EYE

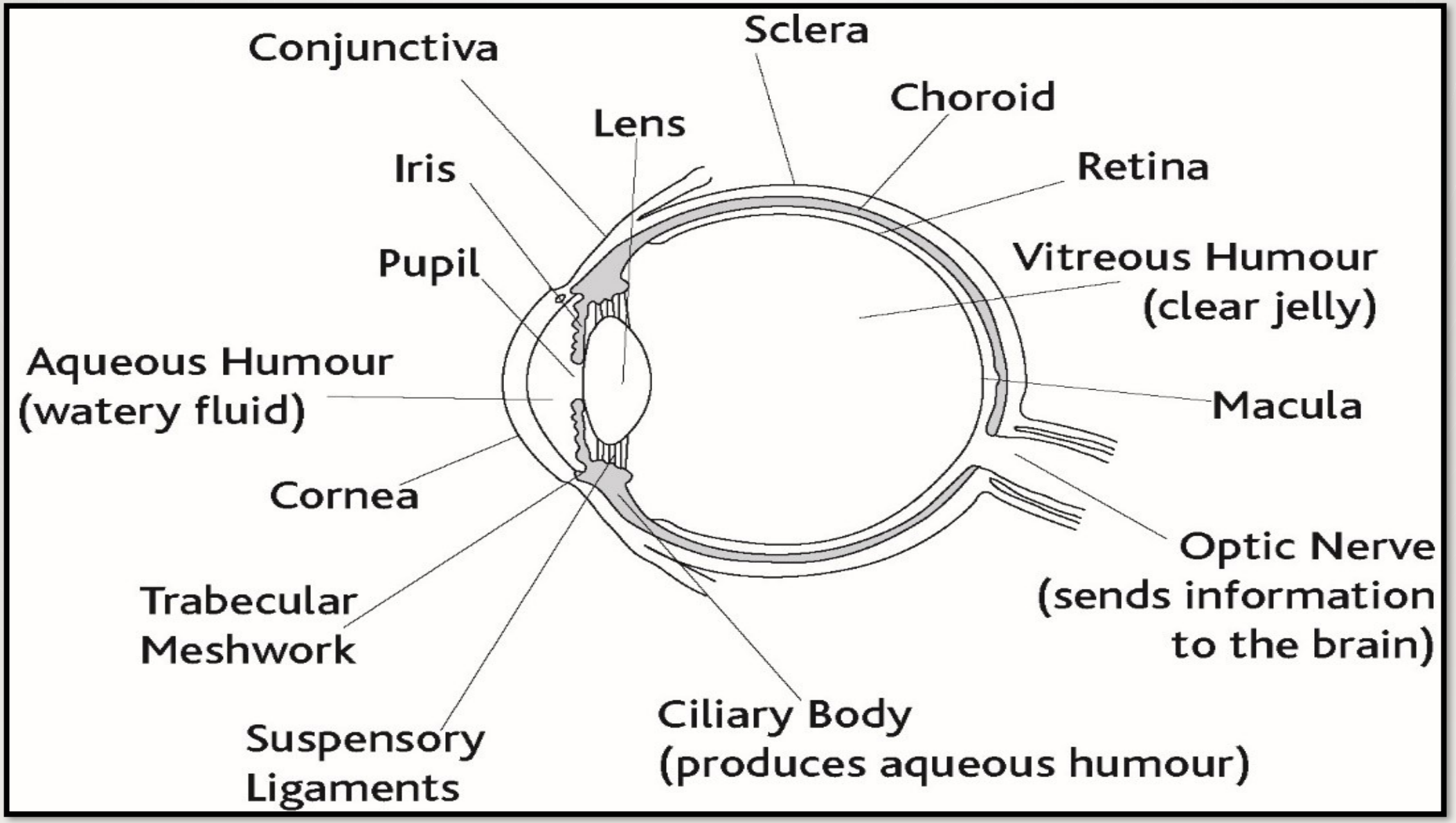
- **The eye is an organ of the sense of sight situated in the orbital cavity and it is supplied by the optic nerve (2nd cranial nerve).**
- **It is almost spherical in shape and is about 2.5 cm in diameter. The space between the eye and the orbital cavity is occupied by adipose tissue. The bony walls of the orbit and the fat, help to protect the eye from injury.**
- **Structurally the two eyes are separate but, unlike the ear, some of their activities are co-ordinated so that they function as pair. It is possible to see with only one eye but 3 dimensional vision is impaired when only one eye is used, especially in relation to the judgement of distance**

STRUCTURE

There are three layers of tissue in the walls of the eye:

- **The outer fibrous layer: sclera and cornea**
- **The middle vascular layer or uveal tract: choroid, ciliary body and iris**
- **The inner nervous tissue layer: retina**

Structures inside the eyeball are the lens, aqueous fluid (humour) and the vitreous body.


Conjunctiva
Sclera
Choroid
Lens
Iris
Retina
Pupil
Vitreous Humour
(clear jelly)
Aqueous Humour
(watery fluid)
Macula
Cornea
Optic Nerve
(sends information
to the brain)
Trabecular
Meshwork
Ciliary Body
(produces aqueous humour)
Suspensory
Ligaments

Sclera and Cornea

- The sclera, or white of the eye, forms the outermost layer of tissue of the posterior and lateral aspect of the eyeball and is continuous anteriorly with the transparent cornea.
- It consists of a firm fibrous membrane that maintains the shape of the eye and gives attachment to the extraocular or extrinsic muscles of the eye.
- Anteriorly the sclera continues as a clear transparent epithelial membrane, the cornea. Light rays pass through the cornea to reach the retina. The cornea is convex anteriorly and is involved in refracting or bending light rays to focus them on retina.

Choroid

- **The choroid lines the posterior five-sixth of the inner surface of the sclera. It is very rich in blood vessels and is deep chocolate brown in colour. Light enters the eye through the pupil, stimulates the nerve endings in the retina and is then absorbed by the choroid.**

Ciliary body

- The ciliary body is the anterior continuation of the choroid consisting of ciliary muscles (smooth muscles fibres) and secretory epithelial cells.
- It gives attachment to the suspensory ligament which at its other end, is attached to the capsule enclosing the lens.
- Contraction and relaxation of the ciliary muscles changes the thickness of the lens which bends or refracts light rays entering the eye to focus them on the retina. The epithelial cells secrete aqueous fluid into the anterior segment of the eye, i.e. the space between the lens and the cornea.
- The ciliary body is supplied by sympathetic branches of the oculomotor nerve (3rd cranial nerve) stimulation causes contraction of the smooth muscle and accommodation of the eye.

Iris-

- **The iris is the visible coloured part of the eye and extends anteriorly from the ciliary body, lying behind the cornea and in front of the lens.**
- **It divides the anterior segment of the eye into anterior and posterior chambers which contain aqueous fluid secreted by the ciliary body.**
- **It is a circular body composed of pigment cells and 2 layers of smooth muscle fibres, one circular and the other radiating.in the centre there is an aperture called the pupil.**
- **The iris is supplied by parasympathetic and sympathetic nerves.**
- **Parasympathetic- constricts the pupil**
- **Sympathetic- dilates the pupil**
- **The colour of the iris is genetically determined and depends on the number of pigment cells present. Albinos has no pigment cells and people with blue eyes have fewer than those with brown eyes.**

Lens

- The lens is a highly elastic circular biconvex body, lying immediately behind the pupil
- It consists of fibres enclosed within a capsule and it is suspended from the ciliary body by the suspensory ligament.
- Its thickness is controlled by the ciliary muscle through the suspensory ligament. When the ciliary muscle contracts, it moves forward, releasing its pull on the lens, increasing its thickness. The nearer is the object being viewed, the thicker the lens becomes to allow focusing.
- The lens refracts light rays reflected by objects in front of the eye. It is the only structure in the eye that can vary its refractory power, which is achieved by changing its thickness.

Retina

•The retina is the innermost layer of the wall of the eye. It is extremely delicate structure and is well adapted for stimulation by light rays.

•The light sensitive layer consists of sensory receptor cells: rods (dim light)and cones.(bright light)

•The retina lines about three quarters of the eyeball and is thickest at the back. It thins out anteriorly to end just behind the ciliary body.

•Near the center of the posterior part is the macula lutea, or yellow spot. In the center of the yellow spot is a little depression called the fovea centralis, consisting of only cones. Towards the anterior part of the retina there are fewer cones than rods.

•The rods and cones contain photosensitive pigments that convert light rays into nerve impulses. About 0.5 cm to the nasal side of the macula lutea all the nerve fibres of the retina converge to form the optic nerve. The small area of retina where the optic nerve leaves the eye is the optic disc or blind spot. It has no light sensitive cells.

Blood Supply to the eye

- The eye is supplied with arterial blood by the ciliary arteries and the central retinal artery. These are the branches of the ophthalmic artery, one of the branches of the internal carotid artery.
- Venous drainage is by a number of veins, including the central retinal vein, which eventually empty into a deep venous sinus.
- The central retinal artery and vein are encased in the optic nerve, entering the eye at the optic disc.

Optic nerve

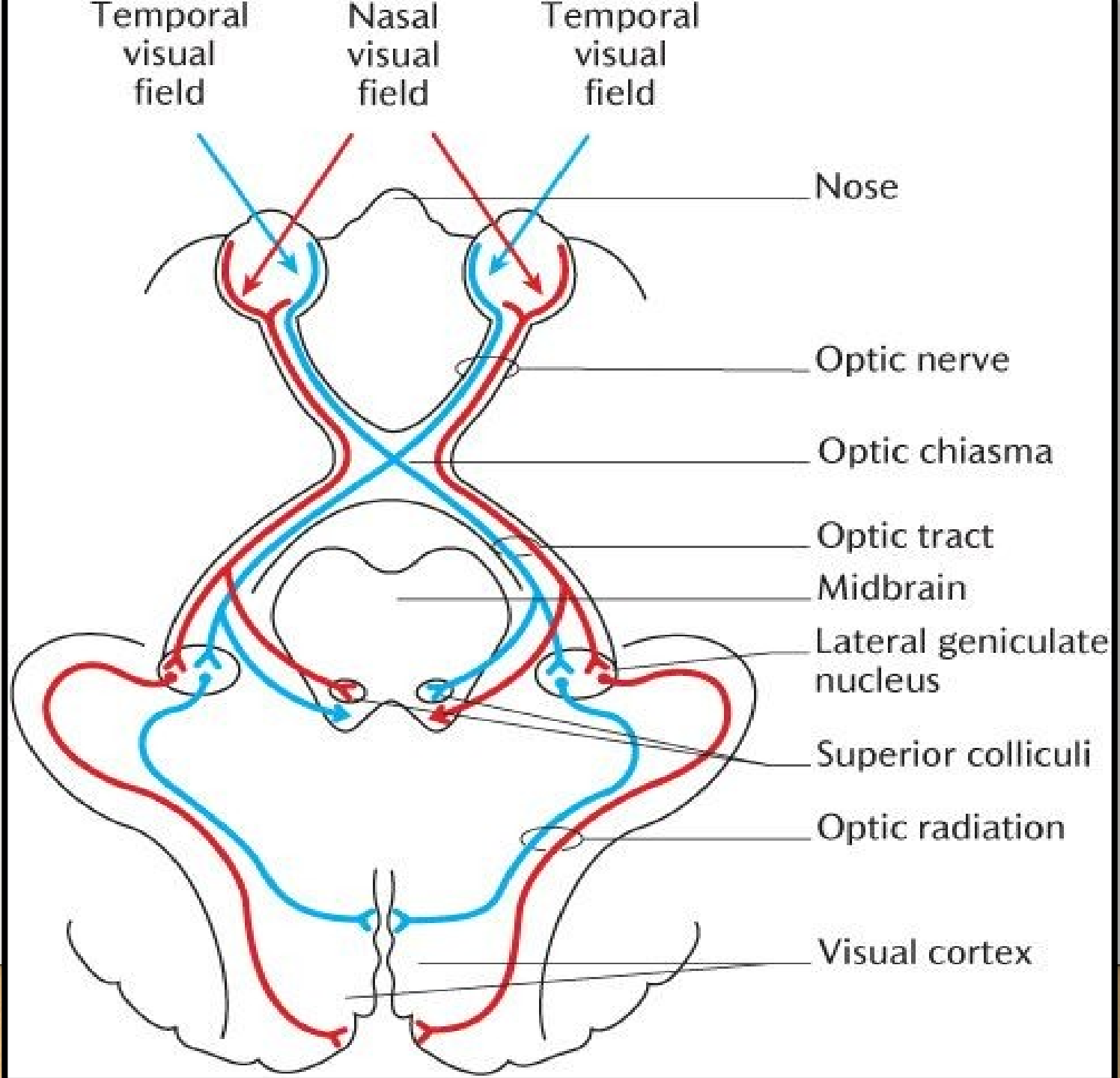
- The fibres of the optic nerve originate in the retina and they converge to form the optic nerve about 0.5 cm to the nasal side of the macula lutea.
- The nerve pierces the choroid and sclera to pass backwards and medially through the orbital cavity. It then passes through the optic foramen of the sphenoid bone, backwards and medially to meet the nerve from the other eye at the optic chiasma.

Optic chiasma

- **This is situated immediately in front of and above the pituitary gland, which is in the hypophyseal fossa of the sphenoid bone.**
- **In the optic chiasma the nerve fibres of the optic nerve from the nasal side of each retina cross over to the opposite side. The fibres from the temporal side do not cross but continue backwards on the same side. This crossing over provides both cerebral hemispheres with sensory input from each eye.**

Optic tracts

- These are the pathways of the optic nerves, posterior to the optic chiasma. Each tract consists of the nasal fibres from the retina of one eye and the temporal fibres from the retina of the other. The optic tracts pass backwards to synapse with nerve cells of the lateral geniculate bodies of the thalamus.
- From there the nerve fibres proceed backwards and medially as the optic radiations to terminate in the visual area of the cerebral cortex in the occipital lobes of the cerebrum.


Temporal visual field
Nasal visual field
Temporal visual field
Nose
Optic nerve
Optic chiasma
Optic tract
Midbrain
Lateral geniculate nucleus
Superior colliculi
Optic radiation
Visual cortex

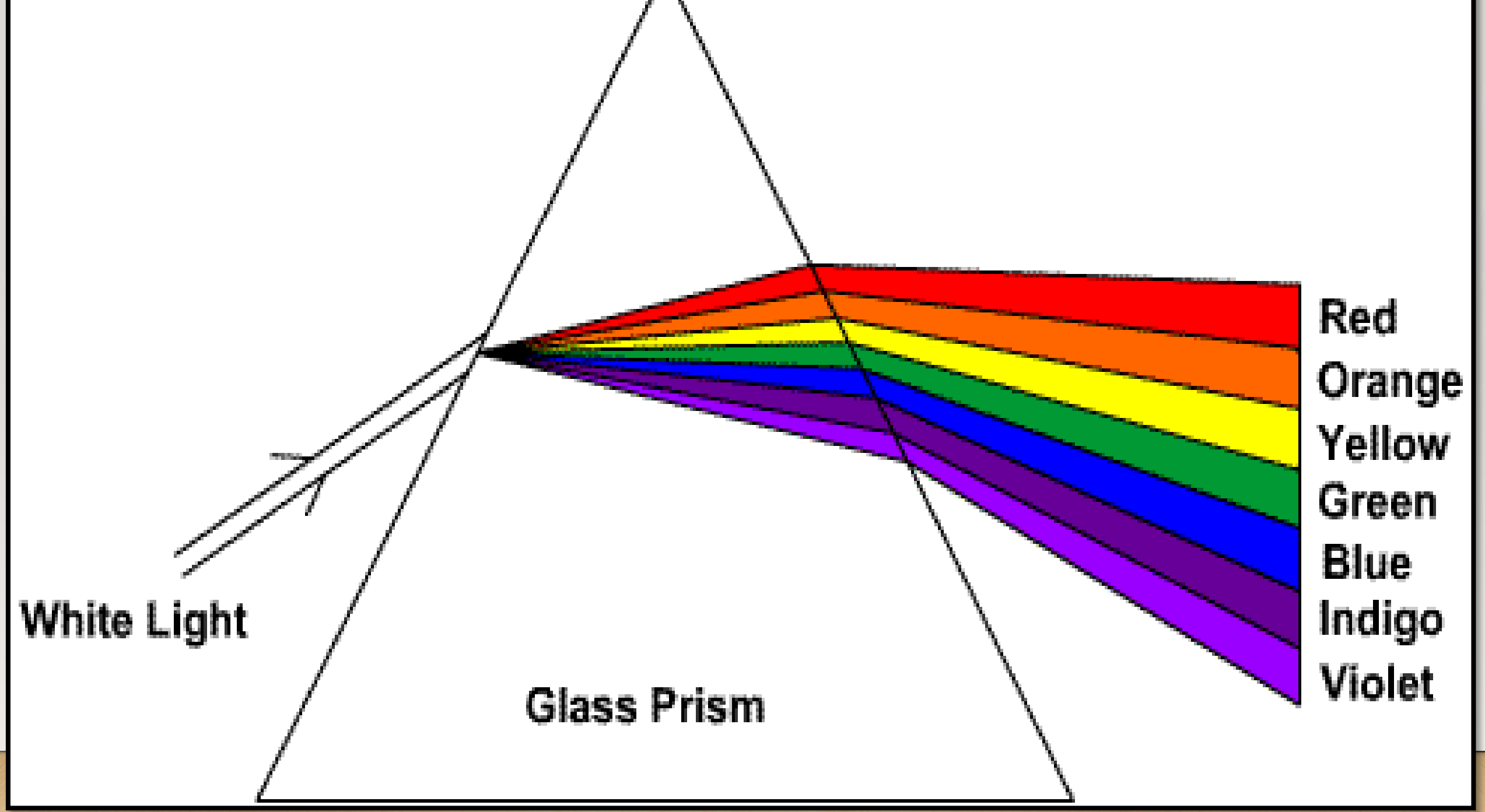
PHYSIOLOGY OF SIGHT

- **Light waves travel at a speed of 300000 kilometre per second. Light is reflected into the eyes by objects within the field of vision.**

- **White light is a combination of all the colours of the visual spectrum (rainbow), i.e. red, orange, yellow, green, blue, indigo and violet. This is demonstrated by passing white light through a glass prism which bends the rays of different colours to a greater or lesser extent, depending on their wavelengths. Red light has the longest wavelength and violet the shortest. This range of colour is the spectrum of visible light.**

The electromagnetic spectrum

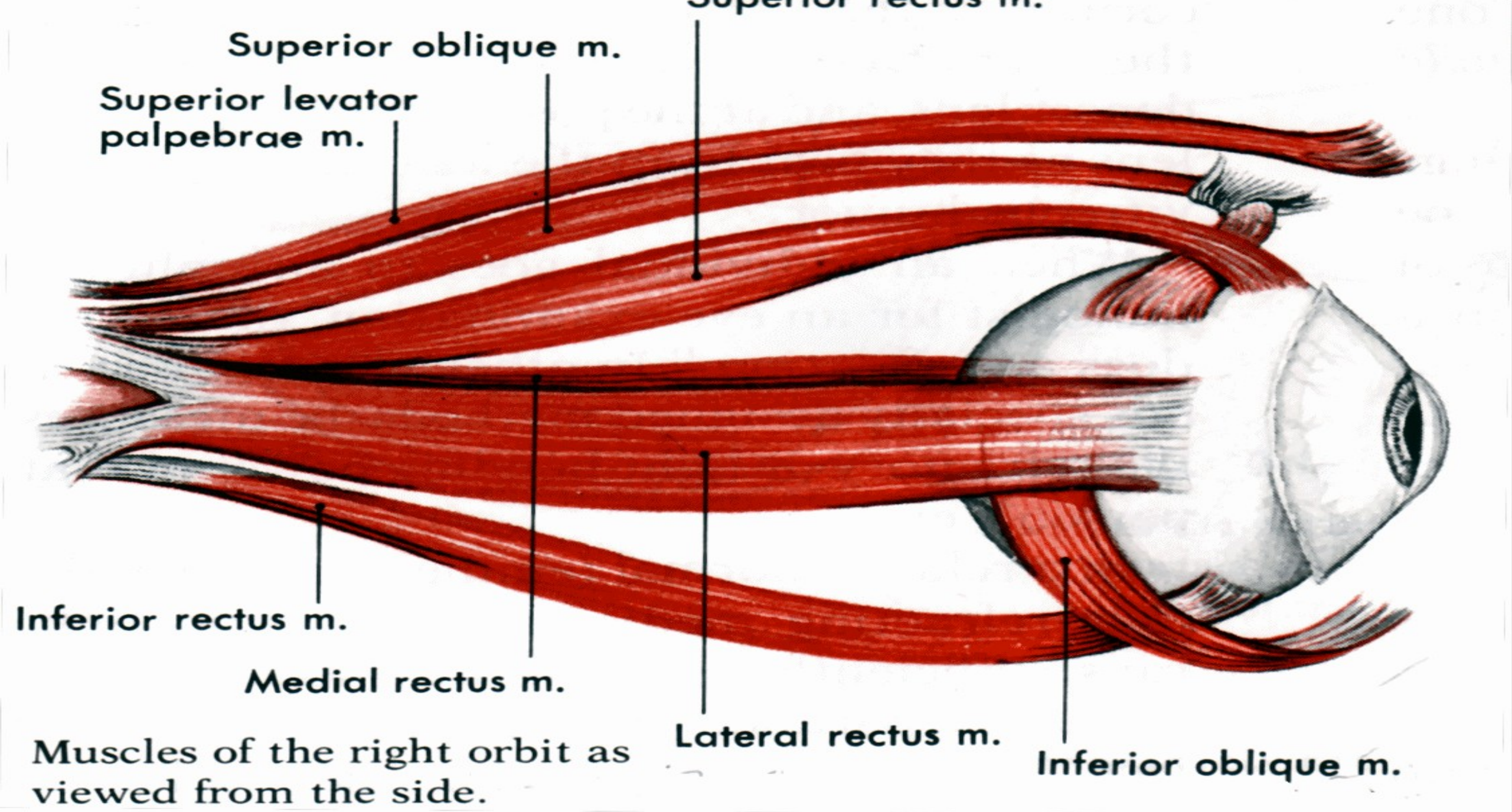
- The electromagnetic spectrum is broad, but only a small part is visible to the human eye. A specific colour is perceived when only one wavelength is reflected by the object and all others are absorbed. E.g. an object appears red when only the red wavelength is reflected. Object appears white when all wavelengths are reflected, and black when they are all absorbed.
- In order to achieve clear vision, light reflected from the objects within the visual field is focused on to the retina of each eye.
- The processes involved in producing a clear image are refraction of the light rays, changing the size of the pupil and accommodation (adjustment of the lens for near vision).
- Although these may be considered as separate processes, effective vision is dependent upon their coordination.


White Light
Glass Prism
Red
Orange
Yellow
Green
Blue
Indigo
Violet

EXTRAOCULAR MUSCLE OF THE EYE WITH THE NERVE SUPPLY

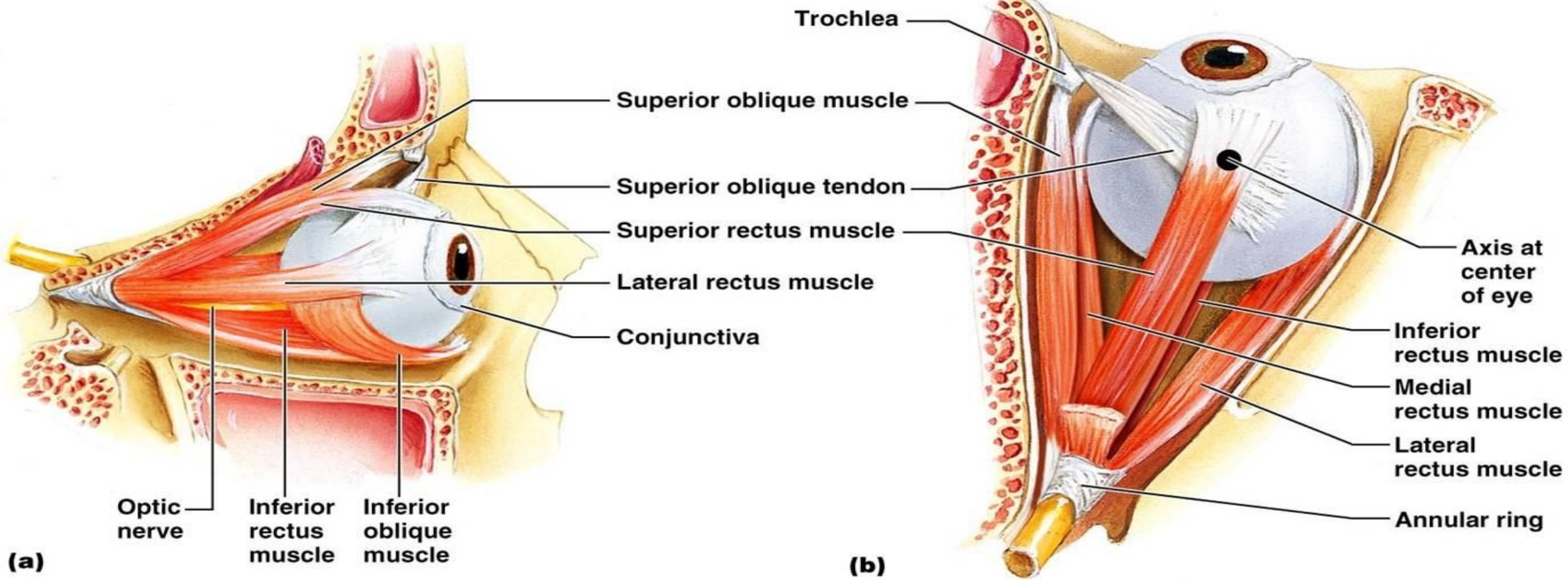
- **These include the muscles of the eyelids and those that move the eyeballs. The eyeball is moved by six extrinsic muscles, attached at one end to the eyeball and at the other to the walls of the orbital cavity.**

- **There are four straight (rectus) muscles and two oblique muscles.**



Muscles of the right orbit as viewed from the side.

- **Moving the eyes to look in a particular direction is under voluntary control, but coordination of movement, needed for convergence and accommodation to near or distant vision, is under autonomic (involuntary) control.**

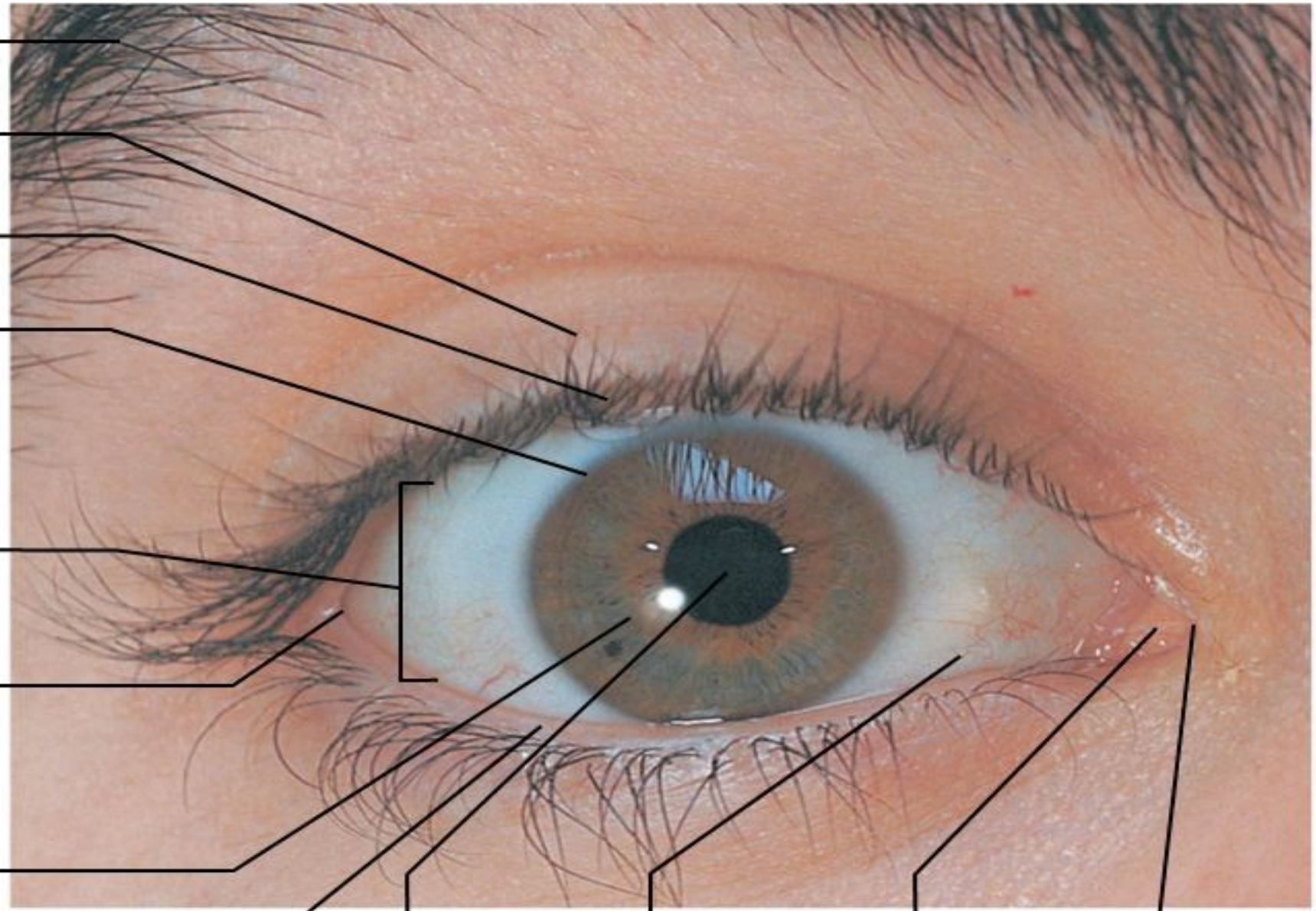


(c)

Name	Action	Controlling cranial nerve
Lateral rectus	Moves eye laterally	VI (abducens)
Medial rectus	Moves eye medially	III (oculomotor)
Superior rectus	Elevates eye and turns it medially	III (oculomotor)
Inferior rectus	Depresses eye and turns it medially	III (oculomotor)
Inferior oblique	Elevates eye and turns it laterally	III (oculomotor)
Superior oblique	Depresses eye and turns it laterally	IV (trochlear)

ACCESSORY ORGANS OF THE EYE

- **The eye is a delicate organ which is protected by several structures**
- **Eyebrows**
- **Eyelids and eyelashes**
- **Lacrimal apparatus**


Eyebrow
Eyelid
Eyelashes
Site where conjunctiva merges with cornea
Palpebral fissure
Lateral commissure
Iris
Eyelid
Pupil
Sclera (covered by conjunctiva)
Lacrimal caruncle
Medial commissure

EYEBROWS

- These are two arched ridges of the supraorbital margins of the frontal bone. Numerous hairs (eyebrows) project obliquely from the surface of the skin.
- They protect the eyeball from sweat, dust and other foreign bodies.

EYELIDS (Palpebrae)

- The eyelids are two movable folds of tissue situated above and below the front of each eye. On their free edges there are short curved hairs, the eyelashes.
- The layers of tissue forming the eyelids are-
- The thin covering of skin.
- A thin sheet of subcutaneous connective (loose areolar) tissue
- Two muscles- the orbicularis oculi and levator palpebrae.
- A thin sheet of dense connective tissue, the tarsal plate, larger in the upper than in the lower eyelid, which supports the other structures
- A lining of conjunctiva.

Conjunctiva

- This is a fine transparent membrane that lines the eyelids and the front of the eyeball. Where it lines the eyelid it consists of highly vascular columnar epithelium.
- When the eyelids are closed the conjunctiva becomes a closed sac. It protects the delicate cornea and the front of the eye.
- The medial and lateral angles of the eye where the upper and lower lids come together are called respectively the medial canthus and the lateral canthus.

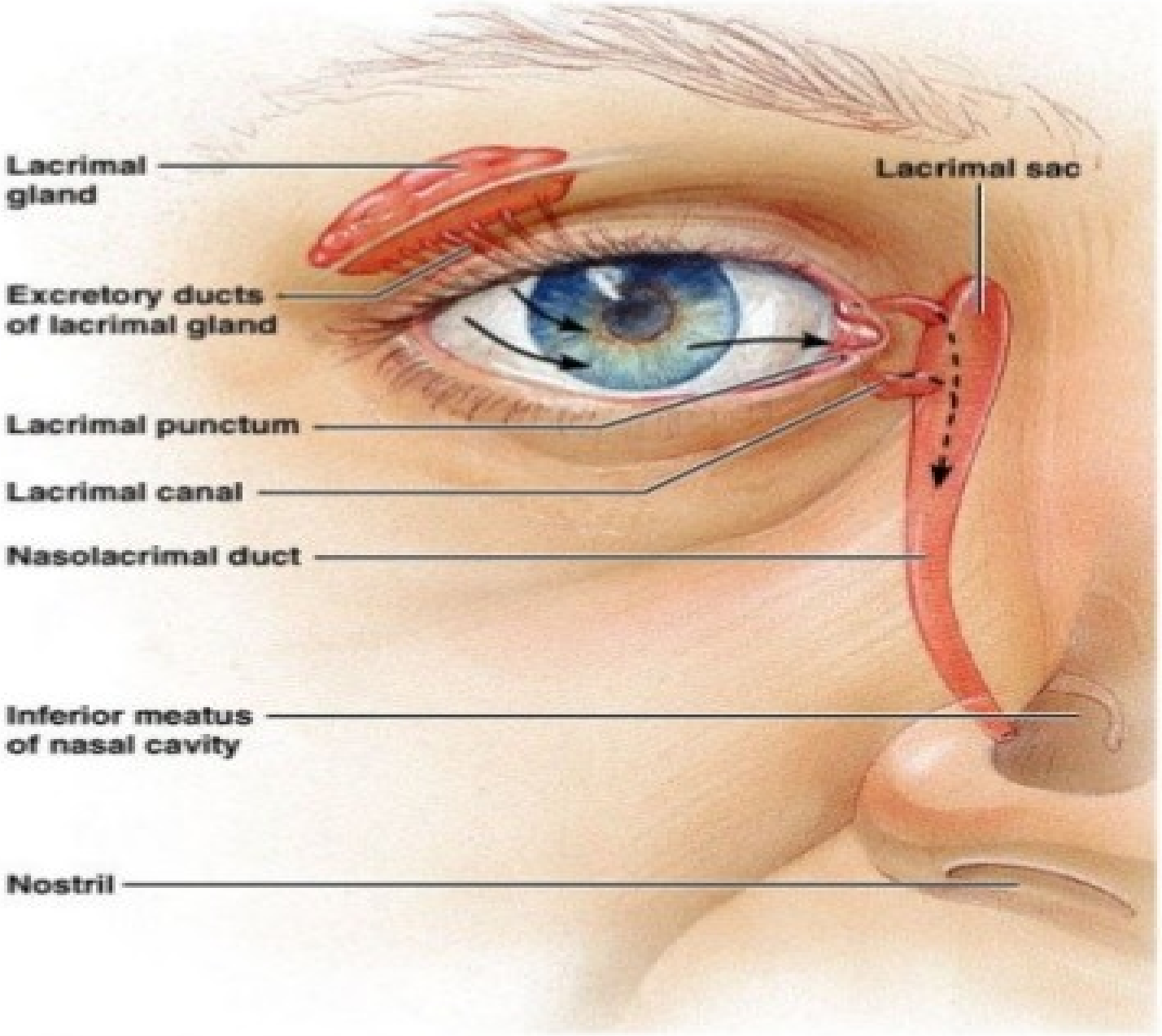
Eyelid margins

- Along the edges of the lids there are numerous sebaceous glands, some with ducts opening into the hair follicles of the eyelashes and some on to the eyelid margins between the hairs.
- Tarsal glands (Meibomian glands) are modified sebaceous glands embedded in the tarsal plates with ducts that open on to the inside of the free margins of the eyelids. They secrete an oily material, spread over the conjunctiva by blinking, which delays evaporation of tears.

Function-

- **The eyelids and eyelashes protect the eye from injury:**
- **Reflex closure of the lids occurs when the conjunctiva or eyelashes are touched, when an object comes close to the eye or when a bright light shines into the eye- this is called corneal reflex.**
- **Blinking at about 3-7 seconds intervals spreads tears and oily secretions over the cornea, preventing drying.**
- **When the orbicularis oculi contract, the eyes close. When the levator palpebrae contract, the eyelids open.**

Lacrimal Apparatus



FLOW OF TEARS

Lacrimal gland

↓

Lacrimal ducts

↓

Sup. or inf. lacrimal canal

↓

Lacrimal sac

↓

Nasolacrimal duct

↓

Nasal cavity

- **The lacrimal glands are exocrine glands situated in recesses in the frontal bones on the lateral aspect of each eye just behind the supraorbital margin.**
- **Each gland is composed of secretory epithelial cells. These glands secrete tears composed of water, mineral salts, antibodies and lysozymes, a bacterial enzyme.**
- **The tear leaves the lacrimal gland by several small ducts and pass over the front of the eye under the lids towards the medial canthus where they drain into the two lacrimal canaliculi; the opening of each is called the punctum.**

- **The two canaliculi lie one above the other, separated by a small red body, the caruncle. The tears then drain into the lacrimal sac, which is the upper expanded end of the nasolacrimal duct. This is a membranous canal app. 2 cm long, extending from the lower part of the lacrimal sac to the nasal cavity, opening at the level of the inferior concha.**
- **Normally the rate of secretion of tears keep pace with the rate of drainage. When a foreign body or other irritant enters the eye the secretion of tears is greatly increased and the conjunctival blood vessels dilate. Secretion of tears is also increased in emotional states- crying, laughing.**

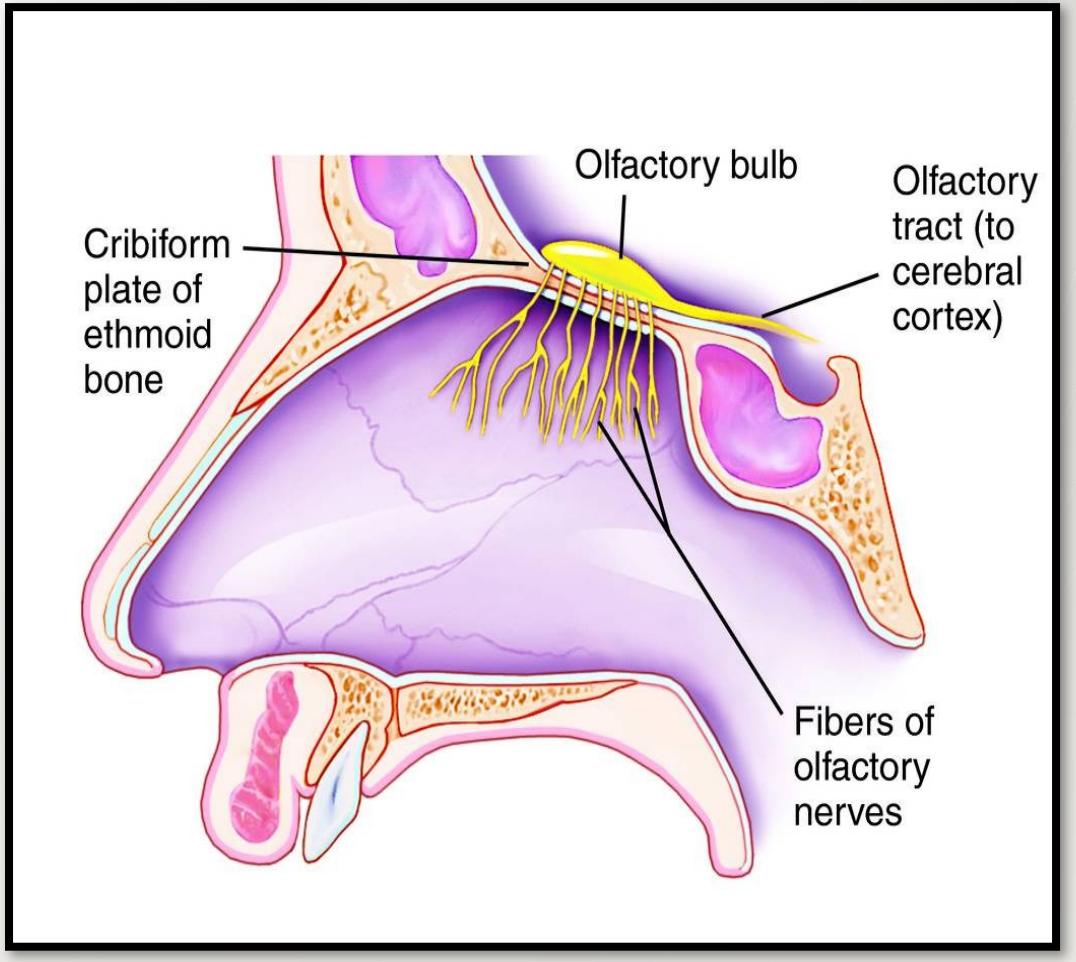
NOSE (SENSE OF SMELL)

- **The sense of smell or olfaction, originates in the nasal cavity, which acts as a passageway for respiration.**

OLFACTORY NERVES

- **These are the sensory nerves of smell. They originate as specialised olfactory nerve endings in the mucous membrane of the roof of the nasal cavity above the superior nasal conchae.**

- **On each side of the nasal septum nerve fibres pass through the cribriform plate of the ethmoid bone to the olfactory bulb where interconnections and synapses occur**
- **From the bulb, bundles of nerve fibres form the olfactory area in the temporal lobe of the cerebral cortex in each hemisphere where the impulses are interpreted and odour perceived.**



PHYSIOLOGY OF SMELL

- **The human sense of smell is less acute than in other animals. Many animals secrete odorous chemicals called pheromones that play an important role in chemical communication. The role of pheromones in human communication is unknown.**
- **All odorous materials give off volatile molecules, which are carried into the nose with the inhaled air and even very low concentrations, when dissolved in mucus, stimulate the olfactory chemoreceptors.**

- **The air entering the nose is warmed, and convection currents carry eddies of inspired air to the roof of the nasal cavity. Sniffing concentrates volatile molecules, in the roof of the nose. This increases the number of olfactory receptors stimulated and thus the perception of smell.**
- **Inflammation of nasal mucosa prevents odorous substances from reaching the olfactory area of the nose, causing loss of the smell (anosmia).**

Adaptation- when an individual is continuously exposed to an odour, perception of the odour decreases and ceases within a few minutes. This loss of perception affects only that specific odour and adaptation probably occurs in both neurones within the central nervous system and sensory receptors in the nasal cavity.

SKIN

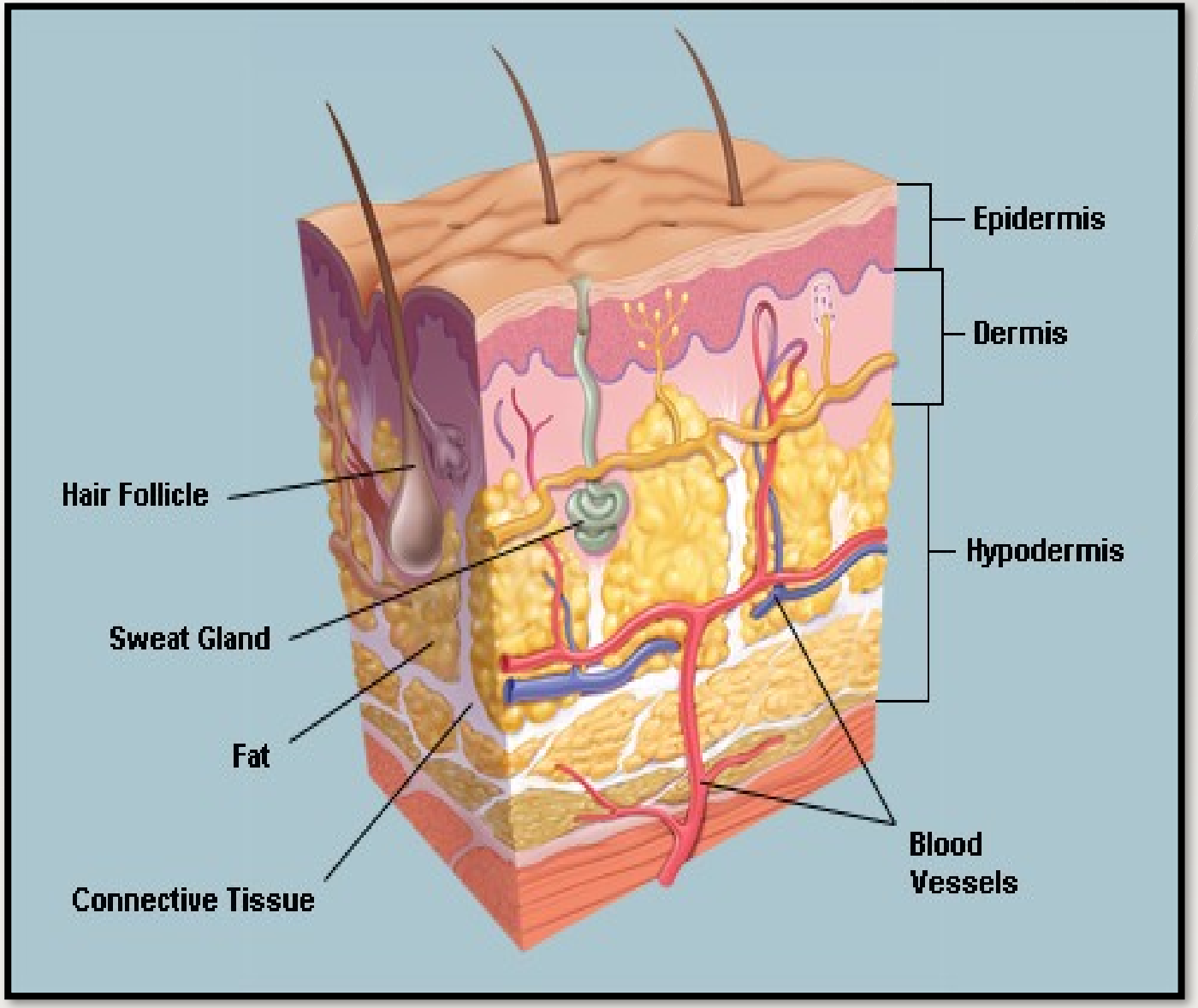
Structure-

- The skin is the largest organ in the body and has a surface area of about 1.5 to 2m sq. in adults and it contains glands, hair and nails.
- There are two main layers- epidermis and dermis
- Between the skin and the underlying structures is a layer of subcutaneous fat.
- Epidermis is the most superficial layer of the skin and is composed of stratified keratinised squamous epithelium.

- **There are no blood vessels or nerve endings in the epidermis, but its deeper layers are bathed in interstitial fluid from the dermis, which provides oxygen and nutrients, and is drained away as lymph.**
- **The dermis is tough and elastic. It is formed from connective tissue and the matrix contains collagen fibres interlaced with elastic fibres.**
- **The structures in dermis are- blood vessels, lymph vessels, sensory (somatic) nerve endings, sweat glands and their ducts, hairs, arrector pili muscles and sebaceous glands.**

Functions-

- **Protection**
- **Regulation of body temperature**
- **Heat production**
- **Heat loss**
- **Control of body temperature**
- **Formation of vitamin D**
- **Cutaneous sensation**
- **Absorption**
- **Excretion**

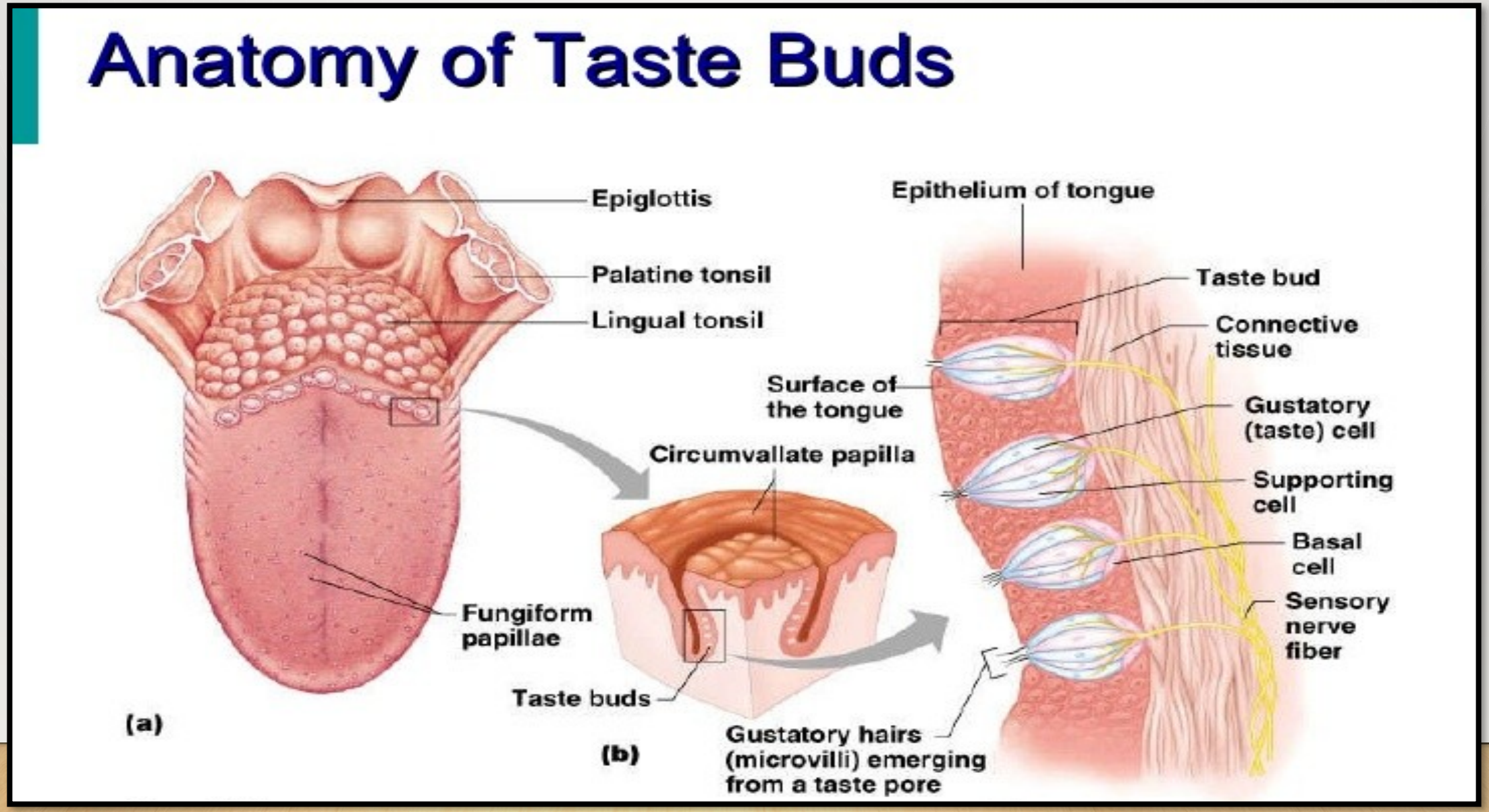


TONGUE (SENSE OF TASTE)

- **The sense of taste, or gustation, is closely linked to the sense of smell and, like smell also involves stimulation of chemoreceptors by dissolved chemicals.**
- **Taste buds contain sensory receptors (chemoreceptor) that are found in the papillae of the tongue and widely distributed I the epithelia of the tongue, soft palate, pharynx and epiglottis. They consist of small sensory nerve endings of the glossopharyngeal, facial and vagus nerves.**
- **Some of the cells have hair like microvilli on their free border, projecting towards tiny pores in the epithelium.**

- **The sensory receptors are stimulated by chemicals that enter the pores dissolved in saliva. Nerve impulses are generated and conducted along the glossopharyngeal, facial and vagus nerves before synapsing in the medulla and thalamus. Their final destination is the taste are in the parietal lobe of the cerebral cortex where the taste is perceived.**

Physiology of taste-



- **4 fundamental sensation of taste have been described- sweet, sour, bitter and salt.**
- **This is probably an oversimplification because perception varies widely and many ‘tastes’ cannot be easily classified.**
- **However, some tastes consistently stimulate taste buds in specific parts of tongue-**

- **Sweet and salty, mainly at the tip**
- **Sour, at the sides**
- **Bitter, at the back**

- **The sense of taste triggers salivation and the secretion of gastric juice. It also has a protective function, e.g. when foul tasting food is eaten, reflex gagging or vomiting may be induced**
- **The sense of taste is impaired when mouth is dry, because substances can only be tasted when in solution.**