INTER AMERICAN UNIVERSITY OF PUERTO RICO
METROPOLITAN CAMPUS
SCHOOL OF SCIENCE AND TECHOLOGY
NATURAL SCIENCE DEPARTMENT
MASTER'S IN SCIENCE IN MOLECULAR MICROBIOLOGY

SYLLABUS

I. GENERAL INFORMATION

Course Title	:	Biochemistry of biomolecules I
Code and number	:	MOMI 5101
Credits	:	3
Academic term	:	
Instructor	:	
Office hours and location	:	
Office telephone	:	
E-mail	:	

II. DESCRIPTION

Evaluation of the structure, function, metabolism, thermodynamics, expression, and interactions of nucleic acids. Emphasis on DNA biochemistry I prokaryotic systems.

III. OBJETIVES

At the end of the course, the student is expected to be able to:

1. Describe the chemical and physical properties of DNA/RNA and the importance of these properties in the study of nucleic acids.
2. To evaluate the roles of gene replication, transcription, and translation in the control of gene expression.
3. Evaluate molecular techniques used in the elucidation of gene structure and function.
4. To establish the importance of DNA in the advancement of molecular biology and research in the area of nucleic acids.

Competencies of the graduate's profile addressed in the course:

1. C2. Evaluate scientific information from diverse sources.
2. D2. Evaluate the most useful platforms for analyzing molecular microbiology data using emerging tools.

IV. CONTENT

A. Introduction and structures of DNA y RNA
    1. Primary structures
    2. Secondary structures
    3. Tertiary structures (RNA)
    4. Methods to study DNA and RNA structures
        a) Nuclear Magnetic Resonance Spectroscopy
        b) X-ray crystallography
    5. Denaturalization and renaturalization
    6. Conditions favoring renaturalization
        a) temperature
        b) salt concentration
        c) pH
    7. Renaturation kinetics
    8. Southern blot
    9. Topoisomerases (general aspects)
    10. Restriction endonucleases
    11. DNA physical map
    12. DNA/RNA binding
    13. Modification of DNA terminals
    14. DNA cloning
    15. Gene isolation
    16. Chromosome Walking
    17. DNA conformations
    18. DNA size, shape, and angle
    19. DNA winding

B. DNA and RNA hybridization and thermodynamics
    1. Base-pair stability rules
    2. Fusion
    3. Hybridization
    4. hypocronism
    5. Microarrays
C. Nucleotide biosynthesis
    1. Purine biosynthesis

a) *De novo* biosynthesis
b) Regulaciones de la biosíntesis de purinas
c) Purine salvage
Diseases associated with irregularities in the biosynthesis of purine: Lesh-Nyham Syndrome

2. Biosynthesis of pyrimidines
    a) De novo biosynthesis
    b) Regulation of pyrimidine biosynthesis
3. Formation of NAD+, FAD and Coenzyme A from ATP.
4. Pathological conditions caused by the interruption of nucleotide metabolism.
5. Applications of nucleotide biosynthesis in drug development. Replicación del DNA en sistemas procarióticos
6. DNA polymerases
    a) E. coli polymerase I and its applications in drug design.
    b) Polymerase III
    c) DNA sequencing and methods for DNA sequencing
        1. Mass spectrometry
        2. PCR
            a. DNA Amplification (Polymerase Chain Reaction, PCR)
            b. Real-time PCR (kinetics PCR)
        3. Gel electrophoresis
        4. Sanger method
        5. Maxam-Gilbert method (chemical cleavage)
        6. Shotgun sequencing
        7. RFLP analysis Clonación de cDNA
7. Replication of E. coli DNA
    a) DNA polymerase III holoenzyme
    b) Other replication proteins: DnaA, DnaB (helicase), DnaC, DnaG (primase), SSB (single-strand binding protein), DNA ligase.
8. Initiation of DNA replication in oriC
9. Leader Strand Synthesis
10. Lagging Strand Synthesis
11. Maturation of Okazaki fragments
12. Segregation of circular DNA daughter molecules.

D. DNA replication in eukaryotic systems
1. Functions of some proteins in in-vitro replication processes
    a) T antigen
    b) RPA
    c) DNA alpha polymerases/primases

d) DNA delta polymerases
e) DNA epsilon polymerases
f) RFC
g) PCNA
h) Topoisomerases I, IIa and IIb (general aspects)
i) FEN-1
j) RNaseH1
k) DNA ligase I

2. Telomerases and their functions
3. Telomerase elongation mechanisms

E. DNA Topoisomerases (Specific Aspects)
1. Topoisomerases of Family IA
2. Family IB Topoisomerases
3. Family II Topoisomerases
a) E. coli DNA gyrase (Topoisomerase II)
b) Topoisomerase IV of E. coli DNA
4. Applications of DNA topoisomerase in drug design.

F. DNA repair

G. DNA recombination

H. Prokaryotic transcription
1. RNA polymerase
2. Promoters
3. Sigma factor
4. Elongation complexes
5. Termination

I. Prokaryotic gene regulation
1. Lactose operon
2. Circular DNA repression
3. Catabolic repression

J. Eukaryotic transcription
1. Initiation factors
2. Transcription machinery
3. Fidelity in RNA polymerase II transcription 4.
4. Capping
5. Polyadenylation pathway and regulation
6. Splicing

K. Eukaryotic gene regulation
1. Eukaryotic transcription factors.
2. Regulatory proteins
3. Mechanisms of hormonal control of Nuclear-Receptor Activity

4. Repressor Proteins
5. RNA polymerase I
6. RNA polymerase III

L. Genetic code
M. Translation
    1. Functions of transfer RNA
    2. Deletions
    3. Ribosomes
    4. Initiation, elongation and release protein factors.
    5. Prokaryotic translation initiation (E. coli)
    6. Eukaryotic translation initiation
    7. Molecular mimicry
    8. Elongation
    9. Termination
    10. Ribosome Recycling Factor
N. Prions
O. Oncogenes
P. Tumor suppression genes
Q. DNA Interactions
    1. DNA-water interactions
    2. DNA-water-ion interactions
    3. DNA-drug interactions
    4. DNA-protein interaction
R. Biochemical methods to study complexes
    1. Affinity curves ("Binding curves")
    2. migratory mobility in gel
    3. fingerprinting/interferences
    4. crosslinking
    5. filter binding
    6. FRET
    7. ChIP
S. Protein structural motifs for nucleic acid binding
    1. Helix-turn-helix
    2. zinc fingers
    3. bZIP proteins
    4. TBP
    5. hnRNP
    6. Molecular Visualization
T. Sequencing and specific recognition of nucleic acids
    1. Major Groove vs. minor Groove

2. Hydrogen bridges
3. Direct and indirect reads
4. Deformability
5. RNA recognition

U. Chromosome structure
1. Nucleosomes
2. Chromatin
3. High-order structures
4. Telomerases

V. LEARNING ACTIVITIES

1. Conference
2. Blackboard
3. Student participation
4. Practice exercises
5. Homeworks

VI. EVALUATION

Course evaluation consists of:

		Score	% Final Grade
3 exams		300	75
Final exam or equivalent		100	25
	Total	**400**	**100**

None of the exams are dropped, but the student will have the option to substitute the lowest midterm grade for the equivalent of 100 points accumulated during the semester at the professor's discretion. One of the midterm exams will be made-up at the end of the course.

VII. SPECIAL NOTES

A. Auxiliary services or special needs

All students who require auxiliary services or special assistance must request these at the beginning of the course or as soon as they know that they need them, through the proper registry, in the Office of Orientation with Sr. José Rodríguez.

B. Honesty, fraud, and plagiarism

Dishonesty, fraud, plagiarism and any other inappropriate behavior in relation to academic work constitutes major infractions sanctioned by the General Student Regulations. The major infractions, as stated in the General Student Regulations, may have as a consequence, suspension from the University for a definite period greater than one year or the permanent expulsion from the University, among others sanctions.

C. Use of electronic devices

Cellular telephones and any other electronic device that could interrupt the teaching and learning processes or alter the environment leading to academic excellence will be deactivated. Any urgent situation will be dealt with, as appropriate. The handling of electronic devices that allow students to access, store or send data during evaluations or examinations is prohibited.

D. Compliance with the Provisions of Title IX

The Federal Higher Education Act, as amended, prohibits discrimination because of sex in any academic, educational, extracurricular, and athletic activity or in any other program or function, sponsored or controlled by a higher education institution, whether or not it is conducted within or outside the property of the institution, if the institution receives federal funds.

In harmony with the current federal regulation, in our academic unit an Assistant Coordinator of Title IX has been designated to offer assistance and orientation in relation to any alleged incident constituting discrimination because of sex or gender, sexual harassment or sexual aggression. The Assistant Coordinator, Sr. George Rivera, can be reached by phone at 787-250-1912, extension 2262 o 2147, or by e-mail griverar@metro.inter.edu.

The Normative Document titled Norms and Procedures to Deal with Alleged Violations of the Provisions of Title IX is the document that contains the institutional rules to direct any complaint that appears to be this type of allegation. This document is available in the Web site of Inter American University of Puerto Rico (www.inter.edu).

VIII. EDUCATIONAL RESOURCES

Textbook

Molecular Biology. Weaver, R. F., McGraw Hill, 5th edition. 2012. ISBN 978-0-07-352532-7.

Supplementary Readings

The Chimpanzee Sequencing and Analysis Consortium (2005). "Initial sequence of the chimpanzee genome and comparison with the human genome." *Nature* **437**, 69-87.

Cosma, M. P., Tanaka, T. and Nasmyth, K. (1999). "Ordered recruitment of transcription and chromatin remodeling factors to a cell cycle- and developmentally regulated promoter." *Cell* **97**(3), 299-311.

Moser, H. E. and Dervan, P. B. (1987). "Sequence-Specific Cleavage of Double Helical DNA by Triple Helix Formation." *Science* **238**, 645-650.

Naktinis, V., Turner, J. and O'Donnell, M. (1996). "A Molecular Switch in a Replication Machine Defined by an Internal Competition for Protein Rings." *Cell* **84**, 137-145.
Ren, B., Robert, F., Wyrick, J. J., Aparicio, O., Jennings, E. G., Simon, I., Zeitlinger, J., Schreiber, J., Hannett, N., Kanin, E., Volkert, T. L., Wilson, C. J., Bell, S. P. and Young, R. A. (2000). "Genome-Wide Location and Function of DNA Binding Proteins." *Science* **290**, 2306-2309.

Seeman, N. C., Rosenberg, J. M., and Rich, A. (1976). "Sequence-specific recognition of double helical nucleic acids by proteins." *Proc. Natl. Acad. Sci. USA* **73**, 804-808.

Watson, J. D. and Crick, F. H. C. (1953). "Molecular Structure of Nucleic Acids: A structure for deoxyribose nucleic acid." *Nature* **171**, 737-738.

Zaug, A. J. & Cech, T. R. (1986). "The Intervening Sequence RNA of Tetrahymena Is an Enzyme." *Science* **231**, 470-475.

Zenkin, N., Yuzenkova, Y., and Severinov, K. (2006). "Transcript-Assisted Transcriptional Proofreading." *Science* **313**, 518-520.

IX. BIBLIOGRAPHY

Nucleic Acids in Chemistry and Biology. Blackburn, M., Gait, M. J., Loakes, D., and Williams, D. M., RSC Publishing, 3rd edition. 2006. ISBN-10: 0-85404-654-2/ISBN-13: 978-0-85404-654-6.

DNA Topology. Bates, A. D. and Maxwell, A., Oxford University Press, 2nd edition. 2005. ISBN-13 978-0198506553

Nucleic Acids: Structure, Properties and Functions. Bloomfield, V.A., Crothers, D.M., and Tinoco, I., Jr. University Science Books, Sausalito CA. 2000. ISBN-13 978-0935702491

Genes & Signals. Ptashne, M. and Gann, A. Cold Spring Harbor Laboratory Press. 1st edition.2001. ISBN-13 978-0879696337

Chromatin: Structure and Function. Wolffe, A. Academic Press, Inc. 3rd ed. 1999. ISBN-13 978-0127619156

Electronic Resources

National Center for Biotechnology Information. http://www.ncbi.nlm.nih.gov/ (Accedido noviembre de 2013)

RCSB. Protein Data Bank. http://www.rcsb.org/pdb/home/home.do (Accedido noviembre de 2013)

Principle of Biochemistry (Tutorial Web Page). http://bcs.whfreeman.com/lehninger5e/ (Accedido noviembre de 2013)

Interchemistry. http://www.internetchemistry.com/biochemistry/nucleic-acids.htm (Accedido noviembre de 2013)

Biochemistry tutorial. http://themedicalbiochemistrypage.org/nucleic-acids.html (Accedido noviembre de 2013)

FTMap Protein Mapping server. http://ftmap.bu.edu/ (Accedido noviembre de 2013)

Nucleic Acid Data Base. http://ndbserver.rutgers.edu/ (Accedido noviembre de 2013)

Swiss Institute of Bionformatics and Molecular Modeling Group. http://www.swissdock.ch/ (Accedido noviembre de 2013)

UCSF CHIMERA an Extensible Molecular Modeling System. http://www.cgl.ucsf.edu/chimera/ (Accedido noviembre de 2013)

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