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COURSE CODE: MCB 221

COURSE TITLE: MICROBIAL ECOLOGY

NUMBER OF UNITS:3 Units/Compulsory

COURSE DURATION: Three hours per week

COURSE LECTURER: EZEANYA, Chinyere C.

INTENDED LEARNING OUTCOMES

At the completion of this course, students are expected to:

1. Define the concept of microbial ecology.
2. Understand all the types of microbial interaction.
3. Understand the concept of microbes and ecological theory.
4. Apply the concept of the different types of adaptation of microbes to their environment and articulate solutions to simple problems.
5. Carry out projects to:
 - Identify possible microbial interaction in an environment.
 - Demonstrate the concept of morphological adaptation of microbes to their environment.

COURSE DETAILS:

Week 1-2: *Introduction to concept of microbial ecology.*

Week 3-4 *Concept of ecological theory: emphasis on microbes.*

Week 5: *Introduction to the microbial interaction.*

Week 6-7: Compare and contrast the different types of microbial interactions, understanding the advantages and disadvantages of each type.

Week 8-9 Introduction to the concept of adaptation and discussion of the various forms of adaptation: physiological, biological, morphological and genetic.

Week 10-11: Projects.

Week 12 Revision

RESOURCES

- **Lecturer's Office Hours:**

- **EZEANYA, Chinyere C.** Mondays: 12:30-2:30pm.

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| Course | lecture | Notes: |
|---------------|----------------|---------------|

<http://www.edouniversity.edu.ng/oer/micro/mcb221.pdf>

- **Books:**

- *Microbial Ecology* by Larry L. Baron, Diana E. Northup. 2011. ISBN: 978-0-470-04817-7 (recommended).

- **Course Project:**

- Multiple parts (2 or 3).
- Must be done in the Microbiology Laboratory.
- Homeworks + Project: ~ 30% of final grade.

- **Exams:**

- Final, comprehensive (according to university schedule): ~ 70% of final grade

Assignments & Grading

- **Academic Honesty:** All group work should be done in teams, otherwise stated.
- General solution to problems should be discussed extensively in groups but must have individual write ups.

NO LATE HOMEWORKS ACCEPTED

- All home works are to be submitted online on the class group platform.
- All home works are due at the time stated.
- Late projects will not be accepted.

PREAMBLE:

Microorganisms are organisms that cannot be perceived with unaided eyes. They are cosmopolitan in nature and postulate the greatest multiplicity of life. They form varied level of interaction with their environment and other organisms. Microbial response to environmental conditions is regulated by their adaptation features. Microorganisms have acquired a group of specialized mechanisms which support both individual cells and cellular populations to identify ecological changes.

TYPES OF MICROBES

Microbes are divided into six groups:

- Archaea
- Bacteria
- Fungi
- Protists
- Viruses
- Prions

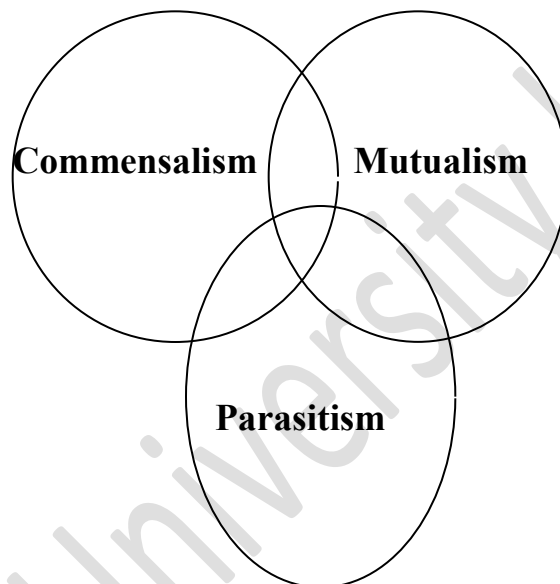


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MICROBIAL INTERACTIONS

The inter-and the intra- relationship among various microorganisms which is occasionally positive or negative is called MICROBIAL INTERACTION. Positive microbial interactions are described as SYMBIOSIS. Symbiosis is a mutual relationship or a close association between two or more different species of microorganism. On the other hand, there could be negative microbial interaction which is described as ANTIBIOSIS such as bacteria to bacteria interaction.

Types of interactions



These are the three major types of interaction. Commensalism and Mutualism are all positive interactions whereas Parasitism is antibiosis. Other types of microbial interaction include:

- Neutralism
- Predation
- Amensalism
- Competition
- Cooperation

Commensalism: This interaction involves one organism benefiting from the association while the other is neither harmed nor benefits. It is a unidirectional association as only one organism benefits. The organism benefitted is called the commensal while the other organism that is neither benefitted nor harmed is called the host.

Examples;

- ❖ Bacteria habiting the human gut.

Mutualism: Here, both microorganism have an essential association. Thus, both gain from the association and require each other to survive. The association is highly specific. The organism involved in this type of interaction is called the mutualist.

Examples;

- ❖ Rhizobium bacteria growing in nodules on the roots of legumes.
- ❖ Lichen-Fungi.

Parasitism: A type of symbiosis in which one organism benefit from the other and the host is usually harmed. Here, one organism solely depends on another organism for nutrition, growth and survival. This type of interaction is similar to Predation.

Example: Viruses- they are intracellular parasites.

There are two major types of parasites

- **Ecto-parasite:** As the name implies 'ecto' meaning on, outer or surface. The parasites are found living on the surface or outer covering of their host.

Examples include: fleas, ticks, and mites.

- **Endo-parasite:** This is the opposite of ecto-parasite. Here, the parasite resides inside or in the body of the host. Examples; parasitic worms such as tapeworm, guinea worm and pathogenic microorganisms.

Neutralism: In this type of relationship, the effect of interaction among microorganism is neutral hence the name 'neutralism'. Mostly occur in natural communities.

Predation: Is hunting another species for food. The hunting organism is termed the predator. The predator targets, attack and eventually kills its prey. This is a bilateral association. The predators are sometimes obligate or facultative that is they can perform their predatory role in more than one way.

Examples; Members of predatory bacteria are called *Bdellovibrio*.

Amensalism: In this type of interaction, one organism is harmed while another is not due to the production of specific product by one of the organisms. For example; microbial antibiotics like penicillin produced by the fungus *Penicillium* inhibits the growth of organism. This is similar to Parasitism as it is unidirectional.

Competition: An association of diverse organisms in a population utilizing the same resources e.g. nutrient-water, vitamins etc. It is regarded as an important regulating factor of population size. Therefore, organisms involved in this interaction can both be harmed. For example; micro-organisms involved in lactic acid fermentation.

Cooperation: This interaction is also a positive one like commensalism and mutualism but not obligatory interaction as mutualism. Both organisms can exist without the other.

Example: Azotobacter-Cellulomonas.

ARCHAEA MICROBES

Archaea are genetically and biochemically dissimilar from bacteria. They were discovered in 1970 by Carl Woese. They are relatively small in size. They are prokaryotes. There are of four groups of Archaea:

- Methanogen
- Halophiles (extreme)
- Thermophiles (extreme)
- Psychrophiles (sulfate-reducing).

Examples of archaea are: Methanobrevibacter, Halobacterium.

Bacteria Microbes

Bacteria are single-cell microbes. They are prokaryotes like Archaea. Bacteria grown in many types of habitats, as well as live on animals and plants. Some exist independently or in symbiotic relationship with other micro-organisms. Examples of bacteria are: Escherichia coli, Staphylococcus.

Fungi microbes

Fungi is a member of the kingdom Fungi. They are eukaryotes. Bread yeast is an examples of fungi, they are sometimes referred to as molds and mushrooms. Fungi are microbes that have some of their members that are macroscopic. They are three basic types of fungi:

- Saprophytic fungi colonizes non- living organism like dead animals.

- A parasitic fungus forms a symbiotic relationship with living organisms causing harm on their host.
- Symbiotic fungi are in symbiosis with other organism although no harm to the host. In some cases the relationship is has mutual benefit (mutualism).

Protists Microbes

Protists are unicellular microbes. They can be found as multicellular organism.

Examples are Dinoflagellate, *Euglena gracilis* etc.

There are three main sub-categories of Protists:

- Animal-like
- Plant-like
- Fungus-like

Fungus-like Protists have cell walls and reproduction is by spore formation.

Viruses' microbes

Viruses can be described as microscopic infectious agents that are non-living.

Viruses lack self- replicating abilities in the absence of a host cell. They are inactive outside the host cell hence are called non-living infectious agents. Viruses have a wide host range and are host specific. They infect other micro-organisms like bacterial cells (eg. Bacteriophages) and also human cells. Examples of viruses are Rabies Virus (dog), Poxvirus (man and animal) etc.

Effects of viruses

1. Virus causes serious and deadly diseases e.g. Ebola.
2. It alters the body immune system.

Prions microbes

Prions are proteins. Proteins are the fundamental components of living cells. They are similar to virus as both are non-living agents. Prions were discovered in 1943 to cause infectious diseases.

Features of Prions

1. Proteinaceous infectious agents.
2. Highly resistant to heat,
3. Exhibits irradiation insensitivity.
4. Resistant to DNase and RNase.

ADAPTATION

Biological Adaptation

- Biological adaptation is also termed an Adaptive trait, is a contemporary trait in the historical description of an organism which preserves and progresses via natural selection.
- During the growth phase of organisms, phenotypic traits develop consequently to series of environmental problems.

Physiological Adaptation

- These are adaptive structures present in an organism which supports specific biochemical reactions.
- Generalized functions as growth, temperature regulation, ionic balance are reflective of physiological adaptation.
- Some aspect of adjustment by micro-organism in their internal environment thereby maintaining a stable equilibrium or balance.

Morphological Adaptation

- These are specialized organelles possessed by organisms which contribute to its survival in its natural habitat (e.g. presence of flagellum).
- It is the survival limit of an organism in a given collections of habitats.

Genetic Adaptation

- It described by the change in a population to a most adaptable phenotype in a given environment.
- It covers the behavioral pattern of an organism showing little observable effect on the reproduction of the organism.

Modes of microbial adaptation to their environment:

- 1) Temperature and solute uptake
- 2) Genetic variation
- 3) The consequences of osmotic pressure on gene expression
- 4) pH homeostasis
- 5) Structures of microorganisms
- 6) Flexibility

ECOSYSTEM

It is an interaction that takes place in the population of living organisms in unification with non-living aspects of the environment. Energy, water, nitrogen and soil minerals are other essential abiotic components of an ecosystem.

Ecosystem are controlled both external and internal factors.

Consequence of Ecosystem

1. Ecosystem provides knowledge on the amount availability of solar energy.
2. Inter-relationships among organisms and their abiotic environment can be established.
4. Increased productivity.

Types of Ecosystems

1. Freshwater Ecosystems
2. Terrestrial Ecosystems
3. Marine Ecosystems.

FRESHWATER ECOSYSTEMS:

1. It has relatively small area which includes lakes, rivers, streams and ponds.
2. It promotes life species.
3. Forms the base for food-web. Example; Plankton (small microscopic organisms)
4. They are can be divided into two: lentic and lotic. The latter comprises of running water while the former refers to still water.

TERRESTRIAL ECOSYSTEMS

1. It has many and diverse types of ecosystems. There are seven major types:
 - Tundra

- Taiga
- Tropical rain forest
- Grassland
- Desert

2. Its location is usually on landforms.

MARINE ECOSYSTEMS

1. Earth's surface is covered by 71% of water.
2. High amount of dissolved salts and minerals.
3. There are two common types of marine ecosystems: ocean ecosystem and coral reef ecosystem.

Major groups of micro- organisms in the ecosystem include: Bacteria, Fungi, Algae, Protozoan and Viruses.



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