Model Question Paper- I

Fourth Semester B.E Degree Examination

Biology for Engineers (21BE45)

TIME: 03 Hours **Max.Marks:100**

Note:

1. *Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE***
2. M: Marks, L: Bloom's level, C: Course outcomes.

		Module -1	M	L	C
Q.1	a	Discuss the potential of cellulose-based water filters in addressing water pollution issues. What are the advantages and limitations of it.	10	L2	CO1
	b	Describe the following i) RNA vaccines for Covid19 ii) DNA Fingerprinting	10	L2	CO1
		OR			
Q.2	a	Discuss the advantages and challenges of plant-based proteins as sustainable alternatives to animal-based proteins.	10	L2	CO1
	b	Explain the following i) Lipids as cleaning agent ii) Role of glucose-oxidase in biosensors	10	L2	CO1
		Module - 2			
Q.3	a	Compare and contrast the central nervous system (CNS) and the peripheral nervous system (PNS) in terms of their structure and functions.	10	L2	CO2
	b	Discuss types of brain activity that can be detected with EEG	10	L2	CO2
		OR			
Q.4	a	Explain the Architecture of Rod and Cone Cells with neat diagram	10	L2	CO2
	b	Discuss the following i) reasons for blockages of blood vessels ii) Defibrillators	10	L2	CO2
		Module – 3			
Q.5	a	Explain Abnormal Lung Physiology - COPD	10	L2	CO2
	b	With neat sketch, Explain Heart-lung machine	10	L2	CO2
		OR			
Q.6	a	Explain mechanism of filtration in human kidney	10	L2	CO2
	b	Write a note on bioengineering solutions for muscular dystrophy and osteoporosis	10	L2	CO2
		Module – 4			
Q.7	a	Explain the following i) Ultrasonography ii) Bionic leaf	10	L2	CO3
	b	Discuss the potential applications of i)shark skin-inspired swim suits ii) Lotus leaf effect - self-cleaning surfaces iii) Plant burrs - Velcro	10	L2	CO3
		OR			
Q.8	a	Explain the following i) sonars ii) photovoltaic cells	10	L2	CO3

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	b	Write a short note on following i) Hemoglobin-based oxygen carriers (HBOCs) ii) Perflourocarbons (PFCs)	10	L1	CO3
Module – 5					
Q.9	a	Write a short note on Bioprinting techniques and materials	10	L1	CO4
	b	Explain Bioimaging and Artificial Intelligence technique in disease diagnosis	10	L2	CO4
OR					
Q.10	a	Describe the concept of self-healing bio-concrete and explain the role of bacillus spores, calcium lactate nutrients, and biomineralization processes in this technology	10	L2	CO4
	b	Explain the process of biomining via microbial surface adsorption and how it can be used for removing heavy metals like Lead, Cadmium, Mercury, and Arsenic.	10	L2	CO4

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1 a) Discuss the potential of cellulose-based water filters in addressing water pollution issues. What are the advantages & limitations of it.

Sol. Cellulose-based water filters hold great potential in addressing water pollution issues due to their unique properties & advantages. Cellulose, a natural biopolymer found in the cell walls of plants, can be derived from various renewable sources such as wood pulp, cotton, & plant materials.

i) Cellulose fibers possess excellent filtration capabilities. They can effectively remove suspended solids, sediments, particulate matter & even microorganisms from water.

ii) Cellulose has inherent adsorption properties enabling it to adsorb certain dissolved contaminants, such as heavy metals organic compounds, & pesticides.

iii) Cellulose is a biodegradable material making cellulose-based filters environmentally friendly. Once discarded, these filters can decompose naturally, minimizing their contribution to waste & pollution.

iv) Cellulose based filters can be produced at a relatively low cost due to the abundance & easy availability of cellulose. This cost-effective makes it a viable

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Advantages

1) Environmentally friendly.
2) Cost-effective
3) High porosity.
4) Versatile
5) Large surface area.

Limitations

1) Low resistance to high temperature.
2) Low filtration efficiency for certain contaminants.
3) Limited life span.
4) May affect water taste.

1b) Describe the following i) RNA vaccine for Covid 19 ii) DNA fingerprinting.

Sol i) RNA vaccine for covid 19.

RNA vaccine for covid 19 are a type of vaccine that use genetic material from the SARS-Cov-2 virus in the form of RNA, to stimulate an immune response against the virus. The vaccine works by introducing the virus' RNA into the body, where it is taken by cells & used to produce viral proteins. These proteins are then displayed on the surface of the cells, which triggers an immune response & the production of antibodies against the virus.

Importance of RNA vaccine for covid 19.

* High efficacy :- RNA vaccines have been shown to be highly effective at preventing covid-19 infections.

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* Easy to modify :- RNA vaccines can be easily modified to target new strains or variants of the virus.

ii) DNA Finger printing

DNA fingerprinting, also known as DNA profiling or genetic fingerprinting is a technique used in forensic science to identify an individual based on their unique DNA profile. The process involves analyzing specific regions of an individual's DNA, called markers which can vary from person to person.

DNA Finger printing steps, it contains Sample collection, DNA amplification, DNA analysis & DNA comparison.

DNA fingerprinting has numerous applications including forensic investigations, paternity testing, & identifying human remains. In forensic cases, DNA samples obtained from a crime scene can be compared to a suspect's DNA fingerprint to determine if they match. In paternity testing, the DNA fingerprints of a child & alleged parents are compared to establish biological relationships.

Q.2. a) Discuss the advantages & challenges of plant-based proteins as sustainable alternative to animal-based proteins.

Sol

Advantages

i) Environment sustainability: Plant-proteins have a significantly lower environmental impact compared to animal-based proteins. The production of plant based proteins requires fewer natural resources such as water, land & energy.

ii) Reduced deforestation:- Animal agriculture, particularly for livestock, is a major driver of deforestation, as forests are cleared to make way for grazing lands or to grow animal feed crops.

iii) Water conservation:- Animal agriculture is a water-intensive process, requiring large amounts of water for livestock drinking, feed production & processing.

iv) Health benefits:- Plant-based proteins are generally lower in saturated fat & cholesterol making them healthier choices for cardiovascular health. They are also rich in dietary fiber, vitamins, minerals & phytonutrients that can promote overall well-being.

(4)

Challenges:-

1. Nutrients balance:- Plant-based proteins may lack certain essential nutrients like vitamins B_{12}, iron, zinc & omega-3 fatty acids. However, with careful planning & a diverse diet, these nutrients can be obtained from plant-based sources or through fortified foods & supplements.

2) Taste & texture:- Some people find it challenging to transition to plant-based proteins due to difference in taste & texture compared to animal-based proteins.

3) Availability & accessibility:- While the availability of plant-based proteins options has improved over the years, it can still be limited in certain regions or communities, making it less accessible to everyone.

4) Cultural & social factors:- Dietary preferences & cultural traditions can influence the acceptance & adoption of plant-based proteins. Some cultures have strong culinary traditions centered around animal-based proteins, which may pose challenge in transitioning to plant-based diets.

Q.2 b. Explain the following.
i) Lipids as cleaning agent.
ii) Role of glucose-oxidase in biosensors.

Sol Lipids as cleaning agent

* Personal care products:- Lipids, such as fatty acids & glycerides, are commonly used as emulsifiers & surfactants in personal care products, such as shampoos, soaps & lotions.

* Industrial cleaning:- Lipids can be used as cleaning agents in various industrial applications, such as metal cleaning, degreasing & stain removal.

* Laundry detergents:- Lipids, such as fatty acids & glycerides, are used as ingredients in laundry detergents to improve their cleaning & stain performance.

* Cleaning agents for hard surfaces:- Lipids can be used as cleaning agents for hard surfaces such as floors, countertops, & walls, to remove dirt & grime.

Lipids have several properties that make them suitable as cleaning agents, including their ability to emulsify & dissolve grease & oils.

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ii) Role of glucose-oxidase in biosensors.

* Glucose oxidase (GOx) is a enzyme commonly used in biosensors for the detection of glucose levels in biological fluids, such as blood & urine. The enzyme catalyze the oxidation of glucose to glucono-lactone & hydrogen peroxide (H_2O_2), which can be easily detected & quantified by a transducer.

* In glucose biosensors, Gox is typically immobilized on a substrate, such as a polymeric film, to ensure stability & specificity. The transducer in the biosensor can be an electrode, a fluorescence-based system, or other type of sensor, depending on the desired level of sensitivity & specificity.

Advantages of biosensors

* Sensitivity, Specificity, Rapid response time, Portability & cost effectiveness.

Limitations of biosensors

* Stability, interference, Calibration. Limited shelf-life & Complexity.

Quiz

Q3. a. Compare & contrast the central nervous system (CNS) & the peripheral nervous system (PNS) in terms of their structure & functions.

Sol

Structure

1. Central nervous system (CNS).

* The CNS consists of the brains & spinal cord.
* The brains is the control centre of the body, responsible for complex cognitive functions & processing sensory information
* The spinal cord extends from the base of the brain & is responsible for relaying information b/w the brain & the rest of the body.

2. Peripheral Nervous system (PNS).

* The PNS consists of all the nervous tissue outside the CNS.
* It includes the nerves, ganglia & sensory receptors throughout the body.
* The PNS can be further divided into the somatic nervous system (SNS) & the autonomic nervous system (ANS).

Functions :

1. Central nervous System (CNS)

* The CNS integrates & processes information received from the sensory organs.
* It is responsible for coordinating motor functions & initiating appropriate responses.
* The CNS control higher cognitive functions such as memory, learning, reasoning & emotions.

2. Peripheral nervous System (PNS) :-

* The PNS serves as a communication network by the CNS & the rest of the body.
* The somatic nervous system controls voluntary movements & transmits sensory information from the body to the CNS.
* The automatic nervous system regulates involuntary functions such as heartbeat, digestion, respiration, & glandular activity.
* The ANS can be further divided into the sympathetic & parasympathetic divisions which have opposing effects on various bodily functions.

Q3.b. Discuss type of brain activity that can be detected with EEG.

Sol EEG signals have unique features that correspond to different types of brain activity. The type of brain activity that can be detected with EEG are:-

* Delta waves (0.5-4 Hz):- Delta waves are low frequency waves associated with deep sleep infancy, & brain disorders such as brain damage or dementia.
* Theta waves (4-8 Hz):- Theta waves are also associated with sleep & relaxation, as well as meditation & hypnosis.
* Alpha waves (8-12 Hz):- Alpha wave are present when the brain is relaxed & not focused on any particular task.
* Beta waves (12-30 Hz):- Beta waves are present when the brain is focused on a task, such as problem-solving or decision making.
* Gamma waves (30-100 Hz):- Gamma waves are associated with high-level cognitive processing, such as attention, perception, & memory.

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Q.4 a) Explain the architecture of rod & cone cell of eye with neat diagram.

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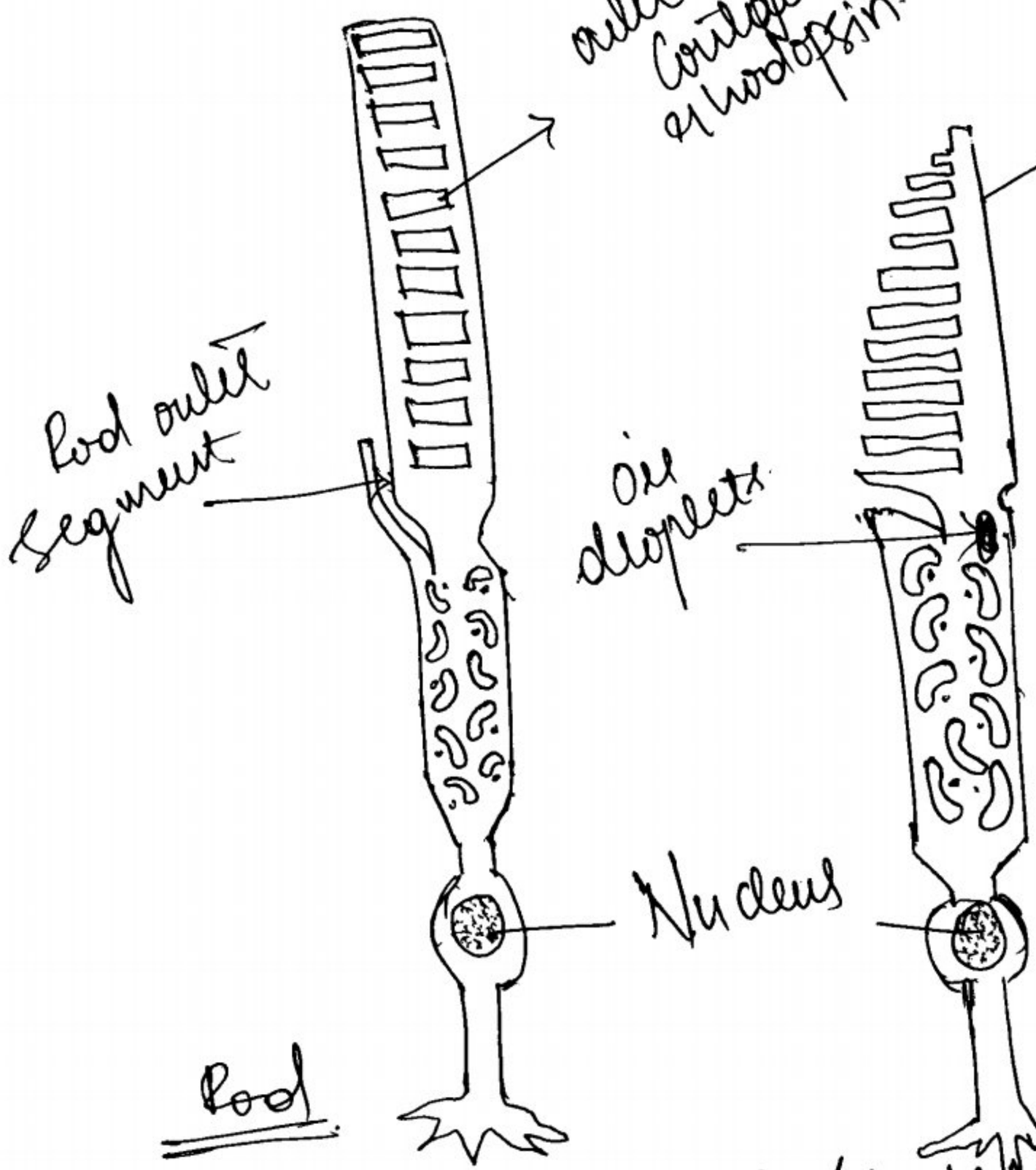

Rods & Cone cells have a similar basic structure but there are some differences that are crucial for their different functions.

Both types of cells have photoreceptor outer segments that contains the photo pigment that absorbs light & triggers a change in membrane potential. The inner segment contains the cell's organelles, including the nucleus & mitochondria.

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The major difference b/w rod & cone cells is their shape. Rod cells are elongated & cylindrical while cone cells are shorter & more conical in shape. This difference in shape affects the distribution of photopigments & the number of synaptic contacts with bipolar & ganglion cells, which - ultimately the signals to the brain. Rod cells have a single long outer segment, while cone have several shorter segments.

Q4. b) Discuss the following.

i) Reasons the blockages of blood

ii) Defibrillators. vessels.

i) Blockages in blood vessels are known as arterial blockages or atherosclerosis, can occur for several reasons.

* High cholesterol levels:- Excessive amounts of low-density lipoprotein (LDL) cholesterol in the blood can lead to the formation of plaque in the blood vessels, which can narrow or block them.

* High blood pressure:- over time, high blood pressure can cause damage to the blood vessels, leading to the formation

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of plaque & blockages.

* Smoking:- Smoking can damage the inner walls of blood vessels & promote the build up of plaque, leading to blockages.

* Ages:- As people age, the blood vessels can become stiff & less flexible, increasing the risk of blockages.

ii) Defibrillators

A defibrillator is a medical device that delivers an electric shock to the heart to restore its normal rhythm in case of cardiac arrests or other life-threatening heart rhythm disorders.

Defibrillators can be external (placed on the chest) or internal (implanted within the body).

Automated External defibrillators

External defibrillators, also known as automated external defibrillators (AEDs), are designed for use by lay people & are commonly found in public places such as airports, shopping centres, & schools. They are relatively simple in design & typically have voice prompts & visual cues to guide the users through the process of

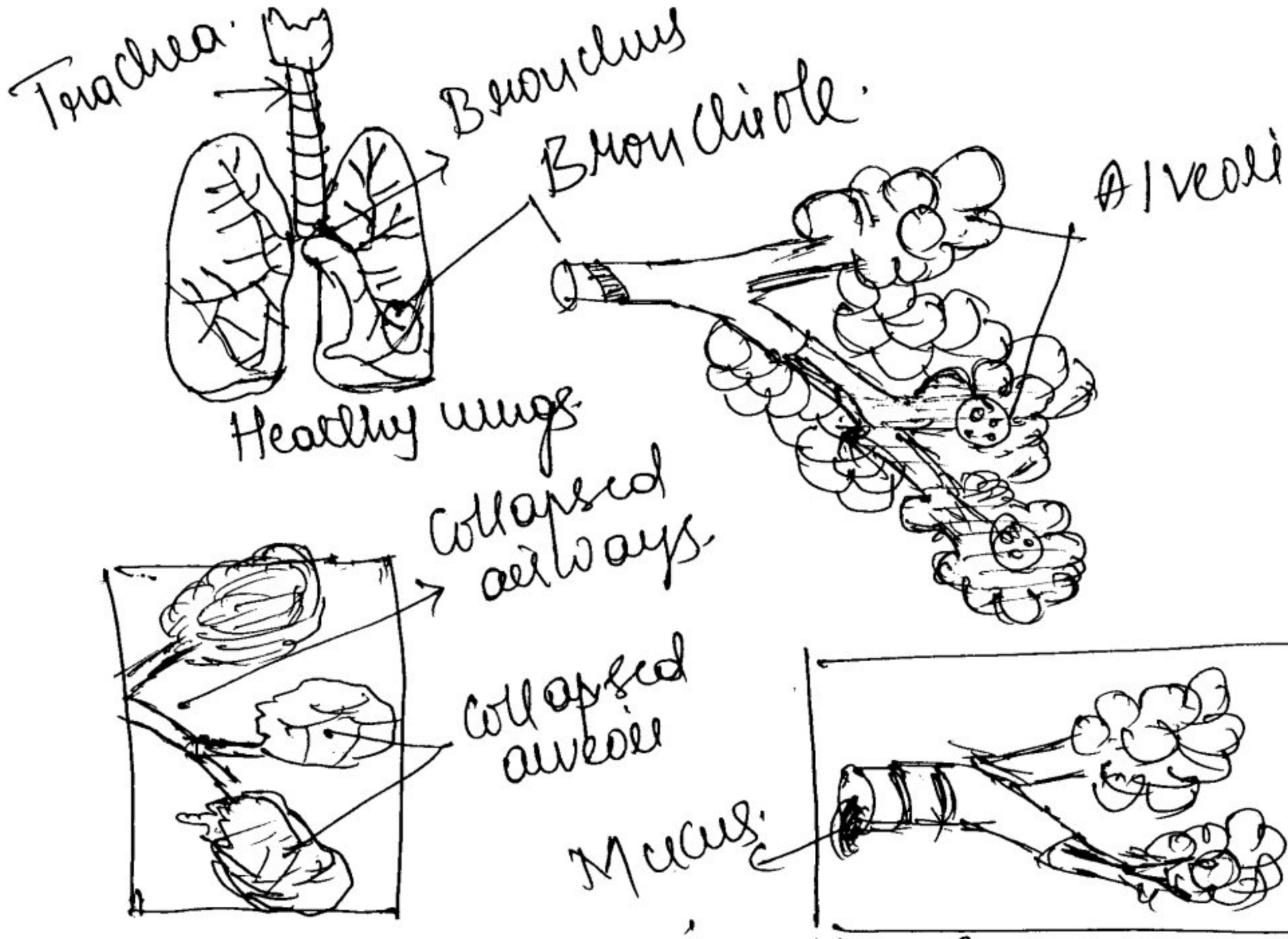
delivering the electric shock.

Implantable Cardioverter defibrillators

Internal cardioverter defibrillators, also known as implantable cardioverter defibrillators (ICD's), are surgically implanted within the body & used to those people with a high risk of sudden cardiac arrest. They are typically more complex in design, including features such as continuous monitoring of the heart rhythms, & automatic delivery of shocks when necessary.

Q.5 a) Explain Abnormal Lung physiology - COPD.

Sol



Representing the cause of COPD.

COPD is a chronic lung condition characterized by abnormal lung physiology. It is usually caused by long-term exposure to irritants that damage the lungs most commonly cigarette smoke.

Abnormal lung physiology in COPD primarily involves two major components: chronic bronchitis & emphysema.

1. Chronic bronchitis:- Chronic bronchitis is the inflammation & irritation of the bronchial tubes in the lungs in response to prolonged exposure to irritants, the lining of the bronchial tubes becomes swollen & produces excessive mucus. The increased mucus production & inflammation narrow the airways, making it difficult for air to flow in and out of the lungs. This leads to symptoms such as persistent cough, excessive sputum production & shortness of breath.

2. Emphysema:- Emphysema is a condition where the air sacs in the lungs are gradually destroyed. These air sacs are responsible for the exchange of oxygen & carbon-di-oxide b/w the lungs & the bloodstream. In emphysema, the walls of the air sacs lose their elasticity, become weakened & eventually rupture.

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As the result, the lungs lose their ability to effectively transfer oxygen to the blood stream & remove Carbon-di-oxide.

Q.5.b With neat sketch. Explain heart-lung machine.

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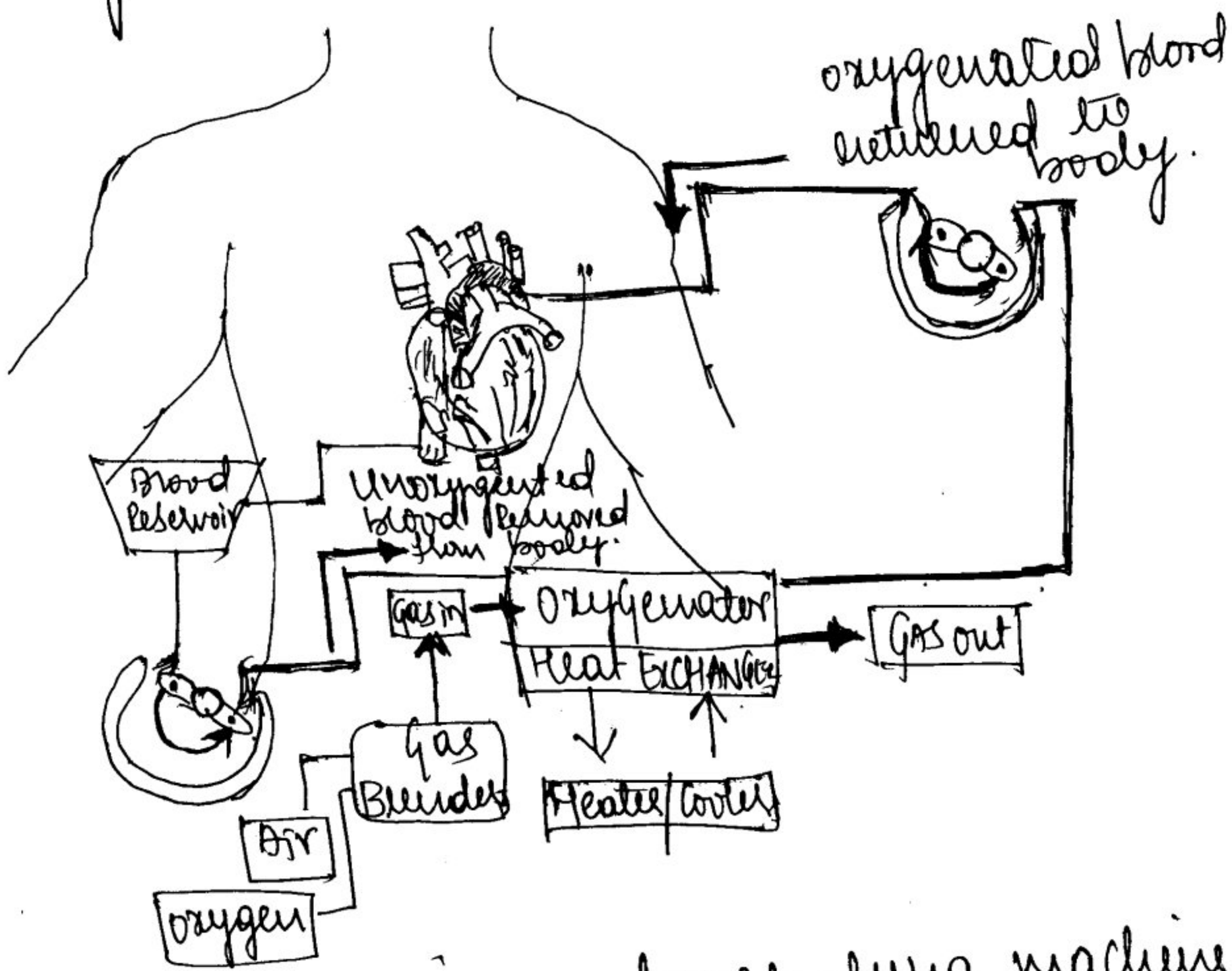

Representing a heart-lung machine

A heart-lung machine, also known as a cardiopulmonary bypass machine, is a device used in cardiovascular surgery to temporarily take over the functions of the heart & lungs. The heart lungs m/c is used during open heart surgery, such as coronary artery bypass graft (CABG) surgery & valve replacement surgery, to support the patient's

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circulatory & respiratory functions while the heart is stopped.

The heart-lung m/c works by circulating blood outside of the body through a series of tubes & pumps. Blood is taken from the body, oxygenated, & then returned to the body. This allows the heart to be stopped during the surgery without causing any harm to the patient.

The use of a heart-lung m/c during surgery carries some risks, including the potential for blood clots, bleeding & infections.

Additionally there may be some long-term effects on the body, such as cognitive decline, that are not yet fully understood. However, the use of a heart lung machine has revolutionized the field of cardiovascular surgery, allowing for more complex procedures to be performed & ignoring improving patient outcomes.

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Q6. a) Explain mechanism of filtration in human kidney.

Sol The following is a summary of the steps involved in the filtration process:

* Blood enters the kidney through the renal arteries & flows into tiny filtering units called glomeruli.
* At the glomerulus, the pressure in the blood vessels causes a portion of the plasma & dissolved substances to filter out & enter a structure called bowman's capsule.
* In bowman's capsule, the filtrate is then transferred into the renal tubules, which are the main filtering units of the kidneys.
* In the renal tubules the filtrate passes through a series of specialized cells, such as proximal tubular cells & distal tubular cells, which reabsorb important substances such as glucose, amino acids, & electrolytes back into the bloodstream.
* At the same time, the renal tubules secrete waste product, such as urea & creatinine back into the filtrate.

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* Finally, the filtered fluid now known as urine, is transported through the renal pelvis & ureters to the bladder, where it is eventually eliminated from the body.

Q.6 b) Write a note on bio engineering solutions for muscular dystrophy & osteoporosis.

Sol

Bio engineering solutions for muscular dystrophy.

* Gene therapy :- This involves delivering a functional copy of the missing or mutated gene to the affected muscle cells. The goal is to restore the production of the missing protein & improve muscle function.

* Stem cell therapy :- This involves using stem cells to replace the damaged muscle cells & promote repair & regeneration of the muscle tissue. Stem cells can be taken from the patients own body or from donor.

* Tissue engineering :- This involves using a combination of materials, such as scaffolds, & growth factors to promote the growth & repair of muscle tissue.

Bioengineering Solutions for Osteoporosis.

* **Tissue engineering**:- This involves using scaffolds & growth factors to stimulate the growth of new bone tissue & promote the repair of damaged bones.

* **Stem cell therapy**:- This involves using stem cells to replace the damaged bone cells & promote the repair & regeneration of bone tissue.

* **Biomaterials**:- This involves using synthetic or natural materials to replace or augment damaged bone tissue.

* **Gene therapy**:- This involves delivering a functional copy of a gene involved in bone growth & repair to the affected bone cells. The goal is to restore the production of the missing protein & improve bone health.

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Q7. a) Explain the following i) ultrasonography
ii) Pidric leaf.

Sol) i) Ultrasonography :-
Ultrasonography, also known as ultrasound imaging or diagnostic sonography, is a medical imaging technique that uses high-frequency sound waves to produce images of the inside of the body.

During an ultrasound examination, a device called a transducer is used to emit high-frequency sound waves into the body. These sound waves travel through the body tissues & bounce back when they encounter different types of tissues or organs. The transducer then receives the reflected waves & converts them into electrical signals. These signals are processed by a computer to create real-time images on a monitor.

ii) Ultrasound imaging is commonly used in obstetrics, abdominal imaging, cardiac imaging, musculoskeletal, vascular imaging etc.

(21)

ii) Bionic Leaf:-

The concept of a bionic leaf refers to an artificial system that mimics the process of photosynthesis the natural process by which plants convert sunlight, water & carbon di-oxide into energy rich sugar. The aim of developing a bionic leaf is to create a more efficient & sustainable method for generating renewable energy & producing fuels.

The potential applications of bionic leaf technology are wide-ranging. It offers a renewable & carbon-neutral approach to energy production, reducing reliance on fossil fuels & mitigating climate change. It is also be used in remote and developing countries with limited access to electricity, providing a decentralized & sustainable energy source. Furthermore the bionic leaf technology holds promise for developing novel approaches to carbon capture & utilization, helping to address the issues of excess carbon-dioxide in the atmosphere.

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Q.7 b) Discuss the potential applications of
i) Shark skin - inspired swim suits
ii) Lotus leaf effect - self cleaning
iii) Plant burrs - velcro.

Sol i) Shark skin - inspired swim suits :- The unique texture of shark skin has inspired the development of swim suit that mimic its properties. This concept has been utilized in the design of swim suits to improve hydrodynamics & enhance swimming performance.

The potential applications of shark skin inspired swim suits extend beyond competitive swimming. Thus swim suits can be used by recreational swimmers who want to improve their speed & efficiency in the water. It can also be used professional swimmers, such as lifeguards & rescue divers, who require enhanced mobility & endurance.

ii) Lotus leaf effect - Self cleaning :-
The potential applications of the lotus leaf effect are vast. Self-cleaning coatings can be applied to the building exteriors, windows & solar panels to maintain their cleanliness & efficiency.

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By repelling dirt & contaminants, these surfaces requires less frequent cleaning. Saving time, water & maintenance costs.

(iii) Plant buns - velcro:-

The application of velcro are wide-ranging it is commonly used in clothing, shoes & accessories to create adjustable closures & fastening. velcro straps are used in sports equipments, medical devices, & orthopedic supports to provide secure yet adjustable fastenings. It is also utilized in various industries for temporary installations, cable management, & organizational purpose.

Q.8 a) Explain the following i) sonars ii) photovoltaic cells.

(8) i) Sonars.

Sonar (Sound navigation & ranging) - is a technique that uses sound propagations (usually underwater, as in submarine navigations) to navigate, measure distances (ranging) communicate with or detect objects on or under the surface of the water.

such as other vessels.

Sonars can refer to one of two types of technology

* Passive sonar means listening for the sound made by vessels.
* Active sonar means emitting pulses of sound & listening for echoes.

* Sonar may be used as a means of acoustic location & measurement of the echo characteristics of "targets" in water.

* Acoustic location in the air was used before the introduction of radar.

* Sonar may also be used for navigation & SODAR is used for atmospheric investigations.

ii) Photovoltaic Cells

Photovoltaic cells, also known as solar cells, are electronic devices that convert sunlight directly into electricity through the photovoltaic effect.

They are the building blocks of solar panels & are widely used in solar power systems to generate clean, renewable energy.

The photovoltaic effect is a process in which certain materials, known as semiconductors, can absorb photons & convert their energy into an electrical current.
The commonly used semiconductor material in PV cells is silicon, but other materials can be used like copper etc.
Photovoltaic cell have a wide range of applications across various sectors like Residential solar power, Commercial & industrial solar power, off grid power system, solar farms, Portable solar devices, Transportation, Space applications.

Q9. a) Write a short note on Bioprinting techniques & materials.

Sol. There are several bioprinting techniques that have been developed, each with its own advantages & limitations.

* Extrusion-based bioprinting :- This technique involves depositing bioinks, which consist of living cells & a hydrogel-based support material, layer-by-layer through a fine nozzle. The bioink is extruded under pressure to create the desired structure.

2. Inkjet-based bioprinting:- Similar to traditional inkjet printing, this technique uses thermal or piezoelectric actuators to propel small droplets of bioink onto a substrate.

3. Laser-assisted bioprinting:- In this technique a laser is used to create a focused energy source that propels a bioink containing cells or microdroplets onto a receiving substrate.

4. Stereolithography:- Stereolithography employs a laser or other light source to selectively cure a liquid photopolymer into solid layers.

The choice of material in bioprinting is crucial to provide structural support, mimic the natural extracellular matrix & promote cell growth & differentiation.

1. Hydrogels:- Hydrogels such as alginate, collagen, gelatin & fibrin provide a 3D environment that mimic the extracellular matrix.

2. Synthetic polymers:- Biodegradable polymers like polylactic acid (PLA), polyglycolic acid (PGA) & polycaprolactone (PCL) are widely used in bioprinting.

Q 9. b) Explain bioimaging & Artificial intelligence technique in disease diagnosis.

Sol

Bioimaging (in Nanomedical).

* Bioimaging is a non invasive process of visualizing biological activity in a specific period. There are several technique in the bioimaging like - Magnetic resonance imaging, Fluorescence imaging, nuclear imaging & computed-tomography.

Magnetic resonance imaging:

Magnetic resonance imaging (MRI) is a non-invasive imaging technique that provides detailed physiological & anatomical information within living tissues. It is based on the same principle as chemical nuclear magnetic resonance (NMR), detecting the spinning & rotation of particular atomic nuclei inside the organism.

Generally, the MRI signals is derived from endogenous mobile water protons, which are measured in the subject's body. When the strong static magnetic field is applied to a subject, the magnetic moment associated with protons tends to align with the direction of the magnetic field & nuclei of the proton are brought

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out of this equilibrium by pulsed radio-frequency (RF) radiation. After the RF radiation is removed, the nuclei are returned to equilibrium & induce a transient voltage fluctuating the NMR signal in the receiver antenna.

Artificial intelligence can assist pharmacy in a variety of patient care & intelligent health systems.

In artificial intelligence, system planning is the fundamental abstract design of the system.

It includes the framework's views, the course of action of the framework, & how the framework carries out under heated-clear condition.

A solid grip of the framework design can help the client realize the limits & boundaries of the said framework in pre-preparing, real-world information requires upkeep & pre-paring before being taken care of by the calculation.

According, information pre-preparing takes this crude information cycles to eliminates errors & shapes it an extra examination.

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information experiences a progression of steps during pre-handling. Information is purged by various strategies in information cleaning. These strategies involves gathering information, such as filling the left clear information spaces that are left or decreasing information, such as the disposal of commas or other obscure characters.

Q.10 a) Describe the concept of self-healing bio-concrete & explain the role of bacillus spores, calcium lactate nutrients & biomineralization process in this technology.

Self-healing bio concrete is a type of concrete that has the ability to repair cracks & damage on its own. It incorporates biological agents, such as bacteria or fungi, along with nutrients & minerals. These cultures to facilitate the healing process.

Steps involved in the self-healing bio concrete based on bacillus spores, calcium-lactate nutrients & biomineralization process typically works.

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Step 1:- Bacillus Spores:- Bacillus bacteria are often used in self-healing bio concrete. This bacteria can form spores, which are dormant & highly resistant to environmental conditions.

Step 2:- Nutrients:- Calcium lactate is a common nutrient source for the bacteria. It act as a food supply for the bacteria & provides the necessary calcium ions for the mineralization process.

Step 3:- Encapsulation:- The bacillus spores & calcium lactate nutrients are encapsulated in the biodegradable capsules or microfibers. This encapsulation protects the bacteria & nutrients from the harsh concrete environment until they are activated.

Step 4:- Activation:- When a cracks forms in the bio concrete, it allows water to penetrate & reach the encapsulated bacteria & nutrients. The water triggers the activation of the bacteria forming their spore form into an active state.

Step 5:- Metabolic activity:- Once activated, the bacteria start to metabolize the calcium lactate nutrients.

As the result, they produce calcium carbonate or calcite, a mineral that can fill the cracks & gaps in the concrete.

Step 6:- Biomineralization:- The bacteria facilitate the biomineralization process, where the calcium carbonate precipitates & forms solid mineral deposits within the cracks. This mineralization helps to bind the concrete back together & restore its structural integrity.

Q 10. b) Explain the process of biomining via microbial surface adsorption & how it can be used for removing heavy metal like lead, cadmium, mercury & Arsenic.

Sol) Biomining via microbial surface adsorption is a process that involves the use of microorganisms to remove heavy metals from various sources, such as contaminated water or soil.

Step 1:- Microorganism Selection:- Specific strain of bacteria or fungi are selected based on their metal adsorption capabilities. Different microorganisms have varying affinities for different metals, so the choice of microorganisms

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depends on the targets metal to be removed.

Isolation & Cultivation :- The chosen microorganisms are isolated from natural environments or obtained from culture collections. They are then cultured & grown under optimal conditions, allowing them to multiply & reach high biomass concentrations.

Metal Contact :- The microorganisms are brought into contact with the contaminated metals, such as wastewater or soil. The heavy metal ions present in the solution or soil interact with the microbial cell surfaces or enter the cells.

Adsorption mechanism :- The heavy metals bind to the surface of cell membranes of the microorganisms through various mechanisms, including ion exchange, electrostatic interactions & complexations.

Metal removal :- once the microorganisms have adsorbed the heavy metals, they can be physically separated from the solution or soil through different techniques such filtration, centrifugation, or sedimentation.

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This step allows for the recovery of the metal loaded microorganisms.

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