B. Ed. Spl. Ed. (M. R. / H. I. / V. I)- ODL Programme

AREA - C

C-12 : INDENTIFICATION OF CHILDREN WITH VISUAL IMPAIRMENT AND ASSESSMENT OF NEEDS

A COLLABORATIVE PROGRAMME OF
NETAJI SUBHAS OPEN UNIVERSITY
AND
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AREA - C ● DISABILITY SPECIALISATION COURSES

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INDENTIFICATION OF CHILDREN

WITH VISUAL IMPAIRMENT AND ASSESSMENT OF NEEDS

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The Self Instructional Material (SIM) is prepared keeping conformity with the B.Ed.Spl. Ed. (MR/HI/VI) - ODL Programme as prepared and circulated by the Rehabilitation Council of India, New Delhi and adopted by NSOU from the 2015-2017 academic session.

Netaji Subhas Open University

From the Vice-Chancellor's Desk

Dear Students, from this Academic Session (2015-17) the Curriculum and Course Structure of B. Ed.- Special Education have been thoroughly revised as per the stipulations which featured in the Memorandum of Understanding (MoU) between the Rehabilitation Council of India (RCI) and the National Council for Teacher Education (NCTE). The newly designed course structure and syllabus is comprehensive and futuristic has, therefore, been contextualized and adopted by NSOU from the present academic session, following the directives of the aforesaid national statutory authorities.

Consequent upon the introduction of new syllabus the revision of Self Instructional Material (SIM) becomes imperative. The new syllabus was circulated by RCI for introduction in the month of June, 2015 while the new session begins in the month of July. So the difficulties of preparing the SIMs within such a short time can easily be understood. However, the School of Education of NSOU took up the challenge and put the best minds together in preparing SIM without compromising the standard and quality of such an academic package. It required many rigorous steps before printing and circulation of the entire academic package to our dear learners. Every intervening step was meticulously and methodically followed for ensuring quality in such a time bound manner.

The SIMs are prepared by eminent subject experts and edited by the senior members of the faculty specializing in the discipline concerned. Printing of the SIMs has been done with utmost care and attention. Students are the primary beneficiaries of these materials so developed. Therefore, you must go through the contents seriously and take your queries, if any, to the Counselors during Personal Contact Programs (PCPs) for clarifications. In comparison to F2F mode, the onus is on the learners in the ODL mode. So please change your mind accordingly and shrug off your old mindset of teacher dependence and spoon feeding habits immediately.

I would further urge you to go for other Open Educational Resources (OERs) - available on websites, for better understanding and gaining comprehensive mastery over the subject. From this year NSOU is also providing ICT enabled support services to the students enrolled under this University. So, in addition to the printed SIMs, the e-contents are also provided to the students to facilitate the usage and ensure more flexibility at the user end. The other ICT based support systems will be there for the benefit of the learners.

So please make the most of it and do your best in the examinations. However, any suggestion or constructive criticism regarding the SIMs and its improvement is welcome. 1 must acknowledge the contribution of all the content writers, editors and background minds at the SoE, NSOU for their respective efforts, expertise and hard work in producing the SIMs within a very short time.

Professor (Dr.) Subha Sankar Sarkar
Vice-Chancellor, NSOU

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C-12 : INDENTIFICATION OF CHILDREN WITH VISUAL IMPAIRMENT AND ASSESSMENT OF NEEDS

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Netaji Subhas Open University

AREA - C

C-12 : INDENTIFICATION OF CHILDREN WITH VISUAL IMPAIRMENT AND ASSESSMENT OF NEEDS

C-12 ❐ Indentification of Children with Visual Impairment and Assessment of Needs

Unit -1 ❐ Anatomy and Physiology of Human Eye

Structure

1.1 Introduction

The eye is one of the most complex sense organs of the human body which gives us the sense of light. It allows us to observe and learn more about the surrounding world than we do with the help of any of the four other senses. We use our eyes in almost every activity we perform, whether watching, reading, writing, working, viewing television, driving a cycle, and in countless other ways. It also allows us to see and interpret the shapes, colours and dimensions of objects in the world they reflect or emit. The eye is able to detect bright light or dim light, but it cannot sense object when light is absent. In the following sections the structure and functions of human eye, vision development and process of seeing, principles of refraction and refractive errors, blindness and low vision and other related concepts are discussed.

1.2 Objectives

After going through the self-instructional materials in Sub-Unit 1, the learners will be able to:

- Know about the structure and functions of human eye;
- Understand normal vision development and process of seeing;
- Understand the principles of refraction and refractive error;
- Understand the blindness, impairment and low vision;
- Understand the Concepts of Visual Acuity, Visual Field, Depth Perception, and Contrast Sensitivity.

1.3 Structure and Function of Human Eye

1.3.1 Structure of Human Eye

The human eye is one of the most complex organs in our body. It is amazing that something so small an organ can have so many working parts. But when you consider how difficult the task of providing vision really is, perhaps it's no wonder after all.

The outer covering of the eyeball consists of a relatively tough, white layer called the **sclera** (or white part of the eye). Near the front of the eyeball, in the area protected by the eyelids, the sclera is covered by a thin, transparent membrane, known as **conjunctiva,** which runs to the edge of the cornea. The conjunctiva also covers the moist black surface of the eyelids and eyeballs (Figure: 1).

Light enters the eyeball through the **cornea,** the clear, curved layer in front of the **iris and pupil.** The cornea serves as a protective covering for the front of the eye and also helps focus light on the **retina** at the back of the eye. After passing through the cornea, light travels through the pupil (the black dot in the middle of the eye). The iris—the circular, coloured area of the eye that surrounds the pupil—controls the amount of light that enters into the eyeball. The pupil dilates (enlarges) and constricts (shrinks) like the aperture of a camera lens as the amount of light in the immediate surroundings changes. The iris allows more light into the eye when the environment is dark and allows less light into the eye when the environment is bright. The size of the pupil is controlled by the actions of the pupillary **sphincter muscle and dilator muscle.**

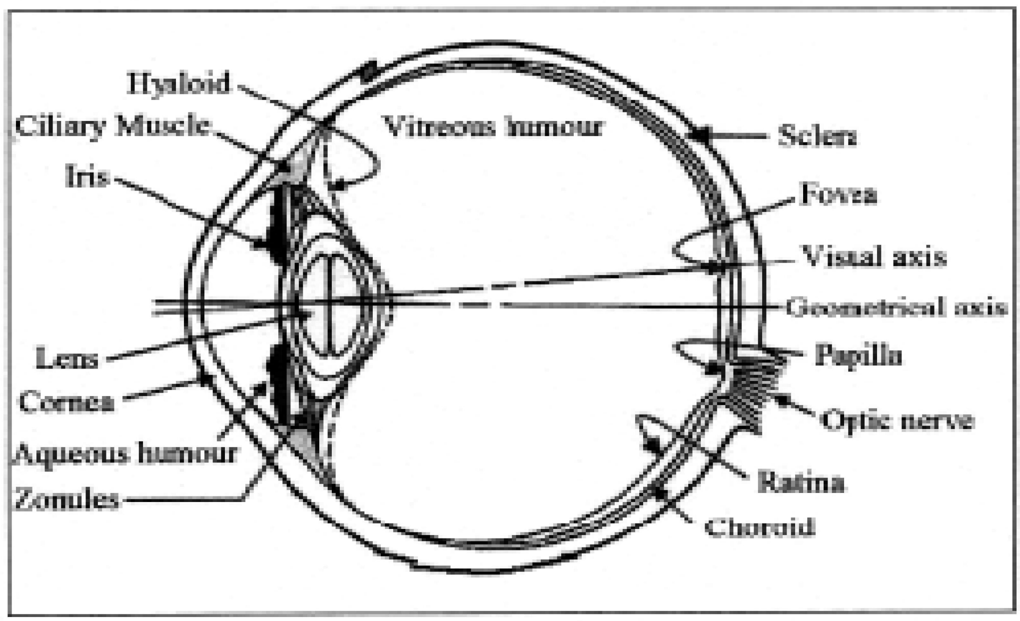

Figure 1: Schematic Diagram of Human Eye

Behind the iris sits the lens. By changing its shape, the lens focuses light onto the retina. Through the action of small muscles, the lens becomes thicker to focus on nearby objects and thinner to focus on distant objects.

The retina contains the cells that sense light (photoreceptors) and the blood vessels that nourish them. The most sensitive part of the retina is a small area called the **macula,** which has millions of tightly packed photoreceptors (the type called **cones).** The high density of cones in the macula makes the visual image detailed, just as a high-resolution digital camera has more megapixels, Each photoreceptor is linked to a nerve fibre. The nerve fibres from the photoreceptors are bundled together to form the **optic nerve.** The **optic disk,** the first part of the optic nerve, is at the back of the eye. The photoreceptors in the retina convert the image into electrical signals, which are carried to the brain by the optic nerve.

There are two main types of photoreceptors - **cones and rods. Cones** are responsible for sharp, detailed central vision and colour vision and are clustered mainly in the macula. The **rods** are responsible for night and peripheral (side) vision. Rods are more numerous than cones and much more sensitive to light, but they do not register colour or contribute to detailed central vision as the cones do. Rods are grouped mainly in the peripheral areas of the retina.

The eyeball is divided into two sections, each of which is filled with fluid. The front section (anterior segment) extends from the inside of the cornea to the front surface of the lens. It is filled with a fluid called the **aqueous humor,** which nourishes the internal structures. The back section (posterior segment) extends from the back surface of the lens to the retina. It contains a jellylike fluid called the **vitreous humor.** The pressure generated by these fluids fills out the eyeball and helps maintain its shape.

The anterior segment is divided into two chambers. The front (anterior) chamber extends from the cornea to the iris. The back (posterior) chamber extends from the iris to the lens. Normally, the aqueous humor is produced in the posterior chamber, flows slowly through the pupil into the anterior chamber, and then drains out of the eyeball through outflow channels located where the iris meets the cornea.

Some important structural components of human eye and their functions are given below:

1. **Sclera** - Sclera is the white part of the eye which forms the larger portion of the eye ball.

Function: a. It helps to maintain the shape of the eye.

b. It supports delicate structures within the eye.

2. **Conjunctiva** - a thin clear mucous membrane which covers the front of the sclera and follows around to line the inside of the eyelids is the Conjunctiva.

Function: It covers the interior surface of lids and joins them to the eyeball.

3. **Cornea** - A crystal-clear window at the front of the eye is known as Cornea, it is a thin convex-concave living tissue which is kept moist by a thin film of tear and bathed on the posterior surface by the aqueous humour. It is kept smooth by blinking of the lids.

Function: It permits the light to pass through and helps focusing it on the retina along with the lens.

4. **Iris** - The black disc beneath the cornea is Iris. The posterior surface of the iris is pigmented. The colour of the iris decides colour of the eye.

Function: Muscle in the iris make the pupil larger or smaller.

5. **Pupil:** The black hole in the centre of the iris is Pupil. The pupils in both the eye-balls look black due to the darkness of the interior of the eye.

   Function: (a) It controls entry of light into the eye - In bright light, the circular muscles of the iris contract and the pupil becomes smaller to reduce the amount of light that enters into the eye, while in dark, muscles help the pupil to widen allowing more light to enter into the eye.

6. **Anterior Chamber** - is situated between the cornea and the iris. It is filled with clear fluid called the aqueous humour.

Function: a. The aqueous humour keeps the posterior surface of the cornea moist.

b. It plays a major role in the maintenance of the pressure of the eye.

7. **Lens** - Lens is situated behind the iris in the eye-ball. It is transparent and consists of an elastic capsule filled with clear material. It is suspended by transparent fibres of **zonules.** Function - Focusing the rays of light to the back of the eye.

8. **Retina** - it is the light sensitive membrane of nerves which lines the inner surface of the eye and consists of - (a) an outer layer of pigment epithelium, (b) inner portions of rods, cones and (c) connecting nerve cells.

Function - It changes light waves into electrical impulses.

9. **Vitreous Body** - It is the clear, viscous liquid, like a jelly filled in the open area between the lens and retina.

Function - This fluid basically holds the lens place and gives support to the eye coats.

10. **Optic Nerves** - the fine fibres arising from each nerve cell come out of the eye-ball through the optic nerve and join the fibres coming from the either eye at an interaction in the brain called ‘chiasm’.

Function - It carries impulses to the back of the brain where the consciousness of colour and shapes takes place.

11. **Macula-** It is a small area situated at the centre of the retina. It is the most sensitive visual part of the eye which is also called the yellow spot.

Function - It is used for activities that need fine vision like reading and writing.

1.3.2 Functions of Human Eye

Basic function of the eye is to visualize world around us. It includes:

1. Optic system projecting an image;
2. System that perceives and encodes the received information for the brain;
3. Life-supporting' servicing system.

How does the Human Eye Work?

In a number of ways, the human eye works much like a digital camera:

1. Light is focused primarily by the cornea — the clear front surface of the eye, which acts like a camera lens.
2. The iris of the eye functions like the diaphragm of a camera, controlling the amount of light reaching the back of the eye by automatically adjusting the size of the pupil (aperture).
3. The eye's crystalline lens is located directly behind the pupil and further focuses light. Through a process called accommodation, this lens helps the eye automatically focus on near and approaching objects, like an autofocus camera lens.
4. Light focused by the cornea and crystalline lens (and limited by the iris and pupil) then reaches the retina — the light-sensitive inner lining of the back of the eye. The retina acts like an electronic image sensor of a digital camera, converting optical images into electronic signals. The optic nerve then transmits these signals to the visual cortex — the part of the brain that controls our sense of sight.

1.4 Vision Development and Process of Seeing

1.4.1 Normal Vision Development

At birth, baby sees only in black and white and shades of gray. Nerve cells in their retina and brain that control vision are not fully developed. Also, a newborn infant's eyes don't have the ability to accommodate (focus on near objects). If baby doesn't seem to be "focusing" on objects, including mother's face. It just takes time. Despite these visual limitations, studies show that within a few days after birth, infants prefer looking at an image of their mother's face to that of a stranger. Researchers believe this preference depends on large, high-contrast stimuli, like the boundary of the mother's hairline to her face. {In studies, if these boundaries were masked with a scarf or bathing cap, the infants' preference of looking at their mother's face went away).

One thing anybody may notice about newborn baby is how large their eyes are. This is because that normal infant development proceeds from the head down. At birth, baby's eyes are almost 65 percent of their adult size.

Vision Development in Babies

Babies' vision goes through many changes in the first months after birth. Baby's eyes are not very sensitive to light in the first month of life. In fact, the amount of light required for a 1-month-old infant to be aware that light is present (called the light detection threshold) is 50 times higher than that of an adult.

Infants start to develop the ability to see in colours very quickly. At one week after birth, they can see red, orange, yellow and green. But it takes a little longer for them to be able to see blue and violet This is because blue light has shorter wavelengths, and fewer colour receptors exist in the human retina for blue light.

Many advances in vision development take place in months two and three. Infants develop sharper visual acuity during this period, and their eyes are beginning to move better as a team. The child should follow moving objects at this stage and starting to reach for things s/he sees. Also, infants at this stage of development learn how to shift their gaze from one object to another without having to move their head. And their eyes are becoming more sensitive to light; a 3 months old infant's light detection threshold is about 10 times that of an adult.

Focus and Tracking:

Newborn babies have peripheral vision (the ability to see to the sides) and in the first weeks of life gradually develop the ability to focus on an object or point in front of them. At one month, a baby can focus briefly on objects up to three feet away.

By two months, infants are also able to track (follow) moving objects, as their visual coordination and depth perception improve. By three months they also have the hand/ arm control needed to bat at nearby moving objects. If a baby's eyes are not working together to focus and track objects by three months of age, a paediatrician should be consulted. Distance vision continues to develop in the early months. By four months a baby may smile when they see a parent across a room, and they can see objects outside when looking through a window.

Light and Images:

At birth, babies are very sensitive to bright light, so their pupils remain constricted to limit the light coming into the eyes. After about two weeks, the pupils begin to enlarge and babies can see a range of shades of light and dark. As the retinas (the light-sensitive tissue inside the eye) develop, the ability to see and recognize patterns improves. High contrast images like black-and-white pictures, bull's eyes or very simple face shapes are most likely to attract babies' attention in the early weeks.

The human face is always babies' favourite image. When someone holds a baby, he or she will look intently at the person's face, especially the eyes. As the baby's visual span increases in the first month, he/she will be able to see the person's whole face and will be much more responsive to facial expressions.

Colour Vision:

Babies' colour vision matures at about the same rate as the other visual abilities. At one month, they are sensitive to the brightness or intensity of colour and will look longer at bold colours and contrasting patterns than at lighter tones. By about four months babies can differentiate and respond to the full range and shades of colours.

To help or stimulate a 2 to 3-month-oId child's vision development, the American Optometric Association (ADA) has the following recommendations:

- Add new items to their room or frequently change the location of their crib or existing items in the room.
- Talk to the baby as you walk around the room.
- Keep a night light on to provide visual stimulation when they are awake.
- While infants should be placed on their backs for sleep to decrease the risk of sudden infant death syndrome {SIDS}, put them on their stomachs when they are awake and you can supervise them. This provides important visual and motor experiences.

Vision Development in Preschool and School-aged Children:

The child is now mobile, crawling about and covering more distance than you could ever have imagined. S/He is better at judging distances and more accurate at grasping and throwing objects.

This is an important developmental period for the child. At this stage, infants are developing a better awareness of their overall body and are learning how to coordinate their vision with their body movements.

Focusing, tracking, depth perception, and other aspects of vision continue to develop throughout early and middle childhood, Convergence, the ability of both eyes to focus on an object simultaneously, becomes more fully developed by about age seven; this is one reason any problems a child has with focusing or eye alignment should be treated before that age.

Most children are naturally somewhat **farsighted** (hyperopic) but can see well at other distances. More pronounced **myopia** (nearsightedness) and astigmatism are thought to be inherited. There is some evidence from recent studies in the United States and Australia that the amount of time school-aged children spend outdoors, in natural light, may have some impact on whether they develop mild myopia.

To stimulate the development of child's eye-hand-body coordination, get down on the floor with him and encourage him to crawl to objects. Place a favourite toy on the floor just out of his reach and encourage him to get it. Also provide plenty of objects and toys that she can take apart and put together.

1.4.2 Process of Seeing

The physical components of the human visual system include the eye, the visual centre in the brain, and the optic nerve which connects the eye to the visual centre. The light rays passing from the environment to the eye through the cornea. The cornea is the external covering of the eye and in the presence of light it reflects visual stimuli. These reflect light rays passed through the pupil which is an opening in the iris. The pupil regulates the amount of light entering the eye. The lens focuses the light rays by changing their direction so that they strike the retina directly. As in a camera lens, the lens of the eye reverses the image. The retina consists of light sensitive ceils namely rods and cones that transmit the image to the brain through optic nerves. Images form in the retina upside down until they are flipped over the visual centre of the brain as the brain interprets the images.

Both the eyes have slightly different fields of vision since they are separated by the nose. Each of these visual fields are divided into the right and leftside. Each individual eye takes in different information, due to the different visual fields. Signals from the left visual fields of both eyes are sent to the right visual cortex and vice-versa. The information received at one eye is incomplete since only one part of the image is available. Therefore, both eyes immediately send their information to the brain, so that the information can be combined. Along the way at the **optic chiasma,** some of the nerves from each optic nerve cross over, so that information from the left visual fields comes together and the same goes for the right visual field. The **optic nerve** is essentially made up of a bundle of nerve fibres that carry electrical impulses down to minute cables. After reaching the optic chiasma, another swapping of information takes place at the cell station or the **geniculate body.** This connection functions in accordance with the reflexes of the pupils. From here, the nerve spread out on their respective sides around the temporal part of the brain. Finally, they pass through the main exchange reaching the visual cortex. The images are interpreted at this point.

How does the eye see ?

For people with normally functioning eyes, the following sequence takes place:

1. Light reflects off the object we are looking at.
2. Light rays enter the eye through the cornea at the front of the eye.
3. The light passes through a watery fluid (aqueous humor), and enters the pupil to reach the lens.
4. The lens can change in thickness to bend the light, which will focus it onto the retina at the back of the eye.
5. On the way to the retina, the light passes through a thick, clear fluid called a vitreous humor. The vitreous humor fills the eyeball and helps maintain its round shape.
6. The light then reaches the back of the eye and hits the retina. The retina translates the light into electrical impulses which are then carried to the brain by the optic nerve.
7. Finally, the visual cortex of the brain interprets these impulses as what we see.

1.5 Principles of Refraction and Refractive Error

1.5.1 Principles of Refraction

Refraction is the bending of light as it passes between materials of different optical density. If there is irregular bending of light due to error in medium of reflection, this becomes refractive error.

The purpose of the eye-ball is to receive light from the outside world and transmit it to the brain for processing. There are three aspects to this function. In the first instance, the light rays have to be correctly focused on to the back of the eye. Secondly, the light-sensation related information has to be converted to electrochemical signals by the cells within the retina. Finally, that electromechanical signal is to be transmitted to the brain through the optic nerve.

Refraction of Eye

Refraction refers to the state of focus of the eye. It is the ability of the eye to bend light so that an image is focused on the retina. So, refraction is the deflection of light from a straight path through the eye by various ocular tissues, including the cornea, lens, aqueous humour, and vitreous body.

1.5.2 Concept of Refractive Error

Error in refractive media, the eye gets unclear or blurring image. When there is a deviation in light rays from a distant object brought to a focus on the retina, the image that is formed on the retina appears blurred. The variation in image formation is known as **ametropia** in which parallel rays are not accurately focused on the retina. Ametropia includes **hypermetropia, myopia** and **astigmatism.** Therefore, refractive error is defined as "a defect in the eye that prevents light rays from being brought to a single focus exactly on the retina" (Bourgeault, 1969). The principles of refractive errors are:

1. Corneal curvature,
2. Depth of the anterior chamber,
3. Shape of the lens,
4. Length of the eye (axial length).

These four elements change over time as the eye grows (e.g., axial length) and matures in later years (e.g., quality of tears which affects the air-tear interface). The emmetropic eye is able to achieve a perfect focus. Ametropia is the global term referring to any refractive error. Refractive development is influenced by both the environmental and genetic factors.

Significance of Refractive Errors

- Refractive errors are important because they account for half the cases of avoidable vision impairment globally (153 million people).
- Undetected refractive errors in childhood may lead to behavioural problems and adversely affect social interaction and performance (academic or sporting) at school.

- It has been found that a minor reduction in vision has been associated with an increased risk of death and physical-social-emotional problems in people aged over 50 years.
- Under-corrected refractive error may account for up to 75% of all vision impairment in the third-world countries.

Interventions to treat refractive errors (e.g., spectacles) are simple and cost-effective. However, global estimates indicate that more than 2.3 billion people in the world experience poor vision due to refractive error of which 670 million people are considered visually impaired because they do not have access to corrective treatment.

Types of Refractive Error

There are different types eye-problems due to refractive errors in the eyes. Some of these are given below:

1. Myopia:

As the normal eye is virtually round, the rays of light coming from outside, touch the retina. The myopic eye is longer from the front to the back and the extra length prevents the image being in sharp focus. Actually, in myopia, the eyes are too deep and cornea is too curving which are the main causes of myopia.

There are mainly three types of myopia:

i. Congenital Myopia

- Present at birth,
- May be unilateral as well as bilateral,
- Bilateral myopia may be associated with squint.

ii. Simple Myopia

- Most common type of myopia,
- Does not progress after adolescence.

iii. Pathological Myopia

- Type of progressive and degenerative myopia,
- Begins at the age of 5-10 years,
- Strongly hereditary,

- Common in women, Jews and Japanese.

Symptoms of Myopia:

- Black spots are seen floating before the eyes,
- Discomfort in performing near work,
- Flashes of light may be seen,
- Indistinct distant vision is the most common symptom. Usually the young children are unable to see clearly.

Treatment of Myopia:

- It is treated by prescribing suitable corrected concave lens for concave use. In high myopia, spectacles should be made to fit closely to the eye.

2. Hypermetropia

This is opposite to myopia. Short length of eye ball is the cause of it. It may also consist of flat curvature of cornea.

Newborns are invariably hypermetropic. The incidence decreases rapidly with age remaining at about 50% after 20 years.

Symptoms of Hypermetropia

- Blurring of vision for near work,
- Frontal headache and eye strain,
- Burning and dryness in the eye.

Treatment of Hypermetroopia

- It is treated by prescribing suitable correcting spherical convex lenses.

3. Astigmatism

It is that condition of refraction in which a point of light cannot be made to produce a punctuate image upon the spherical retina. It is due to unequal curvature of cornea and decentring of lens.

Regular Astigmatism

Normally cornea is flatter from side to side (horizontal meridian) perhaps because of the pressure of the eyelids. It is curved above downwards (vertical). Regular astigmatism is present when the two principal meridians are at the right angles. It can be corrected by lenses.

- According to the rule - the vertical meridian is more curved, e.g., as in normal cornea.
- Against the rule - the horizontal meridian is more curved, e.g., as after cataract surgery.
- It is present when the corneal surface is irregular. It cannot be adequately corrected by lens, e.g., as following healed corneal ulcer. In that case, Soft Contact lens may be used.

Symptoms of Regular Astigmatism;

- Diminished visual acuity is the most troublesome clinical symptom;
- Eye strain and headache after short time of near work is usually present;
- The letters in the book appear to be 'running together'.

Treatments of Regular Astigmatism

- When there are symptoms, suitable cylindrical lenses are prescribed for constant use.

1.6 Concept and Definitions of Blindness and Low Vision

Visual impairment describes vision that cannot be fully corrected by ordinary prescription lenses, medical treatment, or surgery. The term visual impairment includes conditions ranging from the presence of good usable vision, low vision, or to the absence of any sight at all-total blindness. Many terms are used when people refer to visual impairment. These terms are explained below:

1.6.1 Blindness

The term blindness means no light perception of both the eyes of a human being. Probably the best way to describe this is not to stand in a dark place or cover your eyes, but rather think about what you can see directly behind you. Now, do not turn your head, but use your eyes to see directly behind you. That may utter sense of darkness where only other senses describe what is behind you is the closest to no light perception a sighted individual may see. Even if you close your eyes and stand with a blind fold in utter darkness, your eyes still try to perceive some form of imagery.

Blindness with light perception has several different forms. However, people often see light with shadows or shadows with some light. The way one sees in this state depends on the condition of the eye and the cause for the sight loss.

Legal blindness refers to a term developed to determine cut off assessments for sight loss. It refers to a visual acuity on a Snellen's Chart of 20/ 200 corrected with best eye. This means that the size of a sign of a normally sighted person sees at 200 feet, a legally blind individual must be 20 feet away. A second classification for legal blindness involves tunnel vision. In this case, a person must have a field of view less than 20 degrees while looking forward.

Definition of Blindness :

Simple Definition: Inability of a person to count fingers from a distance of 6 meters or 20 feet.

Technical Definition: Vision of 6/ 60 or less with the best possible spectacle correction and Diminution of field vision to 20° or less in better eye.

- ***Severe Visual Impairment***

  Severe visual impairment is a term used by researchers at the National Center for Health Statistics (NCHS) to describe visual impairment in people who are unable to read ordinary newsprint even with correction. This term, used primarily for studying visual impairment in the population, is not used in clinical references by eye care professionals. People with a severe visual impairment may or may not be legally blind.

- ***Visually Impaired***

  The term visually impaired, also used by the National Center for Health Statistics for studying visual impairment in the population, describes visual impairment in people who have difficulty reading ordinary newsprint even with correction. Like the term severe visual impairment, visual impairment is used by researchers who study the population, and is not used in clinical references.

- ***Presbyopia***

  Presbyopia refers to the eye's loss of accommodation, the eye's focusing power and ability to adjust the focus of the eye on the distance between the individual and the object People with presbyopia, typically those age 40 and older, experience a progressive inability to focus for near vision viewing as the lens becomes less elastic with age. Lenses with magnification are used to provide the correction needed. These lenses are commonly referred to as "reading glasses," or necessary magnification can be added to a person's regular eyeglasses as bifocals, or trifocals. Variable focus lenses are also available to correct presbyopia.

1.6.2 Low Vision

Low vision is a reduced level of vision that cannot be fully corrected with conventional glasses. It is not the same as blindness. Unlike a person who is blind, a person with low vision has some useful sight. However, low vision usually interferes with the performance of daily activities, such as reading or driving. A person with low vision may not recognize images at a distance or be able to differentiate colours of similar tones.

One is legally blind when the best corrected central acuity is less than 20/ 200 (perfect visual acuity is 20/ 20} in the better eye, or the side vision is narrowed to 20 degrees or less in the better eye. People who are legally blind may still have some useful vision. It may be noted that if anybody is legally blind, s/he may qualify for certain government benefits. Furthermore, It is estimated that approximately 17 percent of normal people over the age of 65 years are either blind or have low vision.

Symptoms of Low Vision:

- Difficulty in recognizing objects at a distance (viz., street signs or bus signs)
- Difficulty in differentiating colours (particularly in the green-blue-violet range)
- Difficulty in seeing well up close (viz., reading or cooking)

The symptoms described above may not necessarily mean that anybody has the low vision. However, if you experience one or more of these symptoms, contact the eye doctor for a complete examination. The specialist eye doctor can tell the difference between normal changes which are common with age and changes caused by eye disease.

Causes of Low Vision:

Although low vision can occur at any stage in life, it primarily affects the elderly, but it is not a natural part of aging. Although most people experience some physiological changes with age (presbyopia), these changes usually do not lead to low vision. Most people develop low vision because of eye diseases. Common causes of low vision, particularly with older adults, include muscular degeneration, glaucoma, and diabetic retinopathy. When vision impairment is recognized early, treatment can be more effective, enabling people to maintain as much independence as possible.

Low Vision Aids:

Many types of assistive devices are available to help people with low vision. These items include special glasses and other magnification devices and large print reading materials. Other communication aids include computer software and various other technological devices.

1.7 Concept of Visual Acuity, Visual Field, Depth Perception and Contrast Sensitivity

1.7.1 Visual Acuity

Visual acuity (VA) commonly refers to the clarity of vision. Visual Acuity is dependent on some optical and neural factors, i.e., (i) the sharpness of the retinal focus within the eye, (ii) the health and functioning of the retina, and (iii) the sensitivity of the interpretative faculty of the brain.

Visual acuity is a measure of our centra! vision, the ability to distinguish details and shapes of objects. Distant vision is tested with a chart with differently sized letters read from a distance of six metres away. This is called the Snellen's Test Types.

Visual acuity is typically measured while fixating, i.e. as a measure of central (orfoveal) vision, for the reason that it is highest there. However, acuity in peripheral vision can be of equal (or sometimes higher) importance in everyday life. Acuity declines towards the periphery in an inverse-linear (i.e. hyperbolic) fashion.

Visual acuity is a measure of the spatial resolution of the visual processing system. As it is sometimes referred to by optical professionals, visual acuity of a person is tested to identify so-called optotypes - stylized letters, Landolt rings, Le symbols, or other patterns - on a printed chart (or some other means) from a set viewing at a fixed distance. Optotypes are represented as black symbols against a white background (i.e. at maximum contrast). The distance between the person's eyes and the testing chart is set so as to approximate **optical infinity** in the way the lens attempts to focus (far acuity), or at a defined reading distance (near acuity).

Normal visual acuity is commonly referred to as 20/ 20 vision, the metric equivalent of which is 6/ 6 vision. At 20 feet or 6 meters, a human eye with nominal performance is able to separate contours that are approximately 1.75 mm apart. Vision of 20/ 40 corresponds to lower than nominal performance and vision of 20/10 corresponds to better performance.

Acuity is a measure of visual performance and does not directly relate to the eyeglass prescription required to correct vision. Instead, an eye examination seeks to find the prescription that will provide the best corrected visual performance achievable. The resulting acuity may be greater or less than 20/ 20 = 1.0. Indeed, a subject diagnosed as having 20/ 20 vision will often actually have higher visual acuity because, once this standard is attained, the subject is considered to have normal (in the sense of undisturbed) vision and smaller optotypes are not tested. Emmetropic subjects with 20/ 20 vision or 'better' (20/ 15, 20/ 10, ect), may still require an eyeglass correction for other problems related to the visual system, such as eye strain ocular injuries.

Measurement:

Visual acuity is measured by a psychophysical procedure and as such relates the physical characteristics of a stimulus to a subject's percept and her/ his resulting responses. Measurement can be made by using an eye chart, by optical instruments, or by computerized tests like the 'FrACT.

Care must be taken that viewing conditions correspond to the standard, such as correct illumination of the room and the eye chart, correct viewing distance, enough time for responding, error allowance, and so forth. In the European countries, these conditions are standardized by the European norm (EN ISO 8596, previously DIN 58220).

1.7.2 Visual Field

The visual field refers to the total area in which objects can be seen in the side (peripheral) vision while you focus your eyes on a central point. The visual field is the "spatial array of visual sensations available to observation in introspectionist psychological experiments."

The equivalent concept for optical instruments and sensors is the 'field of view' (FOV).

In optometry and ophthalmology a visual field test is used to determine whether the visual field is affected by diseases that cause local scotoma a more extensive loss of vision or a reduction in sensitivity (increase in threshold).

Normal limits :

The normal human visual field extends to approximately 60 degrees nasally (toward the nose, or inward) from the vertical meridian in each eye, to 100 degrees temporary (away from the nose, or outwards) from the vertical meridian, and approximately 60 degrees above and 75 below the horizontal meridian. In the United Kingdoms, the minimum field requirement for driving is 60 degrees either side of the vertical meridian, and 20 degrees above and below horizontal. The macula corresponds to the central 13 degrees of the visual field; the fovea to the central 3 degrees.

Measuring the Visual Field:

The visual field is measured by perimetry. This may be kinetic, where points of light are moved inwards until the observer sees them, or static, where points of light are flashed onto a white screen and the observer is asked to press a button if s/he sees it. The most common perimeter used is the automated Humphrey Field Analyzer and Heidelberg Edge Perimeter.

Another method is to use a campimeter, a small device designed to measure the visual field. Patterns testing the central 24 degrees or 30 degrees of the visual field, are most commonly used. Most perimeters are also capable of testing the full field of vision.

Another method is for the practitioner to hold up 1, 2, or 5 fingers in the four quadrants and center of a patient's visual field (with the other eye covered), ff the patient is able to report the number of fingers properly as compared with the visual field of the practitioner, the normal result is recorded as 'full to finger counting' (often abbreviated FTFC). The blind spot can also be assessed via holding a small red object between the practitioner and the patient. By comparing when the red object disappears for the practitioner, a patient's abnormally large blind spot can be identified. There are many variants of this type of examination (e.g., wiggling fingers at visual periphery in cardinal axes).

Visual Field Loss:

Visual field loss may occur due to disease or disorders of the eye, optic nerve, or brain. Classically, there are four types of visual field defects:

i. Altitudinal field defects, loss of vision above or below the horizontal - associated with ocular abnormalities;

ii. Bitemporal hemianopia, loss of vision at the sides;

iii. Central scotoma, loss of central vision Homonymous hemianopia, loss at one side in both eyes - defect behind optic chiasm (see below);

In humans, confrontational testing and other forms of perimetry are used to detect and measure visual field loss. Different neurological difficulties cause characteristic forms of visual disturbances, including hemianopsias (shown below *without* macula sparing), quadrantanopsia, and others.

1.7.3 Depth Perception

Depth perception is the visual ability to perceive the world in three dimensions (3D) and the distance of an object. Depth perception arises from a variety of depth cues. These are typically classified into binocular cues that are based on the receipt of sensory information in three dimensions from both eyes and monocular cues that can be represented in just two dimensions and observed with just one eye. Binocular cues include stereopsis, eye convergence, disparity, and yielding depth from binocular vision through exploitation of parallax. Monocular cues include size: distant objects subtend smaller visual angles than near objects, grain, size, and motion parallax.

Disorders Affecting Depth Perception:

i. Ocular conditions such asamblyopia, optic nerve hypoplasia, and strabismus may reduce the perception of depth.

ii. Since (by definition), binocular depth perception requires two functioning eyes, a person with only one functioning eye has no *binocular* depth perception.

iii. It is typically felt that depth perception must be learned in infancy using an unconscious inference.

1.7.4 Contrast Sensitivity

Contrast sensitivity is a very important measure of visual function, especially in situations of low light, fog or glare, when the contrast between objects and their background is often reduced. Driving at night is an example of an activity that requires good contrast sensitivity for safety.

As mentioned above, contrast sensitivity describes the ability of the visual system to distinguish bright and dim components of a static image. Visual acuity can be defined as the angle with which one can resolve two points as being separate, given that the image is shown with 100% contrast and is projected onto the fovea of the retina. Thus, when an optometrist or ophthalmologist assesses a patient's visual acuity using a Snellen's chart or some other acuity chart, the target image is displayed at high contrast (e.g., black letters on a white background). A subsequent contrast sensitivity exam may demonstrate difficulty with decreased contrast (e.g., grey letters on a white background)

To assess a patient's contrast sensitivity, one of several diagnostic examinations may be used. Most charts in an ophthalmologist's or optometrist's office will show images of varying contrast and spatial frequency. Parallel bars of varying width and contrast, known as 'sine-wave gratings', are sequentially viewed by the patient. The width of the bars and their distance apart represent spatial frequency, measured in cycles per degree.

Studies have demonstrated that medium-level spatial frequency, approximately 5-7 cycles per degree, is optimally detected by most individuals, compared with low or high-level spatial frequencies. The contrast threshold can be defined as the minimum contrast that can be resolved by the patient. The contrast sensitivity is equal to I/ contrast-threshold.

Using the results of a contrast sensitivity exam, a contrast sensitivity curve can be plotted, with spatial frequency on the horizontal, and contrast threshold on the vertical axis. Also known as contrast sensitivity function (CSF), the plot demonstrates the normal range of contrast sensitivity, and will indicate diminished contrast sensitivity in patients who fall below the normal curve. Some graphs contain "contrast sensitivity acuity equivalents", with lower acuity values falling in the area under the curve. In patients with normal visual acuity and concomitant reduced contrast sensitivity, the area under the curve serves as a graphical representation of the visual deficit. It can be because of this impairment in contrast sensitivity that patients have difficulty driving at night, climbing stairs and other activities of daily living in which contrast is reduced.

The graph demonstrates the relationship between contrast sensitivity and spatial frequency. The target-like images are representative of center-surround organization of neurons, with peripheral inhibition at low, intermediate and high spatial frequencies. Used with permission from Brian Wandell, PhD.

Recent studies have demonstrated that intermediate-frequency sinusoidal patterns are optimally-detected by the retina due to the center-surround arrangement of neuronal receptive fields. In an intermediate spatial frequency, the peak (brighter bars) of the pattern is detected by the center of the receptive field, while the troughs (darker bars) are detected by the inhibitory periphery of the receptive field. For this reason, low- and high-spatial frequencies elicit excitatory and inhibitory impulses by overlapping frequency peaks and troughs in the center and periphery of the neuronal receptive field. Other environmental, physiologic and anatomical factors influence the neuronal transmission of sinusoidal patterns, including adaptation.

Decreased contrast sensitivity arises from multiple etiologies, including retinal disorders such as Age-Related Macular Degeneration (ARMD), amblyopia, lens abnormalities, such as cataract, and by higher-order neural dysfunction, including stroke and Alzheimer's disease. In light of the multitude of etiologies leading to decreased contrast sensitivity, contrast sensitivity tests are useful in the characterization and monitoring of dysfunction, and less helpful in detection of disease.

1.8 Check your Progress

1. Draw the structure of human eye and label its different component.
2. Compare the functions of human eye with a digital camera.

3. What is Sclera?

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4. What do you mean by retina?

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5. State the structure and functions of cornea.

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6. What is the normal vision of the new born baby?

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7. Discuss the process of seeing with an illustration.

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8. What do you mean by 'light direction threshold'?

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9. How images are formed in the eyes of the baby at the age between 2-12 weeks?

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10. What is meant by ‘Optic Chiasma’?

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11. Discuss the principles of refraction in the eye with a suitable diagram.

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12. Explain the concept of refractive error?

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13. What is the significance of refractive errors?

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14. Mention three types of refractive errors.

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14. What is Myopea?

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16. Define blindness.

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17. How can you try to express the feeling of blindness?

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18. How can blindness be differentiated from low vision?

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19. Explain the symptoms of low vision.

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20. What are the causes of low vision?

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21. Discuss the concept of visual acuity.

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22. How can the visual acuity be measured?

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23. What do you mean by visual field?

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24. What is depth perception?

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25. State the significance of contrast sensitivity.

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1.9 Let us sum up

Our eye is one of the most complex sense organs of the body. It helps us to see & interpret the shapes, colours & dimensions of the objective world. While cruesing into the lesson, we ventured through the sophisticated structure of an eye, its components, viz, sclera, conjunctiva, cornea, pupil, anterior chamber, lens, retina, vitreous body & optic nerves and their respective functions. All these structural components functions to visualize world around us. The human eye works much like a digital camera. At birth, babies are very sensitive to bright light & thus light coming to the eyes is limited. Babies vision goes through many changes. Vision development during the preschool & school-aged children are based on few parameters like-focusing, tracking, depth perception & other aspects of vision. All these functionaries follows certain principles of refraction & refractive error. There are different types of eye-sight problems like myopia, hypermetropea, astigmatism etc. All these problems are the result of certain refractive errors in the eyes. There are treatments available for such kinds of eye problems. Another pertinent issue concerning eye & vision is the concept of blindness & low vision. Visual impairment describes vision that cannot be fully corrected by ordinary prescription. There are different types of visual impairment, some are manageble while others are not. Many types of assistive devices are available to help people with low vision.

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