Teaching beyond our expertise: A student-led toxicology course

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Biennial Conference on Chemical Education
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Where I Teach

- Liberal arts college
- Southwest Ohio
- 1800 students
My Background

• BS – Biochemistry
• PhD – Organic Chemistry
  – 50% synthesis
  – 35% computational
  – 15% spectroscopy
• Teaching
  – Organic
  – Computational
  – Active learning

chemistry.about.com
Student Background

- 5 chemistry majors
  - 3 seniors
- 3 BMB majors
- 2 Biology majors
- All had at least Organic 1
- Several had A&P, Pharmacology, and/or Biochemistry
Principles / Goals

• Molecular understanding of toxicology
  – The purpose of this course is to provide an overview of common environmental toxicants, their mode of toxicity, and how they are eliminated from biological systems. Particular attention will be paid to understanding these processes at the molecular level.

• Build upon Organic 1
• Compliment other upper-level courses
• Actively engage students
Course Structure

• 15 weeks
• One 3-hour session per week
  – Approx. six 20-minute presentations
• Grading
  – 50% presentation
  – 10% participation
  – 20% midterm
  – 20% final
An Introduction to Toxicology

1) History of Modern Toxicology
2) Core Concepts
3) Toxicokinetics
4) Toxicodynamics
5) Adaptive Responses
6) Liver and Kidney
7) Chemicals and the Unborn
8) Cancer
9) Alcohol
10) Tobacco
## Presentations - Rubric

<table>
<thead>
<tr>
<th>Presenter: ___________________________</th>
<th>Reviewer: ___________________________</th>
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</thead>
<tbody>
<tr>
<td><strong>Preparation</strong> – The presenter seemed to be prepared.</td>
<td><strong>Score (5-9)</strong></td>
</tr>
<tr>
<td><strong>Organization</strong> – The presentation was organized in a helpful manner.</td>
<td></td>
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<tr>
<td><strong>Learning Objectives</strong> – Each of the learning objectives was clearly addressed.</td>
<td></td>
</tr>
<tr>
<td><strong>Resources</strong> – The presentation included appropriate references to the textbook and other resources.</td>
<td></td>
</tr>
<tr>
<td><strong>Speech and Visuals</strong> – The presentation was clear and free of verbal annoyances. The presentation included clear and useful visual aids.</td>
<td></td>
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<tr>
<td><strong>General</strong></td>
<td></td>
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</tbody>
</table>

| **Total** |
Presentations – Learning Objectives

Sections 3.1-4 Learning Objectives

3.1 Introduction
- Be able to define and differentiate between toxicodynamics and toxicokinetics
  - Be able to provide at least one concrete example of each

3.2 Absorption
- What are the three major routes of absorption?
- Describe the effect of the following on absorption
  - Size
  - Solubility
  - Charge
- Describe how LogP and Polar Surface Area predict permeability

3.3 Distribution
- What properties typify blood-born xenobiotics vs. those that accumulate in body tissues?
- How does xenobiotic distribution effect drug responsiveness? Examples?
- Explain how \( V_{\text{dist}} \) describes the distribution of a xenobiotic in the body

3.4 Metabolism
- Be able to explain the difference in specificity between most enzymes and those that process xenobiotics
- Be able to provide examples of and recognize:
  - Reductive metabolism
  - Oxidative metabolism
  - Conjugative metabolism
  - Nucleophilic-trapping reactions
Exams

- Questions written by students
  - Discussed characteristics of “good questions”
  - 1-3 definitions / 1 essay per section
  - Also wrote answers

- Compiled and distributed questions

- Used about $\frac{1}{3}$ questions on exams
Conclusions

- Students (and I) learned a lot
  - Many fantastic, imaginative, informative presentations
  - Midterm: 78-98%
  - Final: 61-100%
- Require a semester of general biology
- Base midterm questions on a movie or TV show
- Make presentation rubric more rigorous
  - Change scale to 0-5
Questions?

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