Essential Study Skills for Science Students

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CHAPTER 1

Developing Good Study Habits

You wouldn’t set up a desk in Grand Central Station to study for an exam. Nor would you invite your friends to your room to hang out while you prepare for an important test. But many students might as well. They study in the noisiest, most distractive setting they can find, often in front of the TV or on the couch with the stereo blasting.

Some students argue that they get better results that way. However, when their tests are returned, the verdict is inescapable: Noise and other forms of distraction decrease your ability to concentrate. If you can’t concentrate, it’s likely that you’re not learning much.

Getting good grades in college requires that you study in a quiet, distraction-free setting. There’s a lot more to getting good grades than picking a good spot to study, though. You must also learn (1) how to get into the habit of studying, (2) when the best time is for you to study, (3) how much time you should spend studying each subject, (4) how to avoid procrastination, and (5) when to take your breaks. This chapter covers these and other important topics that will help you improve your study habits.

When you’ve completed the chapter, take a moment to review the suggestions given here, and make a list of ways to improve your study skills.

TIP 1 Study in a well-lighted, distraction-free environment.

Quiet is the first requirement of an appropriate study spot. Select a relatively noiseless room in your home or library. Study at a desk or a table with a straight-back chair. Avoid sofas or easy chairs; they often invite sleepiness because they’re so comfortable and relaxing. Be certain that the location is well lighted. A window looking out on trees or a park might be suitable if there aren’t too many distractions that will draw you away from your books. Make sure that you have plenty of room to spread out, too. Cramped quarters can cramp your style. A good dictionary and other reference books appropriate to the subject under study should be within arm’s reach. Once you’ve established a suitable study spot, stick with it.

TIP 2 Set aside a study time each day.

After you have set up a place to study, how are you going to pull yourself away from the TV or telephone or friends? You’ll need willpower, certainly, but establishing an unbreakable daily study time may help. Your best bet is to set aside a study period each night, say from seven to ten o’clock (more on this later). When the clock strikes seven, it’s time to hit the books. No excuses.
**TIP 3** Reward yourself when you stick to your schedule.

You may find that rewards help you stick to your schedule. If you like to jog, for example, promise yourself a run after studying. Or, how about a chocolate sundae at the end of a study period? If you’re a music buff, top off the evening by listening to your favorite records. If you like to read or watch TV, reward yourself with a good book or a television program.

**TIP 4** Don’t skimp on study time.

Many students find it difficult to sit in one place for very long. A three-hour study session may as well be a three-year jail sentence. To get good grades, though, you have to dedicate some time to studying. Learning takes time.

As a rule of thumb, most teachers recommend at least two to three hours of study per credit hour per week. Therefore, if you are taking a three-credit anthropology course, you should expect to study about six to nine hours per week.

Rules are made to be broken, however, and this one is no exception. For some classes, such as science or math, you may find it necessary to devote five hours of study for each credit hour. For others, an hour may suffice. Apply the rule of thumb, but adjust it according to your needs. If you are having trouble with a class, increase the study time. It will pay off in the long run. Be sure to make your adjustment early on so you don’t fall behind.

Clearly, no two courses are alike—nor are any two students. Just because a friend gets by with one hour of study before an exam doesn’t mean you can. He may have taken a similar course in high school or may have read a lot on the subject or may simply be a faster learner.

Chapter 5 points out that studying each subject a little every night will greatly improve your retention and will help you avoid cramming—the surest way to stress yourself and forget the most information in the shortest time.

**TIP 5** Train yourself to study more.

If three or four hours of study per day seems like an eternity to you, try working up to it gradually. For example, during the first week, pledge to study one hour each night. To make this a little less painful, you can break each hour into twenty-minute study sessions followed by five- to ten-minute breaks. An alarm clock might be helpful to keep track of the study periods. When the alarm goes off, finish your thought and take a break. Do some exercises, or take a quick walk. This will help you stay awake. Raid the refrigerator, or listen to some music. When your break is over, sit down for another twenty minutes. After that session, you may want to reward yourself with a special treat. A mental pat on the back is always a good idea.

Soon you will find that twenty minutes pass in a flash. You may want to increase your study periods to thirty or forty minutes followed by ten-minute breaks to clear your head and relax your muscles (more on this later).

Gradually, over a few weeks, you can increase your total study time to two hours a night and then three or four hours. You will be amazed at how quickly three hours pass. You will find that learning to concentrate on your studies for several hours at a time may help you immensely later in life.
**Tip 6** Study when you are most alert.

Some folks are morning people; they pop out of bed, bright and chipper, ready to tackle the world. Others tend to come alive a bit later in the day, maybe after a few hours of bumping into things. Still others function optimally at night. In short, everyone has a time when the mind is most alert. Use that time to study if you can. By studying during these peak periods, you absorb the greatest amount of information in the shortest time.

If you are uncertain when your peak efficiency occurs, try keeping a record of your mental alertness for a week. Four or five times a day, make a notation about your mental state on a calendar or in a notebook. If you fade quickly after dinner, it is best to spend that time relaxing. If you are drowsy first thing in the morning but join the living by ten, schedule some of your studying after that hour.

Some people have several peaks of mental acuity. Others have none whatsoever. They always feel a bit groggy. If this is the case for you, trying getting to bed earlier or sleeping later. Improvements in diet and increased exercise can also be beneficial. If these steps don’t help, you might want to consult with a physician to see if you have a medical condition that affects your wakefulness. If you’re emotionally troubled, you might want to visit a therapist. Emotional difficulties can often drain us of energy.

Several studies have shown that students retain more information if their study session is followed by sleep. A few hours can elapse, but long periods between study and sleep tend to erase facts from your memory. This is why I recommended the seven-to-ten study period earlier in the chapter.

The key to successful study is choosing the most efficient time. Why study for four hours with a brain that is working at half its capacity, when a two-hour session at peak brain efficiency will get the same job done? Hitting peak efficiency helps free up time for other activities.

**Tip 7** Avoid procrastination.

No human vice is as common as procrastination—putting work off until another time. Unfortunately, procrastinators always pay for this bad habit. In college, putting off studying or term papers usually creates panic and stress and often results in poor grades.

How do you avoid procrastination? Perhaps the most important step you can take is to set aside a time to study each day. Make it part of your daily routine. Let your friends know about your study time so they won’t tempt you with better offers.

**Tip 8** Plan your time efficiently.

Many of the most successful people are great managers of time. They work fast and waste few hours. The efficient use of time reduces stress and increases productivity.

To begin to learn how to plan your time better, take a blank sheet of paper and draw seven columns on it—one for each day of the week. Label the columns along the top Monday through Sunday, and write in your waking hours along the left-hand side of the page. Now fill in the columns,
noting each scheduled class, seminar, lab, and recitation. Indicate times for breakfast, lunch, and dinner, and fill in some suitable time for exercise or relaxation. Finally, mark off several hours for study each day, and note additional hours on the weekend.

Try your schedule for a week or two, then modify it as needed. Keep your schedule with you at all times so that if something comes up, you can check your commitments. If you decide to "blow off" a study period for a game of volleyball, say, schedule another period to make up for lost time.

**T I P 9** Make to-do lists each day.

To optimize the limited number of hours available to you each day, consider making a daily list of things to do. Each morning after you get out of bed, jot down a list of the things you would like to accomplish during the day. I find it helpful to begin my list at the end of the previous day. That way I don’t forget important obligations. Be sure to include all of your classes and labs, errands you need to perform, and study periods. I’d even recommend scheduling entertainment, exercise, and relaxation time. Otherwise, it’s too easy to skip these important aspects of life.

You may find it helpful to note the actual time you will spend in each activity. Your to-do list might take the form of a schedule:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>7:30-8:00</td>
</tr>
<tr>
<td>Sociology</td>
<td>8:30-9:30</td>
</tr>
<tr>
<td>Chemistry</td>
<td>9:30-10:30</td>
</tr>
<tr>
<td>Study</td>
<td>10:30-11:30</td>
</tr>
<tr>
<td>Lunch</td>
<td>11:30-12:30</td>
</tr>
<tr>
<td>Study</td>
<td>12:30-1:30</td>
</tr>
<tr>
<td>Chemistry lab</td>
<td>1:30-4:30</td>
</tr>
<tr>
<td>Volleyball</td>
<td>4:30-5:30</td>
</tr>
<tr>
<td>Dinner</td>
<td>5:30-6:30</td>
</tr>
<tr>
<td>Study chemistry</td>
<td>7:30-9:30</td>
</tr>
<tr>
<td>Study sociology</td>
<td>9:30-10:30</td>
</tr>
</tbody>
</table>

This kind of to-do list assists you in keeping on track and meeting all of your obligations. Alternatively, you may want to indicate just the time requirements for each activity. On a Saturday, for example, your list might look like this:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study chemistry</td>
<td>2</td>
</tr>
<tr>
<td>Study sociology</td>
<td>2</td>
</tr>
<tr>
<td>Library research for paper</td>
<td>2</td>
</tr>
<tr>
<td>Study math</td>
<td>1</td>
</tr>
<tr>
<td>Softball game</td>
<td>2</td>
</tr>
</tbody>
</table>

Whatever you do, be realistic. Don’t include so many things on your list that it will take you two days to complete them. Overscheduling is frustrating and stressful, and it can work against you in the long run by increasing your anxiety level. Bite off a little at a time. The thought of sitting down to study organic chemistry for three hours is enough to kill just about
anyone's spirit. But how about one hour or forty minutes? That's a little more manageable.

You may find that setting an alarm clock (or any kind of timer) at the beginning of your study session helps you to buckle down. With the clock ticking away, you'll feel the urgency to study.

As noted earlier in the chapter, be sure to reward yourself. When you cross something off your list of things to do, congratulate yourself. When you are done with the whole list, treat yourself to a game of racquetball, a dip in the pool, a soft drink, or a favorite TV show.

T I P 10 • Keep your mind alert.
Keeping your mind alert is one of the most important ways to increase your efficiency and reduce unnecessary study time. As you are probably aware, sleep is essential for mental alertness. A healthy diet and exercise are also vital, as are efforts to reduce stress.

As noted earlier, you should study during your hours of peak efficiency. But even so, continuous reading, problem solving, and review of notes can fatigue the mind and dull the memory. To avoid this, try stopping every once in a while for a break. You may find that a break every two hours works best for you, or you may need to break every thirty to forty minutes. Experiment to see what time interval works best.

What do you do when you stop? Perhaps the best way of restoring your mental acuity (sharpness) is to exercise. Two minutes of running in place, jumping jacks, or aerobics are often enough to awaken you. Try this for a week after each study session to see if it increases your efficiency.

If you are not favorably disposed to exercise, you may find study breaks a perfect time to do household chores: washing dishes, laundry, or cleaning up around the house. Whatever you do, though, get your limbs moving. If you can't seem to ward off mental fatigue, you might consider a short nap.

T I P 11 • Study alone.
Many students head off to the library each night with a cadre of friends. Although the camaraderie is great, this arrangement often deteriorates. One member cracks a joke, another notices a particularly attractive student nearby and nudges you to look, another whispers incessantly. At the end of a three-hour study session, you may have gotten only a half hour's worth of work done.

Studying is more than just sitting down with the books for a few hours each night. You can't learn by osmosis. If that's all it took, we'd all be Noble Prize-winning scientists or accomplished educators. To study effectively, you must be able to concentrate. You simply can't learn much if you're constantly being distracted by your friends' antics.

Study alone unless you're engaged in productive group study (more on this in Chapter 5). Find a spot away from your friends where you can concentrate on your notes and reading. Stay away from other noisy groups. You'll be rewarded many times over. By spending your time more effectively, you'll have plenty of time for socializing later.
T I P 12 Keep a record of all tests, term papers, and other major commitments.
During the first week of classes, most professors hand out a course syllabus—an outline of the topics to be covered each session, with a list of test dates and due dates for papers. Put all these dates on an engagement calendar or, perhaps even better, a wall calendar so you can keep track of large periods of time. Scheduling important events, such as tests, will assist you in budgeting your time. For example, if you find that you have two tests on the same day, you'll know that you need to start studying a little earlier for them.
Sharpening Your Memory

Memory is a funny thing. Some people seem to be endowed with a good memory, and others... well... let's just say they're not so lucky. For students with poor memories, facts are often elusive. Lecture material goes in one ear and out the other. For them, life can be a frustrating ordeal. College can be a nightmare.

Fortunately, it doesn't have to be this way. Memory is like a muscle: the more you use it and develop it, the more powerful it gets. This chapter discusses a three-step method for sharpening your memory.

**TIP 1: Practice self-affirmation.**
Why is it that some people can remember facts, dates, and definitions with computerlike precision, while others struggle to remember their own phone numbers? Is it because some people are smarter than others? Perhaps. In many cases, though, certain people seem smarter than others simply because they know how to remember things better. In other words, they have developed useful skills that help them remember.

Equally important, they've probably developed a winning attitude: They know they can remember, and they want to remember. In contrast, you may be trapped in a self-fulfilling cycle: "I can't remember. I have a rotten memory. I don't want to remember. I won't remember."

Those days must come to an end. You can remember. You have the potential to have a good memory. If you want to remember things, you can. Tell yourself these things over and over again.

This technique, called self-affirmation, is a way of changing your attitude and building confidence. It can help you break down some of the walls that prevent you from realizing your full potential. By getting rid of the old messages ("I can't remember"), you free up your mind to perform one of the functions it's designed to perform—storing information.

**TIP 2: Practice the PMC method.**
Developing your full memory potential will take time and some practice, but it's well worth the effort. Persistence will pay off handsomely.

The technique presented in this chapter is one of my own devising. It involves three steps: (1) paying attention, (2) making information memorable, and (3) correlating new facts and concepts with things you already know. I call it the PMC method. Can you guess why?
**T I P 3**  
Pay attention.

Many of us go through life in a daze: daydreaming, taking in the sights, listening to music while the world goes by. We pay only marginal attention to our environment. In many respects, our minds are in neutral.

To improve your memory, you must first get out of this bad habit. You must learn to pay attention to the world around you. You must activate your mind, and when you do you’ll find that your mind will begin to fill up with interesting facts and concepts.

In the classroom, paying attention means just what it says. You cannot sit in a classroom, gazing out the window and thinking about last night’s date, and expect to get much out of the lecture. Sit up straight, take notes, and keep your mind on the topic. Sometimes it even pays not to look at the speaker. Annoying mannerisms, unusual dress, and unruly hair can distract you. Don’t let your mind be snared by the distraction. If you find your attention wandering, try looking away. Watch the board, or keep your eyes on your notebook. Take more notes. You will be amazed how much more you hear if you pay attention.

Another way to heighten your level of attention is to ask yourself questions beforehand. You’ve no doubt noticed that long-standing questions tend to linger in your mind like a hungry animal waiting to be satisfied. When the fact that answers your question presents itself, the mind grasps it and rarely lets go.

You can use this natural phenomenon to your advantage. Here’s how:

As noted earlier in the book, most professors hand out a syllabus, or course outline, at the beginning of the semester. In a sense, the syllabus is a road map of the course. To make the most use of it, consult it before every lecture to determine the topic of discussion. Or, ask the professor or a fellow student what the topic of the day will be. After you find out, pause for a few minutes to think up some questions about it.

As an example, suppose your lecture is on cellular energy production. Stop and think about it. What questions come to mind?

1. Where does a cell produce energy?
2. Do all cells make energy?
3. What is energy?
4. What do cells make energy from?

These important questions will probably be answered during the lecture. You’ll retain the new information more easily if your mind is primed beforehand.

After you formulate your questions, stop for a moment to review what you already know. In other words, activate your memory. Pull out facts you’ve learned in other classes. Get the wheels turning.

Paying attention, therefore, involves at least three changes in behavior: attentiveness in class, posing questions, and reviewing what you already know. These simple steps put the mind in gear.

You can use these techniques to improve your reading skills as well. For instance, before you begin to read an assigned article or a chapter in your textbook, take a moment to question what is going to be covered, then
review what you already know (more on this in Chapter 4). The few seconds it will take will pay huge dividends in the long run.

To begin, look at the title of the article and note the questions it suggests. Suppose the title is “Symbolism of e.e. cummings’ poetry.” What questions come to mind?

1. Who is e.e. cummings?
2. What is symbolism?
3. When did the poet live?
4. What was his favorite subject matter?
5. Is he a British or an American poet?

Next, look at the subheadings and ask a few questions about each one. Photographs, drawings, and graphs in the reading material also bear some study. Read the legends, and ask a few questions about each. You may find it helpful to jot down your questions.

After questioning, review what you know about the subject. Maybe you have already read a poem by e.e. cummings. What do you remember about it? Take five to ten minutes to question and review, then begin reading. Not all of your questions will be answered all of the time, and new facts for which you didn’t have questions will come up. That’s to be expected.

**T I P 4** Find ways to make information memorable.

Paying attention means putting your mind in gear. Making information memorable, step 2 of the PMC method, means doing something to make what you learn stick with you. It’s a way of making things harder to forget. You can use a variety of techniques to make things stick in your memory. For example:

- Repetition
- Mnemonics: initials and words
- Poems, lyrics, and memorable sayings
- Word relations
- Roots and origins of words
- Pictures and diagrams

Unfortunately, memory devices fail from time to time. What doesn’t? However, the more attention you give to creating them and the more practice you get with them, the more reliable they’ll become.

**Repetition.** For some people, repeating a new fact silently or out loud will suffice to make it linger in memory. Try this. When you want to remember something, say it to yourself or say it out loud. Suppose you meet someone and want to remember her name. One way is to repeat it several times in the conversation. “Hello, Natasha. How are you? Natasha is a pretty name. Is it Russian? I’ve never met a woman named Natasha.” Later, when you leave, repeat the name one last time. “So long, Natasha. Give me a call.”
You can do the same when you read, study, or take notes. If your professor introduces a new term, write it down and say it several times to yourself. Do the same when you are studying.

**Mnemonics: initials and words.** The mind sometimes needs a little extra assistance, especially when faced with a lot of new information. Other tricks can be used. One of those is mnemonics. Mnemonics are memory devices—tricks that help you remember. Suppose, for instance, your environmental science teacher tells you that the key to building a sustainable society lies in five principles: conservation, recycling, renewable resources, restoration, and population control. How can you remember all of this? One way is to take the first letter of every word and form, if you can, another word. In this case, you are out of luck. You come up with CRRRP, but that may not be enough to jog your memory. Alternatively, you might think of the word carp.

The phrase “Matt Hill, V.P.” may be meaningless to you, but to a biochemistry student, it represents the first letters of the ten essential amino acids (methionine, arginine, threonine, tryptophan, histidine, isoleucine, leucine, lysine, valine, and phenylalanine).

This technique can be used in the sciences, where long lists of facts must often be committed to memory. It can also be used in the humanities—for example, to remember a list of Romantic poets or countries that export rubber. The next time you have to remember a list of items, try using their initials to make a word and see how much faster it is than just plain memorizing.

**Poems, lyrics, and memorable sayings.** Poems, lyrics, and memorable sayings can also be used to log information in your brain. Consider this phrase: “The simple way to remember Chuck, if the tank’s too hot you’re out of luck.” It may sound like nonsense to you, but to a scuba diving student it’s a way of remembering Charles’s Law, which states that pressure increases with temperature. (Thus, leaving a full air tank on a hot beach could be disastrous.) “Charles Pit” might be an easier reminder: Charles’s Law says that pressure increases with temperature.

Be creative. Take the words you want to remember and make a poem or saying if you can. If this doesn’t work, try the initials. Good teachers will help by suggesting mnemonics for remembering new information.

**Word relations.** Mnemonics are just one element in your growing bag of memory tricks. Word relations is another important device. For instance, suppose you want to remember that a high-pressure system rotates clockwise, while a low-pressure system rotates counterclockwise. How do you go about this? It’s easy. Think of your kitchen. High on the wall is the clock. Below it, the counter. What could be easier? A high-pressure system rotates clockwise, and a low-pressure system rotates counterclockwise.

**Roots and origins of words.** Breaking words apart into their roots, suffixes, and prefixes often helps to jog the memory. For example, a chemistry student trying to learn the term exothermic reactions can break the first word
into its parts. Ex means from, and thermic means heat. Exothermic reactions, then, are those that give off heat. Try breaking apart new terms that you want to learn. A few seconds with the dictionary can lock a word permanently into your memory.

Sometimes the origins of words are so interesting that they help you recall what the word means. The word comet, for example, comes from the Greek word meaning hair. Energy from the sun pushes a comet's gas and dust away to form a luminous white tail that looks like hair. Sanguine comes from the Latin word for blood. In English, sanguine means "blood red." The word laudry is a contraction of St. Audrey, a cheap and showydresser.

Take a few seconds when you encounter a new term. Break it apart to see if you can make sense out of it. If that doesn't help, and it won't always, look up the word in the dictionary to search out its origins.

Pictures and diagrams. Other useful tools that can help you remember information, especially processes and relationships, are pictures and diagrams. Drawing pictures is an especially useful way to learn structures of cells or parts of the body. Drawings and diagrams are often easier to remember than just plain words. (One very useful tool for organizing material is the concept map, which is discussed in Chapter 3.)

TI P 5 Correlate new facts and concepts with previous knowledge.

Paying attention, step 1 of the PMC method, means putting your mind in gear. Making the information memorable, step 2, means working to make facts and concepts stick in your memory. Step 3 involves efforts to correlate new facts and concepts with the information you already know and to tie new facts and concepts together to create a cohesive whole.

Correlation means tying things together—making sense of the bits and pieces of information you are learning and have learned in other courses. Instead of being content with a mind full of facts and concepts, take a few moments to see what they mean. This step alone often makes the difference between a B student and an A student. Correlation is useful in all aspects of study, especially in reviewing lecture or reading notes as you prepare for a test.

How do you go about correlating the information you're learning with what you've already encountered in your life? The answer is simple: by taking a few minutes to search your memory for related information. Suppose, for example, that you read that young children whose parents smoke suffer twice the number of upper respiratory infections as children whose parents refrain from this habit. Take a moment to think about friends and relatives. Did any of their parents smoke? Did they suffer from an increased number of colds?

You can also correlate with other facts about lung disease. For instance, you might recall from a previous class that children are more susceptible to pollutants than adults are because they tend to breathe deeper (they're generally more active). This might explain why they are susceptible to pollution from their parents' cigarettes.
Besides relating what you're learning to past lessons, correlation also involves a concerted effort to piece all the new facts together to create an understanding of the whole. In other words, it involves steps to assemble the big picture. The most successful students do it regularly. Graduate students, law students, and medical students, for example, will have a rough time in school if they just cram facts into their heads.

Here's a suggestion for assembling the big picture: After studying a section of your notes or reading a chapter in your book, summarize it in your own words, using the following guide:

1. What are the main points?
2. How has the author supported these points?
3. What new facts did I learn?
4. In what areas has my existing knowledge deepened?
5. What does this information mean?
6. How can I use it?

You can assemble the big picture in the shower or on your way to and from classes. Have a good talk with yourself as you hike or ski or swim. Imagine yourself in front of a classroom, explaining the information you just learned.

Not only does correlating facts tie information together, but it also helps keep your mind active, and it makes information truly more memorable. It has another benefit of great importance: It helps you become a thinker as well as a memorizer.
CHAPTER 3

Getting the Most Out of Lectures and Labs

Lectures are the backbone of a college education. Getting the most out of lectures requires students to be good note takers. In fact, exemplary note-taking skills are essential to success in college because many professors test from their lecture material, asking few questions from the textbook readings they assign. Note taking also helps students keep their attention focused, preventing the mind from drifting off to faraway places or to distractions in the classroom.

The goal of note taking during a lecture is simply this: to create a legible, easy-to-follow summary of your professor’s talk. Easy as that may sound, it takes a certain skill and a lot of practice to take good notes, especially in science classes, where teachers often use a variety of visual aids—such as overhead transparencies and slides—to supplement their lectures.

To understand the complexity of the task at hand, consider what goes on in a lecture. First, you must listen and understand what is being said. You must then analyze the information, though the pace of many lecturers leaves far too little time to think about what is being said. Next, you must sort through the incoming material, selecting what you want to write in your notes. Finally, you must jot the information down quickly so as not to miss the next point. That’s a lot of brain work and handwork in quick succession. With some helpful tips, though, you will find that the task is doable.

Laboratories present their own challenges. These structured learning environments require students to do most of the work. With a little guidance, though, you can excel in lab work and get good grades for your effort.

TIP 1 Know the subject of each lecture before you walk in the door.

Many students walk into a lecture unaware of the topic of the day. If they’re lucky, their professor will devote a few minutes at the beginning of the lecture to an overview—that is, listing the topics that will be discussed during the class period. Some professors will even write an outline on the board. Unfortunately, most professors simply say, “Today, we’re going to be talking about such and such,” and leave it at that. In this case, the lecture may seem like a disconnected set of facts, figures, concepts, and terms.

If your professor does not offer a daily outline of topics, you might ask him or her to provide one. Otherwise, you must do the work yourself.
Before each lecture, look up the topic of the day on your class schedule. Study the assigned chapter or reading material. At the very least, this entails a few minutes of time spent looking over the main headings and studying the key words, tables, and figures. You might also want to read the topic sentences of each paragraph. This procedure helps immensely, ensuring that the information you hear in lecture won’t be totally foreign. While other students are learning information for the first time, you’ll hear words and concepts that are familiar to you, helping you retain them more easily. (Chapter 4 discusses this topic in more detail, outlining a strategy to help you preview each reading assignment.)

The important point is that if your professor won’t supply you with an outline of each day’s material, you must learn the topic yourself before entering the class. While you’re at it, it is also helpful to spend a few minutes before each class reflecting on any facts you know about the subject to be discussed—that is, correlating the new information with what you already know. Spend some time asking questions as well. This is part of the technique for paying attention that is described in Chapter 2.

**T I P 2**

Spend some time before each lecture reading previous notes.

Reviewing your notes from previous sessions before every lecture is a useful learning tool. It helps you keep up with the lecture material, reducing the time you’ll need for study later on. It also helps you recall important facts and concepts that may be alluded to in the lecture. That is, it refreshes your memory, reviving information you will be expected to know in order to understand new concepts, facts, and terms. If you’re conscientious about reviewing lecture notes, it’s much less likely that you’ll feel lost. So, get to class a bit early, and spend five to ten minutes quickly reading through your notes from the previous lecture or two. You won’t be sorry you did.

**T I P 3**

Attend lecture regularly.

This rule needs little explanation. For many of us, learning requires repetition. We must hear and read information a number of times for it to sink in. Lecture is one of those times. Study sessions are meant to fix facts and concepts in your memory. If you don’t attend class and take notes, chances are you won’t get much out of the course—unless, of course, you’re a genius or extremely adept at learning outside of class.

Important as attending lecture is, some students skip class frequently, confident that they can learn the material from other people’s notes or from the reading assignment. Bear in mind, however, that borrowed notes may be far from perfect. They may cover only 20 to 50 percent of what was said in the lecture; important information may be missing. In addition, the note taker may have gotten facts wrong.

**T I P 4**

Write as legibly as you can.

A surprisingly large number of students have trouble reading their own lecture notes when they try to study them some time later. As a result, they
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miss important points, and their exam grades usually reflect this. Write as legibly as you can. If your notes are a mess, rewrite them or type them that same day.

T I P 5 Study your notes within a few hours of each lecture, and fill in the missing information.

If you decide to redo your lecture notes, use that time to study them, as recommended in Chapter 5. In other words, don't just copy them mechanically; think about them. Try to fix the information in your memory.

Besides helping you to learn the material you just encountered in lecture, reviewing your notes provides an opportunity to add information that was mentioned in lecture but that you failed to write down. To make this process easier, be sure to leave extra space when you're taking them the first time.

Even if you don't need to rewrite your notes, it is helpful to study them within a few hours of lecture. One technique that's quite useful is to try to recall what was said before looking at your notes. Run over the main points and whatever supporting information you can recall, then turn to your notes.

Forcing yourself to recall the information given in a lecture clearly helps you remember lecture material better. It can also reduce overall study time. Studies show that you will forget 75 percent of what was said in a lecture within one week if you haven't forced yourself to recall it. Within three weeks, 98 percent of what was said in a lecture will be forgotten. That's why it is so important to rewrite or study your notes and fill in the missing information soon after a lecture.

T I P 6 Develop a shorthand system to reduce writing during lecture.

You can waste a lot of time in lecture writing commonly used words and phrases. This laborious task might cause you to miss important details. Because of this, I recommend developing a shorthand system of your own. This will reduce writer's cramp and will help you avoid missing important information. Here is a list of symbols you can use in many courses:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>=</td>
<td>equals</td>
</tr>
<tr>
<td>≠</td>
<td>does not equal</td>
</tr>
<tr>
<td>w</td>
<td>with</td>
</tr>
<tr>
<td>w/o</td>
<td>without</td>
</tr>
<tr>
<td>&gt;</td>
<td>greater than</td>
</tr>
<tr>
<td>&lt;</td>
<td>less than</td>
</tr>
<tr>
<td>↑</td>
<td>increase</td>
</tr>
<tr>
<td>↓</td>
<td>decrease</td>
</tr>
<tr>
<td>.:</td>
<td>therefore</td>
</tr>
<tr>
<td>e.g.</td>
<td>for example</td>
</tr>
<tr>
<td>i.e.</td>
<td>that is</td>
</tr>
</tbody>
</table>

Abbreviations of commonly used words or phrases can also be a part of your shorthand system. In a biology course, for instance, the word muscle can be abbreviated mm, and species can be abbreviated sp. In a chemistry course, energy might be indicated by the letter E. In an American government course, FG might stand for federal government, C might be Congress, and SL might be state legislature.
Good note takers use a large number of time-saving abbreviations and symbols. Don’t make the mistake of trying to learn those that work for others. Develop your own system. Whatever you do, be consistent. Keep a list in the back of your notebook to ensure that you’re not using the same symbol to mean two different things.

Some students like to save time by omitting the vowels of certain words. For example: Omt vwls rdc wrng tme. This system takes some practice, but it can save time.

**T I P 7** Don’t write down every word your professor says.

Afraid that they’ll miss an important point, some students insist on writing down virtually everything the professor says. Although verbatim transcripts of lectures may seem like a good idea, it has its drawbacks. For one, if the lecturer talks faster than you write, you will fall behind and may miss many important points. Second, with this technique you become a parrot. Information generally won’t remain in your memory unless you “own” it—that is, unless you understand it and write it down in your own words.

Still, I recommend erring on the conservative side—that is, taking as many notes as possible. Concentrate your energy on writing down the major points and any supporting information and examples. Grasp the essentials, and leave room to fill in some of the details when you copy and review your notes later.

**T I P 8** Watch for signals that indicate important material.

Most professors want you to succeed. They love their subject and want you to learn it. Consequently, many professors give usually subtle, sometimes obvious, signals during lecture to show you what’s important—what’s worth remembering.

The most obvious clues include phrases such as “This is an extremely important point” or “This would be a good test question!” Be aware of these hints.

Many professors also summarize key points on the board or on an overhead projector. When they stop to write, they usually do so for one of two reasons: (1) It’s a difficult word or concept to spell, or (2) it’s an extremely important concept that they want you to get it in your notes. Some students only write what the professor writes, but that’s not enough.

**T I P 9** Sit toward the front of the class.

If at all possible, sit near the front of the class. The farther back you are, the more distractions exist between you and your professor. A snoozing student, talking friends, shuffling papers, and many other distractions draw your attention away from the lecture, making you miss important points.

In classes in which students are seated alphabetically by last name, you may end up in a place that doesn’t suit you. If you’re stuck in the back, ask your professor if you can move forward. If you explain that you find it too distracting to sit in the back and really want to get the most out of this important class, your professor may find you a spot up front. Don’t be shy! It’s your education that’s at stake.
T I P 10 • Ask questions.
If you are unclear about a point made in lecture, ask immediately. Chances are that other students are confused as well. If you don’t get the point clarified, you will fall behind or become confused later on in the lecture. If you’re too shy to ask a question in class, ask your professor for an explanation after class. If you don’t have the time to talk to your professor after class, make an appointment to talk to him or her or to the teaching assistant as soon after class as possible.

T I P 11 • If your professor talks too quickly, politely ask him or her to slow down.
In my college days, I had a few “motor mouths”—professors who talked ninety miles per hour. One particularly challenging professor spoke rapidly while writing complex chemical formulas on the board. Students could either write down what he wrote on the board or take down his words, providing only half of what we needed to know. Most of us felt lost and a bit angry.

You may encounter a few motor mouths yourself in your college career. If you’re faced with this dilemma, you have several choices. During class politely ask your professor to slow down, or send your professor a polite note explaining that you and other students are having a hard time keeping up. If that doesn’t work, you may want to get together with other students after class to compare notes. You may also want to tape the lecture, if that’s acceptable to your professor. Taping will allow you to fill in the gaps. If none of these solutions works, drop the class and try another professor next semester.

T I P 12 • Remain an active participant during lecture.
Education is a two-way street. As a rule, you won’t get much out of it if you don’t put much into it. Note taking is one of your inputs. As mentioned earlier in this chapter, note taking helps you keep your mind focused on the lecture, preventing you from drifting off into never-never land.

Tape recorders and note-taking services are two alternatives to taking notes yourself. As a rule, neither one is recommended. Tape recorders, for example, give you a false sense of security. When using tape recorders, many students stop taking notes. Instead, they sit and listen. If you’re not actively taking notes, your mind tends to wander. Before you know it, you’re thinking about last night’s date or an upcoming party. You drift in and out of the lecture, picking up bits and pieces but losing the continuity.

If you want to use a tape recorder, use it only to back up your note taking. In other words, use it to fill in the empty places in your notes.

Note-taking services are available at some colleges and universities. Professional note takers are hired to sit through a lecture and take notes. They type up the notes, which are distributed to students who have subscribed to the service.

Although they may sound appealing, these services are a lot like tape recorders. They give students a false sense of security. In fact, some students use them as an excuse to skip lecture. Other students stop taking notes during lecture, sure that the note taker will get it all down. If you’re
not actively taking notes, your mind may start to wander. Before you know it, you're getting little out of the lecture. You're wasting time sitting in class. To make matters worse, note takers aren't always accurate; if you rely solely on their notes, you could be learning incorrect information.

If you think you need a lecture service, use it only as a backup. Take good notes. Review your notes soon after each lecture. Recopy them, if necessary. Rethink them. Fill in the blanks from memory. Then use the lecture notes from the service to fill in any remaining gaps. Use the lecture notes to serve as a good summary.

**T I P 13** Use loose-leaf notebooks for note taking.

By far, the majority of the students I have taught over the past fifteen years use spiral notebooks for taking notes. Spiral notebooks offer a number of advantages. Perhaps the most important is that they help you keep all of your notes together. However, spiral notebooks can hinder your learning. How?

If your professor is disorganized, jumping around from place to place, and you record your notes in a spiral notebook, your notes will reflect the professor's scattered approach. If, however, you use a loose-leaf notebook, you can move pages around. A topic in lecture 7 that fits better in lecture 5 can be written on a separate sheet, removed, and placed where it is more appropriate. Moreover, a loose-leaf notebook allows you to integrate reading notes and handouts into your lecture notes. You can organize your notes and all of the ancillary information in a way that makes them easier to study.

**T I P 14** When taking notes, highlight important information.

When it comes to note taking, you have at least four options. First, you can write everything out in paragraph form. This method is the least desirable of all. Nothing stands out in your notes except a bunch of paragraphs. If you insist on taking notes this way, underline key concepts and terms as you write. That way, at least, important information will be highlighted.

You can also use an outline form, listing main topics and subtopics as shown below:

```
The Cell Membrane

I. Structure of the membrane
   A. Electron microscopic structure
      1. Appears as double membrane
      2. Two dark bands separated by clear band
   B. Model of membrane structure
```

Outlines help you recognize the organization of a lecture and pick out important details at a glance. For many students, however, they aren't worth the effort. Too much time must be spent thinking about the mechanics of outlining while important information escapes you.

A third method is to organize your notes by major topics, listing supporting information below them. This is a modified form of outline
without all the numbers and letters. The previous outline might be written as follows:

The Cell Membrane

Structure of the membrane
- Electron microscopic structure
- Appears as double membrane
  - Two dark bands separated by clear band
- Model of membrane structure

Use bullets (*) or dashes (—) if you want to group information. This method is fast and efficient. It helps you organize the information you hear, much as an outline does but without all the hassle.

The fourth option is more graphic. Known as concept mapping, this technique uses boxes, lines, and circles to show the relation of key concepts and facts to one another. Concept mapping is useful for a number of subjects. Consider an example from psychology. Below is an abbreviated schematic from a lecture on motivation:

```
Motivation

Definition
The reason someone has acted
Hunger—good example
Not complete agreement in psychological community on definition of motivation
Some psychologists prefer narrow definition limited to internal events (e.g., hunger)

Biological motivation
Hunger

Thirst

Others concentrate on broader definition—to include anything that makes an organism act
```

This method helps you organize material in your mind by showing key relationships. It will help you grasp the big picture and often makes information more memorable.
Concept mapping is also helpful when taking notes on reading material. Some recent college textbooks and some study guides that accompany textbooks contain concept maps. Nonetheless, I recommend that you develop your own; that way, you'll organize the information in ways that make the most sense to you. When you're done, consult the concept maps in your study guide to compare your organization with the author's and to see if you've omitted any important concepts, facts, or relationships.

A few words of advice about concept mapping: It is advised that you begin with the more general concepts at the top of the map. List the more specific concepts below. Concepts of equal weight should be placed on the same line. Enclose all of the concepts in boxes or circles, as shown in Figure 3-1. Use lines to link the concepts in various ways. For example, horizontal lines show the relation of concepts on the same level, and vertical lines connect general concepts to specific concepts. Rather than simply drawing lines from one box to another, it is often useful to include a few words to explain the linkage. As you make concept maps, you'll find that you can make very simple ones that illustrate key concepts and that you can later refine these maps by adding more detail.

**T I P 15** Take your book to class if your professor uses visual aids based on the book's art program.

In many classes, especially the sciences, professors rely on a variety of visual aids to illustrate concepts and relationships. The two most commonly used aids are overhead transparencies and slides. Today, however, more and more professors use videos, films, and video disks. What can you do to make the most out of visual aids?

This discussion focuses on the more traditional visual aids, slides and overhead transparencies, which often contain a wealth of information—too much to sketch or capture in your notes in a darkened classroom. Fortunately, many professors provide handouts with the same material so you can follow along and jot notes in the margins. If your professor doesn't provide handouts of key visual aids, a polite request might be in order.

If your professor refuses, you may be able to get by if you bring your textbook to class. Most publishers provide professors with slides and overhead transparencies based on artwork in the text. If this is the case, it's wise to bring a copy of the book to class so you can refer to the diagram during the discussion. You might ask the professor where the transparency comes from—that is, the figure and page number—so you can refer to it quickly and not waste time paging through the book to locate it. Many publishers include this information on transparencies. With slides, though, you're out of luck. Unless your professor has a list on hand, he or she won't be able to pull the slide from the projector to get the information.

**T I P 16** Take notes during audiovisual presentations.

Videos, films, and video disks present a distinctly different chal-
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lenge—hundreds of images and loads of information in a short period. Unfortunately, most students view these presentations as a time to relax. They tend to sit back and watch, passively absorbing the material they see and hear. When the presentation is over, they have no written record of the material, only some fleeting memories. Accordingly, most of the information is lost soon after the class ends.

If videos, films, and similar presentations are meant to underscore previously made points, then there’s probably little reason to take notes. If they’re used to present useful and testable information, though, it’s a good idea to take some rudimentary notes during the presentation.

But how can you take notes when most professors turn the lights down when they show a video? Surprisingly, you can actually see a lot once your eyes have adjusted to the dim light of a lecture hall, at least enough to scratch out some key points. You might find it useful to team up

FIGURE 3-1
Sample concept map.

with several other students. Together, you can probably get most of the information you need from the presentation. If you really want to take notes, you might acquire a small flashlight to illuminate your notebook.

**T I P 17** Prepare for labs by reading the lab exercise and background material in your text and notes.

A number of college classes, including foreign languages, are accompanied by laboratories. Most labs, however, are held in conjunction with science classes. Most science labs provide hands-on experience with laboratory equipment and introduce you to the process of scientific discovery. Ultimately, lab exercises are meant to hone your observational and analytical skills.

Science laboratories are usually quite time-consuming. They require an inordinate amount of time in the lab itself and lots of time outside the lab analyzing and writing up results.

To optimize this learning experience, before each lab read the objectives and procedures to be followed. Don’t do your first reading of the lab exercise during the lab period. If you’re unclear about terms and concepts in the laboratory workbook, look them up in your textbook or notes. Background material in your textbook and notes can help make the lab more meaningful.

**T I P 18** Record your results accurately and neatly.

During your laboratory exercise, you will record observations and data in a notebook or in your lab workbook. Be thorough. Take time to make measurements accurately and to record your results precisely and legibly. This will help you later when the time comes to write up your results.

**T I P 19** When you write up your lab report, be thorough, thoughtful, and prompt.

As you write up your reports, be thorough. Lab instructors generally like to see more than the bare minimum. Find room to integrate material you learned from the lecture or from your textbook or readings.

Even if the results turned out all wrong, try to offer an explanation for your “failure” to produce the desired results. In science, “failures” can sometimes be more instructive than successes.

Most laboratory instructors require students to turn in their lab reports every week or several times during the semester. In either case, it helps to write up your results promptly after completing each lab. This minimizes forgotten observations and reduces the crunch of having ten lab reports due tomorrow.

This chapter offered many suggestions on how to make the most out of lectures and labs. Take a moment to review the main ideas and list those that you would like to implement.
Habits we develop early in life often come back to haunt us as we grow older. For example, as children we learn to read one word at a time and usually out loud. This habit carries over into adulthood. Although as adults we generally read silently, many of us continue to read one word at a time, saying the words we’re reading to ourselves—a habit known as subvocalization. Both subvocalization and the one-word-at-a-time habit serve as brakes on reading speed.

These are not the only bad reading habits we learn. Another especially troublesome habit is the linear approach to reading. That is, early in life, most of us learn to start at the beginning of a reading assignment and pore straight through until we reach the end. Although this may sound like a logical strategy, it’s not always the most efficient one.

All three of these habits not only reduce reading efficiency, but also decrease retention, as you shall soon see. To be an effective reader and to optimize your limited time, it’s essential to “unlearn” the habits that hold you back. This chapter teaches you how to do that and shows you ways to read faster and more effectively. It deals principally with textbooks and outside readings that you will encounter in your classes.

TIP 1 • Before you begin reading your textbook, read the preface.

Many students bypass the preface of a book. This is a bad policy because the preface often contains valuable information. The preface usually describes the organization of the book and its main theme and subthemes. In other words, it gives you the big picture. This helps you remain oriented as you work your way through the book. Reading the preface will help you understand how the information fits together. It may also assist you in uncovering biases that may crop up in subjects such as environmental science and political science (more on this subject in Chapter 8).

The preface typically lists the main features of the book, such as end-of-chapter questions, summaries, and other learning tools. Look over the list of these items so you know what tools you have at your disposal when you start to study the material.

TIP 2 • Preview the chapter or assigned reading.

Most students approach a reading assignment as they might approach a walk home from school; they take the shortest course, usually a straight
line between point A and point B. That is to say, most students start reading at the beginning and read straight through until they reach the end.

Although this may work for a novel, it's a rather inefficient way of reading a textbook or an article. In fact, the fastest and most efficient way of reading class material does not follow a straight line.

Before you plunge into a reading assignment, preview the material. Read the title of the chapter or article first. Study the main headings. Nowadays, many texts include chapter outlines at the beginning of each chapter that permit you to preview the material at a glance.

The purpose of previewing is to see how the material in the reading assignment is organized. This helps you set up logical categories in which to place the new information you are about to learn. Moreover, previewing shows how important concepts are related.

Consider an example. Chapter 2 of a health book called Life Choices by Eleanor Noss Sizer and Francis Sienkiewicz Whitney (Brooks/Cole Publishing Company) contains the following main topics:

- Sensors and Stress
- Body Systems: Nervous, Hormonal, Immune Systems
- The Stress Response
- Stress Management Strategies

By looking over the headings, you get a good idea of how the authors have organized the material. First, they talk about sensors and stress. They then look at key body systems that are affected by stress. Next, they look at the body's response to stress, and they conclude with stress management strategies—that is, ways to reduce stress. As you read the chapter, you will learn more about each topic.

**T I P 3** Ask a question or two about each heading.

After you understand the organization of the material you are about to read, it is time to probe a little deeper. Perhaps the best technique is to ask a question or two about each heading. This deepens your involvement and primes the brain by setting up expectations. Later, when you answer the questions, it's more likely that you will truly remember the material. Consider the example used in Tip 2. Below are the main headings and a few questions that came to my mind:

- Sensors and Stress
  - What are sensors?
  - Are they part of the nervous system?
  - Are special sensors involved in stress?
  - What exactly is stress?

- Body Systems: Nervous, Hormonal, Immune Systems
  - What is a body system?
  - What is the nervous system?
  - What is the hormonal system?
  - What is the immune system?
How are these three body systems related to stress?

The Stress Response
  My heart rate responds to stress; does everyone’s?
  How else do people respond to stress?
  Will stress hurt me?

Stress Management Strategies
  I know you can reduce stress by relaxing, but what other methods can you use?
  Can exercise reduce stress?
  What about biofeedback?

Asking questions not only forces you to think about the material, it also forces you to recall what you already know about it. In addition, it creates hooks (questions) on which you can hang the new information. Learning to ask questions will take practice, but after a short while you will get the hang of it. As you read through your assignment, many but not all of your questions will be answered. You will learn a lot more than you expected, too.

Although this process seems like a lot of work, it ultimately saves time. It will make facts and concepts stick in your memory and will reduce your study time.

**T I P 4** Read the first sentence of each paragraph.

After you have read and studied the outline, which should take only one minute, and have asked questions, which may take two or three minutes, you can get on with your reading. Right? Wrong.

Now it’s time for another previewing feat. It’s time to read the first sentence of each paragraph. In most nonfiction readings you will encounter, the first sentence of each paragraph is usually a topic sentence that describes the subject of each paragraph and is therefore the author’s signal to you. It is the author waving a flag and saying, “This is what the paragraph you are about to read is all about.”

By reading all of the topic sentences in an article or chapter, you get a better feel for the material covered. Be sure to take your time as you read the topic sentences. If the first sentence isn’t clear, read the next one, but no more. If it still doesn’t make sense, move on. Don’t get bogged down at this stage.

**T I P 5** Preview tables and figures.

After previewing the main topics of the chapter, asking questions, and reading the topic sentences, you may want to look over all of the illustrations and tables. In well-written textbooks, the illustrations usually tell a vivid story. If the author and publisher have been conscientious, the figures and tables should provide a graphic account of the chapter’s contents. A well-drawn figure will condense hundreds, perhaps thousands, of words. Drawings and pictures also help make information more memorable.
Tip 6 After previewing, read the chapter or article, taking notes and highlighting key terms or concepts.

At this point, you have spent ten minutes looking over the chapter, familiarizing yourself with its organization and content, and fixing some of this information in your memory. Now it’s time to read.

As you read, move quickly, highlighting key facts and concepts. Underlining and highlighting in the conventional manner are extremely time-consuming. Instead, try putting check marks in front of important sentences, or run a straight line down the left-hand margin of a paragraph that’s extremely important.

Also, make notes in the margin of the book or on a separate page, but be sure to use your own words. If you merely repeat the author’s words, you probably won’t remember the information as well as if you paraphrase it.

If you must underline or highlight, do it sparingly. Underline or highlight material after you have finished a paragraph, and only highlight the most important information. If an entire paragraph seems important, a line down the left-hand side of the paragraph will suffice.

In fiction courses, a word to the wise: Don’t lose the forest for the trees. That is, don’t pay so much attention to detail that you fail to see the big picture. Fiction classes don’t require you to memorize a story, but you should be able to discuss the plot, the author’s theme, the historical or psychological relevance of the piece, the style, and so on. Make notes on these features in the margins or on a separate sheet of paper. Put them in your own words. They are an expression of your understanding and will stick in your memory better than words you attempt to memorize. Some details may be necessary to support your contentions. Jot them down or mark them in the book itself.

When reading, don’t take notes until you have finished reading a block of material; otherwise, you may go overboard, jotting down lots of details that aren’t necessary. Waiting until you have finished a paragraph or even a section will help you learn to be more discriminating—that is, it will help you learn to pick out the most important information.

Although textbooks are becoming quite costly, many students find it advantageous to buy new books. That way, they can avoid someone else’s scribbling and underlining. If you can’t afford a new book, try to find a used one that hasn’t been marked up or has been highlighted sparingly. Don’t trust the existing markings. The book’s previous owner might have gotten an F because he or she underlined the wrong information.

Tip 7 Take frequent breaks.

Many people read hour after hour. As they do, they get more and more fatigued (mentally and physically) and become less and less efficient. The decline in learning efficiency means that they will have to put more hours into their study, creating a self-defeating cycle.

The best advice is to pace your study. Read or study for fifty minutes or so at a time, then take a break. Go out for a ten-minute walk. Do some
jumping jacks or run in place, then come back for another fifty-minute period. For some people, fifty minutes is too long. They grow tired after thirty minutes. Work with the period that suits you best.

The bottom line is this: When you find yourself getting tired, get up and move around. If you are really tired and can't seem to concentrate, take a nap or go out for a vigorous walk or run. You’re wasting your time studying if you’re half asleep, so be on the alert for telltale signs of fatigue.

**TIP 8** Reread the assigned material and notes a few days later.

After you have read the material, wait a few days, then reread it. If you wait longer than a few days, you will forget too much. Rereading helps you fix information in your memory. It could cut study time for an exam considerably.

**TIP 9** Be sure you understand all terms as you reread.

It’s tempting when rereading to skip terms and concepts that are confusing or difficult to grasp. Unfortunately, in many cases that information becomes essential to understanding new facts and concepts. If you don’t make an effort to understand confusing or difficult material, you’ll fall behind. Skipping terms you don’t understand is like leaving bricks out of a building you are constructing. Sooner or later, if you leave enough out, the building will topple.

Thus, when you encounter a term or concept that isn’t explained clearly or is difficult to understand, read the material one more time. Think about it for a minute or two. If it still doesn’t make sense, try another source. Look up the term in the glossary in the back of the textbook. If that doesn’t work, try a dictionary. Special dictionaries are available for the sciences (biology, environmental science, chemistry, and so on) and are a worthwhile investment. In some cases, a definition from another source may make more sense than the one your book offers. You may also want to try using an encyclopedia, although the coverage there may be far greater than you need.

**TIP 10** Use study aids.

Nowadays, most textbooks come with a wide range of study aids to help you retain the information in your memory. Key terms, for example, are often boldfaced. Pay attention to them. Make sure you can define each term clearly and accurately after you have reread the chapter.

Many texts also offer end-of-chapter glossaries—lists of terms and definitions located at the end of the chapter. Use them to study. Other texts put definitions in the margins of the book.

Most introductory-level textbooks also offer chapter summaries. Summaries usually cover just the key concepts, although some authors write fairly comprehensive summaries that include many facts and definitions. If you don’t have time to reread a chapter, be sure that you at least read the summary a day or two after you complete a chapter to refresh your memory.
Another useful study tool is the end-of-chapter question section found in all textbooks. Most textbooks offer a variety of questions, including fill-in-the-blank, multiple-choice, and essay questions. End-of-chapter questions help you review the material. They also permit you to detect weak spots in your growing knowledge base as well as areas of strength. Answer these questions after you have reread and studied the chapter.

One suggestion about essay questions bears mention. Many students who are pressed for time look over essay questions and say, "Yeah, I know that," then move on. For most college classes, you must illustrate some depth of knowledge, and you can't assess your depth of knowledge until you try. When you do, you may find that you have omitted a few key points—points that will result in a lower test score than you might have anticipated.

So, don't skip over essay questions. Take the time to write an answer to each question as if you were turning it in for a grade. Check your answers against the book and your notes to be sure you have included all of the pertinent information and have expressed it correctly. Save your answers for later study.

Tip 11: Use a study guide to help streamline your studying.
Most introductory-level textbooks are published with an accompanying study guide. Study guides frequently contain detailed outlines and summaries of text material. They also offer concept maps and additional questions to review and judge your knowledge of the material presented in the book.

Study guides offer three advantages. First, although the summaries in study guides are more detailed than the end-of-chapter summaries in your textbook, they are generally not as lengthy as the actual chapters. Therefore, you can read the study guide summary fairly quickly, which saves you a second or third reading of the chapter.

The second advantage is that study guides are frequently written by someone other than the textbook author. Consequently, you get a chance to read the same material from another perspective. In some instances, the study guide author may actually write more clearly and may explain some concepts better than the textbook author. Additionally, just hearing a concept, fact, or process explained in a different fashion frequently makes the information stick in your memory better.

The third advantage of study guides is that they offer many more sample questions and often a greater variety of questions than textbooks. Use the questions as a review tool and as a diagnostic tool to spot your strengths and weaknesses. If you miss a question, reread the material in the study guide or your textbook.

Tip 12: Work through all the problems in the chapter.
Many math and science courses (genetics, chemistry, and physics, for example) require you to know important terms, concepts, and facts. Many courses also require students to be able to work through problems by manipulating formulas and numbers.
Along this line, many textbooks offer sample problems within the text. In such instances, the author typically "walks" you through the problem, showing its resolution. For instance, the author provides the equation and then shows how it is applied, using the information given in the problem. Many students read over sample problems and say, "Yeah, I see," then move on. When test time arrives, the questions are often changed a little bit. Students are confused and unable to solve the problems because they never really understood what they were doing.

To make sample problems really effective, work through them with the author. Then close your book and do them from memory. This ensures that you understand what you're doing. Why use a particular equation? Why wouldn't another work? On a test, what equations might seem workable but would lead you down the wrong path? What constants are used? What units of measurement are you dealing with?

After you have worked through all of the sample problems, try the problems at the end of the chapter. Work through each one, then check your answer. If you're having trouble, ask for help.

**T I P 13** → **Read other textbooks.**

I had a physics textbook during my junior year in college that nearly drove me insane. At night, I would read and reread the book, desperately trying to understand the material. Many times, I would heave the book across the room in frustration, thinking I was just too dense when it came to physics. Unfortunately, it never occurred to me that it was the book that was dense, not I. In fact, some years later, while teaching, I had to look up some material in my college physics book. Much older and more able to judge the quality of writing, I quickly realized that the author was incomprehensible. I borrowed a physics book from a friend, and sure enough, everything made sense.

Although college textbooks have improved considerably since the late sixties and early seventies when I was a student, there are some losers out there. If you are having trouble understanding your book, don't assume that the problem is yours. It may be the author's.

If you're wondering who's thicker—you or the book—try another text. Your bookstore or library may have some on the shelves. Your professors and teaching assistants may also have books they can lend you. Professors often have shelves full of textbooks that they've received from book publishers. Tell them you're having problems and you want to try another book. They'll appreciate your diligence and may be willing to help. If not, you can try a bookstore at a neighboring college. Ask your professor or other professors in the department for recommendations. A few phone calls to bookstores may turn up a text that's more enjoyable and more understandable than your assigned book.

**T I P 14** → **Avoid subvocalization.**

As mentioned at the beginning of this chapter, most of us subvocalize when we read—that is, as we read silently, we say the words to ourselves. Subvocalization is like driving a car with your foot on the brake. Fortu-
nately for many, subvocalization is a relatively easy habit to kick.

As you read, be aware of subvocalization. To test yourself, reread a few paragraphs in this book. Are you subvocalizing? If so, read the material again without talking to yourself. By learning to read without subvocalizing, you can cut your reading time. This will make your studying more efficient and will save you many hours.

How do you teach yourself to avoid subvocalization? It’s simple. Keep reminding yourself not to do it as you read. After a while, you will be able to read material without a little voice in your head reading it to you.

**T I P 15** Read word groups.

Another bad habit we develop early on—and one that’s also easy to break—is reading one word at a time. It’s a little like stepping on the accelerator and then immediately stepping on the brake over and over again as you drive down the street. Obviously, this won’t get you anywhere fast.

To test yourself, read a few lines. Are you reading one word at a time, or does your eye focus on groups of two or three words at a time?

If you are reading one word at a time, you’re reading too slowly, and you’re wasting valuable time. To break the habit, try this: Place your index finger under the first line of the previous paragraph. Read across the page, stopping several times on each line as your eye focuses on two to three words. In the first glance, you will read, “To test yourself.” In the next jump, you will see, “read a few lines.” In the third jump, you will see, “Are you reading,” and so on.

Each stop is called a fixation. During the momentary fixation, your eye fixes on a number of words, which your brain attempts to interpret. The group of words is a thought unit. As you train your eye, you may be able to grasp larger and larger segments, linking the key thought units together in a coherent picture.

Now, read a second line using this technique. Try another line, then an entire paragraph. At first, you may want to hop along two words at a time. If that’s comfortable, fine, but try eventually to read three or four words at a time.

This technique will train your eyes to see more, and it will allow you to increase your reading speed. It may even help you increase your comprehension. Reading too slowly allows the mind to wander. The more you push your eyes (and your mind), the more attention you are paying and the less your mind will wander.

Practice this technique every day for the next couple of weeks, during the summer, or over spring or holiday break. Some courses on speedreading recommend using a light novel for practice, but I think textbooks make excellent practice material. Don’t worry about comprehension at first. Your job is to train your eyes to sweep across the line of text. Use your finger until you have trained your eyes to jump across the page. Remember that you have a lot of bad training to counteract, so don’t be dismayed if you don’t seem to be catching on at first. Comprehension will come with practice.
TIP 16 Read for key words.

You can train yourself to read even faster and, ironically, more efficiently by learning to read key words. Consider the sentence you just read. Look back at it, and underline the key words. It should look something like this:

You can train yourself to read even faster and, ironically, more efficiently by learning to read key words. This technique allows you to grasp the meaning of a sentence and ignore the unessential.

Let’s try a paragraph from a textbook I wrote on environmental science. Read through the paragraph and underline the key words. Here’s it is:

Conservation must be at the heart of all energy strategies. Nations that rely on energy cannot afford to waste it. Conserving energy offers numerous advantages. First, it can significantly reduce the cost of producing goods, giving industries an economic advantage in the marketplace, reducing inflation, and saving consumers millions of dollars. Second, it also helps us stretch fossil fuel supplies and thus gives us more time to find substitutes. Third, energy conservation can reduce environmental pollution and waste disposal.

See how easy the key words are to spot? Even though this material may be new to you, your eye quickly picks up the main nouns and verbs.

Training yourself to read key words will take a little practice, but it’s well worth the investment of time. If you don’t have the initiative to learn on your own, sign up for a speed-reading course at your college. You could easily double or triple your reading speed without a loss of comprehension.

Surprisingly, reading key words often makes it easier for you to read technical material, which is sometimes poorly written and confusing. Reading the key words allows you to cut through the author’s poor writing and pull out the important terms.

TIP 17 Avoid regression.

Reading one word at a time and subvocalizing reduce the speed with which you read. But these are only two of the bad habits that most of us have developed. Many people also regress as they read—that is, they constantly look back over the material they have just read to be sure they’re not missing important points.

Regressions slow you down and waste a lot of time. In most cases, you got the point, but you’re a bit uncertain about it. Trust your own mind. Chances are the author will repeat the point or elaborate on it in a way that will clarify the confusion you may be feeling.

As a rule, avoid regression and move swiftly through your reading. If you find yourself regressing, chances are you’re tired, distracted, or hungry—or a combination of all three. It might be better to get a little rest, a bite to eat, or a little exercise.
In closing, good reading skills are an important asset that will pay huge dividends throughout your life. Take some time now to break old habits and develop useful new ones. Read over the suggestions given in this chapter, and implement those that appeal to you the most.
Tests are a prominent feature in most college courses. For most students, they’re one of the least enjoyable aspects of college life. You may be surprised to learn that many teachers aren’t very fond of tests either.

No matter how unpopular they are among all participants, tests are a necessary part of our educational system. They give students an opportunity to crystallize the information they’re studying and fix it in their memory. They enable teachers to assess how much students are learning and, ultimately, how well they’re doing as educators. Tests also provide an opportunity to create a quantitative measure (a grade) that’s mighty helpful in sorting out candidates for graduate school, medical school, dental school, and so on. Grades help employers in their selection of employees as well.

Most of us have a long (and sometimes painful) history of test taking before we even enter college. Four years of college promise many more tests and (in some cases) sleepless nights—not an exciting prospect for many students.

My years of teaching suggest that most students have a bad attitude toward tests. This, in turn, often makes studying for tests and taking them all the more difficult. Thus, a negative attitude toward tests can become a stumbling block that decreases your performance level. Looking at tests in another light, however, may eliminate some of the bad feelings that have built up over the years. How do you go about erasing your unfavorable view of tests?

Think about the studying that you must do to perform well on tests as a chance to solidify your knowledge—that is, to make sense of the information you’ve been studying. Much of this information could be useful in your life. It may come in handy during chats over coffee, in political debates, or on the job.

Tests give you an opportunity to become more knowledgeable and potentially more successful in life. This is especially true if you work hard to find ways to make the subject relevant to your life (as discussed in Chapter 2). The more connections you find, the more useful your education will become.

Doing well on tests requires more than an attitude change. It requires numerous changes in how you study and how you take notes. In fact, virtually every step you have learned so far—from tricks to improve your memory to tips on becoming a more effective reader—will help make studying for tests and test taking more efficient, more enjoyable, and more
profitable. This chapter offers additional ideas that will help you prepare for exams more efficiently and become a more successful test taker.

## PREPARING FOR TESTS

### T I P 1 Review your lecture notes before and after each class.

Perhaps one of the most important pieces of advice anyone could give you as a college student is to keep up with your class work. Don’t fall behind, waiting until a few days or even the night before your exam to decipher your notes and read your text.

Staying abreast of all of your classes is actually quite simple, requiring only a few hours a week. One technique is to take a few minutes after each lecture to review your notes, as discussed in Chapter 3. Go over the main points. Get a general idea of what was said. If time permits, write out the main topics on a separate sheet of paper. This will help you retain them in your memory.

Another good idea is to spend some time after each lecture filling in the details that you may have learned but failed to write down. This will require a little more of your time, but it’s time well spent. (See Chapter 3 for more on this subject.)

Reviewing before each lecture also helps you keep abreast of your class work. It helps prevent confusion when your professor mentions material from a previous lecture or covers topics that require an understanding of previous material. Remember, education is a building process. New topics are generally built on an understanding of other concepts and facts. If you don’t build a solid foundation, new facts may seem meaningless and disjointed.

### T I P 2 Keep up with the assigned reading.

Many students wait until the last minute to read assigned material and then complain that there was too much information to comprehend. To avoid this counterproductive strategy and to get the most out of your reading assignments, read your textbook and reading materials before each lecture. If you don’t have time, skim the chapter. Read the major headings to determine how the chapter is organized. Then read the topic sentence of each paragraph, study the figures, and read the summary. This will familiarize you with the basics and acquaint you with new terms that you’ll need to know. (For more tips on reading, see Chapter 4.)

### T I P 3 Determine how much of the test will come from notes and how much from the textbook.

Most professors are more than willing to tell their students the percentage of material on the test that will come from the lecture notes and from readings. Many professors cover this topic early—during the first day of class. That’s one reason why it’s so important to attend the first class! Many professors also give a breakdown in the class syllabus, which is generally
distributed on the first day. Be sure you read the syllabus carefully. Underline or note important class requirements so you know what’s expected of you.

**T I P 4** Prepare outlines of lecture notes and reading material.  
Another recommendation that may help you excel in your test preparations is to take some time at the end of each week to prepare an outline of your lecture notes. Concentrate on the main points or ideas. First, flesh out your outline with your notebook closed. When you are done, compare your written outline (made from memory) with your lecture notes. Fill in the points you skipped over, perhaps in a different color pen or pencil. This will help you pinpoint the information you’re having difficulty remembering.

If your instructor assigns readings and expects you to know that material for the test, it’s also a good idea to outline the reading material. As noted in Chapter 4, many textbooks include brief chapter summaries that present the key points. However, most summaries do not provide enough information for a thorough understanding of the material.

Therefore, write your own outline after reading and studying each assignment. List the main concepts and facts and then any important supporting information. Determine weak areas by comparing your outline to the reading assignment. Fill in the points you missed.

Although outlining may seem like a lot of work, it could save you time in the long run. Outlines of reading material and lecture notes are excellent tools for preparing for exams.

If your instructor tests heavily on reading material and expects you to integrate your lecture notes with it, you will need to draw the two outlines together. In other words, you will need to transfer information from your reading outline to your lecture outline. If this is the case, leave some room in your lecture outline to add reading material. You may want to highlight reading material by using a different color pen or pencil.

As you study your combined outline, you may feel a sense of pride and accomplishment knowing that you are drawing together information from different sources and integrating it into a cohesive whole. In the world of business, engineering, politics, and science, that’s generally how learning takes place. The more adept you are at this process, the farther you will go in life.

**T I P 5** Use software tutorials to improve your understanding of the material.  
In addition to study guides, which were described in the last chapter, many publishers offer computer programs that students can use to study class material. If you own a computer or have access to one, you might want to try one of these fairly inexpensive interactive tutorials.

Tutorials can be used in a variety of ways. For example, they can provide a supplementary explanation of material covered in the textbook or lecture. If you’re having trouble understanding your text or your
professor, you can turn to a tutorial for alternative explanations in the same way that you would refer to other textbooks or study guides.

Tutorials can also be used in place of study guides to review material before or after lecture. If you review the material before class, the tutorial will help make the lecture more meaningful. If you use it after class, it will help you solidify concepts presented in lecture. Using it both before and after lecture confers both benefits.

Computer tutorials also serve as a means of monitoring your progress—your areas of strength and weakness. After you take the quizzes, the program will often explain why some of your answers were incorrect.

Finally, tutorials can be used to review material. Some programs have quick-access functions that allow you to obtain summaries of topics covered in the tutorial. If you want to review specific information that you have pinpointed as a weakness, you can access it through this function.

T I P 6 Avoid cramming.
Cramming for an exam is something of an American pastime. The unfortunate thing is that cramming often works—that is, it earns students decent grades. Most of us can sit down the night before an exam and cram in a lot of information. The next day we dutifully spit it out on the exam. Soon after, though, most people find that little, if any, of the information has been captured in long-term memory.

In other words, cramming may help you get good grades, but it’s not learning, and learning is what college is about. Most students may focus on grades, but they should be a secondary consideration. A 4.0 grade point average is meaningless if it was achieved by cramming lots of information into short-term memory.

Besides being counterproductive to learning, cramming doesn’t always work, especially for topics that require a deeper understanding. You may be able to spit back facts and figures, important dates and events, but you may have no idea how they all fit together. If your teacher is testing for comprehension, you will be in trouble—deep trouble. Ultimately, then, cramming is like skating on thin ice. If you’re not careful, you can easily fall through. It’s easy to become confused when your knowledge is thin.

T I P 7 Space your study sessions.
The way to learn a subject and to take a test with confidence is to space your studying. If you review your lecture notes before and after each class, stay abreast of your reading assignments, recopy your lecture notes, and prepare a weekly outline of reading and lecture material, you’re doing great! To get truly excellent grades and learn the subject cold, though, you’ll need to go through all of the material two or three times during the week before the exam, using the memory devices described in Chapter 2 to help make the information stick. During this spaced study period, you’ll need to spend some time correlating the material—discovering the connections and looking at the big picture.

Here’s how a spaced study session should go: About one week before your exam, carefully read and study all of your lecture notes. (You should
have at least rewritten them and filled in the missing material.) Study for two nights (or whatever time is best for you), then take a day off. During your study sessions, try to make it through all of your notes at least once. Make sure you understand everything.

After your day off, study some more for a couple of days. Once again, go through all of the material. This time, though, concentrate on memorizing details. It won’t be that hard if you have been reviewing your lecture notes, using the glossary and dictionary, and finding ways to make terms and concepts more memorable.

Then, take another day off. After this short respite, make one final push before the exam, being sure to study not only the facts and concepts, but also how they are related. Spend some time thinking about the way these facts correlate with what you know and what you’re learning. Why is this material important, and how do the various parts fit together?

In this final review, solidify all of the facts by repeating them out loud, writing them out, lecturing a friend... whatever. Close your eyes and repeat what you’re learning, or imagine that you are teaching someone the subject. After studying a section, write out the key points and supporting information and facts. Be certain you can define all terms and give relevant examples. Draw key structures over and over until they remain in your memory.

Unlike cramming, which puts a lot of information into your brain for a one-time event, spaced studying puts a lot of information in your memory for quite some time. Spacing your study sessions not only helps you avoid inefficient cramming, it can also reduce test anxiety. The better you know your facts, the more confident you will be. The more confident you are, the less anxiety you will suffer.

A word of warning, however. Learning to space your studies may take a while, so be patient. Don’t try it once and give up on it if you don’t get an A. Practice.

As suggested earlier, spaced studying works even better if you review lecture notes and keep up with your reading as the semester proceeds. It produces even better results if you conscientiously outline your reading notes and lecture notes each week. The more reviewing you do as you go along, the less work you will have to do in the final days before an exam.

**T I P 8**  
Use flash cards to review terms and concepts.

In the second and third phase of your spaced study program, you’ll commit a lot of concepts, facts, and so on to memory. Flash cards are a helpful tool in memorizing. Jot down key terms, facts, dates, and concepts on note cards as you learn them (for example, when you’re reviewing lecture notes and reading material), rather than wait until your pretest study period.

Put a term on one side of the card and the definition on the other. Do the same with concepts and dates. Be sure that you write all definitions and explanations in your own words. Don’t copy down what the book says or what your professor said. By using your own words, you force yourself to think about the subject and come up with meaningful explanations.
Be creative with your cards. Jot down memory joggers—mnemonics, riddles, acronyms, or root words—anything that helps you remember a term!

Use your flash cards to study while riding to school on the bus or while waiting for a friend to show up for dinner. You may want to use the cards at the end of each pretest study period. This will provide a quick review.

**T I P 9: Write your own tests.**

During the second and third phase of your spaced study program, you may find it beneficial to write (and take) tests of your own making. This technique is useful for a number of reasons. First, it forces you to review the material. Second, it helps you eliminate surprises come test time.

With a little practice, you can learn to write an exam that's remarkably similar to the one your professor will write. Following are some suggestions that will make this process easier for you.

First, determine the kinds of questions your professor will ask. Most professors are willing to tell their students the types of questions they'll include on an upcoming test. Many will actually give you a precise breakdown—for example, twenty points in essay questions, fifty points in multiple-choice, and thirty points in fill-in-the-blank.

Next, take a few minutes to look over your lecture notes, imagining that you are a teaching assistant who must write the test for the class. As you examine your notes, look for information that lends itself to the assortment of questions your professor has indicated will be on the test. Be on the lookout for potential essay, fill-in-the-blank, multiple-choice, true-or-false, and matching questions.

Essay questions provide a way of testing your understanding of a subject—that is, how well you comprehend important processes and concepts and how well you have correlated or assimilated the facts. If your professor is fond of this type of question, take some time to look through your notes for big blocks of information that lend themselves to essays.

Long, detailed explanations of processes make for excellent essay questions. If you are studying a biological process, such as evolution, for example, you might be asked to write an overview of the process. An essay question such as this will require anywhere from half a dozen to a dozen main points.

Multiple-choice questions usually focus on material that has three to four main points. Look through your notes. Can you find subjects that have three or four supporting facts? If so, turn them into multiple-choice questions. Fill-in-the-blank, matching, and true-or-false questions are usually used for testing knowledge of terms and concepts.

With a little practice, you can become an expert at second-guessing your professor. But your job isn't done yet. A day or two before the exam, take your own test. To save time, don't write out answers to essay questions; simply list the key points in a logical order.

Taking your own test gives you a chance to see how well you have learned the material covered in your class work. Although it may take a few hours, it could help enormously in the long run. If you study with friends,
you may want to divide the task up a bit, asking each classmate to write a portion of the test.

**T I P 10** Study tests from previous years if possible.
Some professors give the same, or nearly identical, exams year after year. As a rule, professors who give the same exam from one year to the next try to keep exams from circulating among students—for example, by collecting them after students have looked them over and seen their grades. Occasionally, however, exams are pirated by less-than-upright students and kept on file for future reference. Using copies from test files is frowned upon by professors for obvious reasons.

If you have access to bootlegged exams, you will have to decide for yourself whether to use them. Some students feel that, because other students are using these exams and getting good grades, they should too. Other students would rather succeed on their own. They believe that cheating is an intolerable shortcut and that education is meaningless if it is based on cheating.

Some professors who write new exams every year put copies of previous exams on file in the library for students to study. If this is the case, by all means spend some time looking at them. Study the types of questions, and check your level of knowledge—but only after you have studied your notes. Don’t use these sample exams as your primary means of learning. It won’t work.

**T I P 11** Use tests in textbooks, study guides, and tutorials to assess your progress.
If you don’t feel like writing your own tests and don’t have access to tests from previous years, take a look at those provided in your textbook, study guide, or computer tutorial. They will provide an opportunity to determine whether you have gaps in your knowledge. They may show that you’ve misinterpreted what your professor said or what you read in your book.

Where should you incorporate testing in your study schedule? There are several possibilities. You might want to test yourself after completing each chapter of your text—that is, after reading and rereading a chapter. Or, you might test yourself at the tail end of phase two and three of your spaced study program. After you have studied the material, memorized terms, and seen how the information fits together, take one of the various tests at your disposal—either the one you wrote or a test from your textbook, study guide, or computer tutorial. Pinpoint specific gaps in your knowledge, and review the material in those areas.

**T I P 12** Consider forming a study group.
The more you talk about what you’re learning, the better it will sink in. Study groups can be a useful way of learning. A group that meets weekly, for example, can compare notes and talk over difficult concepts. You can spend some time testing one another as well.
Several words of caution, however. First, don’t go to a study group unprepared, expecting to learn from the hard work of other students. Education isn’t a passive process. You can’t be a sponge and learn much. Before each session, study your notes and jot down questions that come up. Be prepared to be an expert on one or two subjects so you can help others.

Second, choose your group carefully. If there are too many passive participants in your group—that is, people who want to benefit from your hard work—drop out and form a new group. Select people who are motivated to learn and are willing to play an active role. It’s also helpful to find people who are intellectually on the same level. Broad gaps in intellectual abilities can slow down your progress.

Finally, to make the most out of group study, set goals or general guidelines for each study session early on.

**T I P 13** *Attend review sessions.*

Most professors or their teaching assistants offer review sessions before exams. Attend these sessions if possible. What you get out of a session, however, depends on how you approach it. If you haven’t done any studying and go just to soak up information, you probably won’t benefit from attending. If you study hard before a session and go with written questions, you will get a lot more out of it. Pay attention to the answers to all questions, not just your own. You may find areas of weakness that will require more study.

Listen for helpful hints about the test. Many professors will inadvertently tip their hand—that is, they’ll give you a hint or two about what will be on the exam. Many professors look fondly on students who attend review sessions and are often disposed to be somewhat more generous with them. You can often tell by an embarrassed smile that you have asked a question that will be on the upcoming exam. Professors often present material that they feel they should review. You can be sure that they don’t do this for their own health but are saying, “Hey, this is important stuff. It will probably be on the exam.”

**T I P 14** *Seek answers to your questions as they arise.*

Over the years, I’ve encountered many students who have fallen behind in class work. They’ve failed to keep up with lecture material and reading. In some cases, they don’t understand material and wait until they’re far behind to try to ask questions. Waiting until you’re lost is too late to call for help. At that point, nothing can save you. Too much information has been missed for you to catch up.

That’s why it is important to get questions answered as soon as they arise. If an equation is confusing or a fact or theory is not clear, ask your professor or teaching assistant. If the answer doesn’t make sense, look it up in the book. If your text doesn’t explain it adequately, go to a dictionary, an encyclopedia, or another textbook. This extra work will pay huge dividends.
**T I P 15** Use a tutor when necessary.

Take advantage of free or low-cost tutoring offered by your school, or hire a private tutor to help you through difficult material. Tutors can clarify confusing issues for you. But remember that learning is a two-way street. A tutor can't help unless you put in the time on your own. Study before and after each tutoring session. Don't be afraid to say you don't understand something even after it has been explained to you. You may have to ask for other reading sources to clear up your confusion. Not all tutors are good teachers, and yours may not be able to explain concepts in a way that makes sense to you. If this is the case, try someone else.

If you are stuck on a concept, you may have missed some important material. Look back over your notes, or go to your tutor for help. Ask that he or she look for the background information that may be keeping you from missing a key point. It may only be a small detail, but if your tutor can help you discover it, you will make much faster progress.

**TAKING TESTS**

You're all ready for the test. You've reviewed your lecture notes before and after each lecture, you've kept up with your reading, you've rewritten or prepared outlines of lecture and reading notes, and you've gotten help as you needed it. You have memorized and correlated all of the material and spaced your study sessions.

Unfortunately, all of this preparation may be for naught if you feel tired or mentally exhausted on the day of the exam. It's a sad fact of life, but exams test not only your level of knowledge but also your performance at one particular moment in time. If you're tired, mentally exhausted, emotionally drained, or some combination of the three, your test performance may suffer. You may know your notes inside out, backward and forward, but if you feel awful, you'll probably perform badly. This section offers some guidelines to ensure optimum performance on the day of the test.

**T I P 16** Eat well and get plenty of exercise and sleep before the test.

Most people are aware of the impact of eating and sleeping habits on optimum performance. I want to underscore here the importance of a good diet and sufficient sleep. If you are having trouble learning—if concepts and facts just don't seem to stick—chances are you aren't eating well or getting enough sleep. Relaxation and exercise are also essential to proper mental function. You ignore them at your own peril.

**T I P 17** Remain calm during the test.

Your state of mind during a test affects how you perform. If you have studied conscientiously, practicing the tips given earlier in the chapter, you may find that you are more confident. Competence builds confidence. If you find yourself jittery, chances are you aren't well prepared.
That said, it's important to point out that, no matter how well some students have prepared, they are always excessively nervous before or during exams. This phenomenon, called test anxiety, makes it difficult to concentrate and think. Because many students suffer from test anxiety, numerous colleges and universities offer treatment programs. A few sessions with a counselor can help you get over your test anxiety and learn to perform optimally.

Anxiety can be brought on by stimulants, such as coffee and chocolate, consumed before exams. The caffeine in these and other foods makes some students jittery and reduces their ability to concentrate. If you're sensitive to caffeine, avoid it on exam day.

Deep breathing before or during exams can help reduce the jitters. If you find yourself getting shaky, stop, close your eyes, and take some deep breaths. Slowly breathe in through your nose, hold your breath for eight seconds, then exhale slowly.

**T I P 18** Arrive at the exam early or on time.
One common cause of test anxiety is poor time management. If you leave your dorm room moments before the test is to start, you're more likely to arrive with frazzled nerves. To avoid having to rush around, leave fifteen minutes or even a half hour before the test is scheduled to begin. When you arrive, you will feel calm and collected, with all of your mental faculties intact.

**T I P 19** Look over the test before you begin.
After you receive a copy of the test, what do you do with it? After writing your name and student number on it, if required, take a few moments to look over the exam before beginning work on it.

Exams are usually divided into sections according to the type of questions being asked: multiple-choice questions, fill-in-the-blank questions, and so on. Take a moment to see how the exam is organized. Once you have an idea of what's being asked of you, quickly budget your time. If there's an essay worth twenty points, you will want to set aside at least fifteen to twenty minutes to answer it. If there are thirty multiple-choice questions, you will probably need about thirty seconds to one minute for each. True-or-false questions require only about ten to thirty seconds each. After you have made a quick schedule, get to work, paying attention to the clock or your watch.

I recommend starting with the easiest questions. True-or-false or multiple-choice questions, for example, are a good starting point. Why begin with the easiest questions? The answer is to build your confidence and relax your mind and body. Good teachers often begin their tests with really easy questions, just to help you relax.

**T I P 20** Skip questions you can't answer right away.
As you go through a test, skip questions that don't make sense or that seem too hard. You can come back to them at the end of the session if you have time. Don't get bogged down. Keep moving along, answering the ques-
tions that are easiest to you. Be sure to mark the questions you skip so you don’t forget to come back to them. You may have a thought later in the exam that triggers the answer to a question you’ve skipped. When your mind is freed from pressure, you’ll be surprised how easily facts will just pop out.

**T I P 21** - If you don’t understand a question, ask your professor.

Don’t be shy. If you don’t understand a question, chances are it isn’t worded clearly. Ask for help from your professor or teaching assistant. They owe you clear explanations. In some cases, your professor may decide to scrap a question because enough students asked about it.

**T I P 22** - Understand the question before you answer it.

Some students jump the gun, answering questions before they have read them over carefully. In rushing through, they overlook important key words, such as the word *not*. It’s imperative, then, to read each question carefully and to be sure that you understand its full meaning before you answer it. Underline key words, then respond.

When you have finished, reread the question to be sure you have answered correctly. This is particularly essential for essay questions. Many students lose points on essay questions because they don’t provide enough information. They overlook a part of the question or simply fail to provide adequate detail. If your professor asks a question worth ten points, you should provide at least ten points worth of material; this usually translates into ten terms, facts, or concepts. When you finish writing, imagine that you are grading the test, and keep track of the points you make. If you haven’t produced ten points worth of material, add some. It’s a good rule of thumb anyway to “overanswer”—that is, to provide two or three additional facts or figures. That way, if you miss an essential point, you might get extra credit for your additional material.

**T I P 23** - For essays and definitions, organize your ideas before you start writing.

When faced with an essay question or definition, many students begin writing before they have organized their thoughts. The result is a jumbled, disorganized answer that’s not only difficult to understand, but also bound to be graded down. By simply taking a few seconds to organize your thoughts on the back of the test, you can write acceptable essays and definitions and improve your scores considerably.

Many professors provide clues for answering essay questions. For example, a professor might ask, “Describe the production of energy by cells, including glycolysis, the citric acid cycle, and the electron transport system.” The wording of the question indicates that these are key topics, and it suggests how the answer should be organized.

In asking you to describe a process or event, your professor might include key terms in the question. For example, he or she might ask, “Describe the role of buffers in regulating pH in the body. Be sure to include the following terms: acid, base, and pH.” This is a clear signal to
you to define these terms in your answer. But don't stop there. Add additional material.

Answer essay questions in short, clear sentences. Imagine that you are explaining the concept to someone who understood little, if any, of the subject matter. You're being tested on your understanding of concepts and facts. If you don't explain them clearly, accurately, and fully, your professor will assume that you don't know them, and you'll be graded accordingly.

This chapter covers a great deal of practical information that will assist you in preparing for and taking tests. Take a few minutes now to review the main concepts, and make a list of the suggestions you will adopt.
Many people I know studied diligently during college, dutifully spewing out facts and figures for tests. For the most part, they received good grades for their hard work. Despite their success, though, many of them now complain that they actually got little out of their college years. That is, they didn’t learn very much for all the time they spent in class.

The comedian behind Father Guido Sarducci of “Saturday Night Live” fame invented the Five-Minute University as a symbolic jab at our educational system. For $25, his faculty teaches students everything they will remember two years after graduation. The entire curriculum takes five minutes.

Unfortunately, the comedian isn’t far from the truth. Many students and their parents spend tens of thousands of dollars on a college education, but for what? A few vague memories?

While we’re quick to blame teachers, a lot of the fault may lie in ourselves for not really learning information in the first place. In fact, many people who feel shortchanged by their college experience could have avoided this disappointment by practicing the PMC method (this strategy for increasing memory is presented in Chapter 2). Spaced studying and many other techniques discussed in previous chapters would also have helped them retain more.

Colleges and universities are also frequently criticized for their failure to promote thinking. I’ve heard many students complain that they are just being asked to spit back facts. The blame for this can be pinned on professors who don’t encourage assimilation and thoughtful analysis, but it falls on students’ shoulders as well. After all, students should be active participants in the learning process and must accept some responsibility for learning to thinking.

Learning to think is a threefold challenge. First, it requires facts. You can’t think very well if you don’t know anything. Second, it requires correlation, which is discussed in earlier chapters. By correlating facts with previous information and seeing how facts fit together to form the big picture, you become a deeper, better thinker. But correlating facts is not enough. To become a real thinker, you must also learn to think critically to prove their case. This leads to the next recommendation for critical thinking.

Critical thinking means many things to many people. I define it as the capacity to distinguish between facts and beliefs (or opinions). In other words, critical thinking allows you to distinguish between well-estab-
lished facts and people's judgments, which are often tainted by values or preconceived notions.

Critical-thinking skills help you analyze problems, issues, and information. They help you determine the accuracy of information presented to you and avoid illogical thinking and other mistakes in reasoning. Critical-thinking skills will allow you to draw sound conclusions from factual information, and they make you less likely to be swayed by emotional arguments. You will no longer fall prey to the merely eloquent—those skillful verbal manipulators who could sell real estate on the moon.

Critical thinking is as essential to your intellectual development as good food is to proper nutrition. If you're heading for a career in any one of dozens of fields, such as business, law, medicine, science, engineering, or education, critical-thinking skills will be essential. Without them, you'll always be at a disadvantage.

**TIP 1** Become an active participant.
One of the first requirements of critical thinking is that you take an active part in acquiring information. Don't sit back and accept everything you read and hear. Question what you learn, and seek other sources.

**TIP 2** Understand all terms.
As you study, you will encounter many new terms. They are the bricks in the foundation of your understanding of various subjects. Without a clear definition of new terms, you will be unable to master a subject, and you will be incapable of thinking clearly and critically.

Understanding terms and making sure that others define terms when they talk with you will help bring clarity to conversations. In fact, many arguments turn on a failure of one or both participants to understand the specific meaning of words that are being used. The Greek philosopher Socrates destroyed many arguments in his time by insisting on clear definitions of terms. You can become a critical thinker by always being certain that you understand the specific language of your subject.

**TIP 3** Question the methods by which facts were derived.
In attempting to sort facts from judgments, it is important to determine how the facts being presented to you were derived. Did they come from scientific experiments, or were they derived from random, unscientific observations?

A proper experiment in the biological sciences and medicine typically involves two groups: an experimental group and a control group. The experimental group is the one that is manipulated; the control group is treated the same way in every respect except that it is not manipulated. For example, to test the effect of excess vitamin ingestion, a researcher might start with two groups of people. In a good experiment, both groups would be as similar as possible in age, sex, weight, race, and so on. Both groups would be treated the same throughout the experiment. They would, for example, receive the same diet and would be housed in the same facility.
Ideally, they would be exposed to the same levels of stress and would work and rest equally. In a well-run experiment, the only difference in the two groups would be the vitamin supplements given to the experimental group. Any observed differences between the groups, therefore, can be attributed to the treatment.

Good experiments require an adequate number of experimental and control subjects to be sure that any observed differences are real. In many laboratory experiments, at least ten test animals are required. More than ten is even better. For human health studies, much larger groups are generally used.

Thus, when assessing the validity of information being presented to you, find out if the study was adequately performed. Did the experiment have a control group? Were the control and experimental groups treated identically except for the experimental variable? Did the researchers use an adequate number of subjects?

In science, one experiment is rarely adequate to draw firm conclusions. Thus, caution is advised when the results of new experiments are announced. The media are especially fond of publishing the results and conclusions of new studies, but such reports should be viewed with considerable caution. Follow-up studies often present contradictory results.

To ensure confidence in the conclusions of a new study, the experiment should be repeated by other researchers. If similar results are obtained, you can be more confident in the conclusions.

**T I P** 4  
**Question the conclusions derived from facts.**

When analyzing any issue, argument, or scientific finding, it is important to determine if the facts support the conclusions being made. Ask yourself if what you're hearing is really true. Are there alternative explanations?

Consider an example. One of the first scientific studies on the causes of lung cancer revealed that people who ate large amounts of white sugar (sucrose) had a higher incidence of lung cancer than those who consumed smaller quantities of sugar. The researchers concluded that sugar caused lung cancer.

A careful reexamination of the patients, however, showed that the relationship between cause and effect in this experiment was not what researchers had originally thought. Upon reexamination, the researchers found that smokers tended to consume more sugar than nonsmokers. Thus, a more probable cause of lung cancer was smoking, not sugar consumption.

This example illustrates a key principle of medical research: Correlation doesn't necessarily mean causation. In other words, two factors that appear to be connected may not be causally related.

Another example illustrates the importance of this rule. In 1989, U.S. physicians reported that some of their patients were suddenly becoming ill. When health officials at the Centers for Disease Control looked into the problem, they found that the affected individuals had been ingesting large doses of L-tryptophan, an amino acid available in pill form in most health-
food stores. L-tryptophan presumably helps some people get to sleep and is believed to ease the symptoms of premenstrual syndrome in some women.

Within a short period, physicians documented more than twelve hundred cases of L-tryptophan "poisoning." Some victims died; many others became paralyzed or were severely impaired. Because of the severity of the problems, L-tryptophan was quickly taken off the market. Further research has shown, however, that the culprit in this tragic incident was not L-tryptophan, but a chemical contaminant found in the pills. As in the lung cancer example, the cause was incorrectly assigned.

Conclusions may also be based on inaccurate data. In some instances, a person may base an argument on data that he or she believes are true but in fact are not. In others, a person may base an argument on an outright lie. Watch for such instances. They're surprisingly common.

Another pitfall to watch for is the selective inclusion or exclusion of data. Many people become "one-study" experts. They learn one fact or a few facts and then base entire arguments on this limited base of knowledge. In so doing, they may omit a wealth of information that contradicts their case. In addition, a lot of people seek out facts that support their points of view; they make up their minds and then seek to prove their case. This leads to the next recommendation for critical thinking.

**TIP 5** Look for hidden assumptions and bias.

Another surprisingly common problem with the conclusions some people draw is that they are often influenced by incorrect assumptions and bias. Critical thinking requires that you uncover assumptions and biases that underlie the conclusions of others.

Consider the following example of an underlying assumption. Many people believe that all radiation exposure is deleterious to human health. Is this conclusion based on any underlying assumptions? Is it valid? The conclusion is based on a belief that there is no safe threshold level for radiation—that is, a level below which no harm occurs—and that, as a result, all exposure is dangerous. Scientists, however, still debate this assumption. Some claim that there is a safe threshold level. Thus, the conclusion that all radiation is harmful is not universally accepted.

**TIP 6** Question the source of facts.

Being on the lookout for bias and deceit forces you to question the source of information. Beware especially of "experts." Salespeople are notorious for passing themselves off as experts on a wide range of subjects, from home heating to nutrition. Often, however, these people are presenting a limited subset of facts that support their point of view (and sell their product).

This rule applies to more than just salespeople. It applies as well to venerable professionals—even physicians. For example, consider with skepticism the nutritional advice you receive from a physician. Should you count on it? Most physicians in practice today have received little, if any, formal training in nutrition. In the seventies, a study of hospital patients
showed that many who were under a doctor's care for prolonged periods suffered severe malnutrition. Although this study resulted in a dramatic reanalysis of nutritional instruction in medical schools, a study of U.S. medical schools in the mid-eighties showed that nutrition training was still woefully inadequate in many schools. Even today, apparently, many medical students graduate without a sound understanding of the role of nutrition in preventing disease and promoting good health.

**T I P 7**

Don't expect all the answers.

Ironically, critical thinking requires a tolerance for a certain amount of ambiguity. Ambiguity exists in all fields of study. That is to say, hard-and-fast answers are not always available. As a result, you must become comfortable with uncertainty.

For example, many credible atmospheric scientists believe that the surface temperature of the Earth is increasing as a result of the buildup of carbon dioxide and other gases from a wide assortment of human activities over the past two hundred years. In fact, many of these scientists are willing to stake their reputations on this conclusion, and they can quote an impressive body of information in support of their view.

Not all scientists agree, however. A small number believe that projections of global warming are wrong. They argue that other factors may reduce warming or may eliminate it altogether. Global warming is therefore an issue about which critical thinkers might reserve opinion. But before you close the book on the subject, read on.

**T I P 8**

Examine the big picture.

If it materializes, global warming could result in a dramatic shift in world climate that could turn productive farmland to desert and could eventually flood 20 percent of the world's land mass as glaciers and the Antarctic ice cap melt. It could have devastating effects on plant and animal life. Because of this, critical thinkers might choose to take action despite the scientific uncertainty. That is, destroying the climate of a planet poses such a serious threat that steps to eliminate the problem may be the most intelligent choice, even if we are not 100 percent certain that there is a problem.

The threat of global warming can be reduced by marked improvements in energy efficiency in automobiles, factories, and even our own homes. Some think of this as a kind of insurance policy that has the added benefit of reducing urban air pollution, stretching limited supplies of oil and other fuels, and saving substantial amounts of money.

Consider another example of the benefits of examining the big picture. In 1988, researchers at Monsanto announced that they had discovered a way to alter the genetic material of wheat to make it resistant to a fungus that causes enormous crop damage. Farmers currently control the fungus by rotating crops—that is, planting wheat one year and another crop that does not support the pest the next year. The new genetically altered strain, however, would eliminate the need to rotate crops, allowing farmers to plant their fields in wheat year after year. It would even allow farmers to plant larger crops.
Although this may sound like a great idea, critical thinking shows that it could be an invitation to disaster. Why?

First, crop rotation helps build soil fertility. Rotating beans, clover, alfalfa, and other legumes with wheat, for example, adds nitrogen to the soil and helps maintain soil fertility. Not rotating crops often drains a soil of its nutrients, reducing its long-term productivity.

Second, crop rotation helps reduce insect pests. By planting a new crop in a field every year, farmers reduce food sources for insects that prefer one crop over another. Because the food supply is not constant from one year to the next, pest populations remain low and manageable. Eliminating crop rotation may result in repeated outbreaks of harmful wheat-eating insects.

In solving the fungus problem, then, science may contribute to several other problems. The lesson in this case is that a careful examination of the ecological relationships (the big picture) often throws into question the apparent wisdom of new actions.

**T I P 9**

Examine multiple cause and effect.

This rule is an extension of the previous rule, examine the big picture. As intelligent as humans can be, we are also often rather narrow-minded. We fall back on simplistic thinking with surprising frequency. In the seventies, for instance, Paul Ehrlich, a noted ecologist, argued vigorously that the world's environmental problems stemmed from overpopulation—too many people for the available resources. Another equally reputable and distinguished scientist, Barry Commoner, argued that the problems were due to technology and its by-product—pollution.

A more careful analysis suggests that the environmental problems that the United States faces are caused by numerous underlying factors. In other words, overpopulation and technology are just two of many root causes. Inadequate laws and poor education must be factored into the equation, as must various psychological factors—for instance, our view of the world as something to conquer. Many more could be added to the list.

Critical thinking clearly demands a broader view of cause and effect. It demands that you consider all of the contributing factors and their relative contributions to the problem. It forces you to avoid simplistic thinking, which often leads to simple solutions that fail miserably.

One form of simplistic thinking is called dualistic thinking. Dualistic thinking is that which accepts only two viewpoints. It's black-or-white, right-or-wrong reasoning. Presenting a person with only two choices when there are many is called a false dichotomy. It should be a signal to a critical thinker to look deeper. When presented with only two alternatives, look for a third or a fourth. They're often there, and they're often valid.

**T I P 10**

Watch for thought stoppers.

Thought stoppers are words or phrases that switch off your critical thinking faculties. They elicit an emotional, gut-level acceptance of an argument, rarely an intellectual one. Thought stoppers work because they
arouse emotions; they sound so good that you lose track of your thinking. Many repeat old myths.

When talking about individual actions to help protect the environment, many people say to me, "So what? What effect do my actions have?" This is a thought stopper par excellence. It plays on our feelings of helplessness and insignificance. It's a hard one to answer—until, of course, you start thinking. It's true that individual actions don't amount to much, but when added together, they can become meaningful. After all, many of our problems are the result of the cumulative effect of individual actions—carelessness and waste. If they create our problems, they can also be part of the solution.

T I P 11 \* Beware of labels.

Labels are convenient tags that help us organize the world around us, but they can be misleading. For one thing, they are often inaccurate or, at best, may be a partial truth. Labels are common in the political arena, where individuals are often labeled as "liberals" or "conservatives." In reality, a person might be liberal on some issues and more conservative on others. Labeling that person as a liberal thus misses the true breadth of his or her views. In the environmental arena, a liberal is one who seeks to preserve open spaces and protect the environment. Isn't that really a conservative outlook?

The point here is to be careful of the labels you apply to people and ideas. Also be careful of the labels that others apply to them. The truth is often more complicated than a label implies.

T I P 12 \* Understand your own biases and value judgments.

Critical thinking requires a careful analysis of information that other people present, ferreting out their biases, misinterpretations, and deceit. Just as important, though, critical thinking demands an awareness of your own biases. In other words, you must turn your critical-thinking skills on yourself.

Each of us has a set of values taught to us by parents, teachers, clergy, friends, experience, and so on. These values influence our reasoning. Although you cannot change the teachings you've been exposed to and the experiences you've had, you can learn to recognize your own biases and to see how values affect your judgment. Be aware of them, and attempt to discover how they influence your thinking.

T I P 13 \* Don't mistake ignorance for perspective.

A man and woman live in a twenty-foot-deep hole in the ground. One day, someone peeks over the edge and asks them what the world is like. Their response is quite predictable. "The world's a rather dark place. Not much happening."

This extreme example is introduced to make a point: We often mistake ignorance for perspective. Our lack of knowledge about the world or events sometimes gives us a false sense of understanding. We may know
a few facts—like the couple in the hole—but basically we understand very little. That tiny bit of knowledge can be illusory. We may think that we have an accurate picture when in fact we see only a slice of reality.

Watch out for this trap. I warned you earlier to be wary of the one-study experts. These are people who have dug their holes, so to speak, and are certain they understand the truth, when in fact what they understand is only a tiny piece of it. Don’t become one of them yourself.

This chapter has presented a number of important rules for critical thinking. Take a few minutes to review them and list those you would like to put into action.