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Internal Assessment Test - I

Sub:	**BIOLOGY FOR ENGINEERS**							Code:	BBOC407
Date:		Duration:	90 mins	Max Marks:	50	Sem:	4th	Branch:	Common for CSE

Answer **Any FIVE FULL** Questions

		Marks	OBE	
			CO	RBT
1	Discuss the various components of Eukaryotic cells.	10	CO1	L3
2	a. Explain the properties of carbohydrates b. Explain the functions of lipids	5+5	CO1	L2
3	what are the stem cells? Explain the classification and application of stem cell.	10	CO1	L2
4	Highlighting the properties of cellulose, justify cellulose as an effective water filter.	10	CO1	L3
5	What are bioplastics? Justify the use of PLA as bioplastic mentioning its properties and applications.	10	CO1	L3
6	Explain about the properties and applications of PLA	10	CO1	L2
7	Explain the working and development of RNA vaccines by taking suitable example.	10	CO1	L2

CI **CCI** **HoD**

1.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.

✔ As in figure , 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.

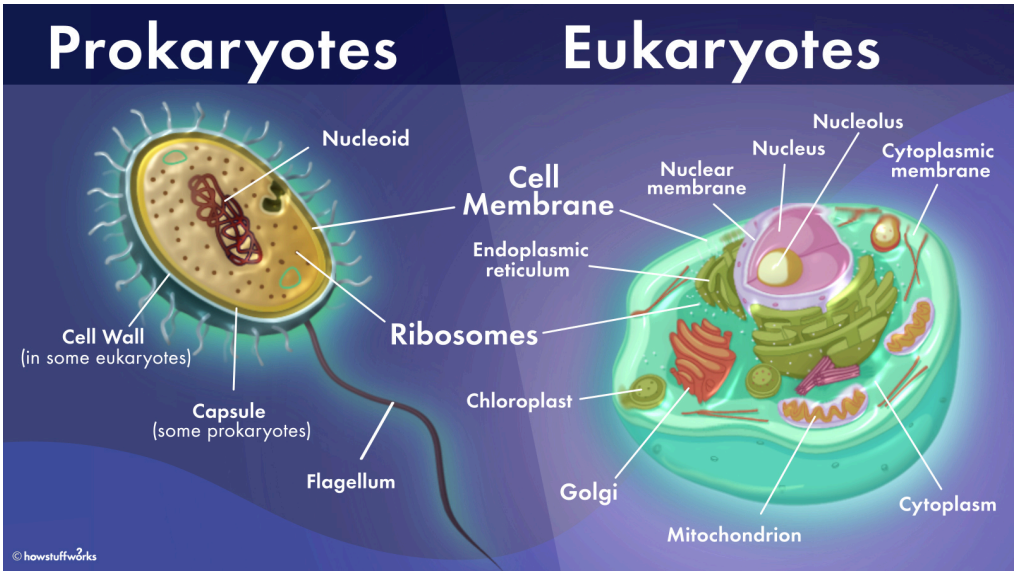


Fig . Schematic of A Eukaryotic Cell

✔ As shown in figure 2, cells have well defined nucleus and has complex structure.

✔ Its slightly oval in shape.
✔ It has Ribosomes, Endoplasmic reticulum, Mitochondrion, Centrosomes, Golgi body, Lysosome.

Functions of a cell.

● Cellular Respiration :
✔ Means generation of energy.
✔ The Mitochondrion, generates energy in the form of Adinosine Tri Phosphate (ATP), through cellular respiration.
✔ It is a process of producing energy by cell.
● Photosynthesis (in Plant Cells) :
✔ Process of generating food by cells present in plant leaves.
✔ Plants absorb water from soil using roots, which gets transferred to leaves.
✔ Leaves contain specialized cells called CHLOROPLAST that converts sunlight into glucose.
● DNA Replication and Cell Division :

✔ The Nucleus (Eucrayotic) having DNA has this process.
✔ DNA produces single strand, that will grow into double strand and replicates it.
✔ Replication and division of cell is controlled by cell for the purpose of growth in animals.
● Protein Synthesis :
✔ Ribosomes synthesis proteins using the feed (genetic information) given by nucleus.
✔ Proteins are generated in cells and are very essential for any animal.
✔ Type of protein to be generated in cell is decided by genetic information or DNA.
✔ Based on requirement proteins are synthesized or supplied.

2.a. CARBOHYDRATES
● These are class of organic compounds.
● They play crucial role in biology and are important energy source.
● They are composed of carbon (C), hydrogen (H), and oxygen (O) atoms and are classified based on their molecular structure and function.
Functions
1. Energy Source :
● Primary Role : Carbohydrates serve as a primary source of energy for living organisms.
● Conversion : Monosaccharides (particularly Glucose) are broken down through the process called cellular respiration which generates ATP.
● ATP’s are the universal energy currency of cells. They power the essential actions like muscle contraction.

2. Energy Storage:
● Glycogen (in Animals): Excess glucose is stored in the form of glycogen in animals, primarily in the liver and muscles.
◆ If energy is required by body Glucogen can be broken down to form glucose.
● Starch (in Plants): Plants store surplus glucose as starch in various plant tissues like seeds and fruits, which serve as energy reserve.
3. Structural Support:
● Cellulose (in Plants): These are complex Carbohydrates. They contribute to provide structural rigidity (plants stand straight and maintain their shape).
◆ They provide structural support to plant cell walls through the formation of cellulose

4. Transport of Energy:
● Sucrose : Carbohydrates like sucrose facilitate the transport of energy in the form of sugars within plants.
◆ It is synthesized in leaves & then transported in plants to provide energy to plants.
5. Quick Energy Release:
● Glucose: It is readily available energy. Rapid breakdown of glucose (through cellular respiration) provides quick energy for cellular processes.
6. Metabolic Regulation:
● Blood Sugar Regulation: Carbohydrates play a vital role in regulating blood sugar levels by controlling release of glucose in blood, ensuring a steady energy supply.
◆ Fibres also help in regulating blood sugar levels.

b. Lipids are a group of organic compounds that include fats, oils, waxes, and some hormones.
● They form membrane structure.
● Our body has 70% water.

Figure 13. Lipids

● Head of Lipid has interaction with water molecules where as tail does not..
● Non Polar come together to form a spherical or other structure as

3. Stem Cell
● 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

Applications
● Regenerative Medicine : Stem cells are used to regenerate damaged tissues & organs.
1. Tissue Repair
2. Orthopedic Treatments : Joint and bone regeneration

● Treatment of Diseases
1. Blood Disorders : treating Anaemia, leukemia by replacing blood cells.
2. Neurological Disorders : In Parkinson and Alzheimer diseases.
● Drug Development and Testing : For testing new drugs before using on animals.
● Understanding Disease Mechanisms : In labs and controlled manner, diseases and their spread and control, can be studied using stem cells.
● Cell-Based Therapies : To address various medical conditions and treating a particular malignant cell to stop spreading of disease.
● Personalized Medicine : Tailoring treatments based on personalized traits and genetics and characteristics.
Challenges
● Controlling Cell Differentiation : ensure precise control of differentiation of stem cells into specific stem cells.
● Genetic Stability : Maintaining stability during their growth, so that mutation / abnormalities does not happen.
● Tumor Formation : Potential of stem cells to form tumors to be addressed.
● Immunological Rejection : In some treatments body may not accept stem cells injected in / may be bio incompatible, this called immunology rejection.

4. Cellulose: a complex carbohydrate, or polysaccharide, consisting of 3,000 or more glucose units.
It is extremely abundant, easily renewable, and biodegradable. Due to inter- and intramolecular hydrogen bonding between the hydroxyl groups of the neighboring cellulose chains, cellulose is insoluble in water, despite being hydrophilic, and is difficult to dissolve with common organic solvents.

Taking benefit of these advantages of cellulose, we have a best application of cellulose, that is, 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).
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.

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.

Properties of cellulose-based water filter Cellulose-based water filters have several properties that make them an attractive choice for water filtration:

- A renewable resource, cellulose
- reducing the dependency on non-renewable resources.
- Good mechanical strength
- To maintain their structure and perform effectively over time
- resistant to most chemicals, including acids and bases,
- water treatment applications

- high porosity structure
- remove impurities and contaminants from water
- made from a biodegradable material, cellulose
- reduces their impact on the environment compared to synthetic polymer filters
- more affordable than traditional synthetic polymer filters
- making them accessible to a wider range of consumers and communities.

Large surface area:

- large surface area, which enhances their filtration capabilities
- reduces the frequency of filter replacement.
  - Safe and clean water: Cellulose-based water filters effectively remove impurities and contaminants from water, making it safer and more potable for various applications, including household, industrial, and agricultural use.
  - Sustainability: Cellulose-based water filters are made from a renewable resource, cellulose, and are biodegradable, reducing their impact on the environment and promoting sustainability in water treatment processes.
  - Affordability: Cellulose-based water filters are often more affordable than traditional synthetic polymer filters, making them accessible to a wider range of consumers and communities, especially in developing countries.
  - Versatility: Cellulose-based water filters can be used in various types of filtration systems and can be produced in different sizes and shapes to fit specific needs.
  - Alternative to synthetic filters: Cellulose-based water filters provide an environmentally friendly alternative to traditional synthetic polymer filters, reducing the dependency on non-renewable resources and reducing waste.

Construction of cellulose-based water filters involves the following steps:

1. Cellulose Material Selection: The type of cellulose material used in the water filter will depend on the desired properties such as strength, porosity, and chemical resistance. Common cellulose materials include paper, cotton, and wood fibers.
2. Cellulose Preparation: The cellulose material is prepared by cutting it into small pieces, washing it to remove impurities, and drying it for use.
3. Cellulose Layer Formation: The cellulose material is formed into a layer by either stacking it or compacting it using heat and pressure.
4. Filter Medium Attachment: The cellulose layer is attached to a filter medium such as a mesh or a support structure to provide stability and increase the filter surface area.

Chemical Treatment: The cellulose layer may be chemically treated to modify its properties, such as increasing its hydrophilicity or adding antimicrobial agents.

6. Housing Assembly: The filter medium is assembled into housing that provides a means to attach it to a water source and to collect the filtered water.

7. Filter Testing: The completed filter is tested to ensure that it meets the desired specifications, such as filtration efficiency and flow rate.

- Cellulose acetate is a synthetic form of cellulose that has properties such as good chemical resistance, high porosity, and high flow rate, making it suitable for use in household water filters.

6. POLY LACTIC ACID [PLA] AND POLYHYDROXYALKANOATES [PHA]:
Just like, how we introduced biodegradable water treatment plant from cellulose, we also have a replacement for toxic, non-biodegradable plastics which we are using in our daily life. That is, Bioplastics.
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.

Production of biopolymers

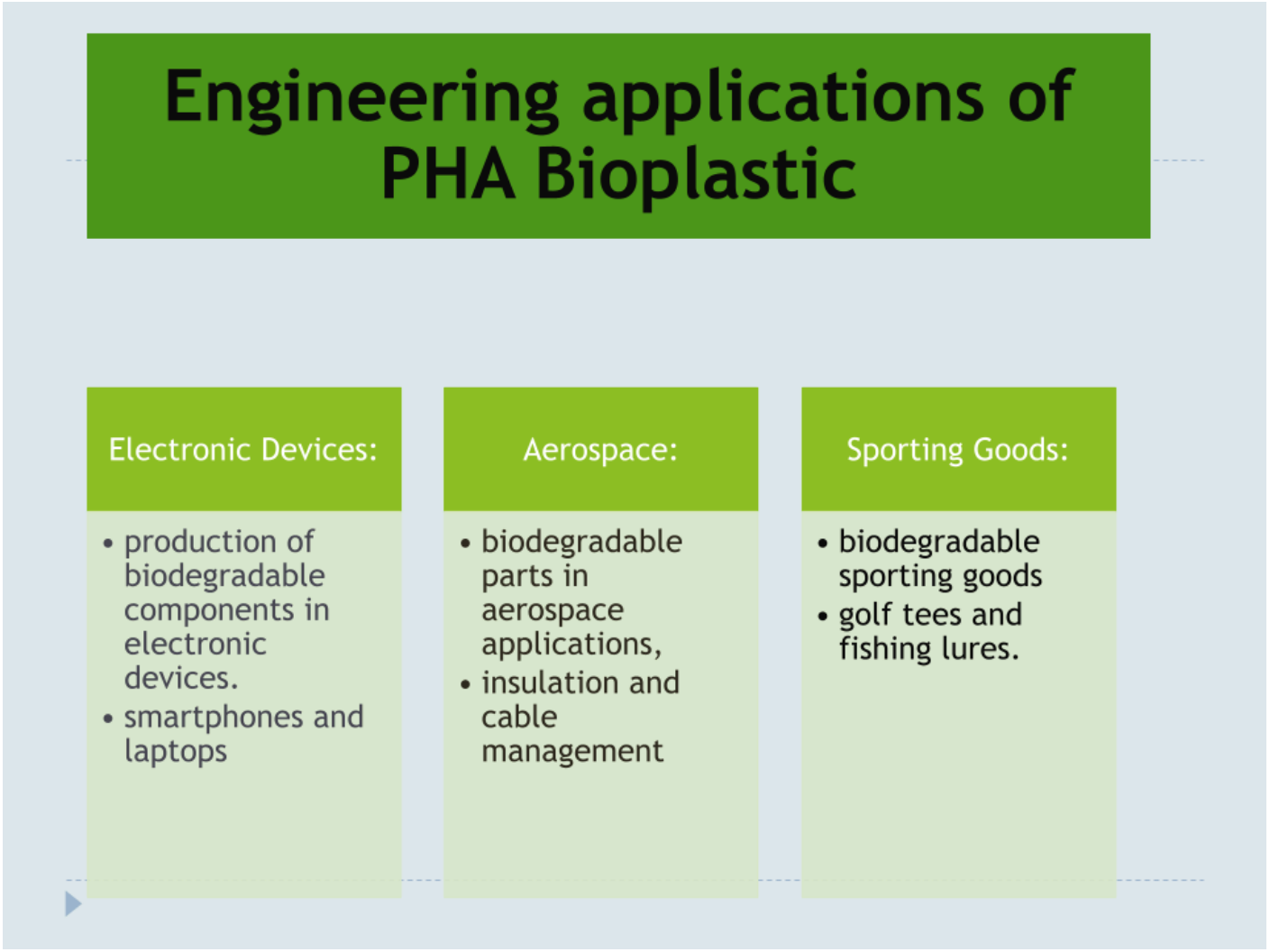
PLA is both: biobased and biodegradable under industrial composting conditions (at a high temperature, around 58 °C). Because of its good mechanical properties, processability, renewability, and non-toxicity, PLA is considered today as one of the most commercially promising bioplastics. When compared with most other biodegradable polymers, PLA has better durability, transparency, and mechanical strength.

Properties of PHAs have several properties that make them ideal for use as bioplastics:

Biodegradability	• biodegradable and can break down into water and carbon dioxide • reducing their impact on the environment.
Biocompatibility	• medical devices-sutures and implants • without causing adverse reactions in the body
Mechanical properties	• petroleum based plastics, making them suitable for various applications.
Processing	conventional plastic processing techniques such as injection molding, blow molding, and extrusion

Engineering applications of PHA Bioplastic

Packaging such as food containers, beverage cups, and clamshell containers	Textiles: biodegradable textiles	**Medical devices** such as sutures, implants, and drug delivery systems.	Agricultural Mulch Films to reduce soil erosion and conserve moisture



5.Polylactic Acid (PLA) is a biodegradable and bio-based plastic made from corn starch, sugarcane, or other natural resources.

- It is commonly used as a sustainable alternative to traditional petroleum-based plastics in various applications such as packaging, disposable tableware, and 3D printing.
- It's important to note that while PLA is biodegradable in industrial composting facilities, it may not break down in the environment as quickly as advertised and may still have negative impacts on wildlife and ecosystems if not properly disposed of.

Engineering applications of PHA Bioplastic

Electronic Devices:	Aerospace:	Sporting Goods:
• production of biodegradable components in electronic devices. • smartphones and laptops	• biodegradable parts in aerospace applications, • insulation and cable management	• biodegradable sporting goods • golf tees and fishing lures.

Properties of PLA as bioplastic

Biodegradable: reduce waste in landfill

Renewable: corn starch or sugarcane, but can reduce needs on petroleum products

Clear/Transparent: packaging applications

Biocompatible: non-toxic and biocompatible, packaging and medical devices.

Heat-resistant:relatively low melting temperature, but can sustain temp upto 60 degree C

Stiffness and Strength: good stiffness and strength

Printability: 3D printing due to its good printability

7. 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.

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.