**Biopolymer Basics:**

Polymers are long chain molecules with a wide range of physical and chemical properties. One of the main advantages of the polymer materials is the ease of fabrication to produce various shapes (rod, film, fiber, sheet, etc.). The advances in polymer chemistry have made it possible to tailor the properties of polymers for specific application.

**1- Classification of Polymers:**

Polymers can be classified according to their sources, chain structures, thermal

behaviors, stabilities, etc. , as discussed below.

1.1 Source

By source, polymers can be divided into two groups. They are naturally occurring

polymers and synthetic polymers.

Table 1 listed some examples of naturally occurring polymers.

|  |  |  |
| --- | --- | --- |
|  | Polymer | Source |
| A. Proteins | Silk  Keratin  Fibrinogen  Elastin  Collagen | Animals  Animals  Animals  Animals  Animals |
| B.Polysaccharides | Cellulose  Starch  Chitin  Alginic  Agar | Plants  Plants  Animals  Brown Seaweeds  Red seaweeds |

Synthetic polymers are synthesized via polymerization reaction using monomers.

Some of the commonly used polymers are listed in Table 2.

Table 2 Commonly seen synthetic non-biodegradable polymers.

|  |  |  |
| --- | --- | --- |
| Type of Polymer | Name of Polymer | Polymerization Mechanism |
| Polyolefin  Polyacrylate  Polyamide  Polyurethane  Polyester  Polycarbonate  Poly( ether ether ketone)  Polysulfones | Polyethylene  Polypropylene  Poly( methyl methacrylate)  Nylon 66  Nylon 6  Poly( ether-urethane)  Polyester-urethane  Poly( ethylene terephthalate)  Poly( butylene terephthalate)  Bisphenol a polycarbonate  Poly( ether ether ketone)  Polysulfones | Radical,ionic chainreaction polymerization  Ionic chain-reaction polymerization  Radical polymerization  Step polymerization  Step polymerization  Step polymerization  Step polymerization  Step polymerization  Step polymerization  Step polymerization  Step polymerization  Step polymerization |

**2- Polymer Stability:**

Polymeric materials can be divided into two main classes — biostable and biodegradable polymers according to their stability when they are used in contact with biological systems.

Biodegradable polymer is a polymer in which the degradation is mediated at least partially by a biological system. The biodegradation of a polymer can be caused by hydrolytic, enzymatic or bacteriological degradation processes occurring within a polymer matrix. The degradation process will cause a deleterious change in the properties of a polymer due to a change in the chemical structure.

Most of the biodegradable polymers discovered so far contain hydrolysable linkages, such as ester and amide in their backbone structure. Among them, the flexible ester containing polymers, and in particular aliphatic polyesters, appear to be the most attractive biodegradable polymers because of their useful biodegradability and their versatility regarding physical, chemical and biological properties. Table 3 listed some examples of biostable and biodegradable polymers for biomedical applications.

Table 3 Some commonly seen synthetic biodegradable polymers.

|  |  |  |
| --- | --- | --- |
| Polymer | Physical Characteristics | Applications |
| Poly( glycolic acid) (PGA) | Thermoplastic crystalline polymer  Tg = 22.5°C, Tm = 40°C -45°C | Absorbable suture and meshes |
| 10/90 Poly ( L-lactide-co-gly- colide) | Thermoplastic crystalline polymer  Tg = 43 °C, Tm =205°C | Absorbable suture and meshes |
| Poly( p-dioxanone) (PDS) | Thermoplastic crystalline polymer  Tg = 10°C, Tm=110°C-115°C | Sutures |
| 85/15 Poly ( DL-lactide-co- glycoside) | Amorphous polymer  Tg = 50 °C -55°C | Sutures |
| Poly( e-caprolactone) (PCL) | Thermoplastic crystalline polymer  Tg= -60°C, Tm =59°C-64°C | Sutures |

**Naturally Occurring Polymer Biomaterials:**

Naturally occurring polymers are used as biomaterials largely because their structures are similar to the human tissue they intend to replace. They are also available cheaply and easily in large quantities. Usually, the naturally occurring biomaterials can be degraded by naturally occurring enzymes and therefore they are biodegradable, which offers an additional advantage over the use of synthetic non-biodegradable polymers. However, the use of naturally occurring polymers often has the problem to provoke immune reaction of the host tissue. Therefore, many of the naturally occurring polymers have to be chemically modified before they are used as biomaterials.

1- General Introduction to Proteins:

Proteins are monodisperse polymers of amino acids. They are essential components of plants and animals. There are twenty different α-amino acids, which can join together by peptide linkages to form polyamides or polypeptides. Polypeptides are often used by biologists to denote oligomers or relatively low molecular weight proteins. All α-amino acids found in proteins, except glycine (Gly), contain a chiral carbon atom and are L-amino acids.



 Because amino acids have both amino and carboxylic groups, they can be ionized. The net ionic charge of an amino acid varies with changes of solution pH. At certain pH an amino acid can be electrically neutral and this pH is called isoelectric point. For simple amino acids which contain only one acid and one amine groups, this isoelectric point occurs at a pH about 6 at which a dipole or zwitterion is formed, as shown below.

Because these amino acids can be ionized, they are water-soluble polar compounds, which migrate toward an electrode at pH values other than that of the isoelectric point in a process called electrophoresis.