

# How To **Succeed** In Organic Chemistry

Advice from Students (mainly)

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## About This Book

Every fall the same questions bubble up from people about to take organic chemistry:

“Is organic chemistry hard?”

“What can I expect?”

“How do I excel? What study strategies are successful?”

You're not the first person to ask these questions. Many others have come before you - and gone on to do well in the course.

This book has two main goals:

- 1) It explains what organic chemistry is about, and why people sometimes find it hard.
- 2) It's a collection of “best practices” by people (students) who excelled in organic chemistry.

I hope you find that this addresses all of your common questions and is a useful and inspiring resource.

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## Introduction: What To Expect

### So... What the heck *is* organic chemistry?

Chemistry is the “operating system” for the stuff that surrounds you. Everything in your field of view is connected to chemistry in some way; everything in your body, everything you’re wearing, everything you eat... everything! Our world is made of atoms, and the laws of chemistry are the set of rules that determines how these atoms fit together. Think of it as a very intricate and beautiful miniature Lego set.

Of all the elements, the chemistry of carbon is probably the richest in terms of the variety of known structures. The name “organic chemistry” has its origins in the fact that many carbon-containing molecules were originally isolated from biological sources. For thousands of years, human beings have extracted carbon compounds from plants, animals, and fungi to use as medicines, perfumes, and poisons, among many other uses.

Although organic chemistry has a reputation for being complicated, this great variety flows from just a few fundamental rules of physics: electrostatic attraction and repulsion, and the quantum structure of the atom. In that sense, organic chemistry is a little bit like the game of chess. From a few simple rules can arise great complexity. The rules can be learned in a few minutes, but the principles behind good play take much longer to learn. Thankfully, there are a finite number of important concepts to learn.

## What's with all these people saying organic chemistry is hard?

A lot of it is about expectations. If you're used to courses where you simply look for the right formula to apply, or the right list of terms to memorize, you will find organic chemistry to be a big adjustment. That's a common reason why students find it "hard". It's a lot like learning a language: a mixture of learning vocabulary and applying the rules of grammar.

Here's some important ways in which organic chemistry is different from general chemistry.

Every unit is connected. In general chemistry it's not unusual to do a unit on a certain topic for two weeks and then move on to a completely different topic. Organic chemistry isn't nearly as modular. The knowledge in organic chemistry builds on itself, like a pyramid. The topics you learn in the first few weeks will still be extremely relevant for at the end of the course (and in the next semester's material, for that matter).

There's a lot of new vocabulary, which makes it a bit like learning a whole new language. Prepare yourself to learn over 100 individual new terms within the first 5 chapters.

There is a lot of new chemical symbols. Organic chemistry has a rich visual language for describing the structures of organic molecules, their three-dimensional structures, and their reactions. You'll learn about line diagrams, the dash-wedge convention, curved arrows and many more.

All this is prologue: then there's the actual content of the course.

There are a wide range of facts to command. Organic chemistry is an experimental science and a lot of the material that is given to you represents the results of laboratory experiments; it's often not information you could have figured out from first principles. Examples include information on properties such as acidity, bond strengths, electronegativity, and the bonds formed and broken in different chemical reactions.

Finally, there are all the concepts. This is really the core testable aspect of organic chemistry. Expect to see a lot of questions of the form, "How does [property A] affect [property B], and why?". For example, "how does hydrogen bonding affect boiling points, and why? This is where understanding the material comes in. You will be often be tested on your ability to understand trends.

Unlike physics and general chemistry, there aren't many formulas to learn. But here's a trick: there are a LOT of patterns! One of the keys to succeeding in organic chemistry will be to look for patterns in each chapter, and understand how those patterns affect chemical behavior.

## **How organic chemistry courses are structured**

Introductory organic chemistry is really two courses. In the first few weeks, you learn about the structure of organic molecules, their bonding patterns, their 3-dimensional shapes, and how to draw them properly.

In the second part of the course you learn about reactions; how electrons flow, and how bonds form and break. Electrons are the real "currency" of chemistry, and chemical reactions are events where electrons are exchanged between atoms.

The transition between these two topics usually happens around halfway through the course. If you have been told that organic chemistry is extremely hard, the first few weeks might take you by surprise as they are not particularly difficult. However, once reactions start to be introduced, the amount of material to know starts piling up quickly. This is where good preparation will help you. If you're already clear on the material from the beginning of the course you will have a much better time of focusing on the key patterns you'll see in reactions.

Second-semester organic chemistry builds on the material from first-semester organic chemistry. There are a handful of important new concepts, but the main focus is on new reactions.

## Study Advice For Organic Chemistry

For any endeavor there are really three ingredients to success: Motivation, Ability, and Triggers.

### **Motivation**

The fable of “The Tortoise And The Hare” applies to real life! The world has its share of both brilliant underachievers and successful plodders. An individual who is clear in their goals and disciplined in their approach will always be more successful than a lazy person with more talent.

Knowing *why* you are taking organic chemistry and where this fits into your plans is key. I’m consistently awed by what good students post-baccalaureates are, because they’re so clear about their goals.

If you’re excited about learning the rules for how the world works, great! You’ll find organic chemistry to be both awesome and beautiful. If you’re not so excited... try to look at it as a choice you are making rather than something that’s been forced upon you. If your goal is to go to a professional school, you are also choosing to take organic chemistry. Even if it's just a means to an end, try to get yourself interested in the course material. Focus on the things you can control: your attitude and how you study. If you find yourself deeply lacking in motivation, maybe it's necessary to step back and re-evaluate what you want out of your program.

“Don’t let yourself get psyched out by the people around you whining about how difficult organic chemistry is. I let myself get taken in by the horror stories around the first exam and did substantially worse on the first exam than I should have simply because I bought into the idea that it was tough and I was going to fail. I learned a lot more about myself and self-confidence during the first few weeks than I did about chemistry. If you’re surrounded by negative and pessimistic people, tell them to piss off – don’t get sucked into their game. Prepare and study well – play your game, not theirs.” – MSO

## Ability

Innate ability, or talent, for lack of a better word, is something you don't have a lot of control over. So I don't think it's worth worrying much about. What is worth thinking about is your *perception* of your ability. You have probably met people who were not all that talented, but had tremendous confidence; and others who were extremely talented but immobilized by their own fears. Somewhere between ignorant overconfidence and paralyzing self-doubt there is a happy medium of cautious self-assurance. Strive for that.

In other words, it's not your ability, but your perception of your ability that is truly important.

## Triggers

Willpower can be an unreliable thing to rely on for studying. You want to set up a system of good habits and a routine so that you're automatically - with little effort - doing all the right things.

It's possible to manipulate yourself and your environment so as to rely less on willpower to succeed and more on consistent habits.

What's a great way to develop good study habits? First of all, surround yourself with others who have good study habits! We might not like to admit it, but our peer group can have a tremendous influence on our behavior. Secondly, strategically put yourself in situations where you don't have to rely as much on willpower to carve out uninterrupted study time. To avoid having study times interrupted by e-mail, turn off notifications. Use a crappy cell phone that doesn't accept email. Use services [like Self Control] that block your access to Facebook for a certain number of hours throughout the day. As much as possible, you want to set up automatic systems so that you rely less on your own willpower and more on the triggers you create.

"When I study alone, it's usually at home. It's terrible. There are quite a number of distractions. Subtle things. Your room's messy so subconsciously, you're wondering when you can clean it. Your house has a fridge and you're a bit hungry so you start wondering about when you'll go eat., Things like that. And of course, internet!

Sometimes I study in those cubicles in the library. The kind that literally force you to focus because you can't look at anything else. I used to hate them. I felt trapped. But now, I value my grades and my time so much that they are becoming my best friend and I study there as often as I can. I WANT to be trapped" - John



## Preparation

If you know you're taking organic chemistry in the future, how much does it help to plan ahead?

There are really two types of "planning ahead" to think about.

*Reviewing concepts from general chemistry.* Since so much of organic chemistry builds on concepts from general chemistry, it's essential to be familiar with the key concepts of your introductory course before beginning organic chemistry. In particular, you'll want to make sure you're familiar with concepts such as the octet rule, Lewis structures, covalent and ionic bonding, electronegativity, resonance, acids and bases, equilibria, rate laws, and thermodynamics, among others. For a full treatment you might want to check out my e-book *From General Chemistry to Organic Chemistry*.

*Reading ahead.* If you have the time, pre-reading the first few chapters of your textbook, and doing problems can be helpful. Since the whole course sequence (Org 1 and Org 2) builds upon the core concepts covered in these chapters, time spent familiarizing yourself with these concepts will pay off handsomely later on.

I'm convinced that a year of physics, even if only at a conceptual level (i.e. without all the math), would make organic chemistry a lot easier. Understanding transition states, activation energies, conformational changes, and a host of other things in organic chemistry would be a lot easier with an understanding of some basic physics. My advice to organic chemistry students that really want to stack the deck in their favor: wait until you've had the entire physics sequence before taking organic chemistry – MSO

I did not do any preparations whatsoever before ochem. I have to say that I had very solid background in the general chemistry courses on the way in, and had spent a great deal of time already studying molecular orbital theory, valence bond theory, hybridization, Lewis dot structures, and resonance forms. Having a good background in these things usually encompasses most of the first 4 chapters in most organic books that I've seen – Terry

## Do Something Every Day

Organic chemistry isn't a sprint, it's a marathon. If you can get a little bit done every day, you'll find it goes smoother than if you try to study the whole course the night before the midterm.

One trait of successful students is that they do something related to the course on a daily basis. If you can make it a habit while the course isn't too intense, it will serve you well when the course gets more time-intensive.

Granted, this can add up to a lot of time. It's a new language; don't expect overnight success. But daily studying is like compound interest - over time, the growth can be phenomenal.

I would never miss a class and always be engaged with the teacher. Found out half the battle is just showing up, while also going over the class notes every day over and over. If I was to give any advice to students it would be to put in at least an hour of chemistry every day no matter what. You're going to get discouraged but keep your mind on your end goal and keep on working. Hard work is the cure to the organic epidemic haha.- Matt

Some advice to first time organic 2 students would be: go home after every lecture and learn the material presented. This will help you from getting behind and cramming for exams. Look at the material everyday because eventually you will be able to understand it. The last bit of advice is not to get discouraged if you don't do well on your first exam, learn from it and know your weaknesses for your next one! - Tiffany

Consistency is key. This is the hardest part for me, but I think it is possible to be as happy as a clam in Ochem if you are consistent. - John

Look at the material everyday because eventually you will be able to understand it. - Logan

## **Make your own notes.**

Take what you've learned in class, and summarize it. Condense it down as much as you can so that it fits on only a few pages. Try and explain it to yourself or a friend in the fewest possible words. The more you can condense it and keep the essence, the better.

There are a finite number of core concepts in organic chemistry.

A major part of the studying and learning in this class for me is the composition of my review notebook. This is a 3 ring binder that I fill with notes from the chapters in the book. The pages consist of careful and neat notes on what was said in the book, complete with full arrow pushing mechanism, important notes and explanations, and everything else I found important to the readings. What I also do is mark REALLY important words or phrases or parts of pictures. I also use a highlighter to mark the arrows in the mechanisms. When I fill the front and back of a loose leaf paper, it goes in my binder after the last one, creating a chronological in-depth outline of the class material. – RM

Keep up with the assigned reading, even get ahead if you can. Reading ahead in the chapter in preparation for lecture was really helpful. In the periods of time between each exam (2–3 weeks) I would generally go through each chapter on my own around 3 times. The first time would be a relatively superficial run through, the second time I would go through and do the chapter problems, and the third time I would go through and do reaction mechanisms.– Jay

Keep a running list of all mechanisms as you learn them. Perhaps two running lists – one with the reactants and products only, and the other showing the mechanism. And read through all of them EVERY DAY. It's amazing how many I forgot while learning other mechanisms. – Jen

## Focus on understanding. Look for patterns.

Contrary to what you might hear, success in organic chemistry NOT all about memorization.... but memorization is not irrelevant. The key is understanding its proper role.

Chemistry is largely an empirical discipline - that is, based on observations made from doing experiments. Many of the concepts, reactions, and reagents you will learn about were not deduced from first principles, they were discovered. Since you won't be running these experiments yourself, there's some things you just need to "take our word for". So you'll be learning the names of reagents, reactions, functional groups, some common names of molecules and other facts that you can't derive from first principles. In some sense, these facts must be in your memory.

That being said, always be on the lookout for patterns. Watch for key patterns in how electrons flow, in the factors that stabilize charges, in the patterns of bonds that form and break for different classes of reactions. A big part of success will be recognizing the patterns and applying them; knowing what parts of a problem are important, and what parts you can ignore.

One of the key things is recognizing functional groups and learning the patterns. I always tell my students to try to not get intimidated by molecules (even if the molecule looks intimidating) because, sometimes, the bulk of the structure isn't involved in the reaction of interest. "A molecule will tell you what it wants to and can do", I often say, "it's up to you to learn to recognize the message."

Learn to simplify the question to everyday language, especially with mechanism type questions. Asking "what has happened here?" is a powerful question that can reveal the path to solving many problems.

One of the biggest roadblocks for me was not learning the patterns. I think I wasn't told there were patterns. To be honest, it wasn't until graduate school that I actually "got" organic chemistry... I was pushed to think deeply. It turns out organic chemistry wasn't that complicated after all. I just have to look for the patterns. Sure, there were always things that don't fit the pattern. Learning to accept that was also something I had to learn. - an organic chemistry instructor

KNOW WHY! This, for me, is the MOST IMPORTANT part of getting through OChem. Knowing why something does what it does is infinitely useful because it allows you to apply it to other situations. Take the extra time to understand why carbonyl carbons are so electrophilic for example. If you truly understand the theory and reasoning of what you're being taught, you will be better able to apply it to other sections of OChem. And trust me, a big semantically connected way of thinking is better processed in the brain than processing small, seemingly disconnected topics.- Nathan

## How Important Is Memorization?

In an attempt to compensate for the tendency of students to declare that “organic chemistry is all memorization”, some instructors go the other way and say, “don’t memorize”. Don’t take this advice verbatim; there are some things that you cannot figure out from first principles, and as mentioned above, they must be in your memory. You have to know the names and structures of functional groups, what each reagent does, common abbreviations and names. You might find memorization useful for learning these facts; however, if you do lots and lots of practice problems, you will find that you will gain enough familiarity with the course material in a way that will make rote memorization largely unnecessary.

Ultimately the extent to which you apply memorization depends on your own instructor and school. Despite what some people might like to think, some professors *really do* test the ability to memorize lots of reactions. And others largely test the ability to apply concepts. Keep your eyes open.

I wish I had understood much earlier that there is a place for memorization in Orgo – like the reagents and what they contribute to a relationship, what reactions they are used with, etc. We were heavily discouraged not to memorize for the class – and I think it hurt my study plan. What we should have been told is “understand the mechanism – movement of electrons”, but you must memorize reagents, format of reactions, etc. I know he had good intentions, but he was not clear. It was at this point that I began to struggle. I did make an A, but spent the entire time between Orgo I and Orgo II reviewing and making sure I got the information I needed in my head. This was the single most difficult issue I faced – trying not to memorize”. – Sue

My study strategy for each course is different, but for organic chemistry it is all about grouping similar reactions together and understanding things based on fundamental concepts like charge, electronegativity, and resonance effects. I’m more of a logical learner and so mathematics and physics are my strengths; I try to keep memorization to a minimum in this course. Yet, unfortunately, there are some things that we are forced to memorize, such as reagents for particular reactions. – Terry

## **Do Practice Problems**

It's not enough to simply understand the course material. It's crucial to test your understanding of the key concepts through applying these concepts by doing practice problems. The best way to practice your understanding is to do practice problems from the textbook.

I do practice problems in the textbook. Our teacher assigns homework which is optional, but IMO if you want to do well, the homework is not optional. – John

From the beginning to the end I realized there are many ways to study organic. A few that I did on a daily basis were doing every chapter assigned problem from the book once if I understood... 2–3 times with guidance is necessary for questions that bothered me. Always making sure I was capable of doing them on my own afterwards. – Matt

For a student taking ochem for the first time, I would advise them to do lots and lots of practice problems. I realized that the more sets I did, the more comfortable I was during test time... because after all, there's only so many types of ochem questions that the prof can ask. My strategy was to first understand the material and then do the book problems, then problem sets, and then if I had questions or needed clarification, I visited the professor during office hours or asked a tutor. – Tiffany

Once your reading is done, it is best to attempt problems. I believe that organic chemistry is learned best by application, not by memorization. Start off with the easy problems on the assigned homework and work your way through to the tougher ones. So how do you make sure you are ready for the trick question? Easy answer, if you have seen it, it is not a trick. And that is the key to organic. The key to doing well is to expose yourself to as many lines of thought as possible. If you have done enough problems then most of the problems on an exam will scream out to you that you already know the answer. And you will. For most chem courses across the country, organic is standardized, as are the types of questions they ask. If you have done enough of them, it becomes like stoichiometry (you better remember that!) and there are only so many ways a professor can ask a question that would be found in a typical Organic course. – Terry

## **But...! Use the answer key with extreme caution**

My advice is this. When you hit a road block, use all the resources you can think of to find the answer to your problem, and I don't mean take the study guide and look at the answer. Search around (google, textbooks, peers, TA's, office hours) until you are satisfied you could explain this problem to someone else. I believe that there is much more value in finding the answer yourself, than relying on other means. Continue doing problems (do not do only the assigned problems, do every problem that you can get your hands on!!!). The internet is a wonderful thing and it is even more wonderful for those taking this course. There are many fantastic chemistry problems across the country that have treasure troves of exercises, problems, and explanations on line.– Terry

## **There will be hard times.**

Ups and downs are part of the course. Remember why you are taking the course, and keep going. Rough spots are normal. Stay focused.

Don't get discouraged if you don't do well on your first exam, learn from it and know your weaknesses for your next one. – Logan

I would estimate that I spent around 15–20 hours per week on organic chemistry (including reading, homework problems, worksheets, pre-labs, and lab reports – Jay

This class is tough and there were concepts that proved to be more challenging than others. But don't give up. You never know where the chips will fall. – Grant

Confidence is necessary – confidence that this will eventually make sense. Not being deterred or discouraged when you feel like “what the eff is going on???!!!. Just accept confusion as a part of the learning process, period. – Ron

I don't know anyone for whom learning organic chemistry is easy. The top five students in my class probably spent 20 hours every week studying for the class. I would say that organic chemistry came somewhat easier for me, but it still required me to put in a huge amount of time.” – MSO

## Study Groups - pro and con

Having someone you can rely on to do problems with, teach material to (and in turn be taught), and provide mutual accountability is a valuable asset. However, it's possible to do well without a study partner too.

I have to admit I am not the biggest fan of study groups. I find that those who study mainly in groups tend to have lower test scores than if they mastered the material on their own (or taught it to someone else). The reason for this is that in a study group there tends to always be someone who is more advanced than the rest, which leads to dependence on this person when it comes to problem solving. That person will not be there to hold your hand during an exam.

On the other hand, I am a fan of having study slams with a select and small group of people from your class that are all nearly at the same level as you. I tend to have these slams only during test weeks and with no more than 4-5 people including myself. In these slams my group tends to have already amassed a large amount of problems, previous exams, and answers. Because the other people in the group have similar study habits to myself, we literally fly through problem after problem, old exam after old exam. When there is a tough problem, we are able to figure it out together. In order for something like this to be successful, everyone must be able to pull their own weight. If you have to teach basics to someone in your group, while it is a nice thing to do, it takes away from your focus and your own performance. Try to keep that at a minimum feeling during exam time, but any other time, have at it! It is great to teach people, it only makes you better. But it is dangerous for someone like me. I am too generous and will forget that I have work to do... Don't do that to yourself. – Terry

After reading through my notes I am usually ready for the exam, but if I have extra time I do practice synthesis problems that my friends create on a white board where me and a friend line up on each side of a double sided white board and race to see who finishes it first. I find that if you can recall the information quickly in a competitive manner then you can do so in a stressful exam environment. – RM

Note - you only get to do your exam once, but see here how R.M. has simulated the stress and time-sensitivity of the exam environment? This is an instance where having a good “study buddy” can come in handy, in that you have someone to test and challenge you in a practice setting.



## How to fail

Just as instructive as lessons in what worked is knowing what doesn't work!

I know how to ENSURE you fail Ochem. I had a friend who just dropped the class yesterday. We both studied the same way for the first test. We weren't consistent in study. We didn't do as many practice problems as we could. We were just trying to memorize different concepts. We both failed. Then I realized that O.chem is about the big picture. I can't just pick and choose what to focus on. Everything can be tested and everything is useful to understanding 1 problem. So I started doing what I listed above. My friend didn't. I told him "Look, if we study the same way we studied last time, we are going to FAIL." He failed. I made a 90. I sent him a text "Consider dropping this course. If you don't change how you study, I guarantee you are going to fail this course. Period." And he came to the realization I was right and dropped it! – John

The primary reason I saw people fail organic chemistry wasn't intelligence. It wasn't lack of memorization abilities. It wasn't the teaching. It was their study habits. There was a group of about seven girls in the back of our class, the "Chatty Kathys", that waited until the night before the homework was due to start on it and didn't do any outside reading or problems on their own. I doubt they failed, but they probably comprised the bulk of the C grades in the course. Organic isn't hard, but that doesn't mean you can just sit in lecture and expect to have the understanding and ability to solve problems to just leap inside your head. Maybe that's part of why medical schools scrutinize organic chemistry grades so much – it definitely reveals the quality of your study habits. – MSO

Quotes from those who have taken organic chemistry before you: "What I Wish I Knew At The Beginning of Orgo That I Know Now"

- "OChem takes a lot of practice (each day) something I wish I would have done"
- "Studying only the night before doesn't work out very well"
- "That everything builds upon each other quickly so study every night"
- "The best way to learn organic chemistry is by doing LOTS of practice problems"
- "Nucleophiles attack electrophiles -> it answers almost every question! (magic!)"
- "If you do not keep up with the work as you are supposed to, you will not understand it when test time comes around."
- "Ochem is not as scary as I thought it would be – but at the same time it is a lot of work and practice"
- "Remain calm. Although you may hear many horror stories from older students, it is not that bad. You will survive!"
- "Memorize the basics! OChem builds on top of itself, so if you miss the basics, you will be far behind. "

## Final Words: Keys to Success

Asked to summarize the key points for success in a sentence or paragraph, here's some "summary" advice:

Try to get interested in the material! The more interested in and passionate about organic chemistry that you can get, the better you'll do in the course. Studying becomes less of a burden when it's something you find interesting. – Jay

The keys to success: be prepared, focus on understanding, work enough problems outside of class to learn the concepts – you'll never learn the concepts unless you make mistakes on problems and learn from them – and stay caught up with the material. – MSO

This is probably the most important – I think taking organic chemistry is a great way to develop critical thinking skills, so not being averse to thinking is key. Many questions in organic chemistry require you to take the time to re-interpret the question, look at all aspects of the question, winnow out the unimportant aspects, then follow an "if this, then that" scenario. If you don't follow through, most often you will miss the point and the answer. It is very difficult to do well in organic chemistry if you hate being pushed to think or are a lazy thinker. You have to be willing to be engaged. – an organic chemistry instructor.

Most colleges use this course to "weed out" hopeful medical students. And the people they weed out are not dumb or stupid, they just don't have great study skills, and unfortunately, this can ruin a career. You do not have to let this happen to you. You have the choice, and the power, and the resources to not only understand this material, but to love it, learn it, and use it. The best thing one can do to do well in this course is simply to take responsibility for your actions. You may want to be a doctor, and you can't blame anyone but yourself when you make a mistake. Rise to the challenge, it's an amazing feeling and it will empower you to succeed through grad school, med school, or whatever you choose to do. This is bigger than the organic chemistry course, this is a chance to learn something incredibly valuable that will be applicable your entire life (until you get lazy and retire of course). – Terry

## Conclusion

This book is not even close to being finished yet - it needs your story! Take the advice here, go out, excel, and come back and share your study advice or personal experiences with organic chemistry here:

<http://masterorganicchemistry.com/feedback>

## Further Reading

Virtual Textbook of Organic Chemistry

Organic Chemistry at Arizona State University (requires free registration, but worth it)

Not Voodoo (all about laboratory technique)

[My site] Master Organic Chemistry (resource guide)

Ask a question at Chemical Forums

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## About the Author

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