Biogeochemical Cycles: The non loss of energy in the ecosystem is achieved through recycling of materials via biogeochemical cycling. Biogeochemical cycling is a cyclic movement of materials/nutrients from the different points of the ecosystem. In such a movement, nutrients stored in a particular part (reservoir) of the ecosystem are taken to other parts of the ecosystem and after such are brought back to the reservoir. Such involves transformation of the nutrients from organic to inorganic forms (or vice versa) or from the elemental to compound forms (or vice versa). It may also involve the nutrients moving the biotic to abiotic component of the ecosystem. The nutrients may be transformed from solid to liquid and to gaseous form or vice versa. In biogeochemical cycling, the nutrients pass through the living organisms, as well as through soil, air, water and rock. Biogeochemical cycling is essential for continuous availability of nutrients in the ecosystem and to ensure sustenance of the ecosystem. Nitrogen, carbon, water, phosphorus and sulfur are some examples of nutrients involved in biogeochemical cycling.

Nitrogen cycle: This is a biogeochemical cycle which is divided into four stages; nitrogen fixation, ammonification, nitrification and denitrification. **Nitrogen Fixation**: changing of elemental nitrogen to absorbable compound nitrogen. This may involve biological processes (through nitrogen fixing bacteria like Azotobacter, Clostridium, Rhizobium) and non-biological processes (through thunderstorm). Nitrogen fixation can also be taken artificially through the production of nitrogen fertilizer (e.g. Haber process). **Ammonification**: Production of ammonia (ammonium salts) from dead organisms or excretory products. Ammonium products can also be produced through the activities of nitrogen fixing bacteria and decomposing bacteria and fungi. **Nitrification**: An oxidation process that leads to converting nitrogen to nitrate. Nitrogen is first converted to nitrite and nitrite to nitrate. Nitrification may also involve the conversion of ammonia to nitrite (through the activities of Nitrosospira and Nitrosomonas) and nitrite to nitrate (through the activities of (Nitrobacter). Conversion of nitrite to nitrate in the marine habitat is accompanied by the activities of Nitrococcus. This process requires oxygen and occurs rapidly in well aerated soils or well oxygenated water bodies. **Denitrification**: A reduction process that breaks down nitrates to nitrogen gas. It involves the conversion of nitrate to nitrite, nitrite to nitrous oxides and then to nitrogen. It is facilitated by denitrifying bacteria like Pseudomonas denitrificans and Thiobacillus denitrificans. It leads to loss of nitrogen from the biotic component of the ecosystem to the atmosphere.

Carbon cycle: this Involves carbon fixation which occurs through photosynthesis where atmospheric carbon dioxide is converted to sugars. The sugar is stored in the plant tissues as food. Carbon in plants is passed on to the consumers through feeding. Carbon in plants and animals is released to the atmosphere in the form of carbon dioxide through respiration. Carbon in plants and animals (carbonates) is released to the soil/water through decomposition. The carbonate in soil returns back to the plants through absorption. Carbon can be leached to the underground to form sediments/fossil fuels.

Water cycle: the aquatic ecosystems (the seas, oceans, streams, rivers, lakes and ponds) serve as water reservoirs where it exists as liquid. Water from these reservoirs is taken up to the atmosphere as gas through evaporation. The water condenses and falls to the earth through rainfall. The water that fell is collected either as surface water or can seep into the soil as underground water. The surface water can evaporate back to the atmosphere or is taken by animals or aquatic plants. The underground water can be taken up by plants and can be passed on to animals or to the atmosphere through transpiration.

ECOLOGICAL INTERACTIONS

Ecological Interactions: Deals with relationships existing between or among organisms. It can be for shelter, food, reproduction and/or struggling for existence. It can be between plants (plant-plant), between animals (animal-animal), between plant and animal (plant –animal), between plants and microbes (plant-microbe), between animals and microbes (animal-microbe) or between microbes (microbe-microbe). Ecological interactions can also exist between biotic and abiotic components of an ecosystem. It can produce positive (+), negative (-) or no detectable effect (0). Such effects can be on either of the interacting partners or on both partners. In some cases, the partners may have mixed effects with one having positive effect and the other negative or neutral effect. The positive effect shows that the partner(s) benefit or is enhanced by the interaction, the negative effect shows that the partner(s) is inhibited/harmed or losses due to the interaction while the neutral (no detectable effect) shows that the partner(s) does not have any effect from the interaction. The following key ecological interactions outline different types of interactions between two individuals in an ecosystem, categorized by their effects on each individual. **Key Interactions: Neutralism:** Neither species is affected by the interaction. For instance, a deer and a squirrel living in the same forest may coexist without directly impacting each other. **Mutualism:** Both species benefit from the interaction. A classic example is the relationship between bees and flowers. Bees obtain nectar, while flowers are pollinated, ensuring the production of seeds. **Protocooperation:** Similar to mutualism, both species benefit, but the interaction is not obligatory. For instance, a bird may clean a crocodile's teeth, removing parasites. While both benefit, neither relies solely on the other for survival. **Commensalism:** One species benefits, while the other is unaffected. A common example is a bird nesting in a tree. The bird benefits from the shelter, while the tree remains unaffected. **Amensalism:** One species is harmed, while the other is unaffected. This can occur when a large tree shades a smaller plant, preventing it from receiving sunlight. **Parasitism:** One species (the parasite) benefits, while the other (the host) is harmed. Ticks feeding on a dog's blood are a prime example. **Predation:** One species (the predator) kills and consumes another species (the prey). A lion hunting a gazelle is a classic predator-prey relationship. **Allelopathy:** One organism produces chemicals that inhibit the growth or survival of another organism. For instance, some plants release chemicals into the soil to prevent competitors from growing nearby. **Competition:** Both species are harmed as they compete for the same limited resources. For example, two species of birds competing for the same insects in a specific area.

The following are terms beyond fundamental ecologies. **Molecular Ecology:** The important relationship between ecology and genetic inheritance predates modern techniques for molecular analysis. Molecular ecological research became more feasible with the development of rapid and accessible genetic technologies, such as the polymerase chain reaction (PCR). Molecular ecology uses various analytical techniques to study genes in an evolutionary and ecological context. **Applied Ecology**: Using ecological principles to maintain conditions necessary for the continuation of present day life on earth. **Industrial Ecology**: The design of the industrial infrastructure such that it consists of a series of interlocking "technological ecosystems" interfacing with global natural ecosystems. Industrial ecology takes the pattern and processes of natural ecosystems as a design for sustainability. It represents a shift in paradigm from conquering nature to becoming nature. **Ecological Engineering**: Unlike industrial ecology, the focus of Ecological Engineering is on the manipulation of natural ecosystems by humans for our purposes, using small amounts of supplemental energy to control systems in which the main energy drives are still coming from non-human sources. It is the design of new ecosystems for human purposes, using the self-organizing principles of natural ecosystems. [Note: The popular definition of ecological engineering is "the design of human society with its natural environment for the benefit of both."]. **Ecological Economics**: Integrating ecology and economics in such a way that economic and environmental policies are reinforcing rather than mutually destructive. **Urban ecology**: For ecologists, urban ecology is the study of ecology in urban areas, specifically the relationships, interactions, types and numbers of species found in urban habitats. Also, the design of sustainable cities, urban design programs that incorporate political, infrastructure and economic considerations. **Conservation Biology**: The application of diverse fields and disciplines to the conservation of biological diversity. **Restoration Biology**: Application of ecosystem ecology to the restoration of deteriorated landscapes in an attempt to bring it back to its original state as much as possible. Example, prairie grass. **Landscape Ecology**: "Landscape ecology is concerned with spatial patterns in the landscape and how they develop, with an emphasis on the role of disturbance, including human impacts" (Smith and Smith). It is a relatively new branch of ecology that employs Global Information Systems. The goal is to predict the responses of different organisms to changes in landscape, to ultimately facilitate ecosystem management. **Production ecology**: deals with gross and net production in different ecosystems like freshwater, sea water, cropland, etc. Production ecology also uses proper management of the ecosystem in order to obtain maximum yield from them. **Human ecology** may be defined: (1) from a bio-ecological standpoint as the study of man as the ecological dominant in plant and animal communities and systems; (2) from a bio-ecological standpoint as simply another animal affecting and being affected by his physical environment; and (3) as a human being, somehow different from animal life in general, interacting with physical and modified environments in a distinctive and creative way. **Ecological genetics** is the study of how ecologically relevant traits evolve in natural populations. It is thus a point of view in which awareness of variability among organisms is involved in the study of all kinds of ecological interactions, both biotic and abiotic. Ecological geneticists increasingly explore how evolutionary dynamics shape ecological properties. As a consequence, ecological genetics is highly relevant to practical questions that lie at the interface of ecology and evolution. **Ecological Genomics** refers to the use of any genome-enabled approach, whether aimed at discovering the ecological functions of single or multiple genes. It can be defined as an integrative field of study that seeks to understand the genetic mechanisms underlying responses of organisms to their natural environment. These responses include modifications of biochemical, physiological, morphological, or behavioral traits of adaptive significance.

The following are careers in ecological studies. **Ecologists** help people understand the connection between living things and their environment. There are many fields in ecology, including animal behavior, population biology, conservation biology and marine ecology. Within these fields there are many amazing careers to pursue on land and sea. Ecologists must be really curious about how life works on earth. **Ecoinformatics Specialists** use computers and other advanced technologies to manage the vast amounts of information that are gathered from scientific observation. Ecoinformatics is a pretty new field in ecology, and there are a lot of opportunities to apply computer skills like programming to help other ecologists and land managers organize their information and make sense of it. **Ecotoxicologists** study the effects of chemicals or other stresses on plants and animals. Their research helps policy makers to set environmental standards so that humans do not release harmful chemicals into the environment. Ecotoxicologists usually have training in chemistry and physiology. **Environmental Consultants** look at the ecological impacts of development or conservation. They also recommend different methods to solve ecological problems. Environmental consultants may spend a lot of time outside, as well as writing reports and talking to policy makers, and they can work on many different types of projects. **Environmental Economists** try to translate environmental issues into money. It is pretty new for lawmakers to have to compare environmental costs to business costs when they are making decisions about conservation. Environmental economists can help to answer questions such as: how much is this land worth if we do not develop it? **Environmental Educators** teach students and adults about nature, new discoveries, and the ecological problems we are facing today. **Environmental Lawyers** specialize in legal issues that concern environmental problems, such as helping to find compromises between people who want land conserved for nature and those who would like to develop land for businesses.. Environmental lawyers have advanced degrees in law and sometimes also in natural sciences or business. **Research Assistants** collect and analyze results from field and lab studies. Generally college and high school students are encouraged to explore working as research assistants. Here in Santa Barbara, and at other universities, there is a large demand for research assistants and it's a good opportunity for students to find out whether or not they like research! **Research Scientists** usually work in groups and come up with new questions, ideas and techniques to solve ecological problems facing the world today. These are the people that need research assistants to help them with their research. **Professors** teach at colleges, universities, and sometimes high schools. They also do research, and guide graduate and undergraduate students. **Program Managers** find ways to use information from research assistants, research scientists, and professors to manage environmental resources and help policy makers understand the ecological problems we are facing today. **Science Writers** write about scientific discoveries, issues, and problems. They write for magazines, newspapers, books and the web. Some science writers specialize in writing about the environment.