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Review Paper

Lipid Based Nanocarriers for Ocular Drug Delivery Systems

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ABSTRACT

The controlled delivery of the medicines to the eye is one of the many pharmaceutical search challenges. Low level of medication Contact time and poor biotisage owls for the solution drainage, tears circulation and his dilution or return is Problems relating to conventional systems. In addition, anatomical obstacles and physical conditions of the eyes I am also the important settings that control the distribution of medicine. Nanomatic Transporters as Micro / Nano-Suspensions, liposomes, Niosomes, Nanoparticles, Independent Hydropic and Products developed for this purpose. These new systems offer many perks to conventional systems because they Increase the distribution's efficiency of medication to improve the release profile and reduce medicine toxicity. Liver systems are diluted with tears, bring by the tear glands and usually demand regular administration. Time intervals after the nanocarriers release the drugs in a constant rate for an extended period of time and therefore improve their absorptivity Setting sorts and distribution of the site. This compilation offers a tune of different aspects of the eyeball distribution of eyeballs, With a particular fire in non-carrier strategies, including the eye structure, they are their hurdles, management and challenges. Legends / restrictions related to the development of new nanocarkers. Recent Advancement in the treatment of eye diseases As well as gene wheres are included, so future options should be regarded as well as a shipping perspective. Recent and Peptid and Peptide's Occanive Distribution have also involved in the reader's benefits.

INTRODUCTION

Drug administration is one of the most attractive and challenges facing pharmaceutic science. The eye is a small, complex organ, multi -part. Anatomy, physiology and his biochemical made a lot Insupportable to Xenobiotics. The main challenge is to be surrounded Remove these protective obstacles from the eye so that medicine Arrive at Bio -Avire in sufficient amounts to handle ophthalmic problems. Microscopic disease[1,2] . The drug's eye administration has

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advantage. associated marily with the necessity of treating the mattress of thalamic and is not considered a means of taking systemic medicine Actions. Common conditions requiring administration of the eyes Including your eyes infections as conjunctive and horny Disorders as glaucoma. Some of the typical classes of Drugs used for eye management are myotic, mydriatics / cyclopolégic, anti-swelling, anti-infectious, surgical help and diagnostics and all are meant for treatment of Local eyes disorders. Gene for some eyes disorders It's also desired and a lot of work is also developed in this area. Conventional drug distribution systems; that includes solutions, suspensions, gel, ointment and inserted, suffer from Trouble as a poor drainage of inserted solutions, tears Circulation, confirmation of the confirmation, nasolacrimal. Systemic absorb and vision incline[3]. The last few decades tried individual in the research; Purposely In the development of advanced distribution systems Destination by optimized and controlled distribution of therapeutic items in the target sites or increase their penetration Trending in the middle of the mucous membrane or exciting machine contact time laughed at the surface of the eye. Some important criticism have was written before they discuss the importance of the medication of the eyes Delivery recommended to readers for detailed knowledge in a specified area.Appeared the nanokarriers be more attractive and are subject to deep studies completely[7]. Has been reported that the particles distribution system as microsse and nanoparticles; vesicular as liposomes, the colosomes, pharmacosomes and concerns Phallic and pharmacodinemic and pharmacodinamic features. Features of different types of minor molecules. In new development.The distribution systems controlled as dandrimers, micro-emulsions, mucic polymers, idroghel, ionofo Administration of retrieving medicines, laser therapy with scaler plugs, Non-viral genography, cell technology and sard The approximation of-claim is underway. Progress in matters Sciences and trainings have provided new Administrat medicines opportunities in the back segment of the eye As well [8] .This summary offers a summary of The challenges that the formulation of the formation convenient As new future tendencies and recent advances in The science field of the delivery of Optalmic drug.

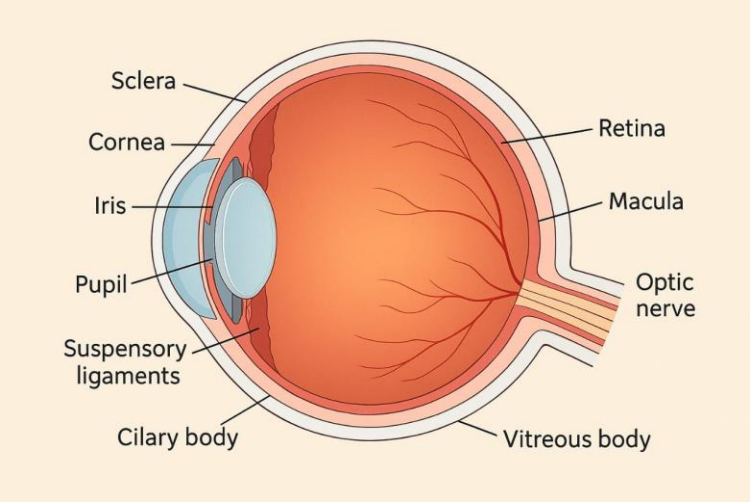


Fig1.Anatomy of Eye

Anatomy of eye:

The human eye, from the anterior segment to the rear segment, is created The glass of glass, more a

lens, horny, conjunctive, aquatic, iris, choroid, retina and sclera. Form of The human eye is spherical with a diameter of nearly 23 mm. it she has a complicated series of delicate mechanisms later visible parts that operate in the union to convey an image of the object seen in the brain. The extent and quality of light The entry in the eye is regulated and leaked by the student, which expand and contract as needed. In functioning The natural ingredients of the eye can be divided in three Layers: (i) the outer layer includes the clear and transparent layer White and dark sclera and scler; (ii) the intermediate layer holds Iris ahead, the returning choreoid and inter- ciliary body The mediative party; (iii) the internal layer has a retina, which is a Tension of the central nervous system. Fluid systems, moods to the glass moods and aquatic glass, they play an important and crucial role in keeping the house of the eye. Horny, an optical transparent tissue that has diameter of 11.7 mm and a thickness of 0.5 to 0.7 mm, functions as The main refractive element of the eye. Ordinary eye Disorders disorders include the macular degeneration of age, diabetes Edema, Cataract, vitreorethetically praliferous Uveitis, Foot Galovirus and Glaucoma. Detailed The discussion of eye disorders is beyond the purpose of this Manuscript.[1,2,6]

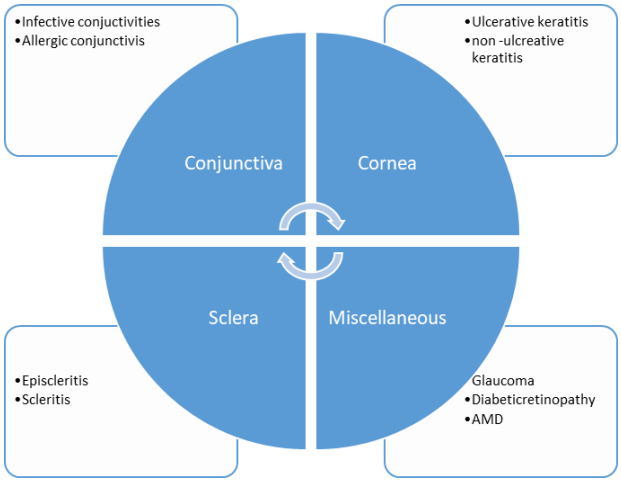


Fig 2 . common ocular disorder associated with various tissues of eye.

Routes of drug delivery :

The common routes of the eye medication administration are current, sub-Conjunctival, intrasional, backbobbar and intraracameral. On top of the medicine is administered using bearing drops in the form of solutions or suspensions. The main limitation is that the systems have a short time of contact with eyeworking mucosa; However, may be extended by modifications.The possible formulations such as gel, insert and implants [9].In this case, lipophilic drugs remain in the horny epithelium.lium and released slowly in the inner layers of horny, subthen in the front room. Subconfunctive road used to introduce medicines that do not penetrate the front segment. Basically drug is injected below junction that happens to sclere in the eye, as The sclera is more permeated than horny. Is usually Is used for antibiotics, cyclopolic and midriutic.The intravitreal path gives medication directly to the glass of glass and retina Small molecules, usually less than 500 from, are scattered Faster than the great ones. The administration medicines are Eliminate two main roads after intravial injection Or anterior and / or poster (through blood and flow of blood) .From the retrieving path, the dragging drugs can penetrate Glob because orbit is not very

vascularly and therefore the effect From this road is very less. The injection of retrieving includes Place a needle on the eyelid and orbital and orbital Place the medicines after the globe in the recovery space. This route is used to give medication in the back segment, to make the nerve structure in this area. Retort Injections of bulbar commonly used for regional anesthesia of orbit or face, but can also be used for local depot of Teravoric agents, as Anticibiotics, Corticosteroids and vasodilators. The injection of retrieving can sometimes damage Orbital structure as the optic nerve. Injection intracameral used for direct distribution of medicines in front rooms. Ber (eg Atontylchine) and in the glass room (eg Amphotericn b). General anesthesia is required for administration. Stratification of entrance injection. Physical or chemical Damage to intra -ocular facilities such as the endothelium of the wood, in wood Iris and fewer can be combined during intraracameral injection. tion Finally, the way and the action mechanism of the drug and Illness are vital problems that limit the formulator for the choice of the road.offer important features- Ture related to the remedies of medicine and suitable Considerations necessary during drug design[10].

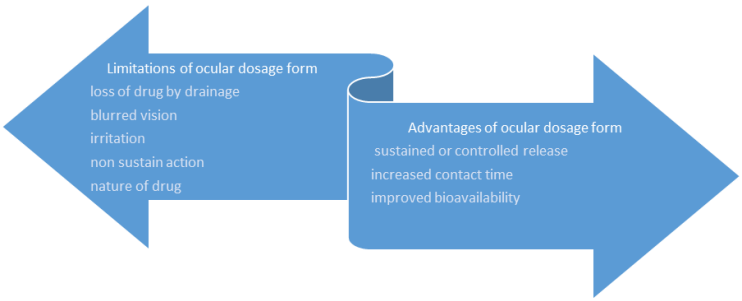
Barriers in ocular drug delivery:

The major barriers and determining factors in the distribution of the drug testing, their elimination of tears and non-horny. Inhalation. Drug transport along the corneal epithelium is mainly found by paracellular routes or tranquillary. Hydrophilic drugs mainly over the paracellular road, that includes a passive or damaged spreads through the intercellular spaces while lipophilic drugs prefer the transcellular road. Lipophop Shemet, Solubility, Size and Molecular size, Ionization charge also affects the road and grade of penetration in a horny. Chemical balance between the ionized and non-ionized medicines affects the penising drug pennies, ie, weak acid and poor basic[10]. It party -Carriers were reported to track the endocytic path. Most embedded volume of liquid doses as solutions, suspicions and are drained from the conjunctival bag in the nasolabial channel of the prerequisites. The drug is removed primarily from the precorneal tears of the drainage and absorbing bending and not through the conjunctive of the eye. These factors and The corner's barrier limits the eyeward drug penetration and only a small percentage of the administrate drug reaches the intraocular tissue. It is interesting that the tunnel of the tunes that held the protective thorax against extinct molecoses and also an obstacle against Ionic transport. Anatomically in a whole interactional epithelious, intercellular intersections narrow (okluuzens zoom) completely support more superficial cells; However, intercellular spaces are wider between arms cells and the basal cells. This allows for paracellular distribution of great molecules only through these cell layers.[11,12]

Limitations of conventional system in ocular drug delivery:

Conventional medicine medicines systems to introduce dose forms are very convenient and easy to use for all the groups of age, even if you are presenting some challenges. When the eyes drops are administered in the inferior conjunctive form of dose dose reaches in intraocular tissue and most medicine administered is taken by tears or absorbed. Systemically in the nasolacrimal channel and phoning sites[17]. Another obstacle is the low drug permeability on the spiritual surface of the horny. The rear's eye disorders are one of the main causes of blindness. As the eyes of eyes during the current administration remain in the front segment And do not ensure the distribution of medicines in the back segment of the eye. So, he needs a secure distributions systems, effective and additional to bring medicine to the target sites[18]. Such restrictions imposes a formula

restore to develop a conventional doses for effective medicines for the abode aiming. Show the options and options available related to eyebatical systems used for eyeworking therapy.



Role of penetration enhancer in ocular drug delivery:

Phenyl Enhancement promoting medication penetration through the cortical barriers and chemically modified the integrity of the epithelial layer. Pain formation Forms include Cyclo-Dextrin, dmsil sulfoxide (dmso), the acidyminarytraceracera --rtracera park, clochoolol ate, cholate, two 1935, Saponins and Salt Bill, etc. Cycles are cylindrical oligosaccharides having a central glycophagic cavity and an external hydrophobic surface that increases the solubility of the water the medicine; Improve their absorbency and stability that reduces the eye irritation. Disrupt the integrity of the membrane Be infiltrating it, or forming complex with cholesterol and membrane phospholipites. CycDexers improve the topic distribution of medicines in the eye blank drops. Benzalkonium's inclement has been proved to be sure as an improvement of penetration in the transcency of at least snow permit, drug permanent in the retina and choroids. Hydrogels containing or microems or brij97 of the cycling eyeball. The results show that the two gels have loaded with the surgeon can give therapeutic doses for a period of approximately 20 days and so extend the effect of their destination.[19,20]

Controlled and targeting ocular drug delivery:

The first distribution distribution device against the eye of the eye was developed in the form of the calculus, capable of giving the pilocarpin to a constant fail for a week constituted. Following The distribution of distribution of substantial drugs and controlled tissue began and continue to be a key purpose of their formulating scientists in the appearance of more and more Powerful medicines / biomolecule. Sahoo et coll. 2008 discussed the application of the Nanececnologie in the distribution of eye medicines. They explain how different props in anencetology, as Nanodiagnostics, Nanoimaging and Nanomomedicine can be used to explore the bounds of the distribution of eyeballs and therapy. Mainardes RM et al. The year 2005 examines the note in the developers of Colleid's carriers for the distribution of the optionalmic[23].

Nanocarriers in ocular drug delivery:

The nanotechnological treatment strategies is now is usually applied to the treatment of eye disorders touching anterior and posterior segments of the human body Today The apparent influence of nanotechnologies on this issue is that conventional distribution systems limitations in the eyes of the eyes Administration of medicines and various

obstacles present in the eye can to overcome successfully. Nanocarriies, what are they now largely accepted for contribution of controlled and destination drug, It seems to be the next hope in this area. Nanokarriers Aim to steady release of molecules to the level the desired page. Liquid dosage form as microduration, nano-suspension; Particles carriers as micropestic, polymers Eric and Lipids - Nanoparticles, vesicular carriers such as Liposome, niososma and discomairs with many others as As DelenRimers, Idroxel Systems and Product Access etc., have developed. In the following parts, we will Discuss in these nanocarri and their potential in eye medicines Delivery with full description of each[24]

Microemulsion:

Microems, a water distribution of water and oil and savacant, is used as a drug carrier, oral administration. Microwages provide an attractive alternative and potential alternative system for the distribution of doctors and transparency and preparation and only drifting without a supertantal system. Due to their internal properties and their specific structures, microemulsions constitute a form of promising dose[25]. For the natural protection of the eye. Once they are arranged by free trials from self-emotion or energy input, and can be easily sterilized. In living results and the preliminary studies in healthy volunteers with microemulsion showed a delayed effect and increased drug availability. Proposed mechanism is based on the adsorption of the nanodrofules representing The internal stage of microemulsion, that makes up a drug reservoir in the horny and then should limit their drainage.[26] For example, the actual administration of the hempan and an ionic pair with the octanoate picture through the use of a military inquiry in water that contains lecithin as a surgeon. The biotiscovering of the weapon eyeball after microemulsion's solutions and pair of ions was 3.2 and 4,2 times higher than that estuary.

Nanosuspension:

Nanosuspensions are Colloidal Distribution of Pure Partitions Depressed Deposit Depositable by Surfacters. Using nanotechnology to formulate poor water medication, as Nanosuspensions offers potential to address a lot of the few collections associated with this class of molecules. Nanosuspensions are emerged as a promising strategy for effective hydrophobic drug distributions because of their competition features and unique perks. Techniques such as the media move and high-depression homogenization were Used business to produce nanosuspense. Piscamente and coli. 2002, development of flurispen (grip) loaded AcryLate Polymer Nanosuspensions for the Ophthalmologist[27] Application intended to improve drug availability in intraocular prospect for myosy prevent During the surgeon of the cataract's surgeon. A profile of flu controlled by nanoparticles are obtained. NanosSusPosses loaded with tossing with the eyewidest tissue showed inhibition of the mooting reply to comparable trauma comparable to a formulation of control eyes. A significantly low concentration of the free medicine in conjunctive Bag theme is obtained from the Nanoparticulic system. Drug levels in aquatic mood were even higher after application of nanosuspens. [26]Similar results have been obtained Contains Eudragit Rs100 nanosuspensions for ibuprofen opportunistic distribution of ibuprofen [36]. They bored ital. 2006, in another study, the retarding retarding nosususus and cloricomen's obicibuting distribution. Saliti -pared nanosususors and less or no surface amount (tween 80) showed exterography stability Water solutions. Cassem is Coli. The 2007's Evaluated Nanocovernment as a Detailed Distribution System for some glucocorticoid drugs such as hydrocortisone,

prednisolone and defametarone. NanosusPitosions improved the degree and extension of the medication of medicine, and also the intensity of the action of prolonged length of drug effect. to a considerable measure. Agnihitri and Aran-developed nanosususpentions and smithalmologist and proposed the daddies of these careers for the distribution of non-irritating distributions[27].

Micro and nano particles:

Particles carriers as microsse, microsse, nanosseces and nanopricles belong to a promising medicines for medicines for optional applications. The inhalation of medicine in The eye has improved significantly compared to the loss solutions of eye because of the grade much slower of particles eating particles. Microparticles are sometimes large May not be better tolerated by the eyewarmer and may then undergo the patient ignore[41]. However,Nanoparticans can represent very comfortable systems of long -ating optional and have been studied widely. A large number of polymers are used to develop secure and effective or efficient oriented oriented formulation of various medicines. Eg, poles (alkyl cyanoacrology) (PACA) Nanoparticles and nanoopapapsules are shown to increase and prolong the penetration of hydrophilic and lipophilic drugs. In spite of these positive results, the potential Nanopartics Pack is limited to the question of interrupts, Cause to the horny epithelial level. In another study, policaprolaconon nanokapsulon (Pecome) shown benefits as a display drug systems. Specifically, these nookapapsules were demonstrated to increase the odd labophical drugs as metepranolol and betaxolol. Calarily be coll. 1996 reported that Nanoparticules PecC, nanokapsula Pecl and The submission emulsion that contains indomitault improves the struggling songs in Indometthacin compared to a business wording. Read the balls. 1986 has studied the Progesterone Ocean Distribution using Nanoparticles. [3H] Progerone's concentrations in various heating tissues have been monitored in different points after the current nanoparticle suspension or solutions of control. Comparison time profession has shown that the concentration of the Proesteron's tissue after the current Nanoparticles' administration was four at five times as though that took with control solutions. Nanopartic Service as a hiding distribution system may depend on the hydrophilic properties of the policies, in addition to increasing push of prediction. The absorb and the fate of Nanoparticles are essential in the distribution of eye medicines. Zimmer et al. 1991 he studied the nanopitic pbca transport with pbca in the eye tissue. has been proposed that Nanoparticle's Endocytosis from Conjunctive tissue or wall of the Nanoparticle's metabarritic degrading degradation can be the potential mechanism. A fluorescence sign in horny cells in its possible to get the transcellular path.[43]

Solid lipid nanoparticles:

Lipid solid name-Grams (SLN) are a lipid-based system consisting of triglycerides that are oriented to form a polar polar oriented. Sln are cutting edge of cutting edges (50-1000 contribution to join some innovative treatments (solid Matrix for controlled clearance), emulsions and Liposomes (toxicological physiological material) and without many disadvantages of these supports. Kuaj r is Col. 2002 slins investigated as a hiding distribution system for Tobramycin (OTB). A suspension of tob (Tob-slns) slnsing 0.3% w / v tob was administered top for rabbits, and tob concentration in the water of the water until six hours. In compared to a equal tob dose by standard eyes, the tob-sln has significantly produced significantly in the median water. Humor Attama AA et al. 2007 has developed the sln oil containing the fospolipides that can prove that they are a good circular drug distribution that takes the hunger of

particle and tolerance Lipids of the ingredient. Sln provides a declined drug release with negligible toxicity compared to polymer systems. Therefore they can try better if you carefully explain for eyewitness in the future[47].

Liposomes:

Liposomes are lipids of spherical lipids in which the aquatic heart is blocked in phospholipid bilays. Liposomes, of being bioadable and non -toxic in nature, presenting yourself as a possible support for the distribution of eye drugs. Liposomes are able to develop an intimate contact with tissue or cunno and conjunctive and so make sure more than medicines. An extended release of bioactive The place of administration and slight modification for the purpose of the purpose of the purpose of making versatile and unique in terms of ocular therapy. Liposomes also protected medicine Metabolic enzymes present in tears and / or epitselio of the corneal. These were possible to be adopted as possible of possible hydrophilic transportants as pilocarpine, of the onloxacin, Diclofenac sodium, Ganciclovir and chlorophenol Liposomes have improved the appearance of the eyes. Bio -Patient Bio compatibility and respect to reduce medication administration frequency. The surface load of liposomes show an important impact on the eyewarm. Liposomes Cystic Acyklovir Sodium, Acebium, AceAzolamide shows gantlldovrR's racing the excitant contained counting a local and neutral and neutral lipos. Diclofenac the Diclofenac Lipo improved the biodispersity of the eye and increased contact time Independent of the loading, liposomans that are multilamels fairly stabbed, as in the liposomes maintained 89%, the lip of your words, and neutral Precedent They showed more prolonged effect and a larger decrease in intricate pressure in comparison to the lipoperation of inverted phase evaporation[48]. Liposomes positively charges Tropikamide showed the larger withholding in the precarious area after aspiration. Kawakami et al. 2004 observed highest in vivo transfection efficiency of plasmid DNA in cationic liposome complex for the treatment of ocular diseases . Vasoactive peptide peptid (VIP) caught in a liposomal wording showed a higher eye bioacaustivity of its solution. Velpandian t et al. 2006 reported that flow liposomes do not exhibit retina toxicity even up to a 200 G / 0.1 ml concentration. Chloramphenicol with Dimllyistoyyl phosphoStaratidylcholine (DMPC) in Has developed a liposomal wording for eye bacterial infections. Although liposomes are versatile carriers, have some disadvantage as the poor stability and Playing, low blockage efficiency of drug blockage, the absorption of phagocytosis and intraocular opacipulation when administered by intravital injection[49].

Niosomes:

Niosomes are non-ionic surface, biodegradable in nature. Niosis are chemically stable in nature that liposomes that meet certain stability issues. During storage because it is composed of phospholipid. Have blocked hydrophobic and hydrophylic drugs. The ionic surrender are commonly used for eyeworking includes Solular, Chitosan, Carbopol and InCofatho phosphates. Collester can be added to improve the nosome nosomic sustainability against plasma protein and serum [50].The nosomes are Is used as a carrier for drug distribution as peptide. Cases in ophthalmology to give medicines in the eye to handle the eyeball disorders, diclofenac sodium, acetotolic. etc. Our group first reported the downtown of the timolol in the head for the glaucoma treatment. Ionic Surfactants based on known discoveries such as (disimpleted) loaded with male timolol were formulated for their vivid parameters. The solol c24 was used in the nosomes, which affected the transition phase from the vesicle to disgrace. These discoveries were great and have a high medication

charge of medication. In living studies showed that discomfort the relastified content in a Bappasic profile if the drug has been charged using a gradient technique. The dispute can act as potential drug carriers as releasing medicine in a steady way in the eye. The older formulation fit in the 40/60-tag: cholesterol was developed in three different reports (7: 4, 7, 7). In the living studies found that ratio 7: 6 has had the highest efficiency blocked while 7: 4 ratio molar[52,47]

Implant :

The implants are drug distribution effects for chronic eye diseases. Once is seated, implants in the eye extend the time of the medication of medication to a suitable length. Are usually used to handle eye disorders like retinite cytomalovirus (cmv), an eye invention found in patients with aids and a principal cause of blindness. Cleaned purified, un -Booiders were used but their introduction required surgical procedures. And an irradishment, but the trend has slipped in biodegradable products. Bio -Digradosi Bio Poliseros as secure and effective populations in the distribution of doctors in the glass cavity and do not show effects. Toxic signs during the insertion. In the comments on the episarial claims by the essolinium-DTPA has shown that these implants have brought the midway through the glass cavity. The seating disasters scleral while being implemented the cupatar episcinary episcinary episcindario in a steady manner for dry kheratononjunnic I implants of Flighter Flight Flighted Flight have been developed for the rear segment treatment and were reported to control the swelling of eye retina. Epidermidized facts with algina -coated Algina demonstrated prompted applications to the dry eyewalk.[53]

Prodrug:

Prodrugs are derivates simple drugs that are chemically and / or enzymes in their active parent's remedy. The 9th drugs that contain functional groups as alcohol, fenol and amines that are amma liking for derivators with medical medical, for example; Epinalphins dipigil, tennic, cyclackulto and tilisolol. The produce can extend dose residence time in Sack of conjunctival. Dominiques that are very little immediate in the blood and unable to outstand they are transfluid in products that easily for a drug and promoting[54]. If you And pilocarpine irritation and is modified with the add of polymer and ciclodess to eyes solutions. Their o'dipropony has produced [1,4-xyllylene] Bispylocarpic acid reduces small levels and prolongs the length of mines compared to the pilocarpin. Cycludextrins helped reduce irritation. Horny penetration was successfully was perfect as studies found that acetyl, and budrylol and pianzyl between 30 and 140 min when it is incubated with Plasma, aquatic humor. Prodrug redeems the ink dose and incidence of undergoing and respiratory side effects. The uterus and collars studied the eye regulations Ganciclovir and his monoester, properties, merge and valerate. They found the management of hydrolysis and the product of the produced glass in the dash of the extremity increased residence increased 3- to 4 times.[55]

Hydrogels:

Hydrogels consists of molecular hydrophilic policies that form a 3d networks in water, eg aimed (pva) and karbomer etc. Hydrogels increase the drug Eyebrow busoodiscover because You have a long time on block. The village agent's precarious time of residence can be many hours to improve the effect of medicine on the destination site. observed that environmental factors such as temperature, the ionic force can cause the viscosity of hydropotes plants. Alginated / hpmc -arded almost developed as a goal agent in the country from Liu Z et al. 2006. Studies show their

combination kept medicine better than algina or hpmc. A polish system (n -isoprope) the character loaded of Timulol) -Cs has been developed as a thermosensible gel in the country for eyebound distribution. The system has shown a low toxicity indicator to a concentration of 0.5 to 400 g / ml. 2 times the higher concentration of medicine and reduce intramuscular pressure. A controlled liberation ID was found by Amina-

Have et al. 2002 to evaluate the response to the smart hydrogel stimuli using isopropyl akrlamlamlamlam dampe poles n for inside and External responses. It is observed that polymer subject Sol-Xel's solitary transition in response as temperature, pH, ionic strength as current, lights, etc. Camini is Coll. 2005 Ionforus of Tresmalal 2005 of XDamethasar fosphatory After 1 min Ionforcon horny with a current intensity of 1 but for 1 to 4 min. A higher level of drug was observed, as well as the high drug withholding in the retina and conjunction. In another study, licamicin hydropots plants have been administered in the breath eye from the Ionaphorosis. The maximum drug concentration was 12-15 times higher after the Ionaphorosis that after simple loss. Cicloporin and IDROGEL in BLIJ97 Microems and Idrogel of P-HemraCant loaded with surfaced has shown Increase the availability of bio. The Ipromel Iconophoff technique has been used to give methylpednisolon to the back of the eye. The microanalysis of hydrogel summoned collagen consisting of the distribution of calculated medicines and implants were rated for their mucous effect. The Cerciopher Certofeakers carbopatine were used and an increase in the Therapic medication level has been observed. Zappedtarcarrichers, when they ship to the eye through the Ion IDrOnge. They show an increased level of aspiration.[56,57]

Dendrites:

Dendrimers can provide medicines with improved water sipability, biology and biocompatibility and have successfully explained different of drug distribution. For political decent (Amidoamine) for the contribution contribution of eye medicines Contains fluorescent has been developed and appreciated by Vandamme et al. 2005. Have determined the impact of a progressive increase controlled in the size of molecules Weight and Amina Groups Number, Carboxilate and Idroval in multiple denim series. Stay the time was longer for the solutions that contain dances with Surface carboxylic groups and hydroxyl groups. While an extended rear time has been observed as the denim concentration (0.25-2%) increased. In a different study study, positively ligated loads were synthetized and their subsequent ability to give oligonucleotide sense (odn-1) The nucleus of d407 cells in culture was assessed. Dendrimer / Odn-1 complex has caused a significant decrease of the puff expression during an initial 24-hour period (40 to 60% and maintained this level of diminishing ves nugf during a period of subsequents, showing protection of odn-1 against the effects of Endendairs. Time center studies showed the dendrimer/ ODN-1 complex remaining coated for until the denimere men provided the effects of nucleus[58,59,60].

Ocular inserts:

The first hiding insectivane were developed by the alza cradiporous, as a flat, flexible device intended to distribution prolonged optalmologist. Occumes are a sterile, comfortable preparation to use and negligible or less affected by the nasolacrimal injuries. When administered, reduce doses and also provide a precise dose. Icuberrers provide a Extension of drug residence time with controlled release. Biodegradable policeners as chitosan, alcohol poly-world, Hydroxyl-Proply, Polyvinylrypyrrolidone, hyCleaners in anonic and non-biding acid and biding as the ethilia lies, both

are loose by its production. A biodizer insert in situation of situation Almost almost Sesquihydrate showed that 95-99% of the drug was released by a resilient film in 8-12 hours after the omniscience of the alive and vivo. Inserts are available in different varieties depending on their composition and applications[61]. Lacrellert is a sterile device to the dry eye syndrome treatment and sour dry and has been introduced by Matteck, hung in 1981. When you entered, absorb water from horny and conjunctive and form a hydrophil movie that horny lubricates. Another type of eye insertion is the soluble insertion of the drug hate (sodi), which is a small oval Wafer, composed soluble soles as ancylamide, n-vinilepyrolidone and ethyle acril. It's a sterile dirty movie with a thickness of 0.35 mm and about 15 mg. in weight. When it comes to the eye, I'm suffering in 10 to 15 seconds, trained in a polymer clot and then distribute to free medication[62]. Nods are the drug flags that contain 0.4-0.5g solid alcohol stopped attached to a covering paper . The flag, entered in the conjunctive bag, you sore medications from the flag that shares Selected in the fluid of tear. Nodes are easy to use and ensure increased drug availability in comparing to eyelas solutions. The collagen shield, a erid erid disk made of interconnected collagen, was introduced by o'brien et al. 1988. Them. Are possible distribution systems, they help heal the injury and release stable of a large medicines as tobramylin and steroids. In a study, chitosan insertion has shown the Sustainable delivery of of Floxacin in rocky tissue and improve their careless traverse. However, cause the eye interference and seek a doctor's help for insertion[63].

Protein and peptide delivery to ocular sites:

The concept of therapeutic protein / petive has received a lot of attention in the last few years. However, restrictions as membrane permanability, great size, the metabolism and The solution limits its effective distribution. A number of approaches are used to overcome these restrictions. The poor hydropedic porpoise can be improved by seeing the compound structure, increases their permanes permanable. The eye walk is not the preferred path for the systemic administration of molecules like that. However, for the local distress of the evidence of the evidence, these molic classes must have expedited as the nanomometricin. Immunoglobulin g was effective efficient in the retina in transscaler mode with insignificant systemic absorption. The peptide drugs, ganclovin, ganciclovir and vip have been removed to the eye villages using nanocarries as nanoparticles plaga. and liposomes[64]. Ship the extra powders Gracyclovir Based (Valine (VAL) and Glycine (Glycin (Glylys) developed and demonstrated to improve the cell's biodisco and the Therapeutic of Ganclovir

Challenges in commercialization of ocular nanopharmaceuticals:

The security and efficiency are key concerns when developing lnp for the use of eyes. Formulation sterilization is also a challenge, while the filth of membrane is used for this purpose. Lnps can be manufactured in an industrial structure with a high homogenization shear that are usually accessible[65]. The great challenges Relate to the lipid-rapid-sized formation production and reproduction and reliability of used (Halalan et al., 2021). A multi-component processing line is required for the NP production for the process often has multiple stops, As the centromation, Sparring, natural ampleity, importing, Heamonette, sary loopoon, emulsification, evaporation of the organic meal solvents, homogenization, filter and grinding. So it's harder to choose the process settings in getting quality features in order to repress a business scale, even the small prostiances are relatively simple to get.

However, the products of lnp -based eyes like ikvvis® or cequad® are trade available[66,67]

CONCLUSION

Drug delivery challenges due to the various ocular barriers confound potential setbacks for scientists working on targeted drug delivery in the ocular tissues. Nevertheless, considerable efforts have been made so far, and the trends still continue in seeking ocular drug delivery, seeking efficacious, safe, and biocompatible therapeutic drug delivery approaches.

At present, researchers working in this domain strive to enhance the performance of the conventional formulation in vivo. Many drug delivery carrier systems with nanotechnology applications are being designed and formulated at a large scale, including polymer NPs, solid lipid NP, lipidic vesicles, micelles, micro- and nanoemulsions, nanosuspensions, microneedles, and dendrimers. For instance, several ocular drug delivery studies are only limited to in vitro performances, and explorations of in vivo studies using ocular models of cell lines may further facilitate the development of precise data at the preclinical and clinical stages. Nanotechnology-based drug delivery systems so far have been useful in reducing toxicities, multiple dosing, dose-related undesired effects, and fluctuations in drug plasma concentration, associated with a traditional drug delivery system. However, research on ocular therapeutic systems still suffers from a large gap, and the design process of a novel carrier that could be nontoxic, biodegradable, biocompatible, and efficacious in mitigating both the posterior and anterior segments of the eye disease is underway. The current attempts and prospects made by scientists regarding ocular therapeutic systems may translate nanomedicine into clinics with promising precorneal residence time and high drug accumulation in targeted ocular tissues, reduced frequency of administration, and good bioavailability. Finally, combining both the therapeutic and diagnostic agents in one nanocarrier system may bring better visual acuity in ocular therapy.

REFERENCES

1. Urtti A. Challenges and obstacles of ocular pharmacokinetics and drug delivery. Adv Drug Deliv Rev 2006; 58: 1131-35.
2. Gaudana R, Jwala J, Boddu SHS, Mitra AK. Recent perspectives in ocular drug delivery. Pharm Res 2009; 26(5): 1197-216.
3. Bourlais CL, Acar L, Zia H, Sado PA, Needham T, Levergȼ R. Ophthalmic drug delivery systems- recent advances. Prog Retin Eye Res 1998; 17: 33-58.
4. aur IP. Development of effective ocular preparations of antifungal agents. J Ocul Pharmacol Ther 2008; 24: 481-93.
5. Conway BR. Recent patents on ocular drug delivery systems. Recent Pat Drug Deliv Formul 2008; 2: 1-8.
6. Vandervoort J, Ludwig A. Ocular drug delivery: nanomedicine applications. Nanomedicine 2007; 2: 11-21.
7. Kaur IP, Garg A, Singla AK, Aggarwal D. Vesicular systems in ocular drug delivery: an overview. Int J Pharm 2004; 269: 1-14.
8. Hughes PM, Olejnik O, Chang-Lin JE, Wilson CG. Topical and systemic drug delivery to the posterior segments. Adv Drug Deliv Rev 2005; 57: 2010-32.
9. Hornof M, Toropainen A, Urtti A. Cell culture models of the ocular barriers. Eur J Pharm Biopharm 2005; 60: 207-25.
10. Rojanasakul Y, Wang LY, Malanga CJ, Ma JKH, Liaw J. Targeted Gene Delivery to alveolar macrophages via Fc receptor-

mediated endocytosis. Pharm Res 1994; 11: 1731-36
11. Chrai SS, Robinson JR. Ocular evaluation of methylcellulose vehicle in albino rabbits. J Pharm Sci 1974; 63: 218-23
12. Grass GM, Robinson JR. Mechanisms of corneal drug penetration: In vivo and in vitro kinetics. J Pharm Sci 1988; 77: 3-14
13. Tonjum AM. Permeability of horseradish peroxidase in the rabbit corneal epithelium. Acta Ophthalmol 1974; 52: 650-8
14. Hedbys BO, Mishima S, Maurice DM. The inhibition pressure of the corneal stroma. Exp Eye Res 1963; 2: 99-111.
15. Schoenwald RD. Ocular drug delivery, pharmacokinetic consideration. Clin Pharm 1990; 18: 255-69.
16. Barar J, Javadzadeh AR, Omidi Y. Ocular novel drug delivery: impacts of membranes and barriers. Exp Opin Drug Deliv 2008; 5:567-81.
17. Geroski DH, Edelhauser HF. Drug delivery for posterior segment eye diseases. Invest Opthalmol Vis Sci 2000; 41: 961-64.
18. mo EM, Urtti A. Current and future ophthalmic drug delivery systems: a shift to the posterior segment. Drug Discovery Today 2008; 13: 135-43.
19. Okabe K, Kimura H, Okabe J, Ogura Y. Ocular tissue distribution of betamethasone after anterior-episcleral, posterior-episcleral and anterior intrascleral placement of non-biodegradable implants. Retina 2007; 27: 770-7.
20. Kapoor Y, Chauhan A. Ophthalmic delivery of cyclosporine A from brij-97 microemulsion and surfactant-laden p-HEMA hydrogels. Int J Pharm 2008; 361: 222-9.
21. Furrer P, Mayer JM, Plazonnet B, Gurny R. Ocular tolerance of absorption enhancer in opthalamic preparation. AAPS Pharm Sci 2002; 4: 1-5.
22. Sigurdsson HH, Stefánsson E, Gudmundsdottir E, Eysteinsson T, Thorsteinsdottir M, Loftsson T. Cyclodextrin formulation of dorzolamide and its distribution in the eye after topical administration. J Control Release 2005; 102: 255-62.
23. Sahoo SK, Dilnawaz F, Krishnakumar S. Nanotechnology in ocular drug delivery. Drug Discov Today 2008; 13: 144-51.
24. Mainardes RM, Urban MC, Cinto PO, Khalil NM, Chaud MV, Evangelista RC, et al. Colloidal carriers for ophthalmic drug delivery. Curr Drug Targets 2005; 6: 363-71.
25. Santos P, Watkinson AC, Hadgraft J, Lane ME. Application of microemulsions in dermal and transdermal drug delivery. Skin Pharmacol Physiol 2008; 21: 246-59.
26. Jadhav KR, Shaikh IM, Ambade KW, Kadam VJ. Applications of microemulsion based drug delivery system. Curr Drug Deliv 2006; 3: 267-73.
27. Vandamme TF. Microemulsions as ocular drug delivery systems: recent developments and future challenges. Prog Retin Eye Res 2002; 21: 15-34.
28. Gasco MR, Gallarate M, Trotta M, Bauchiero L, Gremmo E, Chiappero O. Microemulsions as topical delivery vehicles: ocular administration of timolol. J Pharm Biomed Anal 1989; 7: 433-9.
29. Fialho SL, da Silva-Cunha A. New vehicle based on a microemulsion for topical ocular administration of dexamethasone. Clin Exp Ophthalmol 2004; 32: 626-32
30. Lv FF, Li N, Zheng LQ ,Tung CH. Studies on the stability of the chloramphenicol in the microemulsion free of alcohols. Eur J Pharma Biopharm 2006; 62: 288-94.
31. Radomska-Soukharev A, Wojciechowska J. Microemulsions as potential ocular drug delivery systems: phase diagrams and

physical properties depending on ingredients. Acta Pol Pharm 2005; 62: 465-71.
32. Baspinar Y, Bertelmann E, Pleyer U, Buech G, Siebenbrodt I, Borchert HH. Corneal permeation studies of everolimus microemulsion. J Ocul Pharmacol Ther 2008; 4: 399-402.
33. Ma SW, Gan Y, Gan L, Zhu CL, Zhu JB. Preparation and in vitrocorneal retention behavior of novel cationic microemulsion/in situgel system. Yao Xue Xue Bao 2008; 43: 749-55.
34. Vandamme TF. Microemulsions as ocular drug delivery systems: recent developments and future challenges. Prog Retin Eye Res 2002; 21: 5-34.
35. Patravale VB, Date AA, Kulkarni RM. Nanosuspensions: a promising drug delivery strategy. J Pharm Pharmacol 2004; 56: 827-40.
36. Pignatello R, Bucolo C, Spedalieri G, Maltese A, Puglisi G. Flurbi-profen-loaded acrylate polymer nanosuspensions for ophthalmic application. Biomaterials 2002; 23: 3247-55.
37. Pignatello R, Ricupero N, Bucolo C, Maugeri F, Maltese A, Puglisi G. Preparation and characterization of eudragit retard nanosuspensions for the ocular delivery of cloricromene. AAPS Pharm Sci Tech 2006; 7: E27.
38. Kassem MA, Rahman AAA, Ghorab MM, Ahmed MB, Khalil RM. Nanosuspension as an ophthalmic delivery system for certain glucocorticoid drugs. Int J Pharm 2007; 340: 126-33.
39. Agnihotri SM, Vavia PR. Diclofenac-loaded biopolymeric nanosuspensions for ophthalmic application. Nanomedicine 2008; Sep 25.
40. Desai SD, Blanchard J. Pluronic® F127-based ocular delivery system containing biodegradable polyisobutylcyanoacrylate nanocapsules of pilocarpine. Drug Deliv 2000; 7: 201-7.
41. Losa C, Marchal-Heussler L, Orallo F, Vila Jato JL, Alonso MJ. Design of new formulations for topical ocular administration: polymeric nanocapsules containing metipranolol. Pharm Res 1993; 10: 80-7.
42. Zimmer A, Kreuter J. Microspheres and nanoparticles used in ocular delivery systems. Adv Drug Deliv Rev 1995; 1: 61-73.
43. Calvo P, Vila-Jato JL, Alonso MJ. Evaluation of cationic polymercoated nanocapsules as ocular drug carriers. Int J Pharm 1997; 153: 41-50.
44. Li VH, Wood RW, Kreuter J, Harmia T, Robinson JR. Ocular drug delivery of progesterone using nanoparticles. J Microencapsul 1986; 3: 213-8.
45. Zimmer J, Kreuter J, Robinson JR. Studies on the transport path-way of PBCA nanoparticles in ocular tissues. J Microencapsul 1991; 8: 497-504.
46. De Campos AM, Sánchez A, Alonso MJ. Chitosan nanoparticles: a new vehicle for the improvement of the delivery of drugs to theocular surface. Application to cyclosporin A. Int J Pharm 2001; 224: 159-68.
47. Merodio M, Espuelas MS, Mirshahi M, Arnedo A, Irache JM. Efficacy of ganciclovir-loaded nanoparticles in human cytomegalovirus (HCMV)-infected cells. J Drug Target 2002; 10: 231-8.
48. Chu TC, He Q, Potter DE. Biodegradable calcium phosphate nanoparticles as a new vehicle for delivery of a potential ocular hypotensive agent. J Ocul Pharmacol Ther 2002; 18: 507-14.
49. Giannavola C, Bucolo C, Maltese A, Paolino D, Vandelli MA, Puglisi G, et al. Influence of preparation conditions on acyclovir loaded poly-d,l-lactic acid nanospheres and effect of

PEG coating on ocular drug bioavailability. Pharm Res 2003; 20: 584-90.
50. Bourges JL, Gautier SE, Delie F, Bejjani RA, Jeanny JC, Gurny R,et al. Ocular drug delivery targeting the retina and retinal pigment epithelium using polylactide nanoparticles. Invest Ophthalmol Vis Sci 2003; 44: 3562-9.
51. de Campos AM, Diebold Y, Carvalho EL, Sánchez A, Alonso MJ. Chitosan nanoparticle as new ocular drug delivery systems: in vitro stability, in vivo fate and cellular toxicity. Pharm Res 2004; 21: 803-10.
52. de Kozak Y, Andrieux K, Villarroya H, Klein C, Thillaye-Goldenberg B, Naud MC, et al. Intraocular injection of tamoxifen-loaded nanoparticles: a new treatment of experimental autoimmune uveoretinitis. Eur J Immunol 2004; 34: 3702-12.
53. De TK, Bergey EJ, Chung SJ, Rodman DJ, Bharali DJ, Prasad PN. Polycarboxylic acid nanoparticles for ophthalmic drug delivery: an ex vivo evaluation with human cornea. J Microencapsul 2004; 21: 841-55.
54. Amrite AC, Kompella UB. Size-dependent disposition of nanoparticles and microparticles following subconjunctival administration. J Pharm Pharmacol 2005; 57: 1555-63.
55. Sakai T, Kohno H, Ishihara T, Higaki M, Saito S, Matsushima M,et al. Effect of betamethasone phosphate-loaded polyactide nanoparticles on experimental autoimmune uveoretinitis. Exp Eye Res 2006; 82: 657-63.
56. Enriquez ADS, Diebold Y, Calonge M, García-Vazquez C, Callejo S, Vila A, et al. Chitosan nanoparticles as a potential drug delivery system for the ocular surface: toxicity, uptake mechanism and in vivo tolerance. Invest Ophthalmol Vis Sci 2006; 47: 1416-25.
57. Vega E, Egea MA, Valls O, Espina M, García ML. Flurbiprofen loaded biodegradable nanoparticles for ophtalmic administration. J Pharm Sci 2006; 95: 2393-405.
58. Kompella UB, Raghavan SS, Escobar ERS. LHRH agonist and transferring functionalization enhance nanoparticle delivery in a novel bovine ex vivo eye model. Mol Vis 2006; 12: 1185-98.
59. Diebold Y, Jarrin M, Saez V, Carvalho ELS, Orea M, Calonge M,et al. Ocular drug delivery by liposome-chitosan nanoparticle complexes. Biomaterials 2007; 28: 1553-64.
60. Motwani SK, Chopra S, Talegaonkar S, Kohli K, Ahmad FJ, Khar RK. Chitosan-sodium alginate nanoparticles as submicroscopic reservoirs for ocular delivery: formulation, optimisation and in vitro characterisation. Eur J Pharm Biopharm 2008; 68: 513-25.
61. Eljarrat-Binstock E, Orucov F, Aldouby Y, Frucht-Pery J, Domb AJ. Charged nanoparticles delivery to the eye using hydrogel iontophoresis. J Control Release 2008; 126: 156-61.
62. Amrite AC, Edelhauser HF, Singh SR, Kompella UB. Effect of circulation on the disposition and ocular tissue distribution of 20 nm nanoparticles after periocular administration. Mol Vis 2008; 14: 150-60
63. Yenice I, Mocan MC, Palaska E, Bochot A, Bilensoy E, Vural I, et al. Hyaluronic acid coated poly-epsilon-caprolactone nanospheres deliver high concentrations of cyclosporine A into the cornea. Exp Eye Res 2008; 87: 162-7.
64. Badawi AA, El-Laithy HM, El Qidra RK, El Mofty H, El dally M. Chitosan based nanocarriers for indomethacin ocular delivery. Arch Pharm Res 2008; 8: 1040-9.
65. Alonso MJ. Polymeric nanoparticles: new systems for improving ocular bioavailability

of drugs. Arch Soc Esp Oftalmol 2001; 76: 453-4.

66. Bu HZ, Gukasyan HJ, Goulet L, Lou XJ, Xiang C, Koudriakova T. Ocular disposition, pharmacokinetics, efficacy and safety of nanoparticle formulated ophthalmic drugs. Curr Drug Metabol 2007; 8: 91-107.

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