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## OCULAR DRUG DELIVERY SYSTEM

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### ABSTRACT

Topical management for ocular therapeutics is good due to smaller doses required in comparison to the systemic use, its fast onset of movement and freedom from systemic toxicity. Topically implemented ocular capsules should attain the internal parts of the attention and transcorneal penetration is thought to be the most important path for drug absorption. Corneal absorption is plenty slower system than elimination. The unique purpose of designing a healing machine is to obtain an greatest awareness of a drug on the energetic web website online for the precise duration. Ideal ophthalmic drug transport have to be capable of maintain the drug launch and to stay withinside the region of the front of the attention for extend duration of time. Consequently it's far vital to optimize ophthalmic drug transport; one of the manner to accomplish that is via way of means of addition of polymers of diverse grades, improvement of in situ gel or colloidal suspension or the usage of erodible or non erodible insert to extend the pre corneal drug retention. This overview centered on managed and sustained drug transport has end up the usual in cutting-edge pharmaceutical layout and numerous viable routes of drug transport into the ocular tissues.

**Keywords:** Ophthalmic drug transport, Corneal drug transport, Controlled and sustained drug transport.

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### INTRODUCTION

Eye is maximum thrilling organ because of its drug disposition characteristics. Generally, topical utility of capsules is the approach of desire beneathneath maximum occasions due to its comfort and protection for ophthalmic chemotherapy [1]. A considerable assignment to the formulator is to circumvent (bypass) the protecting obstacles of the attention with out inflicting everlasting tissue damage. Development of newer, greater touchy diagnostic strategies and novel healing dealers keep to offer ocular shipping structures with excessive healing efficacy. Conventional ophthalmic formulations like solution, suspension, and ointment have many risks which end result into terrible bioavailability of drug withinside the ocular cavity. The precise goal of designing a healing machine is to acquire an most advantageous awareness of a drug on the energetic web website online for the correct length [2]. Ocular disposition and removal of a healing agent depends upon its physicochemical residences as properly because the applicable ocular anatomy and physiology. A hit layout of a drug shipping machine, therefore, calls for an included understanding of the drug molecule and the restrictions supplied via way of means of the ocular course of management [3]. The diverse processes which have been tried to growth the bioavailability and the length of the healing movement of ocular capsules may be divided into categories. The first one is primarily based totally on using sustained drug shipping structures, which offer the managed and non-stop shipping of ophthalmic capsules. The 2nd includes maximizing corneal drug absorption and minimizing precorneal drug loss [3]. Ideal ophthalmic drug shipping should be capable of preserve the drug launch and to continue to be withinside the location of the front of the attention for extend duration of time. Consequently it's miles vital to optimize ophthalmic drug shipping; one of the manner to accomplish that is via way of means of addition of polymers of diverse grades, improvement of in situ gel or colloidal suspension or the use of erodible or non erodible insert to extend the pre corneal drug retention [4].

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### IN SITU FORMING GELS FOR OPHTHALMIC DRUG DELIVERY

Recently, managed and sustained drug shipping has grow to be the usual in current pharmaceutical layout and an in depth studies has been beneathneath taken in reaching lots higher drug product powerful ness reliability and safety. In this regard many polymers are very beneficial which go through reversible sol to gel section transition in reaction to physiological stimuli [5]. In situ gels are simply dropped as an answer into the conjunctival sac, in which they undergo a transition right into a gel with its beneficial house time. The sol-gel transition takes place because of a chemical/ bodily alternate precipitated through physiological environment. This kind of gel combines the benefit of an answer beinaffected person handy with the beneficial house time of a gel for boosting the ocular bioavailability [6,7]. The sol-gel transition may be precipitated through a shift in the pH as for cellulose acetate phthalate, a shift in temperature as for the thermogelling Poloxamer 188 or through presence of cations as for deacetylated gellan gum and alginates. Thus, the in situ gelling structures for ophthalmic use may be categorised as pH touchy, temperature touchy and ion-activated structures. The charge of gel formation in situ, is crucial due to the fact whilst dropped in the attention, earlier than a sturdy gel is formed, an answer or a susceptible gel is susceptible to removal through the fluid mechanics of the attention [8]. The ion activated in situ gelling device may be formulated the use of sodium alginate, the sodium salt of alginic acid, as a herbal hydrophilic polysaccharide containing kinds of monomers,  $\beta$ -D-mannuronic acid (M) and x-Lguluronic acid (G) which paperwork a gel withinside the cul-de-sac due to the presence of divalent calcium ions

withinside the lacrimal fluid [9]. Thus with using those in situ gelling structures, house time of the drug in the attention is increased. Continuous shipping of medicine in a managed way to the anterior chamber of the attention will put off the requirement for common drug administration, inflicting higher affected person compliance and could bring about prolonged period of action, for this reason decrease quantity of general dose required, which in flip will reduce the nearby and/or systemic facet effects [10].

## THE ANATOMY OF THE EYE

The human eye, stylish in its element and design, represents a gateway to the procedure we name vision. The eyeball is round in form and approximately 1 inch across. It homes many systems that paintings collectively to facilitate sight. The human eye is made from layers and inner systems, every of which plays awesome functions. The special description of every eye component is given below.

### A. Sclera

The sclera (white part of the eye) is the difficult white sheath that bureaucracy the outer-layer of the ball. It is a organization fibrous membrane that continues the form of the attention as an about globe form. It is lots thicker toward the back/posterior element of the attention than toward the front/anterior of the attention [11].

### B. Conjunctiva

The conjunctiva is a skinny obvious mucous epithelial barrier, traces the internal of the eyelids, and covers the anterior one-0.33 of the eyeball. The respective element of conjunctiva is known as the palpebral and bulbar conjunctiva. The conjunctiva consists of layers: an outer epithelium and its underlying stroma (substantia propria). The uncovered floor of the attention consists of conjunctiva and cornea and is included with the tear movie. The conjunctiva contributes to the formation of the tear movie with the aid of using manner of secreting huge electrolytes, fluid, and mucins.

### C. Cornea

The cornea is a robust clean bulge positioned on the front of the attention. Surface of the person cornea has a radius of about 8mm. It has an crucial optical feature as it refracts mild getting into the attention which then passes via the student and onto the lens (which then focuses the mild onto the retina). The cornea, a non-vascular structure (does now no longer comprise any blood vessels) receives the important vitamins from the capillaries that terminate in loops at its circumference. It is furnished with the aid of using many nerves derived from the ciliary nerves. These input the laminated tissue of the cornea. It is consequently extraordinarily sensitive.

### D. Aqueous humor

The aqueous humor is a jelly-like substance positioned withinside the outer/the front chamber of the attention. It is a watery fluid that fills the "anterior chamber of the attention" that is positioned right now at the back of the cornea and in the front of the lens. The aqueous humor may be very barely alkaline salt answer that consists of tiny portions of sodium and chloride ions. It is constantly produced, specially with the aid of using the ciliary processes, flows from the posterior chamber via the student into the anterior chamber, and exits through the trabecular path on the perspective and the uveoscleral path. Schlemm's canal (canal of Schlemm or the scleral venous sinus), is a round channel that collects aqueous humour from the anterior chamber and supplies it into the bloodstream through the anterior ciliary veins. It is positioned on the junction of the cornea and the sclera. In human, the fee of aqueous humor turnover is about 1% - 1.5% of the anterior chamber quantity in keeping with minute. The fee of aqueous formation is about 2.5  $\mu\text{l}/\text{min}$ . Aqueous humor includes strain based and strain impartial pathways. The strain based outflow refers back to the trabecular meshwork-schlemm's canal-venous system, even as strain impartial outflow refers to any non trabecular outflow and is known as a uveoscleral outflow [12].

### E. Pupil

Pupil typically seems to be the dark "centre" of the attention, however may be greater appropriately defined because the round aperture withinside the centre of the iris via which mild passes into the attention. The length of the student (and consequently the quantity of mild this is admitted into the attention) is regulated via way of means of the pupillary reflex (additionally referred to as the "mild reflex").

### F. Iris

The iris is a skinny round contractile curtain positioned in the front of the lens however in the back of the cornea. The iris is a diaphragm of variable length whose characteristic is to modify the length of the student to adjust the quantity of mild admitted into the attention. It is the colored part of the attention (sun sunglasses might also additionally range in my view like blue, green, brown, hazel, or grey).

### G. Ciliary Muscle

The ciliary muscle is a hoop of striated clean muscle tissues in the attention's center layer that controls lodging for viewing items at various distances and regulates the float of aqueous humour into schlemm's canal. The muscle has parasympathetic and sympathetic innervation. Contraction and rest of the ciliary muscle alters the curvature of the lens. This system can be defined clearly because the stability current at any time among states: Ciliary Muscle relaxed (This allows the attention to attention on remote items) and Ciliary Muscle contracted (This allows the attention to attention on close to items).

### H. Lens

The lens is a obvious shape enclosed in a skinny obvious capsule. It is positioned in the back of the student of the eye and encircled via way of means of the ciliary muscle tissues. It facilitates to refract mild visiting via the attention (which first refracted via way of means of the cornea). The lens focuses mild into an photograph at the retina. It is capable of do that due to the fact the form of the lens is modified in step with the gap from the attention of the object(s) the individual is asking at. This adjustment of form of the lens is referred to as lodging and is performed via way of means of the contraction and rest of the ciliary muscle tissues.

### I. Vitreous Humour

The vitreous humour (additionally referred to as the vitreous body) is positioned withinside the massive location that occupies about 80% of every eye withinside the human body. The vitreous humour is a wonderfully obvious skinny-jelly-like substance that fills the chamber in the back of the lens of the attention. It is an albuminous fluid enclosed in a sensitive obvious membrane referred to as the hyaloid membrane.

**J. Retina**

The retina is positioned behind the human eye. The retina might also additionally be described because the "screen" on which an image is shaped via way of means of light that has exceeded into the attention through the cornea, aqueous humour, pupil, lens, and sooner or later the vitreous humour earlier than accomplishing the retina. The characteristic of the retina isn't simply to be the display screen onto which an image can also additionally be shaped however additionally to accumulate the records contained in that image and transmit it to the mind in an appropriate shape for use via way of means of the body. The retinal "display screen" is consequently a light-sensitive shape lining the interior of the eye. It includes photosensitive cells (referred to as rods and cones) and their related nerve fibers that convert the light they discover into nerve impulses which might be then despatched onto the mind alongside the optic nerve.

**K. Macula**

The middle of the retina is referred to as the macula. The macula includes a excessive awareness of photoreceptor cells which convert light into nerve alerts. Because of the excessive awareness of photoreceptors, we're capable of see quality info including newsprint with the macula. At the very middle of the macula is the fovea, the web page of our sharpest vision.

**L. Choroid**

The choroid layer is placed in the back of the retina and absorbs unused radiation and nourishes the outer quantities of the retina. It is a thin, surprisingly vascular (i.e. it includes blood vessels) membrane this is darkish brown in shade and includes a pigment that absorbs extra light and so prevents blurred vision (because of an excessive amount of light at the retina). The choroid has one of the maximum blood flows within the body. The choroid is loosely connected to the internal floor of the sclera via way of means of the lamina fusca.

**M. Optic nerve**

The optic nerve (a package deal of over 1 million nerve fibers) is liable for transmitting nerve alerts from the eye to the mind. These nerve alerts comprise records on an image for processing via way of means of the mind. The front floor of the optic nerve, that is seen at the retina, is referred to as the optic disk. Accessory organs of the eye: The eye is included via way of means of numerous structures.

**Eyebrows**

- Eyelids and eyelashes
- Lacrimal apparatus

Eyebrows defend the anterior component of eyeball from sweat, dirt and overseas bodies. The eyelids have diverse layers of tissue which include conjunctiva which protects the sensitive cornea and the front of the attention. When eye drops are administered, they're located in decrease conjunctival sac. The lacrimal glands secrete tears composed of water, mineral salts, antibodies and lysozyme, a bactericidal enzyme. Drainage of the attention drops thru nasolacrimal gadget into gastrointestinal tract starts off evolved right now on instillation. This takes vicinity whilst both reflex tearing or the dosage shape reasons extent of fluid in peripheral tissue to exceed the regular lacrimal extent of 7-10  $\mu\text{l}$ . The extra fluid extent enters the advanced and inferior lacrimal puncta, movements down the canalicula into the lacrimal sac, and maintains into the gastrointestinal tract [13].

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**ROUTES OF OCULAR DRUG DELIVERY**

There are numerous viable routes of drug transport into the ocular tissues. The choice of the course of management relies upon usually at the goal tissue.

**Topical course**

Typically topical ocular drug management is carried out with the aid of using eye drops, however they have got best a brief touch time on the attention floor. The touch, and thereby length of drug action, may be extended with the aid of using method design (e.g.m gels, gelifying formulations, ointments, and inserts).

**Subconjunctival management**

Traditionally subconjunctival injections were used to supply pills at elevated stages to the uvea. Currently this mode of drug transport has received new momentum for diverse reasons. The development in substances sciences and pharmaceutical method have furnished new interesting opportunities to expand managed launch formulations to supply pills to the posterior section and to manual the restoration procedure after surgery.

**Intravitreal management**

Direct drug management into the vitreous gives awesome benefit of greater trustworthy get entry to to the vitreous and retina. It must be noted; but that transport from the vitreous to the choroid is greater complex because of the issue with the aid of using the RPE (Retinal Pigment Epithelium) barrier. Small molecules are capable of diffuse swiftly within the vitreous however the mobility of big molecules, mainly definitely charged, is restricted.

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**BARRIERS FOR OCULAR DELIVERY:**

Drug loss from the ocular floor After instillation, the go with the drift of lacrimal fluid eliminates instilled compounds from the floor of eye. Even alevn though the lacrimal turnover charge is best approximately 1  $\mu\text{l}/\text{min}$  the extra extent of the instilled fluid is flown to the nasolacrimal duct swiftly in multiple minutes. Another supply of non-effective drug elimination is its systemic absorption as opposed to ocular absorption. Systemic absorption might also additionally take location both at once from the conjunctival sac through neighborhood blood capillaries or after the answer go with the drift to the nasal cavity.

**Lacrimal fluid-eye barriers**

Corneal epithelium limits drug absorption from the lacrimal fluid into the attention. The corneal epithelial cells shape tight junctions that restriction the paracellular drug permeation. Therefore, lipophilic pills have commonly at the least an order of value better permeability within the cornea than the hydrophilic pills. In general, the conjunctiva is leakier epithelium than the cornea and its floor place is likewise almost 20 instances more than

that of the cornea.

#### **Blood-ocular limitations**

The eye is blanketed from the xenobiotics within the blood move with the aid of using blood-ocular limitations. These limitations have parts: blood-aqueous barrier and blood-retina barrier. The anterior blood-eye barrier consists of the endothelial cells within the uvea (The center layer of the attention under the sclera. It includes the iris, ciliary body, and choroid). This barrier prevents the get admission to of plasma albumin into the aqueous humor, and additionally limits the get admission to of hydrophilic tablets from plasma into the aqueous humor. The posterior barrier among blood move and eye is comprised of retinal pigment epithelium (RPE) and the tight partitions of of the choroid has massive blood float and leaky partitions. Drugs effortlessly advantage get admission to to the choroidal extravascular space, however thereafter distribution into the retina is restrained with the aid of using the RPE and retinal endothelia.

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## **MECHANISM OF OCULAR DRUG ABSORPTION**

Drugs administered with the aid of using instillation ought to penetrate the attention and achieve this commonly thru the cornea observed with the aid of using the non-corneal routes. These non-corneal routes contain drug diffusion throughout the conjunctiva and sclera and seem to be mainly critical for tablets which are poorly absorbed throughout the cornea [14].

#### **Corneal permeation**

The permeation of medication throughout the corneal membrane takes place from the precorneal space.

#### **Various Barriers to drug Absorption:**

In tears have an instantaneous concerning performance of drug absorption into the internal eye. The effective absorption of maximum ophthalmic tablets outcomes from diffusional manner throughout corneal membrane. The performance of absorption manner is a feature of charge and quantity at which the delivery tactics of eye. The flux of any drug molecule throughout the organic membrane relies upon at the physicochemical houses of the permeating molecule and its interplay with the membrane. The quantity to which the delivery or absorption manner takes place is likewise feature of physiological mechanism of precorneal fluid drainage or turnover. In phrases of transcorneal drug permeation, the cornea may be taken into consideration to include 3 number one layers (epithelium, stroma and endothelium). The epithelium and endothelium incorporate at the order of a hundred fold more quantity of lipid cloth than the stroma. Consequently, relying at the physicochemical houses of a diffusing drug, the resistance presented with the aid of using the person layers varies greatly. Epithelium, being lipodal, represents a diffusional barrier imparting excessive resistance to ionic or different aqueous soluble or polar species. In contrast, compounds with especially low polarity come upon a extra diffusional resistance within the hydrophilic stroma layer. This often mentioned idea of drug permeation throughout the corneal membrane is mentioned as "differential solubility idea".

#### **Non-corneal permeation**

Primary mechanism of drug permeation is the sclera is probably to be diffusion across the intercellular aqueous media within the case of structurally comparable corneal stroma. Therefore the opportunity of partitioning mechanism can not be eliminated. Although like cornea, the conjunctiva consists of an epithelial layer masking an underlying stroma, the conjunctival epithelium gives drastically much less resistance than does the corneal epithelium.

#### **Various elements answerable for disposition of ocular capsules**

Bioavailability of medication administered to the attention is an crucial consideration. There are physiological elements, which could have an effect on a drug's bioavailability such as protein binding, drug metabolism and lachrymal drainage. Protein sure capsules are incapable of penetrating the corneal epithelium because of the dimensions of the protein drug complex. Because of the quick time wherein an ophthalmic answer may also continue to be found in the attention (because of lachrymal drainage), protein binding of a drug substance ought to fast negate its healing fee through rendering it unavailable for absorption. One of the fundamental troubles encountered with traditional ophthalmic answers is the fast and significant removal of medication from the precorneal lachrymal fluid. It ought to be referred to that this excessive drainage fee is because of the tendency of the attention preserve its house quantity at 7–10  $\mu$ L permanently, while volumes topically instilled variety from 20–50  $\mu$ L. In truth it's been confirmed in vivo that 90% of the dose changed into cleared inside 2 min for an instilled quantity of fifty  $\mu$ L and, inside four min for an instilled quantity of 10  $\mu$ L. Consequently, the ocular house time of traditional answers is restrained to three minutes, and the normal absorption of a topically carried out drug is restrained to 1–10%. As within the case with different organic fluids, tears comprise enzymes (inclusive of lysozymes) able to the metabolic degradation of the drug substance. In addition to the physiological elements affecting ocular bioavailability, different elements because the physicochemical houses of the drug substance, and product formula are crucial. Because the cornea is a membrane-barrier containing each hydrophilic and lipophilic layers, it's miles permeated maximum correctly through drug materials having each hydrophilic and lipophilic characteristics. It is effective for corneal penetration to regulate the pH of the answer to boom the share of unionized drug within the instilled Dose. Drugs, which might be exceedingly water insoluble, do now no longer with no trouble permeate the cornea [14].

#### **Nasolachrymal drainage gadget**

The nasolachrymal drainage gadget includes 3 parts: the secretory gadget, the distributive gadget and the excretory gadget. The secretory gadget includes fundamental secretors which might be inspired with the aid of using blinking and temperature extrude because of tear evaporation and reflex secretors which have an efferent parasympathetic nerve deliver and secrete in reaction to bodily or emotional stimulation. The distributive gadget includes the eyelids and the tear meniscus across the lid edges of the open eye, which unfold tears over the ocular floor with the aid of using blinking, for this reason stopping dry regions from developing. The excretory part of the nasolachrymal drainage gadget includes: the lachrymal puncta, the superior, inferior and not unusual place canaliculi; the lachrymal sac and the nasolachrymal duct. In humans, the 2 puncta are the openings of the lachrymal canaliculi and are located on an expanded region referred to as the lachrymal papilla. It is notion that tears are in large part absorbed with the aid of using the mucous membrane that strains the ducts and the lachrymal sac best a small quantity reaches the nasal passage [15].

#### **Interests of novel ophthalmic drug transport:**

Ophthalmic drug transport is one of the maximum exciting and challenging endeavors dealing with the pharmaceutical scientist. The panorama of ophthalmic drug transport is exceedingly aggressive and unexpectedly evolving. New instructions of prescription drugs and biologics are fueling the call for novel drug transport. The essential purpose of pharmacotherapeutics is the attainment of powerful drug awareness on the webweb page of movement for the enough time frame to elicit a reaction. The task is to offer a gadget with progressed ocular drug bioavailability and extended period of activity, however nonetheless with a minimal danger of ocular complications. A main trouble of ophthalmic drug transport isn't always the dearth of green tablets however the attainment in their top-rated awareness on the webweb page in their top-rated awareness on the webweb page of movement [14,15]. The emergence of recent and modern way for enhancing healing efficacy shows that a more desire of dosage bureaucracy might be furnished to physicians and sufferers withinside the subsequent decade. Most of the components efforts purpose at maximizing ocular drug absorption via prolongation of the drug house time withinside the cornea and conjunctival sac, in addition to to sluggish drug launch from the transport gadget and limit precorneal drug loss. Various ophthalmic formulations and their house term in the ocular hollow space are given below [16].

### **Ophthalmic drug formulations**

Ophthalmic capsules are formulated to deliver the lively capsules in touch with the attention floor to permit for absorption. Extension of corneal touch time might also additionally bring about multiplied drug penetration & better intraocular drug delivery. In addition to the lively drug, ophthalmic formulations ought to incorporate different components to govern numerous traits of the formulation, along with the buffering and pH, osmolality & tonicity, viscosity & antimicrobial preservatives. Although those components are indexed inactive, they are able to have an effect on permeability of drug throughout the ocular floor barriers & modify the healing effectiveness of the drug.

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## **EYE INFECTIONS**

Eyes can get infections from micro organism, fungi or viruses. Eye infections can arise in components of the attention and might have an effect on simply one eye or both. Common eye infections are Conjunctivitis, Corneal ulcers & Endophthalmitis.

### **A) Conjunctivitis:**

Conjunctivitis is swelling (infection) or contamination of the membrane lining the eyelids (conjunctiva). It is characterised via way of means of cell infiltration and exudation. Staphylococcus aureus is the maximum not unusual place motive of bacterial conjunctivitis and blepharo-conjunctivitis. Many different organisms like Haemophilus influenzae, Streptococcus pneumoniae additionally motive conjunctivitis. Conjunctivitis may be categorized as

- (1) Infective – Acute, Subacute & Chronic
- (2) Allergic conjunctivitis.

### **B) Corneal ulcers/ Keratitis:**

Inflammation of cornea (Keratitis) is characterised via way of means of corneal oedema, cell infiltration & ciliary congestion. Being the maximum anterior a part of eyeball, cornea is uncovered to atmosphere & as a result susceptible to get inflamed easily. Bacterial corneal ulcers are the maximum usually because of virulent organism. Common micro organism related to corneal ulceration are Staphylococcus aureus, Pseudomonas pyocyanea, E.coli and Proteus etc.

### **C) Endophthalmitis:**

It is excessive shape of intraocular infection (purulent uveitis) related to ocular cavities & internal coats of eyeball. Causative organisms consist of Streptococci, E.coli, Pseudomonas, etc. Accordingly, the armamentarium of to be had antimicrobials used withinside the prevention and remedy of those infections consists of antivirals, antifungals, and antibacterials. Common topical antibacterials used withinside the remedy of ocular infectious sicknesses consist of sulfonamides, aminoglycosides, polymyxin-primarily based totally combinations, and fluoroquinolones.

The fluoroquinolones constitute an increasing magnificence of extensive-spectrum antibacterials, which cowl a number of Gram-terrible and anaerobic species liable for ocular infections. These antibacterials have received reputation in them ophthalmology discipline because they had been proven to be equal to aggregate remedy withinside the remedy of many ocular infections. Fluoroquinolones also are powerful in opposition to plenty of Gram-high-quality organisms, consisting of Streptococcal and Staphylococcal species; however, resistance is rising amongst a number of those organisms. The category and mechanism of motion of fluoroquinolones are given below

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## **MANAGEMENT OF OCULAR INFECTIONS**

Ocular infections, each superficial and deep along with conjunctivitis, corneal ulcers and endophthalmitis are resulting from various institution of bacteria, viral and fungal pathogens. Accordingly the armamentarium of to be had antimicrobials used withinside the prevention and remedy of those infections consists of antivirals, antifungals and antibacterials. Common topical antibacterials utilized in remedy of ocular infectious sicknesses encompass sulfonamides, aminoglycosides, polymyxin-primarily based totally mixtures and fluoroquinolones. These fluoroquinolones are indicated for extreme bacterial keratitis, endophthalmitis, blepharo-conjunctivitis, corneal ulcers, persistent post-filtration hypotony etc. The fluoroquinolones constitute an increasing magnificence of extensive spectrum antibacterials which cowl a number of Gram terrible and anaerobic species liable for ocular infections. These antibacterials have received reputation withinside the ophthalmology discipline because they had been proven to be equal to aggregate remedy in remedy of many ocular infections. Fluoroquinolones also are powerful in opposition to plenty of Gram high-quality organisms consisting of Streptococcal and Staphylococcal species [18]. Fluoroquinolones provide all of the attributes of an excellent antimicrobial agent consisting of extensive antimicrobial spectrum, precise tissue penetration and bioavailability, excessive charge of clearance, chemical and organic stability, low diploma o toxicity, excessive binding affinity for melanin, higher affected person compliance, handy dosage paperwork and dosing agenda and comparatively low prevalence of drug interactions.

## MECHANISM OF ACTION

Fluoroquinolones act via way of means of inhibiting enzymes concerned in bacterial DNA synthesis, each of which might be DNA topoisomerases that human cells lack and which are vital for bacterial DNA replication, thereby allowing those retailers to be each particular and bactericidal. DNA topoisomerases are liable for keeping apart the strands of duplex bacterial DNA, placing any other strand thru the break, after which resealing the at the beginning separated strands. DNA gyrase introduces terrible superhelical twists withinside the bacterial DNA doublehelix in advance of the replication fork, thereby catalyzing the separation of daughter chromosomes. This hobby is important for initiation of DNA replication and lets in for binding initiation proteins. Topoisomerase IV is chargeable for decatenation that is, putting off the interlinking of daughter chromosomes thereby permitting segregation into daughter cells on the stop of a spherical of replication. Fluoroquinolones have interaction with the enzyme-sure DNA complicated (i.e., DNA gyrase with bacterial DNA or topoisomerase IV with bacterial DNA) to create conformational modifications that bring about the inhibition of ordinary enzyme hobby. As a result, the brand new drug-enzyme-DNA complicated blocks development of the replication fork, thereby inhibiting ordinary bacterial DNA synthesis and in the longrun ensuing in speedy bacterial mobileular death. Older fluoroquinolones show off a pretty constant sample with recognize to specificity of enzyme inhibition in one-of-a-kind forms of bacteria. The more modern fourth era fluoroquinolones like moxifloxacin, gatifloxacin have a dual-binding mechanism of action, inhibiting each DNA gyrase and topoisomerase IV, in Grampositive species [19,20].

### Polymeric drug delivery

Hydrogels are one in all the imminent instructions of polymer-primarily based totally managed launch drug transport structures. Polymeric drug transport structures had been considerably studied a good way to remedy the ability issues related with tablets or bioactive molecules which includes toxicity, webweb page dependence, low effectiveness, terrible solubility, brief 1/2 of lifestyles, fast degeneration and fast clearance from the body. Considering numerous residences which includes flexibility, structure, biocompatibility, and hydrophilicity, 3 dimensional matrices, hydrogels, are being considerably used as drug transport carriers.

### Advantages of polymeric drug transport

- Reduce poisonous consequences at the wholesome tissue and attain webweb sites which are conventionally Inaccessible because of the presence of numerous boundaries nine via way of means of centered drug transport.
- Increase the 1/2 of-lifestyles of tablets, stopping their fast degradation, and decrease the charge of elimination, as a result retaining drug awareness inside a therapeutically powerful window.
- Reduce the quantity of drug required to reap healing efficacy.
- Cut down the range of repeated invasive dosage required for positive situations and as a result allows to enhance patient's compliance and gives higher living [21,22].

**Table 1. Barriers for the Ocular delivery**

	Conjunctiva	Cornea	Sclera
Surface area	17.65 ± 2.12 cm <sup>2</sup>	1.04 ± 0.12	16 – 17
Thickness	-	0.57 mm	0.4 -0.5 mm
Structural composition	Mucus membrane Epithelium Vasculature	5 layers Epithelium Bowman's membrane Stomata Descemet's membrane Endothelium	Collagen fibers Water Proteoglycans Monopolysaccharides Elastic fibers Fibroblast

**Table 2. Commonly Used Fluoroquinolones in Ophthalmic Delivery**

Anti biotic generation	Example	Activity
1 <sup>st</sup> GENERATION	Nalidixic acid	Have limited activity against gram negative & gram positive organism
2 <sup>nd</sup> GENERATION	Oxolinic acid Cinoxacin Pipemic acid	➤ Improvement in gram negative coverage including Antipseudomonal activity. ➤ Shows limited activity against Gram positive organism.
3 <sup>rd</sup> GENERATION	Norfloxacin Ciprofloxacin Leavofloxacin Ofloxacin	➤ Having antipseudomonal activity against gram negative bacilli
4 <sup>th</sup> GENERATION	Ciprofloxacin Moxifloxacin Gatifloxacin	➤ Having dual mechanism of action in gram positive bacteria in addition reducing efflux from the bacterial cell. ➤ Improved spectrum of Activity.

Fig 1. Anatomy of eye

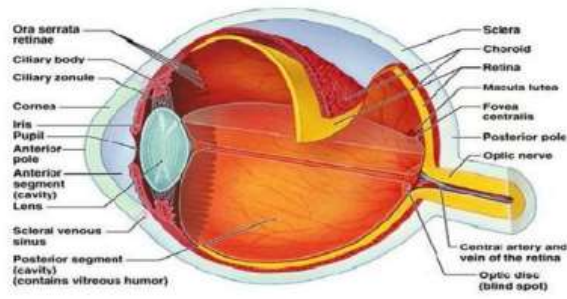


Fig 2. Pathway of Aqueous Humor

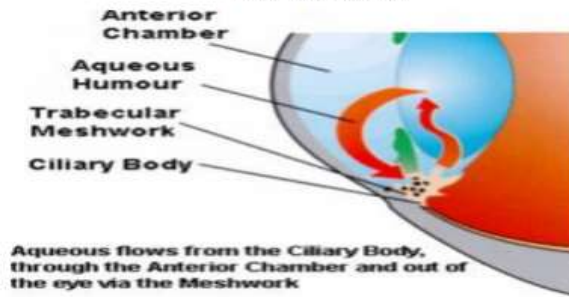


Fig 3. Posterior view of eye

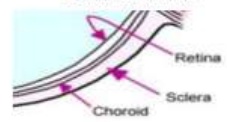


Fig 4. Different Routes for Ocular Drug Delivery

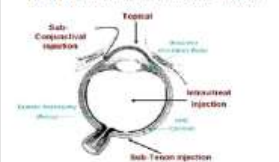
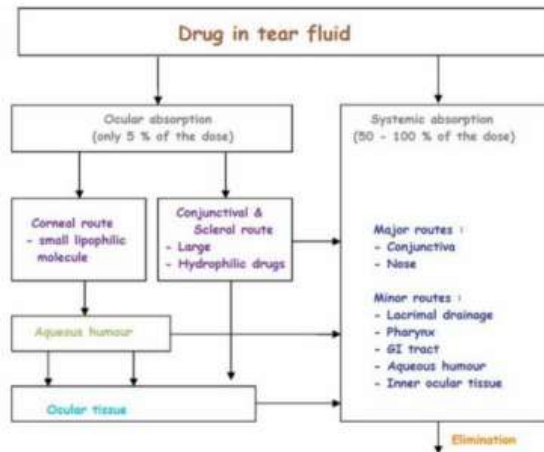


Fig 5. Ocular Drug Absorption



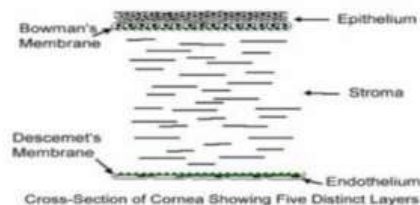


Fig 7. Nasolacrimal Drainage Apparatus

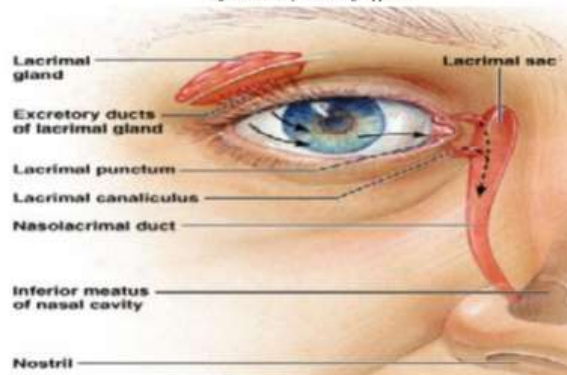


Fig 8. Duration of action of ocular drug delivery systems



## CONCLUSION

New ophthalmic transport machine consists of ocular inserts, collagen shields, ocular films, disposable touch lens and different Novel drug transport structures like liposomes and nanoparticles. Newer fashion is a mixture of drug transport technology for enhancing the healing reaction of a non efficacious drug. This can provide a advanced dosage paperwork for topical ophthalmic application. Among those drug transport structures, simplest few merchandise have been, commercialized. An perfect machine need to have powerful drug attention on the goal tissue for a tended time period with minimal systemic effect. Patient popularity could be very essential for the layout of any snug ophthalmic drug transport machine. Major Improvements are required in every machine like development in sustained drug release, big scale production and stability. Combination of drug transport structures should open a brand new directive for enhancing the healing reaction of a non-efficacious machine. They can triumph over the restrictions and integrate the blessings of various structures.

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