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A REVIEW ON RECENT ADVANCES IN OCULAR DRUG DELIVERY SYSTEM

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Abstract:

Pharmaceutical researchers find that the ocular drug delivery system (ODDS) is one of the most difficult topics to discuss. The ability to sustain a therapeutic dose of drug at the site of action is the key obstacle to long-term ocular pharmaceutical use. Ailments interfere with the ability to focus for the duration of this eye care. The barriers that shield the eyes make this ocular drug delivery device difficult to use. The main obstacle to be addressed is the active drug substance's bioavailability. Because topical administration has a faster beginning of effect than systemic use, it is excellent for ocular therapies because a lesser dose is needed. This trans-corneal penetration, which occurs when topical absorption reaches the interior regions of the eye, is thought to be the primary drug application method. The more slower method of removal is called ocular absorption. To treat ocular diseases, this traditional ocular dose form—including eye drops—is no longer enough. Conventional drug therapy is a crucial component of ocular pharmacokinetics and investigates a range of techniques to increase the drug's ocular bioavailability, including eye ointment, gels, prodrugs, penetration enhancers, liposomes, niosomes, ocular inserts, implants, intravitreal injection, nanoparticles, nanosuspension, microemulsion, iontophoresis, and periocular injection. They supply the medication to the anterior and posterior chambers in a continual and regulated manner.

KEYWORDS: Ocular drug delivery system (ODDS), soluble ophthalmic drug delivery insert (SODI), polyvinyl alcohol (PVA), polyvinyl pyrrolidone (PVP) corneal drug delivery, controlled and sustained drug delivery, anterior and posterior segment delivery challenges.

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INTRODUCTION:

The eye is a complicated organ with a distinct physiology and architecture. There are two primary components to the construction of the eye: the anterior and posterior segments (Figure 1). The anterior segment makes up around one-third of the eye, with the posterior section taking up the remaining space. The anterior section is composed of tissues including the ciliary body, lens, iris, cornea, conjunctiva, and aqueous fluid. The choroid, neural retina, retinal pigment epithelium, optic nerve, vitreous humor, and sclera are components of the posterior segment, also known as the back of the eye. Many conditions that might impair vision affect both the anterior and posterior segments of the eye. Conditions that impact the anterior segment comprise, but are not limited to, cataract, allergic conjunctivitis, anterior uveitis, and glaucoma. However, macular degeneration is associated with aging. The two most common conditions affecting the posterior region of the eye are AMD and diabetic retinopathy.

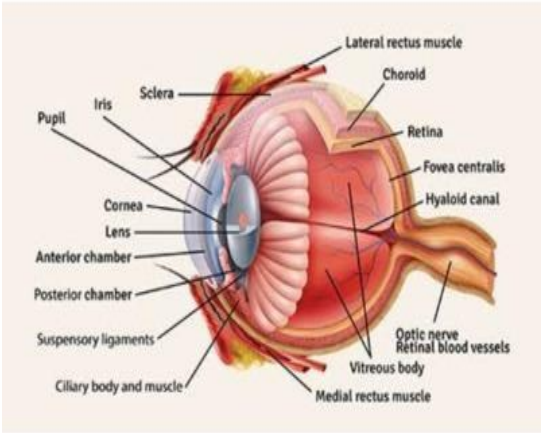


Figure no: 1
Structure of the eye.

The most popular non-invasive method of administering medication to address conditions affecting the anterior region is topical installation. Ninety percent of the marketed ophthalmic formulations are in conventional dose forms, like eye drops. Patient compliance and convenience of administration could be the cause. However, topical drop delivery results in very limited ocular absorption. Deeper ocular medication absorption is hampered by several anatomical and physiological barriers, including tear turnover, nasolacrimal drainage, reflex blinking, and ocular static and dynamic barriers. Because of this, less than 5% of the dose administered topically reaches the deeper eye structures. The obstacles make it challenging to attain therapeutic medication concentration in posterior segment ocular tissues after topical eye drop application. Several delivery methods, including intravitreal injections, periocular injections, and systemic administration, can be used to deliver the medication to the posterior segment ocular tissues. However, systemic administration is not a viable technique due to the tiny volume of the eye in comparison to the total body and the presence of blood retinal barriers. The most popular and generally advised method of administering medication to treat illnesses of the posterior eye is intravitreal injection. However, the requirement for frequent intravitreal injections and punctures of the eyes results in a number of adverse consequences, including poor patient tolerance, bleeding, endophthalmitis, and retinal detachment. An alternate method of delivering drugs to the posterior ocular tissues is the transscleral drug delivery with periocular administration route. Drug penetration is hampered with transscleral distribution, despite the fact that it is relatively simple, less invasive, and patient-compliant. Obstacles that are both static and dynamic impair drug penetration. Static barriers, such as the sclera, choroid, and retinal pigment epithelium (RPE), and dynamic barriers, such as the lymphatic flow in the conjunctiva and episclera and the blood flow in the conjunctiva and choroid, are examples of ocular barriers to transscleral medication delivery.

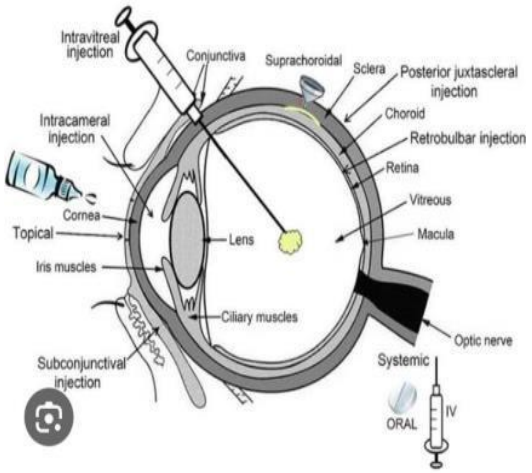
- Many traditional and innovative drug delivery methods, including emulsions, ointments, suspensions, aqueous gels, nanomicelles, nanoparticles, liposomes, dendrimers, implants, contact lenses, nanosuspensions, microneedles, and in situ thermosensitive gels for the ocular diseases, have been developed to get around the obstacles to ocular drug delivery and increase ocular bioavailability. An overview of the many traditional and cutting-edge ophthalmic drug delivery systems created to administer medication to infected ocular tissues to cure ocular disorders will be given in thisarticle.

OCULAR DRUG DELIVERY SYSTEM ADVANTAGES:

1. To improve precision dosing to mitigate the adverse effects of pulsed dosing caused by the traditional method.
2. To offer regulated and continuous medication administration.
3. To lengthen corneal contact time in order to enhance the drug's ocular bioavailability. The corneal contact time can be lengthened to

accomplish this. Effective adherence to the corneal surface can accomplish this.

4. To stop the loss of additional ocular tissues, these ocular drug delivery systems (ODDS) offer targeting within the ocular globe.
5. In doing so, get around safety precautions like drainage.
6. To make the patient more comfortable, increase patient compliance, and enhance the medication's therapeutic effect.
7. To offer a housing delivery system that is more efficient.
8. They typically absorb quickly and cause fewer systemic and visual side effects.
9. The patient can easily administer them on his own.
10. There is improved patient compliance with this ocular medication delivery system.



OCULAR DRUG DELIVERY SYSTEM DISADVANTAGES:

1. The medication solution is only briefly present on the surface of the eye.
2. They might obstruct one's vision.
3. It can demonstrate the drug's instability after dissolution.
4. The use of preservatives is required.
5. The drug should normally be eliminated from the body quickly through eye blinking and tear flow, which shortens the duration of the therapeutic effect and necessitates a frequent dosing schedule.
6. Most of the dose is drained into the lacrimal duct, where it results in unfavorable systemic side effects.
7. The cornea's restricted permeability, which results in a low absorption of ophthalmic drug formulation, is the physiological restriction.

SPECIAL ROUTES FOR DELIVERY OF DRUG:

INTRAVITREAL: This method of administering a drug orother substance involves injecting it into the vitreous humor of the eye, where it is then absorbed into the eye. Various conditions are treated with this intravitreal route of administration. Intracameral: This method of administering the medication inside a chamber, like the anterior or posterior chamber of the eye, is known as intracameral administration.**AN EXAMPLE** During surgery, an anesthetic agent is typically injected into the anterior chamber of the eye.

PERIL OCULAR: To treat intraocular inflammation or ocular swelling, an injection of peril ocularsteroids is administered around the eye.

SUPERA CHOROIDAL: The suprachoroidal space is located in the gap that separates the choroid and the sclera. These are the ways that the medication is administered in the suprachoroidal area.

SUB CONJUNCTIVAL: The medication is administered to the mucous membrane, which coversthe exposed part of the eyeball and the inside surface of the eyelids, using the sub conjunctiva route.

TOPICAL: They are primarily used to treat anterior segment diseases as eye drops, ointments, gels, or emulsions. Because of its low cost and ease of administration, this approach is the most popular one.

SYSTEMIC: The main barriers for the anterior and posterior segments of the ocular drug deliverysystem are typically the blood-aqueous barrier and the blood-retinal barrier.

CONVENTIONAL OPHTHALMIC DOSAGE FORM PHYSICAL APPROACHES:

1. **INHIBITORS OF VISCOSITY:** Numerous ophthalmic drug formulations employ different polymers to boost viscosity. Additionally, they lengthen the precorneal residence time, which increases the drug's trans corneal penetration into the anterior chamber. Enhancers improve the bioavailability of the least number of human effects in this viscosity. Polyvinyl alcohol (PVA), methylcellulose, polyvinylpyrrolidone (PVP), hydroxyethyl cellulose, hydroxypropyl cellulose, and HPMC are the polymers that are utilized. Additionally, xanthan gum, veegum, and HA are

utilizedas natural polymers to increase viscosity.

2. OPTICAL OINTMENT: These ointments are primarily made with a blend of semi-solid and solid ingredients. The hydrocarbon contains most of this solid mixture (paraffin). The mixture shown above has a near melting or softening point.they don't irritate the eyes and they adjust to body temperature. The medicinal ingredients are added to the base in this primarily micronized powder. Their ointments disintegrate into tiny drops when applied to the eye in this mixture. Consequently, the ointment's growing bioavailability is beneficial.

3. IMPROVERS OF PIGMENTATION: As transport characteristics across the cornea can be minimized, the permeability of the corneal epithelial membrane is generally increasing. When an appropriate substance is used to temporarily improve the permeability characteristics of the cornea, it is known as a permeability enhancer, and this increases the bioavailability of ophthalmicdrugs. Another name for these permeability enhancers is absorption promoters

4. PRODRUG: The fundamental idea behind a prodrug is to increase a drug's permeability by altering its hydrophilicity or lipophilicity.In addition to having a high partition coefficient and increased lipophilicity, the perfect prodrug also needs to be highly susceptible to enzymes.

AN OBSTACLE DRUGS DELIVERY BARRIER: The primary drawback of systemic administration of ocular therapeutics is that only 1 to 2% of the administered dose reaches the anterior segment and there is low ocular bioavailability. As a result, the topical delivery of therapeutics has been the preferred mode of administration in these clinical practices of ocular diseases related to the anterior segment of the eye, which includes the cornea, conjunctiva, sclera, anterior uvea, etc. To get to the intended site of action, this route of administration needs to get past a few physicochemical, metabolic, and biological obstacles.

THE OCULAR DRUG DELIVERY SYSTEM INCLUDES THE FOLLOWING BARRIER.

1. Physical constraints on the ocular drug delivery system
2. Drug dispersion from the surface of the eyes
3. Obstacles caused by lacrimal fluid
4. Ocular blood barriers
5. Walls of the eyes
6. Barricades retinales

1. ODDS PHYSIOLOGICAL BARRIER:

Usually, the drug applied topically diffuses and absorbs productively through these physiological barriers. Both the corneal and precorneal spaces are home to them. The precorneal constraints that cause the poor ocular bioavailability of conventional ophthalmic dosage include lacrimation, tear turnover, tear dilution, solution drainage, and conjunctival absorption. Shapes. Within two minutes of the humans being installed, the precorneal area is in the dose leaves. 50–70µl of the eye drops are delivered by this ophthalmic dropper. The eye can hold approximately 30 µl without spilling onto the cheek if these patients do not blink.

2. SUBTLE LOSS OF DRUG MAINTENANCE:

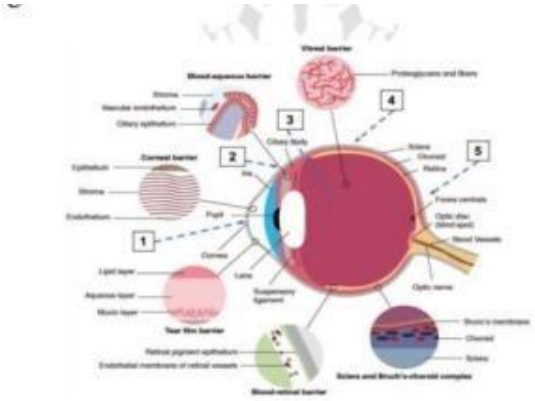
It cleans the surface of the eye of instilled compounds following the insertion of the lacrimal fluid. This is where the ocular surface—where the tear film contacts—is formed by the superficial layers of the cornea and conjunctiva. Generally speaking, this ocular surface is designed to act as a barrier of defense against the infiltration of undesirable molecules. Although the lacrimal turnover rate of the instilled is only approximately 1 µl/min, the excess volume of the The injected fluid quickly travels to a nasolacrimal duct in a matter of minutes. The elimination of the drug's systemic absorption rather than its ocular absorption is another cause of its ineffectiveness. This rate of systemic absorption can occur both when the solution enters the nasal cavity and when it exits the conjunctiva sac directly through the local blood capillaries. They are constructing a protective layer on this ocular surface to stop unwanted molecules from penetrating. Just 5% of the entire ocular surface is made up of the cornea; the conjunctiva occupies the remaining 95% of the surface. The low ocular bioavailability—less than 5%—contrasts with this. The concentration of the drug in lacrimal fluid is significantly reduced by drug absorption in the systemic circulation.

Therefore, since most of the drugs are cleared by local systemic absorption anyway, this continuous drug release from the solid delivery system to the tear fluid may only result in an ocular bioavailability of roughly 10%.

3. EYE BARRIERS IN LACRIMAL FLUID:

The corneal epithelium limits of drug absorption from the lacrimal fluid into the eye have been implicated in these lacrimal fluid-eye barriers. In comparison to hydrophilic drugs, the corneal epithelial cells derived from the drug usually exhibit

a permeability in the cornea that is at least one order of magnitude higher. This corneal barrier develops as the epithelial cells mature. Usually, they move from the limbal area to the apical surface and the cornea's center. Usually, the conjunctiva is the leakier in these. transcorneal permeation is the primary and crucial pathway via which drugs enter the aqueous humor from the lacrimal fluid. Its surface area is also almost 20 times larger than that of the corneal epithelial layer. epithelium than that of the cornea. Since the bulbar conjunctiva also fairly permeates hydrophilic molecules, drug absorption across this conjunctiva has been receiving more attention lately. Moreover, bigger bio-organic compounds like proteins and peptides may be absorbed through it. The majority of these medicinal products are lipophilic.



4. BLOOD-OCULAR BARRIERS: The blood-ocular barriers primarily shield the eye from the xenobiotics in blood steam. This blood-ocular barrier is primarily split into two sections:
Anterior blood barriers: the blood aqueous barrier.
A posterior blood eye barrier, also known as the blood retina barrier.

The uvea's endothelial cells typically make up these anterior blood-ocular barriers. These blood ocular barriers restrict the entry of hydrophilic drugs from the plasma into the aqueous humor as well as the entry of plasma albumin into the aqueous humor. The retinal pigment epithelium (RPM)and its tight wall of retinal capillaries make up the posterior barrier that separates the bloodstream from the eye. In contrast to the retinal capillaries, the choroid's vasculature is characterized by a large blood flow and porous walls. The primary medications can readily enter the choroidal extravascular space, but the RPE and other structures restrict how much of them can reach the retina. Endothelium of the retina. Generally, they have inflammation in their plasma aqueous humor, which could compromise the integrity of this barrier. As a result, in the absence of specific targeting, the retina and choroid receive only a small portion of the oral or intravenous drug dose. The expression of the drug's transporter, metabolic enzymes, and terms have not been described by the blood-ocular barrier. A thorough understanding of the fundamentals of pharmacokinetics is imperative before delving into the specifics of the blood-ocular barrier.

5. PERSONAL WALL BARRIERS:
The ocular wall barriers in these cases are primarily the rigid scleral collagenous shell that makesup the eye globe's skeleton. The uveal tract typically lines the inside of that. The posterior wall covers this sclera. 80% of the globe of the eye, excluding the tiny posterior aperture that houses the optic nerve head. The cornea typically covers the anterior portion of the rest of the globe. Collagen bundles, fibroblasts, and a moderate amount of ground substance make up this scleralstroma. Usually, this is a superficially vascular episclera that is essentially avascular. The sclera allows these wide channels to pass through, allowing the vessels and their nerves to travel to thechoroid side.

6. BARRIER RETINAL: -
Typically, there are ten layers in it. 1.The epithelium of retinal pigment.
External segments of photoreceptors.
The membrane that limits the outside.
The nuclear outer layer. 5.The interior nuclear layer.
Inner layer of plexiform
The layer outside the plexiform structure.
Layer of Ganglion Cells.
Layer of nerve fibers. 10.Limiting membrane inside.

Ocular drug absorption mechanism: Drugs injected into the eye must first pass through the cornea before passing through the non-corneal pathways. These non-corneal routes, which entail drug diffusion through the sclera and conjunctiva, seem to be especially crucial for medications that are not well absorbed through the cornea. Corneal permeation: Drugs enter the cornea through the precorneal space and pass through the corneal membrane. Numerous obstacles todrugs.

ABSORPTION: The effectiveness of medication absorption into the inner eye is directly impacted by tears.The majority of ophthalmic medications are efficiently absorbed due to the diffusion process across the corneal membrane.The rate and degree at which the eye's transport processes occur determine the absorption process's efficiency. The physicochemical characteristics of the permeating

molecule and its interaction with the membrane determine the flux of any drug molecule across the biological membrane. The physiological mechanism of precorneal fluid drainage or turnover also affects how much of the transport or absorption process takes place. The cornea can be divided into three main layers for the purpose of transcorneal drug permeation: epithelium, stroma, and endothelium. The amount of lipid material in the epithelium and endothelium is approximately 100 times higher than that of the stroma. Consequently, the resistance provided by the individual layers varies greatly depending on the physicochemical properties of a diffusing drug. Due to its lipodal nature, epithelium serves as a diffusional barrier with strong resistance to ionic and other aqueous solubleas arctic species. On the other hand, in the hydrophilic stroma layer, compounds with comparatively low polarity face a higher diffusional resistance. "Differential solubility concept" is the term used to describe this widely discussed idea of medication permeation through the corneal membrane. Lack of corneal penetration Diffusion across the intercellular aqueous medium is most likely the primary mechanism of drug permeation in the sclera in the case of structurally similar corneal stroma. Thus, it is impossible to completely rule out the possibility of a partitioning mechanism. Conjunctival epithelium provides a lot less resistance than corneal epithelium, despite the fact that both are made of an epithelial layer covering an underlying stroma, just like the cornea.
The following is the mechanism of controlled drug release into the eye.

DIFFUSION, first The drugs released in this diffusion mechanism are usually continuously transferred into tear fluid through the membrane at a regulated rate. The drug is released when it diffuses through the process, moving from one area of higher drug concentration to another across the concentration grade. If their inserts are solid, non-erodible bodies with pores and distributed medication. Diffusion through the pores is typically how the medication is released.

OSMOSIS: Using this osmosis mechanism, inserts can pass from the first to the second compartment by passing through an impermeable elastic membrane inside of them. The impermeable material and its elastic membrane surround the first compartment, which is boundedby a semipermeable membrane leading to an impermeable elastic membrane.

2.SOLUBLE CONCERTS: These soluble inserts are generally characterized as monolithic, erodible polymeric devices that release the medication and do not require removal as they gradually dissolve. True dissolution of these polymers mostly happens during swelling, whereas erosion is related to a chemical or enzymatic hydrolytic process. The glassy polymers used in this swelling-controlling device allow the active ingredients to be evenly distributed. When the inserts are inserted into the eye, the water from the tear fluid starts to seep into the matrix, releasing the drug and causing swelling and, ultimately, polymer chain relaxation.

The primary benefit of this system is the drug diffusion, which eliminates the need to remove the application site. These soluble inserts fall into two groups:

a. **Organic polymer**
b. **Polymers that are semi-synthetic and synthetic**

a. **NATURAL POLYMERS:** Soluble ophthalmic inserts made of these natural polymers can be utilized in place of preferred collagen. Preferably, the soaking inserts have been absorbed by the therapeutic agents. Before applying this medication-containing solution to the eye, let it dry and then rehydrate. The amount of the drug-loaded well depends on the concentration of the drug solution in which the composite is soaked, the length of the soaking, and the quantity of binding agents present. The medication is progressively released from the spaces between the collagen molecules as these natural polymers dissolve the collagen.

b. **SYNTHETIC AND SEMI-SYNTHETIC POLYMERS:** These synthetic and semi-synthetic polymers are the second subtype of the soluble inserts. Typically, these rely on the utilization of polymers, specifically semi-synthetic polymers (such as derivatives of cellulose). The release rate of the obtained was decreased by the synthetic polymer (example: polyvinyl alcohol) by using eudragit, a polymeric that is typically used for the enteric coating or as a coating agent of the insert.

3. BIO-ERODIBLE OCULAR INSERTS: Polyester and cross-linked gelatin derivatives are usedto create these bio-erodible ocular inserts. If the chemical bonds in these are hydrolyzed and dissolve. The ability to adjust the rate of erosion by changing the final structure of the bio-erodibleocular insert polymer during synthesis is its primary benefit. They may be the cationic or anionic surfactant added.

These are a few of the significant ocular inserts that are offered in the market for soluble collagen shields.There are two subtypes of bio-erodible ocular inserts in this: a. Soluble ophthalmic drug inserts.
Collagen clovers.

a. SOLUBLE OPHTHALMIC DRUG INSERTS: Originally created by Soviet scientists for cosmonauts unable to use eye drops in weightless environments, this SODI is typically a small oval wafer.

b. COLLAGEN SHIELDS: These make up over 25% of the protein in a mammal's total body andare a structural component of bones, tendons, ligaments, and skin. This body protein is derived from intestinal collagen and has multiple biomedical applications. whose primary use is most likely in catgut stitch.

A modification to the ophthalmic drug delivery system

In order to provide the ocular delivery system with high therapeutic efficacy, there are particular challenges in designing a therapeutic system. One of these challenges is achieving an optimal concentration of the drug active site for an appropriate duration. The cornea's physiology, barrierfunction, and anatomy all work against quick drug absorption. To keep the therapeutic drug level in the tear film or at the site of action, frequent application of eye drops is required. However, the repeated use of a highly concentrated solution by them may result in harmful side effects and ocular surface cellular damage. Precorneal loss factor, which includes solution drainage, lacrimation, tear dynamics, tear dilution, tear turnover, and conjunctiva absorption, is primarily responsible for the poor drug bioavailability of the ocular dosage form.non-productive absorption, the corneal epithelial membrane's relative impermeability, and the brief duration of residence in the cul-de-sac. The ophthalmic drug delivery system has the following difficulties.

NEW METHODS FOR CURRENT DRUG DELIVERY SYSTEMS:

1. POLYMERIC GELS: These typically use a standard technique for the drug's extended ocular residence time. In order to raise the viscosity of the solution, these medications increase intraocular diffusion. Polymeric gels can be classified into two groups: the first group co mprises classically performed gels, while the second group consists of in-situ forming gels. Additionally, their in-situ gel-forming liquids are viscous liquids that transition into a viscoelastic gel upon exposure to physiological conditions in a cul-de-sac.

2. BIO-ADHESIVE HYDROGELS: These are materials that remain in contact with one another over an extended length of time, especially when one of the materials is biological. Bio-adhesive hydrogels are frequently utilized in this Excipients are hydrophilic polymers that fall into various classes. These include cellulose derivatives of polyacrylic, such as sodium hyaluronate, carbomer, povidone, and polyvinyl alcohol. The carbomer has the ability to form strong non- covalent bonds and has bio-adhesive properties that can increase viscosity and residence time. They can also coat biological membranes. Typically, a variety of gels are sold to alleviate the symptoms associated with dry eyes. The contact time is extended by these movies. Because of their great water-retaining capacity, they encourage the tear to be delivered continuously andIn contrast to eye drops, they enable a reduction in installation frequency.They are increasingly being used to treat dry eye syndrome with hydrogels based on hyaluronic acid (HA). A biological polymer with a high molecular weight, HA is made up of linear polysaccharides found in the extracellular matrix. Gentamicin, an antibiotic, was included in the 0.25% HA formulation. In the volunteers, it lengthens their precorneal drug residence period. It has been demonstrated to provide 340 patients with long-lasting antibiotic efficacy and to prefer chloramphenicol eye drops.

3. IN-SITU FORMING HYDROGELS: This ocular drug delivery method uses an easy-to-handle device to administer a precise concentration of the medication over a predefined period of time. With this novel approach to drug dosage forms, they aim to integrate the benefits of both the gels and solutions. They are deposited as a solution into their conjunctival sac for their in-situ gels, where they change into the gel due to a shift in either Ph or temperature-induced ion concentration. These characteristics are shared by a number of polymers.

4. GELATION CAUSED BY TEMPERATURE: The sustained drug delivery method in temperature-induced gelation is typically accomplished by utilizing polymers, such as poloxamers, that transition from solution to gel at eye temperature. These poloxamers are nonionic triblock copolymers made up of two hydrophilic polyethylene oxide chains joined by a central

hydrophobic polypropylene oxide chain. There are numerous poloxamers with slightly different properties due to the length of the polymer blocks. Additionally, they go by the trade name of The Pluronic This produces transparent, colorless gels, which are the most widely usedpolymer in medical technology. The monomolecular micelles are formed by pluronic gels at this low concentration (10.4–10.5%).

5. OSMOTICALLY INDUCED GELATION: A naturally occurring polymer called gellan gum is taken from pseudomonas elodea cultures. For use in human medicine, these are sold under the GelriteR brand. Generally speaking, polymers are low acyl gellan gums that, when exposed to mono- or divalent cations, form a transparent gel. The aqueous solution of the active ingredients dissolves the sodium salt from its solution. The prolonged therapeutic effect is caused by the alginate's in-situ gelling interaction with mucus, which generally enhances viscosity. Their tenacious behavior was because the formulation's low surface tension (31.5 mN/m) of alginate. They are less than the mucin-coated cornea's critical surface tension of 38 mN/m.

6. POLYMER COMBINATION: Combining different polymers increases compliance and boosts therapeutic efficacy because some polymers have disadvantages. The polyacrylic acid (carbopol 940) in the ophthalmic delivery system of ofloxacin functions as a viscosity-enhancing agent in conjunction with HPMC. Lin and Sung created an ophthalmic drug formulation of pilocarpine that contains either carbopol, plutonic, or a combination of the two in a US patent. This formulation is preferred over the one that has 14% pluronic and 0.3% carbopol combined. Better drug retention was the outcome compared to the individual polymer mixture. Comparing the pharmacological response to the aqueous pilocarpine solution, there was a 1.85-fold increase in retention.

The inotroporesis Because ocular iontophoresis can be delivered noninvasively to both the anterior and posterior segments, it has attracted a lot of attention lately. This type of iontophoresis is known as trans corneal iontophoresis because the sclera has a higher surface area than the cornea (17 cm2 v/s 1.3 cm2), a lower cell count, a high degree of hydration, and a permeability to large molecular weight compounds.

7. EYE OINTMENTS: A combination of semi-solid and solid hydrocarbons, such as paraffin, is typically used to formulate ointments. Their melting or softening point is in proximity to the body's temperature and is visible to the naked eye. The system of the ointment is two-phase. Either a solution or a powder with fine particles is added to the base containing the medicinal agents. Ointment fragments into tiny droplets upon application to the eye and stays in a drug-induced cul-de-sac for a long time. When it comes to increasing drug bioavailability, ointments work better.

Factors affecting a drug's specific bioavailability:

1. TEAR: → The lacrimal gland typically secretes these tears. A significant part of preserving regular eye function is tears. Tears in healthy individuals consist of water, mucins, proteins, lipids, and electrolytes. Additional elements, such as cytokines, antigens, and inflammatory mediators, are present in some disease conditions. reducing the amount of time the medication can enter the ocular tissues as a result.

Conjunctive: − Mucus tissue typically makes up the conjunctiva. The conjunctiva generates mucus and antimicrobial peptides, which aid in lubricating and shielding the eye. There is a lot of vascularization in these conjunctivae. They serve as a crucial barrier of defense for the surface of the eyes. The application of the posterior segment is impeded by the systemic absorption. Because of this, administering medication through the subconjunctiva is a more effective way to improve the effectiveness of topical drug application.

CORNEA: − The front layer of the eye is called the cornea. The cornea not only shields eye tissue but also has the ability to refract light.334-04. It is distinguished by a high water content, which prevents lipophilic molecules from passing through the corneal layer. Usually, they are the corneal epithelium and To a greater extent, the stroma serves as a barrier that prevents macromolecules from penetrating. Because of their hydrophilic and lipophilic characteristics, molecules should appear to have an amphiphilic nature upon penetrating the three layers.

4.SCLERA: To support the extraocular muscle, the sclera preserves the shape of the eye globe by resisting both internal and external forces. Usually, these sclerae consist of glycoproteins and collagen fibrils. It has been reported that the drug molecules' charge, geometry, and molecular radius influence how well they permeate the sclera layer. There are reports that this sclera is more permeable. It is challenging to capture both tiny molecules of negatively charged glycoproteins.

CONCLUSION:

For researchers in the field, developing effective treatments for ocular diseases is a significant challenge. Insertable collagen shields, disposable contact lenses, ocular films, and other formulations are all part of this new ophthalmic delivery system. The more recent trend in these ocular delivery systems is the combination of drug delivery technologies to enhance the therapeutic effect or therapeutic response of an effective medication. Effective drug concentration at the target tissue should be present in these ideal systems. This usually had a minimal impact on the system. Enhancing patient acceptance is a critical component of designing a comfortabledrug delivery system for the eyes. Stability, larger-scale manufacturing, and sustained drug release all need significant improvements. In these, the ocular drug delivery technology of eye patches offers numerous benefits like enhancing patient compliance through fewer dosages administered frequently. They lower the dosage and lessen the medication's negative effects in addition to providing continuous and regulated drug delivery. These combinations of drug delivery methods may provide a new path for enhancing a system that isn't working well in terms of therapeutic response. They are able to get around restrictions and combine the benefits of various systems.

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