

UNIT-V

MATERIALS USED IN MEDICINE

5.2 BIOMATERIALS FOR BONE AND JOINT REPLACEMENT

Biomaterials used in **bone and joint replacements** must be **biocompatible, strong, wear-resistant, and capable of integrating with bone tissue**. They can be categorized into **metals, ceramics, polymers, and composites**.

1. Metallic Biomaterials (Strong & Load-Bearing)◆ **Titanium (Ti) and Titanium Alloys (Ti-6Al-4V)**

- High strength, corrosion-resistant, lightweight.
- **Osseointegration** (bonds well with bone).
- Used in: **Hip, knee, shoulder implants, and dental implants**.

◆ **Cobalt-Chromium (Co-Cr) Alloys**

- Harder and more wear-resistant than titanium.
- Used in: **Hip and knee replacements, artificial joints**.

◆ **Stainless Steel (316L Surgical Grade)**

- High strength but less biocompatible than Ti and Co-Cr.
- Used in: **Temporary implants, fracture fixation plates, screws, rods**.

2. Ceramic Biomaterials (Wear-Resistant & Biocompatible)◆ **Alumina (Al_2O_3) and Zirconia (ZrO_2)**

- **Highly wear-resistant & biocompatible**.
- Used in: **Hip and knee joint surfaces, dental implants**.

◆ **Calcium Phosphates (Hydroxyapatite, Tricalcium Phosphate)**

- **Bone-like material**, promotes bone growth.
- Used as coatings for **metal implants** or in bone grafts.

◆ **Bioglass (Silicate-Based Ceramic)**

- Encourages bone bonding and tissue integration.
- Used in: **Bone grafts, facial and spinal implants**.

3. Polymeric Biomaterials (Flexible & Shock-Absorbing)

✦ Ultra-High Molecular Weight Polyethylene (UHMWPE)

- Tough, wear-resistant, low-friction.
- Used in: **Joint replacement bearings (hip, knee, shoulder).**

✦ Polymethyl Methacrylate (PMMA) – Bone Cement

- Used to **fix metal or ceramic implants** to bone.
- Common in: **Hip and knee arthroplasty.**

✦ Polyetheretherketone (PEEK)

- High strength, bone-like flexibility.
- Used in: **Spinal implants, knee meniscus replacements.**

4. Composite Biomaterials (Mimic Bone Structure)

✦ Carbon Fiber Reinforced Polymers (CFRP)

- Stronger and lighter than metals.
- Used in: **Orthopedic plates, spinal implants.**

✦ Hydroxyapatite-Coated Titanium

- Enhances **bone integration.**
- Used in: **Hip and knee replacements, dental implants.**

5. Future & Experimental Biomaterials

✦ 3D-Printed Bioactive Scaffolds – Regenerative bone implants.

✦ Stem Cell-Infused Materials – Promote natural bone healing.

✦ Magnesium-Based Biodegradable Metals – Absorbable implants.