BIOC 4004 (formerly 63.404) - Industrial Biochemistry

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Lectures / Workshops:
Mondays 10:05-11:25 @ CO208?
Wednesdays 10:05-11:25 @ CO208?
Fridays 11:35-13:25 @ TB432

Office Hours:
I am somewhat constrained by the fact that my office and lab are off-campus. I will hold "office hours" immediately after each class, but please feel free to contact me by phone or by e-mail. I will do my best to get back to you ASAP.

Introduction:
Biotechnology is the application of biochemistry in an industrial context. For example, biochemical concepts have been put to use in solving problems in the development and production of pharmaceuticals, crop enhancement in agriculture, development of enzymatic processes for food and chemical production, among others. The aim of this course is to expose you to some of the advances in the fields of chemistry, biochemistry, microbiology, and molecular biology that have made biotechnology possible and that have accelerated its growth. An emphasis will be placed on the burgeoning field of genomics and its place in modern biotechnology research.

Topics of Discussion:

- Genes and proteins
  - Eukaryotic vs. prokaryotic gene structure
  - Introns, Exons, Promoters, gene regulation
  - Transcription, Translation, degeneracy of the genetic code

- Recombinant DNA technology:
  - Manipulation of DNA using restriction/modification enzymes
  - Cloning vectors, Cloning strategies
  - Southern, Western, Northern blots
  - DNA sequencing
  - The Polymerase Chain Reaction (PCR)
  - Novel applications of PCR

Topics of Discussion: (cont')

- Expression and purification of recombinant proteins
  - Protein structure (primary, secondary, tertiary)
  - Protein engineering, site-directed mutagenesis, "synthetic genes"
  - Monoclonal and polyclonal antibodies
  - Enzyme assays

- The "OMICS" Sciences
  - Genomics (genome sequencing projects, bioinformatics, DNA chips)
  - Proteomics (2D-gels, Mass-Spec)
  - Metabolomics
  - Structural Biology

- "Big Pharma"
  - Development of pharmaceuticals and vaccines
  - High-throughput screening
  - The microarray concept
  - Combinatorial chemistry

- Biotech and medical research
  - Gene therapy
  - Diagnostics (antibody-based, DNA-based…)
  - Stem-cell research

- Agrifood and biotech
  - Transgenic plants and animals (GMOs), cloning of animals
  - "Pathway engineering"

- Ethical, legal, social, economic, and ecological issues of biotechnology.

Important dates:

- Jan 16 Last day for course changes
- Feb 06 **Research Proposal Topic & Paragraph** is due
- Feb 16-20 Winter break – no classes
- Feb 27 **First Evaluation Exercise** (tentative date)
- Mar 12 Last day for withdrawing from course
- Apr 02 **Second Evaluation Exercise** (tentative date)
- Apr 12 **Research Proposal** is due

COURSE ORGANIZATION

This course is organized into modules of one-week duration. Lectures dealing with the module theme will be given on Tuesdays and Thursdays. On Fridays, students will give group presentations on applications related to the theme of the module. We will also work on Problem Based Learning Exercises. Student participation is workshops is mandatory, and will account for 10% of your final grade. Absenteeism will result in a lower Workshop Participation Mark.

EVALUATION

First Evaluation Exercise	20%
Seminar	20%
Research Proposal	20%
Participation	10%
Second Evaluation Exercise	20%
Assignment	10%
Total	**100%**

EVALUATION EXERCISES (2 x 20% = 40%)
There will be **two Evaluation Exercises**: one at approximately the middle of the term, and another at the end of the term. The **Evaluation Exercises** will consist of a written examination of two hours duration. These will be conducted during the Workshop Periods on Fridays. Questions will be drawn from the lectures, workshops and assigned readings. Selected questions from student seminars will also be used. Tentative dates for the **Evaluation Exercises** have been set for: **February 27th, 2004** and **April 2nd, 2004.**

SEMINAR (20%)
Seminars will be evaluated by the instructor, by your groupmates, and by your classmates. The following mark distribution will be used:

Instructor's evaluation	10%
Audience evaluations	5%
Group members evaluations	5%
Total for Presentation	**20%**

See the section entitled **Seminars** for additional information. In addition, familiarize yourself with the **Seminar Evaluation Sheet** and **Groupmember Evaluation Sheet** which give you the criteria that will be used in the student evaluations.

RESEARCH PROPOSAL (20%)
You are required to write a **Research Proposal**. This is NOT an essay summarizing someone else's work, but rather a proposal for new research that you think up. The instructor must approve the proposal topic before you proceed, so it is imperative that you start thinking about proposal topics very early in the course. You should focus on the molecular aspects of the process. Research Proposals draw on qualities and skills in written communication. The objectives for the proposal are first, to learn how biochemistry is applied to solve industrial problems, second to develop effective academic writing skills, which include correct grammar, good analysis and construction of a logical and persuasive argument. The proposal will evaluate your knowledge base, ability to collect and analyze data, and also your ability to integrate and synthesize information and develop a logical argument. Critical appraisal skills foster independent thinking and learning. Writing skills are also necessary in graduate work, and in the professional world.

PARTICIPATION (10%)
Workshops will be held Fridays at 11:35 AM. The workshop will consist of the following:
1. Student seminars.
2. Presentation and discussion of the PBL exercises.

Your attendance at the workshops is mandatory and your participation in the workshops will be evaluated by the instructor. It is essential that you read the assigned papers, and prepare questions and ideas for discussion during the workshops.

What do I mean by participation? Well, you can participate in several ways:

- contribute to the discussion of PBL topics during workshops
- ask questions at student seminars
- contribute to the discussion of the assignment problems
- ask questions in class
- share interesting internet resources with fellow students

ASSIGNMENT (10%)
A bioinformatics assignment will be given requiring molecular sequence analysis (contig assembly, gene prediction, and assignment of functions, etc…). You will be expected to take advantage of bioinformatics resources available on the WWW to perform your analysis. More details will be forthcoming.

SEMINARS

Future employers will expect you to effectively communicate information, both orally and in written form. For most people, this requires considerable practice. In addition to helping you and the other students to understand course materials, the Seminars will provide you with an opportunity to improve your ability to communicate effectively. The presentations should last **20 minutes**, followed by 5 minutes of questions and discussion. You should address the following points:

1. **What is the significance of the work?**
-introduce your topic briefly, clearly and in simple terms

2. **What are the questions the authors are asking?**
-clearly identify the main question(s) the authors are asking in the paper

3. **How do they answer the questions?**
-outline the approach the authors take to answer the question

4. **What are the central experiments?**
-you will not have enough time to present all the data (so don't attempt to).
-identify the major points
-make sure you understand the experimental details

5. **Prepare and use effective visual aids.**
-use PowerPoint slides and keep them simple
-do not write everything you want to say on the slides

6. **Practice your talk, and present the work confidently and coherently.**
-do not read from a script, speak clearly, with intonation and be conscious of your speed of delivery

7. **Provide a brief summary at the end of the presentation and state the conclusions.**
-prepare a final slide that states the main conclusions briefly and clearly

8. **Prepare a brief abstract of your talk for distribution to other students.**
-write a one paragraph summary of your presentation and prepare copies for the rest of the students (also E-mail me a copy of your abstract)

9. **Prepare a question based on your presentation for distribution to other students.**
-write a short answer question based on your presentation and include it on the same sheet as your abstract
-I will use some of these questions on the **Evaluation Exercises**

Please have a look at the **Evaluation of Presentation** form in the next page for an idea of how presentations will be graded.

EVALUATION OF PRESENTATION

Presenter: _____ Date: _____
Topic: _____

Please read the following statements and in each one circle the phrase that best describes your reaction to today's presentation.

1. During this presentation I learned:
nothing new a little some quite a lot a great deal
1 2 3 4 5

2. The presentation was organized:
badly poorly somewhat quite well very well
1 2 3 4 5

3. The effectiveness of the visual material was:
not effective poor average very good excellent
1 2 3 4 5

4. The effectiveness of the oral presentation was:
not effective poor average very good excellent
1 2 3 4 5

5. The content of the talk was:
not appropriate poor average good excellent
1 2 3 4 5

6. The overall style of the presentation was:
bad poor average good excellent
1 2 3 4 5

7. The speed of the speaker was:
too fast/too slow poor average good excellent
1 2 3 4 5

8. The speaker's knowledge of the topic was:
bad poor average good excellent
1 2 3 4 5

9. Interaction of the speaker with the audience was:
not at all a little somewhat quite a bit excellent
1 2 3 4 5

10. My interest in the subject material has been increased:
not at all a little somewhat quite a bit extremely
1 2 3 4 5

Comments:

_____

_____

Marker: _____

RESEARCH PROPOSAL

The Research Proposal has several objectives. First, it allows you to pursue a topic that interests you, in more detail than is possible in lectures. Second, it will give you experience in summarizing and synthesizing information from the primary literature. Third, it will give you experience in the preparation of a proposal with a ***defined format*** and ***deadline.***

The **Research Proposal** should have the following format:

Length: 5-6 pages (including references)

Font: 12 point (or 10 cpi)

Spacing: double spaced

Margins: 1" on all sides

Brief review of the literature on your topic: 1 to 2 pages
Explicit statement of the question you are asking: 1 sentence
Statement of hypothesis: 1 paragraph
Proposed experiment(s): 2 to 3 pages
Statement of the significance of the proposed research: 1 paragraph
References (properly formatted)

Your topic should be based on an application of biochemistry in medicine, agriculture, pharmaceutical, food or chemical industries. Look through recent issues of biochemistry and biotechnology journals for topic ideas. I strongly suggest you do this as soon as possible because first, I have to approve the topic you select, and second, I will allocate topics on a first come, first serve basis.

The **Research Proposal** topic and a very brief (~150 words) description of the area covered by your proposal will be due on **February 6th, 2004**. Please get cracking on this ASAP as this will ensure that a) you get to cover the topic of your choice, and b) you get ample time to think about things a bit. You can submit the topic to me by E-mail, or on a double spaced typed page. Although the topic deadline is February 6th, I would urge you to contact me sooner if you'd like to have a quick chat about potential topics.

This Research Proposal comprises 20% of you final grade in this course. You will be expected to submit a well written, well thought-out document that **thoroughly emphasizes the molecular aspects of the topic you choose.** There is ample time to work on this assignment, so ***expectations are high.*** My evaluation of your proposal will be based on several parameters, including conciseness, accuracy, logical organization, coherence and grammatical correctness. I will not accept proposals that are incoherent! You should take advantage of spell checkers, grammar checkers, etc. that are available with most word processing software. Please take a look at the **Research Proposal Evaluation** form in the next page, it spells out explicit guidelines of what is expected from this assignment.

RESEARCH PROPOSAL EVALUATION FORM

Student _____

Research Proposal Title

_____

_____

/5 Is the title informative and appropriate?

/10 Was the primary literature reviewed adequately?

/5 Was the literature review up to date?

/10 How well was the paper written?

/5 How well was the paper proofread?

/5 Is the format correct? (font, spacing, margins)

/5 Is the question stated clearly?

/5 Is the hypothesis explained concisely and clearly?

/5 Is the significance of the proposed research explained clearly?

/10 Are the proposed experiments explained clearly?

/10 Does the paper exhibit an understanding of the experimental methods used?

/5 Are the references formatted properly?

/10 Was the proposal developed logically and clearly?

/10 Is the proposal an "original synthesis?"

___**PENALTIES:** Was the paper handed in on time?

/100 Final Mark = _____/20

General Comments

_____

_____

_____

_____

PROBLEM BASED LEARNING

Some students have difficulty connecting basic biochemical principles and concepts to their applications. Problem-based learning (PBL) is an instructional method that uses real world problems as a context for students to learn critical thinking and problem solving skills, and acquire knowledge and understanding of the essential concepts of the course. PBL enables students to learn the concepts of biochemistry in a context close to situations where they will be applied, such as in industry. As a result, these concepts will be more easily recalled when they are needed.

The following format will be used for PBL exercises.

Step 1:

1. Students are organized into groups of 4 to 5 (ideally 4, and definitely no more than 5).
2. A problem is presented.
3. Students read the problem and organize their ideas and previous knowledge related to the problem. "What do we need to know to solve this problem?"
4. Students then identify aspects of the problem that they do not understand. "What don't we know?" We will call these learning issues. The learning issues are written down.
5. Students rank the learning issues in order of importance. Students decide which issues will be followed up by the whole group, and which issues are assigned to individuals, who will later share that information with the rest of the group.

Step 2: Research

Research learning issues and work on solutions to problem. Groups are encouraged to meet during the week to discuss their research and solutions. We will discuss the research and solutions to the problems presented in subsequent workshops, and PBL problems have a way of appearing on evaluation exercises

Some of the topics covered in PBLs…

- Molecular biology solutions to protein engineering
- Application of protein engineering concepts to solve an industrial problem; enzyme improvement
- Problems related to protein recovery and purification; Improvement of Large-scale protein production
- Proteins as drugs; proteins and diagnostics
- Applications of bioinformatics; Modelling metabolic pathways using bioinformatics, Computional Prediction of Subcellular Localization of Proteins
- Applications of genomics; Genomics of extremophiles, bioremediation, gene prospecting
- Applications of proteomics; Novel applications of proteomics and/or microarrays
- Debate on GMOs; Agricultural Biotechnology
- Genetic Screening: scientific and ethical considerations; Recent developments in screening technologies, SNPs