

Pharmacology: It's the Memorization, Stupid!
Or:
They Way You Are Probably Being Taught Pharmacology Sucks

Let's start off with an experiment.

Take a look at Table 1, below.

Table 1. Whatizzit?	
Property	Specification or Meaning
ID (VIN)	First digit: country of manufacture First two letters: manufacturer and make Second digit: type of vehicle Next two letters: engine size Next digit: introduction date Next digit: check digit Next letter: model year Next letter: place (plant) of assembly Next 6 digits: serial number
Fuel	Octane: 97 or greater Capacity: 3.7 U.S. gal (incl. 0.5 gal reserve)
Oil, engine	Rating: HD 240, multigrade Viscosity: 2W/50 above 40°F (4°C) 10W/40 below 40°F (4°C) Capacity: 3 U.S. qts. (2.8 L, 2.5 imp. qts.)
Fork oil	Type HD Type E or equivalent Capacity Wet: 9.0 U.S. oz. (266 mL) Capacity Dry: 10.2 U.S. oz. (302 mL)
Primary drive capacity	32 U.S. oz (946 mL, 33.3 imp. oz.)
Backplate-to cylinder head bolt torque	4-21 lb-ft. (19-28 N·m)
Compression	120 psi (8.3 kg/cm ²)
Alternator	Stator coil resistance 0.2 – 0.4

Can you recognize what this information is about? Obviously some sort of motorized vehicle or other mode of transportation. Why do I say obviously? What clues are there to help you make that conclusion? With just a bit of information, can you tell which is “important?”



Now take a look at Figure 1. Does that give any clue? The photo certainly doesn't show the entire “thing,” but I'll bet you have enough information stored in your brain, from prior experience, to add the “missing parts” and make a mental picture of the entire object — a motorcycle — without the need for having all the information (in words or pictures) in front of you.

OK. The data and photo are for my Harley-Davidson motorcycle. The data are just a tiny fraction of all the supposedly important stuff found in various books and manuals. The photo shows only a small part of the entire thing. And even though probably fewer than 10% of you ever owned or rode a motorcycle, most of you recognized it as a motorcycle without having to think too hard.

Now that we've identified the object, we can ask: *What information must I know to use the motorcycle safely, or to maintain it? What should I commit to memory, and should I memorize both U.S. and metric units for various variables? Which pieces of data can I ignore altogether?*

Let's see.

I might need to know what the various digits and letters of the Vehicle Identification Number (VIN) represent, but probably not too often. I need to provide the VIN to my insurance agent, to the motor vehicle registration folks, and will have to give it to the police should my wheels get stolen. But I can look that up when needed, and the truth is I'll probably need that information only a few times in the many years I'll be riding my cycle.

I have to fill my Harley with gas every week (about every 95 miles), or face the fact that I'll have to switch to reserve unless I want to run out of gas and walk. I have to have those mileage/fuel range numbers memorized, but with just a couple of fill-ups committing that “need to know it” sort of thing to memory is a piece of cake. I'd better know to use the right fuel octane too, and the consequences of not knowing or ignoring the stats. Can't avoid memorizing any of that because, well, it's just too important and

used too often. Besides, I'd look stupid if every time I pulled up to the pump I had to whip out my owner's manual and *look it up*.

But do I need to know the principle of the test involved in determining the octane rating? The molecular formulae for all the chemicals that spew out of the gas pump? The reactions involved in their combustion. Must I buy the expensive brand name gas, or use fuel from a less-expensive "generic" gas station or convenience store? I know the answer to that too.

It's all gotta be important because it's all there in the book I'm looking at! And it was written by experts!

I change the oil myself every 2,000 miles, so I need to know sort of often what type to use under what conditions, and how much to add. The guy at the Harley place knows which filter I should buy once I tell him the model and year. And, since I'm in the good old U.S. of A., I really need to know just the U.S. measurements. I can forget all about the equivalent measures unless I want to don my scientist's cap and be in a metric mood when I do the work. That's need to know but not commit to memory stuff, and it's all I need to know for my limited periodic maintenance.

Then, of course, there's tons more information: how tight to tighten certain bolts or screws; all sorts of data about the nuances of the ignition system (resistances, voltages, what the different colored wires mean, etc.); valve timing and clearances. You name it. However, you'll find a few sections of my 200+ page shop manual highlighted, and I've transferred that key stuff to "flash cards" I take to the garage when I need to. But why lug around the whole book?

But I don't give a shit about it. Screw most of what the books say.

I'm never going to do advanced maintenance or repair work! I hope my "authorized service representative" knows it; better yet, I hope that even though they may be professionals, specialists, he (or she) will still consult the shop manual for "the facts" on my bike before the last screw is tightened and the ignition is fired up after proclaiming my ailing wheels are in good health once again.

I know some of my bike's quirks — things it does "on occasion" — some of which I can predict, some of which I can't, and I know those oddities don't happen to ostensibly identical bikes owned by some of my buddies.

And now that we have all the technical stuff down pat (or not), I have to know how to use (ride) the darned thing. To get licensed to ride legally I have to demonstrate certain cognitive and technical skills competencies above and beyond what I had to do with a car.

Gotta know that if I go too slow I may go splat on my side; that once I get going a little bit the bike will turn left if I *push* on the left handle bar; and that should I run into a bridge abutment at 137 miles per hour certain bad things will happen. I'd be toast, and my family would be toasting my insurance settlement.

But I don't need to know anything about the laws of physics that govern that gyroscopic jazz which says push right on the handlebar to go left (yes, laws of physics make what they call countersteering — counterintuitive steering — work!); or what happens when a large mass in motion like my 137 mph cycle hits a larger mass like a bridge abutment at rest.

To stay alive and out of trouble I just have to know to stop fully at stop signs and red lights. I learned that when I got my auto driver's license, and it translated perfectly to motorcycle operation. But I sure don't have to cite chapter and verse of the Michigan Uniform Traffic Code, or Section 257.627. I don't need to know how my state defines what a motorcycle is (it's section 257.31, because I know where to look that up). I know I needn't wear a helmet while riding in Ohio, but I'd better have one on in my home state of Michigan. (I also know that if I see anyone trying to drive while they're talking on their cell phone, I stay away.)

I know, too, that my bike is just fine for short pleasure rides or commuting, but if I had to go cross-country, or haul half a dozen kids to swim practice, I'd have to find some other more appropriate means of conveyance.

Last, I learned most of what I need to know for my Harley on a rather run of the mill, prototypic 70's-something Honda. What I learned from that old bike served me just fine when I switched to a Suzuki sport bike before the Harley, and later when I got a big Kawasaki to keep the Harley company in the garage. I chose to buy and use those different breeds for different reasons, some subjective some not.

I can hop on just about any other motorcycle out there (cheap or expensive, slow or go-fast, dirt bike or highway cruiser) and ride off after just a moment or two of acclimation and some automatic recall about the fundamentals learned elsewhere and in a different context. Of course there are differences, some important to some people at some time; many others that aren't. Those various cycles are more alike in many respects than they're different.

Get the point? My Harley (or your Chevy... or Rolls Royce; or your grandma's TV or next door neighbor's microwave oven) is like drugs. Motorcycles — riding them, maintaining them, fixing them — are a lot like drugs and how they work; how and when they're used; and how most people react to them, good or bad.

Sure, motorcycles were new to me at one time, but I learned what I needed to ride and do a sufficient amount of practical maintenance. I learned some things on my own (first, of course, by getting down the basics, and then through "graduate training" in the schools of experience and hard knocks); by reading the right books (the technical manuals came well after the basics were under my belt); and by taking the right course (on basic motorcycle safety, not one on petroleum chemistry or physics).

And I'm still learning more in all sorts of ways, from all sorts of sources. Why, when I really need to — *if* I really need to, or if I just get curious and want to — I'll learn more of that now meaningless techie stuff and what it means and how I apply it.

That's the way I approach this dreaded, complicated, voluminous subject — drugs, more affectionately known as *pharmy* by many of you — that often means the difference

between health and illness, or even life or death. Believe it or not, learning about drugs can be as painless and practical and fun (you're asking what I'm sniffing, I'm sure) as learning to drive a car or a motorcycle.

Pharmacology is the Epitome of Information Overload

If medical school curricula (perhaps the preclinical years in particular) suffer from information overload, then pharmacology might be damned as one of the biggest contributors to it. (I personally give top honors to our gross anatomy and neuroanatomy friends.)

Let's face it: so many drugs, all of which cause more than one effect (both good and bad); mechanisms to learn; drug interactions to be aware of. All those "specifications." You get the drift.

Bull shit. You don't need to learn, let alone memorize, it all.

It's the Memorization, Stupid

One study aid for medical students advises that "*even though your profs may tell you otherwise, pharmacology is 'pure memorization.'*" The discipline is the "*ultimate challenge in medical memorization*" and one for which some "remedy to dull the pain" of the subject is needed.

Well, I'm "telling you different." Come on! I didn't have to sit down and rotely memorize all the specs and laws before I first rode or serviced my motorcycle (or my car). Had that been a prerequisite, I'd be walking to work every day. How about you? How much do you really know about that car you drive, or the computer you log on to every day.

If you think your profs want you to "just memorize" stuff, ask them directly for clarification. If they say that that's all it takes, do what you can to get them removed from teaching.... Forever.

If they have you learn stuff about more than three or four drugs in a class, ask why that's important.

For many years I've been teaching pharmacology using prototype drugs. Give me a topic, and instead of having you memorize stuff about a couple of dozen drugs I can get you to learn (and not just memorize) the basics about just a few representative agents. It works.

The new experts on teaching have discovered this prototype approach to teaching about 5 – 10 years ago. I've been teaching that way for well over 20 years, folks, and published the first textbook that presents information that way!

You can't possibly learn about every drug that's out there. We can't possibly teach it all. And when you get to be a practitioner, will you (do you dare?) decline to treat a patient because he or she is taking drugs you didn't specifically learn about in one of your

classes? “Sorry, ma’am, we didn’t learn about that drug in med school. You’ll have to go somewhere else.”

Or, are you gonna be the first kid on your block to prescribe the newest, greatest, most sexy-mechanistic drug that some drug company touts? (Hope not! I’d rather not be your patient.)

Sure, there’s lots to be memorized, information you must carry around in your head. But just memorizing “stuff” is an inefficient (if not painful) way for most of us to learn. More important: simply committing isolated facts to memory is a terrible way to see and appreciate the many threads of information woven through seemingly disparate areas of pharmacology and clinical medicine.

Making those connections — not just involving pharmacology but all your basic science and clinical course content — is how you must practice medicine! Just memorize and you miss that. (In your leisure time, pick up a copy of Gilbert and Sullivan’s *Pirates of Penzance*. In it you’ll find a description of Major General Stanley, whose head was crammed with “cheerful facts” about all sorts of matters. Unfortunately, he had no idea about how to put those facts together, put them to use, in any coherent or meaningful way.)

But there’s one other relief for the information overload—just memorize the stuff problem: when the material to be learned is winnowed to the essential kernels, and when it’s presented properly, there is much less to memorize than you might be led to believe, and the essential linkages between areas or disciplines becomes much more apparent — just as the parts of any complex object or concept must fit and work together.

(For those of you who criticize your profs for presenting information you deem “irrelevant,” shame on you. No matter what you might think, they’re miles ahead of you in knowing what counts.) Clearly, selecting the core information and presenting it in the right way will show you the relevance. See the relevance and the learning makes more sense; it becomes easier; and, for some, seeing the relevance and applicability actually motivates one to learn more.

Less is More

Information overload is the killer. And so I have another teaching philosophy, summed up by the header above. Therefore, the goal here is for us to identify what we consider core information, and present it in an understandable way. That way, learning it — yes, even memorizing stuff — should be much less a burden and make much more sense. “Know” the prototype, and when you encounter a different drug that’s actually more like the prototype than different from it, you’ll be able to recognize the important similarities quickly, and put that and the new information you read about for the new drug, to good (and hopefully safe) use.

While there are thousands of drugs and drug combination products to prescribe or buy over the counter, there’s a much smaller number that are most representative. They’re

like your “typical” Chevrolet. Learn the “big points” about the prototypes, and when you’re confronted with just a bit of information about a largely similar drug, your mind will allow you to fill in the blanks with much of the other information — just as your mind created a more or less entire picture of a motorcycle when I showed you just part of the front end of my Harley.

Too Little Knowledge is a Dangerous Thing

You’ve heard that too, and it’s true. Learning the material here — and any other information you may have to learn for your profs or for any other exams — won’t make you a good doc. If you think that’s not true, don’t try to prove your hypothesis: you — and your patients — are liable to be in big trouble. Nonetheless, you need a core of knowledge, and that’s what we’re here to present.

Drugs and.... Cars?

OK. Few of you probably have a motorcycle. Let’s consider something more familiar. Apply the points I made, the data I presented, the questions I asked, in the context of my Harley to your car. Consider what was involved when you learned to drive a car—how to operate it; what its parts and how they work; how to figure out and perhaps prevent or fix problems; the rules of the road.

Now think of a model other than yours. A Chevy? Pontiac? Ford? VW? Are any of you rather well-heeled med students who tool around in a Bimmer or a Porsche? Sure, there may be some unique differences, but all those vehicles are more alike than different, despite what the label on the car may say, or where the curves in the body work are located. Many cars in the General Motors family share similar platforms and other key components. Even relatively inexpensive Volkswagens share many components found in their more expensive siblings, the Audis.

And, we think it’s safe to say, whether you spent most of your driving hours in a US-made car or an import, expensive or not, without too much problem you can hop into a totally different vehicle, and with just a bit of orienting yourself to the important differences you can drive away.

Basically the same goes for learning drugs, pharmacology. That’s where learning according to the *prototype approach* comes in; that’s how we organize material here.

What is a prototype?

A fairly standard dictionary definition of a prototype is “an original of something — an early type or form that serves as the basis or standard for later stages of the thing.”

If we use cars as an example, here in the US you might consider the Model T Ford as the prototypic car; even though Model Ts came and went long ago, they fit the bill. (And it’s not too much of a stretch to view it as the prototypic truck, too, since it’s a relatively simple matter to put on a truck body instead of a passenger compartment.

Prototype drugs, and who gets to pick them.

Who picks the prototypes? Well, there's no official list. For some drug classes more or less everyone with more than a little familiarity with it will agree, more or less, on what's "most representative." You'll soon learn about a widely used group of drugs called β -adrenergic blockers, and just about everyone will agree that one drug in the large group, propranolol, is the best example. With other groups of drugs, especially those for which there are new agents being approved and older ones fading into disuse, there may be some disagreement. We'll pick 'em as we see 'em.

What do you need to learn, and why?

Like it or not, you have to serve several masters, each having different expectations of what you need to learn and how you need to apply it.

First, there are your profs. If your profs are pretty typical — as far as pharmacology profs go — you'll probably have lots more to learn than might be actually absolutely necessary (whatever absolutely necessary is).

I had calculus drummed into my head, and poor grades etched on my college transcript, years ago. I "had" to learn calculus, and got graded on what I knew about this must know topic. Hate to tell you folks, but I've gotten several NIH grants, have served in many administrative roles in my top-10 medical school, and have gotten lots of teaching awards. But I know squat about calculus, and will never have to know anything about it.

Each prof tends to put a different spin on what he or she teaches and, therefore, what they expect you to learn.

Some profs tend to put a strong biochemical or molecular biological slant on what they teach. There may be a medicinal chemistry focus, emphasizing structure-activity relationships between similar drugs (how sometimes slight substitutions of chemical groups on the core of a molecule can change the actions of the various chemicals). Some profs introduce lots of current research information about the drugs they teach. Some of those folks add a liberal dose of their own research — what's in their latest grant — in the area to their presentations. (You've all seen that, I'll bet.)

Some profs are generalists, in the pharmacologic sense. They have a knack of identifying what they believe is a reasonable amount of core material to provide an adequate learning basis and knowledge store for your clinical years and beyond. And, they try to put a clinical slant on things so you get a better perspective on how the information you learn might be useful in real-world clinical situations.

Whether you like these various approaches is sort of irrelevant. You have exams to take and pass. Whether you think the material you're expected to learn is too clinical or too basic, relevant or not, you have to learn it. Your profs can stick you with anything they want, even if they can't distinguish between the important and not at all important stuff in their own minds.

Then there are licensure exams. Medical students eventually must pass all three steps of the USLME to get licensed. Of more immediate concern is just passing Step 1 to get promoted to the clinical years. But then there are those who want to score as high as possible on Step 1, because there's some evidence that the higher the score, the better the chance of getting certain residencies.

Passing Step 1 is, arguably, just as big a hurdle as passing your pharmacology course(s), and it's probably a more fearsome challenge. It covers all of what you should have learned in all your basic science years. Some questions are focused on a particular topic, such as pharmacology. Others — and a growing number — force you to do more of what's expected of you in the clinical years: integrate your knowledge from a host of disciplines and apply the information correctly.

You have huge piles of notes (and probably a couple of required but never read books, too from the first two years of med school — maybe even some definitive text that's three inches thick and tips the scales at a whopping 8 or so pounds; you have all sorts of board study books of various sorts (now, this one); you may have spent some money on special exam prep courses; you've availed yourself of the excellent materials provided by the National Board of Medical Examiners, who prepares USMLE exams.

These resources vary in scope, depth, and mode of presentation. Some students like tables that hit the high points; others learn (or review) best from lists of short bulleted items, and seem to have an almost photographic memory for facts — even facts that might be largely useless. Others (most, we hope) want to understand the “whys,” not just the “whats.” Overall, it's difficult to right the one and only text that will be best for everyone in terms of his immediate or future learning needs and learning styles.

I like a middle-of-the road approach, and I don't think that's a bad approach at all. (If we did, we wouldn't be doing things this way.) I try to take a vast amount of information and shrink it to focus on what I think is the most important. I try to balance “just the facts” with clear explanations of why they're important. I take material that, without looking more broadly, appears to have narrow applicability to a particular area of pharmacology; then show you how this information spans many areas in ways that are important for you to know and understand.

Because, of course, the ultimate need for your gaining knowledge now is to prepare you for your future learning and clinical practice needs, often in a setting where your seeking out the information — called “life-long self-directed learning” by the medical education gurus — will be much more important and essential than information that's laid in your laps.

Learn a lot about a little. Care to learn more, and spend the time to learn on your own. Be considerate of every one of your patients.

Then, you will not only pass the boards, but you just might become a good physician.