Chapter 10 Microbial Ecology

Life science involves issues on different levels including biosphere, ecosystem, community, population, individual, organ. The fourth levels deal with ecology.

Biosphere is all the space where life distribtues。

Ecosystem is the whole system in which life and environment enact with each other.

Microbial ecology is the study of the behavior and activities of microorganisms in their natural environments.

Section 1 Microorganisms in natural ecosystem

1 Microorganisms in soil

1) Soil is natural medium for microorganisms

There are many factors which favor the growth of microbes in soil. These factors include residues from plants and animals, rich mineral nutrients, fertilizer and organic matter in cultivated soil and favorable environment conditions(water, oxygen, pH and temperature). Therefore, there are a large amount of microbes living in soil!

2) Types of soil microorganisms

Types and quantity of microbes in soil

Microbes	Numbers / g	Biomass (kg / Mu）
Bacteria	108	75
Actinomycetes	107	--
Mould	106	150
Yeast	105	7.5
Algae	104	7.5
Protozoa	103	15

3) Distribution of microbes in soil

Distribution of microbes in soil depends on many factors. These factors include types of soil, fertility of soil, moisture of soil, depth of soil and season.

4) Rhizosphere Effect .

Rhizosphere is the soil region ranging 2-3mm from the surface of root.

Rhizosphere effect is the phenomenon that in the rhizosphere, microbial populations reach much higher densities than in the free soil.

R/S Ratiois the ratio of microbes in rhizosphere to those in soil.

Rhizosphere effects are caused by such factors in rhizosphere as metabolites from plants and extracellular enzyme, fragments of the root, increasing availability of mineral nutrients by acidifying the niche with organic acid or by solution of carbodioxide in water and increasing oxygen by such plants as rice.

Beneficial effects of rhizosphere microbes on plants ：

* It removes hydrogen sulfide, which is toxic to the plant roots.

* It increases availability of mineral nutrients by mineralization of organic molecules and acidifying insoluble inorganic molecules.

* It synthesizs vitamins, amino acids, auxins, gibberellins that stimulate plant growth.

* It antagonizes potential plant pathogens through competition and the production of antibiotics.

2 Microorganisms in water

In fresh water and in the oceans, microorganisms exist in large quantity, showing less biodiversity than in soil.

Microorganisms play essential roles in nature, for example, they can serve as foods to fish and other aquatic life , and play an important role in the food chain of marine ecosystem. Microorganisms help self cleaning in water(removing organic or inorganic material). Microorganisms also serve as index for water treatment.

3 Microorganisms in air

Air is not favorable for growth and reproduction of microorganisms.

* It is temporary place for microbes to stay.

* It is significant for the distribution of microbes all around the earth.

Section 2 Microbial interactions

Neutralism is the relationship in which microbes have no obvious impacts on others.

Metabiosis is the relationship in which microbes are favorable to others, including commensalism and synergism.

Symbiosis is the relationship in which microbes live together to form a new structure where microbes benefit each other.

Competition is the relationship in which microbes compete for nutrient and space for survival.

Antagonism is the relationship in which microbes give off metabolites to inhibit or kill others.

Parasitism is the relationship in which microbes live in or on other microbe to obtain nutrient and destroy the hosts in the end.

Predation is the relationship in which microbes prey on others.

Section 3 Biogeochemical cycles in nature and microorganisms

1、Carbon cycle

Carbon exists mainly in forms of oil, natural gas, coal and peat. The rest exists in the body of organisms, atmosphere, etc.

CO_2 in the air will be used up by plants in about 20 years by photosynthesis. However, the carbon in organism can be decomposed by microbes in the process of decomposition, respiration, fermentation and production of CH_4 , which can return the carbon to atmosphere. The cycle of carbon is therefore completed in this way.

2、Nitrogen cycle

Nitrogen in nature exists in three forms, element nitrogen, inorganic nitrogen and organic nitrogen.

194×10^{15}t of nitrogen exists in deposits of the earth, 3.8×10^{15}t exists in the air and 8.5×10^{11}t exists in the body of organism(mainly plants).

There is a small amount of nitrate and ammonium needed by plants in soil. The cycle of nitrogen involves such processes as biological nitrogen fixation, nitrification, assimilation of nitrate, ammonification, assimilation, dinitrification of nitrate, nitrification, and ammonification of nitrite.

3、Sulfur cycle

Sulfur exists in nature mainly in forms of organic sulfur(-2), mineral sulfur(0) and sulfate(+6).

In the decomposition of organic matters containing sulfur, protein is decomposed into amino acid and through the process of deulfuration, hydrogen sulfide is given off. The example of microbe for this process is *Proteus vulgaris*.

In the process of sulfur oxidation, hydrogen or element sulfur is oxidated into sulfate and energy is obtained by the microbes. The examples of microbes include *Thiobacillus*， *Beggiotoa*， *Chromatium.*

In the process of sulfur reduction, sulfate is reduced into hydrogen or element sulfur. The example of microbes is *Desulfovibrio.*

4、Phosphorus cycle

Phosphorus in soil exists mainly in two forms, organic phosphorus and inorganic phosphorus. The two forms of phosphorus could be transformed by only microbes in soil to be absorbed.

In the process of decomposition of organic phosphorus, organic phosphorus is decomposed into inorganic phosphorus.

Insoluble inorganic phosphorus could be acidified and transformed to soluble inorganic phosphorus, which is to be taken up by plants.

5、Transformation of iron and manganese

In the transformation of iron, Fe^{2+} could be changed into Fe^{3+} by microbes.

In the transformation of manganese, Mn^{2+} could be changed into Mn^{4+} by microbes.

6、C:N Ratio and availability of fertility

Favorable C:N ratio for the growth of microoganisms is 25:1 generally.

If C:N ratio in organic fertilizer is more than 25（rice），the extra carbon will combine nitrogen in soil and therefore cause temporary shortage of nitrogen in soil.

On the other hand, if C：N ratio is less than （alfalfa），the extra nitrogen will be added in soil. But in the long run, either case will increase the amount of nitrogen in soil.

Organic fertilizer should be applied after composting.