Texas A&M University - Corpus Christi
CHEM 4402 Biochemistry II – Spring 2009
TR 11:00 –12:15 pm ST 104

Instructor:	Dr. Patrick Larkin
Office:	Center for Science 206
Office Hours:	T 9-11am, Th 1-3pm, or by appointment
Phone:	825-3258
Email:	Patrick.larkin@tamucc.edu
Web:	www.tamucc.edu/~plarkin

Course Description

CHEM 4402 is the second part of a two-semester course that covers the structure and function of the major biomolecules (amino acids, lipids, carbohydrates, proteins, lipids, nucleic acids and polysaccharides) as well as the major metabolic pathways involved in their synthesis and catabolism. Completion of this course will enable the student to understand the functioning of living organisms at the molecular level, and appreciate the complexity, sophistication and efficiency inherent in cellular activity.

Learning Outcomes

Upon successful completion of this course, students will be able to:

- Apply the principles of chemical thermodynamics and kinetics to biochemical situations.
- Identify the role that oxidation and reduction has in biological energy transfer.
- Understand how carbohydrates, lipids, amino acids and nucleotides are catabolized and recycled, with the concomitant production of biological energy.
- Identify the key role that the citric acid cycle has in the aerobic catabolism of nutrients, production of biological energy and provision of precursors for biosynthesis.
- Determine how glucose, lipids, amino acids and nucleotides can be synthesized from a combination of inorganic and biological molecules, and identify the cellular cues that regulate their rate of synthesis.
- Identify the key reaction mechanisms in metabolism, including oxidation-reduction, decarboxylation, and transamination reactions, as well as the enzymes and cofactors that facilitate these reactions.
- Understand the biological carbon cycle, including its fixation, regulation and incorporation into various biomolecules.
- Understand the biological nitrogen cycle, including its fixation, regulation, and incorporation into various biomolecules.
- Understand how the metabolic pathways are coordinated, integrated and regulated.
- Perform basic biochemical laboratory techniques, including review of the primary literature, database analysis, bioinformatics, DNA extraction, digestion, ligation, transformation and sequencing, the polymerase chain reaction (PCR), gel electrophoresis, spectrophotometry, protein expression, purification and analysis.
- Prepare a professional, written project report.

Texts:
Principles of Biochemistry, 5th Edition (2004) Lehninger, Nelson and Cox (required).

Biochemistry II (CHEM 4402) Study Guide, Larkin (recommended).

Biochemistry: Lippincott's Illustrated Reviews, Champe, Harvey and Ferrier (suggested)

Lecture Format: The CHEM 4402 lecture will be taught in a peer-centered format, which requires participation on the part of the students. Briefly stated, the lecture period will be broken up into mini-sections covering fairly specific topics. At the end of a topic, example problems are posed and the class surveyed for the correct answer. If it appears that the concept still requires clarification, students are asked to work with one another for approximately one minute to consider the reasoning for their answer. To facilitate this type of interaction, we will be utilizing a set of answer cards (A,B,C,D) that are included in the recommended study guide. PLEASE BRING THESE CARDS TO EACH CLASS. Participation is required.

Lecture Exams: There will be three semester examinations in addition to a comprehensive final examination. Examinations will be predominantly multiple choice but may include short answer, brief calculation or structure drawing questions. All answers on exam scantrons are final, so please either fill in your answer choices on your scantron as you proceed with your test, double check your answers on your scantron, or both. If you feel you have a legitimate disagreement with your score on a particular test question, please write Dr. Larkin a note explaining the situation. Please provide text pages or notes to back up your argument. If your argument is sound, then you will be given additional credit. **You must have your note ready by the second lecture after the exams are returned**

Exam 1	100 pts
Exam 2	100 pts
Exam 3	100 pts
Final Exam	100 pts
Total	400 pts

Exams will take place during regular class time. Please let me know ahead of time if you have a university-approved excuse, if possible, so alternate arrangements can be made. **All make-up exams will be short answer to essay-type tests**.

We will not "drop" any of the examinations in the calculation of your final grade. However, there will be the **opportunity to obtain 10 extra credit points by taking a series of reading quizzes** (see below). In other words, if you score a total of 300 points on your 4 exams, and obtain all 10 points from the reading quizzes, your total score for the lecture portion of the course would be 310 points.

Reading Quizzes: Reading quizzes will be made available via **WebCT** to encourage students keep up with the reading and prepare for lecture. A particular quiz will be available from approximately 5 days before lecture up to the time of class. While not mandatory, each quiz is worth 0.4 extra credit point. To access WebCT, go to the online classes link on the main campus website (**http://islandonline.tamucc.edu**).). If you have problems accessing WebCT or have other technical issues please utilize the Help resources on the islandonline website first, or

contact the Helpdesk at 825-2825, as these problems are usually beyond Dr. Larkin's control. You may also contact the Collegis WebCT Support line at 1-877-725-4357.

Special WebCT note. The most common problem reported with WebCT is the inability to access a quiz once it has been selected. **Be sure that your browser has the feature that blocks "pop-up" web pages turned off**. WebCT quizzes are delivered in this manner.

Course Grading: A combined grade for both lecture and laboratory will be given for the course. The lecture component will count for 75% of the grade and the laboratory component for 25%. **This course will not have a curve**. The scale below indicates the minimum course score (out of a possible 100) required to obtain a particular grade.

Grade	Score
A	90
B	80
C	70
D	55
F	< 55

The course score is calculated by adding the lecture and laboratory scores:

$$\text{lecture score}: \frac{(\text{exam points} + \text{reading quiz points})}{400} * 75$$

$$\text{laboratory score}: \frac{(\text{lab reports} + \text{worksheets} + \text{exam points})}{200} * 25$$

As noted above, there are 400 points possible in lecture from the three regular and one final examination. Remember that extra credit points earned from taking the reading quizzes may supplement the lecture total. There will be a total of 200 points that can be earned in the laboratory component of the course from lab reports, worksheets, a mid-term examination, a final examination and laboratory performance.

Two examples are provided below that outline the type of final grade one might expect with a laboratory percentage of either 90% or 80%. Each example shows the final outcomes expected when varying levels of lecture points have been earned. The point is to show that a good score needs to be obtained in BOTH lecture AND lab in order to obtain a good overall grade for the course. DO NOT expect a good lab score to boost a weak lecture score by a full letter grade.

Total Lecture points earned	Lecture Score	Total Laboratory points earned	Laboratory Score	Course Score (Lecture+Lab Score)	Final Grade
200 (50%)	37.5	180 (90%)	22.5	60.0	D
240 (60%)	45.0	180 (90%)	22.5	67.5	D
280 (70%)	52.5	180 (90%)	22.5	74.5	C
320 (80%)	60.0	180 (90%)	22.5	82.5	B
360 (90%)	67.5	180 (90%)	22.5	90.0	A
200 (50%)	37.5	160 (80%)	20	57.5	D
240 (60%)	45.0	160 (80%)	20	65.0	D
280 (70%)	52.5	160 (80%)	20	72.5	C
320 (80%)	60.0	160 (80%)	20	80.0	B
360 (90%)	67.5	160 (80%)	20	87.5	B

Decorum: The best way to encourage learning is to provide an environment conducive to listening, concentration and discussion. As in any class, students are expected to maintain the highest standards of decorum and to conform to college-level standards of ethics and academic integrity. Most of these involve common sense and courtesy, but please refer to the section on academic policies and regulations in the university catalog for a more thorough description of these expectations.

Please remember that biochemistry is **NOT a "Spectator Sport"**. Keep up with the reading, do end-of chapter problems, come to class, review and annotate your notes and use the study guide. Copies of an additional, "official" study guide (Osgood and Ocorr) will also be made available on reserve at the library, and can be quite useful. Forming a study group with 1-2 other students is another strategy many students find helpful.

Note for students with disabilities The Chemistry Program complies with the Americans with Disabilities Act in making reasonable accommodations for qualified students. If you need disability accommodations, or if you suspect that you may have a disability (physical impairment, learning disability, psychiatric disability, etc.), please contact the Services for Students with Disabilities Office (Driftwood 101, ph. 825-5816). It is important that you contact them in a timely fashion as it may take from several days to weeks review requests and prepare accommodations.

Outline and Tentative Schedule

Date		Topic	Reading	Reading
			Chapter:pages	Quiz
January	15	Bioenergetics	13:485-511	-
January	20	Bioenergetics	13:512-521	1
January	22	Glycolysis	14:527-551	2
January	27	Glycolysis/Gluconeogenesis	14:551-563	3
January	29	Regulation/Glycogen metabolism	15:569-588, 594-609	4
February	3	Citric Acid Cycle	16:615-630	5
February	5	Citric Acid Cycle	16:630-641	6
February	**10**	**Exam I**		
February	12	Fatty Acid Oxidation	17:647-655	7
February	17	Fatty Acid Oxidation	17:655-668	8
February	19	Amino Acid Oxidation	18:673-687	9
February	24	Amino Acid Oxidation	18:687-702	10
February	26	Oxidative Phosphorylation	19:707-723	11
March	3	Oxidative Phosphorylation	19:723-742	12
March	5	Photophosphorylation	19:742-754	13
March	10	Photophosphorylation	19:754-764	14
March	**12**	**Exam 2**		
March	**17/19**	**Spring Break**		
March	24	Carbohydrate biosynthesis	20:773-794	
March	26	Carbohydrate biosynthesis	20:773-794	15
March	31	Carbohydrate biosynthesis	20:773-794	16
April	2	Lipid biosynthesis	21:805-815	17
April	7	Lipid bioynthesis	21:815-831	18
April	9	Lipid bioynthesis	21:831-845	19
April	14	Amino Acid biosynthesis	22:851-860	20
April	16	Amino Acid biosynthesis	22:860-882	21
April	21	**Exam 3**		
April	23	AA products/Nucleotide metabolism	22:882-891	22
April	28	Nucleotide metabolism	22:892-896	23
April	30	Regulation of Metabolism	23:901-930	24
May	5	Regulation of Metabolism	23:901-930	25
May	**12 (Tues.)**	**Final (Lab & Lecture) 11-1:30 pm**	**Comprehensive**	

CHEM4402 Laboratory

Green Fluorescent Protein - The Project

This semester will revolve around a central theme, the isolation, characterization and purification of the Green Fluorescent Protein (GFP). GFP is a naturally occurring protein found in certain species of jellyfish (*Aequorea victoria*). As the name indicates, its unique structure allows it to fluoresce, that is, radiate energy in the electromagnetic spectrum that we interpret as yellow-green light. The theme of the semester will involve several investigations of GFP; locating the DNA sequence for GFP in genomic databases, producing copies of the gene using the Polymerase Chain Reaction (PCR), purifying the expressed protein from a bacterial strain which carries a cloned copy of the gene, etc. Throughout this process, you will be exposed to several molecular techniques such as DNA isolation, PCR, electrophoresis, cloning, DNA sequencing and chromatography. It is hoped that by focusing on a single gene, and progressing sequentially through the various steps involved in expressing that gene, that you will attain a greater understanding of the relevant biochemical processes involved in the conversion of genetic material (DNA) to functional proteins.

Due to the fact that each lab builds upon information and data obtained during the previous week, it is crucial that you show up for every lab. We will not be turning in formal lab reports every week. Instead, you will be responsible for acquiring data and formatting it for presentation on a weekly basis. At the end of the semester, you will combine this data into a comprehensive lab report. Therefore, you will still need to keep a laboratory notebook/folder with each week's relevant experimental details and results as well as an electronic copy of any formatted results. For the most part, course grading will be based upon preparation of these results in the proper format and upon assigned questions covering the theory and technique of the week's experiment.

Required Laboratory Materials

Text: **Experiments will be posted in portable document format (.pdf files) to Dr. Larkin's web site (www.tamucc.edu/~plarkin) in advance of the lab**. Please download and print a copy prior to lab. You will need adobe acrobat on your computer to download the documents. A link is provided on Dr. Larkin's web site. **Provision of hardcopies of each week's experiment is the student's responsibility, not the laboratory instructor's.**

Laboratory Notebook (required): A separate (not used for other classes) notebook is required for performing pre-laboratory work, recording observations, etc. Traditional, string-bound hard-covered versions are available at the University Bookstore.

Safety Glasses/goggles

Lab Coat

Attendance: Students are required to attend all laboratory periods. Please arrive on time and remain until the laboratory procedure is completed. Check with your instructor before leaving. Absence from laboratory without a university approved excuse and/or prior approval from the instructor will result in a grade of zero for that class. Occasionally a student may be permitted to attend another laboratory section if a conflict arises with their scheduled section, and IF it is cleared with all instructors involved BEFOREHAND, but no make-up lab periods will be held outside of the scheduled sections.

Safety Lecture: You must be registered for, and complete, one of the Lab Safety Briefings (PSCI 0091) prior to performing experiments in the laboratory.

Eye Safety: When in lab, always wear your safety goggles. A first violation will result in a verbal notification. Subsequent violations may result in the student being asked to leave the laboratory, with a grade of zero for the day. Also, be advised that wearing contact lenses in the laboratory can be harmful to your eyes, even when you wear safety goggles over them.

Clothing: No open toe shoes or shorts (or short dresses) are allowed in the laboratory. A lab coat must be worn at all times.

Keep it Clean: Keeping things clean will keep any chemicals in the lab and not in your home. Always wash your hands just before leaving the lab. Never take samples or glassware out of the lab. **Do not place your coats, backpacks and other personal items on the bench tops or floor in the lab. They can be placed in the cabinets under the benches.** Keep in mind; anything you bring into the lab should be treated with care at home. Your notebook and lab book may be picking up stuff you spilled on the bench or floor and did not clean up.

Disposal of Chemical Wastes: During the experiments, you will generate several types of waste, which need to be handled properly. Organic wastes should be placed in an appropriately marked bottle for organic waste. Aqueous (water-based) waste should be poured into the appropriately marked bottles. Solid wastes should be placed in an appropriately labeled solid waste bottle. Broken glassware should be placed in the broken glassware box. Never put glass into the regular trashcans.

Ask for Assistance: If you have any questions about the safety of any procedure, please ask your instructor before proceeding.

A few reminders:

- No eating or drinking is allowed in the laboratory
- Know the location of fire extinguishers, eyewash stations, safety showers, fire alarms and Material Data Safety Sheets (MSDS forms)
- If an accident occurs, immediately notify the instructor or TA

Laboratory Facilities: Your laboratory fees, tuition and tax dollars pay for the instruments and labware in the laboratory. We will teach you how to use all of the necessary equipment for each exercise. To ensure optimal performance of instruments, do not attempt to use any equipment until your instructor gives you directions. If equipment malfunctions, **notify the instructor immediately so we can repair or replace it as soon as possible**.

This laboratory receives heavy use. As a courtesy to your fellow students, all lab teams are expected to clean up their stations after each period. This includes replacing all equipment to their original locations, turning off and covering instruments, cleaning glassware, and wiping down laboratory workspaces. Each team must check out with their instructor prior to leaving.

Grading: Your laboratory score will be determined based on points earned from weekly assignments, laboratory reports, a mid-term exam, a final exam and laboratory performance. There are a total of 200 points that can be earned. Laboratory counts for 25% of your course grade and is calculated as follows:

$$laboratory\ score: \frac{(lab\ reports + worksheets + exam\ po\ \text{int}\ s)}{200} * 25$$

All assignments are due at the **beginning** of the next laboratory period. We realize that the average student has a great many academic demands during the semester. Therefore, we offer a special **stress-relief clause**. You may turn in **one** assignment late (except the final laboratory report) for any reason. **Please let your instructor know that you intend to use your "free late" in writing at the time the assignment is due**. Your assignment will then be due at the beginning of lab the following week. Any other assignments turned in late will be penalized 10% for each additional day.

Laboratory performance. A portion of your grade (~ 5%) will also depend on your laboratory performance. This is not "extra credit", but a score based on individual student behavior. Points are earned by avoiding behavior including, but not limited to:

- Arriving late to class
- Being unprepared for the laboratory
- Performing in a lackluster manner (not paying attention, not taking initiative, etc.)
- Leaving the laboratory before completing the exercise
- Being disrespectful to your instructor or fellow students
- Failing to clean up at the end of the laboratory
- Violating safety regulations
- Plagiarizing another student's work
- In general, conducting oneself unprofessionally

Remember, **while Dr. Larkin is the coordinator of the biochemistry labs, the Teaching Assistant is the instructor.** Each teaching assistant is in charge of his/her laboratory sections, including attendance, instruction, assistance with assignments, grading, and handling of missed laboratory periods. Your instructor should be the first person you go to with questions related to the laboratory. Be sure to find out the best way to contact your instructor, their office location and their office hours.

Laboratory Assignments and final Report: A final report will be required at the end of the semester. Be sure to retain both electronic and "hard" copies of all data results from the labs (photographs, tables, charts, etc.). The standard laboratory report format will be used, as described below.

Even though students work in teams, lab reports and assignments are expected to be the result of individual effort. Thus, while we encourage students to work together in regards to data analysis and interpretation, we also expect individuality in interpretation and style of writing, especially regarding the introduction and discussion sections. **If we suspect copying or plagiarism neither assignment will be accepted and a grade of zero will be recorded.**

Laboratory reports are to be typewritten, photocopies taken directly from your laboratory notebooks are **not** acceptable. Reports should meet the key tests of being both legible and understandable. Legible means correct spelling and intelligible, complete sentences. Understandable means complete tables and graphs, with units, legends, column headings and axis titles present and clearly identified. Graphs and tables are to be computer-generated. Many

software packages, such as Microsoft Excel and Word have convenient tutorials ("wizards") for the construction of tables and graphs.

The full lab report should consist of a title page, introduction, procedure, results and discussion.

Title Page:

- Laboratory report title
- Your name
- Your lab partner's name
- Your section number
- The name of your instructor or TA
- The date

Introduction: Clearly state the aim of the procedures used during the semester, Include background information on the basic principles and theory underlying the particular experimental techniques.

Procedure (Materials & Methods): Include a brief narrative description of the major steps for a particular technique/procedure (" ..using primers "X" and "Y" and the Polymerase Chain Reaction", ...using Gel permeation chromatography with "X" as the chromatography matrix", etc.). You ***do not*** **need to rewrite a step-by-step description** of the procedure from your text, but try to summarize the important steps.

Results: This section should include all experimental data and its manipulation in the form of example calculations, photographs, tables, etc. Example calculations should be used instead of separate calculations for each sample. Be sure all experimental data is clearly labeled with column headings, axis titles, figure legends, chart and graph titles, etc. This is where students lose the most points.

Discussion: This section is for showing your understanding of the experiments. Be sure to analyze your results and argue why you can draw certain conclusions. Discuss any expected results compared with your actual results and observations. Draw on the theory and your experience in order to rationalize the outcome of the experiment, especially possible reasons for deviations from the expected results.

Laboratory Notebooks: A well-written laboratory notebook will be an invaluable aid in preparing your reports. However, laboratory notebooks are not intended to look perfect. Use your notebook to write down notes on what you think is happening in a particular exercise, hand-draw rough graphs and jot down observations to aid your analysis or conclusions. In addition, each notebook should contain your name, section number and a table of contents. This makes it much easier to find data, results, procedures, etc. on any given experiment. It also makes it easier for us to return a notebook if it should be left in the laboratory.

Pre-lab: As part of each experiment, we ask that you prepare a pre-lab in your laboratory notebook. This section should provide enough specific information on the procedure (e.g., identity and quantity of materials, times, temperatures, etc.) to enable you to perform the experiment. It should be organized in a summary format and include: title of the experiment, purpose of the experiment, technique(s) or procedure(s) being used, outline of steps, tables for data and sample preparation. Your Pre-lab **will not** be turned in as part of your formal laboratory report

Schedule

Week of		Laboratory	Topic	Points
January	14	No Lab		
January	19	1	Introduction/Literature Searching	10
January	26	2	Database Searching	10
February	2	3	Primer Design	10
February	9	4	Polymerase Chain Reaction (PCR)	12
February	16	5	Electrophoresis & gel-extraction of DNA	17
February	23	6	Ligation & Bacterial Transformation	12
March	2	7	Plasmid DNA isolation/Restriction enzymes I	17
March	9	8	Restriction Enzymes II/DNA sequencing I	17
March	16	No Lab	Spring Break	
March	23	9	DNA sequencing II/ Lab Mid-term	12, 10
March	30	10	Protein Explorer (Bioinformatics)	10
April	6	11	GFP Induction	12
April	13	12	Gel Permeation Chromatography	12
April	20	13	SDS-Polyacrylamide Gel Electrophoresis	2
April	27	13 (cont'd)	SDS Gel Photo/Checkout/Laboratory Final	5,10
May	4		Lab Reports Due (see TA for arrangements)	22
			Total	200