

MODEL ANSWER
B.Sc Botany 6th Semester

LBC 601: Plant Ecology

Q. 1 Multiple choice questions/fill in the blanks

10 x 1= 10

- i. **c. Increasing population**
- ii. **Within communities**
- iii. **Hutchinson**
- iv. **Standing state**
- v. **Respiration**
- vi. **Bare**
- vii. **Clements**
- viii. **Oligotrophic**
- ix. **Aluminium**
- x. **Increases**

Q 2. Long answer type question (attempt any four)

4 x 5 = 20

- i. What are the various hypotheses given for community?

Answer

Community is an assemblage of different populations of different species present in an environment. Following are the two important hypotheses given for the community:

- a. Individualistic concept/organismic view proposed by H A Gleason
- b. The community-unit hypothesis/ integrated hypothesis formulated by F E Clements

Individualistic concept/organismic view

The individualistic hypothesis of community structure depicts a community as a chance assemblage of species found in the same area because they happen to have similar abiotic requirements for rainfall, temperature, or soil type.

The individualistic hypothesis predicts that communities should generally lack discrete geographic boundaries because each species has an independent, individualistic, distribution along the environmental gradient.

In most cases where there are broad regions characterized by gradients of environmental variation, the composition of plant communities does seem to change continuously, with each species more or less independently distributed.

The individualistic hypothesis emphasizes single species

The community-unit hypothesis/ integrated hypothesis

The integrated hypothesis of community structure depicts a community as an assemblage of closely linked species locked into association by mandatory biotic interactions.

The community functions as an integrated unit, as a super-organism.

The integrated hypothesis emphasizes assemblages of species as the essential units for understanding the interactions and distributions of species

The integrated hypothesis predicts that species should be clustered into discrete communities with noticeable boundaries because the presence or absence of a particular species is largely governed by the presence or absence of other species.

- ii. Define ecological pyramids. What are the various types of ecological pyramids in an ecosystem?

Answer:

It is a graphical representation or pyramid shaped diagram which depicts the number of organisms, biomass and productivity at each trophic level. Ecological pyramids begin with the producers at the bottom and proceed through the different trophic level.

There are three types of ecological pyramids as follows:

- a. Pyramid of number
- b. Pyramid of biomass
- c. Pyramid of energy

a. Pyramid of number:

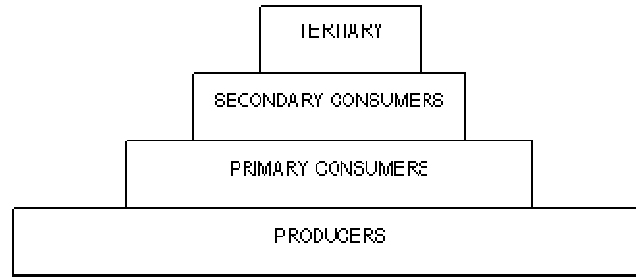
When plotted the relationships among the number of producers, primary consumers (herbivores), secondary consumers (carnivore of order 1), tertiary consumers (carnivore of order 2) and so on in any ecosystem, it forms a pyramidal structure called the pyramid of number. The shape of this pyramid varies from ecosystem to ecosystem.

There are three types of pyramid of numbers

- Upright
- Partly upright
- Inverted

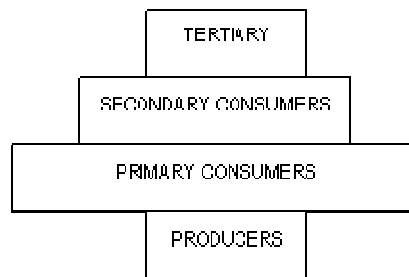
Upright Pyramid of Number

In *aquatic and grassland ecosystem* numerous small autotrophs support lesser herbivores which support further smaller number of carnivores and hence the pyramidal structure is upright.



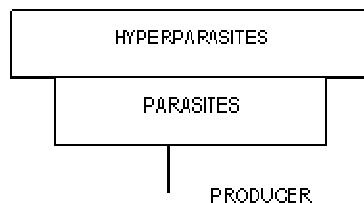
Partly upright pyramid of Number

In forest ecosystem lesser number of producers support greater number of herbivores who in turn support a fewer number of carnivores.



Inverted Pyramid of Number

In *parasitic food chain* one primary producer support numerous parasites which support still more hyperparasites.



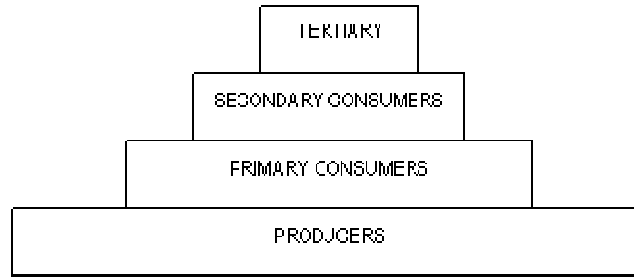
b. Pyramid of Biomass:

When we plot the biomass (net dry weight) of producers, herbivores, carnivores and so on we have a pyramid of biomass.

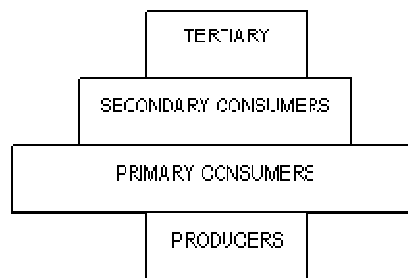
Two types of pyramid of biomass are found

- Upright
- Inverted

Upright Pyramid of Biomass: When larger weight of producers support a smaller weight of consumers an upright pyramid results. eg forest ecosystem

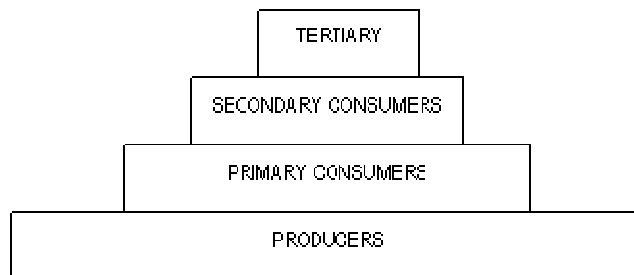


Inverted Pyramid of Biomass: When smaller weight of producers supports larger weight of consumers an inverted pyramid of biomass is formed eg aquatic ecosystem



c. Pyramid of Energy:

The pyramid of energy is drawn after taking into consideration the total quantity of energy utilized by the trophic levels in an ecosystem over a period of time. As the quantity of energy available for utilization in successive trophic levels is always less because there is loss of energy in each transfer, the energy pyramid will always be upright.



iii. Describe the various stages during succession on rocks.

Answer

The succession on rock is known as litharch and the different successional stages are known as lithosere. Following are the important stages during succession on rocks.

a) Crustose - lichen stage

Lichen species like *Graphis Rhizocarpon*, *Rinodina* and *Lacanora* forms the pioneer community in a lithosere, as they can tolerate desiccation. Organic acids produced by lichens corrode the rock surface and release minerals for proper growth of lichens. Wind borne soil particles and organic matter collect in the depressions, which initiates soil formation, leading to the growth of foliose lichens like *Parmelia*, *Physcia* etc.

Foliose lichen retains more water and accumulates more soil particles, helping in the development of a fine layer of soil on the rock surface.

b) Moss stage - Accumulation of soil and humus leads to the growth of mosses such as *Polytrichum* and *Grimmia*. Over a period of time, collection of more soil and organic matter favour the growth of moisture loving mosses like *Hypnum*, *Bryum* etc.

c) Herb stage - Death and decay of mosses produce a mat of organic moss on partially fragmented rock help the germination to seeds of hardy grasses like *Eleusin*, *Aristicla*, *Poa*, etc. Further decomposition of these annual grasses lead to replacement by perennial grasses like *Cymbopogon*, *Heteropogon* etc.

d) Shrub stage - Further weathering of rocks and death of herbs make the habitat more suitable for the growth of shrubs like *Rhus*, *Caparis*, *Zizyphus* etc. Since the shrubs are larger in size and their roots penetrate more deeply in the rocky substratum causes more weathering and soil formation.

e) Forest stages - Many light demanding, stunted and hardy trees invade the area. Vegetation finally becomes mesophytic. A steady state is reached between the environment and the biotic community. Type of climax community depends upon the climate.

For e.g., A rain forest is formed in a moist tropical area, coniferous forest in temperate area, a grassland in area with less rainfall etc.

The stages of succession on rocks may be depicted as given below:

Trend of succession in Lithosere					
Pioneer Community	Seral Communities				Climax Community
1	2	3	4	5	6
Crustose lichens stage e.g <i>Rhizocarpus,</i> <i>Rinodina,</i> <i>Lacanora</i>	Foliose lichens stage e.g <i>Parmellia,</i> <i>Dermatocarpon</i>	Moss stage e.g <i>Polytrichum,</i> <i>Tarula,</i> <i>Grimmia</i>	Herbs stage e.g <i>Eleusine,</i> <i>Aristida</i>	Shrub stage e.g <i>Rhus,</i> <i>Phytocarpus</i>	Forest stage e.g Mesophytic trees
-----General trend of succession ----->					

- iv. Define biomagnifications. Discuss the role of biomagnifications in relation to ecotoxicology

Answer:

Biomagnification is the increase in concentration of a substance that occurs in a food chain as a consequence of:

- a. Persistence nature of substance (can't be broken down by environmental processes)
- b. Food chain energetics
- c. Low (or nonexistent) rate of internal degradation/excretion of the substance

Biological magnification often refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into rivers or lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues or internal organs as they move up the chain.

Process of biomagnifications is the most important cause for the toxicity of many environmental pollutants which because of their nature tends to accumulate in the environment and after reaching to a certain levels they become toxic to the living organisms.

An example of biomagnification in nature is when birds of prey consume toxic amounts of DDT because they eat big fish which have eaten small fish which have eaten zooplankton

which have eaten algae which have ingested small amounts of DDT from polluted water. This has resulted in the reductions of bird population because their egg hatches before maturity due to weaker egg shells.

In a classic example of biomagnification, microorganisms in the ocean are exposed to pollutants, and the fish which eat them also ingest these pollutants. Larger fish eat the smaller fish, and the larger fish are eaten by seals. At every step of the way, the concentration of the pollutant becomes ever higher, representing the pollution passed on from dozens or hundreds of animals. When a polar bear eats the seal, the biomagnified pollutants will build up to unprecedented levels in the body of the polar bear, causing the polar to get sick, pass on genetic abnormalities to its children, or die.

Lead is another popular example for bioaccumulation. Lead can accumulate in the bones. It is eliminated only very slowly once ingested and can mimic calcium (it can also mimic iron and zinc, as well) and be deposited in bone structures.

Certain species of animal even use this as a natural defense. They can consume toxic material once it is there and the materials either rendered the animals too toxic to be consumed.

The issue of biomagnified pollutants is of special concern to regulatory agencies, because these agencies must think about the impact of pollutants not only on individual organisms, but on the food chain as a whole. If a chemical is approved for the market and it later turns up as a biomagnified pollutant in scientific research, this can reflect poorly on the regulatory organizations which are supposed to protect the environment.

- v. What is acid rain? What are the deleterious effects of acid rain on ecosystem?

Answer:

Acid rain" is a broad term referring to a mixture of wet and dry deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids (pH < 5.4). The precursors, or chemical forerunners, of acid rain formation result from both natural sources, such as volcanoes and decaying vegetation, and man-made sources, primarily emissions of sulfur dioxide (SO₂) and nitrogen oxides (NO_x) resulting from fossil fuel combustion. The result is a mild solution of sulfuric acid and nitric acid. When sulfur dioxide and nitrogen oxides are released from power plants and other sources, prevailing

winds blow these compounds across state and national borders, sometimes over hundreds of miles.

Following are the deleterious effects of acid rain on ecosystem:

- a. The acid rain causes excessive leaching of labile minerals from the soil reducing its fertility.
- b. The nitrogen fixers such as *Rhizobium* and other cyanobacteria are very sensitive to change in pH of the soil and water and henceforth the fertility of soil in terms of nitrogen will be reduced.
- c. Acid rain prevents the decomposition of litter by destroying the microbial population and therefore reduces the fertility of soil by locking the minerals in the biomass.
- d. Acid rain leads to aluminium toxicity in rice fields because of its increased concentration.
- e. The acid rain causes bleaching of chlorophyll pigment from the plant leaves because the acid causes removal of magnesium metal from the chlorophyll and leads to the formation of pheophytin. The pheophytin is colourless and hence the colour of chlorophyll fades.
- f. The reduced content of the chlorophyll will lead to reduced rate of photosynthesis.
- g. The reduced photosynthesis will lead to reduced photosynthate and ultimately the plants will be weak since plants will not get sufficient nutrition.
- h. The weaker plants are more sensitive to be attacked by the pathogens and may be killed and their population will be reduced and ultimately eliminated.
- i. The lichens population are sensitive to acid rain and their population will be eliminated.
- j. The loss of lichens from an area may prevent succession on rocks and therefore may disturb the ecosystem.
- k. The acid rain destroys the symbiotic association of *Rhizobium* and legumes which may have serious consequences on the soil nitrogen content.

vi. Describe the nitrogen cycle occurring in nature

Answer:

Nitrogen is an essential element for the survival of biotic components of the ecosystems and therefore recycling of nitrogen is necessary between the biotic and abiotic components of the environment. Following are the four processes participating in the cycling of nitrogen through the biosphere:

- a. nitrogen fixation
- b. decay
- c. nitrification
- d. denitrification

Microorganisms play major roles in all four of these.

a. Nitrogen Fixation

The nitrogen molecule (N_2) is quite inert. To break it apart so that its atoms can combine with other atoms requires the input of substantial amounts of energy. Three processes are responsible for most of the nitrogen fixation in the biosphere:

- a. atmospheric fixation by lightning
- b. biological fixation by certain microbes — alone or in a symbiotic relationship with some plants and animals
- c. industrial fixation
- d. atmospheric fixation

The enormous energy of lightning breaks nitrogen molecules and enables their atoms to combine with oxygen in the air forming nitrogen oxides. These dissolve in rain, forming nitrates that are carried to the earth.

Atmospheric nitrogen fixation probably contributes some 5–8% of the total nitrogen fixed.

Industrial Fixation: Under great pressure, at a temperature of 600°C , and with the use of a catalyst, atmospheric nitrogen and hydrogen can be combined to form ammonia (NH_3). Ammonia can be used directly as fertilizer, but most of it is further processed to urea and ammonium nitrate (NH_4NO_3).

Biological Fixation: The ability to fix nitrogen is found only in certain bacteria and archaea. Some live in a symbiotic relationship with plants of the legume family (e.g., soybeans, alfalfa). Some nitrogen-fixing bacteria live free in the soil. Nitrogen-fixing cyanobacteria are essential to maintaining the fertility of semi-aquatic environments like rice paddies.

b. Decay

The proteins made by plants enter and pass through food webs just as carbohydrates do. At each trophic level, their metabolism produces organic nitrogen compounds that return to the environment, chiefly in excretions. The final beneficiaries of these materials are microorganisms of decay. They break down the molecules in excretions and dead organisms into ammonia.

c. Nitrification: Ammonia can be taken up directly by plants — usually through their roots. However, most of the ammonia produced by decay is converted into nitrates. This is accomplished in two steps:

Bacteria of the genus *Nitrosomonas* oxidize NH_3 to nitrites (NO_2^-).

Bacteria of the genus *Nitrobacter* oxidize the nitrites to nitrates (NO_3^-).

Many legumes, in addition to fixing atmospheric nitrogen, also perform nitrification — converting some of their organic nitrogen to nitrites and nitrates. These reach the soil when they shed their leaves.

d. Denitrification

The three processes above remove nitrogen from the atmosphere and pass it through ecosystems. Denitrification reduces nitrates to nitrogen gas, thus replenishing the atmosphere. The nitrogen cycle may be depicted as given below

