Chemistry 1810 – Chemical biology

Syllabus · Fall 2016 · University of Pittsburgh

Instructor: Professor W. Seth Childers
Office: Chevron Science Center, Room 801
Office Hours: M 10-11, M 4-5, and F 10-11 (subject to change)
E-mail: wschild@pitt.edu

Class meetings

MWF, 3:00-3:50 PM
Recitation W 4:00-4:50
228 Eberly Hall

Course Description

This course is designed to teach biochemistry from a chemical and molecular perspective. Revolutionary transformations in chemistry and biology have led to a merging at the boundary of these disciplines where contributions from both fields impact our molecular and quantitative understanding of biology. Throughout the course particular emphasis will be placed on the molecular interactions in biomolecules and chemical biology approaches to understand biological systems.

Text

Van Vranken, David & Weiss, Gregory. *Introduction to Bioorganic Chemistry and Chemical Biology*, 1st ed.; Garland Science: New York, 2013.

Some course material will consist of advanced topics from published journal articles. Students can acquire these references online through the university library.

Attendance

New material will be introduced at each lecture period, and you are responsible for all material discussed in lectures. Exams will be centered on material presented in the course and highlighted in the learning objectives. If you know you will miss a class, an email notice of your expected absence is appreciated.

CourseWeb

Materials presented in class will be posted on CourseWeb typically within 2 days after each class period. Reading assignments, videos, learning objectives and suggested text problems and other activities will also be posted on CourseWeb to help you prepare for each class.

Disability Resources:

If you have a disability that requires special testing accommodations or other classroom modifications, you need to notify both the instructor and Disability Resources and Services no later than the second week of the term. You may be asked to provide documentation of your disability to determine the appropriateness of accommodations. To notify Disability Resources and Services, call (412) 648-7890 (Voice or TTD) to schedule an appointment. The Disability Resources and Services office is located in 140 William Pitt Union.

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Academic Integrity:

Students in this course will be expected to comply with University of Pittsburgh's Policy on Academic Integrity (http://www.as.pitt.edu/fac/policies/academic-integrity). Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity.

Copyright Notice:

Course materials may be protected by copyright. United States copyright law, 17 USC section 101, et seq., in addition to University policy and procedures, prohibit unauthorized duplication or retransmission of course materials. See Library of Congress Copyright Office (http://www.copyright.gov/) and the University Copyright Policy (http://oscp.library.pitt.edu/intellectual-property/copyright/pitt-policies-on-copyright/).

Statement on Classroom Recording:

To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.

Grading

The overall course grade will be based on the following distribution (dates subject to change). I will not accept late individual and group assignment. There will be no final exam for this course.

Component	Tentative Dates	
Exam 1: Chapter 1-4	Sep 28, 2016	25%
Exam 2: Chapter 5-6	Oct 26, 2016	25%
Exam 3: Chapter 7-9	Nov 30, 2016	25%
Individual Literature Assignment 1	Oct 31, 2016	2%
Individual Literature Assignment 2	Nov 9, 2016	2%
Group Presentation Assignment 1	Nov 21, 2016	2%
Group Presentation Assignment 2	Dec 2,2016	2%
Literature Presentation	Dec 5-9, 2016	15%
Literature Presentation Audience Questions and Feedback	Dec 5-9, 2016	2%

*No final exam will be given for this course.

Exam Re-grades:

If you believe that part of an exam was scored in error, you may request that I regrade it. Such requests must be made in writing no later than the next class period after exams are returned. Attach a cover page identifying which problem(s) you believe were scored incorrectly. I will review the entire exam and return it promptly. This is the only mechanism by which an assigned exam grade will be reconsidered.

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Tentative Dates	Course Topics
8/29-9/7	Central dogma, non-covalent interactions, DNA structure; DNA origami
9/9-9/16	RNA, transcription, translation and unnatural amino acids
9/19-9/26	Operons, plasmids, recombinant DNA technology, sequencing technology
9/28	**Exam 1: The Central Dogma (Chapters 1-4)**
9/30-10/7	Amino acids, protein structure, protein-protein and protein-ligand interactions
10/10-10/19	Enzyme functions, Enzyme Kinetics, Engineering new enzymes, and proteomics
10/21-10/24	Fluorescent proteins, bioconjugation, activity based profiling
10/26	**Exam 2: Protein Structure and Function (Chapters 5-6)**
10/28-11/4	Polyketide synthesis, Terpene synthesis, lipids, metabolism
11/7-11/14	Signal transduction; scaffolding proteins; allosteric regulation; quorum sensing
11/16-11/28	Glycobiology: glycan structure, cell-cell recognition, glycan arrays
11/30	**Exam 3: Signaling, Glycobiology, and Polyketides (Chapters 7-9)**
12/2-12/9	**Current Topics in Chemical Biology – Student Presentations**

Final Literature Presentation

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Purpose

Chemical biology is a fast-paced, diverse field, and we are only scratching this surface this semester. Much of the latest discoveries in this field can not be found in text books, so this assignment will help you become more familiar with the primary literature and current research topics.

Assignment

Each themed literature review will be presented as a group of 3-4 students that will summarize a 4 or less recent literature articles published within the last 10 years during the last two weeks of class.

> As an example last year's CHEM1810 presentation topics included: metabolic engineering, CrispR-Cas9, engineered gene circuits, optogenetics, chemical origins of life, G-protein coupled receptors, and directed evolution. Some of this year's topics may be similar and there will likely be some new topics.

Your group's goal is to integrate knowledge from the few assigned papers on this topic and teach these findings to your peers. Listed below is a timeline of events that will help your group build up to the final presentation in the course. As we approach these deadlines more specific instructions will be posted on courseweb or handed out in class.

Timeline

Dates (tentative)	Goal
Sep 19	A list of special topics in chemical biology will be posted on Courseweb.
Oct 3	Select top four chemical biology topics you'd like to learn more about.
Oct 10	Groups of 3-4 students will be assigned a general theme based on their interest. One paper will be assigned to each person with the goal of becoming an expert in that field.
Oct 31	Individual assignment 1: The primary literature is filled with specialized jargon. Your first step is to create a glossary of new scientific terms related to your manuscript.
Nov 9	Individual assignment 2: Identify major key points and describe each figure of the manuscript.
Nov 21	Group assignment 1: Submit rough draft of slides to paired group for peer review: (1) integrated intro (2) present best experiments, (3) proposed future experiment.
Dec 2	Group assignment 2: Submit peer review summaries (one per group) of presentations.
Dec 5 – Dec 9	Literature presentations in-class

Final Literature Presentation

Presentation Guidelines

(1) Each presentation will be **20 minutes long including 5 minutes for questions**, below is a guideline to get you started constructing the presentation:

Section	Estimated number of slides	Estimated Time (min)
An integrated introduction of the background and/or major motivations in the field	2-3	3-5
Highlight 1-2 major experiments and findings from each paper	8-12 (2-4/paper)	10-12
Propose your group's best future directions	2-3	3-5
Total Presentation Time		18-20
Questions from audience		5

(2) Final presentation slides **must be e-mailed to me noon on the day of your presentation in PowerPoint or Google Slides format**, so that I can run the presentations from a central computer.

(3) Presentations should be well rehearsed to ensure your timing and pace does not exceed 20 minutes.

(4) The presentation time should be divided roughly equally among group members.

(5) Spoken content **must be scripted and memorized** using only information projected on slides as to briefly remind you of content that you will orally present. This will help ensure good eye contact with your audience and keep your group within the time constraints of the presentation.

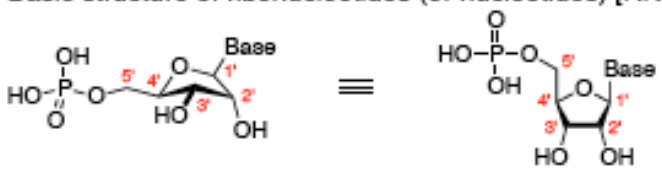
(6) Slides must use graphical data from manuscripts and other illustrations you have made together with minimal text to help explain the experimental results and resulting models.

(7) Future directions should emphasize your question, hypothesis or engineering design, and how you would test it. In most cases illustrating your designed experiment will best convey your ideas.

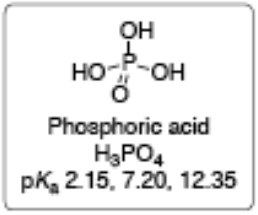
(8) During the 5 minutes of questions, audience members are expected to ask questions that: clarify the presentation, and productively and respectfully critique presented materials.

CHEM 1810: Chemical Biology
Nucleic Acids and Amino acids

Basic structure of ribonucleotides (or nucleotides) [RNA]



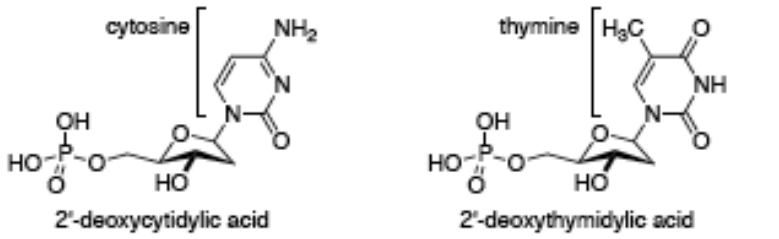
Basic structure of 2'-deoxynucleotides (or deoxynucleotides) [DNA]

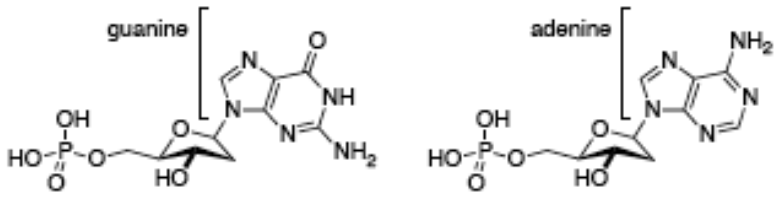


Nucleotides used in RNA & DNA

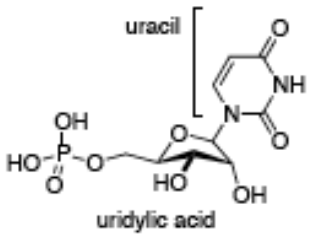
DNA: **dA, dG, dC, dT**
RNA: **A, G, C, U**

2'-deoxynucleotides found in DNA

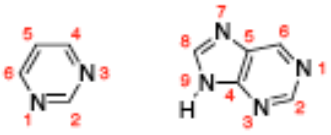




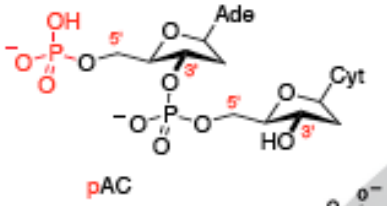
ribonucleotide specific to RNA



Base scaffolds

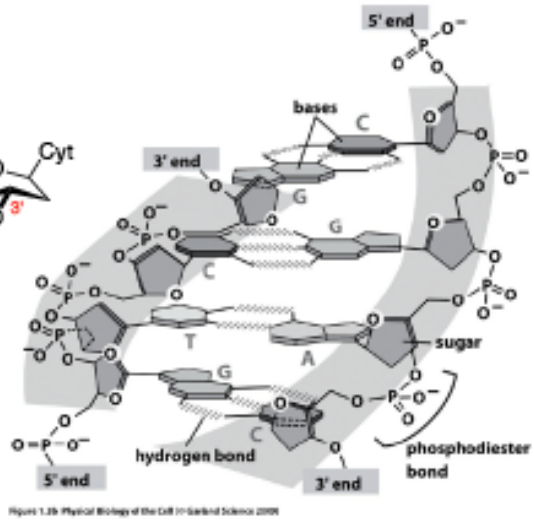


5'-phosphorylated oligonucleotide

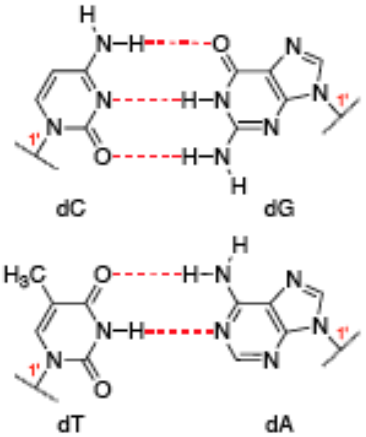


pAC

Note:
At physiological pH, phosphoric acids exist in deprotonated form



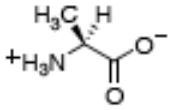
Watson-Crick base pairing



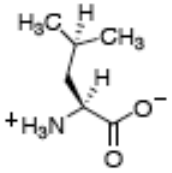
H bonds ~ 2.8–3.0 Å btw heteroatoms
C1' to C1' ~ 10.8 Å

CHEM 1810: Chemical Biology
Nucleic Acids and Amino acids

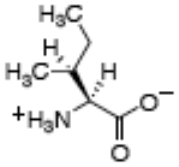
Hydrophobic amino acids



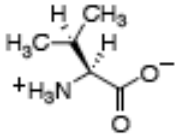
Alanine, Ala
A



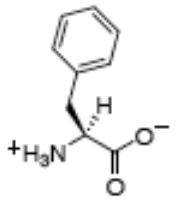
Leucine, Leu
L



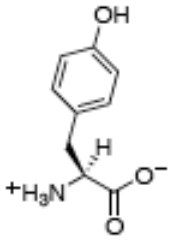
Isoleucine, Ile
I



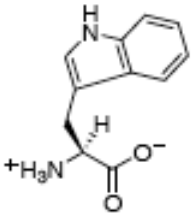
Valine, Val
V



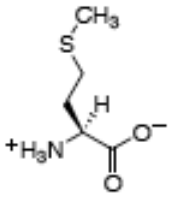
Phenylalanine, Phe
F



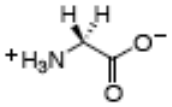
Tyrosine, Tyr
Y, $pK_a \sim 10$



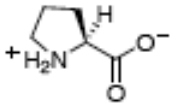
Tryptophan, Trp
W



Methionine, Met
M

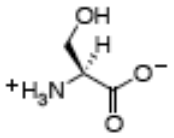


Glycine, Gly
G, "flexible"

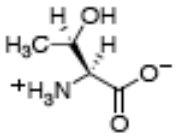


Proline, Pro
P, "rigid"

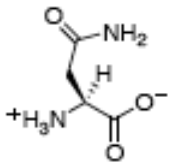
Polar amino acids



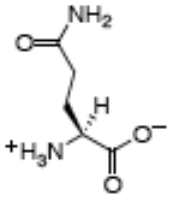
Serine, Ser
S, $pK_a \sim 14$



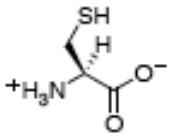
Threonine, Thr
T, $pK_a \sim 14$



Asparagine, Asn
N

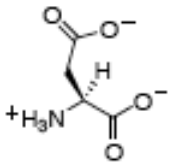


Glutamine, Gln
Q

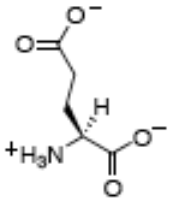


Cysteine, Cys
C, $pK_a \sim 9$
(forms
disulfide bonds)

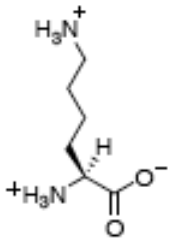
Charged amino acids



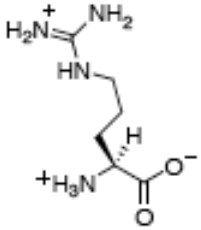
Aspartic acid, Asp
D, $pK_a \sim 4$



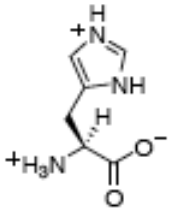
Glutamic acid, Glu
E, $pK_a \sim 5$



Lysine, Lys
K, $pK_a \sim 10$



Arginine, Arg
R, $pK_a \sim 12$–13



Histidine, His
H, $pK_a \sim 6$–7

The pK_a values quoted are typical values for side chain dissociating groups in proteins. Two other important protein pK_a values are those for a terminal α-amino group ($pK_a \sim 8$) and for a terminal α-carboxyl group ($pK_a \sim 3$).