 Barbara Moran

How to Get an A- In Organic Chemistry

And why it matters.

THE molecule looked like a giant jellyfish. Or maybe a spider.

Halfway through my organic chemistry final, the monster lay there on the page, mocking me. My task: explain how the ungainly molecule folds into a tidy package. The problem: I had no clue. Maybe if I looked at it sideways? No, that didn't help. This was getting ugly.

Contemplating a midlife career change from science writer to doctor, I spent eight months last year at Harvard Extension School slogging through two semesters of organic chemistry, or orgo, the course widely known for weeding out pre-meds. At 42, I was an anomaly, older than most of my classmates (and both professors), out of college for two decades and with two small children. When I wasn't hopelessly confused, I spent my time wondering what the class was actually about. Because I'm pretty sure it wasn't just about organic chemistry. For me, the overriding question was not "Is this on the test?" but rather "What are they really testing?"

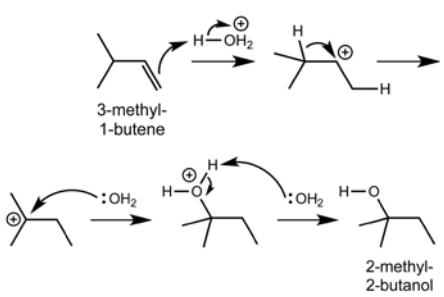
Orgo has been haunting pre-meds since 1910, when the Carnegie Foundation for the Advancement of Teaching released a landmark report calling for tougher admission standards to medical school and for medical training based on science. Hence emerged science prerequisites that have remained virtually unchanged: two semesters each of biology, physics and general and organic chemistry.

The report was meant to professionalize medicine but led to generations of doctors more grounded in science than in the humanities. This is not necessarily bad, but lately a sense has emerged that the pendulum has swung too far. Medical schools are tweaking admission protocols, looking beyond an "A" in orgo for future doctors who are less Spock and more Kirk.

I asked two medical school deans — Dr. Robert Witzburg at Boston University and Dr. Lee Goldman at Columbia University — about admission philosophies. Both are proponents of holistic review, the newish idea that medical schools look beyond grades and test scores to evaluate the whole applicant. "We have to find people who can do both the personal and the scientific," Dr. Goldman said. But both also emphasized the continued importance of orgo, not because doctors actually use it but because it lays the groundwork for biochemistry and pharmacology.

In 2015, the Medical College Admission Test will change, with added sections on social science, psychology and ethics, but sorry, orgo will remain prominent. "The organic chemistry on the MCAT is chemistry that students need to know to succeed in medical school," said Karen Mitchell, senior director of the MCAT Program.

So what is organic chemistry, anyway? And why is it so difficult? Basically, orgo examines how molecules containing carbon interact, but it doesn't require equations or math, as in physics. Instead, you learn how electrons flow around and between molecules, and you draw little curved arrows showing where they go. This "arrow pushing" is the heart and soul of orgo. Here's the arrow pushing mechanism for a simple reaction, adding acidified water (H_3O+) to a carbon molecule called an alkene (don't worry, this is all the orgo you'll have to learn):



Learning how to interpret the hieroglyphics is pretty easy. The hard part is learning where to draw the little arrows. To do this, you learn rules about how molecules behave. For instance, in the third step of the drawing above, you can see an arrow pointing from the "O" (oxygen) of OH_2 to a plus sign (a positive charge). This means oxygen is donating electrons to a positively charged carbon atom. After you draw oxygen donating electrons to a positive carbon a zillion times, it becomes second nature. An arrow pointing from a plus sign toward oxygen then seems viscerally wrong, like ketchup on sushi.

But the rules have many, many exceptions, which students find maddening. The same molecule will behave differently in acid or base, in dark or sunlight, in heat or cold, or if you sprinkle magic orgo dust on it and turn around three times. You can't memorize all the possible answers — you have to rely on intuition, generalizing from specific examples. This skill, far more than the details of every reaction, may actually be useful for medicine.

"It seems a lot like diagnosis," said Logan McCarty, Harvard's director of physical sciences education, who taught the second semester. "That cognitive skill — inductive generalization from specific cases to something you've never seen before — that's something you learn in orgo."

To develop orgo intuition, you solve problems and draw arrow-pushing mechanisms again and again, until they become instinctive. This takes a huge amount of time, for me 20 to 30 hours a week. The class turned me into a bore, a sleep-deprived, orgo-obsessed grind who saw the shapes of molecules in every sidewalk crack and snack cracker.

My study partners and I called orgo the "bad boyfriend," because it stole so much time from our personal lives. As in, "I just blew off Thanksgiving dinner to hang out with the bad boyfriend." Once, my 3-year-old clung to my leg as I tried to leave for class. "Mama, don't go!" he cried. "No more chemistry!" Sorry, little buddy. Bad boyfriend's calling.

This is one thing that orgo is testing: whether you have the time and desire to do the work. "Sometimes, if a student has really good math skills, they can slide through physics, but you can't do that in orgo," Mr. McCarty told me, adding, "You can't slide through medical school, either."

At first, this commitment of time and psyche did not pay off. On the first exam I scored well below the mean. My problem sets came back with whole pages slashed out in red pen. I felt stupid and demoralized. But slowly, orgo awakened my long-dormant spatial-reasoning skills, and I (occasionally) started to enjoy some of the problems.

Second semester, I had a breakthrough. On the third exam, stuck halfway through the final problem, I tried a new strategy. I put down my pencil, leaned back and stopped thinking. For a moment, nothing happened. Then the answer sprang into my mind's eye. "Oh, my God!" I thought. "I actually have orgo instinct!" After that, everything started clicking.

When the final exam came, I was ready. I chugged through the first few pages, then stopped. There lay the giant jellyfish-spider, streaming carbon chains like tentacles. Draw the arrows? I didn't even know where to start. Next problem, just as bad. The test became not a showcase of my new orgo instinct but a scramble for damage control. I guessed I got a C.

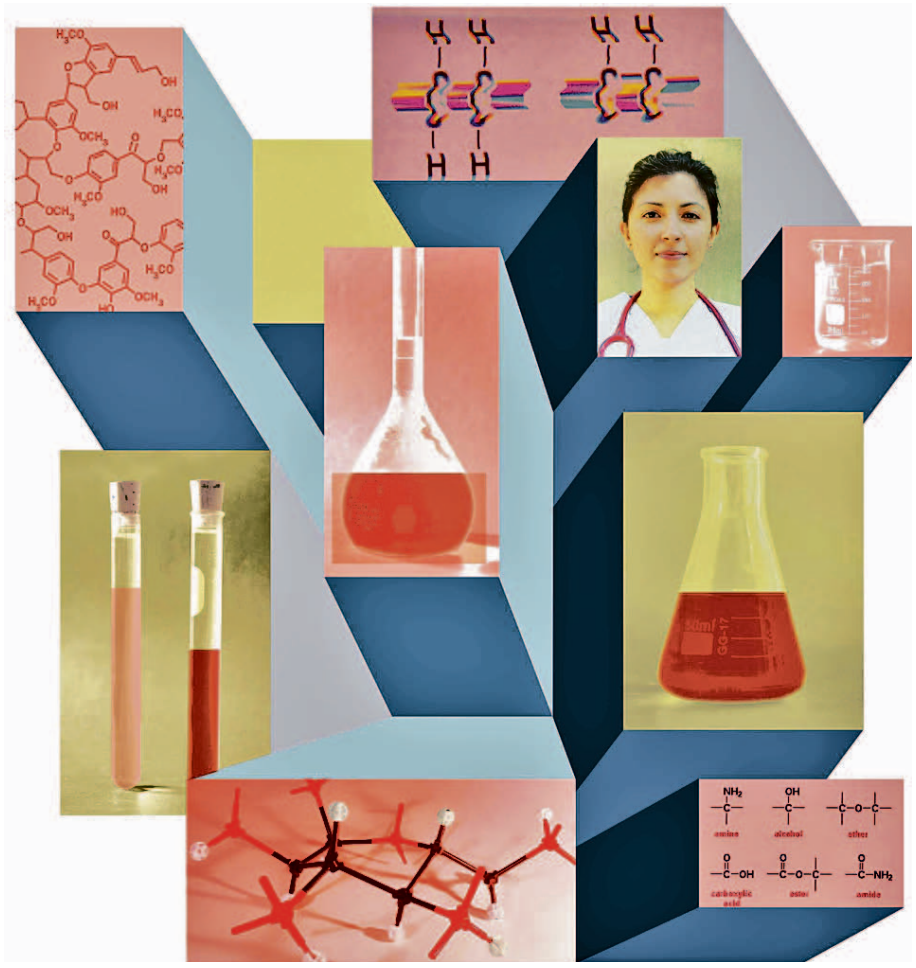
When the test ended, the students sat stunned. "What was that?" my study partner asked. "A monkey could have done better on that exam than me." Later, in the bathroom, one of our classmates sobbed as another consoled her.

The day after the final, a physician friend gave me a celebratory gift: a stethoscope. I told her about the exam, and she nodded. "That's a terrible feeling," she agreed. "It's kind of how you feel when you lose your first patient."

Of course, bombing a test isn't the same as watching someone die. But what's similar is that dreadful realization of your own limits, that terrible moment when you stop controlling the situation and start mitigating the damage. I expect that's an all-too-common feeling in medicine. I often felt that way in orgo, but kept going back for more. That's what orgo is testing, I think: resilience. And humility.

I got a B on the final, by the way.

Grade for the class: A-.



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