

marine microbiology.

marine microbiology is the study of the micro org (bacteria, archae, viruses & microbial eukaryotes) in the marine environment, including their biodiversity, ecology & biogeochemistry.

Marine ecology & sampling

Marine habitats - (सागर अधिवास)

- earth acquires 71% water of the surface & the ocean contains 96.5%.
- ocean / sea is the largest geographic biotic unit on the earth.
- study of the sea is known as oceanography.
- oceanography includes all branches of science including marine microbiology.
- marine habitat is mainly divided into the 2 habitats.

i) Pelagic (पेलैजिक)

- away from the bottom of the ocean

ii) Demersal

- near the bottom of the ocean

Some of the marine habitats -

1) Estuaries

- Estuaries is a type of coastal habitat where the freshwater of the river meets the salty water of sea
- mixing of freshwater & salty water resulting in brackish water formation

↓
(not exactly salty as sea)

- this act as transition zone betⁿ sea & river
- as estuaries also known as bay, lagoon, slough.

↓
(small water body)

- different type of estuaries

a) coastal plain estuaries

- formed due to sand bar

b) Estuaries formed due to Tectonic plate
eg. California's San Francisco Bay

c) Estuaries formed due to Fjord (glacier)
eg. Chesapeake Bay.

2) Mangroves - eg. flora & fauna (all types)

- mangroves are the group of trees & shrubs that live in coastal intertidal zones.

- Intertidal zone is the area betⁿ low tide mark & high tide mark

- mangroves are the only trees which grow vigorously in salt water, i.e. salt tolerant trees. at the edge of land & sea, mangroves form intertidal forest.
- mangroves also known as 'Mangals'. mangroves of india are further divided into following type
- 1) Deltaic / eastern coast mangroves
 - 2) estuarine & backwater / western coast mangroves
 - 3) Insular mangroves or Andaman & nicobar islands.

this ecosystem contains a variety of plants, microorg like bacteria, fungi, microalgae, birds, crabs etc.

Bacteria develop mutual relationship with mangrove trees / shrubs.

Bacteria fix nitrogen & trees provide root exudates.

- fungus also show mutual relationship with mangrove
- mangrove trees also provide oxygen (O_2) to other life forms, fungi, bacteria, protozoa, algae. $\rightarrow$ are decomposed of this habitat.
- they decompose organic matter by using cellulase, protease, amylase, pectinase like enzymes.

- microbes play a role in various microbial processes like nitrogen fixation, phosphate solubilization & sulfate reduction.

Nitrogen fixation $\rightarrow$ atmospheric nitrogen
 $\downarrow$
 ammonia
 $\downarrow$
 eg. cyanobacteria

anaerobic decomposition occurs $\rightarrow$ sulfate reduction
 eg. Desulfosarcina

phosphate $\rightarrow$ insoluble phosphate form which
 solubilizing org are ppt at the bottom
 & make them into soluble form.
 eg. Bacillus amyloliquefaciens

3) coral reefs (underwater ecosystem)

- coral reefs can be found in tropical destinations around the world, mostly in areas around the equator where the water is warmest.
 - Reefs are simply known as rainforest of sea.
 - coral reefs are the most diverse & dynamic group of ecosystem in the world.
- eg. Tropical coral reef
- coral reefs are made up of coral polyps & other calcium depositing

animals.

They attach to the solid rocky surface of the ocean near the coast line.

sedimentation (heavier insoluble particles at the bottom of a liquid), cementation (deposition of dissolved mineral components in the interstices of sediments), solidification of coral processes also occur during zooxanthellae (microalgae).

coral polyps (which are animals & zooxanthellae, the specialized cells that live within them, have a mutualistic relationship) provide protection to the algae & zooxanthellae provide energy by doing photosynthesis.

Role of coral reef in ecosystem

- i) protects coastal lines
- ii) supports other species growth & provides habitat
- iii) Prevent erosion
- iv) People depend on reefs for food income
- v) medicinal properties - To treat cancer, ulcers, asthma, heart disease
- vi) Source of nutritional supplements
- vii) source of enzyme
- viii) economic development - tourism

responsible facts for the imbalancing coral habitats & create threat to coral life, are as,

- i) overfishing
- ii) emission of greenhouse gas

iii) ocean warming iv) ocean acidification
v) pollution vi) coral bleaching vii) climate
change - sea level rise, temp fluctuation

- Research institutions in India

- research institutes works on monitoring
management & research on coral reefs
are as follows,

i) ministry of earth science

ii) central marine fisheries research
institutes

iii) National Institute of oceanography.

4) salt marshes - (मीठे दलदलीय प्रदेश) -

- one of the most biologically productive
habitats on earth, salt marshes serve
as a transitional zone betⁿ terrestrial
& marine ecosystem.

- Salt marshes occur in intertidal
zone, present in betⁿ sea & land &
forms brackish water. so, it is natural
or semi natural terrestrial habitat.

- The nutrient cycles & food webs for
both terrestrial and marine ecosystem
are greatly influenced by this
productivity.

- Insects, mollusks, arthropods, & fish
are all plentiful food sources
for migratory birds.

- the nutrient cycles & food webs
for both terrestrial & marine ecosystem

are greatly influence by this productivity environment is used by marine life to create vital breeding grounds for both invertebrate & vertebrate species such as oysters, crabs, sharks, & other fish species

- major competing environmental elements that produce hard conditions with high salinity, submersion, & low oxygen levels are the cause of this productivity.
- The main element influencing salt marsh habitats is salt from saltwater despite the fact that the marsh is mostly made up of sea water, which has a salinity of 3.4%. evapotranspiration frequently causes the salinity to exceed of sea water.
- most salt marsh plant species cannot grow in environments with salinities greater than 7%. eg. *Spartina* spp.
- Halophytic plants, algae, plankton & halophytic fishes get easily isolated from this habitat?
- most of the plants are unable to grow but some of the such as, turtle weed, *Spartina* spp are grown in salty marshes.
- They have a limited no. of animal species, especially, invertebrates, birds & crabs
- Fungi, bacteriae are involved in decomposition of vegetation located in salt marshes.

- fungal species $\rightarrow$ mycosphaerella spp, spartinicola, alphaproteobacter
- bacteria $\rightarrow$ gammaproteobacteria, betaproteobacteria are dominant species of bacteria occur in rhizospheric region because of the decomposition of grasses.
- sulfur reducing bacteria are also easily found in rhizospheric soil.

5] coastal ecosystem - (नदी किनारा) ^{occur where the land meets the sea}

- marine coastal env is marine ecosystem in which many habitats include coral reefs, estuaries, salt marshes, mangrove forest, kelp forests etc.
- marine ecosystem is the biggest ecosystem in the world in which coastal ecosystem are rich in diversity & provide nutrients & shelter to other life forms.
- due to the presence of sunlight & nutritional factors, sunlight reaches upto 50-100 meters into water and forms a photic zone in the ocean, hence shallow coastal areas show autotrophic growth.
- landform which changes due to the erosion and deposition along with the coast is nothing but the coastal landform which changes due to the

erosion & deposition. These erode coastline and break the shore.

- according to xiaojun yang (2008) coastal ecosystem is classified into five categories like, estuaries, mangroves, coastal marshes, seagrass system, benthic system.

- seagrass system - (nursery habitats)

- also known as 'submerged aquatic vegetation' is an aquatic flowering plant that survives completely submerged in a salty coastal env.

- seagrasses have roots, stems & leaves & produce flowers & seeds.

- seagrass can grow in large beds that are dominated by one or more species.

- seagrass beds also offer environmental services & goods to coastal zones, such as fishing areas, generating O_2 , minimizing coastal erosion & preventing storms.

- naturally events including storms, desiccation & grazing are among the hazards & disturbances to seagrass.

- Benthic ^{area} system - (at the bottom of a body of water)

- The group of species living on the ocean floor where macrophytes are absent is known as the benthic system.

- benthic habitats are essentially subsurface settings with unique, physical, chemical & biological features.
- They vary significantly based on their depth, location, salinity, & sediment.

6) Deep sea-

- the deep sea is broadly defined as the ocean depth where light begins to fade, at an approximate depth of 200m or the point of transition from continental shelves to continental slopes.
- condⁿ within the deep sea are a combination of low temp, darkness & high pressure.
- bioluminescent org produce their own light. eg. jellyfish, squid, plankton.
- deep sea classified into 3 zones
 - ① midnight zone
 - ② Abyss zone
 - ③ trenches

7) Hydrothermal vents-

- The greatest habitat on earth is found under the surface of the deep sea.
- from the oceans bottom to the continental shelf's edge, it extends to a depth of around 200m.
- The shelf break, when the floor slopes downward toward the edge of the continental shelf, is where the shelf breaks.
- The so-called continental rise is a sizable

sedimentary deposit, is located under the continental slope.

- The ocean bottom may be found at a depth of about 4000 meters, & typically reaches a depth of 5,000 m over the ocean habitats basins.
- The abyssal plain is what it is termed.
- Bathyal zone refers to the region betⁿ the continental shelf and the abyssal plain.
- In certain locations, the sea floor descends once more into lengthy tunnels that are betⁿ 10 to 11 km deep.
- Benthic organisms including worms, mollusks, crabs, shrimp, fish, sea cucumbers, & sea urchins create a variety of mounds & depression on the deep sea bottom.

7) Hydrothermal Vent -

- All unicellular org. that exist & reproduce in an area that is chemically different from hydrothermal vents are included in the hydrothermal vent microbial community.
- these might be cells floating freely in the envn, microorg on the bacterial mat or bacteria living in endosymbiotic harmony with mammals.
- Chemolithoautotrophic bacteria use the

the geological activity around hydrothermal vents to fix carbon into organic forms, as a source of nutrition & energy.

- The study of viruses' impact on the microbial ecology in these habitats is a growing area of study since they are a component of the hydrothermal vent bacterial community.
- microbial populations that live there must adapt to the harsh circumstances of the hydrothermal vent habitat.
- Hyperthermophiles / microorg that thrive at temp exceeding 90°C , are known to inhabit this area.
- Sulfur oxidizing org $\rightarrow$ thiothrix & beeggiatoa
methane-oxidizing org $\rightarrow$ methanogens, methanococcus, methane oxidizing bacteria
Hydrogen-oxidizing org $\rightarrow$ methanogens, methane oxidizing bacteria
actinomycetoma, Hydrogenobacter.

8) Polar habitat-

- Psychrophiles are found in permanently cold envs. such as snow, ice, rivers, lakes & deep oceans of both polar regions.
- microbes are universal & different members of all natural communities.
- In marine & brackish ecosystem, microorg form the base of the food

chain supporting advanced trophic situations.

- Polar habitats cover the top & bottom of planet earth at the north & south poles.
 - The north pole is surrounded by the arctic ocean.
 - There isn't any land here, just a group of continually shifting ice sheets.
 - parts of Canada & Greenland are near the north pole.
- eg. snowy owl, polar bear, arctic fox.

i) Arctic -

- microbes defined then as bacteria, archaea & single celled eukaryote are ubiquitous & diff. members of all natural communities.

ii) Antarctica -

- Antarctica is earth's southernmost & least-peopled mainland.
- Antarctica is on average the coldest, driest & windiest of the mainlands, & it has the loftiest average elevation.

iii) Southern ocean -

- Southern ocean, also known as the Antarctica ocean.