KLS Vishwanathrao Deshpande Institute of Technology

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

University / Model Question Paper

Scheme & Solution

Faculty Name	:	Ashwin Garaddi
Course Name	:	Biology for Engineers
Course Code	:	BBOK407
Year of Question Paper	:	June/July 2024
Date of Submission	:	14/6/25

Faculty Member

HoD

Head of the Department
Dept. of Electronic & Communication Engg.
KLSVDIT, HALIYAL (U.K.)

Dean (Acad.)

CBCS SCHEME

USN | | | | | | | | | | |

BBOK407

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2024
Biology for Engineers

Time: 3 hrs. Max Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

			M	L	C
		Module – 1			
Q.1	a.	What is Cell? Explain Prokaryotic cells and Eukaryotic cell in brief.	10	L2	CO1
	b.	With a neat figure, explain the structure of plant cell and animal cell.	10	L2	CO1
		OR			
Q.2	a.	What is a biomolecule? Explain the classification of biomolecule.	10	L1	CO1
	b.	Explain the properties and functions of Enzymes.	10	L2	CO1
		Module – 2			
Q.3	a.	What are Bioplastics? Compare the properties of PHA and PLA as bioplastics.	10	L1	CO1
	b.	With an example, explain the development of DNA vaccines.	10	L3	CO2
		OR			
Q.4	a.	Explain the importance of lipids and its application in cleaning agents.	10	L2	CO1
	b.	Discuss the development of vaccine for Covid 19.	10	L3	CO2
		Module – 3			
Q.5	a.	Discuss about the Human Brain as a CPU system.	10	L3	CO2
	b.	What is ECG? Describe the various parts of ECG.	10	L2	CO1
		OR			
Q.6	a.	Describe the kidney as a filtration system.	10	L3	CO2
	b.	What are Pacemakers? Briefly explain the various kinds of pacemakers.	10	L2	CO2
		Module – 4			
Q.7	a.	What is Echolocation? Discuss the application of echolocation in Ultrasonography.	10	L1	CO2
	b.	Explain the structure and design of Kinglisher's beak led to bullet trains.	10	L3	CO2
		OR			
Q.8	a.	Discuss about the human blood substitutes.	10	L1	CO1
	b.	What is a lotus effect? Explain the mechanism and applications of lotus leaf effect.	10	L1	CO2

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGG. KLS VDIT HALIVAL

		Module – 5			
Q.9	**a.**	Explain the architecture of Muscular and Skeletal systems as Scaffolds.	**10**	**L3**	**CO4**
	b.	Discuss the applications of Artificial intelligence in the diagnosis of disease.	**10**	**L4**	**CO4**
		OR			
Q.10	**a.**	What is Bioprinting? Discuss the process and applications of Bio printing.	**10**	**L4**	**CO4**
	b.	Write a note on : (i) Electrical Tongue (ii) Self-healing Bioconcrete.	**10**	**L3**	**CO4**

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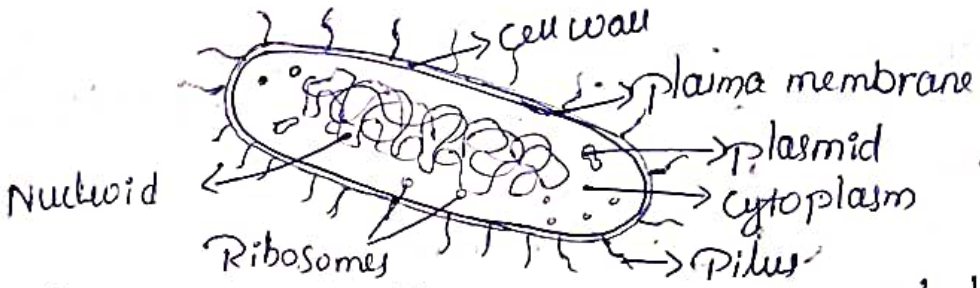
Biology for Engineers — June/July 2024

1 a. what is cell explain Prokaryotic cell and Eukaryotic cell — 10M

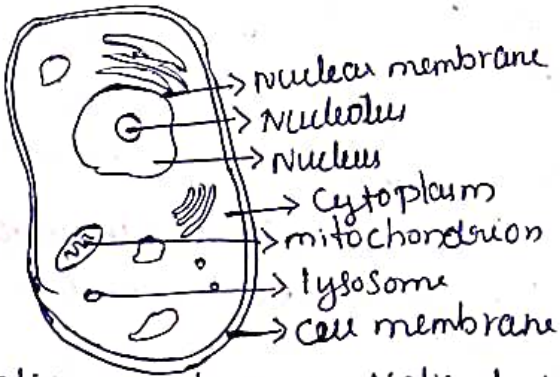
→ A cell is a structural and functional unit of life

Prokaryotic cell:-



* prokaryotic cells are the cells that do not have a true nucleus and membrane bound organells.
* prokaryotic cells are single celled microorganisms known to be the
* the photosynthetic prokaryotes include cyanobacteria that perform Photosynthesis.
* Plasma membrane: It is an outer protective covering of pho spholipid molecule which separate the cell surrounding Env.
* Ribosomes - protein Synthesis occurs here...

Eukaryotic cell

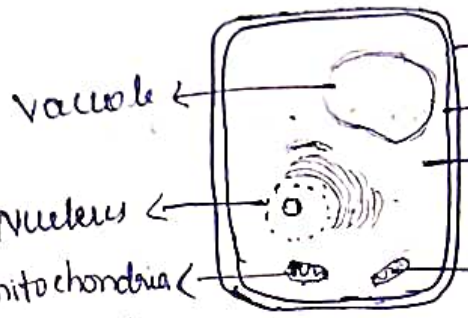


* Nucleus: Eukaryotic cells have a distinct nucleus enclosed within a nucleus envelope which separates the genetic material from the cytoplasm
* mitochondria: Eukaryotic cells typically contain mitochondria which are responsible for cellular respiration and Energy Production through the Process of oxidative phosphorylation

* Reproduction: Eukaryotic cells are generally larger and more complex than prokaryotic cells

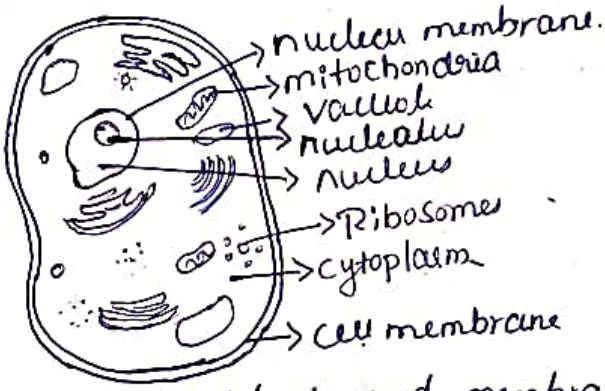
1 b) with a neat figure, Explain the structure of plant cell and animal cell

→



* PLANT Cell

* cell wall: Plant cell wall is a tough layer that is made up of cellu
- lose, lignin, pectin. Primary function to protect and provide structural suppo
* Cell membrane is a Semi permeable membrane present in a plant cell
* Nucleus: Nucleus is a membrane bound organelle that is found in Eukaryotic cells
* mitochondria: often referred to as the powerhouse of the cell these are the double membraned organelle that provide Energy to the cell by breaking down carbs and sugar molecules



* Animal Cell

* The cell membrane is a double layered membrane made up of of phospholipids that surrounds the Entire cell.
* Cytoplasm: is a gel like substance that contains various cell organe
* Ribosomes are found freely in the cytoplasm of the cell
2 * mitochondria: is also known as the powerhouse of the cell
- the process of cellular respiration occurs here during Energy released
* Lysosome: are Pherical organelles membrane bound organelle

2 a) what is a biomolecule? Explain the classification of biomolecule 10M

→ Biomolecule also called biological molecule any of numerous substances that are produced by cells and living organisms.

* Carbohydrates:- which are made up primarily of molecules containing atoms of carbon hydrogen and oxygen are essential energy sources and structural components of all life.

* Lipids:- another key biomolecule of living organisms, serving stored energy and acting as chemical messengers they also form membranes.

* Nucleic acid: these are biopolymers, macromolecules essential to all known forms of life they are composed of nucleotides which are the monomers made of three components nucleic acids are naturally occuring chemical components strings of nucleotides are bonded to form helical backbones typically one for RNA two for DNA and assembled into chains of base pairs selected from the five primary nucleobases

* Proteins: Protein present throughout the body in muscle bone, skin hair and virtually every other body part it makes up the enzymes that power many chemical reactions and the hemoglobin that carries oxygen in your blood

* the process of of synthsizing protein from an mRNA template is known as translation

* Proteins are the chief actors within the cell said to be carrying out the duties specified by the information encoded genes.

2 b) Explain the properties and functions of Enzymes. 10M

→ another important biomolecule that help speed up metabolism in our body our bodies naturally produce enzymes it has many functions as

*Functions

1) Digestion: Enzymes break down complex food molecules into simpler forms for absorption
2) DNA Replication: they help unwind and copy DNA strands during cell division
3) metabolism: Enzymes regulate metabolism pathways converting nutrients into energy
4) Detoxification: Liver Enzymes break down toxins and drugs in the body
5) Cell Regulation: they assist in hormone production and cellular signaling
6) Bioremediation: Enzymes are used to break down pollutants in the environment such as oils pesticides and toxic waste.
7) Biofuel production: Enzymes are used to convert plant material into biofuels.
8) Food and beverage production: Enzymes are widely used in the food and beverage industries for process such as baking
9) Textile production: Enzymes are used in laundry detergents to break down protein.
10) pharmaceuticals: Enzymes are used in pharmaceuticals such as vaccines & antibodies production.

*Properties:

1) Specificity: Enzymes have a high level of specificity for substrates they bind and the reactions they catalyze.
2) Reactivity: Enzymes increase the chemical reactions
3) Stability: Enzymes are stable at wide range of temperature and pH values
4) Renewability: Enzymes are biodegradable and can be produced from Renewable resources
5) Cost Effectiveness: Enzymes can be produced in large quantities they are cost effective.

Q3 a) what are bioplastics? compare the properties of PHA and PLA as bioplastics.

→ Bioplastics are one type of plastic which can be generated from natural resources such as starch and vegetable oil this are basically classified as bio based and biodegradable

Properties of PHA

* Biodegradability: PHA are biodegradable and can breakdown into water and carbon dioxide reducing their impact on the Environment.
* Bio Compatibility: PHA are biocompatible and can be used in medical devices such as sutures and implants without causing adverse reactions in the body
* mechanical properties: PHA have similar mechanical properties to traditional petroleum based plastic making them suitable for varies applications
* Processing: PHA can be processed using conventional plastic processing techniques such as injection molding blow molding and Extrusion.

Properties of PLA

* Biodegradable: PLA can be broken down by microorganism in industry reducing waste in landfills
* Renewable: PLA is derived from renewable resources such as corn starch.
* Clear/transparent: PLA has a clear and transparent appearance making it suitable for packaging
* heat resistance: PLA has a relatively low melting temperature and is not recommended for high heat applications
* Printability: PLA is commonly used in 3D printing due to its Printability.

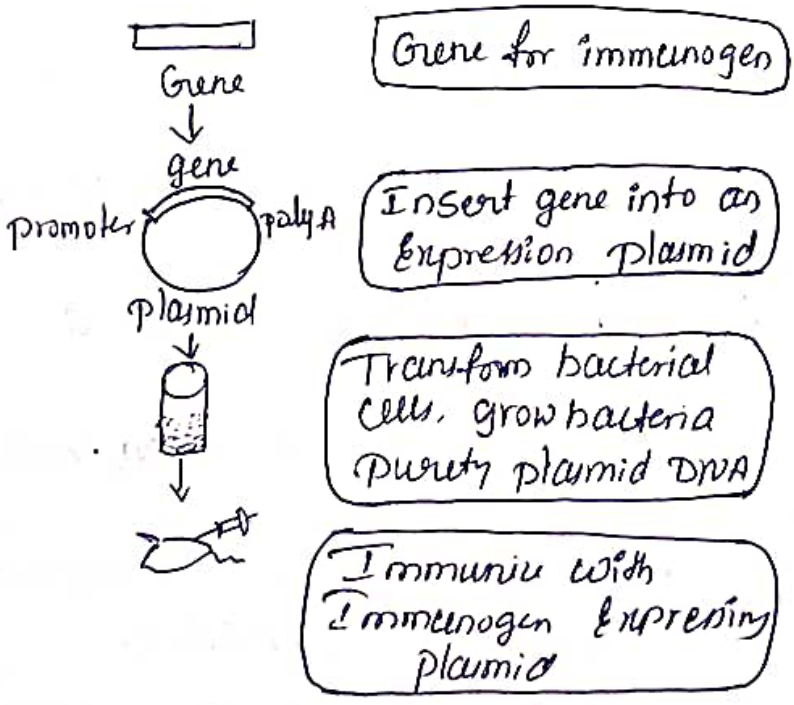
3b) with an example explain the development of DNA vaccines. 10M.

→ DNA vaccine is a type of vaccine that uses a piece of viral or bacterial DNA to stimulate an immune response. DNA vaccines are being actively researched & developed for a range of diseases including cancer, rabies, influenza etc.

We have example as DNA vaccine for rabies

* the vaccine works by introducing the rabies virus DNA into the body where it is taken up by cells and used to produce viral protiens.
* then viral protiens displayed on the surface of the cell which triggers an immune response and the production of antibodies against the rabies virus.

RADNA vaccine using a pcd-nco plasmid encoding the glyco protein gene of a mexican isolate of rabies virus was developed to induce long lasting protective immunity in the dogs



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4a) Explain the importance of lipids and its application in cleaning agents.

→ * Lipids are major source of storage in the body.
* Lipids helps to insulate the body helping to regulate the body temparature.
* lipids are major components of cell membrane helping to maintain stability
* Some lipid help in hormone synthesis and production

Applications

* Personal care products - Such as fatty acids and glycerides are commonly used for personal care
* Industrial cleaning - Lipids can be used as cleaning agents in various industrial applications such as metal cleaning.
* Laundry detergents: Lipid such as fatty acids and glycerides are used as ingredients in laundry detergents to improve their cleaning performance
* cleaning agents for hard surface such as floors, walls.
* Soap - It is a traditional cleaning gent made from the reaction of an alkali with a fat or oil
* Fatty acids: Fatty acids such as stearic acid can be used as cleaning agents in personal careproducts
* Glycerol - Glycerol is a byproduct of soap production and can be used as cleaning agents
* Fatty alcohol - Fatty alcohol such as lauryl alcohol can be used as plant and animals and are biodegreelable

4b) Discuss the development of vaccine for covid-19

→ Coronavirus is disease (covid19) is an infectious disease caused by the SARS COV 2 virus mensanger RNA instructs cell to make a protein that generates an immune response in the body
* thus produces the antibodies thus that produces the protection against a disease

* It is the bases for the Pfizer/BioNTech and moderna Covid-19 vaccine being used by government worldwide
* In the UN supported COVAX global vaccin solidarity initiative messanger ribonucleic acid (RNA) is a molecul that provide cell with instructions for making proteins
* mRNA vaccine contain the instructions for making the SARS COV-2 spike protein this protein found on the surface of the virus that cause Covid-19.
* the mRNA molecul is Essentially a recipe telling the cells of the body how to make the spike protein Covid-19 mRNA vaccine are given by injection.

5a) Discuss about the Human Brain as CPU System

* the human brain can be thought of a high sophisticated and complex information processing system.. similar to computer central processing unit, Both the brain and CPU receive and process inputs. store information and perform calculations to produce output
* Human brain has ability to learn and adapt while a computers 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 CPU
* In the human brain information is processed in a distributed manner across multiple regions each with specilized function 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 brain

* Just like how a computers CPU has an arithmetic logic unit (ALU) to perform mathematical calculations, the human brain has specilized regions for processing mathmatical and logical operations.

* Construction → Brain has Neurons and synapse when in Computer ICS, transistors diode, capacitors, transistors

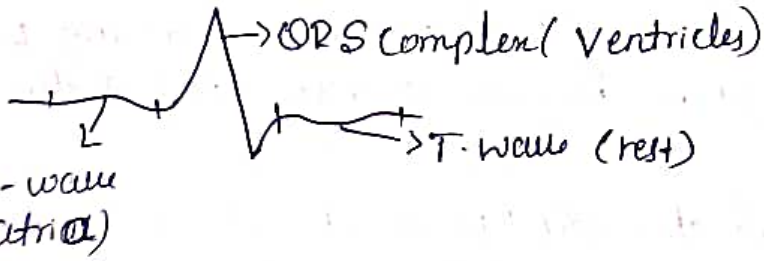
* memory growth → Increase each time by connecting synaptic links in Brain, In computer memory increase by adding more memory chips

* Information Storage → In Brain electrochemical and electric impulses and in computers 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.

5b) what is ECG? Describe the various parts of ECG

→ The Electrical signaling can be monitored using an electrocardiogram (ECG) which records the electrical activity of the heart and provides important information about the heart function



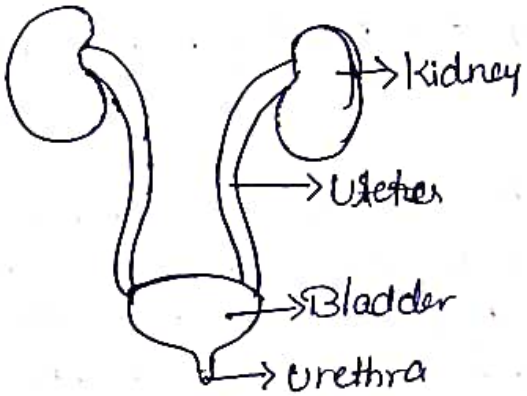
* P-wave → this represents the Electrical depolarization of a atria

* QRS complex: this represents the Electrical depolarization of the ventricles

* T-wave -> This Represents the repolarization of the ventricles.
* PR-Segment -> the flat line between the End of the P-wave and the beginning of the QRS Complex
* QT. Interval -> the time between the start of the QRS Complex and the End of the T-wave.
* ST segment -> the flat line between the End of the QRS Complex and the beginning of the T. wave.

Q6 a) Describe the kidney as filtering Sys.

-> Kidney remove waste and Extra fluid from the body kidneys also remove acid that is produced by the cell of the body and maintain a healthy balance of water salts and minerals such as Sodium, Calcium phosphorus and potassium.



* Each kidney is made up of about a million filtering units Called nephrons Each nephron includes a filter called the glomerules
* The nephron work through two step Proces the glomerules filter blood and the tubule returns needed substances to your blood and removes wastes
* Bowmans capsule:- this is a cup shaped structure that Surrounds the glomerules and filters waste and Excess fluid from the blood stream into the renal tube

6(b) What are Pacemaker? Briefly explain the various kinds of Pacemakers.

→ A pacemaker is a small device that placed in the chest to help control the heartbeat. It's used to prevent the heart from beating too slowly Implanting a pacemaker in the chest required a Surgical procedure a pacemaker is also called a cardiac pacing device

Types:- Single chamber pacemaker.→ This type carries Electrical impulses to the right Ventrical ~~and~~ right atrium of your heart to help control the timing of contractions between the two chambers.

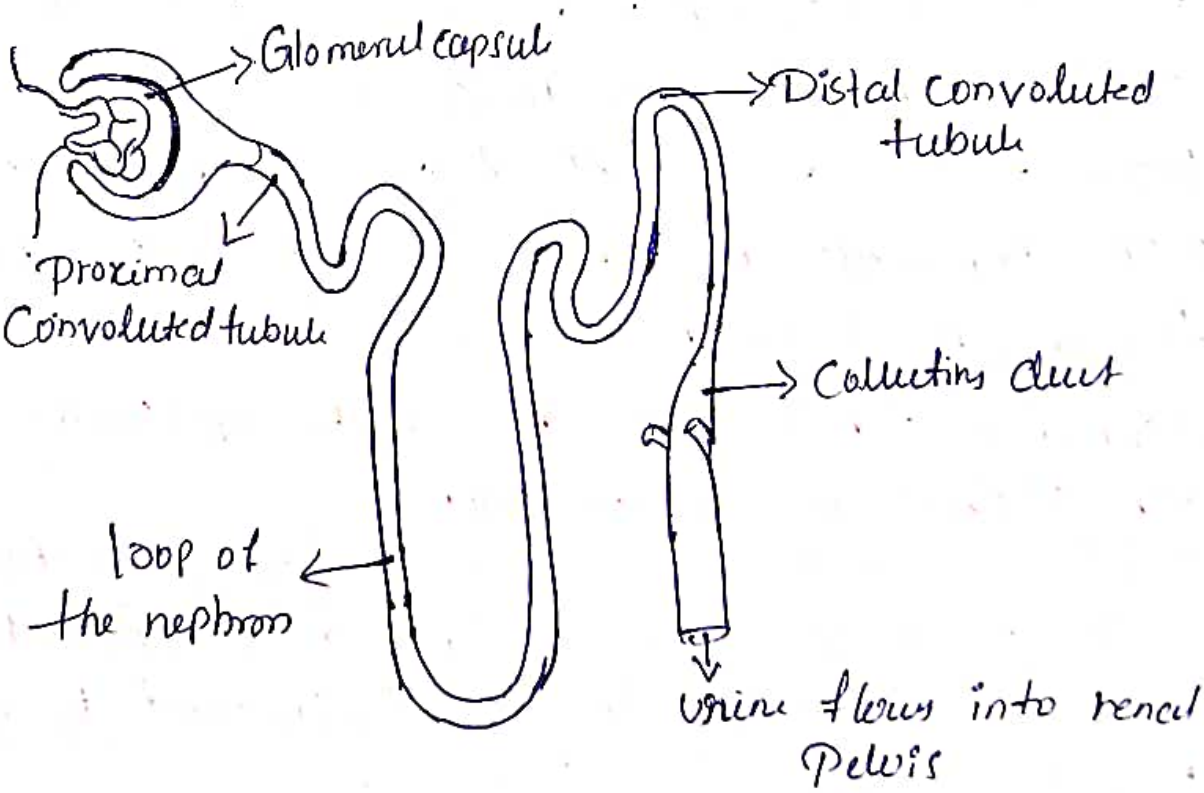
* Dual chamber pacemaker:- this type Carries Electrical impulses to the right ventricle and the right atrium of your heart to help control the timing of Contractions between the two chambers

* Biventricular pacemaker:- Biventricular pacing also called Cardiac resynchronization therapy is for people who have heart failure and heartbeat problems this type of pace maker stimulates both of the lower heart chambers to make the heart beat more Efficiency

7a) what is Echolocation? Discuss the application of Echolocation in Ultrasonography.

→ Echolocation is a biological or technical process that involves Emitting Sound waves and listening to the Echos that bounce back off of objects in the Environment to determine their location distance and shape.

* Glomerule: - A network of tiny blood vessels within the Bowmans capsul that filter waste and excess fluid from the blood stream on to the renal tube
* Proximal Convoluted tubule:- A segment of the renal tubule that reabsorbs important substances such as glucose amino acids and electrolytes back in to blood streams
* loop of Henle: A 'U' shaped segment of the renal tubule that is critical for the reabsorption of ions and water
* Distal convoluted tubule: A segment of the renal tubule that regulates the level of electrolytes and other substances in the blood stream
* Collecting duct: A series of ducts that collect the filter from the renal tubules and transport it to the renal Pelvis and drains in to the ureter and eventually in to the bladder.



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Applications:-

* Obstetrics and gynaecology:- Ultrasonography is commonly used to monitor the growth and development of a fetus during pregnancy as well as to evaluate the reproductive organs and female pelvic organ for conditions such as ovarian cysts.
* Abdominal imaging:- Ultrasonography is used to image the organs of the abdomen such as the liver gallbladder, pancreas spleen and kidney to diagnose conditions such as liver disease
* Musculoskeletal imaging:- Ultrasonography is used to image the muscles tendons and ligament to diagnose conditions such as muscle strains.
* Vascular imaging:- Ultrasonography is used to image blood vessels such as the arteries and veins to treat conditions such as blood clots blockages.
* Eye and neck imaging:- Ultrasonography is used to image the eye and neck
* Emergency medicine:- Ultrasonography is often used in Emergency medicine to quickly and accurately diagnose conditions such as appendicities, Pneumothorax and fluid buildup in the abdomen and chest

7b) Explain the structure and design of kingfisher's beak led to bullet trains.

→ The kingfisher is long slender and sharply pointed switch helps reduce drag or air resistance

* the beak of the kingfisher is long slender and sharply pointed which helps reduce drag or air resistance as the bird dives into the water. the streamlined shape allows the kingfisher to smoothly cut through the air and minimize the energy required for the dive
* when kingfisher hits the water it encounters the resistance caused by surface tension
* The use of the kingfisher beak as a design inspiration for the front of the bullet train
* Example of how nature-inspired engineering can lead to innovative solutions that improve performance and efficiency of machines.
* the streamlined design minimizes drag as the train travels at high speeds allowing it to maintain stability and efficiency the smooth tapered shape reduces the pressure difference between the front and rear of the train reducing noise and vibration
* when the high speed train moves through a tunnel it creates pressure waves that can cause noise and discomfort. The nose is designed to reduce the pressure waves by effectively managing airflow and minimising the compression and expansion of air as the train enters and exits the tunnel

8a) Discuss about the Human blood substitutes.

→ Human blood substitutes are synthetic products that are designed to act as a replacement for blood in the human body.

* Effective oxygen transport:- Human blood substitute must be capable of efficiently carrying and delivering oxygen to the body tissues This is a fundamental function of natural blood.

* Safety and Compatibility:- Blood substitutes should be safe for use in the human body and well tolerated by the recipient they should be not cause any adverse reactions

* Storage and transport:- Human blood substitutes should be stable and capable of being stored and transported Easily

* There are two types of human blood substitutes:- Hemoglobin based oxygen carriers (HBC) and perfluoro-Carbon (PFC). HBOC are based on the hemoglobin molecule which is the protein in red blood cells that carries oxygen to the body tissues

* HBOC can be help to increase the amount of oxygen available to the tissues

* HBOC is a type of blood substitute that is designed to carry and deliver oxygen to the body tissues

* HBOC's have longer shelf life and it have reduced risk of infection

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8 b) what is lotus Effect? Explain the mechanism and applications

→ lotus leaf Effect also known as the lotus Effect refers to the ability of lotus leaves to repel water and self-clean through their unique surface structure.

* The lotus leaf surface has a microscale and nanoscale structure that consists of numerous small bumps and wax coated hairs this structure creates a high contact angle b/w the water droplets and the surface, causing the droplets to roll off and carry away any dirt this self cleaning property is due to the lotus leafs ability to repel water and resist adhesion.

Surface of lotus leaf

* Super hydrophobic and self cleaning surface have applications in industries such as aerospace, automotive building material and medical device
* Self cleaning coatings can be used on the Exterior of buildings to reduce the need for cleaning and maintenance while super hydrophobic coating can be used to prevent icing on aircraft wings.

9 a) Explain the architecture of muscular skeletal System as scaffolds

→ The musculoskeletal system is a human body sys that provides our body with movement, stability, shape and support it is subdivided into two broad sys

Contract in response to the message when the muscle activates it pulls on the tendon

(b) Discuss the applications of artificial intelligence in the diagnosis of disease

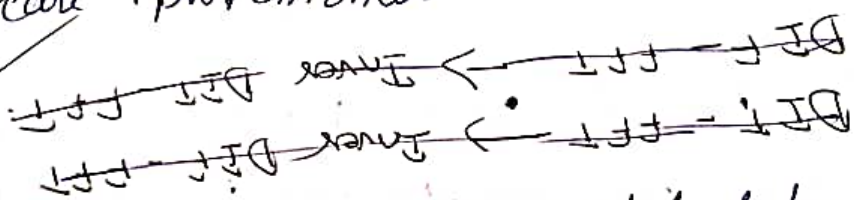
→ Image analysis :- AI algorithms analyze medical images such as X-rays - CT scans and MRIs to detect signs of disease for example - AI algorithm can identify patterns in medical images that may indicate presence of particular conditions

→ Data Analysis :- AI algorithms can analyze large amounts of data such as electronic health records to identify patterns and trends that may indicate a disease.

→ Diagnosis :- AI algorithm can be used to diagnose disease by evaluating symtoms test results and other patients information.

→ Personalized medicine :- AI algorithm can be ~~used to~~ Integrated into electronic health records, personalized treatments plans for patients based on their specific medical histories

→ Clinical decision support :- AI algorithm can be integrated into electronic health records to provid healthcare professionals



→ ~~AI algorithm can be integrated into Electr~~

muscular System:- which includes all types of muscle in the body Skeletal muscles in particular are the ones that act on the body joints to produce movements Besides muscle the muscular system contains the tendons which attach the muscles to the bones

Skeletal Sm: whose main component is the bone, Bones articulate with each other and form the joints Providing our bodies with a hard core yet mobile skeleton the integrity and function of the bones and joints are supports by the accessory structure of the Skeletal System articular, cartilage, ligaments and bursae

* Besides its main function to provide the body with Stability and mobility the musculoskeletal system has many other functions the Skeletal part plays a important role in other homeostatic functions Such as storage of minerals and hematopoiesis mechanism

* the nerve Sm controls your voluntary muscle movements. Voluntary muscles are one you control intentionally some involve large muscle groups to do activities like jumping other use

* Movement:- Our nervous Sm sends a message to active your Skeletal muscles, our muscle fibers

→ AI algorithm can provide physcians with information about the best diagnostic tests to order, the most effective treatment to consider and the best way to manage patient care.

Q) what is bioprinting? Discuss the process and application-ons of Bio Printing.

→ Bioprinting is a rapidly growing field that uses various techniques to produce three-diamensional structure and functional tissues for medical and scientific applications

3D Scanning → 3D Design → Bioink synthesis

↓

application ← maturation ← 3D Bioprinting proces

* Bioprinting materials also known as bioinks are specifically designed to be compatible with living cell and provide a supporting environment for their growth and organization.

Basic steps of bioprinting procen

* Preparation of the bioink:-

The bioink used in bioprinting is a mixture of cells growth factors and other biological material that are formulated to promote cells growth and tissue formation

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* Design of the tissue structure:

The tissue to be printed is designed using Comp-uter aided design software which is then used to control the movement of the print head. *

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↓

* Printing:
The bioprinting dispenses the bioink in a controlled manner layer to build up the final tissue structure the bioink is deposited in a manner that promotes cell survival and tissue formation

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* Incubation:-
After printing the tissue is incubated in a controlled Environment such as cell culture incubator to promote cell growth and tissue formation

↓

* Assessment:
The printed tissue is assessed for its functional Properties Such as cell viability tissue structure and tissue functions

Applications

* Drug Discovery and testing
* Regenerative medicine
* Disease modeling
* Personalized medicine
* In vitro and in vivo modeling
* wound Healing
* orthopaedic applications
* Cancer Research
* High throughput assays
* plastic surgery
* Cardiovascular Disease
* Cosmetic Surgery

ob) write note on

i) Electrical tongue:-

* The technique behind electrical tongue involve the measurement of electrical properties of a food sample the electrical tongue typically consists of a sensor array which is placed in contact with the food sample
* sensor array used in electric tongue are potentiometer ion selective electrodes. then measure the concentration of specific ions associated with taste.
* optical sensors, conductometric sensors, mass sensitive sensors
* materials used in electrical tongue are polymers such as PVA & PEO are substrate material in electrical tongue
* metal oxides used such as SnO_2, ZnO to change in ion concentration.
* Carbon nanotubes are are used to change in ion concentration
* Dendrimers are synthtic branched nanostructure that can be functionalized for specific tastes

10b

2) Self healing Bioconcrete:- Self healing bio concrete is a type of concrete that incorporate microorganisms such as Bacillus fragments into the mixture along with Calcium as a nutrient source. the microorganisms are activated when the concrete crack and they produce calcium carbonate which fills in the crack and repairs the concrete

Self healing bio concrete is still a relatively new technology and is currently in the research and development phase

Self healing bio concrete works by incorporating Bacillus bacteria into the concrete mixture along with calcium lactate as a nutrient source the bacteria are dormant within the concrete and do not become active until the concrete cracks

Self healing bio concrete has several important technical advantages such as increased durability improved sustainability, Reduced maintainability, Increased longevity.

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