

MODULE 2: APPLICATIONS OF BIOMOLECULES

Syllabus

1. Carbohydrates in cellulose-based water filters production.
2. PHA and PLA in bioplastics production.
- 3 Nucleic acids in vaccines and diagnosis.
4. Proteins in food production, lipids in biodiesel and detergents production, Enzymes in biosensors fabrication.
5. Food processing, detergent formulation and textile processing.

Introduction: Biomolecules are organic molecules that assist performance, maintenance, and metabolic processes of living beings. They are building blocks which are demarcated as utmost vital organic molecules that serve in the upkeep and metabolic progressions of life. They are being recognized to perform numerous functions, and hence, a lot of research is being dedicated to explore their benefits to maximum. They have dominated almost every field including medicine, scientific, and engineering. Biomolecules can be tailored to make them suitable for the proposed applications and can be synthesized and produced in large scales using advanced techniques. Biomolecules find their applications in cosmetics, therapeutic, pharmacy, textile, biofuels, pulp and paper industries, waste water treatment, and various others.

Carbohydrates in cellulose-based water filters production:

Cellulose is the most abundant organic compound on earth with a chemical formula ($C_6H_{10}O_5$) n. Cellulose is a complex carbohydrate consisting of oxygen, carbon, and hydrogen. It is chiral structured molecule with tasteless and has no odour. The interest in the use of bio-based 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 bio-based membranes for micro- and ultra filtration from cellulose.

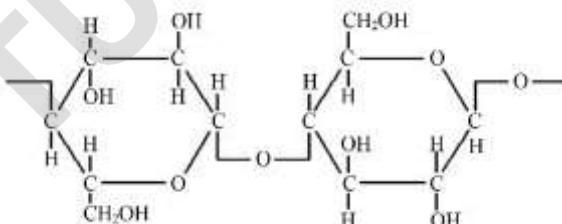


Figure-1 Structure of cellulose

Because of its filtration properties, structural support, binding capabilities and biodegradability, cellulose based water filters are considered as a promising option for water filtration applications. They offer effective filtration performance while minimizing environmental impact and reducing waste.

Role of Cellulose in water filters:

Cellulose plays important roles in water filters. Here are some of the key functions that cellulose serves in water filtration.

1. **Filtration:** Cellulose is a fibrous material with a complex, porous structure. This structure allows water to pass through while trapping particles and impurities in the filter material. Cellulose can be used to create both depth filters and membrane filters, which work by trapping particles as they pass through the filter material.

2. **Structural Support:** Cellulose can provide structural support to water filters. Cellulose fibers can be combined with other materials, such as diatomaceous earth or perlite, to create a porous filter material that maintains its shape and does not collapse under pressure.
3. **Binding Agent:** Cellulose can be used as a binder to hold other filter materials in place. For example, cellulose can be combined with activated carbon to create a filter material that holds the activated carbon in place and prevents it from leaching into the filtered water.
4. **Biodegradability:** Cellulose is a biodegradable material that can break down naturally in the environment. This makes it an attractive option of water filters, as it can be disposed of without causing harm to the environment.

Design and development of cellulose based water filters:

The design and development of cellulose based water filters involves the following steps.

Material selection: Cellulose can be sourced from a variety of natural sources, including wood pulp, cotton, and other plant fibers. Cellulose is available abundantly, cost effective, and have desired properties of the filter.

Processing: Cellulose is typically processed into a form suitable for use in a water filter. This may involve purification, drying, and milling to produce a fine powder or fiber.

Filter design: The filter design will depend on the intended application and the level of filtration required. Cellulose filters can be designed to trap different types of impurities, such as sand, silt and sediment, as well as organic and inorganic contaminants.

Chemical treatment: The cellulose filter may be treated with chemicals to enhance its filtration properties or to add antimicrobial properties.

Testing: The cellulose filter should be tested to ensure that it meets the required filtration standards and is effective at removing impurities from water.

Production: Once the filter has been designed and tested, it can be produced at a scale for commercial use.

Bioplastics:

Bioplastics are plastic materials produced from renewable biomass sources, such as vegetable fats and oils, corn starch, straw, woodchips, sawdust, recycled food waste, etc. Some bioplastics are obtained by processing directly from natural biopolymers, while others are chemically synthesised from sugar derivatives (e.g., lactic acid) and lipids (oils and fats) from either plants or animals, or biologically generated by fermentation of sugars or lipids. In contrast, common plastics, such as fossil-fuel plastics (also called petro-based polymers) are derived from petroleum or natural gas.

Polyhydroxyalkanoates (PHA) as bioplastic:

Polyhydroxyalkanoates or PHAs are polyesters produced in nature by numerous microorganisms, including through bacterial fermentation of sugars or lipids. These are biodegradable and are used in the production of bioplastics.

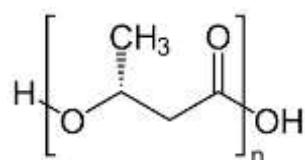


Figure-2 Structure of R-3-polyhydroxyalkanoate

Production of PHA:

PHA (Polyhydroxyalkanoates) can be produced using bacterial fermentation. Here are the general steps involved in PHA production.

Selection of Microorganism: The first step in PHA production is to select a microorganism that produces PHA. The most commonly used microorganisms for PHA production are bacteria, such as Cupriavidus necator, Pseudomonas oleovorans, and Alcaligenes eutrophus.

Growth of Microorganism: Once the microorganism has been selected, it is grown in a nutrient-rich medium that contains a carbon source, such as glucose, starch, oil, lignocelluloses or a waste stream from the agriculture and food industry. The microorganism uses this glucose, starch oil as carbon source to produce PHA

Extraction of PHA: After the microorganism has produced sufficient amounts of PHA, it is harvested and the PHA is extracted from the bacterial cells. This can be done using a variety of different methods, such as chemical extraction, enzymatic digestion, or physical disruption of the bacterial cells.

Purification of PHA: Once the PHA has been extracted, it is purified to remove any impurities or residual bacterial cells. This can be done using methods such as filtration, centrifugation, or solvent extraction.

Processing of PHA: Once the PHA has been purified, it can be processed into a variety of different forms such as films, fibers or 3D-printed structures. The specific processing methods used will depend on the desired end-use application for the PHA.

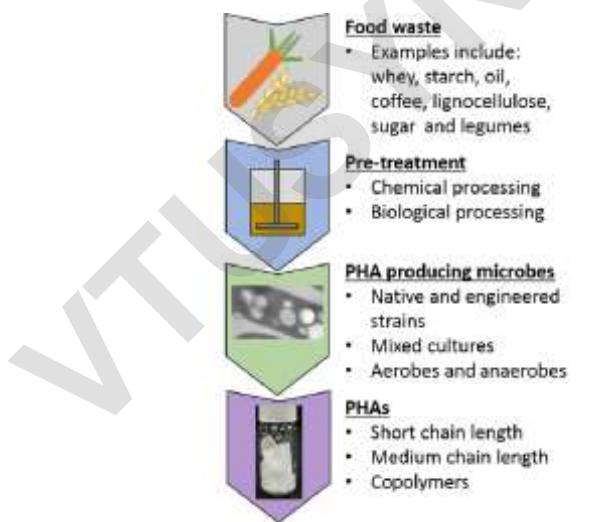


Figure-3 Conversion of food waste into PHA

Design and development of PHA bioplastics

Fermentation: Bacteria, such as Alcaligenes eutrophus or Pseudomonas oleverans are cultures in a nutrient-rich solution that contains a carbon source. The bacteria consume the carbon source and produce PHA storage material

Extraction: Once the bacteria have produced PHA, they are harvested and the PHA is extracted from the cells.

Purification: The extracted PHA is then purified and processed into plastic form such as pellets.

Processing: The PHA pellets are melted and moulded into various shapes to create products such as packaging materials, bags and utensils.

Advantage of PHA bioplastics

1. They are biodegradable in various environments, including soil, marine and waste water, which helps to reduce plastic pollution.
2. PHA bioplastics are renewable since they can be produced from various sources such as agricultural waste and plant oils.

Polylactic acid (PLA) as bioplastic:

Polylactic acid, also known PLA is a thermoplastic polyester obtained by condensation of lactic acid with loss of water. PLA has become a popular material due to it being economically produced from renewable resources. The monomer is typically made from fermented plant starch such as from corn starch, sugarcane or sugar beet pulp.

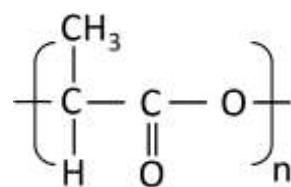


Figure-4 Structure of Polylactic acid

PLA is produced by polymerizing lactic acid, which is derived from the fermentation of com starch or other plant-based sources. The resulting polymer can be used to make a wide range of products, including packaging materials, food containers, disposable utensils, and even clothing

Properties of PLA:

Biodegradability: PLA is biodegradable and can break down into natural substances such as carbon dioxide, water, and organic compounds under specific conditions.

Renewable Resource: PLA is made from renewable resources, which it a sustainable alternative to traditional plastics made from fossil fuels.

Versatility: PLA can be used in a wide range of applications, including packaging materials, food containers, disposable tableware, and 3D printing filaments. Properties: PLA has good mechanical properties, such as high tensile strength, which makes it suitable for various applications.

Low Environmental Impact: The production of PLA generates lower greenhouse gas emissions and uses less energy than traditional plastics, which makes it more environmentally friendly.

Thus, PLA is a promising alternative to traditional plastics due to its ly biodegradability, sustainability, and versatility. Its properties make it suitable for many applications, and it has the potential to reduce the environmental impact of plastic waste.

PLA production:

Polylactic acid (PLA) is produced through a fermentation process using renewable resources. Here are the basic steps involved in PLA production:

Raw Material Preparation: PLA can be produced from a variety of renewable resources, such as corn starch, sugarcane, or cassava. The raw material is first processed to extract the starch or sugar that will be fermentation.

Fermentation: The extracted starch or sugar is then formed microorganisms, such as Lactobacillus or Bacillus, to produce lactic acid. **Purification:** The lactic acid is purified using a series of chemical physical processes to remove impurities and obtain high-purity lactic

Polymerization: The purified lactic acid is then polymerized into PLA using heat and catalysts

Processing: The PLA is then processed into various forms, such as pellets or sheets, which can be used to manufacture a wide range of products. The specific details of PLA production can vary depending on the raw material and the manufacturing process used. However, the use of renewable resources and the potential for biodegradability make it an attractive alternative to traditional plastics made from fossil fuels.

Development of bioplastic from PLA:

To develop bioplastic from PLA, you will need to follow a few basic steps:

Material Preparation: PLA is available in the form of pellets or granules, which can be melted and moulded to create plastic products. First you will need to obtain the PLA material and ensure that it is clean and free of contaminants.

Melting and Moulding: The next step is to melt the PLA pellets and mould them into the desired shape. This can be done using various techniques such as injection moulding, extrusion or thermoforming.

Cooling and Finishing: After moulding, the plastic product needs to be cooled and finished. This can include trimming any excess material, smoothing rough edges and applying any necessary coatings or finishes.

Testing and Quality Control: Once the plastic product is finished, it should be tested to ensure that it meets the required specifications and quality standards. This may involve testing for mechanical properties, biodegradability, and other factors.

Nucleic acids in vaccines and diagnosis:

Nucleic acids are biomolecules that are essential for life as they carry genetic information in all living organisms. There are two main types of nucleic acids: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

DNA is a double-stranded helix that stores genetic information in the form of a sequence of nucleotide bases: adenine (A), cytosine (C), guanine (G), and thymine (T). The sequence of these bases determines the genetic information that is passed on from parent to offspring. RNA is a single-stranded molecule that is involved in protein synthesis. There are three types of RNA: messenger RNA (mRNA), transfer RNA (tRNA), and ribosomal RNA (rRNA). Both DNA and RNA are made up of nucleotides, which consist of a sugar molecule (deoxyribose in DNA and ribose in RNA), a phosphate group, and a nitrogenous base (A, C, G, or T/U).

DNA vaccine for rabies:

A DNA vaccine is a type of vaccine that uses a small piece of DNA to stimulate an immune response in the body. The DNA used in the vaccine encodes for a specific antigen, which is a protein found on the surface of a pathogen. When the DNA vaccine is injected into the body, the cells take up the DNA and use it to produce the antigen, which then triggers an immune response.

Rabies is a viral disease that affects the central nervous system of humans and other mammals. It is typically spread through the saliva of infected animals, most commonly through bites or scratches. The virus can also be transmitted through contact with the eyes, nose, or mouth if infected saliva comes into contact with these areas.

A DNA vaccine for rabies is a type of vaccine that uses a small piece of DNA that encodes the genetic instructions for producing a protein from the rabies virus. This protein is then produced by the cells of the vaccinated individual, which triggers an immune response and produces immunity to the virus.

To create a DNA vaccine for rabies, first identify the gene that codes for a protein on the surface of the rabies virus that is targeted by the immune system. This gene is then inserted into a plasmid, which is a small circular piece of DNA that can replicate independently of the host's DNA.

The plasmid with the gene is then injected into muscle tissue of the individual receiving the vaccine. The muscle cells take up the plasmid and begin producing the rabies protein. This triggers an immune response, leading to the production of antibodies against the rabies virus.

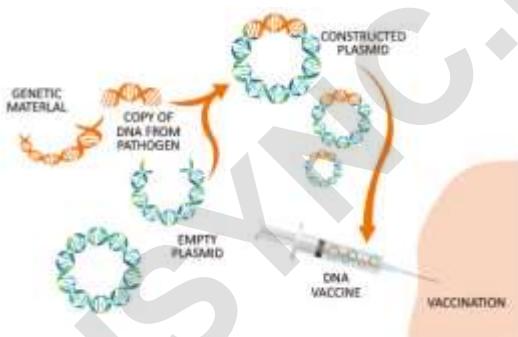


Figure-5 Principle of DNA vaccine development

RNA vaccine for COVID-19:

An RNA vaccine is a type of vaccine that uses a small piece of messenger RNA (mRNA) to stimulate an immune response against a specific pathogen or disease. The mRNA carries the genetic code for a specific antigen, which is a protein that triggers an immune response. The mRNA is usually introduced into the body through harmless lipid nanoparticles that protects the mRNA from degradation and helps it to enter cells. Once the mRNA enters the cells, it instructs them to produce the antigen or protein encoded by the mRNA, which triggers an immune response and leads to the production of antibodies against the pathogen.

RNA vaccines have been developed for a range of diseases, including COVID-19, influenza, and Zika virus, and have shown promising results.

RNA vaccines are a type of vaccine that works by using a small piece of the virus's genetic material, in this case, the COVID-19 virus's RNA, to stimulate an immune response in the body. The mRNA vaccine for COVID-19, such as Pfizer-BioNTech and Moderna, contain a small piece of the virus's RNA, which instructs cells in the body to produce a harmless piece of the virus called the spike protein. Once the spike protein is produced, the immune system recognizes it as foreign and mounts an immune response, producing antibodies that can recognize and neutralize the actual virus if the person is later exposed to it.

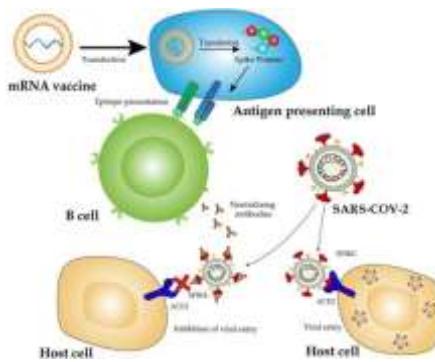


Figure-6 Principle of mRNA vaccine development

DNA fingerprinting in forensic:

DNA fingerprinting, also known as DNA profiling or genetic fingerprinting, is a technique used in forensic science to identify individuals by analyzing their unique DNA profiles. Forensic scientists obtain DNA samples from a crime scene, such as blood, semen, or hair follicles, and compare them to DNA samples taken from suspects or victims. The DNA is then extracted from the samples and amplified through a process called polymerase chain reaction (PCR), which makes many copies of the DNA.

The amplified DNA is then subjected to a process called gel electrophoresis, which separates the DNA fragments according to their size. The resulting pattern of bands, known as a DNA profile or DNA fingerprint, is unique to each individual and can be used to identify a person with a high degree of accuracy. Suspects or victim can be identified by matching the bands of DNA.

Forensic scientists can compare DNA profiles from different samples to determine if they come from the same individual or related individuals. This information can be used to identify suspects or link individuals to a crime scene. DNA fingerprinting has been used to solve numerous high-profile cases and has revolutionized forensic science.

The process of DNA fingerprinting involves several steps:

DNA extraction: DNA is extracted from biological samples such as blood, saliva, or hair found at the crime scene.

Polymerase chain reaction (PCR): PCR is used to amplify specific regions of the DNA to generate enough material for analysis.

Gel electrophoresis: The amplified DNA fragments are separated by using gel electrophoresis, creating a pattern of bands unique to individual.

Hybridization: A DNA probe is added to the gel, which binds to specific DNA fragment of interest and creates a visible signal.

Analysis: The resulting DNA fingerprint is compared to DNA profiles of potential suspects to determine if there is a match.

DNA fingerprinting has revolutionized forensic science and has become a critical tool in criminal investigations. It is highly accurate and can be used to link suspects to crimes, exonerate innocent individuals, and identify victims of crime or disaster. It is also used in paternity testing and medical diagnosis.

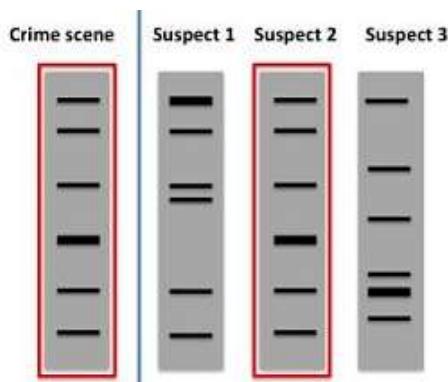


Figure-7 Amplified DNA separated bands

Proteins:

Proteins are large biomolecules that are essential for the structure, function, and regulation of cells, tissues, and organs in living organisms. They are composed of long chains of amino acids that are folded into complex three-dimensional structures.

Proteins have a wide range of functions in the body including:

Structural support: Proteins such as collagen, elastin, and keratin provide strength and elasticity to tissues such as skin, hair and nails.

Enzymatic catalysis: Enzymes are protein that facilitates chemical reactions in the body by lowering the activation energy required for the reaction to occur.

Transport: Proteins such as hemoglobin and albumen transport such as myosin nutrients and hormones throughout the body **Immune defence:** Antibodies are proteins that recognize and neutral foreign invaders such as bacteria and viruses.

Regulation: Hormones such as insulin and growth hormone are protein that regulates physiological processes such as metabolism and growth

Movement: Proteins such as actin and myosin are responsible for contraction of muscle fibers.

Protein as food: Protein is an essential macronutrient that is important for building and repairing tissues in the body. It is also necessary for the production of enzymes, hormones, and other molecules that are involved various metabolic processes.

Protein is found in a wide range of foods, including meat, poultry, fish, eggs, dairy products, legumes, nuts, and seeds. Animal-based foods tend to be good sources of complete protein, which means that they contain all of the essential amino acids that the body needs, while plant-based foods may need to be combined in specific ways to ensure a complete protein intake.

Protein is important for maintaining muscle mass and strength and can help to support weight loss by promoting feelings of fullness and reducing appetite. It is also important for maintaining bone health and for supporting the immune system.

Whey protein and meat protein are two different types of dietary proteins.

Whey protein is a type of protein that is derived from milk; specifically the liquid portion that is left over after milk is curdled and strained to make cheese. Whey protein is a complete protein,

meaning it contains all of the essential amino acids that the body needs. It is commonly used as a dietary supplement and is often consumed by athletes and bodybuilders to support muscle growth and repair.

Meat protein, on the other hand, is derived from animal sources such as beef, poultry, pork, and fish. Meat is also a complete protein and is a good source of other nutrients such as iron, zinc, and vitamin B12

While both whey protein and meat protein can provide a source of dietary protein, they can have different effects on the body. Whey protein is digested quickly and can help to promote muscle protein synthesis, making it a popular choice for athletes and people looking to build muscle. Meat protein, on the other hand, is generally digested more slowly and may provide a more sustained release of amino acids to support muscle growth and repair.

It is important to consume a balanced diet that includes a variety of protein sources, including both plant-based and animal-based sources, to ensure adequate intake of all of the essential amino acids and other nutrients.

Whey protein analogues:

A whey protein analogue refers to a protein product that mimics the properties of whey protein but is not derived from milk or dairy. This can include plant-based protein sources such as pea protein, soy protein, or rice protein, or even synthetic proteins created in a laboratory.

These analogues are designed to provide similar nutritional benefits as whey protein, such as being a source of high-quality protein that is easily digestible and absorbed by the body. They can be used as a dietary supplement for those who are lactose intolerant, vegan, or have other dietary restrictions that prevent them from consuming whey protein.

An example of a whey protein analogue is pea protein. Pea protein is a plant-based protein source that is derived from yellow split peas. It is a complete protein, meaning it contains all the essential amino acids that the body needs, and has a similar amino acid profile to whey protein. Pea protein is easily digestible and absorbed by the body, making it a popular alternative to whey protein for people who are lactose intolerant, vegan, or have other dietary restrictions. Pea protein is also lower in fat and carbohydrates than whey protein, making it a good choice for those who are looking to manage their calorie intake. Other examples of whey protein analogues include soy protein, rice protein, and hemp protein.

Meat protein analogue:

A meat protein analogue refers to a protein product that mimics the texture, flavour and nutritional properties of meat but is made from non-animal sources. This can include plant-based proteins such as soy, wheat, peas and mushrooms as well as laboratory-grown meat alternatives, also known as cultured meat or cell-based meat.

Plant-based meat alternatives typically use a combination of sources, such as soy and peas, to create a texture and taste that resembles meat. These products are often fortified with vitamins and minerals to provide a nutritional profile that is similar to meat. Additionally they are lower in saturated fat and cholesterol than traditional meat, making them a popular choice for people who are looking to reduce their meat intake for health or environmental reasons.

Cultured meat is produced by taking a small sample of animal cells and growing them in a lab under controlled conditions. The resulting meat is nutritionally identical to traditional meat but is produced without the need for animal slaughter. This technology is still in its early stages but it has the potential to provide a more sustainable and ethical source of meat protein in the future.

Examples of meat protein analogues include products such as Beyond Meat, Impossible Foods, and Quorn, which are plant-based meat alternatives as well as Memphis Meats and Mosa Meat which are companies that are working on production of cultured meat.

Both whey protein analogs and meat protein analogs can provide a source of dietary protein, while also offering potential health benefits.

Plant based proteins:

Plant-based proteins are proteins that are derived from plants, such as grains, legumes, nuts, seeds, and vegetables. These proteins are a great alternative to animal-based proteins for people who follow a vegetarian or vegan diet, or for people who simply want to incorporate more plant-based foods into their diet. Some common plant-based proteins include

Legumes: Such as lentils, chickpeas, black beans, kidney beans, and peas.

Nuts and seeds: Such as almonds, peanuts, cashews, chia seeds, flax seeds and pumpkin seeds.

Grains: Such as quinoa, brown rice, oats, and barley.

Vegetables: Such as broccoli, spinach, kale, and Brussels sprouts.

Soy products: Such as tofu, tempeh, and edamame.



Figure-8 Cereals

Plant-based proteins are often lower in saturated fat and cholesterol than animal-based proteins, and they are also rich in fiber, vitamins, and minerals. Additionally, many plant-based proteins are considered "complete" proteins meaning they contain all nine essential amino acids that the body needs to function properly.

Lipids:

Lipids are a group of biomolecules, insoluble in water and soluble in organic solvents. They are an essential component of all living cells, and play a variety of important roles in the body, including providing a source of energy, forming cell membranes, and acting as signalling molecules.

There are several different types of lipids, including: Fatty acids: these are the building blocks of most lipids, and are used to larger molecules such as triglycerides and phospholipids.

Triglycerides: these are the main form of fat stored in the body, and are composed of three fatty acids attached to a glycerol backbone.

Phospholipids: these are a major component of cell membranes, and are composed of two fatty acids attached to a glycerol backbone, along with a phosphate group.

Steroids: These are a type of lipid that includes hormones such as testosterone and estrogens as well as cholesterol, which is an important component of cell membranes.

Lipids are an important source of energy for the body, as they are broken down into fatty acids and used as fuel for cellular processes.

Lipids are source to biodiesel:

Lipids can be a source for biodiesel. Biodiesel is a renewable and friendly alternative to petroleum-based diesel fuel, and can be produced from a variety of sources, including vegetable oils, animal fats, and recycled cooking oils.

The production of biodiesel from lipids involves a process called transesterification, where the lipids are chemically reacted with an alcohol and a base to produce a fatty acid alkyl ester, which is the main component of biodiesel.

Vegetable oils such as soybean oil, canola oil, and palm oil are commonly used as feedstock for biodiesel production as they are rich in triglycerides which can be easily converted into biodiesel through transesterification. Animal fats such as tallow and lard, can also be used as feedstock for biodiesel production.

Using lipids as a source for biodiesel has several benefits, including reducing dependence on fossil fuels, reducing greenhouse gas emissions, and providing an alternative market for agricultural crops.

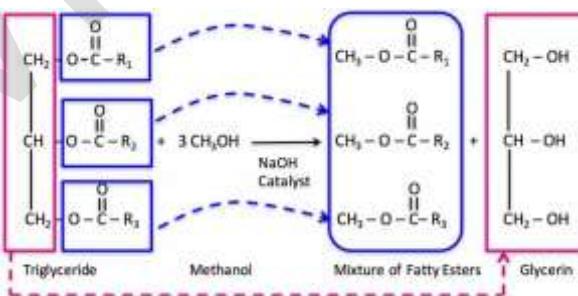


Figure-9 Transesterification reaction

The production of biodiesel typically involves the following steps:

Feedstock preparation: The first step in producing biodiesel is to prepare the feedstock, which is typically vegetable oil, animal fat, or recycled cooking oil. The feedstock must be cleaned and dried to remove impurities and water.

Transesterification: The cleaned and dried feedstock is then reacted with an alcohol, such as methanol or ethanol, and a catalyst, such as sodium hydroxide or potassium hydroxide, in a

reactor vessel. The reaction breaks down the triglycerides in the feedstock into fatty acid alkyl esters and glycerol. The fatty acid alkyl esters are the main component of biodiesel.

Separation: The fatty acid alkyl esters and glycerol are then separated in a settling tank where the heavier glycerol sinks to the bottom and the lighter biodiesel floats on top. The glycerol can then be removed and used for other purposes.

Washing: The biodiesel is then washed to remove any remaining impurities, such as catalyst residues or unreacted alcohol. This is typically done using water, which is then separated from the biodiesel using a centrifuge or settling tank.

Drying: The final step in producing biodiesel is to dry the fuel to remove any remaining water. This is typically done using a vacuum or a desiccant.

The resulting biodiesel can be used as a fuel in diesel engines, either on its own or blended with petroleum diesel fuel. It is a renewable and environmentally friendly alternative to petroleum-based diesel fuel and can help to reduce dependence on fossil fuels and greenhouse gas emissions.

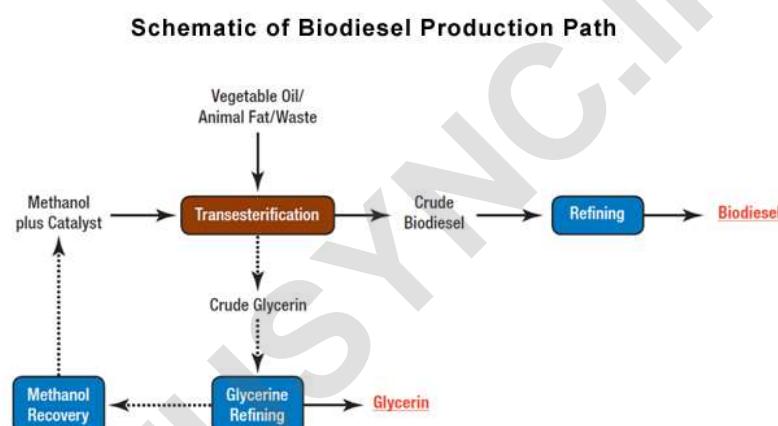


Figure-10 Flowchart of biodiesel production

Lipids as detergent:

Lipids act as detergents due to their amphiphatic nature. Phospholipid is major component of cell membranes. Phospholipids have hydrophilic heads and hydrophobic tails which allow them to form a bilayer in water with the hydrophilic heads facing outwards and the hydrophobic tail facing inwards. This means they have both hydrophobic (water-repelling) and hydrophilic (water-loving) regions. This allows them to interact with both water and oil making them effective at removing dirt, grease and other substances from surfaces.

Lipids can be used in cleaning products such as dish soaps, laundry detergents and all-purpose, one example of a lipid-based cleaning product is soap. Soap is made by mixing fatty acids with an alkali to create a salt. This salt is able to dissolve in and can attach to dirt and grime on surfaces allowing it to be easily removed.

Another example is citrus-based cleaners, which use the natural oils found in citrus fruits to break down and dissolve dirt and grime. These oils contain fatty acids that can act as detergents, allowing them to clean surfaces effectively.

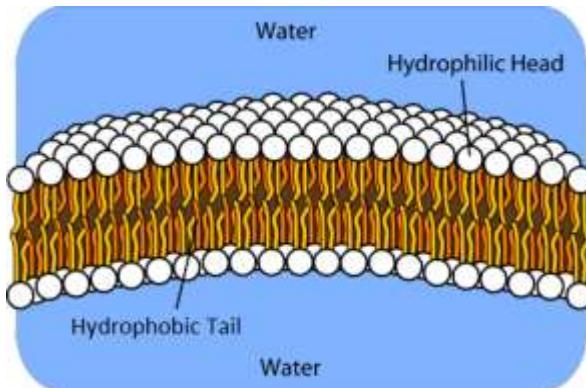


Figure-11 Structure of lipid bi-layers

Enzymes:

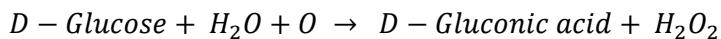
Enzymes are proteins that catalyze (speed up) chemical reactions in living organisms that convert substrate to product. They play an essential role in metabolism, which is the set of chemical reactions that occur in cells to maintain life. Enzymes are highly specific in their actions, meaning that they only catalyze specific reactions and are not used up or altered in the process.

Enzymes are made up of long chains of amino acids that fold into complex three-dimensional shapes. The specific sequence of amino acids determines all the shape of the enzyme and its catalytic activity. Enzymes typically have a pocket or active site where the reaction takes place. This active site is highly specific, allowing it to bind to a particular substrate, or molecule it acts upon.

Enzymes have many important applications in biotechnology, biosensors, medicine, and industry. For example, enzymes are used to produce biofuels, food and beverages, biopharmaceuticals, and other products. They are also used in diagnostic tests and as therapeutic agents for treating disease.

Glucose oxidase:

Glucose oxidase is an enzyme that catalyzes the oxidation of glucose to produce hydrogen peroxide and gluconic acid. It is commonly found in individuals in many microorganisms, including bacteria and fungi, and is often used in various industrial and biomedical applications.



In the medical field, glucose oxidase is used in diagnostic tests to measure blood glucose levels. Glucose oxidase-based tests are commonly used by people with diabetes to monitor their blood sugar levels. The enzyme reacts with glucose in a blood sample, producing hydrogen peroxide, which is then detected by a colour change or other indicator.

Glucose oxidase as biosensor to detect blood glucose:

Glucose oxidase is commonly used in blood glucose monitoring systems to detect glucose levels in blood. The process involves a biosensor that contains glucose oxidase which catalyzes the reaction of glucose and oxygen to form gluconic acid and hydrogen peroxide.

The biosensor typically consists of a test strip that contains a small amount of glucose oxidase and other chemicals, including a mediator and the use of plant stabilizer. The

test strip is inserted into a glucose meter which contains another value-added pr electrode that measures the amount of electrical current generated by the reaction between glucose oxidase and glucose.

When a drop of blood is applied to the test strip the glucose in the blood reacts with glucose oxidase, producing gluconic acid and hydrogen peroxide. The mediator in the test strip facilitates the transfer of electrons from the reaction to the electrode generating an electrical current proportional to the amount of glucose present in the blood. The glucose meter then calculates the glucose concentration in the hood based on the electrical current measured by the electrode. The glucose level displayed on the meter's screen allowing the over to mom their blood e levels and adjusts their insulin dose or diet needed.

Glucose oxidase-based blood glucose monitoring systems are widely d by people with diabetes to manage their condition. These systems provide accurate, convenient, and non-invasive glucose monitoring, allowing individuals to maintain tight control of their blood glucose levels and prevent complications associated with high or low blood sugar.

Lignolytic enzymes:

Lignolytic enzymes are a group of enzymes that are capable of degrading lignin, a complex polymer that is a major component of plant cell walls. Lignin is highly resistant to degradation, which makes it a major barrier to the use of plant biomass as a feedstock for the production of biofuels and other value-added products. There are several types of lignolytic enzymes including

Laccases: Laccases are copper-containing enzymes that catalyze the oxidation of phenolic compounds which are major components of lignin.

Peroxidases: Peroxidases are enzymes that use hydrogen peroxide or other oxidants to oxidize lignin.

Manganese peroxidases: Manganese peroxidases are enzymes that require manganese ions for their activity and are capable of oxidizing both lignin and aromatic compounds

Lignolytic enzymes are produced by a variety of organisms including fungi, bacteria and plants. They play an important role in the natural cycling of carbon in forest ecosystems where they are involved in the decay of woody debris. Lignolytic enzymes are also being investigated for their potential applications in the production of biofuels, bioplastics, and other by-products from lignocellulosic biomass

Lignolytic enzyme as biobleaching agents:

Lignolytic enzymes have been used in bio bleaching as an eco-friendly alternative to chemical bleaching agents in the pulp and paper industry. The lignin in wood pulp is responsible for the yellowish colour of the paper and it needs to be removed during the bleaching process to produce high quality white paper. Traditional bleaching methods involve the use of harsh chemicals, such as chlorine, which can generate toxic by-products and have negative environmental impacts.

Lignolytic enzymes particularly laccases and peroxidases, have been shown to effectively degrade lignin in wood pulp under mild conditions reducing the need for harsh chemicals in the bleaching process. Laccases and peroxidases are able to catalyze the oxidation of lignin and its derivatives, leading to the breakdown of lignin into smaller, more soluble compounds that can be removed from the pulp.

Bio bleaching with lignolytic enzymes has several advantages over traditional bleaching methods, including reduced environmental impact, improved paper quality and reduced energy consumption. As a result lignolytic enzymes have the potential to revolutionize the paper industry by providing a more sustainable and cost-effective approach to paper production.

Important questions

1. Explain the design and development of cellulose based water filters.
2. Explain the production of PHA, design and development of PLA bioplastics.
3. Explain the development of bioplastic from PLA.
4. Write a note on RNA vaccine for COVID-19.
5. Explain the steps involved in the process of DNA fingerprinting.
6. Describe the functions of proteins in the body.
7. Explain the production of biodiesel from the lipids.
8. Explain how lipids acts as detergent.
9. Write a note on glucose oxidase as biosensor.
10. Explain the biobleaching nature of lignolytic enzymes.