

## Development of ear

The ear is the organ of balance and hearing which consists of an internal, a middle, and an external ear. The ear develops in week 4 from a thickening of the surface ectoderm called the otic placode.

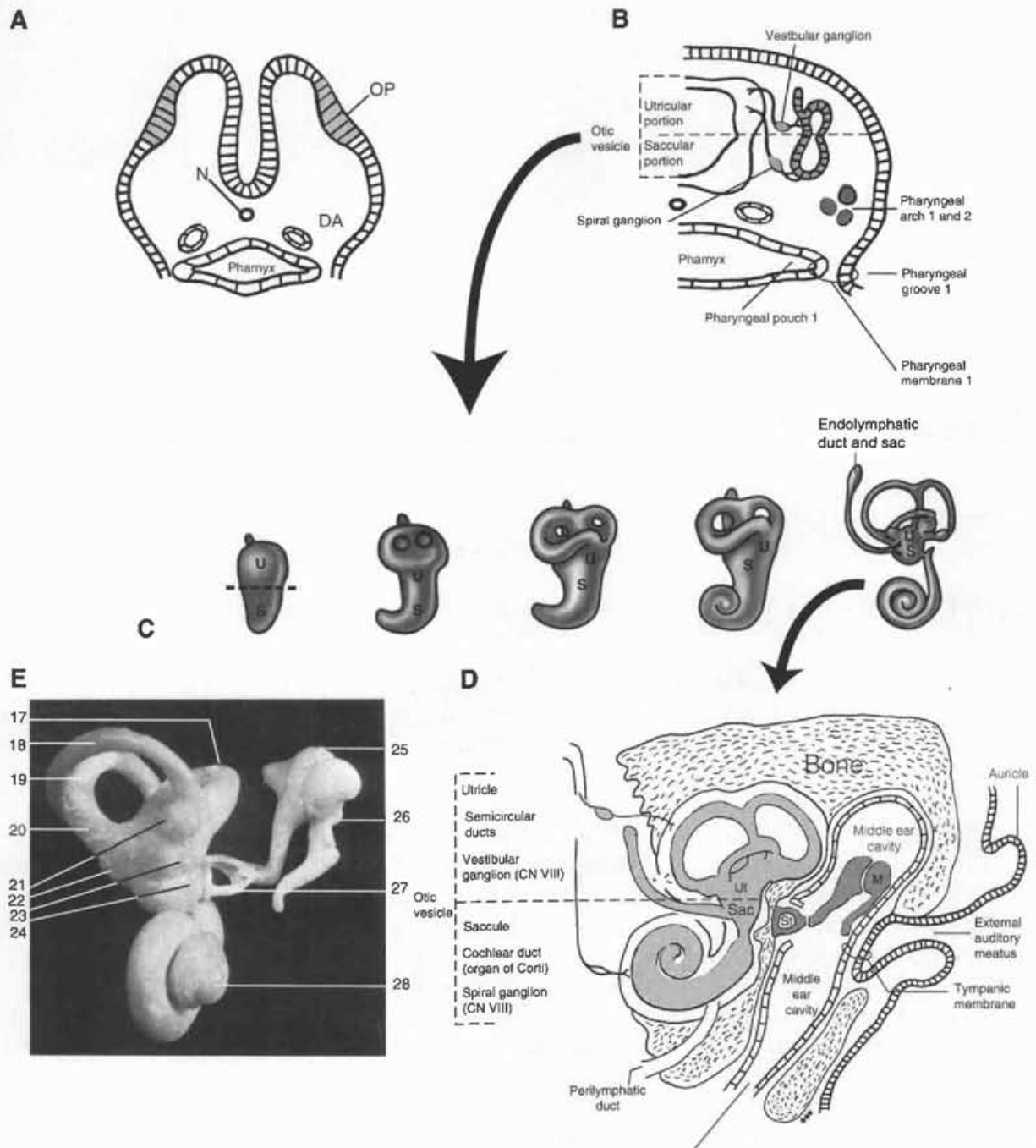
The otic placode invaginates into the connective tissue (mesenchyme) adjacent to the rhombencephalon and becomes the otic vesicle. The otic vesicle divides into utricular and saccular portions.

### **A.** Utricular portion of the otic vesicle gives rise to the following:

1. Utricle contains the sensory hair cells and otoliths of the macula utriculi. The utricle responds to linear acceleration and the force of gravity.
2. Semicircular ducts contain the sensory hair cells of the cristae ampullary. They respond to angular acceleration.
3. Vestibular ganglion lies at the base of the internal auditory meatus.
4. Endolymphatic duct and sac is a membranous duct that connects the saccule to the utricle and terminates in a blind sac.

### **B.** Saccular portion of the otic vesicle gives rise to the following:

1. Saccule contains the sensory hair cells and otoliths. The saccule responds to linear acceleration and the force of gravity.
2. Cochlear duct: is involved in hearing.
3. Spiral ganglion of carinal nerve VIII:



**Figure 8-1.** Schematic transverse sections showing the formation of the otic placode and otic vesicle from the surface ectoderm. (A) The otic placode is distinguished by a thickening of the surface ectoderm. *DA* = dorsal aorta; *N* = notochord; *OP* = otic placode. (B) The otic placode invaginates into the underlying connective tissue (mesenchyme) and becomes the otic vesicle. (C) The otic vesicle undergoes extensive changes to form the adult membranous labyrinth. *U* = utricle; *S* = saccule. (D) The adult ear. *M* = malleus; *I* = incus; *St* = stapes. (E) The adult auditory ossicles in connection with the membranous labyrinth (or internal ear). 17 = lateral semicircular canal; 18 = anterior semicircular canal; 19 = posterior semicircular canal; 20 = common crus; 21 = ampulla; 22 = beginning of the endolymphatic duct; 23 = utricle; 24 = saccule; 25 = incus; 26 = malleus; 27 = stapes; 28 = cochlea.

## The Membranous and Bony Labyrinth

The membranous labyrinth consists of all the structures derived from the otic vesicle. The membranous labyrinth is initially surrounded by neural crest cells.

The connective tissue closest to the membranous labyrinth degenerates, thus forming space containing perilymph. This sets up the interesting anatomic relationship whereby the membranous labyrinth is suspended (or floats) within the bony labyrinth by perilymph.

### Middle Ear

- A. Ossicles of the middle ear.
- B. Auditory tube and middle ear cavity both develop from pharyngeal pouch 1.
- C. Tympanic membrane develops from pharyngeal membrane 1.

### External Ear

- A. External auditory meatus develops from pharyngeal groove 1.
- B. Auricle develops from six auricular hillocks that surround pharyngeal groove I.

## Development of eye

### Development of optic vesicle

Begins at day 22 with the formation of optic **sulcus**, which evaginates from the wall of the diencephalon as the **optic vesicle** consisting of **neuroectoderm**. The optic vesicle invaginates and forms a double-layered **optic cup** and optic stalk.

## A. **The optic cup and its derivatives**

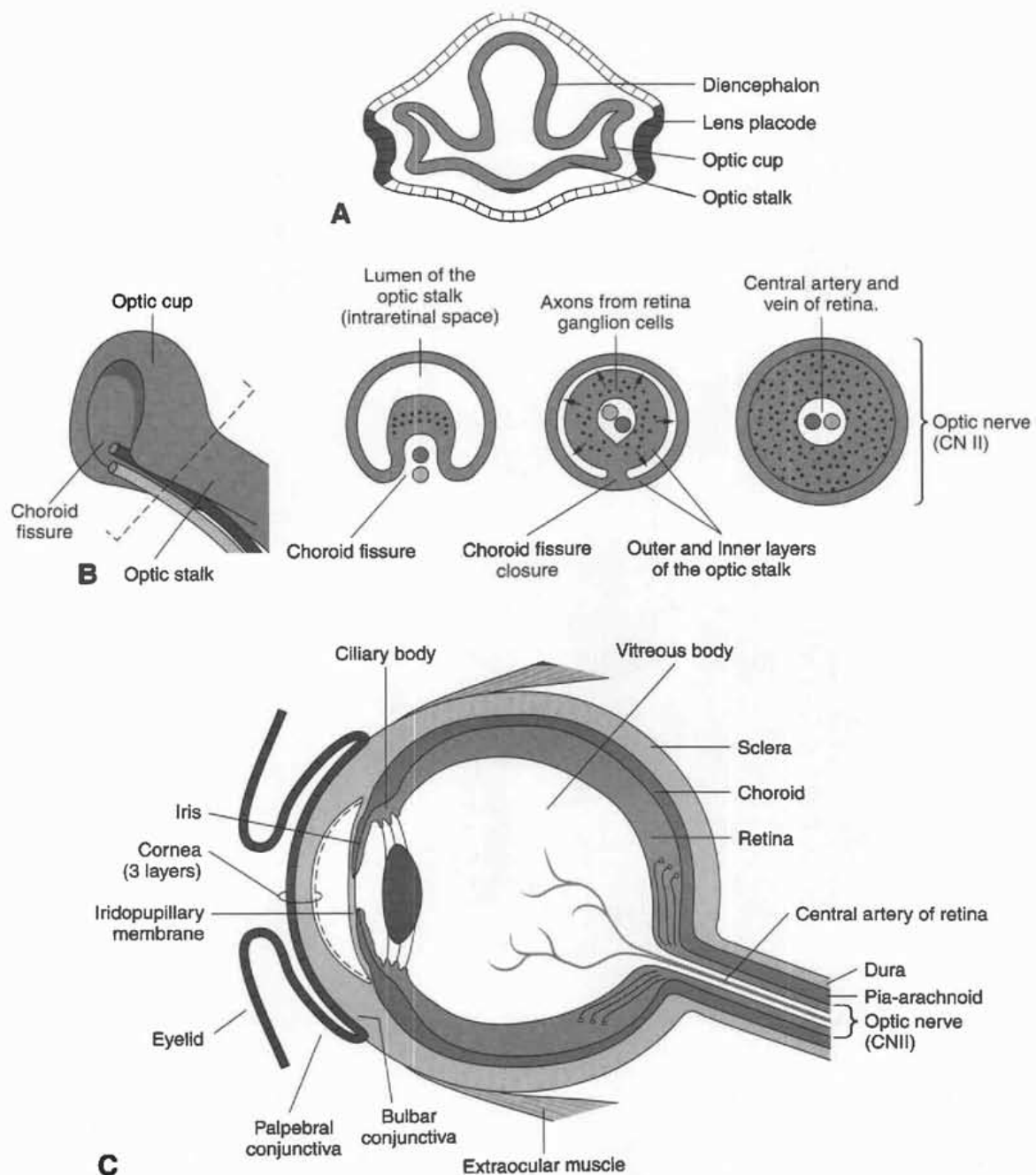
The double-layered optic cup consists of an outer pigment layer and **inner neural layer**.

- 1. Retina.** The outer pigment layer of the optic cup gives rise to the pigment layer of the retina. The intraretinal space separates the outer pigment layer from the inner neural layer. The inner neural layer of the optic cup gives rise to the neural layer of the retina (i.e., the rods and cones, bipolar cells, ganglion cells, etc.).
- 2. Iris** The epithelium of the iris develops from the anterior portions of both the outer pigment layer and inner neural layer of the optic cup, which explains its histologic appearance of two layers of columnar epithelium.
- 3. Ciliary body** :The epithelium of the ciliary body develops from the anterior portions of both the outer pigment layer and the inner neural layer of the optic cup, which explains its histologic appearance of two layers of columnar epithelium. The ciliary body contains the **ciliary Muscle**

## B. **The optic stalk and its derivatives**

The optic stalk contains the choroid **fissure** in which the hyaloid artery and vein are found. The hyaloid artery and vein later become the **central** artery and **vein of the** retina.

The optic stalk contains axons from the ganglion cell layer of the retina. The choroid fissure closes during week 7 so that the optic stalk, together with the axons of the ganglion cells, forms the optic nerve (CN II), optic chiasm, and optic tract. The optic nerve (CN II) is a tract of the diencephalon and has the following characteristics:



**Figure 9-1.** (A) The optic cup and optic stalk are evaginations of the diencephalon. The optic cup induces surface ectoderm to differentiate into the lens placode. (B) Formation of the optic nerve (CN II) from the optic stalk. The choroid fissure, which is located on the undersurface of the optic stalk permits access of the hyaloid artery and vein to the inner aspect of the eye. The choroid fissure eventually closes. As ganglion cells form in the retina, axons accumulate in the optic stalk and cause the inner and outer layers of the optic stalk to fuse, obliterating the lumen (or intraretinal space) and forming the optic nerve. (C) The adult eye. Note that the sclera is continuous with the dura mater and the choroid is continuous with the pia-arachnoid. The iridopupillary membrane is normally obliterated.

1. It is not completely myelinated until 3 months after birth; it is myelinated by oligodendrocytes.
2. It is not capable of regeneration after transection.
3. It is invested by the meninges.

## Development of other eye structures

### **A.Sclera**

The sclera develops from mesoderm surrounding the optic cup.

### **B.Choroid**

The choroid develops from mesoderm surrounding the optic cup.

### **C. Anterior chamber**

The anterior chamber develops from mesoderm over the anterior aspect of the eye. It undergoes vacuolization to form a chamber.

**D. Cornea** The cornea develops from both surface ectoderm and mesoderm lying anterior to the anterior chamber. The surface ectoderm forms the **anterior epithelium of the** cornea. The mesoderm forms the substantia propria of the cornea and corneal endothelium.

**E. Lens** The lens develops from surface ectoderm that forms the **lens** placode. The lens placode invaginates to form the lens vesicle.

**F. Vitreous body** The vitreous body develops from mesoderm that migrates through the choroid fissure and forms a transparent gelatinous substance between the lens and retina.

**G. Canal of Schlemm** The canal of Schlemm is found at the sclerocorneal junction called the limbus .

**H. Extraocular muscles** The extraocular muscles develop from mesoderm of **somitomeres 1, 2, 3** (also called preotic myotomes) that surround the optic cup.