ATME College of Engineering

Biology for Engineers

BBOK405

Module 3: HUMAN ORGAN SYSTEMS AND BIO DESIGNS - 1

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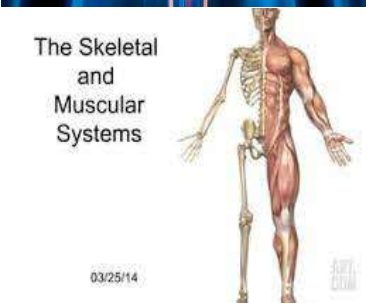
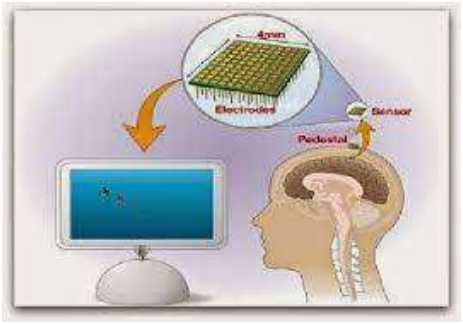
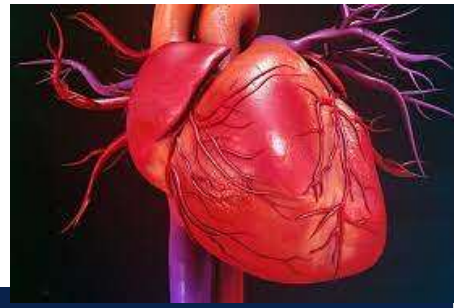
HUMAN ORGAN SYSTEMS AND BIO DESIGNS



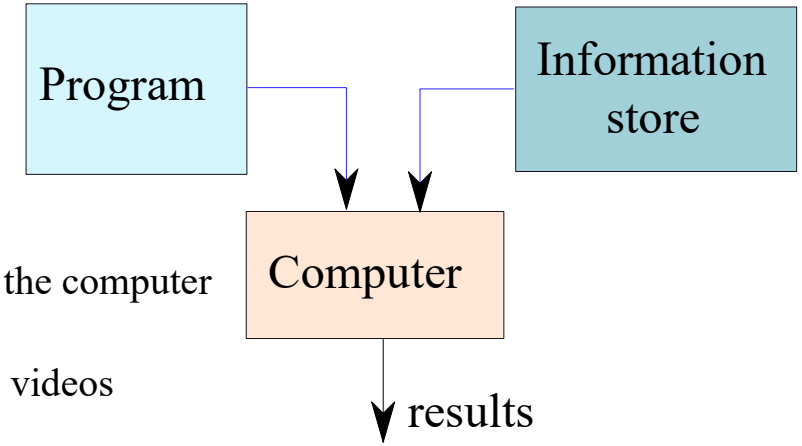
- The brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).
- Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye).
- Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart-related issues, reasons for blockages of blood vessels, design of stents, pacemakers, defibrillators).
- Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine).
- Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems).
- Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis).





What is a Computer?

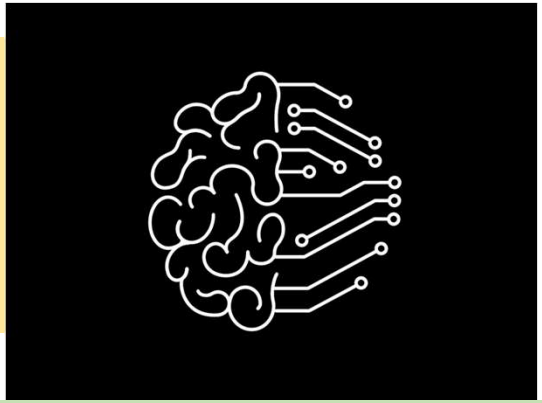
A computer is a general-purpose device that can be programmed to process information, and yield meaningful results.



- **Program** – List of instructions given to the computer
- **Information store** – data, images, files, videos
- **Computer** – Process the information store according to the instructions in the program

What is the most intelligent computer?

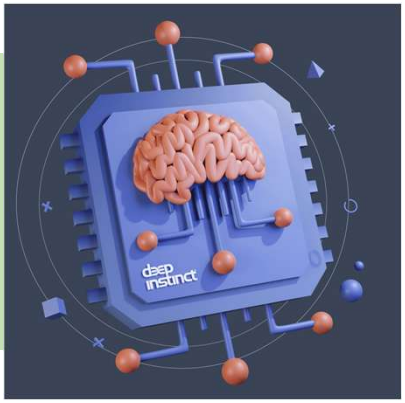
The brain as a CPU system

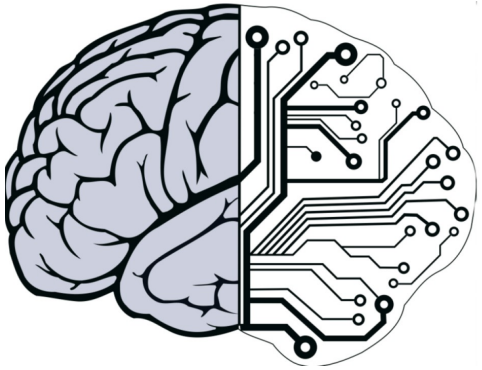


- **The brain is a complex CPU (Central Processing Unit) system with its own architecture and components.**
- **It consists of Central Nervous System (CNS) and the Peripheral Nervous System (PNS), which work together to process and transmit signals throughout the body.**

Both the brain and CPU:

- Receive and process inputs.
- Store information.
- Perform calculations.





Significant differences between the two.

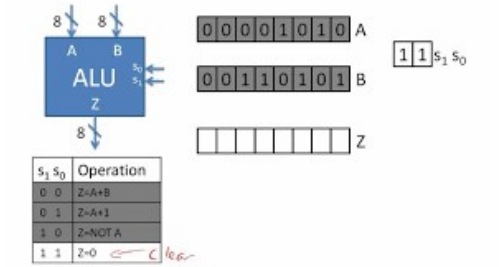
- Human brain has the ability to learn and adapt.
- The human brain is capable of performing tasks such as perception, thought, and emotion.

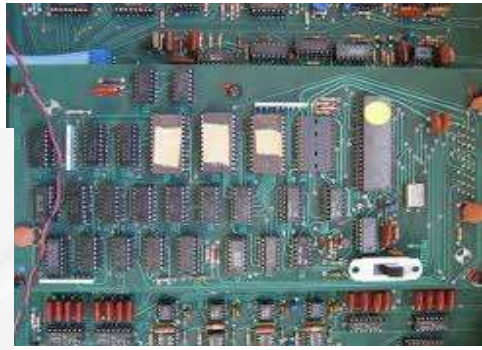
Basis for Comparison	Brain	Computer
Construction	Neurons and synapses	ICs, transistors, diodes, capacitors, transistors, etc.
Memory growth	Increases each time by connecting synaptic links	Increases by adding more memory chips
Energy consumption	12 watts of power	Gigawatts of power
Information storage	Stored in electrochemical and electric impulses.	Stored in numeric and symbolic form (i.e. in binary bits).
Transmission of information	Uses chemicals to fire the action potential in the neurons.	Communication is achieved through electrical coded signals.
Input/output equipment	Sensory organs	Keyboards, mouse, web cameras, etc.
Structural organization	Self-organized	Pre-programmed structure

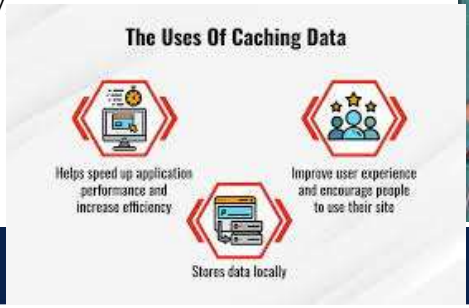
CPU Architecture

A CPU is the primary component of a computer responsible for executing instructions and performing calculations.

- **Control Unit (CU):** Manages the flow of data and instructions within the CPU, coordinating the activities of other components.
- **Arithmetic Logic Unit (ALU):** Performs arithmetic and logical operations, such as addition, subtraction, multiplication, division, and comparisons.
- **Registers:** High-speed memory units that store and transfer data within the CPU.
- **Cache:** A small, fast memory located on the CPU chip which stores frequently accessed data and instructions, reducing the need to fetch them from slower main memory

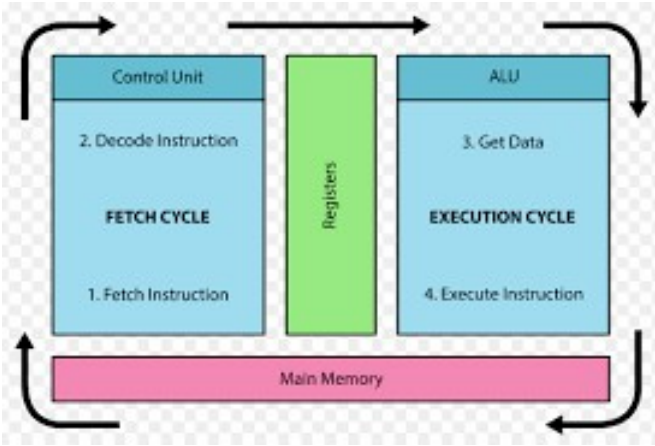


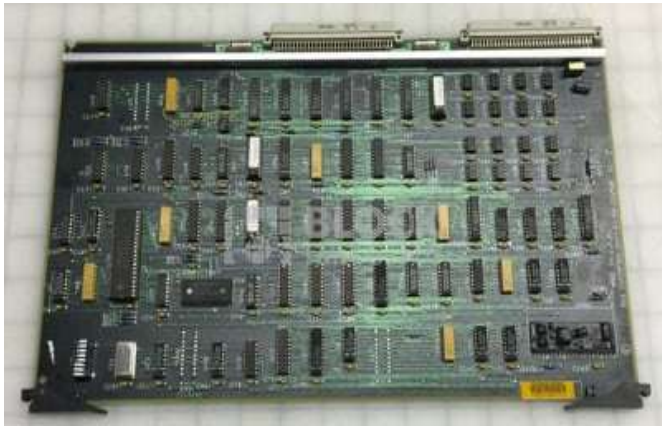




CPU Architecture

- **Instruction Fetch/Decode/Execute:** These stages form the instruction pipeline. The CPU fetches instructions from memory, decodes them to understand their meaning, and executes them by interacting with other components.
- **Bus Interface Unit (BIU):** The BIU manages communication between the CPU and other hardware components, facilitating data transfer over buses.





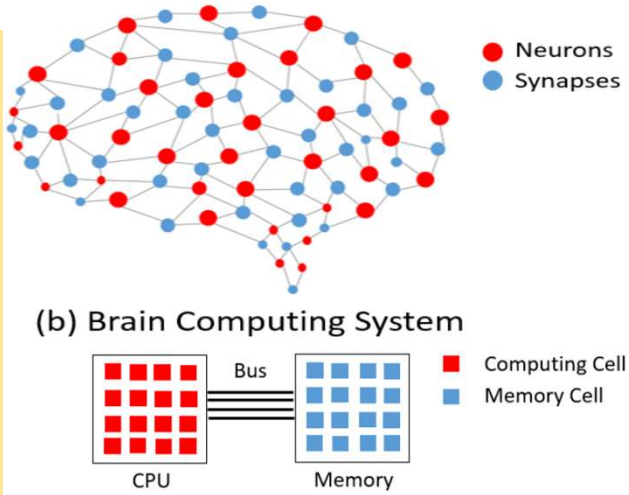
Brain as a CPU system

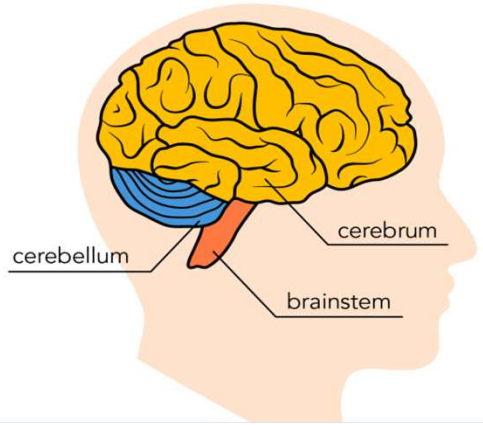
The Architecture of the Brain:

The architecture of the human brain as a CPU system can be compared to that of a **Parallel distributed processing system**, as proposed to the Von Neumann architecture of traditional computers.

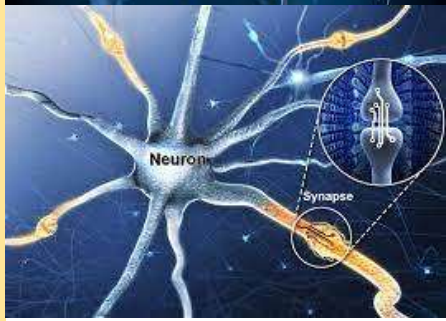
1. In the human brain, information is distributed **across multiple regions**, each with **specialized functions.**
2. **Whereas computers** are processed sequentially in a single centralized location.

3. On the other hand, the human brain is an incredibly complex organ composed of **billions of neurons and their connections**. While a precise understanding of its architecture is still being studied, some key features can be described:

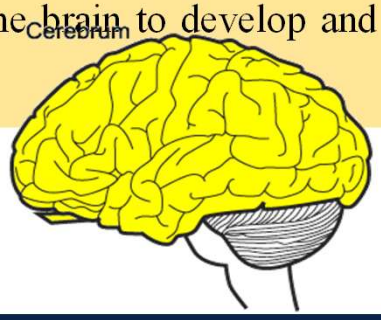


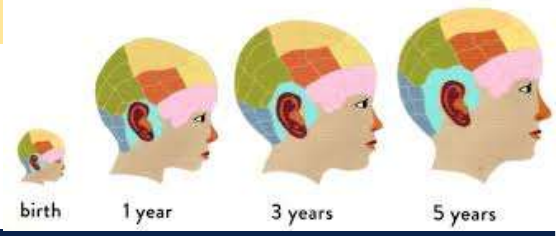


Brain as a CPU system

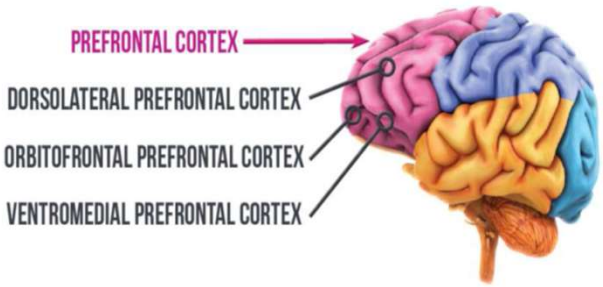


1. **Neurons:** Neurons are specialized cells in the brain that **transmit electrochemical signals**. They are interconnected to form complex neural networks.
2. **Synapses:** Synapses are the connections between neurons where information is transmitted. **Electrical signals** called **action potentials** trigger the release of neurotransmitters, which carry signals across the synapse.
3. **Brain Regions:** The brain is divided into different regions, each responsible for specific functions. The main divisions include the cerebrum, cerebellum, and brainstem.
4. **Plasticity:** The brain exhibits plasticity, which means it can reorganize and adapt its structure and connections based on experience and learning. This allows the brain to develop and acquire new skills throughout a person's lifetime. The architecture





Brain as a CPU system



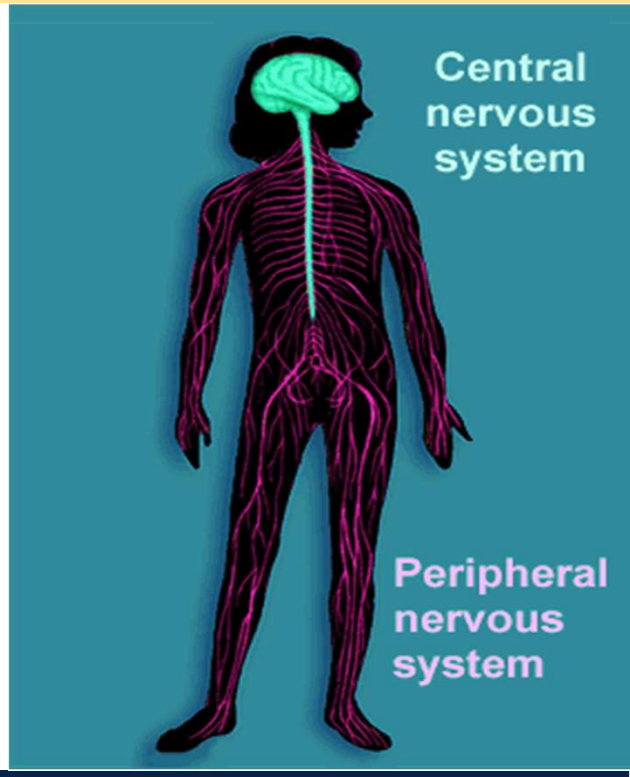
1. Computer's CPU also has memory units for storing information, and the human brain has **several regions** dedicated to **memory storage**.
2. It is important to note that the human brain is a **vastly more complex** and **capable system**, with many functions that are still not fully understood.

CNS and PNS

The **Central Nervous System (CNS)** and **Peripheral Nervous System (PNS)** are the two main components of the nervous system in the human body.

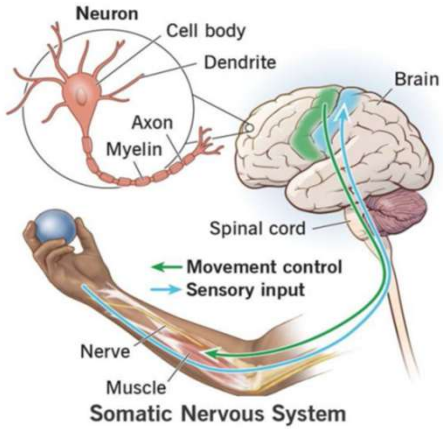
CNS (Central Nervous System): The CNS consists of the **brain and the spinal cord.** It serves as the main control center of the body, **processing and coordinating** information received from the **peripheral nervous system**.

1. **Brain:** The brain is the most complex and critical organ in the CNS. It controls and regulates various **bodily functions, including cognition, memory, emotions, sensory perception, and motor control**.
2. **Spinal Cord:** The spinal cord is a long, **cylindrical bundle of nerves extending from the brain's base** down the **vertebral column**. It acts as a **relay between the brain and the rest of the body**. The spinal cord is responsible for transmitting sensory information from the body to the brain and carrying motor commands from the brain to the muscles and organs.



The Peripheral Nervous System

1. It is responsible for transmitting sensory information from the periphery of the body (such as the skin, muscles, and organs) to the CNS, and transmitting commands from the CNS to the periphery.
2. The PNS can be further divided into the somatic and autonomic nervous systems.
3. The somatic nervous system controls voluntary movements, while the autonomic nervous system controls involuntary functions such as heart rate, digestion, and respiration.

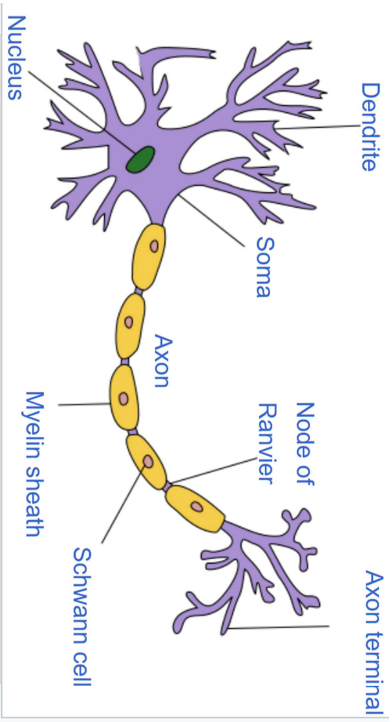


Somatic Nervous System

Signal Transmission

Signal transmission in the brain occurs through the firing of nerve cells, or neurons.

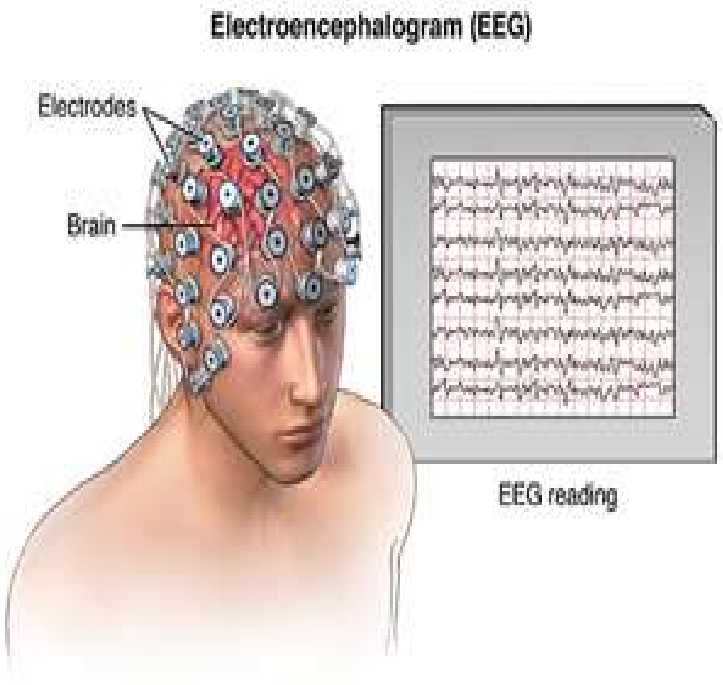
- A neuron receives inputs from other neurons at its **dendrites**, integrates the information, and then **generates an electrical impulse, or action potential**, that travels down its **axon** to the terminals.
- At the **terminals**, the neuron releases **chemical neurotransmitters**, leading to the initiation of another **action potential.**
- This process of transmitting information from one neuron to another is known as **synaptic** transmission and forms the basis of communication within the brain

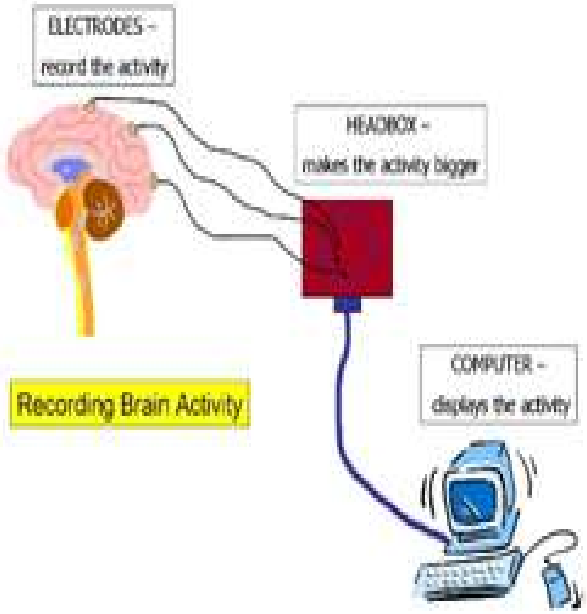


EEG

Signal transmission in the brain occurs through the firing of nerve cells, or neurons.

- Electroencephalography (EEG) is a technique used to record and **analyze the brain's electrical activity**. It measures the **electrical potentials generated by neurons** in the brain using **electrodes placed on the scalp**.





EEG

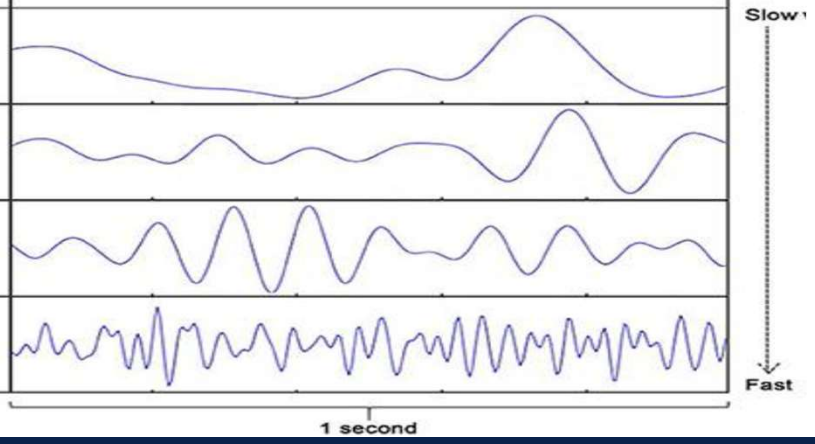
EEG Signals and Types of Brain Activity

- **Electrodes:** EEG electrodes are typically placed on the scalp and are used to detect and measure the electrical signals produced by the brain. The electrodes are connected to an amplifier **that amplifies and filters the signals for analysis**.
- **Brainwaves**: EEG recordings capture the brain's electrical activity in the form of brainwaves. Brainwaves are rhythmic patterns of electrical activity generated by groups of neurons firing together. Different types of brainwaves are associated with different states of consciousness and mental activity.
- **Frequency Bands:** EEG signals are divided into different frequency bands associated with specific mental states and functions.
- **Event-Related Potentials (ERPs):** ERPs are specific patterns of EEG activity that are time-locked to a specific event or stimulus.

EEG

- **Delta (1-4 Hz):** Waves Associated with deep sleep and unconsciousness.
- **Theta (4-8 Hz):** Theta waves are present during light sleep, relaxation, and creative states.
- **Alpha (8-12 Hz):** Alpha waves are seen when the brain is in a relaxed and calm state, such as during meditation or when closing the eyes.
- **Beta (12-30 Hz):** Beta waves are associated with wakefulness, active thinking, and focused attention.

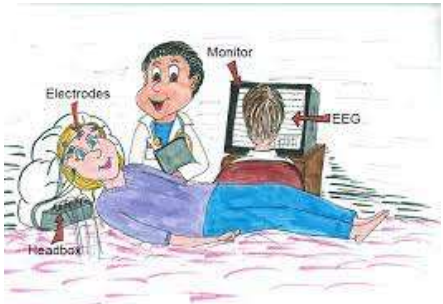
Frequency band	Speed (Hz)	Mental state	Electroencephalography (EEG) recording
Delta	1-4	Deep sleep	
Theta	4-8	Drowsy	
Alpha	8-12	Relaxed	
Beta	12-30	Focused	

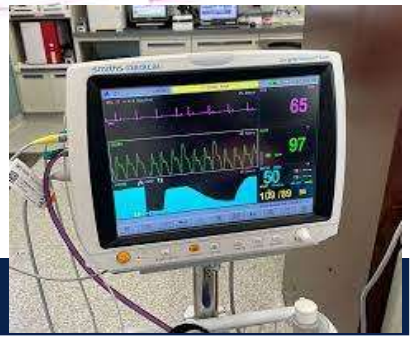


EEG

Applications

- **Diagnosis of Epilepsy:** EEG is a widely used tool to diagnose **epilepsy** and other **seizure** disorders
- **Sleep Studies:** EEG is often used in sleep studies to evaluate sleep patterns and diagnose sleep disorders.
- **Research on Brain Function:** EEG is used in research to study brain function during various activities such as reading, problem-solving, and decision-making. EEG can also be used to investigate how the brain responds to stimuli such as light, sound, and touch.
- **Diagnosis of Brain Disorders:** EEG can be used to diagnose a wide range of brain disorders including dementia, Parkinson's disease, and traumatic brain injury.
- **Anesthesia Monitoring:** EEG can be used to monitor the depth of anesthesia during surgery to ensure that the patient remains safe and comfortable.
- **Monitoring Brain Activity during Coma:** EEG is also used to monitor brain activity in patients who are in a coma to determine the level of brain function and assess the likelihood of recovery.






EEG Devices
Brain Products
BioSemi
EGI
Neuroscan
Mindo
mBrainTrain
Cognionics
Mitsar
Muse
Advanced Brain Monitoring
G.tec
Emotive
NeuroSky
OpenBCI
Wearable Sensing
Neuroelectrics

Major point

Signal transmission in the brain occurs through the firing of nerve cells, or neurons.

- A neuron receives inputs from other neurons at its **dendrites**, integrates the information, and then **generates an electrical impulse, or action potential**, that travels down its **axon** to the terminals.
- At the **terminals**, the neuron releases **chemical neurotransmitters**, leading to the initiation of another **action potential.**
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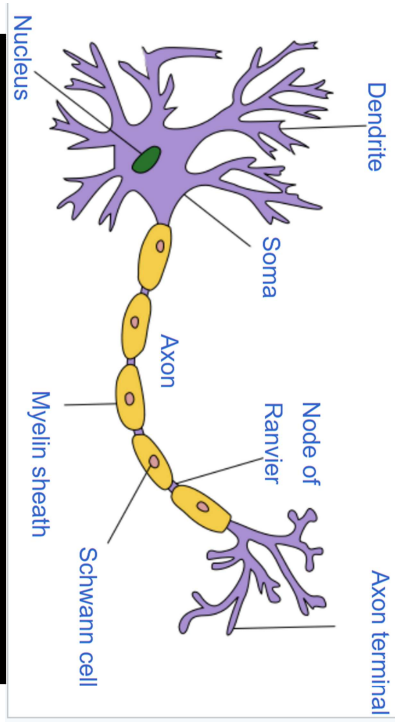
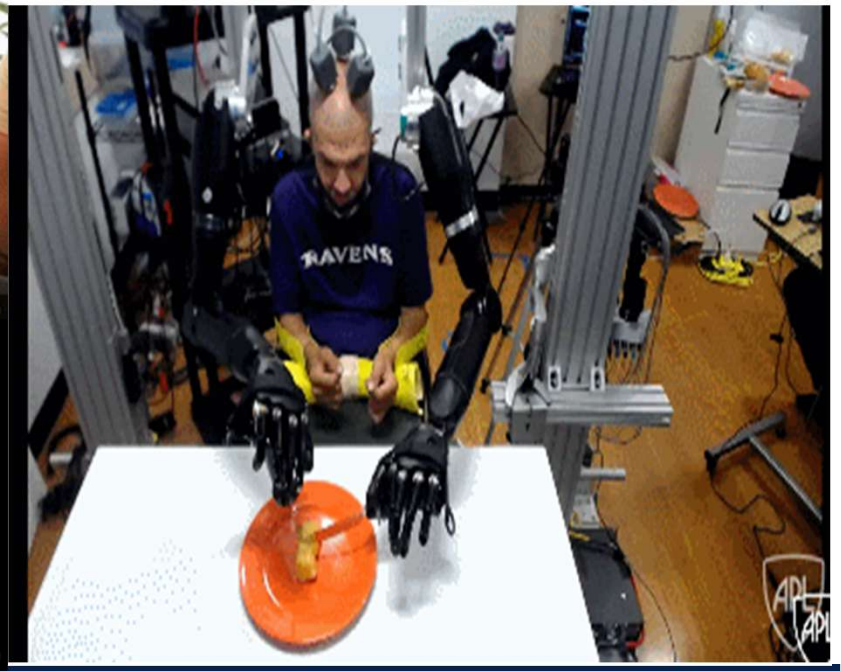


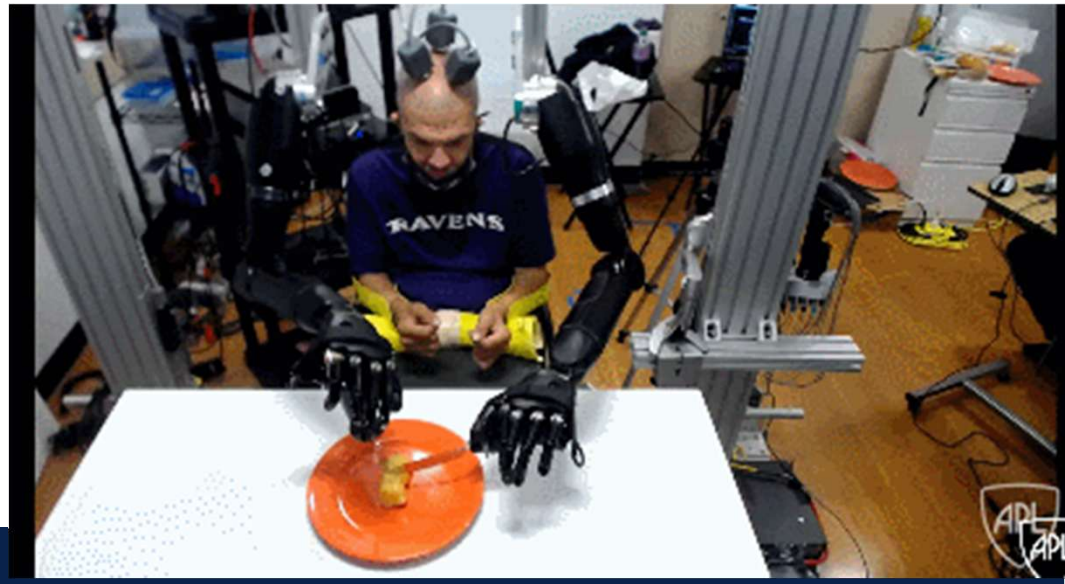
Robotic Arms for Prosthetics

- **Robotic arms for prosthetics (Artificial body parts)** are advanced prosthetic devices that use robotics technology to **restore functionality** to individuals with upper limb amputations (Complete removal of body parts).



Robotic Arms for Prosthetics

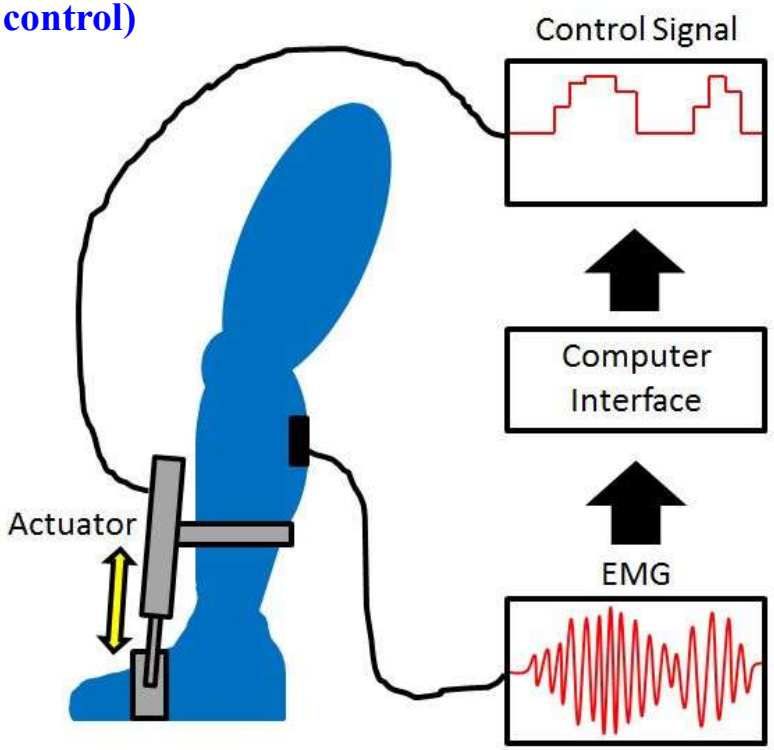
- These devices typically use **motors, actuators, and sensors** to mimic the movements of a human arm and hand, allowing the wearer to perform tasks such as reaching, grasping, and manipulating objects.
- Robotic arms for prosthetics can be controlled in a variety of ways,
  - **Direct control through muscle signals (myoelectric control) or brain-machine interfaces**, which use electrodes implanted in the brain or placed on the scalp to detect and interpret brain activity.



Robotic Arms for Prosthetics

Robotic Arm Prosthetic Direct Control through Muscle Signals (myoelectric control)

- Sensors on the **skin detect electromyography (EMG)** ***(An electromyograph detects the electric potential generated by muscle cells)*** signals from the muscles of the wearer's leg(s)
- The system involves electrodes placed on the skin or muscle. Then it **detects and interprets the electrical signals generated by the muscle contractions.**
- Each signal measured is then sent to a **controller,** which is either an onboard **microcontroller (mounted to the exoskeleton) or to a nearby computer.**
- When the wearer **contracts their muscles**, the electrodes detect the electrical signals and send them to a **control unit**, which interprets the signals and uses them to control the movement of the robotic arm.



Robotic Arms for Prosthetics

Advantages

- Myoelectric control has the advantage of being **directly controlled by the user**, allowing for more natural interaction with the prosthetic.
- It can also provide a high level of control and precision, as the electrical signals generated by the muscles are unique to each individual and can be used to perform a wide range of movements.

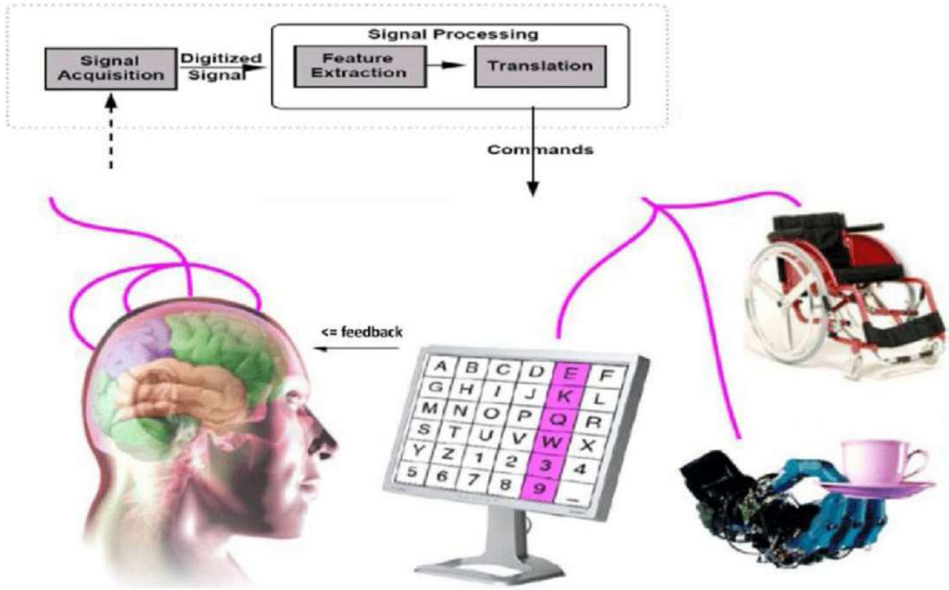
Disadvantages

- However, myoelectric control systems can be complex and may require extensive rehabilitation and training to use effectively.
- Regular Maintenance to ensure proper function.

Robotic Arms for Prosthetics

Robotic Arm Prosthetic Direct Control through Brain Signals

- Brain-machine interfaces (BMIs) are a type of technology that allows a user to control a robotic arm prosthetic directly with their brain activity.
- The system typically involves electrodes placed on the scalp or implanted directly into the brain to detect and interpret the user's brain signals.



- When the user thinks about moving the prosthetic arm, the electrodes detect the corresponding brain activity and send the signals to a control unit, which uses algorithms to interpret the signals and control the movement of the prosthetic. The user can then control the movement of the prosthetic in real-time by thinking about the desired movement.

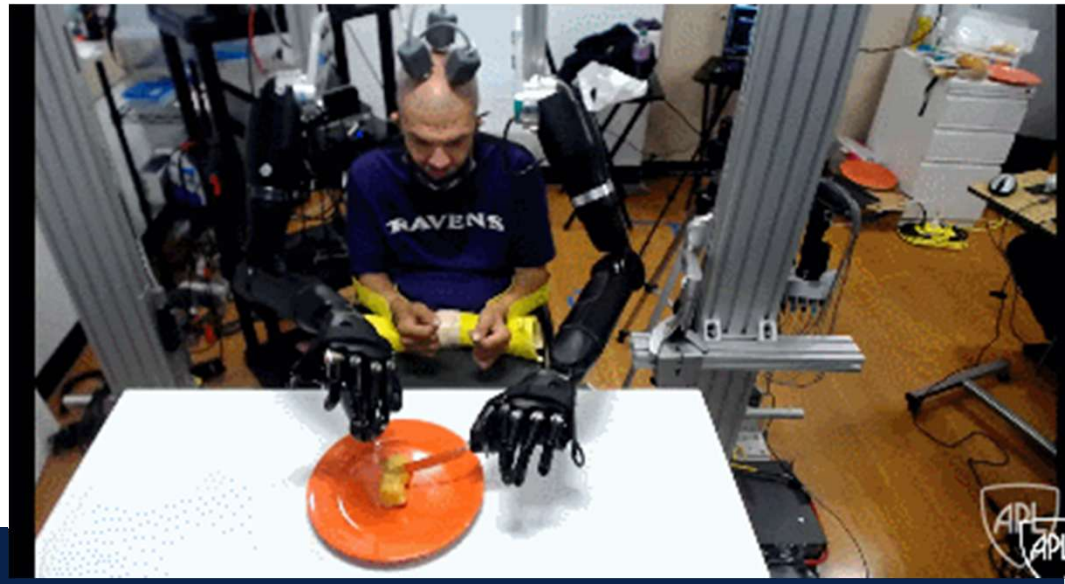
Robotic Arms for Prosthetics

Advantages

- BMIs have the advantage of providing a direct and intuitive connection between the user's brain and the prosthetic, allowing for a high level of control and precision.
- Additionally, BMIs can be used to provide sensory feedback to the user, allowing them to experience the sensation of touch through the prosthetic.

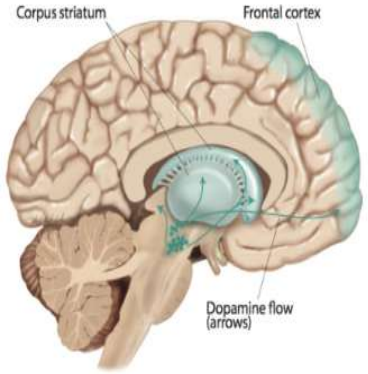
Disadvantages

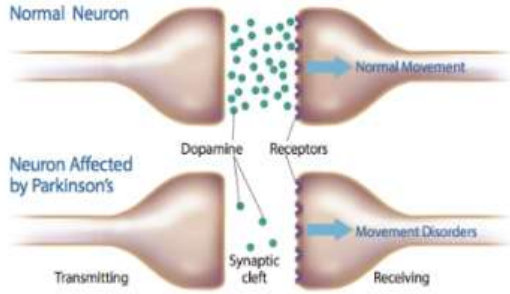
- BMIs can be complex and invasive systems, requiring surgical implantation and ongoing maintenance to ensure proper function.

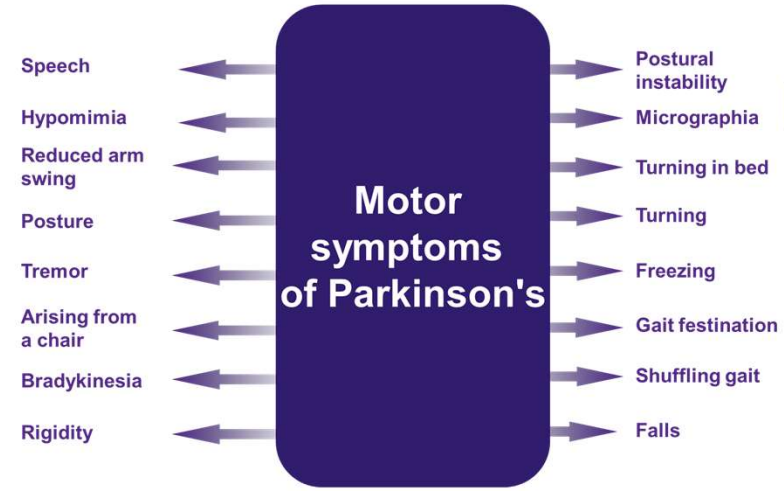


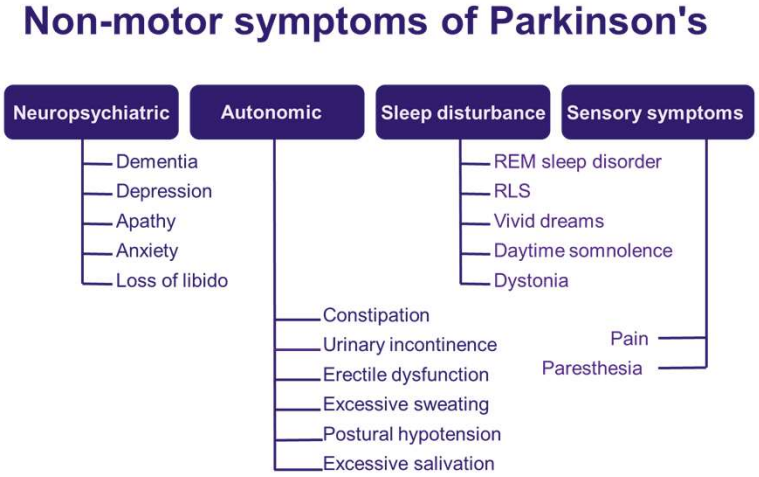
Parkinson's Disease

A neurological syndrome or disease caused by a lack of dopamine a neurotransmitter which ensures smooth movement of muscle within the brain. It is incurable, degenerative and eventually impacts all aspects of daily life. Symptoms of Parkinson's begin to surface once 80% of the dopamine-producing cells have died.

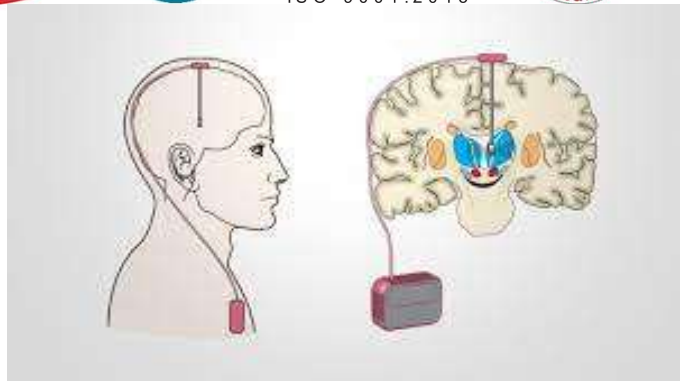






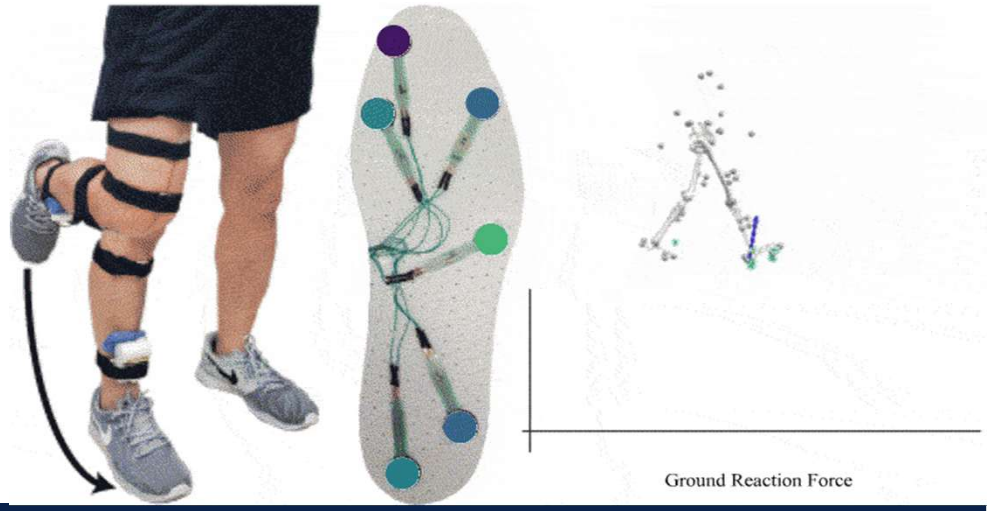


Engineering solutions for PD



Deep Brain Stimulation (DBS): DBS is a surgical procedure that involves implanting electrodes into specific brain regions, such as the subthalamic nucleus or globus pallidus. These electrodes deliver electrical impulses to modulate abnormal brain activity, helping to alleviate symptoms like tremors, rigidity, and bradykinesia (slowness of movement).

Wearable Devices: Various wearable devices have been developed to assist individuals with Parkinson's disease. These devices can monitor symptoms, provide real-time feedback, and improve mobility and balance. Examples include smartwatches with motion sensors to detect tremors, wearable cueing devices to enhance gait and balance, and vibrating wristbands to reduce tremors.



Engineering solutions for PD

Assistive Technologies: Assistive technologies aim to enhance independence and improve the quality of life for individuals with Parkinson's disease. Examples include voice-activated home automation systems to control appliances and environments, adaptive utensils and tools with specialized grips to assist with eating and daily activities, and voice-controlled personal assistants to perform tasks and provide reminders.

Medication Delivery Systems: People with Parkinson's disease often require precise timing and dosage of medication to manage their symptoms. Engineering solutions such as smart pill dispensers and wearable drug delivery systems can help individuals adhere to their medication schedules and ensure accurate dosing. These systems can provide reminders, dispense medications at specific times, and monitor medication intake.

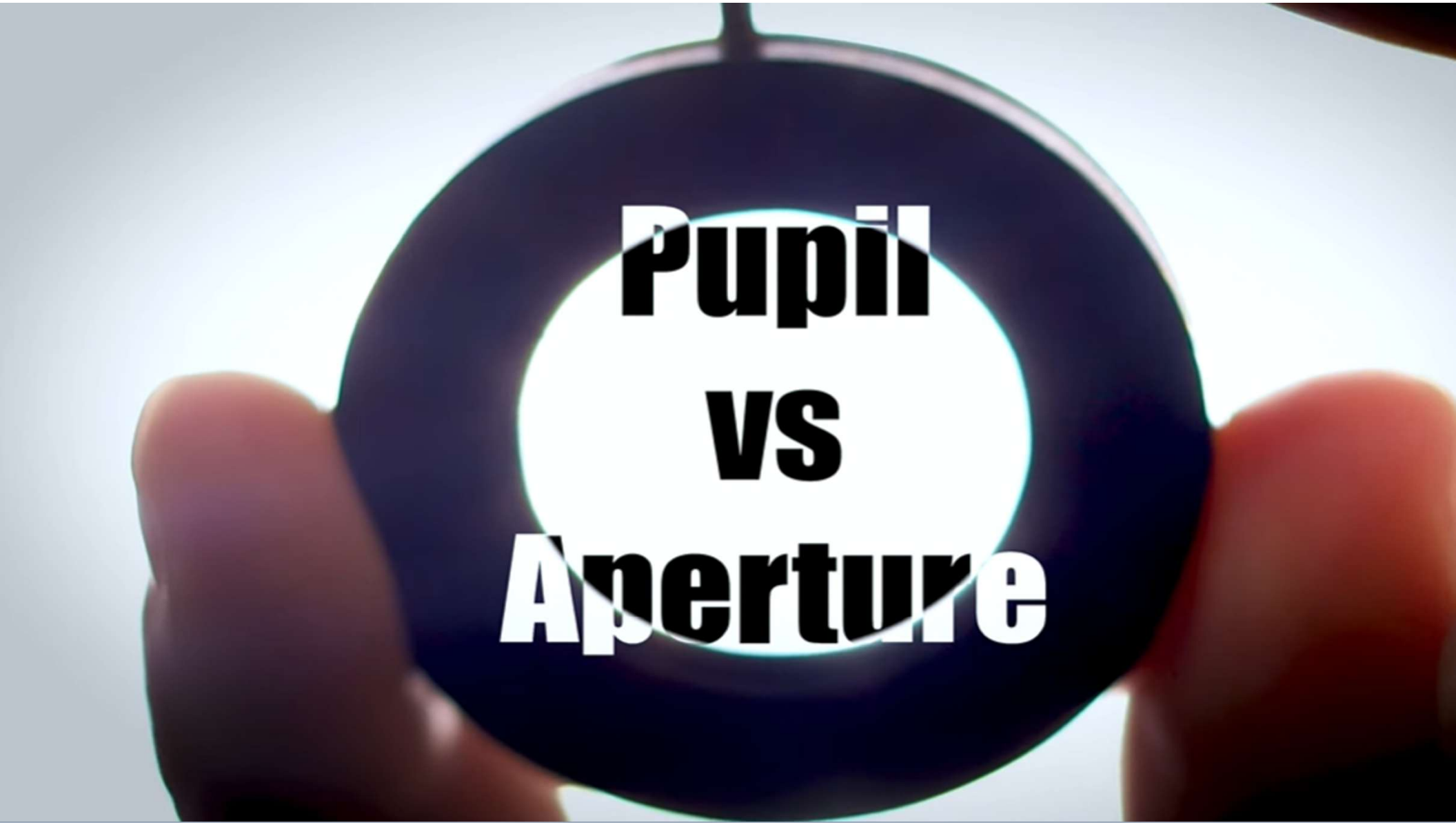
Engineering solutions for Parkinson's disease

Virtual Reality (VR) and Gamification: VR technology has shown promise in improving motor symptoms and balance in Parkinson's disease. Virtual reality games and exercises can be designed to encourage movement, enhance coordination, and promote rehabilitation. These immersive experiences provide visual and auditory cues that help individuals engage in therapeutic activities.

Robotic Rehabilitation: Robotics has been employed in the rehabilitation of individuals with Parkinson's disease. Robotic devices can assist with repetitive exercises and movement training, providing precise and controlled assistance. These devices can help improve motor function, muscle strength, and coordination.


Canon
50mm 1:1.8 STM


Canon
CANON EF LENS 50mm 1:1.8 STM
Φ49mm


Pupil
vs
Aperture

Normal Eye

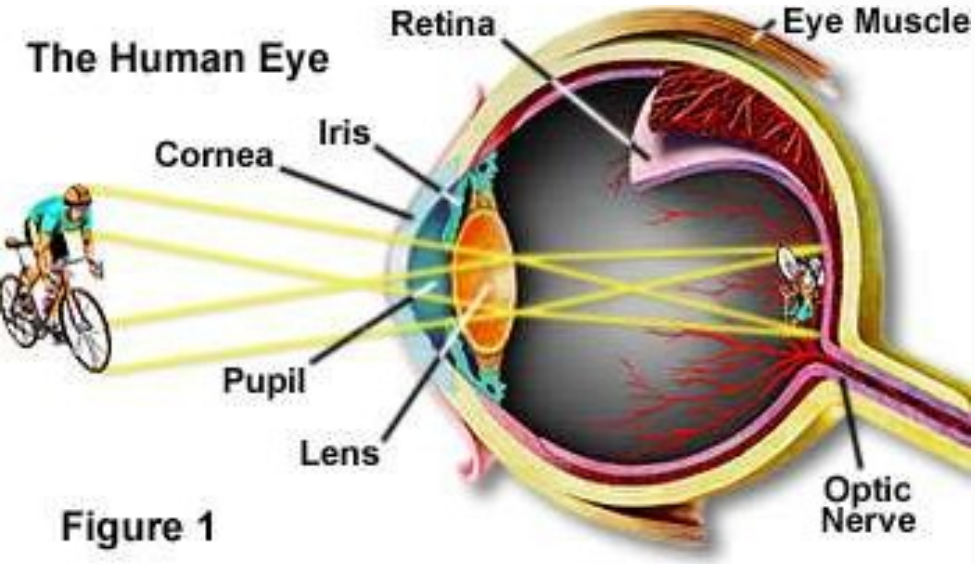
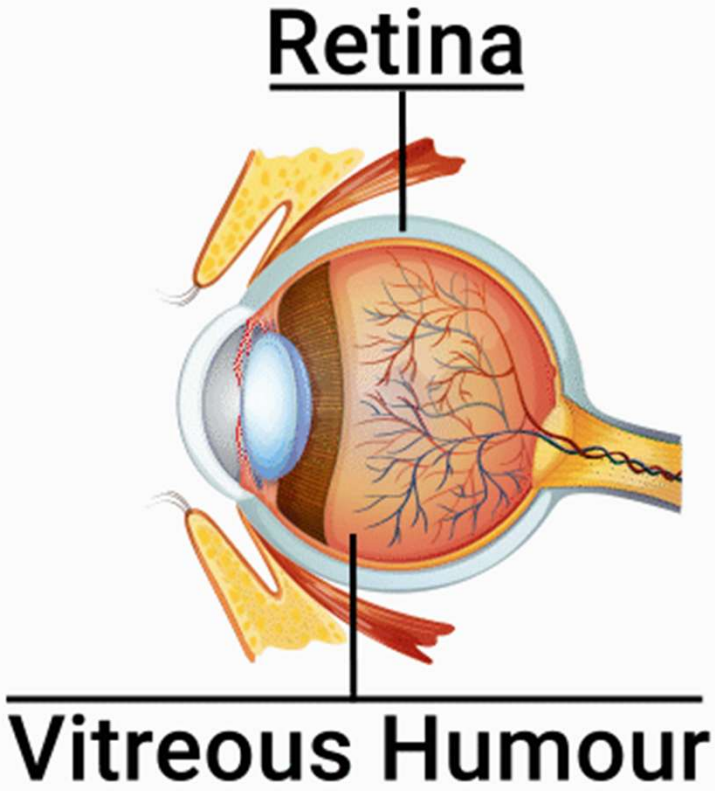


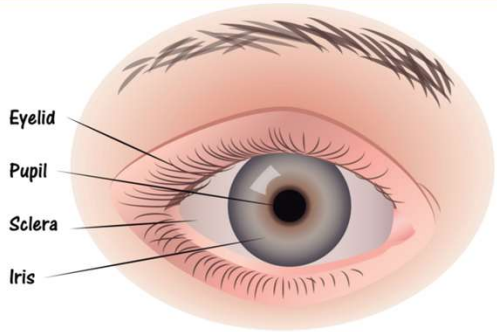
Figure 1

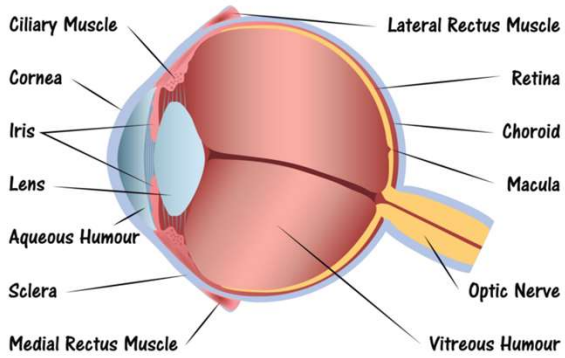


Eye as a Camera system

The eyeball is just like a camera, it can't function without the presence of light. As light hits the eyes, it's focused by the eye like a camera lens.

- **Step 1:** Light passes through a thin layer of moisture
- **Step 2:** **Light hits the cornea**. The transparent cornea is the first layer to focus light within the eye. The cornea is connected to the **sclera,** which is a **tough fiber** that acts as **protection.**
- **Step 3:** Behind the cornea is another liquid layer of **humour**; its job is to maintain **pressure levels**.
- **Step 4:** Once the light has passed through the aqueous humour, it has finally reached the **pupil.**
- **Step 5:** Once the pupil determines how much light it will let inside your eye, the job passes to the lens. Step 6: As the light reaches the centre of the eye passes and reaches the final stop, **The Retina.**

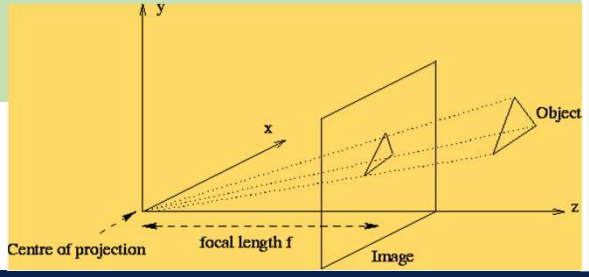


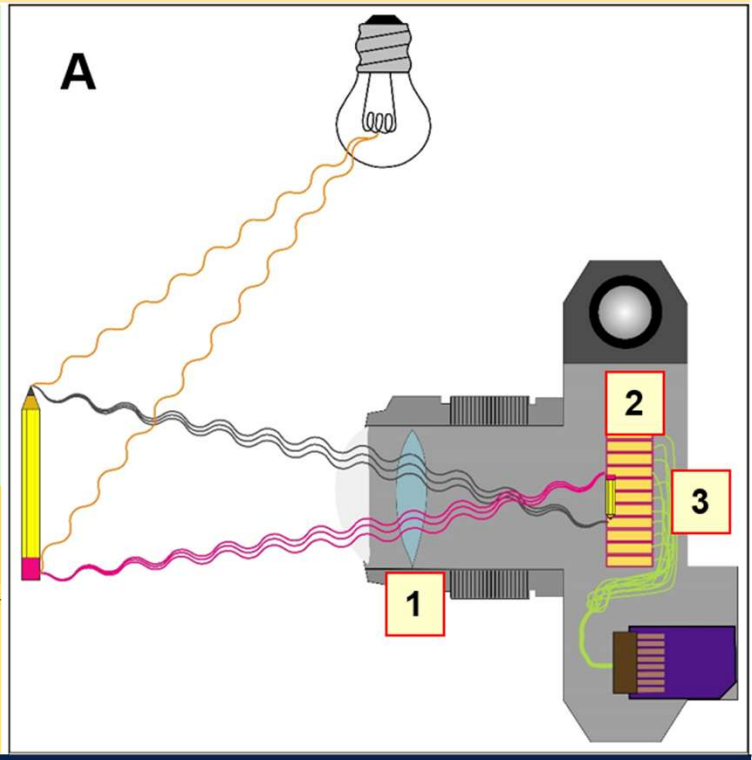


Eye as a Camera system

Pinhole camera model: The pinhole camera is the simplest, and the ideal, model of camera function. It has an infinitesimally small hole through which light enters before forming an inverted image on the camera surface.

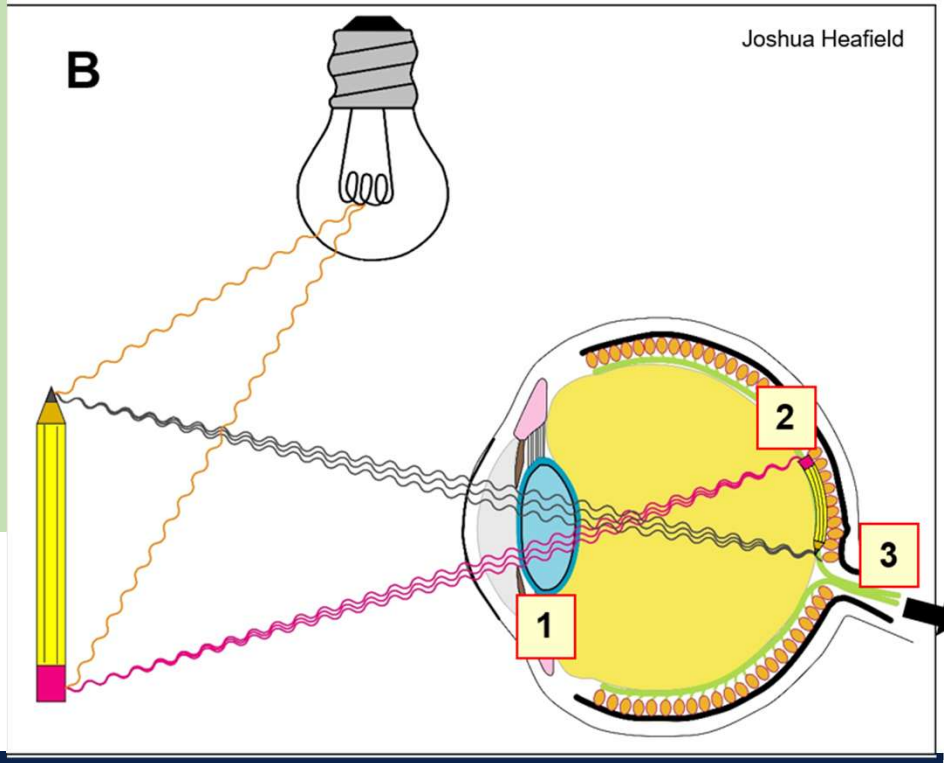
- Rays of light reflect from an object (a pencil) and enter the camera through the lens (1), which focuses it onto the camera sensor chip (2).
- On the sensor chip (2), light-sensitive cells convert the light energy into an electrical signal.
- The electrical signal and circuit (3) are sent to a processing unit. Which processes the image and stores it.

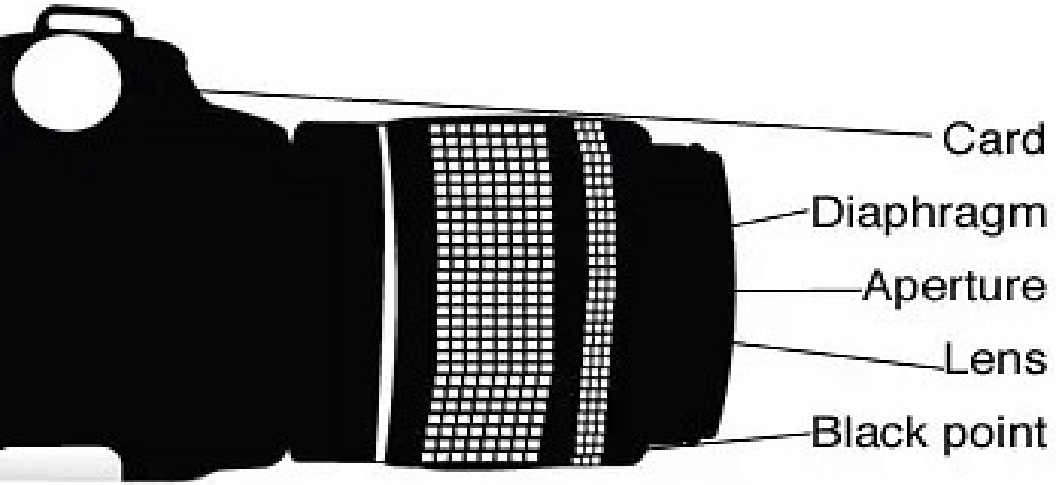


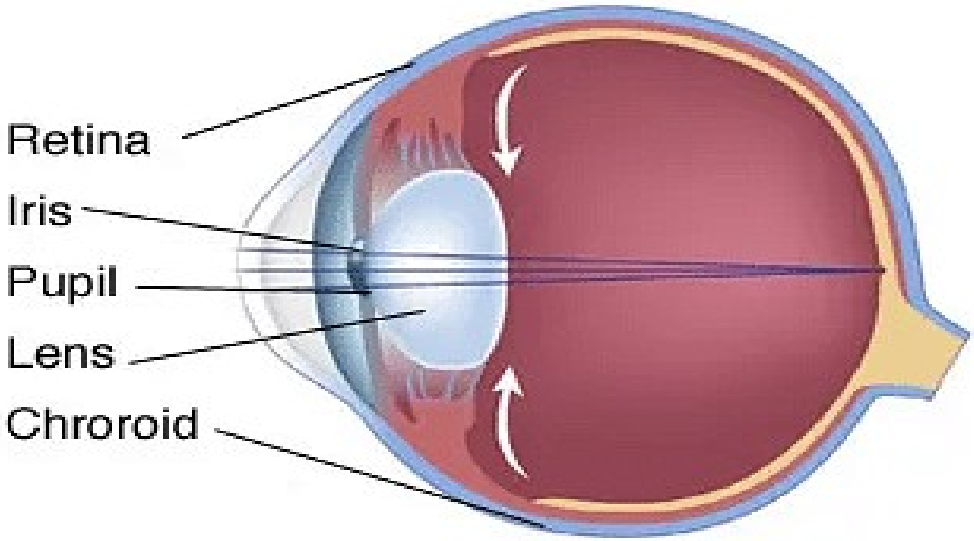


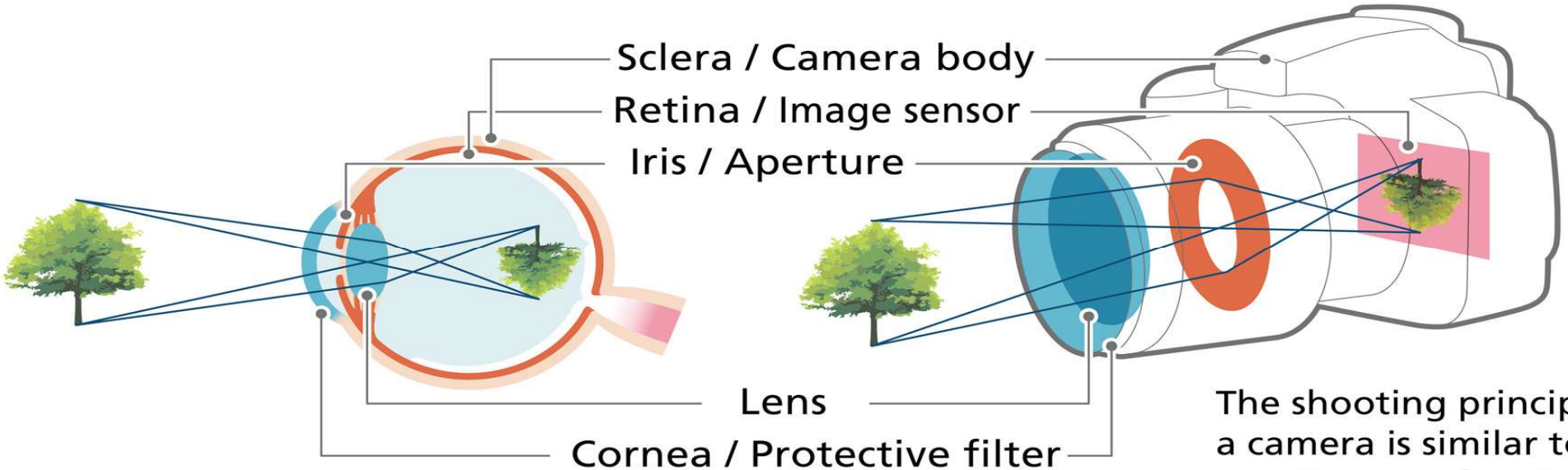
Eye as a Camera system

- The lens cornea (1) focuses light onto the retina (2).
- Photoreceptor cells in the retina (Rod and Cone Cells) (2) convert the light energy into nerve impulses.
- The nerve impulses are sent through the optic nerve (3) toward the brain (black arrow).
- Neurons (Synaptic) send information via electrical impulses known as action potentials









The shooting principle of a camera is similar to the way the eyes function.

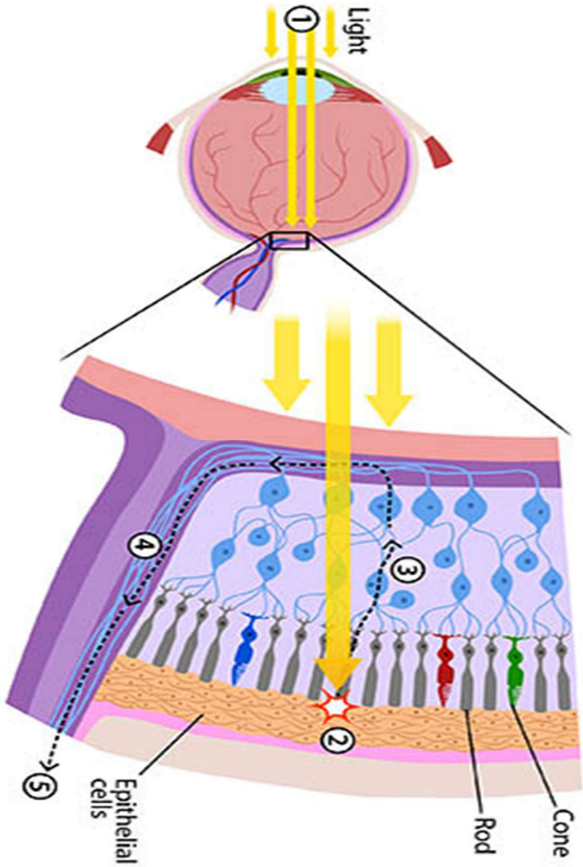
Eye as a Camera system

Architecture of rod and cone cells

Photoreceptors: **Split into two designations – Rods and cones.**

Cones:

- **Function:** Cone cells are responsible for colour vision and visual acuity in bright light conditions. They allow us to perceive various colours and provide sharper, high-resolution images.
- **Structure:** Cone cells have a tapered shape and contain different types of light-sensitive pigments that respond to specific wavelengths of light, corresponding to the colours blue, green, and red.
- **Density:** The human retina has approximately 6 to 7 million cone cells, making them less numerous than rods.
- **Visual Acuity:** Cones have high visual acuity, allowing them to resolve fine details.



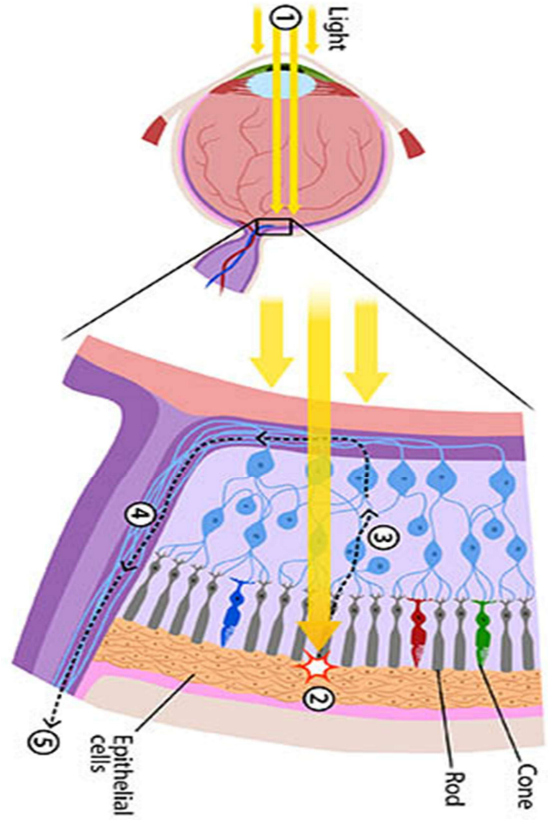
Eye as a Camera system

Architecture of rod and cone cells

Photoreceptors: Split into two designations – Rods and cones.

Rods:

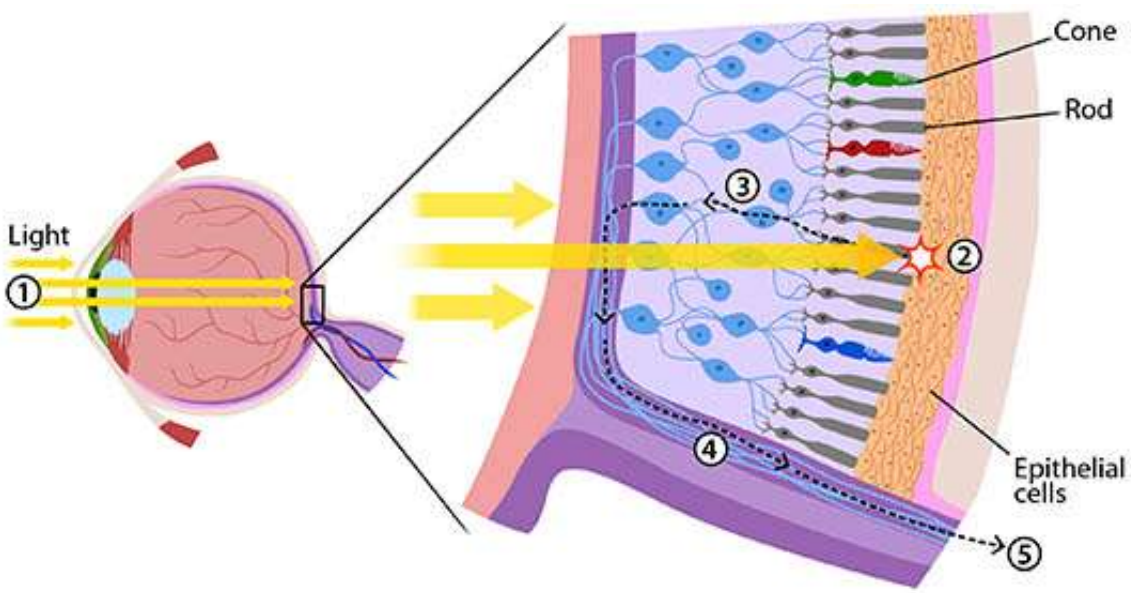
- **Function:** Rod cells are responsible for vision in low-light conditions, providing us with black-and-white, or grayscale, vision. They are highly light-sensitive and allow us to see in dim environments.
- **Structure:** Rod cells are elongated, cylindrical cells with a stacked arrangement of membranous disks containing light-sensitive pigments.
- **Density:** The human retina has approximately 90 to 120 million rod cells, making them more numerous than cones.
- **Visual Acuity:** Rods have lower visual acuity than cones, meaning they cannot distinguish fine details as effectively.

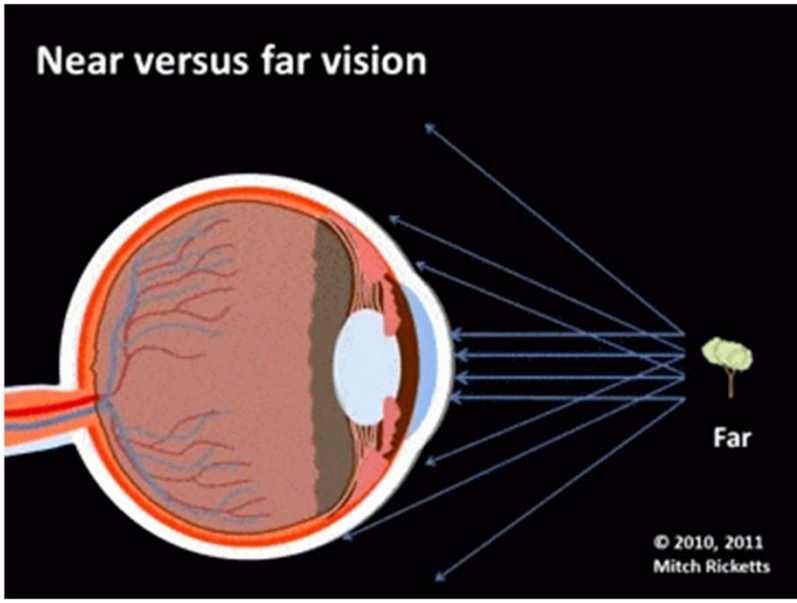


Eye as a Camera system

Architecture of rod and cone cells

The electrical signals generated by the rods and cones are further processed. After the processing, signals are transmitted to the brain.



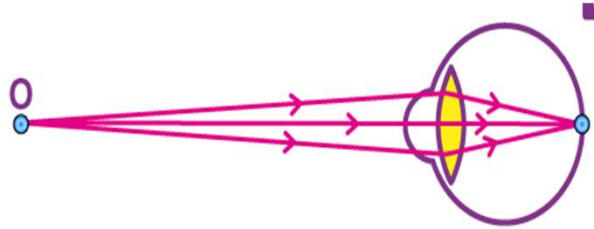


Eye as a Camera system

Optical Corrections

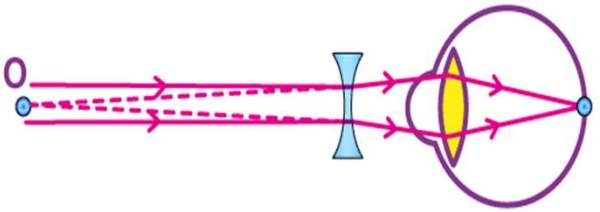
Defects in the eye happen due to many reasons. Due to growing age, the vision also decreases, and when the focal length alters, the vision also alters.

- When the eye loses its ability to adjust its **focal length,** problems appear like a person cannot see the image correctly (**blurring of vision**), unable to view **nearby** or **far away objects**.
- When the defect in the **refractive index occurs**, the person cannot see the objects **comfortably and distinctly**. If not taken timely care of, the eyes might completely lose the power of accommodation.



(a) Far point of a myopic eye

(b) Myopic Eye

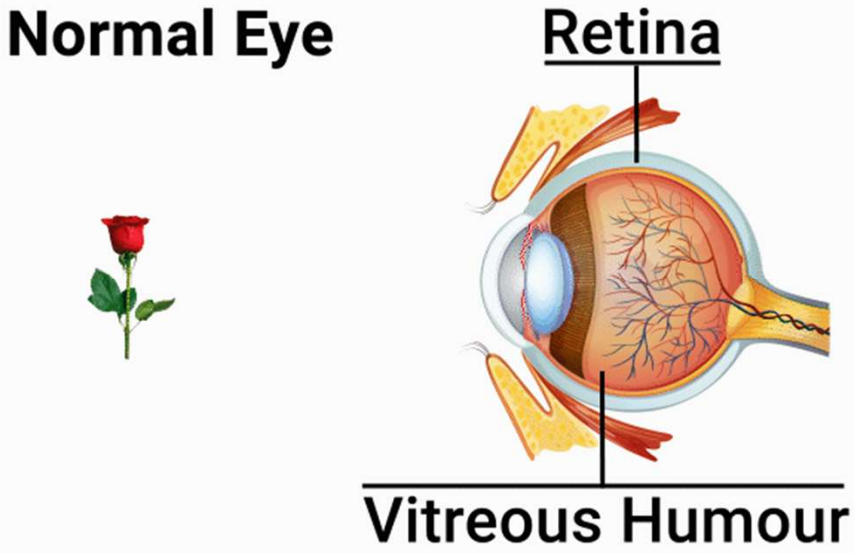


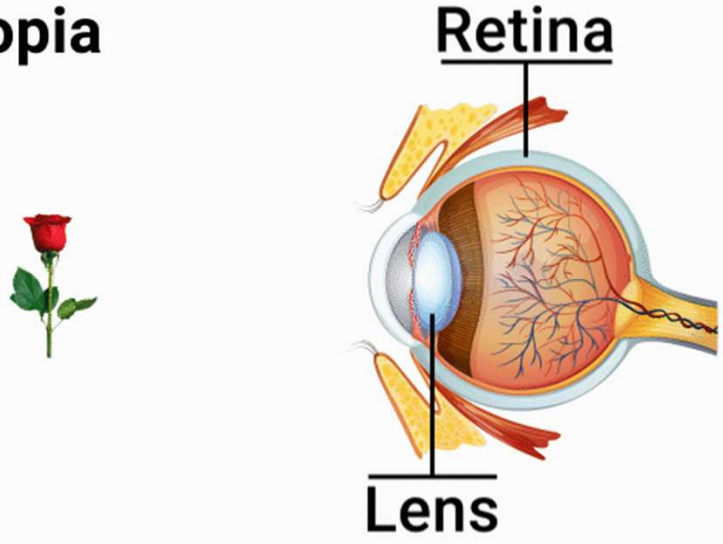
(b) Correction for Myopic Eye

Eye as a Camera system

Optical Corrections: Myopia or near-sightedness.

- **Myopia** is commonly known as **near-sightedness**. In this condition, the person can see the **objects nearby** but cannot see **distant objects clearly.** Faraway objects appear blurry.
- Myopia is due to the shape of the eyes leading the light rays to bend incorrectly**, focusing images in front** of the retina rather **than focusing on the retina**.





Eye as a Camera system

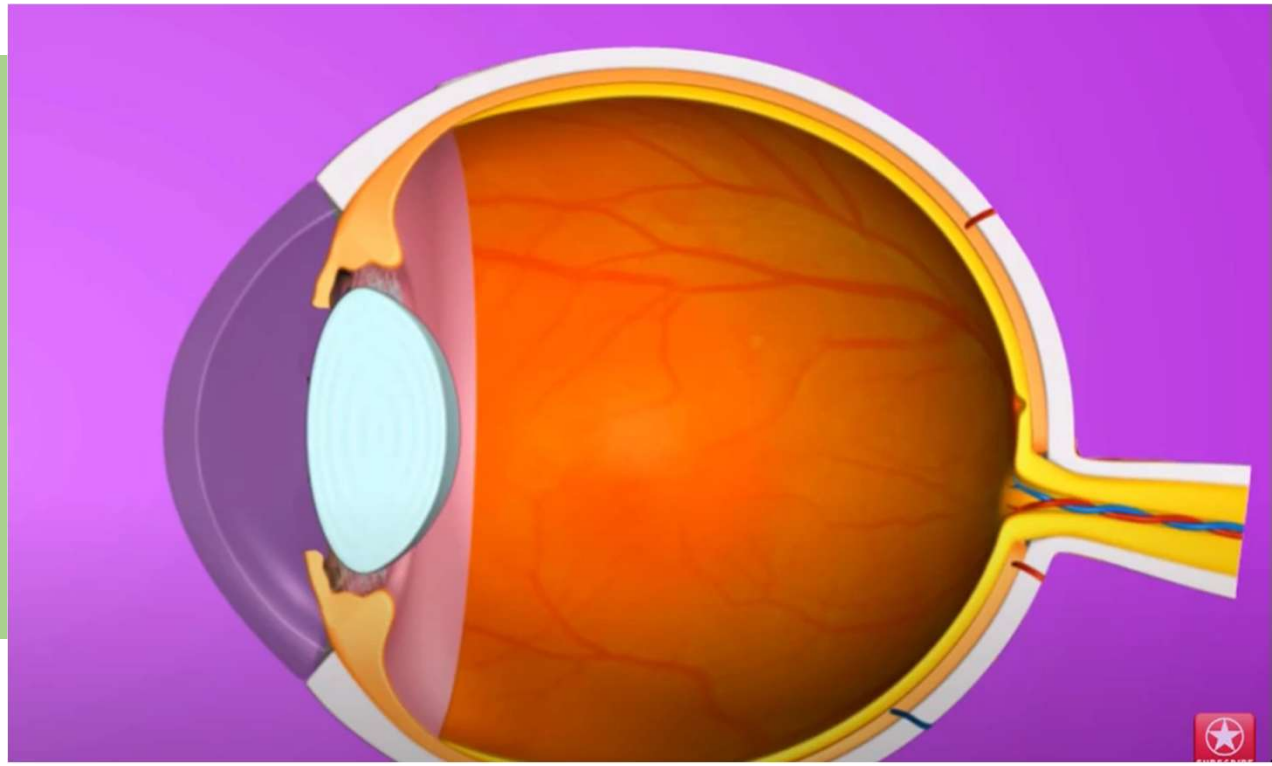
Optical Corrections: Myopia or near-sightedness.

Symptoms:

- Blurry vision.
- Difficulty in seeing while driving, particularly during night times.
- Headaches due to eyestrain.

Correction:

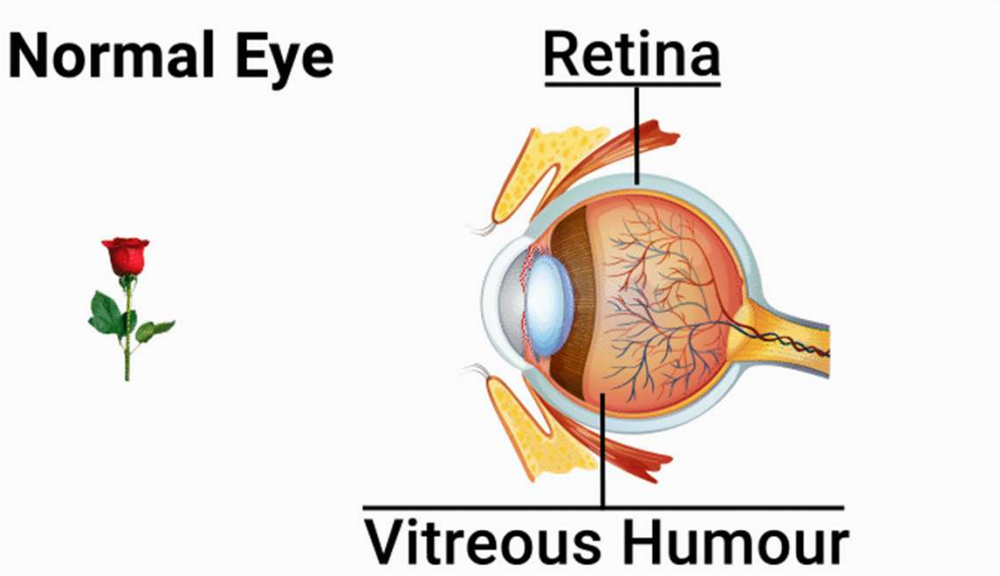
- When a concave lens of suitable power is used, it assists in focusing the image onto the retina.

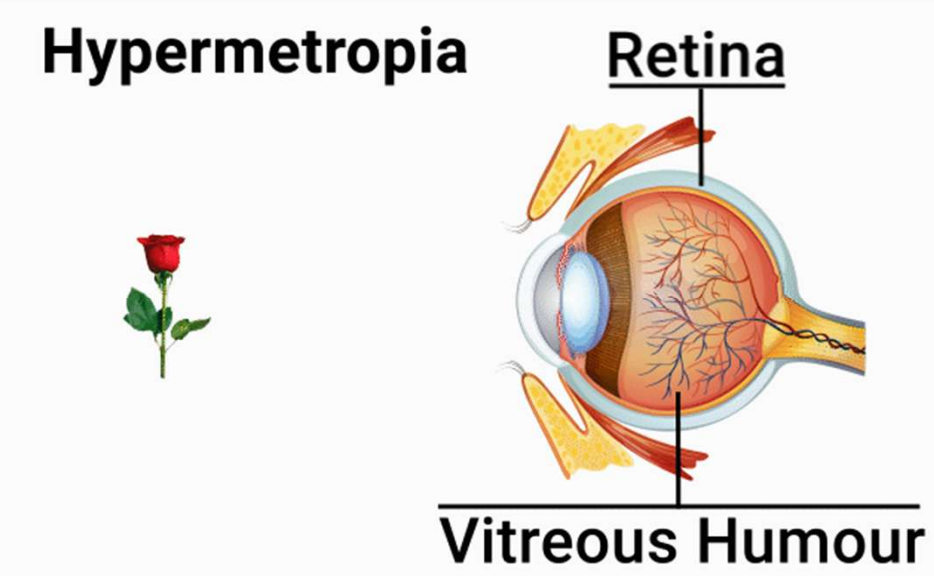


Eye as a Camera system

Optical Corrections: Hypermetropia or Far-Sightedness.

- Hypermetropia is commonly known as **far-sightedness**. In this condition, the person can see objects at a **distance but cannot see nearby objects clearly.**
- Hypermetropia is caused when the **light rays from a closeby object are focussed at a point behind the retina**.





Eye as a Camera system

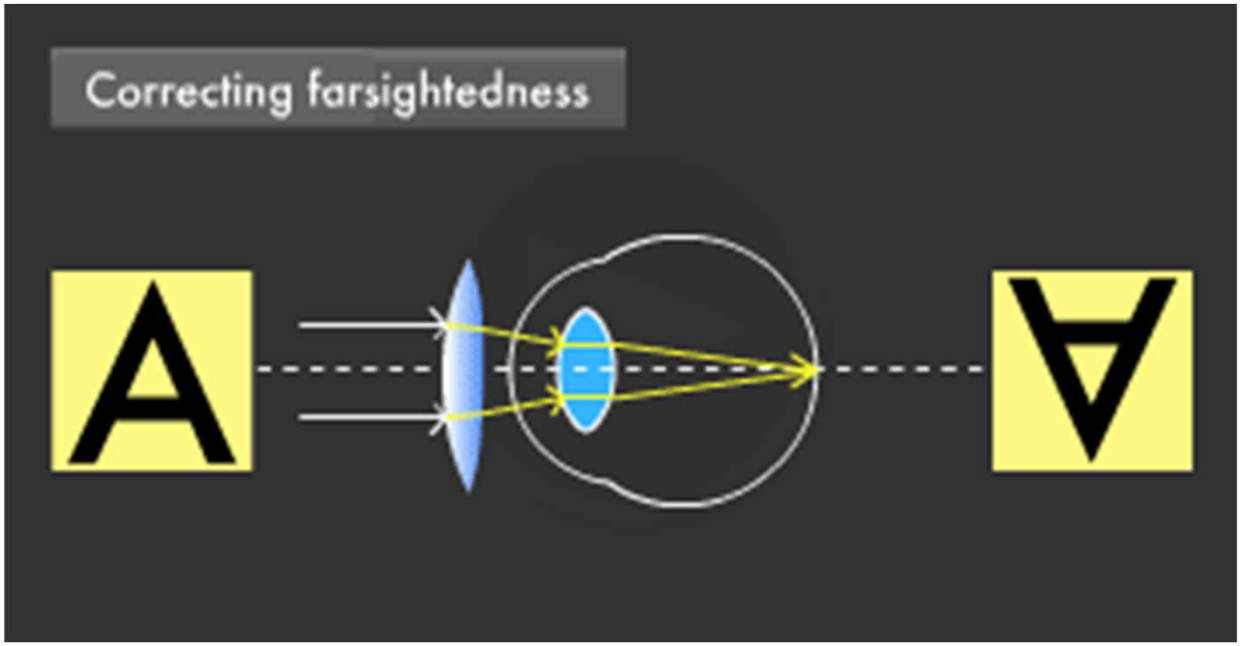
Optical Corrections: Hypermetropia or Far-Sightedness.

Symptoms:

- **Blurry vision.**
- **Headaches due to eyestrain.**
- **Squinting.**

Correction :

Using spectacles with a converging lens imparts additional focusing power and thus helps form the image on the retina.

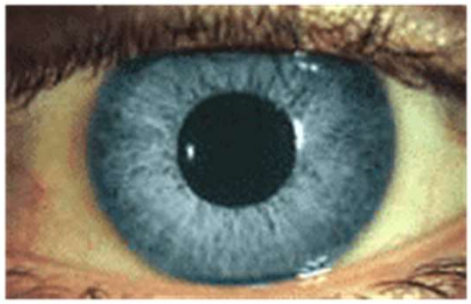


Eye as a Camera system

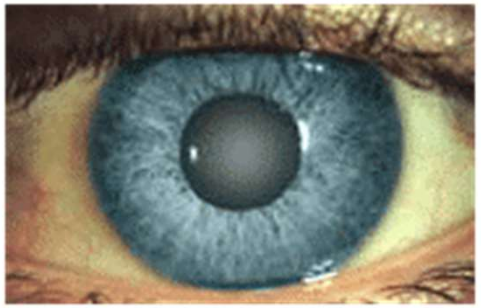
Cataract

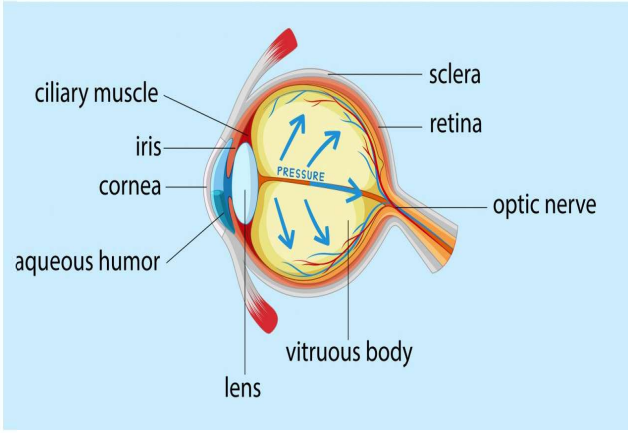
- **Cataract** is the gradual loss of your eye's ability to focus on nearby objects. It's a natural, often annoying part of ageing.
- **Cataract** usually becomes noticeable at the age of 60.
- Most cataracts develop when ageing or injury changes the tissue that makes up the eye's lens. And also due to genetic disorders.
- Proteins and fibers in the lens begin to break down, causing vision to become hazy or cloudy.
- People have difficulties viewing nearby objects clearly without the assistance of corrective eyeglasses.

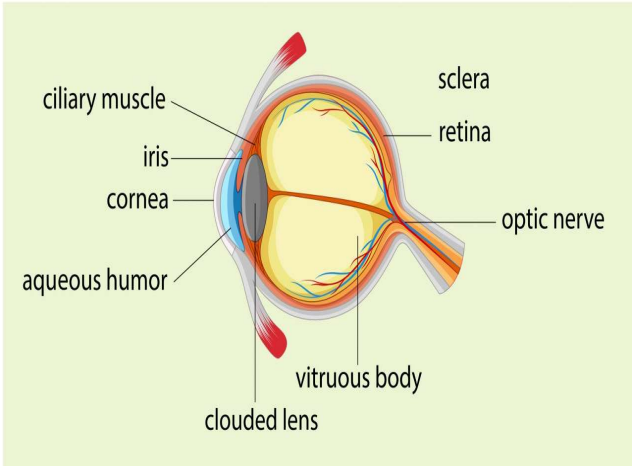
NORMAL EYE



EYE WITH CATARACT



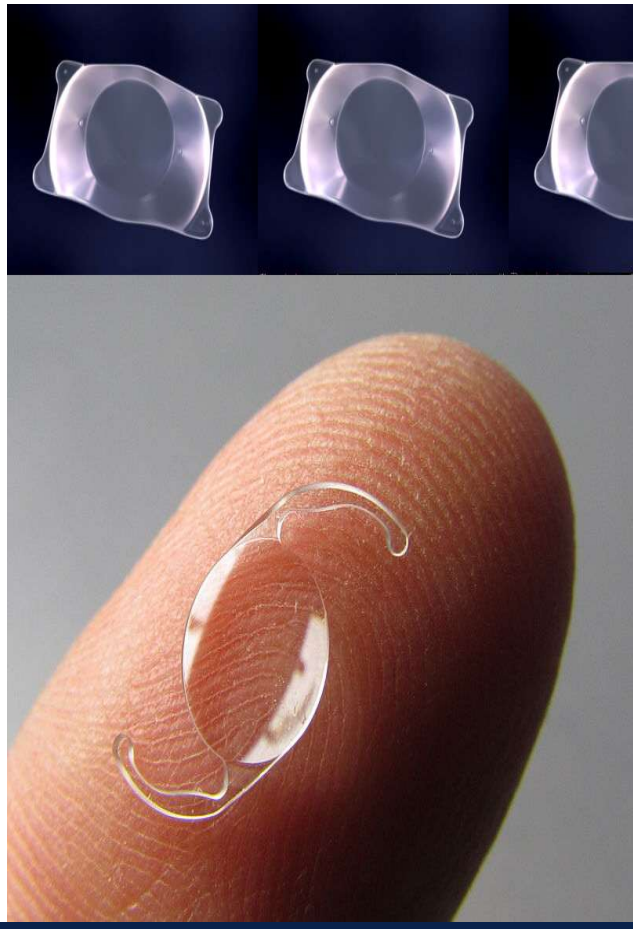




Eye as a Camera system

Intraocular lens : Lens Material

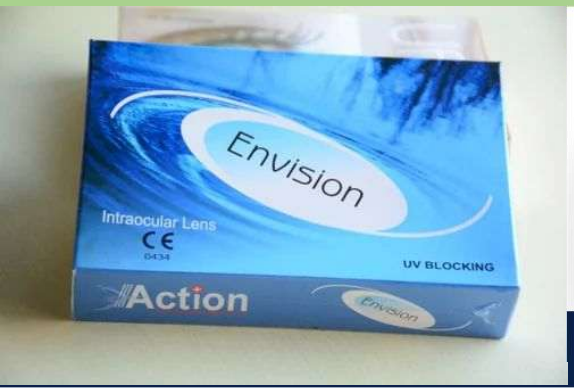
- **Intraocular lenses (IOLs)** are artificial lenses implanted in the eye during cataract surgery or refractive lens exchange to replace the eye's natural lens that has become cloudy or is causing vision problems.
- These lenses help restore clear vision and can also correct certain refractive errors such as myopia (nearsightedness), hypermetropia (farsightedness), and astigmatism. Various types of intraocular lenses are available, each made from different materials.
- An Intraocular lens (IOL) is implanted in the eye, usually as part of a treatment for cataracts or correcting other vision problems.



Intraocular lens : Lens Material

Polymethylmethacrylate (PMMA):

- PMMA was one of the **first materials used for IOLs** and has a long history of successful use.
- It is a rigid material and does not fold, so the incision needed for implantation is larger than with foldable lenses.
- It offers **excellent optical clarity and stability** once implanted.
- However, due to their rigid nature, PMMA lenses may cause more discomfort post-surgery compared to foldable lenses.



<Dr. Avinash K>

Hydrophobic Acrylic:

- Hydrophobic acrylic IOLs are the most used lenses today, composed of crosslinked copolymers of acrylic esters.
- They have a foldable design, allowing for smaller incisions during surgery, leading to quicker recovery and less post-operative discomfort.
- The material is biocompatible and lightweight, providing good optical quality and long-term stability.
- Hydrophobic acrylic lenses have a low affinity for water, making them less susceptible to clouding or glistening.

Eye as a Camera system

Intraocular lens : Lens Material

Silicone:

- Silicone IOLs were among the first foldable lenses introduced.
- They offer excellent flexibility and are easy to fold, allowing for smaller incisions during surgery.
- Silicone lenses are biocompatible and have good long-term stability.
- However, compared to acrylic lenses, they may have a higher risk of some complications.

Eye as a Camera system

Intraocular lens : Lens Material

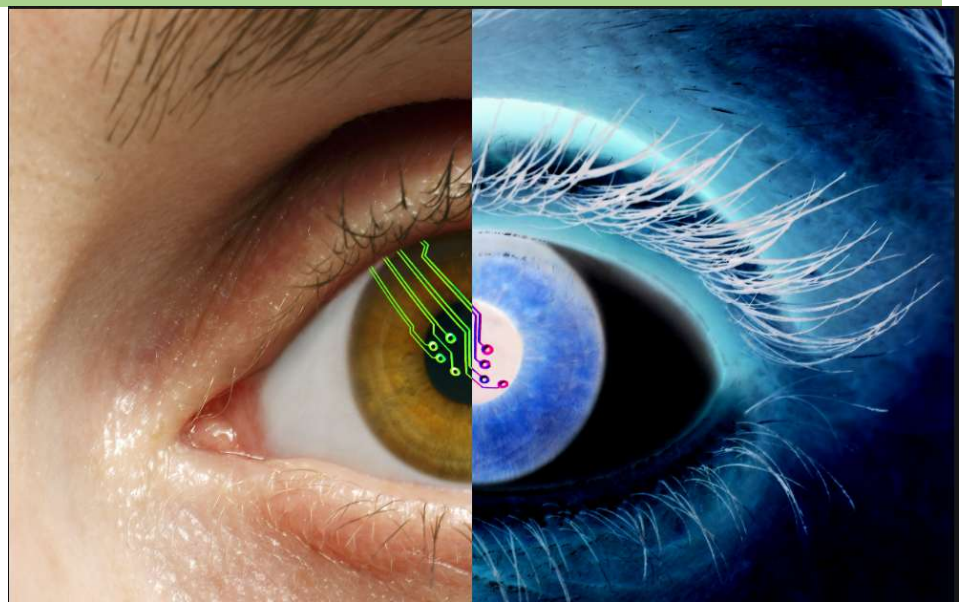
Hybrid Lenses:

- **IOLs use a combination of materials, such as acrylic and silicone, to take advantage of the benefits of both materials.**
- **The hybrid design aims to minimize potential drawbacks while maximizing optical quality and biocompatibility.**

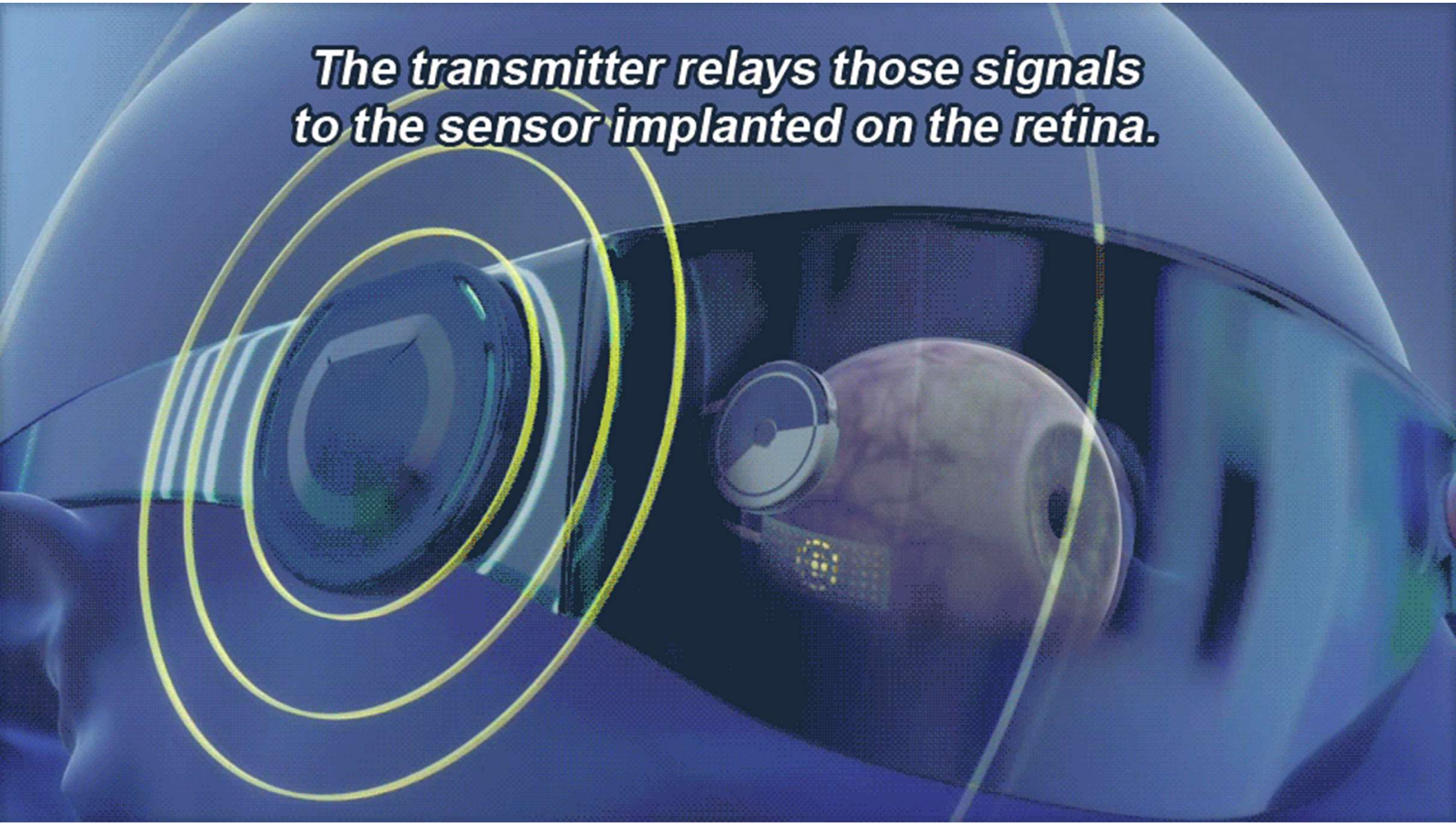
Eye as a Camera system

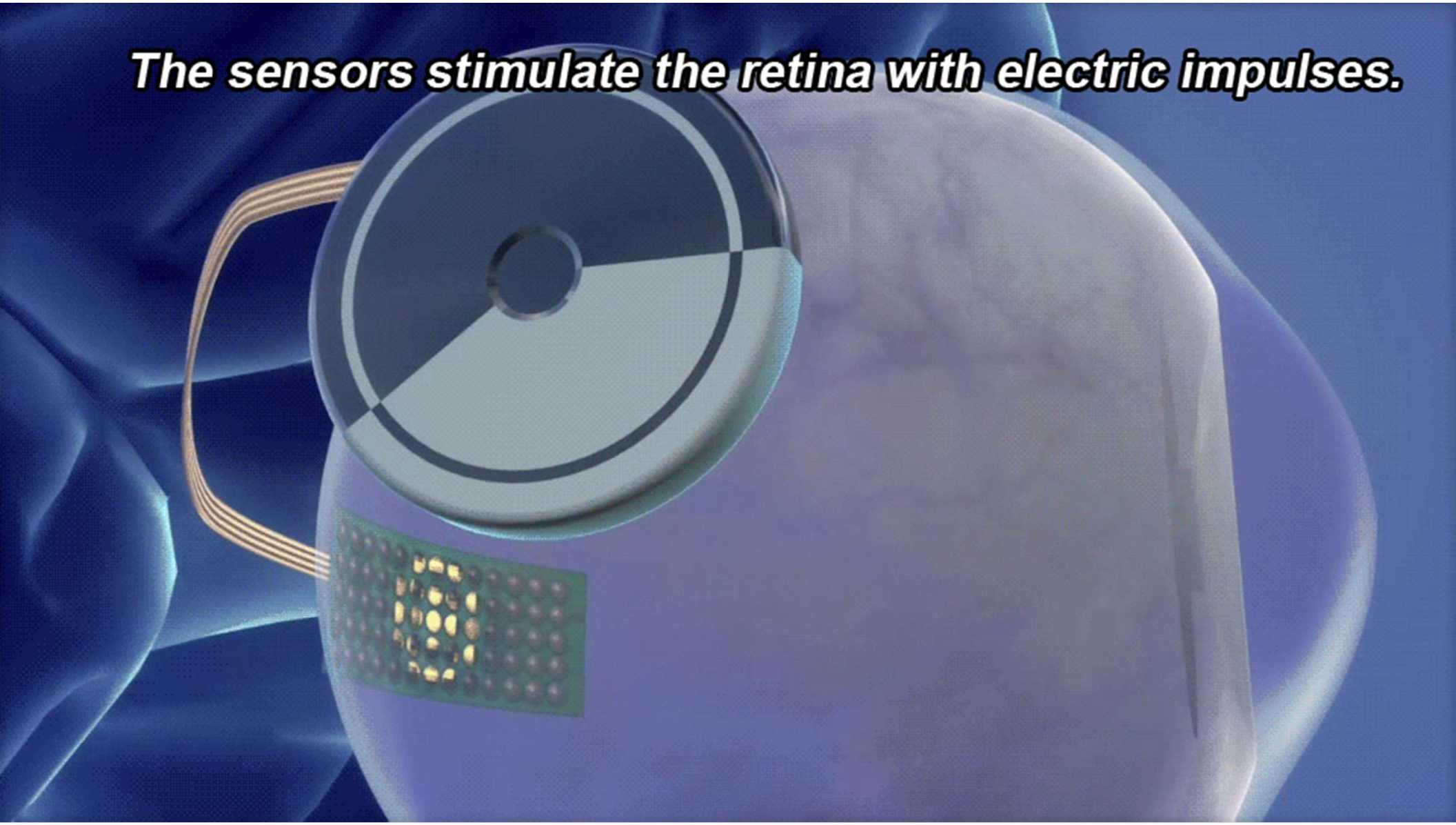
Bionic eye

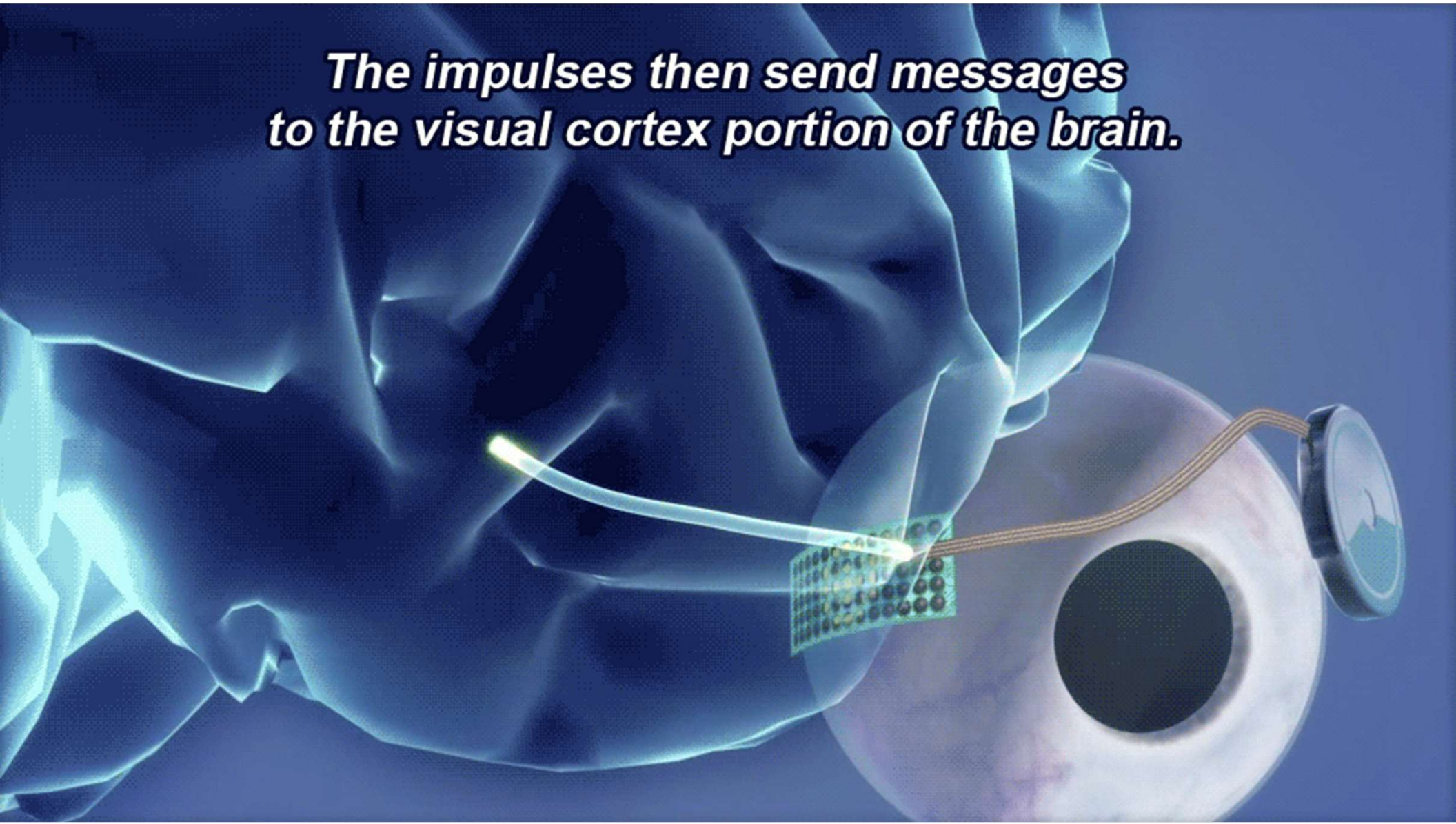
- **Bionic eyes**, also known as artificial or electronic eyes, are advanced medical devices designed to restore vision or enhance visual perception in individuals with severe vision impairment or blindness.
- These devices use sophisticated technology to stimulate the visual system and enable users to perceive visual information.




The camera on the glasses streams images in real time.
The signals are then sent to a wireless transmitter.


The transmitter relays those signals
to the sensor implanted on the retina.


The sensors stimulate the retina with electric impulses.


The impulses then send messages
to the visual cortex portion of the brain.

Bionic eye

Purpose and Function:

- Bionic eyes are developed for people with vision loss caused by conditions like Infections and age-related macular degeneration (AMD).
- The primary goal of bionic eyes is to bypass damaged or non-functional parts of the eye, such as the retina or optic nerve, and directly stimulate the remaining healthy cells or visual pathways to generate visual signals.

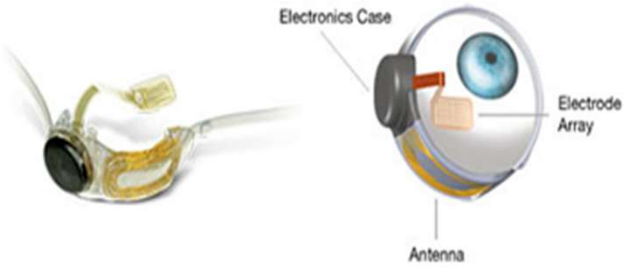
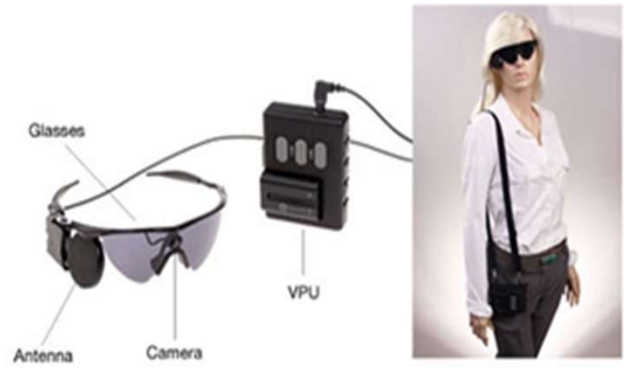


Image courtesy of Second Sight

Components:

- Bionic eyes have several components, including an external camera, a processing unit, and an implanted electrode array.
- The external camera captures visual information from the surrounding environment and sends it to the processing unit.
- The processing unit converts the visual data into electrical signals and transmits them to the implanted electrode array.



Bionic eye

Implantation:

- The electrode array is surgically implanted into the eye, typically on the retina or the brain's visual cortex.

Visual Perception:

- Bionic eyes do not restore normal vision but aim to provide users with visual perception and object recognition.

Training and Rehabilitation:

- After implantation, users need training and rehabilitation to adapt to and use the bionic best.

Limitations:

- Bionic eyes have limitations, including limited resolution and field of view.
- The visual perception provided by bionic eyes may not match the natural vision and experience some visual distortions.

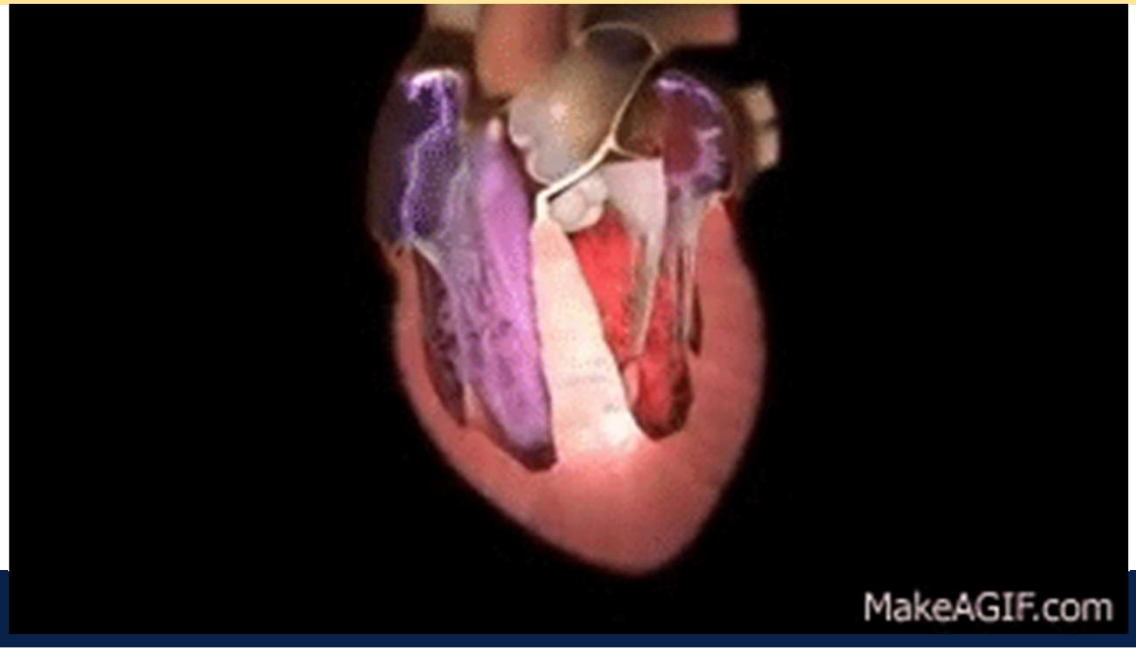
Research and Development:

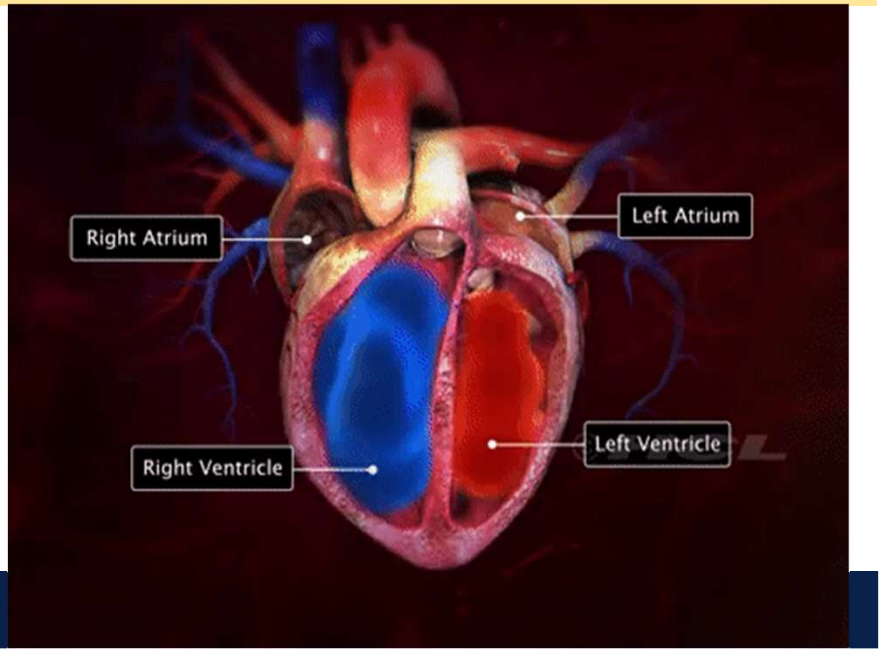
- Bionic eye technology continuously evolves, with ongoing research and development to improve the devices' performance and safety.
- Researchers are exploring new techniques, materials, and designs to enhance the functionality of bionic eyes and make them accessible to more individuals with visual impairments.

Heart as a pump system

The architecture of the Heart:

- **The human heart can be considered a sophisticated pump system that is responsible for circulating blood throughout the body.**
- **It consists of four chambers: Two Atrium and Two Ventricles.**
- **The heart's pumping action is regulated by an electrical signaling system, ensuring that the chambers contract and relax in a coordinated manner to maintain blood flow.**





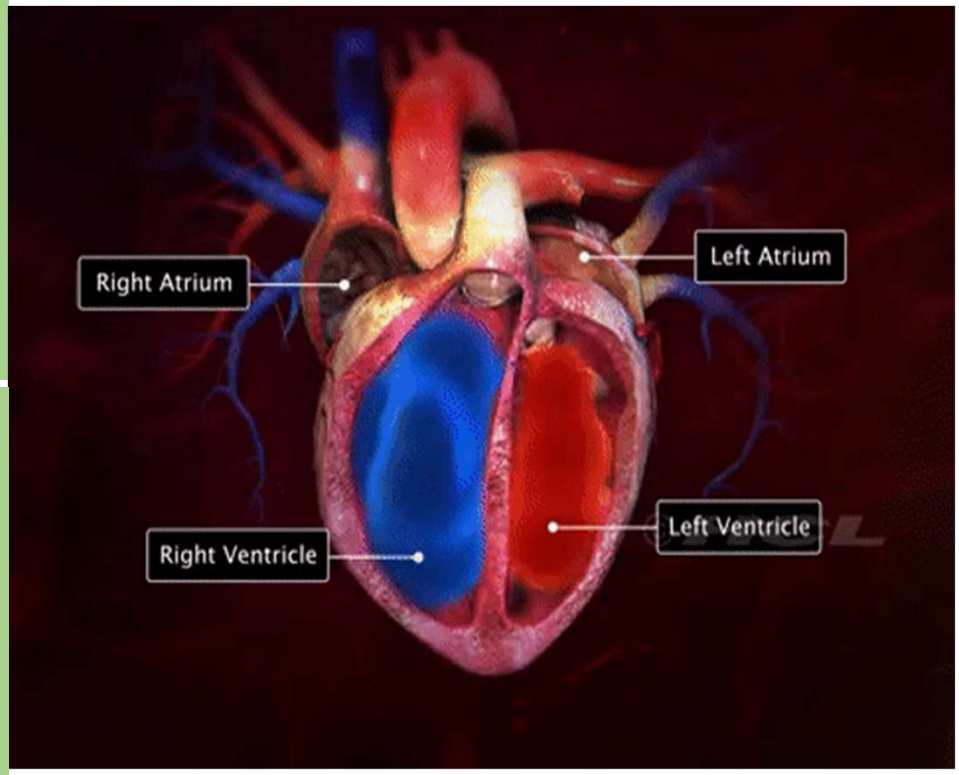
Heart as a pump system

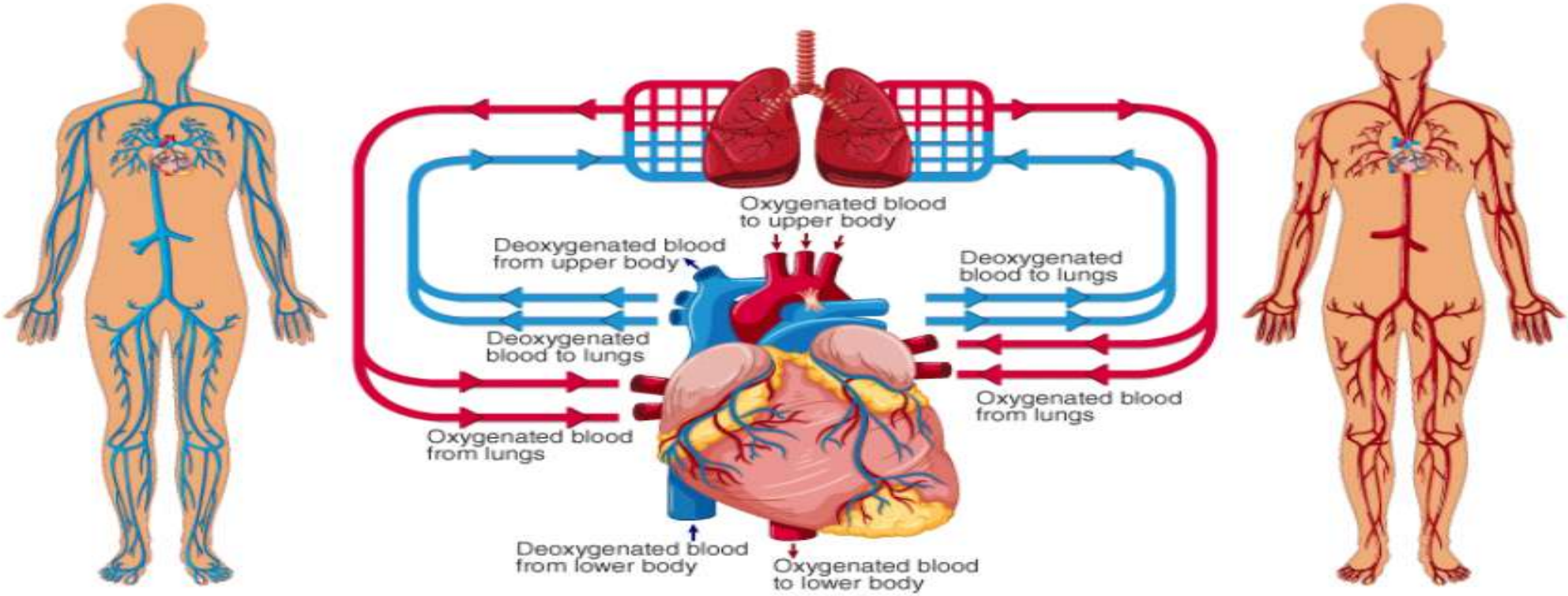
Atrium: The two upper chambers of the heart are the Right and Left Atrium.

- The right atrium receives deoxygenated blood from the body.
- The left atrium receives oxygenated blood from the lungs.
- The atria act as reservoirs that collect and store blood before it moves to the ventricles.

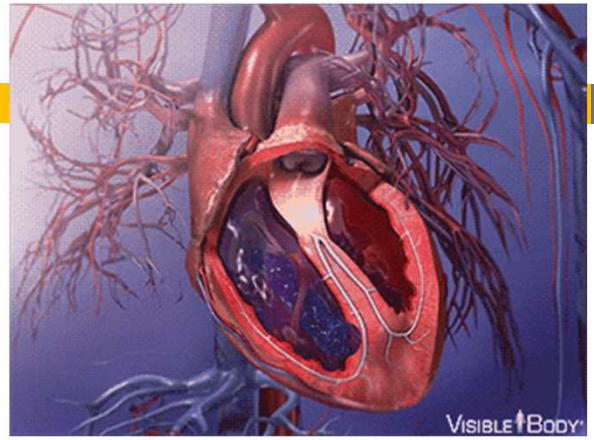
Ventricle: The two lower chambers of the heart are called the ventricles.

- The right ventricle pumps deoxygenated blood to the lungs for oxygenation.
- The left ventricle pumps oxygenated blood to the rest of the body.



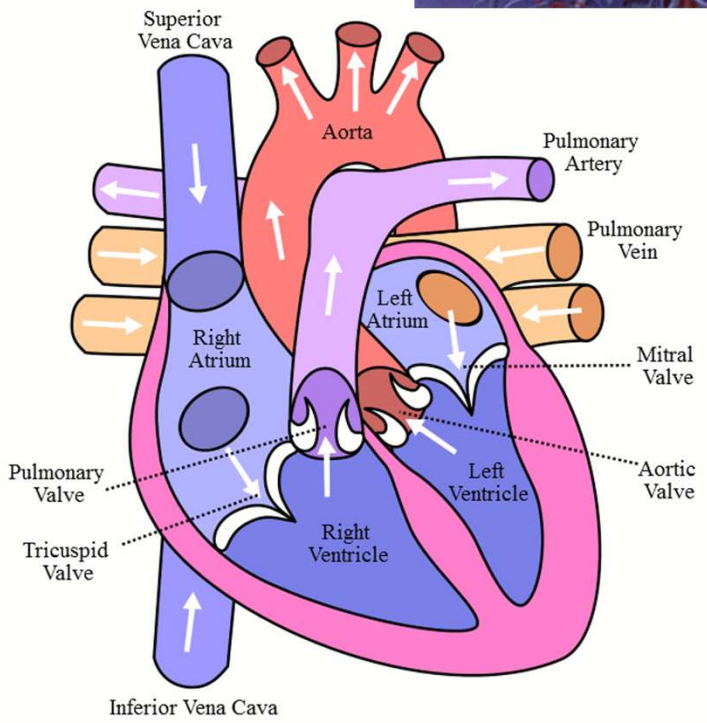

Oxygenated blood
to upper body
Deoxygenated blood
from upper body
Deoxygenated
blood to lungs
Deoxygenated blood
to lungs
Oxygenated blood
from lungs
Oxygenated blood
from lungs
Deoxygenated blood
from lower body
Oxygenated blood
to lower body

Heart as a pump system



Blood flow through the heart:

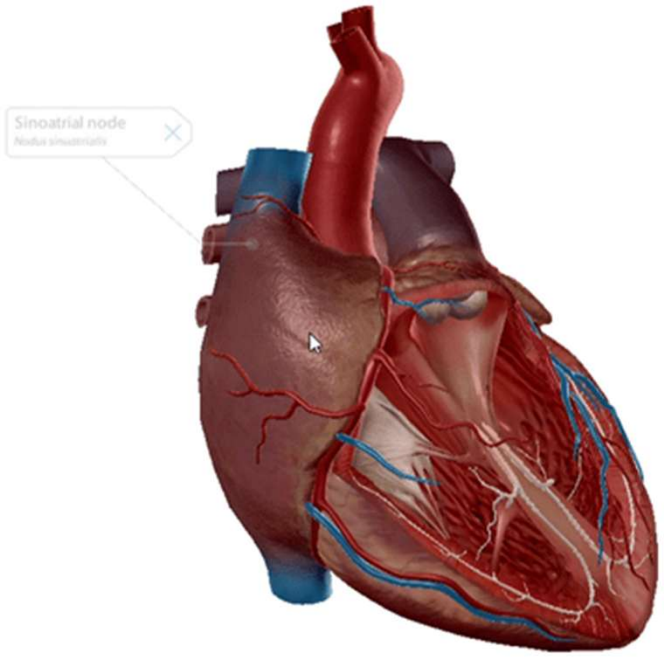
- Deoxygenated blood enters the right atrium from the body via the superior and inferior vena cava.
- From the right atrium, it moves into the right ventricle. The right ventricle then pumps the blood to the lungs through the pulmonary artery for oxygenation.
- Oxygenated blood returns from the lungs to the left atrium via the pulmonary veins. From the left atrium, blood flows into the left ventricle, which then pumps it out to the rest of the body through the aorta.



The Heart Beat

Sinoatrial node

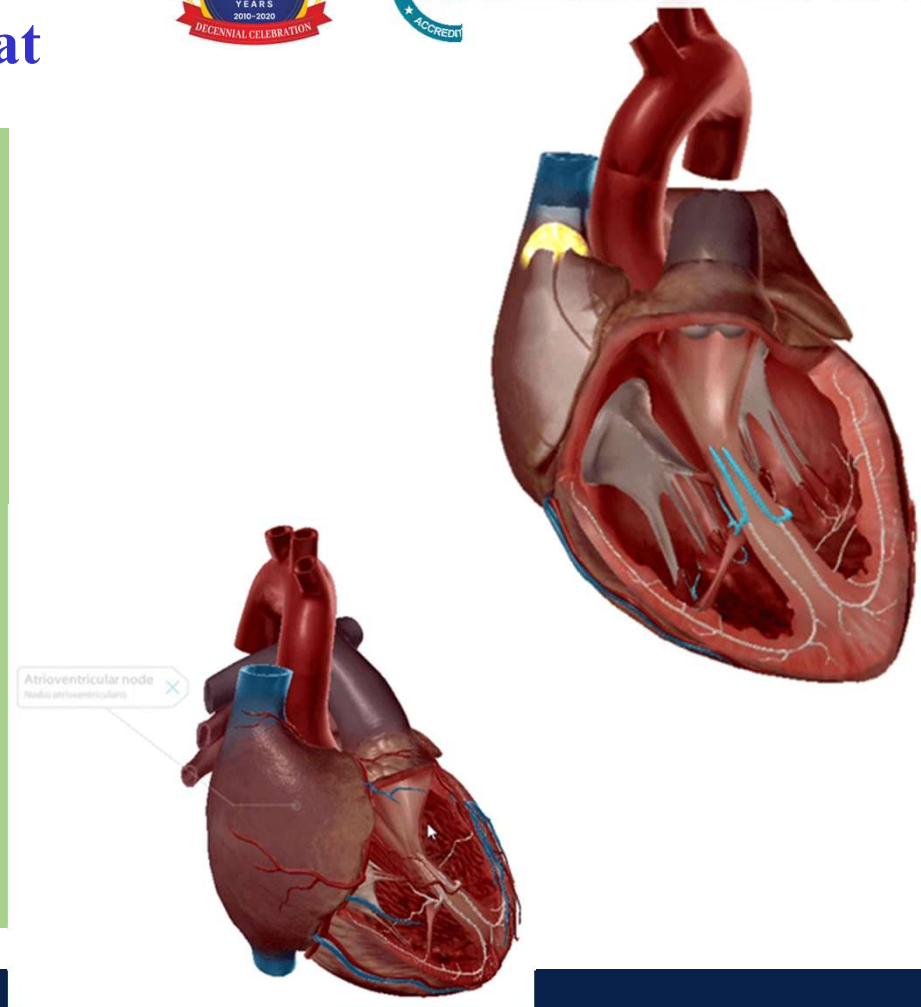
- Known as the SA node for short, the sinoatrial node is nicknamed the pacemaker. The SA node is flat, up to 25 millimeters in length, and is located in the wall of the right atrium.
- It's made up of pacemaker cells: myocardial cells that are specialized to conduct electrical impulses.
- The SA node generates an electrical stimulus 60-100 times per minute, creating the sinus rhythm, which is the normal electrical pattern of the heart.
- A pathway called the interatrial bundle carries impulses to the left atrium.

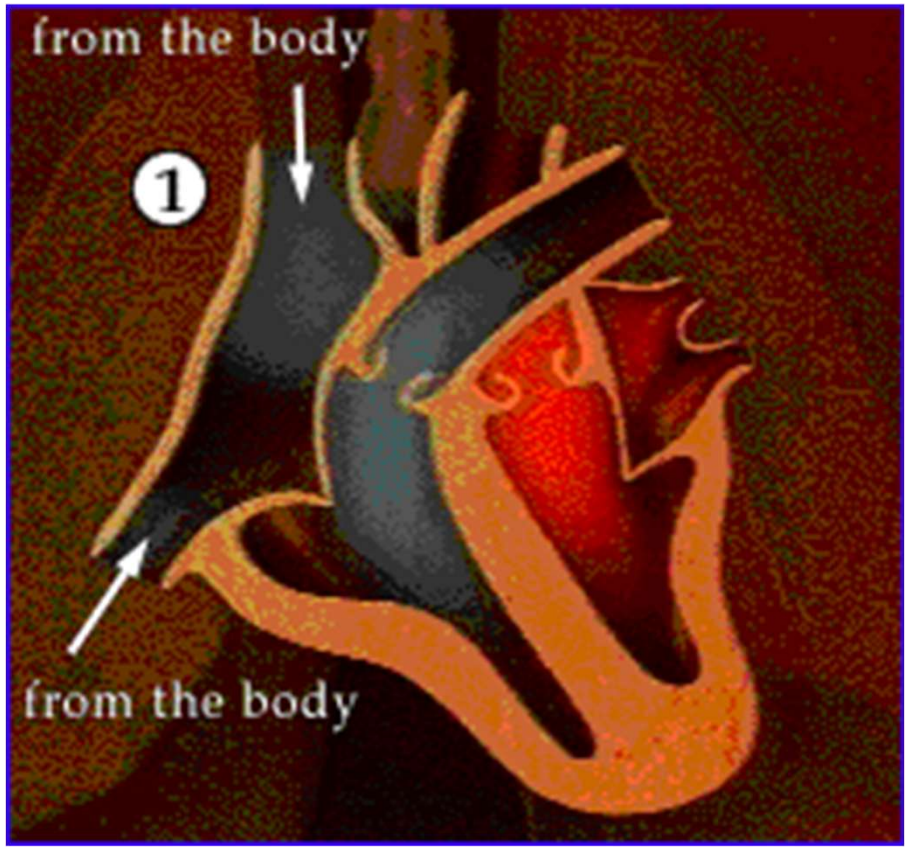


The Heart Beat

Atrioventricular node

- The atrioventricular or AV node is the "secondary pacemaker" of the heart. It acts as a middleman, conducting electrical impulses from the SA node.
- The AV node creates a slight pause before the electrical impulse is sent down the line.
- This pause allows the atrial to pump blood into the ventricles before the next impulse reaches the ventricles.
- The AV node conducts electricity slower the more it is stimulated. This protects against an excessive heart rate if the heart beats irregularly.




from the body
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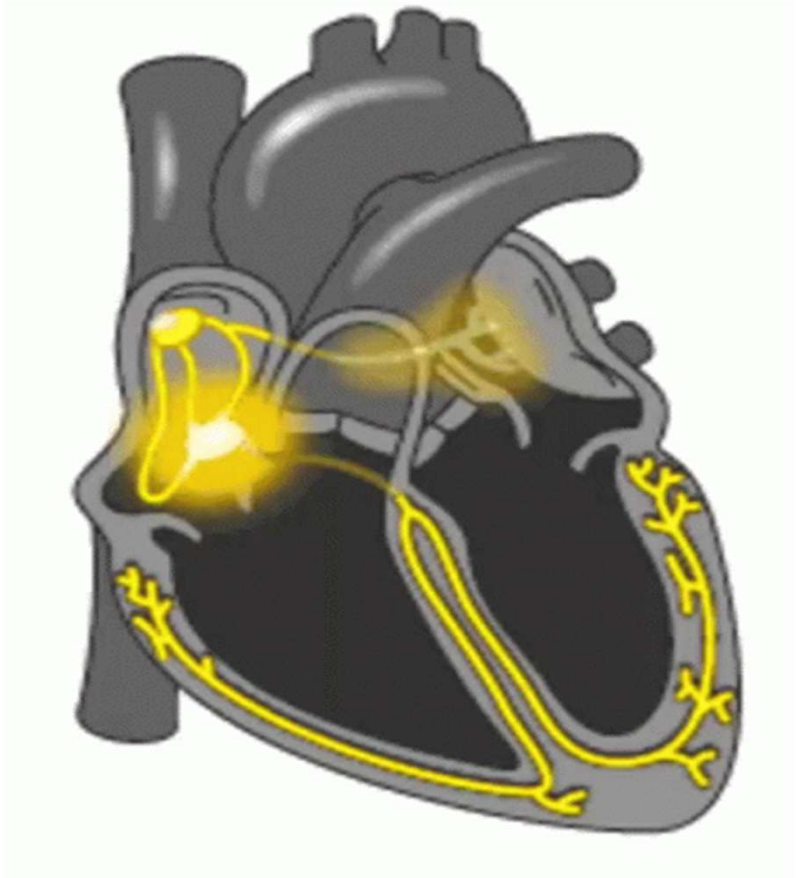
from the body



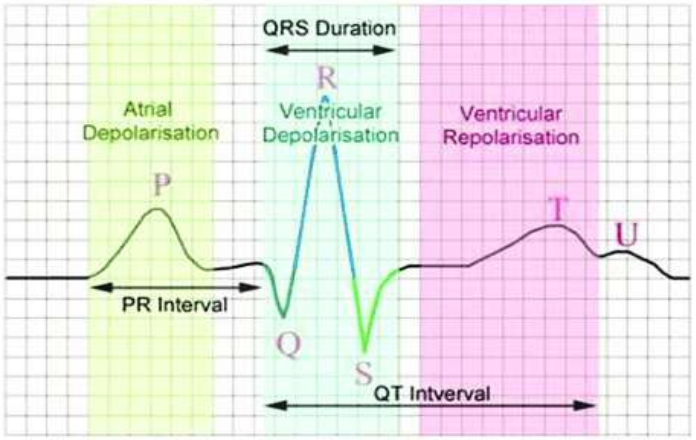
Electrocardiography (ECG)

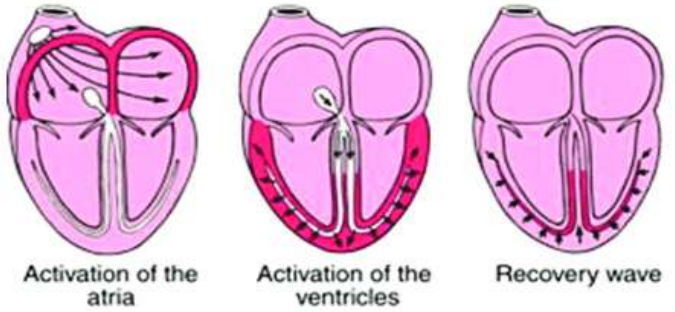
Cardiac Conduction System and Understanding ECG, Animation.

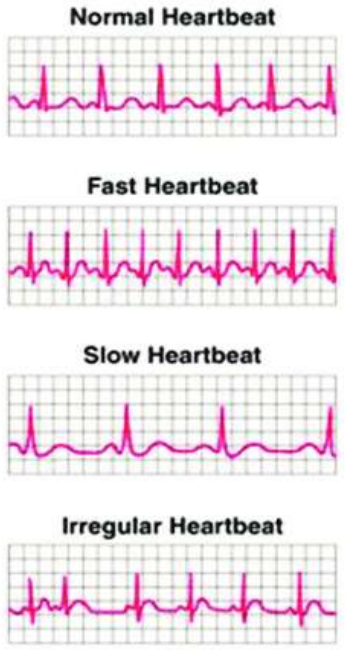
- YouTube

Electrocardiography

- Electrocardiography produces an electrocardiogram (ECG) by recording the heart's electrical activity through repeated cardiac cycles.
- It is an electrogram of the heart, which is a graph of voltage versus time of the heart's electrical activity using electrodes placed on the skin.
- These electrodes detect the small electrical changes that result from cardiac muscle depolarization followed by repolarization during each cardiac cycle (heartbeat).







Electrocardiography (ECG)

Electrocardiography

Purpose of ECG Monitoring:

- ECG monitoring is used to evaluate the heart's rhythm and detect any irregularities in electrical activity.
- It can help diagnose various heart conditions, such as arrhythmias (abnormal heart rhythms)
- Coronary artery disease, heart attacks (myocardial infarction),
- Disease treatments, Electrolyte abnormalities, such as hyperkalemia
- Pacemaker, working.

Electrocardiography

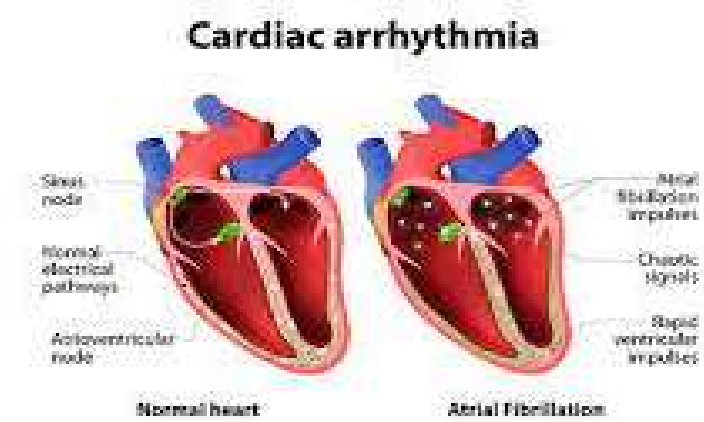
Types of ECG Monitoring: There are different types of ECG monitoring depending on the duration and context of monitoring:

- **Resting ECG:** A standard ECG is done while the patient rests.
- **Holter Monitor:** A portable device worn by the patient for 24 to 48 hours to continuously monitor the heart's activity.
- **Event Monitor:** A portable device worn by the patient for a more extended period (e.g., up to 30 days).
- **Stress Test (Exercise ECG):** An ECG is performed while the patient exercises to assess the heart's response to physical activity.

Electrocardiography (ECG)

Some common heart-related issues that can be diagnosed or monitored using an ECG include:

- **Arrhythmias:** Abnormalities in the heart's rhythm or rate can be detected using an ECG.
- **Heart disease:** Changes in the heart's electrical activity can indicate the presence of heart diseases, such as coronary artery disease or heart attacks.
- **Heart attack:** An ECG can help diagnose a heart attack by detecting changes in the heart's electrical activity that indicate a lack of blood flow to the heart.

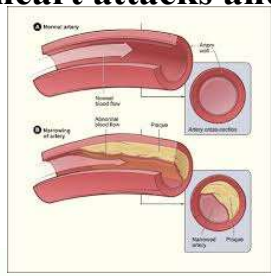


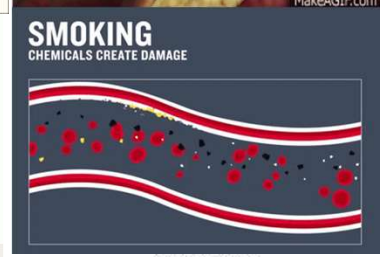
Reasons for Blockages of Blood Vessels

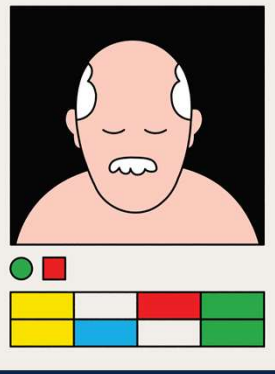
Blockages in blood vessels can have serious health consequences, such as heart attacks and stroke.

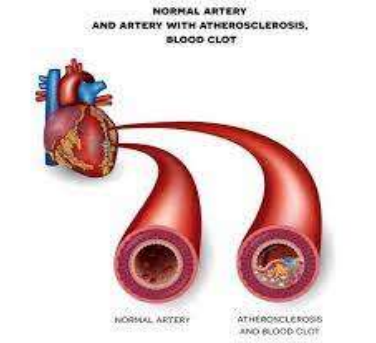
Blockages in blood vessels, known as arterial blockages/atherosclerosis, can occur for several reasons:

- **High cholesterol levels:** Excessive amounts of cholesterol in the blood lead to the formation of plaque in the blood vessels, which can narrow or block them.
- **High blood pressure:** High BP causes blood vessel damage over time, leading to blockages.
- **Smoking:** Smoking damages the inner walls of blood vessels and promotes plaque buildup, leading to blockages.
- **Diabetes:** People with uncontrolled diabetes are at a higher risk of developing blockages in their blood vessels due to blood vessel damage from high glucose levels.
- **Age:** Blood vessels become stiff and less flexible, increasing the risk of blockages.
- **Genetics:** People may be predisposed to develop blood vessel blockages due to genetic factors.
- **Poor diet:** A diet high in saturated fats, trans fats, and cholesterol increases the risk of developing blockages.







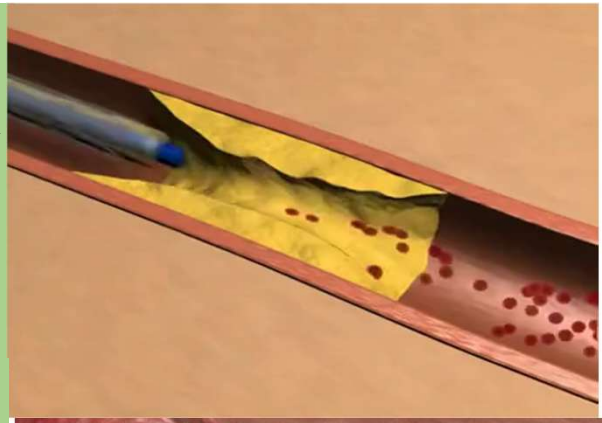


Design of Stents

Stents are medical devices that open and support narrowed or blocked blood vessels. They play a crucial role in treating various cardiovascular conditions, such as coronary artery disease.

Stent Deployment:

- **Balloon-Expandable Stents:** Compressed stents mounted on a deflated balloon expand when the balloon is inflated at the target site.
- **Self-Expandable Stents:** Stents made of shape-memory alloys that can expand on their own once released from the delivery system.



Considerations for Stent Design:

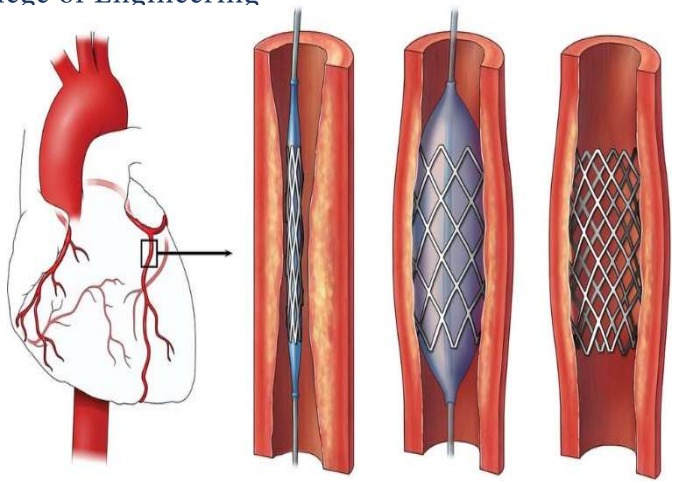
Biocompatibility: Ensuring that the materials used do not provoke harmful reactions.

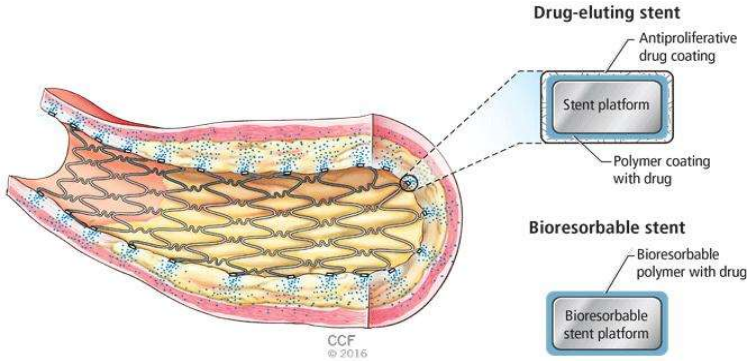
Flexibility: should be flexible enough to adapt to the vessel's contours during deployment.

Drug Delivery (for DES): Optimal drug release rate and dosage to prevent restenosis effectively.

Strut Thickness: Balancing minimizing obstruction and maintaining structural integrity.

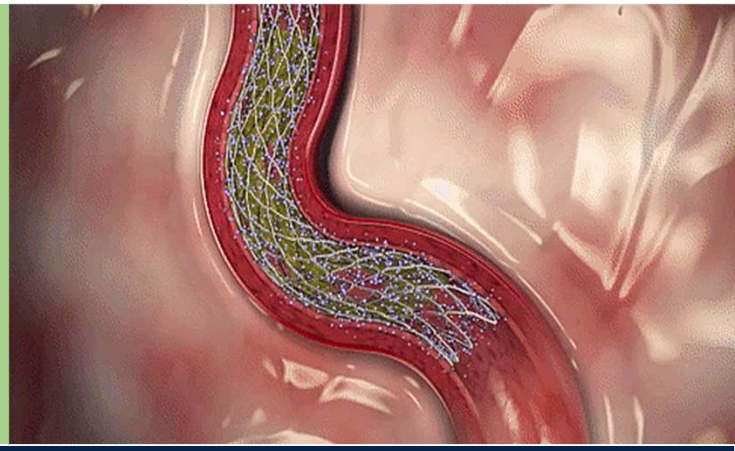
Design of Stents





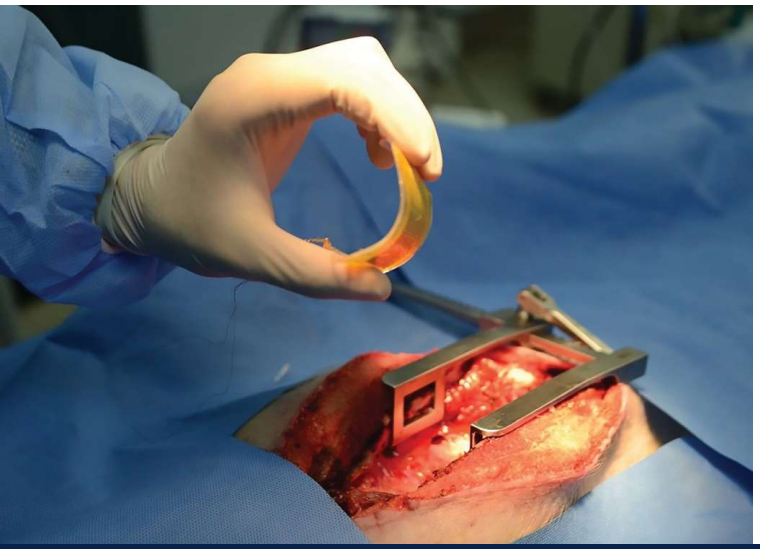
Stents Materials:

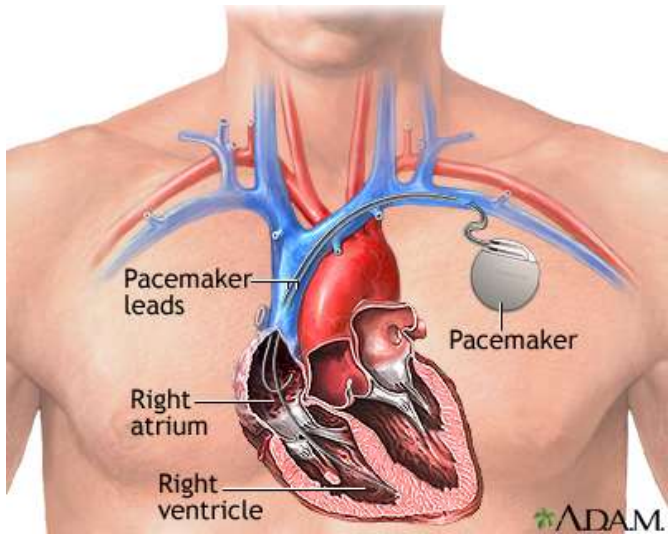
- **Bare Metal Stents (BMS):** These stents are metal (usually stainless steel) and provide structural support to keep the artery open.
- **Drug-Eluting Stents (DES):** These stents have a polymer coating that releases medication over time to prevent restenosis (re-narrowing) of the artery.
- **Bioresorbable Stents** gradually dissolve, leaving only the healed artery behind.

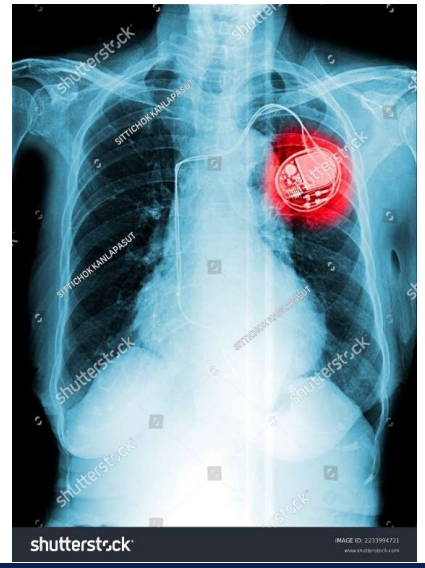


Pacemaker

- A **Pacemaker** is a medical device that helps regulate a person's heart rhythm.
- It is implanted, in the heart that generates electrical pulses by electrodes to one or more of the heart's chambers, the upper atria or lower ventricles.
- Each pulse causes the targeted chamber(s) to contract and pump blood, thus regulating the function of the heart's electrical conduction system.





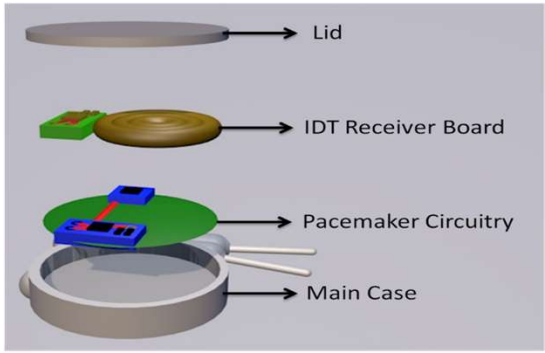


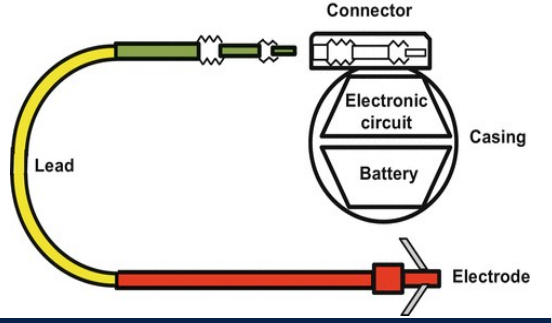
Pacemaker

Construction of a Pacemaker

The construction of a pacemaker involves using high-quality materials to ensure their safety and reliability.

1. **Medical-grade plastics:** Medical-grade plastics, such as polycarbonate, are used to construct the device's exterior and provide insulation and protection for the internal components.
2. **Metals:** Metals like stainless steel and titanium are used to construct the leads and electrodes to ensure their durability and long-lasting performance.
3. **Electronic components:** Electronic components, such as microprocessors, batteries, and capacitors, are used to control the delivery of electrical impulses and to provide power to the device.
4. **Adhesives:** Adhesives, such as cyanoacrylate and epoxy, are used to secure the components.



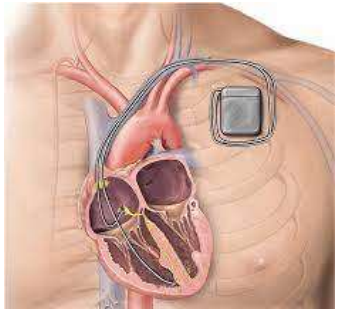


Defibrillators

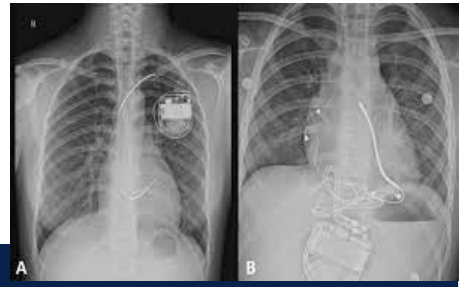
Defibrillators work by delivering a controlled electric shock to the heart. The shock interrupts the chaotic electrical activity of the heart during ventricular fibrillation, allowing the heart's natural pacemaker to reestablish a normal rhythm.

Types of Defibrillators:

- **Automated External Defibrillators (AEDs):** Portable devices designed by non-medical personnel, such as first responders or laypersons. AEDs analyze the heart rhythm and provide voice prompts to guide the rescuer through defibrillation.
- **Implantable Cardioverter Defibrillators (ICDs):** Surgically implanted devices defibrillations for patients at high risk of sudden cardiac arrest due to underlying heart conditions. ICDs continuously monitor the heart rhythm and deliver an electrical shock when an abnormal rhythm is detected.



- **Transvenous Defibrillators:** Implanted in a patient's chest, connected to the heart through lead wires threaded into the blood vessels. These are used in patients who need long-term defibrillation support.



Defibrillators

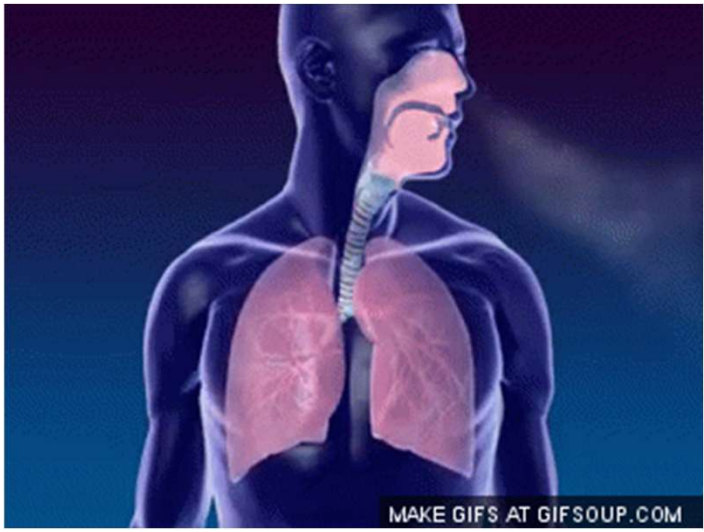
Defibrillators are safe to use, as they will not deliver a shock unless they detect a shockable rhythm (VF or pulseless VT). AEDs are designed to be user-friendly and can be used by individuals with minimal or no training.

A quick application of defibrillation is crucial for the best chances of survival in cardiac arrest cases.

It is important to remember that while AEDs can be life-saving devices, proper CPR and AED usage training can significantly improve the outcome in emergencies.

If you are in a situation where someone is experiencing cardiac arrest, immediately call for medical help and start CPR while waiting for the AED to arrive.

Lungs as purification system



Every cell in your body needs oxygen to live.

The air we breathe contains oxygen and other gases.

The respiratory system's main job is to move fresh air into your body while removing waste gases.

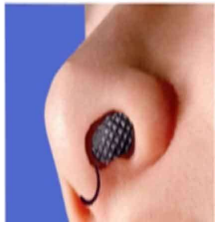
Once in the lungs, oxygen is moved into the bloodstream and carried through your body, oxygen is exchanged for a waste gas called carbon dioxide.

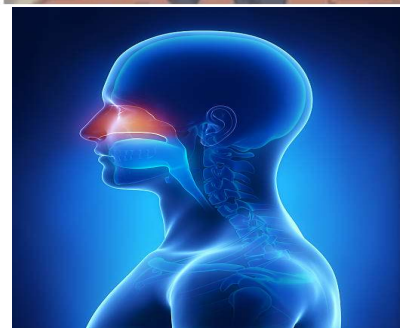
Your bloodstream then carries this waste gas back to the lungs where it is removed from the bloodstream and then exhaled.

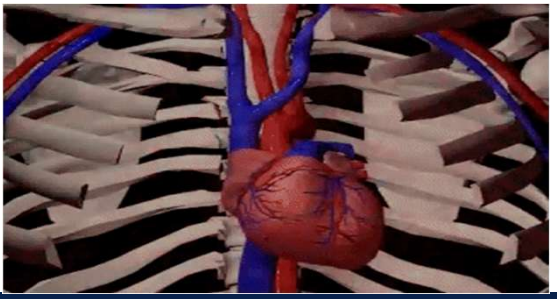
In addition to gas exchange, our respiratory system performs other roles like.

- Bringing air to the proper **body temperature** and **moisturizing** it to the right humidity level.
- Protecting your body from harmful substances. This is done by **coughing, sneezing, and filtering**.
- Supporting your **sense of smell**.

In the nostrils, the air gets warmed and moistened. Tiny hairs in the nose called **cilia** filter out dust and other particles.





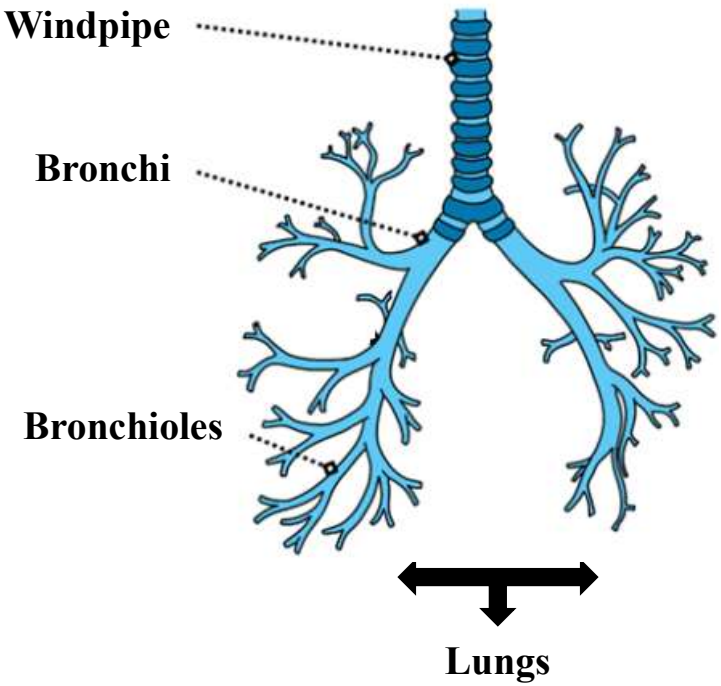


Lungs help in the purification of blood

When the breath is inhaled, oxygen from the air meets the impure blood and the blood takes up oxygen, releases CO_2, and is purified in the lungs. The purified blood is carried to the heart by the veins.

Bronchi **Lobes** **Alveoli** **Pulmonary Capillaries** **Pleura** **Diaphragm**

- The trachea, or windpipe, divides into two main bronchi—one leading to each lung.
- These bronchi then branch out into smaller bronchi, which further divide into bronchioles.



Uses

- Carry air to and from your lungs.
- The bronchi also help moisturize the air you breathe and screen out foreign particles

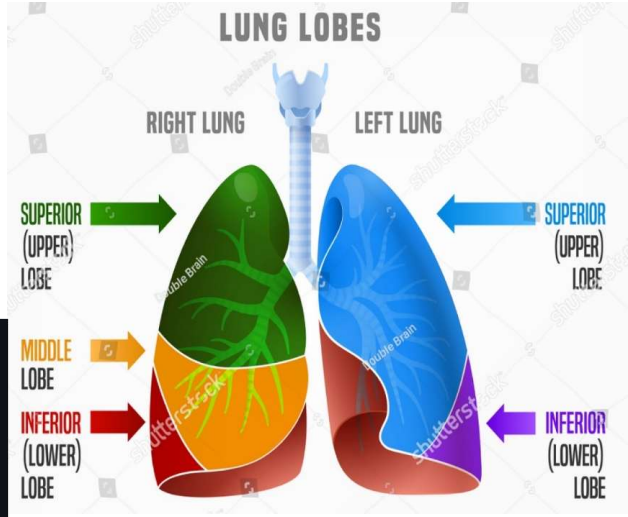
Lung's architecture

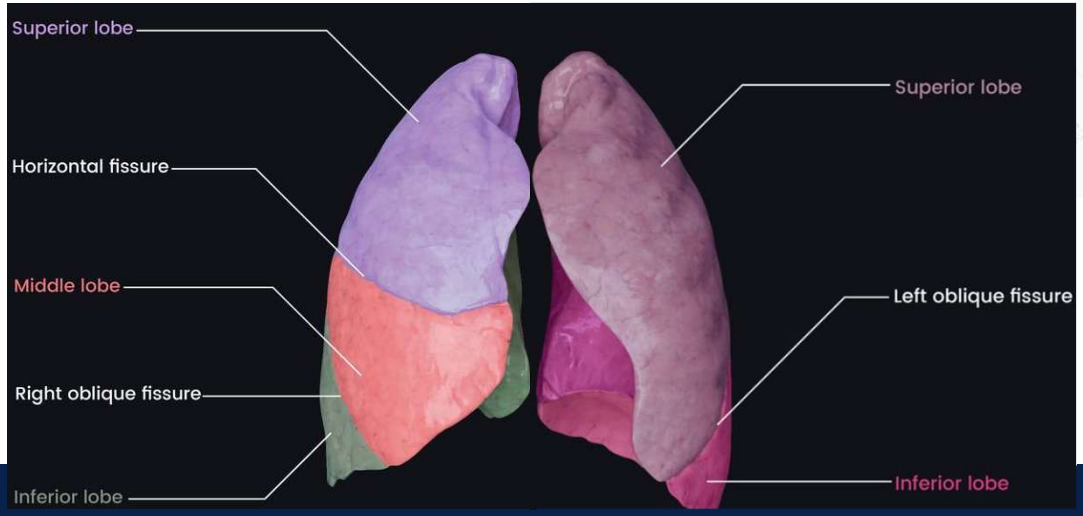
Bronchi **Lobes** **Alveoli** **Pulmonary Capillaries** **Pleura** **Diaphragm**

The human lungs are divided into two main sections called the left and right lungs.

The right lung has three lobes: the superior, middle, and inferior lobes.

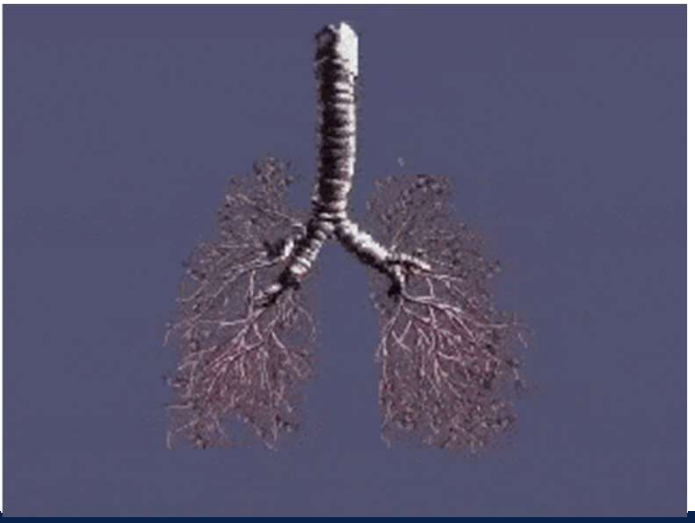
The left lung is slightly smaller and has two lobes: the superior and inferior lobes.

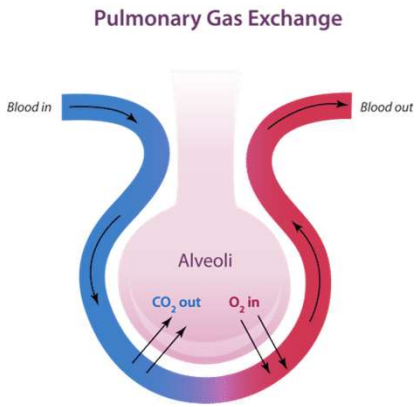


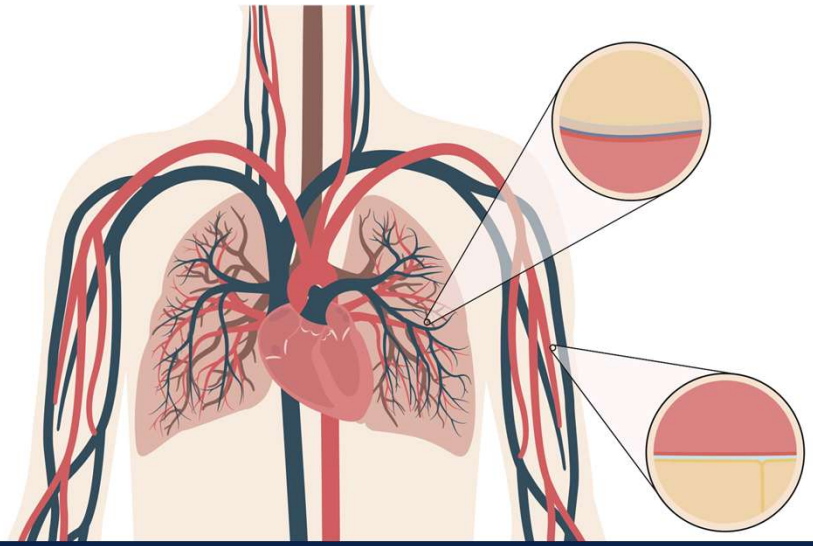


Lobes **Bronchi** **Alveoli** **Pulmonary Capillaries** **Pleura** **Diaphragm**

- At the end of the terminal bronchioles,
- These grape-like structures are the primary sites of gas exchange.
- It allows for the diffusion of oxygen from the alveoli into the bloodstream and the release of carbon dioxide into the alveoli.



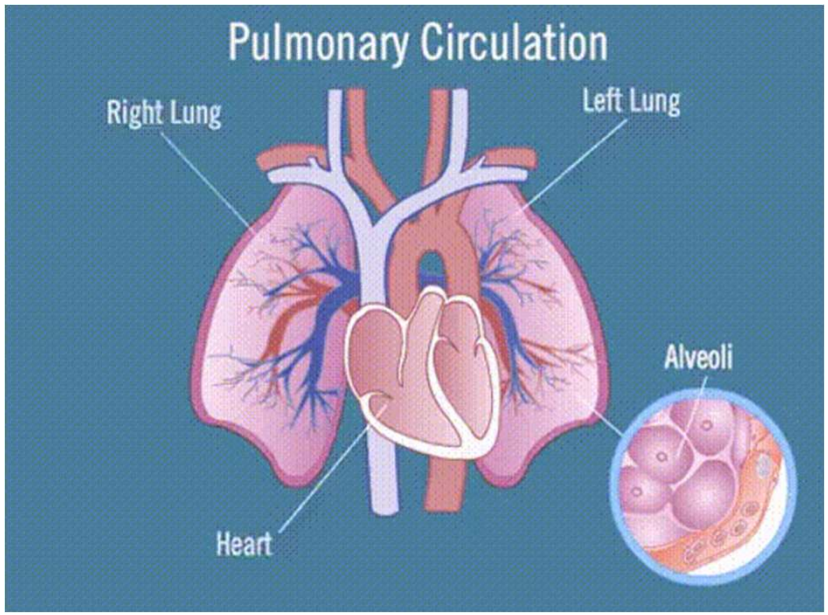


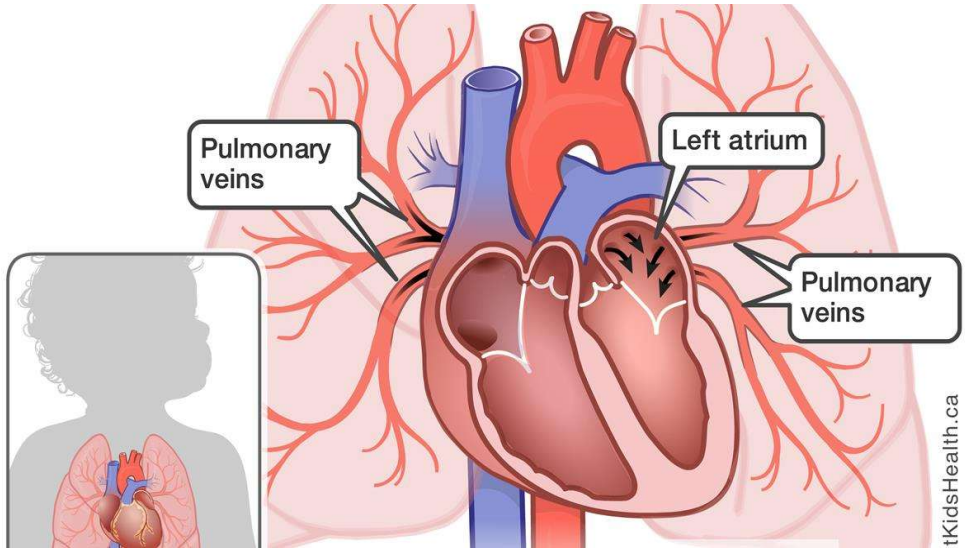


Lobes **Bronchi** **Alveoli** **Pulmonary Capillaries** **Pleura** **Diaphragm**

Deoxygenated blood enters the pulmonary arteries from the right side of the heart and is delivered to the **pulmonary capillaries**.

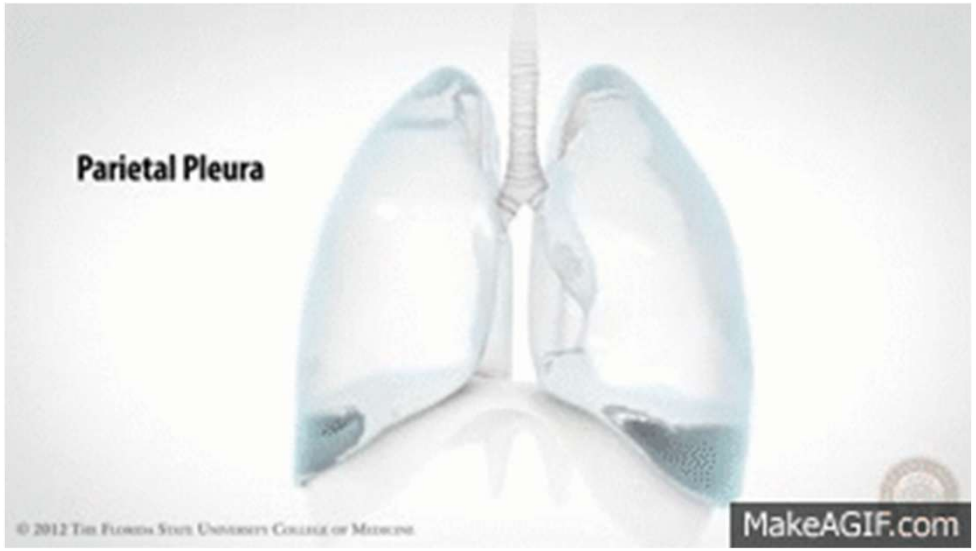
It is the smallest blood vessel inside of the lungs, attached to the walls of the alveoli which exchange gases between the alveoli and the bloodstream.

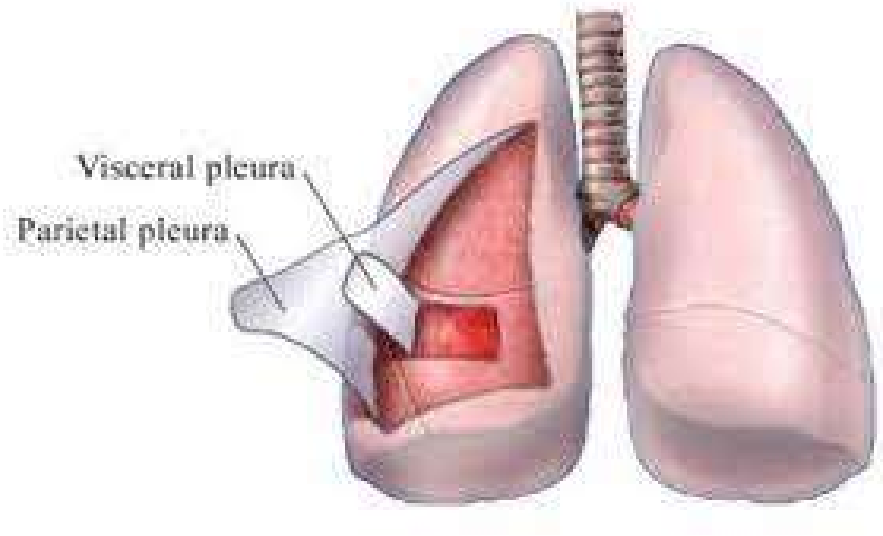




Lobes **Bronchi** **Alveoli** **Pulmonary Capillaries** **Pleura** **Diaphragm**

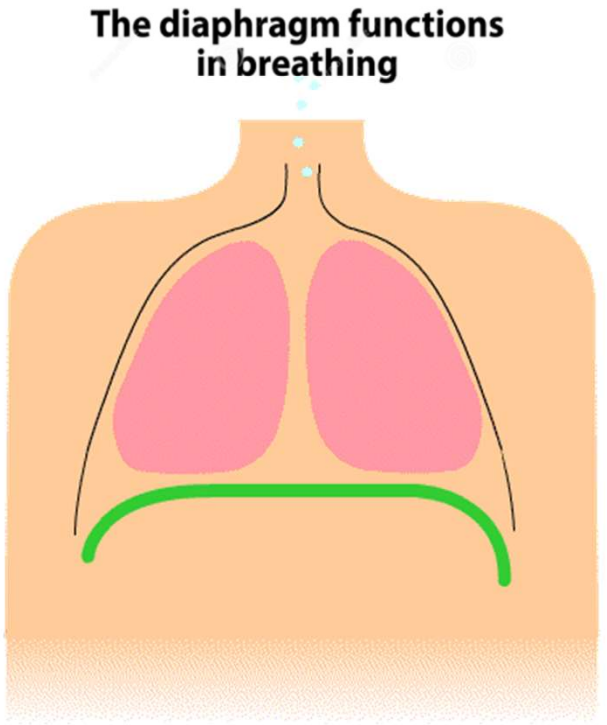
The lungs are covered by a double-layered membrane called the pleura.





Lobes **Bronchi** **Alveoli** **Pulmonary Capillaries** **Pleura** **Diaphragm**

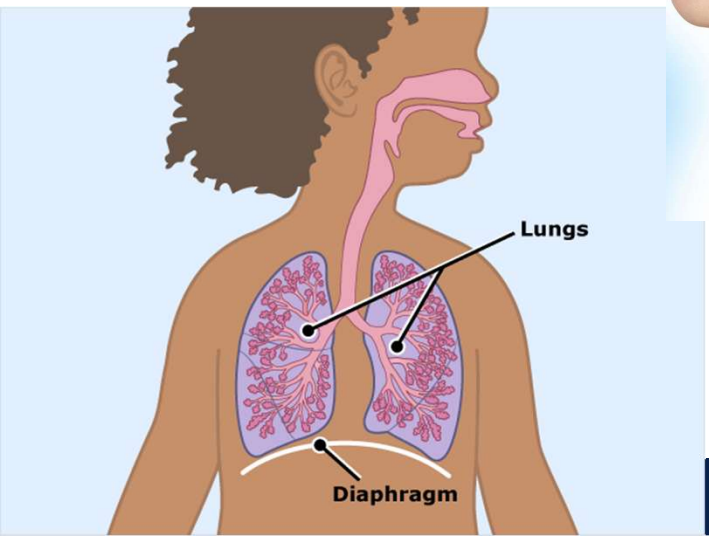
- The diaphragm is a dome-shaped muscle located at the base of the lungs.
- It plays a crucial role in respiration by contracting and flattening during inhalation, allowing the lungs to expand and fill with air.
- When the diaphragm relaxes, it returns to its dome shape, helping to expel air from the lungs during exhalation.

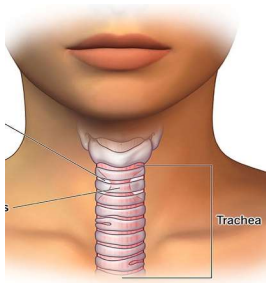


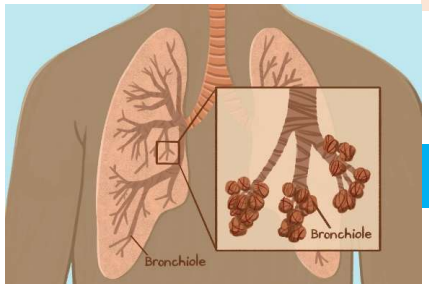
GAS EXCHANGE MECHANISMS:

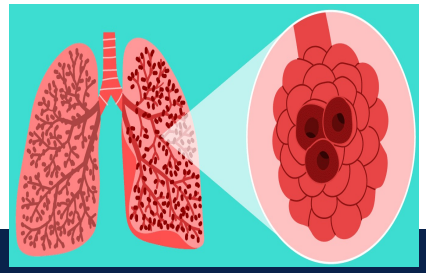
- Air enters the body through the mouth or nose and quickly moves to the throat.
- it passes through the voice box and enters the trachea.
- Within the lungs, the trachea branches into a left and right bronchus. These further divide into smaller and smaller branches called bronchioles. The smallest bronchioles end in tiny air sacs. These are called alveoli.

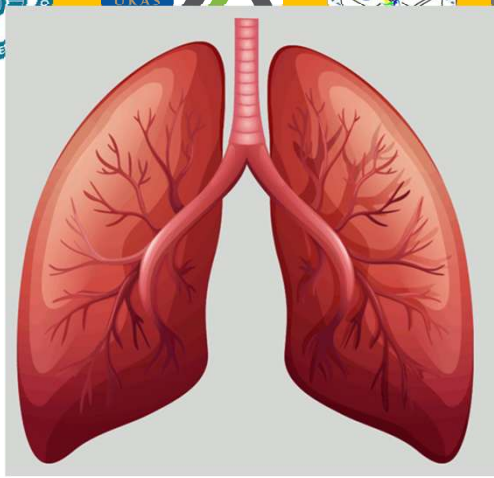
Air → Mouth or nose → Throat → Vice box → Trachea → Left/Right branches → Bronchioles → Alveoli



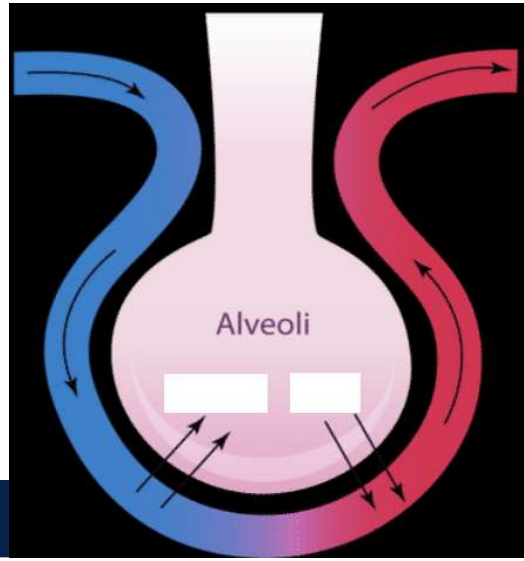








- They **inflate** when a person inhales and **deflate** when a person exhales.
- During gas exchange oxygen moves from the lungs to the bloodstream. At the same time, carbon dioxide passes from the blood to the lungs.
- Oxygen molecules attach to red blood cells, which travel back to the heart. At the same time, the carbon dioxide molecules in the alveoli are blown out of the body the next time a person exhales.
- The gas exchange allows the body to replenish the oxygen and eliminate carbon dioxide. Doing both is necessary for survival.



SPIROMETRY

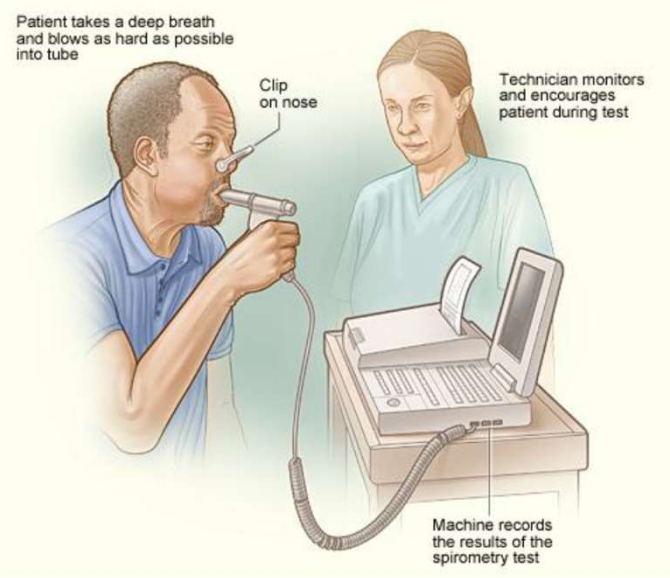
Spirometry is a standard office test used to assess **how well your lungs work** by measuring

How much air you **inhale**, how much you **exhale**, and how **quickly** you exhale.

Spirometry diagnoses **asthma, chronic obstructive pulmonary disease (COPD)**, and other conditions that affect breathing.

During a spirometry test, you will be asked to breathe into a specialized spirometer device. The spirometer measures various lung volumes and capacities as you breathe in and out. The test is typically performed while you are sitting or standing.

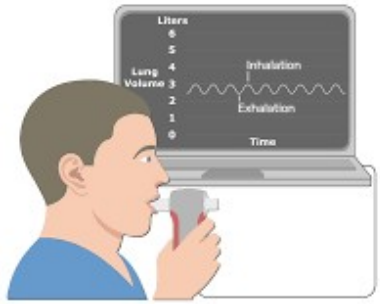
Spirometry results are compared to predicted values based on age, height, gender, and ethnicity.

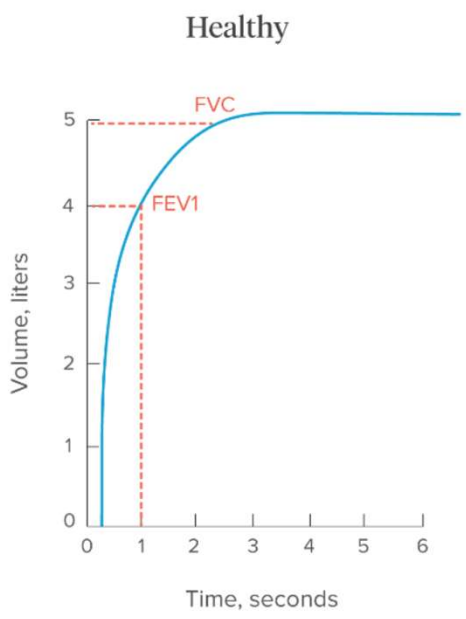


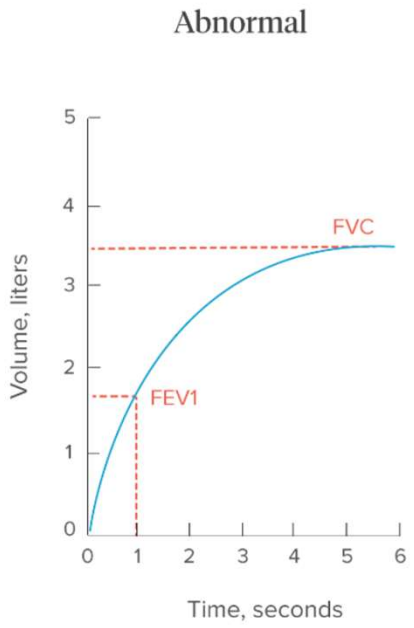
HOW TO CALCULATE THE NORMAL RATE OF RESPIRATION IN A SPIROMETER:

RATE OF RESPIRATION = $\frac{forced\ expiratory\ volume}{forced\ vital\ capacity\ of\ the\ lungs}$

- In healthy adults of the same gender, height, and age, the normal Predicted percentage should be between **70% and 85%.**
- Percentages **lower than 70%** are considered abnormal







ABNORMAL LUNG PHYSIOLOGY:

Age	Rate
Newborn	30-40 breaths/minute
Infants	30-60 breaths/minute
Toddler	26-32 breaths/minute
Child	20-30 breaths/minute
Adolescent	16-20 breaths/minute
Adults	16-22 breaths/minute

Normal Respiration rate

SAMPLE USE ONLY

nucleus
MEDICAL MEDIA

Chronic obstructive pulmonary disease (COPD)

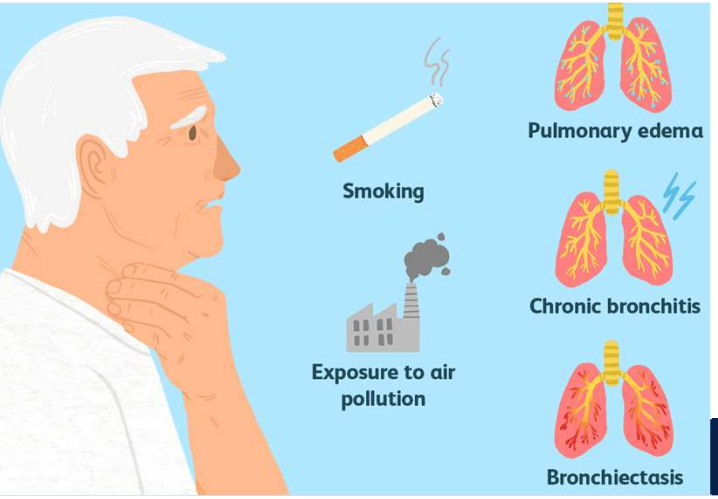
It is a chronic inflammatory lung disease that causes obstructed airflow from the lungs.

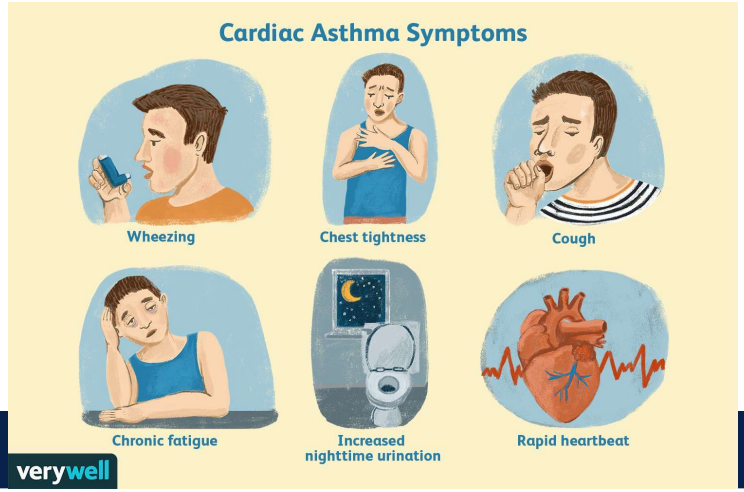
Symptoms:

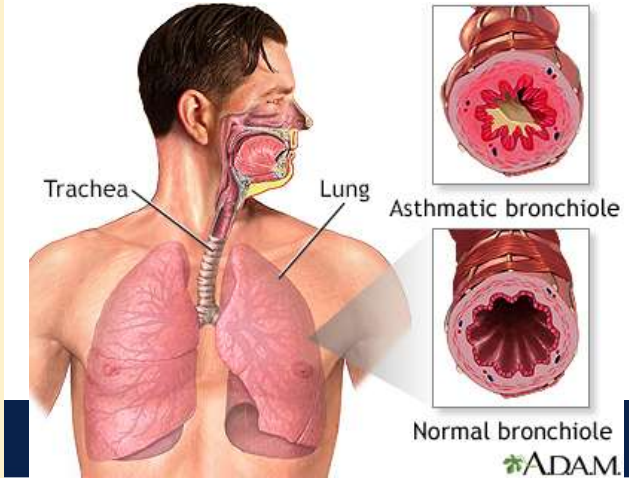
1. Breathing difficulty
2. Cough
3. Mucus (sputum) production, and
4. Wheezing.

Causes due to

1. long-term exposure to irritating gases.
2. Cigarette smoke.
3. Age-related issues.







Chronic obstructive pulmonary disease (COPD)

Signs and symptoms of COPD may include:

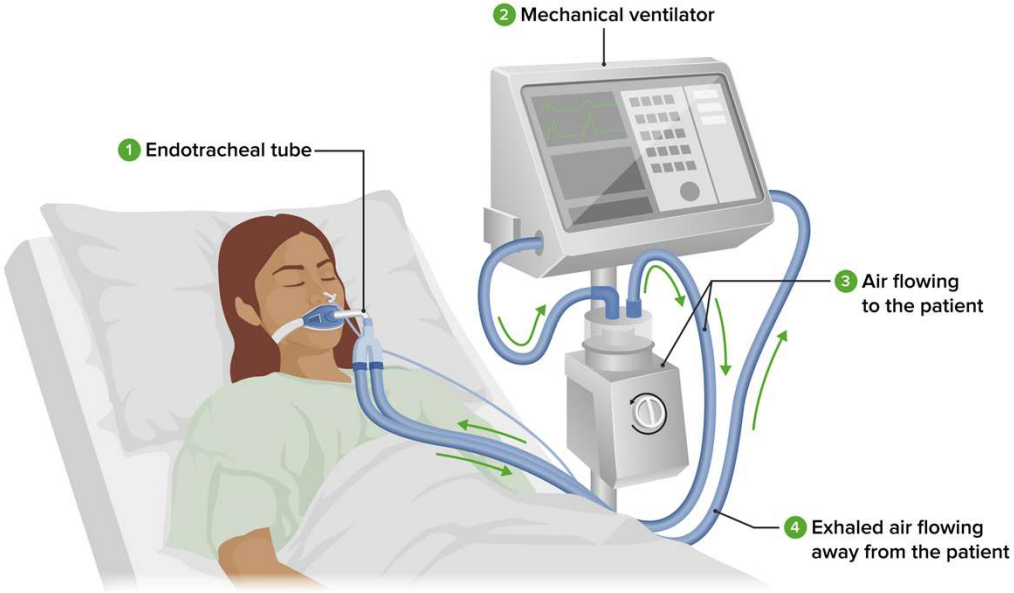
1. Shortness of breath, especially during physical activities
2. Wheezing
3. Chest tightness
4. A cough produce mucus that may be clear, white, yellow, or greenish
5. Frequent respiratory infections
6. Lack of energy
7. Unintended weight loss (in later stages)
8. Swelling in ankles, feet, or legs

Tests may include:

1. Lung (pulmonary) function test.
2. Chest X-ray.
3. CT scan.
4. Arterial blood gas analysis.
5. Laboratory tests.

VENTILATOR:

Mechanical ventilators are automated machines that breathe for patients who cannot use their lungs.

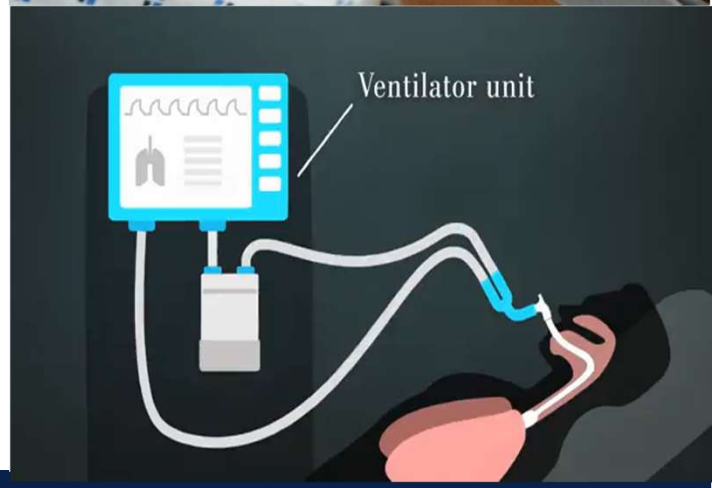


Ventilators are commonly used when patients are experiencing severe shortness of breath, such as that caused by a respiratory infection or by conditions such as chronic obstructive pulmonary disease (COPD).

They may also be used in persons with traumatic brain injury or stroke when the nervous system can no longer control breathing.

Working of Ventilator

- Ventilators deliver oxygen directly to the lungs, and they can also be programmed to pump out carbon dioxide for patients who cannot exhale on their own.
- The ventilator delivers oxygen via a tube inserted through the patient's nose or mouth in a procedure known as intubation, or that is placed directly into the trachea, or windpipe, in a surgical procedure known as tracheostomy.
- The opposite end of the tube is connected to a machine (the ventilator) that pumps air and oxygen through the tube and into the lungs.
- The air is warmed and humidified before it goes into the body.
- The ventilator further plays a vital role in maintaining positive air pressure to help prevent small air sacs (alveoli) in the lungs from collapsing.
- Ventilators are set to pump air into the lungs several times per minute. The patient's heart, respiratory, and blood pressure are monitored constantly.

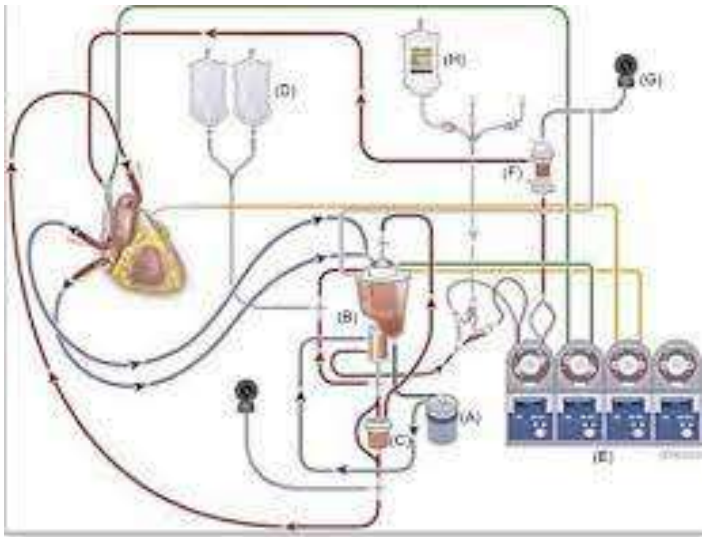


HEART LUNG MACHINE:

A heart-lung machine is a piece of equipment that temporarily takes over the work of the heart and/or lungs, providing blood and oxygen to the body.

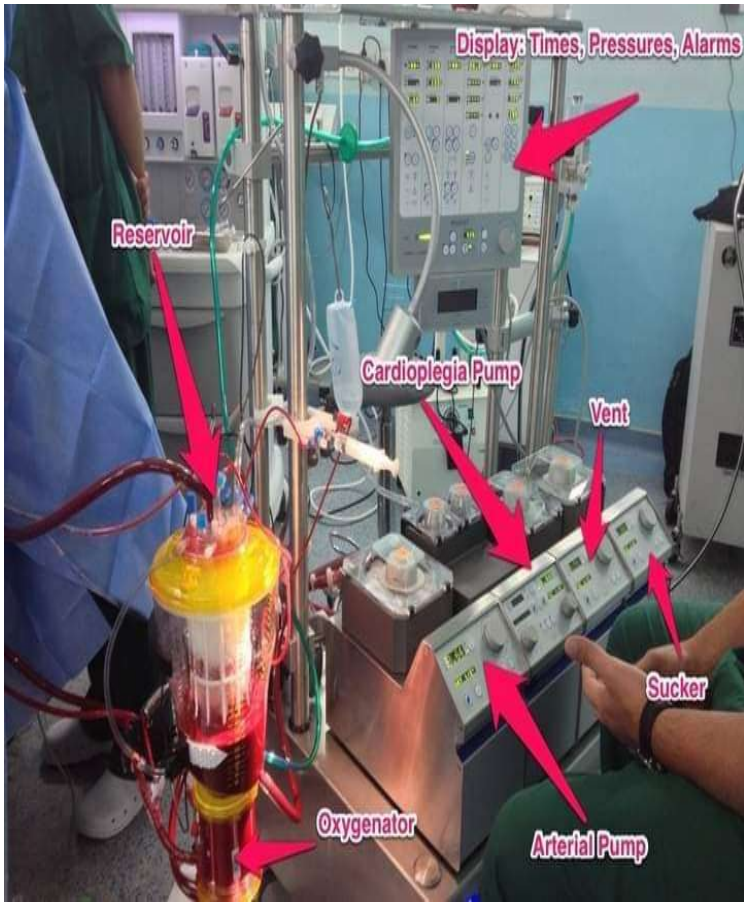
Also called a cardiopulmonary bypass machine (CBM) or a heart-lung bypass machine, it is most often used during serious procedures that require the heart to be stopped.

A heart-lung machine may also be used on a person who needs heart or respiratory support for non-surgical reasons.

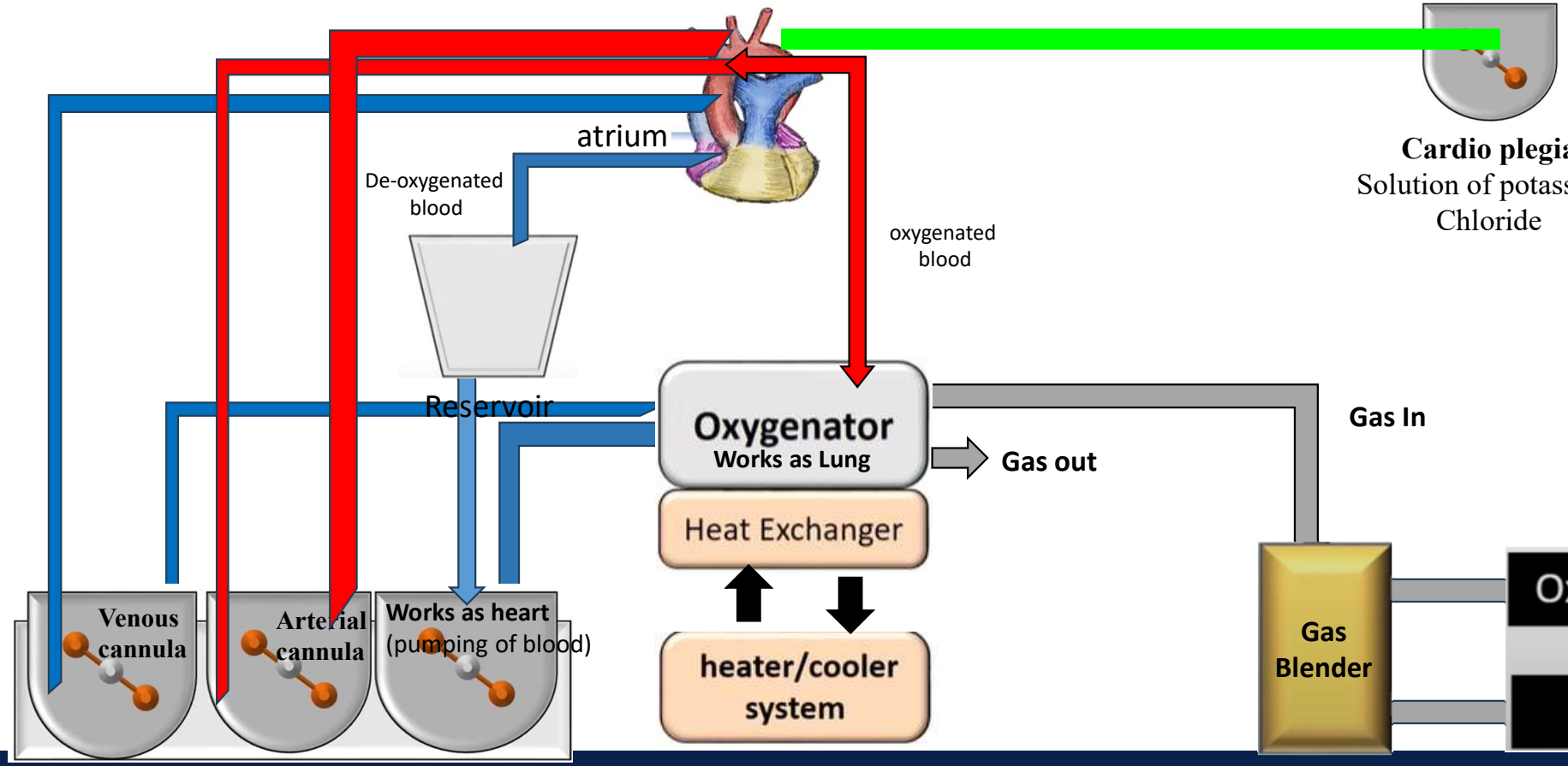


Components: The heart-lung machine has several components, including a pump, oxygenator, filters, temperature control, and monitoring devices. The pump is responsible for circulating the blood, while the oxygenator replaces the function of the lungs by adding oxygen and removing carbon dioxide.

- During surgery, The surgeon attaches special tubing to a large blood vessel. The machine draws deoxygenated blood from the body, pumps it through the oxygenator to add oxygen and remove carbon dioxide, and then returns the oxygenated blood back to the body, thus maintaining blood circulation.
- To prevent blood from clotting within the machine, anticoagulants (blood-thinning medications) such as heparin are administered. Continuous monitoring of the patient's blood clotting parameters is crucial to prevent excessive bleeding or clotting.
- A third tube is also inserted near or directly into the heart, but not connected to the CPM. It is used to flush the heart with cardioplegia, a potassium solution which stops the heart. Once the cardioplegia takes effect, the CBM is initiated and takes over the heart and lung function.
- Cannulas (tubes) are inserted into large blood vessels. The arterial cannula is placed in the aorta to deliver oxygenated blood back into the systemic circulation, while the venous cannula is inserted into the right atrium or superior vena cava to draw blood from the body into the machine.



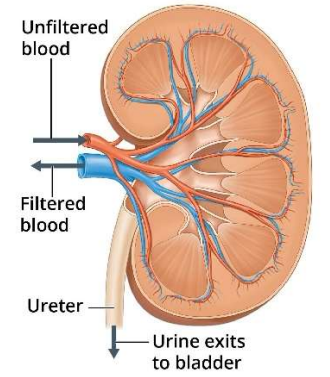
HEART LUNG MACHINE:

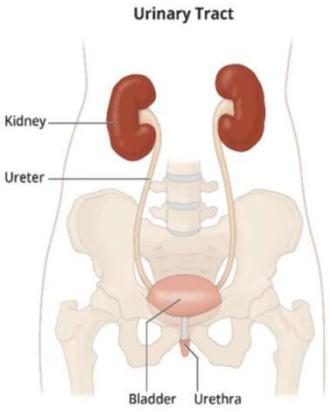



GKT IYER
HEALTHIER HEARTS
Heart-Lung Machine
A Video Explainer
www.gktiyer.com

KIDNEY AS FILTRATION SYSTEM

- The kidneys are two **bean-shaped** organs located just below the **rib cage.**
- Kidneys **remove wastes** and extra fluid from the body
- Kidneys also **remove acid** produced by the body's cells and maintain a healthy **balance of blood water, salts, and minerals.**
- Without this balance, **nerves, muscles, and other tissues** in the body may not work normally.
- Healthy kidneys filter about **half a cup of blood every minute**, removing wastes and extra water in the form of urine.
- The urine flows from the **kidneys** to the bladder through **ureters** connected to the **bladder** and stored in it.

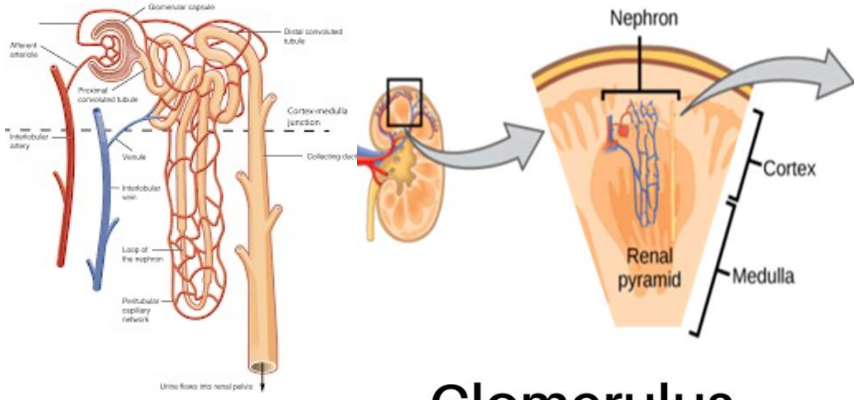




MECHANISM OF FILTRATION:

Parts in kidney

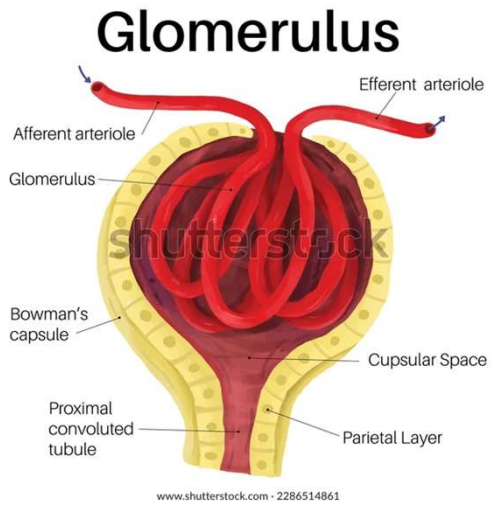
- Each kidney is made up of about a million **filtering units called nephrons**
- Each nephron includes a filter, called the **glomerulus**, and a **tubule**
- **Glomerulus** filters blood, and the Tubule **removes wastes (Urine)**.



Blood flows into Nephron

Glomerulus
(Which allows only smaller molecules and larger molecules like protein & blood cells stays in blood)

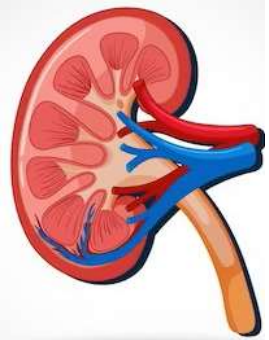
Tubule
(returns needed substance to blood and removes waste)



Mechanism

- Blood flows into each nephron and then enters to **glomerulus** through blood vessel.
- The thin walls of the glomerulus allow **smaller molecules to diffuse**, and allow larger molecules, such as **proteins and blood cells** stay in the blood vessel.
- The tubule **returns needed substances** to the blood and **removes wastes** in urine.
- The tubule also helps remove **excess acid from the blood**.

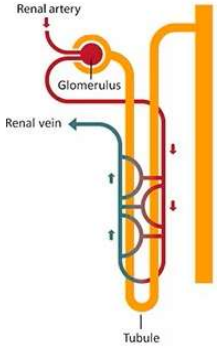
How does blood flow through kidneys?



Kidney

Blood flows into the kidney

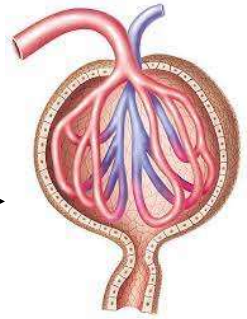
In the kidney, blood passes through millions of smaller blood vessels and reaches the nephrons



Nephron

Improper working of kidney leads to Chronic kidney disorder

Blood is filtered by the tiny blood vessels of the glomeruli



Glomeruli

Then flows out of the kidney through the **renal vein**

Wastes are removed out of the body through urine (1-2 liters per day)

Healthy kidney filters approx. 200 liters of blood in single day

This process continuous many times a day

Chronic kidney disease

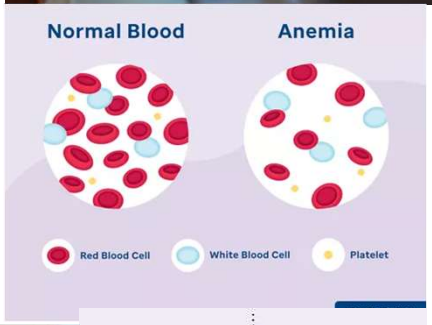
Chronic kidney disease includes conditions that **damage kidneys** and decrease the ability of filtering **wastes from your blood**

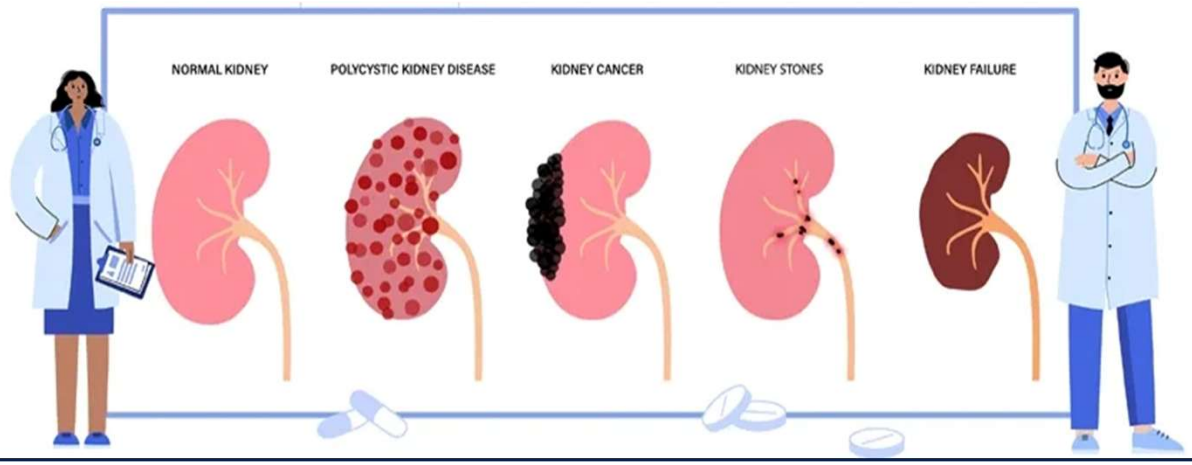
- High blood pressure
- Anaemia (low blood count)
- weak bones
- Poor nutritional health
- Nerve damage

Symptoms:

People with CKD may not feel ill or notice any symptoms.

- CKD diagnosed through specific **blood** and **urine** tests.
- These tests include the measurement of both **the creatinine level in the blood** and the **protein in the urine**.



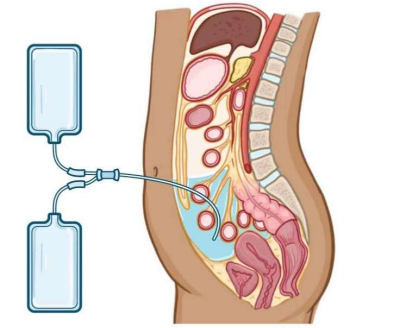


DIALYSIS:

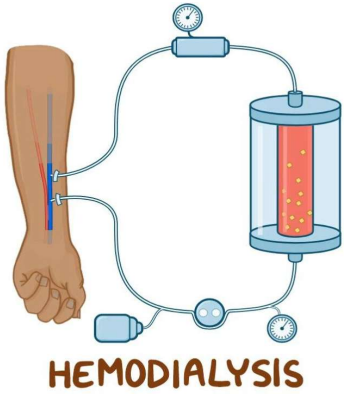
Dialysis is a procedure to **remove waste products and excess fluid** from the blood when the **kidneys stop working correctly**.

There are 2 main types of dialysis:

Peritoneal dialysis involves **pumping dialysis fluid** into the space inside your abdomen (tummy) to draw out waste products from the blood



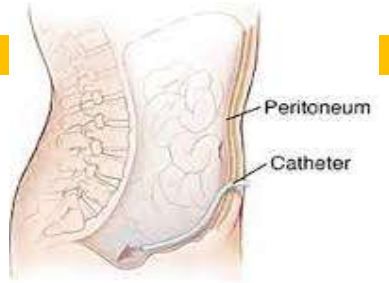
Hemodialysis involves **diverting blood into an external machine**, where it's filtered before being returned to the body.



It involves using the peritoneal membrane, a thin, natural lining surrounding the abdominal organs, as a filter to remove waste products and excess fluids from the blood.

Hemodialysis is typically performed by artificially filtering and purifying blood under the supervision of trained healthcare professionals.

Peritoneal dialysis

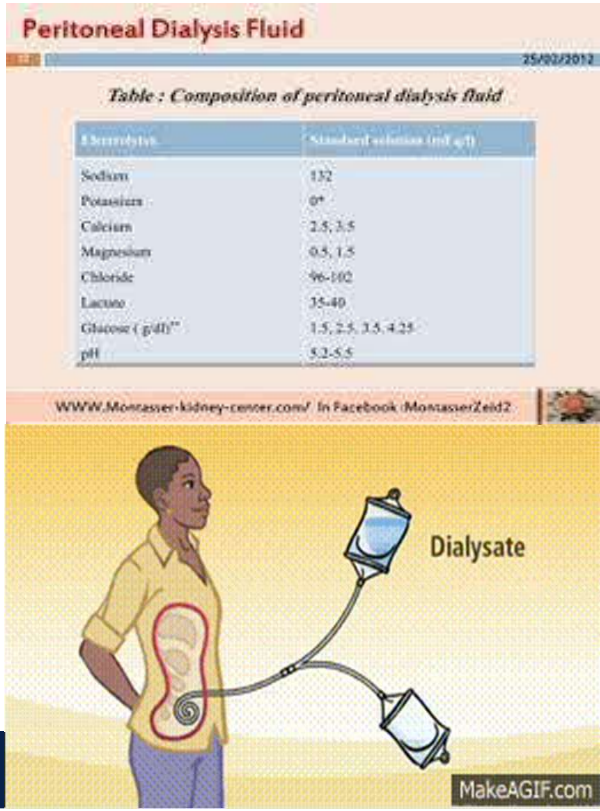


1.Catheter Placement: A soft, flexible catheter is surgically placed into the abdominal cavity. This catheter serves as the access point for the dialysis solution to enter and exit the peritoneal cavity.

2.Dialysis Solution (Dialysate): A sterile dialysis solution consisting of electrolytes, glucose, and other substances, is infused into the peritoneal cavity through the catheter. The solution is left in the cavity for a specific period, absorbing waste products and excess fluids from the bloodstream.

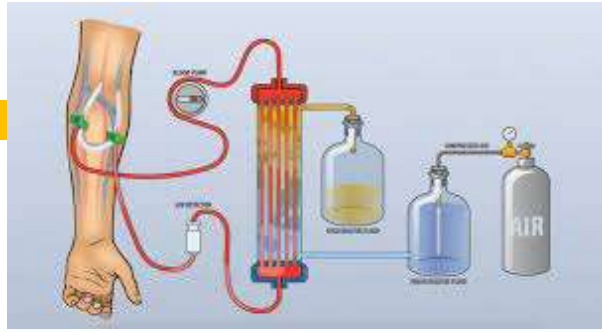
3.Diffusion and Osmosis: The peritoneal membrane acts as a semipermeable barrier. Waste products, excess fluids, and electrolytes move across the membrane from the blood vessels into the dialysis solution through diffusion and osmosis.

4.Drainage: After a prescribed **dwell** time, the dialysate, now containing waste products and excess fluids, is drained out of the abdominal cavity and discarded.



Peritoneal dialysis is typically performed in cycles, with multiple daily and night exchanges. The frequency and duration of exchanges depend on the individual's needs and the type of peritoneal dialysis being performed.

Hemodialysis



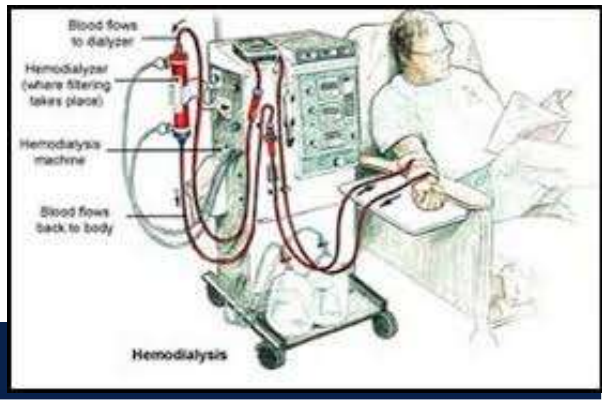
1.Vascular Access: a synthetic tube connection between an artery and a vein.

2.Blood Circulation: The patient's blood is diverted from their body through the vascular access point into the dialysis machine.

3.Dialysis Machine: The dialysis machine has a special filter called a dialyzer or artificial kidney. The dialyzer contains two compartments separated by a semipermeable membrane. Blood flows through one compartment, and a dialysis solution (dialysate) flows through the other.

4.Filtration and Purification: As blood passes through the dialyzer, waste products, excess fluids, and electrolytes diffuse across the semipermeable membrane and into the dialysate. This process helps mimic the kidneys' natural function by filtering waste and excess substances from the blood.

5.Return of Purified Blood: After filtration, the cleaned blood is returned to the patient's body through the vascular access point.



Hemodialysis sessions typically last around 3 to 5 hours and are usually performed thrice weekly. While hemodialysis effectively removes waste products and excess fluids from the blood, it may also cause fluctuations in blood pressure and other potential complications.

THANK YOU!