# How to Study in Medical School

Osmosis

# How to Study in Medical School

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**About Osmosis**
Created by medical students at Johns Hopkins and the former Khan Academy Medicine team, Osmosis helps more than 250,000 current and future clinicians better retain and apply knowledge via a web- and mobile platform that takes advantage of cutting-edge cognitive techniques.



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# Introduction

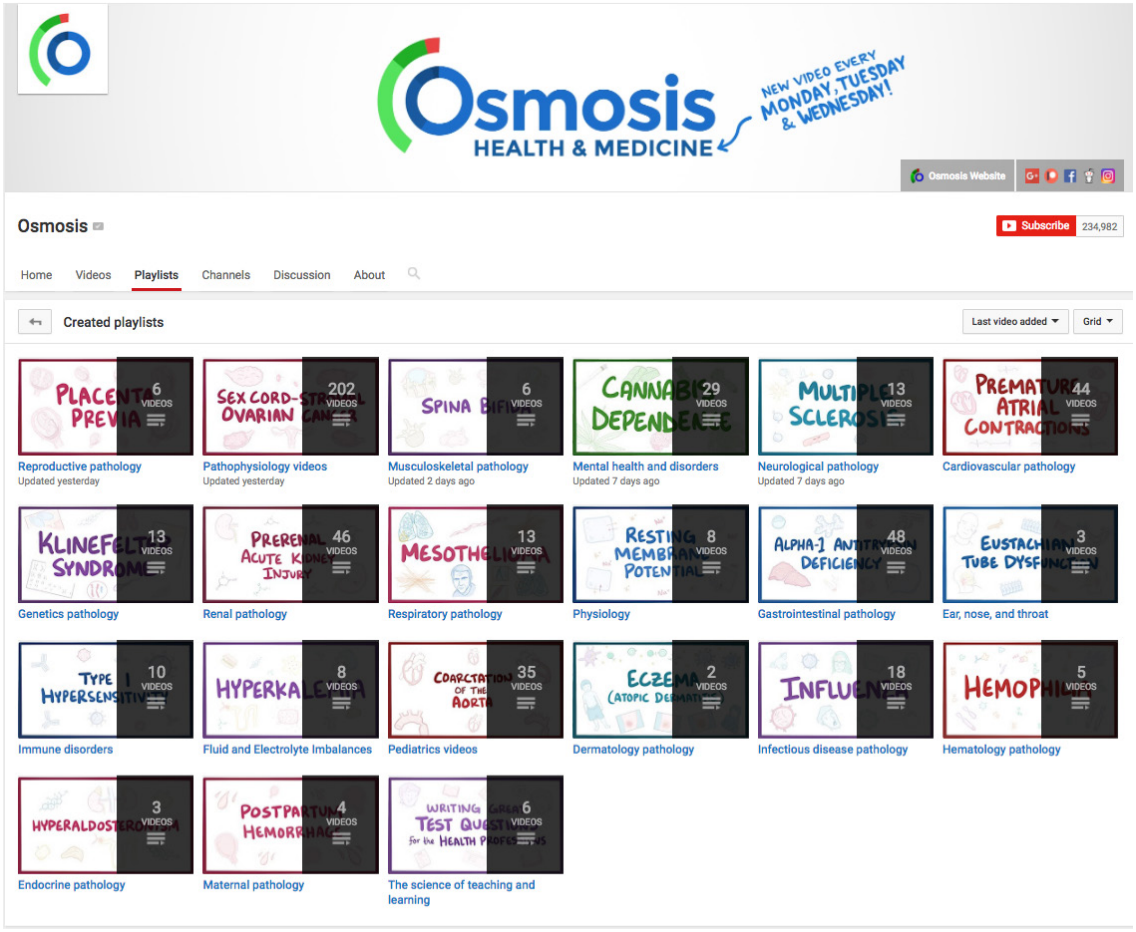
Students don't get into medical school by accident. If you're here, it's because you worked hard and dedicated your college years to study and discipline. It's a good bet that well before your White Coat Ceremony, you'll have already honed yourself into a lean, mean, test-taking machine. But unfortunately (or fortunately, depending on how you look at it), being a medical student is very different from being an undergraduate student. The skills that got you to where you are now may not be the ones you need to succeed in this new stage of your life.

For example, like most students, you've probably crammed the night before an exam, and you probably did well.


Unfortunately, that isn't going to help you much in medical school. First, the volume of information that you need to take in and memorize in medical school is comparable to drinking out of a fire hose. To succeed, you'll not only need more time, but also better time management. Second, unlike college (where you can cram, do well, and then forget everything after the exam) the content in medical school is cumulative, meaning that the information you learned in your first year remains relevant months and even years after you first learned it. Not only do you need to make sure that you remember this information, but you also need to constantly update it as well, as new research (which you'll also be expected to keep up with) makes some of the things you learned more relevant and makes others out of date.

Third, the stakes in medical school are so much higher. Forgetting a critical piece of information won't just result in a lower test score; it can seriously harm your patients.

Thankfully, decades of evidence-based research has shown that there are ways we can alter our behavior to increase the likelihood we'll be able to remember and recall important information. Here, we'll highlight five of the most effective, neuroscience-backed study techniques that we've incorporated into Osmosis and that every clinical student should know. We've boiled this information down to just the basics. By the end of this study guide, you'll understand the science behind these five study techniques, and how you can actively and strategically apply them to your own education. Check out the resources at the end for more information, or watch videos on these topics (and many more) on our YouTube channel: www.youtube.com/osmosis.



# 1 Problem 1: Rapid Forgetting

**Problem 1:** The large amount of information taught to students in medical school lends itself to rapid forgetting.

**Solution:** Apply strategies such as spaced repetition and interleaved practice in order to combat the natural forgetting curve.

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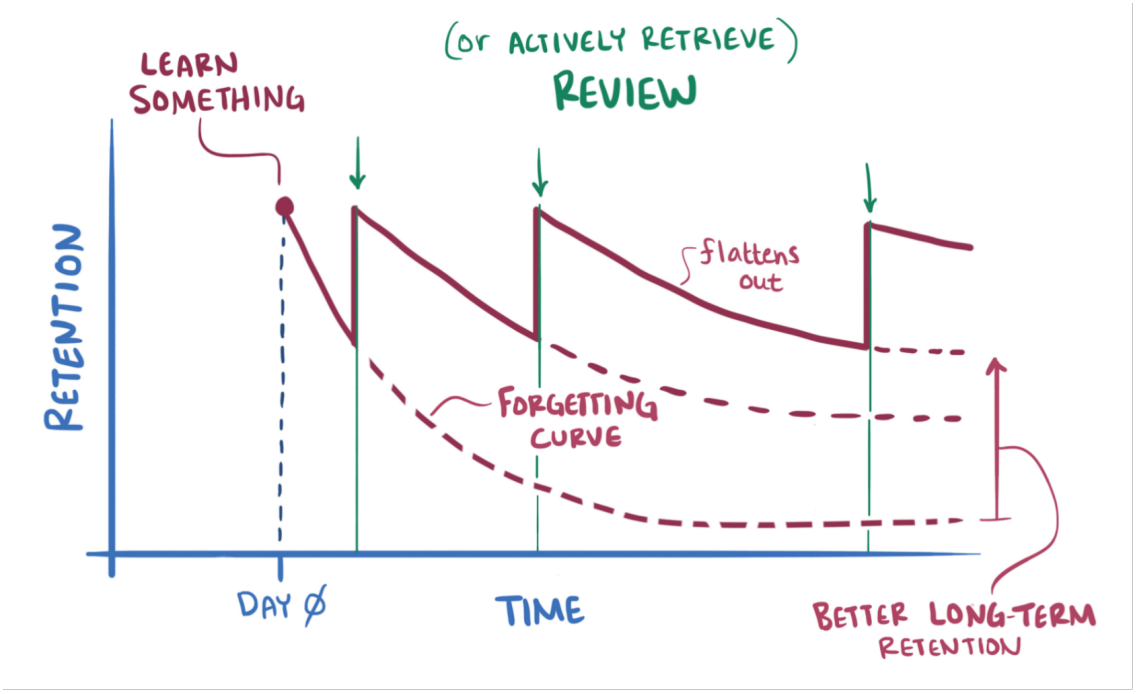
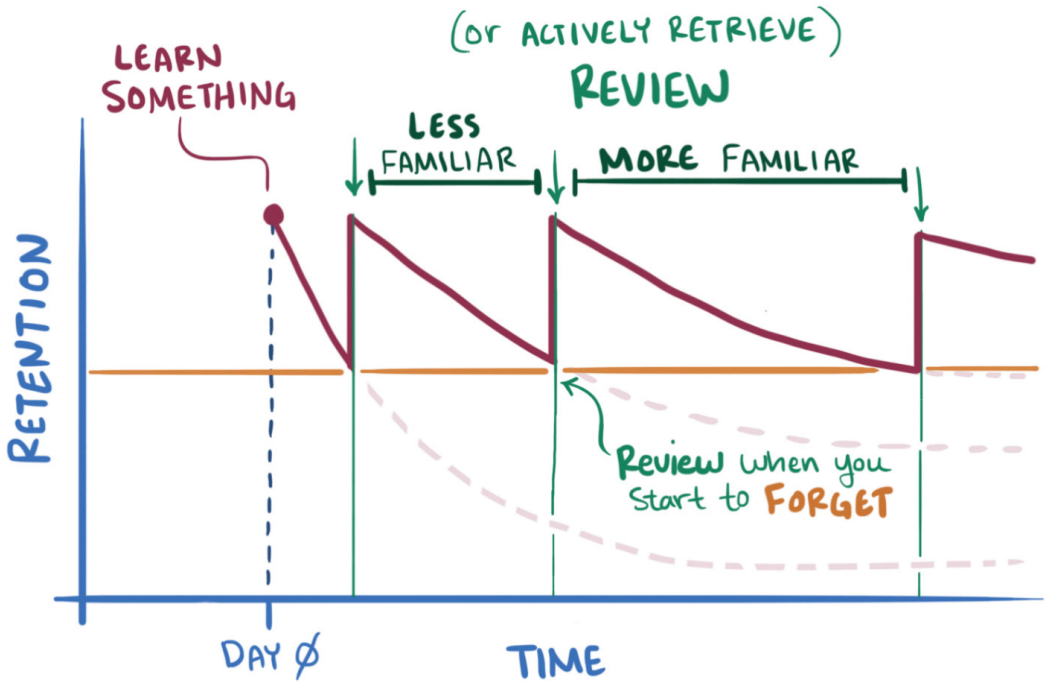
To understand how we can better remember relevant information, it's helpful to learn more about why we forget. In a series of experiments in the 1880s, German psychologist Hermann Ebbinghaus found that if you plot your retention, or how much you remember about a topic vs. how much time has elapsed since studying it, it forms an exponential decay curve. So, if you learn something on day 0, and don't review, the "forgetting curve" will look a lot like what we see below.



However, if you review (or better yet, actively retrieve) the material at increasingly spaced intervals after learning it, then the forgetting curve starts to flatten out, and you'll experience much better longer-term retention (see figure below). Also, reviewing the material just once before an exam is not enough. To really learn it, you have to space out your learning and practice, which is a strategy known as spaced repetition.



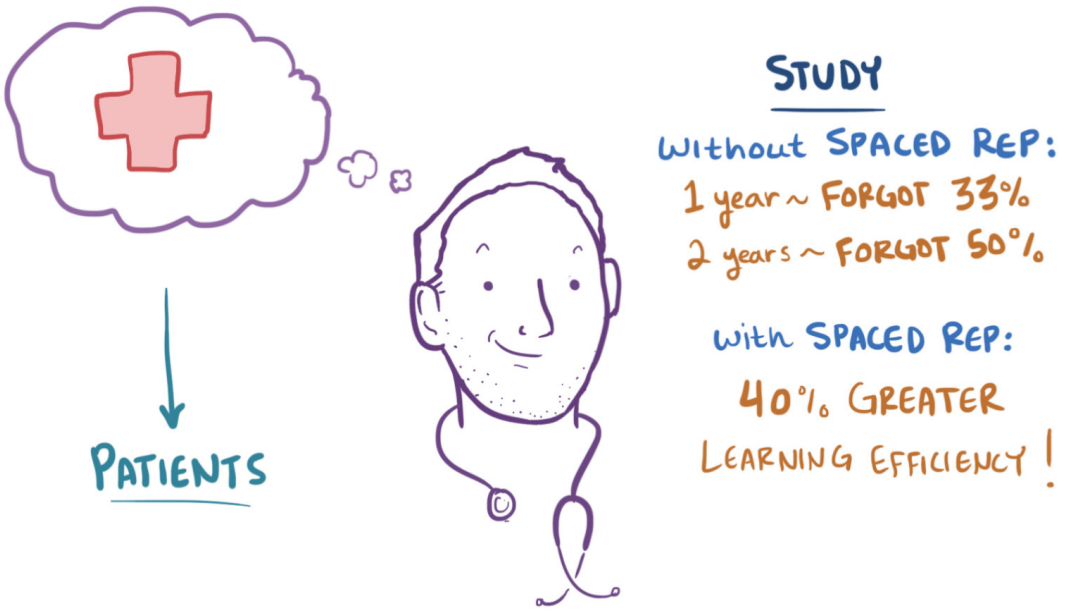

You can also use interleaved practice, which is also called varied practice, variable practice, and mixed practice. This strategy involves mixing up the information you're being tested on instead of breaking that information into chunks. Together with spaced repetition, it can lead to the most successful learning outcomes.

## More Information About Spaced Repetition

Spaced repetition is not only about revisiting the material more often, but also about reviewing it at the right time. It turns out that the best time to revisit information that you're trying to learn is right around the time when you'd naturally forget it. Because forgetting typically follows this exponential curve (see figure above), the trick becomes timing your study sessions around it and revisiting key points of information right when they're about to fade from your memory. The key concept is spacing your studying and self-testing over time, as opposed to massing, or "cramming," because this helps to flatten your forgetting curve so you retain information longer.

Since our familiarity with different subjects can vary greatly, different bits of information will have different forgetting curves. Studies show that you should have more widely spaced intervals between study times for material that you're more familiar with and shorter intervals between study sessions for material that you're less familiar with.

While this strategy is effective for all fields of study, it's especially important for students in the medical field, who have to retain key knowledge and skills in order to care for their patients. Kind of frighteningly, one study found that without spaced repetition, medical students forgot up to 33% of their basic science knowledge after one year, and more than 50% after two years! But when students and residents applied spaced repetition strategies in their studying, they significantly outperformed their counterparts, with some studies showing close to 40% greater learning retention.

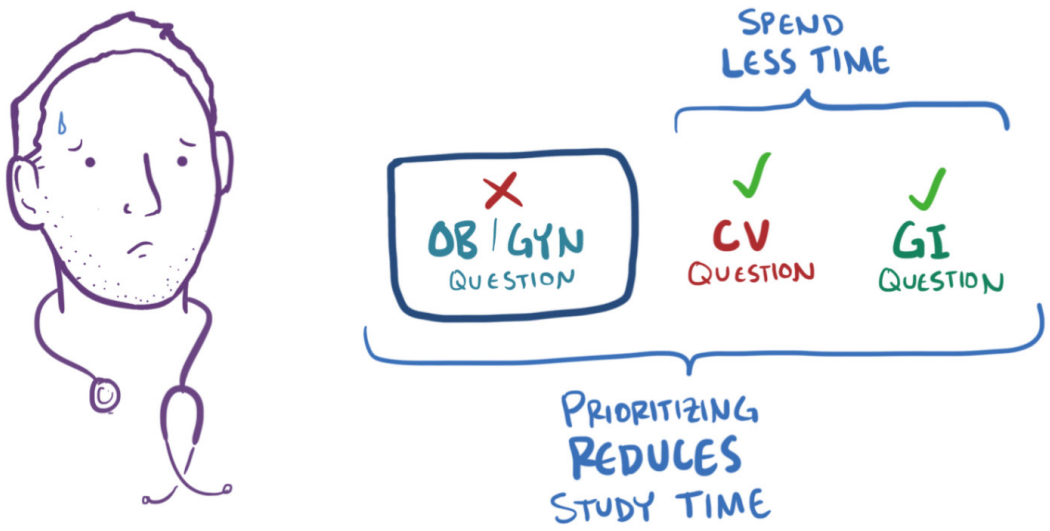



Knowing all of this, why does cramming persist as a popular behavior? The truth is that it's often more effective in the short term. Pulling an all-nighter can certainly help you pass tomorrow's exam, but one month later, you'll have forgotten much of that information. Given that learning medicine is more akin to an ultramarathon than a sprint, it's a good idea to space out your study sessions. And it's also important to note that spaced repetition doesn't just help with knowledge retention; it also helps with skill development, whether you're placing an IV or performing a lumbar puncture.

## How to Apply Spaced Repetition

Knowing about spaced repetition is one thing, but what about applying it? Students—especially those in the health and medical fields—have to remember thousands of "bits" of knowledge and skills. Because of this, it can be incredibly hard to keep track of when it's time to revisit each piece of information, especially since each bit of information follows its own learning curve. This is why researchers and software developers have created computer algorithms to help students optimize their studying.

These algorithms can help you learn by sorting information based on your responses to questions, meaning that if you get a question wrong, the algorithm automatically prioritizes that bit of information for repetition over the information in questions you answered correctly. By doing this, these algorithms can actually reduce your overall study time by making sure the time you're spending studying for your exams isn't wasted on information that you can already reliably recall.

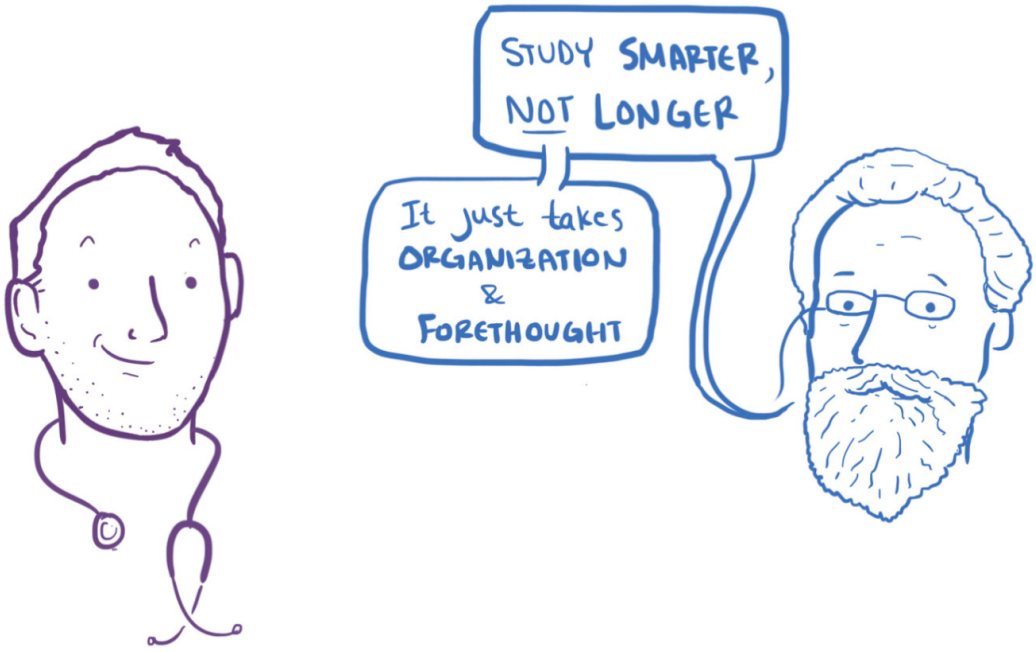



One of the best things about spaced repetition is that it suggests that we can gain a lot by studying smarter, not necessarily longer. With just a little more organization or forethought on your part, you can achieve a whole lot more. That said, spaced repetition means challenging yourself to apply your learning right at the point when you're starting to forget it, and that can be kind of hard! So, just know that if a spaced repetition regimen feels difficult, even frustrating, that often means it's doing exactly what it's supposed to be doing.

## How to Apply Interleaved Practice

Let's say that you want to learn concepts A, B, and C. The traditional model of education has you master each in turn through massed practice, which is also called block practice, and looks like this: AAABBBCCC. On the surface, this strategy makes sense. You practice a skill until you achieve proficiency and then (and only then) do you move onto the next one. However, this strategy often falls short. First, topics rarely build on each other so directly. Second, learning new topics can help you to reinforce others. That's what interleaving does: it allows you to work on multiple skills at the same time by alternating between them, which looks like this: ABCBCABAC. This may seem like a lot of work, but making the effort to go through each concept every time helps you figure out how they overlap and differ, which increases your retention overall.

So, when you learn about the various diuretics, do not practice all the thiazides followed by all the loops; instead, interleave them, and mix up how you learn things! These first three techniques all fall under what UCLA psychology researcher Robert Bjork and his colleagues call "desirable difficulties." These are counterintuitive strategies that lead to reductions in short-term performance but improvements in long-term performance.



# 2 Problem 2: Passive Studying

**Problem 2:** Passive studying doesn't lead to information retention.

**Solution:** Apply active learning techniques such as the testing effect and memory association strategies such as the "memory palace".

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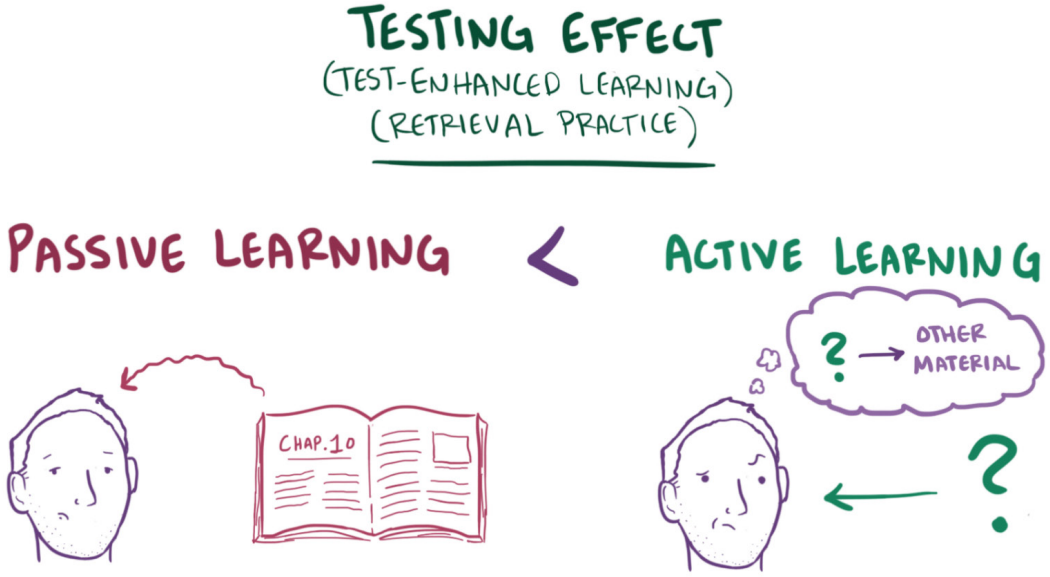
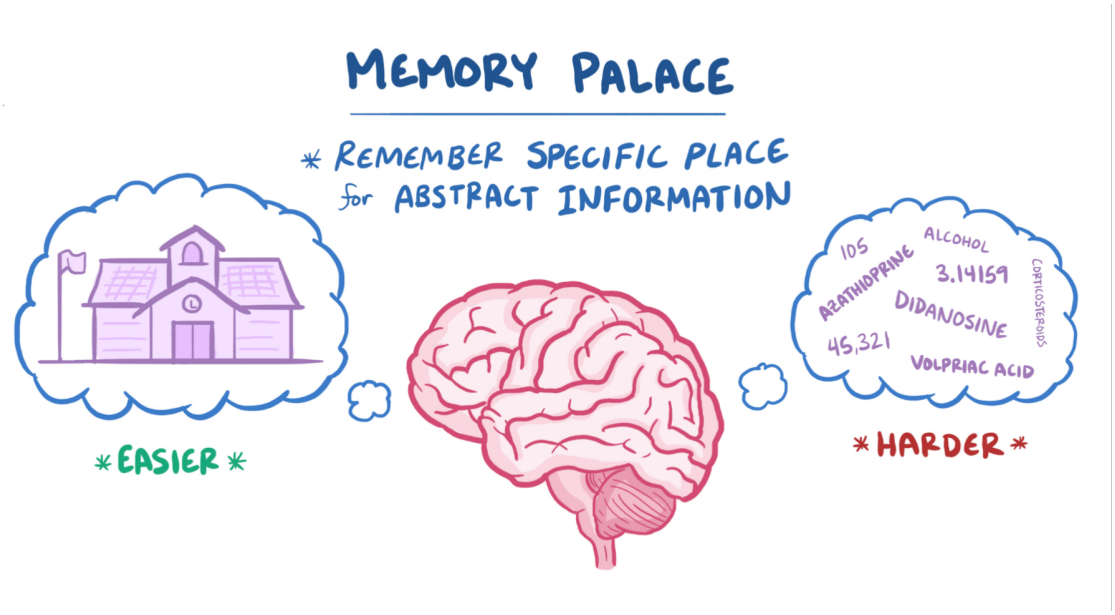
Let's say you have a big exam coming up and you need to review the material—what would be the best way for you to study? You might think that you should re-read the textbook or look over your notes, but as it turns out, one of the most effective ways to learn information is by studying actively, by testing yourself on the material, instead of passively. In other words, the mere act of answering questions will strengthen your memory. This phenomenon is called the testing effect, or sometimes test-enhanced learning or retrieval practice.



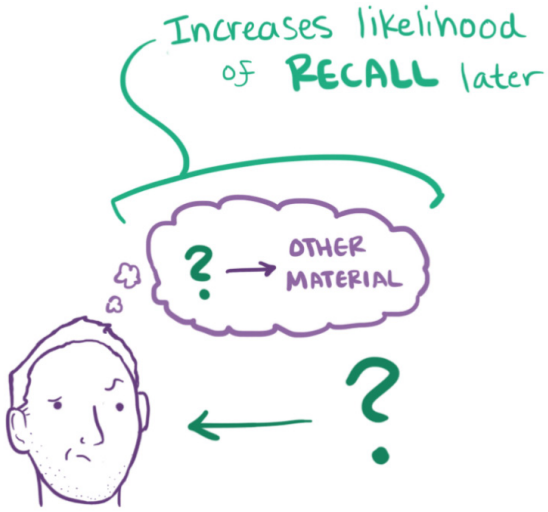
Having said that, you can learn actively even while you read as long as you make the effort to attach the information you're reading to content that you already know. Studies show that the more associations you can draw between whatever you're trying to learn, the more likely you are to remember it in the future because there are more paths you can take to retrieve that information. One of the most successful memory association techniques you can use is called a memory palace, where you imagine a physical location to help you remember more abstract information.



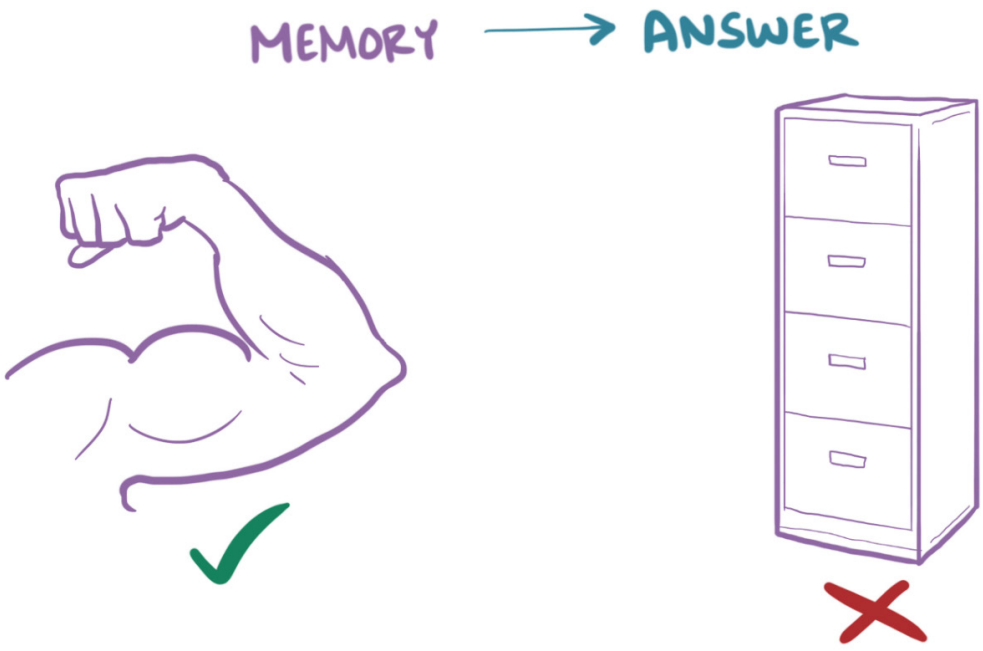

## More Information About the Testing Effect

Having taken dozens of high-stakes summative tests, ranging from class finals to the MCAT, SAT, and ACT, you've probably come to associate tests with the end of a learning experience, rather than as part of it. But the truth is that low-stakes formative testing can play an integral role in the learning process. This phenomenon happens for a number of reasons. One is that active learning is better than passive learning. When we read a textbook chapter or re-read our notes, we're engaging with the material in a relatively passive way. We like to think that we're information sponges—that we absorb knowledge as it passes across our eyes—but it turns out that real learning happens when we actively engage with the material, like when we think about how it relates to other material we've learned or are learning. Actively thinking about the material increases the likelihood that we'll recall the information when we need it later on, like during an exam. So active retrieval of information through testing strengthens the underlying knowledge. In other words, testing has been shown to more effectively improve knowledge retention compared to less active forms of studying, such as rereading information or rewatching lectures.

In fact, the more actively you can engage with the material, the better. Research has shown that you should take the time to test yourself in ways that force you to struggle with the material, rather than just focusing on plain recall. The benefits of testing are greatest when the questions are complex and you really need to push yourself to come up with the answer.

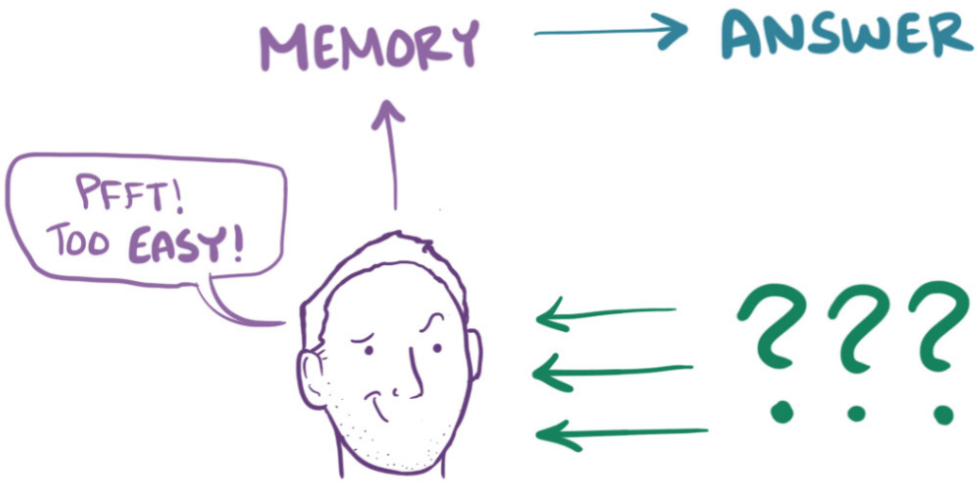



Another reason that testing is so effective has to do with the dynamics of recalling. In order to answer a question on a test, you have to search through your memory and retrieve the answer, right? Well, it turns out that—at least in one respect—your memory is more of a muscle than a filing cabinet.



When you first rode a bike, you probably fell over a lot, and your movements were rough and wobbly, but with practice, those movements became easier and smoother. We can think of memory as working in the same way: the more you practice testing yourself and recalling the information, the easier it'll be for you to recall it again later.

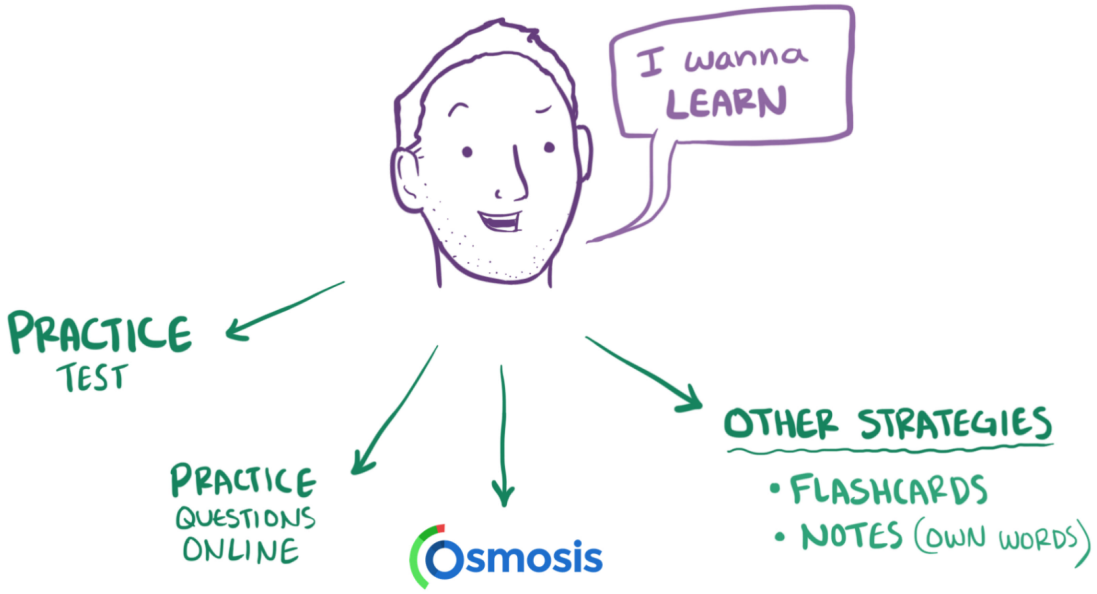
For example, one study compared medical residents who tested themselves versus those who simply restudied information about two diseases. Those who underwent practice testing achieved, on average, scores that were 13% more than those of their counterparts who simply re-read the information. This was six months after they first learned the material, which shows greater long-term retention. And if you practiced retrieving information during the intervening months, recall would be even greater.




## How to Apply the Testing Effect

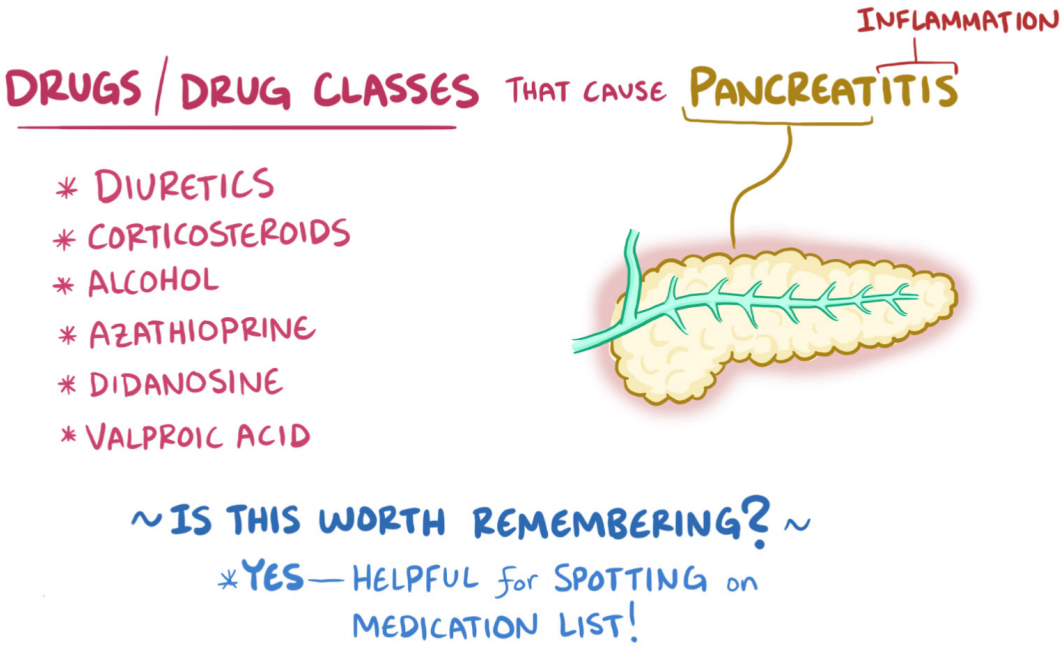
You can tap into this phenomena by using any strategy that forces you to actively engage with the material, like making flashcards or taking notes where you put the information you need to learn in your own words. Studies show the testing effect is most effective when it takes place right after you first learned the material—so don't wait! You should also make sure to complete any practice tests your professor gives you. If they don't make any available, find some practice questions online, or use sites like ours (Osmosis) that can automatically send you questions as you approach your exam.

Also, change your mindset about testing more generally. Don't think of exams as only being about assessing your learning. Instead, see them for what they are—an important learning opportunity. Make sure you always review your exams and quizzes to see what you got wrong!



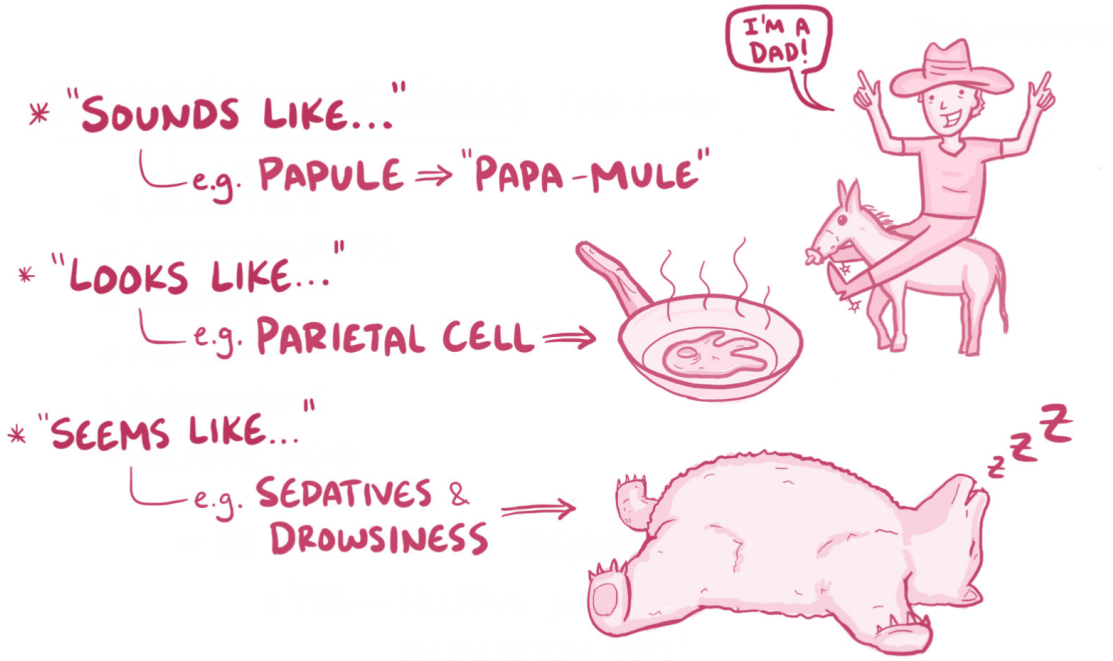

## How to Apply the Memory Palace Technique

Let's say you're trying to remember the six drugs or drug classes that are known to cause pancreatitis, or inflammation of the pancreas. The list is: diuretics, corticosteroids, alcohol, azathioprine, didanosine, and valproic acid. Clinically, it's really helpful to have these six drugs or drug classes in your working memory so that you can spot them on a medication list and think about them as a potential cause of pancreatitis.

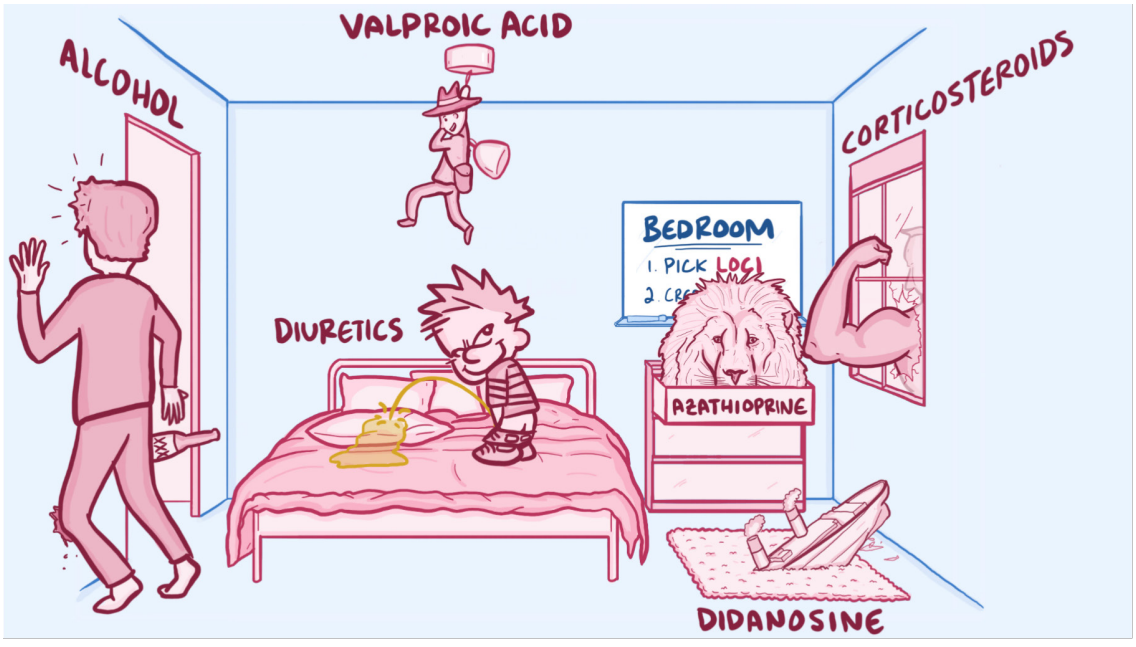


Start with picking a place that you're familiar with, like a bedroom. This can be any place you know, like the gym, a store, or someplace you've seen or imagined, like in the TV show The Office. Next, you can start identifying specific spots called "loci" in that place. It's nice to pick really distinct spots, and in this case, we can pick out six spots since there are six things to remember. Let's pick the bed, the window, the doorway, the dresser, the rug, and the ceiling light. Next, you have to create images for each term you're trying to remember. You can try a few approaches here.


First you might go with "sounds like": for example, "papule" sounds like papa and mule, so you can imagine an excited new dad riding around on his baby mule. Another trick is to go with "looks like": for example, a parietal cell looks like a fried egg. Finally, you might try "seems like": for example, taking sedative medication and feeling drowsy seems like what a bear might feel while hibernating through the winter. Rather than try to analyze which trick you're using, you should simply use whichever image first springs to mind.

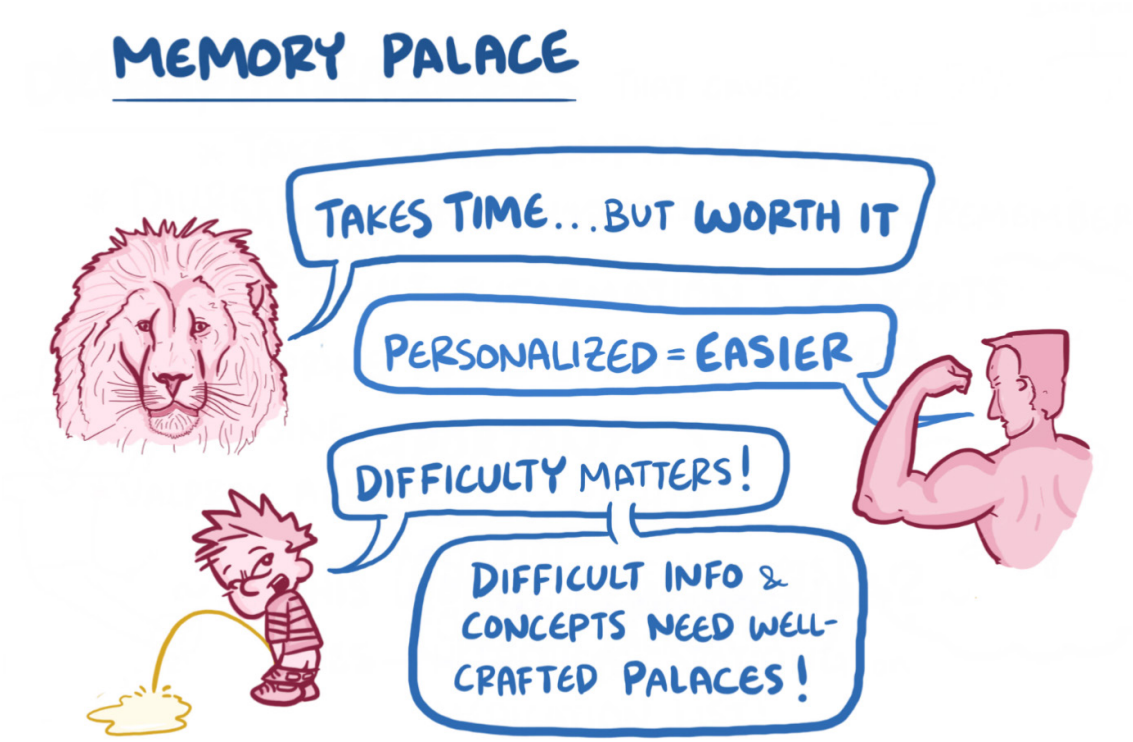



So in our pancreatitis example, you might imagine someone urinating all over the sheets to help you think of diuretics on the bed; a giant, angry body-builder on steroids smashing the window to think of corticosteroids and the window; a drunk person missing the doorway and running straight into the wall for alcohol; Aslan (the lion from Narnia) hiding in your dresser drawer for azathioprine; maybe the Titanic sinking into the fuzzy rug for didanosine; and finally, a valiant professor (Indiana Jones!) swinging from the ceiling light for valproic acid.



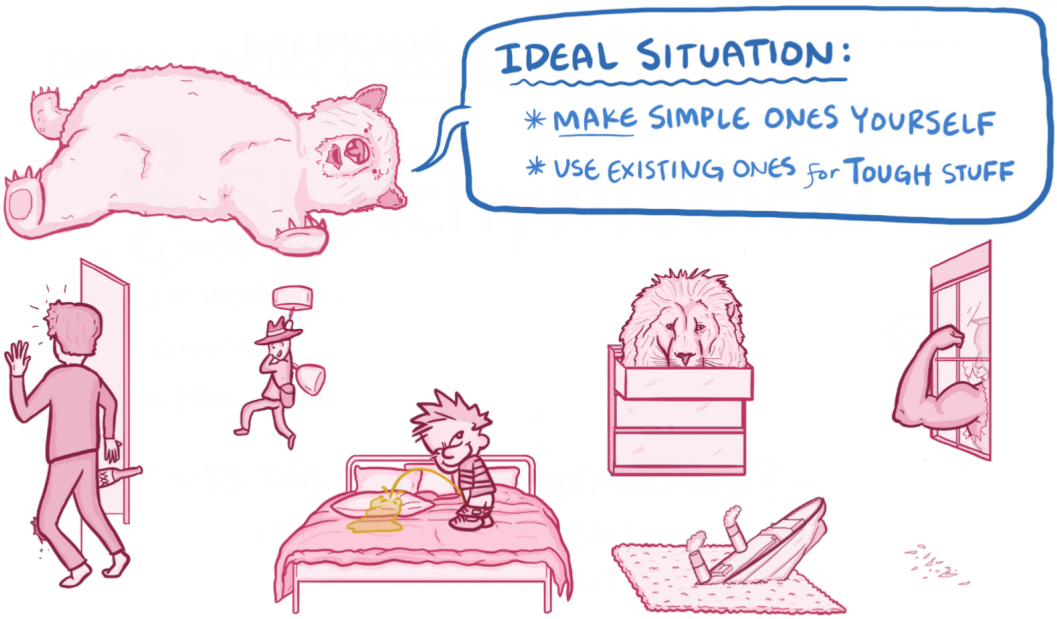
Don’t worry if you’re not a good artist, because you don’t have to draw anything. You can simply imagine the memory palace, and it works just as well. It’s always important to pick the right material to apply this learning tool. Typically, you want to pick something where the learning objective is really clear, like learning the steps of a process or a list.

The reason that memory palaces work so well is that our brains are better at remembering concrete images and locations, as opposed to abstract things like names and numbers. By using these images as a model, the memory palace provides a scaffold for abstract information, and over time, it can help your brain organize and connect concepts. You learn faster while forgetting less, and creating the images themselves makes learning more enjoyable, adding a little flavor to the usual study routine.




The more unique and descriptive an image you choose, the better it will stick, because the mind loves to hang on to interesting visual images in familiar settings. This may seem like a lot of work, but studies suggest that it’s worth the effort to make a memory palace because it’s more personalized and therefore easier to remember.

Having said that, the difficulty of the material really matters, and for difficult information and concepts, really well-crafted memory palaces are likely to be more accurate and higher quality. When applying this method to a study group, it can be helpful to think about a memory palace that will be accessible to other people. While it may not be as personal to you, having to think about how you would make the memory palace relevant to others will also increase the likelihood of recall.



# 3 Problem 3: Past Behaviors

**Problem 3:** Letting the behaviors that led you astray during your undergraduate degree continue to impact your life.

**Solution:** Change your mindset and implement behavioral changes that will allow you to become a better medical student.

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Now that you know a few proven techniques to help you learn more efficiently and remember material for longer, how do you actually make a habit of them? This is where the Fogg Behavior Model and attaining a growth mindset can transform your life (and help you counsel your future patients better, too!).

## How to Apply the Fogg Behavior Model

Stanford behavioral scientist BJ Fogg reduces behavioral change to three variables: motivation, ability, and trigger. If you think about any behavior—exercising, quitting smoking, or studying using the techniques described above—you need a certain level of motivation and ability, followed by a trigger to implement the behavior.

Let's say you want to study new material and review past concepts on a daily basis. Your motivation is a desire to do well in classes and board exams and, more importantly, to be able to take good care of your patients. You can increase your motivation through engaging practices like gamified learning and social accountability (e.g. study groups). You can increase your ability by using tools like mobile apps which make your study materials readily accessible wherever you are. Finally, you can trigger the behavior through reminder emails, text messages, and push notifications.

On this last point, the key is not to burn out on the triggers so that they lose their effectiveness. One way to decrease the likelihood of this happening is by making each trigger relevant by syncing it to your individual curriculum and schedule—so you get, for example, practice questions on gram-positive bacteria when you're actually learning about them in class or seeing patients with infections in clinic, rather than getting that information at random less meaningful moments.

## How to Apply a Growth Mindset

Stanford researcher Carol Dweck has found that when people are faced with challenges, they often develop different mindsets, or thought patterns, surrounding their problem and their ability to overcome it. Those with a fixed mindset believe that one is either born with a skill or without it, and that only so much can be done to change this initial ability. Those with a growth mindset believe that actions and hard work are more important than inborn biological talent. When students with these mindsets were given easy problems to work on (much like the problems you may have encountered in undergraduate), both groups were successful. However, they acted quite differently when faced with a more challenging, difficult task. Those with a fixed mindset (such as a belief that intelligence is inborn and cannot change) were quick to give up on the task when it suddenly became difficult. Those with a growth mindset, however, were more likely to persevere, and worked hard on the challenging problem until they found the solution. When asked to choose between additional easy or difficult problem sets, the students with a growth mindset expressed excitement about working on challenging problems, while those with a fixed mindset were only interested in solving problems when they knew they would succeed.

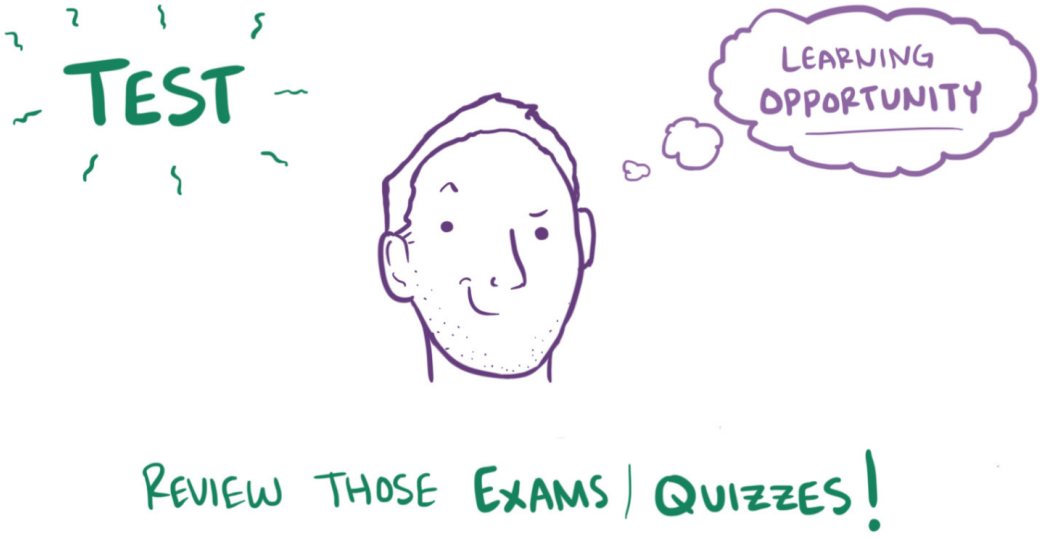
The most important part of this research was not discovering that these mindsets existed, but how easily they could be overcome when students were made aware of them. In other words, life-long mindsets about achievement and ability can hold us back, but they are not set in stone, and those who overcome them are more likely to succeed. Even if you are someone who breezed through your undergraduate years, you will undoubtedly face challenging topics in medical school. Remember that it is not natural for all topics to come easily to a person, and that you can move forward by working hard and applying yourself to the topics you struggle with the most.

# Conclusion

With the start of each new school year, 25,000 incoming medical students in the United States—and hundreds of thousands around the world—will be faced with the challenges that come along with intense coursework, board exams, and working in the clinic. But this year is different, because this year, you will be one of them. Decades of neuroscience research have provided an entire toolkit of techniques that can guide you on your path to success, but you need to make the choice to use them. Pay attention to the suggestions listed in this study guide, and you'll be well on your way to being a successful medical student!

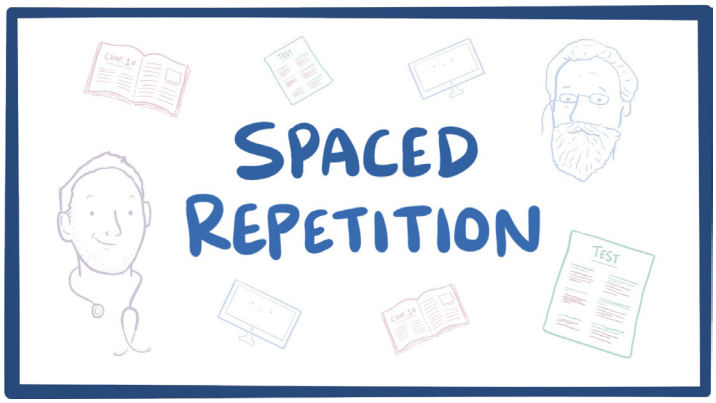
If you're interested in learning more about the techniques listed in this study guide, we suggest you take a look at three books in particular: *Make It Stick: The Science of Successful Learning, Moonwalking With Einstein: The Art and Science of Remembering Everything,* and *Learning Medicine: An Evidence-Based Guide*. Osmosis Prime, a learning platform that incorporates these learning techniques , helps ensure that you will learn—and retain—all of the information that you need to succeed in medical school and beyond.

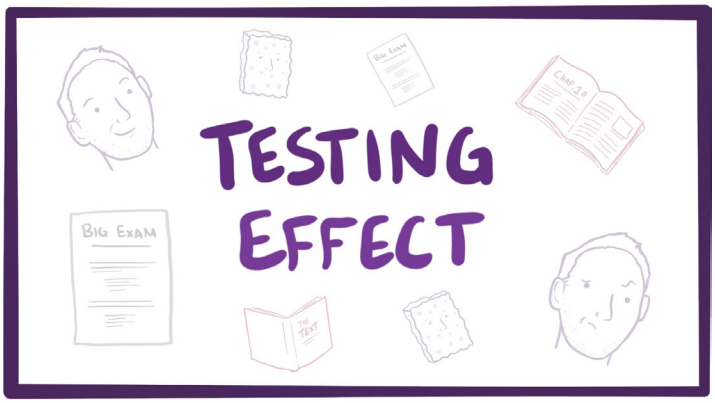
Happy studying!

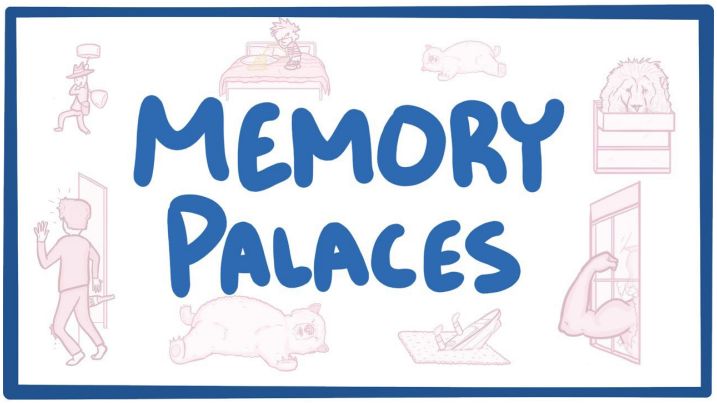


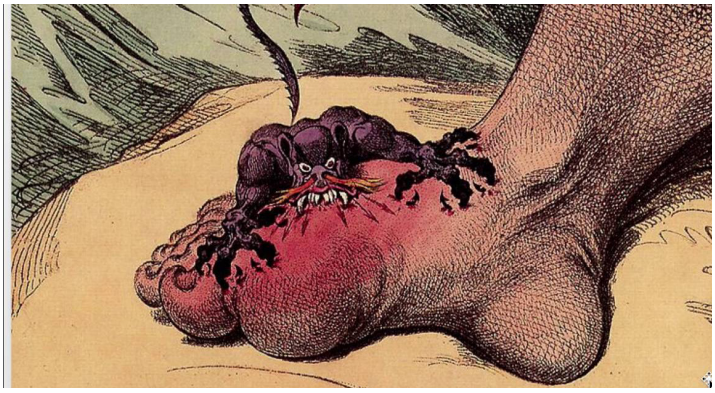
## Additional Resources

Watch these videos to learn more about each topic.



5 Study Techniques Every Medical &
Health Professions Student Should Know

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