

Ecology and Ecosystems



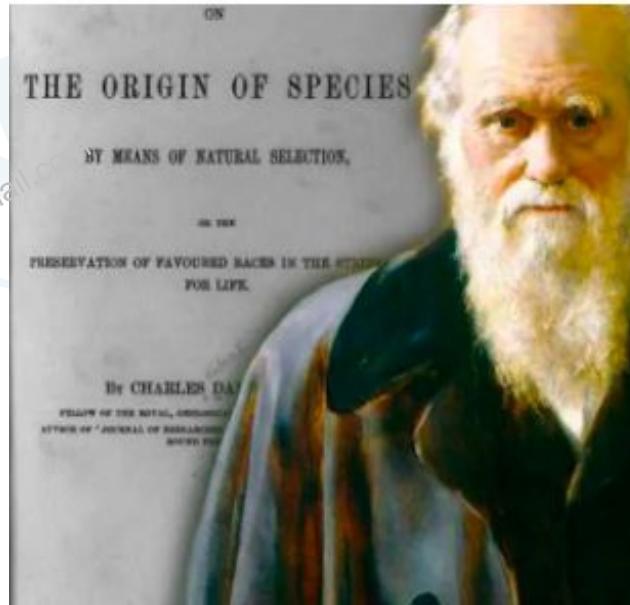
Year/Topics	Number of Questions
2011	19
2012	21
2013	21
2014	25
2015	15
2016	16
2017	14
2018	12
2019	19
2020	20
2021	23
2022	16
2023	20
Total	241

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Year/Topics	Basics of Ecology	Biodiversity including Protected Areas	Climate change and Ozone Depletion	Pollution and Waste Management	Conservation and Sustainability	Total
2011	5	9	3	2	0	19
2012	2	9	3	1	6	21
2013	8	6	0	4	3	21
2014	3	12	3	3	4	25
2015	1	6	2	1	5	15
2016	0	3	5	1	7	16
2017	1	6	2	3	2	14
2018	1	1	2	1	7	12
2019	0	5	2	6	6	19
2020	1	8	1	4	6	20
2021	3	9	2	3	6	23
2022	3	3	1	4	5	16
2023	1	10	4	1	4	20
Total	29	87	30	34	61	241

Evolution of Species

- **Principle of Natural Selection**
 - the process by which certain traits become more or less common in a population over generations
 - based on their effects on an organism's chances of surviving and reproducing.
 - Individuals with advantageous traits that help them better survive and reproduce in their environment are more likely to pass those traits on to their offspring.
- **Four Principles:**
 - Variations
 - Heritability
 - The Struggle for Existence
 - Survival and Reproductive Rates
- **Adaptation**
 - trait that has evolved in an organism over time through natural selection and enhances its survival and reproduction in a specific environment.
 - Adaptations can be structural, behavioral, or physiological.

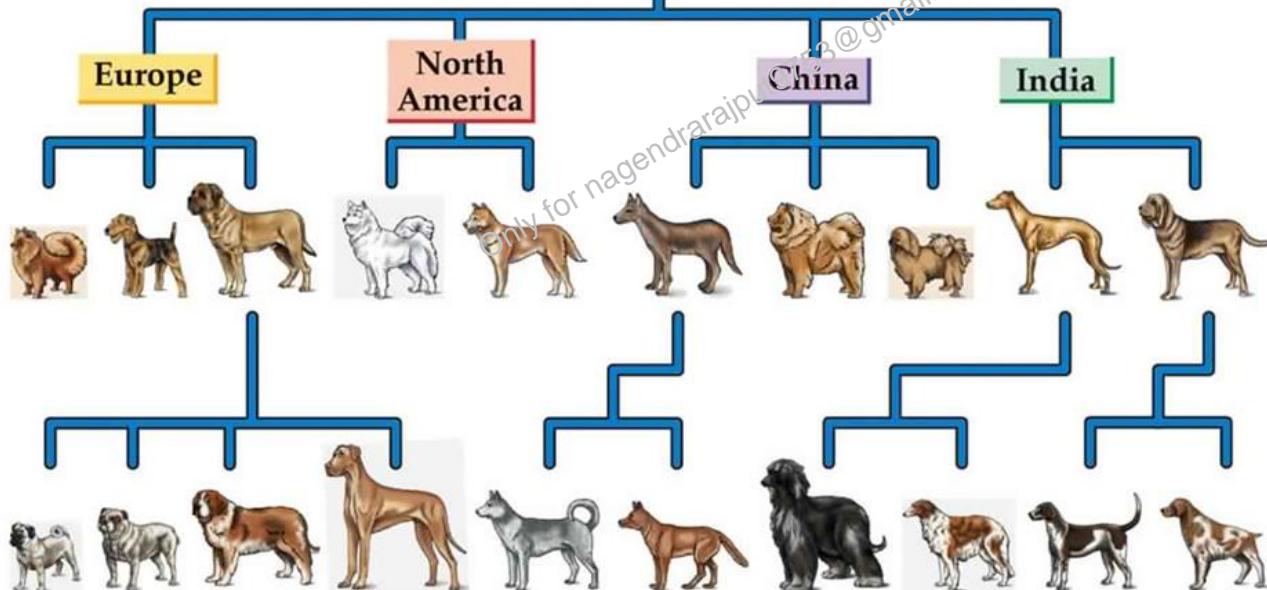


Evolution of Species

- **Mutation**
 - spontaneous and random change in the DNA sequence of an organism's genes.
 - can occur due to errors in DNA replication, exposure to radiation, chemicals, or other environmental factors.
 - Some mutations can be harmful, neutral, or beneficial.
 - mutations that confer a selective advantage may become more common in a population over time.
- **Speciation:**
 - **A group of organisms that can interbreed and produce fertile offspring**
 - Speciation is a process by which new species evolve from existing ones.
 - It occurs when populations of a species become reproductively isolated from each other
 - geographical barriers, genetic changes, or behavioral differences.
 - enough genetic differences and that they can no longer interbreed and produce viable offspring.



Gray wolf
(Common ancestor)

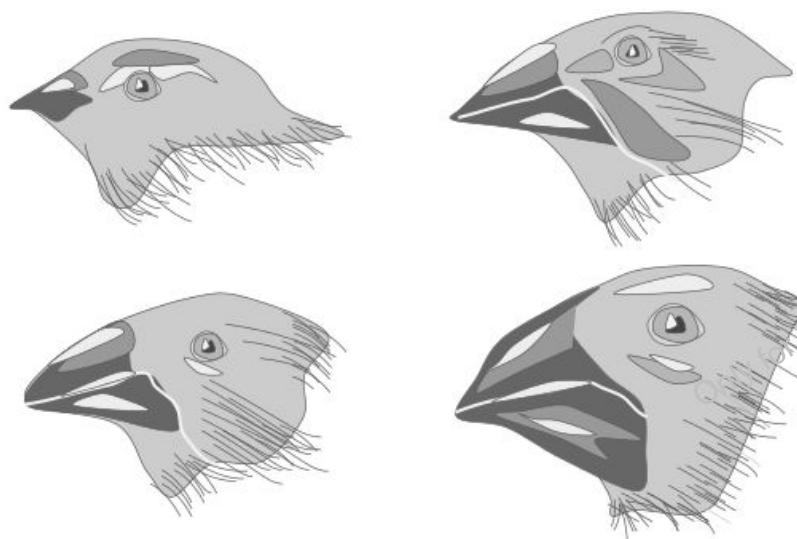


Impact of Humans on Evolution



- Only at 2% of population in early eighteenth century London, the dark peppered moth became 95% of the population by late 19th century.
Impact of industrial revolution
- Because of the darkening of trees due to coal soot, black peppered moth could better camouflage from predators.

Character Displacement



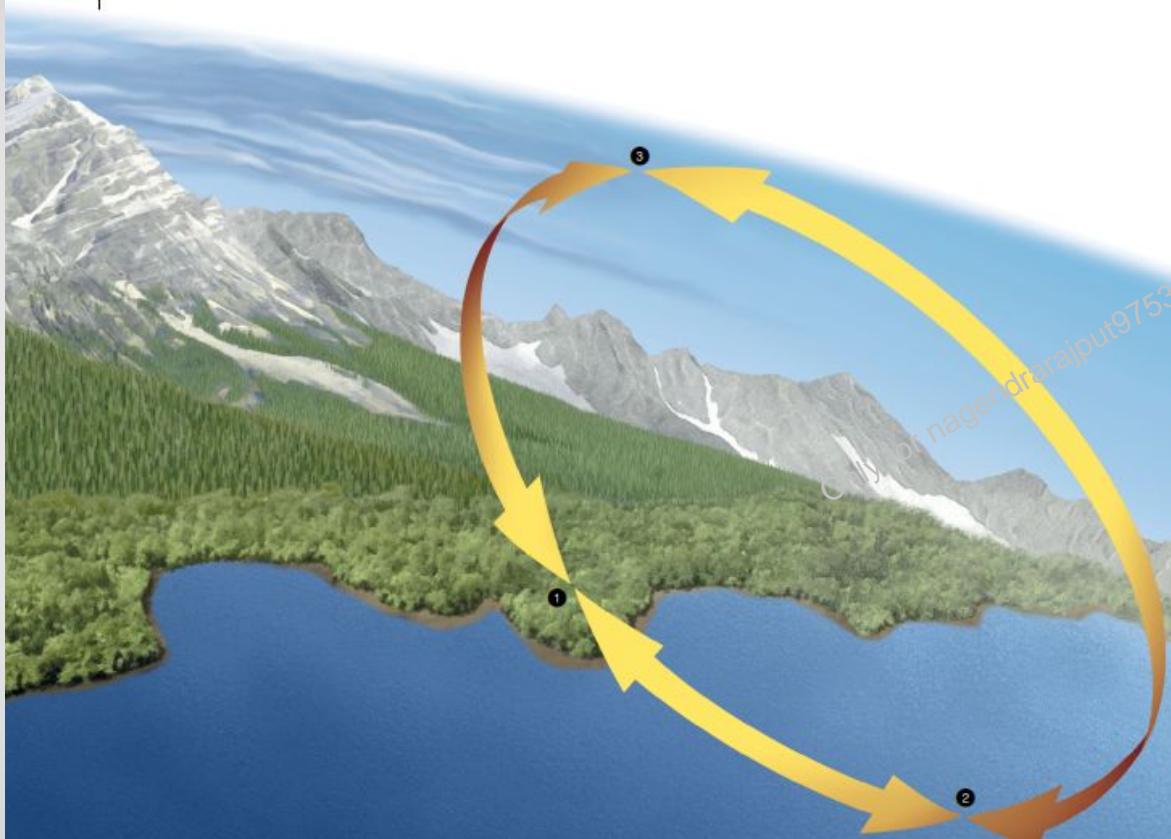
**Galapagos
Finches**

- Darwin studied finches on Galapagos islands and found birds to have distinct phenotypes
- When similar species inhabit the same environment.
- Under such conditions, natural selection favors a divergence in the characters
- Changes in morphology, behavior, or physiology

Origin of Ecology

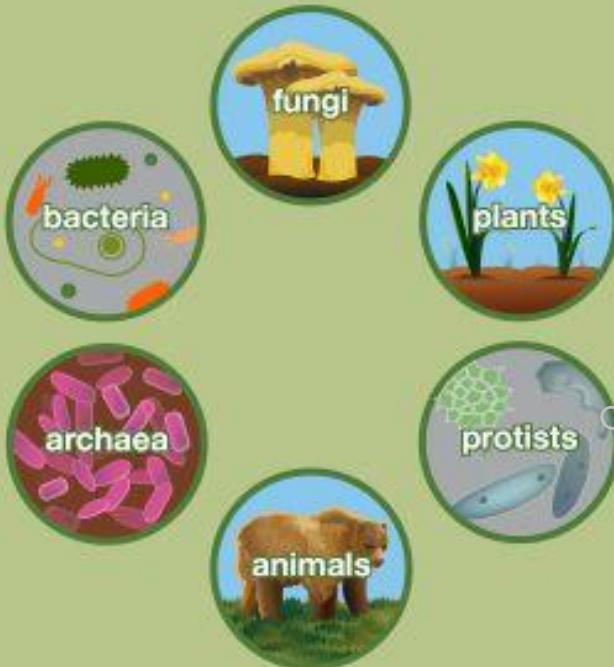
- Ecology can be defined as scientific study of the relationship of living organisms with each other and with their environment.
- coined in 1869 by the German biologist **Ernst Haeckel**.
- two Greek words, '**oikos**', meaning home or estate and '**logos**' meaning study.
- It can go back to ancient philosophies, study of natural history, botany, evolutionary biology among others
- Modern advances in remote sensing, computational methods, environmental science has further enhanced the scope of study.

Biosphere



- 1. Lithosphere
- 2. Hydrosphere
- 3. Atmosphere

Biotic Factors



Abiotic Factors

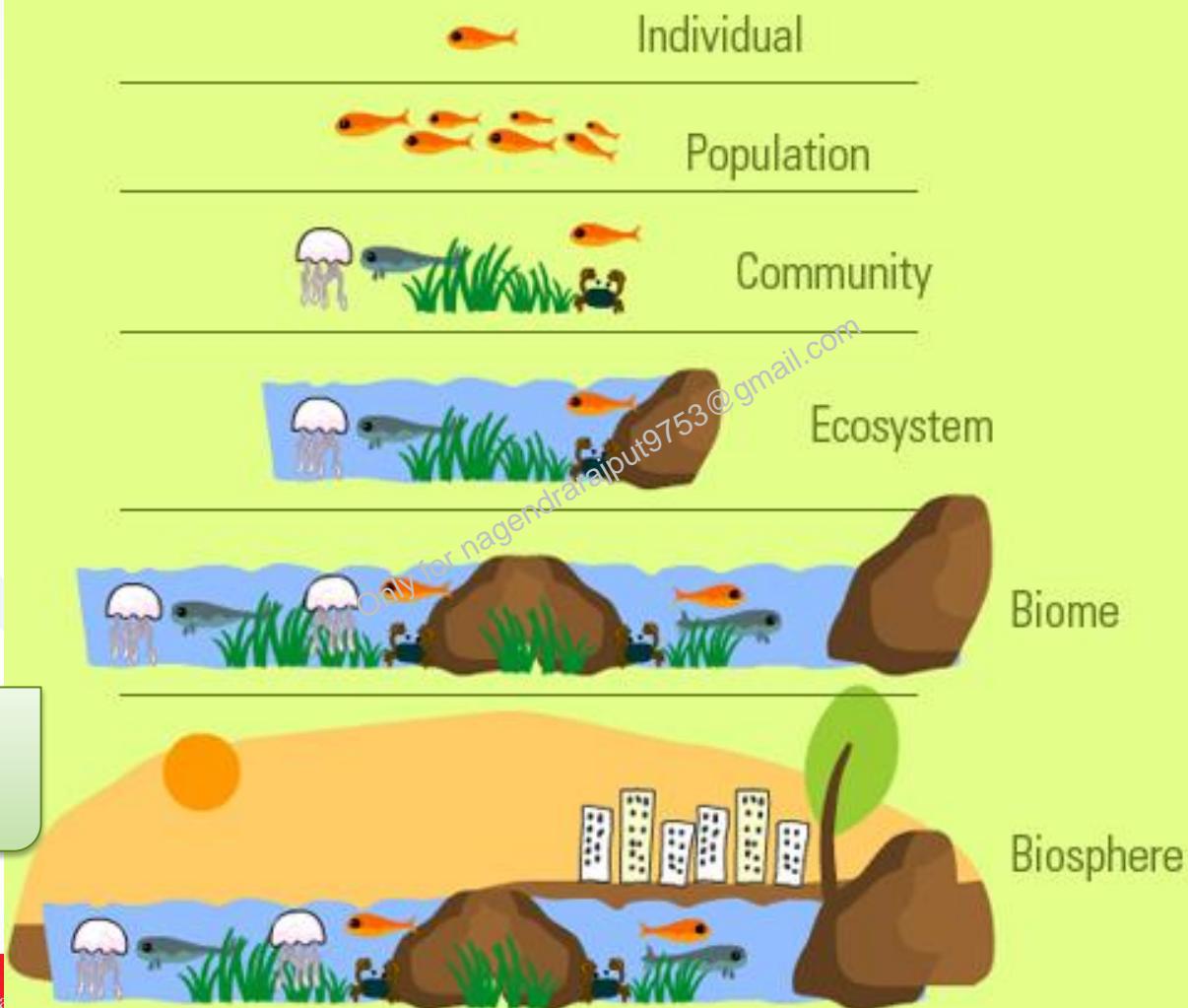


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- Abiotic Factors can also be categorized into **Climatic and Edaphic factors**

DEFINITION	Climatic Factors	Edaphic Factors
Only for narendraraajput9753@gmail.com	Climatic factors are the factors that affect the climate around the world	Edaphic factors are soil properties that affect the diversity of organisms living in the soil environment
RELATED TO	Air and water	Soil
EXAMPLES	Temperature, sunlight, humidity in air, pressure in the air, radiation and ionization in the air, chemical components of water and atmosphere	Soil type and structure, soil pH and salinity, soil temperature, soil moisture, organic carbon and nitrogen content, heavy metal content, etc.
IMPORTANCE	Important in determining the growing plants in particular regions. Moreover, they affect forest structural attributes, diversity and biomass	Important in determining the species composition of soil microbial communities and their activity and functionality

Levels of Ecological Organizations





**Marine
Ecosystem**



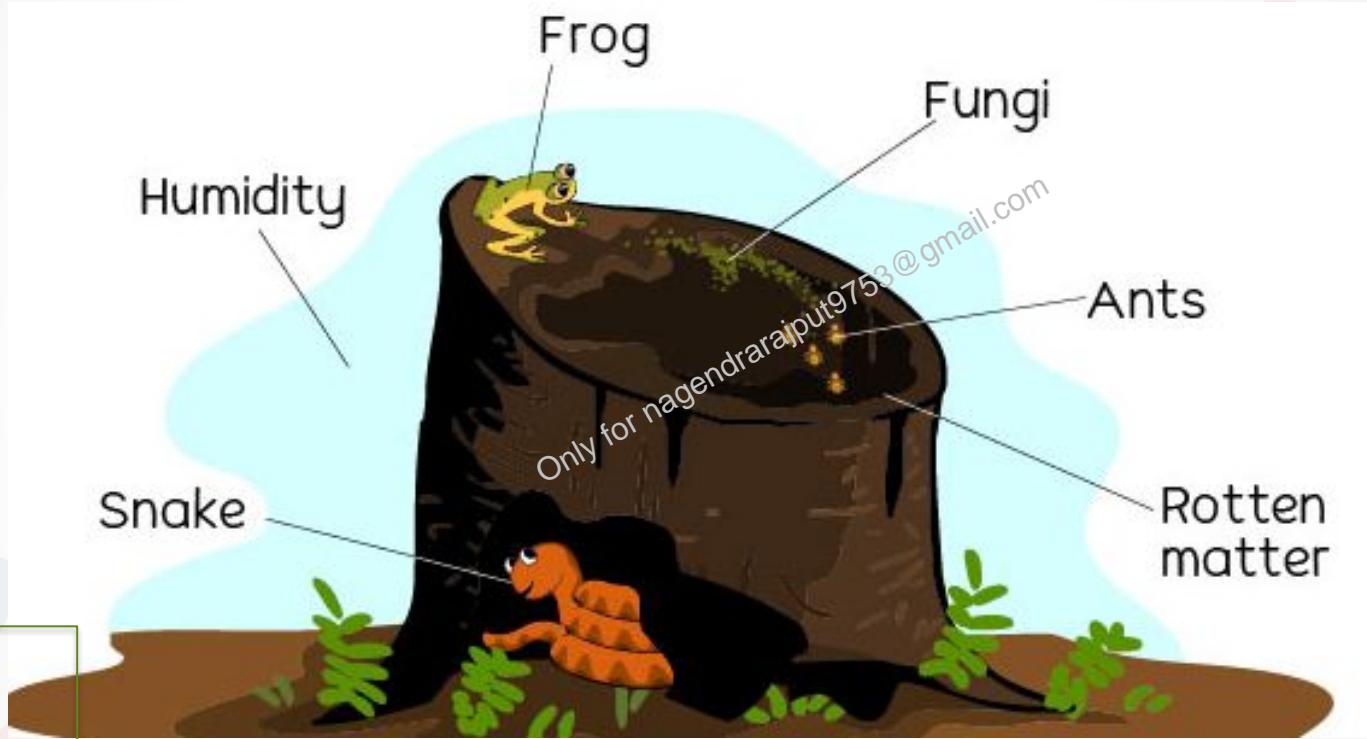
**Desert
Ecosystem**



**Forest
Ecosystem**

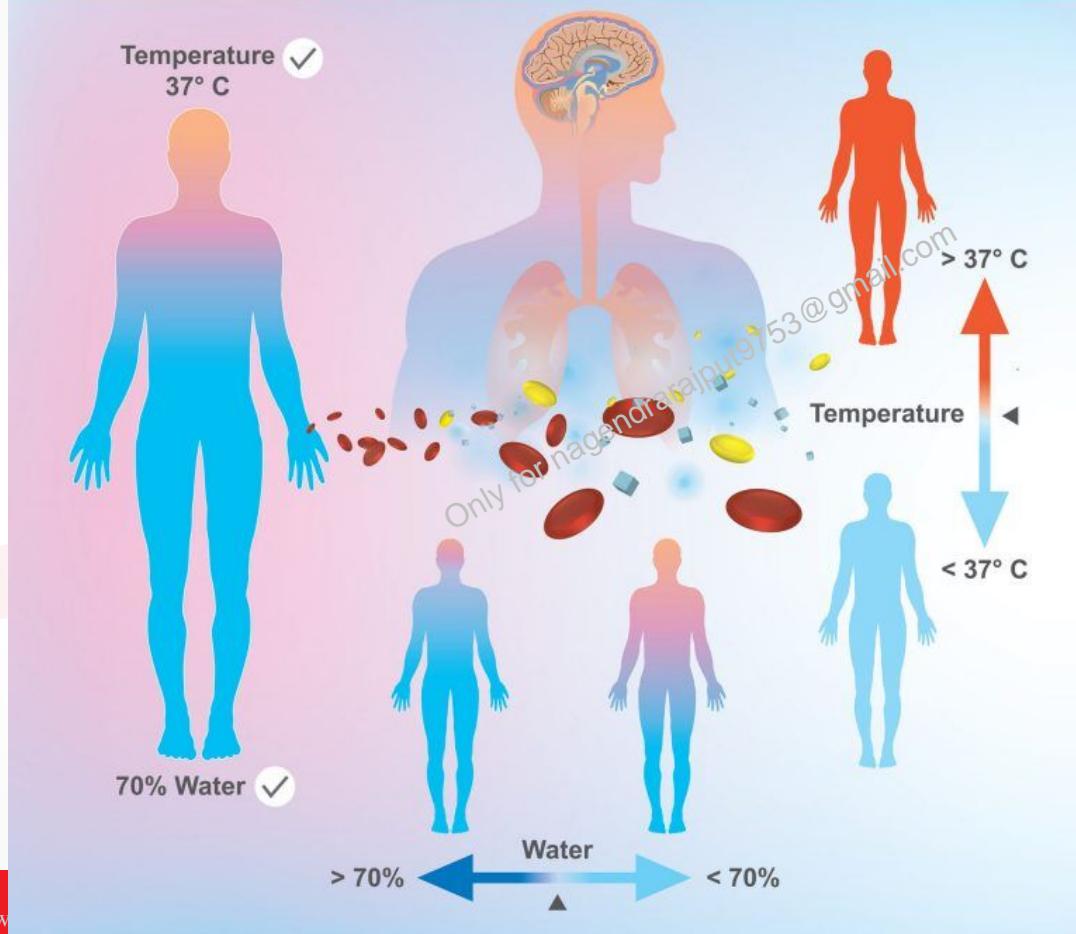


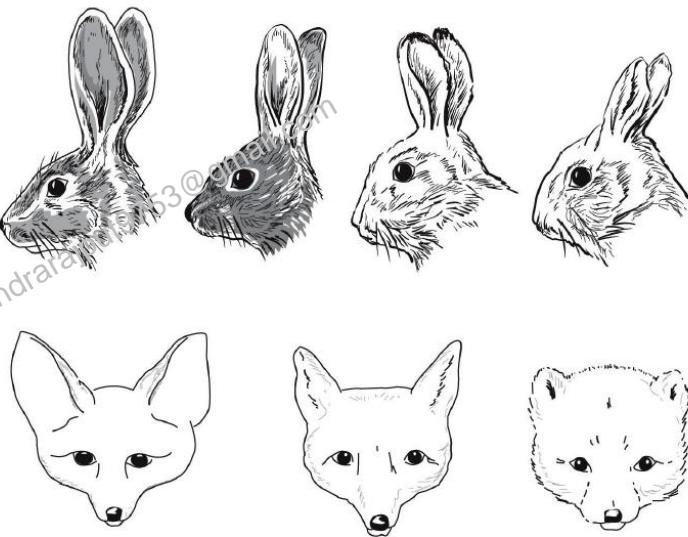
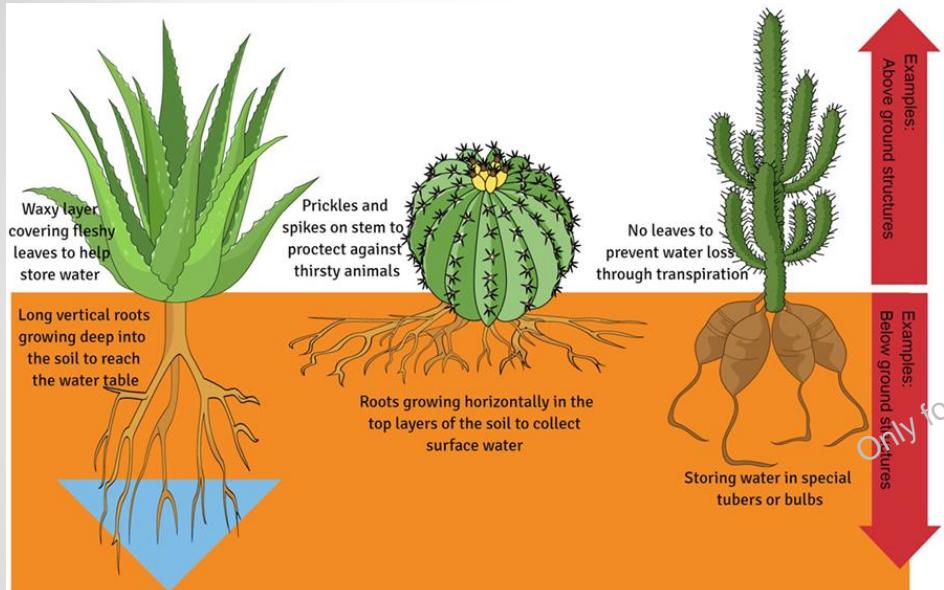
**Grassland
Ecosystem**



Tree Trunk Ecosystem

Homeostasis





Adaptation in desert plants

Allen's rule – shorter ears of polar animals



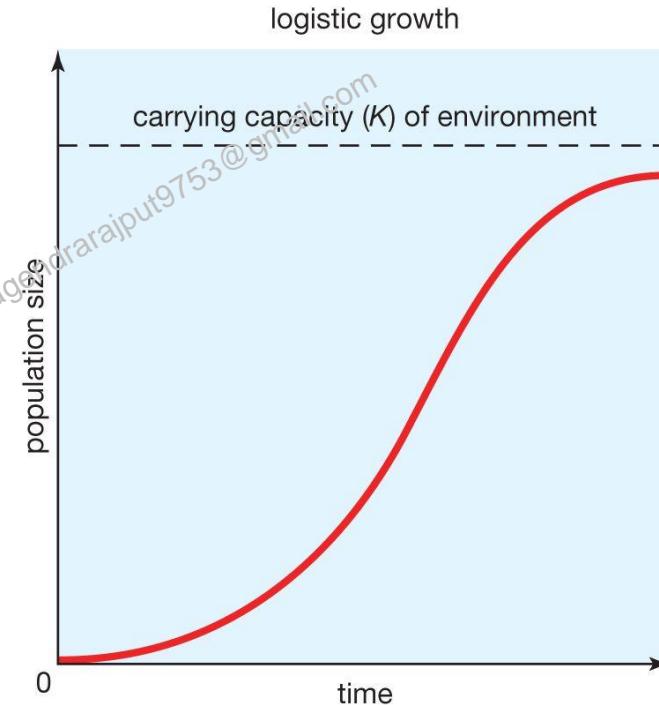
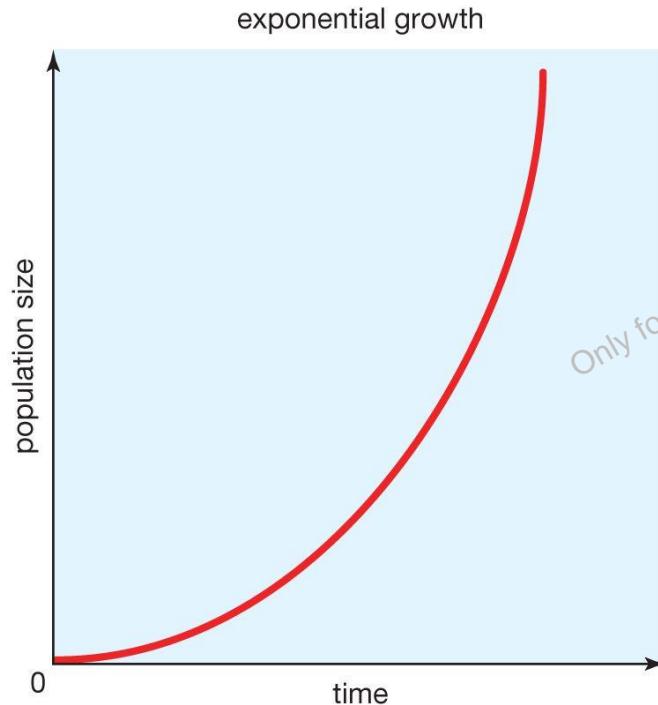
Arctic Fox



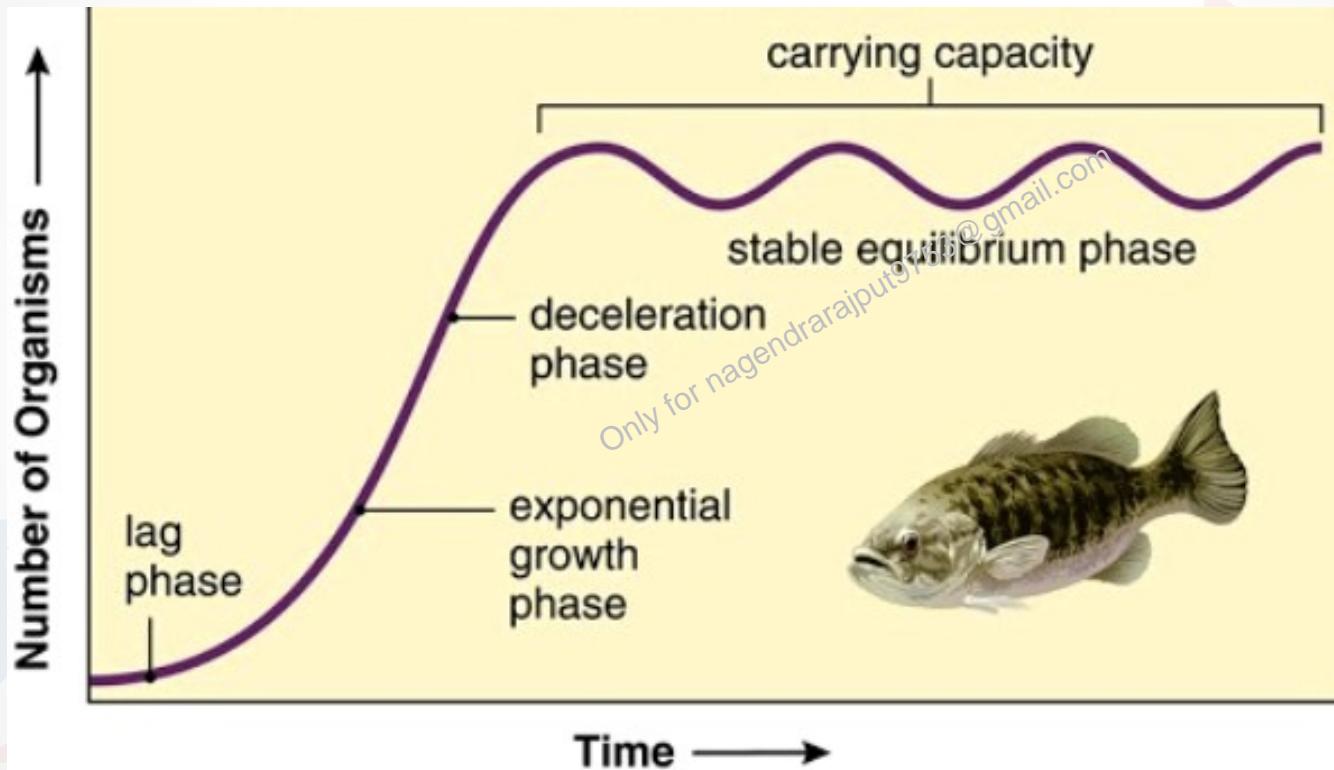
Desert Fox

Population Growth

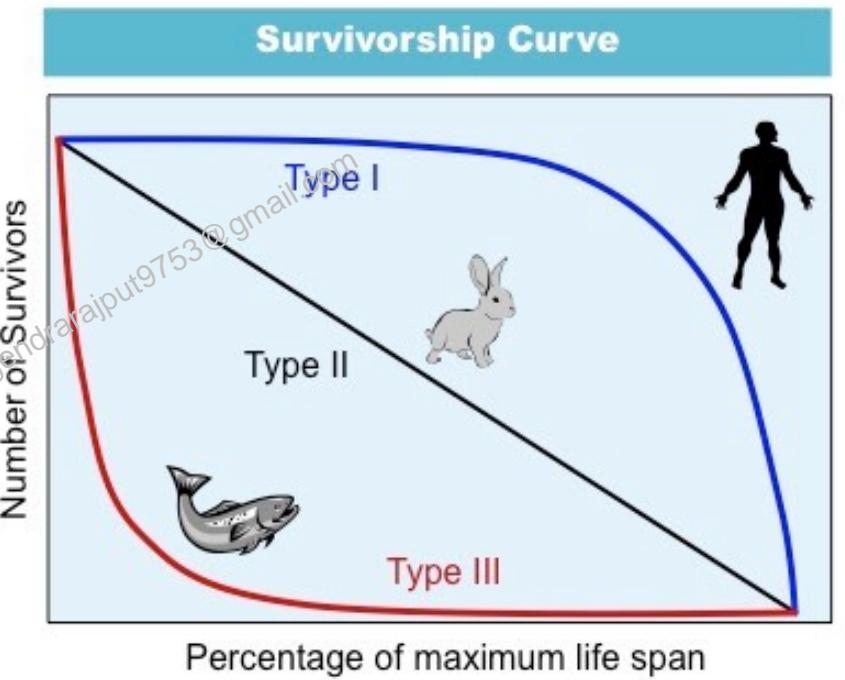
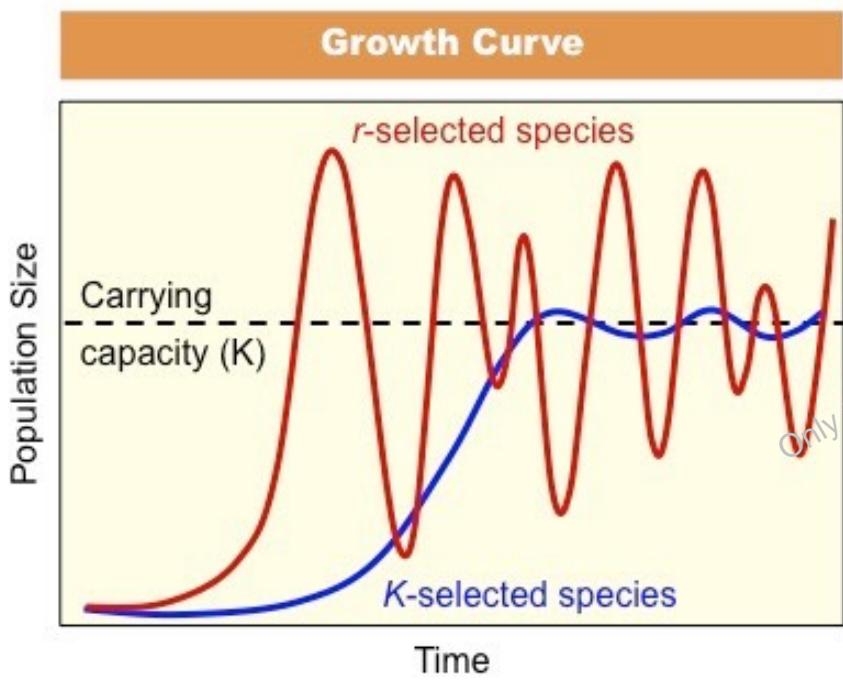
Exponential versus logistic population growth



Population Growth



R vs K selection



R vs K selection



Oyster
500 million a year



Fish (Tuna)
6,000 a year



Frog
200 a year



Hare
12 a year



Large Cat (Puma)
2 a year



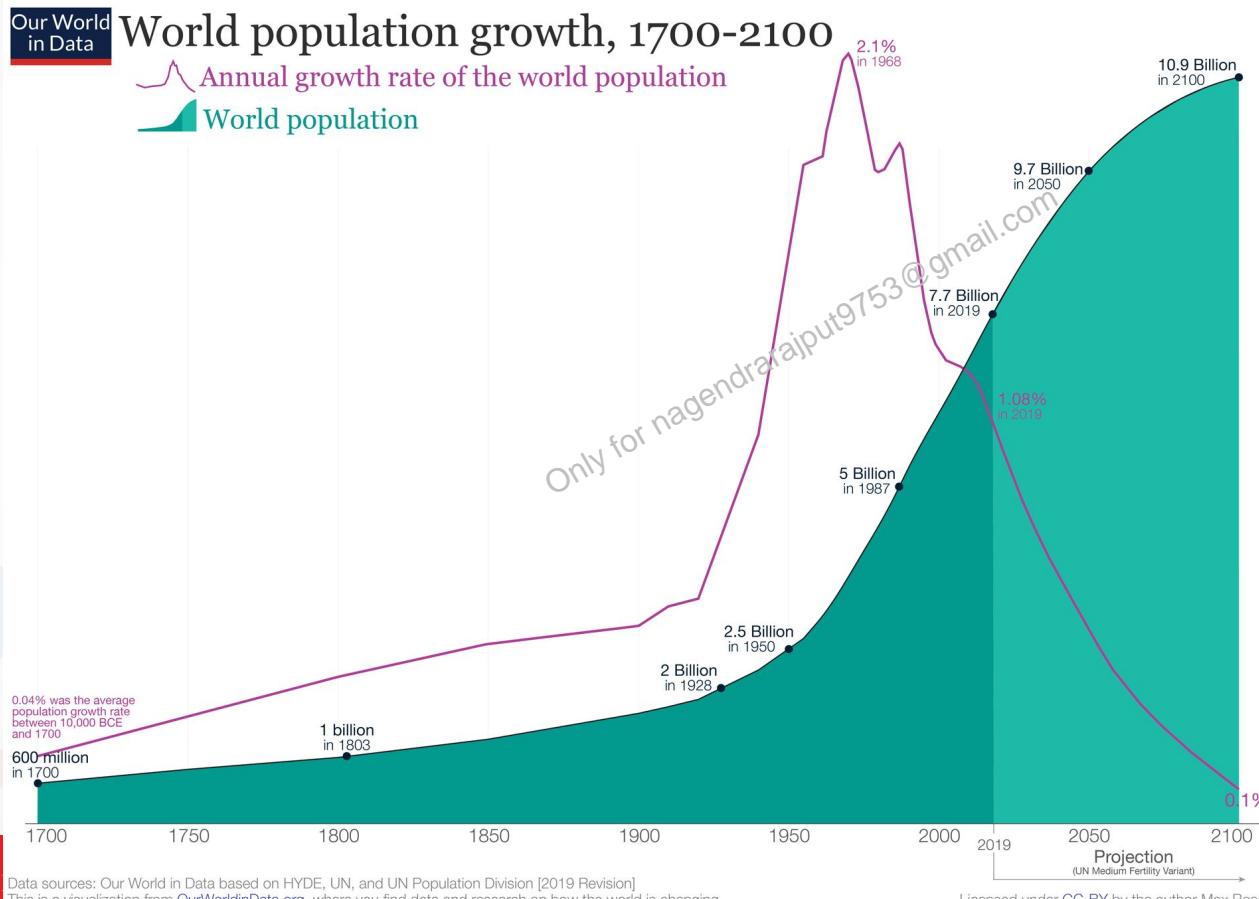
Chimpanzee
1 every 5 years

r

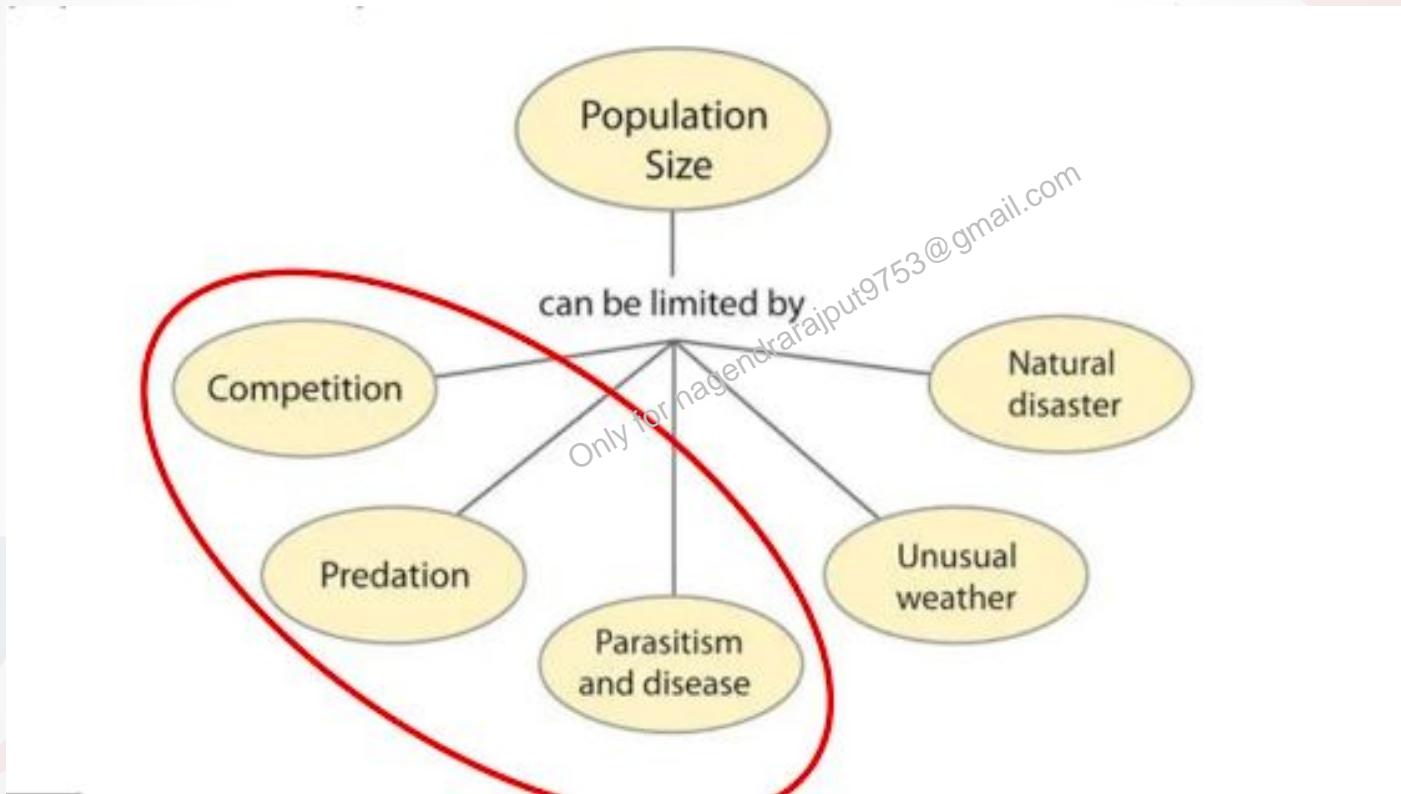


K

Human Population growth



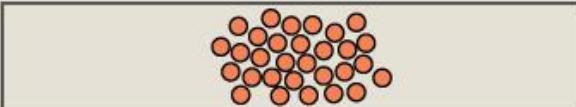
Limiting Factors



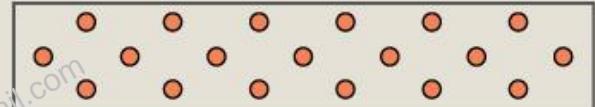
Population Dispersion



Random



Clumped



Uniform



(a)

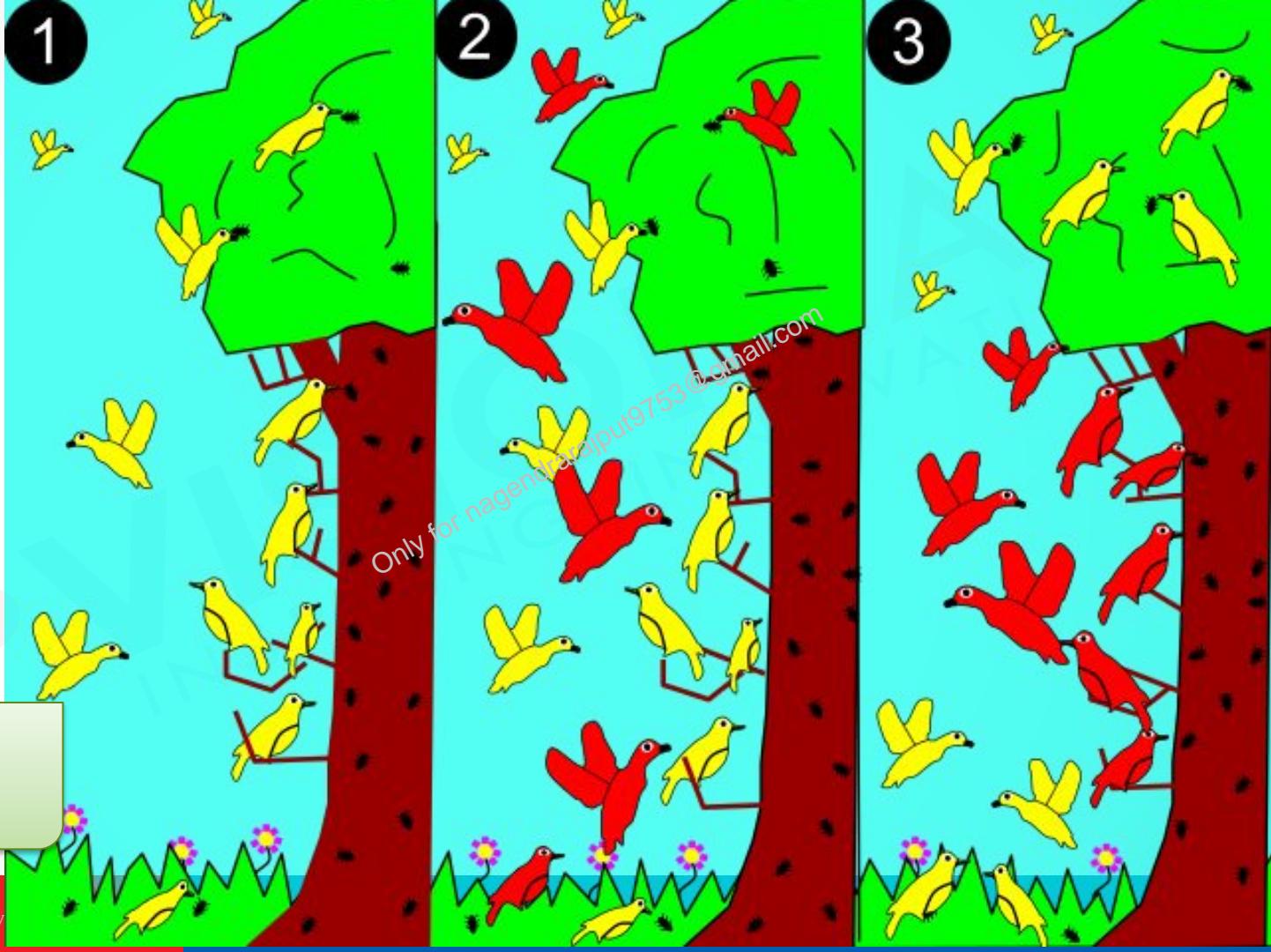


(b)



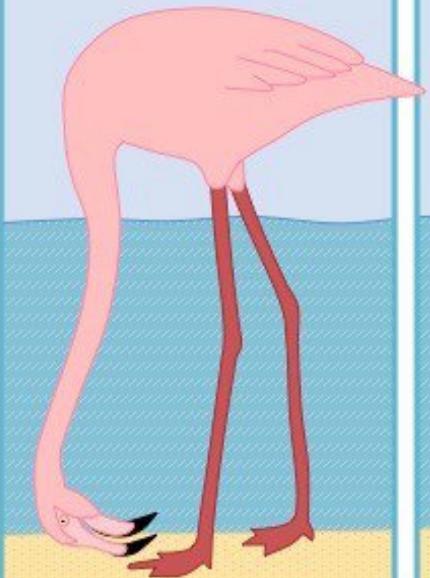
(c)

Competitive Exclusion Principle (Gause's law)



Resource Partitioning and Niche

Flamingos



Ducks



Avocets



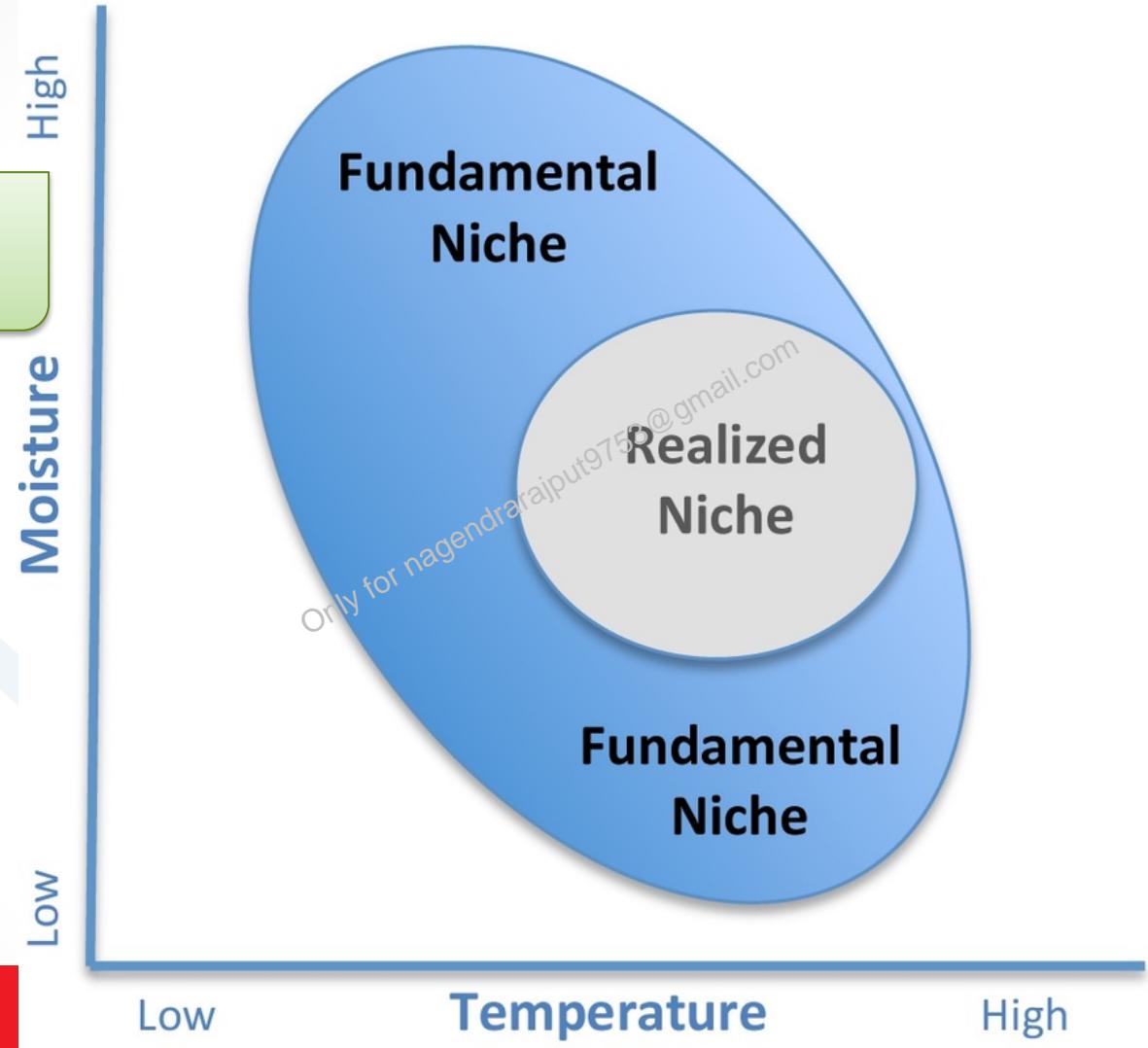
Oyster catchers



Plovers



Fundamental and Realized Niche



Biotic Interactions

Species A	Species B	Name of Interaction
+	+	<i>Mutualism</i>
-	-	<i>Competition</i>
+	-	<i>Predation</i>
+	-	<i>Parasitism</i>
+	0	<i>Commensalism</i>
-	0	<i>Amensalism</i>

Mutualism



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Symbiotic mutualistic relationships



Lichen

Mycorrhizae

Coral

Commensalism



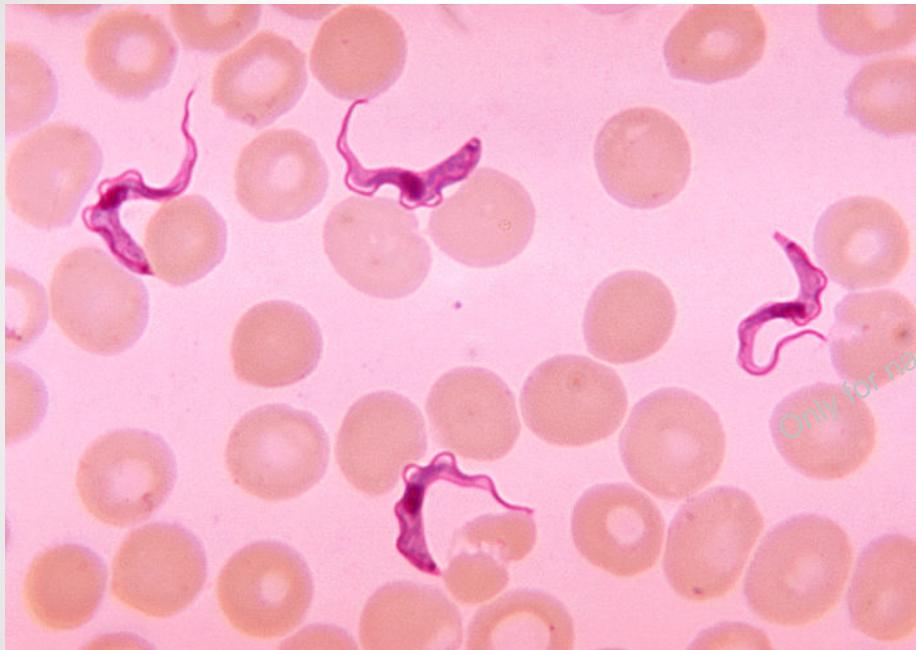
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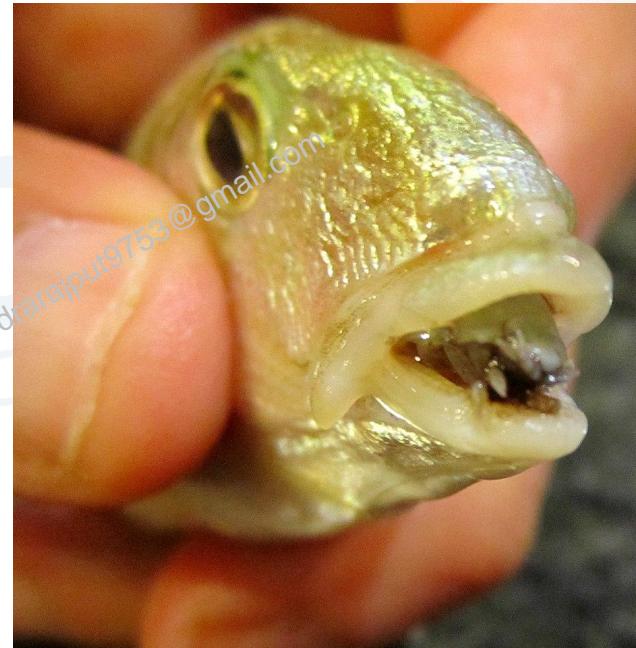
Predation



Parasitism



Protozoa in red blood cells



Fish parasite replacing the tongue

Amensalism



Competition

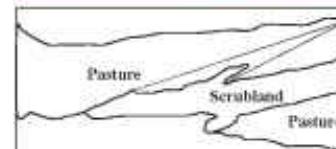


Interspecific competition

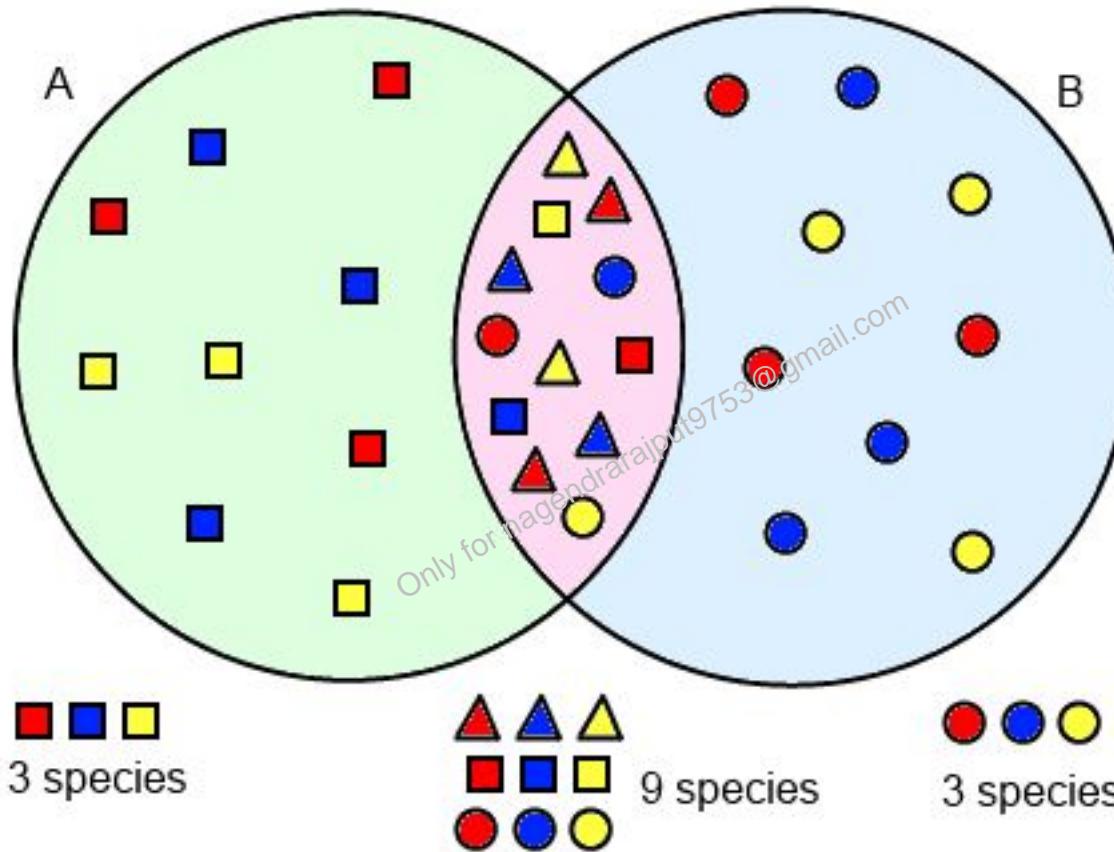


Intraspecific competition

Ecotone

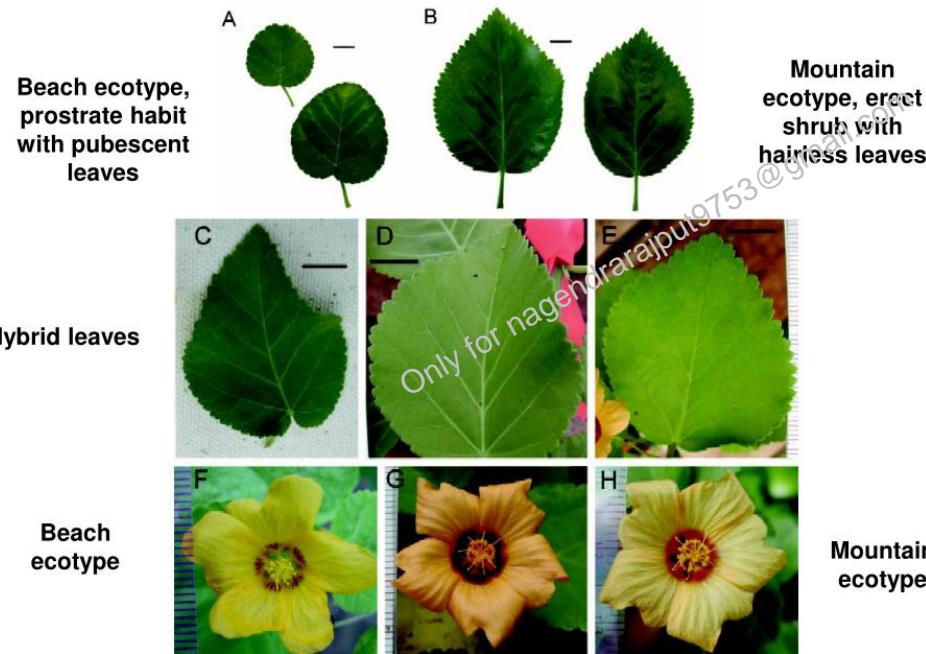


Edge Effect



Ecotype

Ecotypes: example



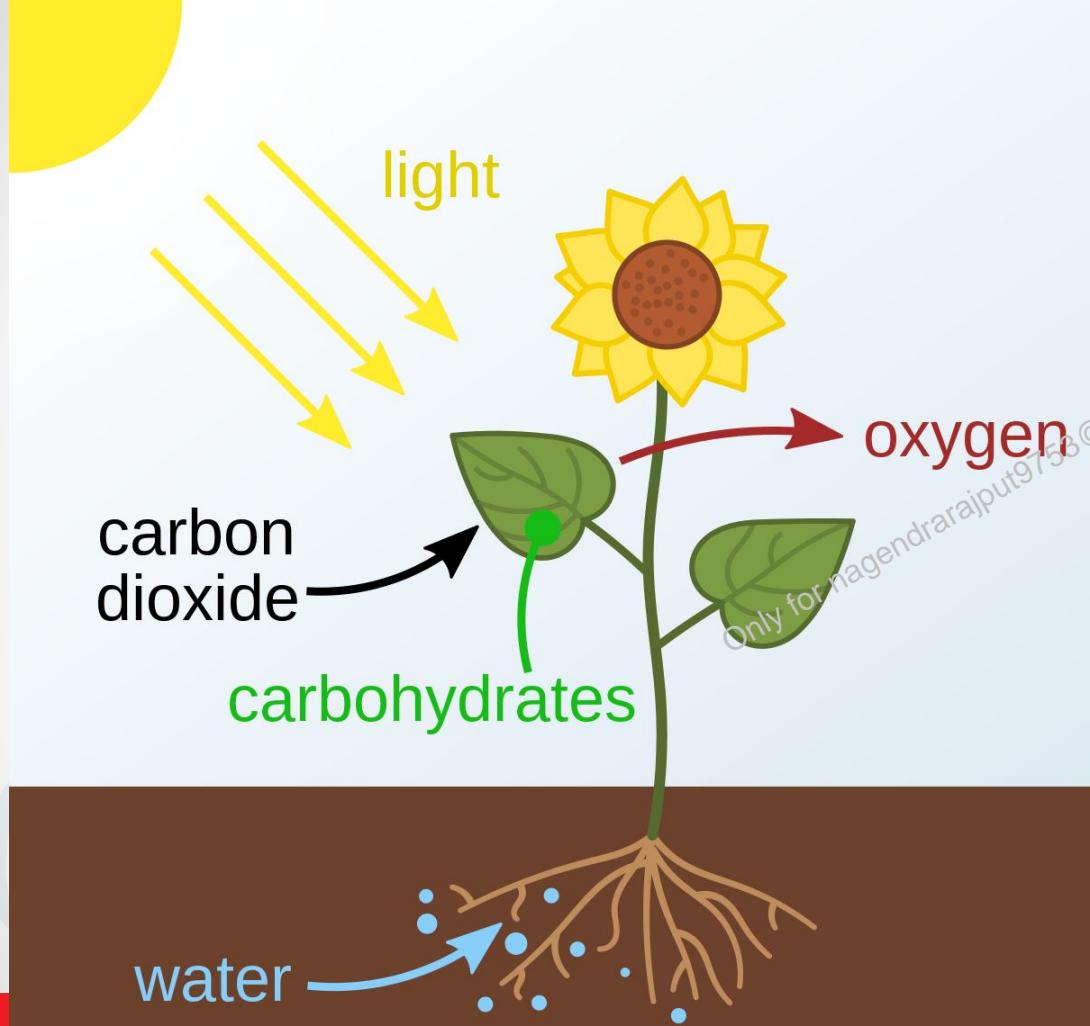
Ecotypes of *Sida fallax* and their hybrids in Hawai'i. A. Beach ecotype. B. Mountain ecotype. C, D, and E: hybrid leaves. F: Beach flower. G. Hybrid flower. H. Mountain flower.

Ecophene



Euphorbia hirta (Asthma Plant)

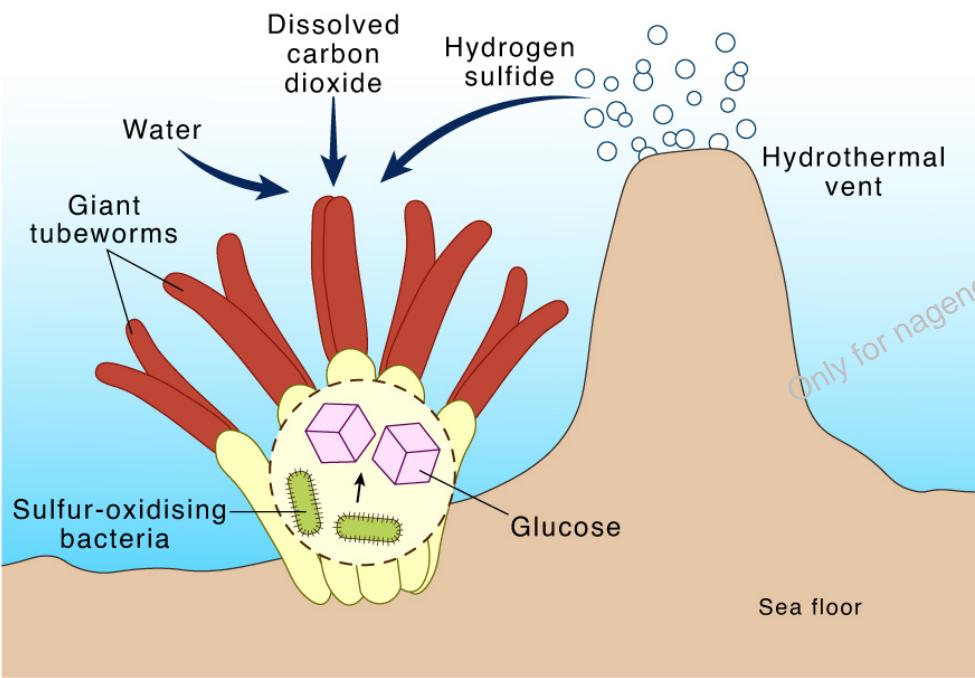




Photosynthesis

Chemosynthesis

ScienceFacts.net



Hydrothermal Vent

Which one of the following is the best description of the term 'ecosystem'?

- (a) A community of organisms interacting with one another
- (b) That part of the Earth which is inhabited by living organisms
- (c) A community of organisms together with the environment in which they live
- (d) The flora and fauna of a geographical area

2015

Which one of the following terms describes not only the physical space occupied by an organism, but also its functional role in the community of organisms?

- (a) Ecotone
- (b) Ecological niche
- (c) Habitat
- (d) Home range

2013

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Which of the following leaf modifications occurs/occur in desert areas to inhibit water loss?

1. Hard and waxy leaves
2. Tiny leaves or no leaves
3. Thorns instead of leaves

Select the correct answer using the codes given below.

- (a) 1 and 2 only
- (b) 2 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

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2013, 2018

Which one of the following is the process involved in photosynthesis?

- (a) Potential energy is released to form free energy
- (b) Free energy is converted into potential energy and stored
- (c) Food is oxidized to release carbon dioxide and water
- (d) Oxygen is taken, and carbon dioxide and water vapour are given out

2014

In the context of ecosystem productivity, marine upwelling zones are important as they increase the marine productivity by bringing the

1. decomposer microorganisms to the surface.
2. nutrients to the surface.
3. bottom-dwelling organisms to the surface.

Which of the statements given above is/are correct ?

- (a) 1 and 2
- (b) 2 only
- (c) 2 and 3
- (d) 3 only

2011

Consider the following :

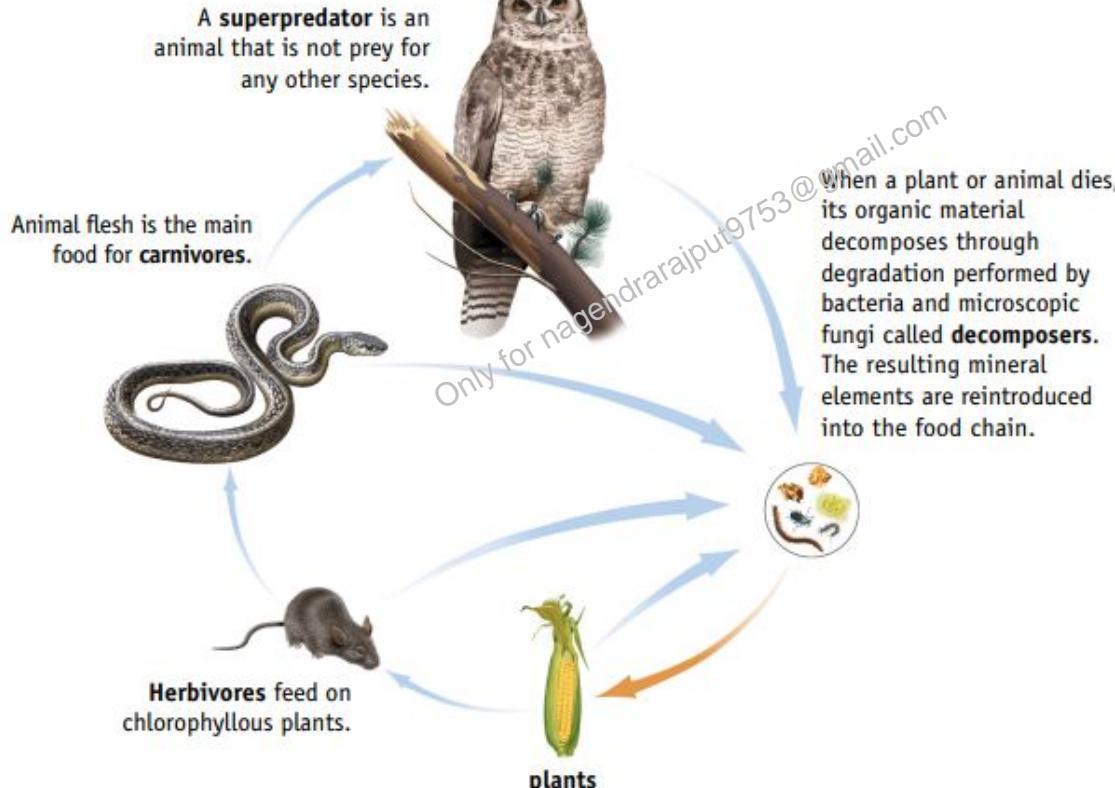
1. Bats
2. Bears
3. Rodents

The phenomenon of hibernation can be observed in which of the above kinds of animals?

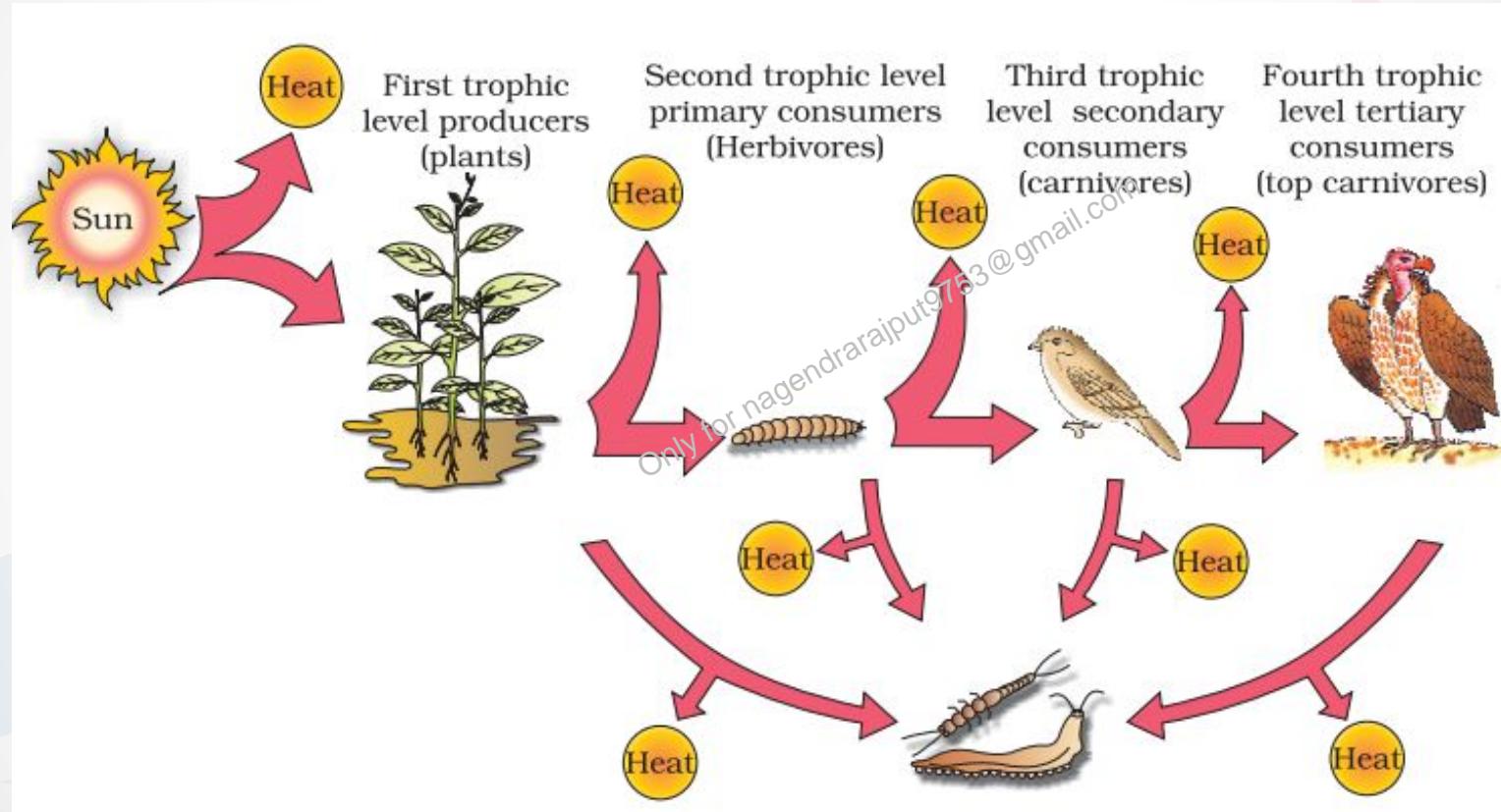
2014

- (a) 1 and 2 only
- (b) 2 only
- (c) 1, 2 and 3
- (d) Hibernation cannot be observed in any of the above

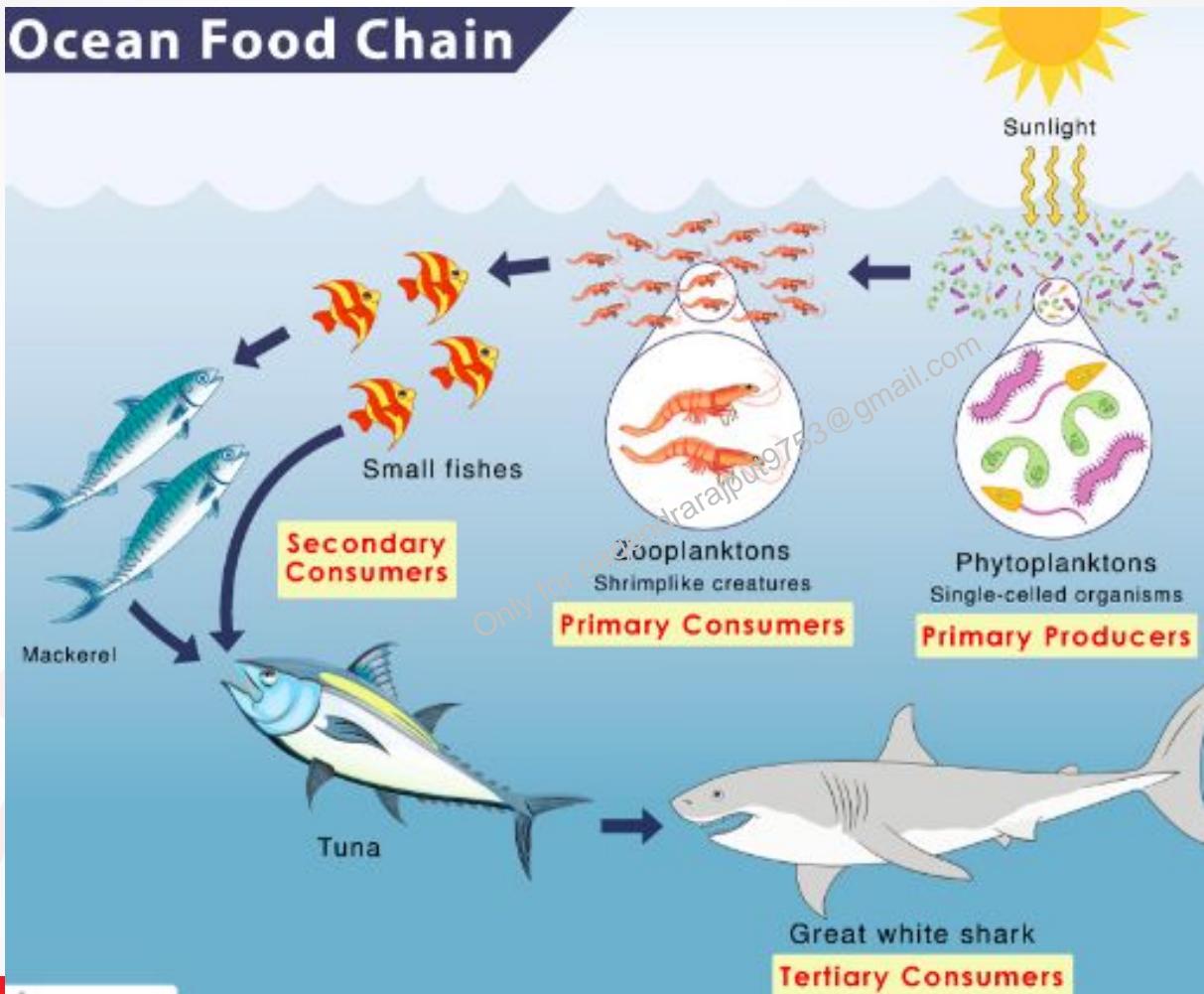
Food Chain



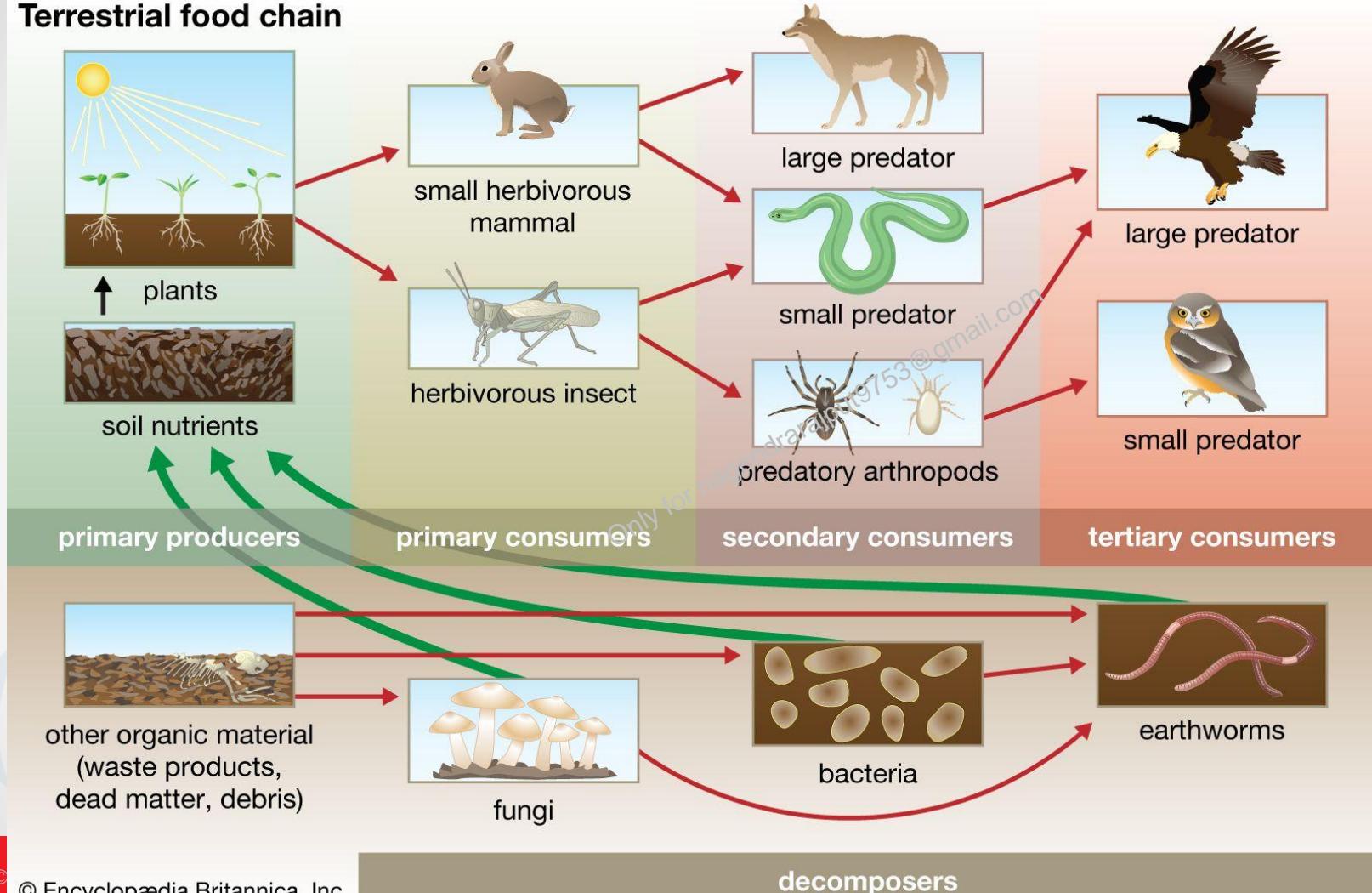
Energy flow through Trophic Levels

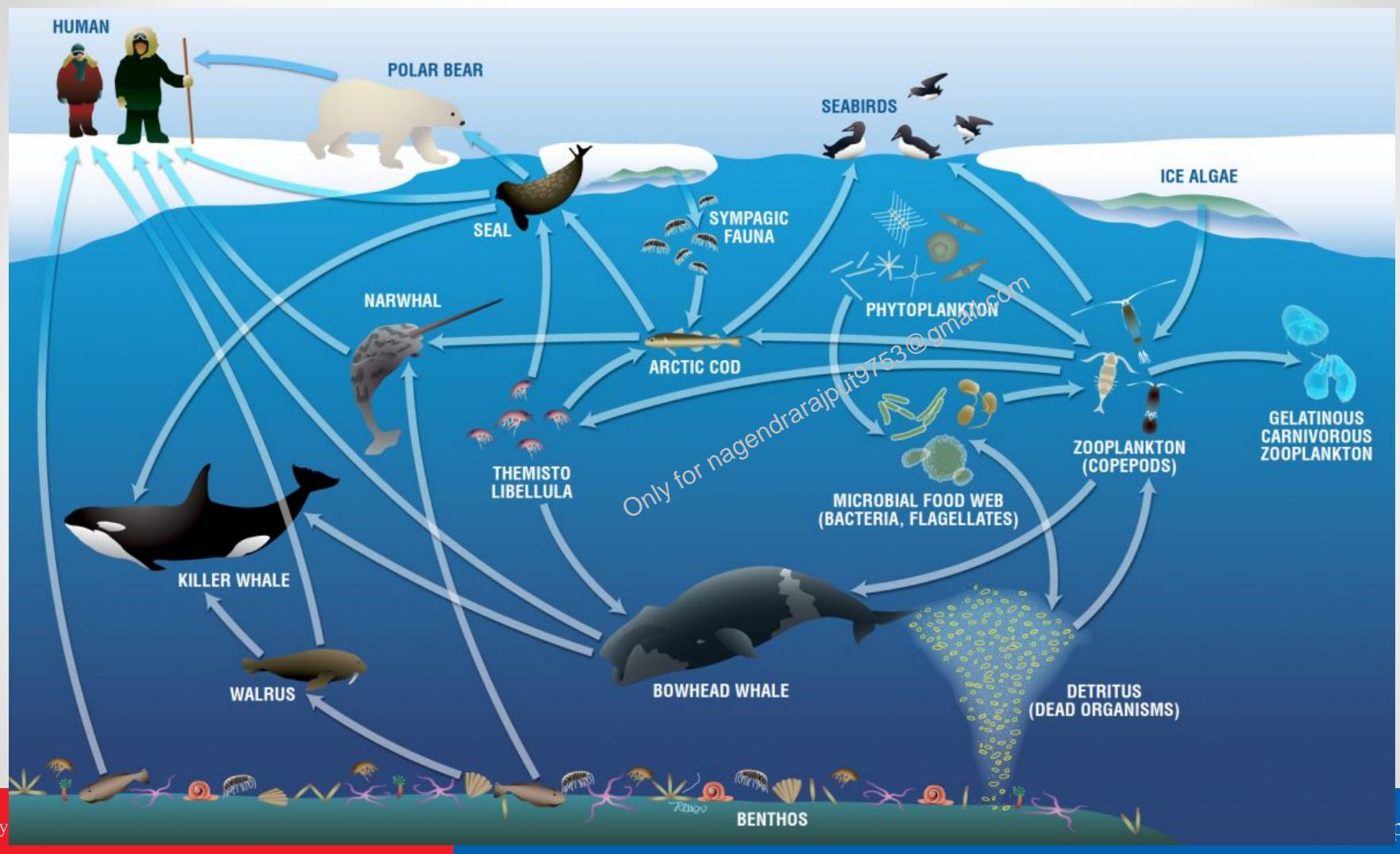


Ocean Food Chain

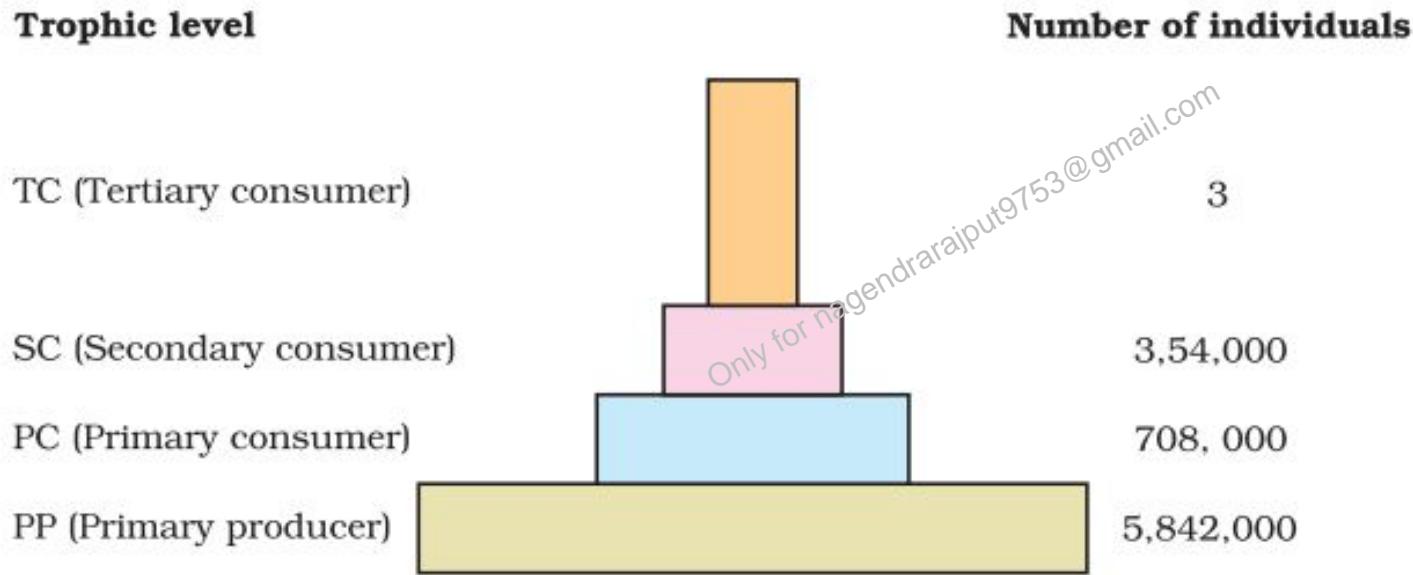


Terrestrial food chain





Ecological Pyramids - Number



Ecological Pyramids - Number

Upright pyramid

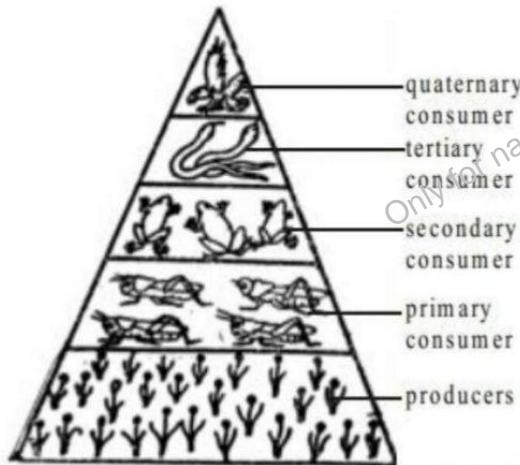
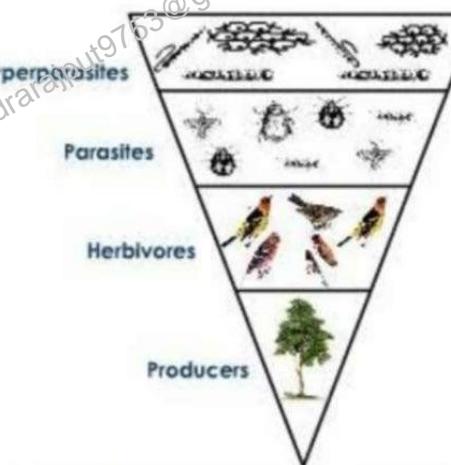


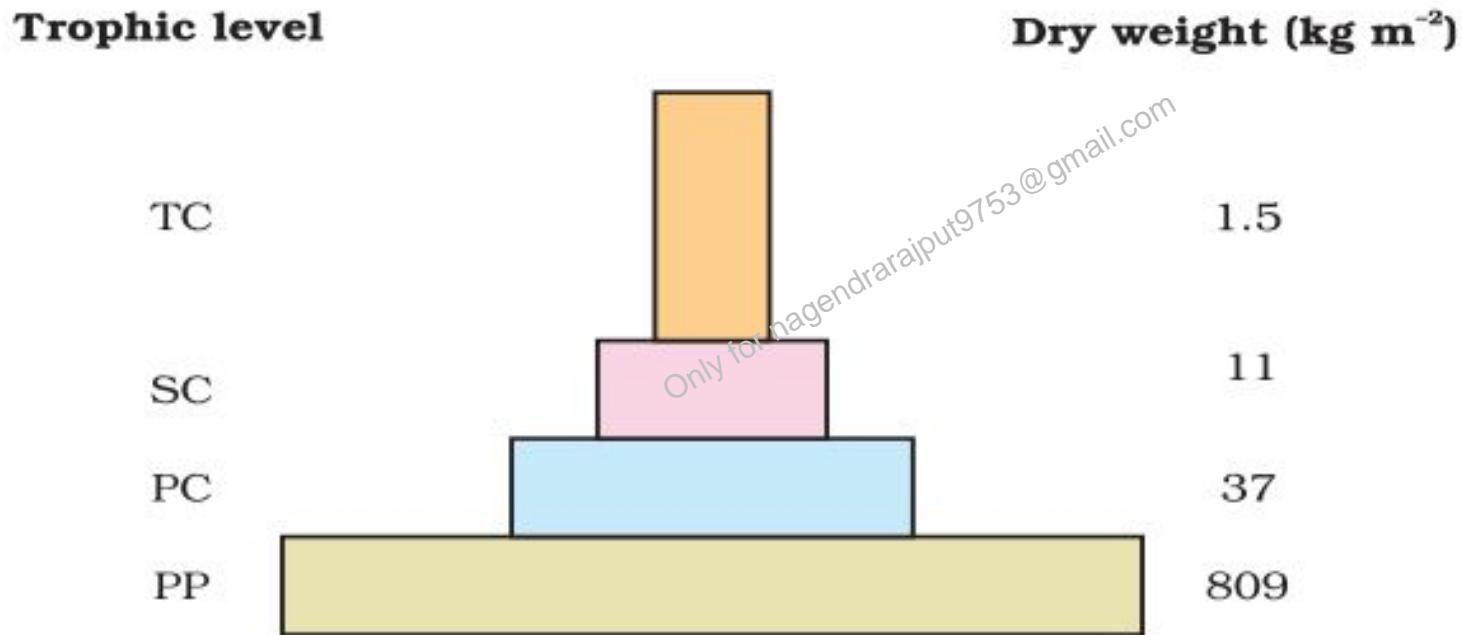
Fig. Pyramid of numbers in a grassland

Inverted pyramid



Inverted pyramid of number

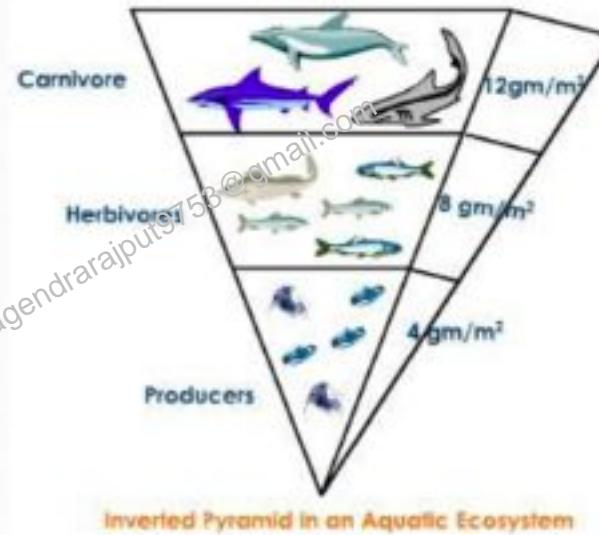
Ecological Pyramids - Biomass



Ecological Pyramids - Biomass

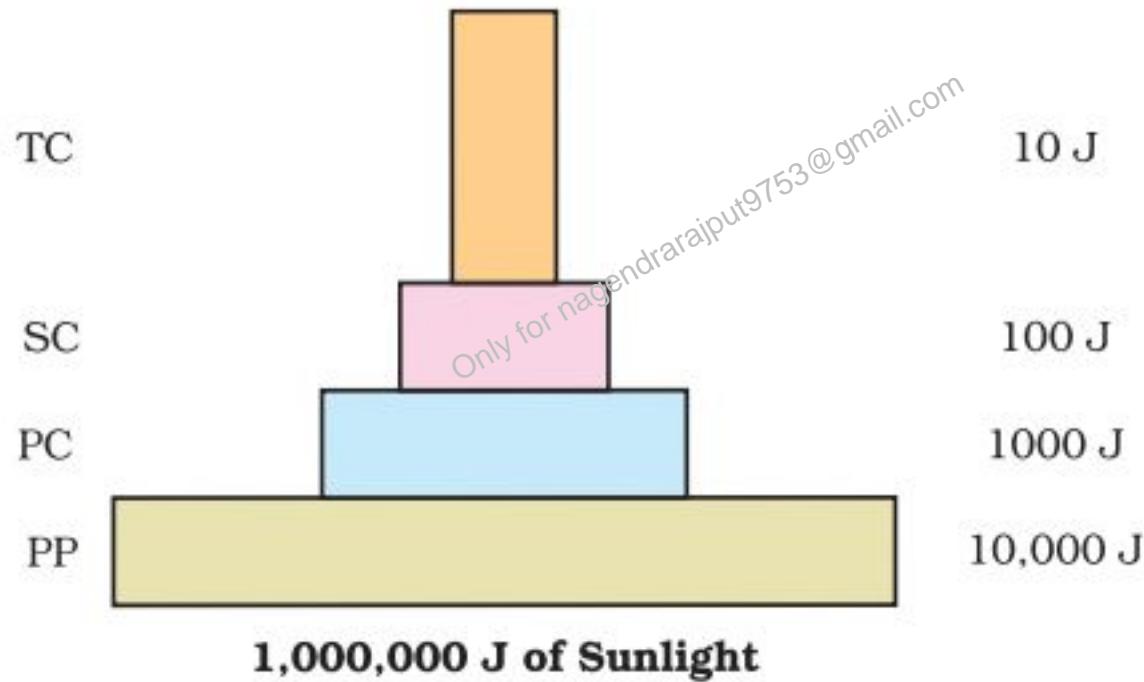


Upright

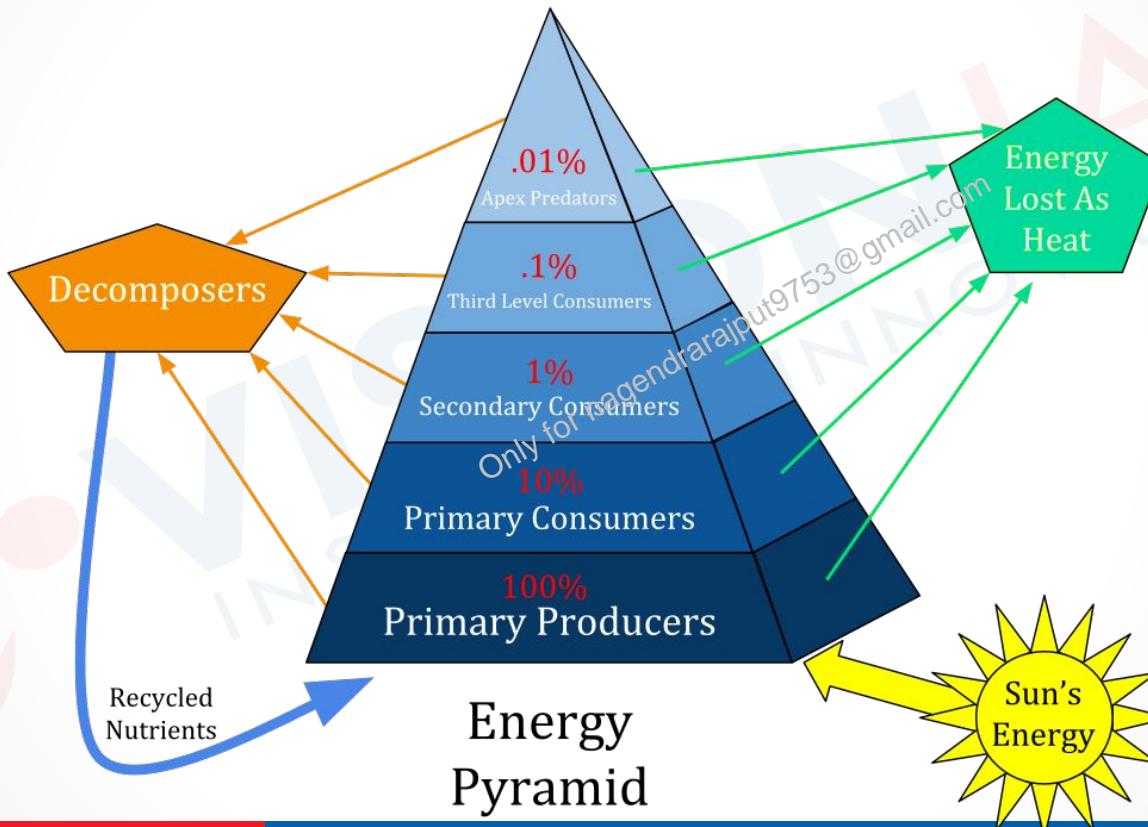


Inverted

Ecological Pyramids - Energy



Ecological Pyramids - Energy



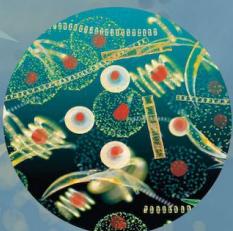
BIOMAGNIFICATION AND BIOACCUMULATION

How can pollutants have long-term effects on organisms?

Even when pollutants are not dangerous enough to kill animals outright, their presence can have lasting effects on food webs through **bioaccumulation** and **biomagnification**.

Toxins may increase in concentration as they are passed up the food chain, a process called **biomagnification**.

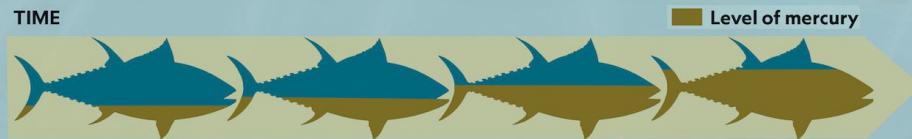
Pollutants such as **polychlorinated biphenyls (PCBs)** enter the ocean as industrial waste and are absorbed by microscopic **phytoplankton** at the bottom of the food chain.



PCBs



Even though phytoplankton absorb only a tiny amount, small creatures called **zooplankton** eat large quantities of the phytoplankton, taking in all the PCBs from what the phytoplankton eat.



Bioaccumulation occurs when pollutants build up in a single organism's body over time. Mercury, for example, is a pollutant that has entered waterways and lakes through industrial processes. Fish and shellfish absorb the mercury directly from their environment, and although they may only absorb small amounts at a time, the mercury can remain in the fish's body for months or even longer. This leads to the mercury building up, or **accumulating**, in the fish's body, posing a danger to any organism that eats the fish.

Small fish then feed on the zooplankton, continuing to **magnify** the amount of PCBs up the food chain.



In the waters of the Pacific Northwest, **apex predators** like the killer whale (*Orcinus orca*) end up with the highest concentrations of toxins due to biomagnification.

NATIONAL
GEOGRAPHIC

Which one of the following is the correct sequence of ecosystems in the order of decreasing productivity?

- (a) Oceans, lakes, grasslands, mangroves
- (b) Mangroves, oceans, grasslands, lakes
- (c) Mangroves, grasslands, lakes, oceans
- (d) Oceans, mangroves, lakes, grasslands

2013

With reference to food chains in ecosystems, consider the following statements :

1. A food chain illustrates the order in which a chain of organisms feed upon each other.
2. Food chains are found within the populations of a species.
3. A food chain illustrates the numbers of each organism which are eaten by others.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 1 and 2 only
- (c) 1, 2 and 3
- (d) None

2013

Due to some reasons, if there is a huge fall in the population of species of butterflies, what could be its likely consequence/consequences ?

1. Pollination of some plants could be adversely affected.
2. There could be a drastic increase in the fungal infections of some cultivated plants.
3. It could lead to a fall in the population of some species of wasps, spiders and birds.

Select the correct answer using the code given below :

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

2017

What would happen if phytoplankton of an ocean is completely destroyed for some reason?

1. The ocean as a carbon sink would be adversely affected.
2. The food chains in the ocean would be adversely affected.
3. The density of ocean water would drastically decrease.

2012

Select the correct answer using the codes given below :

- (a) 1 and 2 only
- (b) 2 only
- (c) 3 only
- (d) 1, 2 and 3

With reference to the food chains in ecosystems, which of the following kinds of organism is/are known as decomposer organism/organisms?

1. Virus
2. Fungi
3. Bacteria

Select the correct answer using the codes given below.

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

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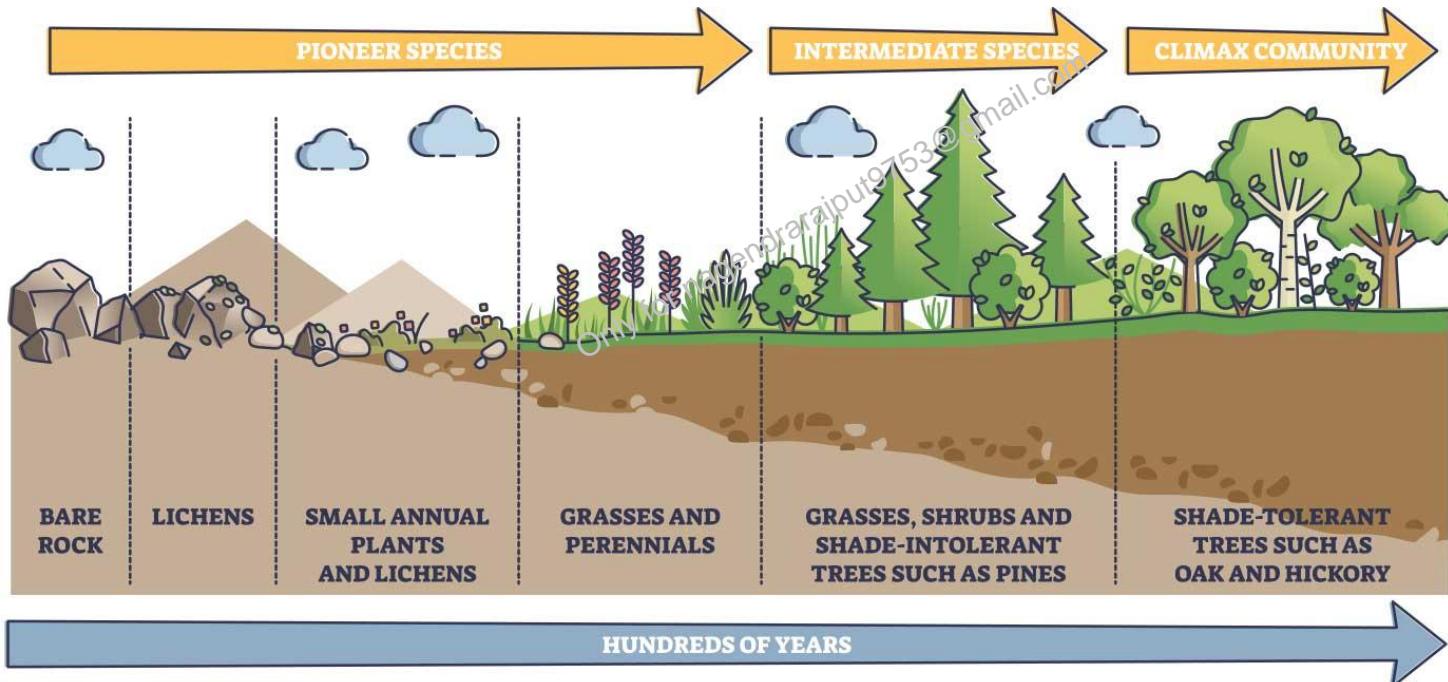
2013

Lichens, which are capable of initiating ecological succession even on a bare rock, are actually a symbiotic association of

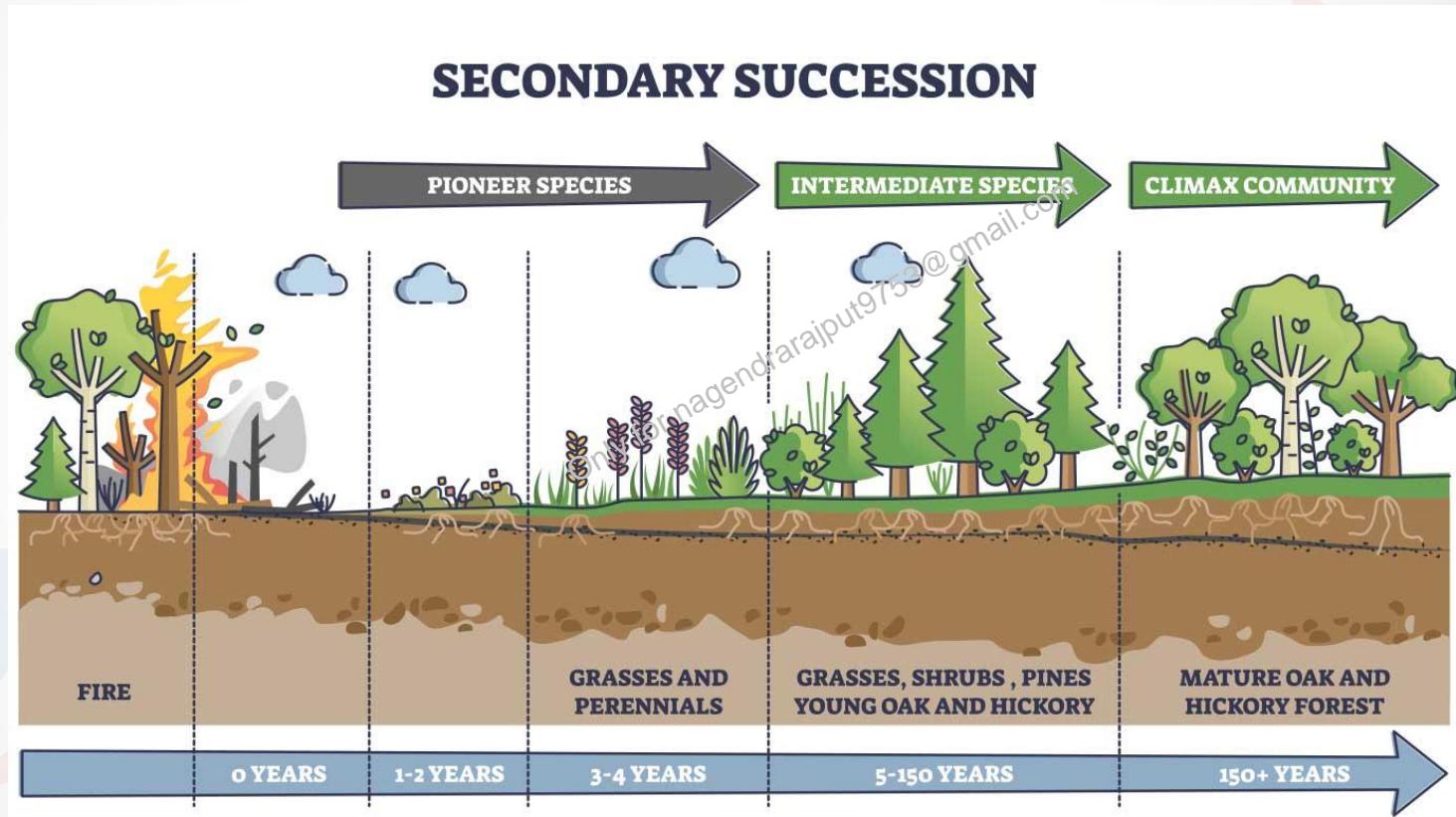
- (a) algae and bacteria
- (b) algae and fungi
- (c) bacteria and fungi
- (d) fungi and mosses

Ecological Succession

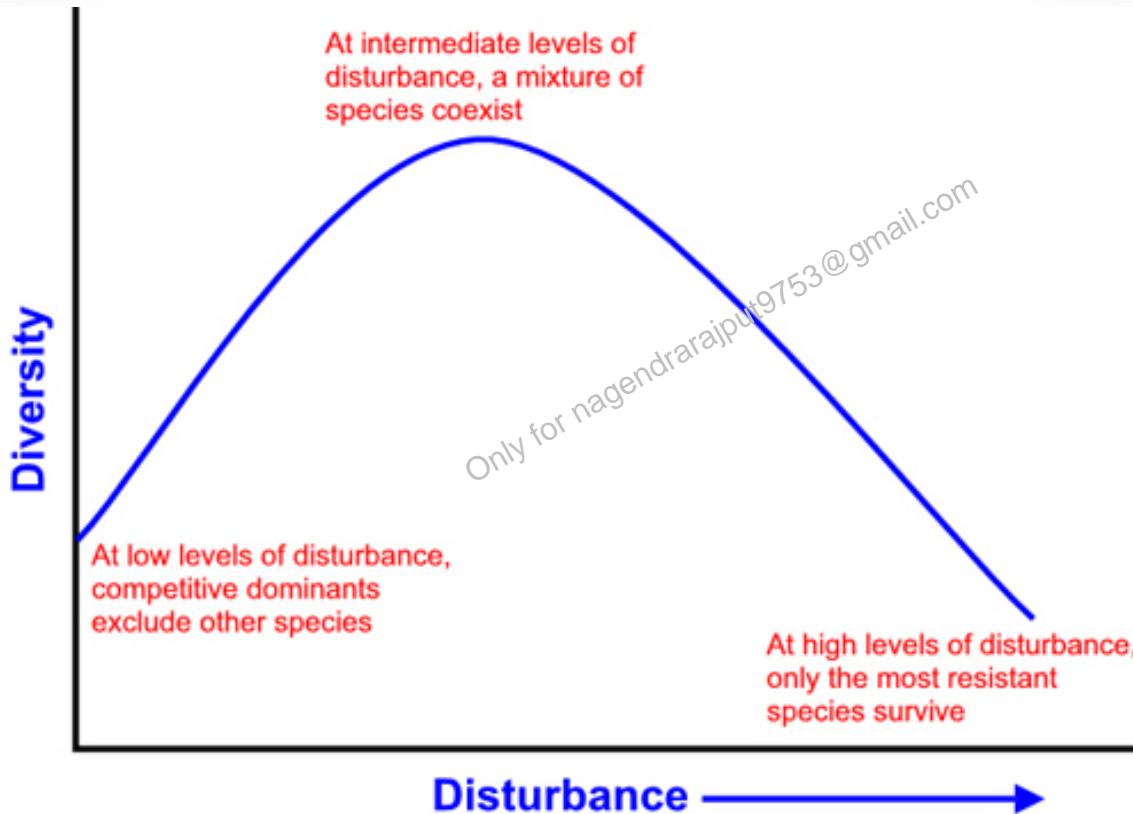
PRIMARY SUCCESSION



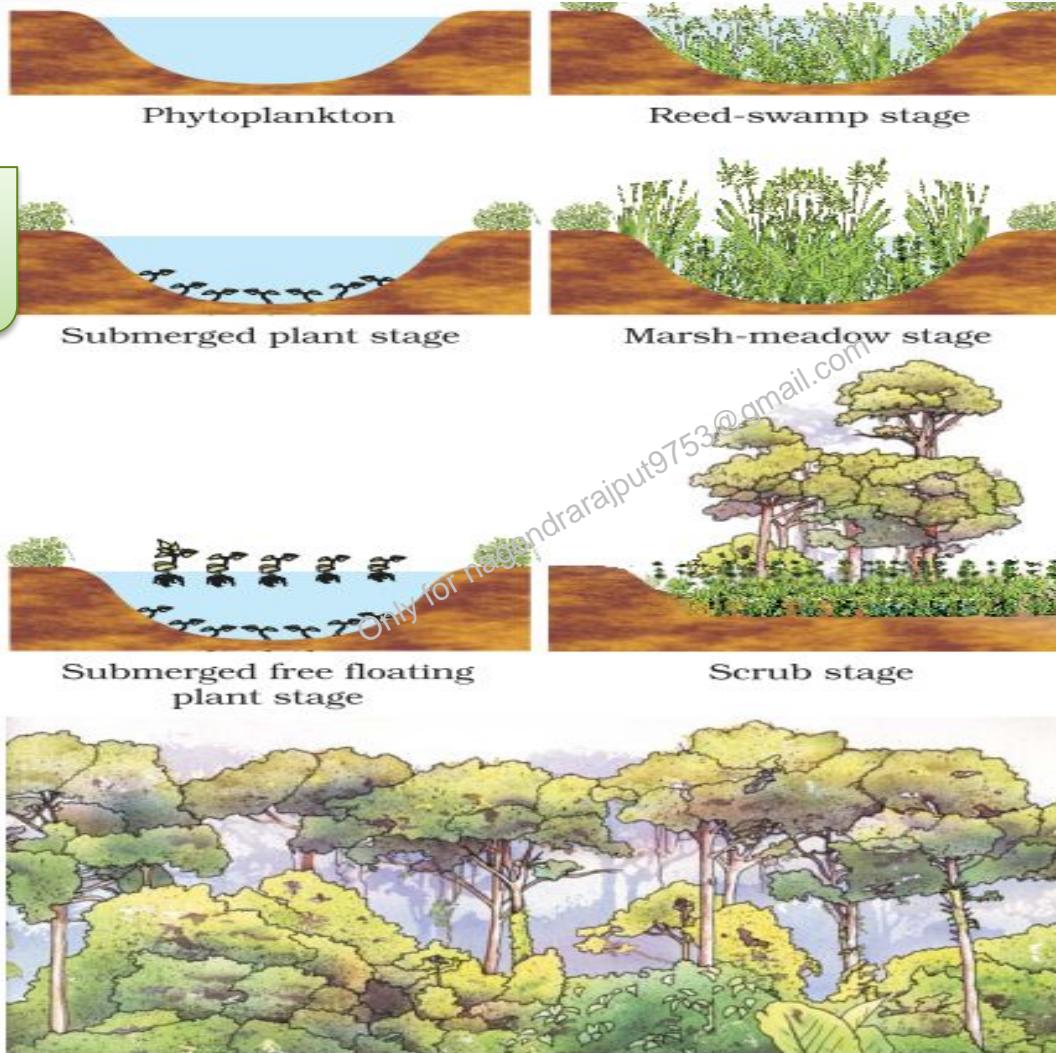
Ecological Succession

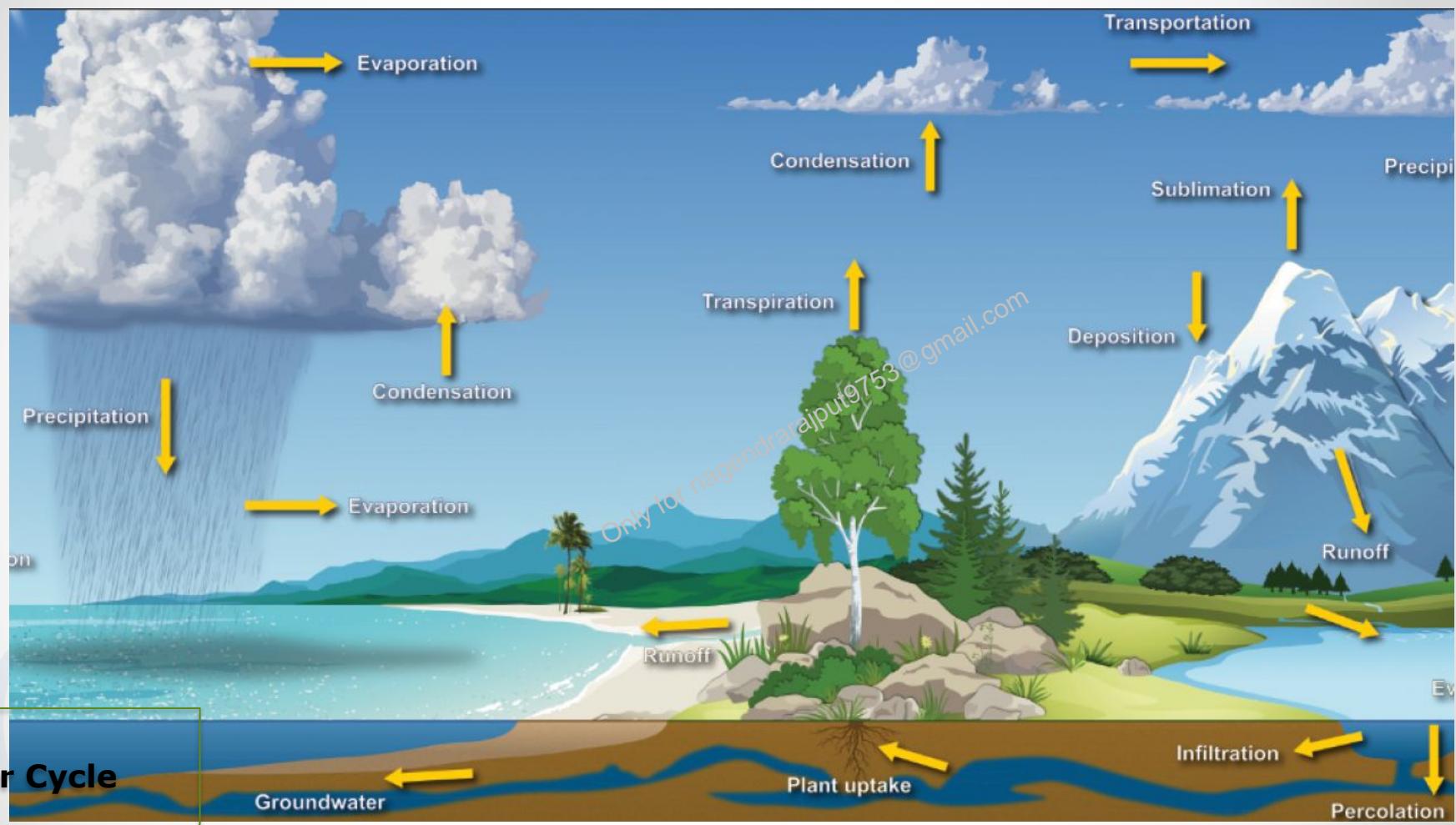


Intermediate Disturbance Hypothesis

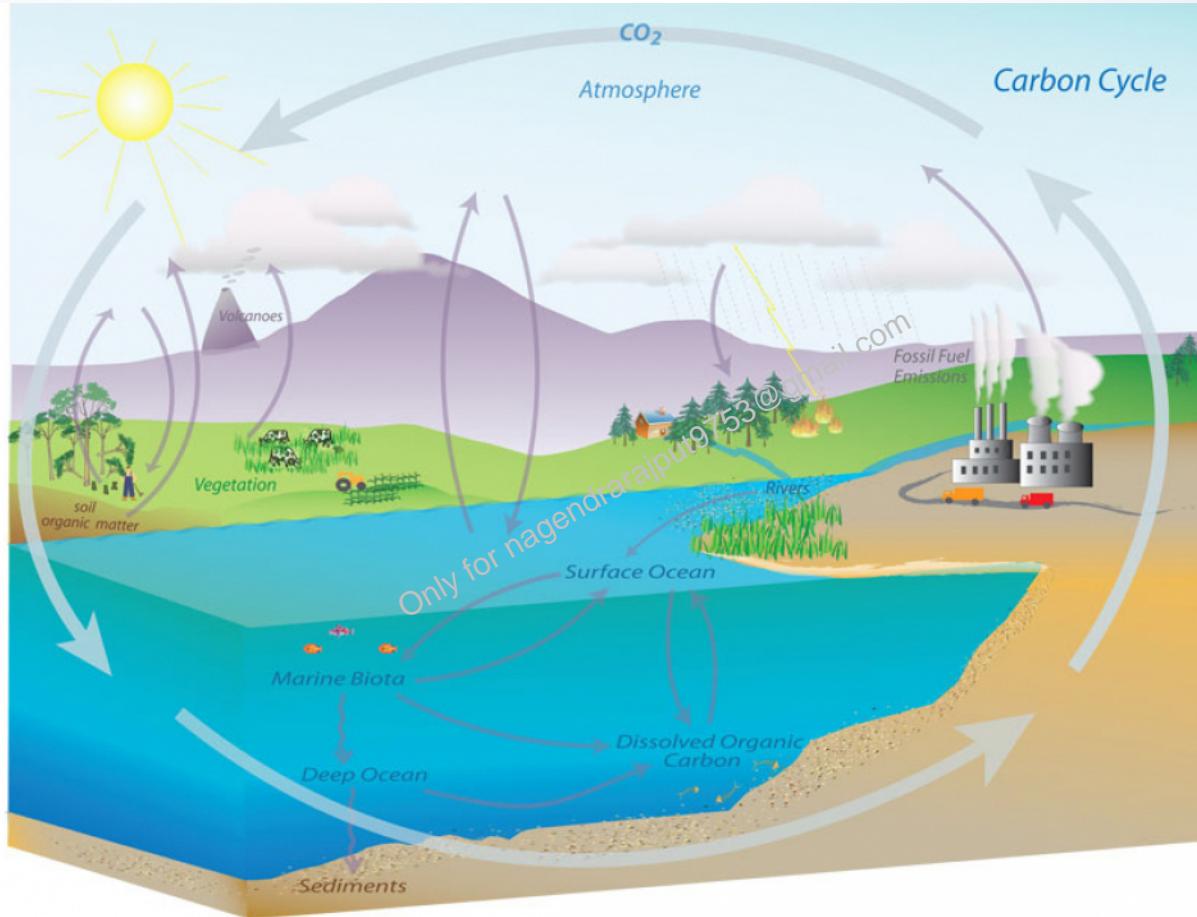


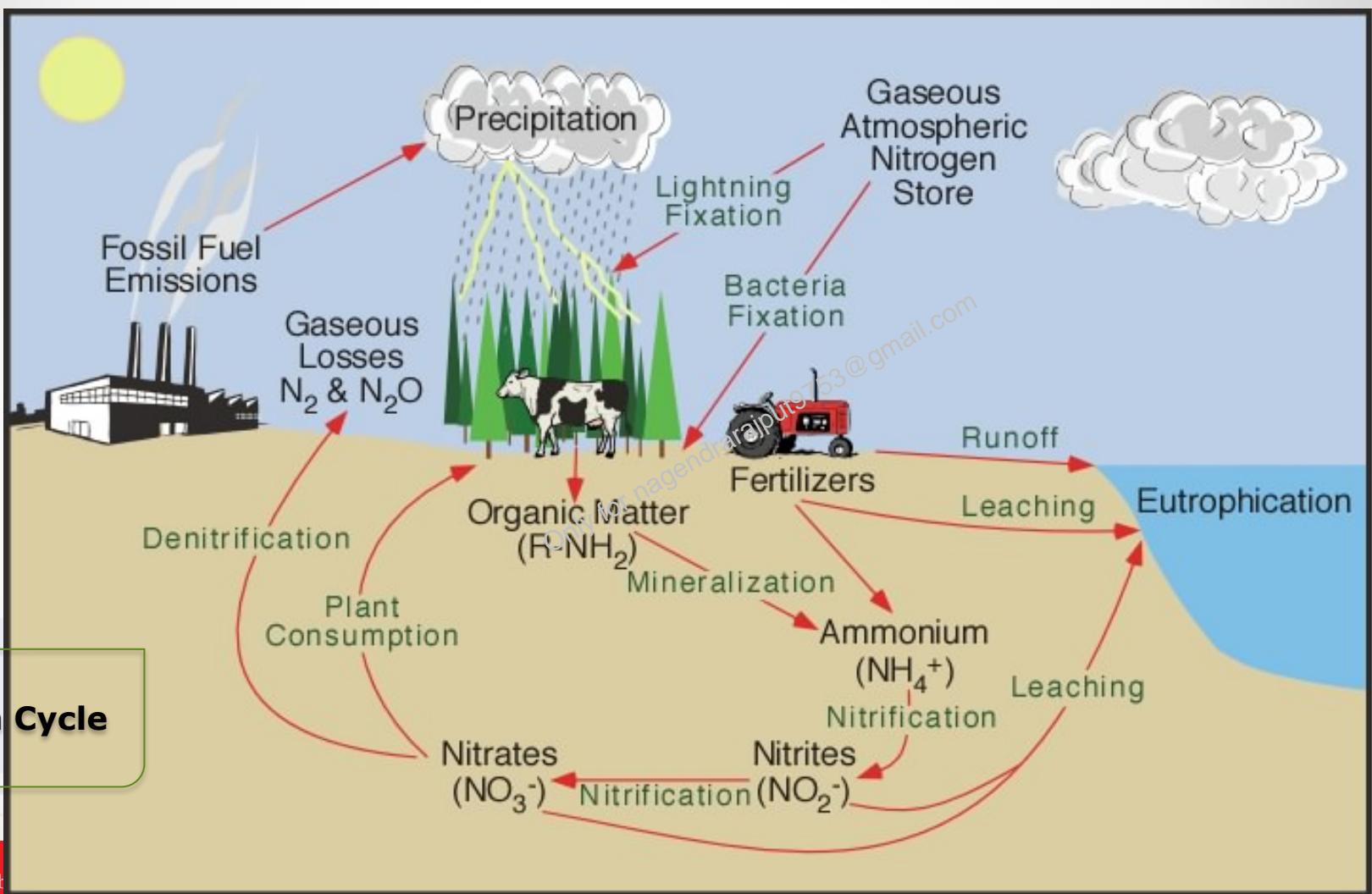
Hydrarch and Xerarch Succession

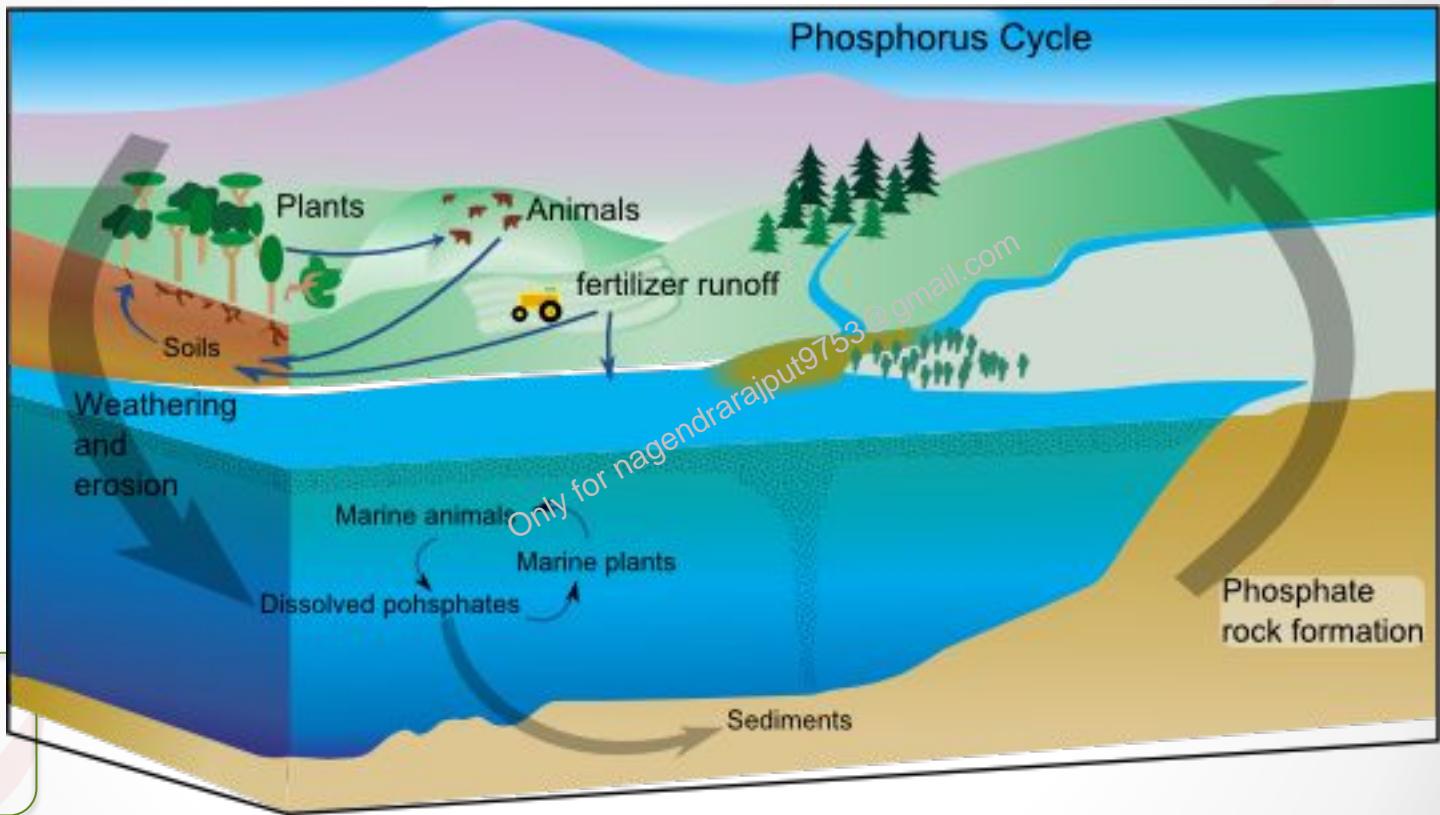




Carbon Cycle

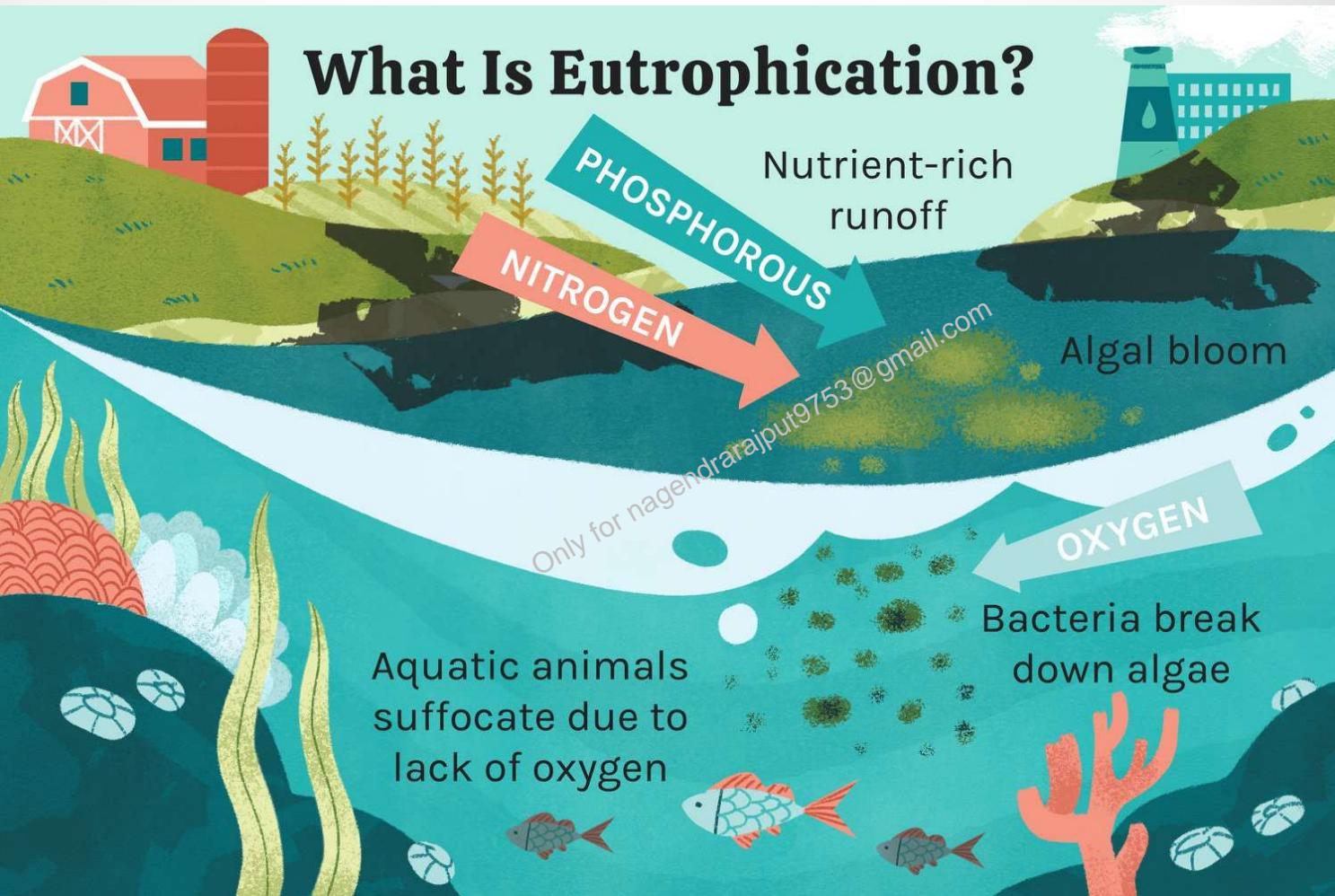




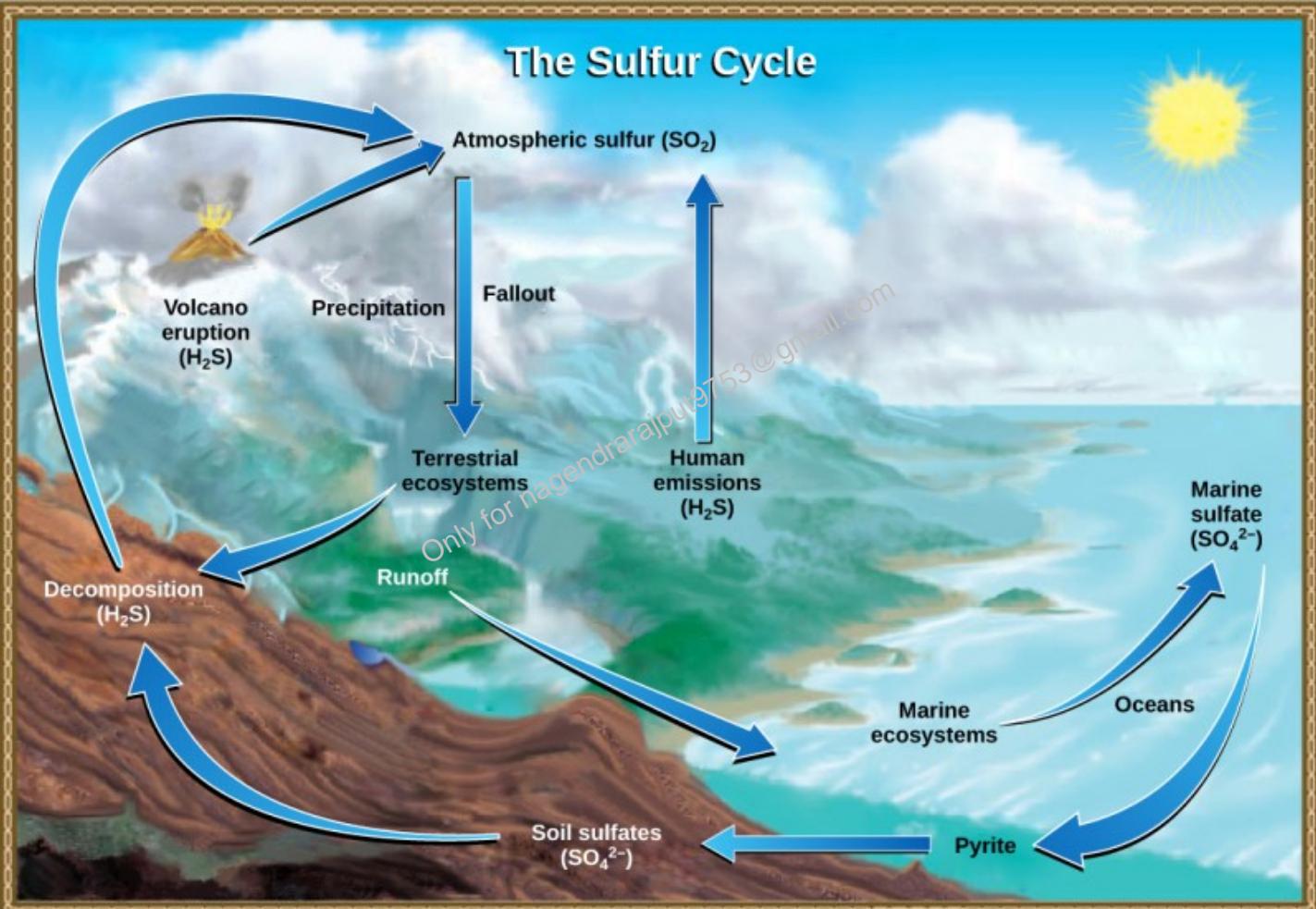


Phosphorus Cycle

What Is Eutrophication?



Sulphur Cycle



Consider the following :

1. Photosynthesis
2. Respiration
3. Decay of organic matter
4. Volcanic action

Which of the above add carbon dioxide
to the carbon cycle on Earth ?

- (a) 1 and 4 only
- (b) 2 and 3 only
- (c) 2, 3 and 4 only
- (d) 1, 2, 3 and 4

2011, 2014

There is a concern over the increase in harmful algal blooms in the seawaters of India. What could be the causative factors for this phenomenon ?

1. Discharge of nutrients from the estuaries.
2. Run-off from the land during the monsoon.
3. Upwelling in the seas.

Select the correct answer from the codes given below :

- (a) 1 only
- (b) 1 and 2 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

2011

Which of the following are nitrogen-fixing plants ?

1. Alfalfa
2. Amaranth
3. Chickpea
4. Clover
5. Purslane (Kulfa)
6. Spinach

Select the correct answer using the code given below :

- (a) 1, 3 and 4 only
- (b) 1, 3, 5 and 6 only
- (c) 2, 4, 5 and 6 only
- (d) 1, 2, 4, 5 and 6

2022

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In case of which one of the following biogeochemical cycles, the weathering of rocks is the main source of release of nutrient to enter the cycle?

- (a) Carbon cycle
- (b) Nitrogen cycle
- (c) Phosphorus cycle
- (d) Sulphur cycle

Which of the following adds/add nitrogen to the soil?

1. Excretion of urea by animals
2. Burning of coal by man
3. Death of vegetation

Select the correct answer using the codes given below.

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

2013

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Ecosystem Services

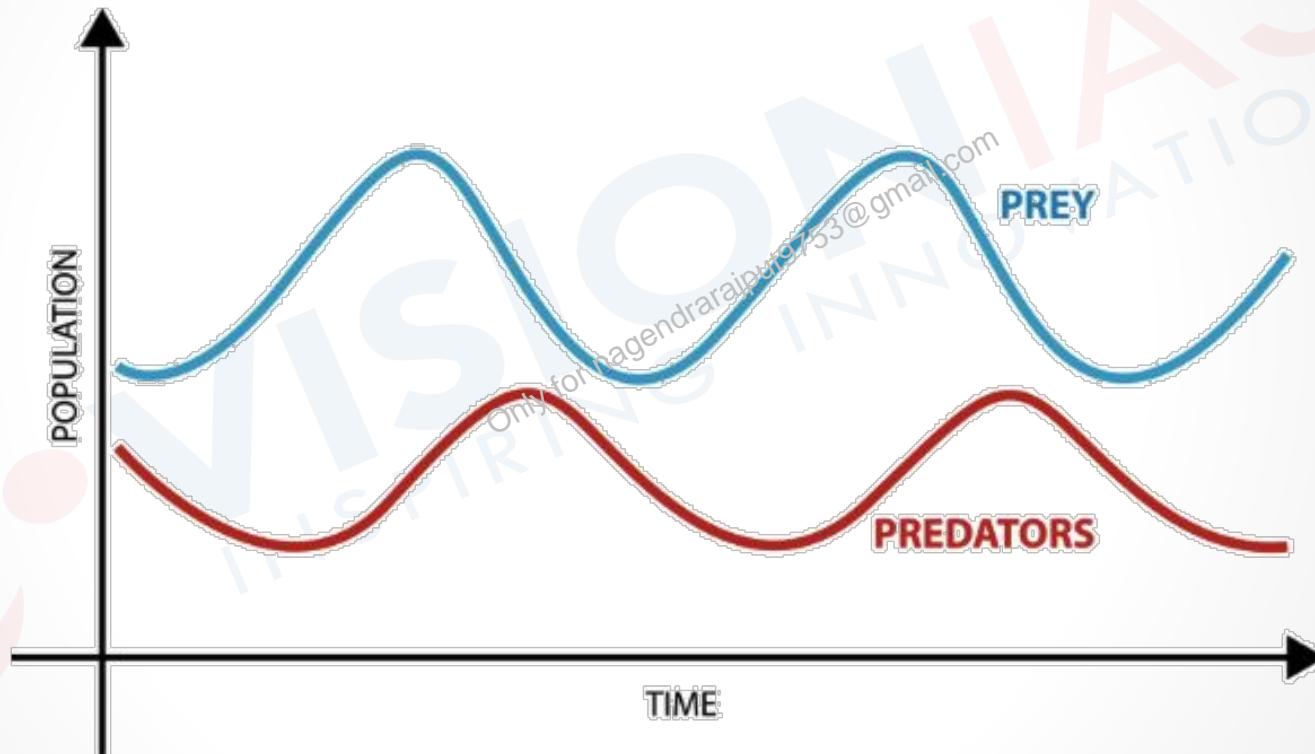


The Millennium Ecosystem Assessment describes the following major categories of ecosystem services—provisioning, supporting, regulating, preserving and cultural. Which one of the following is supporting service?

- (a) Production of food and water
- (b) Control of climate and disease
- (c) Nutrient cycling and crop pollination.
- (d) Maintenance of diversity

2012

Feedback Mechanisms



Lake Ecosystem

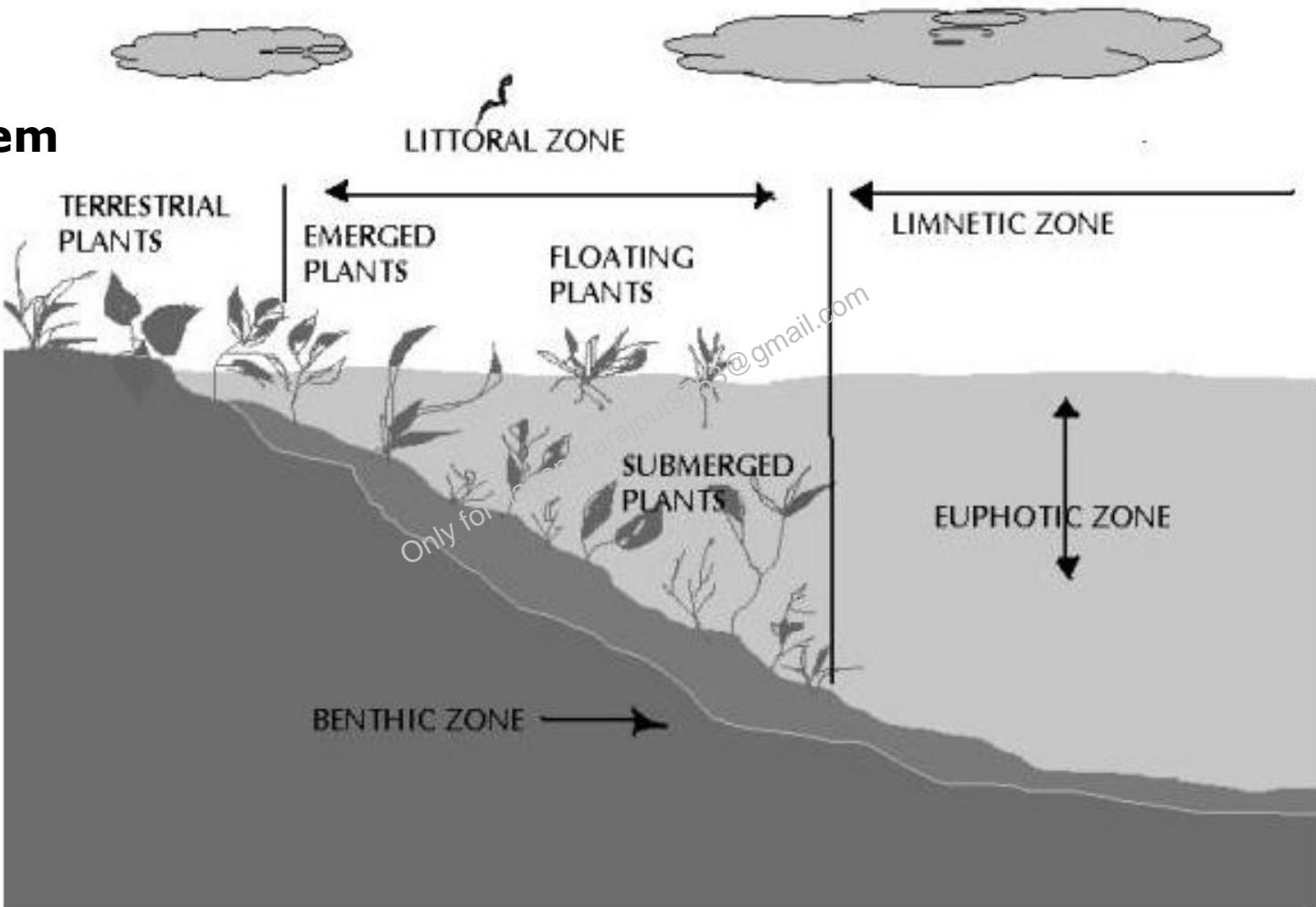


Figure 1.3: Sketch showing major zones of lake

Wetlands



Coastal Lagoons



Mangrove



Swamp



Marshes



Bog



Peatland

<https://www.youtube.com/watch?v=8Mm2tMIcEYE>

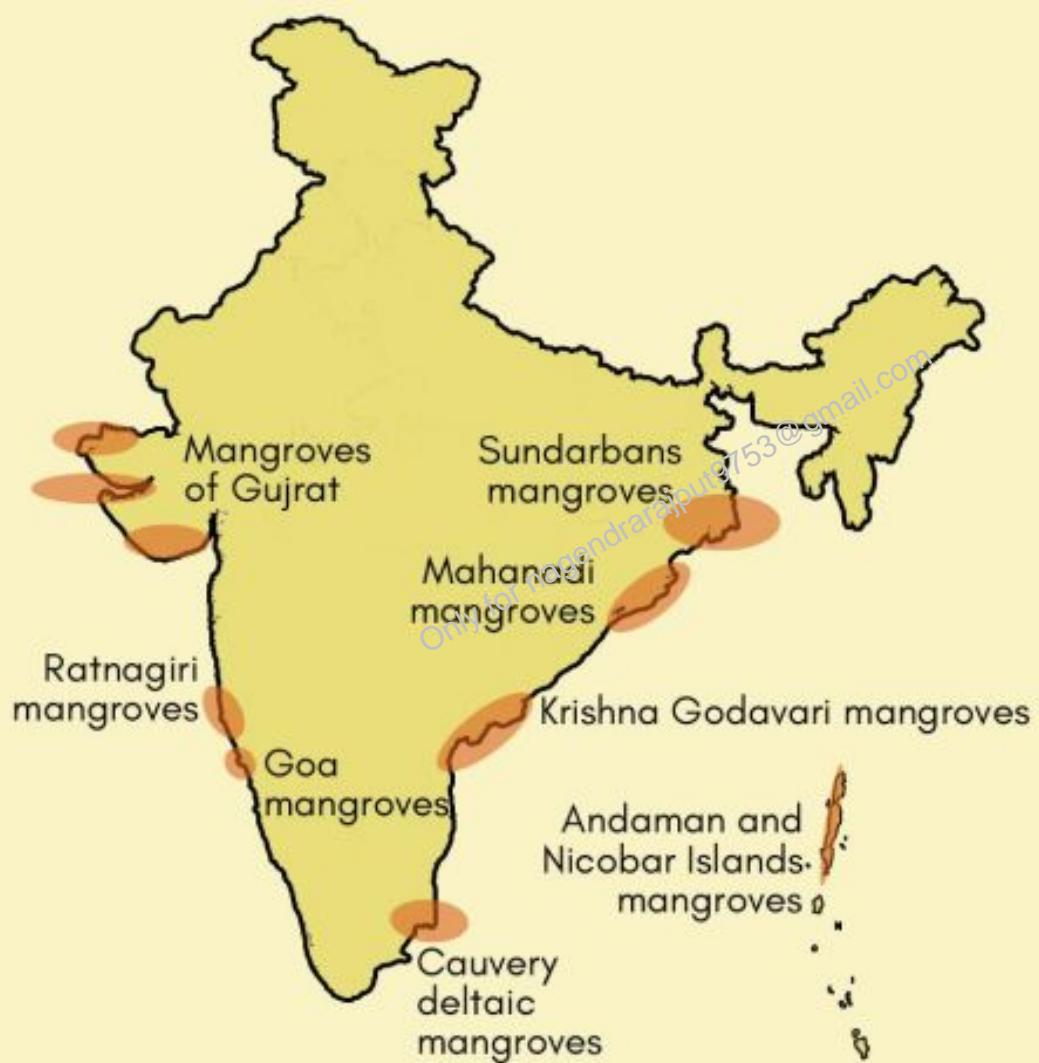
Mangrove Forests





Mangrove as Natural Barrier

<https://www.youtube.com/watch?v=4HDQRduj5f8>



Corals and Coral Reef



[https://www.youtube.com/watch?v=ZiULxL
LP32s&t=131s](https://www.youtube.com/watch?v=ZiULxL
LP32s&t=131s)

Great Barrier Reef Australia



Coral Bleaching



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The Ecological Footprint

MEASURES

how fast we consume resources and generate waste



Energy



Settlement



Timber & Paper



Food & Fiber



Seafood

COMPARED TO
how fast nature can absorb our waste and generate new resources.



Carbon Footprint



Forest



Cropland & Pasture



Fisheries

The 2004 Tsunami made people realize that mangroves can serve as a reliable safety hedge against coastal calamities. How do mangroves function as a safety hedge ?

- (a) The mangrove swamps separate the human settlements from the sea by a wide zone in which people neither live nor venture out
- (b) The mangroves provide both food and medicines which people are in need of after any natural disaster
- (c) The mangrove trees are tall with dense canopies and serve as an excellent shelter during a cyclone or tsunami
- (d) The mangrove trees do not get uprooted by storms and tides because of their extensive roots

2011

“Biorock technology” is talked about in which one of the following situations ?

- (a) Restoration of damaged coral reefs
- (b) Development of building materials using plant residues
- (c) Identification of areas for exploration/extraction of shale gas
- (d) Providing salt licks for wild animals in forests/protected areas

2022

"If rainforests and tropical forests are the lungs of the Earth, then surely wetlands function as its kidneys." Which one of the following functions of wetlands best reflects the above statement ?

- (a) The water cycle in wetlands involves surface runoff, subsoil percolation and evaporation.
- (b) Algae form the nutrient base upon which fish, crustaceans, molluscs, birds, reptiles and mammals thrive.
- (c) Wetlands play a vital role in maintaining sedimentation balance and soil stabilization.
- (d) Aquatic plants absorb heavy metals and excess nutrients.

2022

If a wetland of international importance is brought under the 'Montreux Record', what does it imply?

- (a) Changes in ecological character have occurred, are occurring or are likely to occur in the wetland as a result of human interference
- (b) The country in which the wetland is located should enact a law to prohibit any human activity within five kilometres from the edge of the wetland
- (c) The survival of the wetland depends on the cultural practices and traditions of certain communities living in its vicinity and therefore the cultural diversity therein should not be destroyed
- (d) It is given the status of 'World Heritage Site'

2014

Consider the following statements :

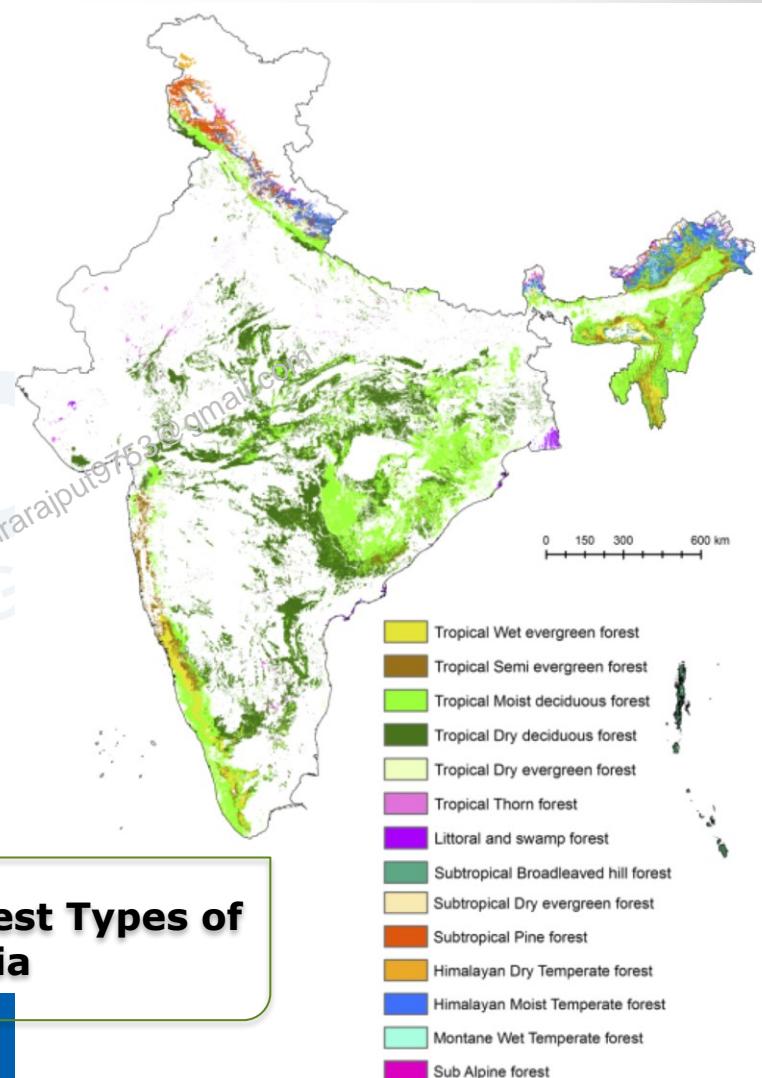
- 1. Under Ramsar Convention, it is mandatory on the part of the Government of India to protect and conserve all the wetlands in the territory of India.
- 2. The Wetlands (Conservation and Management) Rules, 2010 were framed by the Government of India based on the recommendations of Ramsar Convention.
- 3. The Wetlands (Conservation and Management) Rules, 2010 also encompass the drainage area or catchment regions of the wetlands as determined by the authority.

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2020

Which of the statements given above is/are correct?

- (a) 1 and 2 only
- (b) 2 and 3 only
- (c) 3 only
- (d) 1, 2 and 3



Forest Types of India



Tampara Lake



Hirakud Reservoir



Ansupa Lake



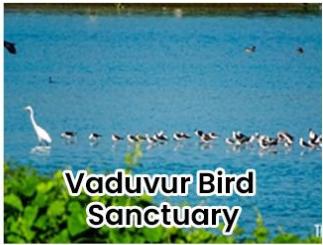
Yashwant Sagar



Chitrangudi Bird
Sanctuary



Suchindram Theroor
Wetland Complex



Vaduvur Bird
Sanctuary



Kanjirankulam
Bird Sanctuary



Thane Creek

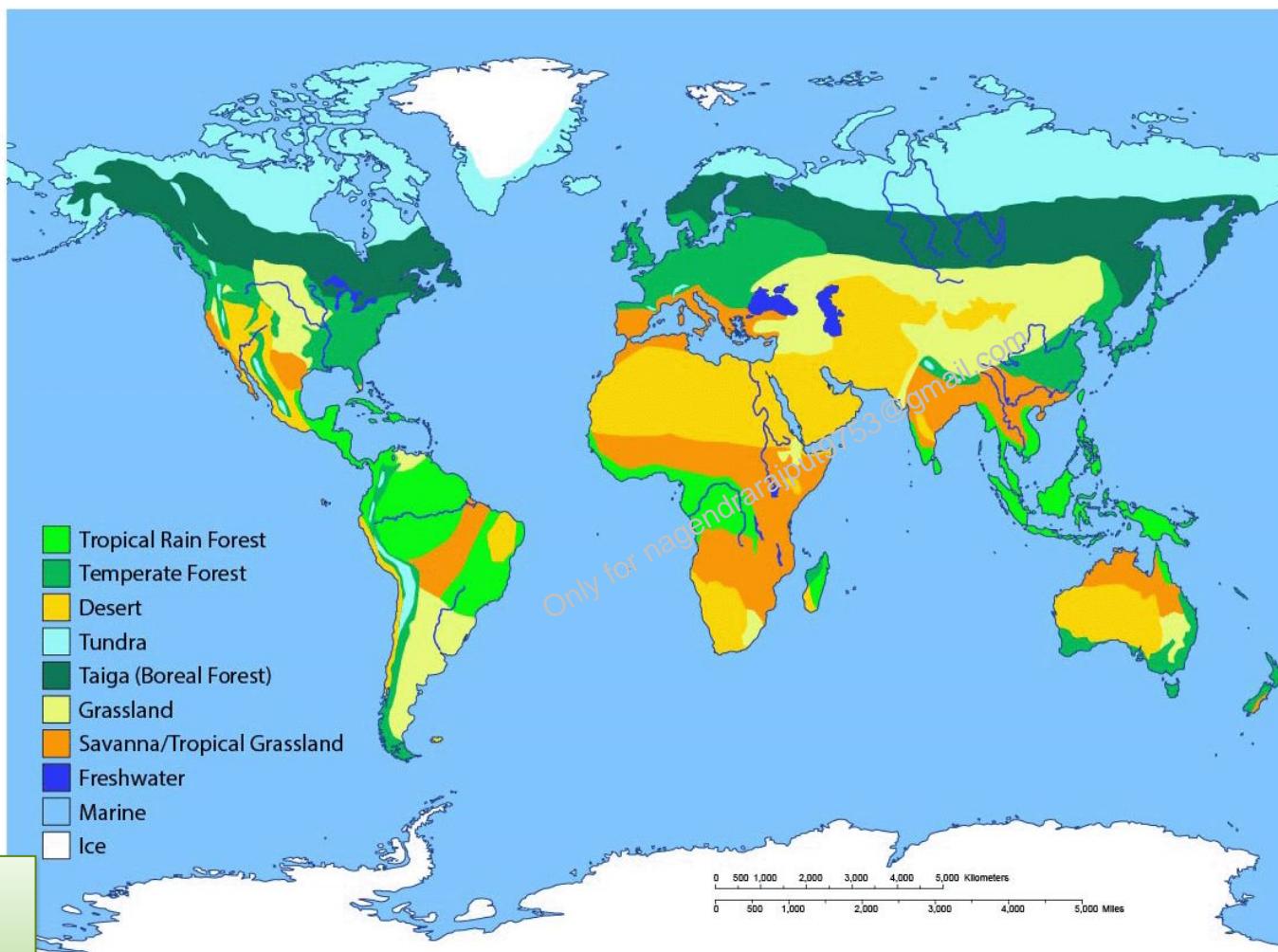


Hygam Wetland
Conservation Reserve

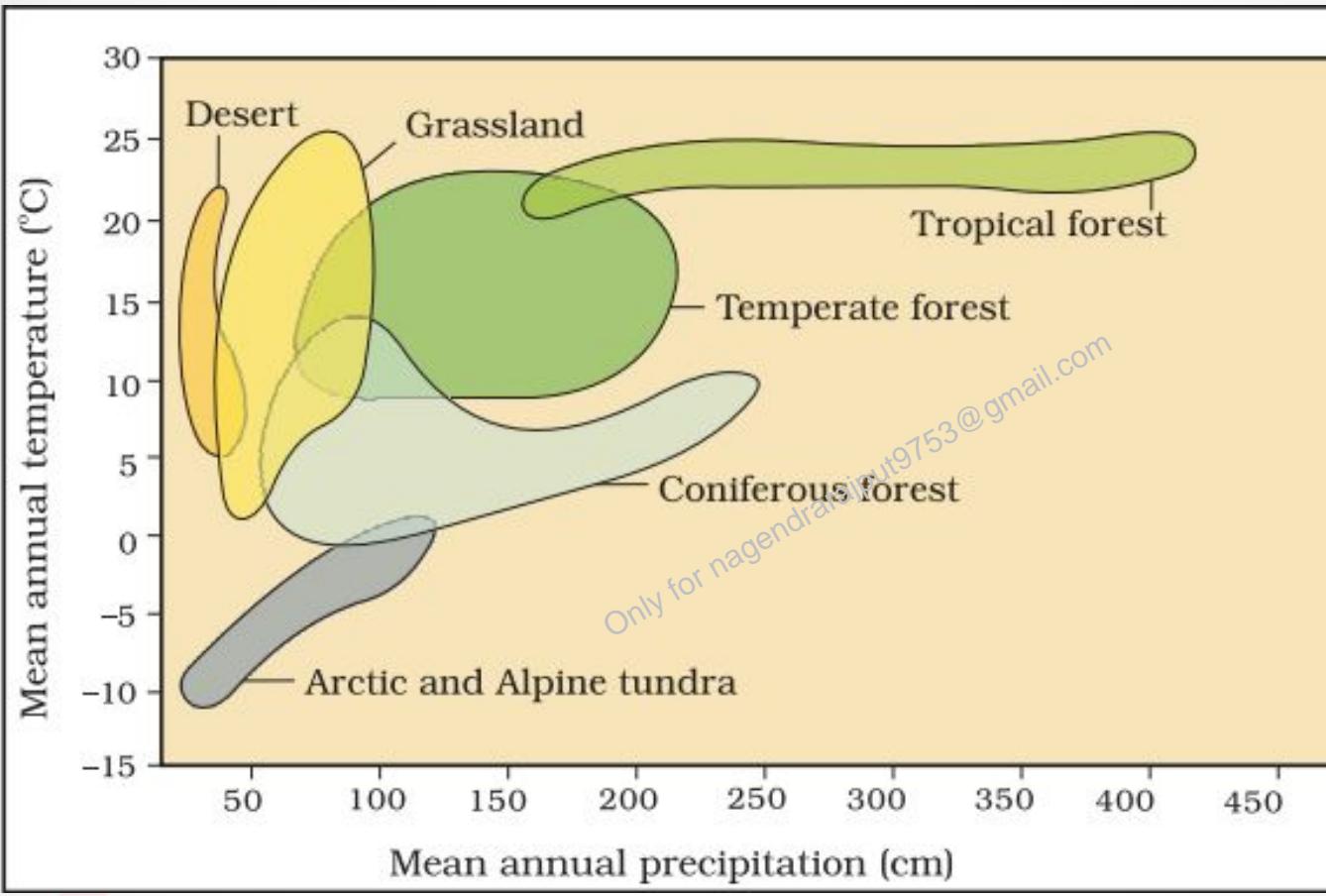


Shalibugh Wetland
Conservation Reserve

11 New Ramsar sites in
India – Total 75



Biomes



Biome distribution with respect to annual temperature and precipitation



Tropical Rainforest



Temperate Forest



Coniferous Forest (Taiga)



Tropical Grassland (Savannah)



Temperate Grassland



Mediterranean



Desert



Tundra



Mountain

If a tropical rain forest is removed, it does not regenerate quickly as compared to a tropical deciduous forest. This is because

- (a) the soil of rain forest is deficient in nutrients
- (b) propagules of the trees in a rain forest have poor viability
- (c) the rain forest species are slow-growing
- (d) exotic species invade the fertile soil of rain forest

2011

2013

In the grasslands, trees do not replace the grasses as a part of an ecological succession because of

- (a) insects and fungi
- (b) limited sunlight and paucity of nutrients
- (c) water limits and fire
- (d) None of the above

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Which of the following is/are unique characteristic/characteristics of equatorial forests?

1. Presence of tall, closely set trees with crowns forming a continuous canopy
2. Coexistence of a large number of species
3. Presence of numerous varieties of epiphytes

Select the correct answer using the codes given below.

- (a) 1 only
- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

2013

2021

"Leaf litter decomposes faster than in any other biome and as a result the soil surface is often almost bare. Apart from trees, the vegetation is largely composed of plant forms that reach up into the canopy vicariously, by climbing the trees or growing as epiphytes, rooted on the upper branches of trees." This is the most likely description of

- (a) coniferous forest
- (b) dry deciduous forest
- (c) mangrove forest
- (d) tropical rain forest

2021

The vegetation of savannah consists of grassland with scattered small trees, but extensive areas have no trees. The forest development in such areas is generally kept in check by one or more or a combination of some conditions. Which of the following are such conditions?

1. Burrowing animals and termites
2. Fire
3. Grazing herbivores
4. Seasonal rainfall
5. Soil properties

Select the correct answer using the code given below.

- (a) 1 and 2
- (b) 4 and 5
- (c) 2, 3 and 4
- (d) 1, 3 and 5

Consider the following statements :

Statement-I :

The soil in tropical rain forests is rich in nutrients.

Statement-II :

The high temperature and moisture of tropical rain forests cause dead organic matter in the soil to decompose quickly.

Which one of the following is correct in respect of the above statements?

- (a) Both Statement-I and Statement-II are correct and Statement-II is the correct explanation for Statement-I
- (b) Both Statement-I and Statement-II are correct and Statement-II is not the correct explanation for Statement-I
- (c) Statement-I is correct but Statement-II is incorrect
- (d) Statement-I is incorrect but Statement-II is correct

2023