Ocular Drug Delivery Systems

Ocular Drug Delivery Systems (ODDS): Overview

- Ocular drug delivery systems are designed to overcome the eye's protective barriers, such as tear production, rapid tear turnover, and the corneal epithelium, which hinder effective drug delivery and retention.
- These systems improve therapeutic outcomes by enhancing corneal absorption, prolonging retention time, and targeting specific ocular tissues.



Types of Ocular Drug Delivery Systems



1. **Topical ODDS:** Includes gels, ointments, suspensions, and nanoparticle-based solutions applied directly to the eye.
2. **Posterior ODDS:** Targets the posterior segment using intravitreal injections, implants, and particulate systems.

3. **Contact Lens ODDS:** Drug-impregnated contact lenses provide slow, controlled drug release.
4. **Mucoadhesive ODDS:** Uses polymers to enhance drug retention on the ocular surface.

Advantages of ODDS

1. **Prolonged Retention:** Enhances the residence time of drugs on the eye surface.
2. **Targeted Delivery:** Delivers drugs specifically to desired ocular tissues or cells.
3. **Improved Bioavailability:** Reduces drug wastage and ensures higher efficacy.
4. **Reduced Side Effects:** Minimizes systemic exposure and associated side effects.

Disadvantages of ODDS

1. **Complex Formulation:** Requires advanced technology and expertise.
2. **Potential Irritation:** Some systems may cause discomfort or allergies.
3. **Cost:** More expensive than traditional eye drops or ointments.
4. **Invasiveness:** Techniques like intravitreal injections can be invasive and risky.

Anatomy of the Eye: Overview for Ocular Drug Delivery

- The eye's anatomy is integral to designing effective ocular drug delivery systems (ODDS).
- Each structure plays a critical role in vision and presents unique challenges for drug delivery due to physical and dynamic barriers.

Key Structures of the Eye

A. Cornea:

- **Function:** Refracts light and focuses it onto the retina.
- **Drug Delivery Barrier:** Highly selective, prevents many drugs from penetrating.

B. Conjunctiva:

- **Function:** Protects the sclera and inner eyelids.
- **Drug Delivery Role:** Provides an alternative absorption route for some drugs.

C. Sclera:

- **Function:** Maintains the eye's shape and protects inner structures.
- **Drug Delivery Barrier:** Limits penetration of large molecules.

D. Iris:

- **Function:** Regulates light entering the eye by adjusting pupil size.
- **Drug Delivery Relevance:** Can be targeted for conditions like glaucoma.

E. Pupil:

- **Function:** Allows light to pass to the lens and retina.
- **Drug Delivery Note:** Accessed indirectly through corneal absorption.

F. Lens:

- **Function:** Focuses light onto the retina.
- **Drug Delivery Challenge:** Shields posterior segment from anterior drug diffusion.

G. Ciliary Body:

- **Function:** Adjusts lens shape (accommodation) and produces aqueous humor.
- **Drug Delivery Target:** Key site for treating glaucoma.

H. Aqueous Humor:

- **Function:** Maintains intraocular pressure and nourishes the eye.
- **Drug Delivery Challenge:** Its flow clears drugs rapidly from the anterior chamber.

I. Vitreous Humor:

- **Function:** Maintains the eye's shape and supports the retina.
- **Drug Delivery Target:** Often accessed via intravitreal injections for posterior eye diseases.

J. Retina:

- **Function:** Converts light into electrical signals for the brain.
- **Drug Delivery Barrier:** Blood-retinal barrier restricts systemic drug access.

K. Optic Nerve:

- **Function:** Transmits visual information to the brain.
- **Drug Delivery Role:** May be targeted in neuroprotective therapies.

L. Choroid:

- **Function:** Supplies oxygen and nutrients to the retina.
- **Drug Delivery Barrier:** Dense vascularization limits drug diffusion.

Intraocular Barriers in Drug Delivery

- Intraocular barriers are structural and functional mechanisms that protect the eye while presenting significant challenges to drug delivery.
- These barriers are categorized into **static** and **dynamic** barriers.

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