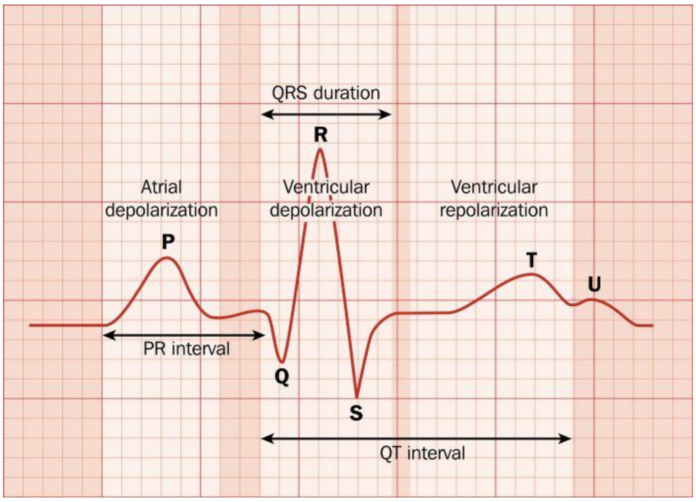
1. What is Electro cardiogram (ECG)? Describe various parts of the ECG.

An electrocardiogram records the electrical signals in the heart. It's a common and painless test used to quickly detect heart problems and monitor the heart's health.



- An ECG has three main components: **the P wave, which denotes depolarizing atria**; **the QRS complex, which denotes the depolarization of the ventricles**; **and the T wave represents repolarizing ventricles.**
- During each pulse, a healthy heart has an ordered process of depolarization that starts with pacemaker cells in the sinoatrial node, extends throughout the atrium, and moves through the atrioventricular node into its bundle and into the fibers of Purkinje, spreading throughout the ventricles and to the left.
- The electrical activity occurs in a small patch of pacemaker cells called the sinus node during a regular heartbeat.
- This produces a small blip called the P wave when the impulse stimulates the atria.
- It then activates the main pumping chambers, the ventricles, and produces the large up-and-down in the middle, the QRS complex.
- The last T wave is a time of regeneration as the impulse reverses over the ventricles and travels back.
- If the heart is beating normally, it takes about a second (approximately 60 heartbeats per minute) for the entire cycle

2. Write a note on Hemoglobin-based oxygen carriers (HBOCs) and per flourocarbons (PFCs).

Human blood substitutes are synthetic products that are designed to act as a replacement for blood in the human body.

Hemoglobin-based oxygen carriers (HBOCs) are a type of human blood substitute that is designed to carry and deliver oxygen to the body's tissues.

Advantages of hemoglobin-based oxygen carriers

- **Increased oxygen-carrying capacity**: HBOCs can potentially carry more oxygen per unit volume than whole blood.
- **Universal compatibility**: Unlike blood transfusions, which require blood typing and cross-matching to ensure compatibility, HBOCs can potentially be universally compatible with any blood type.
- **Longer shelf life**: HBOCs have the potential for longer storage and shelf life compared to donated blood, which has a limited lifespan.

Examples: Hemopure, Oxyglobin, Hemospan.

Perfluorocarbons (PFCs) are a type of human blood substitute that are designed to deliver oxygen to the body's tissues. Unlike hemoglobin-based oxygen carriers (HBOCs), which are based on natural proteins, PFCs are synthetic chemicals that are similar in structure to some types of industrial solvents.

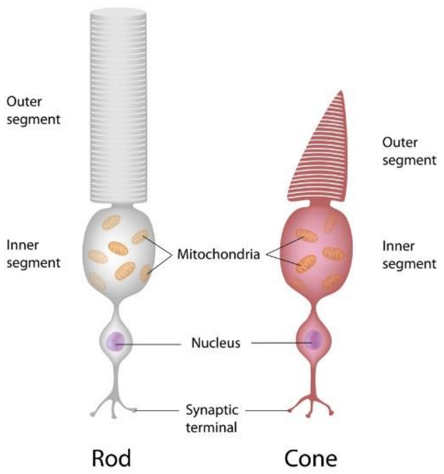
Advantages of PFCs High oxygen-carrying capacity:

- PFCs have the **ability to dissolve a significant amount of oxygen**, much higher than that of blood. This allows for efficient oxygen delivery to tissues, even in low-oxygen environments.
- **Stability and long shelf life**: PFCs are chemically stable and have a long shelf life, making them suitable for storage and use in emergency situations where the availability of fresh blood or other oxygen carriers may be limited.
- **No blood typing or cross-matching required**: PFCs are not dependent on blood typing. This makes them potentially universal oxygen carriers, suitable for use in individuals of any blood type.
- **Reduced risk of infection transmission**: PFCs are synthetic substances, eliminating the risk of transmitting infectious diseases associated with blood transfusions.

Examples: Perftoran, Oxycyte, Oxycyte PFC Emulsion

3. Compare the structure (with suitable diagram) and function of rod and cone cells in the human eye.

These are the photoreceptor cells in the retina that detect light.



Rod Cells

❖ Function in dim light (night vision)

❖ More sensitive to light, but do not detect color

❖ Found mostly in the peripheral retina

❖ Around 120 million rods in each eye

Cone Cells

- ❖ Function in bright light (day vision)
- ❖ Responsible for color vision
- ❖ Three types: Red, Green, Blue
- ❖ Found mainly in the central retina (fovea)
- ❖ About 6 million cones per eye

Component	Function
Outer Segment	Contains stacks of membranous discs with photopigments (e.g., rhodopsin in rods, opsins in cones) that absorb light.
Connecting Cilium	A thin stalk that links the outer segment to the inner segment.
Inner Segment	Contains mitochondria, ribosomes, and Golgi apparatus; responsible for metabolism and protein synthesis.
Cell Body (Nucleus)	Houses the nucleus.
Synaptic Terminal	Forms a synapse with bipolar and horizontal cells to transmit visual signals.

4. What is lotus leaf effect? Explain the mechanism and application of super hydrophobic effect.

The Lotus Leaf Effect refers to the self-cleaning and water-repellent property observed on the surface of lotus leaves. This remarkable property is due to the **super hydrophobic nature** of their surface.

Mechanism:

1. **Surface Micro/Nano Structure**

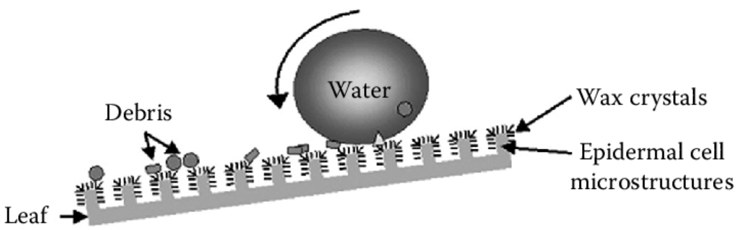
- The surface of the lotus leaf is not smooth. It contains microscopic bumps (papillae) and nanoscopic wax crystals.
- These structures trap air between the leaf surface and the water droplet, minimizing the contact area.

2. Low surface energy Coating

- The surface is coated with a waxy substance (a type of hydrophobic hydrocarbon), which reduces surface energy and enhances water repellency.

3. Water behaviour

- Water droplets rest on top of the rough structures, forming nearly spherical shapes due to high surface tension.
- These droplets easily roll off the surface, picking up dust and dirt—thus showing a self-cleaning effect.



Applications of Lotus Leaf Effect

- Self-cleaning glass (windows, solar panels)
- Waterproof fabrics and paints
- Anti-fog and anti-icing coatings
- Medical devices (anti-biofouling surfaces)
- Stain-resistant materials

5. What is Bioprinting? Discuss the process and applications of bioprinting.

Bioprinting is a rapidly growing field that uses various techniques to produce three-dimensional (3D) structures and functional biological tissues for medical and scientific applications. The main objective of bioprinting is to mimic the structure and function of human tissues and organs, leading to the development of replacement parts for damaged or diseased organs.

The Basic Steps of Bioprinting Process

Preparation of the bioink:

The bioink used in bioprinting is a mixture of cells, growth factors, and other biological materials that are formulated to promote cell growth and tissue formation.

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Design of the tissue structure:

The tissue structure to be printed is designed using computer-aided design (CAD) software, which is then used to control the movement of the bioprinter's print head.

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Printing:

The bioprinter dispenses the bioink in a controlled manner, layer by layer, to build up the final tissue structure. The bioink is deposited in a manner that promotes cell survival and tissue formation.

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Incubation:

After printing, the tissue is incubated in a controlled environment, such as a cell culture incubator, to promote cell growth and tissue formation.

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Assessment:

The printed tissue is assessed for its functional properties, such as cell viability, tissue structure, and tissue function.

Applications:

1. **Organ and Tissue Engineering:** Bioprinting enables the fabrication of complex 3D tissues like skin, cartilage, and even liver constructs for transplantation.

2. **Drug Testing and Development:** Engineered tissues created through bioprinting serve as realistic models for testing drug efficacy and toxicity. This reduces animal testing and accelerates pharmaceutical development.
3. **Cancer Research:** Bioprinted tumor models mimic the actual tumor microenvironment, allowing better study of cancer behavior and drug resistance. This helps in developing more targeted therapies.
4. **Wound Healing and Skin Grafting**: Bioprinted skin grafts can be customized for burn victims or chronic wound patients. These grafts promote faster healing and minimize the risk of rejection.
5. **Personalized Medicine**: Bioprinting allows for the creation of patient-specific tissues using their own cells. This leads to tailored treatments and improves compatibility in therapeutic applications.

6. Explain the use of electrical tongue in food science.

The electrical tongue is a device used in food science to analyze the taste and flavor of food and beverages. It works by measuring the electrical conductivity, impedance, and capacitance of a food or beverage sample, which are related to the concentration of ions in the sample and the texture of the sample. Electronic tongue is used in various applications, including food and beverage analysis, quality control, and flavor profiling.

Application:

1. Quality Control and Standardization: E-tongues are widely used to ensure batch-to-batch consistency in food products. They help monitor taste attributes such as sweetness, saltiness, bitterness, and umami, allowing producers to maintain product quality and uniformity across large-scale production.
2. Detection of Adulteration: The e-tongue is highly sensitive in detecting adulterants or contaminants in food and beverages.
3. Shelf-Life Monitoring: By measuring changes in taste profiles over time, the e-tongue helps assess the freshness and shelf-life of perishable products like juices, dairy, and meat.
4. Analysis of Beverages: E-tongues are extensively applied in wine, coffee, tea, and soft drink analysis. They help classify brands, detect counterfeit products, and evaluate regional variations based on chemical signatures.
5. Nutritional and Functional Food Evaluation: For fortified and functional foods, where added nutrients might alter taste, e-tongues help ensure that nutritional enhancement does not negatively impact palatability.
6. Monitoring Fermentation Processes: In industries like brewing, dairy, and soy processing, the e-tongue tracks fermentation progress by monitoring taste changes. This improves process control and end-product quality.