

1. a. A biomolecule is an organic molecule that is produced by living organisms & plays a crucial role in various biological processes.

Biomolecules are classified into four major categories based on their chemical composition & function:  
Carbohydrates, lipids, proteins, & nucleic acids.

1. Carbohydrates:- Carbohydrates are composed of carbon, hydrogen & oxygen atoms. They are the primary source of energy for living organisms & can be further classified into monosaccharides, disaccharides & polysaccharides.

2. Lipids:- Lipids are a diverse group of biomolecules that are insoluble in water but soluble in non-polar solvents. They are primarily composed of carbon, hydrogen & oxygen atoms.

3. Proteins:- Proteins are large biomolecules composed of amino acids linked together by peptide bonds. They are essential for various biological functions including reaction & defense mechanisms.

4. Nucleic acids:- Nucleic acids are biomolecules responsible for storing & transmitting genetic information.

- b. Role of DNA Vaccine for rabies.
1. DNA vaccines against rabies contain a plasmid encoding the rabies virus glycoprotein, which is responsible for attaching to the neutralizing antibody.
  2. When the DNA plasmid is introduced into the host cells, the host cell machinery produces the G protein, leading to the production of viral antigens. These are recognized by the immune system, triggering an immune response.
  3. These viral antigens are recognized by the host's immune system, triggering an immune response.
  4. DNA vaccines for rabies have shown promising results in animals. Studies & clinical trials offering potential advantages over traditional inactivated or live-attenuated rabies vaccines & ease of production.

- Role of RNA vaccine for COVID-19.
1. Biotech & messenger RNA (mRNA) technology
  2. The mRNA in these vaccines encodes the SARS-CoV-2 spike protein, which is the primary target for neutralizing antibodies against the virus.
  3. The mRNA vaccines for COVID-19 have shown rapid development & high efficacy in clinical trials & have been widely used in vaccination campaigns worldwide to combat the COVID-19 pandemic.
- Quinn

1. C.

Cellulose-based biofilters are an innovative & environmentally friendly technology that utilizes cellulose, a natural polymer found in plant cell walls, as filtration medium.

1. **Composition & Structure:** Cellulose-based biofilters are typically composed of a porous matrix made of cellulose fibers or derivatives, such as cellulose nanofibrils or cellulose nano crystals. These materials are derived from renewable sources like wood, cotton, or agricultural waste. They are biodegradable & biodegradable.

2. **Filtration Mechanism:** The porous structure of cellulose-based biofilters allows for effective filtration through various mechanisms, including size exclusion, adsorption, & biodegradation.

3. **Applications:** Cellulose-based biofilters have found applications in various domains including water treatment, air purification & industrial effluent treatment. Heavy metals, dyes, organic pollutants, & microplastic from water streams.

4. **Advantages:** They are environmentally friendly, biodegradable, & can be produced from renewable sources. Additionally, they have high porosity, excellent adsorption capabilities.

Qa. DNA fingerprinting, also known as DNA Profiling is a powerful technique used in forensic science to identify individuals based on their unique genetic makeup.

1. DNA extraction: The first step in DNA fingerprinting is to extract DNA from a sample found at a crime scene; such as blood, semen, hair or other biological material.

2. DNA amplification: - Since the amount of DNA obtained from crime scene samples is often very small, a technique called Polymerase Chain Reaction (PCR) is used to amplify or make multiple copies of specific regions of the DNA.

3. Electrophoresis: - The amplified DNA fragments are separated based on their size using a process called electrophoresis. This involves passing the DNA fragments through a gel, where they separate based on their molecular weight & charge.

A. DNA profile generation: - The separated DNA fragments from a unique pattern of bands or peaks, which is then converted into a numerical representation called a DNA profile.

5. Database Comparison: - The DNA profile obtained from the crime scene sample is then compared against DNA profiles stored in various databases, such as the Combined DNA Index System (CODIS) used by law enforcement agencies in the United States.

~~Qub~~

2b. Lipids plays a crucial role in the formation & effectiveness of cleaning agents, particularly in the context of removing greasy or oily agents.

1. Emulsification: - Lipids, specifically surfactants act as emulsifying agents in cleaning products. They help to break down & disperse oils, greases, & other lipid-based stains by reducing the surface tension b/w the oil & water molecules.

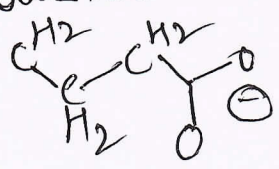
2. Solubilization: - Certain lipids, such as fatty acids & their derivatives, can solubilize oily or greasy substances. Lipids interact with non-polar portions of the stain, allowing them to be dissolved & washed away more effectively.

3. Wetting & Penetration: - Lipids enhance the wetting & penetration abilities of cleaning agents. As they spread evenly & penetrate into porous surfaces, & reach better cleaning efficiency.

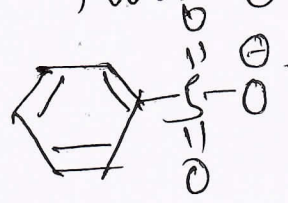
4. Foaming & Lathering: - Many cleaning agents contain lipids that contribute to the formation of stable foams & lather.

5. pH adjustment: - Certain lipids, like fatty acids, can act as pH regulators in cleaning formulations.

Applications: - Laundry detergents, dishwashes, liquids, industrial cleaners, floor cleaners, etc.



Na<sup>+</sup>  
(a soap)



an anionic detergent.

2c)

Biosensors: They are analytical devices <sup>min</sup> combines a biological component (eg: Enzymes, antibodies, microorganisms) with a physicochemical transducer to detect & quantify specific analytes.

1. Biological Component - Provides high sensitivity & specificity for the target analyte due to its biologically derived nature.
2. Transducer - Convert the biological recognition event into a measurable electrical, optical, or other signals.
3. Applications: - used in various fields like, health care, environmental monitoring, food quality control.
4. Advantages: High sensitivity, rapid response, portability for miniaturization & portability.

Bio plastics: Bio plastics are group of plastic derived from renewable source, shell of natural or microorganisms, rather than from fossil fuels.

1. Feed stocks: Bio plastics can be made from sources like corn, sugarcane, cellulose, starch produced by bacteria.
2. Biodegradability: - Some bio plastics are biodegradable, meaning they can be broken down by microorganisms, into water, CO<sub>2</sub> under specific environmental conditions.

Ques

3. Applications: used in packaging materials, disposable, cutlery, agricultural mulch films, & consumer products.

3a. The human brain can be compared to a central processing unit (CPU) system in several ways.  
 Both human brain & CPU receive & process inputs, store information, & perform calculations to produce outcome/output.  
 The below table compares the brain with CPU on various activities.

Part of Comparison Construction	Brain Neurons & Synapses	CPU. ICs, transistors, diodes, capacitors, transistors
Memory growth	increases each time by connecting synaptic units.	increases by adding more memory chips.
Backup systems	Built-in backup system.	Backup system is constructed manually.
Memory power.	100-200 flops	100 million megaflops
Memory density	$10^7$ circuits/cm <sup>3</sup>	$10^{14}$ bits/cm <sup>3</sup>
Energy consumption	12 watt power	Gigawatts power
Information storage	Stored in electro-chemical & electrical impulses.	Stored in numeric & symbolic form.
Size & weight.	The brain's volume is 1500 cm <sup>3</sup> & weight is around 3.3 pounds.	Variable size & weight. Few grams to tons.
Information processing power	Low.	High.

3b. The human eye can be compared to a camera system, as both have similar components & functions - that enable them to capture & process visual information

1. Cornea & Lens

- \* The Cornea & lens in the eye act like the lens system in a camera.
- \* The unpaired cornea surfaces & focus light onto the lens, which focuses along the focal points of the light rays

2. Iris & Pupil

- \* The iris is the colored part of the eye & functions like the aperture in a camera.
- \* The pupil is the opening in the center of the iris, & its size is controlled by the surrounding muscles.

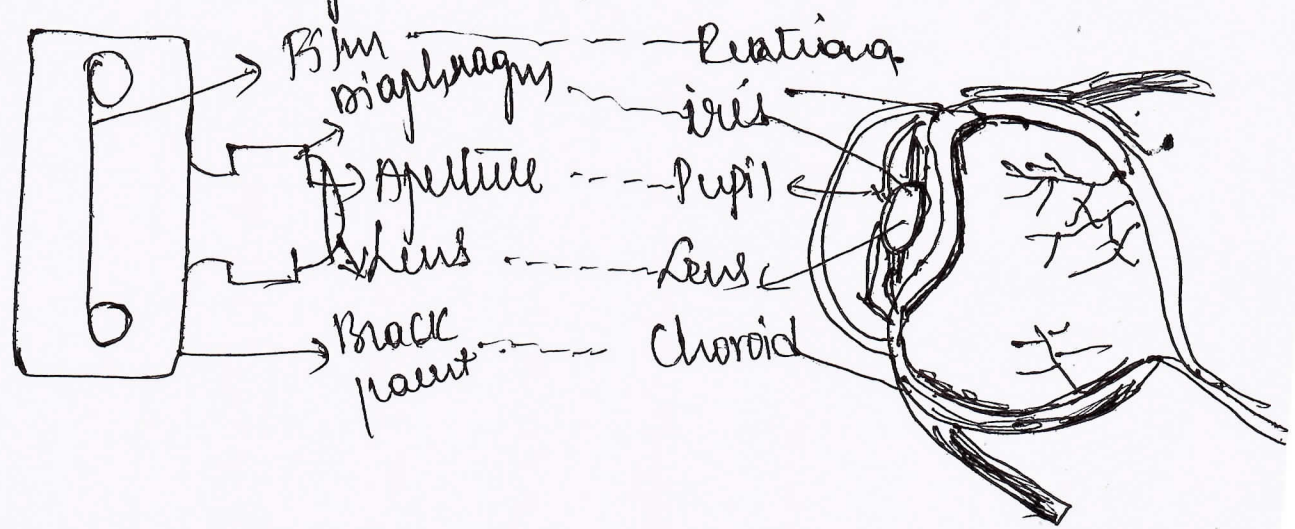
3. Retina

- \* The retina is the light-sensitive layer at the back of the eye, analogous to the image sensor or film in a camera.
- \* The retina contains photo receptors called rods & cones, which convert light energy into electrical signals.

4. Optic Nerve

- \* The optic nerve is a bundle of nerve fibers that carries signals from the retina to the brain.

~~Ques~~





3.C

A Cardiac pacemaker is a small, battery-powered medical device that helps regulate the heartbeat. It is implanted under the skin, usually below the collarbone, & connected to the heart with thin, flexible wires called leads.

The primary function of a pacemaker is to monitor the heart's electrical activity & provide electrical impulses when the heart skips a beat. These electrical impulses stimulate the heart to contract & maintain a normal heart rhythm.

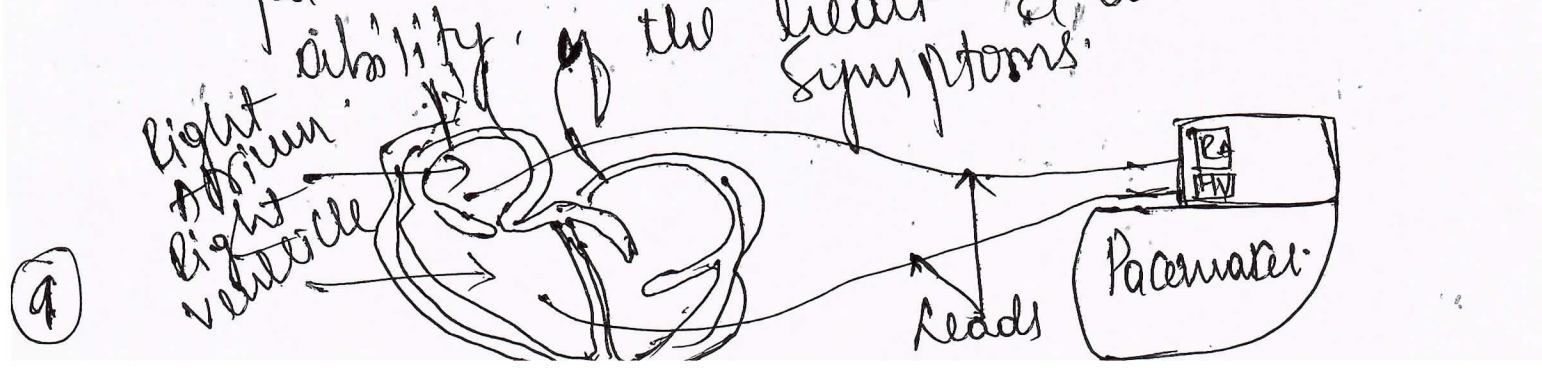
Pacemakers are commonly used to treat various types of arrhythmias & conditions that cause the heart to beat too slowly.

\* Sick Sinus Syndrome: A condition where the heart's natural pacemaker does not function properly.

\* Heart block - A condition where the electrical signals from the upper chambers of the heart are partially or completely blocked from reaching the lower chambers.

~~Q no.~~

\* Congestive heart failure. In some cases, pacemakers can help improve the pumping ability of the heart & alleviate symptoms.



4

4a. Robotics arms for prosthetics are advanced artificial limbs that aim to mimic the functionality & dexterity of a human arm & hand.

These prosthetic devices are designed to provide individuals with limb loss or congenital limb deficiencies greater independence & improved quality of life.

1. Functionality: Robotic prosthetic arms are designed to replicate the movements & capabilities of a natural arm & hand. They are equipped with multiple degrees of freedom, allowing for various motions such as flexion, extension & grasping.

2. Control System: - Robotic arms for prosthetics are controlled through various interfaces that translate the user's intentions into movement. (EMG) signals, which detect muscle contractions in the residual limb & (MPK) - Targeted muscle reinnervation.

3. Sensory Feedback: - Ability to provide sensory feedback to the user through sensors integrated into the prosthetic that detect touch, pressure & temperature.

4. Adaptability & Customization: - This includes adjustments to the size, weight, attachment or looks for specific tasks or activities.

~~Ques~~

46.

The heart is a muscular pump system that is responsible for circulating blood throughout the body.

- Structural Components: - The heart is a muscular organ divided into four chambers: two upper chambers called atria & two lower chambers called ventricles. These help us rhythmically to pump blood.
- Pumping Mechanism: - The heart functions as a double pump, with the right side pumping deoxygenated blood to the lungs, & the left side pumping oxygenated blood to the rest of the body.
- Valves & blood flow: - The heart contains four valves that regulate the direction of blood flow. The tricuspid & mitral valves control the flow of blood b/w the atria & ventricles, while the pulmonary & aortic valves control the flow of blood out of the ventricles into the pulmonary & systemic circulation.
- Electrical Conduction System: - The sinoatrial node located in the right atrium, acts as the natural pacemaker, initiating electrical impulses that cause the atria to contract.
- Regulatory mechanisms: - The heart's pumping ability is regulated by various mechanisms, including the autonomic nervous system, hormones, & intrinsic factors.

~~4/10/20~~

11

H.C.

Engineering solutions for Parkinson's aim to improve the quality of life & enhance the independence of individuals living with this neurological disorder.

1) Deep brain stimulation (DBS): Deep brain stimulation (DBS) is a surgical procedure that involves implanting electrodes in specific areas of the brain. These electrodes deliver electrical impulses that can modulate abnormal neural activity & with Parkinson's disease, such as tremor, stiffness & difficulties with movements.

2. Assistive devices & robotics: Various assistive devices & robotic technologies have been developed to aid individuals with Parkinson's disease in performing daily activities.

3. Sensor-based Monitoring & Feedback: Wearable sensors & mobile applications can be used to monitor & provide real-time feedback on movement patterns, tremor, & other symptoms.

4. Virtual Reality & Gaming: Virtual reality & gaming technologies have been explored as potential therapeutic tools for Parkinson's disease.

~~5.~~

Prosthetic & Brain-Computer Interfaces (BCI): BCI can interpret neural signals & translate them into commands for prosthetic limbs, allowing improved mobility.

59. The lungs act as a purification system in the human body by performing the vital functions of gas exchange, which involves the intake of oxygen & the removal of carbon di-oxide.

1. Air intake & bronchial tree: - The process begins with the inhalation of air through the nose & into the bronchial tree, consisting of the bronchi & bronchioles.
2. Alveoli & gas exchange: - The bronchioles lead to the alveoli, which are tiny air sacs surrounded by a network of capillaries. The alveoli provide a large surface area for gas exchange to occur b/w the air in the lungs & the blood in the capillaries.
3. Oxygenation & Purification: - The oxygenated blood is the carried by the pulmonary veins to the left side of the heart, where it is pumped. As the heart pumps the oxygenated blood, it provides the oxygen for cellular respiration & metabolic processes in various tissues & organs.
4. Exhalation & Carbon-di-oxide removal: - During exhalation, the carbon-di-oxide rich air is expelled from the lungs, effectively removing this waste product from the body.

~~Ques~~

## 5b. Structure & Function

The Kidney are two bean-shaped organs located on either side of the spine, just below the rib cage. Each kidney contains around a million nephrons, which are the functional units responsible for filtration.

- \* Nephrons. Structure
- \* Glomerulus: A tiny ball of capillaries where blood filtration begins.
- \* Bowman's Capsule: Envelopes the glomerulus & collects the filtered blood.
- \* Filtration
- \* Glomerular filtration: Blood enters the glomerulus under high pressure, forcing water, ions, & small molecules through the capillary wall into the Bowman's capsule forming a filtrate.

- \* Formation of urine
- \* The remaining filtrate, now containing waste products & excess substances, continues into the collecting duct where further water reabsorption occurs under the influence of antidiuretic hormone.

## Regulation & Homeostasis

- \* Electrolyte balance, Acid base balance
- \* Blood pressure & Red blood cell production

Waste Elimination  
The kidney efficiently remove metabolic wastes like urea, creatinine, & drugs from the bloodstream, ensuring the body's internal environment remains clean & stable.

~~Ques~~

## 50. Spirometry:-

1. Spirometry is a diagnostic test used to assess lung function & measure the amount of air a person can inhale & exhale.
2. It measures the forced vital capacity (FVC) which is the maximum amount of air that can be forcefully exhaled after the maximum inhalation.
3. It also measures the forced expiratory volume in one second (FEV<sub>1</sub>), which is the amount of air exhaled in the first second of the FVC maneuver.
4. Spirometry is useful in diagnosing & monitoring conditions such as asthma, chronic obstructive pulmonary disease (COPD).

## Ventilator:-

1. A ventilator, also known as a respirator or breathing machine, is a medical device that provides mechanical ventilation to assist with breathing.
2. It is used for patients who cannot breathe effectively on their own due to various reasons, such as respiratory failure or lung disease.
3. Ventilators deliver a controlled flow of air or oxygen into the patient's lungs through an endotracheal tube, or mask, helping to maintain adequate oxygen levels & remove CO<sub>2</sub> from the body.

~~Give~~

6a.

1. Skeletal system as a scaffold.
  - \* Bones form a rigid framework providing structural support & protection for the body.
  - \* Axial skeleton acts as a central scaffold protecting vital organs.
  - \* Appendicular skeleton serves as a scaffold for muscle attachment & locomotion.

2. Muscular system as a scaffold.
  - \* Skeletal muscles are attached to bones via tendons, providing the force for movement.
  - \* Muscles work in tandem with the skeleton system, acting as a dynamic scaffold during movement.
  - \* Core abdominal muscles form an entire scaffold, supporting & protecting internal organs.

3. Integration of muscular & skeletal systems.
  - \* Skeletal system provides the rigid framework, while the muscular system provides dynamic support.
  - \* Together, they create an entire scaffolding system within the body.
  - \* This scaffolding allows for structural integrity, organ support & wide range of movement.

~~Quora~~



## 6.b. Gene therapy:-

- \* For muscular dystrophy, gene therapy aims to introduce functional copies of the defective gene responsible for the condition, potentially restoring muscle function.
- \* For osteoporosis, gene therapy can target genes involved in bone remodeling & mineral homeostasis, promoting bone formation & strength.

## Cell therapy

- \* For muscle dystrophy, stem cells can potentially replace damaged muscle cells & restore function.
- \* For osteoporosis, stem cells can differentiate into osteoblasts, enhancing bone formation & density.

## Tissue Engineering

- \* For muscle dystrophy, engineered muscle tissue could replace or supplement damaged muscles.
- \* For osteoporosis, engineered bone grafts could promote bone regeneration & repair fracture.

## Biomaterials & Scaffolds

- \* For muscular dystrophy, scaffolds can provide a structural framework for muscle cell migration & regeneration.
- \* For osteoporosis, scaffolds can be designed to promote bone formation & mineralization.

8C. \* COPD is a progressive lung disease characterized by airway inflammation & breathing difficulties. It is due to long-term exposure to gases, cigarette smoke, air pollution & dust.

\* The two main types of COPD are chronic bronchitis (characterized by excessive mucus production & cough) & emphysema (characterized by the destruction of alveoli, leading to air trapping & reduced gas exchange).

\* Symptoms: Common symptoms of COPD include persistent cough, excessive mucus production, shortness of breath, wheezing, & fatigue.

\* Risk factors: The major risk factor for COPD is smoking, exposure to air pollutants, occupational exposures, & genetic factors.

\* Diagnosis & treatment: COPD is typically diagnosed through a combination of medical history, physical examination, & lung function tests.

Prevention & Management - Prevention strategies for COPD focus on reducing exposure to risk factors, such as quitting smoking & avoiding air pollution.

~~Qw~~

## 1. Echolocation

- \* it is a technique used by certain animals, such as bats, dolphins, & whales to detect & locate objects by emitting high-pitched sounds & listening for the echoes that bounce back from those objects.
- \* The animals emit a series of ultrasonic pulses or clicks & the time it takes for the echoes to return provides information about the distance, size & shape of the object.

## ultra sonography

- \* it is a diagnostic imaging technique that uses high-frequency sound waves to produce images of structure within the body.
- \* An ultrasound device emits high-frequency sound waves which are reflected off different structure in the body, & these echoes are detected & recorded to create real-time images.
- \* ultra sonography is widely used for medical diagnosis, particularly for examining fetuses during pregnancy.

## Sonars

- \* Sonar is a technique that uses sound propagation to navigate, communicate or detect object underwater or in the air.
- \* There are two main types of sonar: active sonar, which emits sound waves & listens for echoes, & passive sonar which only listens for sounds emitted by other sources.

~~Yuv~~

1)

# Photosynthesis

Photosynthesis is a process carried out by plants, algae, & certain bacteria, where they convert light energy from the sun into chemical energy in the form of glucose & oxygen.

\* Light reaction: In this stage, chlorophyll absorbs sunlight & this energy is used to split water molecules into hydrogen & oxygen. The oxygen is released as a byproduct & the hydrogen is used in the next stage.

\* Calvin cycle: In this stage, the hydrogen from the light reaction is used to convert carbon dioxide into glucose using the energy from ATP & NADPH produced in the light reaction.

# Photo voltaic cells

\* Photovoltaic cells, also known as solar cells, are devices that convert light energy from the sun directly into electrical energy through the photo voltaic effect.

\* They are made of semi conductor materials typically silicon, which absorb photons of sunlight & generate an electrical current.

\*) Working: When sunlight hits the semi conductor material of the solar cell, it knocks electrons loose from their atoms, creating the electric field potential in the cell. This causes the electrons to flow towards the front of cell, while the holes move towards the back, generating an electrical current.

\*) This current can be used to power electrical devices or be stored in batteries for later use.

- 7C. Bionic Leaf -
- \* The bionic leaf is an artificial device that mimics the process of photosynthesis to produce liquid fuels from sunlight, water & CO<sub>2</sub>.
  - \* It utilizes a catalyst made of cobalt & phosphorus to split water molecules & generate hydrogen & oxygen gases.
  - \* The bionic leaf has the potential to provide a renewable source of liquid fuels, contributing to a sustainable energy future.

GPS (Global Positioning System)

- \* GPS is a satellite-based navigation system that provides location & time information to users with GPS receivers.
- \* GPS receivers on the ground or in devices calculate their positions by analyzing the signals from multiple satellites.
- \* GPS technologies are widely used for navigation in various applications, including mapping, surveying & location-based services.

Bird Flight

- \* Birds have evolved unique adaptations that enable them to fly, defining the force of gravity.
- \* Birds use their wings & specialized muscles to generate lift & thrust, allowing them to take off, as well.

Aircraft

- \* Aircraft are human-made machines designed for flight, capable of lifting & propelling themselves through the air.
- \* Aircraft are equipped with engines, control surfaces, & instruments for propulsion, navigation, & control during flight.

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8a)

Lotus Leaf effect - The lotus leaf effect refers to the highly water-repellent & self-cleaning properties observed on the leaves of the lotus plant.

- \* The surface of lotus leaves is covered with a micro & nano scale hierarchical structure that creates a very high surface roughness.
- \* This rough surface, combined with the waxy, hydrophobic chemistry of the leaf surface, causes water droplets to bead up & easily roll off, picking up dirt.

Plant burrs

- \* Plant burrs are the seed-dispersal units of certain plants, such as burdock, the horseweed, and the thistle.
- \* Burrs typically have small hooks or barbs that allow them to easily attach to animal fur or clothing.
- \* This mechanism enables the plants to disperse their seeds to new locations.

Superhydrophobic & Self-Cleaning Surfaces

- \* Superhydrophobic surfaces are those that are highly water-repellent, with a water contact angle greater than 150 degrees.
- \* This surface causes water droplets to bead up & roll off readily, similar to the lotus leaf effect.
- \* Self-cleaning surfaces are those that do not require manual cleaning or other external intervention; they remove dirt, dust, or other contaminants that collect on their surface by expelling the rolling water droplets that carry away the contaminants.

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## 8b. Shark Skin

- i) Sharks have evolved a unique skin surface that consists of tiny, tooth-like scales called "dermal denticles" or placoid scales.
- ii) These scales are composed of a hard, enamel like material & are arranged in an overlapping pattern, creating a rough surface texture.
- iii) This rough texture reduces turbulence & drag in the water, allowing sharks to swim more efficiently & at higher speeds.

### Swimsuits

- i) Inspired by the shark skin's hydrodynamic properties, swimsuit manufacturers have developed swimsuits with a specialized fabric texture that mimics the rough surface of shark skin.
- ii) The fabric is coated with polydimethylsiloxane (PDMS) which creates microscopic ridges or grooves, similar to the structure of dermal denticles.
- iii) This biomimetic texture reduces drag in the water & allows swimmers to move more efficiently & potentially improve their performance.

### Bullet Train

- i) The concept of a "bullet train" is inspired by the aerodynamic design of various biological organisms, such as birds & fish.
- ii) The sleek, streamlined shape of bullet trains is optimized to reduce air resistance & turbulence, allowing the train to reach high speeds with less energy expenditure.
- iii) The design principles used in bullet trains such as the use of smooth, curved surfaces & tapered ends, & derived from the study of aerodynamic shapes found in nature.

~~Yes~~  
23

- C. Hemoglobin-based oxygen carriers (HBOCs)
- i) HBOCs are synthetic oxygen carriers that are derived from hemoglobin, the oxygen carrying protein found in the red blood cells.
  - ii) HBOCs are designed to mimic the oxygen transport function of natural hemoglobin but they are modified to increase stability, reduce toxicity, & extend their circulatory half-life.
  - iii) HBOCs have the potential to be used as blood substitutes or oxygen therapeutics in situations where blood transfusions are not viable or desirable such as in emergency medical settings, surgical procedures, or for patients with certain allergies or medical restrictions.

Perfluorocarbons (PFCs) :-

- i) PFCs are synthetic compounds composed of carbon & fluorine atoms, with the ability to dissolve & transport high volumes of respiratory gases, such as oxygen & carbon dioxide. Unlike hemoglobin, PFCs do not bind to oxygen chemically. Instead, they dissolve & transport oxygen physically. PFCs have been explored as potential blood substitutes or oxygen carriers in blood perfusion situations where long-term storage & sterilization is required, as they are more stable & do not degrade into products like natural products.

~~Q. 11)~~



## 9a. DNA organic Computing:-

- \* DNA organic Computing involves using biological molecules, particularly deoxyribonucleic acid (DNA), to perform computational operations.
- \* It leverages the inherent properties of DNA such as its ability to store & process information, as well as its self-assembly & molecular recognition capabilities.
- \* DNA molecules can be designed & synthesized to represent data & perform logical operations, making them suitable for tasks like computing, data storage, & signal processing.

## DNA BioComputing

- \* DNA BioComputing is a broad term that encompasses the use of biological components including DNA, enzymes, & other biomolecules for computing purposes.
- \* It aims to harness the inherently parallel & energy-efficient processing capabilities of biological systems for computational tasks.
- \* DNA BioComputing can be used for various applications, such as DNA-based data storage, molecular computing, & the development of biosensors & biochips.
- \* DNA organic & bio computing offer the potential for ultra-compact & energy-efficient computing systems, as biological molecules are inherently small & operate at low energy levels.

# 9b. Bio-imaging

\* Bio-imaging refers to the various imaging techniques to visualize & study biological structures & processes with living organisms.

\* Common bio-imaging modalities include magnetic resonance imaging (MRI), Computed Tomography (CT), ultrasound, & microscopy techniques like Confocal, & Fluorescence microscopy.

\* These imaging techniques provide detail visual representation of tissues, organs & cellular structures, enabling the identification & analysis of abnormalities or pathological conditions.

## Artificial Intelligence in disease diagnosis

\* Artificial Intelligence (AI) techniques, particularly machine learning & deep learning algorithms, are being employed in disease diagnosis to analyze & interpret medical imaging data.

\* AI algorithms can be trained on large datasets of labeled medical images to learn patterns & features associated with specific diseases or conditions.

\* These trained AI models can then analyze new medical images & provide diagnostic predictions, assisting healthcare professionals in detecting & diagnosing diseases accurately & efficiently.

\* The combination of bio-imaging & AI technique offers a powerful approach to disease diagnosis & monitoring.

~~Yours~~

9C.

## Definitions & Concepts

- \* Self-healing bio-concrete is a type of concrete that has the ability to heal or repair cracks & damages on its own, without the need for external interventions.
- \* It is achieved by incorporating specific types of bacteria into the concrete mixture which can survive in the highly alkaline environment of concrete.

## Mechanism of Self-healing

- \* The bacteria used in self-healing bio-concrete are typically from the genus *Bacillus* such as *Bacillus pasteurii* or *Bacillus pseudo-firmus*.
- \* These bacteria can induce a process called microbially induced calcium precipitation (MICP) where they produce calcium carbonate ( $CaCO_3$ ) as a byproduct of their metabolic activities.

## Advantages of Self-healing bio-concrete:

- \* increased durability & extended service life of concrete structures.
- \* Reduced maintenance costs & the need for frequent repairs.
- \* improved sustainability by reducing the need for frequent replacement of concrete structures.

## Applications & Research

- \* Self-healing bio-concrete has been studied & explored for various applications including building, bridge, tunnels & other infrastructure projects.

~~Yours~~

(27)

10.2. Bio-imaging or biological imaging, is a crucial field that has revolutionized our understanding of biological processes & systems.

1. Visualization & Analysis - of a Cellular & Molecular processes: Bio imaging techniques, such as fluorescence microscopy, Confocal microscopy & super resolution microscopy, allow researchers to visualize & analyze cellular structure, organelles, & molecular interactions at high resolution. This provides valuable insights into the mechanisms underlying various biological processes, including cell division & signaling pathways, & disease pathogenesis.

2. Non-invasive in vivo imaging: Techniques like magnetic resonance imaging (MRI), positron emission tomography (PET), & optical imaging make non-invasive monitoring & imaging of living organisms including humans. These methods are invaluable for studying physiological processes, diagnosing diseases, & monitoring the effectiveness of therapeutic interventions without causing harm to the subject.

3. Drug discovery & development: Bio imaging plays a pivotal role in drug discovery & development by facilitating the visualization & analysis of drug-target interactions, drug delivery mechanisms, & the effect of potential therapeutic compounds on biological systems.

Q. 10.2

# 4. Biomedical research & disease diagnosis:-

Bioimaging techniques are essential tools in biomedical research, enabling the study of disease mechanisms, the development of diagnostic markers & the monitoring of disease progression or response to treatment.

10.6

Bioremediation & Bio-mining via microbial surface adsorption all employ processes that leverage the capabilities of microorganisms to address environmental challenges & recover valuable resources.

\* Microbial surface adsorption:- Microbial surface adsorption is the process by which microorganisms, such as bacteria & fungi, can bind & accumulate various substances including heavy metals, radionuclides & organic pollutants, onto their cell surfaces.

\* Bioremediation:- Bioremediation is the utilization of microorganisms & their metabolic processes to degrade, transform, or immobilize environmental pollutants & contaminants thereby reducing or eliminating their harmful effects.

\* Bio-mining:- Bio-mining, also known as bio mining or microbial mining, is the process of extracting valuable metals or minerals from low grade ores or waste materials using microorganisms. In this context microbial surface adsorption contribute to the selective binding & concentration

~~Yours~~

- \* target metals or minerals, facilitating their subsequent recovery & extraction.
- \* Environmental Sustainability: Both bio-mediated & bio-mining via microbial surface adsorption contribute to environmental sustainability by providing eco-friendly & cost-effective approaches to address environmental challenges.
- \* Versatility & Adaptability: Microorganisms exhibit a remarkable versatility & adaptability enabling them to interact with a wide range of compounds & thrive in diverse environments.

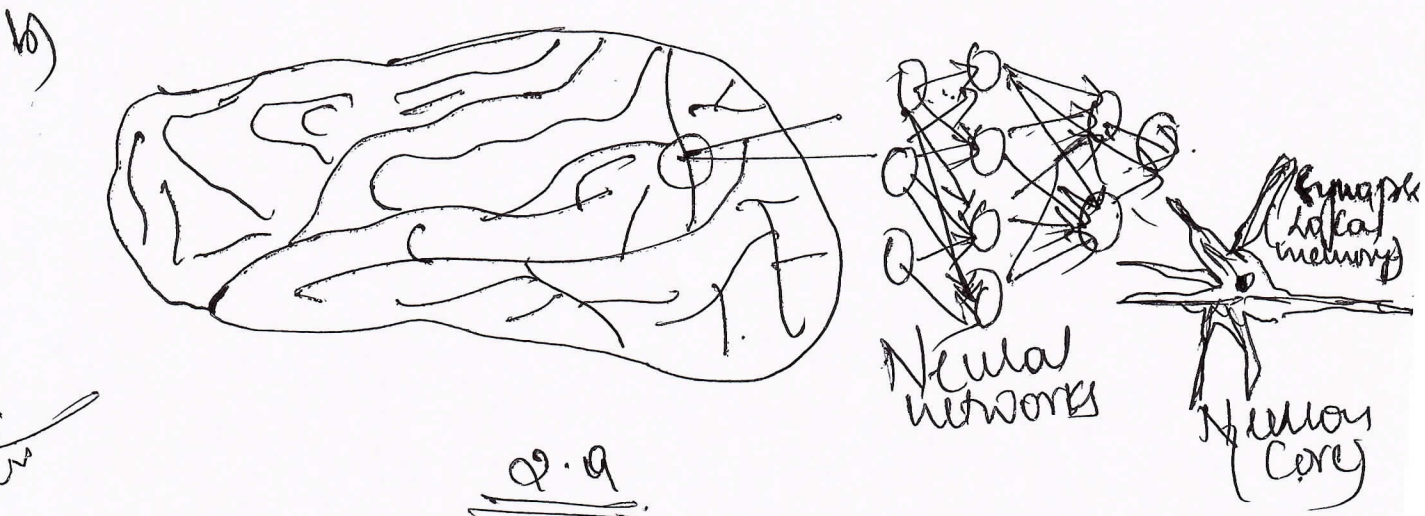
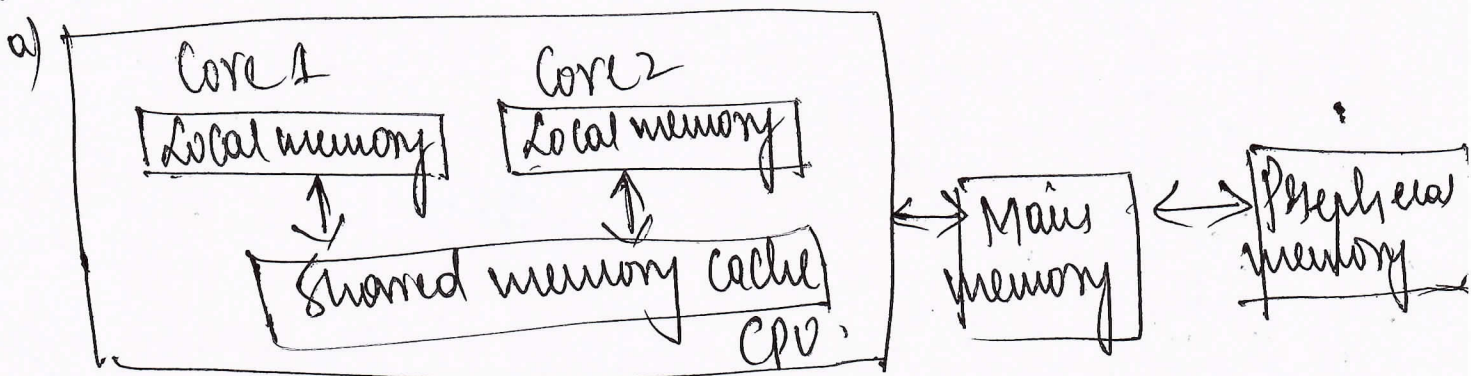
10.C: Nanomedicines

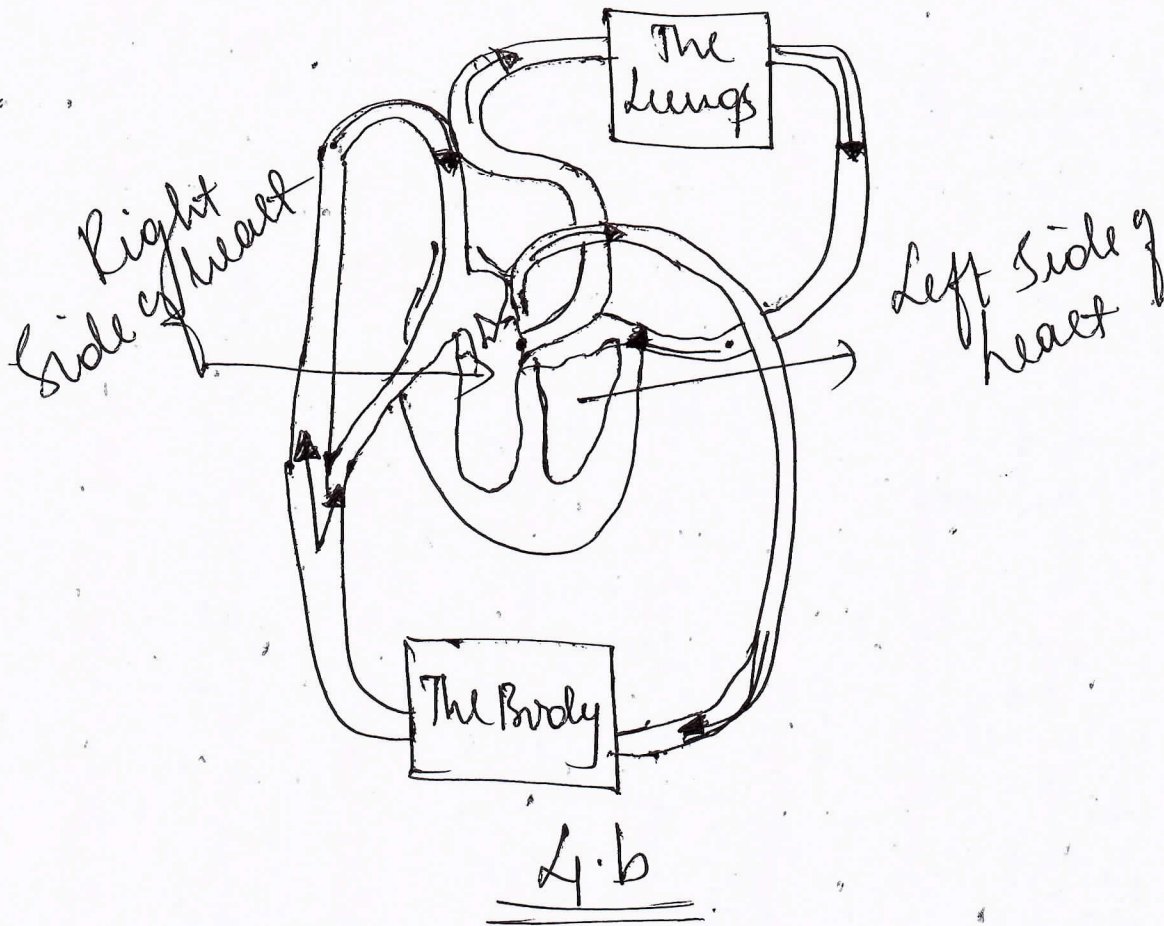
- \* Nanomedicines are engineered materials or devices at the nanoscale (1-100nm) designed for therapeutic or diagnostic applications in healthcare.
- \* Examples include nanoparticles for targeted drug delivery, nanostructured scaffolds for tissue engineering, & nanobiosensors for disease detection.
- \* Advantages of nanomedicines include improved drug solubility & bioavailability, targeted delivery to specific sites & enhanced diagnostic capabilities.

*Ques*

# Bioleaching

- \* Bioleaching is a process that utilizes microorganisms such as bacteria & archaea, to extract various metals from low-grade ores or mineral concentrates.
- \* It involves the microbial oxidation of metal sulfides, converting insoluble metal compounds into soluble forms that can be recovered.
- \* Bioleaching offers an environmentally friendly & cost-effective alternative to traditional metal extraction methods particularly for low-grade ores.





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 29/05/24  
 (Mr. Gungajiff)

Ataas  
 30/5/24

+ Free

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