

An Overview on Transmucosal Permeability and Formulation

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DESCRIPTION

Transmucosal drug delivery has gathered important attention in pharmaceutical research due to its potential to bypass systemic barriers and deliver therapeutics directly to target sites. Mucosal surfaces, including the gastrointestinal tract, respiratory tract, ocular surface, and vaginal mucosa, offer different opportunities for drug absorption. However, the permeability of mucosal membranes presents a important challenge in achieving effective drug delivery. In this article, we discover the concept of transmucosal permeability, elucidate the factors influencing mucosal absorption, and discuss formulation strategies aimed at enhancing drug permeation for improved therapeutic outcomes.

Understanding transmucosal permeability

Transmucosal permeability refers to the ability of drugs to traverse mucosal barriers and enter systemic circulation or target tissues. Mucosal membranes feature epithelial layers composed of cells joined by tight junctions, which regulate the passage of molecules across the mucosa. Factors such as molecular size, lipophilicity, charge, and solubility influence transmucosal permeability, with smaller, lipophilic, and neutrally charged molecules exhibiting higher permeability.

Factors influencing mucosal absorption

Several physiological and formulation-related factors influence the permeation of drugs across mucosal membranes. Physiological factors include the surface area and thickness of the mucosa, blood flow, enzymatic activity, and the presence of efflux transporters. Formulation-related factors encompass drug properties, excipients, formulation pH, particle size, and the use of permeation enhancers or mucoadhesive agents. Understanding these factors is important for designing optimized formulations capable of overcoming mucosal barriers and enhancing drug absorption.

Nanoformulations: Nanoparticulate systems, such as liposomes, polymeric nanoparticles, and nanosuspensions, offer advantages in transmucosal drug delivery by improving solubility, stability, and bioavailability. Nanoparticles can bypass mucosal barriers,

penetrate epithelial cells *via* endocytosis, and facilitate sustained drug release, thereby enhancing permeation across mucosal surfaces.

Permeation enhancers: Permeation enhancers are compounds that transiently disrupt mucosal barriers, thereby increasing drug permeability. Common permeation enhancers include surfactants, bile salts, fatty acids, and cyclodextrins. These agents act by loosening tight junctions, enhancing membrane fluidity, or inhibiting efflux transporters, thereby promoting drug absorption across mucosal membranes.

Mucoadhesive formulations: Mucoadhesive polymers, such as chitosan, poly(acrylic acid), and hydroxypropyl methylcellulose, adhere to mucosal surfaces and prolong residence time, thereby facilitating contact between drugs and mucosal membranes. Mucoadhesive formulations promote sustained drug release and enhance absorption by maintaining close proximity to the absorption site.

pH modulation: Formulation pH plays an important role in transmucosal drug delivery, as it influences drug solubility, stability, and absorption. pH-modulating excipients, such as buffer systems or pH-responsive polymers, can optimize drug solubility and enhance permeation across mucosal membranes. Additionally, pH-sensitive nanoparticles can exploit pH gradients to trigger drug release and enhance absorption at specific mucosal sites.

Targeted delivery systems: Targeted delivery systems, such as ligand-functionalized nanoparticles or microparticles, enable site-specific drug delivery to mucosal tissues. By conjugating targeting ligands, such as antibodies or peptides, to drug carriers, targeted formulations can selectively bind to receptors expressed on mucosal surfaces, thereby improving drug localization and efficacy. Despite the ability of advancements in transmucosal drug delivery, several challenges remain, including variability in mucosal physiology, safety concerns associated with permeation enhancers, and regulatory difficulty. Future research efforts should focus on addressing these challenges through the development of safe and effective formulations, advanced delivery technologies, and personalized approaches customized to individual patient needs.

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CONCLUSION

Transmucosal drug delivery represents a ability to approach for enhancing the efficacy and targeted delivery of therapeutics across various therapeutic areas. By overcoming mucosal barriers and enhancing drug permeation, formulation strategies such as

nanoformulations, permeation enhancers, mucoadhesive formulations, pH modulation, and targeted delivery systems offer opportunities for improving therapeutic outcomes and patient compliance. As researchers continue to innovate in this field, transmucosal drug delivery plays a key role in advancing the field of pharmaceutical science and revolutionizing patient care.