SMART BIOMATERIALS

1. Smart Hydrogels
2. Smart Nanoparticles
3. Smart Surfaces
4. Smart Nano fibers
5. Shape-Memory Materials

1.Smart Hydrogels

Hydrogels are three-dimensional (3D) materials with the ability to absorb large amounts of water while maintaining their dimensional stability.

Hydrogels can also be separated into two groups on the basis of their natural or synthetic origins.

Hydrogel-forming natural polymers include proteins such as collagen and gelatin, and polysaccharides such as alginate and agarose.

advantageous features

1. low toxicity
2. good biocompatibility

Applications of Smart Hydrogels

biomedical fields

1. wound dressings
2. super absorbents
3. drug delivery systems
4. tissue engineering

Smart hydrogels have been used in diverse applications

1. making actuators
2. valves
3. the immobilization of enzymes and cells
4. sensors
5. in concentrating dilute solutions in bioseparation

Hydrogels may also have many different physical forms, including

1. solid molded forms (e.g., soft contact lenses)
2. pressed powder matrices (e.g., pills or capsules for oral ingestion)
3. microparticles (e.g., as bioadhesive carriers or wound treatments)
4. coatings (e.g., on implants or catheters; on pills or capsules, or coatings on the inside capillary wall in capillary electrophoresis)
5. membranes or sheets (e.g., as a reservoir in a transdermal drug delivery patch)
6. encapsulated solids (e.g., in osmotic pumps)
7. liquids (e.g., that form gels upon heating or cooling

2- Smart Nanoparticles

Targeted Drug Delivery

the targeting system of carriers having affinity with specific cancer cells has been called active targeting. The nanocarriers of active targeting are equipped with some factors for recognizing the cancer cells such as low-molecular-weight molecules, peptides, antibodies.

Carbohydrates are abundant materials in nature and are inexpensive biomolecules. In the living body, however, carbohydrates play important roles in cellular recognition processes, for instance, cell growth regulation, differentiation, adhesion, cancer cell metastasis, cellular trafficking, inflammation by bacteria and viruses, and immune response. Moreover, cancer cells usually express sites that recognize carbohydrates, which are used in combination with drug carriers for the active targeting system.

2. Biosensing and Bioimaging

Early detection is important for medical treatment. several types of nanomaterial such as

1. fluorescent organic molecules,
2. quantum dots (QDs)
3. metal particles
4. inorganic particles have been developed.

- **metal nanoparticles** such as gold, silver, platinum, and magnetic particles also have the tendency to show high aggregation and toxicity with decreasing diameter [133– 135]. Therefore, from the structural point of view, it is very important to achieve high fluorescence intensity, high dispersibility, and low toxicity of fluorescent materials. For solving these problems, biocompatible polymers and silica materials are used as conjugated materials to protect these fluorescent materials from body environments. Silica materials are suitable to coat for fluorescent materials for their biocompatibility, high dispersibility, and easy modification

- There are also various types of equipment in medical fields

1. optical imaging
2. magnetic resonance imaging (MRI)
3. computed tomography (CT)
4. ultrasound (US)
5. positron emission tomography (PET)
6. single-photon emission computed tomography (SPEC) for the microscopic detection of abnormalities in the body

3- Smart Surfaces

Applications of Smart Surfaces

smart polymer-grafted surfaces, a wide range of biomedical applications

Adsorption Control

In various biomaterial applications, the adsorption of biomolecules onto surfaces is the most important means of modulating the biocompatibility, nonfouling, antibacterial property, cell adhesion, and biological cascade properties of the surfaces.

When proteins and peptides in aqueous solution come in contact with a solid substrate, they are rapidly adsorbed on the surface of the material via various interactions including hydrophobic and electrostatic interactions and hydrogen bonding

4- Smart Nano fibers

Fibrous materials have a major role to play in fields of biomedicine including:-

1. biomaterials
2. tissue engineering
3. regenerative medicine.

1- Sensors

The role of sensors is to transform physical or chemical responses into signals on the basis of the targeted application. It is considered that highly sensitive sensors can be assembled using nanofibers that possess high surface area and porosity hydrogel fibrous glucose sensor that has the following significant advantages:

1. The fibers can remain at the implantation site for an extended period, whereas microbeads disperse from the implantation site.

2. The fibers can be implanted at a readily controllable fluorescence intensity by cutting them to a specified length, thereby enabling stable and repeatable sensing.

3. The fibers can be easily and nonsurgically removed from the body.

2- Filters

Owing to the high specific surface area and high porosity of nanofibers, they have been developed as filter media, which are very useful for the separation or purification of not only waste water but also biomolecules. Furthermore, filtration has been improved and new types of nanofiber have been developed, such as hollow fibers.

5- Shape-Memory Materials

Shape memory materials are a class of smart and intelligent materials that have the ability to “memorize” a given shape as permanent or temporary, and then “recover” to an original (permanent) shape when triggered by external stimuli. Shape-memory materials have attracted much attention from basic and fundamental (academic) research to industrial and practical applications. Many academic and industrial researchers are interested in shape-memory materials because of their ability to remember two or more shapes under different conditions.

Applications of Shape-Memory Materials

Implantable SMP Devices

- Polymeric medical devices can also be engineered to elicit a shape-memory effect. SMPs are a class of mechanically functional “smart” materials that can recover relatively large strains in response to a stimulus. The activating stimulus can include temperature, pH, humidity, light, electric power, or other means capable of facilitating molecular motion and enabling shape recovery. SMPs have most notably been promoted owing to their potential in minimally invasive surgery, where a compacted device could be passed through a smaller incision and deployed to its full shape once inside the body.
- For biomedical devices, the heating of the polymer to activate the shape-memory effect has been proposed via body, optical/laser heating, and remote inductive heating.