Iontophoresis: Application of Electrochemical Materials and Methods for Therapeutics and Diagnostics

by J. Anand Subramony

Iontophoresis is a method of transporting substances into and across biological tissues by the application of an electric current. More specifically, it is a transdermal method of transporting substances such as drugs into the body non-invasively, by applying an electrical potential. The flux of molecules by iontophoresis is higher than passive diffusion of molecules from medicated patches. An iontophoretic drug delivery system consists of several components[1] and the rate of delivery by iontophoresis is typically proportional to the applied current and therefore programmable with the possibility of "on demand" delivery. Iontophoretic drug delivery is an interdisciplinary technology requiring the knowledge of materials science for identifying materials, such as polymeric gels, as drug reservoirs; electrochemistry for the choice of electrode materials; the understanding of transport properties of molecules in the skin[2] to maximize the efficiency of drug delivery and to avoid undesirable side reactions; and pharmaceutical science for the formulation of drugs using appropriate biocompatible excipients. This technology is of great interest because it provides a safe and convenient way to administer drugs in a controlled and non-invasive manner. Iontophoresis can be used both for therapeutics such as the delivery of drug molecules into the body and diagnostics such as in glucose sensing, which involves extracting biological fluids from the body. Several commercial systems based on iontophoretic technology are available for topical use. There has been an increased interest in transdermal delivery of compounds via iontophoresis due to the possibility of precise control of dosage and due to the ability to allow control of drug delivery by patients. The technology can also be potentially used to create closed loop systems that can control and monitor drug delivery as a function of response levels from the body to prevent both over- and under-dosing.

The delivery system consists of an anode, a reservoir containing the drug, a counter electrode, and a battery as the electrical energy source (Fig. 1). Under the application of an electrical potential, drug ions (D^+) move into the skin while biological anions such as Cl^- migrate from the body into the donor compartment to maintain electrical neutrality.

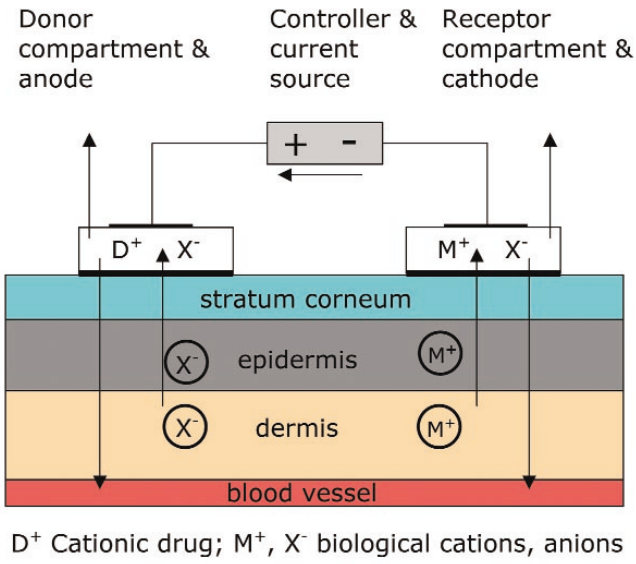

FIG. 1. An iontophoretic drug delivery system.

Identifying new materials as drug reservoirs and electrodes to maximize drug delivery; the formulation of a drug in the desired form in the donor compartment to maintain the pH, minimize competing ions; and the choice and design of electronic components such as power source and control circuitry are some of the key challenges in optimizing and enhancing drug delivery by iontophoresis.

ECS is conducting a one-day symposium on ionotophoresis during the upcoming 205th meeting at San Antonio in May 2004. Advances in iontophoretic drug delivery, molecular transport in the skin, developments on the diagnostics front to minimize skin irritation, and product development will be some of the topics presented during the symposium. Papers are solicited on the developments in iontophoretic delivery including transport efficiency, new materials as drug reservoirs/electrolytes, electroporation, electrochemical materials for administering drugs via ionotophoresis, cathodes for anionic drug transport, and methods to reduce skin irritation and competing ions. For more information on submitting the abstracts, please visit the ECS website or see the advertisement on page 57. ■

References

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About the Author

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