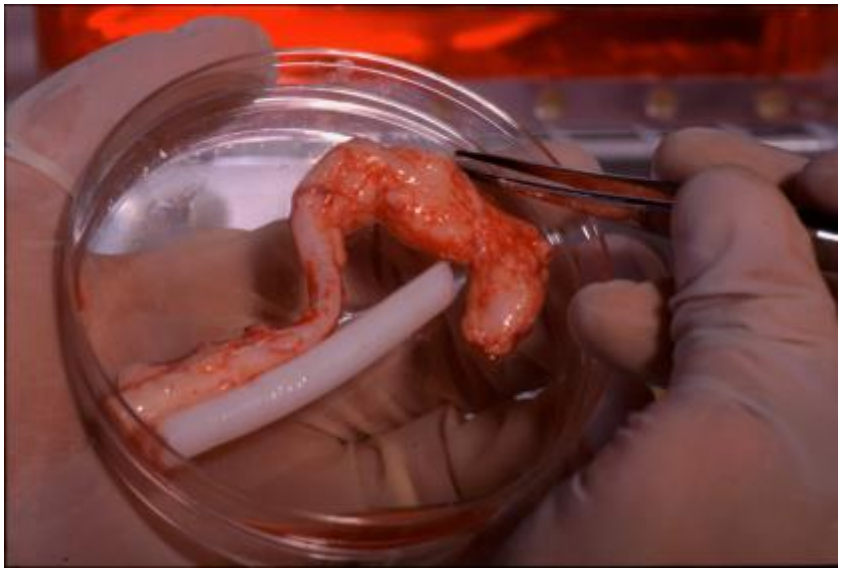
Chapter 4
Biomaterials



Outline:

- 4.1 Introduction
- 4.2 Classes of biomaterials
- 4.3 Applications of biomaterials
- 4.4 Characteristics of biomaterials
- 4.5 Development of biomaterial devices
- 4.6 Examples of biomaterials

Learning outcomes:

- Define biomaterials.
- Describe the characteristics and applications of biomaterials.

4.1 Introduction

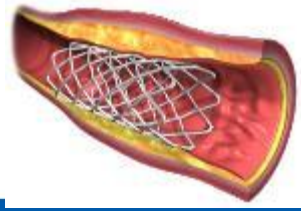
- Biomaterial is a nonviable material used in a medical device, intended to interact with biological systems.

4.1 Introduction

- **A biomaterial**
  - **is used to make devices to replace a part of a function of the body in a safe, reliable, economic, and physiologically acceptable manner.**
  - **is any substance (other than a drug), natural or synthetic, that treats, augments, or replaces any tissue, organ, and body function.**
  - **has a particular lifespan in the human body.**

4.1 Introduction

- **The need for biomaterials stems from an inability to treat many diseases, injuries and conditions with other therapies or procedures :**
  - **replacement of body part that has lost function (total hip, heart)**
  - **correct abnormalities (spinal rod)**
  - **improve function (pacemaker, stent)**
  - **assist in healing (structural, pharmaceutical effects: sutures, drug release)**



4.2 Classes of biomaterials

- **Metals**
  - stainless steel, cobalt alloys, titanium alloys
- **Ceramics**
  - aluminum oxide, zirconia, calcium phosphates
- **Polymers**
  - silicones, poly(ethylene), poly(vinyl chloride), polyurethanes, polylactides
- **Natural polymers**
  - collagen, gelatin, elastin, silk, polysaccharides

4.3 Applications of biomaterials

Organ/Tissue	Examples
heart	pacemaker, artificial valve, artificial heart
eye	contact lens, intraocular lens
ear	artificial stapes, cochlea implant
bone	bone plate, intramedullary rod, joint prosthesis, bone cement, bone defect repair
kidney	dialysis machine
bladder	catheter and stent
muscle	sutures, muscle stimulator
circulation	artificial blood vessels
skin	burn dressings, artificial skin
endocrine	encapsulated pancreatic islet cells

4.4 Characteristics of biomaterials

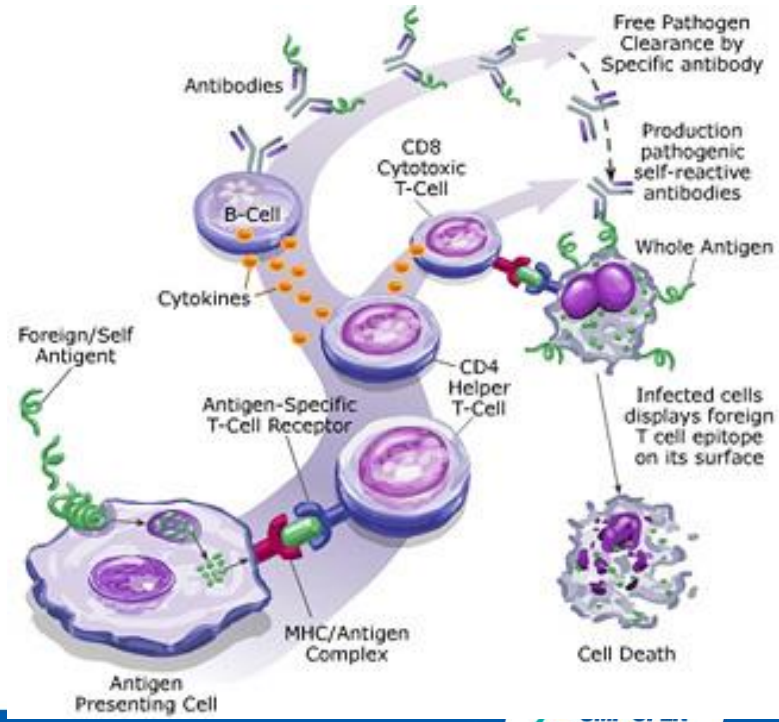
Property	Desirables
Biocompatibility	**Noncarcinogenic, nonpyrogenic, nontoxic, nonallergenic, blood compatible, non-inflammatory**
Sterilizability	**Not destroyed by typical sterilizing techniques such as autoclaving, dry heat, radiation, ethylene oxide**
Physical characteristics	**Strength, elasticity, durability**
Manufacturability	**Machinable, moldable, extrudable**

4.4 Characteristics of biomaterials

- **Biocompatibility: The ability of a material to perform with an appropriate host response in a specific application.**
- **Host response: the reaction of a living system to the presence of a material**

4.4 Characteristics of biomaterials

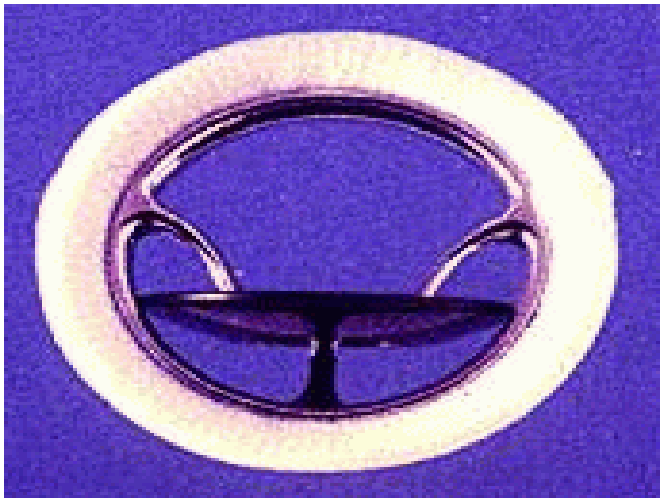
- **Host Reactions to Biomaterials**
  - **Thrombosis**
  - **Hemolysis**
  - **Inflammation**
  - **Infection and Sterilization**
  - **Carcinogenesis**
  - **Hypersensitivity**
  - **Systemic Effects**



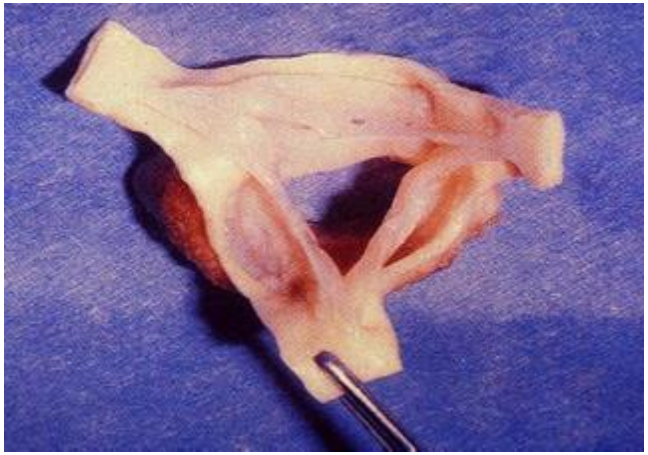
4.5 Development of biomaterial devices

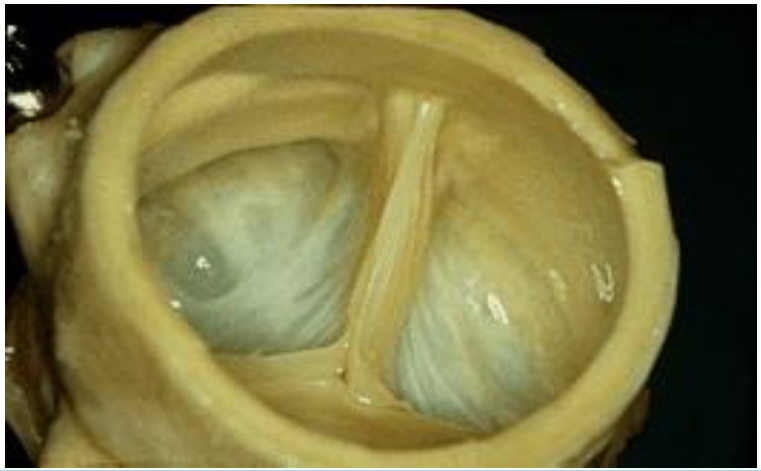
- **The various steps involved in the development of biomaterial devices are:**
  - **Identifying a need**
  - **Device design**
  - **Material Synthesis**
  - **Material Testing**
  - **Fabrication**
  - **Sterilization and Packaging**
  - **Device Testing**
  - **Clinical Use**

4.6 Examples of biomaterials



Heart Valves

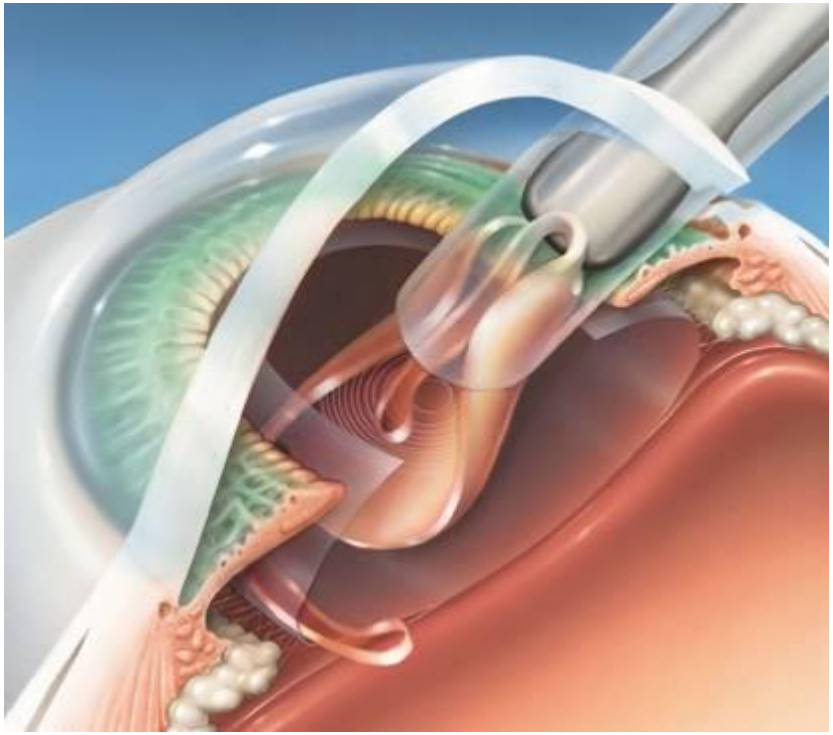




4.6 Examples of biomaterials

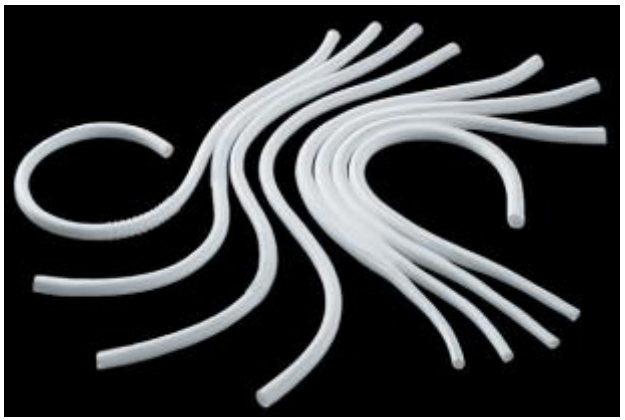
Dental Implants

4.6 Examples of biomaterials



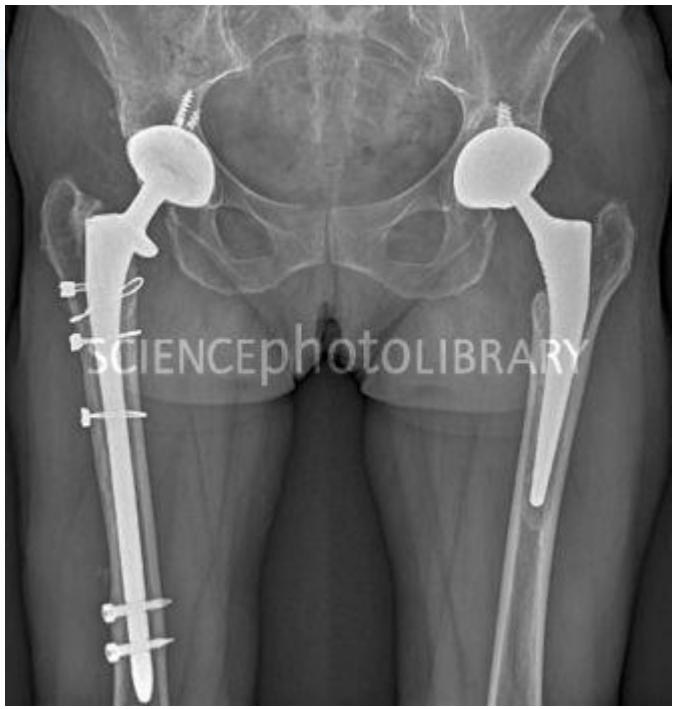
Intraocular Lenses

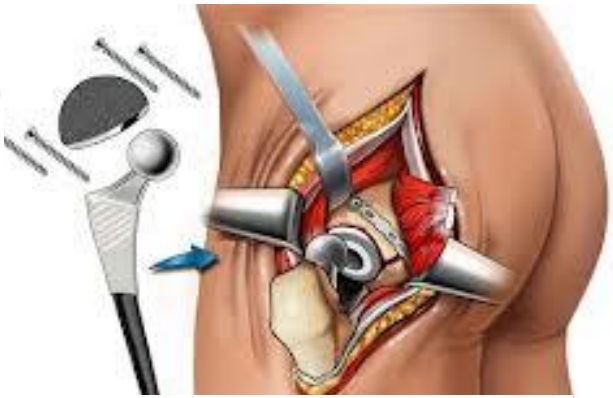
4.6 Examples of biomaterials

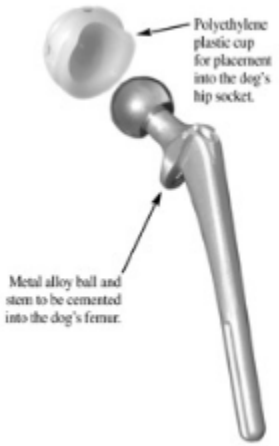


Vascular Grafts

4.6 Examples of biomaterials







Hip-Replacements

4.6 Examples of biomaterials

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