

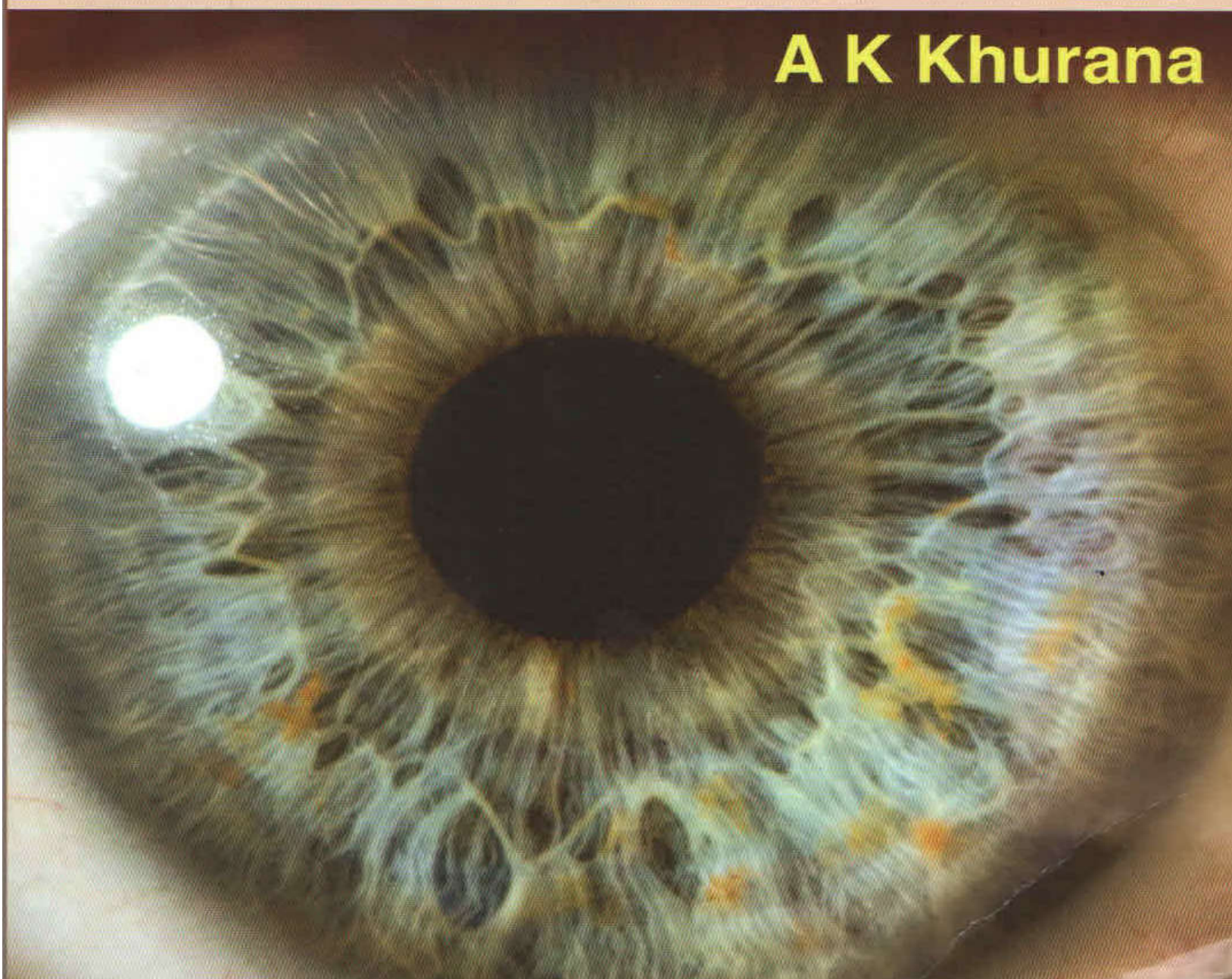


A Free Companion to
Comprehensive Ophthalmology, 6/E

Review of

OPHTHALMOLOGY

A K Khurana



Review of
OPHTHALMOLOGY

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OPHTHALMOLOGY

Quick Text Review & MCQs

Sixth Edition

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Dedicated to

My parents and teachers for their blessings

My students for their encouragement

My children for their patience

&

My wife for her understanding

PREFACE

Sixth edition of *Review of Ophthalmology* has been thoroughly revised and updated with recent advances in each aspect to keep abreast with newer concepts and principles of investigative modalities, treatment modalities and surgical procedures evolved over the period. However, the main layout and organisation of the book has not been changed. Twenty chapters of the book have been arranged.

Quick Text Review provides a quick reference to the main aspects of Ophthalmology in an orderly and easily reproducible manner. Though a quick review, the subject in this heading has been covered in depth and extensively including the recent advances. The important text on which MCQs are based has been highlighted with under rule.

Multiple Choice Questions (MCQs) arranged in twenty chapters matching the text review. Most of the MCQs are single best response type, barring a few extra edge questions. While framing the thought-provoking MCQs, Particular care has been taken to include all those important MCQs which have repeatedly appeared in various postgraduate medical entrance tests held in the last ten years up to 2014. Answers to the MCQs have been given at the bottom of each page to facilitate easy reading.

Key features of sixth edition

- Main feature of this book is that it is based on the *Khurana's Comprehensive Ophthalmology*, a textbook, which is used by most of the students during their graduation course.
- Provides a means for quick text revision and self-assessment to the medical students preparing for competitive postgraduate entrance examinations.
- Quick review of the text given in Section I provides an opportunity for preparing for the viva questions commonly asked in clinical/practical examinations and various interviews.
- Includes description of femtosecond laser and its role in cataract and corneal surgery.
- Community ophthalmology chapter has been updated in view of the objectives under Vision 2020, National Program for Control of Blindness in India, during 12th five year plan (2012-2017).
- Chapter on Clinical Methods in Ophthalmology includes uses of recently introduced sophisticated equipment
- Important feature of the sixth edition of the book is the active role of two young ophthalmologists, Aruj K Khurana, trained at Sankara Nethralaya, Chennai and Bhawna Khurana, trained at Guru Nanak Eye Centre, Maulana Azad Medical College, New Delhi, who have virtually revamped the text.

It is my great pleasure to convey my gratitude to all those, whose blessings and contribution has made this venture possible. I shall remain ever indebted to my parents and teachers for their unending blessings. I wish to express my deep sense of gratitude to Sr Prof CS Dhull, Director, PGIMS and Sr Prof SS Sangwan, Vice-Chancellor, University of Health Sciences, Rohtak, Haryana, for providing a working environment. I owe a lot of my students who have been a constant source of inspiration and encouragement. The sincere help rendered by Dr Shweta Goel needs to be acknowledged.

My wife Dr Indu Khurana and my daughter Arushi Khurana, the main forces behind me, need special mention for their endless love, patience and sacrifices.

I thank Shri Jitendar P Vij (Group Chairman), Mr Ankit Vij (Group President) and Mr Tarun Duneja (Director-Publishing) of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, for their enthusiastic cooperation and accomplishing the task in a splendid manner.

Sincere efforts have been made to verify the correctness of text and the answers to the MCQs. However, in spite of the best efforts, ventures of this kind are not likely to be free from human errors, some inaccuracies, ambiguities and typographic mistakes. Therefore, a feedback from the users will be of utmost help in improving future editions of the book. Endeavour of this kind shall be highly appreciated and duly acknowledged.

AK Khurana

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CHAPTER

1

Anatomy, Development and Physiology of Eye

Quick Text Review

ANATOMY OF EYE

EYEBALL

Dimensions of an adult eyeball

- Anteroposterior diameter : 24 mm
- Vertical diameter : 23 mm
- Horizontal diameter : 23.5 mm
- Circumference : 75 mm
- Volume : 6.5 cc
- Weight : 7 g

Segments and chambers of the eyeball

Anterior segment. It includes crystalline lens and structures anterior to it viz. iris, cornea and two aqueous humour filled spaces, the anterior and posterior chamber.

Angle of anterior chamber from anterior to posterior comprises:

- Schwalbe's line
- Trabecular meshwork
- Scleral spur
- Band of ciliary body and
- Root of iris

Anterior chamber. Its depth in the centre is 2.5–3 mm, it is comparatively shallow in very young children and old people. The chamber shallows by 0.01 mm per year. It is shallower in hypermetrops and deeper in myopes. Usually males have larger anterior chamber dimensions than female and volume of aqueous humour in it is 0.25 ml. Posterior chamber contains about 0.06 ml of aqueous humour.

Posterior segment. It includes structures posterior to the lens viz. vitreous humour, retina, optic disc, choroid and pars plana (part of ciliary body).

CORNEA

- It is a transparent, dehydrated and avascular structure.
- Forming 1/6th of the outer fibrous coat of eyeball.

Dimensions

- Anterior vertical diameter : 11 mm
- Anterior horizontal diameter : 12 mm
- Posterior diameter : 11.5 mm
- Radius of curvature of central part
 - Anterior : 7.8 mm
 - Posterior : 6.5 mm
- Thickness
 - at the centre : 0.52 mm
 - at the periphery : 1 mm
- Refractive index : 1.33
- Refractive power : 45 D

Note:

- **Pachymetry** 500-600 micron, always central thickness measured because centre is the thinnest part.
- **Specular microscopy** is a detailed microscopic analysis of individual cell morphology and an estimate of cellular density.

Layers of cornea

- **Epithelium:** Stratified squamous type. Corneal epithelium replaces itself about once a week.
- **Bowman's membrane:** Once destroyed does not regenerate.
- **Stroma:** Constitutes 90% of total thickness. Consists of collagen fibres (lamellae arranged in many layers).
- **Pre-Descemet's membrane or Dua's layer** (discovered in 2013) is about 15 micrometer thick acellular structure which is very strong and impervious to air.
- **Descemet's membrane:** Once destroyed, it regenerates. Its prominent peripheral end forms Schwalbe's line.
- **Endothelium:** Cell density in a young adult is about 6,000 cells/mm². Metabolically, it is the most active layer of cornea.

SCLERA

Thickness of sclera

- At posterior pole: 1 mm (thickest)
- At the insertion of extraocular muscles: 0.3 mm (thinnest)
- Equator: 0.5 mm
- Lamina cribrosa is the thinnest sieve like sclera through which pass fibres of the optic nerve.

CRYSTALLINE LENS

Dimensions

Lens is a transparent, biconvex, crystalline structure placed between iris and vitreous in a saucer shaped depression called patellar fossa.

- *Diameter*: 9-10 mm
- *Thickness* varies with age from 3.5 mm (at birth) to 5 mm (at 60 to 70 years); in an adult average is 4.25 mm
- *Thickness of the lens capsule* at anterior pole is 14 μ m.
- *Weight* varies with age from about 135 mg (0-9 year), 175 mg (20-30 years) to 255-275 mg (60 to 80 years)
- *Radius of curvature*
 - Anterior : 11 mm
 - Posterior : 6 mm
- *Refractive index* : 1.39
- *Refractive power* : 15-16D

Structure

Lens capsule is thinnest at the posterior pole.

Lens epithelium. It is a single layer on the anterior (front) surface. There is no epithelium on posterior surface.

Nucleus: It is the central part of the lens containing oldest lens fibres.

- ***Embryonic nucleus:*** Corresponding to the lens at 1-3 months of gestation. It consists the oldest primary fibres
- ***Fetal nucleus*** (3 months gestation till birth). Its fibres meet around the Y-shaped sutures (anterior Y is erect and, posterior Y is inverted).
- ***Infantile nucleus:*** From birth to puberty
- ***Adults nucleus:*** Lens fibres formed after puberty to rest of life

Cortex: It is the peripheral part containing the youngest fibres.

IRIS AND CILIARY BODY

- *Iris is thinnest* at its root.

- ***Anterior limiting membrane*** is the anterior most condensed part of stroma. It is deficient in the area of crypts. Definitive colour of the iris depends upon the amount of pigment in this layer.
- ***Anterior pigmented epithelium*** of ciliary body is forward continuation of the pigment epithelium of the retina.
- ***Posterior non-pigmented epithelium*** of ciliary body is forward continuation of the sensory retina.
- ***Ciliary processes*** (About 70-80 in number) are white, finger-like projections from the pars plicata, part of the ciliary body.

VITREOUS, RETINA AND VISUAL PATHWAY

Vitreous

- ***Volume*** of vitreous is approximately 4 cc (about two-third of the volume of the eye).
- ***Vitreous consists*** of large molecules of hyaluronic acid.
- ***Subhyaloid space*** refers to the potential space between vitreous and retina.
- ***Vitreous base*** refers to its strongest attachment to the pars plana and the retina in the region of ora-serrata.

Retina

- ***Dimensions of retina***
 - Optic disc : 1.5 mm
 - Macula lutea : 5.5 mm (15° visual field)
 - Fovea centralis : 1.5 mm (5° visual field)
 - Foveola : 0.35 mm
 - Thickness of retina : 0.5 mm near optic disc, 0.2 mm at equator, and 0.1 mm most anteriorly
- ***Optic disc***, 1.5 mm in size, is responsible for blind spot of Mariotte
- ***Rods and cones*** are sensory end organs of the vision
- ***Rods are absent*** in the foveal region. Ganglion cell layer is thickest in the macular region
- ***Henle's layer*** refers to thickened outer plexiform layer in the foveal region
- ***Foveola*** is the most sensitive part of retina. It contains only cones and their nuclei covered by a thin internal limiting membrane
- ***Major retinal vessels*** are present in the nerve fibre layer
- ***Superficial capillary network*** of the retina is present at the level of nerve fibre layer
- ***Nourishment of macula-lutea*** is entirely dependent upon the choroid.

Visual pathway

Visual sensation neurons

- *First order*—bipolar cells
- *Second order*—ganglion cells
- *Third order*—neurons of lateral geniculate body.

Optic nerve

- *Fibres of optic nerve* once cut, do not regenerate, because they are not covered by neurilemma.
- *Length of optic nerve*
 - Total length : 47-50 mm
 - Intraocular part : 1 mm
 - Intraorbital part : 30 mm
 - Intracanalicular part : 6-9 mm
 - Intracranial part : 10 mm
- *Diameter of optic nerve*
 - Intraocular (optic disc) : 1.5 mm
 - Intraorbital part : 3-4 mm
 - Intracranial part : 4-7 mm
- Intraocular part of optic nerve is closely related to ophthalmic artery, which crosses obliquely over it.

EXTRAOCULAR MUSCLES

Origin and insertion

- *Four rectus muscles* (superior, inferior, medial and lateral) arise from the common tendinous ring (annulus of Zinn) at the apex of the orbit, and are inserted on the sclera at following distances from the limbus:
 - Medial rectus : 5.5 mm
 - Inferior rectus : 6.5 mm
 - Lateral rectus : 6.9 mm
 - Superior rectus : 7.7 mm
- *Superior rectus and medial rectus* have an attachment with the dural sheath of the optic nerve, this accounts for the painful movements in retrobulbar neuritis.
- *Lateral rectus* muscle arises by two heads.
- *Inferior oblique* (shortest extraocular muscle), is the only muscle arising from the floor of the orbit. It is inserted on the sclera posterior to the equator in the area coinciding with the macular region.
- *Superior oblique* (longest extraocular muscle) arises from the apex of the orbit, turns around the trochlea and is inserted in the upper and outer part of the sclera behind the equator.

Nerve supply

- *3rd cranial nerve*: Superior rectus, medial rectus, inferior rectus and inferior oblique.
- *4th cranial nerve*: Superior oblique.
- *6th cranial nerve*: Lateral rectus. Palsy produces eyeball inward, i.e. esotropia or convergent squint, and homonymous (uncrossed) diplopia.

Actions

Muscle	Primary action	Secondary action	Tertiary action
MR	Adduction	—	—
LR	Abduction	—	—
SR	Elevation	Intorsion	Adduction
IR	Depression	Extorsion	Adduction
SO	Intorsion	Depression	Abduction
IO	Extorsion	Elevation	Abduction

APPENDAGES OF THE EYE AND ORBIT

Conjunctiva

1. *Epithelium*: Stratified squamous non-keratinized
 - Marginal conjunctiva - 5 layered
 - Tarsal conjunctiva - 2 layered
 - Fornix and bulbar conjunctiva - 3 layered
 - Limbal conjunctiva - 5 layered
 - Globlet cells are seen in nasal part of conjunctiva. Maximum density of globlet cell is present infero-nasally and in the fornices.
2. *Adenoid layer*: Consists of fine connective tissue reticulum. It is most developed in the fornices. It is not present since birth but develops after 3–4 months of life (so conjunctival inflammation in infants does not produce follicles). Limbal stem cells are present in the limbal conjunctiva.
3. *Fibrous layer*: It contains all the blood vessels and nerves.

Glands of eyelids

- *Meibomian glands* (Tarsal glands) are modified sebaceous glands; about 20-30 in each lid.
- *Glands of Zeis* are modified sebaceous glands which open into follicles of eye lashes.
- *Glands of Moll* are modified sweat glands which open into hair follicles.
- *Accessory lacrimal glands* of Wolfring are present near the superior border of upper tarsus.

Lacrimal apparatus

- *Accessory lacrimal glands of Krause* are about 42 in the upper fornix and 6–8 in the lower fornix
- *Tears* are produced after one week of life
- *Lacrimal sac* when distended, is about 15 mm in length and 5–6 mm in breadth
- *Angular vein* is situated 8 mm medial to the medial canthus.

Nasolacrimal duct

- *Length* 12–24 mm, diameter 4–5 mm
- *Directed* downward, slightly outwards and backwards
- *Opens in* inferior meatus
- *Narrowest point* is near the upper end
- *Valve of Hasner* is present near its lower end.

ORBIT

- *Volume*—30 cc. The eyeball occupies one-fifth of the volume
- *Thinnest wall*—medial
- *Thickest wall*—lateral
- *Floor* is commonly involved in blow-out fractures
- *Surgical spaces* in orbit—four (subperiosteal space, peripheral space, central space or muscle cone and Tenon's space).

Bones, walls and fissures of orbit

Walls of orbit are formed by following bones:

1. *Medial wall*

- Frontal process of maxilla
- Lacrimal bone
- Orbital cribriform plate of ethmoid and
- Body of sphenoid

2. *Lateral wall*

- Zygomatic bone
- Greater wing of sphenoid

3. *Superior wall (roof)*

- Orbital Plate of frontal bone
- Lesser wing of sphenoid

4. *Floor* (commonly involved in blow out fracture)

- Orbital surface of maxillary bone
- Orbital surface of zygomatic bone
- Palatine bone

Fissures and foramen of orbit are:

- *Inferior orbital fissure*
 - Present between floor and lateral wall
- *Superior orbital fissure*
 - It is at orbital apex, lateral to optic foramen
- *Optic canal/Optic foramen*
 - Formed by two wings of lesser wing of sphenoid at orbital apex.

DEVELOPMENT OF THE EYE

Eyeball and its related structures are derived from the following primordia:

- *Optic vesicle* (Neuroectodermal structure)—an outgrowth from the prosencephalon
- *Lens placode* (a specialised area of surface ectoderm) and surrounding surface ectoderm
- *Mesoderm* surrounding the optic vesicle
- *Visceral mesoderm* of maxillary process.

STRUCTURES DERIVED FROM THE EMBRYONIC LAYERS1. **Surface ectoderm**

- The crystalline lens
- Epithelium of the cornea
- Epithelium of the conjunctiva
- Lacrimal gland

- Epidermis of eyelids and its derivatives viz., cilia, tarsal glands and conjunctival glands
- Epithelium lining the lacrimal apparatus.

2. **Neural ectoderm**

- Retina with its pigment epithelium
- Epithelial layers of ciliary body
- Epithelial layers of iris
- Sphincter and dilator pupillae muscles
- Optic nerve (neuroglia and nervous elements only)
- Definitive or secondary vitreous
- Ciliary zonules.

3. **Associated paraxial mesoderm**

- Blood vessels of choroid, iris, ciliary vessels, central retinal artery and other vessels
- Substantia propria, Descemet's membrane and endothelium of cornea
- The sclera
- Stroma of iris
- Ciliary muscle
- Sheaths of optic nerve
- Extraocular muscles
- Fat, ligaments and other connective tissue structures of the orbit
- Upper and medial walls of the orbit
- Connective tissue of the upper eyelid.

4. **Visceral mesoderm of maxillary process below the eye**

- Lower and lateral walls of orbit
- Connective tissue of the lower eyelid.

IMPORTANT MILESTONES IN THE DEVELOPMENT OF THE EYE**Embryonic and fetal period**

<i>Stage of growth</i>	<i>Development</i>
2.6 mm (3 weeks)	Optic pits appear on either side of cephalic end of forebrain
3.5 mm (4 weeks)	Primary optic vesicle invaginates
5.5 to 6 mm	Development of embryonic fissure
10 mm (6 weeks)	Retinal layers differentiate, lens vesicle formed
20 mm (9 weeks)	Sclera, cornea and extraocular muscles differentiate
25 mm (10 weeks)	Lumen of optic nerve obliterated
50 mm (3 months)	Optic tracts completed, pars ciliaris retina grows forwards, pars iridica retina grows forward and lid folds develop

60 mm (4 months)	Hyaloid vessels atrophy, iris sphincter, dilator and ciliary muscles develop
230-265 mm (8th month)	Fetal nucleus of lens is complete, all layers of retina nearly developed and macula starts differentiation.
265-300mm (9th month)	Except macula, retina is fully developed, infantile nucleus of lens begins to appear, pupillary membrane and hyaloid vessels disappear. Medulation of optic nerve reaches lamina cribrosa.

Eye at birth and post-natal development

- *Anterior posterior diameter* about 16.5 mm (70% of adult size) which is attained by 7-8 years of age.
- *Corneal diameter* is about 10 mm. Adult size (11.7 mm) is attained by 2 years of age.
- *Lens* is spherical and 3.5 mm thick at birth. Lens grow through out life and become 5 mm thick at 60 years of age.
- *Macula* differentiate 4-6 months after birth.
- *Refractive status*. New born in hypermetropic by +2 to +3 D.
- *Fixation status* developing at 1 month and is completed by 6 months.

PHYSIOLOGY OF EYE

PHYSIOLOGY OF TEAR FILM

(See page 75)

PHYSIOLOGY OF CORNEA

Corneal transparency is the result of:

- *Peculiar arrangement* of corneal lamellae (lattice theory)
- *Avascularity of cornea*
- *Relative dehydration* maintained by epithelial and endothelial barriers and active bicarbonate pump of the endothelium
- *Swelling pressure* of stroma
- *Corneal crystallines* (water soluble proteins of keratocyte)

Corneal metabolism. Epithelium is metabolically more active than endothelium:

- Glucose and other solutes are derived from aqueous humour and perilimbal capillaries
- Oxygen is derived from the air through tear film
- Respiratory quotient of cornea is 1.

PHYSIOLOGY OF CRYSTALLINE LENS

Lens transparency is the result of:

- Avascularity
- Tightly-packed lens fibres
- Arrangement of lens proteins
- Semipermeable lens capsule
- Active pump mechanism in lens fibres
- Auto-oxidation and high concentration of reduced glutathione
- Aquaporin-O also help in maintaining transparency.

Lens metabolism

- *Metabolic activity* of the lens is largely limited to epithelium and cortex, nucleus is relatively inert
- *80% glucose is metabolised* anaerobically by the glycolytic pathway, 15% by HMP shunt, and a small proportion via Kreb's cycle
- *Sorbital pathway* plays role in diabetic cataract
- *Respiratory quotient* of lens is 1
- *Preventive antioxidants mechanism* of lens are enzymatic (glutathione, glutathione peroxide, superoxide dismutase and catalase) and non-enzymatic (vitamin C, vitamin E and carotenoids).

PHYSIOLOGY OF AQUEOUS HUMOUR

(See page 44)

PHYSIOLOGY OF VISION

Initiation, processing and transmission of visual impulse

Sensory nerve endings for visual sensation are rods and cones. Each eye contains about 120 million rods and 6 million cones and only 1.5 million ganglion cells.

Visual pigments (in rods rhodopsin with spectrum of 500 nm and in cones erythrolabe with spectrum 565 nm, chlorolabe with spectrum 535 nm, and cyanolabe with spectrum 440 nm), absorb light and trigger receptor potential which unlike other receptor systems leads to hyperpolarization of the cells and not the depolarization. This phenomenon of conversion of light energy into nerve impulse is called phototransduction.

Receptor potential generated in the photoreceptors is transmitted by electronic conduction to other retinal cells up to ganglion cell. Ganglion cells, however, transmit by action potential to the LGB cells.

Parvocellular system of visual pathway consisting of P ganglion cells and other P cells transmit information about colour and fine details of vision.

Magnocellular system consisting of M ganglion cells and other M cells is concerned with contrast and motion.

Visual perceptions

1. The light sense: It is the awareness of the light. The minimum brightness required to evoke a sensation of light is called the *light minimum*. The rods are more sensitive to low illumination than the cones. Dark adaptation is the ability of the eye to adapt itself to decreasing illumination. Dark adaptation is delayed in:

- Vitamin A deficiency
- Glaucoma
- Pigmentary retinal dystrophy.

2. The form sense: It is the ability to discriminate between the shapes of the objects. Cones play major role in this faculty, therefore form sense is most acute at the fovea where cones are most densely packed and highly differentiated. Visual acuity recorded by Snellen's test chart is the measure of form sense.

3. Sense of contrast: It is the ability of the eye to perceive slight changes in the luminance between

regions which are not separated by definite borders. Contrast sensitivity is decreased in:

- Glaucoma
- Refractive errors
- Diabetes
- Optic nerve diseases
- Cataractous changes.

Measurement of contrast sensitivity: In clinical practice, the contrast sensitivity can be measured by using any of the following charts with letters or stripes represented in various shades of gray:

- Arden gratings
- Cambridge low-contrast gratings
- Pelli-Robson contrast sensitivity chart which consists of low contrast letters with same size
- The Visitach chart, and
- Functional acuity contrast test (FACT).

4. Colour sense vision: It is the ability of the eye to discriminate between different colours. It is a function of the cones. There are three primary colours—red, green and blue. All other colours are produced by mixture of these primary colours (Young Helmholtz's trichromatic theory).

Note: Colour vision involves opponent colour cells and difference between rods and cones is all (intensity, number and colour) except signal transduction.

Multiple Choice Questions (MCQs)

1. **Anteroposterior diameter of normal adult eyeball is:**
 - A. 25 mm
 - B. 24 mm
 - C. 23.5 mm
 - D. 23 mm
2. **Smallest diameter of the eyeball is:**
 - A. Vertical
 - B. Horizontal
 - C. Anteroposterior
 - D. More than 24 mm
3. **Circumference of an adult eyeball is:**
 - A. 80 mm
 - B. 65 mm
 - C. 75 mm
 - D. 70 mm
4. **Volume of an adult eyeball is:**
 - A. 7.5 mL
 - B. 6.5 mL
 - C. 5.5 mL
 - D. 8 mL
5. **Weight of an adult eyeball is:**
 - A. 7 g
 - B. 9 g
 - C. 11 g
 - D. 13 g
6. **Anterior segment of the eyeball includes structures lying in front of the:**
 - A. Iris
 - B. Crystalline lens
 - C. Vitreous body
 - D. Cornea
7. **Posterior segment of the eyeball includes structures present posterior to the:**
 - A. Posterior surface of the lens and zonules
 - B. Iris and pupil
 - C. Vitreous body
 - D. Anterior surface of the lens and zonules
8. **Diameter of an adult crystalline lens is:**
 - A. 5–6 mm
 - B. 7–8 mm
 - C. 9–10 mm
 - D. 11–12 mm
9. **Thickness of the adult crystalline lens is about:**
 - A. 2.5 mm
 - B. 3.5 mm
 - C. 4.25 mm
 - D. 5 mm
10. **Radius of curvature of the anterior surface of an adult crystalline lens with accommodation at rest is:**
 - A. 7 mm
 - B. 10 mm
 - C. 8 mm
 - D. 9 mm
11. **Capsule of the crystalline lens is thinnest at:**
 - A. Anterior pole
 - B. Posterior pole
 - C. Equator
 - D. None of the above
12. **Infantile nucleus of the crystalline lens refers to the nucleus developed from:**
 - A. 3 months of gestation to till birth
 - B. Birth to one year of age
 - C. Birth to puberty
 - D. One year of age to 3 years of age
13. **The lens fibres meet around the Y-shaped sutures in which part of nucleus of the crystalline lens:**
 - A. Embryonic nucleus
 - B. Fetal nucleus
 - C. Infantile nucleus
 - D. All of the above

1 : B 2 : A 3 : C 4 : B 5 : A 6 : C
7 : A

8 : C 9 : D 10 : B 11 : B 12 : C 13 : A

- 14. The youngest lens fibres are present in:**
 A. Central core of the lens nucleus
 B. Outer layer of the nucleus
 C. Deeper layer of the cortex
 D. Superficial layer of the cortex
- 15. Schwalbe's line forming part of the angle of anterior chamber is the prominent end of:**
 A. Sclera
 B. Descemet's membrane of cornea
 C. Anterior limit of trabecular meshwork
 D. Posterior limit of trabecular meshwork
- 16. In a normal adult person the depth of anterior chamber in the centre is about:**
 A. 2.5 mm
 B. 3 mm
 C. 3.5 mm
 D. 4 mm
- 17. Is a sweat gland:**
 A. Gland of Moll
 B. Gland of Zeis
 C. Meibomian gland
 D. All of the above
- 18. The layer of the cornea once destroyed does not regenerate is:**
 A. Epithelium
 B. Bowman's membrane
 C. Descemet's membrane
 D. All of the above
- 19. All of the following are true about corneal endothelium except:**
 A. Cell density is about 3000 cells/mm² at birth
 B. Corneal decompensation occurs when cell count is decreased by 50 percent
 C. Endothelial cells contain active pump mechanism
 D. Endothelium is best examined by specular microscopy
- 20. Adult size of the cornea is attained by the age of:**
 A. 2 years
 B. 3 years
 C. 5 years
 D. 9 years
- 21. Sclera is weakest at the level of:**
 A. Macula
 B. Equator
 C. Insertion of extraocular muscles
 D. Ora serrata
- 22. The definitive colour of the iris depends upon the:**
 A. Anterior limiting layer
 B. Stroma
 C. Anterior pigmented epithelium
 D. Posterior pigmented epithelium
- 23. Circulus iridis major is formed by the anastomosis of:**
 A. Long posterior ciliary arteries with short posterior ciliary arteries
 B. Anterior ciliary arteries with short posterior ciliary arteries
 C. Long posterior ciliary arteries with anterior ciliary arteries
 D. Long posterior arteries with anterior conjunctival arteries
- 24. Layer of non-pigmented epithelium of the ciliary body is the forward continuation of the:**
 A. Pigment epithelium of the retina
 B. Sensory retina
 C. Internal limiting membrane of the retina
 D. Bruch's membrane of the choroid
- 25. The number of ciliary processes is about:**
 A. 20-30
 B. 50-60
 C. 70-80
 D. 90-100
- 26. All of the following are true about circulus arteriosus minor except:**
 A. It receives contribution from anterior ciliary arteries and long posterior ciliary arteries
 B. It is an arterial and venous plexus
 C. It lies near the pupillary margin
 D. It is the seat of formation of aqueous humour
- 27. The strongest attachment of the vitreous body to the surrounding structures is at the level of:**
 A. Vitreous base
 B. Optic disc
 C. Posterior surface of the lens
 D. Foveal region
- 28. Diameter of the optic disc is:**
 A. 1.5 mm
 B. 2.5 mm
 C. 3.5 mm
 D. 5 mm
- 29. Diameter of the macula lutea is:**
 A. 1.5 mm
 B. 3.5 mm
 C. 4.5 mm
 D. 5.5 mm

14 : D 15 : B 16 : A 17 : A 18 : B 19 : B
 20 : A 21 : C

22 : A 23 : C 24 : B 25 : C 26 : D 27 : A
 28 : A 29 : D

- 30. Diameter of fovea centralis is:**
 A. 0.5 mm
 B. 1.0 mm
 C. 1.5 mm
 D. 2.5 mm
- 31. Henle's layer refers to the thickened outer plexiform layer in the region of:**
 A. Foveola
 B. Foveal region
 C. Parafoveal region
 D. Paramacular region
- 32. Major retinal vessels are present in:**
 A. Between the vitreous and internal limiting membrane
 B. The nerve fibre layer
 C. The inner plexiform layer
 D. The inner nuclear layer
- 33. Optic nerve consists of axons of:**
 A. Ganglion cells
 B. Bipolar cells
 C. Rods and cones
 D. All of the above
- 34. Optic nerve fibres once cut, do not regenerate because they are not covered by:**
 A. Myelin sheath
 B. Neurilemma
 C. Both of the above
 D. None of the above
- 35. Neurons of first order for visual sensations are:**
 A. Rods and cones
 B. Bipolar cells
 C. Ganglion cells
 D. None of the above
- 36. Neurones of third order for visual sensations lie in:**
 A. Layer of bipolar cells
 B. Layer of ganglion cells
 C. Lateral geniculate body
 D. Visual cortex
- 37. The longest extraocular muscle is:**
 A. Superior oblique
 B. Inferior oblique
 C. Superior rectus
 D. Inferior rectus
- 38. The shortest extraocular muscle is:**
 A. Superior oblique
 B. Inferior oblique
 C. Superior rectus
 D. Inferior rectus
- 39. The posterior end of which muscle insertion lies near the macula ?**
 A. Inferior oblique
 B. Superior oblique
 C. Superior rectus
 D. Inferior rectus
- 40. The nerve which has the longest intracranial course is:**
 A. Fourth cranial nerve
 B. Third cranial nerve
 C. Sixth cranial nerve
 D. Fifth cranial nerve
- 41. Glands of Zeis are:**
 A. Modified sebaceous glands
 B. Modified sweat glands
 C. Modified lacrimal glands
 D. Modified meibomian glands
- 42. Ducts of the main lacrimal gland open in:**
 A. Superior fornix
 B. Inferior fornix
 C. Both of the above
 D. None of the above
- 43. Accessory lacrimal glands of Krause are present in the:**
 A. Upper fornix
 B. Lower fornix
 C. Both of the above
 D. None of the above
- 44. Length of the nasolacrimal duct is about:**
 A. 8–12 mm
 B. 22–34 mm
 C. 12–18 mm
 D. 18–21 mm
- 45. Nasolacrimal duct opens into:**
 A. Superior meatus
 B. Middle meatus
 C. Inferior meatus
 D. Maxillary sinus
- 46. Nasolacrimal duct is directed:**
 A. Downwards, slightly outwards and backwards
 B. Downwards, slightly inwards and backwards
 C. Downwards, slightly outwards and forwards
 D. Downwards, slightly inwards and forwards
- 47. In the nasolacrimal duct, valve of Hasner is present at its:**
 A. Upper end
 B. Lower end
 C. Middle
 D. None of the above

30 : C 31 : B 32 : B 33 : A 34 : B 35 : B
 36 : C 37 : A 38 : B

39 : A 40 : A 41 : A 42 : C 43 : C 44 : C
 45 : C 46 : A 47 : B

48. Thinnest wall of the orbit is:

- A. Medial wall
- B. Floor
- C. Roof
- D. Lateral wall

49. Thickest wall of the orbit is:

- A. Medial wall
- B. Lateral wall
- C. Roof
- D. Floor

50. The volume of the orbit is about:

- A. 30 cc
- B. 40 cc
- C. 50 cc
- D. 60 cc

51. All of the following ocular structures are derived from the surface ectoderm except:

- A. Crystalline lens
- B. Substantia propria of the cornea
- C. Conjunctival and corneal epithelium
- D. Lacrimal glands

52. Crystalline lens is derived embryologically from the:

- A. Surface ectoderm
- B. Neuroectoderm
- C. Surface ectoderm and mesoderm
- D. Neuroectoderm and mesoderm

53. Definitive or secondary vitreous is embryologically derived mostly from:

- A. Neuroectoderm
- B. Mesoderm
- C. Surface ectoderm
- D. Surface ectoderm and mesoderm

54. Sphincter and dilator pupillae muscles are derived embryologically from the:

- A. Surface ectoderm
- B. Mesoderm
- C. Neuroectoderm
- D. All of the above

55. All of the following ocular structures are derived embryologically from the neuroectoderm except:

- A. Epithelial layers of ciliary body and iris
- B. Sphincter and dilator pupillae muscles
- C. Optic nerve
- D. Optic nerve sheaths

56. Normal A: V ratio of retinal blood vessels is:

- A. 1 : 2
- B. 2 : 3
- C. 3 : 2
- D. 3 : 4

57. 'Safe zone' of the eye ball is:

- A. At the limbus
- B. 3-4 mm behind the limbus
- C. 8-9 mm behind the limbus
- D. 12 mm behind the limbus
- E. 1 mm behind the limbus

58. Yoke muscle for right superior rectus is:

- A. Left superior rectus
- B. Left inferior oblique
- C. Left inferior rectus
- D. Left superior oblique

59. The short posterior ciliary arteries are about in number:

- A. 10
- B. 20
- C. 30
- D. 40
- E. 45

60. The canal of Schlemm possesses the following anatomic characteristics except:

- A. Contains red cells
- B. Contains aqueous
- C. Lined by endothelium
- D. Contains partitions resembling the dural venous sinuses

61. Muscle in the lid attached to posterior tarsal margin is:

- A. Levator palpebrae superioris
- B. Superior oblique
- C. Muller's muscle
- D. Superior rectus

62. Which of the following extraocular muscle has sympathetic innervation:

- A. Levator palpebrae superioris
- B. Muller's muscle
- C. Superior rectus
- D. Inferior rectus

63. Most sensitive part of eye is:

- A. Fovea centralis
- B. Macula lutea
- C. Blind spot
- D. Temporal retina

64. Volume of the vitreous is:

- A. 2 mL
- B. 3 mL
- C. 4 mL
- D. 7 mL

65. Avascular coat in eye is:

- A. Sclera
- B. Cornea
- C. Retina
- D. Choroid

48 : A 49 : B 50 : A 51 : B 52 : A 53 : A
54 : C 55 : D 56 : B

57 : C 58 : B 59 : B 60 : A 61 : C 62 : B
63 : A 64 : C 65 : B