Internal Assessment Test 2 – May 2025

Sub:	**BIOLOGY FOR ENGINEERS**				Sub Code:	**BBOC407**	Branch:	**AIML /CSE(AIML)**
Date:	**23/05/25**	Duration:	**90 minutes**	Max Marks: **50**	Sem/Sec:	**IV**		**OBE**

		IAT SOLUTIONS	**MARKS**	**CO**	**RBT**
1	a	Explain Brain as a central processing unit.	[10]	2	L1

The human brain can be thought of as a highly sophisticated and complex information processing system, similar to a computer's Central Processing Unit (CPU). Both the brain and CPU receive and process inputs, store information, and perform calculations to produce outputs.
However, there are significant differences between the two, such as the way they store and process information and the fact that the human brain has the ability to learn and adapt, while a computer's CPU does not.
Additionally, the human brain is capable of performing tasks such as perception, thought, and emotion, which are beyond the scope of a computer's CPU.
In the human brain, information is processed in a distributed manner across multiple regions, each with specialized functions, rather than being processed sequentially in a single centralized location.
Brain architecture is comprised of billions of connections between individual neurons across different areas of the brain. These connections enable lightning-fast communication among neurons that specialize in different kinds of brain functions.
Just like how a computer's CPU has an arithmetic logic unit (ALU) to perform mathematical calculations, the human brain has specialized regions for processing mathematical and logical operations. The prefrontal cortex, for example, is responsible for higher-level cognitive functions such as decision making and problem solving.

BASICS FOR COMPARISON	BRAIN	COMPUTER
Construction	Neurons and synapses	ICs, transistors, diode, capacitors, transistors.
Memory growth	Increase each time by connecting synaptic links.	Increases by adding more memory chips.
Information storage	Stored in electrochemical and electric impulses.	Stored in numeric and symbolic form.
Structural organization	Brain is self-organizing self-maintaining and reliable.	Computers perform a monotonous job and can’t correct itself.
Transmission information	Use chemicals to fire the action potential in the neurons.	Communication is achieved through electrical coded signals.

The nervous system has two main parts: The central nervous system is made up of the brain and spinal cord. The peripheral nervous system is made up of nerves that branch off from the spinal cord and extend to all parts of the body.

CNS:

CNS includes the brain and spinal cord. The brain is the body's "control center." The central nervous system (CNS) is made up of the brain and spinal cord. It is one of 2 parts of the nervous system. The other part is the peripheral nervoussystem, which consists of nerves that connect the brain and spinal cord to the rest of the body.

The central nervous system is the body’s processing center. The brain controls most of the functions of the body, including awareness, movement, thinking, speech, and the 5 senses of seeing, hearing, feeling, tasting and smelling.

The spinal cord is an extension of the brain. It carries messages to and from the brain via the network of peripheral nerves connected to it. Nerves also connect the spinal cord to a part of the brain called the brainstem.

The nervous system is made up of basic units called neurons.

The neurons are arranged in networks that carry electrical or chemical messages to and from the brain.

The brain and spinal cord are protected from damage by a clear liquid called cerebrospinal fluid, 3 layers of membranes called the meninges, and the hard bones of the skull and backbone.

The brain is made up of different parts. These include the cerebrum, the cerebellum, the thalamus, the hypothalamus and the brainstem.

The cerebrum is the largest part of the brain. It controls intelligence, memory, personality, emotion, speech, and ability to feel and move. It is divided into left and right hemispheres, linked by a band of nerve fibers in the center of the brain called the corpus callosum.

PNS:

The peripheral nervous system includes all of the nerves that branch out from the brain and spinal cord and extend to other parts of the body, including muscles and organs.

The primary role of the PNS is to connect the CNS to the organs, limbs, and skin. The nerves of the PNS extend from the central nervous system to the outermost areas of the body.

The peripheral system allows the brain and spinal cord to receive and send information to other areas of the body, which allows us to react to stimuli.

The PNS is then subdivided into the autonomic nervous system and the somatic nervous system.

The autonomic has involuntary control of internal organs, blood vessels, smooth and cardiac muscles.

The somatic has voluntary control of skin, bones, joints, and skeletal muscle. The two systems function together, by way of nerves from the PNS entering and becoming part of the CNS, and vice versa.

The somatic system is responsible for transmitting sensory information as well as for controlling voluntary movement. This system contains two major types of neurons:

Motor neurons: Also called efferent neurons, motor neurons carry information from the brain and spinal cord to muscle fibers throughout the body. These motor neurons allow us to take physical action in response to stimuli in the environment.

		Sensory neurons: Also called afferent neurons, sensory neurons carry information from the nerves to the central nervous system. The sensory neurons allow us to take in sensory information and send it to the brain and spinal cord. The autonomic system is further divided into two branches: Sympathetic system: By regulating the flight-or-fight response, the sympathetic system prepares the body to expend energy to respond to environmental threats. When action is needed, the sympathetic system triggers a response by accelerating heart rate, increasing breathing rate, boosting blood flow to muscles, activating sweat secretion, and dilating the pupils. Parasympathetic system: This helps maintain normal body functions and conserve physical resources. Once a threat has passed, this system will slow the heart rate, slow breathing, reduce blood flow to muscles, and constrict the pupils. This allows the body to return to a normal resting state.			
2	a	Write a note i. Self-healing bio concrete Bio-concrete is a self-healing form of concrete designed to repair its own cracks. To heal cracks in the concrete, Jonkers chose bacteria (Bacillus pseudo?rmus and B. cohnii), that are able to produce limestone on a biological basis. The positive side-effect of this property: the bacteria consume oxygen, which in turn prevents the internal corrosion of reinforced concrete. However, the bacteria do not pose a risk to human health, since they can only survive under the alkaline conditions inside the concrete. Based on these findings, Jonkers and his team of researchers developed three different bacterial concrete mixtures: self-healing concrete, repair mortar, and a liquid repair system. In self-healing concrete, bacterial content is integrated during construction, while the repair mortar and liquid system only come into play when acute damage has occurred on concrete elements. Self-healing concrete is the most complex of the three variants. Bacterial spores are encapsulated within two-to four-millimeter wide clay pellets and added to the cement mix with separate nitrogen, phosphorous and a nutrient agent. This innovative approach ensures that bacteria can remain dormant in the concrete for up to 200 years. Contact with nutrients occurs only if water penetrates into a crack – and not while mixing cement. This variant is well-suited for structures that are exposed to weathering, as well as points that are difficult to access for repair workers. Thus, the need for expensive and complex manual repairs is eliminated. Self-healing concrete is nothing but concrete which can retain itself to the original state when it is subjected to cracks." Bio-concrete is a material that will biologically produce minerals like limestone with the help of bacteria present in it, which will heal cracks that appear on the	[10]	4	L2

concrete surfaces.Bacterial self-healing is an innovative technology allowing repairing open
micro-cracks in concrete by $CaCO_3$ precipitation. This bio-technology improves the durability of
the structure. In this paper, peptone, yeast extract and Bacillus Subtilis were added as microbial
adjuvant in concrete mix design.

Rahbar predicts self-healing concrete could extend the life of a structure from 20 years, for
example, to 80 years. Other research into creating self-healing concrete has focused on adding
microbes and Bacillus megaterium, a spore-forming bacteria that produces an enzyme that is
expelled into the concrete mix.

The healing agent consisting of B. cohnii spores, calcium lactate and yeast extract immobilized
in light-weight aggregates was also combined with cement, fly ash, limestone powder,PVA
fibers,water in a repair mortar.

ii. Bioremediation

Bioremediation is a biotechnical process, which abates or cleans up contamination. It is a type of
waste management technique which involves the use of organisms to remove or utilize the
pollutants from a polluted area.

Types of Bioremediation

Bioremediation is of three types –

1) Biostimulation:

As the name suggests, the bacteria is stimulated to initiate the process. The contaminated soil is
first mixed with special nutrients substances including other vital components either in the form
of liquid or gas. It stimulates the growth of microbes thus resulting in efficient and quick
removal of contaminants by microbes and other bacterias.

2) Bioaugmentation:

At times, there are certain sites where microorganisms are required to extract the contaminants.

For example – municipal wastewater. In these special cases, the process of bioaugmentation is
used. There’s only one major drawback in this process. It almost becomes impossible to control
the growth of microorganisms in the process of removing the contaminant.

3) Intrinsic Bioremediation:

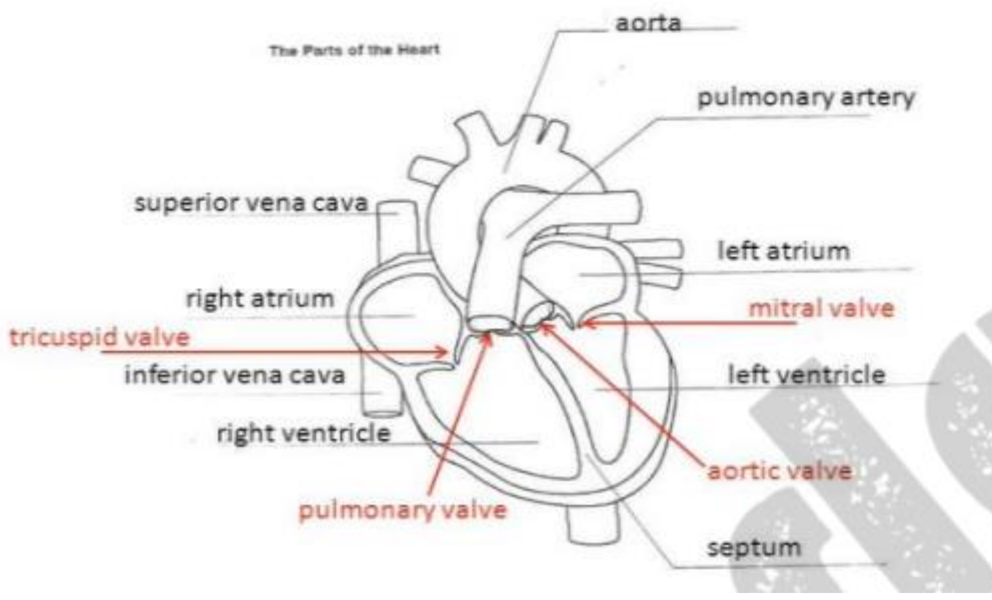
		The process of intrinsic bioremediation is most effective in the soil and water because of these two biomes which always have a high probability of being full of contaminants and toxins. The process of intrinsic bioremediation is mostly used in underground places like underground petroleum tanks. In such place, it is difficult to detect a leakage and contaminants and toxins can find their way to enter through these leaks and contaminate the petrol. Thus, only microorganisms can remove the toxins and clean the tanks. Bioremediation helps clean up water sources, create healthier soil, and improve air quality around the globe. But unlike excavation-based remediation processes, which can be disruptive, bioremediation is less intrusive and can facilitate remediation of environmental impacts without damaging delicate ecosystems. Immobilization of microbial cells and enzymes by adsorption takes place through their physical interaction with the surface of water-insoluble carriers. This method, commonly used in bioremediation processes, is quick, simple, eco-friendly and cost-effective. Microorganisms are utilized in bioremediation because of their ability to degrade environmental pollutants due to their metabolism via biochemical pathways related to the organism's activity and growth.			
3	a	With a diagram explain heart as pump system. Heart is sort of like a pump, or two pumps in one. The right side of your heart receives blood from the body and pumps it to the lungs. The left side of the heart does the exact opposite: It receives blood from the lungs and pumps it out to the body. The human heart is very strong and is capable of pumping blood up to 30 feet distance. An average heart beats maximum of 70-80 beats per minute and is considered healthy. The efficiency of the heart can be maintained and improved by performing physical activity. The heart is called a double pump because each side pumps blood to a	[10]	2	L3

different circulation. Deoxygenated blood from the body drains to the right side of the heart. This is the first pump that sends blood to the lungs, called the pulmonary circulation, where it becomes oxygenated and releases carbon dioxide.

The blood first enters the right atrium. The blood then flows through the tricuspid valve into the right ventricle. When the heart beats, the ventricle pushes blood through the pulmonic valve into the pulmonary artery. The pulmonary artery carries blood to the lungs where it “picks up” oxygen. It then leaves the lungs to return to the heart through the pulmonary vein. The blood enters the left atrium. It drops through the mitral valve into the left ventricle. The left ventricle then pumps blood through the aortic valve and into the aorta.

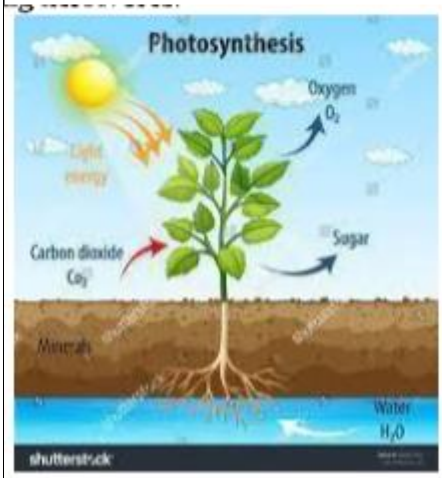
The aorta is the artery that feeds the rest of the body through a system of blood vessels.

Blood returns to the heart from the body via two large blood vessels called the superior vena cava and the inferior vena cava. This blood carries little oxygen, as it is returning from the body where oxygen was used. The vena cava pump blood into the right atrium and the cycle begins all over again.



The human heart is a four-chambered muscular organ, shaped and sized roughly like a man's closed fist with two-thirds of the mass to the left of midline.

The heart is enclosed in a pericardial sac that is lined with the parietal layers of a serous membrane. The visceral layer of the serous membrane forms the epicardium.

		The myocardium of the heart wall is a working muscle that needs a continuous supply of oxygen and nutrients to function efficiently. For this reason, cardiac muscle has an extensive network of blood vessels to bring oxygen to the contracting cells and to remove waste products.			
4	a	Compare the process of photosynthesis to the functioning of photovoltaic cells. Most life on Earth depends on photosynthesis. The process is carried out by plants, algae, and some types of bacteria, which capture energy from sunlight to produce oxygen (O2) and chemical energy stored in glucose (a sugar). Herbivores then obtain this energy by eating plants, and carnivores obtain it by eating herbivores.  The Process: During photosynthesis, plants take in carbon dioxide (CO2) and water (H2O) from the air and soil. Within the plant cell, the water is oxidized, meaning it loses electrons, while the carbon dioxide is reduced, meaning it gains electrons. This transforms the water into oxygen and the carbon dioxide into glucose. The plant then releases the oxygen back into the air, and stores energy within the glucose molecules. Chlorophyll: Inside the plant cell are small organelles called chloroplasts, which store the energy of sunlight. Within the thylakoid membranes of the chloroplast is a light-absorbing pigment called chlorophyll, which is responsible for giving the plant its green color. During photosynthesis, chlorophyll absorbs energy from blue- and red-light waves and reflects green-light waves, making the plant appear green. PHOTOVOLTAIC CELLS:	[10]	3	L2

The sun's copious energy is captured by two engineering systems: photosynthetic plant cells and photovoltaic cells (PV). Photosynthesis converts solar energy into chemical energy, delivering different types of products such as building blocks, biofuels, and biomass; photovoltaics turn it into electricity which can be stored and used to perform work.
Understanding better the way by which natural photosynthetic complexes perform these processes may lead to insight into the design of artificial photosynthetic systems and the development of new

technologies for solar energy conversion. A broad variety of bio-inspired concepts and applications are emerging, ranging from light-induced water splitting, Plant Microbial Fuel Cells to hybrid systems. These latter combine photosynthesis and photovoltaics and have great potential in agriphotovoltaic concepts such as the side-by-side arrangement of solar cells and plants, and systems consisting of transparent solar cells which are placed in front or above the plant. One of the applications that can contribute to bringing together the worlds of photosynthesis and photovoltaics is the photovoltaic cell.

A solar cell, or photovoltaic cell, is an electronic device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Individual solar cell devices are often the electrical building blocks of photovoltaic modules, known colloquially as solar panels. The common single-junction silicon solar cell can produce a maximum open-circuit voltage of approximately 0.5 volts to 0.6 volts.
Application:
- Remote Locations
- Stand-Alone Power.
- Power in Space.
- Building-Related Needs.
- Military Uses.
- Transportation.

5	a	Explain the mechanism and bioengineering solutions for muscular dystrophy and osteoporosis. Awareness is increasing that bone morbidity due to osteoporosis is a major complication of Duchenne muscular dystrophy (DMD) and its treatment and that it requires monitoring for early diagnosis and intervention to prevent clinically important sequelae. The traditional method of fabricating 3D muscle constructs first developed more than 25 years ago involves casting myogenic cells within a cylindrically shaped collagen-I gel that is anchored at the ends to porous felts. In this system, cell-mediated gel compaction and remodeling result in the generation of uniaxial passive stress within the gel, which, in turn, promotes the fusion of myoblasts into myotubes and also myotube alignment. Alternatively, myoblasts, or mixtures of myogenic precursors and fibroblasts, can be cultured on laminin- or hydrogel-coated dishes until spontaneous contractions of formed myotubes detach the entire cell layer, allowing it to self- assemble into a cylindrical tissue construct attached at the ends to premade suture anchors. Although cell alignment within 3D constructs is not required for the formation of contractile myotubes, it increases fusion efficiency while passive stress promotes both cell survival and myogenesis. In addition to collagen I, different natural hydrogels and their chemically modified derivatives can support the 3D growth and fusion of myogenic cells; the most functional results have been achieved using fibrin-based gels. Carefully optimizing the composition of the fibrin gel to enhance cell-matrix interactions as well as optimizing the starting cell population to improve myogenic fusion and SC maintenance and providing dynamic culture conditions to improve cell survival and maturation have enabled rodent skeletal muscle tissues to be engineered with contractile properties comparable to those of native muscle (e.g., twitch and tetanus-force amplitudes). Rapid-prototyping techniques for hydrogel molding can be further used to vary local myofiber alignment and to design complex muscle structures, and advanced biomaterials can deliver angiogenic, myogenic, and pro-survival factors to cells in a spatiotemporally controlled fashion. In addition to using biomaterial scaffolds, scaffold-free muscle tissue constructs have been generated using magnetic fields that allow the controlled assembly of	[10]	4	L3

		magnetically labeled cells, as well as thermo-responsive polymers that allow controlled cell detachment from culture surfaces. Although hydrogels have been the dominant muscle-engineering scaffold in vitro, in vivo studiesof muscle repair have mainly utilized acellular natural scaffolds, porous matrices made ofdegradable polymeric materials, or scaffold-free myoblast sheets.			
6	a	Explain the lotus leaf effect. The lotus leaf is well-known for having a highly water-repellent, or superhydrophobic, surface, thus giving the name to the lotus effect. Water repellency has received much attention in the development of self-cleaning materials, and it has been studied in both natural and artificial systems. SUPERHYDROPHOBIC AND SELF-CLEANING SURFACES: The self-cleaning function of superhydrophobic surfaces is conventionally attributed to theremoval of contaminating particles by impacting or rolling water droplets, which implies the action of external forces such as gravity. Here, we demonstrate a unique self-cleaning mechanism whereby the contaminated superhydrophobic surface is exposed to condensing water vapor, and the contaminants are autonomously removed by the self-propelled jumping motion of the resulting liquid condensate, which partially covers or fully encloses the contaminating particles. The jumping motion of the superhydrophobic surface is powered by the surface energy released upon the coalescence of the condensed water phase around the contaminants. The jumping-condensate mechanism is shown to spontaneously clean superhydrophobic cicada wings, where the contaminating particles cannot be removed by gravity, wing vibration, or wind flow. Our findings offer insights into the development of self-cleaning materials. Mechanism:	[10]	3	L1

		An autonomous mechanism to achieve self-cleaning on superhydrophobic surfaces, where the contaminants are removed by self-propelled jumping condensate powered by surface energy. When exposed to condensing water vapor, the contaminating particles are either fully enclosed or partially covered with the resulting liquid condensate. Building upon our previous publications showing self-propelled jumping upon drop coalescence (5, 6), we show particle removal by the merged condensate drop with a size comparable to or larger than that of the contaminating particle(s). Further, we report a distinct jumping mechanism upon particle aggregation, without a condensate drop of comparable size to that of the particles, where a group of particles exposed to water condensate clusters together by capillarity and self-propels away from the superhydrophobic surface.			