Controlling the Movement of Molecules

Robert Langer, Institute Professor, Massachusetts Institute of Technology

Abstract

The ability to control the movement of molecules is both fascinating scientifically as well as being critically important to the well-being of our planet and its people. In particular, the sustained release of molecules over prolonged periods at controlled rates has had and will continue to have enormous implications for the delivery of substances in medicine, agriculture, the environment, nutrition, aquaculture, household consumer products, and numerous other areas. This field is advancing at a rapidly accelerating pace. In this article, I largely discuss our own work, starting 45 years ago, in enabling the controlled release of macromolecules from biocompatible polymers. I also discuss the synthesis of novel materials to affect molecular movement and I then examine external approaches for controlling the movement of molecules through materials, using forces such as electric, acoustic, and magnetic fields. I further discuss approaches for controlling molecular movement through physiologic barriers, such as the skin, lung, and intestine. Finally, I outline several future areas of this field, including how it can affect the developing world, the ability to control the movement of molecules into mammalian cells, and the design of intelligent approaches to control molecular delivery.