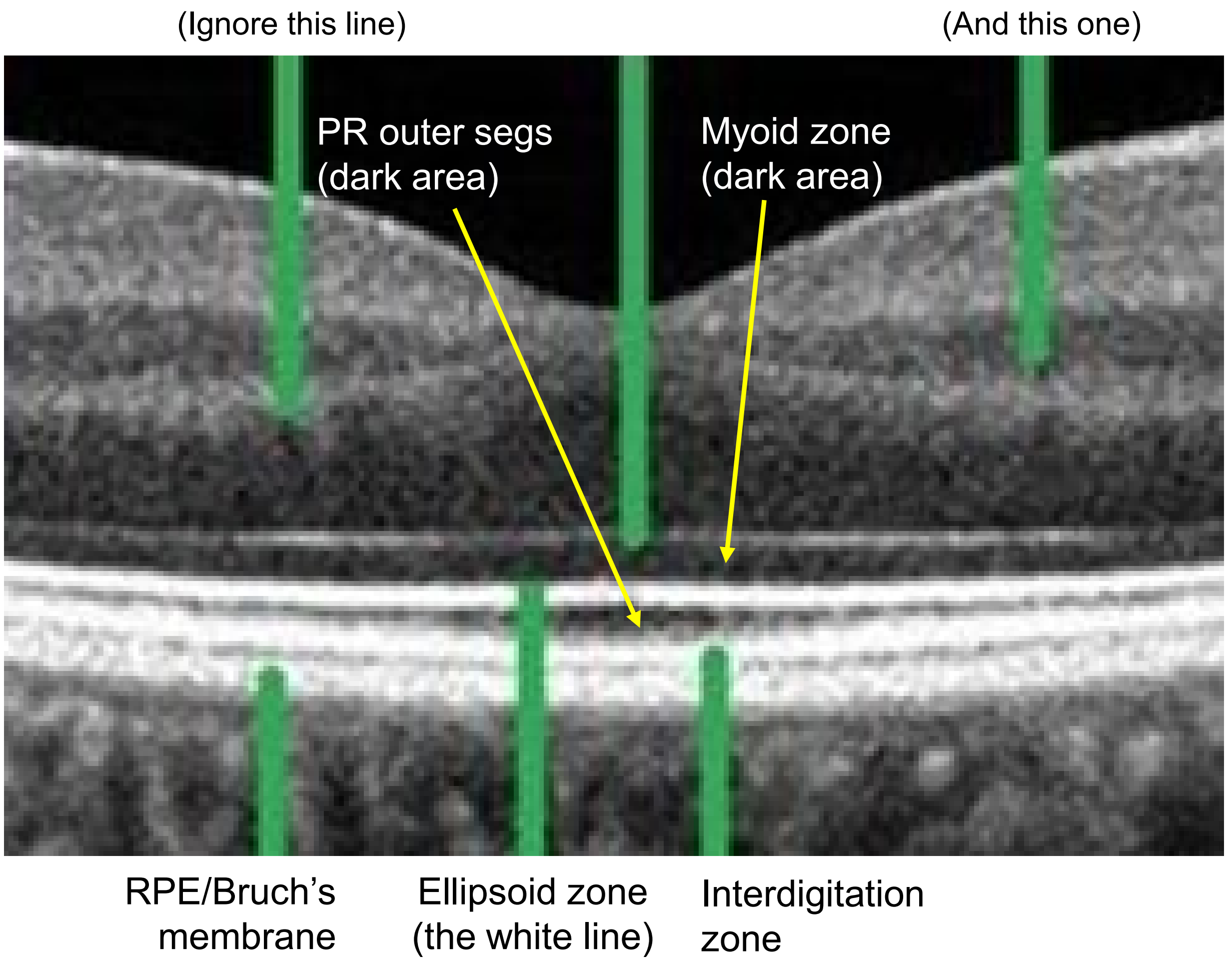
PR outer segs

Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

Next is the myoid zone.
The dark band just inside the ellipsoid zone



The ELM

The myoid zone

The ellipsoid zone

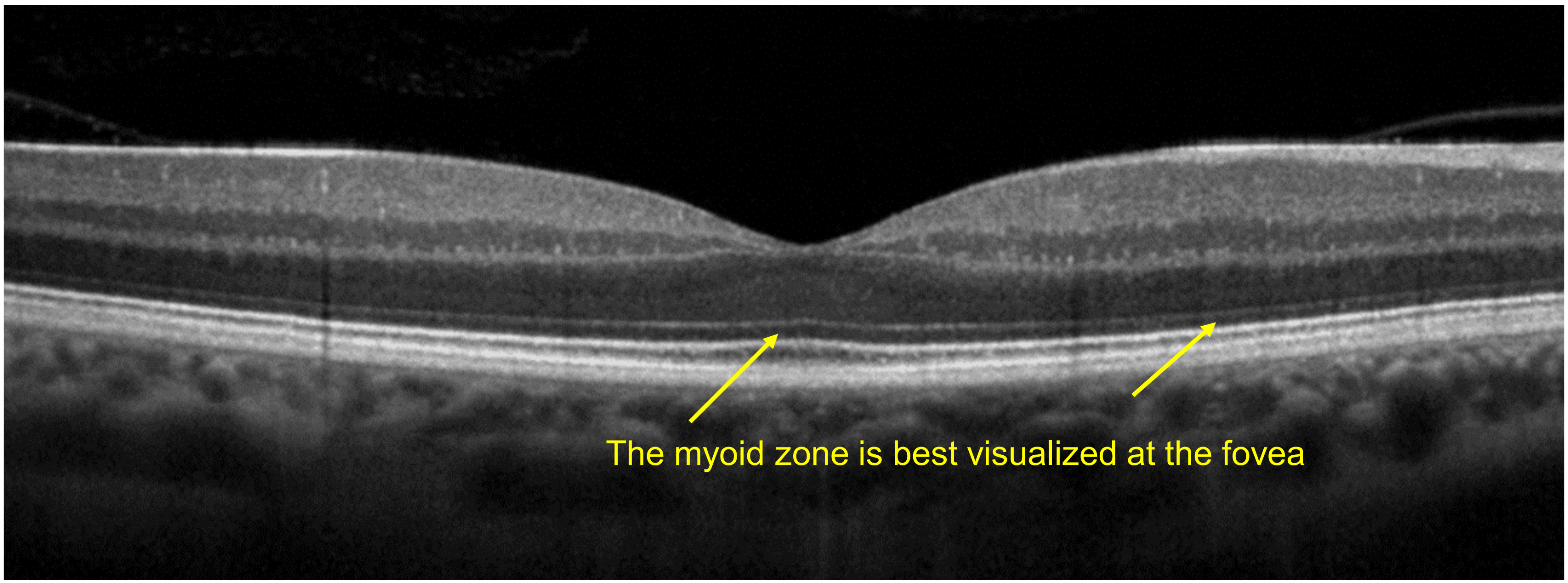
PR outer segs

Interdigitation zone

RPE/Bruch's membrane

Retinal Anatomy and Histology

Next is the **myoid zone**.
The dark band just inside the ellipsoid zone

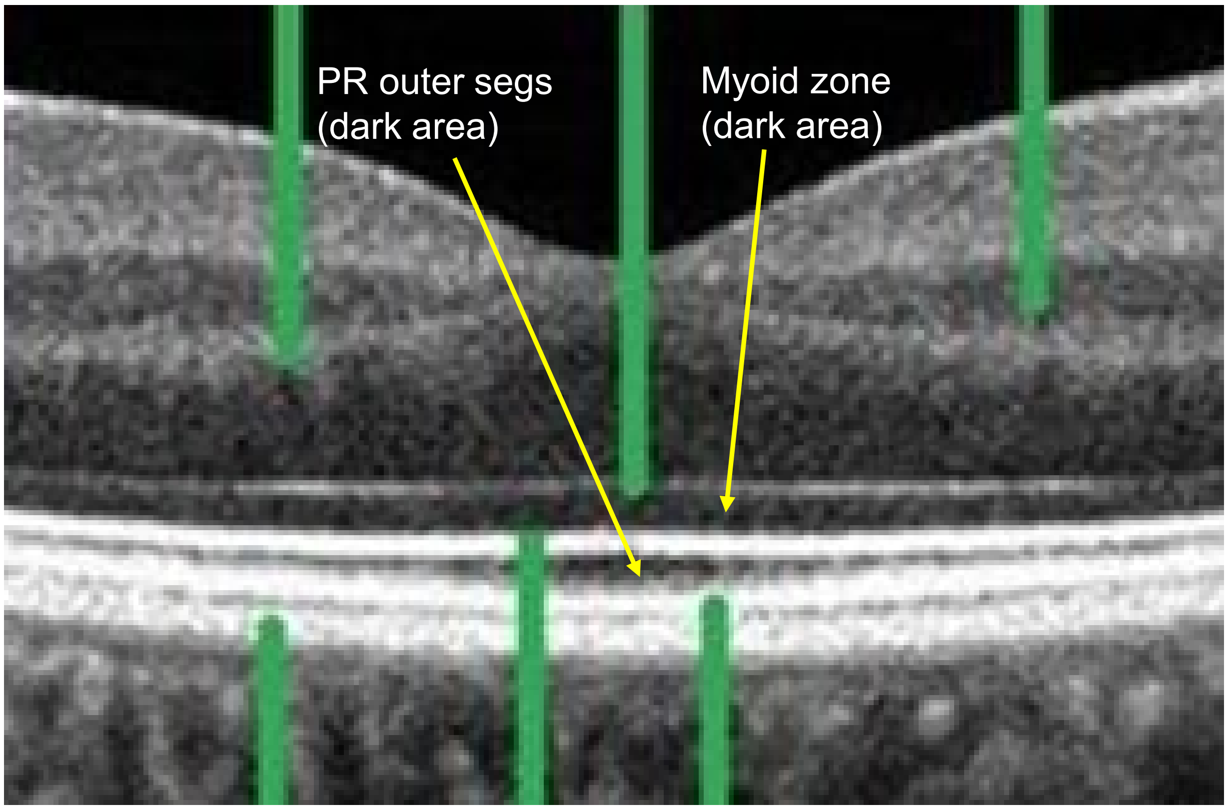


(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology

Next is the ELM.

(Ignore this line) (And this one)



RPE/Bruch's membrane

Ellipsoid zone (the white line)

Interdigitation zone

The ELM

The myoid zone

The ellipsoid zone

PR outer segs

Interdigitation zone

RPE/Bruch's membrane

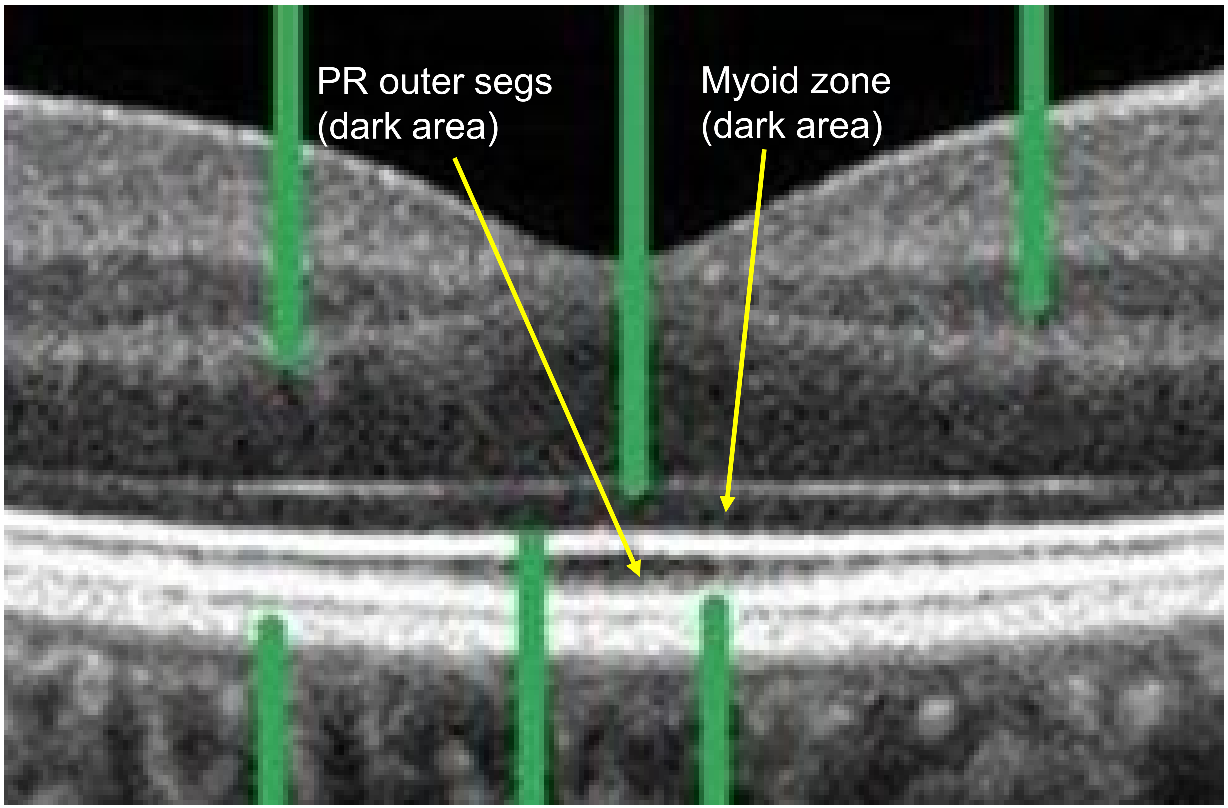
Retinal Anatomy and Histology

Next is the ELM.
It's the thin white band just inside the myoid zone

(the white line)
ELM

(Ignore this line)

(And this one)



RPE/Bruch's membrane

Ellipsoid zone (the white line)

Interdigitation zone

The ELM

The myoid zone

The ellipsoid zone

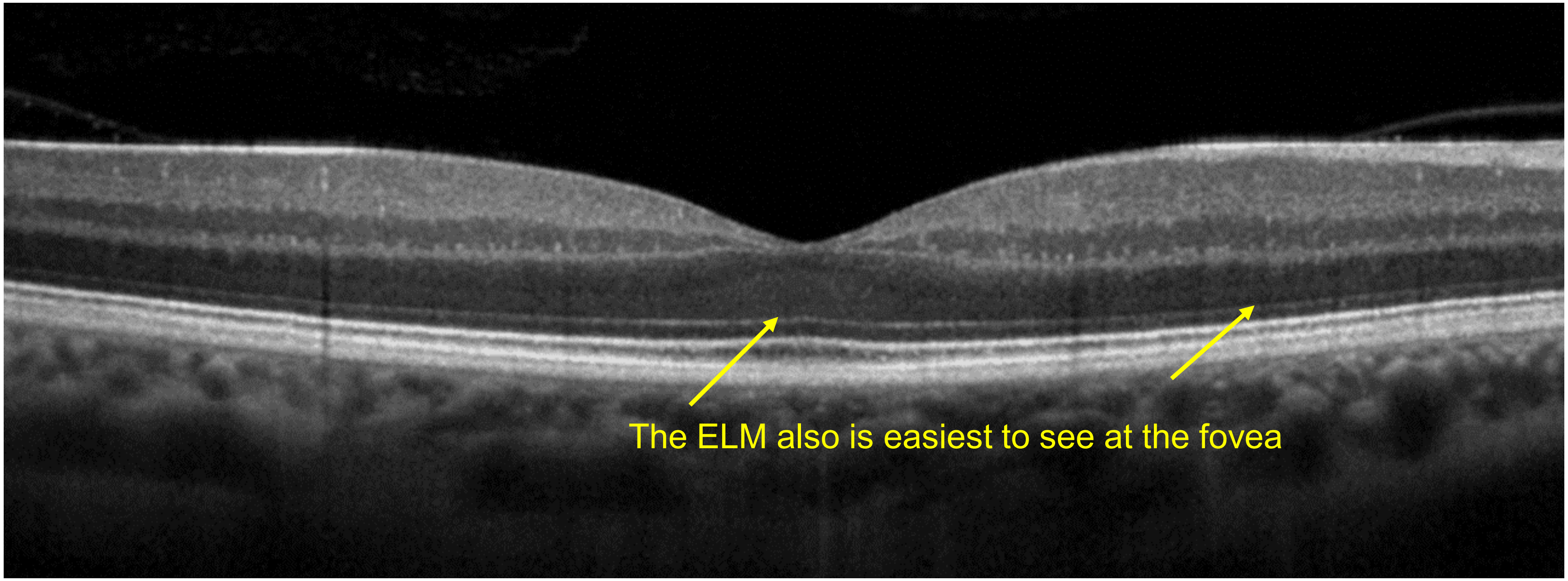
PR outer segs

Interdigitation zone

RPE/Bruch's membrane

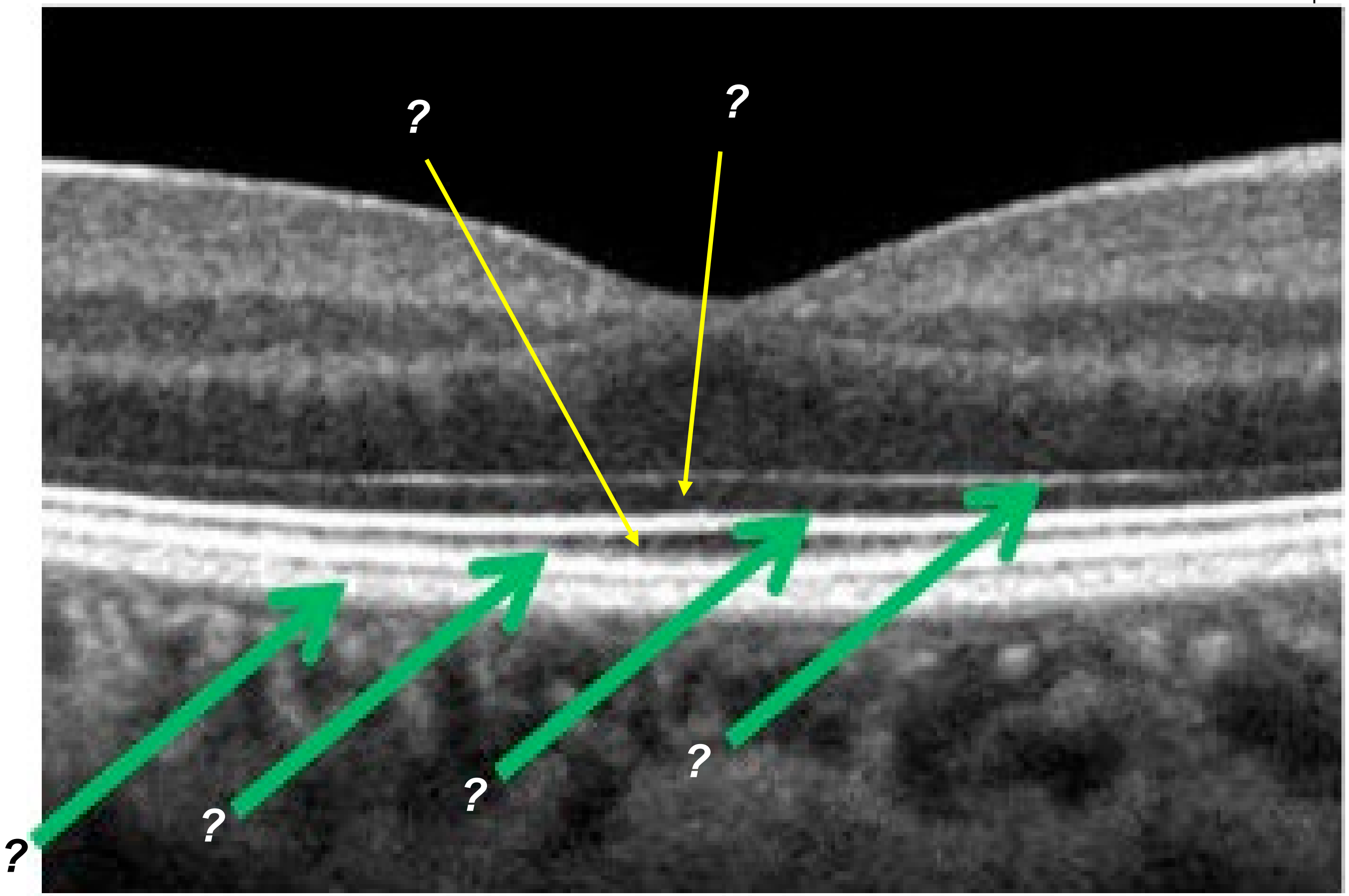
Retinal Anatomy and Histology

Next is the **ELM**.
It's the thin white band just inside the myoid zone



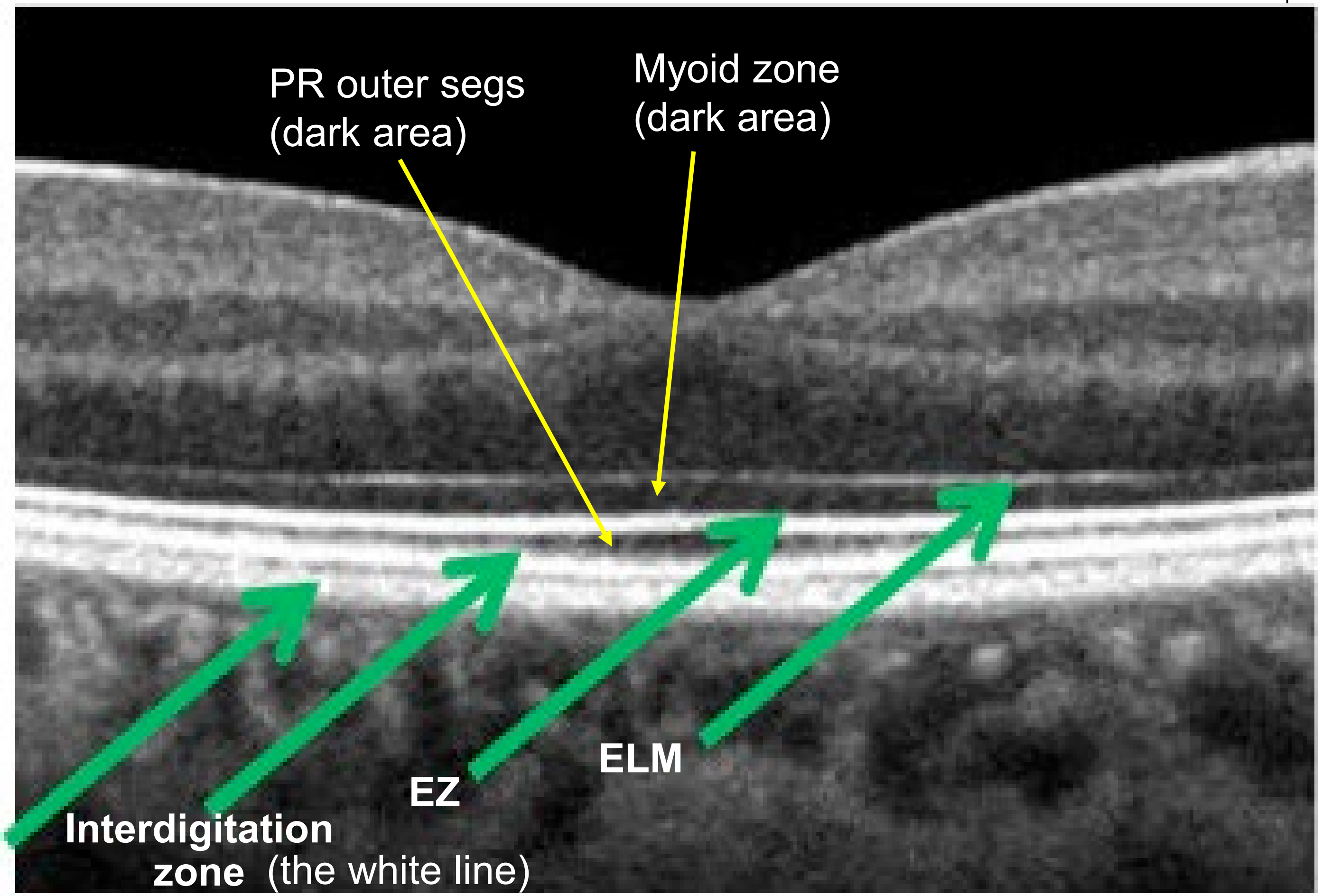
(Locating the same structure on a full-size OCT image)

Retinal Anatomy and Histology



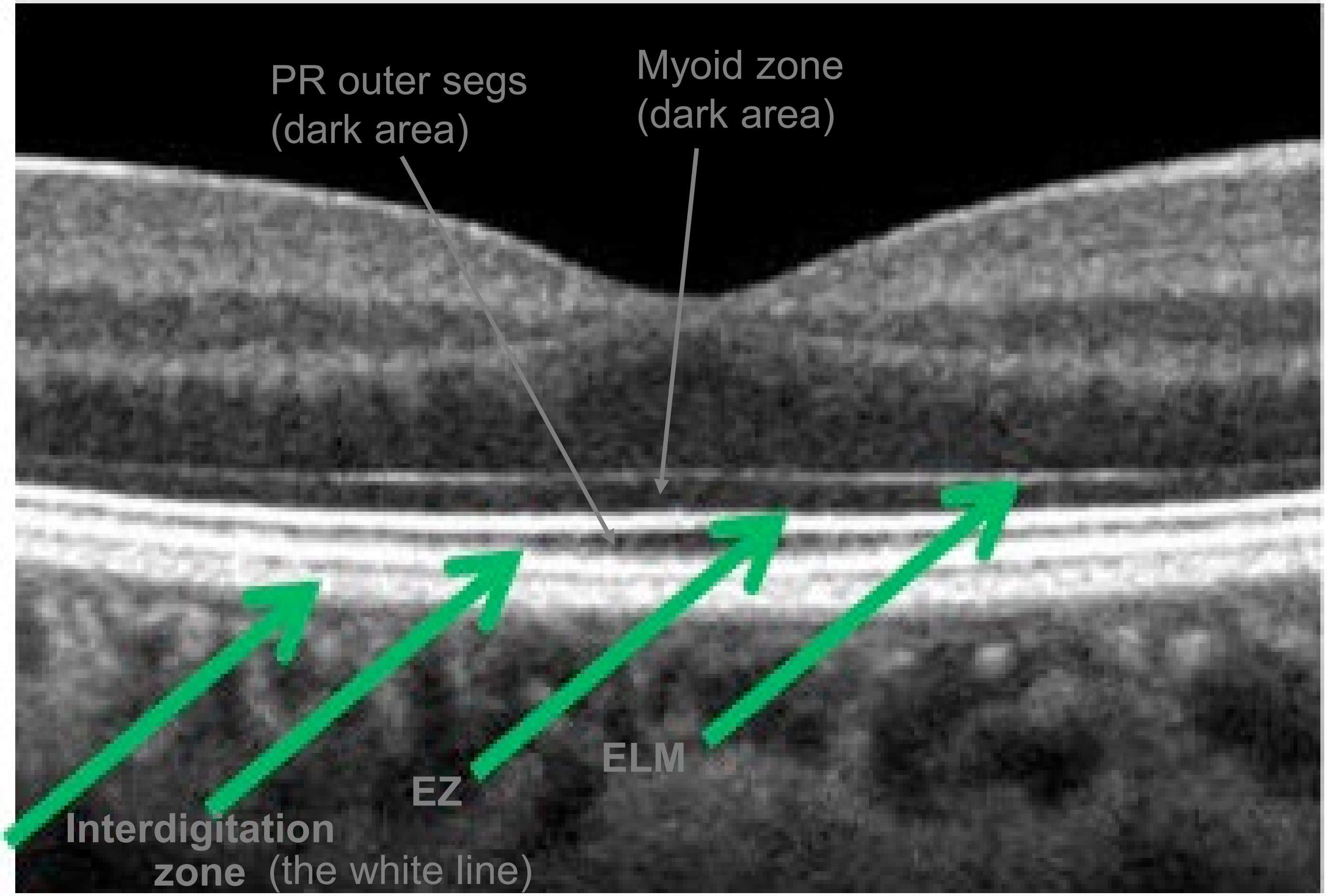
Quiz yourself by toggling back and forth between this slide and the next

Retinal Anatomy and Histology



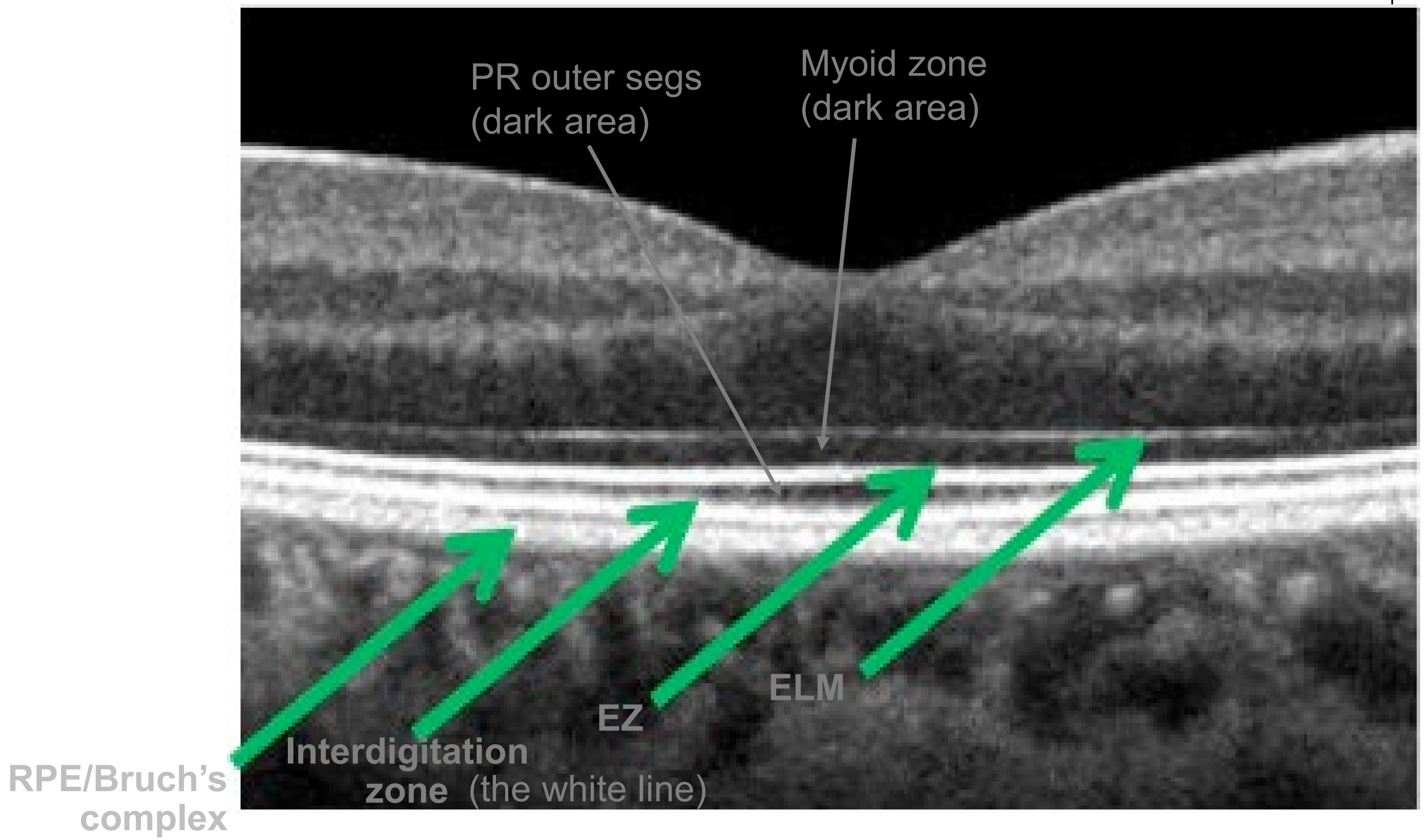
Quiz yourself by toggling back and forth between this slide and the next

Retinal Anatomy and Histology



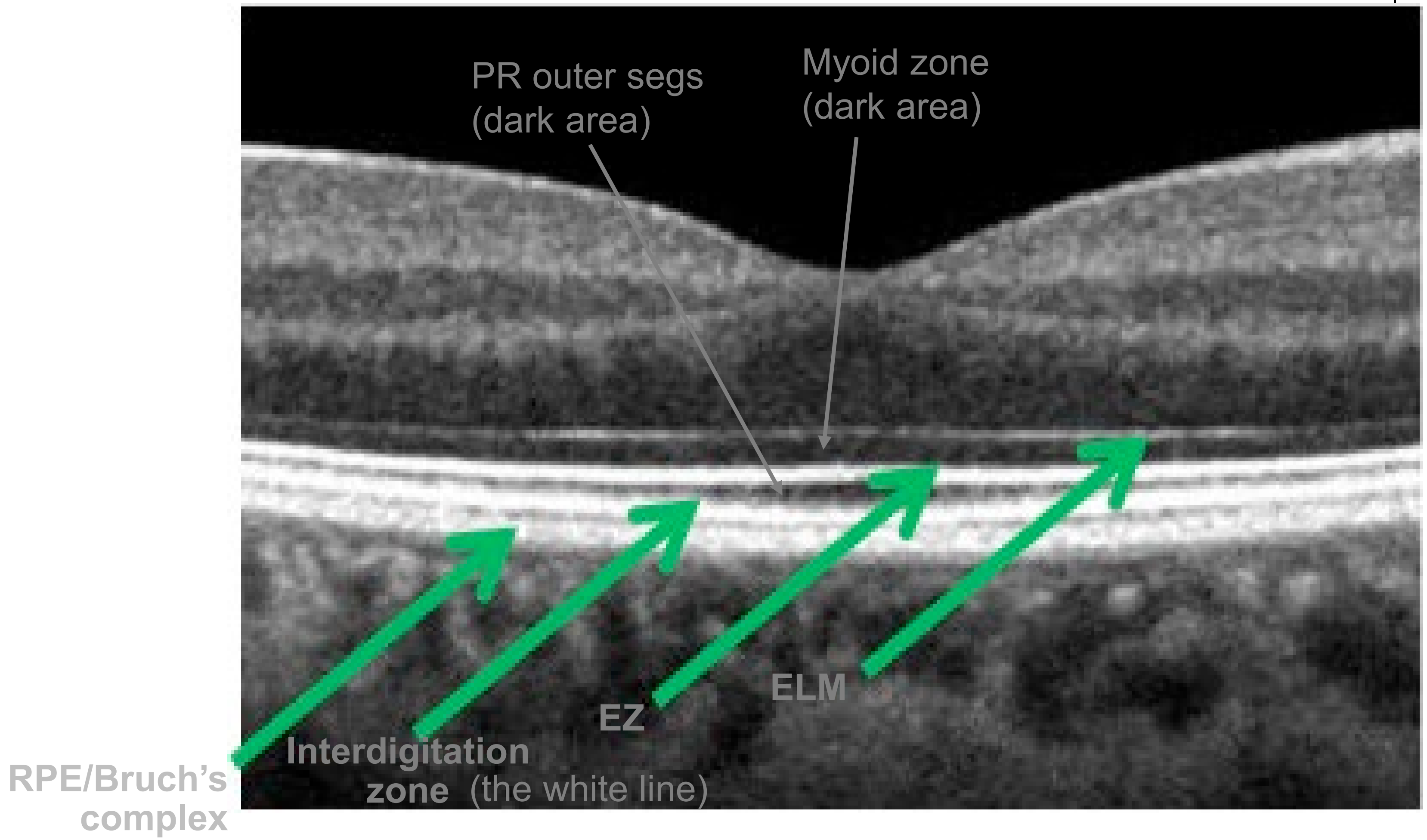
An important meta-point to come away with from all this is, OCT bands are determined by differences in tissue reflectivity, but *differences in reflectivity don't necessarily correlate 1:1 with retinal* ***anatomy***.

Retinal Anatomy and Histology



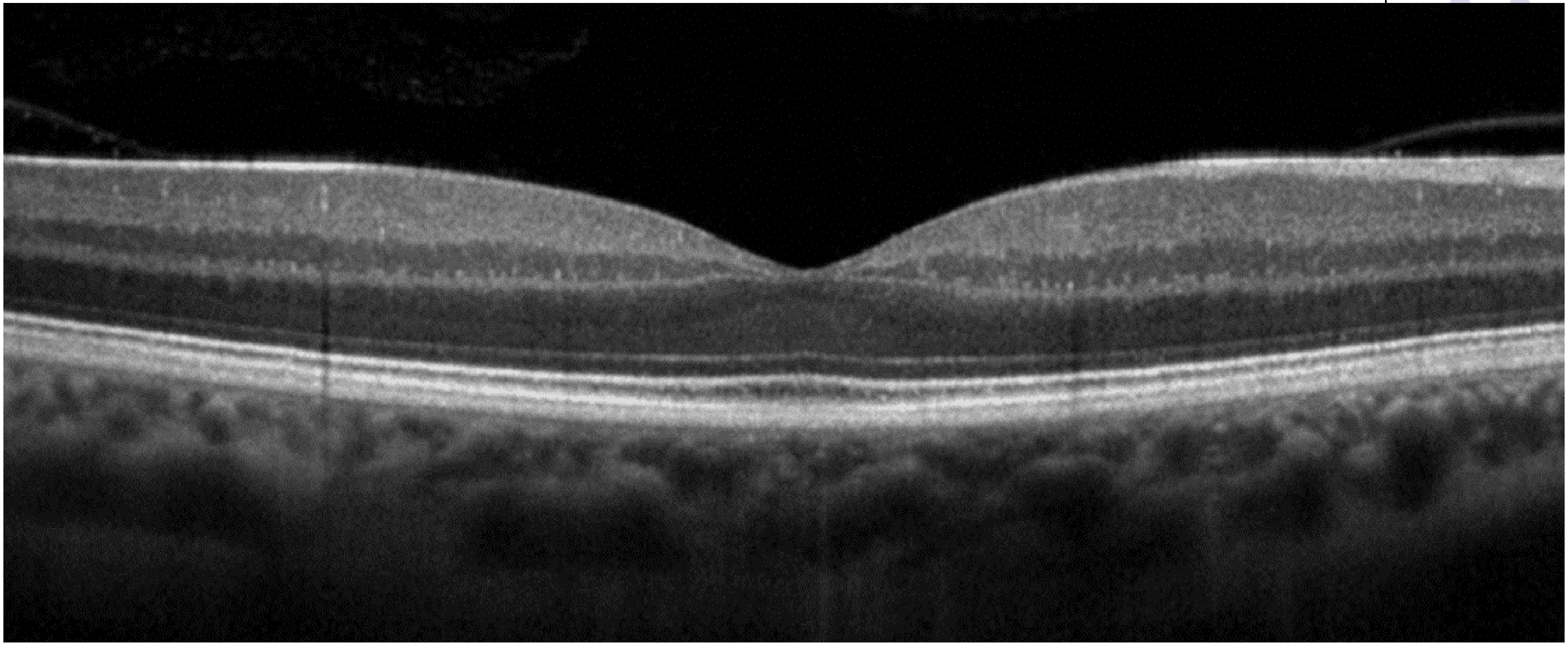
An important meta-point to come away with from all this is, OCT bands are determined by differences in tissue reflectivity, but *differences in reflectivity don't necessarily correlate 1:1 with retinal* ***anatomy***. Consider the ellipsoid and myoid of the PRs. They are parts of the same anatomic structure (the PR inner seg), but to the OCT scanner, they look **radically** different from one another.

Retinal Anatomy and Histology



An important meta-point to come away with from all this is, OCT bands are determined by differences in tissue reflectivity, but *differences in reflectivity don't necessarily correlate 1:1 with retinal **anatomy***. Consider the ellipsoid and myoid of the PRs. They are parts of the same anatomic structure (the PR inner seg), but to the OCT scanner, they look **radically** different from one another. Remember, the OCT is under no obligation to 'see' the retina the way an anatomist sees it.

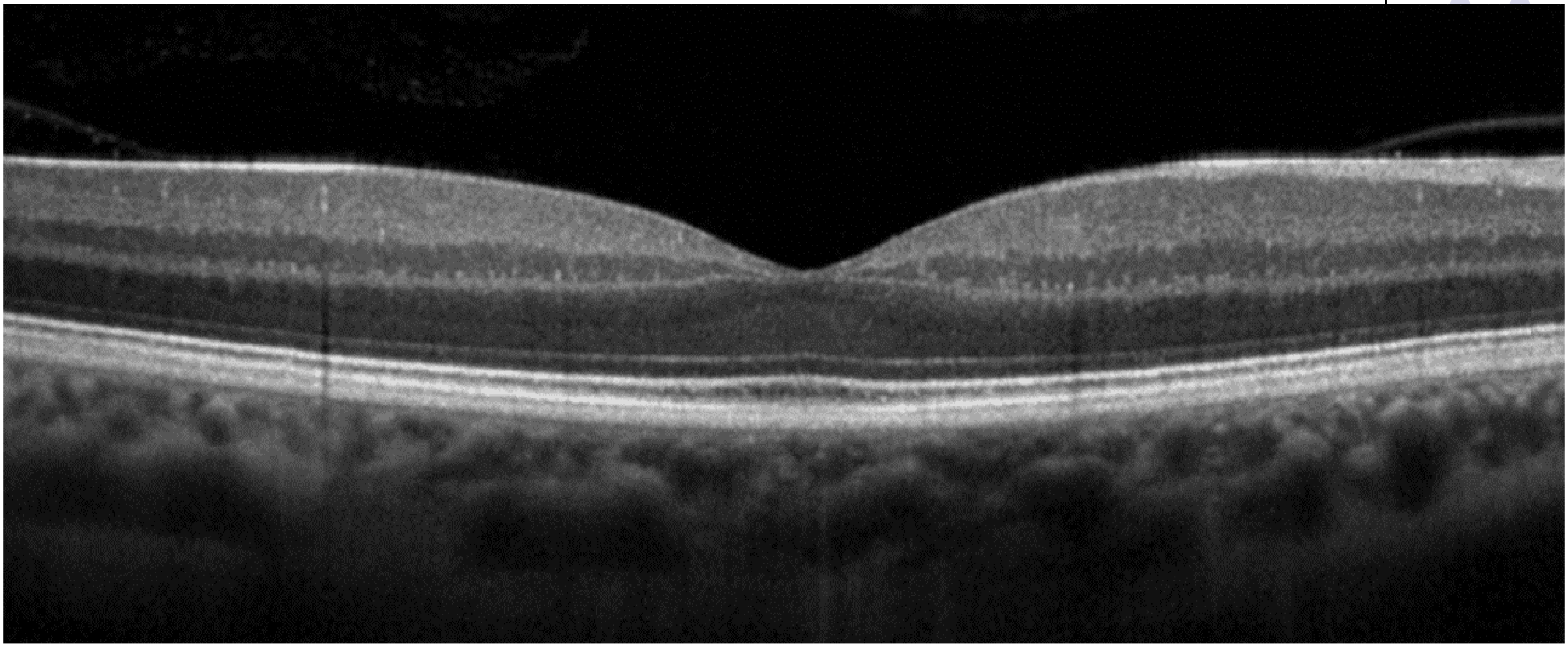
Retinal Anatomy and Histology



For the remainder of our intro to OCT, we're going to switch gears and work ***outward*** *from the* ***inner*** *aspect of the scan*

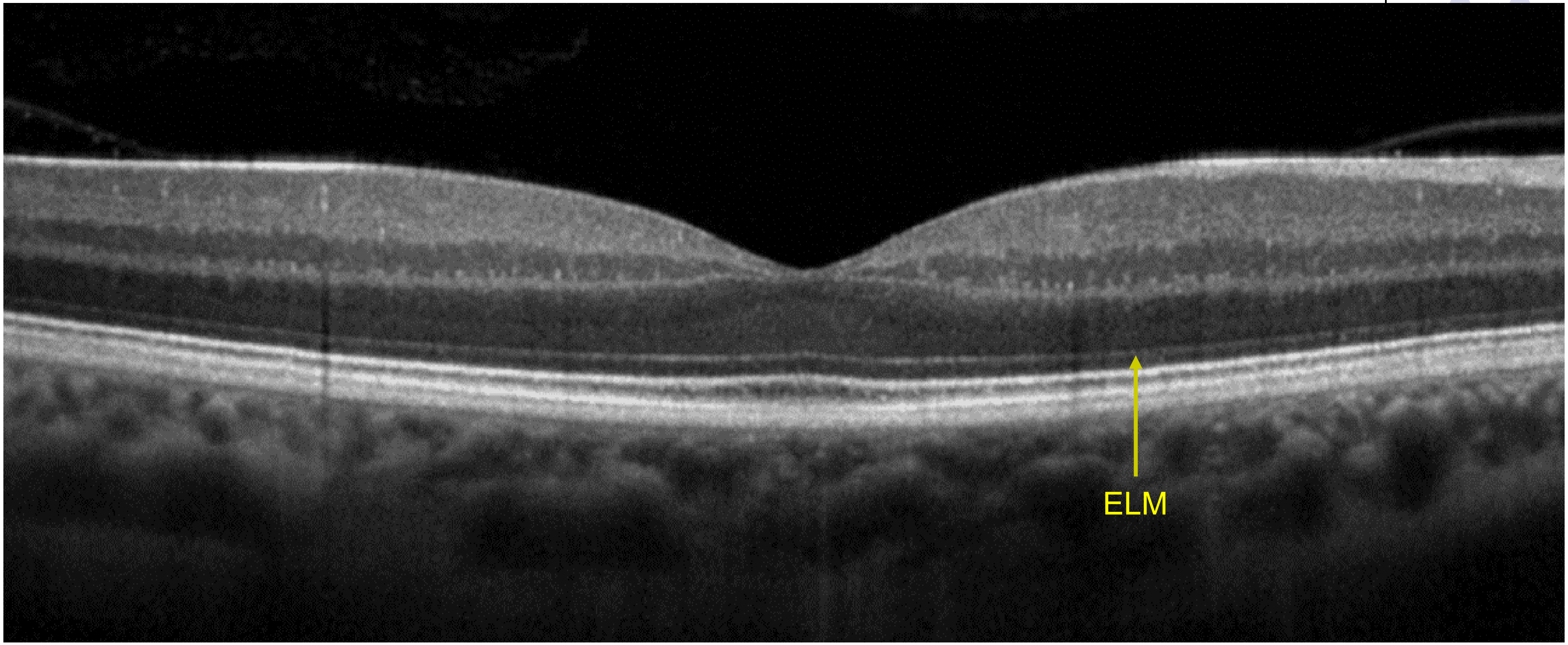
(No question—proceed when ready)

Retinal Anatomy and Histology



First things first: In order to 'set the floor' re how far down we need to go, locate the ELM:

Retinal Anatomy and Histology



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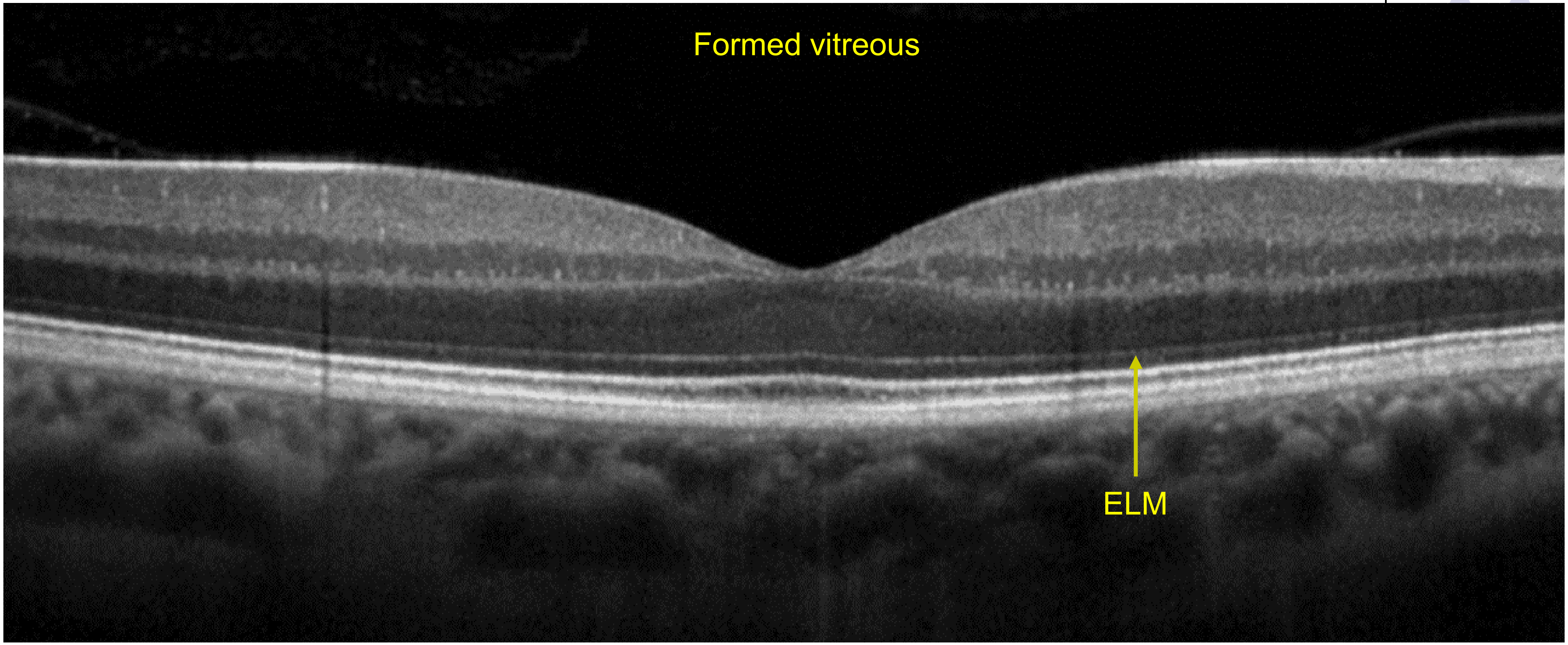
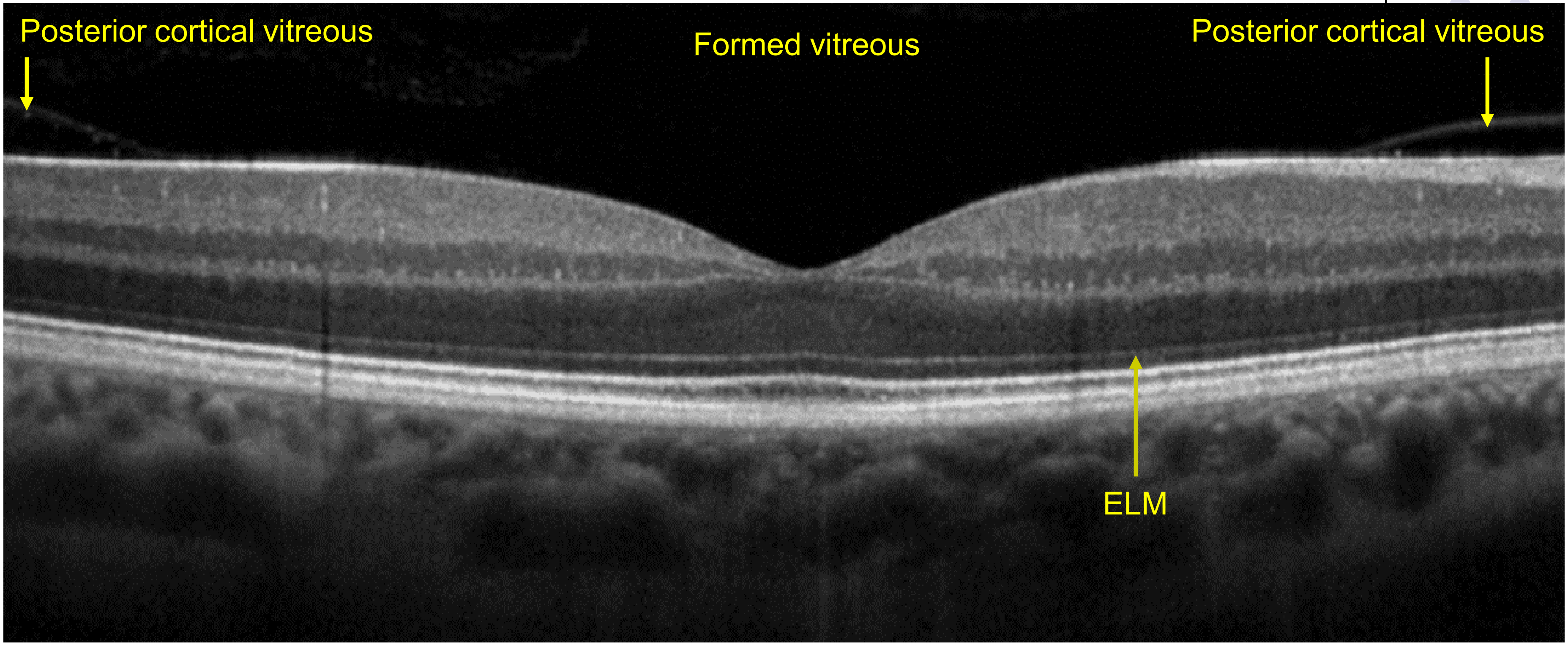
Retinal Anatomy and Histology



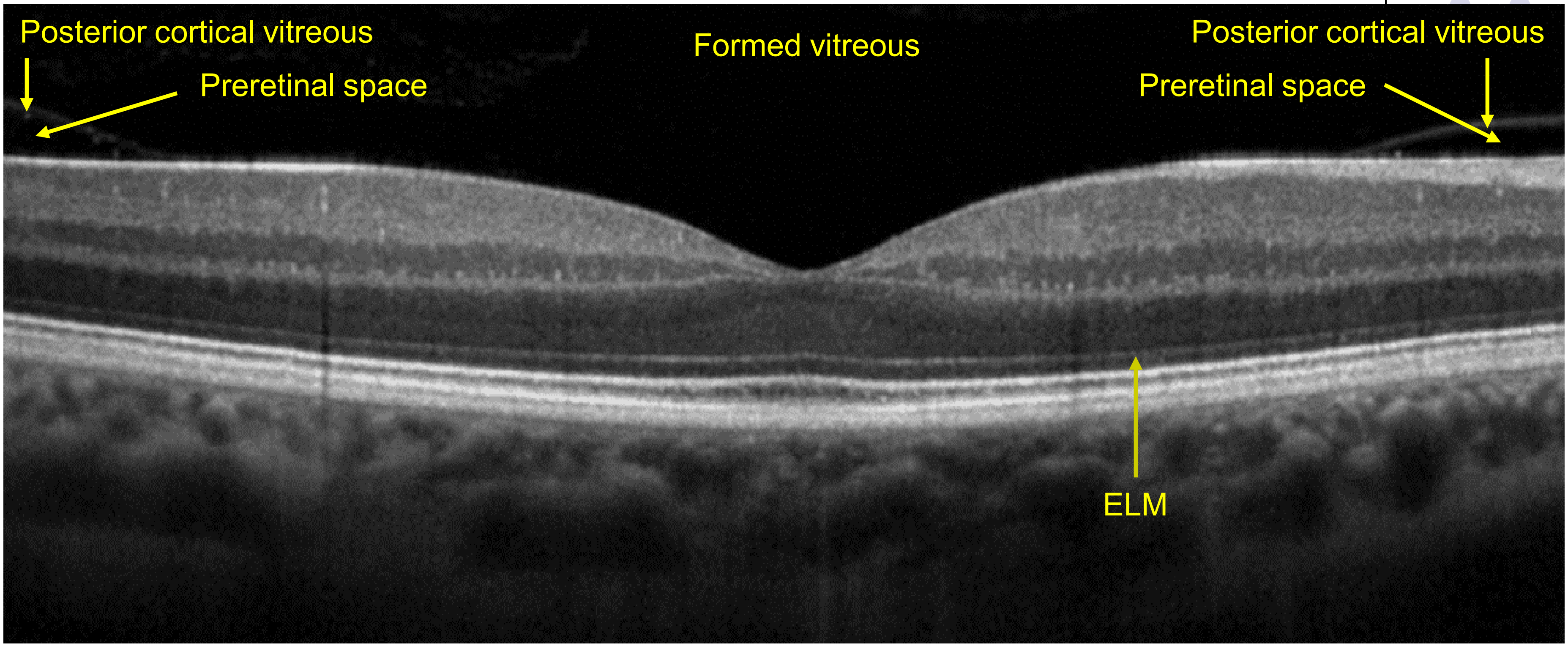
Next, let’s identify the following preretinal structures:
--The formed vitreous

Retinal Anatomy and Histology



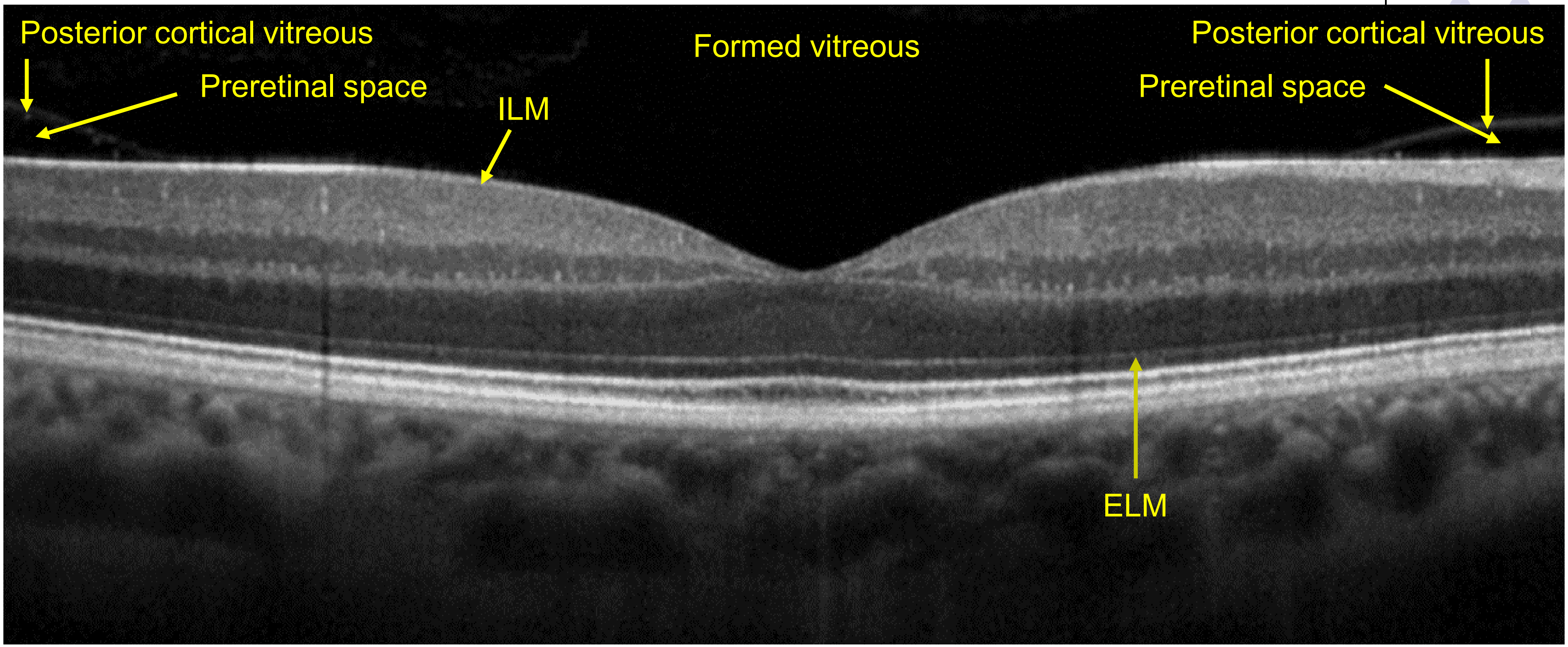
Next, let's identify the following preretinal structures:
--The formed vitreous
--The posterior cortical vitreous

Retinal Anatomy and Histology



Next, let's identify the following preretinal structures:
--The formed vitreous
--The posterior cortical vitreous
--The preretinal space

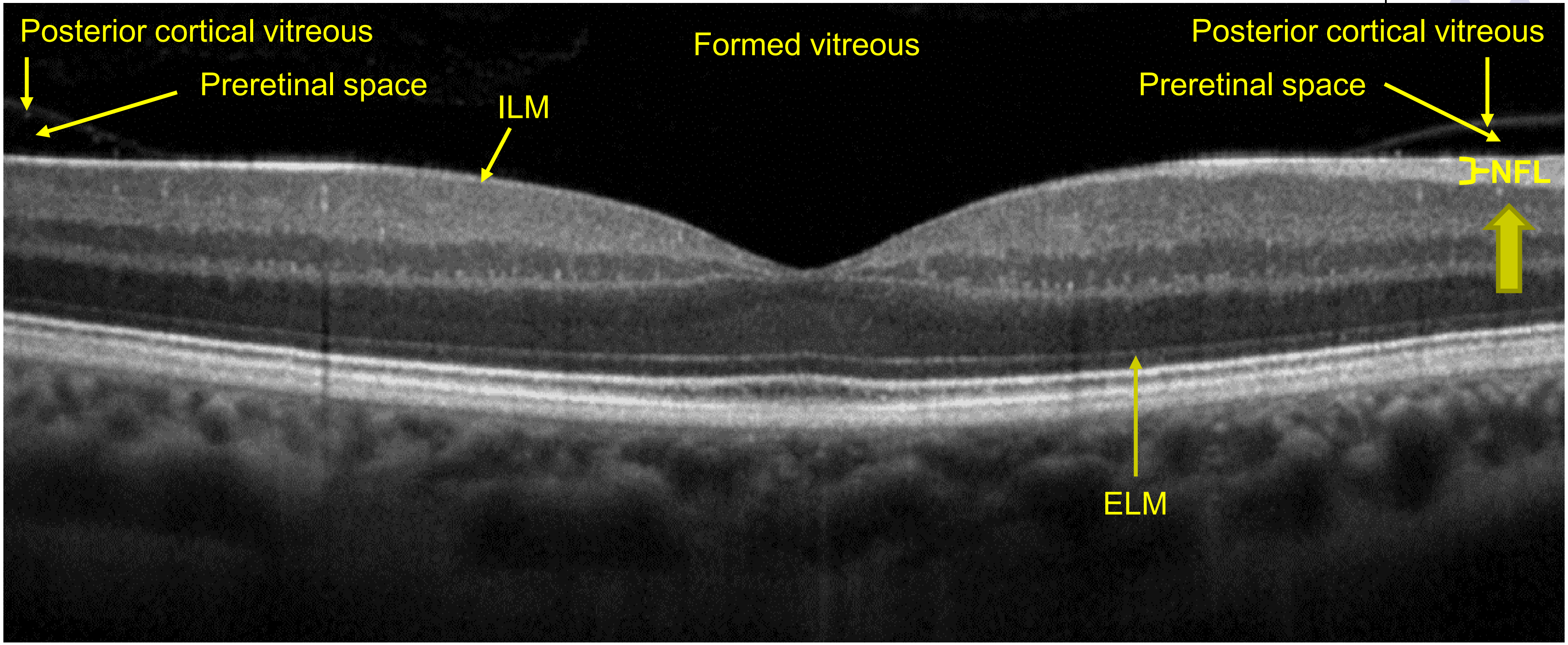
Retinal Anatomy and Histology



Next, let's identify the following preretinal structures:
--The formed vitreous
--The posterior cortical vitreous
--The preretinal space

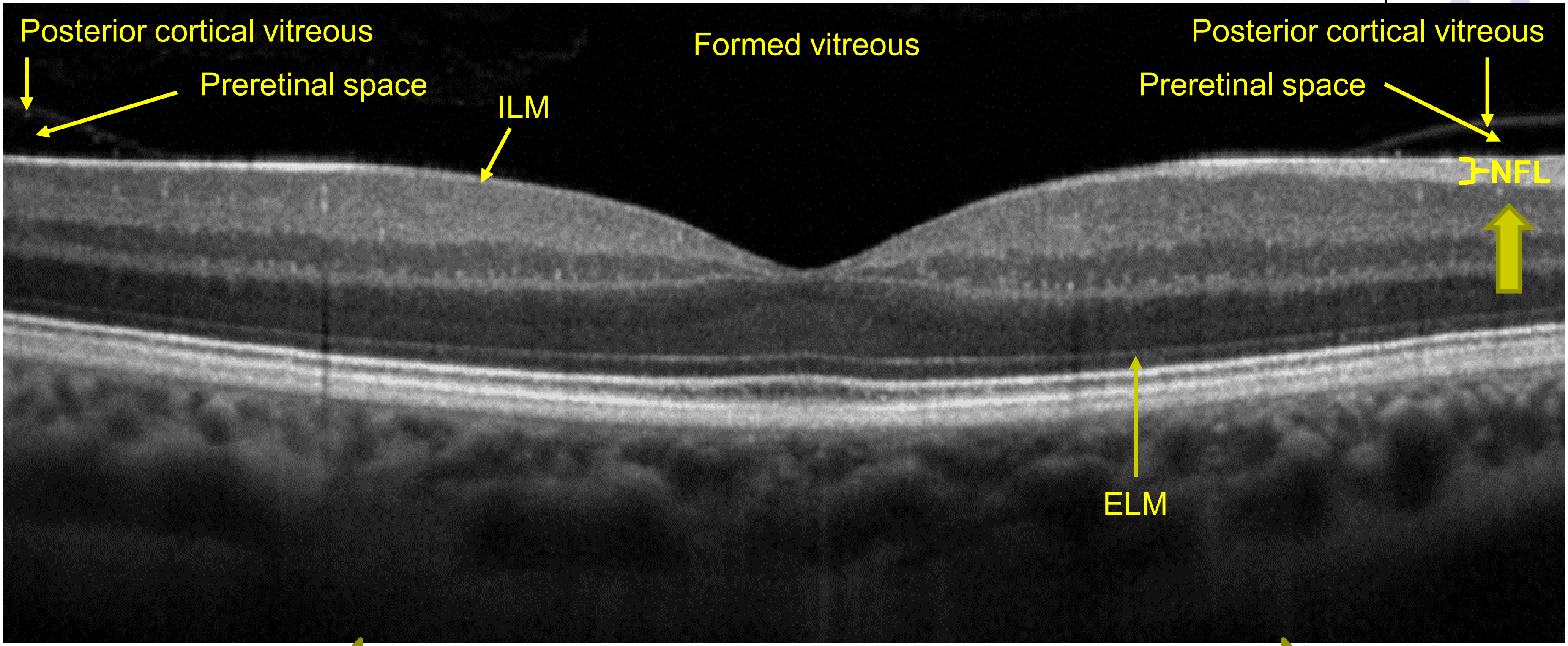
And now the innermost **retinal** structure, the ILM:

Retinal Anatomy and Histology



Next commences the layers of neural elements, starting with the nerve fiber layer

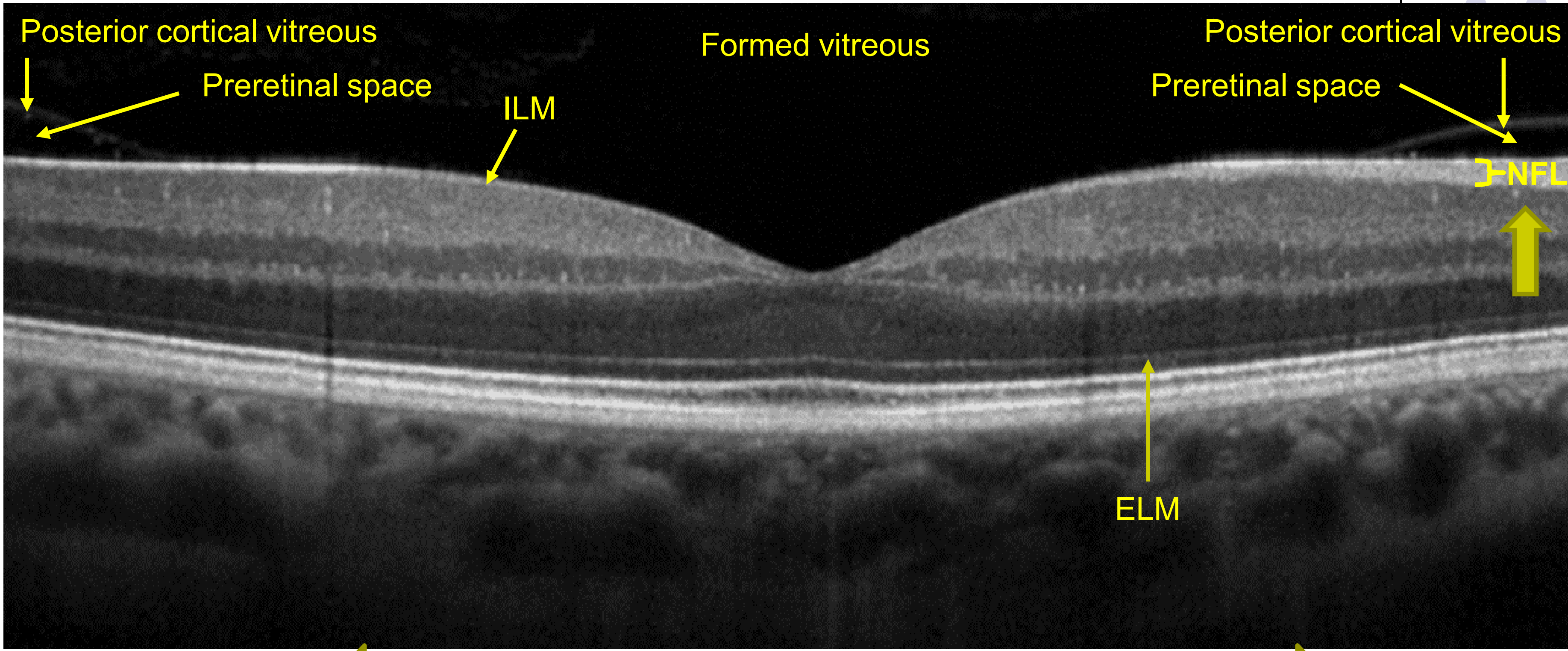
Retinal Anatomy and Histology



Next commenc... the layers of neural elements, starting with the nerve fibe... yer

Temporal On this scan, this side is temporal, and this side is nasal. ***Nasal***

Retinal Anatomy and Histology

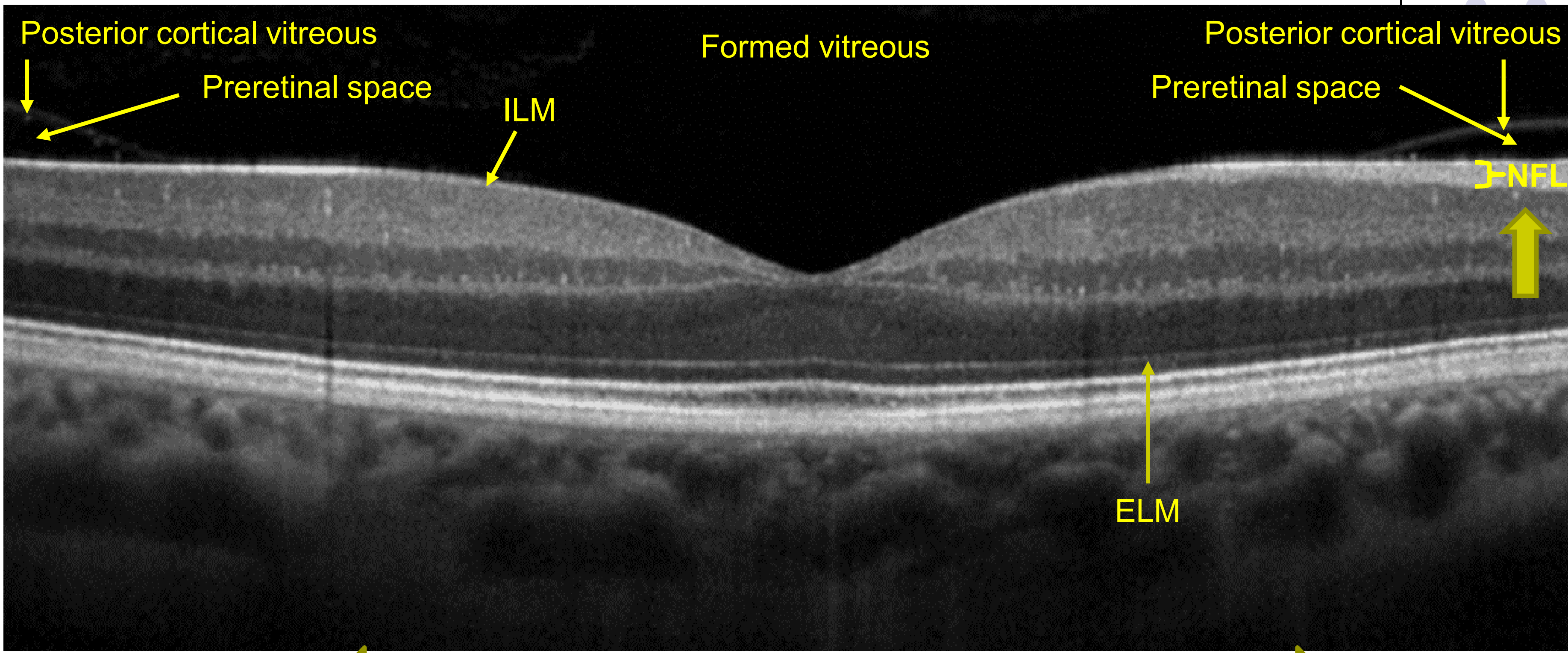


Next commenc the layers of neural elements, starting with the nerve fibe yer

Temporal On this scan, this side is temporal, and this side is nasal. ***Nasal***

You can tell because the NFL is always thicker on the nasal side, owing to the fact that this is the side the papillomacular bundle is located on.

Retinal Anatomy and Histology



Next commenc the layers of neural elements, starting with the nerve fibe yer

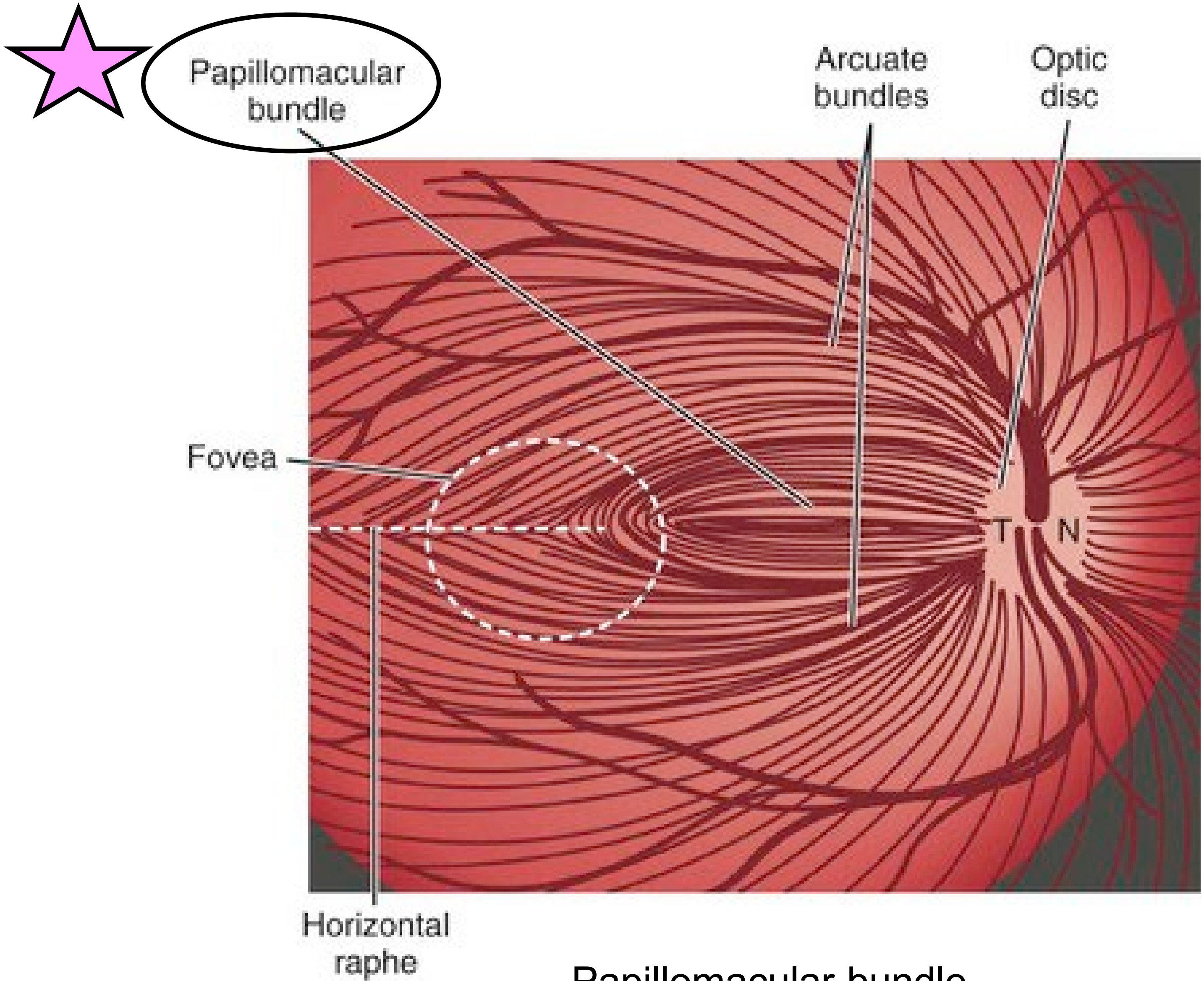
Temporal

On this scan, this side is temporal, and this side is nasal.
You can tell because the NFL is always thicker on the nasal side, owing to the fact that this is the side the **papillomacular bundle** is located on.

Nasal

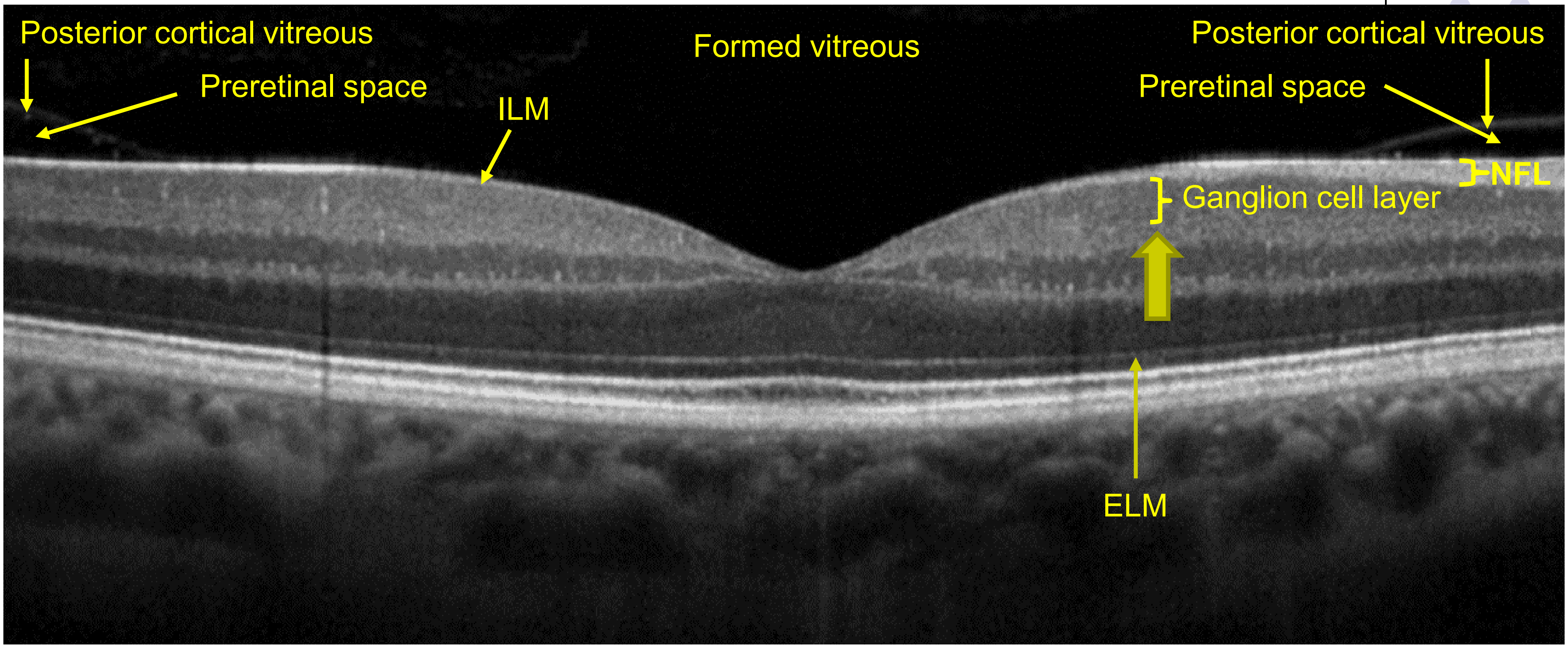
The PMB is the set of fibers running from the fovea directly to the ONH

Retinal Anatomy and Histology



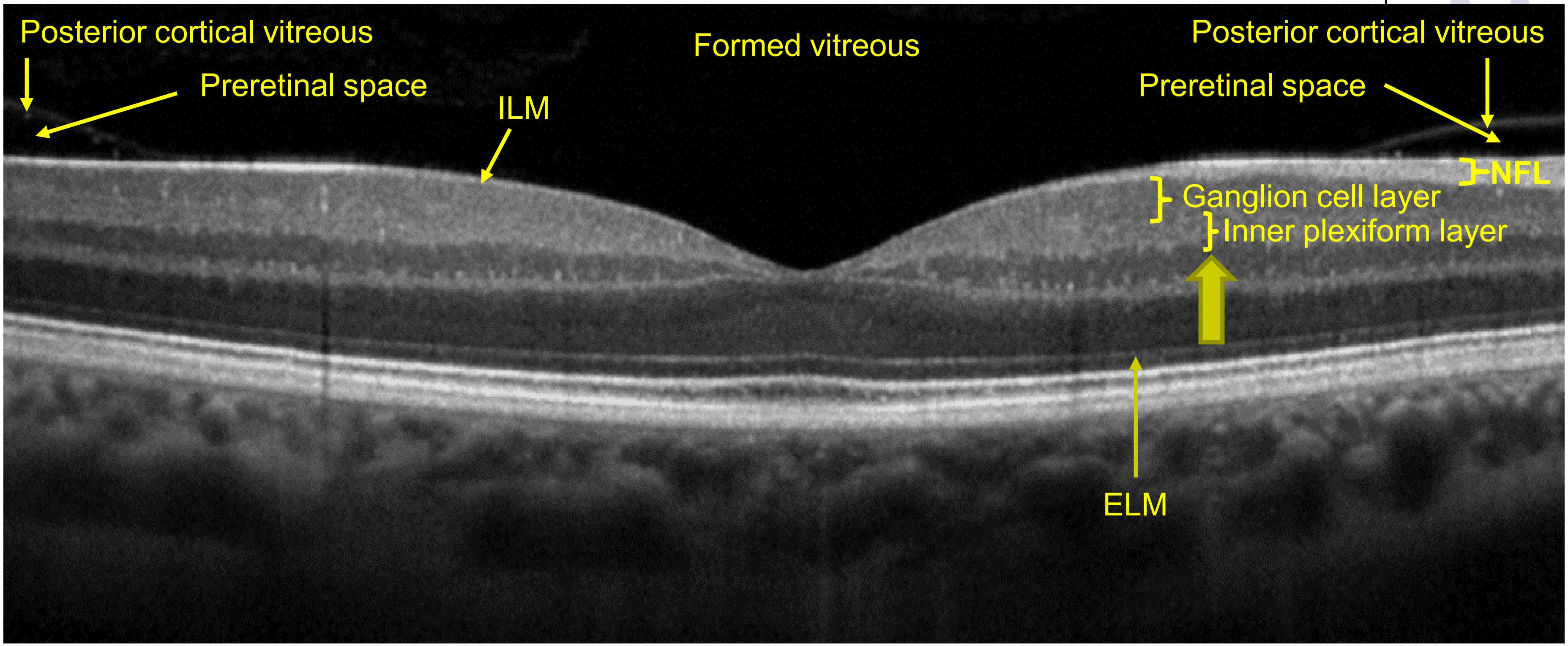
Papillomacular bundle

Retinal Anatomy and Histology



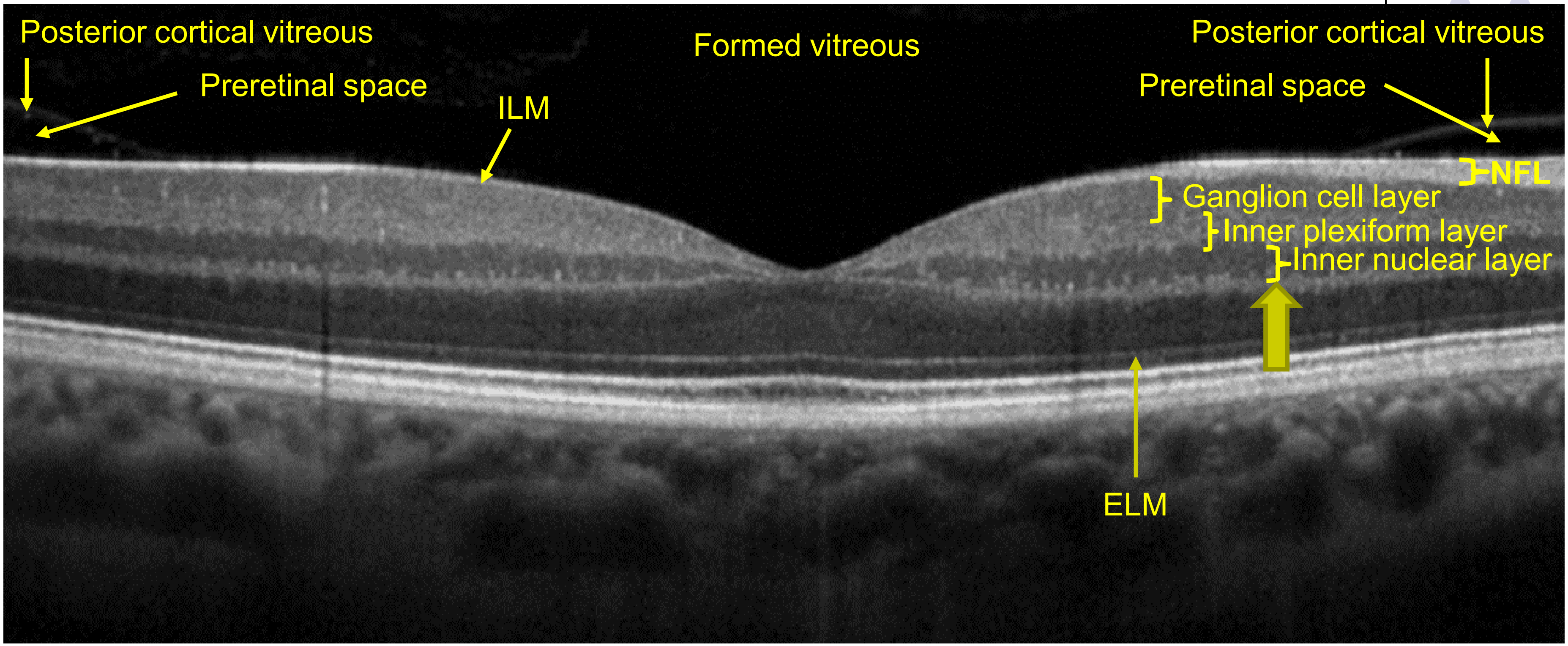
Next commences the layers of neural elements, starting with the nerve fiber layer . As the composition of the layers alternate, the next one must contain cell bodies; sure enough, it is the ganglion cell layer .

Retinal Anatomy and Histology



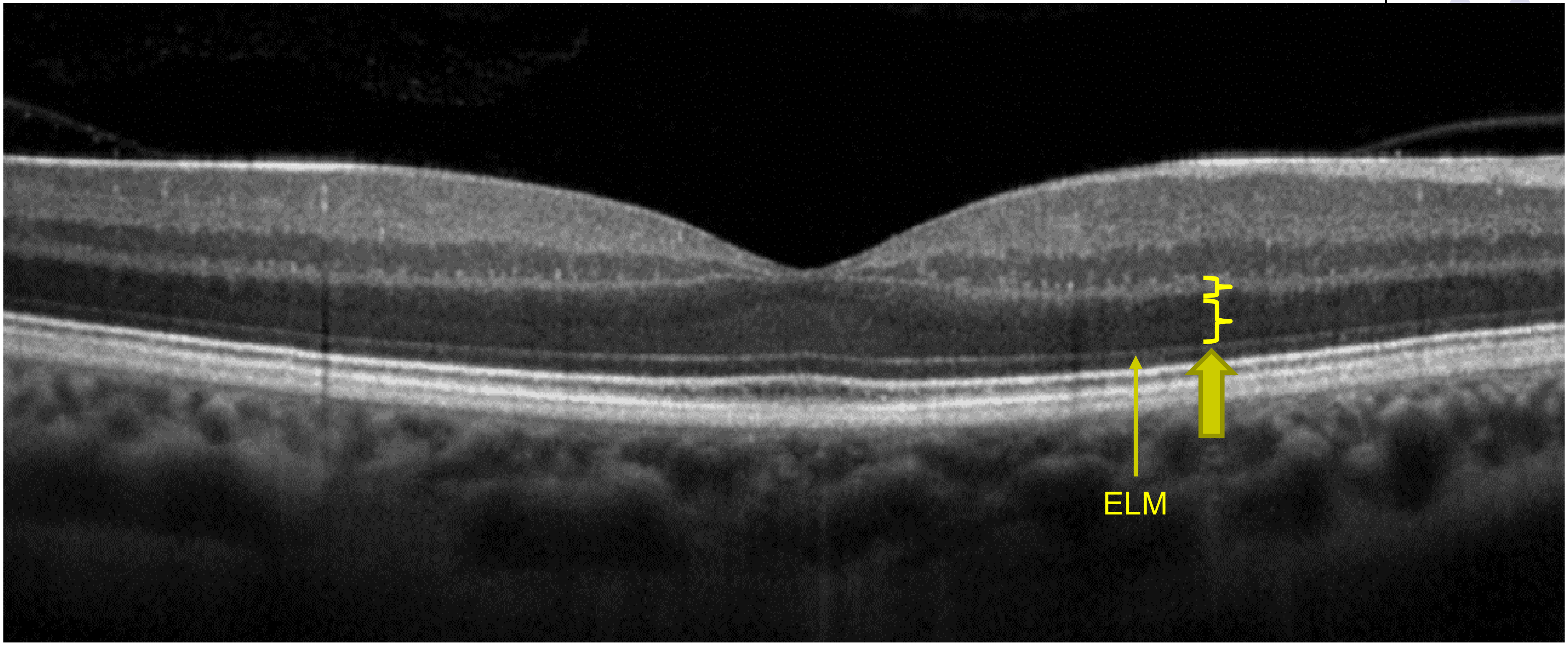
Next commences the layers of neural elements, starting with the nerve fiber layer . As the composition of the layers alternate, the next one must contain cell bodies; sure enough, it is the ganglion cell layer . The next, 'processes' layer is the inner plexiform layer

Retinal Anatomy and Histology



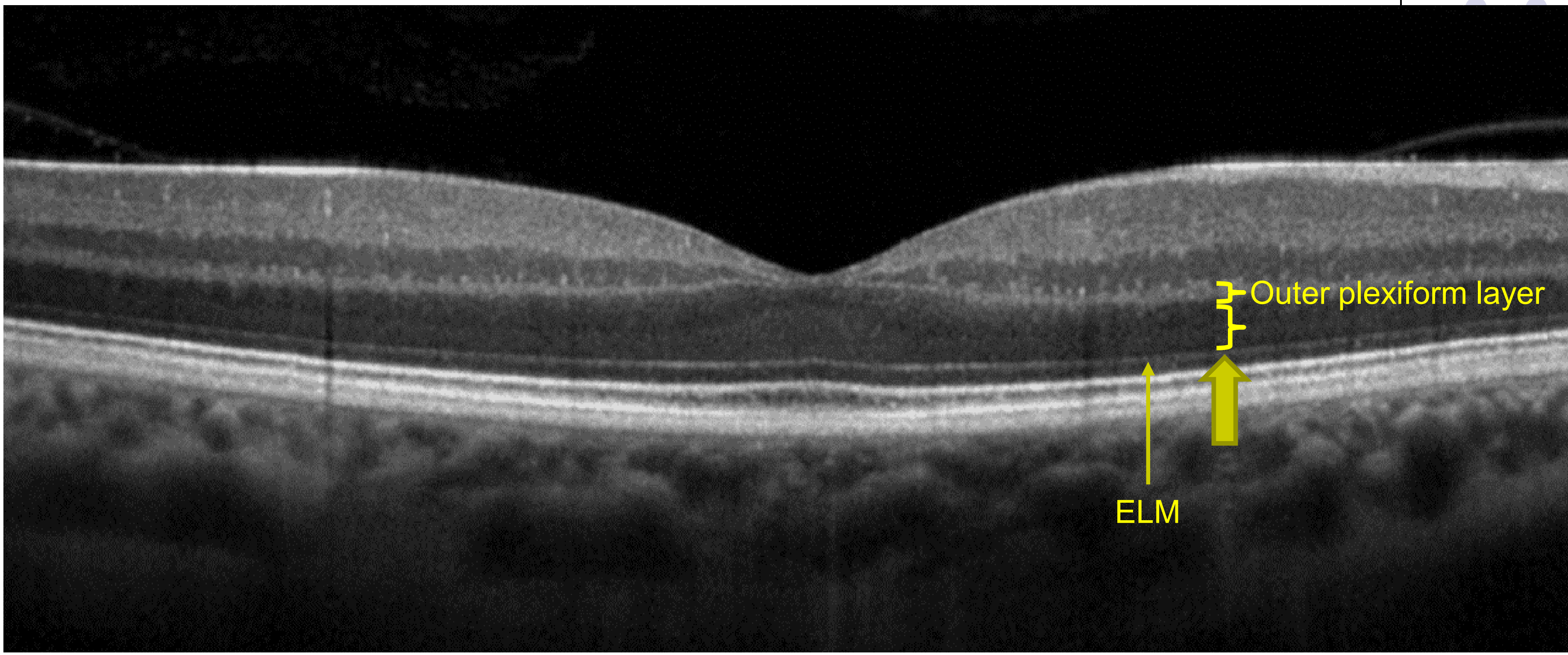
Next commences the layers of neural elements, starting with the nerve fiber layer . As the composition of the layers alternate, the next one must contain cell bodies; sure enough, it is the ganglion cell layer . The next, 'processes' layer is the inner plexiform layer , followed by the next cell-body layer, the inner nuclear layer .

Retinal Anatomy and Histology



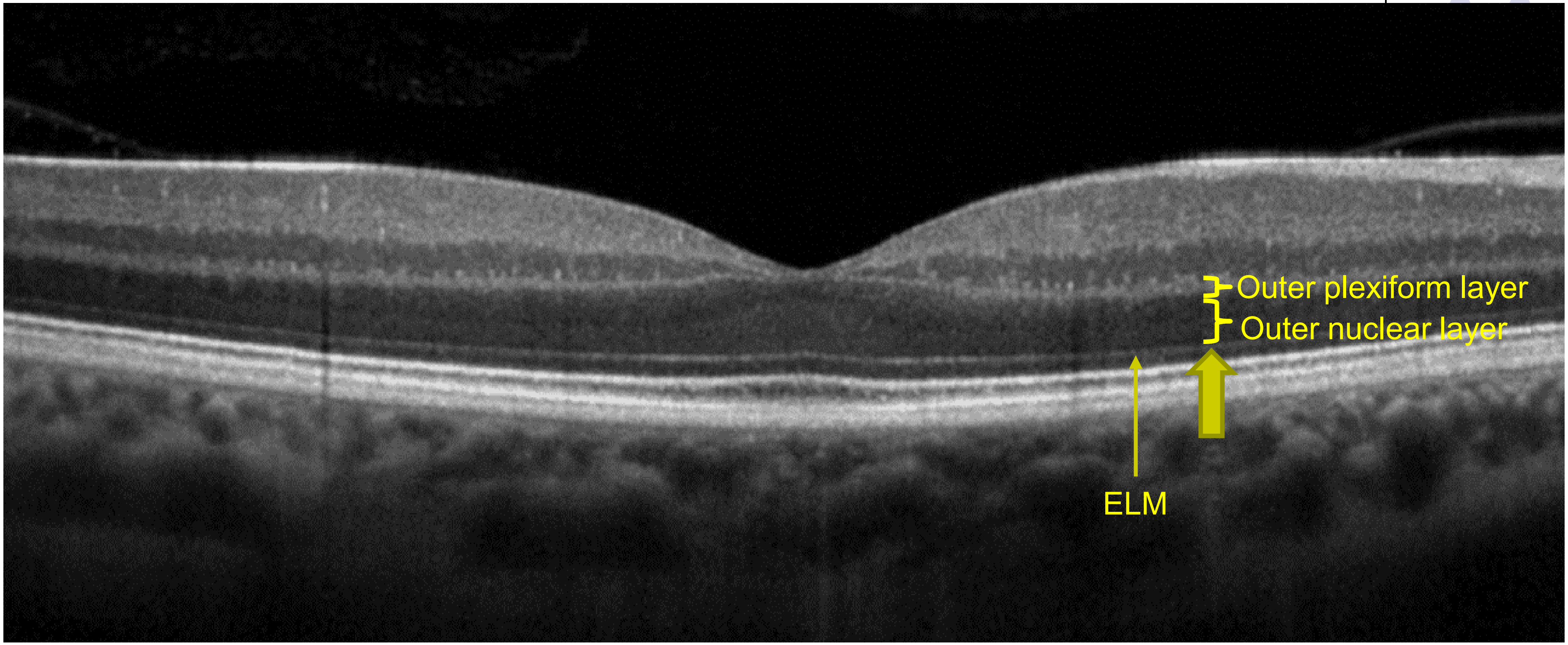
Things seem to be working out perfectly. The OCT appears to have two layers left to identify.

Retinal Anatomy and Histology



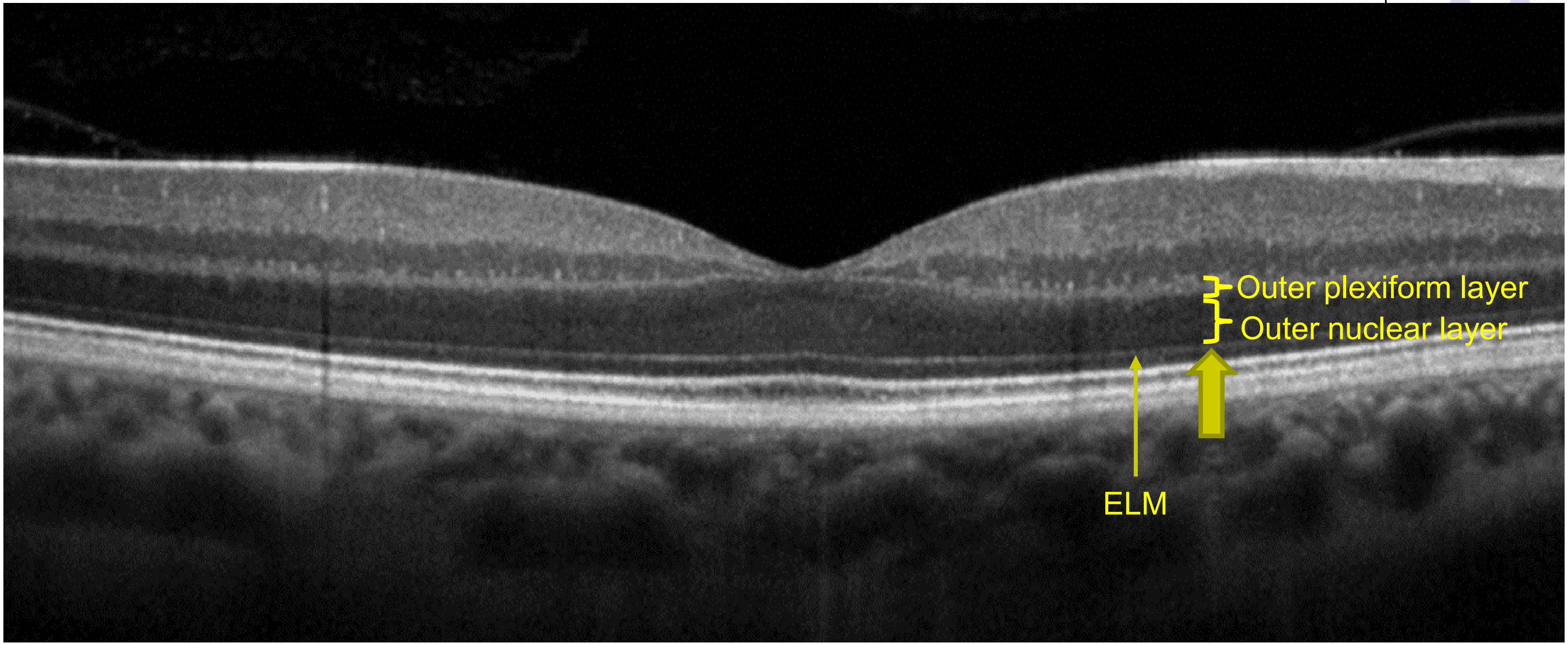
Things seem to be working out perfectly. The OCT appears to have two layers left to identify. Conveniently, there are two yet-unassigned layers—a processes layer (the outer plexiform layer)

Retinal Anatomy and Histology



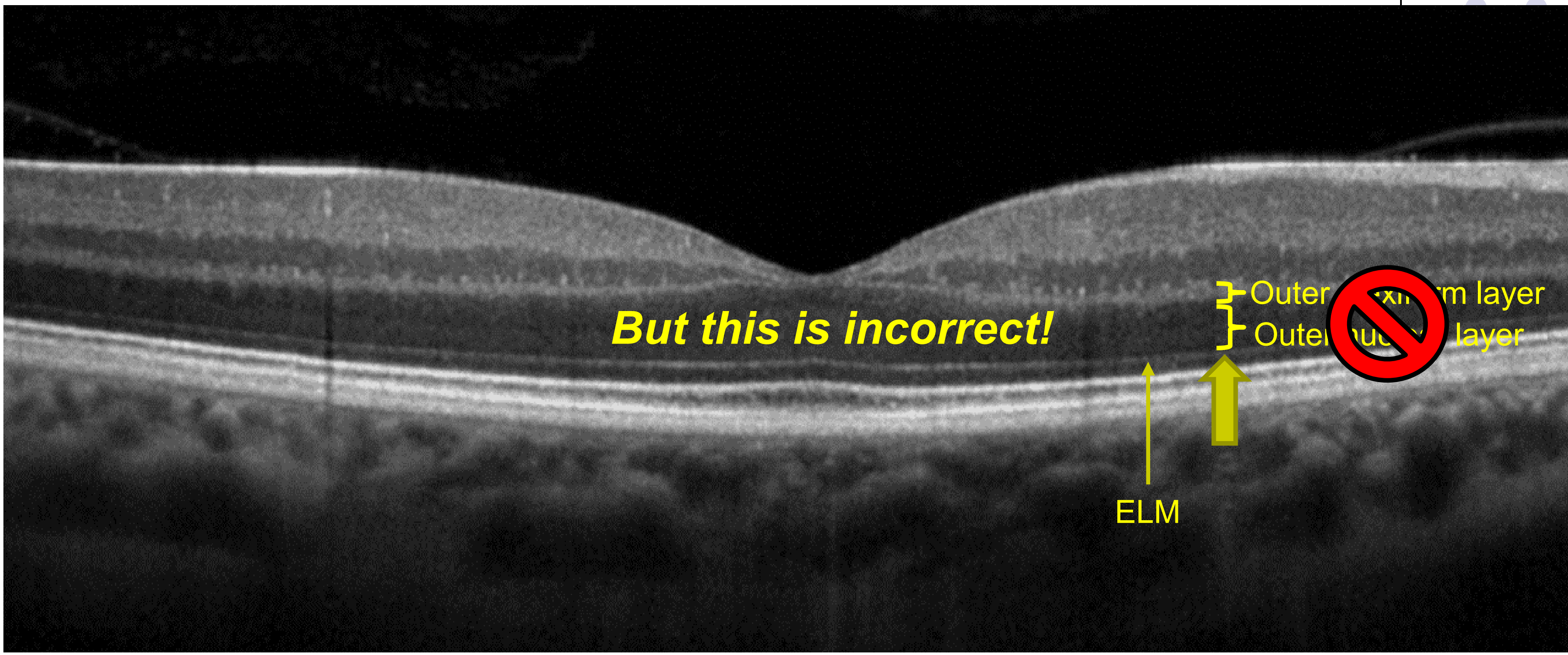
Things seem to be working out perfectly. The OCT appears to have two layers left to identify. Conveniently, there are two yet-unassigned layers—a processes layer (the outer plexiform layer), and a cell-bodies layer (the outer nuclear layer).

Retinal Anatomy and Histology



Things seem to be working out perfectly. The OCT appears to have two layers left to identify. Conveniently, there are two yet-unassigned layers—a processes layer (the outer plexiform layer), and a cell-bodies layer (the outer nuclear layer). Not uncommonly, you will see OCTs labeled in just this fashion.

Retinal Anatomy and Histology



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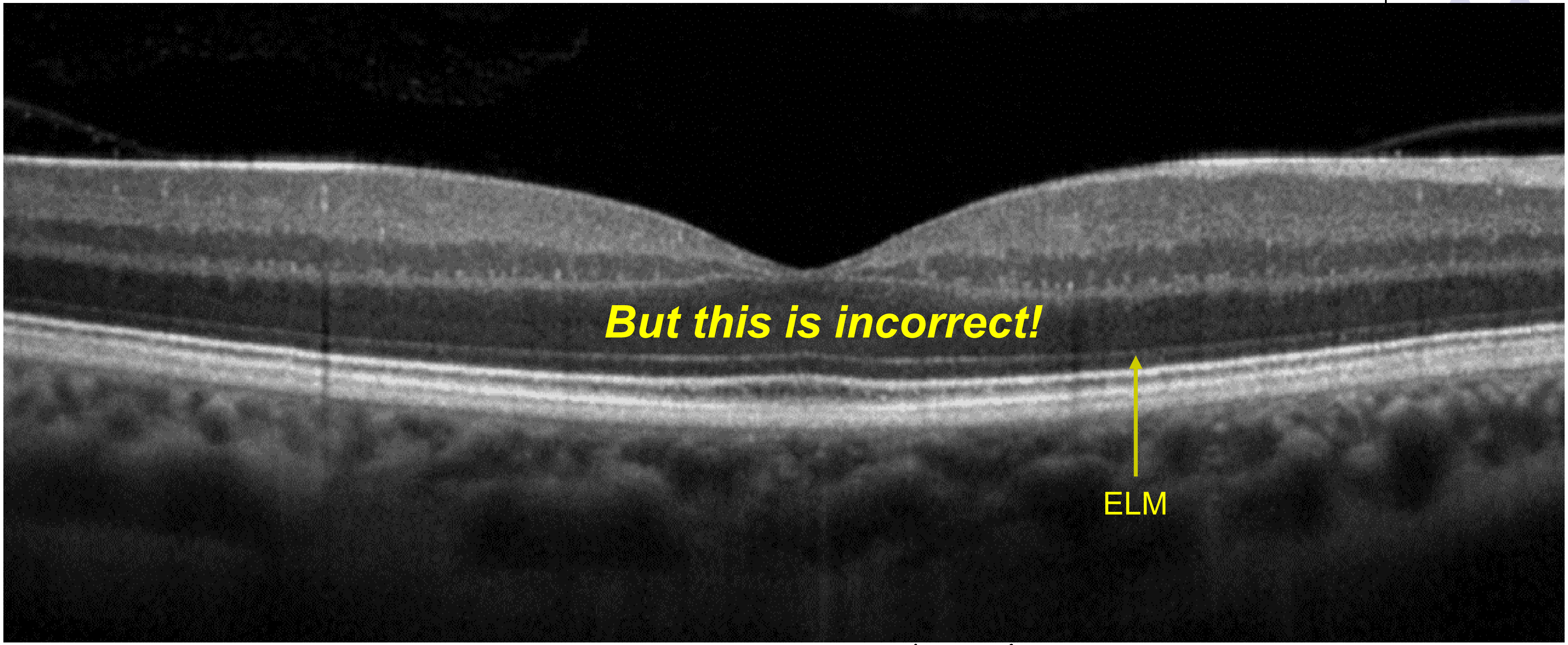
But this is incorrect!

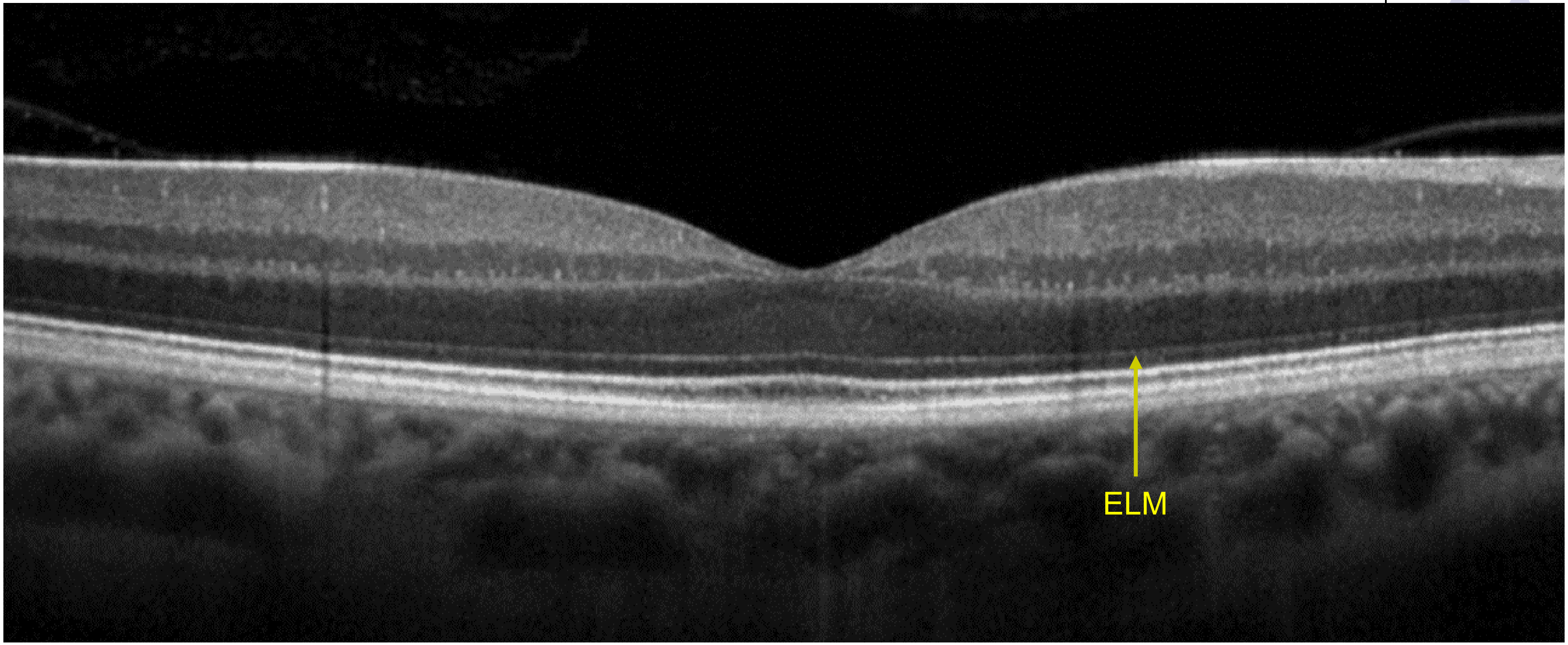
Retinal Anatomy and Histology



Things seem to be working out perfectly. The OCT ~~appears to have two~~ has three layers left to identify. Conveniently, there are two yet-unassigned layers—a processes layer (the outer plexiform layer), and a cell-bodies layer (the outer nuclear layer). Not uncommonly, you will see OCTs labeled in just this fashion.

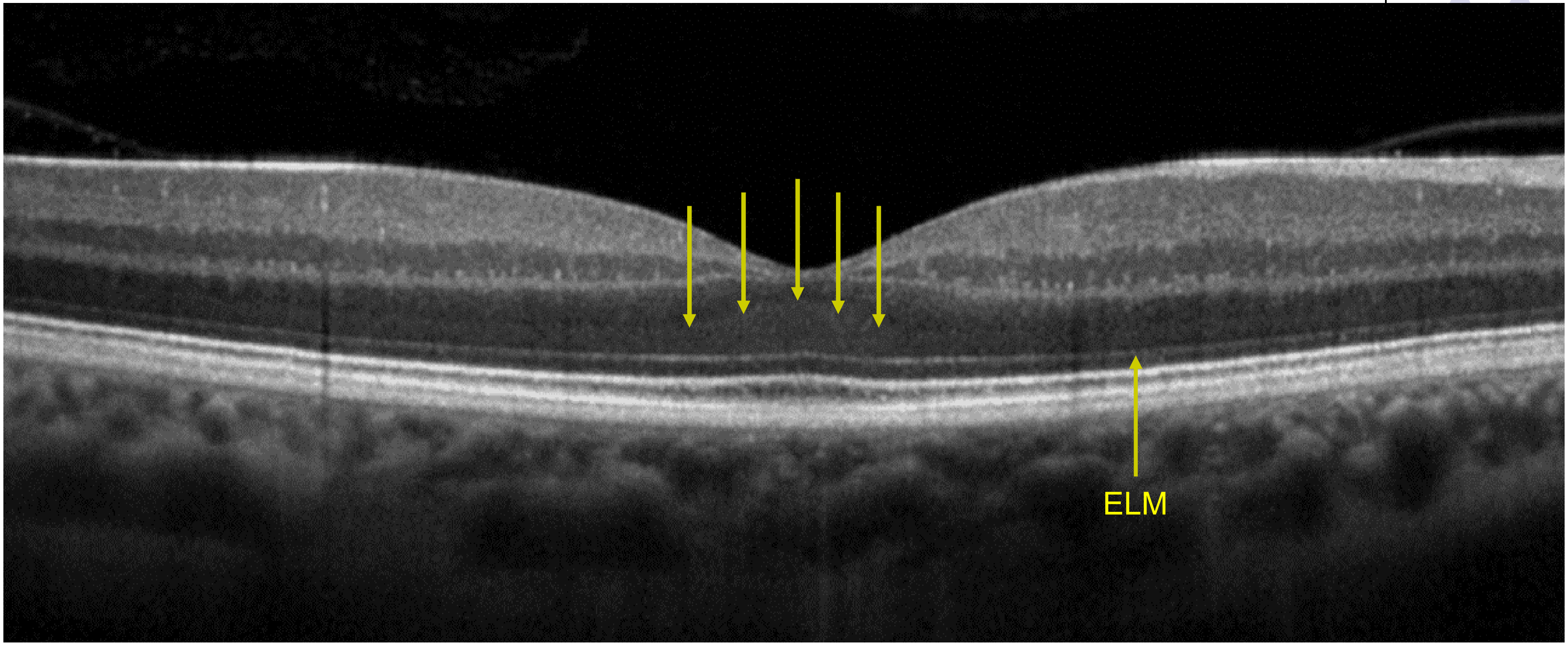
Why is it incorrect? Because the OCT has **three** layers left—not two!

Retinal Anatomy and Histology



Look carefully at the remaining darker portion, and you will note the presence of a subtle demarcation line within it. (I will point it out on the next slide.)

Retinal Anatomy and Histology



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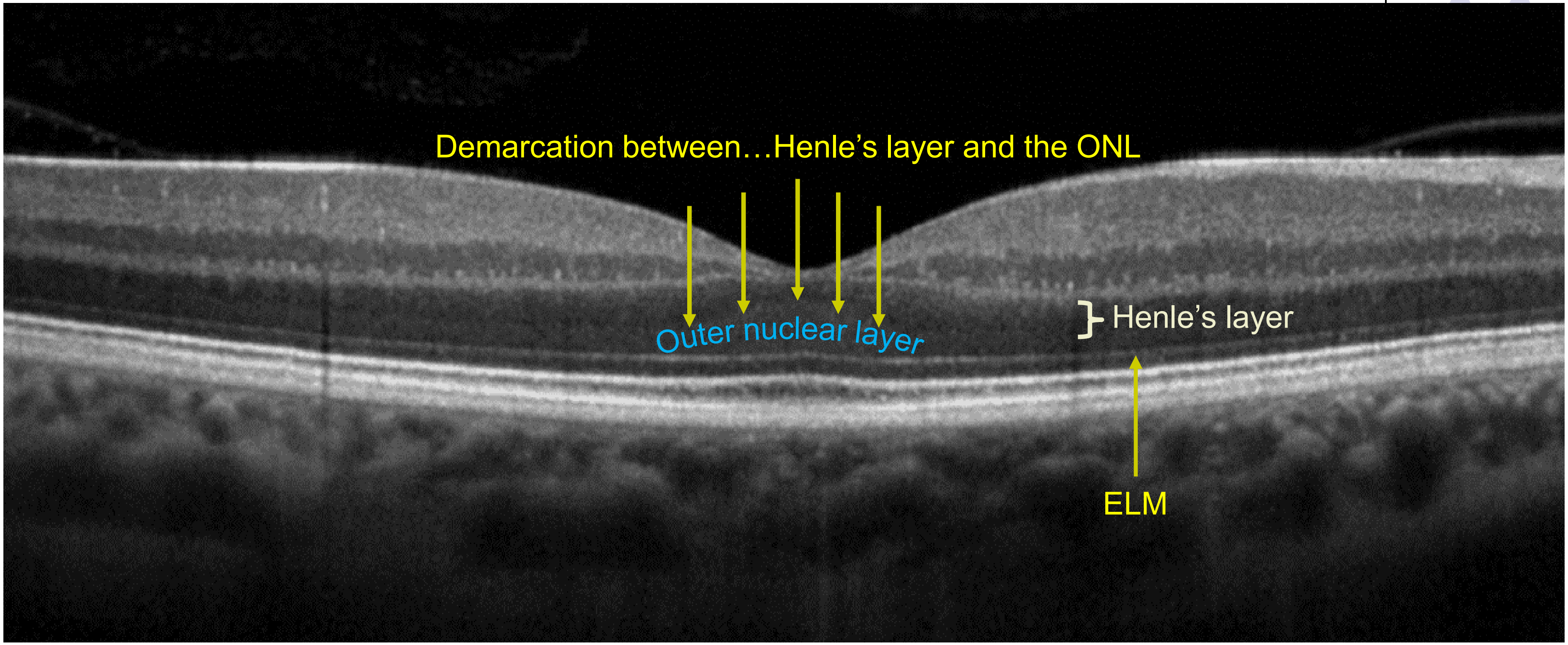
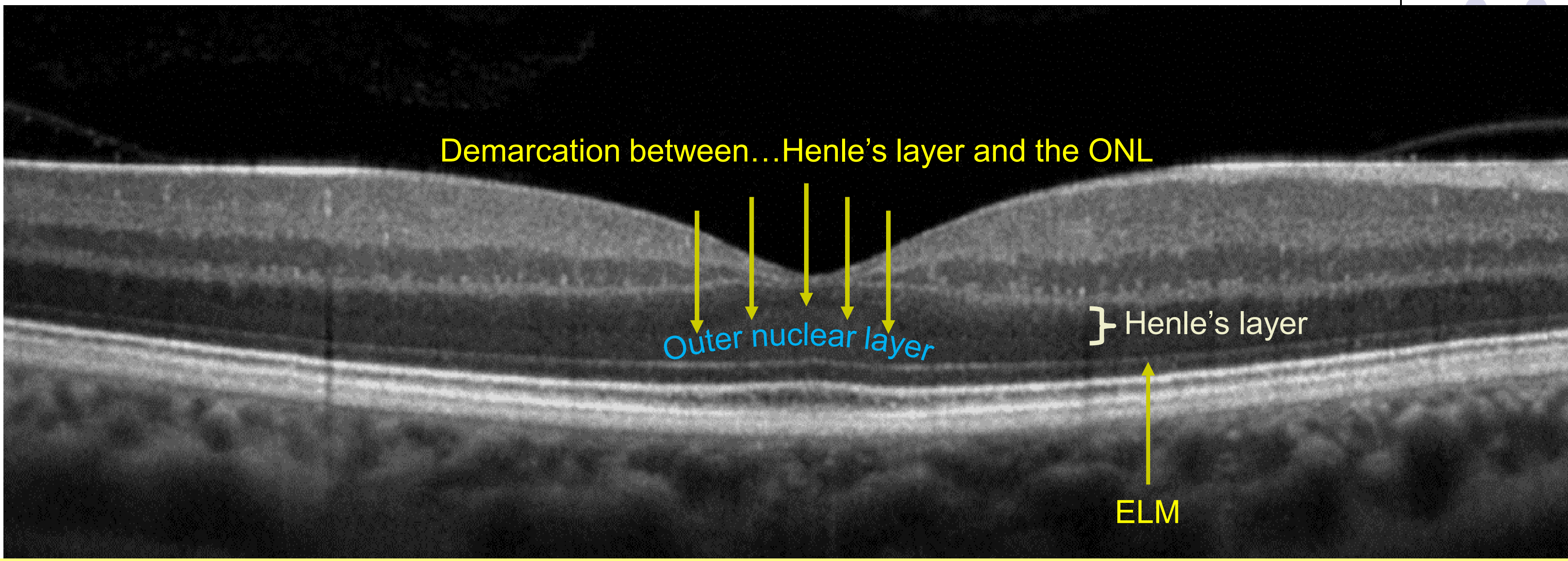
Retinal Anatomy and Histology



Look carefully at the remaining darker portion, and you will note the presence of a subtle demarcation line within it. (I will point it out on the next slide.) This line demarcates between the outer nuclear layer and *Henle's layer* .

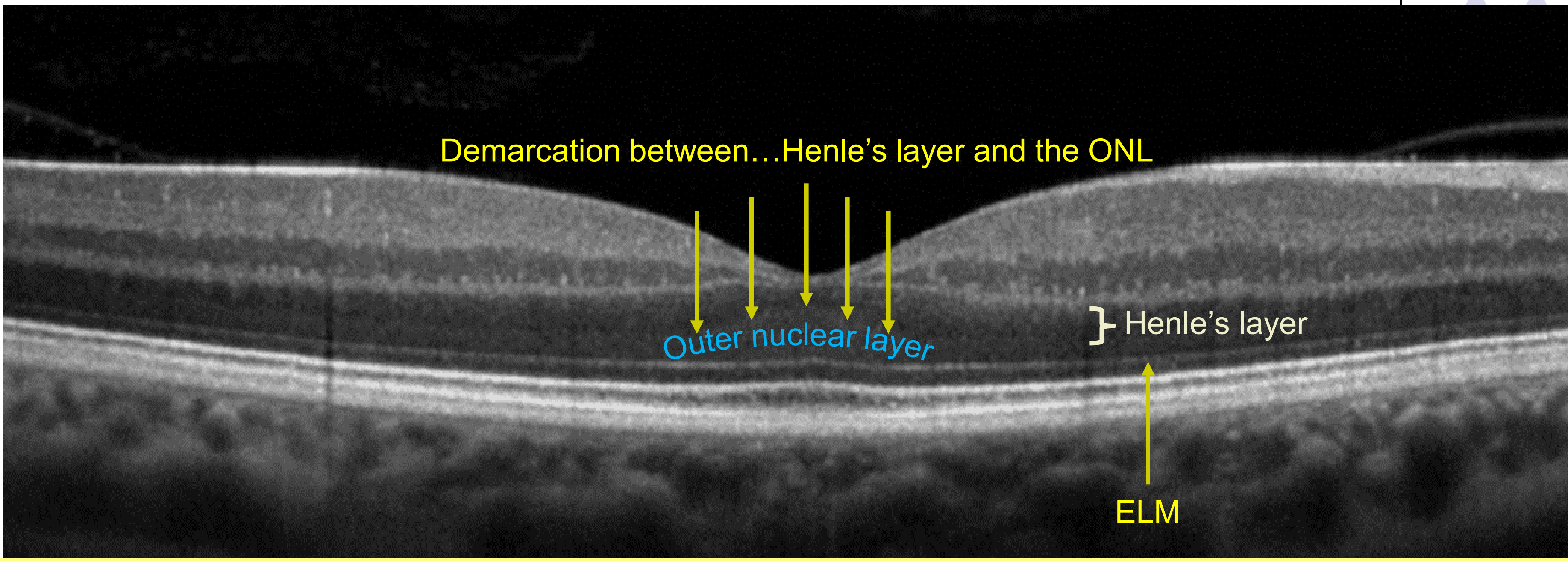
Retinal Anatomy and Histology



We mentioned Henle’s layer earlier in the context of the OPL , when we noted that the terms were often (and erroneously) treated as synonyms.

the outer nuclear layer and ***Henle’s layer*** .

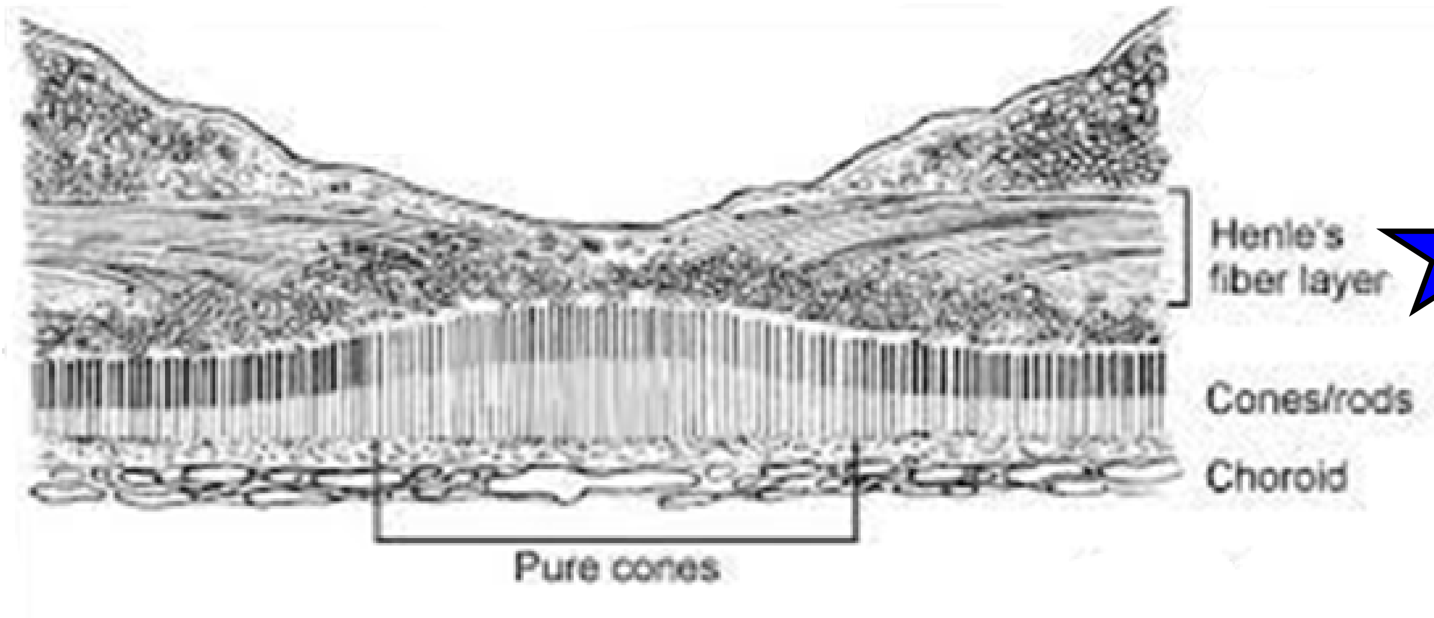
Retinal Anatomy and Histology



We mentioned Henle's layer earlier in the context of the OPL, when we noted that the terms were often (and erroneously) treated as synonyms. Here's why they're not synonymous. Recall that the OPL consists of the axonal processes of the PRs and the dendritic processes of the bipolar cells. (There's some horizontal-cell processes in there as well.)

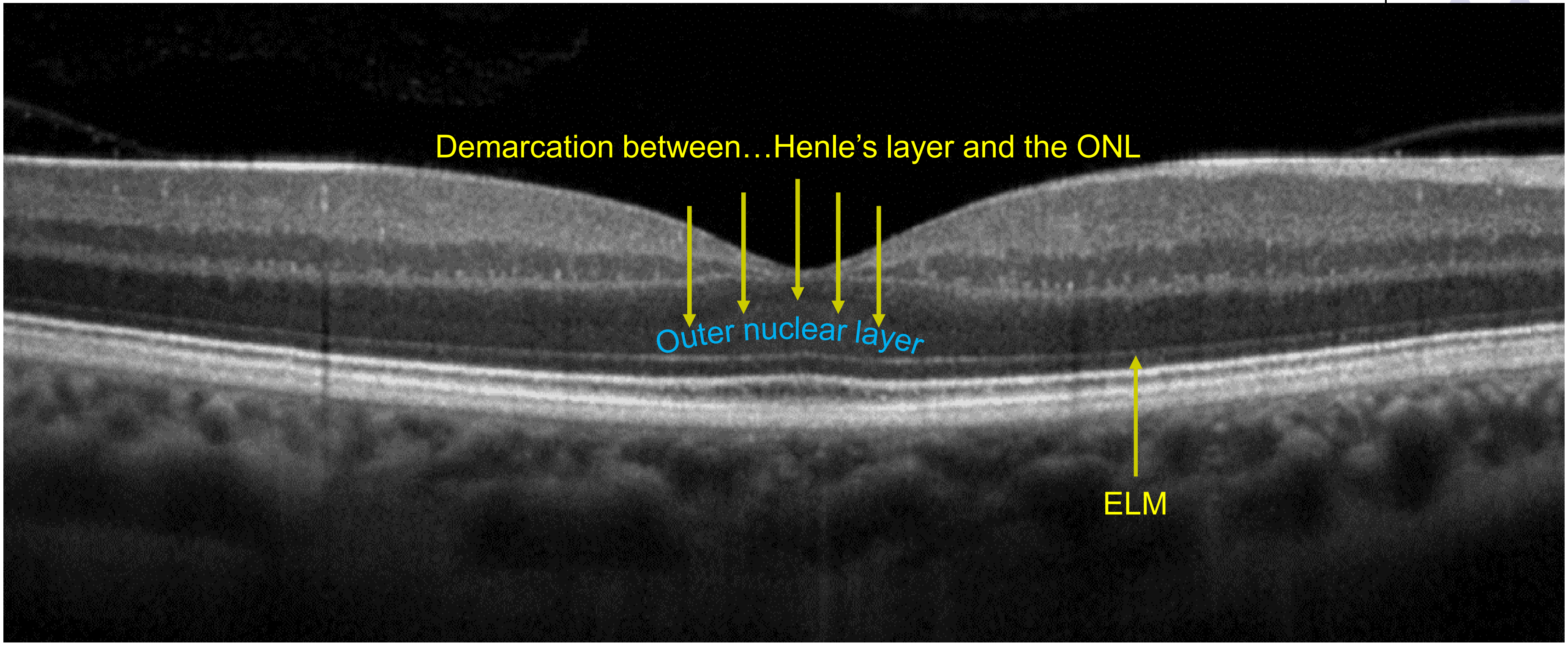
the outer nuclear layer and ***Henle's layer*** .

Retinal Anatomy and Histology



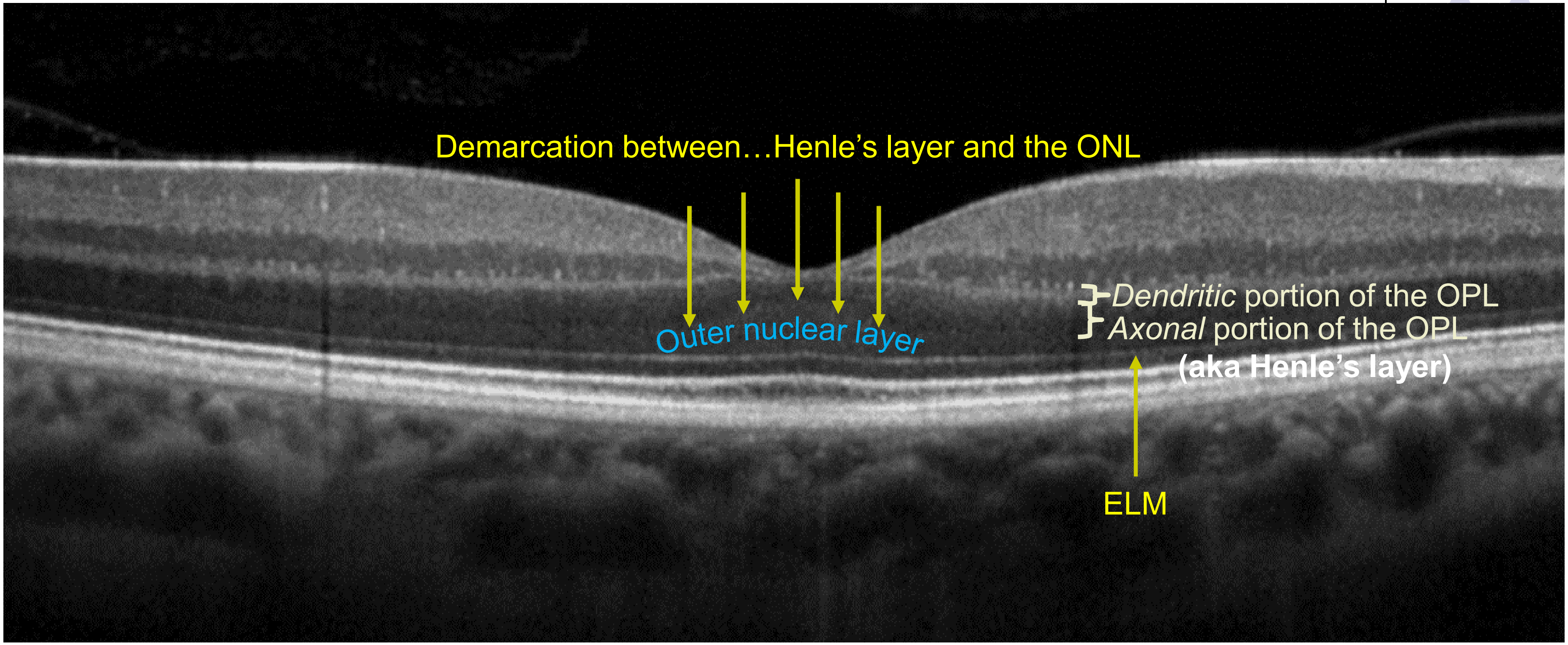
However, in the fovea/parafoveal region, the axonal processes of the PRs are elongated, and radiate directly away from the foveal center in all directions, running almost parallel to the retinal surface (see above). *These long, radially oriented axonal fibers comprise the Henle's layer portion of the OPL.*

Retinal Anatomy and Histology



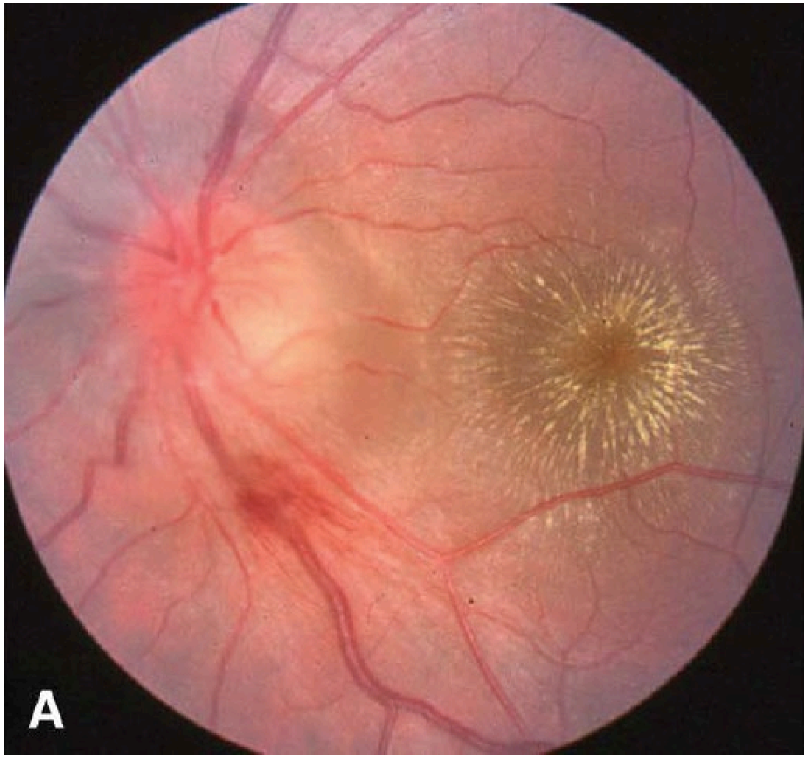
You can now appreciate the appearance of the OCT in the foveal region. The orientation of the PR axons leads the OCT to 'see' them as a layer separate and distinct from that of the bipolar-cell dendrites with which they form the outer plexus.

Retinal Anatomy and Histology



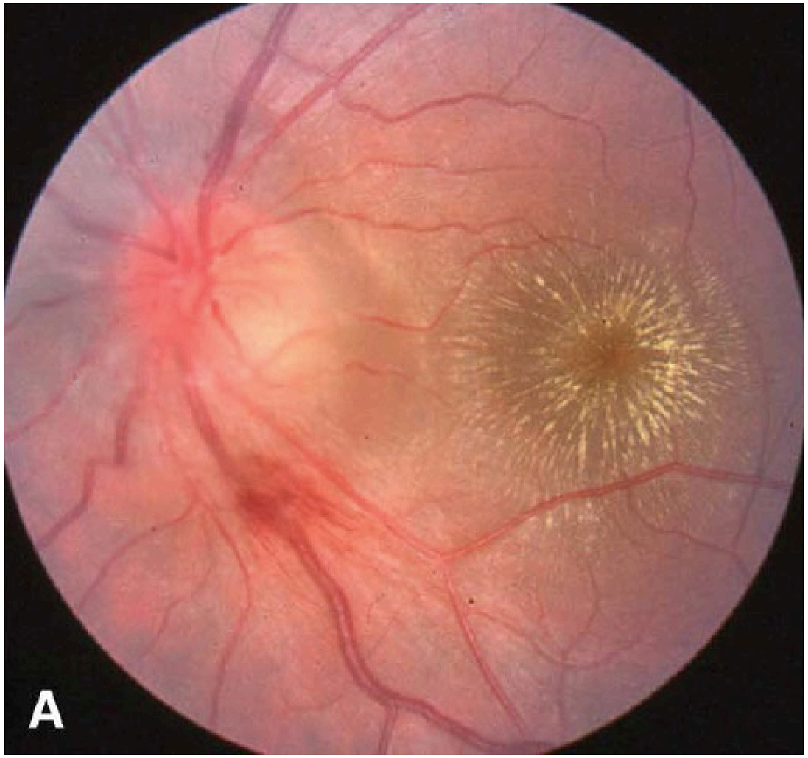
You can now appreciate the appearance of the OCT in the foveal region. The orientation of the PR axons leads the OCT to 'see' them as a layer separate and distinct from that of the bipolar-cell dendrites with which they form the outer plexus. This is why it's misleading to treat the terms *Henle's layer* and *OPL* as synonyms: Technically speaking, <u>Henle's layer is the axonal portion of the OPL in the foveal and parafoveal region</u>.

Retinal Anatomy and Histology



Highly relevant sidebar: The condition depicted above is *neuroretinitis*. (The *neuro*- part refers to the ONH swelling.) The classic cause is infection with *Bartonella henslae*; it is a form of *cat-scratch disease*. The descriptive term for the appearance of the macula in neuroretinitis is a *macular star*.

Retinal Anatomy and Histology



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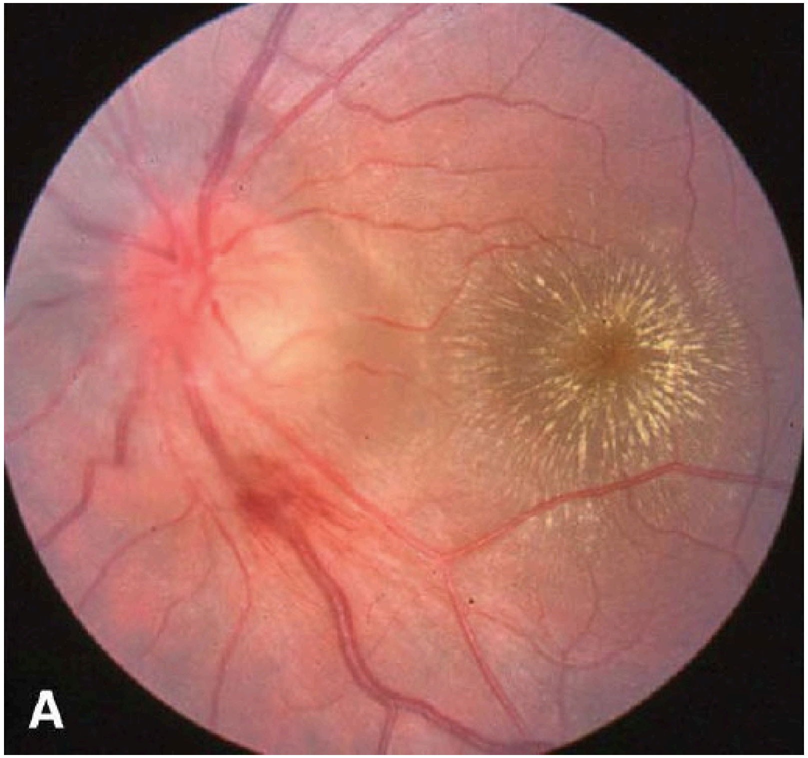
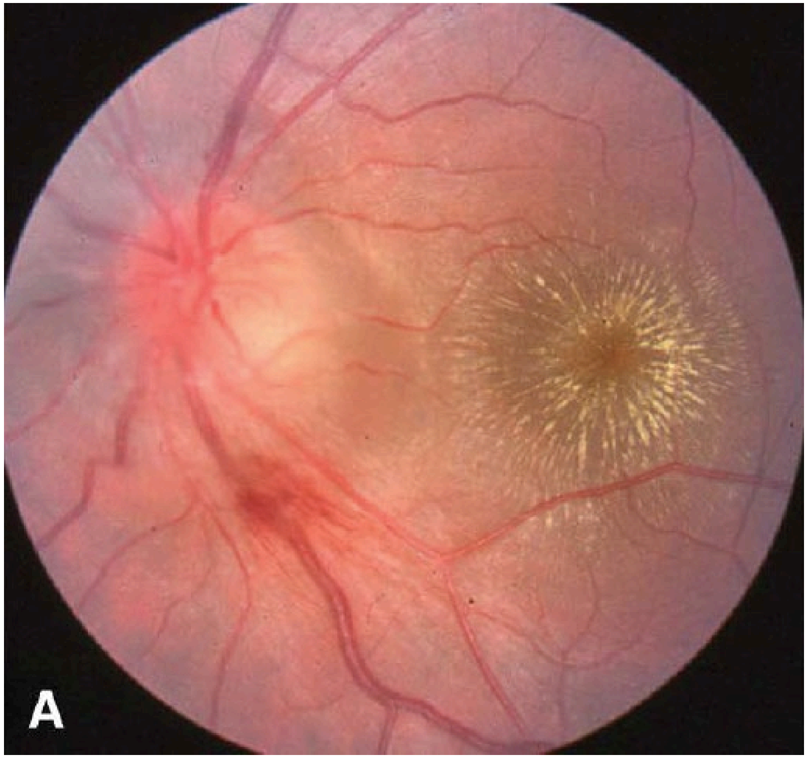
The point of this sidebar: The reason a macular star look the way it does is that the exudate is located in Henle's layer, and thus it mirrors Henle's radial orientation.

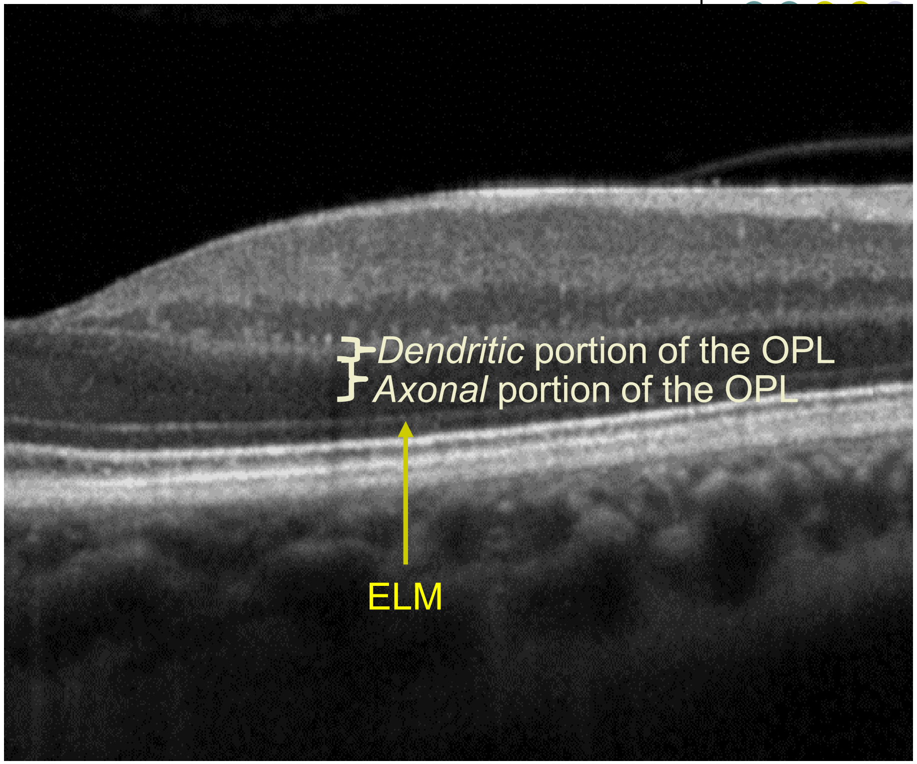
Retinal Anatomy and Histology



Make a connection in your head between the clinical appearance of a macular star…

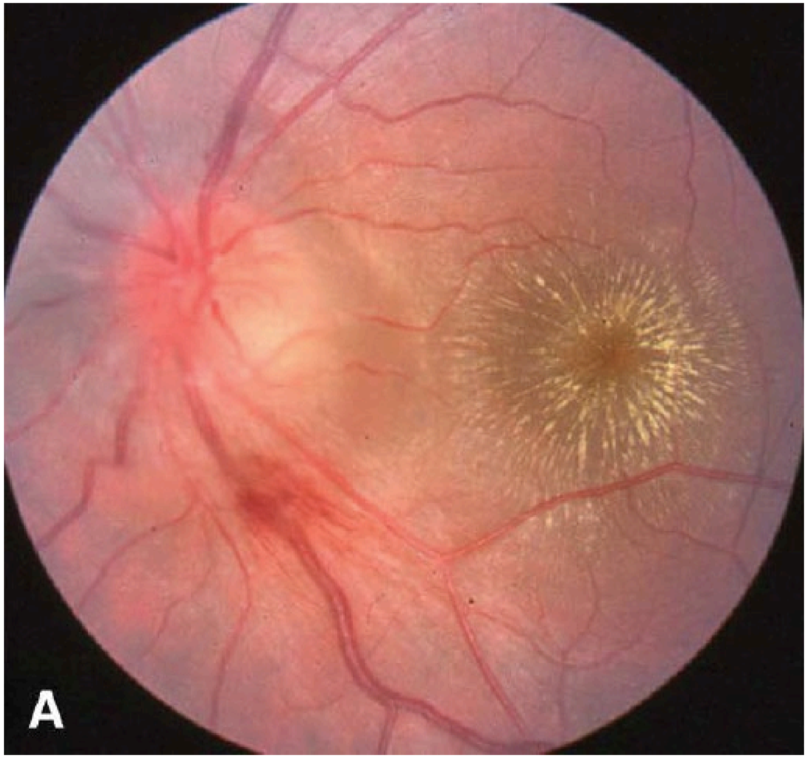
Retinal Anatomy and Histology

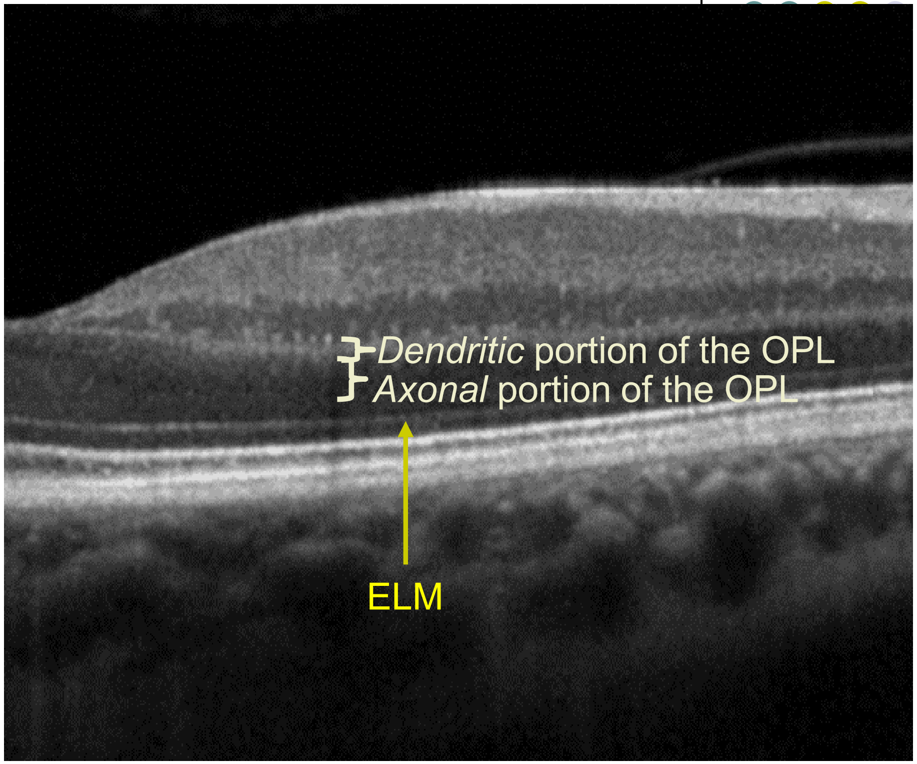




Make a connection in your head between the clinical appearance of a macular star…
and the OCT appearance of Henle's layer.

Retinal Anatomy and Histology



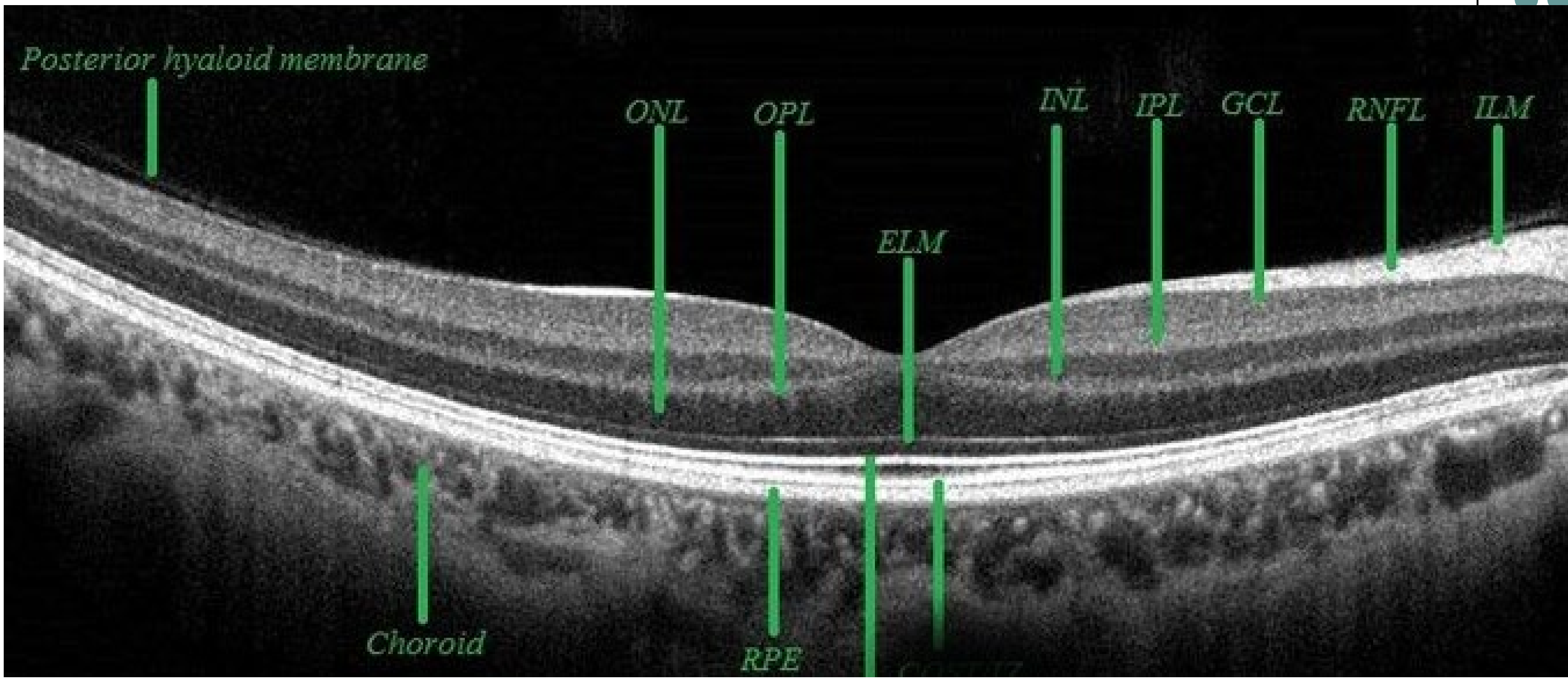


Make a connection in your head between the clinical appearance of a macular star… and the OCT appearance of Henle's layer. While they look nothing like one another, each arises from the same fundamental fact of retinal anatomy/histology!

Retinal Anatomy and Histology

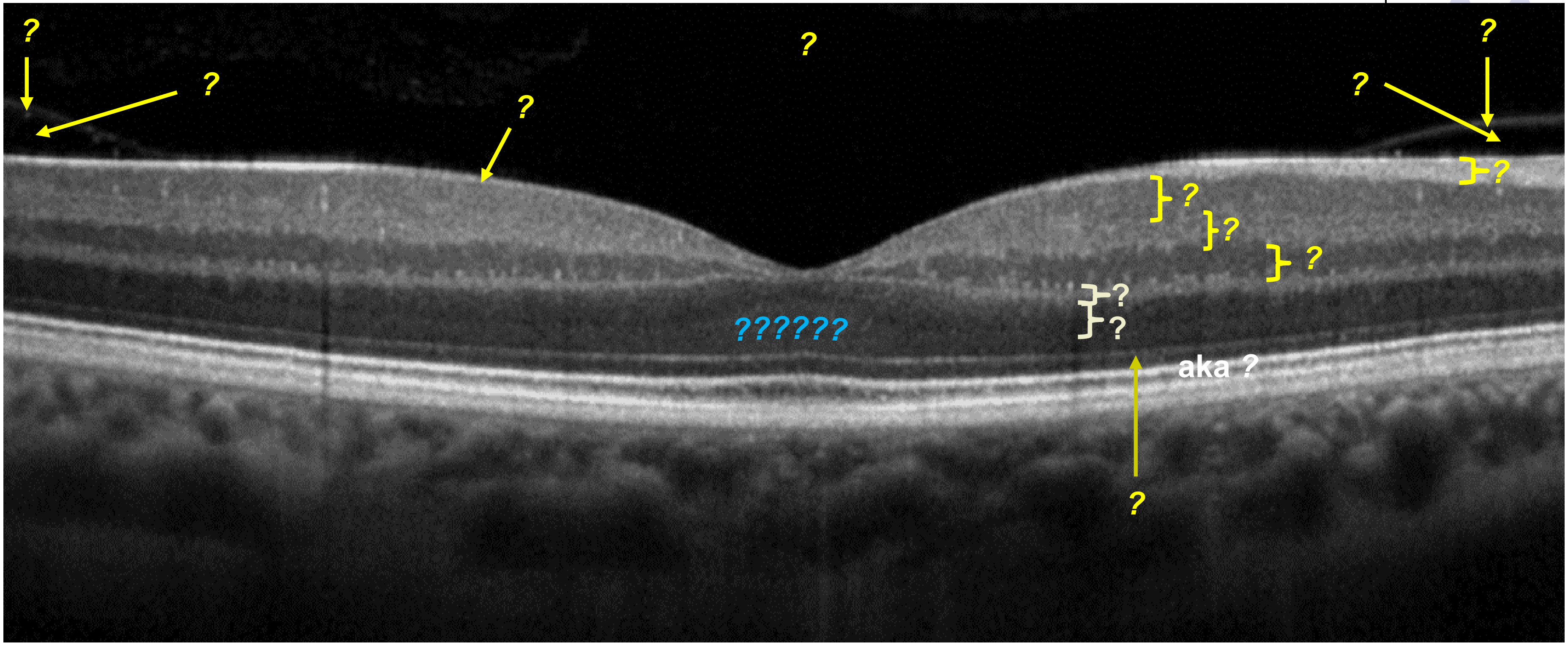
One last word about this OPL/Henle's layer issue—you will find that the *BCSC* books are not consistent in how they use these terms. (For example, the *Retina* book uses them as synonyms on one page, and as referring to separate layers two pages later.)

Retinal Anatomy and Histology



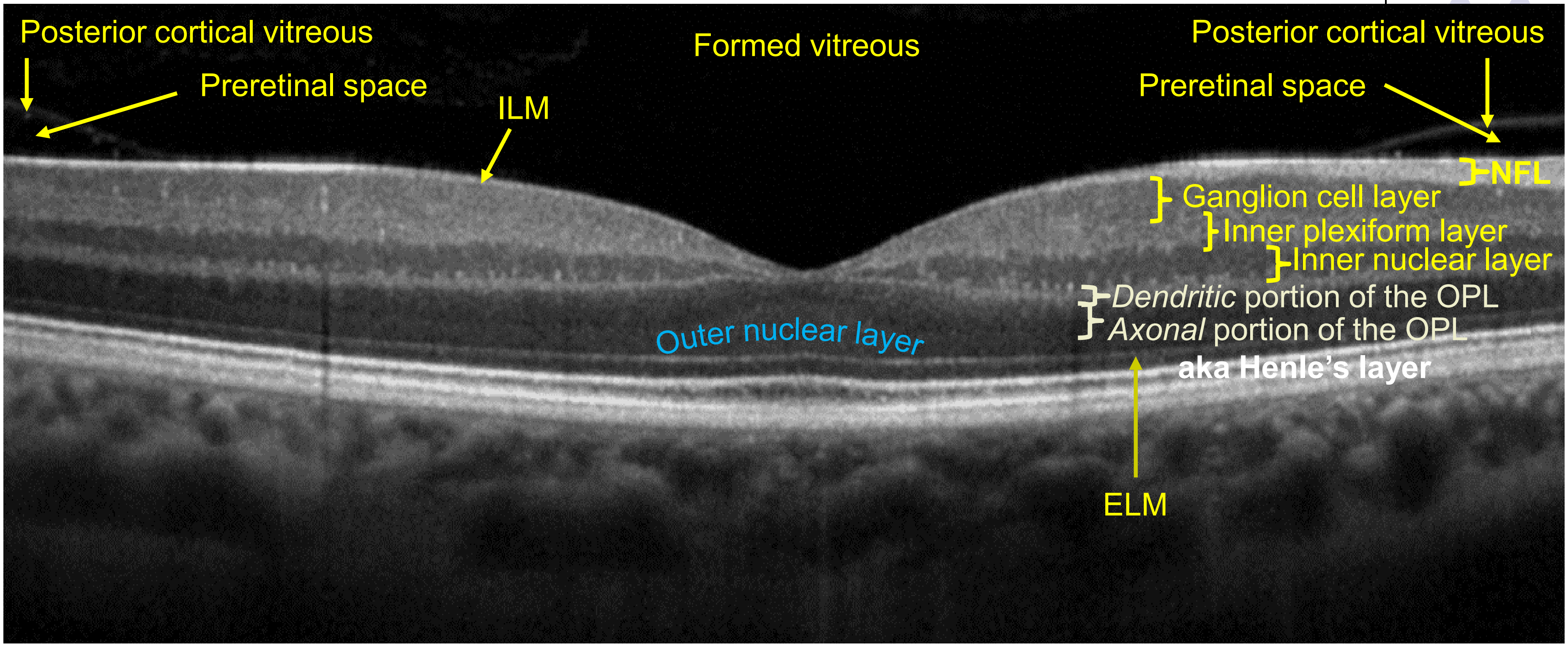
One last word about this OPL/Henle's layer issue—you will find that the *BCSC* books are not consistent in how they use these terms. (For example, the *Retina* book uses them as synonyms on one page, and as referring to separate layers two pages later.) Likewise, you will frequently encounter OCT images labeled in a manner that is unclear or misleading regarding what is the OPL, what is Henle's, and what is the ONL (eg, the above). You may also find that your program's retina specialist disagrees with how I've laid things out here. **Caveat emptor.**

Retinal Anatomy and Histology



Quiz yourself by toggling back and forth between this slide and the next. When you've got it, you're done!

Retinal Anatomy and Histology



Retinal Anatomy and Histology

That's it! Go through this slide-set a couple of times (at least) until you feel like you have a handle on it. When you're ready, do slide-set *R17*, which covers this material in a Q&A format (and more detail).