

## Strategies for Studying

(from *Make It Stick: The Science of Successful Learning* by PC Brown, HL Roediger III and MA McDaniel, 2014. Harvard University Press)

**Practice Retrieving New Learning from Memory:** this means self-quizzing, thinking about topics from memory, pausing when you are studying lecture notes to ask yourself questions like “what are the key ideas?” “what does this mean in the big picture of the process?” “how do the ideas relate to what I already know?” Use the study questions at the ends of textbook chapters. Generate questions for yourself (or swap questions with a study buddy)

**\*The harder it is for you to recall new learning from memory, the greater the benefit of doing so.** Making errors will not set you back, so long as you figure out the mistakes and correct them from there on out. By retrieving you are pulling from your long-term memory, strengthening the synapses of your neurons to reinforce the connections and learning. Many students reread their lecture notes and texts to the point of fluency, their fluency gives them the false sense that they’re in possession of the underlying content, principles, and implications that constitute real learning, but again, only retrieval practice can contribute towards real understanding and learning for the long run. **Retrieval helps strengthen neural connections, long-term potentiation (LTP) and consolidation of memories in long-term memory.**

**Space Out Your Retrieval Practice:** study in shorter sessions during the day more than once but leave considerable time between practice sessions (e.g. instead of studying in one 60 minute block, study for 20 minutes and take a break and then study for another 20 minutes and after another long break, study for a final 20 minutes). If you don’t want to take a break completely from studying, change courses so that you interleave biology with chemistry and then go back to biology (for example).

**\*If we practice something over and over we often see our performance improving, but these gains are short-lived. These memories are stored in short-term memory and will fade quickly.**

**Interleave the Study of Different Problem Types:** Don’t do the same type of math or chemistry problem over and over again; instead alternate different problems that call for different solutions. If you are studying biology processes or specimens, mix up the examples.

**\*This improves your ability to discriminate between types, identify the unifying characteristics within a type, and improves your success in a later test or in real-world settings where you must discern the kind of probe you’re trying to solve in order to apply the correct solution (so you don’t say “my professor never showed us how to solve this kind of problem”)**

**Elaboration:** improves your mastery of new material and multiplies the mental cues available to you for later recall and application of it. Find additional layers of meaning in new material by **relating the material to what you already know, explaining it to somebody else in your own words, or explaining how it relates to your life outside of class.**

**Generation:** has the effect of making the mind more receptive to new learning. It is an attempt to answer a question or solve a problem before being shown the answer or the solution. Try filling in a missing word in a text or read new class material by trying to explain beforehand the key ideas you expect to find in the material and how you expect they will relate to your prior knowledge. Then read material to see if you are correct. For math, physics or chemistry, try to solve problems before you get to class where you will go over them together.

**Reflection:** is a combination of retrieval practice and elaboration that adds layers to learning and strengthens skills. It is the act of taking a few minutes to review what you have been learning in a recent class or experience and asking yourself questions. What went well? What could have gone better? What other knowledge or experiences does it remind you of? What might you need to learn for better mastery?

**Mnemonic Devices:** help you retrieve what you have learned and to hold arbitrary information in memory. They give you handy ways to store information and find it again when you need it. An example would be “King Philip Came Over From Greece Singing” to remember the taxon order from largest to smallest → Kingdom, Phylum, Class, Order, Family, Genus, Species.

***Studying to truly learn and remember does not have to be difficult or time-consuming, but it needs to be deliberate and mindful. Plan out time to engage in some of these strategies above and try the different techniques to discover what works well for you. The payoff is worth it!***