A. *POLYMERIC BIOMATERIALS (10)*

The development of polymeric biomaterials can be considered as an evolutionary process. Reports on the applications of natural polymers as biomaterials date back thousands of years [48]. Polymers are the most widely used materials in biomedical applications. Polymers are organic materials that form large chains made up of many repeating units. The uses for polymeric materials are more diverse than for metallic implants, but their interchangeability is not as great. In most of applications, polymers have little or no competition from other types of materials. Their unique properties are: Flexibility, Resistance to biochemical attack, Good biocompatibility, Lightweight, Available in a wide variety of compositions with adequate physical and mechanical properties, Can be easily manufactured into products with the desired shape. A few of the major classes of polymer are listed below:

Poly (methyl methacrylate), PMMA:

It is a hard brittle polymer that appears to be unsuitable for most clinical applications, but it does have several important characteristics. It can be prepared under ambient conditions so that it can be manipulated in the operating theater or dental clinic, explaining its use in dentures and bone cement. The relative success of many joint prostheses is dependent on the performance of the PMMA cement, which is prepared intraoperatively by mixing powdered polymer with monomeric methylmethacrylate, which forms dough that can be placed in the bone, where it then sets. **Silicone Rubbers:**

Both heat-vulcanizing and room temperature vulcanizing silicones are in use today and both exhibit advantages and disadvantages. Room temperature vulcanizing silicones are supplied as single- paste systems. Heat-vulcanizing silicone is supplied as a semi-solid material that requires milling, packing under pressure.

Ultra High Molecular Weight Polyethylene (UHMWPE):

Much research is progressing in examining the wear properties of UHMWPE. The coefficient of friction between polyethylene and cobalt-chromium alloy has been reported to be between 0.03 and 0.16, with excellent wear rates. UHMWPE is used as the bearing surface in total joint arthroplasty, it has 90% success rates at 15 years with metal on polyethylene. Submicron particles found in periprosthetic tissues when polyethylene wear present. (But no better material has been developed to date)

The mechanical properties of polymers depend on several factors, including the composition and structure of the macromolecular chains and their molecular weight. Table 7 lists some mechanical properties of selected polymeric biomaterials.

Examples of current applications include vascular grafts, heart valves, artificial hearts, breast implants, contact lenses, intraocular lenses, components of extracorporeal oxygenators, dialyzers and plasmapheresis units, coatings for pharmaceutical tablets and capsules, sutures, adhesives, and blood substitutes, kidney, liver, pancreas, bladder, bone cement, catheters, external and internal ear repairs, cardiac assist devices, implantable pumps, joint replacements, pacemaker, encapsulations, soft-tissue replacement, artificial blood vessels, artificial skin, Dentistry, Drug delivery and targeting into sites of inflammation or tumors, Bags for the transport of blood plasma.

TABLE 7 MECHANICAL PROPERTIES OF POLYMERS [49]

Polymer	Tensile Strength UTS (MPa)	Young's Modulus, E(GPa)	% Elongation
Poly(methyl methacrylate) (PMMA)	**30**	**2.2**	**1.4**
Nylon 6/6	**76**	**2.8**	**90**
Poly(ethylene terephthalate)	**53**	**2.14**	**300**
Poly(lactic acid)	**28-50**	**1.2-3**	**2-6**
Polypropylene	**28-36**	**1.1-1.55**	**400-900**
Polytetrafluoroethylene	**17-28**	**0.5**	**120-350**
Silicone rubber	**2.8**	**Up to 10**	**160**
Ultra-high-molecular- weight polyethylene (UHMWPE)	**>35**	**4-12**	**>300**