CHE6525 – CHEMISTRY OF LIVING SYSTEMS

Spring, 2004 — Monday 6:00 – 9:00 PM
Germany Lecture Hall *(MCC402)* — 3 semester hrs.

Instructor: Dr. Anthony Dribben
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Text: Biochemistry, 3rd Edition; by Mary K. Campbell, **1999**; Saunders College Publishing.
ISBN: 0030244269.
The textbook for CHE 6525 is one on the organizing principles of the course. Students are expected to read the text and to acquire much of the basics from the text, particularly biochemistry nomenclature, structures and other facts. The course outline indicates the topics, which will be discussed during the semester, and students should be able to locate needed information by using the Table of Contents and the Index of the text.

Course Websites: http://bio-che.mc.edu/dribben/che6525/
Textbook companion site available at http://www.brookscole.com/

Prerequisites: Eighteen semester hours of undergraduate and/or graduate chemistry.

Course description: An introduction to the fundamental principles of biochemistry, enzyme mechanisms and kinetics, metabolic pathways of the major classes of biomolecules, hormonal regulation, and protein biosynthesis.

Rationale for course: CHE 6525 is a one-semester introductory biochemistry course offered for graduate credit. Most students who take this course are working in areas such as biology, chemistry, education, agriculture, technology, nursing, physics, geology, or nutrition. Beginning biology, general chemistry, and at least one semester of organic chemistry are assumed in preparation.

Attendance: Your attendance at class meetings is expected, following established University guidelines (see the *2003-2004 Mississippi College Graduate Bulletin*). If a regular class meeting is missed, it is the responsibility of the student to obtain any assignments or instructions that were given by the instructor. Missing a class is not an excuse for not preparing for the next class meeting or not having any assignments ready on time. *Note that the last day to drop this course is Monday, March 29, 2004. After that date, dropping the course will result in a failing grade.*

Disclaimer: Although I expect to conduct the course according to the following, I reserve the right to make modifications if circumstances dictate.

Methods of Instruction: Class will consist primarily of lectures and working problems.

Course Overview: The course covers material presented in chapters 1-20 of the textbook. *(See course outline for further details.)*

Required Practices: You are expected to read the appropriate sections of your text and work any problems assigned before coming to class.

Graded Activities: Graded activities for the semester include:

A. Examinations: Two tests are scheduled during the semester. Each test will be worth 100 points. While the focus of each test will be the most recent material (material not previously tested), students are expected to be familiar with all material covered in the course.

B. Term paper: A term paper, worth 50 points, which should be 5-6 pages in length. Topics for discussion include a recent discovery or application in biochemistry, a notable researcher in the field, a medically-related application of biochemistry, or other topic approved by the instructor.

C. Final Examination: A comprehensive final exam will be worth 150 points.

Make-Up Tests: As a matter of policy, I do not give make-up exams. Students are expected to take all exams unless they have an acceptable excuse. If you anticipate missing an exam, you must see me ***before*** the exam date. If you have questions about the grading of your exams, you may submit the exam for re-grading. The exam should be accompanied by a neatly written explanation of why the grading was incorrect. The entire test will be re-graded.

Grading: Grades in the course will be determined based on the total points in the course. The grading scale for this course is given in the table below. The "plus" system (B+, C+, etc) is used in accordance with university procedures (see the *2003-2004 Mississippi College Graduate Bulletin*).

A range	> 90 %
B range	80%
C range	70%
D range	60%
F range	< 60%

Academic Dishonesty: University policy clearly defines the behavior that the college considers to be academically dishonest (see *2003-2004 Mississippi College Graduate Bulletin*). Students are expected to conduct themselves as professionals. If dishonest behavior is detected, it will be reported to the appropriate administrator and the student will receive no credit for the work.

Learning Objectives: *(This is not an exhaustive list)*

1. Learn basic concepts of thermodynamics and how they apply to biochemical systems
2. Learn how intramolecular and intermolecular forces are used in biochemical systems
3. Learn how the properties of water affect biochemical systems
4. Learn how to calculate pH, pKa, and pI
5. Learn how buffer systems work, and important buffer systems at work in biology
6. Learn the structure and properties of the 20 commonly occurring amino acids
7. Learn structure and properties of peptides and the 4 levels of structure of proteins
8. Learn the models of allosteric behavior
9. Learn the how to measure catalytic activities of enzymes
10. Learn the Michaelis-Menten treatment of enzyme kinetics
11. Learn how inhibitors affect enzyme kinetics
12. Learn how enzymes and proteins are regulated
13. Learn how lipids are used in biochemistry
14. Learn membrane structure and function
15. Learn structure and properties of carbohydrates (monosaccharides, disaccharides, and polysaccharides)
16. Learn the principle reactions of the glycolytic pathway
17. Learn the fermentation pathway
18. Learn the principle reactions of the pentose phosphate pathway
19. Learn the gluconeogenesis pathway
20. Learn the principle reactions of the citric acid cycle - reaction mechanisms
21. Learn the electron transport chain of reactions
22. Learn the proton-coupled mechanism of oxidative phosphorylation and production of ATP
23. Learn how the carbohydrate metabolism pathways are regulated
24. Learn basic structural features and functions of the vitamins.
25. Learn amino acid biosynthetic pathways in vertebrates
26. Learn how transamination reactions work, and the role of vitamin B_6
27. Learn the reactions and regulation mechanisms of the urea cycle, and it's importance to ammonia elimination
28. Learn the main pathways of amino acid catabolism
29. Learn the regulation pathways of the endocrine system
30. Learn the role of secondary messengers in the endocrine system
31. Learn the structure and function of the nucleotides
32. Learn the mechanism and regulation of replication and recombination
33. Learn the molecular mechanisms of DNA manipulation (sequencing, amplification, cloning, etc.)
34. Learn the mechanism and regulation of transcription and RNA editing
35. Learn the mechanism and regulation of translation and protein modification

Special Accommodations: If you need special accommodations due to learning, physical, psychological, or other disabilities, please contact Dr. Buddy Wagner in the Counseling and Career Development Center. He may be reached by phone at (601) 925-3354 or by mail at P.O. Box 4063, Clinton, MS 39058. E-mail: wagner@mc.edu.

COURSE OUTLINE - CHE6525

I. General Concepts and Background Material

- A. Overview of Biochemistry
- B. Biological concepts necessary for biochemistry
- C. Chemical concepts necessary for biochemistry
    1. Thermodynamics
    2. Stereochemistry
    3. Chemical bonding and intermolecular forces
    4. Properties of water, acids and bases
    5. pH and buffer solutions

II. Amino acids & Protein structure

- A. Amino acid structure and properties
- B. Peptide structure and properties
- C. Four levels of protein structure

III. Enzymes

- A. General characteristics of a catalyst
- B. Classification of enzymes
- C. Enzyme-substrate binding and specificity
- D. Enzyme kinetics
    1. Effects of substrate concentration
    2. Steady-state assumption
    3. Michaelis-Menton kinetics
- E. Enzyme inhibitors and their kinetic effects
    1. Competitive inhibition
    2. Noncompetitive inhibition
    3. Uncompetitive inhibition
- F. Mechanisms of Enzyme catalysis
- G. Regulation of enzymes

IV. Lipids & Membranes

- A. Lipids used for energy storage
- B. Lipids used in membrane structure
- C. Lipid metabolism

V. Biological Membranes and Transport

- A. Molecular constituents of membranes
- B. Structure and general function of membranes
- C. Types and mechanisms of transport

First Examination

VI. Nucleic Acids: Structure & Function

- A. Genetic significance
- B. Structure and function of DNA
    1. Relationship of genes and DNA structure
    2. DNA supercoiling
- C. Structure and function of RNA

VII. DNA Metabolism & Manipulation

A. Mechanism and regulation of replication
    1. DNA repair mechanisms
    2. Postreplication modification

VIII. RNA metabolism & Protein Synthesis

A. Mechanism and regulation of transcription
    1. DNA-dependent synthesis of RNA
    2. Regulation of transcription
    3. Posttranscriptional modification
B. Protein biosynthesis
    1. Genetic code and t-RNA
    2. Mechanism and regulation of translation
    3. Posttranslational modification

IX. Nucleic acid biotechnology techniques

A. DNA Manipulation
    1. Sequencing DNA
    2. DNA amplification
    3. DNA cloning
B. Polymerase chain reaction

Second Examination

X. Carbohydrate metabolism

A. Structure and chemistry of monosaccharides
B. Glycoside bonding and disaccharides
C. Polysaccharide structure and function
D. Glycolysis - aerobic and anaerobic conditions
    1. Reactions involved
    2. ATP production
    3. Regulation
E. Fermentation
F. Sources of glucose for glycolysis
G. Regulation of carbohydrate catabolism
    1. Feedback regulation
    2. Hormonal regulation
H. Pentose phosphate pathway and NADPH production

XI. Citric Acid Cycle

A. Structures and reactions of cycle
B. Regulation of cycle
C. Glyoxylate cycle

XII. Electron Transport & Oxidative Phosphorylation

A. Structures and reactions of cycle
B. Regulation of cycle
C. Energy production

Final Examination, May 3, 2004

CHE 6525 - Chemistry of Living Systems

Term Paper

Spring, 2004

TOPICS:

Possible topics include:

- Taxol - uses and mechanism of action
- Enediyne antibiotics
- Treatments for penicillin-resistance in bacteria (clavulinic acid, etc.)
- Catalytic RNA (ribozymes) or catalytic antibodies
- Biochemistry behind a disease or ailment
- Site-directed drug delivery
- Use of NO (nitric oxide) as a signaling molecule in the cardiovascular system
- Gene therapy
- Rheumatoid arthritis - causes and treatments
- Biochemical effects of recent "health store" supplements (*i.e. - Epiandrosterone, chondroitin, creatine, etc.*)
- Recent Nobel prize winners and research dealing with biochemical topics:

(i.e - 2003, 2002, or 1997 prizes in Chemistry or 2002, 2001, 2000, 1999, 1998, or 1997 prizes in Medicine)

Other topics are welcomed, as long as you have obtained prior approval.

The term paper should be a well-researched (include a complete bibliography - 6 references *minimum*), scientifically-written review of the topic of choice. Students are encouraged to start literature search on the chosen topic as soon as possible to allow time for journals/articles not held locally to be obtained (via interlibrary loan). Use of off-campus library facilities is encouraged, though not required.

Papers should be no fewer than six (6) double-spaced pages. Figures should be properly labeled, cited in the text of the paper, and attached in the appendix of the paper. All references need to be cited in the paper. Term papers should have a title page, and simply be stapled together (no binders or folders necessary).

DEADLINES:

The deadline to turn in your selected topic for your term paper is *Monday, March 8, 2004.*

The deadline to turn in your completed term paper is *Monday, April 19, 2004.*