Venous drainage

Veins draining uveal blood are (Fig. 1.7):

1. *Anterior ciliary veins.* These are tributaries of the muscular veins. Since they carry blood only from the ciliary muscle, they are smaller than the corresponding arteries.

2. *Smaller veins from the sclera.* These correspond to the scleral branches of the short ciliary arteries. They only carry blood from the sclera and not from the choroid and are, therefore, smaller than the corresponding arteries.

3. *The venae verticosae (vortex veins or posterior ciliary veins).* These are usually 4 in number (superior temporal, inferior temporal, superior nasal and inferior nasal). They pierce the sclera obliquely on each side of the superior rectus and inferior rectus muscles, about 6 mm behind the equator of the globe. Of these, superior temporal vein is most posterior (8 mm behind the equator) and inferior temporal is most anterior (5.5 mm behind the equator).

At their choroidal end, the vortex veins have an ampulliform dilatation.

Venae verticosae drain blood from:

- Whole of the choroid
- Receive small veins from optic nerve head
- Sometimes small veins from retina also join it
- Anterior tributaries come from the iris, ciliary processes, ciliary muscle and anterior part of the choroid. There is no major venous circle corresponding to major arterial circle

Oblique scleral canals through which the vortex veins pass are about 4 mm long and directed posteriorly in such a way that the four veins appear to converge towards the apex of the orbit.

Superior vortex veins open into the superior ophthalmic vein directly or through its muscular or lacrimal tributaries.

Inferior vortex veins open into the inferior ophthalmic veins.

PHYSIOLOGICAL CONSIDERATIONS

FUNCTIONS OF UVEAL TISSUE

The uveal tissue performs the following physiological functions:

1. It is the source of blood flow to the ocular tissues.
2. It is the site of aqueous humour production and maintenance of intraocular pressure.
3. It constitutes the blood–aqueous barrier.
4. Musculature of the ciliary body plays role in the process of accommodation.
5. Eicosanoids are synthesized in the iris and ciliary body.
6. Uveal tissues play role in the detoxification and antioxidation in the anterior segment.

BLOOD–OCULAR BARRIER

By virtue of blood–ocular barrier, the protein and other large molecular size substances are largely prevented from entering the cavities (anterior chamber, posterior chamber and in tear cavity) of the eyes. This mechanism is essential to maintain the clarity of the media of the eye.

Blood–ocular barrier consists of two parts—the posterior blood–retinal barrier and the anterior blood–aqueous barrier.

Blood–retinal barrier in turn consists of two parts—the inner and the outer. The inner blood–retinal barrier is composed of the tight junction of retinal capillaries, endothelial cells and the outer blood–retinal barrier consists of tight junctional complexes (zonula occludens and zonula adherans) which are located between adjacent RPE cells (Fig. 1.8).

Blood–aqueous barrier is formed by the tight junctions (zonula occludens and the zonula adherans) between the cells of the inner non-pigmented epithelium of the ciliary body

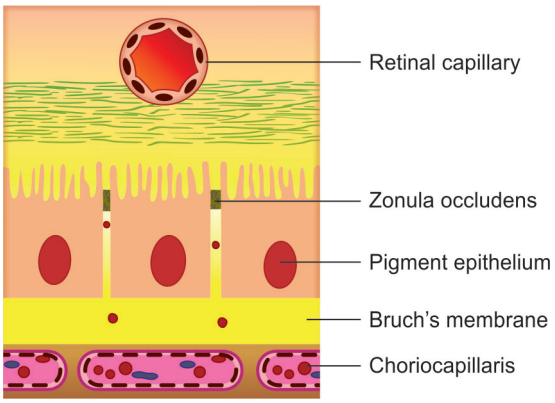

Fig. 1.8 *Blood–retinal barrier.*

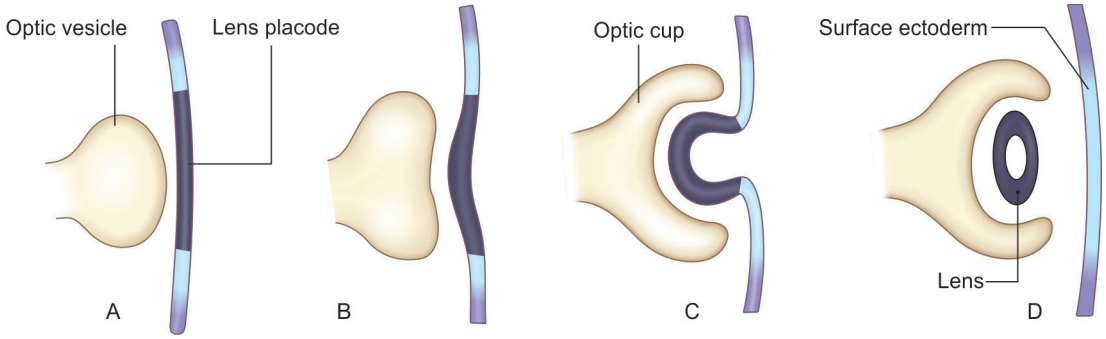

Fig. 2.2 *Formation of lens vesicle and optic cup.*

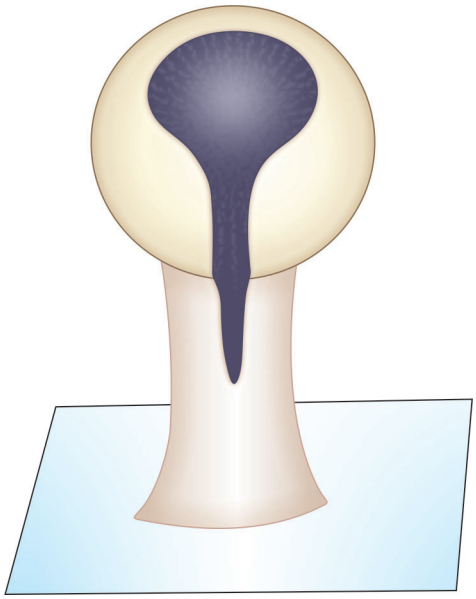

Fig. 2.3 *Optic cup and stalk seen from below to show the choroidal fissure.*

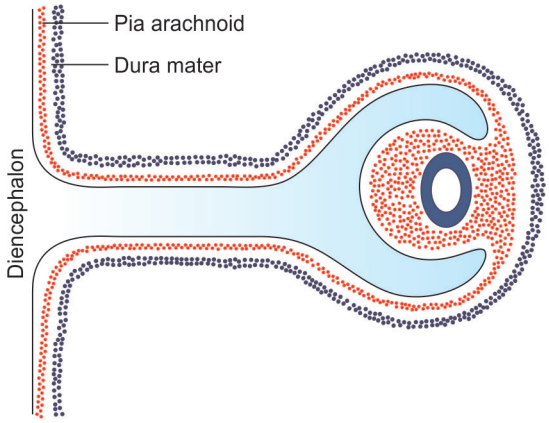

Fig. 2.4 *Developing optic cup surrounded by mesoderm.*

vesicle itself. Later, this mesenchyme differentiates to form a superficial fibrous layer (corresponding to dura), which will form the sclera and cornea and a deeper vascular layer (corresponding to pia-arachnoid) which will form stroma of uveal tissue (Fig. 2.4).

With the formation of optic cup, part of the inner vascular layer of mesenchyme is carried into the cup through the choroidal fissure. With the closure of this fissure, the portion of mesenchyme which has made its way into the eye through the fissure is cut off from the surrounding mesenchyme and gives rise to hyaloid system of the vessels (Fig. 2.5). The fibrous layer of mesenchyme surrounding anterior part of optic cup forms the cornea. The corresponding vascular layer of mesenchyme becomes iridopupillary membrane, which, in the peripheral region, attaches to the anterior part of the optic cup to form iris. The central part of this lamina is pupillary membrane and also forms the tunica vasculosa lentis (Fig. 2.5).

In the posterior part of optic cup, the surrounding fibrous mesenchyme forms sclera and extraocular muscles, while the vascular layer forms the choroid and ciliary body.

FORMATION OF TUNICA VASCULOSA LENTIS

During embryonic and fetal development, the lens receives nourishment via an intricate vascular capsule, the tunica vasculosa lentis, that completely encompasses the lens by approximately 9 weeks. It is formed from the mesenchyme that surrounds the lens. Three components of tunica vasculosa are anterior

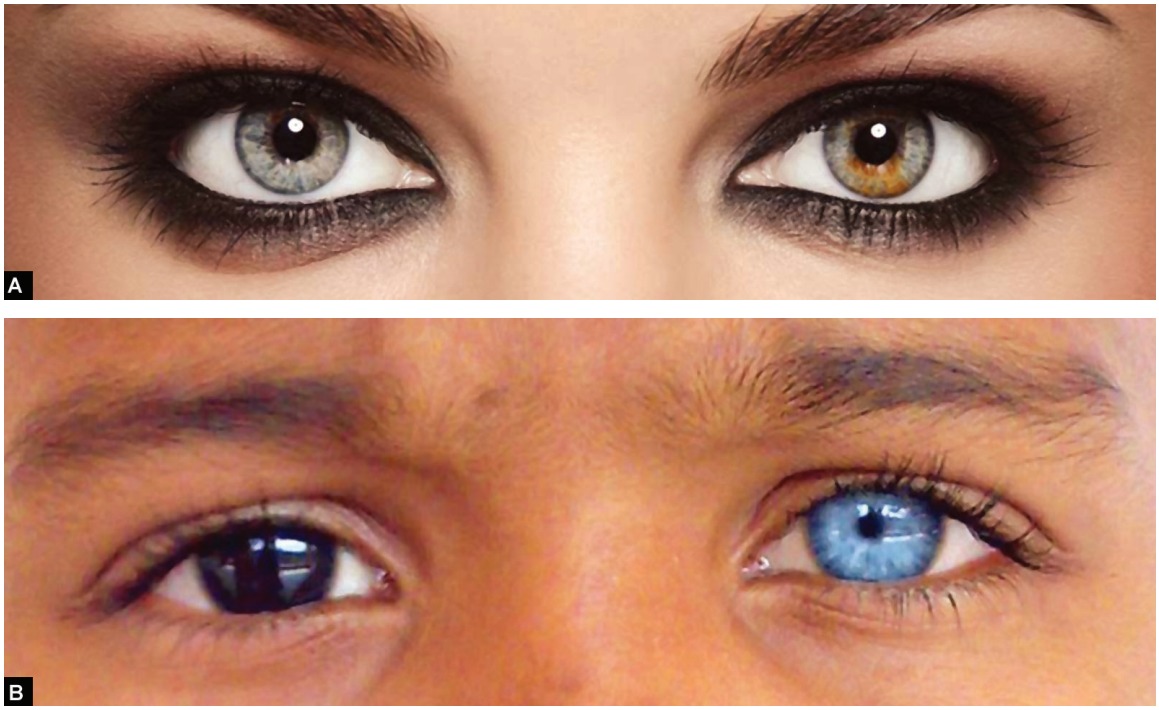

Fig. 2.11 *Heterochromia iridum (A) and iridis (B).*

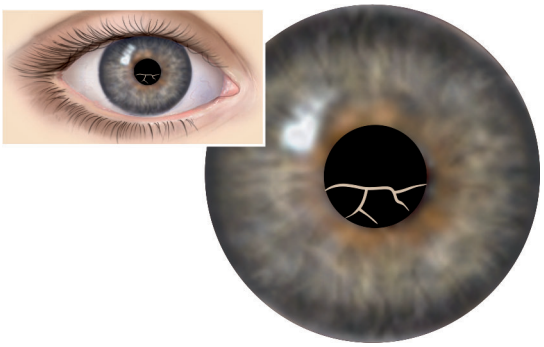

Fig. 2.12 *Persistent pupillary membrane.*

Such iris tags occur frequently and are of no pathological importance. Minute remnants of the pupillary membrane are very commonly seen in slit-lamp examination of adults. They can be differentiated from post-inflammatory synechia as they always come from the anterior surface of the iris from the region of collarette.

CONGENITAL CYST OF IRIS

An iris cyst, or uveal cyst is a small hollow structure either attached to iris or may sometime even float freely in the anterior chamber. An iris cyst is composed of single layer of epithelium and is filled with fluid.

Types. Congenital cyst of the iris is a rare anomaly and may arise either from the pigment epithelium or stroma of iris:

- *Cyst of pigment epithelium of iris* appears to failure of fusion of the two neuroepithelial layers of optic vesicles.
- *Stromal cyst of iris* is believed to be derived from the ectopic cells of the surface ectoderm from which the crystalline lens is developing.

Differential diagnosis of congenital cyst of iris needs to be made from the acquired iris cysts which include:

- *Implantation cyst* which occurs following perforating ocular injury or an intraocular surgery. The implantation cyst has characteristic pearly appearance.
- *Serous cyst of iris* may occur following closure of iris crypts associated with retention of fluid.
- *Parasitic cyst* of iris.

Antibodies. Antibodies or immunoglobulins (Igs) are gamma globulins which are produced in response to antigenic stimulation.

Immune system. The immune system that constitutes the body's defence system consists of lymphoid organs, reticuloendothelial components and the various types of immunological cells distributed throughout the body.

Immune response. The immune system of the body responds to an antigen by two ways:

- *Humoral or antibody-mediated immunity (AMI)* which is mediated by antibodies produced by plasma cells, and
- *Cell-mediated immunity (CMI)* which is mediated directly by the sensitized lymphocytes.

Immune tolerance. Immune tolerance refers to the inability of a host to express a specific immunological response to an antigen.

Autoimmunity. Refers to the condition when the body's immune response gets directed towards its own tissues which are normally exempted as self.

Immunomodulation refers to process of modifying the body's immune response. It may be in the form of:

- *Immunoenhancement* (immunopotentiation), i.e. to enhance the antibody or cell-mediated immune response against an antigen, and
- *Immunosuppression*, i.e. to reduce the body's immune response against the antigens.

Hypersensitivity. Refers to an abnormal immune response which produces physiological or histopathological damage in the host.

ARCHITECTURE (COMPONENTS) OF IMMUNE SYSTEM

The immune system is a complex network of organs containing cells that recognize foreign substances in the body and destroy them. It is a system of many biological structures and processes within an organism that gives protection against pathogen or infectious agents, such as viruses, bacteria, fungi, and other parasites. The organs of the immune system are positioned throughout the body (Fig. 3.1.1). They are called lymphoid organs because they serve as a home to lymphocytes, small white blood cells, that are the key players in the immune system.

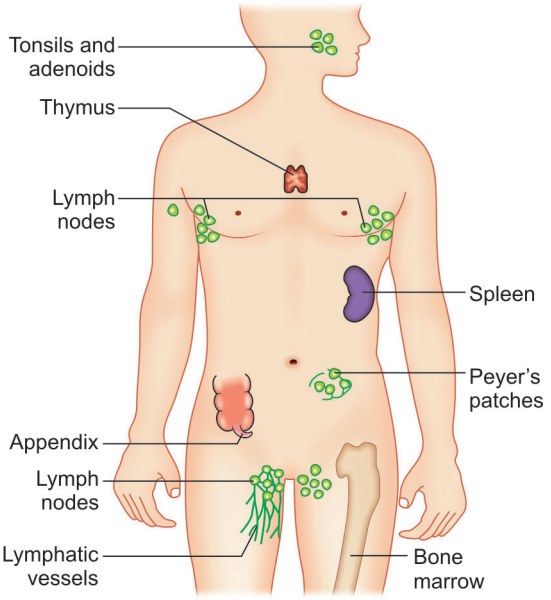

Fig. 3.1.1 *Organs of immune system.*

The immune system consists of immunological cells distributed into two main components:

1. Mononuclear phagocytic system, and
2. Lymphoid component.

MONONUCLEAR PHAGOCYTIC SYSTEM

Mononuclear phagocytic system (MPS), also known as *tissue-macrophage system*, is the new name given to the system previously called as reticuloendothelial system (RES).

Formation of mononuclear phagocytic system

The monocytes enter the blood from the bone marrow and circulate for about 3 days. From the blood, the monocytes migrate into the tissue where they attain maturity, i.e. they increase in size and a large number of lysosomes and mitochondria develop in their cytoplasm. In this way, they acquire the ability to phagocytose and thus get converted to macrophages. The macrophages wander through tissues (*mobile macrophages*) and perform scavenger functions of eliminating microorganisms and other foreign particles that invade the tissues. Some of these macrophages become attached to certain tissues in the body (*fixed macrophages*) and remain there

Contents