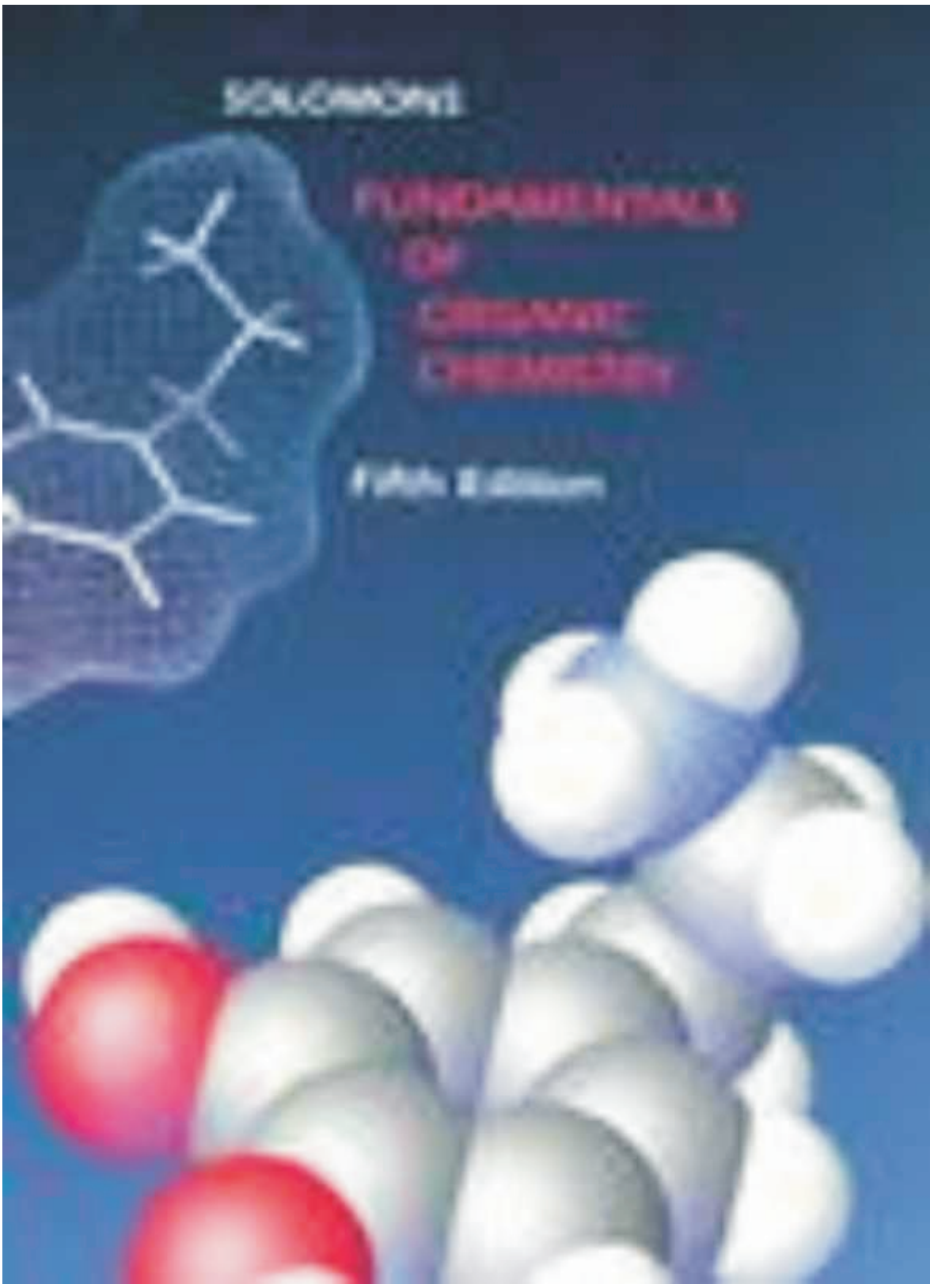

Table of Contents

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ADVICES FOR STUDYING ORGANIC CHEMISTRY

1. **Keep up with your studying day to day — never let yourself get behind, or better yet, be a little ahead of your instructor.** Organic chemistry is a course in which one idea almost always builds on another that has gone before.

2. **Study materials in small units, and be sure that you understand each new section before you go on to the next.** Because of the cumulative nature of organic chemistry, your studying will be much more effective if you take each new idea as it comes and try to understand it completely before you move onto the nest concept.

3. **Work all of the in-chapter and assigned problems.**

4. **Write when you study.** Write the reactions, mechanisms, structures, and so on, over and over again. **You need to know the material so thoroughly that you can explain it to someone else. This level of understanding comes to most of us** (those of us without photographic memories) **through writing.** Only by writing the reaction mechanisms do we pay sufficient attention to their details:

   1) which atoms are connected to which atoms.
   2) which bonds break in a reaction and which bonds form.
   3) the three-dimensional aspects of the structure.

5. **Learning by teaching and explaining** (教學相長)**.** Study with your student peers and practice explaining concepts and mechanisms to each other.

6. **Use the answers to the problems in the *Study Guide* in the proper way:**

   1) Use the *Study Guide* to check your answer after you have finished a problem.
   2) Use the *Study Guide* for a clue when you are completely stuck.

The value of a problem is in solving it!

7. **Use the introductory material in the *Study Guide* entitled "Solving the puzzle — or — Structure is everything (Almost)"** as a **bridge** from general chemistry to your beginning study of organic chemistry. Once you have **a firm understanding of structure**, the puzzle of organic chemistry can become one of very manageable size and comprehensible pieces.

8. **Use molecular models when you study.**

ADVICES FROM STUDENTS TAKING ORGANIC CHEMISTRY COURSE *CHEM 220A* AT YALE UNIVERSITY

The students listed below from the 2000 fall term have agreed to serve as mentors for *Chem 220a* during the 2001 fall term. They are a superb group of people who did exceptionally well in *Chem 220a* last year. They know the material and how best to approach learning it. Some of them have provided their thoughts on attaining success in the course.

Partial List as of April 20, 2001

- **Catherine Bradford**

My advice on Organic Chemistry:

1. Figure out what works for you and stick with it.
2. **Tests:** I think the key to doing well on the tests is as much about getting a lot of sleep as it is about studying. **It's important to be sharp when you walk into a test,** so that you'll be able to think clearly about the tricky problems. As far as studying goes, **start studying for them a few nights early**. My suggestion for a test on

Friday is to go through the material on Monday, Tuesday, and Wednesday nights, then relax on Thursday night and review as needed.

3. **Problem Sets:** Don't save them for Sunday night. Work out the problem sets so that YOU understand them. Get people's help when needed, but **the most important thing is actually understanding how to get the right answer**.
4. Don't look at Organic Chemistry as if it were a monster to be battled. Rather, think about it as a **challenge**. When you come across a problem that looks long and complicated, just **start writing down what you know and work from there**. You might not get it completely right, but at least you have something.

- **Claire Brickell**

1. As far as I'm concerned, the only way to do well in orgo is to do your work all along. I wish there were a less obnoxious way to say it, but there it is. You probably already think I'm a dork by now, so I'm going to go ahead and say this, too: I like orgo. **There is a really beautiful pattern to it, and once you get past the initial panic you'll realize that most of what you're learning is actually interesting.**
2. The thing is, if you do your work regularly, you'll realize that there really isn't ALL that much of it, and that **it really isn't as hard as you think**. I can't really give you advice on HOW to do your work, because everybody learns differently. I hate memorizing, and I am proud to say that I have never used a flash card in my life. I found ***the best way to learn the reactions was to do as many problems as possible***. Once you've used your knowledge a couple of times, it sort of memorizes itself.
3. Last thing: there are a ton of people out there who know a lot about orgo, and a lot about explaining orgo to other people. Use them. The STARS help sessions are really helpful, as are the tutors.

- **Caroline Drewes**

So I'm sure by now all of you have heard the “nightmares” that organic chemistry is universally associated with. But don't worry!! **The rumored nights of endless memorization and the “impossible” tests that follow them are completely optional.**

By optional I mean that if you put the work in (some time before the night before a test) ***by reading the textbook before class***, ***taking notes*** in Ziegler's (helpful) lectures, ***spending time working through the problem sets*** and going to your invaluable TA's at section, then you'll probably **find orgo to be a challenging class but not unreasonably** so. And don't let yourself be discouraged! Orgo can be frustrating at times (especially at late hours) and you may find yourself swearing off the subject forever, but stick with it! Soon enough you'll be fluent in the whole "***orgo language***" and you'll be able to use the tools you have accumulated to solve virtually any problem — **not necessarily relying on memorization but rather step-by-step learning**. I would swear by **flashcards**, complete with mechanisms, because they're lighter to lug around than the textbook meaning you can keep them in your bag and review orgo when you get a free minute at the library or wherever. Going over the reactions a whole bunch of times well before the test takes 5-10 minutes and will help to solidify the information in your head, saving you from any "day-before-anxiety". One more hint would be to utilize the extensive website — you never know when one of those online ORGO problems will pop up on a test! So good luck and have fun!!

- **Margo Fonder**

I came to the first orgo class of the year expecting the worst, having heard over and over that it would be impossible. But **by mid-semester, the class I'd expected to be a chore had become my favorite**. I think that the key to a positive experience is to ***stay on top of things*** — with this class especially, it's hard to play catch-up. And once you get the hang of it, solving problems can even be fun, because each one is like a little puzzle. **True — the problem sets are sometimes long and difficult, but it's worth it to take the time to work through them because they really do get you to learn the stuff.** Professor Ziegler makes a lot of resources available (especially the old exams, old problem sets, and study aids he has on his website) that are really helpful while studying for exams. I also found copying over my (really messy) class notes to be a good way to study, because I could make sure that I understood everything presented in class at my own pace. My number one piece of advice would probably be to use Professor Ziegler's

office hours! It helped me so much to go in there and work through my questions with him. (Plus, there are often other students there asking really good questions, too.)

- **Vivek Garg**

There's no doubt about it, organic chemistry deals with a LOT of material. How do you handle it and do well? You've heard or will hear enough about going to every class, reading the chapters on time, doing all of the practice problems, making flashcards, and every other possible study technique. Common sense tells you to do all of that anyway, but let's face it, it's almost impossible to do all the time. So, my advice is a bit broader. You've got to know the material AND be able to apply it to situations that aren't cookie-cutter from the textbook or lecture. We'll assume that you can manage learning all of the facts/theories. That's not enough: the difference between getting the average on an orgo test and doing better is applying all of those facts and theories at 9:30 Friday morning. When you study, **don't just memorize reactions** (A becomes B when you add some acid, Y reacts with water to give Z), **THINK about what those reactions let you do**. Can you plot a path from A to Z now? You better, because you'll have to do it on the test. **Also, it's easy to panic in a test. DON'T leave anything blank, even if it seems totally foreign to you. Use the fundamentals you know, and take a stab at it. Partial credit will make the difference.** For me, ***doing the problem sets on my own helped enormously***. Sure, it's faster to work with a group, but forcing yourself to work problems out alone really solidifies your knowledge. The problem sets aren't worth a lot, and **it's more important to think about the concepts behind each question than to get them right**. Also, the Wade textbook is the best science text I've ever had. Tests are based on material beyond just lecture, so make the text your primary source for the basics. Lastly, you're almost certainly reading this in September, wondering what we mean by writing out mechanisms and memorizing reactions...come back and **re-read all of this advice after the first test or two**, and it will make much more sense. Good luck!

- **Lauren Gold**

Everyone hears about elusive organic chemistry years before arriving at college, primarily as the bane of existence of premeds and science majors. The actual experience however, as my classmates and I quickly learned, is not painful or impossible but rather challenging, rewarding, and at times, even fun. All that's required, moreover, is **an open mind and a willingness to study the material until it makes sense**. No one will deny that **orgo is a LOT of work**, but by coming to class, reading the chapters, starting problem sets early and most of all, working in study groups it all becomes pretty manageable. By forming a good base in the subject it becomes easier and more interesting as you go along. Moreover, the relationships you'll make with other orgo'ers walking up science hill at 9 am are definitely worth it.

- **Tomas Hooven**

When you take the exams, you'll have to be very comfortable WRITING answers to organic problems quickly. This may be self-evident, but I think ***many students spend a lot of time LOOKING at their notes or the book while they study without writing anything***. I don't think reading about chemical reactions is anywhere near as useful as drawing them out by hand. I structured my study regime so that I wrote constantly. **First, I recopied my lecture notes to make them as clear as possible.** **Then I made flash cards to cover almost every detail of the lectures.** After memorizing these cards, **I made a chart of the reactions and mechanisms that had been covered and memorized it.** Also, throughout this process **I worked on relevant problems from the book to reinforce the notes and reactions** I was recopying and memorizing.

- **Michael Kornberg**

Most of the statements you've read so far on this page have probably started out by saying that Organic Chemistry really isn't that bad and can, in fact, be pretty interesting. I think it's important to understand from the start that this is completely true…I can almost assure you that you will enjoy Orgo much more than General Chemistry, and the work & endash; although there may be a lot of it & endash; is certainly not overwhelming. Just **stay on top of it** and you'll be fine. **Always read the chapter before starting the**

problem set, and make sure that you read it pretty carefully, doing some of the practice problems that are placed throughout the chapter to make sure that you really understand the material. Also, **spend a lot of time on the problem sets** & endash; this will really help you to solidify your understanding and will pay off on the exams.

As for the exams, everyone knows how they study best. Just be sure to **leave yourself enough time to study** and always go over the previous years' exams that Dr. Ziegler posts on the website & endash; they're a really good indicator of what's going to be on your exam. That's all I have to say, so good luck.

- **Kristin Lucy**

The most important concept to understand about organic chemistry is that it is a "do-able" subject. Orgo's impossible reputation is not deserved; however, **it is a subject that takes a lot of hard work** along the way. As far as tips go, **read the chapters before the lectures**; **concepts will make a lot more sense**. **Set time aside to do the problem sets**; they do tend to take a while the first time around. Make use of the problems in the book (I did them while I read through the chapter) and the study guide and set **aside several days prior to exams for review**. Your TA can be a secret weapon — they have all the answers! Also, everything builds on everything else continuing into 2nd semester. Good luck and have fun with the chairs and boats!

- **Sean McBride**

Organic chemistry can, without a doubt, be an intimidating subject. You've heard the horror stories from the now ex-premeds about how orgo single handedly dashed their hopes of medical stardom (centering around some sort of ER based fantasy). But do not fret! Orgo is manageable. ***Be confident in yourself.*** You can handle this. With that said, the practical advise I can offer is twofold:

1. When studying for the tests, look over the old problem sets, do the problems from the back of the book, and utilize the website!! **Time management is crucial. Break down the studying. Do not cram.** Orgo tests are on Fridays. It helps if you divide the material and study it over the course of the week.

2. **Work in a group when doing the problem sets.** **Try to work out the problems on your own first**, then meet together and go over the answers. I worked with the same group of 4 guys for the entire year and it definitely expedited the problem set process. Not only that, but it also allows you to realize your mistakes and to help explain concepts to others; ***the best way to learn material is to attempt to teach it***. It may feel overwhelming at times and on occasion you may sit in lecture and realize you have no idea what is going on. That is completely and totally normal.

- **Timothy Mosca**

So you're about to undertake one of the greatest challenges of academia. Yes, young squire, welcome to Organic Chemistry. Let's dispel a myth first: **IT'S NOT IMPOSSIBLE!** I won't lie & it is a challenge and it's gonna take some heavy work, but in the end, contrary to the naysayers, it's worth it. **Orgo should be taken a little at a time** and if you remember that, you're fine. Never try to do large amounts of Orgo in small amounts of time. Do it gradually, a little every day. The single most important piece of advice I can give is to **not fall behind**. You are your own worst enemy if you get behind in the material. If you **read BEFORE the lectures**, **they're going to make a whole lot more sense and it'll save you time**, come exams, so you're not struggling to learn things anew two days before the test, rather, you're reviewing them. It'll also save you time and worry on the problem sets. Though they can be long and difficult, and you may wonder where in Sam Hill some of the **questions** came from, **they are a GREAT way to practice what you've learned and reinforce what you know**. And (hint hint!), **the problem sets are fodder for exams**; similar problems MAY appear! Also, use your references: if there's something you don't get, don't let it fester, talk to the mentors, talk to your TA, visit Professor Ziegler and don't stop until you get it! Never adopt the attitude that a certain concept is needed for 1 exam. See, ***Orgo has this dastardly way of building on itself and stuff from early on reappears EVERYWHERE!*** You'll save yourself time if, **every now and again, you review**. **Make a big ol' list of reactions and mechanisms somewhere and keep going back to it**. Guaranteed, it will help! And finally, don't get discouraged by minor setbacks & even *Wade* (the author of the text)

got a D on his second exam and so did this mentor!! Never forget & Orgo can be fun! Yes, really, it can be; I'm not just saying that. Like any good thing, it requires practice in problems, reactions, thinking, and, oh yeah, problems. But by the end, it actually gets easy! So, BEST OF LUCK!!!!

- **Raju Patel**

If you are reading these statements of advise, you already have the most valuable thing you'll need to do well in organic chemistry: **a desire to succeed**. I felt intimidated by the mystique that seems to surround this course, about how painful and difficult it is, but realized it doesn't need to be so. **If you put in the time**, and I hesitate to say hard work because it can really be enjoyable, **you will do well**. It's in the approach: think of it as a puzzle that you need to solve and to do so you acquire the tools from examples you see in the book and the reasoning Prof. Ziegler provides in lecture. Take advantage of all resources to train yourself like your TA and the website. Most importantly, **do mad amounts of practice problems** (make the money you invested in the solutions manual and model kit worth it). When the time comes to take the test, you won't come up against anything you can't handle. Once patterns start emerging for you and you realize that **all the information that you need is right there in the problem**, that it is just a matter of finding it, it will start feeling like a game. So play hard.

- **Sohil Patel**

Chemistry 220 is a very interesting and manageable course. The course load is certainly substantial but can be handled by keeping up with the readings and using the available online resources consistently through the semester. ***It always seemed most helpful to have read the chapters covered in lecture before the lecture was given so that the lecture provided clarification and reinforcement of the material you have once read.*** **Problem sets provided a valuable opportunity to practice and apply material you have learned in the readings and in lecture.** In studying for tests, **a certain degree of memorization is definitely involved**, but **by studying mechanisms and understanding the chemistry behind the various reactions, a lot of unnecessary memorization is**

avoided. Available problem sets and tests from the past two years were the most important studying tools for preparing for tests because they ingrain the material in your head, but more importantly, they help you think about the chemistry in ways that are very useful when taking the midterms and final exam. And more than anything, **organic chemistry certainly has wide applications that keep the material very interesting**.

- **Eric Schneider**

I didn't know what to expect when I walked into my first ORGO test last year. To put it plainly, I didn't know how to prepare for an ORGO test — my results showed. The first ORGO test was a wake-up call for me, but it doesn't need to be for you. My advice about ORGO is to **make goals for yourself and set a time-frame for studying**. Lay out clear objectives for yourself and use all of the resources available (if you don't you're putting yourself at a disadvantage). Professor Ziegler posts all of the old exams and problem sets on the Internet. They are extremely helpful. Reading the textbook is only of finite help — ***I found that actually doing the problems is as important or even more important than reading the book because it solidifies your understanding***. That having been said, **don't expect ORGO to come easily** — it is almost like another language. **It takes time to learn, so make sure that you give yourself enough time.** But once you have the vocabulary, it's not that bad. While knowing the mechanisms is obviously important, you need to understand the concepts behind the mechanisms to be able to apply them to exam situation. Remember — ORGO is like any other class in the sense that the more you put in, the more you get out. It is manageable. Just one more tip — **go to class!**

- **Stanley Sedore**

1. Welcome to Organic Chemistry. The first and most important thing for success in this class is to **forget everything you have ever heard about the "dreaded" orgo class**. It is a different experience for everyone, and **it is essential that you start the class with a positive and open mind**. It is not like the chemistry you have had in the past and you need to give it a chance as its own class before you judge it and your

own abilities.

2. Second, organic chemistry is about organization. You'll hear the teachers say it as well as the texts: organic chemistry is NOT about memorization. **There are hundreds of reactions which have already been organized by different functional groups. If you learn the chemistry behind the reactions and when and why they take place, you'll soon see yourself being able to apply these reactions without memorization**.
3. Third, **practice**. This is something new, and **like all things, it takes a lot of practice to become proficient at it**. Do the problems as you read the chapters, do the problems at the end of the chapters, and if you still feel a bit uneasy, ask the professor for more.
4. Remember, many people have gone through what you are about to embark upon and done fine. **You can and will do fine**, and there are many people who are there to help you along the way

- **Hsien-yeang Seow**

Organic Chemistry at Yale has an aura of being impossible and "***the most difficult class at Yale***". It is certainly a challenging class but is in no way impossible. Do not be intimidated by what others say about the class. **Make sure that you do the textbook readings well before the tests — I even made my own notes on the chapters.** The textbook summarizes the mechanisms and reactions very well. Class helps to re-enforce the textbook. Moreover, the textbook problems are especially helpful at the beginning of the course. ***DO NOT fall behind...make sure you stay on top of things right at the beginning***. **Organic Chemistry keeps building on the material that you have already learned.** I assure you, that if you keep up, the course will seem easier and easier. I personally feel that the mechanisms and reactions are the crux of the course. I used a combination of flashcards and in-text problems to help memorize reactions. However, as the course went on, I quickly found that instead of memorizing, I was **actually learning and understanding the mechanisms and from there it was much easier to grasp the concepts and apply them to any problem**. There are lots of

resources that are designed to HELP you...The TA's are amazing, the old problems sets and tests were very helpful for practicing before test, and the solutions manual is a good idea. Good luck.

- **Scott Thompson**

The **best way** to do well in Organic Chemistry is to really try to **understand the underlying concepts of how and why things react the way that they do**. **It is much easier to remember a reaction or mechanism if you have a good understanding of why it is happening.** Having a good grasp of the concepts becomes increasingly beneficial as the course progresses. So, I recommend working hard to understand everything at the **BEGINNING** of the semester. It will pay off in the exams, including those in the second semester. **If you understand the concepts well, you will be able to predict how something reacts even if you have never seen it before.**

Organic Chemistry is just like any other course; the more time you spend studying, the better you will do.

1. **Read the assigned chapters thoroughly and review the example problems.**
2. **Work hard on the problem sets, they will be very good preparation.**
3. **Do not skip lectures.**

Most importantly, **begin your study of "Orgo" with an open mind**. Once you get past all the hype, you'll see that it's a cool class and you'll learn some really interesting stuff. Good Luck!

1. **Keep up with your studying day to day.**
2. **Focus your study.**
3. **Keep good lecture notes.**
4. **Carefully read the topics covered in class.**
5. **Work the problems.**

COMPOUNDS AND CHEMICAL BONDS

1.1 INTRODUCTION

1. Organic chemistry is the study of *the compounds of carbon*.
2. The compounds of carbon are the central substances of which all living things on this planet are made.
   1) DNA: the giant molecules that contain all the genetic information for a given species.
   2) proteins: blood, muscle, and skin.
   3) enzymes: catalyze the reactions that occur in our bodies.
   4) furnish the energy that sustains life.
3. Billion years ago most of the carbon atoms on the earth existed as CH_4:
   1) CH_4, H_2O, NH_3, H_2 were the main components of the primordial atmosphere.
   2) Electrical discharges and other forms of highly energetic radiation caused these simple compounds to fragment into highly reactive pieces which combine into more complex compounds such as amino acids, formaldehyde, hydrogen cyanide, purines, and pyrimidines.
   3) Amino acids reacted with each other to form the first protein.
   4) Formaldehyde reacted with each other to become sugars, and some of these sugars, together with inorganic phosphates, combined with purines and pyrimidines to become simple molecules of ribonucleic acids (RNAs) and DNA.
4. We live in an *Age of Organic Chemistry*:
   1) clothing: natural or synthetic substance.
   2) household items:
   3) automobiles:
   4) medicines:
   5) pesticides:
5. Pollutions:
   1) insecticides: natural or synthetic substance.
   2) PCBs:

3) dioxins:

4) CFCs:

1.2 THE DEVELOPMENT OF ORGANIC CHEMISTRY AS A SCIENCE

1. The ancient Egyptians used indigo (藍靛) and alizarin (茜素) to dye cloth.
2. The Phoenicians (腓尼基人) used the famous "royal purple (深藍紫色)", obtained from mollusks (墨魚、章魚、貝殼等軟體動物), as a dyestuff.
3. As a science, organic chemistry is less than 200 years old.

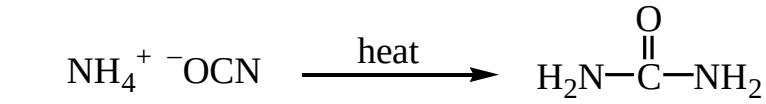
1.2A Vitalism

"Organic" —— derived from living ***organism*** (In 1770, Torbern Bergman, Swedish chemist)

⇒ the study of compounds extracted from living organisms

⇒ such compounds needed **"vital force"** to create them

1. In 1828, Friedrich Wöhler Discovered:



Ammonium cyanate (***inorganic***) → Urea (***organic***)

1.2B Empirical and Molecular Formulas

1. In 1784 Antoine Lavoisier (法國化學家拉瓦錫) first showed that organic compounds were composed primarily of carbon, hydrogen, and oxygen.
2. Between 1811 and 1831, *quantitative* methods for determining the composition of

organic compounds were developed by Justus Liebig (德國化學家), J. J. Berzelius, J. B. A. Dumas (法國化學家).

3. In 1860 Stanislao Cannizzaro (義大利化學家坎尼薩羅) showed that the earlier hypothesis of Amedeo Avogadro (1811, 義大利化學家及物理學家亞佛加厥) could be used to distinguish between **empirical** and **molecular formulas**.

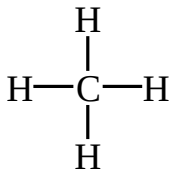
   molecular formulas C_2H_4 (ethylene), C_5H_{10} (cyclopentane), and C_6H_{12} (cyclohexane) all have the same empirical formula CH_2.

1.3 THE STRUCTURAL THEORY OF ORGANIC CHEMISTRY

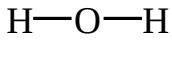
1.3A. The Structural Theory: (1858 ~ 1861)

August Kekulé (German), Archibald Scott Couper (Briton), and Alexander M. Butlerov

1. The atoms can form a fixed number of bonds (**valence**):



Carbon atoms are tetravalent

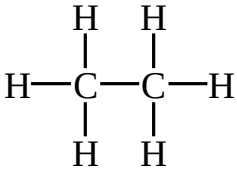


Oxygen atoms are divalent

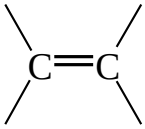
Hydrogen and halogen atoms are monovalent

2. A carbon atom can use one or more of its valence to form bonds to other atoms:

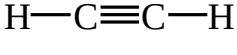
Carbon-carbon bonds



Single bond



Double bond



Triple bond

3. Organic chemistry: **A study of the compounds of carbon** (Kekulé, 1861).

1.3B. Isomers: The Importance of Structural Formulas

1. **Isomers**: **different compounds that have the same molecular formula**
2. There are two isomeric compounds with molecular formula C_2H_6O:

1) dimethyl ether: a gas at room temperature, does not react with sodium.

2) ethyl alcohol: a liquid at room temperature, does react with sodium.

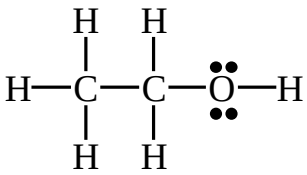
Table 1.1 Properties of ethyl alcohol and dimethyl ether

	Ethyl Alcohol C_2H_6O	Dimethyl Ether C_2H_6O
Boiling point, °C[a]	78.5	–24.9
Melting point, °C	–117.3	–138
Reaction with sodium	Displaces hydrogen	No reaction

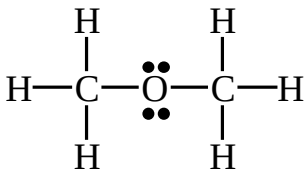
[a] Unless otherwise stated all temperatures in this text are given in degree Celsius.

3. The two compounds differ in their **connectivity**: C–O–C and C–C–O

Ethyl alcohol



Dimethyl ether



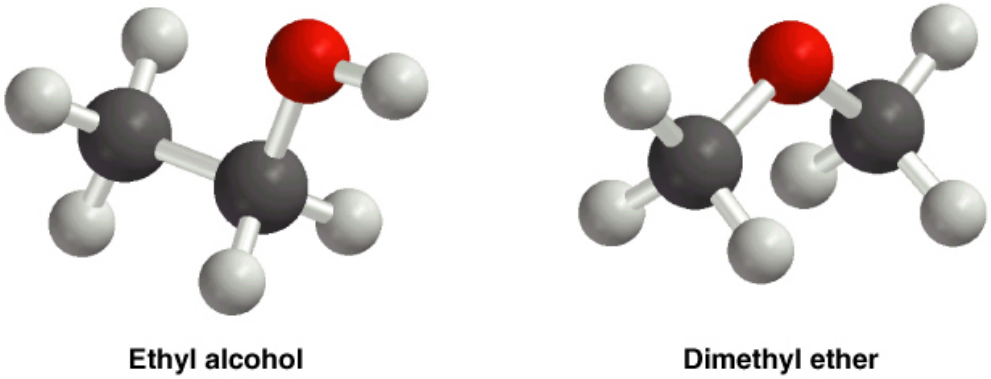
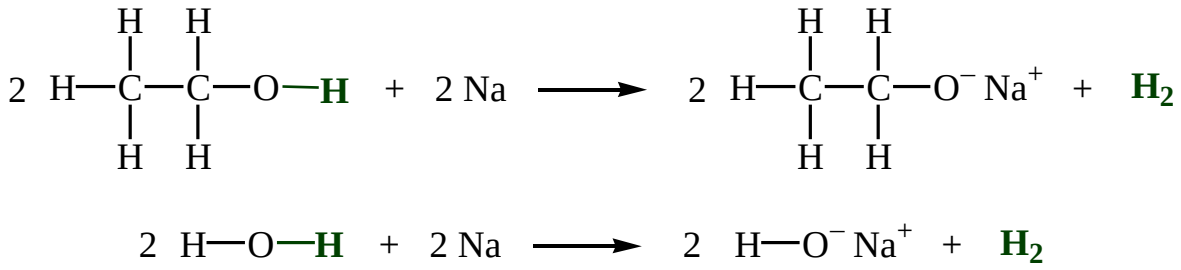


Figure 1.1 Ball-and-stick models and structural formulas for ethyl alcohol and dimethyl ether

1) O–**H**: accounts for the fact that ethyl alcohol is a liquid at room temperature.



2) C–**H**: normally unreactive

4. **Constitutional isomers:* different compounds that have the same molecular formula, but differ in their connectivity** (the sequence in which their atoms are bounded together).

* An older term, **structural isomers**, is recommended by the International Union of Pure and Applied Chemistry (IUPAC) to be abandoned.

1.3C. THE TETRAHEDRAL SHAPE OF METHANE

1. In 1874, Jacobus H. van't Hoff (Netherlander) & Joseph A. Le Bel (French):
   The four bonds of the carbon atom in methane point toward the corners of a regular tetrahedron, the carbon atom being placed at its center.

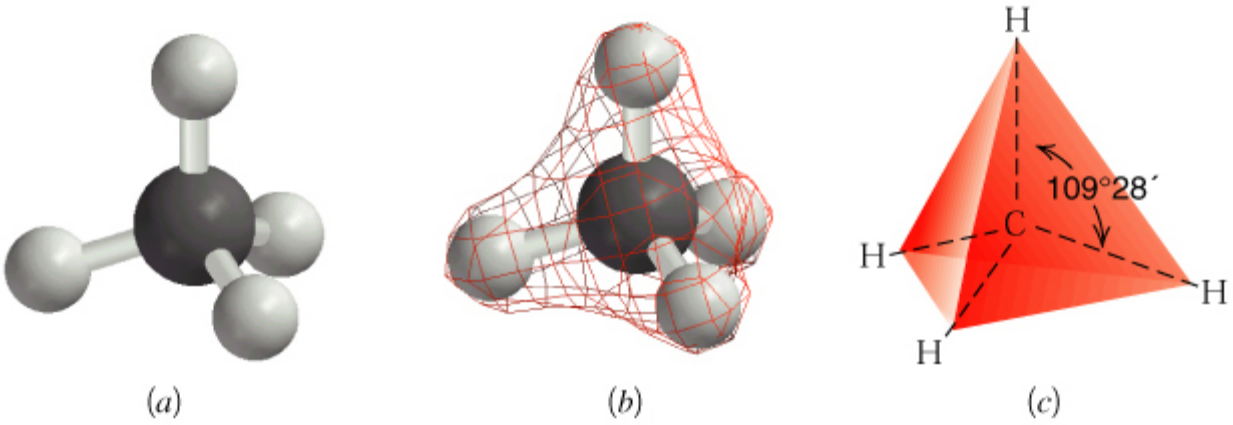


Figure 1.2 The tetrahedral structure of methane. Bonding electrons in methane principally occupy the space within the wire mesh.

1.4 CHEMICAL BONDS: THE OCTET RULE

Why do atoms bond together? more stable (has less energy)

How to describe bonding?

1. G. N. Lewis (of the University of California, Berkeley; 1875~1946) and Walter Kössel (of the University of Munich; 1888~1956) proposed in 1916:
   1) The **ionic** (or **electrovalent**) bond: formed by the transfer of one or more electrons from one atom to another to create ions.
   2) The **covalent** bond: results when atoms share electrons.
2. Atoms without the electronic configuration of a noble gas generally react to produce such a configuration.

1.4A Ionic Bonds

1. **Electronegativity measures the ability of an atom to attract electrons.**

Table 1.2 Electronegativities of Some of Elements

H 2.1						
Li 1.0	**Be** 1.5	**B** 2.0	**C** 2.5	**N** 3.0	**O** 3.5	**F** 4.0
Na 0.9	**Mg** 1.2	**Al** 1.5	**Si** 1.8	**P** 2.1	**S** 2.5	**Cl** 3.0
K 0.8						**Br** 2.8

   1) The electronegativity increases across a horizontal row of the periodic table from left to right:
   2) The electronegativity decreases go down a vertical column: