QualityCore™

Biology

Course Description and Syllabus

Contents

The information in this booklet is based on a joint study conducted by ACT and The Education Trust, *On Course for Success: A Close Look at Selected High School Courses That Prepare All Students for College*.

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Description of a Rigorous Biology Course

Peek inside a rigorous Biology classroom and you will see a class engaged in a dynamic learning process. For instance, the teacher might be using salad forks, kitchen tongs, and chopsticks to teach biological specialization and natural selection by analogy. Students are taking what they learn and extending it by thoroughly investigating its implications. That classroom, however, doesn't happen by chance. Research (National Research Council, 2002) shows that a rigorous Biology course is created when that course aims to

- create a supportive environment that fosters collaboration, questioning, and investigation;
- invite students to be responsible for their learning by building upon their interests;
- emphasize higher-order reasoning through discussion, relevant learning, and experimentation; and
- assert that process teaches content and vice versa.

In other words, a rigorous Biology course relies upon processes that are central to science itself—investigation, experimentation, collaboration—to develop deep understanding and, consequently, raise student achievement.

A rigorous Biology course covers the primary aspects of the discipline, including cells and their functions; introductory biochemistry; genetics; animals, plants, and the relationships among organisms; ecology; and evolution. In addition, it explores the foundations and practices of science in general, teaches the basic processes of scientific inquiry, and emphasizes the importance of mathematics and measurement. In a rigorous course, however, content and process are not separate. In its position statement on scientific inquiry (2004, p. 2), the National Science Teachers Association affirms, "Understanding science content is significantly enhanced when ideas are anchored to inquiry experiences." For that reason, rigorous Biology courses emphasize problem solving, critical thinking, and decision making. In doing so, they reflect an understanding of ways that students learn.

Students learn when topics are organized in meaningful, coherent ways. Such organization encourages students to build understanding, then to expand upon it. For example, a rigorous course might seek to develop a robust understanding of the interconnections between biological structure and function. A lesson about how the genetic information encoded in DNA is processed, therefore, might be tied to previous lessons about enzyme structure and function to illustrate the variety of functions that proteins carry out. Then, students would be asked to deduce how molecular information yields observable effects, such as the way the mutation causing cystic fibrosis affects human physiology. Conceptually organized content empowers students to make such connections on their own.

Addressing issues that affect a student's world is one of the primary ways that a rigorous Biology course uses context to teach content. For example, a rigorous course might ask students to debate the ethical problems surrounding genetic engineering. While studying ecology, they might discuss the environmental costs of urban sprawl. Concepts are taught in the context of the real world.

Similarly, a rigorous Biology course emphasizes skills in the context of their use. Students apply and refine their mathematical and statistical skills, by using ratios when studying Mendelian genetics or by employing simple statistical analyses, such as average and median, when

collecting data in simulations of natural selection. Other statistical methods become valuable as students collect and analyze sets of data to determine trends and relationships among them.

In context, students also develop facility with the basic tools of science. In laboratory investigations, they work with precision measurement tools (e.g., computer-linked probes, microscopes, balances, titration materials, pipettes, thermometers, graduated cylinders, electrophoresis equipment) and in the process learn how to understand the data they collect as they investigate scientific questions. Introducing students to other common indicators, such as iodine or Lugol's solution (to detect the presence of starches), Benedict's solution (to detect the presence of sugars), or litmus paper (to indicate a substance's acidity or alkalinity), teaches the students other important ways to collect data.

Analysis and interpretation of data thus become vital for students' success. Students come to understand that precision and accuracy are crucial to measurement. Moreover, asking students to then write reports that require them to interpret data accustoms them to the choices they must make when presenting scientific information. With guidance from the teacher and their peers, they discover which method of presentation, from graph to chart to table to written description, most effectively illustrates what the data say.

In the process of inquiry students also read and carry out other research. Thus they become accustomed to the language of scientific study. They learn to identify independent and dependent variables and controls in experiments. At the same time, they develop an understanding of the nature of science and of how the definitions of terms such as *fact*, *law*, *hypothesis*, and *theory* differ in science and everyday speech. In their research, moreover, students seek valid and pertinent information in print and other sources. Teachers emphasize reading strategies that enable students to better understand the scientific articles they discover. As they read, students further learn how professional scientists approach problems, perform research, test findings, analyze and effectively present data, and then write and publish results. Throughout the course, teachers emphasize academic integrity and the responsible reporting of all research.

Because students must present data and research, a rigorous Biology course hones students' technical writing and oral presentation skills. Through journals, notes taken during class discussion, and written or spoken responses to challenging, open-ended questions, students reflect on learning and extend thinking. Students also write and speak formally. They prepare well-written, organized, and complete lab reports. A rigorous course teaches valuable writing and speaking skills that students will need for future education or work.

To ensure that a rigorous Biology course builds a solid base of knowledge, students are asked many different types of questions in labs and other activities. Literal, inferential, and application questions require them to think about the processes they study. Throughout the course, particularly as students respond to broader questions that allow them to describe their thought processes, teachers listen carefully, then respond with probing and clarifying questions. Teachers adjust instruction, as necessary, to help students gain deeper understanding of content and concepts.

Students learn in a rigorous course because it is strongly interactive. A rigorous Biology course is interactive when the course's content is relevant to the students' lives. When students explain why animals such as deer, whose eyes lack cones but have more rods than humans do, can see at dusk and dawn but can't distinguish a hunter's orange vest, they connect their own knowledge of biological function with their experiences. Laboratory investigations that allow

students to experience and experiment also encourage learning, particularly when they reconcile new discoveries with their current understanding. If a lab reveals that some bacteria can grow in the presence of an antibiotic, a teacher in a rigorous course will take advantage of the discovery to confront the common misconception that all antibiotics are effective against all bacteria. Such discussions encourage students to formulate new perspectives and to understand firsthand the concept of antibiotic resistance.

A rigorous course also gives students an opportunity to make progressively more significant decisions about experiments. Students establish research questions and designs; they decide how many trials are appropriate; they form, present, and defend their conclusions. Students refine and revise their approaches throughout the course, generating more sophisticated questions and reaching more authoritative conclusions.

From the fundamental assumptions of science and the foundational areas of biology to relevant instruction that sets high standards of performance and enables students to achieve those standards, a rigorous Biology course is a vibrant learning environment. Through investigation, experiment, and collaboration the course places students in the best position to achieve.

Model Course Syllabus—Biology

On Course for Success (2004) revealed that rigorous Biology syllabi share several important characteristics. Not only do they describe the course and identify the content it will cover, but they also outline policies to which teachers and students are held accountable. This model syllabus is a composite drawn from the syllabi studied in *On Course for Success*. As a model, it is addressed to students and should be used as a general guideline, adapted according to a particular district's, school's, or teacher's policies.

Course Overview

Biology is an inquiry-based course designed to familiarize you with science processes, skills, and understandings related to a wide range of topics in biology. During this course, you will learn to identify the basic questions and concepts that guide scientific investigation and to design and conduct your own investigations. Some important skills you will develop include microscopy, graphing and measurement, identification of research questions, making connections, and the ability to be a self-directed learner.

Course Content

- Scientific Inquiry
- Mathematics and Measurement in Science
- Science in Practice
- Foundations
- Biochemistry
- Cells
- Genetics
- Evolution
- Animals
- Plants
- Relationships Among Organisms
- Ecology

Course Materials

- Textbook: (Title, Author, Publisher, Year of Publication)
- Class/Laboratory notebook (a three-ring binder)
- Pen/pencil
- Calculator

Course Policies

Attendance/Absences/Makeup Work: According to school policy, you must make up, within one week, tests, quizzes, and laboratory work missed due to excused absences. Homework assigned prior to an absence must be turned in the day you return, and homework assigned during your absence is due the day after you return, unless I extend the deadline because of unusual circumstances.

Classroom Rules/Expectations: You are expected to arrive each day on time and ready for instruction, to act responsibly and contribute to an orderly learning environment, and to follow the behavior guidelines outlined in the school handbook.

Homework Policy: Assignments must be completed on appropriate paper. Late work will receive only partial credit.

Grading Policy

Grade Distribution: Quarter grades will be calculated as follows: 50% will be determined by homework, lab reports, and activities, and 50% will be determined by tests and special projects. For most assignments, I will provide the rubrics and/or explain the expectations in advance.

Extra Credit: Extra credit will be awarded only to students who have completed all assignments.

Course Procedures

Lectures and Labs: Lectures will emphasize biology concepts. They are intended to help you become conversant with the language biologists use and the type of work that biologists do. Labs will familiarize you with skills needed to investigate scientific questions, allow you to establish effective research habits, and reinforce information learned during lecture. Communication is an important part of science, and clearly written lab reports are essential.

Laboratory Notebook: You will be expected to write lab reports in your laboratory notebook (see "Laboratory Report Format," below). Notebooks will be collected and graded.

Scientific Literature: To make scientific progress, it is important for scientists to share information with each other and with the public both orally and in writing. You will be responsible for reading, summarizing, critiquing, discussing, and presenting information from scientific articles.

Laboratory Report Format

Directions: Each lab report should include the following sections:

- *Title*: What is the activity called?
- *Purpose*: What do you hope to accomplish, or what is your reason for doing this lab? (Include sufficient background information.)
- *Hypothesis*: What are you testing with this lab?
- *Materials/Equipment*: List the materials and/or equipment that you used for this procedure.
- *Procedures*: Describe how the lab is done. Be thorough enough to be able to repeat the experiment using your lab report as a guide.
- *Data and Observations*: Record all the information that you collected during the exercise. This should include any observations, drawings, graphs, etc. Be as complete as possible.
- *Analysis*: Interpret the collected data; describe trends and relationships.
- *Questions*: Answer all assigned questions. Questions may be found in the lab handout or on the board.
- *Conclusions*: Summarize what happened in the lab and evaluate results. Use complete paragraphs. Also, tell what you learned or gained by doing this lab.

Personal Statement

It is very important that you review your notes, homework, and labs frequently! This is especially true when homework has a purpose. Most homework has one or more of the following aims:

- *Practice* reinforces the learning of material presented in class and helps you master specific skills.
- *Preparation* provides information—history, skills, definitions—for forthcoming instruction; it is intended to allow you to benefit when the new material is covered in class.
- *Extension* or elaboration involves the transfer of previously learned skills to new situations.
- *Integration* asks you to apply skills and concepts to produce a single product (e.g., book report, science project).

I will make every effort to communicate the purpose of homework assignments to you. If you are having difficulties with any of the topics covered in this course, see me as soon as possible. Times when I am available for extra help are included below.

This will be an exciting and interesting class if we all work together. *Remember, the more effort you put in the more reward you get out!*

Laboratory Safety

Please read and sign the attached laboratory safety contract.

Additional Information

Contact Information: I will be in my classroom or office for most of the school day. I am also available for help after school on Monday, Tuesday, and Thursday and some mornings by appointment.

School telephone number: _____
Best time to call: _____
E-mail: _____

Science Fair: The school science fair will be held in March. The science fair is optional; however, I encourage you to participate.

Internship Opportunities: Information about internship opportunities will be made available throughout the course.

Signatures: Discuss this course syllabus with your parent(s) or guardian(s). You were given two copies—the blue one is for you and your parent/guardian to sign, and the yellow one is for you to keep. Please have your parent/guardian sign the bottom of the blue copy and return it in ___ days. I am looking forward to working with you this year.

I, _____ (Student Name), have read and understand the Biology course syllabus and expectations.

I, _____ (Parent/Guardian Name), have read and understand the Biology course syllabus and expectations.

Student Signature: _____ Date: _____

Parent/Guardian Signature: _____ Date: _____

References

ACT, Inc., and The Education Trust. (2004). *On course for success: A close look at selected high school courses that prepare all students for college.* Iowa City, IA: Author.

National Research Council. (2002). *Learning and understanding: Improving advanced study of mathematics and science in U.S. high schools.* Washington, DC: National Academy.

National Science Teachers Association. (2004). NSTA position statement: Scientific inquiry. Retrieved June 8, 2007, from the National Science Teachers Association Web site: http://www.nsta.org/about/positions/inquiry.aspx