

Environmental Biotechnology





Environmental Biotechnology Course (409 E)

Part II: New Technologies for Biofuel Production

For

**Fourth year Environment Science & Environment Science &
Chemistry students**

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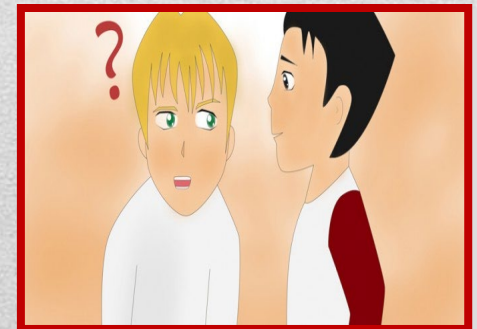
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INSTRUCTIONS



Lecture 2

Environmental Biotechnology

& its Applications



Environmental Biotechnology

Is the branch of biotechnology that addresses environmental problems, such as the removal of pollution, renewable energy generation or biomass production, by exploiting biological processes.

Environmental biotechnology in particular is the application of processes for the protection and restoration of the quality of the environment.

Environmental biotechnology can be used to detect, prevent and remediate the emission of pollutants into the environment in a number of ways.

Solid, liquid and gaseous wastes can be modified, either by recycling to make new products, or by purifying so that the end product is less harmful to the environment. Replacing chemical materials and processes with biological technologies can reduce environmental damage.

In this way environmental biotechnology can make a significant contribution to sustainable development.

Objectives of Environmental Biotechnology

According to Agenda 21, the aim of environmental biotechnology is to:

prevent, arrest and reverse environmental degradation through the appropriate use of biotechnology in combination with other technologies, while supporting safety procedures as a primary component of the programme.

Specific Objectives

1. To adopt production processes that make optimal use of natural resources, by recycling biomass, recovering energy and minimizing waste generation.
2. To promote the use of biotechnological techniques with emphasis on bioremediation of land and water, waste treatment, soil conservation, reforestation, afforestation and land rehabilitation.
3. To apply biotechnological processes and their products to protect environmental integrity with a view to long-term ecological security.

Applications

Renewable energy
generation

Bioenergy

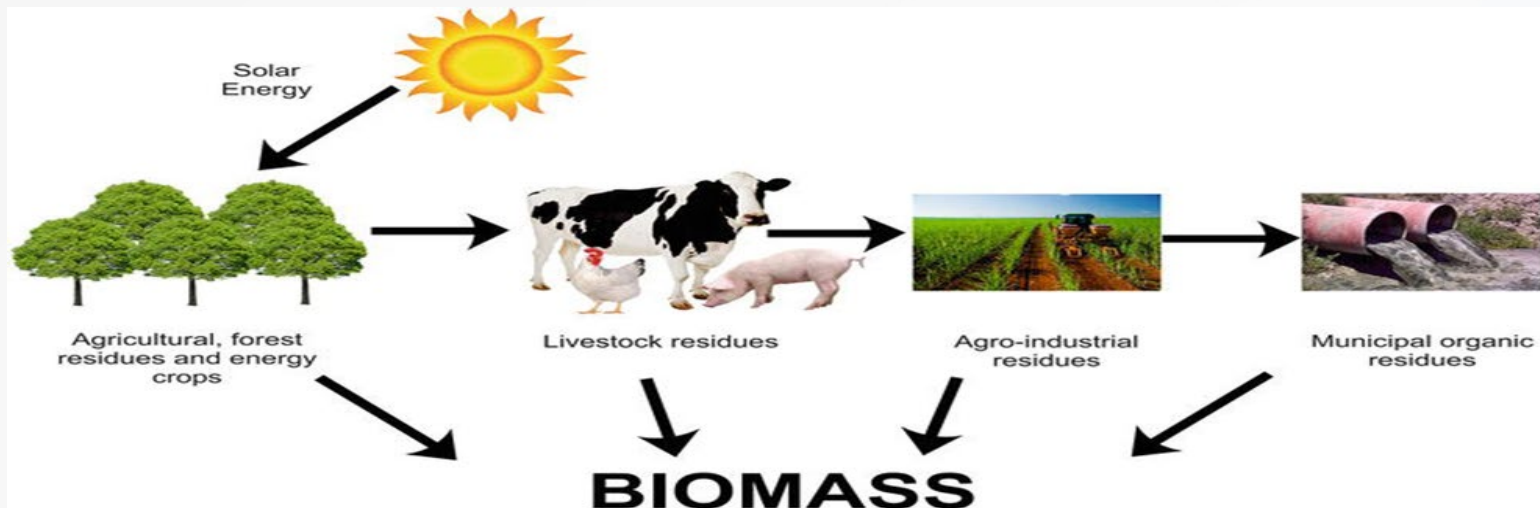


Bioenergy

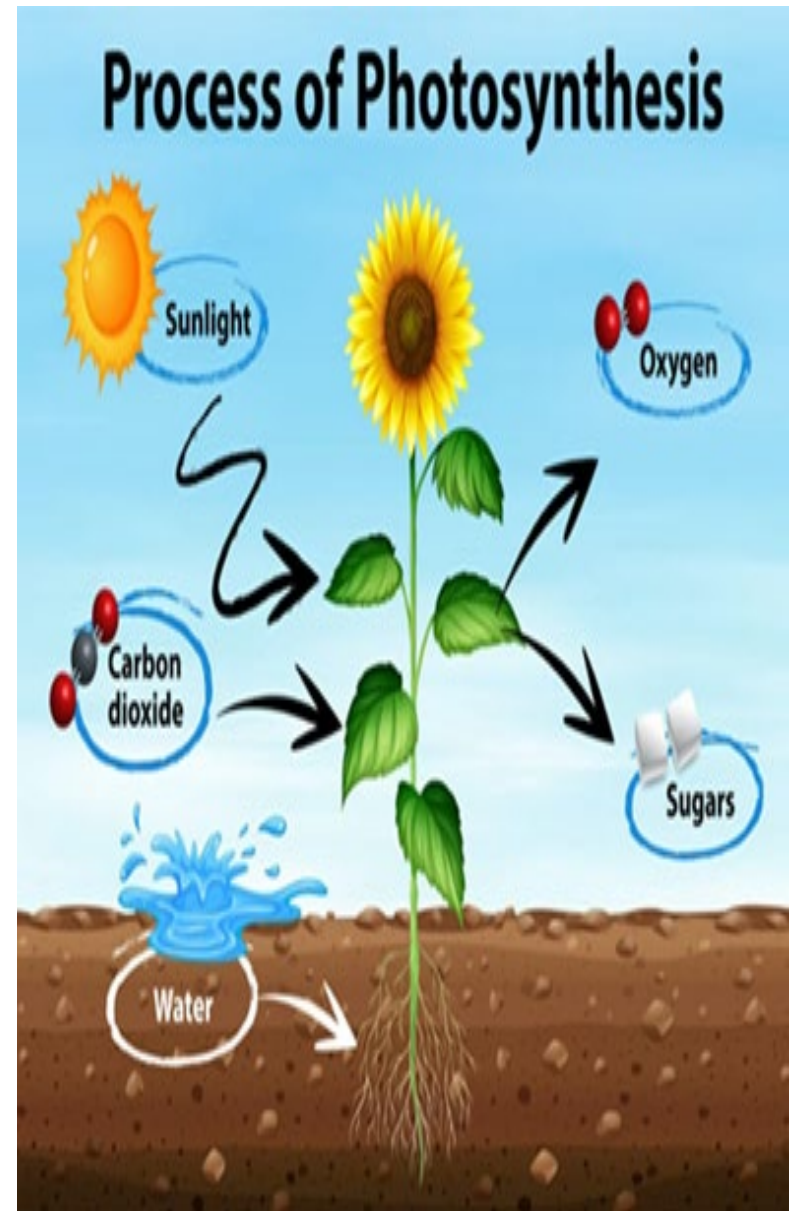
- ✓ Bioenergy is one of many diverse resources available to help meet our demand for energy.
- ✓ Bioenergy is currently the main contributor, accounting for **10.3%** of global primary energy supply.
- ✓ **Bioenergy** refers to energy production from biomass or renewable waste materials through direct use of the biomass as fuel or the production of other biofuels from further processing of the biomass.

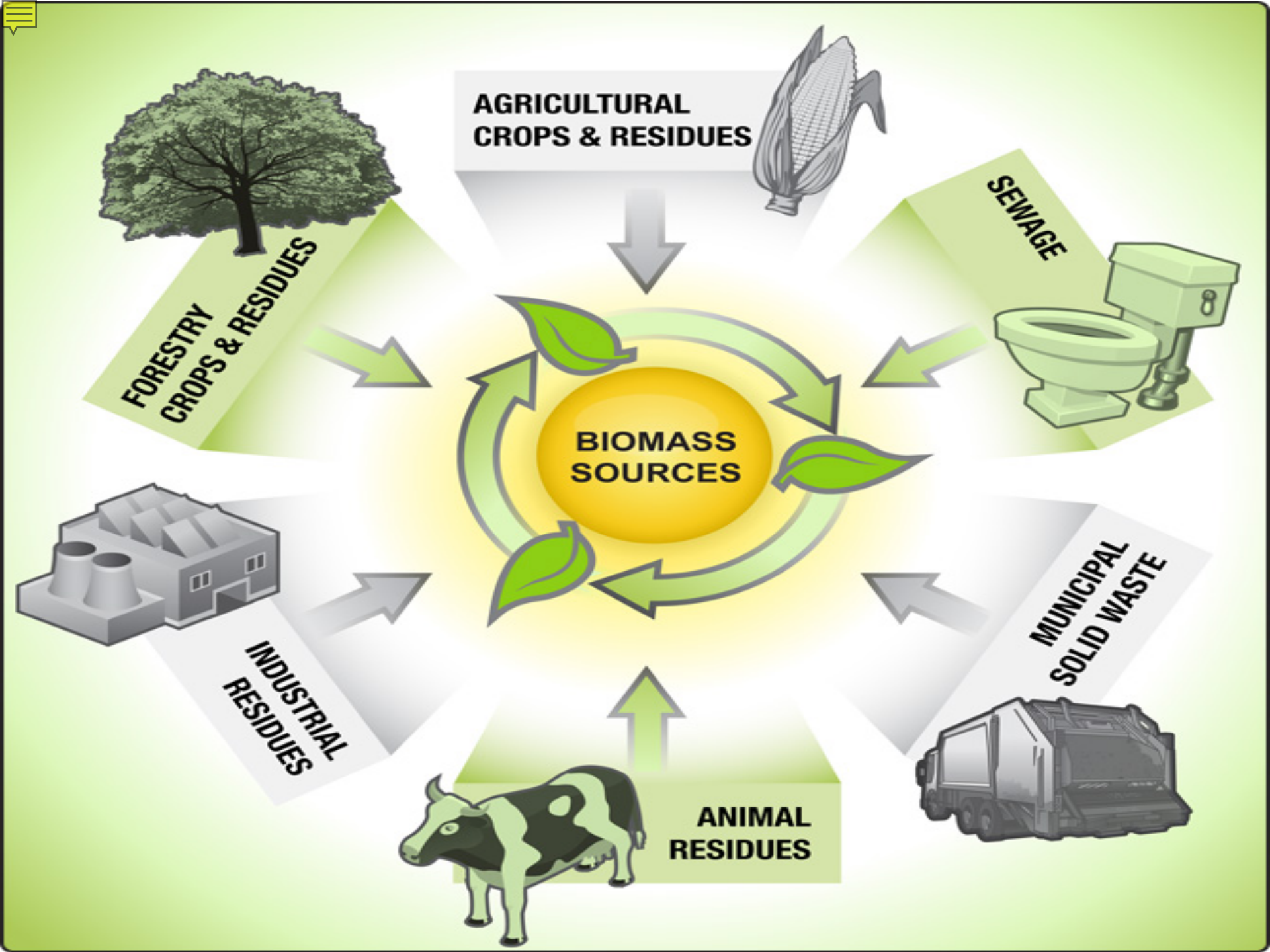
Biomass

Biomass is a term used to describe all organic matter produced by photosynthesis, existing on the earth's surface. They include all water- and land-based vegetation and trees, and all waste biomass such as municipal solid waste (MSW), municipal biosolids (sewage), and animal wastes (manures), forestry and agricultural residues, and certain types of industrial wastes.



- **Biomass** contains stored energy from the sun. Plants absorb the sun's energy in a process called photosynthesis.
- When biomass is **burned**, the **chemical energy** in biomass is released as heat.
- Biomass can be burned directly or converted to liquid biofuels or biogas that can be burned as fuels.





- **Biomass can be used for production of heat, power, transport fuels, and bioproducts.**
- **When produced and used on a sustainable basis, it is a carbon-neutral carrier and can make a large contribution to reducing greenhouse gas emissions.**

Biofuel the future of energy



Biofuels

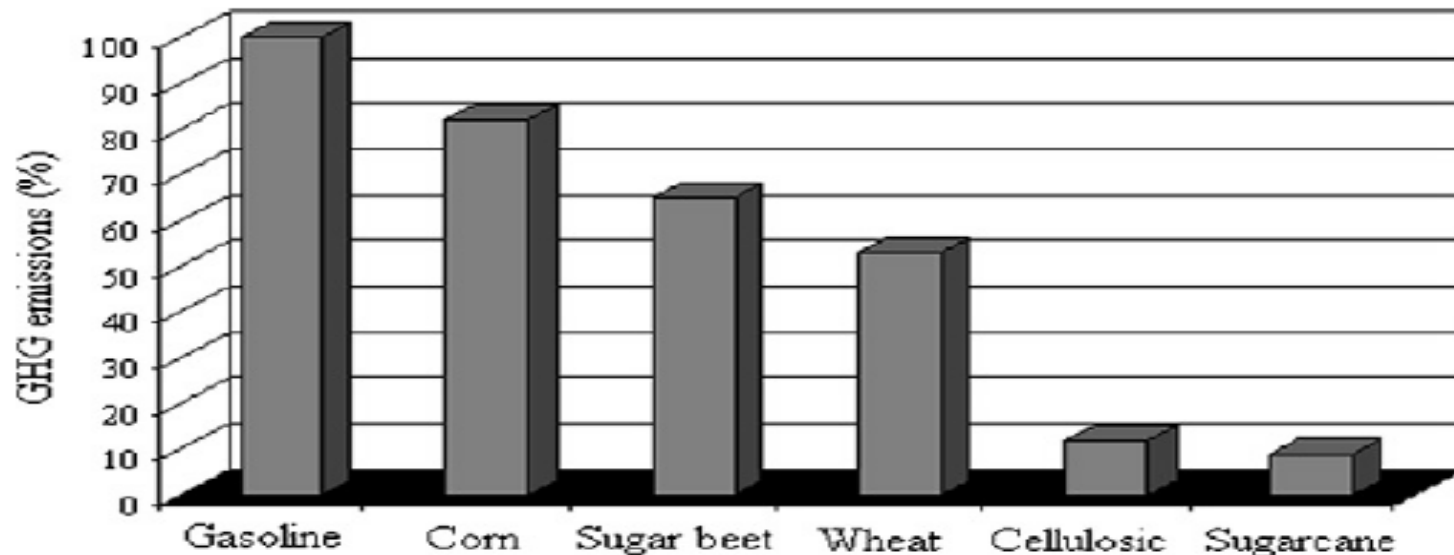
- Biofuels are solid, liquid or gaseous fuels that can be produced from biochemical/biological or thermochemical routes from a wide variety of substrates ranging from lignocellulosic biomass to renewable waste materials.

Advantages over petroleum-based fuels:

- 1) Biofuels can be easily extracted from many renewable resources either directly from plants, or indirectly from agricultural, commercial, domestic, and/or industrial wastes.

- 2) They are sustainable due to biodegradable property and their combustion based on carbon-dioxide.**
- 3) The use of biofuels can contribute to the mitigation of greenhouse gas (GHG) emissions as it provides a clean and sustainable energy source.**

- The utilization of organic wastes for biofuels production is the innovative approach towards the resolution of issues pertinent to waste management, fossil fuel dependency and harmful greenhouse gases (GHG) emissions.
- For example, the using of sugarcane and cellulosic bioethanol result in almost 90% lower GHG emissions



Biofuel examples



Ethanol

Ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) is a renewable fuel used:

- As feedstock for the chemical industry, as energy carrier and in alcoholic beverages.
- Moreover, it is the most widely used biofuel for transportation worldwide.
- It can be used as a complete transportation fuel or as a supplement to gasoline which improving octane and reducing emissions.



Higher Alcohols

- **Butanol** is considered a chemical of great industrial importance and also can be used as an advanced biofuel or in a blend with gasoline to enhance the octane rating.
- Its energy density (27 MJ/L) is close to that of gasoline (32 MJ/L) and it can be blended with it at basically any concentrations.
- **Butanol** is superior to ethanol as a fuel due to its higher energy content (ethanol 21 MJ/L vs n-butanol 27 MJ/L), less **hygroscopic, less volatile, less corrosive** and **less explosive** which makes it safer to use than ethanol.

Therefore, there is no need for any adjustment in vehicles or engines run on butanol rather than fossil fuels.

Hexanol

- **Hexanol** is another alcohol that can be blended with biodiesel or gasoline and has more advantages as a fuel than ethanol or n-butanol.
- Hexanol has several other industrial applications. It is also used in the pharmaceutical, cosmetic/ perfumes, textile, detergents, pesticides and leather industry.
- **n-Propanol** has also been considered as a candidate for the replacement of gasoline and is an important chemical for ink, cosmetics, vegetable oils, polymer and pharmaceutical industries
 - Therefore, the higher alcohols have been the focus of recent research initiatives.

2,3-butanediol

- **2,3-butanediol** the organic compound with the formula $(\text{CH}_3\text{CHOH})_2$.
- Has various applications in manufacturing industries, such as in the production of food, pharmaceuticals, printing inks, perfumes, fumigants, synthetic rubbers, octane boosters, or plasticizers.