ORGANIC CHEMISTRY LABORATORY 221 L
Fall 2012

Instructor	Ms. Brenda Harmon 220A Pierce Hall 4-8341	**Office Hours** Mon, Tues, and Wed 10:45-12:00 and by appointment ***Drop-in Mon., Tue., Wed. during labs (2-4)

"In theory, there is no difference between theory and practice.
In practice, however, there is."
- Jan van de Snepscheut

Required materials

- Pre-lab reading materials and background information will be made available via a blackboard site. You will be provided with a copy of the handouts that are required while in the laboratory at the beginning of the semester for a $5 printing fee. You may print the background material to keep in your binder for use during lab, choose not to print the background material,or bring a laptop computer to lab.
- ***Carbon-copy notebook** (your old gen chem. lab book is fine to start with), a **three-ring binder**, and instructor approved **safety glasses** are required.

A liberal-arts intensive laboratory course for organic chemistry

This course is taught in a very different format to most standard organic chemistry laboratory courses. Many laboratory courses focus on developing techniques (given detailed procedural instructions) and applying them randomly to many different synthetic reactions discussed throughout lecture. Sort of a "show and tell" approach. This laboratory course, in line with the Oxford College mission statement, takes a liberal-arts intensive approach.

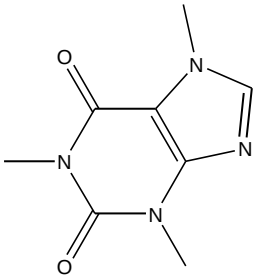
The focus in this course is in developing a rich understanding of the chemistry behind the techniques and connecting the macroscale (what you see and do in lab) to the microscale (the theories and concepts from lecture). Instead of following detailed procedures, students are guided to develop their own procedures and to develop the disciplined habits of mind of a scientific researcher. There is a focus on improving scientific thinking and inquiry skills, critical components of a liberal arts education. Instead of focusing on synthetic methods important only to students planning to go to graduate school in organic chemistry, experiments and synthetic procedures have been selected that highlight the importance of organic chemistry on a broader scale - in consumer products, environmental concerns, and biological and health science topics.

What will you be able to do at the end of this course?

You will be able to design their own unique procedure for separating caffeine from all the other compounds present in a natural product or consumer beverage. Once the caffeine is separated, you will be able to identify the white needle shaped crystals and determine their purity.

Here is an example of this type of challenge:

Caffeine is an *alkaloid* -A naturally occurring compound containing nitrogen.



caffeine

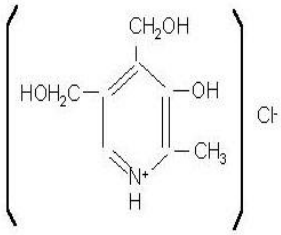
Ingredients listed on the back of a can of Red Bull:

Carbonated water, sucrose, glucose, sodium citrate, taurine, glucuronolactone, caffeine, inositol, niacin, D-pantothenol, pyridoxine HCL, vitamin B12, artificial colors

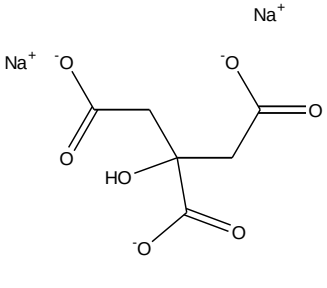
(Carbonated water ….$CO_{2(gas)}$ + H_2O –will form *some* carbonic acid H_2CO_3 The equilibrium favors the reactants.)

*Your first task would be to find the structures for all the ingredients in the mixture. The structures of each of the compounds allow you to identify their polarity and the intermolecular forces that they undergo. With his knowledge you should be able to predict a compound's solubility in water or in organic solvents and design a separation (or series of separations) that would eventually isolate just the caffeine from the mixture.

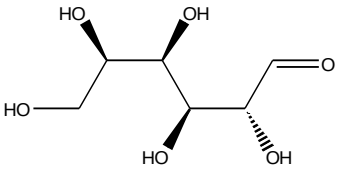
Molecular structures of the ingredients:



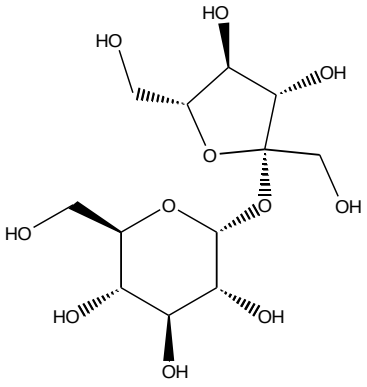
pyridoxine• HCl



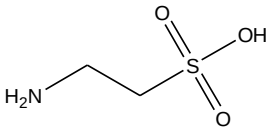
sodium citrate



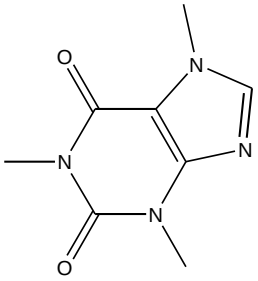
glucose



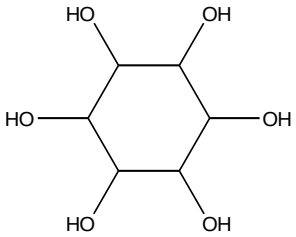
sucrose



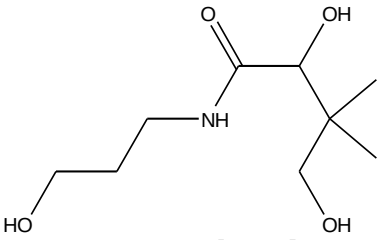
taurine



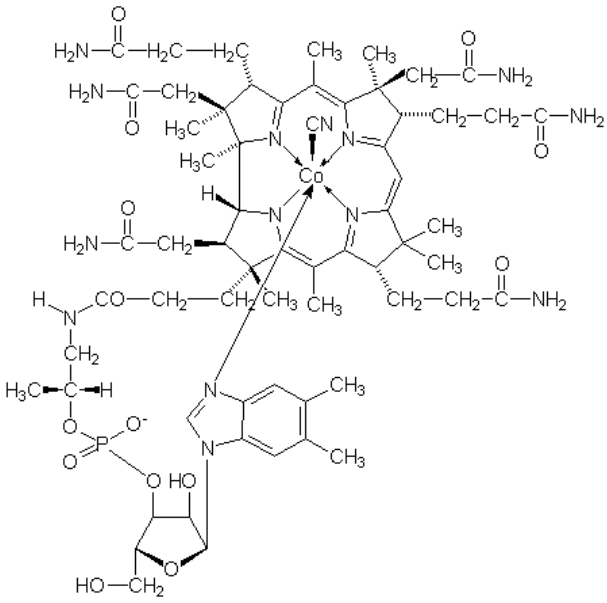
caffeine



inositol



D-pantothenol



Vitamin B12

How will you know what to do?

Every week in lab, your group will be working together to create your own procedures using the techniques. When you have to use a technique to create something new, you need a much deeper understanding of the concepts involved. You will be combining the techniques and solving more complex problems all semester long, gaining the knowledge and comprehension necessary for the important higher order thinking skill: **application**. Because you will be 'practicing' these application skills in every lab session, you will be prepared for the final challenge. In addition, many of the experiments during the semester will involve caffeine, so you will already have practical experience dissolving, separating, and identifying caffeine.

Course Goals

Cognitive Domain

Students will demonstrate their ability to:

- *Think like a chemist* by applying content knowledge from the general chemistry organic lecture courses to problem-solving in real laboratory situations.
- Employ trouble-shooting skills (backward diagnosis) while problem-solving in real laboratory situations.
- Interpret, manipulate, and analyze matter and chemical phenomena on both a macroscopic and a microscopic scale.
- Employ disciplined habits of mind that characterize scientific thinking.
- Use scientific record keeping skills in keeping a laboratory notebook.
- Observe closely and use scientific insight.
- Apply oral communication skills working with a team of peers.
- Diagram a separation procedure using a flow chart.
- Organize and present qualitative and quantitative evidence.
- Use simple statistics to analyze and evaluate the validity of quantitative evidence.
- Construct valid arguments using logic and reasoning skills.

Affective Domain

Students will demonstrate their ability to:

- Know the laboratory safety rules and practice them.
- Prioritize time and multitask to meet the needs of the laboratory time constraints.
- Cooperate in group activities (displays teamwork).
- Use failure as a tool for producing more effective learning. (Mistakes are an important part of the scientific method, often more can be learned by making mistakes than by being right the first time.)
- Show self-reliance when working independently.
- Question new concepts, models, etc. in order to fully understand them.
- Revise judgments and changes behavior in light of new evidence.

Content Goals

Students will demonstrate their ability to apply the concepts of **molecular structure, polarity, and intermolecular forces** in order to **predict physical and chemical properties** and to **use these properties to separate mixtures and identify pure substances**.

Separation

Extraction (solid/liquid, liquid/liquid, acid/base)
Chromatography (column chromatography, thin-layer chromatography)

Identification

Melting points
Thin-layer Chromatography

Scientific Inquiry Goals

Students will demonstrate their ability to engage in inquiry through the disciplinary lens of chemistry in several key areas:

- Questioning
  - Asking "good" questions at important "key moments" that drive a chemistry laboratory problem to a solution
- Problem-solving
  - Creating procedures, developing methods to solve chemistry problems in the laboratory. Troubleshooting in order to make the methods 'work'.
- Obtaining and evaluating evidence (data)
  - Identifying the assumptions inherent in a given laboratory method and assess the limitations of a particular separation or identification technique.
  - Communicating analytical results/data in an appropriate, clear, and concise manner.
- Using evidence (data) and argument to make conclusions
  - Assessing the quality and source of evidence (data); questioning its accuracy, precision, relevance and completeness.
- Evaluation of their own inquiry process
  - Using evidence and argument to convince others (and yourself) that your conclusions are logical and valid.

Grading Methods and Course Requirements

Each lab session is worth **100 total points**:

40 points notebook content and style
20 points pre- and post- quizzes
20 points post-lab write-up results/conclusion
20 points scientific thinking skills
group: problem-solving and troubleshooting
individual: logic, reasoning, analysis and evaluation

Total lab grades	**65 %** of your final course grade
Written lab final	**20%** of your final course grade
Lab practical (caffeine)	**15 %** of your final course grade

Grades are based on percentages and usually assigned as follows:

93 - 100% A	78 - 80% C+
90 - 92% A-	74 - 77% C
88 - 90% B+	70 - 73% C-
84 - 87% B	68 - 70% D+
80 - 83% B-	60 - 67% D
	Below 60% F

Quizzes

Pre-lab Quizzes

A 5-question quiz will be given at the beginning of each lab period to determine your level of preparation. You *will be allowed to use the procedure and table of reagents sections of your laboratory notebook to answer three questions specific to the procedure*. Two further questions will investigate your understanding of the material. The quiz will be followed by a brief discussion of the quiz questions and a 20-30 minute lecture about the concepts, techniques, and procedures to be followed for that lab session.

Post-lab Quizzes

A 10 minute quiz will be given at the end of most laboratory sessions. These quizzes will cover the concepts behind the experiments or techniques just completed and may include concepts from previous experiments. Much of the information learned in this lab class is cumulative; therefore you will be held responsible for these thematic concepts throughout the semester. These quizzes may or may not be announced.

Post-lab Write-up

The most important aspect of this course is for you to understand the chemistry behind what you are doing and to use this understanding to further develop your scientific thinking and inquiry skills. After completing each lab challenge you will be required to prepare a typed, formal, results/ conclusion.

Written final exam

Everything you learn in this course is interconnected. Every technique builds on previous techniques and concepts. You will be learning a series of techniques that you will have to use and apply throughout the year. Not only do you need to learn HOW to perform all the techniques, you must understand the chemistry behind them. Consequently, you will be tested on your understanding and application of these techniques in an hour long written exam.

Lab Practical

At the end of the semester you will be given a laboratory practical exam that will present a problem requiring you to use many or all of the techniques learned during the semester: You will be evaluated by your level of sophistication in demonstrating: planning and organizational skills, knowledge, confidence, safety skills, technique, data analysis, and conclusions.

Attendance

Attendance during your assigned scheduled lab time is mandatory. There will be no make-up sessions for lab. In the event of extenuating circumstances (e.g. a serious illness) arrangements that do not involve a penalty can be made with your instructor. It is the student's responsibility

to let the instructor know PRIOR to the missed lab any extenuating circumstances. If the instructor is not contacted **prior** to the missed lab the student will receive a zero for that lab. NO exceptions!

Late Work

If work is turned in late, the penalty is one letter grade per day. In the event of extenuating circumstances penalties may be waived. This will be determined on a case-by-case basis.

Honor Code Policy

Lab sessions are a perfect place to promote and utilize collaborative learning. You are encouraged to discuss the experiments with others before lab (group study) and while in lab. However, your results and conclusions (including tables, graphs, etc) are to be **your work alone**. You should not work with another student after the lab is over. Collaboration on any report is a violation of the Oxford College Honor Code and will be treated as such. This rule applies to any portion of reports from previous semesters as well as papers available over the internet. Your name on your results and conclusions is your pledge that the work is yours and that you did not give or receive unauthorized assistance. The usual penalty for students who are found to have violated the honor code is an F in the course.

Group Work

You will be asked to form small groups for working in and out of organic lab. You will perform most of the procedures by yourself or in pairs, but you will prepare, discuss, and trouble-shoot the procedures in small groups of 4 students. The groups will have two primary activities.

I. You will be asked to meet with your group ***before* your lab** day to develop a laboratory plan and to work on assigned problems. You should be completely prepared for lab when your group meets so that you can fully contribute. The reason for this group meeting is to allow you to think about what you are going to be doing in lab and to discuss it BEFORE coming to lab. This enhances the learning experience since you will get more out of lab if you come in with some prior understanding of the procedure. In fact, coming to lab well prepared is the ONLY way to be able to leave lab on time.

II. You will work with your assigned group on many activities during lab. You will discuss and trouble-shoot the procedures and concepts during lab in these larger groups.

Group evaluations:

Your group will work together in lab to develop lab procedures, problem-solve, and trouble-shoot (diagnose). I will evaluate your group each week on the level of sophistication the group demonstrates in problem-solving. The members of the group will have the opportunity to evaluate how the group works together and who are the major contributors to the group effort.