

Study Strategies in Understanding Biology

By: Dr. Alan Jaslow, Rhodes College Biology Department, 2005

These study strategies are helpful tips that I've read about or learned from past students. Obviously, you won't be able to do everything here all the time, but I wanted to give students a list of things to try that have been helpful to others.

- **STUDY TO UNDERSTAND**, not just to memorize words and notes, not just to put in more and more time.

- **CONTENT BEFORE INTEGRATION**

You need to have content learned and understood before you can go to the next level of understanding using integration. This is one reason it is so important to turn around your notes quickly and answer any fact and detail questions right away. It will be the only way you will be ready to learn and practice at a level of understanding that assumes integration.

"Content before Integration" is the same as "Rules before Strategy" in games. In sports or card games you have to know rules (4 downs in a possession in football, spades beat hearts in bridge) and individual skills (catching in football; card counting in bridge) before you can win using game strategies which integrate the knowledge on a different level.

- **COMMITMENT**

The study strategies discussed here will take more time and active work on your part than many of your friends and hall-mates might be doing. Remember to have a goal in mind and remember that succeeding in your goal is what you should be focused on. There will still be time (a bit) to play with all those great friends at college and to participate, but if you are like 98% of my past successful biology students you will not be playing as often or have as much time as other students at Rhodes. This means that you will have to pick your extracurricular activities with care. Pick one! Focus on your goal. You can always add more activities or play time later when you have attained the understanding and grades that you want. Your academic work at Rhodes is planned by the faculty to be a full time job. Make sure that you are doing that full time job as your first priority. [Assumed: go to class, do all assignments.]

- **8 STUDY STRATEGIES**

- **Notes**

- Take notes even when professors give you outlines or PowerPoints. In fact in those cases get the outline or presentation in advance and review the key points and flow before class. Then add as much detail of what is said during lecture. Keep a column free on the edge of your paper to write the words, concepts, case studies or whatever, that you do not know and will need to look up later or study. Other forms of flagging such terms could be to use a colored pen to indicate such terms in your notes. Obviously taking notes requires attending class. Students have been shown over and over again to do more poorly on sections where they are using borrowed notes.

A very small minority of students learn more from a lecture by listening only, without taking notes. Unfortunately, if this is true of you, you'll leave the lecture without any notes

to use. Try taping the lectures so that you can go back to listen to the lecture a second time to write out complete notes to study with.

- **Flesh out notes in 24-48 hour cycle. “Note Massage”**

- After lecture add to, or rewrite, your notes using complete sentences. This will allow you to make sense of topic headers, buzzwords and phrases in the weeks to come, as well as help you to learn by repetition of material.
- Get all missing holes filled. Use other students and use your book. Go ask the professor if these first attempts fail.
- Always carry paper and pencil when meeting with a professor or an advisor to jot down notes.
- For all topics which you do not fully understand, get explanations. Don't wait until close to the exam to fill in this understanding. Get it now. Before the test you will want to be studying at a different level of understanding.

- **Flash cards for terms, concepts, case studies, factoids**

Make flash cards for terms, another set for concepts and case studies.

Many of you are like me in that I am very good at recalling every detail and definition on a page if I can visualize that page of notes. So if I know that the term is from the lecture that had xyz topics, I can remember the notes. I'm not as good when I'm asked to recall the terms in random order and with other terms from all parts of a course. In these randomly presented exam questions, I'm missing the context that allows me to visualize that page of notes. For me and others, randomly shuffled flash card decks help. If you don't have time or motivation to make flash cards, try taking looser notes (more space), then using a copier to copy them all and cutting them up into pieces to act as randomly ordered flash cards.

- **Use Classmates (at least a bit)**

Some people do much better with study groups than working alone. Studies again and again show the value of a safe work-sharing study group in grade improvement for some students. A good regularly meeting group can provide a resource of fact checkers, some division of labor, as well as the practice partners, as discussed below. Other students do better studying alone and only occasionally meeting with others. Forming a study group with a formal goal and work distribution is one effective thing to try if you have not been successful alone. Minimally, you should meet with others in the class occasionally to:

- fill in holes in your notes
- fill in holes in your understanding
- practice writing and answering questions

- **Practice questions and answers**

- Successful students often practice coming up with questions that a professor could ask on course material as well as practicing and refining answers. On one level this is a method of asking yourself to deal with the material in a different way than simply reviewing the notes. It can give you insights in how a professor makes up exam

questions. (Sometimes there is only one way that we can ask a question on a certain topic). Practicing answers that require longer explanation and require demonstration of understanding is a great way to be prepared without being surprised during an exam. In the same way that practice interviews help job candidates, these practice exam questions and answers will give you an advantage over other students who are starting from scratch in formulating an answer during the exam.

- Before a test you can always take a practice question and answer to the professor and ask how they view your answer.
- I have often recommended to students that well before an exam he/she study for a subset of the material as if the exam on that topic was tomorrow and then to visit the professor and tell him/her what you have done and ask if he/she would see whether you understand the material at the level he/she would expect on an exam.
- **Ask; “Why did my professor pick this [fact/study/example] to discuss?” and “How is this connected to all other course content?”**
This is another way to study course material that differs from simple review. Of course the selection of specific examples or terms may be random or unknown to you. But often, one topic of many is chosen because it is an elegant example of a process or concept. This ties the facts to a larger picture. Another way that we often choose material is if it builds on prior course content or can be built on later. In these cases, if you can see how these disparate lecture topics are connected, you might have a head start in integrating material from two or more different lecture topics, rather than seeing it for the first time on an exam. Try to map out all connected material. You can do this graphically.
- **Take the Time Needed**
See the comments under Commitment starting on page 1.
- **Biological principles of learning. How to use biology to make your life easier.**
 - I often call these rules “lazy man/women study methods” when really they are smart ways to utilize biological knowledge to increase performance; “better living, and easier learning, through biology”. I call them, incorrectly, “lazy” because they don’t require any additional work or time. Instead they require an awareness of time, habits, sleep and nutrition. As a biologist you should know that proper nutrition and rest increases neuron and brain activity, as well as recall and learning. In fact, recently, studies have shown that some sugar and glucose before tests can increase standardized test scores in elementary school children. So eat, exercise, and sleep right, for healthy nervous systems. Don’t stay up late before a test!
 - Biologists and psychologists also have been studying how neuronal anatomy and physiology as well as hook up is initiated, maintained, and changed during learning. As a neuronal pathway gets more use there are changes in cell connections. In simple systems this means better memory. So repetition helps, you already knew that. But, if you do all of your study at one time even if you repeat your concept over and over, it may not count as repeated uses or it may not be as significant for learning as repeating the study over several separate shorter periods over different days. Try

studying the same material over many days and in different settings (if it suits your habits) and at different times. Don't do all of your studying at night. The more different memories that are cross "filed" with the information that you want to be able to recall, the more likely you are of retrieving it. If you only have it associated with one other memory, one other piece of information, one context, or one time of review, it may be harder to remember it.

- Study all of the material all along, not just before tests.
- Memorizing, memory and associations
 - Many students have success with their own memory aides. How many of you learned “Every Good Boy Deserves Fudge” to remember the order of notes in the musical treble clef. These mnemonic letter association phrases can be used for new lists or categories of terms, concepts, or other factoids. One of my past social students came up with “Can our silly dates carve pumpkins” to remember the Periods of the Paleozoic Era. Another student who was a runner came up with “R U that fast” to remember the order: radius, ulna, tibia, fibula.
 - I've known students who wrote and knew a short story with different figures, places and objects associated with the terms or reaction steps that they were trying to memorize.
 - Every year I have successful students who make up and easily remember songs that they used to remember information. Think how easy it is to learn song lyrics of even nonsense songs.
 - On two different occasions I've had successful students choreograph dances to help them successfully learn and remember anatomical terms. (Only one needed to dance during the practical to remember. We all enjoyed it!). Studies have shown that some young children learn best with physical motion. Not only is there an association formed with the fact or term to memorize, but these learners have a different part of the brain (motor activities) associated with the course material.
 - One of the common ways to associate content or definitions with words is to know the etymology or origin of the word. If you have had Greek or Latin this can be an aid with many biological terms, where the literal meaning of the word can be known from the meaning of the word parts. Most students can get help with this without studying Greek or Latin. Try using the glossary in the back of many biology books that lists the meaning of biological suffixes or prefixes. Many online glossaries exist for this as well. Even a good English dictionary will have some etymology.
 - One thing that will be hard to do with some material, but it should work, is to find a way to make learning the information important to you (beyond doing well on an exam). It is always easier to learn information when you are

interested in the material or the learning is perceived as important. Think about a childhood grievance where one sibling unfairly got something first. You'll take this memory to the grave. It was once important to you. The hard part is making foreign information important to you. If you can find ways to be motivated and to have a (non-test) reason to learn the material and view it as important to being a biologist or other goal, you should have an easier time learning it.

■ SPECIFIC TYPES OF TEST QUESTIONS, COURSE ASSIGNMENTS AND STRATEGIES

• General Test Strategies

- Ask the professor if you do not understand a question or word when reading the test. The worst thing a professor can say is "You should know that," or "That was covered in class." In that case you have lost little and learned that you missed something in your studies. If you are prepared and have kept up in class, more often the professor will rephrase the question or in reading it add a pause that defines a phrase that you missed. Sometimes just hearing the question can help you to think about it differently than your reading it. Remember the biology; you are using different brain pathways when you listen than when you read. Maybe it will help. (However, don't expect the professor to read more than a question or two for you. Save this for times when you do not understand the question.)
- Here is another thing to try during a test when you are working to ensure that you know what the question is asking. Rewrite it in your own words. Then ask the professor if your rewritten text is the same as he or she asked.

• Multiple Choice Questions

- Students often say that they do worse on multiple choice than on other types of questions. In most cases when I calculate the percentages, I find that students usually miss similar percentages of questions and points on multiple choice and essay sections. Remember however, that while it is hard to receive a zero (no partial credit) for essay answers, it is rare to get any partial credit on multiple choice questions. Be sure that your self evaluation of your success with different types of questions is correct, by calculating these question specific percentages. Remember also, that most post graduate tests and professional boards will be multiple choice tests, so it is good to learn how to do well with them.
- Different professors have different styles for multiple choice; for example:
 - Questions with more factual short answers
 - Questions requiring more integration and understanding from different areas of the course.
 - One correct answer
 - One best answer
 - Multiple correct answers possible.

You will learn what type or types your professor uses, but it is worth making sure that you are clear from the start about the last three choices.

- Even if there is only one correct answer, be sure to read and evaluate each answer. Don't just stop when you first think you have a correct choice. By finishing out the list you can check to see that your first choice still stands alone as a single correct answer in the list.
 - Start with the question. Is it asking for the thing(s) that are true or the thing(s) that are false? Circle or note which. In 99% of multiple choice questions you can approach or treat the answers individually and put a little T or F (or other relevant code depending on the question) next to them as you go. Then go back up to see if you were asked for the true or the false statements or facts.
 - Some students say that they understood the question and knew all about the topic but just got confused on choosing among the multiple choice answers or did not see an answer. If you find that you have time to go back to such a question, you can always write an essay answer or outline to your essay answer on the back of the adjacent pages. If you are correct in understanding the topic and have practiced a good essay answer previously, then your text should have the correct answer or allow you to make that determination. Maybe reading from your text will allow that brain trigger to correctly "see" the answer in the multiple choices.
- **Matching**
Be sure to read whether or not all possible answers are meant to be used (rare). Be sure to determine whether possible answers can be used more than once (common). Sometimes more than one answer could be correctly used but one is the most specific of those potential correct answers. Determine whether you are to give all correct answers in an answer space or only the most specific of those presented. If this is true, here is a good reason to read and evaluate all possible answers and not to stop when you first get to a correct answer.
- **Essay Questions**
 - There are often multiple questions or parts in a single question. Be sure to circle and number the phrases or points that are being asked. Later make sure that you can identify a clear answer for each of these question parts, or questions, in your answer. Some professors will even appreciate your separating and organizing your answer to address the different points, instead of using a simple paragraph answer.
 - If you are asked to explain, argue, or present reasons, do not just list words or phrases. For example if the question was "Explain various sources of evolution in a population" A list of: "Natural Selection", "Genetic Drift", "Migration", "Random Extinctions," would not be a complete answer. In addition you would need to explain what these words mean and why they are sources of evolution. The latter would require a definition of evolution and then an explanation of why each of these sources would fulfill the definition. It's always a good ideal to start with a definition where appropriate, even if the question does not literally request it. I recommend circling those words in the question like "Explain" "Refute", "Discuss" and "Argue" or add them where they are tacitly implied. Then make sure that you have this part of the question as well as the list of topics in your answer.

- Write as clearly as you can. Write large enough for us older faculty to read. You can always add “continued on the back of page 3” to the bottom of the space that you were allotted on the exam, and then continue your written answer at that specified location. However, usually an experienced faculty member, can judge how much space is required for the average student with average (large enough to read) writing for a complete answer.
- The hardest part of an essay question is knowing whether your explanation is complete enough. Be sure to be as specific in your explanation as the course material was. Also, be sure to give all of the levels of explanation and mechanisms necessary to answer the question, assuming these various levels were covered in your current course. Admittedly, that is easier to do if you could set our paper aside for a few days and come back to it fresh. Obviously this won’t be possible on an exam.
 - One way to ensure complete answers on a test is to forget that you are writing for the professor (who knows a lot about the subject). Instead write for one of your biology student peers who has not had the course that you are currently taking. This will keep you from assuming a level of knowledge that we (the professors) do have, but which we want to know that you have as well. We can’t assume that understanding.
 - A second thing to try during a test is to see if you have used any terms, assumptions, or concepts in your answer that were covered in class and which you could further define or explain.
 - A third thing to try is to ask, “Have I gone beyond just having true statements written down?” Ask yourself, “Does my statement distinguish this concept, term, or case study from other such items in the course?” For example, a question might be “Define what a quarterback does.” If you say, “He plays offense,” you have answered truthfully but you have not distinguished him from any other offensive player.
 - Going back to the second strategy and using this same example if “play” was covered as a series of steps or broken down into running vs. passing, you have left out detail and explanation that was covered in the course.

Although it is important and sometimes hard to manage your time on an exam, remember that if you have time, students are rarely penalized for having too much detail or explanation. (However, I do know of rare professors that feel that an answer with too much explanation beyond the specific question is evidence that the student does not fully understand the topic and the specific question. The assumption is that he or she is simply writing down all that they have memorized about a topic without demonstrating an understanding of it). If in doubt, ask the professor. She or he can

always tell you to “Do the best you can.” or “What do you think you need in the answer?”, but we may also look to see what detail you are covering and comment on the need for that level.

- **Papers and Lab Reports**

- Be sure that you understand the assignment and required format. Make sure that you understand how to properly cite sources and how to avoid charges of plagiarism (even if unintentional). Start with plenty of time to easily complete all parts and to reread and “massage” your writing. Work with the writing center or other students who can act as editors, if allowed by your professor.
- Just like on essay questions, have a check list for the points required by the professor, not just the required sections of a report. Go through and make sure that you can clearly see all requested sections, points, figures, etc. The easiest grading on a project that we professors can do is to remove points because of a missing requirement.

- **Group Work**

- It is very hard to coordinate a group and to be able to be both responsible for being graded on all parts of a project while at the same time delegating work. However, future work in your life beyond college will require these same skills and this same balancing act.
- Remember, you are responsible for all parts of the final product. You will receive a group grade that is determined by the entire product. Too many starting students are surprised with a part of a lab presentation that a fellow group member turns in. (as in “Good ole trusty Joe, who is said to have quite the artistic eye, brings in the final poster that he volunteered to paste up and it looks worse than your 8 year old brother’s 3rd grade science project.” True story. I saw one of these with ragged cut out panels, rough marking pen lettering, and slack-jawed lab partners.) When you defer final review to a group member you are giving up any right to affect that part of your grade. Remember an incomplete project or one that does not fulfill assigned goals is incomplete for everyone in the group. You must ensure that your group members have their individual work done long before the final product is due. Then all members can, and must, be involved in editing and reviewing the parts and the completed project before it is turned in.

- **Oral Presentations**

(See all comments above under papers or reports and group work if appropriate). Stand up straight, make eye contact, and smile. Act the part of the competent knowledgeable young scholar. No really, I mean act as in acting and theatre. Don’t worry about the “death mask” looks you get from the audience. Audience faces are always way too weird looking to try to interpret. Instead, stick to your practiced plan. Work on clarity without jargon. Be sure that all figures and illustrations are clearly visible and clear in explanation to the back of the room. Don’t use too much text or extraneous information on your slides. Interact with your slides. Point to images and figures without waving or making circling motions with your pointer. Explain what the audience is looking at. Practice in front of a

live audience. This is usually harder than the real presentation, once you get started. Use the practice audience's comments to help you edit your talk and/or figures.

- **Lab Practicals**

Work with a partner to quiz each other in a random way. This will be more effective than trying to quiz yourself or simply reviewing. Be sure to study for lab practicals using the animals, plants, slides, or equipment that is in the lab. Lab courses provide ways for you to return to study with those objects. Don't study using just pictures and notes. It's harder to make several trips back to lab to do such study, but it is much harder to learn lab things from pictures and then try to interpret the more difficult and now foreign to you, real animal or object when encountered at the practical. Instead it will be much, much, easier at the test if you study with the three dimensional things that you can touch and manipulate (maybe even smell). Not only will this be the way the question is asked, but in learning structures this way you will have the term "cross-linked" with mechanical touch centers of the brain, not just vocabulary and vision regions, and recall should be easier.