

Institutional Effectiveness

2018-2019

Program: Biology BS

College and Department: College of Arts & Sciences – Department of Biology

Contact: Christopher Brown

Mission: The primary mission of the Department of Biology at Tennessee Tech is to promote biological education in, and advance biological knowledge for, the region, state, and nation through teaching, research, and public service.

The Department of Biology has three-degree programs (B.S. in Biology, B.S. in Wildlife and Fisheries Science, and M.S. in Biology). Each degree program has a separate report. Program Goals and Student Learning Outcomes for the undergraduate programs are similar since Wildlife and Fisheries Science is applied Biology; however, assessment results differ for most goals and outcomes based on the assessment techniques used. The graduate program has a unique set of goals and learning outcomes.

Program Goals:

PG 1: Increase the percentage of students in the Biology major who complete a cooperative program ("co-op"), experiential internship, and/or study abroad during their undergraduate years.

The goal is to have 10% of students in the Biology major complete one or more cooperative program ("co-op"), experiential internship, or study abroad opportunity during the time they are an undergraduate.

PG 2: Faculty in the Department of Biology will increase the incorporation of active-learning strategies in courses offered.

All departmental faculty members are expected to receive pedagogical training in active-learning techniques and strategies during their first 3 years of employment. We would like at least 75% of Department of Biology faculty to incorporate active-learning/critical-thinking strategies into their individual courses to improve the reasoning ability of our students. We also would like Department of Biology faculty to select critical thinking as an important or essential component of a course on 50% of IDEA course evaluations.

PG 3: The Department of Biology will increase undergraduate retention.

Our goal is to increase the retention rate so that it equals or exceeds that of the university's average rate of retention.

PG 4: The Department of Biology will make significant progress toward increasing diversity.

The Department of Biology will make significant progress toward desegregation and affirmative action objectives.

Student Learning Outcomes:

SLO 1: Undergraduate Biology majors will demonstrate improved critical thinking skills.

Our goal is for students to meet or exceed the national average score on the California Critical Thinking Skills Test (CCTST).

SLO 2: Biology majors will participate in extracurricular activities related to their discipline.

Our goal is to have at least 25% of all Biology majors participate in extracurricular activities related to their discipline.

SLO 3: All students completing a degree in Biology at Tennessee Tech University will use scientific reasoning as codified by the structured process commonly known as the scientific method.

Our goal is to have all graduating seniors obtain a perfect score (100% correct answers) on the departmental Scientific Method Questionnaire.

SLO 4: Biology majors will be able to demonstrate a command of general biology concepts and the general principles in various specific areas of biology.

Our goal is to have our students perform above average in the ACAT Major Field Examination.

A departmentally developed curriculum map can be found in Appendix 1 that shows the connections between courses and student learning outcomes.

Assessment Methods:

PG 1: Increase the percentage of students completing a co-op, internship, or study abroad

1. Senior Questionnaire

Graduating seniors are asked to complete a short Senior Questionnaire concerning extracurricular activities at the time they take their major field exam, including an assessment of how valuable they considered the experiences. One of the questions on the questionnaire is devoted specifically to internships and co-ops. The departmental chair tracks student internship participation rates through time. The departmental Planning Committee, consisting of five departmental faculty members selected by the department chairperson, continually revises the senior questionnaire to provide more detailed information about activities that are most valuable to undergraduate students.

PG 2: Increase the incorporation of active-learning strategies in courses offered

1. Faculty Annual Report

Conducted annually each Spring semester. Each faculty member submits a Faculty Annual Effort report to the chairperson that discusses their efforts for the previous calendar year. The departmental chair tracks the number of faculty participating in active-learning training and mentoring, and the incorporation of active learning/critical thinking strategies by gleaning such information from these reports.

The department chair discusses each individual faculty member's progress as summarized in Faculty Annual Reports. Active-learning is assessed by determining the number of Department of Biology faculty that enhance their knowledge of active-learning teaching approaches by participating in on- or off-campus training and development workshops devoted to such approaches. In addition, 100% of new Department of Biology faculty are paired with a faculty mentor who has experience with active-learning techniques in the classroom during their first year of employment. On-going progress on active learning/critical thinking implementation is summarized and included in the Departmental Annual Report submitted by the chair to the Dean of the College of Arts and Sciences.

2. Course Evaluation Reports

Course Evaluations are administered in each class during Fall and Spring semesters. IDEA Evaluation Reports are used institution-wide and provide a mechanism for faculty to evaluate if they have achieved specific objectives in their respective courses. When completing IDEA Evaluation Forms, departmental faculty are encouraged to increase their selection of critical thinking and active learning objectives. The departmental chair and Planning Committee track these percentages from IDEA reports and provide feedback to the entire department at the start of each Fall Semester. In addition, the departmental chair and Planning Committee track percentages of students who responded with a "4" or "5" for items selected by faculty as important or essential in the "Progress Towards Goals" categories for teamwork, communication, and critical thinking.

PG 3: Increase undergraduate retention

1. Enrollment and Retention Rates

Enrollment and retention rates are reviewed by the chair to acquire information on institution-wide enrollment, demographics, and retention. Enrollments are compared from year to year. Retention is assessed by comparing number of freshmen enrolled during fall and the following spring. Departmental retention is compared to the university-wide average.

PG 4: Increase diversity

1. Enrollment data disaggregated by gender and race/ethnicity is used to assess this program goal.

SLO 1: Demonstrate improved critical thinking skills

1. California Critical Thinking Skills Test (CCTST)

The CCTST is administered during Fall and Spring semesters to graduating seniors, and evaluates students' abilities to critically think based on skills that they have learned in their courses.

2. Select items on the National Survey of Student Engagement (NSSE)

The NSSE was given Spring semesters 2006, 2009, 2011, 2014, 2017. The NSSE assesses students' abilities to work as a team, communicate, and critically think. These values will be compared to data from the senior questionnaire and results from course evaluation reports.

The NSSE report changed how data are categorized from 2011 to 2014. As a result, the results provided for 2014 combines Biology with Biochemistry or biophysics, Biomedical science, Botany, Cell and molecular biology, Chemistry; Earth science (including geology), Marine science, Mathematics, Microbiology or bacteriology, Natural science, Other biological sciences, Physical sciences (general), Physics, and Zoology. Therefore, the comparisons are not necessarily representative of Biology alone.

SLO 2: Participate in extracurricular activities

1. Select items on NSSE
2. Senior Questionnaire

SLO 3: Use scientific reasoning

1. Scientific Method Exams:

Scientific Method Exams developed by the Biology Department are administered to students in selected classes that determine the degree to which students have learned the scientific method and to determine if they agree that our classes are adequately teaching the scientific method. Biology majors enrolled in two courses (a freshman course and an upper-division course) are required to complete a Scientific Method Exam at the end of the semester during which they take the courses. Results are evaluated by the departmental chair and the course instructors to determine the degree to which students have learned the scientific method and to determine if they agree that our classes are adequately teaching the scientific method. Comparisons are made for scores achieved by students in the freshman course and those achieved in the upper-division course.

SLO 4: Demonstrate a command of general biology concepts and principles

1. ACAT Major Field Examination:

Administered each Fall and Spring semester. The ACAT exam breaks subject matter into a number of biological categories. We can select which categories should be used in evaluating our majors. These categories include bacteriology, cellular biology, ecology, genetics, botany, zoology, and evolution. This option is especially appealing because of the different focus of our program (i.e., organismal) from that of many other biology programs (i.e., molecular) in the state and nation.

All graduating senior Biology majors are asked to take the ACAT Major Field Examination during the semester in which they intend to graduate. Scores are compared to the national mid-point range for the areas of bacteriology, cellular biology, ecology, genetics, botany, zoology, and evolution. The departmental chair tabulates scores and reports the results to the departmental Planning Committee at the start of each Fall semester.

Results:

PG 1: Increase the percentage of students completing a co-op, internship, or study abroad

Internships and cooperative programs usually are not as popular among Biology majors as Wildlife and Fisheries Science majors. Until recently, the internship program in the Department of Biology has been directed towards field programs, and almost all of the students who took advantage of this opportunity have been Wildlife and Fisheries Science majors. During the last five years, a few Biology majors chose to pursue internships, especially in the health-related disciplines. This trend continued during the last academic year, as only 3.0% of students participated in internships or co-op assignments; overall, we are not meeting our target goal of 10% (Table 1). Note that we only had data from Spring 2019 this year, as the questionnaires from Fall 2018 have been misplaced.

Table 1. Percent of Biology graduates completing internship (BIOL 4900) or co-op assignment (n = number of students surveyed).

Academic Year	Sample Size (n)	Percent (%)
2014-2015	23	0.0
2015-2016	46	8.7
2016-2017	45	0.0
2017-2018	47	2.1
2018-2019	33	3.0

PG 2: Increase the incorporation of active-learning strategies in courses offered

The department continues to be committed to faculty training in active learning techniques and skills, with the number of faculty participating in such training increasing each of the past five years (Table 2). In the most recent year (2018-2019) we had four faculty participate in Academic Learning Communities, two obtain EDGE QEP grants, and two participate in outside active learning programs (one through McGraw-Hill and one through the American Society of Microbiologists).

Table 2. Number of tenured or tenure-track faculty in the Department of Biology that reported that they had participated in active-learning workshops during the last five years.

Academic Year	Sample Size (n)	Participants
2014-2015	17	1
2015-2016	21	3
2016-2017	17	5
2017-2018	17	5
2018-2019	16	6

Since 2014, at least 80% of departmental faculty incorporated active-learning/critical-thinking strategies into their individual courses (Table 3). The most commonly listed approaches were analysis and interpretation of independently gathered data in lab exercises and reviews of peer-reviewed articles. Several courses required students to work in teams to gather data that could not be collected as individuals, and they were required to provide a team report at the end of these exercises. Many lab exercises attempted to simulate real-world problems, and students were required to develop solutions to these problems. Many upper division labs are designed to be "on-going", and each week's exercise

builds on techniques or information learned during the previous week. All of our majors must complete a group research project as part of the BIOL 3920 course and present their findings and interpretations in a written and oral format. There have also been attempts at doing a flipped classroom in several courses over the past several semesters. Thus, we feel that we are doing an admirable job of incorporating critical thinking and active learning in our courses, but we will continue to develop additional approaches in these areas.

Table 3. Percent of Department of Biology faculty incorporating active-learning/critical- thinking strategies in their courses during the last five years.

Academic Year	Sample Size (n)	Percent (%)
2014-2015	18	83
2015-2016	21*	95
2016-2017	21*	95
2017-2018	20	95
2018-2019	19	95

*A total of 21 faculty members (tenure-track, tenured, and non-tenure-track) belong to the Department of Biology, but one did not receive IDEA evaluations during at least one semester during this academic year.

Departmental faculty members are incorporating active-learning/critical thinking strategies in their courses; however, objectives incorporating teamwork, communication, and critical thinking are incorporated at varying levels. We have not met our goal (25%) for teamwork in the last five years (Table 4). Our goal (25%) for communication has been met the past two years, after not being met in the previous three years. In the last five years, our critical-thinking goal (50%) was met only in 2016-2017 and 2018-19. The five-year averages in these categories were 16.8% for teamwork, 21.7% for communication, and 45.1% for critical thinking.

Table 4. Percent of IDEA evaluation forms where Department of Biology faculty selected critical-thinking and active-learning objectives as essential or important during the last five years.

YEAR	TEAMWORK	COMMUNICATION	CRITICAL-THINKING
2014-2015	10.7%	16.7%	32.1%
2015-2016	16.7%	21.4%	40.5%
2016-2017	22.2%	18.9%	66.7%
2017-2018	14.0%	25.0%	32.0%
2018-2019	20.3%	26.7%	54.2%

PG 3: Increase undergraduate retention

The Department of Biology has monitored enrollment trends for several years and used these trends to develop strategies to meet this goal (Table 5). Although enrollment was not viewed as a concern by the department in 2018, in order to maintain a perspective on retention, enrollment data are included. In Fall 2014 and 2015, enrollment reached a high of 345 and declined to 285 in the fall of 2017 before rising slightly in 2018 (an increase of ~3%). Health Sciences Biology is still the most popular concentration in the department, representing approximately 23% of all Biology majors, although enrollment in the Cellular/Molecular concentration is increasing and edging nearer to the enrollment in Health Sciences biology. As we have for several years, our departmental retention rate falls below the University average.

Table 5. Number of students enrolled as Biology majors and freshman fall-to-spring retention rates (percent) for undergraduates within the Department of Biology and Tennessee Tech University.

Fall	Enrollment – Biology	Retention – Biology	Retention – TTU
2014	345	87.8	90.6
2015	345	82.1	91.9
2016	316	86.3	92.4
2017	285	84.7	90.3
2018	294	86.4	91.3

PG 4: Increase diversity

On-going evaluation of departmental efforts towards meeting diversity objectives indicated that a slow increase in minority students occurred in the B.S. Biology degree program over the last five years (Table 6). Over the last five years, over 50% of all undergraduate Biology majors have been females. Currently, 195 of 292 Biology majors are female. Attractiveness of certain programs to females (e.g., health-related biology and microbiology), as compared to others (e.g., applied field biology), probably provides the best explanation for this difference in gender balance among programs.

Table 6. Percent of Biology majors as minorities and females during the last five years.

Fall	Minorities (%)	Females (%)
2014	15.3	58.3
2015	13.3	60.9
2016	14.9	59.2
2017	14.4	62.8
2018	17.0	66.3

SLO 1: Demonstrate improved critical thinking skills

CCTST results for TTU Biology majors averaged 18.5 for 2018-2019. The TTU average for this time period was 16.8, and the national average was 15.42. Based on these results, our Biology majors learn critical thinking skills better than other students at both our University and at other universities administering the CCTST.

NSSE 2017 data indicate that for communication and critical thinking, our majors improved from their freshman year through their senior year (Mean values for written communication improved from 2.56 (\pm 0.2) to 2.89 (\pm 0.15). Mean values for oral communication improved from 2.69 (\pm 0.2) to 2.93 (\pm 0.13). Mean values for critical thinking improved from 3.13 (\pm 0.22) to 3.26 (\pm 0.13)). NSSE 2017 data for teamwork indicated slightly more autonomy between freshman and senior years for Biology majors: 2.44 (\pm 0.26) to 2.85 (\pm 0.15), but not statistically different. Therefore, we seem to be meeting this learning outcome and our active-learning program goal is being achieved.

IDEA Course Evaluation Reports now provide the percentages of students who respond with a “4” or “5” for items selected by faculty as important or essential. This allows a means of evaluating if students are learning the goals of teamwork, communication, or critical thinking in classes in which faculty consider

these learning outcomes important by ranking the class as a “4” or “5” (Student Learning Outcome 1). To provide a more meaningful understanding of how students perceive if the goals are being met, the number of courses that students rated at least 50% of the time with a “4” or “5” was calculated. Based on these results (Table 7) it appears that during this last academic year, the percent of sections that were rated by students where substantial or exceptional progress was made increased slightly across all three categories compared to the previous year, although values are still below those seen from 2014 to 2017.

Table 7. Percent of Unit courses that undergraduate Department of Biology students rate more than 50% of the time with a “4” or “5” in the “Progress Towards Goals” categories for teamwork, communication, and critical-thinking over the last five years.

YEAR	TEAMWORK	COMMUNICATION	CRITICAL-THINKING
2014-2015	100%	82.4%	96.6%
2015-2016	100%	66.7%	88.2%
2016-2017	75.0%	82.4%	95.0%
2017-2018	48.0%	40.2%	63.1%
2018-2019	51.0%	46.8%	71.9%

SLO 2: Participate in extracurricular activities

During the past 5 years, an average of 87.8% of graduating Biology majors indicated that they participated in extracurricular activities while at TTU, and well over half (range 54.5 - 85%) indicated that these experiences contributed positively to their education (Table 8). The senior questionnaire that was initiated in 2002-2003 has provided a more realistic estimate that is consistent with our impressions that students engage in a wide variety of major-oriented extracurricular activities.

Table 8. Percent of graduating Biology majors participating in extracurricular activities related to their discipline by academic year.

	2014-2015 (N=23)	2015-2016 (N=46)	2016-2017 (N=68)	2017-2018 (N=47)	2018-2019 (N = 33)
Ext-Cur. Activities	78.3%	80.4%	92.6%	93.6%	93.9%
Clubs	34.8%	32.6%	35.3%	38.3%	48.5%
Internships	0.0%	8.7%	0.0%	2.1%	3.0%
Sp. Topics	26.1%	19.6%	29.4%	25.5%	30.3%
Sci. Mtg.	30.4%	39.1%	26.5%	38.3%	39.4%
Seminars	65.2%	80.4%	76.5%	89.4%	60.6%
Other	26.1%	26.1%	20.6%	42.6%	36.4%
Positive Contribution	69.6%	76.1%	73.5%	85.1%	54.5%

National Survey of Student Engagement NSSE data for 2017 seniors indicated that seniors in the Biological Sciences participated in extracurricular activities for an average of 6.06 hours each week. Our data indicate a high participation rate (93.9% in 2018-2019; see Table 8).

SLO 3: Use scientific reasoning

Scientific Method Exams. Student understanding of the scientific method, as assessed using the Department of Biology Scientific Method Exam, was evident (Table 9). Results are consistent with long-term trends in the BIOL 1000 class that indicate that most of our freshmen students recognize the components of the scientific method and understand how to apply it. In general, upper division students in BIOL 3920 score higher than first-semester students. In the past, we concluded that reinforcement does occur throughout the program and that most senior students have retained some level of understanding of the process.

Table 9. Student performance (percent) on the scientific method exam administered to students in BIOL 1000 (freshman course) and BIOL 3920 (upper division).

Year	Average Score (%)		100% Correct (%)		> 90% Correct (%)		< 70% Correct (%)	
	1000	3920	1000	3920	1000	3920	1000	3920
2014-2015*	74.9	71.5	13.8	0.0	18.4	0.0	33.8	44.4
2015-2016	74.4	90.0	10.5	52.3	16.3	65.9	37.2	13.6
2016-2017	74.1	89.2	14.1	52.3	18.8	63.6	43.8	13.6
2017-2018	78.2	86.7	17.1	36.8	23.2	52.9	26.8	16.2
2018-2019	74.4	86.9	19.4	40.7	37.5	57.1	25.0	11.0

*Data from Spring 2014 only.

SLO 4: Demonstrate a command of general biology concepts and principles

ACAT Major Field Examination. Our majors have generally performed above average in some areas (e.g., genetics) and consistently low in others (e.g., evolution) (Table 10). The most recent academic year saw a marked decline in several areas, although this may be due to a low sample size and the lack of Spring 2019 data.

Table 10. Results of the ACAT Biology Exam during the last five years. For the 2019-2019 academic year, only Fall 2018 scores were available as of 12 August 2019.

Year & Sample Size	Bacteriology		Cellular Biology		Ecology		Genetics		Botany		Zoology		Evolution	
	Score	%tile	Score	%tile	Score	%tile	Score	%tile	Score	%tile	Score	%tile	Score	%tile
2014-2015 (n = 44)	486	44	486	44	458	34	526	60	456	33	469	38	467	37
2015-2016 (n = 70)	488	45	490	46	487	45	508	53	471	39	461	35	487	44
2016-2017 (n = 49)	483	43	488	45	488	45	488	45	471	39	468	37	478	33
2017-2018 (n = 47)	489	46	506	52	509	54	516	56	498	49	481	41	484	43
2018-2019 (n = 16)	470	38	455	33	453	32	442	28	480	42	499	50	462	35
AVG (n = 226)	483.2	43.2	485	44	479	42	496	48.4	475.2	40.4	475.6	40.2	475.6	38.4

Modifications for Improvement:

PG 1: Increase the percentage of students completing a co-op, internship, or study abroad

Biology majors increased from 2.1% participation to 3.0% in internships during the 2018-2019 academic year. Although this was a slight increase in participation, it does not represent a significant numerical change, as we still have typically only one or two biology majors take part in internships.

The department continues to administer the student questionnaire to graduating Biology majors to assess Program Goal 1 and evaluates the percentage data for participation in internship and co-op assignments on an annual basis. Due to low participation by Biology majors, departmental faculty post opportunities for Biology majors on the internship board, announce opportunities in classes, and forward e-mail announcements pertaining to internships and co-ops to students.

PG 2: Increase the incorporation of active-learning strategies in courses offered

Faculty members will continue using their current approach to teaching to including active learning strategies in courses, given that 95% of Biology faculty members included active learning strategies in their courses during the 2018-2019 academic year. The department plans to assess the percentage of courses using active learning strategies again during the 2019-2020 academic year.

Although the department has not conducted active-learning workshops, we are interested in this approach. Our data indicate that other than during 2006- 2007 when this goal was added and we had 12 of 14 faculty members participating, we have maintained a relatively steady number of faculty members participating in active-learning workshops. All newly hired faculty members have been paired with mentors and have participated in active-learning workshops. More than 75% of faculty members incorporated active-learning strategies into their courses. This indicated that we have achieved our goal every year during the last five years that this goal has been monitored. One area for improvement could be increased participation by tenured faculty, as currently the majority of those attending active-learning instruction are tenure-track faculty and lecturers.

PG 3: Increase undergraduate retention

Although 2018 data were not available, over a five year period the Department of Biology has a fall-to-spring retention rate on average lower than the university rate. Despite this, the department underwent a program review during the 2015-2016 academic year and retention was found to be "the envy of any department..." We will continue using our current methods to improve retention given our results.

PG 4: Increase diversity

An ad-hoc committee of faculty members in the Department of Biology was assigned the task of investigating options to increase diversity in terms of underrepresented minorities. Options were presented during the 2016-2017 academic year from which one will be pursued. The department planned to send one faculty member to high schools that have a high minority presence, given available funding, but was unable to do so due to lack of available faculty. The department is pursuing this in light of program review comments that indicated we may be at the limit given the demographics the institution draws in general.

Unlike minority enrollment, our recruitment and retention of female students has been successful, and mirrors the general trend in the biological sciences of increased enrollment of women, particularly in the health-related and lab-based concentrations.

This is an issue that will require a new approach in the upcoming academic year. Our diversity subcommittee has been inactive for several years due to some turnover in the department, but we plan on reviving it this year and coming up with new strategies. This may make better use of the university diversity offices than have been done in the past.

SLO 1: Demonstrate improved critical thinking skills

Faculty report a much higher inclusion of critical thinking skills as a part of their courses than are represented in the IDEA evaluations. There are many other factors in the IDEA evaluations to consider and some of those factors may be considered of greater importance. The greater the number of factors included for evaluation the poorer the score may be and this, in combination with the importance of critical thinking skills relative to the other factors, may preclude inclusion of critical thinking skills and direct assessment via the IDEA evaluation. Faculty will be encouraged to include metrics that reflect the critical thinking skills in their IDEA evaluations for better assessment.

SLO 2: Participate in extracurricular activities

Historically, the departmental faculty has encouraged participation when advising, in classes, and via flyers announcing opportunities. With such methods approximately 93% of students have engaged in extracurricular activities during their academic career in the Biology degree program. To increase that number, we will continue to make opportunities available by reaching out to students through electronic media (e.g., email) in addition to the currently used methods.

Results from our survey indicate that a higher percent of our Biology graduates participated in extracurricular activities than data posted in the 2017 NSSE survey. Since the level of participation varies among various activities (e.g., seminars vs. internships), we may develop target participation rates for various activities in the future. We may also start to include study abroad, since that is becoming more common for our biology majors.

SLO 3: Use scientific reasoning

The department will assess the instrument used to quantify how well students understand the scientific method. If the faculty deem it necessary to modify the instrument used, appropriate modifications will be made.

Recommendations for new survey tools or modifications to provide more meaningful results are discussed at departmental faculty meetings and voted upon before being implemented.

SLO 4: Demonstrate a command of general biology concepts and principles

Courses that habitually have lower than average scores will be assessed to determine what can be done to improve retention of knowledge. We will also discuss ways to encourage students to perform well on the exam; since it has no grade associated with it, students often fail to take it seriously and may not study for it. This can lead to lower scores than might otherwise obtain. We will continue to monitor student progress through the ACAT Major Field Examination.

Appendices

1. Biology BS Curriculum Map
2. Senior Questionnaire
3. Scientific Method Questionnaire

Appendix 1: Biology BS Curriculum Map

Course No.	Title	Learning Outcomes			
		Critical Thinking	Extra-curricular Activities	Scientific Method	Demonstrated Knowledge
BIOL 1000	Intro. to Biol. Methods	X	X	X	
BIOL 1010	Introduction to Biology	X		X	X
BIOL 1020	Diversity of Life	X		X	X
BIOL 1080	Concepts of Biology	X	X	X	X
BIOL 1113	General Biology I	X		X	X
BIOL 1123	General Biology II	X			X
BIOL 2010	Human Anat. & Phys. I	X		X	X
BIOL 2020	Human Anat. & Phys. II	X		X	X
BIOL 2310	General Botany	X	X		X
BIOL 2350	Intro. Anat. & Phys.	X			X
BIOL/WFS 2991-4	Topics				X
BIOL 3040	Comparative Vert. Anat.	X			X
BIOL 3120	General Ecology (no lab)	X		X	X
BIOL/WFS 3130	General Ecology	X		X	X
BIOL 3140	Cellular Biology	X	X	X	X
BIOL 3200	General Microbiology	X		X	X
BIOL 3230	Health Science Microbiol.	X		X	X
BIOL 3240	Field Botany	X		X	X
BIOL 3330	Entomology				X
WFS/CJ 3500	Wildlife Law Enforcement		X		X
BIOL 3530	Animal Physiology	X			X
BIOL 3700	Humanism in Medicine	X			X
BIOL 3810	General Genetics	X		X	X
BIOL 3920	Biol. Comm. Skills	X	X	X	X
BIOL 4000	General Parasitology	X			X
BIOL 4040	Immunology	X			X
BIOL 4060	Hormones/Chem. Comm.	X			X
BIOL 4100	Evolutionary Biology	X	X	X	X
BIOL 4130	Enviro. Microbiology	X		X	X
BIOL 4140	Pathogenic Bacteriology	X			X
BIOL 4150	Molecular Genetics	X			X
BIOL 4160	Genetic Engineering Lab				X
BIOL/WFS 4220	Biostatistics	X		X	X
BIOL/WFS 4230	Animal Behavior	X			X
BIOL 4320	Plant Physiology	X	X	X	X
BIOL 4330	Plant Ecology	X		X	X
WFS 4500	National Wildlife Policy	X			X

BIOL 4610	Invertebrate Zoology	X		X	X
BIOL/WFS 4630	Ornithology	X			X
WFS 4640	Waterfowl Ecology & Mgt.	X			X
BIOL/WFS 4650	Marine Biology	X		X	X
WFS 4660	Wild Bird Ecology				X
WFS 4670	Wild Mammal Ecology				X
WFS 4700	Habitat Management	X		X	X
WFS 4710	Fisheries Management	X		X	X
WFS 4711	Fisheries Mgmt. (no lab)	X			X
WFS 4730	Conservation Biology	X	X	X	X
WFS 4740	Wildlife Principles	X			X
BIOL 4750	Medical Microbiology	X			X
WFS 4760	Fish Culture	X	X		X
WFS 4770	Nongame Species Mgmt.	X	X		X
BIOL 4780	Phycology	X		X	X
WFS 4790	Wildlife Techniques	X	X	X	X
BIOL/WFS 4810	Ichthyology	X	X		X
BIOL/WFS 4820	Mammalogy	X	X		X
BIOL/WFS 4830	Herpetology	X	X		X
BIOL/WFS 4840	Limnology	X		X	X
BIOL 4850	Applied Microbiology	X		X	X
BIOL/WFS 4900	Internship				X
BIOL/WFS 4991-4	Advanced Topics	X	X		X

Appendix 2: Senior Questionnaire

**GRADUATING SENIOR
QUESTIONNAIRE**

Department of Biology

1. Activities - Please check any of the extracurricular activities in which you participated during your program at Tennessee Tech, and briefly indicate if you felt that these activities contributed to your academic development.

- Beta Beta Beta active member
- Chem-Med Club active member
- Student Fisheries Association active member
- Wildlife Society active member
- Internship (BIOL/WFS 4900)
- Special topics (BIOL/WFS 4990)
- Attended one or more professional meetings
- Attended special seminars or talks
- Attended departmental sponsored activities not class related

Do you believe that your participation in these activities contributed to your academic development? If so, how? (Please leave this section blank if you did not participate in any of the above activities).

2. Classes - List below required classes that you felt best contributed to your academic development and classes that contributed least to your development. What other classes do you think should be required of your major?

Most Important Classes: _____

Least Important Classes: _____

Other Classes that should be required: _____

3. Other Suggestions - Please provide any suggestions that you believe would improve the quality of education in your major. (Use the back if necessary)

Degree and Concentration: _____

Appendix 3: Scientific Method Questionnaire

Scientific Method Questionnaire

Please select the response that best completes the sentence or answers the question.

_____ 1. _____, in which the experimental variable has been omitted, are used in research as standards of comparison against which experimental data are compared.

- A. Theories B. Controls C. Hypotheses D. Observations E. Replicates

_____ 2. A _____ is a tentative answer to a research question, which will be evaluated using an experiment.

- A. Theory B. Control C. Hypothesis D. Experiment E. Law

_____ 3. _____ is the use of multiple observations in a study.

- A. Hypothesis B. Control C. Theory D. Experiment E. Replication

_____ 4. True (A) or False (B): Science is knowledge obtained by observation.

_____ 5. True (A) or False (B): A theory is a very tentative idea with little or no scientific evidence to support it.

_____ 6. True (A) or False (B): Publishing results in a peer-reviewed journal is an important part of the scientific process.

Does oatmeal really reduce bad cholesterol? You decide to try to answer this question. You predict that people who eat oatmeal 5 times a week for a month will have lower cholesterol than those who don't. You select 10 people, 5 of whom you put on this oatmeal diet, and 5 of whom you don't. At the end of the month, you measure cholesterol in all 10 people.

_____ 7. The statement "Oatmeal reduces bad cholesterol levels" is the _____ of this research.

_____ 8. Using more than 1 person in each group illustrates the concept of _____.

_____ 9. Using a group of people who do not eat oatmeal illustrates the concept of _____.

- A. Observation B. Control C. Hypothesis D. Experiment E. Replication

Please arrange the following steps of the scientific method in the correct order.

_____ design an experiment

_____ make observations

_____ publish results

_____ formulate research hypothesis

_____ draw conclusions

_____ collect data