Chapter 1

Introduction

Cataract is a cloudiness or opacification of the transparent crystalline lens of the eye, which causes a gradual progressive decrease in visual acuity, eventually leading to blindness. The word “cataract” is derived from the Latin word “cataracta” means “waterfall”. The grey white appearance of mature cataract was thought to look like the streaky white appearance of falling water. Morphologically, cataract can be defined as any disturbance of the optical homogeneity of the crystalline lens. If the cataract forms in the area of the lens directly behind the pupil, vision may be significantly impaired. Cataract that occurs on the outer edge or side of the lens will create less of a visual problem.

Cataract is a condition that develops in the lens of the eye. Cataract can cover the eye lens partially or completely. It can be stationary, meaning its growth is in one place and slow or stopped, or it can be progressive and grow rapidly. Cataracts can also be hard or soft. Often cataracts cause no problems for many years but as the cataracts mature, the cloudiness increases in the lens, the light reaching the retina decreases and significant sight loss and perhaps blindness can result. Human cataractous lenses may vary in colour from pale yellow to deep brown, in sodium concentration from 20 mM to 200 mM and in total protein content from 20 mg to 90 mg (Duncan 1974).

Cataract is considered as a condition and not a disease, they develops due to multiple reasons. Secondary cataracts develop from procedures preformed to correct other vision problems such as glaucoma.
Traumatic cataracts develop from injury to the eye lens or the eye as a whole. Congenital cataracts are genetic and are found in babies and sometimes develop in childhood. There are also radiation cataracts that develop after some kinds of exposure such as excessive sunlight, ultraviolet or infrared light. It has been shown that cataracts can develop from long term use of certain steroids as well as some lifestyle habits.

According to World Health Organization's (2011) global estimate, approximately 90% of visually impaired people live in the low-resource developing countries of Africa and Asia, mostly in rural areas with few or underutilized eye-care facilities. Globally 80% of all visual impairments are avoidable i.e. either preventable or curable. Nearly a fifth of them are in India. There are some 7 million new cases of blindness each year and that despite every intervention; blindness in the world is still increasing by 1 to 2 million cases a year (WHO, 2002). Even after operation outcome may not be favorable in all cases. In developing countries, its prevalence is believed to be greater and the onset at earlier ages, making the social and medical cost of blindness from cataract highly disproportional in the areas of the world that can ill afford them.

Generally, the normal aging and cataractous changes in the lens are related to its metabolic activity. Despite extensive and ongoing results on the pathogenesis of cataract we are still unable to prevent the natural aging changes of the human lens. Senile cataract (nuclear sclerosis) is the most common cause of lens opacity seen by the Ophthalmologists. Increasing age is associated with an increasing prevalence of cataract. Over the next 20 years, it is estimated that the World’s population will increase by about one third. This growth will occur predominantly in developing areas. During the same period, the numbers of people over 65 years of age will be
more than double. If nothing else alters, these demographic changes will lead to a doubling in the amount of cataract, visual morbidity and need for cataract surgery. The current 20 million people with severally reduced vision of 3/60 or verse as a result of cataract will have swelled to 30.1 million by the year 2020.

According to Sharma et. al (2009), studies evaluating risk factors for the development of cataracts have implicated dietary factors, medications, exposure to sunlight, race, level of education, metabolic abnormalities, smoking, body mass, hand grip strength and family history in the causation of cataract. With such a large list it is obvious that cataractogenesis is multi-factorial (Varely, 1993). Hence one finds that outside the primary risk factor of age, some environmental, physical and nutritional risks have also been associated with earlier onset or progression of cataract (Krumszay & Klaus, 1996). Although surgery is effective, preventing or delaying the development of cataract remains the preferred approach to confront the global cataract problem. A factor should be found to delay cataract onset by ten years the number of cataract operation is estimated to decrease by 45% (Kupfer, 1985).

The burden of blindness is more in remote rural community of developing countries. These countries are characterized by high backlog of unoperated cataract and increasing incidence of cataract due to population aging. However, these countries have inadequate and inefficient cataract surgical service. For these regions of the world, it becomes imperative to develop a cost effective, sustainable service delivery system of cataract surgery. With three out of every four Indians residing in the rural areas, there is a concentration of blindness in agriculture dependent communities in India.
1.1. Senile cataract

Senile cataract is an opacity or cloudiness of the lens producing a whitish appearance of the pupil and impairing or obstructing the passage of light, occurs with advanced age, usually above 45 years. The most common type of cataract in older patients involves the lens nucleus. Age related cataract is a major cause of blindness worldwide, and cortical cataract is the second most prevalent type of age related cataract. Among the three age related cataract like nuclear, cortical and subcapsular, the cortical cataract is known to be highly heritable, although few genes have been linked to its etiology. A single primary cause of senile cataract most likely does not exist.

Cataract associated with aging (senile or age-related cataract) most often occurs in both eyes, with each cataract progressing at a different rate. Initially, cataract may not affect vision. If the cataract remains small or at the periphery of the lens, the visual change may be minor. Normal aging of the lens leads to yellowing and hardening of the lens nucleus. Smoking, diabetes and exposure to ultraviolet light are the most consistent factors known to cause oxidative stress and degenerative lens changes such as protein degradation, membrane breakage, and cell disruption, culminating in loss of transparency and the development of age-related cataract.

Nuclear cataracts result from excessive nuclear sclerosis and yellowing with consequent formation of a central lenticular opacity. In some instances the nucleus can become very opaque and brown termed a brunescent nuclear cataract. Changes in the ionic composition of the lens cortex and the eventual change in hydration of the lens fibers produce a cortical cataract. Formation of granular and plaque-like opacities in the
posterior subcapsular cortex often heralds the formation of posterior subcapsular cataracts.

Fig. 1.1 - A patient with a cataract in her right eye

Ocampo (2009), reports that in all probability, its pathogenesis is multi-factorial involving complex interactions between various physiological processes. As the lens ages, its weight and thickness increases while its accommodative power decreases, as the new cortical layers are added in a concentric pattern, the central nucleus is compressed and hardened in a process called nuclear sclerosis. Multiple mechanisms contribute to the progressive loss of transparency of the lens. The lens epithelium is believed to undergo age-related changes particularly a decrease in lens epithelial cell density and an aberrant differentiation of lens fiber cells. Although the epithelium of cataractous lenses experiences a low rate of apoptotic death, which is unlikely to cause a significant decrease in cell density, the accumulation of small scale epithelial losses may consequently result in an alteration of lens fiber formation and homeostasis, ultimately leading to loss of lens transparency. Furthermore as the lens ages, a reduction in the rate at which water and perhaps water-soluble low-molecular weight metabolites can enter the cells of the lens nucleus via the epithelium and cortex occurs, with a subsequent decrease in the rate of transport of water, nutrient's and antioxidants. Consequently progressive oxidative damage to the lens with
aging takes place leading to senile cataract development. Various studies showing an increase in products of oxidation (e.g., oxidized glutathione) and a decrease in antioxidant vitamins and the enzyme superoxide dismutase underscore the important role of oxidative processes in cataractogenesis. Another mechanism involved is the conversion of soluble low-molecular weight cytoplasmic lens proteins to soluble high molecular weight aggregates, insoluble phases and insoluble membrane-protein matrices. The resulting protein changes causes abrupt fluctuations in the refractive index of the lens, scatter light rays and reduce transparency. Other areas being investigated include the role of nutrition in cataract development particularly the involvement of glucose and trace minerals and vitamins.

1.2. **Congenital cataract**

A blind child is an individual aged less than 16 years, who has a visual acuity in the better eye of <3/60 (Gilbert, 2001). In children, cataracts may be caused by infections, trauma or may develop due to a genetic predisposition. As yet, no treatment has been identified to prevent the cataract formation. Cataracts that occur in people other than the early are much less common. Congenital cataract occurs very rarely in newborns. Genetic defects or an infection or disease in the mother during pregnancy are among the causes of congenital cataract. Traumatic cataract may develop after a foreign body or trauma injures the lens or eye. Systematic illnesses such as diabetes may result in cataract. Cataract can also occur secondary to other diseases for e.g. an inflammation of the inner layer of the eye (uveitis) or glaucoma. Such cataract are called complicated cataract. Toxic cataract results from chemical toxicity such as steroid use. Cataract can also result from exposure to the sun’s ultraviolet (U.V) rays and infrared rays.
Childhood blindness in the developing countries, particularly in the Indian subcontinent is high and cataract is one of the major causes. It has far reaching effects on educational, professional, personal, and social aspects of the child and his family. The prevalence of blindness in children i.e., the proportion of the child population who are blind varies from approximately 0.3/1,000 children in wealthy regions of the world to 1.2/1,000 in the poorer countries/regions. Blindness in children is more common in poor regions for two main reasons: firstly, there are diseases and risk factors which can lead to blindness from causes that do not now occur in industrialized countries (e.g., measles, vitamin A deficiency, ophthalmia neonatorum, malaria) and secondly, there are fewer well equipped eye departments with ophthalmologists, nurses and ophthalmic paramedics trained in managing treatable causes of blindness (e.g., cataract and glaucoma). The incidence is therefore higher, and fewer blind children have their sight restored. Incidence data are very difficult to obtain but it has been estimated that there are 8 new blind children for every 100,000 children each year in industrialized countries. The figures are likely to be higher in developing countries.

Fig. 1.2 - Congenital cataract- A child with cataract in his eyes

Globally there are estimated to be 1.4 million children who are blind, and around three quarters live in developing countries. Although the
actual number of children who are blind is much smaller than the number of adults blind, eg. from cataract the number of years lived with blindness by blind children is almost the same as the total number of ‘blind years’ due to age-related cataract. Children have more year service for the country than adults. The high number of blind years resulting from blindness during childhood is one of the reasons why the control of childhood blindness is a priority of the WHO/IAPB Vision 2020: The Right to Sight programme.

1.3 Toxic cataract

Toxic cataract is a cataract caused by drugs or chemicals. Patients maintained on systemic corticosteroids for many years in treatment of asthma, rheumatoid arthritis, prophylaxis of a renal graft rejection etc, may develop cataract. A dose of 15 mg prednisolone a day is regarded as safe in an adult for two or three years. The cataract is typically posterior subcapsular and starts in the axial part of the lens. Its affect on vision is therefore early. Stopping steroids may stop progression but this is rarely possible because of the nature of the treated systemic disorder. Rarely, posterior subcapsular cataract has been described following long-term use of local steroids to suppress uveitis. Some miotics, particularly anticholinesterases used to treat glaucoma or accommodative esotropia have been reported to produce anterior subcapsular opacities.

1.4 Classification of cataract

Depending on the age onset, cataract can be classified clinically as embryonic, foetal, adult or senile. It is often further identified according to its anatomical location like polar, capsular, sub-capsular, cortical, equatorial, nuclear, sutural etc. The density and location of the cataract depend upon
the amount of vision affected. A far advanced cataract is termed a Morgagnian cataract if the cortex liquefies and the nucleus sinks to the bottom of the capsular bag. Trauma or a fall can dislocate a far advanced cataract as it has weak zonules. Sometimes cataract changes appear as polychromatic crystals within the lens, it is then called a Christmas tree cataract.

![Diagram of human lens showing various types of cataracts](image)

**Fig. 1.3 - Schematic drawing of human lens showing various types of cataracts.** NC - nuclear cataract. ACC and PCC- anterior and posterior cortical cataracts, PSC- posterior subcapsular cataract.

Ophthalmologists classify cataracts according to their location in the lens. It is possible for a person to have more than one type of cataract. Based on the region of opacification cataracts are mainly of three types; nuclear, cortical and posterior subcapsular cataracts (Fig.1.3).

- **Nuclear cataract** is most commonly seen as it forms. Nuclear cataract (NC) is located in the center of the lens and takes place due to slow oxidative changes which may be related with aging. This cataract forms in the nucleus, the center of the lens and is due to natural aging changes and with smoking as a risk factors. Nuclear cataracts grow slowly over many years but can become very large and
hard, which complicates their removal. They are sometimes called brunescent cataracts because they are characterized by deposits of brown pigment that give the lens an amber color.

- **Cortical cataract**, which forms in the lens cortex, gradually extends its spokes from the outside of the lens to the center. Anterior and posterior cortical cataracts (ACC and PCC) are located in anterior and posterior cortical region of the lens and develop due to degeneration and liquefaction of cortical lens fibers. Many diabetics develop cortical cataract. It develops more rapidly than nuclear cataracts but remains softer and are easier to remove. They are thought to be caused by an increase in the water content of the lens. Risk factors for cortical cataracts include female sex and African or Caribbean heritage.

- **Posterior Subcapsular (PSC) cataracts**-Posterior subcapsular cataract (PSC) is located just beneath the posterior capsule and takes place due to abnormal differentiation and migration of lens epithelial cells (LEC). This type of cataract, which develops between the back of the lens and the lens capsule, is the softest and most rapidly growing type. PSC cataracts tend to scatter light at night and thus interfere with night time driving. People with diabetes, high farsightedness or retinitis pigmentosa or those taking high doses of steroids may develop a sub capsular cataract.

### 1.5. Cataract surgery

There has been a substantial increase in cataract operations from 1.6 million in 1992-93 to 3.3 million in 1998-99. In the case of any type of cataracts the procedure for treatment and eventually removal are similar. Cataracts surgery is one of the most progressive surgeries, having little or no
side effects or post surgery complications. Cataracts surgery is the most common surgery performed on people over the age of 65, is covered by medicaid and most medical insurance and the positive results are obvious within a week after surgery. Once a cataract is removed it never comes back.

When a cataract is sufficiently developed it should be removed by surgery, the most effective and common treatment is to make an incision (capsulotomy) into the capsule of the cloudy lens in order to surgically remove the lens. There are two types of eye surgery that can be used to remove cataracts: extra-capsular (extracapsular cataract extraction or ECCE) and intra-capsular (intracapsular cataract extraction, or ICCE).

Extra-capsular (ECCE) surgery consists of removing the lens but leaving the majority of the lens capsule intact. High frequency sound waves (phacoemulsification) are sometimes used to break up the lens before extraction. Intra-capsular (ICCE) surgery involves removing the entire lens of the eye, including the lens capsule, but it is rarely performed in modern practice. In either extra-capsular surgery or intra-capsular surgery, the cataractous lens is removed and replaced with a plastic lens (an intraocular lens implant) which stays in the eye permanently.

Fig. 1.4: The intraocular lens in the capsular bag
1.6. Risk factors

Researchers revealed the multi-factorial nature of cataract formation in man; several risk factors working concurrently lead to the loss of lens transparency. For example it is generally accepted that the age, corticosteroid use, ionizing radiation, diabetes, trauma and perhaps oxidative stress and dehydrational crisis all may accelerate the rate of cataract formation in human. Risk factors for cortical cataract development include female gender, sunlight exposure and myopia. Other risk factors for nuclear cataract include brown iris and cigarette smoking. In addition to these risk factors several eye diseases are associated with cataract formation (McCarty, 2000).

Some of the most important risk factors to which humans are commonly exposed:

1. Ultraviolet light, long wavelength U.V (UVL) and UV-B.
   (a) Sunlight
   (b) Occupational exposure (chemists, laundry workers, currency examiners, dentists, orthopedic technicians).

3. Radio frequency and microwave radiation (military, industrial, scientific).

4. Toxic drugs and chemicals (i.e., corticosteroid, phenothiazine, miotic cholinergics, trace elements and others).

5. Diabetes (glucose-sorbitol; enzyme aldose reductase).


7. Family history (families with cataract prevalence).

   (a) galactokinase deficiency.
   (b) Elevated plasma tryptophan level
   (c) Glucose-6- phosphate dehydrogenase deficiency.
   (d) Protein (insolubilization).
   (e) Lipid (lipid peroxidation).
   (f) Oxidative insult ($O_2$ radicals).

9. Smoke (household fuel, cigarette and beedi smoking).

10. Dehydrational crisis (diarrhoea or heat stroke).

11. Nutrition: Current evidence points to the role of sugar (high), proteins (low), tryptophan (oxidative photoprodut), calcium (hyper and hypocalcemia) and lowered intake of antioxidants (riboflavin, Vitamin-C, Vitamin-E and beta carotene), in the production of senile cataract (Balasubramanian et al., 1990).
1.6.1. Over-Exposure to Sunlight

The light we see with our eyes is really a very small portion of what is called the "Electromagnetic Spectrum." The electromagnetic spectrum includes all types of radiation - from the X-rays used at hospitals, to radio waves used for communication and even the microwaves you cook food with.

Radiation in the electromagnetic spectrum is often categorized by wavelength. Short wavelength radiation is of the highest energy and can be very dangerous - Gamma, X-rays and ultraviolet are examples of short wavelength radiation. Longer wavelength radiation is of lower energy and is usually less harmful - examples include radio, microwaves and infrared. A rainbow shows the optical (visible) part of the electromagnetic spectrum and infrared (if you could see it) would be located just beyond the red side of the rainbow (Simon & Zieve, 2011)

Exposure to even low-level UVB radiation from sunlight increases the risk for cataracts. Neale et al., (2003), provided new evidence supporting the link between sun exposure and nuclear cataracts. The risk was highest among those who had significant sun exposure at a young age. Additional studies suggesting risk associated with sunlight exposure reported the following:

* The closer people live to the equator the greater the chance for cataracts. As suggested by a study (Simon & Zieve, 2011) in Southern France, sunlight exposure in these climates also increases the risk for severe cortical or mixed cataracts. In this study, even wearing sunglasses did not reduce the risk for these cataracts, although it did for posterior subcapsular cataracts.
* People whose jobs expose them to sunlight for prolonged periods are at higher risk. People in Southern France whose occupations, such as fishing or oyster farming, exposed them to very intense sunlight were at high risk for all cataracts, including posterior subcapsular cataracts. People in more Northern climates with similar occupations may not have as high a risk.

* Occupational exposure to very intense artificial light, such as arc welding, increases the risk for cataracts.

* Exposure to high levels of ionizing radiation that occur around industrial sources such as the x-rays used in nondestructive testing at maintenance facilities, and high levels of industrial microwave radiation, which occur at radar sites, can be cataract hazards unless protective measures are in place. The U.S. Occupational Safety and Health Administration, the U.S. Federal Aviation Administration and other civil aviation authorities have established safety requirements for maintenance and radar sites to guard against radiation hazards. Other types of radiation may also be causes.

Rafnsson et al., (2005) conducted a study in Iceland suggests that airline pilots have a higher risk of developing nuclear cataract than non-pilots and that the cause may be exposure to cosmic radiation. Cucinotta (2001), suggests that astronauts, too, are at risk from cosmic radiation.

1.6.2. Exposure to lead

Life time lead exposure may increase the risk of developing cataract, scientists from the National Institute of Environmental Health Sciences, USA revealed. A study published in 2002 found lead exposure to
be a risk factor; another study in December 2004, of 795 men age 60 and older, came to a similar conclusion (Schaumberg et al., 2004).

1.6.3. Steroids

The association between steroid use and development of cataract is well established. There seems to be consensus that higher the dose of steroid and longer the duration of use, the higher will be the risk for posterior subcapsular cataract. It is difficult to determine a safe steroid dose even by pooling all published data because of the differing cataract diagnosis criteria of the studies as well as the differing potency of steroids used. Steroids differ in their potency as well as in the side effects potential. Pred Fort (prednisone acetate) eye drops are perhaps the most widely prescribed steroid eye drop for eye inflammation treatment. There are now several steroid eye drops that have less tendency to cause eye pressure rise or cataract than Pred Forte (FML, Vexol, Lotemax or Alrex, HMS), in part because they are metabolized in the cornea to some extent. Steroids like Inflamase (prednisone phosphate) penetrate the cornea less. The same goes for users of steroids, diuretics and major tranquilizers, but more studies are needed to distinguish the effect of the disease from the consequences of the drugs themselves. Some eye care practitioners believe that a diet high in antioxidants, such as beta-carotene (vitamin A), selenium and vitamins C and E, may forestall cataract development. Meanwhile, eating a lot of salt may increase your risk (Cataract-Eye care article, 2012).

*Oral Steroids* - Patients treated with Prednisone in amounts less than 10 mg/day for one year stand a negligible chance of developing a PSC cataract. However 75% of patients receiving more than 15 mg/day Prednisone for more than one year were found to have cataracts (Black et al., 1960). Other studies have shown that children develop cataracts much
earlier than adults, often as early as within 6 months with similar steroid doses.

Topical steroids- The total dose of steroids that produced a PSC cataract in half of the cataract patients was 765 drops of 0.1% dexamethasone over 10.5 months. 765 drops represent slightly less than 8 bottles of 5 ml each. By reducing the dose to 360 drops (less than 4 bottles of 5 ml each) the chances of developing a cataract are significantly reduced. Prednisone acetate 1% (Pred Forte) is expected to behave similar to 0.1% dexamethasone eye drops (Donshik et al., 1981).

Inhalation Steroids- In adult patients who use less than 14 puffs per week of Beclomethasone inhaler, the presence of cataract is increased, but not too much (about 30% higher). However, if twice as much steroid inhalations are used i.e. 28 puffs per week or more, then cataract presence is about 3 times more. When the cumulative dose of Beclomethasone is more than 2000 mg, the odds of developing a PSC cataract increases 10 times (Cumming et al., 1997).

1.6.4 Diabetes and Other Medical Conditions

People with certain medical conditions, notably diabetes are at high risk for cataracts, either because of a direct effect of the disease, its treatments, or both reported in Cataract-Health topics A-Z.

Autoimmune Diseases and Conditions Requiring Steroid Use: Medical conditions requiring high use of corticosteroids (commonly called steroids) pose a particularly high risk. Many of these medical conditions are autoimmune diseases, including rheumatoid arthritis, psoriasis, multiple sclerosis, systemic lupus erythematosus, Behcet's disease, and others.
Diabetes and people with high blood glucose levels: People with diabetes type 1 or 2 are at very high risk for cataracts and are much more likely to develop them at a younger age. They also have a higher risk for nuclear cataracts than non-diabetics. Cataract development is significantly related to high levels of blood sugar called glycemia, and cataracts in people with diabetes are sometimes referred to as so called sugar cataracts. Even non-diabetics with higher than normal blood sugar levels are at high risk for cataracts. Some doctors now recommend that children with diabetes undergo an eye exam to check for cataracts at the time they are diagnosed.

1.6.5. Ethnicity

A nine-year population study, published in the March 2004 issue of Ophthalmology, revealed that African Americans have a 1.8 times higher risk of developing cataracts than whites. Analysis of the 3,000 participants also demonstrated for the first time that the risk of cortical cataracts is three times higher in African Americans than Caucasians. Earlier studies have also identified a higher cataract risk in the black population, suggesting that it may be due to other medical illnesses, particularly diabetes. It has long been known that African Americans are much more likely to become blind from cataracts and glaucoma than white Americans, mostly due to lack of treatment (Cataract-Health topics A-Z, 2012).

1.6.6. Smokers and Alcoholics

Smokers: A study of nearly 18,000 physicians in 1992 showed that those who smoked 20 or more cigarettes a day had approximately twice the risk of developing cataracts. Smokers are at particular risk for cataracts located in the nuclear portion of the lens, which limit vision more severely than
Cataracts in other sites. In some cases quitting may reverse some of this damage (Christen et al., 1992).

The observational evidence linking cigarette smoking with risk of cataract is well-established; heavy smoke (15 cigarettes/day or more) have up to three times the risk of cataract as nonsmokers. Smoking is thought to increase risk of cataract, at least in part, by increasing oxidative stress in the lens. Oxidative stress can be caused by free radicals produced by reactions in the presence of tobacco smoke or other air pollutants; these free radicals may directly damage lens proteins and the fiber cell membrane in the lens. Intake of certain antioxidants has been shown to decrease cataract in a number of studies. A study investigated the effect of smoking cessation on cataract in US men and women, suggested that any healing from damage due to cigarette smoking occurs at a very modest pace, and this emphasizes the importance of never starting to smoke or quitting early in life (Weintraub et al., 2002). Compared with current smokers, former smokers who had quit smoking 25 or more years previously had a 20% lower risk of cataract extraction. However risk among past smokers did not decrease to the level seen among never smokers.

**Alcohol Users**: Chronic drinkers are at high risk for a number of eye disorders, including cataracts. Alcohol has been implicated in cataract development in a number of studies. Wine provided the least risk, and the more moderate the drinking the lower the risk. Alcohol may work directly on the proteins in the lens itself and indirectly by affecting absorption of nutrients important to the lens.

Heavy beer drinking specifically increased the risk for cataracts in the cortex. Interestingly, however, a 2000 study reported that darker ales
and stouts reduced the incidence of cataracts in animals by as much as 50%. Researchers attribute this benefit to antioxidants reported in Cataract-Health topics A-Z.

1.6.7. **Physical Features**

- *Eye Features.* People who are nearsighted and those with brown eyes may be at higher than average risk. Not all studies, however, report a higher risk in people with darker eyes.

- *Obesity and Height.* Studies have now reporting obesity as a risk factor for cataracts, notably posterior subcapsular cataracts, which form toward the back of the lens. According to one study of 17,150 people, there are specifically higher association in overweight people who are tall and whose fat distribution is primarily in the abdomen.

1.6.8 **Gender**

Women face a higher risk than men. Women who started menstruating late are at an even higher risk. A number of epidemiological studies using cross-sectional data have shown an increased prevalence of cataract in women compared with men. Although some have shown an increased prevalence of cataract generally, most have demonstrated an increased prevalence of cortical cataract, with only one study showing an increased prevalence of nuclear cataract (MacCarty *et al.*, 1999). The cause of the gender differences in cataract occurrence is not clear but could be related to the hormonal differences between women and men. Postmenopausal estrogen deficiency may be a factor. A blue mountain eye study epidemiologic data provide some evidence that estrogen and hormone replacement therapy (HRT) may play a protective role in
reducing the incidence of age-related cataract and cataract surgery (Younan et al., 2002). Data from the Beaver Dam Eye Study have found that early age of menarche, current and longer duration of estrogen therapy, as well as ever use of the oral contraceptive pill, is protective for nuclear cataract (Klein et al., 1994). The Beaver Dam Eye Study has assessed possible associations between reproductive exposures and incident cataract (Klein et al, 2000).

Studies on the prevalence of senile cataract between males and females have yielded contrasting results. In the Framingham Eye Study from 1973-75, females had a higher prevalence than males in both lens changes (63% vs. 54.1%) and senile cataract (Khan et al., 1977). Sperduto and Hiller (1984), reported that each of the 3 types of senile lens opacities was found more often in women than in men. In a separate investigation by Nishikori and Yamamoto (1987), the male-to-female ratio was 1:8 with a female predominance in patients older than 65 years who were operated on for senile cataract. In a hospital-based, case-control study of senile cataract conducted in Japan, it was observed that an increased risk of cataract was found in males who were presently spending 7 hours or more outdoors than females. However, in another analysis by Martinez et al., (1982) no sexual difference was noted in the prevalence of senile cataract.

1.6.9 Age

Aging is the primary risk factor for cataracts, but other factors are involved in determining overall risk, the age of onset, and the severity. Nearly everyone who lives long enough will develop cataracts to some extent. About 40% of people between 55 and 64 years old had some opaque areas in their lenses, and 5% had fully-developed cataracts. About 70% of people between 65 and 74 years old had opaque areas, and 18%
had cataracts. More than 90% of people between 75 and 84 had opaque areas, and almost half had cataracts.

One French study (2004) indicated that posterior subcapsular cataracts are the most common type in people under 70 years old while nuclear and mixed cataracts are the most common in people over 80. The risk for nuclear cataracts also increases with age. Age is an important risk factor for senile cataract. As a person ages, the chance of developing a senile cataract increases. In the Framingham Eye Study from 1973-1975, the number of total and new cases of senile cataract rose dramatically from 23.0 cases per 100,000 and 3.5 cases per 100,000, respectively, in persons aged 45-64 years to 492.2 cases per 100,000 and 40.8 cases per 100,000 in persons aged 85 years and older (Khan et al., 1977).

1.6.10 Other Conditions

Other conditions that can trigger the process leading to cataracts include the following:

- **Physical injury to the eye (such as a hard blow, cut, or puncture).**

  Certain sports have a significant risk of producing physical injuries to the eye, including the lens. A frequent complication of this type of injury is a traumatic cataract which can develop within hours. For example, direct injury to the eye by a baseball can be a major hazard. An accidental penetration of the eye by a handgun pellet, a fragment of a bullet or a dart is very likely to produce a cataract.

- **Chemical burns, Electrical shock injuries, Chronic exposure to intense heat or cold, Air pollution**

  The vast majority of cataracts develop very slowly. Some (cortical cataracts) begin in the outer perimeter of the lens and do
not cause visual impairment until they eventually begin to close in on the central portion of the lens. Others (nuclear cataracts) begin in the central part of the lens and impair vision early in their formation. A decrease in visual acuity, even with the best refraction, is a possible symptom of a developing central lens cataract. An eye specialist, using standard optical viewing equipment, can detect this type of cataract. Flight crew members can practice precautionary measures that minimize the development of cataracts. And, when cataracts first appear, they can be compensated for sometimes by a change in eyeglass prescription. After a cataract has become severe enough, however, surgery to replace the affected lens or lenses is the only treatment but such surgery is a relatively minor operation, and is successful more than 90 percent of the time. Most people who begin to develop cataracts have reached at least the age of 50, and more typically cataracts are diagnosed in those older than 60. Various factors appear to increase the likelihood of developing the disorder. Occasionally, genetic factors are involved in cataract development. One example is galactosemia, an inheritable disorder that interferes with the metabolism of milk and milk products. If not treated, galactosemia also can result in cataracts (Kinoshita, 1965).

1.7. Human eye- Applied anatomy and physiology

Eye sight being the gateway of perception, people fear blindness rather than any other disability. In the human eye, there are four elements which must function together to provide a sharp image. These are the cornea, a fluid called aqueous humor, the lens and the jelly-like substance the vitreous. The iris governs the amount of light entering the eye by increasing or decreasing the size of the pupil opening. The iris is a
diaphragm made up largely of circular and radiating muscle. These muscles, by contraction or stretching are able to shrink or enlarge the size of the light-admitting hole, the pupil. When the individual is doing close work, such as reading the pupil shrink slightly to sharpen the image. On the other hand the pupil become larger to admit more light when one is looking at a distant object. In human eye, the distance between the lens and the retina is fixed, unchangeable. Under the circumstances, the lens flattens out and thereby lessens its refractive power. This process of changing shape to meet the need of near and far vision is known as accommodation. Accommodation takes place almost instantaneously; enabling man to shift his gaze from near to far objects without a focusing problem. As people age, the lens hardens and changes its shape less easily. As a result, the accommodation process becomes more difficult, making it harder to see up close. This generally occurs around the age of 40 and continues until about age 65. The condition is called presbyopia. It is a normal condition of aging, generally resulting in the need for reading glasses. It must be remembered; however that humans can focus on only one thing at a time.

The human eye is roughly spherical in shape; operate on the same principle as a camera. It is bounded by three distinct layers of tissue. The outer layer, the *sclerotic coat*, is extremely tough. It is white in colour except in the front. Here it forms the transparent *cornea*, which admits light into the interior of the eye and bends the light rays so that they can be brought to a focus. The surface of the cornea is kept moist and dust-free by the secretion from the tear glands. Like tissues of the central nervous system, the major metabolic fuel for the tissues of the eye is glucose. The cornea, which is not a homogenous tissue, obtains a relatively large percentage of its ATP from aerobic metabolism. The middle coat of the
eye, the **choroid coat**, is deeply pigmented with melanin and well supplied with blood vessels. It serves the very useful function of stopping the reflection of stray light rays within the eye. This is the same function that is accomplished by the dull black paint within a camera.

In the front of the eye, the choroid coat forms the iris. This may be pigmented and is responsible for the colour of the eye. An opening, the pupil, is present in the center of the iris. The size of this opening is variable and under automatic control. In dim light (or times of danger) the pupil enlarges, letting more light into the eye. In bright light, the pupil closes down. This not only protects the interior of the eye from excessive illumination, but improves its image-forming ability and depth of field. Photographic enthusiasts, too, make a practice of "stopping down" the iris diaphragm of their cameras to the minimum permitted by the amount of light available in order to get the sharpest possible pictures.

The inner coat of the eye is the retina. It contains the visual sensing apparatus (the actual light receptors, the rods and cones, and thus functions in the same way as the film of a camera). The exterior of the cornea is bathed by tears, while the interior is bathed by the aqueous humor. It is an iso-osmotic fluid containing salts, albumin, globulin, glucose, and other constituents. The aqueous humor brings nutrients to the cornea and to the lens and removes end products of metabolism from these tissues. The vitreous humor is a collagenous or gelatinous like mass that helps maintain the shape of the eye, but also allows it to retain some pliability.

There are no mitochondria in the outer segments of the rods and cones, where the visual pigments are located. The lens of the eye is located just behind the iris. It is held in position by ligaments. Ordinarily, these are kept under tension and the lens is correspondingly
flattened. However, contraction of muscles attached to these ligaments relaxes them permits the lens to take on a more nearly spherical shape. These changes in lens shape enable the eye to shift its focus from far objects to near objects and vice versa.

**Fig-1.6. Human Eye**

### 1.7.1 The lens

An optically dense, flexible living tissue located between the primary fixed refracting surface of the cornea and the retina is the lens. The shape of the human lens is bi-convex, with anterior and posterior surface that approximate to parabolas. Equatorial diameter is about 10mm, and sagittal thickness between 3.5 mm to 5mm depending on the age and accommodative state. Compared to the anterior surface the posterior surface is the most steeply curved both unaccommodated and maximally accommodated. It is curious that this flattened shape is shared with other species who share a similar accommodative facility; wildest species to accommodate have more spherical lenses. The crystalline lens is suspended
radially from the ciliary body by the zonular fibres attached on either side of its equator. Ciliary body is roughly triangular in cross section and encircles the lens. It forms a separated ring roughly concentric with the lens, being attached anteriorly at the scleral spur, and posteriorly at the ora serrata. When the muscle within this ciliary body contracts, the body swells radially and reduces the ciliary annulus which via the zonules, allows the elastic lens to take up its preferred accommodated (and more spherical) state. Tension is returned to the lens zonule system by relaxation of the ciliary muscle, causing the lens to flatten ready for distance focusing.

The lens is a relatively simple tissue in the sense that is made up of cells from only one cell lineage, e.g. blood, connective tissue or nerve cells are not present. Lens cells are present in two distinct forms; fiber cells make up the bulk of the lens and a monolayer of epithelial cells covers the anterior surface of the fibers. The normal human lens has two functions to fulfill. It has to transmit light and to change its shape according to the requirement of the accommodative process. These functions are determined by the lenticular, optical and mechanical properties respectively.

The method of changing focus by changing the shape of the lens has no parallel in photography. Focus is changed in cameras by moving the position of the entire lens with respect to tech film. This method is also used in the eyes of some fishes, amphibians, snakes, and some molluscs. Eyes are in continuous movement during watching. Even, when they are observing a resting object they are doing small, involuntary movements. Movement of the eyeball is accomplished by three pairs of muscles, the members of each pair working antagonistically. The coordinated action of these muscles enables the eyeball to be rotated in any direction. Thus we are able to train both eyes in a single direction. This produces two slightly
differing views of the same scene which our brain is able to fuse into a single, three-dimensional image.

The lens has to transmit and focus light on the retina. The optical properties required to do this are transparency and refraction. Accommodating lenses also need controlled flexibility, elasticity and the ability to maintain all their required properties during repeated shape changes. The physiological and biochemical processes of the lens must include maintenance of those optical properties, which allow it to focus images on the retina. The lens needs energy, metabolites, ions, and biochemical communication to remain functional like all cellular structures.

**Fig. 1.7. The lens focuses an image onto the retina**

Lens isolation and lack of blood supply, suggest an unconventional physiology. The lens must get all it needs without a blood supply, (including a waste disposal service) from either the aqueous or the vitreous. The flowing aqueous seems the more likely candidate to supply the majority of these requirements and it is no surprise to find that most active pumping mechanisms are located in the epithelium, which being on the anterior surface is closest to the aqueous. The communication with other
tissues is achieved via biochemical messages carried via the vitreous or the aqueous. The necessity for transparency demands tight limitation on space between cell and fibres. The high protein concentration of the lens should result in a colloidal osmotic pressure to draw in water, which would be disastrous to transparency. There is actually a protein gradient, with the highest concentration of protein found in the nucleus and lowest superficially. Water needs to be kept out and metabolites transported in. Since there is very little extracellular space, transport deep within the lens of ions and metabolites via the extracellular clefts are restricted. Lens fibre membranes are of a more non-leaky permeability although epithelial cells have average permeability to passive transport of ions. Specialized gap junctions occur extensively throughout the lens and provide cell to cell and fibre to fibre communication. The lens epithelium is therefore able to control ion transport throughout the lens. Most processes requiring energy or metabolites are situated close to the lens surface. The sodium pump is really a N+ K+ ATPase pump is a mechanism by which sodium levels are kept low and potassium high. This pump is located in the apical and apicolateral regions of the epithelium and in the anterior superficial lens fibres. There is also a Ca+ ATPase pump to keep calcium ions low. Opacity occurs in experimental lenses when calcium or sodium levels elevate, and raised sodium and calcium levels are found in naturally occurring cataract. Protein concentrations in the lens are very high yet the colloidal osmotic pressure is somehow opposed and the proteins resist their natural urge to stick together, denature and opacify (Stafford, 2001).

The lens is made up of approximately 33% protein and 67% water. The lens increases in weight and thickness throughout the human life span. Overall from birth to 65 years of age the human lens will increase 63% in
equatorial diameter, while increasing only 22% in A-P axial thickness. Cell growth dramatically influences the contour of the anterior and posterior lens surfaces but is not the sole factor affecting lens form. On average the lens may increase threefold in size and approximately 1, 5-fold in thickness from birth to about age 80. Like any other lens, it is a refractive device.

The lens cells are contained by an elastic capsule which is their basement membrane and allows the passage of nutrient into the lens as well as waste product out of the cell. The anterior surface of the lens is lined by a single layer of the lens epithelial cells. Based on the location the lens epithelium is divided into central, pre-equatorial and equatorial zone. In the equatorial region of lens, these lens epithelial cells terminally differentiate to form lens fibres which do not possess any nucleus and cell organelle. The absence of nucleus and cell organelles, on one side, mean crystal clear transparency of the lens but, on other side the lens fibres lose machinery that keeps them metabolically active. Being the most anterior portion of the lens, the lens epithelium is the first target site exposed to any sort of insult coming through the aqueous humour which may result in cataract.
Although the lens epithelial cells has machinery to combat with cataractogenic insults, any alteration in the lens epithelium precede further in the lens and may lead to cataract. Generally the cells of central zone are mitotically quiescent while cells of pre-equatorial zone are proliferative and produce new cells that migrate towards the equatorial zone where they terminally differentiate to form fiber cells. Fiber cells constitute central major mass of the lens and they do not possess cell organelles and nucleus (Stafford, 2001).

1.7.2 Lens metabolism

The lens is metabolically rather less active than most other tissues. Energy is required for all active processes essential to growth and maintenance of transparency such as cell division, transport of metabolites and waste products, and the sodium/potassium ion pump. The epithelial cells are the most metabolically active part of the lens whilst the most superficial developing lens fibres are less active and the deeper lens fibres of the deep cortex and nucleus relatively inactive. Transport of metabolites such as ions, glucose, amino acids and lipid precursors, occurs from the aqueous to the lens by facilitated transport mechanisms controlled primarily by the lens cells.

The main source of energy to fuel active mechanisms, cell division and growth is glycolysis. Glucose is broken down to produce ATP which are the power units of the cell. The only available oxygen is in the aqueous and vitreous which surround the lens, both of which have only low oxygen content. Therefore, production of roughly 70% ATP must be able to occur anaerobically. Some aerobic glycolysis has been shown to occur in the epithelial cells closest to the aqueous that carries the major part of oxygen is available to the lens. Production of ATP in the presence of oxygen is
Energy production in the lens is a carefully balanced affair. The three enzymes that control anaerobic glycolysis (hexokinase, phosphofructokinase and pyruvate kinase) are all tightly co-ordinated based on the need of the lens for ATP. Other metabolic pathways such as the citric acid cycle, the hexose monophosphate shunt, glycogenolysis and the sorbitol pathway are also present in the lens, all delicately controlled and interacting with each other.

1.7.3 Transparency of the lens

The transparency of the lens is due to its optical homogeneity. In common with all the transparent parts of the eye the lens is avascular. The lens is essentially cellular and cells are not usually transparent to light due to absorption and scatter. Light is scattered by most of the constituents of a normal cell including the cell walls, the cytoskeleton and organelles within the cytoplasm. Many molecules absorb light but the lens needs to transmit those wavelengths required by the retina, whilst being opaque to those that may otherwise harm it. The young human lens transmits light with wavelengths between 450 and 1200 nm (Stafford, 2001).

Lens fibres are arranged in layers, each layer approximately perpendicular to the light entering the eye and there is little extracellular space to disrupt the regular array. Thus light scatter due to the plasma membranes, although still present is minimized. Lens fibres have very few organelles to scatter or absorb light and those that remain in immature lens fibres are confined to the equatorial regions, shaded by the iris. There is very little light scatter from cytoplasm of normal lens fibres and their
proteins are soluble. Trokel (1962), suggested that the transparency is a consequence of an even distribution of lens proteins throughout the cytoplasm so that there are no large fluctuations in refractive index. Benedek (1971) accounted for the transparency of the normal lens fibre cytoplasm by suggesting that there is an absence of scattering units. The lens proteins within the cytoplasm may be too small relative to the wavelength of light to cause scatter or that spacing between the proteins (scattering units) is such that destructive interference occurs. So transparency is due to the optical homogeneity of the lens fibres, which is dependent on the tightly ordered packing of unusually small soluble proteins - the crystallins. The cytoskeleton may have the important role of maintaining the even distribution and close packing of the crystallins. The lens membranes and the cytoskeleton consist of insoluble proteins and lipids and have a higher refractive index than the fibre cytoplasm (Stafford, 2001).

1.7.4 Lens Crystallins

The lens crystallins or lens proteins, are rather special and are produced within the lens during the formation of lens fibres. The higher the proportion of soluble crystallins to water in the lens fibre cytoplasm, the higher the refractive index. The percentage of soluble protein is important to transparency, too much or too little water and the cytoplasm becomes turbid. They all have a tight spherical shape.

They were not known to have enzymatic or other specific actions, crystallins have traditionally been referred to as structural proteins. Lens crystallins are not only lens specific but some are closely related to other body proteins having quite different functions. There are three main classes of crystallins α, β and δ crystalline. β- crystalline is the most abundant
crystalline, α-crystalline has the highest molecular weight and δ-crystalline is the smallest both in size and concentration. α- crystalline has chaperone like qualities which is a term applied to proteins, which protect other protein molecules from unwanted damage, denaturing, or aggregation. As lens proteins are synthesized during lens fibre development, and retained lens fibres can be as old as the organism to which they belong. The useful properties of α- crystalline is the tendency for the lens protein to change with age. Proteins tend to increase in average molecular weight and lose their compact curled up shape. This result in larger proteins causing light to scatter (Stafford, 2001).

1.7.5 The lens capsule

The lens is enclosed in thick basement membrane called lens capsule. It is a highly elastic, replicated basal lamina, formed from the basement membrane of the epithelium. The capsule’s elasticity may be due to a superhelical arrangement of filament strands. There is a denser outer layer, which is believed to contain a mixture of capsular collagen filaments and zonular elastic microfibrils. Zonular fibrils run tangentially to the lens surface at their attachment into the capsule. Most penetrate only a short distance into the capsule, but some bundles of these fibrils are found as deep as the epithelial surface.

At birth, the human lens capsule is fairly thick, about 4µm around the anterior and equatorial lens, thinning slightly at the posterior pole to 3.5µm. As the lens volume increases, the capsule has to grow to maintain its thickness but it also continually thickens anteriorly and equatorially, by deposition of new lamellae, either on the inside of new lamellae, or added at the inner surface and pushed through towards the outer surface.
1.7.6 Lens epithelium

The lens epithelium is derived from the original cells of the lens vesicle and forms a monolayer beneath the anterior and equatorial capsule, in the mature cell. Cells appear cuboidal in section, and roughly hexagonal in flat mount except at the equator, where differentiation and elongation occur. Neighboring cells have interdigitations with each other associated with junctional specializations (desmosomes and gap junctions) which not only hold the cells tightly together but also allow excellent communication between cells. These lateral interdigitated membranes are involved also in enzyme production and with the active pumps such as the sodium ion pump.

In addition to lens fibre production epithelial cells have many roles. Synthesis of crystallins and membrane proteins, transport through active pumps of ions and water, and secretion of capsular precursors, are just a few of their duties and they are rich in cytoplasmic organelles. Junctional specializations are important for mechanical stability and for control of both ion transport between cells which have no nerve supply and transport of metabolites between cells which have no blood supply.

1.7.7 Lens fibres

The lens fibres are never shed because they originate from the inner surface of the lens capsule. The bulk of the lens consists of lens fibres. These are actually vastly elongated lens epithelial cells that have lost their nuclei and many of their organelles. Since they are no longer cells and are of great length they are called lens fibres. Between the capsule and the outermost layer of lens fibres is a single layer of epithelial cells. These true lens cells continue the task of dividing, to create new lens fibres. The lens nucleus contain original embryonic (primary) lens fibers, surrounded by
the fibres (secondary) of the foetal nucleus which join at the Y sutures, and then in turn the postnatal lens fibres of the infant and adult nucleus. These latter and those of the cortex, terminate at more complex branching sutures. The newest lens fibres are found in the outermost layer of fibres in the superficial cortex and are continually formed by the epithelium, so that the lens increases in size and weight throughout life. Lens fibres appear to be tightly joined by a network of junctional structures and membrane modifications with little intracellular space.

Cortical fibres are very thin, roughly hexagonal in cross section, and very long and are slightly spindle-shaped, being wider and thicker as they cross the equator. The membranes can be so heavily interdigitated and the fibres so thin deeper cortical layers, that the six-sided nature of the fibres is not at all clear. Nuclear fibres although a little narrower, tend to be thicker. In young human, lens fibres from the cortex are approximately 7-10mm in length, very thin, roughly hexagonal in section, and appear tightly joined by complex interconnections. Specialized gap junctions are abundant and often associated with processes.

The gap junctions allow metabolic communication throughout the avascular lens, and these seem to be adapted to their unusual environment. In primates electrical coupling of lens fibres by gap junctions. In lens fibres gap junctions are different to those found elsewhere in epithelia and larger with less tightly packed particles and the gap between adjacent membranes is smaller than in other tissues. The actual protein combinations of the connexions are unique to the lens.

Three types of fibre surface structures have been identified. The first type is the interlocking processes along the six edges of the lens fibre, which appear to join adjacent fibres. The edge processes appear similar to a
zip made up of three rows of teeth. These interdigitating edge processes are more common in the areas of greatest shape change, the equator and periaxial zones, so it is possible that they may have a role in accommodation. They are also more marked in the deeper cortical zones and the nucleus. A second type of functional structure occurs on the lateral faces of lens fibres and is usually referred to as the ‘ball and socket’ junction. These only connect two lens fibre faces, and are most profuse in the cortex, para-equatorially, where perhaps zonular forces are most evident. Gap junctions have been observed in association with ball and sockets. In the deep cortex and nucleus, all six surfaces can display folds, sometimes called tongue and groove junctions, or microplique. It has been suggested that they may aid in reducing lateral sliding between lens fibres during lenticular shape changes. The areas of furrowed membrane as microvilli laying flat on their sides, and reattached apically, suggesting that the deepening tongue and groove pattern in the oldest fibres are a consequence of age, and perhaps have no role in accommodative shape changes (Stafford, 2001).
Relevance of the work

According to World Health Organization's (2011) global estimate, there are 285 million people worldwide who are visually disabled, of whom 246 million have low vision and 39 million are blind, and the number is steadily increasing because of population growth and aging. Million's of cataract extractions are caring out each year in India. In spite of this huge effort, evidence from recent prevalence data suggests that cataract blindness is increasing (survey conducted by the National Blindness Prevention and Control Programme, WHO). Cataract blindness in India is too massive to be solved by the surgical programme alone, particularly in view of the aging population trend which is expected substantially to increase the number of new cases of blindness from cataract (Minassian and Mehra, 1990).

Looking at this background in India, the present study of cataract prevalence in the southern districts of Kerala may to some extend throw light on the gravity of cataract incidence in our state. The possible background causes or risk factors may also be brought to light. Cataract prone areas may also be able to be mapped out. Efforts in controlling cataract blindness should be directed at developing strategies to reduce the incidence of blinding cataract. Many risk factors have been recognized in the development of senile cataract. Measures are to be initiated to control deficiencies and various other risk factors, thus aiming at reducing substantially the number of new cases of cataract blindness that occur each year. Blindness is not only a medical and personal problem but also a socioeconomic issue for the individual and the community. So prevention is better than cure.
The Objectives of the Study

1. Statistical survey of cataract incidence in the 5 southern districts of Kerala state (Thiruvananthapuram, Kollam, Pathanamthitta, Alappuzha and Kottayam).

2. To estimate the human cataract prevalence among the total population of the 5 selected districts and trying to map more cataract prone areas of the southern districts.

3. To estimate the gender prevalence and prevalence in different age groups from the existing reports from the hospitals.

4. Probing into the possible background causes.

5. Assessment of various risk factors giving special reference to nutrition versus cataract incidence.

6. Comparative study of human normal and cataractous lenses to find out the structural abnormalities in the different types of cataract by histomorphological techniques (using light microscope and scanning electron microscopes) to assess the structural changes takes place during the cataractogenesis with special reference to the lens fibres.