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Journal of Membrane Science 308 (2008) 1–34
journal of MEMBRANE SCIENCE
www.elsevier.com/locate/memsci

Review

Medical applications of membranes: Drug delivery, artificial organs and tissue engineering

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Received 29 April 2007; received in revised form 20 September 2007; accepted 27 September 2007
Available online 3 October 2007

Abstract

This paper covers the main medical applications of artificial membranes. Specific attention is given to drug delivery systems, artificial organs and tissue engineering which seem to dominate the interest of the membrane community this period. In all cases, the materials, methods and the current state of the art are evaluated and future prospects are discussed.

Concerning drug delivery systems, attention is paid to diffusion controlled systems. For the transdermal delivery systems, passive as well as iontophoretic systems are described in more detail. Concerning artificial organs, we cover in detail: artificial kidney, membrane oxygenation, artificial liver, artificial pancreas as well as the application of membranes for tissue engineering scaffolds and bioreactors.

This review shows the important role of membrane science and technology in medical applications but also highlights the importance of collaboration of membrane scientists with others (biologists, bioengineers, medical doctors, etc.) in order to address the complicated challenges in this field.

Keywords: Membranes; Medical applications; Drug delivery; Artificial organs; Tissue engineering

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doi:10.1016/j.memsci.2007.09.059

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1. Introduction

Membrane technology is of major importance in medical applications, in particular in a number of life saving treatment methods. Membranes are used in drug delivery, artificial organs, tissue regeneration, diagnostic devices, as coatings for medical devices, bioseparations, etc.

The total membrane area produced for medical applications almost matches all industrial membrane applications together [1]. In fact in fiscal terms, the value of medical membrane products is far larger than all other applications combined [1]. Only in the US for example, the medical membrane market approaches 1.5 billion dollars per year and grows steadily.

The biggest part of the medical market involves membranes in drug delivery, hemodialysis, other artificial organs (oxygenators, pancreas, etc.) and tissue engineering. These areas will be covered extensively in this review. In all cases, biocompatible and in some applications biodegradable materials are required for the membrane fabrication. Therefore, prior to the specific applications, we briefly discuss the issues of biocompatibility and biodegradability.