How to Study for BIOCHEMISTRY Daily

Lectures in BIOCHEMISTRY are prepared and presented assuming that students will have already read about the topic and studied it before hearing the lecture. It is <u>extremely important</u> that the students get their second (not first) exposure to the course material during lecture presentation. This means that the student should do the assigned readings and look at the learning objectives prior to the lecture.

Important: S<u>tudents should never study before lecture from the lecture slides.</u> The slides are provided to help students with taking notes during lecture. Studying before lecture should involve readings, not slides.

Reasons for doing the assigned readings

The textbook provides a different explanation of the material than is presented in lecture. Hearing the same thing explained in two different ways (by two different people) is far better for understanding than only hearing just one version of the explanation.

To be effective, your reading must be thoughtful and deep. By deep, it is meant that you should be letting the reading trigger thoughts of all sort s of related things and all sorts of questions: Why? Why not? What else? What does this have to do with this topic? This can't be true because… etc.

When reading before lecture it is particularly important to note anything that confuses you or any question you have and cannot answer from the reading alone. These are what you will be listening most carefully for during lecture. In this way, the lecture and readings are synergistic.

Also when reading before lecture, it's a good idea to look at the learning objectives and find where these are described in the reading and pay particularly close attention to whether or not you understand them from the reading or if you need additional clarification.

Some excuses often given for not reading the textbook, and why those excuses are not valid:

A. "There's not enough time to read it all." MCP 208 covers 18 chapters, comprised of 720 pages of the textbook, in 40 lectures. About half those pages are figures, tables of contents, references, and problems at the ends of the chapters. The remainder is about 360 pages of text to read, or an average of 9 pages per lecture. That should take about 60 minutes to read thoughtfully and deeply and take notes relative to the learning objectives. That's about 40 hours in the entire semester, or just 3 hours per week. Since students are expected to study at least 3 hours for every lecture "hour," the reading represents only 1/3 of that. Yes, the ratio of 3 hours outside of class for each lecture means that students taking 16 credit hours should study an average of 48 hours per week outside of class. While that may sound like a lot, remember that the amount one learns is directly related to the amount of effort one puts into learning.

B. "The textbook is too expensive" New it may cost $155 or as little as $125 from some on-line retailers or just $75 for an eBook (from eTextbook). For the 6 years leading to a PharmD at Purdue, the resident cost of attendance is approximately $160,000 to $200,000. This textbook represents an additional cost of (at most) 0.1% of the cost of one's education. Since reading the textbook is as important as attending the lectures, it seems pretty silly to throw away so much of the educational value of college to save 0.1%.

How to Study Before Each Lecture

Readings

The readings for each topic are listed on the course web site topic pages. The vast majority of these will be readings in the assigned text, but in some cases other readings or eLesson materials are indicated and links to this material will be provided on the course web site or the material will be provided. For some topics, optional (i.e., suggested) readings and/or tutorials are also indicated. Students are highly encouraged to read or utilize these optional reading materials.

Before each lecture, read the assigned reading and make notes of anything you find confusing or difficult or impossible to understand. Note any questions you have from the readings. If you can, also read any optional readings and look at any optional learning aids.

Learning objectives

The learning objectives are the facts, processes, and concepts that should be learned in BIOCHEMISTRY. These have been identified for each topic covered and are listed on each topic page on the course web site. Within each topic, these have been grouped as: "Facts to be learned", "Formulaic process learning," and "Concept learning." For some topics, only one or two of these groups may be represented. Practice problems will be made available on the course web site for each formulaic process to be learned.

About these three kinds of learning objectives:

> **Facts** are considered "stand-alone" items of information that require only background knowledge and a general understanding of the language to understand and use. Such facts can be memorized. However, it is very important to link each fact to its topic, and thus also group facts belonging to the same topic. These associations make it possible to apply these facts to new problems, and also provide reinforcement to the learning of each fact and its association with a topic.
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> **Formulaic processes** are processes which can be committed to memory without much understanding of the principles and concepts involved. For instance, one can remember the process used to solve certain math problems, such as solve $x + 5 = 13$ for x. Along with the process, one has to learn how to recognize when to use it. Also, like facts, it is important for general problem solving to remember the topic with which the process is associated. This helps to group the process with the facts and helps build the overall topic as a concept.
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> **Concepts** are anything that is more complex than isolated facts and formulaic processes. They can be as simple as definitions, or as abstract as the similarities among (or sometimes distinctions or even other types of relationships) among a group of subcomponents which might be things (molecules or cellular structures, for instance) or abstractions of things (such as metabolic pathways, enzyme catalysis, enzyme inhibitors, cellular signaling systems) or abstractions (concepts, definitions, causes, responses, etc.) Like the other two types of learning objectives, it is important to remember the linkage of each concept to its topic. This is very important for solving complex problems that might require combining one or more facts and/or formulaic processes with one or more concepts. Remembering the associated topic for each concept makes it much easier to quickly identify which concepts might apply to any specific complex problem.

Knowledge integration

When some students study the learning objectives, they focus so much on each learning objective that they fail to associate that knowledge with the larger picture, such as the general subjects of the topic and chapter and other learning objectives in the topic that have a relationship with the objective being learned. This creates problems similar to an over-focus on memorization and under-focus on conceptual learning. But a concept learned in isolation of all other knowledge is a concept that is easily forgotten and will not be useful for building on during future learning.

Some students have an under-developed ability for integrating knowledge. This may have been caused by a lack of awareness of its importance. It can also result from prior course instructors "flagging" or identifying (perhaps indirectly) the topic of each problem on exams and quizzes. Though direct flagging is less common, it is still done by many instructors. Usually this is done by indicating a topic name for a set of questions (or section of the exam) or the topic is indicated in the problem. Indirect indications occur more frequently. Most often this is done by the choices in a multiple choice problem all having relevance only for a single topic or concept. While doing this makes the questions easier to answer, it can also cause some students to assume that this kind of hinting always happens. Problems in real life often have links to multiple topics, some of which may be far less important than others. Realistically, knowledge must be fully integrated for it to be useful in real-world problem solving.

To increase integration of learning, think about how each learned concept or fact relates to the other concepts and facts, including the concepts represented by the topic title and the chapter title. Also, think about how a topic in general relates to the other topics in that chapter and how that chapter relates to the other chapters. Also, think about how each learning objective concept or fact might relate to facts or concepts in other topics. Sometimes there are such relationships with concepts or facts in other topics, even occasionally with concepts or facts in topics covered other chapters. Used here, "have a relationship" or "relates to" can mean "be similar to" but sometimes it can mean "be the opposite of."

Self-assessment of learning

Before each lecture, but after doing the assigned reading, review the learning objectives for the topics to be covered in that lecture and note which you know well and which you don't know well. Also, you should note which learning objectives are unclear or confusing or any questions you have about them.

Some students in BIOCHEMISTRY find it very difficult to determine if they really have learned what is indicated in a learning objective. Listed below are some ways to help with this:

> **Commitment to memory** can be tested by simple flash card methods used when working alone, or lists when working with a study partner. When the associations between topics and facts, processes, and concepts are included with all the facts to be learned, there is a lot to be learned for 208, so try to be as efficient as possible. Also, you will find that associations with topics become easier to remember if the concept, fact, or process is learned first. In some cases, there are some shortcuts available where learning can be prioritized so less important information is learned last and only if time is available. Listen for clues about what is most important during the lecture. Also, if it is shown in the slide it is more important than if not shown in a slide. If it is discussed (mentioned verbally), it is more important than if it was not discussed in lecture. In some cases, the instructor may simply say which things are more important and/or less important to learn.

Formulaic process learning can be tested using the practice problems provided on the course web site.

Concept learning is the most difficult to assess, due the variety of types of concepts. In general, concept learning must produce understanding of the concept, not mere memorizing it without any understanding. Conceptual understanding means that you can apply the concept. How the application is done depends on the type of concept. Definitions are the clearest among concepts to be learned. Understanding of a definition is best tested by testing ones ability to correctly identify cases that meet the definition from those cases that are similar but do not meet the definition. This does not mean it is adequate for understanding to memorize which examples fit and which do not fit a definition. Understanding means that you are able to use (apply) the definition with any case (even cases you have never seen before) and from your understanding reach a conclusion about whether the definition fits or not. Understanding of a relationship, including similarity or distinction, between things can be tested by applying it to other, unrelated things. So, if you understand the relationship in the abstract sense, you can test it by applying it to concrete examples, including examples other than the ones you used to learn the concept. For example, a rider is to a horse, as what is to an airplane? (pilot). Typically concepts that are described as relationships are simply definitions that are not easily put into a few words and are best described via examples and counter-examples. Simply memorizing the examples does not produce understanding of the concept, any more than memorizing the words of a definition provides understanding of the meaning of the defined word (think about a situation where the word and its definition are in a language that you do not understand – memorizing the definition is possible without any understanding whatsoever.) One must be able to apply the understanding to new (never before seen) examples. Thus, the best way to test for such understanding is to test your ability to apply the concepts.

One of the best ways to test if a concept is understood well enough is to written a description of the concept in your own words without looking at any reference material (textbook, notes, on-line information, etc.) It is not helpful to simply memorize descriptions of concepts, because memorizing concepts does not provide enough understanding to apply the concept. The only problem with this method of assessment (writing out the concepts in your own words) is with determining whether one's description is correct or not. In simple cases the concept can be looked up. But more complex cases may require group study or even checking with a TA or instructor.

Do not rely on intuition! Often students simply assess their learning by reading the learning objectives and checking each off as learned if one "feels like" the objective has been adequately learned. This practice of intuitive assessment can be used successfully only by experts, not by novices. Don't try this in MCMP 208 unless you are an expert at learning biochemistry. Instead of intuitive assessment, the best method to use is to write each learning objective in your own words – while not looking at any reference material (notes, slides, text, online information, etc.) The entire set of objectives for a single topic should be written without looking up anything. By physically writing them it helps with remembering them. Coming up with one's own words from one's learned knowledge forces one to think carefully about each objective. Of course, what is written should be checked for accuracy.

How to Learn More During Each lecture

Assuming one has prepared for lecture as described above, there are six things to note during lecture:

1. The answers to your questions that you identified during your preparation for lecture
2. New material not in the readings (or that you don't remember from the readings)
3. Hints about what is more important and what is less important
4. New associations or related facts and concepts that you were not already aware of
5. Corrections of the reading material or differences between the lecture and the reading material
6. Questions or confusion that arises in your mind during the lecture

How to Study After Each Lecture

Generally, if you do all of the activities recommended above, you should have no need to listen to lecture a second time. However, if you could not prepare adequately for lecture, you missed attending lecture, or you feel that you did not make adequate notes of all six types of things noted above during lecture, then it may be worth your time to listen to the lecture a second time after you have prepared adequately for it (as indicated above).

However, even those well prepared for lecture may have questions that came up during the lecture or may have questions that arose before lecture and did not get resolved during lecture. Those should be resolved by studying as soon after lecture as possible.

Also, after each lecture review the learning objectives for each topic covered in that lecture to make sure you have learned each. This is especially important for those objectives which were inadequately understood *before* lecture.

Not enough time? Then your study methods are not efficient enough

If you think you have more studying to do for Biochemistry but can't fit it into 9 to 10 hours per week then you probably are not studying in the most efficient manner.

To assess your time usage, keep track of how much time you spend on each activity, such as reading and thinking before lecture, rereading, listening to lecture recordings, group study, practice problems, practice quizzes (taking and then reading the key), studying for quizzes and exams, time spent after each exam figuring out what you are doing wrong, etc. Don't include time in class or travel to or from class. Total up the time each week over a period of two or three weeks and see what your average time per week is and which tasks you spend the most time on.

For each task you did, ask yourself if it was worth the effort.

Also, identify additional study methods that you could do if you had more time and that you think would improve your learning. Might any of those help your learning more than the approaches you have been using? Or perhaps they would be no more effective, but might be more time efficient.

Often students listen to every lecture a second time via the audio recordings. This takes 2.5 hours per week or about 30% of the 9 hours. Is this really time well spent? In most cases it is not time well spent because it over emphasizes memorization and underemphasizes conceptual learning. Simply listening more carefully during lecture usually eliminates the need to listen to recorded lectures.

Learning concepts is more time efficient than memorizing facts, because concepts include facts and provide a means to validate (double check) fact recall, something that memorizing facts does not provide. Thus, putting more time into concept learning and less time into memorizing will improve the efficiency of your studying.