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DEPARTMENT OF CIVIL ENGINEERING

19GET277- Biology for Engineers

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AP/CIVIL

Biological Neural Networks Bioremediation, Bioenergy Biofertilizers, Biocontrol Biosensors, Biopolymers Biomaterials, Biochip Bioinstrumentation

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BIOLOGICAL NEURAL NETWORKS

Biological neural networks are known to have such structures as hierarchical networks with feedbacks, neurons, denritic trees and synapses; and perform such functions as supervised and unsupervised Hebbian learning, storing knowledge in synapses, encoding information by dendritic trees, and detecting and recognizing spatial and temporal multiple/hierarchical causes.

A biological neural network is a group of neurons that are connected by synapses, and that work together to process information, learn, and remember:

Structure

- **Biological neural networks are made up of neurons, dendrites, synapses, and axons. Neurons can be connected to hundreds of thousands of other neurons.**

BIOLOGICAL NEURAL NETWORKS

Function

- **Biological neural networks perform functions like storing knowledge in synapses, encoding information in dendrites, and learning.**

Signals

- **Neurons send and receive electrochemical signals called action potentials. These signals can be excitatory, amplifying the signal, or inhibitory, suppressing the signal.**

Brain

- **The brain is made up of about 10 billion neurons, with each neuron connected to about 10,000 other neurons.**

Inspiration

- **The structure and function of biological neural networks have inspired the development of artificial neural networks, which are used in speech recognition, image analysis, and other applications.**

BIOREMEDIATION

Bioremediation is a branch of biotechnology that employs the use of living organisms in the removal of contaminants, pollutants, and toxins from soil, water, and other environments. These organisms can include microbes and bacteria.

Bioremediation can be used to clean up contaminated groundwater or environmental problems, such as oil spills.

Bioremediation relies on stimulating the growth of certain microbes that utilize contaminants including oil, solvents, and pesticides for sources of food and energy. These microbes convert contaminants into small amounts of water as well as harmless gases such as carbon dioxide.

BIOREMEDIATION

Bioremediation requires a combination of the right temperature, nutrients, and foods. The absence of these elements can prolong the cleanup of contaminants. Conditions that are unfavorable for bioremediation can be improved by adding “amendments” to the environment such as molasses, vegetable oil, or simple air. These amendments optimize conditions for microbes to flourish, accelerating the completion of the bioremediation process.

Bioremediation can be done "in situ," at the site of the contamination, or "ex situ," at a location away from the site. Ex situ bioremediation may be necessary if the climate is too cold to sustain microbe activity or if the soil is too dense for nutrients to distribute evenly. Ex situ bioremediation can require excavation and cleaning of the soil above ground and this can add significant costs to the process.

BIOFERTILIZERS

Biofertilizers are substances that contain microorganisms, which when added to the soil increase its fertility and promotes plant growth.

- **Biofertilizers are substance that contains microbes, which helps in promoting the growth of plants and trees by increasing the supply of essential nutrients to the plants.**
- **It comprises living organisms which include mycorrhizal fungi, blue-green algae, and bacteria.**
- **Mycorrhizal fungi preferentially withdraw minerals from organic matter for the plant whereas cyanobacteria are characterized by the property of nitrogen fixation.**
- **Nitrogen fixation is defined as a process of converting di-nitrogen molecules into ammonia. For instance, some bacteria convert nitrogen to ammonia. As a result, nitrogen becomes available for plants.**

BIOFERTILIZERS

Importance of Biofertilizers

Biofertilizers are important for the following reasons:

- Biofertilizers improve the soil texture and yield of plants.
- They do not allow pathogens to flourish.
- They are eco-friendly and cost-effective.
- Biofertilizers protect the environment from pollutants since they are natural fertilizers.
- They destroy many harmful substances present in the soil that can cause plant diseases.
- Biofertilizers are proved to be effective even under semi-arid conditions.

BIOCONTROL

Biological control is used by humans of beneficial insects such as predators and parasitoids, or pathogens such as fungi and viruses, to control unwanted insects, weeds, or diseases. Biological control dates back to 324 BC, when Chinese growers were recorded using ants to feed on citrus pests.

Biological control, or biocontrol, is a method of controlling pests and diseases using living organisms or the things they produce. It's a practical and environmentally sound way to reduce pest populations, and is often used in integrated pest management (IPM) programs.

Some approaches to biological control include:

- Importing natural enemies: Importing exotic natural enemies to control pests
- Conserving beneficial organisms: Conserving beneficial organisms that are already present or have been introduced
- Mass producing natural enemies: Mass producing natural enemies and releasing them periodically

BIOCONTROL

Drinking water treatment

- **Biofilters like granular active carbon (GAC) filters, rapid sand filters (RSFs), and slow sand filters (SSFs) are used to remove biodegradable organic carbon from drinking water.**

Some advantages of biofilters include: Low investment and operation costs, Simple construction, Effective removal of biologically degradable components, Low pressure drop, and Little waste water and material.

BIOSENSORS

A biosensor is a device that measures biological or chemical reactions by generating signals proportional to the concentration of an analyte in the reaction

A biosensor is a device that detects the presence or concentration of a biological analyte, such as a microorganism, biomolecule, or biological structure. It's made up of three parts:

- **Biological component: This component recognizes the analyte and produces a signal. It can be an enzyme, antibody, nucleic acid, plant proteins, or complex materials like tissue slices, organelles, or microorganisms.**

BIOSENSORS

- Signal transducer: This converts the biological response into a measurable electrical, optical, or thermal signal.
- Reader device: This device reads the signal.

Biosensors are used in a variety of fields, including healthcare, food safety, environmental monitoring, security, pharmaceutics, and forensics.

BIOPOLYMERS

Biopolymers are natural polymers produced by the cells of living organisms. Like other polymers, biopolymers consist of monomeric units that are covalently bonded in chains to form larger molecules

- A biopolymer is a natural polymer that is made up of repeating units, or monomers, that are covalently bonded together to form larger molecules.
- Biopolymers can be derived from a variety of sources, including plants, animals, and microbes, and are known for their biodegradable properties.

BIOPOLYMERS

- They are used in a wide range of applications, including food packaging, pharmaceuticals, and biomedical products. Here are some things to know about biopolymers:

Structure

- Biopolymers have a more complex structure and shape than synthetic polymers, which is important for their specific functions.

Sources

- Biopolymers can be derived from a variety of sources, including plants, animals, and microbes. For example, starch is a biopolymer that comes from plants like rice, corn, wheat, and potatoes.

Uses

- Biopolymers are used in a wide range of applications, including food packaging, pharmaceuticals, and biomedical products. For example, starch-based films are used in food packaging because they are non-toxic, renewable, and biodegradable.

Types

- Biopolymers can be repetitive (like polysaccharides and lipids) or nonrepetitive (like proteins and polynucleic acids).

BIOENERGY

Bioenergy is a form of renewable energy generated when we burn biomass fuel. Biomass fuels come from organic material such as harvest residues, purpose-grown crops and organic waste from our homes, businesses and farms.

Bioenergy is a renewable energy source that comes from organic materials like plants, animal waste, and harvest residues. It can be used to produce heat, electricity, transportation fuels, and other products.

Bioenergy has many benefits, including:

- **Environmental benefits: Bioenergy can help reduce air, water, and land pollution. It can also help reduce the use of fossil fuels.**
- **Social and economic benefits: Bioenergy can create jobs and business opportunities, and help reduce energy import bills. It can also help develop independent communities.**
- **Decarbonization: Bioenergy can help decarbonize industries.**

There are two main types of bioenergy use: traditional and modern. Traditional bioenergy uses include burning wood, animal waste, and charcoal. Modern bioenergy technologies include liquid biofuels, biogas, and wood pellet heating systems.

BIOMATERIALS

Biomaterials may be natural or synthetic and are used in medical applications to support, enhance, or replace damaged tissue or a biological function. The first historical use of biomaterials dates to antiquity, when ancient Egyptians used sutures made from animal sinew

Biomaterials are substances that interact with biological systems, and are used to treat, enhance, or replace damaged tissue or biological functions. They can be natural or synthetic, and can be made from a variety of materials, including metals, ceramics, plastic, glass, and living cells and tissue.

Some examples of biomaterials include pacemakers, skin grafts, vascular grafts, and hernia mesh. Other types of biomaterials include artificial joints, cochlear implants, contact lenses, and sutures.

Biomaterials processing is a crucial stage that involves mechanical and chemical treatment of the source material to be developed into a biocompatible and bioactive product for a specific clinical application.

BIOMATERIALS

	Biomaterials
Definition	Materials that interact with biological systems, and are used to treat, enhance, or replace damaged tissue or biological functions
Examples	Polymer scaffolding perfused with cells
Uses	Medical devices that augment or replace natural tissue for therapeutic effect
Types	Natural or synthetic
Materials	Metals, ceramics, plastic, glass, living cells and tissue
Applications	Biomedical applications like treating an injury or growing biological cells
Study	Biomaterials science or biomaterials engineering

BIOCHIP

A biochip is a miniaturized device that can perform thousands of biological reactions simultaneously, such as decoding genes, in a short amount of time. Biochips are made up of many tiny test sites, or microarrays, that are arranged on a solid surface.

Biochips are used in a variety of applications, including:

- Genetics: Biochips were instrumental in identifying the roughly 80,000 genes in human DNA.
- Toxicology: Biochips are used in toxicological research.
- Protein research: Biochips are used in protein research.
- Biochemical research: Biochips are used in biochemical research.

Some other things to know about biochips include:

- The term "biochip" was first used in 1982.
- Biochips are similar to computer chips, which can perform millions of mathematical operations in a second.
- Biochips can contain hundreds or thousands of biological material probes.
- Passive biochips have a very long life because they don't contain a battery or anything that wears out

BIOINSTRUMENTATION

Bioinstrumentation or biomedical instrumentation is engineering concerned with devices and mechanics used to measure, evaluate, and treat biological systems. It focuses on using multiple sensors to monitor the physiological characteristics of a human or an animal.

Biomedical instrumentation is the engineering of devices and systems that measure, evaluate, and treat biological systems. It's used to monitor physiological characteristics of humans and animals, and is essential for diagnosing diseases, monitoring vital signs, and delivering therapies.

The fundamental parts of biomedical instrumentation include:

- Measurand: The physical quantity that the system measures, which is usually generated by the human body as a bio-signal
- Sensor/Transducer: Converts one form of energy into another, usually electrical energy
- Signal Conditioner: Converts the transducer's output into an electrical value
- Display: A visual representation of the measured quantity, such as a chart recorder or cathode ray oscilloscope
- Data Storage and Data Transmission: Records data for future use, or transmits data to another location

Thankyou