Eye embryology made simply ridiculous

Regarding the embryology of the lens: There are two anatomic structures we must concern ourselves with…
This is the outer body wall of the embryo in the region destined to become the head. The surface of the outer body wall is lined with cells.
Eye embryology made simply ridiculous

Surface Ectoderm cells resting on the outer body wall of the embryo

(Outside of embryo; space filled with amniotic fluid)

This is the outer body wall of the embryo in the region destined to become the head. The surface of the outer body wall is lined with surface ectoderm cells.

(Inside of embryo; space filled with embryo stuff)
Neuroectoderm cells resting on the inner wall of the optic vesicle (Cell apices)

This is the **optic vesicle**, an outpouching of the neural tube. The inner surface of the optic vesicle is lined with neuroectoderm cells.
This is the **optic vesicle**, an outpouching of the neural tube. The inner surface of the optic vesicle is lined with **neuroectoderm** cells.
Neuroectoderm cells resting on the inner wall of the optic vesicle

This is how the surface ectoderm and optic vesicle are spatially related early in embryogenesis.

Eye embryology made simply ridiculous
The proximity of the optic vesicle to the surface ectoderm induces those cells to grow taller, forming a structure known as the **lens placode**.
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The proximity of the optic vesicle to the surface ectoderm induces those cells to grow taller, forming a structure known as the *lens placode*. This occurs in the first month of embryogenesis.
The optic vesicle starts to **invaginate**, and…
The optic vesicle starts to invaginate, and... as it does, the lens placode follows.
Eye embryology made simply ridiculous

This process of invagination/following continues…
Eye embryology made simply ridiculous

This process of invagination/following continues…
and continues…
This process of invagination/following continues… and continues… until the two walls of neuroectoderm are apposing, and the surface ectoderm has formed a sphere.
Eye embryology made simply ridiculous

Note that the surface ectoderm re-establishes a continuous body wall

This process of invagination/following continues… and continues… until the two walls of neuroectoderm are apposing, and the surface ectoderm has formed a sphere.
Eye embryology made simply ridiculous

Note that the surface ectoderm re-establishes a continuous body wall

This process of invagination/following continues… and continues… until the two walls of neuroectoderm are apposing, and the surface ectoderm has formed a sphere.

Note that this part will become the [two words]
Eye embryology made simply ridiculous

Note that the surface ectoderm re-establishes a continuous body wall

This process of invagination/following continues... and continues... until the two walls of neuroectoderm are apposing, and the surface ectoderm has formed a sphere.

Note that this part will become the optic nerve
This process of invagination/following continues... and continues... until the two walls of neuroectoderm are apposing, and the surface ectoderm has formed a sphere.

Note that the surface ectoderm re-establishes a continuous body wall.

Note that this part will become the optic nerve.

**Eye embryology** made simply ridiculous

The re-established surface ectoderm will eventually give rise to a number of eye-related structures:

1) Epithelium of the conjunctiva
2) Epithelium of the cornea
3) Eyelids
4) Lacrimal gland
This process of invagination/following continues... and continues... until the two walls of neuroectoderm are apposing, and the surface ectoderm has formed a sphere.

Note that this part will become the optic nerve.
This process of invagination/following continues... and continues... until the two walls of neuroectoderm are apposing, and the surface ectoderm has formed a sphere.

Note that the surface ectoderm re-establishes a continuous body wall.

The re-established surface ectoderm will eventually give rise to a number of eye-related structures:

1) Epithelium of the conjunctiva
2) Epithelium of the cornea
3) Eyelids
4) Lacrimal gland

Note that this part will become the optic nerve.
Eye embryology made simply ridiculous
The pinched-off sphere forms the lens vesicle.
The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) Pupillary dilator muscle

The pinched-off sphere forms the lens vesicle

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
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6) Pupillary dilator muscle
The pinched-off sphere forms the lens vesicle.

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3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) Pupillary dilator muscle
The invaginated neuroectoderm gives rise to the:

1) Neurosensory retina
2) 
3) 
4) 
5) 
6) 

Note that the embryology explains why the neurosensory retina is upside down in the eye.
The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) 
3) 
4) 
5) 
6)
The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Iris epithelium (posterior)
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1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) Pupillary dilator muscle

Note also that the embryology explains why the RPE and receptor cells are arranged apex-to-apex.

Eye embryology made simply ridiculous
Eye embryology made simply ridiculous

The pinched-off sphere forms the lens vesicle.

Also, the embryology explains why rhegmatogenous retinal detachments occur. The neurosensory retina and RPE are not attached to one another, but rather are separated by a potential space—the remnant of the space contained within the optic vesicle. Breaks in the retina allow syneretic vitreous to gain access to this space—and the result is a rhegmatogenous RD.

The invaginated neuroectoderm gives rise to the:

1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) Pupillary dilator muscle
The pinched-off sphere forms the lens vesicle.

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The pinched-off sphere forms the lens vesicle.

Also, the embryology explains why rhegmatogenous retinal detachments occur. The neurosensory retina and RPE are not attached to one another, but rather are separated by a potential space—the remnant of the space contained within the optic vesicle. Breaks in the retina allow syneretic vitreous to gain access to this space—and the result is a rhegmatogenous RD.

What does rhegmatogenous mean in this context?
It means ‘associated with a break or tear’

What does syneretic mean in this context?
It means ‘liquified’
The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Iris epithelium (posterior)
4) Pupillary sphincter muscle
5) Pupillary dilator muscle
The pinched-off sphere forms the lens vesicle.

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The pinched-off sphere forms the lens vesicle.

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1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) Pupillary dilator muscle

Note that the embryology explains why the ciliary body has two epithelial layers that are arranged apex-to-apex.
The invaginated neuroectoderm gives rise to:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) 
5) 
6)
The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4)
5)
6)

Note that the embryology explains why the ciliary body has two epithelial layers that also are arranged apex-to-apex.

One CB epi layer is pigmented, and one isn’t. Which is which? The inner (nearest the lens) layer is nonpigmented; the outer (next to the CB stroma) is pigmented.
The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Pupillary sphincter muscle
5) Pupillary dilator muscle

Note how the embryology can help you remember this, because the pigmented CB epi is continuous with the (heavily pigmented) RPE, while the nonpigmented CB epi is continuous with the (largely nonpigmented) retina.

One CB epi layer is pigmented, and one isn’t. Which is which? The inner (nearest the lens) layer is nonpigmented; the outer (next to the CB stroma) is pigmented.

The pinched-off sphere forms the lens vesicle.
The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) Pupillary dilator muscle
The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) Pupillary dilator muscle
Eye embryology made simply ridiculous

The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) Pupillary dilator muscle

Note that the embryology explains why the iris has two epithelial layers that are arranged apex-to-apex, but it is less helpful for remembering that both epithelial layers are pigmented (you’re on your own for that fact!).
The pinched-off sphere forms the lens vesicle.

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
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The invaginated neuroectoderm gives rise to:
1) Neurosensory retina
2) RPE
3) Ciliary-body epithelium (both pigmented and nonpigmented layers)
4) Iris epithelium (posterior)
5) Pupillary sphincter muscle
6) The pinched-off sphere forms the **lens vesicle**
Eye embryology made simply ridiculous

The invaginated neuroectoderm gives rise to the:
1) Neurosensory retina
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The pinched-off sphere forms the lens vesicle
The pinched-off sphere forms the lens vesicle.

Note that embryology explains why the lens is composed of epithelial cells on the inside with their basement membrane on the outside.
The pinched-off sphere forms the lens vesicle. Note that embryology explains why the lens is composed of epithelial cells on the inside with their basement membrane on the outside.

What structure of the adult lens derives from this basement membrane?
The pinched-off sphere forms the lens vesicle.

Note that embryology explains why the lens is composed of epithelial cells on the inside with their basement membrane on the outside.

What structure of the adult lens derives from this basement membrane? The lens capsule.
Soon the cells on the posterior aspect of the lens vesicle start to grow anteriorly, eventually obliterating the lumen entirely.
Soon the cells on the posterior aspect of the lens vesicle start to grow anteriorly, eventually obliterating the lumen entirely. The structure thus formed is called the **embryonic nucleus**.
Soon the cells on the posterior aspect of the lens vesicle start to grow anteriorly, eventually obliterating the lumen entirely. The structure thus formed is called the embryonic nucleus.
The equatorial cells of the embryonic lens will then grow anteriorly and posteriorly, insinuating themselves between the fetal fibers and the lens capsule. These fibers meet and interdigitate at the anterior and posterior poles of the lens.
The equatorial cells of the embryonic lens will then grow anteriorly and posteriorly, insinuating themselves between the fetal fibers and the lens capsule. These fibers meet and interdigitate at the anterior and posterior poles of the lens. *This entire structure is known as the* [two words].
The equatorial cells of the embryonic lens will then grow anteriorly and posteriorly, insinuating themselves between the fetal fibers and the lens capsule. These fibers meet and interdigitate at the anterior and posterior poles of the lens. This entire structure is known as the **fetal nucleus**.
The equatorial cells of the embryonic lens will then grow anteriorly and posteriorly, insinuating themselves between the fetal fibers and the lens capsule. These fibers meet and interdigitate at the anterior and posterior poles of the lens. This entire structure is known as the fetal nucleus.

What two structures, easily observable in the adult lens, do these interdigitations form?
Embryonic Nucleus

What two structures, easily observable in the adult lens, do these interdigitations form? The Y sutures

The Y sutures are oriented such that the anterior Y suture is upside down, and the posterior Y suture is right side up.

The equatorial cells of the embryonic lens will then grow anteriorly and posteriorly, insinuating themselves between the fetal fibers and the lens capsule. **These fibers meet and interdigitate at the anterior and posterior poles of the lens.** This entire structure is known as the **fetal nucleus**.

What two structures, easily observable in the adult lens, do these interdigitations form? The Y sutures
The equatorial cells of the embryonic lens will then grow anteriorly and posteriorly, insinuating themselves between the fetal fibers and the lens capsule. **These fibers meet and interdigitate at the anterior and posterior poles of the lens.** This entire structure is known as the **fetal nucleus**.

**What two structures, easily observable in the adult lens, do these interdigitations form?**

The Y sutures

**What are the orientations of the two Y sutures?**
The equatorial cells of the embryonic lens will then grow anteriorly and posteriorly, insinuating themselves between the fetal fibers and the lens capsule. These fibers meet and interdigitate at the anterior and posterior poles of the lens. This entire structure is known as the fetal nucleus.

What two structures, easily observable in the adult lens, do these interdigitations form? The Y sutures.

What are the orientations of the two Y sutures? The anterior Y suture is right-side up; the posterior Y suture is upside down.
Eye embryology made simply ridiculous

In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

one word

three words
Eye embryology made simply ridiculous

In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

Mesoderm

Neural crest cells
In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

**Mesoderm**

What is mesoderm?
In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

Mesoderm

What is mesoderm?
One of the three primary germ layers of the embryo
In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

**Mesoderm**

*What is mesoderm?*  
One of the three primary germ layers of the embryo

*What are the other two primary germ layers?*  
--  
--
Eye embryology made simply ridiculous

In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

**Mesoderm**

*What is mesoderm?*
One of the three primary germ layers of the embryo

*What are the other two primary germ layers?*
--Ectoderm
--Endoderm
In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

**Mesoderm**

*What is mesoderm?*
One of the three primary germ layers of the embryo

*What ocular structures derive from mesoderm? (mnemonic coming…)*
- 
- 
- 
-
Eye embryology made simply ridiculous

In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

**Mesoderm**

What is mesoderm?
One of the three primary germ layers of the embryo

What ocular structures derive from mesoderm? (mnemonic coming…)

--M
--E
--S
--O
Eye embryology made simply ridiculous

In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

Mesoderm

What is mesoderm?
One of the three primary germ layers of the embryo

What ocular structures derive from mesoderm? (mnemonic coming…)
--Muscles (EOMs)
--Endothelium of the blood vessels
--Schlemm’s canal
--Oh, and don’t forget that small portion of the sclera!
In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

Mesoderm

Neural crest cells

What is/are neural crest cells?
In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

Mesoderm

Neural crest cells

What is/are neural crest cells?
A special subpopulation of neuroectodermal cells that migrate across the embryo and deposit themselves at a wide variety of locations, eventually differentiating into a number of different tissues.
**Eye embryology** made simply ridiculous

*What ocular structures derive from neural crest cells?*
Just about everything that has yet to be mentioned:
--
--
--
--
--

**Neural crest cells**

*What is/are neural crest cells?*
A special subpopulation of neuroectodermal cells that migrate across the embryo and deposit themselves at a wide variety of locations, eventually differentiating into a number of different tissues.
Eye embryology made simply ridiculous

**What ocular structures derive from neural crest cells?**
Just about everything that has yet to be mentioned:
--Corneal stroma and endothelium
--Trabecular meshwork
--Iris stroma
--Choroid
--Most of the sclera (except the small part deriving from mesoderm, as mentioned)

*Neural crest cells*

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Eye embryology made simply ridiculous

**Neural crest cells**

*What is/are neural crest cells?*
A special subpopulation of neuroectodermal cells that migrate across the embryo and deposit themselves at a wide variety of locations, eventually differentiating into a number of different tissues.

Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’

*Which wave involves which future structure?*

**First wave:**
Second wave:
**Third wave:**

---

**What ocular structures derive from neural crest cells?**
Just about everything that has yet to be mentioned:
--Corneal stroma and endothelium
--Trabecular meshwork
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--Most of the sclera (except the small part deriving from mesoderm, as mentioned)
Eye embryology made simply ridiculous

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Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’
Which wave involves which future structure?
First wave: *Corneal endothelium*
Second wave: 
Third wave:
Eye embryology made simply ridiculous

What ocular structures derive from neural crest cells?
Just about everything that has yet to be mentioned:
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Which wave involves which future structure?
First wave: Corneal endothelium
Second wave:
Third wave:
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*Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’*

*Which wave involves which future structure?*
*First wave: Corneal endothelium*
*Second wave: Iris stroma*
*Third wave:
In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

- **Mesoderm**
- **Neural crest cells**

**What is/are neural crest cells?**
A special subpopulation of neuroectodermal cells that migrate across the embryo and deposit themselves at a wide variety of locations, eventually differentiating into a number of different tissues.

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Just about everything that has yet to be mentioned:
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- Choroid
- Most of the sclera (except the small part deriving from mesoderm, as mentioned)

**Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’**

**First wave:** Corneal endothelium
**Second wave:** Iris stroma
**Third wave:**
What ocular structures derive from neural crest cells?
Just about everything that has yet to be mentioned:
--Corneal stroma and endothelium
--Trabecular meshwork
--Iris stroma
--Choroid
--Most of the sclera (except the small part deriving from mesoderm, as mentioned)

Neural crest cells

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Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’
Which wave involves which future structure?
First wave: Corneal endothelium
Second wave: Iris stroma
Third wave: Corneal stroma (keratocytes)
In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with: Mesoderm and Neural crest cells.

What is/are neural crest cells?
A special subpopulation of neuroectodermal cells that migrate across the embryo and deposit themselves at a wide variety of locations, eventually differentiating into a number of different tissues.

What ocular structures derive from neural crest cells?
Just about everything that has yet to be mentioned:
--Corneal stroma and endothelium
--Trabecular meshwork
--Iris stroma
--Choroid
--Most of the sclera (except the small part deriving from mesoderm, as mentioned)

What is a neurocristopathy?
A congenital/developmental abnormality owing to flawed neural-crest cell migration or differentiation

What are some examples of neurocristopathy?
Some of the important ones include…

Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’
Which wave involves which future structure?
First wave: Corneal endothelium
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Eye embryology made simply ridiculous

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Just about everything that has yet to be mentioned:
-- Corneal stroma and endothelium
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First wave: Corneal endothelium
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Eye embryology made simply ridiculous

What ocular structures derive from neural crest cells?  Just about everything that has yet to be mentioned:
- Corneal stroma and endothelium
- Trabecular meshwork
- Iris stroma
- Choroid
- Most of the sclera (except the small part deriving from mesoderm, as mentioned)

**Neural crest cells**

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Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’
- First wave: Corneal endothelium
- Second wave: Iris stroma
- Third wave: Corneal stroma (keratocytes)
Eye embryology made simple

What ocular structures derive from neural crest cells?
Just about everything that has yet to be mentioned:

- Corneal stroma and endothelium
- Trabecular meshwork
- Iris stroma
- Choroid
- Most of the sclera (except the small part deriving from mesoderm, as mentioned)

**Neural crest cells**

*What is a neurocristopathy?*
A congenital/developmental abnormality owing to flawed neural-crest cell migration or differentiation

*What are some examples of neurocristopathy?*
Some of the important ones include...

- Axenfeld-Reiger syndrome
- Peters anomaly
- Posterior keratoconus
- Posterior embryotoxon
- Microcornea and megalocornea
- Sclerocornea and cornea plana
- CHED
- CHSD

Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’
*First wave: Corneal endothelium*
*Second wave: Iris stroma*
*Third wave: Corneal stroma (keratocytes)*
Eye embryology made simple

In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

- **Mesoderm**
- **Neural crest cells**

What is/are neural crest cells?

A special subpopulation of neuroectodermal cells that migrate across the embryo and deposit themselves at a wide variety of locations, eventually differentiating into a number of different tissues.

What ocular structures derive from neural crest cells?

Just about everything that has yet to be mentioned:

- Corneal stroma and endothelium
- Trabecular meshwork
- Iris stroma
- Choroid
- Most of the sclera (except the small part deriving from mesoderm, as mentioned)

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- CHED
- CHSD

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**First wave:** Corneal endothelium

**Second wave:** Iris stroma

**Third wave:** Corneal stroma (keratocytes)
**Eye embryology made simple**

In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

- Mesoderm
- Neural crest cells

**What is neural crest cells?**

A special subpopulation of neuroectodermal cells that migrate across the embryo and deposit themselves at a wide variety of locations, eventually differentiating into a number of different tissues.

**What ocular structures derive from neural crest cells?**

Just about everything that has yet to be mentioned:

- Corneal stroma and endothelium
- Trabecular meshwork
- Iris stroma
- Choroid
- Most of the sclera (except the small part deriving from mesoderm, as mentioned)

**What is a neurocristopathy?**

A congenital/developmental abnormality owing to flawed neural-crest cell migration or differentiation.

**What are some examples of neurocristopathy?**

Some of the important ones include:

- Axenfeld-Reiger syndrome
- Peters anomaly
- Posterior keratoconus
- Posterior embryotoxon
- Microcornea and megalocornea
- Sclerocornea and cornea plana
- CHED
- CHSD

**Neural crest cells**

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**Neural crest cell migration concerning the anterior segment occurs in three ‘waves.’**
- **First wave:** Corneal endothelium
- **Second wave:** Iris stroma
- **Third wave:** Corneal stroma (keratocytes)
**Eye embryology made simple**

What do CHED and CHSD stand for?
- **CHED**: Congenital hereditary endothelial dystrophy
- **CHSD**: Congenital hereditary stromal dystrophy

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**What ocular structures derive from neural crest cells?**

Just about everything that has yet to be mentioned:
- Corneal stroma and endothelium
- Trabecular meshwork
- Iris stroma
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Which wave involves which future structure?
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Eye embryology made simply ridiculous

In addition to surface- and neuroectoderm, there are two embryologic cell/tissue types we must concern ourselves with:

- **Mesoderm**
- **Neural crest cells**

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A special subpopulation of neuroectodermal cells that migrate across the embryo and deposit themselves at a wide variety of locations, eventually differentiating into a number of different tissues.

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Rule of thumb: Guess ‘neurocristopathy’ for any condition involving anterior-segment dysgenesis—chances are you will be correct!

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Finally, what major ocular structure have we yet to mention, and what gives rise to it?

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The **vitreous** derives from surface ectoderm, neuroectoderm, mesoderm—pretty much everything BUT neural crest.

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