Welcome to Bis2A

Welcome to Biological Sciences 2A at UC Davis. BIS2A is a 5-unit course with either three 50 minute or two 1 hour and 50 minute lectures (depending on the quarter) plus a 2-hour discussion each week. BIS2A is the first of three courses in the lower division core sequence in the biological sciences. BIS2A provides a foundation in key biological concepts that are of use across a broad spectrum of majors. Students are introduced to the fundamental chemical, molecular, genetic, and cellular building blocks of life, biological mechanisms for the recruitment and transfer of matter and energy, basic principles of biological information flow and cellular decision making, and core concepts underlying the relationships between genetic information and phenotype.

It is important to realize that BIS2A is not a survey course in biology. Biology is an exciting, broad, and dynamic field. It is critical for students in biology or related fields to develop a strong conceptual foundation and to demonstrate their ability to use it in contexts that may be novel to them. Students in Bis2A will be asked to begin developing the ability to identify and articulate the key scientific and biological questions that are at the core of the course content. Students will be expected to learn and use correct technical vocabulary in their discussions of course content. Students will be expected to begin conceptualizing course content from a question-driven and problem-solving perspective.

Yes, BIS2A will require you to work hard, but we also hope that you will have fun discovering new aspects of biology and exploring the many unanswered questions concerning what it means to be alive.

The main course learning objectives include:

- Apply principles of chemistry and bioenergetics in the context of biological systems to describe how cells acquire and transform matter and energy to build and fuel various life sustaining processes, including chemical
transformations of elemental compounds, cellular replication, and cellular information processing.

• Explain the relationship between genotype and key genetic processes that create phenotypic diversity.

• Describe the processes regulating the management of cellular information; how information is stored, read, rearranged, replicated; how cells interact with their environment and how these processes can control cellular physiology.

**Who should I ask when I have questions about the course?**

1. General information about the course: The syllabus provides most of this type of information. **For the quickest answers to many of your questions, we highly recommend looking at the syllabus before contacting one of the staff.**

2. General information about topics in BIS2A: The BIS2A Learning Center (BLC), which is in RM 2089 SLB, is a resource center for all BIS2A students. The BLC is staffed by the instructors and teaching assistants associated with all BIS2A sections. Any BIS2A instructor or TA having office hours in the BLC should be able to answer general questions about the lecture and discussion material. If they can’t answer your questions, they will be happy to refer you to someone who can.

3. Lecture material and Nota Bene assignments: Your Lecture TA is a great source of information about the lecture material and any lecture related reading specific to your section of BIS2A.

4. Discussion material: Your discussion TA is the best source of information about the discussion material present in your specific discussion section.

5. All course content related material: Your instructor is a great resource for questions about course related material. Find your instructor after class and go to their office hours whenever possible.

**Some of your responsibilities**

BIS2A is a team effort. Several professors are involved in developing the course content and assessment materials. There are also teaching assistants, who not only run the discussion sections, but also provide insights into which concepts students find the most difficult.

Please keep up with your responsibilities as a student. Do the assigned reading and start to learn new vocabulary before coming to class. Come to class prepared to engage - your instructor will assume that you have read the material before class and that the lecture will not be your first exposure to the content. After class, review your notes, the podcast, and the post-study guide. Seek out assistance immediately when you need it. If everyone in the class can conscientiously do these things, we’ll all have fun this quarter (even while working hard) and be a happy and smarter bunch at the end of the term!

**Strategies for Success**

Research shows that the most successful students are those who take charge of their own learning and follow a simple but disciplined strategy.

• Identify the important vocabulary words and key concepts presented in lecture. Be able to recall this information from your memory and find opportunities to use it outside class: limiting your studying to reading the text book does not constitute effective studying in this class. To be successful, you need to be able to use the information. Therefore, we have designed interactive, question-driven lectures that will ask you to practice using your knowledge in both the lecture and your discussion sections.
• Recall information from your memory regularly: effective studying cannot be done the day before the exam. If you want to master a concept, you need to work on problems that ask you to apply that concept at regular intervals throughout each week. (When you attend lecture regularly, we will help you do this during class time!)
• Apply your knowledge to different problem types and new situations: we will give you the chance to do this in class and outside of class with pre and post study guide questions.

Investment of Time

To be successful in BIS2A, you need to make sure that you have sufficient time each week to devote to the class. Units at UC Davis are assigned based on time spent in class and time requirements associated with out-of-class work. For one lecture unit, you are expected to attend one hour of lecture per week and to spend about two hours per week out-of-class studying the material associated with this lecture. BIS2A has three hours of lecture per week, so you are expected to spend at least six additional hours per week studying the lecture material. BIS2A also has two hours of discussion per week. For the two discussion units, you are expected to attend one two-hour discussion section per week and to spend about four hours per week out-of-class studying the material associated with this discussion. So in total, you are expected to be spending -15 hours/week on BIS2A.

What is the most productive way to use this -15 hours/week? Material in BIS2A is cumulative and getting behind can have a major negative impact on your grade. Therefore, the key to being successful in BIS2A is to study the material every day. “Studying” includes any time spent learning the vocabulary, doing the reading and Nota Bene assignments, preparing for class by doing the pre-study guide, reviewing the slides and your notes after class, listening to the podcast, and completing the post-lecture study guide and homework assignments.

How to Prepare for Class

For each lecture, we have prepared a study guide designed to help you get the most out of the lecture.

• One purpose of the study guide is to provide you with a targeted list of tasks that will help you prepare for lecture (a suggested “what to do” list). It will help you decide what to read, what vocabulary to review, and what skills/knowledge to review from earlier lectures. It will also help you get a perspective on what the instructor thinks is important for you to practice before coming to class.
• Before coming to lecture, do the suggested assignments outlined in the study guide. The study guide contains the assigned reading (NB assignments and any supplemental reading), vocabulary lists and most importantly the Learning Goals for the lecture. The study guides are designed to help you prepare for lecture and EXAMS by helping you focus on what the instructor thinks is important for you to understand.
• You are expected to do all of the assigned reading before coming to lecture. Take the commenting on these assignments in Nota Bene seriously. Read the whole document and comment on all parts - particularly the suggested discussion items. This is an opportunity to learn from and with your classmates and to use information you’ve learned from earlier lectures. Your thoughtful participation/commenting in the reading assignments will also help your instructors identify where you are having conceptual difficulty. If enough people appear to have similar questions in the readings the instructor will see this as a sign to spend some extra time the following day in class clarifying the points of most frequent and/or serious confusion.
Nota Bene

Nota Bene NB is an online resource for collaborative commenting and discussion. You will be required to contribute thoughtful comments, intelligent questions, or even answers to questions from your classmates on selected readings or movies. Your instructors will assign the relevant content via URLs. The reading and discussion forum are intended to help you prepare for lecture, learn the core course concepts, and to develop the intellectual skills we expect from our students. **Assignments in NB will be graded and your score will depend on the quality of your contributions.**

As your instructors and TAs, we look forward to reading the NB discussion. We will add our own comments, flag misconceptions, and highlight particularly good or informative comments or threads. We hope that you'll find the feedback useful. These discussions also help us to focus our limited time together in lecture on the content/skills that seem most confusing or difficult to master. As each class is slightly different, this will hopefully allow us to more effectively tailor lecture time for your needs.

**What happens in lecture**

Class time will be spent discussing course topics. Your instructor will expect that you have completed the assigned reading before you come to class and that you have attempted the assignments outlined in the pre-lecture study guide.

**Active Learning in Lecture**

One of the goals of the lecture is to give you the opportunity to practice your problem-solving skills. To facilitate this, the instructor will pose a question and ask the class to discuss the question in small groups. Following the discussion, you might be asked to "vote" on answer choices to problems by holding up a folded multicolor piece of paper (the paper serves as a cheap iClicker substitute), by raising your hand, or with an iClicker - the mode will depend on your instructor. This technique gives the instructor instant feedback about how the whole class doing on a specific topic.

For some questions, you or a classmate may be called upon to summarize your group's discussion and to share this information with the class. When someone is called on in class to answer a question, **don't take a mental break!** This is a time for you to listen to your classmate, compare their ideas with what you might have shared had you been called upon. Did your classmate have a particularly insightful idea? Perhaps that will help you. Did they have problems answering the question? Did you have similar difficulties with the question? This is not "dead" time - stay mentally involved and active. Your classmates are an important source of information and one of the great reasons we all get together in the same place.

Most students get a little nervous about answering questions in class. This is understandable. However, it is important to remember that your thoughts, no matter how well or ill-formed, are valuable contributions to the classroom discussion. **The important thing is to try!** Whether you are responsible for speaking or whether you are actively listening, view the questions covered in class as a clue from your instructors about what they think is important. Ask yourself if you understand the key concepts associated with any question asked in lecture. If not, be sure to go over the question after lecture and if you still are having difficulties answering it, talk to an instructor or your TA in office hours. Isn't it better to realize in class that you don't understand a particular topic than on the exam itself?
What to do after class

Study materials for after lecture

After each lecture, you will be given access to the lecture slides and a podcast of the lecture. The slides and podcast will allow you to review the lecture and to confirm the accuracy of your lecture notes. The lecture study guide will also provide you with problems and exercises that will help you practice and reinforce what you learned in lecture.

The study guide - after lecture

• The study guide contains a variety of exercises that reinforce the mental muscles that are important for mastering the learning goals associated with the specific lecture. The problems/exercises on the study guide are a mix of short-answer questions, thought questions, and exercises that help you to build mental models that are important for success in the class (e.g. you may be prompted to sketch a picture of a particular molecule or process).

• The study guides also contain some multiple choice questions designed to model the kind of thinking that will be expected on the exam. Many of these questions are taken from old midterm exams.

It is important that you complete the study guides as soon as you can after class. Use this document to identify areas where you are having difficulties and figure out the best way to master this material. Waiting to do these exercises until the last minutes defeats much of their purpose.

The cumulative nature of BIS2A

By its very nature, the material in BIS2A is cumulative and it is very easy to get behind. We recognize this challenge and have designed the pre and post-lecture study guides to help you prevent this. The guides include a variety of exercises such as creating vocabulary study lists, creating sketches of molecules and biological processes, specific instructions to review lecture content, sample multiple choice questions that are formatted in exam style, and a variety of other study aides. Some of the exercises may feel strange at first, but remember they're designed by the same people who are designing the lectures and the exams. There is a reason why we are asking you to practice these exercises.

If the rationale for an exercise is not clear, it is important that you not ignore it. Instead, ask yourself why the instructors might be asking you to do that specific exercise. The exercises are designed to help you master the learning goals specified in the study guide. Cross-check each exercise with those learning goals and see if you can draw a connection. If you still don't understand why you're being asked to do something in the study guide, ask a classmate, talk to a TA, or ask the instructor.

Once you're convinced that you have mastered the learning goals and have practiced/reinforced key concepts and skills using the study-guides, we recommend that reenforce your understanding by creating mock exam questions that are designed to test a fellow student's understanding of the learning goals.

Previous exam questions

Another way to test your understanding of the material is to take a practice exam that contains exam questions from previous quarters. Some of these questions appear in the post-lecture study guide. You may also be asked to work collaboratively on Nota Bene to answer previous exam questions.
However, please be advised that we have found that many students don't use these questions as effectively as they could. These are NOT meant to be exercises in memorization! Your instructor will not, in all likelihood, ask you the exact same question. Many students fall into a trap of using these questions as a last second study guide, cross-referencing with a key and mentally checking off that they understand a topic, because the answer choice "makes sense". Beware, if you are falling into this trap, you likely have a false sense of the depth of your real understanding.

How to use previous exam questions effectively

• Ask yourself if there are any vocabulary terms that appear multiple times in the exam or any vocabulary words that you don't understand. Sometimes, just knowing the precise meaning of a term is enough to answer the question.

• Ask yourself WHAT learning goal(s) are associated with each question and what skills do you need to have mastered in order to be able to answer the question. Remember, some questions may require you to integrate learning goals.

• Ask yourself HOW the instructor is testing whether or not you have mastered the learning goals you identified above. Figure out what you needed to know or be able to do to answer the question and how did the instructor ask you to demonstrate this.

• Ask yourself how you might RECAST the question (changing some details or specifics) in a way that still tested whether or not a student had mastered the associated learning goals and not just memorized the answers to the old exam questions. We as instructors do this all the time.

• Asking yourself how you might CREATE a new question that an instructor could use to test the same learning goals. We as instructors do this all the time too.

Habits associated with highly successful BIS2A students

Over the years, your instructors have talked with many, many students to try and understand why some students are more successful than others. The picture is, as you might expect, complicated. However, there seem to be at least two habits that we can consistently associate with highly successful students and that we find are practiced much less frequently by students who struggle. These are:

• Reviewing and studying material associated with a lecture THAT SAME DAY. This includes reviewing the lecture notes, vocabulary, and doing associated exercises. This ALSO includes making lists of concepts that still aren't clear and trying to have those questions cleared up before the following lecture.

• Constant self testing. That is, most successful students have developed methods (there are many) for assessing their comfort level with their understanding of the course material and spending more time on areas they find MOST challenging.

The first point is relatively easy to understand. Don't procrastinate. Material builds up quickly, concepts are often layered and exams sneak up on you very fast in the quarter system. It is difficult to identify the holes in your understanding of a topic and fill them appropriately two days before the exam.

The second point about self testing is more subtle. Basically, students that are good at this skill have ways of asking themselves "do I really understand the point of this question and the reason for the answer?" This can happen in a number of ways. We suggested one above. Try to invent new exam style questions for a concept or skill. Another good way to test yourself is to work in groups and force yourself to explain a topic or question to another student, as if you were the instructor. This is often more difficult than it seems. While this exercise can be hard - particularly if you are not
used to flexing these mental muscles - this type of introspection is important to develop for both your short and long term success and we encourage you to look inward and test yourself and your understanding often when you are studying.

## Active Learning in Bis2A

In every lecture, we will ask you to answer questions, either in a small group or individually. These questions serve several purposes:

### Functions of In-class Questions

- Questions stimulate students to examine a topic from a different perspective, one that the instructor considers relevant to their learning?

- Questions act as mini "self-tests" for students. If you are uncertain about what question is being asked or how to answer it, this is a good time to (a) ask the instructor for clarification and/or (b) take note to review this immediately after class with a TA, the instructor, classmates or the internet. If the instructor took the time to ask you the question in class, this is a big clue that he/she thinks that both the question and the answer are important.

- Some in-class questions will ask students to formulate questions themselves. This is typically an exercise that is designed to force the student to reflect on and try to articulate the point of the lesson. These are critical exercises that force you to think more deeply about a topic and to place it in the broader context of the course.

- Some questions may ask the student to interpret data or to create a model (e.g. perhaps a picture) and to communicate what they see to the class. This exercise asks the student to practice explaining something out-loud. This can be a great self-test and learning experience, both for the person answering and fellow students who should also be using the time to examine how they would have answered the question and how that compares with the feedback of the instructor.

- Questions, the discussion that follows and the thought process involved in solving a problem or answering the questions are opportunities for the instructor to model expert behavior in an interactive way - sometimes it is equally important to understand HOW we arrive at an answer as it is to understand the answer.

Some questions are designed to stimulate thought and discussion rather than to elicit a discrete answer. If called on, you should not feel compelled to have one "right" answer!! Understanding this is very important. Once you realize that it is perfectly acceptable (and sometimes desirable) to not know all of the answers (if you did, what would be the point of coming to class) it can take away a lot of the anxiety of getting called on. While it is okay to not know "the answer", it is nevertheless important for you to attempt to make a contribution to the discussion. Examples of other meaningful contributions might include: Asking for clarification. Associating the question with another class topic (trying to make connections). Expressing what you are comfortable with and what confuses you about the question. Don't be afraid to say "I don't know". That's perfectly okay and even expected sometimes. Be prepared for the instructor to follow up with a different question, however, that will try to either highlight something that you likely do know or to ask for your help with identifying a point of confusion.
Getting Ready for Lecture

To help you get ready for each lecture, we provide study-guides that include instructions on how to prepare for class. You should do your best to complete the assigned reading and suggested "self-assessments" before coming to class. This will ensure that you are ready for discussions and that you can make the most of your time during class. We do not expect you to be an expert before lecture, but we do expect you to do the pre-reading and by doing so make yourself familiar with the required vocabulary and spend some time thinking about the concepts that will be discussed. We will build on that basic knowledge in lecture. If you do not have at least some of the basic building blocks before hand, you will make less efficient use of your time in class.

We cannot emphasize too strongly that **YOU have the primary responsibility for learning the material in this (or any other) course.** Although we are invested in your success, your instructors and TAs cannot magically implant knowledge. Like any other discipline that requires mastery (e.g. sports, music, dance, etc.), we can help guide you and critique your performance, but we can not replace the hours of practice necessary to become good at something. You would never expect to become a proficient pianist by going to lessons once or twice a week and never practicing. To most of us, it seems self-evident that you need practice to become good at something like music, art, or sports. It should not be surprising that the same rule applies with learning biology or any other academic subject.

We see ourselves as your coaches for this class; we want all of you to succeed. However, for this to happen, you have to take your practice seriously. This means coming to class prepared, participating in class, studying the material covered in class as soon as possible, identifying where you are uncertain and getting help to clarify those topics as soon as possible, and trying to make thoughtful contributions to the on-line discussions (not just the bare minimum required to "get the points").

Bottom line: You need to be active participants in your learning.

Knowledge and Learning

Teaching and Learning Science

Teaching and learning science are both challenging endeavors. As instructors, we need to communicate complex, highly interconnected concepts that will serve as a foundation for all your future studies. We also want our students to demonstrate mastery of these ideas at a high level. As students, you need to learn a large new vocabulary, create mental models on which you can "hang" the new conceptual knowledge, and demonstrate that you can actually use this new knowledge. The process challenges both the instructor and the student. Although the process involves hard work, it can also be incredibly rewarding. There is nothing more satisfying for an instructor than those "Aha!" moments when a student suddenly understands an important concept.

In BIS2A we face some interesting teaching and learning challenges. One key challenge is that we discuss physical things and ideas that exist or happen on time and/or size scales that are not familiar to most students. What does this
mean? Consider the following example:

**Example: Some challenges associated with creating mental models**

An instructor teaching wildlife biology may want to talk about concepts in evolution by using bird beaks as a starting point for discussion. In this case, the instructor does not need to spend time creating mental pictures of different shaped bird beaks (or at the very least only needs to show one image); most students will readily draw on their past knowledge and everyday lives to create mental pictures of duck, eagle, or woodpecker beaks and infer the different functional reasons why Nature might have selected different shapes. As a consequence, the students will not need to expend any mental effort imagining what the beaks look like and can instead focus all of their energies on the core evolutionary lesson.

More colloquially: If you are asked to think about something new that is closely related to something you already know well, it is not too difficult to focus on the new material.

By contrast, in BIS2A we ask students to think about and discuss things that happen on the atomic, molecular and cellular scales and at rates that span microseconds to millennia. Most students, we will guess, have not lived life on the micro to nanometer scale. Yet, this length scale is where most of the events common to all biological systems takes place. Beginning students, who have not thought much about how things happen at the molecular scale, lack of mental models upon which to add new information. This starting point places a burden on both the student and the instructors to create and reinforce NEW mental models for many of the things we talk about in class. For instance, to really talk about how proteins function, we first need to develop a common set of models and vocabulary for representing molecules at the atomic and molecular levels. Not only do these models need to find ways of representing the molecule’s structure, but the models must also contain abstract ideas about the chemical properties of molecules and how these molecules interact. Therefore, students in BIS2A need to put some effort into constructing mental models of what proteins "look" like and how they behave at the molecular scale. Since the entire course centers around biomolecules and processes that happen at a microscopic scale, a similar argument can be made for nearly every topic in the class.

**Note: Possible Discussion**

How do you interpret the term mental model and why do you think that it is important for learning?

Some of the in-class and study guide exercises are designed to help with meet this challenge; most students have found them very useful. However, some students are more accustomed to studying for exams by memorizing information rather than understanding it. (It’s not their fault; that’s what they were asked to do in the past). As a result, if the problems are approached with the "memorize-at-all-costs" attitude some of the BIS2A exercises may initially seem pointless. For instance, why are your instructors asking you to repeatedly draw some of the concepts described in class? What multiple-choice question could that exercise possibly prepare you for? While it is true that some of your instructors won’t ask you to draw complicated figures on an exam, these drawing exercises are not trying to prepare students for one specific question. Rather the instructor is trying to encourage you to begin creating a mental model for yourself and to practice using it. **The act of drawing can also serves as a "self test."** When you force yourself to write something down or to create a picture describing a process on paper, you will be able to independently assess how strong your conceptual grasp of a topic really is by seeing how easy or hard it was to put your mental image of something onto paper. If it is hard for you to draw a core concept or process from class WITHOUT EXTERNAL...
ASSISTANCE, it is likely that you need more practice. If it is easy, you are ready to add new information to your model. Throughout the course, you will continue to add new information to your mental model or to use the concept represented in your mental model in a new context. Keep your drawings - or other self-testing mechanisms - current. Don't fall behind.

Incidentally, the presentation of a course concept on an exam in a context that the student has never seen before is NOT an evil plot by the instructor. Rather it is a way for the instructor and student to assess whether the concept has been learned and whether that knowledge can be used/transfered by the student outside of the specific example given in class or in the reading. Asking the student to repeat the latter would represent an exercise in memorization and would not be an assessment of valuable learning and independent thinking or a representation of what happens in real life.

**IMPORTANT:** The idea that students in BIS2A will be tested on their ability to USE concepts in specific contexts that they haven't seen before is critical to understand! Take special heed of this knowledge. Developing usable conceptual knowledge takes more discipline and work than memorizing. The quarter also moves VERY fast and concepts are layered one on top of the other. If you get too far behind, it is very, very difficult to make up for lost time two or three days before an exam. Be as disciplined as you can and keep up with course materials.

So, some concepts are hard to teach and to understand. What are we to do? Something instructors and students both do is to use various communication tricks to simplify or make abstract ideas more relatable. We use tools like analogies or simplified models (more on the importance of these shortly) to describe complex ideas. Making things more relatable can take various forms. Instructors might try to use various similes or metaphors to take advantage of mental pictures or conceptual models that students already have (drawn from everyday life) to explain something new. For instance, the thing X that you don't understand works a little like thing Y that you do understand. Sometimes, this helps ground a discussion. Another thing you might catch an instructor or student doing is anthropomorphizing the behaviors of physical things that are unfamiliar. For example we might say molecule A "wants" to interact with molecule B to simplify the more correct but more complex description of the chemical energetics involved in the interaction between molecules A and B. Anthropomorphisms can be useful because, like similes and metaphors, they attempt to link the creation of new ideas and mental models to concepts that already exist in the student's brain.

While these tools can be great and effective they nevertheless need to be used carefully - by both the instructor and the student. The main risk associated with these simplifying tools is that they can create conceptual connections that shouldn't exist, that lead to unintended misconceptions, or that makes it more difficult to connect a new concept. So while these tools are valid, we - students and instructors - also need to be vigilant about understanding the limits these tools have in our ability to learn new ideas. If these pedagogical tools are useful but their use also carries risk, how do we proceed?

The remedy has two parts:

1. Recognize when one of these "simplifying" tools is being used and

2. Try to determine where the specific analogy, metaphor etc. works and where it fails conceptually.

The second instruction is the most difficult and may prove challenging for learners, particularly when they are first
exposed to a new concept. However, the act of simply thinking about the potential problems associated with an analogy or model is an important metacognitive exercise that will help students learn. In BIS2A your instructors will occasionally expect you to explicitly recognize the use of these pedagogical tools and to explain the trade-offs associated with their use. Your instructors will also help you with this by explicitly pointing out examples or prodding you to recognize a potential issue.

Note: Possible Discussion

Can you give an example from your previous classes where an instructor has used an anthropomorphism to describe a nonhuman thing? What were/are the trade-offs of the description (i.e. why did the description work and what were its limitations)?

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**Using vocabulary**

It is also worth noting another problematic issue that can needlessly confound students just starting out in a discipline - the use of vocabulary terms that potentially have multiple definitions and/or the incorrect use of vocabulary terms that have strict definitions. While this is not a problem unique to biology, it is nevertheless important to recognize that it occurs. We can draw from real-life examples to get a better sense of this issue. For instance, when we say something like "I drove to the store", a couple of things are reasonably expected to be immediately understood. We don't need to say "I sat in and controlled a four-wheeled, enclosed platform, that is powered by the combustion of fossil fuel to a building that collects goods I want to obtain and can do so by exchanging fungible currency for said goods" to convey the core of our message. The downside to using the terms "drove" and "store" is that we have potentially lost important details about what really happened. Perhaps the car is battery powered and that is important to understanding some detail of the story that follows (particularly if that part of the story involves calling a tow truck driver to pick you up after the car has broken down). Perhaps knowing the specific store is important for understanding context. Sometimes those details don't matter, but sometimes if they aren't known it can lead to confusion. Using vocabulary correctly and being careful about word choice is important. Knowing when to simplify and when to give extra detail is also key.

Aside:

In the laboratory, undergraduate students in biology will often report back to their mentors that "my experiment worked" without sharing important details of what it means to have "worked", what the evidence is, how strong the evidence is, or what the basis is for their judgment - all details that are critical to understanding exactly what happened. If and/or when you start working in a research lab do yourself and your advisor the favor of describing IN DETAIL what you were trying to accomplish (don't assume they'll remember the details), how you decided to accomplish your goal (experimental design), what the exact results were (showing properly labeled data is advised), and providing your interpretation. If you want to end your description by saying "therefore, it worked!" that's also great.

Note: Possible Discussion

Can you think of an example where the imprecise or incorrect use of vocabulary caused needless confusion in real life? Describe the example and discuss how the confusion could have been avoided.
Problem Solving

Educators and employers alike have all argued strongly in recent years that the ability to solve problems is one of the most important skills that should be taught to and nurtured in university students. Problem solving ability consistently ranks as one of the most sought after traits employers want from their hires. Medical, professional, and graduate schools alike look for students with demonstrated ability to solve problems; the MCAT has even recently changed its format to more specifically assess student’s ability to solve problems. Life is full of problems to solve, irrespective of the profession one chooses. This is important!

Despite a clear demand for this skill set it is surprisingly rare to find problem solving taught explicitly in formal educational settings, particularly in core science courses where the transmission of “facts” usually takes precedence. In BIS2A we aim to start changing this. After all, nobody really cares if you’ve memorized the name or catalytic rate of the third enzyme in the citric acid cycle (not even standardized tests), but a lot of people care if you can use information about that enzyme and the context it functions in to help develop a new drug, design a metabolic pathway for making a new fuel, or to help understand its importance in the evolution of biological energy transformations.

Your instructors believe that the ability to solve problems is a skill like any other. It is NOT an innate – you’ve either got it or you don’t – aptitude. Problem solving can be broken down into a set of skills that can be taught and practiced to mastery. So, even if you do not consider yourself a good problem solver today, there is no reason why you can’t become a better problem solver with some guidance and practice. If you think that you are already a good problem solver, you can still get better.

Cognitive scientists have thought about problem solving a lot. Some of this thinking has focused on trying to classify problems into different types. While problems come in many different flavors (and we’ll see some different types throughout the course) most problems can be classified along a continuum of how well structured they are. At one end of the continuum are well-structured problems. These are the types of problems that you usually encounter in school. They usually have most of the information required to solve the problem, ask you to apply some known rules or formulae, and have a pre-prescribed answer. On the other end of the continuum are ill-structured problems. These are the types of problems you will usually face in real life or at work. Ill-structured problems may start poorly defined, usually do not present themselves with all of the information required to solve them, there may be different ways of solving them, and possible “correct” outcomes/answers can be different.

Note: Possible Discussion

Well-structured problems (like the story-problems you might often encounter in text books) are often set in an artificial context while the ill-structured problems one faces in everyday life are often set in a very specific context (your life). Is it possible for multiple people to observe the same situation and perceive different problems associated with it? How does context and perception influence how one might identify a problem, its solution, or its importance?

To have a fruitful/enriching discussion it pays to start by presenting an example AND some direct reasoning. Replies that acknowledge the initial comment and either provide an extension of the original argument (by way of a new perspective or example) or provide a reasoned counter-argument are most valuable follow-ups.

Problems can also be “simple” or “complex” depending on how many different variables need to be considered to find
a solution or be considered "dynamic" if they change over time. Other problem classification schemes include story problems, rule-based problems, decision-making problems, troubleshooting problems, policy problems, design problems, and dilemmas. As you can see, problem solving is a complicated and deep topic and a proper discussion about it could fill multiple courses.

While the topic of problem solving is fascinating, in BIS2A we aren't interested in teaching the theories of problem solving per se. However, we ARE interested in teaching students skills that are applicable to solving most types of problems, giving students an opportunity to practice these skills, and assessing whether or not they are improving their problem solving abilities. **Note: Since we are asking you to think explicitly about problem-solving it is fair to expect that your ability to do so will be evaluated on exams. Do not be surprised by this.**

We are going to incorporate problem solving into the class a number of different ways.

- **First:** We will be explicitly teaching elements of problem solving in class.
- **Second:** We will have some questions on the study guides that encourage problem solving.
- **Third:** We will make frequent use of the pedagogical tool we call the “Design Challenge” to help structure our discussion of the topics we cover in class.

When we are using the Design Challenge in class we are working on problem solving. Within the context of the Design Challenge your instructor may also present other specific concepts related to problem solving – like decision-making. Slides will be marked explicitly to engage you to think about problem solving. Your instructor will also remind you verbally.