1-2: Functions of the ecosystem: …….Week 3

Basic features of Production , Consumption and Decomposition

Production and productivity :

1. Photosynthesis

The photosynthetic equation indicates that green plants can combine carbon dioxide with water , and using the energy of sunlight and the enzyme systems of chlorophyll and ultimately produce sugar and oxygen .

$$6CO_2 + 6H_2O \xrightarrow{\text{sunlight + chlorophyll enzymes}} C_6H_{12}O_6 + 6O_2\uparrow$$

This organic synthesis is not accomplished simply and in one step . In brief , photosynthesis involves two major stages :

1. Light reaction :

The photolytic cleavage of water in which light energy absorbed by chlorophyll provides the energy for the initial separation of water . Thus , the gaseous oxygen is produced early in the photosynthetic process in the same stage that produces hydrogen , as follows :

$$4\,Fe^{+3} + 2H_2O \xrightarrow{\text{sunlight + chlorophyll enzymes}} 4Fe^{+2} + 4H^{+} + O_2\uparrow$$

If we consider " A " represents any oxidant ion , Thus ;

$$2A + 2H_2O \xrightarrow{\text{sunlight + chlorophyll enzymes}} 2AH_2 + O_2\uparrow$$

2. Dark reaction :

The combination of atomic hydrogen with CO_2 to produce the first chemical union of carbon , hydrogen and oxygen . In this reaction , ATP (adenosine triphosphate) provides the energy source , as follows :

$$2AH_2 + CO_2 \xrightarrow{ATP} 2A + CH_2O + H_2O$$

Through several subsequent stages of reactions , finally glucose 6 – phosphate is synthesized .

Ecologically , photosynthesis requirements include all of the followings :

1. Green plants containing chlorophyll
2. Visible light energy (400 – 700 nm) or infrared (800 – 850 nm)
3. CO_2
4. Water
5. Some oxidant ions such as , iron or magnesium
6. Phosphorus as phosphates

Green plants have the additional capacity to synthesize higher organic compounds including starches , lipids , proteins , vitamins and nucleic acids . The proteins , for example , contain carbon , oxygen , hydrogen , nitrogen and usually sulfur as their basic elemental constituents . Thus , the importance of these five elements in ecology , is due to their presence in all major chemical components of living cells .

There are also few photosynthetic bacteria which utilize sunlight energy , but differ from green plants in that they do not produce oxygen as a by—product . The purple bacterium *Rhodospirillum* which can grow anaerobically , is an example of this group .

2. Chemosynthesis:

Another mechanism by which organic compounds can be synthesized from inorganic materials through bacterial action . The chemosynthetic bacteria are able to obtain energy by chemical oxidation of inorganic compounds rather than from sunlight . For example , the oxidation of ammonia(NH_3) to nitrite(NO_2) , nitrite(NO_2) to nitrate (NO_3) , sulfides(H_2S) to sulfur (S) and ferrous (Fe^{+2}) to ferric ions (Fe^{+3}) are all oxidative processes yielding energy which can then be used in organic synthesis by this mechanism .

Productivity :

All life depends upon the basic productive capacity of green plants and bacteria , though the chemosynthetic bacteria almost play only a very minor role in production . Plant productivity is called " primary production " . Two types of primary production are known ; "gross productivity" and the actual or "net productivity" **. Gross productivity is a measure of the total production of organic matter per unit area per unit time .** Typical ecosystem productivities vary from 0.5 – 20 g / m^2 / day **. Net productivity is the amount of production remaining after the needs for plant respiration and metabolism have been met .** Net productivities are usually only 20 - 30 % of gross productivities .

Consumption :

Consumers of primary production are the primary consumers or herbivores , and the secondary consumers which include carnivores , omnivores and scavengers , as discussed earlier under the section on the components of the ecosystem .

Decomposition :

Decomposition is the process by which complex materials are broken into simpler inorganic compounds that can again be utilized by plants for new growth , and it is also the process by which bacteria and fungi obtain energy and nutrient .

Decomposition , in its basic form may be represented by the same formula for respiration . Respiration in all living organisms is the process by which organic compounds are oxidized to yield energy with carbon dioxide and water as by—products .

Aerobic respiration is essentially an oxidative process, and it is the reverse reaction of photosynthesis, as follows :

$$C_6 H_{12} O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy}$$

This process occurs in living cell without bacterial action , just as it occurs in ecosystems with bacterial action . Similarly , Anaerobic respiration occurs in some cells without bacterial action , just as anaerobic decomposition of dead organic material occurs in ecosystems , with bacterial action. Anaerobic respiration involves the breakdown of simple sugars into triosephosphates , pyruvic acid , ethyl alcohol and finally acetic acid and water with the release of oxygen .

Some organic materials , such as sugars , lipids and proteins , are decomposed rapidly in a series of stages , whereas others , such as cellulose , lignin , hair and bones , are decomposed slowly . The decomposition of cellulose in particular may , in fact , be a limiting factor in some ecosystems .

Decomposer organisms are highly abundant in natural ecosystems . One gram of soil may contain one billion bacterial cell , 5 million actinomycete fungi , 500,000 protozoa and 200,000 molds of various kinds .

No single type of bacterium or fungus performs the complete range of decomposition . For example , in the decomposition of milk (Fig . 3) , *Streptococcus lactis* acts upon lactose to produce lactic acid . As the pH falls , the *S . lactis* can no longer live normally , but the process is continued by *Lactobacilli* which can tolerate more acid conditions . Finally , as very acid conditions are reached , various species of yeasts and molds begin growth to continue the decomposition of lactic acid to carbon dioxide and water . As this occurring other types of bacteria , such as *Pseudomonas* begin the decomposition of proteins into ammonia and simpler nitrogen compounds .

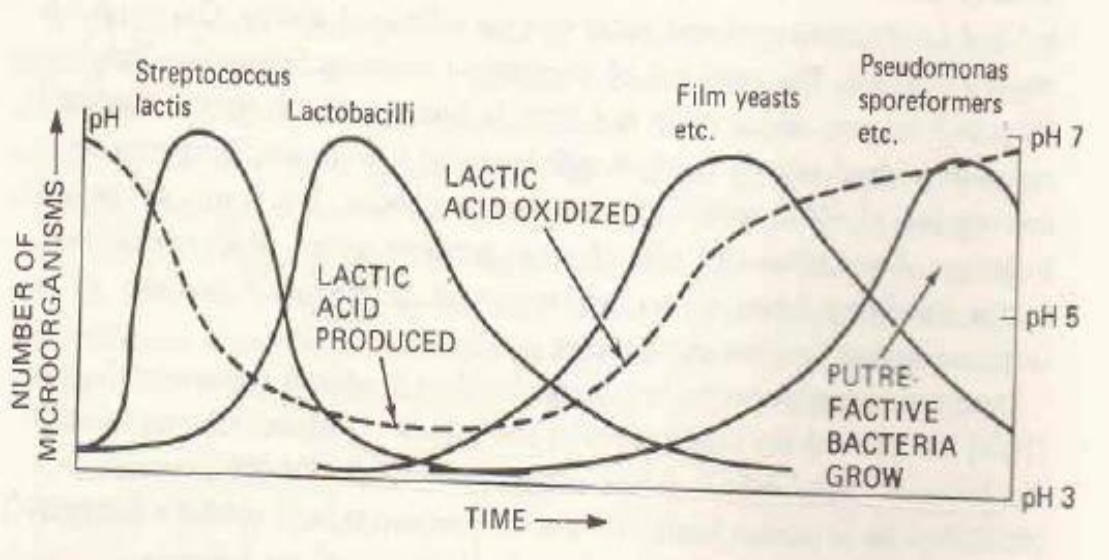

Fig . 3 : The decomposition of milk at room temperature

Another important function of decomposers is the production of metabolic products with a regulatory function on other organisms ,which called " ectocrines " or " environmental hormones " . These are chemical substances produced by one group of organisms which have a regulatory influence on other organisms in the environment . For example , the fungus *Penicillum* release a substance into the environment which inhibits bacterial growth . They are not specifically the products of decomposers alone , since it is known also that higher plants and animals produce and release such substances which have a regulatory influence on other organisms , but the decomposers are more important as sources of ectocrines .