MIND THE GAP: EVALUATING PREREQUISITE CONNECTIONS BETWEEN COURSES
WHY AREN’T STUDENTS “READY” FOR THE NEXT COURSE?

• The prereq course “skipped” a needed topic or
• The prereq course wasn’t rigorous enough or
• The prereq course was so long ago the material has become hazy in the mists of time or
• There’s a gap in the topics/competencies expected in the next course and the prerequisite course or
• Maybe we need to change how we teach some topics (just in time review?) or
• Maybe we need to think about scaffolding some topics more intentionally across courses linked by prereqs
MIND THE GAP

• How do we know that prerequisite courses are teaching the material expected in the subsequent course?
• How do we know that the material taught in the prerequisite courses is being taught at the level expected?
• What skills and competencies do we want students to come into a class with?
• What skills and competencies do we want students to leave a class with?
• How do we make sure students are not falling into gaps in knowledge between classes?
APPROACH AND GOALS

• Keep the focus on student learning and content of courses, not on faculty teaching.
• Get away from lists of topics/sections in textbooks and develop lists of what we expect students to do with those topics (Bloom’s Taxonomy).
• Create lists of prerequisite competencies for courses. Share this list with (1) students and (2) instructors of the prereq courses. If possible, provide assignments or resources so that students can get caught up.
• Create lists of competencies for the course itself that can be used to help new instructors teach the course. Share with students and instructors of the next course in the sequence.
MIND THE GAP

• General Chemistry – full year (CHEM 115/215)
  • taught by lecturers and tenured/tenure-track faculty

• General Organic Chemistry (CHEM 130)
  • one semester organic chemistry course for some biology majors, dietetics majors
  • prereq for a one semester biochemistry course for the same population
  • taught by lecturers

• General Biochemistry (CHEM 349)
  • one semester general biochemistry course for some biology majors, dietetics majors
  • taught by lecturers
<table>
<thead>
<tr>
<th>Specific Learning outcomes from Chem 115/215 useful for Biochem 349</th>
<th>where do they get this?</th>
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</thead>
<tbody>
<tr>
<td>1. calculate the relative number of moles of reactants and products in a reaction</td>
<td>115/215</td>
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<td>2. calculate the molarity of solutions</td>
<td>115/215</td>
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<td>3. identify hydrogen donors and hydrogen acceptors</td>
<td>115</td>
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<td>4. draw hydrogen bonds</td>
<td>215</td>
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<td>5. predict if a chemical reaction will occur from $\Delta G$ values</td>
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<td>6. understand standard free energy</td>
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<td>7. calculate the thermodynamic quantity ( $\Delta Go'$) from equilibrium constants</td>
<td>215</td>
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<td>8. understand relationship between large positive (or negative) $\Delta Go'$ values &amp; magnitude of the equilibrium constants and extent of a reaction</td>
<td>215</td>
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<tr>
<td>9. calculate $\Delta G$ when the concentration of reactants and products are not at equilibrium-apply Le Chatelier's Rule</td>
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<tr>
<td>10. predict rates for zero, first and second order reactions</td>
<td>115/215</td>
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<tr>
<td>11. draw a reaction profile in absence and presence of a catalyst</td>
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<tr>
<td>12. understand the significance of $pK_a$ and its relation to acid strength</td>
<td>115/215</td>
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<tr>
<td>13. identify oxidation/reduction reactions and which molecules are being oxidized (reduced)</td>
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<td>14. balance oxidation/reduction reactions by the &quot;half-reaction&quot; method</td>
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<td>15. predict from $\Delta Eo'$ whether oxidation or reduction is favored</td>
<td>215</td>
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<tr>
<td>16. calculate the $\Delta Go'$ for an oxidation/reduction reaction from $\Delta Eo'$.</td>
<td>215</td>
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WHAT DOES CHEM 349 NEED FROM ORGANIC CHEMISTRY?

Specific Learning outcomes from Ochem useful for Biochem 349

1. Identify (from structures) key organic functional groups - alkanes, alkenes, alcohols, ketones, aldehydes, carboxylic acids, amines (primary, secondary, tertiary), thiols
2. Identify (from structures) the following types of linkages - esters, amides, ethers
3. Relate structures of the key functional groups to physical properties - ie water solubility, acidic, basic nature, and determine the charge on these groups at neutral pH
4. Understand the terms - conjugation, isomers and enantiomers and relate to point 5
5. Identify cis and trans alkenes. Identify chiral carbons and assign R/S configurations
6. Understand carbon ring stability
7. Understand the term aromatic
8. Identify oxidation reduction reactions; Understand that alkanes are more reduced than alkenes: alcohol more reduced than ketone etc
9. Understand how alcohols are formed from alkenes and H2O
10. Understand how esters are made from alcohols and carboxylic acids
11. Understand how amides are made from amines and carboxylic acids
12. Understand how carbon carbon bonds are made - aldol condensation/claisen condensation
CHANGES TO CHEM 130

Chem 130: General Organic Chemistry

Curriculum Goal:
Create a list of competencies for CHEM 130. Review and discuss competencies in the prerequisite course (CHEM 115) and in the next course in the sequence (CHEM 349). Modify and refine competencies as needed.

Textbook:
Essential Organic Chemistry by Bruice

Themes:
1. Molecular Structure and General Reactivity
2. Conformations and Stereochemistry of Alkanes
3. Substitution vs. Elimination Pathways with Haloalkanes
4. Reactivity of Unsaturated Hydrocarbons
5. Reduction/Oxidation Processes
7. Carbonyl Derivatives (Part 2: Reactivity of Nucleophilic α-Carbon)

Course and Learning Objectives by Theme:

1. Molecular Structure and General Reactivity

**Sample Problem Set for (A)-(C) Attached**
CHANGES TO CHEM 130
DETAILED COMPETENCIES

4. Substitution vs. Elimination Pathways with Haloalkanes

(A) Describe the SN1 and SN2 reactions between an alkyl halide and a nucleophile
   - Provide an arrow pushing mechanism for the SN1 and SN2 reactions
   - Explain the stereochemical outcome of each transformation
   - Construct reaction coordinate diagrams for both the SN1 and SN2 substitution reactions
   - Describe the factors (of the alkyl halide and nucleophile) that enhance the rate of each reaction

(B) Distinguish elimination reactions from substitution processes
   - Provide arrow-pushing mechanisms for the E1 and E2 reactions
   - Describe the factors (of the alkyl halide and base) that enhance the rate of each reaction
   - Predict whether a SN1/SN2/E1/E2 reaction will occur under given reaction conditions

(C) Provide examples of non-alkyl halide electrophiles that undergo substitution/elimination reactions
   - Explain why certain non-alkyl halides are suitable electrophiles
   - Recognize biochemical examples where non-alkyl halides will undergo SN1/SN2/E1/E2 reactions
5. Reduction/Oxidation Processes (Chapter 9 and 12)

- PCC oxidation of alcohols (9)
- CrO₃ oxidation of alcohols (9)
- NaBH₄ reduction of aldehydes and ketones (12) - **topic presented from later in text**

6. Carbonyl Derivatives (Part 1: Reactivity of Electrophilic Carbonyl Carbon) (Chapter 11 and 12)

- Hydrolysis of esters and amides (11)
- Transesterification (11)
- Fischer esterification (11)
- Amide synthesis (11)
- Acetal formation (12)
- Imine formation (12)
- Conjugate addition (12)
HOW DID FUNDING THIS PROJECT HELP?

• We could pay faculty to do the work to create prerequisite competencies and course competencies

• We had an all day retreat for people to share the list and meet in small groups to discuss the connections between courses in more detail (65% attendance, representation across all courses)

• External validation that doing the work of curricular revision is valued
ONGOING CHALLENGES

• continue to have ongoing conversations about our courses and updating information continuously
• getting information to the people who need it: those who teach the prereq course, those who teach the subsequent course, and students taking the course
• nudging people towards thinking that maybe they could teach their own class differently to address any gaps.