Institutional Effectiveness
2019-2020

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:

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.

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.

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.

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:

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).

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.

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.

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

SLO 1: Demonstrate improved critical thinking skills

1. California Critical Thinking Skills Test (CCTST)

   The CCCTST 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, 2020. 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 IDEA evaluation reports.

The NSSE report changed how data are categorized from 2011 to 2014. As a result, the results provided for 2014 combines Biology in 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

Senior Questionnaire 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 one of the 18 students (5.5%) responding had participated in an internship/co-op assignment. Thus, we are not meeting our target goal of 10% (Table 1) on a fairly consistent basis. Note that for 2018-2019 we had data only from Spring 2019, as the questionnaires from Fall 2018 had been misplaced. In addition, due to the COVID-19 pandemic, questionnaires were not given in Spring 2020, which accounts for the lower sample size.

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 (%)
2015-2016	46	8.7
2016-2017	45	0.0
2017-2018	46	2.1
2018-2019	33	3
2019-2020	18	5.5

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

The number of faculty participating in active-learning activities has remained fairly stable since 2016-2017, although the specific individuals (and the activities they pursue) changes from year to year. In 2019-2020 we had three faculty with EDGE or CISE grants, two who participated in outside active learning programs (one through Pearson Publishing and one as part of an NSF panel), and two who partook of CITL training.

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
2015-2016	21	3
2016-2017	17	5
2017-2018	17	5
2018-2019	16	6
2019-2020	17	5

Since 2015, at least 90% 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 think that we are meeting our goals and 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-earning/critical- thinking strategies in their courses during the last five years.

Academic Year	Sample Size (n)	Percent (%)
2015-2016	21*	95
2016-2017	21*	95
2017-2018	20	95
2018-2019	19	95
2019-2020	17	94

*A total of 21 faculty members (tenure-track, tenured, and non-tenure-track) belonged to the Department of Biology during these academic years, but one did not receive IDEA course 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 included at varying levels. We have not met our goal (25%) for teamwork in the last five years (Table 4), and we are more consistently between 15-20%. We had met our goal (25%) for communication over the prior two years, but this dropped slightly in 2019-2020. In the last five years, our critical-thinking goal (50%) was met twice (2016-2017 and 2018-19), and was close this current year. The five-year averages for Biology in these categories were 18.3% for teamwork, 23.1% for communication, and 48.0% 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
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%
2019-2020	18.4%	23.7%	46.8%

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 2019, in order to maintain a perspective on retention, enrollment data are included. In Fall 2015, enrollment reached a high of 345 and declined to 285 in the fall of 2017, then rose back to 2015 numbers in 2019. Health Sciences Biology is still the most popular concentration in the department, representing approximately 43% of all Biology majors, with enrollment in the Cellular/Molecular concentration a distant second at approximately 17%. 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
2015	345	82.1	91.9
2016	316	86.3	92.4
2017	285	84.7	90.3
2018	294	86.4	91.3
2019	346	88.5	89.9

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 until 2018, followed by a slight decline (Table 6). However, by raw counts the number of minority students has increased consistently during this period. Over the last six years, over 60% of all undergraduate Biology majors have been females, with the exception of 2016. Currently, 260 of 401 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 between the Biology major and the WFS major.

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

Fall	Minorities (%)	Females (%)
2015	13.9	60.9
2016	11.7	59.2
2017	12.3	62.8
2018	15.6	66.3
2019	14.2	62.8
2020	13.2	64.8

SLO 1: Demonstrate improved critical thinking skills

CCTST results for TTU Biology majors averaged 16.5/76 for 2019-2020 (n = 40 students). The TTU average for this time period was 16.1, and the national average was 15.4. 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 2020 data were aggregated by math and natural sciences, and did not separate out Biology majors. Thus, this data is not reported. If non-aggregated data becomes available, this will be updated.

IDEA Reports 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), percentages in all three areas declined between 2015-16 and 2017-18, before rising again over the past two academic years. It's possible that 2019-2020 are skewed lower due to the Spring

2020 course evaluations being given after classes were moved online due to the COVID-19 pandemic precautions.

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
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%
2019-2020	49.5%	52.4%	73.4%

SLO 2: Participate in extracurricular activities

During the past 5 years, an average of 91% of graduating Biology majors indicated that they participated in extracurricular activities while at TTU, and well over half (range 54.5 - 85.1%) 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. One note: the low percent for scientific meetings for 2019-2020 is very likely due to COVID-19 concerns; many students do this their senior year, and many meetings were canceled during Spring 2020.

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

	2015-2016 (N=46)	2016-2017 (N=68)	2017-2018 (N=47)	2018-2019 (N=33)	2019-2020 (N=18)
Ext-Cur. Activities	80.4%	92.6%	93.6%	93.9%	94.4%
Clubs	32.6%	35.3%	38.3%	48.5%	55.6%
Internships	8.7%	0.0%	2.1%	3.0%	5.5%
Sp. Topics	19.6%	29.4%	25.5%	30.3%	38.9%
Sci. Mtg.	39.1%	26.5%	38.3%	39.4%	16.7%
Seminars	80.4%	76.5%	89.4%	60.6%	83.3%
Other	26.1%	20.6%	42.6%	36.4%	50.0%
Positive Contribution	76.1%	73.5%	85.1%	54.5%	66.7%

SLO 3: Use scientific reasoning

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. Upper division students in BIOL 3920 score consistently higher than

first-semester students. Based on these results, we conclude that reinforcement does occur throughout the program and that most senior students have retained or improved their level of understanding of the process. However, our goal of all upper-division students scoring 100% on this exam has not been reached in any of the past five years, and it is more typical that 40-50% of students achieve this score.

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

	Average Score (%)		100% Correct (%)		> 90% Correct (%)		< 70% Correct (%)	
Year	1000	3920	1000	3920	1000	3920	1000	3920
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
2019-2020	75.2	88.5	18.9	46.2	28.3	62.7	26.6	11.5

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

ACAT Major Field Examination Our majors have generally performed higher in some areas (e.g., ecology, botany, genetics) and consistently lower in others (e.g., evolution, bacteriology) (Table 10). Overall, our students fall below the median percentile in all areas when averaged over the five years. The most recent academic year saw a marked improvement in nearly all areas compared to the 2018-2019 cohort, and three areas saw our students score above the national median percentile. Data from the Spring 2020 cohort were not included; these exams were given online due to the COVID-19 pandemic, and very few students (<5) took them using this format.

Table 10. Results of the ACAT Biology Exam during the last five years.

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
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
2019-2020 (n = 22)	480	42	495	48	502	51	465	36	508	53	492	47	499	50
AVG (n = 204)	482	42.8	486.8	44.8	487.8	45.4	483.8	43.6	485.6	44.4	480.2	42.0	482.0	41.0

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.

Even though we have been lauded for our retention rate by peers, we will need to assess 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.

When compared with data from the National Survey of Student Engagement (NSSE) 2017 results, our students were found to be no different compared to the national average in critical thinking. We await the 2018 results to see if this result holds.

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

		Learning Outcomes			
Course No.	Title	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