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Polymers In Pharmaceutical Drug Delivery System

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ABSTRACT:

Polymers play a major role in the development of drug delivery technology by release of two types of drugs Like hydrophilic and hydrophobic. In a synchronized manner and constant release of formulations over extended periods.There are numerous advantages of polymers acting as an inert carrier to which a drug can be conjugated, for example the Polymer improves the pharmacokinetic and pharmacodynamic properties of biopharmaceuticals through various ways,Like plasma ½ life, decreases the immunogenicity, build ups the stability of biopharmaceuticals, improves the solubility Of low molecular weight drugs, and has a potential of targeted drug delivery. However they have their own limitations,Such as the naturals polymers are most abundant and biodegradable but are difficult to reproduce and purify. Synthetic Polymers have high immunogenicity, which prevent their long term usage. Non-biodegradable polymers are needed to be Sugary after they release the drug at the targeted site. The general characteristic features that makes the polymer a Potential candidate for drug delivery include, safety, efficacy, hydrophilicity, absence immunogenicity biological Inactivity, sufficient pharmacokinetics, and presence of functional groups for covalent conjugation of drugs, targeting Moieties, or formation of copolymer.

Keywords: Polymers, excipients,Biocompatible polymer,smart polymer, Implants

INTRODUCTION:

THE POLYMERS: Polymers and macromolecules have both found use in the technology of extended release medication formulations. Their Primary goal is to guarantee that the patient's body has a steady concentration of the therapeutic substance for the designated period of time. As a result, the class of medications can stop giving the medication more than once during the day and lower its overall dosage. Prolonged medication forms are typically used to treat mental health issues, coronary artery disease, diabetes, and ailments of the heart and digestive Tract. The process of coating, incorporating, complexing, or bonding on the ionites can decrease the absorption of the medicinal substance when Employing sustained release drug forms.

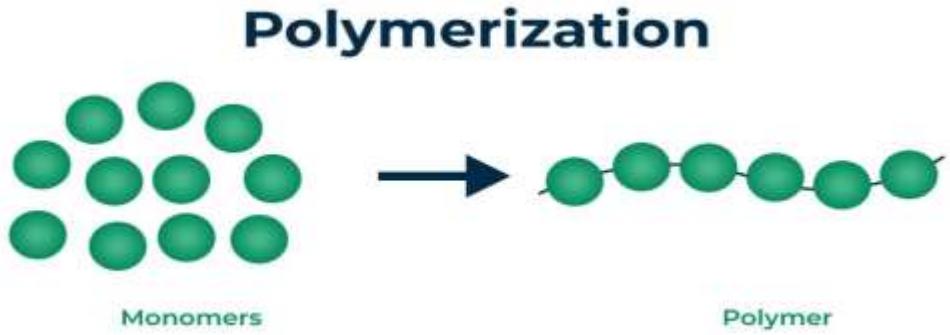

Fig. Polymer formation by polymerization

Large chained macromolecules with a range of functional groups that can be combined with other materials of both low and high molecular weight And customized for any purpose are known as polymers. The foundation of pharmaceutical drug delivery systems is polymers. Because they provide Special qualities that no other material can match, they have been shown to have numerous applications in drug delivery. Polymers are a valuable Tool for controlling the rate at which drugs release from formulations. They are also enhanced when employed as taste-masking, stabilizing, and Protecting agents in oral drug administration. Polymers offer better pharmacokinetic quality; they are becoming a crucial component of drug Delivery systems. They target tissue more specifically because they have a longer half-life than traditional tiny medication molecules. The fields of Polymer therapies and nano-medicines have made extensive use of polymers. The use of polymers in reservoir-based drug delivery systems has Advanced significantly thanks to the development of hydrogels and liposomes.The usage of polymeric materials in medicine is expanding quickly. Numerous biomedical domains, including drug delivery systems, tissue engineering scaffold development, implanting artificial organs and medical Devices, prosthetics, dentistry, ophthalmology, bone regeneration, and many more, have found use for polymers.One of the primary instruments Utilized to regulate the medication release rate from the formulations has been polymers.Because polymers have special qualities that no other Material can match, they have found extensive applications in the administration of drugs.Numerous innovative medication delivery systems have been developed as a result of developments in polymer science. Designing polymers for Diverse drug delivery applications can be facilitated by giving due consideration to both surface and bulk properties. These more recent Technological advancements include the chemical alteration of drugs, drug trapping in polymeric matrices or pumps positioned in specific areas, And carrier-based drug delivery. The effectiveness of medication therapy is increased by these technological

advancements in drug delivery and Targeted strategies, which enhance human health. Chemical engineers, polymer chemists, and pharmaceutical scientists work to develop bioactive Compounds with predictable, controlled distribution. Large-scale Because of their well-established biocompatibility and biodegradability, Biodegradable polymers have found extensive application in the biomedical field. Polymers are typically employed as implants in the biomedical Field, where they are meant to last for a long time. These advancements help reduce side effects and other patient annoyances while also increasing The effectiveness of medical care.

ADVANTAGES OF POLYMERS:

Three benefits can be obtained from polymeric drug delivery products:

Localized drug delivery:

By implanting the device exactly where the medication is needed, systemic exposure to the medication can be minimized. Particularly for toxic Medications that have a number of systemic adverse effects.

Drug delivery that lasts:

The medication is given gradually over time, obviating the need for repeated injections.

This function can help increase patient compliance, particularly with medications that need to be injected frequently and have chronic indications.

Drug stabilization:

By shielding the medication from the physiological milieu, the polymer can increase the drug's stability in vivo. This characteristic makes the Method appealing for the administration of medications that are labile, such as proteins.

ROLE OF POLYMER IN PHARMACEUTICAL DRUG DELIVERY:

❖ **Immediate release dosage forms:**

- **Tablets**:

Polymers have been used for many years as excipients in Conventional immediate-release oral dosage forms, either To aid in the manufacturing process or to protect the drug From degradation upon storage. Microcrystalline cellulose Is often used as an alternative to carbohydrates as Diluents in tablet formulations of highly potent low-dose Drugs. Starch and cellulose are used as disintegrants in Tablet formulations, which swell on contact with water, Resulting in the tablet "bursting," increasing the exposed Surface area of the drug and improving the dissolution Characteristics of a formulation. Polymers including Polyvinyl-pyrrolidone and hydroxypropyl methylcellulose (HPMC) also find uses as binders that aid the formation of Granules that improve the flow and compaction Properties of tablet formulations prior to tableting. Occasionally, dosage forms must be coated with a "non-Functional" polymeric film coating in order to protect a Drug from degradation, mask the taste of an unpalatable Drug or excipients, or improve the visual elegance of the Formulation without affecting the drug release rate.

- **Capsules**:

Capsules are used as an alternative to tablets, for poorly Compressible materials, to mask the bitter taste of certain Drugs, or sometimes to increase bioavailability. Many of The polymeric excipients used to "bulk out" capsule fills Are the same as those used in immediate-release tablets.Gelatine has been used almost

exclusively as a shell Material for hard (two-piece) and soft (one-piece) Capsules. HPMC has recently been developed and Accepted as an alternative material for the manufacture Of hard (two-piece) capsules.

❖ **Modified -release dosage forms:**

It is now generally accepted that for many therapeutic Agents drug delivery using immediate release dosage forms results in suboptimal therapy and/or systemic side Effects. Pharmaceutical scientists have attempted to Overcome the limitations of conventional oral dosage Forms by developing modified release dosage forms.Forms results in suboptimal therapy and/or systemic side-effects'. Pharmaceutical scientists have attempted to Overcome the limitations of conventional oral dosage Forms by developing modified release dosage forms.

- **Extended release dosage forms:**

The therapeutic effect of drugs that have a short Biological half-life may be enhanced by formulating them As extended or sustained release dosage forms. Extended And sustained release dosage forms prolong the time that Systemic drug levels are within the therapeutic range and Thus reduce the number of doses the patient must take to Maintain a therapeutic effect thereby increasing Compliance. The most commonly used water-insoluble Polymers for extended-release applications are the Ammonium ethacrylate copolymers (Eudragit RS and RL),Cellulose derivatives ethylcellulose, cellulose acetate, and Polyvinyl derivative, polyvinyl acetate. Eudragit RS and RL Differ in the proportion of quaternary ammonium groups,Rendering Eudragit RS less permeable to water, whereas Ethylcellulose is available in a number of different grades Of different viscosity, with higher-viscosity grades forming Stronger and more durable films.

- **Gastroretentive Dosage Forms:**

Gastroretentive dosage forms offer an alternative Strategy for achieving extended release profile, in which The formulation will remain in the stomach for prolonged Periods, releasing the drug in situ, which will then Dissolve in the liquid contents and slowly pass into the Small intestine. Unlike a conventional extended release Dosage form, which gradually releases the drug during Transit along the gastrointestinal tract, such a delivery System would overcome the problems of drugs that are Absorbed preferentially from specific sites within the Gastrointestinal tract (for example, many drugs are Absorbed poorly from the distal gut, where an extended-Release dosage form may spend the majority of its time), Producing nonuniform plasma time profile delivery Systems do not relay on polymers present, to achieve Gastroretention mucoadhesive and low-density Polymers have been evaluated, with little success so far, For their ability to extend gastric residence time by Bonding to the mucus lining of the stomach and floating On top of the gastric contents respectively.

TYPES OF POLYMERS IN PHARMACEUTICAL DRUG DELIVERY:

1. **Polymers used as colon targeted drug delivery:**

Polymers plays a very important role in the colon Targeted drug delivery system. It protects the drug from Degradation or release in the stomach and small Intestine. It also ensures abrupt or controlled release of The drug in the proximal colon.

2. **Polymers in the mucoadhesive drug delivery system:**

The new generation mucoadhesive polymers for Buccal drug delivery with advantages such as increase In the residence time of the polymer, penetration Enhancement, site specific adhesion and enzymatic Inhibiton, site specific mucoadhesive polymers will Undoubtedly be uitilized for the buccal delivery of a Wide variety of therapeutic compounds. The class of Polymers has enormous for the delivery of therapeutic Macromolecules.

3. **Polymers for sustained release:**

Polymers used in the sustain by preparing Biodegradable microspheres containing a new potent Osteogenic compound.

4. **Polymers as floating drug delivery system:**

Polymers are generally employed in floating drug Delivery systems so as to target the delivery of drug to a Specific region in the gastrointestinal tract i.e. stomach. Natural polymers which have been explored for their Promising potential in stomach specific drug delivery Include chitosan, pectin, xanthan gum, guar gum, gellan gum, karkaya gum, psyllium, starch, husk, starch, alginates etc.

5. **Polymers in tissue engineering:**

A wide range of natural origin polymers with special focus on proteins and polysaccharides might be potentially useful as carriers systems for active biomoleculesor as cell carriers with application in the tissue engineering field targeting several biological tissue.

CLASSIFICATION POLYMERS:

- **Basis on interaction with water:**

1.Non-biodegradable hydrophobic Polymers:- E.g.Polyvinyl chloride,

2.Soluble Polymers:- E.g. HPMC, PEG

3.Hydro gels:- E.g. Polyvinyl pyrrolidine

- **Based on polymerisation method:**

1.Addition Polymers:- E.g. Alkane Polymers

2. Condensation polymers:- E.g. Polysterene and Polyamide

- **Based on polymerization mechanism:**

1. Chain Polymerization

2.Step growth Polymerization

- **Based on chemical structure:**

1.Activated C-C Polymer

2.Inorganic polymers

3.Natural polymers

- **Based on occurrence :**

1. Natural polymers:- E.g. 1. Proteins-collagen,Keratin, albumin, cellulose

2.Synthetic polymers:- E.g. Polyesters, polyamides

- **Based on bio-stability:**

1. Bio-degradable

2. Non Bio-degradable

DRUG DELIVERY SYSTEMS: POLYMER REQUIREMENTS FOR DRUG DELIVERY DEVICES:

Dendrimers:

Dendrimers are hyperbranched, monodisperse (uniform size particles in a dispersed phase), 3-D molecules of size 1 – 100 nm macromolecules.They accommodate both hydrophilic and hydrophobic medicines, which helps them solubilize. They are made up of three structural parts, 1) Core central(multi-functional)

2)Divisional units

3)Surface teams

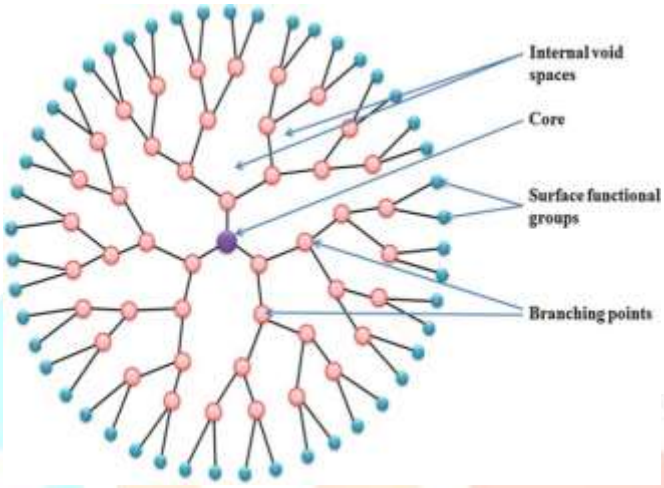

Fig.Dendrimer System as Drug Delivery Devices

Polymeric-Nano Particulate Systems

Depending on how they were prepared, these could be nanospheres or nanocapsules.

Microspheres and microcapsules

Micro/Nano spheres are a type of matrix system where the medication is distributed throughout the particle's body within the polymer. Micro/Nano Capsules are vesicular structures with a drug-containing cavity and an aqueous or oily core.Drugs are delivered by polymer degradation or diffusion Through the micro/nanosphere and micro/nanocapsule. It is possible to inject or swallow micro/nanospheres and micro/nanocapsules. To treat Prostate cancer, Lupron Depot is an injectable microsphere that entraps LHRH and is composed of leuprolide acetate and lactic acid-glycolic acid Copolymer.

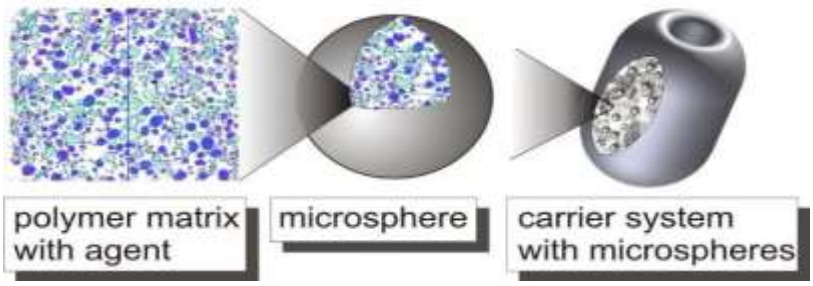

Fig. Microsphere system in Drug delivery system

Hydrogel System

Three-dimensional, cross-linked networks of water-soluble polymers make up hydrogels. Polymers that are synthetic or natural can be used to Create hydrogels. They have a high absorption capacity. Because they are biocompatible and inert to many medications, biodegradable hydrogels Are being employed as carriers for

controlled drug delivery. Because hydrogels have a relatively high porosity, the drug's diffusion coefficient plays

A critical role in determining how quickly the drug releases. Controlling the degree of cross-linking allows hydrogel porosity to be tailored, which In turn affects how quickly the drug particles that are entrapped are delivered

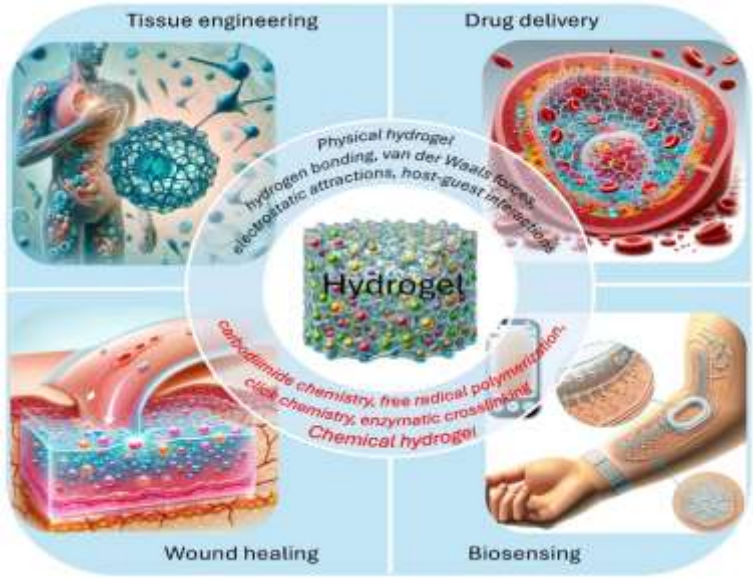

Fig. Hydrogel system for polymer administration.

Solid – Lipid Nanoparticles

Solid lipid nanoparticles are a type of carrier system where melted lipid is homogenized under high pressure or microemulsified in an aqueous Surfactant. They have a solid hydrophobic core and are stable colloidal systems. The dissolved or distributed medications are found in the core. Applying hydrophilic polymers, such as polyethylene glycol (PEG), to the surface reduces their hepatic absorption and increases their Bioavailability. It traps both lipophilic and hydrophilic medications. For oral formulations, ibuprofen-containing solid lipid nanoparticles mixed With dextran hydrogels are appropriate.

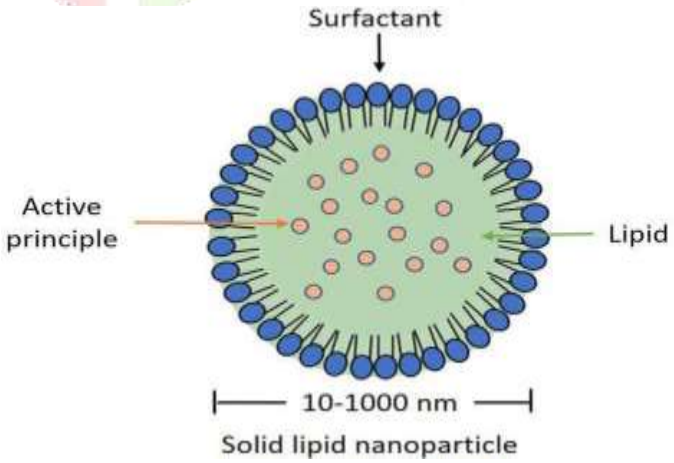

Fig. Solid Lipid Nanoparticles system

Magnetic Nanoparticles

Drugs are injected into the bloodstream bound to magnetic nanoparticles, such as dextran-coated magnetite or oxidized iron. Outside the body, a Strong magnetic field is created, which extracts these medications from suspension and transports them to a specific illness site. By applying a PEG Or dextran coating, these become stable water dispersible systems.

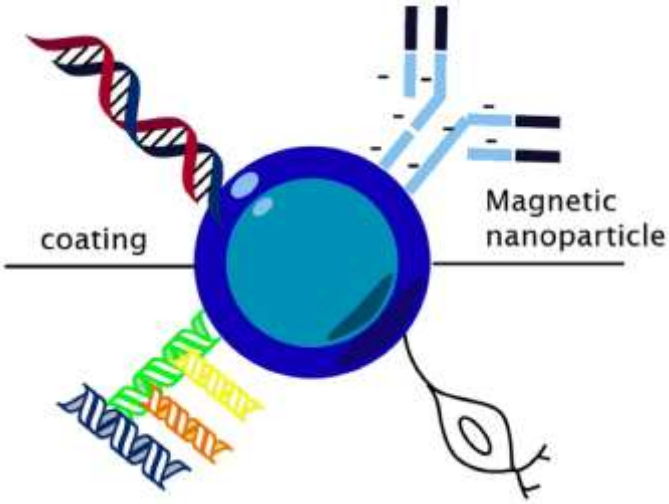

Fig. Magnetic nanoparticles polymeric system.

Smart Polymers

They are high performance polymers which change according to the environment they are residing in. Even Small change in the environment can bring large changes in the polymer's properties. They can change the con-Formation, adhesiveness and water retention properties in response to pH change. They are used for production Of hydrogels and other materials. These properties of smart polymers make them suitable for utilization in drug Formulations. Some smart polymer are formed by the cross linking of the pH sensitive smart polymeric chains.The polymer composition, the nature of the ionizable groups, the hydrophilicity of the polymer backbone and The cross linking density decide the behaviour of the smart polymers. The cross linking density affects the per- Meability of the solute inversely, the higher the cross linking density, the lower the permeability. Alginate Gel beads are co-precipitated with a biologically active agent to form a sustained release gels. This gives the adVantage of high loading of drugs while achieving better protein stability. LCST is a polymer, which have been Tested in controlling drug delivery matrices. Copolymerisation of the NIPAAm with alkyl methacrylate's main-Tains the temperature sensitivity because it increases its mechanical strength. There is reduction in the transport-Tation of the bioactive molecules out of the polymers by surrounding the LCST with a thick layer of poly NI-PAAm polymer.

Implants

In most of the implants (a drug delivery system), a permeable polymeric membrane surrounds the core of solid Drugs. The implants can be modified into different shapes, such as films, pellets, plugs, rods and discs. The Implants can be classified as non-biodegradable and biodegradable implants, depending on the polymer

used. The polymers mostly used in the non-biodegradable implants include polyvinyl alcohol (PVA), silicone and Ethylene vinyl acetate (EVA). Silicone can be customized to be both a permeable or impermeable layer depend-Ing on the grade and thickness of silicone used. Biodegradable systems can be made either b natural polymers (e.g. albumin, gelatin and collagen) or by synthetic polymers, such as Polylactic acid, olyglycolic acid and poly-Lactic-co-glycolic acid (PLGA) copolymer. In biodegradable implants, drug release occurs during polymer Degradation. Implants approved by the FDA for eye: Retisert, Vitrasert, and Ozurdex . Retisert, is an intra-Ocular implant for the treatment of non-infectious uveitis that contains fluocinolone acetonide (FA). It is composed of an FA tablet containing PVA, magnesium stearate and microcrystalline cellulose. Vitrasert, is an intra-Ocular implant that contains ganciclovir surrounded by PVA/EVA. It release drug in controlled fashion and is Used to treat cytomegalovirus (CMV) retinitis. Ozurdex, is a biodegradable sustained release intravitreal implant That delivers dexamethasone to the vitreous humor and retina in order to treat macular edema and noninfectious Posterior uveitis.

Conclusion

Polymer-based pharmaceuticals are starting to be seen as Key elements to treat many lethal diseases that affect a Great number of individuals such as cancer or hepatitis. Although excipients have traditionally been included in Formulations as inert substances to mainly make up Volume and assist in the manufacturing process, they are Increasingly included in dosage forms to fulfil specialized Functions for improved drug delivery because many new Drugs have unfavourable physicochemical and Pharmacokinetic properties. The synthetic polymers can Be designed or modified as per requirement of the Formulation by altering polymer characteristics and on The other hand natural pharmaceutical excipients are Biocompatible, non toxic, environment friendly and Economical. Several polymers have been successfully Used and others are being investigated as excipients in The design of dosage forms for effective drug delivery.

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