



Refractive Errors

[**Color index:** **Important** | Notes: **F1**, **F2** | Extra] [EDITING FILE](#)

Objectives:

➤ Not given.

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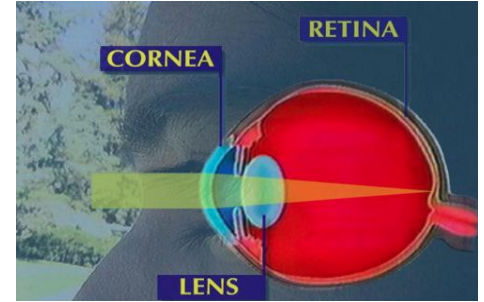
Resources: Slides + Notes + Lecture Notes of Ophthalmology + 434 / 435 Team.

Last 2 pages are extras from Group A!

Physiology

● Refraction

- Simply light enters the eye by going through the cornea and lens. These two organs modify light rays by a phenomenon called **refraction** (انكسار الضوء) in order to have a single point -not two- in the fovea as it should be to see clearly.



- When light waves travel from a medium with a given refractive index to a medium with another refractive index. At the boundary between the two media, the wave phase **velocity is altered, it changes direction**.
- The amount of bend depends on the refractive index of the media and the angle of incidence.

<p>Important: light refracts towards central line from low to high density. For example, when light moves from air (lower density) to water (higher density), light waves will slow down then it will refract towards the medial vertical line (central line).</p>	<p>Light passes two different media and the straw appears to be broken due to refraction but it isn't.</p>	<p>- Light passes through the glass from: * Low to high → TOWARDS central line * High to low → AWAY from central line - Light rays (picture: yellow) are parallel to each other. متوازيين</p>

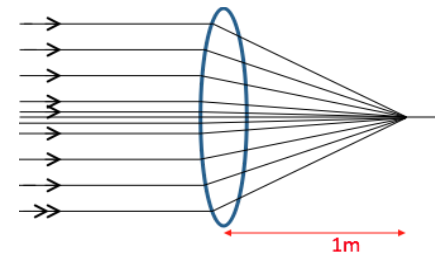
- Unit of refraction:

- **Diopter = 1 / focal length of a lens.**
- The power of the lens is measured by the diopter (D).
- The eye requires about **60 diopters** of power to focus the light from a distant object (6 meters or more) precisely onto the retina.

When looking at a far object, light rays are coming parallel (≥ 6 meters). It will enter through the lens and then it will refract in a single focal point at 1 meter. This is due to the power of lens, which is 1 diopter.


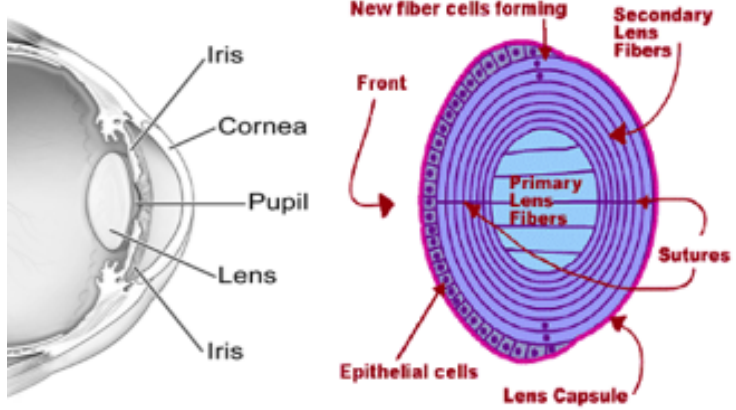
Example: If we used another lens, rather than having a focal point at 1 meter it will be at 25 cm distance. What is the power of the lens? **4 diopter**. How?
 diopter = $1/\text{focal length (m)}$ | $25 \text{ cm} \rightarrow 0.25 \text{ m}$ | diopter = $1/0.25 = 4$

"الليش نقول الكلام هذا؟ لأننا نتعامل مع العين و العين قوتها 60D (مجموع الـ cornea & lens)"



- The refracting surface of the cornea and lens are spherically convex.
- Cornea has a higher refractive index than air; the lens has a higher refractive index than the aqueous and vitreous humours that surround it. The velocity of light is reduced in a dense medium so that light is refracted towards the normal. When passing from the air to the cornea, or from the aqueous to the lens, the rays converge.

● **The eye's optical system: very important**

Cornea	Crystalline Lens
Main refracting surface.	Double purpose: balancing eye's refractive power and <u>and</u> providing a focusing mechanism.
Provides 40 diopters , or 75% of the total refracting power of the eye. (2/3 the power of the eye)	Provides 20 diopters (القوة البؤرية) of refractive power. (1/3 the power of the eye)
Fixed	Changes (depends on how far the object is from the eye)
 <p>In children the power of cornea = 32D. It reaches the maximum power at the age of 18 = 40D. That's why it's NOT recommended to do any refractive surgery before age of 18. At age 40 they will have presbyopia. At age 60 = 0D.</p>	

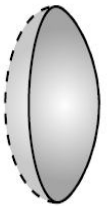
● **Accommodation** “theories of eye accommodation [LINK](#)”

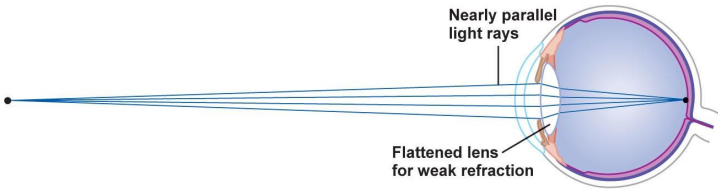
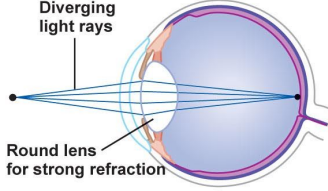
- **Helmholtz theory:** When the eye look at close object → contraction of ciliary muscle → decrease tension in zonule fibers (**relaxation**) → elasticity of lens capsule mold lens into spherical shape **anterior-posterior curvature (diameter) increase** → greater dioptric power → divergent rays are focused on retina.

- Contraction of ciliary muscle is supplied by parasympathetic third nerve.

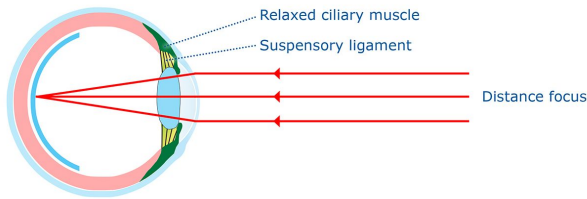
- After prolonged reading there might be ciliary spasm associated headache.

More globular shape of lens attained with accommodation

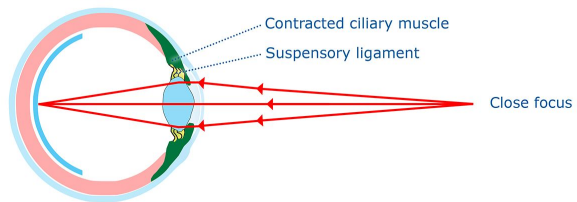


Viewing a DISTANT object (≥ 6 meters)	Viewing a NEAR object (< 6 meters)
	
<p>Relaxed situation: Light rays are coming parallel Accommodation is very relaxed Eye power = 60D (40D + 20D)</p>	<p>* Cornea: will not change. * Lens: the closer the object the more diopter needed to maintain a point at the fovea. * If this mechanism is disrupted, as you get closer to the object the focal point will be behind the fovea (no accommodation) and vision will be unclear. More diopters are needed! (example: at 30 cm, lens goes from 20D -relaxed- to a higher diopter 23/25/28D) Refractive power can increase up to 15D more, like in children (with time it becomes less)</p>

Accommodation



Looking at a far object.
No accommodation.



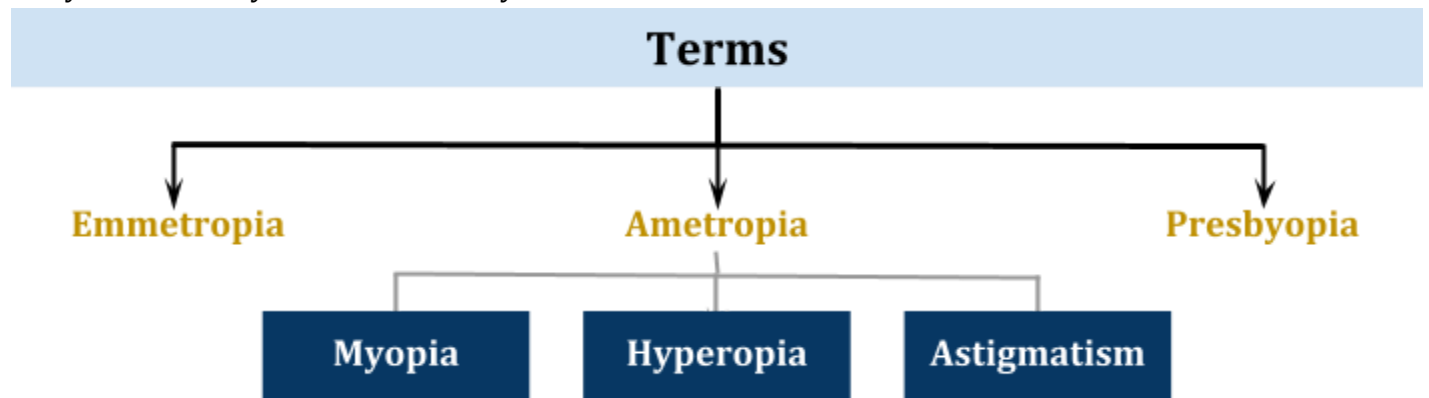
1. **Change of lens shape.** Notice how the shape of the lens changes in relation to different distances (in near object the rays are not parallel, so we need a more powerful lens to maintain the point in the fovea so the lens becomes more thick)
2. **Miosis:** to allow as much light rays as possible to enter.
3. **Convergence:** contraction of medial recti.

● Axial length (AL):

- Normal **axial length is 22.5 mm** (it's measured from the tip of the cornea to the surface of the retina).
- if the axial length is **longer** = the picture will be in **front** of the retina "Myopia".
- If the axial length is **shorter** = the picture will be **behind** the retina "Hyperopia".

Refractive Errors

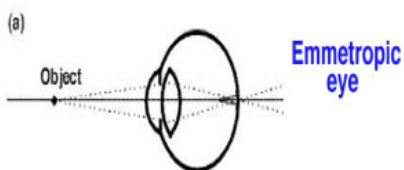
- **Facts:** 75% of avoidable blindness is due to: uncorrected refractive error, cataract, trachoma.
- A mismatch between the **refractive power (RP)** & the focusing distance of the eye. **AL & RP should match!**
- Inability to see clearly is often caused by refractive errors.



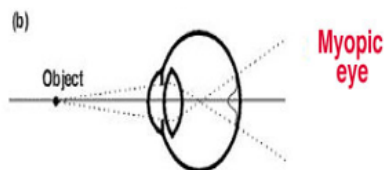
- **Emmetropia (normal)** ما يلبس النظارات ولا يعرفها

- **Ametropia = refractive error**, three types of refractive errors:

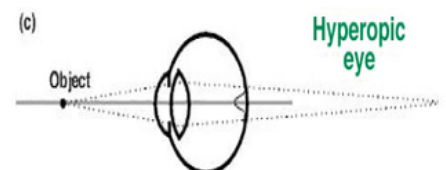
- Myopia (nearsightedness)
- Hyperopia (farsightedness)
- Astigmatism.



Point at the retina
Matching between axial length (AL) & refractive power (RP)



Point in front of the retina
* high RP & normal AL **OR**
* normal RP & long AL



Point behind the retina
* low RP & normal AL **OR**
* normal RP & short AL

Emmetropia

- Adequate correlation **OR** matching between **axial length** (distance from cornea to the fovea) and **refractive power of the eye** (cornea and the lens).
- Rays of light from a distant object are brought to a pinpoint sharp focus on the retina (without accommodation). *fovea* لما يكون قوة العين وطولها متطابقين معناته النقطة بتسقط على الـ
- All refractive errors are some deviation from emmetropia.

Ametropia

Myopia

- More common than hyperopia and astigmatism.
- Most prevalent among Asians (80-90%), African Americans (25%), and Caucasians (13%) *varies according to race*.
- **Etiology:** not clear, **genetic** (family history is important), **acquired** (excessive accommodation, near objects, aging)
- **Average age of onset:** 6/8/10 (preschool/ school age) to 20 years (normally stops at 20)

- Rays of light from a distant objects converge **in front of the retina**, causing a blurred image on the retina.
- The myopes can see close objects clearly, commonly known as "short-sightedness" قصر النظر: القريب أوضح من البعيد
- Myopia can be: **essential** (\uparrow RP, \uparrow AL) **OR secondary** (other causes)



Causes of myopia: refractive & axial

1. Refractive myopia كبيرة ولكن حجم العين طبيعي

a) Change in lens nucleus or shape:

- **Cataract** (ex. senile cataract: high density/**thick/hard**, low elasticity \rightarrow high refractive power = induced myopia)
"طول عمره ما يعرف النظارة لكن لما يوصل عمره 60/70 يبدأ تصوير عنده أرقام myopia جديدة بسبب الـ senile cataract"
- **Spherophakia:** congenital anomaly where the lens is spherical.
- **Diabetes.** How it affects the lens? Through a process called "**osmosis**" due to variabilities in blood sugar.
 - * Diabetics have both myopia and hyperopia depending on the level of the blood sugar.
 - * High blood sugar \rightarrow high sugar in aqueous humour \rightarrow shrink of lens \rightarrow **HYPEROPIA**.
 - * Low blood sugar \rightarrow fluid shift into lens \rightarrow globular shape \rightarrow **MYOPIA**
 - * **Undiagnosed** diabetics might end up with a brain injury. **Uncontrolled** (fluctuations in blood sugar) lead to **blurry vision**.

"لما تتابعي patient ويقولك أنا عندي زغللة نظر مستمرة تعرفي أنه مو controlled الـ blood sugar لأن فيه fluctuation عالي"

b) Lens repositioning:

- **Ciliary muscle shift:** treatments like miotics. Contraction of ciliary muscles **persistently** \rightarrow induced myopia
- **Lens movement** e.g. anterior lens dislocation. **Trauma** \rightarrow lens moves forward \rightarrow image will be in front \rightarrow myopia

c) Ciliary muscle tone: Excessive accommodation, e.g. medical students. Reading a lot at a near distance.

d) Increase corneal power: Keratoconus (cone shaped cornea), Congenital glaucoma (big eye + protrusion of cornea)



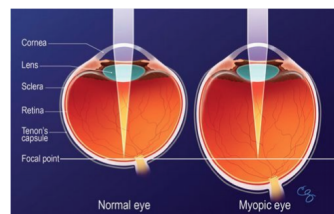
Keratoconus



Congenital Glaucoma

2. Axial myopia

- Excessive long globe. القوة طبيعية ولكن حجم العين كبير
- **More common** ★
- Causes: (what causes big eye)
 - a) Congenital glaucoma,
 - b) Posterior staphyloma (bulging of posterior part of eye).



Myopia Forms

Benign myopia (school age myopia)

- **Commonest type** ★
- Onset 8-12 years, myopia increases until the child stops growing in height.
- Generally tapers off at about **18 to 20 years of age**.

Progressive OR Malignant myopia

- Also called degenerative or pathological myopia.
- Myopia increases rapidly each year and is associated with, fluidity of vitreous and chorioretinal change.
- "الأرقام مستمرة في النزول"

Symptoms

Headache (due to eyestrain), blurred distance vision, squint in an attempt to improve uncorrected visual acuity when gazing into the distance. | **Children:** strabismus & amblyopia.

Morphologic eye changes (axial myopia)

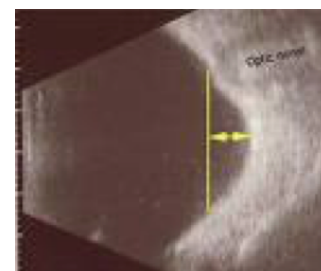
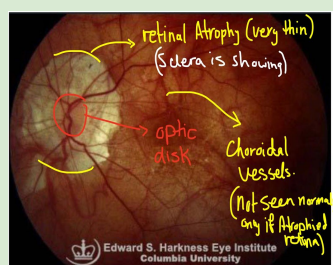
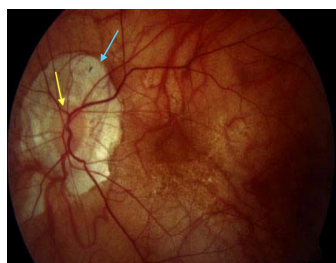
Changes occur with axial myopia specifically. The following changes occur with increase in length (from front to back):

- 1. Deep anterior chamber.** | **2. Atrophy of ciliary muscle.** due to excessive stretching
- 3. Vitreous may collapse prematurely leading to opacification.** The eye is bigger (more space) and the vitreous (gel-like substance) will stay the same. The space will be partially filled with vitreous and the rest with aqueous humour (watery) causing them to mix in a process called "liquefaction" (less density) **[important]**
- 4. Fundus changes:** loss of pigment in RPE, large disc and white crescent-shaped area on temporal side, RPE atrophy in macular area, posterior staphyloma, retinal degeneration → hole → increase risk of retinal detachment & vision loss.

"لو قلنا أن أرضية الغرفة هي الـ retina وجينا بعدنا الجدار، وش حيصير في الأرضية؟ فيه أماكن ما راح يكون فيها coverage في الـ retina، في البداية لو كان موكيت ممكن يجي معاك بس بعدين حينقطع بيصير حاجة اسمها retinal break الـ retina ما عاد تقدر أنها تغطي حجم العين الكبيرة فيصير فيه breaks والجل liquified فيدخل مع الـ breaks هذي، لما يدخل وش يسوي في الـ retina؟ يدها/يفصلها، فيصير عندنا حاجة اسمها retinal detachment أو انفصال الشبكية"

One of the most important risk factors of retinal detachment is high myopia. ويمكن توصل للعمى

Posterior Staphyloma (bulging)



Yellow arrow: optic nerve with distorted margins because of vitreous | **Blue arrow:** retinal margins. | **White area:** The retina (which is transparent) and choroid (red in color) are very thin and the sclera (white) is showing (behind the retina). | **US:** shows bulging at the back of the eye because the pressure of the eye pushes the weak structures. (eye is getting bigger and the walls weaker)

Correction of myopia

Concave lenses (negative)

Hyperopia

- Parallel rays converge at a focal point posterior to the retina. **myopia** نعكس كل الأشياء اللي كانت بالـ
- **Etiology:** not clear, **inherited**. **trauma may cause dislocation of the lens.**

- Rays of light from a distant object now focus **behind the retina.**
- Must accommodate when gazing into distance to bring focal point on to the retina. However, this reduces their accommodative reserve when they want to view close objects. So, their distance vision is generally better than near vision, hence the term "long-sightedness" "الأشياء البعيدة أوضح من القريبة لكن حتى البعيدة مو واضح مره"
- Can be: **essential** (↓ RP, ↓ AL) **OR secondary** (other causes)



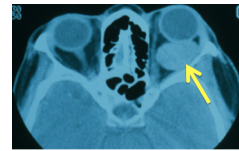
Causes of hyperopia: refractive & axial

1. Refractive hyperopia

- Decreased refractive power of the eye (insufficient):
 - a) Absent (*aphakia*: **absent lens**) or posteriorly repositioned lens (**image at the back**). can be congenital or due to trauma.
 - b) Weak accommodation: trauma (**it affects muscles or zonules**), marijuana. (**causes weak accommodation**)

2. Axial hyperopia

- Decreased effective axial length (excessive short globe)
- More common (**retina is pushed forward**)
- **Causes:** Tumor, orbital mass.
العين ماهي صغيرة فعليًا ولكن في حاجة ثانية دفت العين والـ retina



Symptoms

Eye pain / **strain**, headache in **frontal** region (**especially after reading, they require more accommodation**), visual acuity at near tends to blur (**blurry vision**) relatively early "inability to read fine print" | Pediatrics: strabismus & amblyopia.

Correction of hyperopia

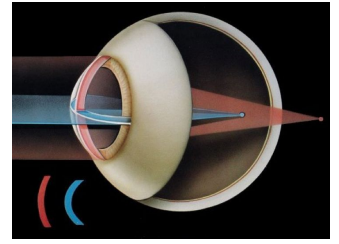
Convex lenses (positive)

	Myopia	Hyperopia
Other name	Nearsightedness / Short-sightedness	Farsightedness / Long-sightedness
Focal point	Single point in front of the retina	Single point behind the retina
Refractive power	Increased	Decreased
Axial length	Increased (long eye)	Decreased (short eye)
Correction	Concave lens	Convex lens
Picture		

Astigmatism

- **اللابؤرية:** ما عندها بؤرة وحدة / الانحراف (misleading لأن الانحراف ممكن يعني حول وهذا مو حول)

- Cornea is usually shaped like half a football. In these eyes there will be no astigmatism. you may describe it to the patient as "your eye is shaped as a rugby ball instead of a football"
- In astigmatism parallel rays come to focus in ≥ 2 focal lines rather than a single point.
- **Etiology:** hereditary.
- **Cause:** refractive media is not spherical \rightarrow refract differently along one meridian than along meridian perpendicular to it \rightarrow focal.



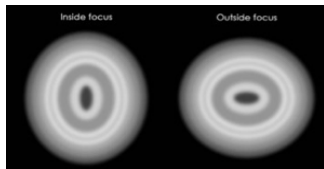
2 Meridians:
Blue: flat
Red: perpendicular
 = 2 focal points

كرة أقطارها متساوية \leftarrow single point focus \leftarrow طبيعي No astigmatism

كرة أقطارها غير متساوية جزء flat وجزء حاد \leftarrow two focal points \leftarrow غير طبيعي astigmatism

Classification

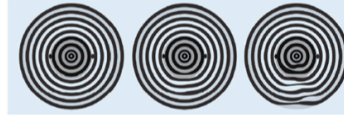
Regular astigmatism 2 focal points.



"لازم أتعامل مع two points، كيف أعالجها؟ (1) أشكلهم ك one بعدين (2) أحطها على الـ retina، أما الـ myopia و hyperopia بس مجرد أحطها على الـ retina"

Irregular astigmatism ≥ 2 focal lines

"اللي على اليسار شكلها منتظم بس اليمين الـ cornea مضروبة بسكين (eye injury) وخططانها لكن باقي المنطقة متعوجة (هي اللي تشنت الأضواء في أكثر من نقطة) وباقي الـ cornea تكون clear، هنا أنا أتعامل مع عشرة نقاط (أكثر من اثنين) فأصعب علاجها! فنجي لطريقة ثانية للـ treatment، أجيب حاجة وأضعها في القرنية فأخلي شكلها منتظم غصب عليها، ما ينفع معها glasses ولا ينفع معها شيء"



Types

فيه افتراضات كثيرة

1. **Simple Myopic Astigmatism:** one before the retina, and one on the retina.
2. **Simple Hyperopic Astigmatism:** one on the retina and another behind the retina.
3. **Compound Myopic Astigmatism:** both are before the retina but at two different locations.
4. **Compound Hyperopic Astigmatism :** both behind the retina but at different virtual locations.
5. **Mixed Astigmatism:** one is before the retina and the other is behind the retina.

Causes

Corneal causes (majority)

- Simple corneal astigmatism. بس جزء بسيط متضرر الباقي منتظم
- Keratoconus (causes myopic astigmatism) very common in our community \rightarrow Disease of the collagen of the cornea \rightarrow astigmatism عالي الدرجة
- Masses e.g. lid tumor يضغط من فوق ويتغير شكلها شيل الـ tumor بيروح الوزن ويطرف الـ lid وترجع الـ cornea للوضع الطبيعي
- Ptosis: لما يكون الجفن مرتخي على الـ cornea يضغطها شوي فـ induce astigmatism، و مهم عند الأطفال، طفل عنده congenital ptosis يصير عنده astigmatism ويسوي له .amblyopia



.amblyopia

Lenticular causes

- "واحد جاه بوكس وصار اختلال في شكل الـ lens"
- Lens dislocation. part of the zonules are cut. جزء من العدسة مرتخي فتصير غير متساوية
- Lenticonus. \downarrow



Symptoms

مع العالي الدرجة، يا عين أو عيني **distortion of vision** (with uncorrected astigmatism > 1.5 Diopters) Asthenopic symptoms (headache, eye pain), blurred vision, and turning, amblyopia (with uncorrected astigmatism > 1.5 Diopters) head tilting



Presbyopia

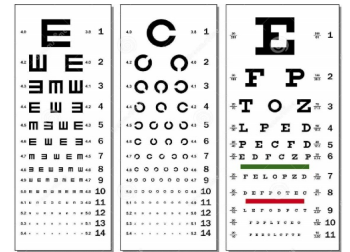
- Physiological loss of accommodation in advancing age
- Deposit of insoluble proteins in the lens with advancing age → elasticity of lens progressively decrease → decrease accommodation.
- **Around 40 years of age, accommodation become less than 3D** → reading is possible at 40-50 cm → difficulty reading fine print, headache, visual fatigue.
- Lens is not as flexible because of decreased elasticity (gets dry) + zonules relaxes.
- Correction of Presbyopia: **convex lenses** for reading.



"المريض يستخدم النظارة للقراءة لكن يناظر كبدونها، تلقى طول عمره ما يعرف النظارة، ولما وصل الأربعين بدأ يلاحظ الأشياء القريبة موب واضحة فيبدأ عشان توضح لكن بعدين مهما بيبدأ ما توضح، فيضطر يستخدم نظارة عشان يقدر يقرأ لكن البعيد كويس"

Testing Vision

- **Visual acuity** "لا تلخبطون بينها وبين الـ refraction حدة البصر"
 - Vital sign of the eye and first thing to do in the clinic with Intraocular pressure (IOP)
 - **Central visual acuity:** display of different sized targets shown at a standard distance from the eye: **Allen's & Snellen chart**. "أشكال أو حروف، تتدرج بالحجم من كبير إلى صغير بقياس معين" "ومسافة معينة"
 - Patient should be sitting & examine each eye alone (cover the other eye). Always start by showing large letters (assuming everyone is blind) and go smaller till normal.
 - VA: 20/20 (American), 6/6 (British) | 20/20 ft = 6/6 m. **What does 20/20 mean?**



The patient can see at 20 feet what the normal population can see at 20 feet. Just like vital signs we have ranges from the normal population. **Examples:** 20/200: the patient can see at 20 ft what the normal population can see at 200 ft (far away from the normal). 20/40: the patient can see at 20 ft what the normal population can see at 40 ft (not that far away from the normal)

● Testing poor vision

First: If the patient is unable to read the largest letter < 20/200 → Move the patient closer e.g. 5/200. "حتى الحرف الكبير ما يشوفه فأول شيء أسويه أقرب المريض، يعني مثلاً بدل ما أخليها 20ft أخليها 10ft وأجي أقول واللهمي he can see the الحرف الكبير 10/200 (he can see at 10 ft what the normal can see at 200 ft) ↓ إلى"

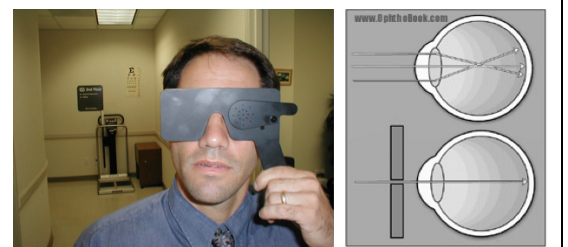
Second: If patient cannot read:

1. Count fingers (CF) examine each eye alone and write down the distance ex. CF at 1 foot or 2 feet. Not ↓
2. Hand motion (HM) Not ↓
3. Light perception (LP) with a torch examine all quadrants: up, down, right, left (sometimes all quadrants are affected except one). You have to document that.
4. No light perception (NLP) complete blindness تماماً ما يشوف

● Pinhole testing simple but very important. Routinely done to all patients with decreased VA.

"مثال: مريض زار العيادة، أول ما جاء قسنا الـ VA حقتة، لقينا حدة البصر 20/100 معناته أنه decreased، و (he is far away from normal)، طبيب ليش؟ هل عنده refractive error ولا lens disease زي الـ cataract ولا retinal ولا optic nerve؟ we don't know نجي هنا نستخدم هذي الـ tool"

"زي البلاستيك يغطي عين والعين الثانية فيها فتحات صغيرة، نط قدامه الـ Snellen chart ونقوله ركز على وحده من الفتحات الصغيرة و نقيس الـ visual acuity مرة ثانية (pinhole will cause muscle spasm) إذا تحسن لـ 20/20 فعنده refractive error بس ما ندري وش نوعه (corrects for about three diopters) وإذا ما تحسن فهو ماهو refractive error (شيء ثاني). كيف يتحسن النظر من فتحة صغيرة وأوصل 20/20؟ لاحظوا في الصورة الـ المريض عنده myopia لما أجي أحط له الـ pinhole بتسمح بدخول central ray فقط وتروح على الـ fovea أما بقية الـ rays هي اللي مسببة لمشاكل و confusion فـ we eliminate them. الفتحة هذي 1.2mm ف (it has to be 1.2) لو زادت أو نقصت بتغير القياسات وما بتوصل 20/20، زي اللي يصغرون فتحة عينهم لما يناظرون التلفزيون يعملون pinholing عشان يتحسن نظرهم"



● **Measuring refraction video (1:05 to 1:31)**



"الآن لقينا بالفعل المريض عنده refractive error، ما ندري عنده myopia ولا hyperopia ولا astigmatism، لازم نفرق هو جاي عندي ويبي أعطيه prescription، نبي نعرف النوع والدرجة in diopter، عشان نفصل له نظارة. فاستخدم الـ " **retinoscopy** "

Correction of Refractive Errors

● **Spectacle lenses "Glasses":** most common

- **Monofocal lenses** لها قوة وحدة: spherical lenses for myopia and hyperopia, cylindrical lenses for astigmatism
- **Multifocal lenses** لها قوتين: for patients with: presbyopia + myopia/hyperopia.

First picture: Hyperopia

إما حجم العين صغير أو القوة ضعيفة، نحتاج عدسة قوية (+) | شكلها Biconvex

Second picture: Myopia

إما حجم العين كبير أو القوة قوية، نحتاج عدسة (-) نصعب عليها الأمور ونبعد الـ rays زيادة لأنها قوية | شكلها Biconcave

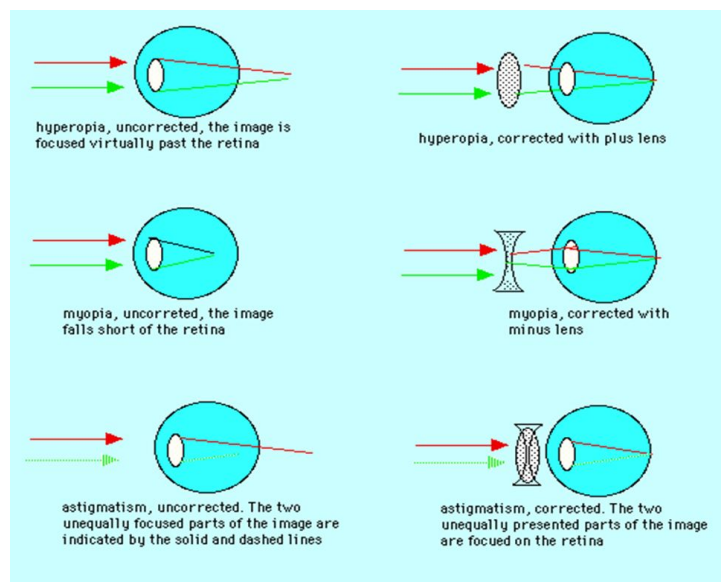
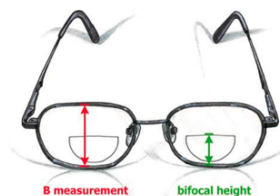
Third picture: Regular astigmatism corrected with cylindrical lens: has both (plus +, minus -)

باقى التفاصيل العميقة و الـ advanced يدرسونها الـ optometrists

بقية التفاصيل العميقة و الـ advanced يدرسونها الـ optometrists

Multifocal lenses

Has 2 lenses (powers) One for far vision (up) and the other for near vision (down).



To summarize the Tx: (1) Cylindrical lens → astigmatism +/- myopia or hyperopia (2) Biconcave lens → myopia (-) (3) Biconvex lens → to correct hyperopia (+)

● **Contact lenses.** common

● **Keratorefractive surgery:** last option, options: cornea (change shape) or intraocular to get rid of glasses

1. Cornea LASIK (Laser-Assisted In-Situ Keratomileusis), **INTRALASIK**, **LASEK** (Laser Epithelial Keratomileusis). We remove part of the stroma (central part) using laser by evaporating tissue from corneal surface. **Video1** | **Video2** (not the same as presented by the doctor)

2. Intraocular: PRK (Photorefractive Keratectomy): another lens ننشيل العدسة الطبيعية ونزرع بدلها (iris تربط العدسة بالـ iris) بدل ما أحط العدسة (نظارة أو عدسة لاصقة) أمام العين أحطها في العين " أو نزرع عدسة أمام العدسة الطبيعية (تربط العدسة بالـ iris) بدل ما أحط العدسة (نظارة أو عدسة لاصقة) أمام العين أحطها في العين "

Clinical Scenario


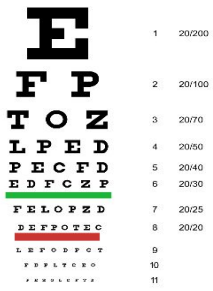
Scenario: 14 year-old boy complaining of difficulty seeing the blackboard (common presentation)

- **Visual acuity (VA):** 20/200 (first thing to do)

- **PH (Pin hole):**

- **Improve:** (1) to 20/20 → Refractive errors | (2) to 20/80 → both. (RE & other cause)
- **No improvement** → Other causes: cataract, optic nerve disease..etc

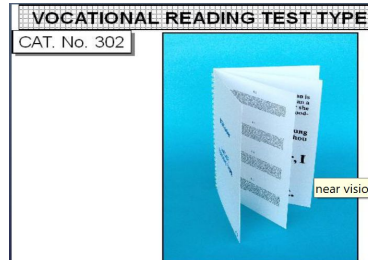
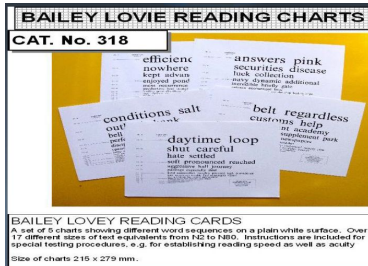
- The refractive index of a medium is defined as the ratio of the phase velocity of a wave light in a reference medium to its velocity in the medium itself.
- To have a clear picture in the retina & to be seen in the brain, there should be a clear cornea, clear anterior chamber, and clear lens, clear vitreous cavity then the picture should be focused on the retina with normal refractive index.
- The retina is responsible for the perception of light. It converts light rays into impulses; sent through the optic nerve to your brain, where they are recognized as images.
- Power of accommodation is $\{(15 - \text{age})/4\}$ of the lens. accommodation is strong in children.
- All three types of ametropia can be corrected by spectacle lenses . These diverge the rays in myopia, converge the rays in hypermetropia, and correct for the non - spherical shape of the cornea in astigmatism.
- Japanese tend to have myopia more due to their crowded narrow surroundings which requires excessive accommodation.
- Symptoms of hyperopia: Accommodative esotropia: because accommodation is linked to convergence leading to esotropia..
- It should be noted that in hypermetropia, accommodative effort will bring distant objects into focus by increasing the power of the lens. This will use up the accommodative reserve for near objects.
- Astigmatism is a common and generally treatable imperfection in the curvature (**mismatched curves**) of the eye that causes blurred distance and near vision. It's the worst in the quality of vision.
- In astigmatism, surface of cornea is not homogenous. Usually it is congenital.
- Regular astigmatism: (2 meridians) power and orientation of principal meridians are constant. The principal meridians are 90 degrees apart (perpendicular to each other). With the rule astigmatism, Against the rule astigmatism, Oblique astigmatism.
- Irregular astigmatism: (different meridians > 2) power and orientation of principal meridians change across the pupil. The principal meridians are not perpendicular.
- **Anisometropia:** (not mentioned by the doctor or slides)
- * Anisometropia is the condition in which the two eyes have unequal refractive power. Generally a difference in power of two diopters or more is the accepted threshold to label the condition anisometropia. the image of an object in one eye differs in size or shape from the image of the same object in the other eye.
- * More than 3 diopters difference if not detected in pediatrics and corrected it can cause unilateral amblyopia “in the weaker eye”.
- * Individuals can tolerate up to 2-3 Diopters of anisometropia before becoming symptomatic.
- * If the difference between 2 eyes: (D=diopter), > 3D → glasses | > 3 but < 7 → contact lenses | > 7D → surgery.
- Causes:** Correction of a refractive error Anisometropia, Antimetropia (being myopic (nearsighted) in one eye and hyperopic (farsighted) in the other.), Meridional aniseikonia occurs when these refractive differences only occur in one meridian (see astigmatism), Refractive surgery.

Allen chart (age 3 – 6 years)	Snellen chart (more than 6 years)
	

- Notes for testing vision & VA:

- * In the first 2 months of life: do light objection test (if the baby objecting or closing the eye in response to light it means he/she is seeing)
- * From 2 months – 3 years: do follow and fixate test. At this age, babies will start to follow the objects, so bring a toy in front of them and do the test. (If following the toy → good vision). OR you can do (central= seeing centrally. Steady= no nystagmus. Maintained= baby is following object & after blinking he/she continues following the same object)
- * The vision maturation is acquired skill for the brain, so babies when they're first born they will be legally blind.

- * The axial length of the eye will grow quickly in the first 6 months. So if anything stops the growing they will have amblyopia (lazy eye) E.g: vitreous hemorrhage, congenital cataract.
- * **Legal blindness:** if the vision in the best eye is w/ best correction and providing less than 20/200, this is considered legal blindness. (patient needs assistance). The criteria used to determine eligibility for government disability benefits and which do not necessarily indicate a person's ability to function. In the US, the criteria for legal blindness are: * Visual acuity of 20/200 or worse in the better eye with corrective lenses. * Visual field restriction to 20 degrees diameter or less (tunnel vision) in the better eye. Note that the definition of legal blindness differs from country to country.
- * **Testing near visual acuity:** It is done at a standard working distance ~ 30-40 cm. A variety of charts are available:



Low Vision Test Card		(or better)	Suggested
		Equivalent	ACD
10M	Your eyes	20/50	240
15M	may have a	20/75	200
20M	lot of problems	20/100	150
30M	but you still have	20/150	100
40M	some vision to work	20/200	75
50M	with. There are several	20/300	60
60M	problems that patients have.	20/400	45
80M	the best needs to be larger and the	20/600	30
100M	words in the test are contained in a	20/800	20
150M	single line of text	20/1200	15
200M		20/1600	10

Not all 40M with best corrected, with an 800 power needed
 100/2000 (40M) and greater to read the words
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* - To assess the effect of pathology on VA. You must eliminate the effect of refractive error. This is achieved by measuring: the patient's best spectacle correction or viewing the test chart through a pinhole.

- Contact lenses:

- * Higher quality of optical image and less influence on the size of retinal image than spectacle lenses
- * Indication: cosmetic, athletic activities, occupational, irregular corneal astigmatism, high anisometropia & corneal disease
- * Disadvantages: careful daily cleaning and disinfection.
- * Complications: infectious keratitis, giant papillary conjunctivitis, corneal vascularization, and severe chronic conjunctivitis.

- Refractive surgery – flattens corneal surface (more successful because it's easier to flatten than to make it more convex) for myopia or increases its curvature in Hyperopia.

- Improves unaided visual acuity but may have complications.

- Intraocular surgery: for high power للتي نقصهم مرة عالي, نشيل العدسة بكبرها ونحط جديدة أو نزرع عدسة قدام العدسة الطبيعية

- o Give best optical correction for aphakia; avoid significant magnification and distortion caused by spectacle lenses.
- o Clear lens extraction (with or without IOL)
- o Phakic IOL (intraocular lenses): lenses made of plastic or silicone that are implanted into the eye permanently to reduce a person's need for glasses or contact lenses.
- o One of the side effects of intraocular lens procedure => loss of accommodation.

	Photorefractive keratectomy (PRK)	Laser-assisted-in-situ Keratomileusis (LASIK)
Flap	No flap. We just remove the epithelium apply laser then the epithelium will grow.	Thin flap.
Advantage	Safer on the long run.	Immediate 20/20 vision, no pain, good visual rehabilitation, can correct high numbers (up to-80)
Disadvantage	Severe pain for 1 week, blurred vision for 2-3 weeks	Severe trauma, the flap can fall down