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Internal Assessment Test I & Answer Key – March 2025

Sub:	Biology for Engineers					Sub Code:	BBOC407	Branch:	AI&DS/CSDS
Date:	27-03-2025	Duration:	90 min's	Max Marks:	50	Sem/Sec:	IV / A, B & C		OBE

	Answer any FIVE FULL Questions	MARKS	CO	RBT
1	a. What is a bio-plastic? Give examples. Bioplastics are one type of plastic which can be generated from natural resources such as starches and vegetable oils. Bioplastics are basically classified as bio based and/or biodegradable. Not all bio-based plastics are biodegradable and similarly not all biodegradable plastics are bio based. Bioplastics are referred to as bio based when the focus of the material is on the origin of the carbon building block and not by where it ends up at the end of its cycle life. Bio plastics are said to be biodegradable if they are broken down with the effect of the right environmental conditions and microbes which in turn use them as a food source. The bioplastics are considered compostable if within 180 days, a complete microbial assimilation of the fragmented food source takes place in a compost environment. Based upon this, we have PHA and PLA. PLA is both: biobased and biodegradable under industrial composting conditions (at a high temperature, around 58 °C). Because of its good mechanical properties, processability, renewability, and non-toxicity, PLA is considered today as one of the most commercially promising bioplastics. When compared with most other biodegradable polymers, PLA has better durability, transparency, and mechanical strength. PHAs are a significant polymer family that are 100% bio-based and bio-degradable. PHAs are microbiologically produced polyesters that have tunable physical and mechanical properties. This is accompanied by low environmental impact due to their biodegradability and non-toxicity nature. Therefore, they are promising candidates for a sustainable future manufacturing. Ranging from brittle thermoplastics to gummy elastomers, PHAs' properties can be altered by the selection of bacteria, fermentation conditions, and substrate. Due to their flexible properties, PHAs can eventually substitute PP, polyethylene (PE), and polystyrene (PS), which are the main polymers of today's global polymer market. b. Mention the differences between plant cell and animal cells.' **Plant Cells:** Cell Wall: A rigid outer layer made of cellulose that provides support and protection. Chloroplasts: Organelles that contain chlorophyll and enable photosynthesis. Large Central Vacuole: A large storage organelle that helps maintain cell shape and stores water and nutrients. Other Plastids:	5 5	CO1	L2

	May contain other types of plastids like leucoplasts and chromoplasts for storage or pigment production. Plasmodesmata: Channels that connect the cytoplasm of adjacent plant cells, allowing for communication and transport. **Animal Cells:** No Cell Wall: Only have a cell membrane, which is a flexible outer boundary. No Chloroplasts: Do not perform photosynthesis. Small Vacuoles: May have small vacuoles, but no large central vacuole. Centrioles and Centrosomes: Involved in cell division and the organization of the cytoskeleton. Lysosomes: Contain enzymes for breaking down waste and cellular debris.			
2	a. What are cells? Give examples. ● It is the fundamental unit of life. ● It represents the smallest structural and functional entity of living organism. Cells are the basic units of life. They are Classified as prokaryotic and eukaryotic cells (membrane bound cells). ● **Cell Components** • ***Cell Membrane*** : It surrounds the cell. It regulates entry and exit of any substance. It is semi permeable, water and air can pass through it. It acts as protective cover. • ***Nucleus*** (present in Eukaryotic Cells) : It contains genetic material like DNA. Its known as "**brain**" of cell since it controls all activities of the cell. • ***Cytoplasm*** : It is gel like substance present inside cell membrane. It has organelles and it helps them to float and also holds them. • ***Organelles*** : They are specialized structure, with specific functions Example- Mitochondrion produces energy in a cell.	5 5	CO1	L2

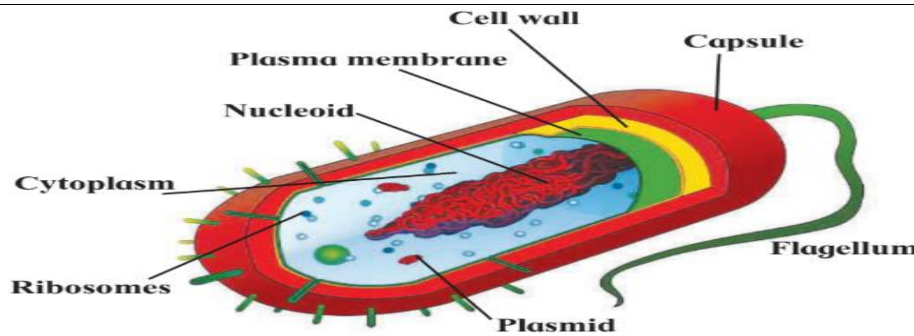

Fig 1. Schematic of A Prokaryotic Cell

- ✓ As in figure 1, cells do not have well defined nucleus but only nucleoid is present, looks like bacteria with long tail and shape.
- ✓ Cytoplasm , Cell wall and cell membrane present.
- ✓ Capsule like Nucleoid is present.
- ✓ Organelles like Plasmid, Ribosomes are present.

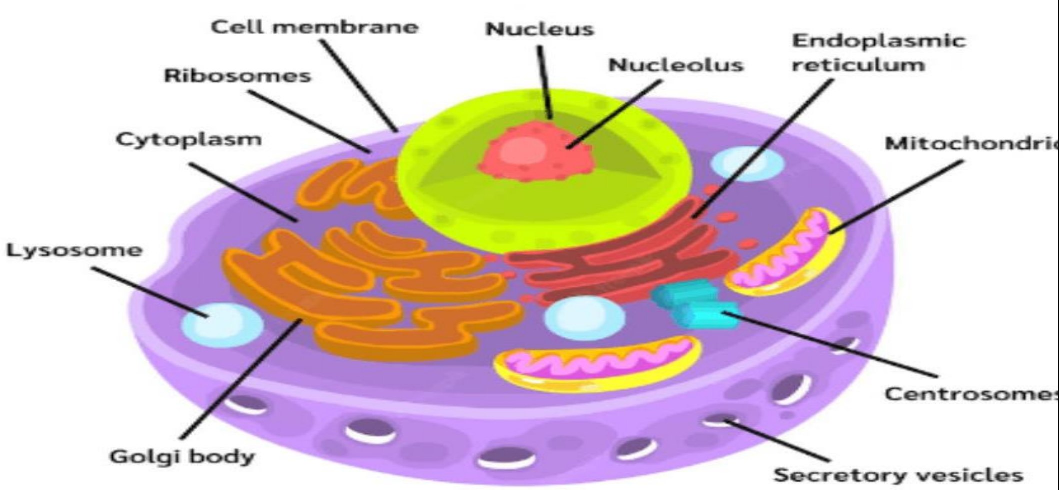

Fig 2. Schematic of A Eukaryotic Cell

- ✓ As shown in figure 2, cells have well defined nucleus and has complex structure.
- ✓ Its slightly oval in shape.

b. What are stem cells? Explain the classification and application of stem cells.

- Stem cells are unique cells.
- They have the ability to develop into various specialized cell types (cells in heart, kidney, eyes are all different).
- They play very crucial role in growth, mainly tissue repair.

Types

1. *Embryonic Stem Cells*

- ◆ These are derived from embryo.
- ◆ They have potential to become any body cells and forms.
- ◆ For example, these cells can become heart cells and tissues or they can become kidney cells and so on.

- After fertilization, within 3 days the healthy embryo is formed and it will contain upto 6 to 10 embryo cells as in figure 3.

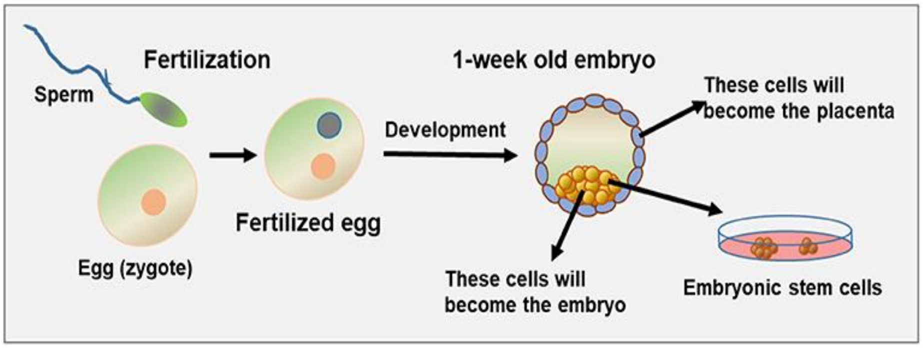

Figure 3. Embryonic Stem Cells

- Within a week a fertilized egg is formed and its called ***Blastocyst***.
- From embryo, cells are separated and stored, for research purpose.

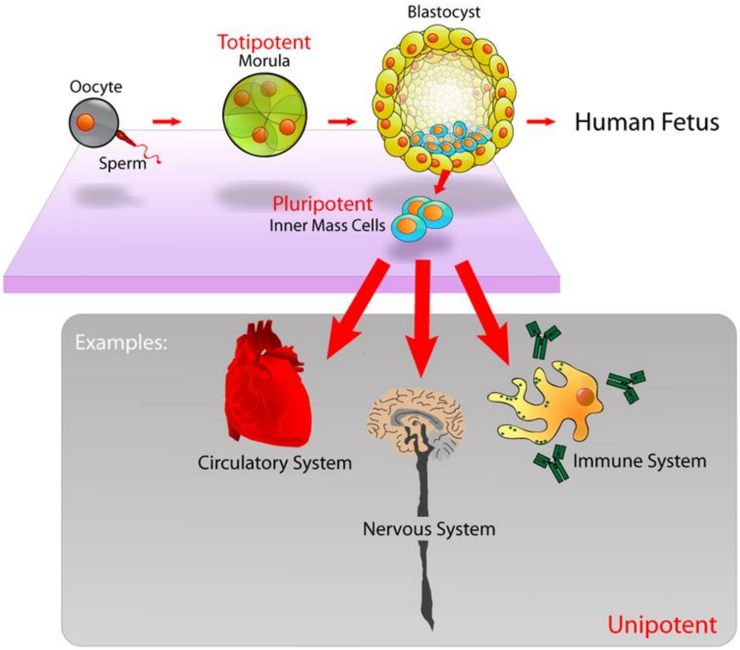

Figure 4. Examples of Embryonic Stem Cells

2. *Adult or Somatic Stem Cells*

- These cells are found in various tissues.
- These cells are obtained from specialized organelles and are adult/ grown up cells.
- If cells are taken from brain, then they become Brain Somatic stem cells, if taken from heart, they become heart somatic stem cells.
- Each cells perform their particular role.
- They can be used to replace damaged cells in organs accordingly.

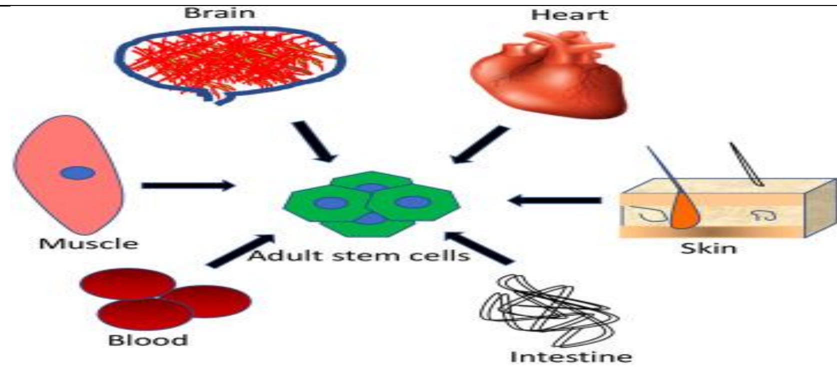

Figure 5. Somatic Stem Cells

3	a. Differentiate between Prokaryotic and Eukaryotic cells.	5	CO1	L4

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Feature	Prokaryotic Cells	Eukaryotic Cells
Type of Cell	Prokaryotic cells are always single-celled organisms.	Eukaryotic cells can be single-celled or multicellular.
Cell Size	They are small, usually between 0.2 µm and 2.0 µm.	These cells are larger, typically 10 µm to 100 µm.
Cell Wall	Prokaryotic cells have a cell wall with a complex structure.	Eukaryotic cells may have a cell wall, but it is simpler.
Nucleus	They do not have a nucleus; instead, DNA is in a nucleoid region.	They have a well-defined nucleus containing the DNA.
Ribosomes	Ribosomes are smaller in size and scattered in the cytoplasm.	Ribosomes are larger and more structured.
DNA Structure	The DNA is circular and floats freely in the cell.	The DNA is linear and found inside the nucleus.
Mitochondria	Mitochondria are not present in these cells.	Mitochondria are present and help in energy production.
Cytoplasm	The cytoplasm is present, but it does not have organelles.	Cytoplasm contains organelles with specific functions.
Endoplasmic Reticulum	These cells do not have an endoplasmic reticulum.	These cells have an endoplasmic reticulum.
Plasmids	Small DNA molecules called plasmids are commonly found.	Plasmids are very rare in these cells.

Lysosome	Lysosomes are not found in prokaryotic cells.	Lysosomes are present in these cells.
Cell Division	Prokaryotic cells divide by binary fission.	Eukaryotic cells divide through mitosis.
Flagella	The flagella are small and simple in structure.	The flagella are larger and more complex.
Reproduction	Reproduction is always asexual in prokaryotic cells.	These cells can reproduce asexually or sexually.
Examples	Examples include bacteria and archaea.	Examples include plants, animals, fungi, and protozoa.

b. Explain the functions of Vitamins.

1. Energy Production:
Vitamins like B1, B2, B3, B5, B6, B7, B9, and B12 are crucial for converting food into energy, supporting metabolism and proper nerve function.
These B vitamins also play a vital role in energy production at the cellular level, helping cells get the energy they need to function.
2. Immune System Support:
Vitamins C and D are well-known for their role in boosting the immune system, helping the body fight off infections and illnesses.
Other vitamins like E, A, and B vitamins also contribute to immune function.
3. Cell Growth and Development:
Vitamin A is essential for vision, skin health, and immune function, while vitamin D is important for bone growth and development.
Folate (vitamin B9) and vitamin B12 are needed for red blood cell formation and nerve function, supporting growth and development.
4. Antioxidant Protection:
Vitamins C and E act as antioxidants, helping to protect cells from damage caused by free radicals, which can contribute to aging and chronic diseases.
These antioxidants neutralize free radicals, preventing damage to cells and tissues.
5. Other Important Functions:
Blood Clotting:
Vitamin K is essential for blood clotting, preventing excessive bleeding.
Bone Health:
Vitamin D and K are needed for strong bones and teeth, along with calcium absorption.
Skin Health:
Vitamins A, C, and E are important for maintaining healthy skin and preventing damage.
Nerve Function:
B vitamins are crucial for nerve function, including brain health and cognitive function

4	a. Explain the RNA vaccine structure for COVID 19.	5	CO2	L2

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus. Messenger RNA, or mRNA technology, instructs cells to make a protein that generates an immune response in the body, thus producing the antibodies that provide protection against a disease. It is the basis for the Pfizer/BioNTech and Moderna COVID-19 vaccines being used by governments worldwide, and in the UN-supported COVAX global vaccine solidarity initiative. Messenger ribonucleic acid (mRNA) is a molecule that provides cells with instructions for making proteins. mRNA vaccines contain the instructions for making the SARS-CoV-2 spike protein. This protein is found on the surface of the virus that causes COVID-19.

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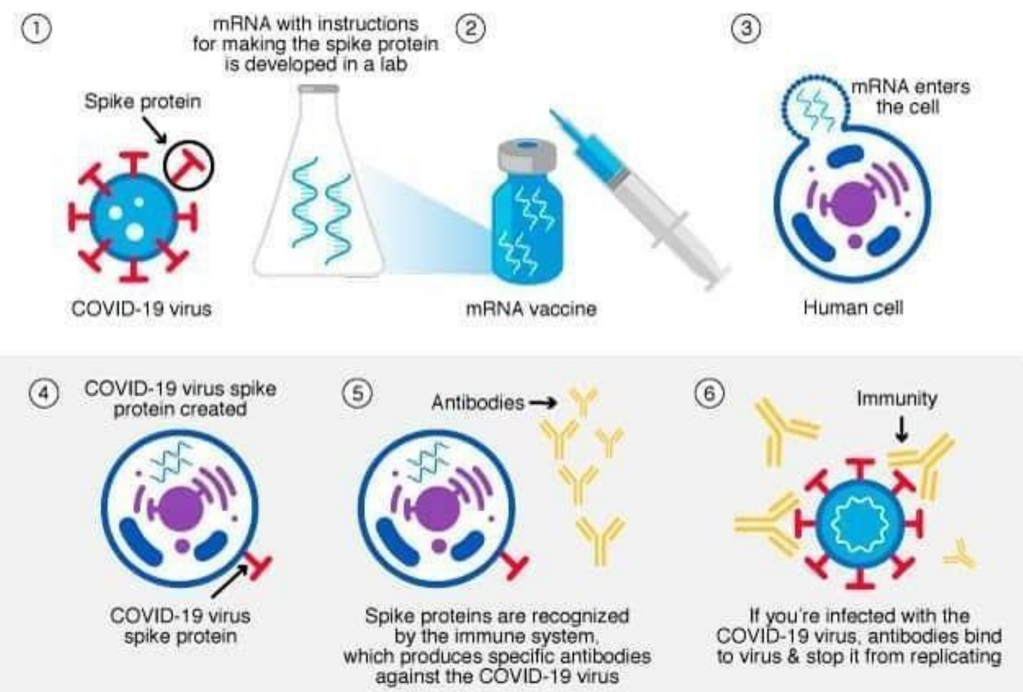
The mRNA molecule is essentially a recipe, telling the cells of the body how to make the spike protein. COVID-19 mRNA vaccines are given by injection, usually into the muscle of the upper arm. After the protein piece is made, the cell breaks down the instructions and gets rid of them. The mRNA never enters the central part (nucleus) of the cell, which is where our DNA (genetic material) is found. Your DNA can't be altered by mRNA vaccines.

The cell then displays the protein piece on its surface. Our immune system recognizes that the protein doesn't belong there and begins building an immune response and making antibodies.



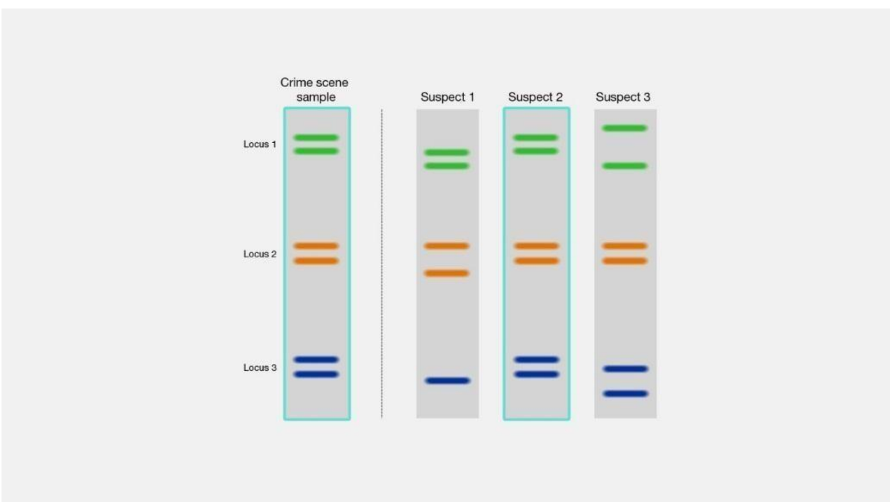
b. Briefly explain the role of DNA in fingerprinting and forensic science.

DNA fingerprinting, also called DNA typing, DNA profiling, genetic fingerprinting, genotyping, or identity testing, in genetics, method of isolating and identifying variable elements within the base-pair sequence of DNA (deoxyribonucleic acid).

The procedure for creating a DNA fingerprint consists of first obtaining a sample of cells, such as skin, hair, or blood cells, which contain DNA. The DNA is extracted from the cells and purified, the DNA was then cut at specific points along the strand with proteins known as restriction enzymes. The enzymes produced fragments of varying lengths that were sorted by placing them on a gel and then subjecting the gel to an electric current (electrophoresis): the shorter the fragment, the more quickly it moved toward the positive pole (anode).

The sorted double-stranded DNA fragments were then subjected to a blotting technique in which they were split into single strands and transferred to a nylon sheet. The fragments underwent autoradiography in which they were exposed to DNA probes—pieces of synthetic DNA that were made radioactive and that bound to the minisatellites. A piece of X-ray film was then exposed to the fragments, and a dark mark was produced at any point where a radioactive probe had become attached. The resultant pattern of marks could then be analyzed.
The DNA testing process is comprised of four main steps, including extraction, quantitation, amplification, and capillary electrophoresis.

DNA fingerprinting is a laboratory technique used to determine the probable identity of a person based on the nucleotide sequences of certain regions of human DNA that are unique to individuals. Forensic genetic fingerprinting can be defined as the comparison of the DNA in a person's nucleated cells with that identified in biological matter found at the scene of a crime or with the DNA of another person for the purpose of identification or exclusion. The application of these techniques introduces new factual evidence to criminal investigations and court cases.



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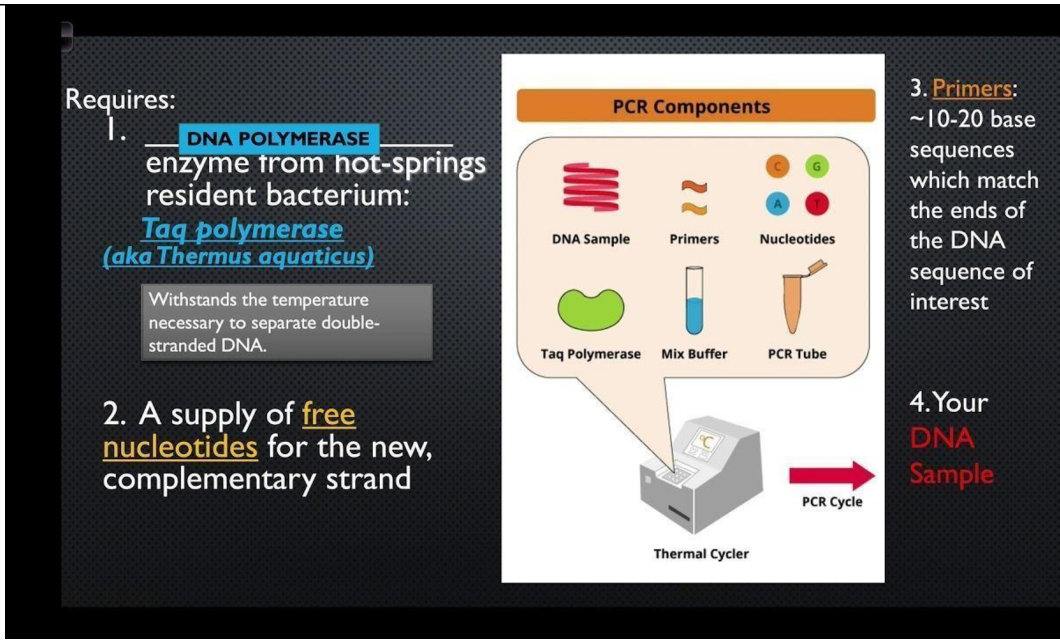
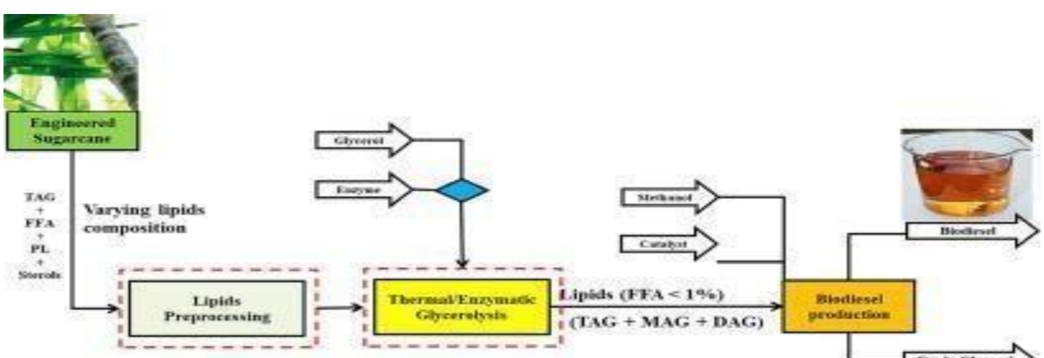


COURTESY: FORENSIC SCIENCE

DNA FINGERPRINTING

So, this is all about nucleic acids, considering the two main nucleic acids, that is, DNA and RNA, discussing about some of the most important applications of these nucleic acids.

5	a. Define biodiesel. Write an explanatory note on biodiesel.	5	CO2	L2
	Lipid obtained from food waste was used as a potential feedstock for biodiesel production using both a chemical catalyst and a biocatalyst. Base (KOH) catalyzed transesterification of the lipid allowed a 100% conversion of biodiesel in 2 h; whereas, Novozyme-435 yielded 90% biodiesel in 24 h. So lipids are having a main application in bidiesel production. Biodiesel demonstrates an animal fat-based or vegetable oil diesel fuel, including long-chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel is generally made by esterifying lipids (e.g., soybean oil, vegetable oil, and animal fat (tallow)) with an alcohol generating fatty acid esters. Biodiesel is suggested to be utilized in standard diesel engines and is thus well defined from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used singly or blended with gasoline in any proportions. Biodiesel blends can also be utilized as heating oil.	5		



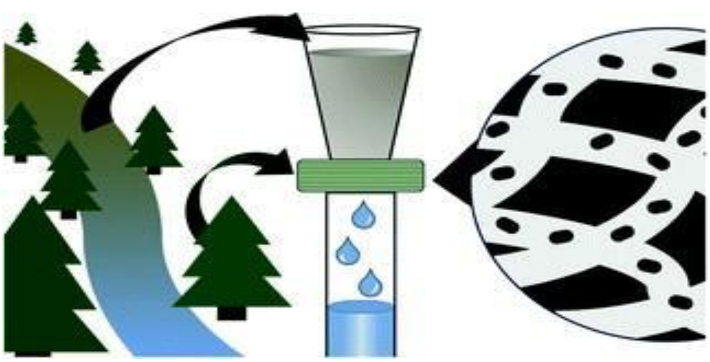
	b. What are lipids? Briefly explain the different types of lipids. Discussing about another important biomolecule, lipids, are a broad group of naturally occurring molecules which includes fats, waxes, sterols, fat-soluble vitamins (such as vitamins A, D, E and K), monoglycerides, diglycerides, phospholipids, and others. The functions of lipids include storing energy, signaling, and acting as structural components of cell membranes. Lipids have applications in the cosmetic and food industries, and in nanotechnology. Lipids may be broadly defined as hydrophobic or amphiphilic small molecules; the amphiphilic nature of some lipids allows them to form structures such as vesicles, multilamellar/unilamellar liposomes, or membranes in an aqueous environment. Biological lipids originate entirely or in part from two distinct types of biochemical subunits or "building-blocks": ketoacyl and isoprene groups.Using this approach, lipids may be divided into eight categories: fatty acyls, glycerolipids, glycerophospholipids, sphingolipids, saccharolipids, and polyketides (derived from condensation of ketoacyl subunits); and sterol lipids and prenol lipids (derived from condensation of isoprene subunits). A biological membrane is a form of lamellar phase lipid bilayer. The formation of lipid bilayers is an energetically preferred process when the glycerophospholipids described above are in an aqueous environment.This is known as the hydrophobic effect. In an aqueous system, the polar heads of lipids align towards the polar, aqueous environment, while the hydrophobic tails minimize their contact with water and tend to cluster together, forming a vesicle; depending on the concentration of the lipid, this biophysical interaction may result in the formation of micelles, liposomes, or lipid bilayers. Other aggregations are also observed and form part of the polymorphism of amphiphile (lipid) behavior. Some of the applications are: Within the body, lipids function as an energy reserve, regulate hormones, transmit nerve impulses, cushion vital organs, and transport fat-soluble nutrients. Fat in food serves as an energy source with high caloric density, adds texture and taste, and contributes to satiety. Lipid obtained from food waste was used as a potential feedstock for biodiesel production using both a chemical catalyst and a biocatalyst. Base (KOH) catalyzed transesterification of the lipid allowed a 100% conversion of biodiesel in 2 h; whereas, Novozyme-435 yielded 90% biodiesel in 24 h. So lipids are having a main application in bidiesel production. **Biodiesel** demonstrates an animal fat-based or vegetable oil diesel fuel, including long-chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel is generally made by esterifying lipids (e.g., soybean oil, vegetable oil, and animal fat (tallow)) with an alcohol generating fatty acid esters. Biodiesel is suggested to be utilized in standard diesel engines and is thus well defined from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used singly or blended with gasoline in any proportions. Biodiesel blends can also be utilized as heating oil.			
6	a. Write a brief note on cellulose based water filters. The interest in the use of biobased filters for water purification has increased in recent years, as such filters have the potential to be affordable, lightweight and biodegradable. Research has been focused on creating biobased membranes for micro- and ultrafiltration from cellulose nanofibrils (CNFs).	5 5	**CO2**	**L2**

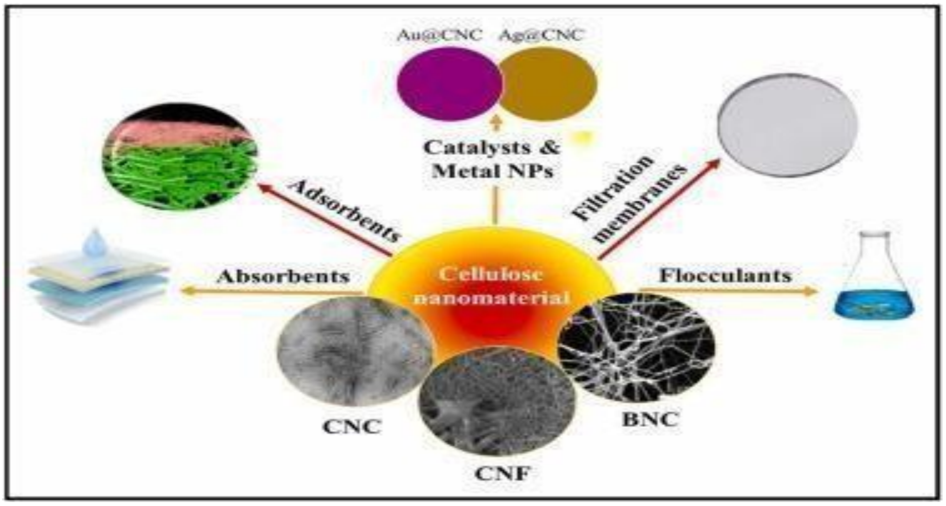
Filters based on cellulose pulp fibers do usually have large pores that facilitate water percolation but they do not sufficiently remove bacteria through size exclusion; other techniques are therefore needed to achieve a bacteria-reducing effect. Several groups have addressed this issue by incorporating antibacterial metal nanoparticles into cellulose-based water filters; both silver nanoparticles (AgNPs) and copper nanoparticles (CuNPs) are known to have good antibacterial effects.
An alternative method to physically remove bacteria from water, while keeping the filter pore size larger than bacteria, is to use positively charged filters that adsorb negatively charged bacteria onto the surfaces of the filters.

This allows negatively charged particles much smaller than the filter pore size to be efficiently removed from water and this is an interesting approach for removing bacteria from water without adding any toxic chemicals or reducing the flow by reducing the pore size. Both Gram-positive and Gram-negative bacteria have a negative net surface charge on the cell envelope, due to peptidoglycans, liposaccharides and proteins in the cell wall, and this makes their removal non-selective and efficient for most types of bacteria.
Methods used for the same are:

- LBL [Layer By Layer] MODIFICATION
- NITROGEN ANALYSIS
- SEM [Scanning Electron Microscope]
- FLOW RATE FOR FREE FLOW FILTRATION
- BACTERIAL REMOVAL EFFICIENCY OF FILTRATION
- FILTRATION OF NATURAL WATER SAMPLES
- FLOURESCENCE MICROSCOPY

Cellulose filter papers are versatile and diverse tools for microfiltration, that work by trapping particulates within a random matrix of cellulose fibers. Cellulose filter papers can be categorized as quantitative or qualitative, depending on their application.



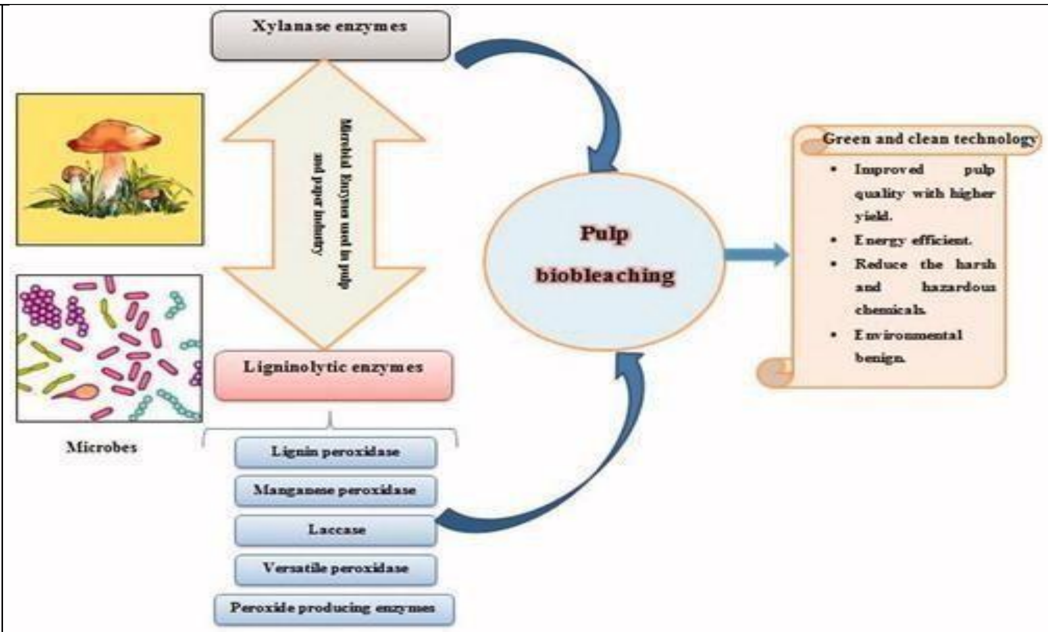


b. Define Biosensor. Explain the functions of lignolytic enzymes in bio-bleaching.

Biosensors are employed in applications such as disease monitoring, drug discovery, and detection of pollutants, disease-causing micro-organisms and markers that are indicators of a disease in bodily fluids (blood, urine, saliva, sweat). Various types of biosensors being used are enzyme-based, tissue-based, immunosensors, DNA biosensors, and thermal and piezoelectric biosensors. There are wide variety of enzymes used in biosensors. One such enzyme is glucose oxidase, mainly in amperometric glucose biosensor.

Ligninolytic enzymes play a key role in degradation and detoxification of lignocellulosic waste in environment. The major ligninolytic enzymes are laccase, lignin peroxidase, manganese peroxidase, and versatile peroxidase.
Ligninolytic fungi and enzymes (i.e., laccase, manganese peroxidase, and lignin peroxidase) have been applied recently in the production of second-generation biofuels.

White-rot fungi are the main producers of lignin-oxidizing enzymes. These fungi secrete a number of oxidative enzymes and some hitherto unknown substances (mediators) into their environment together effecting a slow but continuous degradation. The most important lignin-oxidizing enzymes are lignin peroxidases, manganese peroxidases and laccases. Lignin peroxidase and manganese peroxidase appear to constitute a major component of the ligninolytic system.

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