

B. Ocular/Visual Biology - 90 Items (21%)

"Ocular/Visual Biology" covers the fundamental knowledge and scientific principles that support the application of these principles in the prevention, diagnosis, treatment and management of ocular diseases and traumatic conditions that can present to the optometrist by patients seeking primary eye care. It is composed of four major subdivisions: Anatomy of the Eye, Ocular Adnexa, and Visual Pathway; Ocular and Visual Pathway Development; Ocular Physiology/Neurophysiology; Ocular Pharmacology.

1. Anatomy of the Eye, Ocular Adnexa and Visual Pathway (26-34 Items)

A. Orbit

1. Contents (extraocular muscles, nerves, blood vessels, fat compartments, fascia)
2. Anatomical relationships among orbital structures
3. Bones of the orbit
4. Foramina and openings of the orbit (location, contents)

B. Extraocular muscles

1. Names
2. Origins
3. Insertions
4. Innervation, blood supply
5. Relationship to other orbital structures

C. Blood supply

1. Branches of internal and external carotid arteries related to the orbit, eyelid and upper face
2. Branches of the internal and external jugular veins
3. Dural sinuses

D. Ocular and orbital nerves

1. Cranial nerves I, III, IV, V, VI, VII (intracranial and extracranial course, branches, functions, tissue innervated)
2. Parasympathetic nerves (course, branches, tissue innervated)
3. Sympathetic nerves (course, branches, tissue innervated)

E. Eyelid

1. Anatomic boundaries
2. Layers
3. Muscles (actions)
4. Glands (secretions, functions)
5. Blood supply and drainage, lymphatic drainage
6. Innervation

F. Eyebrow (structure and function)

G. Conjunctiva

1. Location
2. Composition (layers, cell types, glands, Palisades of Vogt)
3. Relationship to tarsal plate, extraocular muscles, sclera, vagina bulbi (Tenon's capsule), cornea
4. Blood supply and venous drainage, lymphatic drainage
5. Innervation
6. Plica simularis (composition)
7. Caruncle (composition)

H. Lacrimal system

1. Lacrimal gland (structure, innervation, blood supply)
2. Accessory lacrimal glands (location, function)
3. Distribution of tears (role of eyelids)
4. Drainage of tears; nasolacrimal duct (cellular lining); lacrimal papillae (location); lacrimal puncta; canaliculi (relationship to Horner's muscle); lacrimal sac (relationship to medial palpebral ligament, Horner's muscle, orbicularis oculi; septum orbitale)
5. Lacrimal fossa (bony structure)
6. Nasolacrimal canal (bony composition, relationship to maxillary sinus)

I. Cornea

1. Normal dimensions including diameter, radii of curvature (anterior and posterior) and thickness (central and peripheral)
2. Epithelium (histology and ultrastructure)
3. Basal lamina (relationship to epithelium)
4. Anterior limiting lamina (Bowman's layer) (relationship to stroma, basal lamina, and epithelium)
5. Stroma (composition, ultrastructure)
6. Posterior limiting lamina (Descemet's membrane) (relationship to stroma and endothelium)
7. Endothelium (composition, ultrastructure)
8. Limbus
9. Innervation
10. Regeneration

J. Sclera

1. Size
2. Radius of curvature
3. Thickness
4. Color
5. Relationship to conjunctiva, Tenon's capsule, suprachoroidal space
6. Emissaria (contents, location)
7. Composition
8. Lamina cribrosa (structure)

K. Anterior chamber and angle

1. Shape and volume
2. Boundaries
3. Diameter and depth
4. Trabecular meshwork (components, ultrastructure)
5. Juxtacanalicular tissue (components, ultrastructure)
6. Schlemm's canal (location, size, ultrastructure of wall, afferent and efferent connections)
7. Scleral spur (composition, location)
8. Schwalbe's ring (composition, location)

L. Iris

1. Gross landmarks, zones
2. Diameter
3. Coloration (factors controlling)
4. Anterior border (composition, ultrastructure)
5. Stroma (composition)
6. Sphincter muscle (type, composition, innervation)
7. Anterior epithelium (ultrastructure)
8. Dilator muscle (type, composition, innervation)
9. Posterior epithelium (relationship to lens, anterior epithelium, pupil margin)
10. Blood supply, venous drainage
11. Innervation
12. Size and location of pupil

M. Posterior chamber

1. Size and volume
2. Boundaries

N. Ciliary body

1. Gross morphology
2. Dimensions
3. Relationship to sclera, anterior chamber, iris, posterior chamber, lens and retina
4. Pars plana (location, components)
5. Pars plicata (location, components)
6. Stroma (components)
7. Ciliary muscle (components, relations, action, innervation)
8. Pigmented epithelium (basal lamina, ultrastructure)
9. Non-pigmented epithelium (basal lamina, ultrastructure, relationship to pigmented epithelium)
10. Blood supply and venous drainage
11. Innervation

O. Lens, zonule

1. Zonule
2. Location of lens
3. Epithelium (capsule, ultrastructure)
4. Cortex (composition of lens fibers, ultrastructure)
5. Nuclei (various names and locations)
6. Sutures (location)

P. Choroid

1. Extent
2. Thickness
3. Relationship to lamina fusca of sclera
4. Choriocapillaris (ultrastructure, type of capillaries)
5. Stroma
6. Blood supply
7. Venous drainage
8. Innervation
9. Bruch's membrane (location, composition)

Q. Vitreous

1. Volume
2. Shape
3. Attachments to retina and lens (ultrastructure)
4. Patellar fossa (location)
5. Anterior hyaloid (location)
6. Posterior hyaloid (location)
7. Cortex (composition)
8. Hyaloid canal (location, origin)

R. Retina

1. Layers (components of each, ultrastructure)
2. Relationship between retinal pigment epithelium and Bruch's membrane
3. Relationship between retinal pigment epithelium and photoreceptor outer segments
4. Synaptic connections within retina
5. Glial cells (name, location, function)
6. Blood supply
7. Anatomical areas (location, size, composition) of area centralis, parafovea, fovea, foveola, macula lutea, ora serrata (ultrastructure)

S. Optic Nerve

1. Surface features
2. Prelaminar portion (composition, blood supply)
3. Laminal portion (composition, blood supply)
4. Retrolaminar portion (composition, blood supply)
5. Central retinal artery and vein (location)
6. Optic disc/cup

T. Visual pathway

1. Localization of retinal fibers along visual pathway; optic nerve, chiasm (crossing), optic tract, lateral geniculate body, optic radiations, visual cortex
2. Layers of lateral geniculate body (afferents, efferents)
3. Layers of visual cortex; areas
4. Blood supply
5. Anatomy related to visual pathology

2. Ocular and Visual Pathway Development (8-12 Items)

A. Orbit

1. Development of bones of orbit (closure of sutures)
2. Abnormalities (faulty development of facial bones)

B. Extraocular muscles

1. Condensation of mesenchyme (bilateral condensation)
2. Motor innervation development
3. Insertion of extraocular primordia into anterior sclera
4. Late development

C. Eyelid

1. Tissue origin
2. Lid folds
3. Fusion of eyelid
4. Ectodermal derivatives (skin, glands, conjunctiva)
5. Mesodermal derivatives (tarsus, orbital septum, orbicularis oculi, aponeurosis of levator, smooth muscle)

D. Conjunctiva

1. Ectodermal specialization forming conjunctiva and glands

E. Lacrimal apparatus

1. Tissue origin of lacrimal glands (main, accessory)
2. Tissue origin of lacrimal and nasal passages
3. Abnormalities

F. Cornea

1. Inductive mechanisms
2. Ectodermal components (epithelium, primary stroma)
3. Mesenchymal components (waves)
4. Corneal nerve development (origin)
5. Factors affecting corneal size, curvature, transparency

G. Sclera

1. Inductive mechanisms
2. Tissue origin
3. Comparison with cornea

H. Anterior chamber and angle

1. Creation of anatomical space
2. Factors that promote growth of anterior chamber
3. Creation of angle (atrophy theory, cleavage theory, reorganization theory, rarefaction theory)
4. Differentiation of Schlemm's canal, scleral spur, trabecular meshwork
5. Endothelial membrane

I. Iris/Pupil

1. Development of iris stroma (anterior leaf, posterior leaf)
2. Development of pars iridica retinae (epithelial layer)
3. Development of dilator and sphincter muscles
4. Pupillary membrane (atrophy)
5. Cilio-iridic circulation
6. Development of iris pigmentation

J. Posterior chamber

K. Ciliary body

1. Tissue origin (mesoderm, neural crest)
2. Development of pars ciliaris retinae (epithelial layers)
3. Development of ciliary processes, ciliary muscles, ciliary vessels

L. Lens, zonules

1. Zonule development
2. Tissue origin
3. Tissue induction and interaction (effect on development of vitreous, iris, cornea, retina)
4. Mechanism of lens fiber orientation
5. Stages of lens development (lens placode, lens pit, lens vesicles)
6. Stages of lens fiber development
7. Developmental nuclei (embryonic, fetal, infantile)
8. Zones of development of lens epithelium

M. Choroid

1. Tissue origin (paraxial mesoderm, neural crest cells)
2. Development of choroidal vasculature (3 stages)
3. Development of Bruch's membrane

N. Vitreous

1. Primary vitreous (hyaloid canal, tissue origin, tissue characteristics)
2. Secondary vitreous (tissue origin, tissue characteristics)
3. Tertiary vitreous (tissue origin, tissue characteristics; hyaloid vasculature remnants)

O. Retina

1. Development of optic cup
2. Analogies between development of retina and central nervous system
3. Fetal fissure (formation, function, fusion, failure to fuse)
4. Retinal differentiation (Stages I, II, III, proliferation, migration, differentiation)
5. Macular differentiation
6. Retinal circulation development (hyaloid system, central retinal artery/vein, hyaloid vasculature remnants)
7. Postnatal events

P. Optic nerve and visual pathway

1. Developmental stages of lower visual pathway, before lateral geniculate body (differences between crossed and uncrossed fibers)
2. Myelination of the visual pathway (lower visual pathway vs. upper visual pathway)
3. Relationship between development of upper visual pathway and central vision
4. Physiological cupping

3. Ocular Physiology/Neurophysiology (29-37 Items)

A. Circulation

1. Hemodynamic patterns (resistance, transmural pressure, flow rate, critical closing pressures)
2. Autoregulation
3. Autonomic nervous system control
4. Unique environment of the eye (high extravascular pressure)
5. Uveal blood flow: choroid, ciliary body, iris (unique characteristics of each, functions of each)
6. Retinal blood flow (unique characteristics, dual supply, functions)

B. Eyelids

1. Normal closure of eyelids (forced, spontaneous)
2. Blink reflexes (spontaneous, menace, auditory, touch, dazzle)
3. Role of eyelids in production, distribution and drainage of tears
4. Protective functions of eyelids

C. Tears and lacrimal apparatus

1. Functions of tears
2. Production of tears
 - a. Sources
 - b. Neural control
3. Composition of tears
 - a. Electrolytes
 - b. Low molecular weight organics (glucose, amino acids)
 - c. High molecular weight organics (proteins, lipids, glycoproteins)
 - d. Cells
 - e. Physiological variations (e.g. aging, open vs. closed eye, contact lens wear) in tear constituents
4. Tear film distribution, structure and stability
5. Elimination of tears
 - a. Nasolacrimal drainage apparatus
 - b. Evaporation and absorption
6. Physico-chemical properties of tears
 - a. Osmotic pressure
 - b. pH and buffering
 - c. Temperature and viscosity

D. Cornea

1. Physical characteristics (water content, protein content, cells, resistance to trauma)
2. Permeability characteristics of various layers
3. Metabolic characteristics of various layers
4. Theories of corneal transparency
5. Factors influencing corneal thickness/hydration (osmolarity of tears, integrity of epithelium and endothelium, epithelial and endothelial pumps)
6. Physiological parameters necessary to maintain corneal integrity (oxygen level, glucose level, pH, etc.)
7. Epithelial regeneration (normal and response to trauma)
8. Physiological characteristics of corneal nerves
9. Aging changes of the cornea

E. Intraocular pressure

1. Methods of measurement
2. Normative values
3. Factors controlling aqueous production and outflow
4. Nervous system regulation of IOP
5. Factors influencing IOP (body position, corneal thickness, blood pressure)

F. Aqueous

1. Functions of aqueous
2. Volume, osmolarity, viscosity
3. Formation (ultrafiltration, active transport)
4. Factors influencing rate of flow
5. Composition
6. Blood aqueous barriers (location, ultrastructure, function)

G. Pupillary pathways

1. Sympathetic pathway to iris
2. Parasympathetic pathway to iris
3. Functional relationships between pupillary pathways and central nervous system

H. Lens

1. Functions of lens
2. Composition of lens
3. Difference in composition between lens and aqueous
4. Metabolism of lens (various pathways essential to the lens)
5. Types of lens proteins
6. Factors which regulate size and solubility of lens proteins (vitamin C, glutathione)
7. Theories of lens transparency
8. Mitotic activity of lens epithelium
9. Aging changes in composition of the lens

I. Uvea

1. Functions of ciliary body
2. Functions of iris
3. Functions of choroid

J. Vitreous

1. Functions
2. Composition
3. Metabolism
4. Aging changes in composition
5. Physical characteristics (volume, water content, transparency)

K. Retina

1. Composition of disc outersegments
2. Formation of disc outersegments (disc renewal, disc shedding)
3. Composition of visual pigments
4. Formation of visual pigments
5. Stages of visual cycle
6. Photoreceptor electrophysiology (membrane potentials, dark current role of sodium, calcium, etc.)
7. Retinal neurotransmitters
8. Function of bipolar, horizontal, amacrine and ganglion cells (receptive fields)
9. Retinal neural mechanisms of color vision (spatial, temporal and chromatic)
10. Physiological relationships in the choroid and the retina, [including retinal metabolism](#)

L. Visual pathway

1. Function of lateral geniculate body
2. Receptive fields of cells in lateral geniculate body (relationship to color vision, binocularity, space perception, etc.)
3. Function of visual cortex
4. Receptive field properties (single cell properties)
5. Functional organization
6. Physiology of binocular vision
7. Mechanism of feature detection
8. Gross electrical potentials
 - a. EOG
 - b. ERG
 - c. VEP (VER)

M. Extraocular muscles

1. Vestibular control mechanisms
2. Supranuclear control of eye movements
3. Agonist-antagonist relationships
4. Primary action, and secondary and tertiary actions
5. Fields of action
6. Conduction and contraction

4. Ocular Pharmacology (13-21 Items) *

- A. General principles
 - 1. Factors affecting ocular drug bioavailability
 - 2. Routes of ocular drug administration
- B. Autonomic drugs
 - 1. Functional concepts and ocular receptor types
 - 2. Ocular cholinergic agents
 - 3. Ocular adrenergic agents
- C. Antiglaucoma drugs
 - 1. Parasympathetic agonists
 - 2. Sympathetic agonists
 - 3. Sympathetic antagonists
 - 4. Carbonic anhydrase inhibitors
 - 5. Prostaglandins and analogues
 - 6. Serotonin antagonists
- D. Properties of topical ocular anesthetics (non-injectable)
- E. Antihistamines
- F. Anti-inflammatory agents
 - 1. Steroids
 - 2. Non-steroids (including mast cell stabilizers)
- G. Anti-infective agents
- H. Dyes
 - 1. Topical diagnostic agents
 - 2. Oral and intravenous agents
- I. Hyperosmotic agents
 - 1. Topical ocular agents
 - 2. Systemic agents
- J. Lubricants and tear substitutes
- K. Preparations used with contact lenses
- L. Toxicology
 - 1. Ocular effects from topical ocular drug administration
 - 2. Ocular effects from systemic drug administration
 - 3. Systemic effects from ocular drug administration
 - 4. Systemic effects from systemic drugs that are used to treat ocular disease

***Note:** Specific basic pharmacology related to the eye and adnexa only. Clinical use of drugs tested in appropriate areas of Clinical Science. Drugs are generally referenced by generic name only.