MPH202T

Targeted Drug Delivery Systems and Biotechnology Products

The recent advances in drug delivery systems basically focuses on smart drug delivery systems which concerns the administration of drug at the right time, right dose and targeted drug delivery with safety and efficacy. These new drug delivery systems led to better patient compliance, also adoption of better therapeutic regimen for patients. Introduction of proteins, peptides, DNA based therapeutics have resulted in advancements in drug delivery systems, thereby deviating from conventional and traditional means like injection and oral ingestion. Liposomes, lipoproteins, monoclonal antibodies, microspheres, microemulsions, etc, have been used as latest drug delivery systems, especially for nasal and pulmonary routes, whereby monoclonal antibodies and liposomes have diagnostic importance, used as biological reagents, used for immunopurification etc. Use of hydrogels, nanoparticles and microencapsulation techniques are a part of the smart drug delivery system. Nanoparticles can be placed in skin, brain or spinal cord and can deliver drugs that range from pain medication to chemotherapy. So, these recent advancements in the drug delivery system have proved to be health improvement techniques for the future because of their association with self-regulation, controlled time drug monitoring system.

The ever-evolving genetic basis of disease will continue to provide novel opportunities for the development of new drugs to treat these disorders, particularly in the field of biotechnology. The discovery of recombinant DNA (rDNA) technology and its application to new drug development has revolutionized the biopharmaceutical industry. Previously, the pharmaceutical industry relied on the use of relatively simple small drug molecules to treat disease. Modern molecular techniques have changed the face of new drug development to include larger, more sophisticated and complex drug molecules. These large biopharmaceuticals have enormous potential to treat disease in ways previously unavailable to small drug molecules. As a result, *biotechnology*, or the use of biological materials to create a specific product, in this case pharmaceuticals, has become an important sector of the pharmaceutical industry and accounts for the fastest growing class of new drugs in the market. Nucleic acid, protein and peptide drugs, and diagnostics are the main drug products emerging from the biopharmaceutical industry.

Many diseases occur as a result of defects or errors in the genes involved in producing essential enzymes or proteins in the body. The genes are coded in *deoxyribonucleic acid* (DNA), helical double-stranded molecules folded into chromosomes in the nucleus of cells. The *Human Genome Project* was created several years ago to sequence the human genome. This national effort has generated information on the role of genetics in congenital defects, cancer, disorders involving the immune system, and other diseases that have a genetic link.

The controlled drug delivery systems have expanded the concept that controlled and continuous drug delivery reduces the dosage of drug and adverse pharmacological reactions are reduced to a great extent. The basic aim of a controlled drug delivery system is to maintain the plasma concentration within the therapeutic window for a longer time and continuous therapeutic action. Targeting is one of the important events associated with a drug delivery system; it delivers the loaded drug to the desired site. Drug carrier involved in drug delivery system is composed of

soluble particles, microparticles made up of insoluble or biodegradable natural or synthetic polymer, microcapsules, cells, micelles etc. The mechanism involved in transfer of drug to the desired site is through active and passive targeting. The novel drug delivery systems is based on biochemical and physical mechanism, the concept of physical mechanism is followed by controlled drug delivery systems which includes osmosis, dissolution, electro transport, diffusion. The biochemical mechanisms include monoclonal antibodies, gene therapy, and vector systems, liposomes etc.

The benefits of this drug delivery systems when assessed on a therapeutic basis is duration of action of drug is optimized, decreased dosage frequency, site of drug release is controlled and a constant level of drug flow is maintained. The controlled drug carrier systems like vesicles, micellar solution and liquid crystal dispersion and nanoparticles have a particle size of 10-400 nm and have great potential as a drug carrier system. There are others like hydrogels which is three dimensional, hydrophilic, polymer network and it imbibes a large amount of water and biological fluids. Nanoparticles and bucky balls are also included where nanoparticles can be classified into nano shells, nano pores, quantum dots, nano wires, nano tubes and nano cantilever. Buckyball is a 60 carbon atom network of a hollow ball and is a constituent of a novel drug delivery system. There are research going on particles of gold, which can serve as an ultradetection systems for DNA and protein markers and is associated with cancer research especially breast and prostate cancer. Controlled drug delivery systems can be defined as sustained drug action at a predetermined rate by maintaining a relatively constant and effective drug level in the body with concomitant minimization of undesirable side effects, or, sometimes localized drug action by spatial placement of release systems or within the diseased tissue.

• Constant release: Alza (DUROS Implant); Guilford Pharmaceuticals (polymer wafers)

• Controllable release: MicroCHIPS (programmable MEMS implant)

There is a classification of controlled drug delivery systems or modified drug delivery systems which controls the rate of drug delivery, has a sustained therapeutic action and targets the delivery of a drug to a tissue. It can be classified into four categories:

a) Delayed release b) Sustained release c) Site-specific targeting d) Receptor –targeting.

MICROSPHERES

The pharmaceutical, pharmacokinetic, and therapeutic properties often combine to reduce the effectiveness of cytotoxic compounds. For vectoring of such compounds to target areas, liposomes, nanoparticles, and microspheres have been suggested. Since organ distributions of the microspheres are dependent upon their size and shape, it is reasonable to attempt second-order targeting of microspheres. At the time of clinical diagnosis, two conditions apply to most tumor bearing patients. The first concerns the biological activities and surface properties of malignant cells, which interfere their recognition and elimination; which, in turn, lead to a progressive biochemical imbalance between tumors and their hosts. Second, biochemical differences between tumor and host cells are always minimal and frequently quantitative rather than qualitative. The aim of targeted chemotherapy is to reduce the tumor/host imbalance by altering

the distribution, uptake, or effects of drugs such that the tumor cells get damaged substantially more than normal cells.

Lipoproteins

Large protein structures (in nanometer range) may be utilized as pharmaceutical carriers of drugs and DNA for targeted and specialized delivery in biological systems. Lipoproteins are structures function as natural biological carriers which transport various types of lipids in blood circulation. There are studies suggesting that lipoproteins can serve as efficient carriers for anticancer drugs, gene or other type of compounds. Certain results showed that hydrophobic cytotoxic drugs could be incorporated into lipoproteins, without changing the integrity of lipoprotein structure.

Nanoparticles

Because of the comparable size of the components in the human cells, nanoparticles are of great interest in drug delivery. In making the biological systems, nanometer Scale has been extensively used. If one has to go hand in hand with nature in treating the diseases one needs to use the same scale, whether for correcting a faulty gene, killing leprosy bacteria sitting inside the body cells, blocking the multiplication of the viral genome, killing a cancer cell, repairing the cellular metabolism, or preventing wrinkles or other signs of aging.

Microemulsions

Microemulsions are systems consisting of water, oil, and surfactant(s), which constitute a single optically isotropic and thermodynamically stable liquid solution or in combination with a co surfactant. These are useful for drug delivery due to their capacity to solubilize water-soluble and oil-soluble compounds in high amounts, their excellent stability, way of preparation, optical clarity, as well as other administration-specific advantages.

Monoclonal Antibodies

An antigen (or immunogen) molecule predominantly possesses antigenic determinants of more than one specificity. Each separate antigenic determinant of the antigen will have a tendency to get bound to a fully mature B-cell whose surface immunoglobin (SIg) specifically matches the characteristic features presented by the concerned determinant. Consequently, a single antigen may activate the B-cells having more than one SIg specificity. The astronomical growth in the field of pharmacobiotechnology in the last two decades has expanded the scope of MABs to a great extent in the following two cardinal aspects of immunodiagnostics, namely:

• MABs in diagnostics.

• MABs in imaging and therapy.

Liposomes

Liposome is a structure where one end is water soluble and the other end is water insoluble, the hydrophobic ends have trappings of water soluble medications whereas phospholipid layer has trappings of fat soluble medications. Liposomes either get attached to cellular membarne and fuses, thereby releases the active components or lysosomes acts on the phospholipid layer of the liposome and by process of phagocytosis active moeity is released. The uses of liposomal anthracyclines have successfully been used as an anticancer agent as the drug encapsulation by these molecules is highly efficient. Moreover, it reduces the cardiotoxic nature of the anticancer drugs. Two forms of liposomal components which being macromolecular carriers remain in circulation for a longer time, they cause extravasation from tumor cells through enhanced permeability and retention effect

Conclusion

Presently, most drugs that are used to treat disease are small-molecular-weight, well-characterized molecules that are generally manufactured by chemical synthesis. In contrast, biotechnology-derived drugs are very large-molecular-weight drugs (eg, proteins) that have complex chemical structures. In some cases, there is limited ability to characterize the identity and structure of the biopharmaceutical and to measure the activity of the clinically active component(s) such as the specific active moiety. These biopharmaceuticals are often manufactured by fermentation, using recombinant DNA or other biosynthetic approaches in which the manufacturing process, original cell lines, and purification process can have an impact on quality, safety and efficacy of the drug.

These large biopharmaceuticals have enormous potential to treat disease in novel ways previously unavailable to small drug molecules. As a result, *biotechnology*, or the use of biological materials to create specific biopharmaceuticals, has become an important sector of the pharmaceutical industry and accounts for the fastest-growing class of new drugs in the market. Nucleic acid, protein and peptide drugs, and diagnostics are the main drug products emerging from the biopharmaceutical industry.

The emerging genetic basis of disease is providing novel opportunities for the development of biotechnology-derived pharmaceuticals (*biopharmaceuticals*) to treat specific disorders. The use of recombinant DNA (rDNA) technology and its application to new drug development has revolutionized the biopharmaceutical industry.