NATIONAL OPEN UNIVERSITY OF NIGERIA

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCES

COURSE CODE: EHS202

COURSE TITLE: INTRODUCTION TO ECOLOGY AND ENVIRONMENTAL SCIENCE

COURSE GUIDE

EHS202: INTRODUCTION TO ECOLOGY AND ENVIRONMENTAL SCIENCE

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COURSE GUIDE

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Introduction

EHS202 titled “Introduction to ecology and environmental science” is a two (2) unit course with three (3) modules and nine (9) units. Ecology’ is the scientific study of the inter-relationship of living organisms - plants, animals and microbes with each other and with their physical environment. It mainly concerns with the directive influences of abiotic and biotic environmental factors over the growth, distribution, behavior and survival of organisms. In other words, ‘Ecology’ is the science which investigates organisms in relation to their environment and a philosophy in which the world of life is interpreted in terms of natural processes.

What you will learn in this course

In this course, you have the course units and a course guide. The course guide will tell you what the course is all about. It is general overview of the course materials you will be using and how to use those materials. It also helps you to allocate the appropriate time to each unit so that you can successfully complete the course within the stipulated time limit.

The course guide also helps you to know how to go about your Tutor-Marked Assignment which will form part of your overall assessment at the end of the course. Also, there will be regular tutorial classes that are related to this course, where you can interact with your facilitator and other students. Please, I encourage you to attend these tutorial classes.

Course Aim

The course aims to give you a understanding of Ecology which an important branch of Biology.

Course Objectives

To achieve the aim set above, there are objectives. Each unit has a set of objectives presented at the beginning of the unit. These objectives will give you on what to concentrate / focus on while studying the unit. Please read the objective before studying the unit and during your study to check your progress.

The comprehensive objectives of the Course are given below. By the end of the course/after going through this course, you should be able to:

i. Define the term Ecology
ii. Its characteristics and importance
iii. Know the Etymological meaning of the term Environment.
iv. Know the importance of Environment and how it influence the animals chances of survival.
v. What the term Environment denotes.
vi. Define the term Hydrologic cycle
vii. Give a schematic diagram of water cycle.
viii. To explain the term ammonification
ix. The definition of an Ecosystem
x. characteristics of an Ecosystem
xi. factors forming the environment
xii. Insight and approaches of population Ecology, Community Ecology, and Evolutionary biology.

xiii. An idea between biological organisms and their abiotic environment, especially at relatively large spatial scales.

xiv. At the end of this unit, you will learn the difference between food chain and food web.

xv. Energy loss in the Food chain and food web.

xvi. To know the interdependence of animals and plants

xvii. To know the intra-specific relationship

xviii. Succession, types and processes of Biotic succession

xix. At the end of this unit, you will learn how energy can be transferred in form of sunlight or chemical compounds.

xx. And also how some organisms use this energy to make food

xxi. At the end of this unit, you will know the importance of Food web

xxii. You will be able to know the two global webs.

xxiii. Also a schematic diagram of food web

Working through this course

To successfully complete this course, you are required to read each study unit, read the textbooks materials provided by the National Open University of Nigeria. Reading the referenced materials can also be of great assistance. Each unit has self-assessment exercises which you are advised to do and at certain periods during the course you will be required to submit your assignment for the purpose of assessment.

There will be a final examination at the end of the course. The course should take you about 17 weeks to complete. This course guide will provide you with all the components of the course how to go about studying and hour you should allocate your time to each unit so as to finish on time and successfully.

The Course Materials

The main components of the course are:

- The Study Guide
- Study Units
- Reference / Further Readings
- Assignments
- Presentation Schedule

Study Units

The study units in this course are given below:

MODULE 1 INTRODUCTION TO PRINCIPLES OF ECOLOGY

Unit 1: Basics of Ecology

Unit 2: Nature of our Environment

Unit 3: Biogeochemical cycles

MODULE 2 BASIC ENVIRONMENTAL CONCEPTS AND THEORIES

Unit 1: Basic Environmental concept

Unit 2: Microbial and parasite Ecology

Unit 3: Food chain

MODULE 3 BIOTIC COMMUNITIES AND ECOLOGICAL SUCCESSION

Unit 1: Biotic communities

Unit 2: Ecological succession

Unit 3: Relationship and Interdependence of organisms

There are activities related to the lecture in each unit which will help your progress and comprehension of the unit. You are required to work on these exercises which together with the TMAs will enable you to achieve the objectives of each unit.

Assignment File

There are two types of assessments in this course. First are the Tutor-Marked Assessments (TMAs); second is the written examination. In solving the questions in the assignments, you are expected to apply the information, knowledge and experience acquired during the course. The assignments must be submitted to your facilitator for formal assessment in accordance with prescribed deadlines stated in the assignment file. The work you submit to your facilitator for assessment accounts for 30 percent of your total course mark. At the end of the course, you will be required to sit for a final examination of 1½ hours duration at your study center. This final examination will account for 70 % of your total course mark.

Presentation Schedule

There is a time-table prepared for the early and timely completion and submissions of your TMAs as well as attending the tutorial classes. You are required to submit all your assignments by the stipulated time and date. Avoid falling behind the schedule time.

Assessment

There are three aspects to the assessment of this course.

The first one is the self-assessment exercises. The second is the tutor marked assignments and the third is the written examination or the examination to be taken at the end of the course.

Do the exercises or activities in the unit by applying the information and knowledge you acquired during the course. The tutor-marked assignments must be submitted to your

facilitator for formal assessment in accordance with the deadlines stated in the presentation schedule and the assignment file.

The work submitted to your tutor for assessment will count for 30% of your total course work. At the end of this course, you have to sit for a final or end of course examination of about a three hour duration which will count for 70% of your total course mark.

Tutor-Marked Assignments (TMAs)

This is the continuous assessment component of this course and it accounts for 30% of the total score. You will be given four (4) TMAs by your facilitator to answer. Three of which must be answered before you are allowed to sit for the end of course examination.

These answered assignments be returned to your facilitator. You're expected to complete the assignments by using the information and material in your readings references and study units. Reading and researching into you references will give you a wider via point and give you a deeper understanding of the subject.

1. Make sure that each assignment reaches your facilitator on or before the deadline given in the presentation schedule and assignment file. If for any reason you are not able to complete your assignment, make sure you contact your facilitator before the assignment is due to discuss the possibility of an extension. Request for extension will not be granted after the due date unless there in exceptional circumstances.

2. Make sure you revise the whole course content before sitting or the examination. The self-assessment activities and TMAs will be useful for this purposes and if you have any comment please do before the examination. The end of course examination covers information from all parts of the course.

Course Marking Scheme

Assignments	**Marks**
Assignments 1 – 4	Four assignments, best three marks of the four count at 10% each = 30% of course marks.
End of course examination	70% of overall course marks
Total	**100% of course materials**

Table 2: Course Organisation

Unit	**Title of Work**	**Weeks Activity**	**Assessment (End of Unit)**
	Course Guide	**Week**	
1	Basics of Ecology	Week 1	Assignment 1
2	Nature of our Environment	Week 2	Assignment 2
3	Biogeochemical cycles	Week 3	Assignment 3
4	Basic Environmental concept	Week 4	Assignment 4
5	Microbial and parasite Ecology	Week 5	Assignment 5
6	Food chain	Week 6	Assignment 6
7	Biotic communities	Week 7	Assignment 7
8	Ecological succession	Week 8	Assignment 8
9	Relationship and Interdependence of organisms	Week 9	Assignment 9

How to Get the Most Out of This Course

In distance learning, the study units replace the university lecturer. This is one of the huge advantages of distance learning mode; you can read and work through specially

designed study materials at your own pace and at a time and place that suit you best. Think of it as reading from the teacher, the study guide tells you what to read, when to read and the relevant texts to consult. You are provided exercises at appropriate points, just as a lecturer might give you an in-class exercise.

Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit and how a particular unit is integrated with the other units and the course as a whole. Next to this is a set of learning objectives. These learning objectives are meant to guide your studies. The moment a unit is finished, you must go back and check whether you have achieved the objectives. If this is made a habit, then you will significantly improve your chances of passing the course.

The main body of the units also guides you through the required readings from other sources. This will usually be either from a set book or from other sources.

Self-assessment exercises are provided throughout the unit, to aid personal studies and answers are provided at the end of the unit. Working through these self-tests will help you to achieve the objectives of the unit and also prepare you for tutor marked assignments and examinations. You should attempt each self-test as you encounter them in the units.

The following are practical strategies for working through this course

1. Read the Course Guide thoroughly.

2. Organize a study schedule. Refer to the course overview for more details. Note the time you are expected to spend on each unit and how the assignment relates to the units. Important details, e.g. details of your tutorials and the date of the first day of the semester are available. You need to gather together all these information in one place such as a diary, a wall chart calendar or an organizer. Whatever method you choose, you should decide on and write in your own dates for working on each unit.

3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course works. If you get into difficulties with your schedule, please let your tutor know before it is too late for help.

4. Turn to Unit 1 and read the introduction and the objectives for the unit.

5. Assemble the study materials. Information about what you need for a unit is given in the table of contents at the beginning of each unit. You will almost always need both the study unit you are working on and one of the materials recommended for further readings, on your desk at the same time.

6. Work through the unit, the content of the unit itself has been arranged to provide a sequence for you to follow. As you work through the unit, you will be encouraged to read from your set books.

7. Keep in mind that you will learn a lot by doing all your assignments carefully. They have been designed to help you meet the objectives of the course and will help you pass the examination.

8. Review the objectives of each study unit to confirm that you have achieved them. If you are not certain about any of the objectives, review the study material and consult your tutor.

9. When you are confident that you have achieved a unit's objectives, you can start on the next unit. Proceed unit by unit through the course and try to pace your study so that you can keep yourself on schedule.

10. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments, both on the tutor-marked assignment form and also that written on the assignment. Consult you tutor as soon as possible if you have any questions or problems.

11. After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives (listed in this course guide).

Facilitators/Tutors and Tutorials

Sixteen (16) hours are provided for tutorials for this course. You will be notified of the dates, times and location for these tutorial classes. As soon as you are allocated a tutorial group, the name and phone number of your facilitator will be given to you.

These are the duties of your facilitator: He or she will mark and comment on your assignment. He will monitor your progress and provide any necessary assistance you need. He or she will mark your TMAs and return to you as soon as possible. You are expected to mail your tutored assignment to your facilitator at least two days before the schedule date.

Do not delay to contact your facilitator by telephone or e-mail for necessary assistance if You do not understand any part of the study in the course material. You have difficulty with the self-assessment activities. You have a problem or question with an assignment or with the grading of the assignment.

It is important and necessary you acted the tutorial classes because this is the only chance to have face to face content with your facilitator and to ask questions which will be answered instantly. It is also period where you can say any problem encountered in the course of your study.

Final Examination and Grading

The final examination for EHS 202: Introduction to Ecology and Environmental Science will be of 1½ hours duration. This accounts for 70 % of the total course grade. The examination will consist of questions which reflect the practice, exercises and the tutor-marked assignments you have already attempted in the past. Note that all areas of the course will be assessed. To revise the entire course, you must start from the first unit to

the twelfth unit in order to get prepared for the examination. It may be useful to go over your TMAs and probably discuss with your course mates or group if need be. This will make you to be more prepared, since the examination covers information from all aspects of the course.

Summary

Ecology is a course that introduces you to the scientific study of the inter-relationship of living organisms - plants, animals and microbes with each other and with their physical environment. It mainly concerns with the directive influences of abiotic and biotic environmental factors over the growth, distribution, behavior and survival of organisms. In other words, 'ecology' is the science which investigates organisms in relation to their environment and a philosophy in which the world of life is interpreted in terms of natural processes.

On completion of this course, you will have an understanding of basic knowledge of biodiversity, the history of men and women who contributed to this field of study by their discoveries during their research works, the general characteristics. In addition you will be able to answer the following questions:

- Define the term Ecology
- List some scientists that contribute to the success of Ecology
- Importance of Ecology
- Give the Etymological meaning of the term Environment
- Conditions that influence the living organism in the Environment.
- What are the divisions of Environment?

The list of questions are expected to answer is not limited to the above list. Finally, you are expected to apply the knowledge you have acquired during this course to your practical life.

I wish you success in this course!

EHS202 **INTRODUCTION TO ECOLOGY AND ENVIRONMENTAL HEALTH**

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MODULE 1 INTRODUCTION TO PRINCIPLES OF ECOLOGY

Unit 1: Basics of Ecology

Unit 2: Nature of our Environment

Unit 3: Biogeochemical cycles

UNIT 1: BASICS OF ECOLOGY

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1.0 INTRODUCTION

This unit on principle of Ecology tells us more about the term ECOLOGY starting from the definition itself to its characteristics and then finally its importance.

2.0 OBJECTIVES

At the end of this unit, you should be able to :

i. Define the term Ecology
ii. Its characteristics and importance

3.0 MAIN CONTENT

3.1 BASICS OF ECOLOGY

Ecology is the scientific study of the inter-relationship of living organisms - plants, animals and microbes with each other and with their physical environment. It mainly concerns with the directive influences of abiotic and biotic environmental factors over the growth, distribution, behaviour and survival of organisms. In other words, 'ecology' is the science which investigates organisms in relation to their environment and a philosophy in which the world of life is interpreted in terms of natural processes.

The term 'Environment', which etymologically means 'surroundings', is considered as a composite term for the conditions in which organisms live and, thus, consists of air, water, food and sunlight which are the basic needs of all living beings and plant life, to carry on their life functions. The environment also includes other living things, temperature, wind, electricity etc. In other words, environment consists of both biotic and abiotic substances. Environment creates favourable conditions for the existence and development of living organisms.

The term 'organism' refers to an individual unit constituted to carry on the activities of life. It is a dynamic biological unit which is greatly influenced by an enveloping and fluctuation environment. For a given organism, the 'environment' includes all the surrounding physical and biological factors with which it interacts. The 'factor' is any external force, substance, or condition that affects organisms in anyway. Thus,

environment is the sum total of everything that directly influences the animal's chances of survival and reproduction.

3.2 LEVELS OF ORGANIZATION

Ecologists study nature on different levels, from a local to a global scale. These levels, reveal the complex relationships found in nature.

i. **Organism:** An organism is an individual living thing, such as an alligator.

ii. Population: A population is a group of the same species that lives in one area, such as all the alligators that live in a swamp.

iii. **Community:** A community is a group of different species that live together in one area, such as groups of alligators, turtles, birds, fish, and plants that live together in the Florida Everglades.

iv. **Ecosystem:** An ecosystem includes all of the organisms as well as the climate, soil, water, rocks, and other nonliving things in a given area. Ecosystems can vary in size. An entire ecosystem may live within a decaying log, which in turn may be part of a larger wetland ecosystem.

v. **Biome:** A biome is a major regional or global community of organisms. Biomes are usually characterized by the climate conditions and plant communities that thrive there.

Ecologists study relationships within each level of organization and also between levels. For example, researchers may study the relationships within a population of alligators, as well as the relationships between alligators and turtles in a community.

3.2.1 Biotic and Abiotic Factors

An ecosystem includes both biotic and abiotic factors.

All ecosystems are made up of living and nonliving components. These parts are referred to as biotic and abiotic factors.

Biotic factors are living things, such as plants, animals, fungi, and bacteria. Each organism plays a particular role in the ecosystem. For example, earthworms play a key role in enriching the soil. Abiotic factors are nonliving things such as moisture, temperature, wind, sunlight, and soil. The balance of these factors determines which living things can survive in a particular environment. In the Caribbean Sea, scientists found that coral reefs located near saltwater marshes have more fish than do reefs farther out at sea. As shown in figure 2.1, the key biotic factor is the mangrove trees that live in the marshes. The trees provide food and shelter for newly hatched fish, protecting them from predators. After the fish mature, they swim to the reefs. Abiotic factors that affect the growth of mangrove trees include low levels of oxygen in the mud where they grow and changing levels of salinity, or saltiness, due to daily tidal changes.

An ecosystem may look similar from one year to the next, with similar numbers of animals and plants. However, an ecosystem is always undergoing some changes. For example, a long period of increased precipitation might allow one plant species to grow better than others. As the plant continues to grow, it may crowd out other plant species, changing the community's composition.

Though the total number of plants in the community may remain the same, the species have changed. As these cyclic changes occur, an ecosystem falls into a balance, which is known as approximate equilibrium.

4.0 CONCLUSION

You have studied the principle of Ecology which is a branch of Biology dealing with the relationships of organisms with their environment and with each other and also knowing the definition, characteristics and importance as well. Ecology' is the scientific study of the inter-relationship of living organisms - plants, animals and microbes with each other and with their physical environment. It mainly concerns with the directive influences of abiotic and biotic environmental factors over the growth, distribution, behaviour and

survival of organisms. In other words, ‘ecology’ is the science which investigates organisms in relation to their environment and a philosophy in which the world of life is interpreted in terms of natural processes.

5.0 TUTOR-MARKED ASSIGNMENT

1. Define the term Ecology
2. List some scientists that contribute to the success of Ecology
3. Importance of Ecology

6.0 REFERENCES/FURTHERING READING

Fundamentals of Ecology and Environment Mark Q. Sutton and E. N Anderson (2010) Introduction to cultural Ecology Second Edition.

Chapman JL and Reiss MJ (1995): Nutrient Cycling and Pollution (151 – 166): In: - ECOLOGY, principles and applications. Cambridge University Press, UK.

Chapman JL and Reiss MJ (1995): Nutrient Cycling and Pollution (151 – 166): In: - ECOLOGY, principles and applications.

UNIT 2: NATURE OF OUR ENVIRONMENT

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1.0 INTRODUCTION

In the previous unit we learnt about Ecology which is the study of the inter-relationship of living organism plants, animals and microbes with their physical environment. On this unit we will be taking a look at the nature of our environment.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

i. Know the Etymological meaning of the term Environment.
ii. Know the importance of Environment and how it influence the animals chances of survival.
iii. What the term Environment denotes.

3.0 MAIN CONTENT

3.1 THE ETYMOLOGICAL MEANING OF ENVIRONMENT

The term Environment which etymologically means surroundings is considered as a composite term for the conditions in which organisms live and, thus, consists of air, water, food and sunlight which are the basic needs of all living being sand plant life, to carry on their life functions. The environment also includes other living things, temperature, wind, electricity etc. In other words, environment consists of both biotic and abiotic substances. Environment creates favourable conditions for the existence and development of living organisms.

For a given organism the environment includes all the surrounding physical and biological factors with which it interacts. The factor is any external force, substance, or condition that affects organisms in anyway. Thus, environment is the sum total of everything that directly influences the animal's chances of survival and reproduction. Environment is a very broad concept. Everything that affects an organism during its life time is collectively called its 'environment.

3.2 FAVORABLE CONDITION FOR THE EXISTENCE AND DEVELOPMENT OF LIVING ORGANISMS

For a given organism the environment includes all the surrounding physical and biological factors with which it interacts. The factor is any external force, substance, or condition that affects organisms in anyway. Thus, environment is the sum total of everything that directly influences the animal's chances of survival and reproduction. Environment is a very broad concept. Everything that affects an organism during its life time is collectively called its 'environment

4.0 CONCLUSION

In the unit, you have learnt the Etymological meaning of Environment, what it denotes, and conditions influencing living organisms. The term Environment which etymologically means surroundings is considered as a composite term for the conditions in which organisms live and, thus, consists of air, water, food and sunlight which are the basic needs of all living beings and plant life, to carry on their life functions.

5.0 TUTOR-MARKED ASSIGNMENT

1. Give the Etymological meaning of the term Environment.
2. Conditions that influence the living organism in the Environment.
3. What are the divisions of Environment.

6.0 REFERENCE/FURTHERING READING

Cambridge University Press, UK Raven, PH and Johnson, GB (1996): The future of the Biosphere, (611-630): In: Biology WCB/McGrow-Hill, Boston.

World Bank/United Nations Report 279/04 (February, 2004): "Nigeria Strategic Gas Plan." Joint UNDP/World Bank Energy Sector Management

Assistance Programme (ESMAP), ESM 279, Report 279/04, February, 2004.

www.wikipedia.com

UNIT 3: BIOGEOCHEMICAL CYCLES

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1.0 INTRODUCTION

Biogeochemical Cycles: This is the process whereby matter such as water, carbon, nitrogen, and phosphorus recycle within the ecosystem and through the atmosphere. All living things depend on water. It is through the processes of condensation, evaporation, and precipitation that water cycles through the atmosphere. It takes one water molecule about 4000 years to make it through the cycle. The hydrologic cycle also known as the water cycle, is the circular pathway of water on Earth from the atmosphere, to the surface, below ground, and back. Part of that pathway involves humans and other organisms, which all have bodies made mostly of water. Precipitation, such as rain or snow, falls to Earth. Some of this precipitation seeps into the ground, some drops into ponds, streams, lakes, or other waterways, and some forms puddles or other temporary pools. Depending on the type of soil and rocks surrounding it and also on its location, groundwater may empty directly into oceans. Sometimes water flows first into lakes,

swamps, or wetlands, but these—along with rivers, streams, and other freshwater sources also feed into oceans.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- Define the term Hydrologic cycle
- Give a schematic diagram of water cycle.
- To explain the term ammonification

3.0 MAIN CONTENT

3.1 HYDROLOGIC CYCLE

The hydrologic cycle also known as the water cycle, is the circular pathway of water on Earth from the atmosphere, to the surface, below ground, and back. Part of that pathway involves humans and other organisms, which all have bodies made mostly of water. Precipitation, such as rain or snow, falls to Earth. Some of this precipitation seeps into the ground, some drops into ponds, streams, lakes, or other waterways, and some forms puddles or other temporary pools. Depending on the type of soil and rocks surrounding it and also on its location, groundwater may empty directly into oceans. Sometimes water flows first into lakes, swamps, or wetlands, but these—along with rivers, streams, and other freshwater sources also feed into oceans.

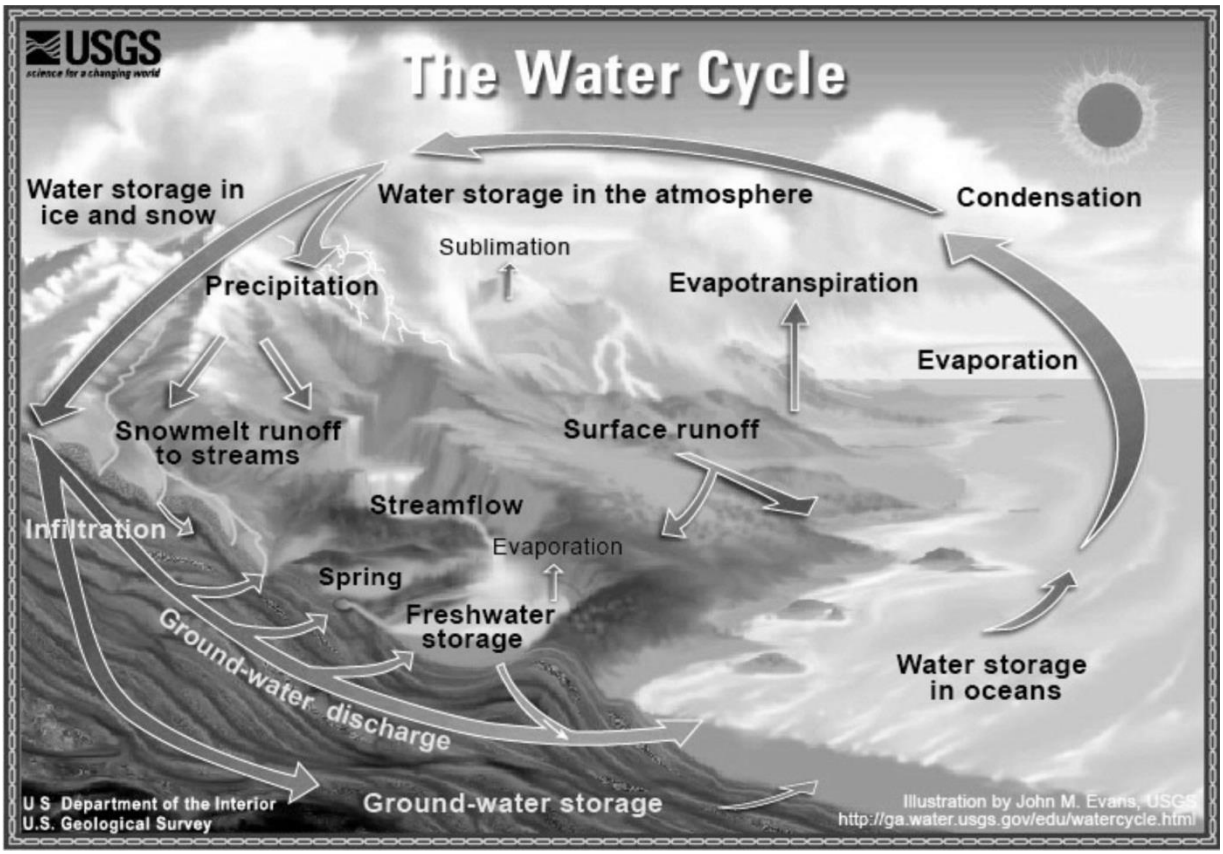

Fig. 1: Water cycle

Source: www.goolge.com

3.2 AMMONIFICATION

Nitrates released by soil bacteria are taken up by plants, which convert them into organic compounds such as amino acids and proteins. Nitrogen continues along the cycle as animals eat plant or animal matter. When decomposers break down animal excretions or dead animal and plant matter, nitrogen is returned to the soil as ammonium, in a process called ammonification.

Denitrifying bacteria use nitrate as an oxygen source, releasing nitrogen gas into the atmosphere as a waste product. Some nitrogen also enters the soil as a result of

atmospheric fixation by lightning. Lightning's energy breaks apart nitrogen molecules in the atmosphere. Nitrogen recombines with oxygen in the air, forming nitrogen oxide. The combination of nitrogen oxide with rainwater forms nitrates, which are absorbed by the soil.

4.0 CONCLUSION

In this unit we learnt that:

- When decomposers break down animal excretion or dead animal and plant matter, nitrogen is returned to the soil as ammonia in a process called Ammonification.
- The nitrogen cycle is of particular interest to the Ecologists, because nitrogen availability can affect the rate of key ecosystem processes.

Depending on the type of soil and rocks surrounding it and also on its location, groundwater may empty directly into oceans. Sometimes water flows first into lakes, swamps, or wetlands, but these—along with rivers, streams, and other freshwater sources also feed into oceans.

5.0 TUTOR-MARKED ASSIGNMENT

1. Draw a schematic diagram of water cycle
2. What is Ammonification

6.0 REFERENCES/FURTHER READING

Cambridge University Press, UK Raven, PH and Johnson, GB (1996): The future of the Biosphere, (611-630): In: Biology WCB/McGrow-Hill, Boston.

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Assistance Programme (ESMAP), ESM 279, Report 279/04, February, 2004.

www.google.com

MODULE 2 BASIC ENVIRONMENTAL CONCEPTS AND THEORIES

Unit 1: Basic Environmental concept

Unit 2: Microbial and parasite Ecology

Unit 3: Food chain

UNIT 1: BASIC ENVIRONMENTAL CONCEPT

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1.0 INTRODUCTION

Ecosystem is a self-sustaining unit of nature. It is defined as a functionally independent unit (of nature) where living organisms interact among themselves as well as with their physical environment. In nature two major categories of ecosystems exist: terrestrial and aquatic. Forests, deserts and grasslands are examples of terrestrial ecosystem.

Ponds, lakes, wet lands and salt water are some example of aquatic ecosystem. Crop lands and aquarium are the example of man-made ecosystems.

The interaction between the living organisms and their environment can be studied in a puddle of water or a hole in a tree, which are very small ecosystems or in large ecosystems such a forest, river or ocean. Irrespective of their sizes all ecosystems share many common characteristics. Let us study moderate sized pond ecosystem.

2.0 OBJECTIVES

At the end of this unit, you should be able to know:

- The definition of an Ecosystem
- characteristics of an Ecosystem
- factors forming the environment

3.0 MAIN CONTENT

3.1 THEORIES OF EVOLUTION

Jean Baptiste de Lamarck was the first evolutionist to believe that organisms change over time. Using fossil records as a guide, Lamarck was able to develop three theories; one is The Theory of Need which states that organisms change in response to their environment. Their ability to survive helped them develop characteristics necessary for them to adapt in a given environment.

Next is The Theory of Use and Disuse; which according to Lamarck, organs not in use will disappear while organs in use will develop. Lamarck believed that giraffes before have short necks, but because of the need to survive and in order to reach tall trees for food, they kept stretching their necks until these became longer and able to reach taller trees. These acquired characteristics were believed to be inherited by their offspring and

propagated by the next generation of giraffes. Lamarck called it as The Theory of Acquired Characteristics.

If you change the color of your hair from black to blond, do you think your child can inherit the blond color of your hair? A young lady keeps on using whitening soap and becomes fair? Can her child inherit her acquired fairness? Many scientists rejected the theories of Lamarck. They understood that if there were changes in cell or body structure, there could be changes in the genetic information of the species.

3.1.1 Darwinian Theory

The more popular Theory of Evolution proposed by Charles Darwin based on natural selection is different from the theories of Lamarck. According to Darwin, giraffe species originally had varying neck lengths but natural selection favored the survival of giraffes with longer necks that could feed on taller trees that were available. Giraffes with short neck were eliminated due to lack of accessible food supply. Fifty years after Lamarck's Theory of Use and Disuse, Charles Darwin suggested the Theory of Natural Selection, after his voyage to the Galapagos Island in HMS Beagle. He was fascinated by the diversity of organisms he found along the journey. In Galapagos Island, he observed that finch species have different beak structures for different food types. The abundance of certain finch species in an island was somehow related to the type of available food for these birds.

Darwin suggested that selection also takes place in nature. In selective breeding, farmer identifies and selects the best and desirable trait to propagate. In natural selection, environmental factors promote the survival of the fittest and eliminates the less fit. Organisms struggle for existence in order to survive; they compete for food and space. Organisms with favorable and advantageous characteristics survive and reproduce. Fitness refers to the ability of an organism to survive

and produce offspring. Different individuals in a population possess different characteristics and abilities. This is called variation. Variation among individuals in the

population would likely bring greater chance of survival. An organism that is adapted and has structures fitted to survive in a given environment would likely produce offspring. Variation increases the chance of survival of living things. Organisms with the best and desirable traits would likely adapt to environmental changes and may gradually become better suited to survive in a given environment.

Organisms which are best adapted to the environment will continue to reproduce and perpetuate their own kind. Mating between surviving populations of the same species may shift the abundance of a new breed of organism because of mutation, gene combination, and natural selection. This then leads to speciation and may subsequently increase biodiversity

4.0 CONCLUSON

In this unit you have learnt that Jean Baptiste de Lamarck was the first Evolutionist to believe that organisms change over time using Fossil records as a guide.

Worthy of notice also is the popular theory of Evolution proposed by Charles Darwin based on natural selection which is different from the theory of Lamarck. According to Darwin, giraffe species originally had varying neck lengths but natural selection favored the survival of giraffes with longer necks that could feed on taller trees that were available.

Basically there are two theories of Evolution viz are:

- Jean Baptiste de Lamarck theory of evolution
- Charles Darwin theory of evolution

5.0 TUTOR-MARKED ASSIGNMENT

i. What is meant by the term Evolution

ii. State the theories of Evolution.

6.0 REFERENCES/FURTHER READING

Cambridge University Press, UK Raven, PH and Johnson, GB (1996): The future of the Biosphere, (611-630): In: Biology WCB/McGrow-Hill, Boston.

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UNIT 2: MICROBIAL AND PARASITE ECOLOGY

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1.0 INTRODUCTION

Ecology has provided an integrative perspective of the interactions between biological organisms and their abiotic environment, especially at relatively large spatial scales. The insights and approaches of population ecology, community ecology, and evolutionary biology. After all, organisms simultaneously experience all the forces of nature, including those that are the foci of evolutionary, population, community, and ecosystem ecology. Each of these perspectives has been, and will continue to be, useful simplifications.

2.0 OBJECTIVES

At the end of this unit, you should have:

i. Insight and approaches of population Ecology, Community Ecology, and Evolutionary biology.
ii. An idea between biological organisms and their abiotic environment, especially at relatively large spatial scales.

3.0 MAIN CONTENT

3.1 POPULATION ECOLOGY

Population ecology is the study of populations (especially population abundance) and how they change over time. Crucial to this study are the various interactions between a population and its resources. Population' is defined as a group of freely interbreeding individuals of the same species present in a specific geographical area at a given time. A population has traits of its own which are different from those of the individuals forming the population.

3.2 DENSITY AND DISTRIBUTION OF POPULATION

Density: The number of individuals per unit area at a given time is termed Health population density which may vary from time to time and place to place.

For example, you may notice more plant and animal species in the garden during the monsoon season. Density of a particular organism in a region is determined by selecting random samples from an area of particular dimension (size) called quadrat from that region. In case of large mobile animals like tigers, leopards, lions and deer, the density may be determined by counting individual animals directly or by the pugmarks (foot imprints) left by the animals in a defined area.

Population distribution is the pattern of dispersal of individuals within the area of interest patterns of distribution.

4.0 CONCLUSION

Population ecology is the study of populations (especially population abundance) and how they change over time. Crucial to this study are the various interactions between a population and its resources. Population' is defined as a group of freely interbreeding individuals of the same species present in a specific geographical area at a given time.

A population has traits of its own which are different from those of the individuals forming the population. Density of a particular organism in a region is determined by selecting random samples from an area of particular dimension (size) called quadrat from that region. In case of large mobile animals like tigers, leopards, lions and deer, the density may be determined by counting individual animals directly or by the pugmarks (foot imprints) left by the animals in a defined area.

5.0 TUTOR-MARKED ASSIGNMENTs

i. What do you understand by the tern Ecology.

ii. Define the term Density in respect to distribution of population.

6.0 REFERENCE/FURTHER READING

Jefferies, M. J. (1997). Biodiversity Conservation. New York: Routledge

O'Riordan, T. (ed) (1995). Environmental Science for Environmental Management. Harlow: Longman.

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UNIT 3: FOOD CHAIN

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1.0 INTRODUCTION

This is the transfer of food from the plants (producers) through a series of organisms with repeated eating and being eaten is called a food chain. It shows the relationships between producers, consumers, and decomposers. All living organisms (plants and animals) must eat some type of food for survival. Plants make their own food through a process called photosynthesis. Using the energy from the sun, water and carbon dioxide from the atmosphere and nutrients, they chemically make their own food. Since they make or produce their own food they are called producers. Organisms which do not create their own food must eat either plants or animals. They are called consumers. Some animals get

their energy from eating plants while other animals get energy indirectly from plants by eating other animals that already ate the plants. Animals that eat only plants are called herbivores. Animals that eat both plants and other animals are called omnivores. Animals that eat only other animals are called carnivores. Some animals eat only dead or decaying materials and are called decomposers.

The arrows show the movement of energy through the food chain. For example, in the food chain shown below, the small fish (silverside) gets its energy by eating the plankton and the large fish (bluefish) gets its energy by eating the small fish. Finally, the bacteria eats the fish after it dies, getting its energy from the large fish. The bacteria also returns nutrients back to the environment for use by the phytoplankton.
Thus the food chain becomes a complete circle. Animals may eat more than one type of food. They may eat many different types of plants or many different animals. This makes everything more complicated and the food chain becomes a food web.

2.0 OBJECTIVES

i. At the end of this unit, you will learn the difference between food chain and food web.
ii. Energy loss in the Food chain and food web.

3.0 MAIN CONTENT

3.1 ENERGY LOSS IN FOOD CHAIN AND FOOD WEB

In a food chain, energy is lost in each step of the chain in two forms: first by the organism producing heat and doing work, and second, by the food that is not completely digested or absorbed. Therefore, the food web depends on a constant supply of energy from producers and nutrients that are recycled by the decomposition of organisms. As food is passed along the food chain, only about 10% of the energy is transferred to the next level.

For example, 10% of the energy phytoplankton received from the sun can be used by zooplankton at the next level. From one level to the next about 90% of the energy used by the previous level is lost. This means that there has to be a lot more organisms at the lower levels than at the upper levels. The number of organisms at each level makes a pyramid shape and is called a food pyramid. To better understand this energy loss, it is helpful to look at a food pyramid. Amount of Biomass passed up the Food Pyramid (in pounds) Organisms at the broader base of the pyramid are greater in number than those at the top. There is, for example, a greater number of phytoplankton than zooplankton and more zooplankton than small fish, etc.

3.2 DIFFERENCES BETWEEN FOOD CHAIN AND FOOD WEB

3.2.1 A food chain

The transfer of food from the plants (producers) through a series of organisms with repeated eating and being eaten is called a food chain. It shows the relationships between producers, consumers, and decomposers. All living organisms (plants and animals) must eat some type of food for survival. Plants make their own food through a process called photosynthesis. Using the energy from the sun, water and carbon dioxide from the atmosphere and nutrients, they chemically make their own food. Since they make or produce their own food they are called producers.

Organisms which do not create their own food must eat either plants or animals. They are called consumers. Some animals get their energy from eating plants while other animals get energy indirectly from plants by eating other animals that already ate the plants. Animals that eat only plants are called herbivores. Animals that eat both plants and other animals are called omnivores. Animals that eat only other animals are called carnivores. Some animals eat only dead or decaying materials and are called decomposers.

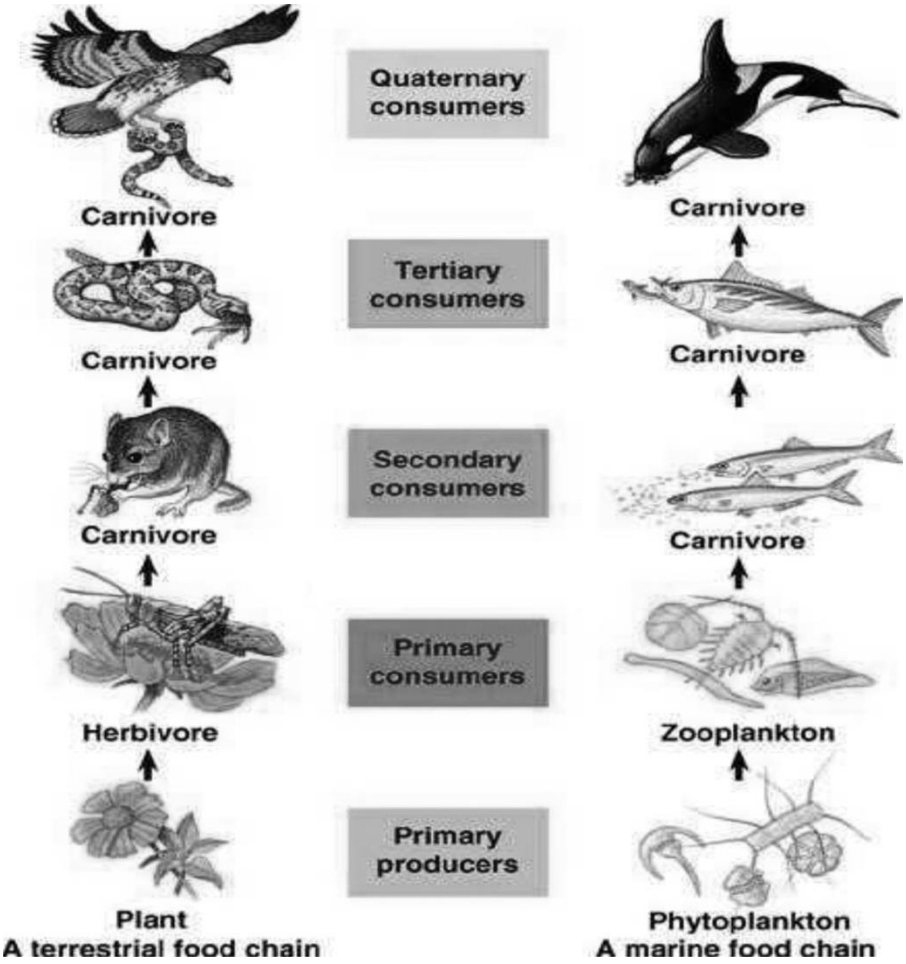

Fig.2: Schematic diagram of food chain

Source: www.Slideplayer.com

3.2.2 Food web

A food web is made up of interconnected food chains. Most communities include various populations of producer organisms which are eaten by any number of consumer populations. The green crab, for example, is a consumer as well as a decomposer. The crab will eat dead things or living things if it can catch them. A secondary consumer may also eat any number of primary consumers or producers. This non-linear set of interactions which shows the complex flow of energy in nature.

In the marine food web, special producers are found. They are tiny microscopic plants called phytoplankton. Since the water is the home for these special tiny plants; it is also the home for tiny microscopic animals called zooplankton. And of course, zooplankton eat phytoplankton. Sometimes zooplankton and phytoplankton are collectively referred to as plankton. In a food web nutrients are recycled in the end by decomposers. Animals like shrimp and crabs can break the materials down to detritus. Then bacteria reduce the detritus to nutrients. Decomposers work at every level, setting free nutrients that form an essential part of the total food web.

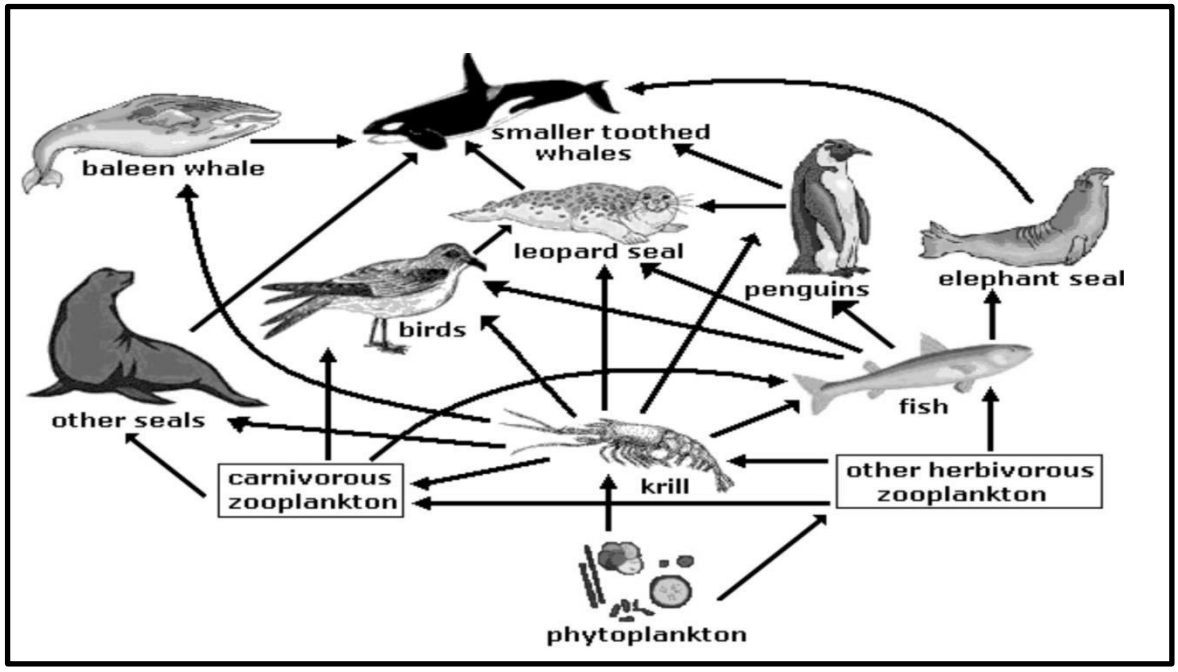

Fig. 3: Schematic diagram of food web

Source: www. freewiring.today.com

4.0 CONCLUSION

In a food chain, energy is lost in each step of the chain in two forms: first by the organism producing heat and doing work, and second, by the food that is not completely digested or absorbed. At the end of the unit you will be able to know the full meaning of the term Food chain, food web and how energy is lost in both food chain and food web.

5.0 TUTOR-MARKED ASSIGNMENTs

i. With a schematic diagram define the term food and food web.

ii. Briefly explain how energy is lost in food chain and food web.

6.0 REFERENCES/FURTHER READING

Chapman JL and Reiss MJ (1995): Nutrient Cycling and Pollution (151 – 166): In: - ECOLOGY, principles and applications. Cambridge University Press, UK

Raven, PH and Johnson, GB (1996): The future of the Biosphere, (611-630): In: Biology. WCB/McGrow-Hill, Boston.

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MODULE 3 BIOTIC COMMUNITIES AND ECOLOGICAL SUCCESSION

Unit 1: Biotic communities

Unit 2: Ecological succession

Unit 3: Relationship and interdependence of organisms

UNIT 1: BIOTIC COMMUNITIES

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1.0 INTRODUCTION

Abiotic community is defined as a group of several populations of different species. The biological community in an area or ecosystem is a complex network of interactions. The interaction that occurs among different individuals of the same species is called intra-

specific interaction while the interaction among individuals of different species in a community is termed as inter-specific interaction.

Interactions between organisms belonging to the same trophic level often involve competition. Individuals of a population may compete for food, space and mates.

For example if a mouse has been eaten by a cat, other cats competing for this resource would have one less mouse to prey on.

2.0 OBJECTIVES

i. To know the interdependence of animals and plants
ii. To know the intra-specific relationship

3.0 MAIN CONTENT

3.1 GENERAL KNOWLEDGE ON BIOTIC COMMUNITIES

3.1.1 Biotic Communities

Abiotic community is defined as a group of several populations of different species. The biological community in an area or ecosystem is a complex network of interactions. The interaction that occurs among different individuals of the same species is called intra-specific interaction while the interaction among individuals of different species in a community is termed as inter-specific interaction.

Interactions between organisms belonging to the same trophic level often involve competition. Individuals of a population may compete for food, space and mates.

For example if a mouse has been eaten by a cat, other cats competing for this resource would have one less mouse to prey on. The snake another predator of the mice would also have fewer mice to eat during the night if the cat has succeeded.

Direct competition, though, between the cat and snake is not much as they prey at different times. They also eat a variety of different foods. So competition may be intra-

specific as well as inter-specific. Inter-specific relationship may be direct and close as between a lion and deer or indirect and remote as between an elephant and a beetle. This is because interactions between two species need not be through direct contact. Due to the connected nature of ecosystems, species may affect each other through intermediaries such as shared resources or common enemies. Specific terms are applied to inter-specific interactions depending upon whether the interaction is beneficial, harmful or neutral to individuals of the species.

Community: In an environment or habitat, different types of plants and animals exist in close association and show interdependence. An actively interacting group of a number of different populations of several species in a common environment is known as biotic community.

Community Ecology: This is the study of interactions among all populations in a common environment. Examples of biotic communities: Pond community, Forest community and Lake community.

3.2 CHARACTERISTICS OF BIOTIC COMMUNITY

The characteristics of biotic community include the following:

1. Interdependence of animals and plants

Communities are not a random mixture of species. The animal, plant and microbial community of a biotic community show fundamental dependence on each other.

- Nutritional interdependence
- Carbon dioxide-oxygen interdependence
- Interdependence in pollination
- Interdependence in dispersal of seeds and fruit

2. Trophic Organisation

A community is characterised by a definite trophic organisation, i.e., trophic levels. All species of a population living in a community can be divided into three trophic levels, producers or green plants, consumers or animals and decomposers or microbes.

3. Stratification

In large terrestrial and aquatic communities, population of each species occupies a particular strata. This is called stratification. Eg: In a forest community, the tree tops, the branches, the leaf litter and the soil bottom are occupied by different species. A pond community has surface dwellers, bottom dwellers and those living in the intermediate depths.

4. Dominance

In any community, one or few species dominate either in numbers or in physical characteristics or in both over the species. For example, in Grassland: Grasses; Pine forest: Pine.

5. Variety of species

A community is formed of many species. These vary from community-to-community. A great variety of species are found in the tropical rainforest whereas only a few species are found in a polar community.

3.3 COMMUNITY INTERACTION

In a community, there is interaction among the organisms of the same species, with other organisms of their own community or among the organisms of different communities. The organisms are related to one another through cooperative or competitive actions so that they maintain a balance.

This relationship between organisms is classified into following two types: Intra-specific relationship and Inter-specific relationship

1. Intra-specific Relationship

It is the relationship among the individuals of the same species. The cooperative interactions in the members of the same species or population include mating behaviour, parental care, family formation, group formation, altruism, dominance subordinate behaviour, animal societies and communication. Communication: It maintains continuous interaction with another among members. E.g. Bees Altruism: It is a form of

behavior among social animals in which one or several organisms sacrifice with their own interest for the welfare of the group. For example: Group of cheetahs and a wild dog. Animal societies: It is among many species, intimate exchange between members and adaptive, cooperative, action are facilitated through formation of permanent social structures called societies. For example: Bees/ants. The competitive interactions are dominance subordinate behaviour, leadership and home range or territoriality. The cooperative relationships are beneficial for the species.

2. Inter-Specific Interaction

a) Positive Interaction

i. Mutualism
ii. Protocooperation
iii. Commensalism
iv. Scavenging

Mutualism is an interaction between two organisms of different species where both the partners are benefited with none of the two capable of living separately. Examples:

i. Mutualism – Lichens

These represent an intimate mutualistic relationship between a fungus and green alga or cyanobacteria. Their body is made up of an alga and a fungus, both living together in intimate symbiotic relationship. The fungus provides substratum, water, minerals and shelter to algal component, while the alga provides fungi with food (carbohydrates).

ii. Protocoorporation

Protocooperation is an association between organisms of different species in which both are mutually benefited but they can live without each other. It means protocooperation is equally beneficial for both but is not obligatory.

Example is commensalism

Commensalism is an association between two different organisms or species in which one is always benefited but the other is neither benefited nor harmed. The species that derives benefit is called commensal and the other is called host. Benefits: Commensals

derive benefit from the host in the form of food, protection, shelter, living space or transportation.

Examples: 1. Sucker fish and Shark: sucker fish gets attached to the under surface of sharks by its sucker. This provides easy transport for new feeding grounds and also food pieces falling from the sharks prey.

iii. Scavenging

Scavenging is the feeding by an animal on the remains or carcasses of dead animals and on the refuse of living animals. Scavenging is a food relationship between a dead animal and its eater. The eater is called scavenger. E.g: Animals such as foxes, hyenas, vultures etc. are the animals, which are natural scavengers. Dogs, crows, ants are occasionally seen to do the work of scavengers.

b) Negative Interaction

i. Predation

Predation is the direct food relation between two organisms of different species in which one animal (predator) captures kills and feeds upon other animal (the prey). Examples: Familiar examples of predator-prey relationship are between Tiger and deer, Hawk and small Bird, Snake and Rat, Frog and Insects. Species like Frog may be both a prey and predator. It is predator for insects but a prey for other animals.

ii. Parasitism

Parasitism is a food relationship between organisms of two different species in which the smaller one lives on or within the larger one and obtains its food from it. The former which obtains food is known as parasite and the latter which provides food and shelter to the parasite is called host. Example: Temporary parasitism and permanent parasitism.

iii. Temporary parasites visit host for a short period for feeding as Bedbugs, Leeches and Mosquitoes. These are called intermittent parasites. However, Mosquito is not a parasite because it transfers parasite to the human beings. So it is a vector.

v. **Permanent parasites** live in contact with host throughout their life. E.g. Ascaris, Taenia, Entmoeba.

3.3.1 Biotic Stability

One of the principles of nature is stability amidst diversity. The larger the number of diverse forms present in a community, the more stable that community will be. It means that the stability of a community depends not on the large populations of a few species but upon the number of populations of different species.

Examples: A large population of a single species of Eucalyptus is likely to be totally wiped out by a fungal disease or insect attack. When there are many species of trees, only one species may be affected by a disease or a pest whereas the rest would survive. The stability of a community is displayed by the large population of wild animals in Africa. In Serengeti plains of Africa, about 20 species of antelopes live together in the area. Each species of antelope eats a different kind of grass or shrub. Some may even feed on the same kind of shrub but at different stages of its growth. This division of food preference enables all animals to get adequate nutrition and also keeps the habitat productive. But it has been observed that destruction of wildlife and introduction of domestic animals for grazing in an area destroys the productivity of land.

4.0 CONCLUSION

i. All the populations are interdependent.
ii. It may be small as a pond community or as a grassland community.
iii. Exhibits both direct and indirect relationships.
iv. All the species are not equally represented. Some may be abundant than others.

Abiotic community is defined as a group of several populations of different species. The biological community in an area or ecosystem is a complex network of interactions. The interaction that occurs among different individuals of the same species is called intra-specific interaction while the interaction among individuals of different species in a community is termed as inter-specific interaction.

4.0 TUTOR-MARKED ASSIGNMENTs

i. What are the basic features of Biotic community

ii. List the characteristics of Biotic community

5.0 REFERENCES/FURTHER READING

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UNIT 2: ECOLOGICAL SUCCESSION

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1.0 INTRODUCTION

This is an orderly and progressive replacement of one community by another till the development of a stable or climax community in a particular area is termed biotic or ecological succession. It can also be seen as the change in either species composition, structure, or architecture of vegetation through time. Vegetation has three important aspects that are subject to change. Species composition includes the roster of the species. There can be many or few species in vegetation. Structure refers to the absolute and relative abundances and other relationships of the species constituting the community. The total number of individuals of each species, or the rank order of abundance of the different species are examples of vegetation structure.

2.0 OBJECTIVES

In this unit, you will be talking on:

i. Succession, types and processes of Biotic succession. This is an orderly and progressive replacement of one community by another till the development of a stable or climax community in a particular area is termed biotic or ecological succession.

3.0 MAIN CONTENT

3.1 TYPES OF ECOLOGICAL SUCCESSIONS

i. Primary Succession
ii. Secondary Succession

i. Primary Succession

This is the type of succession that occurs where community has never existed before. In other words Primary succession occurs in essentially lifeless areas regions in which the soil is incapable of sustaining life as a result of such factors as lava flows, newly formed sand dunes, or rocks left from a retreating glacier.

In this succession, the first biotic lives to be seen are the lichens. It takes about a thousand (1000) years for this type of succession to attain climax.

ii. Secondary Succession

This succession occurs in an area where community has already existed before, just like the primary succession, grasses, shrubs and weeds are the organisms to first colonize the secondary succession. It is typified by smaller-scale disturbances that do not eliminate all life and nutrients from the environment.

It takes about 50 – 100 years for a climax community to be formed in grassland and over 200 years for a forest to reach climax community.

3.2 PROCESS OF BIOTIC SUCCESSION

The process of succession always starts on a bare land and involves following sequential events:

i. Migration: It is transport of spores, seeds or other structures of propagation to the bare area

ii. Ecesis: It is successful germination of propagules into the bare area. The germination of seeds and spores produce new seedlings or new plants. As a result, some individuals of species are established in the bare area.

iii. Colonization and Aggregation

In this stage, the plants that had established themselves multiply and form colonies or aggregate into small or large groups. Competition: When number of these individuals' increases many fold in a given area, they enter into intra-specific and inter-specific struggle. This results in the elimination of unsuitable or weak plants and animals. They start showing various types of interactions.

iv. Invasion

New varieties of plants and animals migrate into this area and establish themselves in spaces created due to elimination of weaker plants. This is called invasion. **Reaction**

New migrants interact with the existing plants. This is called reaction. This leads to a changed environment. The changed environment becomes unsuitable for the existing community. Under environmental pressure, the community also changes or gets replaced by better adjusted species.

v. Stabilisation

This is the final stage of biotic succession. The terminal community becomes more or less stabilised in the environment and remains in equilibrium with climatic and other environmental conditions of that area. The stabilised community is called climax community.

4.0 CONCLUSION

The term "succession" was coined when ecologists assumed that one community of plants gave way to another. Hence, communities succeeded one another. However, we now understand that communities may not always be discrete and that they may blend into one another gradually through time. In addition, there may not be a fixed sequence of

species that necessarily has to occur in a region. General tendencies in succession may appear, although the trends are often probabilistic and flexible. It can also be seen as the change in either species composition, structure, or architecture of vegetation through time. Vegetation has three important aspects that are subject to change. Species composition includes the roster of the species. There can be many or few species in vegetation. Structure refers to the absolute and relative abundances and other relationships of the species constituting the community.

5.0 Tutor-Marked Assignments

- With appropriate example define the term succession.
- Highlight the process of Biotic succession

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Jefferies, M. J. (1997). Biodiversity Conservation. New York: Routledge

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UNIT 3: RELATIONSHIP AND INTERDEPENDENCE OF ORGANISMS

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1.0 INTRODUCTION

Energy enters ecosystems in the form of sunlight or chemical compounds. Some organisms, like producers (autotrophs) use this energy to make food (usable energy).

2.0 OBJECTIVES

i. At the end of this unit, you will learn how energy can be transferred in form of sunlight or chemical compounds.
ii. And also how some organisms use this energy to make food
iii. At the end of this unit, you will know the importance of Food web
iv. You will be able to know the two global webs.
v. Also a schematic diagram of food web
vi. At the end of this lesson, you will be able to know the predator-prey relationship.
vii. Also adaptation to predation.

3.0 MAIN CONTENT

3.1 HOW ENERGY FLOWS THROUGH THE ECOSYSTEMS

Energy enters ecosystems in the form of sunlight or chemical compounds. Some organisms, like producers (autotrophs) use this energy to make food (usable energy). Other organisms (consumers, heterotrophs) get energy by eating the producers. They pass some of the energy on to other consumers when they are eaten. In this way, energy flows from one living thing to another. All living things need energy. They need it to power the processes of life. For example, it takes energy to grow. It also takes energy to produce offspring. In fact, it takes energy just to stay alive. Remember that energy cannot be created or destroyed (first law of thermodynamics). It can only change form. Energy changes form as it moves through ecosystems.

3.1.1 Producers (Autotrophs)

Producers are organisms that produce food for themselves and other organisms. They use energy and simple inorganic molecules to make organic compounds. The stability of producers is vital to ecosystems because all organisms need organic molecules. Producers are also called autotrophs. There are two basic types of autotrophs: photo-autotrophs and chemo-autotrophs.

1. Photo-autotrophs use energy from sunlight to make food by photosynthesis. They include plants, algae, and certain bacteria.

2. Chemo-autotrophs use energy from chemical compounds to make food by chemosynthesis. They include some bacteria and also Archaea. Archaea are microorganisms that resemble bacteria. The energy of the sun is first captured by producers, organisms that can make their own food. Many producers make their own food through the process of photosynthesis. The "food" the producers make is the sugar, glucose. Producers make food for the rest of the ecosystem. As energy is not recycled, energy must consistently be captured by producers. This energy is then passed on to the organisms that eat the producers, and then to the organisms that eat those organisms, and so on. Recall that the only required ingredients needed for photosynthesis are sunlight, carbon dioxide (CO_2), and water (H_2O). From these simple inorganic ingredients, photosynthetic organisms produce the carbohydrate glucose ($C_6H_{12}O_6$), and other complex organic compounds. Essentially, these producers are changing the energy from the sunlight into a usable form of energy. They are also making the oxygen that we breathe. Oxygen is a waste product of photosynthesis. The survival of every ecosystem is dependent on the producers. Without producers capturing the energy from the sun and turning it into glucose, an ecosystem could not exist. On land, plants are the dominant producers. Phytoplanktons, tiny photosynthetic organisms, are the most common producers in the oceans and lakes. An alga, which is the green layer you might see floating on a pond, are an example of phytoplankton. There are also bacteria that use chemical processes to produce food. They get their energy from sources other than the

sun, but they are still called producers. This process is known as chemosynthesis, and is common in ecosystems without sunlight, such as certain marine ecosystems.

3.1.2 Consumers (Heterotrophs)

Consumers are organisms that depend on other organisms for food. They take in organic molecules by essentially ‘‘eating” other living things. They include all animals and fungi. (Fungi don’t really ‘‘eat”; they absorb nutrients from other organisms.) They also include many bacteria and even a few plants, such as the pitcher plant. Consumers are also called heterotrophs. Heterotrophs are classified by what they eat:

- ✓ Herbivores consume producers such as plants or algae. They are a necessary link between producers and other consumers. Examples include deer, rabbits, and mice.
- ✓ Carnivores consume animals. Examples include lions, polar bears, hawks, frogs, salmon, and spiders. Carnivores that are unable to digest plants and must eat only animals are called obligate carnivores. Other carnivores can digest plants but do not commonly eat them.
- ✓ Omnivores consume both plants and animals. They include humans, pigs, brown bears, gulls, crows, and some species of fish.

3.1.3 Decomposers

The organisms that obtain their energy from other organisms are called consumers. All animals are consumers, and they eat other organisms. Fungi and many protists and bacteria are also consumers. But, whereas animals eat other organisms, fungi, protists, and bacteria "consume" organisms through different methods, they are known as decomposers. When organisms die, they leave behind energy and matter in their remains. Decomposers break down the remains and other wastes and release simple inorganic molecules back to the environment. Producers can then use the molecules to make new organic compounds. The stability of decomposers is essential to every ecosystem. Decomposers are classified by the type of organic matter they break down:

- ✓ Scavengers consume the soft tissues of dead animals. Examples of scavengers include vultures, raccoons, and blowflies.

✓ Detritivores consume detritus—the dead leaves, animal feces, and other organic debris that collects on the soil or at the bottom of a body of water. On land, detritivores include earthworms, millipedes, and dung beetles. In water, detritivores include ‘‘bottom feeders” such as sea cucumbers and catfish.

✓ Saprotrophs are the final step in decomposition. They feed on any remaining organic matter that is left after other decomposers do their work. Saprotrophs include fungi and single-celled protozoa. Fungi are the only organisms that can decompose wood.

3.1.4 Decomposers and Stability

Decomposers get nutrients and energy by breaking down dead organisms and animal wastes. Through this process, decomposers release nutrients, such as carbon and nitrogen, back into the environment. These nutrients are recycled back into the ecosystem so that the producers can use them. They are passed to other organisms when they are eaten or consumed. Many of these nutrients are recycled back into the soil, so they can be taken up by the roots of plants. The stability of an ecosystem depends on the actions of the decomposers. Examples of decomposers include mushrooms on a decaying log. Bacteria in the soil are also decomposers. Imagine what would happen if there were no decomposers. Wastes and the remains of dead organisms would pile up and the nutrients within the waste and dead organisms would not be released back into the ecosystem. Producers would not have enough nutrients. The carbon and nitrogen necessary to build organic compounds, and then cells, allowing an organism to grow, would be insufficient. Other nutrients necessary for an organism to function properly would also not be sufficient. Essentially, many organisms could not exist.

Food chains and food webs are diagrams that represent the feeding relationships from producers to consumers to decomposers. They show who eats whom. In this way, they model how energy and matter move through ecosystems.

3.2 FOOD WEB

Food Webs A food web represent multiple pathways through which energy and matter flow through an ecosystem. It includes many intersecting food chains. It demonstrates that most organisms eat, and are eaten, by more than one species. Even food webs are interconnected. All organisms depend on two global food webs.

3.2.1 Trophic Levels and Energy

The feeding positions in a food chain or web are called trophic levels. Generally, there are a maximum of four trophic levels. Many consumers feed at more than one trophic level. Humans, for example, are primary consumers when they eat plants such as vegetables. They are secondary consumers when they eat cows. They are tertiary consumers when they eat salmon. Energy flows through an ecosystem in only one direction. Energy is passed from organisms at one trophic level or energy level to organisms in the next trophic level. Which organisms do you think are at the first trophic level.

Energy is passed up a food chain or web from lower to higher trophic levels. Most of the energy at a trophic level – about 90% – is used at that trophic level. Organisms need it for locomotion, heating themselves, and reproduction. So animals at the second trophic level have only about 10% as much energy available to them as do organisms at the first trophic level. Animals at the third level have only 10% as much available to them as those at the second level.

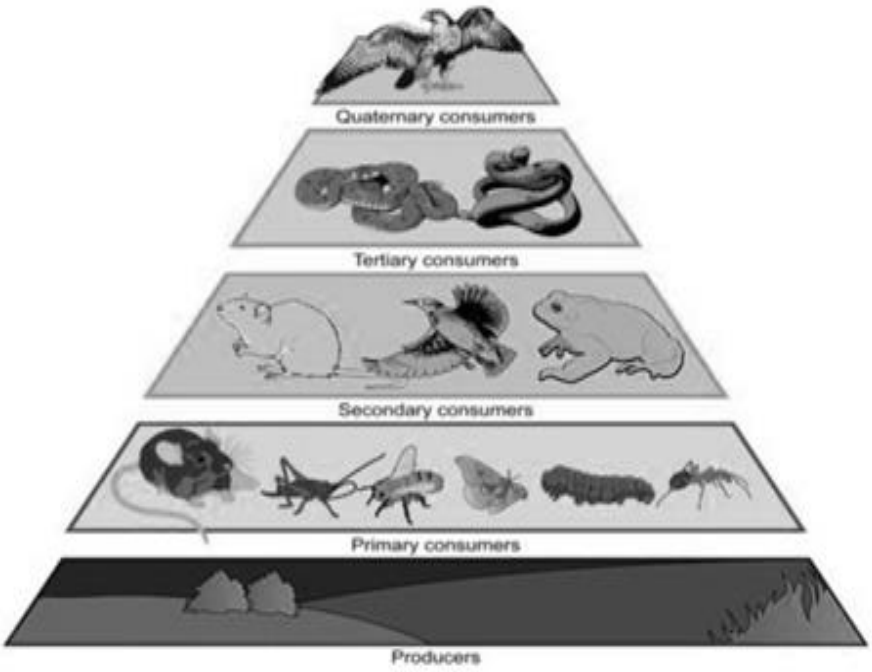

Fig. 4. Trophic level Energy

Source: google.com

3.2.2 Trophic Levels and Biomass

With less energy at higher trophic levels, there are usually fewer organisms as well. Organisms tend to be larger in size at higher trophic levels, but their smaller numbers result in less biomass. Biomass is the total mass of organisms at a trophic level.

3.3 Community interaction

A community is the biotic part of an ecosystem. It consists of all the populations of all the species in the same area. It also includes their biological interactions, the interactions between different organisms in an environment. Species interactions in communities are important factors in natural selection. They help shape the evolution of the interacting species

All living things depend on their environment to supply them with what they need, including food, water, and shelter. Their environment consists of physical factors—such as soil, air, and temperature and also of other organisms. An organism is an individual

living thing. Many living things interact with other organisms in their environment. In fact, they may need other organisms in order to survive. This is known as interdependence. For example, living things that cannot make their own food must eat other organisms for food. Other interactions between living things include predation, competition, and symbiosis.

3.3.1 Predation

Predation is a relationship in which members of one species (the predator) consume members of another species (the prey). The lions and buffalo in Figure 10 are classic examples of predators and prey. In addition to the lions, there is another predator in this figure. The other predator is the buffalo. Like the lion, it consumes prey species, in this case species of grass.

- **Predation and Population**

A predator-prey relationship tends to keep the populations of both species in balance. This is shown by the graph in Figure 9.25 on the next page. As the prey population increases, there is more food for predators. So, after a slight lag, the predator population increases as well. As the number of predators increase, more prey is captured. As a result, the prey population starts to decrease.

3.3.2 Keystone Species

Some predator species are known as keystone species. A keystone species is one that plays an especially important role in its community. Major changes in the numbers of a keystone species affect the populations of many other species in the community. For example, some sea star species are keystone species in coral reef communities. The sea stars prey on mussels and sea urchins, which have
no other natural predators. If sea stars were removed from a coral reef community, mussel and sea urchin populations would have explosive growth. This, in turn, would drive out most other species. In the end, the coral reef community would be destroyed.

3.3.3 Adaptations to Predation

Both predators and prey have adaptations to predation that evolve through natural selection. Predator adaptations help them capture prey. Prey adaptations help them avoid predators. A common adaptation in both predator and prey is camouflage. Camouflage in prey helps them hide from predators. Several examples are shown in Figure below. Camouflage in predators helps them sneak up on prey.

Fig. 11Camouflage

Source: www.google.com

3.4 COMPETITION

Competition is a relationship between organisms that strive for the same resources in the same place. The resources might be food, water, or space. Competition occurs whenever they both try to get the same resources in the same place and at the same time. The two organisms are likely to come into conflict, and the organism with better adaptations may win out over the other organism.

There are two different types of competition:

i. Intra-specific competition occurs between members of the same species. For example, two male birds of the same species might compete for mates in the same area.

This type of competition is a basic factor in natural selection. It leads to the evolution of better adaptations within a species.

ii. Inter-specific competition occurs between members of different species. For example, predators of different species might compete for the same prey.

3.5 INTER-SPECIFIC COMPETITION AND EXTINCTION

Inter-specific competition, in ecology, is a form of competition in which individuals of different species compete for the same resource in an ecosystem (e.g. food or living space). If a tree species in a dense forest grows taller than surrounding tree species, it is able to absorb more of the incoming sunlight. However, less sunlight is then available for the trees that are shaded by the taller tree, thus inter-specific competition. Cheetahs and lions can also be in inter-specific competition, since both species feed on the same prey, and can be negatively impacted by the presence of the other because they will have less food.

Competition is only one of many interacting biotic and abiotic factors that affect community structure. Moreover, competition is not always a straightforward, direct, interaction. Inter-specific competition may occur when individuals of two separate species share a limiting resource in the same area. If the resource cannot support both populations, then lowered fecundity, growth, or survival may result in at least one species. Inter-specific competition has the potential to alter populations, communities and the evolution of interacting species. On an individual organism level, competition can occur as interference or exploitative competition. Direct competition has been observed between individuals, populations and species, but there is little evidence that competition has been the driving force in the evolution of large groups. Many studies have shown major impacts on both individuals and populations from inter-specific competition.

Documentation of these impacts has been found in species from every major branch of organism. The effects of inter-specific competition can also reach communities and can even influence the evolution of species as they adapt to avoid competition. This evolution may result in the exclusion of a species in the habitat, niche separation, and local extinction. The changes of these species over time can also change communities as other species must adapt.

3.5.1 Intra-specific competition and specialization

Intra-specific competition is an interaction in population ecology, whereby members of the same species compete for limited resources. This leads to a reduction in fitness for both individuals. By contrast, inter-specific competition occurs when members of different species compete for a shared resource. Members of the same species have very similar resources requirements whereas different species have a smaller contested resource overlap, resulting in intra-specific competition generally being a stronger force than inter-specific competition.

Individuals can compete for food, water, space, light, mates or any other resource which is required for survival. The resource must be limited for competition to occur; if every member of the species can obtain a sufficient amount of every resource then individuals do not compete and the population grows exponentially. Exponential growth is very rare in nature because resources are finite and so not every individual in a population can survive, leading to intra-specific competition for the scarce resources. Sometimes competition between individuals of the same species can lead to specialization. Specialization allows competing individuals to continue to survive.

Intra-specific competition does not just involve direct interactions between members of the same species (such as male deer locking horns when competing for mates) but can also include indirect interactions where an individual depletes a shared resource (such as

a grizzly bear catching a salmon that can then no longer be eaten by bears at different points along a river).

The way in which resources are partitioned by organisms also varies and can be split into scramble and contest competition. Scramble competition involves a relatively even distribution of resources among a population as all individuals exploit a common resource pool. In contrast, contest competition is the uneven distribution of resources and occurs when hierarchies in a population influence the amount of resource each individual receives. Organisms in the most prized territories or at the top of the hierarchies obtain a sufficient quantity of the resources, whereas individuals without a territory do not obtain any of the resource.

i. Symbiosis

The term symbiosis comes from a Greek word that means “living together”. Symbiosis can be used to describe various types of close relationships between organisms of different species, such as mutualism and commensalism, which are relationships in which neither organism is harmed. Symbiosis can also be used to describe relationships where one organism lives on or in another, called parasitism.

ii. Mutualism

Mutualism is a symbiotic relationship in which both species benefit. An example of mutualism involves goby fish and shrimp. The nearly blind shrimp and the fish spend most of their time together. The shrimp maintains a burrow in the sand in which both the fish and shrimp live. When a predator comes near, the fish touches the shrimp with its tail as a warning. Then, both fish and shrimp retreat to the burrow until the predator is gone. From their relationship, the shrimp gets a warning of approaching danger. The fish gets a safe retreat and a place to lay its eggs.

iii. Commensalism

Commensalism is a symbiotic relationship in which one species benefits while the other species is not affected. One species typically uses the other for a purpose other than food. For example, mites attach themselves to larger flying insects to get a ‘‘free ride.” Hermit

crabs use the shells of dead snails for homes. Clown fish live with sea anemones for protection from predators and the sea anemone is neither helped nor harmed (Figure 9.29). If you saw the movie Finding Nemo, then you probably recognize this fish. It's known as a clownfish, and it's swimming near the tentacles of an animal called a sea anemone. The sea anemone kills prey by injecting poison with its tentacles. For some reason, the anemone doesn't harm the clownfish, perhaps because the fish has a coating of mucus that helps disguise it. But why does the clownfish ‘‘hang out" with the sea anemone? One reason is for the food. The clownfish eats the remains of the anemone's prey after it finishes feeding. Another reason is safety. The clownfish is safe from predators when it's near the anemone. Predators are scared away by the anemone's poison tentacles. In return, the clownfish helps the anemone catch food by attracting prey with its bright colors. Its feces also provide nutrients to the anemone. The clownfish and anemone are just one example of the diverse ways that living things may help each other in nature.

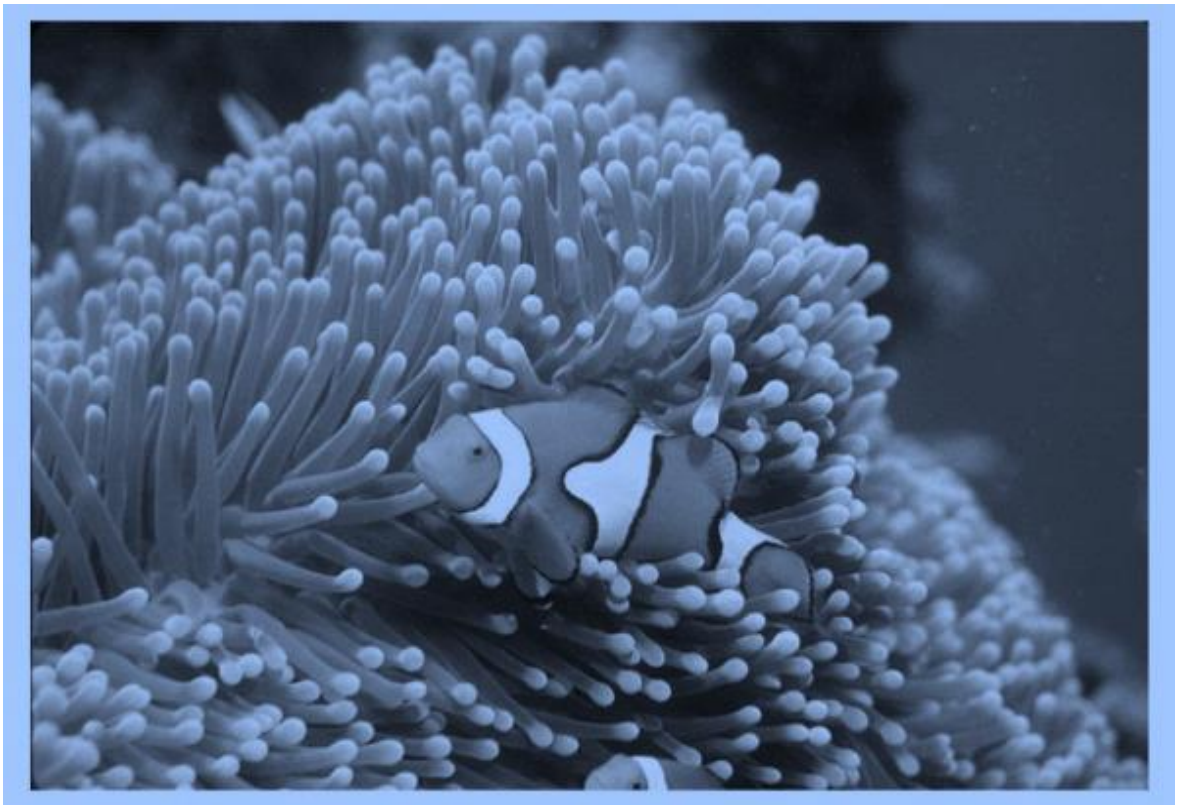

Fig. 5. Commensalism
Source: www.yourdictionary.com

iv. Parasitism

Parasitism is a symbiotic relationship in which one species (the parasite) benefits while the other species (the host) is harmed. Many species of animals are parasites, at least during some stage of their life. Most species are also hosts to one or more parasites. Some parasites live on the surface of their host. Others live inside their host. They may enter the host through a break in the skin or in food or water. For example, roundworms are parasites of mammals, including humans, cats, and dogs. The worms produce huge numbers of eggs, which are passed in the host's feces to the environment. Other individuals may be infected by swallowing the eggs in contaminated food or water.

Some parasites kill their host, but most do not. It's easy to see why. If a parasite kills its host, the parasite is also likely to die. Instead, parasites usually cause relatively minor damage to their host.

4.0 CONCLUSION

In this unit, you have learnt the various pathways through which energy enters into the ecosystem. Energy which can neither be created nor destroyed enters into the Ecosystem in the form of sunlight or chemical compounds. All living things depend on their environment to supply them with what they need, including food, water, and shelter. Their environment consists of physical factors—such as soil, air, and temperature and also of other organisms. An organism is an individual living thing. Generally, there are a maximum of four trophic levels. Many consumers feed at more than one trophic level. Humans, for example, are primary consumers when they eat plants such as vegetables. They are secondary consumers when they eat cows. They are tertiary consumers when they eat salmon.

Energy flows through an ecosystem in only one direction. Energy is passed from organisms at one trophic level or energy level to organisms in the next trophic level.
As the prey population increases, there is more food for predators. So, after a slight lag, the predator population increases as well. As the number of predators increases, more prey is captured. As a result, the prey population starts to decrease. The other predator is the buffalo. Like the lion, it consumes prey species, in this case species of grass. However, unlike the lions, the buffalo does not kill its prey. Predator-prey relationships such as these account foremost energy transfers in food chains and food webs.

6.0 TUTOR-MARKED ASSIGNMENT

1. In what form do energy enters into the ecosystem
2. Highlight the stages in which organisms form their food
3. What do you understand by the term food web? Diagram required.

4. What is community interaction?

5. Define the following terms: Symbiosis, Mutualism, Commensalism and parasitism.

6. Define the term competition and list their types.

7.0 REFERENCES/FURTHER READING

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