**MAN AND HIS ENVIRONMENT**

**Key Concepts**
25.1 Biogeochemical Cycle  
25.2 The Flow of Energy  
25.3 Ecological Succession  
25.4 Population Dynamics  
25.5 Human Impact on Environment  
25.6 Environmental Resources and the Depletion

**EXERCISE**

**SECTION I: Multiple Choice Questions**

Select the correct answer from the following choices.

1. Which is one group of organisms that is able to fix atmospheric nitrogen into forms usable by living organisms?  
   (a) plants  
   (b) fungi  
   (c) insects  
   (d) bacteria

2. Producers of an ecosystem are:  
   (a) autographs  
   (b) absorptive heterotrophs  
   (c) ingestive heterotrophs  
   (d) none of them

3. A population carrying capacity:  
   (a) can be accurately calculated.  
   (b) generally remains constant over time.  
   (c) may change as environmental conditions change.  
   (d) can never be exceeded.

5. Which of the following is also called greenhouse effect?  
   (a) ozone layer depletion  
   (b) global warming  
   (c) acid rain  
   (d) all of them

6. Ozone layer is found in:
7. The main cause of the recent increase in the amount of CO₂ in the Earth's atmosphere:
   (a) increased worldwide primary production  
   (b) increased worldwide standing crop biomass  
   (c) the rapidly growing human population  
   (d) the burning of larger amounts of fossil fuels

8. Which of this ecosystem has the lowest net primary production per square meter?
   (a) a salt marsh  
   (b) an open ocean  
   (c) coastal reef  
   (d) a grassland

9. Which of the following is the graphical representation of ecological data of an ecosystem?
   (a) pyramids  
   (b) succession  
   (c) niche  
   (d) habitat

10. Which of these levels of ecological study involves both abiotic and biotic components?
    (a) organisms  
    (b) population  
    (c) ecosystem  
    (d) conservation ecology

11. Why are ecosystems dependent on a continual supply of solar energy?
    (a) carnivores have a greater biomass than producers.  
    (b) decomposers process the greatest amount of energy in an ecosystem.  
    (c) energy transformation results in a loss of usable energy to the environment.  
    (d) energy cycles within and between ecosystems.

12. Nutrient cycle always involve:
    (a) rocks as reservoir  
    (b) movement of nutrients through the biotic community  
    (c) the atmosphere as an exchange pool.  
    (d) loss of the nutrients from the biosphere.

13. How do nitrogen-fixing bacteria contribute to the nitrogen cycle?
    (a) return nitrogen to the atmosphere.  
    (b) change ammonium to nitrate  
    (c) change N₂ to ammonia  
    (d) absorb nitrate from the soil

Answers

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SECTION II: Short Questions

Give short answers of the following questions.

Q1. Define: ecology, biogeochemical cycle, water table, aquifer, nitrogen, fixation, nitrification, denitrification, ammonification.

Answer

Ecology
The branch of biology dealing with the relations and interactions between organisms and their environment, including other organisms called ecology.

Biogeochemical Cycle
Every organism requires nutrients for its survival. These nutrients are obtained from the environment. The movement of these nutrients in the ecosystem is cyclic. This flow of nutrients from environment to the organisms and back to the environment is called the biogeochemical cycle.

Water Table
When rainwater falls, some of the water sinks or percolates into the ground and saturates the earth to a certain level. The top of the saturation zones is called water table.

Ammonification
The nitrogenous wastes of animals and nitrogenous compounds of dead organisms are decomposed by saprophytic soil bacteria and fungi to form simple substances like water, carbon dioxide, amino acids and energy. The amino acids are converted into ammonia or ammonium ions. Production of ammonia or ammonium compounds in the decomposition of organic matter by microorganisms is called Ammonification. Ammonification occurs in the soil, in an aerobic environment which gives the bacteria and other microorganisms oxygen to work with.

Nitrogen Fixation
Nitrogen gas is composed of two atoms of nitrogen linked by a very strong triple bond. This makes it chemically unreactive and large amounts of energy is required to break the bond. Nitrogen gas can be fixed in three ways.
Atmospheric fixation, Industrial fixation and Biological fixation.

Denitrification
Nitrogen can be lost as a result of the activities of certain soil bacteria; in the absence of oxygen these bacteria breakdown nitrates releasing nitrogen back into the atmosphere and using the oxygen for their own respiration. This process is known as denitrification and such bacteria are called denitrifying bacteria e.g., Pseudomonas reduce nitrates in the soil to gaseous state.

$$\text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{NO} + \text{N}_2\text{O} \rightarrow \text{N}_2 \ (g)$$
Nitrification
Some ammonia escapes into the soil but much of it and ammonium ions are converted into nitrates by nitrifying bacteria. It is accomplished by two groups of nitrifying bacteria. The first group of bacteria e.g., *Nitrosomonas* converts ammonia to nitrates and the second group of bacteria e.g., *Nitrobacter* converts nitrates to nitrates. This process is called nitrification. Nitrification takes place only in well aerated soils because the bacteria responsible for it are aerobic.

Nitrification is a process of nitrogen compound oxidation (effectively, loss of electrons from the nitrogen atom to the oxygen atoms):
1. $2 \text{NH}_4^+ + 3\text{O}_2 \rightarrow 2\text{NO}_2^- + 2\text{H}_2\text{O} + 4\text{H}^+$ (Nitrosomonas)
2. $2 \text{NO}_2^- + \text{O}_2 \rightarrow 2\text{NO}_3^- + 3\text{H}^+ + 2e^-$ (Nitrobacter, Nitrospina)
3. $\text{NH}_3 + \text{O}_2 \rightarrow \text{NO}_2^- + 3\text{H}^+ + 2e^-$
4. $\text{NO}_3^- + \text{H}_2\text{O} \rightarrow \text{NO}_3^- + 2\text{H}^+ + 2e^-$

Aquifer
An aquifer is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a water well. The study of water flow in aquifers and the characterization of aquifers is called hydrogeology.

Q2. Differentiate between: Xerarch, hydrarch succession, renewable and non-renewable resources and conventional and non-conventional energy resources

Hydrarch Succession:
Ecological succession which begins in ponds, lakes, and marshes or elsewhere in water is termed as hydrarch and different stages are called hydrosers.

Xerarch Succession:
Succession initiated on bare rocks, sand dunes, rocky slopes etc. where there is deficiency of water, is termed as Xerarch and different stages of development are collectively called xerosere.

All life on earth is sustained by energy from the sun. Plants and animals can store energy and some of this energy remains with them when they die. It is the remains of these ancient animals and plants that make up fossil fuels.

Renewable Resources
Renewable resources are produced by natural systems that replace themselves quickly enough to keep pace with consumptions. Examples are air, water, land and wild life. Living organisms use them. They are constantly replaced by natural cycles e.g., water cycle, carbon cycle, oxygen cycle, nitrogen cycle etc.

Non-renewable Resources
Non-renewable resources are formed at a rate much slower than their environment consumption. These are exhaustible and cannot be replaced if destroyed. Examples are various metals, non-metallic minerals, coal, oil and natural gas etc.
Conventional Energy Sources
The energy source that has been used from ancient times is called conventional sources of energy. The examples of conventional energy sources are fossil fuels (coal, natural gas, oil), firewood, and sources of energy i.e. electricity are coal, oil, wood, peat and uranium.

The advantages of conventional source of energy e.g. fossil fuels are that these are inexpensive and require established technologies that can produce energy around the clock. The disadvantages of conventional sources of energy are that they have a limited supply because eventually the nuclear elements and fossil fuels will be used up. In addition, burning fossil fuels release significant amounts of greenhouse gases and contribute to acid rain.

Fossil fuels include coal, oil and gas. They provide 95% of the energy requirement. They are nonrenewable. They are called fossil fuels because they are remains of plants and animals that lived millions of years ago.

Nuclear energy is the energy obtained by fission of radioactive atom. This energy is used to produce electricity in nuclear reactors. The primary nuclear fuel is $^{235}\text{U}$. The advantage of nuclear energy is that it emits large amount of energy. The disadvantages are that it generates radioactive waste and is expensive.

Non-conventional Energy Source
Non-conventional Energy Sources or unusual sources of energy are the new sources of energy which are still not in common use. Their contribution to the national power is nominal. These are: Solar power, Hydro-electric power (dams on rivers), Wind power, Tidal power, Ocean wave power, Geothermal power (heat from deep under the ground), Ocean thermal power (the difference in heat between shallow and deep water), Biomass (burning of vegetation to stop it producing methane), Bio-fuel, (producing ethanol petroleum), from plants. Bio-gas. It is also known as renewable energy sources.

The advantages of non-conventional source of energy are that these are abundant in nature, pollution free and eco-friendly. These sources can be renewed with minimum effort and energy. The disadvantages of nonconventional energy sources are that these are often limited to producing energy only under certain circumstances such as sunny days for solar panels and windy days for windmills.

3. How nitrogen gets from the air to a plant?
Answer
Nitrogen is required by all living organisms for the synthesis of organic molecules such as amino acids, nucleic acids and proteins. The nitrogen cycle is the movement of nitrogen between the earth and the atmosphere. The nitrogen cycle can be broken-down into four types of reactions i.e., decomposition (ammonification and nitrification), nitrogen fixation, and assimilation and de-nitrification.

Nitrogen Fixation
Nitrogen gas is composed of two atoms of nitrogen linked by a very strong triple bond. This makes it chemically unreactive and large amounts of energy is required to break the bond. Nitrogen gas can be fixed in plants in three ways.
Atmospheric Fixation:
The nitrogen fixation that occurs spontaneously by lightning is called atmospheric fixation; a small amount (5-8%) only is fixed in this way. Lightning allows nitrogen and oxygen to combine to produce various oxides of nitrogen. These are carried by the rain into soil where they can be used by plants.

Industrial Fixation
The synthesis of nitrogen containing fertilizers is called industrial fixation.

Biological Fixation
Nitrogen-fixing bacteria fix 60% of nitrogen gas in the atmosphere. The reduction of nitrogen gas to ammonia is energy intensive. It requires 16 molecules of ATP and a complex set of enzymes to break the bonds so that the nitrogen can combine with hydrogen. Its reduction can be written as:

\[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]

Q4. What natural areas or situations might favor denitrification?

Answer
Nitrogen can be lost as a result of the activities of certain soil bacteria; in the absence of oxygen these bacteria breakdown nitrates releasing nitrogen back into the atmosphere and using the oxygen for their own respiration. This process is known as denitrification and such bacteria are called denitrifying bacteria e.g., *Pseudomonas* reduce nitrates in the soil to gaseous state.

\[ \text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{NO} + \text{N}_2 \text{O} \rightarrow \text{N}_2 (g) \]

Q5. Why should good drainage and ploughing increase soil fertility?

Answer
Healthy soil is the foundation of the food system. It produces healthy crops that in turn nourish people. Maintaining a healthy soil demands care and effort from farmers because farming is not benign. By definition, farming disturbs the natural soil processes including that of nutrient cycling - the release and uptake of nutrients. Plants obtain nutrients from two natural sources: organic matter and minerals.

Organic matter includes any plant or animal material that returns to the soil and goes through the decomposition process. In addition to providing nutrients and habitat to organisms living in the soil, organic matter also binds soil particles into aggregates and improves the water holding capacity of soil. Decomposition of organic matter occurs more slowly in poorly aerated soils, where oxygen is limiting or absent, compared with well-aerated soils. For this reason, organic matter accumulates in wet soil environments. The increased water availability enhances biomass production, soil biological activity and plant residues and roots that provide organic matter.

The primary purpose of ploughing is to turn over the upper layer of the soil, bringing fresh nutrients to the surface, while burying weeds, the remains of previous crops, and both crop and weed seeds, allowing them to break down. It also provides a seed-free medium for planting an alternate crop. In modern use, a ploughed field is typically left to dry out, and is then harrowed before planting.
Q6. What do nitrogen fixing bacteria do?

Answer
Nitrogen fixing bacteria fix 60% of nitrogen gas in the atmosphere. The reduction of nitrogen gas to ammonia is energy intensive. It requires 16 molecules of ATP and a complex set of enzymes to break the bonds so that the nitrogen can combine with hydrogen. Its reduction can be written as:

\[
\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3
\]

Only a relatively few bacteria (the nitrogen-fixing bacteria) are able to carry out this reaction. Fixed nitrogen is made available to plants by the death and lysis of free-living nitrogen-fixing bacteria e.g., *Azotobacter* (aerobic) and *Clostridium* (anaerobic) or from the symbiotic association of some nitrogen-fixing bacteria with plants e.g., *Rhizobium*.

Q7. What are tropic levels?

Answer
In an ecosystem the organisms are arranged in different feeding groups, each is known as trophic level.

At the first level (T₁), primary producers (plants, algae and some bacteria) use solar energy to produce organic plant material through photosynthesis. Herbivores or primary consumers make up the second trophic level (T₂).

Predators, the secondary consumers that eat herbivores comprise the third trophic level (T₃); if larger predator i.e., tertiary consumers are present; they represent still higher trophic levels. Organisms that feed at several trophic levels (omnivores) are classified at the highest of the trophic levels (T₄) at which they feed.

Decomposers, which include bacteria, fungi, molds, and detritivores such as worms, and insects, breakdown wastes and dead organisms and return nutrients to the soil, occupy the fifth trophic level (T₅).

Q8. Distinguish between primary and secondary succession and give one example of each.

Answer
**Primary Succession**
Primary succession is the change in species composition over time in a habitat that was not previously inhabited by organisms. Bare rock surface, such as recently formed volcanic lava and rock scraped clean by glaciers, are examples of sites where primary succession might occur.

**Secondary Succession**
Secondary succession is the change in species composition over in a habitat already substantially modified by a pre-existing community. Soil is already present at the sites. The common example of sites where secondary succession occurs is:

a) Abandoned farm fields undergo secondary succession as they revert to forest.

b) Succession in forest area where vegetation has been devastated by fire, flood, cyclone etc.
Q9. During succession, how might the early species facilitate the arrival of other species?

Answer
The first requirement in the process of succession in any bare area is the migration of plants and animals from surrounding areas and their aggregation. These migrants are called pioneers. The pioneers become successful in taking hold of the soil. They increase in number. By their death and decay, the pioneers increase organic matter, moisture and nitrogen content of the soil. The enriched soil now becomes suitable for the growth of next group of invaders. These are called seral communities and constitute one seral stage. By their activities, these serals modify the environment and changed environment becomes unsuitable for their growth and a new group of plants and animals invade the environment. The end product of succession after several seral communities is the climax community or relatively stable community.

Q10. Why food chains are usually short?

Answer
When there is a transfer of energy in the form of food, most of energy dissipates into the environment from one trophic level to another. Less energy reaches each successive trophic level from the level beneath it because some of the energy at the lower level is used by organisms to perform work while some of it is lost. Food chains/webs are short because of the dramatic reduction in energy contents that occurs at each successive trophic level.

Q11. Why is only a small portion of the solar energy that strikes Earth’s atmosphere stored by primary producers?

Answer
Of the total solar radiation striking the Earth's outer atmosphere, about 1% total energy from sun is trapped by the producers in an ecosystem. The remaining 99% of solar energy is used to evaporate water, heat up soil and is then lost to the outer space.

Q12. Why is an ecosystems primary production lower than gross primary production?

Answer
The total amount of energy fixed by plants is gross primary production. The amount of energy left after plants have met their respiratory demands is net primary production, which shows up as plant biomass.

Net primary production = Gross primary production – respiratory activity.

Q13. Why does the production pyramid have the same general shape as the biomass pyramid in most ecosystems?

Answer
Energy pyramids and biomass pyramids are ways of illustrating the movement of energy and biomass through an ecosystem. Ecosystems are comprised of the following kinds of organisms (trophic levels): producers (plants), primary consumers (animals that eat plants), secondary consumers (animals that eat animals that eat plants),
Tertiary consumers (animals that eat animals that eat plants) and decomposers.

At every energy transformation some energy is degraded to low grade heat. This energy is essentially lost to the ecosystem and released into the surroundings. Only approximately 10% of the energy (as biomass) that is contained in one trophic level is transferred to the next trophic level as biomass. The remaining 90% is dissipated as heat in the atmosphere.

Therefore, if you assume a producer community made up of 1000 lbs of grass is eaten by primary consumers, only 10% of the 1000 lbs, or 100 lbs, will end up as biomass in the primary consumer level. If those 100 lbs of primary consumer are eaten by secondary consumers, only 10 lbs (10% of 100 lbs) will be turned into secondary consumer biomass and so on.

The resulting graphic for either biomass or energy in an ecosystem are roughly pyramid-shaped with each succeeding level being only 10% as large as the one before/below it.

Q14. Why does the deforestation of a watershed increase the concentration of nitrates in streams draining the watershed?

Answer
Plants and especially trees use nitrates for protein formation. Nitrates are in the soil. If there is deforestation then the top soil will be lost and be washed away in the stream. Mainly deforestation is for more farming land so they add nitrates which will also end up being deposited into the streams.

Q15. What happens to the sun’s energy as it travels through the food chain?

Answer
Energy from the sun is converted into biomass and transferred from one organism to another as it moves through food chains and food webs.

16. How can clear cutting a forest damage the water quality of nearby lakes?

Answer
It would allow huge amounts of run-off to enter the lakes. With nothing to hold back erosion because the trees are gone, any time it rains, the run-off will filter into the lakes. The lake ecosystem will not be accustomed to being infiltrated with huge amounts of sediments. This could feasibly change the water pH (depending on alkalinity or acidity of soil flooding in) which can kill certain species; sediments can cloud the water, which could in turn kill the plants which require sunlight to grow, which in turn may demolish the rest of the food chain that depends upon the native lake flora.

Q17. In what ways humans would benefit by preserving biodiversity?

Answer
Biodiversity, or biological diversity, refers to the variety of plants, animals and microorganisms that exist, the genes they contain and the ecosystems they live in.
Living in the lowland tropics we are blessed with abundant biodiversity. Tropical areas are known to have more species per unit area than temperate areas and biodiversity decreases with increasing altitudes. One of the reasons biodiversity is important is because it helps to keep the environment in a natural balance. An ecosystem which is species-rich is more resilient and adaptable to external stress than one in which the range of species is limited. In a system where species are limited, the loss or temporary reduction of any one could disrupt a complex food chain with serious effects on other species in that same system. Once biodiversity is sufficient, if one nutrient cycling path is affected another pathway can function and the ecosystem - and the biological species it supports - can survive.

**Q18. Why should people be concerned that ozone layer in the stratosphere is being depleted?**

**Answer**

Ozone layer is a layer of atmosphere extending from 10 to 50 kilometers (6 to 30 miles) above Earth. In pure form, ozone is a bluish, explosive and highly poisonous gas.

Most of the UV radiations are filtered out by ozone in the ozone in the stratosphere. In the stratosphere, there is a group of commercially important compounds called chlorofluorocarbons (CFCs). These have been used as propellants in aerosol cans, coolants (e.g., Freon) in air conditioners and refrigerators, foam (e.g., Styrofoam) for insulation and packing and cleaners in the electronic industry. Ultraviolet radiation breaks CFCs and similar compounds into chlorine, fluorine and carbon. Under certain stratospheric conditions, chlorine and fluorine are capable of reacting with ozone, converting it into molecular oxygen.

With depletion of the ozone layer, UV radiations reach Earth’s surface. Excessive exposure to UV radiation is linked to a number of human health problems, including sunburn, premature aging of skin, skin cancer and cataracts. Photosynthesis by phytoplankton is also affected and reduced by ultraviolet radiation.

**Q19. Investigate the careers related to the study of the environmental resources.**

**Answer**

- Environmental attorney, Environmental engineer, Environmental health officer, Environmental impact analyst, Environmental toxicologist, Environmentalist, Natural resource manager, Population biologist, Wildlife conservation officer, Watershed project manager, Natural resource manager etc.

**Q20. Enlist the characteristics of a population?**

**Answer**

- Growth
- Density
- Distribution
- Carrying capacity
- Minimum Viable Population (MVP)
Q21. What is the need of nuclear power and what are the problems of using nuclear power?

Answer
Nuclear power is the use of sustained nuclear fission to generate heat and electricity. As reported in 2005, nuclear power provided 6.3% of the world’s energy and 15% of the world’s electricity. The scarcity of fossil fuels which is not available in all the countries, is the reason for the development of nuclear power stations.

Need of Nuclear Power
Nuclear power costs about the same as coal, so it’s not expensive to make (b) Does not produce smoke or carbon dioxide, so it does not contribute to the greenhouse effect. (c) Produces huge amounts of energy from small amounts of fuels. (d) Produces small amounts of waste. (e) Nuclear power is reliable.

Problems of Using Nuclear Power
The two main problems using nuclear powers are safety of safe operation and safe disposal of the wastes.

Surety of Safe Operation
To achieve optimum safety, in nuclear plants prevention, monitoring and operation i.e., to mitigate consequences of failures are followed: These are: (a) High-quality design and construction. (b) Comprehensive monitoring and regular testing to detect equipment of operator failures, (c) Prevention of significant radioactive releases.

Safe Disposal of the Wastes
Radioactive wastes are wastes that contain radioactive material. Nuclear waste is a cause for concern because it is not bio-degradable, meaning it does not decompose naturally under the effect of the atmosphere. Secondary, it causes a number of health hazard for anyone who comes into contact with the radiation from this waste. Therefore, some measure should be used for disposal of nuclear waste which many include deep ocean disposal geological burial, nuclear waste recycling reprocessing and solidification process.

Q22. Narrate the incidence when one of the four reactors of the Chernobyl nuclear power plant blew up in 1986. Can you name any such happening in Japan in 2011?

Answer
The Chernobyl disaster was a nuclear accident. It occurred on 26 April 1986 at the Chernobyl Nuclear Power Plant in Ukraine. An explosion and fire released large quantities of radioactive contamination into the atmosphere which spread over much of Western USSR and Europe. Approximately over 500,000 workers were affected apart from the 57 direct deaths in the accident itself. United Nations Scientific Committee on the Effects of Atomic Radiation predicted in 2005 that up to 4,000 additional cancer deaths related to the accident would appear “among the 6000,000 persons receiving more significant exposures. Fukushima nuclear disaster happened in Japan in 2011.
Q23. Describe how man is responsible for the depletion of environmental resources?

Answer

Resource depletion is a term referring to the exhausting of raw materials within a region. Resources are commonly divided between renewable resources and non-renewable resources. Use of either of these forms of resources beyond their rate of replacement is considered to be resource depletion.

Cause of Resource Depletion

Man is the main cause of resource depletion. His activities are continuously consuming natural environmental resources with the pace beyond the pace of their renewal. The factors through which man is depleting natural resources include over-consumption/excessive or unnecessary use of resources, non-equitable distribution of resources, overpopulation, slash and burn agricultural practices, technological and industrial development, erosion, irrigation, mining for oil and minerals and pollution or contamination of resources.

Q24. Justify the fact that humans are often responsible for secondary succession.

Answer

Humans often interfere with succession. They replace complex ecosystem with simple ecosystems. These ecosystems are designed to meet human needs. Simple ecosystems have less biodiversity than complex ecosystems. They are often not sustainable. Human disturbance i.e. agriculture, forestry, development, can lead to secondary succession once the land is abandoned by humans.

SECTION III: Extensive Questions

Q1. Locate the primary reservoirs of the biogeochemical cycle.

Answer

Every organism requires nutrients for its survival. These nutrients are obtained from the environment. The movement of these nutrients in the ecosystem is cyclic one. This flow of nutrients from environment to the organisms and back to the environment is called the biogeochemical cycle.

Primary Reservoirs of Nutrients

Let us look first at a general model of nutrient cycling that includes the main reservoir of elements and the processes that transfer elements between reservoirs. Each reservoir is defined by two characteristics: whether it contains organic or inorganic materials and whether or not the materials are directly available for use by organisms.

The nutrients in living organism themselves and in detritus (fig. reservoir a) are available to other organisms when consumers feed and when detritivores consume non-living organic matter. Some material moved from the living organic reservoir to the fossilized organic reservoir (reservoir b) long ago, when dead organisms were buried by sedimentation over millions of years, becoming coal, oil or peat (fossil fuels). Nutrients in these deposits cannot be assembled directly.
Inorganic materials that are dissolved in water present in soil or air (reservoir c) are available for use. Organisms assimilate materials from this reservoir directly and return chemicals to it through the relatively rapid processes of cellular respiration, excretion, and decomposition. Although organisms cannot directly tap into the inorganic elements tied up in the rocks (reservoir d), these elements may slowly become available through weathering and erosion. Similarly, unavailable organic materials move into the available reservoir of inorganic nutrients when fossil fuels are burned, releasing exhaust into the atmosphere.

**Figure: A general model of nutrient cycle. Arrows indicate the process that moves nutrients between reservoirs.**

**Q2. Describe in detail how water is cycled within ecosystems?**

**Answer**

**Water Cycle**

The major reservoir of water is the ocean, which contains over 97% of the available water. The water cycle is driven by solar energy which evaporates water and gravity which draws the water back to Earth in the form of precipitation (rain, snow, sleet, dew).
Water In Environment
Water falling on land takes more varied paths. Some is evaporated from the soil, lakes and streams. A portion runs off the land back to the oceans.

When rain water falls, some of the water sinks or percolates into the ground and saturates the earth to a certain level. The top of the saturation zones is called water table. Whenever the Earth contains basin or channels, water will appear to the level of the water table. The water within the basin is called lakes and ponds and water within channels is called streams or rivers. Sometimes ground water is also located in underground rivers called aquifers.

Water In Living Bodies
Because the bodies of living things are roughly 70% water, some of the water in the water cycle enters the living communities of ecosystems. It is absorbed by the roots of plants and much of this is evaporated back to the atmosphere from their leaves. A small amount is combined with carbon dioxide during photosynthesis to produce high-energy molecules. Eventually these are broken-down during cellular respiration, releasing back to the environment. Heterotrophs get water from their food or by drinking.
Q3. Describe the nitrogen cycle in detail.

Answer

Nitrogen is required by all living organisms for the synthesis of organic molecules such as amino acids, nucleic acids and proteins. The nitrogen cycle is the movement of nitrogen between the earth and the atmosphere. It consists of a series of processes that convert nitrogen gas to organic substances and these back to nitrogen in nature. It is a continuous cycle maintained by the decomposers and other bacteria. The nitrogen cycle can be broken down into four types of reactions i.e., decomposition (ammonification and nitrification), nitrogen fixation, and assimilation and de-nitrification.

Decomposition

Decomposition of organic nitrogen compounds is the first source of soil nitrates. It occurs in two steps: (a) ammonification (b) nitrification.

a) Ammonification

The nitrogenous wastes of animals and nitrogenous compounds of dead organisms are decomposed by saprophytic soil bacteria and fungi to form simple substances like water, carbon dioxide, amino acids and energy. The amino acids are converted into ammonia or ammonium ions. Production of ammonia or ammonium compounds in the decomposition of organic matter by microorganisms is called ammonification. Ammonification occurs in the soil, in an aerobic environment which gives the bacteria and other microorganism’s oxygen to work with.

b) Nitrification

Some ammonia escapes into the soil but much of it and ammonium ions are converted into nitrates by nitrifying bacteria. It is accomplished by two groups of nitrifying bacteria. The first group of bacteria e.g., Nitrosomonas converts ammonia to nitrates and the second group of bacteria e.g., Nitrobacter converts nitrates to nitrates. This process is called nitrification. Nitrification takes place only in well aerated soils because the bacteria responsible for it are aerobic.

Nitrogen Fixation

Nitrogen gas is composed of two atoms of nitrogen linked by a very strong triple bond. This makes it chemically unreactive and large amounts of energy is required to break the bond. Nitrogen gas can be fixed in three ways.

Atmospheric Fixation

The nitrogen fixation that occurs spontaneously by lightning is called atmospheric fixation; a small amount (5-8%) only is fixed in this way. Lightning allows nitrogen and oxygen to combine to produce various oxides of nitrogen. These are carried by the rain into soil where they can be used by plants.

Industrial Fixation

The synthesis of nitrogen containing fertilizers is called industrial fixation.

Biological Fixation

Nitrogen-fixing bacteria fix 60% of nitrogen gas in the atmosphere. The reduction of nitrogen gas to ammonia is energy intensive. It requires 16 molecules of ATP and a
complex set of enzymes to break the bonds so that the nitrogen can combine with hydrogen. Its reduction can be written as:

\[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]

Only a relatively few bacteria (the nitrogen-fixing bacteria) are able to carry out this reaction. Fixed nitrogen is made available to plants by the death and lysis of free-living nitrogen-fixing bacteria e.g., *Azotobacter* (aerobic) and *Clostridium* (anaerobic) or from the symbiotic association of some nitrogen-fixing bacteria with plants e.g., *Rhizobium*.

**Assimilation**

It is the process of utilization of nitrogenous compounds in living bodies. Many microorganisms are able to utilize free nitrogen directly from atmosphere but plants obtain nitrogen in the form of inorganic nitrogenous compounds like ammonia and nitrates from the soil, whereas animals take their nitrogen from the eating of plants or other animals.

**Denitrification**

Nitrogen can be lost as a result of the activities of certain soil bacteria; in the absence of oxygen these bacteria breakdown nitrates releasing nitrogen back into the atmosphere and using the oxygen for their own respiration. This process is known as denitrification and such bacteria are called denitrifying bacteria e.g., *Pseudomonas* reduces nitrates in the soil to gaseous state.

\[ \text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{NO} + \text{N}_2\text{O} \rightarrow \text{N}_2 (g) \]
Q4. Give an account of the roles of bacteria in the nitrogen cycle.

Answer

Nitrogen is an important component of many biomolecules, like proteins and nucleic acids (DNA and RNA). Atmosphere is the reservoir of free gaseous nitrogen. Living organisms cannot pickup this gaseous nitrogen directly from atmosphere (except for nitrogen fixing bacteria). It has to be converted into nitrates to be utilized by plants. Nitrogen cycling involves several stages but we will discuss the ways where bacteria are involved:

a. Formation of Nitrates

   It is done by the following ways:

i. Nitrogen Fixation

   Conversion of nitrogen gas into nitrates is called nitrogen fixation. It occurs in the following ways:

   Some bacteria also have the ability to transform gaseous nitrogen into nitrates. It is called biological nitrogen fixation. Some of these nitrogen fixing bacteria live as symbionts and many are free-living. Nitrogen-fixation bacteria fix 60% of nitrogen gas in the atmosphere. The reduction of nitrogen gas to ammonia is energy intensive. It requires 16 molecules of ATP and a complex set of enzymes to break the bonds so that the nitrogen can combine with hydrogen. Its reduction can be written as:

   \[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]

   Only a relatively few bacteria (the nitrogen-fixing bacteria) are able to carry out this reaction. Fixed nitrogen is made available to plants by the death and lysis of free-living
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nitrogen-fixing bacteria e.g., Azotobacter (aerobic) and Clostridium (anaerobic) or from the symbiotic association of some nitrogen-fixing bacteria with plants e.g., Rhizobium.

ii. Ammonification
Ammonification is the breakdown of the proteins of dead organisms and nitrogenous wastes (urea, uric acid etc.) to ammonia. It is done by ammonifying bacteria.

iii. Nitrification
After the formation of ammonia, it is converted into nitrates and nitrates. It is called nitrification and is done by nitrifying bacteria. First, ammonia is converted into nitrites by bacteria (e.g. Nitrosomonas). The nitrites are then converted into nitrates by other bacteria (e.g. Nitrobacter).

iv. Denitrification
Nitrogen can be lost as a result of the activities of certain soil bacteria; in the absence of oxygen these bacteria breakdown nitrates releasing nitrogen back into the atmosphere and using the oxygen for their own respiration. This process is known as denitrification and such bacteria are called denitrifying bacteria e.g., Pseudomonas reduce nitrates in the soil to gaseous state.

\[
\overline{NO}_3^- \rightarrow \overline{NO}_2^- \rightarrow NO + N_2O \rightarrow N_2 (g)
\]

Q5. Describe productivity in terms of gross primary productivity and net primary productivity.
Answer
The ultimate source of energy for our ecosystem is sun (solar energy). Only 1% of solar energy is incorporated into the ecosystem. The total amount of solar energy which is fixed by the producers during photosynthesis is called gross primary productivity (GPP). On the other hand the amount of energy that remains available for plant growth after subtracting the fraction that plants use for respiration is termed as Net primary productivity (NPP) or biomass.
**Productivity in Land Ecosystem**

Productivity in Land ecosystem generally rises with temperature up to about 30°C, after which it declines and is positively correlated with moisture. On land primary productivity thus is highest in warm, wet zones in the tropics. Where tropical forest biomes are located. In contrast, desert scrub ecosystems have the lowest productivity because their climates are extremely hot and dry.

**Productivity in Aquatic Ecosystems**

In the oceans, light and nutrients are important controlling factors for productivity. In oceans, light penetrates only into the uppermost level of the oceans, so photosynthesis occurs in surface and near-surface waters. Marine primary productivity is high near coastlines. Among aquatic ecosystem, algal beds and coral reefs have the highest net primary production while the lowest rates occur in the open due to a lack of nutrients in the illuminated surface layers.

**Q6. Explain the flow of energy in successive trophic level. Also explain the role of bacteria in an ecosystem**

**Answer**

Ecosystems are transformers of energy. On average about 10% of net energy production at one trophic level is passed on to the next level.

![Energy flow in an ecosystem](image)

**Factor Affecting Energy Flow**

Processes that reduce the energy transferred between trophic levels include respiration, growth, reproduction, defecation and non-predatory death (organisms that die but are not eaten by consumers). The nutritional quality of material that is consumed also influences how efficiently energy is transferred because consumers can convert high-quality food sources into new living tissue more efficiently than low-quality food sources. (fig)
Significance of Decomposers in Energy Flow

The low rate of energy transfer between trophic levels makes decomposers generally more important than producers in terms of energy flow. Decomposers process large amounts of organic material and return nutrients to the ecosystem in organic form, which is then taken up again by primary producers. Energy is not recycled during decomposition, but rather is released, mostly as heat.

Q7. Describe and interpret pyramids of number, biomass and energy.

Answer

Ecological Pyramids

Ecologists compare trophic levels by determining the number of organisms, the biomass or the relative energy found at each level. If these data are graphed, the graph has pyramid shape, which is called ecological pyramids. Ecological pyramids are therefore, graphical representation of ecological data.

Pyramid of Energy

A pyramid of energy indicates the energy contents in the biomass of each trophic level. These pyramids show that most energy dissipates into the environment when going from one trophic level to another. Less energy reaches each successive trophic level from the level beneath it because some of the energy at the lower level is used by those organisms to perform work while some of it is lost. Energy pyramids explain why there are few trophic levels. Food webs are short because of the dramatic reduction in energy contents that occurs at each successive trophic level. (Fig: a)
Pyramids of Biomass
A pyramid of biomass illustrates the total biomass at each successive trophic level. Biomass is a quantitative estimate of the total mass, or amount of living materials; it indicates the amount of fixed energy at a particular time. Units of measure vary; biomass may be represented as total volume, dry weight or live weight. Typically, the pyramids illustrate a progressive reduction of biomass in succeeding trophic levels.

Pyramids of Number:
A pyramid of numbers show the number of organisms at each trophic level in a given ecosystem with greater numbers illustrated by a wider pyramid (Fig: c). In most pyramids of numbers, each successive trophic level is occupied by fewer organisms. Thus, the number of herbivores is greater than the number of carnivores.
Q7. Differentiate between Xerarch and hydrarch succession and explain the xerarch succession.

Answer
A community may begin when new habitat is created, as when a volcanic island rises out of the area or when rocks and soil is deposited by a retreating glacier. New communities also may form in regions that have been disturbed, as by fire or hurricane. Species that arrive early in new or disturbed habitat tend to be replaced later by other species which in turn may be replaced by other species. Earlier species are replaced by later species because the replaced species are better able to grow and reproduce under the environmental conditions of the area. The processes by which species are replaced over time is called ecological succession. Individual succesions are known as seres and the development phases are called seral stages.

Kinds of Succession
There may be two kinds of ecological succession: primary succession and secondary succession.

Primary Succession
Primary succession is the change in species composition over time in a habitat that was not previously inhabited by organisms. Bare rock surface, such as recently formed volcanic lava and rock scraped clean by glaciers, are examples of sites where primary succession might occur.

Secondary Succession
Secondary succession is the change in species composition over in a habitat already substantially modified by a pre-existing community. Soil is already present at the sites. The common example of sites where secondary succession occurs are: (a) abandoned farm fields undergo secondary succession as they revert to forest (b) Succession in forest area where vegetation has been devastated by fire, flood, cyclone etc. (Fig:).

Ecological succession which begins in pond, lakes, and marshes or elsewhere in water is termed hydarch and different stages are called hydrosere. Succession initiated on bare rocks, sand dunes, rocky slopes etc. where there is deficiency of water, are termed Xerarch and different stages of development are collectively called xerosere.

\[\text{Annual Plants} \quad \text{Perennial Plants and Grasses} \quad \text{Shrubs} \quad \text{Softwood Trees- Pines} \quad \text{Hardwood Trees}\]

Figure: Secondary succession

**Stages of Succession**

The first requirement in the process of succession in any bare area is the migration of plants and animals from surrounding areas and their aggregation. These migrants are called pioneers. The pioneers become successful in taking hold of the soil. They increase in number. By their death and decay, the pioneers increase organic matter, moisture and nitrogen content of the soil. The enriched soil now becomes suitable for the growth of next group of invaders. These are called seral communities sand constitute one seral stage. By their activities, these serals modify the environment and changed environment becomes unsuitable for their growth and a new group of plants and animals invade the environment. The end product of succession after several seral communities is the climax community or relatively stable community.

**Xerarch Succession**

Various stages and process of xerarch succession which results in the development of climax community may be describe briefly as follows: (Fig:).

**Crustose-lichen Stage**

It is the pioneer stage. On bare rocks only crustose-lichen can grow. These are growers and can withstand extreme desiccation. When there is rain they absorb water like
sponges and decompose rock by secreting acids. Important members of this stage are *Licamore* and *Rhinodina*.

**Foliose-lichen Stage**
On the little soil, which is accumulated on the rock there appear species of foliose-lichen and by their activates there collects a thin layer of soil. Important members of this stage are *Permelia* and *Dermatocarpum*.

**Moss Stage**
When sufficient amounts of soil have been accumulated in the minute crevices and depressions in the rock, xerophytic mosses being to appear. The mosses increase the amount of the soil. By their death and decay, a mat may be formed on the rock surface. This can hold greater amount of water and alongwith the soil makes habitat suitable for herbs.

**Herb Stage**
Herbaceous weeds, mostly annuals invade the rock. Their roots penetrate deep down, secrete acids and enhance the process of weathering. Leaf litter and death of herbs add humus to the soil. Shading of soil results in decrease in evaporation and there is a slight increase in temperature. As a result the xeric conditions begin to change and biennial and perennial herbs and xeric grasses being to inhabit.

**Shrub Stage**
On the soil appear xeric shrubs. These shrubs may start from seeds or invade from adjacent areas by rhizomes. These make the condition unsuitable for herbs and overshadow them. The herbs are unable to compete and hence are replaced by shrubs. Early invasion of shrub is slow but once a few bushes have become established, birds invade the area and help disperse the seeds. This results in dense growth shading the soil and making conditions unfavorable for the growth of herbs which then begin to migrate.
Tree Stage
Change in environment favors colonization of tree species. The tree saplings begin to grow among the scrubs and establish themselves. The trees form canopy and shade the area. Shade-loving plants continue to grow as secondary vegetation. Leaf litter and decaying roots weather the soil further and add humus to it making the habitat more favorable for growth of trees.

Climax Stage
The first species of trees are relatively xeric. As the weathering process continues and the soil deepens, the xeric trees in turn give place to helophytic species of trees. Ultimate, a forest may develop.

Q9. Describe growth, density, distribution, carrying capacity, minimum/viable size as the characteristics of a population.

Answer
Population dynamics is concerned with the studies of long-term and short-term changes in population size and the factors that regulate population size such as:

Inflow: births, immigration.

Overflow: lower recruitment, higher mortality, poor conditions, increased emigration, and habitat degradation.

Outflow: Culling (to pick and destroy individuals e.g., seal, deer), predation, natural deaths, accidents, emigration. In other words, the way that the numbers and structure of an animal population vary over time and the factors which cause variations are described by population dynamics.

Characteristics of a Population
A population is a group of individuals of a single species living in the same general area. Members of a population rely on the same resources, are influenced by similar environmental factors and have a high likelihood of interacting with and breeding with one another. The characteristics of a population are: growth, density, distribution, carrying capacity and viable size.

Growth
Increase in the number of individuals of a population is called population growth. Consider what happens if a few individuals enter an unoccupied area. Assuming there is enough food and that predation and disease are not too severe, reproduction will occur and the number of individuals will increase. At first, there may be a large phase as the individuals settle into their new environment. As reproduction gets underway, the population shows exponential growth. The population size doubles at regular intervals. During exponential phase the population is said to grow geometrically.

Density
Density is the number of individuals per unit area e.g., number of mulberry trees per square kilometer in Islamabad or the number of E.coli bacteria per milliliter in a test tube.
**Distribution**
The dispersion of individuals in a population is called distribution. There are three distribution patterns found in different populations like clumped (individuals aggregate in patches), uniform (individuals are evenly spaced) or random distribution (unpredictable spacing among individuals).

**Carrying Capacity**
There is a limit to the number of individuals that can occupy a habitat. The carrying capacity is defined as the maximum population size that a particular environment can support. Carrying capacity is not fixed but varies over space and time with the abundance or limiting resources.

![Parent Status and Gender Graphs]

**Minimum Viable Population (MVP)**
It is the smallest biological population size that can exist without facing extinction due to natural disasters, breeding problems or random environmental fluctuations. Typically, however, MVP is used to refer solely to a wild population such as the red wolf.

**Q10. What is the role of the department of population welfare, Government of Pakistan in controlling the growing population of Pakistan?**

**Answer**
Demography is the study of the vital statistics of population, how they change over time, problems related to population explosion and its effect on a overall environment. If we look at the global human population we find that each day the world population increases by over 200,000 demanding the equivalent of a new city for more than a million inhabitants every week. The total crossed seven billion in October 2011 and
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will almost certainly reach eight billion in 2025.

Problems Related to Rapid Growth in Human Population (population explosion)

As the world population continues to grow geometrically, great pressure is being placed on arable land, water, energy, and biological resources to provide an adequate supply of food while maintaining the integrity of our ecosystem. Following problems gradually appeared due to rapid growth in human population.

Insufficiency of food: According to the World Bank and United Nations, from 1 to 2 billion humans are now malnourished, indicating a combination of insufficient food, low incomes and inadequate distribution of food. This is the largest number of hungry humans ever recorded in history. In China, about 80 million are now malnourished and hungry.

Consumption of resources: With increase in population the consumption of resources is also increased rapidly such as reduction in food supply, less availability of suitable space for living, depletion in non-renewable energy resources, like certain metals and fossil fuels, and reduction in water supply.

Control of Population Growth in Pakistan

The Ministry of population welfare, Government of Pakistan is responsible for the control of population growth in Pakistan. Population Welfare Program (PWP) is an ongoing program launched by the ministry of population, Pakistan since 1960. The first ever Population Policy in Pakistan was announced on 11th July, 2002. The Population Policy is wide in scope. It states a commitment to reduce the incidence of unwanted fertility, promote small family norm, make an investment in youthful population and focus on male enrollment. The overall vision of Population Policy is to achieve population stabilization replacement level i.e., a total fertility rate 2:1 children per woman by 2020. Increase awareness of adverse of adverse consequences of rapid growth at the national, provincial, district and community level and promote family planning as an entitlement based on informed and voluntary choice and attain reduction in infertility.

The Department of Population Welfare is providing Family Planning and Reproductive Health Services through various programs.

1) Family Welfare Centers.
2) Mobile Service Units,
3) Reproductive Health Services (RHS) Centers are being run by Various NGOs with assistance of the Population Welfare Department.

Q11. Investigate the effects of human population growth on the environment and the quality of life.

Answer

Population growth effects environment and quality of life in following ways:

a) Inadequate fresh water.

b) Depletion of natural resources.
Q12. How acid rain is produced? What are the causes and effects of acid rain?

**Answer**

The water in the atmosphere has become polluted with Sulphur dioxide of nitrogen. The gases react with water vapour and oxygen in the air. Sulphuric acid and nitric acid are formed. The water vapour with its contents becomes part of a cloud. The water vapour condenses and fall to Earth as acid rain which may be hundreds of miles away from the source of pollution. The acid precipitation also falls as snow or as dry micro particles, mixing with water when it reaches surface on the ground. (Fig:)

![Diagram showing the process of acid rain formation and deposition](image)

**Cause of Acid Rain**

Although Sulphur and nitrous oxides are produced naturally during volcanic eruption and forest fires, humans produce more than half of these chemicals from burning of coal by electricity generating plants, industrial boilers and large smelters that obtain
metals from ores. In addition, nitrogen oxides are emitted by automobiles.

**Effects of Acid Rain**
Some of the effects of acid rain are:

a) It increases soil acidity.

b) Acid rain damages life in farms and forests.

c) It kills aquatic organisms and prevents their successful reproduction.

d) It also increases the quantity of certain metals such as Aluminum that may prove toxic to many organisms in the ecosystem.

e) Acid rain causes extensive damages to buildings and stone structures which is known as stone cancer. For example Taj Mahal (build by Mughal King Shahjahan) at India is eroding due to fumes released by oil refinery.

f) Acid rain adversely affects nervous, respiratory and digestive system of man

![Image showing effects of acid rain](image)

**Figure: Showing effects of an Acid rain on living organisms and property**

**Q13.**

a) **What is the composition of ozone layer? What is its role in protecting the life on Earth?**

b) **What are the sources of chlorofluorocarbons and their role in the depletion of ozone?**

**Answer**

Ozone is a highly reactive molecule that contains three atoms. It is constantly being formed and broken down in the high atmosphere, 6.2 to 31 miles (10 to 50 kilometers) above Earth, in the region called the stratosphere. Today, there is widespread concern that the ozone layer is deteriorating due to the release of pollution containing the chemicals chlorine and bromine.

**Composition of Ozone Layer**
It is a layer of atmosphere extending from 10 to 50 kilometers (6 to 30 miles) above Earth. In pure from, ozone is a bluish, explosive and highly poisonous gas. Ozone is a form of oxygen that is human-made pollutant in the lower atmosphere. In the stratosphere, the normal concentration of ozone is about 0.1 part per million, compared with 0.02 part per million in the lower atmosphere. This ozone enriched layer is called the ozone layer.

**Formation of Ozone Layer**
A small fraction of the radiant energy produced by the sun is called ultraviolet or UV radiation. Ozone is formed in the atmosphere when ultraviolet radiation from the Sun split one oxygen molecules into two oxygen atoms. The atomic oxygen then combines
with another oxygen molecule to form ozone (O₃).

b) **Causes of Ozone Layer Depletion**
Most of the UV radiations are filtered out by ozone in the stratosphere. In the stratosphere, there is a group of commercially important compounds called chlorofluorocarbons (CFCs). These have been used as propellants in aerosol cans, coolants (e.g., Freon) in air conditioners and refrigerators, foam (e.g., Styrofoam) for insulation and packing and cleaners in the electronic industry. Ultraviolet radiation breaks CFCs and similar compounds into chlorine, fluorine and carbon. Under certain stratospheric conditions, chlorine and fluorine are capable of reacting with ozone, converting it into molecular oxygen (Fig: 25.11).

![Diagram of Ozone Layer](image)

**Role of Ozone Layer in Protecting the Life on Earth**
In 1985, English scientist Joe Farman discovered that the spring time levels of stratospheric ozone over Antarctica had declined by over 40% since 1977. A hole had been punctured in Earth’s protective shield. Ozone molecules in the stratosphere absorb incoming solar ultraviolet radiation and this protects life on Earth.

**Effects of Ultra Violet Radiation on Human Health**
With depletion of the ozone layer, UV radiations reach Earth’s surface. Excessive exposure to UV radiation is linked to a number of human health problems, including sunburn, premature ageing of skin, skin cancer and cataracts. Photosynthesis by phytoplankton is also affected and reduced by ultraviolet radiation.

Q14. **Describe conventional and non-conventional energy resources; also explain the causes of resource depletion.**

**Answer**
The energy sources are categorized into two types i.e. conventional and non-conventional.
**Conventional Energy Sources**

The energy source that has been used from ancient times is called conventional sources of energy. The examples of conventional energy sources are fossil fuels (coal, natural gas, oil), firewood, and sources of energy i.e., electricity are coal, oil, wood, peat and uranium.

The advantages of conventional source of energy e.g., fossil fuels are that these are inexpensive and require established technologies that can produce energy around the clock. The disadvantages of conventional sources of energy are that have a limited supply because eventually the nuclear elements and fossil fuels will be used up. In addition, burning fossil fuels release significant amounts of greenhouse gases and contribute to acid rain.

Fossil fuels include coal, oil and gas. They provide 95% of the energy requirement. They are nonrenewable. They are called fossil fuels because they are remains of plants and animals that lived millions of years ago.

Nuclear energy is the energy obtained by fission of radioactive atoms. This energy is used to produce electricity in nuclear reactors. The primary nuclear fuel is $^{235}$U. The advantage of nuclear energy is that it emits large amount of energy. The disadvantages are that it generates radioactive waste and is expensive.

**Non-conventional Energy Source**

Non-conventional energy sources or unusual sources of energy are the new sources of energy which are still not in common use. Their contribution to the national power is nominal. These are: solar power, hydro-electric power (dams on rivers), wind power, tidal power, ocean wave power, geothermal power (heat from deep under the ground), Ocean thermal power (the different in heat between shallow and deep water), biomass (burning of vegetation to stop it producing methane), Bio-fuel producing ethanol petroleum, from plants. Bio-gas. It is also known as renewable energy sources.

The advantages of non-conventional source of energy are that these are abundant in nature pollution free and eco-friendly. These sources can be renewed with minimum effort and energy. The disadvantages of nonconventional energy sources are that these are often limited to producing energy only under certain circumstances such as sunny days for solar panels and windy days for windmills.

**Depletion of Resources**

Resource depletion is referring to the exhausting of raw materials within a region. Resources are commonly divided between renewable resources and non-renewable resources. Use of either of these forms of resources beyond their rate of replacement is considered to be resource depletion.

**Cause of Resource Depletion**

Man is the main cause of resource depletion. His activities are continuously consuming natural environmental resources with the pace beyond the pace of their renewal. The factors through which man is depleting natural resources include over-consumption/excessive or unnecessary use of resources, non-equitable distribution of resources, overpopulation, slash and burn agricultural practices, technological and industrial development, erosion, irrigation, mining for oil and minerals and pollution or
Q15. Discuss the efforts of various government department and NGOs to educate people for the protection of environmental resources.

Answer
Natural resources are vital to our existence. Our health and well-being is closely linked to the quality of our air, water, soils and biological resources. Our landscapes, seascapes and wildlife are inseparable from our culture and inspire art and literature. Our economy and key industrial sectors are directly and indirectly reliant on functioning ecosystems. Many people believe that natural resources have their own intrinsic value, that is, they are important for their own sake regardless of their functional value.

Role of Government
The government control and develop all the country’s forests, dams, major irrigation system, power stations, railways, ports, roads, mines and industries. The ministry of environment is entrusted with planning, protection and coordination of environment and forestry programmes. The ministry is involved in conservation and survey of flora, fauna, forests and wildlife, prevention and control of pollution, afforestation, regeneration of degraded areas and protection of overall environments. The assessments of environmental impact prior to implementing any project which can damage environment is taken up by ministry of environment. To educate the people every year, Earth day on 22nd of April and tree plantation week are observed.

Role of NGOs
NGOs can play a very important role in environmental protection and management and creating mass awareness towards environment. They have made people aware of the environmental problems, which are caused due to neglect and uncontrolled exploitation of natural resources. Some of the NGOs are working for environmental awareness while some are working in research field.

Q16. Justify why science education has become necessary for everyone to understand the basis of mans continued existence and the steps man has to save and improve life?

Answer
People must be educated to: Pay attention to how you use water. Leave your car at home. Walk or ride your bike to work, school and anywhere you can. Turn off lights when you’re not in the room and unplug appliances when you’re not using them. Use CFC free products. Use renewable energy sources. Switch to compact florescent or LED light bulbs. Reuse means instead of throwing things away; try to find ways to use them again. For example we can use glass bottles after sterilization. Recycle means regeneration of waste materials into other useful items. For example any of the things we use every day, like paper bags, soda cans, and milk cartons, are made out of materials that can be recycle.
Q17. Investigate the effects of human population growth on the environment and the quality of life.

Answer
Population growth affects environment and quality of life in following ways:

a) Inadequate fresh water.
b) Depletion of natural resources.
c) Increased levels of air pollution, water pollution, and soil contamination.
d) Deforestation and loss of ecosystems.
e) Changes in atmospheric composition and consequent global warming.
f) Irreversible loss of arable land and increase in deforestation, mass species extinction.
g) High infant and child mortality. Increased chance of the emergence of new epidemics and pandemics, starvation and malnutrition.
h) Poverty coupled with inflation in some region and a resulting low level of capital formation.
i) Low life expectancy occurs in countries with fastest growing populations.

Q18. Outline the advances in medical care and technology that have contributed to an increase in life expectancy, and relate these developments to demographic issues.

Answer
Advances in medical care and technology have contributed to an increase in life expectancy during maternity cases. A good example of how advances in technology have health outcomes over time is in the treatment of pre-term babies. Changes in technology, including special ventilators, artificial pulmonary surfactant to help infant lungs develop, neonatal intensive care and steroids for mother and/or baby, helped decrease mortality, with an overall increase in life expectancy of low-birth weight baby. On one hand, it is beneficial aspect of advances in medical care and technology but on the other hand, it is suspended to be one of the cause of rapid growth of population.

Q19. Justify why science education has become necessary for everyone to understand the basis of man’s continued existence and the steps man has taken to save and improve life?

Answer
People must be educated to: Pay attention to how you use water. Leave your car at home. Walk or ride your bike to work, school and anywhere you can. Turn off lights when you’re not in the room and unplug appliances when you’re not using them. Use CFC free products. Use renewable energy sources. Switch to compact fluorescent or LED light bulbs. Reuse means instead of throwing things away, try to find ways to use them again. For example we can use glass bottles after sterilization. Recycle means regeneration of waste materials into other useful items. For example any of the things we use every day, like paper bags, soda cans, and milk cartons, are made out of materials that can be recycles.
Q20. What do you mean by trophic levels?

Answer

**Concept of Trophic Levels**

In an ecosystem the organisms are arranged indifferent feeding groups, each is known as trophic level. At the first level (T1), primary producers (plants, algae and some bacteria) use solar energy to produce organic plant material through photosynthesis. Herbivores or primary consumers make up the second trophic level (T2). Predators, the secondary consumers that eat herbivores comprise the third trophic level (T3); if larger predator i.e., tertiary consumers are present, they represent still higher trophic levels. Organisms that feed at several trophic levels (omnivores) are classified at the highest of the trophic levels (T4) at which they feed. Decomposers, which include bacteria, fungi, molds, and detritivores such as worms, and insects, breakdown wastes and dead organisms and return nutrients to the soil, occupy the fifth tropic level (T5).

![Energy flow through terrestrial food webs](image)

Q22. Write a note on human’s impact on environment, with reference to nuclear power and global warming.

Answer

**Human Impacts on Environment**

Humans are a part of the natural environment. Population growth leads to the loss of natural habitat. Deforestation causes loss of species of fauna and flora, oxygen production and carbon dioxide elimination. Ozone layer depletion, water pollution, global warming, densification, increased erosion of land, is directly caused by human activities such as use of nuclear fuel, industrialization, urbanization, transportation etc..

**Nuclear Power**

Nuclear power is the use of sustained nuclear fission to generate heat and electricity. As reported in 2005, nuclear power provided 6.3% of the world’s energy and 15% of the world’s electricity. The scarcity of fossil fuels which is not available in all the countries, is the reason for the development nuclear power stations. (Fig:)

---
Advantages of Nuclear Power

a) Nuclear power costs about the same as coal, so it’s not expensive to make.
b) Does not produce smoke or carbon dioxide, so it does not contribute to greenhouse effect.
c) Produces huge amounts of energy from small amounts of fuels.
d) Produces small amounts of waste.
e) Nuclear power is reliable.

Disadvantages of Using Nuclear Power
The two main problems using nuclear powers are surety of safe operation and safe disposal of the wastes.

Surety of Safe Operation
To achieve optimum safety, in nuclear plants prevention, monitoring and action i.e., to mitigate consequences of failures are followed: These are: (a) High-quality design and construction. (b) Comprehensive monitoring and regular testing to detect equipment of operator failures, (c) Prevention of significant radioactive releases.

Safe Disposal of the Wastes
Radioactive wastes are wastes that contain radioactive material. Nuclear waste is a cause for concern because it is not bio-degradable, meaning it does not decompose naturally under the effect of the atmosphere. Secondary, it causes a number of health hazard for anyone who comes into contact with the radiation from this waste. Therefore, some measure should be used for disposal of nuclear waste which may include deep ocean disposal geological burial, nuclear waste recycling reprocessing.
and solidification process.

**Carbon Dioxide and Global Warming**

Due to various human activities such as burning of fossil fuel in motor vehicles and industrial process, amount of CO₂ increases in atmosphere. CO₂ absorbs high energy radiation and thus result in increase in atmospheric temperature. This rise in temperature is known as global warming. (Fig: )

![The Greenhouse Effect](image)

Figure: Showing Causes of increasing concentration of CO₂ in atmosphere

**Causes of Increasing Concentration of CO₂ in Atmosphere**

Human activities are mainly responsible for increasing the amount of CO₂ in the atmosphere. Burning of fossil fuels, such as coal and natural gas for industry, driving our transport, heating our homes and generating electricity are the major sources of human emission. The burning of wild lands, forests are increasing CO₂ in the atmosphere. Deforestation does increase the amount of CO₂. There has been a marked increase in the CO₂ percentage in the atmosphere since industrial revolution. Though it is not the main cause, humans and other animals also increase CO₂ in the atmosphere as they breathe out CO₂. In addition, eruption of volcanoes off and on, is another cause to increase of CO₂ in the world atmosphere.

**CO₂ Concentration and the Global Warming**

At the moment, the amount of CO₂ in the air is increasing. It makes up about 0.04% of the air now, compared with 0.03% in the mid-twentieth century. What does this matter? It is very likely that the raised atmospheric CO₂ levels are causing the average temperature on Earth to increase, a process called global warming or greenhouse effect. CO₂ is one of a number of greenhouse gases.

**Long Term Effects of Global Warming**

The more carbon dioxide there is in the atmosphere, the more reflected infra-red radiation is trapped and the warmer the Earth becomes. An increase of only 1.3°C would make the world warmer than at any time in the past 100,000 years. A worst-case
scenario suggests that the warming would be great near the poles. The resultant melting of polar ice might raise sea level by an estimated 109 m, gradually flooding areas 150 km (or more) inland from the current coastline. A warming trend would also alter the geographical distribution of precipitation, making major agricultural areas drier.

**KEY POINTS**

- **Ecology:** The branch of biology dealing with the relations and interactions between organisms and their environment, including other organisms.
- The movement of nutrients in the ecosystem is cyclic one. This flow of nutrients from environment to the organisms and back to the environment is called the biogeochemical cycle.
- When rain water falls, some of the water sinks or percolates into the ground and saturates the earth to a certain level. The top of the saturation zones is called water table. Whenever the Earth contains basin or channels, water will appear to the level of the water table. The water within the basin is called lakes and ponds and water within channels is called streams or rivers. Sometimes ground water is also located in underground rivers called aquifers.
- Decomposition of organic nitrogen compounds is the first source of soil nitrates. It occurs in two steps: (a) ammonification (b) nitrification
- The amino acids are converted into ammonia or ammonium ions. Production of ammonia or ammonium compounds in the decomposition of organic matter by microorganisms is called ammonification.
- Some ammonia escapes into the soil but much of it and ammonium ions are converted into nitrates by nitrifying bacteria. It is accomplished by two groups of nitrifying bacteria. the first group of bacteria e.g., Nitrosomonas converts ammonia to nitrates and the second group of bacteria e.g., Nitrobacter converts nitrates to nitrates. This process is called nitrification.
- The ultimate source of energy for our ecosystem is sun (solar energy). Only 1% of solar energy is incorporated into the ecosystem. The total amount of solar energy which is fixed by the producers during photosynthesis is called gross primary productivity (GPP).
- On the other hand the amount of energy that remains available for plants growth after subtracting the fraction that plants use for respiration is termed as Net primary productivity (NPP) or biomass.
- Earlier species are replaced by later species because the replaced species are better able to grow and reproduce under ecological succession. Individual successions are known as seres and the development phases are called seral stages.
- Primary succession is the change in species composition over time in a habitat that was not previously inhabited by organisms. Bare rock surface, such as recently formed volcanic lava and rock scraped clean by glaciers, are examples of sites where primary succession might occur.
- Secondary succession is the change in species composition over in a habitat already