Essay: 2016

1. (a) Describe Briefly the nature and distribution of microorganisms in soil.

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Soil contains a diversity of microorganisms

1. bacteria
2. fungi
3. algae
4. *vi*rus / protozoa
5. They belong to different general species.
6. Soil provides a suitable chemical environment and
7. a suitable physical environment (for microbial growth.)
8. The number of microorganisms present depends on the soil environment.
9. In the fertile soil bacteria dominates soil microorganisms.
10. Microorganisms use minerals/ mineral nutrients,
11. (decomposing) organic material,
12. gases CO_2/ O_2 /N_2
13. Water in soil for their growth.
14. More microorganisms are found on surface
15. microorganisms
16. due to availability of oxygen

(b) Discuss the specific role of microorganisms in the natural cycling of carbon and nitrogen in the biosphere.

In the natural carbon cycle element carbon is cycled in different forms in the environment through living organisms.

1. CO_2 in the environment (aquatic and terrestrial) is fixed
2. by chemoautotrophic/ photosynthetic bacteria
3. such as cyanobacteria and
4. Algae
5. by / photosynthesis
6. Dead plant and animal bodies are decomposed by heterotrophic bacteria
7. and fungi
8. and CO_2 is released (to the environment)
9. through respiration of microorganisms.

• in the natural cycle of nitrogen, element nitrogen is cycled in different forms trough atmosphere, living organisms aquatic and terrestrial environments.

10. soil microorganisms
11. such as *Azotobocter and*
12. *Rhizobium*
13. fix (gaseous) nitrogen
14. in to nitrogenous compounds protein/NH_4^+
15. Decomposition of protein/ organic matter in dead organisms.
16. by heterotrophic microorganisms/ bacteria and fungi
17. produce amino acids (proteolysis) which
18. are converted to NH_4^+ (ammonification)
19. Ammonium ions are then converted to nitrite
20. by Nitrosomonas.
21. Nitrite is converted to nitrate
22. by *Nitrobactor.*
23. some nitrates are converted to gaseous nitrogen
24. by denitrifying bacterial Pseudomonas sp.

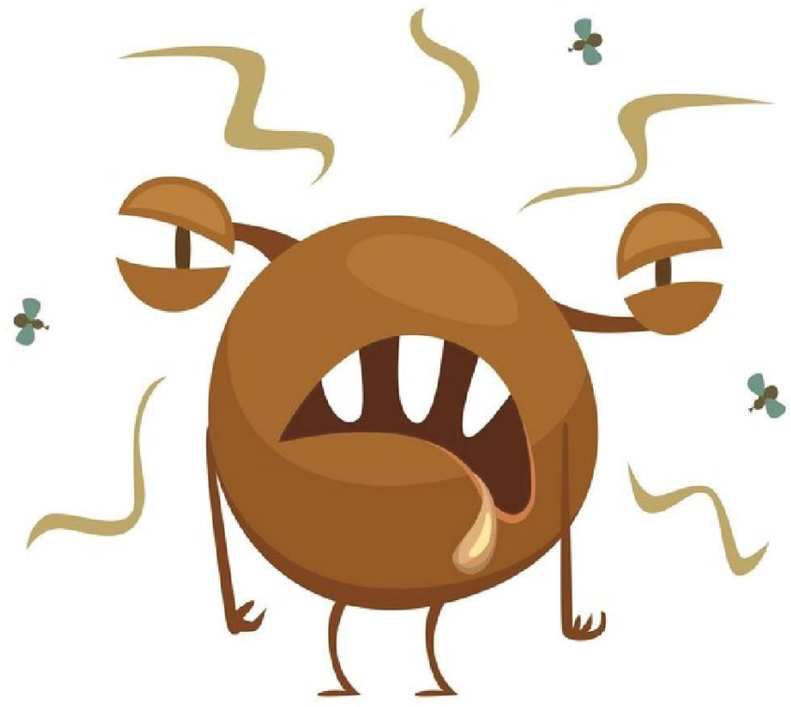
any 20 x 04 marks = 80 marks

(c) State the significances of interactions of soil microorganisms relevant to plant growth.

1. Microorganisms are involved in the formation of soil aggregates
2. Symbiotic nitrogen fixation.
3. Mycorrhiza association between roots and fungi improve phosphate nutrition
4. Root surface (rhizosphere) microorganisms produce growth promoting substances and
5. chemicals that inhibit the growth of plant pathogenic bacteria

Microbiology

4



Unit 09 Microbiology

9.3.0 : Investigates the use of micro-organisms in industry, agriculture, environment and contribution of soil microorganisms for agriculture

9.3.2 : Explores the functions of soil micro-organisms to maintain soil health

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Number of Periods : 06

Nature, distribution and role of soil microorganisms

Soil provides an adequate …….. and ……. environment for growth of microorganisms in terms of space and nutrients which include minerals, decomposing ……., ……..., …….... such as ……..……..., ……. and ……..... Within a few centimeter depth of soil, there are different amounts of oxygen, moisture, light and nutrition, increasing the diversity of soil microorganisms.

The top few centimeters of the soil contains the largest community of ……..... Microbial number ……... rapidly with ……. depth. Majority of soil microflora is represented by …….. In addition, there are ……..., ……..., ……... and ……... Actinomycetes, despite of being a member of domain bacteria, usually it is mentioned separately due to their significances. These microorganisms play a major role in …….. of complex organic substances and participate in ……... of elements in biogeochemical cycles. Elements are oxidized and reduced by microorganisms for their metabolic requirements.

1. Mineralization

Mineralization is the ……. of …….. and ……... residue by using …….. enzymes of bacteria and fungi. These enzymes break down complex ……... materials into simple ……... materials such as CO_2 and H_2O. This is the major process by which plant nutrients are made available and recycling. Mineralization helps in following ways;

- ……
  ……
- ……

2. Role of microorganisms in the carbon cycle

- All organisms contain a large amount of carbon in organic compounds such as ……..., ……., ……... and ……...

Rhizobium - ……..
Nitrobacter - ……..
Anabaena - ……..
Pseudomonas - ……..
Nostoc - ……..

13. State how cyanobacteria are important to maintain nitrogen cycle.
    ……
    ……
14. State scientific names of some of the important cyanobacteria.
    ……
    ……
15. What are special structures present within those cyanobacteria.
    ……
    ……
16. State habitat of *Rhizobium* bacterium.
    ……
    ……
    ……
17. Sate names of some of the anaerobic microorganisms involve in nitrogen cycle.
    ……
    ……
18. State 2 differences between proteolysis and ammonification
    ……
    ……
19. State whether these statements are correct or wrong.
    Clostridium is a nitrifying bacterium ……
    Nitrosomonas is an autotrophy ……
    Pseudomonas improves soil fertility ……
    Acid rains disturbs nitrogen cycle ……
    Some soil microorganisms produce cytokinin ……
20. What is meant by nitrate respiration
    ……

8. Stet the type of microorganisms involve in following events.

1.	Decomposition	
2.	Nitrogen cycle	
3.	Formation of soil aggregates	
4.	Formation of mycorrhizae	
5.	Formation of plant growth substances	

9. State several factors disturbs the activity of soil microorganisms.

.....

.....

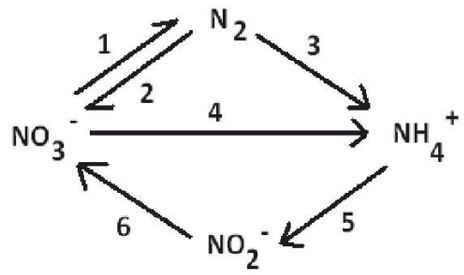
.....

10. What are called as rhizosphere microorganisms.

.....

.....

11. Followings shows the stages relates to nitrogen cycle.



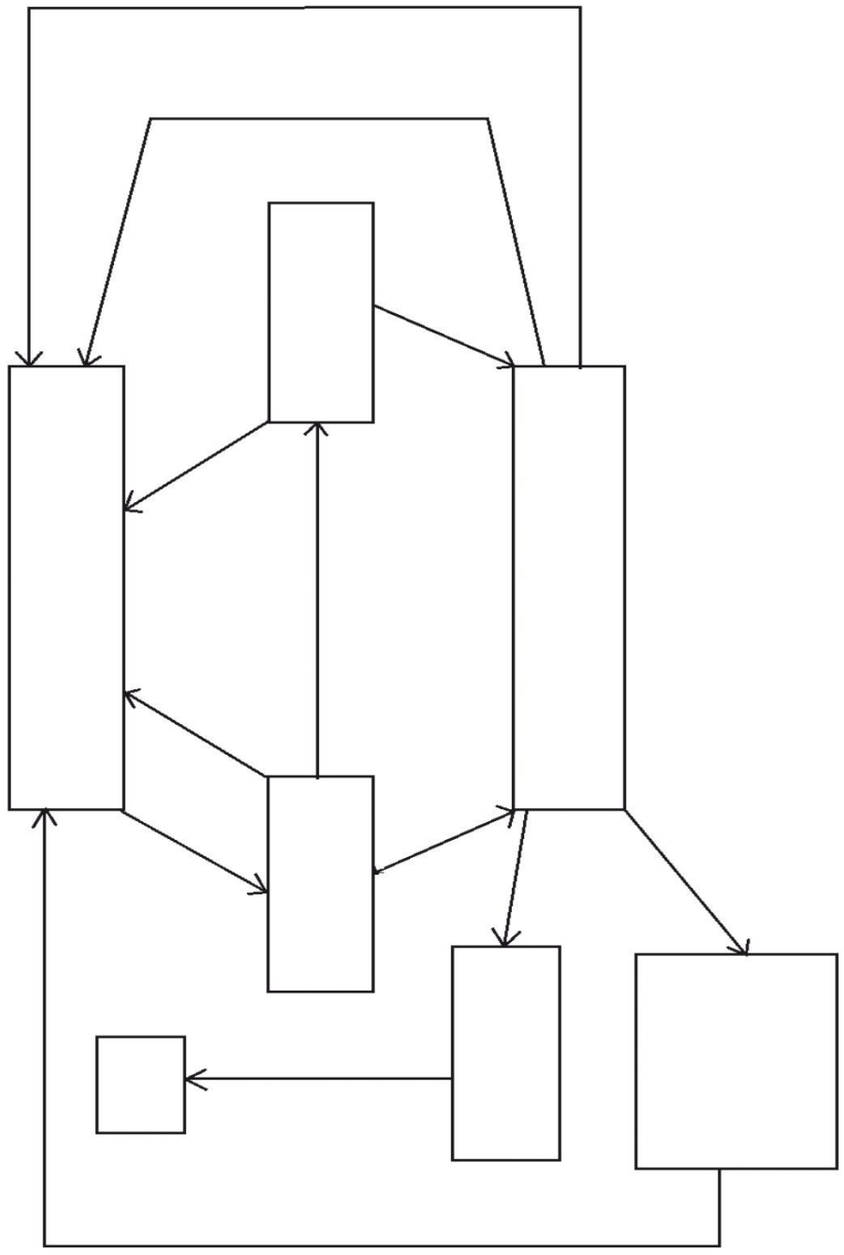
(i) State the number relates to following event.

1. Nitrification - .....
2. Denitrification - .....
3. Biological nitrogen fixation - .....
4. Non biological nitrogen fixation - .....

12. State how following organisms are important for N_2 cycle.

Clostridium - .....

Nitrosomonas - .....



- Photosynthesis is the important first step in carbon cycle, in which, the atmospheric inorganic carbon dioxide is reduced/fixed to form organic compounds by photosynthetic organisms.
  Photoautotrophs such as plants, cyanobacteria, algae and photosynthetic bacteria fix carbon dioxide using energy from sunlight.
- …….. such as animals and protozoa, depend on organic compounds produced by autotrophs to utilize them as their carbon source.
- Through food chain, carbon fixed from carbon dioxide by autotrophs, transferred from organism at lower trophic levels to the organisms at higher trophic levels.
- Both autotrophs and chemoheterotrophs, release a part of their fixed carbon as carbon dioxide to the atmosphere through …….... This carbon dioxide is again made available for autotrophs.
- In chemoheterotrophs, …….. food is released to the environment as …….. which is later decomposed by soil microorganisms.
- Rest of the carbon fixed in organisms, remain within them until they die. Once the organisms are dead, these organic compounds are decomposed and carbon dioxide is returned back to the atmosphere.
- Microorganisms, mainly bacteria and fungi play a major role in organic matter decomposition.
- Microorganisms play another major role in carbon cycle in relation to methane gas- Ocean sediments contain a large amount of methane. However, about …….... of methane generated within ocean is consumed by microorganisms called methanotrophs before it reaches to the atmosphere.
- Despite of the above, methanogenic bacteria in the ocean 's depths are constantly producing more methane.

3. Role of microorganisms in the Nitrogen cycle

All organisms require nitrogen to synthesize protein, nucleic acid and other nitrogen-containing compounds. About …… of molecular nitrogen available in the atmosphere. This is not biologically available for organisms. Therefore, it is essential to convert that atmospheric molecular nitrogen into bioavailable forms of nitrogen. Certain groups of microorganisms are able to fix gaseous molecular nitrogen into bioavailable forms of nitrogen such as ……., …….. and ……..

Learning Outcomes

1. What chemical and physical environment of soil act as a healthy media for the growth of micro-organisms
   ……
   ……
   ……
   ……
   ……
2. Briefly describes the nature, distribution and roles of soil microbes
   ……
   ……
   ……
   ……
3. Briefly describes the natural role of micro-organisms as decomposers in recycling of minerals
   ……
   ……
   ……
   ……
4. Describes the interactions of soil micro-organisms relevant to plant growth
   ……
   ……
   ……
5. Describes the role of micro-organisms in improving soil quality
   ……
   ……
   ……
6. What are different soil microorganisms.
   ……
   ……
7. What is the most common type found in soil.
   ……

at iron limiting conditions and defense against pathogens. In return plants provide organic compounds essential for the microorganisms.

Rhizosphere

This is a kind of symbiotic interaction between plant roots, and soil surrounding the root surface for about few millimeters. This micro-ecological zone is called rhizosphere. Rhizosphere is considered as the most biodiverse and dynamic habitat on earth.

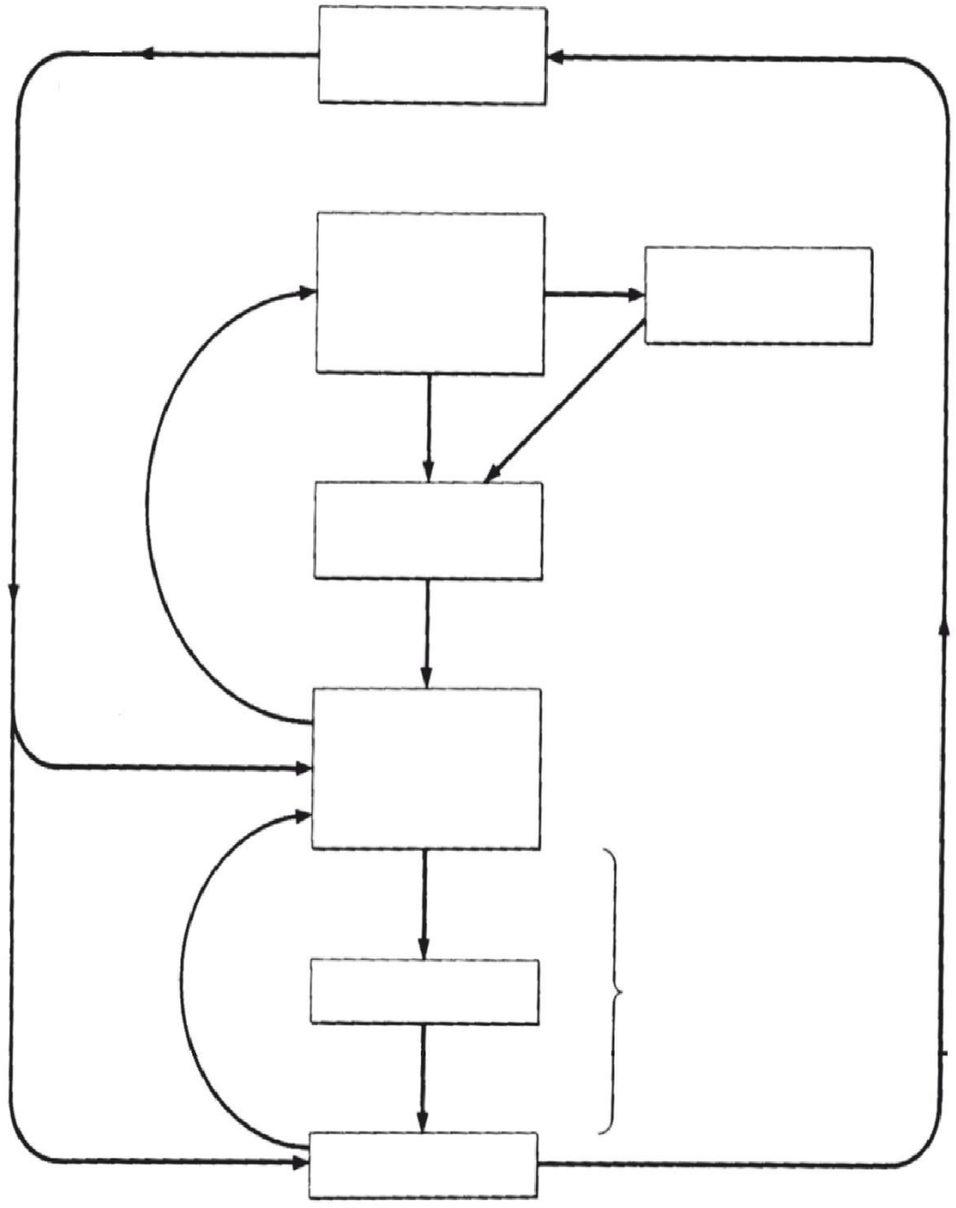
Microorganisms in the rhizosphere feed on the compounds exuded by roots such as sugars, amino acids and various aromatic compounds. Microorganisms compete—antagonize using antimicrobial compounds with each other for resources such as nutrients, space, and water in the rhizosphere. Bacteria are the most numerous organisms in the rhizosphere. Three most common genera of bacteria inhabiting rhizosphere are *Pseudomonas*, *Bacillus* and *Agrobacterium*. Root exudates act as chemical signals for bacteria to move towards the root surface. Both pathogenic and symbiotic fungi associate with the rhizosphere.

Mycorrhizae

Mycorrhizae (myco = fungus, rhiza — root) are symbiotic association between plant roots with fungi. All most all land plants have symbiotic association with one or more mycorrhizal fungi. Mycorrhizal fungi extend the surface area over which nutrients and water can be taken up by the plant. They can reach small pores in soil where plant roots cannot reach and uptake nutrients. Most significantly, mycorrhizae increase uptake of immobile nutrients such as phosphorous, zinc and copper. In return, mycorrhiza receive organic carbon from the plant.

Role of soil microorganisms in improving soil quality

Free living soil microorganisms and those associated with root surfaces, play a major role in improving soil quality. Microorganisms are involved in the formation of stable soil-aggregates, which are characteristics of good soil structure infertile soils. Fungal filaments, Actinomycetes filaments and polysaccharide gums/slimes produced by bacteria are involved in soil aggregation formation.



Therefore, nitrogen available on the earth, organisms and the atmosphere must follow cyclic paths.

There are four key steps in the nitrogen cycle, they are, ……., ……..., ……. and nitrogen fixation.

- **Ammonification**
- More than ……. of organic nitrogen in the soil exist as proteins. Proteins from dead plants and animals are decomposed by extracellular ……... enzymes secreted by ……... into amino acids. Resulting amino acids are taken into microbial cells and are then subjected to ……... in which, amino groups of amino acids are converted into ……... (NH_3). In moist soil, ammonia is ……. in water to form ……. ions (NH_4^+). This ammonium ions are utilized by plants and soil microorganisms. Ammonia in …….. soil rapidly disappear into the atmosphere.

- **Nitrification**
- Nitrification is the process of ……. of nitrogen in the ammonium ion to produce nitrate. This process is done by ……. bacteria living in soil in two stages.
- In the first stage, microorganisms such as ……., oxidizes ammonium ions into nitrites.

$$NH_4^+ \xrightarrow{\textit{Nitrosomonas}} NO_2^-$$

- In the second stage, microorganisms such as ……. oxidizes nitrites into nitrates.

$$NO_2^- \xrightarrow{\textit{Nitrobacter}} NO_3^-$$

- Plants utilize nitrate as their source of nitrogen. Therefore, microorganisms play essential roles in providing nitrogen in bioavailable forms for plants and animals.

- **Denitrification**

  In the absence of atmospheric oxygen, some microorganism use nitrate and reduces it into N_2. This process is called denitrification. Denitrification causes loss of nitrogen Into the atmosphere. Therefore, it reduces available nitrogen in the soil. Denitrification frequently occurs in waterlogged soils, where limited oxygen is present.

  …….

converts nitrate ions into molecular nitrogen through following steps;
Nitrate to nitrite, nitrite to nitrous oxide and nitrous oxide to nitrogen gas.

$$NO_3^- \longrightarrow NO_2^- \longrightarrow N_2O \longrightarrow N_2$$

- **Nitrogen fixation**

  The process of conversion of nitrogen gas to ammonia is termed as nitrogen fixation. Bacteria that are able to fix nitrogen require ……..….. enzyme. Nitrogenase enzyme is inactivated by oxygen. There are two types of nitrogen fixing microorganisms, free-living and symbiotic.

Free-living nitrogen fixing bacteria

- They are abundantly found in the rhizosphere. Rhizosphere is …….. ……..……... Eg. *Azotobacter sp*. Many cyanobacteria are also able to fix nitrogen. Eg. *Nostoc*. These organisms, exhibit mechanisms to prevent the exposure of nitrogenase enzyme to the atmospheric oxygen; Eg: *Azotobacter sp.* have high rate of aerobic respiration, Cyanobacteria– have …….. Some ……bacteria such as ……..... also fixes nitrogen.

Symbiotic nitrogen-fixing microorganism-

- They play an important role in agricultural crops such as leguminous crops, soybean, beans, peas and peanuts. These symbiotic nitrogen-fixing bacteria are commonly known as ……... Leguminous plants are specially adapted to facilitate symbiotic nitrogen fixation. Plants form root ……. where, anaerobic conditions and nutrients for bacteria are given. Bacteria fixes nitrogen and make it bio available to be used by the plant. Some ……. plants can also fix nitrogen symbiotically with different microbial combinations. ……..., a combination of ……. and an ……. or cyanobacteria also fixes nitrogen. In rice paddy waters a small free-floating fern, …….. fixes nitrogen symbiotically with ……..

Interactions of soil microorganisms relevant to plant growth

Microorganisms in the soil directly interact with plants. Interactions in the soil such as rhizosphere, ……... and ……... with symbiotic relationship of bacteria, fungi and plant cells. These microorganisms are beneficial to the plants in numerous ways such as nitrogen fixation, increased uptake of water and nutrients such as phosphorous, secretion of plant hormones such as indole acetic acid, increases iron uptake