Environment and Biodiversity

for

Civil Services Examinations

CENGAGE

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Environment and Biodiversity for Civil Services Examinations

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Preface

If you ever happen to be walking down the streets of places where preparation for Civil Services is done, it will not be uncommon for you to come across or make the acquaintance of 'several' starry eyed yet completely committed IAS aspirants. Yet, 'several' would be an understatement given the number that runs into lakhs! But when we say committed, we mean it; these young men and women are ready to sacrifice almost all their youthful follows including sleep, comfort and even a semblance of a normal life to achieve one goal—IAS!

Sadly, this dream remains a distant one for a large majority of these aspirants in spite of the endless hours of study and sleep forsaken nights. When we tried to unravel WHY, the responses were almost synchronous:

"The subject was so vast that there was too much to cover and I could never complete it."

"I read so much but could not retain it."

"I studied something but was quizzed on something else in the exam."

"I kept reading but did not attempt to solve the past year papers or give a mock exam."

"Subscribing to several sources of information/preparation such as a coaching class, the internet and books was futile; after all there are only 24 hours in a day."

"My almirah was full of too many books,but I could barely complete a few."

And while the candid answers stated above clearly gave us a challenging problem—we did not attempt to solve it. We instead focused on a holistic solution—the synchronizing of effort i.e. Learning and Positive Results!

It is with this aim that we—PrepMate collaborated with Cengage India—are continuously striving to develop a comprehensive learning model that is a combination of online and offline so as to effectively address the issues that most aspirants grapple with.

About the Online–Offline Learning Model

The learning model initiates the process with a series of books targeted at cracking the UPSC exam. The books stand apart from others available because of the following unique features:

- We use a conceptual approach, simple language, explain concepts with diagrams, cite sufficient examples, pose pertinent questions in a reader friendly format—to ensure that the contents of these books can be read and assimilated in a time-bound manner.

- The content is specially designed taking into account the trend in UPSC exams in recent years. We have also included the previous years' questions (with solutions) after every chapter.
- The Practice Questions at the end of each chapter are exhaustive to provide sufficient preparation to crack the exams.
- We have tried to encapsulate all that is required to be learnt for a particular subject into a single book.

Usually, an aspirant purchases a book, but never gets a chance to contact the authors. We believe that the contact among aspirants and authors is important for learning and motivation of the aspirants. That is precisely why we have developed an application and a web portal to answer your queries and provide you with continuous support during your preparation.

It is through this online system that we provide the following services:

1. Videos covering important and difficult topics
2. Daily prelims quiz
3. Assistance in interview preparation
4. Regular updates
5. Daily current affairs
6. Monthly current affairs magazine
7. Radio news analysis
8. Educational videos
9. Previous years' papers and solutions
10. Free study materials

Looking forward to being your partner in the journey towards achieving your dream!

In case you have any specific queries or constructive feedback you can always share the same with us via e-mail at info@prepmate.in.

PrepMate

Acknowledgements

"We cannot accomplish all that we want to do without working together"

The complete UPSC learning module by Prepmate has been the culmination of more than a year of ideation and brain storming with a lot of people. It is only natural that we should gratefully acknowledge their valuable contribution sincerely. Nirmal Singla, Ramnik Jindal, Sharat Gupta, Subhash Singla and Vijay Singla—thank you for your continuous support and motivation.

We would also like to thank Maninder Mann, Rajinder Paul Singla and Sundeep Singh Garha who helped us in first conceiving and later developing the synergistic online–offline model of the project—without you we would be missing our competitive edge.

Implementation of strategy can more often than not prove challenging and the development of the online module did prove to be tougher than we had envisaged. But our technical team was focused on enabling our dream and delivering the best and they surely did. With a specific mention to the testing of both the website and the application,we would like to thank Parth, Tanvir and Surabhi who did their job patiently and effectively in spite of the road blocks.

Our videos and books could not have been possible without the help of our graphics design team—Sandeep, Manjeet, Sukhjinder, Roshni and Uday toiled endlessly to ensure the best designed audio-visuals.

It is an understatement to state that the sourcing and reviewing of existing content and the generation of missing content was the most crucial part of this project and the backbone of our Learning Module. This would just not have been possible without our team of content contributors: Isha Gupta, Shelly Jindal, Gurdeep, Surabhi, Shantnu, Tanvir, Anmol, Kriti, Tanya, Sahil, Suraj and Dilshad, who left no stone unturned in their pursuit of excellence—your pivotal contributions are gratefully acknowledged.

We would like to extend a special thanks to our staff members Geeta, Jitender, Manoj and Pinki, who helped us in the most laborious job i.e. typing through the several manuscripts of our books—your contribution is sincerely appreciated.

It is imperative that we thank Isha Gupta, Shelly Jindal, Anjum Diwan, Rajesh Goel, Shikha Sharma and Ravinder Indoura, for their critical yet constructive feedback that identified and subsequently rectified the errors that crept in during the development process. We will never be able to thank them enough for this—you fortified the very foundation of our model.

We sincerely acknowledge the initiatives and support from the entire editorial team of Cengage India in the process of publishing this book.

PrepMate

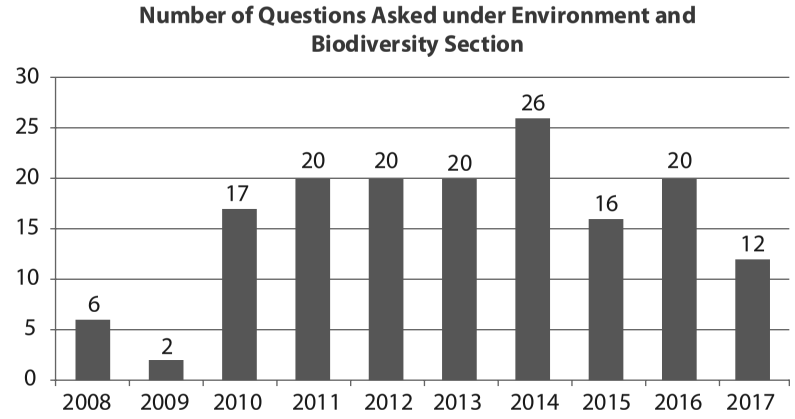
List of Videos

1.	Carbon (C) Cycle
2.	Tropical Evergreen Forest (or Tropical Rainforests)
3.	Coral Reefs
4.	Bioremediation
5.	Classification of Animals
6.	List of Important Animal Species Threatened in India
7.	Plant Diversity
8.	Ocean Acidification
9.	Ozone Depletion

Chapter-wise Break Up of Previous Year's Questions (Prelims)

Chapter names	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	Total
1. Ecology–Basics			1		1						2
2. Functions of Ecosystem				3	2	1	1	1			8
3. Forest Ecosystem		1	3	1	2		2	2		1	12
4. Aquatic Ecosystem	1			1	1	1		1			5
5. Environmental Degradation		1	1	2	3			1			8
6. Environment Restoration Techniques	1						1				2
7. Sustainable Development	1	3	2	2	2	2	2	3			17
8. Biodiversity						1	2				3
9. Animal Diversity	1	2	2	4	4	3	2		1	1	20
10. Plant Diversity				1	1	1	1	1			5
11. Marine Biodiversity					1	1	2				4
12. Protected Area Network			2	3	2	1	3	3		2	16
13. Conservation Efforts for Particular Species	1			1		3					5
14. Climate Change				1		1		2		1	5
15. Acidification					1	1		1			3
16. Ozone Hole						1	1				2
17. Carbon Mitigation Strategies	1	1					1				3
18. India and Climate Change		1				1					2

Chapter names	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	Total
19. International Efforts to Reduce Climate Change Effects	2	3	2	1			1	1	1	1	12
20. Environmental Institutions in India	2	2		2		2	1				9
21. International Efforts for Protection of Environment	2	6	3	4				1			16
Total	**12**	**20**	**16**	**26**	**20**	**20**	**20**	**17**	**2**	**6**	**159**



Unit - I

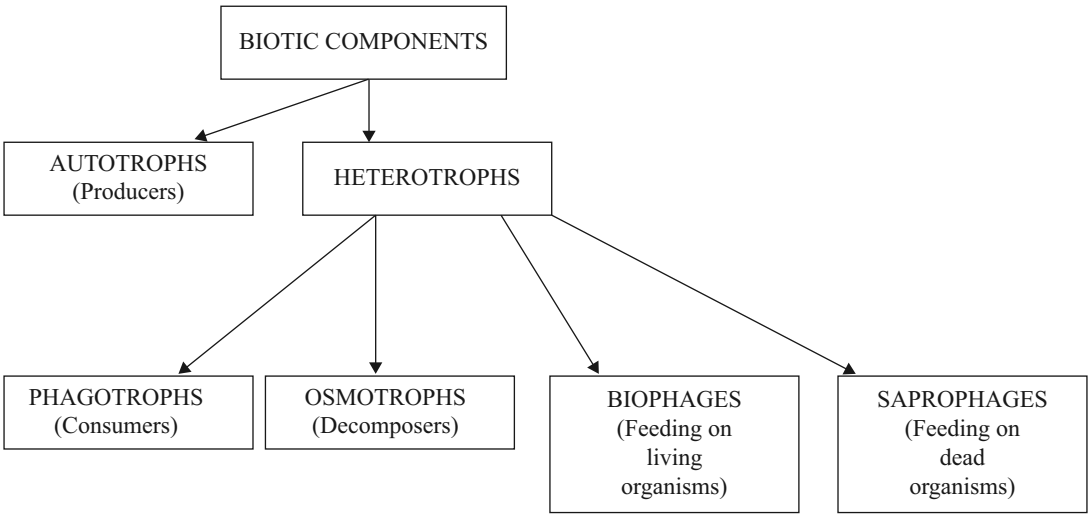
ECOLOGY

Chapter 1 Ecology–Basics

Ecology is the analysis and study of interactions among organisms and their environment.

Ecology consists of biotic (living) and abiotic (non-living) components. Abiotic components include sunlight, precipitation, wind, topography, humidity, soil, temperature, etc.

Biotic components refer to living organisms. Biotic components can be classified as:



1 PRIMARY PRODUCERS (AUTOTROPHS)

Autotrophs are called so because they produce their own food. They have the ability to synthesise carbohydrates from water and carbon dioxide in the presence of sunlight, for example, green plants, algae, etc.

2 CONSUMERS (HETEROTROPHS)

Heterotrophs do not produce their own food. They consume either plants (primary consumers) or animals (secondary consumers). Heterotrophs are further of two types—Phagotrophs and Osmotrophs.

Phagotrophs

Phagotrophs digest their food either derived by plants or animals or both. Phagotrophs are also called macroconsumers.

Phagotrophs are further classified into three types:

1. **Herbivores:** Animals that feed on plants.
2. **Carnivores:** Animals that feed on other animals.
3. **Omnivores:** Animals that feed on both plants and animals.

Osmotrophs

Osmotrophs are those organisms which convert their food into simple substances and absorb those substances. Osmotrophs are also called microconsumers.

Osmotrophs include bacteria and fungi which decompose organic matter to gain nutrients from dead organic substances. The decomposed organic waste is called detritus. Earthworm and certain soil organisms are detritus feeders. These organisms which feed on detritus are called detritivores.

Heterotrophs can also be classified into biophages and saprophytes.

1. **Biophages:** Organisms that derive nourishment for its existence from other living organisms.
2. **Saprophytes:** Organisms that derive nourishment by feeding on dead organisms.

3 SPECIES

A species is a group of organisms capable of interbreeding and producing an offspring. Organisms of a species interact with other organisms, both intra- and inter-species, in a variety of ways.

There are five common types of interaction among species.

Competition

Competition is described as a relationship in which different individuals attempt to use the same limited resource. Competition harms the individuals of the species. Competition can also occur within a population, since all the members require the same resources.

Competition can occur both directly and indirectly. For example, indirect competition can occur between two birds that feed on the same insect; however, one species may eat at day, and the other at night. Direct competition occurs between deer and goat in grassland for the same food sources and territory.

Predation

This type of interaction occurs when one organism, the 'predator' feeds upon another organism, known as 'prey'. In this interaction, one organism benefits, while the other organism is harmed. Predation is a complex web to understand, for, one predator can be the prey to another species.

Parasitism

The relationship between the parasite and the host is known as parasitism. Parasitism is similar to predation, in that it does cause harm to its host, but it does not necessarily 'kill' its host. Some common parasites are ticks, fleas, tapeworms and leeches.

Mutualism

Some species tend to rely on one another for survival, and there are times when neither of the organisms can survive without the other. This close relationship between two species in which each species provides a benefit to the other is known as mutualism.

For example, in the human body, intestinal bacteria use the warm, nutrient-rich walls of the intestine and help regulate our digestive tract by breaking down foods we cannot digest on our own.

Commensalism

Commensalism is the relationship between two species in which one species benefits, while the other species involved in the relationship is not affected. For example, vultures follow closely behind tigers in India, to feed on the tiger's kills.

Another type of relationship, opposite to commensalism is amensalism. Amensalism is any relationship between organisms of different species in which one organism is inhibited or destroyed, while the other organism remains unaffected.

A simple example is the shading out of certain plants under tall trees. The trees reduce the available sunshine at ground level, and numerous plants cannot find adequate light in the shade.

Antibiosis is a specific type of amensalism in which one organism produces a metabolite that is toxic to other organisms.

A common example of amensalism is the release of chemical toxins by plants that can inhibit the growth of other plant species.

The interactions among many species involve a relationship in which two organisms live in close association with one another, which is also known as symbiosis. In order for an interaction to be labelled as an example of symbiosis, at least one organism must be benefitted (such as in predation, commensalism and mutualism).

Determinants of the Behaviour of a Species—Genotype and Phenotype

Genotype is the complete heritable genetic identity. The word genotype can also refer just to a particular gene or a set of genes carried by an individual. For example, if one carries a gene linked to diabetes, one may refer to his genotype just with respect to this mutation without consideration of all the other gene variants that one may carry.

In contrast, phenotype is a description of actual physical characteristics. This includes straightforward visible characteristics like height and eye colour, and also overall health, and even one's behaviour.

Most phenotypes are influenced by both genotype and by the unique circumstances in which one has lived, including one's experiences. Thus, our phenotype is a result of two inputs: 'nature', the unique genome we carry, and 'nurture', the environment in which we have lived our lives.

Many terms are used to denote different species based on their role, importance or origin.

Keystone Species

A keystone species is a species that play a critical role in maintaining the structure of an ecological community. It affects many other organisms in an ecosystem and helps determine the types and numbers of various other species in the community. Without keystone species, the ecosystem would be dramatically different or cease to exist altogether. For instance, tigers are keystone species in the terrestrial ecosystem. If the population of tigers decreases in the ecosystem, the population of the deer would rise. The increase in deer population means more consumption of grass; thus, other species dependent upon grass may not be able to survive.

Flagship Species

A flagship species is a species selected to act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause. Flagship species are usually relatively large, and considered to be 'charismatic'.

The concept of flagship species has its genesis in the field of conservation biology. The concept of flagship species holds that by raising the profile of a particular species, it can successfully leverage more support for biodiversity conservation at large level.

Foundation Species

Foundation species is used to refer to a species that has a strong role in structuring a community. A foundation species can occupy any trophic level in a food web (i.e., they can be primary producers, herbivores or predators).

The term 'foundation species' was coined by Paul K. Dayton in 1972, who applied it to certain members of marine invertebrates and algae communities. Dayton's view was that focusing on foundation species would allow for a simplified approach to more rapidly understand how a community as a whole would react to disturbances, such as pollution, instead of attempting the extremely difficult task of tracking the responses of all community members simultaneously.

Indicator Species

An indicator species is any biological species that defines a trait or characteristic of the environment. For example, a species may delineate an ecoregion or indicate an environmental condition such as a disease outbreak, pollution, species competition or climate change. Indicator species can be among the most sensitive species in a region, and sometimes act as an early warning to monitoring biologists.

Indigenous Species

In biogeography, a species is defined as indigenous or native to a given region or ecosystem, if its presence in that region is the result of only natural process, with no human intervention.

A species may be introduced by human activity; it is then referred to as an introduced species.

Endemic Species

In ecology, endemic means exclusively native to the particular region. An indigenous species may occur in areas other than the one under consideration. Thus, an indigenous species is not necessarily endemic.

The terms 'endemic' and 'indigenous' do not imply that an organism necessarily originated or evolved where it is found.

Introduced or Exotic Species

An introduced, alien, exotic, non-indigenous, or non-native species or simply an introduction, is a species living outside its native distributional range, which has arrived there by human activity, either deliberate or accidental. Non-native species can have various effects on the local ecosystem.

Invasive Species

Introduced species that become established and spread beyond the place of introduction are called invasive species. Most introduced species may have no negative effect or only minor impact. In some instances, the potential for being beneficial or detrimental in the long run remains unknown.

Evolutionarily Distinct and Globally Endangered (EDGE) Species

The EDGE species represent a disproportionate amount of unique evolutionary history. They have few close relatives, or often the only surviving member of their genus, and sometimes the last surviving genus of their evolutionary family. Some examples of EDGE species are elephants and pandas.

Umbrella Species

Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects many other species that make up the ecological community of its habitat.

Important Terms Related to Ecology

Ecosystem

An ecosystem is a community of living organisms in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows.

Ecosystems can be of any size but usually encompass specific, limited spaces (although some scientists say that the entire planet is an ecosystem).

Ecotone

Ecotone is a zone of junction between two or more diverse ecosystems. It can be local or regional, narrow or wide. Here, the conditions are intermediate between the two adjacent systems and hence it is also a zone of tension.

For instance, the coastal areas represent an ecotone between marine and terrestrial ecosystem.

Ecocline

Ecocline is a variation of the physico-chemical environment dependent of one or two physico-chemical factors of life (say, temperature), and it leads to presence or absence of certain species. It can be understood as 'physical transition zone'.

For example, an ecocline can be a thermocline, chemocline (chemical gradient), halocline (salinity gradient) or pycnocline (variations in the density of water induced by temperature or salinity).

Niche or Ecological Niche

A *niche* refers to the unique functional role or place of a species in an ecosystem. A species' *niche* includes the physical, biological and chemical environment to which it is adapted as well as its role as producer and consumer of food resources.

Niche Construction

Niche construction is the process by which an organism alters its own (or another species') environment. These alterations can be a physical change to the organism's environment or even encompass when an organism leaves one habitat to another.

Habitat

A habitat is an ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism. The term typically refers to the zone in which the organism lives and where it can find food, shelter, protection and mates for reproduction.

Home Range

A home range is the area in which an animal lives and moves on a periodic basis. An associated concept is the utilisation distribution which examines where the animal is likely to be at any given time. Earlier, data for mapping a home range was used to be gathered by careful observation, but nowadays, the animal is fitted with a transmission collar or similar GPS device.

Home range includes the territory of an animal. Territory is an area in which an animal, or group of animals, is protected from incursions by others of its species. Territorial boundaries may be marked by sounds such as bird song or scents such as pheromones secreted by the skin glands of many mammals.

Biosphere

The biosphere (from Greek word *bios* = life and *sphaira* = sphere), is the layer of the planet Earth where life exists. This layer ranges up to the height of 10 km above the sea level, used by some birds in flight, to ocean depths of more than 8 km such as the Puerto Rico trench. However, in general, the layer of the Earth containing life is thin. The upper atmosphere has little oxygen and very low temperature; similarly, ocean depths greater than 1 km are dark, cold and lack oxygen.

Biome

Biome refers to enormous regions sharing similar climatic conditions, soil type, flora and fauna. Five biomes in India are:

a. **Tropical humid forests:** These are found in the Western Ghats and the Eastern Himalayas.
b. **Tropical deciduous forests:** Majority of forests in India are of tropical deciduous type.
c. **Deserts and semi-desert vegetation:** This is found in the Western Rajasthan.
d. **Coniferous forests:** These are found in the Middle Himalayas.
e. **Alpine meadows:** These are found at Higher Himalayas.

4 PRODUCTIVITY (IN ECOLOGY)

In ecology, productivity or production refers to the rate of generation of biomass in an ecosystem. It is usually expressed in units of mass per unit area (or volume) per unit time, for instance, grams per square metre per day. Productivity of autotrophs such as plants is called primary productivity, while that of heterotrophs such as animals is called secondary productivity.

Primary Production

Primary production is the synthesis of new organic material from inorganic molecules such as water and carbon dioxide. It is dominated by the process of photosynthesis which uses sunlight to synthesise organic molecules such as sugars. Organisms responsible for primary production include plants, algae and some bacteria (including cyanobacteria).

Gross Primary Production (GPP)

It is the amount of organic matter synthesised by producers per unit area in unit time. In other words, it refers to the total production including the energy utilised for respiration by the producers. Mathematically,

GPP = Rate of increase in body weight or rate of organic matter synthesised by producers
+ the rate of respiration (R) and other utilisation of mass by primary producers.

Net Primary Production (NPP)

It is the amount of organic matter stored by producers per unit area in unit time. In other words, it refers to the net productivity that is converted to organic matter excluding the energy utilised for respiration and other purposes by the producers.

Mathematically,

NPP = Rate of organic matter synthesised by photosynthesis by producers
– the rate of energy utilised for respiration and other purposes.

Secondary Production

Secondary production is the generation of biomass by heterotrophic (consumer) organisms in a system. This is driven by the transfer of organic materials between trophic levels, and represents the quantity of new tissue created through the use of assimilated food.

Organisms responsible for secondary production include animals, protists, fungi and many bacteria.

Compounds that are considered organic must contain carbon bound to hydrogen, and possibly, other elements. By this definition, carbon dioxide is inorganic in nature.

Practice Questions

1. The biomass available for consumption by the herbivores is called:
   (a) Gross primary production
   (b) Net primary production
   (c) Secondary production
   (d) None of the above

2. Amensalism is an association between two species where:
   (a) One species is harmed and the other is benefitted.
   (b) One species is harmed and the other is unaffected.
   (c) One species is benefitted and the other is unaffected.
   (d) Both the species are harmed.

3. A high density of tiger population in an area can result in:
   (a) Predation on one another
   (b) Mutualism
   (c) Intra species competition
   (d) Inter species competition

4. Which one of the following terms is related to the impact of an organism on biotic and abiotic components of its ecosystem?
   (a) Ecotone
   (b) Ecological niche
   (c) Ecocline
   (d) Trophic level

5. A transition zone or region separating two biomes is known as:
   (a) Ecocline
   (b) Ecological niche
   (c) Ecotone
   (d) Ecotype

6. Which of the following statements correctly explains the phenomenon of Antibiosis?
   (a) One species kills to feed on the other species.
   (b) An organism benefiting from the other organisms.
   (c) Production of secretions by an organism which is harmful to other organisms.
   (d) Competition between organisms of the same species.

7. Which among the following correctly describes 'homeostasis'?
   (a) It refers to the gradual process by which communities in the ecosystems change and develop over time.
   (b) It is the process by which an organism maintains a stable internal environment despite changes in external conditions.
   (c) It is the process of transfer of energy from one trophic level to another in a grazing food chain.
   (d) It is the gradual process through which energy requirement in an ecosystem is balanced with the energy available to the ecosystem.

8. Which of the following best describes an indicator species?
   (a) It is a species that has a disproportionately large effect on the ecosystem in which it occurs.
   (b) It is a species which is of invasive nature.
   (c) It is a species which is introduced to balance the species composition in an ecosystem.
   (d) It is a species whose presence, absence or abundance reflects a specific environmental condition.

9. Which one of the following is the best description of the term 'ecosystem'?
   (a) Flora of a particular geographical area.
   (b) Flora and fauna of a geographical area.
   (c) Flora and Fauna along with their environment.
   (d) Flora and fauna of a continent.

10. The ability of an ecosystem to self regulate itself is
   (a) Accommodation
   (b) Adaptation
   (c) Homeostasis
   (d) Evolution

11. In an ecotone, the species which is expanding to other ecosystems on its own are called:
   (a) Invasive species
   (b) Edge species
   (c) Keystone species
   (d) Adaptive species

12. Two animals can be conclusively said to belong to the same species if they:
   (a) Have same biological evolution
   (b) Have similar genetic makeup
   (c) Look similar and possess similar physical makeup
   (d) Can reproduce freely with each other

13. Which of the following is **not** an example of mutualism?
   (a) Algae and fungus
   (b) Rhizobium bacteria and leguminous plants
   (c) Coral polyps and Zooxanthellae algae
   (d) Leech and cattle

14. Consider the following pairs:

	Population	Interaction
1	Mutualism	Both the species are benefitted
2	Competition	Both the species are harmed
3	Commensalism	One species is harmed and the other is unaffected
4	Amensalism	One species is benefitted and the other is unaffected

Which of the pairs given above is/are correctly matched?

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

15. With reference to keystone species, consider the following statements:

1. A keystone species exhibits disproportionately large effect on its environment relative to its abundance.
2. Tigers are keystone species as they determine the species composition in a forest.

Select the correct answer using the codes given below:

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

16. Which of the following is/are the types of positive interaction in a biotic community?

1. Colonisation
2. Competition
3. Protocooperation

Select the correct answer using the codes given below:

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

Note: Colonisation or colonization is the process in biology by which a species spreads to new areas. Colonisation often refers to successful immigration, where a population becomes integrated into a community, having resisted initial local extinction.

Protocooperation refers to the manner of interaction between organisms which is beneficial to both of them.

17. Consider the following statements with reference to primary productivity of ecosystem:

1. Net primary productivity is gross primary productivity minus the amount of biomass consumed by the primary consumers.
2. Primary productivity of water bodies is more than the terrestrial environment.

Which of the statements given above is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Note: Presently, 85% of biomass is produced in terrestrial environment and only 15% biomass is produced in aquatic environment.

18. Which of the following are the abiotic components of the ecosystem?

    1. Water
    2. Insolation
    3. Winds
    4. Decomposers
    5. Soil

    Select the correct answer using the codes given below.

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

19. Consider the following statements:

    1. Ecotone is the transitional area between two biomes or diverse ecosystems.
    2. Ecological niche is the role of a species in an ecosystem.
    3. Ecocline refers to the combination of all physical and chemical factors that play a role in an ecosystem.

    Which of the statements given above is/are correct?

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

20. Consider the following statements:

    1. A dominant species refers to a species which contributes to the highest percentage of biomass in an ecosystem.
    2. A keystone species is one that has the greatest effect on all the other species in an ecosystem.

    Which of the statements given above is/are correct?

    (a) 1 only (b) 2 only
    (c) Both 1 and 2 (d) Neither 1 nor 2

21. In which of the following relationships does one species benefit by harming another species?

    1. Parasitism
    2. Predation

    Select the correct answer using the codes given below:

    (a) 1 only (b) 2 only
    (c) Both 1 and 2 (d) Neither 1 nor 2

22. Which of the following terms defines the gradual change in certain characteristics exhibited by communities along with the gradual change in one or more environmental gradients?

    (a) Ecotone
    (b) Ecocline
    (c) Ecotype
    (d) Ecological niche

PERFECTING PAST PRELIMS

1. Which one of the following terms describe not only the physical space occupied by an organism, but also its functional role in the community of organisms? **(2013)**
   (a) Ecotone
   (b) Ecological niche
   (c) Habitat
   (d) Home range

2. Which one of the following is the best description of the term 'ecosystem'? **(2015)**
   (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.

ANSWER KEYS

Practice Questions

1. (b)	**2.** (b)	**3.** (c)	**4.** (b)	**5.** (c)
6. (c)	**7.** (b)	**8.** (d)	**9.** (c)	**10.** (c)
11. (a)	**12.** (d)	**13.** (d)	**14.** (a)	**15.** (c)
16. (d)	**17.** (d)	**18.** (b)	**19.** (c)	**20.** (c)
21. (c)	**22.** (b)			

Perfecting Past Prelims

1. (b)	**2.** (c)

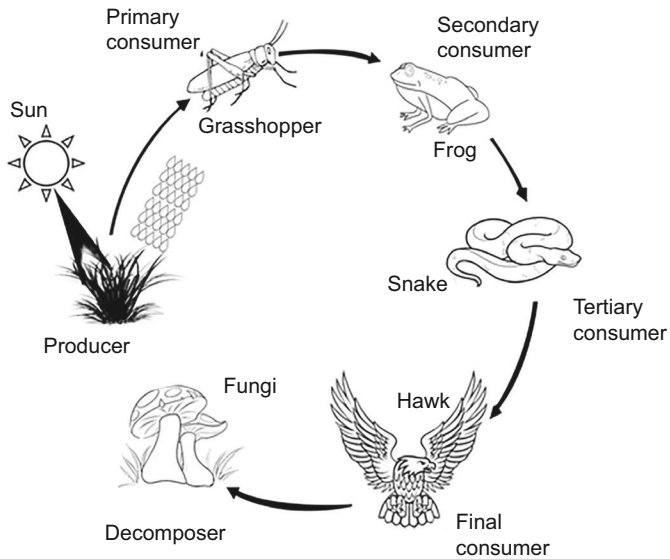
Chapter 2

FUNCTIONS OF ECOSYSTEM

1 FOOD CHAIN

Food chain is a sequence that describes which organism is consumed or eaten by the other organism. It also explains the transfer of energy from plants to primary consumers, from primary consumers to secondary consumers and so on.

Food chain consists of levels called trophic levels. These trophic levels describe the flow of energy among the organisms in a food chain. In other words, the organisms at lower trophic levels are consumed by the organisms at higher level. Usually, the number of trophic levels is not more than four, because the energy loss at each level is very high. Energy loss is high because most of the energy derived by an organism from consuming another organism is required to carry out day to day activities.



Types of Food Chain

There are two types of food chain, namely grazing food chain and detritus food chain.

Grazing Food Chain

This type of food chain begins from plants at the base and the primary consumers are herbivores.

Examples

1. In terrestrial ecosystem, grass is eaten up by a caterpillar which in turn is eaten by a lizard and the lizard is eaten by a snake.

Grass → Caterpillar → Lizard → Snake

2. In aquatic ecosystem, phytoplanktons (primary producers) are eaten by zooplanktons which are eaten by fishes and fishes are eaten by Pelicans.

Phytoplankton → Zooplankton → Fish → Pelican

Detritus Food Chain

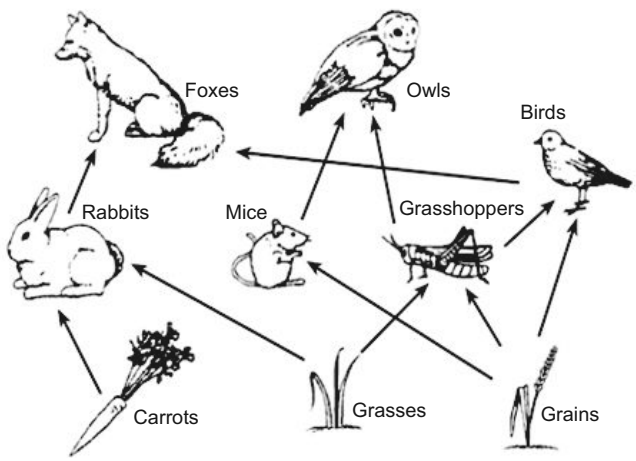
This type of food chain begins from dead organic matter. Dead organic matter is consumed by detritivores which are eaten by other predators.

Dead organic matter → Earth worm → Chicken → Hawk

The distinction between these two food chains is the source of energy for the first level consumers. In the grazing food chain, the primary source of energy is green plants, and in the detritus food chain, the primary source of energy is dead organic matter. The initial energy source for detritus food chain is the dead organic matter which is derived from the grazing food chain.

2 FOOD WEB

A network of food chains is called food web. Typically, the same food resource is a part of more than one food chain, especially when that resource is at the lower trophic level.

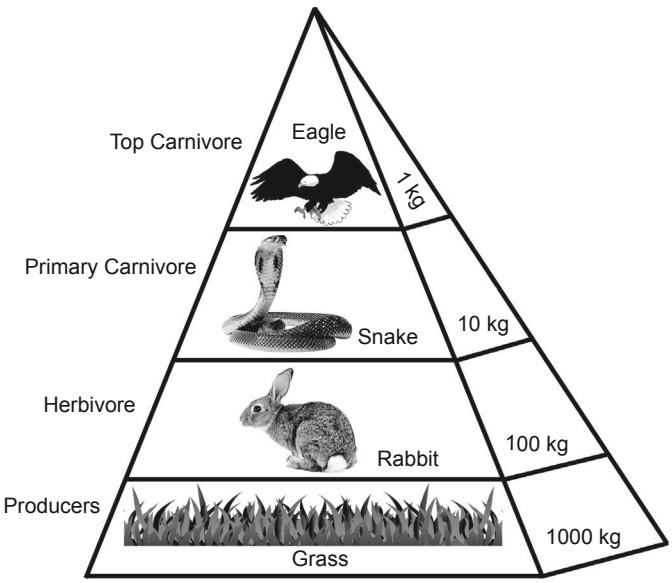


3 ECOLOGICAL PYRAMID

An ecological pyramid consists of a number of horizontal bars depicting specific trophic levels which are arranged sequentially from primary producers to top carnivores. The ecological pyramid is used to depict the amount of energy, biomass and number of organisms at each trophic level.

Upright Pyramid

Usually, the pyramid of energy depicting biomass and the number of organisms is upright.



Upright Pyramid of Biomass in a Terrestrial Ecosystem

In the given pyramid, the number of individuals decreases as we move to higher trophic levels in the food chain.

Similarly, the amount of biomass and energy available at higher trophic levels significantly reduce as most of the energy is consumed by the organisms to carry out their day-to-day activities and only some energy is passed to the next trophic level.

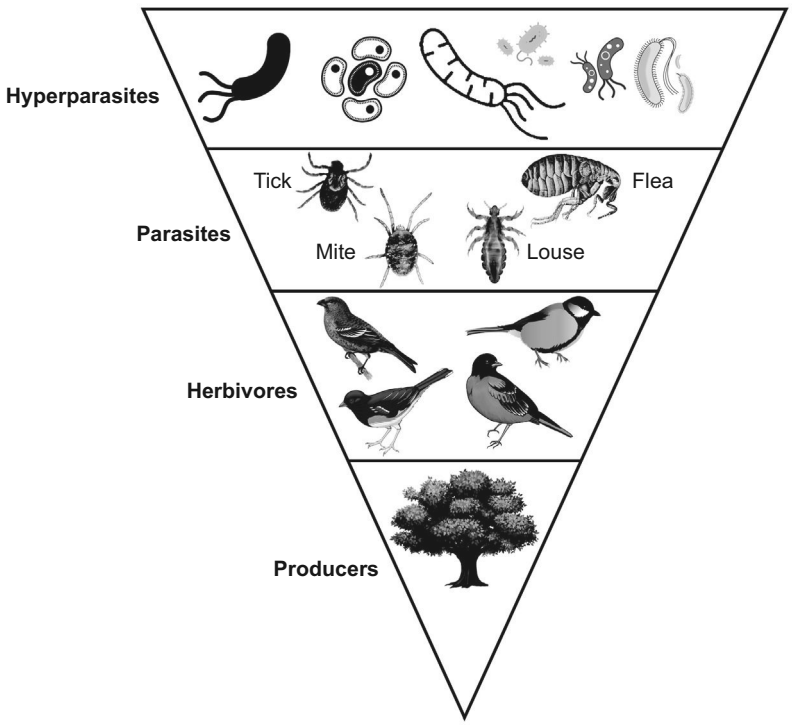
Inverted Pyramid

In rare circumstances, a pyramid of number may be inverted. For instance, a tree provides food to many birds and a bird is a food for many parasites.

Similarly, a pyramid of biomass can also be inverted. It can be inverted in aquatic ecosystems, since the primary producers (phytoplanktons) make up less biomass than the primary consumers (zooplanktons).

Zooplanktons have high biomass, because their rate of reproduction is very high. Pyramid of biomass in aquatic ecosystems is also inverted because the biomass of fishes far exceeds than that of the phytoplankton.

However, a pyramid of energy is never inverted even in rare circumstances because when energy is transferred from a particular trophic level to the next trophic level, some energy is always lost at each step.



Limitations of Ecological Pyramids

1. It never takes into account, the same species belonging to two or more trophic levels.
2. It assumes a simple food chain, something that almost never exists in nature. It does not accommodate a food web.
3. Saprophytes are not given any place in ecological pyramids, even though they play an important role in the ecosystem.

Bioaccumulation

Bioaccumulation refers to increase in the concentration of harmful substances in our body with the passage of time. These substances do not degrade and their rate of discharge from the body is less than their rate of absorption from the environment.

Due to our interaction with the environment, we consume certain fat and water-soluble substances. These water-soluble substances are discharged regularly by our body through urine. Fat-soluble substances do not get dissolved in water and may remain concentrated in our body.

Bioconcentration

Bioconcentration refers to the accumulation of harmful substances in our body from the intake of polluted water. Thus, when bioaccumulation occurs from the consumption of polluted water, it is called bioconcentration.

Biomagnification

Biomagnification (also called, 'biological magnification') refers to the tendency of toxic substances to progressively increase in concentration as these substances move up to higher levels of food chain. Human beings are at the highest risk due to biomagnification, because they are at the top of the food chain.

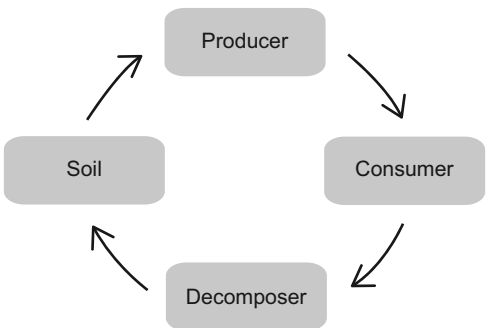
Mercury contamination is a good example of the bioaccumulation process. Typically, mercury (or a chemical version called 'methylmercury') is taken up by the bacteria and phytoplankton. Small fishes eat the bacteria and phytoplankton. Mercury accumulates in bodies of small fishes. The small fishes are in turn eaten by larger fishes, which can become food for humans and animals. The result can be progressive increase in the concentrations of mercury in humans and animals.

4 BIOGEOCHEMICAL CYCLE

A biogeochemical cycle or substance turnover or cycling of substances is a pathway by which a chemical substance moves through both the biotic (biosphere) and abiotic (lithosphere, atmosphere and hydrosphere) components of Earth.

Carbon, hydrogen, oxygen, nitrogen and phosphorus constitute 97% of the mass of our body and more than 95% of the mass of all the living organisms. In addition, 15 to 25 other elements are needed by plants and animals. These elements keep on circulating in the environment.

The common pattern of movement of a substance in a biogeochemical cycle is illustrated in the diagram given below:



On the basis of replacement period of nutrients, biogeochemical cycles are classified as perfect and imperfect cycles.

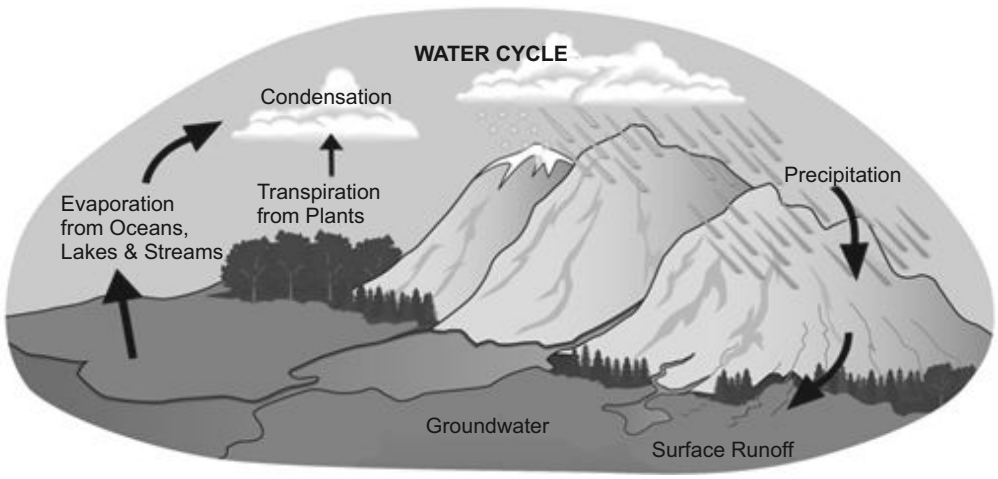
A perfect cycle is a cycle in which nutrients are replaced as fast as they are utilised. Most gaseous cycles are perfect cycles.

An imperfect cycle is a cycle in which nutrients remain stored for a long period and thus, could not be brought to utilisation.

5 IMPORTANT BIOGEOCHEMICAL CYCLES

Water Cycle (Hydrological Cycle)

The water cycle, also known as the hydrological cycle or the H_2O cycle, describes the continuous movement of water on, above and below the surface of the earth.



The water cycle is explained below:

- First, water on the surface of the earth evaporates and is converted into water vapour. Similarly, plants, through the process of transpiration convert water into vapour form.
- Then, water in the form of water vapour gets collected in the sky. This water rises upwards and forms clouds.
- Next, the water in the clouds gets colder and gets converted into liquid again. This process is called condensation.
- Then, the water falls from the sky as rain, snow, sleet or hail. This process is called precipitation.
- The water sinks into the surface and also gets collected in the lakes, oceans, or aquifers. It again gets converted into vapour form through evaporation and transpiration. The process continues forever.

What Is Cloud Seeding?

Seeding involves spraying chemicals into clouds. Cloud seeding is a form of weather modification. It is a way of changing the amount or type of precipitation that falls from clouds, by dispersing substances into the air that serve as cloud condensation or ice nuclei, which alter the microphysical processes within the cloud. The usual intent is to increase precipitation (rain or snow), but hail and fog suppression are also widely practiced in airports.

How Does It Work?

The most common chemicals used for cloud seeding include silver iodide, potassium iodide and dry ice (solid carbon dioxide). Liquid propane, which expands into a gas, has also been used. This can produce ice crystals at higher temperatures than silver iodide. After promising research, the use of hygroscopic materials such as table salt, is becoming more popular.

Introduction of a substance such as silver iodide, which has a crystalline structure similar to that of ice, induces freezing nucleation (molecules gathering in clusters). In mid-latitude clouds, the usual seeding strategy has been based on the fact that the equilibrium vapour pressure is lower over ice than over water. The formation of ice particles in super-cooled clouds allows those particles to grow at the expense of liquid droplets. If sufficient growth takes place, the particles become heavy enough to fall as precipitation from clouds that otherwise would produce no precipitation. This process is known as 'static' seeding.

Beginning of Cloud Seeding

China used this technique during the 2008 Olympics to veer rain away from the inaugural venue and now it has a full-fledged department that blasts rockets into clouds to induce rain and control pollution.

Cloud Seeding in India

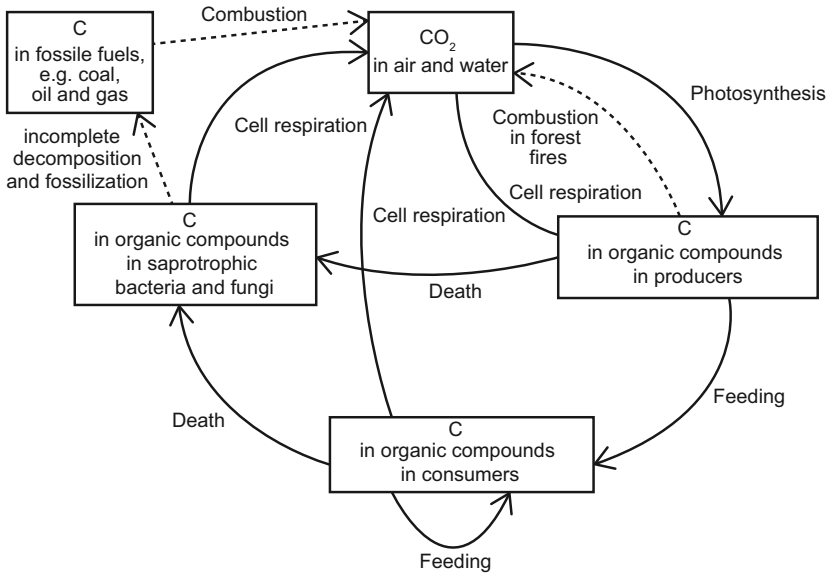
The Government of Maharashtra has decided to respond to frequent droughts in Vidarbha with a three-year cloud seeding experiment.

Cloud Seeding Experiment

1. During monsoon 2017, weather scientists sprayed silver iodine over clouds. Airplanes were used to spray the chemical. However, the cloud seeding experiment failed to increase rainfall. Government has decided to continue with the experiment to get insights into cloud seeding technique.
2. The programme coordinated by the Indian Institute of Tropical Meteorology, was the first controlled experiment to quantify the extent to which clouds form water drops large enough to make rain.

Carbon (C) Cycle

Carbon cycle is classified as a short-term and a long-term cycle. Short-term carbon cycle involves the movement of carbon from animals to plants. Carbon dioxide released by animals through respiration is taken up by plants during the process of photosynthesis. Plants in turn produce carbohydrates and oxygen which are consumed by animals.



'C' is a symbol for Carbon

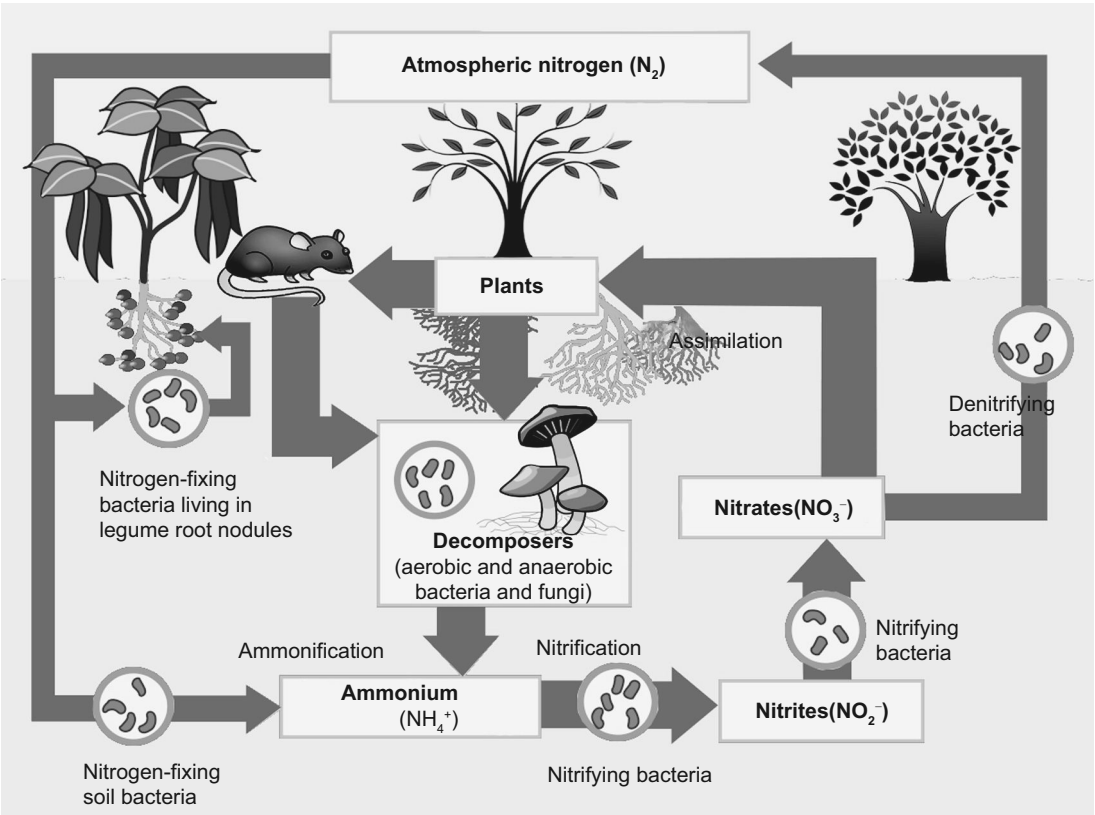
Some of the carbon enters the long-term carbon cycle. Carbon enters the long-term cycle in the following ways:

1. It accumulates in soil in the form of organic content.
2. Mineral carbonates such as calcium carbonates (limestone) remain stored in the earth's crust for a long period of time.
3. In deep oceans, organic content in the soil and mineral carbonate remain stored over millions of years.
4. Carbon present in the dead plants and animals remain stored as a part of fossil fuels for millions of years. This carbon is released into the atmosphere only when fossil fuels are burnt.
5. Moreover, some of the carbon from atmosphere is also transferred to ocean waters.
6. Some of the atmospheric carbon remains stored in polar ice caps in the form of dry ice.

Nitrogen Cycle

Our atmosphere is comprised of a large amount of nitrogen (78% of atmosphere). It is the building block of all the living organisms. Sixteen percent of proteins by weight in the living organisms are comprised of nitrogen.

Even though nitrogen is available in the atmosphere in large quantities, it cannot be used directly by most of the living organisms. Atmospheric nitrogen needs to be fixed or converted into ammonia (NH_4), nitrites (NO_2) and nitrates (NO_3) before it is taken up by the plants. Plants further convert these nitrogen compounds into amino acids and proteins which are consumed by human beings and animals.



Nitrogen fixation can be accomplished in three ways:

1. By man-made activities such as production of fertilisers.
2. Small amount of nitrogen is also converted through natural processes such as thunder and lightning. Natural processes convert atmospheric nitrogen to ammonia and nitrates which fall upon the earth through precipitation. Ammonia and nitrates are consumed by various plants.

   The amount of nitrogen fixed by man-made activities far exceeds than the nitrogen fixed by the natural process.
3. Certain microorganisms are capable of fixing atmospheric nitrogen into ammonia such as free-living **nitrifying bacteria** like aerobic *Azotobacter* and anaerobic *Clostridium*.

Nitrifying bacteria such as Rhizobium, which converts nitrogen into simple compounds, live in symbiotic relationship with leguminous crops (i.e. pulses, etc.). Nitrifying bacteria such as blue green algae also lives in symbiotic relationship with non-leguminous plants.

Ammonia can be directly taken by some plants or oxidised to nitrite or nitrates by some types of bacteria before being utilised by the plants. Ammonia is transformed into nitrites by a bacteria called *Nitrosomonas*. Nitrites are further transformed into nitrates by the bacteria called *Nitrobacter*.

The nitrates are taken up by the plants and converted into amino acids which are used to build proteins. These amino acids are eaten by herbivores which are further eaten by the organisms present at the higher levels of food chain.

During excretion and on the death of an organism, the nitrogen is returned to soil in the form of ammonia.

Denitrifying bacteria such as *Pseudomonas* convert the nitrates in the soil to free atmospheric nitrogen. Pseudomonas can reduce the amount of fixed nitrogen by up to 50 percent, depleting the soil fertility and reducing the agricultural productivity. Without denitrification, the Earth's supply of nitrogen would eventually accumulate in the oceans, since nitrates are highly soluble and are continuously leached from the soil into the nearby bodies of water.

Practice Questions

1. Accumulation of non-biodegradable pesticides in the food chain in increasing amount at each higher trophic level in a food chain is called:
   (a) Eutrophication
   (b) Biomagnification
   (c) Bioaccumulation
   (d) Bioconcentration

2. What will happen if deer are missing in the food chain given below?
   Grass → Deer → Tiger
   (a) The population of both the tiger and grass increases.
   (b) The population of both the grass and tiger decreases.
   (c) There will be no impact on the population of both the tiger and grass.
   (d) The population of tiger decreases and the population of grass increases.

3. Consider the following options. Which one does correctly depict the flow of carbon in a carbon cycle?
   (a) CO_2 in atmosphere → carbon in soil → carbon in animals → carbon in plants
   (b) CO_2 in atmosphere → carbon in plants → carbon in animals → carbon in soil

(c) Carbon in soil → carbon in plants → carbon in animals → CO_2 in atmosphere
(d) Carbon in animals → CO_2 in atmosphere → carbon in plants → carbon in soil

4. The nitrogen molecules present in the air can be converted into ammonia by which of the following microorganisms?
(a) *Azotobacter* (b) *Nitrosomonas*
(c) *Nitrobacter* (d) *Pseudomonas*

5. One of the following processes is **not** a part of the water-cycle operating in nature?
(a) Evaporation (b) Transpiration
(c) Photosynthesis (d) Precipitation

6. When we breathe in air, nitrogen also goes inside along with oxygen. What is the fate of the nitrogen?
(a) It moves along with oxygen into the cells.
(b) It comes out with the CO_2 during exhalation.
(c) It is absorbed only by our body cells.
(d) Nitrogen concentration is already high in our body cells, so it is not absorbed.

7. In the nitrogen cycle, soil nitrates can be transformed into free nitrogen by:
1. Nitrifying bacteria
2. Denitrifying bacteria
Which of the statements given above is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

8. Consider the following statements concerning food chains and say which of the following statements is correct:
(a) Removal of 80% tigers from an area result in the increased growth of vegetation.
(b) Removal of most carnivores will result in reduced population of deer.
(c) The length of food chains is generally limited to 3-4 trophic levels due to energy loss.
(d) None of the above.

9. What is cloud seeding?
(a) Planting seeds in anticipation of expected rains.
(b) A method of faster data transfer using cloud computing.
(c) A method to produce artificial rain.
(d) A method to produce highly productive varieties of plants.

10. Bald Eagle has been at the high risk of extinction due to its:
(a) Large size
(b) Low reproductive potential
(c) High trophic level
(d) Migration to new habitats

11. An inverted pyramid of biomass in a food chain can be found in which of the following ecosystems?
(a) Forest (b) Marine
(c) Grass land (d) Tundra

12. If the carbon atoms fixed by producers have already passed through two species, the trophic levels of the last species would be:

(a) Scavenger
(b) Tertiary producer
(c) Secondary consumer
(d) Tertiary consumer

13. Of the solar energy coming into the biosphere, what percentage of it is actually used in the photosynthesis?
(a) Less than 1%.
(b) Between 1% and 1.5%.
(c) Between 1.5% and 2%.
(d) More than 2%.

14. Which of the following pyramids in a food chain is always upright?
(a) Pyramid of energy
(b) Pyramid of number
(c) Pyramid of biomass
(d) None of the above

15. Consider the following statements:
1. Bioconcentration occurs due to the consumption of polluted water.
2. Water-soluble harmful substances are secreted out of our body periodically.
3. Biomagnification refers to increase in the concentration of harmful substances as they move up to higher trophic levels.
Which of the statements given above is/ are correct?
(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

16. Which of the following forms of nitrogen can be absorbed by the plants?
1. Atmospheric nitrogen
2. Nitrates
3. Nitrites
4. Ammonia
Select the correct answer using the codes given below:
(a) 2 and 3 (b) 1, 2 and 3
(c) 2, 3 and 4 (d) 1, 2, 3 and 4

17. Consider the following statements:
1. The water cycle involves the processes of evaporation, condensation, precipitation and transpiration.
2. Both water and carbon cycles are examples of perfect cycles.
3. Nitrogen can be consumed by plants directly from the atmosphere.
Which of the statements given above is/ are correct?
(a) 1 only (b) 2 and 3 only
(c) 1 and 2 only (d) 1, 2 and 3

18. Which of the following is an ecosystem service provided by a natural ecosystem?
1. Cycling of nutrients.
2. Prevention of soil erosion.
3. Pollutant absorption and reduction of the threat of global warming.
4. Generation of biomass.
Select the correct answer using the codes given below:
(a) 1, 2 and 3 only (b) 1, 3 and 4 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

19. Consider the following statements regarding ecological pyramids:
1. Pyramid of number and biomass can be both upright and inverted.
2. Pyramid of energy can never be inverted.

Which of the statements given above is/ are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

20. For a chemical to be of concern for biomagnification, it must be:
1. Short-lived.
2. Mobile and biologically active.
3. Soluble in water.
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

21. Which among the following is/are the sedimentary nutrient cycles?
1. Carbon cycle
2. Phosphorus cycle
3. Sulphur cycle
Select the correct answer using the code given below:
(a) 1 and 2 only (b) 2 and 3 only
(c) 3 only (d) 1, 2 and 3

22. Consider following statements regarding ecological pyramids:
1. Both food chain and food web can be represented in an ecological pyramid.
2. Saprophytes are not given any place in the ecological pyramids.
Which of the statements given above is /are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

23. Consider the following statements:
1. Biomagnification refers to increase in concentration of a toxin at successive trophic levels.
2. Bioaccumulation is the gradual increase in concentration of a toxin over a period of time in an organism.
Which of the statements given above is/ are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

24. The process of transpiration helps plants in which of the following functions?
1. To pull water to the upper portion of the plants.
2. Maintaining water pressure within the body cells.
3. Regulation of temperature.
Select the correct answer using the codes given below:
(a) 1 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

25. Consider the following statements regarding biomagnification:
1. Biomagnification refers to the absorption of toxicant by an organism from its abiotic environment.
2. It happens when toxic substances accumulated in an organism cannot be metabolised or excreted.
Which of the statements given above is/ are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

26. Consider the following statements:
    1. The green plants in a terrestrial ecosystem capture about only 1% of the solar energy falling on their leaves.
    2. Only 10% of the energy is transferred from one trophic level to the other via the food chain.

    Which of the statements given above is/are correct?
    (a) 1 only (b) 2 only
    (c) Both 1 and 2 (d) Neither 1 nor 2

PERFECTING PAST PRELIMS

1. A pesticide which is a chlorinated hydrocarbon is sprayed on a food crop. The food chain is: Food crop → Rat → Snake → Hawk. In this food chain, the highest concentration of the pesticide would accumulate in which one of the following? **(2010)**
    (a) Food crop (b) Rat
    (c) Snake (d) Hawk

2. Consider the following: **(2011)**
    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 and 4

3. The Millennium Ecosystem Assessment describes the following major categories of ecosystem services: provisioning, supporting, regulating and cultural. Which one of the following is a supporting service? **(2012)**
    (a) Production of food and water.
    (b) Control of climate and disease.
    (c) Nutrient cycling and crop pollination.
    (d) Maintenance of diversity.

    Note: Ecosystem services are grouped into four broad categories: provisioning, such as the production of food and water; regulating, such as the control of climate and disease; supporting, such as nutrient cycles and crop pollination; and cultural, such as spiritual and recreational benefits.

4. With reference to food chains in ecosystems, consider the following statements: **(2013)**
    1. A food chain illustrates the order in which a chain of organisms feed upon each other.
    2. Food chains are found within the population 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

5. Which of the following adds/add nitrogen to the soil? **(2013)**

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

6. Which one of the following process involves photosynthesis? **(2014)**

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

7. Which one of the following is the correct sequence of a food chain? **(2014)**

(a) Diatoms-Crustaceans-Herrings
(b) Crustaceans-Diatoms-Herrings
(c) Diatoms-Herrings-Crustaceans
(d) Crustaceans-Herrings-Diatoms

Note: Diatoms are unicellular algae. Crustaceans are sub-class of arthropods (explained later). Herrings is a type of fish.

8. Which of the following adds/add carbon dioxide to the carbon cycle on the planet Earth? **(2014)**

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

Select the correct answer using the codes given below:

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

ANSWER KEYS

Practice Questions

1. (b)	**2.** (d)	**3.** (b)	**4.** (a)	**5.** (c)
6. (b)	**7.** (b)	**8.** (c)	**9.** (c)	**10.** (c)
11. (b)	**12.** (c)	**13.** (a)	**14.** (a)	**15.** (d)
16. (c)	**17.** (a)	**18.** (d)	**19.** (c)	**20.** (b)
21. (b)	**22.** (b)	**23.** (c)	**24.** (d)	**25.** (b)
26. (c)				

Perfecting Past Prelims

1. (d)	**2.** (c)	**3.** (c)	**4.** (a)	**5.** (c)
6. (b)	**7.** (a)	**8.** (c)		

Solutions for

Practice Questions and Perfecting Past Prelims