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UNIT 1

Biomaterial threads shaping tomorrow

Learning objectives

After learning this unit, you will be able to:

- describe the key categories, characteristics, and recent advancements of biomaterials;
- explain the role of graphene-based electronic tattoos in health monitoring and evaluate their potential applications;
- define technical terms clearly and systematically in writing;
- deliver a speech on an innovative biomaterial with versatile applications.

Lead-in

1 **The use of biomaterials is evident across a variety of fields. Review the applications below and assign each to the most suitable field listed in the table.**

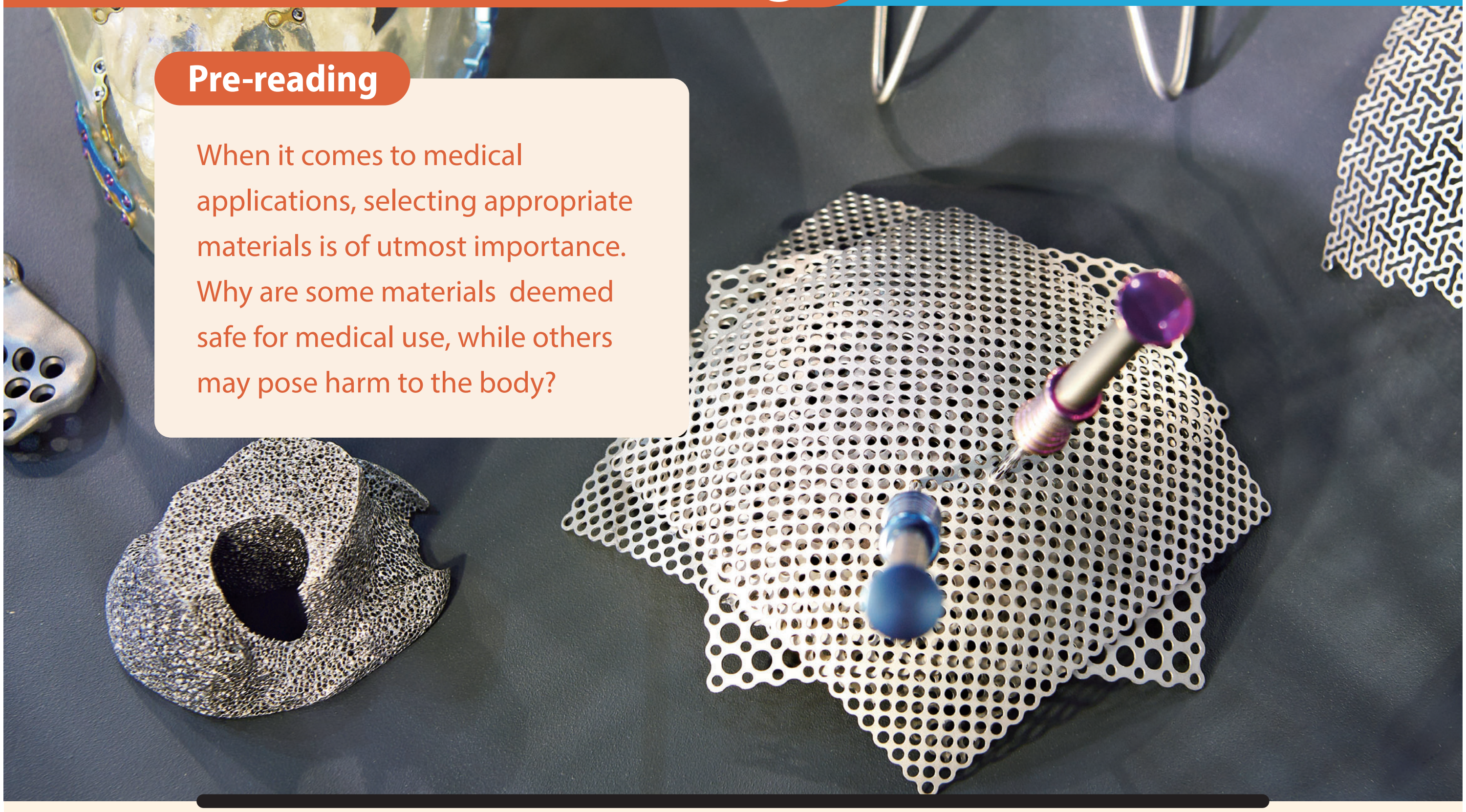
- A Anticancer wafer implant
- B Smart insulin pump
- C Bone fixation screw
- D Lab-grown skin substitute
- E Bioengineered bladder
- F Neural guide conduit
- G Knee replacement
- H Bone cement
- I Targeted nanocarrier
- J Artificial heart valve

Fields	Applications
Orthopedic implant	
Cardiovascular implant	
Tissue engineering	
Drug delivery	

2 **Select one application mentioned above and engage in a discussion with your partner. Consider the following questions:**

- What specific medical problem does the application address?
- How does the application improve patient outcomes compared to traditional methods?

Intensive reading



Pre-reading

When it comes to medical applications, selecting appropriate materials is of utmost importance. Why are some materials deemed safe for medical use, while others may pose harm to the body?

Biomaterials are revolutionizing health care

1 Biomaterials play a pivotal role in the dynamic field of **biomedicine**, where the marriage of natural, biological substances and advanced technology has revolutionized medical treatments and devices that can be offered to patients. These materials, whether biological or **synthetic**, are carefully selected for their ability to integrate **seamlessly** with body tissues to enhance bodily functions.

2 What exactly are biomaterials? Biomaterials are biological or synthetic substances which can be **implanted** into body tissues to improve bodily functions. Any material can technically be a biomaterial but must be compatible with the body tissues it interacts with. This biocompatibility is what **ultimately** makes a material a biomaterial. According to the Pennsylvania State University, a biomaterial is "derived from, or produced by, biological organisms like plants, animals, bacteria, **fungi**, and other life forms," or "used for a biological purpose such as a biomedical application like treating an injury or growing biological cells."

3 Bioinert materials are a widely-used type of biomaterial known for their minimal chemical and biological reactivity within the body, making them ideal for maintaining structural stability in permanent implants. It's crucial that the bonds formed by bioinert materials with your body tissues are healthy and sustainable because they need to last over long periods of time. Some common bioinert materials we see today are made of **stainless** steel, which is often used to make bone plates.

4 **Bioactive** materials fall into one essential group of biomaterials, characterized by their unique ability to actively interact with biological tissues or cells. When in contact with living organisms, these materials can stimulate specific biological responses, such as encouraging tissue growth, accelerating healing, and **facilitating** other beneficial interactions within the body. Their remarkable properties make them indispensable in a wide range of applications, including bone **grafts**, dental materials, and tissue engineering.

5 Biodegradable materials, which are specifically designed to naturally break down within the body over time, constitute another vital category within the field of biomaterials. Unlike bioinert materials, which are intended to remain structurally stable, biodegradable materials gradually **degrade** and are absorbed by the body, eliminating the need for surgical removal. These materials are particularly useful in applications such as **sutures** and temporary implants, where their ability to dissolve safely supports healing processes and minimizes long-term **complications**. Common biodegradable materials include polylactic acid (**PLA**) and polyglycolic acid (**PGA**), which are widely used for their biocompatibility and controlled degradation rates.

6 The biomaterial landscape is dynamic, with many different materials used for different medical purposes. As scientists continue to innovate in this field, more and more advanced biomaterials have become available, such as **hydrogels** and **piezoelectric** biomaterials.

7 Hydrogels, known as an advanced biomaterial, are materials made from "hydrophilic structures" that consist of cross-linked **polymers** and can hold large volumes of water. A good, everyday example of a hydrogel is **jelly**. Like jelly, hydrogels are mostly water, with thread-like **molecules** called polymers preventing water from leaking, maintaining the shape of the hydrogel.

8 Common examples of hydrogels in use include contact lenses and wound **dressings**. Beyond these applications, hydrogel biomaterials hold great potential in areas such as artificial skin and **cartilage** development, sexual organ reconstruction, and **vocal** cords replacement.

9 Scientists from the University of New South Wales (UNSW) recently developed a new