

CBCS SCHEME - Make-Up Exam

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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.	Explain the structure and function of plant cell.	10	L4	CO1
	b.	Discuss briefly about the properties and functions of nucleic acid.	10	L2	CO1
OR					
Q.2	a.	Discuss the classification and application of stem cells in brief.	10	L2	CO1
	b.	Apply the knowledge of lipid molecules use for the production of bio-diesel.	10	L3	CO1
Module - 2					
Q.3	a.	What is bio-bleaching? Explain the role of lignolytic enzymes in bio-bleaching.	10	L2	CO2
	b.	How DNA finger printing technology is applied in forensic applications? Discuss in detail.	10	L3	CO1
OR					
Q.4	a.	Outline the use of whey protein and meat analogues as food supplement. Mention their advantages.	10	L3	CO2
	b.	Illustrate the properties and applications of PHA.	10	L2	CO1
Module - 3					
Q.5	a.	Explain lugs as purification system.	10	L4	CO2
	b.	Describe the following: i) Electro Encephalogram (EEG) ii) Chronic Kidney Disease (CKD)	10	L2	CO2
OR					
Q.6	a.	Illustrate heart as a double pump.	10	L3	CO2
	b.	Write a note on: i) Pacemakers ii) Spirometry	10	L2	CO2
1 of 2					

Module – 4					
Q.7	a.	Distinguish between biological and technological ecolocation. Deliberate its significance in navigation.	10	L4	CO3
	b.	Explain the following : i) Lotus leaf effect ii) Photovoltaic cells	10	L2	CO3
OR					
Q.8	a.	Discuss about engineering application of Velcro technology bio inspired by plant burrs.	10	L2	CO3
	b.	Illustrate the HBOCs and PFCs as human blood substitutes.	10	L3	CO3
Module – 5					
Q.9	a.	Outline the process and materials involved in bio printing.	10	L2	CO4
	b.	Narrate the process of bio mining through microbial surface adsorption.	10	L3	CO4
OR					
Q.10	a.	What are self-healing bio-concrete? Explain the process of self healing mechanism in bio-concrete. Mention its advantages.	10	L2	CO4
	b.	Write a note on : i) Bio-imaging ii) Artificial intelligence for disease diagnosis	10	L1	CO4

Biology for Engineers

BOOK 407

1 @. Structure and functions of a cell.

The cell structure comprises individual components with specific functions essential to carry out life's processes. These components include - cell wall, cell membrane, cytoplasm, nucleus & cell organelles.

Cell membrane :-

It is outer covering of a cell within which all other organelles, such as cytoplasm & nucleus. By structure it is a porous membrane which permits the movement of selective substances in & out of the cell.

Cell wall :-

It is made up of cellulose, hemicellulose & pectin. It protects the plasma membrane & other cellular components.

Cytoplasm :-

It is a thick, clear, jelly-like substance present inside the cell membrane.

Cell organelles	Structure-	Functions.
Cell membrane	A double membrane of lipids & proteins. Present both in plant & animal cells	Provides shape, protects the inner organelles of the cell & acts as a selectively permeable membrane.
Centrosomes	Composed of centrioles & found only in the animal cells	It plays a major role in organizing the microtubule & cell division.
Chloroplasts	present only in plant cells. & green coloured pigment	Sites of photosynthesis
Endoplasmic Reticulum	A network of membranous tubules, present within the cytoplasm of cell	Forms the skeletal framework of the cell.
Golgi apparatus	Membrane-bound, sac-like organelle present within the cytoplasm of the eukaryotic cells	involved in secretion & intracellular transport
Mitochondria	An oval shaped, membrane-bound organelle, also called as powerhouse of the cell.	main site of cellular respiration & involved in storing energy in the form of ATP molecule
Peroxisom	A membrane-bound cellular organelle present in the cytoplasm.	Involved in the metabolism of lipids & catabolism of long-chain fatty acids.

1 (b) Properties and functions of nucleic acids. (2)

Nucleic acids are biopolymers that play a crucial role in the storage & transfer of genetic info. in all living organisms. 2 types are deoxyribonucleic acid (DNA) & ribonucleic acid (RNA).

Function :-

is to transfer of genetic information & synthesis of protein by processes known as translation & transcription.

The monomeric unit of nucleic acid is known as nucleotide & is composed of a nitrogenous base, pentose sugar, & phosphate. The nucleotides are linked by a 3' & 5' phosphodiester bond. The nitrogen base attached to pentose sugar makes the nucleotide distinct.

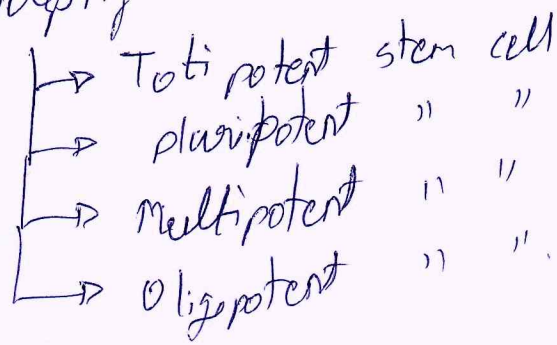
The function of DNA is the transmission of genetic information. It acts as a medium for long-term storage.

RNA is critical for the transmission of the genetic code that is necessary for protein creation from the nucleus to the ribosome.

2 @ Classification of stem cells

- Embryonic stem cell

It contains pluripotent cells that make up the developing foetus.



- Adult stem cell

These stem cells are obtained from developed organs & tissues. They can repair & replace the damaged tissues in the region where they are located.

Induced pluripotent stem cells

These cells have been tested & arranged by converting tissue-specific cells into embryonic cells in the lab.

Mesenchymal stem cells

These cells are mainly formed from the connective tissues surrounding other tissues & organs known as the stroma.

Application of stem cells

- Tissue regeneration
- Treatment of cardiovascular disease.
- Treatment of Brain disease.
- Blood disease treatment.

2 (b) Knowledge of lipid molecules are for the production of bio-diesel.

Lipids can be converted into biodiesel, which is a renewable source of energy. Biodiesel is produced by transesterifying vegetable oils or animal fats with an alcohol, such as methanol, to form methyl esters.

Process of obtaining biodiesel from lipids.

- Raw material preparation.
- Transesterification.
- Separation.
- Washing & drying.
- Purification.
- Final product.

Limitation to the use of lipids as biodiesel, such as higher production costs compared to traditional diesel fuel & the need for more efficient & cost-effective processing methods.

3 @. Bio-bleaching :-
It is a process that uses biological agents, such as enzymes, to remove color & brighten fibers, paper & textiles.

Lignolytic enzyme in bio-bleaching.

Lignolytic enzymes, such as laccases, peroxidases & manganese peroxidases, are used in bio-bleaching to remove color & brighten fibers, paper & textiles.

These enzymes catalyze the oxidation of colored impurities in the fibers, resulting in a brighter & more uniform colour.

- Laccases are copper-containing oxidases that catalyze the oxidation of lignin or a
- Peroxidases are enzymes that use hydrogen peroxide to oxidize organic compounds.

Produced by fungi on bacteria, & are immobilized on a support, such as a ceramic bead or a cellulosic matrix, to ensure stability & prolonged activity.

3 (b) Forensics - DNA fingerprinting.

DNA fingerprinting is a technique used in forensic science to identify an individual based on their unique DNA profile.

Working :-

- Sample collection :- DNA is extracted from a biological sample such as blood, semen or hair. The sample is then purified & processed to isolate the DNA.

- DNA amplification :- The extracted DNA is then amplified using a technique called polymerase chain reaction. PCR produces many copies of a specific DNA region.

DNA analysis :- The amplified DNA is then analyzed using a technique called gel electrophoresis.

DNA comparison:- The DNA profile obtained from the biological sample is then compared to the DNA profiles of other individuals, such as suspect or victims, to determine if there is a match.

4 @ Whey protein as food

Whey protein is a type of protein derived from the liquid that separates from milk during the cheese-making process.

Used as a dietary supplement, particularly by athletes, body builders, & people looking to increase their protein intake.

Several uses of whey protein as food including.

- Weight management.
- Sports nutrition.
- Health promotion.
- Meal replacement.

Meat analogs of protein

(5)

Meat analogs, also known as meat substitutes or meat alternatives, are plant-based foods designed to mimic the taste, texture & appearance of meat. They are made from a variety of ingredients, including soy protein, wheat protein, pea protein & other plant-based ingredients, & are often fortified with vitamins.

Ex :- Tofu, Tempeh, seitan, Veggie burgers, Meatless burgers, meatless meatballs, plant based sauges.

4 (b) Properties of PHA.

→ Biodegradability :- PHAs are biodegradable & can break down into water & CO₂, reducing their impact on the environment.

→ Biocompatibility :- PHAs are biocompatible & can be used in medical devices, such as sutures & implants, without causing adverse reactions in the body.

Mechanical properties:-

PHAs ~~do~~ have similar mechanical properties to traditional petroleum-based plastics, making them suitable for various applications.

Processing:- PHAs can be processed using conventional plastic processing techniques such as injection molding, blow molding, & extrusion.

Application of PHA:

- Packaging
- Medical devices such as sutures, implants etc.
- Textiles - production of biodegradable composites.
- Agricultural mulch films: used on production of biodegradable mulch film.
- Consumer goods: toys, phone cases etc.
- Automotive parts: air ducts, headlamp covers.
- Electronic devices: smartphones & laptops.
- Aerospace: used in the production of biodegradable parts in aerospace applications.
- Sporting goods: golf tees & fishing lures.

5 @ Lungs as purification system :-

6

The lung purifies air by removing harmful substances & adding oxygen to the bloodstream. The process of purifying air in the lungs can be as follows:

→ Filtration :- The nose & mouth serve as a first line of defense against harmful substances in the air, such as dirt, dust & bacteria. The tiny hairs in the nose, called cilia & the mucus produced by the respiratory system trap these substances & prevent them from entering the lungs.

Moisturization :- The air is also humidified as it passes over the moist lining of the respiratory tract, which helps to keep the airways moist & prevent them from drying out.

Gas exchange :-

Once the air reaches alveoli, the gas exchange process occurs, where oxygen diffuses across the thin alveolar & capillary walls into the blood stream, & CO_2 diffuses in the opposite direction from the blood stream into the alveoli to be exhaled.

5 (b). Electroencephalography (EEG)

It is a non-invasive method for measuring the electrical activity of the brain. An EEG records the electrical signals generated by the brain's neurons as they communicate with each other. The signals are recorded through electrodes placed on the scalp & the resulting EEG pattern provides information about the synchronized electrical activity of large populations of neurons.

Application:-

- Diagnosis of epilepsy
- Sleep studies
- Brain computer interfaces
- Research on Brain function
- Diagnosis of brain disorders
- Anesthesia monitoring.
- Monitoring brain activity during Coma.

Chronic Kidney Disease (CKD)

It is a long-term condition in which the kidneys gradually become less able to function properly. Caused due to diabetes, high BP, & other health problems.

Symptoms of CKD are fatigue, swelling in the legs & feet, trouble sleeping, & difficulty concentrating. As the disease progresses, it can lead to more complications, such as anemia, nerve damage, & an increased risk of heart disease & stroke.

Treatment for CKD may include lifestyle changes, such as eating a healthy diet & exercising regularly, as well as ~~is~~ medications to manage symptoms & underlying health conditions.

6@ Heart as a double pump :-

Heart is a single organ, but it acts as a double pump. The first pump carries oxygen-poor blood to your lungs, It then delivers oxygen rich blood back to heart. The second pump delivers oxygen rich blood to every part of ones body.

(8)

Right atrium :- Two large veins deliver oxygen poor blood to right atrium. The superior vena cava carries blood from upper body.

Right ventricle :- The lower right chamber pumps the oxygen poor blood to lungs through the pulmonary artery.

Left atrium :- After the lungs fill blood with oxygen, the pulmonary veins carry the blood to the left atrium.

Left ventricle :- The left ventricle is slightly larger than the right. It pumps oxygen-rich blood to the rest of the body.

6 (b) Pacemakers :-

A pacemaker is a small device that is surgically implanted in the chest to regulate the heartbeat. It is used to treat heart rhythm disorders, such as bradycardia or arrhythmias, by delivering electrical impulses to the heart to regulate its rhythm.

Pacemakers consist of

- Generator :- It contains a battery & electronic circuitry to generate & control the electrical impulses.
- Leads :- leads are thin wires that connect the generator to the heart & carry the electrical impulses from the generator to the heart.
- Electrodes :- These are located at the end of the leads & are used to deliver the electrical impulses to the heart.

6. Spirometry :-

Spirometry is a diagnostic test that measures the function of the lungs by measuring the amount & flow rate of air that can be exhaled. The test is commonly used to diagnose lung conditions such as asthma, chronic obstructive pulmonary disease (COPD), & interstitial lung disease.

By measuring the volume of air exhaled, spirometry can provide info about the functioning of the lungs & the ability of the lungs to move air in & out.

Ex:- A decrease in the volume of air exhaled or a decrease in the flow rate of the exhaled air can indicate a restriction in the airways, which can be a sign of lung condition such as asthma or COPD.

7@

Biological system

Technological system

Sound emission

Biological organisms, such as bats, & cetaceans, have specialized sound emission organs to produce sounds for echolocation.

Technological systems rely on artificial sound emission devices, such as speakers or transducers, to generate sound waves for echolocation.

Bats emit sounds using their larynx & modify the emitted sounds using structures like the nose leaf or mouth cavity.

Ultrasonic sensors or sonar systems emit sound waves through these devices typically using piezoelectric elements or transducers.

Sensory Reception

Biological organisms possess specialized sensory reception organs that allow them to detect & interpret the returning echoes.

Technological systems use sensors & receivers to capture & process the returning echoes.

Bats have highly sensitive ears designed to detect & analyze ultrasonic frequencies.

Ultrasonic sensors are commonly employed, which consist of a transducer that emits sound waves & receives the echoes.

7(b) Lotus leaf effect

(10)

It refers to the ability of lotus leaves to repel water & self-clean through their unique surface structure. This effect has inspired the development of super hydrophobic & self-cleaning surfaces which have a wide range of applications.

The lotus leaf surface has a microscale & nanoscale structure that consists of numerous small bumps & wax-coated hairs. This structure creates a high contact angle between the water droplets & the surface, causing the droplets to roll off & carry away any dirt on debris. This self-cleaning property is due to the lotus leaf's ability to repel water & resist adhesion.

2a. Engg application of velcro technology:-

Clothing and footwear:

Velcro is commonly used in clothing & footwear for closures & adjustable straps. It can be easily opened & closed, making it convenient for users with limited dexterity.

Medical devices:-

Velcro is used in medical devices such as braces, splints & compression garments for its adjustable & secure fastening capabilities.

Aerospace equipment:-

Velcro is used in aerospace equipment, such as satellites & spacecraft, to ensure components are in place & prevent them from vibrating or shifting during launch or flight.

Automotive industry:-

Velcro is used in the automobile industry for a range of applications, such as securing carpets & headliners & attaching door panels & seat cushions.

Packaging industry :-

Velcro is used in reasonable closures on packaging.

in the packaging industry for bags, pouches & other types of (11)

Sports equipment :-

Velcro is used in helmets & gloves.

in sports equipment, such as

8 (b)

HBDCs & PFCs as human blood substitutes.

There are 2 types of human blood substitutes: hemoglobin based oxygen carriers (HBDCs) & perfluorocarbon (PFC).

HBDCs are based on the hemoglobin molecule, which is the protein in red blood cells that carries oxygen to the body's tissues. Hemoglobin is extracted from human or animal blood & then modified to create a stable, synthetic version. When introduced into the body, HBDCs can help to increase the amount of oxygen available to the tissues, which can be.

important in situations where the body is unable to produce or transport enough red blood cells.

PFC are synthetic molecules that are similar in structure to the hemoglobin molecule. However unlike HBCs they do not require modification from natural sources. PFC are ~~available~~ able to dissolve oxygen & transport it throughout the body, similar to the way that red blood cells work.

9@. Process involved in bio printing

Basic steps involved in bio printing process are as follows.

- 1) Preparation of the bioink.
- 2) Design of the tissue structure.
- 3) Printing.
- 4) Incubation.
- 5) Assessment.

The field of bio printing is constantly evolving, & new techniques & materials are being developed to improve the accuracy & reliability of bioprinted tissues & organs.

9 (b) Bio mining through microbial surface adsorption.

Bio mining refers to the use of microorganisms to extract valuable minerals from ore deposits. This process involves the use of microorganisms to dissolve minerals from ore, creating a solution that can be separated & purified to obtain the valuable minerals.

Bio mining is often used in the extraction of metals such as copper, gold & nickel, & has several advantages over traditional minimal methods, including lower energy costs, reduced waste & increased metal recovery.

Application: - Mining operation for metal extraction.

Bio mining via microbial surface adsorption is a process that utilizes microorganisms to remove heavy metals like lead, cadmium, mercury, & arsenic from contaminated environments or ore deposits, respectively.

Bioprinting materials.

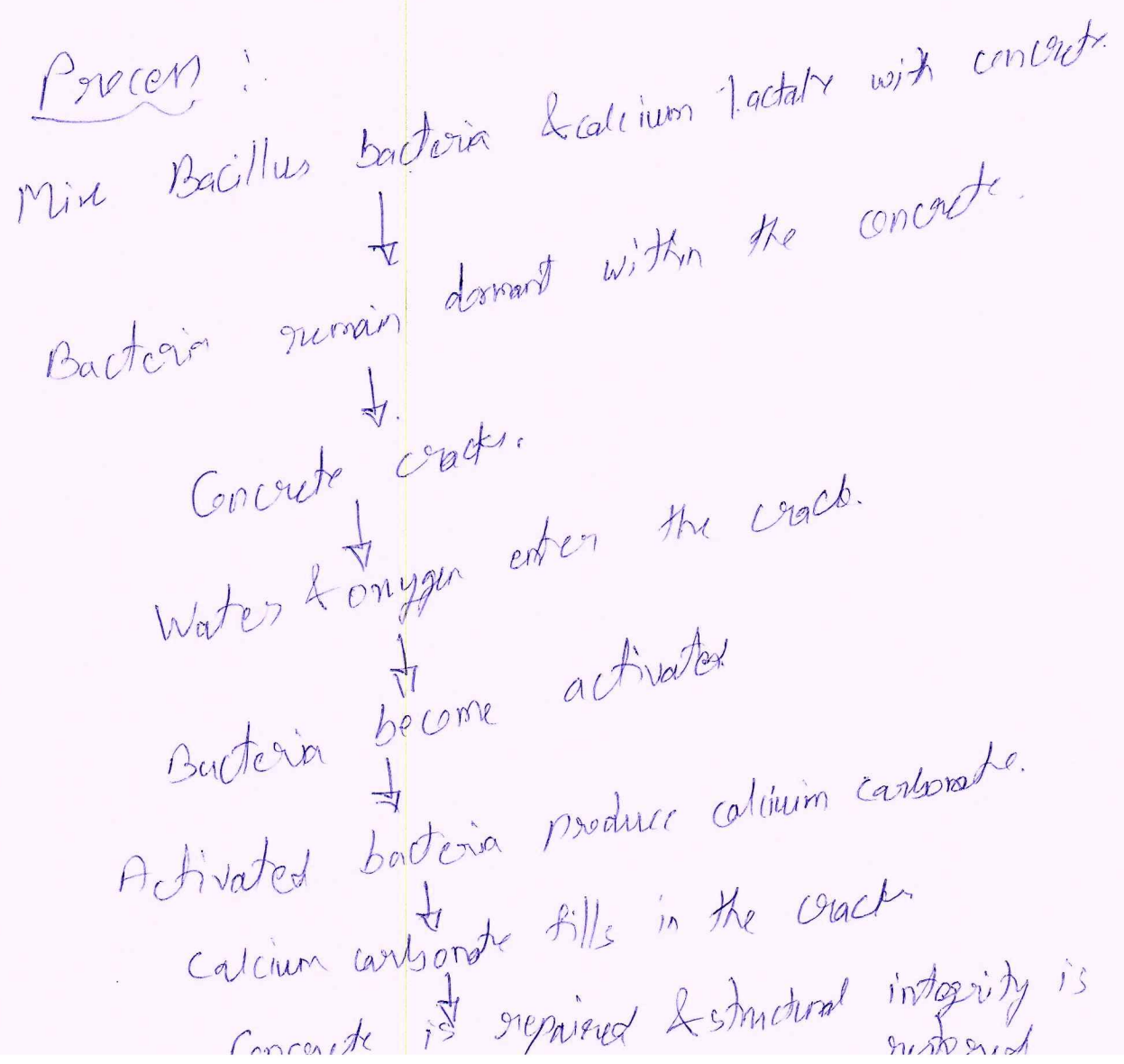
Bioprinting is a rapidly advancing field in which 3-D printing techniques are used to create living tissue & organs for various applications, such as medical research, drug testing & potentially even transplantation. Bioprinting materials play a critical role in the success of bioprinting processes, as they need to be biocompatible, capable of supporting cell growth & differentiation & possess appropriate mechanical properties to mimic native tissues. Commonly used materials are:

- Hydrogels
- Bioinks
- Polymers
- Decellularized Extracellular Matrix (dECM)
- Nanomaterials

10 @ Self-healing bio-concrete.

Self-healing bio-concrete is a type of concrete that incorporates microorganisms such as Bacillus. Lactate is added to the mixture, along with calcium lactate as a nutrient source. The microorganisms are activated when the concrete cracks, & they produce calcium carbonate, which fills in the cracks & repairs the concrete.

Process:



Advantages:-

- Increased durability
- Improved sustainability
- Reduced maintenance costs
- Increased longevity
- New applications
- Reduced carbon footprint

10 (B) Bio imaging :-

Bio imaging involves the use of various imaging techniques to visualise the internal structures & processes of living organisms, including humans. Common bioimaging modalities include X-ray, computer tomography (CT), MRI, ultrasound & molecular imaging techniques such as positron emission tomography (PET) & single photon emission computer tomography (SPECT). Bioimaging provides valuable info about the anatomy, physiology, & function of tissues & organs & is widely used in clinical practice.

for disease diagnosis, monitoring treatment response & guiding surgical interventions. However, the interpretation of bioimaging data can be complex & subjective, & there is a growing need for automated & quantitative analysis methods to improve accuracy & efficiency.

10 (b) Artificial Intelligence for disease diagnosis

Artificial intelligence, particularly ml, learning & deep learning algorithms, can analyze large amounts of data & extract patterns & insights that can aid in disease diagnosis. By training on diverse bioimaging data, AI algorithms can learn to identify disease-specific features, classify different diseases, & predict disease outcomes. AI can also integrate data from multiple imaging modalities & other clinical data to provide a more comprehensive & personalized diagnosis. AI has shown promising results in various medical,

imaging applications, including detection & characterization of tumors, assessment of cardiovascular disease, diagnosis of neurological disorders, & identification of rare diseases.

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