BIOLOGY FOR COMPUTER ENGINEERS IAT 1 SOLUTION

Sub:	BIOLOGY FOR COMPUTER ENGINEERS	Sub Code:	BBOC407	Branch:	ISE		
	Answer any FIVE FULL Questions				MARKS	CO	RBT
1.	How do cells contribute to the functioning of living organisms, and what are the key differences between prokaryotic and eukaryotic cells?				10	CO1	L2
2.	What are the main types of carbohydrates, and what roles do they play in cellular structure, energy storage, and signalling?				10	CO1	L2
3.	What are stem cells, and how do they differ from other types of cells in the body?				10	CO1	L2
4.	What are PHA and PLA bio-plastics, and how do they contribute to reducing plastic pollution?				10	CO2	L3
5.	How do cleaning agents and detergents utilize lipid-based ingredients, and what are the implications for environmental sustainability?				10	CO2	L2
6.	a. What are the nutritional benefits of whey protein and meat analogs, and how do they compare to their animal-based counterparts? b.Describe the structure and function of nucleic acids, highlighting their role in storing and transmitting genetic information.				10	CO2	L2

1. How do cells contribute to the functioning of living organisms, and what are the key differences between prokaryotic and eukaryotic cells?(10M)

Cells are the fundamental units of life, and they play crucial roles in the functioning of living organisms. Here's how cells contribute to the functioning of organisms(5)

1. **Structural Support**: Cells form the structural framework of all living organisms. They provide shape, support, and organization to tissues, organs, and organ systems.
2. **Metabolism**: Cells carry out various metabolic processes necessary for life, such as respiration, photosynthesis (in plant cells), digestion, and synthesis of biomolecules like proteins, carbohydrates, and lipids.
3. **Reproduction**: Cells are responsible for the reproduction of organisms through processes like mitosis (in eukaryotes) and binary fission (in prokaryotes).
4. **Communication**: Cells communicate with each other through chemical signals, allowing them to coordinate activities and respond to changes in their environment.
5. **Homeostasis**: Cells maintain internal balance (homeostasis) by regulating factors like temperature, pH, and concentration of ions and molecules.
6. **Defense**: Some cells, like white blood cells in animals and certain cells in plants, play roles in defending the organism against pathogens and other harmful agents.

Now, let's discuss the key differences between prokaryotic and eukaryotic cells(5M)

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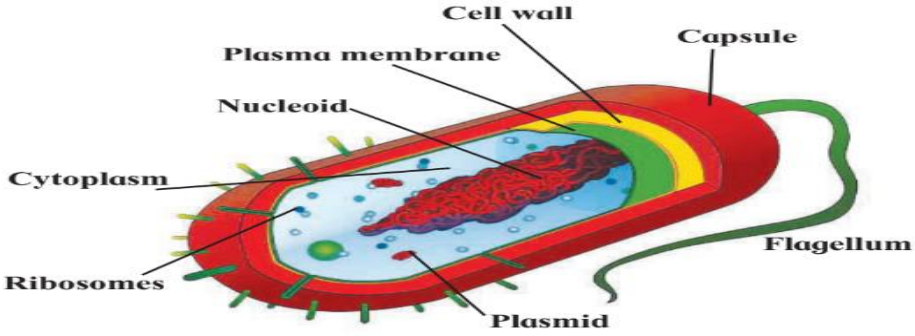
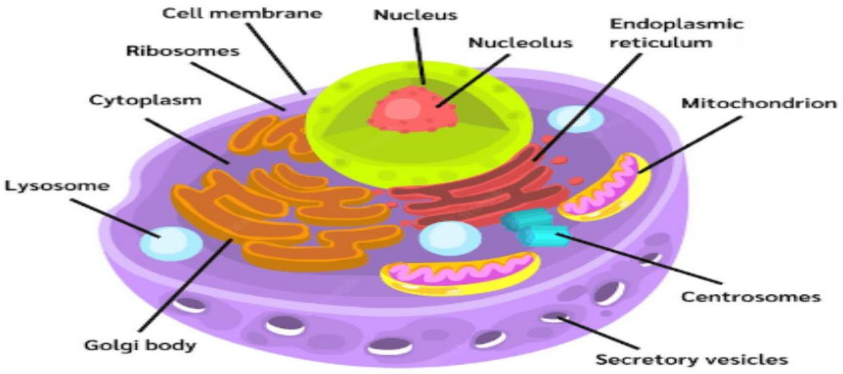


- ✓ As in figure 1, cells do not have well defined nucleus but only nucleoid is present, looks like bacteria with long tail and shape.
- ✓ Cytoplasm , Cell wall and cell membrane present.
- ✓ Capsule like Nucleoid is present.
- ✓ Organelles like Plasmid, Ribosomes are present.



- ✓ 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.

1. **Nucleus**: Prokaryotic cells lack a true nucleus. Their genetic material is present in the form of a single circular chromosome located in the nucleoid region. Eukaryotic cells have a well-defined nucleus enclosed within a nuclear membrane, housing multiple linear chromosomes.
2. **Membrane-bound Organelles**: Prokaryotic cells lack membrane-bound organelles, whereas eukaryotic cells contain various membrane-bound organelles like mitochondria, endoplasmic reticulum, Golgi apparatus, and lysosomes.
3. **Size**: Prokaryotic cells are generally smaller and simpler in structure compared to eukaryotic cells, which are larger and more complex.
4. **Cell Division**: Prokaryotic cells reproduce by binary fission, a simple form of cell division. Eukaryotic cells undergo mitosis for growth and repair and meiosis for sexual reproduction.
5. **DNA Structure**: Prokaryotic DNA is typically a single circular molecule, whereas eukaryotic DNA is organized into multiple linear chromosomes.

6. **Ribosomes**: Prokaryotic ribosomes are smaller (70S) compared to eukaryotic ribosomes (80S).

2. What are the main types of carbohydrates, and what roles do they play in cellular structure, energy storage, and signalling?

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.
- General formula is $\mathbf{C_n(H_2O)_n}$
- Simple Carbohydrates obey this formula where as complex carbohydrates do not obey this formula.
- They are classified as follows:
  - Monosaccharides
  - Disaccharides
  - Polysaccharides

Monosaccharides :

- Simple form of Carbohydrates and are water soluble.
- Having single structure and serve as primary source of energy.
- Carbon having double bond with Oxygen or with single bond
- Example: - Glucose, Fructose.

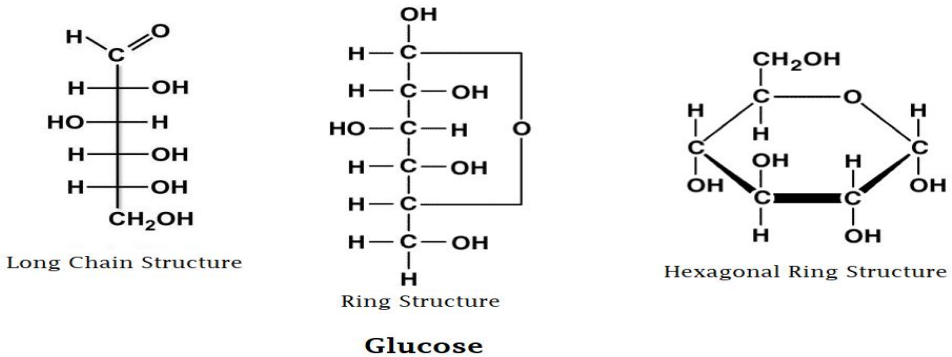


Figure 6. Glucose

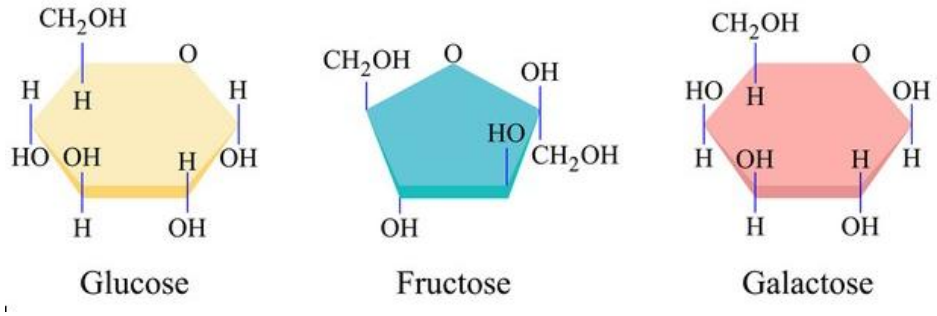


Figure 7. Glucose, Fructose & Galactose

They serve several essential functions:

- **Energy Source**: Monosaccharides are the primary energy source for cellular metabolism. Glucose, in particular, is a crucial source of energy for cells, providing fuel for various metabolic processes like respiration.
- **Building Blocks**: Monosaccharides serve as the building blocks for larger carbohydrates. They can join together through glycosidic bonds to form more complex carbohydrates like disaccharides and polysaccharides.
- **Cellular Structure**: Some monosaccharides, such as ribose and deoxyribose, are components of nucleotides, which form the backbone of nucleic acids like RNA and DNA, essential for genetic information storage and protein synthesis.

Disaccharides :

- Two monosaccharides combined becomes Disaccharides
- They are formed by condensation of 2 monosaccharides
- They are commonly found in Sugar and broken down into monosaccharides.
- Example: Sucrose, Lactose, Maltose

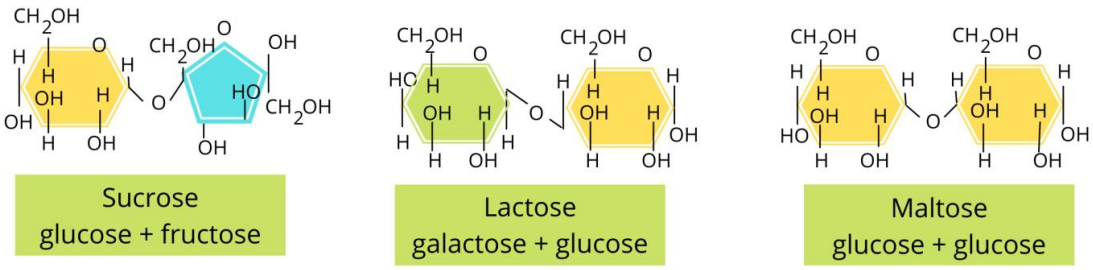


Figure 8. Sucrose, Lactose & Maltose

Their roles include:

- **Energy Storage**: Disaccharides serve as readily available sources of energy. When broken down into their constituent monosaccharides during digestion, they provide a quick source of energy for cellular processes.
- **Transport**: Some disaccharides, like sucrose, serve as transport forms of carbohydrates in plants, facilitating the movement of sugars from photosynthetic tissues (e.g., leaves) to non-photosynthetic tissues or storage organs (e.g., roots, fruits).

Polysaccharides :

- Poly means “many”.
- Many such saccharides combined.

- These are long chain mono saccharides that are linked together.
- Storage molecules of energy.
- Example: Glycogen in animal, Starch in plant.

They fulfill various functions:

- **Energy Storage**: Polysaccharides serve as long-term energy storage molecules in organisms. Starch is the primary energy storage molecule in plants, while glycogen serves the same function in animals and fungi. These polysaccharides are broken down into glucose molecules when energy is needed.
- **Structural Support**: Polysaccharides like cellulose and chitin provide structural support and rigidity to cell walls in plants and fungi, respectively. They contribute to the overall shape and integrity of cells and tissues.
- **Cell Signaling**: Some polysaccharides, such as glycoproteins and glycolipids, play roles in cell signaling and communication. They are involved in processes like cell recognition, immune response, and cell adhesion.

3. What are stem cells, and how do they differ from other types of cells in the body?

Introduction to 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.

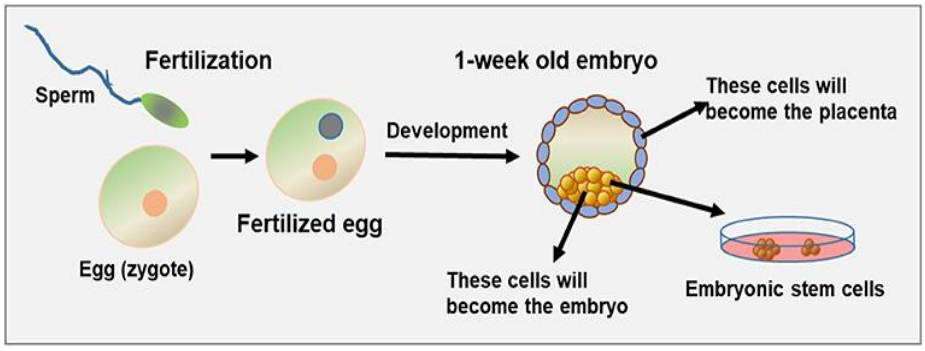


Figure 3. Embryonic Stem Cells

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

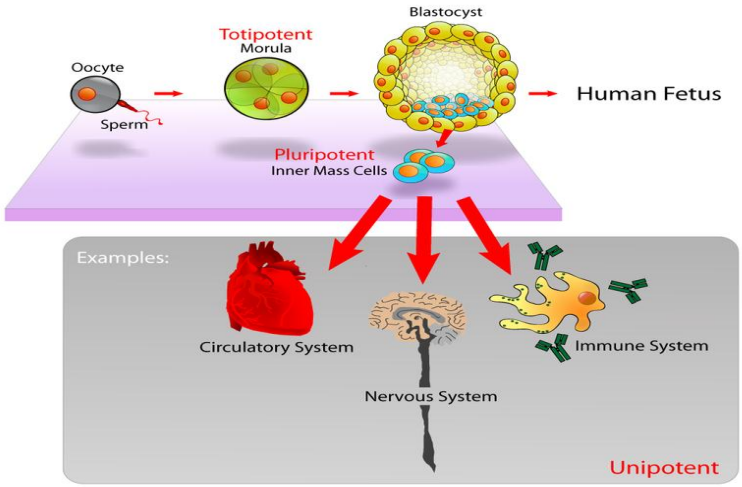


Figure 4. Examples of Embryonic Stem Cells

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.

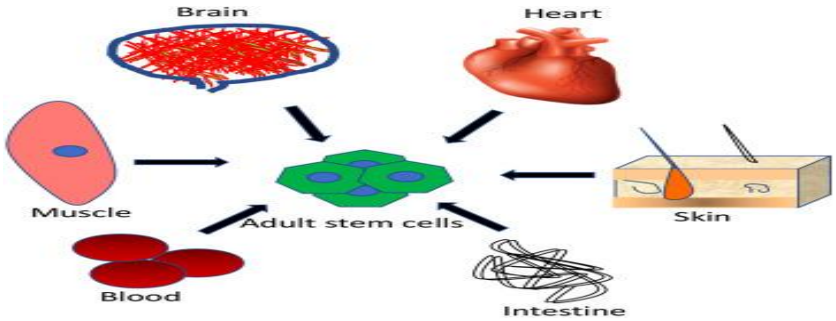


Figure 5. Somatic Stem Cells

(2M)

Here are some key characteristics and differences between stem cells and other types of cells in the body(3M)

1. **Special Ability**: Stem cells can turn into many different types of cells, while other cells usually have a specific job they do.

2. **Source**: Stem cells can come from embryos (embryonic stem cells) or from adult tissues (adult stem cells), while other cells are found throughout the body doing their specific tasks.
3. **Repair Power**: Stem cells are known for their ability to repair damaged tissues, while other cells usually don't have this repair ability.
4. **Ethics**: Using embryonic stem cells can raise ethical questions because they come from embryos, while other cells, like adult stem cells, don't pose such ethical concerns.
5. **Potential Use**: Stem cells are used in research and have potential for treating various diseases, while other cells mainly perform specific functions in the body without such broad potential.

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.

Carbohydrates are one of the main types of macromolecules found in living organisms. They are classified into three main types based on their chemical structure and complexity: monosaccharides, disaccharides, and polysaccharides. Each type plays specific roles in cellular structure, energy storage, and signaling :(0.5M)

4. What are PHA and PLA bio-plastics, and how do they contribute to reducing plastic pollution?

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.
Bio plastics are said to be biodegradable if they are broken down with the effect of right environmental conditions and microbes.
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 biobased and biodegradable under industrial composting conditions (at a high temperature, around 58 °C).

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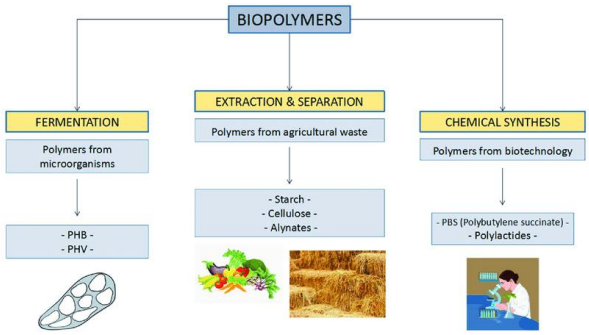
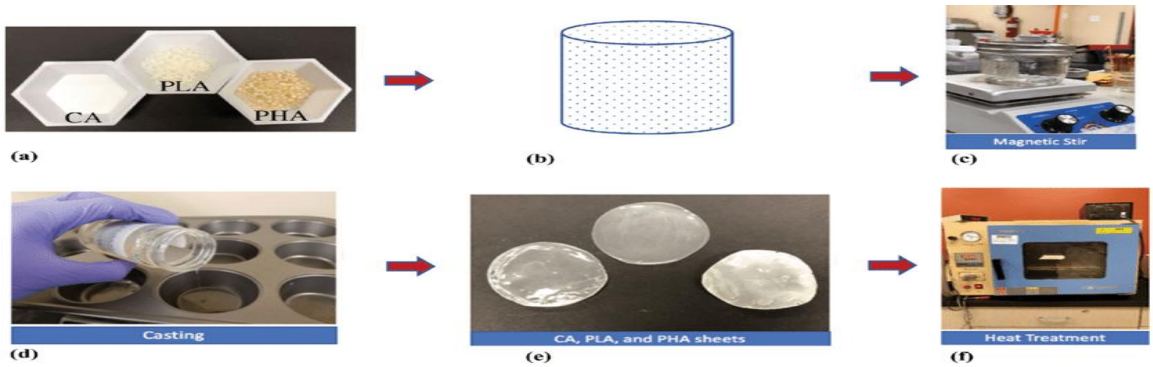
It has good mechanical properties, processability, renewability, and non-toxicity.
PLA is considered as one of the most commercially promising bioplastics.
When compared with other biodegradable polymers, PLA has better

- 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.
They are promising candidates for a sustainable future manufacturing.
PHAs' properties can be altered by the selection of bacteria, fermentation conditions, and substrate.
Due to their flexible properties, PHAs can eventually substitute polypropylene(PP), polyethylene (PE), and polystyrene (PS).



5. How do cleaning agents and detergents utilize lipid-based ingredients, and what are the implications for environmental sustainability?

The hydrophobic end of the phospholipid bilayer stays away from the water. This avoids the dissolution of cell membrane in water.
But the detergent can bind to the hydrophobic end of the cell membrane and form a solution with water, thus breaking the cell membrane barrier.

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Detergent monomers solubilize membrane proteins by partitioning into the membrane bilayer. With increasing amounts of detergents, membranes undergo various stages of solubilization. The initial stage is lysis or rupture of the membrane.
While lipids also have the same general structure as detergents—a polar hydrophilic head group and a nonpolar hydrophobic tail— lipids differ from detergents in the shape of the monomers, in the type of aggregates formed in solution, and in the concentration range required for aggregation.
Detergent monomers solubilize membrane proteins by partitioning into the membrane bilayer. With increasing amounts of detergents, membranes undergo various stages of solubilization. The initial stage is lysis or rupture of the membrane. Lipids have the same general structure as detergents. Lipids differ from detergents in the:

- Shape of the monomers
- Type of aggregates formed in solution, and
- Concentration range required for aggregation

6. a.What are the nutritional benefits of whey protein and meat analogs, and how do they compare to their animal-based counterparts?

WHEY PROTEIN:

- WHEY protein is a mixture of proteins isolated from whey (liquid by-product of cheese production)
- Whey is left over, when, milk is coagulated during the process of cheese production.
- It contains everything, that is soluble from milk, after the pH is dropped to 4.6, during coagulation.
- It is a 5% solution of lactose in water.
- It contains water soluble proteins of milk as well as some lipid content.
- WHEY processing can be done by simple drying.
- The relative protein content can be increased by removing the lactose, lipids and other non-protein materials.
- The primary usage of whey protein supplements is for muscle growth and development.
- Eating WHEY protein supplements before exercise will not assist athletic performance.
- It will enhance the body's protein recovery and synthesis after exercise.
- It increases free amino acids in body's free amino acid pool.

MEAT ANALOGOUS:

- High moisture extrusion cooking enables the production of fresh, premium meat analogues.
- These are texturally like muscle meat from plant or animal proteins.

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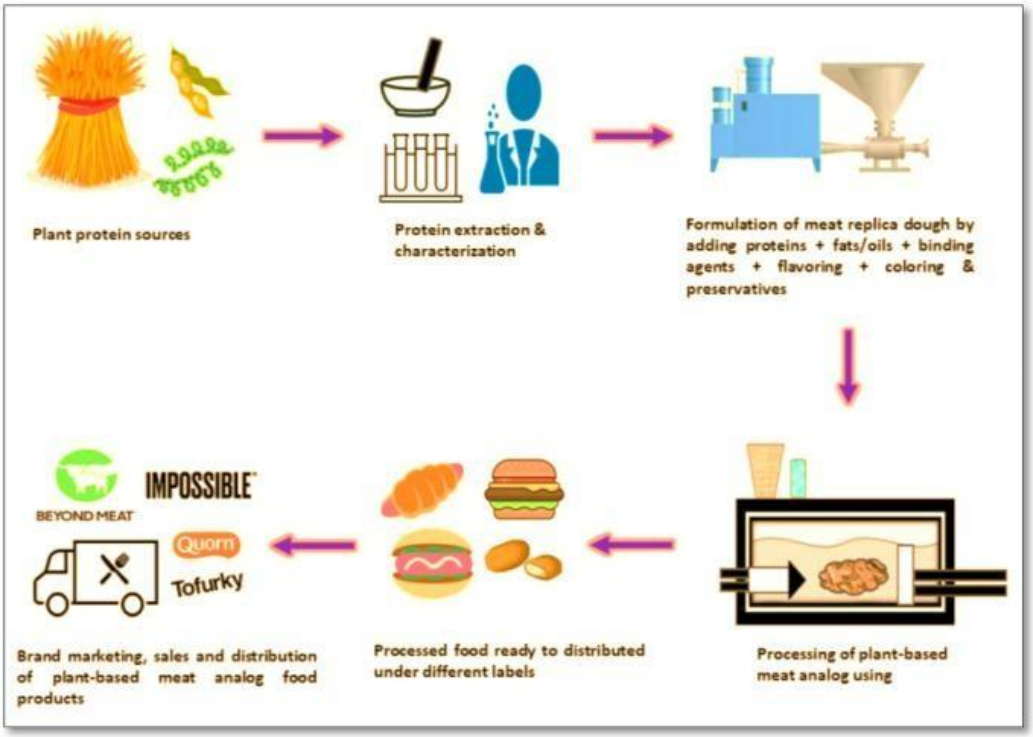
- The appearance and eating sensation are similar to cooked meat while high protein content offers a similar nutritional value.

- Meat analogues, can be defined as:

✓ products that mimic meat in:
✓ its functionality
✓ bearing similar appearance
✓ texture, and
✓ sensory attributes to meat

- Production of meat analogues has been on the increase for healthy, low environmental impact, and ethical meat substitutes.



- The factors that lead to this shift is:

1. due to low fat and calorie foods intake
2. flexitarians, animal disease, natural resources depletion, and
3. reduce greenhouse gas emission.

- Currently, available meat analog products are plant-based meat in which, the quality is similar to the conventional meat.

- The ingredients used are mainly soy proteins with novel ingredients added, such as mycoprotein and soy leghemoglobin

6 b.describe the structure and function of nucleic acids, highlighting their role in storing and transmitting genetic information.

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NUCLEIC ACIDS:

- They are long chain **biological polymers.**
- Same Molecules are repeated many times in sequence.
- It is used for storage and transfer of genetic information.
- Artificial Nucleic Acids are also synthesized now-a-days.
- Types: DeoxyRibonucleic Acid (DNA) and Ribonucleic Acid (RNA).
- Both are used for processes like replication, Transcription , Translation of genetic information.

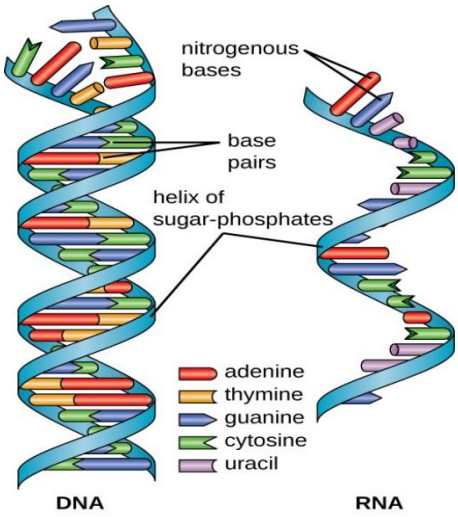

Figure 12. DNA and RNA Schematic representation.

DNA:

- DNA information is for development, functioning and for reproduction.
- It is actually a double stranded helical structure.
- It consists of sugar molecules, phosphates, and Nitrogen bases like Adenine, Guanine, Cytosine and Thymine.

RNA:

- It involves expression of genetic information stored in DNA by carrying the message from DNA to RNA.
- Used to duplicate the genetic information by separating 1 strand from DNA, and this strand is called messenger RNA(mRNA).
- mRNA carries the information of various nucleotides and their sequence.
- The mRNA becomes a copy of DNA, and is used to build/ produce proteins.
- It acts as a base structure, to act and combine, with amino acids, to produce protein, based on requirement.

Genetic Information Storage:

- Nucleic acids, particularly DNA, store and carry genetic information that dictates the hereditary characteristics of living organisms.

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- DNA is a master molecule, that acts as a secure storage device for genetic information, that defines an organism.

Hereditary Transmission:

- Nucleic acids are responsible for transmitting hereditary traits from parents to offspring, ensuring the continuity of genetic information.
- Replication of DNA is involved here.

Transfer of Genetic Code:

- mRNA, a type of nucleic acid, carries the genetic code from DNA to the ribosomes, where protein synthesis occurs.
- mRNA bridges gap between DNA and Ribosomes.