

BENG 100 Frontiers of Biomedical Engineering
Professor Mark Saltzman

Chapter 16

SUMMARY

- Scientists have long searched for methods to replace organs that are lost to disease or failing and the last half of the twentieth century saw major progress in artificial kidneys, hearts, and pancreases.
- Biomaterials are a critical part of the design of artificial organs; while the perfectly biocompatible material is not yet known, there are many materials that function in the body without many side effects.
- The most important biological response to materials in contact with blood is coagulation, whereas the most important response to implanted materials is the foreign body response; the basic mechanisms of these responses are now understood.
- Hemodialysis, which is based solidly on engineering principles of biomaterials and molecular separations, is now well integrated into medical care and it prolongs the lives of many people.
- The rate of movement of a solute across a synthetic membrane is defined by its permeability, which allows for quantitative analysis of concentrations and fluxes.
- Membrane oxygenators revolutionized heart surgery, allowing surgeons to have direct view of the surgical field, by temporarily taking over all of the functions of the patient's heart and lungs.
- Permanent artificial hearts do not yet exist, but major progress has been made in heart design; other devices—such as valves, pacemakers, stents, and ventricular assist devices—have changed dramatically the life expectancy for patient's with many types of heart disease.
- Cells can be used as the basis for artificial organ function, and have been incorporated into the design of the artificial pancreas and artificial liver.

KEY CONCEPTS AND DEFINITIONS

Biocompatibility – the ability of a material to perform with an appropriate host response in a specific application.”

Biomaterial – “a nonviable material used in a medical device, intended to interact with

biological systems.”

Dialysate – a balanced solution of salts and other solutes that is used as an extraction medium during dialysis.

Extracorporeal – literally “outside of the body”, in medicine it is used to refer to procedures that are performed on tissues, such as blood, when the tissue is first taken outside of the patient’s body.

Foreign body response (FBR) – the long-term inflammatory response to a foreign object or material within a tissue.

Neutrophils – a kind of white blood cell, the most numerous kind in the blood, which is involved in the early process of inflammation.

Suture – a material, usually a thread or a fiber, that is used to sew a wound, in order to bring layers of tissue into contact.

QUESTIONS

1. The blood coming out from the dialyzer should not go directly back to the patient. The FDA requires dialysis machines to include a set of monitors and controls to ensure safety. One of these is a pH sensor to monitor the pH of the blood. Think of three other monitors or detectors you would install into a dialysis device.