Supplemental Material

CBE—Life Sciences Education

Kudish *et al.*

Preview Assessment: BIOL 002 2012 Student Course Evaluation

Name BIOL 002 2012 Student Course Evaluation

Instructions This survey is not mandatory. However, we greatly appreciate your participation and we make changes in the course based on the answers we receive here. Please fill out the questions below and click Submit when you are finished. We expect this survey to take less than half-an hour, although this will vary between individuals.
Please take your time in reading questions and choices carefully before answering. We want to make sure your point of view is accurately reflected in your responses.

Multiple Attempts Not allowed. This Survey can only be taken once.

Force Completion This Survey can be saved and resumed later.

Question Completion Status:

Question 1 Save

Please enter your student ID number here

Question 2 Save

Please indicate your lab section:

- 1. Monday:
- 2. Tuesday AM:
- 3. Tuesday PM:
- 4. Wednesday:
- 5. Thursday:

Question 3 Save

What year are you?

- Freshman
- Sophomore
- Junior
- Senior

Question 4 Save

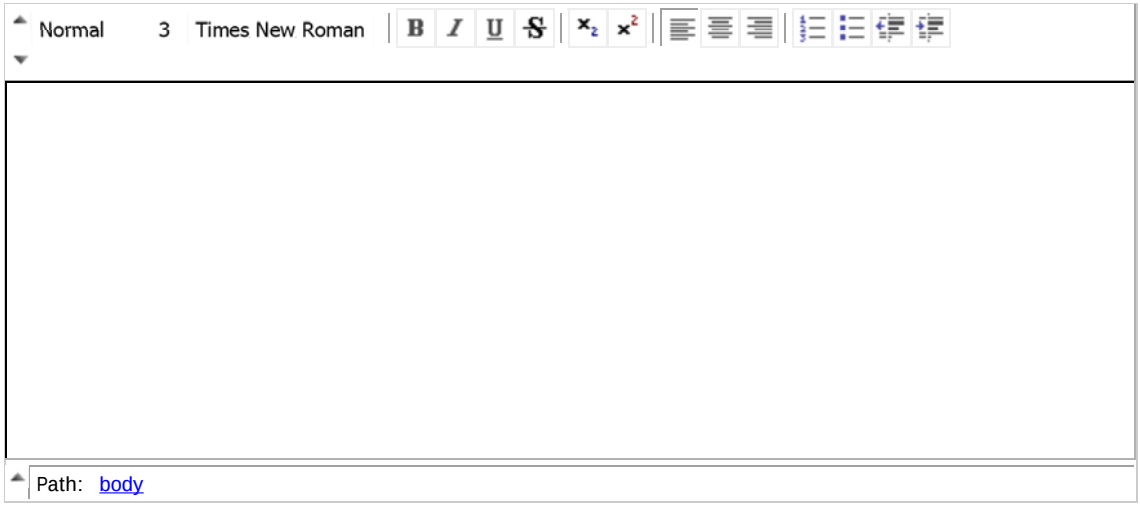
What major do you currently intend to pursue at Swarthmore? Please limit your choices to one or two of the following.

- Undecided
- Art, Music & Dance, Theater, or Film & Media Studies
- Asian Studies, Black Studies, Latin American Studies, or Women's Studies
- Biology or related special major (Biochemistry, Environmental Science, Psychobiology, etc.)
- Chemistry
- Classics
- Computer Science
- Comparative Literature, English Literature, or Interpretation Theory

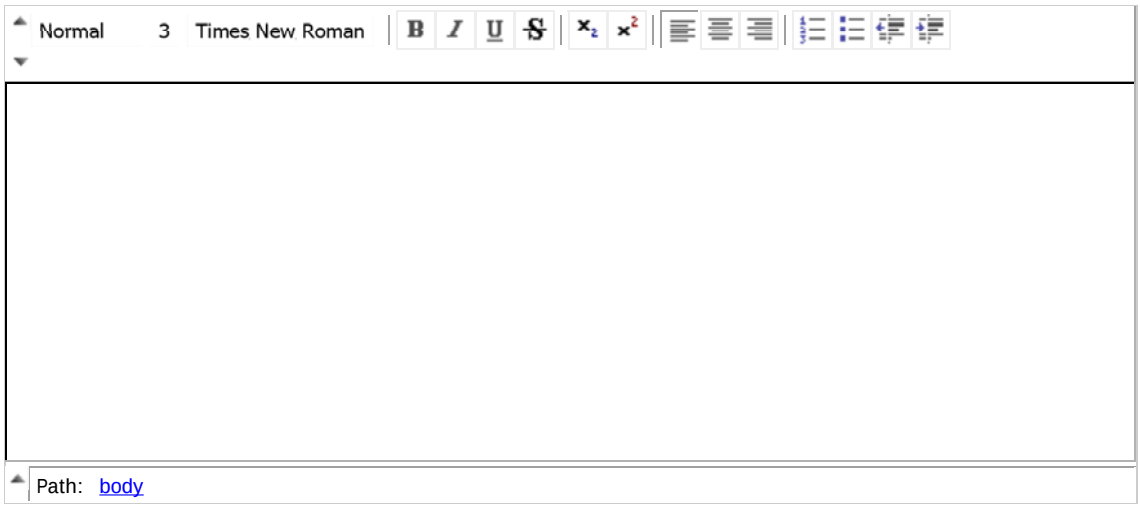
- Economics
- Engineering
- History or Medieval Studies
- Linguistics or Cognitive Science
- Mathematics & Statistics
- Modern Language & Literatures, Francophone, or German Studies
- Philosophy or Religion
- Physics & Astronomy
- Political Science, Public Policy, or Peace & Conflict Studies
- Psychology
- Sociology & Anthropology

Question 5 Save

Lecture Evaluation: Please comment on the effectiveness of the following lecturers (consider content, pace, lecturing style, etc.):

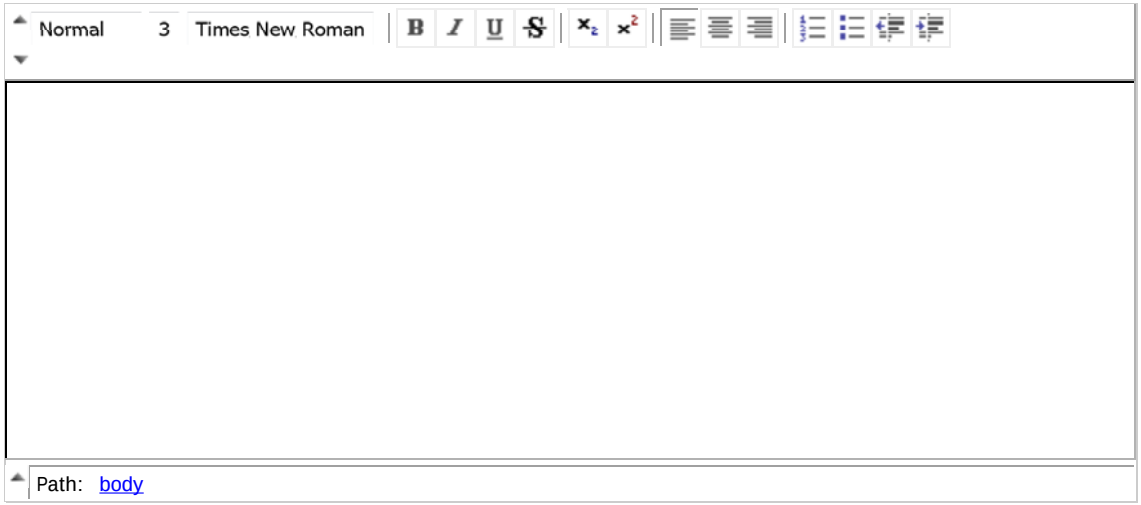


Question 6 Save



Question 7

Save



Question 8

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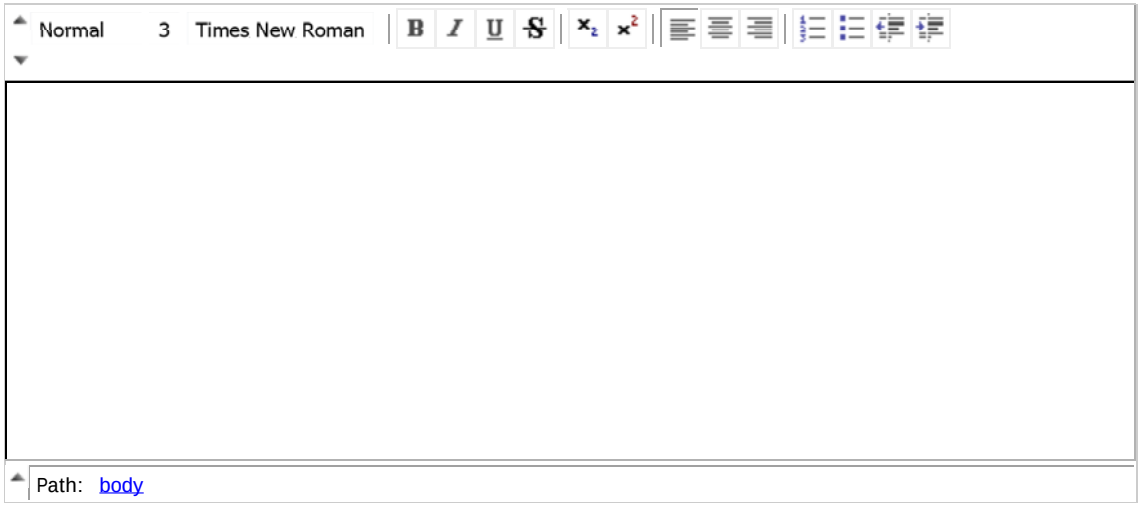


Question 9

Save

Please comment on the effectiveness of instruction in your laboratory section and your interactions with the teaching staff in your section:

Path: body

Question 10 Save

Please evaluate the following activities by rating the GAIN you received by doing them.

- Attending formal lectures
- Reading assignments/ textbook
- Using the Pechenik book
- Using the Bates Writing Website
- Preparing for quizzes
- Taking quizzes
- Reviewing quiz keys
- Writing laboratory reports
- Working on challenge questions
- Attending Science Associates' (SAs') Study Group Meetings (SGMs)
- Individual meetings with writing associates (WAs)
- Evening laboratory teaching assistant data analysis sessions in the Bio 2 lab (Lab TADA)
- Working with lecturers or lab instructors in individual meetings (e.g. office hours)
- Working individually with a tutor through the Dean's office

1. I got nothing from this
2. I gained very little from this
3. This somewhat enhanced my learning of biology
4. This enhanced my learning of biology
5. This greatly enhanced my learning of biology
6. (I did not do this activity)

Question 11 Save

Please evaluate the following activities by rating the PAIN you associate with them:

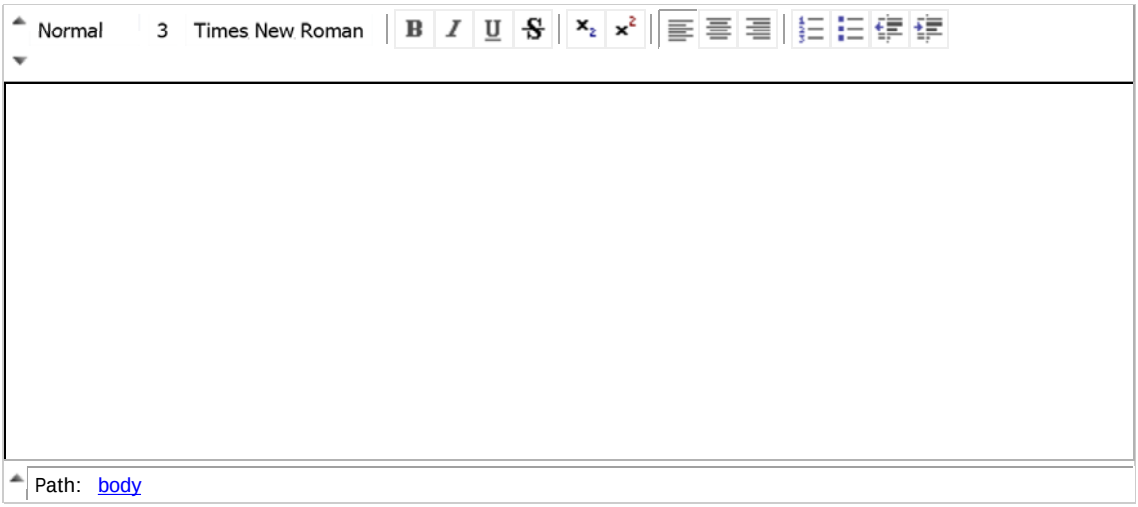
- Attending formal lectures
- Reading assignments/ textbook
- Using the Pechenik book
- Using the Bates Writing Website
- Preparing for quizzes

1. This caused me no pain at all
2. This caused me a little pain
3. This was somewhat painful for me
4. This was painful for me
5. This caused me horrible miserable agony
6. (I did not do this activity)

- Taking quizzes
- Reviewing quiz keys
- Writing laboratory reports
- Working on challenge questions
- Attending Science Associates' (SAs') Study Group Meetings (SGMs)
- Individual meetings with writing associates (WAs)
- Evening laboratory teaching assistant data analysis sessions in the Bio 2 lab (Lab TADA)
- Working with lecturers or lab instructors in individual meetings (e.g. office hours)
- Working individually with a tutor through the Dean's office

Question 12 Save

Please feel free to comment about any of these course activities



Question 13 Save

Please evaluate the GAIN you received from the following laboratories:

- Statistics
- Anemones & Symbiosis
- Mink I & II
- Diving Lab
- Phylogeny, Evolution & Dinosaurs
- Are Plants Really Green?
- Photosynthesis I & II
- Tour of Longwood

1. I got nothing from this laboratory
2. I gained very little from this laboratory
3. This laboratory somewhat enhanced my learning of biology
4. This laboratory enhanced my learning of biology
5. This laboratory greatly enhanced my learning of biology

- Walk in the Woods
- Writing Consultations I & II

Question 14 Save

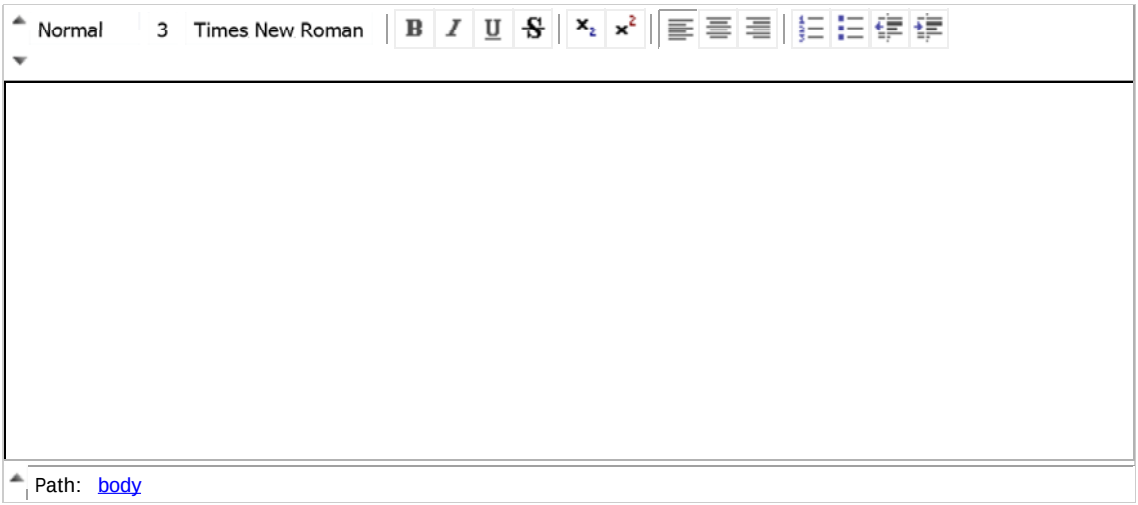
Please rate the PAIN you experienced associated with the following laboratories:

- Statistics
- Anemones & Symbiosis
- Mink Lab I & II
- Diving Lab
- Phylogeny, Evolution & Dinosaurs
- Are Plants Really Green?
- Photosynthesis I & II
- Tour of Longwood
- Walk in the Woods
- Writing Consultations I & II

1. This laboratory caused me no pain at all
2. This laboratory caused me a little pain
3. This laboratory was somewhat painful for me
4. This laboratory was painful for me
5. This laboratory caused me horrible miserable agony

Question 15 Save

We have devoted laboratory time to meeting with students one-on-one to discuss writing. Please give us feedback on your experience and suggestions of how to make it more effective.



Question 16 Save

Please feel free to make comments about any of the laboratories

Path: body

Question 17

Save

Please comment on the feedback you received on graded assignments (quizzes and papers). Do you understand why you got the grade you did and how to improve?

Normal 3 Times New Roman

Path: body

Question 18

Save

Did you attend Science Associates' Study Group Meetings this semester? If you answer yes, please proceed to the next question and continue until you complete the survey. If you answer no, please proceed to question 26 and continue until you complete the survey.

- Yes
- No

Question 19

Save

If you attended Science Associates' (SAs') Study Group Meetings (SGMs), how often did you attend on average?

- Several times a week
- Once a week
- Once every 2 weeks
- Once every 3 weeks
- Once a month
- Only a few times this semester

Question 20

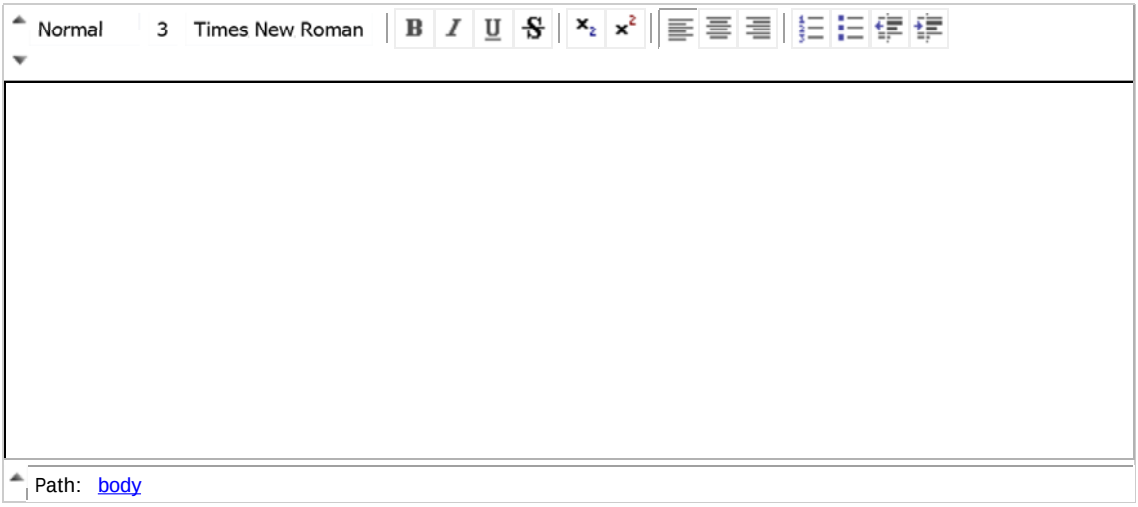
Save

If you attended SGMs, please indicate whether you agree with the following statement:
Going to Science Associates' Study Group Meetings (SGMs) was helpful for me in BIOL 002.

- I strongly disagree
- I disagree somewhat
- I agree somewhat
- I strongly agree

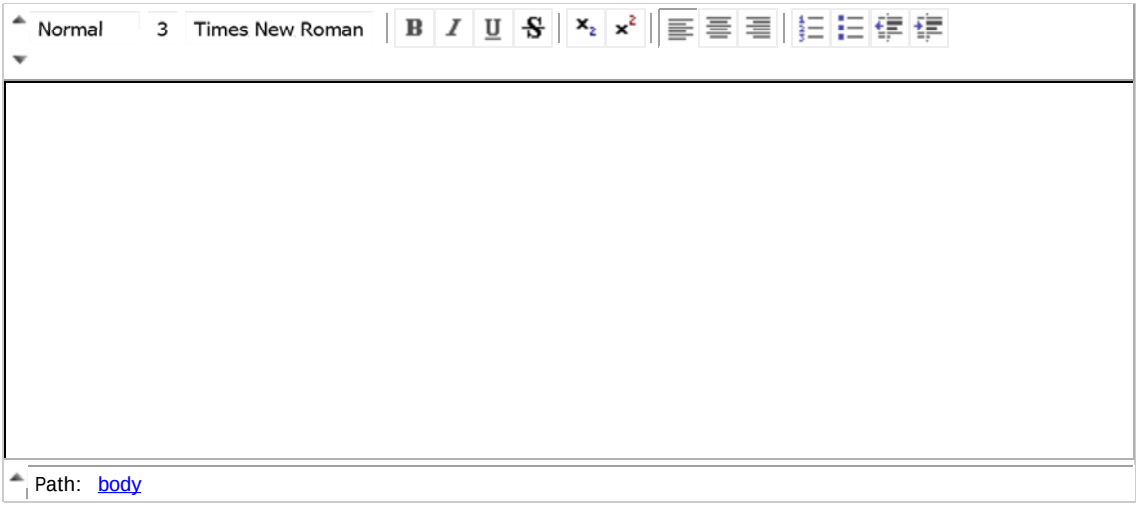
Question 21 Save

If you attended SGMs, what features were most helpful to you?



Question 22 Save

If you attended SGMs, what improvements could you suggest?



Question 23 Save

If you attended, how valuable did you find SGMs for each of the following?

- Working on Challenge Questions
- Synthesizing connections and learning course concepts

1. Not valuable at all
2. A little valuable
3. Somewhat valuable
4. Valuable

- Preparing for quizzes
- Getting help from Science Associates
- Interacting socially with Science Associates
- Getting help from other BIOL 002 students
- Giving help to other BIOL 002 students
- Interacting socially with other BIOL 002 students

5. Very valuable
6. (I did not do this)

Question 24 Save

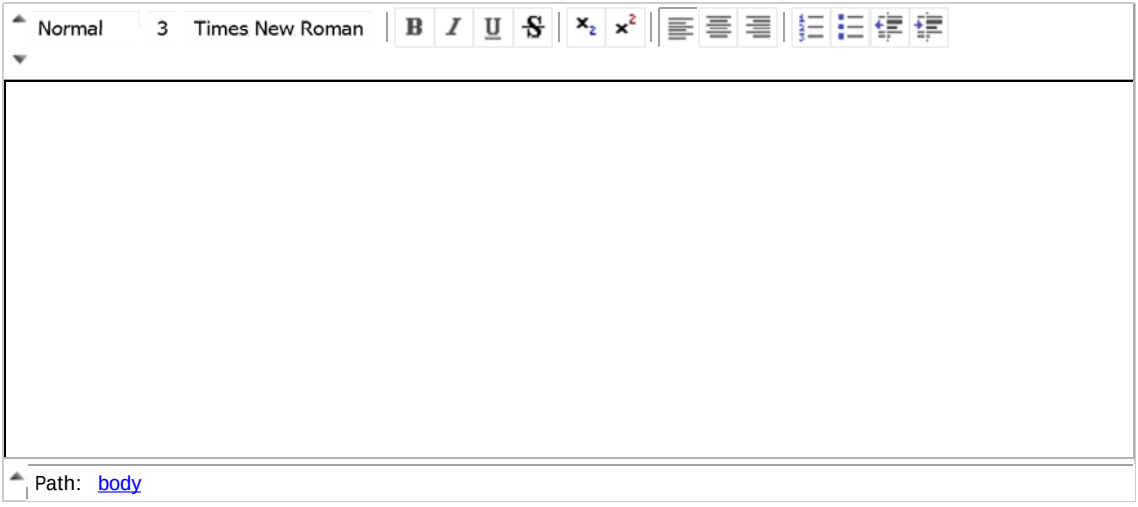
If you attended SGMs, please answer the following: Beyond what you gained from lectures and labs, how valuable were SGMs specifically for enhancing each of the following:

- My interest in biology
- My self-confidence in understanding biology
- My ability to think scientifically
- My conceptual understanding of cellular & molecular biology
- My enjoyment of BIOL 002
- My ability to solve scientific problems
- My ability to articulate solutions to scientific problems
- My comfort level in taking biology courses
- My interest in further learning in biology

1. Going to SGMs did not help this at all
2. Going to SGMs helped this very little
3. Going to SGMs somewhat helped this
4. Going to SGMs helped this a lot

Question 25 Save

If you attended SGMs, do you have anything else to add that would help us in our thinking about practices and policies of Science Associates' Study Group Meetings? If so, please explain.



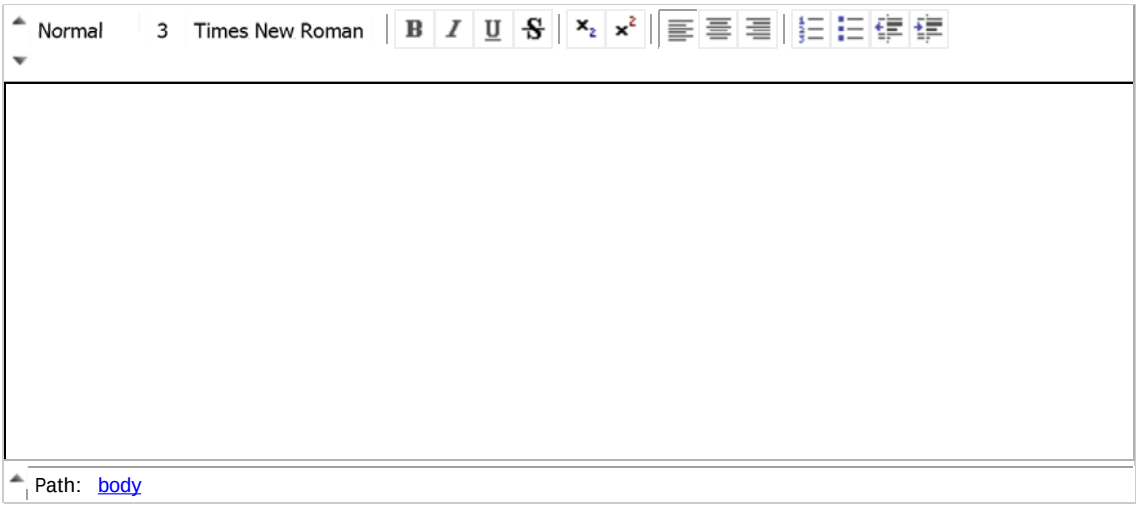
Question 26 Save

If you have never or only rarely attended Science Associates' Study Group Meetings (SGMs), why? (Check all that apply)

- I felt I already had a good grasp of the course material
- I felt I needed to devote greater energy and attention to my other courses
- I had a scheduling conflict with the timing of the SGMs
- I already have other classmates and friends with whom to study biology, outside of SGMs
- I prefer to study alone
- I prefer meeting directly with my biology instructors/professors for help
- I attended at least once and found SGMs unhelpful
- I attended at least once and found SGMs intimidating
- I attended at least once and found SGMs took too much of my time
- I attended at least once and found SGMs too noisy
- I attended at least once and found too few Science Associates were available
- I attended at least once and found Science Associates unhelpful
- Other (please describe in the box provided below)

Question 27 Save

If you had another reason for not attending SGMs, please describe it here



Question 28 Save

How often did you rely on each of the following methods to study for BIOL 002 quizzes and exams?

- Studying independently on my own	1. Never
- Studying informally with friends (not including SGMs)	2. Rarely
- Studying with BIOL 002 class or lab instructors (e.g. in office hours)	3. Some of the time
- Studying in Science Associates' Study Group Meetings	4. Most of the time
	5. Always

Question 29 Save

On average, how many hours a week do you spend on your Bio 2 course (not including time spent in class or lab)?

- 1 to 3 hours
- 3+ to 6 hours

- 6+ to 9 hours
- More than 9 hours

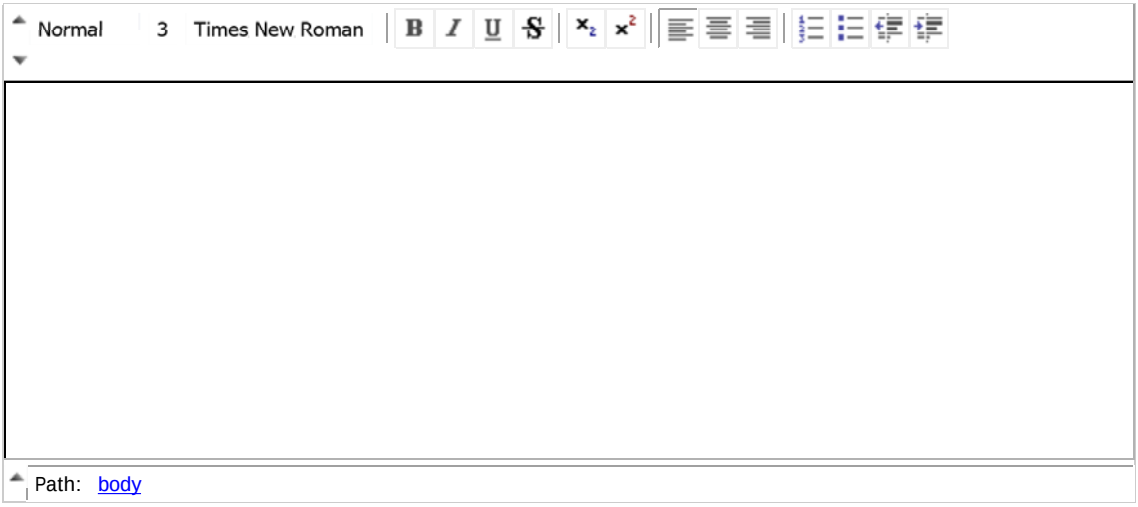
Question 30 Save

On average, is this more or less than for other courses you've taken at Swarthmore?

- Bio took twice as much or more time compared to most other courses
- Bio took somewhat more time compared to most other courses
- Bio took about the same time compared to most other courses
- Bio took somewhat less time compared to most other courses
- Bio took half as much or less time compared to most other courses

Question 31 Save

We tried to provide you with numerous resources to facilitate writing in this course (Pechenik, scientific articles, WA-process, Bates Writing Website, meeting one on one with instructors, etc.). Which ones were most helpful?



Question 32 Save

What major do you currently intend to pursue at Swarthmore. Please limit your choices to one or two of the following:

- Undecided
- Art, Music & Dance, Theater, or Film & Media Studies
- Asian Studies, Black Studies, Latin American Studies, or Women's Studies
- Biology or related special major (Biochemistry, Environmental Science, Psychobiology, etc.)
- Chemistry
- Classics
- Computer Science
- Comparative Literature, English Literature, or Interpretation Theory
- Economics
- Engineering
- History or Medieval Studies
- Linguistics or Cognitive Science

- Mathematics & Statistics
- Modern Languages & Literatures, Francophone, or German Studies
- Philosophy or Religion
- Physics & Astronomy
- Political Science, Public Policy, or Peace & Conflict Studies
- Psychology
- Sociology & Anthropology

Question 33 Save

How confident are you in your ability to comprehend and articulate concepts in biology?

- 1 - No confidence whatsoever
- 2
- 3
- 4
- 5 - Fully confident

Question 34 Save

Indicate your level of agreement with the following statement:
Having taken Bio 2 has increased my confidence in my ability to form arguments (describe evidence, etc.) in a debate with a skeptic about global warming.

- 1 - Strongly disagree
- 2
- 3
- 4
- 5 - Strongly agree

Question 35 Save

Indicate your level of agreement with the following statement:
Having taken Bio 2 has increased my confidence in my ability to explain the evidence for global warming to an interested peer.

- 1 - Strongly disagree
- 2
- 3
- 4
- 5 - Strongly agree

Question 36 Save

Please indicate your level of agreement with the following statements:

Biology is interesting	1. I strongly disagree 2. I disagree 3. I'm not sure 4. I agree 5. I strongly agree
Biology is applicable to the real world outside of school (for example in health or political decision making)	
I plan to take more biology courses after BIOL 002	

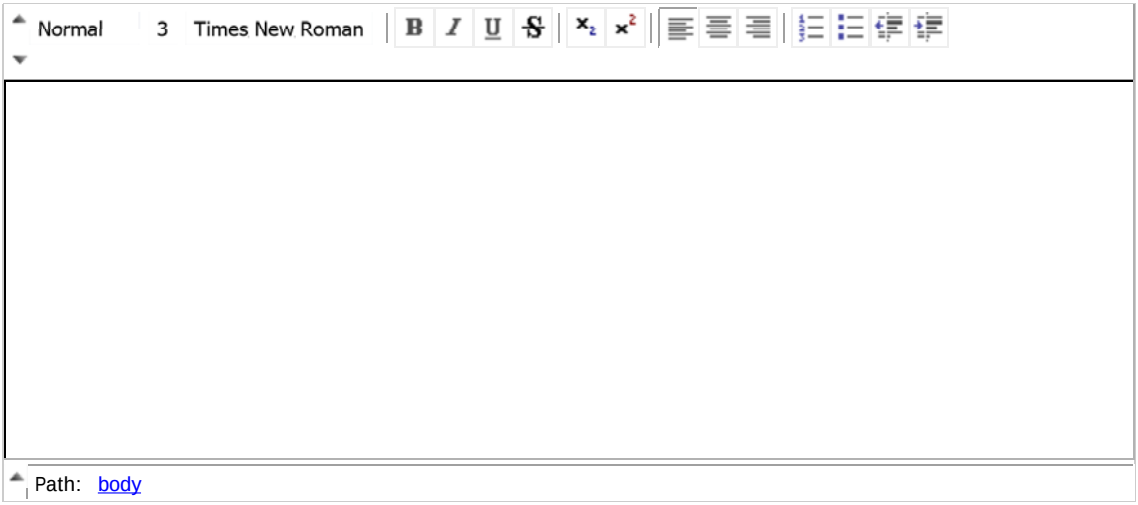
Question 37 Save

Did BIOL 002 excite you and encourage you to delve deeper into biology?

- Yes
- No

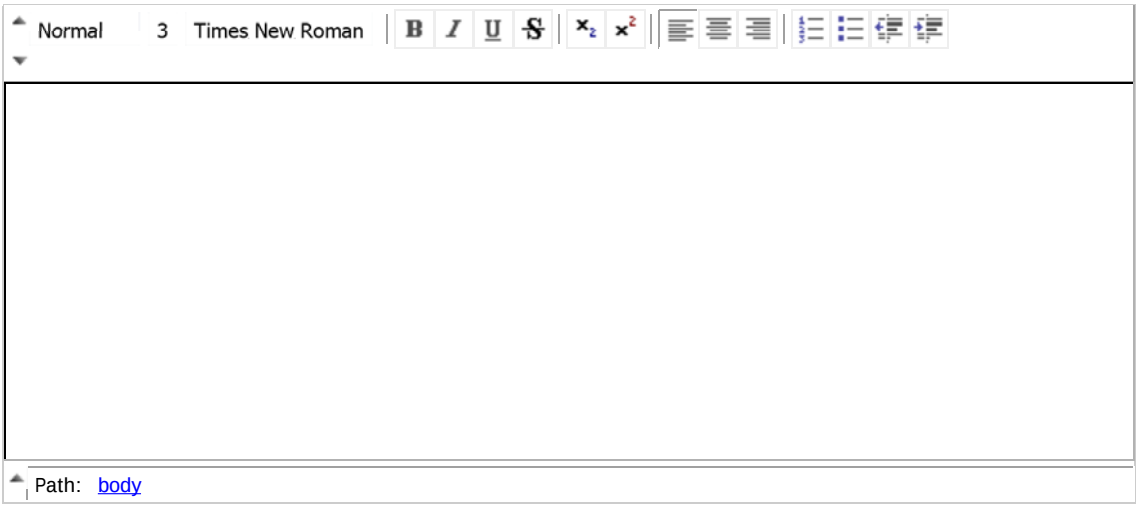
Question 38 Save

If you replied "yes" to the previous question, please describe how you expect to delve deeper into biology.



Question 39 Save

Please tell us one thing that we should keep the same about BIOL 002.



Question 40 Save

Please tell us the most important thing to change about BIOL 002.

Path: body

Question 41

Save

The following space is available for you to write any additional comments about BIOL 002 before you exit the survey. We greatly appreciate your participation in BIOL 002 and in this survey.

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Path: body

Save Submit

Peer-Led Team Learning in Introductory Biology
SUPPLEMENTAL MATERIALS

Supplement 1.
Challenge Questions for Introductory Biology

What would the effect of a H^+ ionophore (a molecule which creates H^+ channels in membranes) be on photosynthesis? On respiration? Be specific.

What are the structural and functional similarities and differences of mitochondria and chloroplasts?

Review all of the monomers that living organisms (including plants) are built from. Compare their elemental composition to that of the compounds that plants can produce from air, water, and sunlight. Now figure out what the major nutrients in plant fertilizer must be (i.e. what do plants have to absorb from the soil in order to grow that they cannot make for themselves?).

When Rubisco evolved, why was there no selective pressure for it to evolve as a carboxylase without any oxygenase activity? What problem does this create for plants?

What effects will the increasing global CO_2 levels which are forcing global temperature increases have on the photosynthetic efficiency of C_3 plants? of C_4 plants? How might these changes affect competition between a C_3 and a C_4 plant?

You are the first scientist to determine the DNA sequence of a newly discovered organism. How would you go about identifying the promoters and other regulatory DNA sequences in your new genome?

Is it possible to select for quantitative traits without using genotyping information (molecular markers)? If so, why do modern breeding programs universally use genotype information?

Why go through the hassle of marker assisted backcrossing when you can use genetic engineering to move genes directly from one organism to another? There are both policy and scientific answers to this question.

A phenotype can be used to infer the molecular function of the gene that causes the phenotype when mutated (the causal gene). The green pea mutant phenotype suggests that the mutated gene has a function in chlorophyll break down. Predict the molecular functions of the other six genes whose phenotypes Mendel studied.

If you wanted to double the amount of milk produced by a population of dairy cows through artificial selection (controlled breeding) what pieces of information would you need, and how would you go about getting those data?

Can an individual evolve? Can populations evolve? Can a species evolve? Can we say that the entire group we call Chondrichthyes evolve? What about the cells in the hand of a chimp, can they evolve? Be sure to justify your answer for each.

Why does the definition of evolution contain the word "heritable" for properties that could evolve? Can only traits that are heritable evolve? If so, why?

Often students will make a mistake and say something like this: "In a system with strong sexual selection, females mate with the males because they are the most fit (i.e. those males have the highest fitness)." What is wrong with this phrase? How could you correct this statement to be correct?

Can sexual selection occur in a species that is strictly monogamous? Why or why not?

Generate a list of any and all possible uses for therapeutic and reproductive cloning. Evaluate the societal implications for two or three reproductive cloning technologies, including ethical implications. For one of these technologies, discuss whether it can or should be regulated.

Find a friend, family member or classmate who is not a biologist. Use a simple analogy to help explain why the cells in their bodies exhibit different functional properties even though they share the same DNA. Write down your explanation. Based on this explanation, discuss why it should be possible to change a cell's identity by manipulating transcription factor activity or expression.

Imagine that a medical researcher wants to determine what proteins are differentially expressed in three different cell types from an individual patient, red blood cells, white blood cells and epidermal cells. The researcher decides to investigate this question by collecting samples of each cell type from the patient and extracting the cytoplasmic, fully processed messenger RNA from each cell sample. She then uses an enzyme called reverse transcriptase to convert the extracted RNA into complementary strands of DNA (this is called cDNA, http://www.bio.davidson.edu/genomics/method/cDNAproduction.html). She then sequences the cDNA from each sample.

Based on today's lecture and information you can find about the structure and function of these cell types, list one or more proteins that would be differentially expressed in each of these cell types.

Explain why the researcher's plan to examine RNA expression will reveal some potential differences in protein expression between these cell types.

What are the limitations of this approach? Why is it that differences in RNA expression may not accurately reflect differences in protein expression or activity?

Would a comparison of genomic DNA have helped her examine differential protein expression in these different cell types?

TP53 is a key "tumor suppressor" gene. Expression of the p53 protein helps ensure that pre-cancerous cells do not form tumors. One 5' regulatory element for p53 has been shown to play an important role in activating p53 expression. Based on this information, **assess the likelihood** that each of the following mutations would promote the formation of a cancerous tumor.

5 base pair insertion in the regulatory element
5 base pair insertion in the promoter
5 base pair insertion in an exon
5 base pair insertion in an intron

Write two stories involving human communication. Use these stories to illustrate all of the aspects of signal transduction listed in Figure 16-13 including - signal, receptor, relay,

amplify, transduce and effect. For one story the response should be analogous to altered gene expression. In the other story, the response should be analogous to altered cell shape or movement.

Evolutionary biologists have posited that non-coding mutations play a predominant role in evolution, as opposed to mutations in coding regions. Use material from lecture to justify this viewpoint.

The hemoglobin-oxygen dissociation curves we have drawn in class represent a large pool of molecules. Draw a dissociation curve for a single molecule of hemoglobin that displays the property of cooperative binding. Draw a second curve on the same axes, this time for a single molecule of hemoglobin that does not show cooperative binding.

Would the structure of a protein be different if it were in pure oil rather than in water? Why? In what way would it be different? What would the structure of the cell membrane be like if it were in pure oil rather than in water?

Explain how anhydrobiosis could result in higher-than-usual amounts of oxidative damage.

A tardigrade tun has no measurable metabolic rate (we cannot detect any cellular respiration). Is it alive?

Some bony fish spend part of their lives in salt water and part in freshwater (e.g., salmon). In which environment will a salmon's osmoregulatory costs be higher? Include Fick's law in your answer, and support your answer quantitatively (i.e., how many times higher is the osmoregulatory cost in one of these environments than the other?).

What are the advantages and disadvantages of being an osmoconformer?

The mummichog possesses the physiological ability to osmoregulate in a range of environmental water concentrations, but it often swims to locations in the estuary where the water has a similar osmotic concentration to its own body fluids. Based on this information, which would you guess is more energetically costly, swimming to different locations in the estuary or physiological osmoregulation (i.e., fueling the kidneys and ion pumps in the gills)?

As a member of the interstellar space fleet, your assignment is to look for examples of different kinds of reproduction on a new planet. Where (under what circumstances) would you look for the following kinds of reproduction: internal and external fertilization, hermaphrodism, asexual reproduction? Be prepared to explain your reasoning.

Some evolutionary biologists argue that parasitism is one of the factors that enforces the advantage of sexual reproduction. First explain why (in an evolutionary context) sexual reproduction would be at a disadvantage (compared to asexual reproduction) and then make an argument for why parasites, in particular, would be an important selection force that favors sexual reproduction. What other circumstances favor sexual reproduction and are they common? What does all this have to do with the Red Queen Hypothesis?

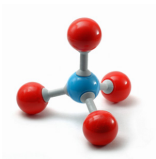
If sexual reproduction is so important to the success of eukaryotic organisms, how do prokaryotes survive without it?

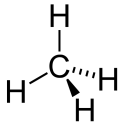
Parthenogenesis has recently been reported in female Komodo Dragons that have been isolated in zoos away from any males for years. Sex determination in these big lizards is based on a ZW scheme (as opposed to our X and Y). Female Dragons are ZW, males are ZZ and WW individuals do not survive. All the living offspring from these isolated females are male. Propose a mechanism for these results. Komodo dragons are island species where an individual may find herself isolated from the rest of the population. How would this version of parthenogenesis help her lineage survive? A detrimental outcome of inbreeding is the "uncovering" of lethal recessive alleles – why is that not typically happening to these parthenogenetic Komodo Dragons?

What would happen if all bonds were covalent? What kinds of things could not happen and how would that change cells and their functions?

What kinds of external forces/conditions might disrupt ionic bonds? hydrogen bonds?

Water is polar. Methane is not polar – its formula is CH_4 and has the shape:





It has been found on Titan, one of Saturn's moons that thre are lakes of liquid methane. So when methane is the major solvent, and not water, if some sort of cellular-based life form were to evolve on that planet, what are two major differences between those cells and the cells found on earth.

Proteins are quite flexible. While we do not know all of the rules of folding, we have a good handle on some of them. Write three rules that might be part of the 'instructions' for how to fold a protein in an aqueous (watery) solvent and explain why. How would these instructions change if the protein were to be embedded in a lipid membrane?

Polyploidy is much more common in plants than in animals. What are at least two different reasons this is true?

Allopatric speciation is a very rare event. It requires that a fraction of the original population be separated and remain that way until that sub-population has developed reproductive isolation. Diagram a theoretical population from separation to speciation showing the change in genetic diversity in the group over time. Where does Natural Selection come into play? For a group that has been separated from the parent population what are other possible outcomes other than speciation? What is the most common? What criteria are used to recognize when speciation has happened?

How are endangered species like the isolated populations at the beginning of allopatric speciation?

Explain why planktic species have lower speciation rates.

If planktic species generally exist longer (have greater species longevity), why do we have any non-planktic species? (hint: One way to think of this is under what conditions do non-planktic species have an advantage over planktic species.) (This is a good complicated question!)

Oak trees (*Quercus*) produce the relatively large seeds we know as acorns. In contrast, poplar trees, aspen and cottonwoods (all genus *Populus*) produce small seeds that are dispersed by wind. *Quercus* has at least 126 species, while *Populus* has only 21.

Considering the work of Thor Hansen on the patterns of speciation and extinction of snails, is the speciation pattern in these trees surprising? Why or why not?

In which group (oaks or poplars) do you expect to find higher extinction rates?

Give two reasons why the group you named would be more vulnerable to extinction.

When a biologist says, "DNA is made into RNA," what does she really mean?

Transcription factors bind to DNA in specific locations based on the nucleotide sequence (ATTA but not ATTG for example). Explain how this is possible, given that the unique portion of the nucleotides (the bases) are facing towards the interior of the DNA double helix and the bases are hydrogen bonded to one another.

How may have the presence of introns contributed to the evolution of new protein sequences and functions? Can you think of an analogy that I could use in the future to describe this to students?

Why are some genes more highly expressed than others? Is a particular gene always expressed at the same level?

How might some cell types splice out different introns than other cell types?

The processes of transcription and translation can be divided into initiation, elongation and termination. Compare and contrast how these steps happen for these processes. What are the enzymes and monomer subunits involved? What are the signals sensed by these enzymes for initiation and termination? Where are the signals found?

SUPPLEMENTAL MATERIALS

Supplement 2.
Pedagogical Principles & Practices Proseminar
Fall Syllabus
Th 5:30-6:30pm

Course Description

BIOL 000-SA *Pedagogical Principles & Practices Proseminar* introduces Science Associates (SAs) to established theoretical frameworks in science education, their methodological implications and opportunities for application through a teaching practicum. Expectations include assigned readings and reflective writing. This is a non-credit course co-requisite with employment requiring attendance at Study Group Meetings (teaching practicum), introductory biology lectures (BIOL 001 *Cellular & Molecular Biology* in the current semester) and content meetings with lecturers.

Proseminar Readings and Assignments

Date	Topic	Readings and Other Assignments
September 1st	Orientation	*Biology Biographies* -due prior to class
September 8th	Personal Constructivist/ Cognitive Lens	McCrudden, M. T., McCormick, M., & McTigue, E. (2011). Do the spatial features of an adjunct display that readers complete while reading affect their understanding of a complex system*? International Journal of Science and Mathematics Education*, 9, 163-185
September 15th	Personal Aesthetic Lens	Pugh, K. J., & Girod, M. (2007). Science, art and experience: Constructing a science pedagogy from Dewey's aesthetics. *Journal of Science Teacher Education, 18,* 9-27
September 22nd	Collaborative Learning/ Social Constructivist Lens	Eberlein, T. Kampmeier, J., Minderhout, V., Moog, R.S., Platt, T., Varma-Nelson, P. & White, H.B. (2008). Pedagogies of Engagement in Science: A Comparison of PBL, POGIL, and PLTL. *Biochemistry and Molecular Biology Education*, 36, 262-273
September 29th	Scientific Community of Practice Lens	Osborne, J. (2010) Arguing to Learn in Science: The Role of Collaborative Critical Discourse, *Science,* 328, 463-466
October 6th	No meeting	N/a
October 13th	Fall Break	N/a
October 20th	Ecosocial/ Identities/ Sociocultural Lens	Lemke, J.L. (2000) Across the Scales of Time: Artifacts, Activities, and Meanings in Ecosocial Systems. *Mind, Culture, and Activity 7*, 273-290
October 27th	Special Topic	Johnson (2007) Unintended consequences: How science professors discourage women of color. *Science Education*, 91, 805-821
November 3rd	Special Topic	Allen D, Tanner K. Approaches to cell biology teaching: questions about questions. Cell Biol Educ. 2002; 1(3):63–67.
November 10th	Discuss *SA Essays*	*SA Essays*–first draft due
November 17th	Buzzword Bingo Brainstorming	Bingo Skit Ideas -due
November 24th	Thanksgiving Break	N/a
December 1st	Buzzword Bingo Rehearsal	Bingo Skit Props -due *SA Essays*–final draft due by end of final exams

Science Associates' Roles

Science Associates' roles include *colleague*, *researcher, recruiter, scholar* and *teacher*. Features of these roles are explained here and in more depth during orientation.

How can I be a good colleague?

- Be prompt and prepared for all classes and meetings.
- Be positive to enrolled students about BIOL 001 content and colleagues.
- Support fellow SAs e.g. clarifying concepts, shifting shifts.
- Support lecturers e.g. feedback on lectures and student comprehension.

How can I be a good researcher?

- Keep an accurate attendance sheet at SGMs.
- Note and share pedagogical ideas and experiences in proseminar.
    - What instructional methods worked well or woefully at SGMs?
    - How might fellow SAs apply this or other information in upcoming SGMs?
    - Which groups or individuals were struggling or strong at SGMs and why?
    - Discuss how you did, might've or might facilitate these students' learning.

How can I be a good recruiter?

- General: Advertise and advocate SGMs -spread the word! :^)
- Struggling students: Be subtle. *Information about student performance is strictly confidential.*

How can I be a good scholar?

- Take time and notes as you read and reflect on assigned readings.
- Come to seminar prepared to participate in discussions.
- Be reflective in your writing and prepared to discuss your work.

How can I be a good teacher?

- Successful teaching is context-dependent, but drawing on established pedagogical principles & practices such as those we will discuss in our proseminar can help.

Proseminar Topics

This course is designed to familiarize you with established principles and practices in science education to inform your teaching in SGMs or other contexts. I have organized these for you as a nested set of five lenses on learning, from least to most holistic as described at the end of this section. We will discuss these and tools for teaching associated with each lens in our weekly meetings. Each lens is an amalgam of one or more established learning theories, which share common or commensurable epistemologies and units of analysis. In our weekly meetings, we will discuss selected articles or excerpts representing each lens.

Stepwise, we may increase or decrease the magnification on a metaphorical microscope to reveal emergent properties at each level from in-the-head cognition to distributed communities. As is true for literal microscopes, stronger lenses illuminate more detail, but at the expense of context (and the reciprocal is also true.) Thus, the ability to flexibly shift between different lenses as warranted by the situation and goal at hand is a powerful one. Moreover, these lenses on learning

are not mutually exclusive. Boundaries between perspectives are pragmatic, rather than rigid so one or more lenses may apply in a given situation for a given goal.

Like physicians, educators are a kind of clinician. Physicians are practical in their use of biological research findings. They draw from findings at the level of the molecule, cell, organism and inter-organismal interaction as needed to treat her or his patient. Rather than drawing from biological research findings, Science Associates and other teachers can draw from educational research findings to diagnose problems and design and apply appropriate interventions for the students in our care. Thus, I encourage you to combine or toggle between these theoretical lenses as needed for students' situation-specific needs.

In proseminar, we will avail ourselves of our common experience in BIOL 001 lectures as a context in which to discuss these perspectives on teaching and learning. As you listen to each lecture, note how the lecturer utilizes teaching tools warranted by respective lenses on learning. Come to proseminar prepared to discuss these observations and implications for your and fellow SAs' teaching in SGMs. What was especially effective? What might be missing from the lecture that warrants emphasis in SGMs? (To address our roles as good colleagues, we will share these observations with the lecturer.)

In preparing to discuss each assigned reading, consider the following questions:

- What epistemologies, values and methods do the author(s) advocate or intimate?
- How might this selection (or the lens it represents) inform your practice in SGMs?
- What is missing from this selection? How might other principles or practices supplement the author(s) recommendations or implications?

Lenses on Learning

The following are brief introductory summaries of each lens. We will discuss each in more detail in proseminar, including a published article or excerpt representing each lens and implications or explications for associated pedagogical practices.

Personal Constructivist/ Cognitive Lens

This lens amalgamates perspectives, which view learning as in-the-head information processing or conceptual ecology. It focuses on cognitive features of expertise including hierarchical organization, assimilation and retrieval of information, pattern recognition, and patterned response to cues.

Aesthetic Lens

Aesthetics as a coherent lens on learning is still somewhat boutique relative to others introduced in this course, but is gaining traction among science education theorists, researchers and practitioners. This perspective is inclusive of Deweyan aesthetics, narrative theories and other perspectives that focus on present affective, motivational qualities of educative experiences.

Collaborative Learning/ Social Constructivist Lens:

Interpersonal interaction is the hallmark of social constructivist depictions of learning and teaching such as cognitive apprenticeship and is described by constructs such as the Zone of Proximal Development. The most popular of these perspectives trace their origin to Lev

Vygotsky, whose work is seminal in higher order sociocultural perspectives that view learning as participation in practices of distributed communities and not merely through direct interlocution. However, collaborative learning benefits, mechanisms and methods are often abstracted from broader sociocultural descriptors in literature. The unique implications of learning at the direct interpersonal level create space for a description of this lens abstracted from the higher order perspectives that follow.

Scientific Community Lens

This lens represents common perspectives of professional scientists and focuses on educating students in correct lexical and methodological conventions grounded in the ontological and epistemic foundations of science and the self-reflective history and philosophy of the distributed scientific community. Conventions include canonical descriptions of natural phenomena, experimental and observational inquiry methods, standards of evidence and argument, and standpoints such as probabilistic and critical thinking.

Ecosocial Lens

An amalgam of sociocultural perspectives including situated cognition, critical theory and identity formation, this lens views learning as testing a new identity and its potential commensurability with a student's extant and desired identities through engagement in a community's practices as a peripheral member in an emergent situation. To adopt a biological identity is to adopt biological habits of perception, action and valuing. Rather than focusing exclusively on minutiae, a central question for this lens is if/how we can facilitate this adoption for students in ways that are commensurable with values and other habits associated with their established and desired memberships e.g. in religious, ethnic, gendered, familial and peer communities.

Reflective Writing Assignments

Biology Biographies –due in advance of the first class

Biology Biographies are 2-page essays to be posted on Moodle to introduce you and your SGMs to the introductory biology students as approachable, helpful and fun. Please write according to the following guidelines: The tone of your text should be informal and friendly. Be sure to include (a) some of your biology-related and (b) non-biology related interests and experiences, (c) your speculative future academic and professional goals and (d) advice about how to be successful in introductory biology e.g. attendance at lectures and SGMs, techniques for note taking and studying, etc. Embed 2 or 3 pictures of yourself in the text as follows: (1st) posed with face recognizable, (2nd) doing a biology-related activity and (optional 3rd) doing a biology or non-biology-related activity.

SA Essays - first draft due Th Nov 10th via electronic submission and a copy for discussion at proseminar -final draft due by the end of final exams.

Reflect on your teaching in light of the assigned readings and class discussions to write a 5-10 page essay according to the following guidelines (roughly 1-2 pages per guideline.)

a. Compare and contrast epistemologies, values and methods advocated or intimated in two or more articles assigned this semester.

b. Describe if/how two or more assigned articles (or the lens each represents) informed your teaching at SGMs this semester.
c. Describe one or more situations in which you felt your teaching at SGMs was especially effective or ineffective and critique this situation using one or more lenses on learning from your orientation handout.
d. Describe if/how participating in BIOL 000-SA Pedagogical Principles & Practices Proseminar influenced your teaching at SGMs (or influenced you in other ways.)
e. Provide recommendations on what is most important to keep and/or change about proseminar content or format for the benefit of future Science Associates.