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Харківський національний медичний університет**

**STUDY GUIDE
FOR SELF-WORK IN OPHTHALMOLOGY
Part 1**

**Методические указания
для самостоятельной подготовки студентов
к практическим занятиям по офтальмологии
Часть 1**

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Compilers P. A. Bezditko
 O. P. Muzhychuk
 O. V. Zavaloka
 Y. N. Pyina
 D. O. Zubkova

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Составители П. А. Бездетко
 О. П. Мужичук
 О. В. Заволока
 Е. Н. Ильина
 Д. О. Зубкова

Topic: "Anatomy: Topographical Features of the Eye Structure"

Orientation to our world is primarily visual. We learn much about our environment and ourselves by means of our eyes. To know the structure of eye is important for doctors of different specialization.

Lesson topic contents.

The organ of vision consists of the globe, supplying and protective structures or adnexa.

The Globe weighs 7.5 gm, measures 2.5 sm. and rests on a pad of fat lining the orbital cavity.

The Globe has three coats or layers and three intraocular chambers.

The **three ocular coats** are:

1. Outer layer: Cornea, Sclera.
2. Middle vascular layer or uvea: Iris, Ciliary Body, Choroid.
3. Inner neural layer: Retina.

The **three ocular chambers** are:

1. Anterior chamber – the space between the cornea and the iris. It is filled with a clear liquid called aqueous humor, which is produced in the ciliary body, drains into the posterior chamber and passes through the pupil into the anterior chamber.

2. Posterior chamber – the space between the iris and the lens.
3. Vitreous chamber – the space behind the lens with its gel-like vitreous body.

The ocular adnexa **are**:

- Orbit and its content.
- Upper and lower lids including eyelashes and eye brows as well as the muscles to open and close the lids.
- Lacrimal glands and lacrimal drainage system.
- Conjunctiva.
- Extraocular eye muscles with Tenon's capsule.
- Blood supply and innervation.
- Optic Nerve.

The Outer Coat and Its Function

The cornea and sclera provide a tough, resistant coat and capsule for the globe. The cornea is the optical window into the eye. It forms the anterior one-sixth of the fibrous layer of the eye. *The cornea* is transparent and shaped like a watch glass with a furrow, the limbus around its edge. It consists of five layers:

1. The epithelium with a basement membrane – the most superficial layer.
2. Bowman's layer – homogeneous sheet of modified stroma.
3. Stroma – consists of approximately 90 % of total corneal thickness.

Consists of lamellae of collagen, cells and ground substance.

4. Descemet's membrane – the basement membrane of the endothelium.
5. Endothelium – a single layer of cells lining toward the anterior chamber.

The functions of the cornea are light-refraction and optical transmission. Due to its flexibility, sensitivity the cornea executes support and protective function.

The sclera is a fibrous outer protective coating. It is white in color and almost completely surrounds the eye except on the anterior surface of the eye ball. A few strands of scleral tissue pass across the anterior portion of the optic nerve as the lamina cribrosa. The outer surface of anterior sclera is covered by a thin layer of fine elastic tissue, the episclera, which contains blood vessels to nourish the sclera.

The sclera can be subdivided into 3 layers:

1. *Episclera* – external layer, loose connective tissue adjacent to the periorbital fat, well vascularized.

2. *Sclera proper*: also called Tenon's capsule. It is the dense investing fascia of the eye composed of dense type I and III collagen. Avascular.

3. *Lamina fusca*: the inner aspect of the sclera, located adjacent to the choroid and contains thinner collagen fibers and pigment cells.

The sclera is thickest posteriorly and thinnest beneath the insertions of the rectus muscles. The functions of the sclera are forming, protective, being the support to the inner eye coats and a place of the muscles attaching it acts as a skeleton to the eye.

The Middle Coat and Its Function

The middle layer, the uvea, is highly vascular. *The iris* is a contractile diaphragm that controls the degree of retinal illumination. The iris contains muscles that open and close its central opening called the pupil in response to decreases and increases in light exposure (exactly like a camera). The Iris consists of two layers – stroma and pigment epithelium.

The ciliary body consists of ciliary muscles and glandular tissues. The functions of these structures are to regulate the light entering the eye through the pupil, to provide accommodation and to form the aqueous.

The choroid consists of the three layers:

1. Layer of large vessels.
2. The layer of small vessels.
3. Bruch's membrane.

The choroid function is to furnish nutrition for the rod and cone layer of the retina and for the pigment epithelium. It is the blood reservoir of the eye and the major ocular nutritional reservoir of the eye.

The Inner Coat and Its Function

The inner layer of the eye is *the retina*. It is a thin transparent, net-like membrane with a high rate of oxygen metabolism. The retina is the fundamental structure involved in the transduction of light into visual signals, i.e. nerve impulses in the ocular system of the central nervous system.

The retina contains two kinds of photoreceptors: the color-sensitive cones and the rods which are sensitive to differences in the degree of illumination and function with reduced illumination (dark adaptation). Rods and cones differ in function. Rods are found primarily in the periphery of the retina and are used to see at low levels of light. Cones are found primarily in the center (or fovea) of the retina. Cones are used primarily to distinguish color and other features of the visual world at normal levels of light.

Functionally the retina consists of two parts – light-sensitive (outer or neuro-epithelial) and light-conductive (cerebral) which are composed of three neurons: 1) neuro-epithelium (rods and cones); 2) bipolar cells and 3) multipolar, ganglion cells. Together they make ten layers:

1. Internal limiting membrane.
2. Basement membrane formed by Müller cells.
3. Ganglion cell layer.
4. Inner plexiform layer.
5. Inner nuclear layer of bipolar, amacrine and horizontal cell bodies.
6. Outer plexiform layer.
7. Outer nuclear layer of photoreceptor cell nuclei.
8. External limiting membrane.
9. Layer of rods and cones.
10. Retinal pigment epithelium.

The two most significant parts of the retina are central placed macula lutea (yellow spot, point of sharpest vision) and the optic disc located toward the nose (papilla, blind spot).

The Anterior Chamber Angle

The anterior chamber angle is delineated by the transition from cornea to sclera and iris and to ciliary body. Schlemm's canal lies at the apex of the angle and is separated from the aqueous by a corneoscleral trabecular meshwork. Schlemm's canal is a tubular structure within the scleral groove, running parallel to the corneal rim. Schlemm's canal is connected with the episcleral venous system and the connection directly runs into the episcleral vein. Schlemm's canal's main function is outflowing of the anterior humour.

The Lens

The lens is a transparent biconvex structure located behind the iris and the pupil and supported by the zonules. The basic lens structure consists of a central nucleus surrounded by the cortex. The nucleus and cortex are contained within the lens capsule. The lens is comprised of 65 % water and 35 % protein. It is avascular. It has not nerves or blood vessels. The lens derives its metabolic needs from the aqueous and vitreous. The lens is a clear part of the eye that helps to focus light, or an image. It focuses light onto the retina at the back of the eye. Early in life, the lens is pliable and can change shape as ciliary

body forces are transmitted to it through the zonules. The changes in lens shape result in accommodation (focusing on near objects). The lens adjusts the eye's focus, letting us to see things clearly both up close and far away.

The Vitreous Body

The vitreous is a clear, avascular gelatinous body filling the space between the lens and the retina comprises two-thirds of the volume and weight of the eye. Its water content is 98 %. The outer surface of the vitreous – the hyaloid membrane – is normally in contact with the posterior lens capsule and zonular fibers. It attaches to the retina and the optic nerve disc.

The vitreous body serves as a buffer to protect the retina against transmitted forces from external blows and pressure. It functions also as a bridge for metabolite transfer between the anterior and posterior chambers of the eye.

The Orbit and its Content

The eye rests within the confines of a bony orbit. This orbit is a cone-shaped cavity formed by the union of cranial and facial bones. The eyeball itself occupies about one fifth of the space of the orbit. The remainder is filled with the lacrimal gland, muscles, blood vessels, nerves and fatty tissue. This fatty tissue serves as a protective cushion for the eye.

The Eye Lids

The upper and lower eyelids are modified folds of skin that can close to protect the anterior eyeball. Blinking helps spread the tear film, which protects the cornea and conjunctiva from dehydration. The upper lid ends at the eyebrows; the lower lid merges into the cheek.

The eyelids consist of the *outer leaf* of skin, subcutaneous connective tissue and two striated muscles – the orbicularis muscle that closes the lid; the levator muscle that elevates the upper lid. The lashes are also a part of the outer leaf of the lid.

The *inner leaf* consists of the tarsal plate, which is the main supporting structure of the lids, with its meibomian glands and mucous membrane (palpebral conjunctiva).

The conjunctiva

The conjunctiva is the thin transparent mucous membrane that starts at the limbus, covers the sclera and lines the inner surface of the eyelids. The conjunctiva is typically divided into three parts:

1. *Palpebral or tarsal conjunctiva* – the conjunctiva that lining the eyelids.
2. *Fornix or transitional conjunctiva* – the conjunctiva where the inner part of the eyelids and the eyeball meet, the palpebral conjunctiva is reflected at the superior fornix and the inferior fornix to become the bulbar conjunctiva.
3. *Bulbar or ocular conjunctiva* – the conjunctiva covering the eyeball over the sclera. This part of the conjunctiva is bound tightly and moves with the eyeball movements. The conjunctiva prevents the entry of foreign bodies, microorganisms or other noxious agents into the orbit.

The Eye Extraocular Muscles

There are six *extraocular muscles* that control the movement of each eye: four rectus (superior, inferior, medial and lateral, which are named according to their insertion into the sclera) and two oblique muscles (superior and inferior). The muscles fan out towards the eye to form a "muscle cone". All the rectus muscles attach to the eyeball anterior to the equator while the oblique muscles attach behind the equator. The optic nerve, the ophthalmic blood vessels and the nerves to the extraocular muscles (except fourth nerve) are contained within the muscle cone.

The Lacrimal System

The lacrimal system consists of the lacrimal gland and a drainage system.

The *lacrimal gland* consists of an upper orbital and a lower palpebral portion. It produces the tears that flow nasally across the eye and enter into drainage system.

The *drainage system* includes conjunctival lake where tears collect, the nasal angle which forms the lacrimal lake, the superior and inferior puncta into which tears drain. The tears then flow into the superior and inferior canaliculus, the common canaliculus, the lacrimal sac and finally drain into the nasolacrimal duct into the nose.

Tears are composed of water, sodium chloride and a mildly antibacterial enzyme. It contains electrolytes, proteins, immunoglobulins, glucose and dissolved oxygen (from the atmosphere). Tears keep the surface of the eye and conjunctiva moistened and lubricated, due to enzyme it functions as an antibacterial agent.

The tear film consists of three layers from anterior to posterior:

1. *The lipid layer* secreted by the Meibomian glands in the inner leaflet of the eyelid. This layer prevents evaporation of the tear film and lubricates the eyelid.

2. *The aqueous layer* constitutes 90 % of the thickness of the tear film and provides oxygen and nutrition for the cornea. This layer also has antibacterial properties and washes away debris. It is secreted by 2 kinds of lacrimal glands: the main lacrimal gland and the accessory lacrimal glands of Krause and Wolfring. They are responsible for basal tearing.

3. *The mucus layer* secreted by goblet cells distributed throughout the bulbar and palpebral conjunctiva. This hydrated glycoprotein layer makes the corneal surface hydrophyllic and decreases surface tension of the tear film.

The Blood Supply

The blood supply of the globe is derived from three sources: the central retinal artery, the anterior ciliary arteries and the posterior ciliary arteries. All these are derived from the ophthalmic artery, which is a branch of the internal carotid artery.

The Optic Nerve

The trunk of optic nerve is formed by the axons of the 1.2 million ganglion cells of the retina and they will not regenerate if severed. The optic nerve meets the posterior part of the globe slightly nasal to the posterior pole and slightly above the horizontal meridian. Inside the eye this point is seen as the optic disc. There are no light-sensitive cells on the optic disc – and hence the blind spot that anyone can find in their field of vision.

The optic nerve contains within its fibers the central retinal artery and the central retinal vein. The optic nerve can be divided into 4 parts:

1. *Intraocular* part.
2. *Intraorbital* part extending from the globe until the apex of the orbit.
3. *Intracanalicular* part within the optic canal.
4. *Intracranial* part merges into the optic chiasm and then optic tract.

The Visual Pathways

Information flows from the eyes, crossing at the optic chiasm, joining left and right eye information in the optic tract. Information from the right visual field (now on the left side of the brain) travels in the left optic tract. Information from the left visual field travels in the right optic tract. Each optic tract terminates in the lateral geniculate nucleus (LGN), which is a sensory relay nucleus in the thalamus of the brain.

The LGN consists of six layers: layers 1, 4, and 6 correspond to information from one eye; layers 2, 3, and 5 correspond to information from the other eye. The neurons of the LGN then carry the visual image through the optic radiation to the primary visual cortex (V1) which is located at the back of the brain (caudal end). The visual cortex is the most massive system in the human brain and is responsible for higher-level processing of the visual image. It lies at the rear of the brain above the cerebellum.

The visual pathways include the following:

- Retina (rods and cones; bipolar cells, ganglion cells).
- Optic nerve.
- Optic chiasm.
- Optic tract.
- Lateral geniculate nucleus.
- Optic radiation.
- Visual cortex.

The Physiology of Vision

The eye is a complex biological device. The functioning of a camera is often compared with the workings of the eye, mostly since both focus light from external objects in the visual field onto a light-sensitive medium. In the case of the camera, this medium is film or an electronic sensor; in the case of the eye, it is an array of visual receptors.

The primary function of the eye is to form a clear image of objects in our environment. These images are transmitted to the brain through the optic nerve and the posterior visual pathways. The various tissues of the eye and its adnexa are thus designed to facilitate this function.

Light entering the eye is refracted (*refraction*) as it passes through the cornea. It then passes through the pupil (controlled by the iris) and is further refracted by the lens. The cornea and lens act together as a compound lens to project an inverted image onto the retina.

The eye can adjust (*accommodation*) to seeing objects at various distances by the flattening or thickening of the lens. Accommodation is also facilitated by changing the size of the pupil. The pupil also constricts with bright lights to protect the retina from intense stimulation.

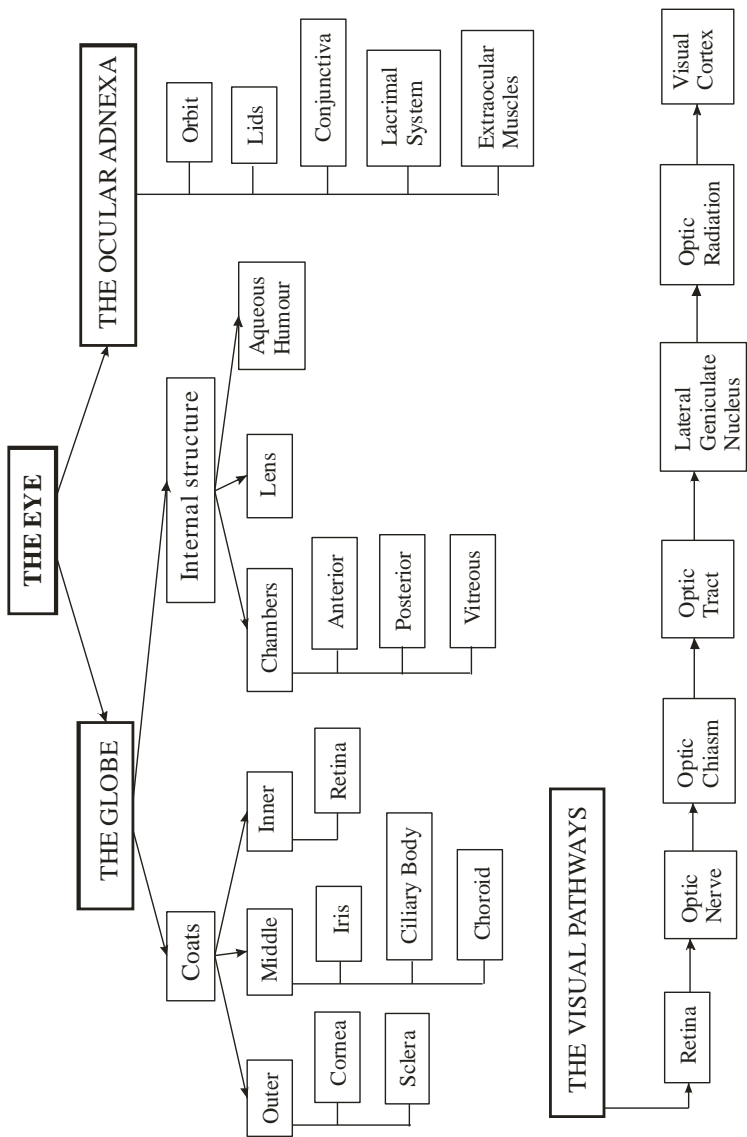
Light rays are absorbed by the photoreceptors on the retina are changed to electrical activity to transmit the image to the cortex. *Bilateral vision* provides depth perception.

Changes in vision with aging

Aging affects many aspects of visual function, both physiologic and anatomic:

- decreased flexibility and elasticity of the lens leads to *presbyopia* (decreased ability of the eye to accommodate for near and detailed work);
- loss of lens transparency – *cataract*;
- irregular curvature of the cornea – *astigmatism*;
- aqueous humor production dropping off – shallowness of the anterior chamber, enables the eye to maintain a stable intraocular pressure;
- quality and quantity of tears decrease – tears evaporate more readily that leads to a feeling of tightness or dryness;
- the drainage system for the tears is less sufficient – may leads to the block of the system with tearing in a result;
- fat deposits through the layers of the cornea around its periphery – *arcus senilis* (hazy grey ring).

Structurally-logic chart of the eye structure



Lesson topic control questions:

1. The shape and size of the globe in children and adults.
2. The coats of the eyeball, their sections and function.
3. The cornea, its structure, blood supply, characteristics and function.
4. The iris, its structure, blood supply, characteristics and function.
5. The ciliary body and choroids, their structure and functions.
6. The peculiarities of structure and functions of the retina.
7. The lens, its function, nutrition, peculiarities.
8. The blood supply of the globe.
9. The extraocular muscles, their innervation and function.
10. The orbit and its content.
11. The lids, their muscles, innervation and function.
12. The lacrimal system of the eye, its structure and function.
13. The conjunctiva, its structure, blood supply and function.
14. The optic nerve, its structure and topography.
15. The central visual pathways and its parts.

Tests

1. What are the main functions of ciliary body?
A. Refraction. D. Aqueous production.
B. Accommodation. E. Aqueous outflow.
C. Aqueous absorbing.
2. What vessels take part in the formation of the uveal tract?
A. Anterior ciliary arteries. D. Short posterior ciliary arteries.
B. Supraorbital artery. E. Lacrimal artery.
C. Long posterior ciliary arteries.
3. What units are used to express a clinical refraction?
A. Angular degrees. D. Conditional units.
B. Centimeters. E. Diopters.
C. Meters.
4. Enumerate the ocular chambers
A. Vitreous. D. Posterior chamber.
B. Anterior chamber. E. Aqueous humor.
C. Lens.
5. Put the corneal layers in order from outside to inside
A. Stroma. D. The epithelium with a basement membrane.
B Endothelium. . E. Descemet's membrane.
C. Bowman's layer.
6. Choose anesthetic solutions used in the ophthalmology
A. Novocaine. D Pilocarpin. .
B. Alcaine. E. Albucid.
C. Dicaine.

7. Name the aberration of the eye optical system
A. Astigmatism. D. Myopia.
B. Coma. E. Chromatic.
C. Spherical.
8. What structures of the eye are transparent?
A. Sclera B. Cornea C. Retina D. Vitreous E. Lens
9. What muscles turn the eye up?
A. Inferior rectus. D. Superior oblique.
B. Superior rectus. E. Medial rectus.
C. Inferior oblique.
10. What muscles of the vascular layer do you know?
A. Sphincter muscle. D. Ciliary muscle.
B. Dilator. E. Orbicularis muscle.
C. Levator.

Recommended literature:

1. Khurana A.K. Ophthalmology / New Delphi, 2006.
2. Lang Gerhard K. Ophthalmology: a short textbook / Stuttgart – New-York, 2000.
3. Kanski Jack J. Clinical Ophthalmology: a systematic approach / Wellington, 1994.

Topic: "Visual functions"

Vision is the one of the most valuable elements of quality of life. Its deficiency limits possibilities for work, social adaptation and self-actualization. Vision maintains huge information flow from environment, for education and communication between peoples.

Every physician should have to know normal indexes and examination methods of visual functions, diagnostic value of its disorders.

Lesson topic contents

Examination methods of rods functions – peripheral vision

Examination methods of peripheral vision:

Control, perimetry, autcampimetry, campimetry

Disorders of peripheral vision:

1. **Scotomas:** By Localization: central, paracentral, peripheral
 By degree of sensitivity loss: absolute, Relative
2. **Hemianopsia:** binasal or bitemporal
 right-side or left-side
 quadrant

Questions for self-control

1. Structure, elements and parts of visual analyser.
2. What main visual functions do you know?
3. Central vision, visual acuity, methods of investigation.
4. Investigation of visual acuity in cases of its significant loss.
5. Peripheral vision, methods of investigation.
6. Types of visual fields impairment.
7. Topical determination of hemianopsias.
8. Light sensitivity, types of eye adaptation.
9. Night and dusk vision, dark adaptation, methods of investigation.
10. Color vision, main theories, methods of investigation.

Tests

A. Enumerate functions of cone subsystem.

- | | |
|------------------------------|--------------------------|
| 1. <i>Peripheral vision.</i> | 4. <i>Visual field.</i> |
| 2. <i>Dark adaptation.</i> | 5. <i>Visual acuity.</i> |
| 3. <i>Photopic vision.</i> | 6. <i>Color vision.</i> |

Model answers: 3, 5, 6.

B. Visual acuity is:

1. *Ability to see on different distances.*
2. *Ability to separate points, seen under a smallest angle.*
3. *Ability to distinguish colors.*
4. *Index of a central vision.*
5. *Space, seen by immobilised eye.*

Model answers: 2, 4.

C. Cones are situated at:

1. *Periphery of the retina.*
2. *Inner layers of retina.*
3. *Central part of the retina.*
4. *Outer layers of retina.*

Model answers: 3, 4.

B. Visual acuity can be examined by means of:

- | | |
|---------------------------|---------------------------|
| 1. <i>Ophthalmoscope.</i> | 4. <i>Optotypes.</i> |
| 2. <i>Perimeter.</i> | 5. <i>Nystagm device.</i> |
| 3. <i>Tables.</i> | |

Model answers: 3, 4, 5.

C. Color vision can be examined by means of:

- | | |
|-------------------------|---------------------------------|
| 1. <i>Optotypes.</i> | 4. <i>Slit lamp.</i> |
| 2. <i>Anomaloscope.</i> | 5. <i>Polychromatic tables.</i> |
| 3. <i>Adaptometer.</i> | 6. <i>Hue panel tests.</i> |

Model answers: 2, 5, 6.

D. Patient can read 1st line of Golovin-Syvtsev table from distance 3 m. His visual acuity is:

1. 0,1. 2. 0,03. 3. 0,06. 4. 0,6. 5. 0,8.

Model answers: 3.

E. Patient cannot distinguish colors. He has:

1. *Trichromasia*. 4. *Tritanopia*.
2. *Dichromasia*. 5. *Achromasia*.
3. *Protanopia*.

Model answers: 5.

F. What are the methods of peripheral vision examination:

1. *Ophthalmoscopy*. 4. *Adaptometry*.
2. *Perimetry*. 5. *Visometry*.
3. *Biometry*. 6. *Campimetry*.

Model answers: 3, 7.

M. What are the methods of dark adaptation examination:

1. *Pourquinie phenomenon*. 4. *Adaptometry*.
2. *Perimetry*. 5. *Visometry*.
3. *Biometry*. 6. *Campimetry*.

Model answers: 1, 4.

N. What are the methods of visual field examination:

1. *Perimetry*. 5. *Adaptometry*.
2. *Biometry*. 6. *Visometry*.
3. *Control method*. 7. *Autocampimetry*.
4. *Campimetry*.

Model answers: 1, 3, 4, 7.

P. What kinds of hemianopsia do you know:

1. *Bitemporal*. 4. *Left side*.
2. *Binasal*. 5. *Right side*.
3. *Concentric*. 6. *Quadrant*.

Model answers: 1, 2, 4, 5, 6.

Q. What kinds of scotomas do you know:

1. *Central*. 6. *Absolute*.
2. *Relative*. 7. *Blind spot*.
3. *Positive*. 8. *Physiologic*.
4. *Hemeralopic*. 9. *Paracentral*.
5. *Negative*. 10. *Macula lutea*.

Model answers: 1, 2, 3, 5–9.

R. What kinds of hemeralopia do you know:

1. *Quadrant*. 4. *Absolute*.
2. *Essential*. 5. *Symptomatic*.
3. *Negative*.

Model answers: 2, 5.

S. What are properties of Blind spot scotoma:

- | | |
|------------------------|------------------------|
| 1. <i>Central.</i> | 6. <i>Hemeralopic.</i> |
| 2. <i>Absolute.</i> | 7. <i>Negative.</i> |
| 3. <i>Relative.</i> | 8. <i>Symptomatic.</i> |
| 4. <i>Positive.</i> | 9. <i>Paracentral.</i> |
| 5. <i>Physiologic.</i> | |

Model answers: 2, 5, 7, 9.

T. What are the normal values of visual fields borders:

- | | |
|---------------------------|-------------------------|
| 1. <i>Temporal – 90°.</i> | 5. <i>Upper – 50°.</i> |
| 2. <i>Nasal – 65°.</i> | 6. <i>Lowest – 70°.</i> |
| 3. <i>Temporal – 70°.</i> | 7. <i>Upper – 25°.</i> |
| 4. <i>Nasal – 35°.</i> | 8. <i>Lowest – 45°.</i> |

Model answers: 1, 2, 5, 6.

U. What kinds of neurons forms visual path in retina:

- | | |
|-------------------------|-----------------------------------|
| 1. <i>Astrocytes.</i> | 4. <i>Ganglion cells.</i> |
| 2. <i>Bipolar.</i> | 5. <i>External nuclear layer.</i> |
| 3. <i>Muller cells.</i> | 6. <i>Rods.</i> |

Model answers: 2, 4, 5.

Tasks

1. Patient counts fingers from distance of 4 m. Calculate visual acuity. What is a formula for visual acuity calculation? / visual acuity of patient is $4/50 = 0.08$. visual acuity calculation formula is : $\text{visus} = d / D = 4 \text{ m} / 50 \text{ m} = 0.08$

2. What methods of checking of color vision do you know? / Polychromatic tables (charts by Rabkin, Yustova et al., anomaloscope, hue panel tests (D15, D100, Farnthwort-Mansel, Holmgren's bundles, Adler's sheets).

3. Patient cannot see objects. How to determine his visual acuity? / If patient cannot see objects /cannot count fingers close to the eyes/, you have to check light sensitivity, directing light source from top, bottom, left, right.

4. Child cannot distinguish 1st line of Orlova's table. How to check his visual acuity? /He must move closer to table, then calculate vision acuity according to Snellen's formula $V.A.=d/D$.

5. Mother came to you with newborn 3 weeks old. How to determine his vision? / First months children's vision is evaluated by availability of follow reactions of eyes, gaze fixation on light, faces, and bright objects.

6. Patient cannot see objects and does not feel the light. How to determine his visual acuity? What are the methods for visual acuity determination? / Patients visual acuity = 0 (zero). Methods for examination of visual acuity are: subjective – /tables, optotypes, light sense; objective – nystagm device, VEP/.

7. Child cannot see objects. How to check his visual acuity? / If the patient cannot see objects (cannot distinguish fingers close to face), you have to

check his light sensitivity: direct light source from different positions: right, left, top, bottom. If the patient determines light source correct, his

V.A. = $1 / \infty$ p.l. certa, else V.A. = $1 / \infty$ p.l. incerta/.

8. Child has no objective vision, he does not feel light. Record his visual acuity. /visus OD/OS = 0 (zero)/.

9. Mother came with child 2 month old and wants to check his vision. What you have to do? /Methods: 1. Moving bright objects in front of each eye checking gaze fixation; 2. Quick approaching of bright objects close to each eye leads to reflective defense reaction of eyelids closing; 3. Check natural vision behaviour – active movement reaction on mother's breasts before nursing/.

10. What theory of color vision is accepted for today? / Now color vision is explained basing on trichromatic vision by Young, M.Lomonosov and Gelmgoltz. According to it, there are 3 kinds of photoreceptors in retina, selectively accepting light of three bands of visible (wavelength 320–780 nanometers) light: long-wave (550...780 nm) – Red, middle-wave (400...550 nm) – Green, and short-wave (320...400 nm) – Blue. All visible hues are seen as a summary excite of these primary three/.

11. Patient came in examination room with aid of other person. What is his probable visual acuity? /His vision is very poor. Probably few ... light sensitivity or even 0 (zero)/.

12. What disorders of color vision do you know? /anomal trichromasia (proto-, deuterio-, tritanomalial / deficit), dichromasia (proto-, deuterio-, tritanopia), (mono-) achromasia/.

13. What is the principle of Rabkin table design? /Every image consists of small color circles differing by hue, brightness and saturation of color. One signs of the table are seen on hue (red, green, etc.) other on brightness. So if patient cannot distinguish hues he names only images build by different brightness circles (light on dark or vice versa). Patients with normal trichromatic color vision first see signs of different hues (red on green or blue background)/. What is the principle of Golovin-Sivtsev table design? /The principle of Golovin-Sivtsev table design: every sign element is seen under the angle 1° and whole sign is seen under the angle 5° from the distance D, recorded near every line ($1^{\text{st}} - 50 \text{ m}$, $10^{\text{th}} - 5 \text{ m}$)/.

14. Patient reads 8 line in Golovin-Sivtsev table with 2 errors. What is his visual acuity? /V.A. = 0,8 /incomplete/

15. Patient reads 8 line in Golovin-Sivtsev table with 3 errors. What is his visual acuity? /V.A. = 0,7. In last 3 lines only 2 errors is allowed/

16. Patient cannot distinguish red colors. What is his type of disorder? /Dichromasia, protanopia

17. Patient cannot distinguish green colors. "What is his type of disorder?" /Dichromasia deuteranopia/

18. Patient has lowered distinguishing of red colors. What is his type of disorder? /abnormal trichromasia, protoanomalopia, protanopia/

19. Patient cannot distinguish any color. What is his type of disorder? /Achromasia/

20. Patient has lowered distinguishing of green colors. What is his type of disorder? /abnormal trichromasia, deuteranomalopia, deuteranopia/.

Approximate chart for mastering practical skills for investigation of the visual acuity

Task	The instructions
To investigate the visual acuity	<ol style="list-style-type: none"> 1. Define availability of complaints of vision loss on each eye. 2. Switch on the light in Rot's device and enough room light. 3. Let patient to be sit on a distance of 5 meters from visual acuity chart. 4. Shield the left eye. 5. Demonstrate to patient consequently from top down one optotype image in each line of Golovin-Sivtsev chart until error occurrence 6. Show all optotypes in the last line, which was seen by patient and determine visual acuity of right eye correspondently to ... for that line (line number) if: <ul style="list-style-type: none"> – From 1st to 4th line there was no error; – From 5th to 7th line there was no more than one error; – From 8th to 12th line there was no more than two errors. 7. Repeat 1...3 for the Left eye. 8. If patient unable to see optotypes in 1st line: <ul style="list-style-type: none"> – Move patient closer to chart; – While 1st line is recognized visual acuity to be calculated according to formula: $\text{visus} = d/D$, where d – distance, from which optotypes were distinguished by patient, D – distance, signed for line, from which they are distinguished for visual acuity 1.0 or – Demonstrate fingers from different distances while they be correct counted by patient. – Calculate visual acuity according to formula: $\text{visus} = d/D$ ($D=50$ m). 9. If the largest optotypes (fingers) can not be distinguished from distance less than 25 sm, you have to move hand vertically and horizontally: in case of correct distinguishing of directions of hand movement, visual acuity = hand movement (h.m.). 10. if not than determine the state of light sensitivity by means of moving in front of the eye bright source of light: <ul style="list-style-type: none"> – in case of correct distinguishing of light direction: visual acuity = $1/\infty$ p. l. c. (light sensation with correct light projection); – in case of incorrect distinguishing of light direction: visual acuity = $1/\infty$ p. l. inc. (light sensation with incorrect light projection); – in case of absence of light sensation from any direction, close to the eye (while controlling thorough closure of other eye!) : visual acuity = 0 (zero) <p>Record the result visual acuity for each eye.</p>

**Approximate chart for mastering practical skills
for investigation of the visual fields**

Task	The instructions
To investigate the visual fields by control method	<ol style="list-style-type: none"> 1. Define availability of complaints of visual field loss on each eye. 2. Let patient to be sit on a distance of 1 meters from you. 3. Shield the left eye of patient, let him keep fixing his gaze on a certain point straight ahead. 4. Sequentially show him test object (pen, finger, candle, etc.) in 8 meridians at a distance 40–50 sm, following imaginary arc path from periphery to center and vice-versa until it appears or disappears in visual field. 5. In each of 8 meridian approximately define the angle between the eye, fixation point and test object (when the last appears/ disappears) and record values of visual field borders on simplified 8 rays star like visual field chart. 6. Repeat p.3–5 for the left eye

**Approximate chart for mastering practical skills
for investigation of the dark adaptation**

Task	The instructions
To investigate the dark adaptation by approximate method	<ol style="list-style-type: none"> 1. Define availability of complaints of dark adaptation disorders. 2. After 10-minutes adaptation to bright light (looking at a blank white sheet of paper, illuminated by lamp) create a dusk (mosopic) environment. 3. Show test images to patient – Polyak's optotypes and color quadrats. 4. Determine the time of Pourquinie phenomenon and distinguishing of optotypes. 5. Repeat p. 2–4 for the left eye

**Approximate chart for mastering practical skills
for investigation of color vision**

Task	The instructions
To investigate the color vision using polychromatic tables (Rabkin, Yustova)	<ol style="list-style-type: none"> 1. Define availability of complaints of color vision disorders on each eye. 2. Place test properly illuminated polychromatic or threshold tables at a distance 30–40 cm at front of right eye. 3. Show test images to patient in a certain sequence, recording each patients answer on recognizing of a pattern (geometric figure, number, character, pattern rotation, color change, etc.). 4. Fill the protocol blank like an example. 5. Repeat p. 2–3 for the left eye. 6. Define normal or type and level of color vision disorder comparing patients answer protocol with etalons, added to tests.

RECOMMENDED LITERATURE

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Составители Бездетко Павел Андреевич
 Мужичук Елена Павловна
 Заволока Олеся Владимировна
 Ильина Евгения Николаевна
 Зубкова Дарья Александровна

Ответственный за выпуск Бездетко П. А.



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**Редакционно-издательский отдел
ХНМУ, пр. Науки, 4, г. Харьков, 61022
izdatknmu@mail.ua**

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