Answers

2.16 Eye and Ear

589. a + b + c – d – e +
The sclera is the hard tough outer connective tissue coat of the eye and is continuous with cornea. The sclera has a white opaque color and is composed of flat collagenous bundles interspersed with flattened fibroblasts.

590. a + b + c + d + e -
The sclerocorneal junction or limbus is the site for the outflow of aqueous humor and contains both the canal of Schlemm and the trabecular network. It is the site of the termination of Bowman's membrane (of the cornea).

591. a + b – c + d – e +

592. a – b + c + d – e +
The cornea is highly transparent and nourished primarily by aqueous humor. Owing to its lack of vascularization it is supplied with oxygen directly from the atmosphere. The anterior cornea has a stratified squamous epithelium, which has extremely good powers of regeneration and mitoses are frequently seen. The epithelium has an abundance of free nerve endings.

593. a + b – c + d + e +

594. a + b – c + d – e +

595. a – b + c + d + e +
Bowman's membrane is found only in the cornea and is thick enough to be visible by light microscopy. It is composed of collagen and forms the outer layer of the substantial propria of the cornea. The substantia propria of the cornea is avascular and is composed of orderly-arranged bundles of translucent collagen fibrils. It serves an important role in the refraction of light entering the eye.

Descemet's membrane is found on the inner surface of the cornea and is visible by light microscopy. It is an acellular homogeneous layer composed of an atypical form of collagen, which is widely regarded as being a highly-developed form of basal lamina. This is believed to be produced by Descemet's endothelium', which is a single layer of squamous cells lining the inner aspect of the cornea.

596. a + b + c + d – e +

597. a – b + c + d + e -
The lens of the eye is transparent and very elastic (through in old age the lens may become occluded and less flexible). The lens is composed of epithelial cells and is coated with a PAS-positive carbohydrate-rich capsule, which is regarded as a well-developed basal lamina. The lens fibers, which constitute the bulk of the

lens, are modified epithelial cells in the form of elongated hexagonal prisms, which are sparse in organelles. There is virtually no turnover of these lens fibers.

598. a + b + c + d+ e +
The middle or vascular layer of the eye consists of the choroids, ciliary body and the iris. This middle coat is rich in melanocytes and their pigment gives this layer its characteristic black color . The choroids is a highly vascularized coat situated posterior to the ciliary body. Between its blood vessels the loose connective tissue has abundant fibroblast and macrophages. The innermost layer of the choroids, known as the choriocapillary layer, has an important role in the nutrition of the retinal photoreceptors.

599. a – b – c – d + e +

600. a + b – c + d + e +
The ciliary body is in the form of a continuous ring and contains smooth muscle, loose connective tissue including elastic fibers, blood vessels and pigment. Contraction of the smooth muscle fibers of the cilliary body affects the shape of the lens and is important in the process of accommodation. The epithelium lining the inner surface of the cilliary body consists of two layers only: an inner layer, which has considerable ion-transporting properties and which produces the aqueous humor, and an outer pigmented layer.

601. a + b + c + d + e +
The iris, which is connected to the cilliary body, separated the anterior chamber of the eye from the posterior chamber. It diminishes in thickness towards both its margins. The iris contains loose, highly vascular, pigmented, connective tissue. The pigment gives the ‘color’ of the eyes. The iris functions as an adjustable diaphragm and has two sets of antagonistic smooth muscles: the circular sphincter at the papillary margin which on contraction reduces pupil diameter, and the radially-disposed dilator muscles.

602. a – b + c – d + e +
Only the posterior part of the retina, behind the oraserrata, contains photoreceptors and is photosensitive. The retina is derived from the optic vesicle of the fetal prosencephalon. It is not well vascularized and is readily detached from the underlying choroids layer. All the light reaching the photoreceptors must pass through the various layers of neurons before reaching the photoreceptors (except in the fovea centralis). This arrangement is referred to as an ‘inverted’ retina and is common to all vertebrates.

603. a – b – c – d + e -
The nuclei of the retina photoreceptors are found in the outer nuclear layer.

604. a + b – c + d + e -

The rod cells have a long cylindrical outer segment packed with stacked membranous disks. Structure resembling cilia are found in the stalk region. The inner segment mitochondria are grouped together in a so-called 'ellipsoid'. Rod photoreceptors are not sensitive to colors but only to shades of black and white. These rod photoreceptor cells are effective and functional in dim light (unlike cone cells).

605. a + b – c + d + e +

606. a + b + c + d + e -

607. a + d + c - d + e +

The pigment 'epithelium' is not a true epithelium as it does not line or cover any cavity and never has any connection with the external environment at any stage. Moreover its cells function as macrophages in engulfing and digesting spent disks of rod photoreceptor cells. It has, however, some morphological characteristics of true epithelium including well-developed junctional complexes that help protect the retina from undesirable metabolites from the choroids. The pigment 'epithelium' consists of a single layer of columnar cells with a regular hexagonal shape when viewed in transverse section. These cells are firmly attached to a broad basal lamina (Bruch's membrane). The basal part of the cells has plasmalemmal invaginations and many mitochondria typical of epithelia involved in active ion transport.

The apical part of the cells contains melanin granules, which help absorb light that has passed through the layer of photoreceptors and this helps prevent undesirable internal reflections. The pigment 'epithelium' contains large stores of vitamin A and it plays an essential role in the regeneration of the visual pigment of the rods. The outer portions of rod photoreceptors cells penetrate between the apical extensions of the pigment cells. In the event of a 'detached retina' when the pigment epithelium is separated from the photoreceptors of the photosensitive retina, the photoreceptors are no longer functional and this can result in blindness.

608. a – b + c – d – e +

The macula lutea in the retina is the small spot with the greatest visual acuity. It has a large concentration of cone photoreceptor cell in its central area (fovea centralis) and the incoming 'light rays fall directly on these photoreceptors as the other neuronal elements are displaced laterally, Moreover the synaptic arrangement is nearly perfect with one photoreceptor in contact with one bipolar neuron, which is in subsequent contact with one ganglion cell. The macula lutea has a yellow pigment in its superficial layers. The macula lutea lacks vascularization, though on viewing it in the living eye by means of an ophthalmoscope it seems red owing to the underlying large choroidal capillaries.

609. a – b + c + d + e +
The vitreous body of the eye is found between the lens and the retina. In non-pathological conditions it is transparent jelly-like substance containing hyaluronic acid and collagen-like fibrils.

610. a + b – c – d – e -

611. a + b + c + d + e +
The optic nerve is not a peripheral nerve, but should be considered as a tract of the central nervous system comparable to a tract of the whit matter of the brain. The optic nerve is composed of myelinated fibers, which have their sheaths formed by oligodendeoglia. The retinal nerve fibers are non-myelinated until they penetrate the scleral coat and lamina cribosa. These fibers then continue as the myelinated optic nerve. The optic nerve, which is derived from the embryonic optic vesicle, is enclosed by all the meninges. The fibers are accompanied by astocytes. The central retinal artery and vein pass through the optic nerve. If the optic nerve is cut it is incapable of any regeneration. Damage to the optic nerve results in loss of retinal function and blindness.

612. a + b + c – d + e +
Conjunctiva is a mucous membrane that covers the inner surface of the eyelids (palpebral conjunctiva) and the 'white' of the eye (bulbar conjunctiva). The conjunctiva is lined wit a stratified columnar or squamous epithelium in which goblet cells are found.

613. a – b + c + d + e +
The lacrimal glands are found beneath the conjunctiva at the lateral upper side of the eyeball and their function is to secrete tears, which lubricate the cornea and conjunctiva. The lacrimal glands are compound serous, tubuloalveolar glands with myoepithelial cells. The antibacterial enzymes, lysozyme, is found in the tears.

614. a + b + c + d + e +
A tarsus is found in both upper and lower eyelids and is their main skeletal support. The tarsus is formed from dense connective tissue as a plate-like structure, which encloses the Meibomian glands

615. a – b + c – d + e –
Meibomain glands are sebaceous glands found embedded in the tarsal plates of the eyelids.

616. a – b + c – d + e +
The pinna of the external ear consists of an irregular plate of elastic cartilage covered with perichondrium that is rich in elastic fibers. Hair follicles, with

associated sebaceous glands, are present especially towards the external auditory meatus. There is a paucity of both nerve endings and sweat glands in the pinna.

617. a + b – c - d + e –
The tympanic cavity is an air-filled space in the temporal bone lined mainly with simple squamous epithelium.

618. a + b + c + d + e –
The tympanic membrane (eardrum) consists of collagenous connective tissue arranged over most of its area in two distinct layers. Fibroblasts are present in these collagenous layers. On the surface facing the external auditory meatus there is stratified squamous epithelium. On the surface lining the middle ear, the epithelium is typically squamous to cuboidal. No glands or hairs are found in thetympanic membrane.

619. a + b + c + d + e +
The cristae ampullares are found in the ampullae of the semicircular canals and are in the form of a transverse ridge lined with a simple squamous sensory epithelium and bearing a jelly-like cupula, which moves in response to the movement of endolymph. Unlike the maculae of the utricle and saccule, no otoliths are present. The function of the cristae ampullars is to detect changes in angular acceleration and deceleration (the rate of change of rotational velocity) and as such act as the sensors of the angular movements of the head.

620. a + b – c + d + e +
The hair cells of the receptors (cristae ampullares) in the ampullae of the semi-circular canals are sensitive to rotary movements (angular acceleration) caused by endolyphatic movements. These hair cells are specialized epithelial cells, on which sensory nerve fibers terminate. The hair cells have stereocilia and a single kinocilium embedded in the jelly-like cupula.

621. Otoliths or otoconia are crystalline bodies composed of calium carbonate suspended in a jelly-like proteoglycan. They are found on the otolithic membrane of the maculae of the saccule or utricle. The otoliths can be seen in light microscope preparations (though the jelly-like support is often dissolved during processing). Movements of the otoliths enable the maculae to function as sensors of gravity and linear acceleration.

622. a + b – c + d – e –
Head movements induce movements in the endolymph in the vestibule, which in turn cause movements of the otoliths. These otolithic movements are deteched by the hair cells of the maculae of the saccule and utricle and this information after transduction is transmitted to the abutting afferent fibers of the vestibular nerve.

623. a – b – c + d + e –

624. a + b + c + d + e +
The organ of Corti is found in the cochlea of the inner ear and is in contact with the tectorial membrane. The hair cells of the organ of Corti are of more than one type and have stereocilia as well as large numbers of mitochondria. The hair cells, which function as auditory receptors, are in contact with fibers of the cochlear nerve.

625. a – b + c + d – e –
Endolymph is found in the cochlear duct including the space between the tectorial membrane and reticular membrane of the organ of Corti. The sensory hair cells of the organ of Corti are bathed in endolyph. Endolymph is also found in the membranous labyrinth of the semi-circular canals. Endolymph is rich in potassium ions and relatively poor in sodium ions and in many respect is similar in ionic composition to intracellular fluid. Perilymph in contrast is rich in sodium ions and poor in potassium ions and is more like an extracellular fluid in its ionic composition. Endolymph is produced mainly by the epithelial cells of the stria vascularis, involving active transport from the blood plasma. Enodlymph is believed to be absorbed in the endolymphatic sac.

626. a – b – c + d + e +
The stria vascularis is stratified epithelium found in the cochlea and is believed to be the source of the endolymph. The cells are active in ion transport so as to maintain the unusual ionic composition of the endolymph. The epithelium is penetrated by blood capillaries and so differs from all the other epithelia of the body which are not vascularized.