**Today we will talk about how we can see images .**

In physics >> the light when move from one media to anther which is different in its density the light will change its direction this is what we call it **light refraction.**

If the surface between two Medias is flat so the light will change its direction to run in parallel direction.

If the surface wasn’t flat so the light will be either : converge or disperse

Same as in lenses **>>** the convex lenses which converge the light and the concave lenses which disperse the light.

**The convex lenses:** will converge the light so the light which comes from different directions will converge at the same point.

**Focal length**: is the distance which is needed to converge the light in one point.

**Now** :-

* The lenses which are not very much round (almost flat) will converge the light at far distance.
* The lenses which their surfaces more rounded will converge the light closer than the first one

“As much as the lens is rounded the convergence point will be closer”

this what we call it the **refraction power of the lens** .

the unit of the refraction power of the lens is “**diopter**” = 1m/focal length

now we are finished talking about physics we will start talking about the eye :

* The front surface of the eye (we talk about the corona) is rounded >> it will refract the light and change its direction.
* To see clearly the light must converge as one point on the **retina** of the eye. Because if it converges as two points we will see the things two times then the image will not be clear.
* The cornea will help the eye to refract the light and converge it as one point on the retina NOT THE LENS because the light when move from one media to another and change its direction >> the amount of refraction will depend on : 1- surface 2- the density of the media “the largest change in density it’s between the cornea and air”
* We said that the light should be converge as a one point on the retina
* The light may come from different sources as two points as an example one of them far away from the person and the other point is closer .
* If the source of the light was from far object then the light will take its time to disperse and run in parallel direction >> so when it is refracted by the cornea and converge it as a one point it’s much easier (as an ex : 50 cm )
* If the source of the light was from an object closer to the eye then >> the light still dispersing from its source so the lens should do two things : first it should refract the light to run in parallel direction then to converge the light as one point on the retina (in this case the point will be more distant for an ex : 70cm )
* If we want to converge the light which comes from short distances at the same point we should use more rounded lens (which has more refraction power) to refract the light which comes from different sources and different distances at the same point.
* this what happened in the eye :
* Mainly the light will be refracted by the cornea and converged as one point on the retina >> this happens normally when we talking about light which comes from distant area.
* When we talking about the closer objects >> the cornea will not be able to refract the light and converge it on the SAME point which was in the first case because the cornea need more distance to disperse the light and then converge it again >> this point will be farther than the first point BUT we know that the distance between the cornea and the retina is constant >> we need to use a larger lens or more rounded one to converge the light on the retina.
* **Lens accommodation:** Are the changes which happened to the lens of the eye from flat lens (for distant source of light) to more rounded lens (for closer source of light).

**CLINCAL CONSIDERATIONS:**

The lens is almost transparence but if this transparency become less by obesity of the eye or anything else didn’t allow the eye to see clearly this is what we call it >> catalet !

Some people can’t refract the light as much as they should either for distant or closer things either by converge the light before the retina of the eye (they won’t be able to see distant things) or by convergence the light after the retina of the eye (they won’t be able to see closer things)

DON’T FORGET THAT TO SEE ANY THING THE LIGHT SHOULD BE REFRACTED AND THEN CONVERGE AS ONE POINT ON THE RETINA OF THE EYE SO ANY LIGHT WHICH WILL NOT REACH THE RETINA WE WILL NOT BE ABLE TO SEE IT ☺

**Vision problems:**

1- Ametropia : refraction error, inability of properly focusing light on the retina, a frequent reason for reduced visual acuity >> **it has two cases** :

a- near-sighted ( قصر النظر ) : the patient almost has a problem either in refraction the light or in eye itself (the eye is longer than its normal length) >> the light comes from its source >> the lens is flat as much as it can BUT the light still converge before reaching the retina >> this patient can’t see the distant objects.

the solution >> Give the patient concave lens by this lens the light will disperse so the lens will take longer time and more distance to converge it as one point.

b- farsighted (طول نظر ) : the is smaller than its normal size >> the light come from its source >> the lens is round as much as it can BUT the light converge after the retina >> this patient can’t see the closer objects .

The solution >> Give the patient convex lens to help him to refract the light more and converge the light at closer point

* The lens of the eye is elastic >> is some cases the elasticity of the lens changes >> this leads to something call >> **Presbyopia**
* **Presbyopia**: Loss of accommodation by the lens because the elasticity of the lens became LESS.
* The problem her is :
* The elasticity of the eye became less
* The eye will not be able to conduct the shape of the lens surface ( to become more flat >> for distant sources of light or become more rounded >> for distant sources of light)
* If the lens can’t become more rounded so the patient will not be able to see closer objects (the lens will not be able to converge the light as much as it should) >> a patient with farsighted >> and this is what happened with old people first
* The elasticity of the eye become less with the age and the muscles of the eye become weaker >> so old people will not be able to see far objects ,too >> they will suffer from nearsighted

**NOTES**:

* The old people with near-sighted and farsighted will not be able to see far and close objects BUT they can see anything between them.
* If the patient has near-sighted this **doesn’t** mean that the patient will not have farsighted
* The patient with farsighted WON’T be able to see far objects more than u >> its problem is by seeing the close objects but the far objects he can see it as ANY NORMAL PERSON.

2- Astigmatism (الانحراف) : irregular curvature of either the cornea or the lens, which lead to blurred or distorted vision due to parts of the image are out of focus.

* The front of the eye is rounded >> the light which comes from different destinations will be refracted in same degree
* If we have a problem with the cornea >> the cornea is not rounded from its all sides >> the cornea has irregular curvature >> the light which comes from different destinations will not be refracted and converged as a one point >> the light will be refracted as more than one point >> one point on the retina and the other is not >> the image will not be clear.
* The astigmatism is happened by: inflammation, congenital, anything else.
* The solution >> give the patent a lens which can refract the light in one plane

We talked about how we can solve vision problems by using different types of lenses according to patient situation >> BUT now a days there is what we call it **lasic** >> lasic can be used for farsighted , near-sighted and for astigmatism .

**NOTE**:

* The eye still growing up until 18 years of old >> the normal growth of the eye is effected by: the amount, source, and the type of light >> the size of the eye, the shape of the retina and the curvature of the cornea all these will be effected
* When our parents told us not to set close to the TV to avoid vision problems they were alright ;)
* Pupillary Adjustment WE WILL TALK ABOUT IT LATER .

Visual acuity:

* If everything is good; the eye and retina is working normally and the refraction is normal >> we have to see images clearly
* The normal person can distinguish contours that are approximately 1.75 mm apart at 6 meters distance from the eye.
* If we put this two points at distance more than 6 m >> the person will have difficulties to see them clearly or distinguish between them.
* Some people can see the 2 points although they were farther than 6m >> in this case the person's visual acuity is "super" more than normal (but this doesn't mean that this person **has farsighted** )
* We can measure the visual acuity by a chart >> this chart will be at 6m away from the patient and the distance between 2 "E" letter equals 1.75mm

Note: in our clinic if the distance between the patient and the chart wasn't 6m >> then we put a mirror at 3 m away from the patient then the total distance will be 3\*3 which is = 6

* Normal person can see until line number 7 in the chart (he can see the line num. 7 clearly)

Notes:

* The line number 7 always take num. 6
* The line number 6 will take num. 9
* The line num. 5 will take num. 12
* The line number 4 will take num. 18
* These numbers says that normal person can see this line at this distance >> as an ex: normal person can see the line num. 6 at distance= 9 m
* Average person can't see the line number 8 but as we said before if he could this will be good and his visual acuity is more than normal
* If the person can't read the line num. 6 then:
* His visual acuity is less than normal
* Ask the patient at which line he can see the letters clearly
* Then we say that the patient visual acuity is = 6/ the number of the line

Ex :

If the patient can see the line num. 6 clearly but he couldn't see the line num. 7 then his visual acuity = 6/9 (according to the number which mentioned before) >> this means that this patient can see the line (which normal person can see at distance = 9m) at distance = 6

**Note**:

The chart just determine if the visual acuity for the person is ok or not But it doesn't determine the focal force which person needed to give him a lens >> to give a patient a lens u should try a lenses in different degrees until he can see the chart clearly to determine which lens must give to the patient

* We have here one problem that this chart will not be useful to tell as if the patient has farsighted >> because this patient has no problem of seeing the far objects he can see them as any normal person as we said before >> in this case :
* Give the patient small chart which he can carry by his hand
* Normally the distance between the hand and his eye = 30cm
* The chart has more than one paragraph in different front sizes
* We ask the patient to read from the chart an determine at which level he lose his ability to read.

We will go back to the retina:

* We said that in retina we have two types of photoreceptors; rods and cones
* The rods can see almost all wavelengths
* The cones have 3 types : each one can see part of the wavelength
* The activity of these three cones represented as a curve >> this means each one has a wide range of wavelength which can make the photoreceptor on to send an action potential to the brain
* In the chart you can see that the wavelength = 400 will turn the first photoreceptor on by 25% (which means that this photoreceptor will send 25 action potential per second)
* If the wavelength = 450 then the frequency of action potential which can give = 100 action potential per second
* Notice that we have overlapping between them >> this means that one wavelength will turn on the photoreceptors but in different degrees ( each photoreceptor will send its own frequency of action potential according to the wavelength )

\*\* don't forget that we see by our brains not by our eyes \*\*

To explain this:

* The eye receives certain wavelength
* The wavelength will turn on the 3 cones at different amount
* The signal will transmit to the brain as frequency of action potential
* EX:
* if the eye received wavelength = 450
* look to the chart :

The first cone will give 97 action potential per second

The second cone will give 0 action potential per second

The third cone will give 0 action potential per second

* **the brain will understand that this colour is BLUE**
* we have more than one degree of the blue colour so the brain should distinguish between them >> the brain do that by the differences in frequency of action potential (each degree has its own frequency )
* if the first frequency of action potential was 97 and the second one was 92 BOTH ARE BLUE but in different degrees ☺
* another example :
* wavelength is around 500
* look to the chart :

The first cone will give 31 action potential per second

The second cone will give 36 action potential per second

The third cone will give 67 action potential per second

* **the brain will understand that this colour is GREEN**

\*\* NOTE : you shouldn't memorise this numbers

**Colour blindness :**

* as we said that normal person has 3 types of cones; blue , red and green
* if one or more cones are not found in the person >> then the person will have problem to distinguish between colours
* there are more than one case for colour blindness :

1. people who don't have any type of cones ( they have rods only) >> they can't see any colour they just see the images in black and white ( this is the worst case but luckily it is the least common one )
2. people who have one type of cones and the other two types is absent >> they will see images like the black and white case But a little bit better
3. people who have 2 types of cones and one type is absent (this is the most common type)

There are 3 cases :

1. The BLUE cones are absent >> the least chance to find because the protein is carried by chromosome number 7 >> this case called "Tritanopia"
2. The red cons are absent >> this case is called "Protanopia"
3. The green cons are absent >> this case is called " Deuteranopia"

\*\* the red green blindness is the most common because the protein is carried by X chromosome

In some cases the cones are found but there is a change in their proteins because of whatever; mutation, congenital factors, etc... >> So the photoreceptor's sensitivity for the light (wavelength) will change which means the curve will be shifted

\*\*\* This case is called **anomaly**

**Anomaly:** shift in the spectrum of one of the proteins >> examples:

Deuteranomaly >> for green cones

Protanomaly >> for red cones

Tritanomaly >> for blue cones

**Note:** you have to differentiate between the ano**maly** and **opia**

The most common anomaly is for green cons >> red cones >> blue cones

* As we said before for normal person :
* The eye will receive certain wavelength
* This wavelength will send activity to the 3 cones by certain frequency
* Example : in the chart if you look to one degree of the green colour you will find that :

The first cone will give 0 action potential per second

The second cone will give 75 action potential per second

The third cone will give 99 action potential per second

* In this case the brain will understand that this colour is **green**
* For a patient with Deuteranopia (green blindness) >> the green cone is not founded so the last reading for same wavelength will be as this:

The first cone will give 0 action potential per second

The second cone will give 75 action potential per second

The third cone will give 0 action potential per second

There is no other area of the wave will give the brain this coding (also the brain can see this object in green colour) >> the patient can see all colours ☺

* The problem for the patients with colour blindness is in distinguish between related colours
* The patient with Deuteranope will see the tree GREEN in colour
* The problem is like this :

If you look to the chart at the two sides of the curve which represent two areas (green with orange/ green with yellow) if there is a problem in green cone then it will not function so the coding will sent to the brain from both areas by (0,90,0)

The patient will see this two colours the same ☺

To examine the patient you give him a chart like the chart like the one which found in the slides :

* Ask the patient which numer he can see
* If the patient can see number 74 then he is normal
* If the patient can see number 21 then the patient has green-red blindness
* To examine if patient has Protanope or Deuteranope we give him the second chart :
* If the patient can see number 4 >> Deuteranope
* If the patient can see number 2 >> Protanope

\*\* sorry for any mistake ☹

