Programme: Bachelor of Science (First Year)

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Course Title: Introduction and Scope of Microbiology

Unit VIII: Ecology and Ecosystems

Module Name: Trophic levels: Primary and Secondary production, food chains and food webs

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Notes

Trophic Levels

The feeding positions in a food chain or web are called trophic levels. All food chains and webs have at least two or three trophic levels. Generally, there are a maximum of four trophic levels.

Trophic Levels and Energy

Energy is passed up a food chain or web from lower to higher trophic levels. However, generally only about 10 percent of the energy at one level is available to the next level. This is represented by the ecological pyramid. The other 90 percent of energy is used for metabolic processes or given off to the environment as heat. This loss of energy explains why there are rarely more than four trophic levels in a food chain or web.

Following table represents the trophic level and the examples

Trophic Level	**Where It Gets Food**
1st Trophic Level: Producer	Makes its own food
2nd Trophic Level: Primary Consumer	Consumes producers
3rd Trophic Level: Secondary Consumer	Consumes primary consumers
4th Trophic Level: Tertiary Consumer	Consumes secondary consumers

Trophic level, step in a nutritive series, or food chain, of an ecosystem. The organisms of a chain are classified into these levels on the basis of their feeding behaviour. The first and lowest level contains the producers, green plants. The plants or their products are consumed by the second-level organisms—the herbivores, or plant eaters. At the third level, primary carnivores, or meat eaters, eat the herbivores; and at the fourth level, secondary carnivores eat the primary carnivores.

Primary production

Primary production is the synthesis of organic material from inorganic molecules. Primary production in most ecosystems is dominated by the process of photosynthesis, in which organisms synthesize organic molecules from sunlight, H_2O, and CO_2. Primary production is sometimes broken down into Net Primary Production (NPP) and Gross Primary Production (GPP). Gross primary production measures all carbon assimilated into organic molecules by primary producers. Net primary production measures the organic molecules by primary producers. Net primary production also measures the amount of carbon assimilated into organic molecules by primary producers, but does not include organic molecules that are then broken down again by these organisms for biological processes such as cellular respiration.

Photoautotrophs

Organisms that rely on light energy to fix carbon, and thus participate in primary production, are referred to as photoautotrophs. Many bacterial taxa are known to be photoautotrophic such as cyanobacteria and some proteobacteria.

Lithoautotrophs

Lithoautotrophs use reduced chemical compounds such as hydrogen gas, hydrogen sulfide, methane, or ferrous ion to fix carbon and participate in primary production. Lithoautotrophic organisms are prokaryotic and are represented by members of both the bacterial and archaeal domains. Lithoautotrophy is the only form of primary production possible in ecosystems without light such as ground-water, hydrothermal vent, soil, and cave ecosystems.

Secondary production

Secondary production is the generation of biomass of heterotrophic (consumer) organisms in a system. This is driven by the transfer of organic material between trophic levels, and represents the quantity of new tissue created through the use of assimilated food. Secondary production is sometimes defined to only include consumption of primary producers by herbivorous consumers but is more commonly defined to include all biomass generation by heterotrophs. Organisms responsible for secondary production include animals, protists, fungi and many bacteria. Secondary production can be estimated through a number of different methods including increment summation, removal summation, the instantaneous growth method and the Allen curve method.

Food Chain

The transfer of food energy from the producers, through a series of organisms (herbivores to carnivores to decomposers) with repeated eating and being eaten, is known as food chain. In nature, basically two types of food chains are recognized – grazing food chain and detritus food chain. Food chains and energy flow are the functional properties of ecosystems which make them dynamic. The biotic and abiotic components of an ecosystem are linked through them. There are two types of food chains:

(i) Grazing food chains: which starts from the green plants that make food for herbivores and herbivores in turn for the carnivores. Ecosystems with such type of food chain are directly dependent on an influx of solar radiation.

This type of chain thus depends on autotrophic energy capture and the movement of this captured energy to herbivores. Most of the ecosystems in nature follow this type of food chain.

A simple grazing food chain (GFC) is depicted below:

The phytoplanktons →zooplanktons →Fish sequence

(ii) Detritus food chains: start from the dead organic matter to the detrivore organisms which in turn make food for protozoan to carnivores etc. The detritus food chain (DFC) begins with dead organic matter. It is made up of decomposers which are heterotrophic organisms, mainly fungi and bacteria. They meet their energy and nutrient requirements by degrading dead organic matter or detritus. These are also known as saprotrophs (sapro: to decompose).

Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them. In an aquatic ecosystem, GFC is the major conduit for energy flow. As against this, in a terrestrial ecosystem, a much larger fraction of energy flows through the detritus food chain than through the GFC. Detritus food chain may be connected with the grazing food chain at some levels: some of the organisms of DFC are prey to the GFC animals, and in a natural ecosystem, some animals like cockroaches, crows, etc., are omnivores.

Parasitic food chain

Parasitic food chain is also a auxiliary food chain. It begins with the host and usually end in parasite.

Food web

Simple food chains are very rare in nature because each organism may obtain food from more than one trophic level. Thus, in an ecosystem, the various food chains are interconnected to each other to form a network called food web. A food web illustrates all possible transfers of energy and nutrient among the organisms in an ecosystem, whereas food chain traces only one pathway of food. Food webs are very important in maintaining the stability of an ecosystem.