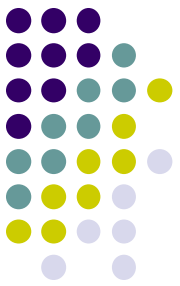
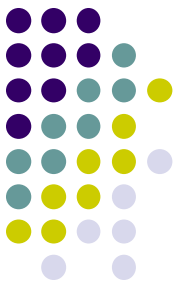


Lens/Cataracts Overview



Before you begin: This is a big topic, and big topics beget big slide-sets. There's are a couple of natural breaks in the material (around slide 251, and again around 372); I placed *break time!* slides at those locations.



Q

Lens/Cataracts Overview

- Anatomy of the mature* lens

- ?

- ?

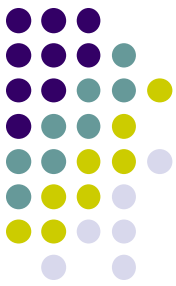
- ?

- ?

- ?

*The human lens has five basic components—
what are they?*

*'Mature' meaning 'postnatal;' **not** referring here to a 'mature' cataract



A

Lens/Cataracts Overview

- Anatomy of the mature* lens

- *Capsule*

- *Epithelium*

- *Nucleus*

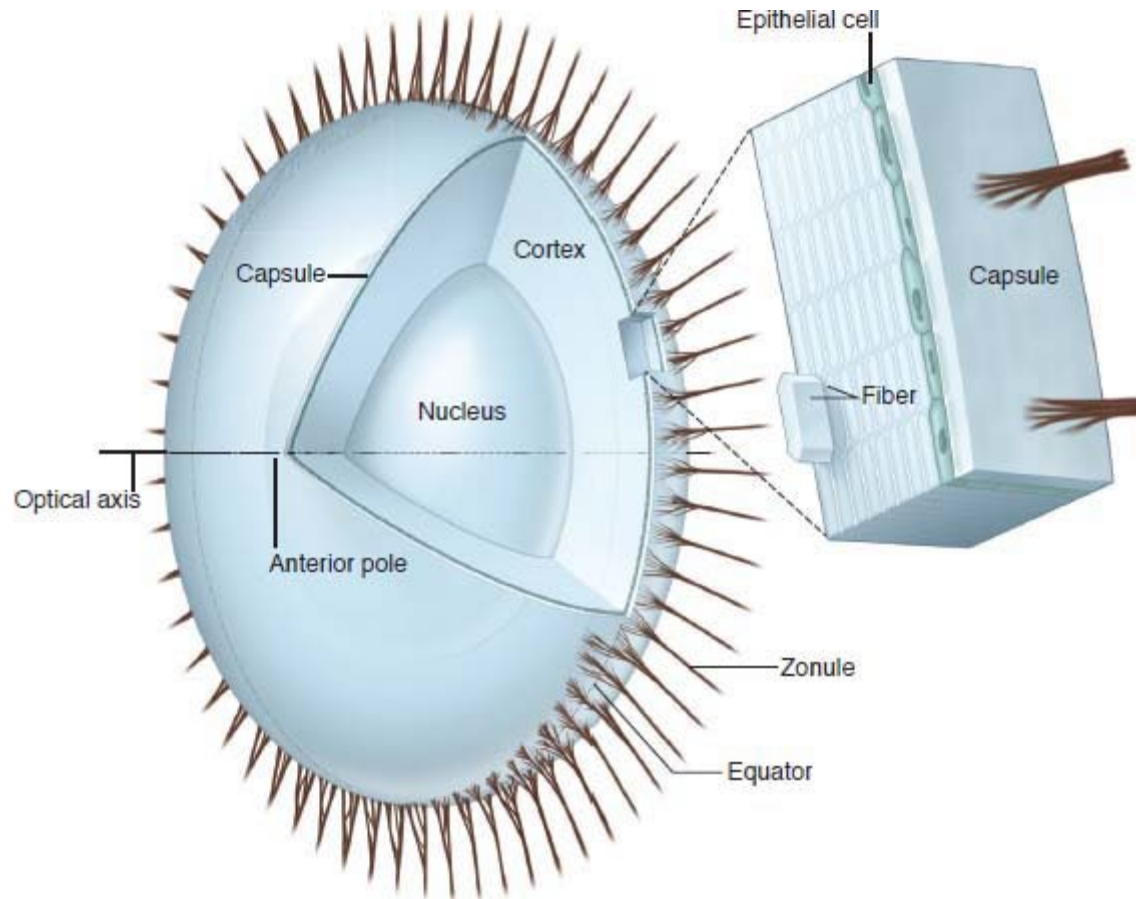
- *Cortex*

- *Zonules*

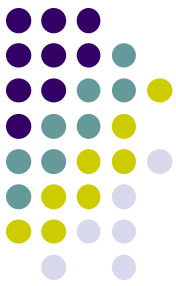
*The human lens has five basic components—
what are they?*

*'Mature' meaning 'postnatal;' **not** referring here to a 'mature' cataract

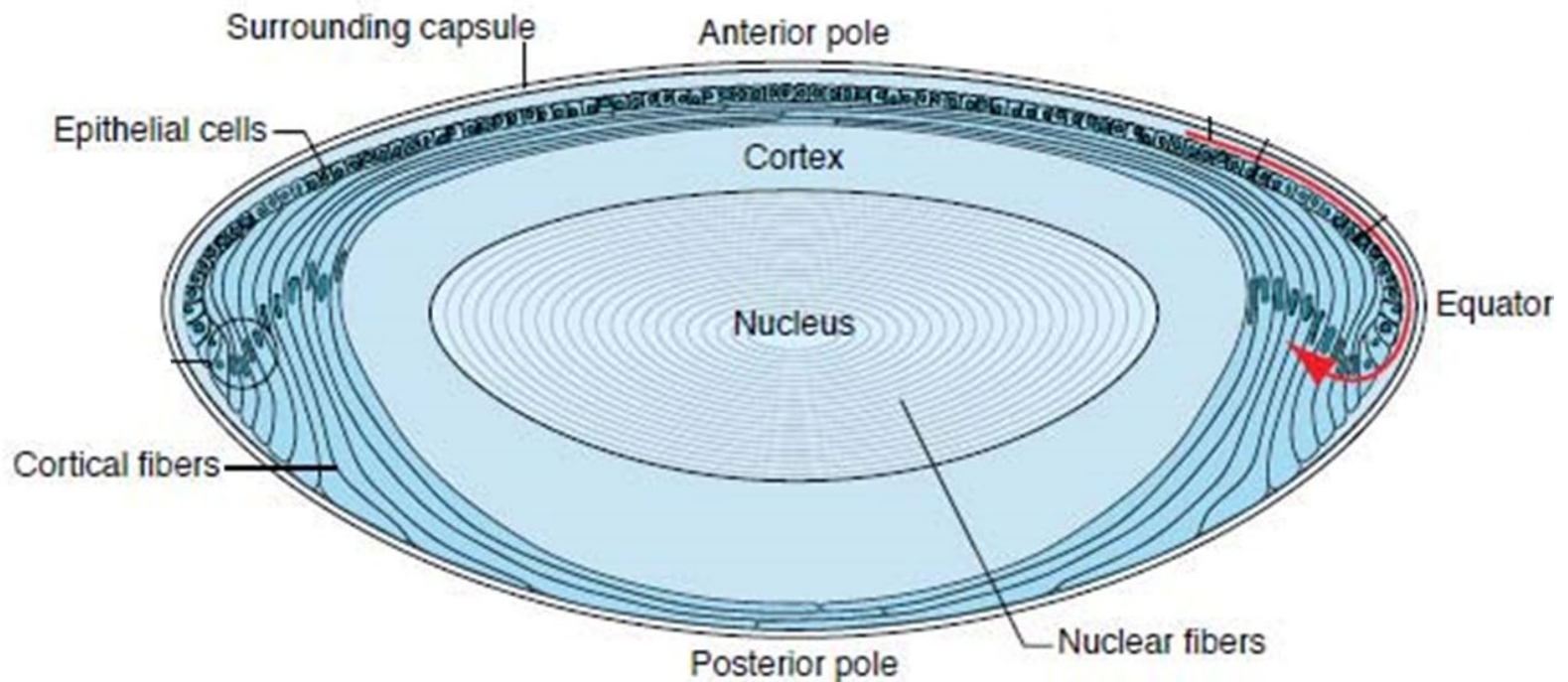
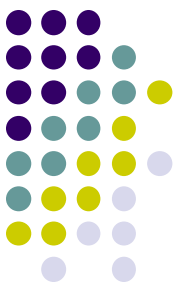
Lens/Cataracts Overview



Basic components of the mature lens



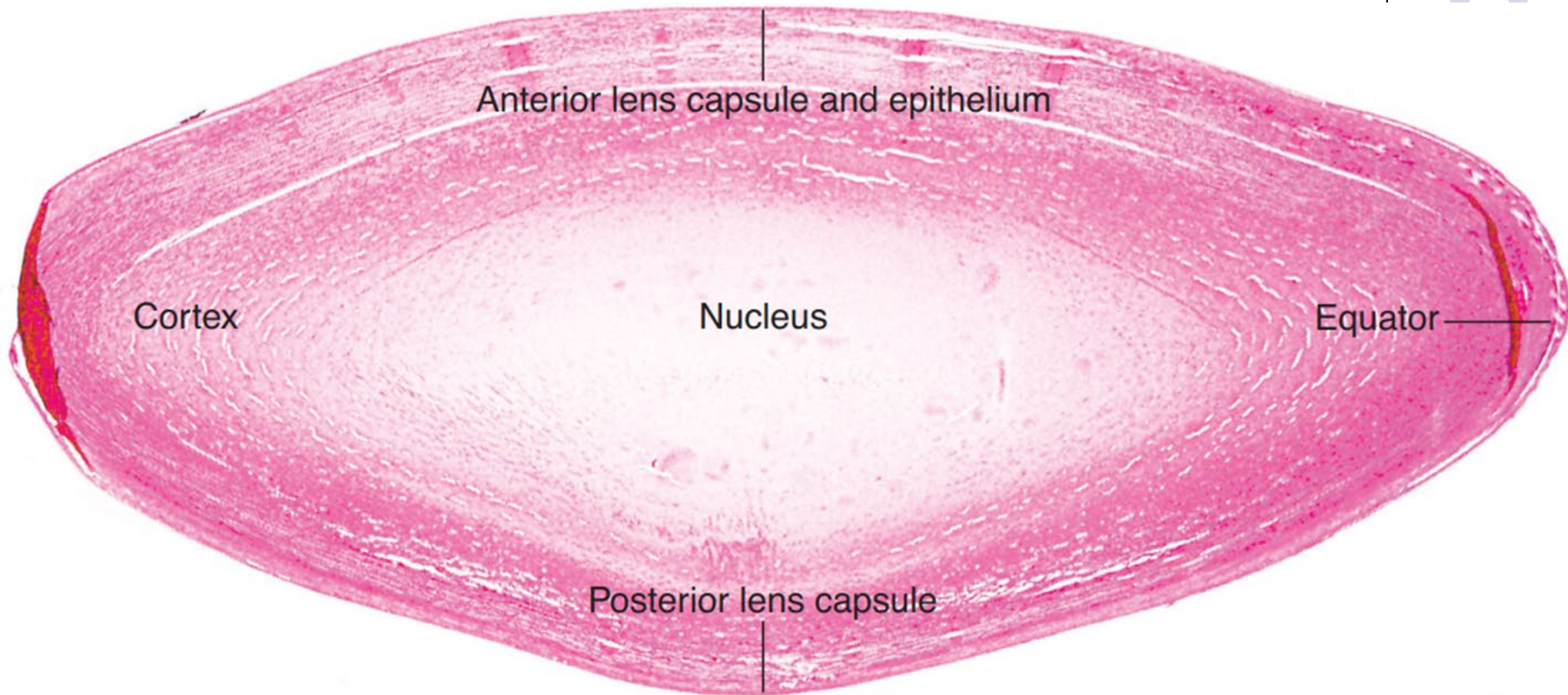
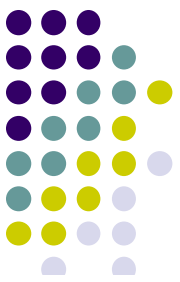
Lens/Cataracts Overview



Basic components of the mature lens: Another depiction

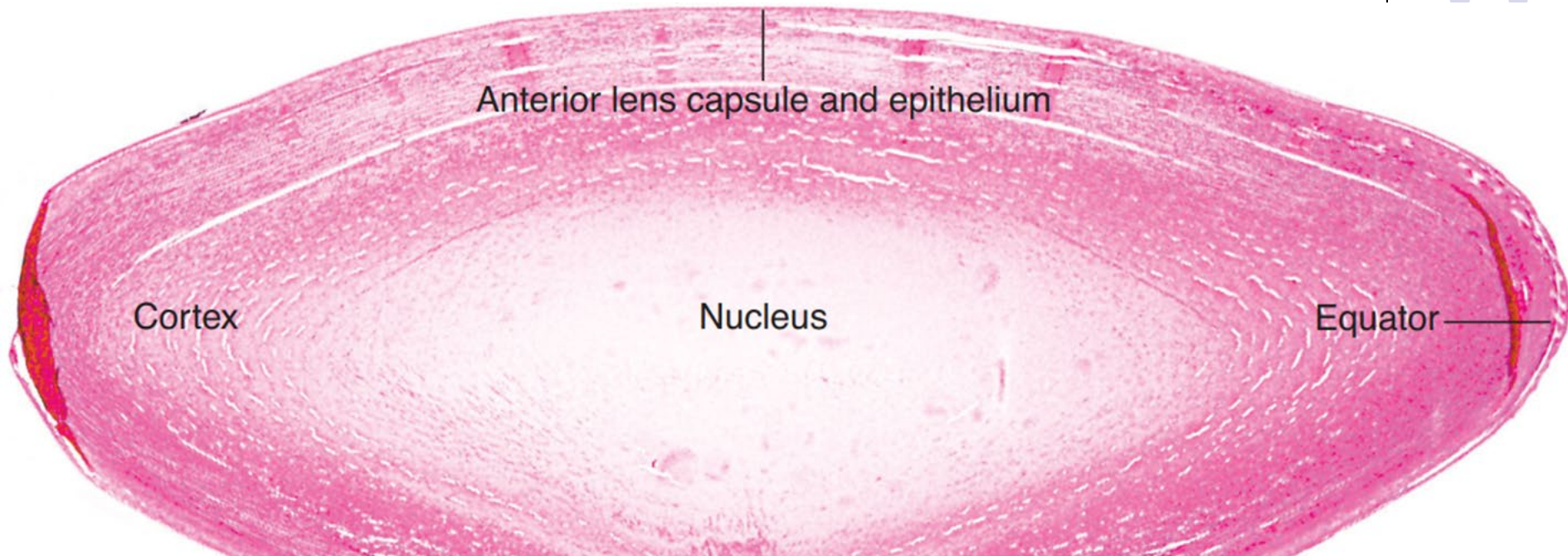
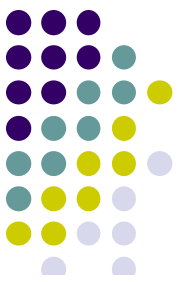
Lens/Cataracts Overview

6



Basic components of the mature lens: Photomicrograph

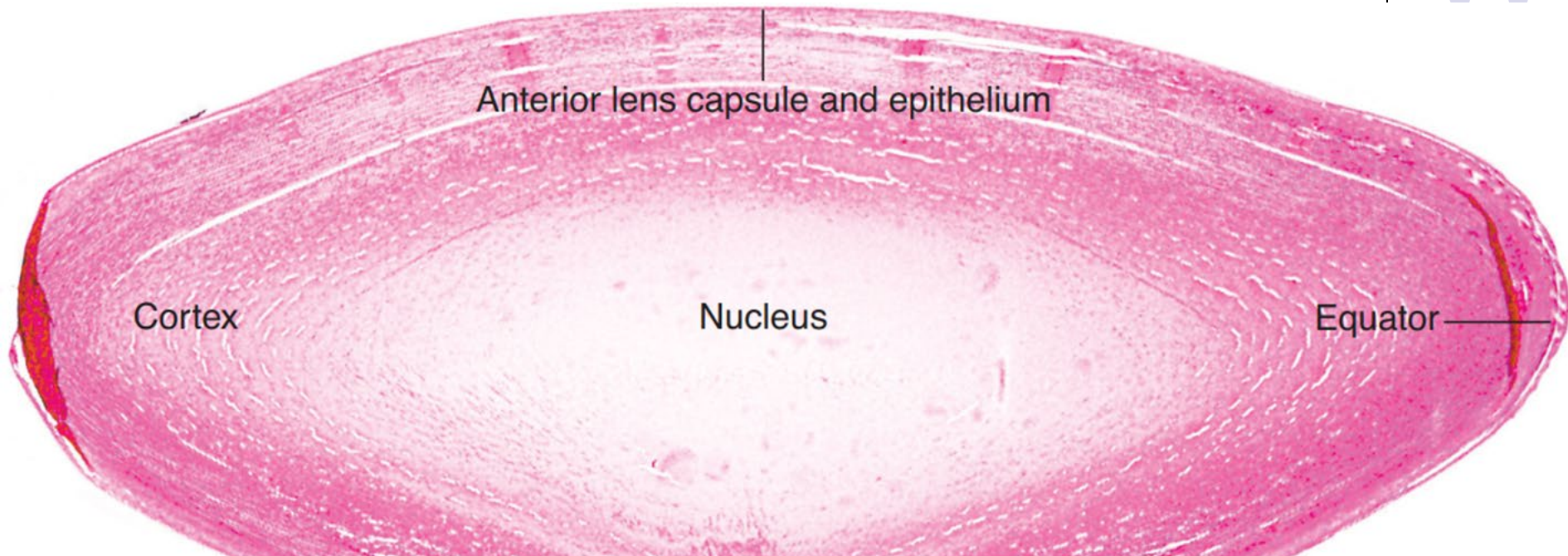
Lens/Cataracts Overview



Bruh, I've watched a lot of cataract surgery, and the labeling here is not right.

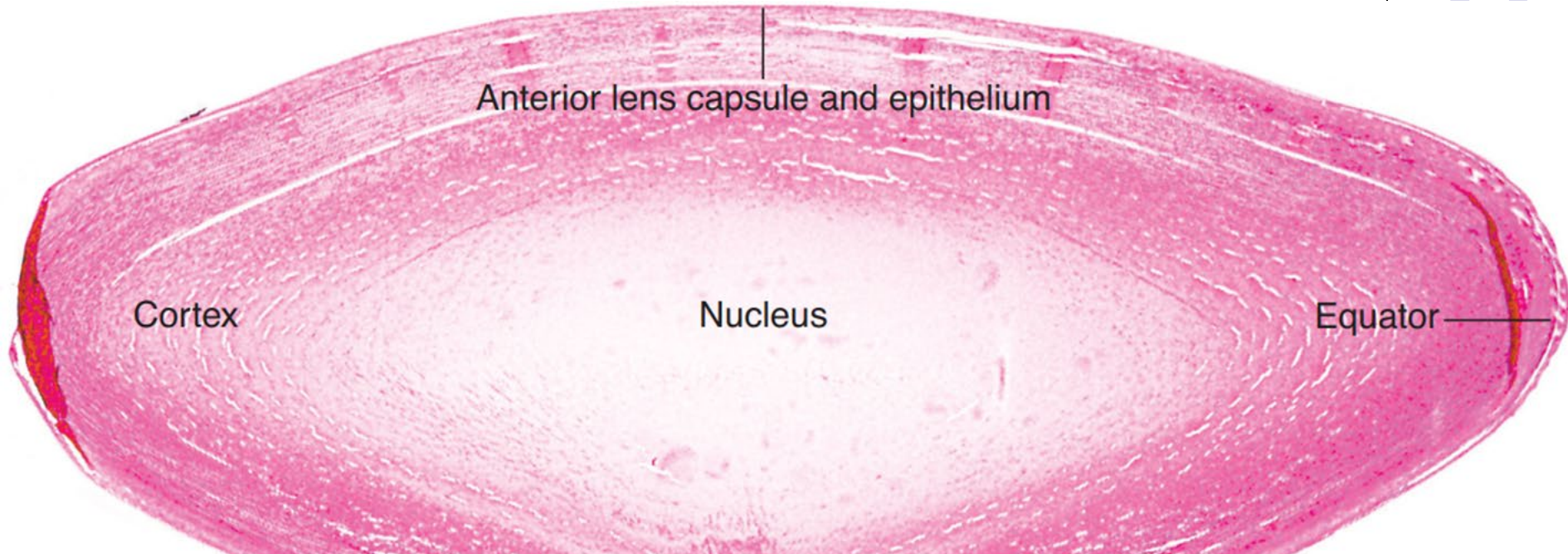
Basic components of the mature lens: Photomicrograph

No question yet—proceed when ready



*Bruh, I've watched a lot of cataract surgery, and the labeling here is not right. For example, the 'cortex' is mos def **not** thick as suggested by this image; rather, it is a very thin layer adherent to the capsule that gets peeled off at the end of a case. What's up?*

Basic components of the mature lens: Photomicrograph



*Bruh, I've watched a lot of cataract surgery, and the labeling here is not right. For example, the 'cortex' is mos def **not** thick as suggested by this image; rather, it is a very thin layer adherent to the capsule that gets peeled off at the end of a case. What's up?*

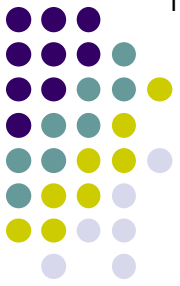
What's up is, you are confusing the *anatomic* cortex with the *surgical* cortex—they are **not** the same. (We will address this head-on later in the slide-set.)

Basic components of the mature lens: Photomicrograph

Q

Lens/Cataracts Overview

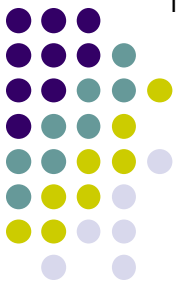
- Anatomy of the mature lens
 - *Capsule*
 - Type#collagen
 - *Epithelium*
 - *Nucleus*
 - *Cortex*
 - *Zonules*



A

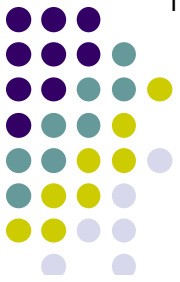
Lens/Cataracts Overview

- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - *Nucleus*
 - *Cortex*
 - *Zonules*



Q

Lens/Cataracts Overview



- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

Speaking histologically, what fundamental tissue structure does the capsule comprise?

- *Epithelium*

- *Nucleus*

- *Cortex*

- *Zonules*

Q/A

Lens/Cataracts Overview



- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

Speaking histologically, what fundamental tissue structure does the capsule comprise?

- *Epithelium*

It is the of the lens epithelium



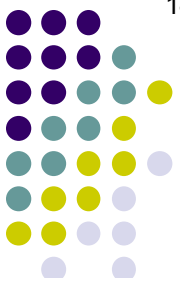
- *Nucleus*

- *Cortex*

- *Zonules*

A

Lens/Cataracts Overview



- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

Speaking histologically, what fundamental tissue structure does the capsule comprise?

- *Epithelium*

It is the basement membrane of the lens epithelium



- *Nucleus*

- *Cortex*

- *Zonules*



Q

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

Speaking histologically, what fundamental tissue structure does the capsule comprise?

- *Epithelium*

It is the basement membrane of the lens epithelium



But but but...The capsule is on the outside of the lens, and its epithelium is on the inside. Given this, how can the capsule possibly be the epithelium's BM?

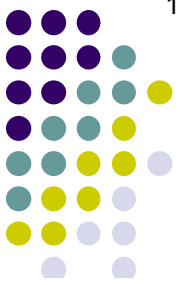
- *Nucleus*

- *Cortex*

- *Zonules*

A

Lens/Cataracts Overview



- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

Speaking histologically, what fundamental tissue structure does the capsule comprise?

- *Epithelium*

It is the basement membrane of the lens epithelium



- *Nucleus*

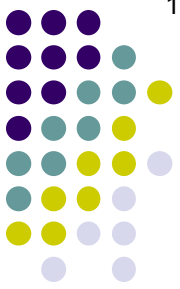
But but but...The capsule is on the outside of the lens, and its epithelium is on the inside. Given this, how can the capsule possibly be the epithelium's BM?

- *Cortex*

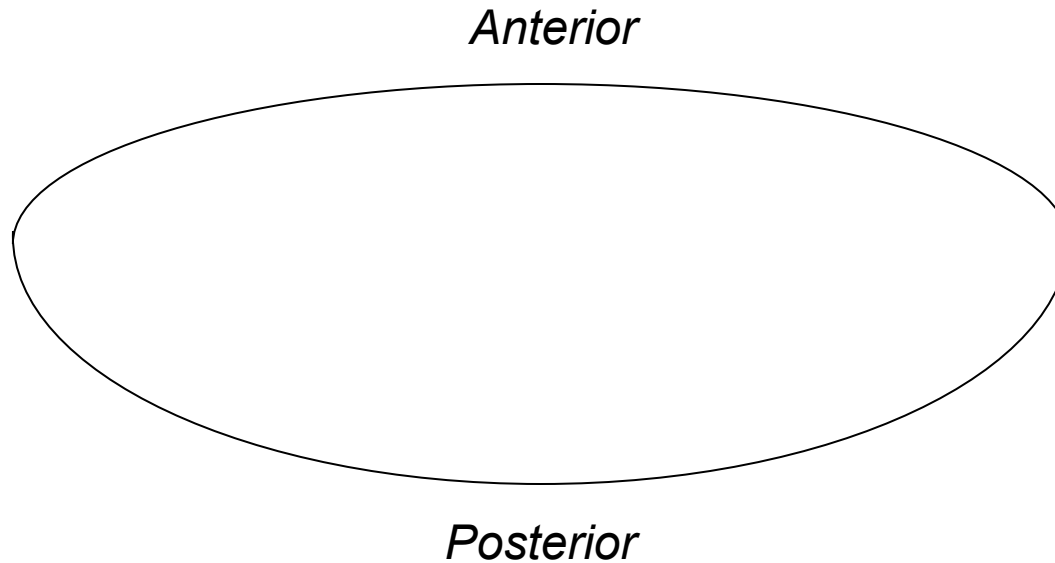
It's possible because **embryology**. We will have a great deal to say about lens embryology later in the slide-set, at which time the 'How' of the epi-capsule arrangement will be made clear.

- *Zonules*

Lens/Cataracts Overview



Lens capsule thickness has important clinical and surgical implications.
Let's review it.

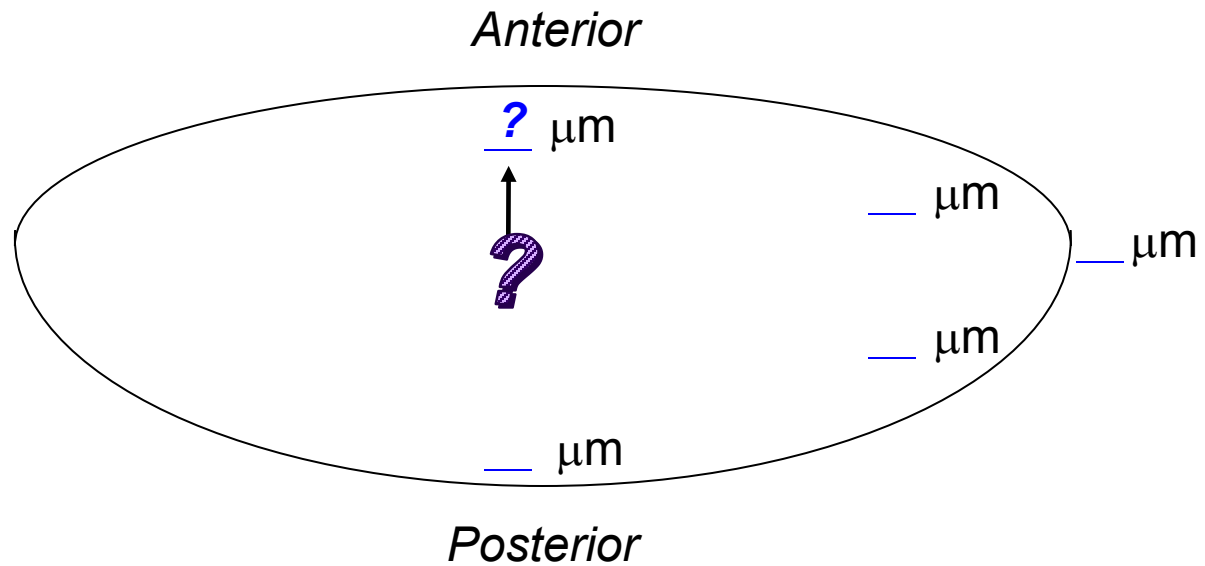


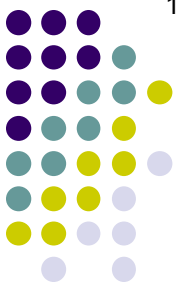


Q

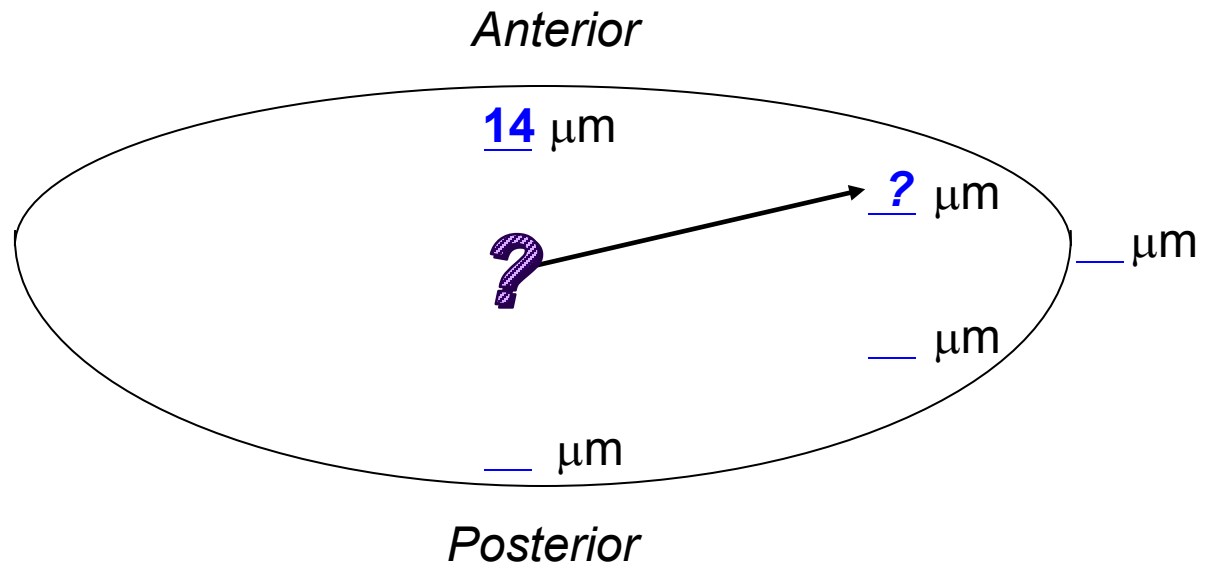
Lens/Cataracts Overview

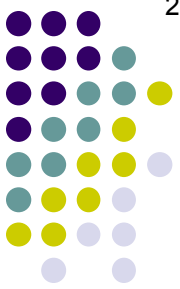
Lens capsule thickness: Fill in the blanks



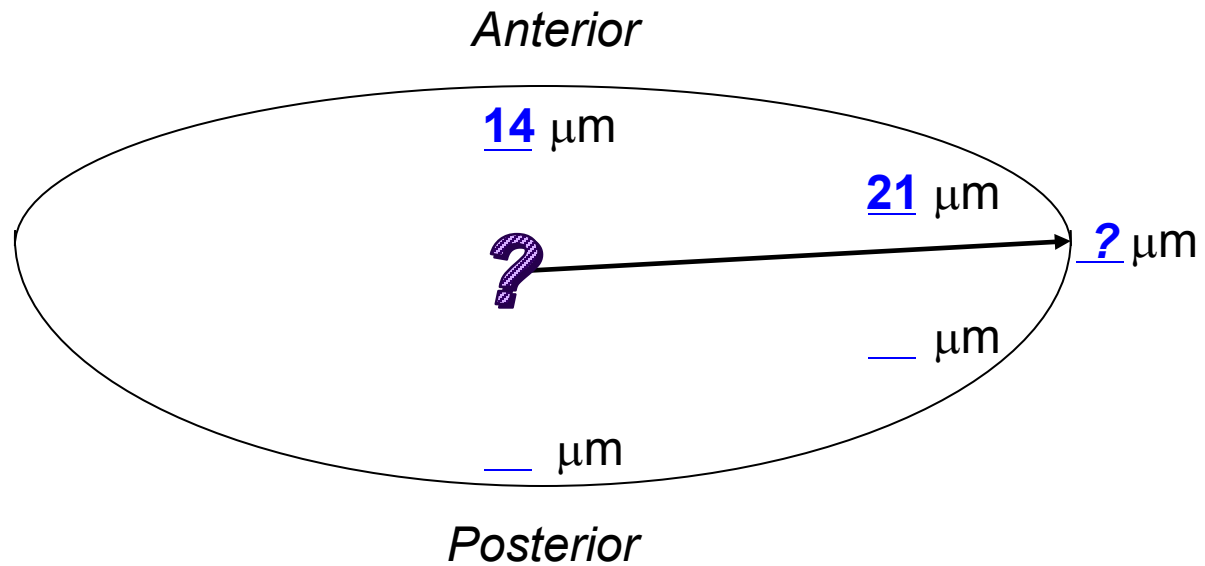


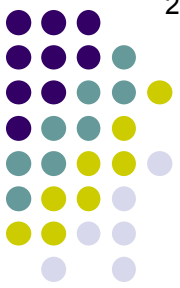
Lens capsule thickness: Fill in the blanks



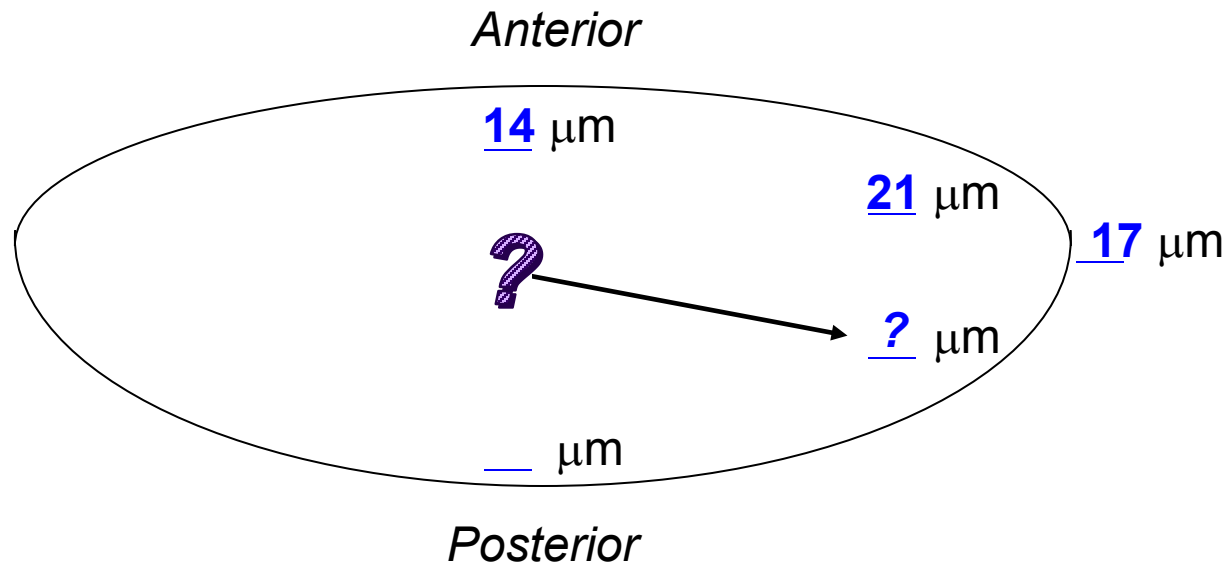


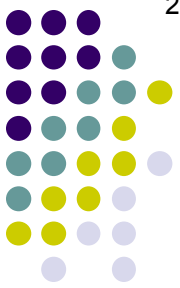
Lens capsule thickness: Fill in the blanks



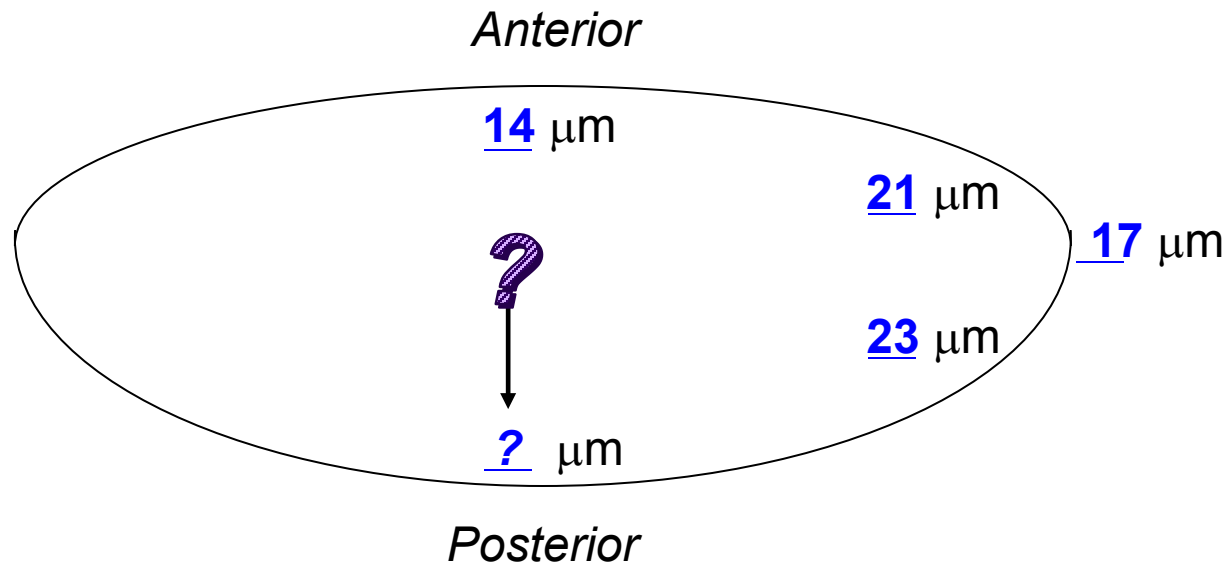


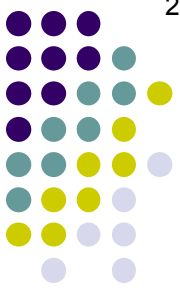
Lens capsule thickness: Fill in the blanks



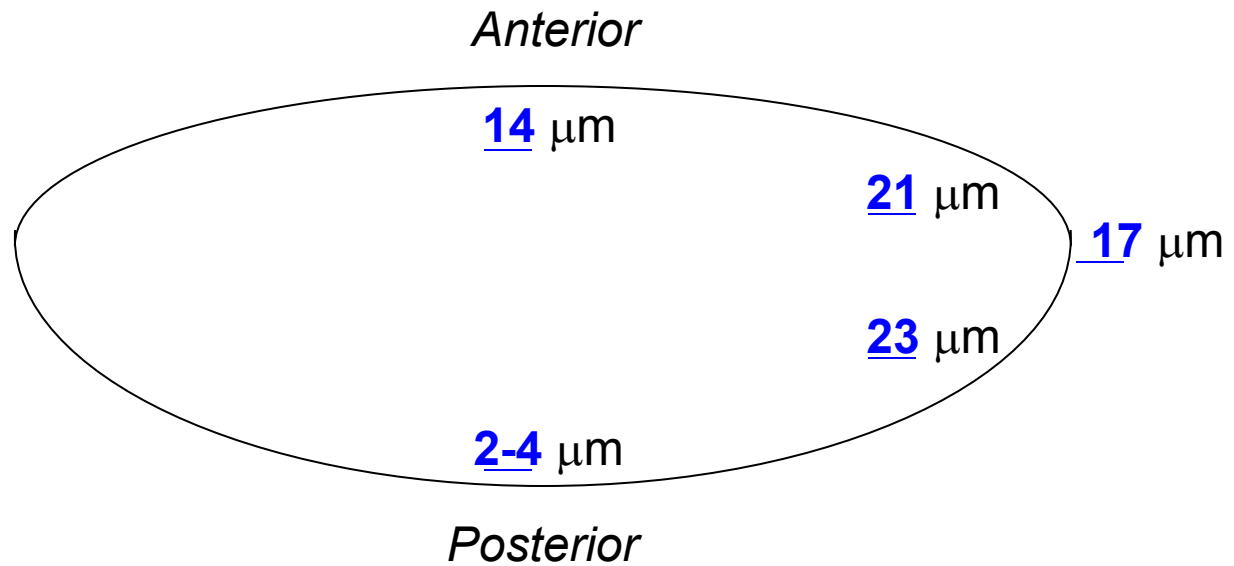


Lens capsule thickness: Fill in the blanks

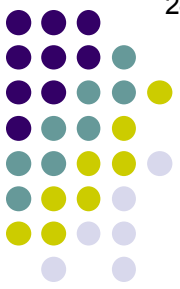




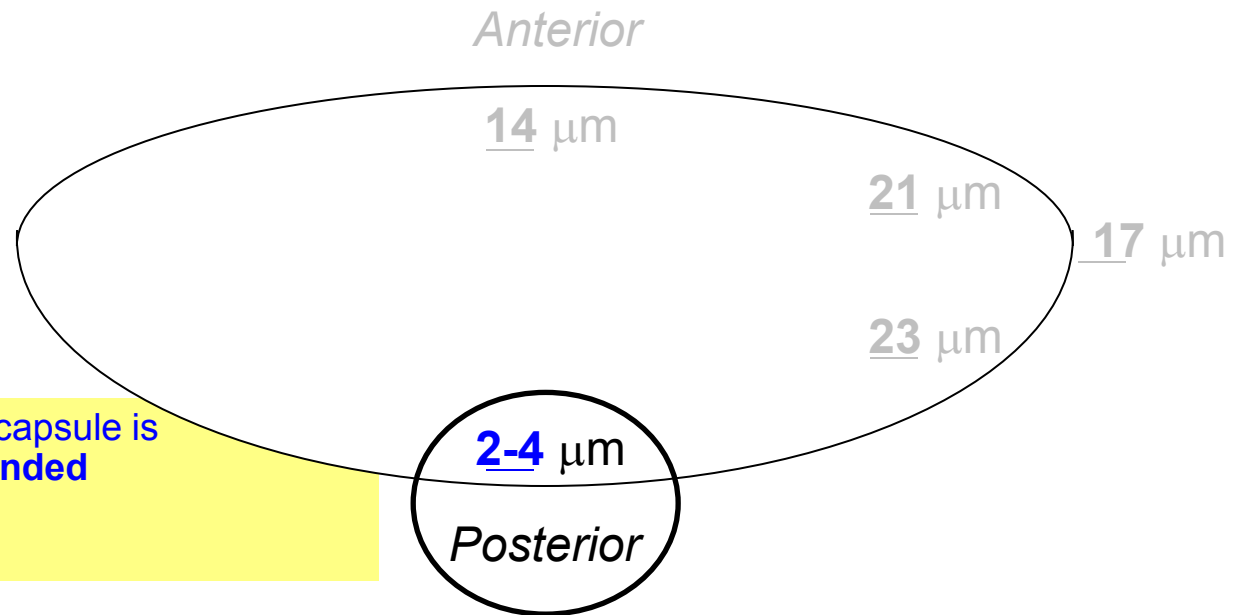
Lens capsule thickness: Fill in the blanks



Lens/Cataracts Overview

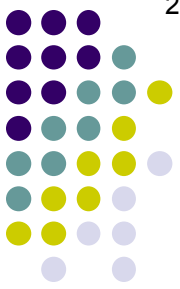


Lens capsule thickness: Fill in the blanks



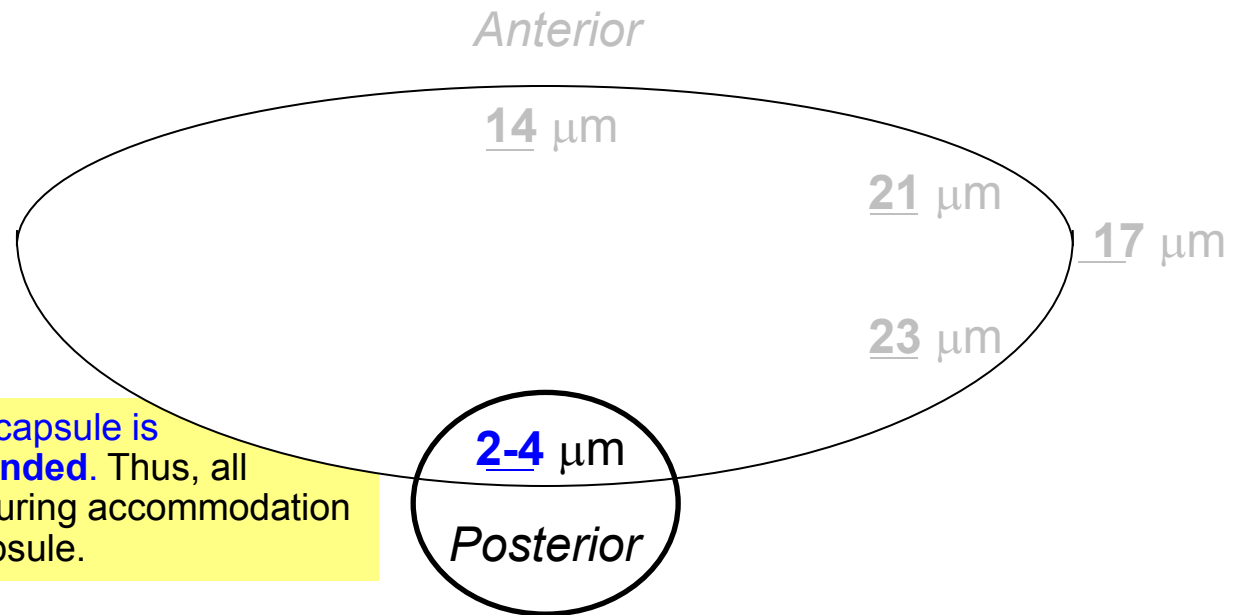
At 2-4 μm , the posterior capsule is so thin it is **always distended**

No question—proceed when ready



Lens/Cataracts Overview

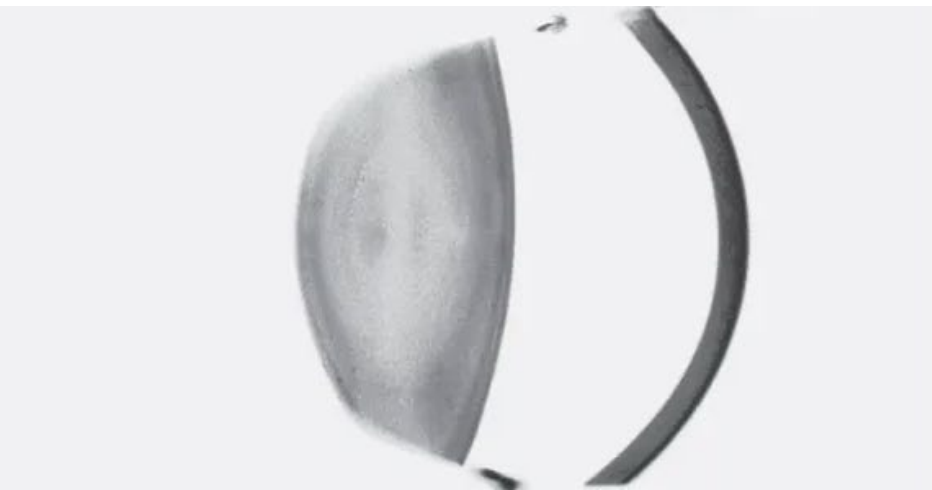
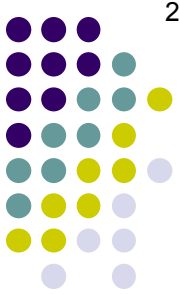
Lens capsule thickness: Fill in the blanks



At 2-4 μm , the posterior capsule is so thin it is **always distended**. Thus, all changes in lens shape during accommodation occur at the **anterior** capsule.

No question—proceed when ready

Lens/Cataracts Overview

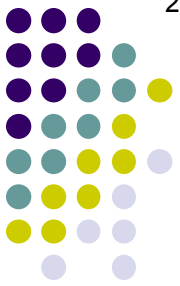


A



B

The lens of a 25-year-old woman demonstrated by Scheimpflug photography. The lens is in the nonaccommodative state in *A*, and accommodating in *B*. Note that the anterior radius of curvature is shortened (ie, the surface is more steeply curved) in *B*.



Q

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

- *Epithelium*

- single vs
multiple

 layer of

shape

 cells

- *Nucleus*

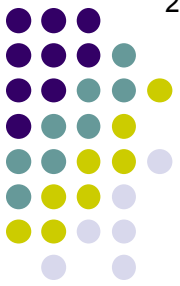
- *Cortex*

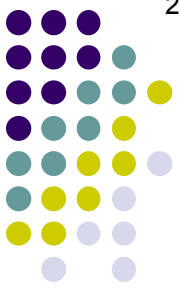
- *Zonules*

A

Lens/Cataracts Overview

- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells
 - *Nucleus*
 - *Cortex*
 - *Zonules*





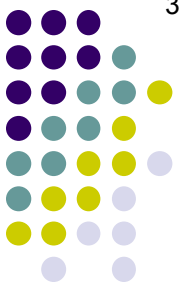
Q

Lens/Cataracts Overview

- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath locale #1 and locale #2 capsule
 - *Nucleus*
 - *Cortex*
 - *Zonules*

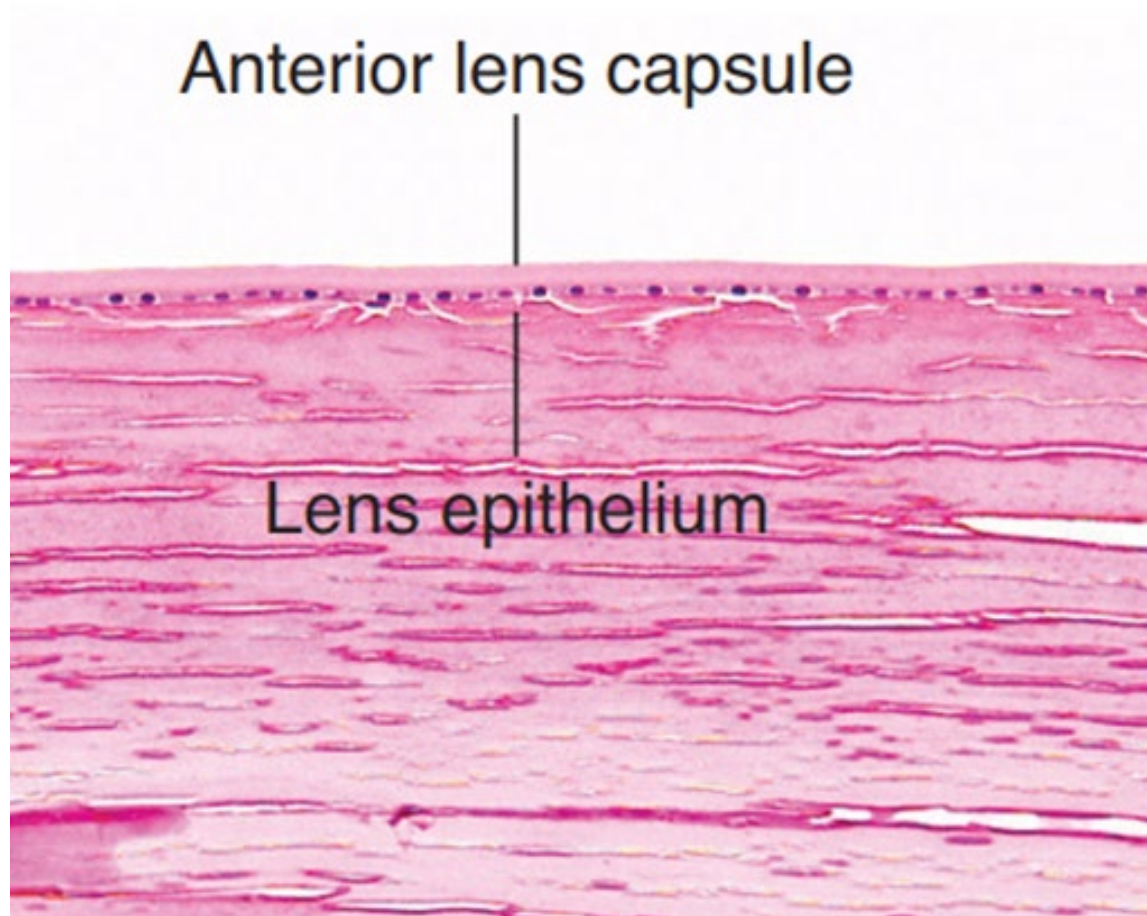
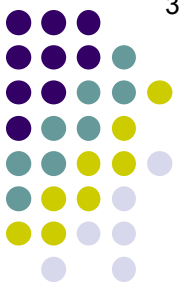
A

Lens/Cataracts Overview



- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - *Nucleus*
 - *Cortex*
 - *Zonules*

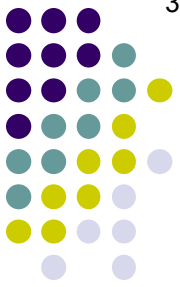
Lens/Cataracts Overview



Lens epithelium

Q

Lens/Cataracts Overview

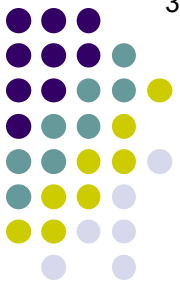


- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - Metabolically

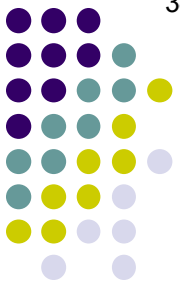
active vs
inactive
 - *Nucleus*
 - *Cortex*
 - *Zonules*

A

Lens/Cataracts Overview



- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - Metabolically active
 - *Nucleus*
 - *Cortex*
 - *Zonules*



Q

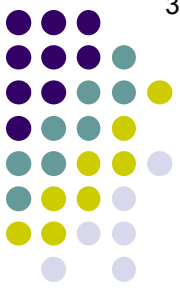
Lens/Cataracts Overview

- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - Metabolically active; mitotically

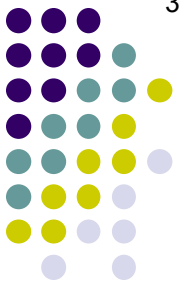
active vs
inactive
 - *Nucleus*
 - *Cortex*
 - *Zonules*

A

Lens/Cataracts Overview



- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - Metabolically active; mitotically active
 - *Nucleus*
 - *Cortex*
 - *Zonules*



Lens/Cataracts Overview

- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - **Metabolically active**; mitotically active

Let's sidebar on a couple of important topics related to lens metabolism

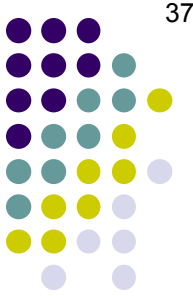
- *Cortex*
- *Zonules*

Q

Lens/Cataracts Overview

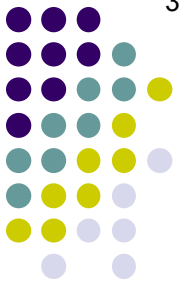
What is the primary substrate in lens metabolism?

?



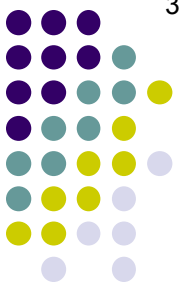
A

Lens/Cataracts Overview



What is the primary substrate in lens metabolism?

Glucose

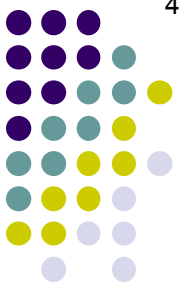


Glucose $\xrightarrow{\text{Hexokinase}}$ G6P

*What is the primary process by which
glucose is used to generate energy?*



(two **?** words)
(majority of glucose)



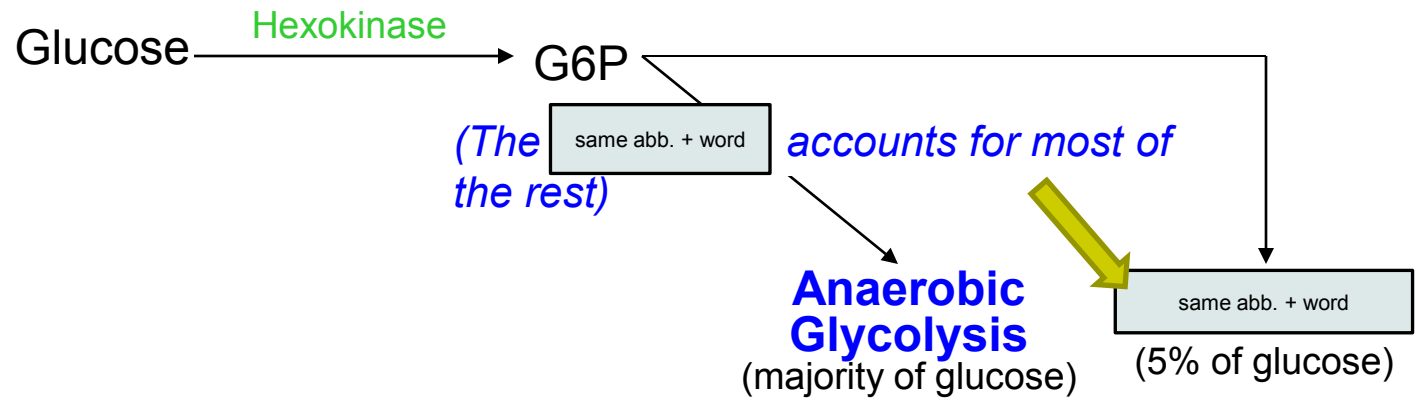
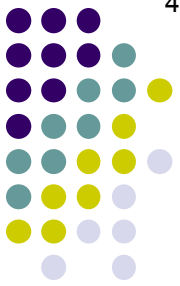
Glucose $\xrightarrow{\text{Hexokinase}}$ G6P

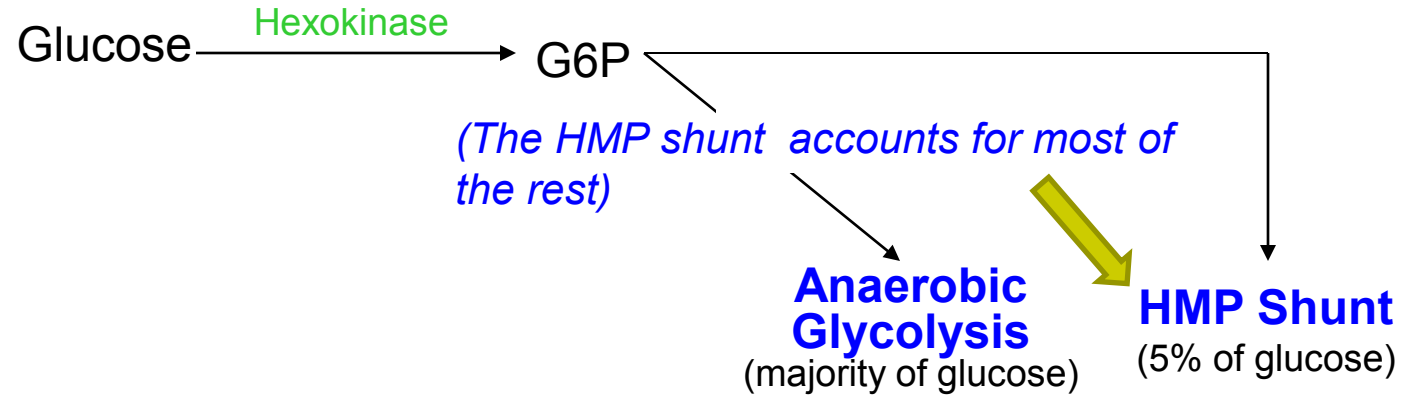
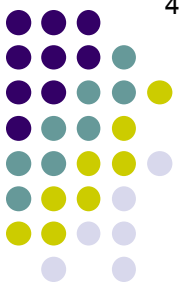
*What is the primary process by which
glucose is used to generate energy?*



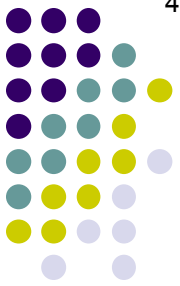
**Anaerobic
Glycolysis**

(majority of glucose)





Lens/Cataracts Overview

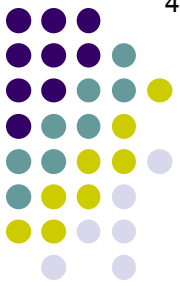


Glucose $\xrightarrow{\text{Hexokinase}}$ G6P

The top-line point: **Lens metabolism is dependent upon the presence of *glucose*, not oxygen.**

Anaerobic Glycolysis (majority of glucose)	HMP Shunt (5% of glucose)
------------------------------------------------------	-------------------------------------

Lens/Cataracts Overview

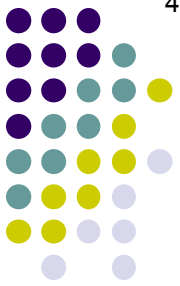


Glucose $\xrightarrow{\text{Hexokinase}}$ G6P

The top-line point: **Lens metabolism is dependent upon the presence of *glucose*, not oxygen.** Even in a zero-oxygen environment (such as can be created in a lab setting), a lens will remain transparent and viable so long as it has an adequate glucose supply.

Anaerobic Glycolysis (majority of glucose)	HMP Shunt (5% of glucose)
------------------------------------------------------	-------------------------------------

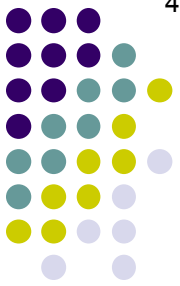
Lens/Cataracts Overview



Anaerobic Glycolysis
(majority of glucose)

HMP Shunt
(5% of glucose)

The top-line point: **Lens metabolism is dependent upon the presence of *glucose*, not oxygen.** Even in a zero-oxygen environment (such as can be created in a lab setting), a lens will remain transparent and viable so long as it has an adequate glucose supply. **However, in the reverse environmental situation—that is, one in which oxygen is abundant but glucose is absent—the lens will become cloudy and nonviable in a matter of hours.**



Q

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

- *Epithelium*

- Single layer of cuboidal cells beneath anterior and equatorial capsule
- Metabolically active: **mitotically active**

The cells in one section of the epithelium are especially mitotically active—which section?

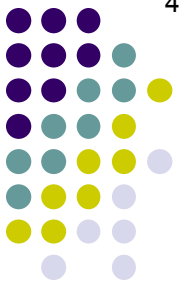
- *Nucleus*

- *Cortex*

- *Zonules*

Q/A

Lens/Cataracts Overview



- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

- *Epithelium*

- Single layer of cuboidal cells beneath anterior and equatorial capsule
- Metabolically active: **mitotically active**

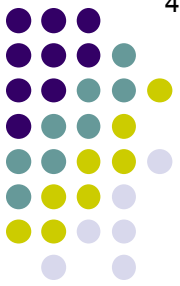
The cells in one section of the epithelium are especially mitotically active—which section?

Those located in the starts with a 'G' zone (GZ)

- *Nucleus*

- *Cortex*

- *Zonules*



A

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

- *Epithelium*

- Single layer of cuboidal cells beneath anterior and equatorial capsule
- Metabolically active: **mitotically active**

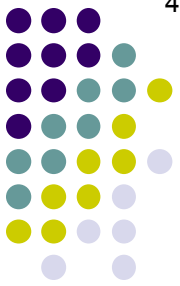
The cells in one section of the epithelium are especially mitotically active—which section?

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Q

Lens/Cataracts Overview

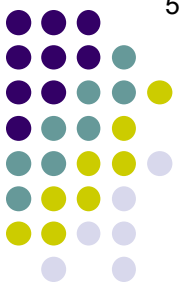
● Anatomy of the mature lens

- *Capsule*
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The cells in one section of the epithelium are especially mitotically active—which section?

Those located in the *germinative zone* (GZ). The -shaped GZ is located in the peripheral v
central aspect of the anterior capsule.

- *Nucleus*
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A

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

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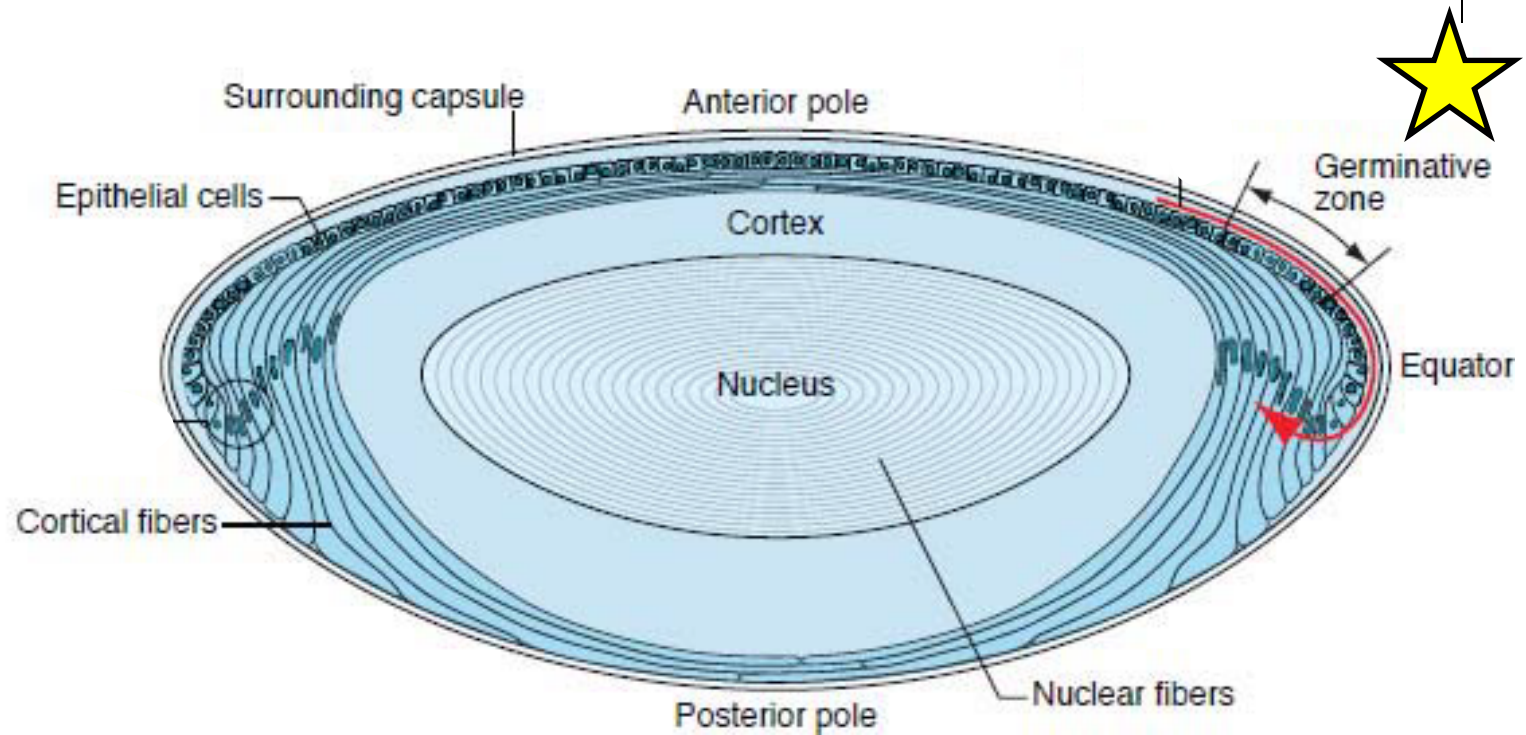
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- *Cortex*

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Lens/Cataracts Overview



Lens epi cells and their relation to the capsule and GZ



Q

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

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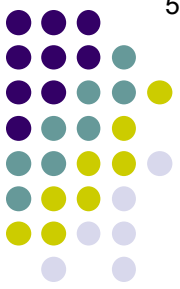
- Single layer of cuboidal cells beneath anterior and equatorial capsule
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- Give rise to all new lens

- *Nucleus*

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Next question

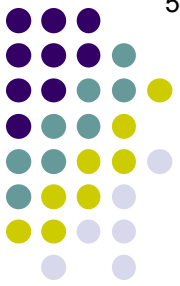


A

Lens/Cataracts Overview

- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - Metabolically active; mitotically active
 - Give rise to all new lens fibers
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Next question



Q

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

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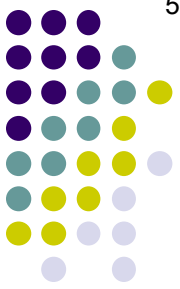
How does the epi give rise to lens fibers?

- *Cortex*

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Q/A

Lens/Cataracts Overview



- Anatomy of the mature lens

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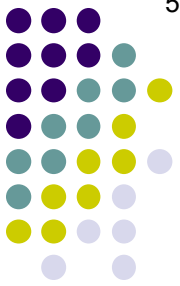
- *Nucleus*

How does the epi give rise to lens fibers?

After their creation in the GZ, newly-minted epi cells migrate to the so-called  region of the equatorial lens

- *Cortex*

- *Zonules*



A

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

- *Epithelium*

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- **Give rise to all new lens fibers**

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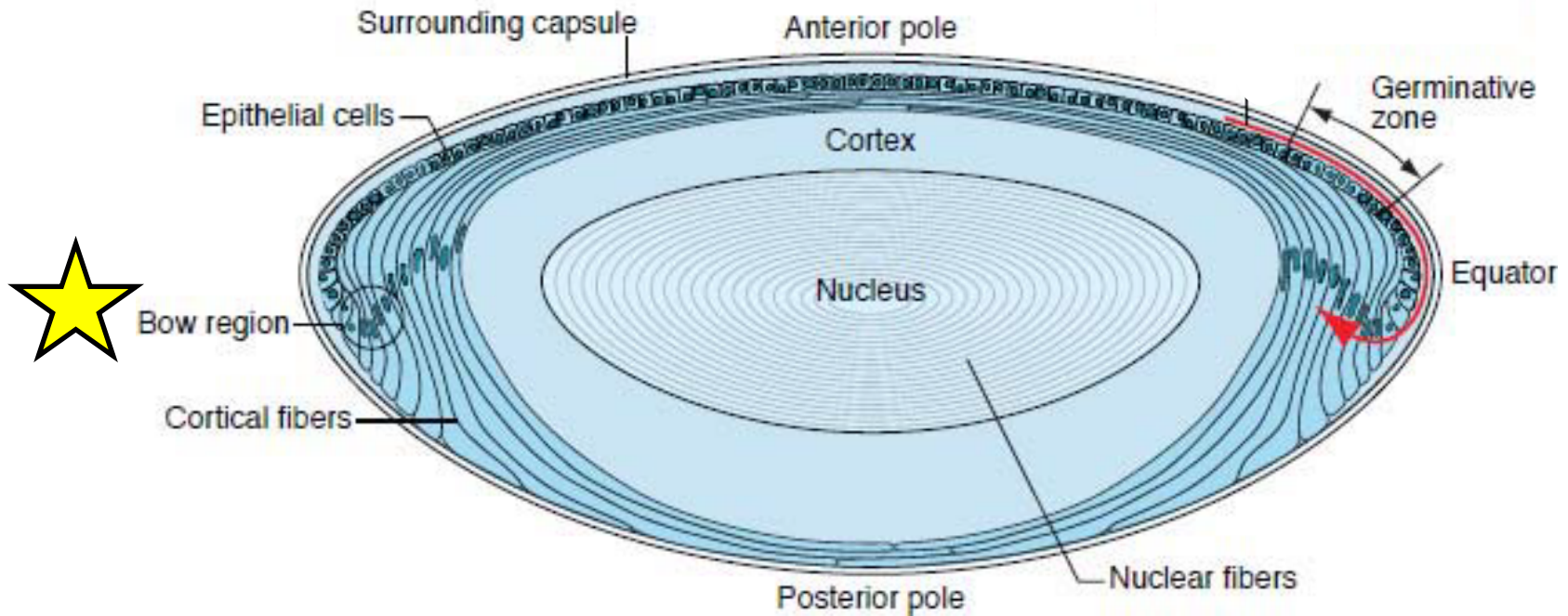
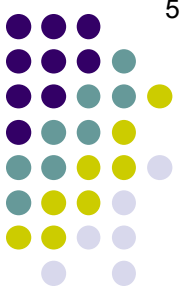
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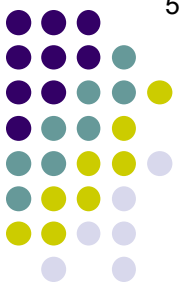
- *Cortex*

- *Zonules*

Lens/Cataracts Overview



Lens epi cells and their relation to the capsule, GZ, **and bow region**



A

Lens/Cataracts Overview

- Anatomy of the mature lens

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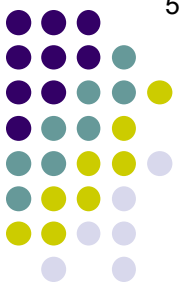
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- *Zonules*

1) elongation of the cell, and 2) the loss of its organelles.



Q

Lens/Cataracts Overview

● Anatomy of the mature lens

● Capsule

- Type IV collagen

● Epithelium

- Single layer of cuboidal cells beneath anterior and equatorial capsule
- Metabolically active; mitotically active
- Give rise to all new lens fibers

● Nucleus

How does the epi give rise to lens fibers?

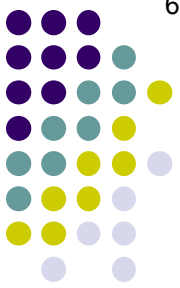
After their creation in the GZ, newly-minted epi cells migrate to the so-called **bow region** of the equatorial lens. It is in the bow

● Cortex

Is it pronounced 'bow' as in 'bow tie,' or bow as in 'take a bow'?

● Zonules

ed by
lles.



A

Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

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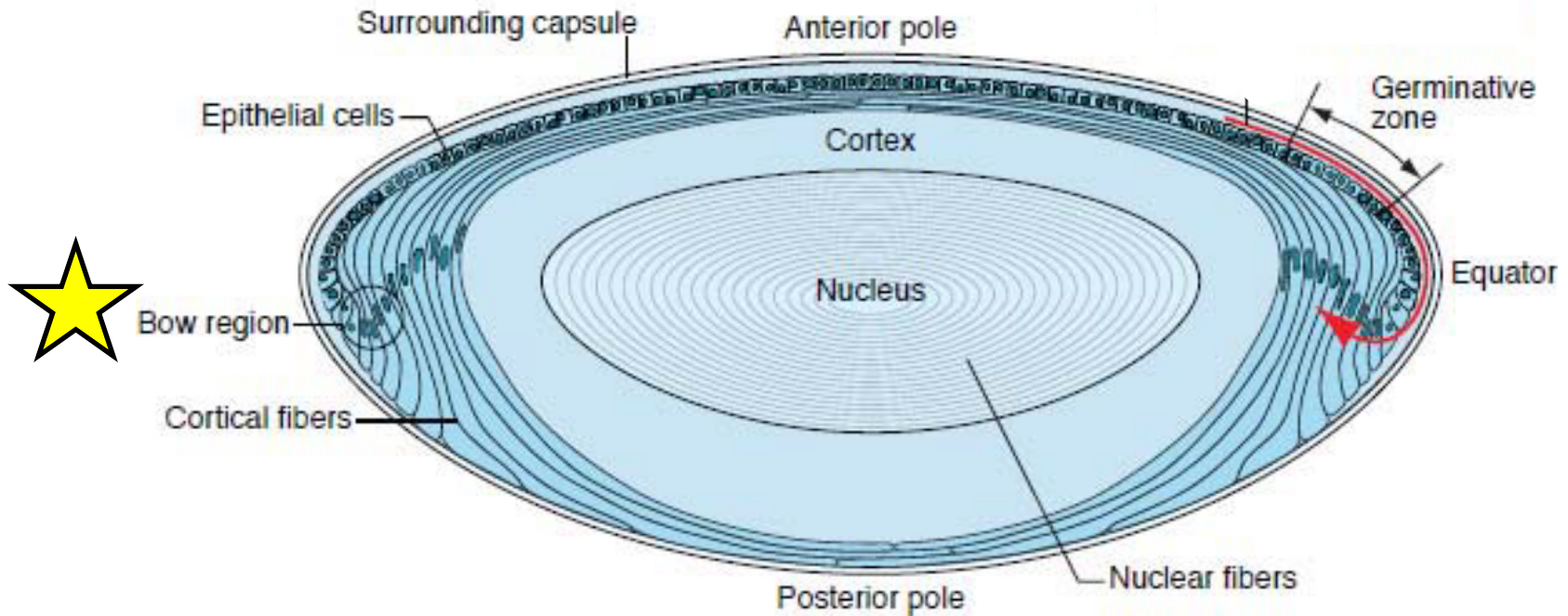
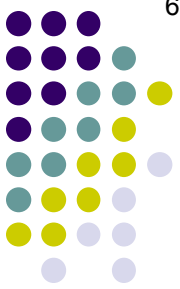
- *Cortex*

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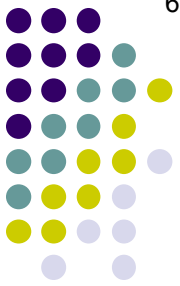
It's pronounced 'bow' as in 'the bow of a ship,' which is what it looks like in cross-section; check it on the Figure again (re-presented on the next slide)

- *Zonules*

Lens/Cataracts Overview



Lens epi cells and their relation to the capsule, GZ, **and bow region**



Q

Lens/Cataracts Overview

● Anatomy of the mature lens

● Capsule

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- Single layer of cuboidal cells beneath anterior and equatorial capsule
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How does the epi give rise to lens fibers?

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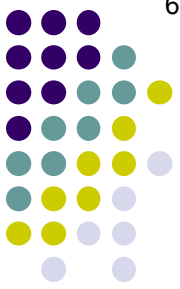
● Zonules

1) **elongation** of the cell, and 2) the loss of its organelles.

How much elongation are we talking about here?

Q/A

Lens/Cataracts Overview



● Anatomy of the mature lens

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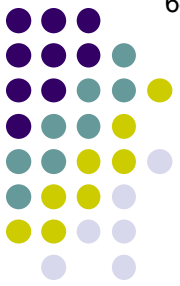
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Lots. As in, fibers elongate both anteriorly and posteriorly until they run into an elongating fiber from the *other* side (occurs near the lens's).



A

Lens/Cataracts Overview

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How does the epi give rise to lens fibers?

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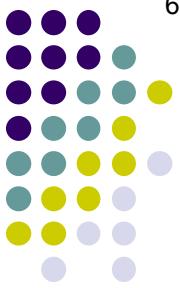
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Lots. As in, fibers elongate both anteriorly and posteriorly until they run into an elongating fiber from the *other side* (occurs near the lens's *poles*). Thus, the typical fiber will run roughly halfway around the extent of the lens.



Q

Lens/Cataracts Overview

● Anatomy of the mature lens

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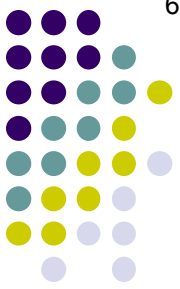
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What do fibers do when they encounter a fellow-traveler elongating from the opposite side of the lens?

Q/A

Lens/Cataracts Overview



● Anatomy of the mature lens

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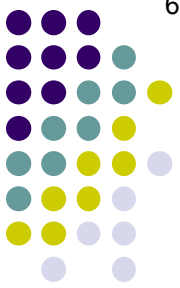
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What do fibers do when they encounter a fellow-traveler elongating from the opposite side of the lens?

The two fibers **buzzword** with one another



A

Lens/Cataracts Overview

● Anatomy of the mature lens

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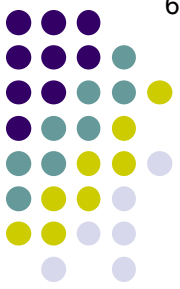
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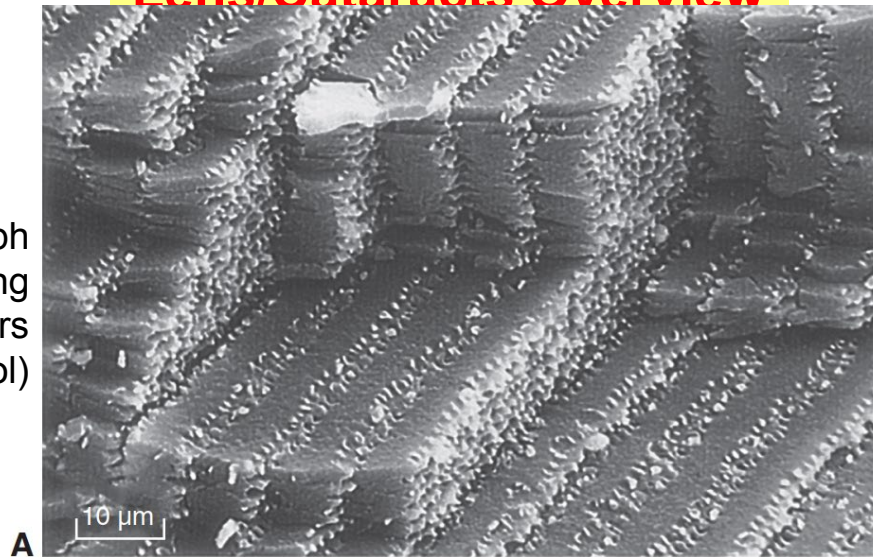
What do fibers do when they encounter a fellow-traveler elongating from the opposite side of the lens?

The two fibers interdigitate with one another

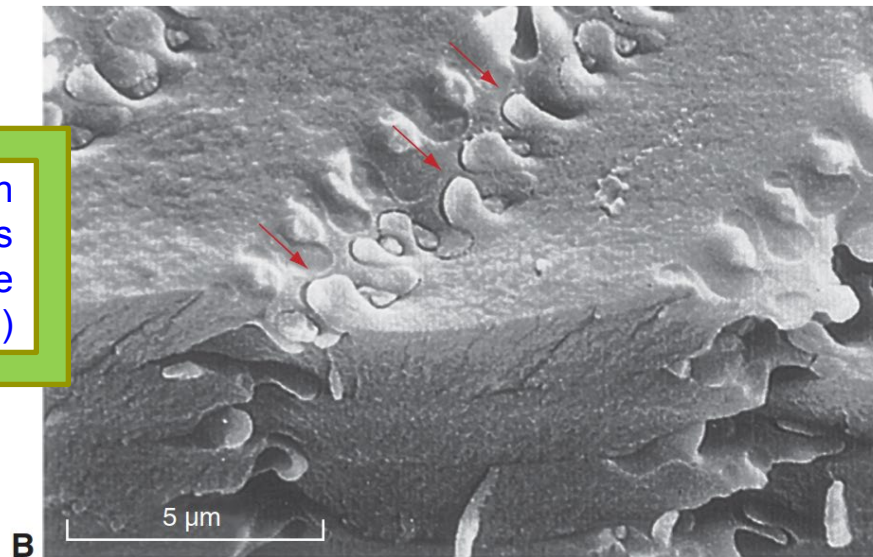
Lens/Cataracts Overview



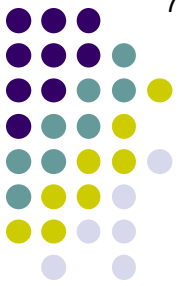
Photomicrograph
demonstrating
'packing' of lens fibers
(just because it's cool)



Photomicrograph
demonstrating fibers
interdigitating* (the
hard-to-see arrows)



*I know, the depicted interdigitations are side-by-side, whereas the discussion has been of interdigitations that are head-on. Couldn't find a pic of that, sorry.



Q

Lens/Cataracts Overview

● Anatomy of the mature lens

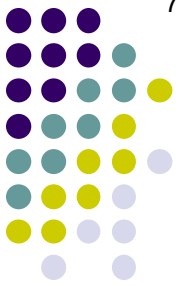
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How does the epi give rise to lens fibers?
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Which organelles go bye-bye?



A

Lens/Cataracts Overview

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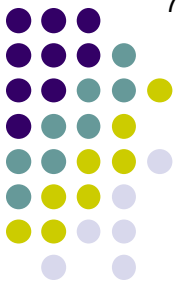
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Which organelles go bye-bye?

Pretty much all of them, including the nucleus and mitochondria



Q

Lens/Cataracts Overview

● Anatomy of the mature lens

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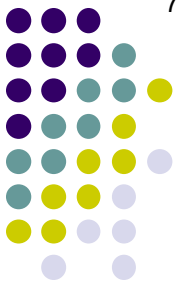
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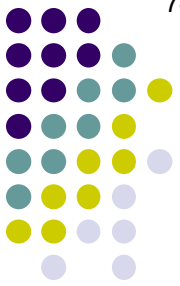
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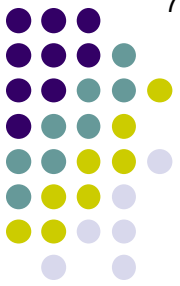
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Q

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Why is organelle disintegration critical to lens function?

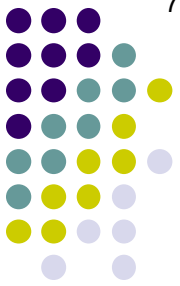
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organelles go bye-bye?
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Q/A

Lens/Cataracts Overview



● Anatomy of the mature lens

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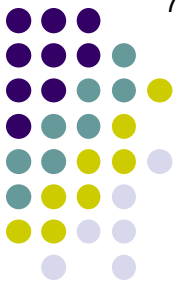
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Why is organelle disintegration critical to lens function?

loss of its organelles

Because most organelles are large enough to where they would *organelles go bye-bye?*
incoming light, and thus their presence would compromise vision *nucleus and mitochondria*

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 - **Give rise to all new lens fibers**
- *Nucleus*

How does the epi give rise to lens fibers?

After their creation in the GZ, newly-minted epi cells migrate to the so-called *bow region* of the equatorial lens. It is in the bow region that these cells begin the process of terminal differentiation into lens fibers, a process characterized by
- *Cortex*

Why is organelle disintegration critical to lens function?

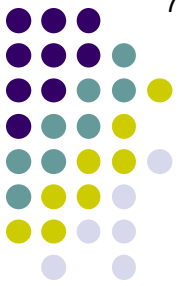
loss of its organelles

Because most organelles are large enough to where they would scatter* incoming light, and thus their presence would compromise vision

organelles go bye-bye?
nucleus and mitochondria

So is it safe to assume lens fibers are nonliving structures, like (say) hair and nails?
Far from it. Not only are they living cells, they **must** be so for the lens to remain optically clear—fiber cells turn opaque within hours if their metabolic needs are unmet. (And to anticipate a reasonable inference—no, fiber-cell death is **not** ir

*If you answered “absorb,” that’s OK too



Q

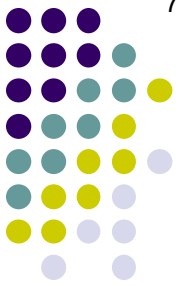
Lens/Cataracts Overview

- Anatomy of the mature lens
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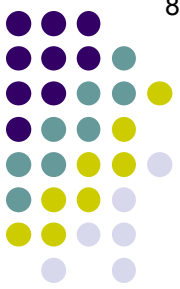
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Q

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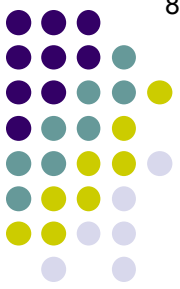
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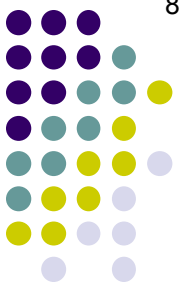
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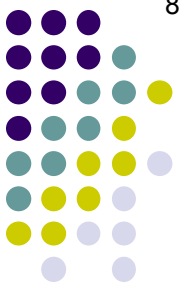
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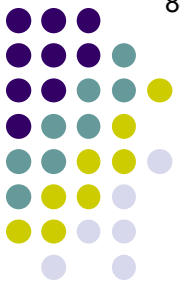
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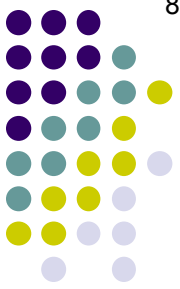
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loss of its organelles

Thus, while the fiber is elongating, its intracellular machinery is cranking out lens proteins to fill the space, a process that can't end until the fiber has fully elongated. (BTW, we will have **much** more to say about lens proteins later in the slide-set.)

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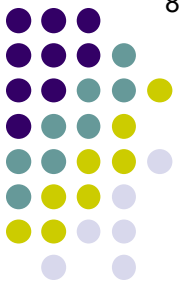
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Rhetorical question—keep going



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No question yet—keep going

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● Anatomy of the mature lens

But first, consider the primary purpose of the lens: Focusing incoming light on the fovea.

capsule

This space has to

contain something

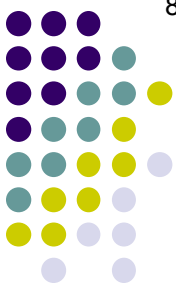
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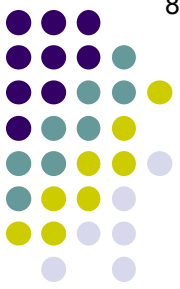
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Q

Lens/Cataracts Overview

● Anatomy of the mature lens

But first, consider the primary purpose of the lens: Focusing incoming light on the fovea. To do this, the lens must supply [] (aka []) power.

capsule

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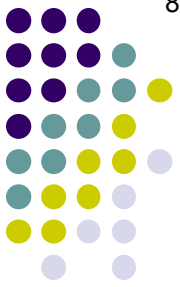
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● Anatomy of the mature lens

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capsule

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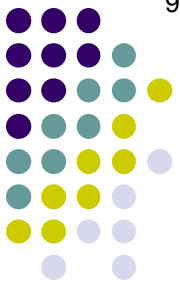
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● Anatomy of the mature lens

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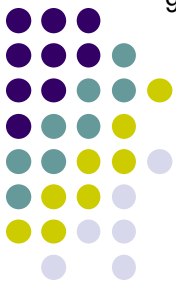
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● Anatomy of the mature lens

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where n' is the refractive index of the substance the light is heading into (the lens in this case), n is the refractive index of the substance the light is coming from (the aqueous), and r is the radius of curvature of the refracting surface (the anterior lens capsule).

contain something

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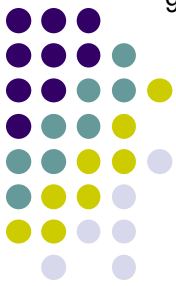
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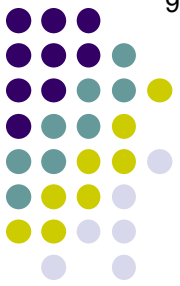
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No question—advance when ready



Lens/Cataracts Overview



● Anatomy of the mature lens

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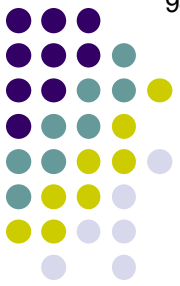
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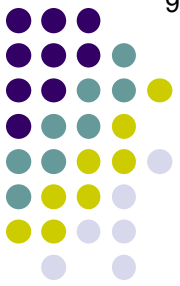
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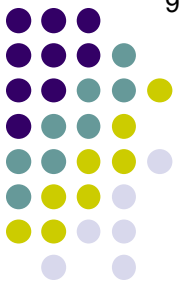
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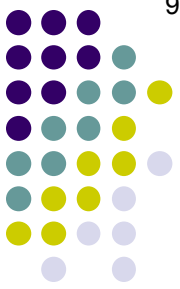
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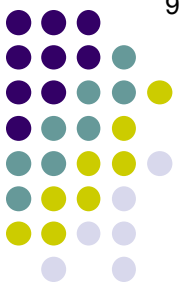
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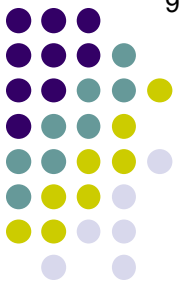
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Far from it. Not only are they living cells, they **must** be so for the lens to remain optically clear—fiber cells turn opaque within hours if their metabolic needs are unmet. (And to anticipate a reasonable inference—no, fiber-cell death is **not** implicated in cataract formation.)

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Lens/Cataracts Overview

● Anatomy of the mature lens

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Here's where Snell's law comes into play. Snell's law tells us that the dioptric power produced at a refracting surface is

$$D = \frac{n' - n}{r}$$

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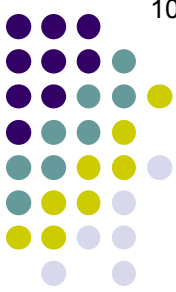
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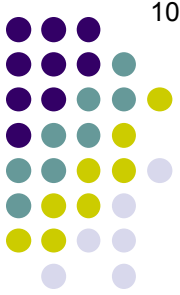
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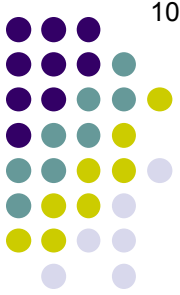
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No question—advance when ready

Lens/Cataracts Overview



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● Anatomy of the mature lens

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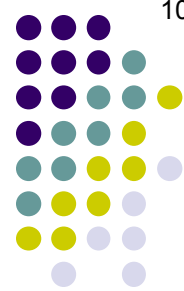
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Closing the loop: All of this is why 1) the lens fibers must be filled with something other than isotonic fluid, and

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Closing the loop: All of this is why 1) the lens fibers must be filled with something other than isotonic fluid, and 2) why that 'something' is proteins.

This space has to contain *something*, and in the case of lens fibers it is filled with lens *proteins*.

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You have probably anticipated the implications of all this for the composition of the intracellular space in lens fibers. If that space was filled with a liquid isotonic to aqueous, the refractive index would be the same as the surrounding aqueous. This would mean the lens would be invisible. Closing some of the space in the lens capsule

Before we move on:

--If you're not grokking this whole *Snell's law* thing, review slide-set *BO17* (or better still, do the whole *Basic Optics* tutorial)

--So as not to get bogged down, I simplified the corneal optics involved. See set *RS3* for a deep dive on this super-important subject.

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Q

Lens/Cataracts Overview

• Anatomy of the mature lens

- *Capsule*
 - Type IV collagen
- *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - Metabolically active; mitotically active
 - **Give rise to all new lens fibers**
- *Nucleus*

How does the epi give rise to lens fibers?

After their creation in the GZ, newly-minted epi cells migrate to the so-called *bow region* of the equatorial lens. It is in the bow region that these cells begin the process of terminal differentiation into lens fibers, a process characterized by 1) elongation of the cell, and 2) the loss of its organelles.
- *Cortex*
- *Zonules*

Next Q

When (ie, at what point in life) does fiber creation cease?



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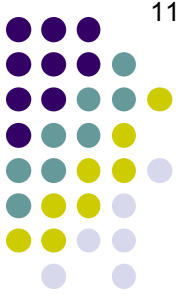
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When (ie, at what point in life) does fiber creation cease?

Not until one has shuffled off this mortal coil, as the Bard put it. That is, lens fiber formation **never ceases**.



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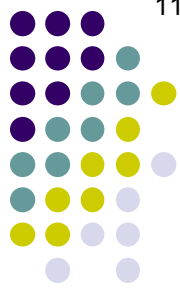
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Not until one has shuffled off this mortal coil, as the Bard put it. That is, lens fiber formation **never ceases**. Further, lens fibers are never lost or discarded (like, say, the sloughing of skin cells). So you still have every lens fiber you've ever created, all packed inside the lens capsule.



Lens/Cataracts Overview

- Anatomy of the mature lens

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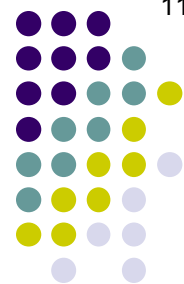
Epithelium

And this poses a significant metabolic challenge for the lens. Let's get into it.

Like every cell in the body, lens fibers must communicate with the 'outside world' to receive metabolic substrates and expurgate metabolic waste. Most (non-lens) cells accomplish this via the circulatory system.

No question yet—proceed when ready

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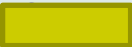
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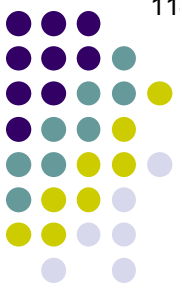
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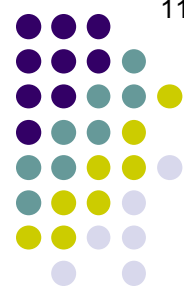
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Rhetorical question—proceed when ready

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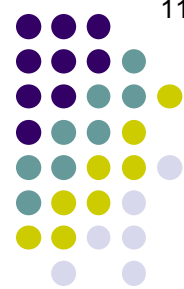
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- Now, communicating in this manner is not difficult for the lens epithelium and outermost cortical fibers, as the fluid is just on the other side of the capsule from them. But what of more centrally located fibers? To connect them to the aqueous and/or vitreous, the lens employs a 'bucket brigade' in which metabolic substrates and waste products are passed cell-to-cell (via two words) to get where they need to go.

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Like every cell in the body, lens fibers must communicate with the 'outside world' to receive metabolic substrates and expurgate metabolic waste. Most (non-lens) cells accomplish this via the circulatory system. But the adult lens is avascular, so this method is not available to its cells. Instead, they communicate with the environment via the fluids that surround the lens—the aqueous anteriorly and vitreous posteriorly.

Now, communicating in this manner is not difficult for the lens epithelium and outermost cortical fibers, as the fluid is just on the other side of the capsule from them. But what of more centrally located fibers? To connect them to the aqueous and/or vitreous, the lens employs a 'bucket brigade' in which metabolic substrates and waste products are passed cell-to-cell (via gap junctions) to get where they need to go.

are never lost or discarded (like, say, the sloughing of skin cells).
So you still have every lens fiber you've ever created, all packed inside the lens capsule.



A

Lens/Cataracts Overview

● Anatomy of the mature lens

- *Capsule*
 - Type IV collagen

Epithelium

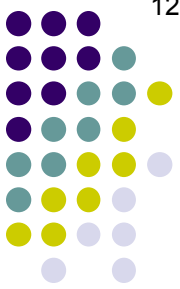
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Lens/Cataracts Overview

• Anatomy of the mature lens

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Epithelium

And this poses a significant metabolic challenge for the lens. Let's get into it.

What is the chief metabolic waste product of the lens?

(You know the answer to this.)

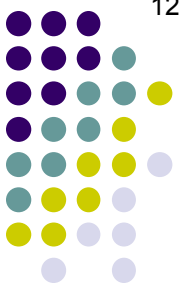
Lactate (lactic acid if you prefer)

metabolic waste

Lens fibers communicate with the 'outside world' to release metabolic waste. Most (non-lens) cells have a blood supply, but the lens is avascular, so this is a challenge. Lens fibers communicate with the environment anteriorly and vitreous posteriorly. Nutrients enter the lens epithelium and exit through the outermost cortical fibers, as the fluid is just on the other side of the capsule from them. But what of more centrally located fibers? To connect *them* to the aqueous and/or vitreous, the lens employs a 'bucket brigade' in which metabolic substrates and waste products are passed cell-to-cell (via gap junctions) to get where they need to go. It should not surprise that *the density of gap junctions in lens-fiber cells is greater than that of any other cells in the body.*

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Why would you assume I know that?

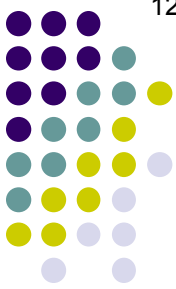
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Q/A

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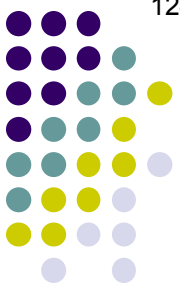
Why would you assume I know that?

Because you know (from this slide-set) that the chief source of energy in the lens is two words, and you know (from med school, if not earlier) that lactate is the main byproduct of that process

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metabolic waste

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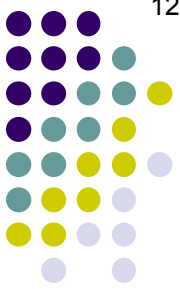
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Lens/Cataracts Overview

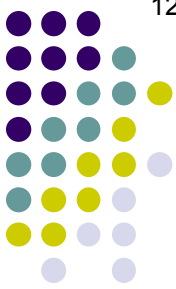
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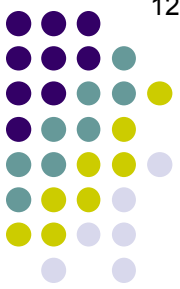
Lens/Cataracts Overview

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Q

Lens/Cataracts Overview

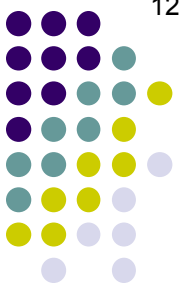


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*The **type** cataract is a function of lens water content.
(We will have much to say about this later on.)

A

Lens/Cataracts Overview



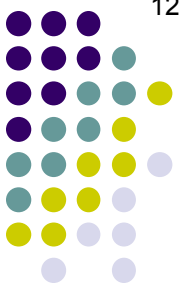
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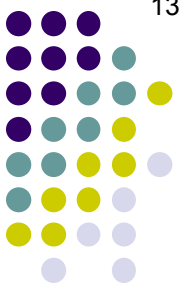
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*If you said *electrolytes*, that's OK too



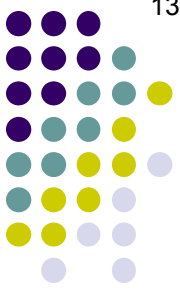
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*Before we get into intralenticular ion levels, let's talk about the closely-related (and highly testable in its own right) topic of **aqueous** ion levels*

Q

Lens/Cataracts Overview

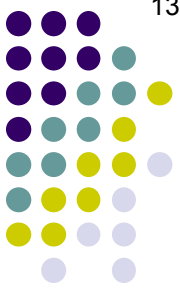


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*What are the two general classes of ions in aqueous? (Note: **Not** 'anions and cations.')*
? and ?

A

Lens/Cataracts Overview

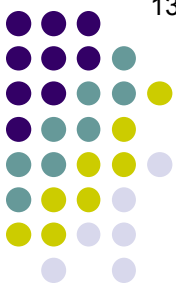


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*What are the two general classes of ions in aqueous? (Note: **Not** 'anions and cations.')*
Inorganic and organic

Q

Lens/Cataracts Overview



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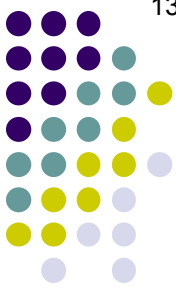
The BCSC fixates on four inorganic ions— which ones?

{
 ?
 ?
 ?
 ?

← Inorganic and organic

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Lens/Cataracts Overview



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Na^+

K^{2+}

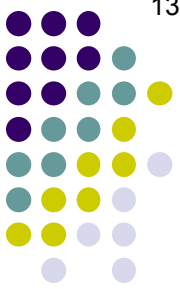
Mg^{2+}

Ca^{2+}

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Lens/Cataracts Overview



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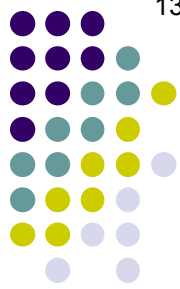
Na^+ ← Inorganic and organic → ?
 K^{2+}
 Mg^{2+}
 Ca^{2+}

*Likewise, it fixates on
one organic ion—
which one?*

A

Lens/Cataracts Overview

137



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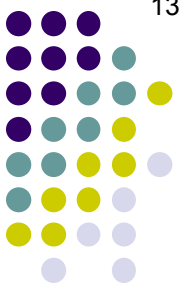
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Na⁺ ← Inorganic and organic → Lactate
K²⁺
Mg²⁺
Ca²⁺

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Lens/Cataracts Overview



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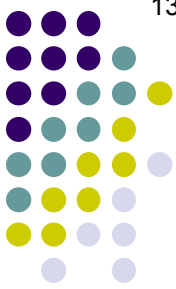
Mg²⁺

Ca²⁺

The concentration of the inorganic ions are all “similar” to that of plasma, with one exception—which is it?

A

Lens/Cataracts Overview



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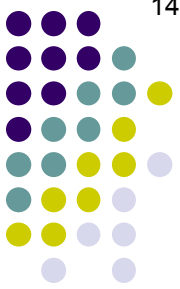
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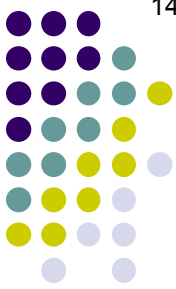
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Ca²⁺

Is [aqueous Ca²⁺] significantly greater than, or less than, [plasma Ca²⁺]?

Q/A

Lens/Cataracts Overview



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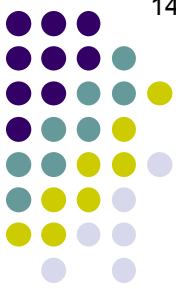
Ca²⁺

Is [aqueous Ca²⁺] significantly greater than, or less than, [plasma Ca²⁺]?

Less than—it is about % that of [plasma Ca²⁺]

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Lens/Cataracts Overview



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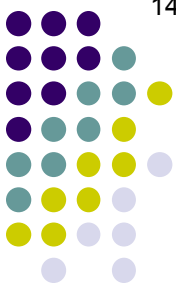
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Less than—it is about half that of [plasma Ca²⁺]*

Q

Lens/Cataracts Overview



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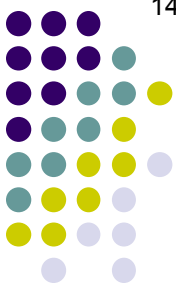
concentrations of these
 What are the ~~two general classes of ions~~ in vitreous? (Note: **Not** 'anions and cations.')

Na⁺ ← Inorganic and organic → Lactate
K²⁺
Mg²⁺
Ca²⁺

Important: The vitreous concentrations of these ions is much higher than
roughly equivalent to
much lower than their aqueous values

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Lens/Cataracts Overview



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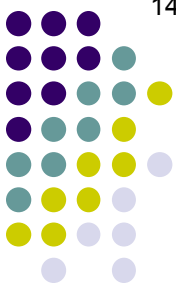
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Lens/Cataracts Overview



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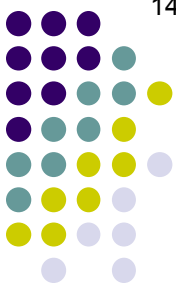
Mg²⁺

Ca²⁺

The presence of lactate in aqueous is due primarily to what physiologic fact?

Q/A

Lens/Cataracts Overview



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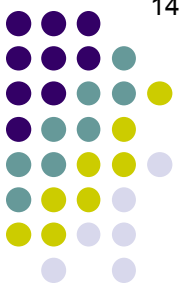
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The fact that structure metabolism is almost 100%

two words



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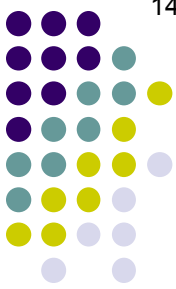
Ca²⁺

The presence of lactate in aqueous is due primarily to what physiologic fact?

The fact that lens metabolism is almost 100% anaerobic glycolysis

Q

Lens/Cataracts Overview



Just as the structure and histology of the lens poses a challenge to meeting its metabolic needs, so too does it challenge the maintenance of lens transparency. Lens transparency is exquisitely sensitive to the water content of the lens's intracellular and extracellular compartments—a touch too much water and the lens scatters light; a touch more and the lens becomes opaque.* Because of this, intralenticular water levels must be scrupulously maintained. And because water follows osmotic gradients, **intralenticular ion levels** must also be closely held.

*What are the two general classes of ions in aqueous? (Note: **Not** 'anions and cations.')*

Na⁺ ← Inorganic and organic → **Lactate**

K²⁺

Mg²⁺

Ca²⁺

The presence of lactate in aqueous is due primarily to what physiologic fact?

The fact that lens metabolism is almost 100% anaerobic glycolysis

(How is [aqueous lactate] related to [plasma lactate])?

Q/A

Lens/Cataracts Overview



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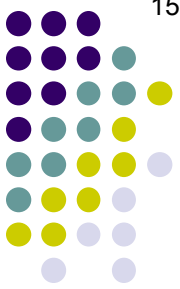
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*How is [aqueous lactate] related to [plasma lactate]?
[Aqueous lactate] is sometimes
usually
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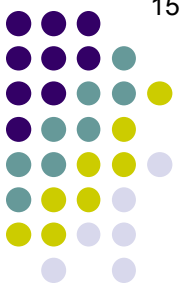
*[Aqueous lactate] is **always** greater than [plasma lactate]*

Note that 'lens anaerobic glycolysis' and 'high aqueous lactate levels' imply one another, so if you can remember one you can deduce the other

Q

Lens/Cataracts Overview

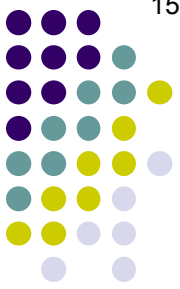
But there's a complicating factor regarding maintenance of appropriate intralenticular hydration: With the exception of the epithelium and the youngest cortical fibers, two words means lens cells lack the membrane machinery required to regulate their ionic milieu.



A

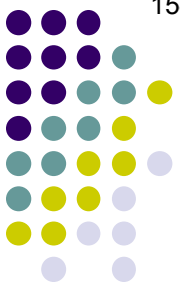
Lens/Cataracts Overview

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Q

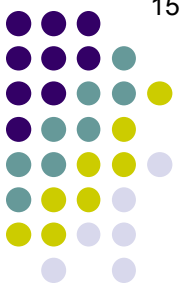
Lens/Cataracts Overview



But there's a complicating factor regarding maintenance of appropriate intralenticular hydration: With the exception of the epithelium and the youngest cortical fibers, organelle loss means lens cells lack the membrane machinery required to regulate their ionic milieu. Once again, the structure and histology of the lens creates a metabolic conundrum; once again, nature finds a way, this time via a process called the two-words system.

A

Lens/Cataracts Overview

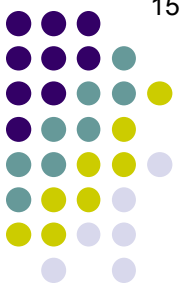


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*aka pump-leak **theory**, aka pump-leak **hypothesis**

A

Lens/Cataracts Overview



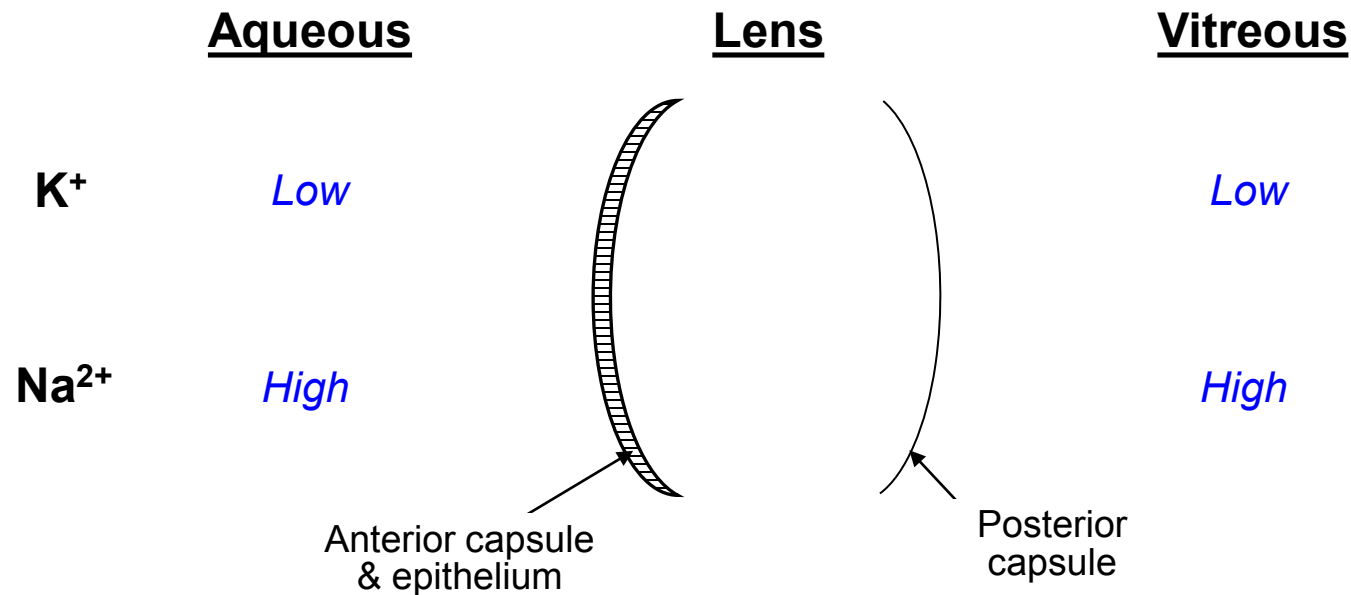
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Lens/Cataracts Overview

The Pump-Leak System

The lens sits between two fluids, both of which have high $[Na^{2+}]$ and low $[K^{+}]$.

No question yet—proceed when ready

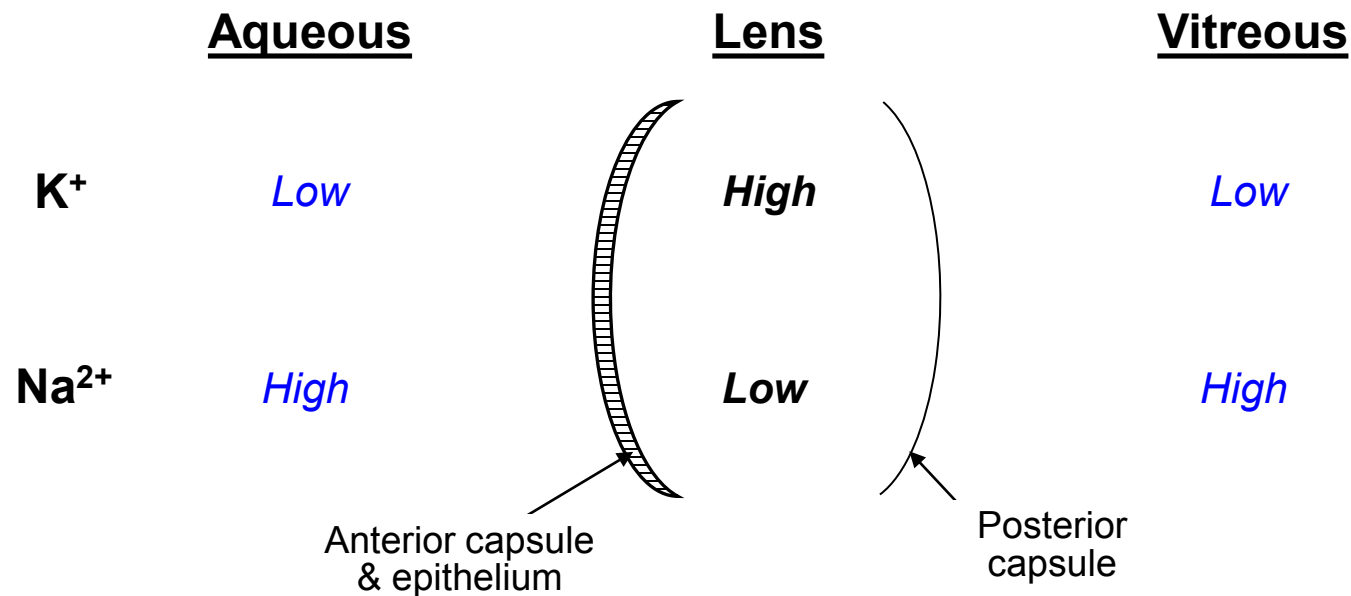


Lens/Cataracts Overview

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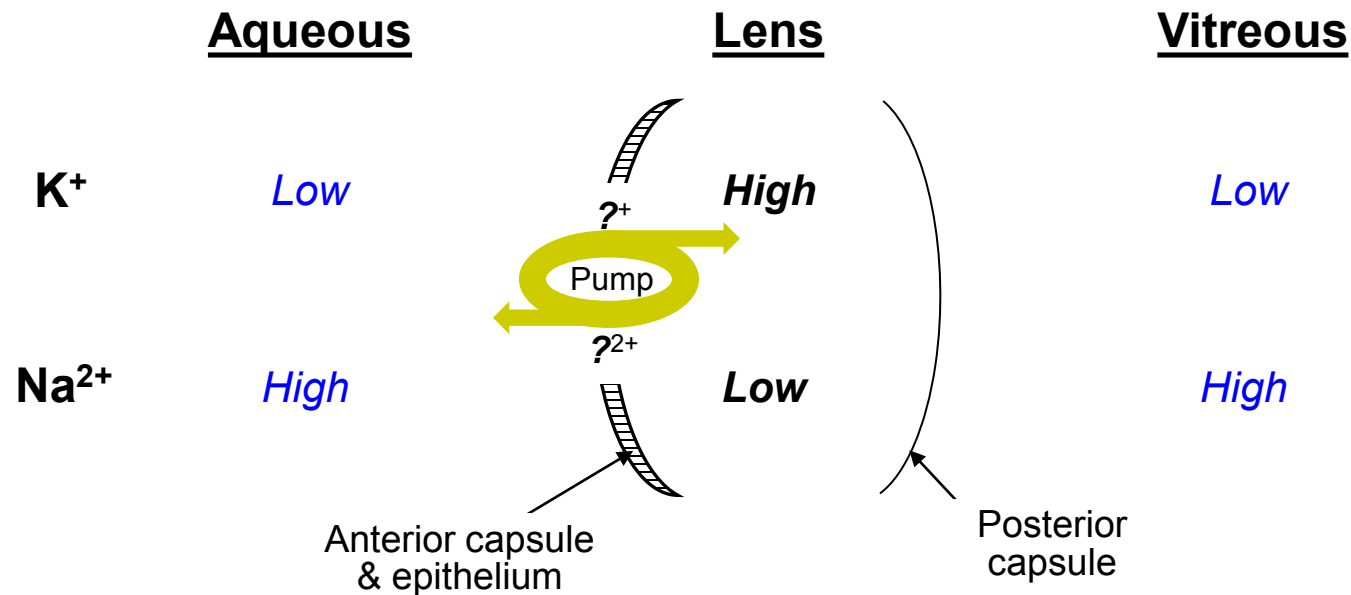


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Lens/Cataracts Overview

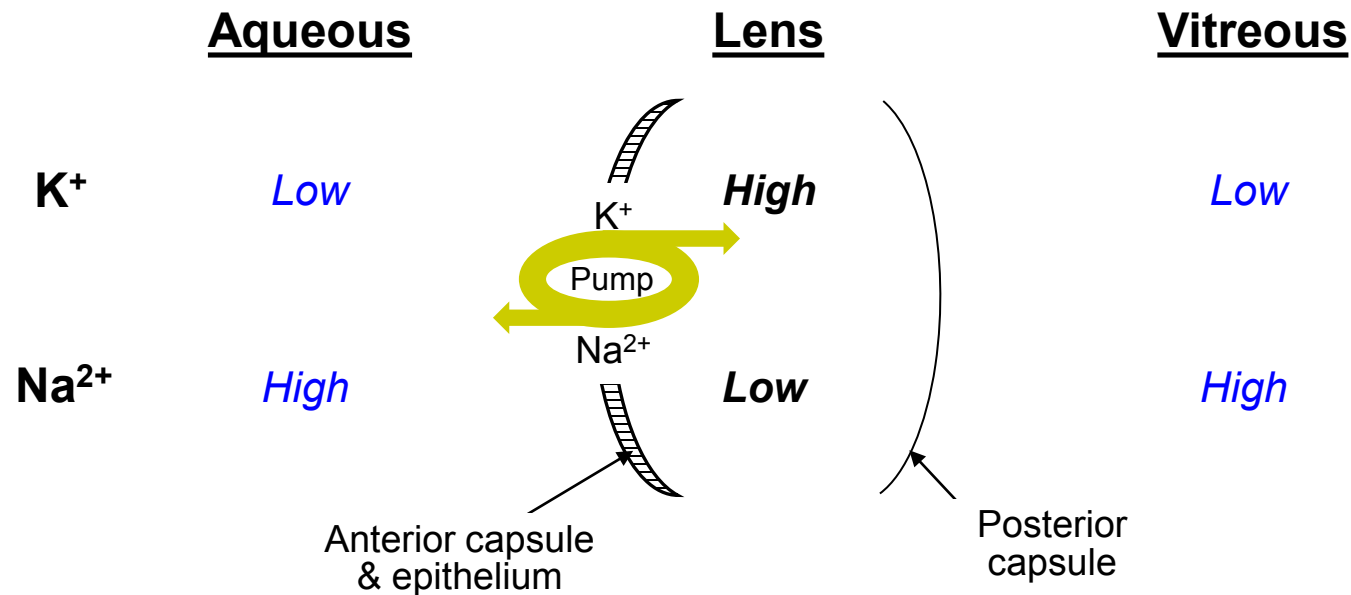
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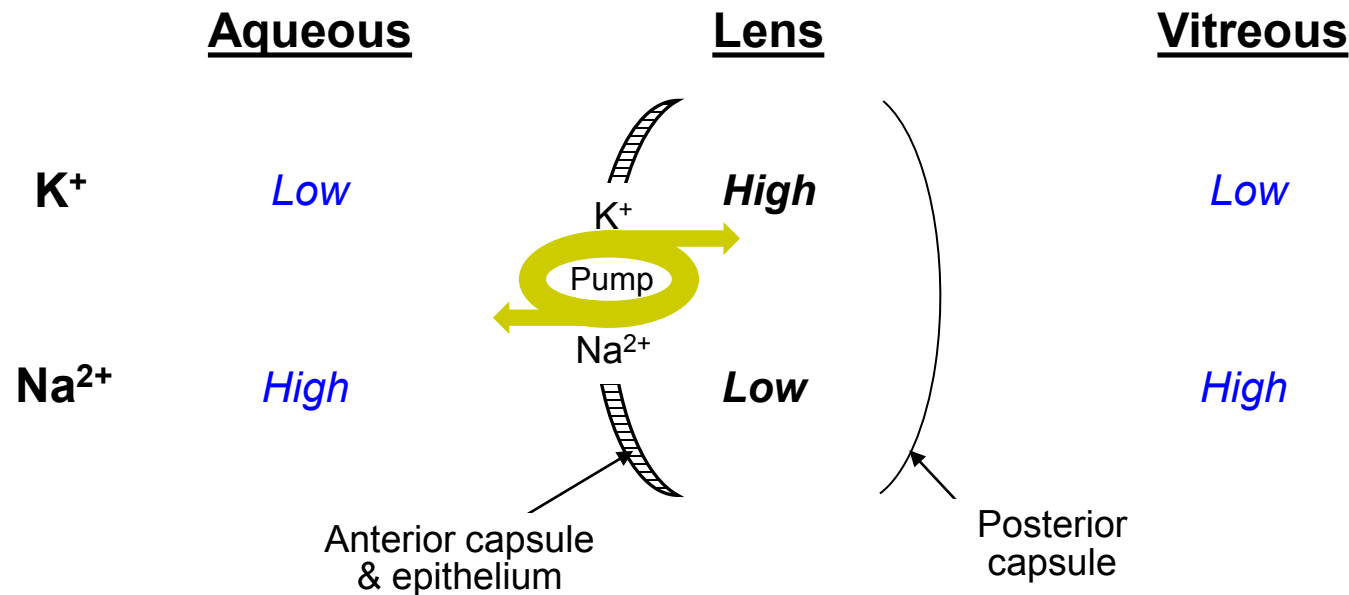


Q

Lens/Cataracts Overview

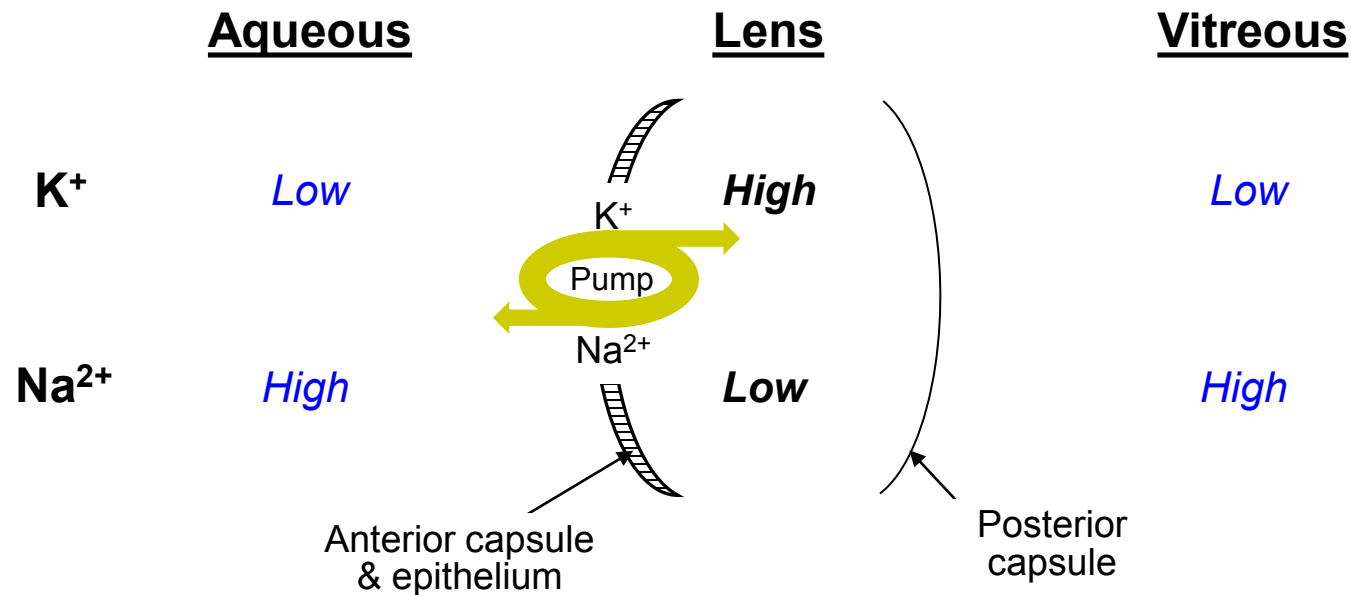
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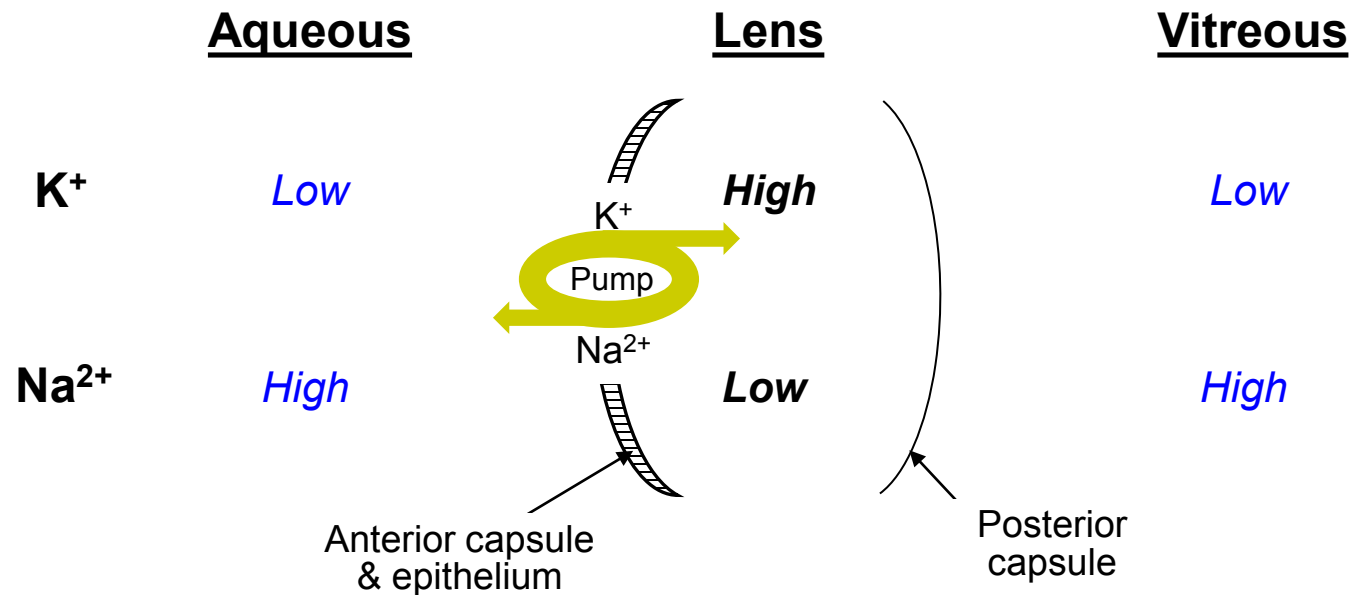


A

Lens/Cataracts Overview

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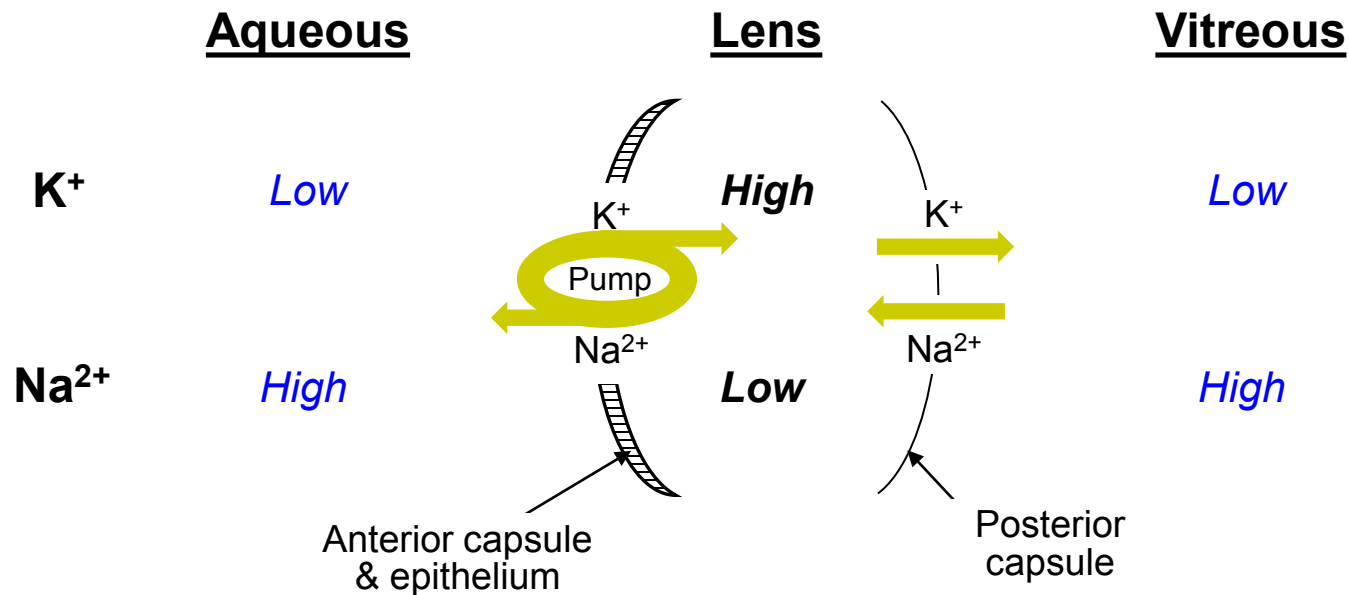


Lens/Cataracts Overview

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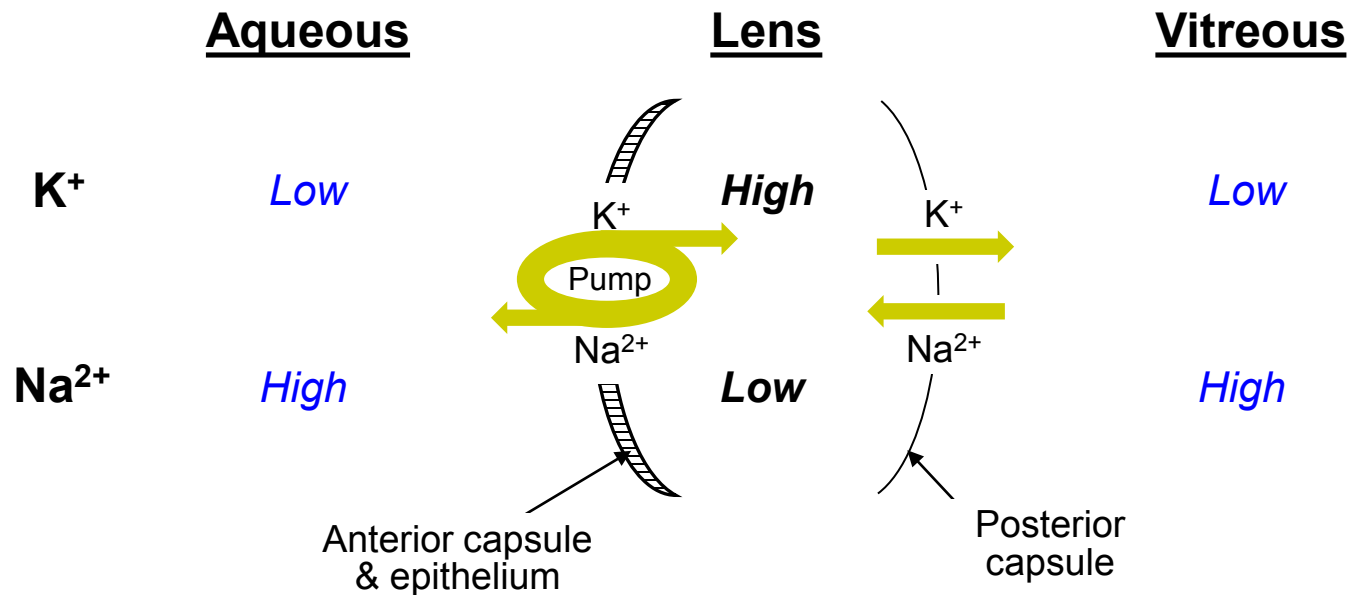
*Note that some leakage occurs across the *anterior* capsule as well.

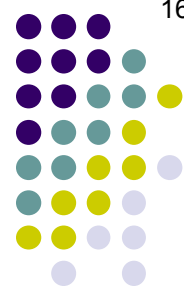


Lens/Cataracts Overview

The Pump-Leak System

The lens sits between two fluids, both of which have high $[Na^{2+}]$ and low $[K^{+}]$. However, to maintain transparency the intralenticular milieu must be the opposite: low $[Na^{2+}]$ and high $[K^{+}]$. To achieve this, lens epithelial cells employ membrane-bound, ATP-powered, sodium-potassium transporters. The activity of these transporters is regulated by the enzyme ATPase to drive Na^{2+} out of the lens and K^{+} into it. This is the 'pump' portion of the pump-leak system. In contrast, at the epithelium-less posterior capsule, ions move passively down their concentration gradients— Na^{2+} in, and K^{+} out. This is the 'leak' portion of the pump-leak system. (Finally, note that the epithelium uses similar active pumping mechanisms to move other critical molecules (eg, amino acids) in and out of the lens.)





Lens/Cataracts Overview

- Anatomy of the mature lens

- *Capsule*

- Type IV collagen

- *Epithelium*

- Single layer of cuboidal cells beneath anterior and equatorial capsule
- Metabolically active; mitotically active
- Give rise to all new lens fibers

- *Nucleus*

- Older fibers densely packed in central lens

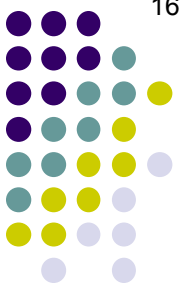
Next (no question, just a factoid)

- *Cortex*

- *Zonules*

Q

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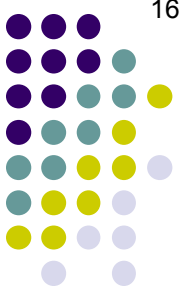
Why are nuclear fibers more densely packed?

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- *Cortex*

- *Zonules*



A

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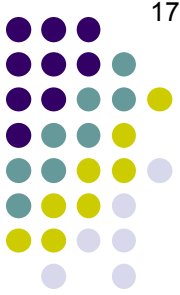
Q

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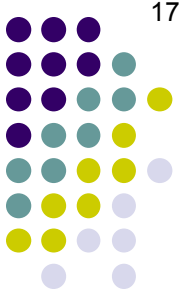
Lens/Cataracts Overview



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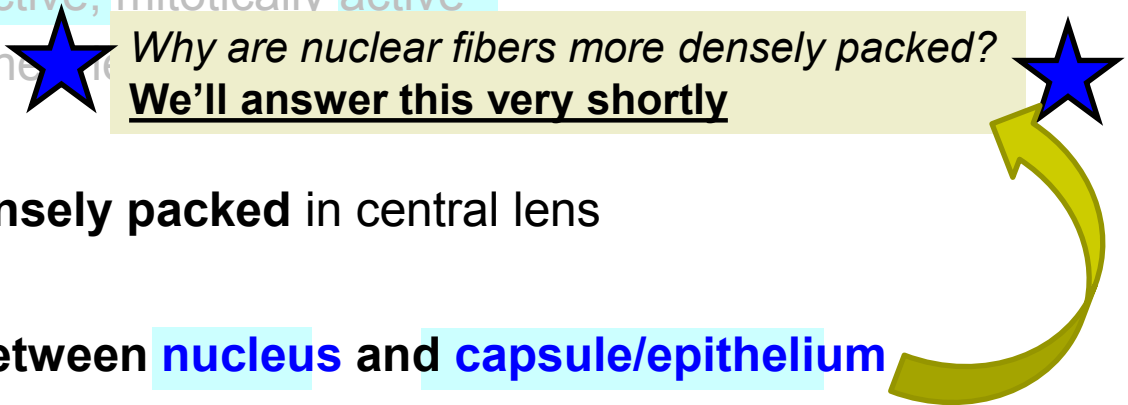
*Having recently developed in the bow region, as you know

Lens/Cataracts Overview

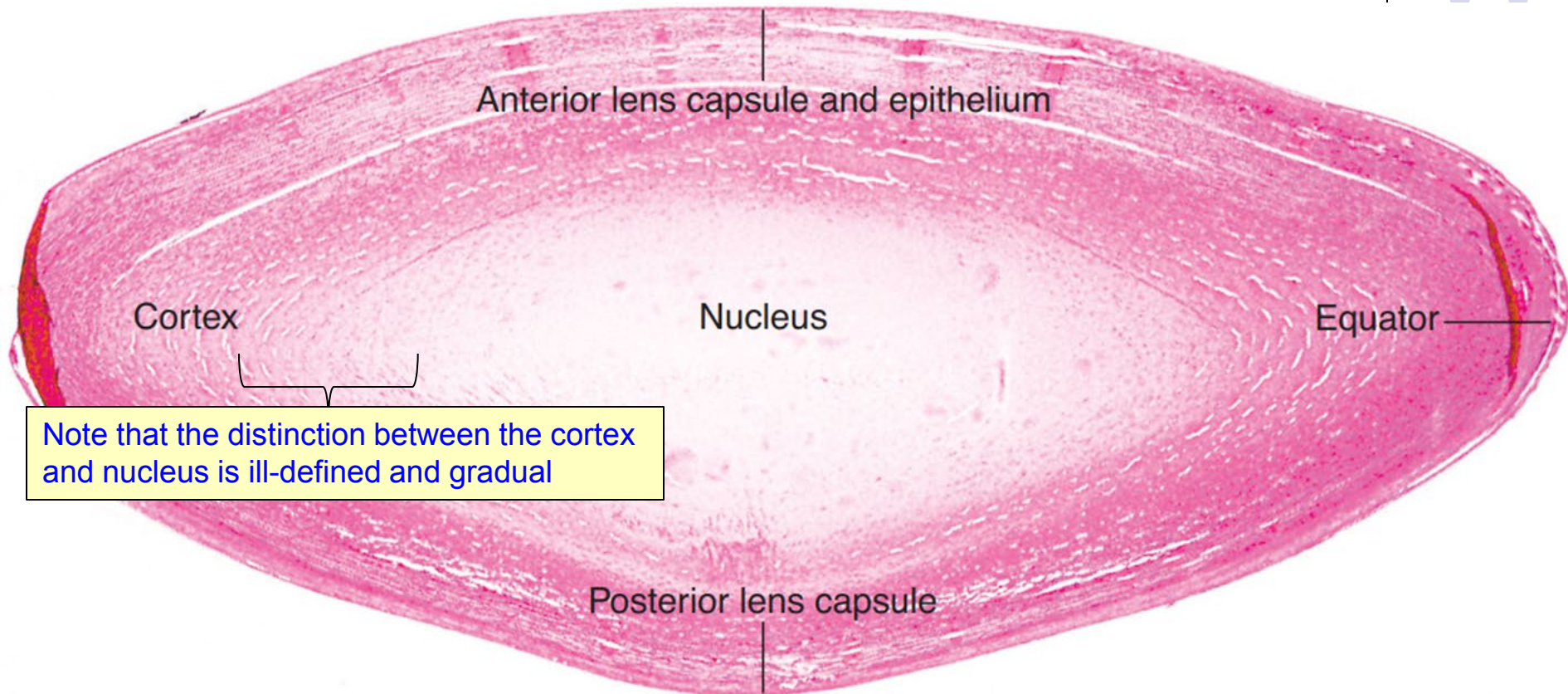
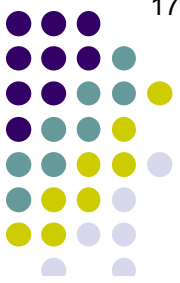


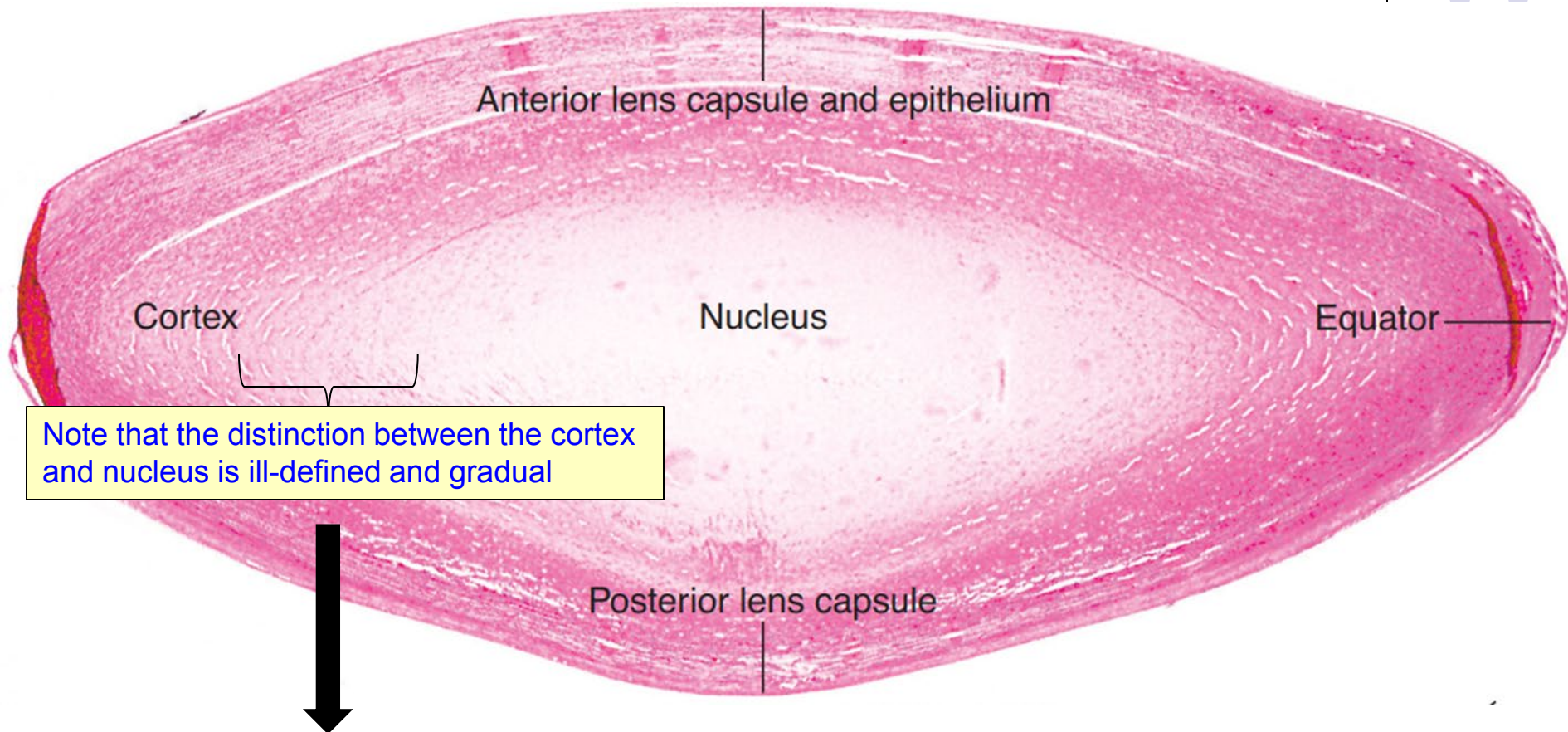
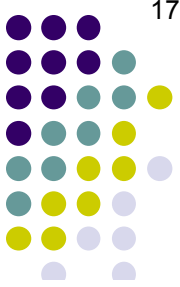
● Anatomy of the mature lens

- *Capsule*
 - Type IV collagen
- *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
 - Metabolically active; mitotically active
 - Give rise to all new fibers
- *Nucleus*
 - Older fibers **densely packed** in central lens
- *Cortex*
 - Newer fibers **between nucleus and capsule/epithelium**
- *Zonules*
 - This is why the nucleus is densely packed—as new fibers are created around it, they compress the older fibers located more centrally



Lens/Cataracts Overview





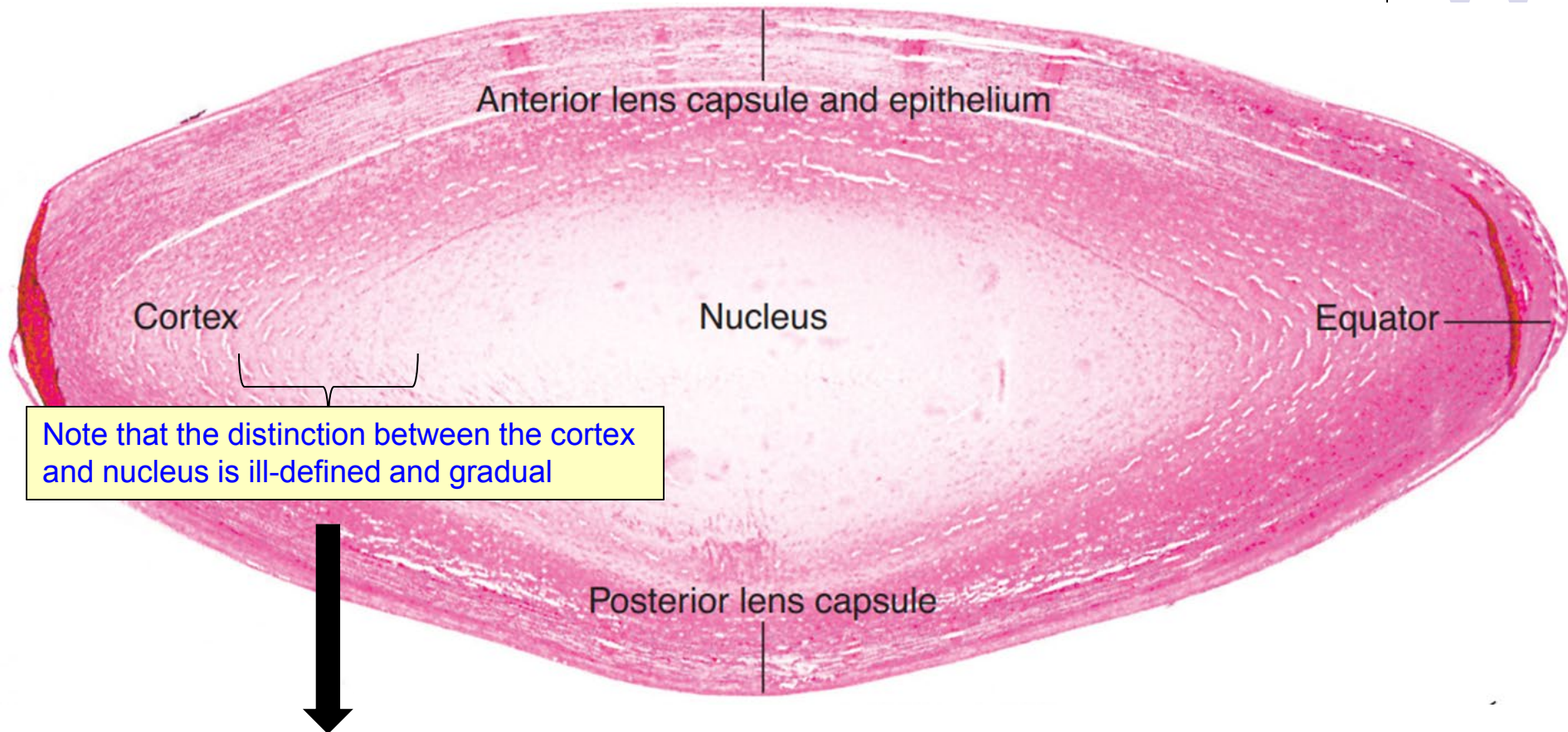
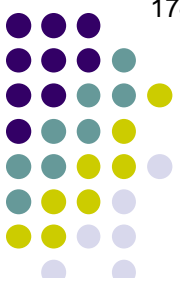
Note that the distinction between the cortex and nucleus is ill-defined and gradual

Do cortical and nuclear fibers have unique properties that allow them to be differentiated histologically?

A

Lens/Cataracts Overview

174



Note that the distinction between the cortex and nucleus is ill-defined and gradual

Do cortical and nuclear fibers have unique properties that allow them to be differentiated histologically?
Nope, they pretty much look the same at a microscope



Q

Lens/Cataracts Overview

• Anatomy of the mature lens

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Why are nuclear fibers more densely packed?

We'll answer this very shortly

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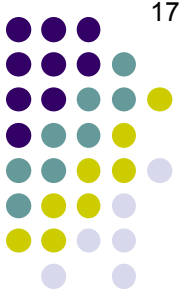
• *Zonules*

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*At what point in life do newly-created fibers not have time to get packed tight enough to be considered nuclear fibers?**

Q/A

Lens/Cataracts Overview



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At what point in life do newly-created fibers not have time to get packed tight enough to be considered nuclear fibers?

Age # and unit, give or take



A

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At what point in life do newly-created fibers not have time to get packed tight enough to be considered nuclear fibers?

Age 20 years , give or take



A

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At what point in life do newly-created fibers not have time to get packed tight enough to be considered nuclear fibers?

Age 20 years, give or take. That is, fibers laid down from age embryo to age 20 form the adult nucleus, whereas fibers created *after* age 20 comprise the lens cortex.



Q

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● Anatomy of the mature lens

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● *Zonules*

- Originate from the very specific tissue of the pigmented vs nonpigmented epithelium of the specific portion 1 and specific portion 2 of the ciliary body

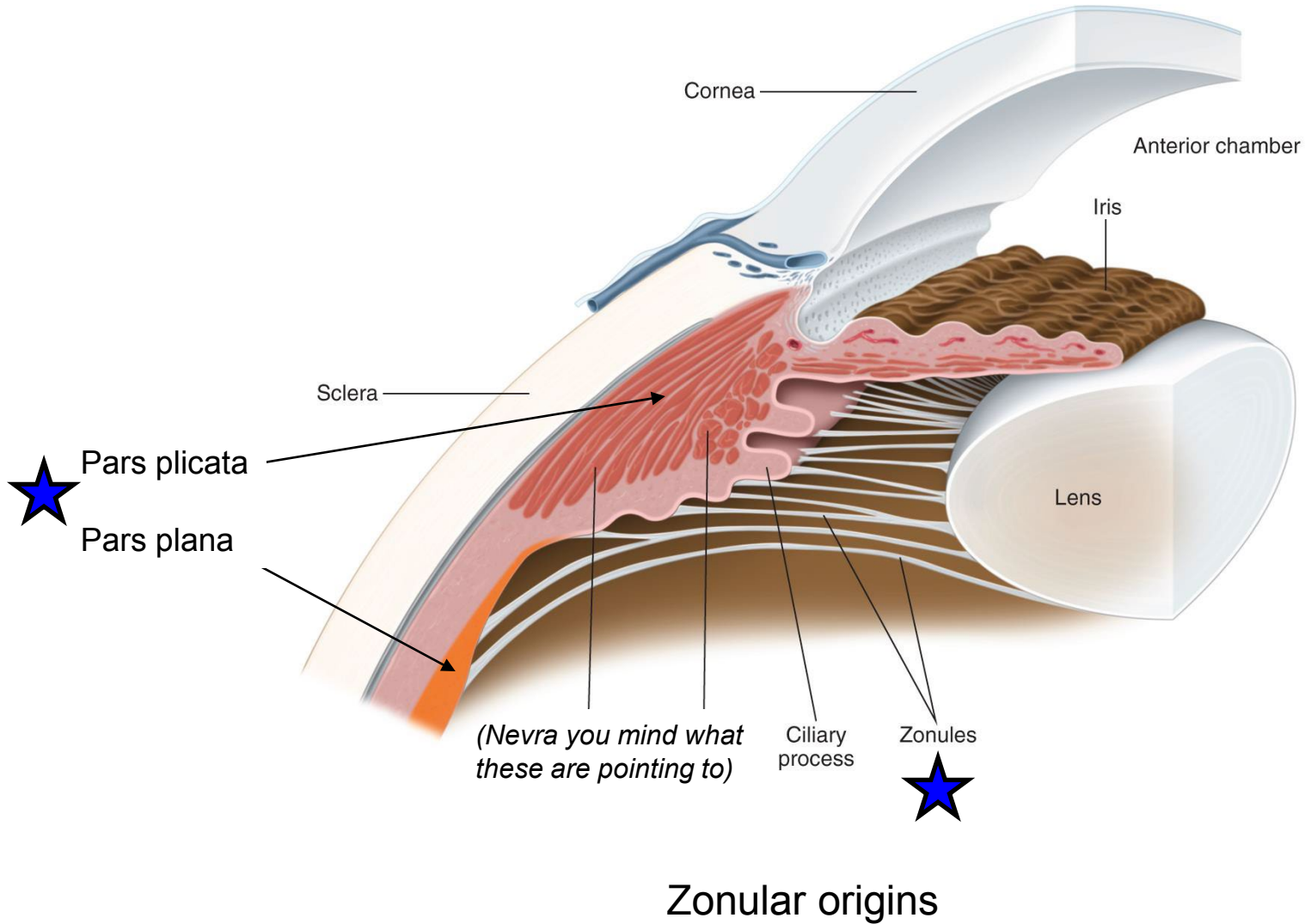
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Lens/Cataracts Overview



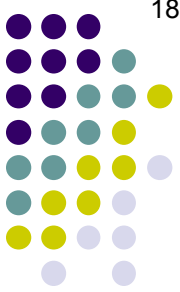
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Lens/Cataracts Overview



Q

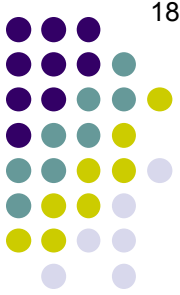
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 - Three sets of fibers:
 - ?
 - ?
 - ?

A

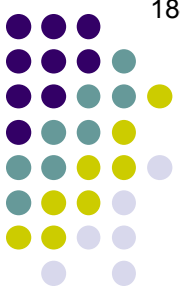
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 - Anterior
 - Equatorial
 - Posterior

Q

Lens/Cataracts Overview



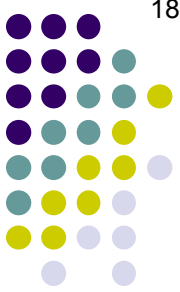
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 - Three sets of fibers:
 - Anterior?
 - Equatorial?
 - Posterior?

One set regresses (to the point of disappearing) throughout life—which one?

A

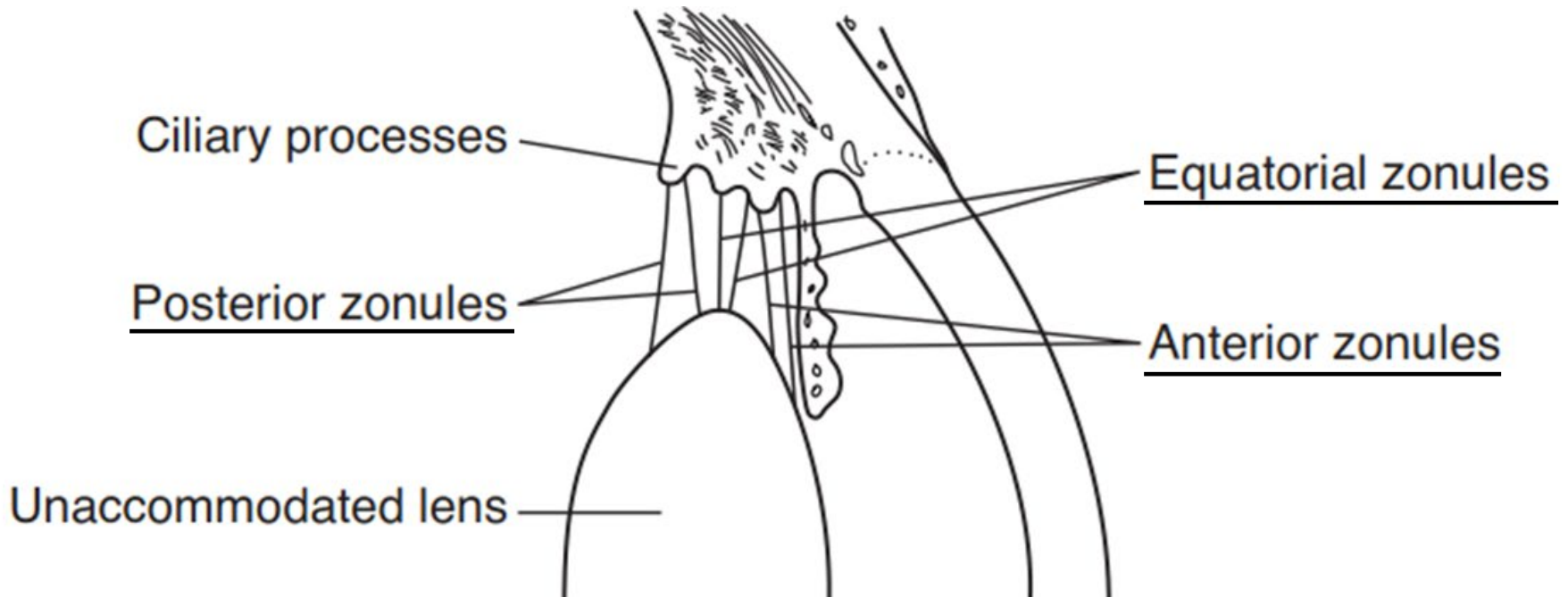
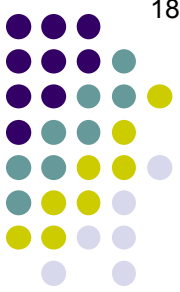
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 - Metabolically active; mitotically active
 - Give rise to all new lens fibers
 - *Nucleus*
 - Older fibers densely packed in central lens
 - *Cortex*
 - Newer fibers between nucleus and capsule/epithelium
 - *Zonules*
 - Originate from the basal lamina of the nonpigmented epithelium of the pars plana and pars plicata of the ciliary body
 - Three sets of fibers:
 - Anterior
 - **Equatorial!**
 - Posterior

One set regresses (to the point of disappearing) throughout life—which one?
The equatorial

Lens/Cataracts Overview



Zonular insertions on the lens

Q

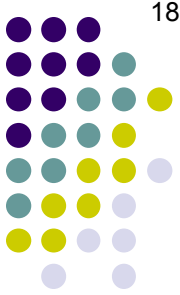
Lens/Cataracts Overview



- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
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 - Three sets of fibers:
 - Anterior: Insert # mm anterior to equator
 - Equatorial
 - Posterior

A

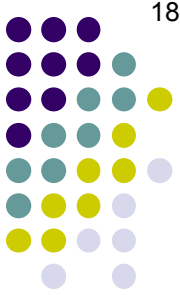
Lens/Cataracts Overview



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 - Originate from the basal lamina of the nonpigmented epithelium of the pars plana and pars plicata of the ciliary body
 - Three sets of fibers:
 - Anterior: Insert 1.5 mm anterior to equator
 - Equatorial
 - Posterior

Q

Lens/Cataracts Overview



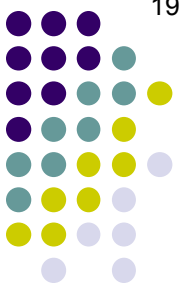
- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
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 - Three sets of fibers:
 - Anterior: Insert 1.5 mm anterior to equator
 - Equatorial
 - Posterior: Insert # mm posterior to equator

A

Lens/Cataracts Overview



- Anatomy of the mature lens
 - *Capsule*
 - Type IV collagen
 - *Epithelium*
 - Single layer of cuboidal cells beneath anterior and equatorial capsule
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 - Give rise to all new lens fibers
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 - Originate from the basal lamina of the nonpigmented epithelium of the pars plana and pars plicata of the ciliary body
 - Three sets of fibers:
 - Anterior: Insert 1.5 mm anterior to equator
 - Equatorial
 - Posterior: Insert 1.25 mm posterior to equator



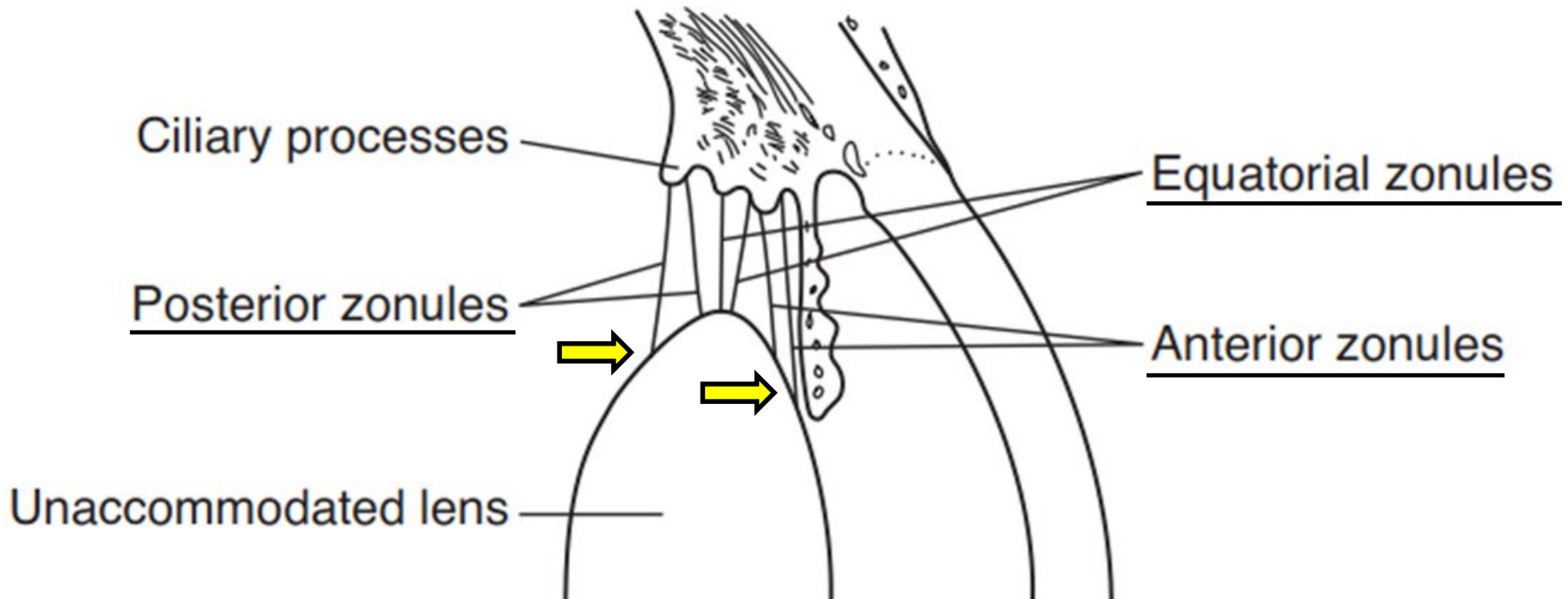
Lens/Cataracts Overview

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 - Older fibers densely packed in central lens
 - *Cortex*
 - Newer fibers between nucleus and capsule/epithelium
 - *Zonules*
 - Originate from the basal lamina of the nonpigmented epithelium of the

Probably more important to remember the relative insertions of the anterior and posterior zonules rather than the specific distances

- **Anterior:** Insert *more* centrally than the posterior
- *Equatorial*
- **Posterior:** Insert *less* centrally than the anterior

Lens/Cataracts Overview



Zonular insertions on the lens

(Note the relative locations of the insertions of the anterior vs posterior zonules—the anterior insert more centrally than do the posterior)



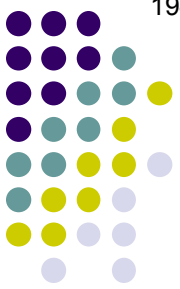
Q

Lens/Cataracts Overview

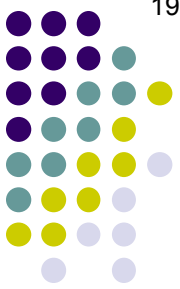
- Lens measurements
 - Birth: mm equatorial, mm anteroposterior

A

Lens/Cataracts Overview



- Lens measurements
 - Birth: 6.4 mm equatorial, 3.5 mm anteroposterior



Q

Lens/Cataracts Overview

- Lens measurements

- Birth: 6.4 mm equatorial, 3.5 mm anteroposterior
- Adult: # to # mm equatorial, # mm anteroposterior

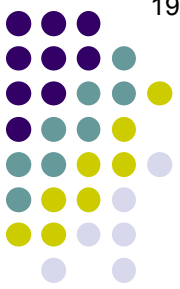
A

Lens/Cataracts Overview



- Lens measurements

- Birth: 6.4 mm equatorial, 3.5 mm anteroposterior
- Adult: 9-10 mm equatorial, 5.0 mm anteroposterior



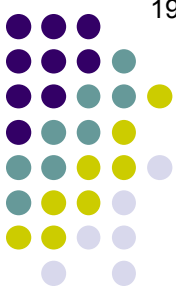
Q

Lens/Cataracts Overview

- Lens measurements

- Birth: 6.4 mm equatorial, 3.5 mm anteroposterior
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Cataract surgeons will sometimes employ an age-based rule of thumb for guesstimating the A-P depth of a lens—what is it?



A

Lens/Cataracts Overview

- Lens measurements

- Birth: 6.4 mm equatorial, 3.5 mm anteroposterior
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Cataract surgeons will sometimes employ an age-based rule of thumb for guesstimating the A-P depth of a lens—what is it?
A-P depth = 'Four (point) pt age' (eg, the A-P depth of the lens in a 65 y.o. is ~4.65 mm)



Q

Lens/Cataracts Overview

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The fact that the magnitude of this number correlates with age implies that the lens never stops getting thicker. Is this the case?



A

Lens/Cataracts Overview

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It is indeed



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Lens/Cataracts Overview

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It is indeed

What is the cause of this thickening?



A

Lens/Cataracts Overview

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The fact that the magnitude of this number correlates with age implies that the lens never stops getting thicker. Is this the case?

It is indeed

What is the cause of this thickening?

The never-ending creation of new fibers (via the process discussed a few slides ago)



Q

Lens/Cataracts Overview

- Lens measurements

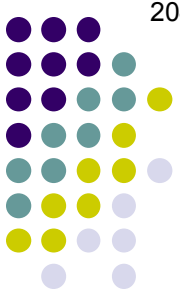
- Birth: 6.4 mm equatorial, 3.5 mm anteroposterior
- Adult: 9-10 mm equatorial, 5.0 mm anteroposterior

- With age...

- Lens curvature increases vs decreases → ↑ or ↓ refractive power

A

Lens/Cataracts Overview



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Lens/Cataracts Overview

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- With age...

- Lens curvature increases → ↑ refractive power
- Refractive index

increases vs decreases

 →

↑ or ↓

 refractive power



A

Lens/Cataracts Overview

- Lens measurements
 - Birth: 6.4 mm equatorial, 3.5 mm anteroposterior
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Q

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So which do people become with age—more myopic or more hyperopic?



A

Lens/Cataracts Overview

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So which do people become with age—more myopic or more hyperopic?

As the change in an individual's refraction is a function of the interplay between these, it can be either

Lens/Cataracts Overview



- Lens measurements

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So which do people become with age—more myopic or more hyperopic?

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Note: The *Lens* book is confusing re what happens to the refractive index and refractive status of eyes as we age. The above is straight from Chapter 2. However, in Chapter 5 it states that NSCs “cause an **increase** in the refractive index” (emphasis mine) and a “myopic shift.” (It goes on to say hyperopic shifts are “rare.”)

Lens/Cataracts Overview



- Lens measurements

- Birth: 6.4 mm equatorial, 3.5 mm anteroposterior
- Adult: 9-10 mm equatorial, 5.0 mm anteroposterior

- With age...

- Lens curvature increases → ↑ refractive power
- Refractive index decreases → ↓ refractive power

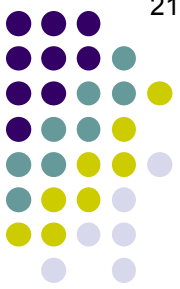
So which do people become with age—more myopic or more hyperopic?

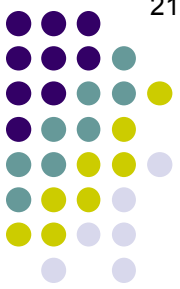
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Note: The *Lens* book is confusing re what happens to the refractive index and refractive status of eyes as we age. The above is straight from Chapter 2. However, in Chapter 5 it states that NSCs “cause an **increase** in the refractive index” (emphasis mine) and a “myopic shift.” (It goes on to say hyperopic shifts are “rare.”) **What makes this confusing is that NSCs are very much age-related. So, maybe refractive index decreases with age until an NSC forms, at which point it reverses course and starts increasing? Caveat emptor on this score.**

Lens/Cataracts Overview

*Let's drill down on the
highly OKAPable topic of **Lens Proteins***





Q

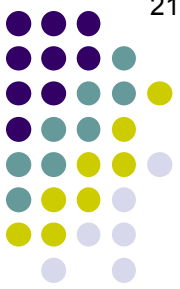
Lens/Cataracts Overview

Let's drill down on the highly OKAPable topic of

Lens Proteins *constitute what proportion of the lens by weight?*

A

Lens/Cataracts Overview

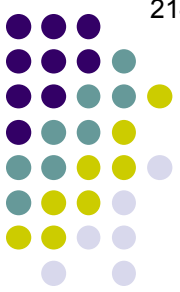


Let's drill down on the highly OKAPable topic of

Lens Proteins *constitute what proportion of the lens by weight? 1/3*

Q

Lens/Cataracts Overview



Let's drill down on the highly OKAPable topic of

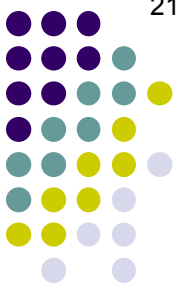
Lens Proteins constitute what proportion of the lens by weight?

1/3

Um, cool story bro. Is that proportion supposed to be impressive?

A

Lens/Cataracts Overview



Let's drill down on the highly OKAPable topic of

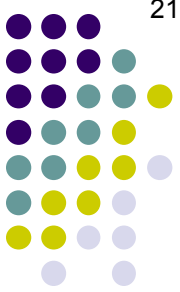
Lens Proteins *constitute what proportion of the lens by weight?*

1/3

Um, cool story bro. Is that proportion supposed to be impressive?
Indeed it is

Q

Lens/Cataracts Overview



Let's drill down on the highly OKAPable topic of

Lens Proteins constitute what proportion of the lens by weight?

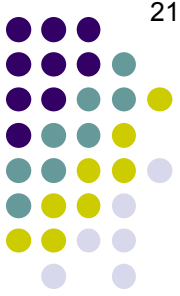
1/3

Um, cool story bro. Is that proportion supposed to be impressive?
Indeed it is

Alrighty then. Is it impressively high, or low?

A

Lens/Cataracts Overview



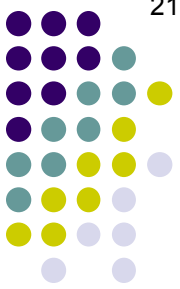
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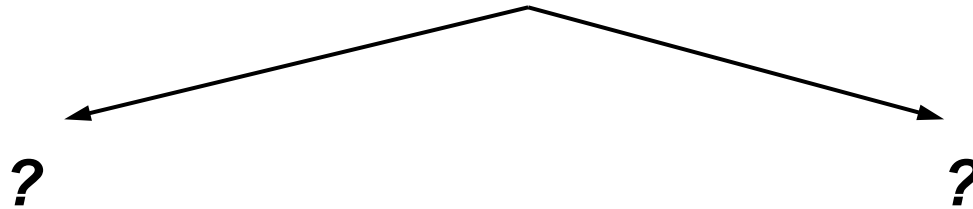
Alrighty then. Is it impressively high, or low?
High—no other tissue comes close (a content-by-weight of a third is **2 to 3 times** the protein content of most other tissues!)



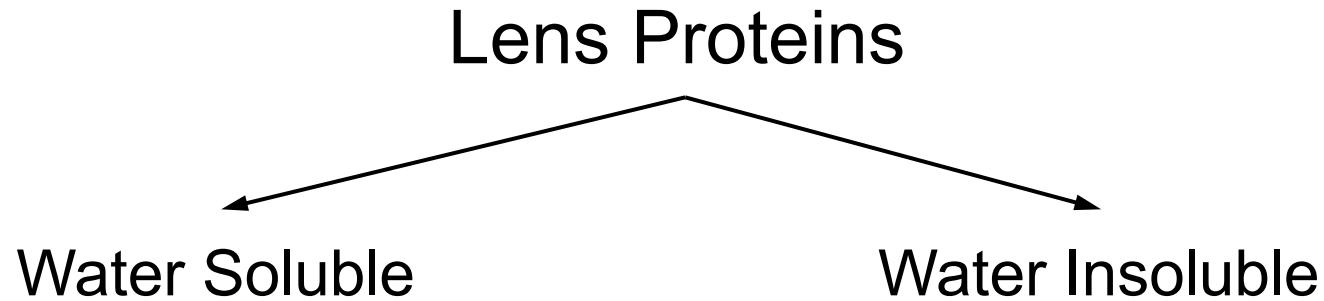
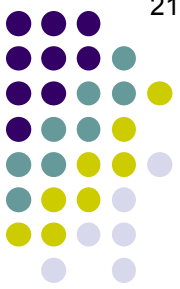
Q

Lens/Cataracts Overview

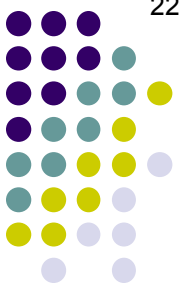
Lens Proteins



*Lens proteins come in one of two basic types. What are they?
(Hint: The types are divided on the basis of a physical property
of the proteins.)*

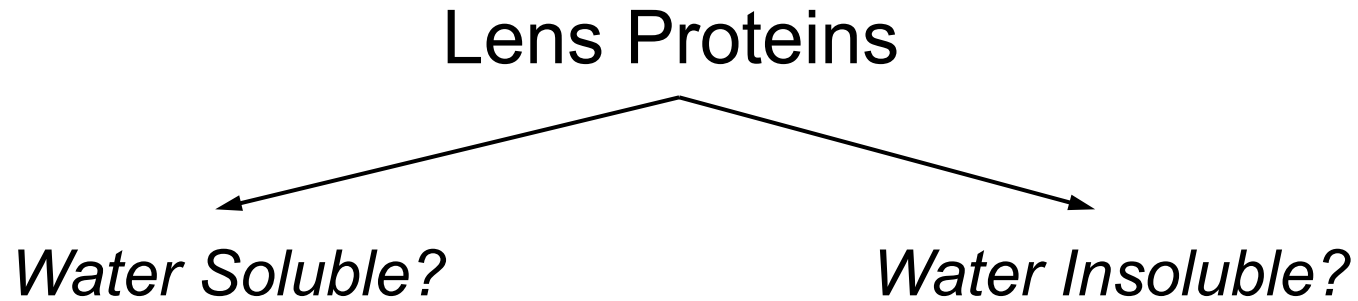


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Q

Lens/Cataracts Overview

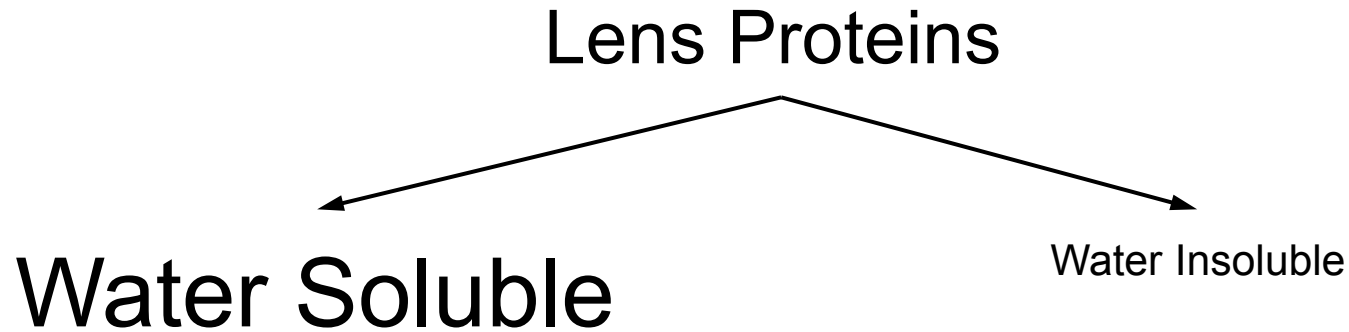
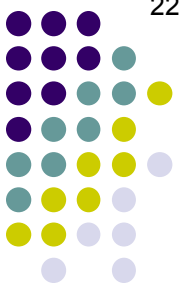


*One of these types predominates in the lens of a young person—
which one?*

A

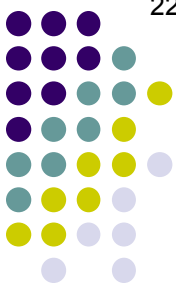
Lens/Cataracts Overview

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*One of these types predominates in the lens of a young person—
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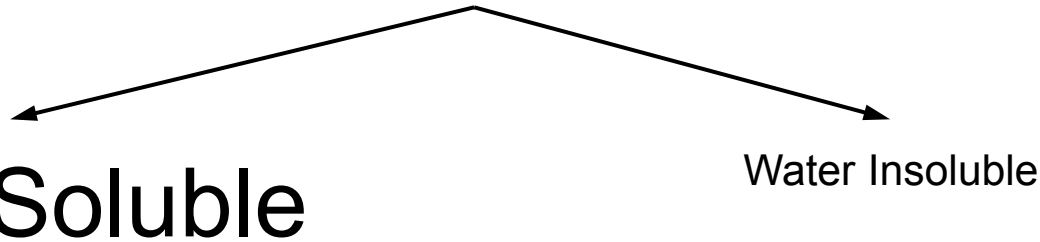
Water soluble



Q

Lens/Cataracts Overview

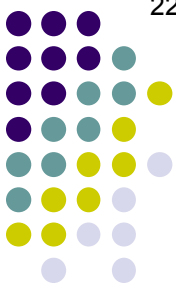
Lens Proteins



Water-soluble proteins comprise what percentage of proteins in the young lens?

One of these types predominates in the lens of a young person— which one?

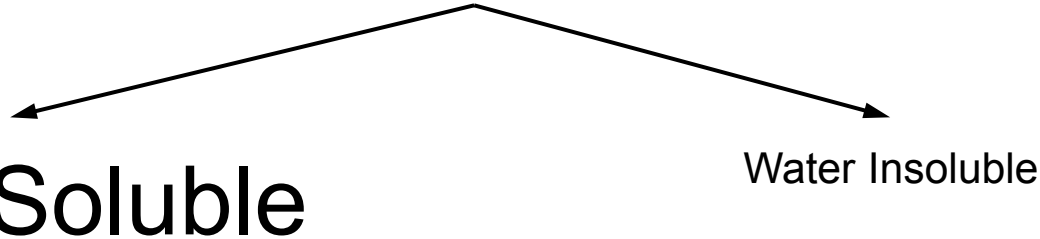
Water soluble



A

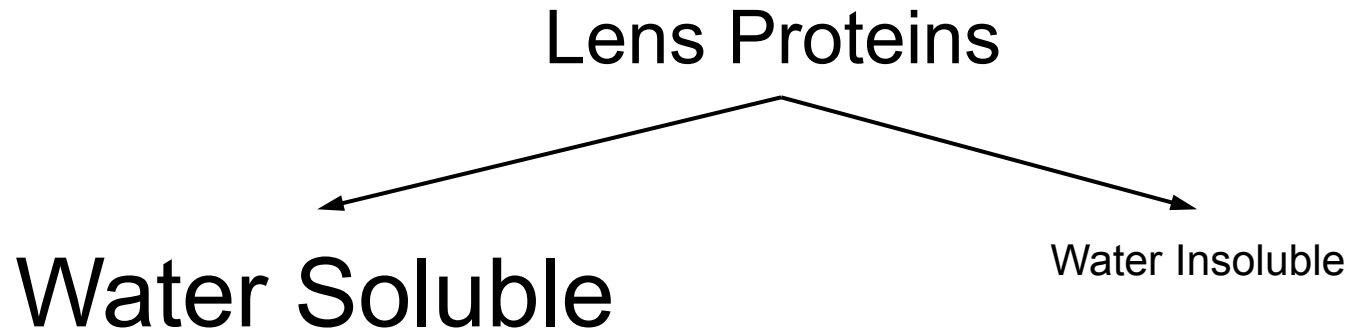
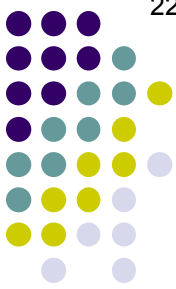
Lens/Cataracts Overview

Lens Proteins



Water-soluble proteins comprise what percentage of proteins in the young lens?
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Water soluble



*One of these types predominates in the lens of a young person—
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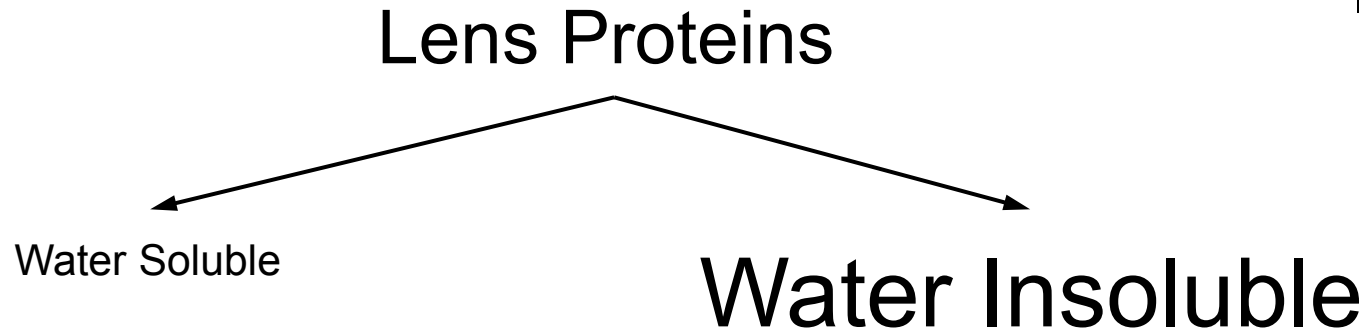
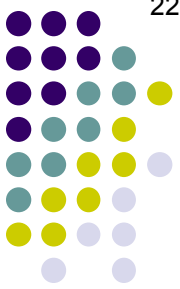
Water soluble

*What happens to the relative proportions of water soluble vs
insoluble proteins as the person ages?*

A

Lens/Cataracts Overview

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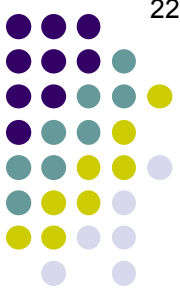


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Water soluble

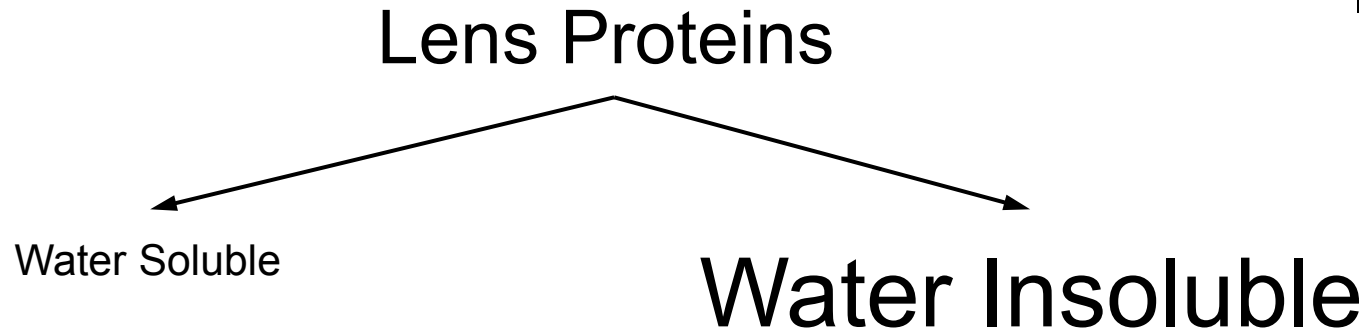
*What happens to the relative proportions of water soluble vs
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It reverses—water insoluble predominates



Q

Lens/Cataracts Overview



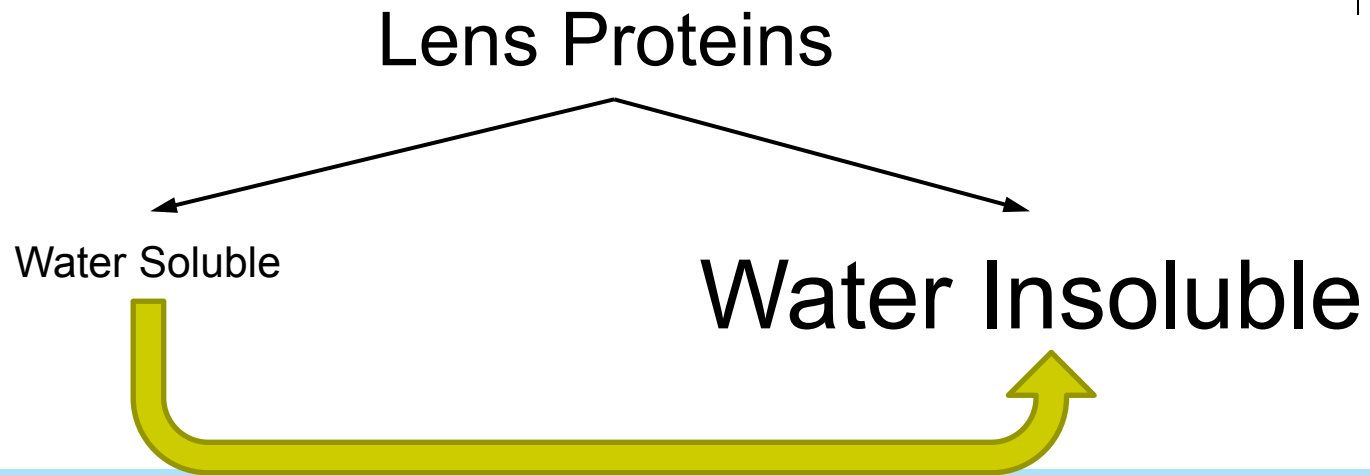
What accounts for this change in the proportion of water-soluble vs insoluble proteins?

It reverses—water *insoluble* predominates



A

Lens/Cataracts Overview



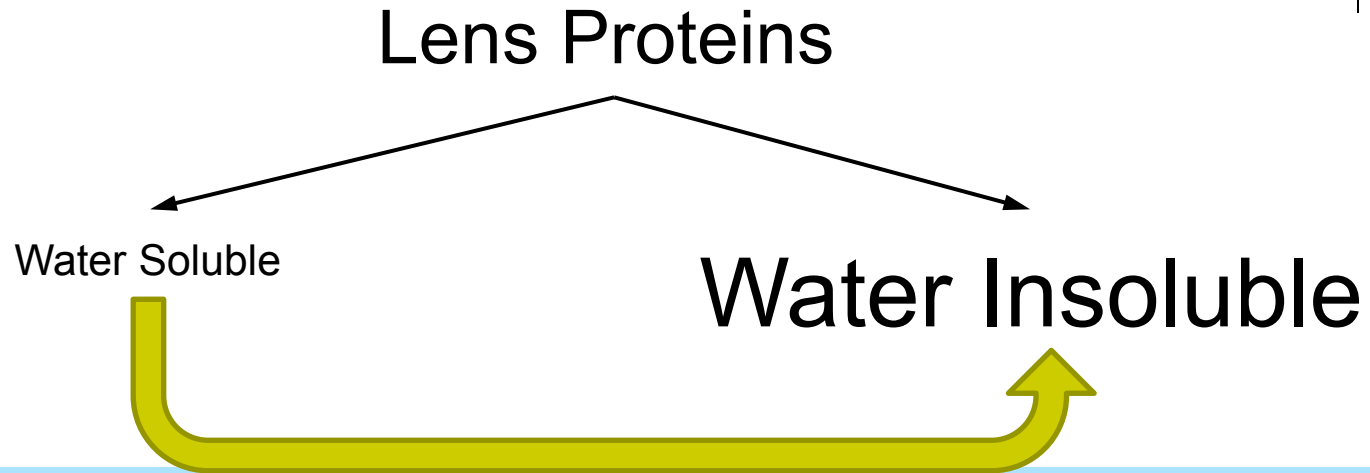
What accounts for this change in the proportion of water-soluble vs insoluble proteins?
It's very straightforward—as the lens ages, water-soluble proteins aggregate, in the process forming particles that are water-insoluble

It reverses—water *insoluble* predominates



Q

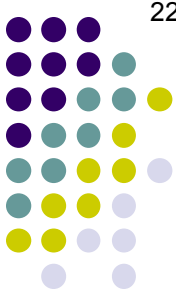
Lens/Cataracts Overview



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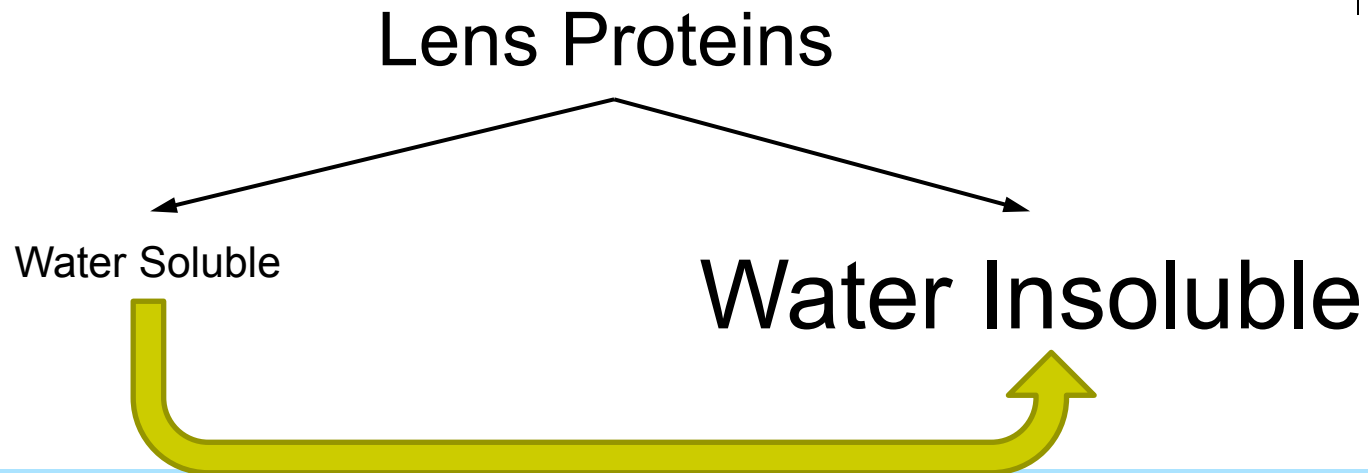
Is this fact of any clinical relevance, or are you just torturing me with minutiae?

It reverses—water *insoluble* predominates



A

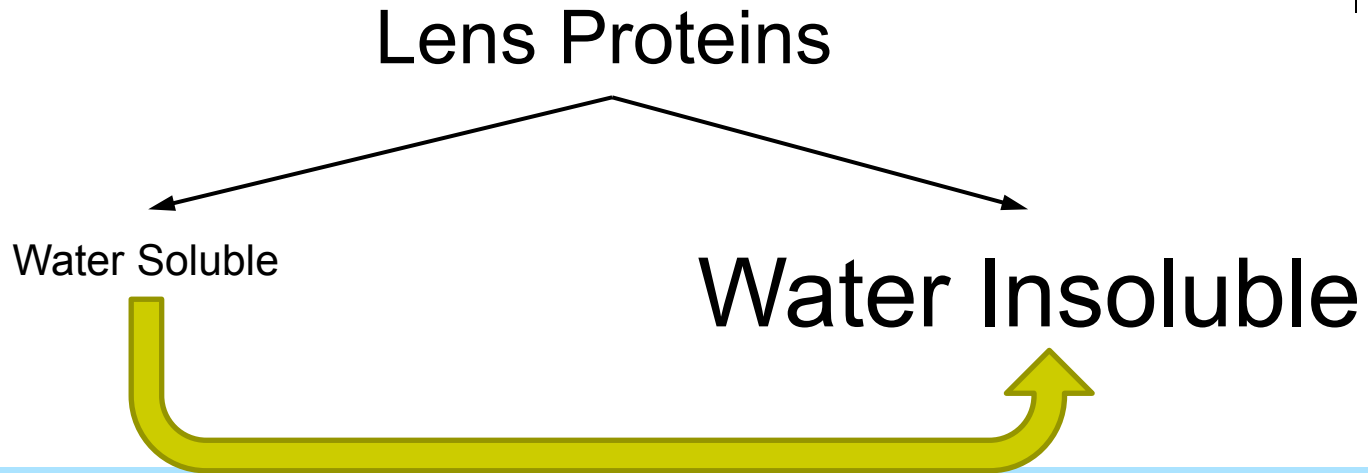
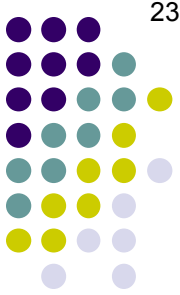
Lens/Cataracts Overview



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 It's very straightforward—as the lens ages, water-soluble proteins aggregate, in the process forming particles that are water-insoluble

Is this fact of any clinical relevance, or are you just torturing me with minutiae?
 Unlike much of the esoterica in this slide-set, a straight line can be drawn from this fact to the exam room. These water-insoluble aggregates are very large and scatter light, thereby reducing acuity.

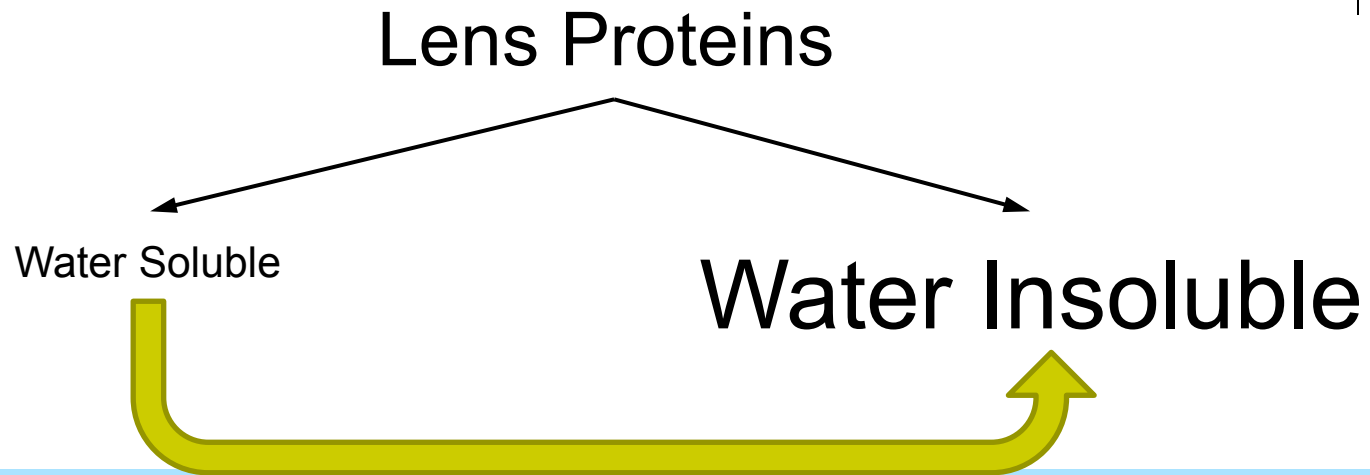
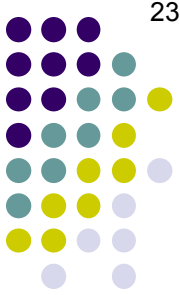
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Is this fact of any clinical relevance, or are you just torturing me with minutiae?
Unlike much of the esoterica in this slide-set, a straight line can be drawn from this fact to the exam room. These water-insoluble aggregates are very large and scatter light, thereby reducing acuity. **Further, there is a direct correlation between the proportion of water-insoluble proteins and how brunescent a cataract is.**

It reverses—water *insoluble* predominates



Water-insoluble proteins comprise what percentage of proteins in an old, brunescent lens?

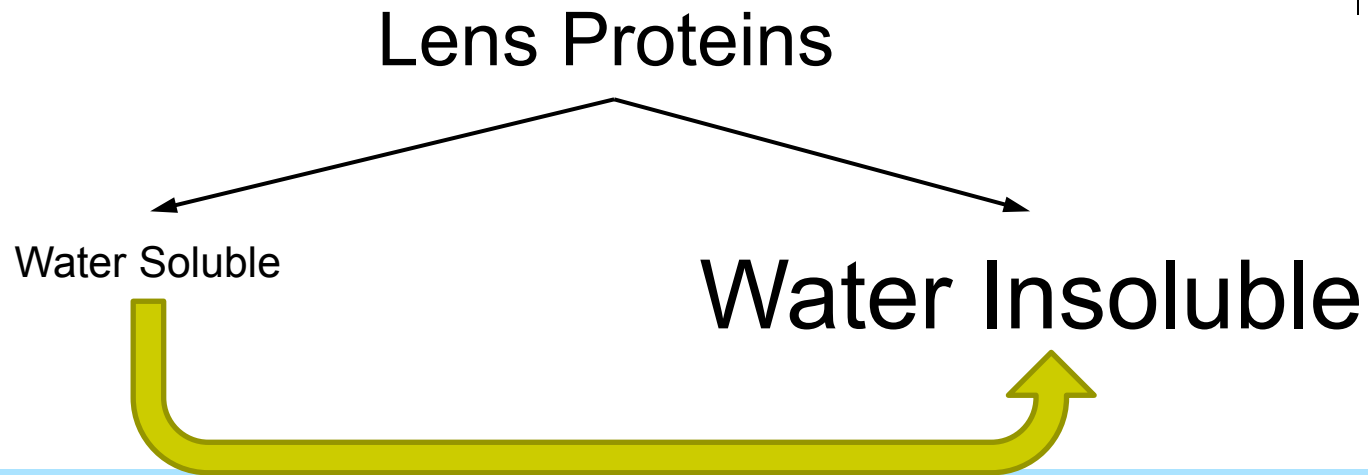
Further, there is a direct correlation between the proportion of water-insoluble proteins and how brunescent a cataract is.

It reverses—water *insoluble* predominates



A

Lens/Cataracts Overview



Water-insoluble proteins comprise what percentage of proteins in an old, brunescent lens? It can be as high as 90%!

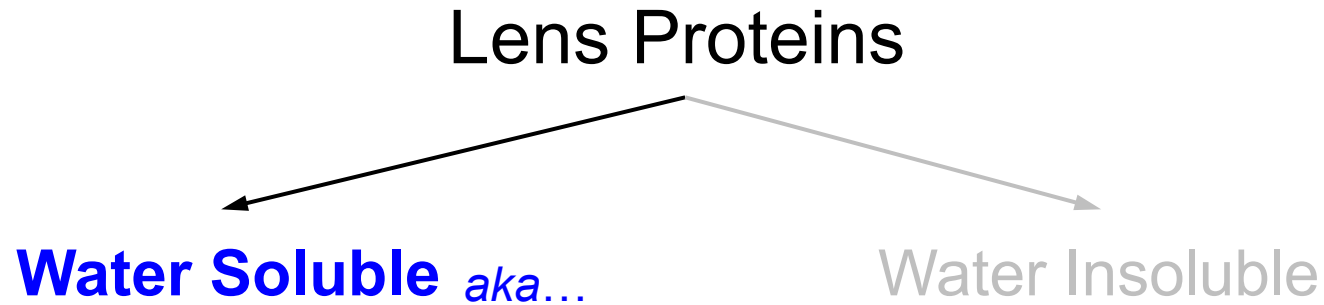
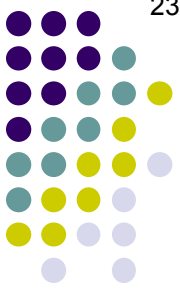
Further, there is a direct correlation between the proportion of water-insoluble proteins and how brunescent a cataract is.

It reverses—water *insoluble* predominates

Q

Lens/Cataracts Overview

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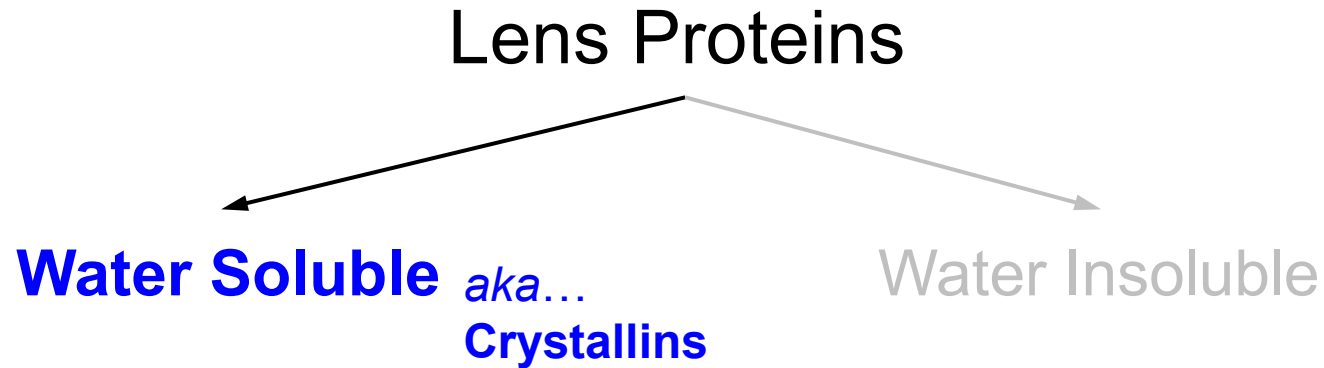
By what other name are the water-soluble proteins known?

A

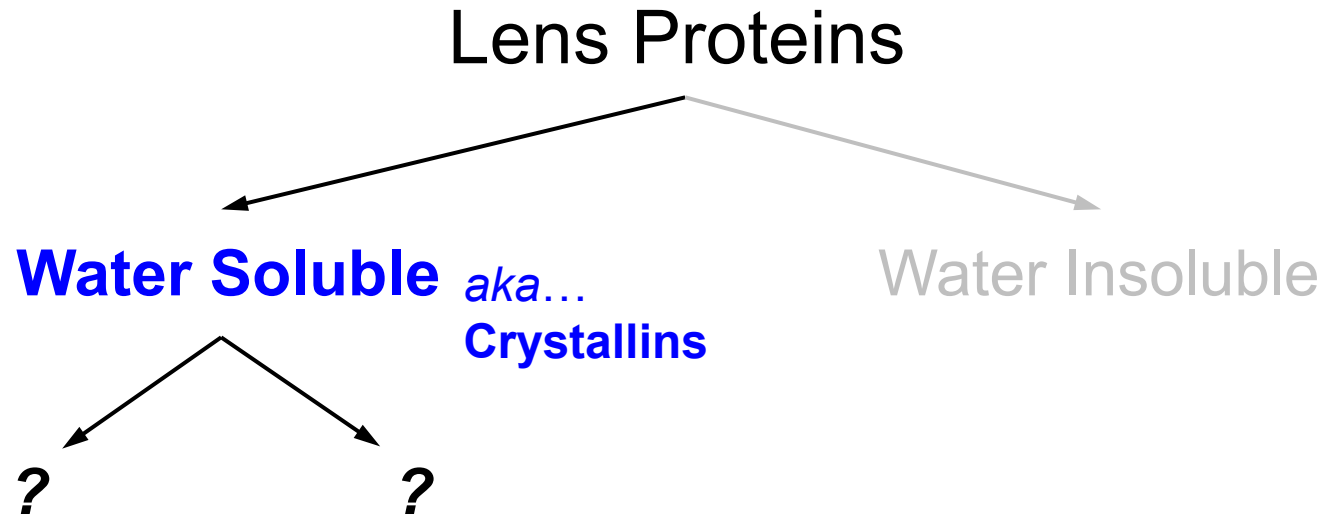
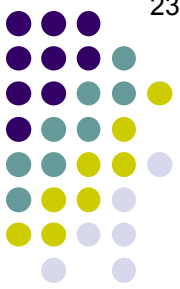
Lens/Cataracts Overview



234

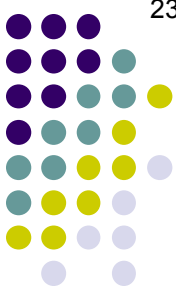


By what other name are the water-soluble proteins known?
'Crystallins'



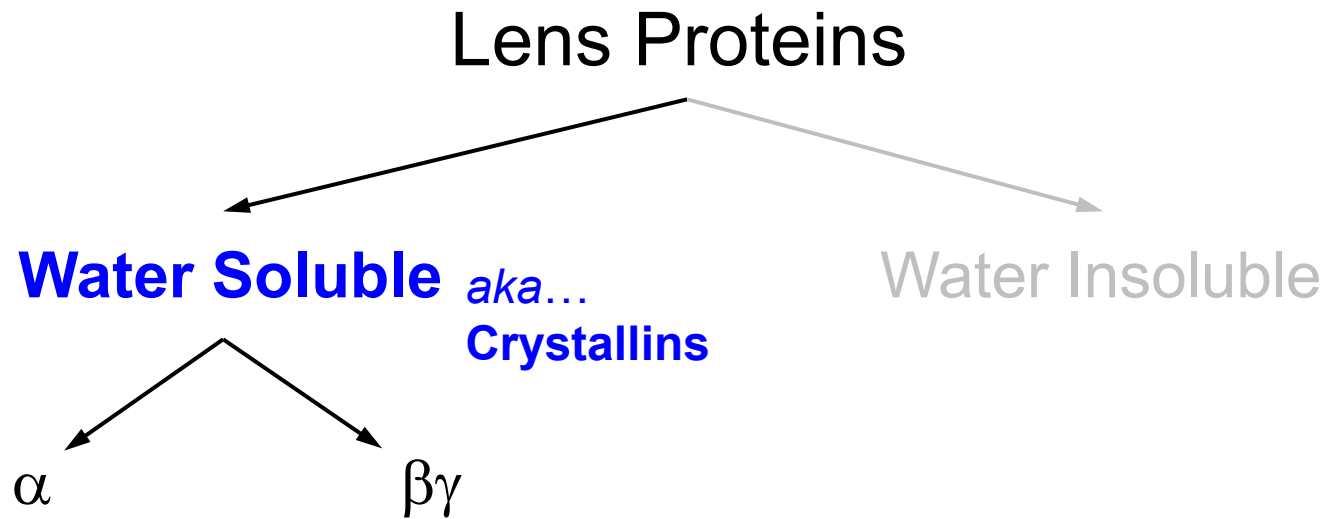
*By what other name are the water-soluble proteins known?
'Crystallins'*

Crystallins come in three forms (two of which are grouped together). What are they?



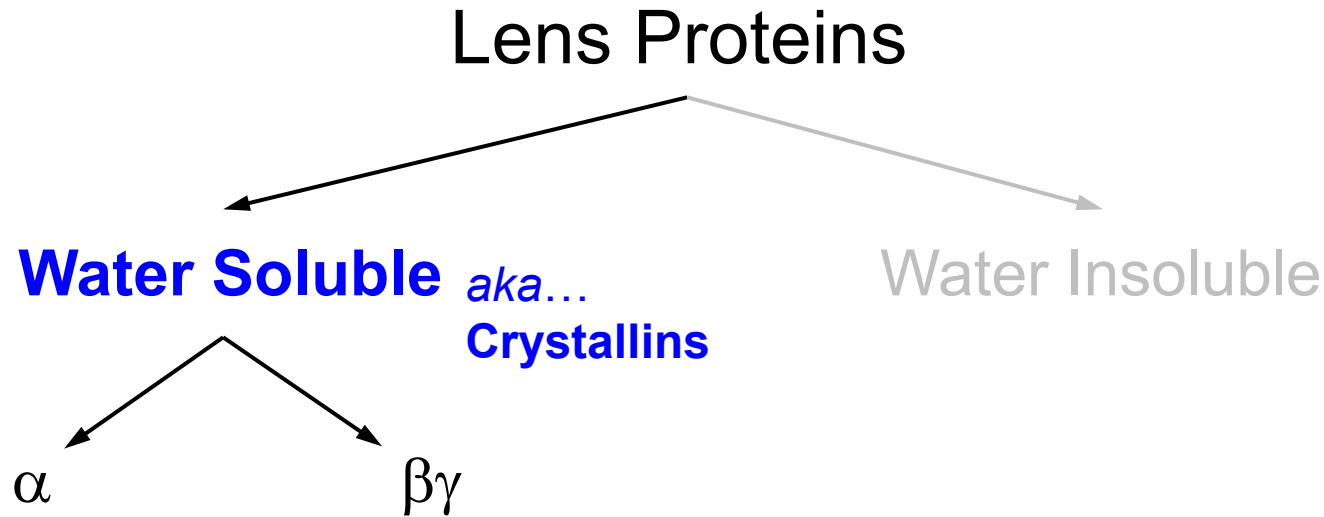
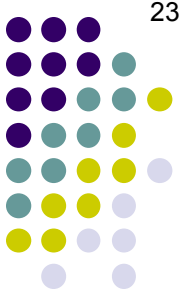
A

Lens/Cataracts Overview



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*By what other name are the water-soluble proteins known?
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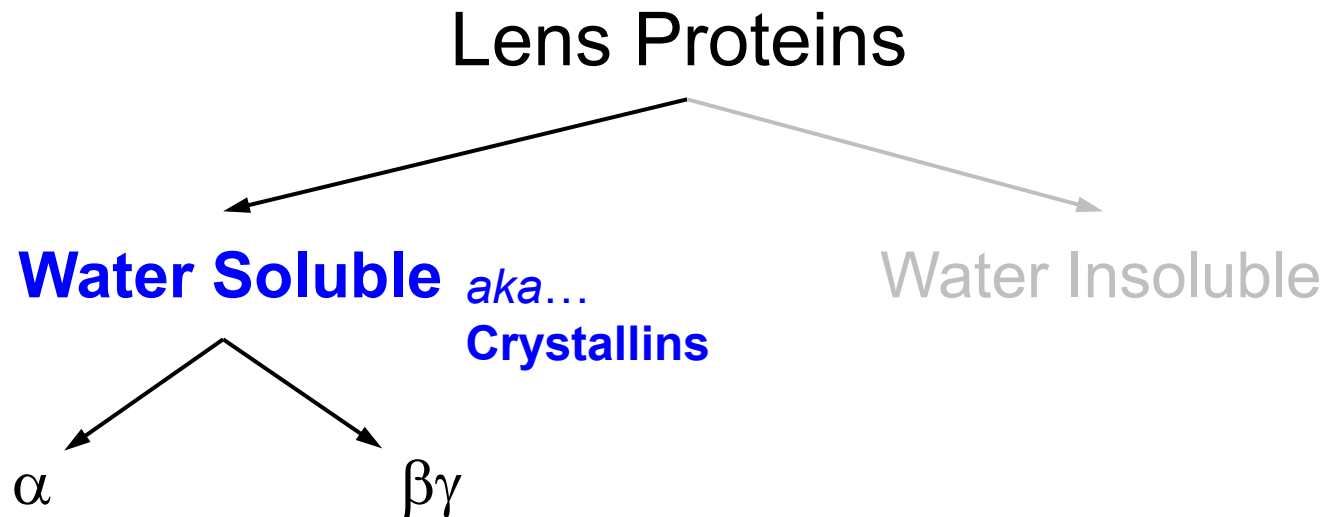
Crystallins come in three forms (two of which are grouped together). What are they?

What vital role do crystallins play in lens function?



A

Lens/Cataracts Overview

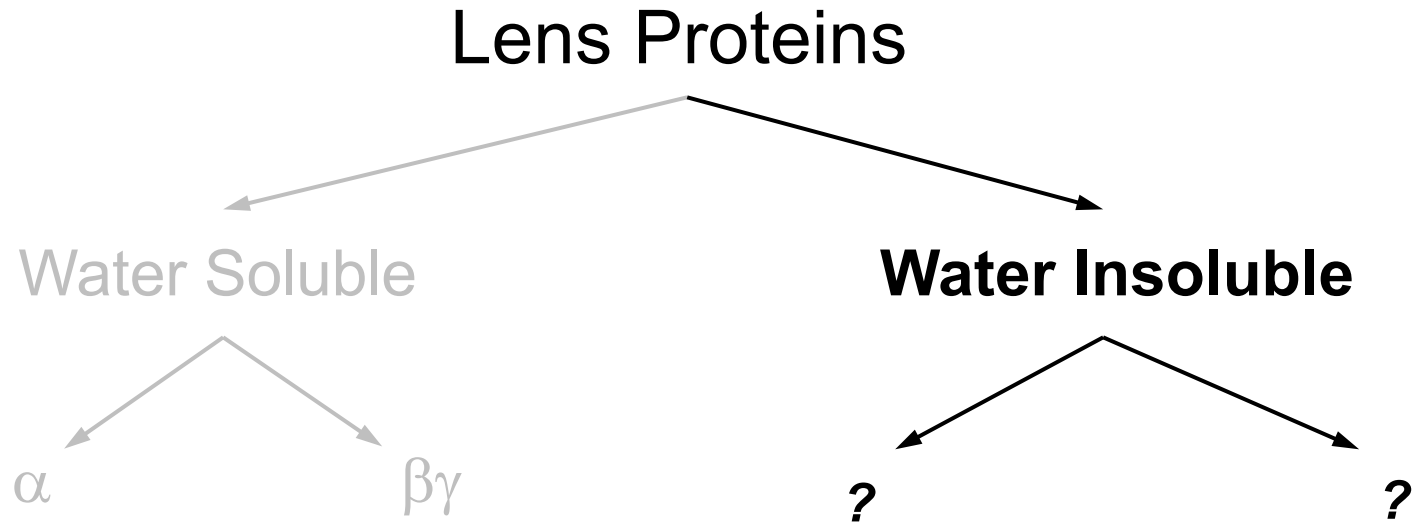
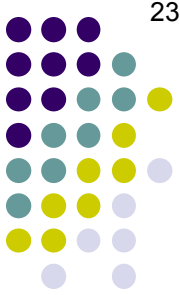


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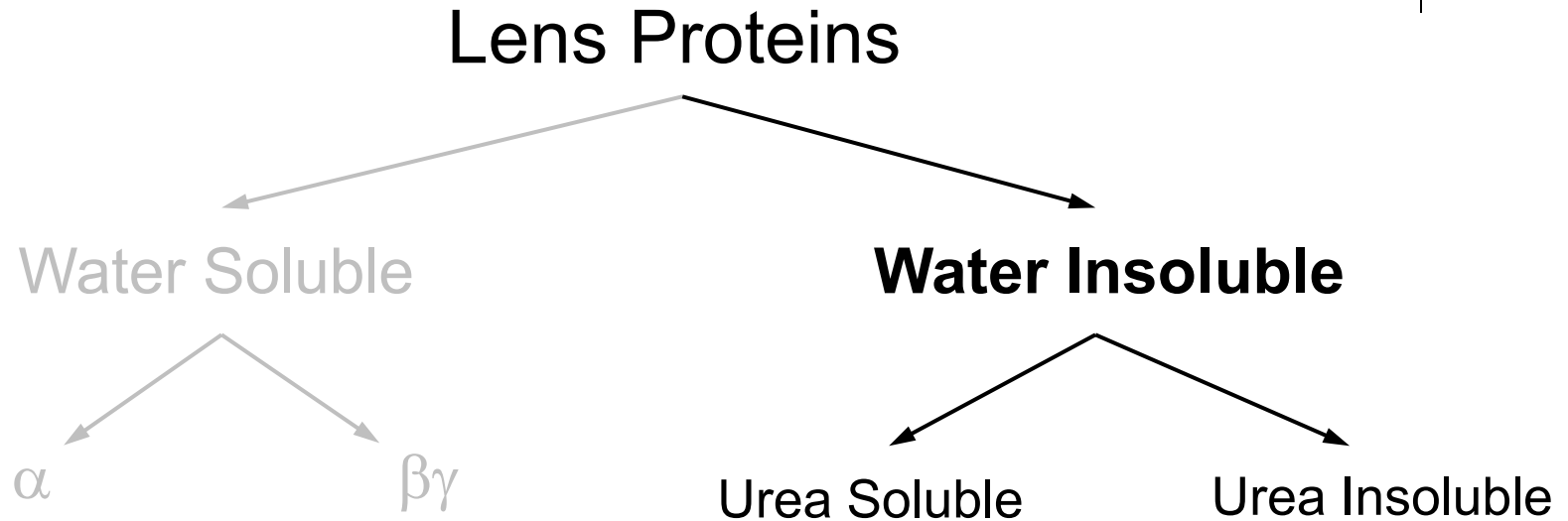
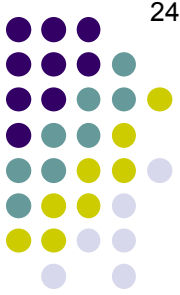
Crystallins come in three forms (two of which are grouped together). What are they?

What vital role do crystallins play in lens function?

They are the proteins cranked out by elongating lens fibers that increase the lens's refractive index enough to render it a viable refracting entity



*Water-insoluble proteins come two basic types. What are they?
(Hint: The types are divided on the basis of a physical property
of the proteins.)*

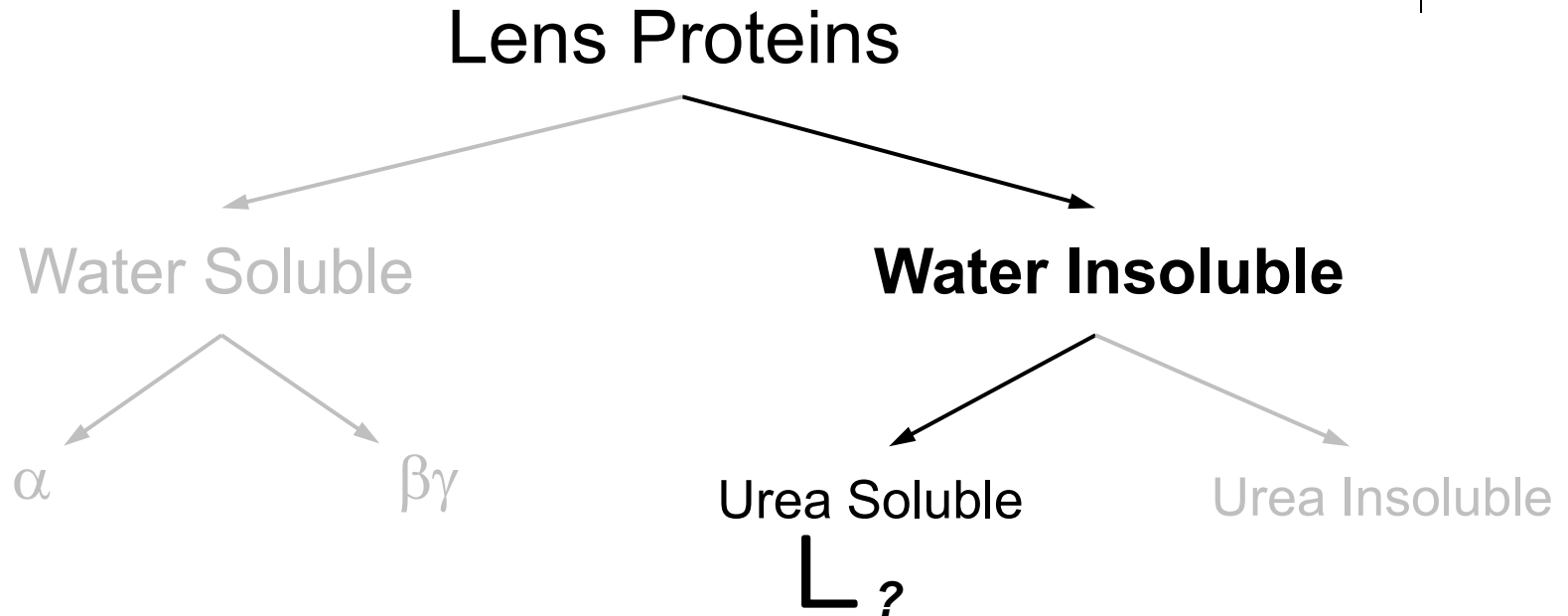


*Water-insoluble proteins come two basic types. What are they?
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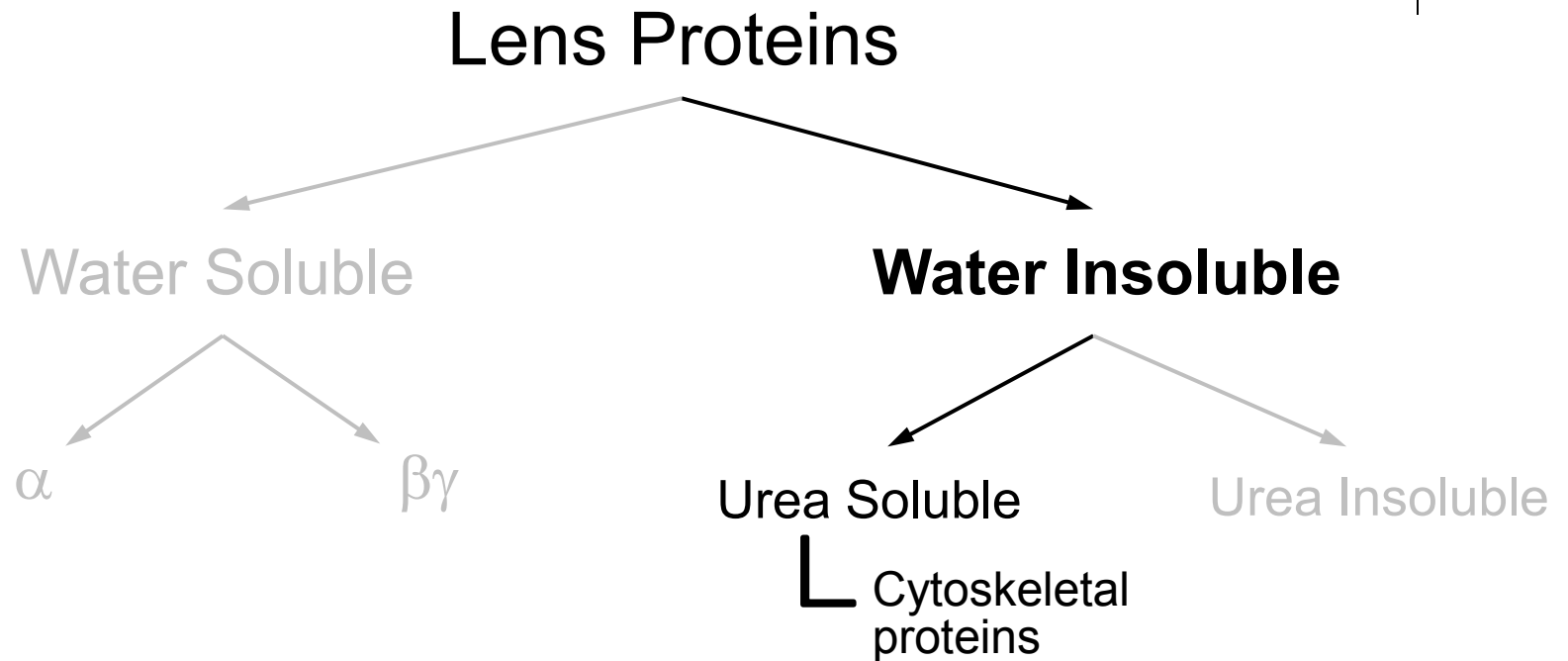
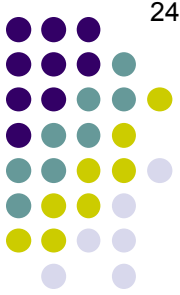
Q

Lens/Cataracts Overview

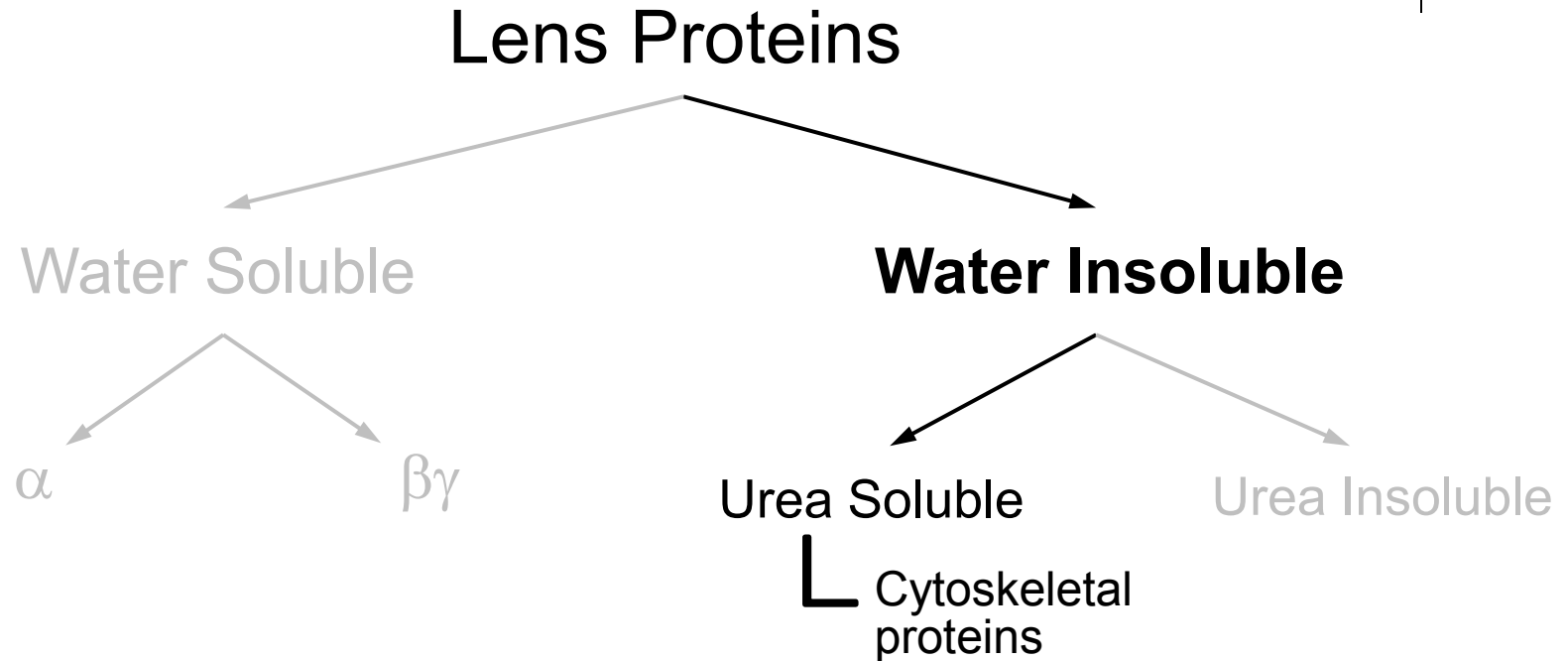
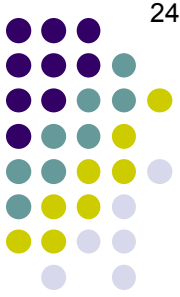
241



What sort of protein comprises the majority of the urea-soluble fraction of the water-insoluble lens proteins?



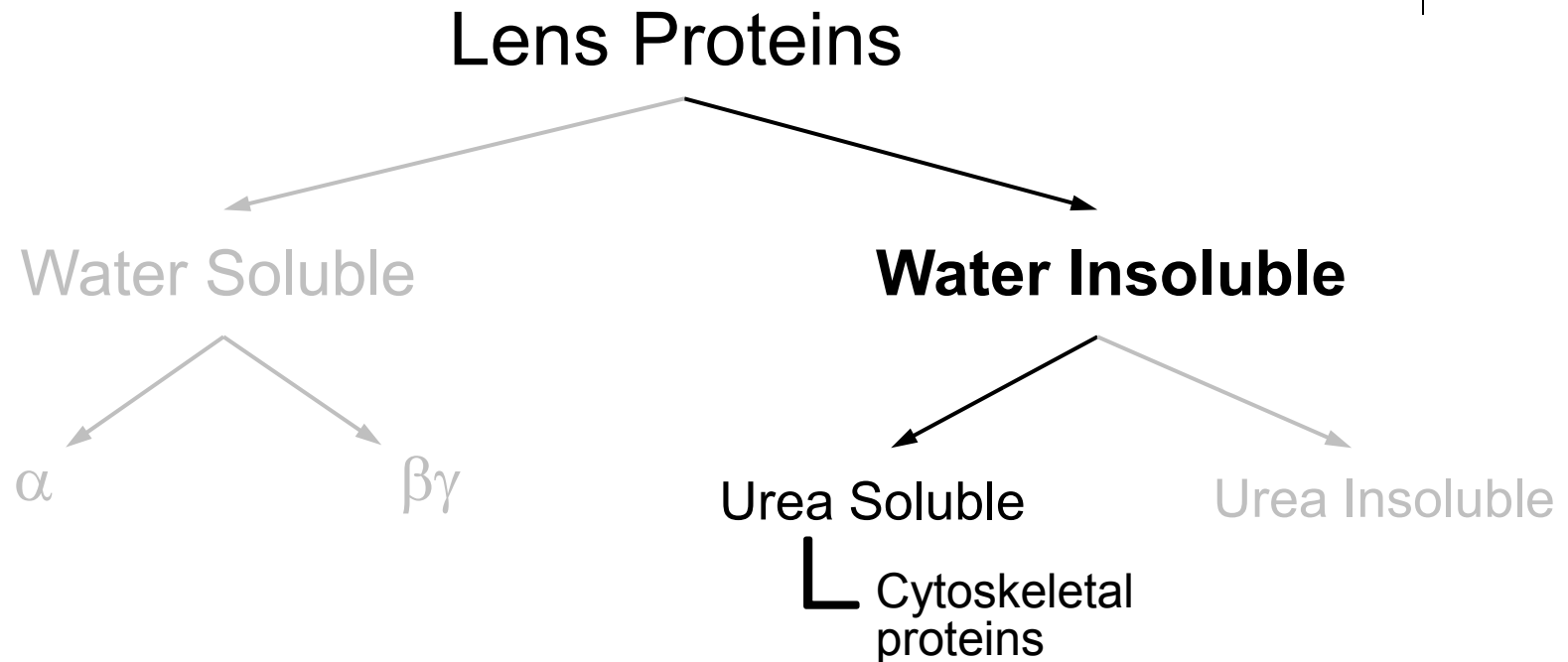
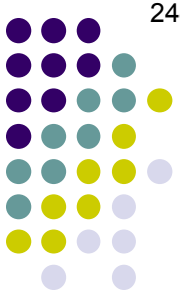
What sort of protein comprises the majority of the urea-soluble fraction of the water-insoluble lens proteins?
Cytoskeletal proteins



What sort of protein comprises the majority of the urea-soluble fraction of the water-insoluble lens proteins?

Cytoskeletal proteins

What function do cytoskeletal proteins serve?

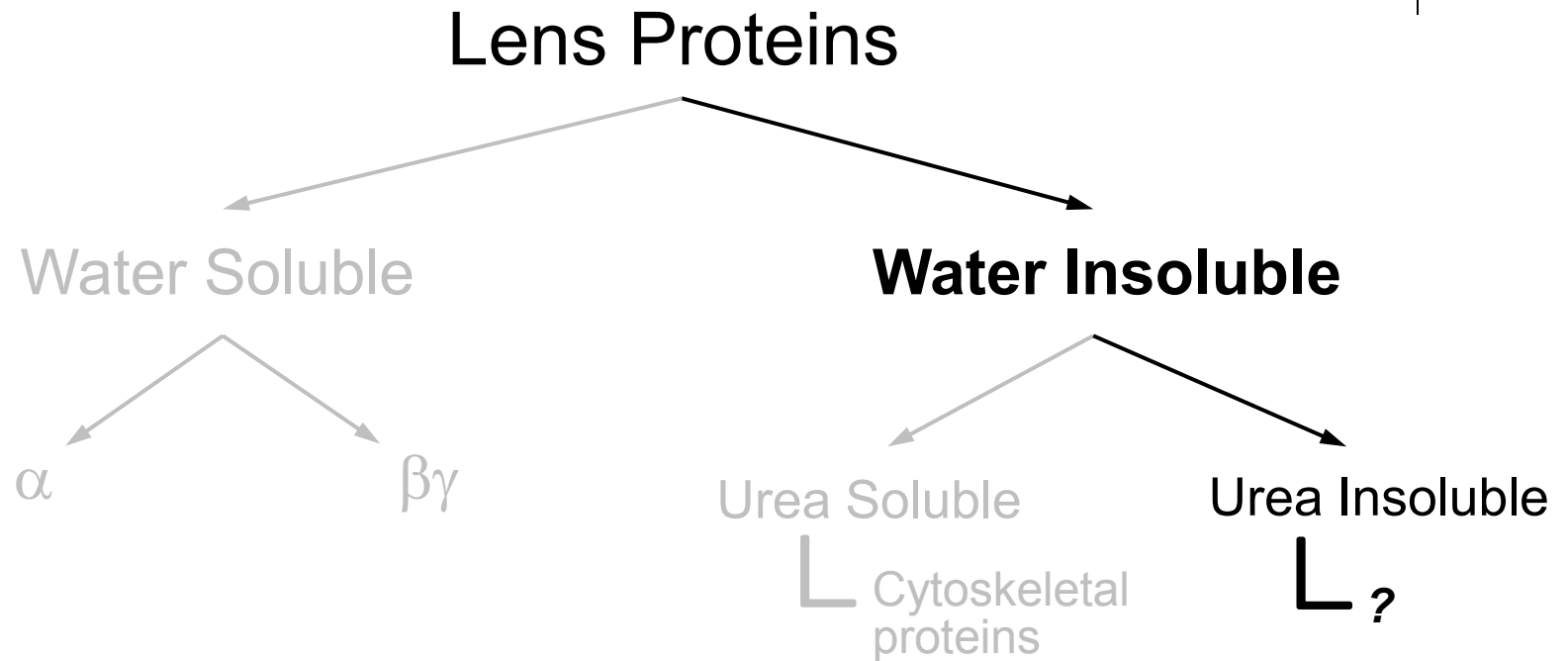
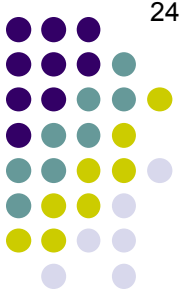


What sort of protein comprises the majority of the urea-soluble fraction of the water-insoluble lens proteins?

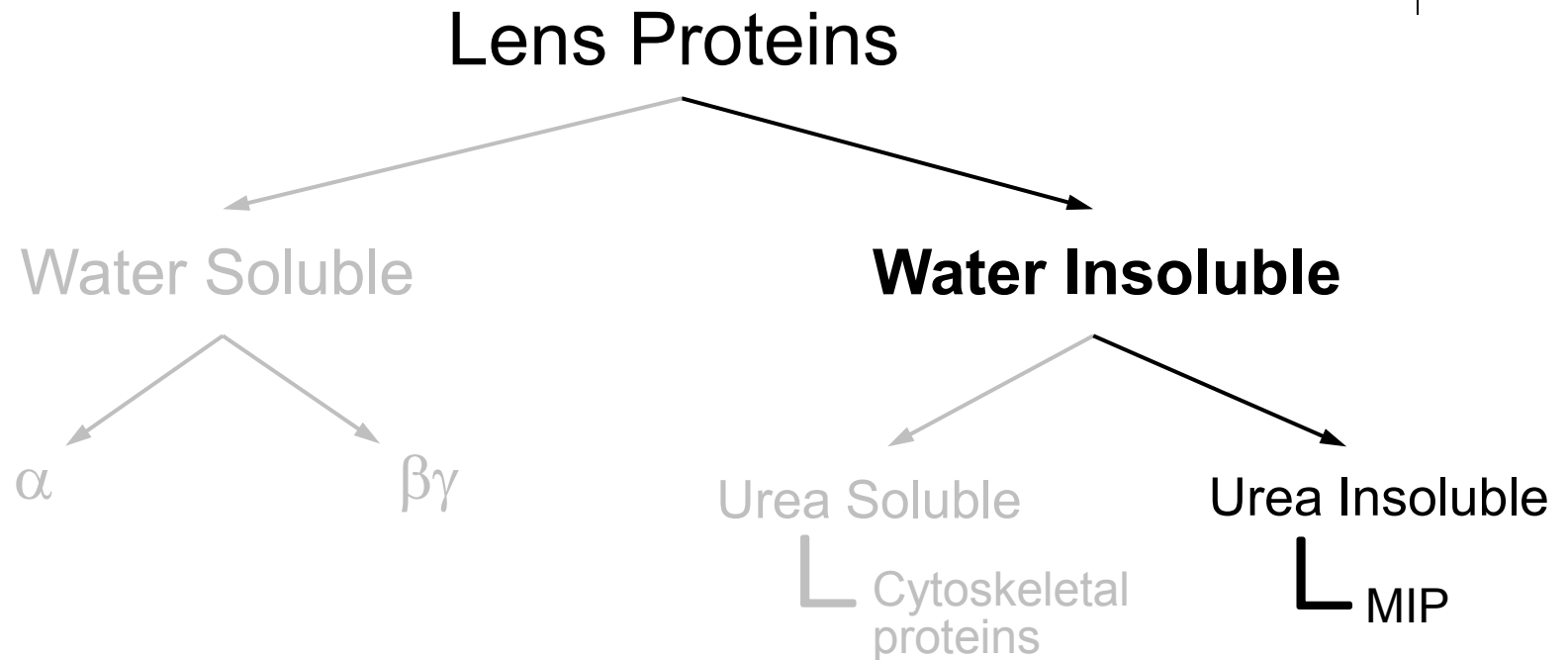
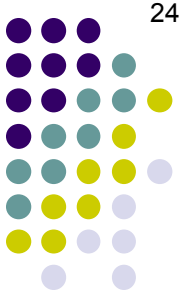
Cytoskeletal proteins

What function do cytoskeletal proteins serve?

They are the primary component of the structural framework of lens cells

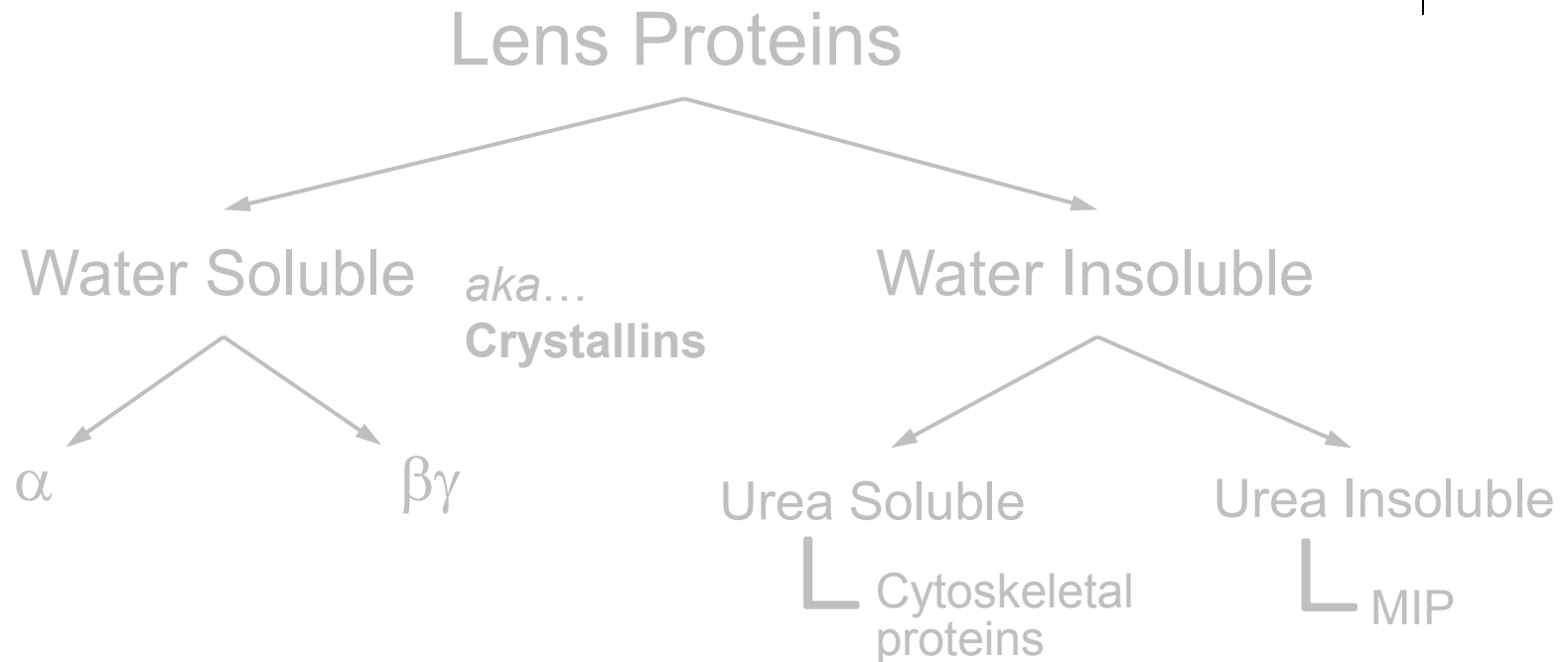
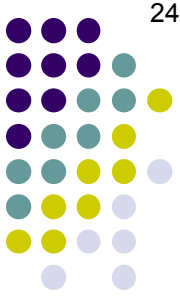


What sort of protein comprises the majority of the urea-insoluble fraction of the water-insoluble lens proteins?



What sort of protein comprises the majority of the urea-insoluble fraction of the water-insoluble lens proteins?
Major intrinsic protein (MIP)

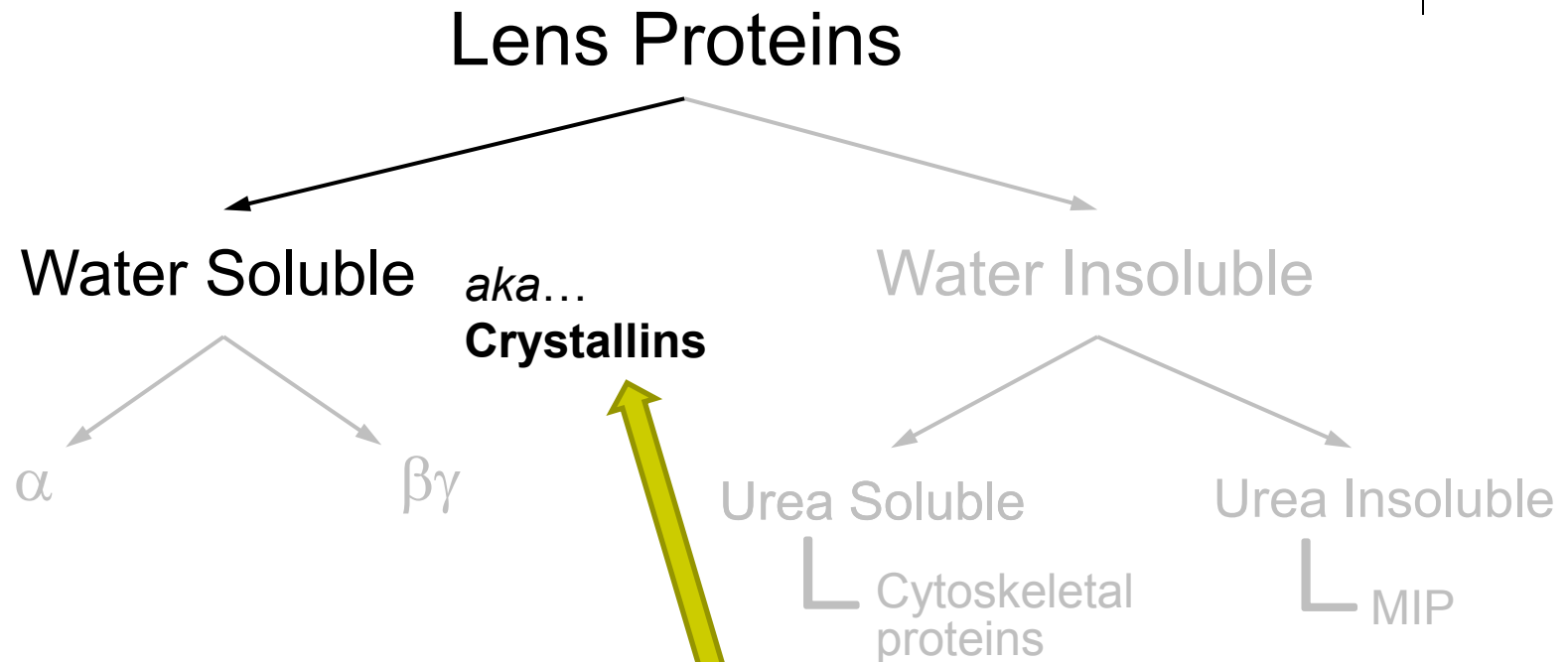
Lens/Cataracts Overview



Remember when we talked about the big bump in lens protein creation that occurs during fiber elongation?

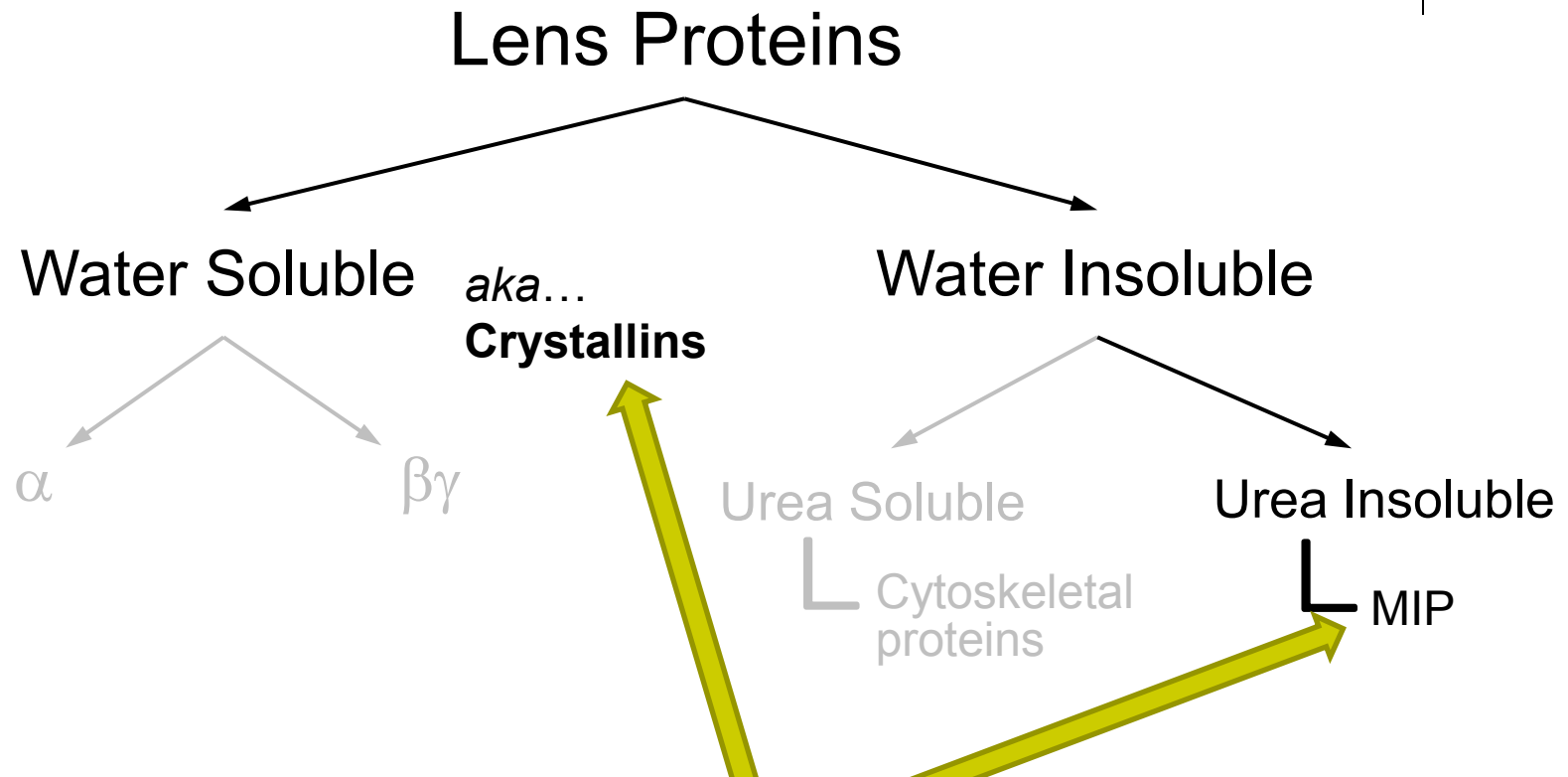
(Rhetorical question)

Lens/Cataracts Overview



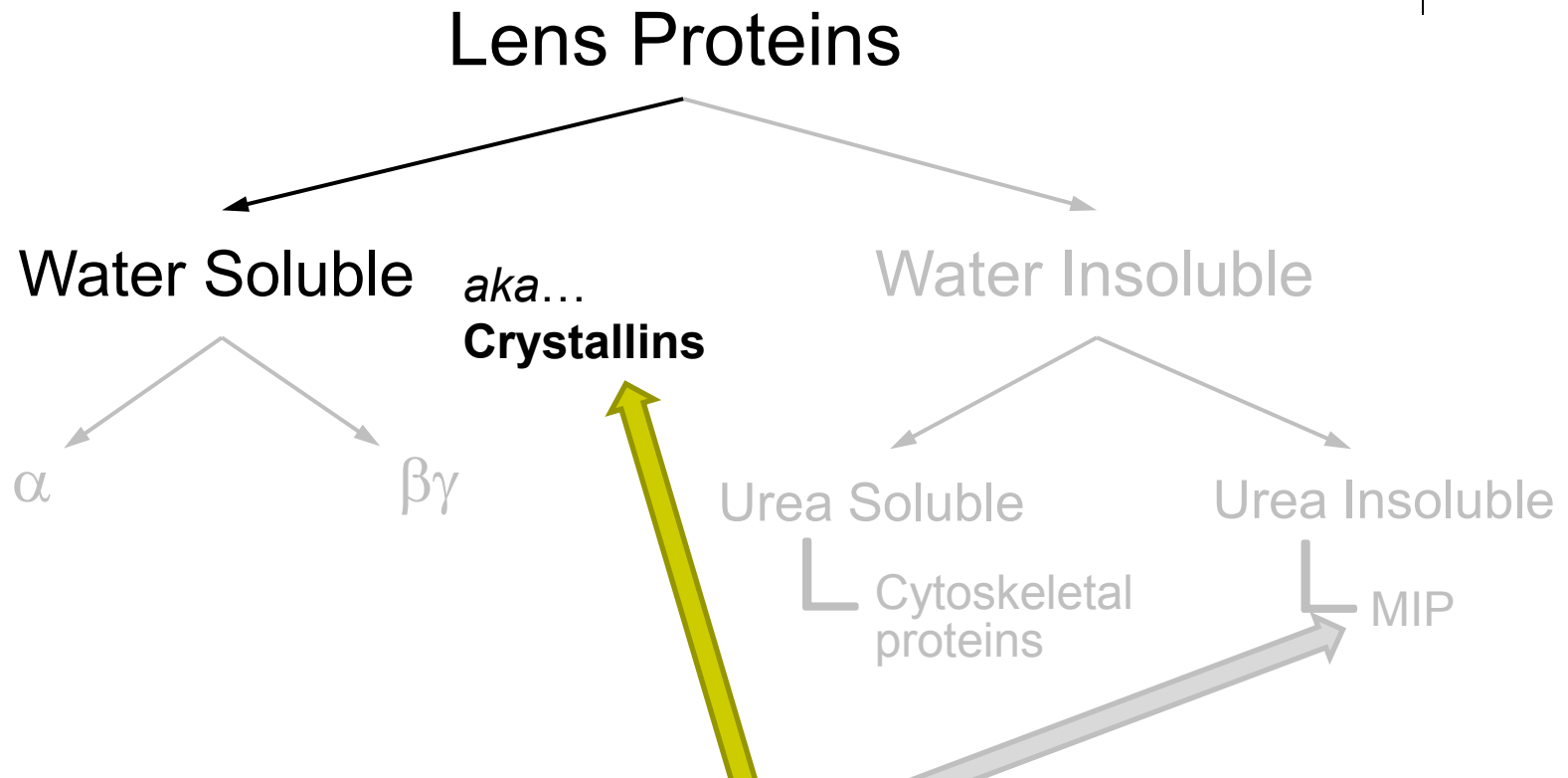
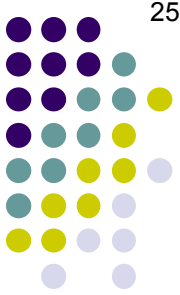
Remember when we talked about the big bump in lens protein creation that occurs during fiber elongation? The *Lens* book states that the proteins thus created are primarily **crystallins**.

Lens/Cataracts Overview



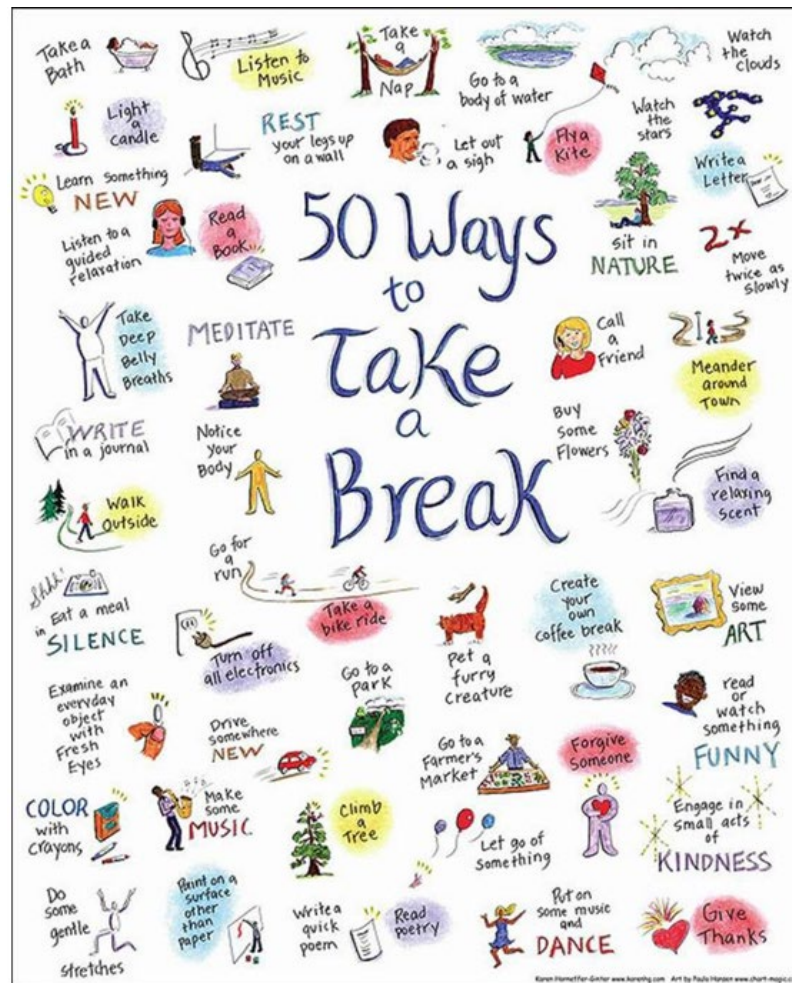
Remember when we talked about the big bump in lens protein creation that occurs during fiber elongation? The *Lens* book states that the proteins thus created are primarily **crystallins**. MIPs production goes up too

Lens/Cataracts Overview



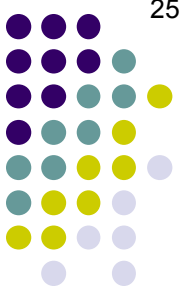
*Remember when we talked about the big bump in lens protein creation that occurs during fiber elongation? The Lens book states that the proteins thus created are primarily **crystallins**. MIPs production goes up too, but it's the crystallins that are responsible for the refractive index effect we discussed.*

No question yet—proceed when ready



(This is a good point in the set to take a break)

Lens/Cataracts Overview



Lens Proteins

Water Soluble

Water Insoluble

*Next we will look at the **development/embryology** of the lens*

α

$\beta\gamma$

Urea Soluble

Urea Insoluble

└ Cytoskeletal
proteins

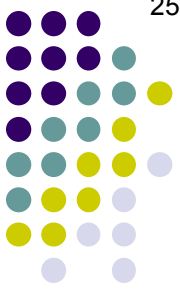
└ MIP

What sort of protein comprises the majority of the urea-insoluble fraction of the water-insoluble lens proteins?
Major intrinsic protein (MIP)

Q

Lens/Cataracts Overview

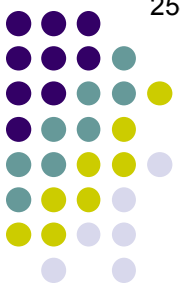
- Which embryologic cell line gives rise to all of the components of the lens?



Q/A

Lens/Cataracts Overview

- Which embryologic cell line gives rise to all of the components of the lens? surface vs neuro- *ectoderm*



A

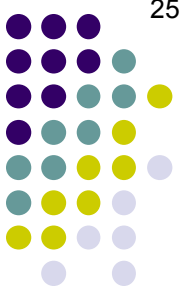
Lens/Cataracts Overview

- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*



Q

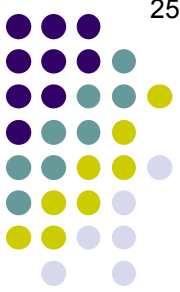
Lens/Cataracts Overview



- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*
- T/F: The optic vesicle is the primordial structure that becomes the lens. It consists of a single layer of cuboidal cells encased within their basement membrane

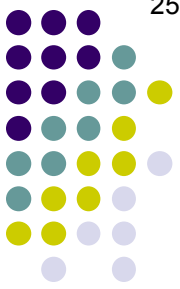
A

Lens/Cataracts Overview



- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*
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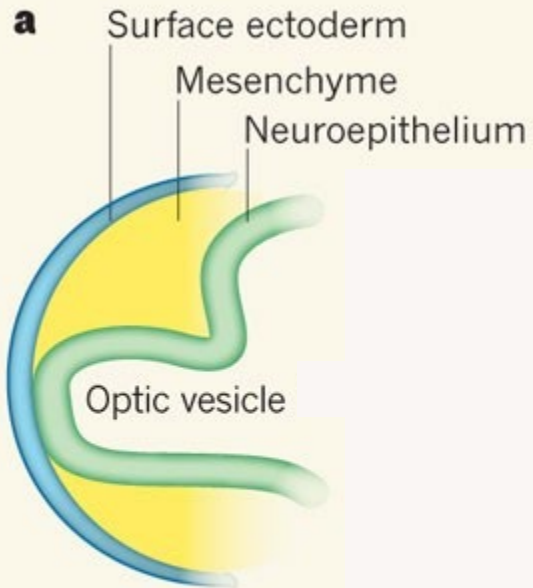
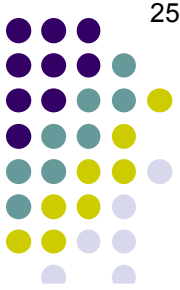
Lens/Cataracts Overview



Re **surface ectoderm** and lens formation:

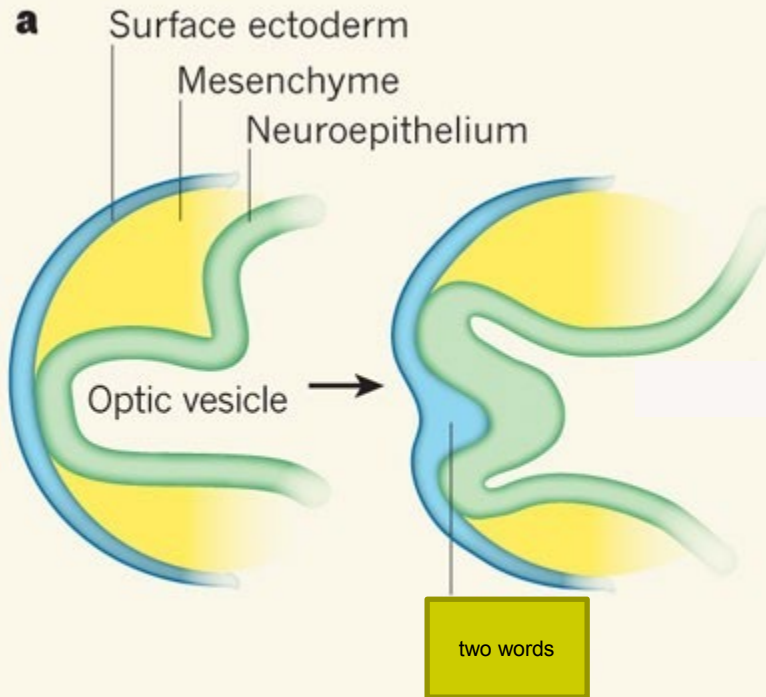
(No info yet—advance when ready)

Lens/Cataracts Overview



Re **surface ectoderm** and lens formation:

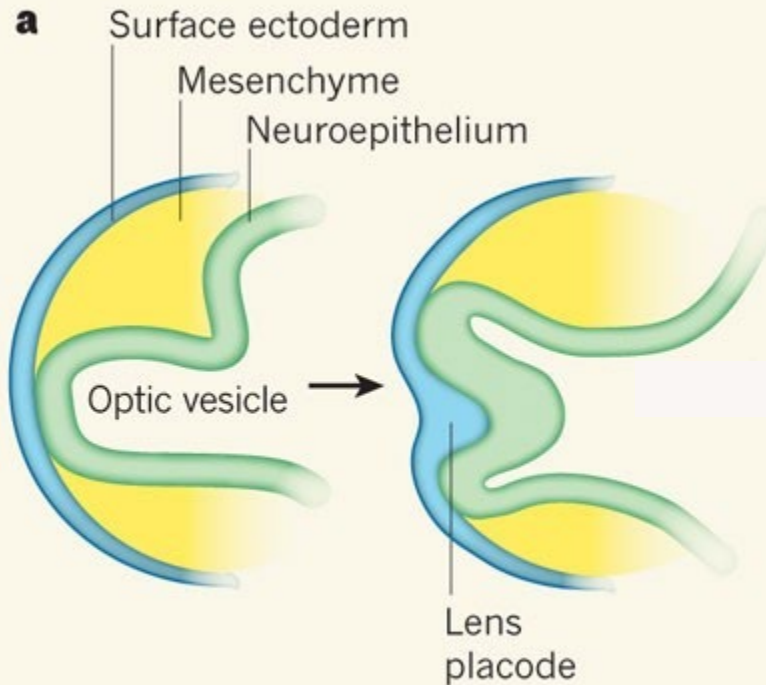
(Glance at this, then keep going to see the points being made)



Re **surface ectoderm** and lens formation:

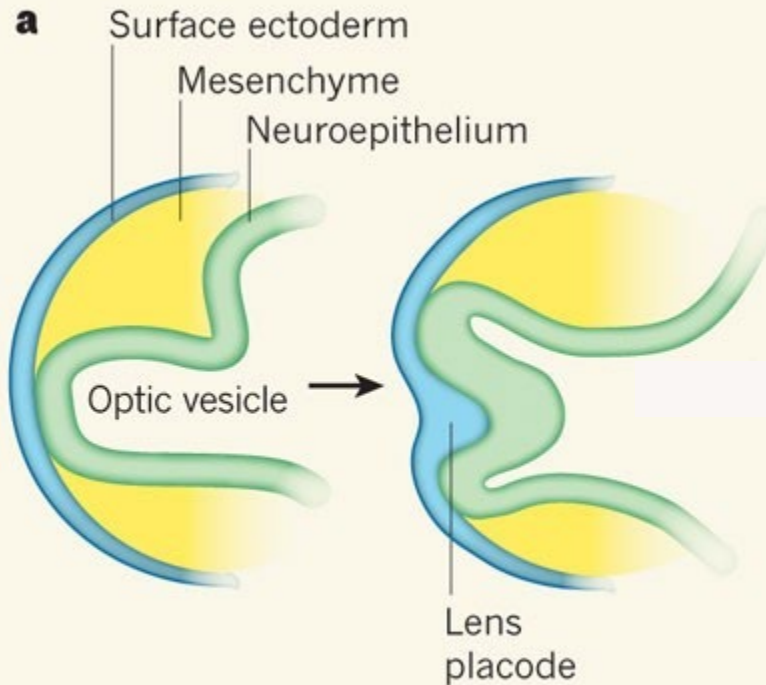
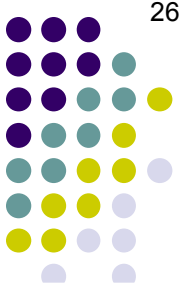
--A portion of **surface ectoderm** thickens to form the

two words



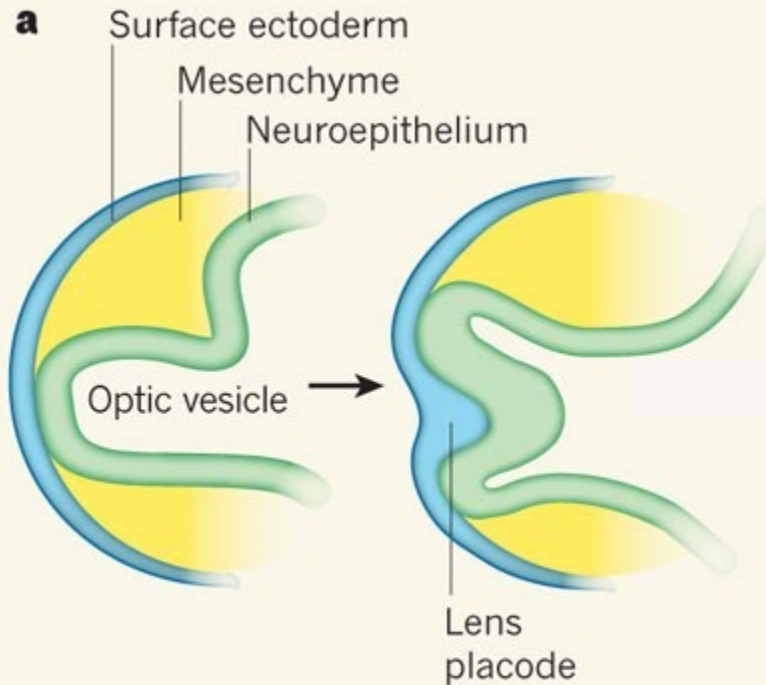
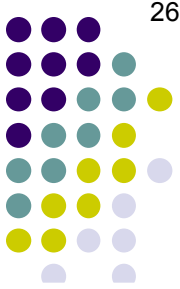
Re surface ectoderm and lens formation:

--A portion of surface ectoderm thickens to form the lens placode



Re **surface ectoderm** and lens formation:

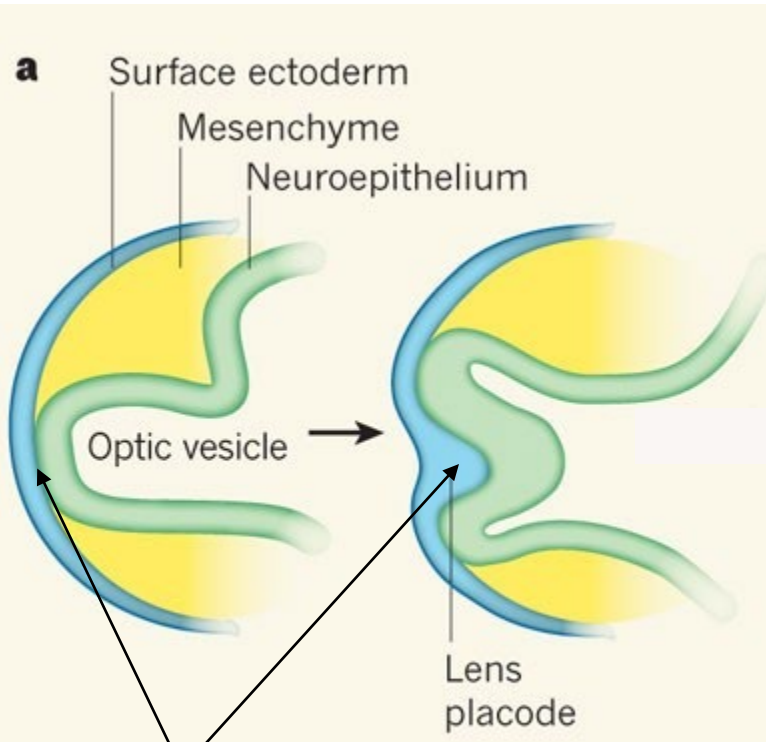
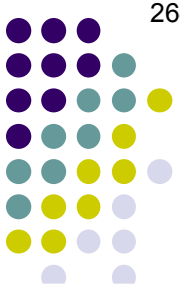
--A portion of **surface ectoderm** thickens to form the **lens placode** (aka the two words)



Re surface ectoderm and lens formation:

--A portion of surface ectoderm thickens to form the lens placode (aka the lens plate)

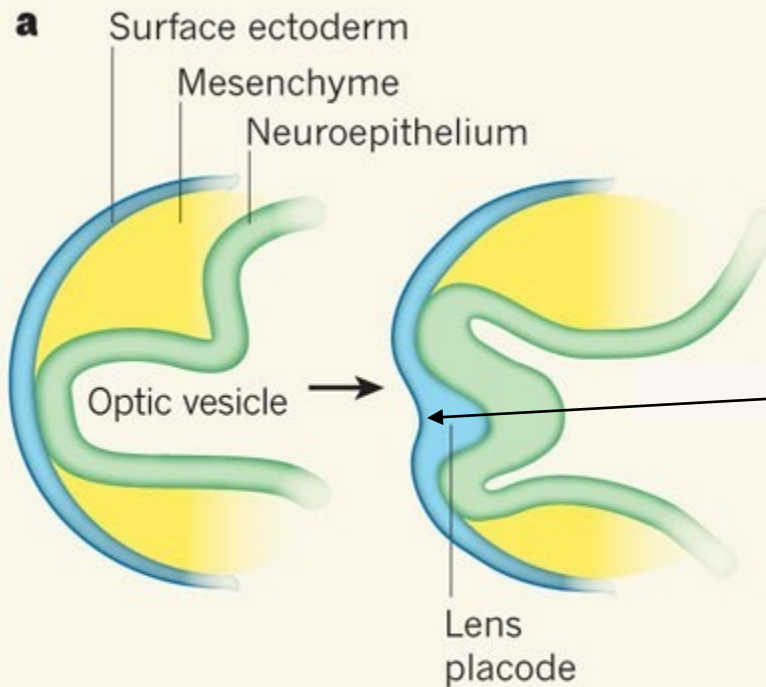
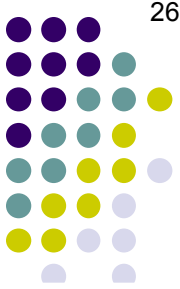
Lens/Cataracts Overview



It's the contact from the optic vesicle that induces the overlying surface ectoderm to thicken and form the placode

Re surface ectoderm and lens formation:

--A portion of surface ectoderm thickens to form the lens placode (aka the lens **plate**)

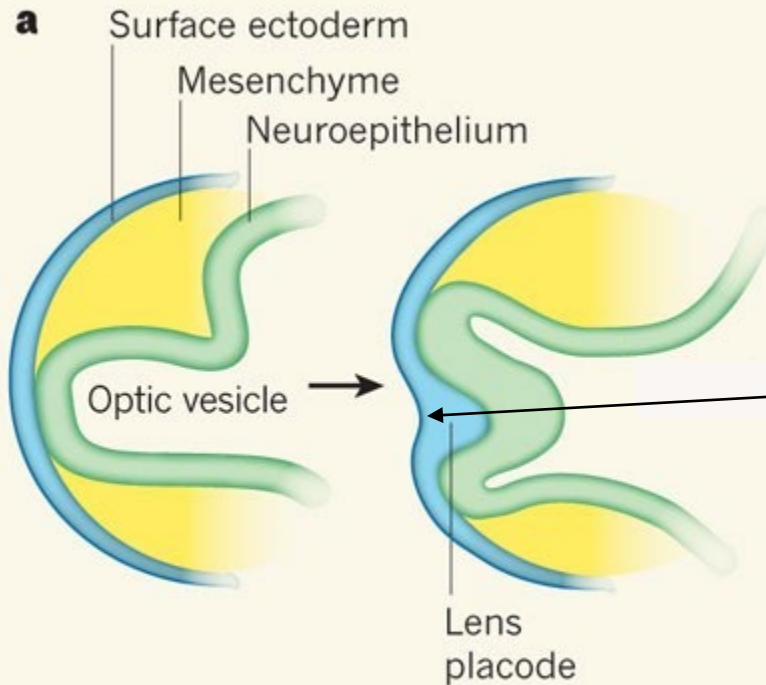


Note the presence of an indentation
in the lens placode; this is called the

two words

Re surface ectoderm and lens formation:

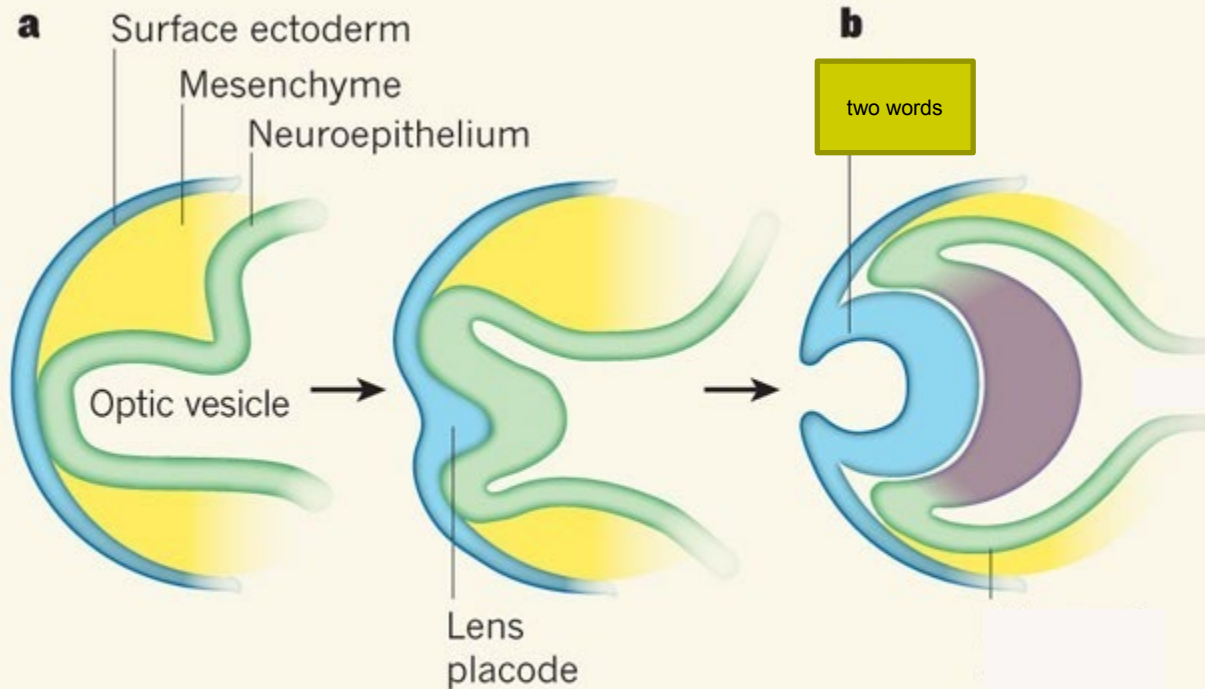
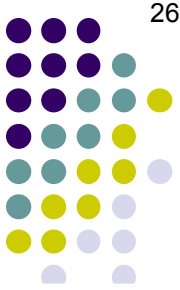
--A portion of surface ectoderm thickens to form the lens placode (aka the lens **plate**)



Note the presence of an indentation in the lens placode; this is called the **lens pit**

Re surface ectoderm and lens formation:

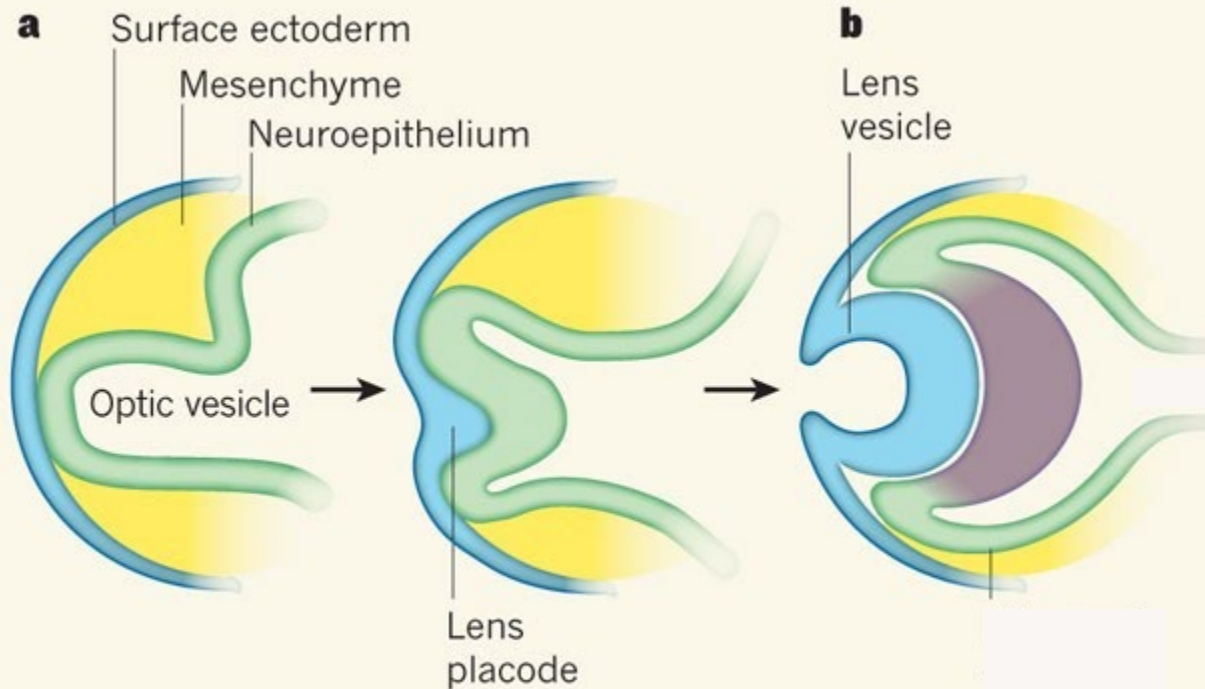
--A portion of surface ectoderm thickens to form the lens placode (aka the lens **plate**)



Re **surface ectoderm** and lens formation:

--A portion of **surface ectoderm** thickens to form the **lens placode** (aka the **lens plate**)

--The placode invaginates to form the **lens**

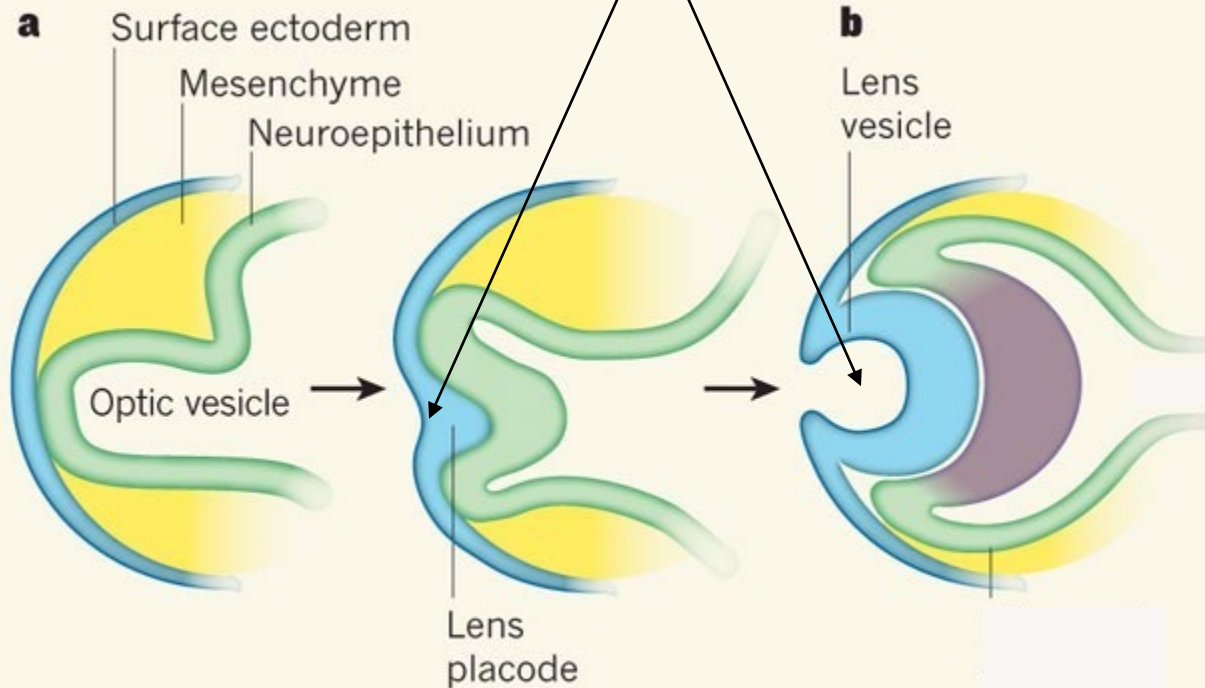


Re **surface ectoderm** and lens formation:

- A portion of **surface ectoderm** thickens to form the **lens placode** (aka the **lens plate**)
- The placode invaginates to form the **lens vesicle**

Lens/Cataracts Overview

(Note that the invagination process consists of a progressive deepening of the lens pit)

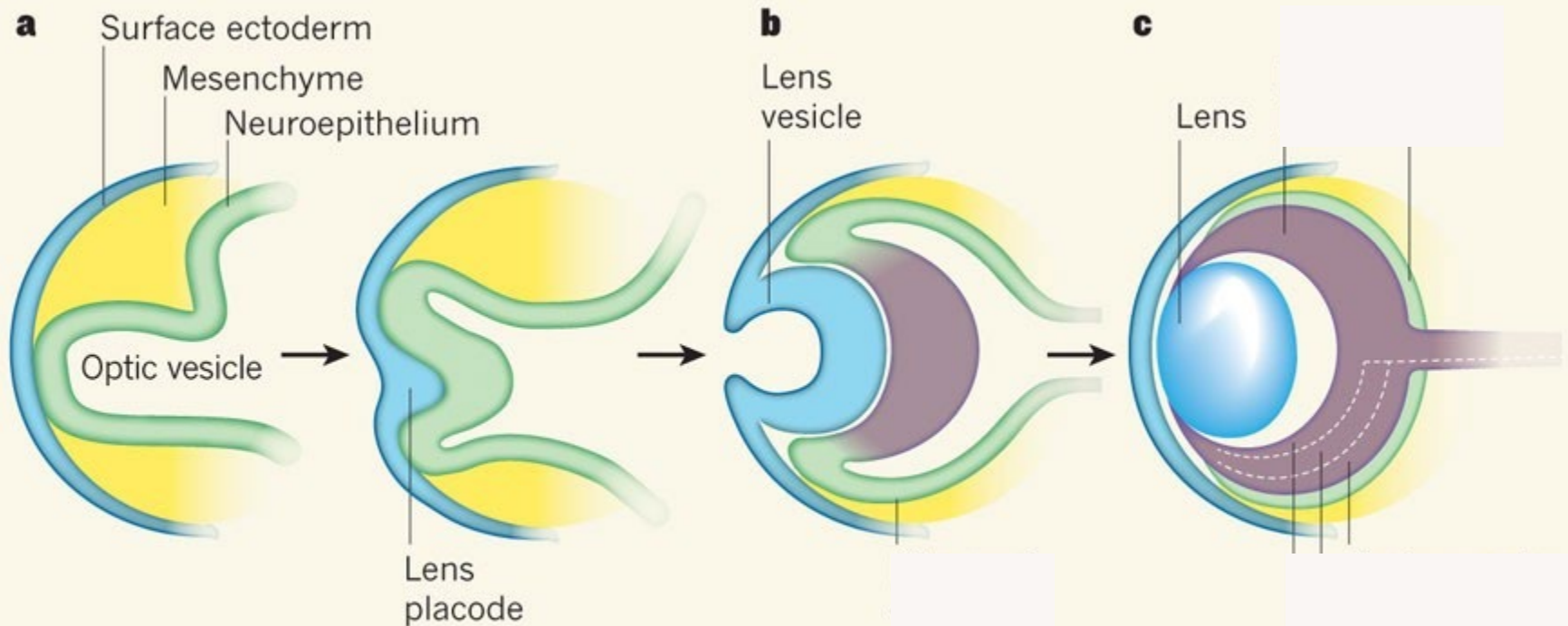


Re surface ectoderm and lens formation:

- A portion of surface ectoderm thickens to form the lens placode (aka the lens **plate**)
- The placode invaginates to form the lens vesicle

No question—proceed when ready

Lens/Cataracts Overview

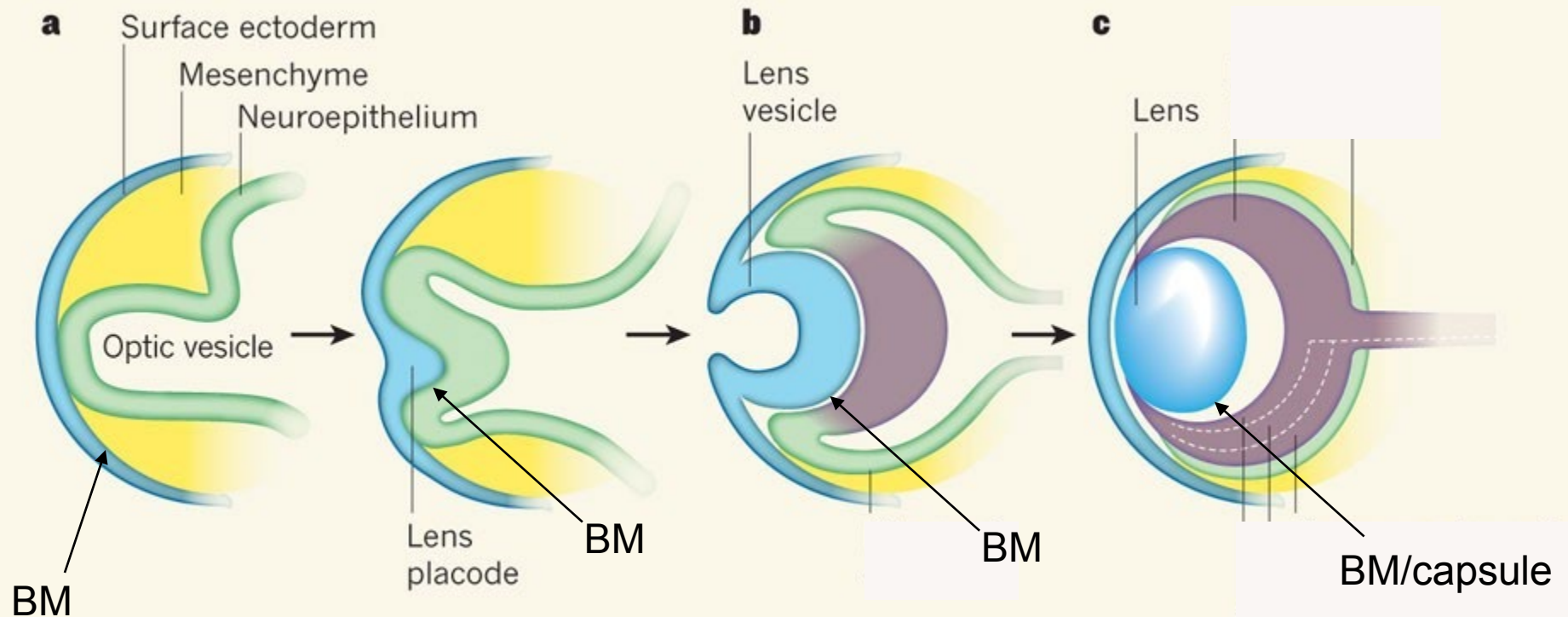


Re **surface ectoderm** and lens formation:

- A portion of **surface ectoderm** thickens to form the **lens placode** (aka the **lens plate**)
- The placode invaginates to form the **lens vesicle**
- The lens vesicle goes on to form (eventually; there are intervening steps) the **mature lens**.

No question—proceed when ready

Lens/Cataracts Overview

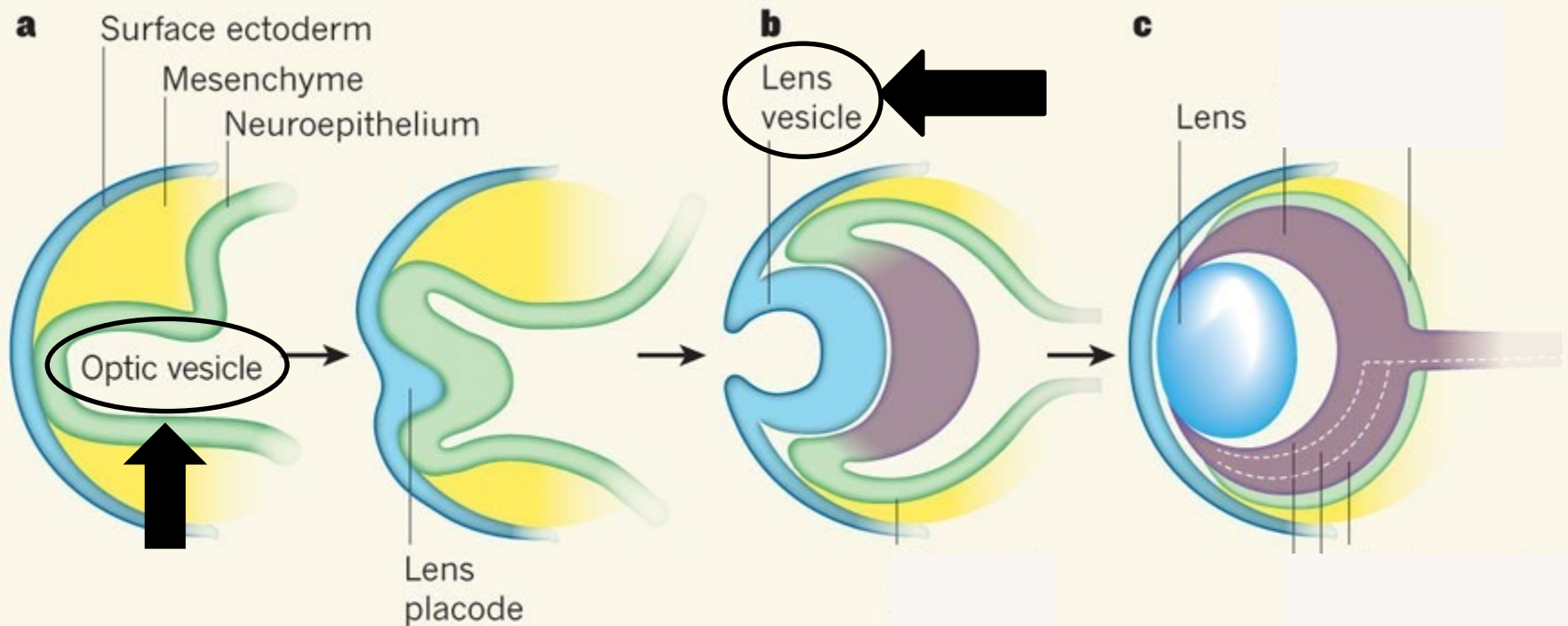


Take note that the invagination process leads to the weird result of a structure (the lens) that has its epithelium on its *inside* and its basement membrane on its *outside*.

--The lens vesicle goes on to form (eventually; there are intervening steps) the mature lens.

No question—proceed when ready

Lens/Cataracts Overview



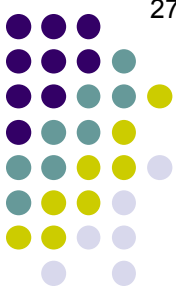
Re surface ectoderm and lens formation

- A portion of surface ectoderm thickens to form the lens placode (aka the lens plate)
- The placode invaginates to form the lens vesicle
- The lens vesicle goes on to form (eventually; there are intervening steps) the mature lens.

Finally: Note that *optic* vesicle and *lens* vesicle are different structures—don't mix them up!

Q

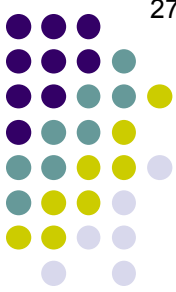
Lens/Cataracts Overview



- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*
- T/F: The ^{lens}~~optic~~ vesicle is the primordial structure that becomes the lens. It consists of a single layer of cuboidal cells encased within their basement membrane **F**
- T/F: The anterior cells of the lens vesicle elongate and progressively obliterate the lumen, forming the embryonic nucleus

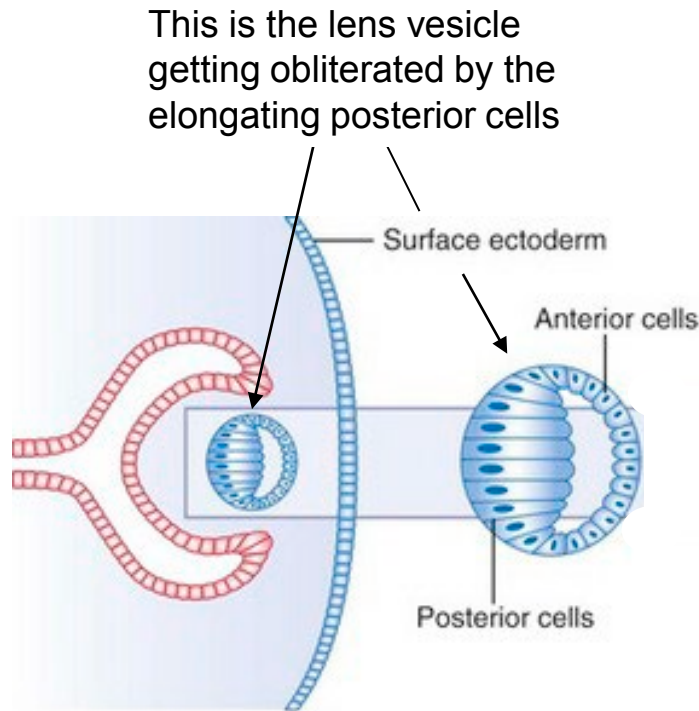
A

Lens/Cataracts Overview



- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*
- T/F: The ^{lens}~~optic~~ vesicle is the primordial structure that becomes the lens. It consists of a single layer of cuboidal cells encased within their basement membrane **F**
- T/F: The ^{posterior}~~anterior~~ cells of the lens vesicle elongate and progressively obliterate the lumen, forming the embryonic nucleus **F**

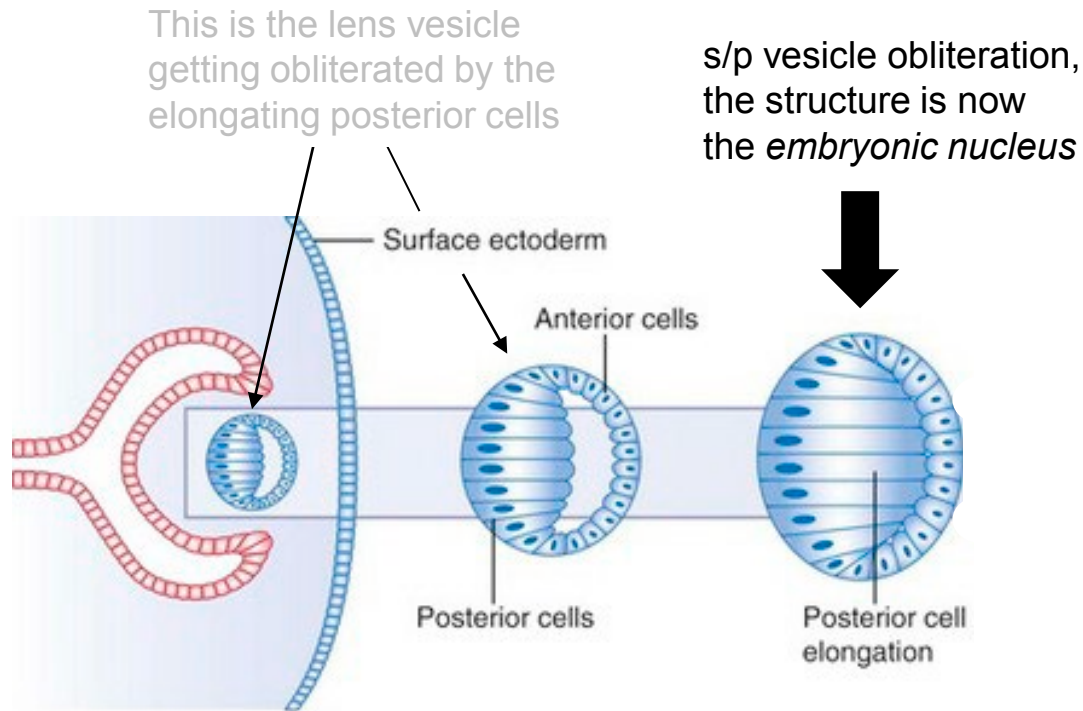
Lens/Cataracts Overview



Posterior cells of the lens vesicle elongate to obliterate the vesicle's lumen, thus creating the **embryonic nucleus**

No question—proceed when ready

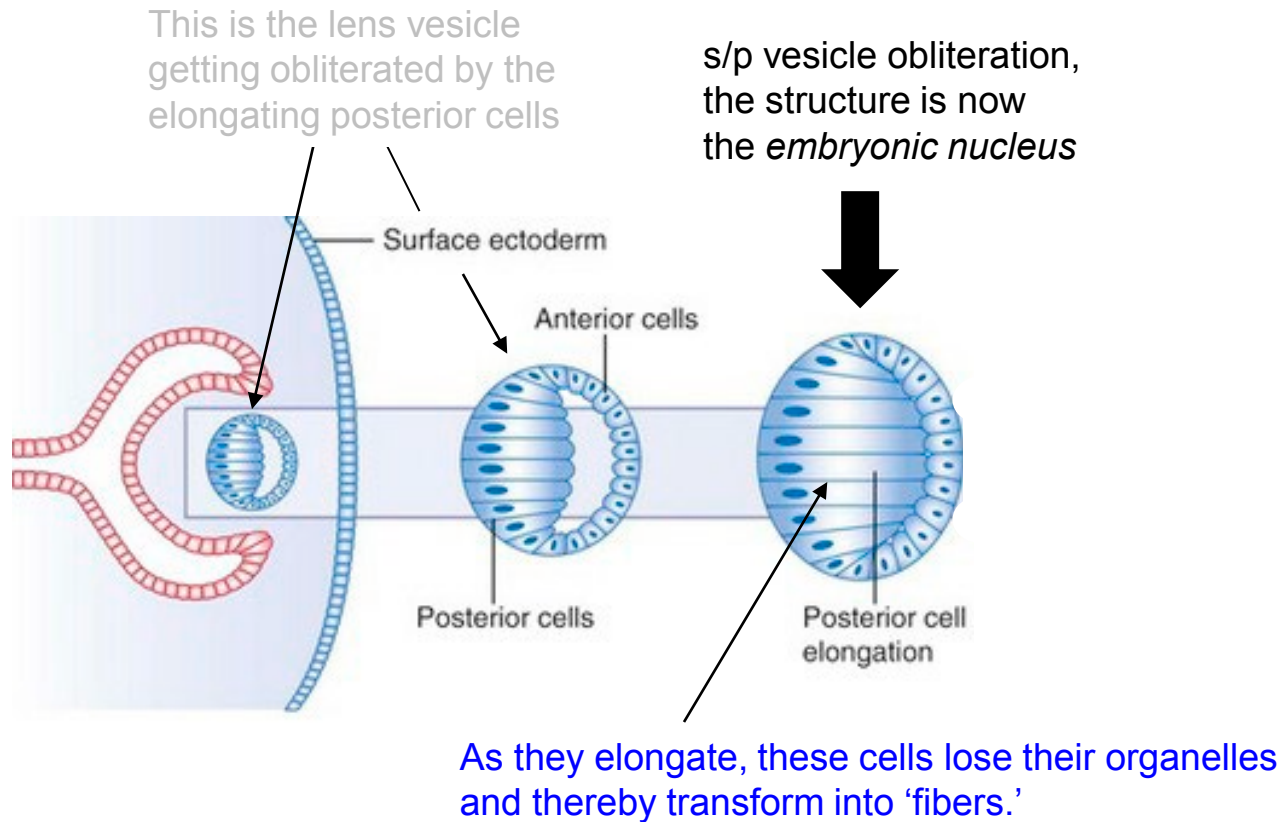
Lens/Cataracts Overview



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No question—proceed when ready

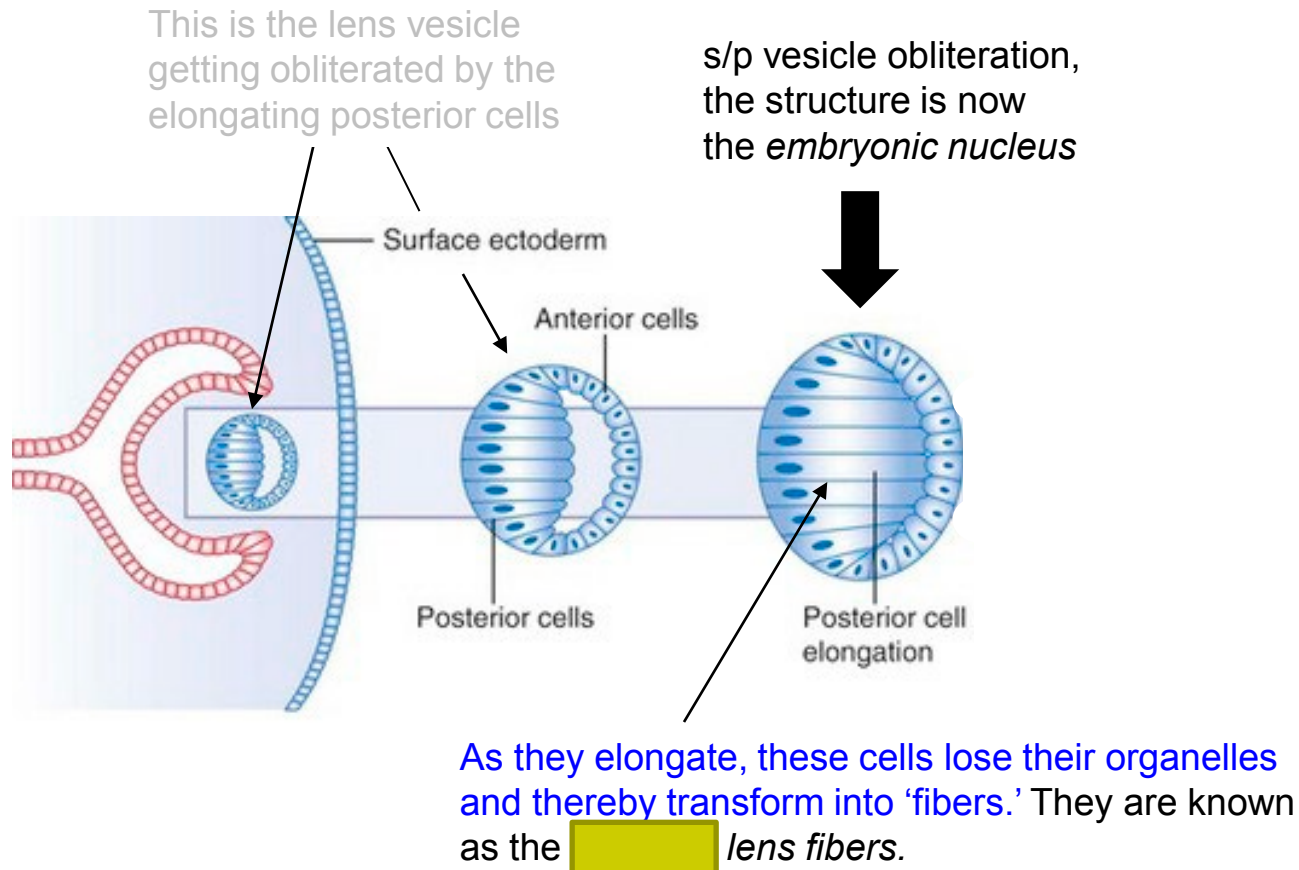
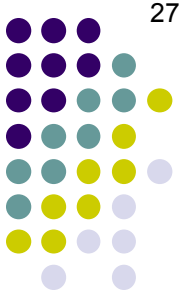
Lens/Cataracts Overview



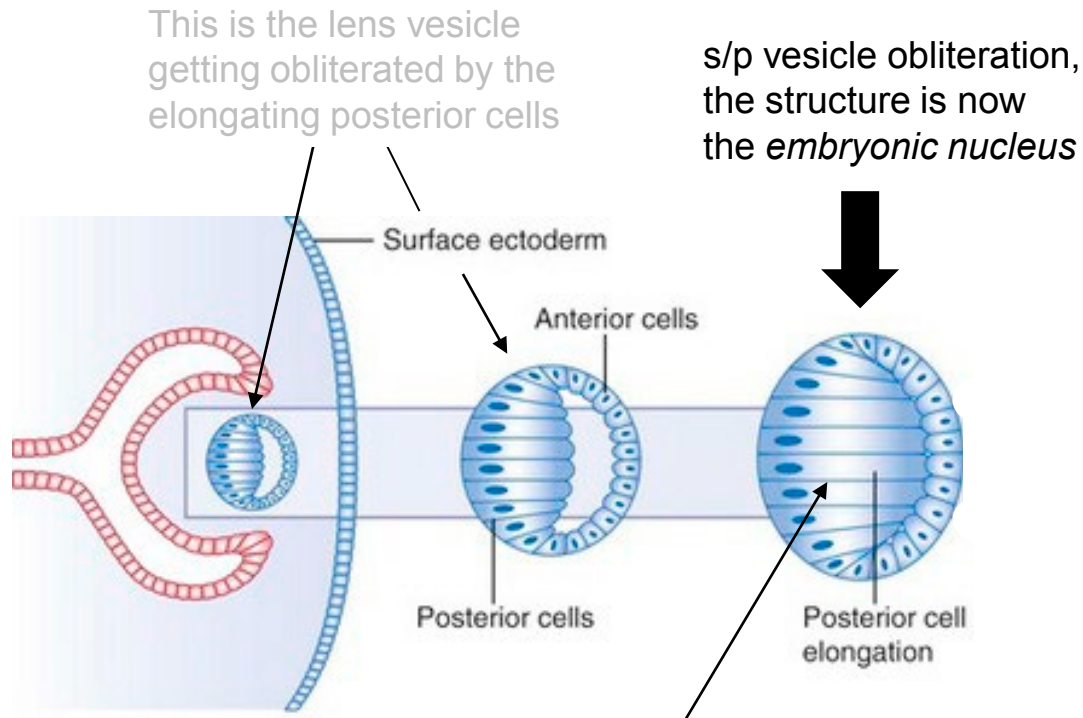
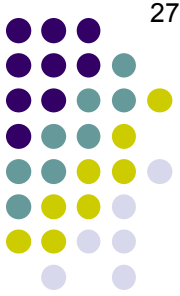
Posterior cells of the lens vesicle elongate to obliterate the vesicle's lumen, thus creating the embryonic nucleus

No question—proceed when ready

Lens/Cataracts Overview



Posterior cells of the lens vesicle elongate to obliterate the vesicle's lumen, thus creating the embryonic nucleus



As they elongate, these cells lose their organelles and thereby transform into 'fibers.' They are known as the *primary lens fibers*.

Posterior cells of the lens vesicle elongate to obliterate the vesicle's lumen, thus creating the embryonic nucleus



Q

Lens/Cataracts Overview

- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*
- T/F: The ^{lens}~~optic~~ vesicle is the primordial structure that becomes the lens. It consists of a single layer of cuboidal cells encased within their basement membrane **F**
- T/F: The ^{posterior}~~anterior~~ cells of the lens vesicle elongate and progressively obliterate the lumen, forming the embryonic nucleus **F**
- The anterior cells become the two words

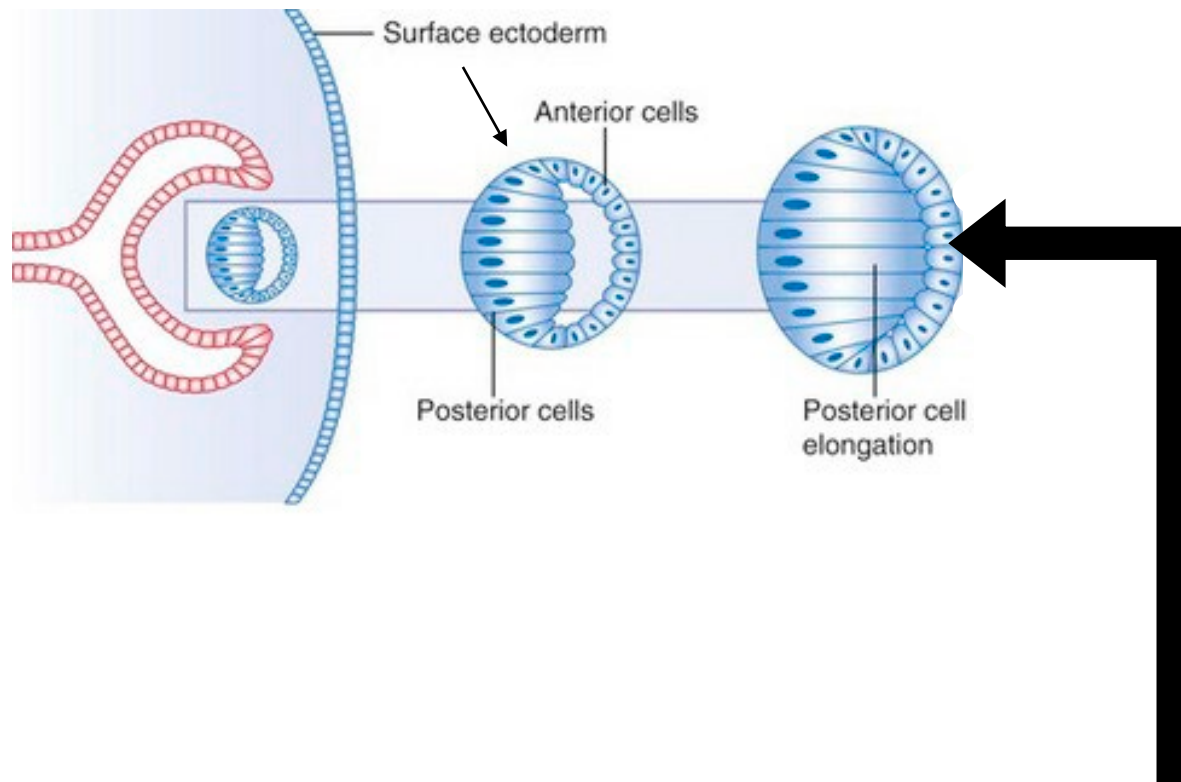
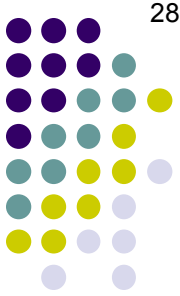
A

Lens/Cataracts Overview



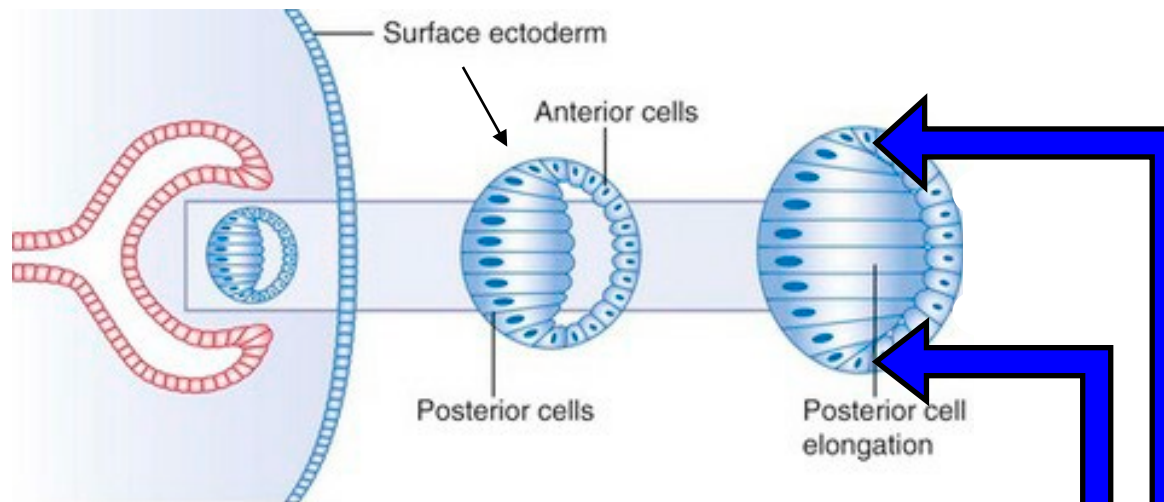
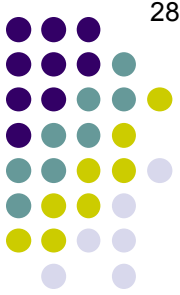
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- The anterior cells become the *lens epithelium*

Lens/Cataracts Overview

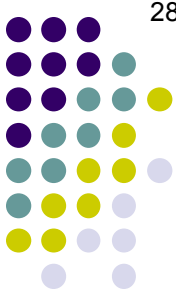


We saw this image a few slides ago. Now take note of the anterior cells—they will/have become the lens epithelial cells.

Lens/Cataracts Overview



We saw this image a few slides ago. Now take note of the anterior cells—they will/have become the lens epithelial cells. Note also that they extend around to the lens' equatorial region.



Q

Lens/Cataracts Overview

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- The anterior cells become the *lens epithelium*
- The equatorial epi cells become fibers that elongate both anteriorly and posteriorly, thereby forming the

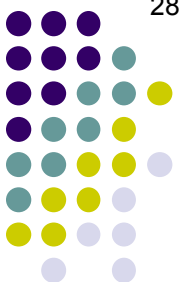
two words

A

Lens/Cataracts Overview

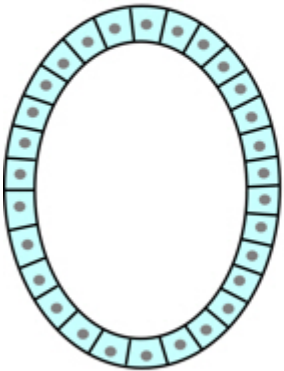


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- The anterior cells become the *lens epithelium*
- The equatorial epi cells become fibers that elongate both anteriorly and posteriorly, thereby forming the *fetal nucleus*

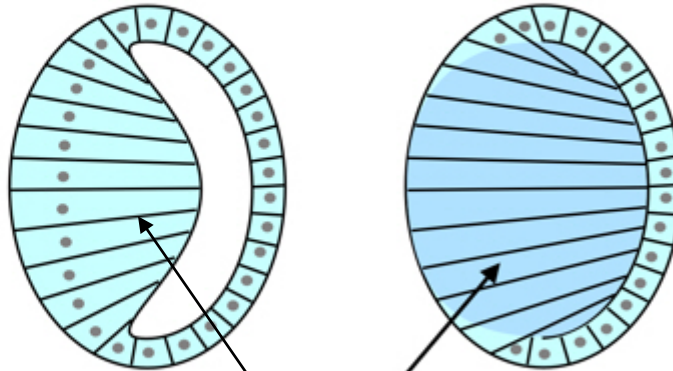


Lens/Cataracts Overview

Lens vesicle



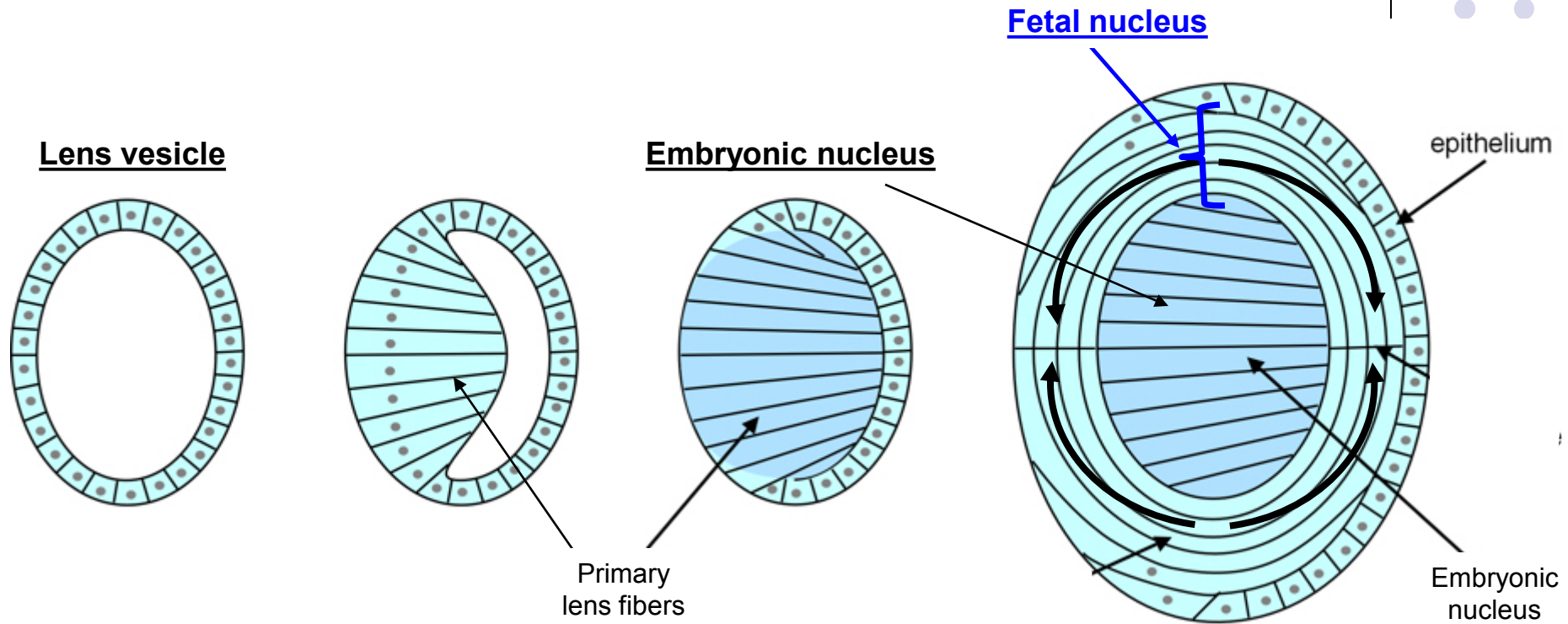
Embryonic nucleus



Primary
lens fibers

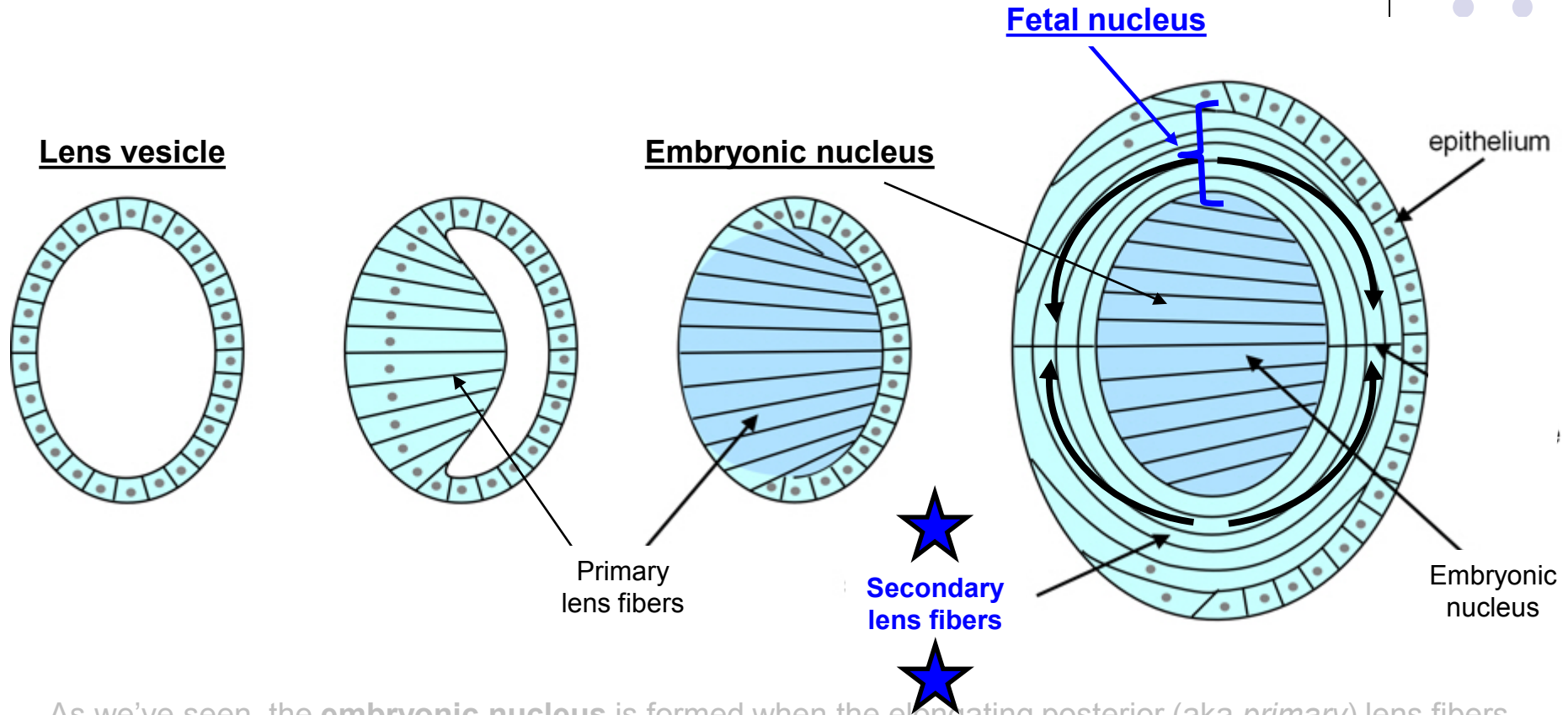
As we've seen, the **embryonic nucleus** is formed when the elongating posterior (aka *primary*) lens fibers obliterate the vesicle.

Lens/Cataracts Overview



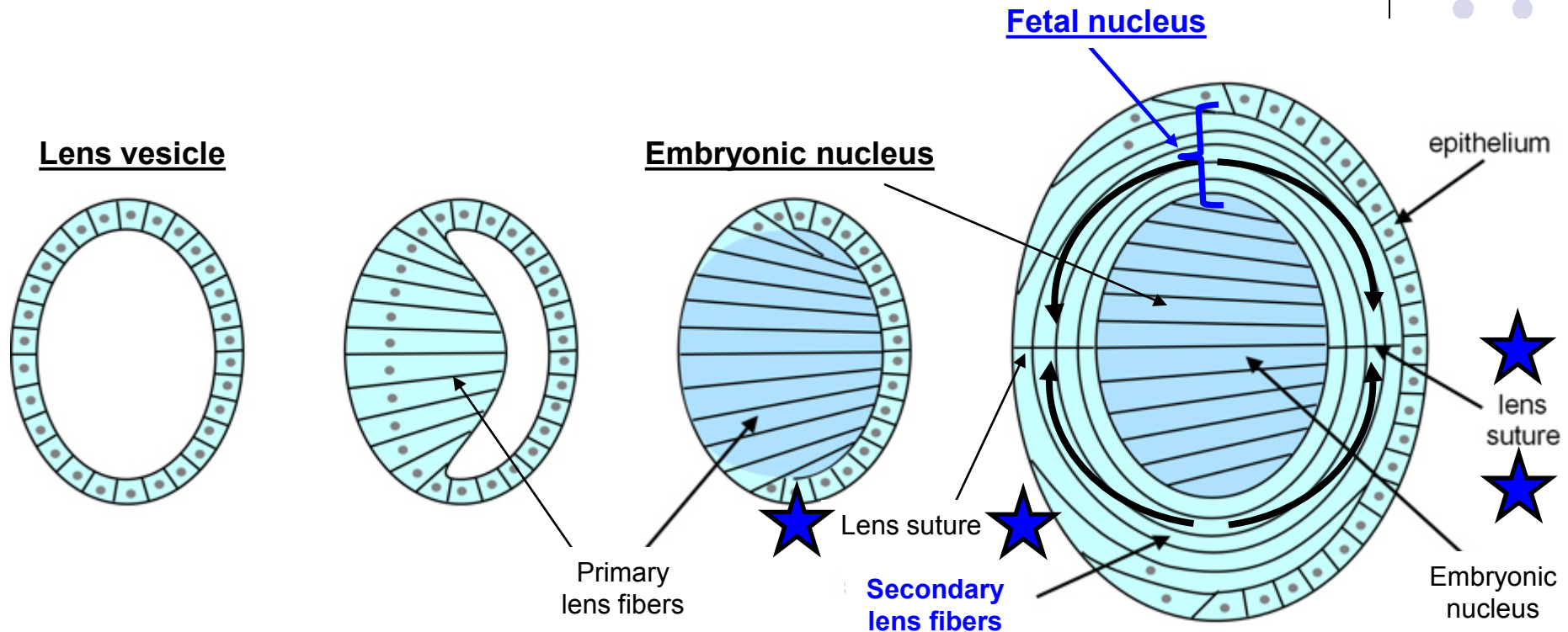
As we've seen, the **embryonic nucleus** is formed when the elongating posterior (aka *primary*) lens fibers obliterate the vesicle. The **fetal nucleus** is formed by the equatorial epithelial cells as they elongate both anteriorly (insinuating themselves between the anterior epithelial cells and the primary lens fibers of the embryonic nucleus) and posteriorly (insinuating themselves between the origins of the primary lens fibers and the underlying capsule).

Lens/Cataracts Overview



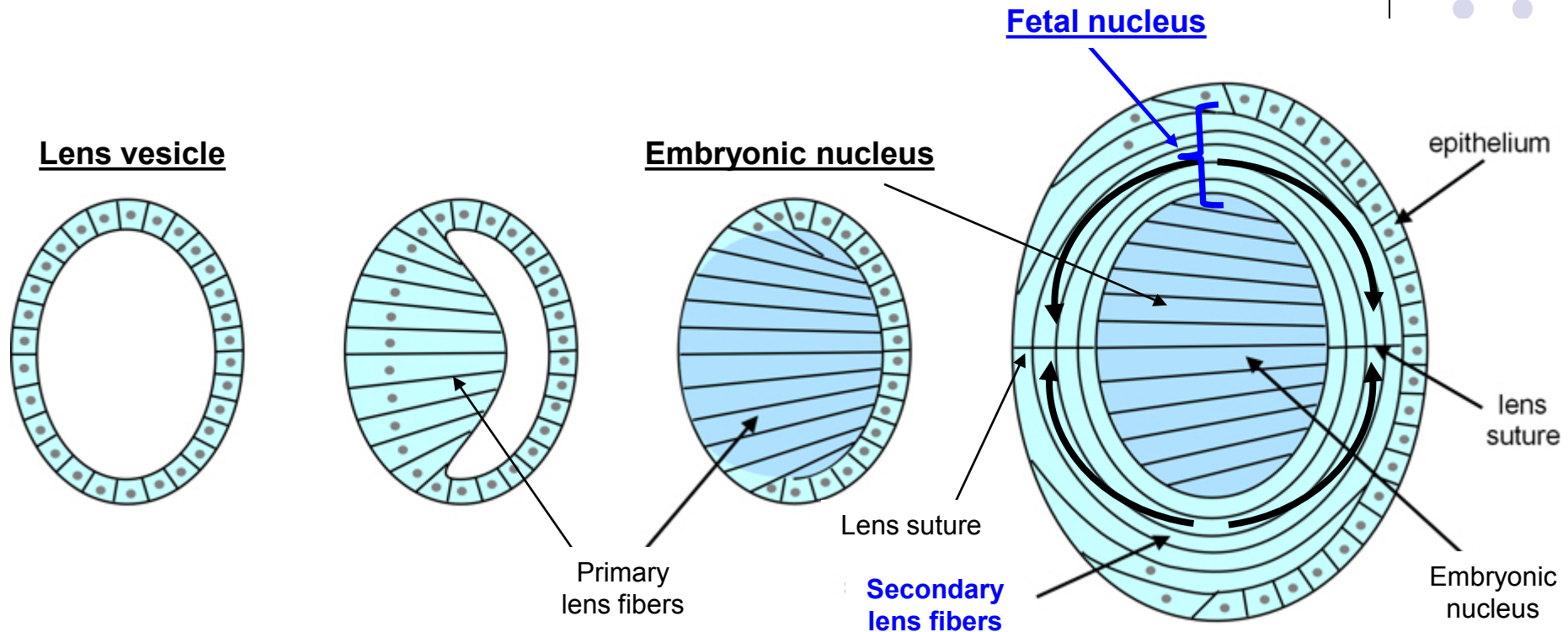
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Lens/Cataracts Overview



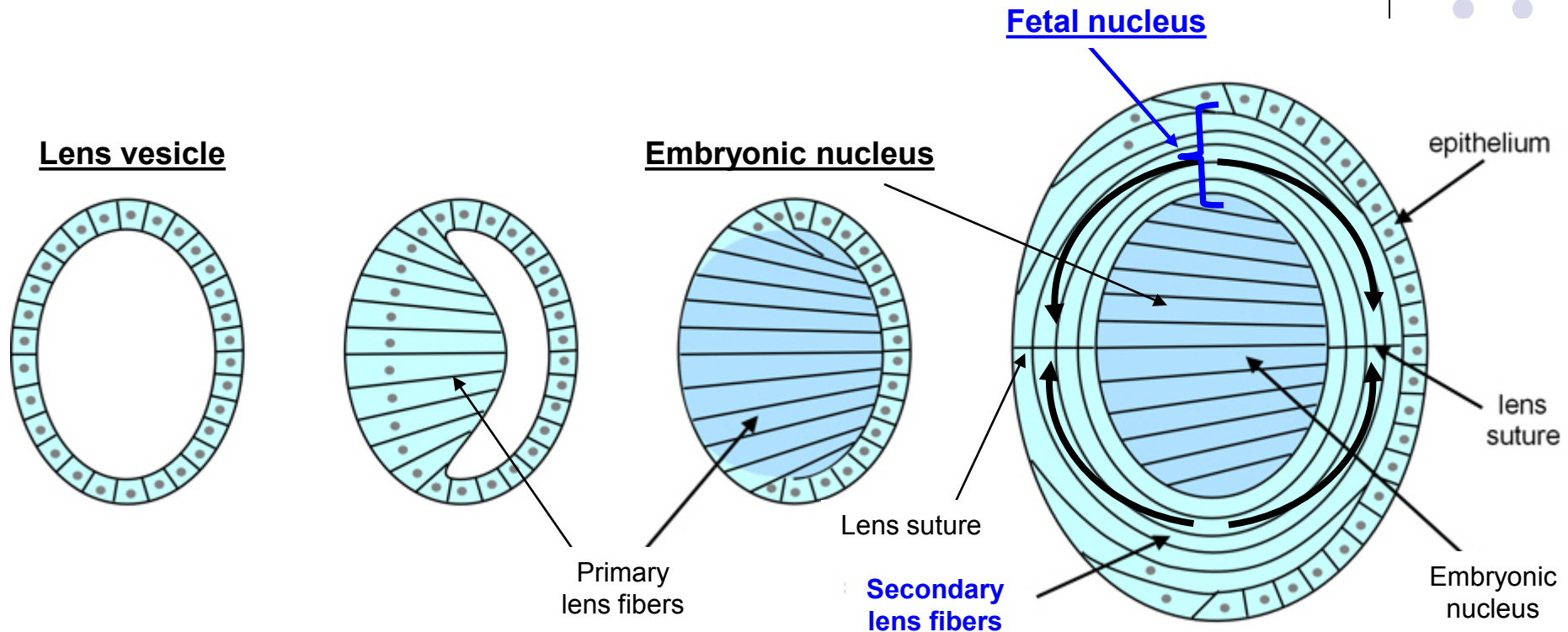
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To be clear: The fetal nucleus is **not** this entire structure; rather, it is only the portion formed by the secondary lens fibers, as indicated by the { .



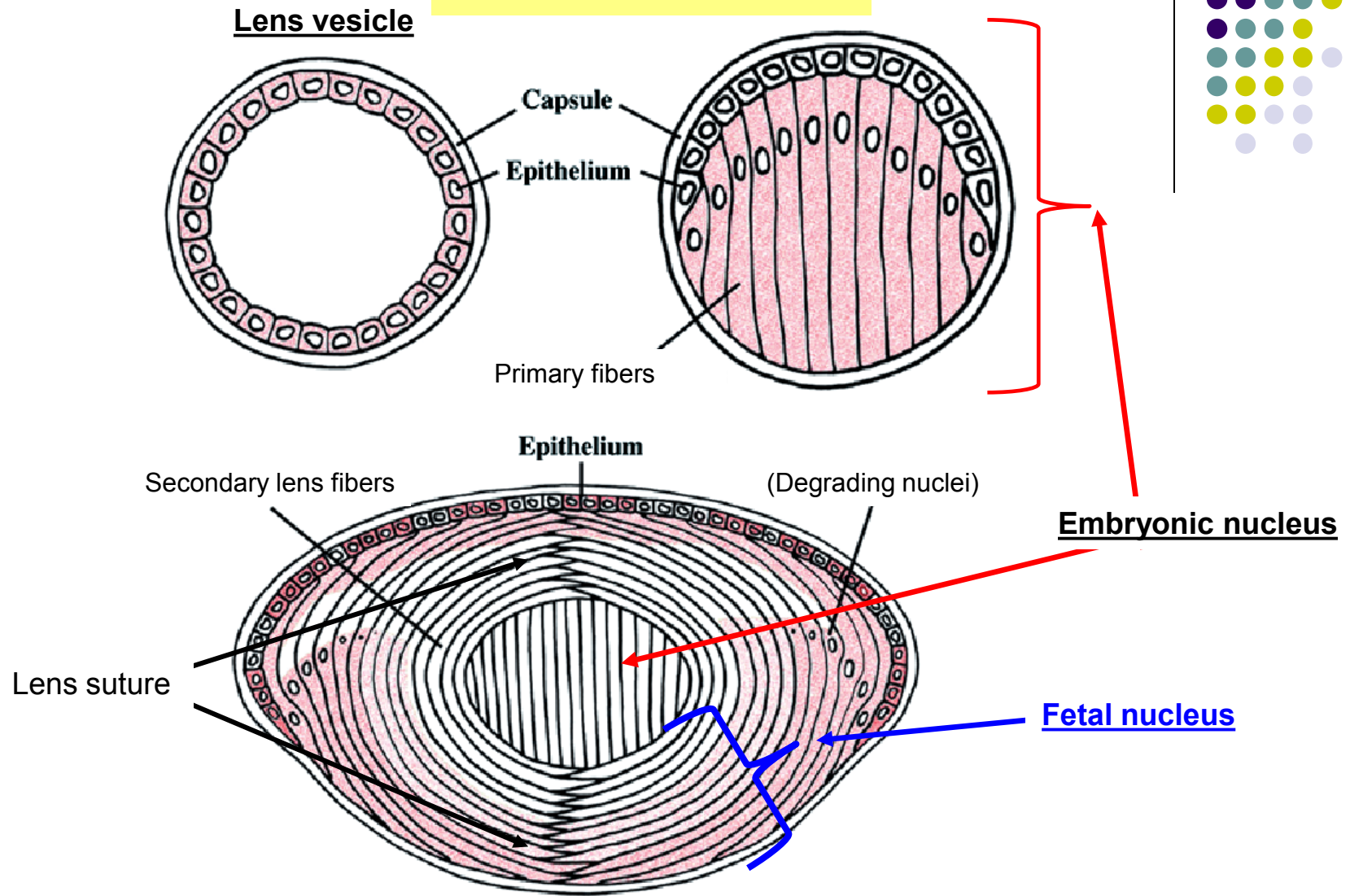
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To be clear: The fetal nucleus is **not** this entire structure; rather, it is only the portion formed by the secondary lens fibers, as indicated by the { . Put another way: The fetal nucleus *surrounds* the embryonic nucleus.



As we've seen, the **embryonic nucleus** is formed when the elongating posterior (aka *primary*) lens fibers obliterate the vesicle. The **fetal nucleus** is formed by the equatorial epithelial cells as they elongate both anteriorly (insinuating themselves between the anterior epithelial cells and the primary lens fibers of the embryonic nucleus) and posteriorly (insinuating themselves between the origins of the primary lens fibers and the underlying capsule). When these elongating fibers run into each other at the anterior and posterior poles, they interdigitate to form lens sutures. (We will have more to say about these shortly.)

Lens/Cataracts Overview



Another illustration making the same set of points



Q

Lens/Cataracts Overview

- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*
- T/F: The ^{lens}~~optic~~ vesicle is the primordial structure that becomes the lens. It consists of a single layer of cuboidal cells encased within their basement membrane **F**
- T/F: The ^{posterior}~~anterior~~ cells of the lens vesicle elongate and progressively obliterate the lumen, forming the embryonic nucleus **F**
- The anterior cells become the *lens epithelium*
- The equatorial epi cells become fibers that elongate both anteriorly and posteriorly, thereby forming the *fetal nucleus*
- The two words (sort of) are formed by the anterior and posterior interdigitations of fetal nucleus fibers

A

Lens/Cataracts Overview



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- The equatorial epi cells become fibers that elongate both anteriorly and posteriorly, thereby forming the *fetal nucleus*
- The *Y sutures* are formed by the anterior and posterior interdigitations of fetal nucleus fibers



Q

Lens/Cataracts Overview

- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*
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- The anterior cells (Here begins the 'more to say about the lens sutures' alluded to previously.)
- The equatorial cells (Why are they called the 'Y sutures'?)
- The **Y sutures** (interdigitations)



A

Lens/Cataracts Overview

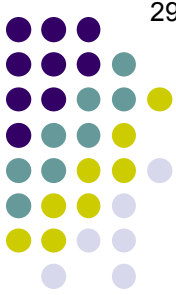
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- The anterior cells *Why are they called the 'Y sutures'?*
- The equatorial cells *Because they look like the letter Y*
- The **Y sutures** interdigitations



Q

Lens/Cataracts Overview

- Which embryologic cell line gives rise to all of the components of the lens? *Surface ectoderm*
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- The equatorial cells
- The posterior cells
- The **Y sutures** (Why are they called the 'Y sutures'? Because they look like the letter Y. How many Y sutures are there?)
- The zonular interdigitations



A

Lens/Cataracts Overview

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Because they look like the letter Y
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Just the two—one anterior, one posterior
- The **Y sutures** interdigitations



Q

Lens/Cataracts Overview

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- The **Y sutures** *How are they oriented?*
interdigitations

Q/A

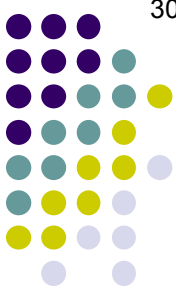
Lens/Cataracts Overview



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(Here begins the 'more to say about the lens sutures' alluded to previously.)

 - The anterior cells
 - The equatorial cells
 - The **Y sutures**
 - Why are they called the 'Y sutures'?*
Because they look like the letter Y
 - How many Y sutures are there?*
Just the two—one anterior, one posterior
 - How are they oriented?*
The ^{anterior vs posterior}one is right-side up; the ^{anterior vs posterior}one, upside down

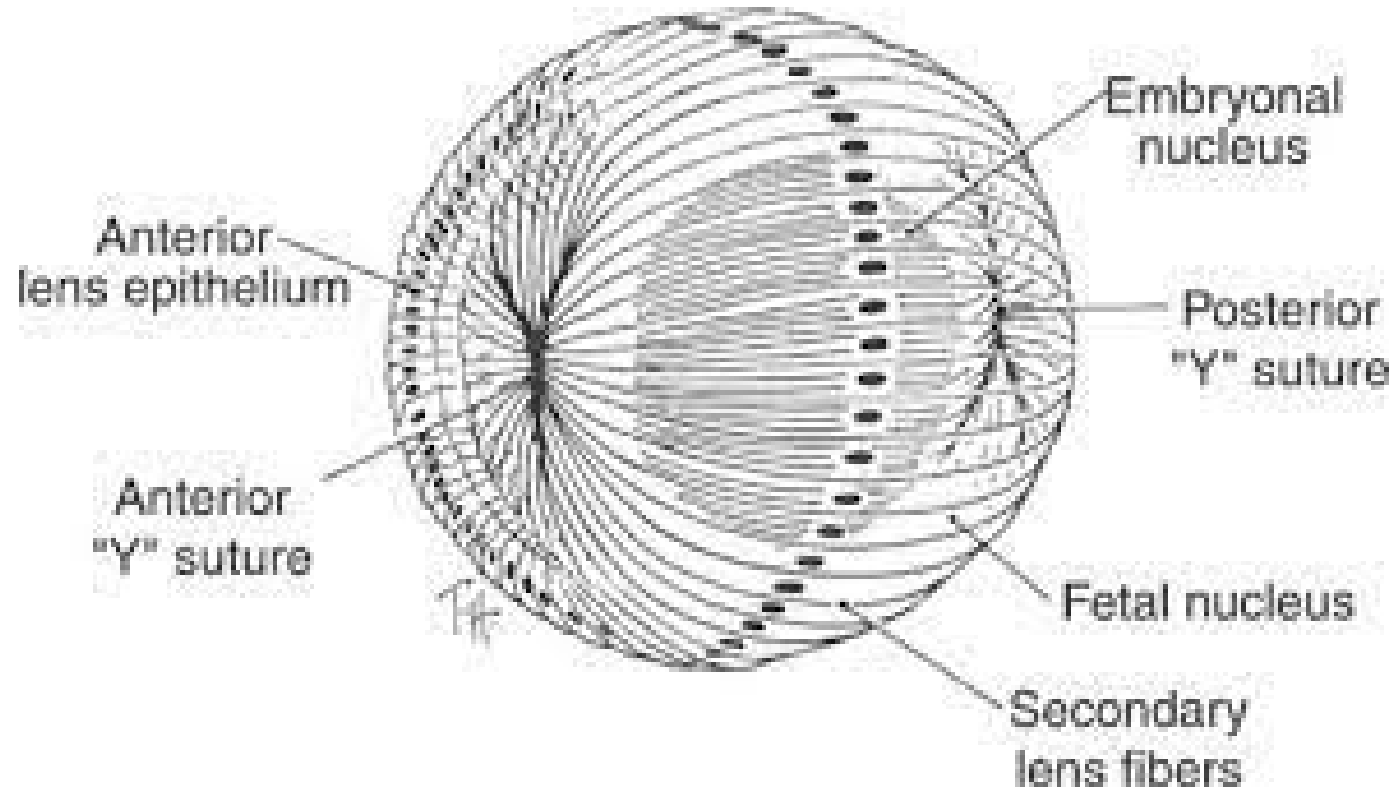
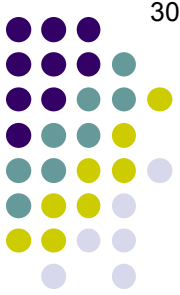


A

Lens/Cataracts Overview

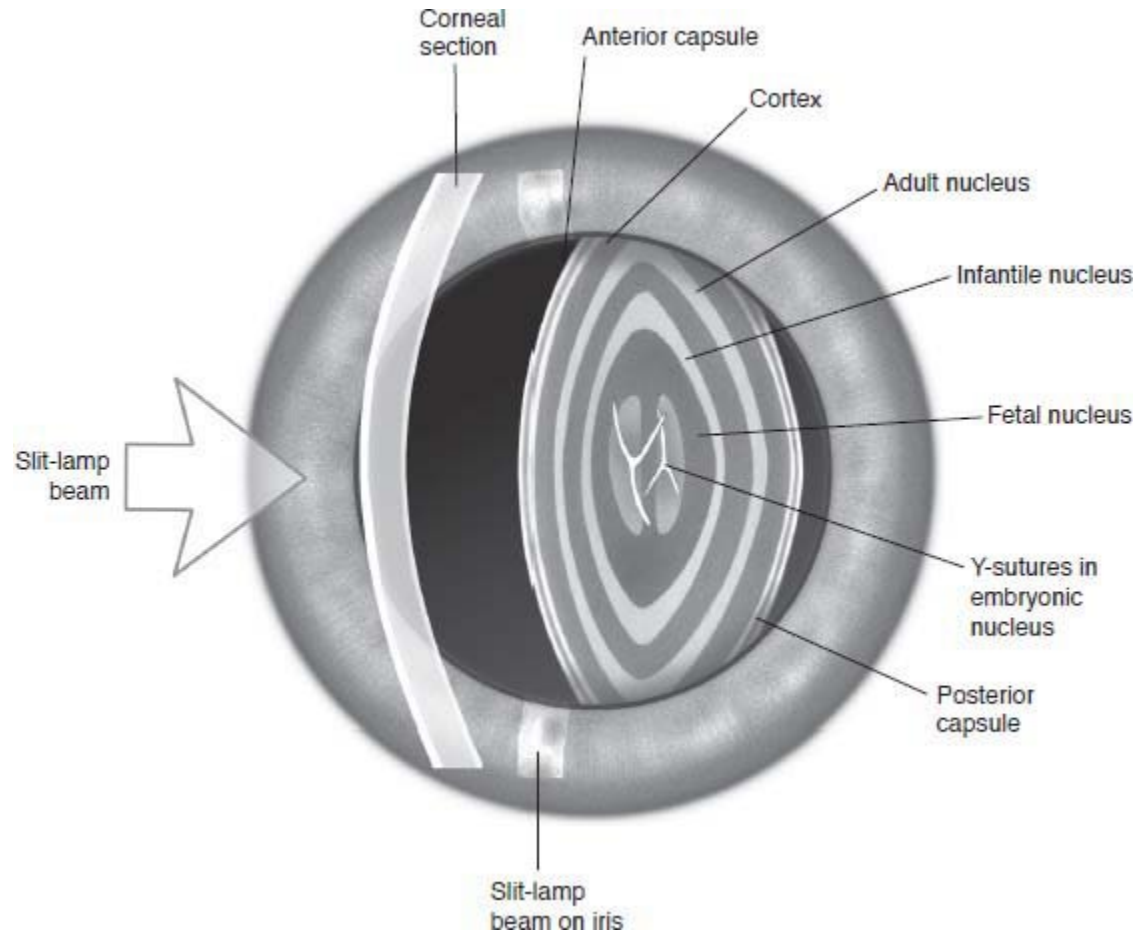
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Just the two—one anterior, one posterior
- The **Y sutures** *How are they oriented?*
The anterior one is right-side up; the posterior one, upside down
- The interdigitations

Lens/Cataracts Overview



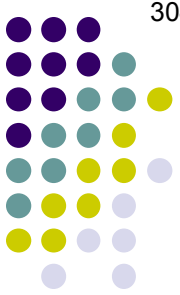
Lens: Y suture formation

Lens/Cataracts Overview



Y sutures as they might be seen at the slit lamp

Lens/Cataracts Overview



The *lens* originates as a thickening of surface ectoderm overlying the *optic* (not lens!) *vesicle*, an outpouching of the primitive forebrain destined to become the neurosensory retina, RPE, and ciliary body epithelium (among other things). This thickened area of surface ectoderm is called the *lens placode*. The placode subsequently invaginates (at the *lens pit*), eventually forming a fluid-filled sphere containing a single layer of cells; this sphere is the *lens* (not optic!) *vesicle*. The outer wall of the lens vesicle consists of the basement membrane of the surface ectoderm cells that line the *inner* aspect of the vesicle; this BM will form the *lens capsule*. The cells at the posterior aspect of the vesicle elongate to obliterate the vesicle's lumen and transform into the *primary lens fibers* that comprise the *embryonic nucleus*. Soon thereafter, equatorial epithelial cells elongate both anteriorly and posteriorly; as they encounter one another at the anterior and posterior poles, they interdigitate in a manner that creates the *Y sutures*. These *secondary lens fibers* comprise the *fetal nucleus*.

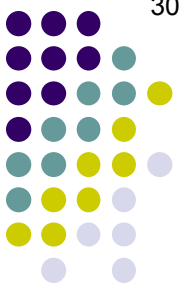
Lens/Cataracts Overview



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Now let's look at the fetal vasculature of the lens

The cells at the posterior aspect of the vesicle elongate to obliterate the vesicle's lumen and transform into the *primary lens fibers* that comprise the *embryonic nucleus*. Soon thereafter, equatorial epithelial cells elongate both anteriorly and posteriorly; as they encounter one another at the anterior and posterior poles, they interdigitate in a manner that creates the *Y sutures*. These *secondary lens fibers* comprise the *fetal nucleus*.



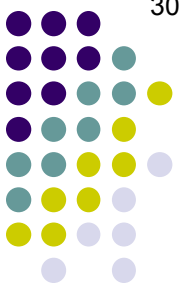
Q

Lens/Cataracts Overview

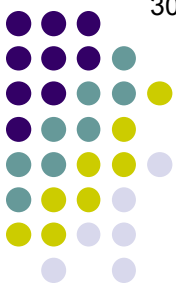
- The vascular supply encapsulating the developing lens is called the something something something

A

Lens/Cataracts Overview



- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**



Q

Lens/Cataracts Overview

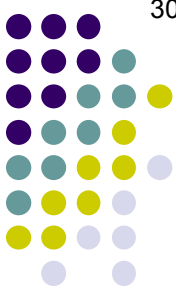
- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

It has three sections:

1) ?

2) ?

3) ?



A

Lens/Cataracts Overview

- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

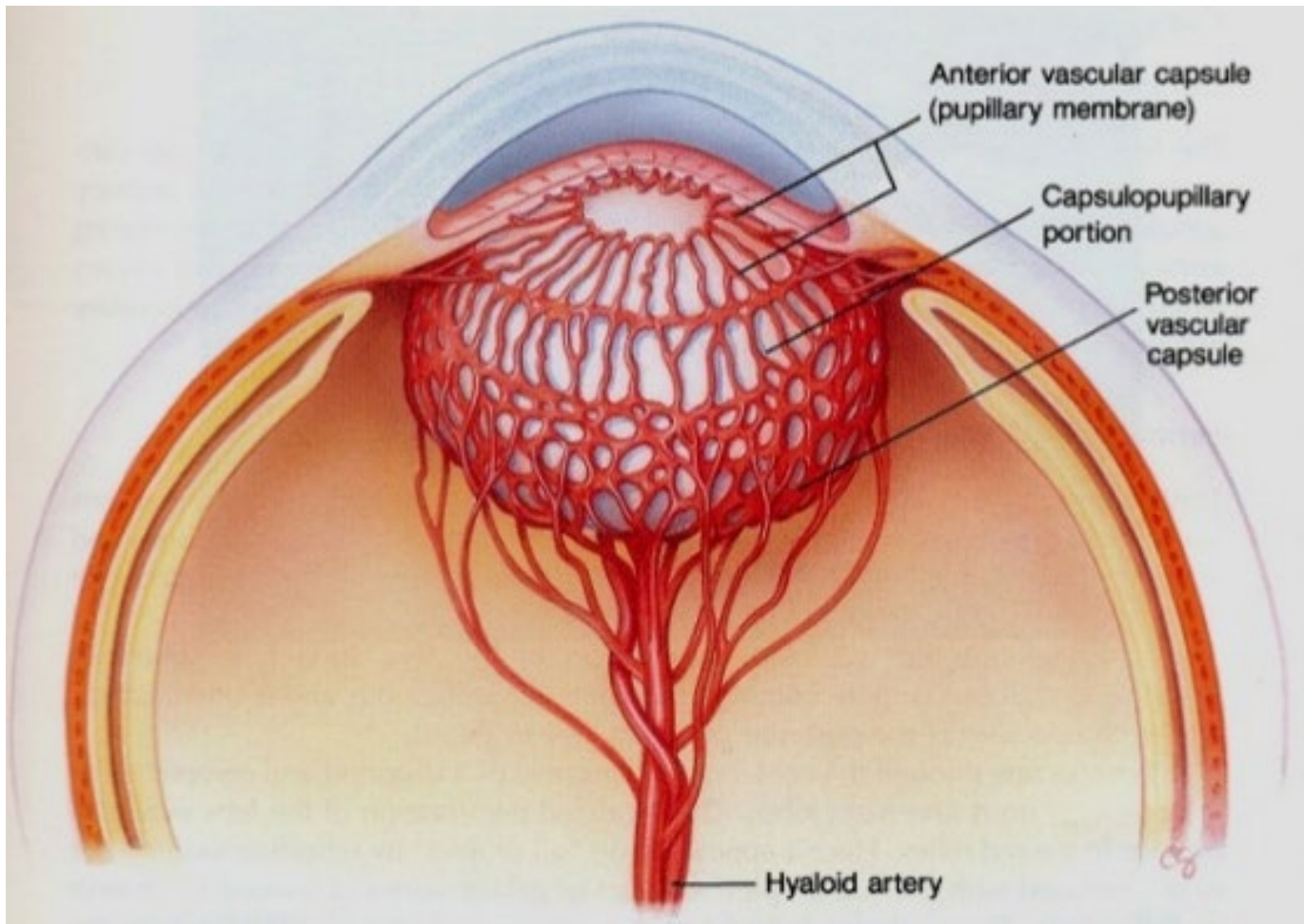
It has three sections:

1) The *posterior vascular capsule*

2) The *anterior vascular capsule*

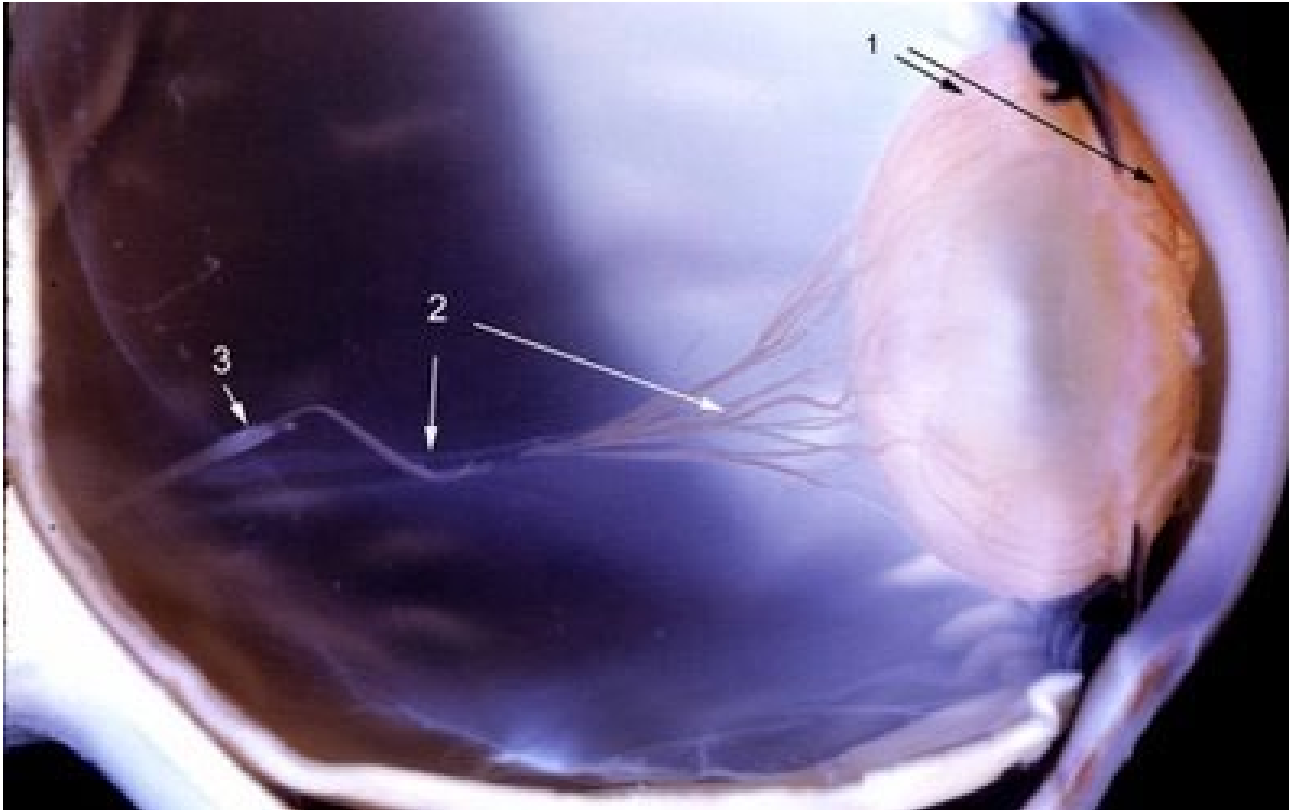
3) The *capsulopupillary portion*

Lens/Cataracts Overview



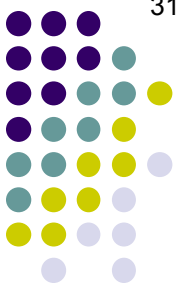
Tunica vasculosa lentis

Lens/Cataracts Overview



In the eye of this very premature infant, the **tunica vasculosa lentis** surrounds the lens (arrows 1).

(We'll get to Arrows 2 and 3 shortly)



Q

Lens/Cataracts Overview

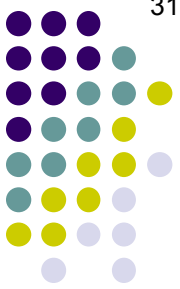
- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

It has three sections:

1) The *posterior vascular capsule* arises from the artery

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



Q

Lens/Cataracts Overview

- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

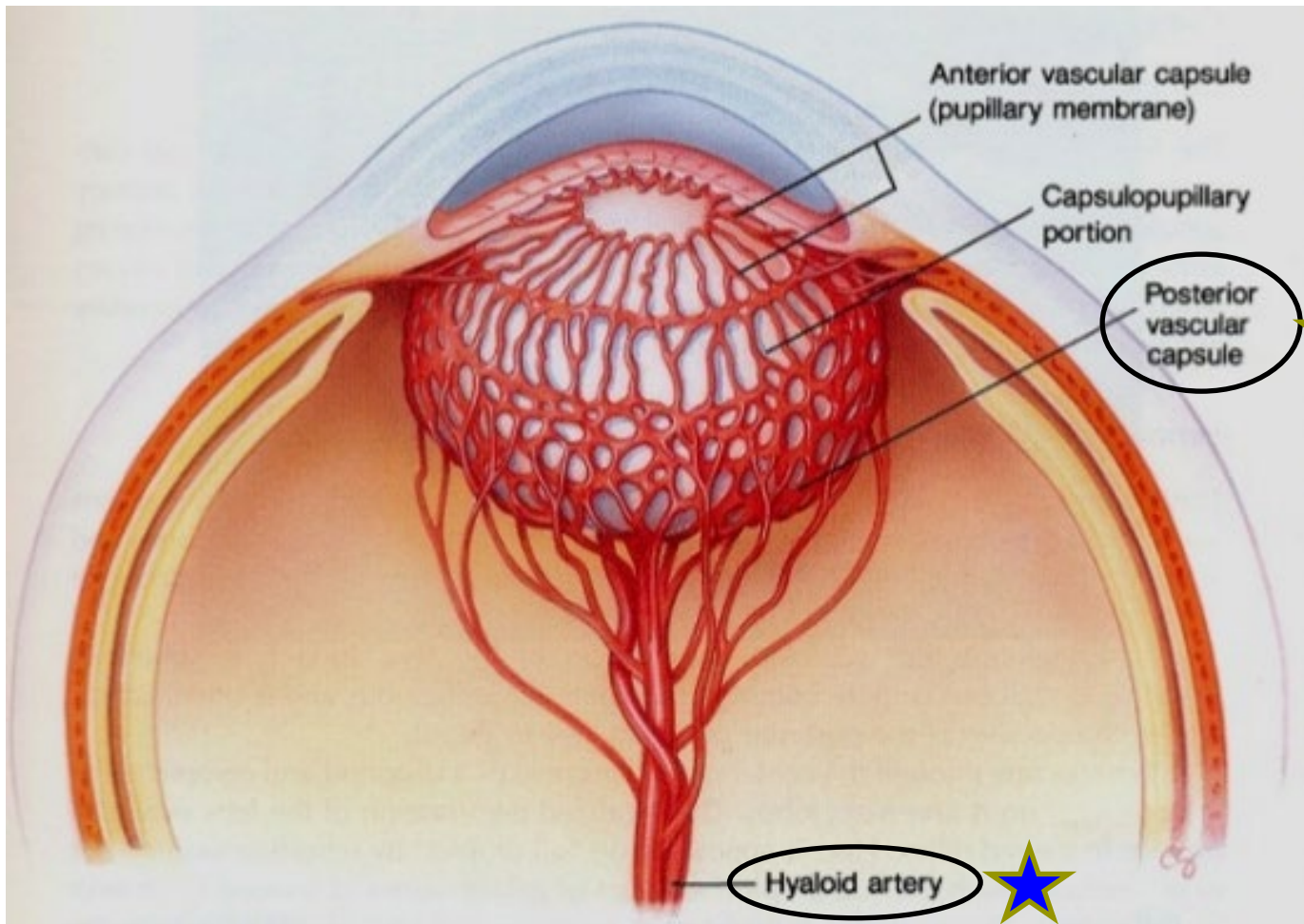
It has three sections:

1) The *posterior vascular capsule* arises from the **hyaloid** artery

2) The *anterior vascular capsule*

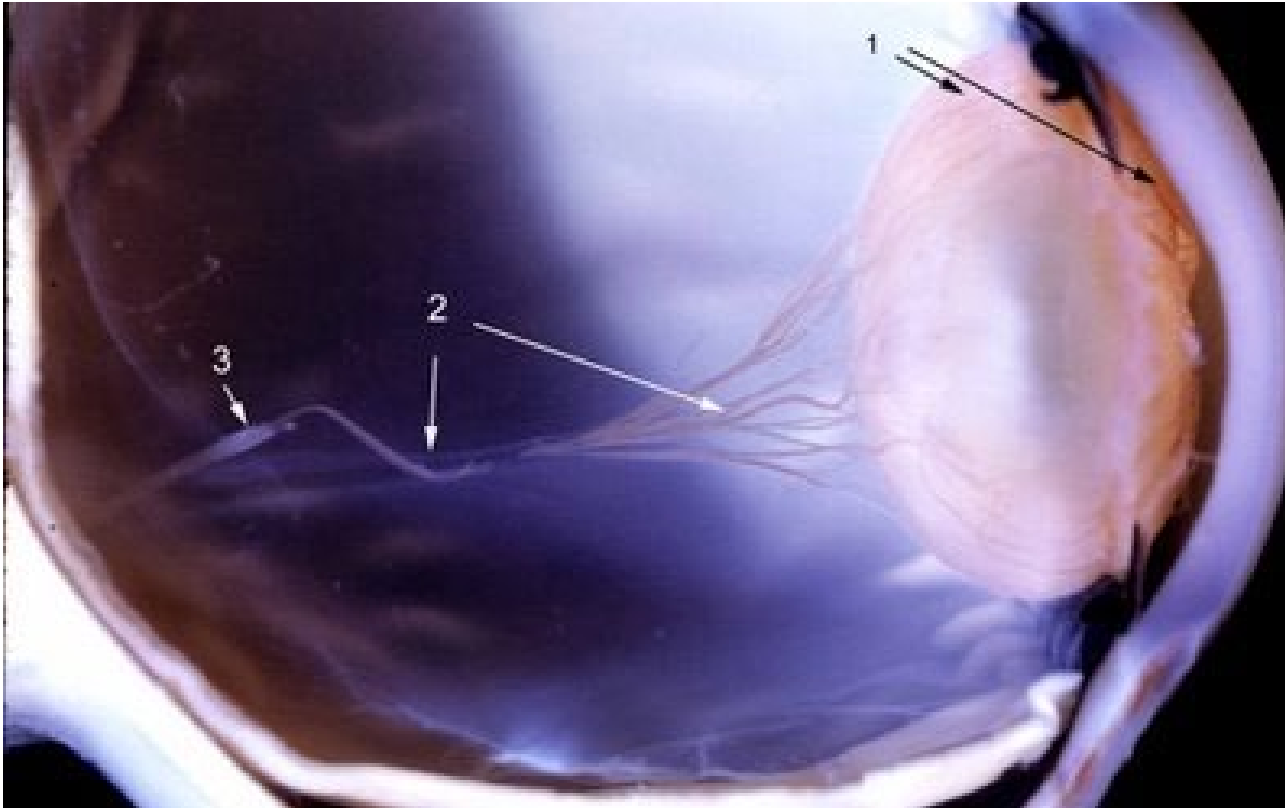
3) The *capsulopupillary portion*

Lens/Cataracts Overview

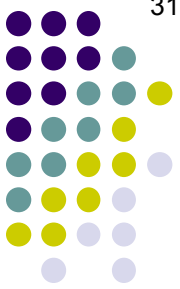


Tunica vasculosa lentis: Posterior vascular capsule

Lens/Cataracts Overview



In the eye of this very premature infant, the **tunica vasculosa lentis** surrounds the lens (arrows 1). It is contiguous with the hyaloid artery and its branches (arrow 2).



Q

Lens/Cataracts Overview

- The vascular supply encapsulating the developing lens.

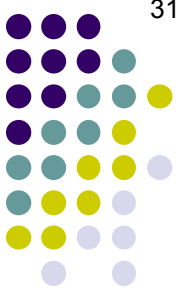
The hyaloid artery runs from where to where?

It

1) The **hyaloid** artery

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



A

Lens/Cataracts Overview

- The vascular supply encapsulating the developing

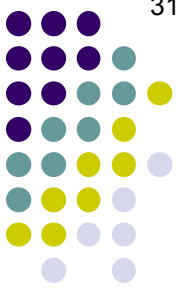
The hyaloid artery runs from where to where?

From the optic nerve head to the back of the fetal lens

1) The **hyaloid** artery

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



Q

Lens/Cataracts Overview

- The vascular supply encapsulating the developing

The hyaloid artery runs from where to where?

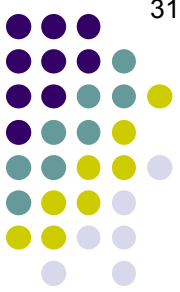
From the optic nerve head to the back of the fetal lens

- 1) *Does it survive into post-fetal life?*

the **hyaloid** artery

- 2) The *anterior vascular capsule*

- 3) The *capsulopupillary portion*



A

Lens/Cataracts Overview

- The vascular supply encapsulating the developing

The hyaloid artery runs from where to where?

From the optic nerve head to the back of the fetal lens

- 1) *Does it survive into post-fetal life?*

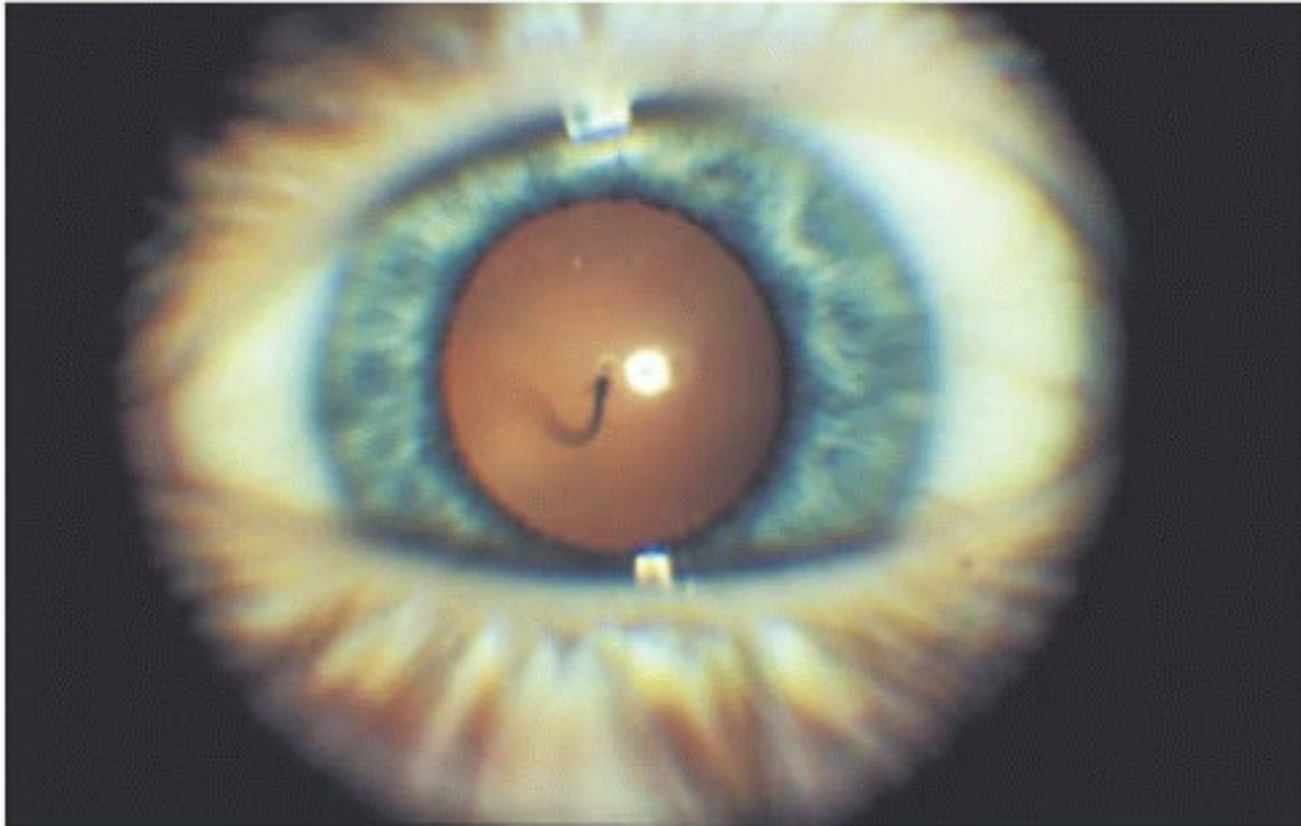
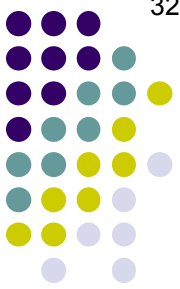
It is supposed to regress prior to birth (but doesn't always, as we are about to see)

the **hyaloid** artery

- 2) The *anterior vascular capsule*

- 3) The *capsulopupillary portion*

Lens/Cataracts Overview



Single loop of a persistent hyaloid artery extending anteriorly within [Cloquet's canal](#) to insert on the posterior capsule of the lens.



Q

Lens/Cataracts Overview

- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

It has three sections:

1) The *posterior vascular capsule* arises from the **hyaloid** artery

- A common, clinically insignificant remnant is the two words

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



A

Lens/Cataracts Overview

- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

It has three sections:

- 1) The *posterior vascular capsule* arises from the **hyaloid** artery
 - A common, clinically insignificant remnant is the **Mittendorf dot**

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



Q

Lens/Cataracts Overview

- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

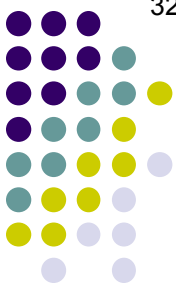
It has three sections:

- 1) The *posterior vascular capsule* arises from the **hyaloid** artery
 - A common, clinically insignificant remnant is the **Mittendorf dot**

(**two words** works
too—more about it shortly)

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



A

Lens/Cataracts Overview

- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

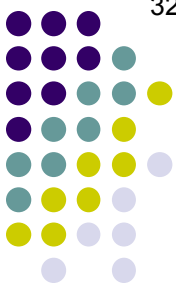
It has three sections:

- 1) The *posterior vascular capsule* arises from the **hyaloid** artery
 - A common, clinically insignificant remnant is the **Mittendorf dot**

(*Bergmeister papillae* works too—more about it shortly)

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



Q

Lens/Cataracts Overview

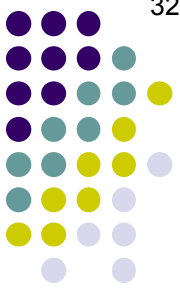
- The vascular supply encapsulating the developing lens is called the **tunica vasculosa lentis**.

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How does a Mittendorf dot present clinically? is the **Mittendorf dot**

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A

Lens/Cataracts Overview

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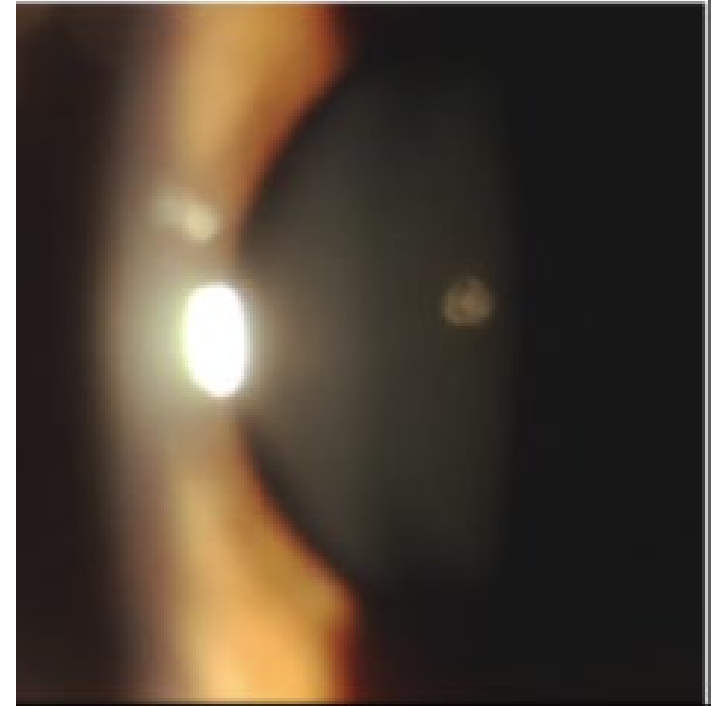
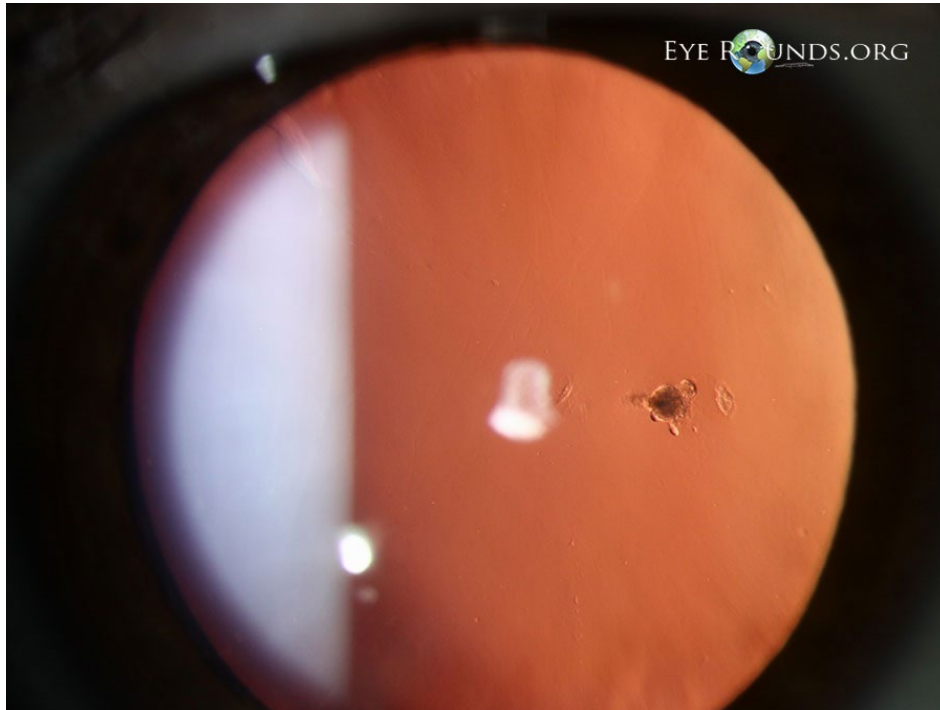
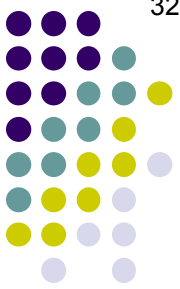
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How does a Mittendorf dot present clinically?
As a small white dot on the posterior capsule of the lens is the **Mittendorf dot**

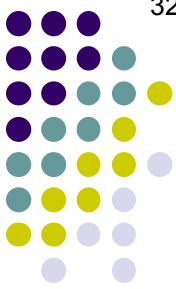
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Lens/Cataracts Overview



Mittendorf dot



Q

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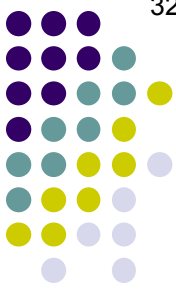
- How does a **Bergmeister papilla** present clinically?

It is the **Mittendorf dot**

Bergmeister papilla

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



Q/A

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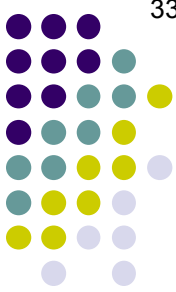
As a tuft of glial-like tissue extending veil-like from the **optic nerve head** vs **posterior capsule** a short distance into the vitreous

is the ~~Mittendorf dot~~

Bergmeister papilla

2) The *anterior vascular capsule*

3) The *capsulopupillary portion*



A

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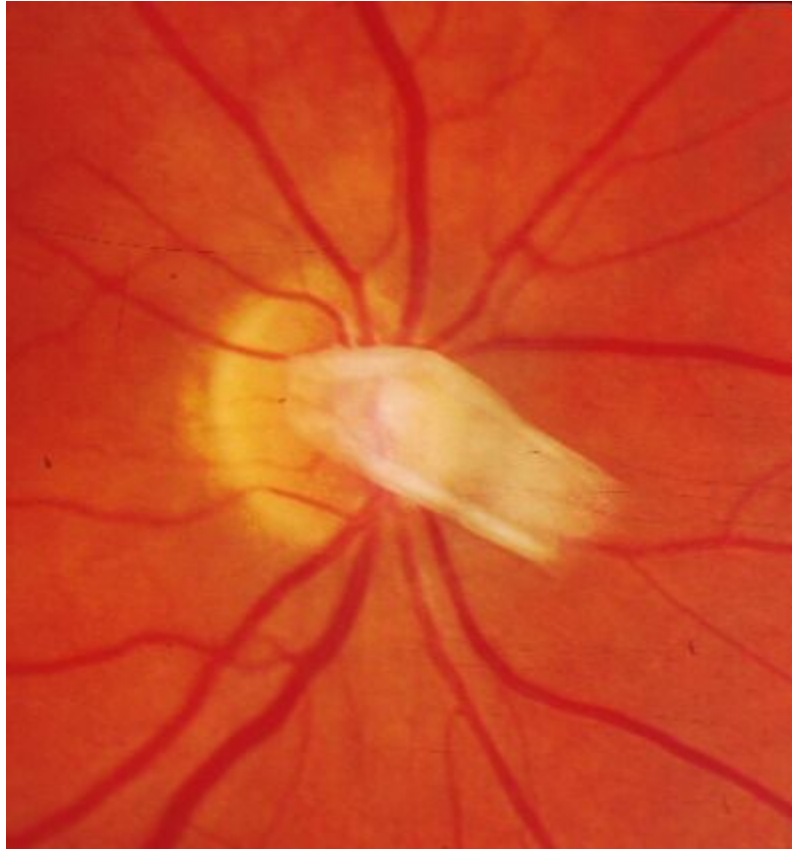
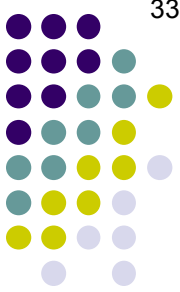
It is the ~~Mittendorf dot~~

Bergmeister papilla

2) The *anterior vascular capsule*

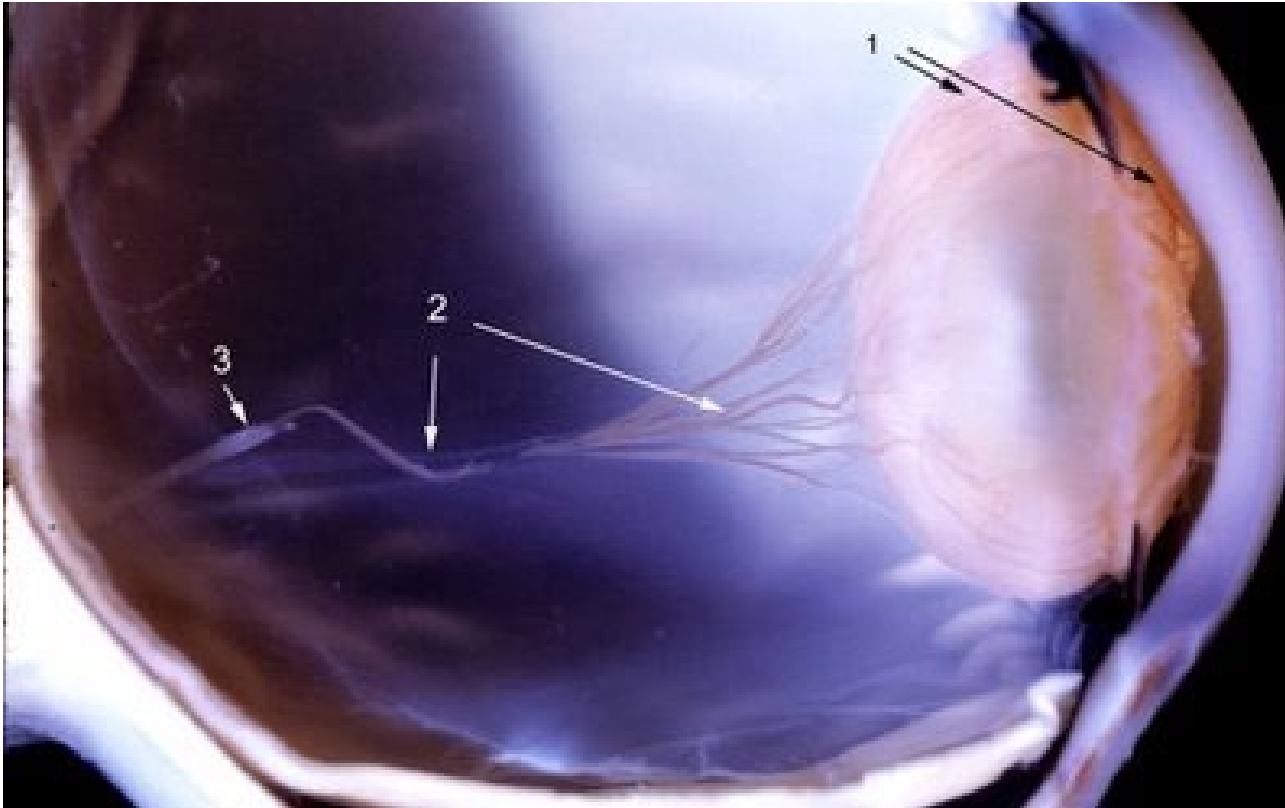
3) The *capsulopupillary portion*

Lens/Cataracts Overview

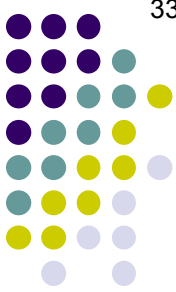


Bergmeister papillae

Lens/Cataracts Overview



In the eye of this very premature infant, the **tunica vasculosa lentis** surrounds the lens (arrows 1). It is contiguous with the hyaloid artery and its branches (arrow 2). Notice the glial sheath of the hyaloid artery (arrow 3).



Q

Lens/Cataracts Overview

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What does PFV stand for in this context?

3) The *capsulopupillary portion*



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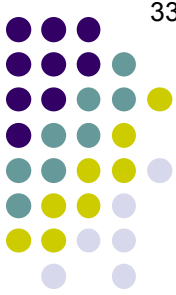
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Persistent fetal vasculature

3) The *capsulopupillary portion*



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By what name was this condition known previously?

- 3) The *capsulopupillary portion*



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Persistent hyperplastic primary vitreous (PHPV)

- 3) The *capsulopupillary portion*



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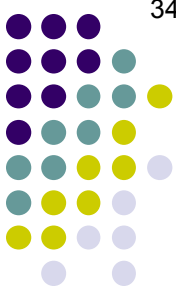
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In a nutshell, what is PFV?

3) The *capsulopupillary portion*



Q/A

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A **three words** that induces a variety of sight-threatening problems

- 3) The *capsulopupillary portion*



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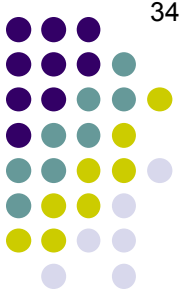
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In a nutshell, what is PFV?

A retrolental fibrovascular membrane that induces a variety of sight-threatening problems

3) The *capsulopupillary portion*

Lens/Cataracts Overview



PFV: Retrolental fibrovascular membrane



Q

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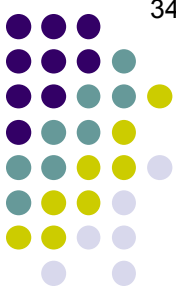
What are the sight-threatening manifestations of PFV?

--?

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- 3) The *capsulopupillary portion*



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In a nutshell, what is PFV?

A retrolental fibrovascular membrane that induces
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What are the sight-threatening manifestations of PFV?

- Cataract
- Progressive AC shallowing → closed-angle glaucoma
- Retinal detachment

- 3) The *capsulopupillary portion*



Q

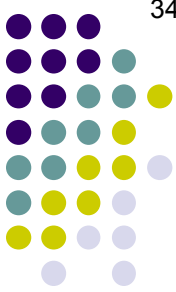
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A

Lens/Cataracts Overview

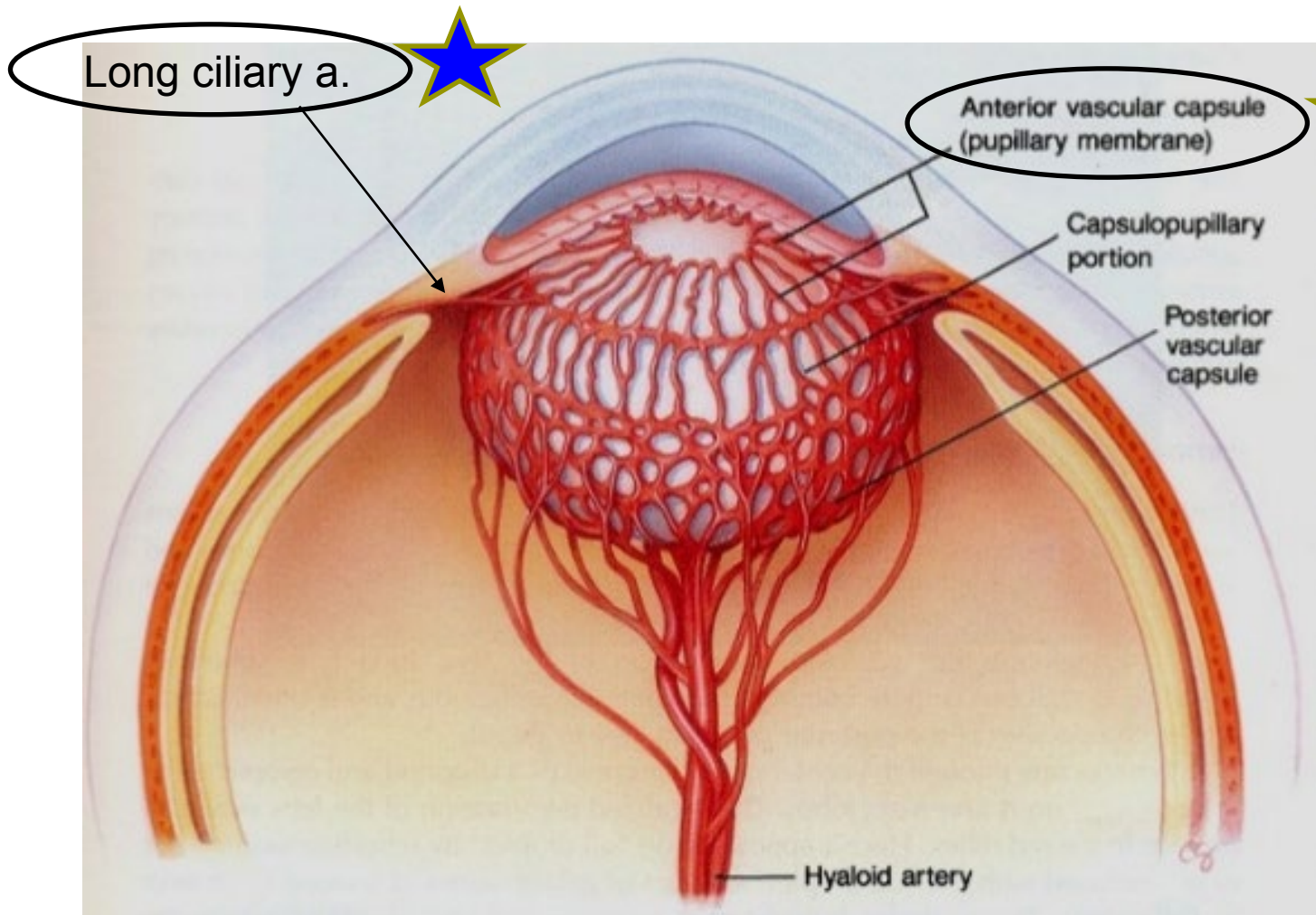
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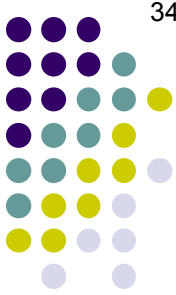
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3) The *capsulopupillary portion*

Lens/Cataracts Overview



Tunica vasculosa lentis: Anterior vascular capsule



Q

Lens/Cataracts Overview

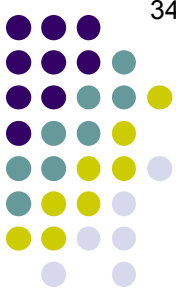
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three words

3) The *capsulopupillary portion*



A

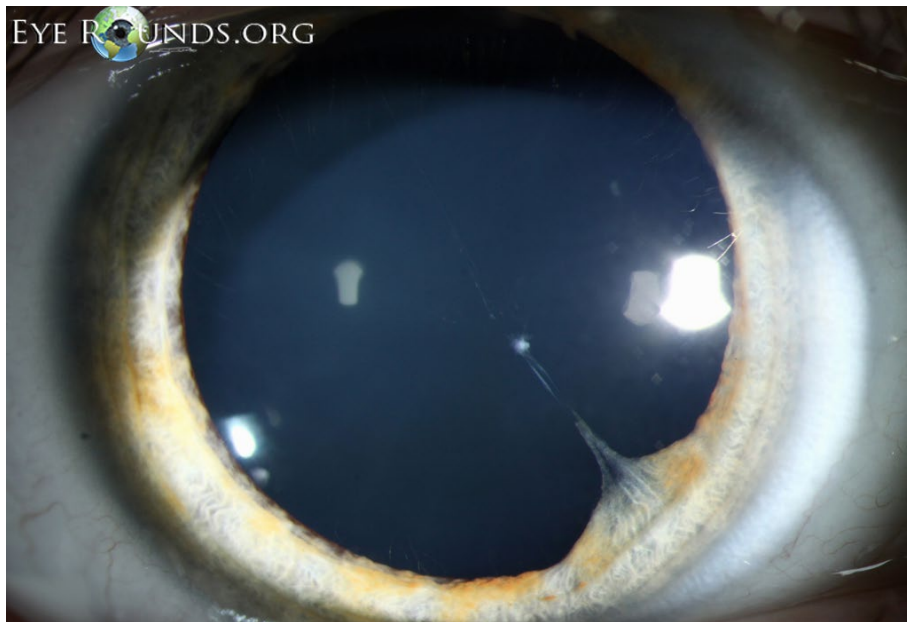
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Lens/Cataracts Overview

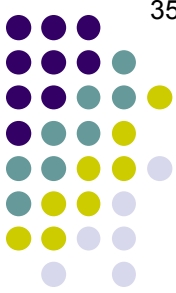


Trivial case



Hey now

Persistent pupillary membrane



Q

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- 3) The *capsulopupillary portion*



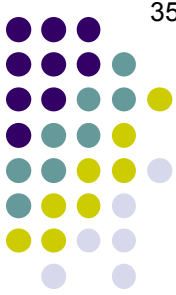
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A

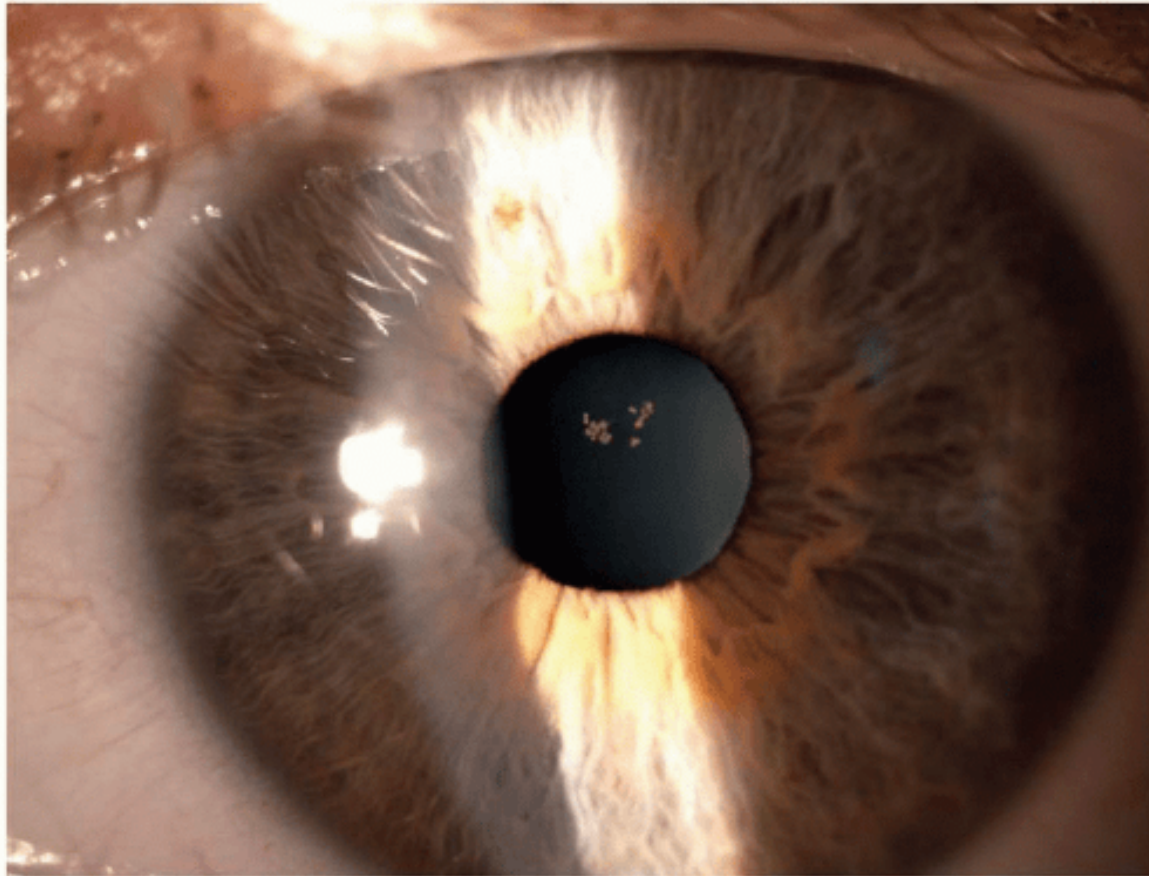
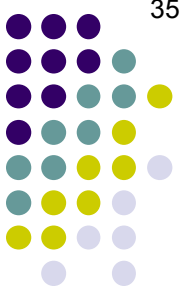
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Lens/Cataracts Overview



Epicapsular star



Q

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- 3) The *capsulopupillary portion* the anterior and posterior sections of the tunica



A

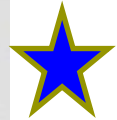
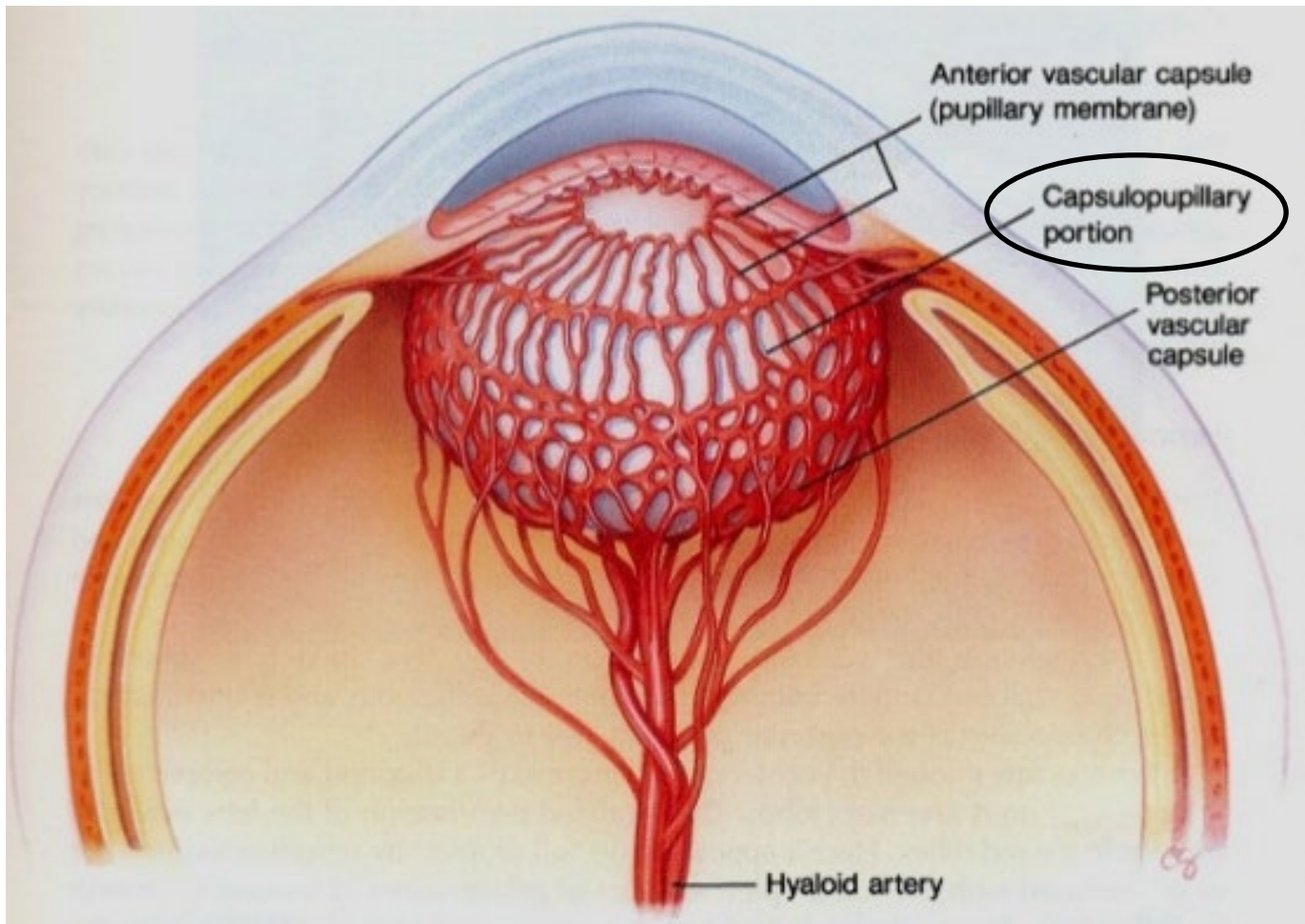
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- 3) The *capsulopupillary portion* **anastomoses** the anterior and posterior sections of the tunica

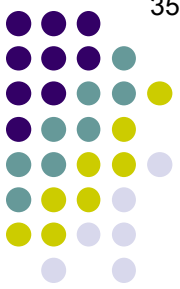
Lens/Cataracts Overview



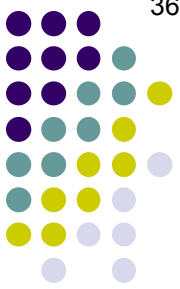
Tunica vasculosa lentis: Capsulopupillary portion

Q

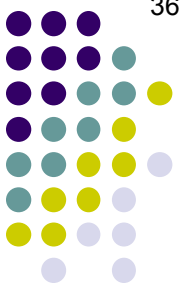
Lens/Cataracts Overview



- Zonules are secreted by the specific structure... near the end of the third month of gestation



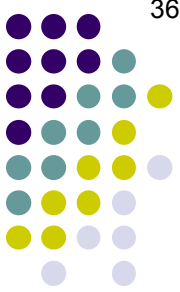
- Zonules are secreted by the ciliary ...and cell type near the end of the third month of gestation



- Zonules are secreted by the ciliary epithelium near the end of the third month of gestation

Q

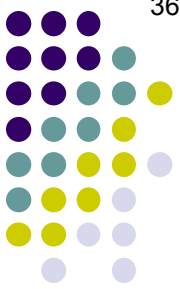
Lens/Cataracts Overview



- Zonules are secreted by the ciliary epithelium near the end of the third month of gestation
- Zonules comprise the so-called 1°? 2°? 3°? vitreous

A

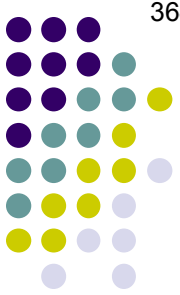
Lens/Cataracts Overview



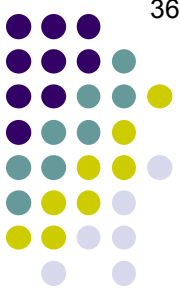
- Zonules are secreted by the ciliary epithelium near the end of the third month of gestation
- Zonules comprise the so-called tertiary vitreous

Q

Lens/Cataracts Overview



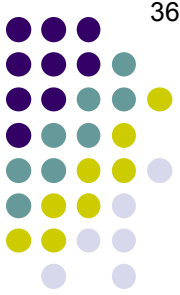
- Zonules are secreted by the ciliary epithelium near the end of the third month of gestation
- Zonules comprise the so-called tertiary vitreous
- This begs the question: *What are the primary and secondary vitreouses? (Vitrei?)*
 - *Primary vitreous:* The two words



- Zonules are secreted by the ciliary epithelium near the end of the third month of gestation
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 - Primary vitreous: The hyaloid vasculature

Q

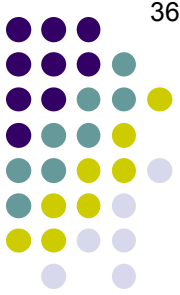
Lens/Cataracts Overview



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 - Primary vitreous: The hyaloid vasculature
 - Hence PFV is aka four words

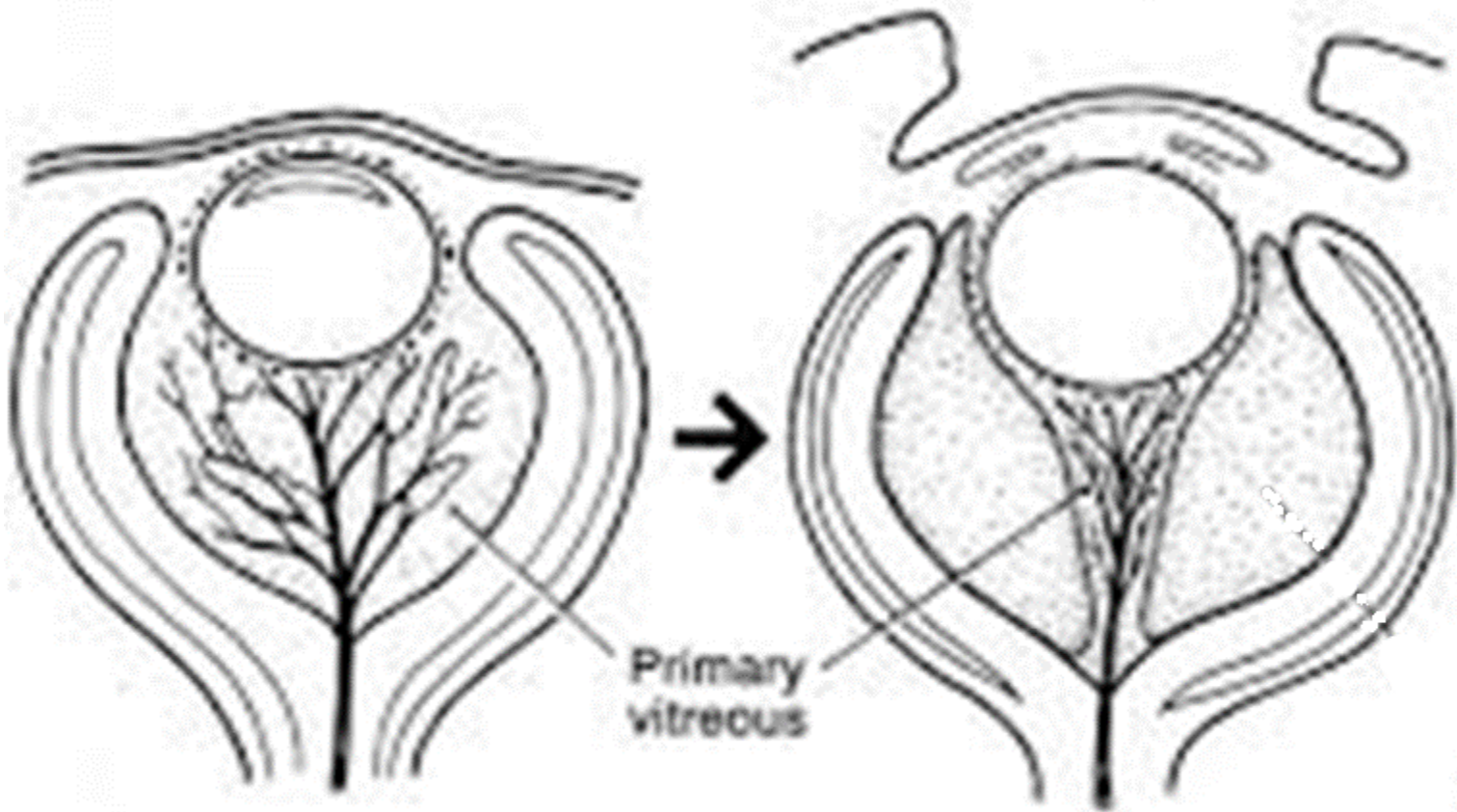
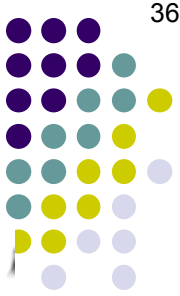
Q

Lens/Cataracts Overview



- Zonules are secreted by the **ciliary epithelium** near the end of the third month of gestation
- Zonules comprise the so-called **tertiary vitreous**
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 - *Primary vitreous*: The **hyaloid vasculature**
 - Hence PFV is aka **persistent hyperplastic primary vitreous**

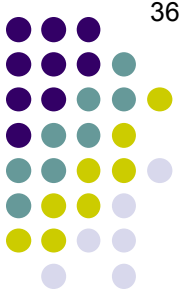
Lens/Cataracts Overview



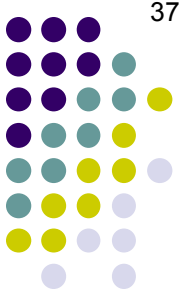
Primary vitreous

Q

Lens/Cataracts Overview

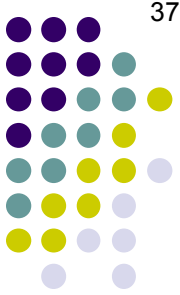


- Zonules are secreted by the **ciliary epithelium** near the end of the third month of gestation
- Zonules comprise the so-called **tertiary vitreous**
- This begs the question: *What are the primary and secondary vitreouses? (Vitrei?)*
 - *Primary vitreous*: The **hyaloid vasculature**
 - Hence PFV is aka **persistent hyperplastic primary vitreous**
 - *Secondary vitreous*: The

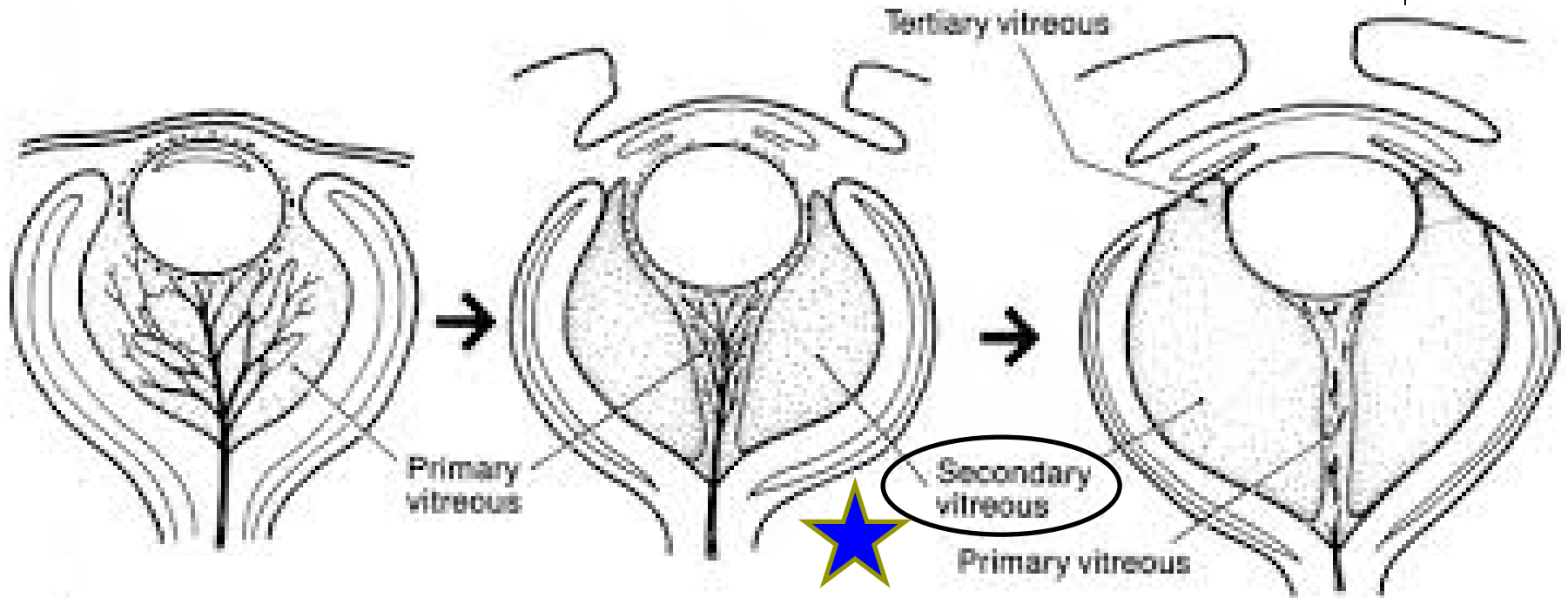


- Zonules are secreted by the ciliary epithelium near the end of the third month of gestation
- Zonules comprise the so-called tertiary vitreous
- This begs the question: *What are the primary and secondary vitreouses? (Vitrei?)*
 - Primary vitreous: The hyaloid vasculature
 - Hence PFV is aka persistent hyperplastic primary vitreous
 - Secondary vitreous: The main vitreous body

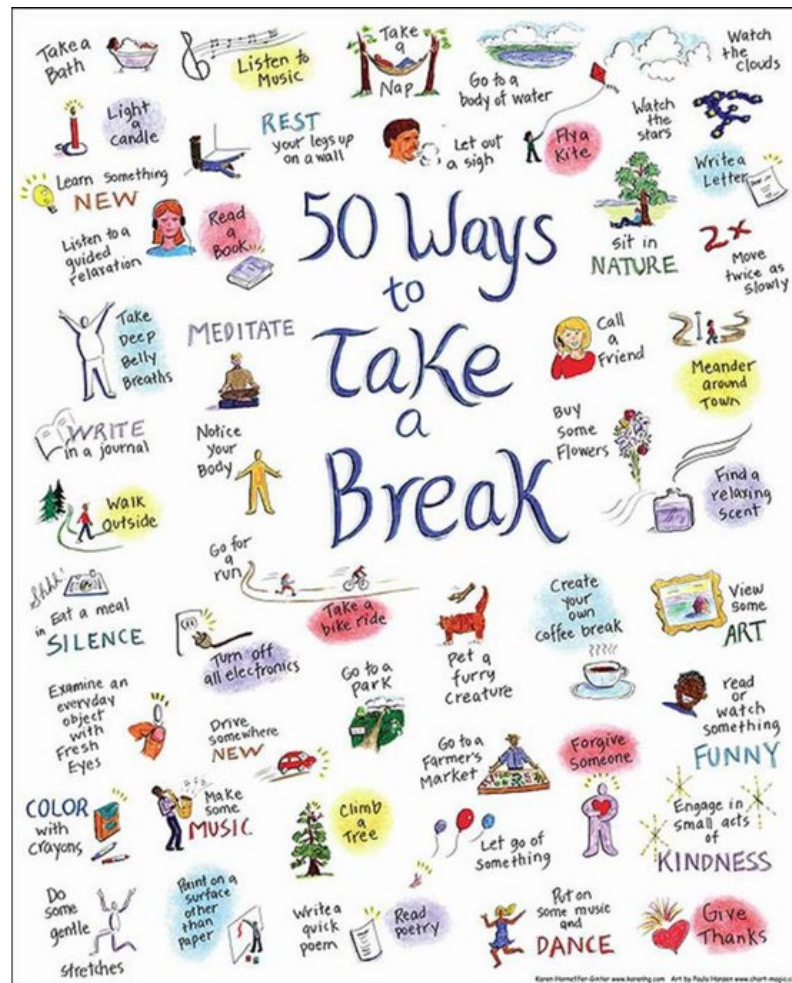
Lens/Cataracts Overview



(Tertiary vitreous will form the zonules)

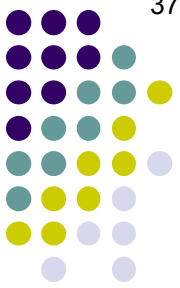


Secondary vitreous



(This is a good point in the set to take a break)

Lens/Cataracts Overview

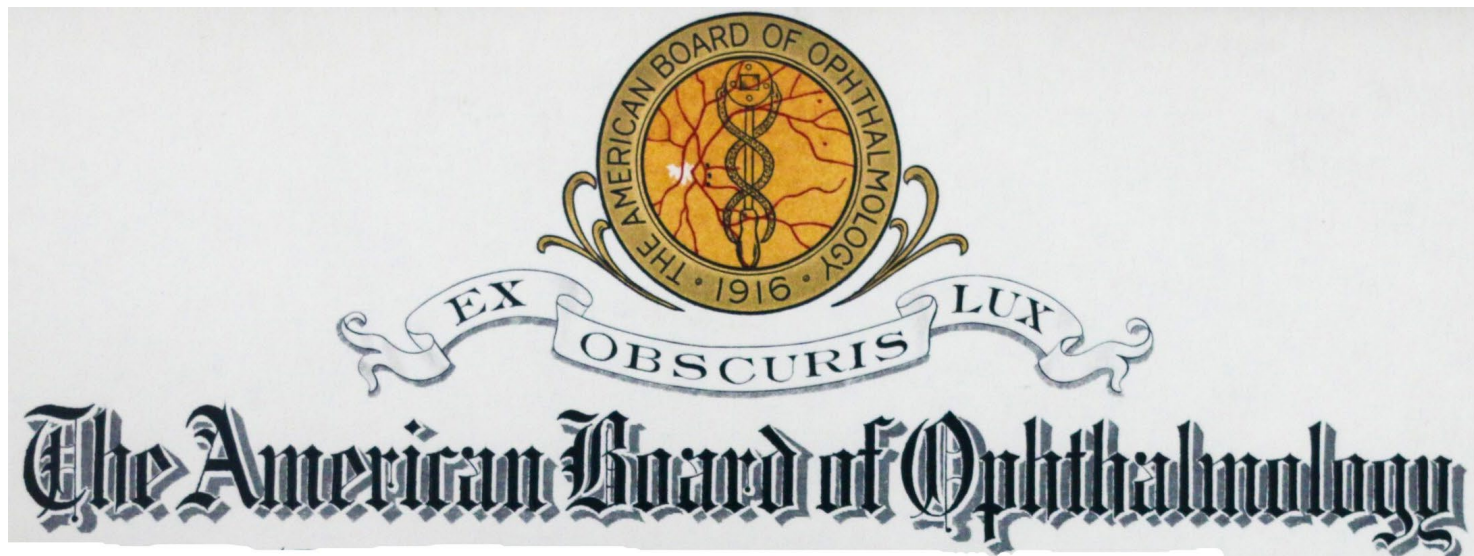


At long last we're ready to address the *cataract* portion of our lens/cataract overview. Obviously, cataracts and their extraction are central to the practice of ophthalmology.

Lens/Cataracts Overview

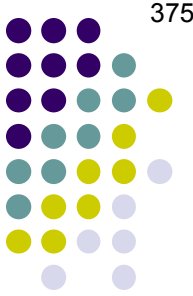


At long last we're ready to address the *cataract* portion of our lens/cataract overview. Obviously, cataracts and their extraction are central to the practice of ophthalmology. In fact, CE is so central to ophthalmology that the motto of the American Board of Ophthalmology, *Ex obscuris lux*, is Latin for 'No one dies with a natural lens.'



Q

Lens/Cataracts Overview

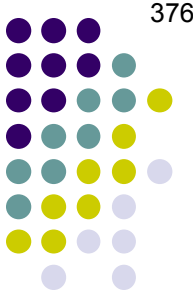


375

Where does cataracts rank as a cause of blindness worldwide?

A

Lens/Cataracts Overview

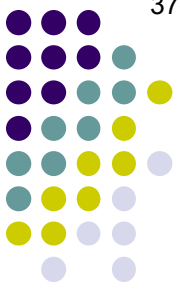


376

Where does cataracts rank as a cause of blindness worldwide?
It is #1



Lens/Cataracts Overview



Where does cataracts rank as a cause of blindness worldwide?

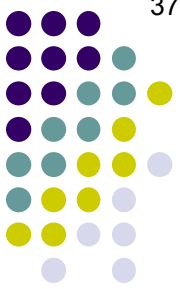
It is #1

What proportion of worldwide blindness does cataracts account for?

A

Lens/Cataracts Overview

378



Where does cataracts rank as a cause of blindness worldwide?

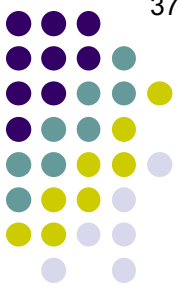
It is #1

What proportion of worldwide blindness does cataracts account for?

An astonishing 1/2!



Lens/Cataracts Overview



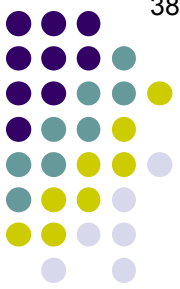
Where does cataracts rank as a cause of blindness worldwide?

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What proportion of the world's population has some degree of visual impairment 2ndry to cataracts?



Where does cataracts rank as a cause of blindness worldwide?

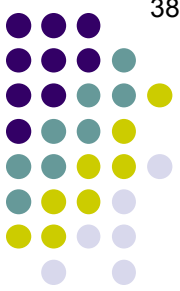
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What proportion of worldwide blindness does cataracts account for?

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What proportion of the world's population has some degree of visual impairment 2ndry to cataracts?

A third



Where does cataracts rank as a cause of blindness worldwide?

It is #1

What proportion of worldwide blindness does cataracts account for?

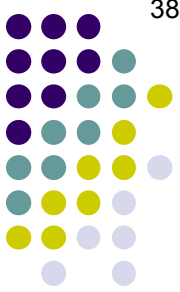
An astonishing 1/2!

What proportion of the world's population has some degree of visual impairment 2ndry to cataracts?

A third. To be clear: The assertion here is not that a third of visual impairment cases are due to cataracts; rather, it's that *a full one-third of the world's population has some degree of visual impairment owing to cataracts!*



Lens/Cataracts Overview



Where does cataracts rank as a cause of blindness worldwide?

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Is it safe to assume that cataracts are the #1 cause of visual impairment worldwide?



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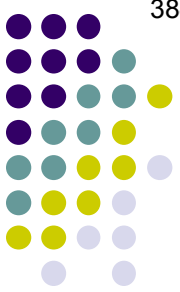
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You'd think so, but no—it ranks second behind

two words



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What proportion of the world's population has some degree of visual impairment 2ndry to cataracts?

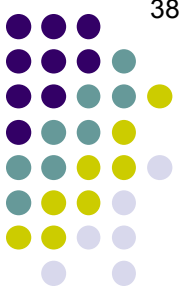
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Is it safe to assume that cataracts are the #1 cause of visual impairment worldwide?

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Q

Lens/Cataracts Overview



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How many cataract surgeries are performed worldwide on a yearly basis?



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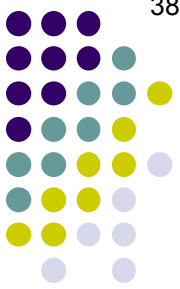
How many cataract surgeries are performed worldwide on a yearly basis?

10 million (and we're still falling behind)

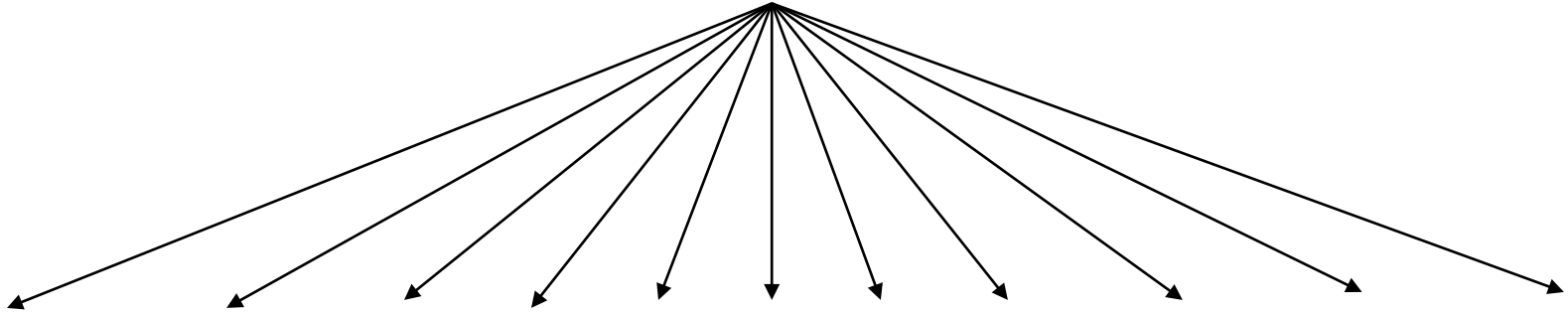
Q

Lens/Cataracts Overview

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Per the Lens book, how many categories of cataracts are there?



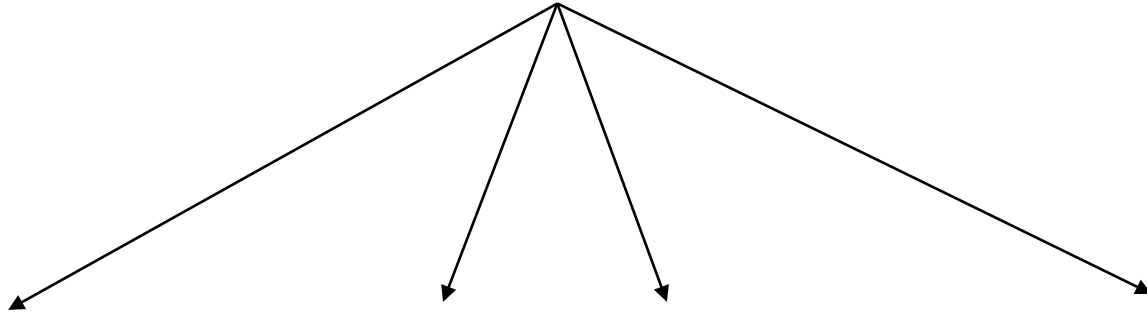
A

Lens/Cataracts Overview

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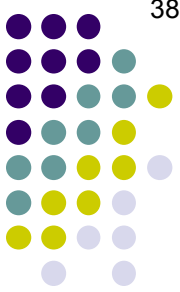
Per the Lens book, how many categories of cataracts are there? Four



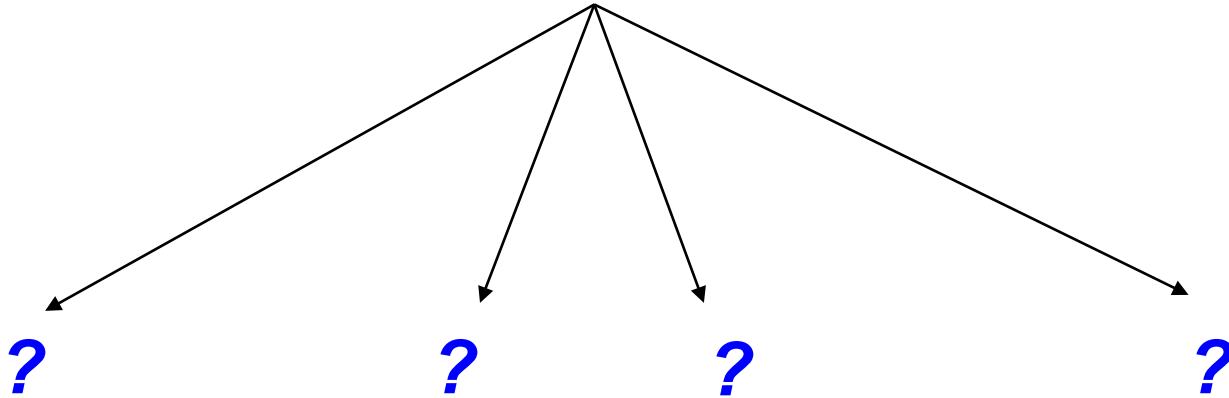
Q

Lens/Cataracts Overview

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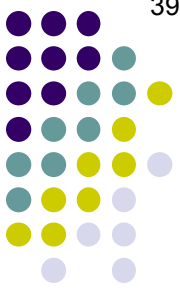
What are the four categories of cataracts?



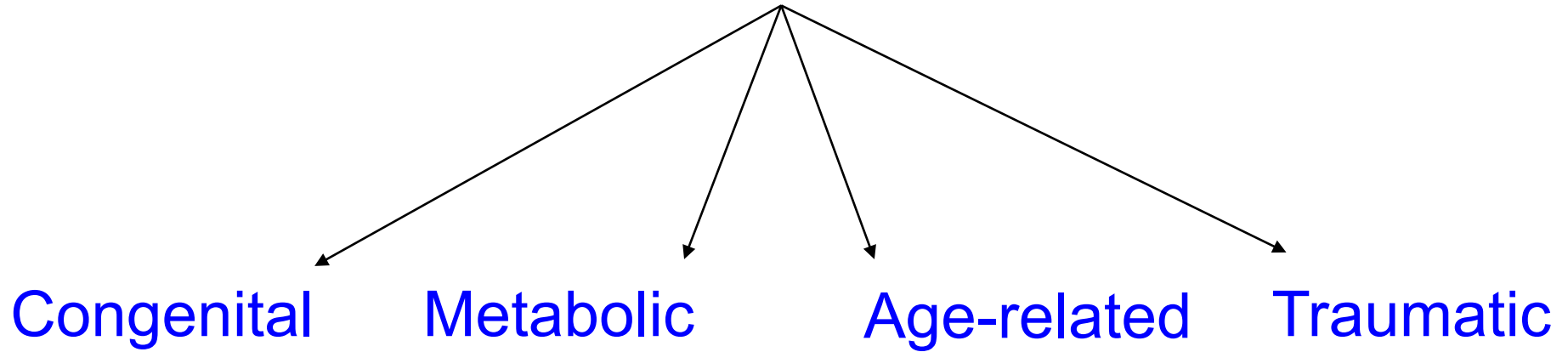
A

Lens/Cataracts Overview

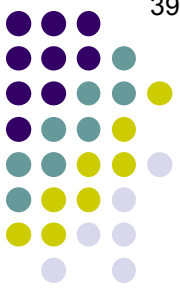
390



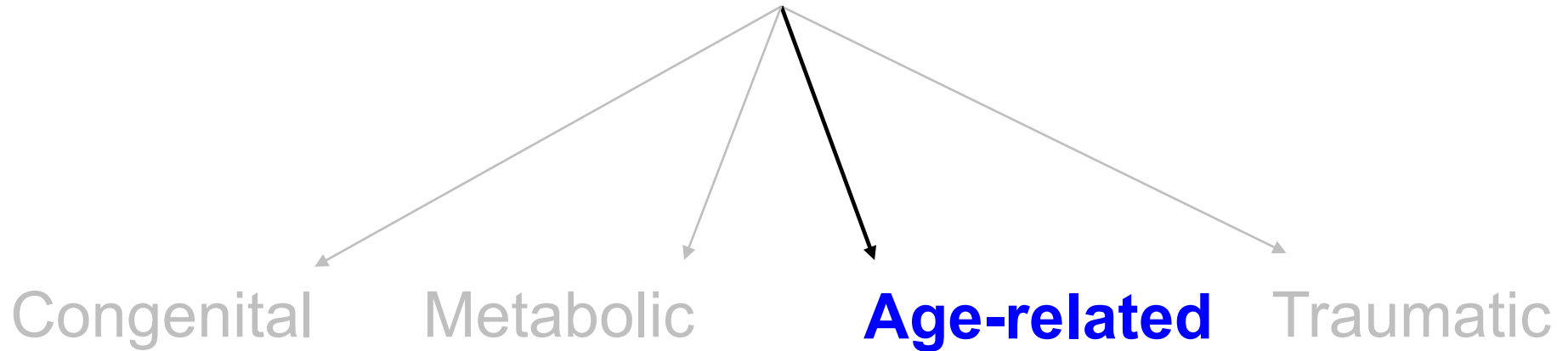
What are the four categories of cataracts?



Lens/Cataracts Overview



What are the four categories of cataracts?

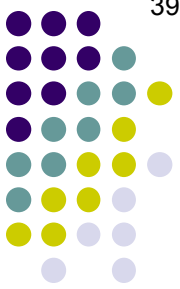


*The remainder of this slide-set will focus on **age-related cataracts***

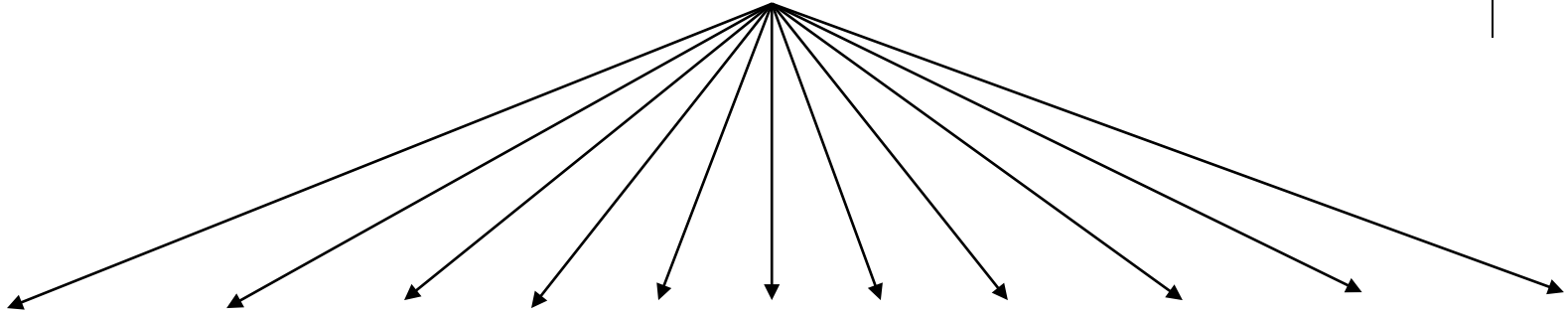
Q

Lens/Cataracts Overview

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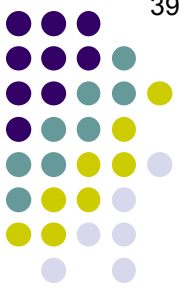
How many 'age-related' types of cataracts are there?



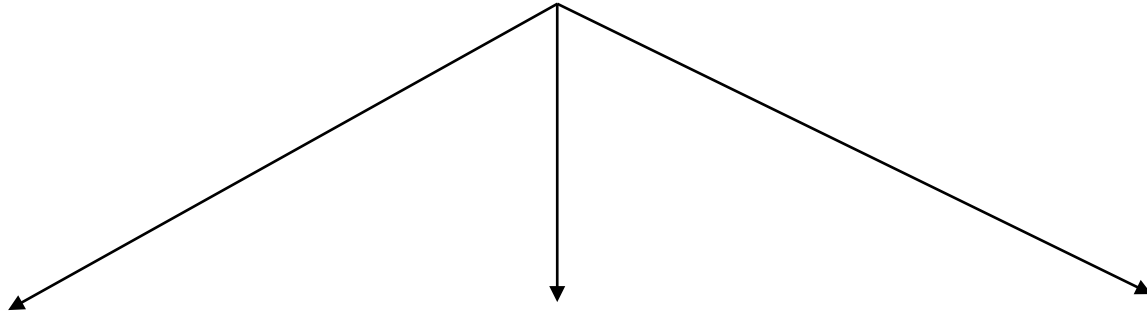
A

Lens/Cataracts Overview

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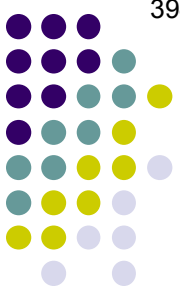
*How many 'age-related' types of cataracts are there? **Three***



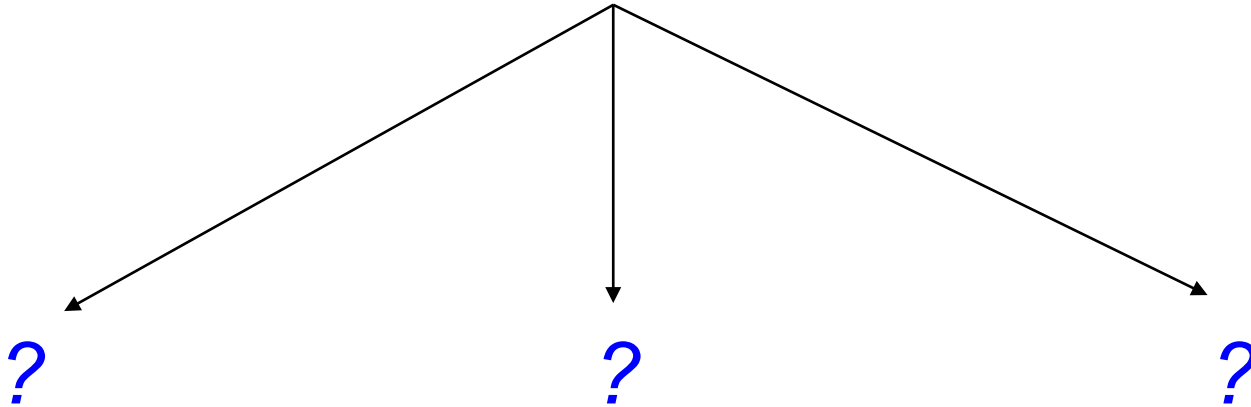
Q

Lens/Cataracts Overview

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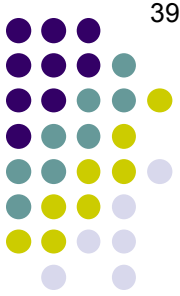
What are the three age-related types of cataracts?



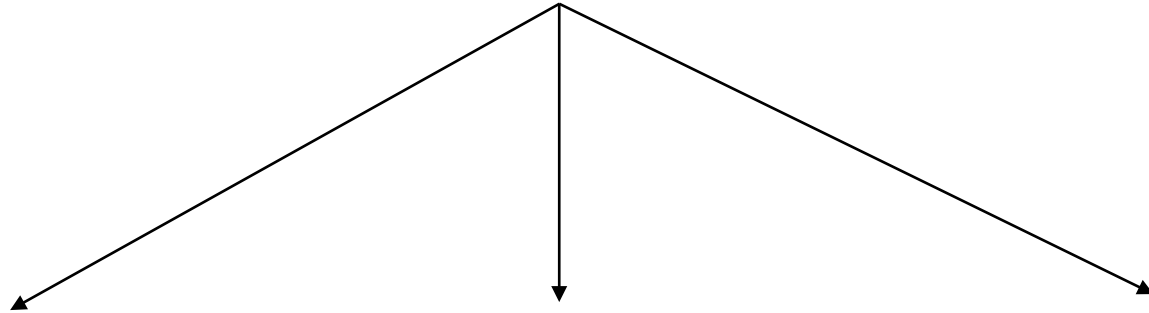
A

Lens/Cataracts Overview

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What are the three age-related types of cataracts?



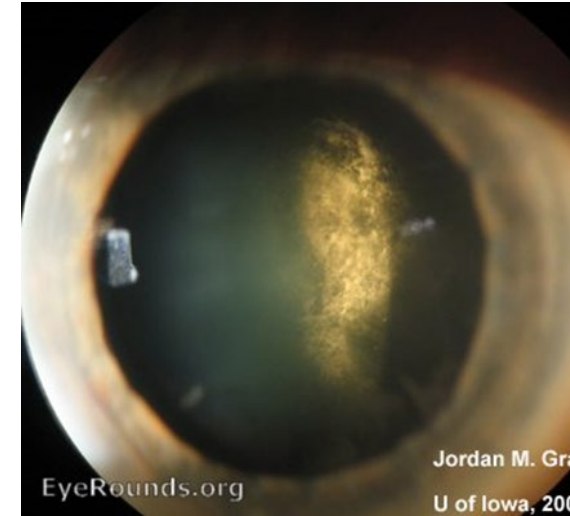
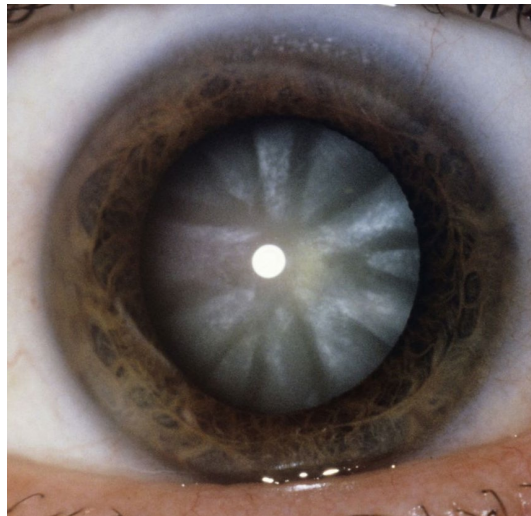
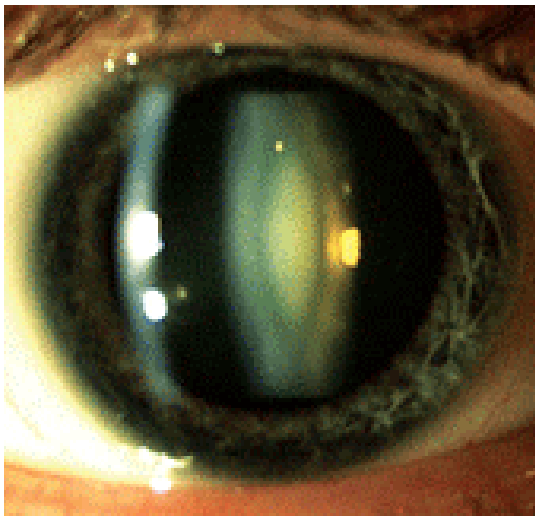
NSC

(Nuclear sclerotic cataract)

Cortical

PSC

(Posterior subcapsular cataract)



EyeRounds.org

Jordan M. Gra
U of Iowa, 200

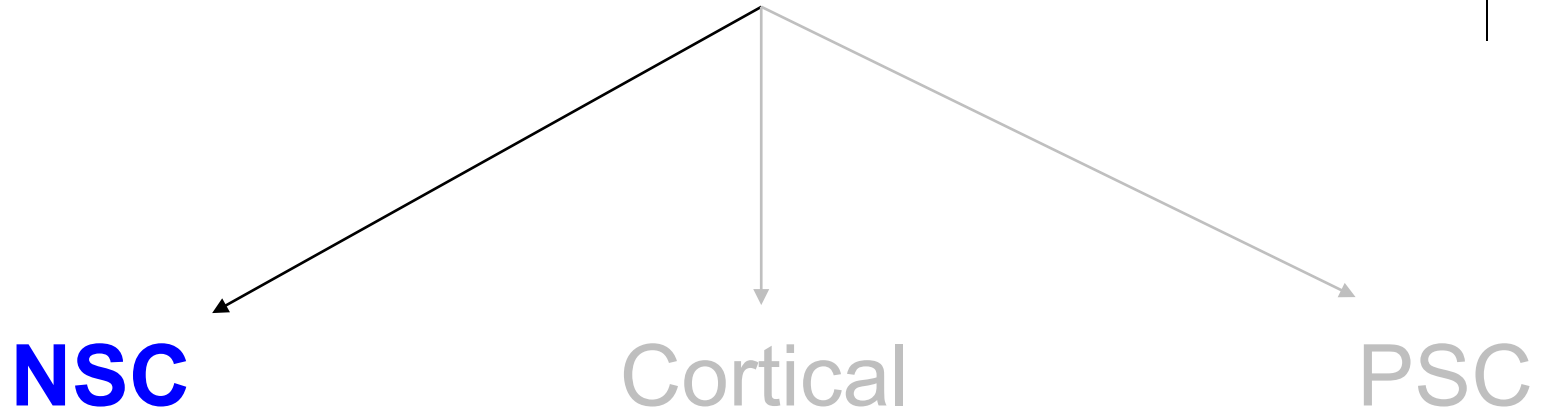
Q

Lens/Cataracts Overview

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What are the three age-related types of cataracts?

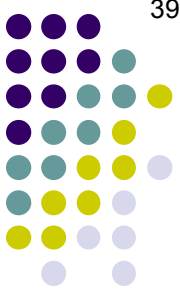


What is the typical color of an NSC?

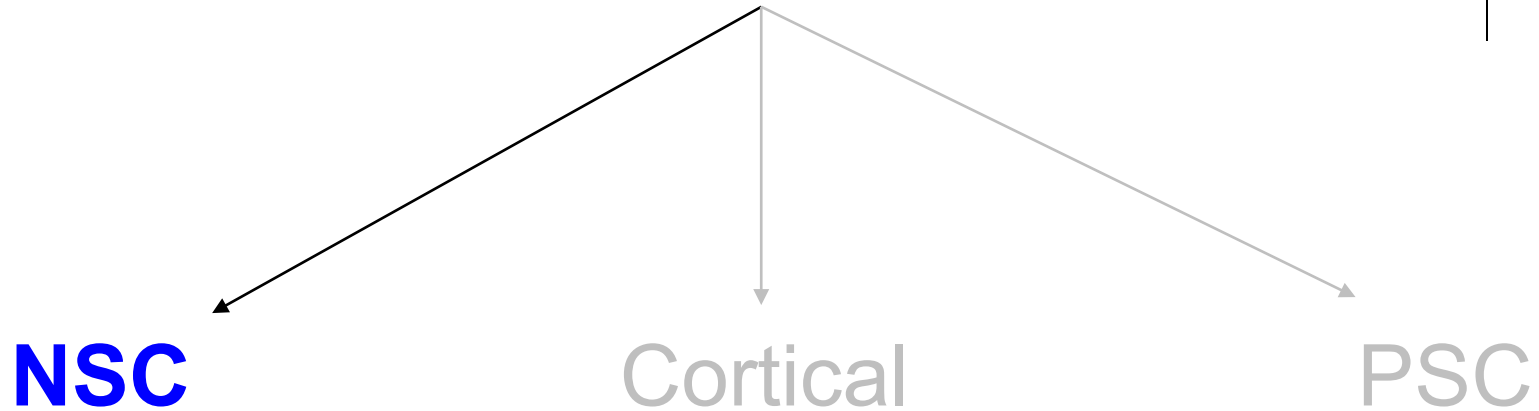
A

Lens/Cataracts Overview

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What are the three age-related types of cataracts?



What is the typical color of an NSC?

Somewhere on the **amber-to-brown** spectrum

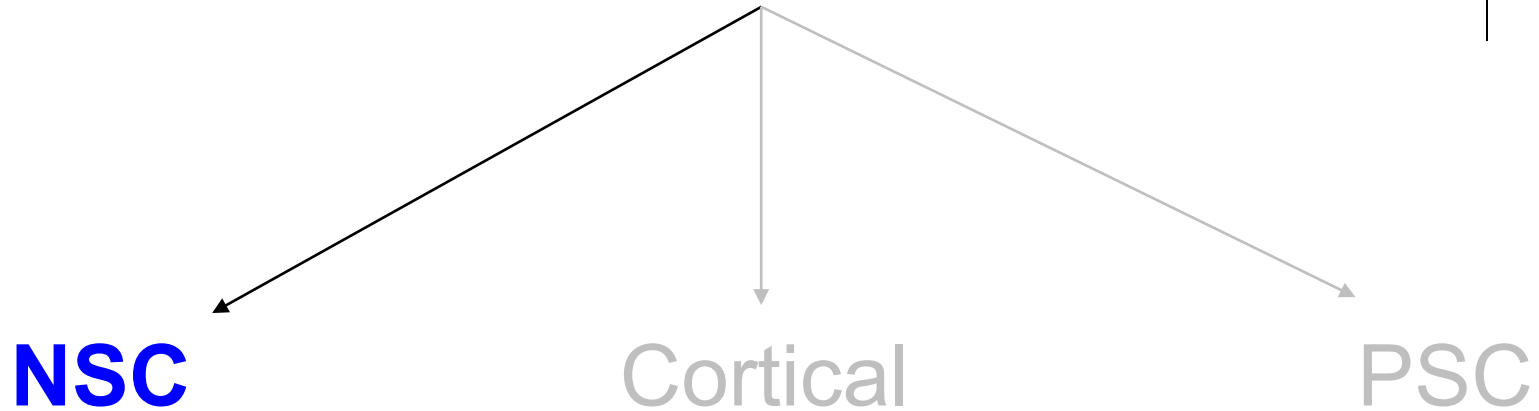
Q

Lens/Cataracts Overview

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What are the three age-related types of cataracts?



What is the typical color of an NSC?

Somewhere on the **amber-to-brown** spectrum

What is the pathogenesis of NSC discoloration?

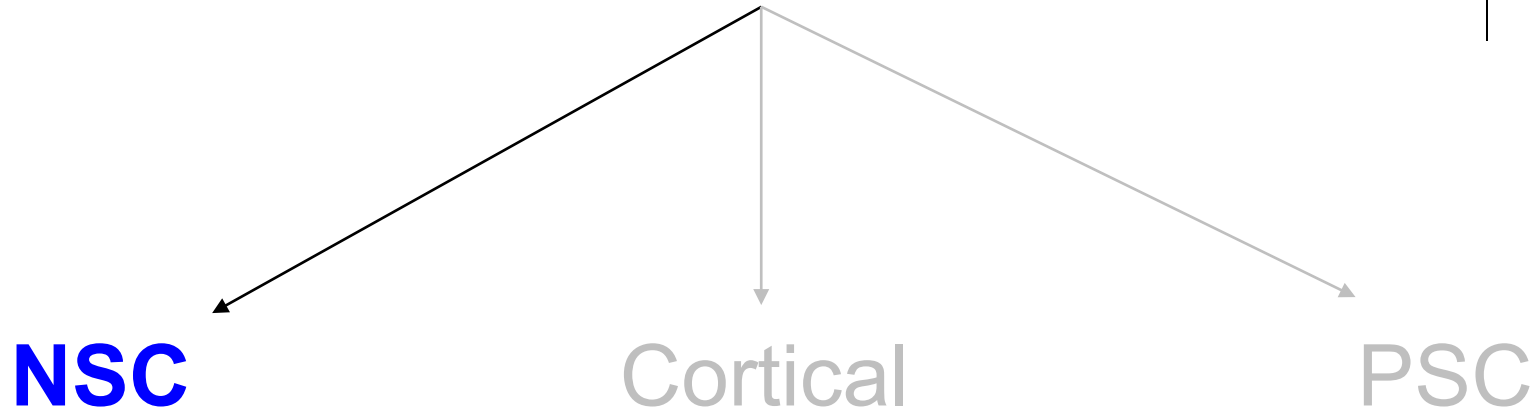
A

Lens/Cataracts Overview

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What are the three age-related types of cataracts?



What is the typical color of an NSC?

Somewhere on the **amber-to-brown** spectrum

What is the pathogenesis of NSC discoloration?

Per the *Lens* book, it is “poorly understood” at this time

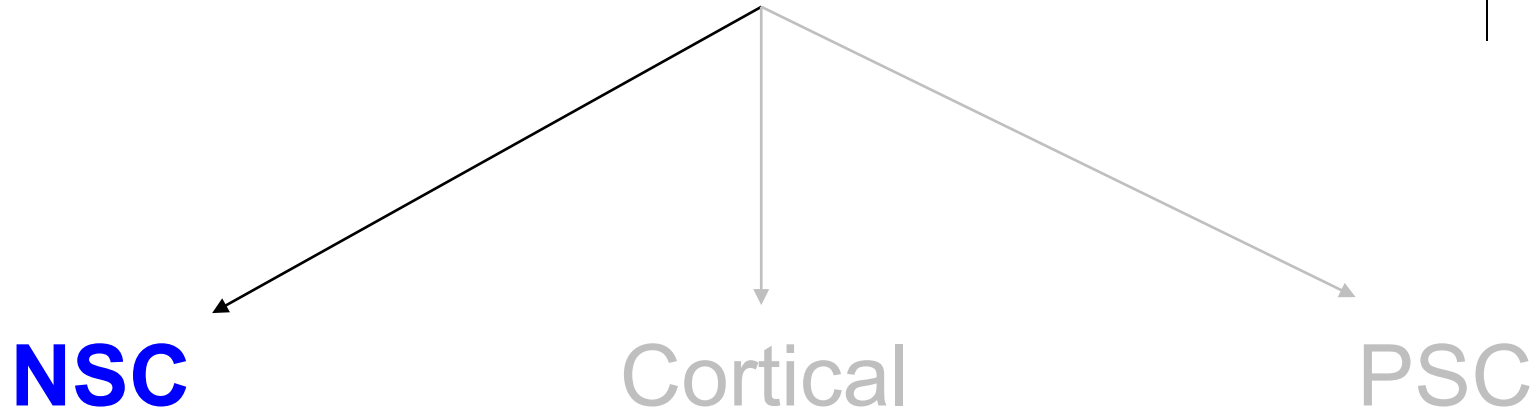
Q

Lens/Cataracts Overview

400



What are the three age-related types of cataracts?



What is the typical color of an NSC?

Somewhere on the **amber-to-brown** spectrum

What is the pathogenesis of NSC discoloration?

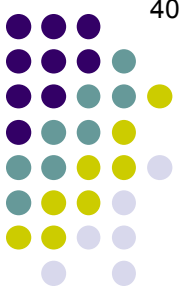
Per the *Lens* book, it is “poorly understood” at this time

What is the typical consistency of an NSC?

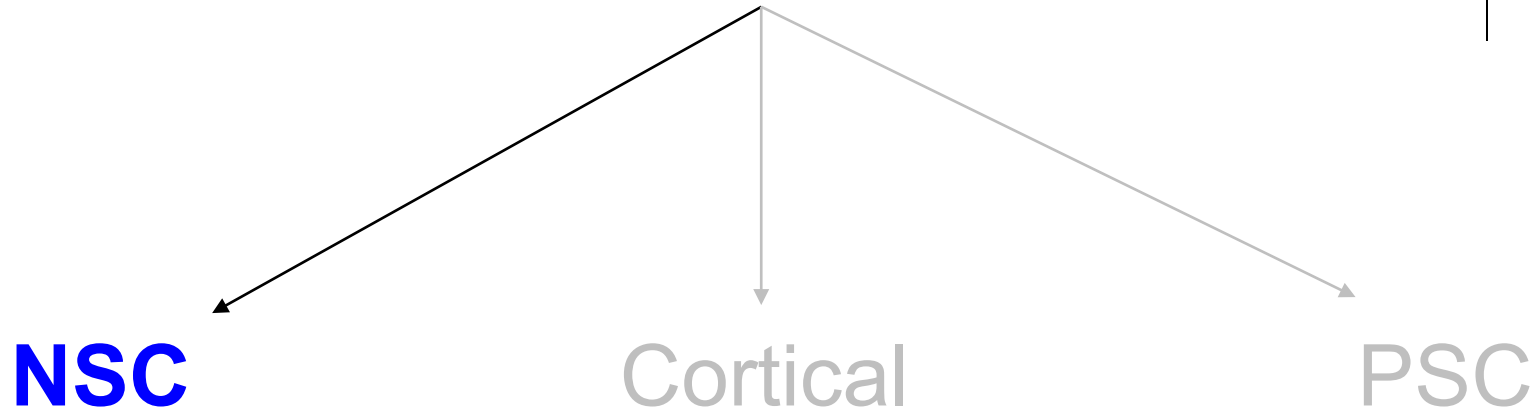
A

Lens/Cataracts Overview

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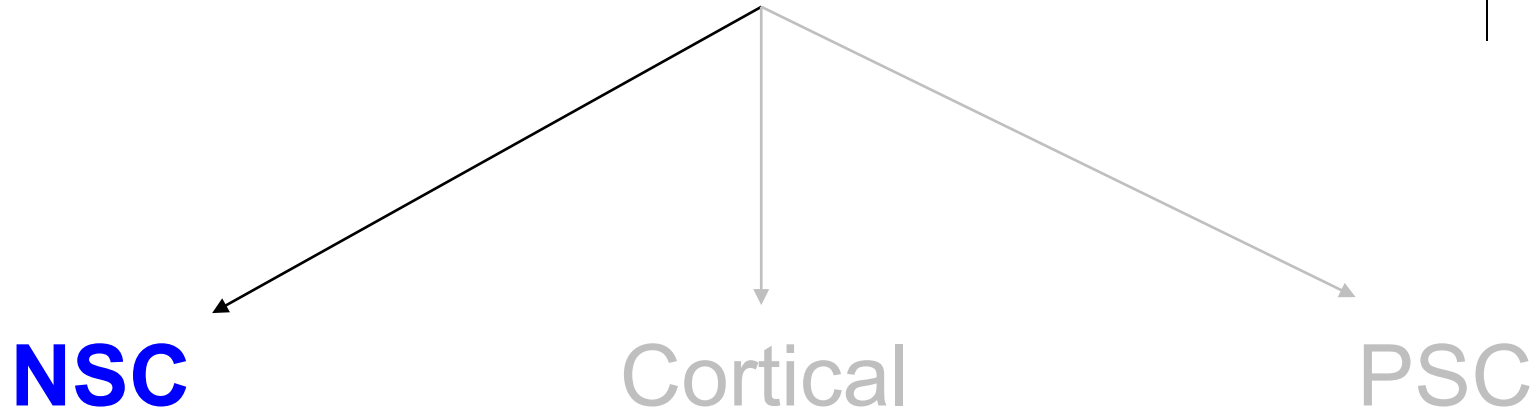
Firm to hard



Q

Lens/Cataracts Overview

What are the three age-related types of cataracts?



What is the typical color of an NSC?

Somewhere on the **amber-to-brown** spectrum

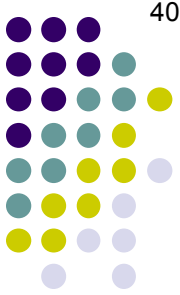
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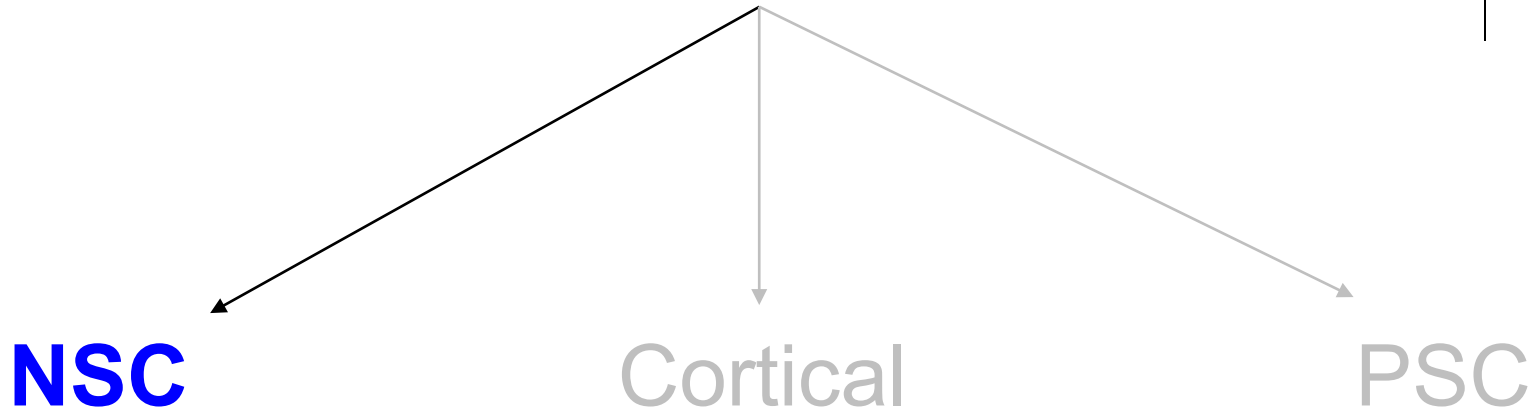
What is the typical consistency of an NSC?

Firm to hard

What is the pathogenesis of NSC hardness?



What are the three age-related types of cataracts?



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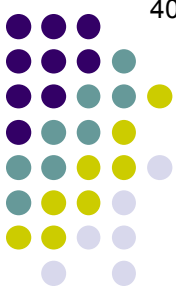
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Firm to hard

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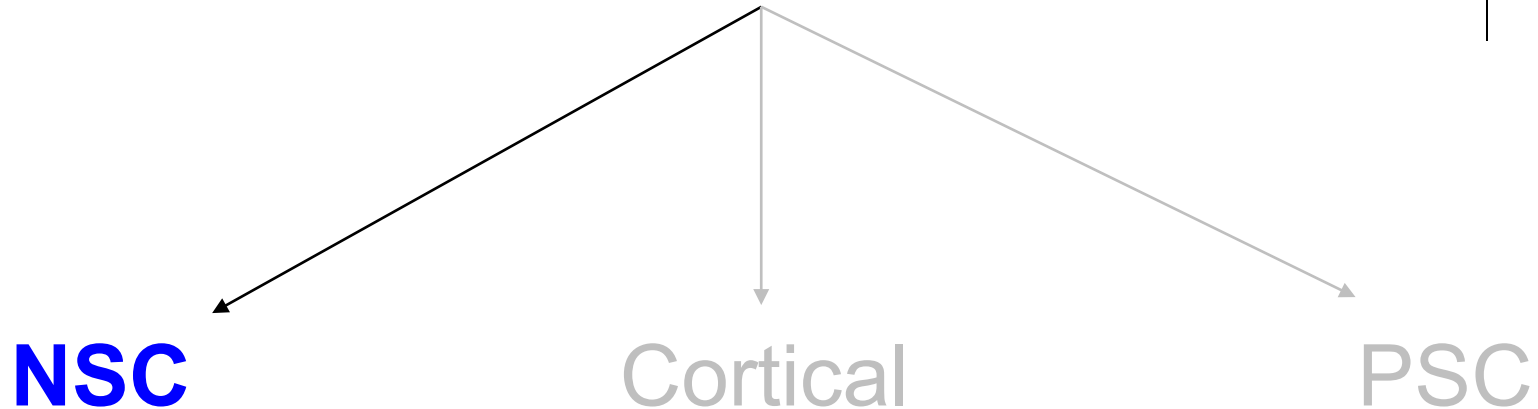
The never-ending creation of new fibers progressively compresses the nucleus, causing it to become progressively denser (and harder) over time



Q

Lens/Cataracts Overview

What are the three age-related types of cataracts?



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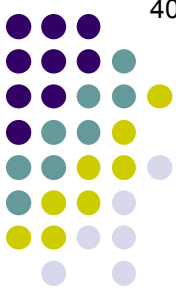
What is the typical consistency of an NSC?

Firm to hard

What's the formal term for this progressive compression and hardening?

What is the pathogenesis of NSC compression?

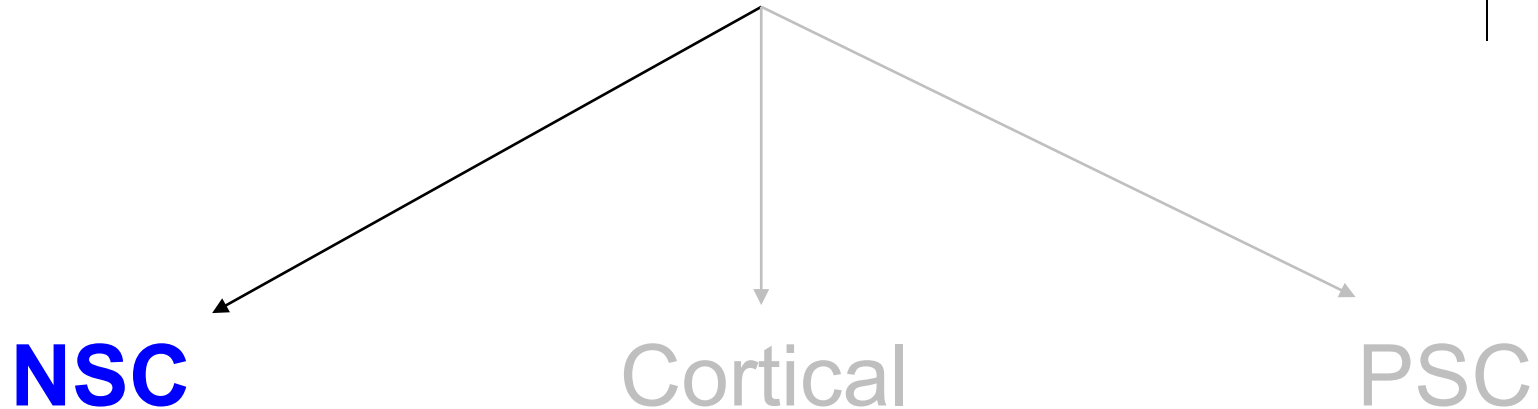
The never-ending creation of new fibers **progressively compresses the nucleus, causing it to become progressively denser** (and harder) over time



A

Lens/Cataracts Overview

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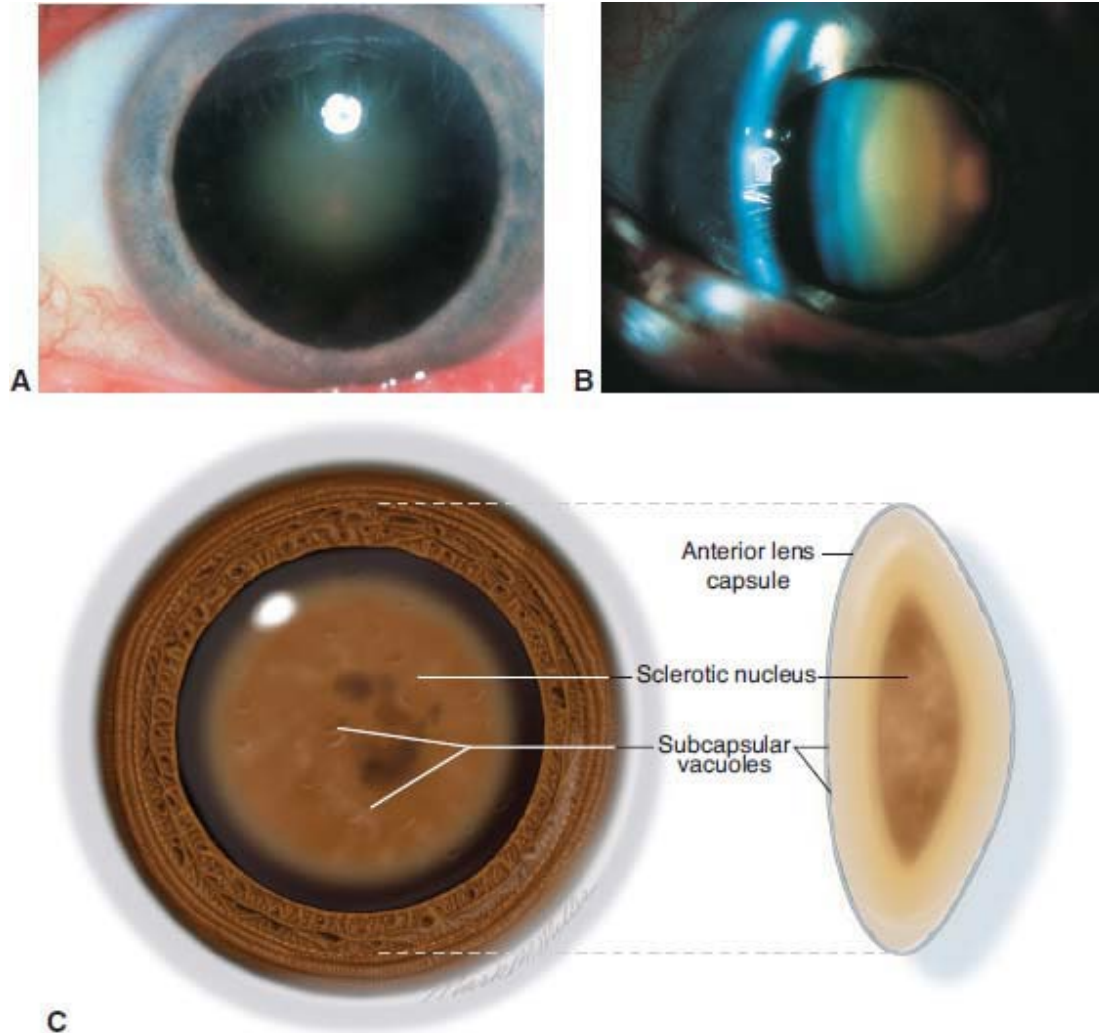
What's the formal term for this progressive compression and hardening?

Sclerosis (as in, a ‘nuclear **sclerotic** cataract’)

What is the pathogenesis of NSC compression?

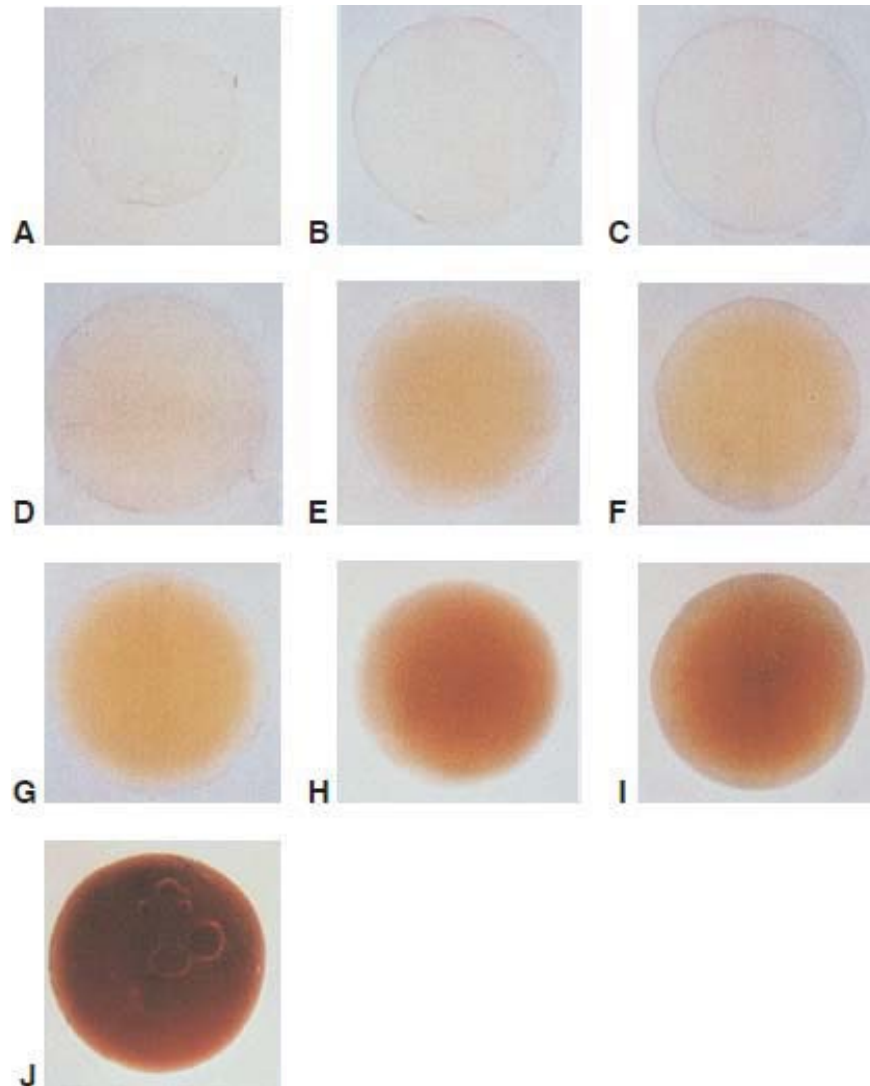
The never-ending creation of new fibers **progressively compresses the nucleus, causing it to become progressively denser** (and harder) over time

Lens/Cataracts Overview



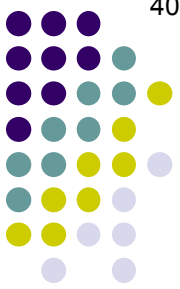
Nuclear cataract viewed with diffuse illumination (A) and with a slit beam (B). C, Schematic of nuclear cataract

Lens/Cataracts Overview

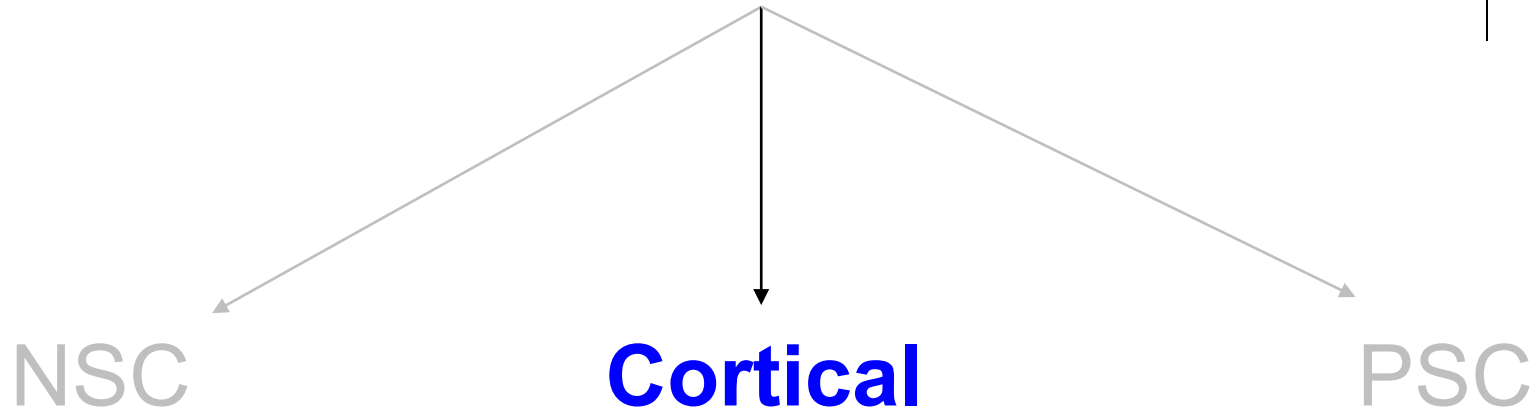


Increasing yellow-to-brown coloration of the human lens from age 6 months (A) to 8 years (B), 12 years (C), 25 years (D), 47 years (E), 60 years (F), 70 years (G), 82 years (H), and 91 years (I). J, Brown nuclear cataract in a 70-year-old patient.

Lens/Cataracts Overview



What are the three age-related types of cataracts?

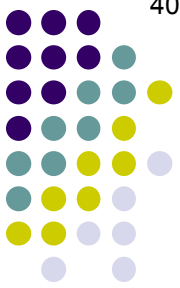


Next let's look at cortical cataracts

Q

Lens/Cataracts Overview

What are the first manifestations of a cortical cataract?



Q/A

Lens/Cataracts Overview

What are the first manifestations of a cortical cataract?

The presence of two words and one word in the cortical region of the lens

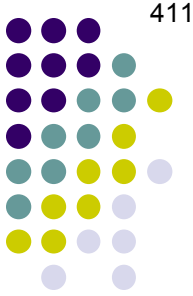


A

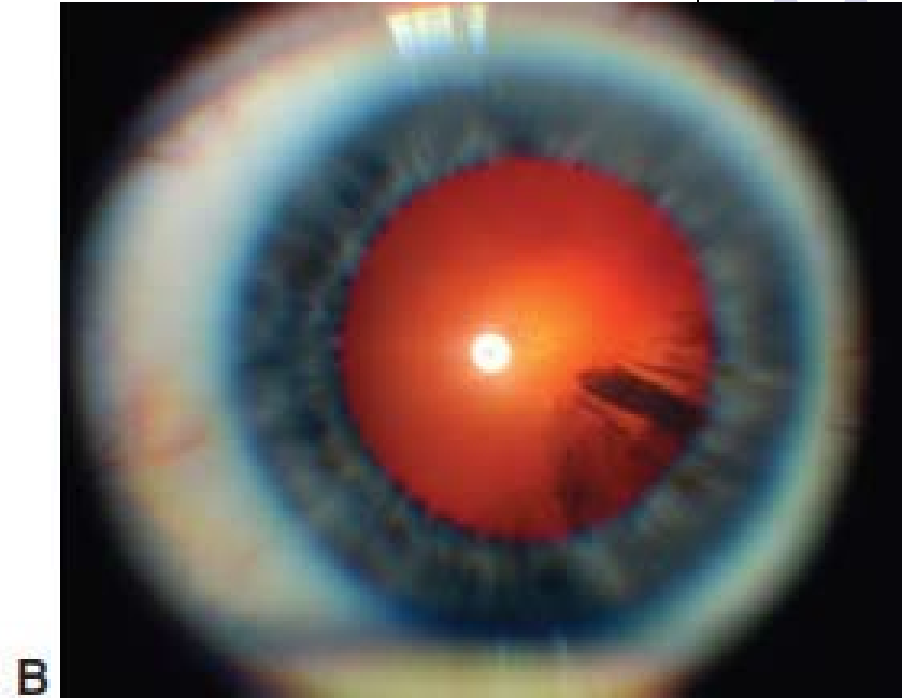
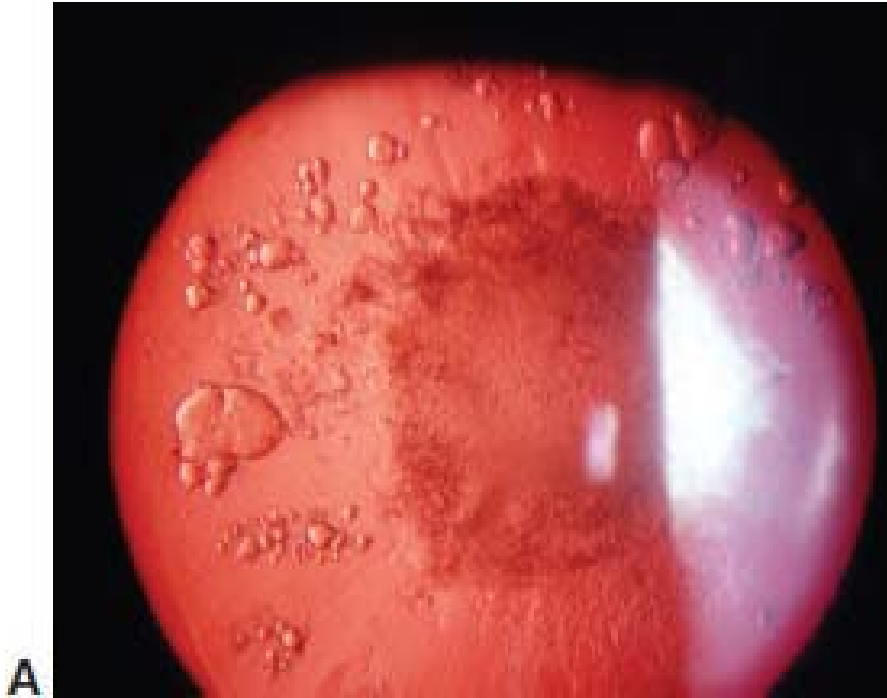
Lens/Cataracts Overview

What are the first manifestations of a cortical cataract?

The presence of water clefts and vacuoles in the cortical region of the lens



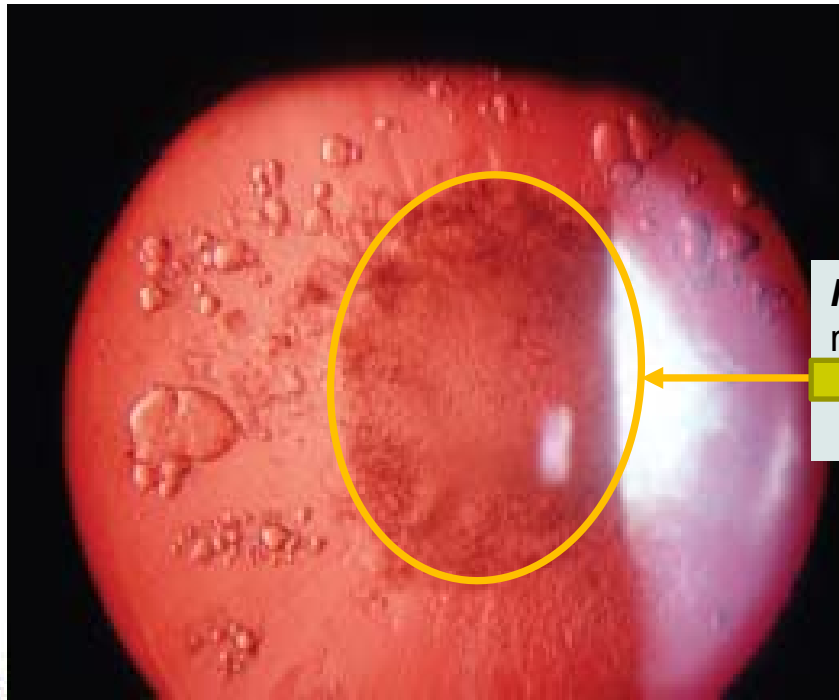
Lens/Cataracts Overview



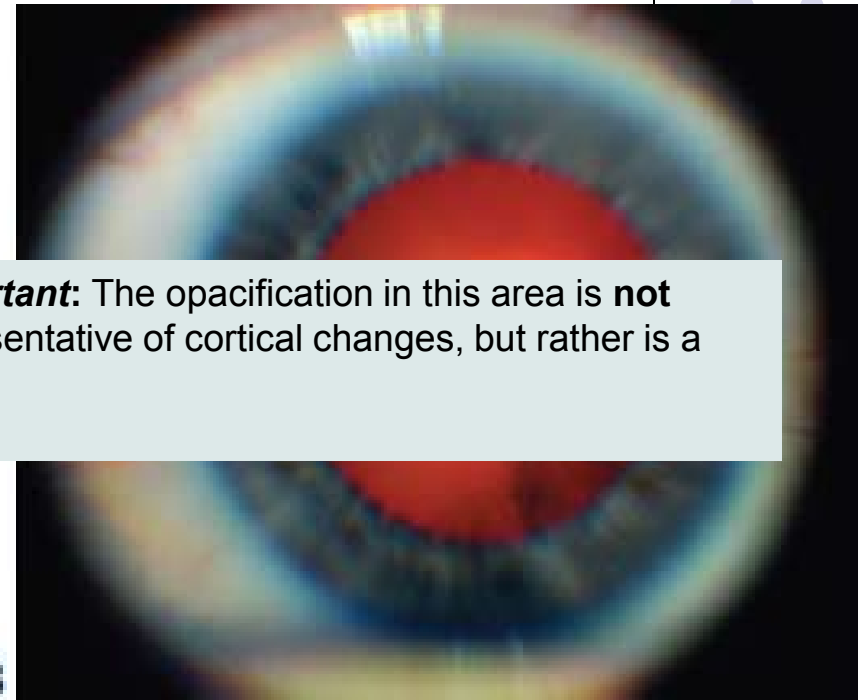
Early cortical cataract development as viewed at the slit lamp using retroillumination. *A*, Vacuoles. *B*, Typical cortical spokes

Q

Lens/Cataracts Overview



A



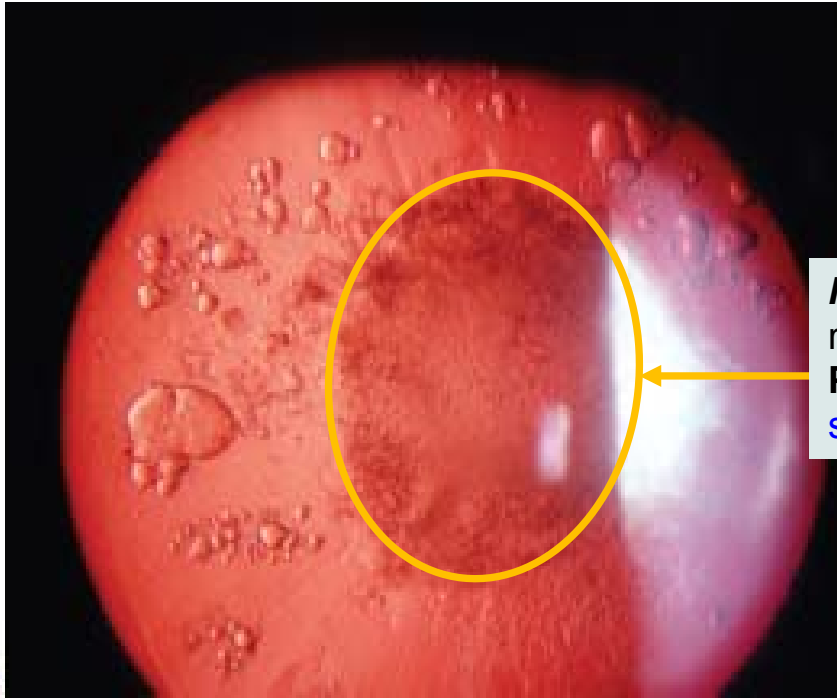
B

Important: The opacification in this area is **not** representative of cortical changes, but rather is a

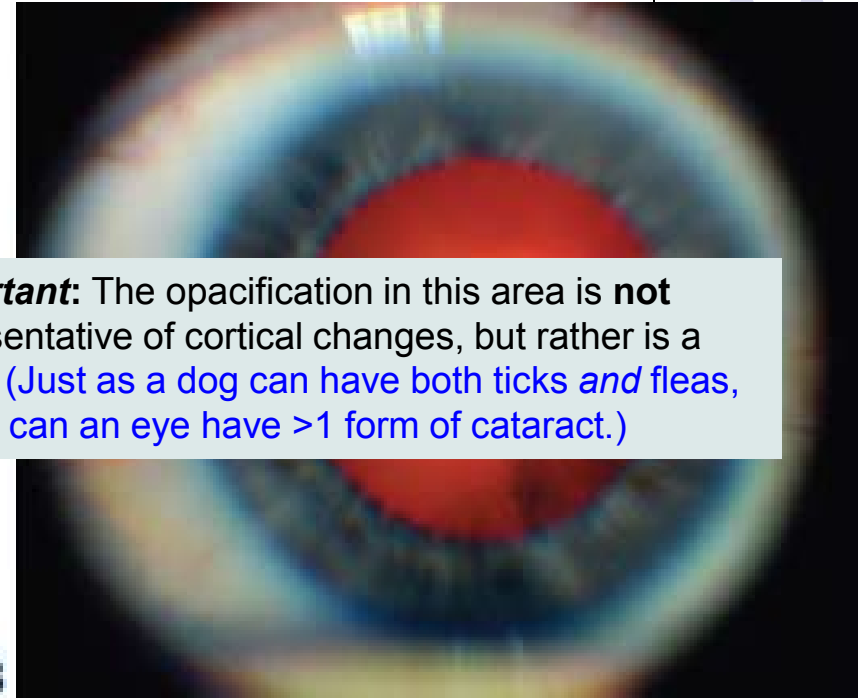
Early cortical cataract development as viewed at the slit lamp using retroillumination. *A*, Vacuoles. *B*, Typical cortical spokes

A

Lens/Cataracts Overview



Important: The opacification in this area is **not** representative of cortical changes, but rather is a **PSC**. (Just as a dog can have both ticks *and* fleas, so too can an eye have >1 form of cataract.)



Early cortical cataract development as viewed at the slit lamp using retroillumination. *A*, Vacuoles. *B*, Typical cortical spokes

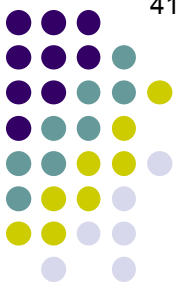
Q

Lens/Cataracts Overview

What are the first manifestations of a cortical cataract?

The presence of water clefts and vacuoles in the cortical region of the lens

What manifestation typically follows water clefts and vacuoles?



Q/A

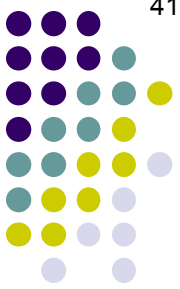
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The appearance of wedge-shaped opacifications (called...(two words)) at the lens periphery



A

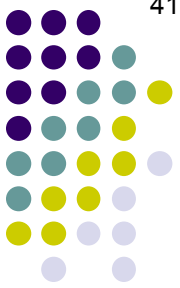
Lens/Cataracts Overview

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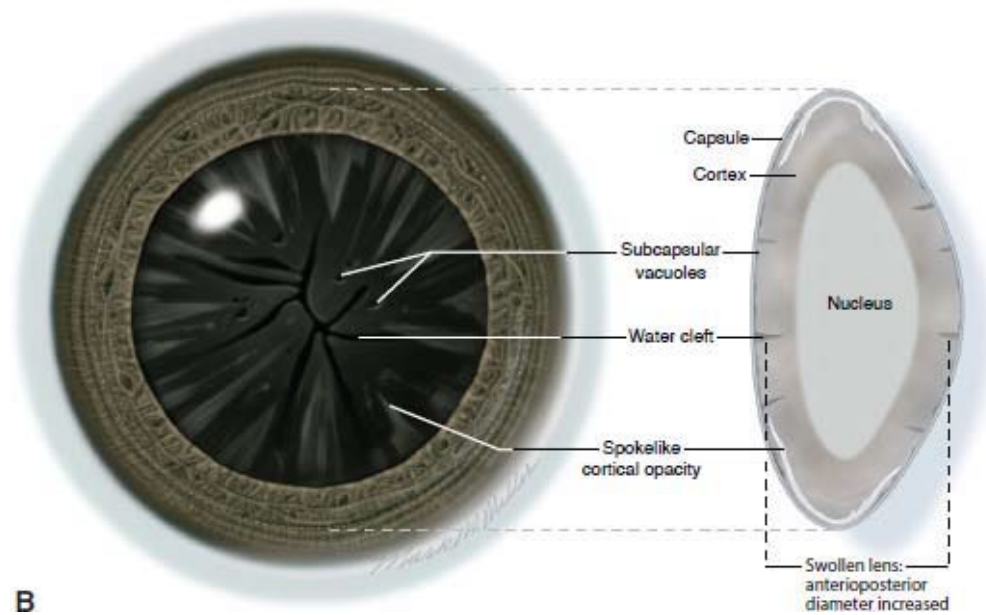
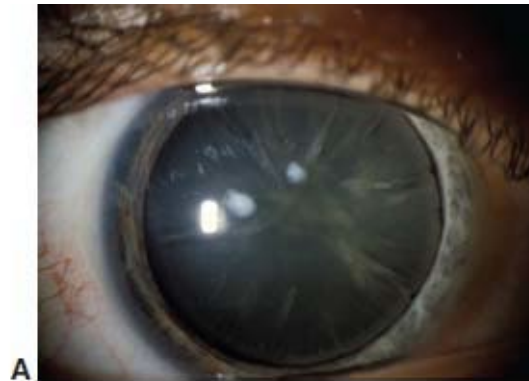
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The appearance of wedge-shaped opacifications ('cortical spokes') at the lens periphery

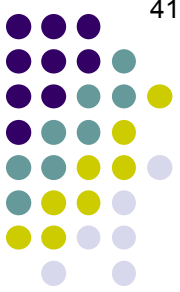


Lens/Cataracts Overview

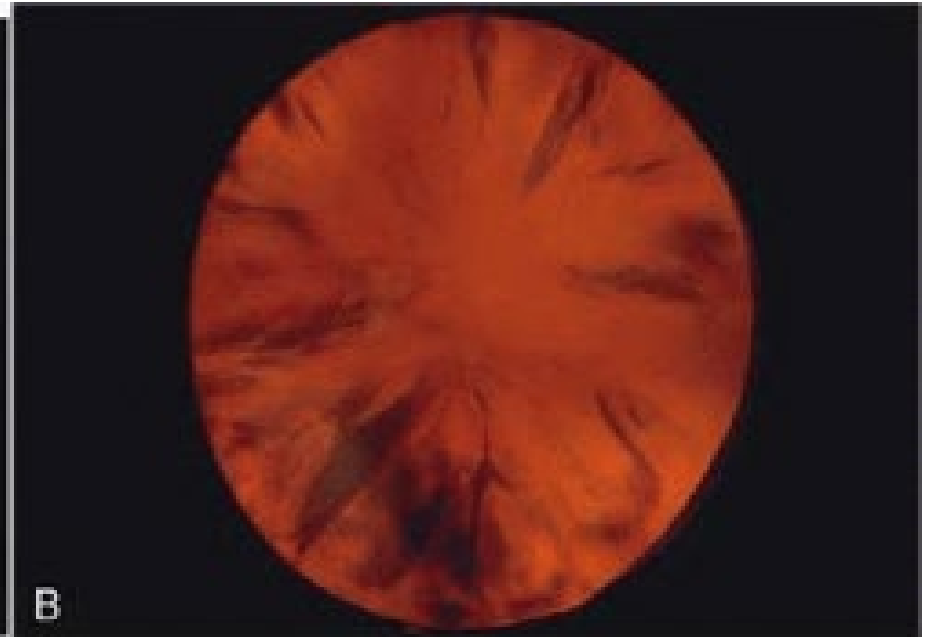


A, Cortical cataract viewed by oblique view at the slit lamp. B, Schematic of immature cortical cataract

Lens/Cataracts Overview



Direct illumination

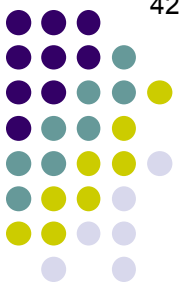


Retroillumination

Cortical cataract: Early spokes

Q

Lens/Cataracts Overview



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The presence of water clefts and vacuoles in the cortical region of the lens

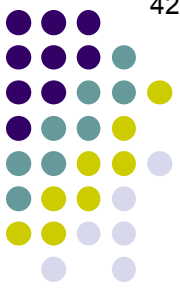
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Eventually, these spokes will turn white and comprise the entire lens. What is the name for such a cataract?

A

Lens/Cataracts Overview



What are the first manifestations of a cortical cataract?

The presence of water clefts and vacuoles in the cortical region of the lens

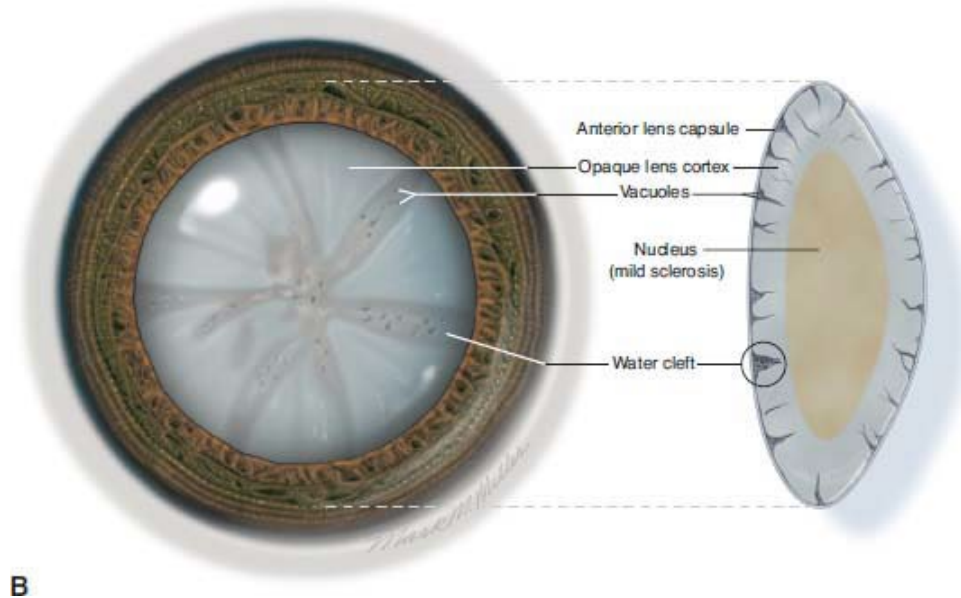
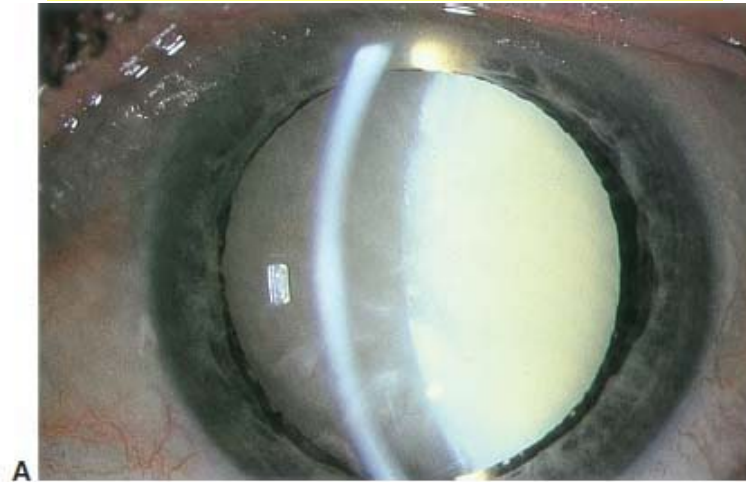
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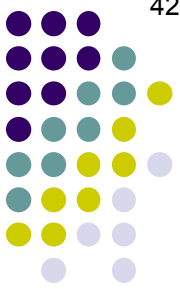
A **mature** cataract

Lens/Cataracts Overview



Mature cortical cataract. *A*, Mature cortical cataract viewed at the slit lamp. *B*, Schematic of mature cortical cataract.

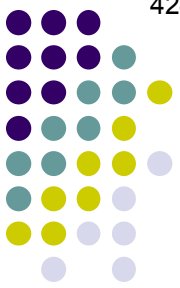
Lens/Cataracts Overview



Cortical cataract: Mature

Q

Lens/Cataracts Overview



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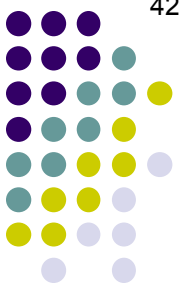
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Occasionally, a mature cataract will absorb a clinically significant amount of water. What is the name for such a cataract?

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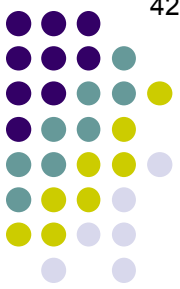
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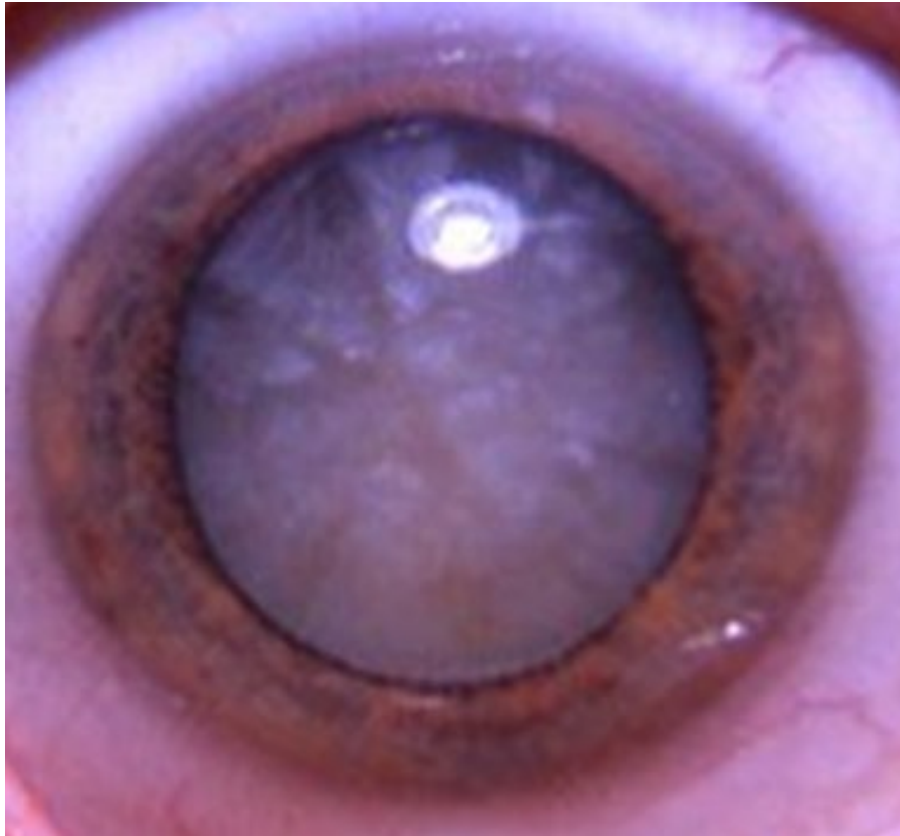
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Occasionally, a mature cataract will absorb a clinically significant amount of water. What is the name for such a cataract?

An **intumescent** cataract



Lens/Cataracts Overview

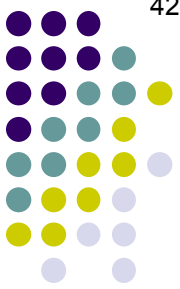


Intumescent cortical cataract

(Lens intumescence isn't really appreciable in a photo, so don't be concerned if it doesn't look significantly different from a mature cataract)

Q

Lens/Cataracts Overview



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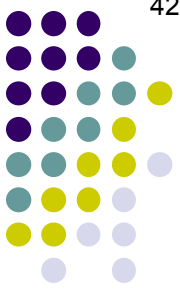
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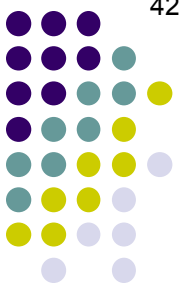
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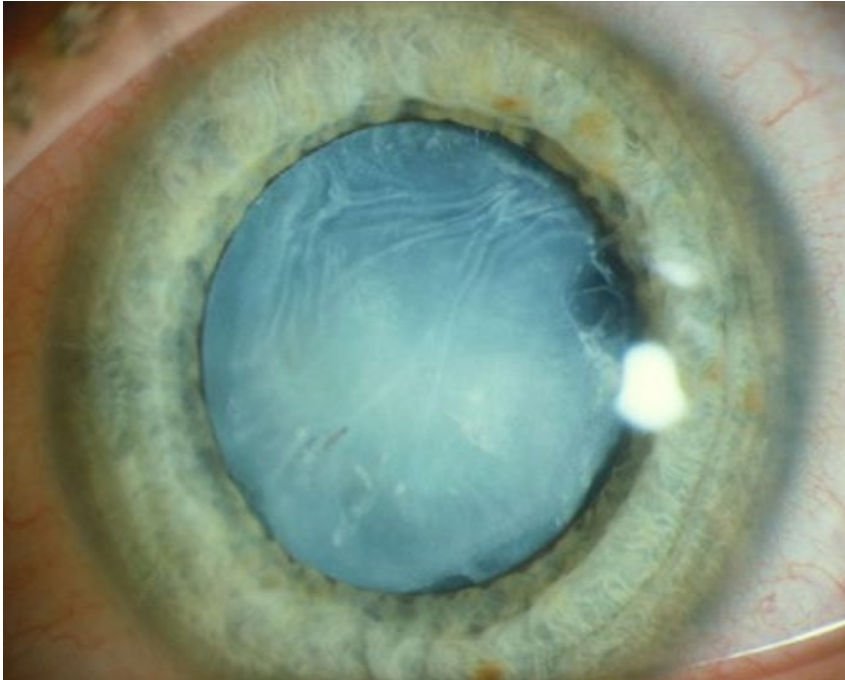
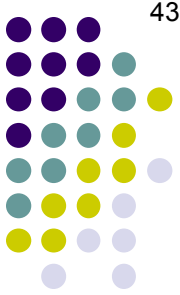
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A **hypermature** cataract

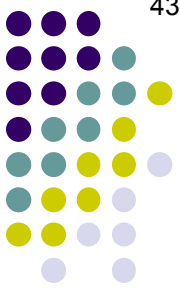
Lens/Cataracts Overview



Hypermature cataract. Note the capsular wrinkling

Q

Lens/Cataracts Overview



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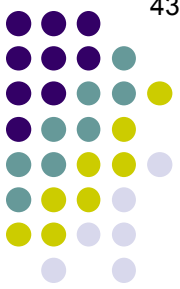
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Occasionally, the entire hypermature cataract liquefies, leaving only a wrinkled bag with an NSC resting at its bottom. What is the name for such a cataract?

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Lens/Cataracts Overview



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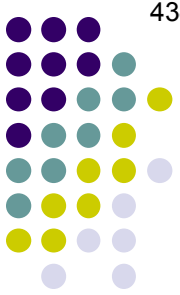
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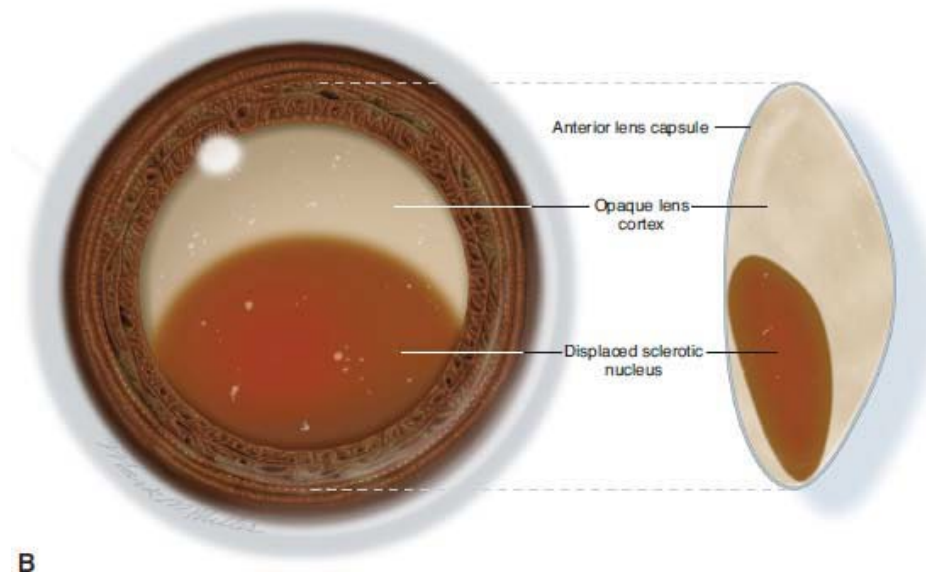
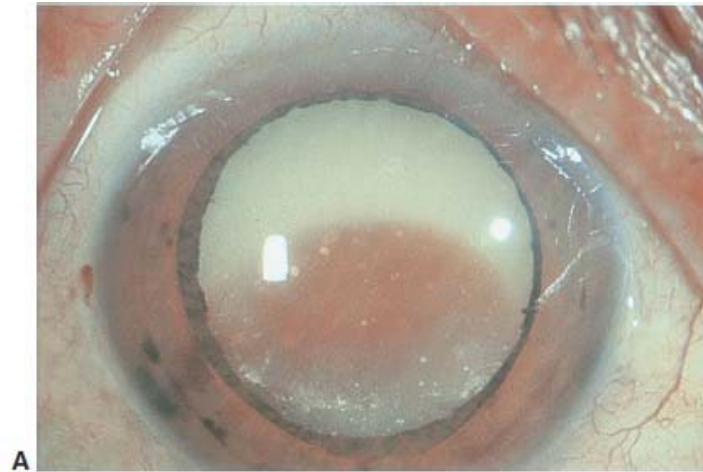
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A **morgagnian** cataract

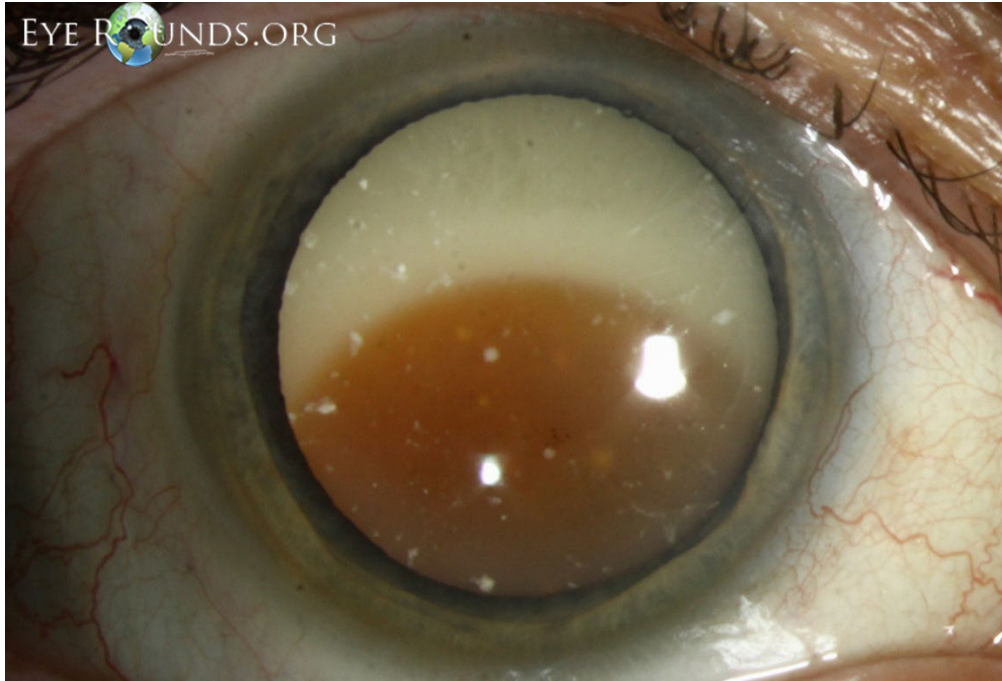
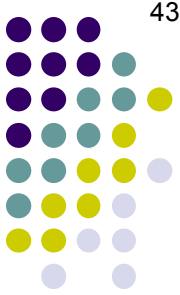


Lens/Cataracts Overview



Morgagnian cataract. A, Clinical photo of morgagnian cataract. B, Schematic of morgagnian cataract.

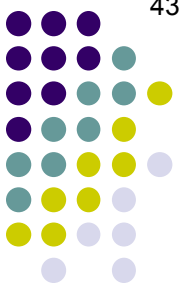
Lens/Cataracts Overview



Morgagnian cataract

Q

Lens/Cataracts Overview



What are the first manifestations of a cortical cataract?

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Take note of the stages:

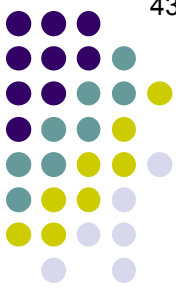
Mature cataract



?

Q/A

Lens/Cataracts Overview



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Take note of the stages:

Mature cataract → intumescent cataract → ?

A

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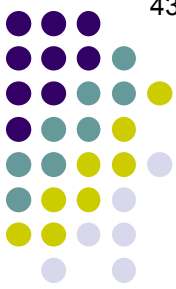
A **morgagnian** cataract

Take note of the stages:

Mature cataract → intumescent cataract → hypermature cataract

Q

Lens/Cataracts Overview



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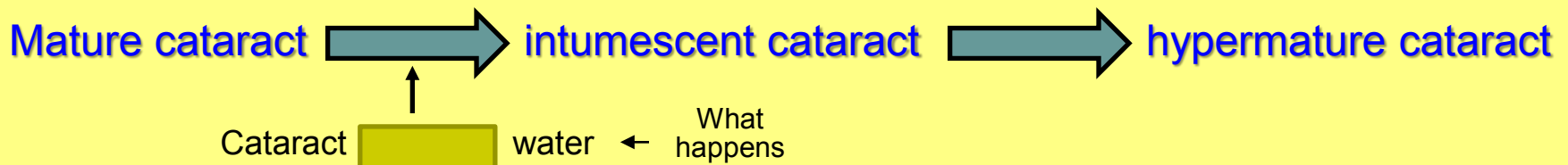
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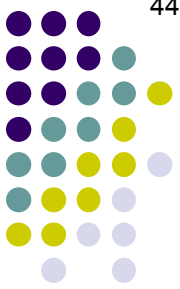
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A

Lens/Cataracts Overview



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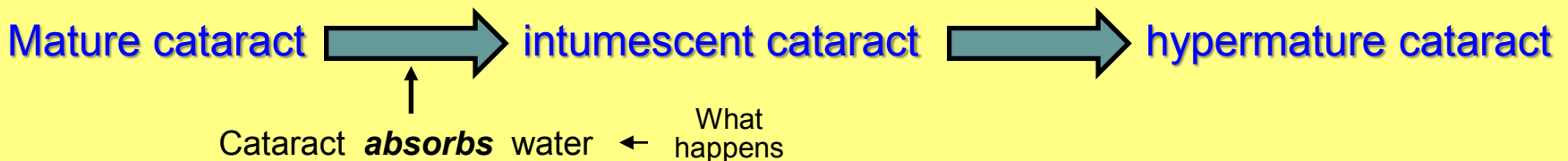
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Lens/Cataracts Overview

The presence of water clefts and vacuoles in the cortical region of the lens

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A mature cataract

An intumescent cataract

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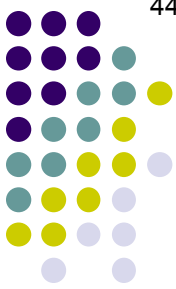
A morgagnian cataract

Mature cataract → intumescent cataract → hypermature cataract

Cataract **absorbs** water ← What happens → Cataract water

A

Lens/Cataracts Overview



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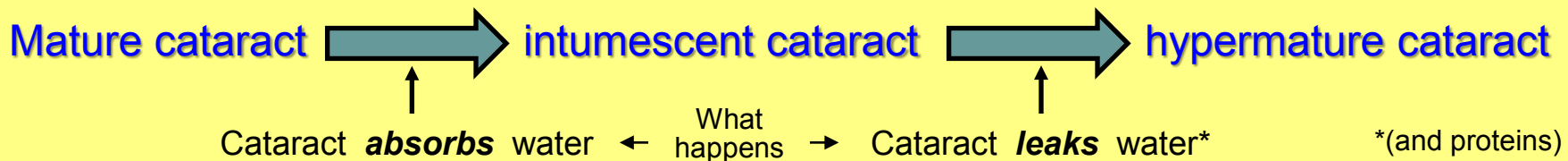
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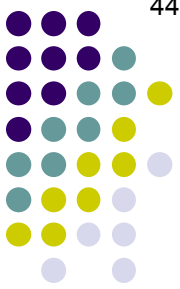
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Q

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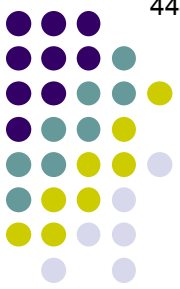
All three of these pose a particular challenge during an early, crucial step in cataract surgery. What step, and what challenge?

Take note of the stages:

Mature cataract → intumescent cataract → hypermature cataract

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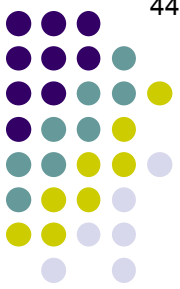
For all three stages, the red reflex is completely obscured. As most cataract surgeons rely on the red reflex to visualize the anterior capsule during capsulorrhexis, this step cannot be performed in a conventional manner.

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Mature cataract → intumescent cataract → hypermature cataract

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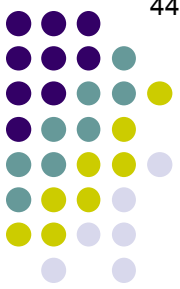
What step do most surgeons take to facilitate capsulorrhexis in these cases?

Take note of the stages:

Mature cataract → intumescent cataract → hypermature cataract

Q/A

Lens/Cataracts Overview



What are the first manifestations of a cortical cataract?

The presence of water clefts and vacuoles in the cortical region of the lens

What manifestation typically follows water clefts and vacuoles?

The appearance of wedge-shaped opacifications ('cortical spokes') at the lens periphery

Eventually, these spokes will turn white and comprise the entire lens. What is the name for such a cataract?

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Occasionally, a mature cataract will absorb a clinically significant amount of water. What is the name for such a cataract?

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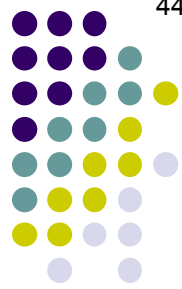
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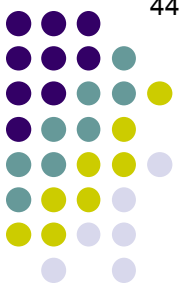
Lens/Cataracts Overview

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An intumescent cataract means 'swollen.' As mentioned a few slides ago, the event that transforms a mature cataract into an *intumescent* cataract is absorption of water, and this absorption results in swelling of the lens.

All the time, the lens is absorbing water. What happens when the absorption is excessive? For a mature cataract, the lens is already swollen. For an intumescent cataract, the lens is even more swollen. For a hypermature cataract, the lens is so swollen that it is on the verge of rupturing the capsule.

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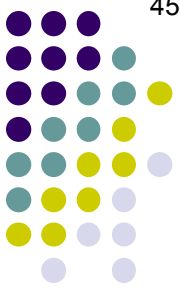
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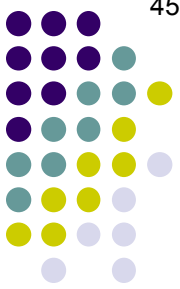
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For a mature cataract, what effect does swelling have on the internal dynamics of the lens?

It increases the pressure within the lens

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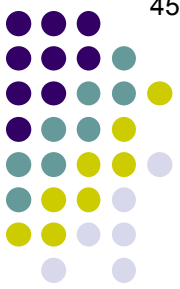
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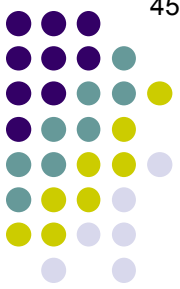
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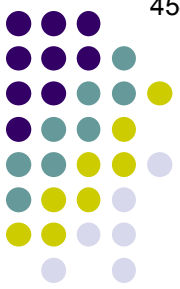
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If/when the rent runs peripherally, what is the resulting appearance of the lens?

What happens next?

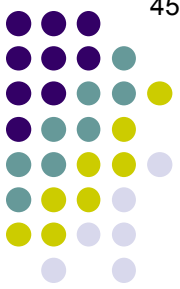
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What is the purpose of trypan blue?

They stain the anterior capsule with **trypan blue**

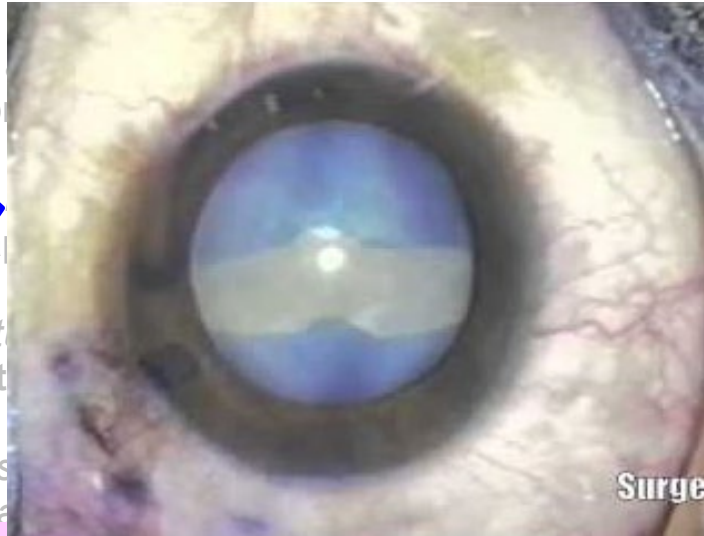
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Lens/Cataracts Overview

A



What is the appearance of an intumescent cataract?

The pressure within the cortical region of the lens

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A mature cataract

Occasionally, a cataract

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Recall that, because of red-reflex obscuration, **trypan blue** is used in all these cases.

Thus, after the rent runs out, the surgeon sees a **white stripe** (the cataract) between **two areas of blue** (the undisturbed, trypan blue-stained capsule).

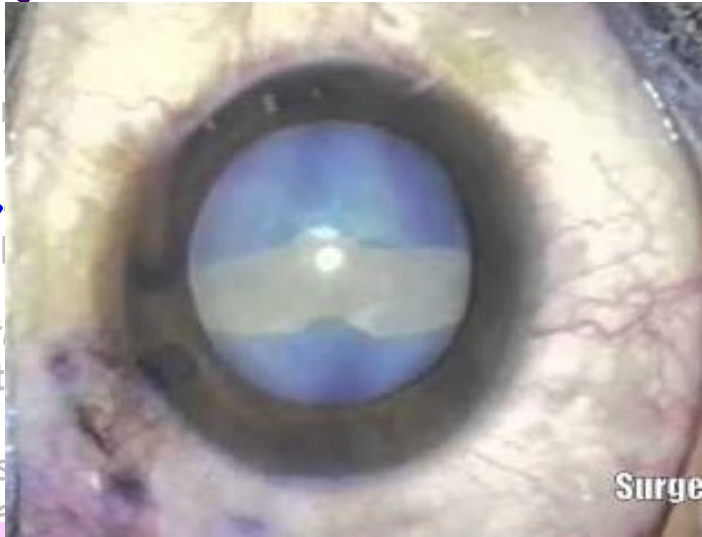
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Lens/Cataracts Overview



Surgeon

This appearance has led to a memorable name for this finding. What is it?

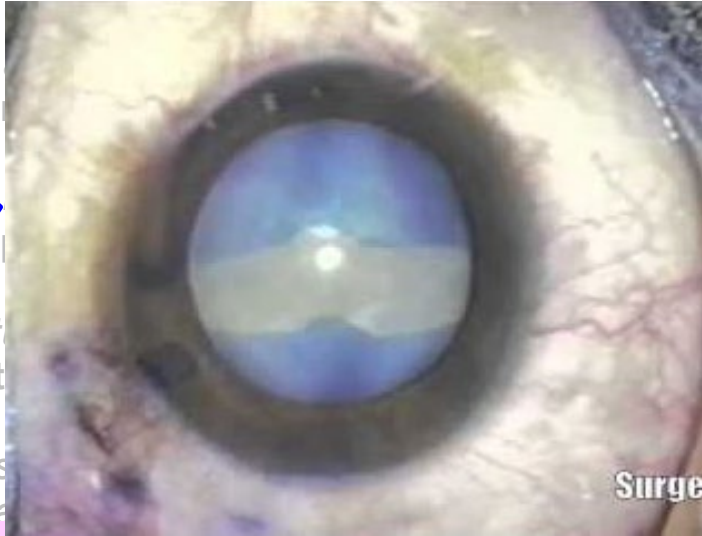
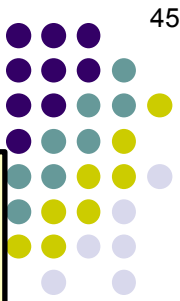
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Lens/Cataracts Overview



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It is known as '**Argentinian flag sign**'

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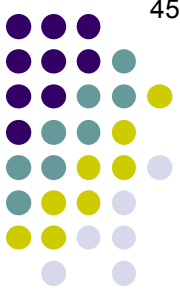
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When faced with an intumescent cataract, what can the surgeon do to minimize the likelihood of seeing an Argentinian flag?

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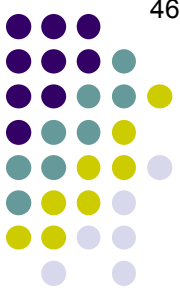
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- Counteract the positive pressure within the lens by filling the AC with a high-viscosity OVD
- Reduce intralenticular pressure by aspirating cortical material immediately upon creating the initial rent

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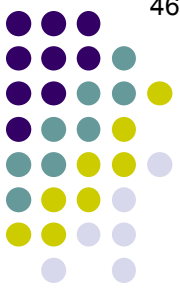
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Occasionally, the cortical material of an intumescent or mature cortical cataract will begin to degenerate and leach through the lens capsule. The accompanying loss of cataract mass will leave the posterior capsule with a wrinkled appearance. What is the name for such a cataract?

A **hypermature** cataract

Occasionally, the entire hypermature cataract liquefies, leaving only a wrinkled bag with an NSC resting at its bottom. What is the name for such a cataract?

A **morgagnian** cataract

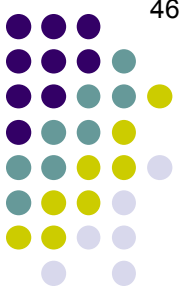
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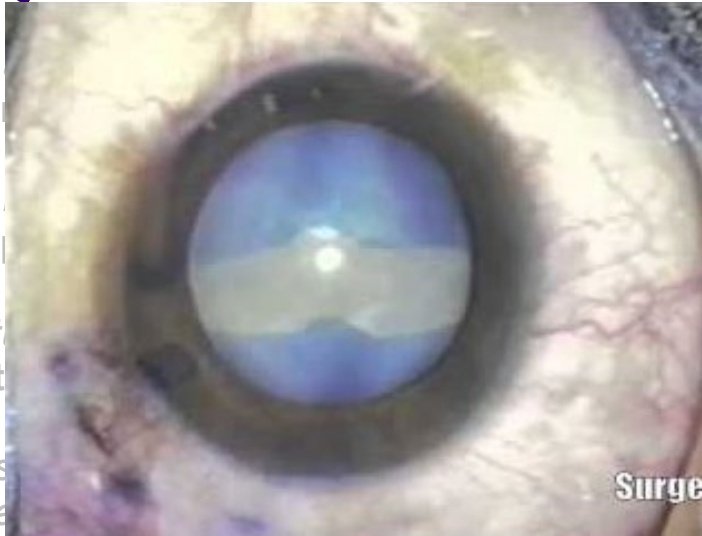
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Morgagnian
cataract

↑



Lens/Cataracts Overview



Are hypermature and/or morgagnian cataracts susceptible to an Argentinian flag-sign event?

Take note of the stages:

Mature cataract → intumescent cataract → hypermature cataract

Morgagnian cataract

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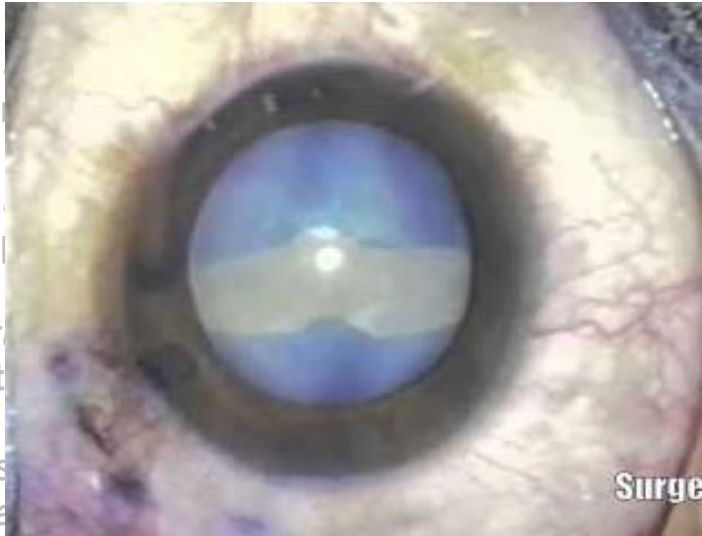
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Lens/Cataracts Overview



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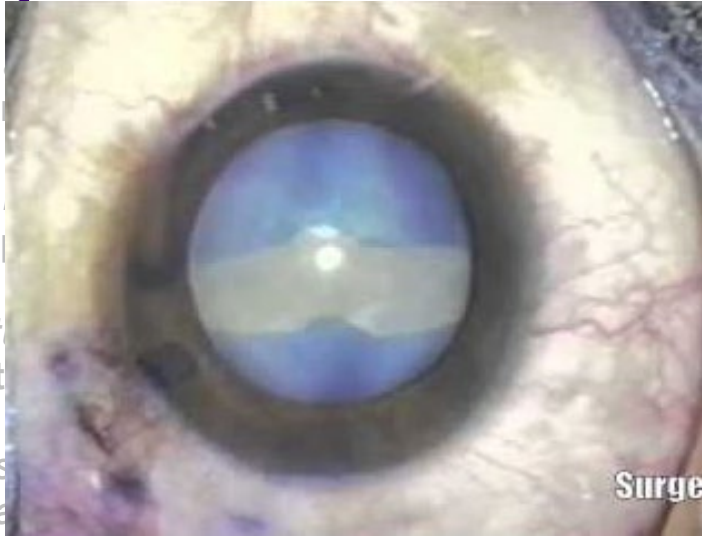
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Lens/Cataracts Overview



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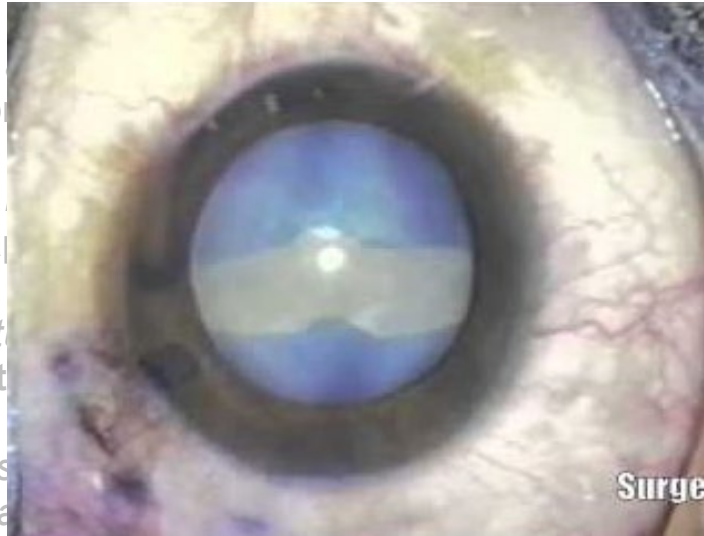
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Because the loss of water removes the hydrostatic pressure that causes it

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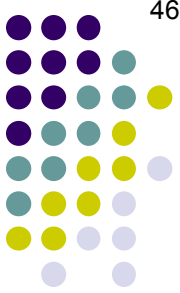
Morgagnian cataract

Cataract **leaks** water

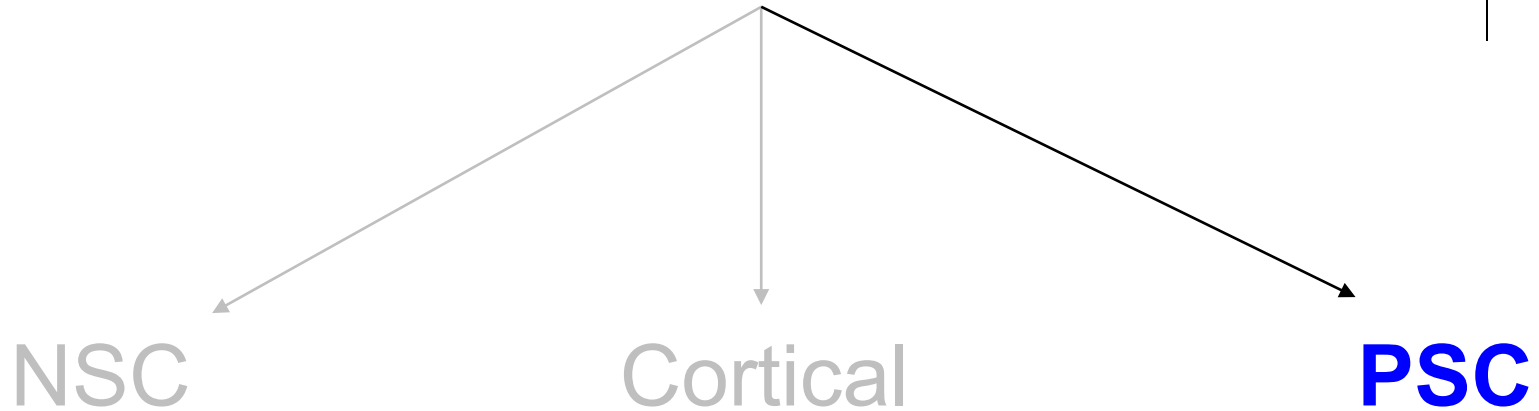
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Lens/Cataracts Overview

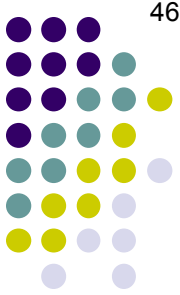
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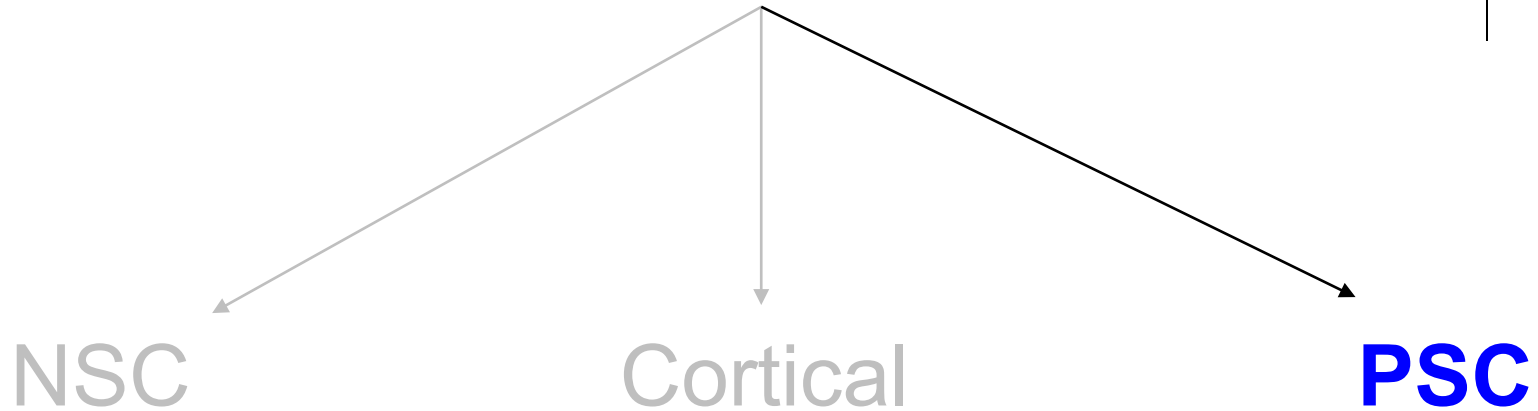
What are the three age-related types of cataracts?



All PSCs are not visually significant. What attribute is needed to make them so?



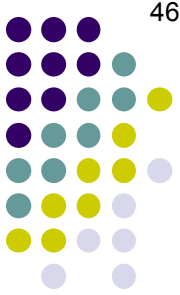
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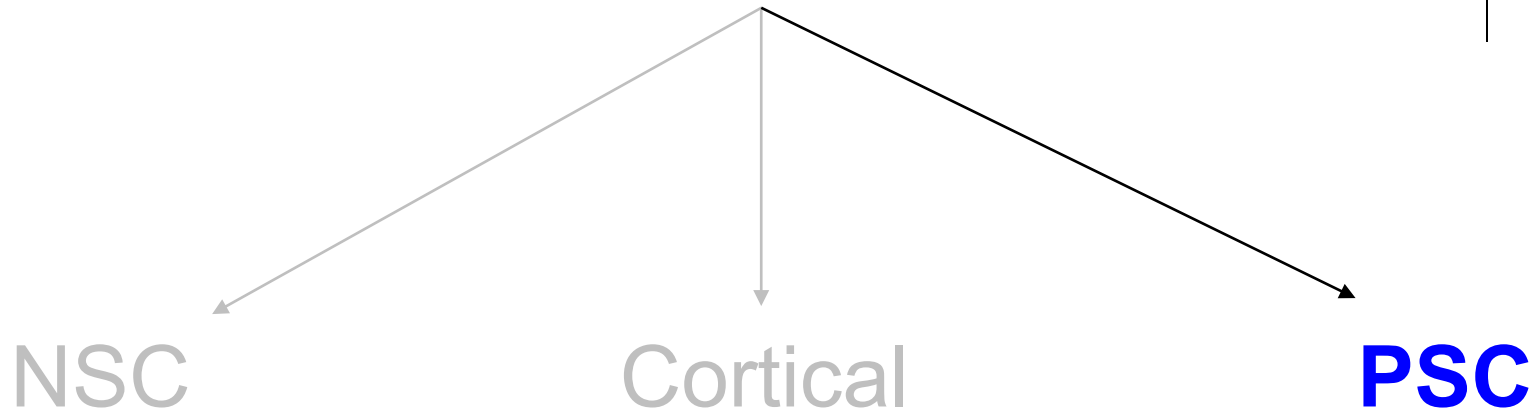
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Being located in the

two words

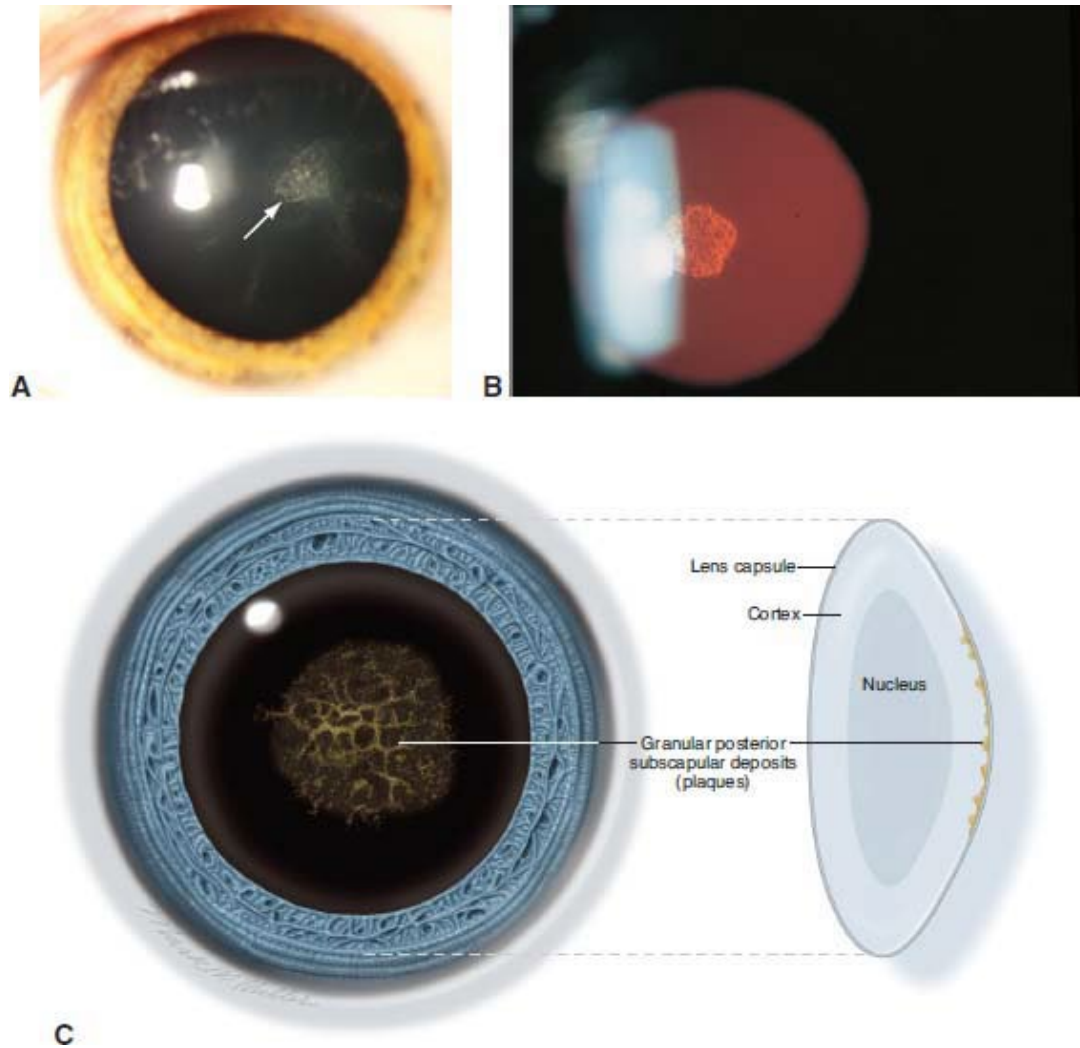


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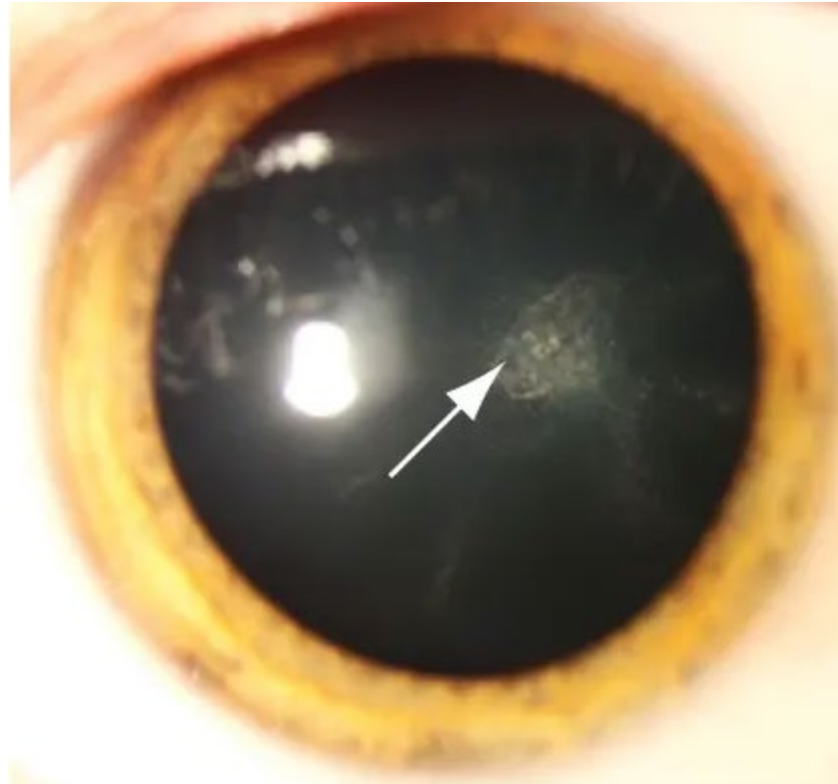
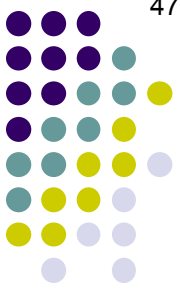
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Lens/Cataracts Overview

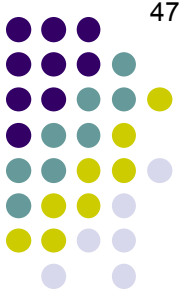


Posterior subcapsular cataract

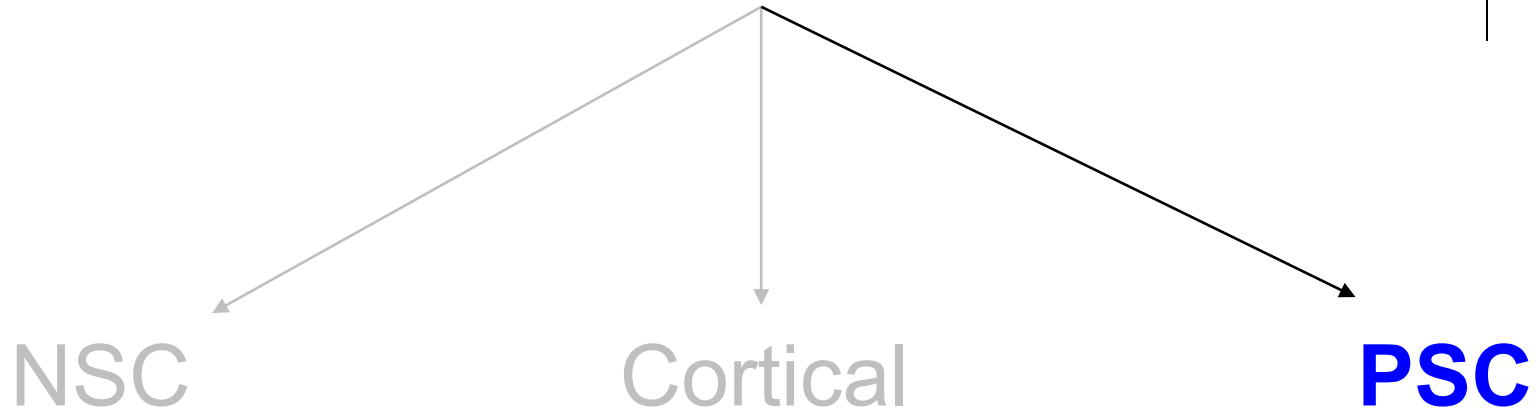
Lens/Cataracts Overview



Posterior subcapsular cataract as seen at the slit lamp

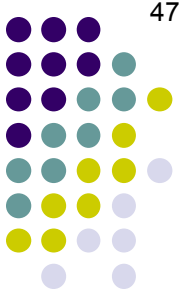


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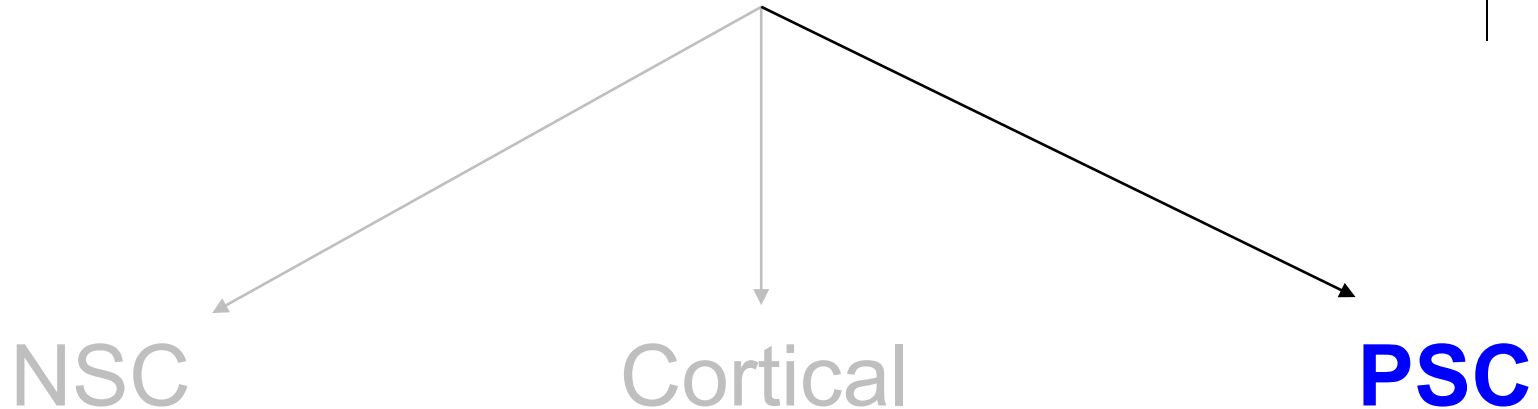


All PSCs are not visually significant. What attribute is needed to make them so?
Being located in the visual axis

What is the first, basic step in PSC pathophysiology?

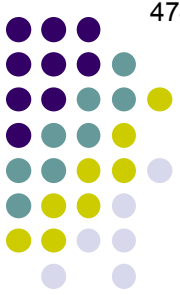


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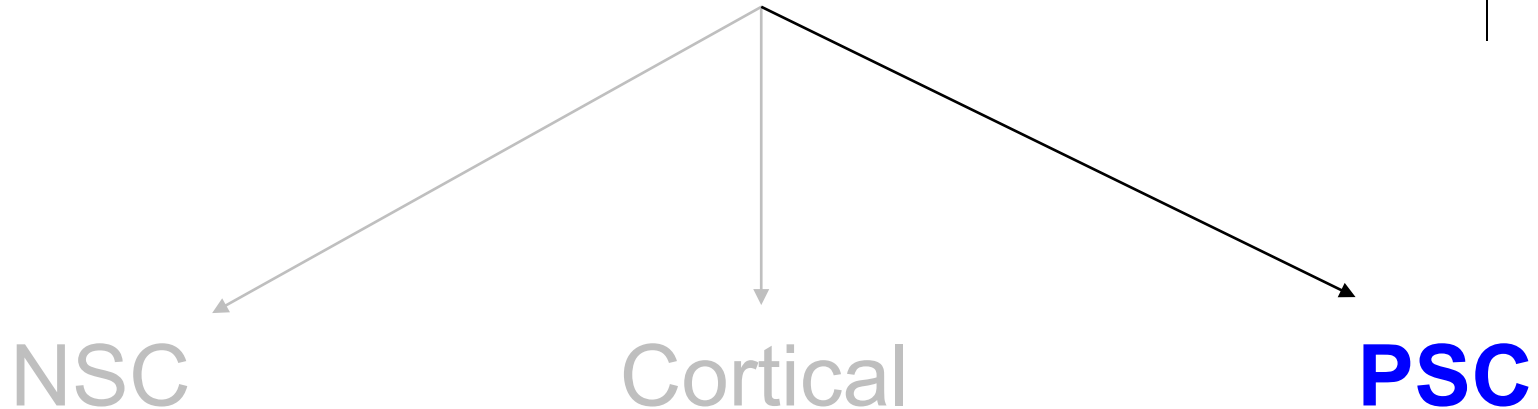


All PSCs are not visually significant. What attribute is needed to make them so?
Being located in the visual axis

What is the first, basic step in PSC pathophysiology?
Migration of two words cells to the posterior capsule

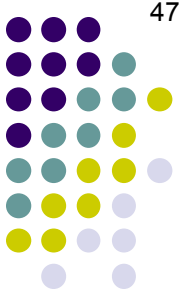


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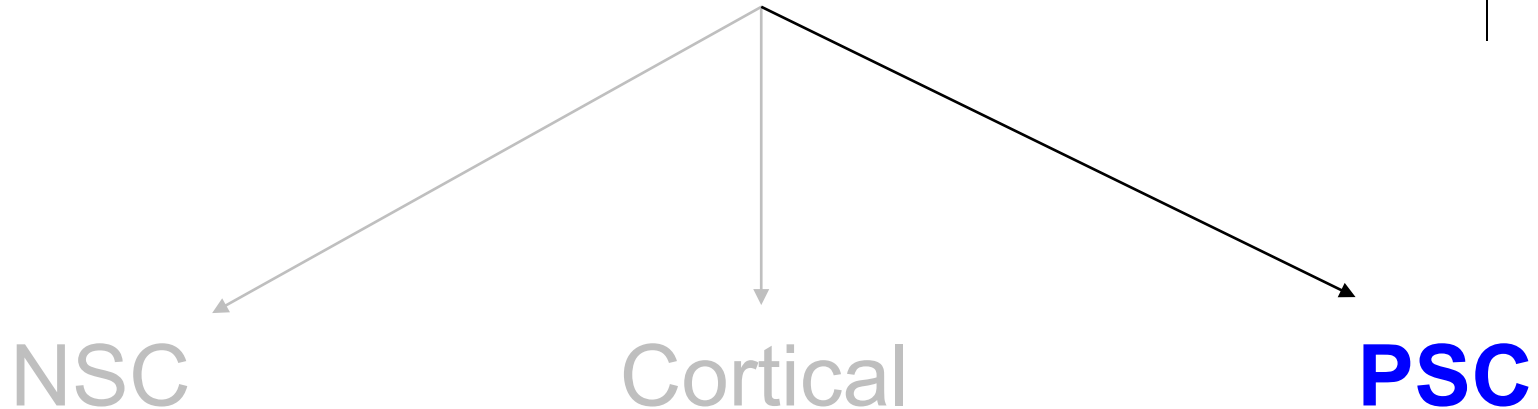


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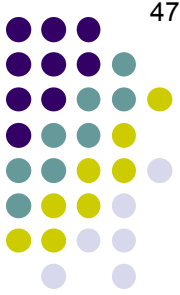
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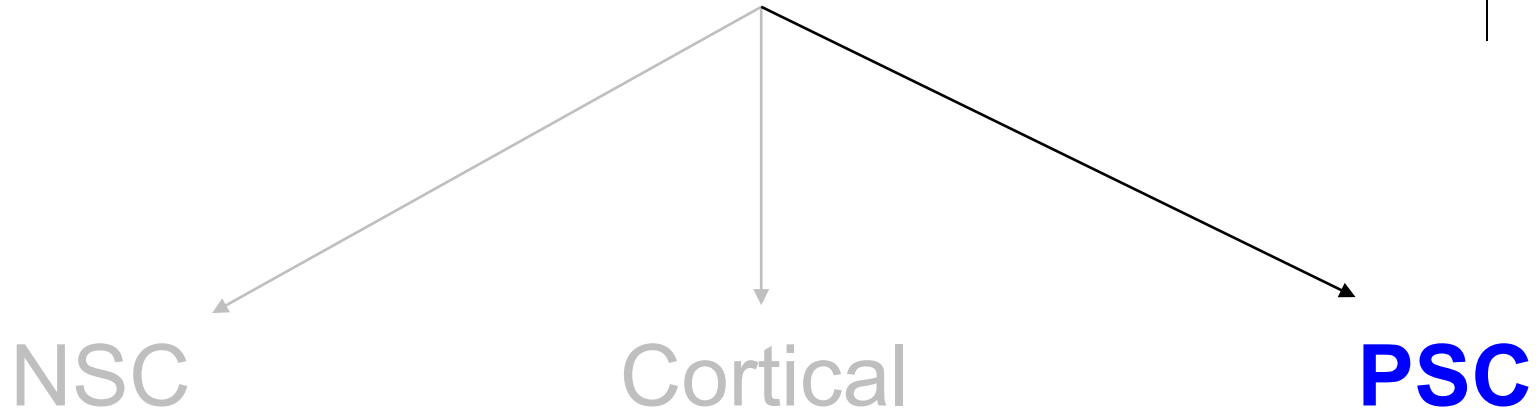
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How does equatorial epi-cell migration produce a PSC?



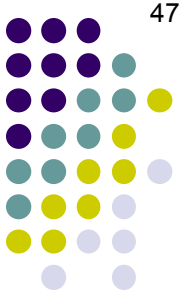
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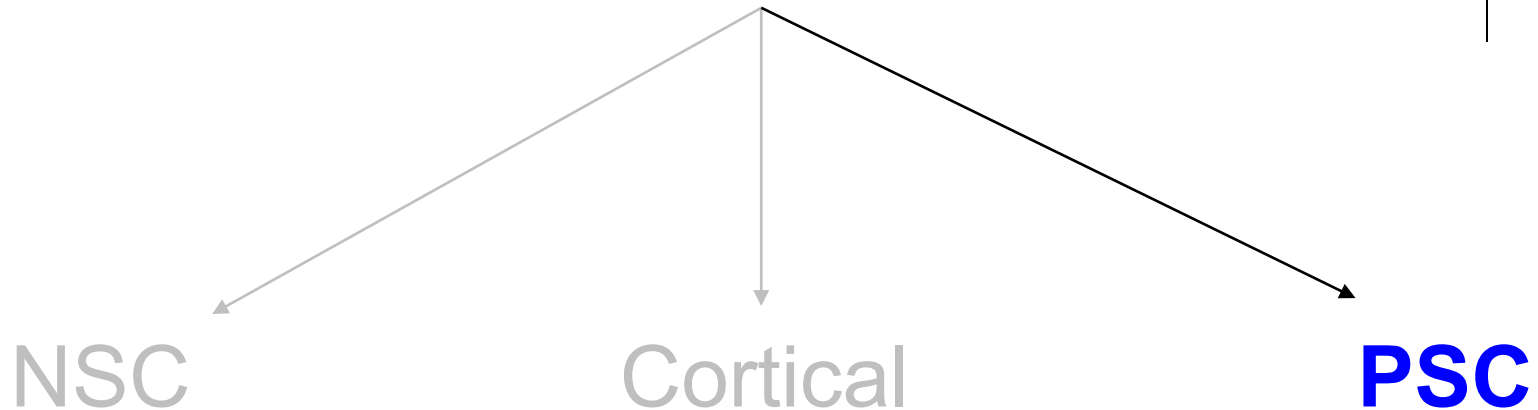
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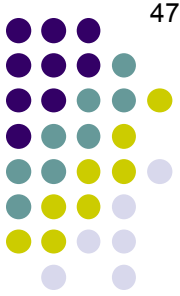
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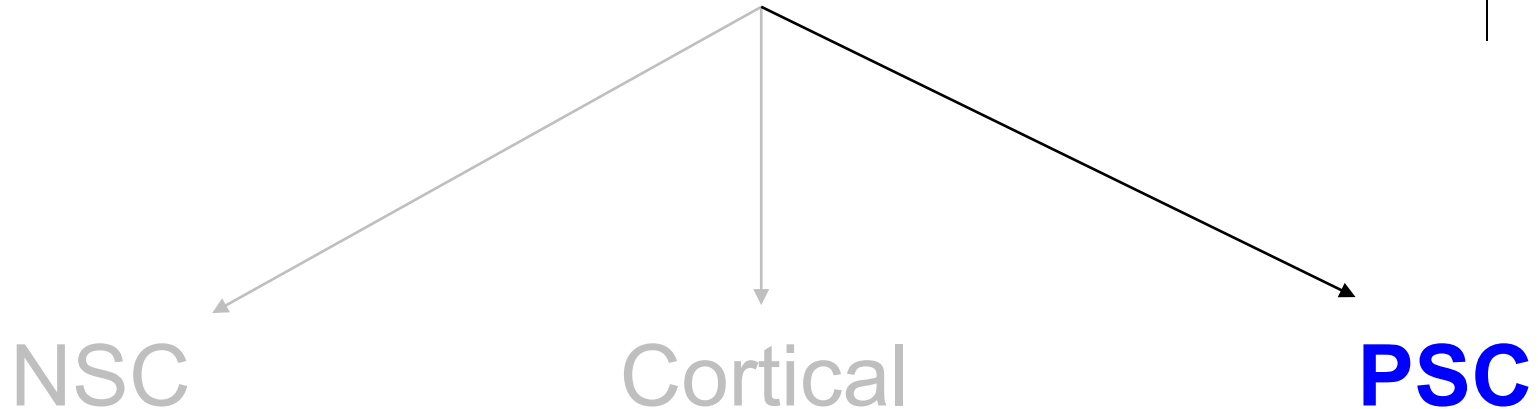
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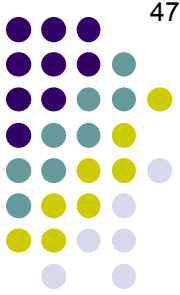
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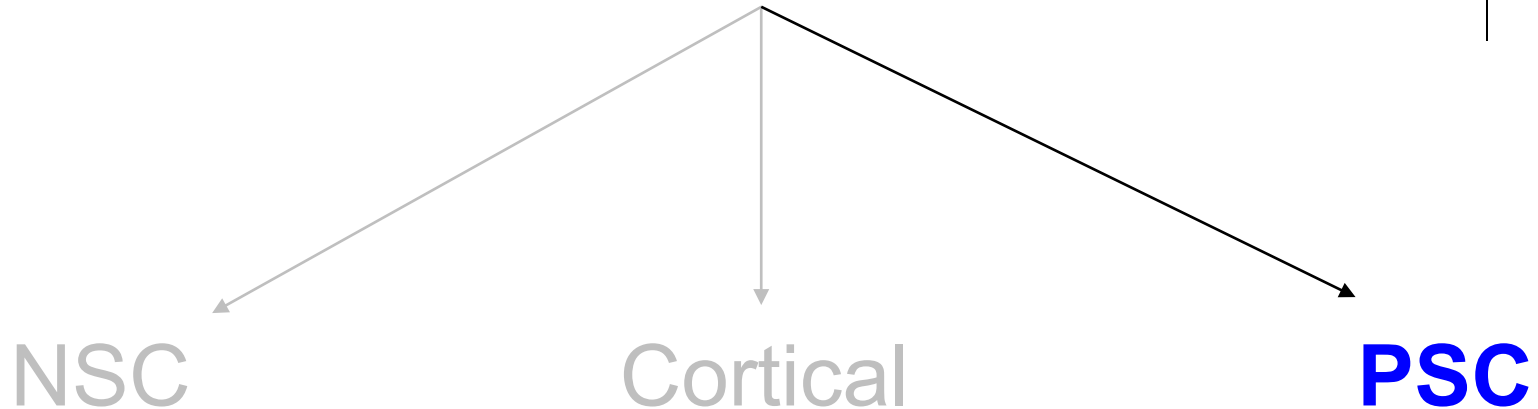
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Q

Lens/Cataracts Overview



What are the three age-related types of cataracts?



All PSCs are not visually significant. What attribute is needed to make them so?

By what name are these cells known? (I assume they're not called 'swole cells' by the good folks at the Academy.)

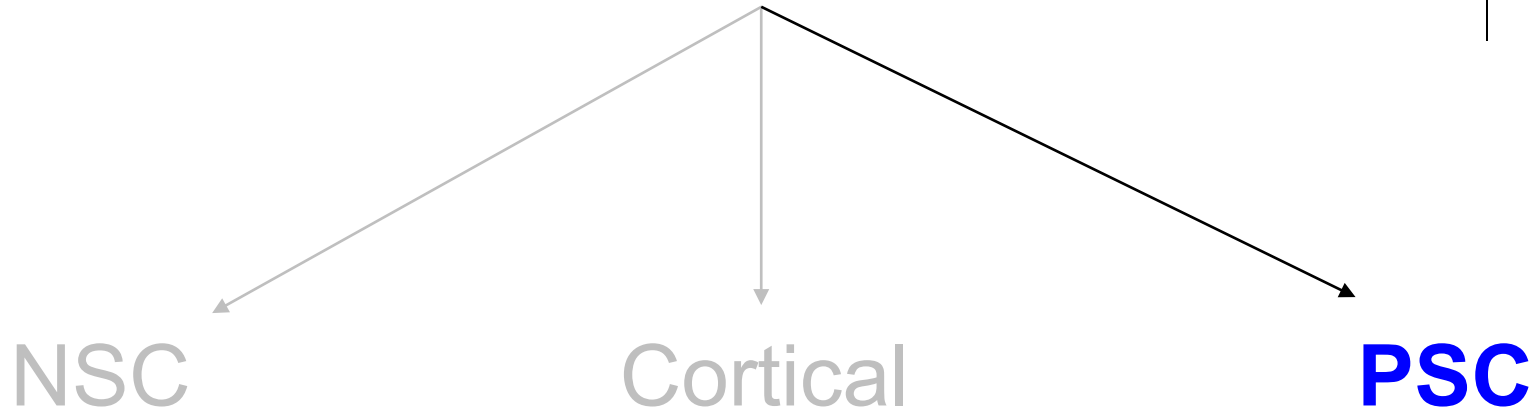
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Lens/Cataracts Overview



What are the three age-related types of cataracts?



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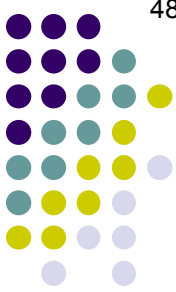
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They're called 'bladder cells'

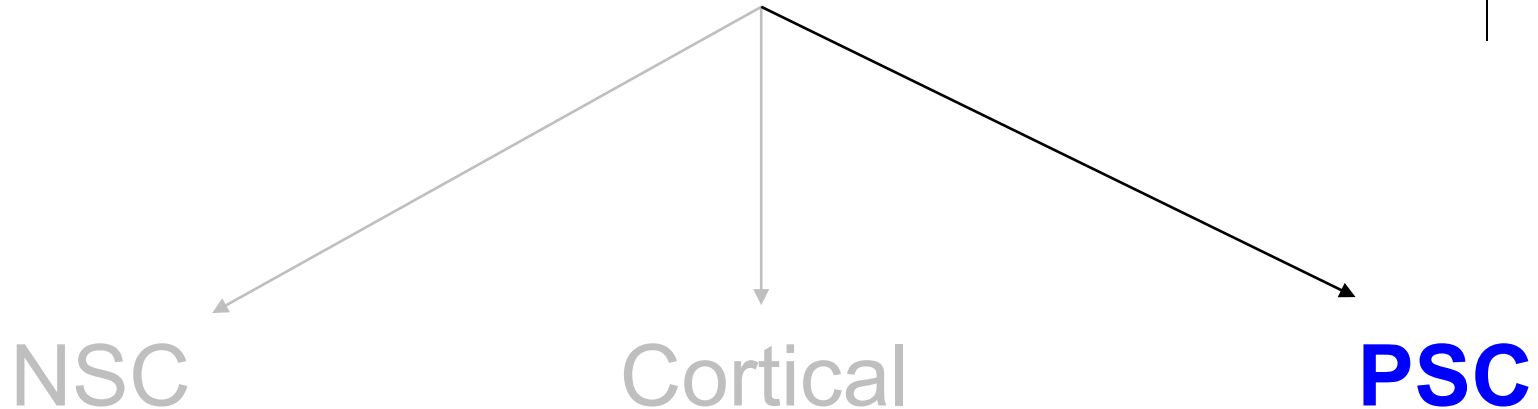
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Lens/Cataracts Overview



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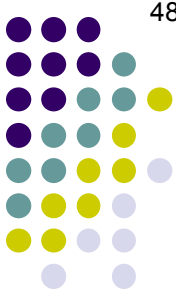
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Like everything else in ophthalmology, I assume also they have an eponymous name. What is it?

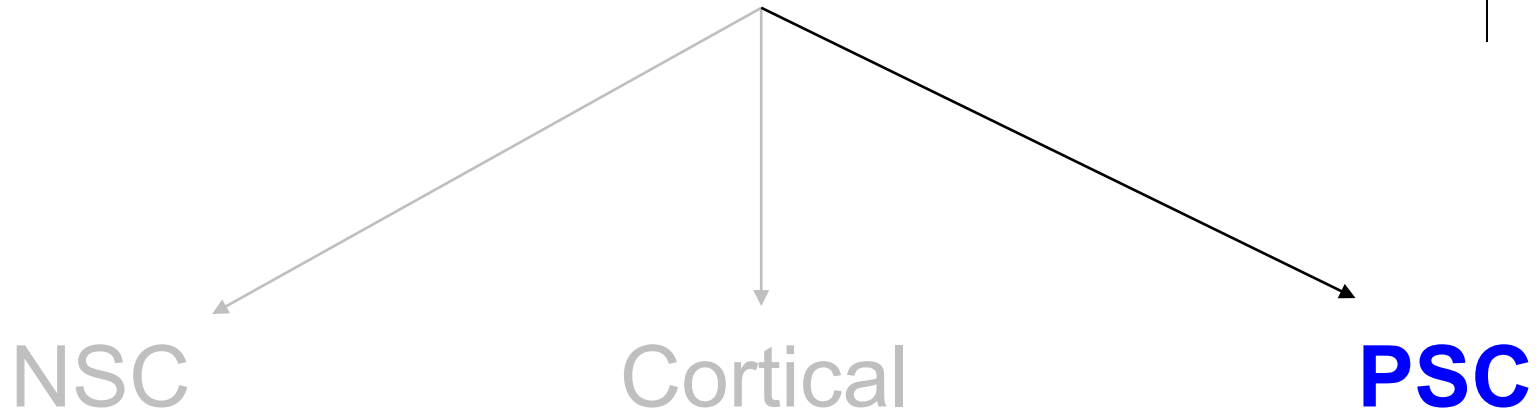
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Lens/Cataracts Overview



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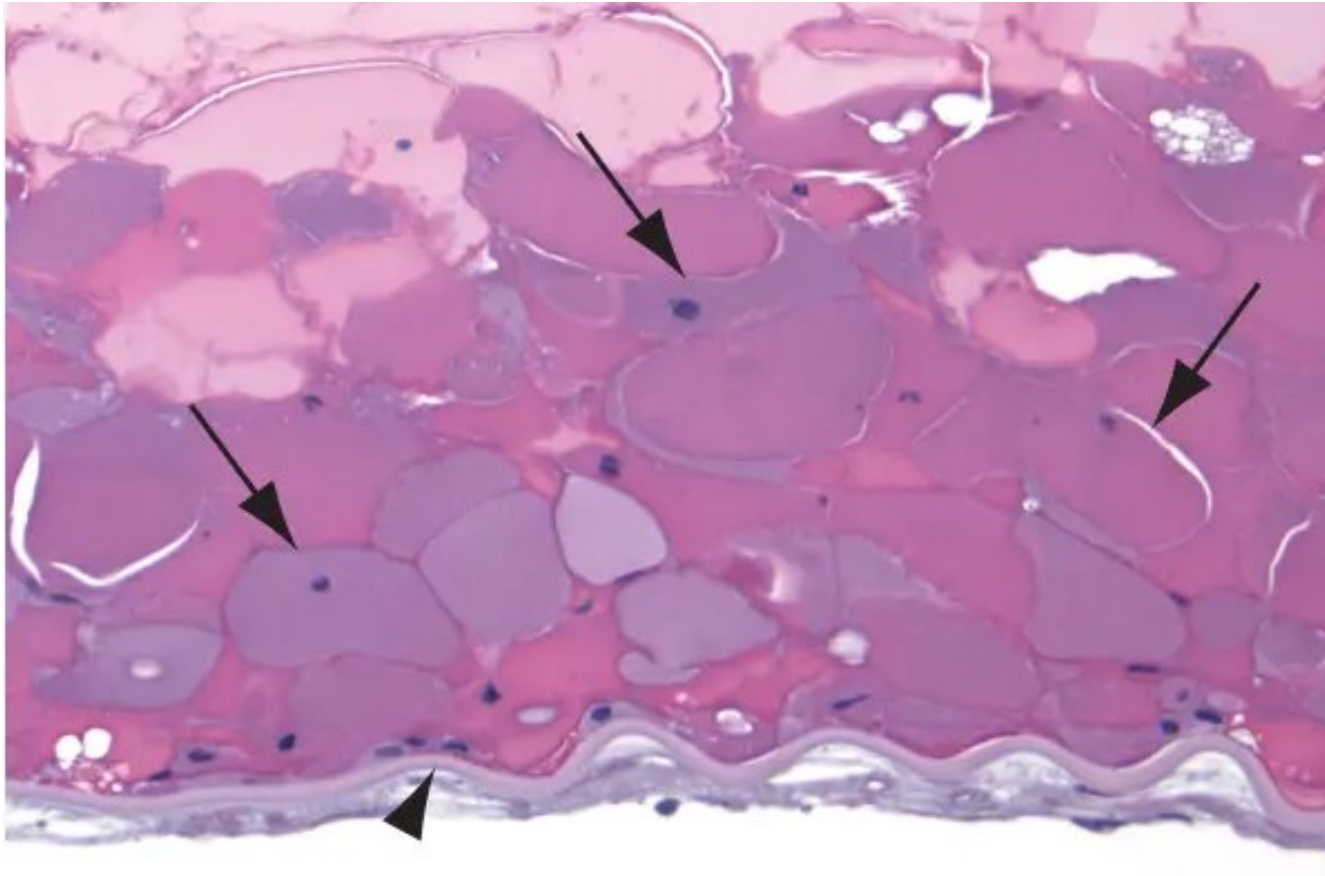
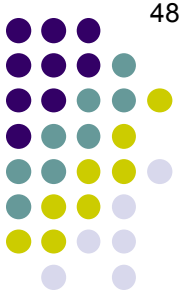
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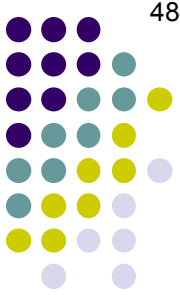
Lens/Cataracts Overview



Posterior subcapsular cataract. Oval to round nucleated Wedl cells (*arrows*) and smaller lens epithelial cells line the posterior lens capsule (*arrowhead*).

Q

Lens/Cataracts Overview



What are the three age-related types of cataracts?

Relevant sidebar: In eye-dentistry, what does PCO stand for?

PSC

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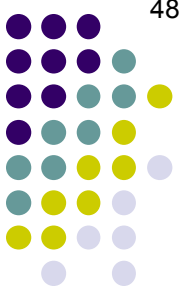
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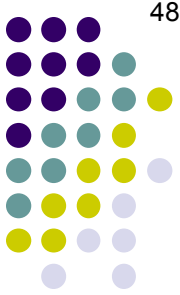
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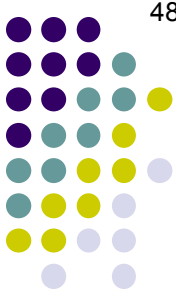
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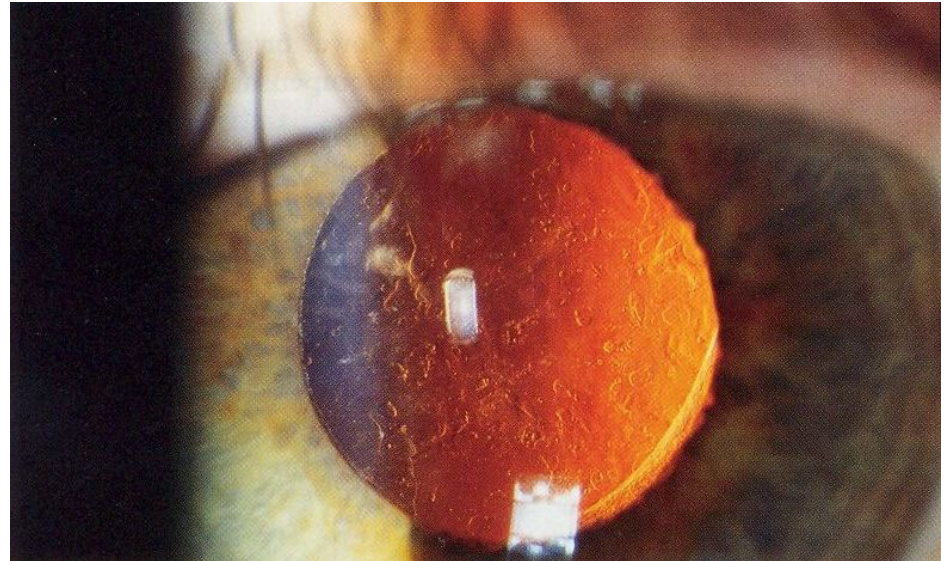
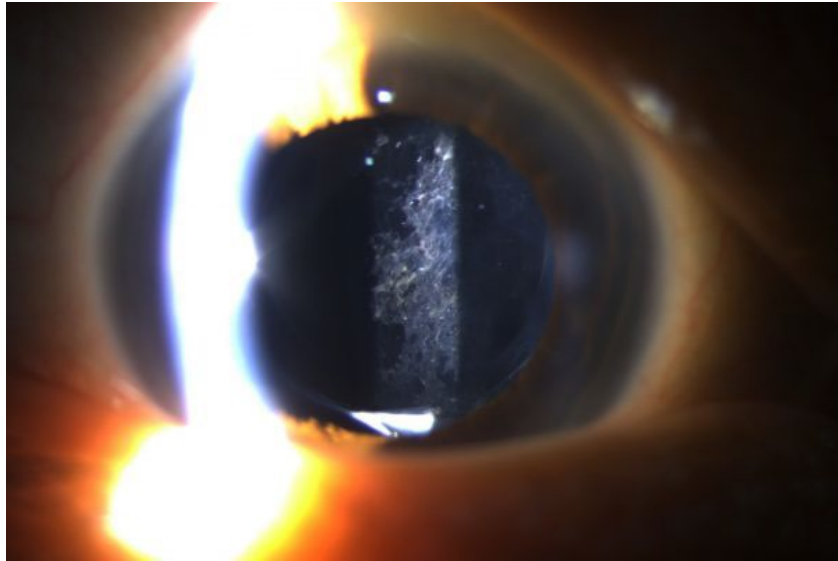
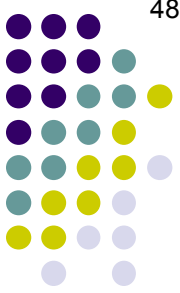
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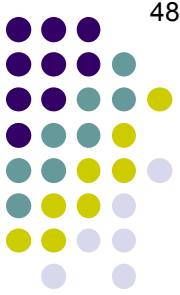
Lens/Cataracts Overview



PCO



Lens/Cataracts Overview



What are the three age-related types of cataracts?

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What proportion of s/p CE eyes will develop a PCO?

PSC

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visual axis

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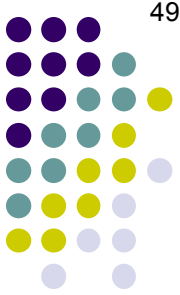
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Up to half

PSC

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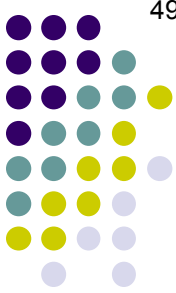
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all?
none?

PSC

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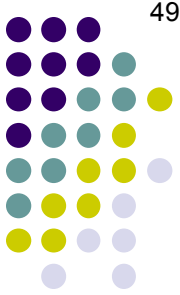
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PSC

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What are the 'swollen cells' by the visual axis?

What is the physiology?

What is the anterior capsule?

What is the anonymous name.

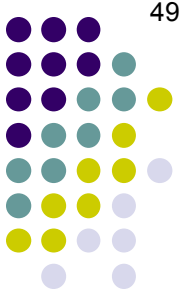
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Lens/Cataracts Overview



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PSC

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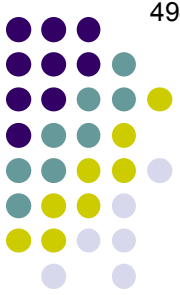
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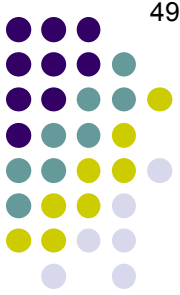
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Lens/Cataracts Overview



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PSC

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...swollen cells' by the

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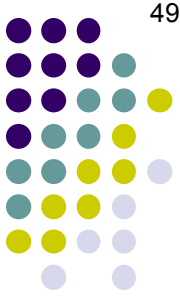
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Is it considered a surgical complication?

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Are we talking about PCOs at this juncture because they have something in common with PSCs?

Indeed we are. As like PSCs, PCOs involve the migration (and swelling) of equatorial epi cells across the PC.

PSC

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cause a PSC?

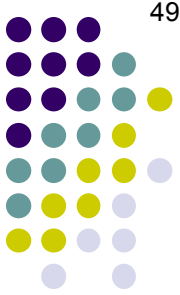
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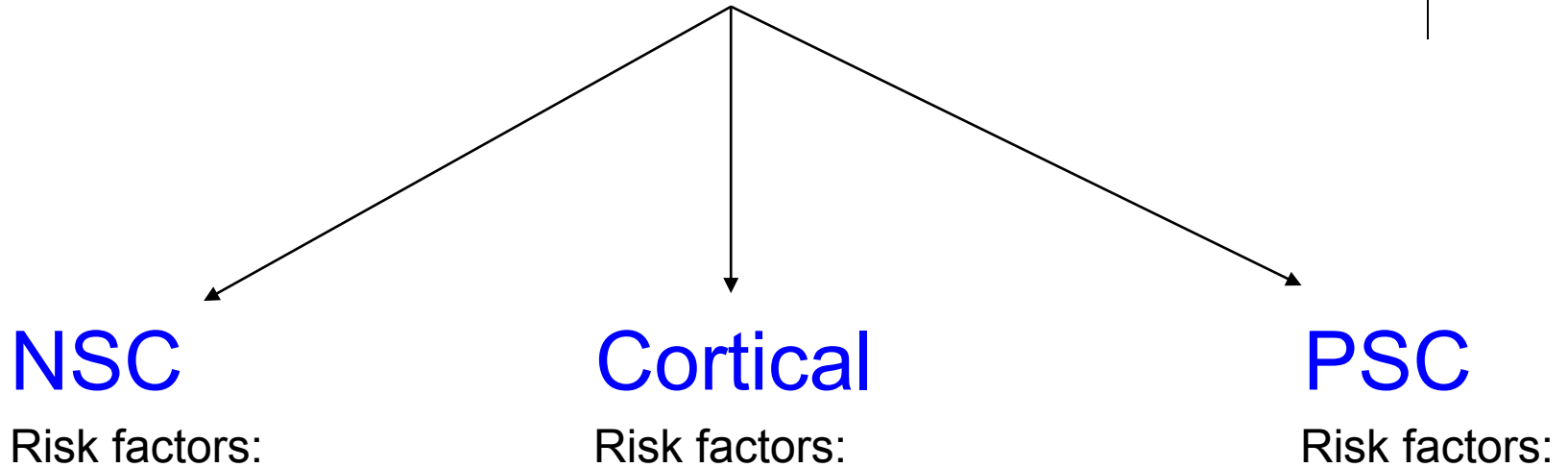
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Lens/Cataracts Overview

498

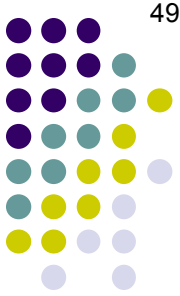


What are the three age-related types of cataracts?



For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Steroids



What are the three age-related types of cataracts?

NSC

Risk factors:

Cortical

Risk factors:

PSC

Risk factors:

--Steroids

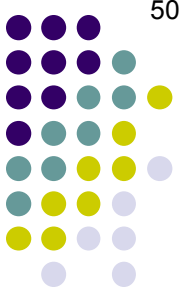
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Steroids

Q

Lens/Cataracts Overview

500



Which of the following routes of steroid administration have been associated with cataract formation:

- Topical?
- Subconjunctival?
- Sub-Tenon's?
- Intravitreal?
- PO?
- IV?
- Inhaled?
- Intranasal?

PSC

Risk factors:

--**Steroids**

ociated

Steroids

A

Lens/Cataracts Overview

501



Which of the following routes of steroid administration have been associated with cataract formation:

- Topical
- Subconjunctival
- Sub-Tenon's
- Intravitreal
- PO
- IV
- Inhaled
- Intranasal

All have been associated with PSC formation!

PSC

Risk factors:

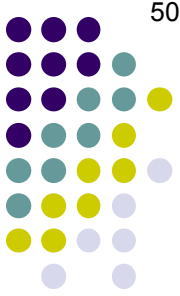
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Q

Lens/Cataracts Overview



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Pts with a propensity to develop a steroid-induced PSC are susceptible to another steroid-related complication—what is it?

PSC

Risk factors:

--**Steroids**

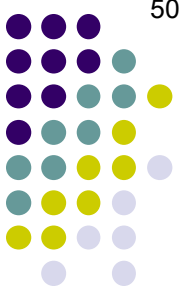
ociated

Steroids

A

Lens/Cataracts Overview

503



Which of the following routes of steroid administration have been associated with cataract formation:

- Topical
- Subconjunctival
- Sub-Tenon's
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- PO
- IV
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- Intranasal

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Ocular hypertension

PSC

Risk factors:

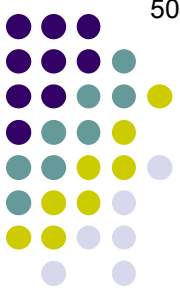
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Steroids



Lens/Cataracts Overview



Which of the following routes of steroid administration have been associated with cataract formation:

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Pts with a propensity to develop a steroid-induced PSC are susceptible to another steroid-related complication—what is it?

Ocular hypertension

Steroid-induced PSCs in children differ in an important way from steroid-induced PSCs in adults. What is it?

PSC

Risk factors:

--**Steroids**

ociated

Steroids



Which of the following routes of steroid administration have been associated with cataract formation:

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- Intravitreal*
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- Intranasal*

Pts with a propensity to develop a steroid-induced PSC are susceptible to another steroid-related complication—what is it?

Ocular hypertension

Steroid-induced PSCs in children differ in an important way from steroid-induced PSCs in adults. What is it?

Cessation of steroid therapy in children may result in regression and resolution of the PSC (this does not occur in adults)

PSC

Risk factors:

--**Steroids**

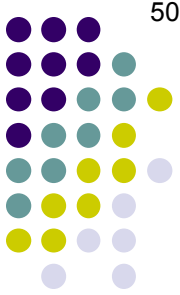
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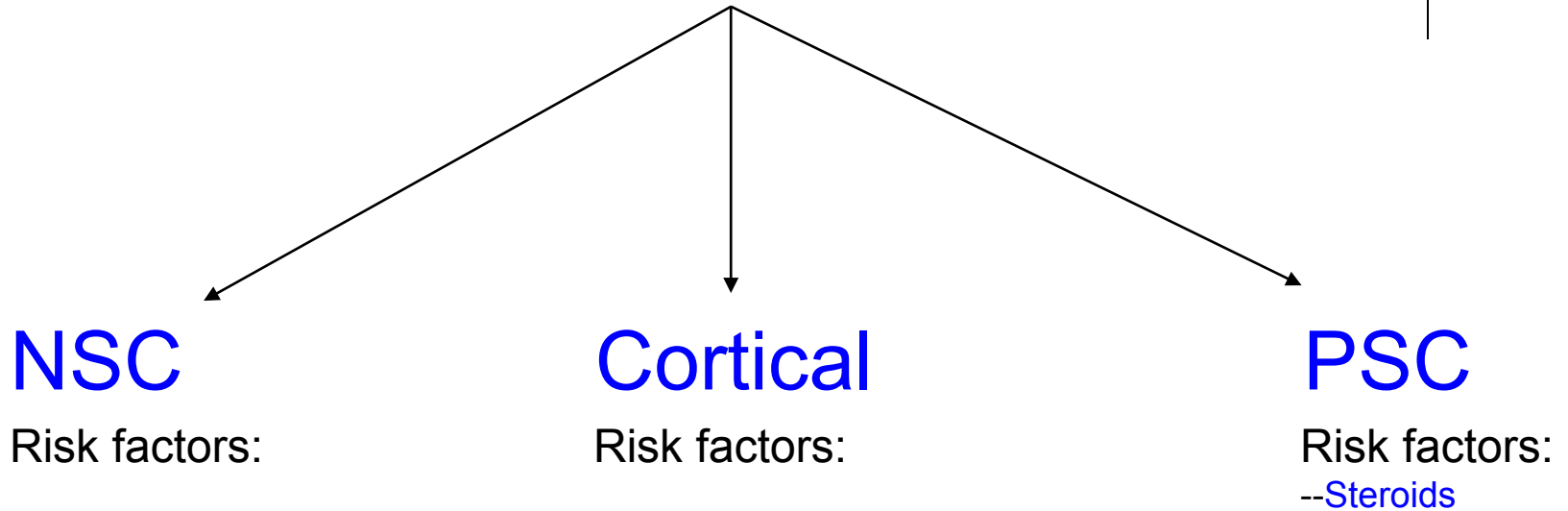
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Lens/Cataracts Overview

506

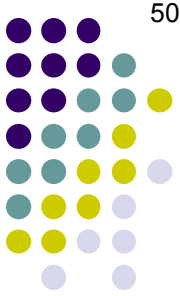


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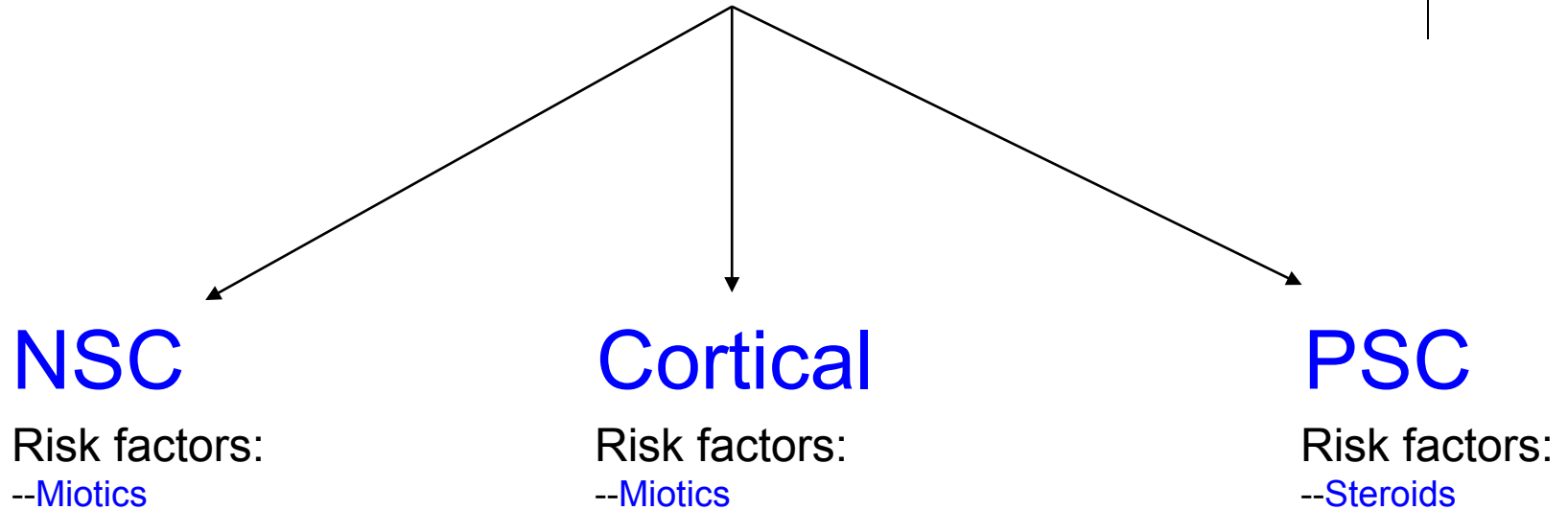


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Miotics

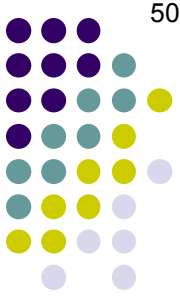


What are the three age-related types of cataracts?



For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

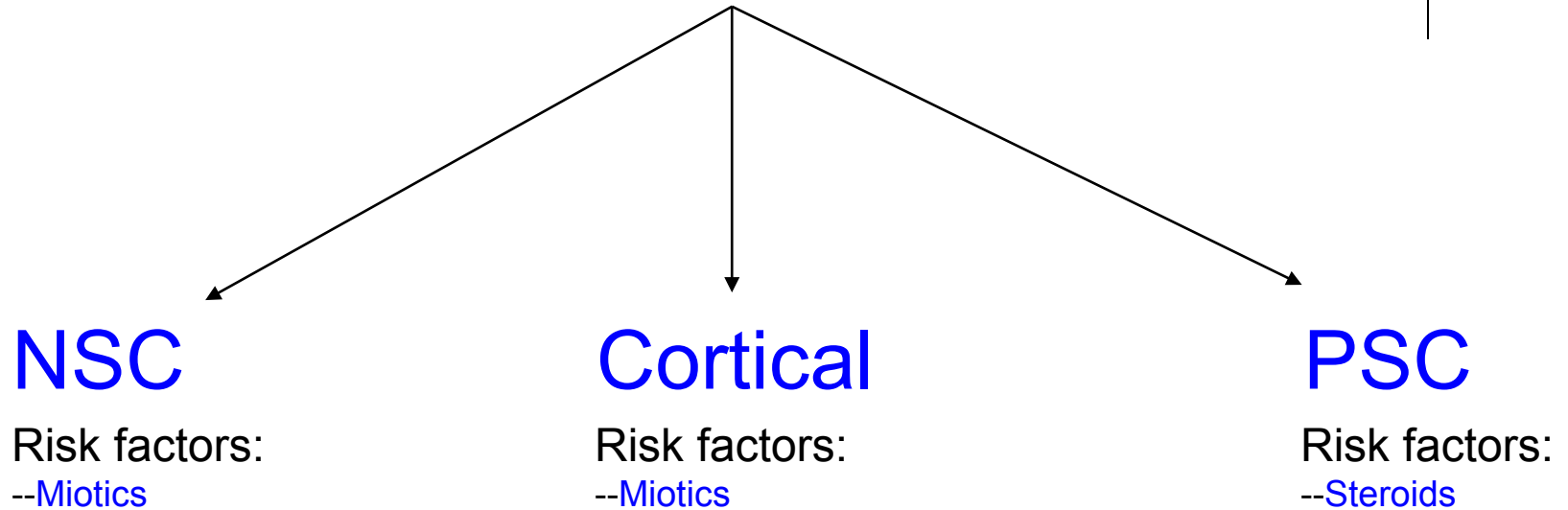
Miotics



Q

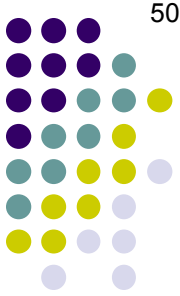
Lens/Cataracts Overview

What are the three age-related types of cataracts?

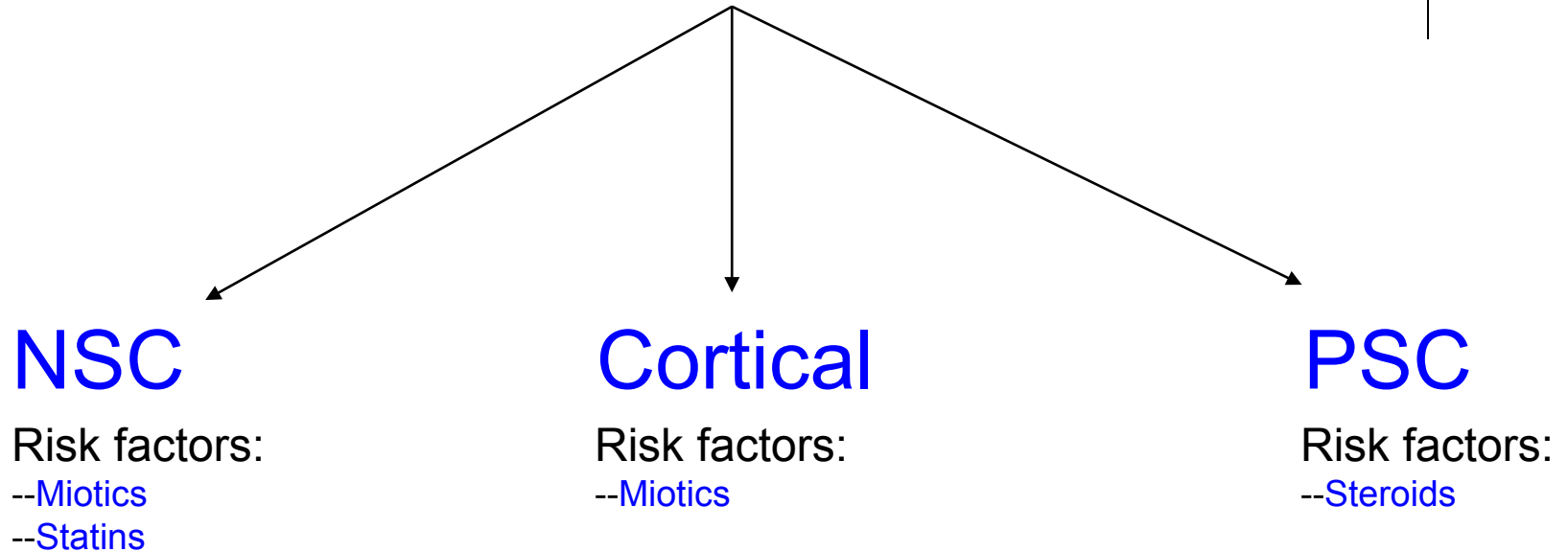


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Statins



What are the three age-related types of cataracts?



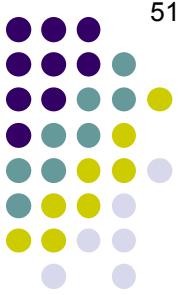
For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Statins

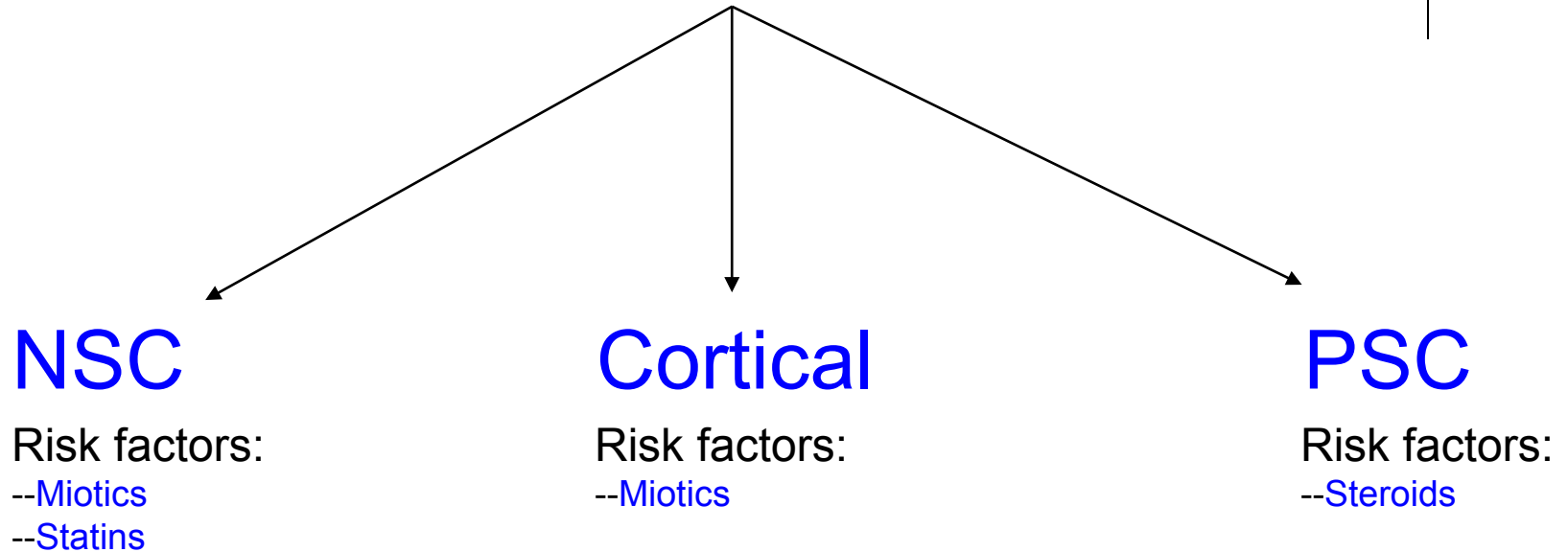
Q

Lens/Cataracts Overview

510

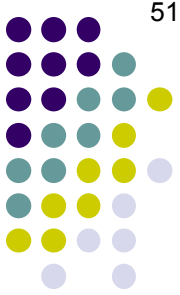


What are the three age-related types of cataracts?

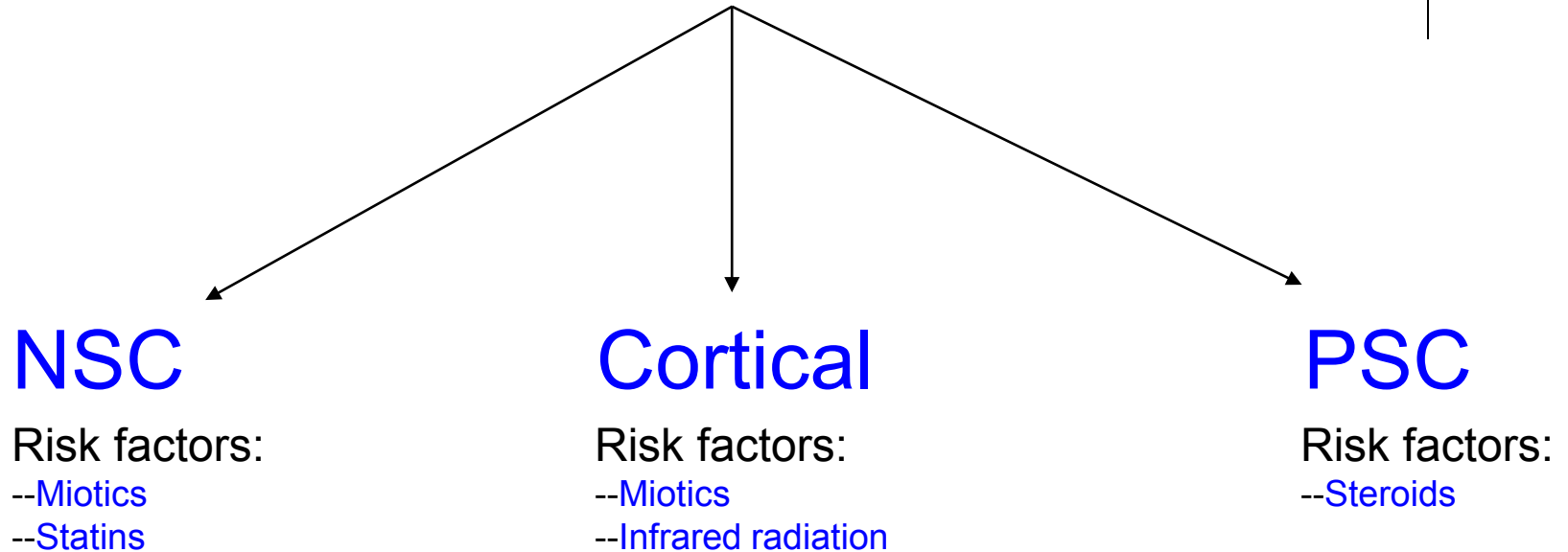


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Infrared radiation



What are the three age-related types of cataracts?



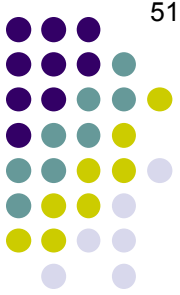
For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Infrared radiation

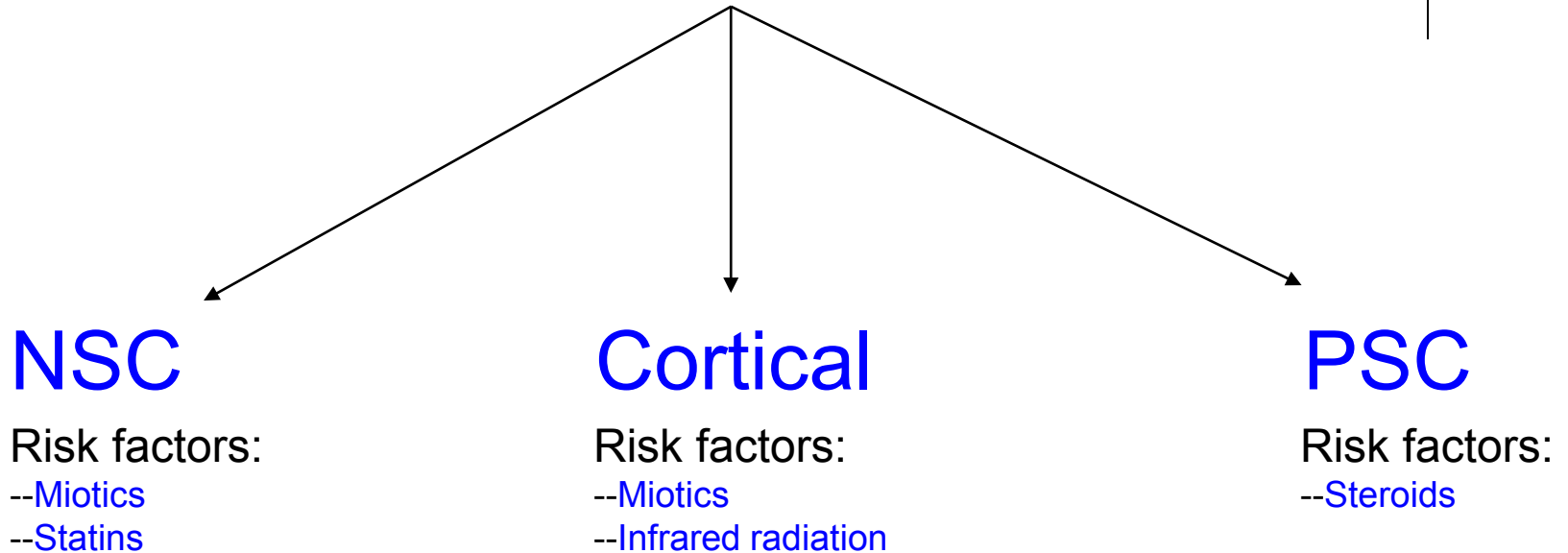
Q

Lens/Cataracts Overview

512

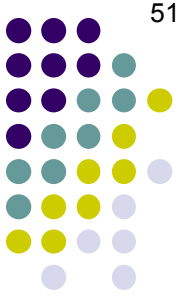


What are the three age-related types of cataracts?

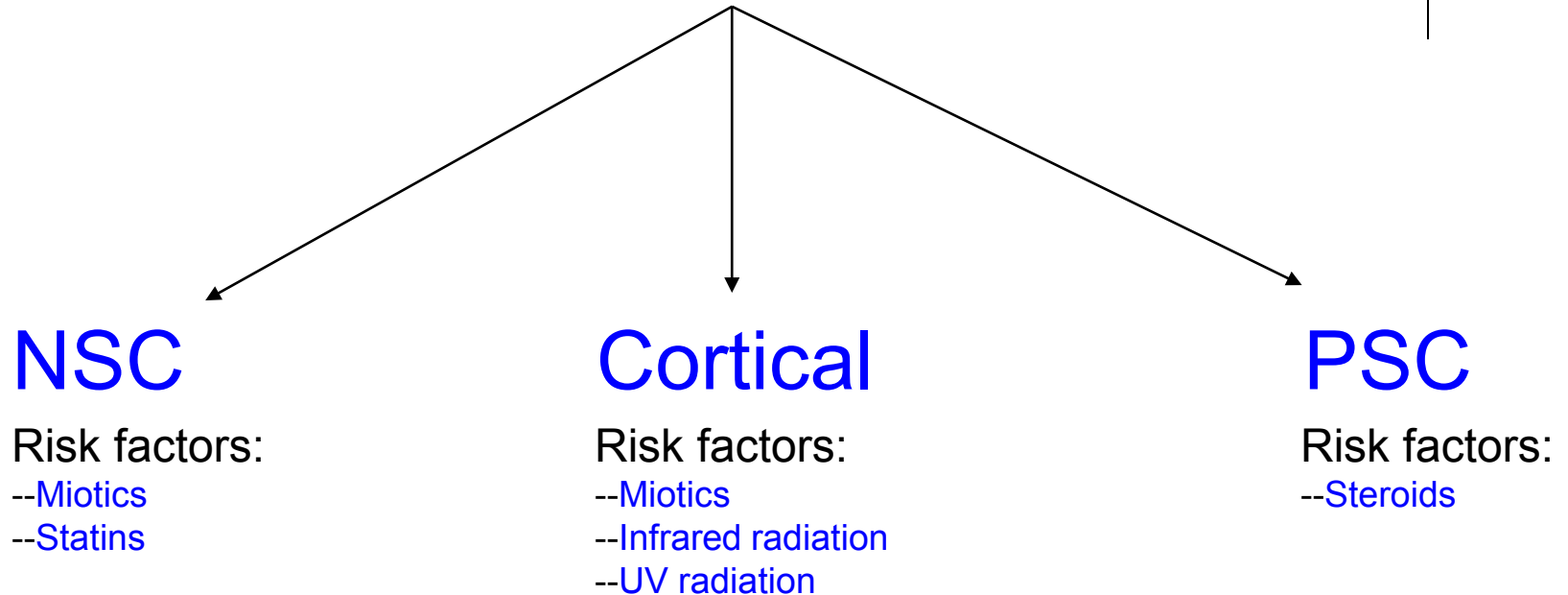


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

UV radiation

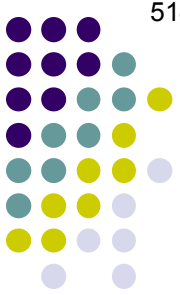


What are the three age-related types of cataracts?

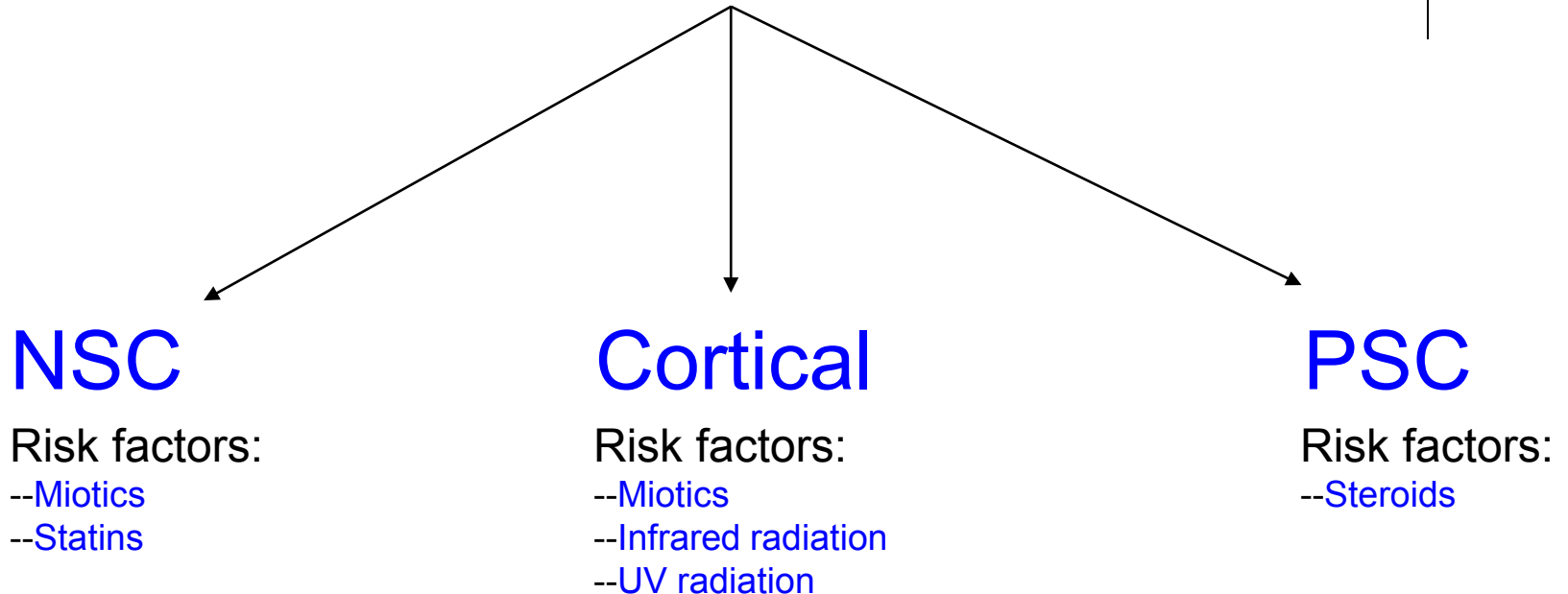


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

UV radiation

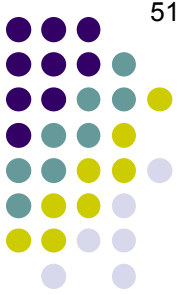


What are the three age-related types of cataracts?

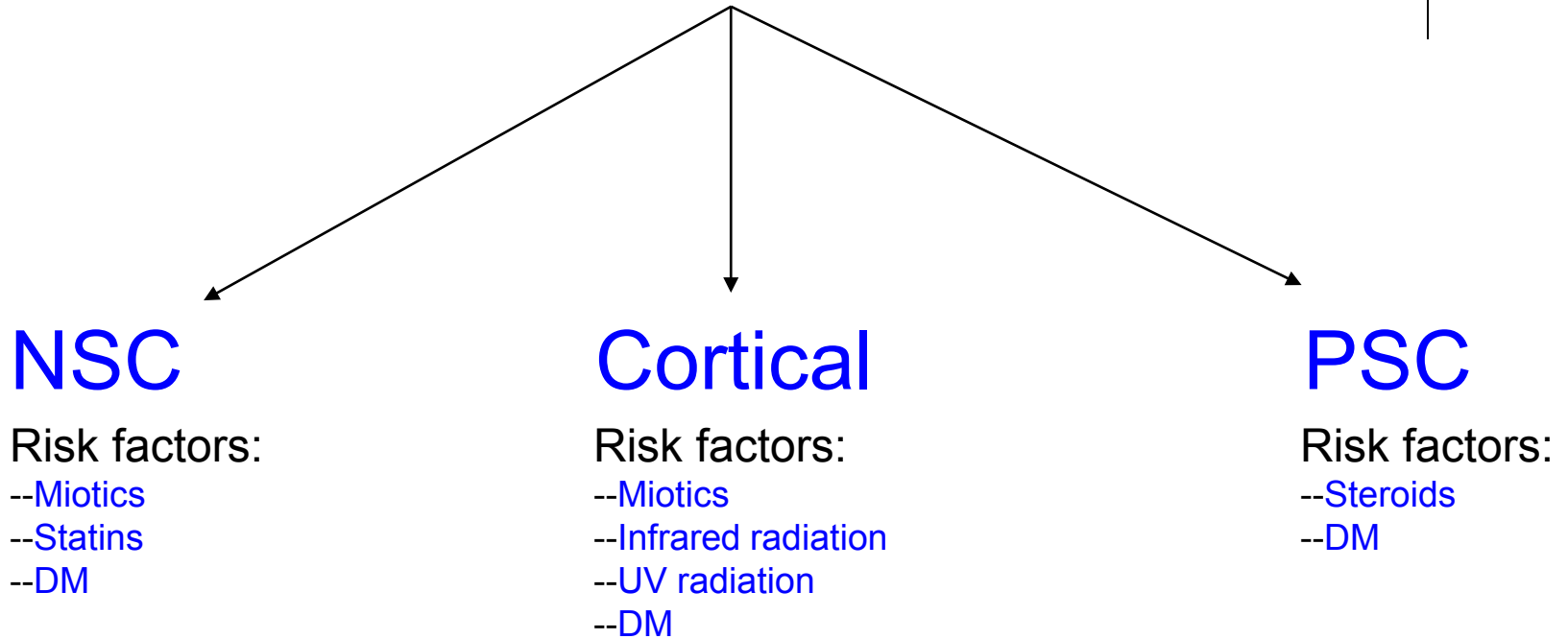


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Diabetes mellitus

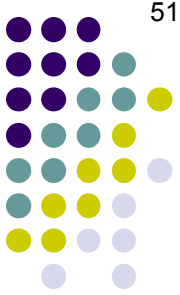


What are the three age-related types of cataracts?

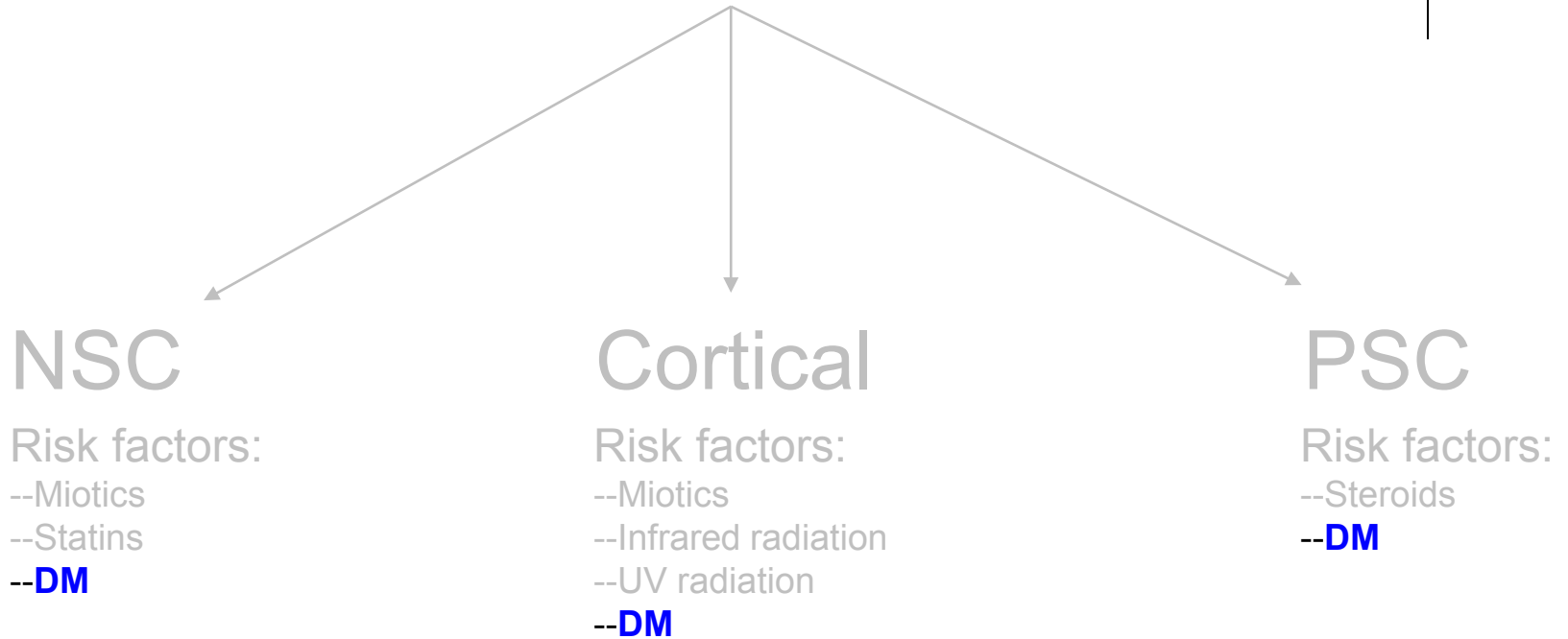


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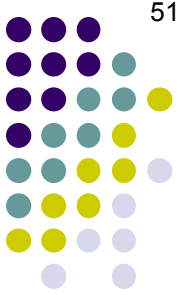
What are the three age-related types of cataracts?



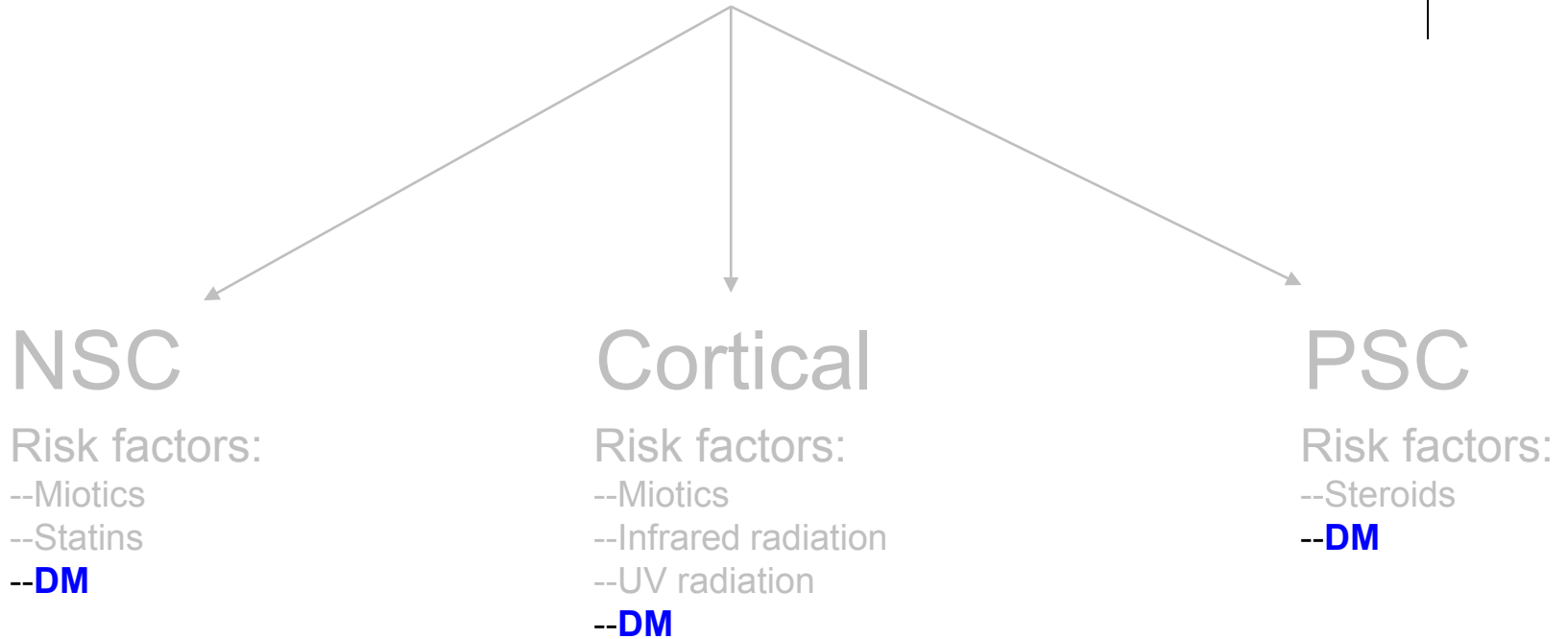
How do diabetes-related NSCs, cortical cataracts, and PSCs differ from those associated with age?

For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Diabetes mellitus



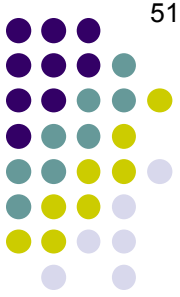
What are the three age-related types of cataracts?



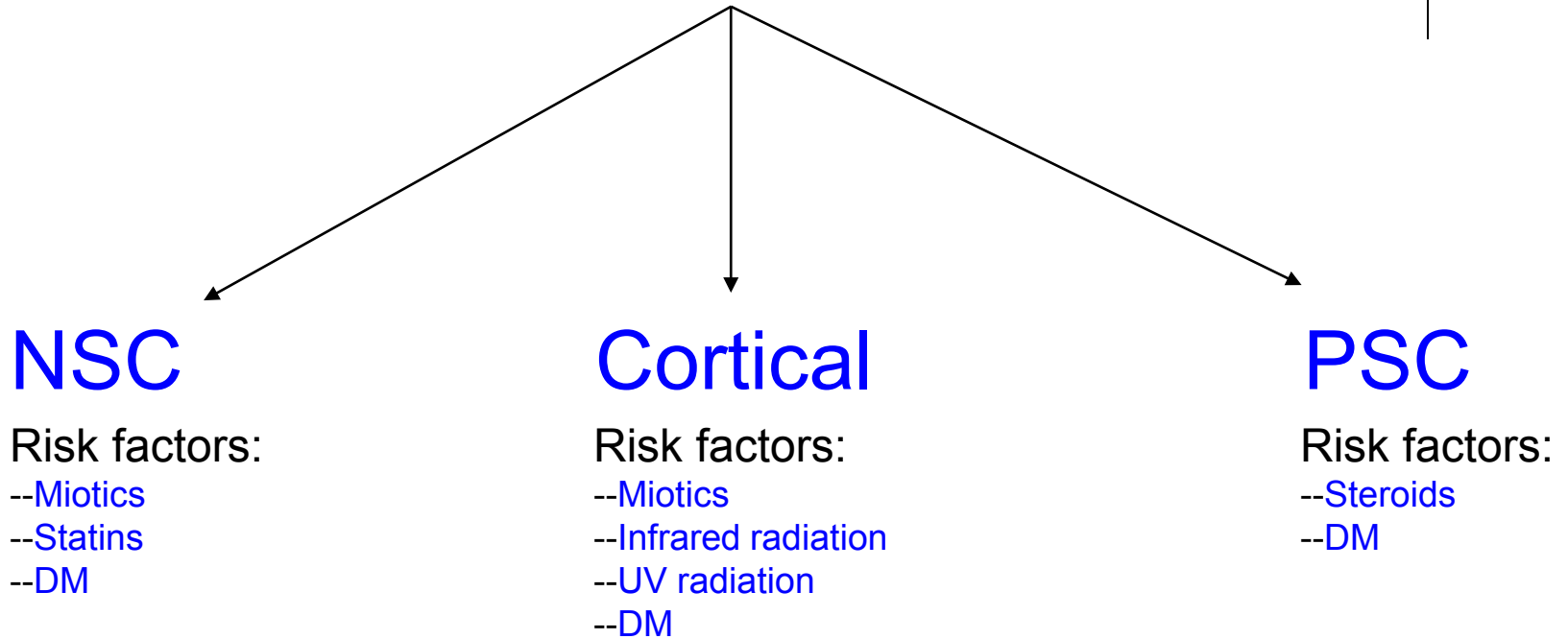
How do diabetes-related NSCs, cortical cataracts, and PSCs differ from those associated with age? They don't; rather, DM seems to cause age-related cataracts to occur at an earlier age

For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Diabetes mellitus

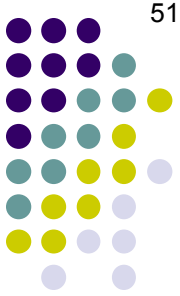


What are the three age-related types of cataracts?

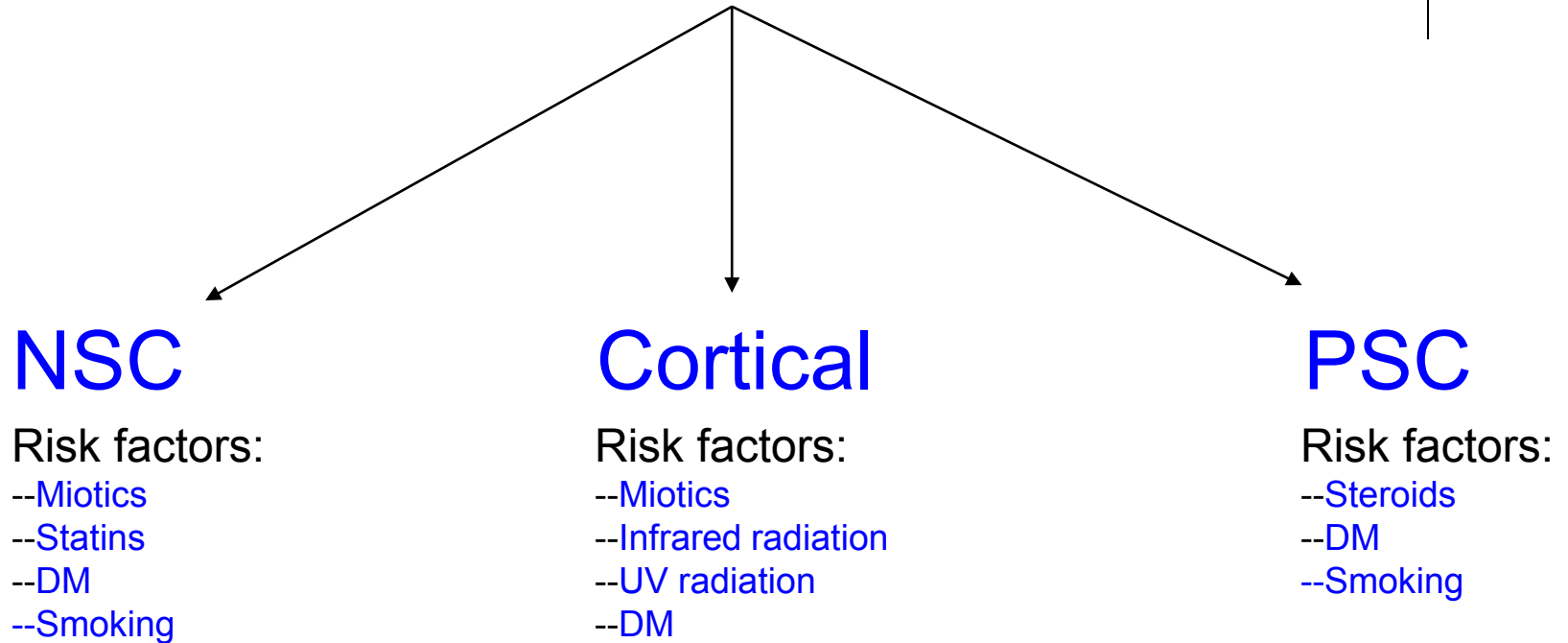


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Smoking



What are the three age-related types of cataracts?



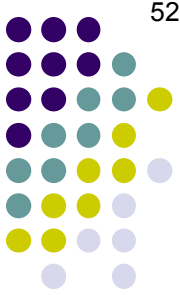
For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Smoking

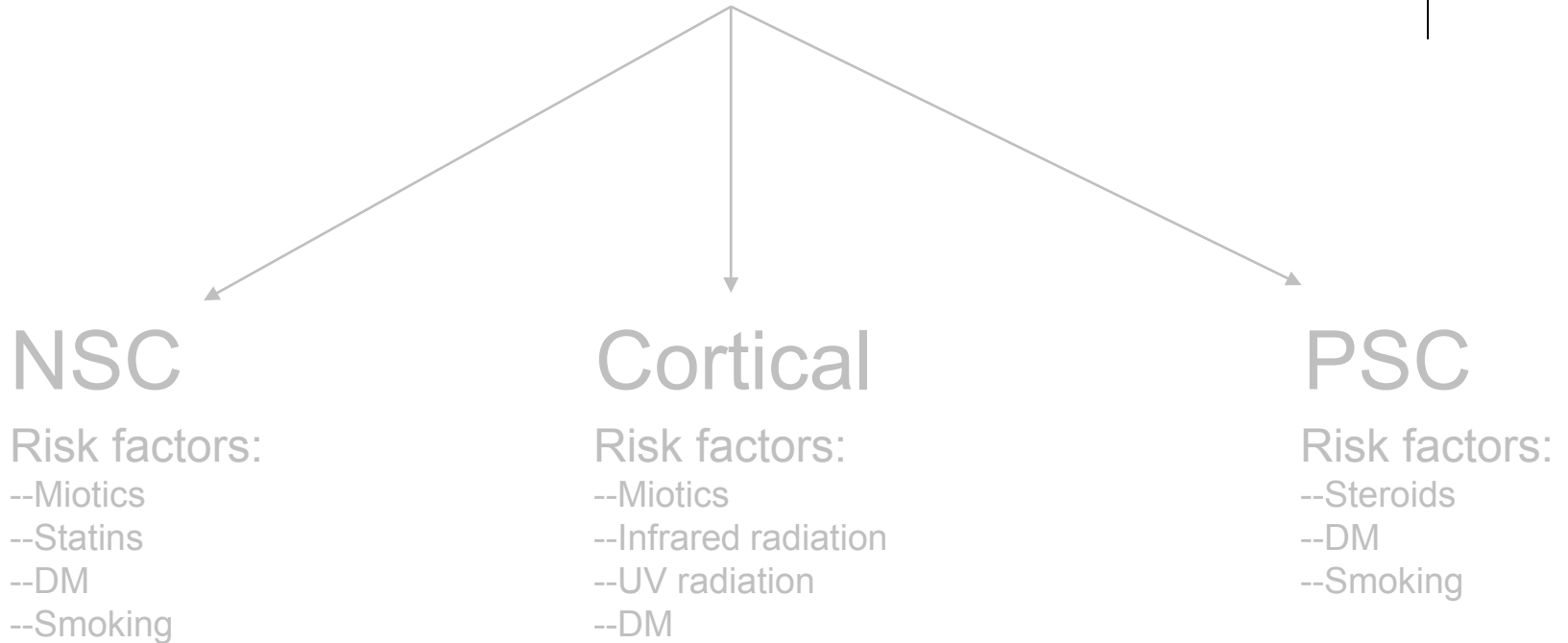
Q

Lens/Cataracts Overview

520



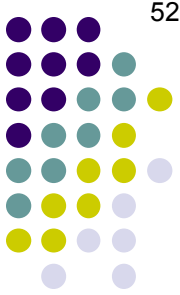
What are the three age-related types of cataracts?



For each risk factor, what about smokeless—does it convey an increased risk of cataracts as well?

with (some will

Smokeless tobacco?



What are the three age-related types of cataracts?

NSC

Risk factors:

- Miotics
- Statins
- DM
- Smoking

Cortical

Risk factors:

- Miotics
- Infrared radiation
- UV radiation
- DM

PSC

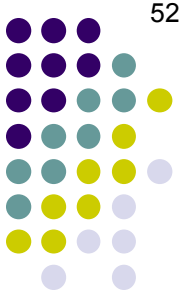
Risk factors:

- Steroids
- DM
- Smoking

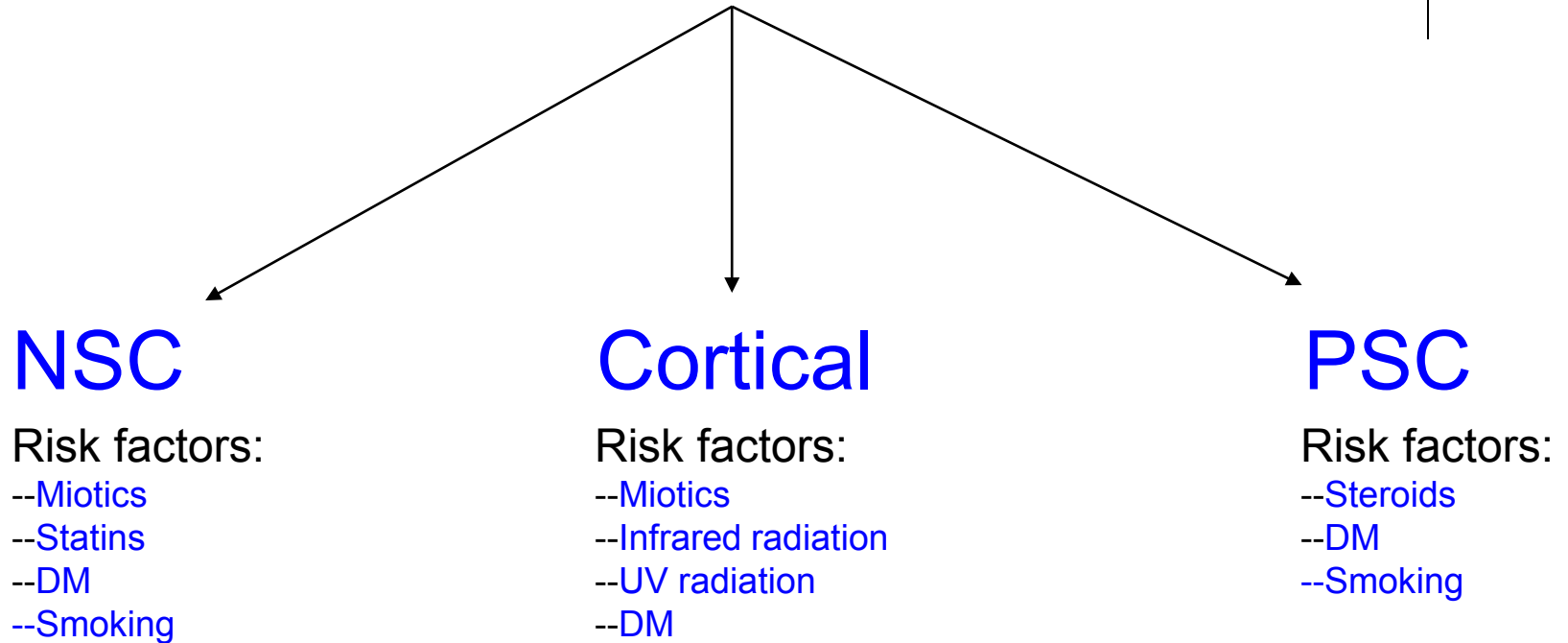
For each risk factor, what about smokeless—does it convey an increased risk of cataracts as well?

Yes (although the *Lens* book does not say which type)

Smokeless tobacco? Yes

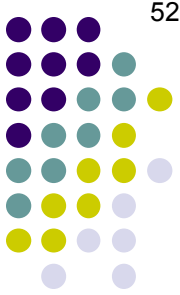


What are the three age-related types of cataracts?

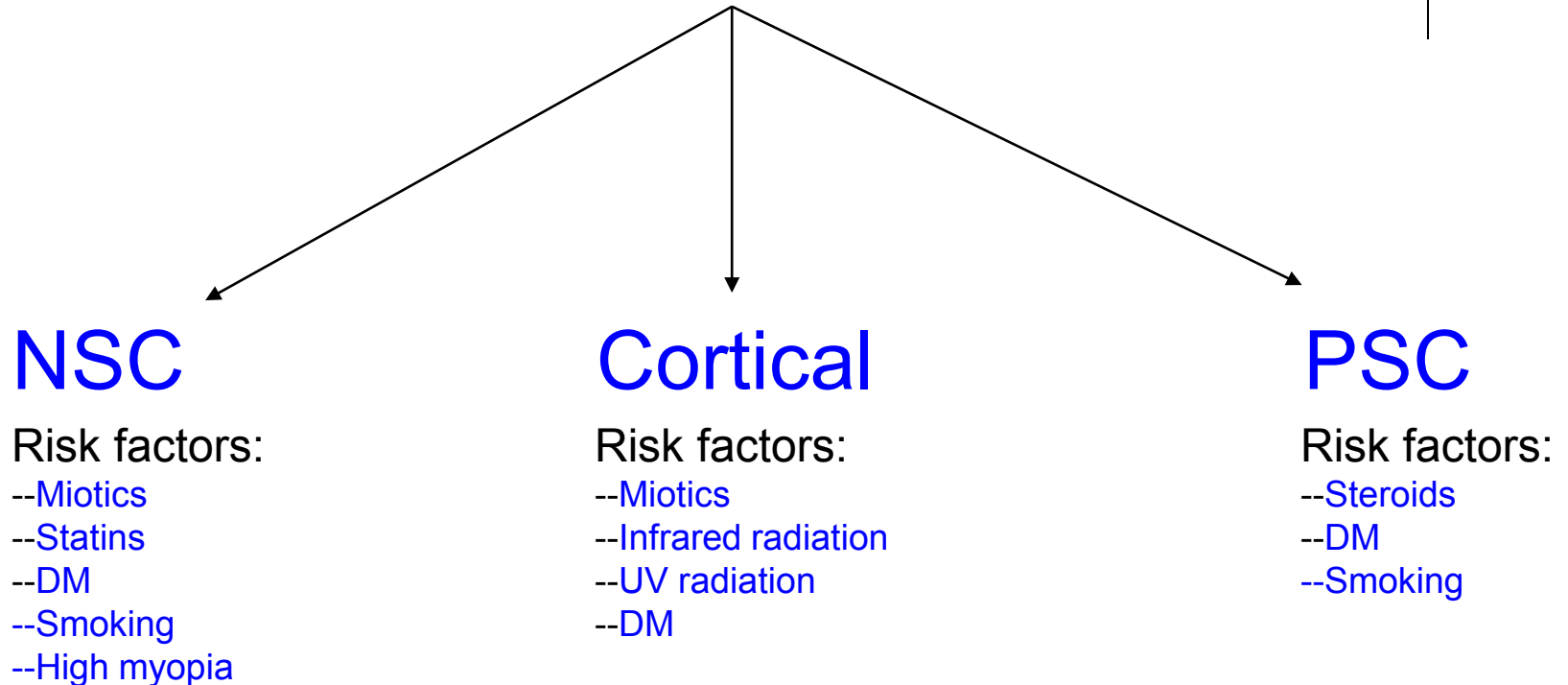


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

High myopia

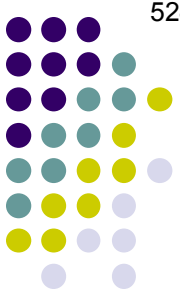


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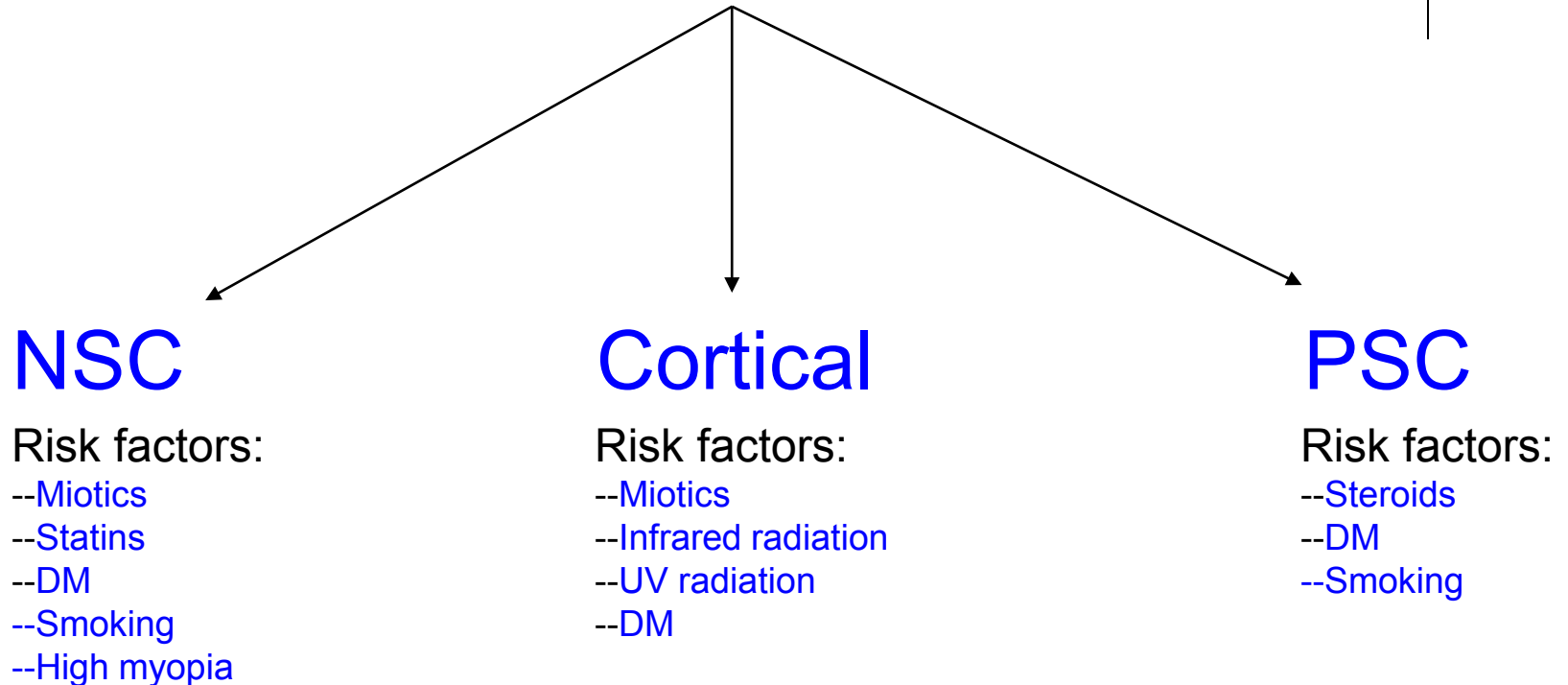


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

High myopia

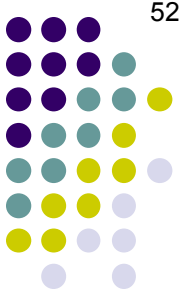


What are the three age-related types of cataracts?

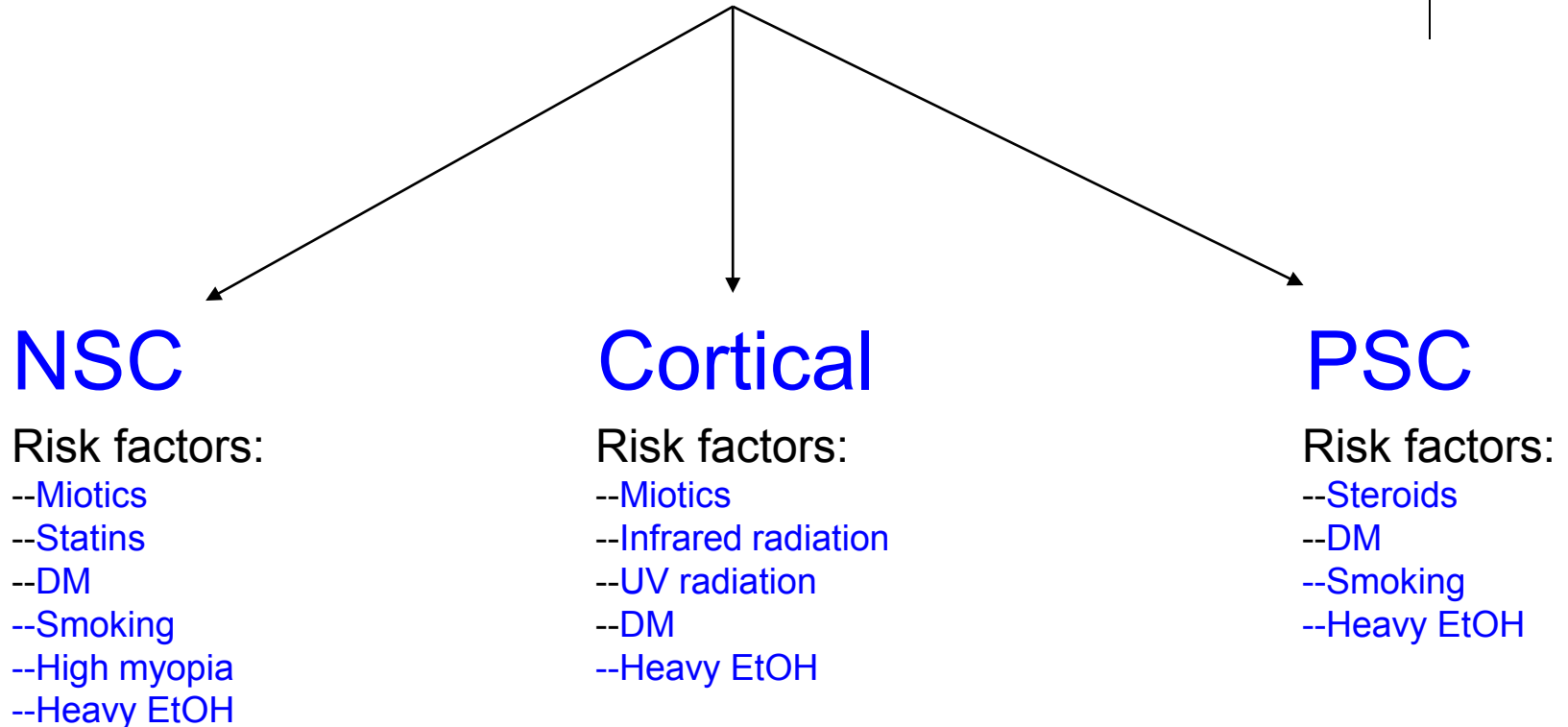


For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Heavy EtOH consumption



What are the three age-related types of cataracts?



For each risk factor, identify which type of cataract it is associated with (some will be associated with more than one):

Heavy EtOH consumption

Q

Lens/Cataracts Overview

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What are the three age-related types of cataracts?

NSC

Risk factors:

- Miotics
- Statins
- DM
- Smoking
- High myopia
- Heavy EtOH

Cortical

Risk factors:

- Miotics
- Infrared radiation
- UV radiation
- DM
- Heavy EtOH

PSC

Risk factors:

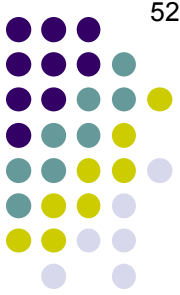
- Steroids
- DM
- Smoking
- Heavy EtOH

What about moderate amount of alcohol—does it convey an increased risk of cataracts as well?

For e
with (

ociated

*Moderate **EtOH** consumption?*



What are the three age-related types of cataracts?

NSC

Risk factors:

- Miotics
- Statins
- DM
- Smoking
- High myopia
- Heavy EtOH

Cortical

Risk factors:

- Miotics
- Infrared radiation
- UV radiation
- DM
- Heavy EtOH

PSC

Risk factors:

- Steroids
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- Smoking
- Heavy EtOH

What about moderate amount of alcohol—does it convey an increased risk of cataracts as well?

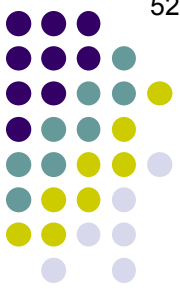
No—in fact, it may convey a **reduced** risk

*Moderate **EtOH consumption?** No! In fact...*

Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)



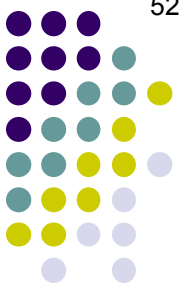
No question yet—proceed when ready

Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

- Associated with the *second sight* phenomenon:

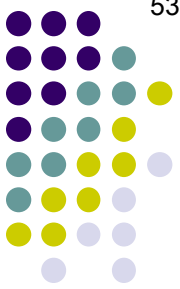


A

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

- Associated with the *second sight* phenomenon: **NSC**



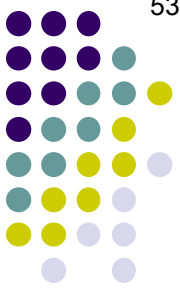
Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
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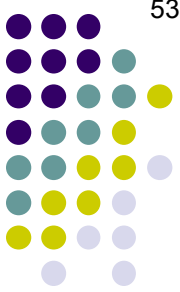
- Associated with the *second sight* phenomenon: **NSC**

What is the second sight phenomenon?



A

Lens/Cataracts Overview



For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

- Associated with the *second sight* phenomenon: **NSC**

What is the second sight phenomenon?

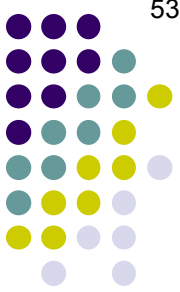
NSC progression often produces lenticular myopia. In some patients this myopia rehabilitates the near vision loss they experienced due to presbyopia, thus restoring the ability to read without glasses.

Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

- Associated with the *second sight* phenomenon: **NSC**
- Related to lens hydration status:

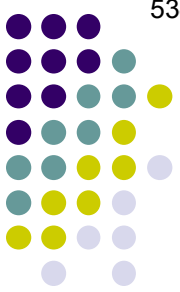


A

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

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- Related to lens hydration status: **Cortical**



Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

- Associated with the *second sight* phenomenon: **NSC**
- Related to lens hydration status: **Cortical**
- Affects scotopic > photopic vision:

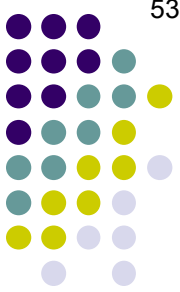


A

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
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Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
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- Affects scotopic > photopic vision: **NSC**
- Affects photopic > scotopic vision:



A

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
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Q

Lens/Cataracts Overview

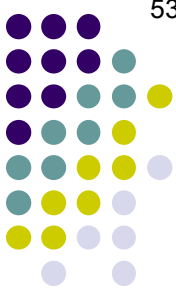
For each statement, identify the associated type of cataract:
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- Affects scotopic > photopic vision: **NSC**
- Affects photopic > scotopic vision: PSC

Define these terms:

Scotopic: Related to vision in...

Photopic



A

Lens/Cataracts Overview

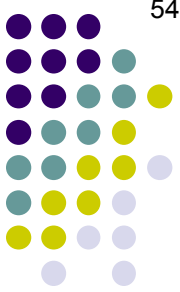
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- Affects photopic > scotopic vision: PSC

Define these terms:

Scotopic: Related to vision in...**dim illumination**

Photopic



Q

Lens/Cataracts Overview

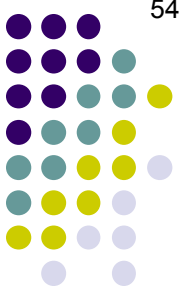
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Define these terms:

Scotopic: Related to vision in...**dim illumination**

Photopic: Related to vision in...



A

Lens/Cataracts Overview

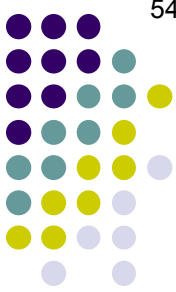
For each statement, identify the associated type of cataract:
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- Associated with the *second sight* phenomenon: NSC
- Related to lens hydration status: Cortical
- Affects scotopic > photopic vision: **NSC**
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Define these terms:

Scotopic: Related to vision in...***dim*** illumination

Photopic: Related to vision in...***bright*** illumination



Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

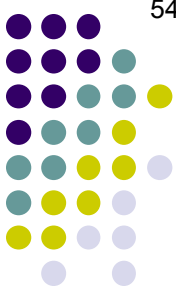
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- Related to lens hydration status: Cortical
- Affects scotopic > photopic vision: NSC
- Affects photopic > scotopic vision: PSC

Define these terms:

Scotopic: Related to vision in...**dim** illumination

Photopic: Related to vision in...**bright** illumination

*As an aside: What is the term describing vision
under low (e.g., twilight) illumination conditions?*



A

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

- Associated with the *second sight* phenomenon: NSC
- Related to lens hydration status: Cortical
- Affects scotopic > photopic vision: NSC
- Affects photopic > scotopic vision: PSC

Define these terms:

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Photopic: Related to vision in...**bright** illumination

*As an aside: What is the term describing vision
under low (e.g., twilight) illumination conditions?*

Mesopic vision

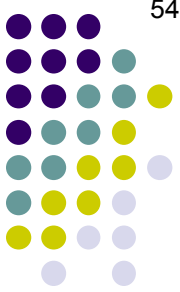


Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

- Associated with the *second sight* phenomenon: **NSC**
- Related to lens hydration status: **Cortical**
- Affects scotopic > photopic vision: **NSC**
- Affects photopic > scotopic vision: **PSC**
- Affects near > distance vision:

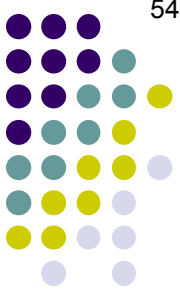


A

Lens/Cataracts Overview

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nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

- Associated with the *second sight* phenomenon: **NSC**
- Related to lens hydration status: **Cortical**
- Affects scotopic > photopic vision: **NSC**
- Affects photopic > scotopic vision: **PSC**
- Affects near > distance vision: **PSC**



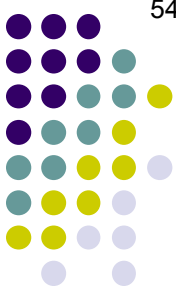
Q

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

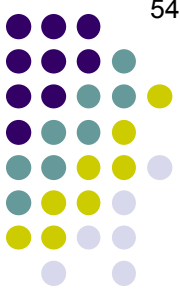
- Associated with the *second sight* phenomenon: NSC
- Related to lens hydration status: Cortical
- Affects scotopic > photopic vision: NSC
- **Affects photopic > scotopic vision: PSC**
- **Affects near > distance vision: PSC**

Photopic vision, near vision—what eye-state do these have in common?



Q/A

Lens/Cataracts Overview



For each statement, identify the associated type of cataract:
nuclear sclerotic (NSC); cortical; posterior subcapsular (PSC)

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- **Affects photopic > scotopic vision: PSC**
- **Affects near > distance vision: PSC**

Photopic vision, near vision—what eye-state do these have in common?
The pupil is relatively in both



A

Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
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The pupil is relatively miosed in both



Q

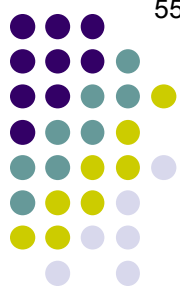
Lens/Cataracts Overview

For each statement, identify the associated type of cataract:
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Photopic vision, near vision—what eye-state do these have in common?
The pupil is relatively miosed in both

Why is vision through a PSC worse when the pupil is miosed?



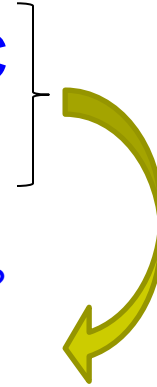
Q/A

Lens/Cataracts Overview



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Photopic vision, near vision—what eye-state do these have in common?
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Why is vision through a PSC worse when the pupil is miosed?
Visually significant PSCs are centrally vs peripherally located.

A

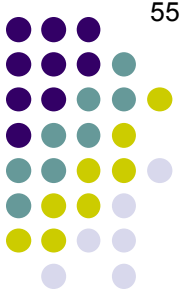
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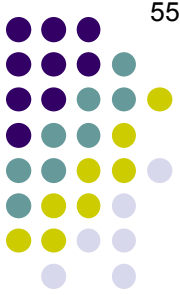
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Lens/Cataracts Overview

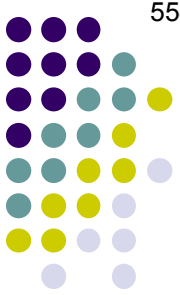
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Why is vision through a PSC worse when the pupil is miosed?

Visually significant PSCs are centrally located. When the pupil is dilated, incoming light can 'go around' the PSC, and vision is less affected. However, when the pupil is miosed, incoming light is limited to that which is passing through the densest portion of the PSC, and thus results in maximally-degraded visual acuity.

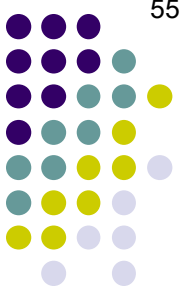


Q

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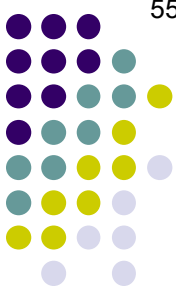
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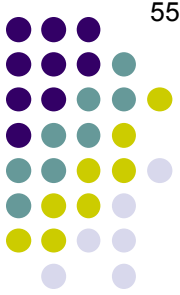
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- Most likely to c/o glare: **Cortical**
- Least likely to c/o glare:

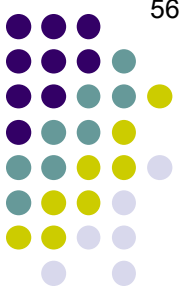


A

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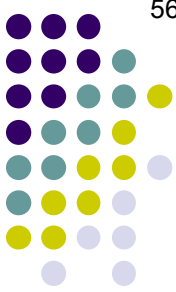
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- Most likely in a younger adult:

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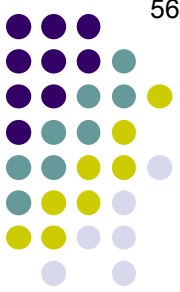


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A

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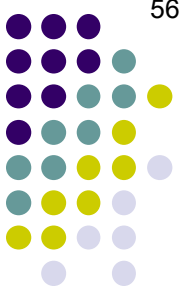


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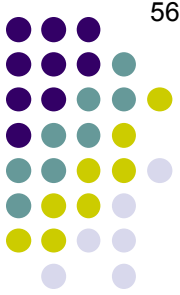


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- Associated with altered color perception:

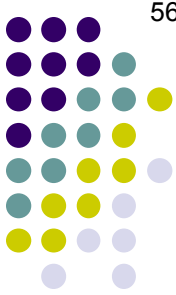
A

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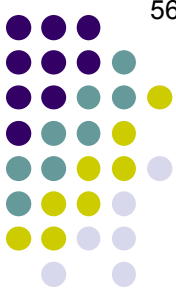


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- Most likely to c/o glare: Cortical
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- Most likely to cause progressive yellowing or browning of the lens causes patients to have poor color discrimination, especially at the red v blue end of the visible-light spectrum
- Associated with **altered color perception: NSC**



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- Least likely to c/o glare: NSC
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- Associated with **altered color perception: NSC**

A

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- Causes cases, patients are frequently unaware of their altered color discrimination.
- Associated with **altered color perception: NSC**

Lens/Cataracts Overview



Finally: Circling back to something touched upon at the beginning of the slide-set...



Q

Lens/Cataracts Overview

Finally: Circling back to something touched upon at the beginning of the slide-set...

- *What are the three lens/cataract layers as encountered in cataract surgery?*

- ?
- ?
- ?



A

Lens/Cataracts Overview

Finally: Circling back to something touched upon at the beginning of the slide-set...

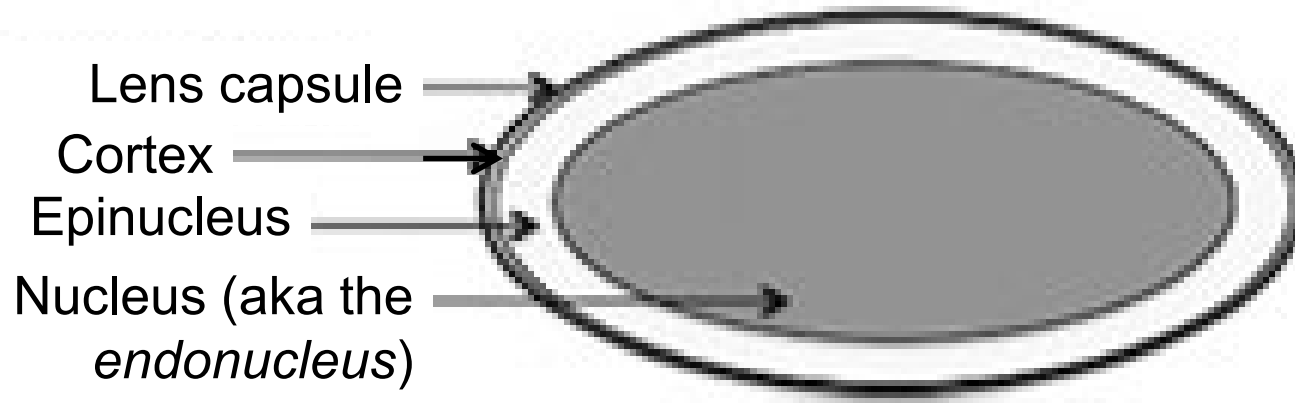
- *What are the three lens/cataract layers as encountered in cataract surgery?*
 - Nucleus
 - Epinucleus
 - Cortex

Lens/Cataracts Overview



Surgical
^

Layers of the lens:

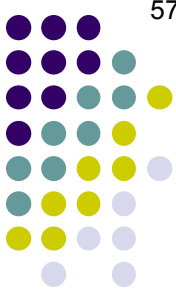




Q

Lens/Cataracts Overview

- *What are the three lens/cataract layers as encountered in cataract surgery? **How do these layers differ from one another histologically?***
 - Nucleus: ?
 - Epinucleus: ?
 - Cortex: ?



A

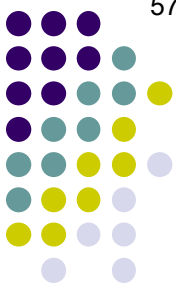
Lens/Cataracts Overview

- *What are the three lens/cataract layers as encountered in cataract surgery? How do these layers differ from one another histologically?*

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- Epinucleus:
- Cortex:



Trick question—they don't! These terms refer to differences in *appearance* and *behavior* of lens material encountered during cataract surgery. They are *descriptive* terms, not histological.



Q

Lens/Cataracts Overview

- *What are the three lens/cataract layers as*

Briefly, how does each layer look and behave during cataract surgery?

Nucleus:

Epinucleus

Cortex

T
differences in **appearance and behavior** of lens material encountered during cataract surgery. They are *descriptive* terms, not histological.



A

Lens/Cataracts Overview

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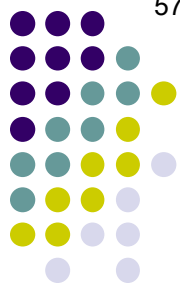
Briefly, how does each layer look and behave during cataract surgery?

Nucleus: Opaque, usually with an amber hue. The nucleus is firm, and cannot be aspirated from the eye until/unless it is broken up (emulsified, hence the term *phacoemulsification*).

Epinucleus

Cortex

7 differences in **appearance and behavior** of lens material encountered during cataract surgery. They are *descriptive* terms, not histological.



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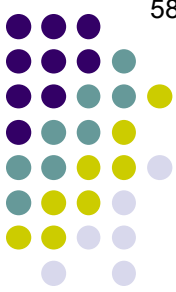
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Epinucleus: Clear to cloudy. The epinucleus is soft, and can be aspirated without emulsification (although emulsifying energy is often employed during epinucleus removal in order to make the process faster/more efficient).

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Cortex: Thin and wispy, the cortex is like a layer of tape stuck to the inner aspect of the capsule. Using aspiration and vacuum power, it is peeled off at the end of the case. It requires no emulsification.

7 differences in ***appearance and behavior*** of lens material encountered during cataract surgery. They are *descriptive* terms, not histological.



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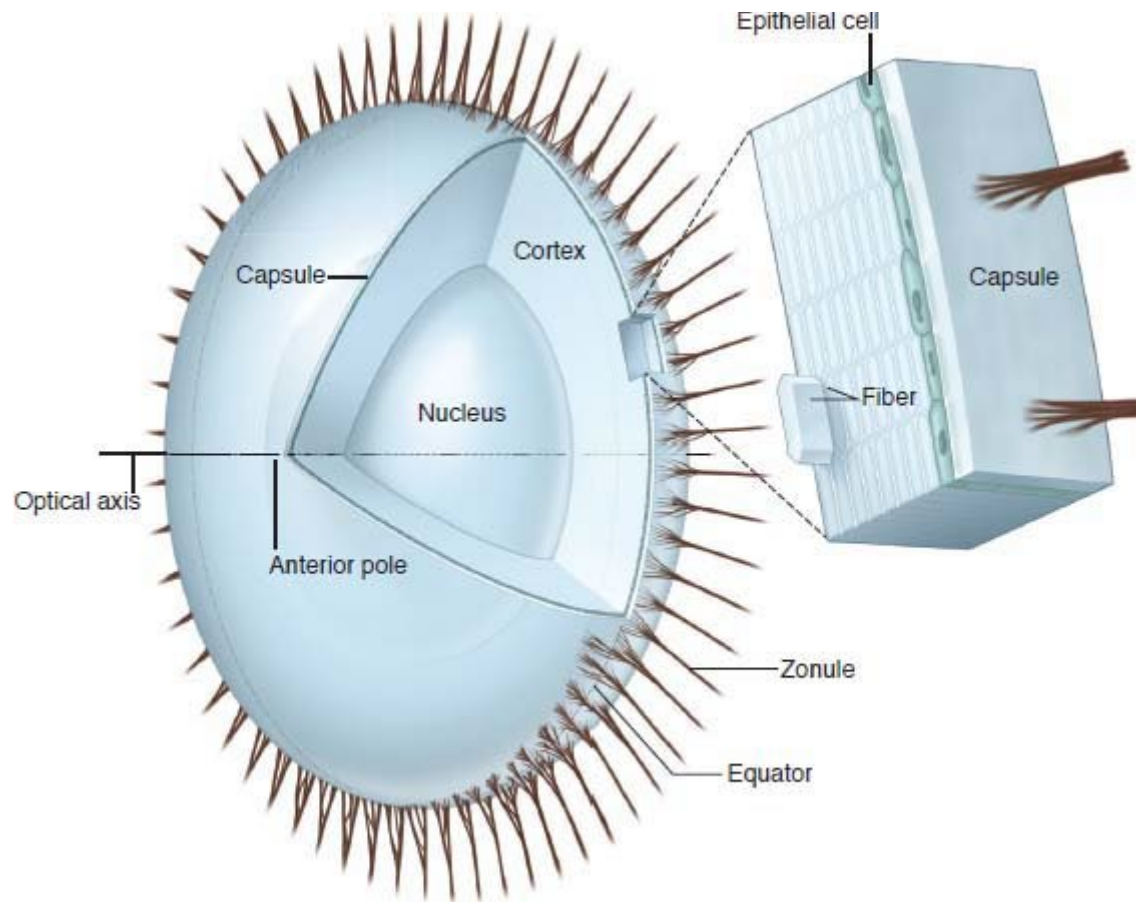
Lens/Cataracts Overview

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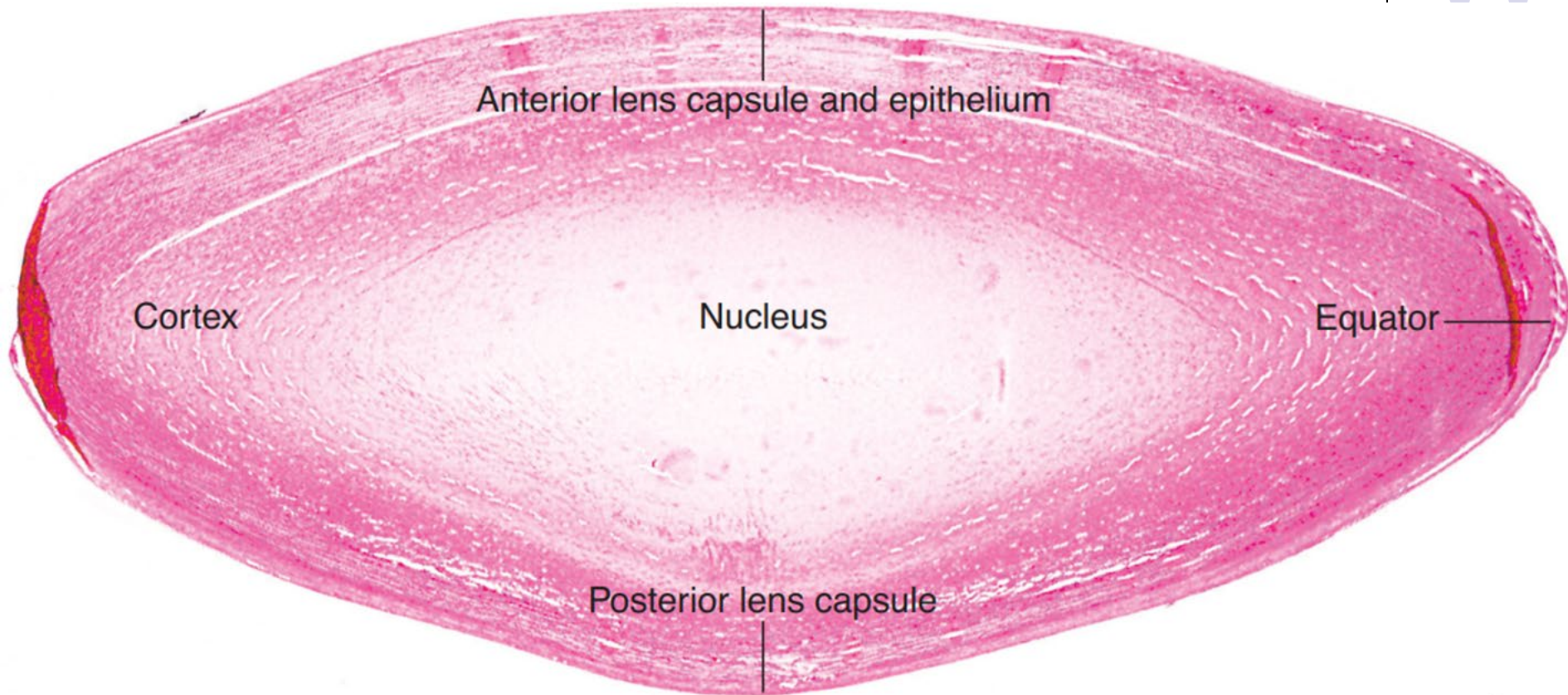
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Lens/Cataracts Overview



Slide depicting the basic anatomy of the adult lens

Lens/Cataracts Overview



Basic components of the mature lens: Photomicrograph



Q

Lens/Cataracts Overview

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Emulsification (ultrasound/emulsifying energy) is often employed during epinuclear removal in order to make the process faster/more efficient).

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Cortex: Thin and wispy, the cortex is like a layer of tape stuck to the inner aspect of the capsule. Using aspiration and vacuum power, it is peeled off at the end of the case. It requires no emulsification.

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