INTER AMERICAN UNIVERSITY OF PUERTO RICO
METROPOLITAN CAMPUS
Faculty of Science and Technology
Department de Natural Sciences

SYLLABUS

I GENERAL INFORMATION

Curse Title General Microbiology
Code and Number BIOL 3105
Credits 4
Academic Term
Instructor
Office hours
Office Phone
Electronic mail

II DESCRIPTION

Study of bacteria, fungi, viruses and protists. Emphasis on the morphology, taxonomy, physiology, genetics and control in bacteria. Description of the relation between the microorganisms and the immune system. Requires 45 hours of lecture and 45 hours of lab. Prerequisites: BIOL 1102, 2013 and CHEM 1111.

III. OBJETIVES

Upon completion of the course, students are expected:

1. to appreciate the relevance of microorganisms.
2. to contrast the fundamental characteristics used to distinguish between prokaryotic and eukaryotic cells, and viral agents.
3. to describe the different criteria used to classify bacteria based on their morphology, staining and growth patterns and nutrition requirements, as well as physiological and biochemical aspects.
4. to compare the different mechanisms used by microorganisms to share genetic information.
5. to appreciate the ethical consequences related to the manipulation of microorganisms.
6. to describe the different mechanisms of microbial-growth control.
7. to establish the relationship between microorganisms and their host's immune system.

8. to use basic techniques for the study and aseptic manipulation of microorganisms.

IV. COMPETENCIES FROM THE MICROBIOLOGY GRADUATE PROFILE

1. Describe the characteristics and structures of microorganisms.
2. Identify the way in which microorganisms interact with their environment and the consequences of these interactions.
3. Describe the action mechanisms of the chemical and physical agents used in the control of growth or microbial activity in diverse environments.
4. Apply the different techniques of dealing with microorganisms for their isolation, culture, observation, identification and control.
5. Appreciate the role that microorganisms play as study models and as adverse and beneficial agents.

V. COURSE CONTENT

A. Introduction
    1. Definition of Microbiology and Microorganisms
    2. Branches of Microbiology
        a. Virology
        b. Bacteriology
        c. Mycology
        d. Protozoology
        e. Phycology
    3. Relevance of Microorganisms
    4. Important Historic Events in Microbiology
        a. Development of Microscopy
            1) Seneca
            2) Zacharias Jansen
            3) Anton Van Leeuwenhoek
        b. Theory of Spontaneous Generation
            1) Francesco Redi (1629-1698)
            2) John Needham (1713-1781)
            3) Lazzaro Spallanzani (1729-1799)
            4) Louis Pasteur (1822-1895)
        c. Germ Theory of Disease
            1) Robert Koch (1834-1910)
            2) Koch's Postulates and the Golden era of Microbiology

d. Diseases Control
1) Élie Metchnikoff (1845-1916) - Phagocytes
2) Paul Ehrlich (1854-1915) and Emil Von Behring (1854- 1917) – Toxins (antigens) and Antitoxins (antibodies)
3) Edward Jenner (1749-1823) - Vaccination
4) Dimitri Ivanowsky – Viral Particles
5) Martinus Willem Beijernick (1851-1931) - TMV
6) Wendell Stanley (1904-1971) – Crystallization of the Tobacco Mosaic Virus (TMV).
7) Discovery of Bacteriophages – Early 1990's

e. The New Golden Age of Microbiology
1) Molecular Biology Techniques
a) Werner Arber, Hamilton Smith and Daniel Nathan (Restriction Enzymes); Paul Berg (Recombinant DNA Technology)
c) Kary Mullis (PCR)

B. Cellular Structure and Function
1. The Prokaryotic Cell
a. Size
1) Mycoplasma
2) *Epulopiscium fishelsoni; Thiomargarita namibiensis*
b. Morphology (form/shape)
1) Coccus (singular), cocci (plural)
2) Rods
3) Spiral
4) Pleomorphic: *Chlamydia; Rhizobium*
c. Arrangement
1) Diplococcus
2) Streptococcus
3) Staphylococcus
4) Micrococcus
5) Sarcina
6) Palizade and Angular Arrangements
7) Filamentous
2. Microscopy
a. The light Microscope
1) Bright Field
2) Dyes
(a) Acid
(b) Basic (alkaline)
3) Staining Techniques
(a) Simple
(b) Differential
(c) Special

2) Dark Field Microscopy
3) Fluorescence Microscopy
4) Phase Contrast Microscopy

b. Electronic Microscope (EM)
1) Transmission (TEM)
2) Scanning (SEM)

3. Bacterial Structures
a. Cell Envelope
1) Plasma Membrane
(a) Phospholipid Bilayer
(b) Intrinsic Proteins
(c) Extrinsic Proteins
2) Cell Wall
(a) Peptidoglycan or Murein
(b) Lateral Tetrapeptic Crosslinking Chains
(c) Teicoic and Lipoteicoic Acid
3) Outer Membrane
(a) O antigen
(b) Core Polysaccharide
(c) Lipid A

b. Specialized Extracellular Structures
1) Capsule
(a) Chemical Composition
(b) Capsule Detection
(1) Negative Staining
(2) Quellung Reaction
2) Glucocalix
(a) Dextron
(b) Dental Plaque
(c) Dental Cavities
3) Pilus (singular), Pili (plural)
(a) Type I pilus
(b) Type F pilus
4) Flagellum
(a) Basal Body
(b) Filamentous
(c) Hook
(d) Motility (movement)
(1) Chemotaxis
(2) Phototaxis
(3) Aerotaxis
(4) Magnetotaxis

c. Intracellular Specialized Structures
1) Nucleoid
2) Plasmids

3) Ribosomes
4) Inclusions
(a) Metachromatic granules
(b) Poly-Beta Hidroxybutirate Granules
(c) Gas Vacuole

d. Vegetative Cell vs. Endospore `
1) Endospore Structure
(a) Exosporium
(b) Cover
(c) Cortex
(d) Wall
(e) Interior Matrix
2) Sporogenesis
3) Endospore Germination

4. Comparison of Prokaryotic and Eukaryotic Cells

C. Nutritional Requirements and Microbial Growth
1. Energy Sources
a. Phototrophic (Photosynthetic)
b. Chemotrophic (Chemosynthetic)
1) Chemoorganotrophic
2) Chemolitotrophic
2. Carbon Sources
a. Autotrophic
1) Photoautotrophic
2) Chemoautotrophic
b. Heterotrophic
1) Photoheterotrophic
2) Chemoheterotrophic
c. Methylotrophic
3. Nutrients
a. Nitrogen
b. Phosphorus
c. Sulfur
4. Growth Factors
a. Amino Acids
b. Purines and Pyrimidines
c. Vitamins
5. Transport of Nutrients
a. Passive Diffusion
b. Facilitated Diffusion
c. Active Transport
d. Group Translocation
6. Physical Requirements for Microbial Growth
a. Cardinal Temperatures

1) Bacterial Classification Based on Cardinal Temperatures
    a. Psychrophilic
    b. Mesophilic
    c. Thermophilic
    d. Hyperthermophilic (Extreme Thermophiles)

b. pH
    1) Neutrophilic
    2) Acidophilic
    3) Alkaliphilic

c. Physical Effect of Water
    1) Water Activity (a_w)
    2) Osmotolerant Bacteria
    3) Asmophilic Bacteria
    4) Natronobacterium

d. Oxygen Requirements
    1) Aerobic Bacteria
    2) Microaerophilic
    3) Facultative Anaerobic Bacteria
    4) Anaerobic Bacteria
    5) Aerotolerant Bacteria

e. Lethal Effect of Oxygen
    1) Oxidation of Cellular Components
    2) Anaerobic Culture of Bacteria
        (a) Gaspak Anaerobic System
    3) Aerobic Bacteria that Grow Better in High Concentrations of CO_2
        (a) CO_2 Incubator
        (b) Anaerobic Culture with a Candle in a Jar

f. Culture Media
    1) Basic Types
        (a) Complex or Chemically-undefined
        (b) Synthetic or Chemically-defined
    2) Special Culture Media
        (a) Enriched Culture Media
        (b) Differential Culture Media
        (c) Selective Culture Media

D. Microbial Population Growth
1. Basic Concepts
    a. Growth
    b. Binary Fission
    c. Generation Time
2. Microbial Growth Measurements
    a. Cell-number Count

1) Direct Counting Methods
(a) Petroff-Hausser Chamber
(b) Acridine Orange Direct Count (AODC)
2) Indirect (viable) Counting Methods
(a) Spread Plate
(b) Pour Plate
b. Most Probable Number (MPN)
c. Turbidimetric Measurements
d. Cell Mass Determination
3. Population Growth Curve
a. Lag Phase
b. Log Phase
c. Stationary Phase
d. Death Phase
4. Special Bacterial Culture Techniques
a. Continuous (open) Cultures
1) Open Culture Types
(a) Chemostat
(b) Turbidostat
b. Synchronized Cultures

E. Control of Microbial Growth
1. Sterilization
a. Wet-heat Methods
1) Autoclave
b. Pasteurization
c. Filtration
d. Dry-heat Methods
1) Incineration
e. Use of Ionizing Radiation
1) gamma rays
f. Use of non-ionizing Radiation
1) Ultraviolet (UV) Light
2. Alternate Growth-control Methods
a. Refrigeration
b. Freezing
c. Dehydration
d. Osmotic Pressure
e. Use of Chemical Agents
1) Sodium Benzoate, Calcium Propionate, Boric Acid, Ascorbic Acid.
3. Antimicrobial Agents
a. "cidal" Classification of Growth-control Agents
1) Algaecidal
2) Bactericidal
3) Fungicidal

b. "static" Classification of Growth-control Agents
    1) Algaestatic
    2) Bacteriostatic
    3) Fungistatic
c. Classification of Antimicrobial Agents
    1) Disinfectants
    2) Antiseptic
    3) Antibiotics
    4) Synthetic Drugs
d. Antifungal and Antiprotozoal Agents
e. Antiviral Drugs

F. Metabolism
    1. Energy Transformations in the Biosphere
    2. ATP-synthesis in Microorganisms
        a. Oxidative Phosphorylation
            1) Cellular Respiration
        b. Photophosphorylation
            1) photosynthesis
        c. Substrate-level Phosphorylation
            1) Glucose Oxidation (Glycolysis; Fermentation)
G. Microbial Genetics
    1. Basic Concepts
    2. Mutations and DNA-modifications
    3. Transference of Genetic Material
        a. Transformation
        b. Transduction
        c. Conjugation

Laboratory Content

a. Introduction to the Microbiology Laboratory and Safety Rules.
b. Use of the Light Microscope
c. Hanging Drop Technique
d. Ubiquity of Microorganisms, Colony Characteristics and Simple Stain
e. Culture-transfer and Streak-plate Techniques.
f. Gram Stain
g. Acid-Fast Stain (Ziehl-Neelsen method)
h. Endospore Stain (Schaeffer-Fulton method)
i. Capsule Stain (Anthony method)
j. Serial Dilutions and Spread-plate Techniques for Bacterial Quantification
k. Selective and Differential Culture Media I
l. Selective and Differential Culture Media II
m. Microbial-Growth Control Agents (Chemical/Antibiotics)

VI. COURSE ACTIVITIES

1. Lectures in Power Point format, available on Blackboard.
2. Audiovisual presentations with video animations and computer simulations.
3. Additional reading material available on Blackboard.
4. Laboratory exercises including the identification of an unknown microorganism.
5. Investigative case-study discussions.

VII. EVALUATION CRITERIA

	Points	Percent
3 exams	300	54
Active-learning Activity	100	18
Laboratory reports	300	23
Attendance	100	5
	800	100

VIII. SPECIAL NOTES

A. *AUXILIARY SERVICES AND SPECIAL NEEDS*

Students who require special accommodations must request these services at the beginning of the course as soon as they notice that they need help. Students can access this service with Professor José Rodriguez, Coordinator of Students with Special Needs at the Guidance and Counseling Office on the first floor at Metro's Student Center.

B. *PLAGIARISM, FRAUD AND HONESTY*

Plagiarism, dishonesty, fraud and any other type of manipulation or inappropriate behavior related with academic performance are unacceptable in our institution. Disciplinary actions will be taken on students found guilty of such practice as established in Chapter V, Article 1, Section B.2 of the Student's Rules and Regulations handbook.
http://documentos.inter.edu/docs/index.php?article=77

Inter American University has very strict regulations regarding plagiarism (using the ideas or words of others without giving proper credit), so it is important that you specifically read Chapter 5, Article 1, Section B.2c of the Student' Rules and Regulations Handbook. This section clearly explains what plagiarism is. In addition, it explains the types of sanctions students are exposed to when they commit it.

C. *USE OF ELECTROIC DEVICES*

Cellular (mobile) telephones and any other electronic device that could interrupt the teaching-learning process or disrupt a milieu favorable for academic excellence will be deactivated. Critical situations will be dealt with in an appropriate manner. The use of electronic devices that permit the accessing, storing or sending of data during tests or examinations is prohibited.

IX. EDUCATIONAL RESOURCES

Text: Bauman, R.W. (2014). 4th Ed. *Microbiology with Diseases by Taxonomy*. San Francisco, CA. Pearson /Benjamin/Cummings.
ISBN-13: 978-0321819314 / ISBN-10: 0321819314

BIBLIOGRAFY:

Reference Books:

- Wessner, D. R., Dupont, C., Charles, T. C. (2013) *Microbiology*.
- Eddison, NJ. John Wiley & Sons, Inc. ISBN: 978-0-471-69434-2.
- Cowman, M. K., Talaro, K. P. (2009). New York, NY. : McGraw-Hill. Interamericana.
- Madigan, M. T., Martinko, J. M., Clark, D. P., Dunlap, P. V., (2009). *Brock Bilogy of Microorganisms.* (12th. ed.). San Francisco, CA.: Pearson Benjamin Cummings.
- Prescott, L. M., Sherwood, L M., Willey, J. M., Woolverton, J. C. (2009). *Principles of Microbiology*. New York, NY. : McGraw-Hill. Interamericana.

Laboratory Manual (for reference only):

Cappuccino, J. G. & Sherman, N. (2013). *Microbiology: A Laboratory Manual*. (9na. ed.). San Francisco, CA. Pearson Benjamin Cummings.

Audiovisual resources:

Lectures on Blackboard

Electronic resources:

- http://www.pearsonmylabandmastering.com/northamerica/masteringmicrobiology/students/get-registered/index.html
- http//www.asmusa.org
- http//www.microbelibrary.org

SYLLABUS REVISSION: November 2015