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Intellectual Property Law

Polymers Help Deliver Medicine

Imagine if a close friend or family member was diagnosed with cancer. Now imagine that that person could go to the hospital to receive a simple injection and be cured within a few hours. This scenario may not be science fiction for long thanks to a rapidly growing new field of medicine known as nanomedicine.

Nanomedicine is an emerging new field within nanotechnology. The term "nanotechnology" generally refers to engineering and manufacturing at the molecular or nanometer length scale. A nanometer is one-billionth of a meter, about the width of six bonded carbon atoms. Nanomedicine is the process of diagnosing, treating, and preventing disease and traumatic injury, of relieving pain and of preserving and improving human health, using molecular tools and molecular knowledge of the human body.

Future potential medicinal applications of nanotechnology are so promising that the country's federal investment in nanoscale science, engineering and technology for fiscal year 2005 is about $982 million dollars. (Source: National Science Foundation "NSF") This money is divided between the NSF and various other federal government institutions such as NASA, DOD, NIH, NIST, DOE, EPA, USDA, DHS, and DOJ. The NSF receives a majority of the money at $305 million dollars and provides research and development grants to various universities, national science and engineering centers, exploratory research and education projects and education for high schools and public outreach.

Polymer technology is an integral part of nanomedicine. Polymer technology applied on the nanoscale level has a strong potential for use in the field of drug delivery. Nanoscale polymeric drug carriers can now be made in the form of spheres with diameters ranging from about 50 billionths of a meter. This can facilitate the transport of drugs to some of the smallest capillaries in the body. These nanospheres are designed to travel to specific sites within the body, release their contents of drug molecules and then degrade. Their degradation by-products are non-toxic and will ultimately be excreted from the body.

For example, chemotherapy treatment of cancer usually involves saturating the body with toxic drugs, which can often result in harmful side effects such as reduced immune response to infection. With the use of polymeric drug carriers, it is possible to direct the drug molecules specifically to the site of a tumor so that a reduced quantity of drug would be required. Consequentially, this would reduce the toxic effect of the drug to the body.

Developments in polymer science have had a great influence on drug delivery. It is now possible to synthesize a wide variety of biocompatible polymers that will release entrained drugs at a rate determined by the chemistry and physical form of the polymer.

The nanopolymeric drug delivery systems are produced involving a method known as emulsion polymerization, in which molecules self-assemble themselves during a chemical process. In an emulsion polymerization, molecules known as surfactant perform the self-assembly by virtue of their amphiphillic nature. Amphiphillic molecules are composed of two or more parts with each part being soluble in a different medium. Generally, a surfactant molecule may have a hydrophilic end and a hydrophobic end.

The surfactant molecules are dissolved in water until the critical micelle concentration (CMC) is reached. At the CMC, the molecules arrange themselves so as to minimize the interaction of the hydrophobic tail with the water. In order to accomplish this the hydrophobic tails align themselves along side each other to form spherical structure called a micelle. The size of the micelles is dependent on the length of the surfactant molecule and ranges from 10-100 billionths of a meter. The interior of the micelle provides the site necessary for polymerization.

Once there are millions of micelles spinning around in the aqueous medium a reactive monomer is introduced which is also hydrophobic. The hydrophobic monomer molecule travels to the interior of the micelles where they are stable. The micelles then swell to accommodate the monomer. The final part of the preparation of the nanoparticles involves the addition of initiator molecules that trigger a chain reaction within the micelle's core leading to a polymerization. Once the core of the micelles have been converted to a solid polymer sphere of approximately 200-1000 billionths of a meter in diameter, the spheres may be removed from the emulsion and are ready for use. Drug molecules either attach to their surface or can be absorbed into their core. The specific site within the body to which the nanoparticles will travel is controlled by the surface chemistry of the nanoparticle. Molecules can be tethered to the particle's surface, which will cause selective uptake by various organs of the body.

As this article illustrates, through nanoscale research of polymer science medicinal treatment possibilities of diseases using nanoparticle drug delivery systems are possible. Through their unique structure and capability to carry drugs on the molecular level throughout the body to specific targets, it is easy to understand how "polymers help deliver medicine".

For more information regarding the patent protection of your company’s innovative medical devices, nanotechnology or other intellectual property, contact Rita E. Kline at ritakline@tarolli.com or 216-621-2234x121.