19 Organs of Special Sense

Eye

Development

Adult Structure

Coats

- Tunica Fibrosa
- Sclera
- Cornea
- Tunica Vasculosa (Uvea)
- Choroid
- Ciliary Body
- Iris
- Tunica Interna (Retina)
- Pars Optica

Lens

Anterior and Posterior Chambers

Vitreous Body

Adnexa

- Eyelids
- Lacrimal Apparatus

Ear

Overview

Auditory System

- External Ear
- Middle Ear
- Auditory Portion of Inner Ear

Vestibular System

- Saccule and Utricle
- Semicircular Canals and Ampullae
- Endolymph Duct and Sac
- Endolympathic Hydrops

Eye

The eye is a fluid-filled sphere with a transparent opening through which light enters and is focused on an epithelium whose highly modified cilia are sensitive to the impact of photons. The membrane depolarization initiated by such impact is then passed through a chain of neurons to the CNS, where it is interpreted as light. In the visual cortex the patterns of this nerve activity are translated into images that represent the structure of the external world. Each globe is set in a bony protective socket (the orbit) (Fig. 19.1) within the skull and fitted with six muscles that provide the precise movement needed for the depth perception made possible by binocular vision, as well as for the coordinated tracking movements.

The globe (Fig. 19.2) is essentially composed of three concentric spheres or balls. The anterior one-sixth of each sphere is modified to permit the access of light, control the amount of it entering the system, and focus it on the light-sensitive lining. As with many organs, the basic pattern is most easily understood when it is studied during its development in the embryo before differentiation of the complex adult features has been completed.

Development (Fig. 19.3)

Each eye originates as a hollow, lateral outgrowth from the forebrain, the optic vesicle. It immediately comes into contact with the overlying ectoderm and, by invagination of its lateral portion, becomes a two-layered optic cup. The cavity of the optic vesicle is obliterated during cup formation, when the inner and outer layers come in contact. These two
Fused layers form the innermost of the three concentric spheres comprising the adult eyeball. Its different regions become retina, ciliary epithelium, and pigmented layers of the iris. The mesenchyme around the outer surface of the optic cup differentiates into two layers. That in contact with the cup becomes the richly vascular and pigmented uvea, the middle layer of the adult globe. Its different regions become choroid, ciliary body, and connective tissue of the iris.

The outer mesenchyme becomes a thick layer of dense connective tissue, the outermost of the concentric spheres of the globe. This tissue differentiates into the opaque white sclera posteriorly and the transparent cornea anteriorly.

Also anteriorly, between the inner and outer layers of mesenchyme coats (and therefore between the future cornea and outer surface of the iris), a fluid-filled cleft develops that becomes lined by a simple squamous epithelium. This is the anterior chamber of the eye. The mesenchyme of the posterior wall of this cleft at first covers both iris and pupil (the iridopupillary membrane). Parts of this persist to form the outer layer of the iris, but that portion over the pupil breaks down. Thus the anterior chamber becomes continuous, through the pupil, with the fluid-filled space between iris and lens, the posterior chamber (Fig. 19.4).

The ectoderm overlying the primitive optic vesicle thickens to become the lens placode. This placode also invaginates, closes over, and pinches free of the ectoderm to lie within the optic cup as the lens vesicle. The lens vesicle is converted to lens by the great elongation of the cells of its posterior wall. These extend forward as long fibers and make contact with the anterior wall, thus filling up the lumen of the vesicle. The anterior wall remains relatively unchanged and hence the anterior hemisphere of the lens is coated with a (cuboidal) lens epithelium. As the lens grows, new fibers are added to its exterior at the equator by elongation of cells from the edge of the lens epithelium.

**Adult Structure**

Each of the components established by the developmental processes outlined above differentiates into the complex structure necessary for its adult function.

**COATS** (Fig. 19.5). The histologic organization of each of the three basic layers and its regional specializations will now be considered.

*Tunica fibrosa.* This tough, dense, connective tissue coat consists of two regions. The *sclera* covers the posterior five-sixths of the globe, and the *cornea* the anterior one-sixth.

*Sclera.* The most important function of this layer is probably the precise maintenance of the shape and rigidity of the eyeball as an optically effective chamber with constant dimensions. It is formed of intertwined and branching bundles and sheets of collagen fibers generally parallel to the surface and embedded in ground substance containing scattered fibroblasts. It is opaque, white in color, and about 0.5 mm thick. The extraocular muscles are inserted into it. Its outer surface is very loosely attached, by tenuous connective tissue fibers, to a sheath of orbital connective tissue (Tenon's capsule), within which the eyeball can be moved by the muscles. It is penetrated by the vortex veins behind the equator, and by posterior ciliary vessels and nerves. Instead of a single large opening posteriorly for passage of the optic nerve, here the sclera is perforated by numerous small openings through which nerve fibers leave in bundles. This perforated area is termed the lamina cribrosa.

*Cornea* (Fig. 19.6). The anterior one-sixth of the globe has a shorter radius of curvature than the rest and consequently bulges from