MCB 221 COURSE COMPACT

COURSE

Course code: MCB 221

Course title: Microbial Ecology

Course unit: 3 Units

Course status: Compulsory

COURSE DURATION

Three hours per week for 15 weeks (45 hours)

LECTURERS DATA

Name of the lecturer:	Dr Akpor OB
Qualifications obtained:	B.Sc, M.Sc, PhD
Department:	Biological Sciences (Microbiology Programme)
College:	Science and Engineering
E-mail:	akpor.oghenerobor@lmu.edu.ng
Office Location:	Room 305
Consultation Hours:	2.00 pm to 4.00 pm (Monday to Wednesday)

Name of the lecturer:	Dr Abalaka M
Qualifications obtained:	B.Sc, M.Sc, PhD
Department:	Biological Sciences (Microbiology Programme)
College:	Science and Engineering
E-mail:	abalaka.moses@lmu.edu.ng
Office Location:	
Consultation Hours:	2.00 pm to 4.00 pm (Monday to Wednesday)

COURSE CONTENT

The course covers the following areas: microorganisms and ecological theory, mechanisms of adaptation of microorganisms to their environment, over of occurrence of microorganisms in soil, water and air; frontiers of microbiology

COURSE DESCRIPTION

The course is a synthesis of a variety of scientific disciplines, including microbiology, molecular biology, ecology and bioinformatics. It is closely linked to ecosystem function and environmental quality.

COURSE JUSTIFICATION

The course is important because microbial ecology is known to drive numerous essential ecosystem functions, production and sustainability, including the cycling of energy and nutrients through ecosystem and the provision of resistance and degradation mechanisms for toxins. The course will provide students with the knowledge and insight to assess and predict the effects of human activities against a background of natural changes and the provision of microbial responses to their abiotic and biotic environments

COURSE OBJECTIVES

Upon completion of the course, students should be able to demonstrate basic knowledge of the following:

- Explain basic ecological concepts
- Microbial interactions, community dynamics and succession
- Determination of microbial numbers, biomass and metabolism

COURSE REQUIREMENT

The prerequisite for the course is successful completion of Introductory Ecology (BLY 122). In addition, the University policy on attendance will strictly apply. Also, students are expected to comport themselves and take course or class activities seriously.

METHOD OF GRADING

S/N	**Grading**	**Score** (%)
1	Test	20
2	Term paper	10
2	Final Examination	70
	Total	**100**

COURSE DELIVERY STRATEGIES

Lecture, periodical assignments and practical

LECTURE CONTENT

Contents	**Facilitator**
Week 1: Principles of microbial ecology, colonization and succession	Dr Akpor
Week 2: Bioconversion: Biodeterioration and biodegradation	Dr Akpor
Week 3: Microbial adaptations to environmental conditions	Dr Akpor
Week 4: Microbial interactions: microbe-microbe interactions	Dr Akpor
Week 5: Microbial interactions: microbe-animal interactions	Dr Akpor
Week 6: Microbial interactions-microbe-plant interactions	Dr Akpor
Week 7: Soil, waste and water management	Dr Akpor
Week 8: Development of microbial communities	Dr Abalaka
Week 9: Determination of microbial numbers, biomass and metabolism	Dr Abalaka
Week 10: Biogeochemical cycling: carbon, hydrogen and oxygen	Dr Abalaka
Week 11: Biogeochemical cycling: nitrogen and sulphur	Dr Abalaka
Week 12: Biogeochemical cycling: phosphorus, iron and other elements	Dr Abalaka
Week 13: Microbial interactions with xenobiotics and inorganic pollutants: part 1	Dr Abalaka
Week 14: Microbial interactions with xenobiotics and inorganic pollutants: part 2	Dr Abalaka
Week 15: Revision	Dr Akpor & Dr Abalaka

WEEK 1: PRINCIPLES OF MICROBIAL ECOLOGY, COLONIZATION AND SUCCESSION

Objectives

- At the end of this week lectures, the students should be able to:
- Define and explain basic ecological concepts
- Understand colonization and succession within microbial communities
- Discuss microbial environments, and the effects of environmental factors on microbial growth

Description

Basic definition in the study of microbial ecology, colonization and succession, succession in natural habitats, microorganisms in ecosystems, methods of study and the isolation of soil microorganisms.

Study questions

- Define the following terms: ecosystem, habitat and niche
- What is the order of successions and colonization of cellophane films as described by Tribes (1960)? On what basis is this succession taking place?
- Discuss the stages involves in the dispersed of air-borne particles and aerial micro-organisms

WEEK 2: BIOCONVERSION: BIODETERIORATION AND BIODEGRADATION

Objectives

At this end of this week lectures, the student should be able to:

- Bioconversion is an aspect of microbial ecology which deals with biodeteration and biodeterdation
- Discuss biodeterioration as a concept which depends on man's economy
- Explain the biology of the causative organism

Description

The lectures will expose the students to the understanding of the concepts of biodeterioration and biodegradation. Students will also be exposed to the technical distinction between the two aspect of bioconversion-biodeterioration and biodegradation, and the importance of biological causation

Study questions

- Using examples, state the technical boundary between the two aspects of bioconversion.
- Biodeterioration is a concept which depends on man's economy. Discuss

WEEK 3: MICROBIAL ADAPTATIONS TO ENVIRONMENTAL CONDITIONS

Objectives

At the end of this week lectures, the students should be able to:

- Discuss the various abiotic factors that influence the ecological distribution and functioning of microbial populations
- Explain the Liebig's law of the minimum and the Shelford's law of tolerance
- Describe how microbes adapt to extreme conditions

Description

The lectures will expose the students to the abiotic limitations to microbial growth, environmental determinants that control microbial growth and activity

Study questions

- What is Liebig's law? How does it explain algal blooms in lakes receiving effluents containing phosphate detergents
- What is Shelford's law? How does it differ from Liebig's law
- Compare autecology and synecology
- How have different microbial populations adapted to growth at low and high temperatures?

WEEK 4: MICROBIAL INTERACTIONS: MICROBE-MICROBE INTERACTIONS

Objectives

At the end of the lectures for this week, the students should be able to:

- Explain positive and negative interactions in microorganisms
- Describe commensal relationships between microbial populations
- Discuss balance of nature and how inter-population interactions explain how balance of nature can be maintained?

Description

The lectures will expose the students to interactions within a single microbial population

and interactions between diverse microbial populations

Study questions

- How do population interactions explain the relatively high numbers of pathogens required to establish an infection in a susceptible animal?
- Describe the cooperative interactions exhibited by populations of the slime mold *Dictyostelium*
- Why does inoculation of an agar plate with a single cell of a bacterium often fail to result in growth and formation of a colony? When they do form, why are the sizes of bacterial colonies limited?

WEEK 5: MICROBIAL INTERACTIONS: MICROBE-ANIMAL INTERACTIONS

Objectives

At the end of the lectures for the week, the students should be able to:

- Explain the beneficial relationships between microbes and animals
- Discuss the how microbes contribute to the nutrition of animals
- Explain how animals and microbes and animals exchange nutrients and maintain suitable habitats

Description

The lectures will expose the students to microbial contributions to animal nutrition, microbial predation by animals and ecological aspects of animal diseases

Study questions

- What predatory strategies do animals exhibit that allow them to obtain nutrition from microbial populations?
- Describe the relationship between leaf-cutting ants and fungi
- How do microorganisms contribute to the nutrition of termites
- What are the differences between grazing and filter feeding? How are they related to the size of the animal and the density of the microbial populations?

WEEK 6: MICROBIAL INTERACTIONS-MICROBE-PLANT INTERACTIONS

Objectives

At the end of this week lecture, the students should be able to:

- Explain how microorganisms interact with plant roots
- Describe positive and negative interactions between microbes and plants
- Discuss how microbial interactions with plants are important in the provision of nutrients

Description

This contact will expose the students to microbial interactions with plant roots, nitrogen fixation in nodules, microbial interactions with aerial plant structures and microbial diseases of plants

Study questions

- Define the terms rhizosphere, rhizoplane and rhizosheath
- Compare the microbial populations in the rhizosphere with those in the root-free soil
- Compare the genera *Rhizobium* and *Bradyrhizobium*
- What are mycorrhiza? Compare the three different types of mycorrhizae
- What is the overall effect of microorganisms on plant productivity

WEEK 7: SOIL, WASTE AND WATER MANAGEMENT

Objectives

At the end of this contact, the students should be able to:

- Discuss the practices of bioderioration control
- Explain the role of microorganisms in the biological treatment of solid and liquid wastes
- Describe how sewage treatment processes are aimed at reducing biological oxygen demand and nutrient removal

Description

This contact will expose the students to the control of biodeterioration, management of agricultural soils and treatment of solid and liquid.

Study questions

- How is biodeterioration of foods prevented?
- How are soil management practices used to maintain soil fertility
- Compare composting and landfills for disposal of municiopal wastes
- What is BOD? Why is it important to reduce the BOD of wastewater before they are discharged into rivers and lakes
- What are primary, secondary and tertiary treatments of sewage

WEEK 8: DEVELOPMENT OF MICROBIAL COMMUNITIES

Objectives

At the end of this week lectures, the students should be able to:

- Explain the ecological hierarchy of microorganisms in individuals and community
- Describe how microbial populations exhibit adaptations for success in various communities
- Discuss the complexity of interactions within a community

Description

The students will be exposed to the concept of microbial community dynamics, genetic exchange in microbial communities, structure of microbial communities and structure and function of microbial communities

Study questions

- What is a guild? Why should intense competition occur within a guild?
- What is niche? How does a niche differ from a habitat?
- What is a microbial community? How does a community differ from a population
- Describe the succession of microbial biofilm community

WEEK 9: DETERMINATION OF MICROBIAL NUMBERS, BIOMASS AND METABOLISM

Objectives

At the end of the lectures for this week, the students should be able to:

- Understand the structure and functioning of ecosystems with respect to numbers, biomass and metabolism

- Discuss quantitative information about numbers of organisms, biomass of populations, rates of activity, rates of growth and death, and cycling and transfer rates of materials within ecosystems
- Describe the methods used determination of microbial number, biomass and metabolism

Description

The lectures will expose the students to the detection of microbial populations (phenotypic detection, lipid profile analyses and molecular detections), determination of microbial numbers (direct counts, viable counts and most probable number), determination of microbial biomass (biochemical assays and physiological approaches) and measurement of microbial metabolism (heterotrophic potential, productivity and decomposition, and specific enzyme assays).

Study questions

- How can you detect all viable individuals of a specific bacterial population in an environmental sample
- Why the plate count procedure is highly criticized for use in environmental studies? Why is it employed
- What is polymerase chain reaction? How can it be used to detect genetically engineered microorganisms?
- What is the relationship between cell numbers and biomass? Compare the applicability of cell number and biomass determination for soil bacteria and fungi

WEEK 10: BIOGEOCHEMICAL CYCLING: CARBON, HYDROGEN AND OXYGEN

Objectives

At the end of this contact, the students should be able to:

- Describe carbon, hydrogen and oxygen as major nutrient elements that are cycled together by the opposing forces of photosynthesis and respiration
- Discuss how atmospheric carbon dioxide reserviour is influenced by human activities

- Explain how microorganisms respond to increased concentrations of carbon dioxide

Description

The topic will exposed the students to the carbon cycling within habitats the hydrogen and oxygen cycles

Study questions

- What is the greenhouse effect? How does it work?
- Why do human activities have a large part on atmospheric carbon dioxide concentration
- What are the two biological processes that drive the cycling of carbon, oxygen and hydrogen? Explain why the cycling of these three elements closely is linked?

WEEK 11: BIOGEOCHEMICAL CYCLING: NITROGEN AND SULPHUR

Objectives

At the end of this contact, the students should be able to:

- Discuss how minerals nutrients like nitrogen and sulphur are usually taken up by autotrophs and prototrophic heterotrophs in the form of mineral salts
- Explain the cycling of nitrogen and sulphur between their oxidized and reduced states

Description

The students will be exposed to the fixation of molecule molecular nitrogen with emphasis on ammonification, nitrification, nitrate reduction and denitrification. They will also be exposed to the sulphur cycle with emphasis on oxidative and reductive sulphur transformations.

Study questions

- Describe the nitrogen cycle. Which microbial populations are associated with each phase of the biogeochemical cycling of nitrogen? What environmental conditions favour each phase of the nitrogen cycle
- Compare nitrogen fixation in aquatic and soil habitats?

- Describe the sulphur cycle
- How could the sulphur cycle be managed to reduce atmospheric sulphur pollutants

WEEK 12: BIOGEOCHEMICAL CYCLING: PHOSPHORUS AND IRON

Objectives

At the end of the lectures of this week, the students should be able to:

- Explain why the phosphorus cycle does not involve oxidation-reduction reactions
- Describe how microorganisms mediate the transformation of phosphorus
- Discuss the oxidation-reduction reactions in the cycling of iron

Description

This lecture will expose the students to the major processes in the phosphorus and iron cycle. The students will also be exposed to the interactions of sulphur and iron cycling

Study questions

- How does the phosphorus cycle differ from the nitrogen and sulphur cycles?
- Describe the role of siderophores in the iron cycle

WEEK 13: MICROBIAL INTERACTIONS WITH XENOBIOTICS AND INORGANIC POLLUTANTS: PART 1

Objectives

At the end of the lectures for this week, the students should be to:

- Explain the structural features of xenobiotics
- Discuss the characteristics of biomagnifiable pollutants
- Understand the molecular, biochemical and environmental factors that determine the fate of xenobiotics

Description

The lectures of this week will expose the students to the persistence and biomagnification of xenobiotic molecules with emphasis on recalcitrant halocarbons, nitroaromatic compounds and polychlorinated biphenyls

Study questions

- Why do we call some synthetic organic compounds “xenobiotics”?
- Name some structural features characteristics of xenobiotic compounds
- What is biomagnification
- What are the two characteristics shared by all pollutants subject to biomagnification?

WEEK 14: MICROBIAL INTERACTIONS WITH XENOBIOTICS AND INORGANIC POLLUTANTS: PART 2

Objectives

At the end of the lectures of this week, the students should be able to:

- Explain the biodegradable steps for normal alkanes and cycloalkanes
- Explain why the many genes associated with biodegradation of xenobiotics reside on plasmids?

Description

This lecture will expose the students to microbial degradation of petroleum hydrocarbons and pesticides

Study questions

- What are the first biodegradtion steps in case of a normal alkane? How does the biodegradation continue
- What are the initial biodegradation steps for a cycloalkane? Why is it difficult to isolate cycloalkane-degrading pre cultures?

RECOMMENDED TEXT

Atlas RM and Bartha R. 1998. Microbial Ecology: Fundamentals and Applications, 4th Edition. Benjamin/Cummings Science Publishing, California.

Coyne M.S. 1999. Soil Microbiology: An Exploratory Approach. Delmar Publishers, New York

Gregory P.H. 1973. The Microbiology of the Atmosphere. Wiley, New York