

ALNOOR UNIVERSITY
Optic Technique Department

2023-2024 2nd Year Stage
Eye Physiology –Theory

Chapter 1- Eye Anatomy

Objective

To learn the structure and functions of the eye parts in brief as overview.

Eye anatomy

The eye has many parts that must work together to produce clear vision:

- The sclera, or white part of the eye, protects the eyeball.
- The pupil, or black dot at the center of the eye, is an opening through which light can enter the eye.
- The iris, or colored part of the eye, surrounds the pupil. It controls how much light enters the eye by changing the size of the pupil.
- The cornea, a clear window at the front of the eye, covers the iris and the pupil.
- A clear lens, located behind the pupil, acts like a camera lens by focusing light onto the retina at the back of the eye.
- The retina is a light-sensitive inner lining at the back of the eye. Ten different layers of cells work together in the retina to detect light and turn it into electrical impulses.
- Tear layer (lacrimal system) is tear producing system in the eye.

Chapter 1- Eye Anatomy

Parts of the eye

1. Tear Layer

The Tear Layer (The Lacrimal System) is the first layer of the eye that moist the eye to keep it smooth and moist.

2. Cornea

It is the clear, transparent front part of the eye that covers the iris, pupil and anterior chamber and provides most of an eye's optical power .

The function of the cornea is to let light rays enter the eye.

3. Anterior Chamber

Is filled with aqueous humor, which is a clear, watery fluid that fills the space between the cornea and the lens. Its function is to nourish the cornea, iris, and lens by carrying nutrients, it removes waste products excreted from the lens, and maintain intraocular pressure and thus maintains the shape of the eye.

Chapter 1- Eye Anatomy

4. Iris

The iris is the pigmented tissue lying behind the cornea that gives color to the eye and controls the amount of light entering the eye by varying the size of the pupillary opening.

5-Pupilالبؤبؤ

It is a variable-sized black circular opening in the center of the iris that regulates the amount of light that enters the eye. The pupil needs to be round in order to constrict constricts with bright illumination and dilated in dim illumination الإضاءة الخافتة.

6. Lens

The lens is transparent, biconvex intraocular tissue that helps bring rays of light to focus on the retina. التحجب

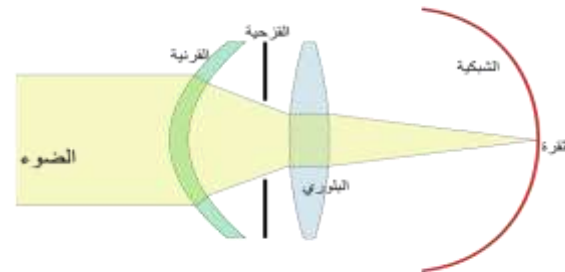
7. Vitreous Humorالسائل الزجاجي

Vitreous Humor is the transparent, colorless gelatinous mass that fills between the lens and the retina, allow light pass through it.

8. Retinaالشبكية

The retina is the light sensitive nerve tissue in the eye that converts images light waves into electrical impulses that are sent along the optic nerve to the brain, to interpret as vision . It include two types of cells: rods and cones. Cones provides the sharp visual acuity under bright lighting.

Rods : works at low light levels (night vision).



Chapter 1- Eye Anatomy

9. Choroid المشيمية

The vascular, central layer of the eye lying between the retina and sclera الشبكية والصلبة. Its function is to provide nourishment to the outer layers of the retina through blood vessels.

10. Sclera الصلبه

The sclera is the opaque, fibrous, tough, protective outer layer of the eye (“white of the eye”) that is directly continuous with the cornea in front and with the sheath covering the optic nerve behind. The sclera provides protection and form.

11. Optic Nerve العصب البصري

Is the largest sensory nerve of the eye, it carries impulses from the retina to the brain.

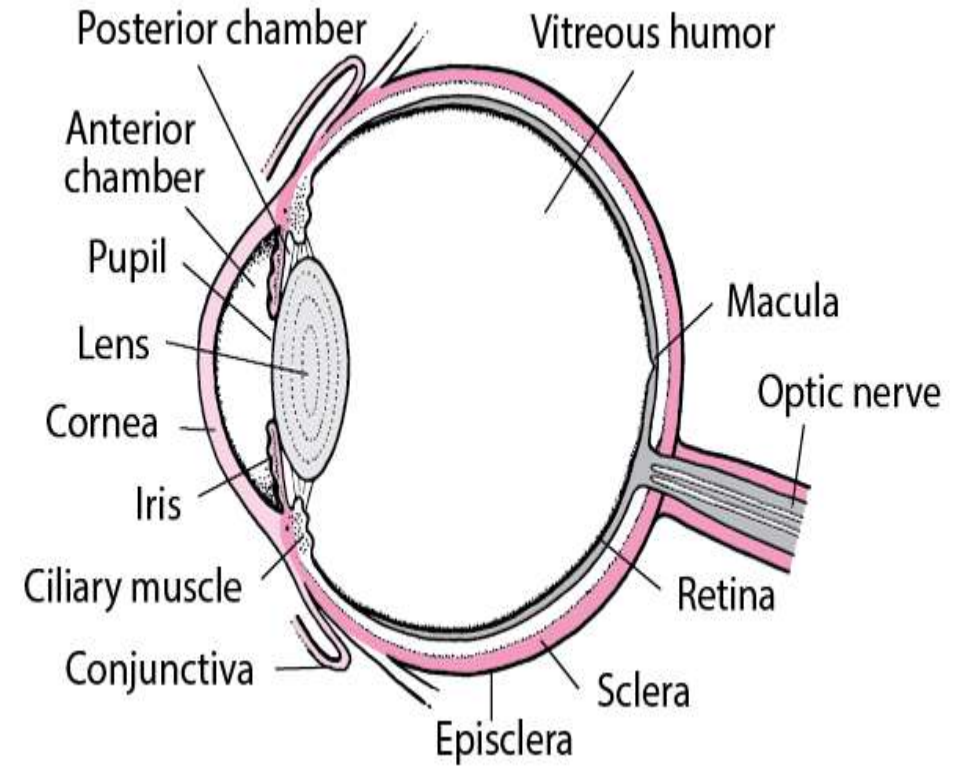
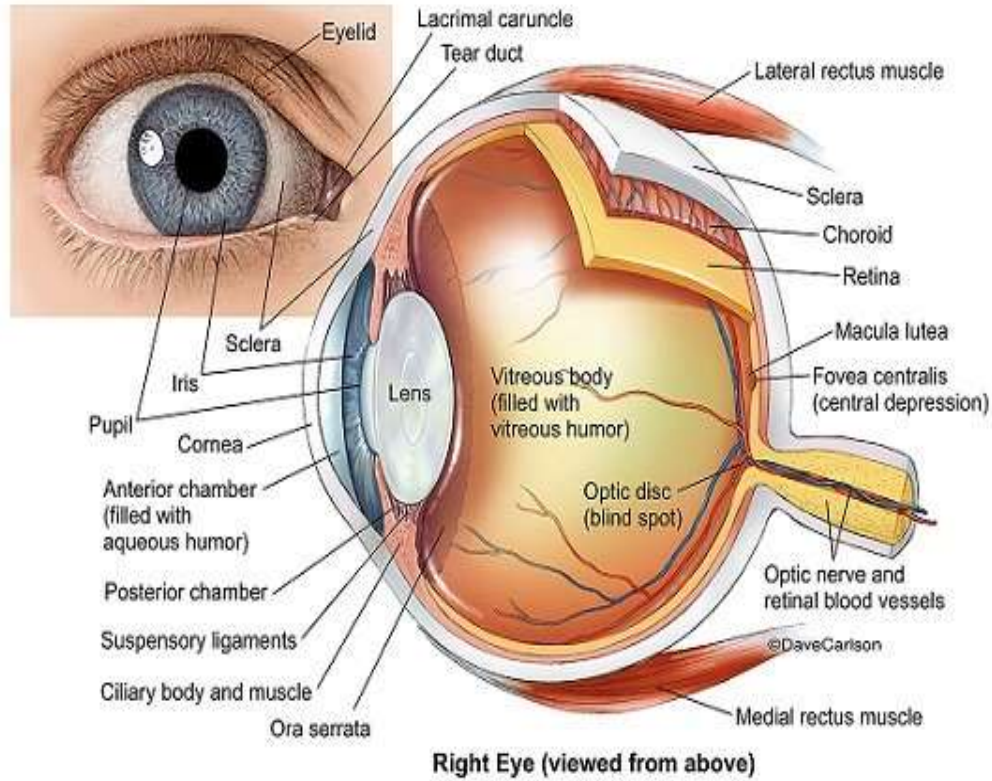
12. Extraocular Muscles العضلات البصريه

There are six extraocular muscles in each eye: 4 rectus muscles and 2 oblique muscles .

4 rectus are responsible for straight movements: Superior , Inferior , Lateral, and Medial .

2 oblique Muscles are responsible for angled movements.

Chapter 1- Eye Anatomy



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Chapter 2- Lacrimal system or apparatus الجهاز الدمعي

The lacrimal apparatus

Is the physiological system containing the structures for tear production and drainage, consists of the lacrimal glands, which secrete the tears, and the lacrimal sac and ducts, which convey the tears into the nasal cavity, it found in upper, outer part of each eye socket.

Structure of lacrimal apparatus

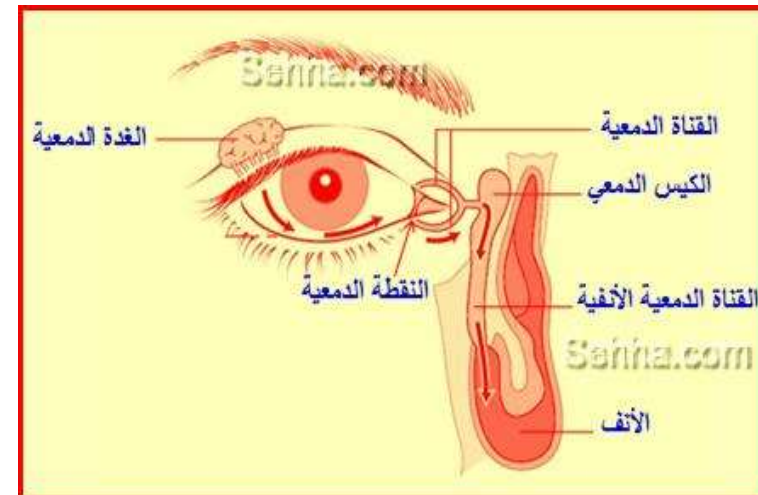
The **lacrimal apparatus** is consist of a set of connected anatomical structures include the following structures:

lacrimal gland الغدة الدمعية

lacrimal canaliculi قناة دمعية

lacrimal sac الكيس الدمعي

nasolacrimal duct قناة دمعية أنفيه



lacrimal glands

Chapter 2- Lacrimal system or apparatus

Is the tear-producing part of the **lacrimal apparatus**. The glands secrete the serous transparent fluid (السائل المصلي الشفاف) via its excretory ducts into the superior fornix قَبو العلوي, in the space between the eyeball and the eyelids جفون.

The tears drain into the **lacrimal canaliculi** that convey يوصل the tears to the **lacrimal sac** الكيس الدمعي, then fluid drains into the **nasolacrimal duct**, that opens into the nasal cavity .

If there is excess of tears, it drains via the nasolacrimal duct into the nasal cavity, thus causing what is called a runny nose.

Tear pathway: Lacrimal gland → LG excretory ducts → superior fornix → space between the eyeball and the eyelids → **lacrimal canaliculi** → **lacrimal sac** → **nasolacrimal duct** → nasal cavity

**As the aqueous fluid is secreted from serous and mucinous cells within the acini, myoepithelial cells are responsible for the expulsion of this fluid from the gland. The myoepithelial cells are organized around acini and ducts within the lacrimal gland and have a contractile response to neuronal stimulation.*

Chapter 2- Lacrimal system or apparatus

Control of tear secretion

The tear secretion of **lacrimal apparatus** are controlled by the autonomic nervous system , by both sympathetic fibers and the parasympathetic fibers .

The gland receives parasympathetic innervation via fibers that originate in the lacrimatory nucleus of the facial nerve in the pons. Sympathetic innervation of the lacrimal gland originates in the superior cervical ganglion.

Tears

Are a clear liquid secreted by the lacrimal glands in the eyes of all land mammals (except for goats and rabbits)lubricating the eyes.

Functions of Tears

- 1-Tear preventing dryness of eye, by coating the surface of the eye.
- 2-Tear supplying oxygen and nutrients to the surface of the eyes.
- 3-Preventing infections by washing the eye, and functions as a medium for removal of debris.
- 4-Tear contain a substance called lysozyme, which has an antibacterial action, that prevent invasion and infection by microbes.
- 4-Healing damage to the surface of the eye.
- 5-Creating a smooth surface on the eye by lubricate and smooth the surfaces of eyes.

Chapter 2- Lacrimal system or apparatus

Types of tears : There are three types of tears:

Basal tears, reflexive tears, and psychic tears.

1-Basal tears are produced to keep the eye lubricated and smooth.

2-Reflexive tears are produced in response to an acute irritant such as dust or dirt.

3-Psychic tears, are produced during strong emotional responses

Tear composition

Tears are made up of water, electrolytes, proteins, lipids, and mucins that form layers on the surface of eyes.

Lacrimal system blood supply

The arterial blood supply of the lacrimal gland is the lacrimal artery, a branch of the. ophthalmic artery الشريان العيني.

Venous blood returns from the lacrimal gland via the lacrimal vein, which feeds into the superior ophthalmic vein that traverses the cavernous sinus..يعبر الجيب الكهفي.

Clinical Significanceالأهمية السريرية

1-Dry Eye Syndrome (DES), is typically a multifactorial disease that results in improper tear film composition and symptoms of ocular discomfort.

2- Dacryoadenitis التهاب الغدد or inflammation of the lacrimal gland , is a common feature of the Epstein-Barr virus. Autoimmune dacryoadenitis is a common feature of sarcoidosis,

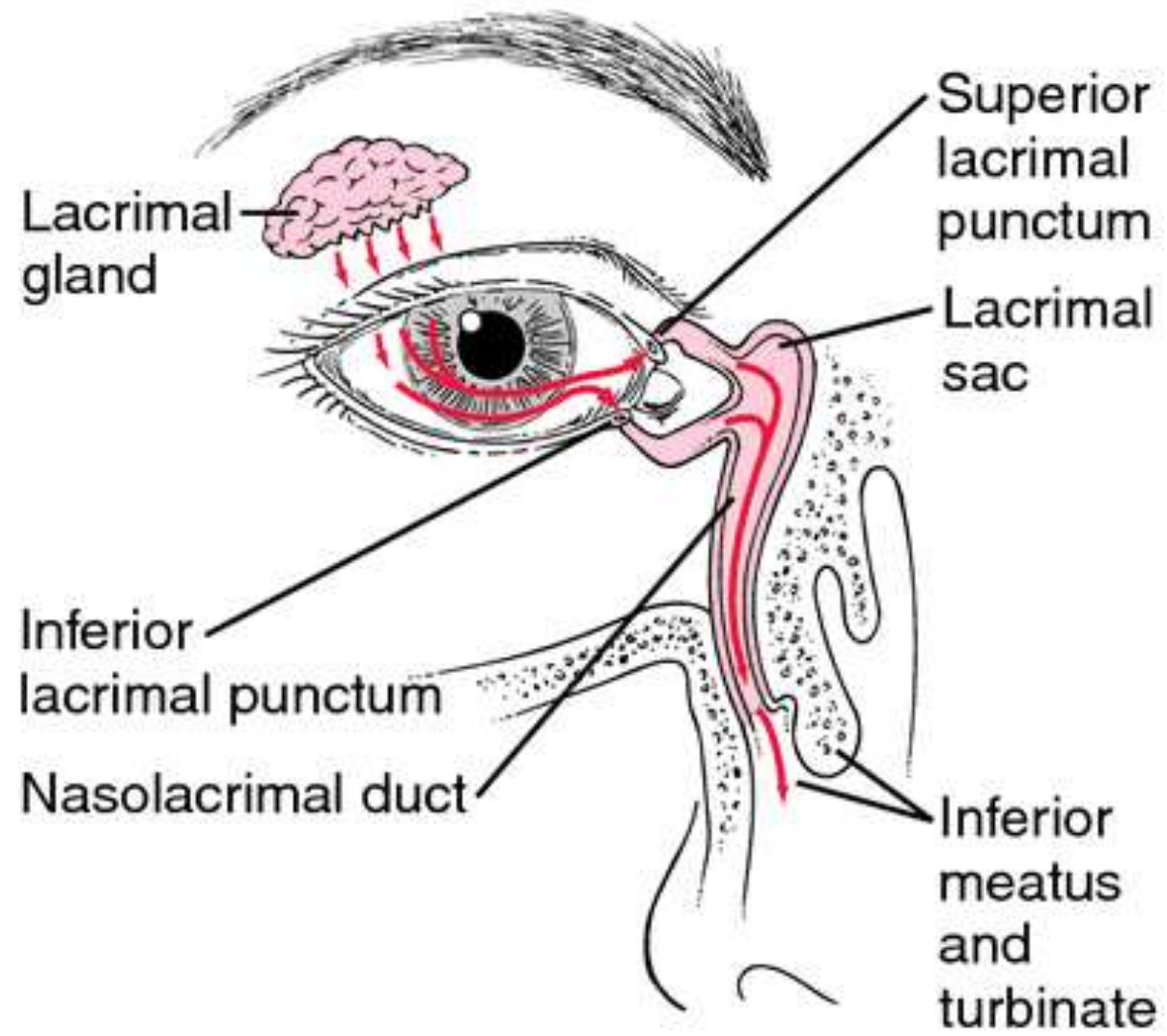
General questions for hand writing answer

Q1 Define lacrimal apparatus and writ its parts.

Q2 explain tear pathway and role of myoepithelial cells for the fluid expulsion.

Q3 Count types of tear and its secretion control.

Q4 count functions of tears.



ALNOOR UNIVERSITY 2023-2024 2nd Year Stage

Optic Technique Department

Eye Physiology- Theory

Chapter 3 - Cornea and Sclera anatomy

Objective : To learn the cornea and sclera constitute layers and the main purpose of this coat in protection of inside the eye.

Cornea and Sclera

Cornea and sclera constitute **the outer covering or coat of the eyeball**. The main purpose of this coat is to protect structures inside the eye.

The cornea

The cornea is a transparent avascular tissue that acts as a structural barrier and protects the eye against infections. Covers the pupil, iris and anterior chamber in the front of the eye .

Cornea structure

It consists primarily of water (78 percent) and collagen protein (16 percent). Collagen gives the cornea its strength, elasticity, and form. The collagen's unique shape, arrangement, and spacing are essential in producing the cornea's light-conducting transparency.

Cornea is actually a highly organized group of cells and proteins. Unlike most tissues in the body, the cornea contains no blood vessels to nourish or protect it against infection. Instead, the cornea receives its nourishment from the tears and aqueous humor that fills the chamber behind it. The cornea must remain transparent to refract light properly, and the presence of even the tiniest blood vessels can interfere with this process. The cornea repair itself quickly from minor abrasions.

Chapter 3 - Cornea and Sclera anatomy

Cornea Function

The cornea's main function is responsible for focusing most of the light that enters the eye on the retina.

Cornea innervation

The cornea is sensitive tissues, it is densely innervated with sensory nerve fibers via the ophthalmic البصري division of the trigeminal nerve للعصب ثلاثي التوائم. The cornea nerve endings are sensitive to touch, temperature and chemicals; for example a touch of the cornea causes an involuntary reflex to close the eyelid.

Cornea transparency

The epithelium and endothelium layers of cornea play important roles in maintaining corneal transparency by serving as a mechanical barrier to fluid diffusion and by creating a gradient that allows osmotic transport of water out of the stroma .

Chapter 3 - Cornea and Sclera anatomy

Layers of cornea

The cornea is comprised of five layers: the epithelium, bowman's layer, the stroma, descemet's membrane, and the endothelium.

1. **Epithelium Layer:** Is the surface layer . They provide barrier function and a smooth surface for the tear film.

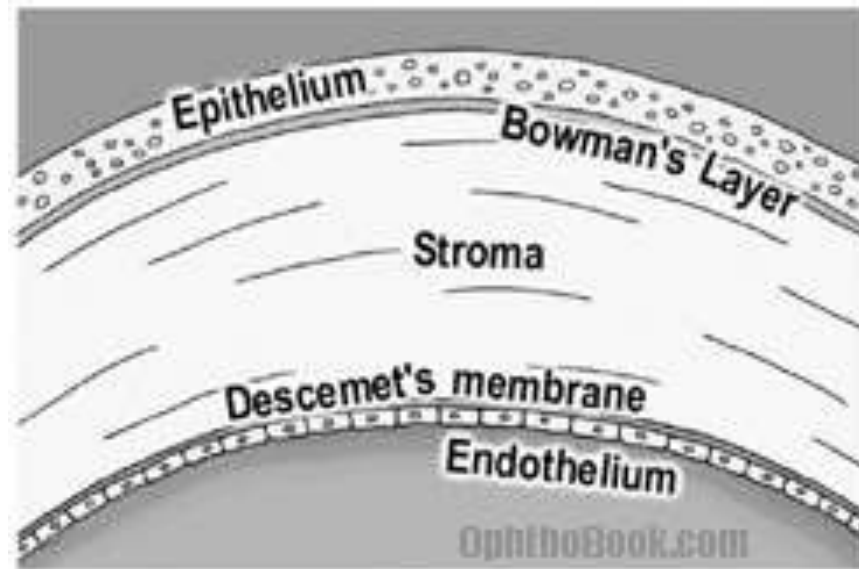
It absorbs nutrients and oxygen from tears and conveys it to the cornea.

2. **Bowmans Layer:** A tough layer under the epithelium, is composed of collagen, its function is keeps the cornea from swelling forward.

3. **Stroma layer:** Is a thick, transparent middle layer, composed of collagen fibers, it provides the majority of the cornea.

4. **Descemet's Layer:** A thin a cellular inner layer , it is important for the health of endothelial cells.

5. **Endothelium:** Most inner layer , it works as a barrier and a pump that keeps the cornea from getting too wet تصبغ مبتلة جد



Chapter 3 - Cornea and Sclera anatomy

Corneal epithelial wound healing التئام الجروح الظهارية القرنية

The adult corneal epithelium is maintained homeostatically by coordinated migration , proliferation , differentiation, stratification.

Impairment of this process results in persistent corneal defect, leading to the blindness of epithelial cells.

Corneal disease

There are many types of corneal disease.

- 1- Corneal abrasion : A condition involving the loss of the surface epithelial layer of the eye's cornea.
- 2-Corneal dystrophy : A condition in which one or more parts of the cornea lose their normal clarity.
- 3-Corneal ulcer :An inflammatory or infective condition of the cornea involving.
- 4-Corneal neovascularization :Is excessive ingrowth of blood vessels toward the cornea.
- 5-Fuchs' dystrophy: Is cloudy morning vision.

Chapter 3 - Cornea and Sclera anatomy

The sclera

The sclera is the dense connective tissue of the eyeball that forms the "white" of the eye, is the opaque, protective, outer layer of the human eye containing mainly collagen and some elastic fiber.

A clear thin layer called the conjunctiva covers the sclera. At the very front of the eye is a clear surface, like a window, called the cornea .

The sclera is relatively inactive metabolically and has only a limited blood supply.

Sclera Function

1-The sclera, along with the intraocular pressure (IOP), maintains the shape of the eyeball.

2- It protects the eye and supporting wall of the eyeball.

Anatomy of the sclera

The sclera is made of tough collagen fibers, which crisscross **متقاطع** in random directions. That random pattern gives eyeball its white color and gives the sclera strength.

The sclera has four layers, from the outside to the inside:

- **Episclera**, clear, thin tissue resting on top of the whites of eyeballs.
- **Stroma**, made up of fibroblasts and collagen fibers, blending into the episclera.
- **Lamina fusca**, a transitional layer between the sclera and the choroid and ciliary body outer layers.
- **Endothelium**, the basal, or innermost layer of the sclera.

Chapter 3 - Cornea and Sclera anatomy

Sclera health problems

1-Scleral icterus (yellow eyes) اليرقان: This condition is a yellowing of the white of the eye. It is associated with hepatitis and other liver disease.

2-Blue sclera: Is caused by a thinning of the sclera , which allows the color of the underlying choroidal tissue to show through it.

3-Episcleritis: This is inflammation of the episclera that lies atop the sclera and under the conjunctiva.

4-Scleritis. This is inflammation of both the episclera and the underlying sclera itself.

QUESTIONS

Q1 Explain Cornea structure and functions

Q2 Count and define Layers of cornea

Q3 Count and define Corneal disease

Q4 Count Sclera Functions and its health problems

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Optic Technique Department

Eye Physiology - Theory

Chapter 4- Eye chambers -Aqueous humor and I.O.P

Objective : To learn eye chambers and fluids and their balances and measurement of IOP.

The chambers of the eye

Eye is divided into 3 chambers – the anterior chamber, the posterior chamber and the vitreous chamber.

- The anterior chamber is the space between cornea and iris.
- The posterior chamber is the space between iris and the lens.
- The vitreous chamber is space between the lens and retinae , filled with vitreous humor.

Both the anterior and posterior chambers are filled with aqueous humor.

Aqueous humor

The aqueous humor is a thin, transparent fluid similar to plasma, it's made up of 99.9% water – the other 0.1% consists of sugars, vitamins, proteins and other nutrients.

The role of aqueous humor

The aqueous humor plays an essential role in the health of eye by:

- 1-Maintain intraocular pressure.
- 2-Nourishing cornea and lens by supplying nutrition.
- 3-Removing wastes from the cornea and lens.

Chapter 4- Eye chambers -Aqueous humor and I.O.P

Aqueous humor production and exits

Is produced by the epithelium of the ciliary body. It is secreted into the posterior chamber, from which it **flows** through the pupil to enter the anterior chamber.

Aqueous humor exits يخرج من from the anterior chamber via many routes.

Aqueous humor works

The aqueous humor is continuously produced by the epithelium of the ciliary body. It is secreted into the posterior chamber, from which it flows through the pupil to enter the anterior chamber. The aqueous humor is drained into the canal of Schlemm, which is a venous sinus found near the limbus. The production must be balanced by drainage at an equal rate. Even small variations in the production or outflow of the aqueous humor has significant impact on eye intraocular pressure.

When the intraocular pressure is increased, it can lead to glaucoma, a major cause of vision loss.

The formation and chemical composition of aqueous humor is accomplished via three processes - **diffusion, ultrafiltration, and active secretion by the ciliary processes** -

Chapter 4- Eye chambers -Aqueous humor and I.O.P

Intraocular pressure (IOP)

IOP is a pressure exerted by the aqueous humor on the internal surface area of the anterior eye. Normal eye pressure ranges from 12-21 mm Hg, and eye pressure of greater than 21 mm Hg is considered higher than normal. When that pressure is higher than normal, it causes ocular hypertension. Low eye pressure is uncommon and usually occurs when there are complications during eye surgery. When IOP is below 5 mm Hg, it's called ocular hypotony.

The IOP can be theoretically determined by the Goldman equation, which is :

$IOP = (F/C) + P$, where F represents aqueous flow rate,

C represents aqueous outflow,

P is the episcleral venous pressure.

A change or fluctuation in any of these variables will inevitably alter the IOP.

IOP regulation & measurement

Intraocular pressure regulation and maintains is by a complex homeostatic mechanism. The sympathetic nervous system directly influences the secretion of aqueous and regulation of IOP.

Intraocular pressure is traditionally measured by applanation tonometry طريق قياس الضغط بالتجانس, which gives an estimate of the pressure inside the anterior eye chamber. Pressures of between 11 and 21 mmHg are considered normal, and diurnal variance of IOP is expected, with higher pressures typically found in the morning.

Chapter 4- Eye chambers -Aqueous humor and I.O.P

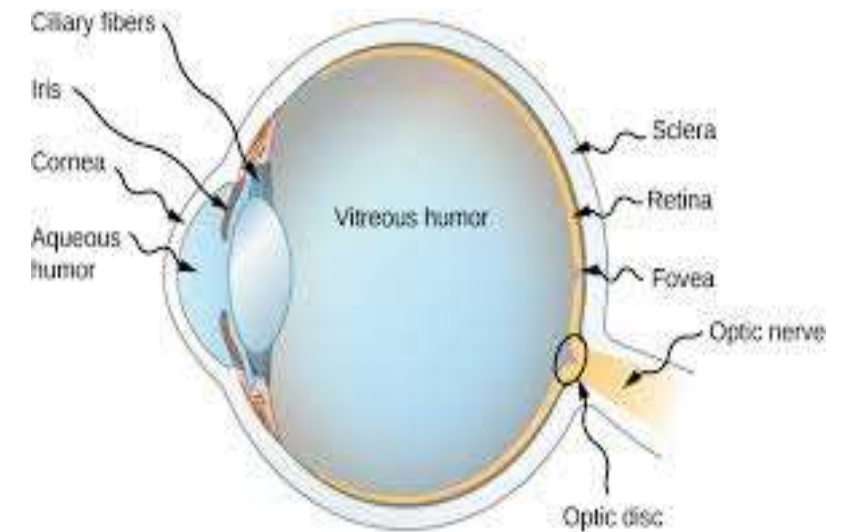
Vitreous humor

Vitreous humor is the fluid-like gel, composed of approximately 98–99% water with trace amounts of hyaluronic acid, glucose, anions, cations, ions, and collagen. The vitreous humor's main role is to maintain the round shape of the eye, which plays an important role in overall eye health. The size and shape of the vitreous humor also ensures that it remains attached to the retina.

Difference between aqueous and vitreous humor

1- Aqueous humor - is clear, watery fluid between the cornea and the front of the vitreous . vitreous humor is gelatinous fluid , contain around 99 percent water and remaining one percent is collagen and hyaluronic acid.

2-The aqueous humor nourishes the lens and maintains pressure within the eye, vitreous humor absorb shocks to the eye and keeps the retina properly connected to the back wall of the eye.



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Eye Physiology- Theory

Chapter 5- The eye lens

Objective

In this chapter, students will learn the role of eye lens in focusing of image on retina and clear vision, and focusing disorders.

The lens

The lens is a transparent, biconvex structure enclosed **مغلف** in a transparent capsule. It is situated behind the iris and in front of the vitreous body and is encircled **محاط** by the ciliary processes.

The lens consists of the lens capsule, the lens epithelium, and the lens fibres. The lens capsule is the smooth, transparent outermost layer of the lens, while the lens fibres are long, thin, transparent cells that form the bulk of the lens. The lens epithelium lies between these two and is responsible for the stable functioning of the lens. The lens bends light and focuses it for the retina to create clear images of objects.

Chapter 5- The eye lens

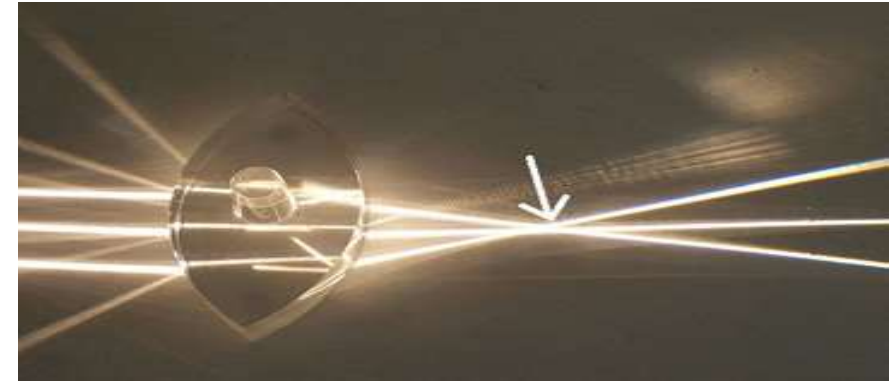
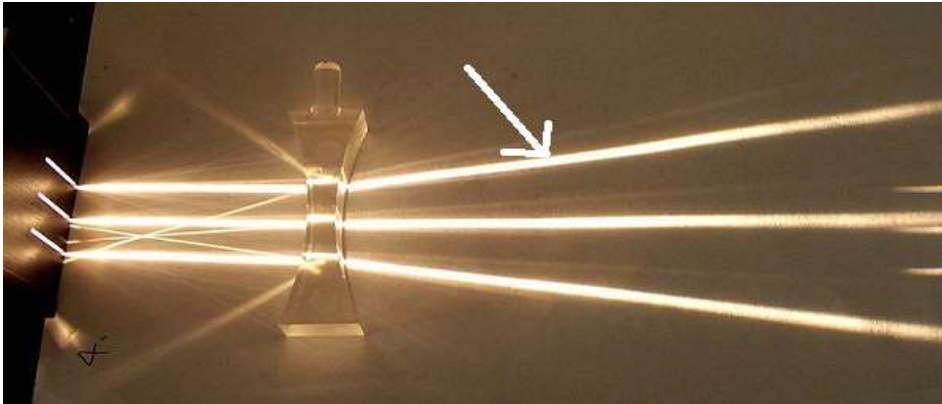
The shapes of the lens:

1-A concave lens العدسات المقعرة

A **concave** lens is thinner in the middle and thicker near the edges, and it causes light rays that pass through it to spread apart
تبعيد.

2-A convex lens العدسات المحدبة

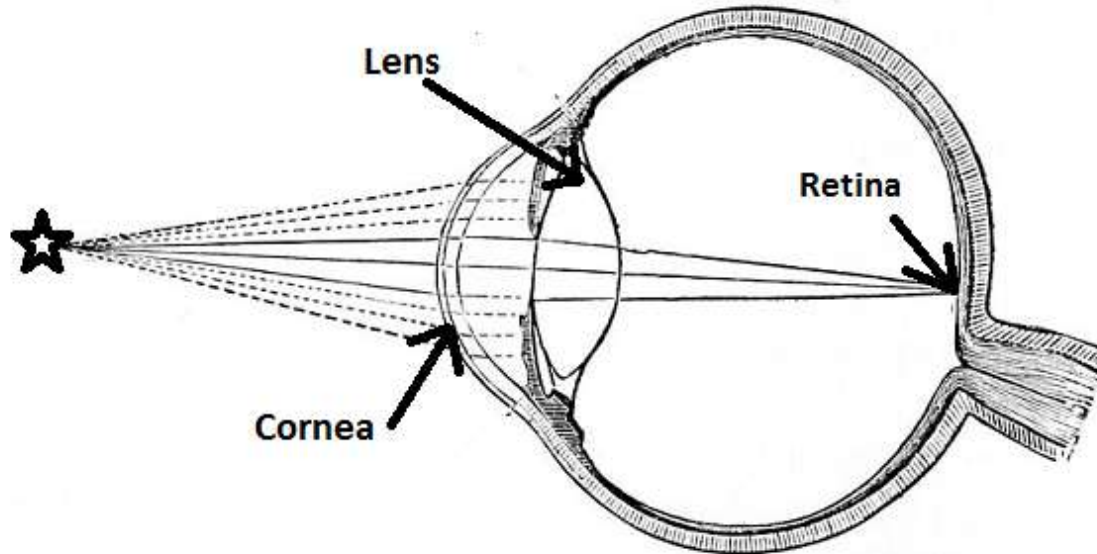
A **convex** lens is thicker in the middle and thinner near the edges, and it causes the light rays that pass through it to focus on closer point.



Chapter 5- The eye lens

Role of lens in images form in eye

The cornea and lens of an eye act together to form a real image on retina. The lens of the eye adjusts its power to produce an image on the retina for objects at different distances and focuses light rays onto the retina, by changing its shape, the lens changes the focal distance of the eye.



Chapter 5- The eye lens

Accommodation of the Lens **تكيف العدسة**

Accommodation is the adjustment of optical power of the eye lens to keep an object in focus on the retina as its distance from the eye varies to maintain a clear image. Accommodation process is achieved by changing the lens its shape. Accommodation is controlled by muscles connected to the lens, called **ciliary muscles**. The ciliary muscles work automatically without conscious control. The ciliary muscles can contract and increase the curvature of the lens so that the lens thickens.

The accommodation reflex

Is a reflex action of the eye, in response to focusing on a near, and a distant object at a time, by coordinated changes in lens shape and pupil size. The normal pupil size in adults varies from 2 to 4 mm in diameter in bright light to 4 to 8 mm in the dark..

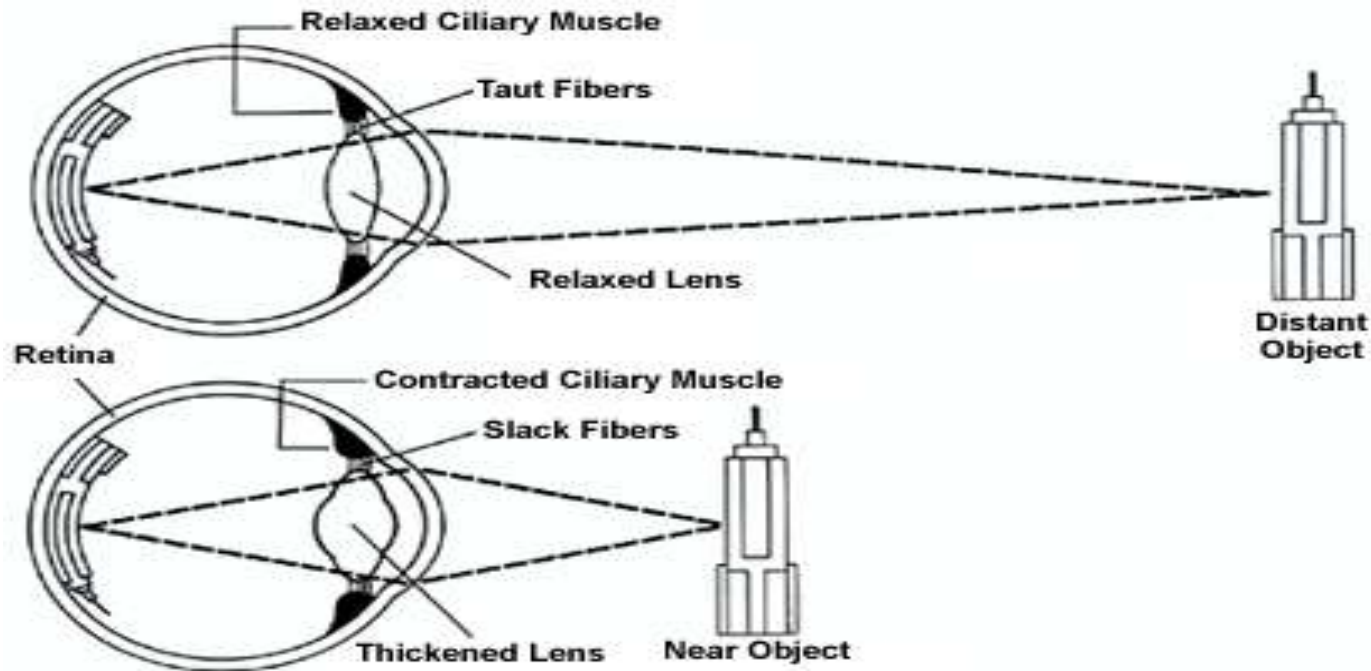
The ciliary muscles are control the lens tighten and relax **الشد والارتخاء**, changing lens shape to help refract light properly.

Power of accommodation is the ability of the eye lens to focus near and far objects clearly on the retina by adjusting its focal length.

How lens shape changes

Chapter 5- The eye lens

The eye lens is held in place by tiny ligaments connected to the **ciliary muscles**, these muscles control the level of tension مقدار الشد in the ligaments and therefore control the shape of the lens. When the eye focus on distance object, **ciliary muscles** is relaxed, causes the lens to be slightly flattened. When the eye focuses on a nearby object , the ciliary muscles contract, cause the lens to become more spherical. As the lens changes shape, it causes the light that passes through it to focus at a different location.



Focusing Disorders of the Lens

Several possible problems that can prevent the lens from focusing properly, and this causes difficulty in focusing and blurry vision رؤية ضبابية.

1-Myopia قصر النظر(nearsightedness)

Is a condition of blurry appear of far away objects , myopia is caused when light focuses in front of the retina. It can be corrected by placing a concave lens(eyeglasses or contact lenses) in front of the eye that causes the light to focus on retina.

2-Hyperopia (farsightedness)

Hyperopia Is a condition of blurry appear of nearby objects, occurs when light from nearby objects focuses behind the retina . It is corrected by placing a convex lens in front of the eye to cause the light to begin to converge before it enters the eye.

3-Presbyopia طول النظر الشيخوخي

Is the irreversible loss of the accommodative ability للقدرة التكيفية of the eye due to aging.

4-Accommodation spasm التشنج التكيفي

Is a condition in which the ciliary muscle of the eye remains in a constant state of contraction, that results in an abnormally point of focus. It occurs when a person is under stress or when a person is reading for a long period of time.

Q1 Explain role of accommodation of the Lens in vision

Q2 How lens shape changes

Q3 Count and define focusing disorders of the Lens

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Eye Physiology -Theory

Chapter 6 - Binocular Vision and Stereopsis

الرؤية بالعينين والتجسيم

Objective : To learn the how information from both eyes form single image in the brain.

Binocular vision

Binocular vision (BV) is the ability to use both eyes together to creating a single visual image by visual fusion الاندماج البصري to achieve a single fused image. تحقيق

Visual Fusion

Is the unification of visual excitations from the corresponding retinal images into a single visual percept. توحيد الإشارات البصرية من الشبكية المقابلة في تصور مرئي واحد.

Advantages of a Binocular vision are:

The advantage of a binocular vision are :

The advantage of a binocular vision are :

1-Single vision.

2-It results in stereopsis.

3-Enlargement of the field of vision. مدى

Binocular vision role in depth perception

Each eye sees slightly different spatial information معلومات مكانية. The brain combines the two images with small differences into one, to make **vision**. The brain uses these small differences to determine distance and **depth** of the object , by this the **binocular vision results in depth perception** (إدراك عمق الاجسام) and 3-D image.

Chapter 6 - Binocular Vision and Stereopsis

Grades of Binocular Vision:

Grade I: (Sensory) Simultaneous perception الإدراك المتزامن. Perception 2 image from both eyes.

Grade II: (motor) fusion الدمج fusion of 2 images from both eyes in one image.

Grade III: Stereopsis التجسيم perception of image depth .

Stereopsis

Stereopsis: is the ability to see three-dimension structure of an objects.

Basis of stereopsis

The basis of stereopsis is that both the eyes should be able to perceive images simultaneously and separately at any given time, and the brain should process and fuse the images from right and left eyes to see a complete object.

Singleness of vision (وحدانية الرؤية)

Mean that each eye , left and right eye's see image of the same object .

Monocular vision

Is vision in which both eyes are used separately in animals and monocular vision in human species is vision when only one eye is used. By using the eyes in this way the field of view is increased, while depth perception is limited.

Chapter 6 - Binocular Vision and Stereopsis

Monocular cues منظر أحادي and **binocular cues**

Monocular cues provide depth information when viewing a scene مشهد with one eye, while **Binocular cues** provide information taken when viewing a scene with both the eyes.

Quantification of stereopsis القياس الكمي للتجسيم

Is quantified by a unit known as seconds of arc ثواني القوس يتم قياسها بوحدة تعرف باسم ثواني القوس.

A circle, which consists of 360 degrees, each degree is divided into 60 minutes of arc, and each minute is divided into 60 seconds of arc. The seconds of arc represent an angle through which stereopsis is quantified and demonstrate the minute difference in depth one can perceive.

****Binocular Vision and Depth Perception***

Each eye sees slightly different spatial information and transmits these differences to the brain. The brain then uses the discrepancies between the two eyes to judge distance and depth. The result is the ability to see a 3-D image and distinguish the relationships between objects.

Chapter 6 - Binocular Vision and Stereopsis

Binocular Vision Problems : Are problems that the eyes can no longer focus on the same object.

1-Strabismus حول

Strabismus is a condition in which the eyes do not properly align with each other (لا يعملان بمحاذاة) when looking at an object.

Strabismus can be caused by problems with the eye muscles, or nerves that transmit information to the muscles, or the control center in the brain that directs eye movements

2-Amblyopia الغمش, or lazy eye العين الكسولة

Amblyopia, also called lazy eye, is a disorder of sight in which the brain fails to process inputs from one eye, it results in decreased vision in an eye.

3-Convergence Insufficiency (CI) قصور التقارب

Convergence insufficiency (CI) is an eye disorder where eyes don't move at the same time , one or both eyes move outward when look at a nearby object.

هو اضطراب في العين حيث لا تتحرك العينان في نفس الوقت ، تتحرك إحدى العينين أو كليهما إلى الخارج عند النظر إلى كائن قريب (CI) قصور التقارب

Treatments of binocular vision

Fortunately, most problems with binocular vision are easily treated through eyeglasses, vision therapy, or surgery.

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Optic Technique Department

Eye Physiology

Chapter 7 - Optics and refraction الابصار والانكسار

Objective

To learn the theoretical bases of the vision defects test, and modes of the corrections.

Refraction in eye انكسار

Is the process of bending light in the cornea and lens to focus on the retina to produce a focused image **صورة مركزة** in the retina . The eye normally creates a clear image because the cornea and lens bend (refract) incoming light rays to focus them on the retina. The shape of the cornea is fixed, but the lens changes shape to focus on objects at various distances from the eye. Most vision problems relates to problems of refract light in the eye.

Refraction in cornea and lens

The cornea and lens focus light on the retina; Most of the refraction in the eye takes place at cornea, is cause the largest change in index of refraction معامل الانكسار. About 80% of the refraction occurs in the cornea and about 20% in the lens. Cornea refracts light entering the eye onto the lens. Lens refracts incoming light and focuses it onto the retina

A refraction test

Is a vision test, to measurement the required power for a eyeglasses or contact lenses, to determine the need for corrective lenses.

A refraction test, involves looking through a device called a phoropter to determine best read for letters or recognize symbols on a wall chart through lenses of differing strength which are contained within the device, the test done to determine whether an individual has normal vision or require eyeglasses or contact lenses.

A refractive error خطأ انكساري

Refractive errors are a type of vision problem that makes it hard to see clearly. They happen when the shape of eye keeps light from focusing correctly on retina . Is non properly light bending when it passes through the lens of eye, the result of refractive errors is blurred vision. The common refractive errors can usually be corrected by relatively simple compensating lenses العدسات التعويضية.

Most common refractive errors :

1-[Nearsightedness \(myopia\)](#) makes far-away objects look blurry.

Is incorrectly light refraction in away the light is focused in front of the retina not on it , because the eyeball shape is too long, or the refractive power of the eye's lens too strong. Myopia can be corrected by concave lenses to correct the refraction index.

2-[Farsightedness \(hyperopia\)](#) makes nearby objects look blurry. Is incorrectly light refraction in away the light is focused behind the retina not on it ,this occurs when the eyeball is too short or the refractive power of the lens is too weak. Hyperopia can be corrected by convex lenses.

3-[Astigmatism](#) can make far-away and nearby objects look blurry or distorted. This defect is when the light rays do not all focus on a single focal point on the retina, but some focus on the retina and some focus in front of or behind it. This is usually caused by a non-uniform curvature of the cornea. Astigmatism can usually be corrected by using a special spherical cylindrical lens.

4-**Presbyopia** makes it hard for middle-aged and older adults to see things up close. Presbyopia is loss of eye ability to change shape caused by a hardening of the lens of eye, which occurs with aging, leading to incorrect light refraction .

5-Cataracts: إعتام عدسة العين

A cataract is loss of the eye lens transparency causing incorrect light pass and refraction.

6-Age-related macular degeneration (ARMD) الضمور البقعي

This is a degenerative condition of the macula البقعة (the central retina). It is caused by the hardening of the arteries that nourish the retina.

7-Glaucoma: الزرق

Glaucoma is a disease caused by increased intraocular pressure (IOP), usually resulting from a malfunction in the eye's drainage system. Increased IOP can cause irreversible damage to the optic nerve .

Calculation of the refractive power of the eye

Dioptr is a unit of measurement of the optical power of a lens or curved mirror, which is equal to the reciprocal of the focal length الطول البؤري measured in meters. (1 dioptr = 1 m⁻¹.) . **D = 1/f**, where D is the power in dioptr and f is the focal length in meters. Lens surface power can be found with the index of refraction and radius of curvature نصف قطر انحناء.

Power of a lens is its ability to converge or diverge the rays of light falling on it. Power of a lens is equal to reciprocal of the focal length of the lens. SI unit of power is dioptr (D).

Question

The focal length of a lens is 50 cm. Calculate the power of that lens. Write the type of this lens.

Focal length, f=50cm

Power, P=100 /f = 100/50

P=2D

Total corneal refractive power (TCRP) This value is **calculated by the actual refractive index of air (1), cornea (1.376) and aqueous humor (1.336)** using Snell's law without relying on any prior assumptions. دون الاعتماد على أي افتراضات مسبقة

The total refractive power of the eye is about 63 dioptr. The largest part of about 43 dioptr is contributed by the cornea and the smaller amount, about 23 dioptr, by the lens. The axial eye length of the normal eye is about 23.5 mm.

Causes of refractive errors

Refractive errors can be caused by:

- Eyeball length (when the eyeball grows too long or too short)
- Problems with the shape of the cornea (the clear outer layer of the eye)
- Aging of the lens (an inner part of the eye that is normally clear and helps the eye focus)

Refractory test significance

The results of the refractory test used to diagnose the abnormal vision conditions: as [Astigmatism](#), Hyperopia, [Myopia](#), [Presbyopia](#), [Macular degeneration](#), [retinal vessel occlusion](#), retinitis pigmentosa.

Treatment for refractive errors

Glasses. Eyeglasses are the simplest and safest way to correct refractive errors.

Contacts. Contact lenses sit on the surface of eyes and correct refractive errors.

Surgery. Some types of surgery, like laser eye surgery, can change the shape of cornea to fix refractive errors.

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2023-2024 2nd Year Stage

Optic Technique Department

Eye Physiology

https://www.youtube.com/watch?v=Kp_2GRrl-Ag

Chapter 8-Eye retina anatomy and physiology

Objective

To learn the histological and cellular anatomy of retina , and processes of light by retinal light sensitive cells , and nerve impulse conduction from retina to brain.

Definition of the retina

The retina is a light-sensitive nerve layer cells lining the inner surface of the eye back, senses light, and convert light signals to electrical signals.

Function of retina

The retina receive light signals from objects , convert the light signals into neural signals, and send these signals through optic nerve to the brain for visual recognition.

Mechanism of retina function

The retina processes light focused on it, through a layer of light-sensitive photoreceptor cells, which are responsible for detecting color and light-intensity. The retina processes the information gathered by the photoreceptor cells and sends this information to the brain via the optic nerve.

Structure of the retina : The retina is divided into following parts:

1-Macula

Is oval yellow spot near the center part of the retina, it contains numerous cones photoreceptors, processes sharp, clear vision , responsible for detailed central vision.

2-Fovea

A tiny central pit located in the macula, composed of closely packed cones that provides the clearest and sharpest image vision , which is necessary in humans for activities, such as reading and driving.

3-Parafovea or the parafoveal belt Is a region in the retina that circumscribes تحدد the fovea and is part of the macula.

4-Purkinje tree

Is pattern of tiny blood vessels branches out from the optic disk (blind spot) where the blood supply comes in and goes out over the surface of the retina and provide it with blood supply.

5-Optic disc

Is the point of exit for ganglion cell axons leaving the eye.

6- Photoreceptors (light sensitive cells)

Are light sensitive cells , which are of two types of Photoreceptors(rods and cones).

a-Rods

Are rod shape photoreceptors , are sensitive to low light levels and supports the vision during dim اخافت light or at night. Rods are, found at peripheral part of retina.

Rods contain a pigment known as rhodopsin or visual purple. Rhodopsin is a purplish pigment, which is rich in vitamin A., this pigment is responsible for the night vision. Rods number are about 120 million cells in each eye.

B-Cones

Are the cone-shaped photoreceptor cells, are found in the center of the retina. Are sensitive to bright light and detect color ,are responsible for the day vision. But the main feature of the cones is that it enhances in distinguishing the different colors. Cones contain a pigment known as iodopsin or violet vision. Iodopsin is photosensitive violet pigment is formed from vitamin A, and is important in daylight vision.

On the basis of color vision, cones are of three types; red, blue and green.

Cones number are about approximately 6 million cone cells in each eye.

Similarities between rods and cones

- 1-Rods and cones are the photoreceptors cells of an eye.
- 2-Both absorb light (photons) at a different wavelength.
- 3-The process of phototransduction is same in both the cells.

Differences Between Rods and Cones

- 1-Rods have rod-like structure, large in number and provide dim light vision, cones are of the cone shape, fewer in number and provides the vision in the day or bright light.
- 2-Rods are found around the boundary of the retina , cones are there in the center of the retina.
- 3- Rods contain rhodopsin pigment, cones contain iodopsin pigment.
- 4- Rods cells do not give color vision, cones provide color vision

Cellular layers of retina : Retina of eye has three layers of cells, these layers are then connected through two intermediate layers of: horizontal cells and amacrine cells .

1-Ganglion cells

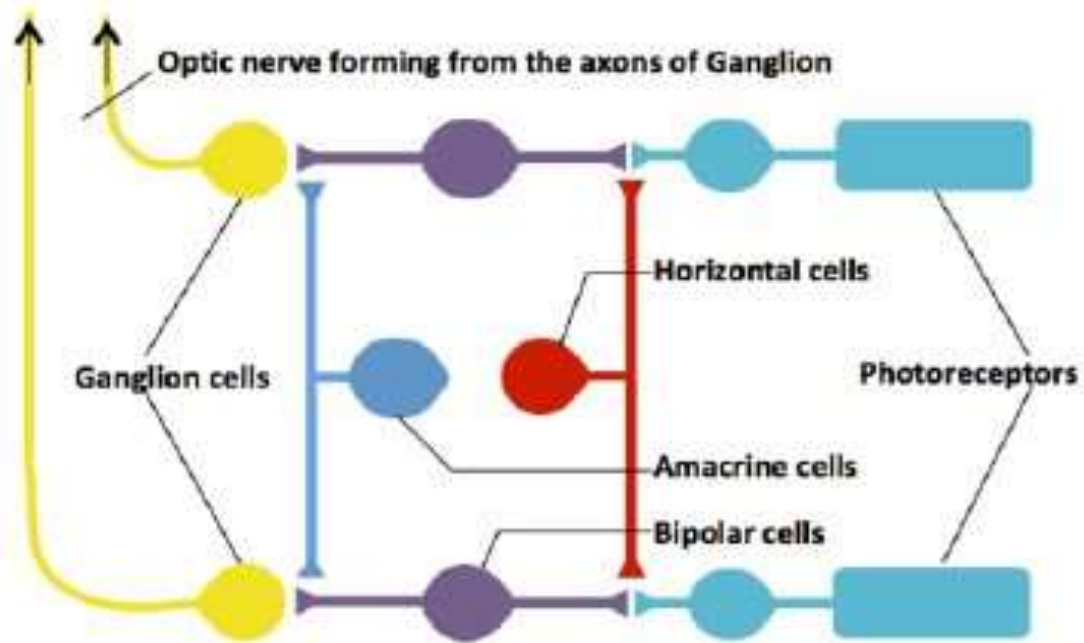
These are outer cell layer and form the optic nerve that carries visual information to the brain. These cells take information from bipolar cells.

2-Bipolar cells

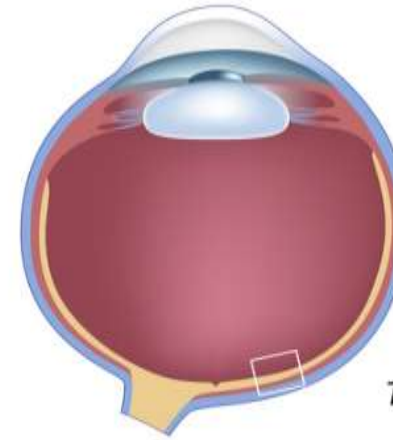
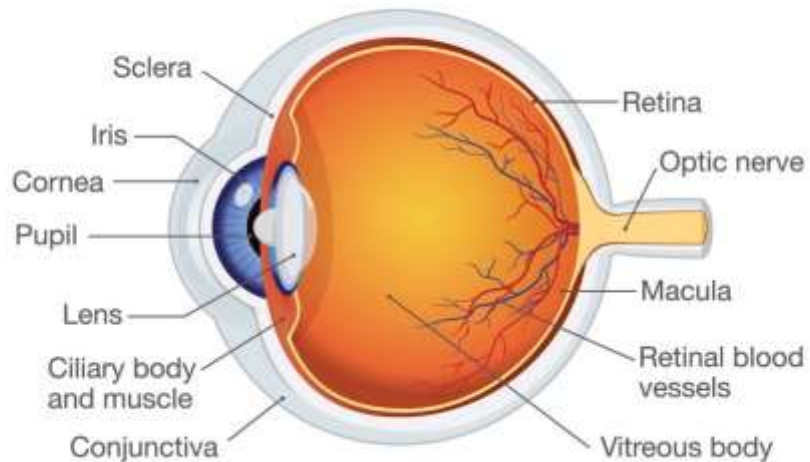
These cells are present next to ganglion cells and take information from photoreceptor cells.

3-Photoreceptor cells

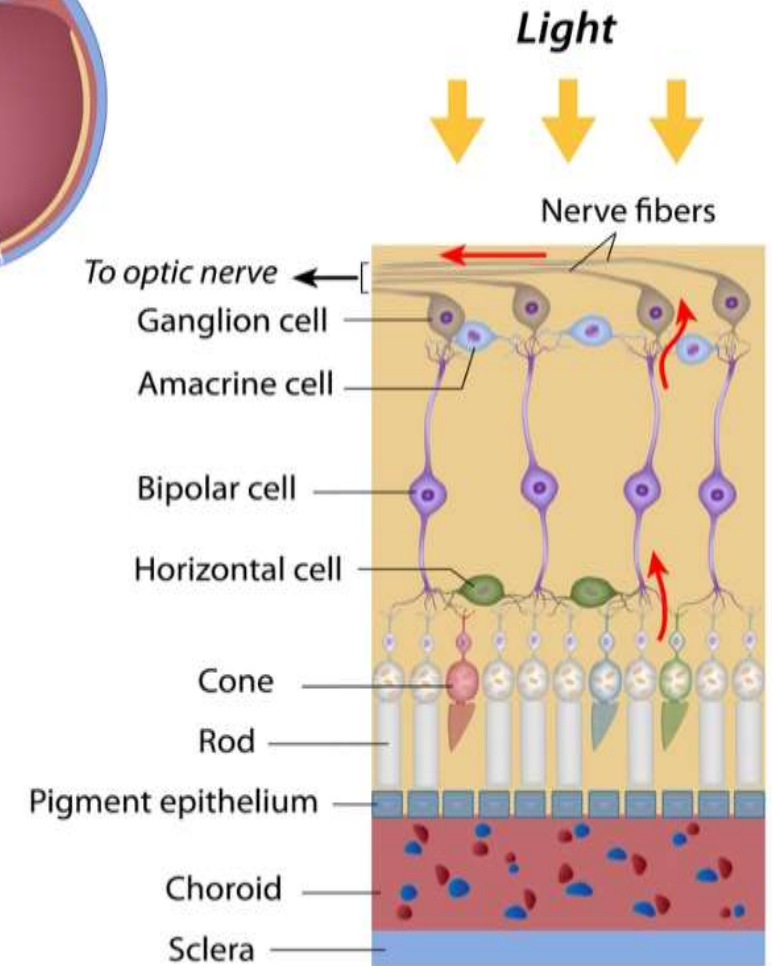
These are present next to bipolar cells and detect the light vision.



Human Eye Anatomy



Structure of the Retina



Retinal vascularization

The retina is supplied with blood through the central retinal artery (CRA) and the posterior ciliary arteries. The central retinal artery, runs along the optic nerve, entering the optic disc. The retinal artery deliver blood which is rich in oxygen to the cells of retina. The vein leave the retinae is called the central retinal vein.

Retinal neovascularization

Is a pathologic state of a new vessels originate from the existing retinal veins and extend along the inner surface of the retina.

Damage to the retina

Damage to retina can lead to permanent vision loss and even blindness. Common retinal damage conditions include:

1-Retinal detachment – This occurs when the retina is detach from the back of the eye and results in loss of vision and need surgery to adhere **ألصق** the retina back to the eye.

2-Vitamin A deficiency – Vitamin A assists in the development of photopigments, which is critical for the photoreceptors in eyes. A deficiency leads to visual degradation **تدهور** over time.

3-Retinitis pigmentosa **التهاب الشبكيه الصباغي** – This is an inherited disorder where a person is unable to keep **احتفاظ** photoreceptor cells over time. This leads to difficulty seeing at night and a loss of peripheral vision **الرؤيه المحيطيه** over time.

4-Macular degeneration **الضمور البقعي** – This is the leading cause of blindness in aging.

5-Diabetic retinopathy – Diabetes damages the retina by damaging the blood vessels that supply blood to the eye.

Protection of the retina

1-Maintain a healthy diet – Vitamin A, C and E, as well as mineral zinc.

2-Strengthen of eyes – by everyday eye exercises by move eyes up, down, and side to side with blinks in between each movement.

3-Don't look directly into bright lights, lasers or beams, and wear protective gear when in hazardous areas.

4-Take time to relax – 10 minutes each day to close eyes and take time for yourself.

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Eye Physiology

Chapter 9- Eye muscles and movements

Objective : To learn types of muscles responsible for eye movements , and to learn how the eye enabled moving upward, downward and for left and right sides , and the mechanism of eye movements controlling.

Eye muscles

There are 2 groups of the muscles responsible for the eye movements, which are extrinsic or extraocular located outside of the eye ball , and intrinsic or intraocular muscles located inside eye ball, extraocular muscles control eye movements, the intraocular muscles control the lens and pupil movements.

1- Extrinsic or extraocular muscles

Are six muscles, 4 straight or rectus & مستقيمة 2 oblique مائلة muscles, attached to the eye ball and the wall of orbital cavity :

1. Superior and Inferior Rectus Muscles, عضلات المستقيمة العليا والدنيا
2. Lateral and Medial Rectus Muscles, عضلات المستقيمة الجانبيه و الوسطيه
3. Superior and Inferior Oblique Muscle. عضلات مائلة

The Rectus muscles are responsible for the movement of the eyeballs in the four cardinal directions لاتجاهات الأربعة الأساسية : up, down, left , right .

Movements extraocular muscles

Lateral rectus - rotates the eyeball outwards للخارج

Medial rectus - rotates the eyeball inwards الداخل

Superior rectus - rotates the eyeball upwards لأعلى

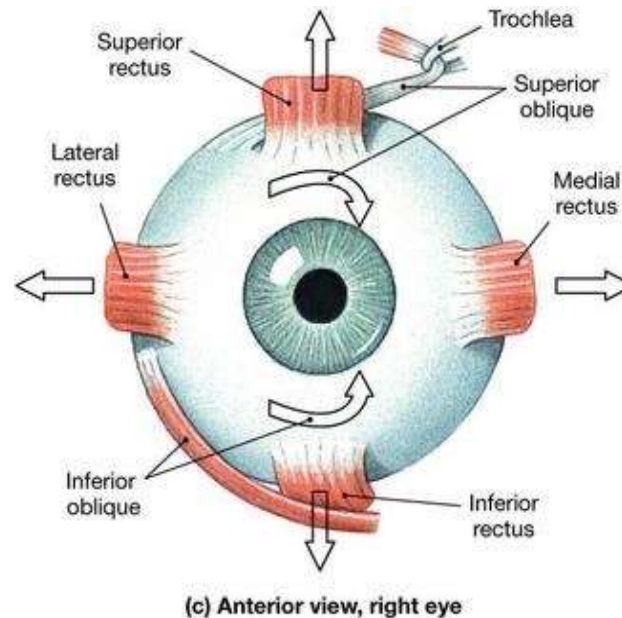
Inferior rectus - rotates the eyeball downwards لأسفل

Inferior oblique - rotates the eyeball upwards and outwards .

Superior oblique - rotates the eyeball downwards and outwards.

The four rectus muscles of the eye control the movement of the eye in the cardinal directions. They work against each other to control the movements of the eye in various directions.

The two oblique muscles of the eye are responsible for the rotation of the eye and controlling the adjustments التعديلات involved in counteracting head movements, مواجهة حركات الرأس



2- Intrinsic or intraocular muscles

Are 2 types of muscles , which are ciliary muscle and iris muscles .

a-Ciliary

Are non-striated muscle, attached through the suspensory ligament الرباط المعلق to the lens capsule, its function is changes the thickness of the lens for accommodation function

b-Iris

Iris has non-striated muscle fibers which constrict and dilate the pupil and regulate the amount of light entering the eye.

Eye muscles innervation

The muscles are supplied by the oculomotor nerve العصب الحركي العيني, with the exception of the superior oblique, which is supplied by the trochlear nerve الوحشي, and the lateral rectus, supplied by the abducens nerve عصب المجهد.

Eye movements

Includes the voluntary and involuntary movements of the eyes, helping in acquiring, fixating and tracking visual stimuli اكتساب وتحديد وتتبع المنبهات البصرية.

Types of eye movements

There are two main kinds of movement: conjugate movement (the eyes move in the same direction) and disjunctive (opposite directions).

1-Conjugate eye movement حركة العين المترافقة

Refers to motor coordination of the eyes that allows for bilateral fixation on a single object.

2 -A vergence movement حركة التقارب

Is the simultaneous movement of both eyes in opposite directions to obtain or maintain single binocular vision.

Control of eye movements

For each eye, six muscles work together to control eye position and movement.

The four cranial nerves involved in vision and movement of the eyes are the optic (I) nerve, oculomotor (III) nerve لعصب, trochlear (IV) nerve العصب البوقي and the abducens (VI) nerve العصب المبعد.
المحرك للعين

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Optic Technique Department

Eye Physiology

Chapter 10- pupillary light reflex

Objective: To learn how the eye control the clear vision for objects at different distances in responses to autonomic reflexes

pupillary light reflex(PLR)or photopupillary reflex منعكس الحدقة الضوئية The pupillary light reflex (PLR) or photopupillary reflex is a reflex that controls the diameter of the pupil, in response to the intensity of light, assisting in adaptation of vision to various levels of lightness and darkness.

The pupillary light reflex pathway

The pupillary light reflex is an autonomic reflex that constricts the pupil in response to light, thereby adjusting the amount of light that reaches the retina. Pupillary constriction occurs via innervation of the iris sphincter muscle, which is controlled by the parasympathetic system .

***Pathway:** *Afferent pupillary fibers start at the retinal ganglion cell layer and then travel through the optic nerve, optic chiasm, and optic tract,, and travel to the midbrain, which sends fibers bilaterally to the efferent Edinger-Westphal nuclei of the oculomotor complex. From the E-W nucleus, efferent pupillary parasympathetic preganglionic fibers travel on the oculomotor nerve to synapse in the ciliary ganglion, which sends parasympathetic postganglionic axons in the short ciliary nerve to innervate the iris sphincter smooth muscle via M3 muscarinic receptors. Due to innervation of the bilateral E-W nuclei, a direct and consensual pupillary response is produced.*

In bright light

Bright light causes the pupil diameter to constrict in response to the relaxation of the iris sphincter muscle **العاصرة القرنية** that controlled by parasympathetic nervous system thereby allowing less light in.

In low light

In low intensity of light the pupil to dilate in response of the iris dilator **موسع القرنية** muscle contraction that controlled by the sympathetic nervous system thereby allowing more light in.

Pupillary Reflex Pathways controlling

The pupil size is under autonomic control in response to light levels hitting the retina. The sympathetic system will dilate the pupil when the retina is not receiving enough light, and the parasympathetic system will constrict the pupil when too much light hits the retina.

Accommodation reflex (accommodation-convergence reflex)

The accommodation reflex is an automatic coordinated change that occurs in the eyes when focus on object that's far away to one that's closer.

Accommodation reflex responses

The accommodation reflex involves three responses:

1-convergence of the eyes تقارب العيون

2-pupillary constriction

3-lens accommodation

1-Convergence of eyes

Is the simultaneous movement of both eyes inward when viewing a near object. Convergence of the eyes keeps the image of the object centered on the fovea, the part of the retina where visual acuity is highest.

2-Pupillary Constriction

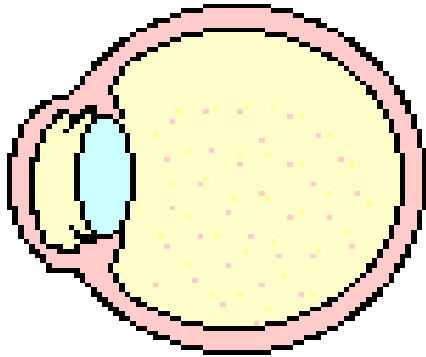
The Pupillary Constriction prevents diverging انشعب light rays from hitting the periphery of the retina and causing a blurred image. When the pupil constricts it allows light to focus on the fovea of the retina for clear vision.

3-Lens Accommodation

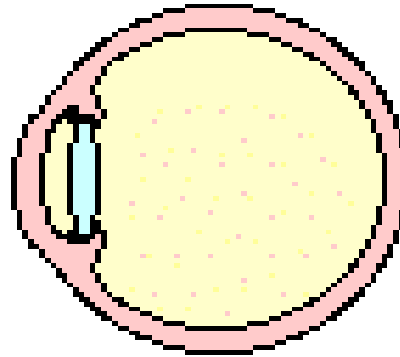
Lens accommodation is the process by which the eye changes its optical power for the adjustment of the optics of the eye to keep an object in focus on the retina as its distance from the eye varies. It is the process of adjusting the focal length of a lens.

Lens accommodation increases the curvature of the lens to increase its refractive (focusing) power. The ciliary muscles control the convexity of the lens shape in response to the distance of the object being viewed.

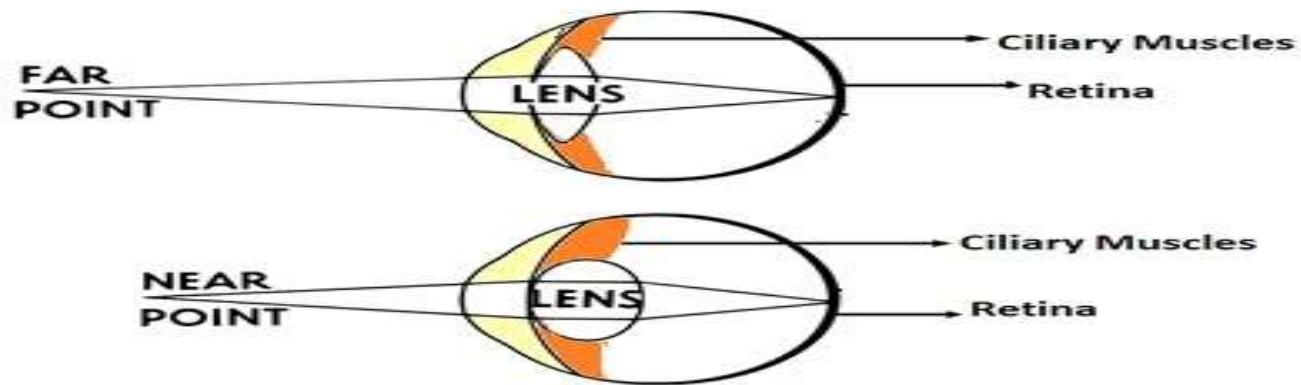
Accomodation



**Short focal length
for nearby objects**



**Long focal length
for distant objects**



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2023-2024 2nd Year Stage
Eye Physiology

Chapter 11- Visual System Pathways مسارات الجهاز البصري

Objective: To understanding cascade of the vision pathway لفهم سلسلة مسار الرؤية.

Visual Pathways Definition

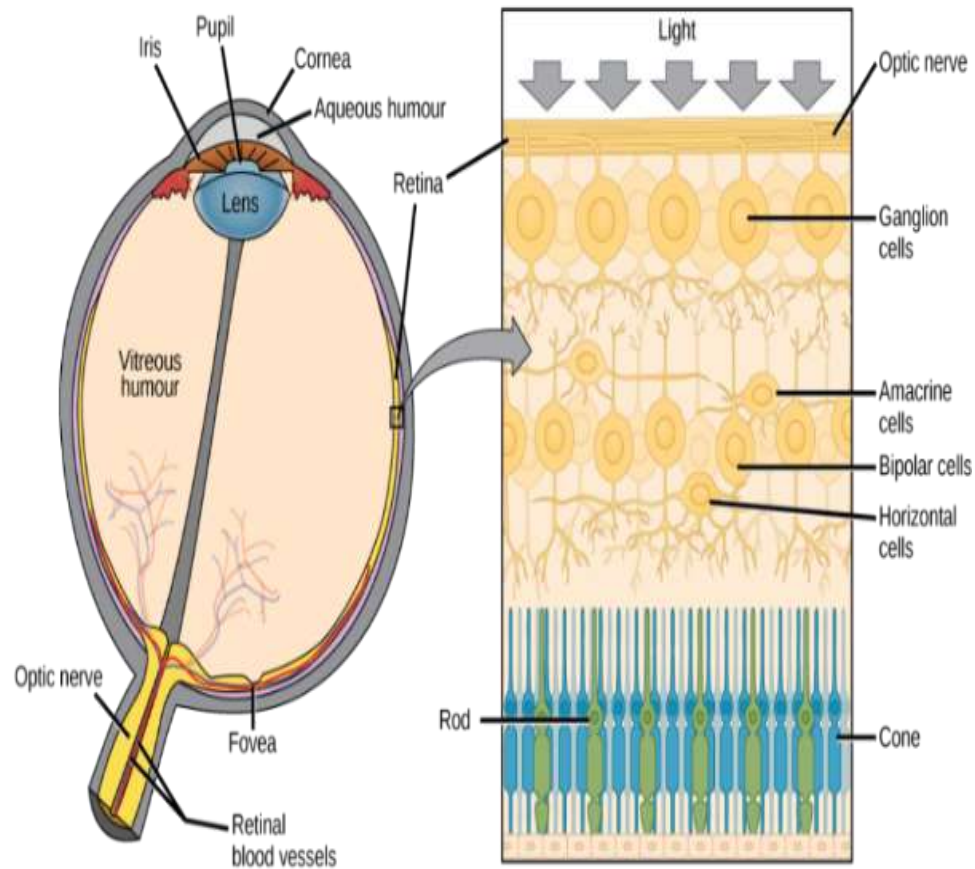
Visual pathway is the pathway through which electrical signals generated by the retinal photoreceptors from light signals , then sent the electrical signals to the occipital lobe in cerebral cortex that processes visual information.

Visual System Pathway

Visual system pathway start in retina photoreceptors (rods and cones) , then through synapse between the photoreceptors dendrites pass to bipolar neurons. Then from bipolar neurons to ganglion neurons, then from axons of the ganglion neurons to the optic nerve , and then to the occipital lobe of brain cortex.

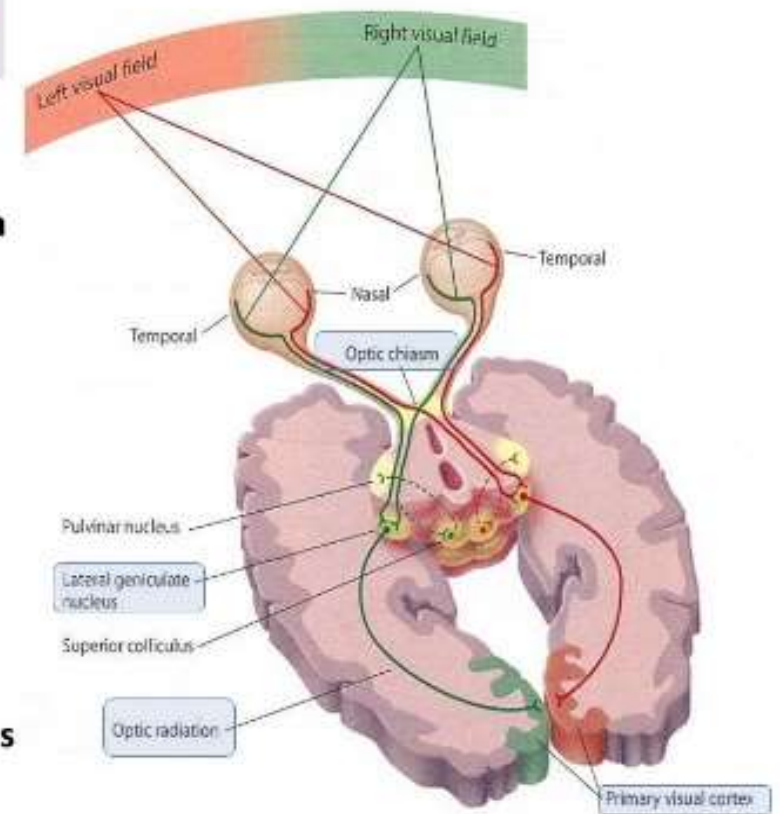
Bioelectric message formation in retina

The photons absorption by retinal photoreceptors activates rods and cones to translate the light signal into a bioelectric message, the activated rods and cones lead to the initiation of a phototransduction and result in converting light signals to electrical message that travel through the optic nerve.



Visual Pathway

1. Cones
2. Bipolar neurons
3. Ganglion cell's axon forms the optic nerve
4. Optic nerve to the Optic Chiasm
5. Optic tract
6. Lateral geniculate nuclei of the thalamus
7. Optic Radiations
8. Primary visual areas of the occipital lobes



Optic nerve, chiasm, and optic tracts

The optic nerve of each eye is composed of a group of unmyelinated axons محاور غير مغلفه of the retinal ganglion cells which emerge from the optic nerve. The optic nerve passes posteriorly from the optic disc, after which it becomes myelinated by oligodendrocytes خلايا قليلة الشحمية.

The optic nerves traveling from both eyes meet at the optic chiasm اتصال بصري anterior to the pituitary gland الغدة النخامية.

The nerve fibers continue after the optic chiasm as the optic tracts مسالك بصرية, fibers allows the right half of the visual field to be processed by the left cerebral hemisphere and the left half of the field to proceed to the right hemisphere. Optic tract lead to the primary visual cortex in the occipital lobe, the visual information is further processed by the secondary visual cortex to identify an object.

Clinical Significance of visual pathway

The visual pathways are complex coordinated systems in which multiple components participate with precision. Even one lesion in the pathway can severely deteriorate the quality of vision, these lesions include:

1-Optic Nerve lesion

A lesion in the optic nerve anterior to the optic chiasm leads to vision loss in the ipsilateral eye العين المماثل.

2-Visual System lesion

Damage at the optic chiasm leads to the bitemporal hemianopia نصف الأصبغة الدموي. This condition frequently results from a pituitary lesion إصابة النخاميه.

Visual information processing in the brain

In each hemisphere of brain, there are 4 "lobes": frontal, temporal صدغي, parietal جداري, occipital قفوي.

Visual information is processed primarily in the occipital lobes, but parallel pathways extend into the temporal and parietal lobes as information-processing becomes increasingly specialized.

Visual lobe of brain cortex

1-Primary Visual Cortex

The **primary visual cortex** is **located** in the posterior pole of the occipital lobe and is the simplest, earliest **cortical visual** area. It is highly specialized for processing information about static and moving objects and is excellent in pattern recognition. Destruction of the primary visual cortex leads to blindness in the part of the visual field that corresponds to the damaged cortical representation.

2-Secondary Visual Areas

This area immediately surrounding the primary **visual cortex** in the occipital lobes, receiving signals from it secondarily for analysis and further discrimination of **visual** input in terms of motion, shape, and position.

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Optic Technique Department **Eye Physiology**

Chapter 13- Neurophysiology and phototransduction

Objective

To learn the structure of nervous system, and role of the nervous system in phototransduction (photons conduction) and perceive the image.

Nervous system

The nervous system serves as the manager of the body control, it communicates with all systems in order to coordinate the performance and regulate body according of physiological demands.
تنسيقthe performance الاداءand regulate
الحاجات الفسلجيه

Nervous system use specialized cells, that relay the messages to tissues, organs, and systems.
تنقلthe messages

Nerve Cells (Neurons)

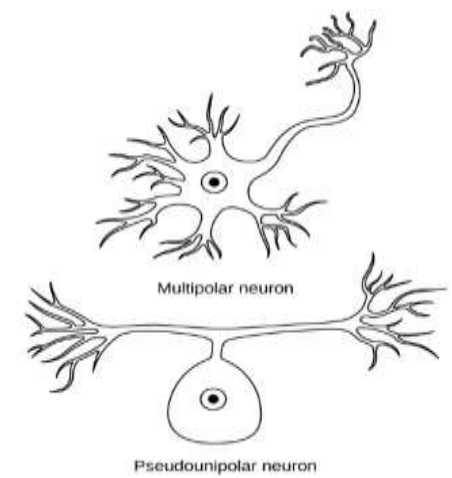
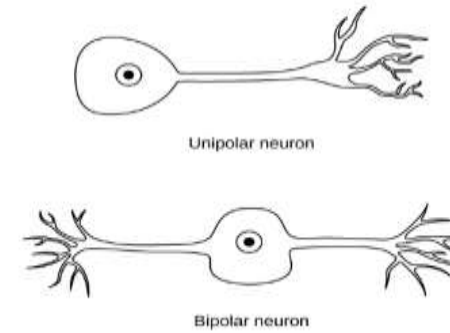
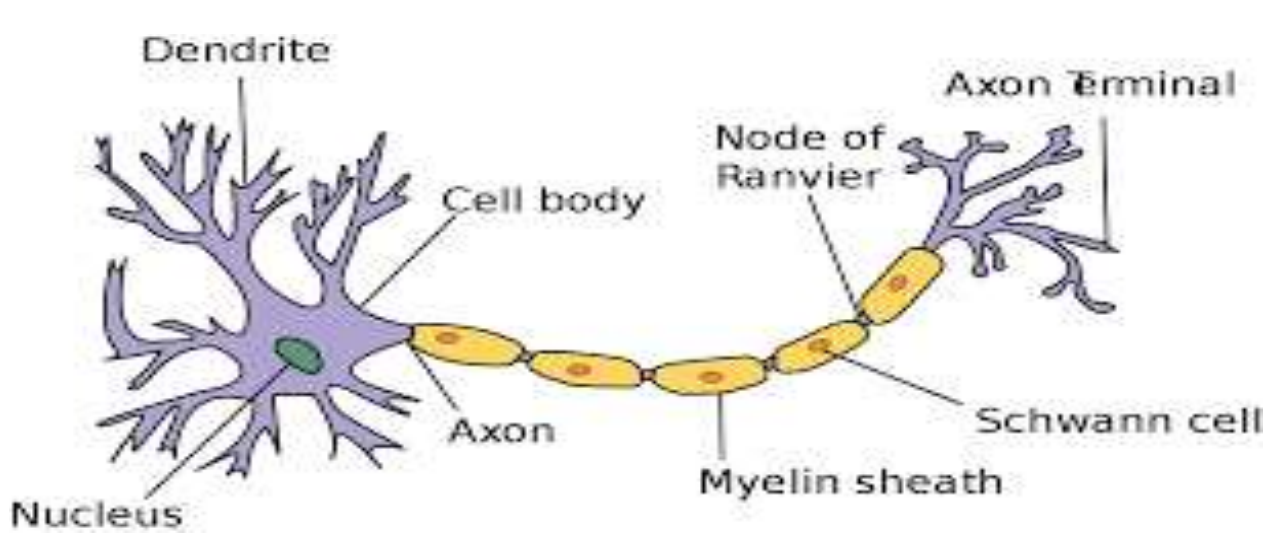
Are specialized cells designed to stimulate other cells in the body. Neurons are **excitable** سريع الانفعال, which means they function by using electrical stimulation. That initiate an electrical message, transduced to the target cells.
تنشئan electrical message, transduced ترسلto the
الخلايا المستهدفه

Neuron structure : Neuron comprise 3 parts :

1-Soma - cell body, contains nucleus and other organelles.

2-Dendrites - are branching extensions from nerve cell body, transmit the impulses towards cell body.

3-Axon - a single long extension that extends from soma to the target cell, transmit the impulses from soma to other neurons, axon bounded by myelin sheath schwann cells .



Function of neurons

- 1-Receive signals or information.
- 2-Integrate incoming signals .
- 3- Communicate signals to target cells (other neurons or muscles or glands).

Types of Neurons

According to the numbers of cell extensions that are found on the cell body , nerve cells divided into:

1. Unipolar neurons : Nerve cells that have one extension connected to the soma.
2. Bipolar neurons: nerve cells that have two extensions.
3. Multipolar neurons : nerve cells have more than two extensions.

Neurons also divided according to the functions into 3 types: sensory, motor, and interneurons.

1-Sensory neurons : Sensory neurons are transmit sense from external and internal environments to central nervous system.

2-Motor neurons : Motor neurons transmit information from central nervous system to bodies effectors as glands and muscles .

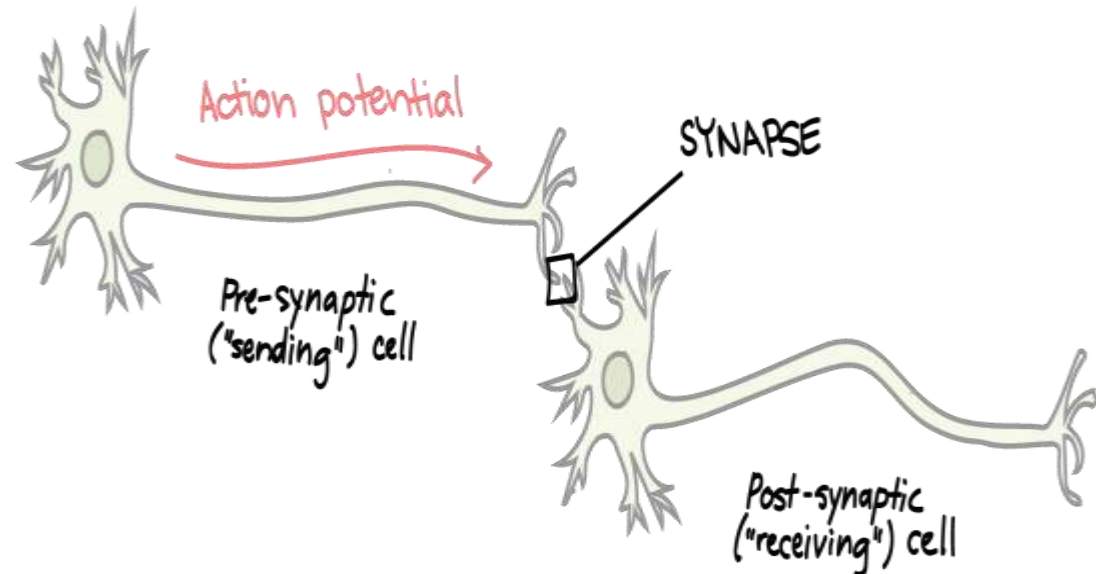
3-Interneurons : Interneurons found in brain and spinal cord. Connect between sensory neurons and motor neurons .

Synapses

Mean a junctions between two successive nerve cells, used for across impulses from cell to next one.

Synapse Parts : Synapse comprise 3 parts :

pre synaptic neuron , synaptic cleft or gap and postsynaptic neuron.



Types of Synapses

Chemical synapses

In a chemical synapse, nerve impulse pass from pre synaptic to postsynaptic neuron by releasing chemical messengers called neurotransmitters.

Electrical synapses

The nerve impulse pass from pre synaptic neuron to postsynaptic neuron by electrical action.

Nerve impulse formation

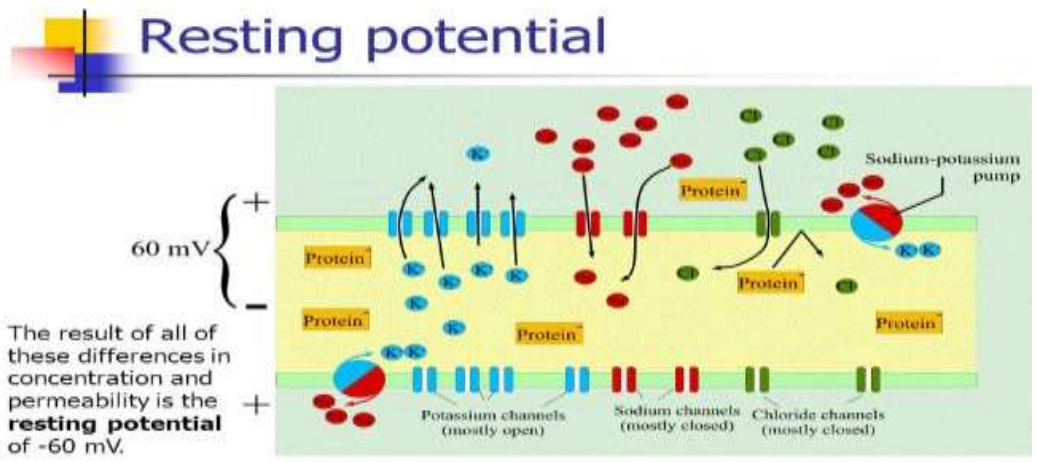
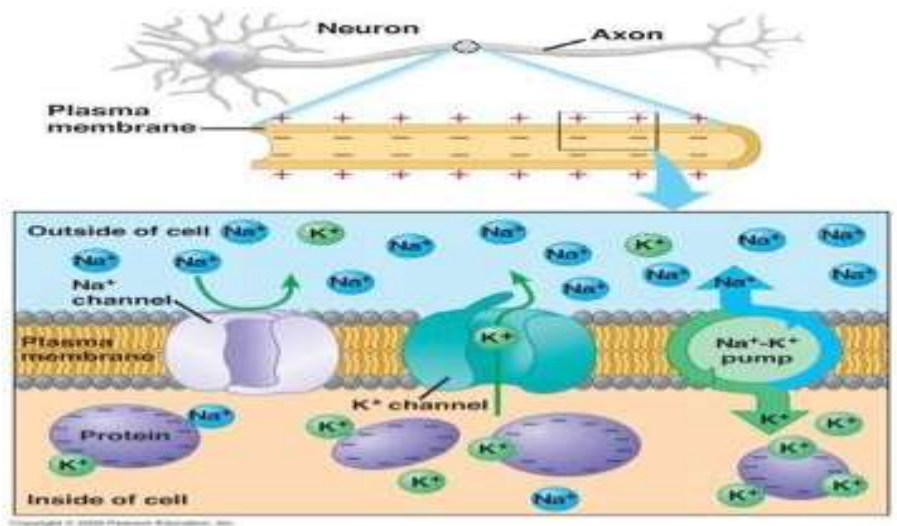
The nerve fibers may be either at resting state called resting fiber or at action state and called active fiber.

Resting state

During the **resting** state, the sodium-potassium pump in the plasma membrane of the neuron keep outer side of the nerve fiber positively charged , and inner side negatively charged, and the fiber membrane at this state called polarized membrane, and the force on the membrane during polarization called resting potential .

Action state

When neurons stimulated cause loss of polarization in the membrane by iterance of positive ions to the inner side cross the neuron membrane through sodium channels, the nerve fiber become depolarized . The force on the membrane at depolarization called action potential .



Eye nerve cells (photoreceptor)

A **photoreceptor cell** is a specialized type of [nerve cells](#) found in the [retina](#), that is capable of [visual phototransduction](#). These cells are stimulated after they absorb photons and convert light (visible [electromagnetic radiation](#)) into nerve impulse in form electrical that transported to the brain by optic nerve.

Types of photoreceptors

The two classic photoreceptor cells in eye retina, are [rods](#) and [cones](#), each contributing to information used by the [visual system](#) to form a [sight](#).

The cones are responsible for daytime or bright vision, while the rods respond under dark or low light conditions.

Phototransduction التوصيل الضوئي

Phototransduction is the process through which photons are converted into electrical signals. Visual phototransduction occurs in the retina through photoreceptors. The retina has many layers of various cell types. The most numerous photoreceptor cells (*rods* and *cones*) form the outermost layer. These the photoreceptors are responsible for mediating the sense sight. The middle retinal layer contains bipolar cells, collect signals from photoreceptors and transmit them to the retinal ganglion cells of the innermost retinal layer. Retinal ganglion cell axons collectively form the [optic nerve](#), via which they project to the brain.

Phototransduction biochemical events

Both rods and cones contain **photopigments**. When **light** hits a **photoreceptor**, it causes a shape change in the retinal, altering its structure from a bent (cis) form of the molecule to its linear (trans) isomer.

