MODULE-05

Trends in Bio-Engineering.

1. Discuss Muscular and skeletal systems as scaffolds.

A scaffold is a supporting structure that provides a framework for cells/tissues to grow and develop. The term scaffold is often used in tissue engineering and regenerative medicine. where scientists use various materials to create structures that imitate the matrix of tissues and organs. Scaffolds can be made from a variety of materials such as synthetic polymers, natural polymers, and biocompatible materials.

The scaffold serves as a template for cells to grow and separate into functional tissues. For example in bone tissue engineering, a scaffold made from biocompatible materials can be seeded with bone cells and implanted into a patient's body where the cells grow and support to form new bone tissue.

In addition to tissue engineering Scaffolds are also important in developmental biology, where they provide a framework for cells to separate and form complex tissues and organs during embryonic development.

The muscular and skeletal systems work together to form the framework of the body providing support, movement, and protection for the body's organs and tissues. The skeletal system is composed of bones, cartilage, and ligaments. The bones provide a rigid framework for the body protecting organs and supporting the body weight. Cartilage acts as a cushion between bones reducing friction. Ligaments connect bones to other bones and provide stability.

The muscular system is composed of muscles and tendons. Muscles are responsible for movement by contracting and relaxing, and they work in pairs to produce opposing movements. Tendons connect muscles to bones, allowing the muscles to pull on the bones and produce movement.

Together, the skeletal and muscular systems provide a scaffold for the body supporting and protecting the body organs and tissues while allowing movement and flexibility.

2. Write a note on Bioprinting techniques.

Bioprinting is a technique used in bioengineering to produce complex 3-D Structures with layer-by-layer deposition of biomaterials using specialized printers. There are several bioprinting techniques.

Inkjet bioprinting: In this technique, small droplets of bioink is deposited onto a substrate. The bioink is composed of living cells and a supporting biomaterial such as hydrogels.

Extrusion Bioprinting: This technique involves the use of a syringe to extrude the bioink material in a controlled manner. The bioink can be deposited layer by layer to create the desired structure.

LASER-Assisted Bioprinting: in this technique LASER beam is used to deposit the bioink onto a substrate. The Laser is focused on the bioink material causing it to solidify and attach to the substrate.

Stereolithography Bioprinting: In this technique, UV Laser is used to solidify photosensitive bioink material layer by layer creating a 3D structure. complex structures with high resolution.

3. Discuss about various Bioprinting materials.

These are the materials that are used to print 3D – biological structures like tissues and organs. Following are the Bioprinting materials

Hydrogels: These are water-based materials that have high water content used to imitate the extracellular matrix of tissues Hydrogels are made of both natural and synthetic materials, the natural materials are collagen fibrin and the synthetic materials are Polyethylene glycol, polyvinyl alcohol.

Extracellular Matrix Bioinks: These are the materials that are made from decellularized tissues or organs. ECM Bioinks can be used to create scaffolds that closely mimic the native tissue

Cell-laden Bioinks: These are hydrogels or other materials that contain living cells, used to print tissues that are populated with cells such as skin, cartilage and bone.

Ceramic-based materials: These materials are used to print bone-like structures.

4. Explain Bioimaging and Artificial intelligence for disease diagnosis.

Bioimaging and Artificial intelligence are used together in disease diagnosis. Artificial intelligence algorithms are trained on large datasets of medical images and use machine learning patterns and make predictions. This approach can help doctors to diagnose diseases with greater accuracy.

Example: I n the field of radiology artificial intelligence algorithms have been developed to detect and diagnose variety of diseases including lung cancer, breast cancer and heart disease. These algorithms can quickly analyze large volumes of medical images, flagging areas of concern and highlighting potential abnormalities.

Another application of Bioengineering and Artificial intelligence is in the analysis of genetic data. By combining genetic data with medical images researchers can identify patterns and correlations that may help to predict disease risk or improve diagnosis.

5. Write a brief note on the electronic tongue.

Electronic tongue is also known as e-tongue. It is an analytical instrument that mimics the human tongue's sense of taste. It is used to analyze the taste and flavor of different food products. The components of e-tongue are mentioned herewith.

Sensor Array: The e-tongue sensor array is the heart of the instrument, consisting of several sensors that are sensitive to specific taste-related chemicals such as salt, and sourness. sweetness, bitterness, etc…

Sample Holder: it holds the food sample during testing. It is made of such a material that it does not interact with food samples.

Signal Processor: it is responsible for analyzing the electrical signals generated by the sensor array in response to the food sample. It converts these signals into to profile of the taste and flavor of the sample.

Data Analysis software: used to interpret the data generated by the signal processor and create a profile of the taste and flavor of the sample.

Calibration solutions: To ensure accurate and reliable results e-tongue requires regular calibration using standardized solutions with known taste and flavor characteristics.

6. Write a brief note on Bio concrete.

It is a type of concrete that incorporates microorganisms to improve its performance and sustainability. The microorganisms are typically added to the concrete mixture in the form of bacteria. Which can help to increase its strength, durability, and resistance to cracking.

The common type of bacteria used in bio concrete is Sporosarcina which produces calcite crystals when exposed to calcium ions. These crystals can help to fill any crack in concrete. Bio concretes are more environmentally friendly. Bacteria used in bio concrete produce calcites. Which reduces the amount of cement required in the concrete. Bio-concrete finds applications in the construction of buildings, bridges and other infrastructure projects.