Course code: BIOL 2360  
Course Title: Biochemistry IIA  
Credits: 3  
Level: 2  
Semester: 1  

Pre-requisites:  
Either BIOL1362 Biochemistry I or BIOL 1061 Cell Biology and Genetics and either CHEM 1062 Basic Chemistry for Life Sciences or CAPE Chemistry or CHEM0060/1 Preliminary Chemistry I & II and either BIOL1262 Living Organisms I or BIOL1263 Living Organisms II or BIOL1261 Diversity of Organisms.

Anti-requisites:  
BIOL2361 Biomolecules & Energy Metabolism; BIOL2365 Comparative Biochemistry

Course Description  
Biochemistry is a fundamental sub-discipline of Biology. This course starts off by exploring the question – Why is life thermodynamically possible? We will also examine how we digest and metabolize sugars, fats and proteins. Subsequently, we will discuss the roles of the main hormones involved in the fed and fasting states and finally we will look at two common metabolic disorders in the Caribbean, diabetes and obesity.

Course Rationale:  
BIOL 2XXX is a core course for the Biology Major in the Department of Life Sciences. This course builds on the topics covered in the year 1 Biochemistry course, BIOL 1362. It covers key biochemical concepts required for understanding modern Biology. Materials covered in this course will be an asset for students who wish to further their studies in fields of medicine or nutrition or wish to pursue careers in teaching or the pharmaceutical industry.

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Letter to the students:
Dear Biochemians,
Congratulations on passing your first year courses. We look forward to guiding you on the rest of your journey here at the UWI. We shall implement a learner-centric approach to this course. There are screencast versions of all the BIOL 2365 lectures so that you can follow and learn at your own pace. This, however, is not a one-way service. You too will be required to create 15-minute YouTube videos of topics from the syllabus. You will have access to a database of student videos from previous years so that you can get a sense of what is required from your videos. I am hoping that you get a better understanding of the topics by seeing it explained by your peers. You will be networking and collaborating with students from the other UWI campuses as well as globally via my BiochemJM Blog and Facebook services. Together, we shall challenge the traditional roles in the classroom and have students present and teach the course. The classroom will be filled with interaction and discussion. It is my sincerest wish that you learn from this course by challenging yourself to think outside the box. Remember, the riskiest thing you can do in life is not to take chances. The safest thing you can do is be remarkable. Imagine, create and innovate.
See you in class,
Biochem JM

Content:
Topics to be covered in this course include:
- Bioenergetics
- Membranes
- Enzyme action
- Carbohydrate metabolism
- Lipid metabolism
- Nitrogen metabolism
- Integration of metabolism

Goals / Aims:
At the end of this course, students will be able to:
- Describe the major metabolic pathways involving carbohydrates, lipids and nitrogen containing compounds, highlighting certain key enzymatic reactions for their regulatory importance
- Apply what they have learnt in the metabolism section of the course to some everyday metabolic disorders such as diabetes and obesity
- Explain the mechanism of enzyme action and how their activities in the cell are controlled
- Explain the thermodynamics of high-energy compounds and redox chemistry.
- Apply critical thinking and creativity to explain selected biochemical concepts
- Demonstrate effective communication skills in the areas of interviewing and presenting
- Demonstrate project management skills and actively use podcasts as a medium for
Learning Outcomes:

**Topic 1: Orientation (1h)**
At the end of this section, students should be able to:
- Appreciate the rationale for this course
- State what is expected from them in this course – attendance of tutorials, labs etc
- State how they will be assessed throughout this course
- Navigate and access the Facebook, Blog, YouTube, Website and myelearning services for this course
- Basic manipulation of video editing software – MS MovieMaker, iMovie, and FinalCut Pro
- Create a podcast using CamStudio
- Start preparing their group video project
(This will be supplemented with instructional YouTube videos specifically created for this orientation session)

**Topic 2: Bioenergetics (1h)**
Gibbs free energy, enthalpy, entropy, equilibrium constant, mass action ratio, ATP, thioesters
At the end of this section, students should be able to:
- Draw energy profile diagrams
- Explain what makes a process spontaneous
- Distinguish between ΔG and ΔG°
- Explain how the change in free energy depends on reactant concentrations
- Discuss how a thermodynamically unfavorable reaction can occur *in vivo*
- Explain the structural basis for the high group transfer potential of ATP
- Explain how phosphorylated compounds, thioesters and reduced cofactors transfer free energy
- Explain why cells control metabolic reactions with large free energy changes

Active learning topics: The role of phosphocreatine in muscle, comparison of ATP generation in sprinters vs. distance runners or migratory birds vs. birds that rarely fly

**Topic 3: Membranes (3h)**
Fluid mosaic model, the thermodynamics of membrane transport, membrane potential, action potential, porins, gated channels, membrane fusion, acetylcholine, SNAREs
At the end of this section, students should be able to:
- Describe the fluid mosaic model of membrane structure
- State the factors which limit membrane protein mobility
- Explain why glycoproteins and glycolipids face the cell exterior
- State what is a membrane potential
- Calculate the membrane potential when ion concentrations are known
- Describe the role of the cell membrane in maintaining membrane potential
- Describe how an action potential is generated and propagated
- Determine when transmembrane movement of a substance is thermodynamically favorable
- Compare active and passive transport
- Compare Na,K-ATPase to other transport systems in terms of mechanism and energy requirement
- Summarize the role of ATP in P-type ATPases and ABC transporters
- Compare secondary active transporters to other transporters in terms of mechanism and energy requirements
- Describe the sequence of events at the nerve muscle synapse
- Describe how the structure of the SNARE complex is related to its function
- Explain why changes in bilayer curvature are required for exocytosis

Active learning topics: Olestra, spicy Indian dishes and whole-milk yogurt, aquaporins, succinylcholine (muscle relaxant), lidocaine (anesthetic), digitalis, botulinum toxin

**Topic 4: Enzyme Action (1h)**
Substrate channeling. Control of enzyme activity.
At the end of this section, students should be able to:
- Using the PDH complex describe
  - the mechanism and benefits of substrate channeling
  - regulation of enzyme activity

**Topic 5: Carbohydrate metabolism (4h)**
Glycolysis (recap), gluconeogenesis, glycogen metabolism, pentose phosphate pathway, Cori cycle
At the end of this section, students should be able to:
- Recall from BIOL 1362 course (pre-req) the role of glycolysis, its enzyme reactions and how it is regulated
- Describe the reactions of gluconeogenesis
- Describe how glucogenic precursors can give rise to glucose
- Compare and contrast the glycolysis/gluconeogenesis pathways
- Describe the Cori cycle
- Describe glycogen metabolism (synthesis and degradation pathways).
- Illustrate both the oxidative and non-oxidative branches of the pentose phosphate pathway and explain the importance of this pathway to cells with respect to providing unusual monosaccharides, biosynthetic reducing equivalents and intermediates for both synthesis of nitrogenous bases and glycolytic intermediates

Active learning topics: Glycogen storage diseases, hemolytic anemia, alcoholism and hypoglycaemia,
Topic 6: Lipid metabolism (5h)

At the end of this section, students should be able to:
- Describe the role of bile and pancreatic lipase in digestion of dietary lipids
- Describe the role of lipoprotein lipase
- Describe the fate of glycerol in the body
- State the different plasma lipoproteins and describe how they are different
- Explain the roles of lipoproteins and apolipoproteins
- Describe the committed step of fatty acid synthesis by showing that acetyl CoA carboxylase is a bifunctional enzyme
- Describe the reactions of the De Novo synthesis of fatty acids
- Discuss how fatty acids can be synthesized in the liver from carbohydrates
- Describe the role of hormone sensitive lipase
- Describe the carnitine shuttle mechanism
- Describe the reactions in fatty acid β oxidation
- Compare the oxidation of saturated, unsaturated and odd-chain fatty acids
- Compare fatty acid synthesis with β oxidation
- State the conditions for ketogenesis
- Give examples of ketone bodies
- Describe the reactions involved in ketogenesis

Active learning topics: MCAD deficiency and ω oxidation, β-oxidation is a chemical source of water for desert animals, brown adipose tissue, white adipose tissue lacking glycerol kinase, LDL and cardiovascular disease, Orlistat, ketonuria

Topic 7: Nitrogen Metabolism (3h)
Nitrogen fixation, protein degradation (endogenous, dietary), transamination, oxidative deamination, urea cycle, nucleotide metabolism.

At the end of this section, students should be able to:
- Describe the structure of the nitrogenase complex and state how its structure is suited for the reaction it catalyzes
- State the reaction of glutamine synthetase.
- State what is an essential amino acid
- Describe the mechanisms for degrading endogenous proteins
- State the enzymes and organs involved in digesting dietary proteins
- Describe transamination reactions using ALT and AST enzymes
- State the reactions of glutamate dehydrogenase
- Explain how transamination, oxidative deamination and reductive amination are involved in amino acid metabolism
- Describe how ammonia is transported to the liver
- Describe the reactions of the urea cycle
- State signs and symptoms of urea cycle enzyme deficiency diseases.
- Outline the roles of nucleotides in the cell
- State which amino acids are required for purine and pyrimidine de novo synthesis
- State the regulated step for purine and pyrimidine de novo synthesis
- Compare CPSI to CPSII

Active learning topics: Urea cycle enzyme diseases, gout, phosphocreatine, NOS

**Topic 8: Integration of Metabolism (5h)**
Well fed and fasting states, roles of insulin and glucagon.

At the end of this section, students should be able to:
- Classify insulin and glucagon as peptide hormones
- Describe the mechanism of action for insulin and glucagon
- Describe the metabolic effects of insulin and glucagon including the organs where these effects are taking place.
- Explain how glycolysis and gluconeogenesis are reciprocally regulated
- Explain how glycogen synthesis and glycogenolysis are reciprocally regulated
- Explain how fatty acid synthesis and fatty acid breakdown are regulated
- Discuss how malonyl CoA affects lipid and carbohydrate metabolism

Active learning topics: Diabetes, obesity, metabolic syndrome.

**Course Assessment**

**Overview**
Coursework  50%
Final exam   50%

**Coursework assessment (50%):**

*Biochemians Got Talent (BGT; 15%):* Students are asked to create 15-minute videos on any topic off the BIOL 2365 course syllabus. (More details about this project are given in Appendix I; pg 12)

*Case Studies (10%):* a problem-based approach involving ‘real life’ situations will be used for selected topics of the syllabus to encourage problem-solving and critical thinking skills.
**Bring Your Notes End of Semester exam (10%):** A 1 hour written exam covering all topics from weeks 1 - 11. Students will be given a note card from the instructor in week 8 of the semester. Students will be allowed to write whatever notes they want on the note card, which they are allowed to bring into the exam in week 12.

**Class participation and continuous assessment (5%):** Students will be assessed continuously throughout the semester using a variety of strategies:

1. answering 10 minute quizzes on Moodle or in the classroom. These quizzes will be based on the basic concepts of the course.
2. contributing to the BiochemJM blog

**Practical (10%):**
Carbohydrate metabolism
At the end of this practical, students should be able to:
- Understand specific enzyme catalyzed reactions in carbohydrate metabolism
- Interpret kinetic data for enzymes – rates of reaction and inhibition
- Use various techniques including micropipetting and spectrophotography
- Write up a biochemical lab report

**Final exam (50%):**
2-hour written examination at the end of the semester consisting of three sections:
- **Section A** 25 MCQ (25%)
- **Section B** True and False, matching, fill in the blanks (25%)
- **Section C** Essay type questions (50%)

ALL questions on paper are compulsory.

**Evaluation:**
- Feedback on the course will be obtained informally from students on an ongoing basis by regular interactions and meetings among students, demonstrators and teaching assistants.
- Formal feedback will be via election of Class Representatives who sit on the Departmental Student-Staff Liaison Committee meetings held twice during the semester. Class reps will channel both concerns and commendations to the meeting as guided by the Department’s Standard Operating Procedures.
- Formal evaluation of the entire course will be accomplished via a UWI Course Evaluation questionnaire administered anonymously and confidentially at the end of the semester.
- All feedback will be considered on an ongoing basis and corrective action or adjustments made or discussed with students promptly or incorporated the following year.
Teaching Strategies:

- **Face to face time in the classroom**
  - Highly interactive
  - Students will be making presentations (mostly on the active learning topics outlined for each topic) in class
  - Question and answer game show type of sessions

- **This course is Moodle supported.**
  - Links to podcasts and useful websites will be posted
  - Links to open source PDF journal articles will be posted
  - Students will have access to course outline, lecture schedule and assignments (instructions and questions)
  - Means by which students will be quizzed online
  - Students will access their coursework marks
  - Official form of communication between instructor and students

- **The BiochemJM YouTube channel**
  - Screencast versions of all the BIOL 2365 lectures have been posted on this channel. Students can learn at their own pace and it frees up the actual face to face time for more interactive activities in the classroom
  - Student created videos. Students create 15 minute videos on any topic of the syllabus and post them up on the BiochemJM channel. This will enable peer review learning with students in the course as well as students regionally and globally

- **The Biochem JM Facebook page and the BiochemJM Blog**
  - Students have an avenue to reflect about the course with their peers
  - Exchange of ideas between fellow students as well as international students
  - Mentorship from past students who did the course
  - Real time communication with the instructor
  - Discussion forum

**Resources:**

Text Books (Library resources) and Lab. Requisitions (Department’s resources) are available.

Department of Life Sciences & Main Library Computer labs to access online services.

**Readings:**

**Main Text**


**Secondary texts**

### Course Calendar (subject to review)

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture subjects</th>
<th>Tutorials / Assignments / Labs</th>
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<tbody>
<tr>
<td>1</td>
<td>Orientation [1]</td>
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<tr>
<td></td>
<td>Bioenergetics [1]</td>
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<tr>
<td>2</td>
<td>Membranes [2]</td>
<td>Tutorial #1</td>
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<td>3</td>
<td>Membranes [1]</td>
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<td></td>
<td>Enzyme action [1]</td>
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<tr>
<td>4</td>
<td>Carb Metab [2]</td>
<td>Tutorial #2</td>
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<tr>
<td>5</td>
<td>Carb Metab [2]</td>
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<tr>
<td>6</td>
<td>Lipid Metab [2]</td>
<td>Lab: Carbohydrate metabolism</td>
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<tr>
<td>7</td>
<td>Lipid Metab [2]</td>
<td>Case Study #1; Tutorial #3</td>
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<tr>
<td>8</td>
<td>Lipid Metab [1]</td>
<td>Tutorial #4</td>
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<td>Nitrogen Metab [1]</td>
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<td>9</td>
<td>Nitrogen Metab [2]</td>
<td>Case Study #2</td>
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<td>Integration of Metab [2]</td>
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<td>Integration of Metab [2]</td>
<td>Tutorial #6</td>
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<td>Video Project is due</td>
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<td>12</td>
<td>Integration of Metab [1]</td>
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<td>End of Semester Exam [1]</td>
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<tr>
<td>13</td>
<td>Review</td>
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</tbody>
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[ ] = number of hours
Additional information:


- Students are reminded that they must attend a minimum of 75% of the practical sessions and tutorials. Failure to do so will result in debarment from the final examination.

- As a general principle, medicals or other excuses may only excuse a student’s presence at an assigned time. Students must still complete the assigned work (make-up lab report or make-up test) in order to obtain the marks for that item of coursework. The student is responsible for liaising with the Course Coordinator or Teaching Assistants to ensure the assigned make-up is completed.

- Students are hereby informed that plagiarism is forbidden and all unsupervised coursework items must be accompanied by a Coursework Accountability Statement in order to be assessed. Specific items may require submission through Turnitin on myeLearning. 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).

HOW TO STUDY FOR THIS COURSE:

- Attendance is mandatory for lectures, tutorials and practicals.

- Prior preparation is strongly advised to able to fully participate in activities and obtain the full value of the sessions.

- Thorough use should be made of the resources provided and students are strongly advised to become familiar with them and start utilising them from the first week. Regular updates on course progress and materials are also highly recommended and you should be checking into myelearning on a frequent regular basis to review materials, assignments and activities.

- 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.