The formation of eye is intimately associated with the formation of the brain. By 27 hours of incubation the differentiation of brain region can be observed. Dilatations of the neural tube are marked off as the forebrain or **prosencephalon,** midbrain or **mesencephalon,** and the hind brain or **rhombencephalon.**

In later stages of incubation, the lateral walls of the proscencephalon become outpushed to form a pair of rounded optic vesicles called the **primary optic vesicles.** At first, there is no constricition between the optic vesicles and the prosencephalon and the lumen of the vesicles communicates with the lumen of the prosencephalon without any demarcation.

Around 33 hours on incubation, the optic vesicles become established as the outpushings of the prosencephalon. These vesicles soon extend so much as to occupy the full width of the head. As a result, the distal portion of each

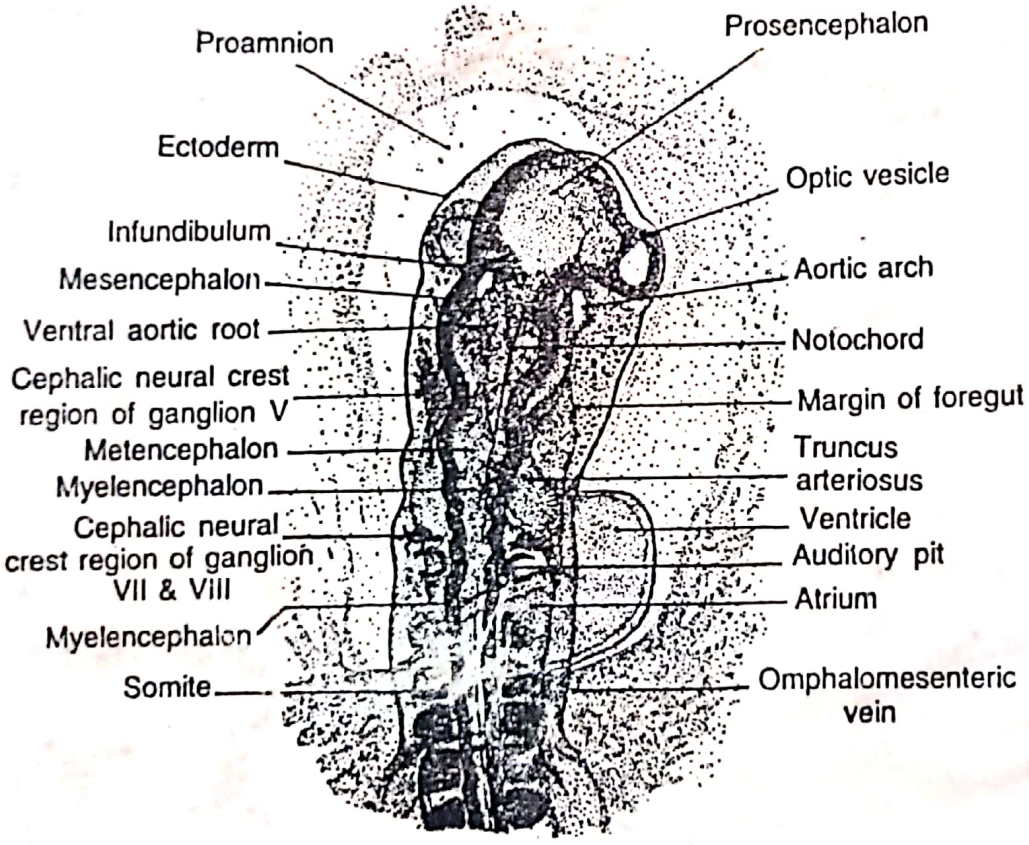

Fig. 7.1. Dorsal view of cephalic and cardiac region of a chick embryo with the seventeenth somite just forming (about 38 hours of incubation)

of the vesicles comes to lie against the superficial ectoderm. The closeness of the vesicle to the ectoderm assumes great importance in the organogenesis of the eye.

Later on the constrictions develop between the optic vesicle and the prosencephalon. This narrows the confluence between the opticocoel and the prosocoel.

Formation of optic Vesicles, optic-cup —

Subsequently optic vesicles undergo changes in their appearance. In 33-hour chick embryo, they are spheroidal and are connected by a broad stalk with the lateral wall of the prosencephalon. By the time the constriction between the optic vesicle and the lateral walls of the prosencephalon has deepened, there occurs an invagination at the distal end of the single-walled optic vesicle. This invagination deepens and the optic vesicle becomes a double walled cup, the **optic cup.** The concavity of the optic cup is pointed laterally. The optic cup is continuous mesially over the optic stalk, which is the projection of the ventro-lateral wall of the diencephalic region of the forebrain. The invaginated layer of the optic cup is designated as the sensory layer. It is this layer which is destined to beome the sensory layer of the retina in the fully developed eye. The sensory layer rests against the layer called the pigment layer which will form the pigmented layer of the retina.The double walled optic cup is also called secondary optic vesicle in order to distinguish it from the primary optic vesicle which is uninvaginated. With the formation of double walled optic cup, the optocoel is practically obliterated. However, there remains a narrow space for a while between the sensory and the pigment layers.This space too is obliterated with the fusion of the these two layers. The optic cup has an incomplete lip on its ventral aspect. This gap in the optic cup is called the choroid fissure. With further development, the optic stalks become more prominent.

Devt of Lens —

The **lens** of the eye is formed from the superficial ectoderm of the head that covers the optic vesicle. Initiation of lens formation can be seen in the embryo of 40 hours of incubation as the local thickening of the ectoderm is very close to the optic vesicles. These patches (placodes) of thickened ectoderm are depressed to some extent from the general surface of the head. This sunken part extends into the secondary optic vesicles and is finally cut off from the superficial ectoderm. The lens is formed from this sunken placode of thickened epithelium. The formation of lens is a result of the induction of the optic cup.

The cells on the deep hole of the lens begin to elongate to finally become the lens fibres. However, the cells that constitute the front surface of the lens do not elongate. They constitute what is called lens epithelium in which the cells are cuboidal. The lens fibres are elongated enough to establish contact with the lens epithelium. This causes reduction in the lens cavity. The formation of lens fibres continues throughout the period of embryonic life. Each lens fibre ultimately extends from one pole of the lens to the other. With

the development of lens, the fibres also grow in length.

As the lens increases in size, it settles deep into the optic cup. Concurrently, the margins of the cup begin to overlap its edges. This overlapping part can be recognized as the epithelial protion of the **iris.** The reduced opening in front of the lens, flanked by iris, is called the **pupil.** The folding of the optic cup close to the iris forms the ciliary body which is radially arranged. Outside the epithelial layer (which forms iris), there is a loosely aggregated mesenchyme which becomes organized to form the muscular portion of the ciliary body. This is the ciliary muscle which controls the

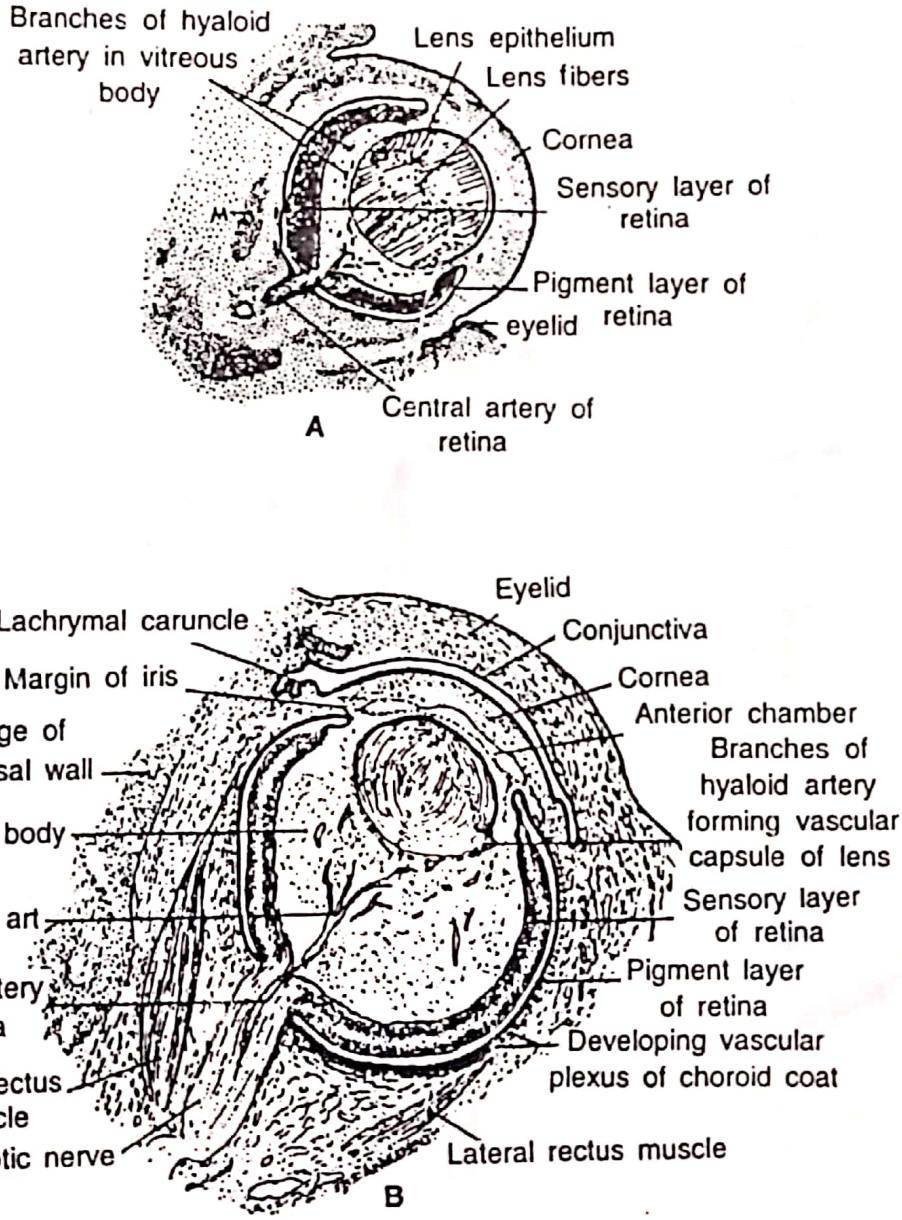

Fig. 7.2. Two stages in development of the eye as seen in coronal section of the head. (*A*) From an embryo of 17mm about 7 weeks. (*B*) From an embryo of 48 mm, about middle of tenth week.

curvature of the lens so that objects at different distances can be made to focus sharply on to the retina.

Outside the optic cup, the mesenchymal cells are massed so that these may subsequently become differentiated into the outer and inner coats. The outer coat is composed of fibrous connective tissue, and is called the scleroid coat or **sclera**. The inner vascular coat forms the **choroid**.

Dev. of cornea

Cornea is the overlying layer of the lens which is the continuation of sclerotic in front of the eye. The outermost layer of the cornea is the epithelial layer derived from the superficial ectoderm. In addition to this epithelial layer, the bulk of cornea is composed of dense fibrous layer, the **substantia propria**. It is also derived from the mesoderm, but these fibres are transparent so as to allow the light to pass through the lens. The curvature of the cornea is such as to bulge out of the eye ball.

Dev. of Eye lids

The **eyelids** develop as folds of skin growing over the cornea. After their formation, they close over the eye very rapidly. The meeting of the two eyelids involves the epithelial layers of the eyelid, the eyelashes and the meibomian glands that lie on the margin of the lids. The eyelashes are specialized hairs and these grow in the manner of a typical hair. Along with the eyelashes develop the sebaceous glands (meibomian gland). For the most part, the epithelium on the inner face of the lid is stratified columnar. It is rendered moist by the secretions of the goblet cells which are mucous, as well as form the lachrymal glands. This epithelium together with some of connective tissue, tunica propria, constitutes the outermost layer of the front portion of the eye, the **conjunctiva**. The epithelial cells of conjunctiva are squamous. The conjunctiva extends from the inner surface of the eyelids up to the sclero-corneal junction. The space between the conjunctiva and the eyelid is called **conjunctival sac**.

Dev. Lacrymal Gland

Lachrymal glands develop from muliple buds which develop into voluminous glands opening into the conjunctival sac.

During organogenesis, the eyes change their relative position. They change their position from the lateral sides to the facial (ventral sides). As the facial structures grow the eyes are shifted forward in the head so as to allow their optical axes to converge. This shifting of position is important in binocular vision.

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