Institutional Effectiveness
2021-2022

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.

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 (see Appendix) at the time they take their major field exam. As part of this they are asked to list any extracurricular activities in which they have participated, as well as assess 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

This goal was historically assessed via our senior questionnaire, which was given to students when they took the major field (ACAT) exam in person. Since the pandemic, the ACAT has been given online, and attempts to have students fill out the questionnaire via email have yielded low return rates (for example, only 4 in 2020-21). Thus, as a proxy we looked at enrollment in our BIOL 4900 internship class

for the past two years as a way to determine how many students were taking internships (study abroad and co-op opportunities continued to be limited or non-existent during the past academic year; Table 1). Four out of 112 Biology students who had applied for graduation during the 2021-22 academic year took the internship course, and this percentage is in line with what we've seen in previous years through the senior questionnaire. We have consistently fallen below our goal of 10% participation in the three activities described in this goal, and these are in general pursued less often by Biology majors than WFS majors in our department (perhaps due to fewer opportunities).

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 (%)
2016-2017	45	0.0
2017-2018	46	2.1
2018-2019	33	3
2019-2020	18	5.5
2020-2021	NA	NA
2021-2022	112	3.6

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

As in most previous years, faculty participation in active-learning training was done by lecturers/instructors or by newly-hired tenure track faculty (see Table 2). Although the number of participating faculty has remained relatively steady, percentage participation has declined somewhat. Most workshops attended during AY 2021-22 were in-house through CITL, although two faculty used on-line resources for 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.

Academic Year	Sample Size (n)	Participants
2017-2018	17	5
2018-2019	16	6
2019-2020	17	5
2020-2021	17	4
2021-2022	18	4

For the second year in a row, all faculty indicated that they had used some form of active learning in their courses (Table 3). Much of this occurs in the laboratory setting, where many of our labs (especially at the upper-division) have exercises that require students to gather information and analyze results (either qualitatively or quantitatively). In the classroom, active learning runs the gamut from very little (e.g., traditional lectures), to more traditional approaches (e.g., group discussions, case studies), to more modern approaches (e.g., in-class assessment quizzes, clever ball/pass the baton games, pair/share work).

Table 3. Percent of Department of Biology faculty incorporating active-learning/critical- thinking strategies in their courses.

Academic Year	Sample Size (n)	Percent (%)
2017-2018	20	95
2018-2019	19	95
2019-2020	17	94
2020-2021	17	100
2021-2022	18	100

Across all IDEA-evaluated courses for AY 2021-22, faculty selected critical-thinking skills as an essential or important component in 58% of their courses (Table 4). This is above our goal of 50% selection of this component. Communication (30.5% of courses) was also selected at levels above our goal of 25%, while Teamwork was selected at exactly our goal (25%; selection was slightly above this in the Spring but slightly below in the Fall). For Teamwork, this is the first time in the past 7 years that our goal has been reached. All three goals are considered to be directly related to active learning.

Table 4. Percent of courses using IDEA evaluation forms where Department of Biology faculty selected critical-thinking and active-learning objectives as essential or important.

YEAR	TEAMWORK	COMMUNICATION	CRITICAL-THINKING
2017-18	14.0%	25.0%	32.0%
2018-19	20.3%	26.7%	54.2%
2019-20	18.4%	23.7%	46.8%
2020-21	13.6%	27.4%	68.0%
2021-22	25.0%	30.5%	58.0%

PG 3: Increase undergraduate retention

Enrollment in the Biology major continues to increase, although the growth this past year was slight compared to that of the preceding several years (Table 5). Retention has also improved over the past 5 years, and for the first time our retention rate in the major exceeded that of the University as a whole (due to both an increase in our departmental retention and a decrease in overall university retention).

Table 5. Number of students enrolled as Biology majors at the start of the Fall semester, and freshman fall-to-spring retention rates (percent), for undergraduates within the Department of Biology and Tennessee Tech University. Retention data for 2022 are not available as of the writing of this report.

Year	Enrollment – Biology	% Retention – Biology	% Retention – TTU
2017	285	84.7	90.3
2018	294	86.4	91.3
2019	346	85.5	89.9

2020	401	88.2	86.8
2021	405	-	-
Average		86.2	89.6

PG 4: Increase diversity

Percentage of minority students in the Biology major matched their highest level from the past 5 years in 2021 (Table 6), while the percentage of female students fell slightly from the previous year. Given the increase in enrollments over the past several years, it's thought that absolute numbers of minority students in the department may be at an all-time high.

Table 6. Percent of Biology majors at the start of the Fall semester identified as minorities and females.

Year	Minorities (%)	Females (%)
2017	12.3	62.8
2018	15.6	66.3
2019	14.2	62.8
2020	13.2	64.8
2021	15.6	63.5

SLO 1: Demonstrate improved critical thinking skills

Over the past 5 years, Biology majors have consistently outperformed the national average on the California Critical Thinking Skills Test (CCTST; Table 7).

Table 7. Average score for Biology majors, and sample size (*n*) on the California Critical Thinking Skills Test (CCTST) during the past five years. NOTE: The test moved from a 34-point maximum score to a 100-point maximum score in 2018-19.

Academic Year	TTU Biology	*n*	National
2017-2018	18.0	82	16.2
2018-2019	79.0	48	16.2
2019-2020	75.0	41	74.0
2020-2021	74.2	32	74.0
2021-2022	75.3	90	73.3

Departmental data from the National Survey of Student Engagement (NSSE) is available for the past three years (Table 8). Looking at the question asking if a student's experience at TTU helped them to think critically and analytically (question 17C in 2019, question 18C in 2020 and 2021), our students

show a slight improvement in average score from the freshman to senior levels, which suggests that to some degree students feel that their critical thinking skills are improving over time at TTU.

Table 8. Average score on the question related to critical thinking skills (Question 17C or 18C) on the National Survey of Student Engagement (NSSE), broken down separately for freshmen and seniors. Departmental data are available for just the past three years. Numbers in parentheses following scores are sample sizes.

Academic Year	Biology Freshmen	Biology Seniors
2019-2020	3.2 (18)	3.3 (16)
2020-2021	3.2 (17)	3.4 (23)
2021-2022	2.9 (32)	3.2 (26)

Because of the difficulties in calculating the percent of courses in which over half the students rated Teamwork, Communication, or Critical Thinking with a 4 or 5 on the IDEA evaluations, a slight change in assessment was used in AY 2021-2022. Here, I've determined the percentage of courses in which the average score on objectives related to these goals was 3.5 or above. A preliminary analysis indicates these two measures are highly correlated. The percentage of students seeing Teamwork as important in their courses has dropped over the past several years, as has the percentage for Communication; both are at their lowest levels over the past 5 years. Conversely, students ranking critical-thinking skills highly continues to occur at much higher levels (above 75%).

Table 9. Percent of Department of Biology courses that undergraduate 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 on IDEA evaluation forms. For 2021-22 data, values represent the percentage of courses with average scores at or above 3.5 in each category.

YEAR	TEAMWORK	COMMUNICATION	CRITICAL-THINKING
2017-18	48.0%	40.2%	63.1%
2018-19	51.0%	46.8%	71.9%
2019-20	49.5%	52.4%	73.4%
2020-21	41.2%	47.6%	79.5%
2021-22	38.5%	29.0%	78.0%

SLO 2: Participate in extracurricular activities

Response rates for senior questionnaires (Table 10) have been very low over the past two academic years (see Results for Program Goal 1), and were low enough for Biology majors not to include them in the current report. Plans are underway this year to improve response rates to resolve this issue. Historically, the overwhelming majority of Biology majors participate in some type of extracurricular activity. Club participation usually runs between one-third and one-half of majors, and roughly one-third will attend scientific meetings and/or take a special topics course. Most attend at least one seminar

during their time at TTU, while internship participation is uncommon. Overall, students generally see these activities as having a positive contribution to their time at TTU.

Table 10. Percent of graduating Biology majors participating in extracurricular activities related to their discipline by academic year.

	2017-18 (n = 47)	2018-19 (n = 33)	2019-20 (n = 18)	2020-21 (n = 4)	2021-22 (n = 2)
Ext-Cur. Activities	93.6%	93.9%	94.4%	100%	-
Clubs	38.3%	48.5%	55.6%	75%	-
Internships	2.1%	3.0%	5.5%	25%	-
Special Topics	25.5%	30.3%	38.9%	25%	-
Scientific Meetings	38.3%	39.4%	16.7%	0%	-
Seminars	89.4%	60.6%	83.3%	50%	-
Other	42.6%	36.4%	50.0%	25%	-
Positive Contribution	85.1%	54.5%	66.7%	75%	-

SLO 3: Use scientific reasoning

Freshman students in BIOL 1000 and junior/senior students in BIOL 3920 are given our departmental scientific method exam. In general, both groups do well on this exam, although students in BIOL 3920 consistently perform better overall in several metrics (Table 11) as is expected. Average scores for the freshman students were quite a bit higher this year than at other times in the past 5 years; whether this is a trend or a one-year anomaly.

Table 11. 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
2017-18	78.2	86.7	17.1	36.8	23.2	52.9	26.8	16.2
2018-19	74.4	86.9	19.4	40.7	37.5	57.1	25.0	11.0
2019-20	75.2	88.5	18.9	46.2	28.3	62.7	26.6	11.5
2020-21	73.9	91.4	16.4	52.9	30.8	66.7	29.7	3.9
2021-22	86.1	90.7	27.2	56.0	50.0	60.0	13.6	8.0

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

Our majors exceeded the 50th percentile in only two categories, cell biology and botany (Table 12). In two categories, bacteriology and evolution, our students fall below the 40th percentile, although only in the latter category is this a long-term trend. Compared to the 2020-21 academic year, our students saw marked improvement in scores on the botany and zoology portions of the ACAT exam, but showed significant declines in scores on the bacteriology and genetics portions of the exam.

Table 12. Results of the ACAT Biology Exam for the past five academic years. NOTE: Exams were not included from Spring 2020; due to the COVID pandemic, less than five students took the exam, as it was administered online.

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
2017-2018 (n = 47)	489	46	506	44	509	54	516	56	498	49	481	41	484	43
2018-2019 (n = 16)	470	38	455	46	453	32	442	28	480	42	499	50	462	35
2019-2020 (n = 22)	480	42	495	44	502	51	465	36	508	53	492	47	499	50
2020-2021 (n = 32)	501	50	513	55	493	47	509	54	494	48	471	39	450	31
2021-2022 (n = 43)	471	38	507	53	489	46	486	45	510	54	486	44	454	32
AVG (n = 160)	483.4	43.3	501.1	50.4	493.9	47.8	492.1	47.1	500.0	50.0	483.7	43.1	469.0	37.8

Modifications for Improvement:

The Biology Department planning committee is being revamped this academic year to include faculty from all levels (tenured, tenure-track, and lecturers/instructors. This committee will begin the process of reviewing our existing goals and learning outcome, and proposing to keep them, modify them, or remove them and add new goals/outcomes. This will be the first major revision of our departmental objectives in at least 10 years, and is overdue, especially since over half of our current faculty were not here when things were last updated.

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