CHEMICAL ASPECTS OF ETHNOBOTANY: BIOL 395
Syllabus
Spring 2008

Supplemental Reading Material:
Chemistry The Molecular Science 4th edition by Olmsted & Williams
Quantitative Chemical Analysis by Daniel C. Harris
Organic Chemistry by Francis A. Carey

Lecture and Laboratory: Monday and Wednesday- 3:00 PM-5:50 PM

Schedule & Professors:

Professor	*SC Office*	*Phone 395-*	*Email*
Dr. Evans	3017	7460	evanst@hope.edu
Dr. Brown	2116	7173	brownk@hope.edu
Dr. Swarthout	2029	7355	swarthout@hope.edu

Office Hours:
Dr. Evans: By appointment (please call or send an email)
Dr. Brown: Tue and Thur 10 AM- 11 AM or By Appointment
Dr. Swarthout:

Course Objective and Philosophy. Students will learn to appreciate how humans are impacted by plants through deliberate intellectual manipulation of chemical and physical properties involved in animal and plant physiology. This will be facilitated by the utilization of analytical tools commonly used to address research problems in the field of pharmacology and medicinal chemistry. This knowledge will be applied to understanding the wisdom or "folk lore" that is embedded in many ethnobotanical practices.

Course Description: An upper level course that is designed to serve students in Chemistry and Biology. Cases studies will provide knowledge about how plant physiology, analytical chemistry, and ethnobotany can be intermingled to address new areas of medicinal needs in our society. Each case study will be broken into four disciplinary approaches:

1. Ethnobotany
2. Plant Physiology
3. Analytical Chemistry
4. Animal Physiological Applications

Ethnobotany
While most medicinal compounds currently used in industrialized nations are chemically synthesized, a large number of medicines can trace their origin to specific compounds isolated from plants. In many cases, these biologically active compounds were first

discovered because of their use by native peoples. Ethnobotanical studies aim to examine how the people of a particular region utilize the plants around them. In this class we will examine the medicinal characteristics and applications of plants by people of various cultures. We will discuss plants from a variety of geographic regions and their use by different cultures, but we will emphasize plants that are native to Michigan. In addition, specific examples will be examined in which we will trace the development of a particular biologically active compound from its local use by indigenous people, through the research and development stages, to its ultimate large-scale production and widespread use in modern medicine.

Plant physiology

Plant physiology is the study of how plants function. Plants are such amazing biochemical factories that are continuously adapting to new selection pressures. As a result, they are evolving continuously at the chemical level. The fields of ethnobotany and pharmacology rely upon the evolution of these chemical novelties to treat new medicinal problems in our modern society. Very little is known about how plants can be manipulated under certain environmental and biotic cues to produce effective quantities of these medicinal chemicals. The central plant physiological theme in each case study will be to gain knowledge about how plants allocate resources to various chemical pools of interest in response to environmental and biotic cues during plant growth, development and survival.

Analytical Chemistry

The methods used to study the chemical properties of compounds involved in certain plants at the cellular level will be drawn primarily from Analytical Chemistry and Organic Chemistry. Various instrumental techniques in the area of Separation Science and Spectroscopy will be used to understand the dynamic and synergistic impact of environmental and biotic manipulative implants of chemicals on animal growth, animal development, and animal survival. Each of these areas will be monitored using modern methods in High Performance Liquid Chromatography with UV and Electrochemical Detection, and Gas Chromatography-Mass Spectrometry. Students working in the course will utilize chemical information from literature resources to acquire background information about the utilization of Analytical Chemistry techniques applied to medicinal chemistry. Students will be required to review basis Analytical Chemistry concepts to include acid/base equilibrium, use of spreadsheets, intermolecular forces in solutions, and basic regression analysis. The professor reserves the right to include more Analytical Chemistry topics as deemed necessary to complement the learning objectives and learning goals of the course.

Animal Physiology Application

Case studies will be chosen to investigate how specific plant chemical compounds extracted will impact the physiological functioning of vertebrate animals (e.g. frogs, mice, rats, humans).

Learning Goals

Interdisciplinary

- Students should gain an appreciation for how the principles of chemistry can be applied at the molecular, cellular, tissue, whole plant and animal levels of organization in the context of pharmacology and ethnobotany.
- Students will gain the interdisciplinary experience of (1) manipulating the conditions of plant growth and development; (2) using analytical tools to extract medicinal chemical compounds; (3) applying the chemical compound to an animal physiological bioassay and (4) extrapolating the findings to current ethnobotanical application in modern society.
- Students will improve in their scientific communication skills (written, oral), data analysis skills and thinking, planning and decision making skills through weekly lab experiments and an independent research project.

Ethnobotany

- Students will review basic plant morphology and plant classification/identification principles.
- Students will the systematic significance of plant secondary compounds.
- Students will examine the role of plants in modern society, with an emphasis on their contribution to medicine, as well as the various conservation pressures facing ecosystems that harbor potentially useful plant species.

Plant Physiology

- Students will gain knowledge about how water, nutrients, light and herbivory interact with each other to bring about a change in resource allocation to the medicinal chemical compound of interest.
- Students will become proficient in using the professional vocabulary to describe how plants function.

Analytical Chemistry

- Students will learn about the tools of Analytical Chemistry used in robust extractions.
- Students will learn how to select an analytical method by defining the problem and evaluating analytical figures of merit.

Animal Physiology

- Students will learn about the function of specific organs in vertebrate animals through chemical manipulation of their physiological conditions.

Learning Activities

Introduction to Ethnobotany

Two overall approaches will be employed during the ethnobotany portion of the class. First, specific case studies will be examined in which pharmacological compounds are traced back to specific plants, often with specific uses by people. These studies will illustrate both the potential value of traditional medicinal approaches, as well as the

complex and expensive procedures involved in isolating, testing, and ultimately marketing those compounds.

Second, we will examine numerous plants of *potential* medicinal value (i.e. close relatives of plants that produce pharmacological compounds, plants that are used by various cultures for "traditional" medicine, etc.) in less detail. By examining a broad array of plants, some of which will have medicinal value and some of which will not, students will begin to appreciate the complexity and value of ethnobotanical studies to modern medicine. Students will employ lab techniques learned in the plant physiology and analytical chemistry portions of the class to test their own hypotheses about the potential pharmacological value of some native plant species.

Development of Case Studies

Each case study will involve gaining an understanding about how plants produce pharmacological chemicals under varying environmental conditions; applying analytical chemistry tools to extract the chemical compound of interest and applying the compound in an animal bioassay to investigate the specific physiological effect that it has on the animal. Students will gain confidence in manipulating environmental conditions for plant growth and development during the weekly lab activities and during their independent projects using the environmental growth chambers and the greenhouse at Hope College.

The animal physiology labs will revolve around modifying current labs used in Human Physiology at Hope College to test the physiological effect of the specific plant chemical compounds on various physiological processes.

This course blends plant physiology, animal physiology, and analytical chemistry in a manner that presents interesting and novel methods of integrating teaching and research to promote more interdisciplinary areas of study.

Grading and Student Assessment

The points that comprise your grade will be distributed as follows:

Laboratory Experiments and Problem Sets:	25%
First hour exam:	20%
Second hour exam:	20%
Third hour exam:	20%
Presentations:	10%
Quizzes & in-class assignments:	5%

Achieving 90% or more of the available points will earn you some sort of an A. Scoring in the 80%'s will merit a grade in the B range, 70's get you C, and 60's a D. A total score of less than 60% will constitute failing the course. Note that there is no limit on the number of A's that can be earned – grading is not done on a curve.

Academic integrity:

Cheating on exams, quizzes, or problems sets will not be tolerated. One is never to misrepresent the origin of one's work. To do so is to risk a zero for the assignment and/or

failure for the course. The college has a clear statement on plagiarism and Academic Integrity in the Catalog, pages 86-88. Cooperation and the sharing of insights is encouraged on problem sets. (which are mostly "individualized" anyway), but simply copying someone else's homework is not allowed. New technology brings new sources of concern which include (but are not limited to) the following:

- You may not use any type of interactive device during quizzes or exams, including pagers, text messaging devices, or cell phones (even if you plan to only use it as your "calculator.")
- You may not use pre-programmed calculator programs or memory storage devices during an exam. Please erase your calculator's memory before each exam.
- You may not share calculators during quizzes or exams.

BIOL 395
Tentative Class Schedule
Spring 2008

Date	**Topic**
Wednesday 9 January	Introductions and Syllabus Why are plants so interesting? (Debbie Swarthout) Introduction to Analytical Chemistry (Ken Brown) Introduction to Ethnobotany (Tim Evans) LAB TIME: No Lab
Monday 14 January	Analytical Chemistry: Organic Chemistry Functional Groups; Structure of Digitoxin; High Performance Liquid Chromotography (HPLC) LAB TIME: Preparation of Digitoxin Standards and HPLC (Ken Brown) **Groups A, B, and C**
Wednesday 16 January	Analytical Chemistry: Quantitative Aspects of HPLC LAB TIME: Preparation of Digitoxin Standards and HPLC (Ken Brown) **Groups D, E, and F**
Monday 21 January	"The physiological impact of digitoxin on frog heart muscle contractions" Heart physiology lecture (Chris Barney) (60 minutes) LAB TIME: Extraction of Digitoxin from Foxglove (Ken Brown) **Groups A, B, and C**
Wednesday 23 January	"The physiological impact of digitoxin on frog heart muscle contractions" Heart physiology lecture (Chris Barney) (60 minutes) LAB TIME: Extraction of Digitoxin from Foxglove (Ken Brown) **Groups D, E, and F**
Monday 28 January	Principles of plant systematics and its role in ethnobotanical studies (Tim Evans) **QUIZ 1** (Ken Brown and Chris Barney)
Wednesday 30 January	Molecular phylogenetics; basic principles (Tim Evans)
Monday 4 February	**EXAM 1**
Wednesday 6 February	Discussion
Monday 11 February	Winter Recess

Wednesday 13 February	The evolution of chemical compounds in plants; case studies, with an emphasis on digitoxin (Tim Evans) LAB TIME: DNA Extractions (Tim Evans) **Groups A, B, and C**
Monday 18 February	Molecular phylogenetics and the evolution of chemical compounds in plants (Tim Evans) LAB TIME: DNA Extractions (Tim Evans) **Groups D, E, and F**
Wednesday 20 February	Remedial Plants I: Internally active plants LAB TIME: PCR and DNA Sequencing (Tim Evans) **All Groups** **QUIZ 2 (Tim Evans)**
Monday 25 February	Remedial Plants II: Topically active plants and deterrents LAB TIME: DNA Sequencing (Tim Evans) **All Groups**
Wednesday 27 February	Injurious plants; an overview LAB TIME: Analyze DNA Sequence **(All Groups)**
Monday 3 March	**EXAM 2**
Wednesday 5 March	LAB TIME: Effects of Digitoxin on Frog Heart Muscle Contractions (Debbie Swarthout) **Groups A, B, and C**
Monday 10 March	LAB TIME: Effects of Digitoxin on Frog Heart Muscle Contractions (Debbie Swarthout) **Groups D, E, and F**
Wednesday March 12	Ethnobotany of edible plants (Tim Evans, Debbie Swarthout, Ken Brown) Journal Club discussion (led by Debbie Swarthout and Ken Brown)
Monday 17 – Friday 21 March	Spring Break
Monday 24 March	**QUIZ 3** (Debbie Swarthout) Ethnobotany (Start independent projects) Faculty presentations – (Ken Brown)
Wednesday 26 March	Ethnobotany (Start independent projects) Faculty presentations – (Ken Brown)
Monday 31 March	Ethnobotany (Continue with independent projects) Faculty presentations – topics of interest
Wednesday 2 April	Ethnobotany (Continue with independent projects) (Faculty presentations – topic of interest
Monday 7 April	Ethnobotany (Student presentations – lecture style presentation on topic of interest) Continue with independent projects
Wednesday 9 April	Continue with independent projects
Monday 14 April	**QUIZ 4** Continue with independent projects
Wednesday 16 April	Ethnobotany (Student presentations – lecture style presentation on topic of interest) Continue with independent projects
Monday 21 April	Independent project oral presentations
Wednesday 23 April	Poster presentations

April 28-2 May	**EXAM 3** AT DESIGNATED TIME DURING FINALS WEEK