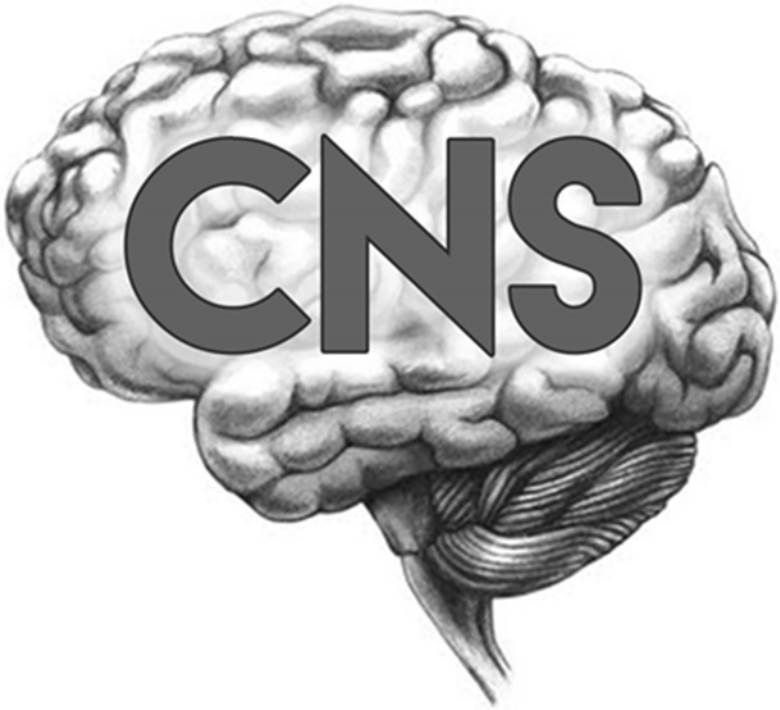


PHYSIOLOGY

Sheet ○ Slide ○ Handout

Number

14

Subject

Thermal sensation and vision

Done By

Sohaib

Corrected by

The correction team 😎

Doctor

Faisal Mohammad

Date: 00/00/2016

-Written according to section 3 recording.

---

① Last lecture review:

- **In the last lecture we talked about pain :**
  1-Types of pain *(fast and slow)*
  2-Pathways of pain *(neospinothalamic for fast pain and paleospinothalamic for slow pain)*
  3-Parts of analgesia system: - the endogenous opioids (chemical) system
  - the gate control theory (called theory because its not proved 100%)

  4-Visceral pain *(poorly localized, referred to the dermatome from which the visceral organ originated in the embryo because the viscera is not represented in the cerebrum cortex.*

---

② Thermal sensation:

- **Transmitted through the anterolateral spinothalamic pathway.**
- **We have 2 types of thermal sensation: warm and cold. Each of them having its own receptors, but the density of *cold* receptors at any part of the body is more than *warm* receptors.**
- **We have 3 types of receptors that contribute to this sensations: cold, warmth and pain receptors, the integration of these results in the different gradations of thermal sensation. Pain receptors are stimulated at extreme degrees of cold and hot.**
  *****So 4 types of nerve fibers could be stimulated: cold fibers , warmth fibers , pain fibers transmitting extreme cold (Cold-pain) and pain fibers transmitting extreme heat (Cold-heat).***
- **The localization of *cold sensation* is the similar to that of fine touch *(more localization in the face, finger tips ...etc)***
- **Cold receptors are attached to Aδ fibers and warm receptors are attached to C fibers.**

➢ Mechanism of stimulation of thermal receptors

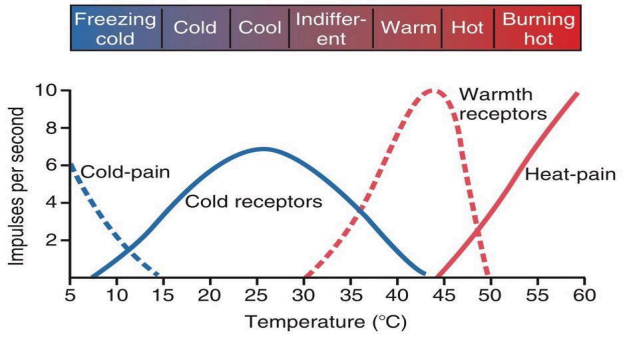
-The receptors response to a change in temperature by changing their metabolism, changing the metabolism will change the permeability of the receptors to certain ions leading to the formation of receptor potential.

Remember:
Receptor potential is local, either depolarizing or hyperpolarizing, graded, doesn't follow all or non law, and the greater the receptor potential the greater the number of action potentials that are going to travel to the afferent neurons (because we're going to stimulate the fibers during the relative refractory period).

-How can we differentiate between varying temperatures? The mechanism is similar to that of position sense. As you remember: when you are extending your arm, there are some neurons that increase their firing rate, and others that decrease it, this combination of impulses is read in the brain as extension, and when you flex your arm, there are other neurons that increase or decrease

their firing rate and the combination is read as flexion *(each combination is specific for 1 degree of either extension or flexion).*

If we look at 15 °C, this is going to stimulate the cold receptors only with certain number of impulses, but if we increase the temperature (35 °C) for example, we can see that now the warmth receptors as well as the cold receptors are stimulated *(each with certain number of impulses).*
So, this is how we determine the temperature we feel, by combination of stimulation of different neurons.



Discharge frequencies at different skin temperatures of a *cold-pain fiber*, a *cold fiber*, a *warmth fiber*, and a *heat-pain fiber*.

➢ Adaptation of thermal sensation

-Unlike pain, thermal sensations adapt and they have 2 phases of adaptation *(fast phase then slow phase).*
-We all have experienced this, for example, when someone takes a hot shower he feels that the water is too hot, but after a while the "hotness" is decreased *(similar thing takes a place in cold temperatures)*
-we explain this by the fact that the number of impulses from the afferent neurons decreases with time, so that the cerebral cortex will "think" that the stimulus *(hotness or coldness)* intensity has decreased, but what really happened is that the number of impulses has decreased to a number that is read by the cortex as a lower temperature.

Not mentioned:
According to Guyton, the impulses decrease rapidly in the first seconds, and decreases more slowly for 30 mins or more (but never decrease to 100%)
I think the doctor mean by fast phase the first seconds, and after it the slow phase.

Not mentioned :
For example, when you take a 40 °C water shower, initially the warmth receptors (for example) will fire 10 impulses/sec, after a while these impulses will decrease to 8 impulses/sec, so that the brain will sense the water as if it's 35 °C.

---

③Vision

➢ Introduction

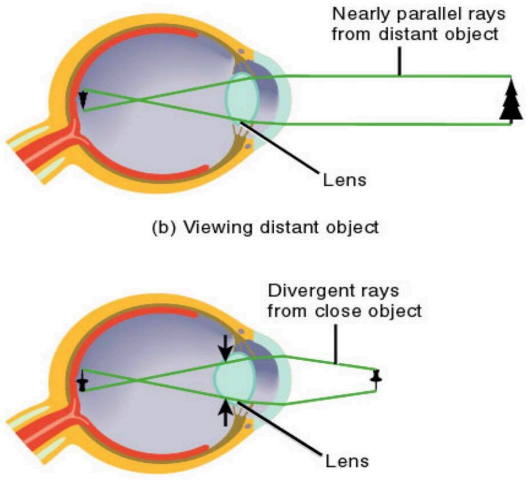
❖ **Vision is considered one of the special sensations; they are called special because their receptors are located in a specialized area.**
For example, vision receptors are located in the retina only, auditory receptors in the ear, taste receptors on the tongue and the pharynx.

- **The power of the lens is measured by a unit called Diopter *(not degree)*.**
- **Accommodation allows us to see both far and near objects clearly, and this is done by changing the thickness/convexity of the lens *(the distance between the eye and the lens is fixed and equals 17mm)*.**
- **In the normal eye there is something called the near point, and it's the minimal distance from the eye in which we can see clearly *(normally around 20-30cm)*. It's shorter than that in near-sightedness and in far-sightedness it's longer than normal (more explanation later on).**
- **The light rays are eventually focused on the retina.**

Near-sightedness and far-sightedness are called errors of refraction, and they differ from visual acuity"حدة الابصار' abnormalities *(visual acuity is what we describe when we say my vision is 7/9 -this numbering differs according to the unit used, feet or meters ...etc)*

➢ Refractive index

- **What we see is light reflected by a certain object.**
- **The speed of light is 300,000 Km/sec, and it passes through air faster than it does through other medias, so it refracts "ينكسر"**
- **Refractive index=**
  the speed of light in air / the speed of light in the substance.
  -Said that, the Refractive index is always >1 because light has the fastest speed in air.
  The doctor didn't discuss the degree of angulation but its mentioned in the slides (#4).



Notice that

-accommodation occurred in the lens when viewing a close object.
–the image is reflected upside down on the retina.

➢ Structure of the eye

❖ **The eyeball consists of 3 layers:**

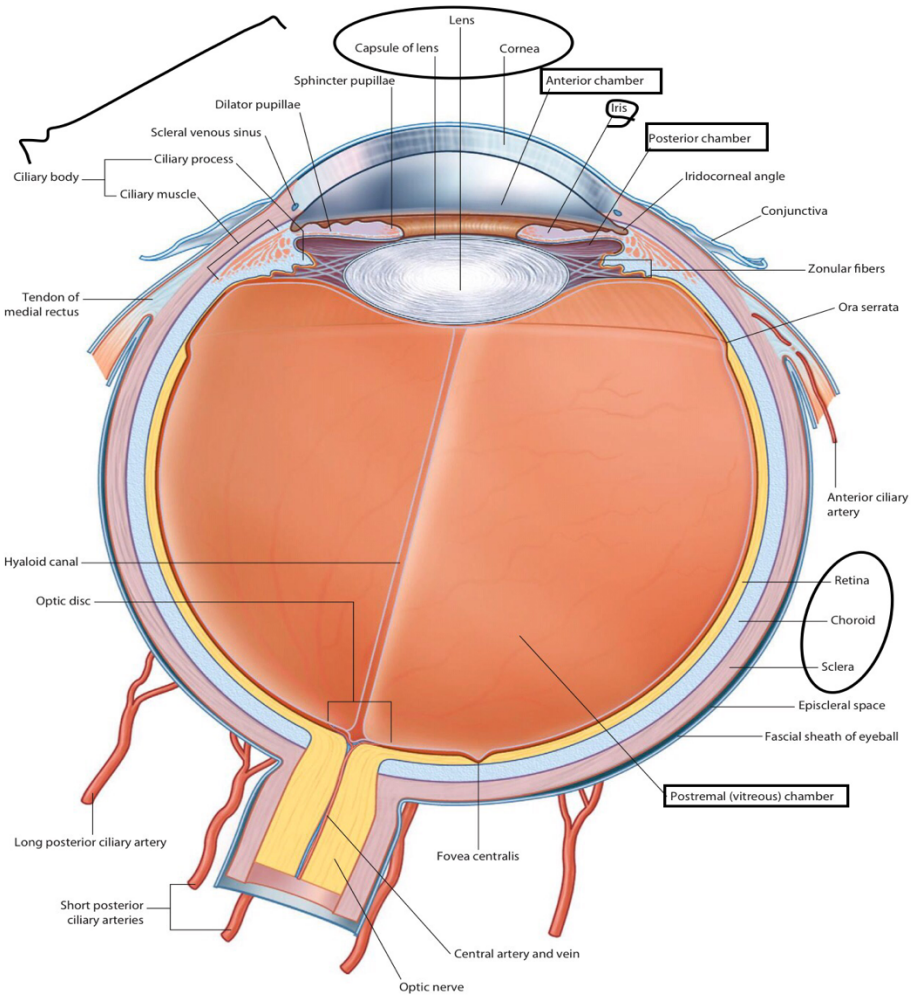
1-Sclera *(outer layer composed of hard connective tissue)*: it closes 4/5 of the eyeball, the remaining 1/5 *(continuation of the sclera)* is occupied by the cornea

The cornea is highly transparent and its avascular, and since its avascular, the cornea doesn't come in contact with the immune system, and that's why we can transplant the cornea from any person without the problem of rejection.

2-Choroid *(the middle layer)* : it's a vascular layer, continues anteriorly as the ciliary body which is connected to the capsule of the lens through the suspensory ligaments. The ciliary body continues as the iris *(the colored part of the eye)* and in the center of the iris there is the pupil.

The lens is composed of a strong elastic capsule filled with viscous, proteinaceous, but transparent fluid. As any other protein, the protein in the lens might be denatured and coagulate, and with age this denatured protein makes the lens opaque (this is called cataract "المي البيضاء").

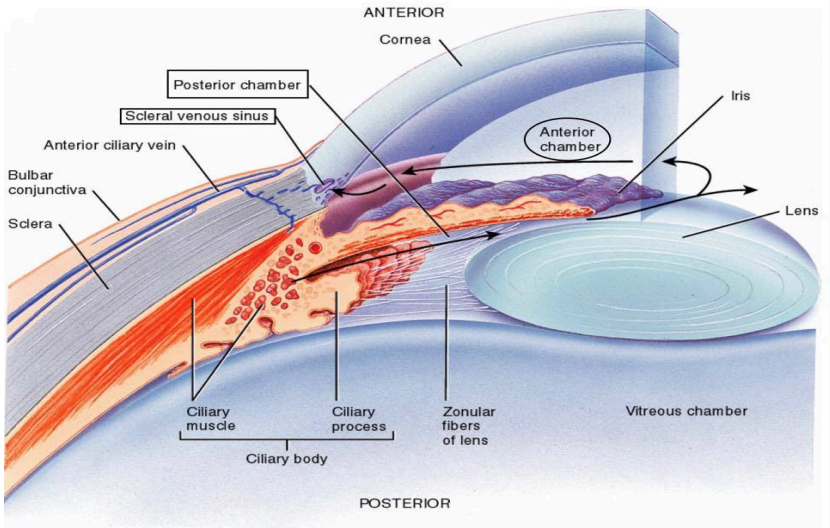
3-Retina *(the inner/neural layer)*: it's derived embryonically from a different layer than the choroid, and that's why they are not connected to each other.



❖ **The lens divides the eyeball into 2 cavities:**
1-Posterior cavity *(between the retina and the lens)* : contains a fluid called *vitreous humor* "gel-like", the vitreous humor is formed once and stays there *(unlike the aqueous humor)* to keep the structures of the eye *(to keep the retina in place by pressing it against the choroid).*

2- Anterior cavity *(between the lens and the cornea)* :
-Divided into anterior and posterior chambers by the iris.
-Contains a fluid called *aqueous humor*, unlike the vitreous humor, the aqueous humor is formed in the posterior chamber –by the ciliary processes- and drained by the canal of schlemm, both formation and drainage of it occurs continuously so that its quantity is fixed. The aqueous humor carries nutrients to the *avascular* cornea.
*****Just like the CSF, the aqueous humor has the same contents of plasma but without proteins.***
*****The canal of schlemm (Scleral venous sinus) drains into the venous circulation.***

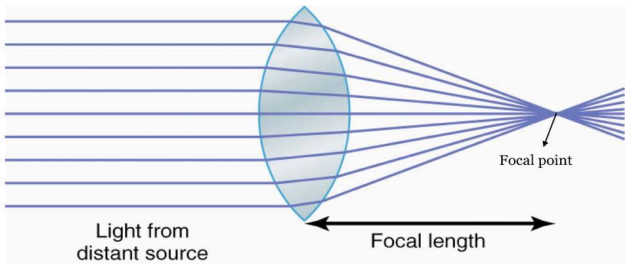
An injury to the eye might cause the vitreous humor to be spilled out (reduce the amount of the vitreous humor) that will result in detachment of the retina from the choroid *(the vascular layer)* and it goes anteriorly, so this detachment separates the receptors from their nutrition, leading to degeneration of these receptors *(eventually blindness).* Detachment of the retina is the only emergency in ophthalmology, and it requires immediate sealing of the retina within 24-48 hours.



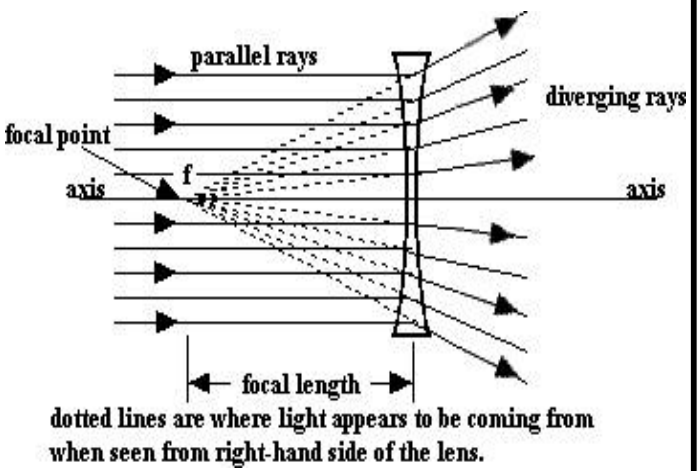
❖ **The pressure of the fluid in the anterior cavity of the eye is called intraocular pressure (normally it's 12-20 mmHg), it might be elevated due to decreased reabsorption by obstruction of the canal of schlemm *(more common)* or increased formation, the increased intraocular pressure is called Glaucoma "المي الزرقاء".**

➢ Refractive principles of a lens

❖ **spherical lenses are of 2 types: convex or concave, *(both of them have a focal point)*.**
-In convex lenses *(converging lenses)*, the light is collected at one point called the *focal point.*
*****The distance between the focal point and the mid line of the lens is called the focal length.***

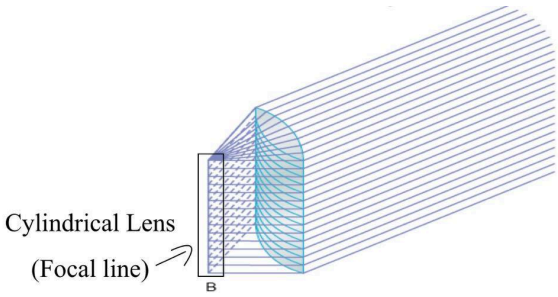


-The concave lenses diverge the light *(diverging lenses),* as if the light is coming from its focal point *(look at the figure and read what's under it)*.
-Because of the direction of the focal point *(and consequently the focal length)* the convex lens is said to be a positive lens and the concave is a negative lens. [When we say a person is wearing a +2 lens this means that the lens is convex and has a power of 2 diopters].



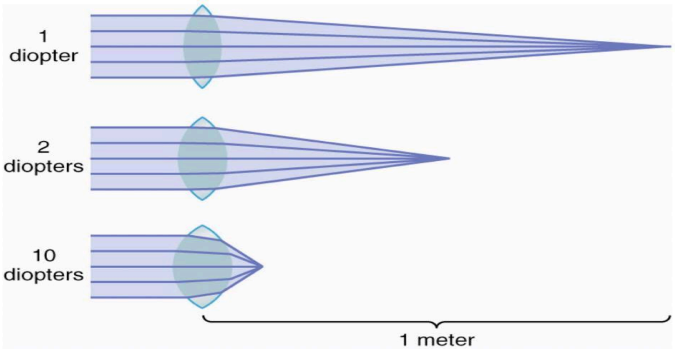
Not mentioned:
The focal point in the case of concave lenses is the backward extensions of the out-going light from the lens.

- **Cylindrical lenses can be thought of as multiple spherical lenses, so that they have *focal line (instead of focal point)***
  We are not going to talk about them until the end of the sheet (in Astigmatism) . From now on, lens = spherical lens.



➢ The refractive power of a lens

- **The power of the lens is measured by *diopters (so, 1 diopter is the ability to focus parallel light rays at a distance of 1 meter)* .**
- **Diopter=1/focal length in meters.**
  Examples:
  - If the lens has the power of 1 diopter then the focal length equals 1.
  - If the focal length is 10cm then the diopter equals 10.
- **The <u>more the convexity</u> of the lens is, the closer the focal point to the midline of the lens *(i.e. the lesser the focal length)*, and the <u>more is the power</u>.**

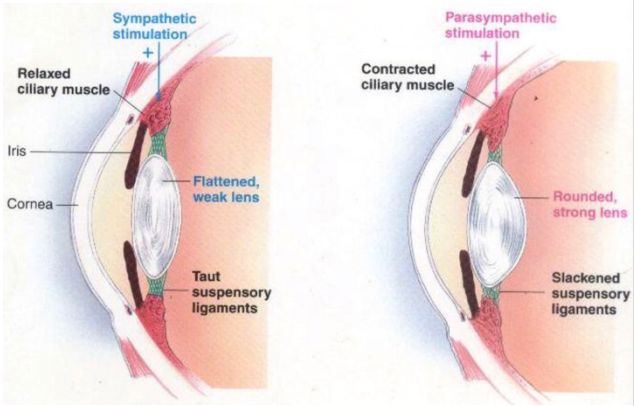


➢ Requirements of image formation on the retina:

1-Light refraction
-The light passes through 4 medias in its way to the retina, these medias are *(sequentially)* cornea, aqueous humor, the lens and vitreous humor.
-Each time the light passes through a media it is refracted.

-The total power of these 4 medias is 60 diopter *(the <u>cornea</u> contributes the most with around 42/60 contribution, the lens contributes <15/60)*. So, to replace all the 4 medias with one lens, the lens should have the power of 60 diopters *(this is called <u>reduced eye</u>, and its used for studying purposes only).*

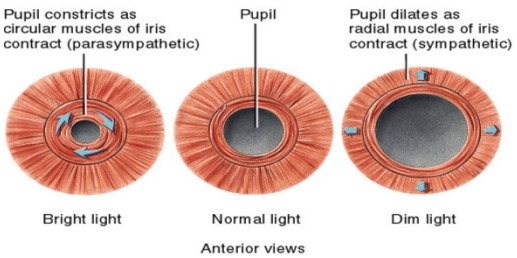
2-Accommodation: An increase in the curvature/convexity of the lens for <u>*near vision*</u>.
-The accommodation is important to focus the image on the retina *(without accommodation the image will fall behind the retina).*
-It occurs due to contraction of ciliary body, and because it contracts anteriorly, the suspensory ligaments become relaxed, so that the lens gets fatter *(more convex)*, and has more power as a result of that.
That's why if a person suffers from a problem in accommodation, he will squeeze his eyes to see near objects.
The ciliary body is under the control of parasympathetic fibers that come with the <u>oculomotor</u> nerve.



-When we look too far the ciliary body is relaxed, so it puts more tension on the suspensory ligaments and the lens gets flatter *(less convex).*
That's why in yoga they say :"look at a far object", because by this the eye relaxes.
-Those suffering from a problem in accommodation "squeeze their eyes" to help in accommodation.
-The lens in children is flexible, so it can change its convexity and consequently its power from 15 diopters for example to 35. But with age, this ability becomes less and less, until -let's say- the age of 40, the lens loses this ability and will become fixed *(this is called Presbyopia)*, and at this point the person must wear glasses to see close objects.
Presbyopia is caused by denaturation of the proteins of the lens making it less elastic.

not mentioned: So a person with Presbyopia holds lets say his phone far from his eyes to see well

3- Constriction (*meiosis*) or <u>d</u>ilation (*my<u>d</u>riasis*) of the pupil
-The iris has 2 types of muscles: radial muscle supplied by sympathetic fibers that dilates the pupil , and circular muscle supplied by parasympathetic fibers *(similar to the ciliary body, they come from the oculomotor nerve)* that constricts the pupil.
-When we look at a near object, the pupil constricts *(we don't need too much light when looking at a near object).*
-When we look at a far object, the pupil dilates.



4-Convergence and divergence of the eyes for binocular vision.

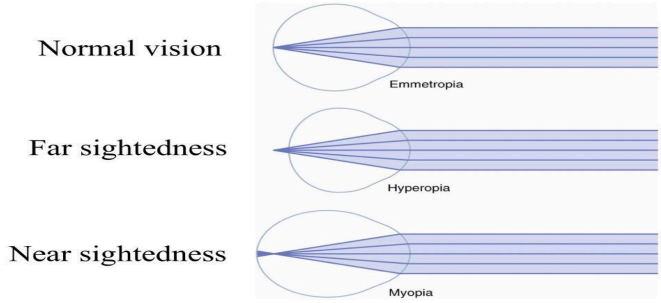
-We have 2 eyes 😮, and in every eye we have an image that is formed in the retina, these images are formed in closely corresponding points in the centres of the two retinas, and when they go to the cortex they overlap so that we see one image but how can both eyes focus the image on these corresponding areas?

By convergence and divergence (*occurs involuntarily)*.

-When we look at a near object, the eyes converge, and when we look at a far object, the eyes diverge.

-If you interfere voluntarily with this process *(by putting pressure on the eye)* you will see 2 images *(this is called <u>Diplopia</u> NOT strabismus "حول".*

➢ Errors of refraction



❖ **Far sightedness *(hyperopia or hypermetropic)*:**

-The image of the object is formed behind the retina.

-It might be a genetic condition in which the distance between the lens and the retina is *shorter* than normal.

-In this condition, if the person is looking at a far object, the image will form behind the retina, to correct this, the ciliary muscle contracts and the lens becomes more convex in shape *(i.e accommodation occurs)*, so that the image now will be formed on the retina, but when this person wants to look at a very close object (lets say 40cm away from him), he will not be able to accommodate because he has reached the maximum ability of the lens to do that.

The near sight point is the closest point at which we can see clearly.

*****In hyperopia the person reaches the max. accommodation at a distance longer than normal (normally, the <u>near sight point</u> is 30cm away from us, in these patients it's 40cm for ex.)***

❖ **Near sightedness *(myopia)*:**

-The image is formed in front of the retina.

-It might be a genetic condition in which the distance between the lens and the retina is *longer* than normal.

***** In myopia, the person reaches the max. accommodation at a distance shorter than normal (normally, the <u>near sight point</u> is 30cm , in these patients it's 20cm for ex.)***

Extra: (from guyton , peace be upon him :P)

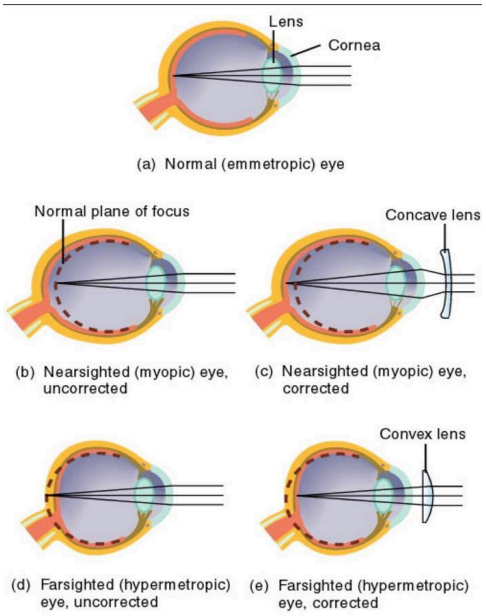
In myopia, when the ciliary muscle is completely relaxed, the light rays coming from distant objects are focused in front of the retina, No mechanism exists by which the eye can decrease the strength of its lens to less than that which exists when the ciliary muscle is completely relaxed. A myopic person has no mechanism by which to focus distant objects sharply on the retina. However, as an object moves nearer to the person's eye, it finally gets close enough that its image can be focused. Then, when the object comes still closer to the eye, the person can use the mechanism of accommodation to keep the image focused clearly.

❖ **How to correct them ?**

-In myopia, we use concave lenses to diverge the light so it is formed further in the back ***(i.e. in the retina in these patients)***

-In hyperopia, we use convex lenses

*****We correct hyperopia just because we want to relax the eyes of the patient (because he always needs to accommodate to correct his vision -without lenses-) , as he can live his life normally without them.***



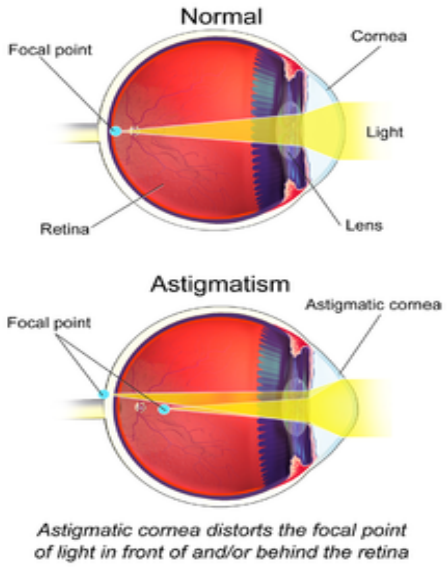
➢ Astigmatism

-Normally, the cornea can be thought of as too many cylindrical lenses, so that the ***<u>focal lines</u>*** **of all these cylinders will meet at one point.**

-If one of the planes of these cylindrical lenses is different ***(i.e. the curvature of the cornea is not normal)*****, the focal lines won't meet at one point so Astigmatism occurs.**

-Corrected by a cylindrical lens ***(not spherical as the previous ones.***

*****To find the suitable cylindrical lens, the doctor just keeps on trying lenses on the patient until the patient starts to see well with one of them...***



Astigmatic cornea distorts the focal point of light in front of and/or behind the retina

Sorry for any mistake 😇😇