

Botany (H) CBCS Syllabus WBSU

Semester IV

Core Course IX: Plant Ecology and Phytogeography

Course Code: BOTACOR09T THEORY

Unit 5: Biotic interactions

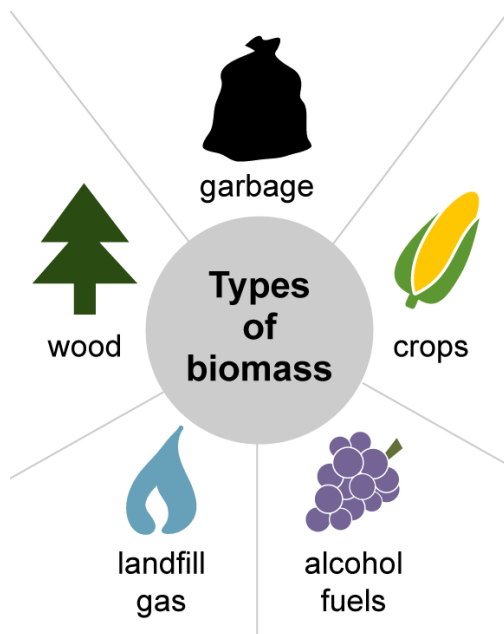
BIOMASS

Biomass refers to the organic material that is used for production of energy.

This energy production process is referred to as Bioenergy. Biomass is primarily found in the form of living or recently living plants and biological wastes from industrial and home use. Due to the breadth of the term, the physical composition of biomass is inconsistent, but generally includes carbon, water and organic volatiles.

For the production of energy from biomass, the term feedstock is used to refer to whatever type of organic material will be used to produce a form of energy. The feedstock must then be converted to a usable energy form through one of many processes.

Feedstock + Process -> Usable Energy Form



Some common biomass conversion processes include:

Combustion: the process by which flammable materials are burned in the presence of air or oxygen to release heat. It is the simplest method by which biomass can be used for energy. In its rudimentary form, combustion is used for space heating (i.e. a fire for warmth) but can also be used to heat steam for electricity generation.

Gasification: is the conversion of biomass into a combustible gas mixture referred to as Producer Gas ($\text{CO} + \text{H}_2 + \text{CH}_4$) or Syngas. The gasification process uses heat, pressure and partial combustion to create syngas, which can then be used in place of natural gas.

Pyrolysis: Consists of thermal decomposition in the absence of oxygen. It is the precursor to gasification, and takes place as part of both gasification and combustion. The products of pyrolysis include gas, liquid and a solid char, with the proportions of each depending upon the parameters of the process.

Anaerobic digestion (or biodigestion): is the process whereby bacteria break down organic material in the absence of air, yielding a biogas containing methane and a solid residue. The methane can then be captured to produce energy. Similarly, the solid residue can also be burned to produce energy.

Fermentation: involves the conversion of a plant's glucose (or carbohydrate) into an alcohol or acid. Yeast or bacteria are added to the biomass material, which feed on the sugars to produce ethanol (an alcohol) and carbon dioxide. The ethanol is distilled and dehydrated to obtain a higher concentration of alcohol to achieve the required purity for the use as automotive fuel. The solid residue from the fermentation process can be used as cattle-feed and in the case of sugar cane can be used as a fuel for boilers or for subsequent gasification.

Some feedstocks are more conducive for certain biomass conversion processes than others. The determination of which feedstocks and processes will be used is determined largely by the availability of resources and the desired end form of energy.

Examples of biomass and their uses for energy

- Wood and wood processing wastes—burned to heat buildings, to produce process heat in industry, and to generate electricity
- Agricultural crops and waste materials—burned as a fuel or converted to liquid biofuels
- Food, yard, and wood waste in garbage—burned to generate electricity in power plants or converted to biogas in landfills
- Animal manure and human sewage—converted to biogas, which can be burned as a fuel

People have used biomass energy—energy from living things—since the earliest “cave men” first made wood fires for cooking or keeping warm.

Biomass is organic, meaning it is made of material that comes from living organisms, such as plants and animals. The most common biomass materials used for energy are plants, wood, and waste. These are called biomass feedstocks. Biomass energy can also be a non-renewable energy source.

Biomass contains energy first derived from the sun: Plants absorb the sun’s energy through photosynthesis, and convert carbon dioxide and water into nutrients (carbohydrates).

The energy from these organisms can be transformed into usable energy through direct and indirect means. Biomass can be burned to create heat (direct), converted into electricity (direct), or processed into biofuel (indirect).

Biomass and the Environment

Biomass is an integral part of Earth’s carbon cycle. The carbon cycle is the process by which carbon is exchanged between all layers of the Earth: atmosphere, hydrosphere, biosphere, and lithosphere.

The carbon cycle takes many forms. Carbon helps regulate the amount of sunlight that enters Earth’s atmosphere. It is exchanged through photosynthesis, decomposition, respiration, and human activity. Carbon that is absorbed by soil as an organism decomposes, for example, may be recycled as a plant releases carbon-based nutrients into the biosphere through

photosynthesis. Under the right conditions, the decomposing organism may become peat, coal, or petroleum before being extracted through natural or human activity.

Between periods of exchange, carbon is sequestered, or stored. The carbon in fossil fuels has been sequestered for millions of years. When fossil fuels are extracted and burned for energy, their sequestered carbon is released into the atmosphere. Fossil fuels do not re-absorb carbon.

In contrast to fossil fuels, biomass comes from recently living organisms. The carbon in biomass can continue to be exchanged in the carbon cycle.

In order to effectively allow Earth to continue the carbon cycle process, however, biomass materials such as plants and forests have to be sustainably farmed. It takes decades for trees and plants such as switchgrass to re-absorb and sequester carbon. Uprooting or disturbing the soil can be extremely disruptive to the process. A steady and varied supply of trees, crops, and other plants is vital for maintaining a healthy environment.

Sources:

<https://www.studentenergy.org/topics/biomass>

<https://www.eia.gov/energyexplained/biomass/>

<https://www.nationalgeographic.org/encyclopedia/biomass-energy/>

*Used for Study Purpose only.

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