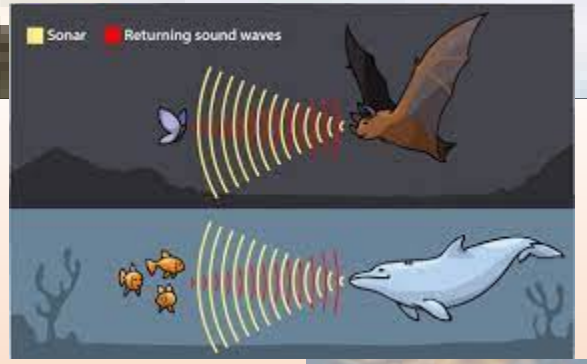
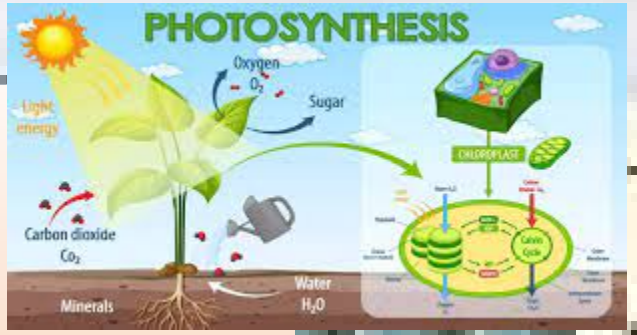
Biology for Engineers
BBOC407

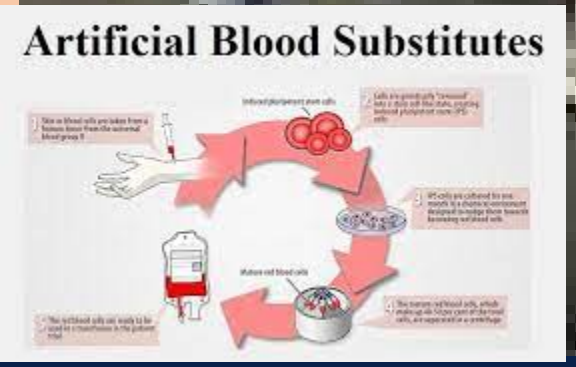
MODULE-4
NATURE-BIOINSPIRED MATERIALS AND MECHANISMS

TEJASWINI B M
Assistant Professor,
Dept. of Chemistry,
ATMECE, Mysuru





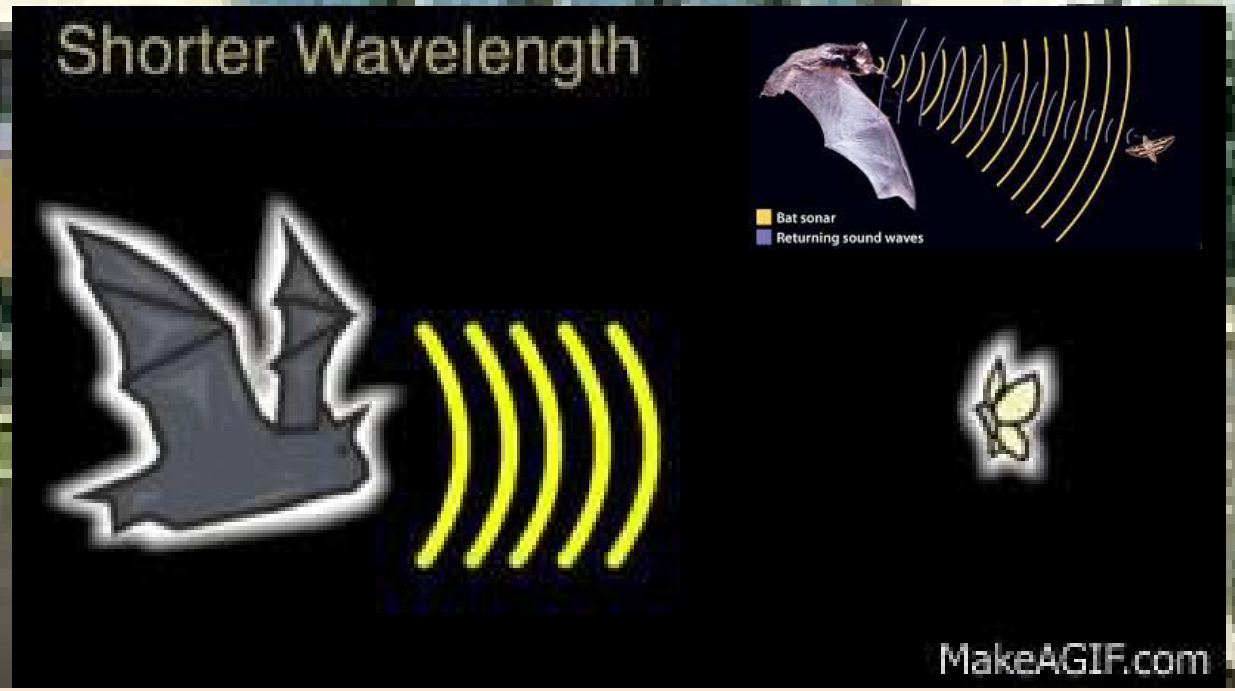
- Echolocation (ultrasonography, sonars),
- Photosynthesis (photovoltaic cells, bionic leaf).
- Bird flying (GPS)
- Lotus leaf effect (Super hydrophobic and self-cleaning surfaces)
- Plant burrs (Velcro),
- Shark skin (Friction reducing swimsuits),
- Kingfisher beak (Bullet train).
- Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).



Echolocation (ultrasonography, sonars)

- Echolocation is a biological phenomenon certain animals use to navigate and perceive their environment using sound waves.
- Example bats, dolphins, whales, and some species of birds also utilize it.

- Nature's own sonar system, echolocation occurs when an animal emits a sound waves that strikes an object, returning an echo that provides information.
- By analyzing the **timing, intensity, and frequency** of these echoes, animals can gather information about the **location, distance, size, shape, texture, and movement of objects** around them.



Echolocation is an incredible adaptation that allows animals to effectively navigate and survive in their environments, especially when other senses like vision are limited.

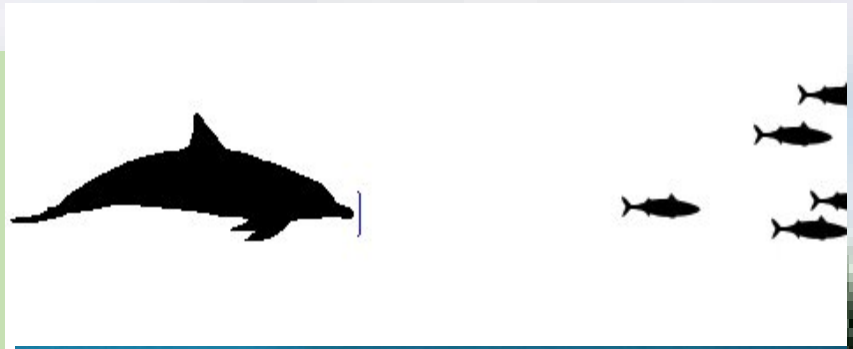
How echolocation works in Animals

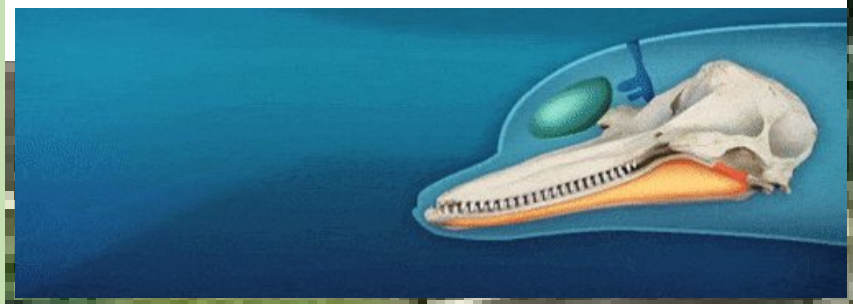
1.Emitting Sound: Animals that use echolocation emit **sound pulses.** These sounds are often high-pitched and beyond the **range of human hearing**.

2.Echo Reception: The emitted sound waves **travel through the air and strike objects in the environment**. When the sound waves encounter an object, they bounce back as echoes.

3.Echo Interpretation: **The animal listens to the echoes** and processes the information contained within them. By analyzing the time taken **by the echoes to return** and the changes in the pitch or frequency of the echoes, the animal can determine the distance of the object.

4.Navigation and Hunting: Echolocation helps animals navigate in their surroundings, avoid obstacles, locate prey, and even detect other animals. Bats, for example, use echolocation to hunt for insects in complete darkness.





Ultrasonography

- Ultrasonography, commonly known as ultrasound, is a medical imaging **technique that uses high-frequency sound waves** to **create real-time images of the body.**
- It is a non-invasive and **safe diagnostic tool** that provides **valuable information about the structure and function of organs, tissues, and blood vessels.**

Ultrasonography and echolocation are related to the use of sound waves for various purposes, but they serve different functions and are applied in different contexts.

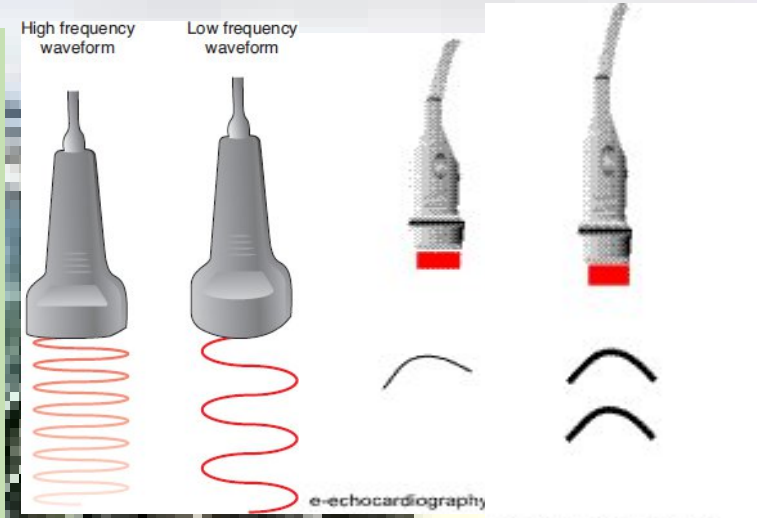
Working of ultrasonography

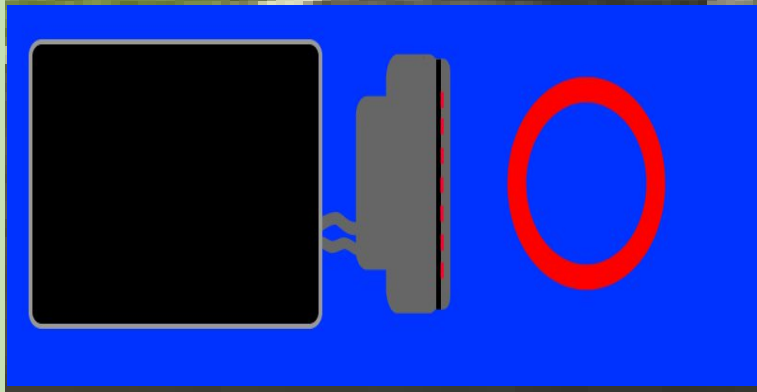
1.Sound Wave Generation: The process begins with an ultrasound machine containing a handheld device **called an ultrasound transducer**. The transducer emits high-frequency sound waves into the body, typically **1 to 20 megahertz (MHz).**

2.Sound Wave Penetration: The sound waves travel through the **body's soft tissues**. They are reflected or scattered by different tissues with **varying properties**. Tissues of **higher density or stiffness, such as bones, reflect more sound waves than softer tissues**.

3.Echo Reception: The sound waves are partially **reflected to the transducer**. These reflected sound waves, known **as echoes**, carry information about the internal structures they encounter.

4.Echo Processing: **The transducer detects the returning echoes and sends them to a computer for processing.** The computer analyzes the timing and intensity of the echoes to create a visual representation.





Working of ultrasonography

5.Image Formation: The processed information generates real-time images on a monitor. These are grayscale images, with shades of grey representing **varying tissue densities**. **Brighter areas indicate strong echoes, while darker areas represent weaker echoes or areas where sound waves were absorbed.**

6.Dynamic Imaging: Ultrasound helps capture movement within the body, **such as heart beating or blood flow through vessels.**

7.Diagnostic Interpretation: The real-time images produced by ultrasonography provide valuable information to healthcare professionals. **They can identify abnormalities, visualize organs & structures, guide medical procedures like monitor pregnancies, & assess blood flow.**

Echolocation	Ultrasonography
It is a natural phenomenon observed in certain animal species.	It is a human-developed technology.
Animals use echolocation for hunting, survival, navigation, & communication & acts as a primary sensory tool for animals.	Used in medicine for diagnostic imaging.
Animals that use echolocation generate sound waves, typically through clicks, chirps, or vocalizations.	Used an ultrasound transducer to emit sound waves into the body & also detects the returning echoes.
Animals rely on the reflection of sound waves from objects in their environment to detect and interpret echoes. The timing, intensity, and frequency of echoes provide information about the environment.	Used machines emit sound waves that penetrate the body and interact with tissues. A computer processes the returning echoes to create real-time images of internal structures based on tissue density and properties differences.
Animals possess specialized anatomical structures like vocal cords, air sacs, etc., that emit sound waves for echolocation.	Used is a handheld device operated by a trained technician or medical professional.
Echolocation is utilized by specific animal species, primarily	Used is used to diagnose & monitor various conditions,

Sonar

- Sonar, short for **"sound navigation and ranging,"** is a technology that uses sound waves to navigate, communicate, and detect objects underwater.
- It operates on a principle like **echolocation,** widely used in marine and underwater applications, including navigation, communication, mapping, and detecting underwater objects and obstacles.

Active Sonar

System generates its sound waves and listens for the echoes. This is used for underwater mapping, navigation, and detecting submarines or other vehicles.

Passive Sonar

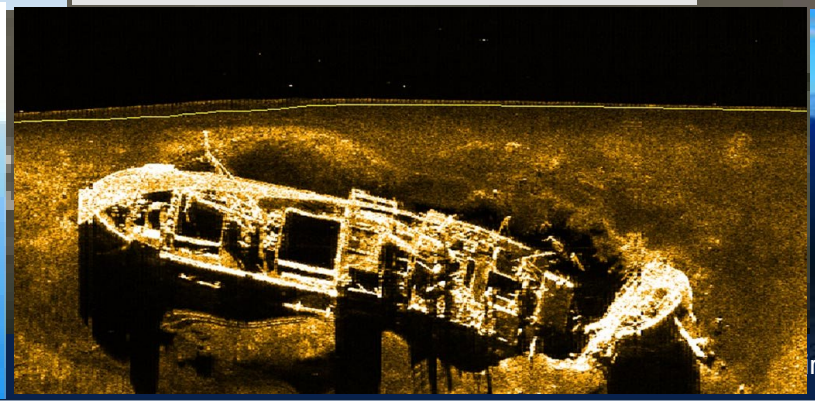
Only listen for sound waves produced by other sources, such as engines or propellers of ships and submarines. Used for detecting & tracking underwater vessels without revealing the sonar system's presence.

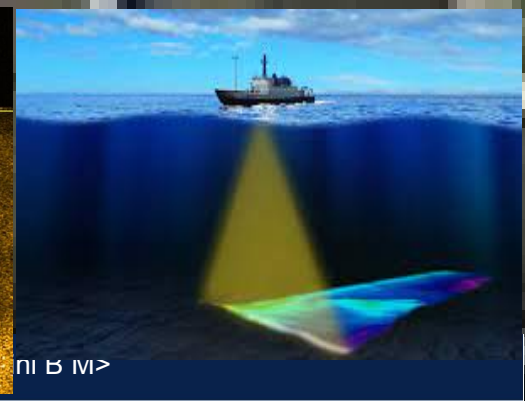
Side Scan Sonar

Provides detailed images of the seafloor by emitting sound waves to the sides and capturing the echoes. Used for underwater mapping & searching for objects like shipwrecks or submerged debris.

Multibeam Sonar

It emits multiple sound beams simultaneously in a fan-like pattern, allowing for rapid and detailed mapping of the seafloor or underwater structures.





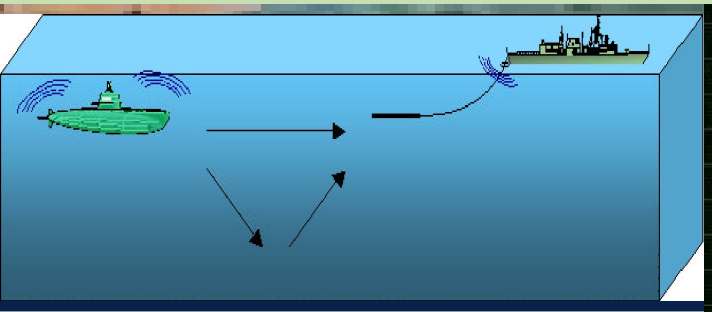
Working of Sonar

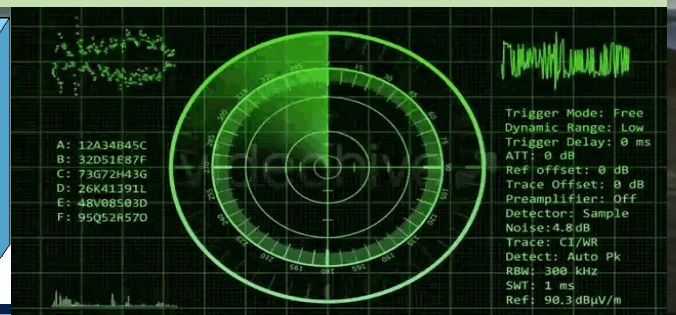
1.Sound Wave Generation: A sonar system emits sound waves into the water, typically in short pulses of sound. These sound waves are often at frequencies beyond the range of human hearing and can travel long distances underwater.

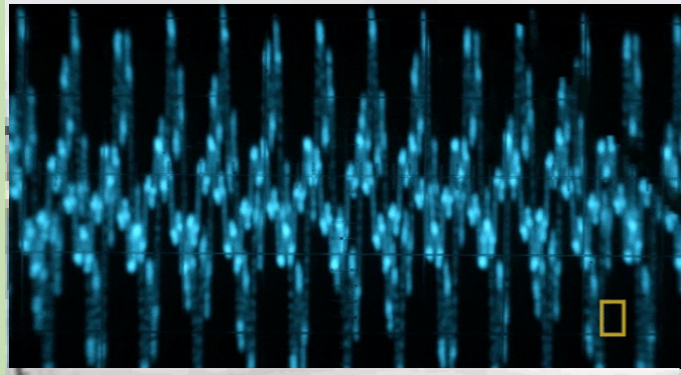
2.Propagation and Reflection: The emitted sound waves travel through the water and interact underwater with various objects, surfaces, and boundaries. When the sound waves encounter an object, they are partially reflected toward the sonar system.

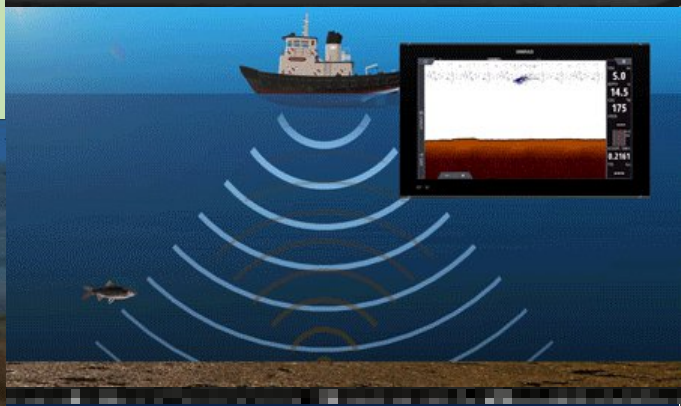
3.Echo Detection and Timing: The sonar system has a receiver that detects the echoes produced by the reflected sound waves. **By measuring the time taken by the echoes to return to the system**, the distance to the object can be calculated using the speed of sound in water.

4.Image or Data Creation: The information gathered from the echoes is processed by a computer to create visual representations or data displays. In some cases, sonar systems can generate detailed images of underwater structures, terrain, or objects based on the echoes and their timing.







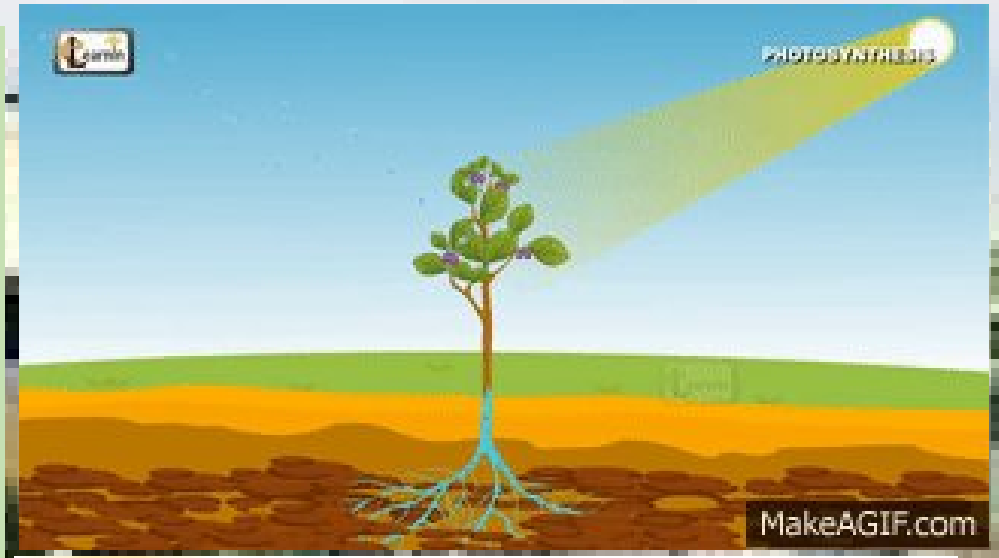


<Tejaswini B M>

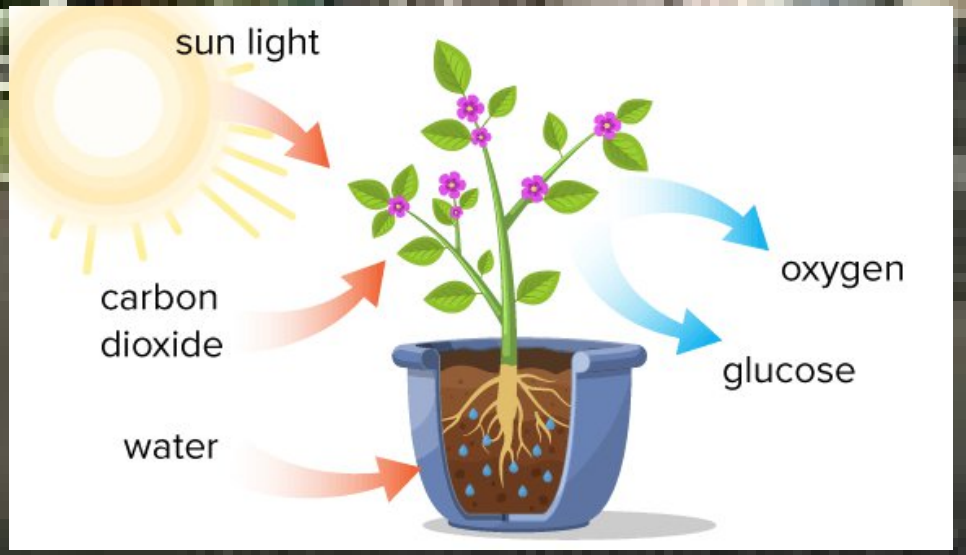
Echolocation	Sonar
It is a natural phenomenon observed in certain animal species.	It is a human-developed technology.
Animals use echolocation for hunting, survival, navigation, & communication & acts as a primary sensory tool for animals.	SONAR is used primarily for underwater navigation, communication, mapping, and detecting objects.
Animals specialized anatomical structures and sensory abilities that allow them to emit and interpret sound waves for survival and orientation..	SONAR uses specialized equipment, including transmitters and receivers, to generate and detect sound waves for specific purposes.
Echolocation used by animals is often more limited in range and resolution than SONAR. However, some animals have evolved highly sophisticated echolocation abilities that allow them to detect and localize objects in their environment accurately.	SONAR technology allows for controlled emission of sound waves at specific frequencies and can cover longer distances underwater. It offers precise measurements and detailed mapping of underwater terrain.
Echolocation is utilized by specific animal species, primarily bats, dolphins, whales, and birds, for survival and orientation.	SONAR is used by submarines, ships, underwater robots, fishing vessels, and research vessels to navigate, communicate, and detect underwater features.

Photosynthesis

- Photosynthesis, the bioengineering process that sustains life on Earth, is a fundamental biological phenomenon that powers the growth, development, and survival of plants and certain bacteria.
- This process transforms sunlight, carbon dioxide, and water into energy-rich sugars and oxygen and is the foundation for Earth's ecosystems and food chains.



Photosynthesis occurs in the chloroplasts of plant cells, primarily in the leaves where light energy from the sun is converted into chemical energy stored as glucose and other organic compounds. This process can be divided into two main stages: the light-dependent reactions and the light-independent reactions



Photosynthesis

The radiations reaching earth from the sun and converting them into different useful forms of energy is called solar energy.

The solar energy can be utilized in two ways,

- Conversion of solar energy directly into electrical energy.
- Ex: Photo voltaic cells

- Converting solar energy to chemical energy and later using it.
- Ex: Photo Synthesis

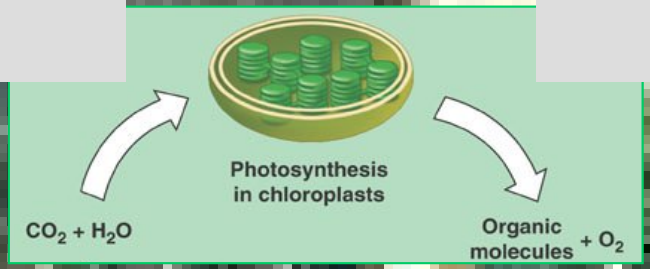
Formula for PHOTOSYNTHESIS

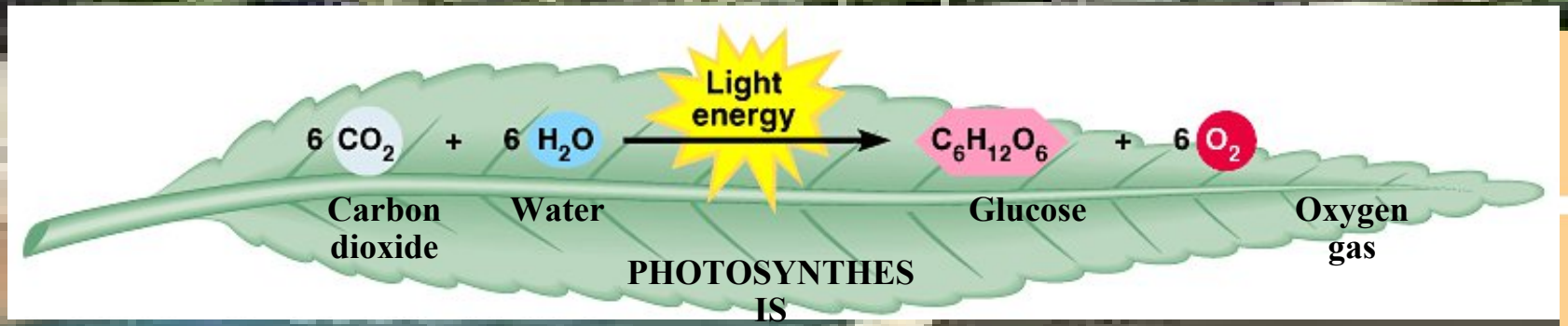
- Photosynthesis is the process by which autotrophic organisms use light energy to make sugar and oxygen gas from carbon dioxide and water

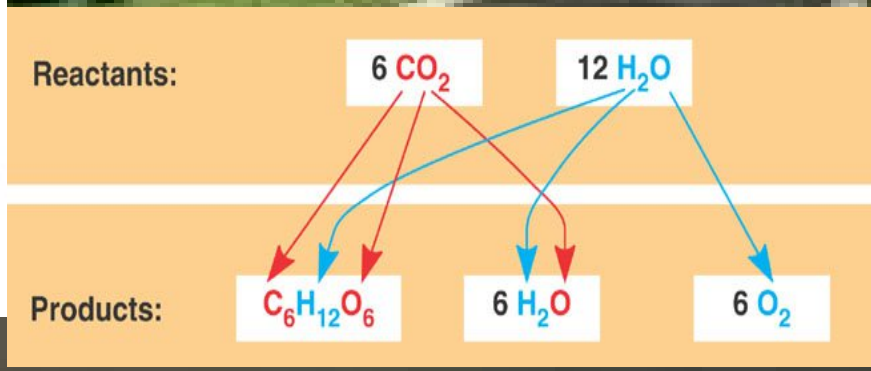
$$6\,CO_2 + 6\,H_2O + light\ energy \rightarrow C_6H_{12}O_6 + 6\,O_2$$

$6\,CO_2 + 6\,H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + 6\,O_2$

Equation for photosynthesis







Photosynthesis

Photosynthesis:

Definition: Photosynthesis is the biochemical process by which plants, algae, and some bacteria convert sunlight, carbon dioxide, and water into glucose (sugar) and oxygen. It is the fundamental process that sustains life on Earth by producing food and oxygen.

Stages:

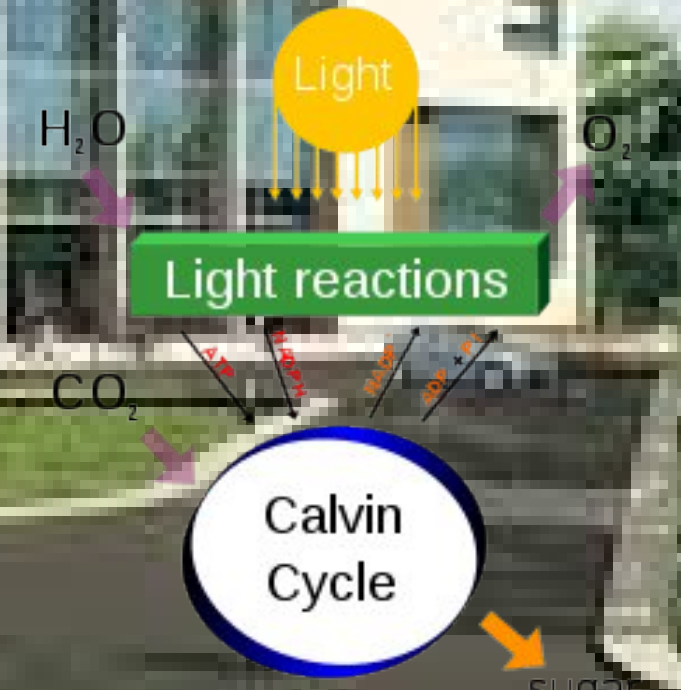
Light-Dependent Reactions: These reactions occur in the membranes of chloroplasts. They involve the absorption of light energy to produce **ATP and NADPH(Nicotinamide Adenine Dinucleotide Phosphate Hydrogen)**, which are used in the next stage.

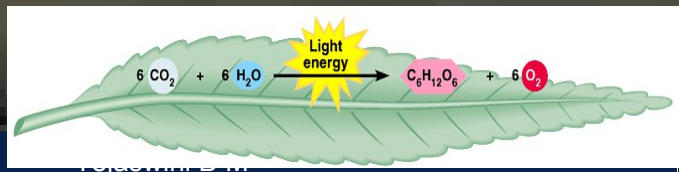
Light-Independent Reactions (Calvin Cycle): These reactions take place in the stroma of chloroplasts. They use ATP and NADPH produced in light-dependent reactions to convert **carbon dioxide** into **glucose.**

Chlorophyll: Chlorophyll is the green pigment in chloroplasts that plays a central role in capturing light energy during photosynthesis.

Products: Photosynthesis produces glucose (a form of stored energy), oxygen (released into the atmosphere),

Importance: Photosynthesis is crucial for the carbon cycle, providing oxygen for respiration and food for all heterotrophic organisms.





Photosynthesis

Photovoltaic Cells (Solar Cells):

Definition: Photovoltaic cells, also known as solar cells, are semiconductor devices that convert sunlight (photons) into electricity (voltage and current).

Materials: Common materials used in photovoltaic cells include silicon (crystalline and amorphous), cadmium telluride, Quantum Dots, and organic polymers.

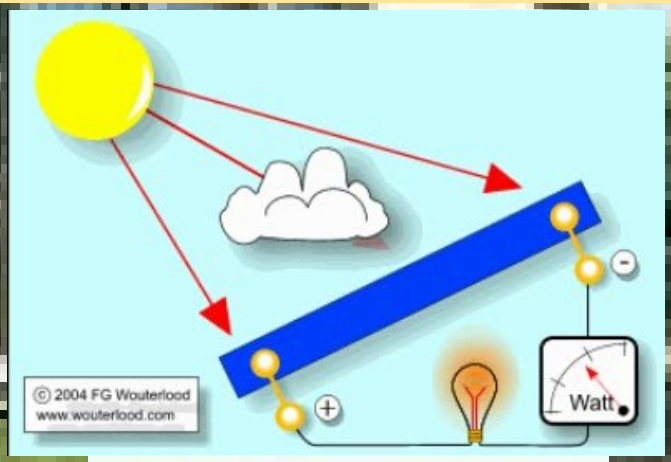
Function:

Light Absorption: Photovoltaic cells have a semiconductor layer that absorbs photons from sunlight, exciting electrons.

Electron Movement: Excited electrons create an electric current when they move through the semiconductor material.

Generation of Electricity: The electric current generated is used as electrical power or stored in batteries for later use.

Efficiency: The efficiency of photovoltaic cells varies by material and technology. It's typically in the range of 15% to 22% for commercial cells, with advanced designs achieving higher efficiencies.



Photosynthesis

Photovoltaic Cells (Solar Cells):

Definition: Photovoltaic cells, also known as solar cells, are semiconductor devices that convert sunlight (photons) into electricity (voltage and current).

Applications:

- **Residential and Commercial Solar Panels:** Photovoltaic cells are widely used to generate electricity for homes and businesses.
- **Solar Farms:** Large arrays of solar panels generate utility-scale power.
- **Portable Solar Chargers:** These are used for charging devices like smartphones and laptops.
- **Space Exploration:** Solar panels are commonly used on spacecraft due to their reliability and ability to generate power from sunlight in space.

Advantages:

Renewable and clean energy source.

Low environmental impact during operation.

Reduces dependence on fossil fuels.

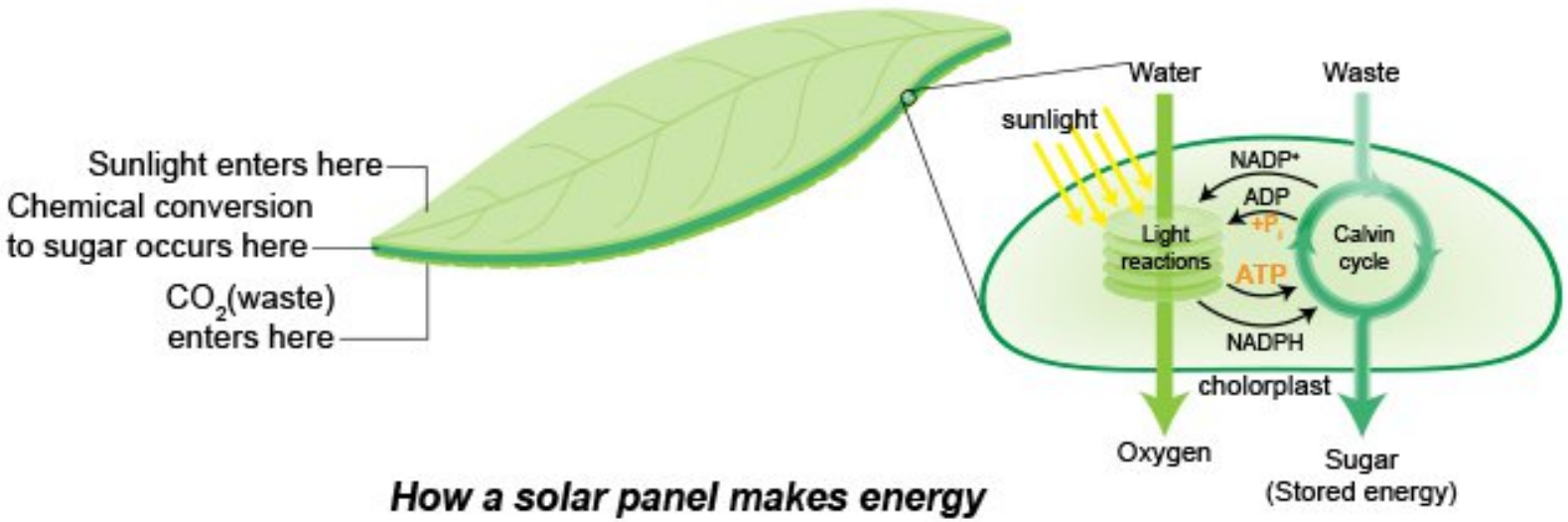
Challenges:

Energy storage is necessary for nighttime or cloudy periods.

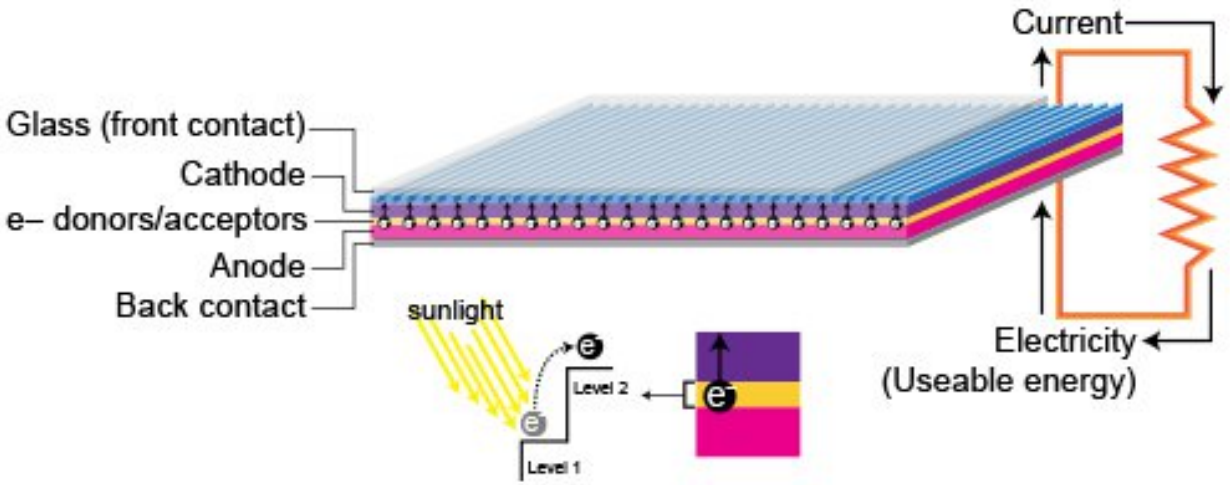
Manufacturing and recycling can have environmental impacts.

Initial installation costs can be high.

How a plant makes energy



How a solar panel makes energy



Bionic Leaf

- A bionic leaf, also **known as an artificial or synthetic leaf**, is a concept inspired by photosynthesis in natural leaves.
- It aims to mimic the process of photosynthesis using advanced technology and materials to generate energy.

Design and Materials:

- The bionic leaf typically consists of semiconductor material, such as silicon or other advanced materials, with cobalt–phosphate cluster (Co-OEC) which can absorb sunlight and convert it into electrical energy.
- These materials are designed to mimic the chlorophyll in natural leaves, which captures sunlight for photosynthesis.

Light Absorption:

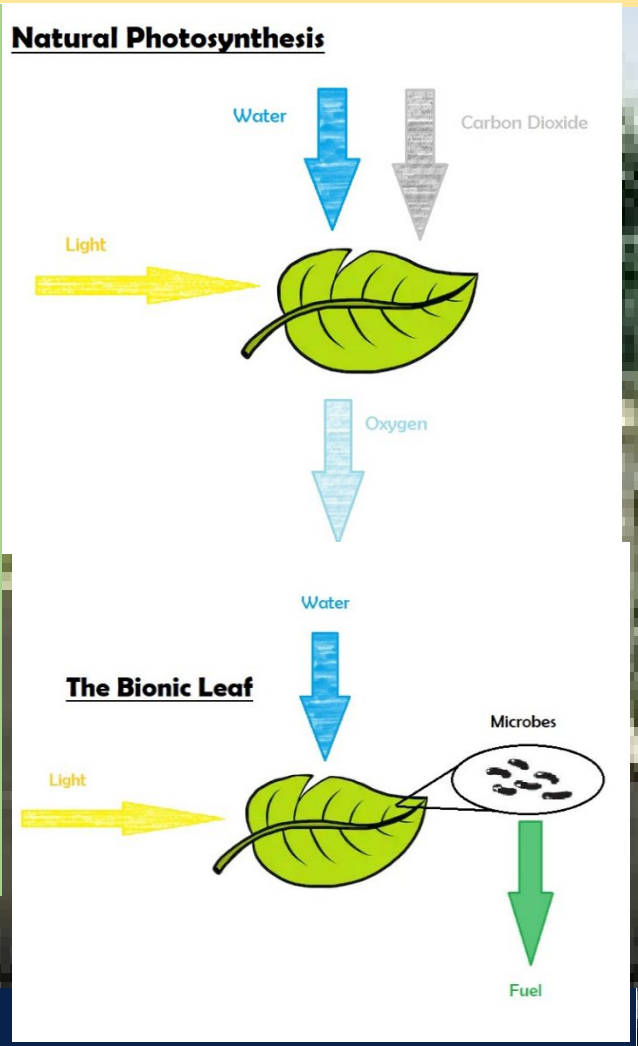
- Just like natural leaves, the bionic leaf is designed to efficiently absorb sunlight across a broad spectrum of wavelengths, including visible and UV light.

Electron Excitation and current generation:

- When sunlight hits the bionic leaf's surface, it excites electrons in the semiconductor material
- The excited electrons flow through a circuit, generating an electric current.

Oxygen Production (optional):

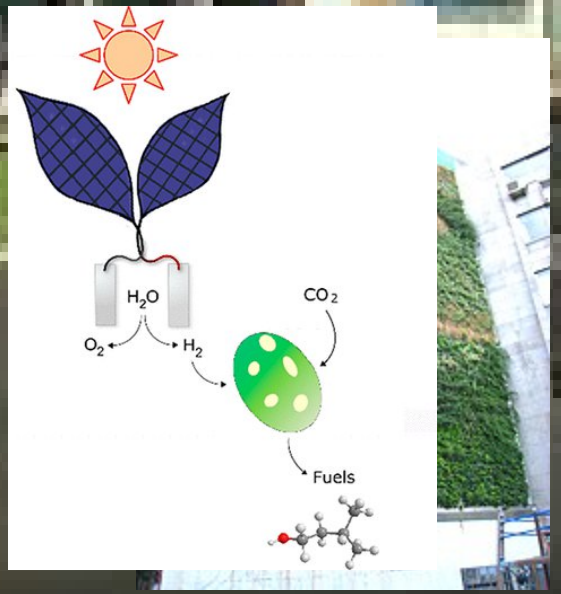
- Bionic leaves, may also be a component that produces oxygen as a byproduct, like the oxygen produced in natural photosynthesis.



Bionic Leaf

APPLICATIONS :

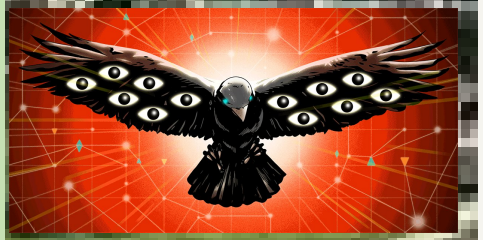
- **Renewable Energy Production:** Bionic leaves can be used to generate energy from sunlight. **This increases efficiency compared with PV Cells.**
- **Microbial Fuel Production:** The Bionic Leaf is a device that uses the power of the sun to split water and produce hydrogen using a catalyst. That renewable hydrogen is then used to feed genetically enhanced bacteria that will produce liquid fuels because of the bioreaction with a stream of carbon dioxide.
- **Hydrogen Production:** Bionic leaves can be used to produce hydrogen gas through a process called water splitting. Hydrogen is a clean fuel that can be used in fuel cells
- **Agriculture:** Bionic leaves could be used in agriculture to improve crop yields and photosynthetic efficiency. They might be integrated into plant structures to enhance the plant's ability to convert sunlight into energy and grow more efficiently.
- **Greenhouse Gas Mitigation:** By capturing and converting carbon dioxide from the atmosphere, bionic leaves could play a role in altering climate change by reducing greenhouse gas concentrations.
- **Biomedical Devices:** Bionic leaves could be used to power small medical devices, providing a sustainable energy source for various medical applications.



Bird Flying

- Bird flight is the primary mode of locomotion used by most bird species in which birds take off and fly.
- Flight assists birds with feeding, breeding, avoiding predators, and migrating.

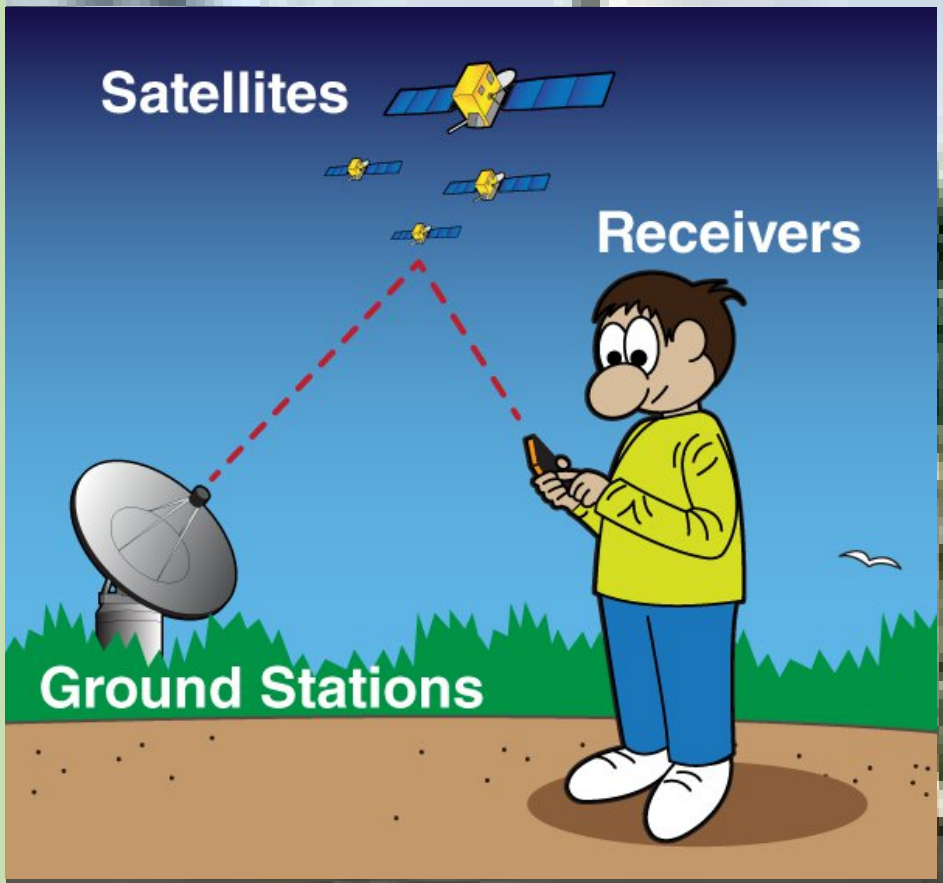
- **Natural Navigation:** Birds have evolved over millions of years with a variety of specialized mechanisms for navigation. They use distinctive abilities and instincts for **flying and migration.**
- **Senses:** Birds use a combination of **visual cues(pictures or symbols), celestial navigation (the position of the sun, stars, and moon),** and **magnetic fields (magnetoreception) to navigate**. They can detect the Earth's magnetic field and **use it as a compass.**
- **Behavioral Adaptations:** Birds often rely on visual landmarks, environmental cues, and learned behaviors. They can recognize specific landmarks, coastlines, rivers, and mountains during flight.
- **No Technology Required:** Birds do not need any external technological devices for navigation. Their navigation skills are entirely natural.



GPS (Global Positioning System)

GPS (Global Positioning System):

- **Artificial Navigation:** GPS is a man-made navigation system that relies on a network of satellites in orbit around the Earth.
- **Satellite-Based:** GPS receivers on Earth communicate with these satellites to determine their precise position and time.
- **Triangulation:** GPS calculates signals from at least four satellites to calculate the user's location. It relies on precise timing and mathematical algorithms.
- **Human-Created Technology:** GPS is a human-created technology that requires satellites, ground-based infrastructure, and GPS receivers to function.
- **Wide Range of Applications:** GPS has many applications beyond navigation, including mapping, surveying, tracking vehicles, and more. It's used for both civilian and military purposes.

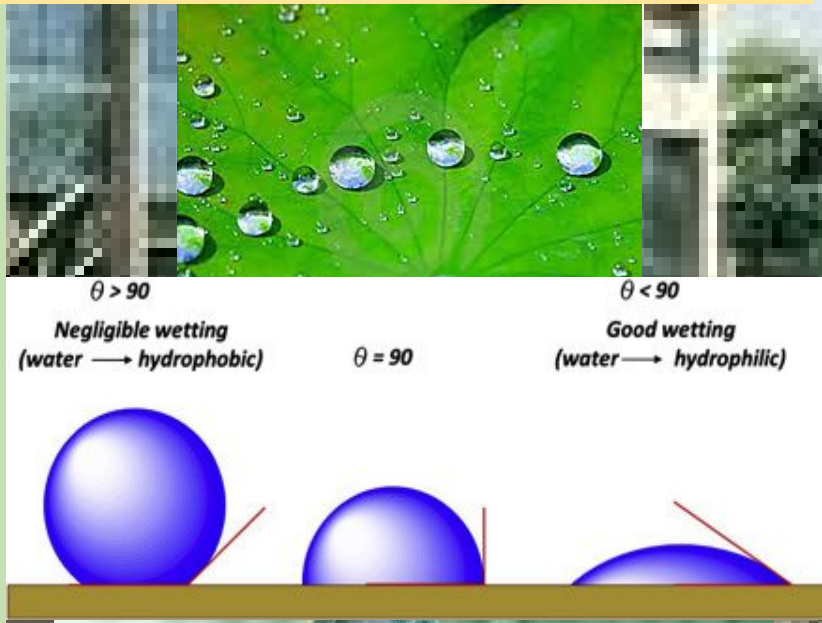


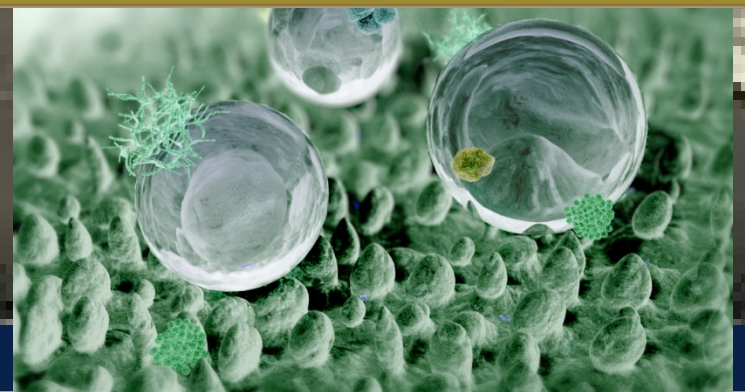
Lotus leaf effect

- The Lotus leaf effect, also known for its **super hydrophobicity and self cleaning**, is a phenomenon observed in lotus leaves and other natural surfaces where water droplets **exhibit extremely high contact angles and low adhesion to the surface**.
- This remarkable property is primarily due to the unique combination of **surface microstructure and surface chemistry**.

Mechanism:

- **Surface Microstructure:** Lotus leaves have a **rough microscale and nanoscale structure**. They are covered **with tiny, cone-shaped papillae**, **and each papillae is further has even smaller nanoscale bumps.** This structure creates a vast amount of air pockets on the leaf's surface.
- **Low Surface Energy:** Lotus leaves have a **wax-like coating made up of hydrophobic chemicals.** This low surface energy prevents water molecules from wetting the surface. Instead, water droplets rest on the tips of the micro/nanostructures.
- **Cassie-Baxter State:** When water droplets land on the lotus leaf, they don't penetrate the surface but rather remain in a state known as the Cassie-Baxter state. In this state, air is trapped between the water droplet and the rough surface, reducing the solid-liquid contact area. This results in a high contact angle, typically greater than 150 degrees, and low adhesion.





Lotus leaf effect

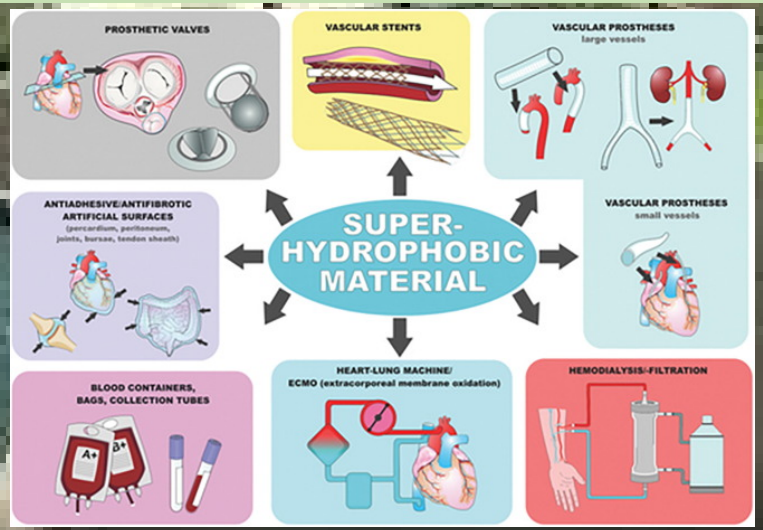
Applications:

- **Self-Cleaning Surfaces:** The Lotus leaf effect has inspired the creation of self-cleaning surfaces for various applications. Surfaces coated with superhydrophobic materials repel water and prevent dirt and contaminants from sticking. This is useful for architectural surfaces, car windshields, and more, reducing maintenance and cleaning efforts. Examples :- Precipitated calcium carbonate, Carbon nano-tube structures, Silica nano-coating.
- **Water-Repellent Textiles:** Superhydrophobic coatings can be applied to textiles, making them water-resistant and stain-resistant. This has applications in outdoor clothing and sports gears.
- **Oil-Water Separation:** The Lotus leaf effect is valuable in oil-water separation technologies. Superhydrophobic materials can selectively repel water while absorbing oils, making them useful in cleaning up oil spills and separating oil and water in industrial processes.

Lotus leaf effect

Applications:

- **Anti-Icing Surfaces:** By repelling water, superhydrophobic surfaces can also reduce ice formation. This has applications in aircraft, power lines, and other infrastructure where ice formation is problematic.
- **Biomedical Devices:** Superhydrophobic coatings can be applied to medical devices to prevent the buildup of biological materials and make them easier to clean and sterilize.
- **Electronics Protection:** Superhydrophobic coatings are used to protect electronic devices from water damage, especially in outdoor or rugged environments.

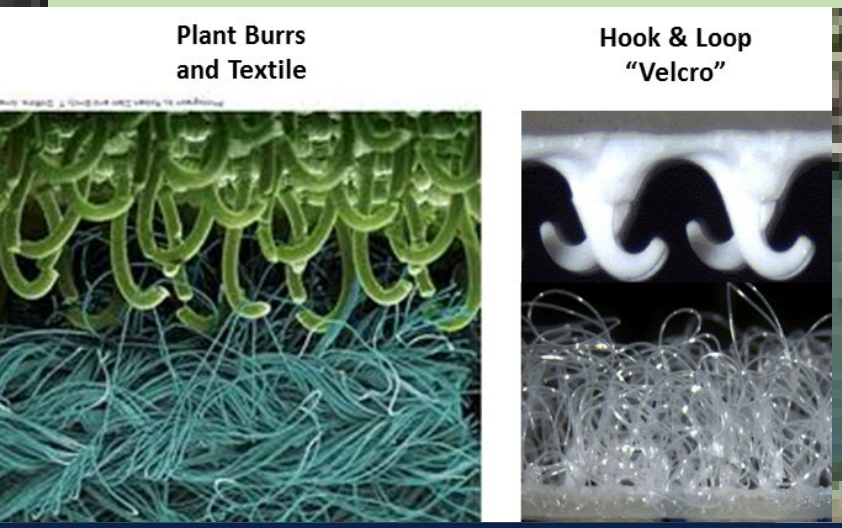


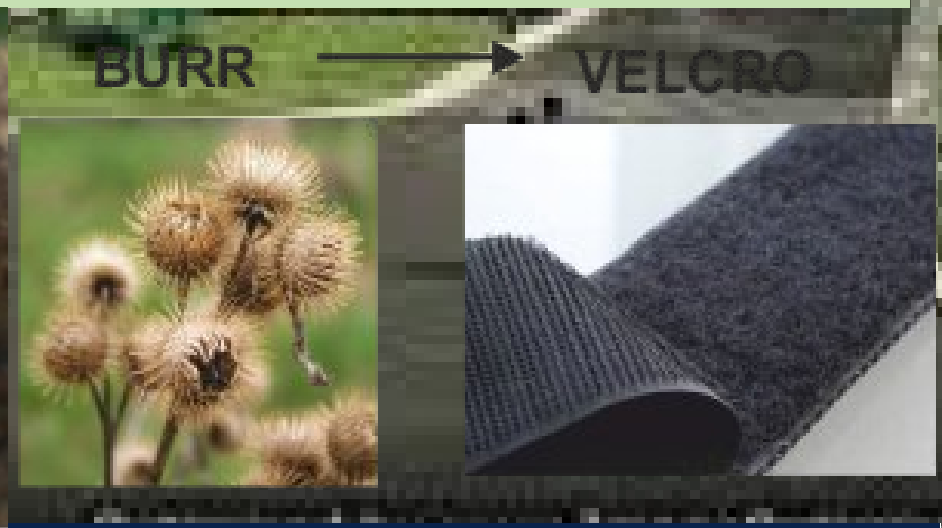
Plant burrs (Velcro)

- **The concept of Velcro,** a popular **hook-and-loop** fastening system, was inspired by the natural design of plant burrs, specifically those of the burdock plant.

Mechanism:

- **Plant Burrs:** Many plants, like burdock and cocklebur, produce seeds with tiny **hooks or barbs. When an animal or passerby brushes against the plant, the hooks catch onto clothing or fur.** These hooks are evolved adaptations that aid in seed dispersal.
- **Velcro Invention:** Inspired by this natural mechanism, **George de Mestral** designed Velcro**. Velcro consists of two strips:** one with tiny **hooks** (like the burr hooks) and another **with loops** (like the fabric of clothing). When pressed together, the hooks catch onto the loops, creating a secure fastening system





Plant burrs (Velcro)

Applications of Velcro:

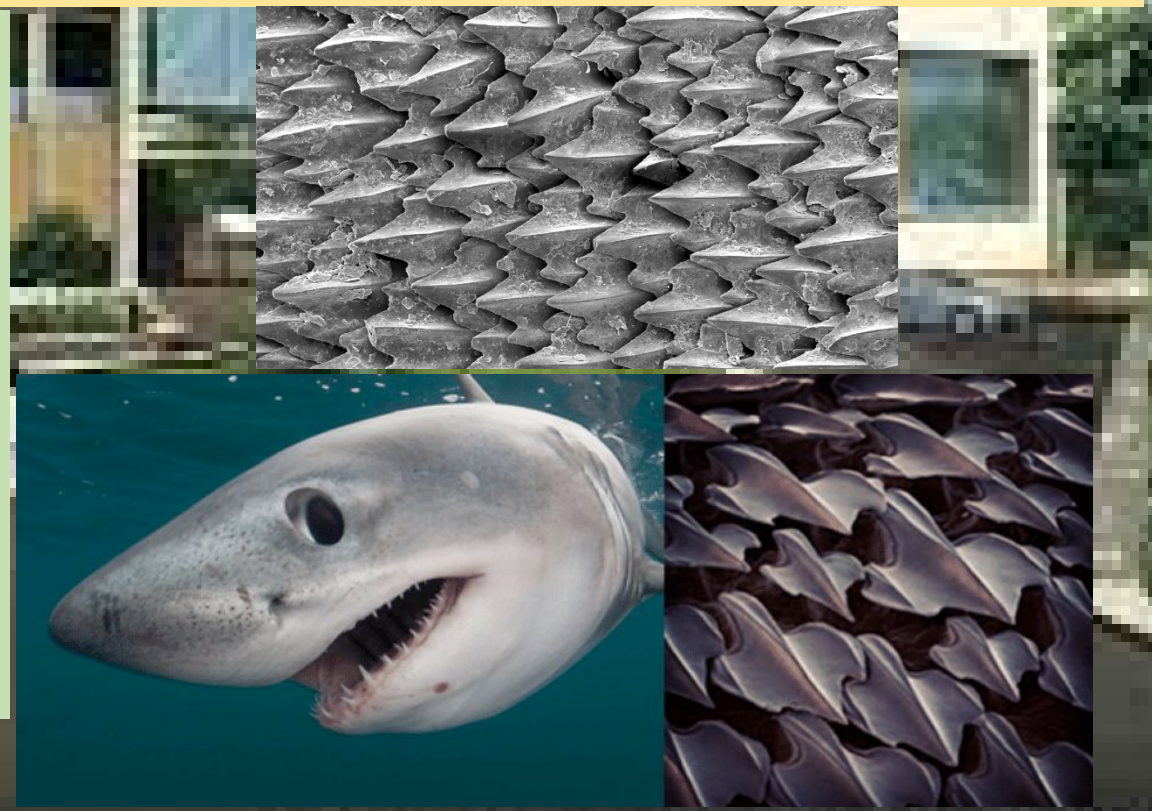
- **Clothing and Textiles:** Velcro is used in clothing, shoes, and accessories for closures, straps, and adjustability.
- **Footwear:** Velcro straps are common in shoes, especially children's and sports footwear.
- **Sports and Outdoor Gear:** Velcro is used in sports equipment, like gloves and pads, and outdoor gear, including tents and backpacks.
- **Medical Devices:** Velcro straps are employed in medical braces, splints, and compression garments.
- **Aerospace:** Velcro is used in spacecraft to secure equipment in a microgravity environment.
- **Automotive:** Velcro secures interior panels, carpeting, and various accessories in vehicles.
- **Packaging:** Velcro can be used as a reusable fastening method in packaging.
- **Military and Tactical Gear:** Velcro is employed in uniforms, gear attachments, and accessories.
- **Arts and Crafts:** Velcro is a popular material for various creative projects and crafts.
- **Cable Management:** Velcro cable ties are used to bundle and organize cables and wires.

Shark skin and Friction reducing swimsuits

- Shark skin has inspired the **design of friction-reducing swimwear** and other types of swimwear intended to improve **hydrodynamics and swimming performance**.
- This biomimetic approach to swimwear design is based on the unique properties of shark skin and how it **reduces drag in water.**

Shark Skin and Its Properties:

- **Dermal Denticles:** Shark skin is covered in tiny **V-shaped scales** called **dermal denticles.** These scales have a **rough texture**, with small ridges running down their length. Importantly, the **orientation of these ridges** is such that they help to reduce drag when the shark swims through the water.
- **Reduced Drag:** The arrangement of the dermal denticles disrupts the flow of water over the shark's skin, **reducing the turbulence and drag** that would typically occur. This, in turn, allows sharks **to swim faster and more efficiently through water.**



Applications in Swimwear:

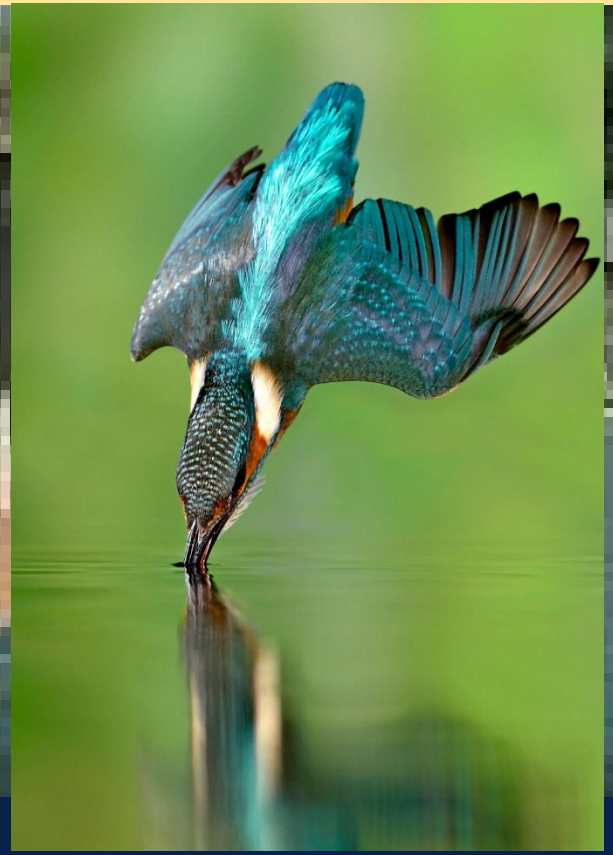
- **Biomimicry in Swimwear:** Researchers and designers have sought to mimic the properties of shark skin in the development of swimwear. The goal is to reduce the drag experienced by swimmers, ultimately improving their performance in the water.
- **Friction-Reducing Swimsuits:** These swimsuits are designed with textured materials that mimic the microstructure of shark skin. By aligning the texture in a way that reduces water resistance, these swimsuits can help swimmers move through the water with less effort and faster speeds.
- **Competitive Swimming:** Friction-reducing swimsuits have been particularly popular in competitive swimming. They are designed to reduce drag and increase buoyancy, enabling swimmers to glide more effectively through the water.
- **Wetsuits:** Wetsuits used for activities such as scuba diving and surfing also benefit from biomimetic design. The texture on the surface of these suits can reduce drag, enhance flexibility, and improve the overall experience for users in the water.

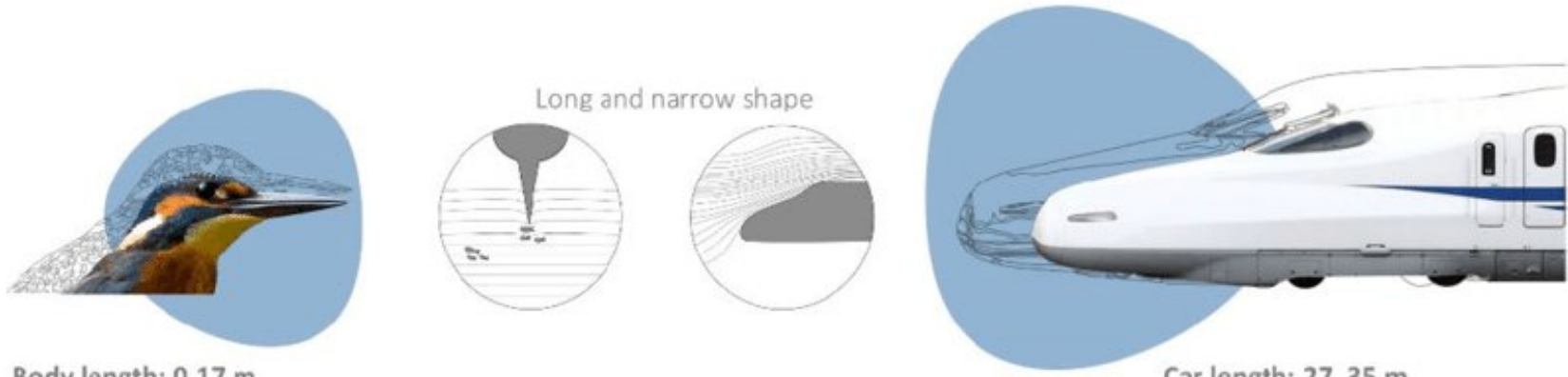
Sharkskin-inspired swimsuits received a lot of media attention during the 2008 Summer Olympics when the spotlight was shining on Michael Phelps.

Kingfisher beak (Bullet train)

The Strategy:

- The secret is in the shape of the kingfisher's beak. A long and narrow cone, the kingfisher's beak parts enters the water without **creating a compression wave below the surface or a noisy splash above.**
- The fine point of the conical beak presents little surface area or resistance to the water upon entry, it penetrates further into the water.





Kingfisher beak (Bullet train)

Biomimicry Inspiration:

- The design of the front end of **Japan's Shinkansen**, or bullet trains, was inspired by the beak of the Kingfisher bird. It can dive into water to catch fish with very little splashing. This is made possible by the beak's streamlined shape, which minimizes disturbances in the water.
- Engineers sought to apply this principle to high-speed trains to reduce the sonic boom created as the train enters and exits tunnels. A sonic boom is the noise created by an aircraft or some other object when it surpasses the speed of sound.
- **Bullet Train Design: The Shinkansen's nose design**, often referred to as **the "Kingfisher nose,"** features a long, tapered, and slender shape. This design minimizes air compression and shockwaves as the train moves through tunnels, thereby reducing noise and vibrations.
- **Efficiency and Speed:** The streamlined nose design also contributes to the train's overall efficiency and allows it to reach high speeds while maintaining stability and safety.

Human Blood substitutes

Human blood substitutes, also known as artificial blood or blood substitutes, **are synthetic or modified substances** designed to perform **some or all the functions** of natural blood. These substitutes are developed to serve as alternatives to traditional blood transfusions and can have **various medical and therapeutic applications**.

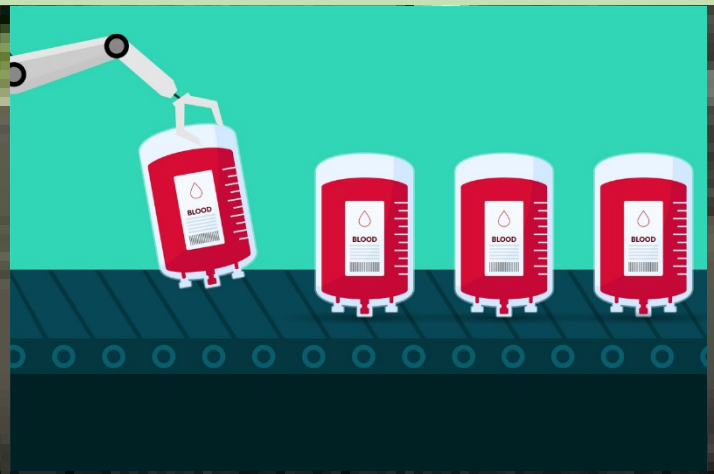
Purpose:

- The primary purpose of blood substitutes is to **provide oxygen transport** and carry out other **vital functions** of natural blood without **relying on donated blood**.
- They can be especially useful in situations where **real blood is not readily available or suitable**, such as during emergencies, in remote locations, or for patients with specific medical conditions.

Types: Blood substitutes can be categorized into two main types:

Hemoglobin-Based Oxygen Carriers (HBOCs): These are derived from **purified** and **modified hemoglobin**, the oxygen-carrying protein found in red blood cells. HBOCs are designed to **mimic the oxygen-carrying capability** of red blood cells.

Perfluorocarbon-Based Oxygen Carriers (PFCs): These substitutes contain **perfluorocarbon molecules**, which have a high oxygen-carrying capacity. PFC-based blood substitutes do not rely on hemoglobin and can dissolve a large amount of oxygen.



Human Blood substitutes

Hemoglobin-Based Oxygen Carriers (HBOCs): Hemoglobin-based oxygen carriers (HBOCs) are substances designed to serve as blood substitutes by carrying and delivering oxygen to tissues in the body. These HBOCs are synthesized in the laboratory and have been developed as potential alternatives to traditional blood transfusions.

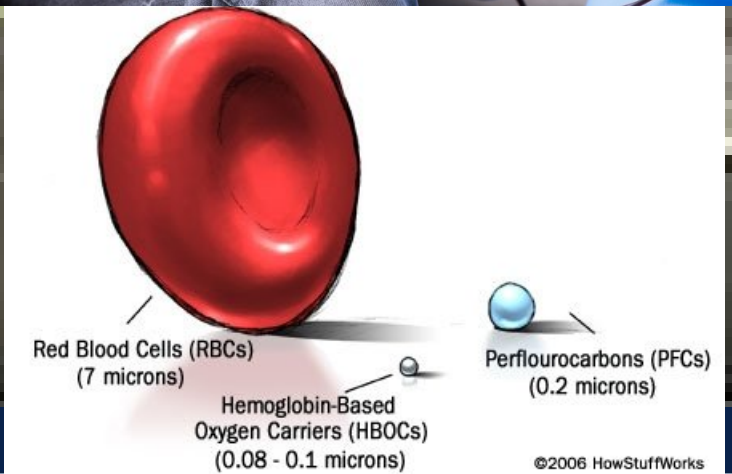
Purpose: The primary purpose of HBOCs is to provide a source of oxygen to the body when traditional blood transfusions are not readily available or not suitable for a patient. This can be especially important in emergency situations, trauma cases, or when blood is in short supply.

Composition: HBOCs are typically made from purified and modified hemoglobin, the protein responsible for transporting oxygen in red blood cells. Hemoglobin molecules can be derived from various sources, including human, bovine, or recombinant DNA technology.

Oxygen Transport: HBOCs can effectively carry and release oxygen to tissues in a manner like red blood cells. When HBOCs are infused into the bloodstream, they can bind to oxygen in the lungs and release it in areas with low oxygen concentrations, such as ischemic tissue.

Benefits: Immediate Availability, Universal Compatibility.

Challenges and Concerns: Short Half-Life, Ethical Considerations



Human Blood substitutes

Perfluorocarbon-Based Oxygen Carriers (PFCs): Perfluorocarbon-based oxygen carriers (PFCs) are a type of blood substitute designed to transport and deliver oxygen to body tissues. They are synthetic compounds composed of carbon and fluorine atoms, and they have several unique properties that make them valuable in medical and industrial applications.

Oxygen-Carrying Capacity: PFCs can dissolve a significant amount of **oxygen and carbon dioxide.** This property makes them efficient oxygen carriers, like hemoglobin in red blood cells.

Lack of Hemoglobin: Unlike hemoglobin-based oxygen carriers (HBOCs), PFCs do not contain hemoglobin, This absence of hemoglobin also means that PFCs are not susceptible to issues like sickling or clotting.

Biocompatibility: PFCs are biocompatible, meaning they do not elicit strong immune responses or adverse reactions when introduced into the bloodstream. This property makes them potentially suitable for a wide range of medical applications.

Liquid at Room Temperature: PFCs are liquid at room temperature, which allows for easy handling and administration. They can be injected directly into the bloodstream, where they can mix with natural blood components.

Blood Replacement: PFCs can serve as a temporary oxygen carrier in situations where blood transfusion is not possible or desired.

Imaging: PFCs are used as contrast agents in medical imaging, such as MRI.

Thank You

Tejaswini B M
Assistant Professor,
Dept. of Chemistry,
ATMECE, Mysuru