

KLS Vishwanathrao Deshpande Institute of Technology



(Accredited by NAAC with "A" Grade)
(Approved by AICTE, New Delhi, Affiliated to VTU, Belagavi)
(Recognized Under Section 2(f) by UGC, New Delhi)
Udyog Vidya Nagar, Haliyal - 581 329, Dist.: Uttara Kannada
www.klsvdit.edu.in | principal@klsvdit.edu.in | hodece@klsvdit.edu.in



DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

University / Model Question Paper Scheme & Solution

| | | |
|------------------------|---|-----------------------|
| Faculty Name | : | A. V. Kolabi |
| Course Name | : | Biology for Engineers |
| Course Code | : | BB04407 |
| Year of Question Paper | : | June/July 2025 |
| Date of Submission | : | 23/02/2026 |

Faculty Member

HoD

Dean (Acad.)

CBCS SCHEME

USN

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BBOK407

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2025 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.*

| Module – 1 | | | M | L | C |
|-------------------|----|--|----|----|-----|
| Q.1 | a. | What are Nucleic acids? Mention its properties and functions. | 10 | L2 | CO1 |
| | b. | Write a short note on all the four types of stem cells. | 10 | L2 | CO1 |
| OR | | | | | |
| Q.2 | a. | Explain the similarities and differences between plant and animal cell. | 10 | L2 | CO1 |
| | b. | Explain the properties and functions of hormones. | 10 | L2 | CO1 |
| Module – 2 | | | | | |
| Q.3 | a. | Explain the application of carbohydrates as cellulose based water filters, mention its advantages. | 10 | L2 | CO2 |
| | b. | Write short note on Meat analogue and Plant protein as food. | 10 | L2 | CO2 |
| OR | | | | | |
| Q.4 | a. | Explain the DNA vaccine for rabies. | 10 | L2 | CO2 |
| | b. | Write short note on PLA as bioplastic. | 10 | L2 | CO1 |
| Module – 3 | | | | | |
| Q.5 | a. | Explain eye as a camera system. | 10 | L3 | CO2 |
| | b. | Describe the architecture of Lungs and gas exchange mechanism. | 10 | L2 | CO2 |
| OR | | | | | |
| Q.6 | a. | Explain the Kidney as filtration system. | 10 | L3 | CO2 |
| | b. | Write a short note on Chronic Obstructive Pulmonary Disease (COPD). | 10 | L2 | CO2 |
| Module – 4 | | | | | |
| Q.7 | a. | Write a short note on : (i) Lotus Leaf effect (ii) Shark skin | 10 | L1 | CO3 |
| | b. | Illustrate the HBO's and PFC's as human blood substituents. | 10 | L3 | CO3 |
| OR | | | | | |
| Q.8 | a. | Write a short note on : (i) Photovoltaic cells (ii) Bionic leaf | 10 | L1 | CO3 |
| | b. | Describe the engineering applications of GPS and Velero technology. | 10 | L3 | CO3 |
| Module – 5 | | | | | |
| Q.9 | a. | Analyze the bio-engineering solutions for muscular dystrophy and osteoporosis. | 10 | L4 | CO4 |
| | b. | Write a short note on self healing bio-concrete. | 10 | L2 | CO4 |
| OR | | | | | |
| Q.10 | a. | Examine the biomedicine and artificial intelligence for disease diagnosis. | 10 | L4 | CO4 |
| | b. | Explain the process of biomining via microbial surface adsorption. | 10 | L2 | CO4 |

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Q.No.1a. What are Nucleic acids? Mention its Properties & func.

Ans: Nucleic acids are complex biomolecules that store & transmit genetic information. The two main types are DNA & RNA.

Nucleic Acid Properties:

- * polymeric structure: made of repeating units called nucleotides.
- * Nucleotide Composition: Each nucleotide consists of a sugar, phosphate group & nitrogenous base. Types of bases Purines & Pyrimidines.
- * Polarity: They have a 5 to 3 direction due to sugar phosphate backbone.
- * Complementary base pairing: A-T (DNA), A-U (RNA) & G-C pairing ensures stability & replication accuracy
- * Solubility: They are soluble in water & form hydrogen bonds
- * Stability: DNA is chemically more stable than RNA due to the absence of the 2'-OH group in its sugar.

Nucleic Acid Functions:

- * Genetic information storage: DNA stores hereditary information in genes
- * Protein synthesis: RNA plays a key role in transcription & translation
- * Replication: DNA can replicate itself to pass genetic information to daughter cells.
- * Gene expression regulation: RNA molecules regulate protein production
- * Evolutionary roles: Mutations in nucleic acids drive genetic variation & evolution.

1b. Write a short note on all the four types of stem cells. ②

Ans → Types of stem cells:

- 1) Embryonic Stem cells (ESCs) Derived from early-stage embryo.

Properties: Pluripotent - Can differentiate into almost any cell-type in the body.

Function: Important for research in development, regenerative medicine & potential therapies for damaged tissues.
- 2) Adult Stem Cells: Found in specific tissues like bone marrow, skin, liver.

Properties: Multipotent can form a limited range of cell types related to their tissue of origin.

Function: Maintain & repair the tissue where they are found.
- 3) Induced pluripotent stem cells: Artificially created by reprogramming adult cells back into a pluripotent state.

Properties: Behave like embryonic stem cells. Capable of forming many cell types.

Function: Useful for disease modeling during testing & personalized medicine without ethical concerns of embryo use.
- 4) Perinatal Stem cells: Found in umbilical cord blood, placenta & amniotic fluid.

Properties: Differentiate into specialized cells, less mature than adult stem cells.

Function: Potential in regenerative therapies, for blood & immune system disorders.

2a) Explain the similarities & differences between plant & animal cell:

Ans: The following are the similarities between plant & animal cell

- * Cell membrane: have a plasma membrane for both that controls entry & exit of substances
- * Cytoplasm: Present in both where metabolic activities occur.
- * Nucleus: Contains DNA & regulates cell functions
- * Mitochondria: powerhouse of the cell producing energy (ATP)
- * Ribosomes: sites of protein synthesis
- * Golgi Apparatus: Modifies, packages & transports proteins.
- * Basic Cell functions: Growth, metabolism & reproduction.

7 The following are the differences.

| Feature | Plant Cells | Animal Cells |
|--------------|---------------------------|-----------------------------|
| Cell wall | Present | Absent |
| Shape | Fixed, rectangular | Irregular or Round |
| Chloroplasts | Present | Absent |
| Vacuole | one large central vacuole | Small or many small vacuole |
| Centrioles | usually absent | Present |
| Lysosomes | Rare | common |
| Food storage | Stores starch | Stores glycogen |

2b. Explain the properties & functions of hormones.

Ans: Properties of hormones:

- * Chemical messengers: produced in small amounts by endocrine glands.
- * Transported via blood: Carried to target organs away from

their side of production

- * Specificity: Act only on particular target cells with suitable receptors..
- * Effective in low concentration: Even minute quantities can trigger significant biological responses.
- * Low molecular weight: Small, soluble organic molecules that diffuse easily
- * Regulatory nature: Maintain homeostasis & coordinate body functions.

> Functions of Hormones:

- * Growth & Development: The growth of hormone regulate body growth
- * Metabolism Control: Thyroxine regulates metabolic rate
- * Reproduction: Estrogen, progesterone & testosterone control reproductive processes.
- * Homeostasis: Insulin & glucagon maintain blood glucose levels
- * permissive fun: It helps regulate movement of substances in & out of cells
- * Co-ordination: Ensure proper functioning of organs & systems in harmony

3a. Explain the application of carbohydrates as cellulose based water filters mention its advantages.

Ans- Following are the Applis of Carbohydrates:

- * Cellulose a carbohydrate polymer made of glucose units is abundant in plant cell walls.
- * It can be processed into nanocellulose or cellulose membranes which act as effective water filters
- * These filters remove impurities suspended particles heavy

metals & even microorganisms from water

(5)

> Advantages:

- * Biodegradable: Environmentally friendly compared to synthetic plastic filters.
- * Renewable resource: Cellulose is naturally abundant & sustainable
- * Cost effective: Production is cheaper than advanced synthetic membranes.
- * High efficiency: Nanocellulose has a large surface area improving filtration capacity
- * Non-toxic: Safe for human use, unlike some chemical based filters
- * Durability: Strong mechanical properties make cellulose filters long lasting

3b. Write short note on meat analogue & plant protein as food.

Ans: The meat analogues are food products designed to mimic the taste texture & nutritional profile of animal meat. It is usually made from soy protein, wheat gluten, pea protein or other plant-based ingredients.

Advantages:

- * Lower in saturated fat & cholesterol
- * Environmentally sustainable compared to livestock production
- * Suitable for people with ethical or religious restrictions on meat

Plant Proteins: Proteins derived from plant sources such as legumes (beans, lentils, peas), cereals, nuts & seeds.

Nutritional Value: Provide essential amino acids though some may be deficient in one or two combining different plant

Proteins ensures balanced nutrition

6

Advantages:

- + Easily digestible & rich in fiber
- + Lower risks of life style diseases (heart disease, diabetes)
- + Sustainable & eco-friendly source of nutrition.

4a. Explain the DNA Vaccine for rabies:

Ans: A DNA vaccine uses a small circular piece of DNA that contains the gene encoding the rabies virus glycoprotein when injected into the body host cells take up this DNA & produce the viral glycoprotein. The immune system recognizes this protein as foreign & generates both antibody-mediated & cell-mediated immune responses.

Advantages:

Prevention of rabies: Provides protective immunity against rabies virus infection

Rapid response: Can be developed quickly in case of outbreaks

Broad immune activation: Induces strong & long-lasting immune memory.

Reduced side effects: Safer than attenuated or killed virus vaccines

Potential for combinations: It can be engineered to include multiple antigens for enhanced protection

4b. Write short note on PLA as bioplastic.

Ans: The Polylactic Acid (PLA) is a biodegradable & bio-based plastic made from renewable resources such as corn starch

Sugarcane or Cassava.

(7)

It is one of the most widely used bioplastics today

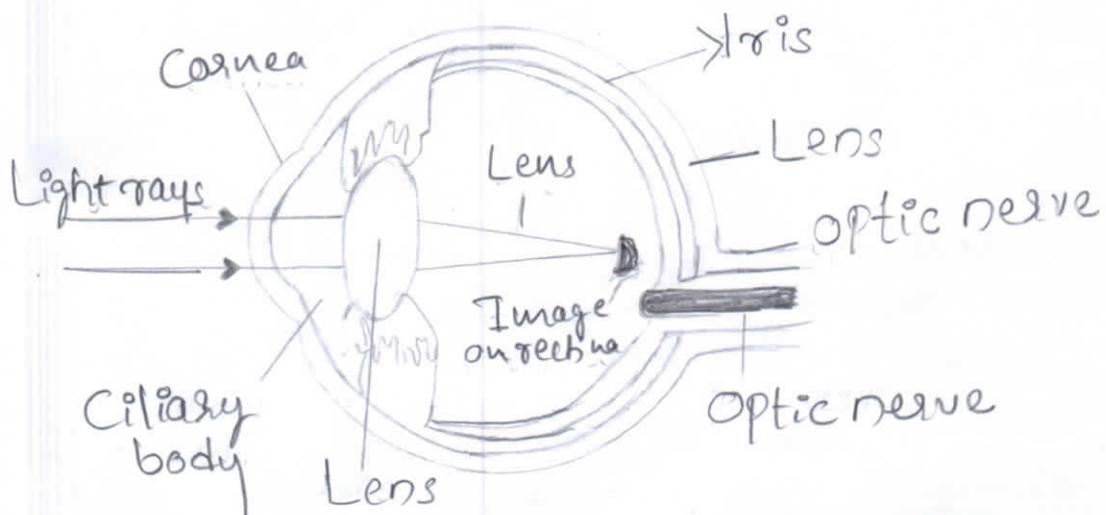
PLA Properties:

- * Biodegradable: Breaks down naturally under industrial Composting Conditions
- * Thermoplastic: It can be molded when heated & solidifies upon cooling
- * Transparent & Glossy: Suitable for packaging apps
- * Mechanical strength: Comparable to conventional plastics like PET.
- * Safe & Non-toxic: Approved for food contact & medical uses

Advantages:

- * Ecofriendly: Reduces dependence on petroleum-based plastics
- * Renewable Source: Derived from agricultural crops.
- * Compostable: Helps in waste management & reduces plastic Pollution
- * Versatile: It can be used in multiple industries.

5a. Explain the eye as a camera system.



The Cornea & Lens are focusing incoming light rays onto the retina just like a camera lens focuses light onto film or a sensor. (8)

Iris & Pupil: The Aperture of iris controls the size of the Pupil regulating how much light enters similar to a camera's aperture.

Retina (Film): The retina captures the image formed by light & converts it into electrical signals just as film or a digital sensor records an image.

Optic Nerve (Data cable): Transmits the Visual info from the retina to brain like a cable sending data from a camera sensor to a computer.

Functions: Light regulation: Iris adjusts pupil size to control brightness.

Image focusing: Lens changes shape to focus objects at different distances.

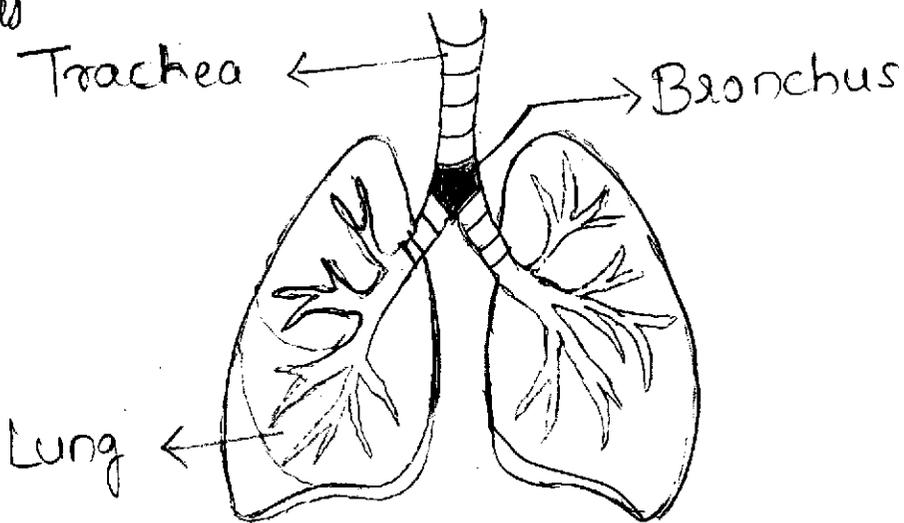
Image formation: Retina receives inverted images which the brain interprets correctly.

Signal Transmission: Optic nerve carries signals to the brain for visual perception.

5b. Describe the architecture of Lungs & gas exchange mechanism.

Ans. The Architecture of the lungs is shown below. The lungs are highly specialized organs designed for efficient gas exchange. Their structure can be broken down into different

levels



Trachea & Bronchi: Air enters through the trachea which divides into two primary bronchi. These bronchi branch into smaller bronchi & bronchioles, forming a tree like structure.

Bronchioles: The bronchioles are smaller airways that lack cartilage & lead directly to the alveolar ducts. They regulate airflow through smooth muscle (contraction & relaxation).

Alveoli: Tiny balloon-like sacs at the end of bronchioles.

Each lung contains providing (about 300 million) alveoli) a massive surface area for gas exchange. The Alveoli are surrounded by dense mass of capillaries.

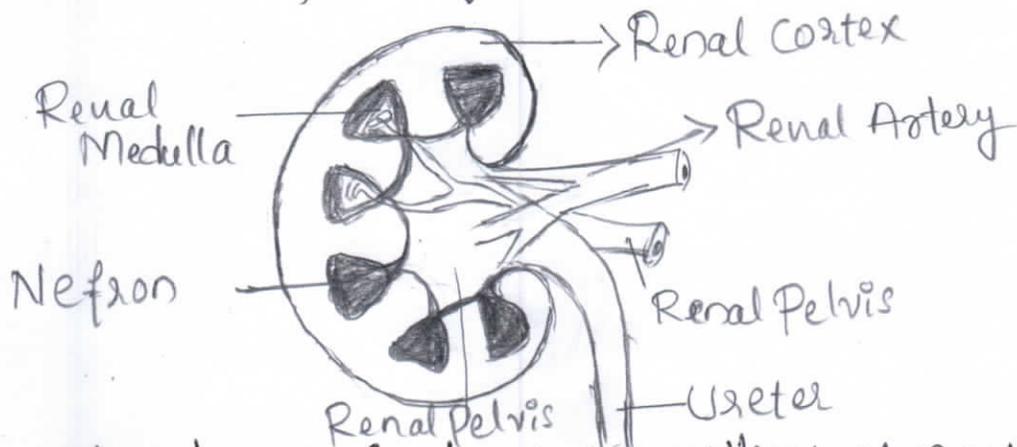
Respiratory membrane: Formed by the alveolar epithelium, capillary endothelium & their fused basement membranes allowing rapid diffusion of gases.

Mechanisms of Gas Exchange: The Gas exchange occurs by simple diffusion driven by differences in partial pressure of O_2 & CO_2 . The inhaled air has a higher partial pressure of O_2 than blood in pulmonary capillaries. O_2 diffuses across the respiratory membrane into the blood (hemoglobin in red blood

(10)
Cells binds O_2 transporting it to tissues. The Blood arriving at the lungs has a higher partial pressure of CO_2 than alveolar air. CO_2 diffuses in to alveoli & is expelled during exhalation.

6a. Explain the kidney as filtration system.

Ans. The structure of kidney renal cortex.



The outer layer containing millions of nephrons initial blood filtration.

Renal Medulla: Inner region organized in to pyramids contains loops of Henle & collecting ducts that concentrate urine.

Renal Pelvis: Funnel shaped cavity that collects urine from the medulla & channels it in to the ureter. Nephron each kidney has about 1 million nephrons.

Glomerulus: A tuft of capillaries where blood filtration begins.

Bowman's Capsule: Surrounds the glomerulus & collects filtrate.

Tubules: Reabsorb water, ions, nutrients.

Collecting Duct: Final site where urine composition is adjusted before leaving the kidney.

6b. Write a short note on Chronic obstructive pulmonary Disease (COPD) (11)

Ans. The COPD is group of progressive lung disorders primarily emphysema & chronic bronchitis that cause air flow limitation & breathing difficulties. Long term exposure to cigarette smoke, irritating gases, dust, particulate matter indoor air pollution i.e burning fuel for cooking in poorly ventilated homes.

Pathophysiology: In chronic bronchitis the bronchial tubes become inflamed & produce excess mucus. Leading to persistent cough. In emphysema alveoli are damaged & lose elasticity reducing the surface area for gas exchange. The both condns often coexist in COPD patients. Chronic cough with sputum production, wheezing & chest tightness, fatigue & frequent respiratory infections. COPD is a major global health burden ranking among the leading causes of death worldwide.

7a. Write a short note on.

i) Lotus Leaf Effect ii) Shark Skin.

Ans i) Lotus Leaf Effect: The superhydrophobic property observed in lotus leaves, where water droplets bead up & roll off the surface taking dirt particles with them. This effect is due to the micro & nanoscale structures on the leaf's surface & a waxy coating which together create extremely low surface energy. This property is mimicked in biomimetic materials for applications like self cleaning surfaces.

ii) Shark skin or dermal denticles: A unique textured surface covering sharks. It is composed of tiny, tooth-like structures that reduce drag as sharks move through water. This smooth streamlined design not only enhances speed but also reduces drag & turbulence. Inspired by shark skin engineers have developed shark skin surfaces for use in swim wear, aircraft & boats to improve efficiency.

7b. Illustrate the HBO's & PFC's as human blood substitutes

Ans. Hemoglobin Based oxygen (HBO's): Modified hemoglobin to transport oxygen. The purified hemoglobin chemically modified or polymerized hemoglobin. The buffer solⁿ stabilizing agents: The oxygen similar to red blood cells used in cases of blood loss when donor blood is not available.

Perfluorocarbon Emulsions (PFC's): These are synthetic compounds that dissolve large amounts of oxygen. The perfluorocarbon compounds emulsifying agents saline or aqueous solⁿ. It dissolve & transport oxygen physically oxygen is released to tissues by diffusion.

8a. Write a short note on

i) Photovoltaic cells ii) Bionic leaf

Ans i) Photovoltaic Cell (PV): These are semiconductor devices that convert sunlight directly into electrical energy using the photovoltaic effect. When sunlight falls on a PV cell photons excite electrons & create electron-hole pairs. Due to the internal electric field of the PV cell these charges

Move in opposite directions producing an electric current (13)
It consists. Semiconductor material (PN Junction), metallic
Contacts, protective glass covering

ii) Bionic Leaf: It is an artificial system that mimics natural photosynthesis to produce fuel or useful chemicals using sunlight, water, & carbon dioxide. It combines a solar cell with special bacteria that use hydrogen & CO₂ to produce liquid fuels or fertilizers. Thus it converts solar energy into chemical energy efficiently.

8b. Describe the engineering applies of GPS & Velcro technology

Ans: 1) Global Positioning System (GPS): It is a satellite based navigation system that provides location, velocity, time information. The Engg Applies are Civil Engg: Land Surveying, Mapping & site layout.

Transportation Engg: The vehicle tracking, traffic monitoring & fleet management

Aerospace Engg: The aircraft navigation & flight control systems.

Marine Engg: The ship navigation & offshore operations

Disaster Management: To search & rescue operation disaster mapping

2) Velcro Technology: It is a hook & loop fastening system inspired by burr seeds. It was invented by George de Mestral.

Applications:

1) Textile Engg: Fasteners in garments, shoes & sports wear

Biomedical Engg: The Bandages, braces & prosthetic fittings. (14)

Aerospace Engg: Securing tools & Equipment in spacecraft

Automobile Engg: Seat Covers, Interior panels & cable management.

Electronics Engg: The cable bundling & mounting components

Qa. Analyze the bio-engineering solutions for muscular dystrophy & osteoporosis.

Ans: Muscular Dystrophy (MD):

It is group of genetic disorders characterized by progressive muscle weakness due to mutations in muscle protein genes such as dystrophin.

1) Gene Therapy:

- * Introduction of a functional dystrophin gene using viral vector
- * CRISPR: gene editing corrects defective genes.

2) Stem Cell Therapy:

- * Transplantation of myoblasts or mesenchymal stem cells.
- * Stem cells differentiate into muscle fibers & repair damaged tissue
- * Improves muscle regeneration

3) Tissue Engg:

- * Development of biomimetic scaffolds that support muscle cell growth
- * Use of biodegradable polymers & hydrogels
- * Promotes formation of functional muscle tissue

4) Exon skipping Technology:

- * Uses antisense oligonucleotides to skip faulty gene sections
- * Helps produce partially functional dystrophin protein

4) Assistive Bio-devices:

- * wearable exoskeletons & electrical stimulation devices
- * Improve mobility & muscle strength.

Osteoporosis: It is a bone disorder characterized by decreased bone mass & increased fracture risks due to reduced bone mineral density.

1) Bone Tissue Engg:

- * use of biocompatible scaffolds
- * Supports osteoblast growth & bone regeneration
- * 3D printed bone grafts are used for defect repair

2) Stem Cell Therapy:

- * Mesenchymal stem cells stimulate new bone formation.
- * Enhances bone healing & density.

3) Biomaterials & Implants:

- * Bioactive Coatings on implants improve osseointegration
- * Use of titanium & composite biomaterials

4) Drug Delivery Systems:

- * Controlled release of calcium, Vitamin-D & bisphosphonates.
- * Nanotechnology based targeted delivery systems.

Q6. Write a short note on self healing bio-concrete.

Ans. Self healing bio concrete is an advanced construction material that can repair its own cracks automatically using microorganisms. It improves durability & reduces maintenance costs of structures.

Need for Self Healing: Conventional concrete develops cracks due to shrinkage load & temperature changes. It allows water & chemicals to enter causing corrosion of steel reinforcement. The repair & maintenance are costly & time consuming.

Working:

(16)

- Bacteria are mixed in to concrete along with nutrients
- When cracks form & water enters, bacteria become active
- Bacteria convert Calcium lactate in to Calcium carbonate
- The produced $CaCO_3$ fills & seals the cracks.

Advantages:

- Increases lifespan of structures
- Reduces maintenance cost
- Environment friendly
- Improves strength & durability
- Waterproof sealing of cracks.

10a. Examine the bioimaging & artificial intelligence for disease diagnosis.

Ans: Bioimaging Techniques:

- 1) X-ray Imaging: uses electromagnetic radiation to detect fractures, infections & lung diseases
- 2) Computed Tomography (CT): Produces cross sectional images of organs. Helpful in detecting tumors, internal bleeding & stroke.
- 3) Magnetic Resonance Imaging (MRI): It uses magnetic fields & radio waves. Provides detailed images of soft tissues
- 4) Ultrasound: uses high freq sound waves, & also used in pregnancy & abdominal diagnosis.
- 5) PET Scan: It detects metabolic activity & used in cancer & neurological disorders.

Artificial Intelligence in Bioimaging:

- 1) Image Classification & detection: AI detects tumors.

fractures, pneumonia & detects COVID-19 in chest scans during the pandemic. (17)

2) Early Cancer Detection: AI improves accuracy in mammography screening, widely used in breast cancer detection.

3) Brain Disorder Diagnosis: AI analyzes MRI scans to detect Alzheimer's & stroke.

4) Image Segmentation: Identifies boundaries of tumors & organs. It helps in radiation therapy planning.

10b. Explain the process of bioimaging via microbial surface adsorption.

Ans: Process breakdown: in the following :-

1) Selection of microorganisms: Microbes with strong adsorption capacity are chosen. Their cell walls contain functional groups that can bind ions or nanoparticles.

2) Surface Adsorption: Target molecules adhere to microbial surfaces through electrostatic interaction, ion exchange. This creates a stable layer of detectable material on the microbes.

3) Labeling for imaging: Adsorbed substances can be fluorescent, quantum dots or metallic nanoparticles. These labels enhance visibility under imaging techniques such as fluorescence microscopy, electron microscopy or Raman spectroscopy.

4) Visualization: Once labeled microbes act as bioprobes, imaging systems detect the adsorbed markers allowing visualization of microbial distribution, mineral interactions, pollutant localization.