What is Chemical Ecology?

I suspect that you are comfortable with the general idea of ecology. As it is usually taught, we focus on the idea that ecological interactions are really competitive interactions for food sources, territorial domains, and attractive mates. The behavior of an organism to secure these resources is often stimulated by physical signs—the color of male birds, the stomping of hooves, the physical features of the barista at the local coffee shop. These are the driving forces responsible for propagating the species allowing “desirable” traits to successfully evolve.

But I am a chemist and am supposed to be more interested in chemicals than behavior… or at least I thought so. As it turns out, there are many ecological interactions that are stimulated by chemical signals, and they make for fascinating stories. The classic example you may have heard about is the Monarch butterfly tasting bad to birds. This story is usually developed ecologically by stating that another butterfly, the Viceroy, mimics the Monarch wing pattern and coloration to avoid predation. This is an example of a physical signal controlling bird behavior. However, this story also has a chemical side to it; the Monarch tastes bad because it contains chemical compounds found in milkweed plants. Milkweeds produce several alkaloids that are believed to prevent herbivores from eating the plant (alkaloids generally taste bitter to us). Because the Monarch caterpillar feeds on the milkweed plant, this butterfly has surreptitiously co-opted these same compounds for its own defense. This is an example of a chemical signal controlling bird behavior. This is also the perspective that chemical ecology focuses on; how do chemicals control the behavior of an organism?

Fortunately, these ecological stories make the chemistry much more accessible to the non-chemist. The chemical concepts that we will deal with are fairly simple and do not require an extensive background in chemistry. You will need to be comfortable with recognizing the functional groups and structures of organic molecules. You must keep in mind that molecules are physical objects and have their own unique shapes that allow them to interact with receptors. At a very introductory level, we will also be learning about the biochemical origins for some of these molecules, so you will need to be generally familiar with metabolic pathways such as glycolysis and the Krebs cycle.

The remaining information in the course, I hope, will be viewed as lessons in natural history. While this sort of information is sometimes viewed as park ranger chitchat on a nature hike, natural history is the oral folklore of nature that seeks to explain why the natural world is the way it is. The antitodal observations by ecologists often guide chemists to explore the unseen molecular world that is in many cases, responsible for the ecological success of a species. As a result, chemical ecology is an interdisciplinary science that allows us to address questions that are easy to comprehend—questions like, “Why does a Monarch butterfly taste bad to birds?” Fortunately, the answers to some of these seemingly simple questions are quite interesting.

Learning Objectives

You can’t judge learning simply on knowing a specific set of facts. Each fact needs to be placed in context and since everybody’s contextual view of the world is different, we each value and use facts in different ways. This is especially true in this course, and I have written course objectives to reflect the flexibility that I feel is necessary for you to learn things you think are meaningful. At the end of this course, you should be able to,

1. Interpret the ecological importance of chemical interactions in controlling behavioral responses in an organism by writing a short paper for a general audience.
2. Identify the chemical basis for observed ecological behaviors and explain how the chemical-behavioral relationships were discovered.

3. Analyze the biochemical origins of secondary metabolites involved in ecological interactions and prepare a biosynthetic abstract describing (or proposing) the biological synthesis of a compound.

Textbooks

I have decided to use two texts for this course. The first (by J. Harborne) is fairly technical and jam-packed with specific details of chemical structures and statistical trends. This data illustrates some of the broad principles underlying chemically-mediated ecological interactions.

The second text (by W. Agosta) is much more fun to read, because it contains the natural histories of chemical interactions that make this field so appealing. These are the stories that you feel you have to tell someone because they are so amazing. Stories like the fly maggot that eats the insides of an ant’s head causing it to fall off. The head then serves as a …well you get the picture. Interestingly, many of these stories are “incomplete” because scientists have not discovered how or why certain behaviors exist. These stories also offer interesting connections to how ecology has affected history or social development in humans.

The contrast of these two books is what I hope you are able to bridge by the end of this course. Harborne’s text illustrates the level of detail at which I expect you to function by the end of this course. Agosta’s text represents the level of detail that you are probably most comfortable with at this point in your education. But more importantly, Agosta’s incomplete accounts of chemical ecology are what pique our scientific curiosities and hopefully will motivate us to creatively apply chemical methods to further understand ecology.


Learning Methods and the Portfolio

My intent in this course is not to tell you how much I know, but instead to focus on your development in understanding the basis of chemical ecology. The idea is for you to become a more independent learner. This means that you will need to identify questions you find personally interesting and then develop the knowledge to answer, or at least approach, these questions. As a result, we will need to step away from the traditional lecture/laboratory style of learning that is the mainstay of the college experience.

Instead, I will be providing you with a framework to help develop questions and to find the resources necessary to explore those questions. Your job is to demonstrate that you took seriously the responsibility to ask, explore, and develop answers to your questions by assembling a learning portfolio. A learning portfolio is a collection of materials that show evidence of learning. There are a number of activities that demonstrate your evidence of learning and are described a bit later in this document. Let me state upfront, however, that providing evidence of your learning does not mean photocopying journal articles or making long list of websites. Demonstrating evidence of learning requires you to process information, organize it, and then communicate your interpretation of it. The learning portfolio is a serious and organized collection of materials that show you have developed a focused understanding about a specific topic.

A portfolio contains informative resources that you feel are worth sharing with other people who have similar interests. It is a form of networking in which you are interacting with your peers at a professional level providing them with a set of shared resources you have evaluated or developed. Portfolios are not simply a collection of photocopied articles or websites.
Evaluating the Learning Portfolio

As this is likely your first portfolio assessment, I will be quite specific about what your portfolio should contain, the details of which are outlined in a separate handout. In brief, your portfolio shall contain a collection of 10 items developed during this block. Out of the 10 items in your portfolio, you must include the following,

1. A written introduction to chemical ecology.
2. An annotated bibliography.
3. A biosynthetic abstract.
5. A lab report.
6. A reflective learning journal.

Because I am not expecting you to learn a specific set of facts (although many of you will), I will be qualitatively assessing your portfolio items using a general rubric for specific “knowledge types” and how well you have developed each specific knowledge type. I will apply this rubric to every item included in your portfolio and calculate an average for your final grade. Here are the relationships between the qualitative categories of the rubric, percentage values, and letter grades.

<table>
<thead>
<tr>
<th>Grade conversion factors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>85-100%</td>
</tr>
<tr>
<td>Competent</td>
<td>70-85%</td>
</tr>
<tr>
<td>Needs Work</td>
<td>60-70%</td>
</tr>
<tr>
<td>Failing</td>
<td>&lt;60%</td>
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</tbody>
</table>

Course Policies

This is the basic boilerplate of my expectations of you in this course as well as reminders about certain college policies. Please note that policies dealing with academic dishonesty are in a separate section due to its importance in the nature of your work here at the college. Should you have questions regarding these or other issues regarding this course, I would be happy to discuss them with you.

Due Dates

Due to the short time frame of our block semesters, I do not accept late assignments. I will, however, arrange alternative deadlines for situations that conflict with the deadline or if you are facing some extenuating health circumstance. I reserve the right to judge if your situation is reasonable, and any alternative deadline must be arranged prior to the original deadline, preferably at the time the assignment is given.

Attendance

I do not officially require attendance simply because showing up for a meeting is “professional” behavior, and at this point in your life, being a student is your profession. Although it is possible to never miss a class, there are times when certain extenuating circumstances (i.e. illness or family emergencies) prevent us from meeting our professional obligations. If you find yourself in this situation, it is your responsibility to notify me before the actual class meeting time that you will not be attending class.

In the event that you need a late withdrawal on the 15th day, your attendance record is one of the things that I consider in deciding if you have made a “determined effort” to participate in the class. In the interest of defining “determined effort” with respect to attendance, I find it unlikely that you would face extenuating circumstances more than twice during the block.
Withdrawals

College policy allows for withdrawing from any course on the 15th day of the block but only if 1) you have met the course attendance policy, 2) that you have completed all assignments, labs, and exams due on or before the 15th day, and 3) that you have, “in the instructor’s opinion, made a determined effort to learn the material, complete the work, and participate in class”.

Special Needs

If you require academic adjustments because of a documented learning disability or health-related concern, it is your responsibility to ensure that you have 1) documented your needs with the Registrar, and 2) notified me within the first 3 days of the block.

Accommodating students with special needs includes things such as help in taking notes, extra time for exams, or supervised tutorial support—it does not include opportunities for extra credit, different grading schemes, or alternative assignments. If you suspect you might have a learning disability but have not been diagnosed, you should consult with the Registrar or the Director of Counseling.

iStuff

I will admit that I am starting to show my age on this one, but I am concerned about the social disruptions that are caused by the use of cell phones and other electronic devices. Classrooms are a social learning environment, and I ask that you respect this environment by not using iStuff while you are in class.

Academic Dishonesty

Part of the professional expectations for all scholars is to explicitly acknowledge the ideas, observations, or data created by others. Failing to do so is a form of academic dishonesty, and academic dishonesty is an extreme form of disrespect towards your peers and mentors. In its most general definition, academic dishonesty involves passing the ideas or information of others as your own original work. Obvious examples of dishonesty include actions such as plagiarism (copying, paraphrasing, or stitching) or cheating on exams; however, there are other examples of academic dishonesty (an how to avoid them) that are outlined in your student handbook, The Compass.

Students misrepresenting their work in this course (i.e. plagiarizing or cheating) will automatically fail the assignment and depending on the circumstances may receive a failing grade for the course. Violations of the College’s policies on academic dishonesty are also referred to the Registrar and the Dean of the College and will be dealt with as described in the student handbook.

A word about plagiarism… Collaboration is a great way to learn, and I strongly encourage you to work with others to help you understand the concepts and practices we undertake in class. Unfortunately it is difficult to identify those thoughts and statements that are specifically yours when working collaboratively. Nevertheless, I will expect you explain what you know in your own words. Copying verbatim, paraphrasing, or simply creating a cooperatively written document simply shows that you don’t take much pride in your work and makes it hard to convince others you are a valuable colleague to work with. Remember that this is not just about “getting through the class”; this is about you developing as an individual.
**Grading Rubric**

In judging your work, I will be categorizing it based on three levels, excellent, competent, and needs more work. These categories roughly correspond to the numerical ranges show in the chart. As I grade your work, I will assign it to a category, give it a numerical score within the category and then use that number to convert it to a grade. You should consult the grade conversion chart in the “Evaluating Learning Outcomes” section of the syllabus.

<table>
<thead>
<tr>
<th>Knowledge Type</th>
<th>Excellent (&gt;85%)</th>
<th>Competent (70-85 %)</th>
<th>Needs work (&lt;70 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
<td>Content is clearly relevant, focused and informative to stated objective.</td>
<td>Content is mostly relevant, focused and informative to stated objective.</td>
<td>Content is only marginally relevant and informative</td>
</tr>
<tr>
<td><strong>Conceptual understanding</strong></td>
<td>Accurate and detailed information used to develop clear understanding of concepts. A strong awareness of how specific information relates to the “bigger picture” is demonstrated.</td>
<td>Shows a high degree of knowledge and awareness of the topic. Information is generally accurate but one or two ideas are not adequately developed or remain vague.</td>
<td>Shows very little knowledge and awareness of the topic. Some knowledge is accurate but there are several ideas that are vague or incorrect.</td>
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<tr>
<td><strong>Inquisitive thinking</strong></td>
<td>Research is thorough and goes beyond basic information/assigned texts. Clearly demonstrates the student’s intellectual journey, including problem solving and decision making capabilities.</td>
<td>Research is adequate but does not go beyond the assigned textbooks or readings. Occasionally reverts to summarizing the literature rather than analyzing and synthesizing the readings for application.</td>
<td>Research is not adequate. Basic information in assigned readings has not been applied.</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>Written work is clear and concise. Correct spelling, grammar and punctuation. Consistent and appropriate writing style with accurate referencing throughout.</td>
<td>Overall written work is concise and clear. Occasional errors in grammar/spelling and punctuation. Generally the writing style and referencing system used are appropriate.</td>
<td>The written work is not clear and many grammatical errors exist. The writing style is not consistently appropriate. Referencing is incomplete, inaccurate, or inconsistent.</td>
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**Portfolio-specific traits**

<table>
<thead>
<tr>
<th>Organization</th>
<th>The portfolio is carefully planned and cohesively organized. Items within sections are well structured, logically developed and appropriately integrated. Contains 10 items including the required items.</th>
<th>Overall, well organized but development and integration of some elements are potentially confusing to the reader. Contains 10 items including the required items.</th>
<th>The portfolio is not well organized and the elements are neither well developed nor well integrated. Contains fewer than 10 items or is missing those that are required.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-reflection</td>
<td>Changes in perceptions and assumptions clearly illustrated.</td>
<td>Changes in perceptions and assumptions are evidence but not well illustrated.</td>
<td>Little evidence of reflection</td>
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</tbody>
</table>