# Guidebook for Studying and Learning in STEM

**STEM = Science, Technology, Engineering, and Math**

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# Table of Contents

Guidebook for Studying and Learning in STEM Table of Contents:




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# Introduction

Why is it that some students seem to perform well in all their classes *except* for their science, technology, engineering, or math (STEM) classes? What is different about STEM classes that makes them more challenging for some students? Are there any "tricks" to learning in STEM classes? Are STEM classes actually different from other classes?

To address these questions we carried out a survey of STEM faculty and students at community colleges. We asked them what they thought was important for learning and success in STEM courses. Then we compared what they told us to what is already found in books on how to study and learn for anything that stood out as different. From those differences we developed the strategies for this Guidebook on Studying and Learning in STEM. Then, knowing that every student is unique, we organized these strategies so that students can pick and choose to read up on the skills they need to succeed.

This guidebook was funded as part of a National Science Foundation project from the Research in Disability Education program (NSF # 0726473). Our project aims to develop methods to improve success for all students, regardless of disability, in STEM courses. One focus of the project was to teach students STEM-specific success strategies, thus driving the survey to gather those strategies. This led to the development of this Guidebook to provide the information to a broader audience. It is our hope that teachers will make this available to their students to increase the chance for every student to succeed.

As you use this Guidebook, keep in mind that it was written for student use and to highlight STEM-specific tips for success. It is not meant to replace other studying and learning books that incorporate a wider range of methods for general education. Instead, this Guidebook is a great companion for those other studying and learning books; it is also a helpful aid for students who do not know what to do to improve their learning. By including the Guidebook on Studying and Learning in STEM in your class, more students should be able to figure out what they need to improve their success in STEM.

## Preface for Students

This Guidebook was written for your use. Succeeding in science, technology, engineering, and math (STEM) courses can be a challenge for any student. But with the right tools, it is much easier to succeed. Being a successful student requires certain:

1. In-Class Techniques
2. Reading Techniques (for mastering the textbook)
3. Outside Class Studying Techniques
4. Test-taking Techniques

These are the chapters of this Guidebook.

Since every student is unique, the Guidebook was designed for easy navigation to any section of interest for each student. For example, if you are looking for ways to stay awake during class, head on over to the In-Class Techniques chapter and to the section on remaining alert. When you get to the chapter of interest to you, the first page of that chapter has a Table of Contents for navigating within that chapter. Feel free to jump around this Guidebook and get the tips you need.

Throughout the Guidebook we have focused on four areas that are important for learning in STEM courses: 1) active learning strategies; 2) terminology; 3) the big picture; and 4) organization. These four areas were revealed as important for all aspects of studying and learning by the respondents of the survey that provided the input for this Guidebook. Active learning simply means learning through action rather than being passive while trying to learn; for example, write and draw notes as you read from the textbook instead of just turning pages. The large amount of new terminology in a STEM course can be overwhelming for some students, so tips to handle the volume of new words are given throughout the Guidebook. It can be a challenge to understand the big picture in STEM courses, as well, but distinguishing which items are big pictures and which items are little details is essential. Finally, with all the information and resources in STEM courses, it is important to be organized in your approach to your courses, so tips are given for that.

Any student can be successful in STEM courses—if you haven't been successful in the past it doesn't mean that you will not be successful in the future. It could just be the approach you were using. This Guidebook should give you new approaches for studying and learning that could make all the difference for you. Keep in mind that it isn't easy to change one's approach to studying and learning. It may feel like a struggle. But the time investment to make the change will be worth it if it helps you do well in your STEM courses.

Finally, it is important to keep in mind that the amount of time spent studying is not necessarily proportional to the amount of learning a student achieves. It is possible to spend a lot of time on techniques that do not work for you. For example, a student who just reads a chapter from beginning to end over and over may not ever understand what they are reading, but it would take a lot of time. In the long run, studying smarter will save you time.

# Chapter 1: In-Class Techniques

What can you do during class time to help you learn the class material better? Some students just don't know what to do with themselves during class. How can they focus better? What should they write down? What's important? Does it even matter if you attend regularly? Here we will focus on approaches toward your time in class that will help you to improve your learning.

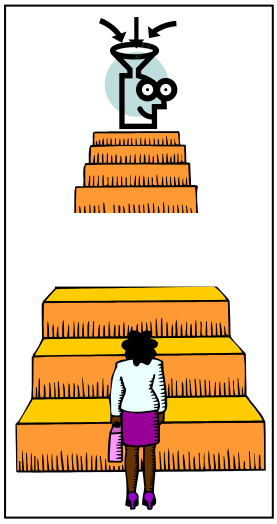
The four major topics of this chapter cover most aspects of student effectiveness for learning during class time. Some of the techniques may be novel for you, while others may seem second nature already. Also included are a few methods for you during your time away from class that will help you be more involved and alert when you are back in class.

Table of Contents for In-Class Techniques:

## 1. Be alert and involved

In order to get the most out of class, you need to remain alert and involved. It is very easy to lose track of what is going on in class when you:

- are falling asleep
- are fighting boredom
- let your mind drift to other topics during class
- pay attention to your phone during class
- get caught up in a off-topic conversation with classmates



We have all had challenges with staying alert and involved, but it is possible. In this section are some suggestions for how you can remain classroom-focused.

Does it really matter if you lose your attention for a little bit? The answer is a resounding YES. You may have experience in some classes where it wasn't so hard to get back on track after losing attention for a short while, but in STEM courses it can be unrecoverable. The material in STEM classes tends to build from the beginning of a class to the end. It's like walking up a staircase to get to your destination. Losing track of a few minutes in class can be like some of the stairs disappearing from the staircase. You could get stuck and never get to the top of the stairs. This could lead to an inability to follow the lecture material or to doing the wrong procedures in lab.

With just a little work, you can help yourself keep your focus on class during class.

**Terminology Tips**

- *Indicate new words in your notes*
- *Write down new words even if the teacher does not (you can always get the spelling later)*
- *You can always look up the definitions later, so don't worry if you don't get them written in your notes*

**Organizational Tip**

*If you are not sure if you will have time to eat before class, keep a snack in your book bag. This "emergency snack" can be a granola bar, a package of pretzels, a piece of fruit, or whatever satisfies your hunger… and it can make all the difference!*

## *A. What can you do to remain alert?*

**Be rested.**

Students who get sufficient sleep the night before class can pay more attention during class. Do you know that feeling of fighting nodding off to sleep? Once that happens, it is hard to spend any effort learning because all of your effort is placed into trying to stay awake.

**Eat before class.**

A hungry stomach can be a distraction from class. Some students also get tired when they get hungry. If your class takes place after a meal time and you have had to skip that meal, your hunger might prevent you from being alert during class.

**Have your wake-up drink before class.**

Some students rely on coffee or tea, others on energy drinks, and others on soda. If you know you need an energy drink before class, make sure you get one.

**Feel prepared.**

If you walk into class feeling prepared and ready for class it is much easier to stay alert. If, however, you walk into class anxious because you didn't do the reading assignment or nervous because you missed the last class and now don't know what is going on, you will likely spend class focused on your errors rather than on the class topic. When a student is not prepared it is easy to feel out of place and lost in the classroom. How can anyone learn when that is how they feel?

A feeling of being underprepared can be especially pronounced in STEM courses. If you are having a difficult time understanding the textbook, then how can you work through any information or reading assignments on your own? If the material did not make sense in the last class, maybe you haven't been able to figure it out yet and you worry that the class is about to move ahead of you. If you are late with a lab report (or two) and your homework is piling up, you may not know how to get out of the hole you are in to move forward with everyone else. If the teacher is seemingly spouting off new terms galore during lecture, you may not understand them and tune out. Tips to avoid these situations are in the table on the next page.

It may seem difficult to feel prepared, but here are some simple things you can do to help you with this:

| **Tips for Being Prepared** |
|---|
| ✓ Stay organized with a class calendar: know when your assessments (quizzes and tests) are scheduled to avoid surprises, and know when your take home assignments (like lab reports) are due. In addition, know what topic is being discussed in class when you walk in (from reviewing the syllabus or the ending topic of the last class).  |
| ✓ Stay organized for your reading: know what the reading assignments are and stay on top of them.  |
| ✓ If you miss a class, contact a classmate and get their notes (and review them) so that you know what you missed and what you have to catch up on. This prevents any gap in the information you are collecting from your notes and keeps you on track with what you need to study.  |
| ✓ Try using the terminology that you are learning, especially by saying the words out loud, in order to get more comfortable with these terms. When the terms become familiar, it is much easier to follow any lecture so you will feel prepared.  |
| ✓ Stay on top of the content material: how to do this is described in the section titled "Be Content-ready" later in this chapter. |
| ✓ Keep in mind that doing problems *along* with your instructor (or following your instructor's explanations) during class can help you stay alert and focused, but are not enough to master the material. You need to try to do these yourself (or with classmates) later as well. |

These tips can be challenging to follow with a STEM course because the material can seem so foreign. Staying on top of reading assignments, for example, can be hard to do when you don't understand the textbook well. This guidebook has other sections that can help you with some of these challenges so that you can navigate through these tips and feel prepared.

### *B. What can you do to become more involved?*

The more involved you remain in your class, the easier it is to pay attention. That is important because attention in class is a significant step toward learning. One way to be more involved is to **ask or answer questions**. If you don't understand something you can ask your teacher. For example, if you don't understand how what you are learning relates to what you just learned, or if you don't know why what you are learning is important, just ask. Maybe you don't understand how something works or why the teacher used a particular formula… just ask. If your teacher asks the class a question, come up with your own answer. If you do not feel comfortable enough to answer out loud, write down your answer in your notebook. You have to think about what is going on in class to become involved, and asking or answering questions helps to think through the material.

Another important tip to become more involved is to **listen** carefully. There's a big difference between hearing someone speaking and listening to what they are saying. Focus on listening. Try to really understand what your teacher or classmates are saying. Some students find it hard to listen while taking notes, while other students listen better while taking notes. You can always get notes from a classmate if you have to stop writing for a little while to listen. You can also ask your teacher if you can record their class so that you can listen to it again later. If you have a hard time keeping your attention on listening during class, ask yourself "why is this important?" or "what does this have to do with the topic for today?" as you listen. As you think through the answers to these questions during class you will find that you are staying involved in the content.

It is also helpful to **participate in discussions or activities** during class to stay involved. If your STEM class offers opportunities for discussion or provides activities for you to do in class, make sure you fully participate. Often, some students in a group sit back and watch their classmates as they talk about an issue or carry out an activity. Once a student removes themselves from the action of the group they are likely to lose sight of the direction the group is taking. If the activity needs a note-taker or someone to cut out paper or someone to look up information, volunteer to do it. If you are very uncomfortable participating in a group discussion, it doesn't mean that you should divert your attention—try writing down the ideas you come up with in your notebook if you don't want to share them. It is important to put your own ideas thoughts into words.

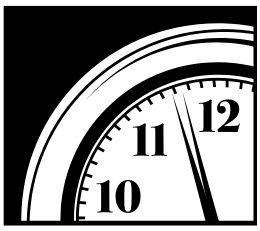
It is imperative to **avoid distractions during class**. This means that you should avoid electronic distractions like phone communication, texting, IMing, e-mails, listening to music, etc. Turn your phone off (do not just put it on vibrate) and put it away. If you are sitting at a computer in class, do not open side windows for e-mailing or web surfing. Avoid other distractions, too. Keep your conversations with other students on class topic during class. Try to let go of personal concerns and worries that are going on outside of class so that you have the ability to focus on class. Avoiding distractions is difficult. Distractions are so tempting. It may seem like sending a few text messages during class could not interfere, but if you lose track of the class or lab it may not be possible to catch up again.

Finally **keep track of the major concepts** that are being covered in class. It could be that one major topic is covered for an entire lecture or lab, but it could also be that a few major concepts are covered. Knowing when the class changes topics will help you stay focused and involved. It is difficult to be involved if you do not know what the topic is. Try circling the major concepts in your notes so that you can keep focused on it. You may find that you haven't been aware of the major concepts being covered in the past. If that is the case, focus on figuring it out in every class and lab, and if you have a hard time with it, talk to your teacher about it.

## 2. Being in Class

It is essential to actually **attend class**. Why? How do we know? When teachers track student attendance and compare it to student course grades they find that there is a very strong correlation between attendance and grades. In other words, students who rarely miss class tend to get higher grades than students who miss more frequently. What is so important about being in class? Can't you get the same information from the notes? When a student is physically in class, they hear what the teacher thinks is important to learn; the material that is important to the teacher is more likely to be on tests and quizzes. In class, the teacher gives students ways to think about the material that is not necessarily written down in someone's notes. Being in class keeps students involved in the class material and content. If a student doesn't go to class, they tend to invest less and less time at home because it is easy to procrastinate if something doesn't feel pressing. In the end, less time on course content leads to poor grades.

When you attend class you **get to know your classmates**. Make sure that as early as possible in the semester you meet some of your classmates. This is often easier in a lab setting where you have a lab partner, but it should be done in all class settings. As soon as you feel comfortable with the classmates you have met be sure to exchange contact information with those classmates. This enables you to contact your classmates to get copies of their notes, form study groups, find out about material covered when you had to miss class, verify quiz or test dates, verify homework assignments, etc. Some students only realize that they do not know how to contact their classmates when they desperately need them—don't be one of those students. Your classmates are excellent resources.




It is also important to **be on time** to class. Many teachers give an overview of what they plan to do and cover in class in the first few minutes… when students arrive after this overview they may feel lost and confused by what is going on in class. Even if there was no overview given, the teacher has already begun their lesson and a late student misses the beginning of it. When a teacher is trying to develop an understanding of a new concept and you walk in late, you will have missed the all the necessary background information needed to get to that understanding. It is also common for teachers to give quizzes and take attendance right at the start of class. Being late means that you might have less time to complete a quiz, or you might even miss it entirely. It also means that you may not be included in the attendance for the day, which could hurt your grade if attendance is part of your course grade. Finally, when you come late you miss the opportunity to network with your peers before class begins; how can you get to know your classmates when you never have time to talk with them?

When you come to class you also need to **bring any needed supplies** with you. This does not just mean a pen/pencil and paper, but anything that would be helpful for class. For example, you may need old quizzes or tests, notes from the last class, assignments that you have been given, your calendar to keep track of deadlines, or questions from your homework or reading. Keeping an organized notebook is a huge help toward this goal. Have a separate section in your notebook for each course (or a separate notebook) and a place to keep all handouts and returned tests/quizzes/homework. Each day be sure to date your notes and keep them in order in your notebook. If you keep everything together and in order, you will be able to bring any questions you came up with from your homework or reading to ask your professor.

## 3. Take effective notes

Many students struggle with how to take notes. What do you need to write? What is important? How can you listen and write at the same time? How neat do your notes have to be? In this section we will focus on how to take notes that will help you learn.

First, we'll go over some options for **styles of note-taking** that may help you. Some students just don't know how they are supposed to write things down on a page.

If you struggle with note-taking, this information should help you improve your note-taking to increase your learning.

Second, we will go over the following **key points** that will help you improve your note-taking.

- Write in your own words
- Write what makes sense
- Do not sacrifice listening for writing
- Indicate important topics/terms
- Notes can be messy– you can fix them later
- Include drawings and make them large enough to annotate (about ¼ of the page)

Keep in mind that changing the way that you take notes is hard. The way we each take notes is a habit, an ingrained behavior—and behaviors are hard to change. You will need to work hard at it and keep trying again and again until it becomes a new habit.

### *A. Two useful note-taking styles:*

These styles are useful for note-taking in all types of courses, not just in STEM courses. However, these styles will help you focus your attention and information which is particularly important in STEM courses. One method is a simple outline format and the other (the T-system) enables you to continue your annotating at home more readily. These are shown on the next page as they would be written on regular, lined notebook paper.

Both of the note-taking styles differ from a simple running commentary of the class period. In other words, they are not just lists of whatever you heard or saw in class. Both styles have some organization to them. The outline format is based on the big topics covered in class. The T-system can have a bit less organization during class but is used after class to refine and clarify one's notes. A feature of both note-taking styles is that they help the student to think about the material more during class, and that makes the notes more meaningful after class. You may also notice in the figure that both include the date of the class period on them; this is not part of the note-taking style, but is essential for note organization. Both styles of note-taking are explained here.

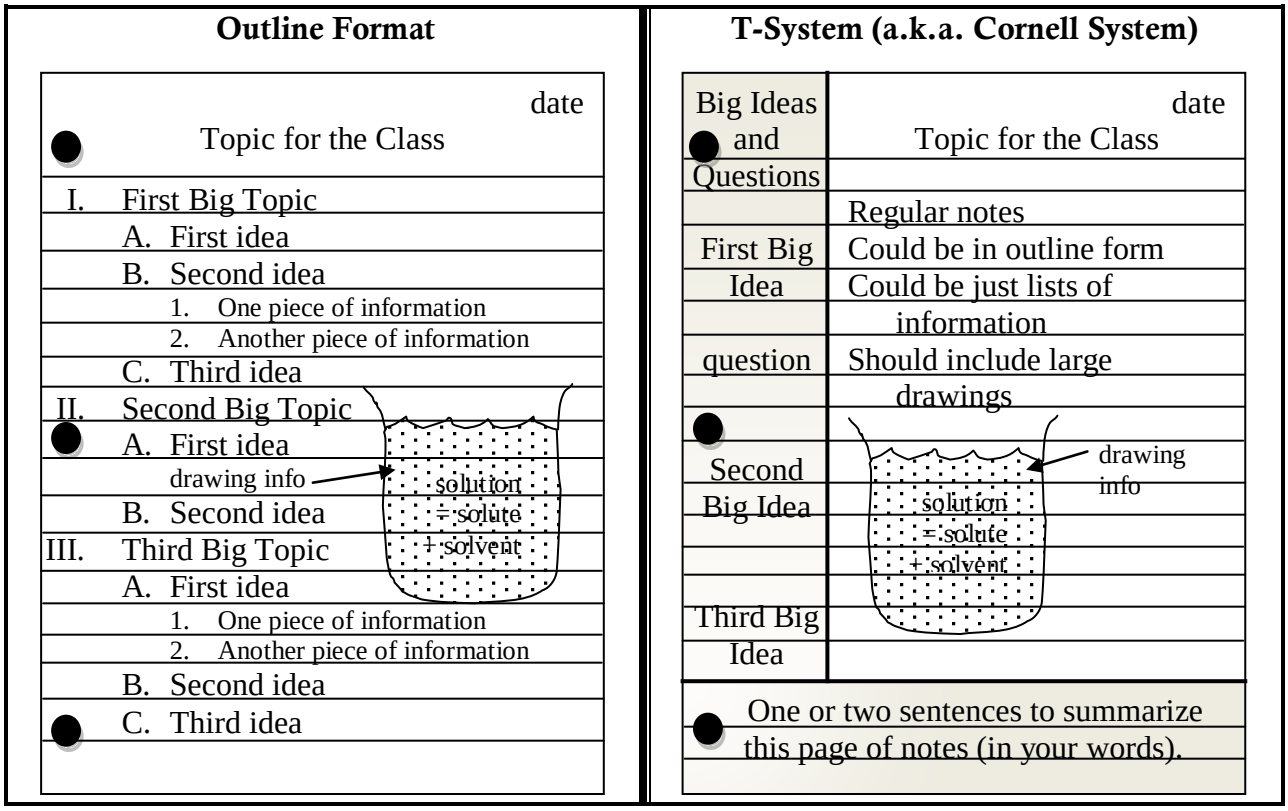



Figure 1: Two methods for note-taking during class. The Outline Format is shown at the left while the T-System is shown at the right.

The **outline format** depends on you being able to figure out what the big topics are as you take notes. This may not always be an easy task. Basically, every time you write down some piece of information, jot a term that was used, or draw an illustration from class you need to place it into the appropriate area of your notes. Figure out what the topics are for the day, list those, and then insert the details under the appropriate topic heading. As you continue to take notes during class it will be important for you to know if new information is a subtopic ("idea" in the figure) of the current topic, an entirely new topic, or even a topic you thought had been finished already. Admittedly, this is not always an easy task. This outline format works especially well if your instructor provides an outline for the class period or emphasizes each time they move to a new topic. If your instructor jumps back and forth between topics, it will not be as straightforward. If you only figure out how the information all fits together into a hierarchical outline after class, then you can re-write your notes to put them into the proper order; leaving your notes disorganized and unclear will not help you later.

The **T-system** got its name from the upside-down "T" ( ⊥ ) that a student draws on the paper before starting to take notes. This "T" cuts the paper up into three sections. The largest section (top right) is where you take notes during class. The other two sections (shaded in the drawing) are for adding information *after* class or, possibly, as you figure out the information during class. The left margin can be used for major topic listings and questions by: 1) recording each major topic next to the area where you took notes on it

(either during or after class); 2) jotting down questions during class so you know what to look up later; 3) noting questions at home to ask the instructor the next day after reviewing your notes (especially if your notes during class are unclear). The bottom margin is for you to fill in after class (maybe at home that night) with a summary statement that reflects all the notes you wrote on the page. This summarization can be difficult to do, because it forces you to put the information in your own words, but it is very helpful.

## *B. Key Points for Note-taking:*

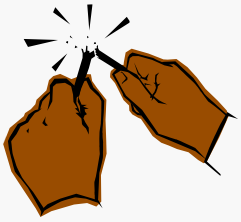
Once you have figured out what style you are going to use for taking notes, now it is time to figure out WHAT to write and HOW to write it. This can be a challenge in any class. There are a few things that are especially helpful to keep in mind for science, technology, engineering, and math (STEM) courses that will help with the usefulness of your notes and with how much you will learn as you write them during class. These key points will help you focus on ways to improve your note-taking.

### Write in your own words

Very often students try to write things down verbatim. So if an instructor has a PowerPoint slide with a definition, students copy the definition down word-for-word. Or if an instructor gives a verbal explanation, students often try to write down every word that instructor used. In addition, if an instructor writes something on the board, the students often copy it all down and stress if the instructor erases the board before they are done copying it all. This is the wrong approach to note-taking. Why isn't it helpful to copy everything down verbatim? Because writing everything word-for-word does not require any thought. It is a physical exercise of copying, but doesn't require any comprehension.

How do you write notes in your own words? As your instructor presents the information (in whatever manner it occurs) write down the essence of what they are saying in a way that is meaningful to you. Sometimes STEM topics are very dense with terminology and complexity. If you write words that don't mean anything to you those words will not help you. They may make some vague sense at the time because the instructor is also motioning with their hands or acting something out or drawing a picture. If what the instructor is *doing* is helping you make sense of the

For example, an instructor might say "*Hydrolysis reactions are catalytic and essential for obtaining monomers of macromolecules*." That may sound like a foreign language. But if the instructor is moving their hands to make it look like they are breaking something you may understand that whatever hydrolysis reactions are must include that they break chemicals down. And if you don't know what "monomers" are, you can write down that hydrolysis reactions make monomers available and indicate that you need to look up what a "monomer" is. If a student just does that much, they will get more out of the single sentence than if they wrote it down exactly. The important thing is that the student thought about the sentence while it was spoken and is now more ready to understand the next thing the instructor says.



information, write what the instructor is doing and how you are interpreting it.

You might be wondering, "What if I don't copy it all down and end up missing something?" This is actually NOT a problem. If you know what topic is being discussed, anything you didn't write down will be found in your textbook in that section. Also, you are not alone! You have classmates and they are also taking notes. Simply arrange with your classmates to share notes.

You may also be wondering, "What if I write notes in my own words and get it wrong?" This is also not a problem. If a student is thinking about everything that is going on during class and makes a mistake along the way, they usually figure it out when some other idea during class doesn't fit into place. When something doesn't make sense, either the student misunderstood that new piece of information or misunderstood something earlier that impacts that new bit of information. If the student isn't sure what is right or wrong, they can ask the instructor a question such as, "Can you explain how this last thing you described works again because it doesn't make sense to me based on this other thing you explained before?" The instructor will help the student correct their mistake. Also, the textbook and classmates are excellent resources to help figure out information that seems confusing.

**Active Learning Tips**

- *Watch what your instructor DOES and write it down*
- *Write key words your instructor SAYS and write why those words might be important*
- *Include what your instructor DRAWS and label the drawings in your notes*

## Write what makes sense

Only write down what makes sense to you. It isn't worth your time to try to write things down that make no sense. If they don't make sense when you write them, they won't make sense later when you review them. If there's something that you need to write in order to look it up later, that is OK… just leave room to add to your notes on it later. By only writing what makes sense you will also be helping yourself to write things in your own words.

## Do not sacrifice listening for writing

There is only so much time in a classroom and an instructor can talk really, really quickly. How is it possible to write everything down and still listen to what the instructor is saying and think about what it all means? It is not always possible. Do not worry about getting everything written down all the time. It is more important to listen to what is being said and think about it. That way, you will know what main topics were being covered and get a general understanding of the material. If you at least write down the main topics you will know what to read about later and will be able to fill in your notes. You can also

usually get permission to make an audio recording of the lesson if that is helpful for you; that way you can listen to the lesson again and take more detailed notes while pausing the playback. You may not need to spend as much time listening instead of writing in your non-STEM courses because they usually are full of language that makes intuitive sense and doesn't need interpretation to really listen. It is OK to approach STEM courses differently.

**Big Picture Tip**

*Listen to the tone of your instructor's voice for emphasis. This often indicates the big, key concepts. Circle/underline any emphasized information.*

Some students may have difficulty listening and taking notes at the same time. If this applies to you or if you have a disability that prevents you from taking notes, the tips above on making an audio recording of the class and using it at home could help a lot. Also, talk to your instructor about having a note-taker to supplement your own notes and free you up to listen more. You may not need a separate note-taker if your classmates share their notes with you. Some students find it helpful to share their notes with each other on a regular basis. One student might miss something that another catches. If you do use a note-taker make sure that it is approved by your instructor and that the individual taking notes is a good student who follows the tips you are reading about taking notes. Remember having a note-taker is never a substitution for being in class. It is meant to supplement what you are already learning in class.

## Indicate important topics/terms

STEM courses are full of terminology. Every time you learn a new word, take the time to highlight it in your notes. Some ways you could use are in the tip box here. It is up to you exactly how you want to indicate these important terms. As long as it is clearly indicated in your notes you will be able to study it and learn it. If you do not get a good definition of the term during class, you can always look it up later and add a definition (in your own words) to your notes at home.

**Terminology Tips**

*Some of the many ways to highlight words in your notes are:*

- *Circle them*
- *Underline them*
- *Write them darkly*
- *Write them in a different color*
- *Write them sideways*
- *Put them in the margin*
- *Use all capital letters*
- *Use a highlighter*

With so many new words to learn it is essential to put them into some organizational system. The course content is the best way to organize the terms, so it is important to figure out what the big topics are so that you can stay organized. Each time the class moves to a new topic it is essential to indicate that new topic in your notes. The tricky thing is that some topics are themselves new terms. For example, "nucleic acids" could be a new topic and a new term at the same time. It is often possible to tell

what the new topics are (if not told directly) by listening to your instructor's tone of voice or referring back to a previous day's notes when the instructor gave a better outline. As you figure out what the topics are, highlight them in your notes. Be sure to use a different method of highlighting the topics than you used for the terms. Going back to the given example, this may mean writing "nucleic acids" down twice in your notes.

## Notes can be messy– you can fix them later

Your notes are yours. Can you read them? Can you make sense of them? Feel free to cross things off or draw something more than once to get all the detail. You do not need to waste time whiting-out mistakes or worrying about whether something was erased well enough. If your notes get too messy, you can always spend a small amount of time later on fixing them. If you use a 3-hole-punch paper instead of a spiral bound notebook it is easy to swap out a single page when you need to. Now is not the time to save paper.

## Include drawings and make them large enough to annotate (at least ¼ of the page)

STEM courses include many illustrations, photos, flowcharts, and formulas. They are used to make specific points. It doesn't matter if you draw well—make an effort to draw *something* on your note paper to be able to make that same point. You may need to annotate your drawing (maybe by making an arrow to an item or adding a label) to indicate whatever was important as well. Since these drawings add information to your notes, they are supposed to take up space on your paper. If you draw them too small you will not be able to decipher the point that was made with the drawing. Or you may not be able to add the necessary annotation. Feel free to make your drawings large. A good rule of thumb is to make every drawing at least ¼ of the page.

## A few additional tips

To try to maximize your listening time, do not write your notes in full sentences that are grammatically correct with perfectly-spelled words. Develop some abbreviations that you can use for long or frequently-used terms (be sure to define the abbreviations in your notes). For example, "rxn" can be used for reaction, "fxn" can be used for function, and "Δ" can be used for change. Note that it is not always possible to come up with good abbreviations because many terms are similar. For example, in one lesson a student might learn about chromatin, chromatids, and chromosomes, so it may be challenging to

**Organizational Tip**

Keep yourself organized by using a 3-ring binder. This way you can swap out or insert pages. You can use a separate binder for each class to stay really organized.

Make a section in your binder for class notes, returned papers and quizzes, lab materials, handouts, etc. This way, all your course information will be readily available whenever you need it.

abbreviate these similar-sounding terms accurately. Another tip is to leave some space in your notes to add in information later; this is especially important if you use a spiral-bound notebook instead of a 3-ring binder. Some students do not want to re-write whole pages of notes, but by leaving space information can be added without re-writing everything.

## Some student perspectives

One's own note-taking approach can be a challenge to change. In fact, many students do not even think that they should try to change their approach. Here are some comments from college biology students after learning about different note-taking styles:

"I could be told a million times 'this is how you take notes,' however taking notes is another story all together. In a nutshell, I still don't know how to take notes very well."

"Learning how to take proper notes was also helpful because it encouraged a better understanding of the material."

"The note taking lesson has been most helpful. I can now retain more for longer and it has been truly eye opening to learn different strategies for success. I have had trouble with school for many years and this has been a wonderful experience."

"I liked learning about the T-notes because, even though I will not use it right then in class, when I go back and rewrite them then I can put them in that form. So I have one spot for what I don't get, a spot for what I do get, and then when I want to put the definition of a word that I can't remember or whatever I have a spot for that, too.

"What surprised me most was that my note taking wasn't great. It has developed into more of a copy and paste of text and learning how to memorize rather than understand the material."

What is clear from these comments is that there is always room for improving note-taking and that many students could benefit from this. Don't be embarrassed by your notes… no one takes perfect notes. Just keep working on improving them!

## 4. Be Content-Ready

Sometimes when an instructor begins a class the new topic sounds so foreign that it is hard to understand anything at all. Other times a student remains so confused from previous information that they cannot move on to try to learn new information. How can a student listen to new information when they are experiencing anxiety from having no idea what is going on in class?! Don't let this happen to you! It doesn't take much time to get ready to learn in class. There are two parts to being content-ready: 1) feel confident that you are on top of the current material; and 2) get ready for new material.

### *A. Feel Confident*

Let's go over those two parts of being content-ready. The first is to **feel confident** about the current class material; this is essential. It doesn't necessarily mean that you have mastered the current material… that takes time. What it does mean is that you are familiar enough with the current material to be comfortable with it and you believe that you can master the current material in time. You can become confident about the new material by reading about it in your textbook and online, by testing yourself, by talking and studying with classmates, and reviewing your notes. You can find out more about how to study at home to gain confidence in STEM material in the "Studying at Home" section of this booklet. The second part of being content-ready is to be prepared for the new material that you are about to learn. This does not mean that you have learned it all on your own before you go to class—no one would expect that. Instead, it means that you know what topic and terms are coming up and are familiar enough with it (even if it is still confusing) that you are ready to figure it out with your instructor's help during class. This can be a bit trickier because to be prepared for new material you need to know what topics are going to be discussed in the next class.

### *B. Get Ready for New Material*

To **get ready** for the topics that are coming in the next class, you have to first figure out what those topics are. Use your syllabus as well as your notes from the previous class to figure out where you are in the material. For example, if your instructor told you that you will be learning about linear inequalities in the next class, you would have written it down in your notes to make a point of it later. Then, take the time to look this topic up in your textbook. You can find where it is in your book by using the index (in the back of the book) or detailed Table of Contents. Once you have found it in your textbook, read a bit about that topic before class. Maybe, instead, your instructor has listed the readings in their syllabus, so you can refer back to the syllabus if you aren't sure what is next. Alternatively,

some instructors give out a handout of information on the next topic so that you have that to read, or they may post the newest reading assignments online. Whichever way you get your information, take the time to look at it ahead of class. This does not mean that you have to read the entire section on the upcoming topic. Only read until you have stopped understanding—not to the point of confusion. The whole idea is to get a little bit familiar with what you are going to learn before you begin learning in class.

**Active Learning Tips**

*To distinguish the big ideas from the little details:*

- *Big ideas are often also headings in your textbook*
- *Little details are often words in bold in your textbook*
- *Many little details can all be grouped together into the big idea categories*
- *Write all the words you are trying to organize onto paper slips to sort them into categories*

If you are still unsure about what is coming up in the next class, another place to look is on any supplemental website (or DVD) for the course. Your instructor may maintain a website specific to your course or may refer you to the textbook website. Your instructor may also have you use multimedia, like a textbook DVD, to familiarize yourself with current or upcoming information. If the next topic is not specifically stated, start on the current topic and see what is posted next. The website may have interactive activities for you that explore these areas. Keep in mind that you may also be able to e-mail your classmates or your instructor to get additional information about what is coming up in class.

Another thing that you can do to get content ready is to try some practice problems before class or quiz yourself before class. These practice problems and quizzes can be on the recently-completed topics so that you gain the confidence to move forward. Some instructors, especially in physics courses, tend to assign problems on the upcoming material for the next class for students to attempt ahead of time. These problems can be really useful as a way to show students how new information can help them solve problems; sometimes students are expected to completely solve the problems, while other times the students are just expected to try to struggle with the problems so that they know that they need some new information to solve them.

As you prepare yourself for class, keep your focus on the big ideas and not all the little details. It can be easy to get lost in the quantity of information and lose sight of the fact that you are just trying to get yourself started. One way to maintain focus is to keep in mind what your instructor emphasizes as important information so that you can target that information when you prepare. You are simply trying to prevent from being surprised in class so that it remains easy to follow the course content during class.

# Chapter 2: Reading Techniques

For many students reading and understanding Science, Technology, Engineering, and Mathematics (STEM) books can be very challenging. STEM textbooks can be very different than those you might see in other courses. These textbooks often use complex scientific language, figures, graphs, charts, and new technical terminology to present information. Students, particularly those new to STEM, can easily become overwhelmed and often struggle with comprehending the scientific concepts presented in their textbooks.

This section will provide some concrete steps students can take that will help them in understanding terminology and in learning scientific concepts. The active learning strategies presented here have been gathered from STEM faculty and from other students who have successfully completed STEM courses. Successful students are those who are organized, plan ahead, and make good use of their time. The material will help students in developing a plan for effectively reading and learning STEM material. The techniques apply, with minor modifications, whether you are reading a book, using Braille, listening to a book on tape, or reading electronic material.

Table of Contents for Reading Techniques

## 1. Overall Approach

What is the purpose of developing an approach to reading? Students often jump in and just start reading. This kind of approach can take more time and cause you to miss valuable information. Not having a plan can easily result in feeling overwhelmed and stressed.

Determining the right approach for you and for the subject you are studying is important. Typically, students are taught to skim the chapter for main headings and ideas before reading. A more detailed reading approach that is often taught to students is the SQ3R reading method. The steps of this method are surveying, questioning, reading, reciting, and reviewing.[1] The survey step is similar to skimming a chapter. For some students SQ3R works quite well. Students using this method follow a systematic approach that helps make reading purposeful and meaningful, so that they use their time most effectively. The method works very well for students in most courses.

However, these reading methods do not always work in STEM courses. For example, if a student skims or surveys a chapter, they may encounter heading after heading filled with new terminology that doesn't inform them about the chapter contents. Some students in STEM courses are confused by the sheer quantity and density of material presented in one STEM chapter; a quick glance at a typical introductory scientific textbook can show 30 to 50 new vocabulary terms, 10 to 20 topic areas, and 15 to 25 charts or graphs in a single chapter. Of course, there is considerable variation in density of the material between authors and subject areas but overall it represents an enormous amount of new information that is frequently organized in ways that are unfamiliar to the beginning student.

### *A. Work in manageable sections*

An overall plan will help you to master the material in a more organized and efficient manner. Before you read a chapter, think about the purpose of the material you are about to read and the major concepts that are being presented. Your primary purpose is to understand these new concepts and the associated terminology. In order for real learning to occur **you must understand rather than just memorize the material** being presented. Before you start, develop a plan that will work for you.

**Big Picture Tips**

- Read the headings within each chapter
- Figure out what the headings mean in your own words; sometimes this is only possible after reading the entire section
- Keep track of which section you are reading to keep the information in context

[1] SQ3R was originally developed by Francis Robinson in 1941 and is widely considered to be an effective method for improving reading comprehension. More information can be found at http://www.studygs.net/texred2.htm

If the material looks overwhelming, start by taking on portions that are more manageable. Many students will work section-by-section, writing down headings, reading and summarizing each paragraph as they go. This is an excellent approach. Also, never plan to read more than a couple of pages of a STEM textbook at a time. It is when a student reads too much at once that they eventually stop and realize that they have no idea what they just read. Don't let that happen to you. Read in small bits, think about what you just read (taking notes as described below), and then continue.

### *B. Build on what you already know*

In the STEM disciplines most topics build upon previous ones. It is therefore important to master each section in your text, as future chapters will build upon these sections. It helps to write the terms from the chapter along with a definition in your own words on a separate page or line. Later you can review all the material to get an understanding of the big picture presented in the chapter. It is also very important to tie the new material you are learning to that which you already know. So think about how this material relates to your life experiences. This connection will help to create a deeper level of learning. The key is to remain organized and active.

## 2. When and Where to Read

It is Sunday night and you know that your Chemistry class is at 9:00 AM tomorrow. So you sit down and plan on reading through the three chapters that you are behind. About two hours later you find your mind drifting off and can barely remember what you have read. What is wrong with this picture?

### *A. When should you study?*

First, falling behind in reading in your STEM class is always troublesome and can be avoided with planning. Developing a schedule for when you will read and sticking to it will help you to keep up with the material. Most successful students indicate that reading a small amount every day keeps the material fresh in their minds, keeps them from falling behind, and reveals areas that they do not fully understand. Time management can be tricky, but if you really examine what you do with your time each day you may find that you could be more productive. One student who took the time to evaluate their time use across an entire week said, "What surprised me the most was finding out how much time I have that I could be studying but instead I'm doing something else. Instead of saving work for the weekend I could be doing more of it on the week days."

The best time to read a text is when you are most alert. For some students that might be first thing in the morning, for others it might be in the evening. Once you determine the best time for you, block the time in your calendar so that you know this time is reserved. Really try to save this time each day just for reading.

Second, reading for long periods of time will rarely be productive, especially when reading technical material. Most sections or paragraphs in STEM books contain at least one concept that you will need to understand. Thus, it is necessary to read slowly and concentrate on important points. Reading in short intervals will also help you to stay alert and will improve your concentration. So, plan to take a stretch or snack break every thirty minutes or so. It is critical to learn how to pace yourself so that you can maximize your efficiency.

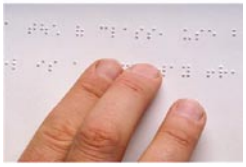
### *B. What is the best place to study?*

Lastly, make sure you pick a place to read that is conducive to concentration. This could be a quiet place at home or a place in the library. An environment that is noisy or one where there are lots of interruptions will pull you away from the task you have set for yourself. On the other hand, don't read in bed. If you are too comfortable you'll soon be sound asleep. Once you have established the right place to read it is time to think about exactly what you will be reading and how you will go about it.

## 3. What to Read

What could be worse that spending your valuable time reading only to find out you read the wrong chapter? Yet many students fail to check their syllabus and class notes to make sure they are reading the right assignments on time. A few minutes checking such details can save you hours in lost time. Unlike material in some of your other classes STEM material is usually sequenced so that what you learn one week is built upon material learned in previous weeks. For this reason falling behind in your reading can be quite confusing. It is particularly important to stay on top of assignments and to make sure each section is understood before you move on. Skimming the material to be covered before the class in which it is covered will help to make you more comfortable with the terminology and concepts and will make material in class easier to understand. Remember, reading and studying take time but will payoff in the long run.

**Organizational Tips**
- Check your assignments
- Schedule time to read in your calendar
- Skim material before class and again after class



Be an active learner. Many students report that it helps to **recite the readings out loud**. It will help you to remember important details and may point to areas that you don't understand. Scientific terminology can be confusing at first. Make sure to **look up unfamiliar vocabulary**. When you don't understand something ask a fellow student, a tutor or your teacher.

## 4. How to Focus on Reading

With so much going on in our lives, it can seem challenging to focus on a textbook that is so full of material and terminology. How can you really focus and extract the information you need? This section gives you some active approaches.

### *A. Take Notes While You Read*

Many students ask "Why should I take notes while reading? What should I write if I do?" First, reading specialists believe that taking a more active approach is the best way to learn new material. Active approaches involve both writing and speaking the meaning of what you have just read. Passively sitting and reading your text will not help you to gain an understanding of the content. Jotting down notes is not the same thing as re-writing your textbook. Instead, it requires you to figure out what the textbook means and re-write the take-home messages from it in your own words.

As previously mentioned many students find it is easier to work in small manageable sections. After each section take notes (in your own words) on what you just read. Make sure you take notes on both the text and the charts or diagrams. Charts, figures, and diagrams convey important information that will help you understand the written sections. It is important to write your notes in your own words. Repeating language that you don't understand will not help you to assess your understanding of material. It is also important to **use examples that have some meaning for you**; examples from your life or work help to create a deeper understanding of the material. A student who works for a trucking company might be able to understand the "vesicles" of a biological cell better if they think of them as if they were trucks carrying a shipment from one place to another and then returning to pick up more material. You want to make the material your own so that you can make connections between the new information (both language and concepts) and what you already know.

Many students try to take notes on the book and then when they can't figure out how to do it they just stop and give up. There are so many ways to get the notes down. One thing that you can do to start if you are stuck is to read a paragraph or two and just write down all words (subject-related or not) that are unfamiliar to you. Don't worry if you end up with a long list. Now take a few minutes to figure out what those words mean and jot down a short definition (in your own words). Go back and re-read those paragraphs you just read… do you understand them better? If so, now try to summarize them in your own words. It should be easier.

Another way to get started with taking notes from the book is to ask yourself the following questions:

- **Is this material important?** In other words, did you discuss this subject in class?
- **Why do you have to learn this?** You should be able to come up with why you should care about this subject. Your teacher is not going to test you on something just because. There must be a reason that you are learning this material.
- **Where does this material fit in with the other material you just learned?**
- **What is the main subject or topic of this paragraph?**

Notice that these are basically just why, what, and where questions. Ask yourself each question and then write down your answers. If you were learning about molecular weights in your chemistry class, you might wonder why you had to learn it. Molecular weights can seem like a simple mathematical drill… but there has to be another reason. Maybe it is so that you can weigh out chemicals to make solutions properly for a job in a research lab. Maybe it is so that you can learn a way to compare one molecule's properties to another so that you can understand them better.

As you work your way through the sections of a chapter you can also jot down questions about areas that you are unsure of. Questions can then be asked in class, e-mailed to your professor, or used as a basis for exploring for more information on the topic. It is very useful to have a handle on which topics you do not understand. Once you have answered all your questions you are likely to be on top of the material.

Creating drawings or charts of your own can also help to see information in a new way and improve understanding. (For more tips on note-taking see the Chapter on In-Class-Techniques, specifically the Key Points for Note-taking section.) Some textbook paragraphs list a sequence of steps in text form. If the textbook says that first one thing happens and then this other thing happens and then this third thing happens, just re-draw it in your notes like:


This type of drawing is called a concept map, and it can make a complex process into something easy to remember. Another way to draw in your notes is to expand and explain ideas or steps. If a math problem is given in your textbook, along with a textbook version of the solution, take the time to re-draw it and expand on it in your notes. Figure 2 shows an example with the math problem: $2\,(x - 1) = 5\,(x + 1)$ .

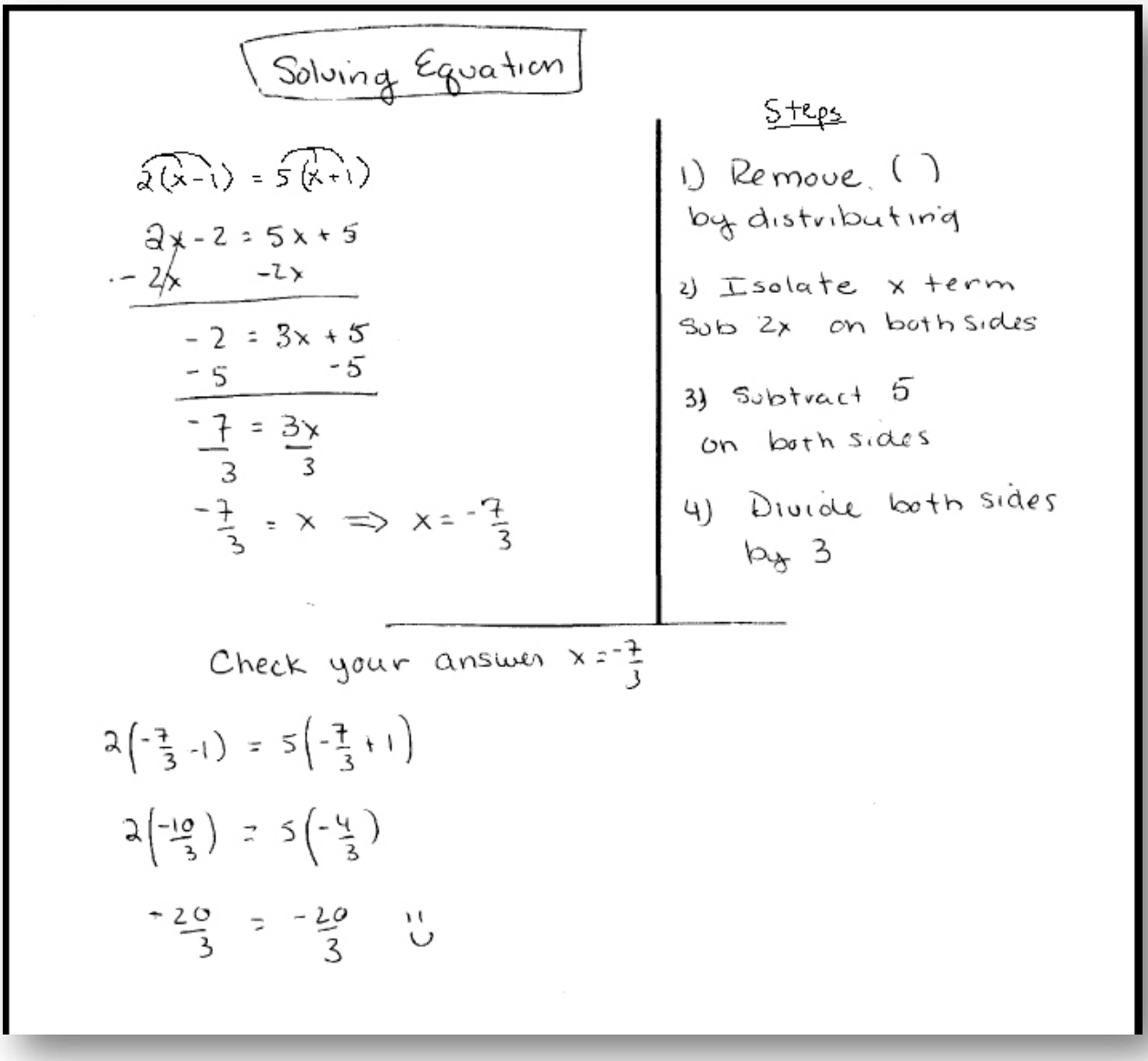



Figure 2: Turning textbook information into a drawing in your notes. If the textbook gives the formula and solves it, take the time to do it yourself but with added explanation. In this example, each of the formulaic steps done on the left side of the notepaper is described on the right side so that the steps are clear and defined. The vertical line down the center of the paper separating the formulas from the descriptions helps to create a visual separation. The horizontal line drawn on the page separates the processes of solving the equation from checking the answer.

Highlighting can also be very useful but only if you focus on key points. Have you ever seen a used textbook with almost every line highlighted? If you have you know that there is little point in designating everything as important. Sometimes beginning students have difficulty picking out the critical points to highlight but don't worry it will improve with practice. Talk to your teacher or to other students and ask how you pick out key information. As you progress and the concepts become more apparent you will learn how to identify what is most important. Highlighting these points will help you later when you are reviewing material.

**Active Learning Tips**
- Take notes in your own words
- Compare your textbook notes to your class notes
- Highlight key points
- Write down questions as you go

## *B. Pay Attention to new technical terms*

As you come across new technical or scientific terms write them down with your own definitions. Later you can match your definitions to the concepts in sections you previously summarized, helping you to link together the terms and concepts. When you have completed a chapter, put all your summaries and definitions together and define for yourself how each section is related to the whole. Then compare these notes to those you took in the classroom to make sure that both sets are consistent. Some examples for dealing with technical terms are described in Figure 3.

**Terminology Tips**
- Write down new terminology
- Look up definitions
- Rewrite in your own words
- Use the word in conversation

Try to use the new words or come up with ways to remember them. In the study of muscle tissue there are A bands and I bands and they appear as dark bands or light bands. A student pointed out that she remembered which was which because A bands are dark bands and I bands are light bands. Simple memory tricks like this are easy to come up with when you write out the words in your notes. Speaking the words aloud not only help them become part of your vocabulary but can also lead to rhymes that help with memorization. An example of a useful rhyme is in the rule for the osmotic gradient of "hy-po, water's gotta go." Osmosis is a difficult topic but the rhyme simplifies it.

| Use new terms every day |
|---|
| **You also might try using new terms in every day conversation. Let's imagine you are reading a textbook on anatomy and physiology and are trying to understand the location and use of various muscle groups. A good approach would be to start with defining the term in your own words and then think of ways you could use the term when talking to friends. For example, the muscle groups could easily be worked into a discussion with your friends about going to the gym. Doing so will help you to remember and truly understand the function and purpose of various muscles in the body.** |

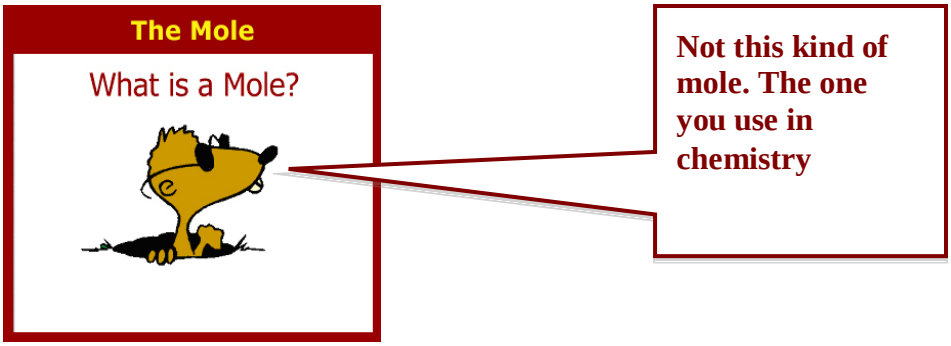
| Put new terms into your own words | |
|---|---|
|  | |
| Standard Definition | **What it really means** |
| **Mole**<br>**a chemical mass unit, defined to be 6.022 x $10^{23}$ molecules, atoms, or some other unit. The mass of a mole is the gram formula mass of a substance.** | Mole<br>The mole represents a numerical value; the number of moles of one substance can be compared to another. Comparisons can be made within a formula or between two formulas as long as it is within a balanced equation. If you compared the size of a mole (6.02 X $10^{23}$) to pennies it would make at least 7 stacks that would reach the moon. |

Figure 3: Examples of ways in which you can apply terminology techniques.

Using these techniques will help you to better understand and remember what you have read. Taking the time to outline important concepts and understand new terminology will help you to ultimately get the "big picture". The process of taking notes while you read can seem tedious at first. In the long run it will keep you organized, help you to understand the scientific and technical content, will help to create a deeper level of learning.

## 5. Techniques for Understanding

Once you have developed an approach and decided when, where, and how to read you will be on the path toward accomplishing your goal. In addition to the points listed above the following active techniques will prove useful.

| Tips for Improving Your Understanding |
|---|
| ✓ **Self-test: Answer the study questions in your book.** Most textbooks will have a section either at the end of the chapter or in the Appendix that will contain study questions. If you can answer these questions it is a good indication that you have learned the material |
| ✓ **Self-test: Create your own study questions.** As you read jot down questions about key concepts. This technique will force you to think about what you are reading and will serve as a study guide later on. |
| ✓ **Create drawings or charts that reflect your readings.** Drawings and charts are different ways of presenting the material in your book. The act of translating language into a drawing will help in understanding, particularly if you are a visual learner. |
| ✓ **Look up unfamiliar vocabulary.** In addition to keeping track of the new terminology in your text make sure you look up other words that you might not understand. Vocabulary used in scientific texts can be difficult to understand and one word can change the meaning of a whole sentence. Make sure you truly understand what is being said. When you're done put the definitions in your own words. |
| ✓ **Meet with fellow students to discuss reading.** Studies have shown that working in groups improves learning. Taking the time to meet with fellow students and talk about will provide you with different viewpoints and improve comprehension |
| ✓ **Bring your questions from reading to class and/or email your professor.** Question everything that doesn't make sense. If you don't understand it chances are others in your class don't either. Don't be afraid to ask questions about material that seems confusing to you |

In summary, the ultimate goal of reading is to master the concepts and gain an understanding of the course material. STEM textbooks can be complicated and it is important to be persistent and not give up. If you follow the tips presented in this section you will be successful in mastering the material. Keep a positive attitude, stick to a plan and schedule, and be an active learner.

# Chapter 3: Outside Class Techniques

How can you study effectively outside of class? What can you do to learn the course material and not just read things over and over or fall asleep? This section gives you many suggestions for how to make the most out of your time studying at home (or in the library, or with classmates, etc.). The emphasis throughout this entire section, though, is on how to do any of these techniques while studying actively. The more active you are the more you will learn and the less you will fall asleep.

Both college faculty and students were surveyed to develop this guidebook, and throughout the survey their answers were similar—except for in this section. Students typically provided passive methods for studying outside of class. For example, students suggested re-reading class notes and the textbook either frequently or before any assessment. Reading and re-reading can be done very passively; students who spend a lot of studying time only reading often express frustration that the material is not sinking in (or that they keep falling asleep when studying). Faculty, on the other hand, suggested many active techniques for studying. For example, faculty almost unanimously suggested taking notes while studying. The active techniques are particularly helpful while studying. Therefore, keep looking for active techniques that you think that you can apply when you are studying.

Table of Contents for Outside Class Studying Techniques:

## 1. Take notes while studying

It is important to take notes while you are studying. The notes should include both written words and drawings. If you are truly learning the subject matter, you will be synthesizing the information you have been learning from class, the textbook, lab, and supplemental information. It is difficult to synthesize all this information from such varied resources without compiling it into one master set of notes. Gathering all your notes together and organizing them is easiest to do when using a 3-ring binder

What will you gain from taking the time to write notes while studying? Most students do not want to do something that takes more time if they don't have to. So here are some reasons for investing this time.

- When you are done you will have a complete content reference sheet
- You will have practiced writing about the content (in your own words) so that you will be prepared to write about it on an assessment
- You will have put all the content together in a way that makes sense for **you**
- You will be more likely to stay awake and alert while studying because you are taking an active role in your learning
- You will gain an overview of the material and a sense of the big picture within it; in this way you will be able to relate what you are learning now to what you learned before and to what comes next

For all these reasons, and more, it is important to take studying notes.

### A. Take written notes while studying

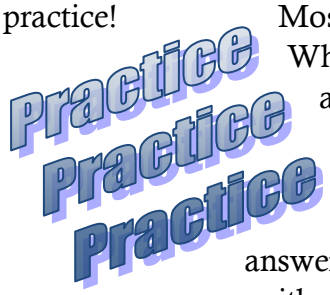
Some of the same rules you have already learned for taking notes during class apply to taking notes while studying. Because a lot of information was written about how to take notes in general in the In Class Techniques chapter, it will only be summarized here.

1. Always write information down in your own words; if you can do this it means that you understand what it is that you are writing
2. Notes do not have to be written in full sentences, but should just have the needed information
3. Leave space to add information, especially for items not yet fully understood
4. Make a point of highlighting the major topics (a.k.a., big pictures, main ideas, etc.)
5. Highlight new terms in a way that works for you
6. Use a simple format, like an outline format or T-system, for taking notes

If you want to read more about these (and other) techniques, take a look back at the In Class Techniques chapter in the section on note-taking.

One mistake to avoid is to just copy over your notes in order to take notes while studying. Copying notes is still passive, even though you are moving your hand and writing. It is passive because no thought is involved in copying over existing notes. It is essential that you **make new notes**. To do this, re-organize, re-work, and re-interpret everything you wrote before in order to synthesize it while studying. You can reorganize the information to have a better flow of logic from topic to topic, add information, correct mistakes in content, add definitions, make flash cards or terminology lists, and more.

Some instructors give out essay questions or objectives or problems for every new chapter. Take the time to write out answers to these. **Practice writing** the answers to the essay questions, **practice writing** out the information that fits each objective, and **practice writing** out the solutions to any problems you are given. In other words, practice, practice, practice!




Most math instructors remind students daily to do practice problems. Why? And why should any student take the time to try to write out answers to essay questions or information within objectives? Because when a student is given an assessment (a test or quiz), they have to be able to write out solutions to new problems in a stressful setting. If the very first time a student writes out any answers is during the assessment, they are more likely to be too stressed to come up with any clear answer or information. If, however, the student has practiced writing out answers or solving problems at home, they find themselves in a familiar situation (although more stressful) during the assessment where they can perform well.

In science, technology, engineering, and math (STEM) courses there are often a lot of different course components. For example, in lab science courses, there are labs that are designed to further student learning on the course content. In technology classes there can be both theory and application given for the same methodologies. In engineering courses there can be projects that go along with and are based in the subject matter. In math classes there are usually many problem sets that are part of working through the course material. It is important to include all of these alternative components to STEM courses as you study so that they are incorporated into your overall learning for the course. This means that you have to **merge all your notes** (your class notes with notes from these other course components).

Merging notes from lecture and other course areas includes more than lecture notes and lab notes or problems. The goal is to gather all the separate bits of information you have learned on any one topic and put them all together by topic. You may need to put

lecture notes, lab notes, textbook reading notes, website information, and feedback from quizzes or tests all together, as schematized in the drawing below. This will lead to a complete reference ("comprehensive notes" in the drawing) for yourself on each major topic. If your comprehensive notes make sense to you, you can review them and recreate them to study further.

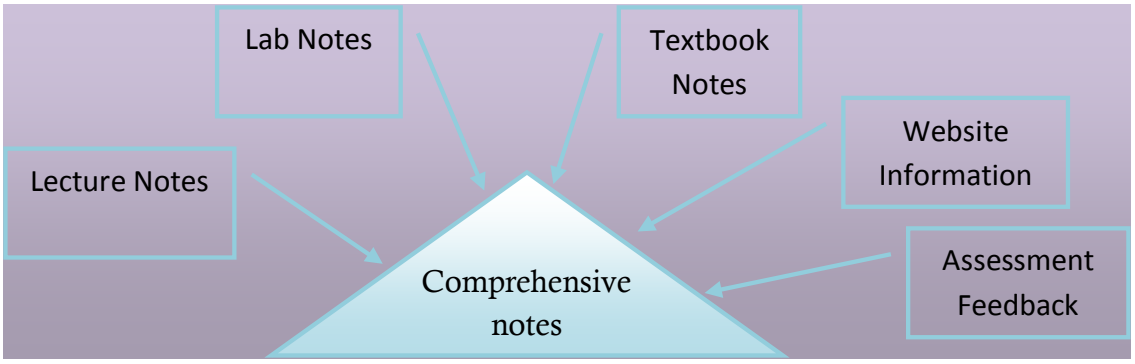



Figure 4: Concept Map depicting how all one's notes (rectangles) are merged into one comprehensive set of notes (triangle) while studying at home.

It may seem difficult to figure out how to start writing things down at home. There are a few simple ways to **get started taking notes at home**. One way you can begin to write things down at home is by filling in any blanks left or answering any questions written in your classroom notes. You could also re-write those notes and fill in the gaps or answer the questions you had left in them. These are both active strategies for starting your notes.

Another way you can begin writing things out at home is to make a list of all the major topics you learned in class that day or week. The major topics (or "big pictures," or "main ideas," etc.) should be identifiable from your classroom notes (if you listened for them and indicated them), but if you were not able to figure them out, use the headings in your textbook chapter to guide you. Once you have a list of the topics you can begin to generate your comprehensive notes or test yourself. To generate your comprehensive notes, gather all your materials together and begin to tackle these topics one at a time. For example, start with the first topic on your list and find where you took notes on it during class and from your textbook reading and from lab and from any other sources. Now begin to re-write your class or textbook notes while adding in any information from the other notes you have. Once you have covered everything in all your sources, move onto the next topic. To begin to test yourself, take the list of major topics and, one at a time, write out everything you have learned about that topic off the top of your head. The first time you do this, you may not have much to write—that's OK. Look over the notes you have on each topic and then close those notes up and try it again. Eventually you will be able to write out information on each and every topic in your own words.

Another way to begin writing things out at home is by writing out a list of all the terminology from the class or the week on one sheet. Then take the time to define each term in your own words. Once you have done this and have an understanding of what each term means, see if you can figure out how these terms are related. Does one term include

another? Are two terms opposite in their meaning? Can you cluster terms together because they seem to fit into a common category? Start drawing arrows between terms or sorting the terms on scrap paper to figure out how they are related, and then write out a description of the relationships you came up with.

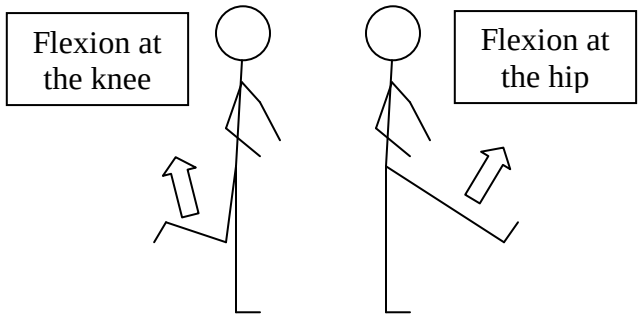
Yet another way to get writing is to take notes on the content in your textbook. Instructors expect that their students will read the book, so they may gloss over items in class that are covered well in the book. There's also no way for a student to write down everything that the instructor covers in class, so anything the student does not get to write down will also be found in the book. If a student hasn't taken the time to go through the book, they will certainly miss information. This guidebook includes an entire chapter on how to read the textbook better and take notes on it, so look there for more information.

While you are taking notes, be sure to write down any questions you have so that you can get them answered. You could always ask the question to your instructor (during, before, or after class, in their office, or via e-mail). You could also ask a classmate if you prefer. The question could also be something that you could come back to later while studying and you could try to answer it after you have learned more. It is best not to leave holes in your knowledge, so if you write down the questions you have, you will remember to figure them out.

## B. Draw notes while studying

Not all notes are just text. There are many ways to write out notes using drawings as well—and they do not require you to be an artist. Many people identify themselves as visual learners, and drawings work well for visual learners. For example, do you remember *where* the information is on a page of your textbook but don't necessarily remember *what* the information was? Or can you recall information by visualizing a figure from your textbook? These are traits of visual learners.

A drawing does not have to have artistic value! One does not need artistic ability to get their ideas through visually. Even simple stick figures can be used to illustrate a variety of actions. For example, body movement terminology can be confusing to a new anatomy and physiology student. The action of "flexion" at the hip versus at the knee can be especially tricky. When trying to capture the notion in words, one could say that flexion at the hip is moving the leg anteriorly as if kicking, while flexion at the knee is bending the knee posteriorly as if moving from straight to bent. But a simple stick figure illustration as shown here can make the distinction simple. Remember that no one other than yourself has to see your notes, so there's no reason to feel embarrassed by how you draw.



Not all drawings even have to be traditional drawings. Figure 5 shows an example of how writing out an algebra problem in an illustrative way can be much more helpful than just generally completing the problem. Note that this illustration is a different approach from the one in Figure 2 (page 27) in the Reading Techniques chapter.

Less Informative Method of Writing:

Don't

$$4\left(\frac{7x+6}{4}\right)=(19)4$$

$$7x = 76-6 = 70$$

$$x = 10$$

More Informative Method of Writing:

Do

$$\frac{7x+6}{4}=19$$

① multiply both sides by denominator to remove it:

$$4\left(\frac{7x+6}{4}\right)=(19)4$$

$$4\left(\frac{7x+6}{4}\right)=(19)4$$

② rewrite:

$$7x+6=76$$

③ isolate the variable

$$7x+6-6=76-6$$

④ simplify:

$$7x=70$$

⑤ reduce:

$$\frac{7x}{7}=\frac{70}{7}$$

⑥ solve:

$$x=10$$

Figure 5: Drawing out a description can be more informative. The same math problem is solved above and to the right. Above, shortcuts in writing were taken to get to the answer. Shortcuts and lack of annotation make this type of note-taking difficult to understand upon review; students may not be able to replicate solving problems like this again. If, however, a student draws out their problem-solving method, as shown in the diagram to the right, they would be more likely to be able to replicate this procedure again and again. Visual cues in this diagram are in the form of: 1) colored and circled numbers sequence the steps; 2) arrows that show what was done in each step; and 3) a different color text for the information about which mathematical procedure was being done. It does not matter that this diagram takes up more space in notes—it is readable and reviewable and understandable.

Another way to do a drawing is to connect words or concepts visually. In Figure 5 two methods of drawing out a formula solution were compared in a do/don't table. It is very helpful to compare and contrast methods or concepts visually like this. You can do this at home, too. One way is to take the topics you are studying and put them into a diagram (called a Venn diagram) like the one in Figure 6. The Venn diagram is an example of a concept map, a way to take words and turn them into an illustration. A different concept map was shown in Figure 4 (page 34) to illustrate an organizational scheme.

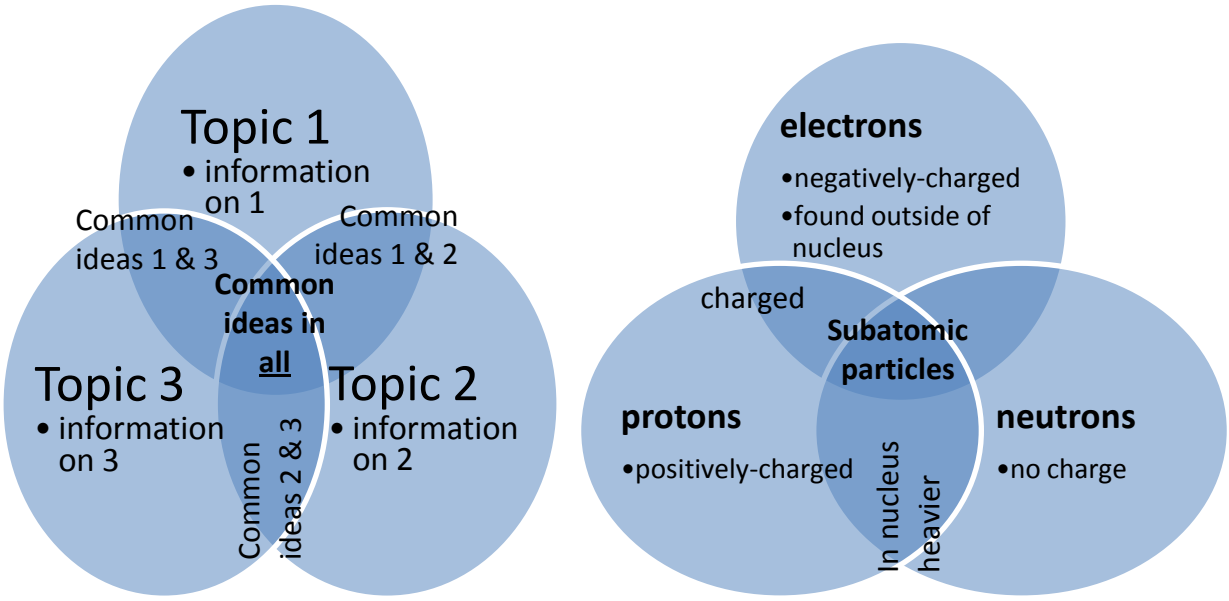
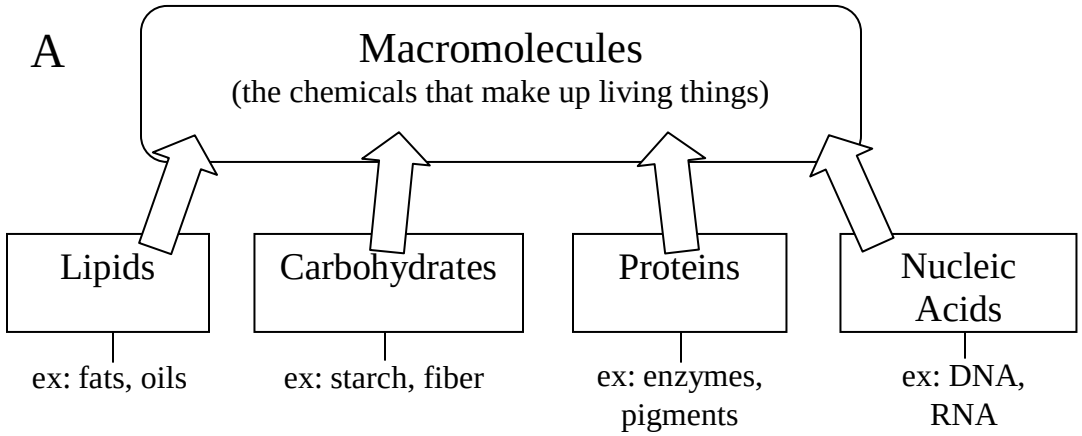



Figure 6: An illustrative way to compare and contrast topics or concepts being studied. Each topic can be written in a circle or oval or box and facts about that topic can be listed. Any facts or information shared by the topics can be written in the overlapping areas of the topics. The diagram on the left is the general idea for how to do this, while the diagram on the right shows an example from chemistry.

There are other ways to make concept maps, and tables can also be useful and visual. Words can simply be put into a table to organize them and illustrate their relationships. Figure 7 offers an example where both a concept map and a table are used for illustrating the same point. In biology classes, students learn that biological organisms are composed from 4 types of macromolecules. They learn examples of each of these macromolecules, too. Figure 7 shows two ways to visually represent this concept.

When actually making a drawing that is more representative, like when drawing an atom to include its electron energy shells or when drawing a cell to include its contents, there are a few things to keep in mind. First, make your drawings large. Always use a quarter of a page or more. If the drawing is too small, separate components within it will blend together and become indistinguishable. Second, always label your drawing. Make arrows to each important component and indicate what that item is. Third, give your drawing an overall label, like a figure legend or a heading, so that you know what it is.

A




B

| **Macromolecule** (chemicals that make up living things) | **Example** |
|---|---|
| Lipids | fats, oils |
| Carbohydrates | starch, fiber |
| Proteins | enzymes, pigments |
| Nucleic Acids | DNA,RNA |

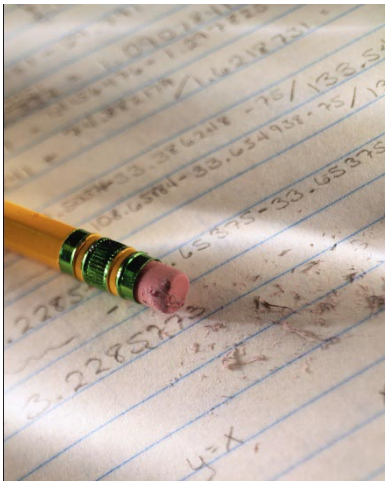
Figure 7: Two ways to illustrate the same point. A shows a concept map while B shows a table. Both diagrams illustrate the types of macromolecules and include some examples of each.

There are many additional tips for drawing in your notes. One option is to write out terms and put arrows between them to indicate their relatedness. Alternatively, take all the new terms and all the new big topics and draw arrows between them or make a table where you group appropriate terms together. Another drawing you can do is to turn any word problems into diagrams or hierarchical steps to follow. Also, if the subject matter involves learning a series of steps, make a simple flowchart of the major steps and number each one. There are so many ways to make your notes more visually-interesting—just give it a try!

## C. Do problem sets and test yourself

Give yourself an opportunity to try out answering questions before you ever walk into a classroom assessment. Test yourself! This is, in effect, like taking a practice test that cannot hurt your grade. Everyone can benefit from that. Here you will learn ways that you can do this.

In math classes, there are almost always **practice problems** given by the instructor. Also, math textbooks usually have problem sets in every chapter. Take the time to try these out. Sometimes students don't think that they need to do these because they understood the examples the teacher gave in class. But there is truly a difference between following along when an expert solves a problem versus doing a problem yourself. The only way you can know that you really understand how to do these problems is by trying them on your own. In addition, if you know you can do the practice problems on your own, when you go into a test situation you will be entering with confidence. Confidence helps with success and prevents anxiety.



There are many other ways that you can **test yourself** that apply to all STEM classes. One method is to start with a list of the major topics for the content area you are studying. You can either develop the list of major topics from your own notes or from the headings in your textbook chapters (listed in the expanded Table of Contents). Go item by item through your list and for each item try to write out what you know about it. Include terms and general information, and try to both write and draw in your descriptions. You may find that some of the major topics are easy for you to write about, while others are more difficult. Take the time to go back to your notes and the textbook to figure out what you could write down on those topics that you found more challenging and to figure out what you missed on other topics. Keep doing this until you can do all of it from your head.

Other ways to test yourself include using chapter/content objectives, problems in your textbook, sample quizzes/tests online, or essay questions given to you ahead of time. Very often STEM textbooks begin with a **list of objectives**, and sometimes instructors give out a list of objectives for each new topic. You can take those objectives and write out what you know about them. If you do not want to write anymore, say what you know about each out loud. If you can expand on the information in the objectives and explain them to yourself, then you have learned them. Many STEM textbooks also have **problem sets** at the end of each chapter. Whether or not your instructor has assigned them, take the time to do them. Completing these problems will help you be ready to complete a problem on a test or quiz in class. There may also be a website associated with your class or with the textbook your class is using. Very often supplemental websites have **sample quizzes and tests** so that you can practice answering questions before you actually have to take a real assessment. Finally, some instructors give out **possible essay questions** for each test so that students have the opportunity to practice answering them ahead of time. Take the time to do this so that you know how to answer it on the assessment.

It will take time to test yourself, but it is well worth the time. If you can practice for a test rather than just show up and be surprised, you will find that your stress levels go down in the testing situation and you can think more clearly. Isn't that what you want—lower stress and better logic? If that is all you need to do in order to perform better on tests, it is well worth the effort.

## 2. Study with peers

Studying with classmates is an excellent approach for studying for most students. Why? One reason is because it is active—when students study together, they don't just sit and read together in silence. Another reason is because students end up talking out loud when they study together. If a student has to explain a concept to another student, they will speak it aloud (usually in their own words). Putting a concept into one's own words requires understanding and thought so it helps with learning. Another reason that study groups work is because each person in the study group has different questions, so when each person poses their questions it makes everyone think about things that they may not have considered before. Also, it is common for students in study groups to test one another, and that way each person gets to practice being in a testing situation before any actual test. You and your study partners can compare class notes for accuracy and thoroughness as well. A productive study group leads to an increase in confidence about the subject matter for each student involved, helping them to do better in class.

Some students find it challenging to study with others. If you can find a classmate (or two) who is interested in working with you so that you both learn, that usually helps. All students in a study group must participate for the group to work well. It may take a couple of meetings until you figure out how to work together, but it will be worth it if the group ends up being effective. Keep in mind that the study group should not replace studying on your own, but it should supplement it.

## 3. Study regularly

It is particularly important in STEM courses to study regularly. It takes time to figure out the course content information and its significance, so it is especially important to spend time thinking about the content. This is not possible when students try to cram for STEM courses. You see, it is not just about memorizing information—it is about getting the information to make sense to you and then memorizing the bits that need memorizing. Each student has to find an appropriate frequency for studying. It could be that you need to review the material that was covered after each class period and then also on the weekend. Alternatively, you may only need to spend a couple of times per week working through the material. You may also find that you need to spend a little bit of time almost every day on the material. Figure out what works for you. How often do you need to study so that you do not feel overwhelmed by the material.

**Organizational Tips**

- *Pick a time of day when you will be able to focus on studying*
- *Keep a calendar to schedule studying and stick to it*
- *Be sure to have your notes and your book available for when you study*
- *Have a drink and/or a snack at the ready*

## 4. Study in an appropriate environment

Where do you study? Some students like to study in a quiet place, like a library. Other students like to study in a busy place, like a coffee shop. Your choice has to work for you. The main thing to keep in mind when picking a place for you is whether or not the location is distraction-free. What kind of distractions interrupt your studying? How about these?

- home phone
- mobile phone
- TV
- family members or roommates
- hunger
- hobbies
- e-mail
- Facebook

This list of distractions is certainly not complete. It is your task to figure out what interrupts your studying and eliminate those things from your studying environment. For example, if you know that you might spend more time texting or on Facebook than studying if you keep your mobile phone on, you could simply turn it off for an hour at a time.

## 5. Use supplementary materials

There are so many supplementary materials that can help with studying at home. Here are some that may be of use:

- ✓ A study guide: Use this to do practice quizzes and tests, and to review the textbook chapter contents.
- ✓ Textbook website: This has a variety of resources including self-testing, online flashcards, animations, glossary, and more.
- ✓ Instructor website: If your instructor has a website for their course it will have all the information in it that your instructor considers essential. Definitely take the time to visit that site.
- ✓ Course website: Some instructors will organize a course website (for example, on BlackBoard or within a textbook website). This website will have deadlines posted, exam dates posted, instructor PowerPoint files, links to supplementary materials, ways to e-mail your classmates, and the latest announcements.
- ✓ Recommended books: Some books are required for certain classes while others are recommended. For example, atlases are often recommended for anatomy & physiology classes. The recommended books have significant value, and could be of use for any student in the class.
- ✓ Alternative websites: Many students find alternative websites through online searches or they use an encyclopedic website like Wikipedia. If you are struggling to understand course content you may find that some other website describes it in a way that you can understand more easily. Just keep in mind that other websites are not necessarily accurate (try to use a website that ends in ".edu" for improved accuracy).
- ✓ CDs/DVDs: These may come with your books or be purchased separately. These may have interactive programs or textbook supplements on them.
- ✓ Instructor PowerPoint files: If your instructor uses PowerPoint slides for their presentations they may make them available to you. If so, take the time to review them or print them out and annotate them (during class or at home later).

**Active Learning Tips**

Active Learning is when you do something while learning. Click on links online, write things down, draw representations, compare information from different sources, carry out an activity, say something out loud. Use these resources to be active.

- ✓ Flashcards: These can be very helpful for memorizing terminology, but only if the definitions on them are written in your own words.

- ✓ Audio recordings of class: Some instructors record their classes for their students or, alternatively, some students record classes for their own use (with instructor permission). Audio recordings of classes can be very helpful for studying. They can be used to add information that you may have missed during class to your notes later. Some students listen to the recordings while doing errands or working out.

One challenge to students is to figure out which of these supplementary resources work for them and how to use them. There are so many options that it can seem overwhelming. The best way to choose is to pick those options that keep you the most active when you are studying and that allow for you to self-test. For example, if you took notes during class on the PowerPoint slide handouts from your instructor, at home you could re-print those handouts and see if you can remember what your instructor said about each slide. Or maybe your textbook website has interactive animations that help you step through some concepts and keep you alert. Whichever options you pick, as long as they keep you active and involved you will find them helpful in your learning.

## 6. Know what you should be studying and why you should be studying

Students often comment that they have no idea what is going to be on the next quiz or test in their STEM course, but they seem to know what is going to be on their non-STEM course assessments. Why is that? One reason is that the names of the topics in STEM courses may be foreign terms to students so they are not sure what it was that they were supposed to be responsible for. Another reason is that each STEM textbook chapter has a great deal of information in it, making it difficult to figure out which parts of the chapter were assigned or difficult to understand the entire chapter. And the most important reason is because often students cannot figure out *why* they are learning the information—it doesn't have any meaning to them—so they cannot keep track of it.

Luckily there are many ways to keep track of the topics in a STEM class. An important resource for keeping track of the class topics is the course syllabus or website. Usually, topics and reading assignments are listed in the syllabus or website, so you can refer back to them for the appropriate information. During class your instructor will also give you the reading assignments and the topics so you should have these written down in your notes. This is especially important, because your instructor will emphasize certain parts of the material more than others, so if you listen carefully in class, you will know where to spend more of your time and energy while studying. Some of your classmates may also have figured out what information is important, so simply communicate with them to get this information. In addition, some instructors are also willing to have you contact them directly if you have questions about what you are supposed to be studying.

Getting the topics to be meaningful to you can be a bit more challenging. It is helpful to ask the **Why?, What?, How?, and Who Cares?** questions as you think about each topic. For example, when a student in introductory biology class has to learn the topic

of "mitosis," they may not know why they have to memorize all that information about it. But if the student takes a moment to ask "Why?" about mitosis, as in "Why do I have to learn mitosis?" or "Why should I care about mitosis?" they will eventually figure out that the reason to learn mitosis is because errors in mitosis lead to cancer cells. In some cases, the only immediate answer to the questions is that understanding the one topic will help you to understand another. But usually there are more interesting answers to these questions. If you are looking for guidance about the reason for learning the information, very often, the lead-in sections of textbook chapters address this. You can also ask your classmates or your instructor. It is so much harder to learn something when you do not see the value in it. Take the time to ask the questions and talk with your classmates and instructors and figure it out. If you can figure out what topics your instructor requires of you and why those topics are important to learn, it will be easy to stay on top of the course content.

## 7. Develop your own review sheet for assessments

What's on the test? If you figure it out yourself, you will be studying for the test while figuring it out and you will gain confidence that you are ready for the test. The most important thing to do to begin developing your own review sheet is to figure out what content is being evaluated on the test. What topics did you learn for this test? What chapters did you read for this test? Make a list of all the main topics from class and your readings. You will use this list to make your review sheet. Here are the steps:

**Big Picture Tip**

*The Detailed Table of Contents in your textbook is an excellent resource for figuring out what the main topics are for any assessment. Just go through the required chapters and turn the book's list into your own words.*

1. Make a list of all the major topics for the test.
2. Re-write your list in your own words, so that you know what each major topic really is.
3. One at a time, take each major topic from your list and expand on it. If there are any subcategories within the major topic, list those (in your own words). Also list all the terminology that applies to each topic.
4. Finally, describe the topic and subtopics (in your own words) and define all the terms (in your own words).

If you can do all of this, you have gotten yourself ready for the test. If you get stuck on any topics or subtopics, now you know which sections of the material you have to spend more time on and figure out.

## 8. Other Suggestions

There are many more ways to study actively on your own. Here are some suggestions:

> **Terminology Tip**
>
> Speak aloud while studying. Make a point of not just reading or writing, but also of speaking the terminology you are learning. New terminology needs to become part of your normal vocabulary—if never spoken aloud, how can new words ever be routinely used?

- ✓ **Use scientific terms in everyday conversation.** When talking with friends, family, or even just with classmates, be sure to use the words you have learned. Really integrate these words into your vocabulary.
- ✓ **Apply material to your everyday life or career**. See if you can figure out how the information you are learning fits into your life. If you can come up with connections between the STEM content you are learning and your own life, you will be much more likely to remember it.
- ✓ **Explain the material to others.** If you really understand something, you should be able to explain it to anyone. Try explaining one of the concepts you are learning to a parent, grandparent, neighbor, or sibling. You may find that they ask you questions you hadn't thought about before and by answering these you will learn even more.
- ✓ **Understand what the instructor expects you to know.** Don't waste your time on material that the instructor has not assigned. For example, if the instructor tells the class that they only have to read the first half of a chapter, don't worry about the second half of it. And if the instructor tells you that one particular topic is really, really important, focus your energy on that topic.
- ✓ **Redraw diagrams when studying.** Try drawing some without labels and then labeling them from memory. Or redraw the diagrams with blank areas and then try to fill them in from memory. See if you can re-create an entire drawing or chart from memory. Keep drawing the diagrams and adding information into them until you fully understand them.
- ✓ **Review key points from your notes.** Some students review their notes right before an assessment, but that can be overwhelming for other students if the notes are loaded with information. Make up a set of notes with the key points and the major topics, then only review those notes for your final review.
- ✓ **Recreate the list of key lecture concepts from memory.** This is a good way to test oneself that you are really aware of what is on the test.
- ✓ **Try to organize all the terms with all the major topics.** This is easily done by writing out all the terms and topics on scraps of paper and sorting them (like dealing playing cards).

# Chapter 4: Test Taking Techniques

"My palms are sweaty, my heart is racing, my mind is blank; the words on the paper are a blur. I knew I would never make it in this class; it is just too hard". Does this sound familiar? For many students the thought of sitting through a STEM exam can create a lot of anxiety but it doesn't have to. Following an active plan for test preparation combined with some concrete strategies will help you to overcome anxiety and master the art of test taking.

Unlike other non-STEM subjects where you answer questions in essay or multiple choice formats, a STEM exam will also usually require you to demonstrate problem solving ability. Often this means being able to understand the terminology being used and to apply appropriate concepts in order to solve a problem. For this reason it is important for the students to be well prepared in a variety of areas before sitting for the exam. This section will help you with the preparation for the test as well as highlight techniques for improving one's overall performance.

Table of Contents for Test Taking Techniques

## 1. Test Preparation

When it comes time to prepare for an exam the first thing a student should know is what material will be covered. This may be as simple as the instructor specifying a number of chapters in a textbook or it may cover a host of other items such as techniques learned in a lab, class discussions, or other outside readings. The important thing to know is what is on the test so that you can be well prepared. Make sure that this is clearly communicated by the instructor as this will save time by not having to concentrate on areas that will not be included.

A study guide for each test is essential. Your instructor is not responsible for giving this to you, so you may have to come up with your own. How can you make up your own study guide? A really good place to start is the detailed Table of Contents of your textbook. For each chapter you were responsible for, write out all the headings from the Table of Contents that you have worked on as a class (your teacher may have skipped some sections of some chapters). Now take each heading and figure out what was really in that section using your chapter and notes. Write out any subtopics within that section. If you keep going in this manner, you will have made yourself your own detailed study guide.

One of the best sources of information for reviewing the course material is often your own class notes. Not only is it written in your own language but it often stresses concepts and terminology that the instructor wanted to emphasize. Reading through your own notes and highlighting the important points can be an effective means of reviewing the material. Once you have refreshed your memory you can then go back and review the textbook. Often doing it in this order reinforces the material that you reviewed in your notes. If there are practice questions at the end of the chapters now is a good time to try and answer these.

Aside from studying the notes and textbooks many students find study groups to be helpful when preparing for an exam. A small group of four or less is ideal for this purpose. It can be fun to quiz each other on the test material and can also be satisfying when you can help another individual to understand something they may find difficult. When you are able to explain a concept to someone else in the group it helps to reinforce that learning in your own mind. Study groups can be conducted throughout the course or may be useful right up to the day before the test.

**Active Learning Tips**
- Join a study group
- Explain concepts to others
- Quiz your peers
- Use flash cards
- Practice writing essays
- Test yourself

When there is a large amount of material that must be committed to memory such as formulas, definitions, symbols, etc., a set of homemade flash cards may be helpful. Write the word, symbol, or name of the formula on the front of the card with the corresponding definition or formula on the back. A quick review of this material can be done quite effectively by scanning through the cards any time you have a few free moments. Since they are small and portable this exercise can be done almost anywhere. Cards can be separated into two

groups as you go along- those that you know the answers immediately and those that require some more thought. This will allow you to focus on the set of cards that requires a bit more concentration. However, always remember that **memorization is not necessarily learning.** Memorization must remain secondary to truly understanding the terminology and concepts presented in your course material.

Practice tests are a great way to check how prepared you are and have the added advantage that they can be taken in a more relaxed setting. You can make your own test from class notes or use the one found in your book. Practice tests can usually be found at the end of a textbook chapter with the answers usually given on a separate page. However, a better gauge of what the test will be like is to obtain a copy of an earlier exam given by your instructor. If they have not made these available you may be able to ask for them before the test. These are usually a good indicator of the type of questions that will be asked as well as the degree of difficulty you are likely to encounter. If you can obtain a copy of an older test do not take it until you have done a fair amount of preparation otherwise you will not be able to accurately determine how ready you are. Remember to practice essay questions as well. Essays are frequently an indication of your true understanding of course material.

If the exam is "open book" or if you are allowed to bring in outside reference materials, it is often helpful to organize your materials ahead of time. This saves time by not having to consult the index or a table of contents during the test. It can be as simple as a set of tabs placed in a textbook highlighting the critical sections or the important tables that you'll need for doing calculations. When you organize the information this way it also helps you to commit it to memory.

Planning for any test accommodations should also be part of your preparation for exams. Everyone is different and if you need to take tests orally, on a computer, or using any kind of special equipment plan ahead, talk to your professor, and make arrangements so that you are organized and worry-free on the day of the exam.

Using the techniques described above will increase your chances of doing well on the test. It is not advised to wait until the night before the test to begin reviewing the material or to "cram". This usually makes you more tired and raises your level of stress prior to the test.

## 2. Taking the Test

For most of us taking an exam is a stressful experience. However, if you have prepared well beforehand, are rested, and have had something to eat that morning you should feel confident about doing well. Try to relax as best you can. Make sure all the simple details are taken care of ahead of time such as sharpened pencils, erasers, working calculators, etc. Now take some deep breaths and find a calm place in your mind until you are allowed to begin. Do not concern yourself with what the other students are doing or how quickly they may be working. You are in control of your own situation not someone else's. Remember that the test is not measuring your intelligence but how well you understand the material covered in this course.

### A. State of Mind

Successful test taking relies a lot on the state of mind going into the exam. A relaxed, well-rested, confident student will perform better than someone that is tired and stressed out. Creating this confident and relaxed state of mind is accomplished both by studying the relevant course material ahead of time as well as preparing your body for the day of the test. To do your best exam day you should try to get a good night sleep the night before. Getting enough rest allows you to think more clearly and is essential for good memory recall. Just as important as a good night's sleep is to remember to eat a good breakfast the morning of the test. Many people don't realize that brain function can be significantly reduced on an empty stomach -so start the day off right.

Taking the test in a distraction free space is important for some students. If an accommodation is appropriate based on disability you can request a private room. Otherwise, try to stay focused on the task ahead rather than the students around you. Wear earplugs if noise bothers you and remember to turn off your cell phone or other distracting devices.

Envision yourself doing well, answering all the questions correctly, and feeling confident about the preparation you have done. For example, just pretend you are sitting at home successfully completely your homework. A positive affirming attitude will set the stage for success.

### B. Setting a Pace

Once the test is started you may want to quickly scan the exam to see how it is organized. Is it all multiple choice, fill in the blank, problem solving, or a combination of these? Seeing the layout will help you to establish a pace for taking the exam. Try to set a pace for yourself that will allow you to give each question ample consideration while allowing yourself a bit of time at the end of the test to check your work. Throughout the test you should be aware of how many of the questions you have answered versus how much

**Organizational Tips**
- Set an appropriate pace
- Answer what you know first
- Ask for clarification
- Look carefully at charts and graphs
- Recheck your work

time is remaining. If you recognize a section that is easier than the others, such as multiple choice, you may want to start there first. Answering these first may boost your confidence for tackling some of the other more difficult sections later on. You may also find clues to answering other more difficult questions.

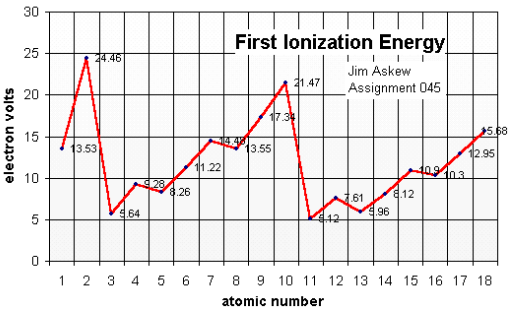
Problems requiring long hand calculations usually take longer to complete so you may want to save these for later. If you encounter a question that seems very difficult or that you simply don't know what approach to take circle it and move on to the next question. If you have time at the end you can come back and spend more time working on the solution.

If you do not understand what the question is asking or if the wording appears vague try to get clarification from your instructor. Sometimes a bit of context from the instructor can help you find the correct answer.

**Big Picture Tip**

If you know what the big topics are for your test, you probably know which ones you have learned the best. You can answer the questions that relate to the big topics you know best first.

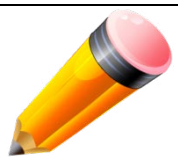
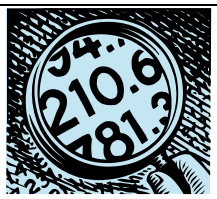
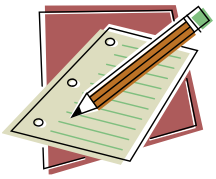
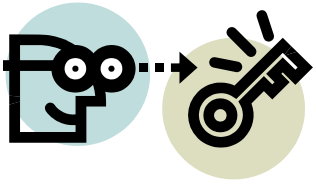
For multiple choice questions always read the question thoroughly from beginning to end. Sometimes your first impulse may not always be the correct answer and the exam may actually be looking for a more in depth analysis. If you do not know the answer immediately you may be able to improve your odds in multiple-choice questions by eliminating some of the answers that you know for sure are incorrect. Circle or underline key words. Often these key words will be key in helping you to match what you know to the correct answer.




When questions involve a chart or graph spend the time to analyze it and to understand what it is telling you. Look carefully at the various details such as the axes, legends, symbols, etc .that are used and see how they relate to the questions. You may have to re read the questions more than once to identify the correct answer in the chart or graph being pictured.

When you're halfway done and you are satisfied with the pace you may want to stop for a moment to stretch or take some deep breaths. You can do this sitting down by rotating your neck, outstretching your arms and legs, and arching your back. This brief pause does two things. It not only relaxes you but will give you renewed energy to go on and complete the exam.

## C. Testing Tips

| | |
|---|---|
| ✓ **Arrive early:** Not having to rush will help you start in a calm relaxed way. |  |
|  | ✓ **Be Prepared:** Bring pencils (with erasers), pens, a calculator, or other resources that your professor has approved. |
| ✓ **Know what you are being asked to do:** Read all the directions carefully so that you have an overall understanding of the purpose and types of questions. |  |
|  | ✓ **Make sure you understand the questions:** Read carefully and pay attention to key words, symbols, or terminology. |
| ✓ **Have scrap paper available:** Write, work out calculations, or draw on scrap paper to work out problems. Writing down what you remember on scrap paper before looking at the test can prevent you from forgetting or freezing once you start. |  |
| underline | ✓ **Underline key words in essay question:** Make sure you know what is being asked. Are you being asked to define, compare concepts, or give an explanation? |
| ✓ **Identify the big topic for each question:** There may be several questions that relate to the same topic. Other questions and answers that relate may help you focus your thoughts. You can also check that your answer is relevant to that big topic. |  |
| ~~wrong answer~~ | ✓ **Eliminate what you know is not correct:** Cross off wrong answers and focus on what you know. |
| ✓ **Pick the best available answer:** When you are not sure, use logic to choose the answer you think might be correct. | A. ~~B~~ C. best D. ~~E~~ |
|  | ✓ **Stay focused and relaxed:** Breathe deeply and take a moment to stretch. |

## D. Review your Work

If you have answered all the questions to the best of your ability and you still have time remaining you should use this time to go back and check your work. Read through each question as if you are seeing it for the first time and see if you arrive at the same answer. For questions requiring calculations always go through and double check your math. Redo each calculation a second time to check for errors in data entry. Your first answer is often correct so don't second-guess yourself. Don't change an item because you are panicking; only change an item that doesn't make sense based on your calculations or logical reasoning.

When finished, sit back and relax knowing that you have done the very best job that you could!

**Terminology Tip**

*When you can't think of a particular term during the test, skip it and come back to it. You may find that the term you are trying to come up with is written into the test itself within some other question. Or another term may help remind you of it.*