Biomaterials

By

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Lecture No. (1)

Introduction of Biomaterials

Principle Concepts of Biomaterials

Biomaterials science: is a relative to materials that use in medicine field involve study the properties and applications of biomaterials (synthetic and natural) that are used in contact with biological systems, these materials are commonly called biomaterials which a strong growth. Therefore, the study of biomaterials is called biomaterials science or biomaterials engineering.

Biomaterial: is a synthetic or natural materials use to make devices to replace any part of biological system (human body) for a medical purpose or to function in close contact with living tissue in safe, reliable, economic, and physiologically acceptable manner.

Or the **biomaterial** is any substance that has been engineered intended to interact with biological systems to evaluate, treat, replace any tissue, organ, function or a diagnostic of the human body.

A variety of devices and materials are used in the treatment of disease or injury. Common examples of biomaterials include suture needles, catheters, fixation plates, teeth fillings, etc. Therefore, with these basic concepts, the biomaterials may be metal, ceramic, polymer and composite. Recently the use of nano and micro technology on biomaterial design in this field.

Biological Material: A material that is produced by a biological system such as (bone, skin, or artery).

Biomedical Device: Any instrument, machine, implant, software and material in vitro study a s reagent, calibrator, intended to interact with biological system, which after manufacture can be used, alone or in combination for human body for one or more of specific purposes, as diagnosis, prevention, monitoring, treatment, supporting or sustaining life, and disinfection of medical devices.

Biocompatibility

The success of a biomaterial as an implant is highly dependent on three major factors: the properties and biocompatibility of the implant, the health condition of the recipient, and the skill of the surgeon who implants and monitors its progress.

Therefore, the **biocompatibility** is acceptance of an artificial implant by the surrounding tissues and by the body as a whole.

Or the **biocompatibility** is the ability of a material to perform in a specific application with an appropriate host response. The appropriate host response means:

1- Resistance to blood clotting.
2- Resistance to bacterial colonization.
3- Normal healing.

The biocompatibility is related to the behavior of biomaterials in various environments under various chemical and physical conditions. Therefore, the biocompatibility classifies into:

1- Structural biocompatibility: Adaptation of the implant structure to the mechanical behavior of the surrounding tissue (host tissue).
2- Surface biocompatibility: Adaptation of the chemical, physical, biological, and morphological surface properties of the implant to the needs of the surrounding tissue (host tissue).

The compatibility characteristics that may be important in the function of an implant device made of biomaterials include:

1- Adequate mechanical properties such as strength, stiffness, and fatigue properties.
2- Appropriate optical properties if the material is to be used in the eye, skin or tooth.
3- Appropriate density, sterilization, manufacturability, long-term storage.

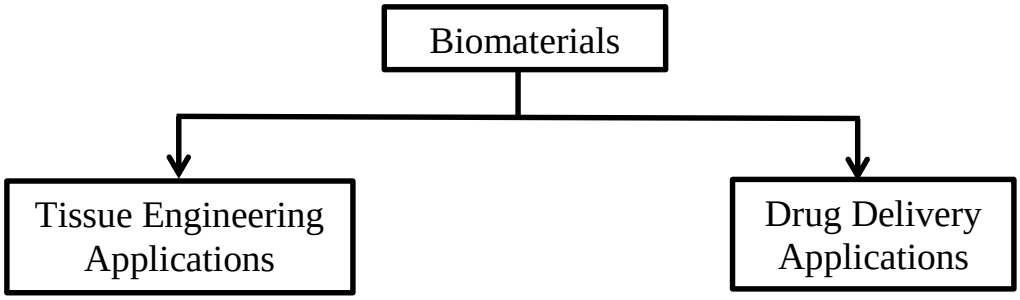
Osteointegration: A chemical bonding between bone and biomaterial will be formed such as (Hydroxyapatite). A direct contact between bone and implant under

light microscope such as (titanium)**.**

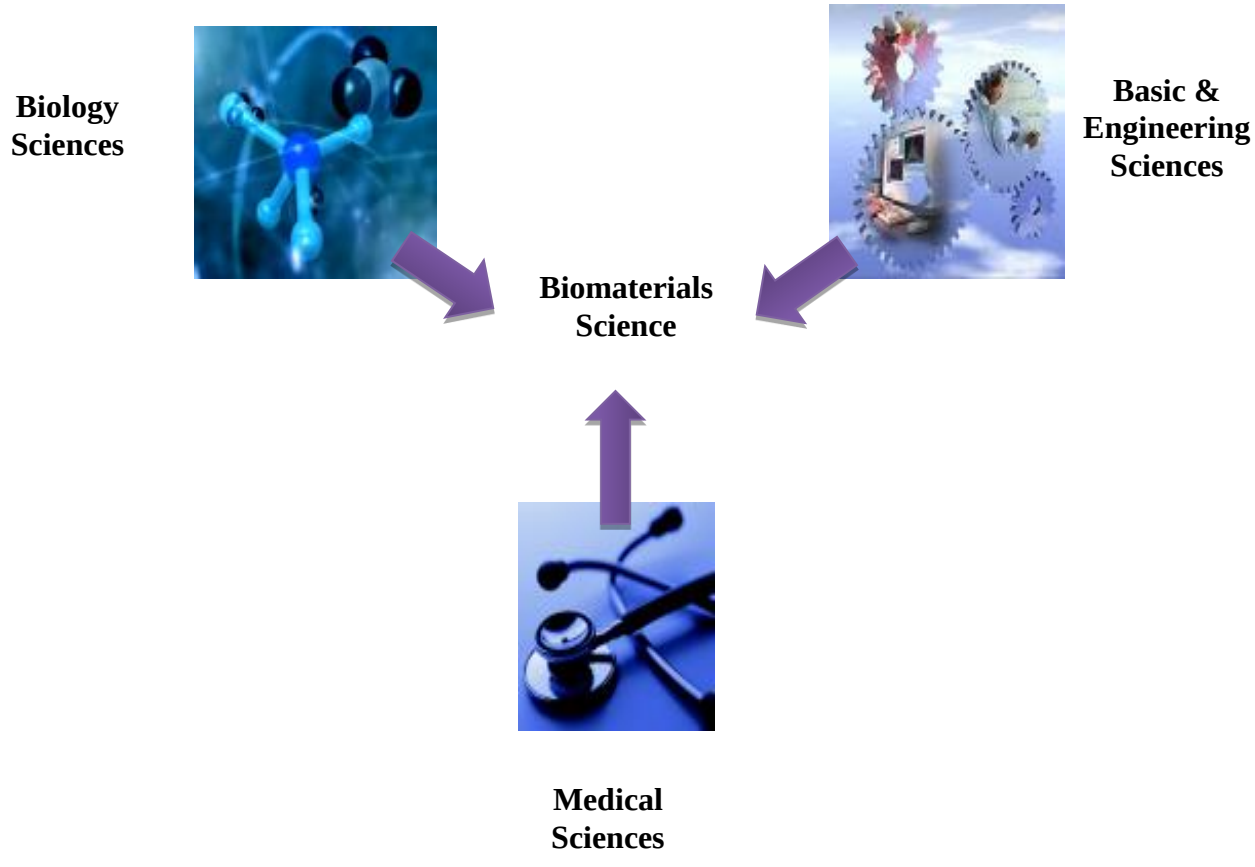
Prosthesis: A device that replaces a limb, organ or tissue of the human body.

Artificial Organ: A medical device that replaces, in part or in whole, the function of one of the organs of the body.

Classification of biomaterials according applications:



Biomaterials science involve elements of medicine, biology, chemistry, tissue engineering, materials science and materials engineering, as shown below figure:



The fields of which knowledge in order to develop and use of biomaterials in medicine and dentistry:

1- **Science and engineering**: (materials science and materials engineering) structure-property relationships of synthetic and biological materials including metals, ceramics, polymers, composites, tissues, etc.
2- **Biology and Physiology**: Cell and molecular biology, anatomy, animal and human physiology, histopathology, experimental surgery, immunology, etc.
3- **Clinical Sciences**: (All the clinical Specialties), dentistry, maxillofacial, neurosurgery, obstetrics and gynecology, ophthalmology, orthopedics, plastic and reconstructive surgery, heart and cardiovascular surgery, veterinary medicine and surgery, etc.

A brief History of Biomaterials

- Romans, and Chinese used gold in dentistry over 2000 years ago, Cu not good.
- Eyeglasses.
- Ivory & wood teeth.
- Aseptic surgery in 1860.
- Bone plates in 1900, joints in 1930.
- Turn of the century, synthetic plastics came into use.
- Polyethylene and stainless steel being used for hip implants in 1960.

General Applications of Biomaterials

1- Skeletal system

- Joint replacement (Hip, knee)
- Bone plate
- Bone cement
- Artificial tendon and ligament
- Dental implant

2- Cardiovascular system

- Blood vessel prosthesis
- Heart valve
- Catheter

3- Organs

- Artificial heart
- Skin repair
- Artificial kidney
- Heart-lung machine

4- Senses

- Cochlear replacement
- Intraocular lens
- Contact lens
- Corneal bandage

5- Wound healing

- sutures
- graft.

6- Drug delivery system

- controlled and targeted delivery of drugs (doctor delivers drug to patient in remote areas).

The following figure represents general applications of biomaterials in human body:

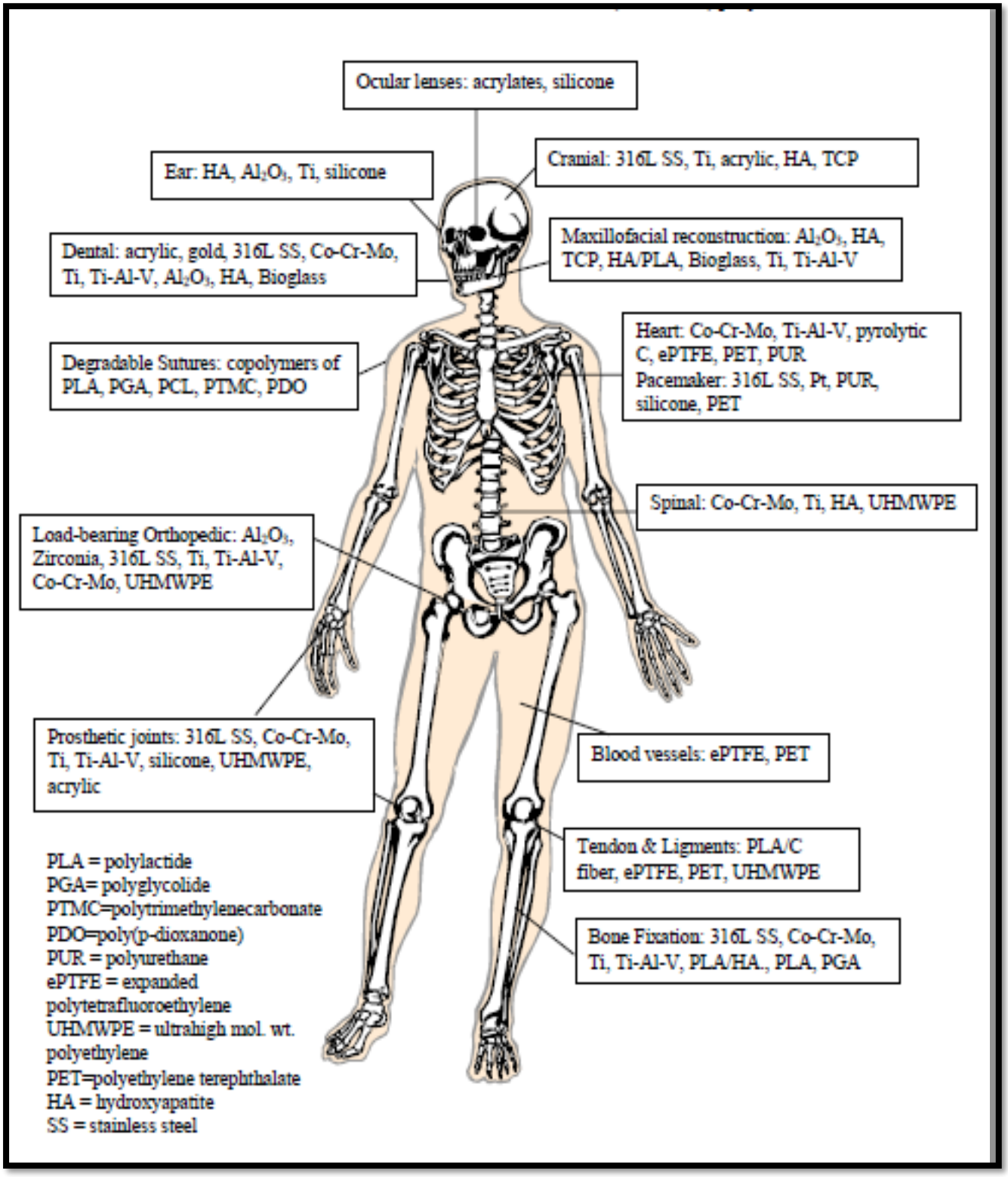


Figure 2: Represents General Applications of Biomaterials in Human Body.