

Unit - II Ecosystem (Nature does nature say one thing and wisdom another) — Juvenal

○ largest biological system is the Biosphere?

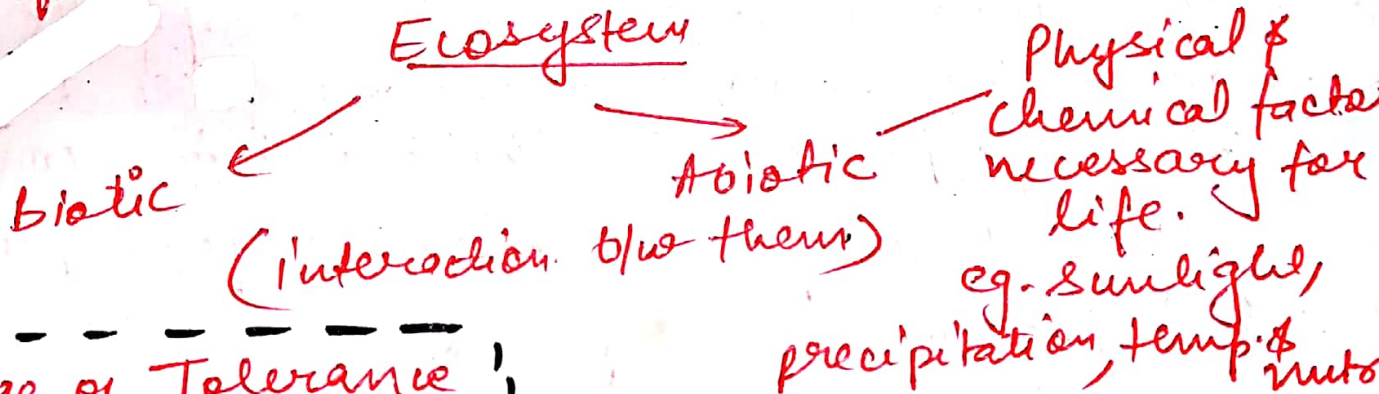
→ Life on the earth is concentrated in a narrow range extending less than 200m below ocean's surface to 6,000m above sea level.

→ Biosphere is a closed system. [NO exchange of material but only energy].

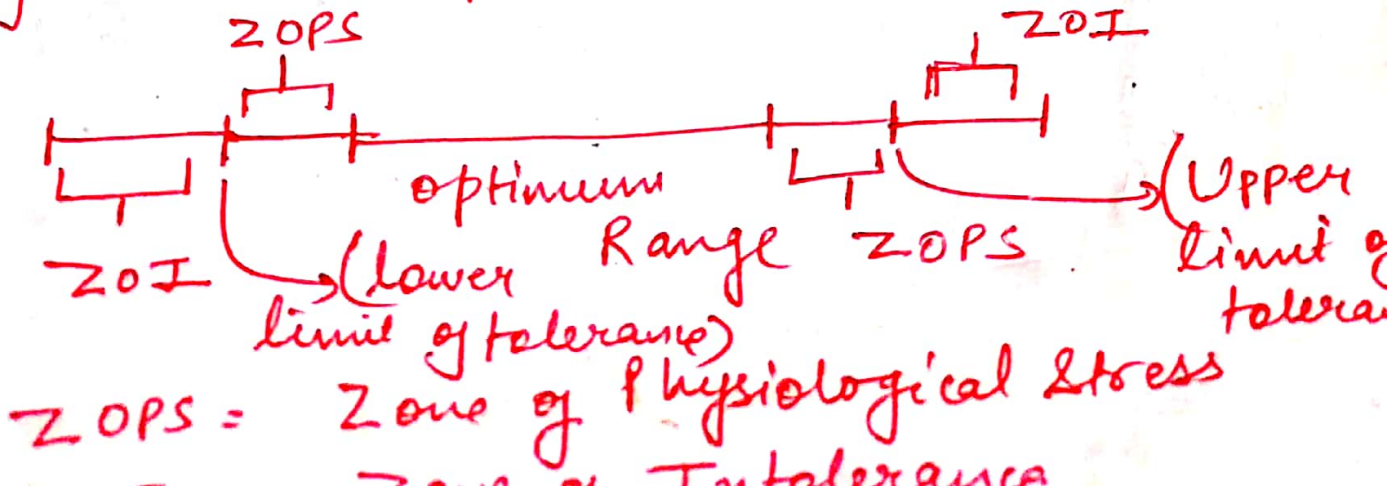
° Biome = is a terrestrial portion of the biosphere characterized by a distinct climate & particular assemblage of plants & animals adapted to it.

° Mesquite tree? — ??

* Aquatic life zones = aquatic equivalent of Biome



* Range of Tolerance: the range of condition to which an organism is adapted k/a = Range of Tolerance



* Law of limiting factor :-

→ Although sp. are sensitive to all of the abiotic factors in their environment, the one factor that is in short supply R/a "Limiting factor" tends to regulate population size.

eg- Phosphate in water bodies.

→ excess of phosphate → algal Bloom → Eutrophication.

→ On land "precipitation" tends to be the limiting factor.

Concept of Habitat & Niche

NOT IN SYLLABUS

→ The Niche of an organism is its functional role compared with that habitat's "address".

→ Organisms in a community occupy the same habitat but most of them have quite different niches — a phenomenon that minimizes competition.

"Competitive exclusion principle"

→ If two sp. occupy identical niches, competition will eliminate one of them.

Ecosystem Structure

SYLLABUS

Biotic

Abiotic

TOPICS

Autotrophs

+ photosynthetic

+ Chemosynthetic

Heterotrophs

+ Herbivores (1° consumers)

+ Carnivores (2°, 3° consumers)

+ Omnivores

+ Detritivores / Decomposers

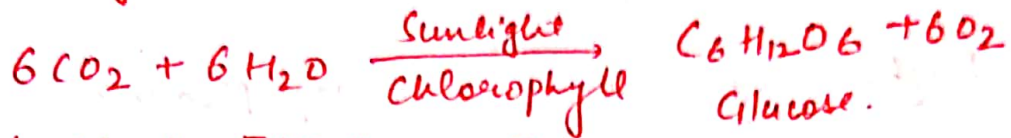
— fungi, Bacteria & insects

Ecosystem :- can be defined as basic functional unit of organism and their environment interacting with each other & with their own components.

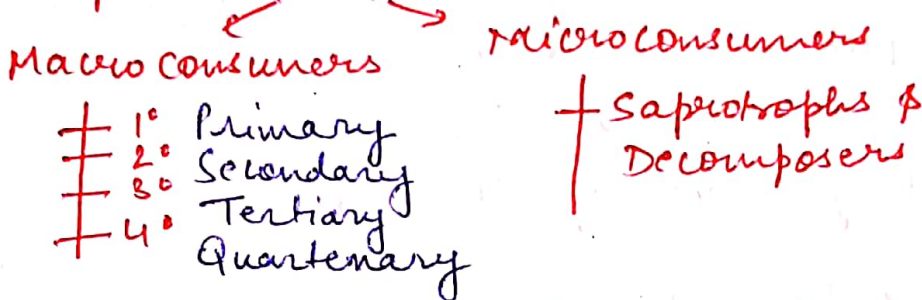
* Structure of Ecosystem $\begin{matrix} \rightarrow \text{Autotrophs} \\ \rightarrow \text{Heterotrophs} \end{matrix}$

(i) Autotrophs :- (Producers)

- Green plant (photosynthetic) + Cyanobacteria
- Chemosynthetic Bacteria.



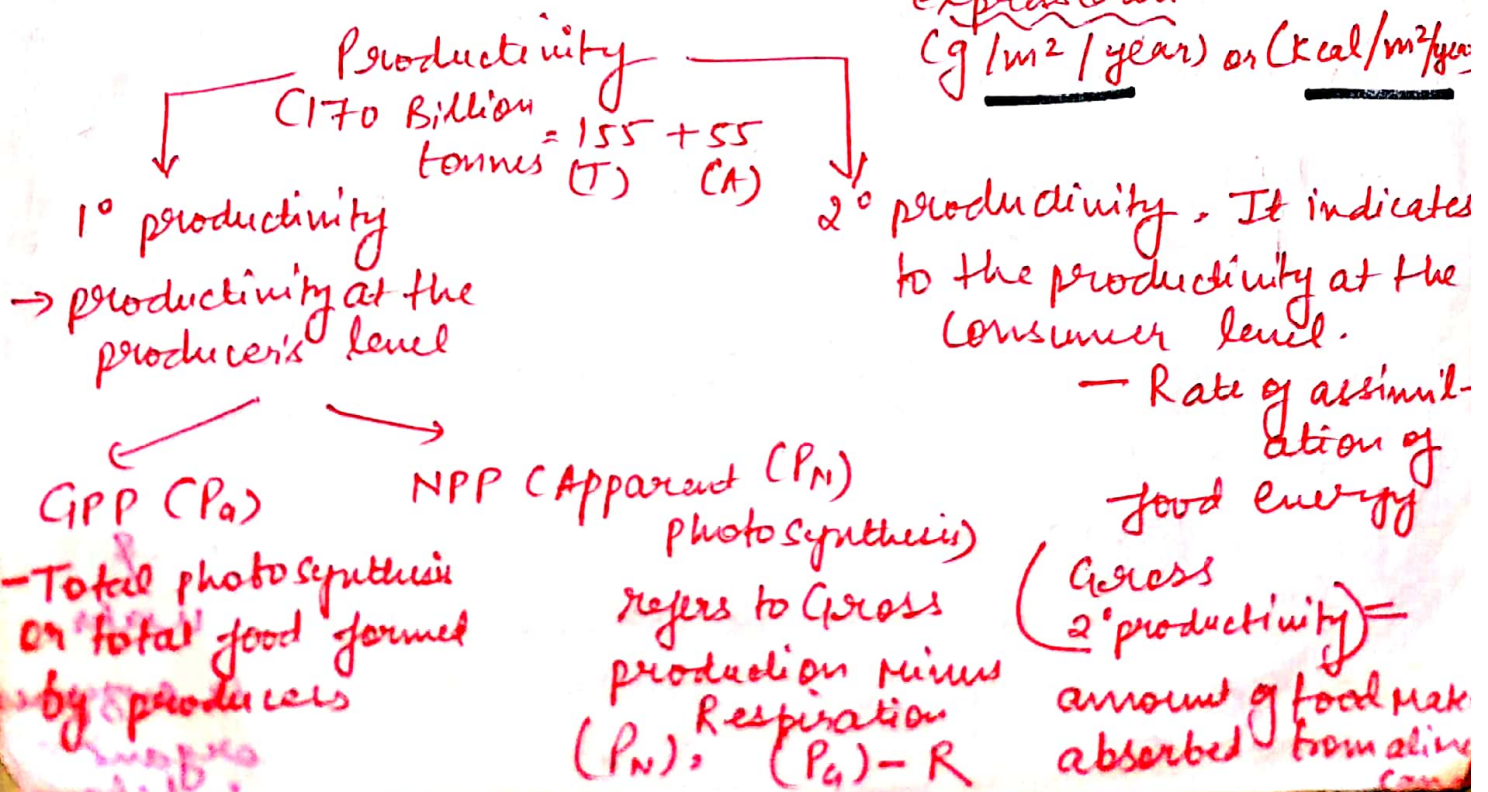
(ii) Heterotrophs :- [Consumers]



Functions of Ecosystem

- ① Productivity - amount of food energy produced or obtained stored by a particular trophic level per unit area / time
 - ② Energy flow
 - ③ Nutrient (Material) Cycling
 - ④ Development & Stabilization
- (or Rate of Biomass production)

expressed in $\underline{\text{g/m}^2/\text{year}}$ or $\underline{\text{Kcal/m}^2/\text{year}}$



calculated as total ingested food minus egested material.
(Net 2° productivity) = Rate of storage at consumer level - Rate of resynthesis of organic food by consumer

* Community productivity - The rate of net synthesis of organic matter (Biomass) by a community per unit time and area.

* Factors affecting primary productivity

- ① Environmental factors - light, temp. range, wind, atmospheric humidity, Nature of soil.
- ② Availability of Nutrients.
- ③ Photosynthetic Capacity of Producers.

* Imp. of Decomposition in an Ecosystem :-

Decomposition - process by which complex organic compounds are broken → simple, inorganic substance.

Decomposition (Mechanism)

→ Stepwise degradation of 'Debris' (dead organic matter formed of excreta & dead bodies of plants & animals)

* ① Fragmentation of debris by detritivores & Bacteria + Fungi → increase the surface area
Stimulate microbial growth ← adds growth substance

② Leaching :-

Simple, water soluble compounds like sugars & inorganic nutrients move downwards with water

Catabolism → decomposers release extracellular enzymes to break down debris → Simple organic → Inorganic substance

* community = assemblage of population of differ. sp.

PIONEER

→ It begins with small pioneer sp. entering the new area and ending with stable community k/a Climax community.

→ The intermediate communities b/w pioneer & climax community are k/a transitional or Seral communities & entire series of communities are k/a Sere. **SERAL**

Types of Succession

Source of Energy & Nutrition

Autotrophic

Heterotrophic

- Rate of production
- > Rate of respiration
- Initially more no. of 1^o producers
- later $P/R = 1$

- Rate of respiration > during initial phase
- Starts in areas rich in organic matter
- Small areas near rivers & streams

Colonization

(Primary)

(Secondary)

* on barren lands / sterile

* first gp of organisms

k/a pioneer sp.

* eg. land formed by volcanic lava.

Interactions

Autogenic

Allogenic

* Start on previously built strata

* has organic matter thus biological fertile

* Successions are more rapid.

Allogenic Succession :- one community is replaced by other due to external condition & not by vegetation itself.
→ eg. sudden influx of nutrients & pollutants in a pond.

General process of Ecological Succession :-

Nudation - development of bare areas without any life form

cause of nudation can be

topographic - soil erosion, land slide, volcanic eruption

climatic - hail, storms, fire

biotic - epidemic, anthropogenic.

(b) Invasion - involves successful establishment of sp. in a bare area. It involves 3 steps -

(i) Migration - reaching of seeds, spore in bare area through air water etc.

(ii) Ecesis (Establishment) - successful adjustment of sp. with the prevailing conditions of that area.

(iii) Aggregation - ↑ in no. of organisms through process of reproduction.

(c) Competition - forms on surface available on surface

In this stage various life compete for limited resource

(d) Reaction :- involves the modification of the environment through influence of living organisms.
→ modified area becomes less favourable for existing community sooner or later replaced by another community.
Sequence k/a Serie
Communities — Serial Communities.

(e) Stabilization :- final stage where a community becomes stable & maintain itself in eq^m with the climate of the area
community k/a climax community.

* Based on nature of environment (primarily based upon moisture relations)

- ✓ Hydrosere / Hydrarch → starting in the regions where water is plenty eg - ponds, bogs
- Metarich → adequate moisture content
- ✓ Xerosere / Xerarch → where moisture is present in minimal amount.

- (i) Rooted Submerged Stage:-
 → plants such as Hydrilla, Vallisneria present along with insect larvae, Cyclops & Daphnia. [depth 10-12 feet]
 Gradually soil particles from nearby land enters and dead plants & organisms deposit to the depth & form humus.
- (ii) Floating Stage → depth of water body ↓ ↑ new vegetation & rooted plants such as Nelumbo, Trapa, Nymphaea along with animals such as Hydra, snails, Frogs, snakes.
 Soil building process ↑ & depth ↓ and invasion by Swamp plants. [6-8 feet depth]
- (iii) Reed Swamp Stage → also known as amphibious stage.
 The depth of pond further ↓ to 1-4 feet.
 vegetation - Typha, Pontederia, Sagittaria plants constitute dense vegetation.
 floating animals are replaced dragon flies, water scorpion & scavenger beetles.
- (iv) Marsh Meadow Stage → Reed Swamp stage disappears due to ↓ in water depth. plants like Juncus, Cyperus & Carex invades the area. At the end of stage, soil becomes marshy.

(v) Woodland Stage:— This stage consists of shrubs and trees. Shrubs like *Cornus*, *Salix* and *Cephalanthus* & tree like *Populus* & *Alnus*. Terrestrial animals invade the area. ↓ in water table.

(vi) Climax Stage:— dead & decaying part of woodland plants causes accumulation of the humus. Soil further enriched with organic matter. Change of sp. composition & types of autotrophs & heterotrophs occur.

Ecological Succession -

The appearance in an orderly sequence of different communities over a period of time in a given area.

→ appearance in an orderly sequence of different communities over a period of time in a given area.

→ The first community to inhabit the area = pioneer communities.

→ last community = climax community.

Pioneer $\xrightarrow{\text{Seral communities}}$ Climax

entire series of community \rightarrow Sere.

* Types of Succession :-

Primary Succession
(Pterisera)

① Starts on primitive substratum, absence of living matter.

② eg- land formed by volcanic lava/newly formed water body.

③ First gp. of plants establishing are known as pioneers.

④ Takes more time eg-

develop. of forest climax community from sand dunes \approx 1000 years.

Secondary Succession
(Subsere)

① Starts from previously built up substrata.

② existing community disappears by any force such as climatic, biotic or fire.

③ Biologically fertile as substratum is built up.

④ More rapid succession.

* NUTRIENT / BIOGEOCHEMICAL CYCLES

- depicts the exchange of nutrients b/w biotic & abiotic components of an ecosystem
- Generally cyclic in nature.
- Mostly dependent on decomposition by decomposers

NUTRIENT CYCLES

A) GASEOUS

- Reservoir of elements/nutrients is Atmosphere
- called as Perfect cycles
- Eg- Carbon, Nitrogen, Oxygen cycle
- Elements/nutrients remain in circulation more or less uniformly

B) SEDIMENTARY

- Reservoir of elements/nutrients is Lithosphere
- called as Imperfect cycles
- Eg- Phosphorous (P) Sulphur (S) cycle
- Bulk of nutrients remain in relatively inactive and immobile reservoir in earth's crust.

NITROGEN CYCLE :-

STEPS

1) NITROGEN FIXATION

conversion of Atmospheric N_2 into NH_4^+ (Ammonium) / NH_3 (Ammonia)

Nitrogen fixation

Physical fixation

→ Through lightning in atmosphere

Biological fixation

fixation of Dinitrogen (N_2) by living organisms

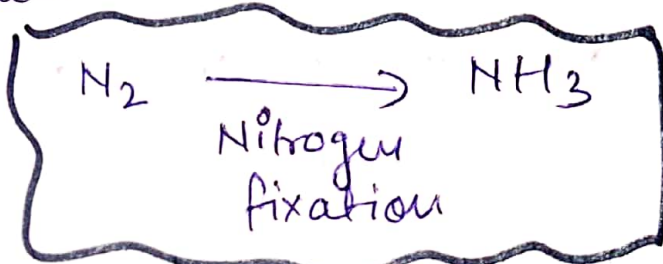
Biological Fixation

By Symbiotic

→ Nitrogen fixation by bacteria Rhizobium in association with legume's roots

Non Symbiotic

→ by bacteria Azotobacter



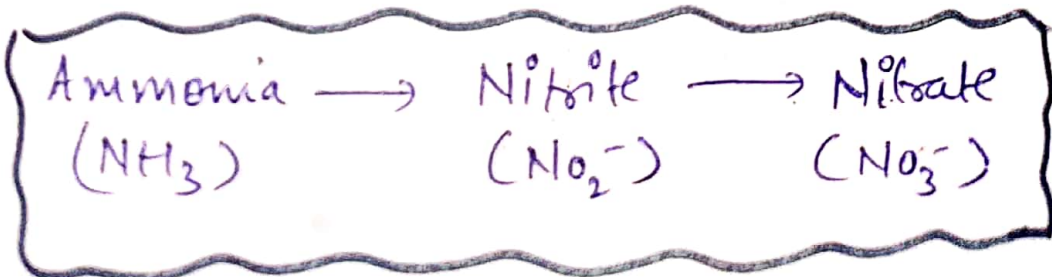
2.) NITRIFICATION

It's two step process where Ammonia is first converted into Nitrites and then Nitrates

↓ (NITRITE)

↓ (NITRATE)

~~Ammonia~~

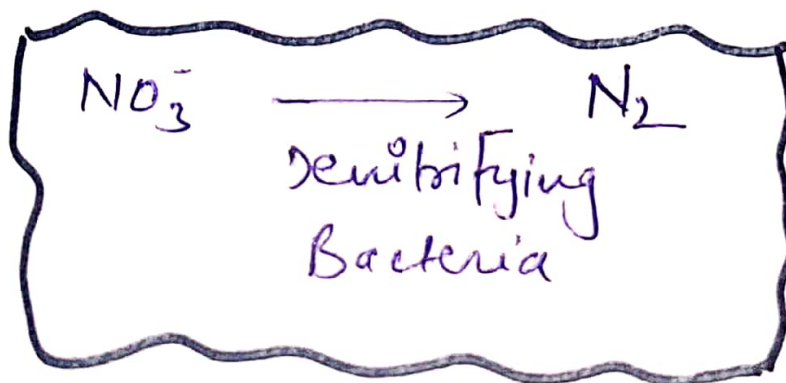


3) AMMONIFICATION

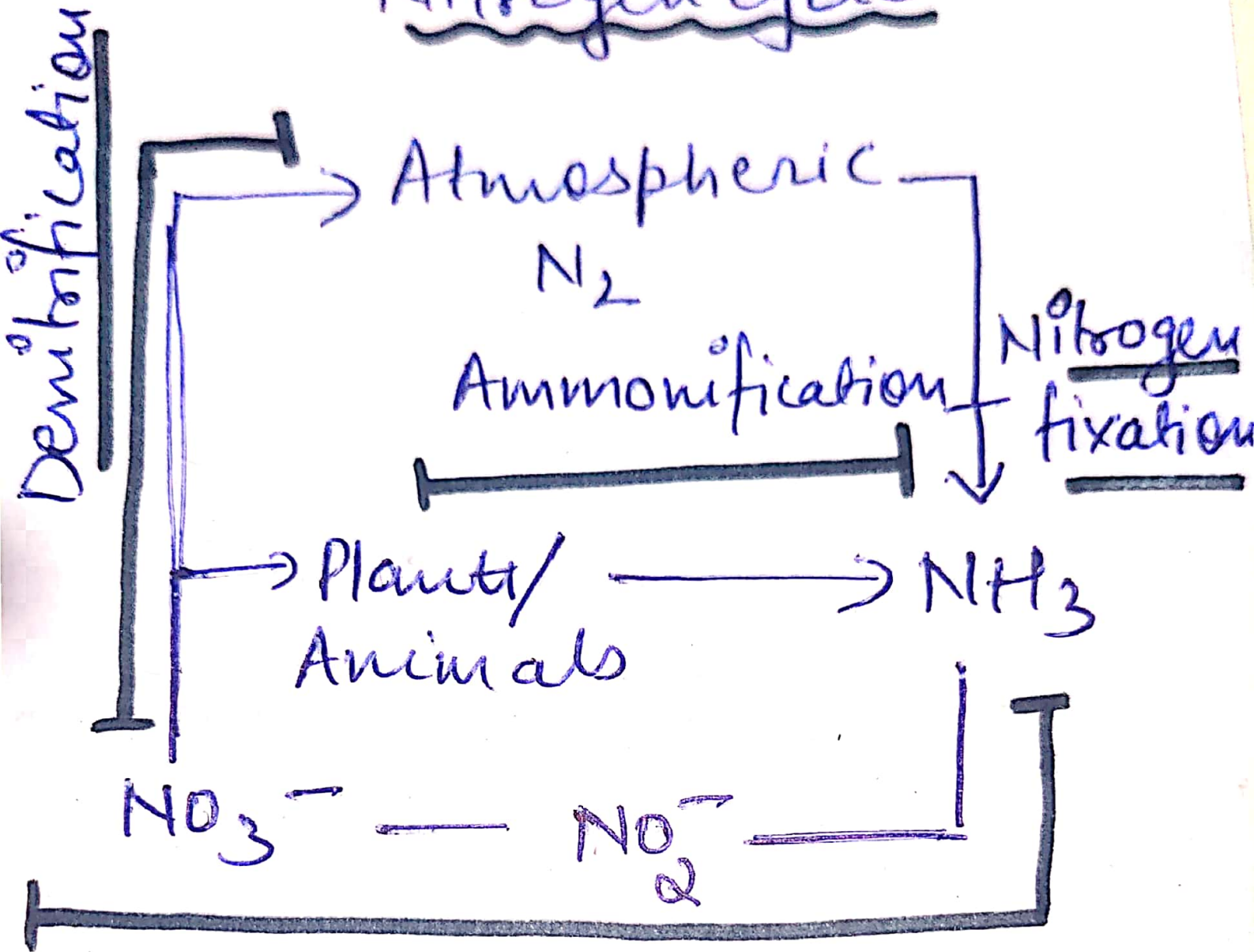
It involves the decomposition of proteins of dead plants and animals (amino acids, proteins & urea) to ammonia in the presence of ammonifying bacteria.

4) DENITRIFICATION

It is a biological process by which ammonium compounds, nitrates & nitrites are reduced to molecular nitrogen in presence of denitrifying bacteria.



Nitrogen Cycle



Nitrification

TYPES OF ECOSYSTEM

① Desert Ecosystem

- Desert occupy approx $1/5^{th}$ or 20% of earth's surface.
- present on every continent except Europe & Antarctica.
- Avg annual rainfall less than 25cm or 10 inches.
- receive most of the moisture as snow or rain during winter months.
- Water does not sink into the ground but runs off into the gullies.
- Variation in day-night temp.
- organisms/animals popⁿ is low, small in size and remains inactive during day.
- Many insects, lizards, snakes, small mammals, grazing mammals and birds are common.
- Modification in plant organs to allow them store water such as cactus.
- Plants open their stomata only at night.
- eg. of plants = Euphorbia, Acacia, Prosopis, Cactus.
- eg. of animals = Scorpions, horned lizard, Collard lizard, Camel, Foxes, desert cats, jackals etc.
- primary productivity is low, less organic matter addition in the soil.

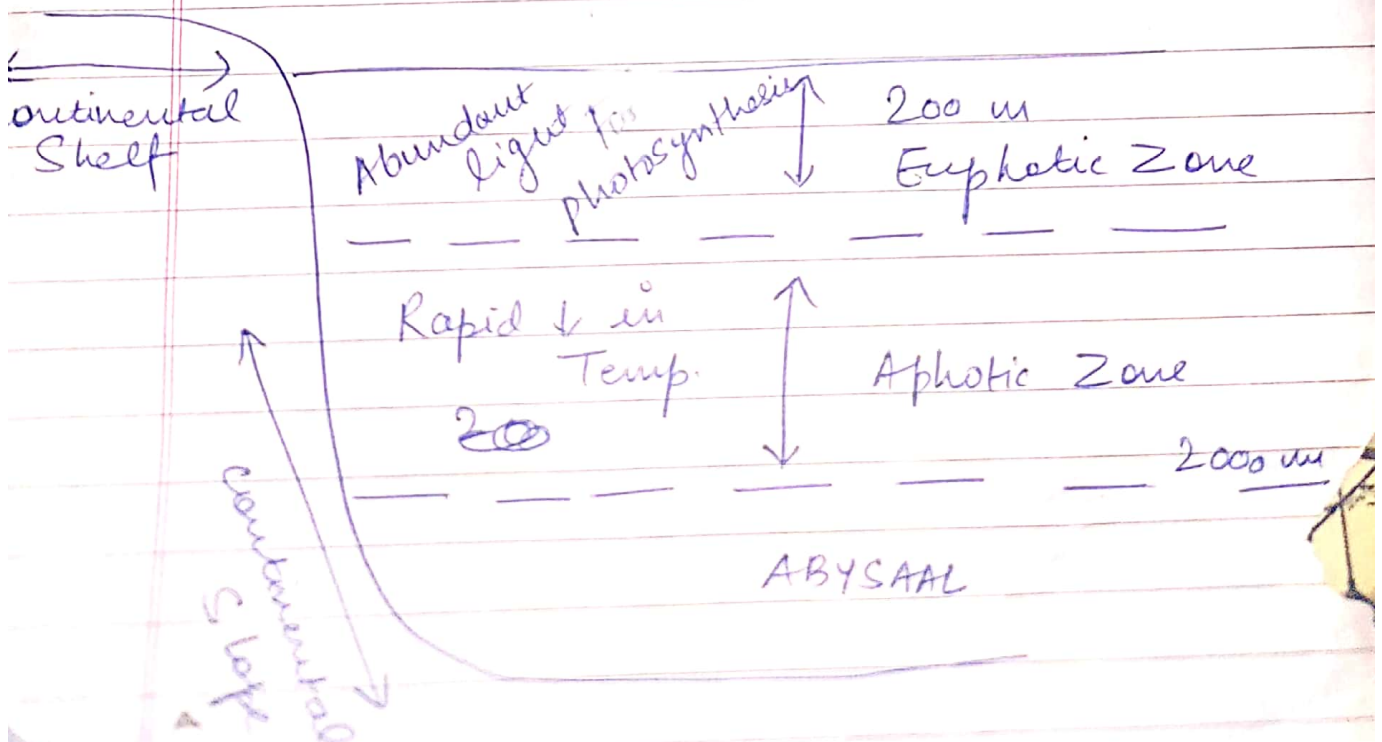
② Aquatic Ecosystem [on the basis of salinity, depth & fluctuation of temp]

- Marine Ecosystems
- + Open Sea
 - + Sea Shores
 - + Estuaries

- Fresh Water ecosystems
- + Rivers
 - + Streams
 - + Lakes
 - + ponds
 - + Marshes

Marine Ecosystem

- cover 64.5% of earth's surface & are characterised by high salt conc.
- Not a single environment further divided as biotic & abiotic.
- Productivity is $1000 \text{ K Cal/m}^2 / \text{year}$ and is less than that of terrestrial ecosystems.
- Main reason for low productivity is low content of Nitrogen & Iron, light ↓ with the ↑ in depth



* On the basis of penetration of sunlight ocean is divided in 3 vertical zone

① Photic or Euphotic zone - upper lighted zone upto a depth of about 200m

- max photosynthesis

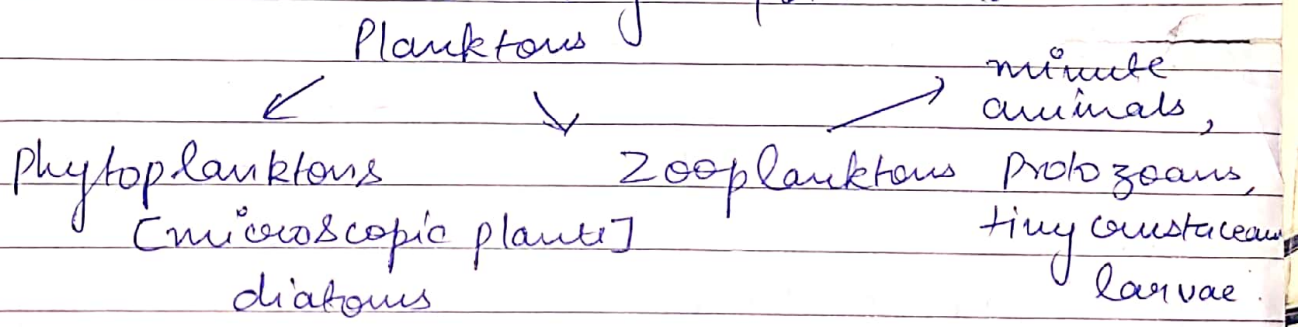
Aphotic → ② less light, insufficient for photosynthesis extends upto the depth of 200 - 2000m

③ Abyssal - present below 2000m and characterized by perpetual darkness.

organisms

① Planktons → small organisms that float and are drifted passively on surface water by waves currents & winds.

→ do not have organs for locomotion



② Nektans → actively swimming Found in surface or deep waters

→ have locomotory organs, mainly feed on planktons or smaller nektans

→ They include jelly fishes, cuttle fishes, bony fishes, turtles.

③ Benthos → bottom dwelling animals

eg - crabs, fishes [Star fish], Sea urchins etc

Freshwater Ecosystem

Standing Water Bodies
Lentic (Lakes and Ponds)
Ponds - Stagnant
inland water.

→ Temp. & distribution of O_2 ,
 CO_2 and minerals are
not uniform.

→ Basis of penetration of
light

+	Epilimnion
+	Hypolimnion
+	Thermocline

* Epilimnion - Upper stratum
exposed to solar radiation,
warmer in summer, cooler in
winter. ($21-22^\circ C$)

* Hypolimnion - Basal stratum
of a lake and is always cool.
($5^\circ C$)

* Thermocline - Transition
zone where steep decline in
temp. observed.

Organisms - algae - Chlorella
+ Spirgyra
+ Chlamydomonas

plants - Nelumbo, Typha
Vallisneria

Animals - Prawns, Crabs,
mussels, Snails,
fishes, Snakes

Running water
Bodies - lotic
(Streams &
Rivers)

→ Inland fresh
water bodies with
everchanging &
running water

→ No thermal
stratification
→ have well oxygen
ated water,
greater availability
of sunlight

→ The nature of
flora & fauna
in rivers &
streams depends
on the source
& land environment
eg - dolphin in
ganges,
Gharial,
Turtles.

(VALLISNERIA)

Grassland Ecosystem

- Grasslands generally receive rainfall b/w 25-75 cm per year.
- windy hot summers and cold to mild winters.
- Grasses make 60-90% of vegetation
- 1° consumers are animals that eat grasses such as bison, wildbeasts, wild horses & various kinds of sheep, cattle & goats
- many kinds of insects grasshoppers dung beetles present along with rabbits, squirrels & mice.
- 2° consumers → coyotes, foxes, snakes & hawks.
- constitute 19% of earth surface.

Forest Ecosystem

21.54.1. (IFSR 2019)

- In India only of land area occupied by forest
- Abiotic components affect the type of forest such as amount of rainfall and temp; latitude & altitude.
 - decide + Tropical Evergreen
 - + Tropical deciduous
 - + Temperate
 - + Coniferous
- Tropical Evergreen Forests are one of the most productive systems on the earth.
- Maximum organic matter formation with diversity in plants and animals.
- 1° consumers — ants, leafhopper bugs, beetles along with deer, elephant, fruit eating bats

2° consumers — snake, lizard, fox

3° consumer — Lion & Tiger.

classmate

Date _____

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Decomposers — sp. of fungi such as Polyporus,
Aspergillus etc

→ Rapid uptake of minerals by trees roots and decomposition is faster in tropical evergreen are followed by temperate & coniferous forest.

→ Tree sp. such as Sal, Sesam, Teak.