Western Oregon University
Biology 100 Series Assessment Report
2009-2010 Academic Year

Contents:

Summary:

This report is a review of the Biology 100 series for nonmajors as offered in the academic year 2009-2010 at Western Oregon University. Online surveys were used to collect demographic information, to compare content knowledge and attitudes about biology and science before and after each course, and to gather laboratory evaluations. Instructor feedback was gained via weekly meetings. Survey response rate was reasonable- over 50% for each course- and approximately 2/3 of students completing surveys did so both before and after a course.

All Bi 100 series courses increased their enrollment this year. Student demographics indicate that most Bi 100 students are freshmen and sophomores and have little or no previous college-level laboratory science. Approximately 1/3 of them are first-generation college students and less than 10% of them are non-native speakers of English. The majority of Bi 100 students are female.

Students taking Bi 100 series courses did increase their understanding of hypotheses and theories, but did not build any other knowledge about the nature of science. In general, their attitudes about biology and science became more negative following participation in a Bi 100 series course. No single demographic predictor really had a consistent significant impact on student understanding or attitudes about science. Students did generally increase their content knowledge related to course learning outcomes, although certain indicators did indicate that learning was weaker (or even increased misconceptions) about particular topics. Again, no single demographic predictor had a consistent significant impact on content knowledge.

Students did respond positively to laboratory activities and the majority of students felt that they learned additional content from specific labs and did not have suggestions for improving the labs. Those students who did suggest improvements tended to focus on particular labs, and also wished to see more clarity in the lab instructions. Students also responded positively to the revision of the Bi 101 labs in Spring term.

Accomplishments during the 2010-2011 school year include increased alignment of lecture and laboratory instruction. All course sections now use a common syllabus with consistent point allocations, policies, and scheduled learning outcomes to be addressed. Exam practices are also consistent across lectures, and laboratory quiz preparation and grading has been totally aligned. We have also implemented policies to help maintain laboratories at a safe size and prevent students from falling through the cracks via excessive laboratory switching. The first draft of Bi 101 and Bi 102 laboratory revisions have been completed and Bi 101 revised labs tested with a first group of students. Bi 103 laboratory revisions are ongoing. The purchase of Vernier interfaces and probes have provided the opportunity to give students a more authentic, hands-on experience and the lab revisions have in general focused on emphasizing the nature of science and allowing students more hands-on activities. Finally, following review of multiple volumes, a new set of custom textbooks have been developed in cooperation with Pearson Publishers as a more affordable option for students.

Recommendations for future activities need to address the current inability of the Bi 100 series to improve students' knowledge of the Nature of Science and failure to help students' recognize the importance of biology and of science to their own lives. Course content will need to shift to include more examples and lecture and lab activities that engage students in problems relevant to them and engage them in scientific thinking. This effort can be monitored via the continued online assessment of randomly selected course sections. Evaluation of student learning will continue to be of importance. Lecture section examinations are still somewhat mis-aligned in rigor and developing a flexible exam framework can address this while maintaining the ability of individual instructors to tailor their evaluations to their teaching style and expertise. The examination of different exam structures will help us identify a method of student evaluation that is most informative about what students know and also best benefits learning habits. Finally, the continued use of "formative" in-class learning activities in both lecture and lab with embedded assessments will benefit both instructional goals and student learning.

Background:

The Biology 100 (Bi 100) series for non-majors serves a diverse array of students at Western Oregon University (WOU). Bi 100 series courses are one of the primary sequences used to fill the LACC requirements and Bi 102 course also fulfills a requirement for the growing population of pre-nursing students at WOU as well as for students in the Early Childhood Only, Early Childhood/Elementary, and Elementary/Middle Education majors.

During the 208-2009 academic year, the focus was on collecting assessment data for sound decision-making about the structure of the Bi 100 series, including prioritizing necessary changes. In 2009-2010, the focus has been on implementing these changes and assessing their impact. The highest priority tasks were to increase the alignment of lecture sections within each course to one another and to align laboratory activities with lecture content. Lower priority tasks were to begin revisions of laboratory activities to emphasize local relevance and provide scientific skills experience for students and to increase the focus within lecture on the nature of scientific thought. Analysis and revision of assessment practices has continued to be an ongoing priority from the previous academic year.

Methods:

Online surveys.

Survey items. The primary assessment mechanism for the Bi 100 series is an online course survey using the online data collection program *Survey Monkey*™. All students participating in a Bi 100 series course have been requested in their lecture sections to complete pre- and post-course surveys. Both pre and post surveys include entry of a code number (combined last name initial and last 3 digits of V#), attitude questions, and a concept inventory. Attitude questions were adapted from the previous year's survey and edited based on correlations between items to streamline the survey and eliminate redundant items. Concept surveys include general scientific knowledge taken from two nationally-used instruments, the National Science Foundation's Science & Engineering Indicators and the Michigan State Science Survey. These questions are included in every course survey in addition to a series of course-specific questions aligned to each course's specific learning outcomes. These concept inventories included two questions for each course learning outcome, including laboratory skills emphasized in each course.

In addition to the pre and post attitude and concept survey questions, pre-surveys also include a series of demographic questions and post-surveys include a reduced set of demographic questions as well as a set of laboratory evaluation questions. Course survey items are included in Appendix A.

Data analysis. To examine demographic trends, pooled data from pre-survey data submitted by all respondents were analyzed. Similarly, all post-survey responses were pooled to analyze laboratory evaluation items. Paired responses (students who completed both a pre- and a post-survey) were used to examine course outcomes related to changes in attitudes and content knowledge. Comparisons of correctly answered conceptual questions were analyzed using paired sign tests and comparisons of Likert-scale attitude questions were compared using paired t-tests. The impact of student demographic elements (year in school, previous laboratory science, first generation, etc.) was analyzed for attitude responses using MANOVA and for whether students correctly answered content questions or not using logistic regression.

Finally, the revision of some of the laboratory exercises in Bi 101 prior to Spring term permitted the opportunity to compare student responses to the laboratories, as well as attitude and content responses between the Fall term (unrevised labs) and Spring term (revised labs). These comparisons were conducted via unpaired t-test for the laboratory survey items and as part of the MANOVA and logistic regressions conducted on the content and attitude items.

Weekly Instructional Meetings

Regular weekly meetings of all Bi 100 instructors each term were most valuable in gathering information from instructors about activities. An additional benefit to these meetings was increased coordination of and communication about laboratory activities. In 209-2010 we set aside a window of Friday afternoons for Bi 100 meetings. These weekly one-hour meetings included discussion of lecture learning outcomes, preparation for upcoming lab activities and discussion of challenges and suggested revisions to completed lab activities. We also took time to follow up on particular issues of concern to instructors; sometimes individual students who were struggling or sometimes a challenging lab or lecture concept. The time provided for instructors to collaborate and develop group solutions was extremely valuable.

<u>Outcomes:</u>

Collection of data

Electronic survey administration. During the 2009-2010 school year, all surveys were administered electronically. Electronic surveys eliminated some of the problems encountered through the use of paper surveys during the 2008-2009 school year. The collection of results was much easier as survey results did not have to be entered by hand into spreadsheets. Students were required to answer demographic questions to complete the survey (the program would not let them leave the demographic screen without answering the questions) and had to make the choices available to them (rather than making their own checkboxes or circling multiple choices on a paper survey).

In the 2008-2009 school year, certain problems were noted with the electronic surveys. These problems were not entirely eliminated, but were greatly reduced following revision of the survey instructions for clarity. In 2008-2009 a small number of students changed their year in school in the post surveys (primarily in Spring term) or added the course in which they were enrolled to their listing of previous college laboratory science courses. Following revision of the instructions to clarify that students should enter their current year in school, no students entered a different year at the end of the term compared to the beginning of the term. Similarly, following revision to the instructions to inform students that they should not include the current course in their answer, none of the students added the course in which they were enrolled to their list of previous Biology courses in the post surveys. A large number of students (over 25%) did not correctly enter their code numbers in the 2008-2009 surveys. The 2009-2010 surveys included a sample code number, and this greatly reduced the erroneous entry of code numbers, although a small proportion of students still used anomalous codes (full V numbers or portions of V numbers with no initial, or both initials rather than only the last initial). The most significant problem that remained with the electronic surveys were that a small proportion of students double-entered their surveys. Student communicated that they completed multiple surveys either because they thought they hadn't completed it, or had had trouble printing the consent/verification form at the end of the survey and re-took the survey to get back to the consent form. These duplicate surveys were easily identified during data analysis, and alternate verification techniques may reduce the number of duplications for verification purposes. Another challenge that is unique to the online electronic surveys is the confusion of the Bi 100 surveys with the online SIR evaluations which were beta-tested by the University in 2009-2010. Multiple students reported being unsure if the two instruments were different, and claimed that they had completed the online SIR when they had actually completed the Bi 100 survey and vice-versa. We will need to determine the best way to combat potential confusion and "survey fatigue" as the electronic SIRs become the standard on campus.

Survey returns. Overall, a total of 1,624 surveys were returned by students. Bi 101 students returned 355 pre-surveys and 284 post surveys. Bi 102 students returned 448 pre-surveys and 402 post-surveys. Bi 103 students returned 64 pre-surveys and 64 post-surveys. Overall, approximately 3% of surveys were replicated when individual students completed more than one pre- or post-survey. Following alignment of pre- and post-surveys completed by the same student it was obvious that not all students completed both a pre- and post- survey. Bi 101 paired surveys represented 61% and 76% of the total pre- and post-surveys submitted, respectively. Bi 102 paired surveys were 67% and 74% of the respective pre-post totals, and Bi 103 paired surveys were 65% of both the pre and post totals. (Bi 103 students in Winter term only returned 2 post-surveys, so this term was removed from the analysis).

Student Demographics.

All figures summarizing student data are in Appendix B. Total enrollment in Bi 101 was 405 students (262 in Fall term; 143 in Spring), in Bi 102 was 517 (145 in Fall and 372 in Winter), and in Bi 103 was 102 (20 in Winter and 82 in Spring). In addition, 20 students enrolled in Bi 101 and 48 students in Bi 102 during Summer term, but surveys were not distributed to these students and as of the compilation of this report those courses were ongoing and not included in these results. These numbers represent a small increase in total enrollment for all three courses compared to 2008-2009.

All three courses are primarily comprised (over 70% in each course) of freshmen and sophomores. Bi 101 had the highest proportion of freshmen, with 54% freshmen and 30% sophomores, Bi 102 with 41% freshmen and 31% sophomores, and Bi 103 with 45% freshmen and 43% sophomores. All three courses are approximately 1/3 first-generation (33% in Bi 101 and Bi 103 and 40% in Bi 102), slightly less than the reported University proportion of 50%). Females greatly outnumbered males in all three courses (69% in Bi 101, 68% in Bi 102, 71% in Bi 103). Non-native speakers of English had the highest enrollment in Bi 101 (11%), with slightly lower enrollments of 8% in Bi 102 and 5% in Bi 103.

Students in Bi 101 had the lowest level of experience with laboratory science. 56% of students had no previous college-level laboratory science and only 14% had some previous experience with college-level biology. Only 27% of students enrolled in Bi 102 had no previous college-level laboratory science experience and 35% of students had some previous college-level biology. Bi 103 has a prerequisite of Bi 102, so all students in Bi 103 had previously taken college-level biology; 19% of them had taken another laboratory science topic in addition to biology.

Bi 102 is the most heavily enrolled of the three courses and also the course that is required for several majors in addition to fulfilling LACC requirements. In the Bi 102 pre-course survey, I asked students about their reason for taking the course. The majority of students in Bi 102 (48%) were taking the course to fulfill an LACC requirement. Of those taking the course to fulfill a particular requirement, the highest proportion (21%) were pre-nursing majors, followed by education majors (18%).

Student Attitudes

In general, participation in a Bi 100 series course did not lead to an overall change in student understanding about the nature of science. Students in Bi 101 and 102 did significantly change their response in understanding that hypotheses are not proven and Bi 101 students also showed a significant increase in their understanding of what a theory is. All other concepts related to the nature of science did not show any significant change. Interestingly, students in Bi 101 and 103 tended to make overall slight gains in their nature of science knowledge while students in Bi 102 actually made overall slight decreases in their nature of science knowledge.

Students also generally increased their negative attitudes about biology and science after participating in a Bi 100 series course. Bi 101 students indicated they were more comfortable using laboratory equipment following the course, although they were less likely to feel that carrying out lab investigations could help them understand the course material. Although there were no other significant changes to Bi 101 students' attitudes about biology class, their attitudes did become increasingly negative. Bi 102 students significantly improved their self-efficacy in lab and felt that carrying out lab investigations increased their understanding, but significantly decreased their feeling that lecture helped them understand the material. Although Bi 102 students did feel they increased their ability to understand scientific information, they increasingly felt science was only useful to scientists, that they were not learning anything important in class, did not have anything to contribute to class and did not look forward to class. Most of the other attitudes were also increasingly negative, although not significantly so. Bi 103 students also increased their lab efficacy, although they did not significantly improve their sense that lab activities increased their understanding. Bi 103 students also showed general increase in negative attitudes, although this was only significant in response to the idea that scientific knowledge is only useful to scientists.

Not surprisingly, a student's predicted grade was the most common factor that significantly influenced student attitude responses in all three courses. Students predicting that they would earn higher grades also felt better about biology and science. With that exception, there was no clear pattern to the impact of student demographics on student understanding about the nature of science or attitudes about biology class. In Bi 101 and 103, most student attitude responses to survey questions were not significantly affected by demographic predictors. In Bi 102, about half of the statements were significantly affected by demographic predictors, but which predictor was extremely variable, with no single predictor consistently influencing student attitudes.

Content Mastery.

Students did improve their content knowledge in all three Bi 100 series courses. The general scientific knowledge represented by the indicators from the national surveys showed moderate increases, primarily related to inheritance (Bi 101 and 102) and to proper use of antibiotics (Bi 102 and 103). Bi 101 students also significantly increased their correct response rate to "the earliest humans were alive at the same time as dinosaurs".

Students did show significant improvements to content knowledge aligned to course learning outcomes. Students in Bi 101 increased their correct response rate to every question, significantly so in all learning outcome categories except nature of science, speciation, and laboratory skills. Students in Bi 102 showed significant increases to their correct response rate in every learning outcome category, but did decrease their correct response rates to questions about photosynthesis and meiosis. Students in Bi 103 had the lowest rate of significant change to correct response rate. Learning outcome categories that did not show significant improvements were body organization, digestion and excretion, immunity, and laboratory skills. Bi 103 students also decreased their correct response rate to a question about the cardiac cycle.

As with student attitude questions, there was no obvious demographic predictor to content knowledge except for a student's predicted grade. Content knowledge in Bi 102 was the least affected of the three courses by demographic predictors; whether or not a student was a non-native speaker was the most common influence on content knowledge. In Bi 101 and 103, there was no single factor that stood out as an influence on content knowledge.

Laboratory Experience.
Students responded fairly favorably to all three lab courses, but the responses to Bi 103 labs were the most positive. Bi 102 students did not indicate a clear favorite or least favorite lab. Their selections were divided fairly evenly between the labs for both favorite and least favorite. Students indicated that the inheritance lab was most enjoyable, but that they learned the most from the diffusion and osmosis lab. They found the photosynthesis lab to be best-connected to lecture and the enzymes lab to be best-connected to other labs. Most Bi 103 (33%) students selected the reflexes lab as their favorite and plant form and function (33%) as their least favorite. The reflexes lab also received the highest scores from students on how much they enjoyed the lab, how well connected it was to lecture and lab, and how much they learned.

Bi 101 students took part in two different lab sequences. Spring term students participated in a lab sequence revised from the original labs offered to students in Fall term. The students taking Bi 101 in Spring responded more positively to the lab sequence across the board. They significantly enjoyed the lab activities more, and also significantly felt more that each lab prepared them for the next, that participating in lab helped them understand the material, that the lab activities connected to lecture, and that lab was a valuable use of their time.

Both groups of Bi 101L students chose the Aquatic diversity lab as their favorite (26% in Fall; 30% in Spring). Both groups listed the course project as their least favorite lab (40% for Christmas Island project in Fall; 26% for Columbia River project in Spring). Fall term students found the Hypothesis (Mystery Box) most enjoyable and learned the most from the Food Web lab, which they also felt was best connected to lecture and to other labs. Spring term students enjoyed the Aquatic Diversity lab the most, but had equivalent responses to the Hypothesis (Population Genetics), Human Evolution, and Aquatic Diversity labs in the other categories. (Note: only 24 students in Bi 101L Spring term had an opportunity to run the Food Web lab due to instructor illness, so the data for this term is missing this lab – which was not one of the revised lab activities – for the majority of students).

Bi 101 and 102 students also provided feedback via open-ended response questions about what they learned in laboratory and suggestions for improvement to the laboratory. Both groups indicated in the highest numbers that they learned content related to specific laboratories. Biology applications was the next highest category followed by reinforcement of lecture concepts in both groups. A higher proportion of Bi 101 students specifically indicated that they learned nothing from lab compared to Bi 102. Bi 101 students did have some differences in their responses between Fall and Spring term; More students indicated that they learned nothing in

Fall term (unrevised labs), but more students also indicated that they learned content from specific labs and learned biology applications and scientific thinking in Fall term as well.

Suggestions for improvement were extremely variable between Bi 101 and 102. The vast majority of Bi 102 students (109) responding to the question wrote that they had no suggestions for improvement (as opposed to leaving the question blank). The next highest response categories were changes to the overall lab structure and clarification of lab instructions (26 and 22 students responding in each category respectively). For Bi 101, no suggestions for improvement was also the highest category in both Fall and Spring terms, although the overall proportion of students making this response was much lower than for Bi 102. The next highest response category for Fall term Bi 101 students was to eliminate or change specific labs, followed by changes to overall lab structure and clarification of activities. These three responses were also had the next highest group in Spring term, but students responded in these three categories at a much lower rate. The highest responses related to changing the overall structure of the lab, followed by eliminate or change specific labs and make clarifications to activities.

Goals & Accomplishments:

Following the collection and analysis of data during the 2008-2009 school year, I made a series of recommendations for the Bi 100 series. We now have the opportunity to reflect on progress made with this course sequence during 2009-2010.

Improved alignment

The primary goal for the Bi 100 sequence in 2009-2010 was improved alignment of instruction between lecture and laboratory sections. This goal is challenging – while it is important to ensure that all course sections meet the same learning outcomes, individual instruction necessarily varies according to the expertise and personality of the instructor. Thus, alignment efforts this year focused on common learning outcomes for each course and synchronizing course policies and grading practices.

Accomplishments in support of this goal included establishment of a common syllabus for lecture and lab in all three courses. This syllabus is now used by all instructors and includes the same point distribution, grading scales, and course policies. Individual instructors have the ability to personalize each syllabus to accommodate individual office hours and contact information, as well as their preferred use of homework or in-class activities and quizzes (as long as the point total for these activities aligns to the established distribution for these types of activities). Each syllabus also includes a schedule of weekly learning outcomes to ensure that individual course sections all remain on the same schedule and meet the same learning outcomes. Instructors have flexibility in how to address these learning outcomes, but each learning outcome is addressed in each section in the same basic order (which also improves alignment between lecture and laboratory activities).

The establishment of consistent lecture and lab policies, especially concerning laboratory absences and makeups has necessitated the need for increased oversight related to these issues. In the past, students missing a lab would simply show up for another lab during the week. In some cases students (especially those with early morning labs) attended their assigned lab section less than half of the term and attended various other lab sections. This led to a variety of problems, including instructors being uncertain as to student attendance rates, safety concerns related to overcrowded labs (particularly in the last lab of the week), and instructors working with an ever-shifting cadre of students (also mainly in the last lab of the week). These problems, coupled with a need to emphasize personal responsibility and self-reflection as part of the WOU General Education learning outcomes led the Bi 100 series team to decide that we needed to better manage lab absences and makeups. We have since put a policy in place that allows students who have excused absences to make up a lab, provided space is available and have developed a system by which students complete a form to apply for a lab change. This has allowed us to establish a paper trail to keep track of students' absences, to maintain lab numbers at 24 in all labs, and to ensure that students do not fall through the cracks. We have also established a waiting list policy for the beginning of each term when labs are full so that a single wait list is maintained, rather than individual instructors signing students into labs and lectures, which in the past has led to some lab sections being overly filled, which is a safety concern. Both the wait list and the lab makeup forms are handled by the Bi 100 series coordinator, which is also easier for students as they have a consistent location to find information and take care of absences and course changes. Although this means a significant increase in one person's workload, it does seem to have reduced the burden on the other Bi 100 instructors and has also allowed us to maintain safe and organized labs.

One of the most common concerns expressed by students has been different lecture and lab sections are evaluated differently depending on who the instructors are. The establishment of consistent point distributions and grading scales now used in all lecture and lab sections has been put in place to address this concern. Additionally, we have established a common exam schedule and practices so that midterm exams are administered during the same week of the term and in the same way (students all have the same amount of time to complete an exam, no study aids or note cards are permitted during exams, and absences and makeup exams are handled consistently). For the laboratory sections, we established a weekly quiz schedule and normalized the structure of the lab quizzes (rigor of questions, proportion of questions from previous and upcoming labs, and proportion of questions based on homework questions). As different instructors were approaching grading of homework in a variety of ways, we also examined this aspect of laboratory evaluation and adopted a strategy in which homework is assigned for practice with quiz questions based directly on that homework. We also developed grading rubrics for the course project in Bi 101 and for the lab reports assigned in Bi 102 and Bi 103. Finally, during this past year we have established quiz banks for each of the laboratory courses. I have also continued to collect and review midterm and final examinations for each course. There are still obvious disparities in the rigor of the exams, with some instructors providing more challenging exams than others, but we have begun an overall movement to more aligned and consistent evaluation of student learning.

Continuing streamlined assessment

Obviously, it is essential that decisions regarding the Bi 100 series be data-driven, but the collection of so much data can be onerous both for faculty and students. For example, paper concept inventories administered during 2008-2009 in the first and last lab sessions each term utilized at 30-45 minutes of each of those classes. Efforts to streamline assessment of Bi 100 courses while continuing to collect high-quality data are ongoing. During the 2009-2010 school year, all survey items were placed online so that students could complete them on their own time. Although we have not achieved a 100% return rate, we have well over 50% return of both pre and post surveys in all courses. The online method has provided some flexibility, allowing for quick editing and inclusion of new questions if needed (for example, a request for Bi 102 students to list their major to determine which groups of students most frequently take that course and if there is a need for a section targeted to a specific major). The establishment of common course learning outcomes has also permitted the alignment of survey items to those learning outcomes, and placing them online, along with the post-course lab evaluation items, has made it possible to spend that half hour in the first and last sessions of each lab section on lab activities rather than assessment activities.

Laboratory revisions
Students in 2008-2009 laboratory sections made many suggestions for improving the lab activities, as did the instructors. This was one of the most labor-intensive, but also the most essential elements of the activities engaged in by the Bi 100 team this year. During each of the terms in which a particular Bi 100 series course was the primary course offering, all of the lab instructors reflected each week on what did and did not work well in each lab and provided feedback during the weekly instructional meetings. This feedback, along with that supplied by the students in the lab evaluation portion of the survey, was used to begin the revision process for the Bi 100 series labs. As 100 series coordinator, it was my responsibility to compile all feedback and use it to make appropriate revisions to the laboratory activities.

Bi 101 is primary course offering in Fall term, thus that lab course was the first to be revised. The majority of instructor and student concerns revolved around the lack of hands-on labs and the project focus on a tropical island system that students found to be disconnected from their personal experience and required group work outside of class- which often led to conflict and strife among groups and excessive complaining to instructors. Instructors also expressed some concerns about poor student understanding of population genetics and thought that a lab activity might help improve student understanding of this concept. One of the primary Bi 101 revisions was a change in the focus of the course project from Christmas Island to the Columbia River and a reduction in group work. I also attempted to increase the number of hands-on activities that involved scientific thinking such as hypothesis formation and testing and data analysis. In the first lab, which focuses on hypothesis testing, I retained an activity that requires students to identify the elements of a sound hypothesis, and added an activity that helps them recognize how hypotheses can change with the addition of new evidence. Finally, I dropped the Mystery Box activity, which focused more on model building, and added an activity that required students to test a hypothesis about change in genetic frequency in a simulated population due to natural selection. I also made edits to the taxonomy lab, by eliminating a simulated pencil-and-paper activity and providing students the opportunity to develop a simple data matrix using characteristics from real plant specimens and then to use that matrix as a tool to build a phylogenetic tree. Finally, I shifted the focus of the Aquatic Diversity lab away from identification and sorting of organisms into Kingdoms and Phyla to sampling techniques to estimate biodiversity.

These revised labs were implemented in Spring term and based on the student response (described in Outcomes, above) and instructor feedback, additional revisions were made prior to the First Summer session. These revisions primarily involved streamlining the revised labs and eliminating activities that took up a lot of time but provided little additional understanding of concepts to students.

As of this report, the first round of Bi 102 revisions (based on instructors' conversations in Winter term and student feedback during Fall and Winter terms) has been completed and implemented during the Second Summer session. The Bi 102 labs have generally been the best received by both the students and the instructors, but some revisions have been necessary to adjust to changes in the lecture schedule, or as new technology has become available. We were extremely fortunate this year to acquire a suite of Vernier interfaces and probes and two mini electrophoresis gel rigs that will allow us to provide students with the opportunity to do more direct collection of data and to use more authentic equipment and methodology to examine the concepts under study. The Bi 102 labs in particular will benefit from this technology and have been revised to reflect its availability. Students (and instructors) expressed considerable frustration with the final three labs (Central Dogma, Mitosis, and Inheritance) in the Bi 102 sequence. These labs, originally adapted from 211 labs have become outdated and rely primarily on simple paper models with step-by-step "cookbook" instructions. They have been extensively revised to align to course learning outcomes and provide more opportunity for hands-on work and critical thinking. The Bi 103 labs have not yet been revised, but I have mapped out a plan for revisions to these labs based on student and instructor feedback and will be working on those during August-September in preparation for Winter term. The use of Moodle to post the lab activities online for students to access and download has permitted us a great deal more flexibility and we can make quick adjustments to the labs without worrying about publication timelines.

Ideally, as laboratory revisions continue, each course will include some type of course project that emphasizes the nature of science and requires deeper critical thinking by students about course content. Currently, Bi 101 is the only course that includes a course project that requires students to spend time outside of class thinking more deeply about a topic (and has a relatively higher proportion of points assigned to it compared to other activities). Bi 102 and Bi 103 did not have any equivalent element. We added a lab report assignment to each of these courses. This lab report currently takes the place of a course project with an equivalent number of points assigned to it and an equivalent amount of student work outside of class required for completion.

Text review
The announcement in Spring 2010 of the publication of a new edition of our current Bi 100 text provided the impetus to review our text options. The Bi 100 team reviewed nearly one dozen text options, and did not find a more favorable option for content. Our other concern was student cost, and we have been able to take advantage of the option to develop custom texts for each course at a greatly reduced cost to students.

<u>Recommendations:</u>
Although the team has made excellent progress in aligning and coordinating the Bi 100 series courses, the survey results as well as student and instructor feedback indicate that there is much room for improvement.

Course content
The survey results indicate that our students are not really improving their knowledge about the nature of science and in most cases are leaving a Bi 100 series course with even worse attitudes about biology and about science than they had when they began the course. I consider this to be our biggest problem with the course sequence. For the non-science majors who comprise our primary audience, these courses may represent their first (and last) formal exposure to science, and it is *essential* that we do a better job of making biology (and science) more accessible, personally relevant, and interesting to them. I am recommending that we substantially revise the course content to focus much more so on understanding the process of science and how it works, and examining how biological concepts and scientific practices influence students' daily experience. This change would mean an overall reduction in content, so as to provide more time for student discussion and reflection on the nature of science. Although all three courses would

retain their content focus, that content would be used to highlight for students how biology impacts them and how they can use scientific thinking to improve their own lives.

For Bi 101 and 103, the above approach will be useful to all students in the courses. Bi 102 is required for pre-nursing majors, and there is a clear need for this group to retain the content that they will need to meet their future education and career goals. Given this, I think it might be valuable to consider offering specific lecture sections of Bi 102 for pre-nursing majors that retain the focus on content and are specifically designed to meet the needs of this group, which are different from the majority of our other Bi 100 students.

For all Bi 100 series courses, laboratories should become increasingly thematic in approach. This will allow us to focus on using science and biology as students answer questions or solve problems of local or personal relevance. By focusing all lab activities in the sequence around a common theme (provided by those questions and problems) students will gain the opportunity to build the additive process skills needed to understand the scientific process. These are the skills that will be most valuable for our non-science majors to take away from the course so that they may apply scientific information and thinking to their daily lives.

Continuing Assessment

Obviously, continuing the assessment of Bi 100 series courses is essential so that we can ensure that we are providing high-quality learning experiences to our students. We need to verify that students are meeting course learning outcomes, that they are gaining in their understanding of the nature of science and improving their attitudes about biology and science. It is essentia that our decisions about instruction and course design are data-driven. However, given that our course numbers continue to increase, and that WOU is moving toward online SIR evaluations, I am recommending that rather than survey every single course section, we enact a random sampling of courses to survey, based on course activities under investigation. For example, we may choose to randomly sample 50% of Bi 101 labs in the Fall term to examine student responses to revised laboratories. We can also use Moodle and other online resources to encourage students to complete surveys. The surveys can also be edited in such a way to increase response rate (for example providing code numbers to students and embedding the survey in an assignment).

Evaluation practices

There are still many challenges with the evaluation of student learning in the Bi 100 series. These include some remaining disparities in the rigor of midterm and final exams, questions about the most effective way to evaluate student learning, and concerns about the grading workload for instructors with multiple laboratory sections.

Rigor of evaluations. We have had some success with the use of quiz banks and a common format for laboratory quizzes. Because the laboratory activities are planned and administered consistently across labs, this is appropriate for lab evaluation. I am more reluctant to provide a similar rigid framework for lecture evaluations, as flexibility according to instructor experience, background, and teaching style is a strength of the Bi 100 series. However, it is important that we recognize the importance of evaluating student achievement of learning outcomes with a consistent level of rigor. Thus, I recommend that we adopt a framework for exam preparation that includes a set proportion of points allotted to each learning outcome and that the level of rigor be made consistent by identifying a proportion of questions that represent different mental processes (identification, application, and analysis and synthesis). The proportion of points allotted to each individual question on an exam also varies between instructors, with disparities of as great as 4 points or 10 points offered by different instructors for the same type of question. Thus, it makes sense to identify types of questions (e.g. multiple choice, fill-in-the-blank, short answer, matching, labeling, and essay) and clarify the number of points that are appropriate to each type). Moreover, the use of study guides has been identified by both students and instructors as a valuable tool, but study guides should be used appropriately and not serve simply as opportunities for students to memorize potential exam questions.

Evaluation structure. Students typically find Biology exams fairly challenging, and have indicated that they struggle with recalling large amounts of material for each exam. They have also indicated a tendency to postpone studying until directly before an exam (a strategy demonstrated by research to be ineffective). The Bi 100 series team has discussed the possibility of adopting an alternative exam strategy, in which students take a series of more frequent, lower-stakes exams. During the 2010-2011 school year, I will be collaborating with Dr. Ava Howard to examine how students respond to this type of evaluation structure compared to the more traditional structure (two midterms and one final). We are examining student performance on a set of questions used in each exam, and student stress level and amount of studying both for each evaluation and throughout the term.

One of the concerns related to examination structure, which may become more of an issue if we use more frequent exams, is how to handle absences and makeups. The current policy is that students must document an excused absence before being allowed to makeup an exam. This policy can mean a large amount of work for instructors and also frustration for students, especially now that the Student Health Center no longer provides documentation for students. One successful approach has been to completely eliminate individual makeup exams throughout the term, and allow students to drop a lowest exam, or to provide a group makeup exam during finals week or simply use the final to stand in for the exam that was missed. I recommend that the Biology department examine these options for a way to better address missed exams. We may also encourage more regular attendance by limiting extra credit opportunities to students who do not have any (or only have a small proportion of) missing work.

Students have indicated that in-class activities and discussion questions are particularly helpful learning tools. Currently, the lecture framework provides for a about 10% of the course grade to be related to these activities. Instructors have the flexibility to decide how to assign these points through a variety of activities including quizzes, discussion questions, or online assignments. I recommend that we maintain these activities, and perhaps increase them. The purchase of a clicker system for NS 103 will allow us to more extensively make use of in-class activities and questions.

Lab evaluation. Evaluation of student performance in the laboratory is probably the most labor-intensive aspect of Bi 100 series courses. Lab grading practices have been aligned and made consistent between sections. This year, we attempted a model in which student homework was assigned for practice (and was not graded) and the primary evaluation mechanism was a weekly quiz. Although the majority of students surveyed did not take issue with this practice, a small proportion felt that such a heavy reliance on weekly quizzes was unfair. Instructors have also noted a general lack of student preparation for lab activities. Thus, it may be reasonable to adopt some sort of weekly activity that students submit at the beginning of each lab or online via Moodle, that can be evaluated for completion rather than for content or can be self-evaluated by students. These preparation activities would be another means to encourage students to read and prepare for each lab, as well as to reflect on the previous week's lab without contributing too much to instructors' grading loads.

The other mechanism for lab evaluation has been completion of a project or a lab report. Students have responded fairly well to these assignments, and in both Bi 102 and Bi 103 indicated that they learned more from this lab as they had to reflect more extensively on it by writing their lab reports. Thus, it seems reasonable to maintain this assignment, but it is essential that it be assigned early in the term so that it can be graded, revised, and re-graded (if necessary) before the end of the term. For the course project in Bi 101, and as we move to adding projects in Bi 102 and 103, we will need to examine ways to limit the needed grading and streamline evaluation of these projects.

APPENDIX A: ASSESSMENT ITEMS

Pre-Course Demographic Questions (all courses)
1. Enter a Code Number:
Your code is the first initial of your first name followed by the last three digits of your V number. For example, if your name is Sam Iam and your V number is V00347829 then your code is S829.

2. What is your year in school?
Freshman
Sophomore
Junior
Senior
5+ year senior

3. Have you taken any other college-level biology course prior to this course? (check all that apply- do not include this course)
None
Biology 101 (ecology & evolution) or equivalent
Biology 102 (cellular biology) or equivalent
Biology 103 (plant & animal physiology) or equivalent

4. Have you taken any other College-level laboratory science courses?
None
Chemistry
Earth Science
Physics

5. Does anyone else in your family have a college degree? (check all that apply)
None
Mother
Father
Sibling

6. Who are your instructors?
(followed by course-specific array of lab and lecture instructors)

7. This question is optional:
What is your gender?
Male
Female

8. This question is optional:
Is English your first language?
Yes
No

This question only asked in Bi 102
Why are you taking this course (choose all that apply)?
LACC requirement
Education (early childhood/elementary) requirement
Education (elementary/middle school) requirement
I was just interested in the course
Pre-nursing requirement
Other requirement

Post-Course Demographic Questions (all courses)
1. Enter a Code Number:
Your code is the first initial of your first name followed by the last three digits of your V number. For example, if your name is Sam Iam and your V number is V00347829 then your code is S829.

6. Who are your instructors?
(followed by course-specific array of lab and lecture instructors)

3. This Question is Optional:
What grade do you think you have earned in the course?
A
B
C
D
F

Pre/Post Course Science Content Questions from NSF Science & Engineering Indicators and Michigan State Science Survey (all courses)

1. Please check true or false for each statement
   - All plants and animals have DNA
   - It is the father's gene that decides whether the baby is a boy or a girl
   - Ordinary tomatoes, the ones we normally eat, do not have genes, whereas genetically modified tomatoes do
   - Antibiotics kill viruses as well as bacteria
   - The earliest humans lived at the same time as the dinosaurs
   - Human beings, as we know them today, developed from earlier species of animals
   - More than 1/2 of human genes are identical to those of mice
   - Humans have less than 1/2 of their DNA in common with chimpanzees

2. Please choose Yes or No for the scenarios below
   - A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness. Does that mean that each of the couples children will have the same risk of suffering from the illness?
   - A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness. Does that mean that if their first child has the illness, the next three will not?

3. Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to 1000 people with high blood pressure and see how many of them experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure and not give the drug to another 500 people with high blood pressure and see how many in both groups experience lower blood pressure levels. Which has the better way to test this drug?
The first scientist (1000 people receive drug)
The second scientist (500 people receive drug, 500 do not)

4. Why did you choose the answer you did in question3?

Pre/Post Course Science Attitude Questions (all courses)

1. What is science ?
Please indicate your response to each statement:
Strongly disagree, Disagree, Unsure, Agree, Strongly agree
   - A theory is a best guess or prediction about what will happen
   - Scientists can prove their hypotheses
   - Science is the search for the best-supported answer
   - Scientists rely on evidence to make decisions
   - Scientists are always right
   - When you follow the scientific method you will get the right answer
   - Scientific knowledge can change over time
   - Humans can understand the natural world using science
   - There is only one best way to conduct science to uncover new knowledge
   - Science can by influenced by societal norms or concerns
   - Creativity and imagination are inappropriate to science

2. How I feel about science
Please indicate your response to each statement:
Strongly disagree, Disagree, Unsure, Agree, Strongly agree
   - I can understand scientific information
   - Science makes me feel uncomfortable and nervous
   - Anyone can learn to use scientific thinking to make decisions
   - I find science interesting
   - Scientists are just like everyone else
   - Scientists work alone
   - Science is boring
   - Scientific knowledge is only useful to scientists
   - Scientific knowledge is not good or bad

3. How I feel about Biology class
Please indicate your response to each statement:
Strongly disagree, Disagree, Unsure, Agree, Strongly agree
   - I look forward to my biology class
   - I can use what I have learned in biology in my daily life
   - Attending biology class makes me feel uneasy and confused
   - I am comfortable asking a question in class
   - I do not feel like I have anything to contribute to class
   - I feel like what I am learning in this course is important
   - I am comfortable using laboratory equipment
   - I can draw appropriate conclusions from the results of a lab investigation
   - I can describe how a lab investigation might relate to everyday life
   - Carrying out laboratory investigations help me understand the material
   - Our lecture and discussions help me understand the material

Post Course Laboratory Evaluation Questions
1-8. *(This Question repeated for each laboratory in the sequence)*
Please Evaluate Your 101 Laboratory Experience:
Strongly disagree, disagree, unsure, agree, Strongly agree

- The lab was enjoyable
- The lab was connected to lecture
- The lab connected to other lab activities
- I learned something from this lab

9. Please provide a general evaluation of your laboratory experience:
Strongly disagree, disagree, unsure, agree, Strongly agree

- I enjoyed the laboratory activities
- I felt like each lab prepared me for the next lab
- I did not see how the lab activities related to the lecture material
- I felt like the labs were disconnected from each other
- Participating in lab helped me understand the lecture material
- I felt like the lab activities connected to the lecture material
- Participating in lab was a valuable use of my time
- I did not gain anything additional to my understanding of biology by participating in lab

9. Which lab was your favorite?
(Followed by array of all labs in sequence)

9a. Why was it your favorite?

10. Which lab was your least favorite?
(Followed by array of all labs in sequence)

10a. Why was it your least favorite?

11. Do you have any suggestions for improvement?

12. What do you think is the most valuable thing you learned in lab?

Pre/Post Content Inventory - Bi 101

1. General Course Outcomes: Indicate your response to each of the following statements (True False)
    - Evolution is the unifying principle of biology
    - Scientists have a good idea of how many species currently exist on earth
    - Population size is controlled primarily by predation and disease
    - Humans do not have any known symbioses with other species
    - Organisms are classified together because they are found living in the same habitats

2. Specific Course Outcomes: Choose the best answer to each question

Learning Outcome	Questions
Nature of Science & Living Things	1. A carefully formulated scientific explanation that is based on a large accumulation of observations and is in accord with scientific principles is termed a/an a. Control b. Hypothesis c. Fact d. Postulate e. Theory 2. Which of the following is/are characteristic of living organisms? a. RNA is molecule of inheritance b. Process energy c. Grow and reproduce d. B & C are correct e. A, B, & C are correct
Foundations of Evolution	3. Evolution can be defined as a. A change in the genetic makeup of a population over time b. A change in phenotype of an individual over its lifetime c. One species diverging into two species d. A change in the genetic makeup of an organism over time e. An individual changing into another species 4. Which of the following statements about mutations is TRUE? a. Mutations have no effect on the survival and reproduction of an organism b. Mutations occur at random and may be good, bad, or neutral c. Mutations are caused by natural selection d. Mutations are almost always better for the organism e. Mutations are very dangerous to the health of organisms
Natural Selection	5. Natural selection can only act upon a certain trait if the trait is a. Favorable b. Morphological c. New d. Behavioral e. Heritable 6. Having greater evolutionary fitness means? a. Having greater strength b. Gathering more food c. Being larger or faster than others d. Having more offspring e. Being able to produce more sperm or eggs
Population Structure & Growth	7. Exponential growth a. Never occurs under natural conditions b. Is represented by an S-shaped curve c. Shows increasingly accelerating growth d. Is limited to bacteria and other single-celled organisms e. Includes carrying capacity 8. Intraspecific competition a. Is between individuals of the same species b. Tends to be more intense than other forms of competition c. Increases near carrying capacity d. All of the above e. Both b & c
Community Interactions	9. Some species can influence the structure of the entire community by their presence or absence. These species are known as a. Awesome b. Essential c. Invasive d. Keystone e. Symbiotic

	10. Predators and prey often place selective pressure on one another. This is known as a. Nature b. Symbiosis c. Co-evolution d. Carrying capacity e. Biotic potential
Energy & nutrient cycles	11. How do energy pathways in the ecosystem differ from nutrient pathways in the ecosystem? a. Energy reservoirs include the atmosphere and terrasphere b. Energy cannot be recycled c. Energy relies on the activities of bacteria and other decomposers to move through the system d. Energy transfer is extremely efficient e. All of the above 12. In a system with 600,000,000 calories of primary productivity, how many calories of energy would be available to organisms at the 3^{o} consumer level? a. 200,000,000 b. 60,000,000 c. 60,000 d. 60,000,000,000,000 e. 18,000,000,000
Speciation	13. Speciation occurs when a. A population is in equilibrium b. There is a mutation in a population c. A population becomes reproductively isolated d. A species becomes extinct and thus makes room for a new species to appear e. A population migrates to a new location 14. A single species of snail from the African continent was displaced to a new habitat on the island of Madagascar, and evolved rapidly into several new species as it exploited new resources. What has occurred in these snails? a. Adaptive radiation b. Divergent speciation c. Polyploidy d. Phyletic speciation e. Stabilizing selection
Classification	15. How did Darwin's and Wallace's evolutionary theory change the significance of the taxonomic categories of organisms? a. Darwin's theory of natural selection has had no effect on taxonomy b. Taxonomists no longer consider anatomical similarity in classifying organisms c. Darwin described the Kingdoms that we use today which include all organisms d. The relationships between organisms became completely known and many species were renamed e. Taxonomic categories are now considered to reflect the evolutionary relationships of organisms 16. Organisms are classified together when we hypothesize that they share a. A habitat b. A common ancestor c. A diet d. An appearance in the fossil record at the same time e. None of the above
History of Life & Evolutionary Innovations	17. If the early Earth's atmosphere contained little or no O_2 then where did most of the O_2 in our modern atmosphere come from? a. Respiration b. The breakdown of CO_2 c. The splitting of water vapor by sunlight d. The oxidation of metals e. Photosynthesis 18. Which group of vertebrates was the first to evolve a waterproof egg, allowing the group to move away from water, further onto dry land a. Birds b. Primates c. Mammals d. Lobefins e. Reptiles

Biodiversity	19. Eukaryotes differ from prokaryotes in that a. Eukaryotes have cell walls b. Eukaryotes have a nucleus c. Eukaryotes can do photosynthesis d. Eukaryotes do not have a nucleus e. Eukaryotes have alternating haploid and diploid generations 20. Periods of climate change in Earth's history have also been tied to what kinds of biological events? a. Pandemics b. Mass extinctions c. Genetic bottlenecks d. Long periods of evolutionary stasis e. Founder events
Laboratory	21. A compound microscope is used to view: a. Objects that are opaque (nontransparent) b. Objects that are larger than a pencil eraser c. Objects that are very tiny d. Objects that are too large to view with a stereomicroscope e. Both a & b 22. What is the dependent variable in the following example: Snails that live in acidic water with a pH of less than 6.5 will have thinner shells than snails living in alkaline water with a pH of more than 7.5. a. The pH of the water b. The number of snails c. The thickness of the shells d. The amount of water e. The device used to measure pH

Pre/Post Content Inventory - Bi 102

1. General Course Outcomes: Indicate your response to each of the following statements (True False)
    - Most genes in a cell are linked and inherited together
    - In photosynthesis, plants produce energy for other living things to use
    - Cells shuttle energy to power reactions by transferring electrons between molecules
    - In DNA replication, each produced double helix has one new and one old strand.
    - The cell membrane prevents any external molecule from entering the cell

2. Specific Course Outcomes: Choose the best answer to each question

Learning Outcome	Questions
Nature of Science & Biology	1. A carefully formulated scientific explanation that is based on a large accumulation of observations and is in accord with scientific principles is termed a/an a. Control b. Hypothesis c. Fact d. Postulate e. Theory 2. Which of the following is/are characteristic of living organisms? a. RNA is molecule of inheritance b. Process energy c. Grow and reproduce d. B & C are correct e. A, B, & C are correct
Atoms & Bonds	3. Atoms react through interactions between their a. Nuclei b. Neutrons c. Protons d. Quarks e. Electrons 4. A chemical bond that forms between molecules as the result of weak electric charges a. Ionic b. Polar covalent c. Nonpolar covalent d. Hydrogen e. Aquatic
Biomolecules	5. Which is not a major category of biomolecule? a. Protein b. Lipid c. Nucleic acid d. Carbohydrate e. Amino acid 6. Many monomers together make up a a. Polymer b. Molecule c. Nucleotide d. Ion e. Salt
Cell structure & function	7. A major difference between prokaryotic & eukaryotic cells is a. Prokaryotic cells do not undergo mitosis b. Prokaryotic cells lack membrane-bound organelles c. Prokaryotic cells lack a nucleus d. All of the above are true e. Only b & c are true 8. Which of the following best describes the path taken by most proteins produced by the cell a. Nucleus → vesicle → Rough ER b. Golgi Apparatus → Rough ER → Smooth ER c. Smooth ER → Rough ER → vesicle d. Nucleus → vesicle → Golgi Apparatus e. Rough ER → Golgi Apparatus → vesicle
Movement across membranes	9. The spontaneous movement of molecules from an area of high concentration to low concentration is known as a. Deconcentration b. Fluidity c. Tonicity d. Diffusion e. Gradient transport

	10. The unique nature of the phospholipid bilayer is that it is a. Hydrophobic inside and hydrophilic outside b. Hydrophilic inside and hydrophobic outside c. Completely waterproof d. Rigid under normal cellular conditions e. Highly permeable to many molecules
Energetics	11. An enzyme a. Lowers the activation energy of a cellular reaction b. Works only under a narrow range of conditions c. Is not used up or permanently changed during the course of a reaction d. All of the above are true e. Both a & b are true 12. The role of ATP in the cell a. Store genetic information b. Regulate which substances enter or leave the cell c. Shuttle energy in the cell d. Provide insulation to the cell e. All of the above
Photosynthesis	13. Photosynthesis is an endergonic process that a. Stores sunlight energy in chemical bonds b. Uses sunlight energy to break chemical bonds and release large amounts of energy for use c. Creates energy for animals to use d. Requires sunlight in green wavelengths, which is why chlorophyll is green e. Is one of the few biological processes that can violate the first law of thermodynamics 14. During photosynthesis a. O_2 is used as a source of electrons to power reactions b. CO_2 provides a source of carbon atoms to build organic molecules c. H_2O is given off as a waste product d. Glucose is used as a source of energy e. CO_2 is produced and released into the environment
Respiration	15. An alternative metabolic pathway that can produce small amounts of energy in the absence of oxygen is a. Glycolysis b. C3 cycle c. Photosystem II d. Fermentation e. None of the above 16. The bulk of the ATP production during cellular respiration occurs during a. Glycolysis b. The Transition Reaction c. The Krebs Cycle d. The Electron Transport System e. All of these phases produce approximately equivalent amounts of ATP
From DNA to protein	17. DNA differs from RNA because a. RNA contains thymine instead of uracil b. RNA is a protein c. RNA has a phosphate-sugar backbone d. RNA is transcribed in a 3' to 5' direction e. RNA is a single strand 18. In eukaryotes, translation occurs a. In the nucleus b. In the ribosome c. In the mitochondrion d. In the golgi apparatus e. Throughout the cell
Cellular reproduction (Mitosis/Meiosis)	19. During mitosis a. Two daughter cells containing haploid chromosomes are produced b. Four daughter cells containing haploid chromosomes are produced c. Four daughter cells containing diploid chromosomes are produced d. Two daughter cells containing diploid chromosomes are produced e. Two daughter cells containing a random number of chromosomes are produced

	20. During Meiosis, Anaphase I and Anaphase II differ because a. In anaphase I homologous pairs line up along the equator with one pair oriented toward each pole b. In anaphase I sister chromatids line up along the equator with one sister chromatid oriented to each pole c. In anaphase I homologous pairs are separated when spindle fibers shorten d. In anaphase I sister chromatids are separated when spindle fibers shorten e. Anaphase I is not followed by cytokinesis
Genetic inheritance	21. In a study of goldfish genetics, the allele for fanned tails is recessive and the allele for forked tails is dominant. If two heterozygous goldfish mate, what proportion will have forked tails? a. 4% b. 25% c. 50% d. 75% e. 100% 22. Color blindness is a sex-linked trait in humans. This means a. Females are more likely to be color blind than males b. Males are more likely to be color blind than females c. The gene for color blindness is on the x-chromosome d. Both a & c e. Both b & c
Laboratory	23. A study of acid diffusion finds that different acids diffuse at different speeds through a block of agar gelatin. The conclusion that it is something about the acid that requires what other experimental condition? a. The gelatin blocks have different concentrations of gelatin b. The gelatin blocks are of different thickness c. The gelatin blocks are all exactly the same d. The gelatin blocks are held at different temperatures e. The gelatin blocks were made at different times- some are older 24. During an experiment of photosynthesis in ambient sunlight, 12 cubic centimeters of oxygen is produced over a thirty-minute period. What is the rate of oxygen production? a. 12 cubic centimeters per minute b. 0.4 cubic centimeters per minute c. 2.5 cubic centimeters per minute d. 2.5 minutes per cubic centimeter e. 0.4 minutes per cubic centimeter

Pre/Post Content Inventory - Bi 103

1. General Course Outcomes: Indicate your response to each of the following statements (True False)
    - Sleeping organisms do not use any energy
    - The main advantage of homeothermy is maximizing efficiency of enzymes
    - Vertebrates are the only animals with skeletons
    - Plants are unable to respond to environmental stimuli
    - Plants and animals each have only one type of tissue

2. Specific Course Outcomes: Choose the best answer to each question

Learning Outcome	Questions
Homeostasis & organization	1. Homeostasis is best defined as a. The regulation of body temperature by animals b. The constancy of the body's internal environment c. The active adjustment to ongoing internal and external changes d. The ability to tolerate either fresh or salt water e. Returning the body to a set condition using feedback 2. A tissue is a. Only found in animals b. Found in both plants and animals c. Is a group of similar cells that together carry out a specific function d. Both A & C e. Both B & C
Nervous & Endocrine systems (How do we control our bodies?)	3. Chemical communication in which hormones are carried from a gland through the bloodstream to a target organ or tissue: a. Nervous b. Exocrine c. Paracrine d. Endocrine e. Lymphatic 4. Nervous communication occurs when a. The voltage charge of a nerve cell changes at all b. The voltage charge within a nerve cell increases above a threshold value c. The voltage charge within a nerve cell decreases below a threshold value d. The voltage charge within a nerve cell equalizes with the outside e. A nerve cell contracts and squeezes out chemicals
Muscles & Bones (What effects movement after a nerve impulse?)	5. What happens when a muscle contracts? a. Thick and thin filaments separate from one another b. The sarcomere lengthens c. Binding sites on actin subunits are exposed for myosin to attach to d. Z-lines are pushed apart e. All of the above 6. Which of the following is NOT a role of bones in the body? a. Protection of organs b. Produce blood cells c. Aid movement d. Control mineral stores in the body e. Bones do all of the above
Digestion & Excretion (urinary) (Where do we get the energy we need for activities and what happens to "leftovers"-wastes?)	7. Where does the majority of digestive activity occur? a. Mouth b. Pharynx c. Stomach d. Small Intestine e. Large Intestine 8. What happens in a nephron? a. Nutrients are absorbed b. Fats are stored c. Waste and excess water are filtered out of the blood, and urine is formed d. Urine is stored prior to release e. Enzymes are produced that neutralize toxins in the blood
Respiration (Where do we get the O2 needed to make ATP from food energy?)	9. Animals that need respiratory systems tend to a. Be very active b. Be very small or thin c. Live in moist environments d. Be very inactive e. All animals need respiratory systems

	10. In vertebrates, O2 and CO2 are exchanged between a. Capillaries and bronchioles b. Arterioles and bronchioles c. Capillaries and tracheoles d. Venules and alveoli e. Capillaries and alveoli
Circulation (How are gasses and other molecules carried where they need to go?)	11. The large blood vessel that carries oxygenated blood from the heart to the body a. Pulmonary Vein b. Superior Vena Cava c. Pulmonary Artery d. Aorta e. Jugular Vein 12. A defibrillator is employed when heart contractions become weak and uncoordinated. What part of the heart is the defibrillator most likely stimulating? a. AtrioVentricular node b. SinoAtrial node c. Aorta d. Pulmonary Arteries e. Semi-lunar valves
Immunity (How do we maintain our bodies?)	13. Human Immunodeficiency Virus is especially dangerous because it targets the immune cells responsible for recognizing antigens and stimulating a full immune response. These cells are a. Natural killer cells b. Helper t-cells c. Macrophages d. Cytotoxic t-cells e. Memory b-cells 14. What is a vaccine? a. A drug that kills viruses b. A drug that kills bacteria or macroparasites c. A weakened pathogen that is used to stimulate production of antibodies for future immune response d. An injection that stimulates the bone marrow to produce more white blood cells to boost the immune response e. Any medical intervention that helps strengthen the immune system
Plant form & function (How do plants maintain life?)	15. Primary growth in plants a. Increases the diameter of a shoot or root b. Increases the length of a shoot or root c. Is determinate d. Occurs at the lateral meristem e. Both a & d 16. Xylem is a plant tissue that a. Moves sugar from roots to shoots b. Moves sugar from shoots to roots c. Moves water from roots to shoots d. Stores sugar following photosynthesis e. Collects sunlight energy for photosynthesis
Plant reproduction & growth (How do plants carry out their life cycle?)	17. The ovary of a plant develops into what structure? a. Flower b. Fruit c. Seed d. Plant embryo e. Nothing- it drops off after fertilization 18. The main role of plant cotyledons is a. Produce hormones that help a seed break dormancy b. Transfer nutrients to a growing plant during sprouting c. Protect a growing shoot as it emerges through the soil d. Provide shade for a baby shoot e. All of the above

Plant-animal interactions (Why are plants and animals essential to one another?)	19. Dodo birds were fruit eaters. Following the extinction of the Dodo bird, an island palm also experienced rapid decline. Some scientists hypothesized that the Dodos ate and defecated the fruits and seeds of the palm, and without the Dodos, the palm could no longer spread and germinate. This is an example of a relationship known as a. Dysfunctional b. Mass extinction c. Co-evolution d. Highly selective e. Predation 20. Some plants, like legumes, have a symbiotic relationship with bacteria that "fix" atmospheric nitrogen into a useable form. This relationship is the foundation behind a. Counting growth rings to estimate the age of a tree b. "Girdling" trees to kill them by removing a strip of bark all the way around the tree c. Crop rotation d. Use of fertilizers e. Vegetarians eating lots of soybeans
Laboratory	21. You want to conduct an experiment examining plant phototropism. You have a choice of using plants that have been grown in full sunlight or plants that have been grown in a darkened greenhouse. What do you use? a. Both types of plants b. The dark-growth plants c. The light-growth plants 22. Your blood pressure reading comes back as 150 over 90. Which reading describes the contractions of the heart that send blood to the body and what is that reading called? a. 150-diastolic b. 90-diastolic c. 150-systolic d. 90-systolic e. You must divide 150 by 90 to get the ventricular reading

APPENDIX B: Tables & Figures

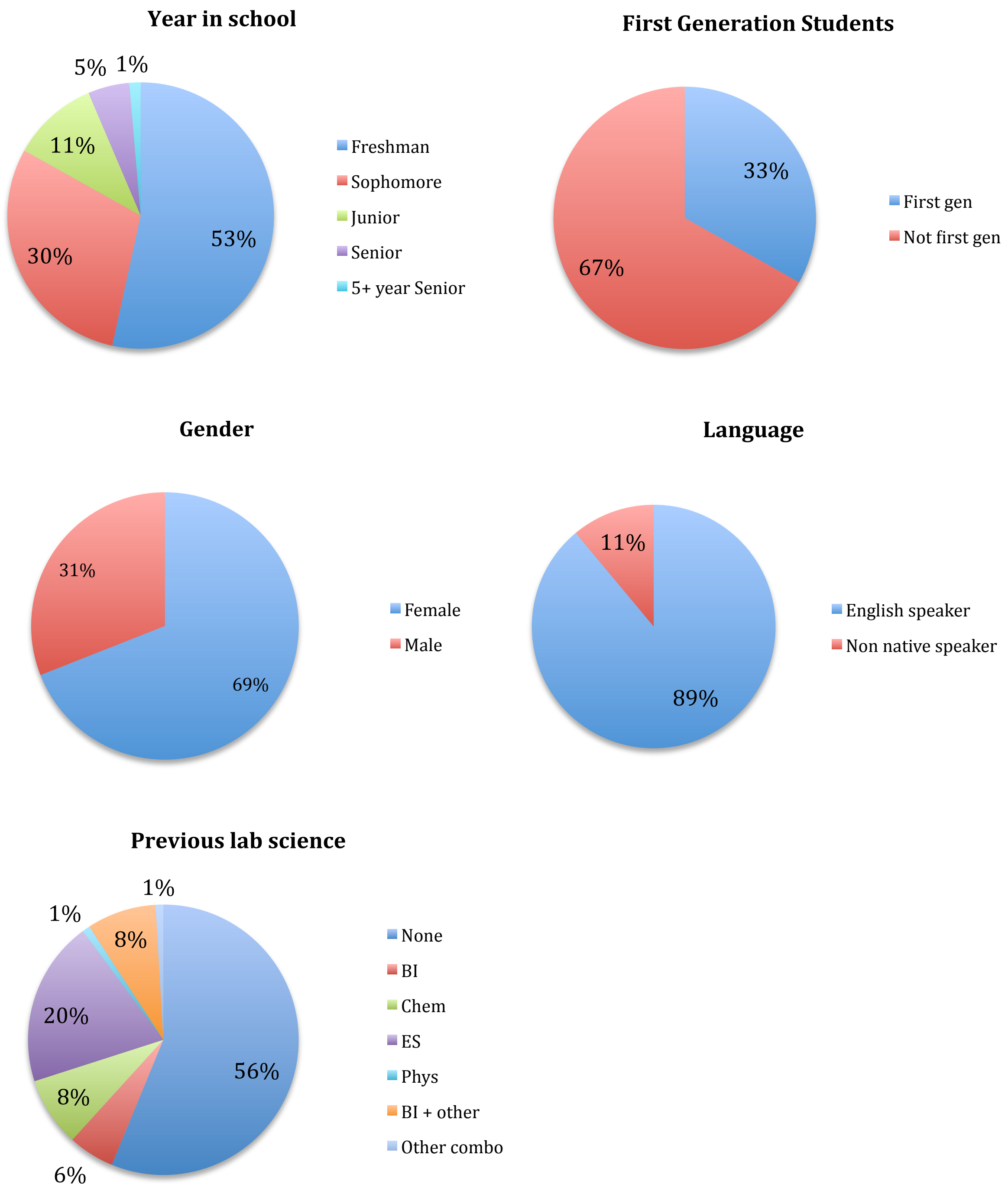

Figure 1: Demographics of Bi 101 courses during 2009-2010 school year. n = 217

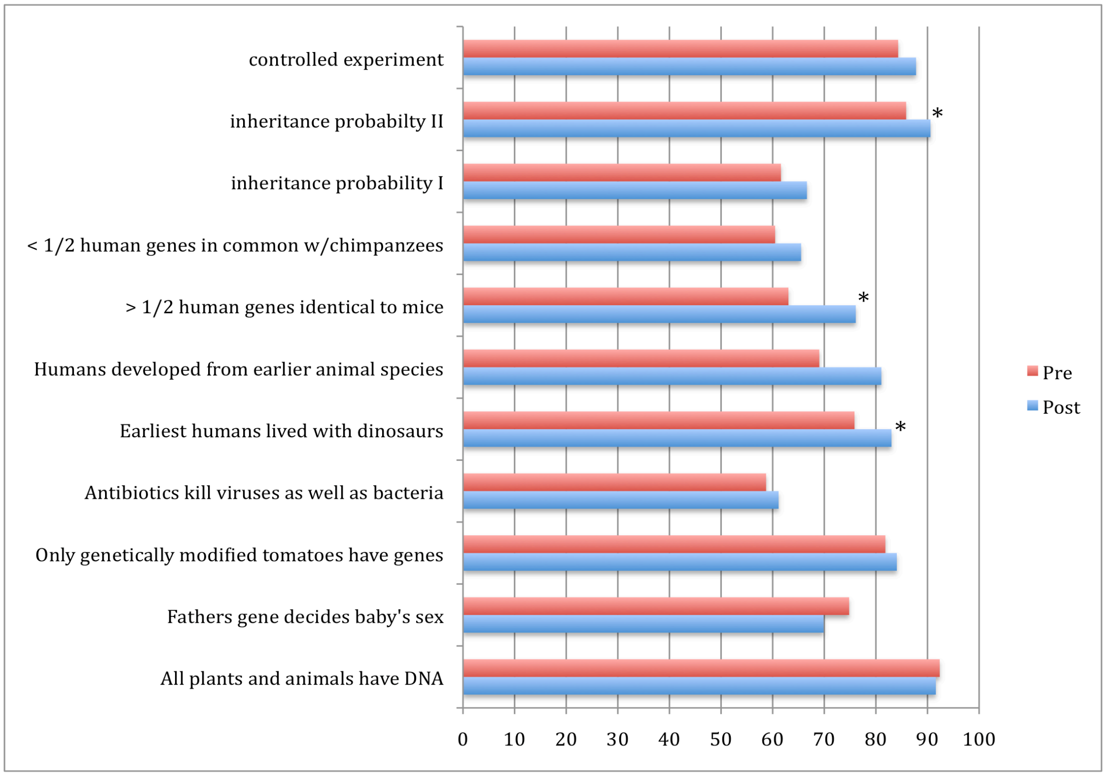

Figure 2: Percentage of Bi 101 students answering correctly on NSF and MSU content items. * indicates significance. n = 217.

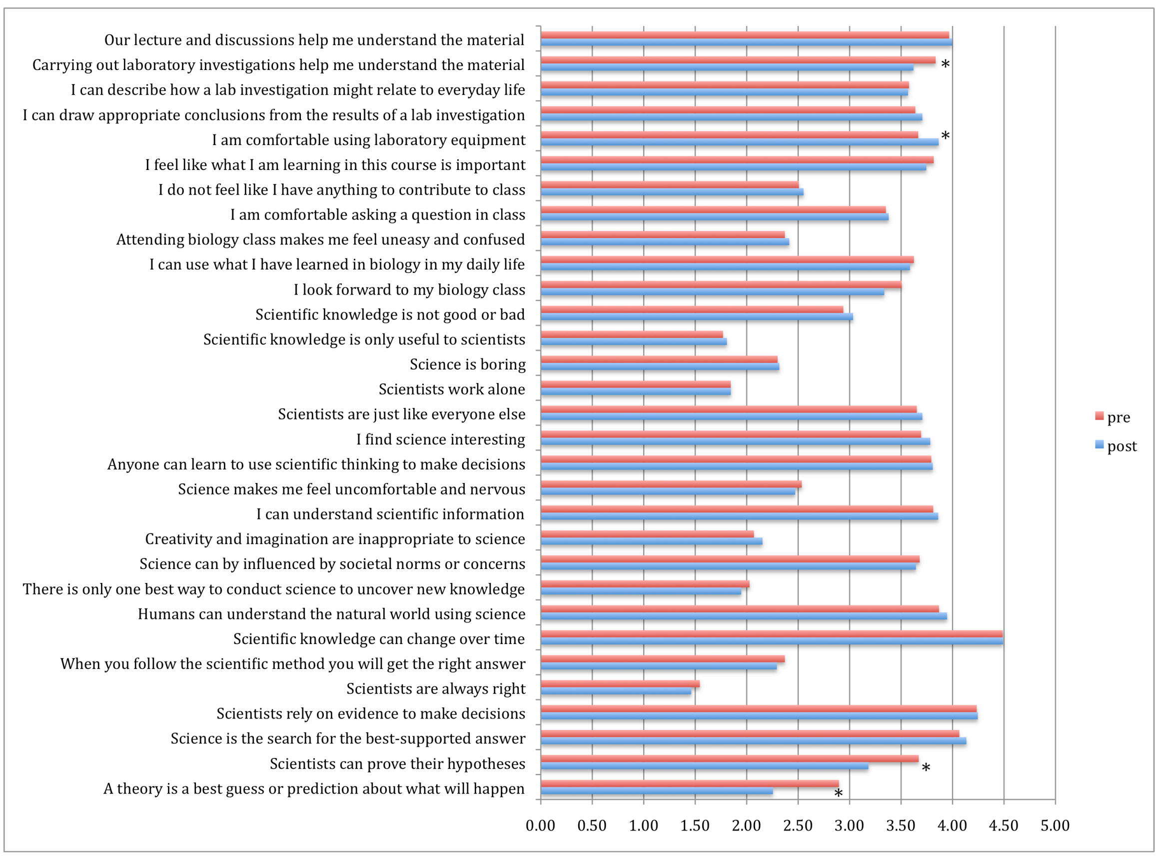

Figure 3: Average Likert response by Bi 101 students to science attitude survey questions. 1 = strongly disagree; 5 = strongly agree. * indicates signficance. n = 217.

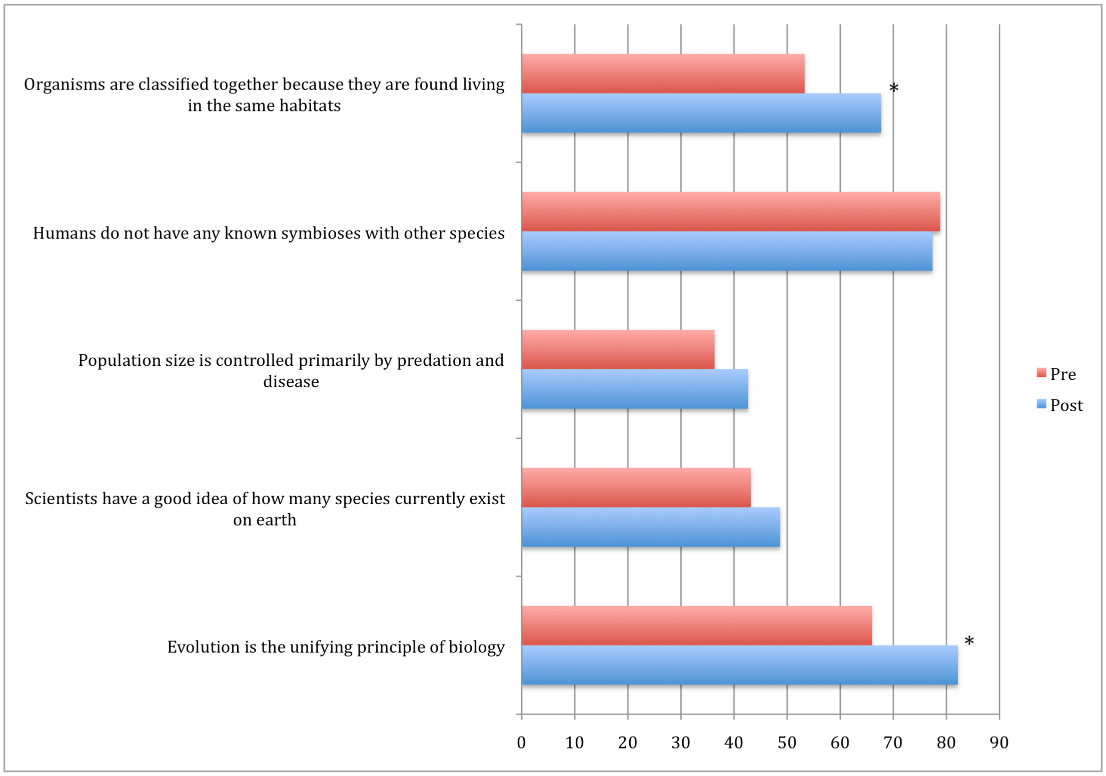

Figure 4: Percentage of Bi 101 students answering correctly on NSF and MSU content items. * indicates significance. n = 217.

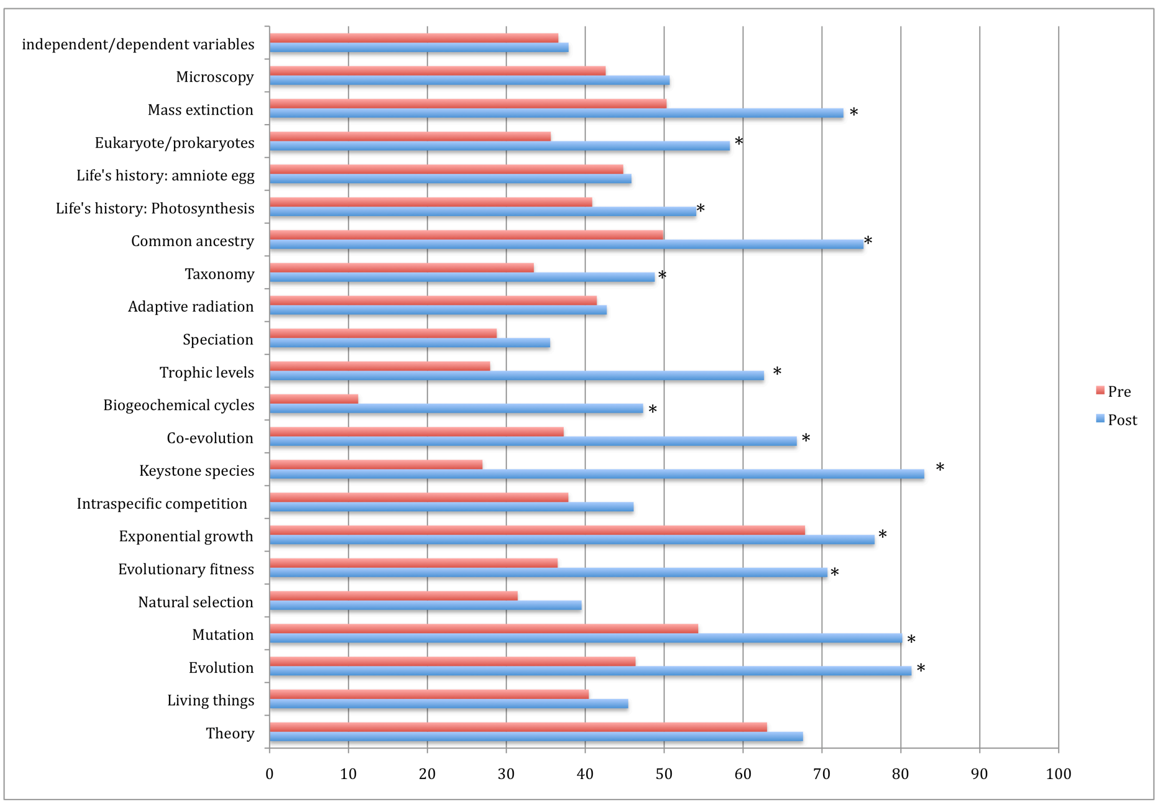

Figure 5: Percentage of Bi 101 students answer correctly on items aligned to Bi 101 course learning outcomes. * indicates significance. n = 217.

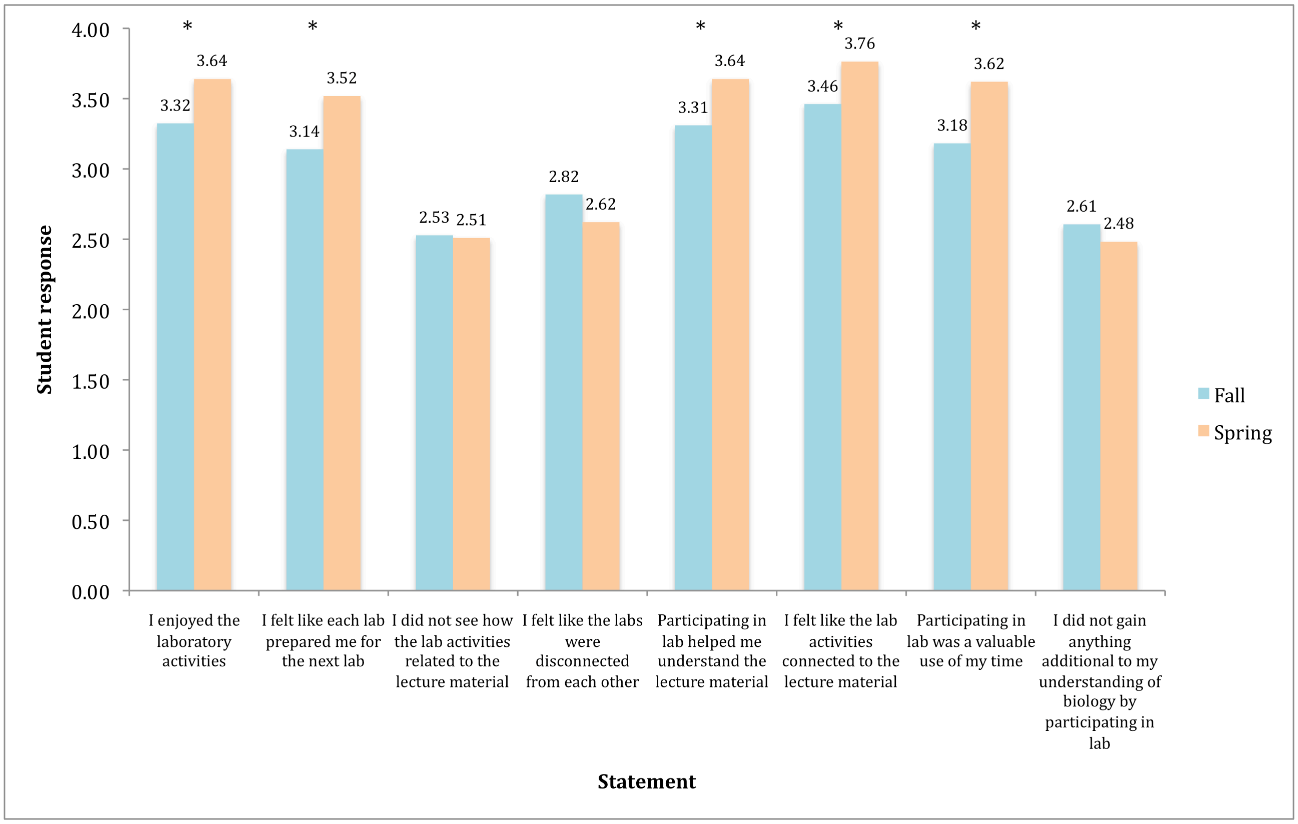

Figure 6: Student Likert response to Bi 101 lab experience in Fall 09 (unrevised labs) and Spring 10 (revised labs) terms. 1 = strongly disagree; 5 = strongly agree. * indicates significance. n = 399.

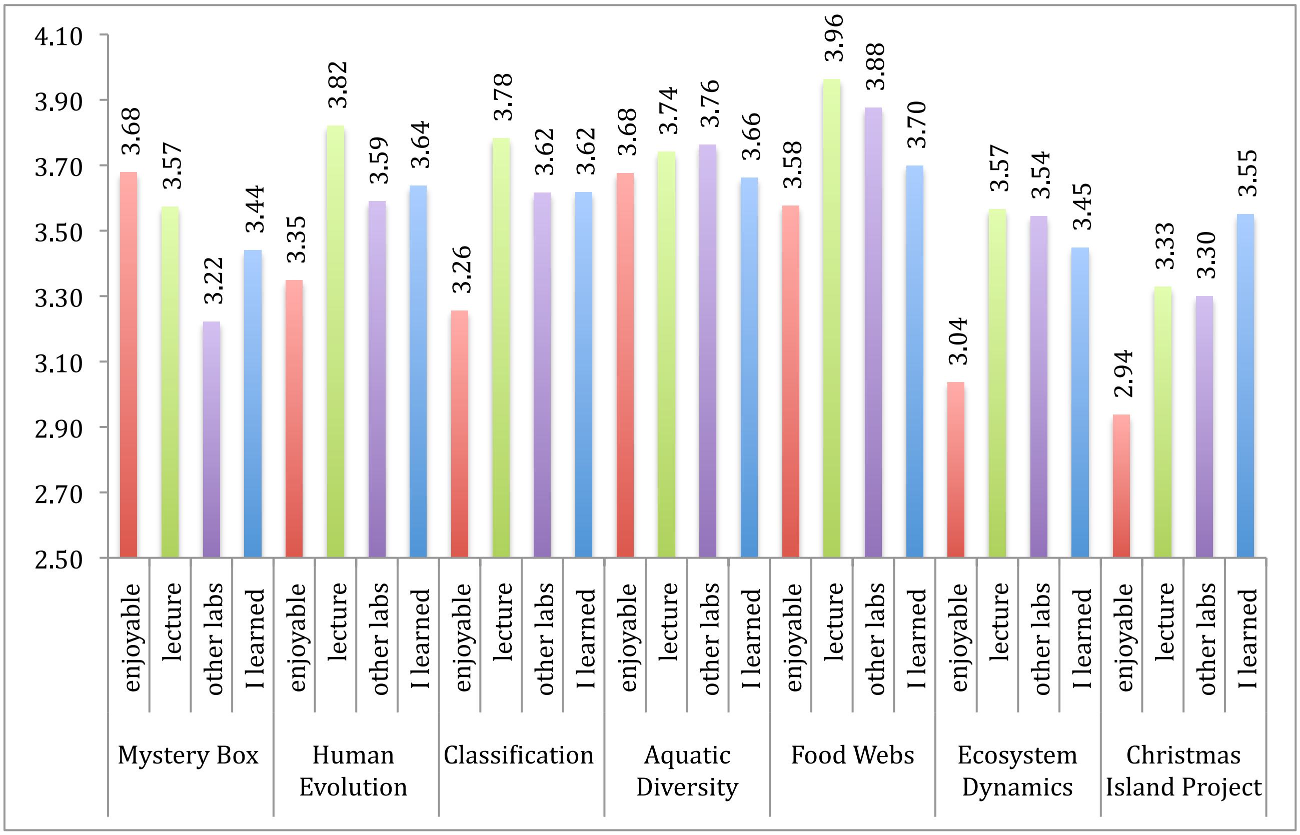

Figure 7a. Student Likert response to individual Bi 101 labs in Fall 09 term. 1 = strongly disagree; 5 = strongly agree. n = 168

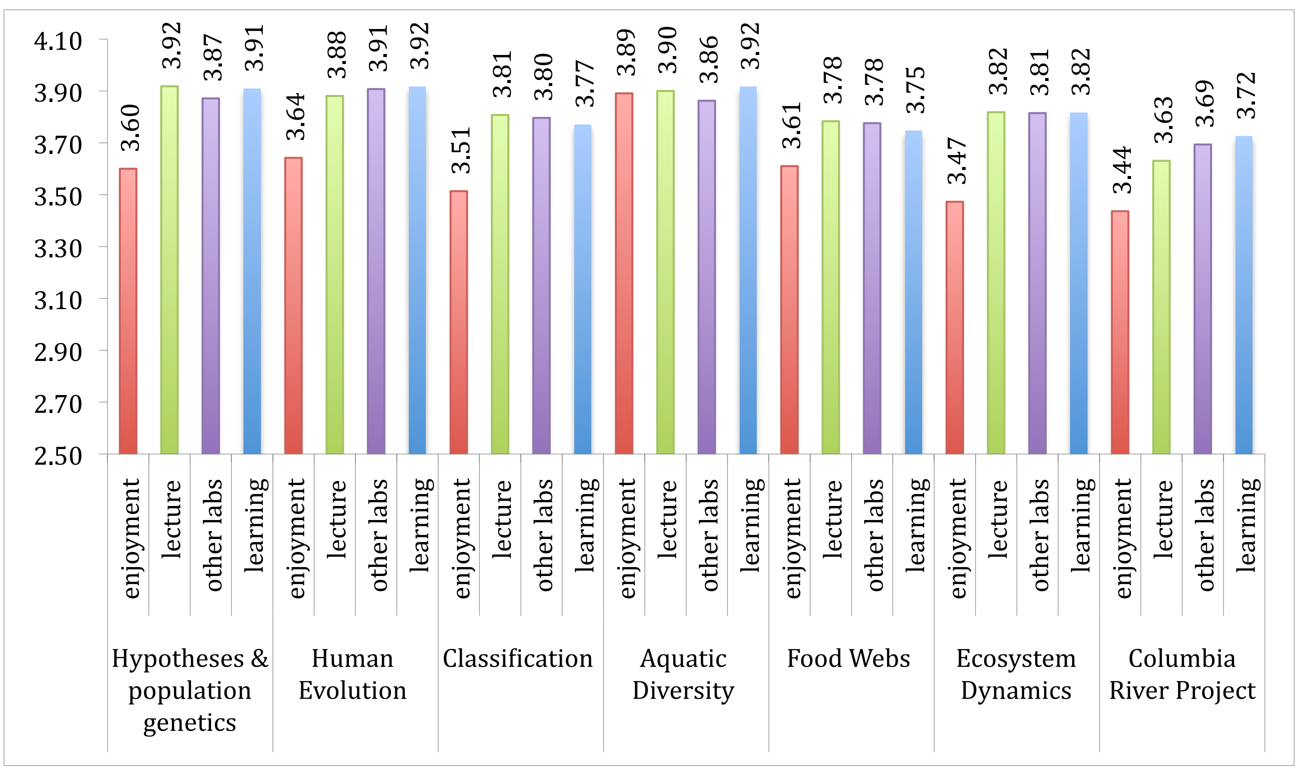

Figure 7b. Student Likert response to individual Bi 101 labs in Spring 09 term. 1 = strongly disagree; 5 = strongly agree. n = 123

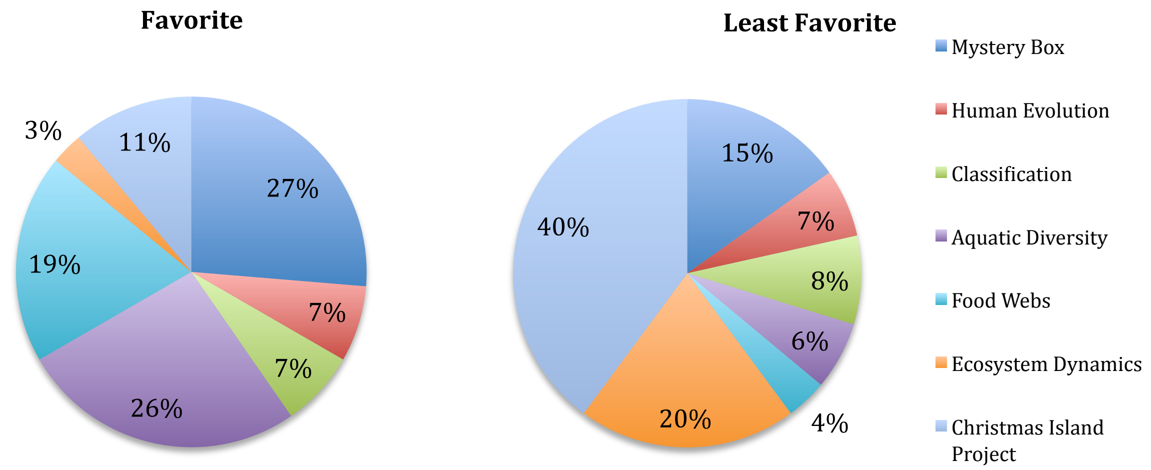

Figure 8a. Percentage of students identifying individual Bi 101 labs as favorite and least favorite in Fall 09 Term. n = 168.

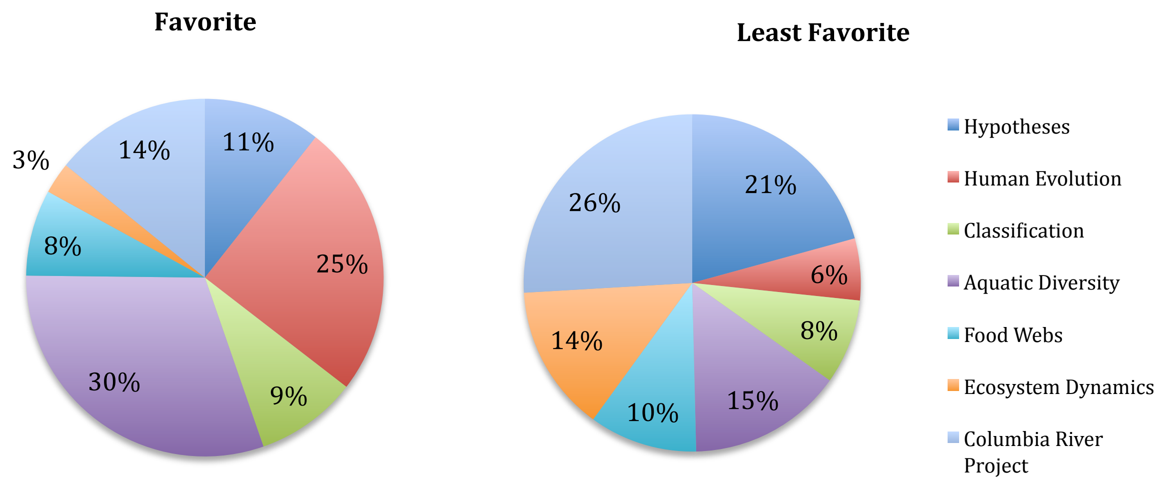

Figure 8b. Percentage of students identifying individual Bi 101 labs as favorite and least favorite in Spring 10 Term. n = 123.

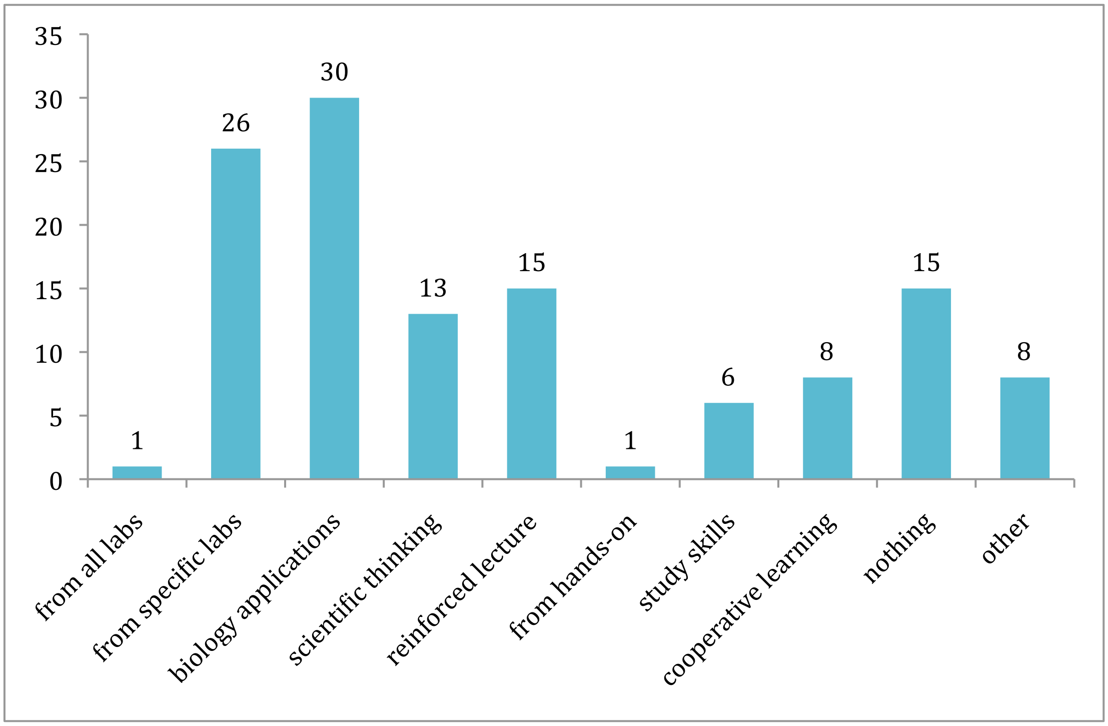

Figure 9a. Numbers of students identifying within each category to open response question: "What is the most valuable thing you learned in Bi 101 lab?" during labs in Fall 09 Term.

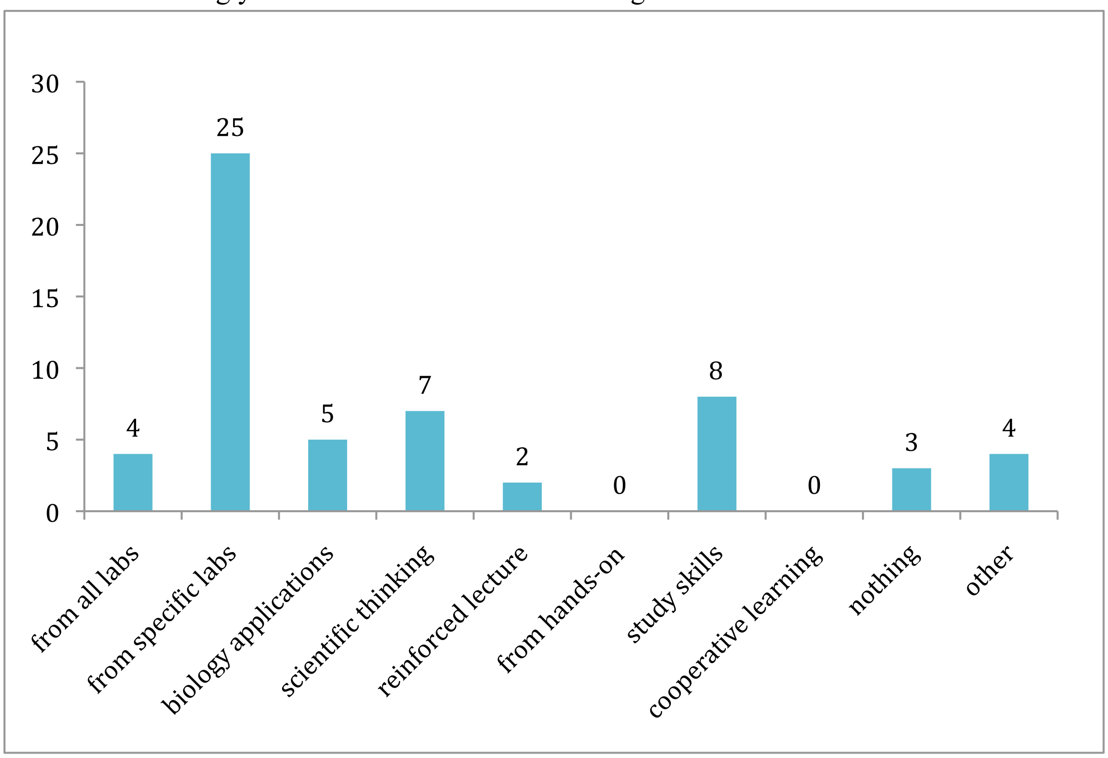

Figure 9b. Numbers of students identifying within each category to open response question: "What is the most valuable thing you learned in Bi 101 lab?" in Spring10 Term.

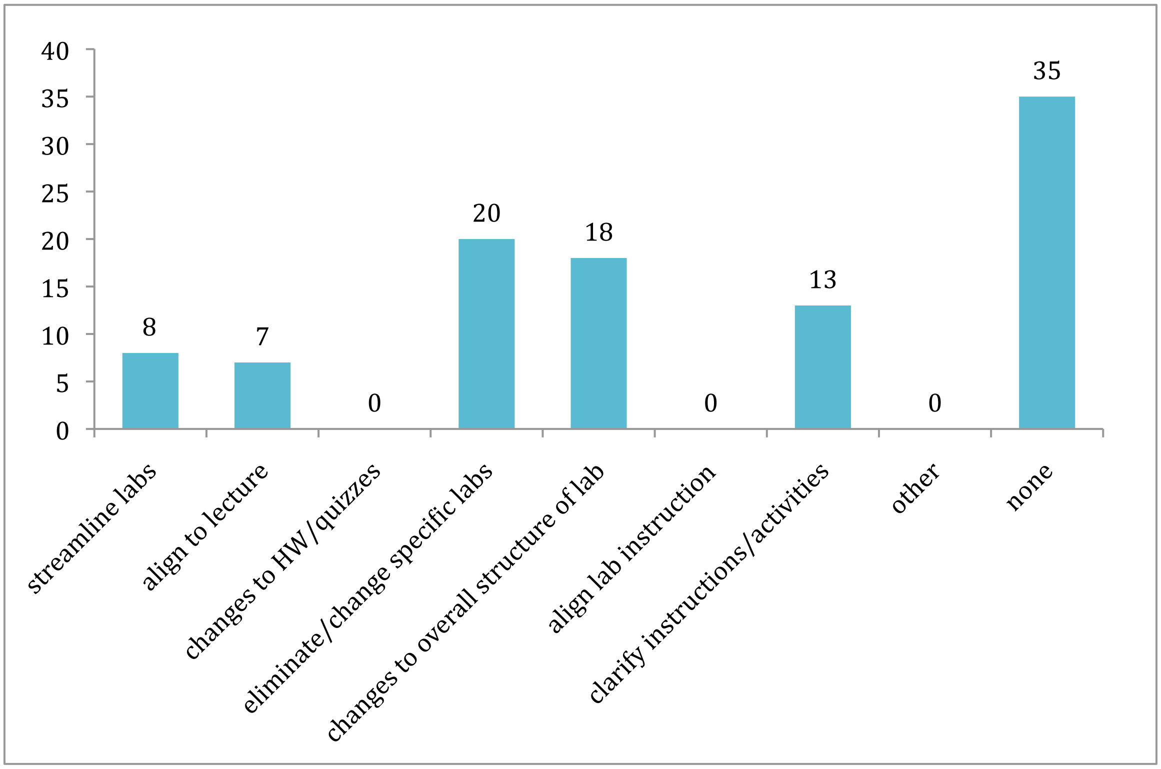

Figure 10a. Numbers of students identifying within each category to open response question: "Do you have any suggestions for improvement?" to Bi 101 labs in Fall 09 Term.

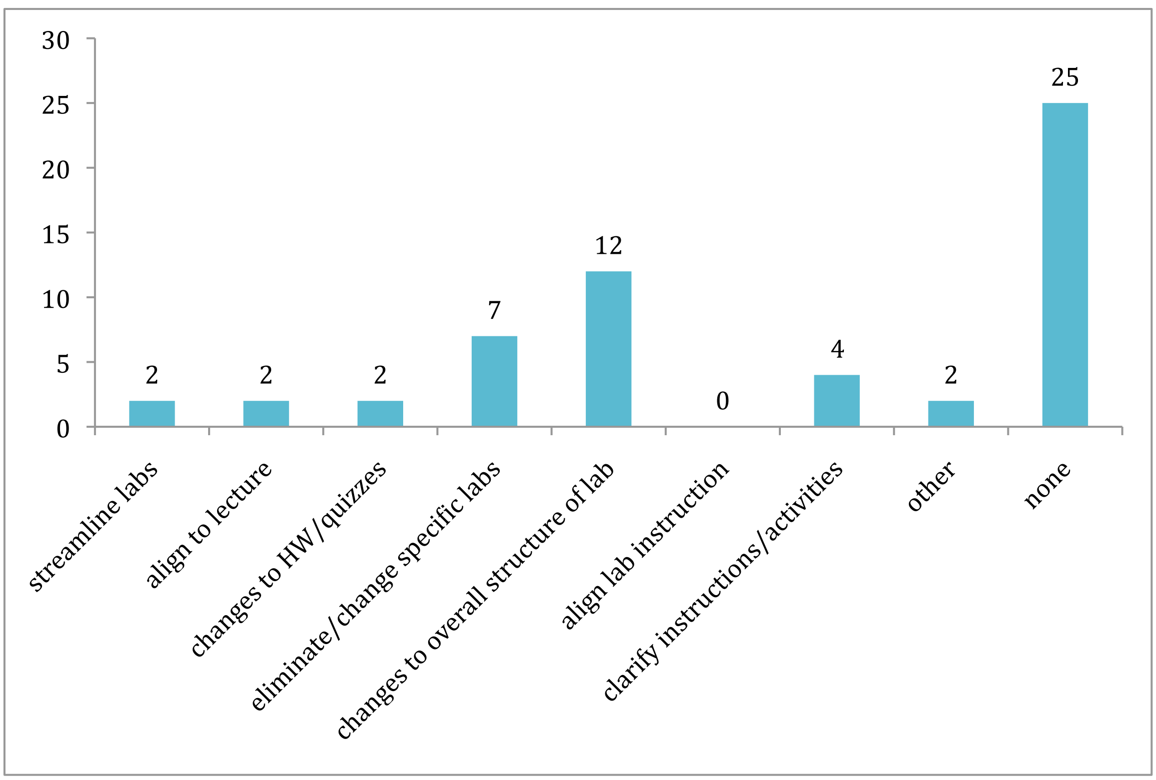

Figure 10b. Numbers of students identifying within each category to open response question: "Do you have any suggestions for improvement?" to Bi 101 labs in Spring 10 Term.

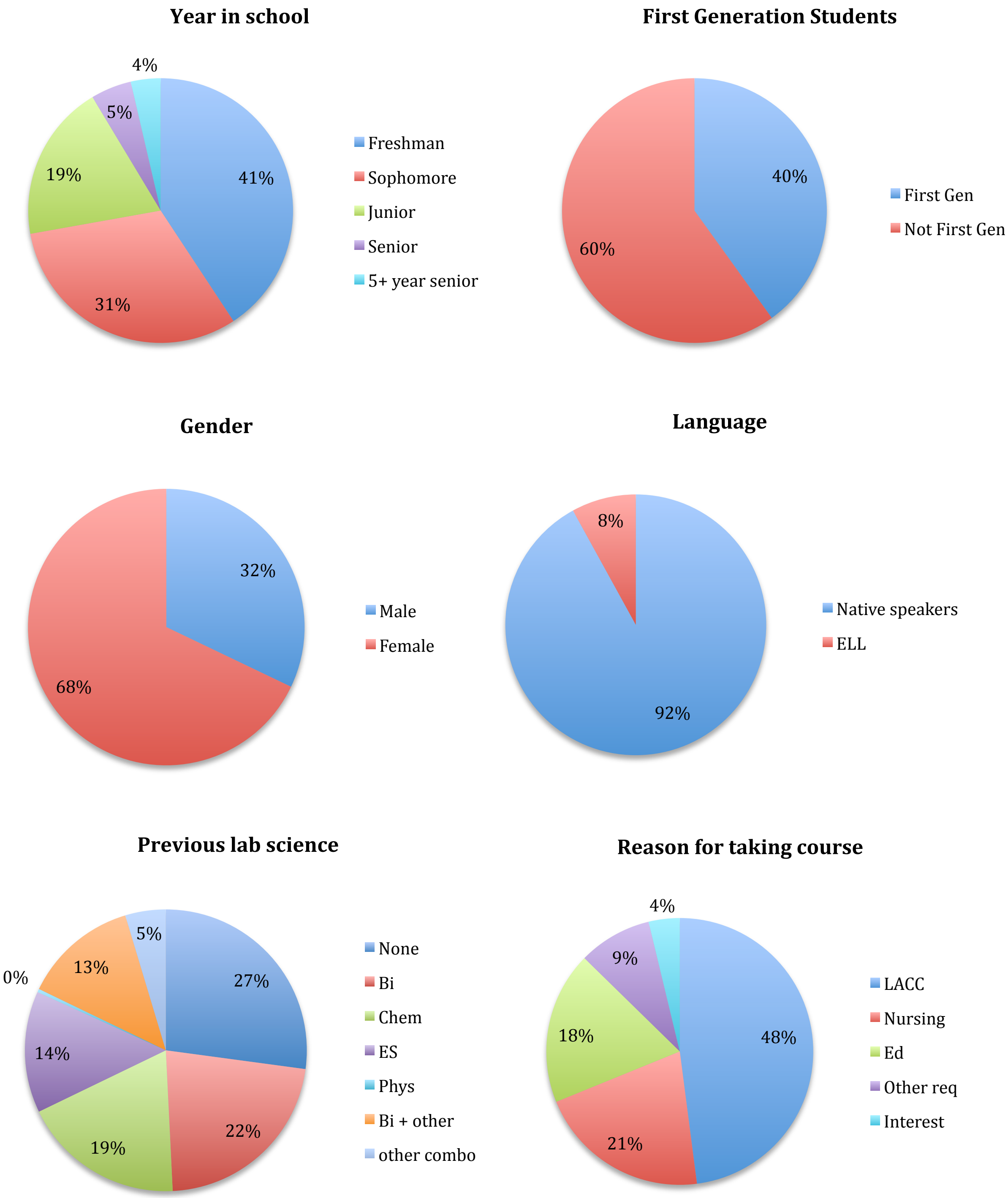

Figure 11: Demographics of Bi 102 courses during 2009-2010 school year. n = 302

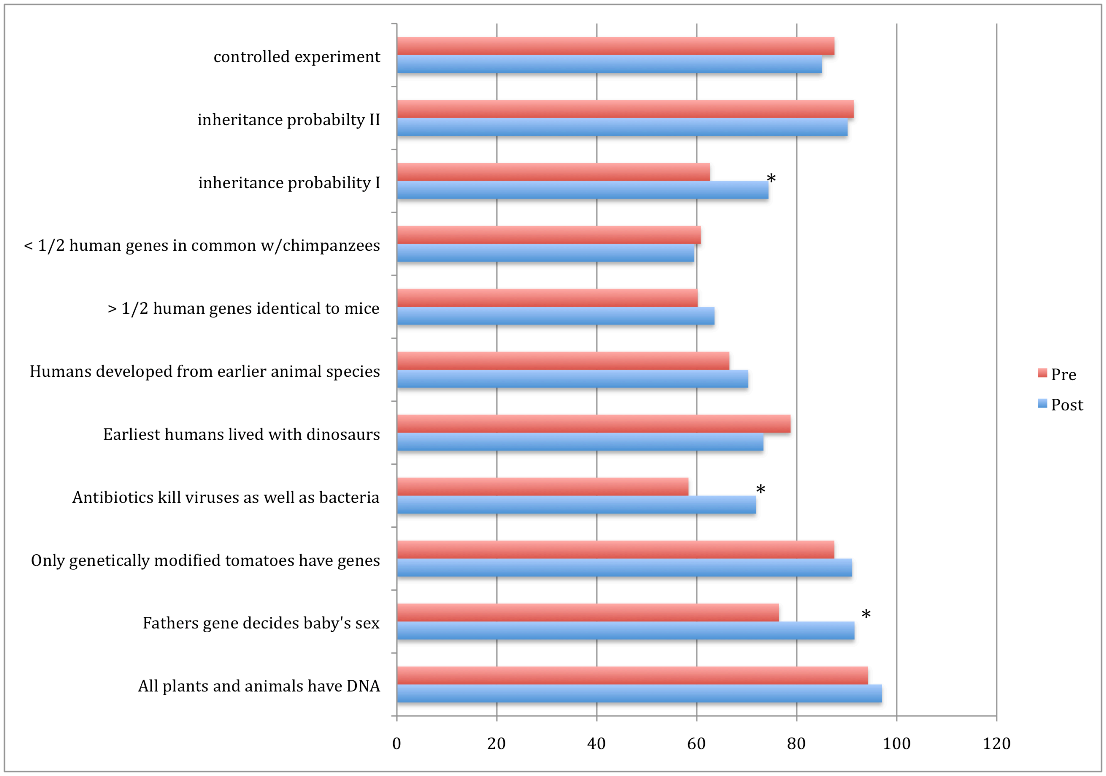

Figure 12: Percentage of Bi 102 students answering correctly on NSF and MSU content items. * indicates significance. n = 302.

Figure 13: Average Likert response by Bi 102 students to science attitude survey questions. 1 = strongly disagree; 5 = strongly agree. * indicates signficance. n = 302.

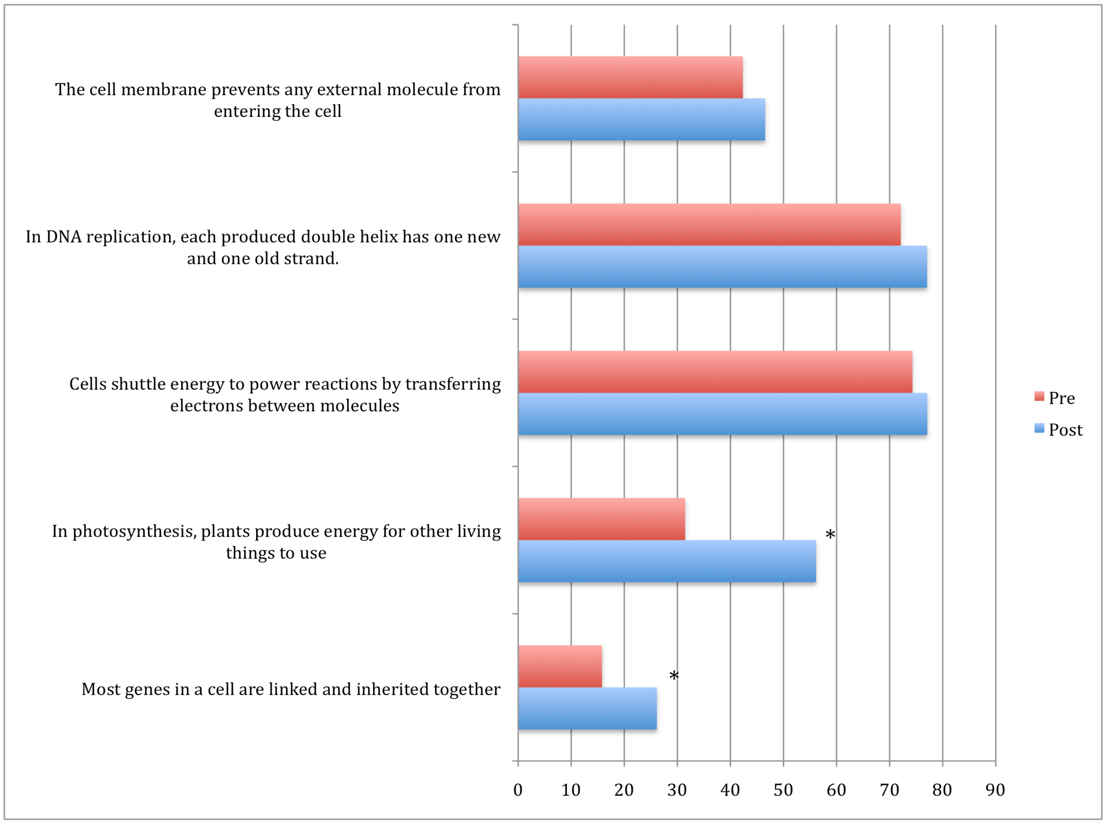

Figure 14: Percentage of Bi 102 students answering correctly on NSF and MSU content items. * indicates significance. n = 302.

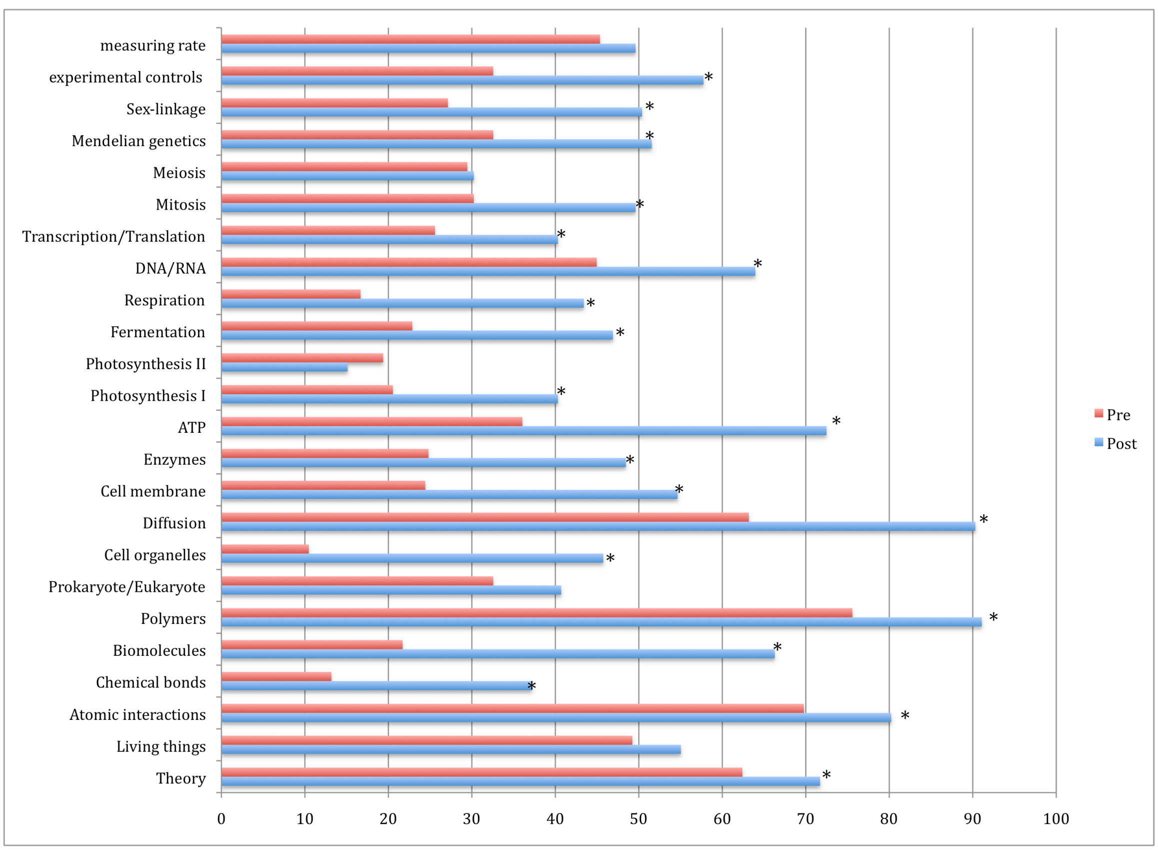

Figure Figure 15: Percentage of Bi 102 students answer correctly on items aligned to Bi 102 course learning outcomes. * indicates significance. n = 302.

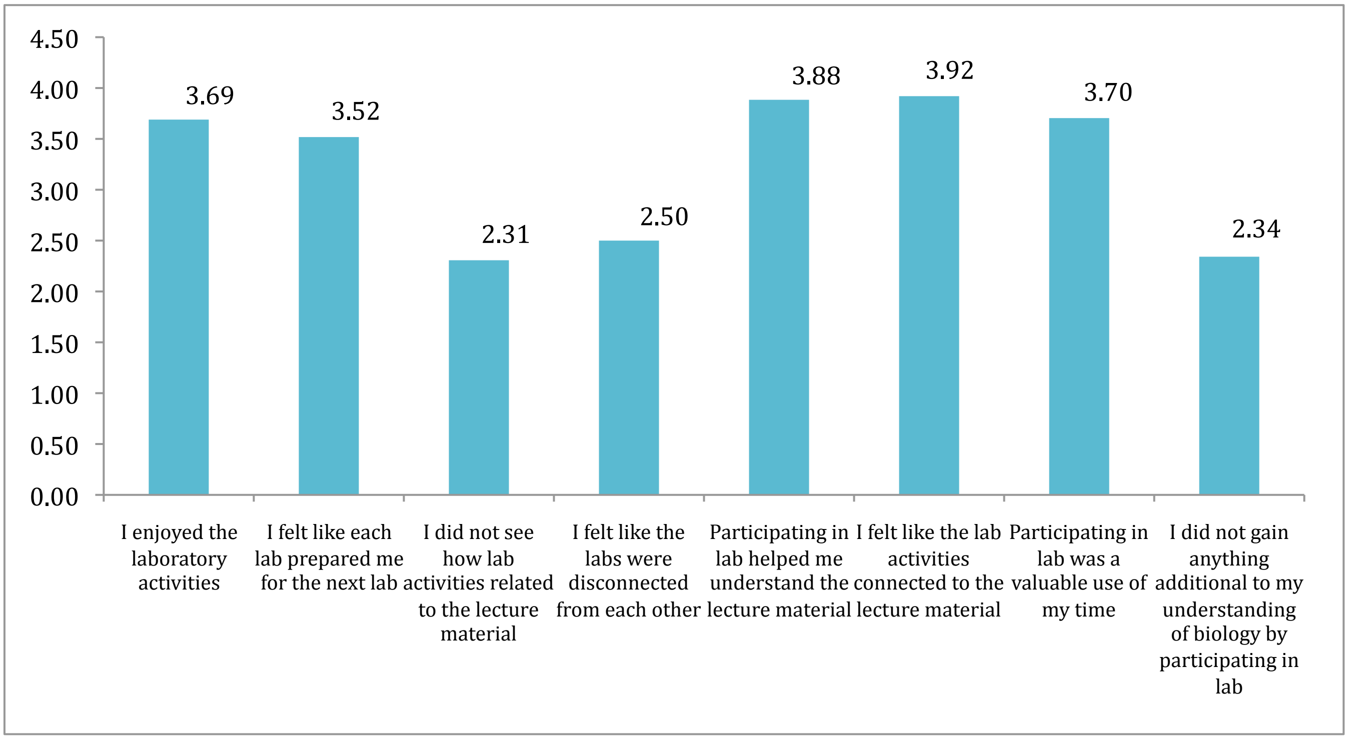

Figure 16: Student Likert response to Bi 102 lab experience. 1 = strongly disagree; 5 = strongly agree. * indicates significance. n = 397.

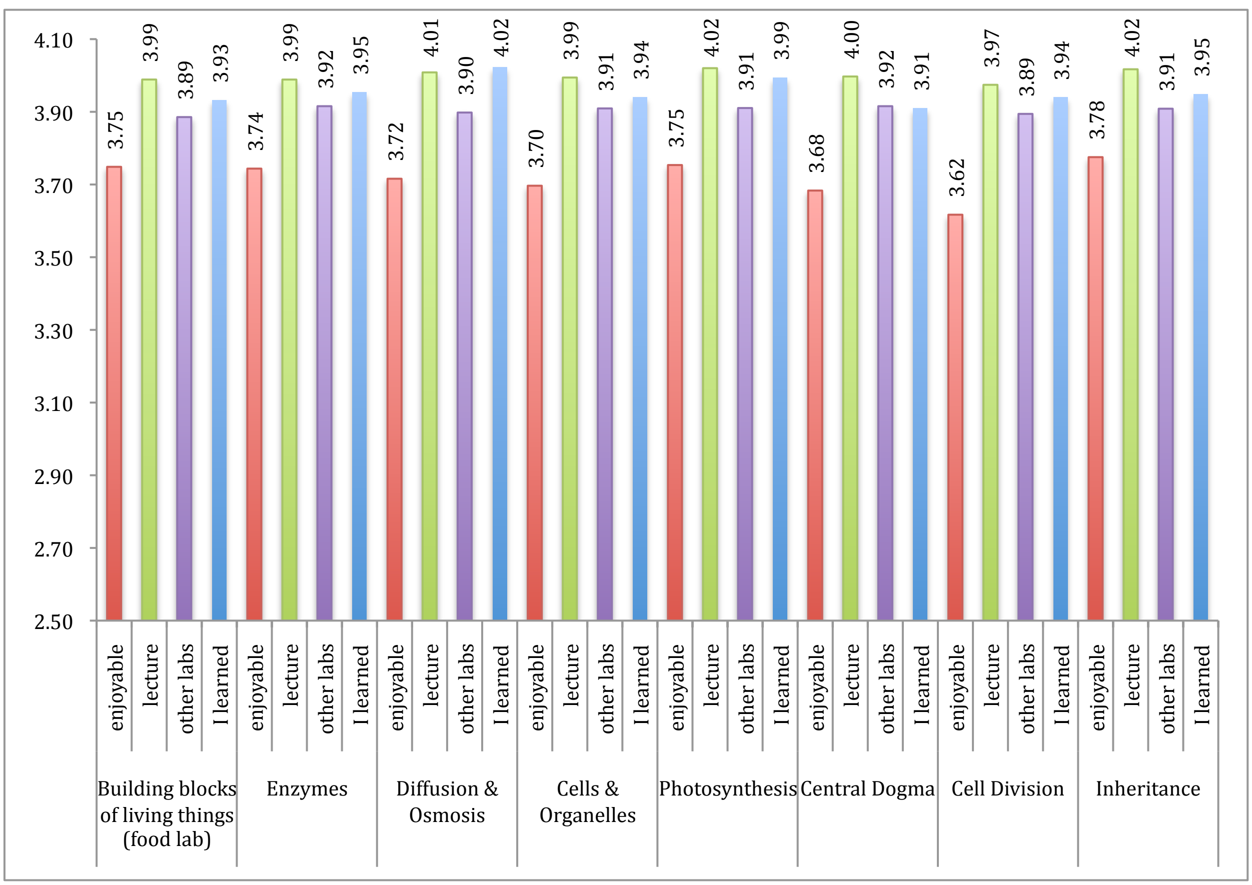

Figure 17. Student Likert response to individual Bi 102 labs. 1 = strongly disagree; 5 = strongly agree. n = 397.

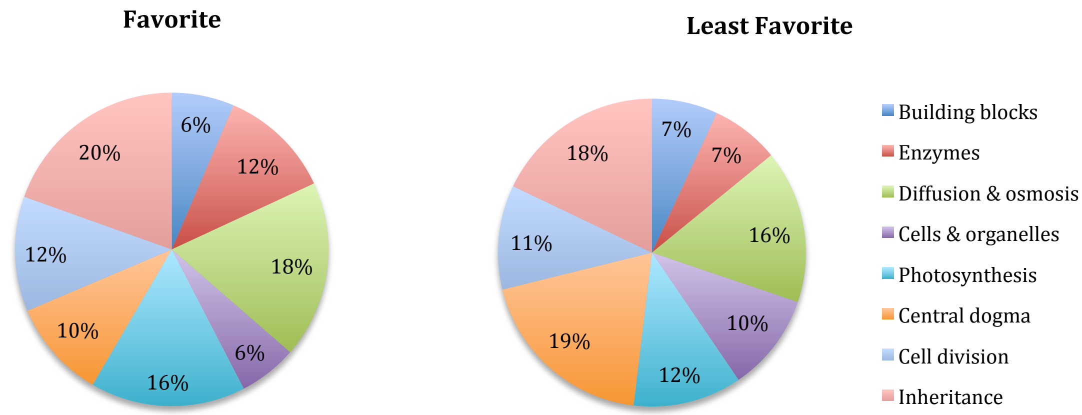

Figure 18. Percentage of students identifying individual Bi 102 labs as favorite and least favorite in Spring 10 Term. n = 397.

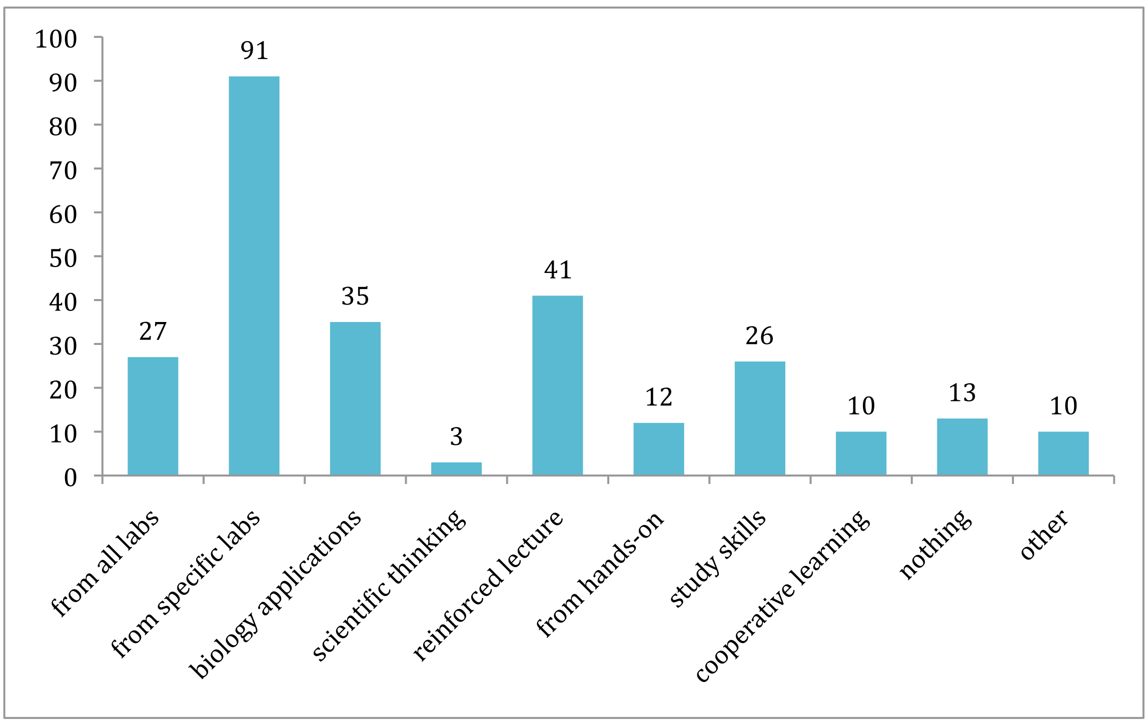

Figure 19. Numbers of students identifying within each category to open response question: “What is the most valuable thing you learned in Bi 102 lab?” in Spring10 Term.

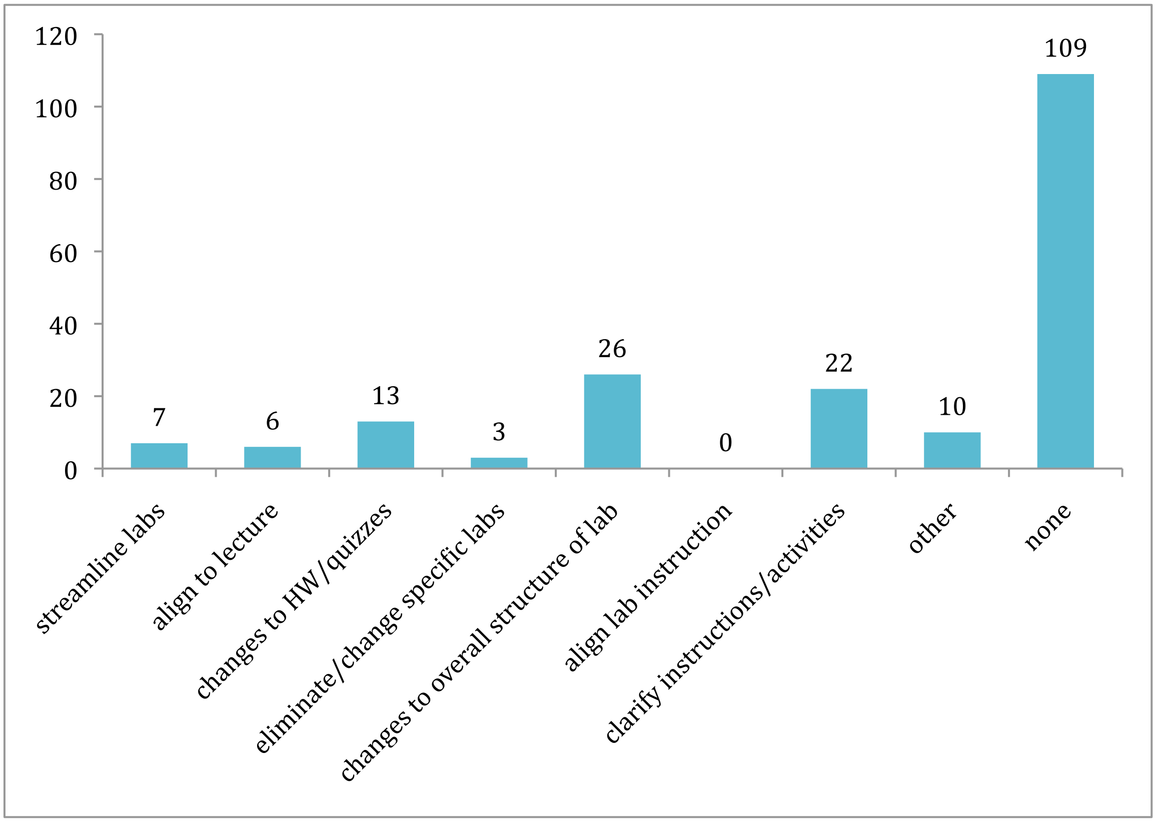

Figure 20. Numbers of students identifying within each category to open response question: "Do you have any suggestions for improvement?" to Bi 102 labs in Spring 10 Term.

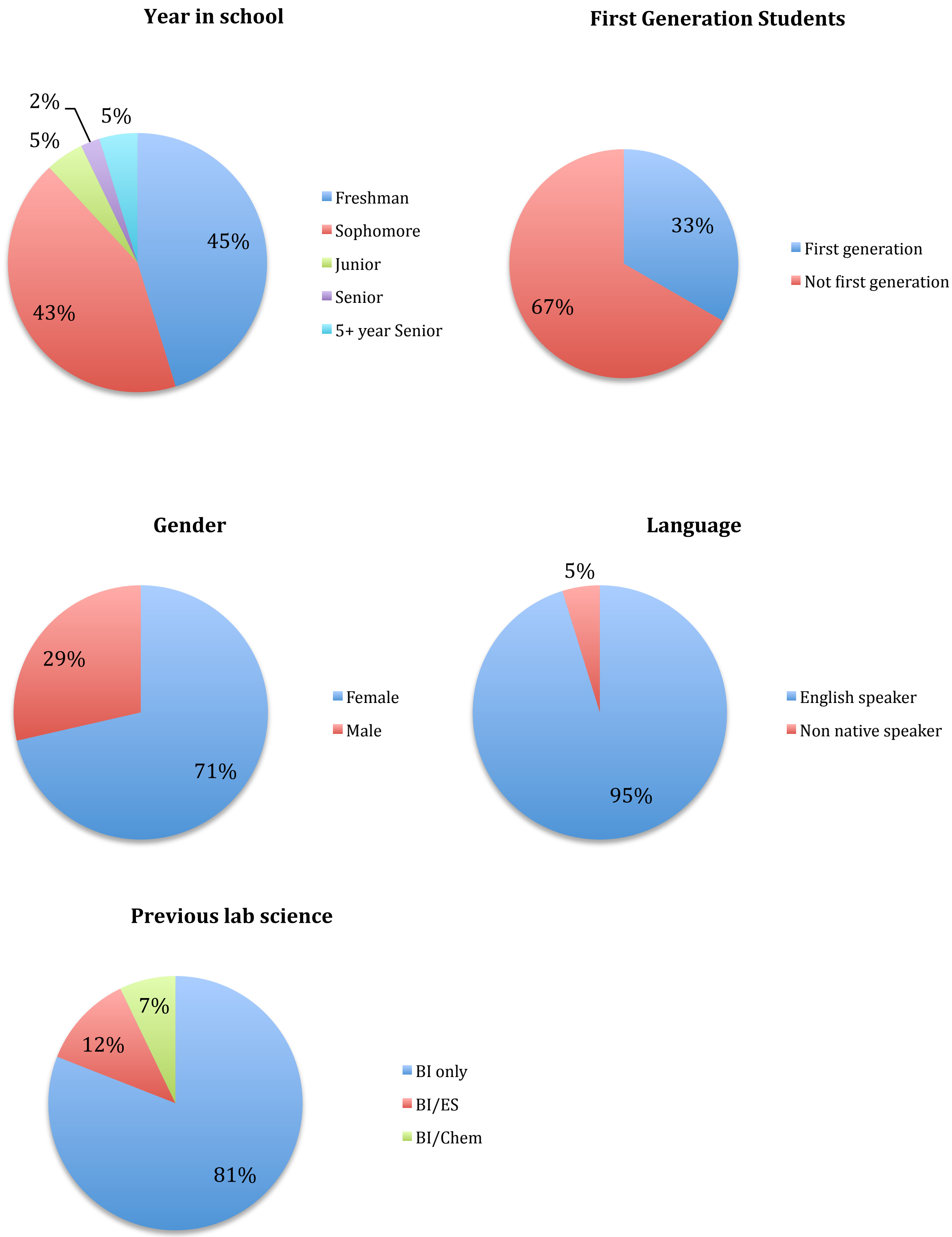

Figure 21: Demographics of Bi 103 courses during 2009-2010 school year. n = 42

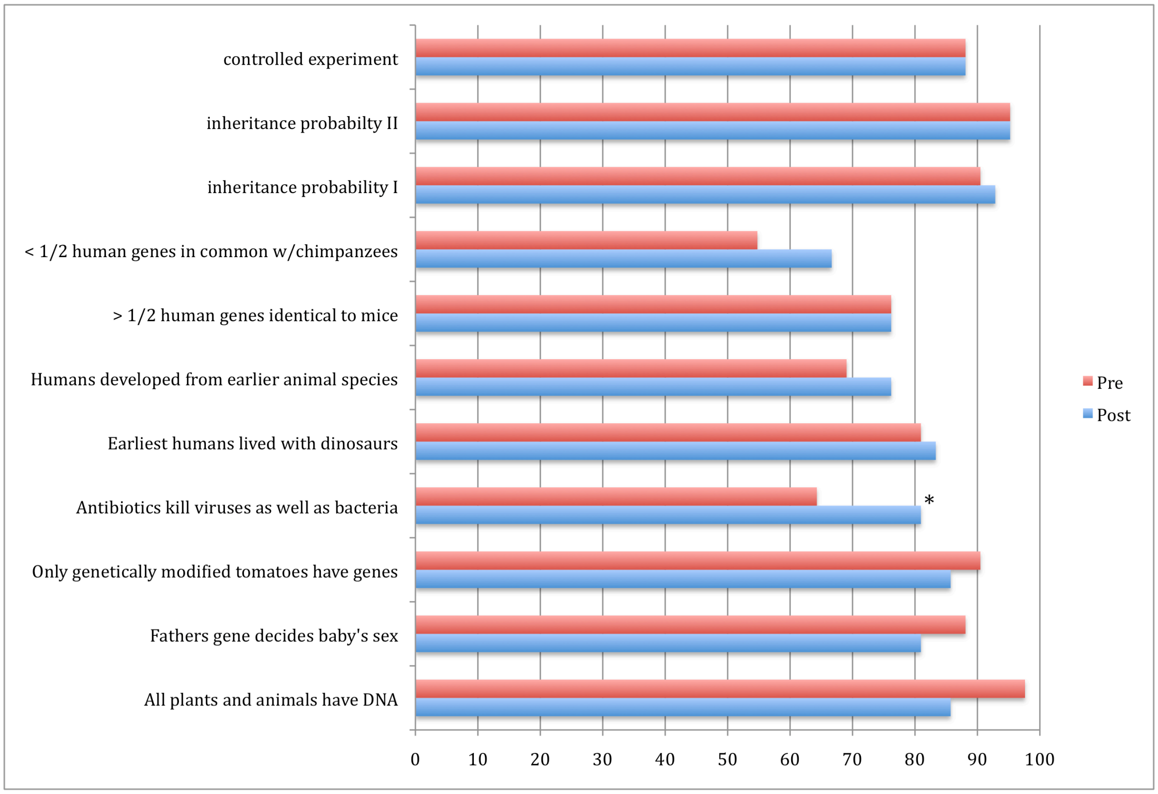

Figure 22: Percentage of Bi 103 students answering correctly on NSF and MSU content items. * indicates significance. n = 42.

Figure 23: Average Likert response by Bi 103 students to science attitude survey questions. 1 = strongly disagree; 5 = strongly agree. * indicates signficance. n = 42.

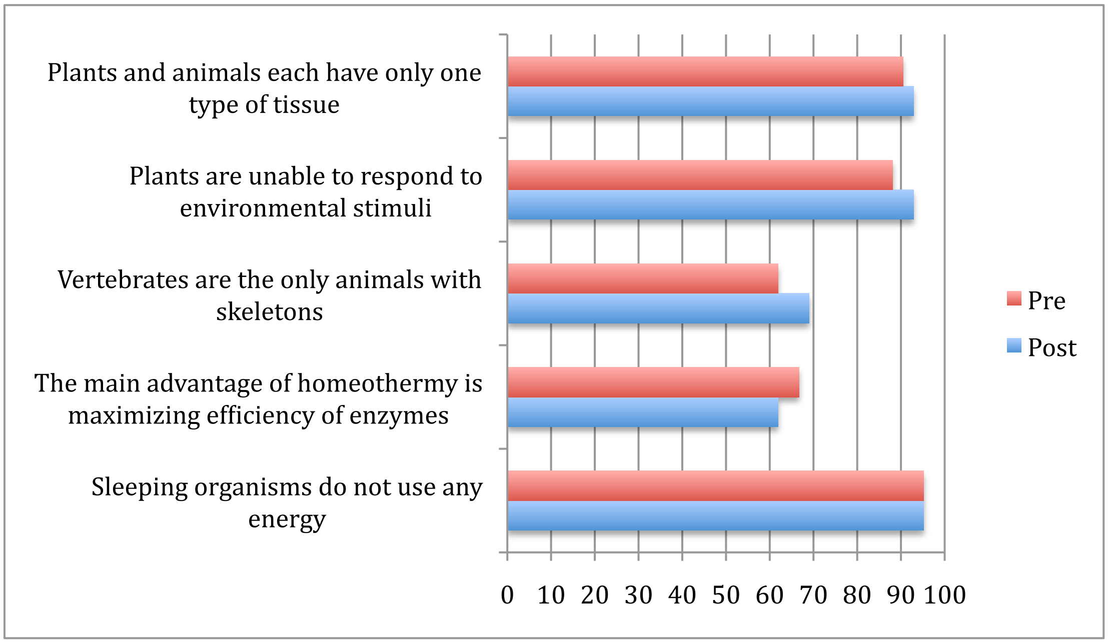

Figure 24: Percentage of Bi 103 students answering correctly on NSF and MSU content items. * indicates significance. n = 42.

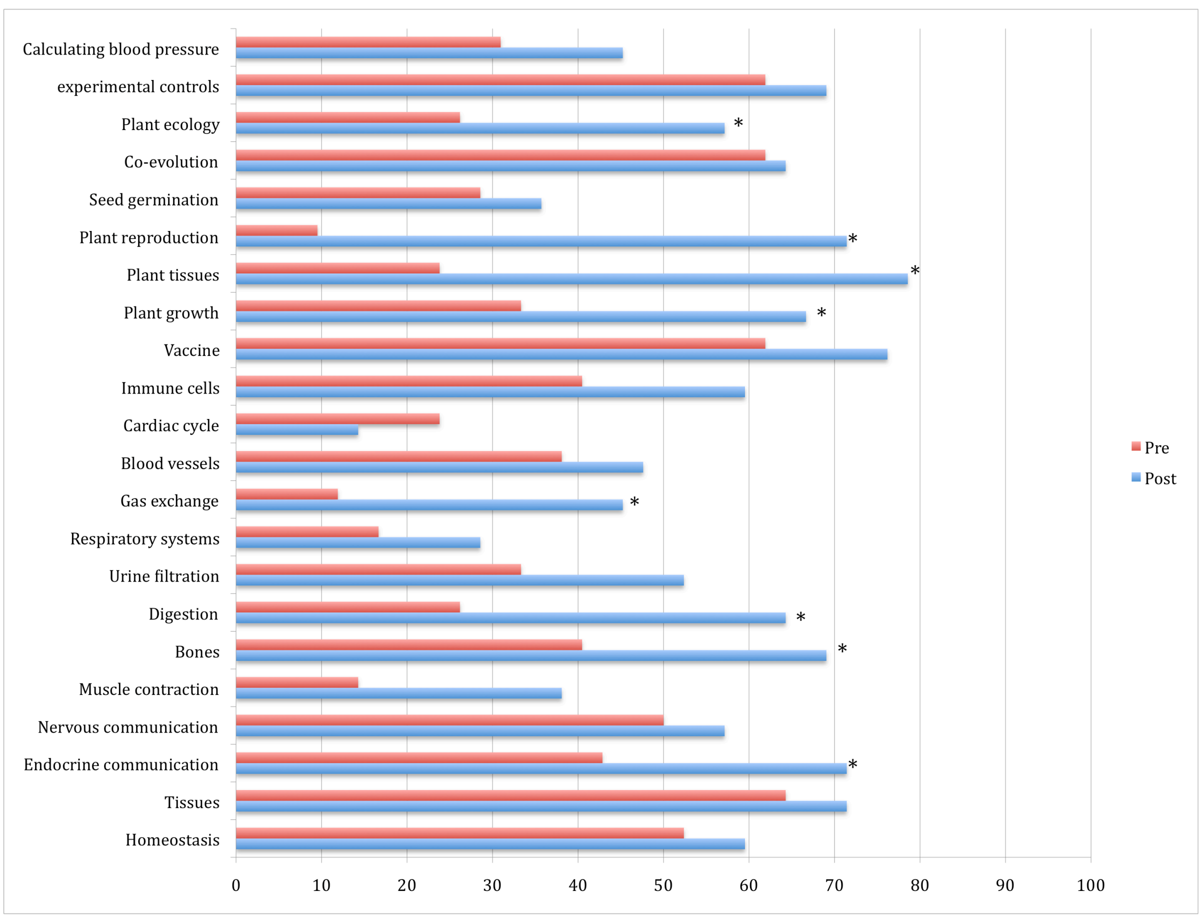

Figure 25: Percentage of Bi 103 students answer correctly on items aligned to Bi 103 course learning outcomes. * indicates significance. n = 42.

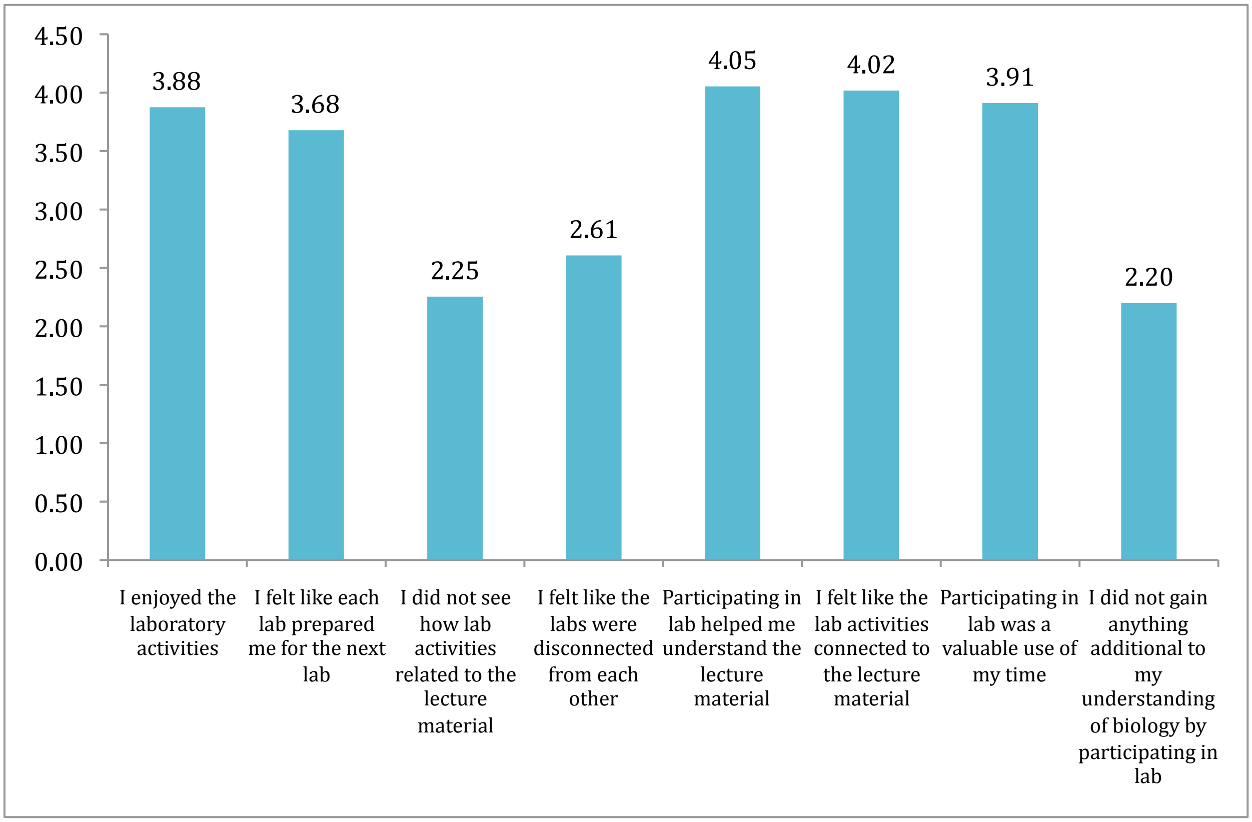

Figure 26: Student Likert response to Bi 103 lab experience. 1 = strongly disagree; 5 = strongly agree. * indicates significance. n = 57.

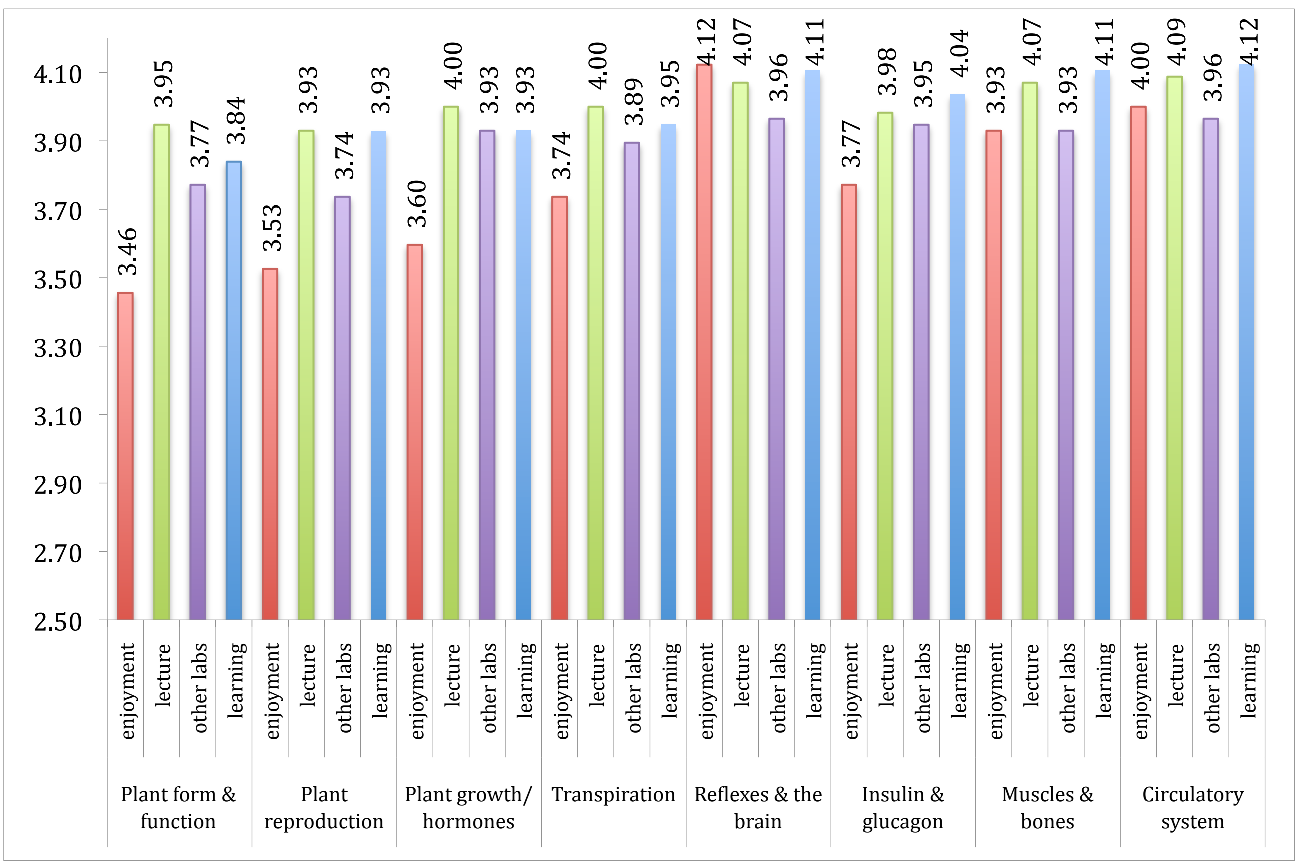

Figure 27. Student Likert response to individual Bi 103. 1 = strongly disagree; 5 = strongly agree. n = 57

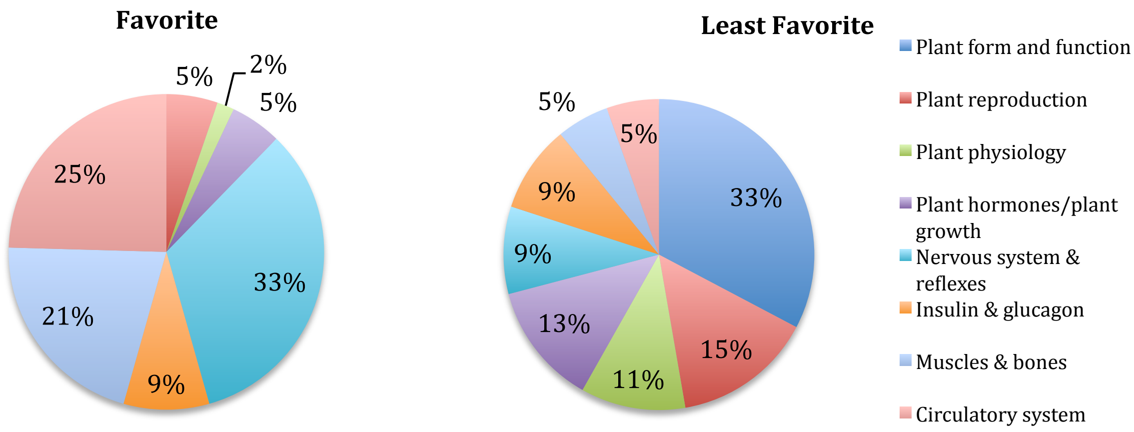

Figure 28. Percentage of students identifying individual Bi 103 labs as favorite and least favorite. n = 57.