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SCHOOL OF COMPUTING SCIENCE & ENGINEERING

CAT-3 Case Study Report File Submission

On

"BIOMATERIAL"

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WELCOME TO BIOMATERIALS

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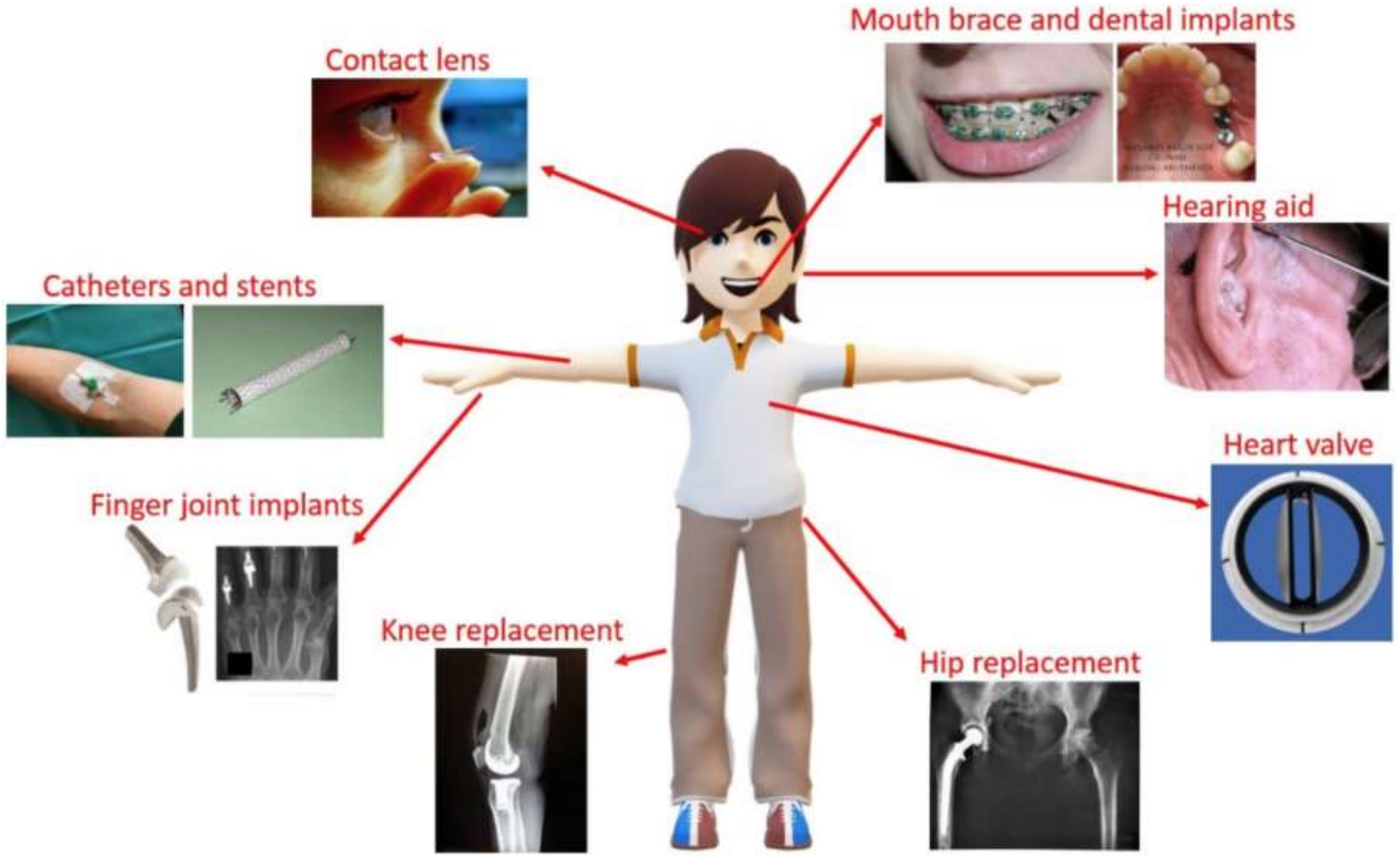
What are biomaterials?

- Biomaterials play an integral role in medicine today—restoring function and facilitating healing for people after injury or disease. Biomaterials may be natural or synthetic and are used in medical applications to support, enhance, or replace damaged tissue or a biological function.
- The first historical use of biomaterials dates to antiquity, when ancient Egyptians used sutures made from animal sinew
- The modern field of biomaterials combines medicine, biology, physics, and chemistry, and more recent influences from tissue engineering and materials science
- Metals, ceramics, plastic, glass, and even living cells and tissue all can be used in creating a biomaterial.
- These may include heart valves, hip joint replacements, dental implants, or contact lenses
- They often are biodegradable, and some are bio-absorbable, meaning they are eliminated gradually from the body after fulfilling a function

Biomaterials



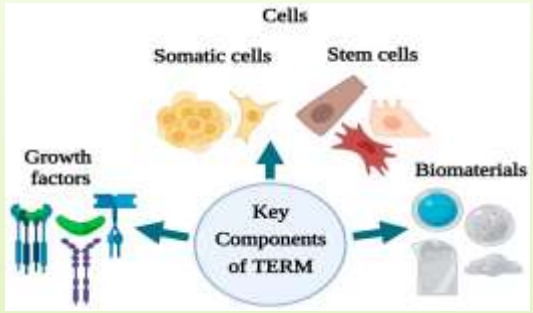
How are biomaterials used in current medical practice?

following are the broad range of applications-

- **Medical implants**: including heart valves, stents, and grafts; artificial joints, ligaments, and tendons; hearing loss implants; dental implants; and devices that stimulate nerves
- **Methods to promote healing of human tissues**, including sutures, clips, and staples for wound closure, and dissolvable dressings.
- **Regenerated human tissues**, using a combination of biomaterial supports or scaffolds, cells, and bioactive molecules. Examples include a bone regenerating hydrogel and a lab-grown human bladder.
- **Molecular probes and nanoparticles** that break through biological barriers and aid in cancer imaging and therapy at the molecular level
- **Biosensors** to detect the presence and amount of specific substances and to transmit that data. Examples are blood glucose monitoring devices and brain activity sensors
- **Drug-delivery systems** that carry and/or apply drugs to a disease target. Examples include drug-coated vascular stents and implantable chemotherapy wafers for

Some pictures of biomaterial applications

Medical implants



healing of human tissues

blood glucose monitoring device

drug-coated vascular stents

• Classification of biomaterials

- Ceramics
- Synthetic Polymers
- natural polymers

1. ceramics

- There has been widespread use of ceramic scaffolds, such as hydroxyapatite (HA) and tricalcium phosphate (TCP), for bone regeneration applications.
- Ceramic scaffolds are typically characterized by high mechanical stiffness, very low elasticity, and a hard-brittle surface

2. *Natural biomaterials*

can further be classified as protein-based biomaterials and polysaccharide-based biomaterials.

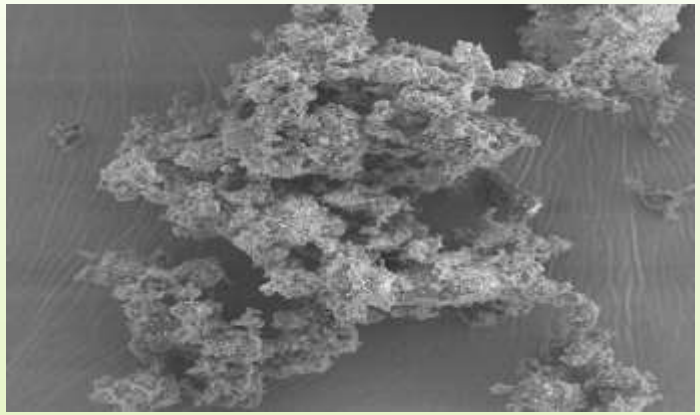
- Protein-based biomaterials include collagen, fibrin, and silk.
- Polysaccharide-based biomaterials include chitosan (CS), alginate, and hyaluronan.

3. *Synthetic biomaterials*

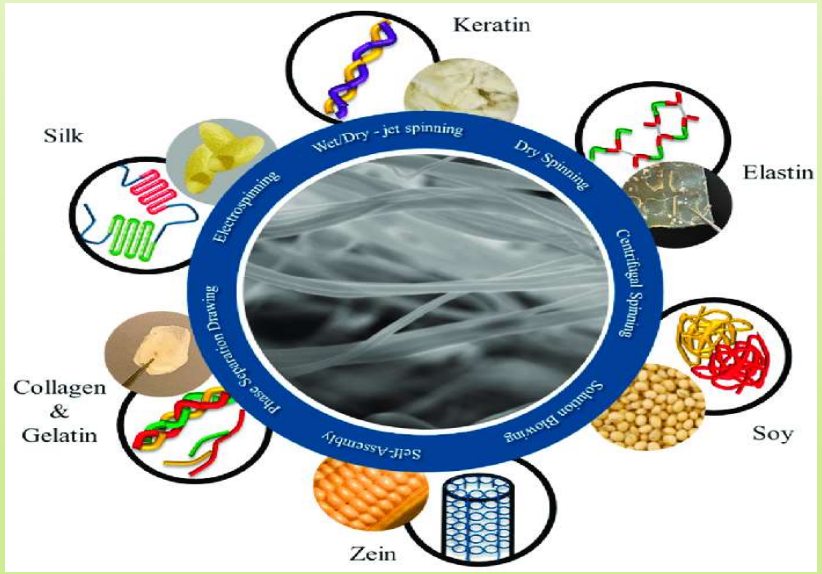
include polymer-based biomaterials, peptide-based biomaterials, and ceramic-based biomaterials.

- Polymer-based biomaterials include PLGA and polyethyleneglycol (PEG).
- Peptide-based biomaterials include short amino acids and self-assembling peptides.
- Ceramic-based biomaterials include bioactive glass and hydroxyapatite.
- Composite biomaterials.

ceramic



bioactive glass *Synthetic biomaterials*



protein-based biomaterials

polysaccharide-based biomaterials

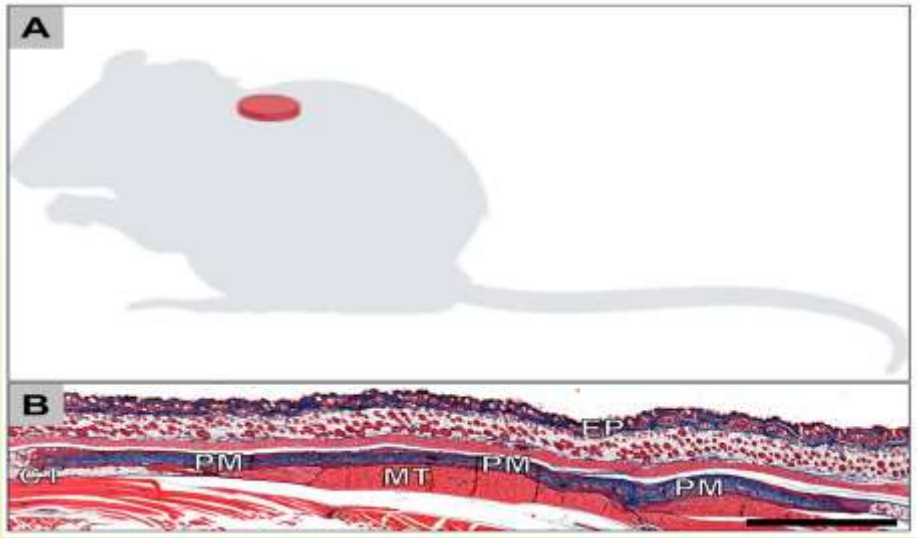
Tissue engineering

Tissue engineering evolved from the field of biomaterials development and refers to the practice of combining scaffolds, cells, and biologically active molecules into functional tissues.
The goal of tissue engineering is to assemble functional constructs that restore, maintain, or improve damaged tissues or whole organs

Biomaterials used in tissue engineering can be classified into-

- Human-derived biomaterials such as human acellular dermal matrix
- Animal-derived biomaterials including processed bovine bone materials and porcine-based collagen membranes
- Other natural biomaterials such as polysaccharide-based biomaterials (cellulose, chitin/CS)
- Synthetic biomaterials such as polymers, composites, and ceramic-based dental biomaterial

human acellular dermal matrix



bovine bone materials and porcine-based collagen membranes

natural biomaterials cellulose

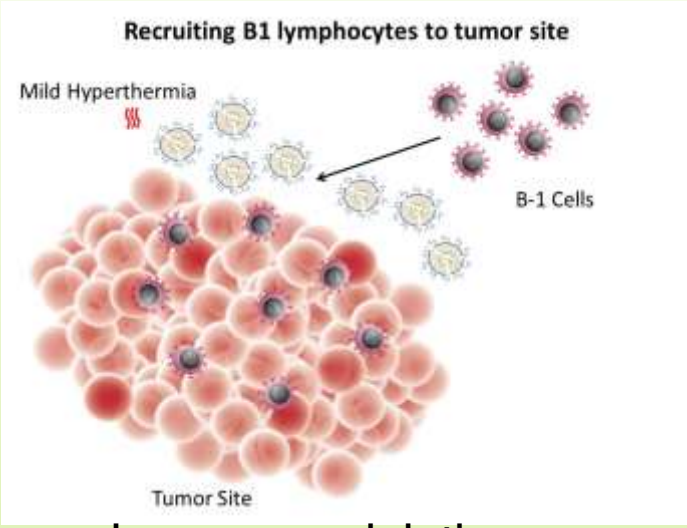
Synthetic biomaterials (polymers)

future research on biomaterials?

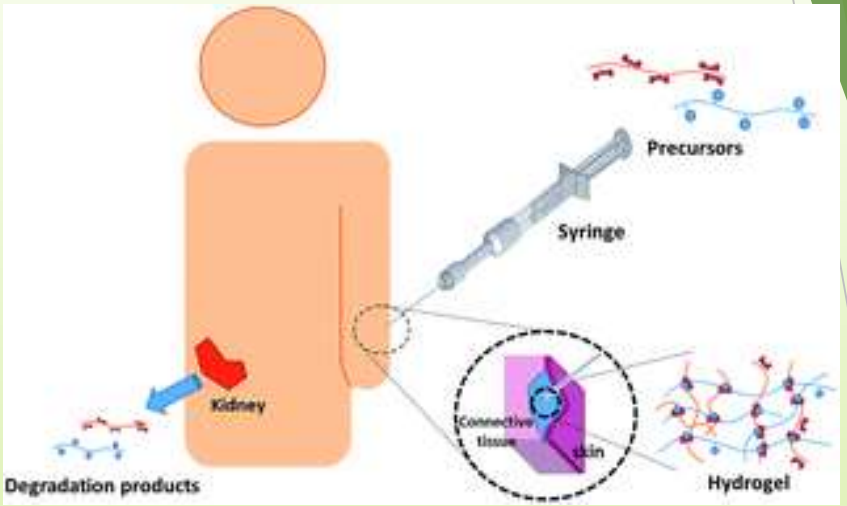
- Three fascinating technologies below suggest directions for biomaterials

1. Immunomodulation is an adjustment of the immune response to a desired level. Immunomodulating biomaterials may help to tackle widespread chronic diseases such as type 1 diabetes, an autoimmune disease where the body's defense destroys insulin-producing cells in the pancreas.

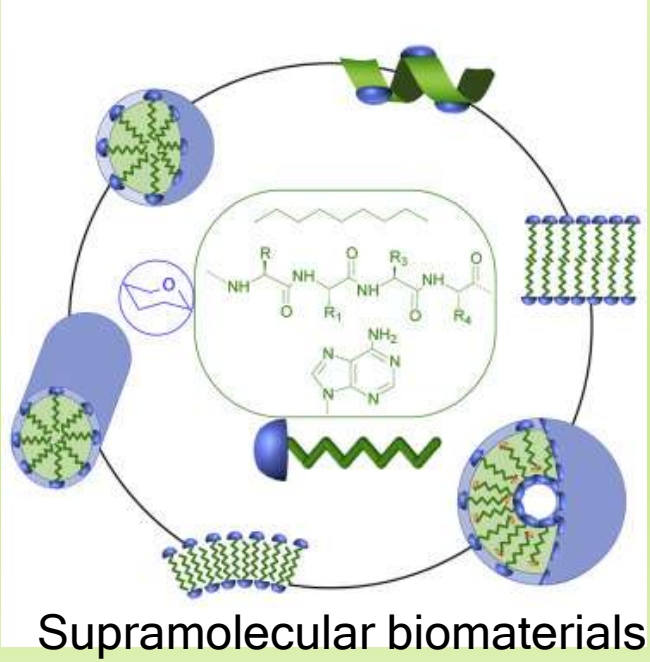
2. Injectable biomaterials are being used increasingly for the delivery of therapeutic agents such as medicine, genetic materials, and proteins. They offer the possibility to treat a variety of conditions by providing targeted delivery while avoiding uptake by the immune system.
3. Supramolecular biomaterials complexes of molecules that exceed the limits of what molecules can do on their own have the potential to both sense and respond, making them ideal materials for treating injury or disease



Immunomodulation



Injectable biomaterials



Supramolecular biomaterials

Thank you