Title: Biochemical Basis of Disease  
Code: BIOC3364  
Credits: 3  
Level: Undergraduate - Year III  
Semester: II

Pre-requisites: BIOC2262-Gene Expression and BIOC2161-Primary Metabolism

Enrolment capacity: 45 students (maximum)

COURSE DESCRIPTION:
The course covers applied aspects of cancer metabolism, gene therapy, diabetes and obesity, signal transduction/apoptosis, sensory systems and neurochemistry. Course materials will include class handouts e.g. illustrations and diagrams and the course will be fully myeLearning-supported. The course is a theoretical course.

COURSE RATIONALE:
This course provides a foundation for current advanced concepts in Biochemistry specifically with respect to cancer metabolism, gene therapy, diabetes and obesity, signal transduction/apoptosis, sensory systems and neurochemistry. Students will be required to build on concepts learnt in metabolism and gene expression courses (year II courses) and semester I final year courses on Experimental Biochemistry and Molecular Biology and Cellular and Molecular Defense Systems.

INSTRUCTOR INFORMATION:
Name of instructor(s): Sephra N. Rampersad  
Office address and phone: Rm 319, 2nd Floor-Old Wing, Natural Sciences Bldg  
Email address: sephra.rampersad@sta.uwi.edu  
Preferred method of contact: E-mail  
Communication policy: Students should use their UWI e-mail account for communication and/or leave a note or message with the Biochemistry secretary.

LETTER TO THE STUDENT:
Welcome to Biochemical Basis of Disease. This course aims to complete the degree offering for a major in Biochemistry and presents critical elements of current concepts Biochemistry specifically with respect to applied aspects of cancer metabolism, gene expression, diabetes and obesity, signal transduction/apoptosis, sensory systems and neurochemistry. Practice in writing out answers including tutorial assignments is also important to understanding the course material. Course
materials will include class handouts e.g. illustrations and diagrams and the course will be fully myelearning-supported. It is important to engage with the materials provided online, in face-to-face lectures and tutorials in order to successfully complete this course. Engagement with all facets of this course will enable you to develop skills of critical thinking (clarity, accuracy, relevance, logic, breadth, depth, precision, significance, completeness and fairness). You are encouraged to ask questions during class time and during tutorial sessions, offer new ideas or ways of studying a topic, offer new approaches to problem solve to support a student-centered learning experience. It is critical that you read the syllabus carefully and pay attention to important assessment dates. The University’s policy and plagiarism and attendance requirements will be enforced. It is important to us that you succeed in this course. Please come to us with any academic or other challenges you may face that could affect your attendance and performance. This course will enable students to have a foundation in these core aspects Biochemistry for teaching at secondary level, conducting research in medicine, pharmacy and/or related disciplines.

**COURSE CONTENT:**
Topic 1: Cancer
A study of the unique characteristics of cancer cells, how these characteristics are acquired and determining how they facilitate oncogenesis, the link between the unique properties of cancer cells and how this is exploited in the treatment of cancers, properties of cancer cells, treatment of cancer, underlying mechanisms of oncogenesis.

Topic 2: Signal Transduction and Apoptosis
Tyrosine kinase receptors/ras activation and MAP kinase cascades; ethylene detection in plants via MAP kinase cascade; Ca2+ and calmodulin dependent kinases; programmed cell death (apoptosis) and suppression of apoptosis.

Topic 3: Gene-based therapies
What is gene therapy, choosing targets for gene delivery; hallmarks of successful gene delivery; 5 approaches to gene therapy; viral vectors in gene therapy; non-viral approaches to gene therapy; new approaches to gene therapy; factors that hinder gene therapy from becoming an effective treatment for genetic disease; case studies in gene therapy treatments.

Topic 4: Diabetes
Definition and determination; insulin secretion: mechanism and factors affecting secretion and synthesis; insulin effects on muscle, liver and adipose tissue, effects on metabolism (carbohydrate, lipid and protein, different types of diabetes, I (TIDM, IDDM), II (T2DM, NIDDM) and MODY.

Topic 5: Obesity
Definition, determination and epidemiology, neuro-hormonal regulation of energy homeostasis: roles of insulin, leptin and the leptin receptor, melanocortins and neuropeptide Y, genetic defects – animal models, specific mutations and mode of transmission, effects of obesity, biochemical basis and treatment.

Topic 6: Sensory Systems
Introduction to neurotransmission – ion gradients, voltage-gated ion channels, action potentials, channel toxins. The different families of neurotransmitters – acetylcholine, catecholamines, amino
acids and derivatives, peptides, gases, biochemistry of vision – pathway for the incorporation of retinal into the light sensitive protein rhodopsin.

Topic 7: Neurochemistry
Memory – classifications and their characteristics, major divisions of implicit and explicit memory; response to stimuli and habituation.

**LEARNING OUTCOMES:**
At the end of this course, students should be able to:-

**TOPIC 1: Cancer**
1. evaluate the processes involved in carcinogenesis.
2. explain the role of cancer-critical genes in carcinogenesis.
3. differentiate between oncogenes and tumour suppressors genes.
4. describe the unique characteristics of cancer cells and how these characteristics enable them to develop tumours.
5. explain the mechanism of metastasis and the conditions that would favour or inhibit it.
6. evaluate how therapy is closely associated with exploiting the unique characteristics of cancer cells.

**TOPIC 2: Signal Transduction and Apoptosis**

**Lecture 1**
1. describe the structures of the receptor tyrosine kinase proteins
2. explain how information can be passed through the plasma membrane
3. describe the series of protein interactions required to activate Ras
4. describe the molecular nature of the Ras protein
5. explain why it is activated through a GEF rather than a GAP
6. describe the MAP kinase cascade
7. explain the importance of the correct activation of the cascade components

**Lecture 2**
1. explain how cross talk is prevented between different kinase cascades
2. explain the problems associated with the prevention of cross talk
3. describe MAP-kinase signaling in plants
4. describe the structure of PIP lipids
5. describe the roles of these lipids in signaling either by PI3 kinase or through the action of PLC”s

**Lecture 3**
1. explain why apoptosis is required by multicellular organisms
2. describe the biochemical nature of caspases and the mechanism of activation
3. explain how the apoptotic pathway can be triggered by intrinsic or extra cellular events
4. describe the molecular nature of the apoptotic initiation pathways
5. explain the roles of survival signals and the molecular roles of Bad and Hid proteins
TOPIC 3: Gene-based therapies
1. explain the meaning of gene therapy
2. evaluate the factors that affect the application of gene therapy in treating genetic disorders
3. explain some of the (selected) hallmarks of successful gene delivery.
4. compare virus-mediated and non-virus mediated gene delivery.
5. differentiate between in vivo vs. ex-vivo gene delivery approaches.
6. evaluate at least 2 methods of overcoming cases of mutated genes and non-functioning proteins.
7. explain what factors hinder gene therapy from becoming an effective treatment for genetic disease.
8. state 5 genes that can be tested for normal or abnormal expression.
9. assess the selection of genetic disorders that are candidates for gene therapy.
10. evaluate the application of targeting gene expression and mutation correction using gene therapy.

TOPIC 4: Diabetes—Offered in alternate years
Lecture 1
1. explain insulin secretion and action.
2. evaluate the mechanism of glucose-stimulated insulin secretion.
3. evaluate factors affecting secretion and synthesis: insulin secretagogues.
4. explain how insulin effects on muscle, liver and adipose tissue, effects on carbohydrate, lipid and protein metabolism.

Lecture 2
1. define diabetes
2. explain how diabetes is diagnosed.
3. explain the classification of diabetes mellitus: Types and subtypes.
4. evaluate the epidemiology of diabetes: examination of global trends.

Lecture 3
1. explain the pathophysiology and complications of diabetes.
2. explain the genetic basis of diabetes using the polygenic model.
3. evaluate the treatment and management options.

Lecture 4
1. evaluate maturity-onset diabetes of the young.
2. explain the genetic basis of the disease using monogenic models -MODY subtypes 1-6 and MODY X).
3. explain the pathophysiology of the disease.
4. evaluate the complications, treatment and management options.

Lecture 5
1. explain the genetic basis of the T2DM disease using polygenic model.
2. evaluate obesity-induced insulin resistance and pathological progression to T2DM.
3. evaluate metabolic syndrome, complications, treatment and management options.
TOPIC 5: Obesity – Offered in alternate years

Lecture 1
1. explain and correctly use basic terms/jargon used in the study of disease.
2. apply the definition of obesity
3. explain the measurement and classification of obesity.
4. evaluate the aetiology and epidemiology of obesity with examination and explanation of global trends.
5. evaluate the relationship between obesity and racial groups.

Lecture 2
1. evaluate the health risk factors associated with overweight and obesity – link to body fat distribution i.e. android vs. gynoid obesity and visceral vs. subcutaneous fat.
2. compare hypercellular and hypertrophic obesity and evaluate the associated disease risk.
3. evaluate the biochemical basis of health risks associated with obesity – alterations in protein, lipid and glucose metabolism (Focus on Type 2 diabetes, hypertension, cardiovascular disease, cancer).

Lecture 3
1. explain energy homeostasis.
2. describe positive and negative energy balance.
3. evaluate sensory and satiety factors: feedback mechanisms.
4. explain neuro-hormonal regulation of energy homeostasis: roles of insulin, leptin, the leptin receptor, the melanocortins, neuropeptide Y, adiponectin, resistin and ghrelin.

Lecture 4
1. compare monogenic and polygenic models of obesity using rodent and human examples.
2. evaluate the nature of specific genetic mutations with respect to protein affected, mode of transmission, association with hyperphagia, and time of onset of obesity.
3. explain and compare “thrifty phenotype” vs. “thrifty genotype”.

Lecture 5
1. evaluate the clinical treatment of obesity in terms of Diet (evaluation of glycaemic index), exercise, pharmaceutics: mechanism of drug actions, surgery, and expected effect of treatment on associated health risks.

TOPIC 6: Sensory Systems
1. explain how higher animals perceive stimuli.
2. outline the 4 regions of the neuron.
3. describe signal transmission.
4. explain how synapses work and the major kinds that exist.
5. explain the 4 characteristics of neurotransmitters and the classes.
6. apply case studies of neurological diseases to explain how synapses and signals can malfunction.
7. explain 3 types of receptors that respond to chemical stimulation and are involved in neurotransmission.
8. explain the use of various drugs in affecting nerve transmission.
9. evaluate the resting membrane potential.
10. evaluate the action potential.
11. explain the relationship between myelin and neurotransmission.
12. evaluate the mechanisms of olfaction and gestation.
13. evaluate sensory transduction in vision and the role of rod and cone cells.

TOPIC 7: Neurochemistry
1. outline the gross anatomy of the CNS (brain and spinal cord)
2. describe the neurocellular anatomy of the brain (motor neuron and neuroglia)
3. describe the blood supply to the brain and the concept of the blood brain barrier
4. explain the origin of cerebrospinal fluid (CSF) and CSF flow in the brain
5. evaluate the role of lipids in the brain and myelin formation
6. describe the energy metabolism of the brain
7. explain the nature of the action potential.
8. explain synaptic transmission and cellular signaling in the CNS
9. give an account of the various neurotransmitters in the brain and their roles
10. describe the various types of receptors for neurotransmitters in the brain
11. evaluate the neurochemical aspects of the neurodegenerative diseases of the brain e.g Parkinson’s and Alzheimer’s disease.
12. explain the mechanism of learning and memory
13. assess the neurochemical aspects of schizophrenia, mood and anxiety disorders, and addiction.
14. evaluate the role of stem cells for the treatment of myelin loss.
15. recognize the use of neuroimaging in diagnosing disorders of the brain e.g hypoxic-ischemic injury.

LEARNING OUTCOMES FOR LIBRARY RESEARCH PROJECT ASSIGNMENT:
At the end of the library research project written assignment, students should be able to:-

1. conduct research on a specific topic within a specified time-frame.
2. define broadly, the types of information sources eg. reference books, journals, internet resources.
3. analyze search results from keyword/subject searching.
4. design and execute an appropriate search strategy from multiple information sources to retrieve specific information.
5. evaluate information sources as relevant, accurate and significant.
6. use information to construct and refine a thesis statement in context.
7. determine what channels of information scholars in a specific discipline use to best disseminate information.
8. explain how information retrieval and filtering are essential to support research ideas.
9. write effectively to convey specific ideas in a logical, systematic manner.
10. develop grammar, vocabulary relevant to the specified discipline.
11. write within a specified presentation format.

COURSE ASSESSMENT:
Assessment will be based on a student’s final mark from the coursework components below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Mark Weighting</th>
<th>Description</th>
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<tbody>
<tr>
<td>5 In-course tests</td>
<td>each worth 4%</td>
<td>4 tests (30 mins duration) based on multiple choice, true/false, short answer questions; exams will cover 2 weeks worth of teaching</td>
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<td>1 library research project as a written assignments</td>
<td>30%</td>
<td>10,000 word investigative report based on current research in disease biochemistry and genetics</td>
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<tr>
<td>Final exam</td>
<td>50%</td>
<td>2-hour written exam to answer 3 out of 5 essay questions; Two sections where students must answer at least one question from each section</td>
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EVALUATION:
- Student opinion on the course with respect to delivery and assessment will be obtained through informal and regular discussions with students. Discussions with demonstrators, teaching assistants and instructor for the course will also be used to identify and address student issues.
- Class Representatives are required to sit on the Departmental Student-Staff Liaison Committee meetings held twice during the semester and at each meeting, to submit a completed reporting form. Class reps are to be guided by the Department’s Standard Operating Procedures.
- The UWI Course Evaluation questionnaire administered anonymously and confidentially at the end of the semester will also be used to assist in identifying student issues.
- All feedback will be considered on an on-going basis; actions will be taken immediately (preferred and as applicable) or incorporated the following year.

TEACHING STRATEGIES:
Contact hours (36 credit hours):
Lectures: 33 h
Tutorials: 3 h

Lectures: Lectures will provide valuable synthesis and evaluation of the growing body of available information, update current issues and events, and prioritize content relevant to course assessment.
For this course, the delivery strategy will be chalk-and-talk with continuous class interaction and engagement. Posting lecture notes prior to class times will not be practiced as this has resulted in a drop in attendance.

Tutorials: Tutorials will cover course topics in a problem-solving format to engage collaborative and active learning techniques.

myeLearning: myeLearning will be used extensively during this course for official communication among students and staff (email, discussions), official posting of important notices (coursework assessment notices, instructions, glossaries, and in-course marks/results), official posting of syllabus, lecture notes, tutorials, posting of important web-related resource materials and links.

**RESOURCES:**

Most resources will be posted to myeLearning and will include:

- Lecture notes and outlines - include learning objectives, summaries, recommended readings
- Resources - links to papers, articles and websites with interactive resources and you tube videos and animations to support delivery
- Tutorials – tutorial questions

Note: Answers to tutorials will not be posted as a strategy to encourage students to attend all tutorial sessions.

**READING:**

Diabetes and Obesity

Neuropeptide Y and Melanocortins, Mediate Lipolysis in Murine Adipocytes. 


9. Schwartz, M. 1999. Model for the regulation of energy balance and adiposity by the 


**Neurochemistry**
Thomas M. Jessel - published by McGraw-Hill

2. *Basic Neurochemistry: Molecular, Cellular and Medical Aspects* - 7th Ed. (2008)- George 
J. Siegel, R. Wayne Albers, Scott T. Brady and Donald L. Price - published by Academic 
Press, Elsevier.

3. *Instant Notes in Neuroscience* - 2nd Ed.(2005) - Alan Longstaff - published by Taylor & 
Francis.

4. *Trends in Neurosciences (Trends. Neurosci. or TINS)*- a current awareness journal in basic 
neuroscience published monthly. Contains many excellent review articles.

**Signal Transduction and Apoptosis**
1. Molecular Biology of the Cell 5th Ed Alberts et alLehninger:


4. Biochemistry and molecular biology of plants Buchanan, Gruissem and Jones ASPP

**Gene Therapy**

2. Gene Therapy Reviews – review journal articles specific to different organ systems – 
rotated in successive years.

**COURSE CALENDAR:**

<table>
<thead>
<tr>
<th>WEEK</th>
<th>LECTURES</th>
<th>LECTURER</th>
<th>PROJECTS</th>
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<tbody>
<tr>
<td>wk1</td>
<td>Introduction/Course Overview</td>
<td>Rampersad</td>
<td>Library Research Project</td>
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<td>Gene therapy</td>
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<td>wk 2</td>
<td>Gene therapy</td>
<td>Rampersad</td>
<td>Library Research Project</td>
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<td></td>
<td>Exam #1</td>
<td>Rampersad</td>
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<td>3</td>
<td>Signal Trans &amp; Apoptosis</td>
<td>Lennon</td>
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<td>Exam #2</td>
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<td>Submission of project</td>
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<td>wk 12</td>
<td>Tutorial</td>
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**HOW TO STUDY FOR THIS COURSE:**

- Attendance is mandatory for lectures and tutorials.
- Continuous reading and studying of lecture material are strongly encouraged to maintain learning momentum.
- Students are strongly advised to become familiar with navigating myelearning and look out for new postings and messages. Students are asked to utilize correct e-mail etiquette in any and all correspondence to staff.
- Students are encouraged to interact regularly with staff on their projects, even outside of the assigned tutorial times to ensure prompt, satisfactory solution of any problems and to monitor progress.

**ADDITIONAL INFORMATION:**

Students must pay attention to the following important information concerning assessment, attendance and plagiarism:-

- As a general principle, medicals or other excuses may only excuse a student’s absence from the original exam. Students must sit the makeup exam at the assigned date and time.
- All course work submissions must be attached to a signed Coursework Accountability Statement in order to be assessed. Refer to ‘University Regulations on Plagiarism’ available from [http://sta.uwi.edu/resources/documents/Exam_Regulations_Plagiarism.pdf](http://sta.uwi.edu/resources/documents/Exam_Regulations_Plagiarism.pdf).
- While it is known that students form FaceBook groups for a particular course, myeLearning remains the official communication platform for the course.