

B.SC - Semester 2

(Core course – Theory)

Course Code – 1ZOOTC0201

Course Title - Comparative anatomy and developmental biology of vertebrates

UNIT: 4

Topic: Photoreceptor

Photoreceptors are sensitive to light radiations in a narrow spectrum of wavelength. The wavelength of spectrum varies among different species. The eyes of vertebrates are highly specialized structure with no homologous in members of other phyla. Vertebrates have two types of eyes.

1. Unpaired median eyes

2. Paired lateral eyes

□ **Unpaired median eyes.** These were occur in most ancient fishes, amphibians and reptiles. They are also found in some living vertebrates in the form of pineal and parapineal organs form as dorsal evaginations of the diencephalon of forebrain. They are light sensitive in cyclostomes. They have a lens and sensory innervations but lack of a retina and do not form an image. It serves as a third eye and is often termed the parietal eye.

□ **Lateral eye.** The lateral eyes of all vertebrates are formed on same structural plan. They are located in deep bony cavities of skull called orbits for safety against injury. These are popularly called eyes. They are of camera types with a lens which focuses images of the external objects on the sensitive retina serving as a photographic film.

Human eye is described as an introduction of study of an organ of sight.

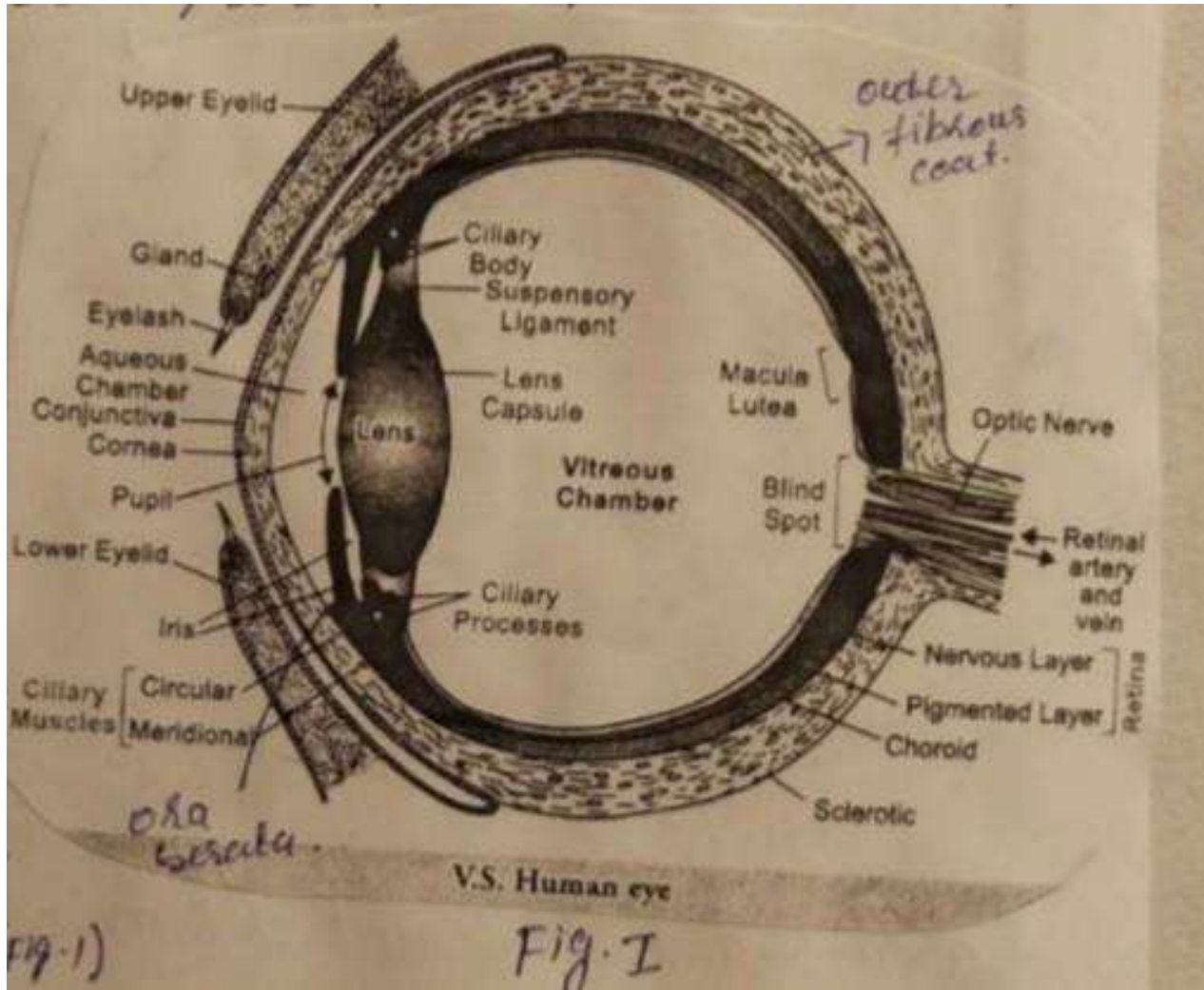
Locations of human eyes

Human eyes are located in the deep bony cavities called orbits of skull for safety against injury.

Structure: The eye is hollow, spherical organ, about 2.5 cm in diameter. It is often referred to as the eye ball. Its wall is composed of three concentric coat.

Outer fibrous coat, middle vascular coat and inner nervous coat or retina .Of these, the fibrous coat alone is complete where as others (middle and inner coats) are incomplete on the front side.

1) **Outer fibrous coat.** It is thick and tough. It protects the eye ball, maintains it's from and provides firm surface for the insertion of eye muscles. It has two distinct but unequal regions 1. Sclerotic or sclera and 2. Cornea (fig. 1)



1 Sclerotic or sclera: It forms the posterior five –sixth part of fibrous coat. It is formed of white fibrous tissues. It is largely hidden in the orbit, a small anterior portion is visible externally is commonly called the white of the eye.

Cornea. It forms the anterior one-sixth part of the fibrous coat, it is transparent, circular and fully visible from in front, it is composed of a particular variety of connective tissue, it has parallel fibers and a small no of cell which are interconnected by long, thin protoplasmic strands. It lacks blood vessels and is nourished by lymph from adjacent area. It is rapidly repaired if injured. The cornea is thicker than sclerotic and is slightly bulged forward. Its curved surface helps the lens in focusing light rays on retina. The cornea and the exposed part of the sclerotic are covered externally by thin, transparent membrane called conjunctiva. The conjunctiva is epidermal in origin and is continuous with the epidermis that lines the eyelids. It is thin and richly supplied with free nerve endings. The part of conjunctiva that covers the cornea is called bulbar or ocular and the part that lines the eyelids is termed palpebral conjunctiva.

2. Vascular or uvea coat (middle coat) it is the middle coat and is incompletely anteriorly. It is formed of three parts.

A) Choroid

B) Iris

C) Ciliary part

A) **Choroid.** It is the greater part of choroid or uvea and present on inner side of sclerotic. It consists of soft, thin, dark-brown vascular membrane containing pigment cells and blood vessels. It performs two functions:

1) It absorbs stray and excess light

2) Provide nutrition to retina

B) Iris : It is at the junction of sclerotic and cornea, the uvea sharply bends in to the cavity of the eyeball to form a thin and coloured portion. This portion is called iris. It is perforated at the middle by an aperture called the pupil. The iris contains two sets of involuntary muscles which regulated its size. Muscles are 1. Spinctor muscles and 2. Dialotor muscles (Fig. 2)

I. Spinster muscles. These are arranged in ring. Their contractions make the size of pupil smaller in bright light so that less light enters the eye.

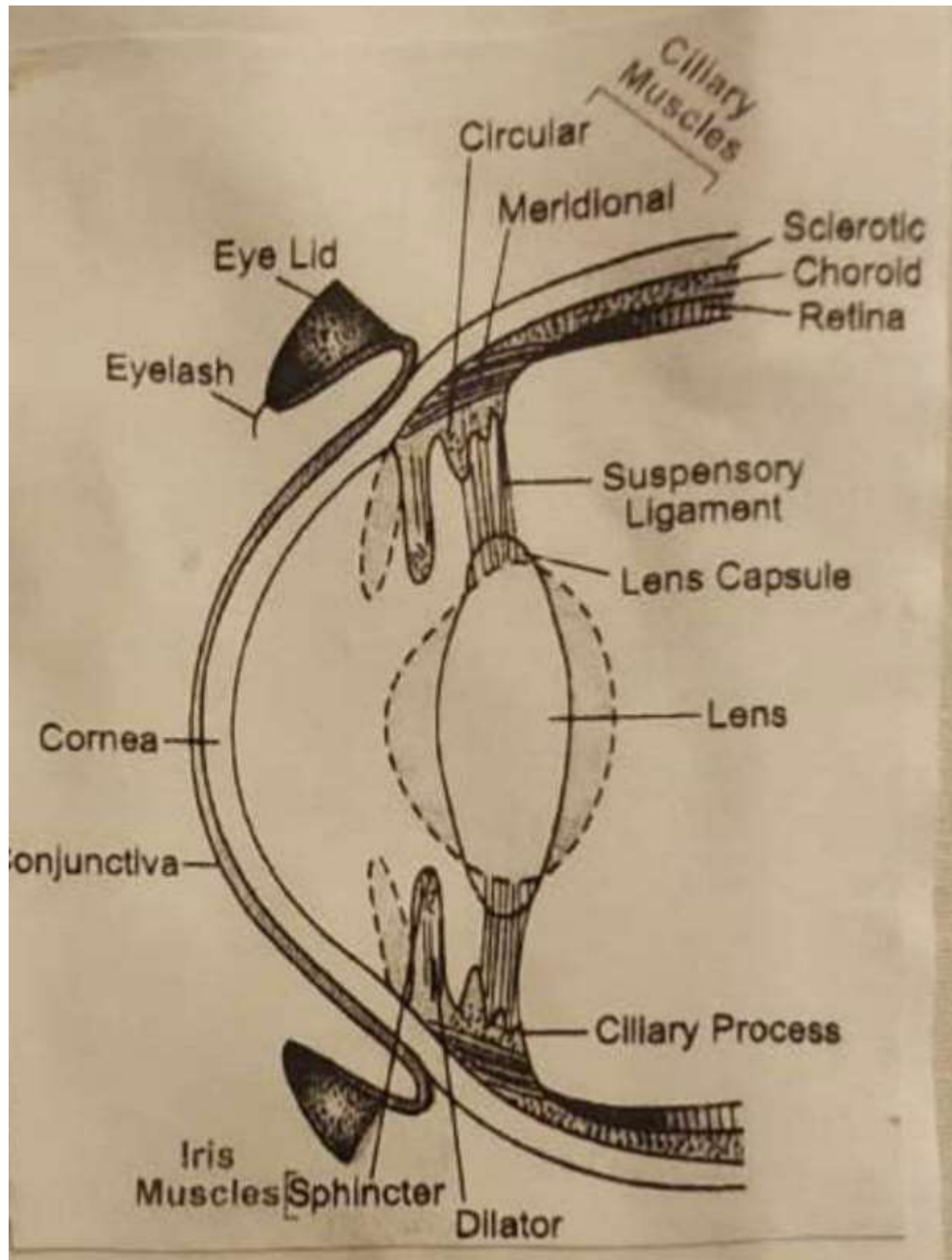


FIG. 2

II. Dilator muscles. These are arranged in radial manner. Their contractions make the size of pupil larger, and allow to enter more light. Iris by regulating the size of the pupil, allows light to pass only through the centre of the lens, which is optically the most effective part.

C. Ciliary part. Behind the peripheral Margin of the iris, the uvea is thicker, less vascular, and less pigmented. This part of the uvea is known as the ciliary body. The inner surface of the ciliary processes, which project into in eyeball. The ciliary body contains smooth muscles called ciliary muscles. These muscles are of two types circular and Meridional muscles (fig 2) the inner ends of the Meridional muscles are attached to the choroid and their outer ends are inserted in the outer coat at the junction of the sclerotic and cornea. Functions of these muscles as

- 1) **Circular muscles.** On contraction, these muscles decrease size of eyeball.
- 2) **Meridional muscles.** On contraction, choroid forward.
- 3) 3rd coat is nervous coat or retina. It consist of three part optical, ciliary and radical

1. Optical part. It is thick, pigmented and photosensitive part present on inner side of choroid. It forms posterior 2/3rd part of the retina fig 1. it has four layers of cells from outer to inner side. These are pigmented cells; photoreceptor cells (rods and cones) bipolar nerve cell and ganglion cells (fig 3). The pigment cells reinforce the light absorbing property of choroid in reducing the scattering of light in the eye. The receptor cells (rods and cones) synapse with the bipolar cells, which in turn snap with ganglion cell (fig 3) the axons of the ganglion cell form the fig 3.

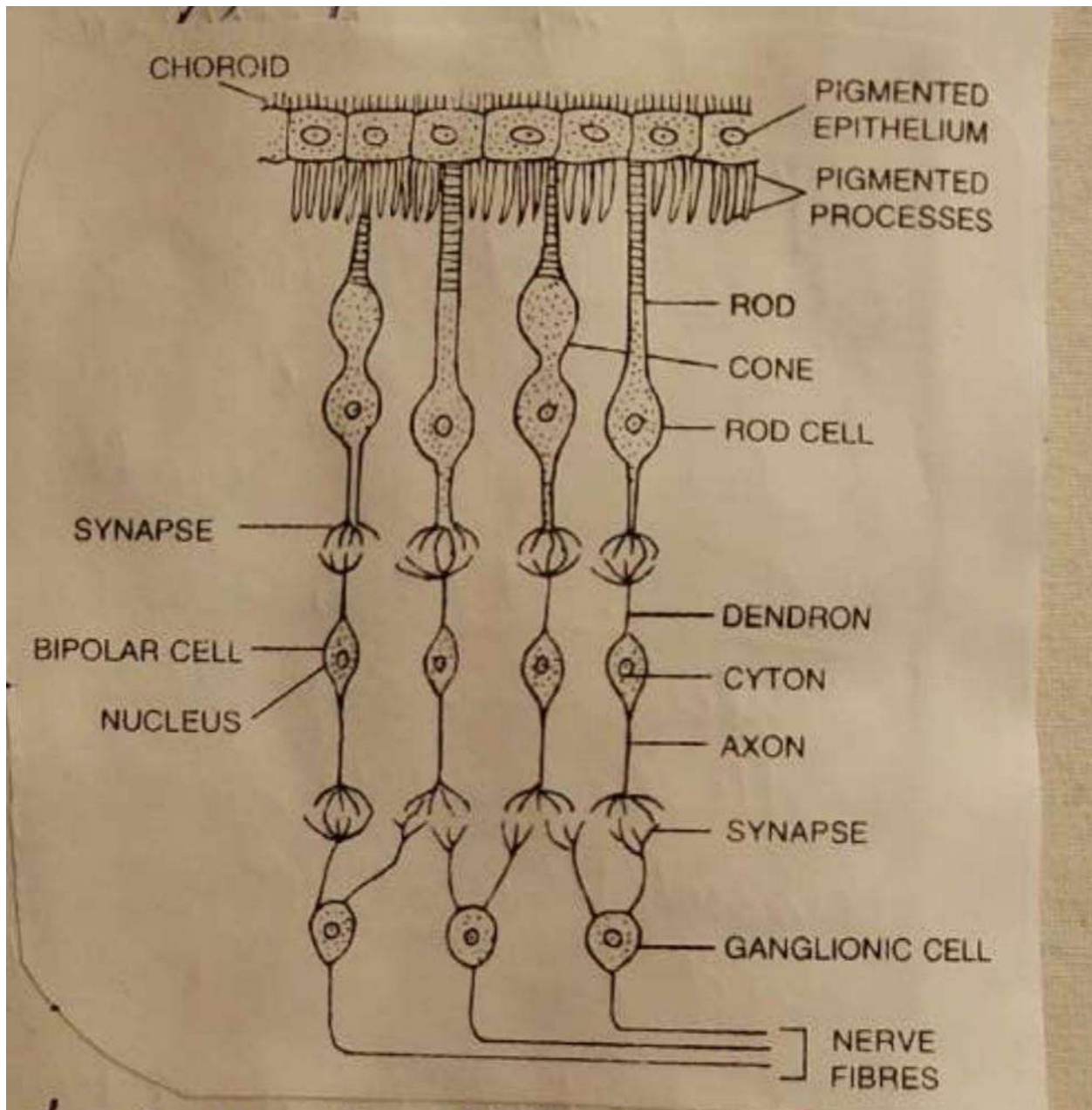


Fig. 3

I. Optical Photoreceptor cells are two types

II. Rod cells

III. Cone cells

I. Rod cell. There are rod-like structure, found concentrated at the outer edges of the retina. They provided twilight vision and are sensitive to dimlight. These cell have a visual purple pigment, called rhodopsin (formed of vitamin A and pepsin protein) rhodopsin is bleached by bright light and is converted to protein cotopsin

and pigments retinal which depolarizes rod cells. The rhodopsin is rapidly regenerated in dimlight so man is blind for sometime when arrives in a well lighted room at night and enters a dark room during day.

B) **Cone cells.** These are cone shape, and having a visual violet pigment called iodopsin (formed of vitamin A and pepsin protein) and are sensitive to bright light. So rods are adapted for twilight (dim light) vision and cones for bright light and colour vision. On the optical part of retina has two spots i.e. **blind spot and yellow spot** .

I. **Blind spot.** It is a small area from where optical nerve arises. It is without rods and cones. therefore this spot is insensitive to light .as a result no image is formed on it.

Yellow spot, It is also called macula. it is a small area on retina which lies opposite to optical axis of the lens. it has only cone cells so much sensitive to day light vision. it is with a depression about 1.5mm in the middle. On either side yellow spot, rods and cones are in equal amount.

ii. **Ciliary part:** it is inner and pigmented part present inner side of ciliary part of choroid. The ciliary part of retina and choroid collectively called ciliary body. it is demarcated from optical part by a small wavy area marked ora serrata .

iii. **Radial part:** it is also thinner and pigmented area present inner side of iridial part of choroid. The iridial part of retina and choroid collectively form iris due to the presence of pigmented cells of iridial part of retina and iridial part of choroid give the colour to the eyes. Colour of eye depends on the amount of pigment (melanin) e.g (albinos have no pigment they cannot recognized in thins clearly) blue eyed person have less pigment. Brown effected person large no of pigmented cells.

Lens

Lens of human eyes is solid circular transparent and biconvex the lens is composed of transparent and flexible tissue and is located directly behind the iris and the pupil it is the second part of the eye after the cornea that helps to focus light and image on retina lense is covered by thin transparent and elastic membrane called lens capsule. Lens is suspended in the cavity of eye-ball by a ring like ligamentous called suspensory ligaments which extends between ciliary part and lens capsule. As a result the cavity of eye ball is divided into two unequal chambers. Aqueous & vitreous chambers.

1) **Aqueous chamber:** it is anterior and smaller chamber present between cornea and lens. it is filled with watery fluid called **Aqueous humor** which helps

i. provide nutrition to non -vascular lens and cornea.

ii. It gives shape to the eye

- ii. It support lens
- iii It Refracts light rays to focus on retina
- iv. Maintains -intra ocular pressure.

iii. Its support the lens.

iv. It refract in light rays to focus on retina

2) **Vitreous chambers:** it is posterior and large chamber. it lies between lens and retina. it is filled with transparent gelatinous material called vitreous humour.

Function

i. provide shape to eye

ii. it support retina and lens

iii. Refracts light rays

iv. Maintains -intra ocular pressure.