# Brooklyn College
# Department of Chemistry

Chemistry 4571, 7571G Fall 2016

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**Course goals**: to learn the foundations upon which modern biochemistry is understood, including the properties of water, amino acids, carbohydrates, lipids, proteins, nucleic acids, and the structure of macromolecules; hemoglobin structure and function; the basics of enzyme kinetics and function; and an introduction to metabolism.

**Text**: *Biochemistry*, 4th Edition, by Mathews, van Holde & Ahern (3rd Edition OK); additionally: *Biochemistry*, by L. Stryer, W.H. Freeman & Co. (available free at PubMed); Biochemistry texts by other authors may be substituted but lecture material usually follows Mathews closely. Supplementary Text (optional; I will hand out some problems from this book): *Biochemical Calculations,* 2nd Edition, I.H. Segel, John Wiley & Sons.

I recommend using the Internet for searching other sources of information relevant to the course material as a tool for study. For example, you may find a whole set of lecture notes posted on the web for Biochemistry I offered at other schools to be very helpful.

Lecture slides/notes and assignments will be posted on *Blackboard*. Laboratory material will also be on Bboard and may also be handed out in lecture or lab. See separate instructions for lab sessions.

**Course Outline**

In sequence: Chapters 1-6, (9), 7, 11, 13, 14, 15 (in Mathews); approximately 1.5-2.0 lectures per chapter; exams will be based closely on lecture material.

Occasional required assignments: find recent original research articles related to material covered in class and summarize one or two, in one paragraph. These will NOT be graded but your submission of the title and abstract along with your summary will be accounted for as a required assignment. You will receive a grade of *INC* if these assignments are not handed in.

**Grading/Exam Schedule (tentative)** Exam I: mid Oct.; Exam II: mid Nov; Final Exam as scheduled by the college during Finals Week. Exams will have T/F, multiple choice, matching column type questions to test your factual knowledge *and* understanding of concepts. *No "extra projects" for grading will be solicited or accepted. NO make-up exams will be allowed. If you miss one exam, your semester average will be based upon the other two exams. You cannot get a grade in the course if you miss two exams or the final exam.* The overall class exam average (usually around 68%) will establish a grade of "C" for the course.

**Final grades** (undergrads) will be calculated as the average of three exam grades (usually weighted 33% each but sometimes more weight given to the cumulative final if it improves averages).

**Graduate students will have extra exam questions to answer in addition to the full undergrad-level exams and will have to hand in additional work and deliver a presentation in class.** No "curve" will be applied for grading in 757.1.

**Lecture schedule:**

Weeks **1-2**: What is biochemistry? Elements, molecules, macromolecules in biological systems. Non-covalent interactions and properties of molecules; Coulombic interaction energy; water, acid-base chemistry (ionic equilibria); pH and buffers (preparation, properties); blood pH regulation; buffer "capacity"; solubility of macromolecules; acid/base titrations. Tools of Biochemistry 2A.

**Learning goals**: gain understanding of the identity and properties of chemicals in biological systems; gain understanding of the various types of electrostatic (non-covalent) interactions between chemical species; improve skills for calculation of the composition of solutions of acids/bases and buffer solutions; interpret titration curve data.

**Assignments**: choose a weak acid (such as formic acid, acetic acid, benzoic acid) and calculate/plot a titration curve for a 0.1 M solution of this acid with strong base using Excel. Do the same for a weak base (ammonia, TRIS) titrated with strong acid. Complete the Problem Set posted on Blackboard. *Completion mandatory but they will not be graded*.

Weeks **3-4**: Review of thermodynamic principles useful in biochemistry; 1$^{st}$ and 2$^{nd}$ Laws; chemical equilibrium (isomerization example, omitted from Mathews 4$^{th}$ Edition); Gibbs' Free Energy; "high-energy" phosphate compounds; coupled reactions involving phosphoryl transfer; OMIT section on redox reactions.

**Learning goals**: gain understanding of the thermodynamics of processes occurring under constant V or constant P; gain understanding of chemical equilibria for typical reactions and coupled reactions. Gain understanding of the application of free energy equation to biochemical reactions.

Weeks **5,6**: Nucleic Acids; chemical/structural properties of nucleic bases; structural elements of monomers; base pairing/hydrogen bonding; polymerization; thermodynamics of polymerization; DNA, RNA structures/functions; commercial synthesis of DNA; sequencing and genome projects; basic molecular biology (PCR, restriction enzymes); genes to proteins (transcription and translation, ribosomes). Tools of Biochemistry 4A, 4B.

**Learning goals**: gain understanding of how structural features of nucleic acids govern functional properties; learn basic chemical properties of nucleic acid subunits and macromolecules including hyperchromicity; examine and understand features of enzymatic replication of DNA. Gain understanding of DNA synthesis including phosphoramidite reactions; gain understanding of modern sequencing methodologies; gain insights into ribosome structure, function and mechanism of protein biosynthesis. Tools of Biochemistry 5A, B.

Weeks **7,8**: Amino acids; structures, functional groups, acid/base properties (titrations); peptide bond; proteases; peptides and proteins; protein overexpression; protein structural analysis.

**Learning goals**: learn the structural/functional classification of the 20 amino acids; learn the three-letter code names (and single letter codes for extra credit at some point on exams); predict the overall charge on peptides as a function of pH.

Weeks **9,10**: 3-D structure of proteins; secondary, tertiary, quaternary structure; Ramachandran plots; examples of structural proteins, examples of globular proteins; collagen biosynthesis, post-translational modification; protein folding; structural predictions.

**Learning goals**: learn details of the geometry of the peptide bond, the α-helix, and β-sheet; interpret Ramachandran plots; learn the features of various structural proteins; learn the structural features of globular proteins; understand the thermodynamics of protein folding and the hydrophobic effect.

Weeks **11,12**: Myoglobin and hemoglobin structure and function; physiology of oxygen transport and storage; % saturation, $p_{50}$ ($p_{1/2}$) and Keq for oxygen binding; cooperativity; Hill plot; allosteric effectors;

**Learning goals**: gain a quantitative understanding of ligand binding; gain an understanding of the mechanisms of allosteric effects in hemoglobin.

Weeks **13,14**. Enzymology (demonstration); Michaelis-Menten kinetic model; meaning of parameters $K_M$ and $V_{max}$. Kinetics data collection and analysis.

Learning goals: understand the development of the Michaelis-Menten equation from basic principles; gain an understanding of the relationship between *in vitro* measurements and their physiological relevance.