Natural Sciences
The Human Experiences and Endeavors Curriculum

Courses submitted for inclusion in the Natural Sciences Core must already exist or must be approved by the Undergraduate Council.

Course Title: Introduction to Biological Investigation
Department and Course Number: BIOL 10523
Instructor(s): Luque and Demarest

Please indicate below which *Student Action Steps**** are appropriate for your course for each *Learning Outcome**. Using the bulleted instructions on page 2 of this form, please provide examples that explain how students will, through the use of *Student Action Steps,* achieve the *Learning Outcomes* in your course.

***Competency*:** TCU graduates will be literate in the natural sciences.

Learning Outcomes:	***Student Action Steps:*** **Indicate which are to be used in your course or add others you will use to reach the selected *Learning Outcome(s).***
Students will demonstrate a basic understanding of some of the methods of investigation in the natural sciences.	Students will explore investigation methodologies and principles through multiple experiences involving laboratory experiments, field studies, or simulations appropriate to the natural science discipline. For each investigation process or principle, students will: determine its purpose, describe it, and compare and contrast it with alternative methodologies. [ ] Other: Students will utilize investigation methodologies, principles, and techniques in laboratory experiments and simulations in Biology. In such investigations, students will: evaluate the purpose or role of the methodologies, principles, and techniques in answering a biological question; apply them in an experiment designed to answer the biological question; analyze the results (data) of the experiment to arrive at an answer to the question; consider the strengths, weaknesses, and limits of the finding; and consider other methodologies, principles, and techniques that could be applied to confirm the findings or further investigate the question.
Students will demonstrate a basic understanding of some of the great ideas in the natural sciences.	Students will examine some of the major ideas appropriate to the area of study, including how such ideas resulted from a scientifically reasoned investigation. For each concept, principle, or theory, students will: describe it, review its history, determine its importance (including influences on other areas of study), review the evidence supporting it, and compare and contrast it with alternative concepts, principles, or theories. [ ] Other: Students will consider and interpret biological observations and experimental results in the context of key concepts, principles, and theories of Biology, as a framework for understanding and/or a test of their validity.

Students will demonstrate a basic understanding of some of the relationships among the natural sciences, technology, and society.	Students will explore the relationships between science, technology, and society appropriate to the natural science discipline. Students will: describe the roles that each plays in the others' development, and identify the benefits and problems associated with each relationship. [ ] Other: Students will explore, consider, and discuss the current and potential future influences, roles, and impacts of biological ideas, techniques, and capabilities in the human experience.

*The *Learning Outcomes* are statements of what we expect our students to know or be able to do upon completion of a course in that category.

**The *Student Action Steps* identify the process(es) that will lead to the intended *Learning Outcome*. As such, *Student Action Steps* must specify an action(s) to be taken by a student to fulfill a specific *Learning Outcome* and be reasonable within the context and time frame of the course. The *Student Action Steps* above are provided as examples of how students might achieve the *Learning Outcomes*.

- Please provide examples that explain how students will, through the use of *Student Action Steps,* achieve the *Learning Outcomes* in your course (2 or 3 examples will suffice). To facilitate understanding, please use language accessible both to faculty who might be outside your discipline as well as to students who might see such language in a course syllabus.

1. **Students will utilize investigation methodologies, principles, and techniques in laboratory experiments and simulations in Biology. In such investigations, students will: evaluate the purpose or role of the methodologies, principles, and techniques in answering a biological question; apply them in an experiment designed to answer the biological question; analyze the results (data) of the experiment to arrive at an answer to the question; consider the strengths, weaknesses, and limits of the finding; and consider other methodologies, principles, and techniques that could be applied to confirm the findings or further investigate the question.**

   Students will learn the principles of experimental design and conduct scientific experiments with analysis in order to answer biological questions. For example, in one series of labs, students will design an experiment to test whether a given chemical causes genetic mutations, using bacteria as their model assay organism. This will involve an understanding and application of multiple genetic and microbiological principles and techniques, and accurate interpretation of the resulting data to draw a supported conclusion. This exercise will culminate in a scientific paper in which the students will explain their methods, share their data, analyze their results, compare them to the current scientific knowledge as published in the scientific literature. In another laboratory, students will use Microsoft Excel to construct different models of population growth, and examine how changes in various biological and environmental variables impact the outcome predicted by the different models. This exercise will introduce students to the purpose of models in scientific investigation, in terms of their practical utility, predictive value, limits, and role in hypothesis testing.

2. **Students will consider and interpret biological observations and experimental results in the context of key concepts, principles, and theories of Biology, as a framework for understanding and/or a test of their validity.**

   Students will regularly evaluate and make sense of observations made in the lab against broader biological ideas in ways that reinforce those ideas, or suggest how they could, in principle, contradict those ideas. For example, students will examine the macroscopic and microscopic anatomies of a variety of tissues and organisms to explore the principle that form follows function, and to confirm the universality among but diversity within different groups of life, and the validity of using key defining and distinguishing characteristics to classify living things and establish their evolutionary (phylogenetic) relationships. Students will also use statistics as a means to contend with the variability inherent within populations, both in terms of describing the nature of the variation in different characteristics and for identifying true differences between groups, and will observe the process of genetic mutation as the source of that ultimate variation. Building on this further, students will conduct a simulation in which they use the rolling of dice to replicate the random mixing of height alleles (gene

variants) via sex in a population, thus demonstrating the manner in which sexual reproduction boosts the diversity of height outcomes that occur in a population and distributes them into a normal curve. Other great ideas and principles that will be explored and confirmed across the lab experience include principles of genetics (inheritance), cell theory, and endosymbiotic theory, among others.

3. **Students will explore, consider, and discuss the current and potential future influences, roles, and impacts of biological ideas, techniques, and capabilities in the human experience.**

   This course will encounter and work with numerous ideas and investigative or manipulative capabilities that hold implications for our lives and society, and we will take time to have conversations about the manner in which these things have shaped and may in the future influence such things as our concept of our place in the world, what it means to be human, our quality of life, and the practical and ethical concerns we raise. For example, questions about how we view and handle biological differences between people and how we treat other animals vs. plants vs. bacteria will be brought to bear as students contend with both the commonality and diversity of life within and between species. Similarly, the various genetic techniques that students will work with will raise questions about the extent to which we can vs. should alter our own blueprint or that of other living things, and for what purpose, either through the selective breeding of the past or the direct and targeted manipulation of gene sequences now and in the future. One experimental series will involve using the polymerase chain reaction (PCR) to amplify genes. This technology has revolutionized scientific research and technological innovation by making possible all of the modern genetic pursuits, ranging from genealogy and identification of paternity and crime scene investigation to genetic engineering and the production of genetically modified organisms, along with all of the societal implications that follow.

- Please attach a syllabus as the primary supporting document for your course proposal. Syllabi should reflect the *Learning Outcomes* and the use of the indicated *Student Action Steps*. They should also indicate how student performance will be evaluated with respect to the outcomes.