MODULE-03

Adaptation of Anatomical Principles for Bioengineering Design

1. Explain the brain as a Central Processing Unit (CPU)

The brain can be considered a complex computational network like a CPU in a computer. The brain receives and processes input from various sources like sensory organs and other body parts. It then uses this information to generate outputs such as thoughts, movements, and behaviors. The similarity between the CPU and the Brain is that The CPU operates through networks of interconnected components where the data is transferred between memory and input and output devices.

In the case of the brain, the networks are formed by the connections between neurons. Which can form complex circuits and pathways that enable the brain to perform a wide range of functions from sensing the environment to generating complex thoughts and emotions.

Like a CPU the brain is capable of processing vast amounts of information, using distributed processing to perform complex tasks quickly and efficiently

2. Describe the Architecture of the Brain

The Architecture of the brain is divided into the following components.

Cerebrum: The Cerebrum is the largest part of the brain. It is divided into two hemispheres connected by the corpus callosum. It is responsible for complex brain functions such as Consciousness, Perception, thinking, and memory.

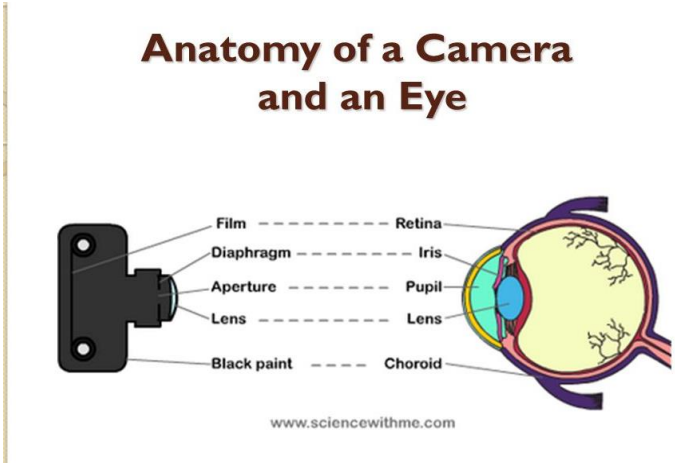
Cerebellum: It is located underneath of cerebrum and is responsible for coordinating movement and balance.

Brainstem: It is located at the base of the brain and connects the brain to the spinal cord. It is responsible for regulating many basic bodily functions such as breathing, heart rate, and blood pressure.

Limbic system: It is a network structure located in the center of the brain. It is involved in regulating emotions, motivations, and memory.

Basal ganglia: These are the group of structures located deep within the brain. They are involved in coordinating movement and muscle control.

3.Explain the Eye as a camera.



The eye like a camera, has several parts that work together to create an image. The cornea and the lens of the eye act like the camera's lens. Focussing light on to the retina. The retina is located at the back of the eye and contains photoreceptor cells called rods and cones, which convert light in to electrical signals that are sent to brain via optic nerve. The rods are sensitive to low levels of light and are responsible for vision in dim light conditions. The cones are responsible for colour vision and are most sensitive to light.

Like the camera's image sensor, the retina can distinguish fine details. However, the eye's ability to focus and adjust to different lighting conditions allows us to see a wide range of detail and color.

The brain then processes these electrical signals from the eye to create the image we see. The brain can interpret the signals from the eye to create a sense of depth and spatial orientation. Thus eye functions like a camera.

4. Explain the Lungs as a purification system.

Lungs are the organs that play an important role in the respiratory system. Which involves the intake of Oxygen and removal of carbon dioxide from the body. They filter out particulate matter and contaminants from the air we breathe.

The lungs contain small air sacs called Alveoli, which are surrounded by tiny blood vessels called capillaries. When we inhale air enters the lungs and oxygen passes through the alveoli into the capillaries, from where it is carried throughout the body.

At the same time, carbon dioxide from the body is exchanged into the alveoli and exhaled out of the body. The respiratory tract also contains tiny hairs called cilia. Which helps to trap foreign particles and prevent them from entering the lungs.

5. Explain the gas exchange mechanism in the lungs. Lungs play an important role in the exchange of gases between the atmosphere and the bloodstream by a process called diffusion. The gas exchange mechanism involves the following steps.

(a) Inhalation: When we inhale, the diaphragm and intercostal muscles contract, causing the volume of the chest cavity to increase and creating a negative pressure gradient, this causes air to flow into the lungs, and into the alveoli.

(b) Oxygen diffusion: The alveoli are surrounded by capillaries, the capillaries transport blood from the heart to lungs. Oxygen from the air circulates across the membrane of alveoli and into the capillaries where it binds to hemoglobin in red blood cells.

(c) Carbon dioxide diffusion: Carbon dioxide from the bloodstream circulates across the membrane of the capillaries and into the alveoli

(d) Exhalation: Once the blood has been oxygenated and carbon dioxide has been removed, it flows back to the heart to be pumped to the rest of the body. When we exhale the diaphragm and intercostal muscles relax causing the chest cavity to decrease and creating a positive pressure gradient. These forces air out of the lungs and back into the atmosphere.

6. With a neat diagram explain the Heart-lungs machine.

It is a medical device that temporarily takes over the functions of the heart and lungs during open-heart surgery. This machine typically includes several components, such as a pump, an Oxygenator, a heat exchanger, a variety of sensors and monitors.

Blood Circulation: This machine circulates the patient's blood through a series of tubing and oxygenators which serves as a temporary replacement for the lungs. The oxygenator removes carbon dioxide from the blood and adds oxygen. Which is pumped back into the patient's body through tubing and cannulas.

Temperature control: The heat exchanger controls the temperature of the patient's blood as it circulates through the machine. This helps to maintain the patient's body temperature and prevent hypothermia.

Blood Pressure Control: The heart-lung machine can be programmed to control the flow rate and pressure of the blood. Which can be adjusted to meet the needs of the patient during the surgery.

Gas exchange: The oxygenator in the heart-lung machine serves as a temporary replacement for the patient's lungs.

Monitoring: The heart-lung machine includes a variety of sensors and monitors to measure the patient's vital signs such as blood pressure, Oxygen levels, and heart rate.

7. Describe the kidney as a filtration system.

The kidneys are an important part of the body's filtration system. They play a crucial role in removing waste products, excess fluids, and other harmful substances from the body. The overview of the kidney filtration system is mentioned herewith.

Nephrons: The functional units of the kidney are called Nephrons. Each kidney contains millions of nephrons which are responsible for filtering the blood.

Glomerulus: it is a tiny blood vessel cluster that acts as a filter. As blood flows through the glomerulus waste products, excess fluids, and other harmful substances are filtered out of the body.

Tubules: The filtered blood from the glomerulus flows into a series of tubules, where additional filtering and reabsorption occur. Nutrients and other essential substances are reabsorbed back into the bloodstream, while waste products and excess fluids are excreted as urine.

Hormones: The kidney also produces hormones that help to regulate blood pressure control the production of blood cells and maintain a proper balance of fluids and electrolytes in the body. Kidneys can be susceptible to various diseases and disorders such as kidney stones, urinary tract infections, and chronic kidney disease which can damage their function and lead to serious health problems.

It is very important to maintain good kidney health through a healthy diet, regular exercise, and avoiding habits like smoking, and excessive alcohol consumption which harm kidneys.