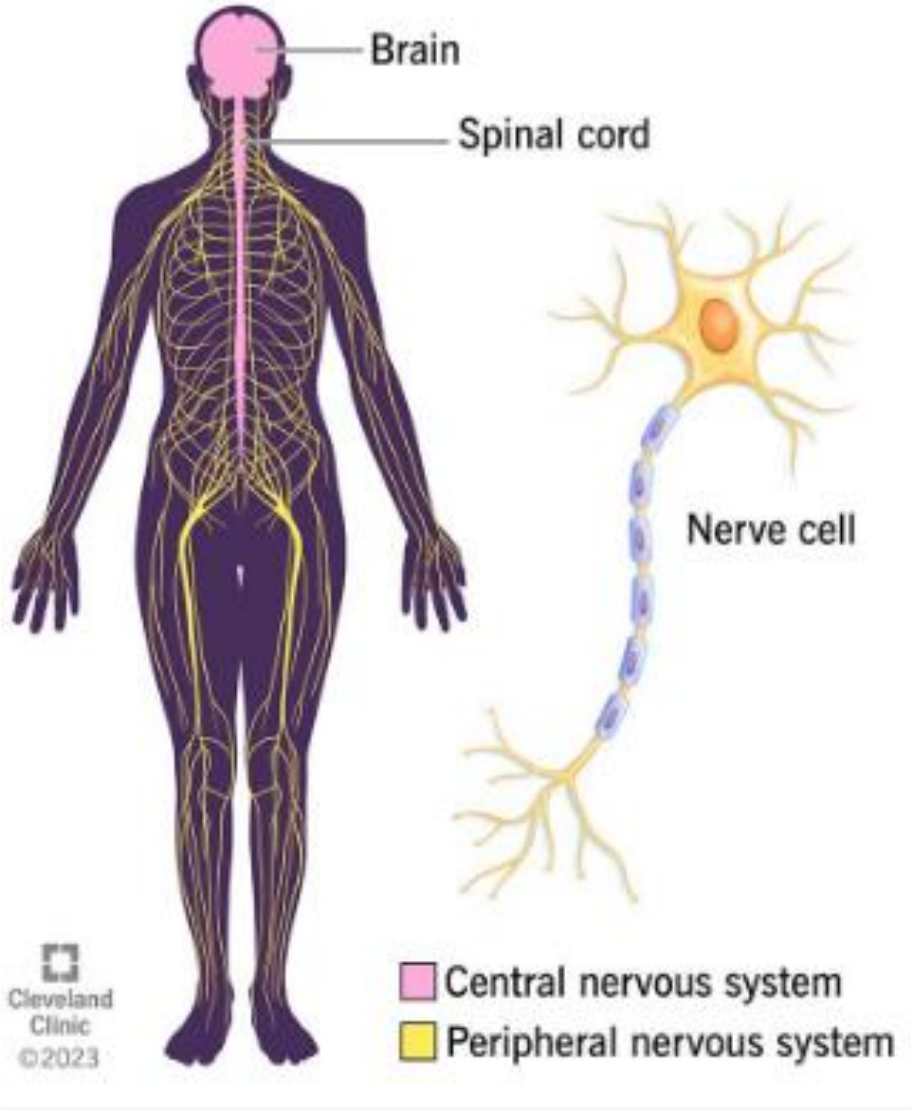
HUMAN ANATOMY & PHYSIOLOGY
ORGAN SYSTEMS (2)

NERVOUS & ENDOCRINE

Monday, September 15, 2025

4. NERVOUS SYSTEM

1. **Nervous system** coordinates its actions and sensory information by transmitting signals to and from different parts of its body.
2. The three main parts of your nervous system are:
   a) Brain
   b) spinal cord
   c) nerves.
3. It contains the **central nervous system** and the **peripheral nervous system.**

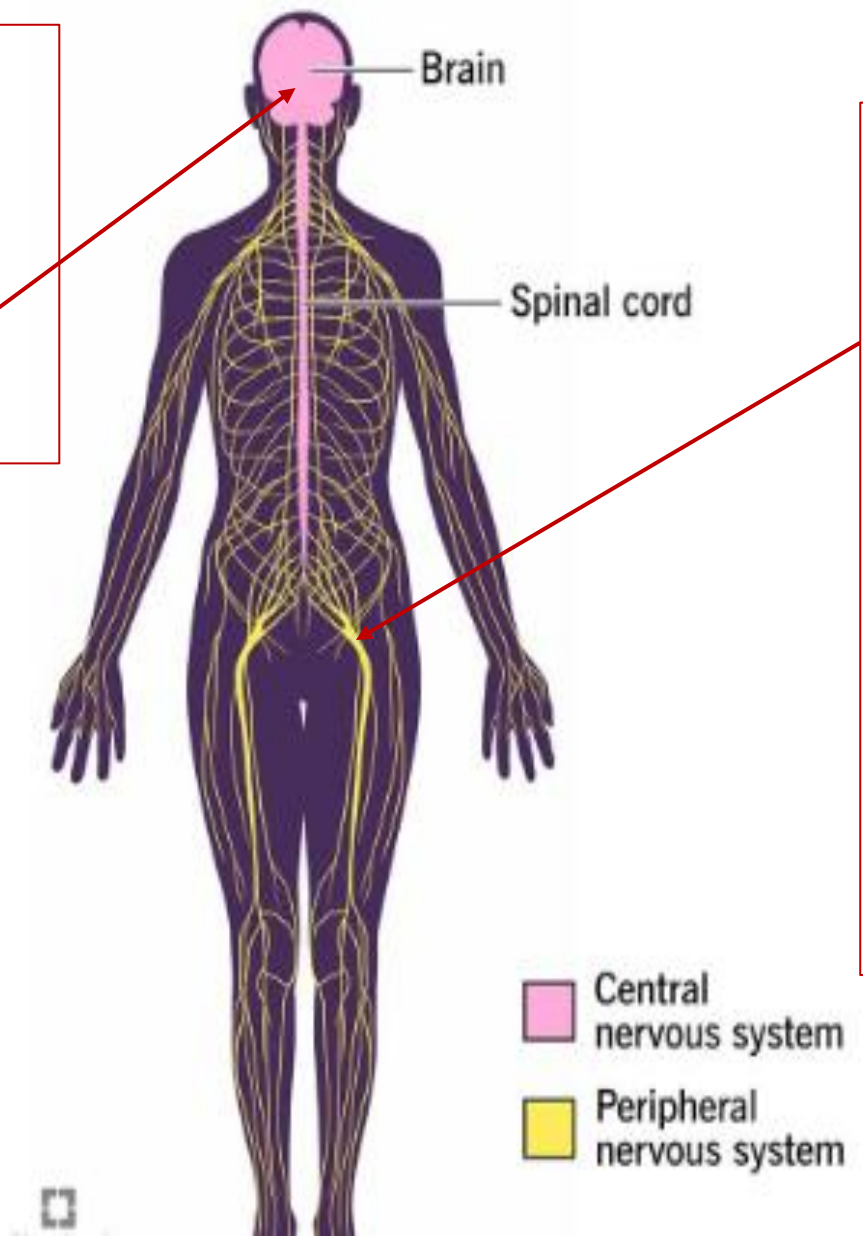


TYPES OF MESSAGES IN THE NERVOURS SYSTEM

1. Nervous system's main function is to send messages from various parts of the body to the brain, and from the brain to the body.
2. Types of messages:
   a) **Thoughts, memory, learning and feelings**.
   b) **Movements** (balance and coordination)
   c) **Senses** (how your brain interprets what you see, hear, taste, touch and feel).
   d) **Wound healing**.
   e) **Sleep.**
   f) **Heartbeat and breathing patterns**.
   g) **Response to stressful situations,** including sweat production.
   h) **Digestion.**
   i) **Body processes**, such as puberty and aging.

MAJOR PARTS OF THE NERVOUS SYSTEM

Central nervous system is composed of the brain and spinal cord. Your brain reads signals from your nerves to regulate how you think, move and feel.

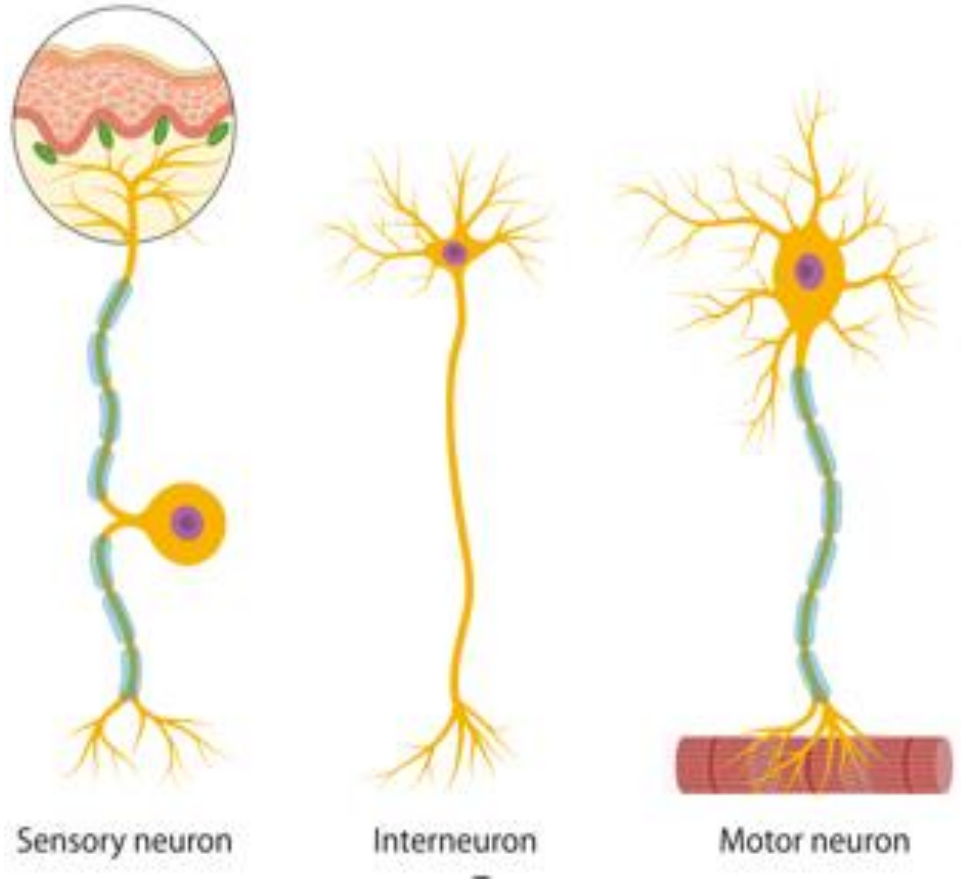


Peripheral nervous system is made up of a network of nerves. The nerves branch out from your spinal cord. This system relays information from your brain and spinal cord to your organs, arms, legs, fingers and toes.

TYPES OF NEURONS

There are THREE types of neurons. Each type of neuron has a different job:

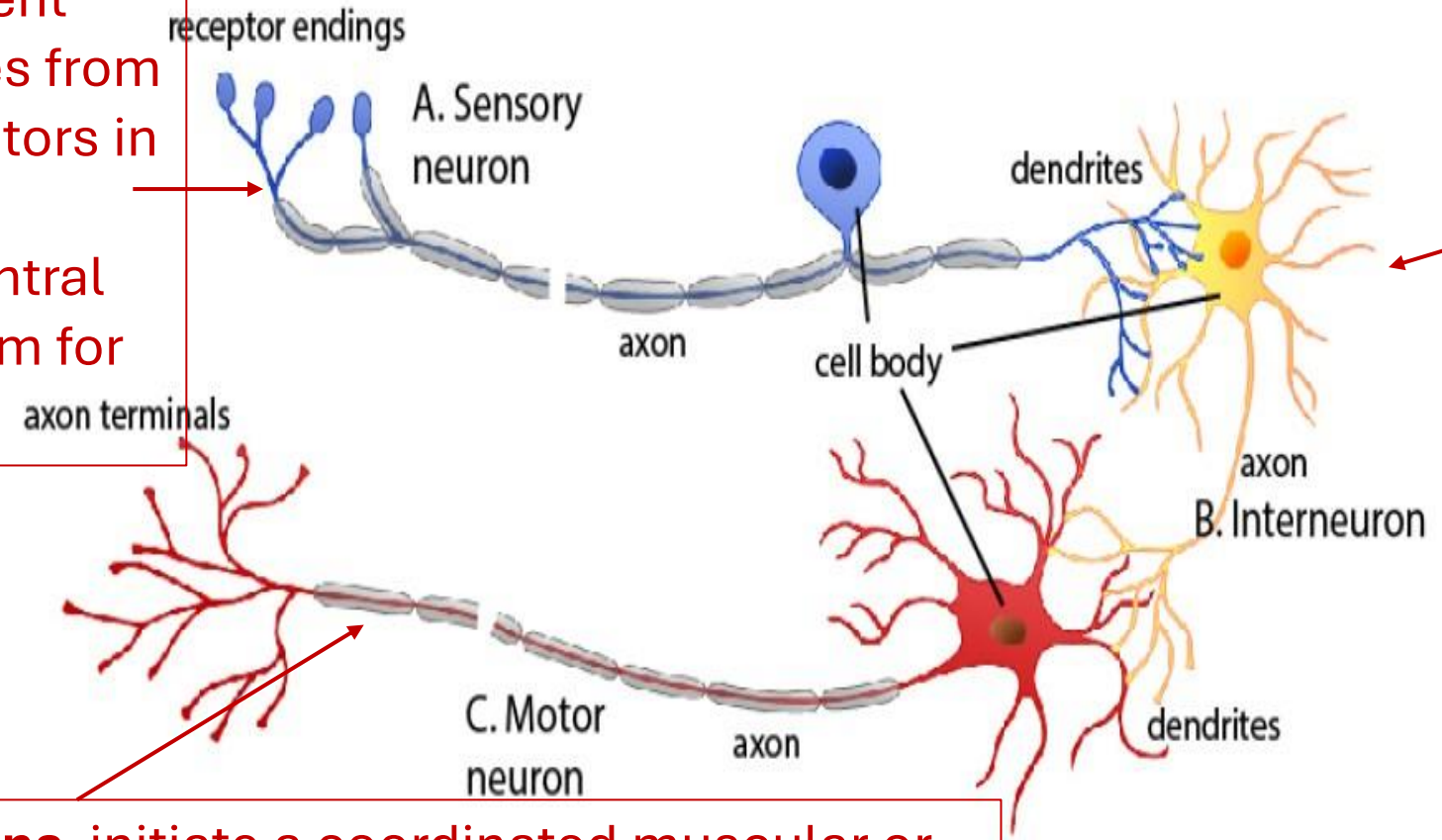
1. **Motor neurons take signals from your brain and spinal cord to your muscles**. They help you move. They also assist with breathing, swallowing and speaking.
2. **Sensory neurons take information from your senses** (what you see, touch, taste, etc.) to your brain.
3. **Interneurons communicate between motor and sensory neurons.** These neurons regulate your movement in response to sensory information (like moving away from a hot surface) and play a role in how you learn, think and remember.



Further Reading:
Neurons (Nerve Cells): Structure, Function & Types (simplypsychology.org)

HOW MOTOR & SENSOR ARE INTERCONNECTED BY INTERNEURONS

1. Sensory neuron transmit afferent nerve impulses from sensory receptors in the periphery toward the central nervous system for processing.



2. Interneurons receive that signal, process and interpret the information and then selectively relay the processed to specific motor neurons

3. Motor neurons initiate a coordinated muscular or glandular response, enabling everything from simple reflexive arcs to complex, learned behaviors.

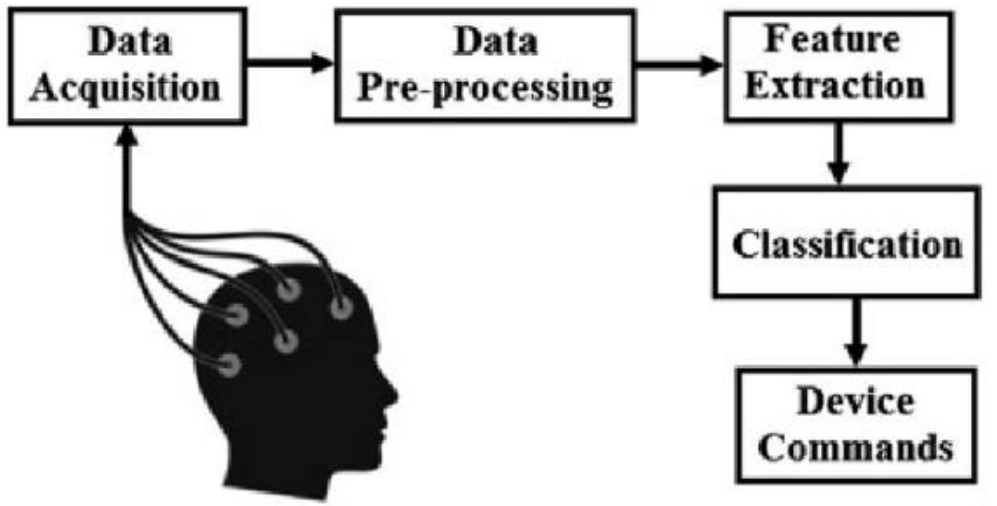
CONDITIONS & DISORDERS OF THE NERVOUS SYSTEM

Some common conditions and disorders of the nervous system are:

1. **Alzheimer's disease** causes a decline in memory, thinking, learning and organizing skills over time. It's the most common cause of dementia and usually affects people over the age of 65.
2. **Stroke happens** when blood vessels are blocked or because of bleeding in your brain. Strokes are a life-threatening emergency, and immediate medical attention is critical to prevent permanent damage or death.
3. **Traumatic brain injury** usually results from a violent blow or jolt to the head or body. An object that goes through brain tissue, such as a bullet or shattered piece of skull, also can cause traumatic brain injury.
4. **Cerebral palsy** happens when there's damage to brain areas that control muscle movement, or when those areas don't develop as they should.
5. **Epilepsy** is a brain disease where nerve cells don't signal properly, which causes seizures. Seizures are uncontrolled bursts of electrical activities that change sensations, behaviors, awareness and muscle movements.
6. **Meningitis** is an inflammation of the protective layers surrounding your brain and spinal cord caused by bacteria and viruses. Symptoms include fever, severe headache, neck stiffness, nausea, vomiting.

AREAS OF INTEREST TO BIOMEDICAL ENGINEERING /01

1. **Neural Interfacing and Brain-Computer Interfaces (BCIs):** Developing electrodes and devices that can record signals from the brain or stimulate neural tissue to restore function, such as allowing paralyzed individuals to control robotic limbs or communicate.

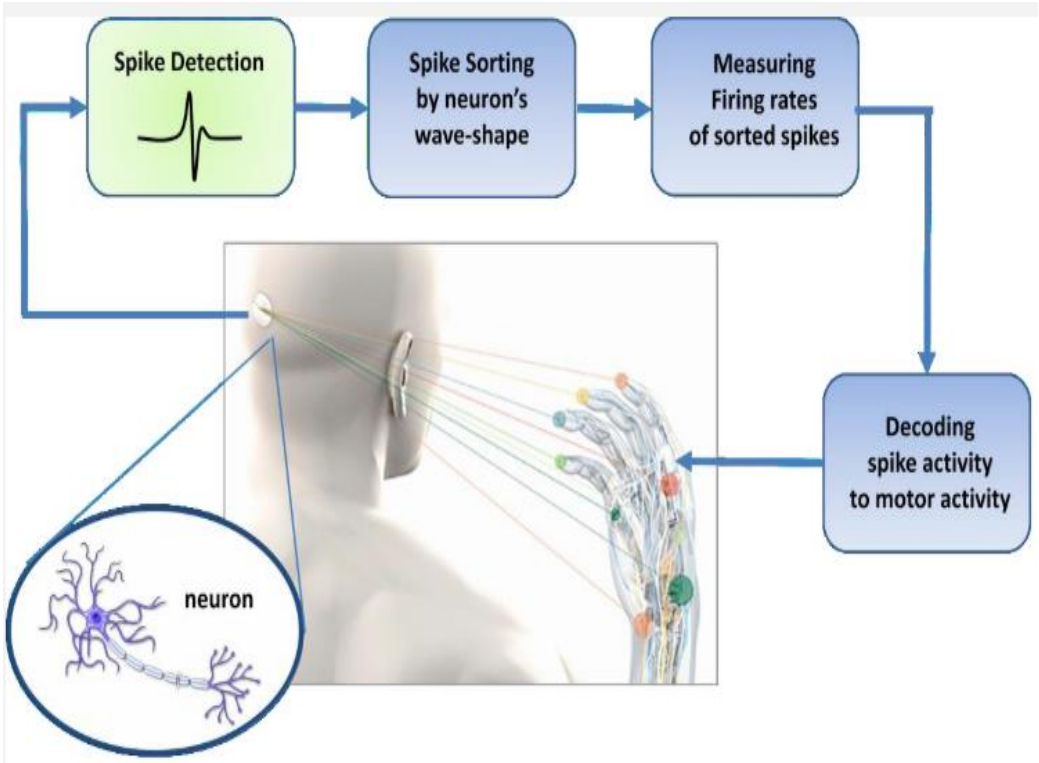


2. **Neuromodulation and Neurostimulation:** Designing implantable medical devices (e.g., deep brain stimulators for Parkinson's disease, spinal cord stimulators for chronic pain, vagus nerve stimulators for epilepsy) that use electrical or chemical signals to regulate dysfunctional neural circuits.

3. **Neural Recording and Decoding:** Creating advanced tools to capture and interpret complex patterns of neural activity to understand brain function and diagnose neurological disorders.

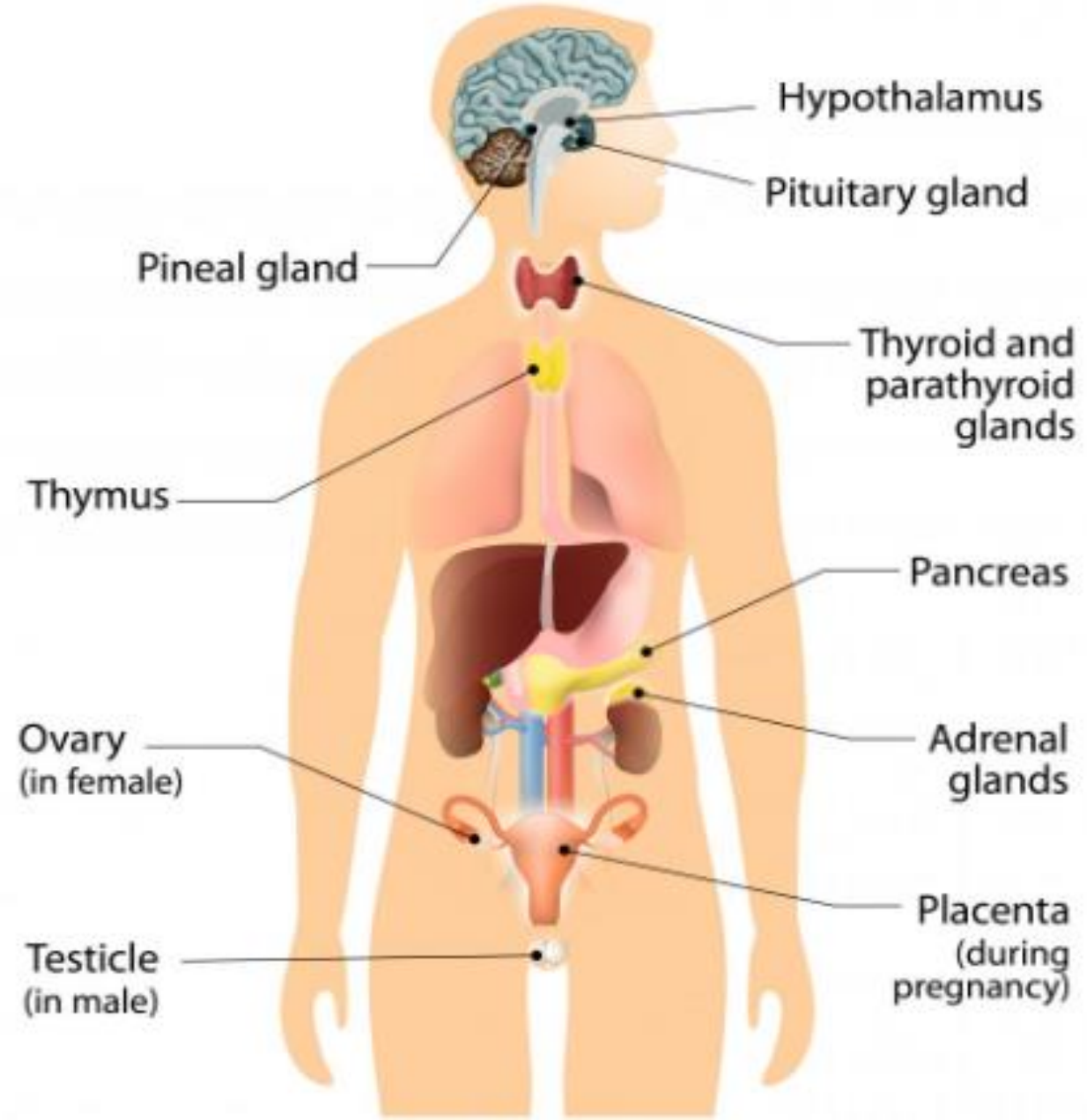
AREAS OF INTEREST TO BIOMEDICAL ENGINEERING /02

4. **Computational Neuroscience and Modeling:** Building computer models and simulations of neurons, neural networks, and entire brain regions to test hypotheses about neural function and the mechanisms of disease.
5. **Neural Tissue Engineering and Regeneration:** Developing biomaterial scaffolds, drug delivery systems, and stem cell therapies to promote the repair and regeneration of damaged nerves or spinal cord injuries.
6. **Neuroimaging and Diagnostics:** Engineering advanced imaging technologies (e.g. EEG) and analytical algorithms to visualize brain structure and activity with high resolution for research and clinical diagnosis.



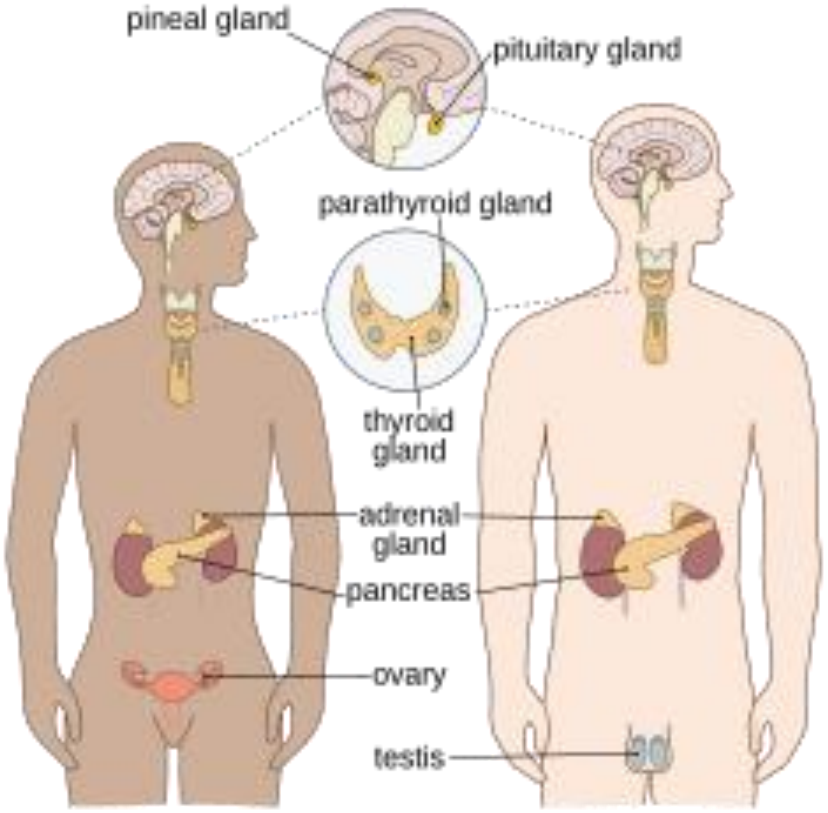
5. ENDOCRINE SYSTEM

1. **Endocrine system** is a complex network of glands and organs which uses hormones to control and coordinate body's metabolism, energy level, reproduction, growth and development, and response to injury, stress, and mood.
2. The endocrine system consists of:
   a) **Glands** located throughout the body;
   b) **Hormones** made by the glands and released into the bloodstream or the fluid surrounding cells;
   c) **Receptors** in various organs and tissues that recognize and respond to the hormones.



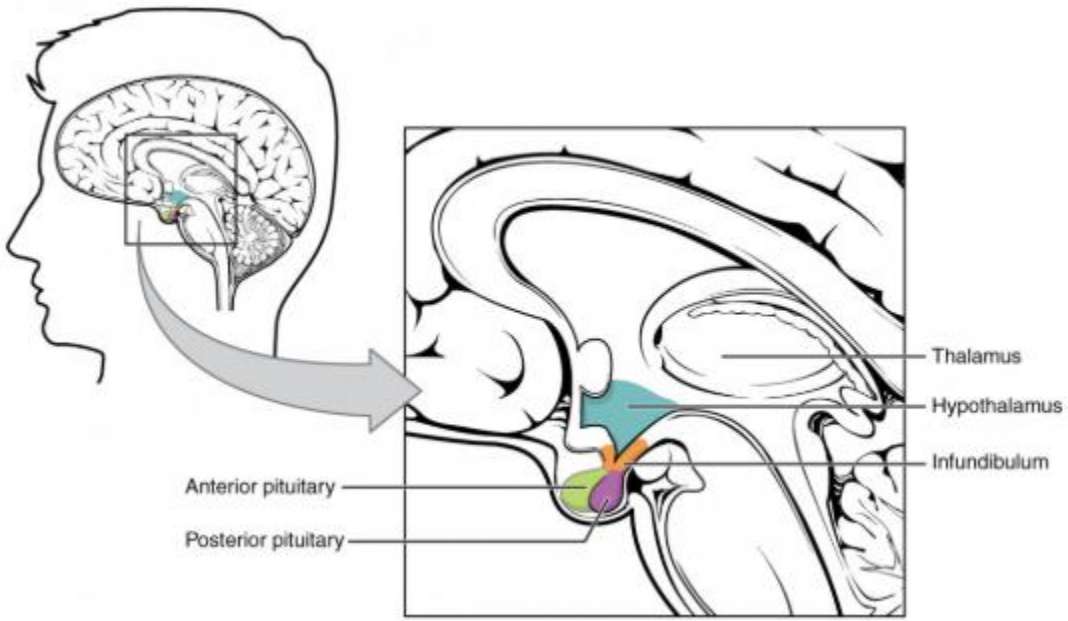
5.1 ORIGIN OF THE WORD ENDOCRINE

1. **The word endocrine** is derived from the Greek terms **"endo," meaning within,** and **"krine," meaning to separate or secrete**.
2. **Endocrine glands do not have ducts to carry their products.** They are called ductless glands.
3. **Endocrinology** is a specialized medicine covering a sub-specialty of internal medicine dealing with the diagnosis and treatment of diseases related to hormones.

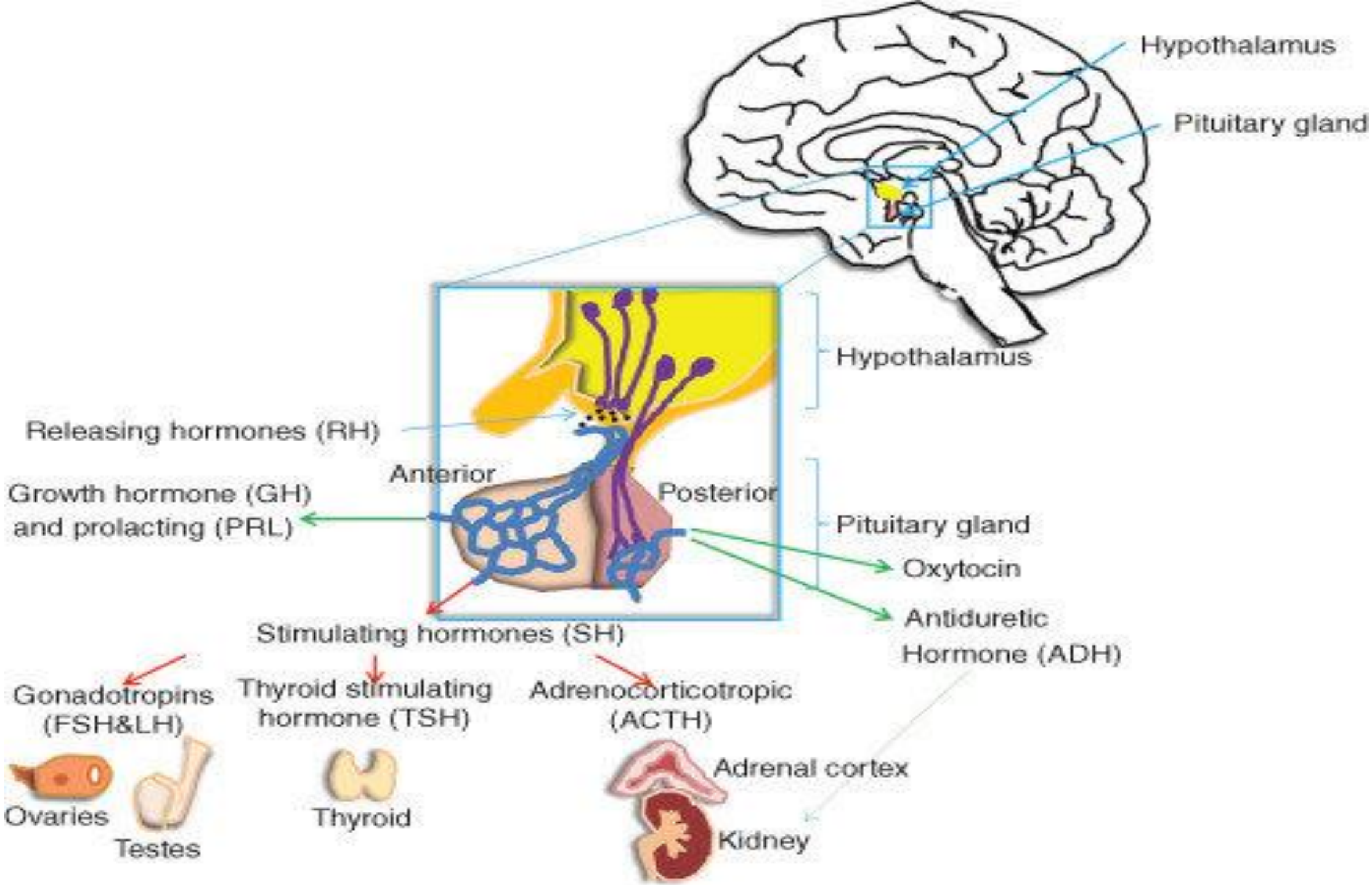


5.1 HYPOTHALAMUS-PITUITARY COMPLEX

1. **Hypothalamus-pituitary** that serves as your brain's central command center to control vital bodily functions.
2. **Functions of the hypothalamus are:**
   a) To sends messages to the autonomic nervous system, which controls things like blood pressure, heart rate and breathing.
   b) To signal the pituitary gland to produce and release hormones that affect other areas of your body.

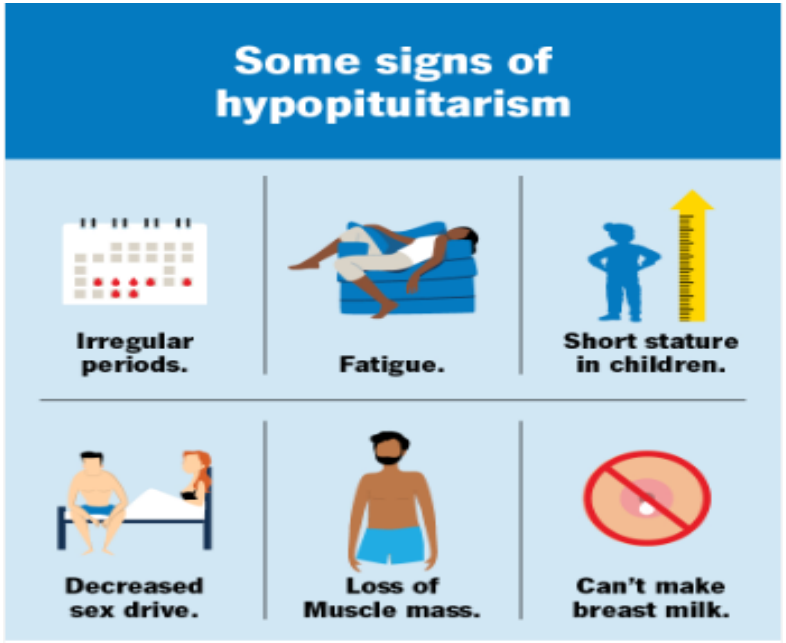


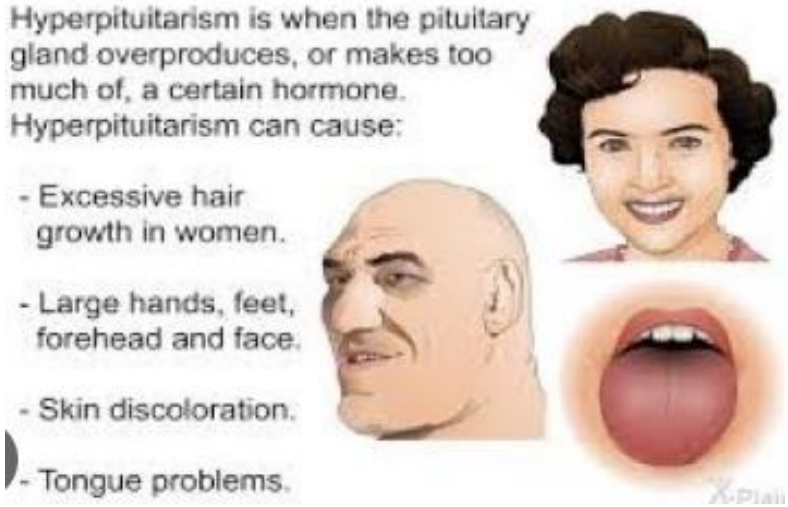
(a) The hypothalamus region lies inferior and anterior to the thalamus


Hypothalamus
Pituitary gland
Hypothalamus
Releasing hormones (RH)
Anterior
Posterior
Growth hormone (GH)
and prolacting (PRL)
Pituitary gland
Oxytocin
Antiduretic
Hormone (ADH)
Stimulating hormones (SH)
Gonadotropins
(FSH&LH)
Thyroid stimulating
hormone (TSH)
Adrenocorticotropic
(ACTH)
Adrenal cortex
Ovaries
Testes
Thyroid
Kidney

CONDITIONS & DISORDERS RELATED TO HYPOTHALAMUS-PITUITARY COMPLEX

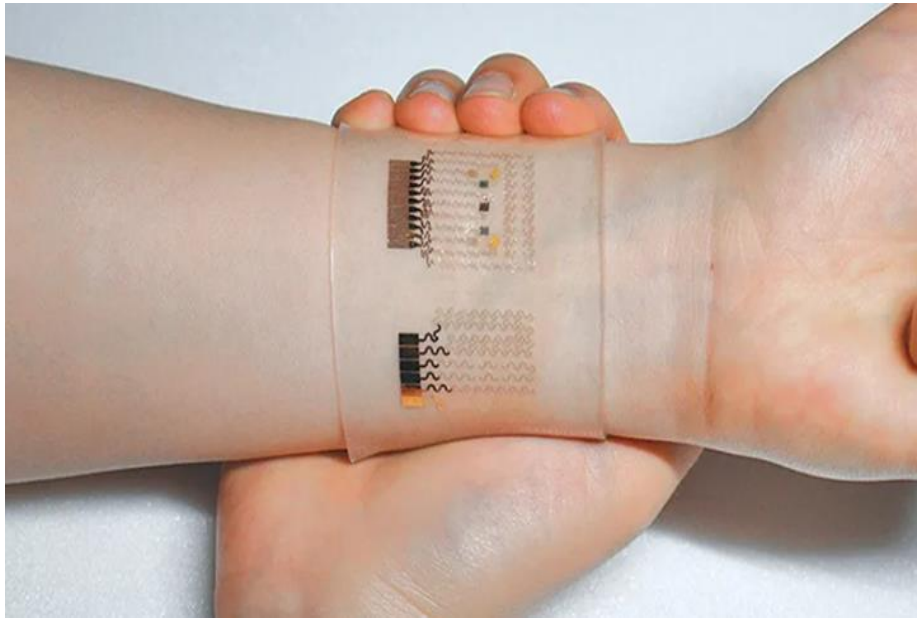
1. **Pituitary adenomas** are benign tumors on the pituitary gland. Although noncancerous, they can interfere with normal pituitary function and cause certain health conditions.
2. **Hypopituitarism** is an underactivity of the pituitary gland leading to deficiency of one or multiple hormones. Symptoms, diagnosis and treatment of hypopituitarism depend on which hormones are lacking.
3. **Hyperpituitarism** is an overactive pituitary gland making the gland produce too much or too little of the hormones that control growth, reproduction and metabolism leading to disorders like gigantism in children to hyperthyroidism in adults





ENDOCRINE SYSTEM: AREAS OF INTEREST TO BIOMEDICAL ENGINEERING

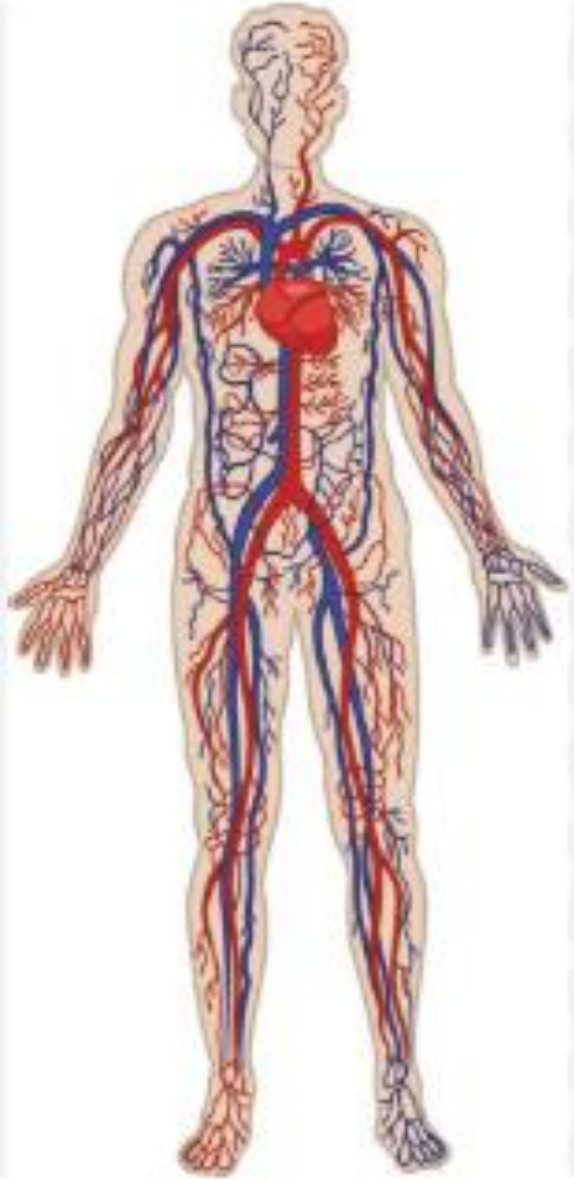
1. **Drug Delivery Systems:** Designing advanced mechanisms for the controlled release of hormones (e.g., insulin, thyroid hormone) to maintain stable physiological levels.
2. **Biosensors and Diagnostics:** Creating highly sensitive and specific devices to detect and monitor hormone levels in real-time from blood, interstitial fluid, or other samples.
3. **Tissue Engineering and Regenerative Medicine:** Developing biomaterials and scaffolds to regenerate damaged endocrine tissues (e.g., pancreatic islets for Type 1 diabetes) or engineering organoids in vitro to model diseases and test drug toxicity.



(a) Wearable Hormone Sensor

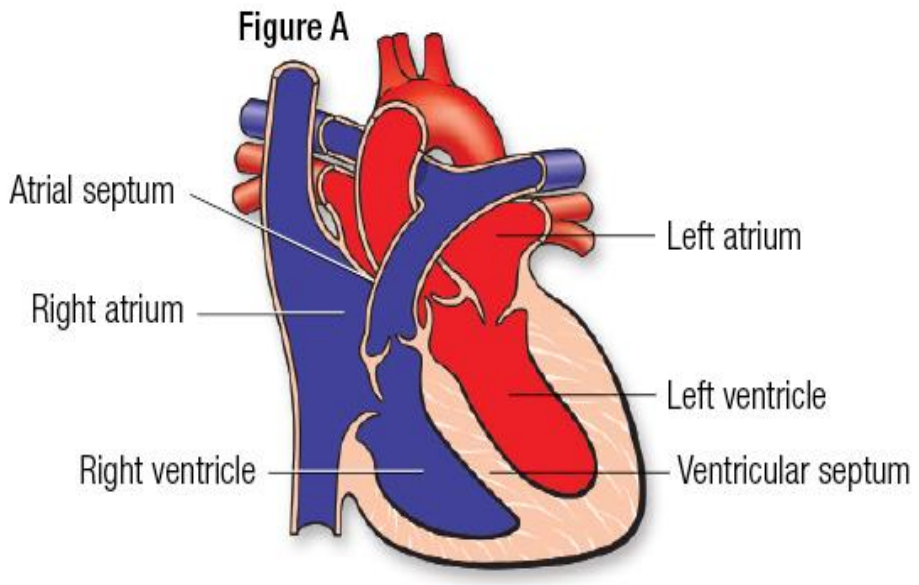
6. CARDIOVASCULAR SYSTEM

1. **Cardiovascular system includes the heart, blood vessels, and blood** which is circulated throughout the entire body .
2. Function of the cardiovascular system are:
   a) Supply body's organs with oxygen and nutrients
   b) Keep temperature at a normal level (37°C)



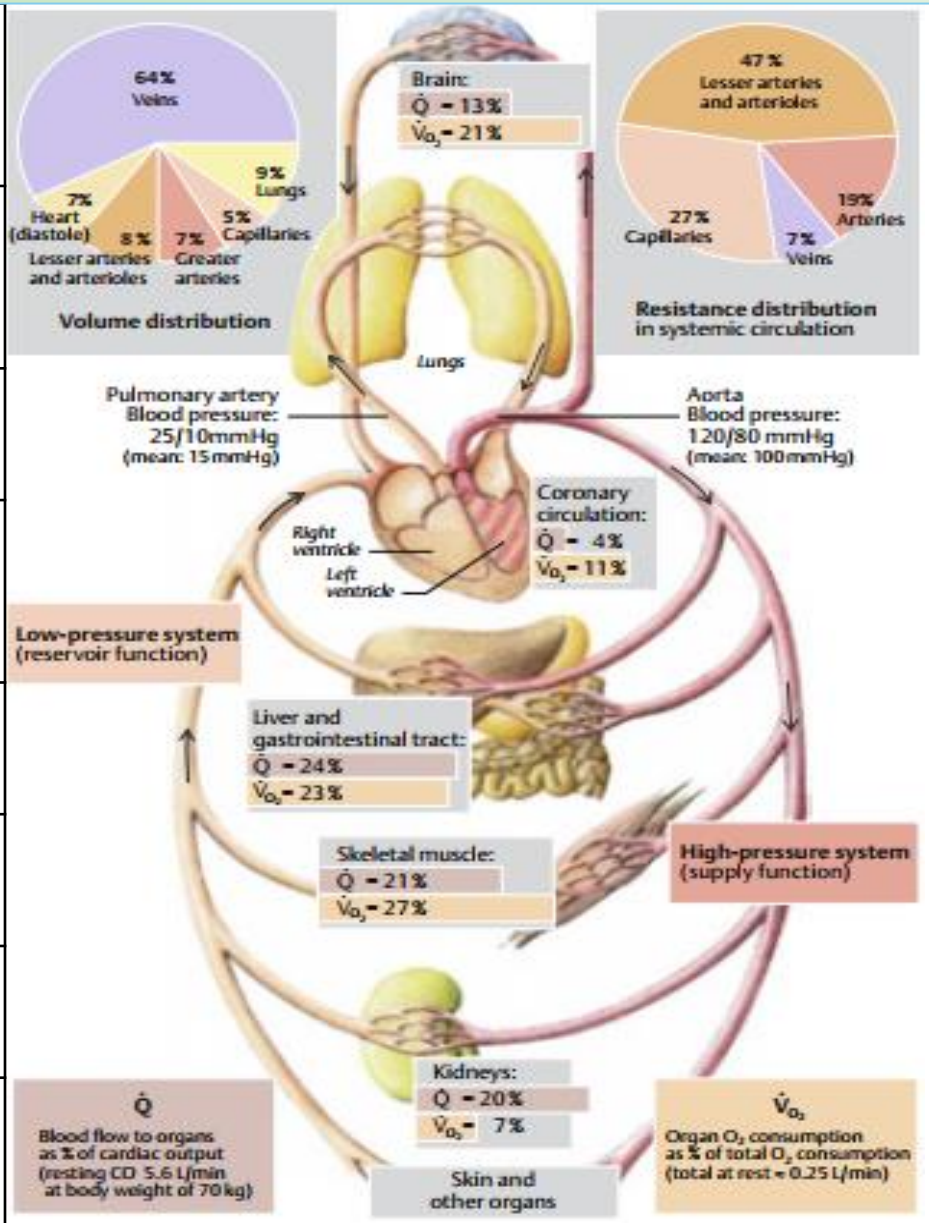
6.1 BLOOD CIRCULATION OVERVIEW

1. **Blood** is pumped from the left ventricle of the heart to capillaries in the periphery via the arterial vessels of the **systemic (or greater)** circulation and returns via the veins to the right heart.
2. It is then expelled from the right ventricle to the lungs via the **pulmonary (or lesser) circulation** and returns to the left heart.
3. **Total Blood volume is roughly 4–5L** (7% of the fat-free body mass)
4. **Approx 80% of the blood** circulates through the veins, right heart and pulmonary vessels, which are jointly referred to as the low-pressure system.



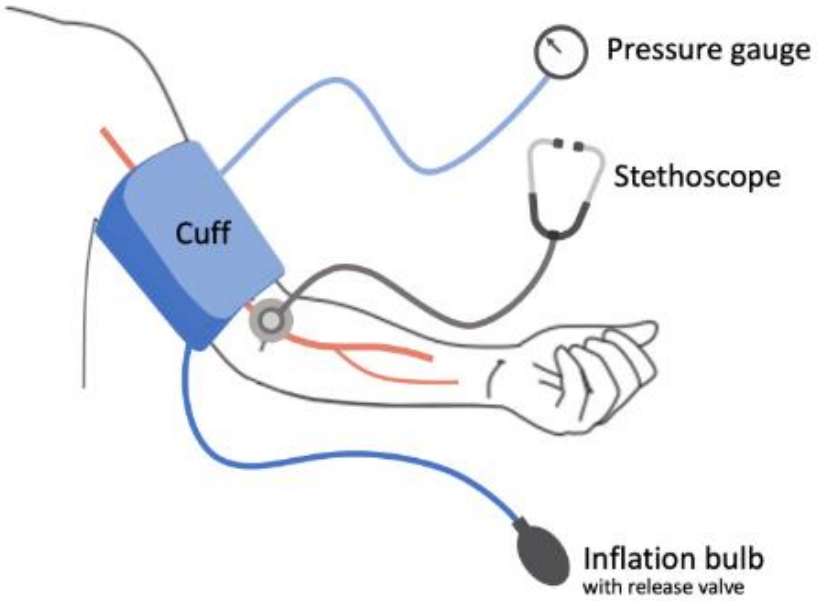
6.2 BLOOD PRESSURE IN THE CARDIOVASCULAR SYSTEM

VESSEL	TYPICAL PRESSURE (MMHG)	REASON FOR PRESSURE CHANGE
Aorta	120 / 80 (systolic/diastolic)	Receives high-pressure output from the powerful left ventricle.
Systemic Arteries	110 / 70	Gradual decrease due to peripheral resistance.
Arterioles	40 - 25	**Largest pressure drop.** High resistance from vasoconstriction/dilation.
Capillaries	25 - 10	Significant energy loss due to friction in tiny vessels.
Vena Cava	~2 - 5	Lowest pressure in systemic circuit.
Pulmonary Artery	25 / 10	Ejected by weaker right ventricle into a low-resistance circuit.
Pulmonary Capillaries	10 - 8	Gentle drop due to minimal resistance in short, wide vessels.



6.3 IS SYSTEMIC PRESSURE MEASURED AT THE ARM CORRECT?

1. **Systemic Pressure:** The pressure generated by the left ventricle is transmitted throughout the entire systemic arterial system. While there is a slight pressure difference between the aorta and more peripheral arteries like the brachial artery in the arm, it is negligible for clinical purposes.
2. **Ease of Access:** The brachial artery in the arm is large, relatively superficial, and easy to compress with a cuff, making it an ideal and practical site for accurate measurement.
3. **Clinical Measurement:** Virtually all guidelines, drug studies, and risk assessments for conditions like hypertension are based on blood pressure measurements taken from the arm. This means the "normal" and "high" thresholds (like 120/80 mmHg) are defined by arm measurements.



6.4 WHAT IS SYSTOLIC & DIASTOLIC BLOOD PRESSURE?

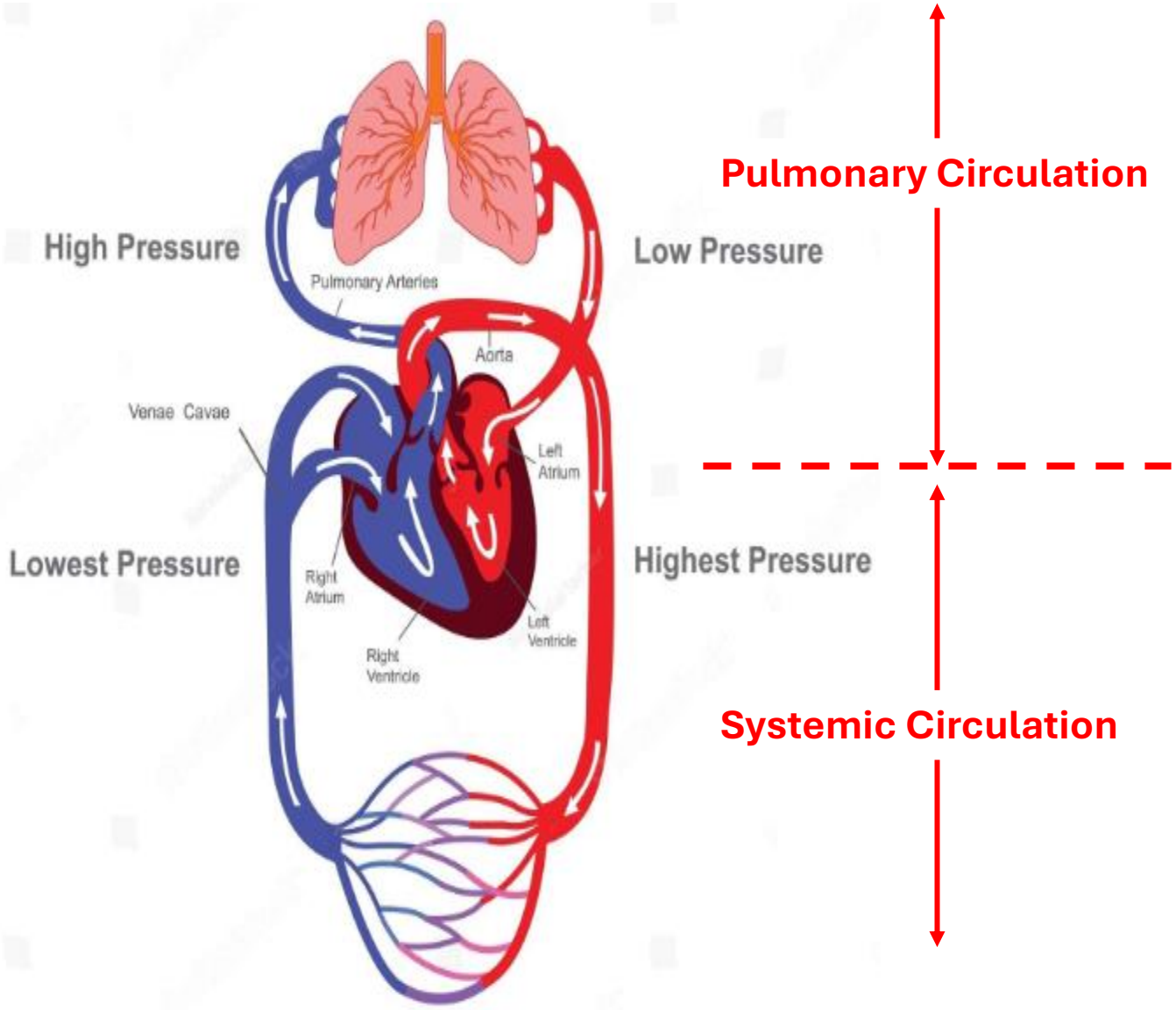
1. **Systolic (e.g., 120 mmHg):** The peak pressure surge caused by the heart's pump (contraction).

2. **Diastolic (e.g., 80 mmHg):** The baseline pressure that remains in the arteries, reflecting the resting pressure and resistance of your blood vessels when the heart is relaxed.

3. **Together, written as 120/80 mmHg**, they provide a snapshot of the force exerted by blood on artery walls throughout the cardiac cycle.

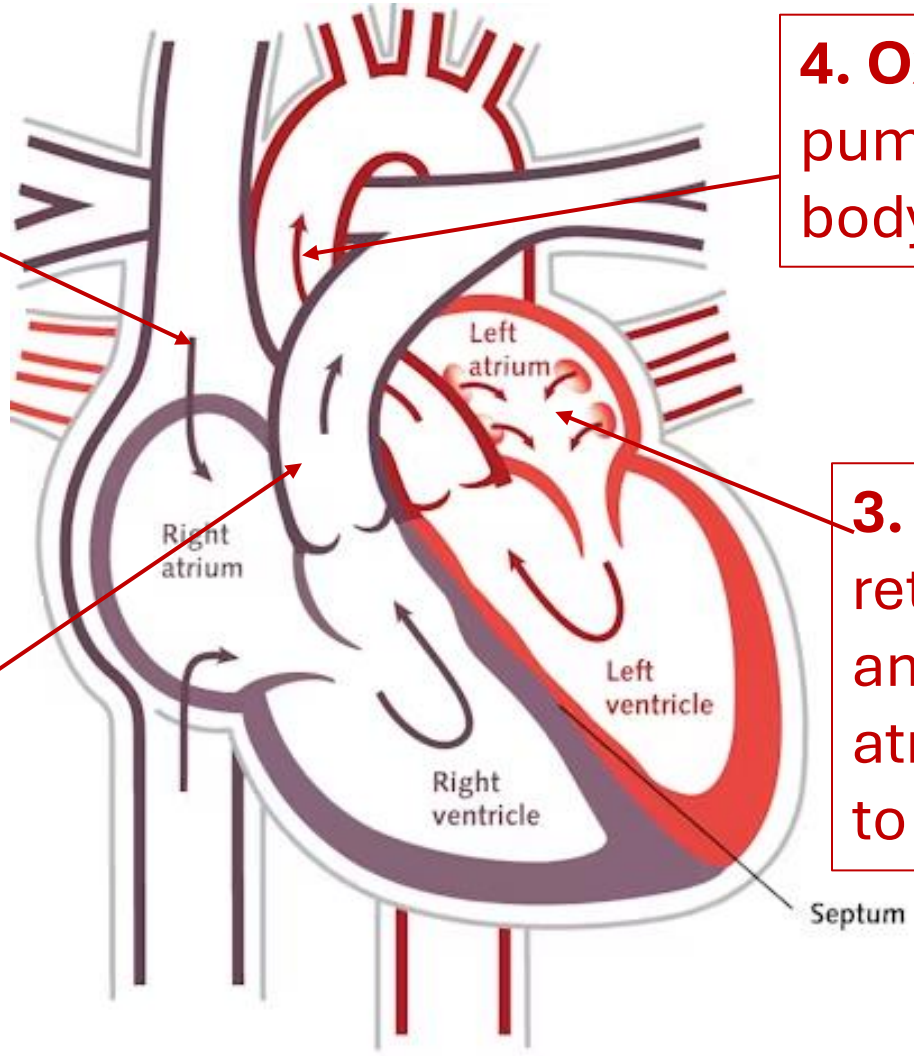
6.5 CIRCULATION PROCESSES

1. **Pulmonary circulation:** Blood without oxygen comes into the right side of your heart and is sent to the lungs to get oxygen and get rid of carbon dioxide. Then the oxygenated blood comes back through the left side of your heart.
2. **Systemic circulation:** Blood that has just gotten oxygen from the lungs and returned through your heart's left side is pushed out to the rest of your body's cells so they can receive oxygen and nutrients.



6.6 PULMONARY CIRCULATION

1. Oxygen-poor blood enters the right atrium and then flows to the right ventricle.



4. Oxygen-rich blood is pumped to the rest of the body through the aorta.

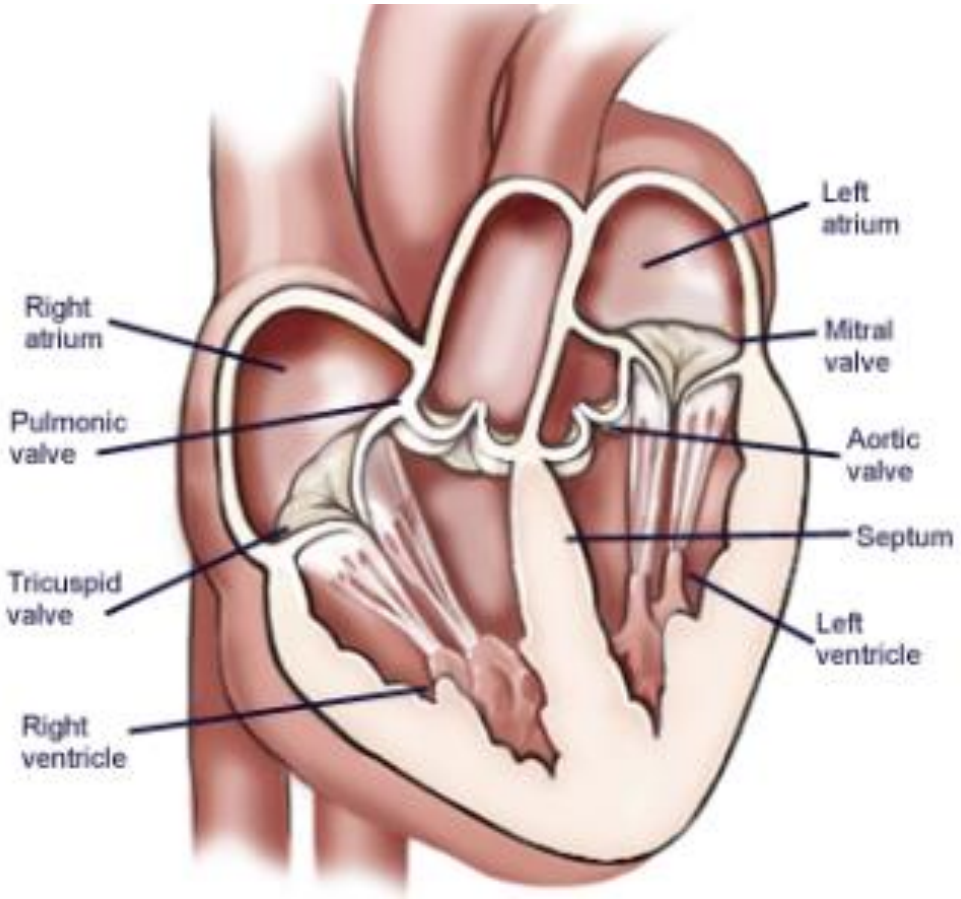
3. Oxygen-rich blood returns from the lungs and enters the left atrium and then flows to the left ventricle.

2. Oxygen-poor blood is pumped to the lungs through the pulmonary arteries.

6.7 VALVES IN THE HUMAN HEART

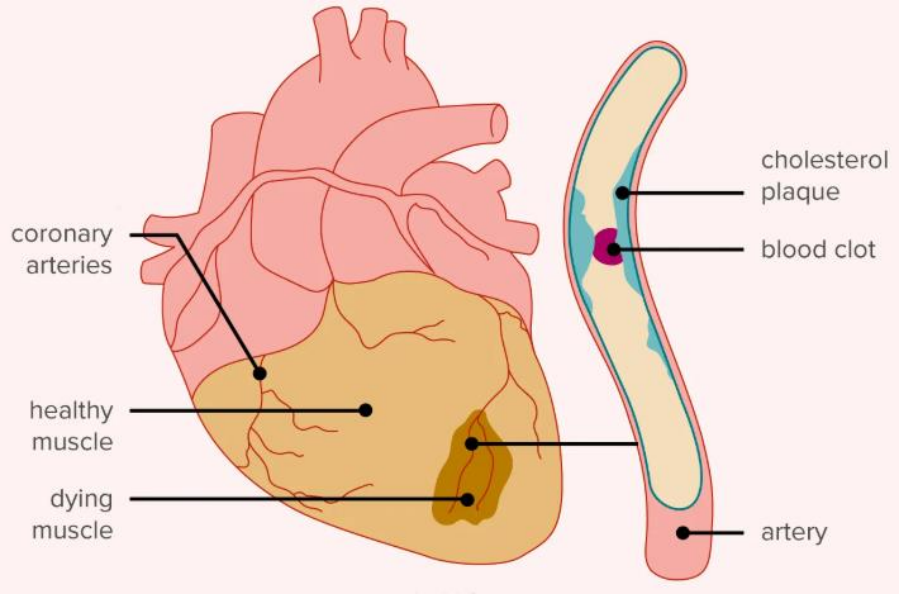
Four valves in your heart make sure blood flows in only one direction through your heart. Your heart's valves are:

1. **Mitral Valve** (between your left atrium and left ventricle).
2. **Tricuspid Valve** (between your right atrium and right ventricle).
3. **Aortic Valve** (between your left ventricle and aorta).
4. **Pulmonary Valve** (between your right ventricle and pulmonary artery).



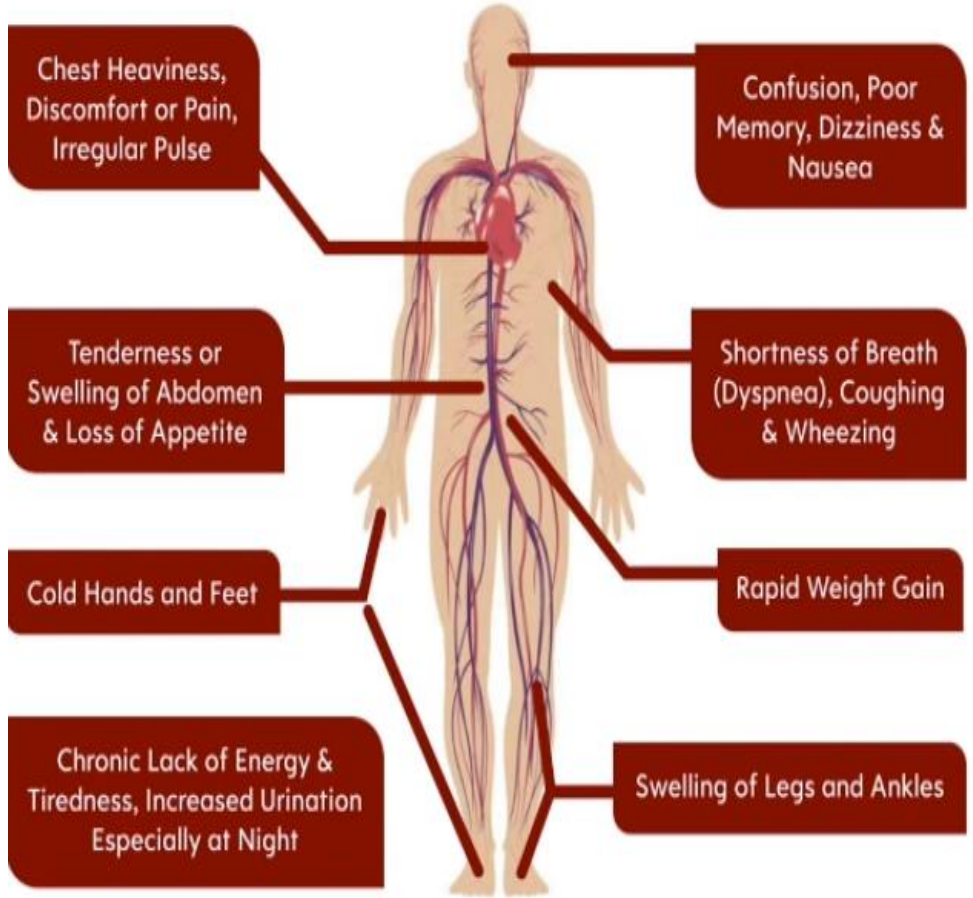
6.8 CONDITIONS & DISORDERS OF THE CARDIOVASCULAR SYSTEM /01

1. **Arrhythmia (abnormal heart rhythm)** refers to the condition where the heart is beating too fast when you're at rest or just not beating in a regular pattern.
2. **Heart attack (myocardial infarction)** is a medical emergency where your heart muscle begins to die due to low blood flow. **A blockage in the arteries that supply blood to your heart usually causes this**. If a healthcare provider doesn't restore blood flow quickly, a heart attack can cause permanent heart damage and death.



6.9 CONDITIONS & DISORDERS OF THE CARDIOVASCULAR SYSTEM /02

2. **Heart valve disease** refers to any of several conditions that prevent one or more of the valves in your heart from working correctly.
3. **Heart failure** is a clinical syndrome where the heart is unable to pump blood at a rate sufficient to meet the metabolic demands of the body's tissues or can only do so with an elevated filling pressure.



(a) Symptoms of heart failure

WHY IS THE CARDIOVASCULAR SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /01

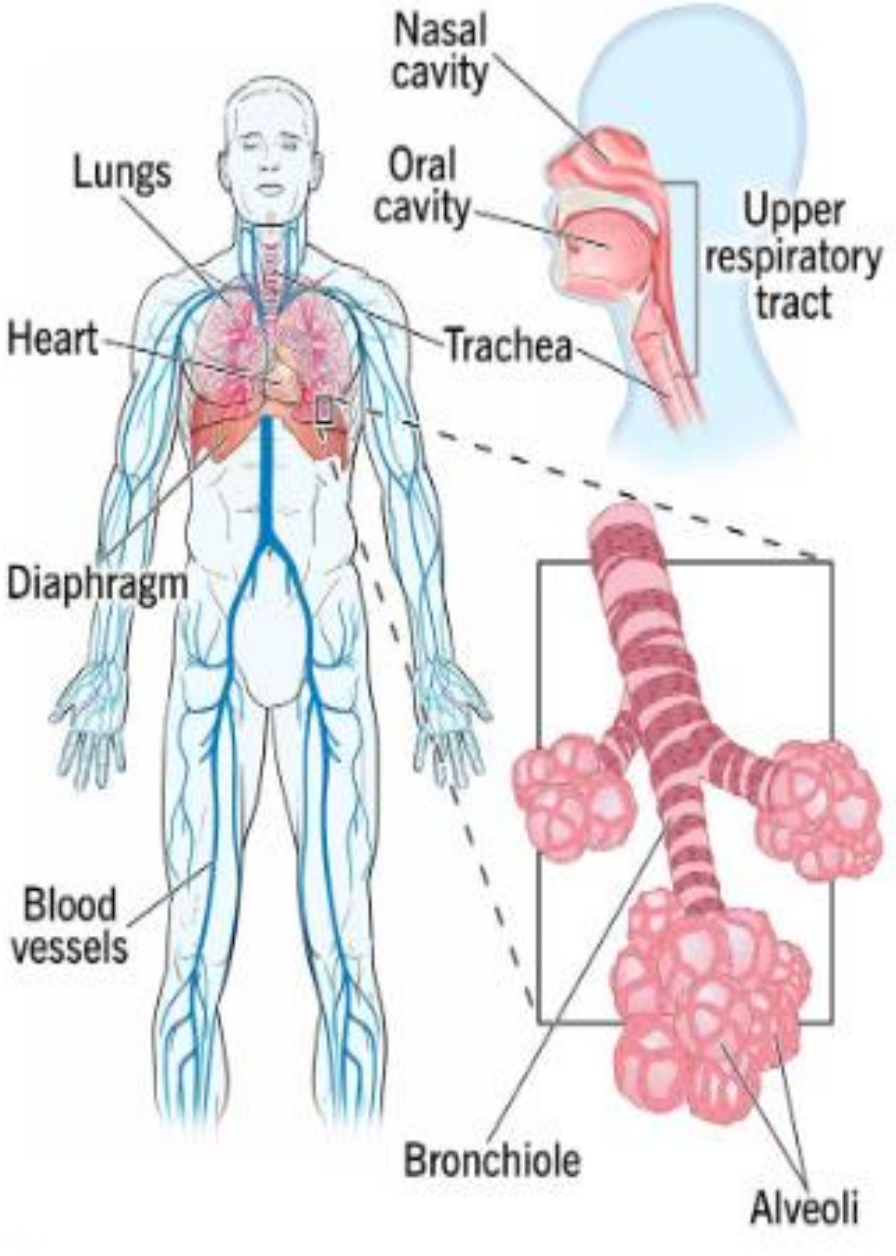
1. **Cardiovascular Biomechanics:** Studying the forces (pressure, flow, shear stress) and mechanical properties (stiffness, elasticity) of the heart, blood vessels, and blood to understand diseases like atherosclerosis, hypertension, and aneurysms.
2. **Design of Medical Devices and Implants such as:**
   a) **Prosthetic Heart Valves:** Designing mechanical and tissue-based valves to replace diseased ones.
   b) **Stents:** Engineering mesh tubes (bare-metal, drug-eluting) to prop open clogged arteries and prevent restenosis.
   c) **Vascular Grafts:** Creating synthetic (e.g., Dacron) or tissue-engineered vessels to bypass blocked arteries.
   d) **Assist Devices:** Developing ventricular assist devices (VADs) and total artificial hearts (TAHs) to support or replace failing heart function.

WHY IS THE CARDIOVASCULAR SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /02

3. **Tissue Engineering and Regenerative Medicine:** Creating biological substitutes to repair or replace damaged heart tissue (e.g., after a heart attack) and blood vessels using scaffolds, stem cells, and biomaterials.
4. **Diagnostic and Imaging Technologies:** Advancing tools like intravascular ultrasound (IVUS), optical coherence tomography (OCT), and wearable sensors for continuous monitoring of blood pressure and cardiac output to improve diagnosis.
5. **Computational Modeling and Simulation:** Creating computer models of blood flow, heart function, and disease progression to predict outcomes, optimize surgical plans, and design better devices without the need for extensive animal testing.

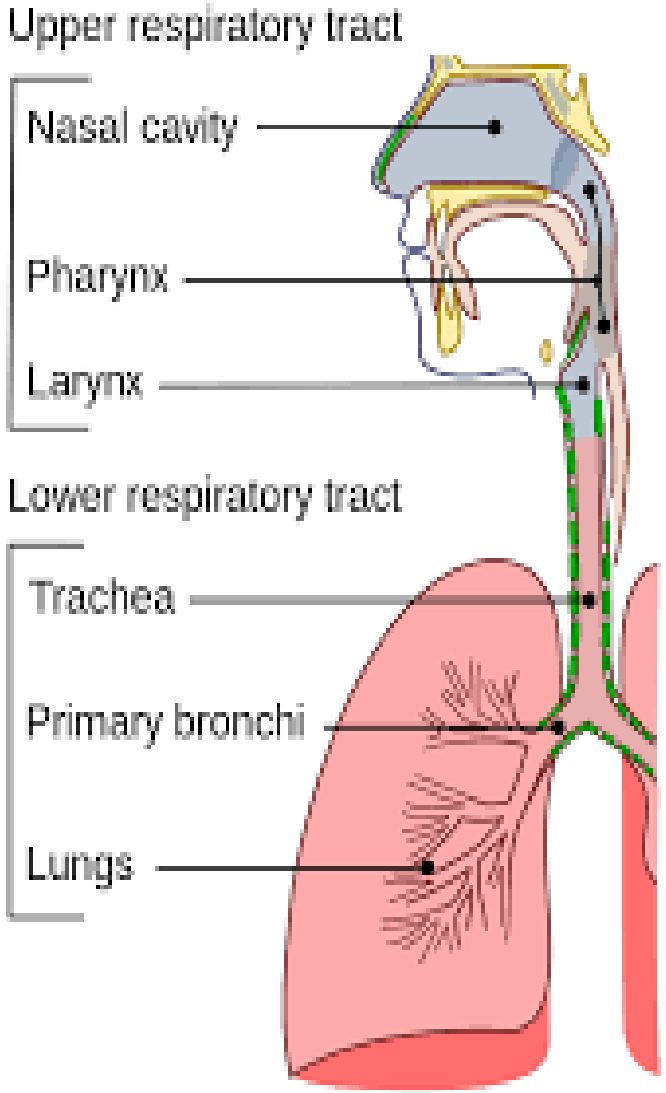
7. RESPIRATORY SYSTEM

1. **Respiratory system** is made up of lungs, airways (trachea, bronchi and bronchioles), diaphragm, voice box, throat, nose and mouth.
2. **The respiratory system** works with the circulatory system to provide oxygen and to remove the waste products of metabolism.
3. **Other functions:**
   a) **Warms and adds moisture to the air you breathe** in to match the temperature & humidity level required.
   b) **Helps protect body from harmful particles and germs**
   c) **It allows body to smell and speak.**
   d) Too much carbon dioxide lowers blood's pH, making it acidic. **By removing CO_2, respiratory system helps maintain the acid-base balance**



7.1 UPPER RESPIRATORY TRACT

1. **Upper respiratory tract starts** with the nose and mouth, where air is pulled to your body. Other parts of your upper respiratory tract include your nasal cavity, sinuses (hollow areas in your cheeks and forehead) and larynx.
2. **Functions of upper respiratory tract:**
   a) **draws air into your body and helps move it toward your lungs.**
   b) **It adds moisture to the air breathe.**



7.2 UPPER RESPIRATORY TRACT

Nasal Cavity

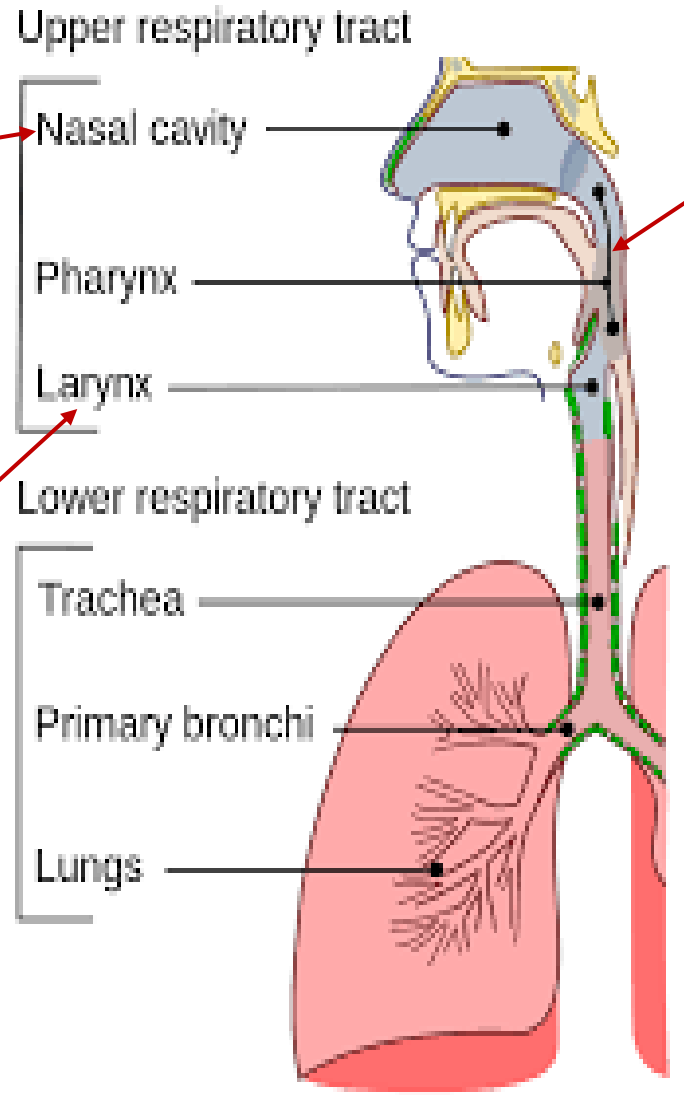
The role of the nasal cavity is:

1. humidify and warm the inspired air.
2. remove minute airborne particles and other debris before the air reaches the lower airways.

Larynx

The function of the larynx in humans and other vertebrates is:

1. to protect the lower respiratory tract from aspirating food into the trachea while breathing.
2. functions as a voice box for producing sounds, i.e., phonation.



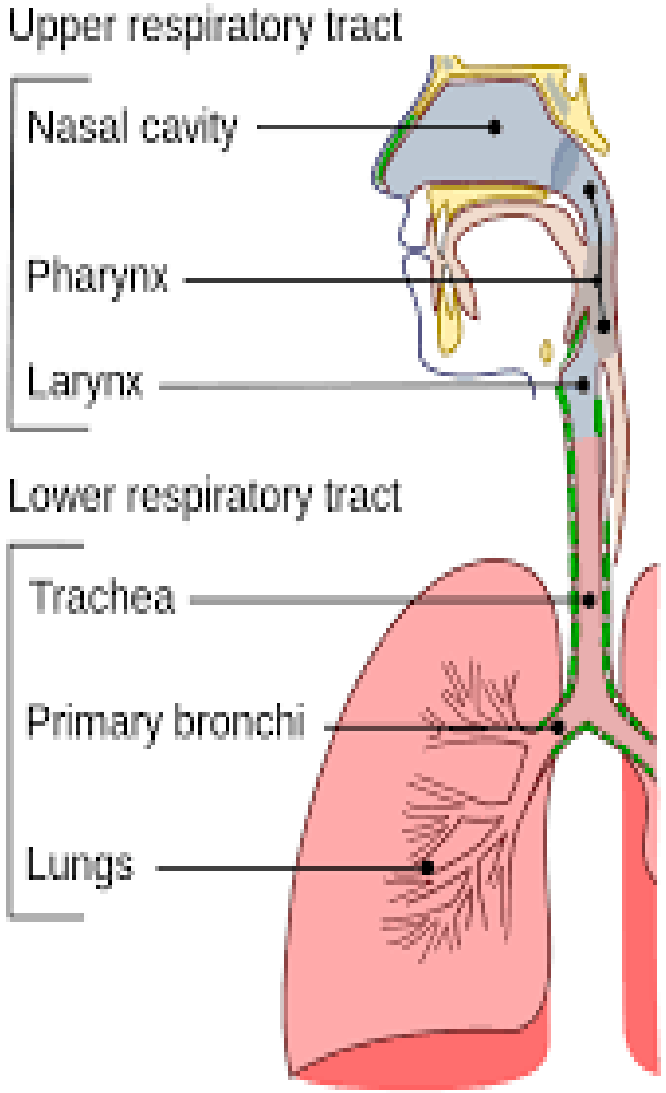
Pharynx:

The role of the pharynx is to:

1. Route air coming in your nose and mouth down to your larynx (voice box), which, in turn, moves air to your trachea and lungs.
2. Deliver food and liquid to your esophagus, which sends them on to your stomach.

7.3 LOWER RESPIRATORY TRACT

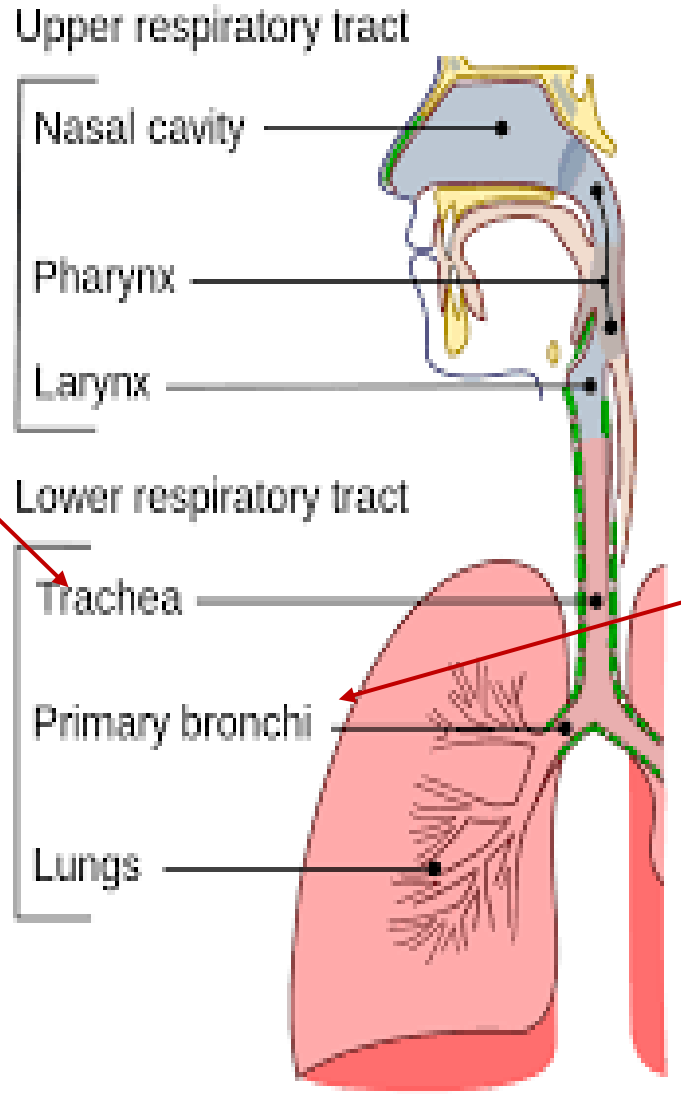
1. **Lower respiratory tract** include the windpipe (trachea) and within the lungs, the bronchi, bronchioles, and alveoli. Deep in the lungs, each bronchus divides into secondary and tertiary bronchi, which continue to branch to smaller airways called the bronchioles..
2. **Functions of lower respiratory tract:**
   a) draw in air from the upper respiratory system
   b) absorb the oxygen
   c) release carbon dioxide.



7.4 LOWER RESPIRATORY TRACT

Trachea has three functions:

1. Provide a safe, sturdy passageway for air to travel from the mouth or nose to the lungs.
2. Prevent the passage of foreign objects into the respiratory system.
3. Regulate the temperature and humidity of air passing into the lungs



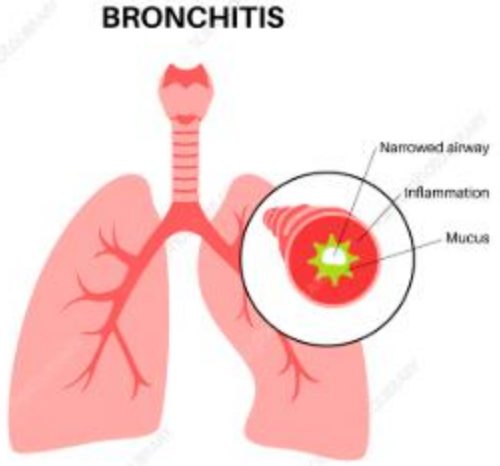
Bronchi carry air to and from your lungs.

Bronchi help moisturize the air you breathe and screen out foreign particles.

Bronchi are lined with cells that create mucus. The mucus keeps your airways moist. It also traps bacteria, viruses, fungi and other particles to protect your lungs and prevent infection.

7.5 CONDITIONS & DISORDERS OF THE RESIRATORY SYSTEM

1. **Asthma:** Chronic inflammation in your airways that makes it difficult to breathe.
2. **Bronchiectasis:** When your bronchi widen and scar, causing you to cough up mucus.
3. **Bronchitis:** Inflammation or infection in your bronchi that may be short-term (acute) or long-lasting (chronic).
4. **Bronchiolitis:** A viral lung infection of the bronchioles.
5. **Bronchopulmonary dysplasia:** A breathing condition that occurs when an infant's lungs do not develop properly.

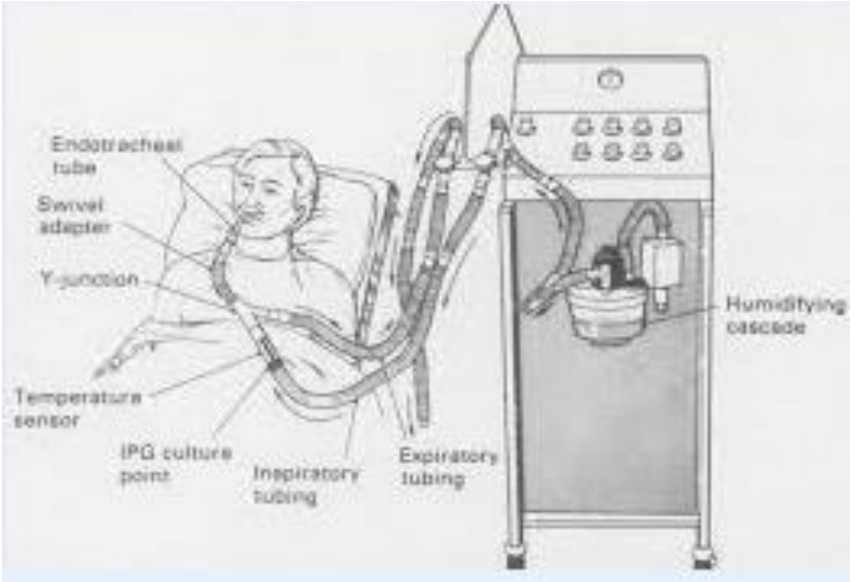


WHY IS THE RESPIRATORY SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /01

1. **Drug Delivery & Aerosol Science:** Designing and optimizing devices like inhalers (metered-dose, dry powder) and nebulizers to ensure efficient deposition of medication (e.g., for asthma or COPD) deep within the lungs.
2. **Tissue Engineering & Regenerative Medicine:** Developing biomaterial scaffolds and bioreactors to create functional lung tissue in vitro for transplantation, to model diseases, or to repair damaged airways and alveoli.

WHY IS THE RESPIRATORY SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /02

3. **Medical Device Development:** Creating and improving life-support and diagnostic equipment, such as:
   a) **Mechanical Ventilators:** Designing sophisticated ventilators that protect the lung from injury while providing support.
   b) **Extracorporeal Membrane Oxygenation (ECMO):** Engineering systems that oxygenate blood directly, acting as an artificial lung for patients with complete respiratory failure.
   c) **Continuous Positive Airway Pressure (CPAP) / BiPAP machines:** Optimizing devices to treat sleep apnea and other disorders.

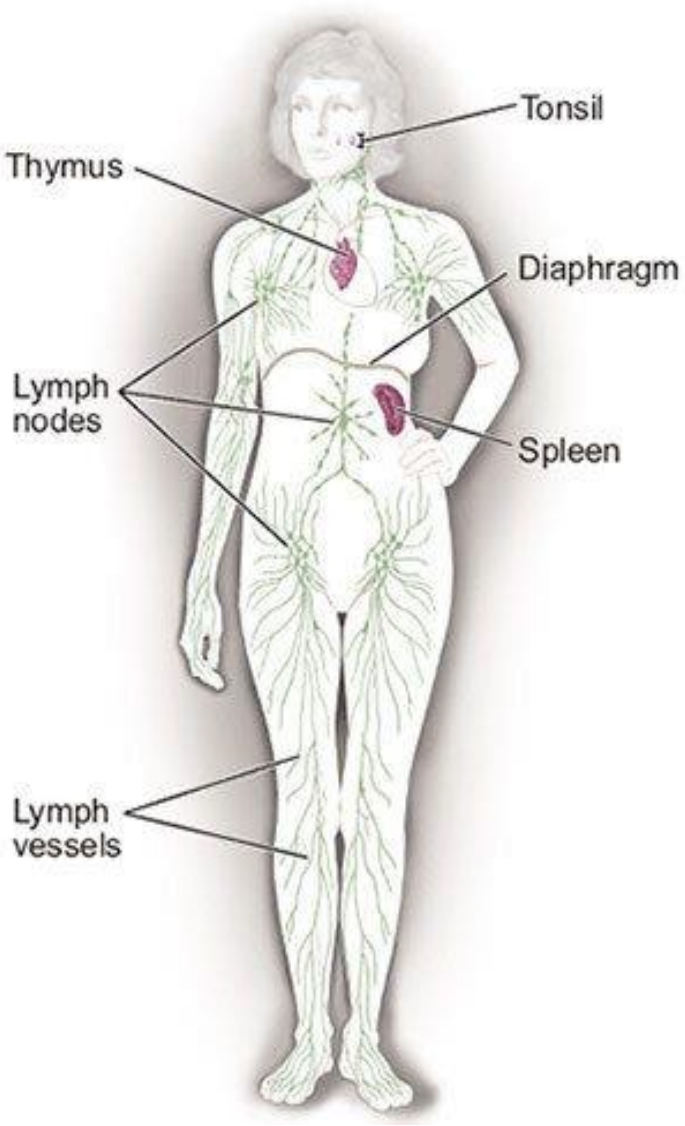


WHY IS THE RESPIRATORY SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /03

4. **Computational Modeling & Simulation:**
   a) **Lung Biomechanics:** Modeling airflow (computational fluid dynamics - CFD) in the airways to understand particle transport, resistance in diseased states, and optimize inhaler design.
   b) **Gas Exchange:** Creating models of oxygen and carbon dioxide transfer in the alveoli to understand disease pathophysiology.
5. **Biomechanics & Biomaterials:** Studying the mechanical properties of lung tissue (e.g., elasticity, compliance) and how they change with disease (e.g., fibrosis, emphysema). Developing compatible materials for implants and devices.

8. LYMPHATIC SYSTEM

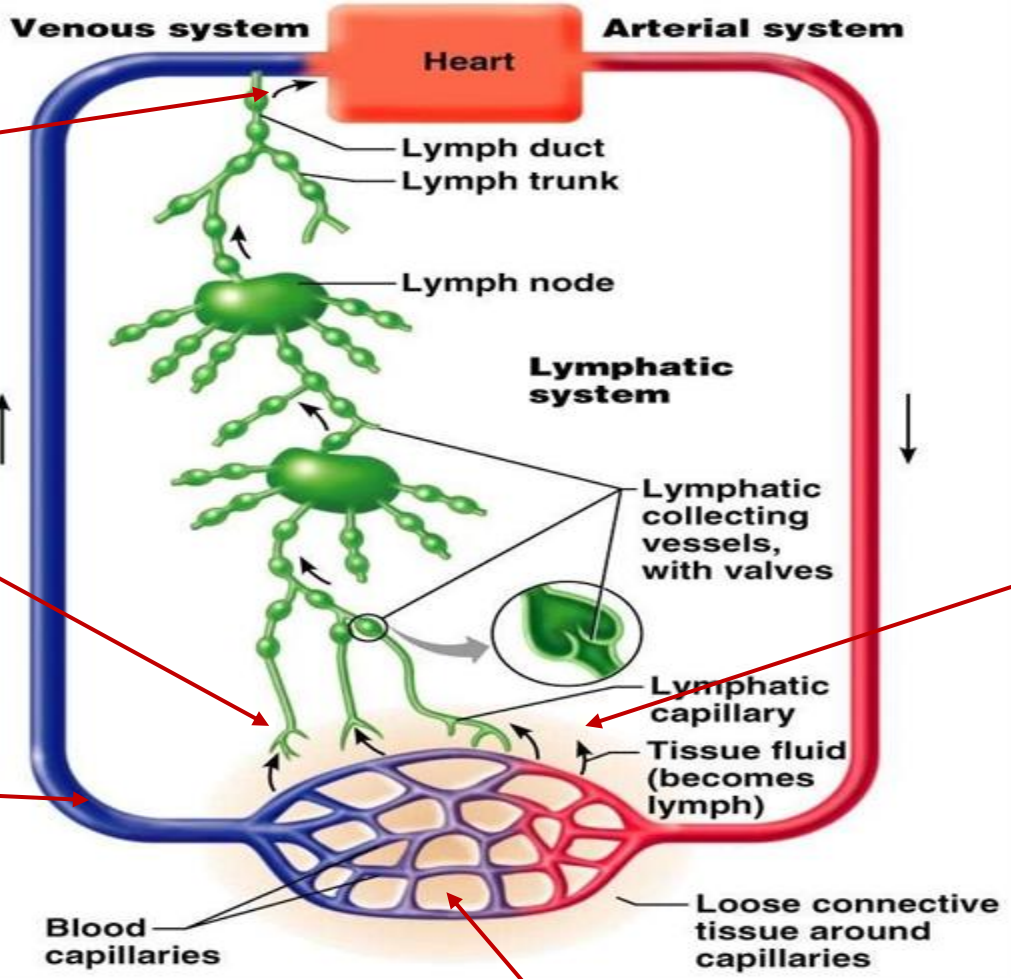
1. **Lymphatic system (or lymphoid system)** is a group of organs, vessels and tissues that protect you from infection and keep a healthy balance of fluids throughout your body.
2. It consists of a large network of lymphatic vessels, lymph nodes, lymphoid organs, lymphatic tissue and lymph.
3. **Functions of the lymphatic system are:**
   a) **Collecting excess fluid from your body's tissues** and returning it to your bloodstream. Lymphatic system also filters out waste products and abnormal cells from this fluid.
   b) **Helping your body absorb fats**. Most nutrients can travel through tiny openings (pores) in the walls of your capillaries, and your body can then absorb and use them. But certain fats and other molecules are too large to travel in this way. The lymphatic system collects such nutrients from the intestines into the bloodstream.
   c) **Protecting your body against invaders**. The lymphatic system immune system produces and releases lymphocytes (a type of white blood cell) and other immune cells. These cells look for and destroy invaders, e.g. bacteria, viruses, parasites and fungi.



6. Lymph is emptied into the subclavian veins and re-enters the blood circulation system.

5. Lymphatic capillaries pick up this remaining 3 litres of fluid (now called lymph) from the tissues.

4. About 17 liters of plasma return to your bloodstream in this way.



1. Every day, about 20 liters of plasma (the liquid part of your blood) flow out of tiny pores in the thin walls of your capillaries.

2. The tissues soak up the nutrients while leaving behind waste.

3. Plasma picks up the waste and returns it to the bloodstream the same way it came, i.e by flowing back through the pores in your capillary walls.

WHY IS THE LYMPATIC SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /01

1. **Lymphatic Physiology and Biomechanics:** Bioengineers study the mechanical forces (e.g., fluid shear stress, stretch) that regulate lymphatic function, including vessel contraction, valve operation, and adaptive responses to pressure changes.
2. **Advanced Imaging and Quantification Tools:** Developing non-invasive imaging techniques (e.g., near-infrared fluorescence imaging, high-speed intravital microscopy) to visualize lymphatic architecture, measure flow dynamics, and assess function in real-time. These tools are crucial for diagnosing diseases and evaluating treatments.

WHY IS THE LYMPATIC SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /02

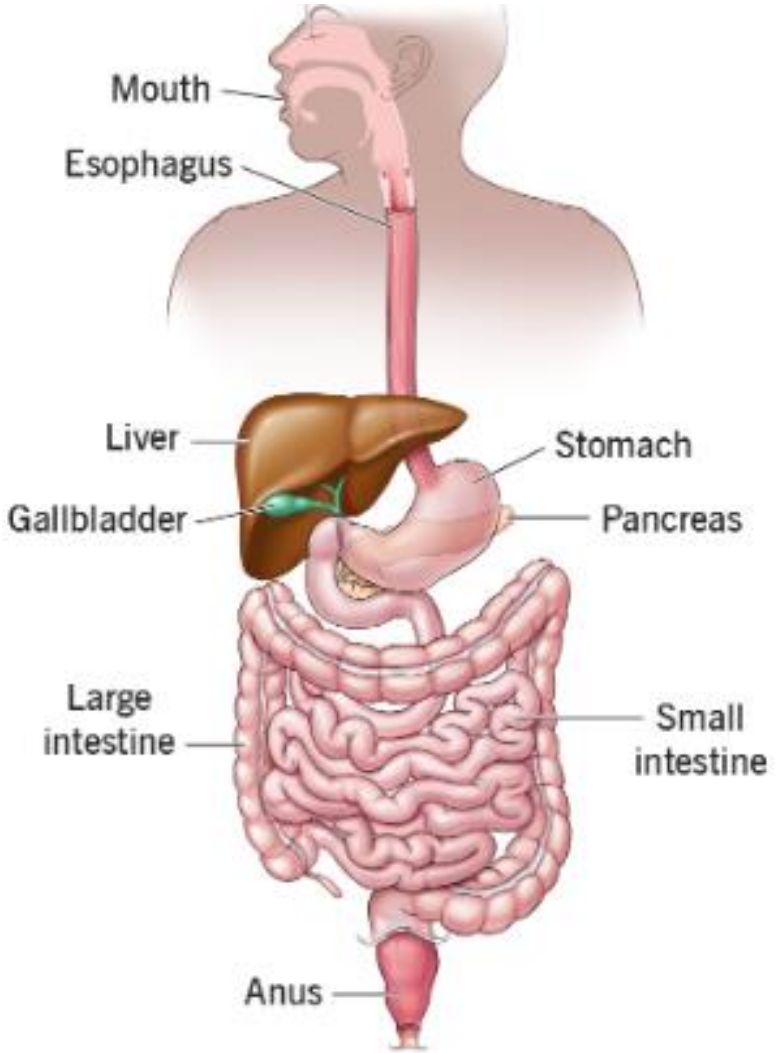
3. **Tissue Engineering and Regenerative Strategies:**
   a) **Biomaterial Scaffolds:** Using hydrogels, decellularized matrices, and synthetic polymers to create 3D environments that support lymphatic endothelial cell (LEC) growth.
   b) **Stem Cell Therapy:** Differentiating embryonic stem cells (ESCs) and induced pluripotent stem cells (iPSCs) into LECs to generate functional lymphatic tissues for transplantation .
   c) **Growth Factor Delivery:** Incorporating pro-lymphangiogenic factors into biomaterials to stimulate lymphatic regeneration.

WHY IS THE LYMPATIC SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /03

4. **Disease Modeling and Organ-on-Chip Platforms:** Creating microfluidic devices (e.g., lymphangion-chip) to mimic lymphatic vessels and nodes. These models enable the study of disease mechanisms (e.g., lymphedema, cancer metastasis) and high-throughput drug screening in a human-relevant context.
5. **Immuno-Engineering and Inflammation Control:** Exploring lymphatic-immune cell interactions to develop therapies for inflammatory diseases, autoimmune disorders, and improved cancer immunotherapy.

9. DIGESTIVE SYSTEM

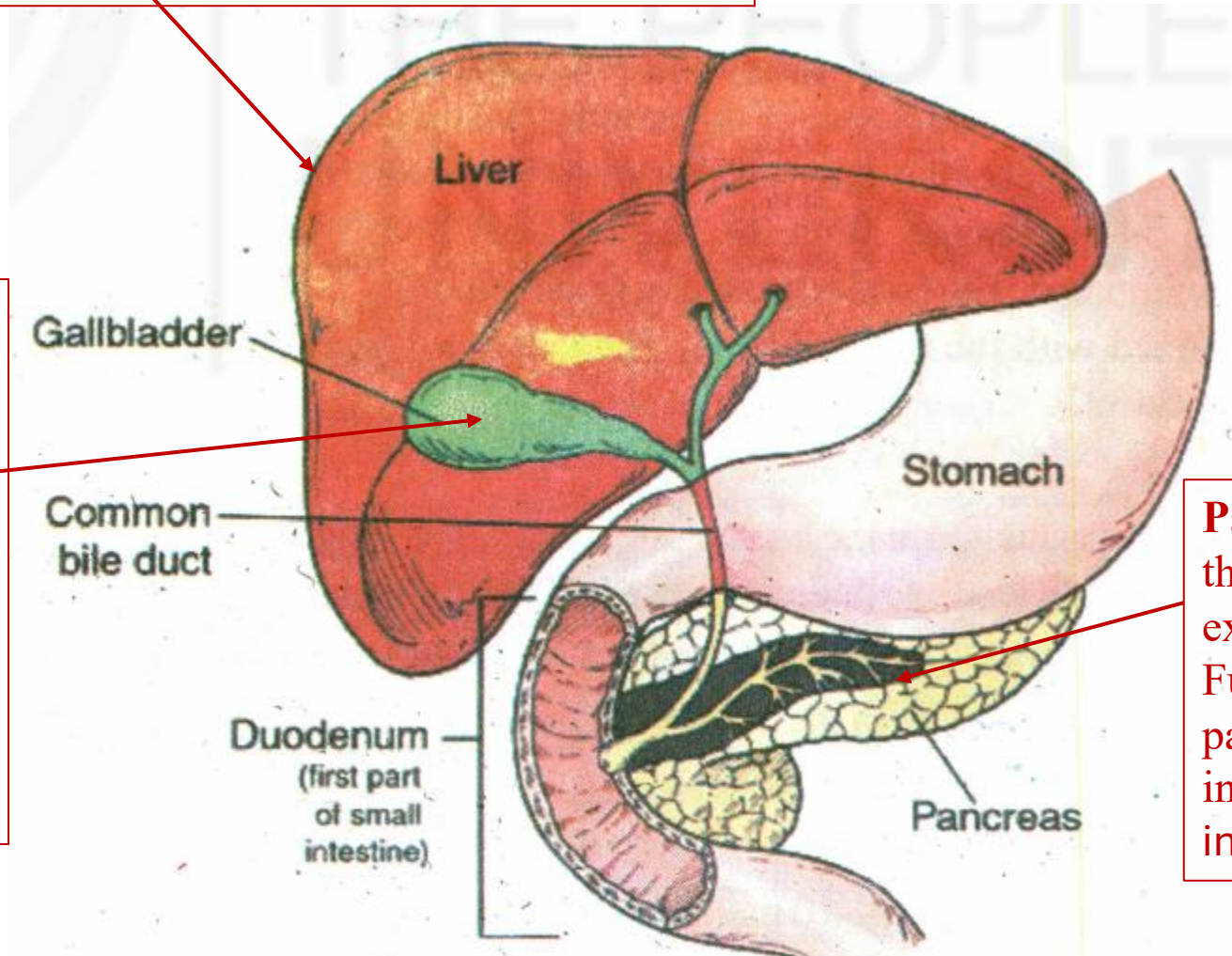
1. **Digestive system** is a network of organs that help you digest and absorb nutrition from your food. It includes:
   a) Gastrointestinal (GI) tract
   b) Biliary system.
2. **Gastrointestinal tract (GI)** is a series of hollow organs that are all connected to each other, leading from mouth to anus.
3. **Biliary system** is a network of organs that deliver bile and enzymes through the bile ducts to the GI tract . Biliary system includes liver, gallbladder, pancreas and bile ducts.



THE BILLIARY ORGANS-LIVER, GALL BLAGGER & PANCREAS

- **Liver** is the largest gland in the body situated in the upper most part of the abdominal cavity on the right side below the diaphram.
- **Bile** is formed in the liver cells and passes through the bile duct to the gall bladder.

1. **Gall bladder** acts as a store house of bile.
2. With the help of contraction of gall bladder the bile is poured into the middle part of the small intestines which helps in dissolving the fats during digestion.



Pancreas is responsible for the production of insulin and exocrine.
Function is production of pancreatic juice which helps in digestion. It is about 7 inches long.

DIGESTIVE CONDITIONS & DISORDER – SHORT TERM /01

Short-term or temporary conditions that affect the digestive system include:

1. **Constipation:** Constipation generally happens when you go poop (have a bowel movement) less frequently than you normally do. When you're constipated, your poop is often dry and hard and it's difficult and painful for your poop to pass.
2. **Diarrhea:** Diarrhea is when you have loose or watery poop. Diarrhea can be caused by many things, including bacteria.
3. **Heartburn**: Although it has "heart" in its name, heartburn is actually a digestive issue. Heartburn is an uncomfortable burning feeling in your chest that can move up your neck and throat. It happens when acidic digestive juices from your stomach go back up your esophagus.
4. **Hemorrhoids:** Hemorrhoids are swollen, enlarged veins that form inside and outside of your anus and rectum. They can be painful, uncomfortable and cause rectal bleeding.

DIGESTIVE CONDITIONS & DISORDER – SHORT TERM /02

6. **Stomach flu (gastroenteritis):** The stomach flu is an infection of the stomach and upper part of the small intestine usually caused by a virus. It usually lasts less than a week. Millions of people get the stomach flu every year.

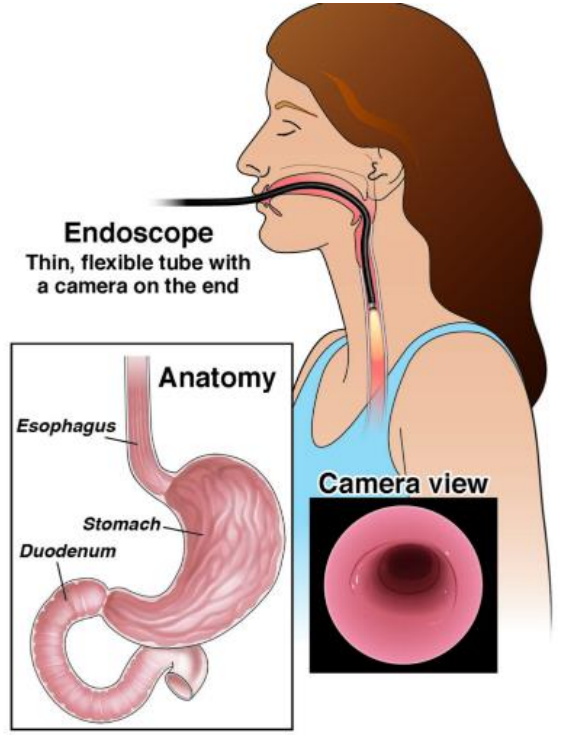
7. **Ulcers:** An ulcer is a sore that develops on the lining of the esophagus, stomach or small intestine. The most common causes of ulcers are infection with a bacteria called Helicobacter pylori (H. pylori) and long-term use of anti-inflammatory drugs such as ibuprofen.
8. **Gallstones:** Gallstones are small pieces of solid material formed from digestive fluid that form in your gallbladder, a small organ under your liver.

WHY IS THE DIGESTIVE SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /01

1. **Diagnostic Technologies:**
   a) **Developing advanced imaging techniques** (e.g., improved MRI/CT for soft tissue, capsule endoscopy) to visualize the GI tract.
   b) **Designing novel biosensors** to detect biomarkers in breath, blood, or stool for conditions like inflammatory bowel disease (IBD), celiac disease, or colorectal cancer.
   c) **Creating lab-on-a-chip devices and microfluidic models** to simulate digestive processes for drug testing and disease study.

WHY IS THE DIGESTIVE SYSTEM IMPORTANT TO BIOMEDICAL ENGINEERS? /02

1. **Therapeutic Devices and Interventions:**
   a) **Engineering endoscopic tools with enhanced capabilities for minimally invasive surgery, biopsy, and treatment** (e.g., robotic endoscopes).
   b) **Designing drug delivery systems that target specific regions of the GI tract** (e.g., pH-responsive capsules, colon-targeted delivery for IBD).
   c) **Developing artificial organs or support systems**, such as bioartificial liver assist devices for patients with liver failure.



(a) GI endoscopy uses a long, thin (about the width of your little finger), flexible tube with a tiny camera on the end, called an endoscope. This tube and camera gives your doctor a clear view inside your body.