

PHYSIOLOGY

Lecture 2

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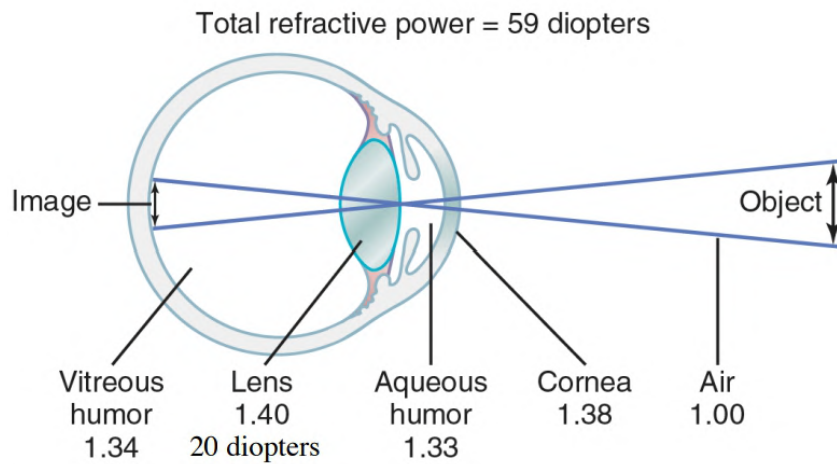
The Eye: I. Optics of Vision

Optics of the eye

The lens system of the eye is composed of four refractive interfaces:

- (1) between air and anterior surface of cornea
- (2) between posterior surface of cornea and aqueous humor
- (3) between aqueous humor and anterior surface of lens of eye
- (4) between posterior surface of lens and vitreous humor.

Consideration of All Refractive Surfaces of the Eye as a Single Lens—The “Reduced” Eye.



- most of refractive power of eye results from surface of cornea
- refractive index of cornea is markedly different from that of air, whereas the refractive index of the eye lens is not greatly different from the indices of the aqueous humor and vitreous humor

◇ نبدأ المحاضرة الثانية على نفس اسلوب المحاضرة الأولى ، في ترابط كبير بيناتهم

○ في العين في اكثر من سطح بنكسر الضوء من خلاله و ممكن تلخيصه زي الموجود فوق الصورة ، بالنسبة لرقم واحد بعض المصادر بتعتمد **tear** كأول طبقة مع الهواء و بعض المصادر بتعتمد ال **cornea** و ذلك لانه **refractive index** تقريبا مساوي لل **tear**

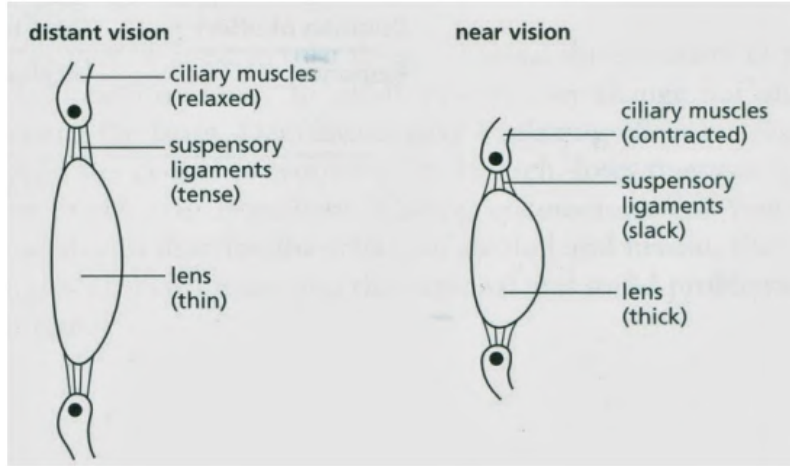
○ احنا حكينا بالمحاضرة الأولى، كلما زاد الفرق بين **refractive index** زاد **refraction of light** ، و اذا بتلاحظوا من الصورة اكبر فرق منلاقه بين **Air** و **cornea** و هذا بمثل $2/3$ من **refraction of light** و **lens** بتعطي حوالي $1/3$ تقريبا 20 **dopters** من أصل 59 لكل الأسطح

○ التقسيم الي فوق للشرح و التوضيح ولكن على أرض الواقع منعتبر محصلة كل الأسطح زي كأنه one lens و بتكون حوالي 59 diopters و اكثر اشي بالاطفال،، هذا بمثل الوضع الطبيعي لما اشوف اشي بعيد ، بس للاجسام القريبة في تغير لل lens رح نحكي عنه لقدام

○ حكيينا بالمحاضرة الأولى ، انه cornea بضلها ثابتة و ما منقدر نغير بال curve فرح اضل تمثل 2/3 (ما يقارب diopters) اما ب lens حكيينا انها بتمثل 20 diopters بالوضع الطبيعي لجسم بعيد و برضه حكيينا انه ممكن نغير ب curve ، بالتالي للاجسام القريبة رح يزيد curve of lens و بضيف 14 diopters ،،، تخيلوا لو ما زاد 14 diopters ، الأجسام القريبة رح يكون ال focal point ورا retina و بالتالي غباش بالنظر

Accommodation

- refractive power of the lens is 20 diopters.
- refractive power can be increased to 34 diopters (in children) by changing shape of the lens
- increasing its curvature by accommodation.
- accommodation is necessary to focus the image on the retina.
- lens is held in place by suspensory ligament which under normal resting conditions causes the lens to be almost flat (moderately convex).



○ ال Accommodation هي قدرة العين على التكيف مع تغير المسافة بين الأجسام و العين مع المحافظة على دقة النظر، اقوى اشي في الأطفال و بضلها تقل مع العمر حتى سن السبعين و وقتها ما بتقدر العين تعمل Accommodation

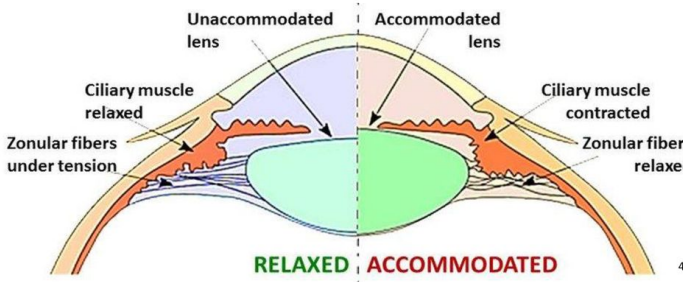
○ حكيينا فوق انه بتصير lens more curved او more flat عن طريق contraction of ciliary body so that relax of suspensory ligaments and lens become more flat كما هو موجود بالصورة

Mechanism of Accommodation

- Eye lens is elastic.
- contraction of ciliary muscle (meridional fibers & circular fibers) » relaxes the ligaments to the lens capsule » more convex
- contraction of ciliary muscle (radial fibers) attached to suspensory ligament pulls fibers of the ligament forward and causes the lens to become very convex which increases the refractive power of the lens.
- under control of the parasympathetic nervous system (III, brain stem).
- When the eyes fixate on a near object, the eyes must converge → cause a mild degree of pupillary constriction

ACCOMMODATION

- Definition: Accommodation is the mechanism by which the eye changes its refractive power by altering the shape of the lens in order to focus objects at variable distances.



الصورة عالشمال خارجية، بس من باب توضيح Accommodation و في كمان فيديو قصير بين حركة lens and ligament and muscle

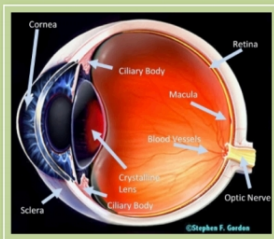
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و الدكتور عرضة animation لحركة العين، بتقدروا تشوفوه من فيديو المحاضرة

○ ذكرنا بالمحاضرة الماضية، من صفات ال lens هي elastic و هذا الي يساعدها على تغيير شكلها

○ هسا suspensory ligament بصير الهم relaxation + move forward، ال relaxation يتم من خلال contraction of ciliary muscle - meridional fibers & circular و اما move forward من خلال contraction of ciliary muscle (radial fibers)

Mnemonic CCC



Ciliary muscles
Contracts for
Close vision

Accommodation-neuronal pathways

- Afferent- optic nerve » » Center-mid brain (superior colliculus)» » Efferent - oculomotor nerve
- Parasympathetic» accommodation & meiosis
- Somatic » eye convergence

○ بعد ما توصل الصورة لل retina و تتحول ل electrical signal و تنتقل من خلال optic nerve رح توصل لل brain stem عند superior colliculus و بترجع عن طريق oculomotor nerve

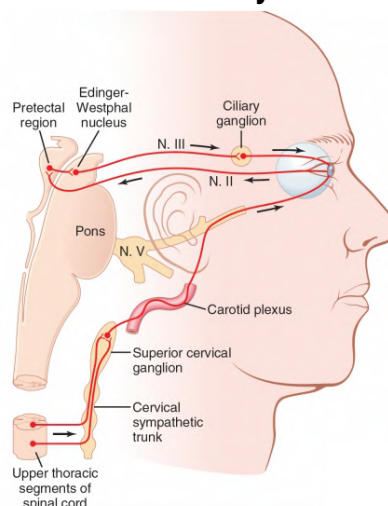
○ ال meiosis هي contraction of papillary

Presbyopia The Inability to Accommodate

- caused by progressive denaturation of the proteins of the lens with age.
- makes the lens less elastic.
- begins about 40-50 years of age (~ 2 diopters accommodation power).
- 70 years- 0 diopters
- no longer accommodate for both near and far vision → bifocal glasses, upper segment focused for distant vision and lower segment focused for near vision

The Autonomic Nerves to the Eyes

- eye is innervated by both parasympathetic and sympathetic neurons.
- parasympathetic fibers arise in the Edinger-Westphal nucleus, pass in the 3rd cranial nerve to the ciliary ganglion.
 - postganglionic fibers excite the ciliary muscle and sphincter of the iris.
- sympathetic fibers originate in the intermediolateral horn cells of the superior cervical ganglion.
 - postganglionic fibers spread along the carotid artery and eventually innervate the radial fibers of the iris.



○ ال postganglionic fibre of parasympathetic تعتبر قصيرة لانه ال ciliary ganglion موجودة بالقرب من eye

○ اما sympathetic fibre فبكون مصدرها من upper thoracic و بتطلع مع carotid artery لحد ما توصل radial fibre of the iris

Pupillary diameter

- meiosis: decreasing of pupillary aperture due to stimulation of parasympathetic nerves that excite the pupillary sphincter muscle.
- Decrease amount of light that enters eye → daylight
- mydriasis: dilation of pupillary aperture due to stimulation of sympathetic nerves that excite the radial fibers of the iris.
- Increase amount of light that enters eye → darkness
- quantity of light entering eye can change about 30-fold as a result of changes in pupillary aperture (1.5-8 mm).
- Depth of focus of the lens system increases with decreasing pupillary diameter, almost all the rays pass through center of lens, and the central-most rays are always in focus.

○ حكينا بالمحاضرة الأولى، في sympathetic لما تشوف أسد مثلا بتحتاج dilatation of pupil حتى تمرر اكبر قدر من الضوء و مشان هيك رح يصير انقباض ب radial fibre ، اما في parasympathetic ف يكون constricted pupil

○ متى بحتاج meiosis ؟ في النهار او لما اشوف أجسام قريبة

○ متى بحتاج mydriasis في الظلمة

○ هسا حكينا للاجسام القريبة بصير miosis و برافقها Accommodation و السبب حتى اركز الضوء في central part of retina كونه ال visual acuity فيها اكبر

Pupillary Light Reflex

- when the amount of light entering the eyes increases, the pupils constrict.
- light through optic nerve to pretectal nuclei.
- from pretectal nuclei fibers pass to Edinger-Westphal nucleus and back through parasympathetic nerves to constrict iris sphincter.
- In dark » reflex is inhibited

Horner's Syndrome

interrupted sympathetic nerves to eye

#signs

Pupil constricted (asymmetric)

superior eyelid drop

blood vessels on corresponding side of the face and head dilated

Lost sweating (asymmetric)



Droopy Eyelid?
Unequal Pupils?
Are You Sure This
is a Big Deal?

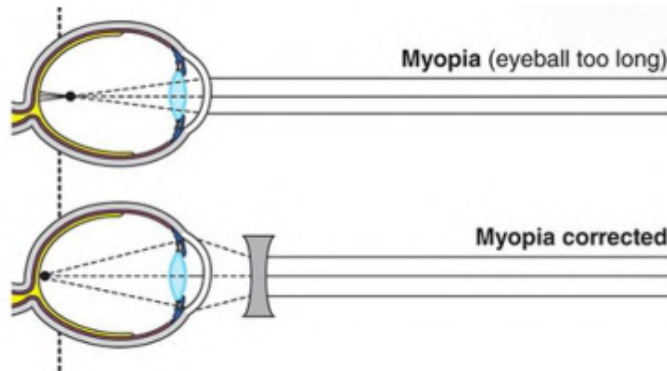
Errors of Refraction

☐ Nearsightedness

☐ Too much refractive power

☐ No mechanism to focus distant objects sharply on the retina.

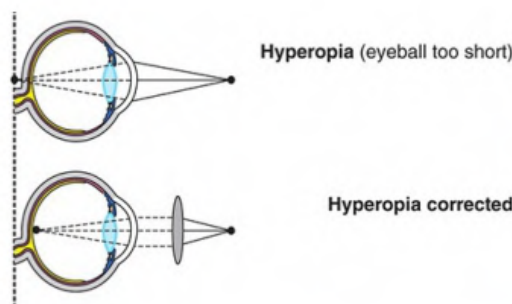
○ ال Nearsightedness او myopia المريض بقدر يشوف الأجسام القريبة بشكل طبيعي لكنه ما رح يقدر يشوف الأجسام البعيدة ، يرجع السبب ل زيادة غير طبيعية ب refractive power نتيجة انه cornea صارت more convex او لانه طول eyeball زاد ،،، هسا لما يزيد refractive power رح يقل focal length و بالتالي ال focal point ما رح تكون على retina رح تكون قدامها و بنفس الوقت الي بتكون في (ciliary body relaxed (no Accommodation) ، العلاج انه نقل refractive power عن طريق استخدام نظارة فيها concave lens والي رح تفرق الضوء و تساعد بتقليل refractive power



☐ Farsightedness

☐ Farsighted person is capable of focusing distant objects on retina until the ciliary muscle has contracted to its limit

☐ presbyopic, farsighted person is unable to accommodate

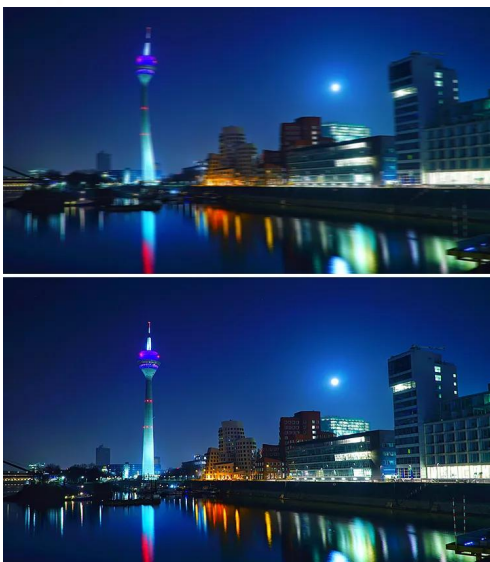
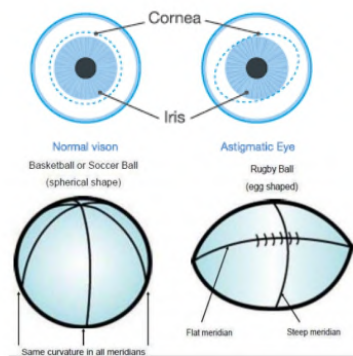
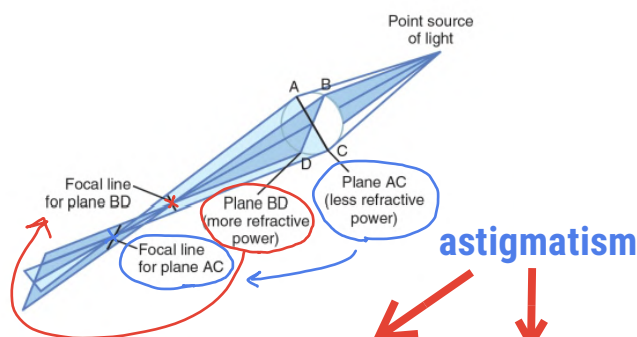


○ ال **Farsightedness** او **hyperopia** المريض بقدر يشوف الأجسام البعيدة بشكل طبيعي لكنه ما رح يقدر يشوف الأجسام القريبة ، يرجع السبب ل انخفاض في **refractive power** نتيجة انه صار **denaturation of proteins in lens** و بالتالي ما بتقدر تعمل **Accommodation** ،،، هسا لما يقل **refractive power** رح يزيد **focal length** و بالتالي ال **focal point** ما رح تكون على **retina** رح تكون وراها و بنفس الوقت الي بتكون في **ciliary body contraction** بس عالفاضي لانه ال **lens** ما بتقدر تصير **more convex or flat** ((لو كان السبب غير عن **denaturation of proteins in lens** ممكن ال **Accommodation power** تزود من **refractive power** و تعالج عالمدى القصير بس عالمدى البعيد رح يصير **denaturation** تحديدا مع تقدم العمر))، العلاج انه نزيد **refractive power** عن طريق استخدام **convex lens** و الي رح تجمع الضوء و تساعد بزيادة **refractive power**

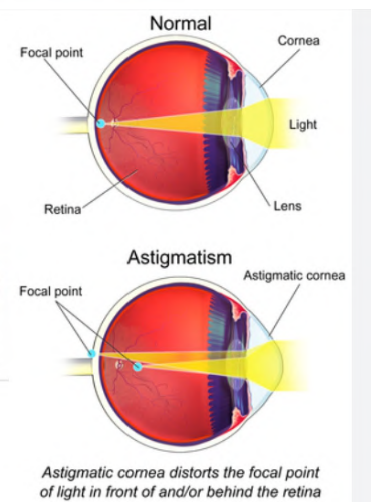
Astigmatism

- unequal focusing of light rays=visual image in one plane to focus at a different distance from that of the plane at right angles
- due to an oblong shape (too great a curvature) of the cornea.
- Corrected with cylindrical lens

○ لما اخذنا عن **spherical lens** حكيما انها بتكون في اكثر من مستوى ل **plane** بس كلهم بكونوا على نفس **curvature** زي كانه كرة تنس و لما يمر الضوء من خلالها بتجمعوا في نقطة واحدة **focal point** و لازم تكون موجودة على **retina**،،، طيب لنفرض صار في **abnormal curvature** زي شكل كرة القدم الأمريكي (بيسبول) معناها رح يتكون اكثر من **focal point**



Comparison of What People See With and Without Astigmatism Is an Eye Opener



cataracts

- cloudy or opaque area of the lens.
- caused by denaturation and coagulation of lens proteins.



العلاج نستبدل lens ب artificial lens و الغالب رح يفقدوا القدرة على Accommodation

Fluid System of the Eye

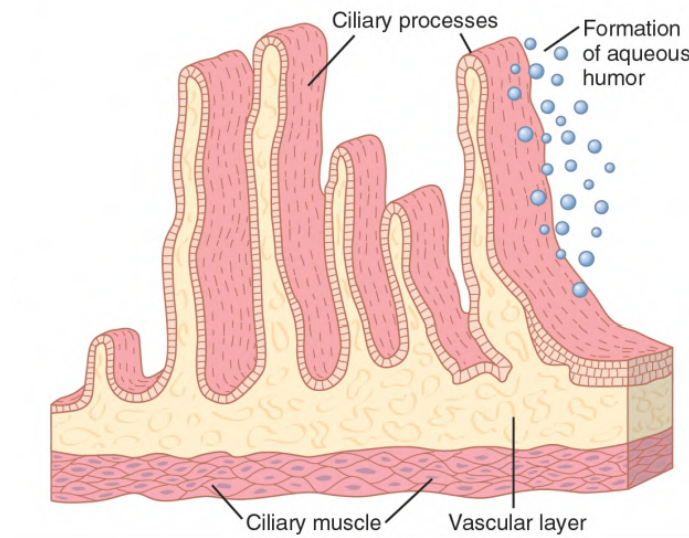
- intraocular fluid keeps the eyeball round and distended.
- 2 fluid chambers.
 - aqueous humor which is in front of the lens.
- freely flowing fluid.
 - vitreous humor which is behind the lens.
- gelatinous mass (proteoglycan) with little flow of fluid.

ال Aqueous humor بصل يتجدد باستمرار، اما vitreous humor بصل ثابت بمكانه

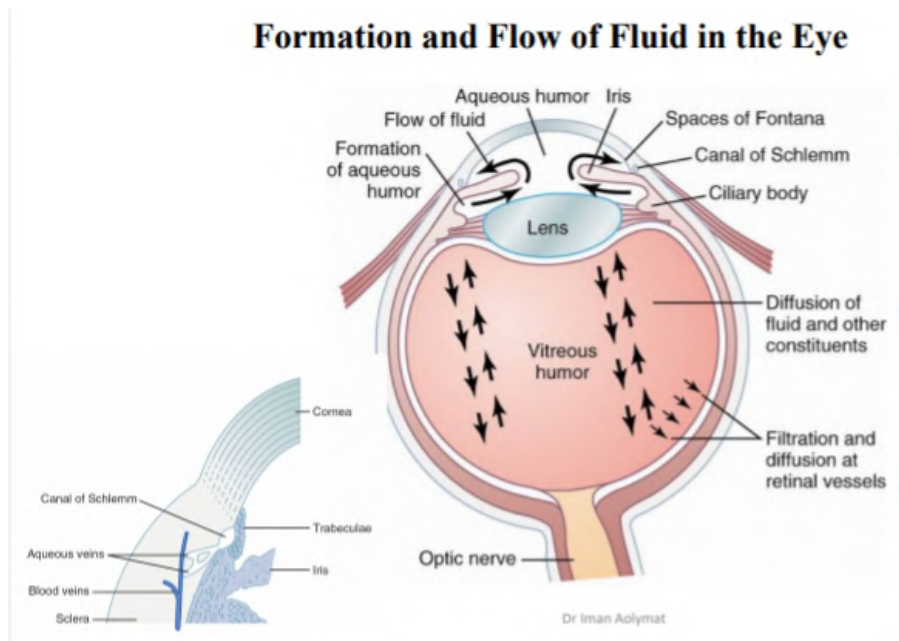
Formation and Flow of Fluid in the Eye

- produced by ciliary processes of ciliary body
- rate of 2-3 microliters/min.
- active secretion- Na secretion, dragging Cl & HCO₃, H₂O by osmosis
- Nutrients (amino acids, ascorbic acid, and glucose) - active transport / facilitated diffusion

ممکن نستخدّم بعض الأدوية الي بتقلل من introcular pressure و الي بتسبب glaucoma بتكون عبارة عن Diamox زي carbonic anhydrase inhibitor



ciliary processes /ciliary body» space behind iris » pupil» anterior chamber» meshwork of trabeculae» Canal of Schlemm » aqueous veins



ال aqueous veins هو عبارة عن Drainage for aqueous humor و ما فيه RBC ، اذا صار resistance of flow or obstructions mainly Canal of Schlemm و بالتالي زاد الضغط جوا العين بتأدي ل glaucoma ،، وجودها بشكل acute يكون خطير لأنها رح تأثر على optic nerve و retina artery و رح تقلل nutrition

Intraocular Pressure

- normally 15 mmHg with a range of 12-20 mmHg.
- the level of pressure is determined by the resistance to outflow of aqueous humor in the canal of schlemm.
- increase in intraocular pressure (Glaucoma) caused by an increase in resistance to outflow of aqueous humor through a network of trabeculae in the canal of schlemm.
- can cause blindness due to compression of the axons of the optic nerve & compression of retinal artery → reducing nutrition to retina

Glaucoma

Cause:

increased resistance to fluid outflow

☆Acute» eye inflammation, WBC & tissue debris

☆Chronic conditions » fibrous occlusion of trabecular spaces in elderly

♣Treatment: reduces the secretion or increases the absorption of aqueous humor.

⊙ ممكن بنفس الوقت يكون في tumor أدى إلى over production of aqueous humor
 ⊙ حالات ال chronic ممكن ما يلاحظوا Glaucoma لانه بتبدأ ب prephral و بتنتهي ب central

Extra Questions

1-A 24-year-old woman sustains a laceration on the right side of the neck in a motor vehicle accident. Physical examination shows that her right pupil is constricted, her right eyelid droops, the skin is dry on the right side of her face, and the conjunctiva of her right eye is red. What is the most likely diagnosis?

- A) Cone-rod dystrophy
- B) Horner's syndrome
- C) Iris heterochromia
- D) Retinoblastoma
- E) Xerophthalmia

2-Which structure secretes the intraocular fluid of the eye?

- A) Ciliary processes
- B) Cornea
- C) Iris
- D) Lens
- E) Trabeculae

3-Which muscle is contracted as part of the pupillary light reflex?

- A) Ciliary muscle
- B) Pupillary dilator muscle
- C) Pupillary sphincter muscle
- D) Radial fibers of the iris
- E) Superior oblique muscle

4-An 85-year-old woman visits the ophthalmologist because of difficulty seeing. The patient is given an eye examination, and bifocal lenses are prescribed. The physician notes that the lenses of her eyes are clear. The woman sees well with her new prescription glasses. Which of the following best describes the most likely vision problem in this woman?

- A) Cataracts
- B) Glaucoma
- C) Hyperopia
- D) Myopia
- E) Presbyopia

Answer: 1-B 2-A 3-C 4- E

نهاية التلخيص
بعتذر عن أي خطأ غير مقصود، و ان وجد رح ينضاف على correction zone
التلخيص عن أرواح شهداء فلسطين ♥