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Attaining Scientific Literacy through a Rhetoric of Science Composition Pedagogy

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ATTAINING SCIENTIFIC LITERACY THROUGH A RHETORIC OF SCIENCE COMPOSITION PEDAGOGY

by

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DEDICATION

This dissertation is dedicated to my family for their patience, faithfulness, encouragement, and love. I especially dedicate this work to my beloved wife, Lisa, who has been my strength and staunchest supporter throughout this process. I am thankful for you all.

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ABSTRACT

For the past sixty years, acquiring scientific literacy has proven to be a daunting task in education, especially for undergraduate nonscience majors. Although some education scholars have recognized the importance and use of arguments to teach science, these pedagogical practices often are aimed at primary school children rather than college students or involve reporting science experiments rather than actually studying or constructing arguments about issues related to science.

However, in this dissertation, I contend that educators often neglect a more available tool that not only examines arguments concerning scientific issues but also demonstrates the very heart of scientific literacy: critical thinking. In this project, I argue that a rhetoric of science course that teaches undergraduate nonscience majors to assess and engage the rhetorical components of scientific arguments provides a more pedagogically sound means of helping these students attain scientific literacy than the course designs in popular *Introduction to Biology* textbooks and their related course syllabi. In order to support this claim, I define and focus on the relationship of five main terms throughout this project as they pertain to the teaching of scientific literacy: *science, scientific literacy, critical thinking, argumentation,* and *rhetoric.* Science is a rhetorical practice through argumentation, and as I explain, argumentation fulfills the process of critical thinking, utilizing the analysis, evaluation, and creation of arguments. Applying an Aristotelian understanding of the term, *rhetoric* involves both the employment and discernment of the means of persuasion. From these terms, I establish that the attainment of scientific literacy is a rhetorical endeavor that necessitates the use of rhetoric of

science, which is the analysis, evaluation, and creation of scientific arguments through composition.

Examining three major *Introduction to Biology* textbooks and nine related course syllabi, I demonstrate that these courses generally emphasize learning facts rather than how to think critically about issues pertaining to science, and any writing required in these courses do not include composing arguments concerning issues related to science. In contrast, I demonstrate how a rhetoric of science that uses rhetorical criticism can be used to help nonscience majors attain scientific literacy as I define the term.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER 1

INTRODUCTION: THE PROBLEM OF SCIENTIFIC LITERACY

INTRODUCTION

Project Purpose Statement

In this project, I argue that in order for nonscience majors to attain scientific literacy, they must be taught to think critically about arguments advanced about scientific issues, and a rhetoric of science course designed to teach students to understand the rhetorical characteristics of scientific arguments is a more pedagogically sound means of assisting nonscience majors to attain scientific literacy than the course designs in popular *Introduction to Biology* textbooks and their accompanying course syllabi. To support this claim, I will focus on the relationship of five main terms throughout this project: *science, scientific literacy, critical thinking, argumentation,* and *rhetoric.* Combined, these terms constitute *rhetoric of science*, or at least how I will define *science* for this study. In this first chapter, I define the terms *science* and *scientific literacy*, and suggest that *how* science is practiced—presenting arguments to persuade an audience to accept scientific claims—and the engagement of these scientific arguments should be the focus of scientific literacy. This engagement of these arguments, as I will demonstrate, is essentially a rhetorical endeavor that I will define as critical thinking. Therefore, from these definitions and in an effort to resolve the specific problems I see with attaining scientific literacy, I suggest that the goal of scientific literacy is critical thinking that is developed through the engagement of scientific arguments, which requires the discernment that rhetoric of science provides.

Overview of the Problem

Although the notion of scientific literacy—an understanding of science for daily life in the modern world—was in use prior to Education professor Paul Hurd's popularization of the term in 1958 at the onset of the Space Age (Feinstein 168), scientific literacy remains desirable yet confusing as an educational goal, especially for nonscience majors. However, I see three related problems with scientific literacy for nonscience majors: definition, purpose, and attainment.

For clarification (and hopefully without offering a circular definition), *nonscience majors* are exactly what the name implies: students who have not chosen any of the Science, Technology, Engineering, or Mathematics (STEM) disciplines as their main course of study. As Physics professor Morris Shamos defines this category, any student not majoring in a science field would be classified as a "nonscience" or "general" student (73).

First, scientific literacy lacks a specific definition that would lead to obtainable educational goals. Science education researcher Rüdiger C. Laugksch best summarizes the problem of defining scientific literacy for science education: scientific literacy serves as "an internationally well-recognized educational slogan, buzzword, catchphrase, and contemporary educational goal" (71) that fluctuates depending on who or what group uses the term. Essentially, *scientific literacy* is a *weasel word* (Dillon 203), with the definition of the term often changing to fit within the context within which it is being used and to the benefit of the group utilizing the term. Despite this ambiguity, scientific literacy remains a rallying cry and goal for science education.

Second, this lack of a specific practical and functional definition leads to scientific literacy's next problem: failure to establish an obtainable purpose or educational goals. Famed astronomer and astrophysicist Carl Sagan touts that science has two responsibilities: "to train more scientists" and "to deepen public understanding of science" (14). Yet, such goals focus more on the *general appreciation* of science rather than the *application* of science. Promoting science appreciation rather than making science practical hardly seems a wise or even worthwhile educational endeavor, especially for nonscience majors. In contrast, Biology professor Randy Moore links two damning aspects of today's science instruction: failure to teach critical thinking and failure to teach effective communication ("Doing More" 260). Conversely, Moore declares that teaching science facts must lead to critical thinking and effective communication, skills that are applicable to other areas within students' lives long after their formal education is completed. In addition, such goals also prepare students for engaging science (and pseudoscience) information as it is in the general media. Students should be able to answer the following questions:

- Is this information important?
- Is this information reliable?
- What should I do about this information?

In light of the current bombardment by various forms of media, including the Internet, fake news, and antiscientific sentiments, this need for critical thinking and engagement is needed even more. For example, these same students become the citizens who must decide if childhood vaccinations are truly necessary or if this medical practice causes autism. Similarly, although the fight for equal time for alternate curricula to evolution seems to have waned, the building of a creationist-inspired ark museum in Kentucky suggests that these students must deal with antievolution idealism. Additionally, these same students must understand and contend with information for and against climate change. Surely, an educational goal of scientific literacy should provide for such engagement.

Third, in addition to a deficient definition and purpose, another problem of scientific literacy is its attainment. To highlight this initial problem, Physics professor Art Hobson reports that within a seventeen-year period (from 1988 to 2005), scientific literacy in the United States rose from 10 percent to 28 percent (405). Although Hobson demonstrates that of those adults studied, scientific literacy increased 18 percent, this improvement took seventeen years—undoubtedly a slow and poor return on an educational investment. Consequently, this achievement reflects a more important implication: at least 72 percent of Americans remain scientifically *illiterate*. Essentially, most Americans have failed to attain scientific literacy, which implies more can be done within science education to improve this outcome.

Together, these three problems seem to suggest that science instruction has room for improvement as it concerns scientific literacy for nonscience majors; thus, a need for improved instruction to attain scientific literacy appears warranted. A better definition of scientific literacy would lead to a better educational goal of scientific instruction, which, in turn, would lead to better attainment of scientific literacy.

Research Questions

If scientific literacy lacks a clear definition, purpose, and attainment, then my primary research question is obvious: How should science be defined to determine an exact purpose of scientific literacy to facilitate a precise means of scientific literacy attainment? From this general research question, the following research questions may be offered:

- What is science, or more precisely, how is science practiced?
- Based on how science is defined, how should scientific literacy be defined? More specifically, what is the purpose or goal of scientific literacy?
- If the goal of scientific literacy is critical thinking, what is critical thinking, and how is critical thinking attained?
- Is rhetoric of science useful in attaining critical thinking in scientific literacy? If so, how is rhetoric of science useful?
- If scientific literacy is not attained currently in undergraduate science nonmajor courses, how are these courses taught?
- If a better method of instruction for scientific literacy for nonscience majors existed, what would such an improved course look like?

These questions direct this project.

Overview of This Study

Within this study, I intend to demonstrate the use of composition and rhetoric—specifically rhetoric of science—as an effective tool toward the attainment of scientific literacy. Admittedly, I see the terms *science, scientific literacy, critical thinking, argumentation,* and *rhetoric* as related, and one focus of this project will be to demonstrate this relationship among these terms. In this chapter alone, I will define the terms *science* and *scientific literacy* while providing a brief literature review of the history of science and scientific literacy; these definitions and the foundational relationships between science, scientific literacy, critical thinking, and rhetoric of science provide the foundation for the remainder of this project. Thus, I will use this first chapter as not only a brief literature review but also the conceptual framework for the study. From this framework, I will then present the outline for the remainder of this study.

DEFINING SCIENCE, SCIENTIFIC LITERACY, AND RHETORIC OF SCIENCE: A CONCEPTUAL FRAMEWORK

As noted, my project relies heavily on the specific definitions of the terms *science* and *scientific literacy*; depending upon how one defines science, the attainment of scientific literacy follows.

Defining "Science"

In general, science can be defined in either an ideal or practical sense, and most current definitions of science can fall within these two broad categories. Famed author George Orwell expresses two subsets of ideal science: a specific discipline such as chemistry or biology, and an "exact science"—or a method of thinking—obtaining "verifiable results by reasoning logically from observed fact" (3). In the first subset, ideal science may be seen as it is taught in school or perceived by both scientists and the public; here, science is broken down into specific fields of study, with each discipline defining the natural world according to natural observation.

In the second subset, practical science, Orwell highlights the scientific method, the means of guiding *inquiry* through stringent *testing*. To define *inquiry*, I simply mean a question that motivates one to search for evidence to discover the best solution to the problem addressed. To define *testing*, I will rely on the definition provided by Science author Robert M. Hazen and Physics professor James Trefil: an ongoing process of observation, theories, and experiments that further clarifies previous theories and drives the need for further observation and experimentation (19). This second subset also hints at what science strives to be or wishes to be perceived as: a means of thinking that guides logic. Often, this concept is called the scientific method. (Figure 1 reflects these categories and subsequent components of science.)

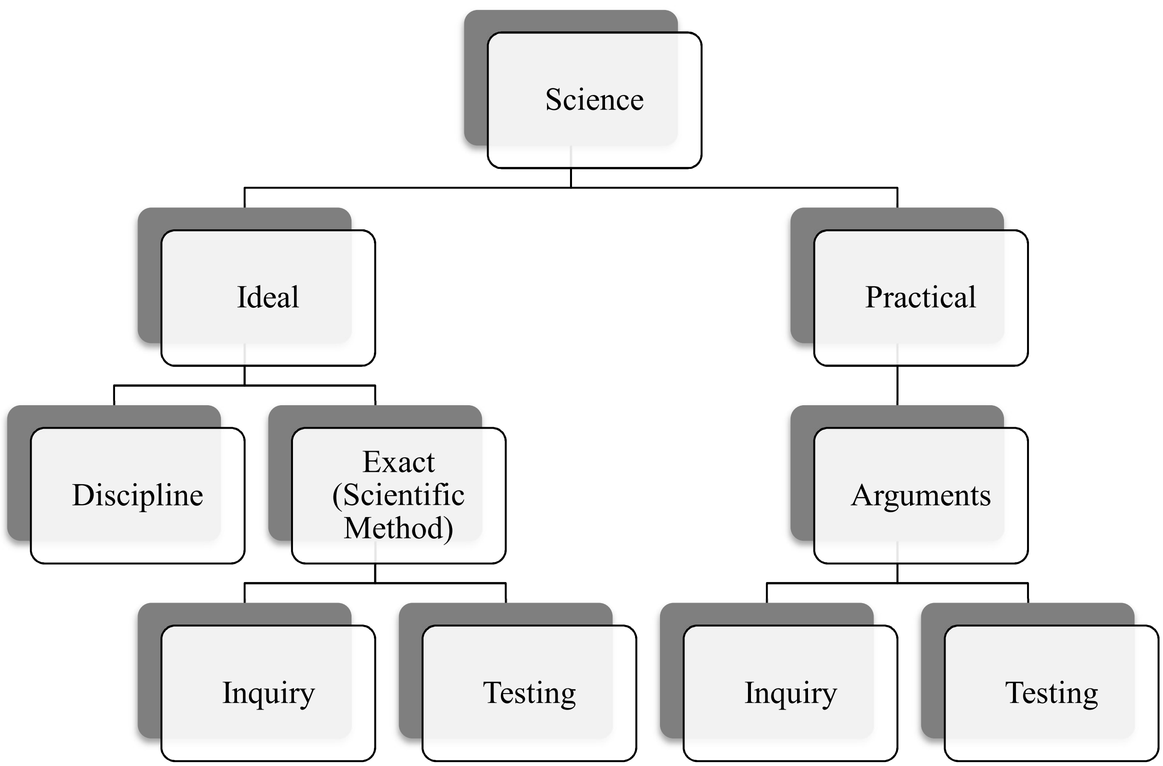

Figure 1. Science Hierarchy

However, another view of this subset also exists, one that describes science as it is actually practiced. Although science is indeed a means to observe natural facts and arrive at new information through tested thinking, the acceptance and testing of such information relies mostly on how these claims are presented. Like an exact science, practical science also involves inquiry and testing, but the methodology is conducted through argumentation.

Interestingly, Philosophy professor Anthony Weston further explains the concepts of *inquiry* and *testing*. Weston notes that arguments are “essential” to determine the best views, evidence, and conclusions; in his view, arguments are “a means of *inquiry*” (xi, Weston’s emphasis). I see Weston’s concept of arguments as not just the beginning but also the guiding factor and means to discovery. Basically, inquiry and testing are conducted through arguments. However, arguments take inquiry and testing further: arguments must explain and defend one’s reasoning. In other words, arguments are also a matter of convincing (Weston xii). In science, such convincing is not optional but rather required.

As rhetorician Carolyn Miller observes, science—in both the ideal and practical sense—is concerned more with the “correspondence of ideas” among scientists, practiced through language—particularly arguments—and as such is a “rhetorical endeavor” (51–52). In a separate but similar observation, Walter B. Weimer states, “[S]cience, in its various functions as a mode of inquiry into an explanation of phenomena, is a rhetorical transaction” (1). The conveyance and testing of these ideas rests ultimately in the persuasion of the logic used by scientists: how convincing is the argument presented to the audience? Thus, Carolyn Miller and Weimer both suggest that science is a rhetorical practice via argumentation.

This view of science is not new. For example, in his groundbreaking work, *The Structure of Scientific Revolutions*, physicist and philosopher Thomas Kuhn points out that science is more about the persuasion of the argument than it is about the evidence (200). As sociologists Bruno Latour and Steve Woolgar explain in *Laboratory Life: The Construction of Scientific Facts*, “The construction of scientific facts, in particular, is a process of generating *texts* whose fate (status, value, utility, facility) depends on their subsequent interpretation" (273, Latour and Woolgar's emphasis). A successful presentation of these texts (in the form of published papers) should result in a successful acceptance of these findings among peers as well as successful future funding.

As a specific example of science as rhetoric and argumentation, Moore compares the work of James Watson and Francis Crick to the similar work of Oswald Avery, Colin MacLeod, and Maclyn McCarty. Both teams present sound evidence concerning the double-helix structure of DNA. However, it is the work of Watson and Crick that is remembered rather than the findings of Avery, MacLeod, and McCarty. Why? According to Moore, Watson and Crick's work "was an accessible and entertaining paper that—in the tradition of Galileo Galilee and Charles Darwin—could be read and understood by educated laypeople" ("Writing about Biology" 23). Thus, Watson and Crick's "rhetorical choices" led to their work's acceptance while Avery, MacLeod, and McCarty's "rhetorical failures" triggered an unfavorable public response (24–25). The fulfillment of science rests not only in scientific findings and facts but also in the presentation of these findings and facts to the public for acceptance.

As a general practice, scientists present their claims through various means of argumentation (Gross, Harmon, and Reidy 9). As English professor Alan Gross succinctly explains, "The truths of science are not beyond argument" but rather "they are achievements of argument; science rests on facts and theories that have been argued into place" (*Starring the Text* 43). The observable facts of science are acceptable only through the tangibility of language that is shaped by arguments. In essence, these arguments attempt to persuade. For nonscience majors especially, perhaps Jonathan Haidt provides a better way to view this issue: “Must I believe it?” is not the same as “Can I believe it?” (85). Here, Haidt highlights the inquiry necessary for science: Is there enough credible evidence to support the scientific claim? Another way to ask Haidt’s question would be, “Have I been persuaded to believe the scientific argument?” To accept scientific arguments without testing them—analyzing their persuasiveness—seems to go against the very nature that science promotes. Again, science is grounded in arguments.

Defining Scientific Literacy

If science can be defined practically, then Communication scholar John Angus Campbell offers a viable proposition for defining scientific literacy that mirrors this understanding of science: “To prepare scientifically literate citizens, science must teach students to reason critically about facts and theories, and know how theories are certified or rejected, not just what they are” (“The Educational Debate Over Darwinism” 57). In Campbell’s view, scientific literacy is not learning merely about science skills or facts but rather the process science uses to secure these facts within the scientific and public communities: critical thinking. However, Campbell’s idea does not provide an adequate pedagogy for developing this critical thinking to attain scientific literacy; such pedagogy seems needed to support an effective argument for scientific literacy as critical thinking.

To flesh out Campbell’s idea of scientific literacy, I will examine four of the most influential scientific literacy scholars whose concepts have provided a foundation used often in the development of scientific literacy pedagogy: Physics professor Morris Shamos, astrophysicist Benjamin S. P. Shen, research scientist Jon D. Miller, and English professor Michael J. Zerbe. From these views, I will select the one ideology that follows closest to the practical definition of science and offers a sound pedagogy for developing critical thinking.

Shamos's Scientific Literacy. To begin this analysis, I look at what I consider the most negative approach to scientific literacy. For Shamos, any goals to achieve scientific literacy are unrealistic; as he bluntly states, "The promise of a meaningful public literacy in science is a myth" (xiv).

Shamos believes that the original purpose of scientific literacy—understanding—evolved into a call for civic scientific literacy. Paradoxically, the call for citizenship interaction with scientific issues is both the "underlying goal" with and the "bottleneck" to scientific literacy (216). Shamos criticizes any approach to scientific literacy that proposes the same "basic ingredients": a basic vocabulary, an understanding of science process, and how science and technology affect society (87). As far as Shamos is concerned, scientific literacy cannot be forced upon a nonscientist.

Shamos argues that formal education may not contribute to scientific literacy; moreover, science literacy attained in school is no predictor of adult scientific literacy, where such literacy matters most (151). Still, Shamos recognizes three levels of scientific literacy. The simplest form of scientific literacy, *cultural scientific literacy*, denotes the most common level where "educated adults who believe they are reasonably literate in science" currently reside. At this level, people "recognize many of the science-based terms (the jargon) used by the media, which is generally their only exposure to science," but these people are "not totally illiterate in science" (88). Yet, this level offers no guarantee that people may be insulated from or equipped to deal with misinformation that may be present in the media. Even with a *functional scientific literacy*, the next level, an individual still is not truly scientifically literate; rather, a person will have a command of science terminology and should be able to "converse, read, and write coherently," using such terminology correctly (88). However, a person with a *"true" scientific literacy* "actually knows something about the overall scientific enterprise" and understands the "foundations of science," where "this individual also appreciates the elements of scientific investigation, the importance of proper questioning, of analytical and deductive reasoning, of logical thought processes, and of reliance upon objective evidence" (89, Shamos's emphasis). When these criteria are met, then a person can think critically about science, allowing for civic interaction. In Shamos's view, the only person who could achieve true scientific literacy *is* a scientist. As evidence of this observation, Shamos concludes his examination of scientific literacy with "the only sensible solution to the problem" of scientific literacy: referring to science experts as advisors in "science/technology-based social issues" (207).

At best, Shamos offers the need for science appreciation, but the only means a nonscientist has to truly understand science is, according to Shamos, to receive such understanding from science experts. Essentially, for Shamos, nonscientists cannot participate in science.

Shen's Scientific Literacy. In contrast to Shamos, Shen, an early proponent of scientific literacy, believes that all nonscientists possess some common sense regarding science. In "Science Literacy and the Public Understanding of Science," Shen defines science literacy as any "acquaintance with science, technology, and medicine" accessed by the public via any mass communication and education (45–46). Within this juncture of public and science, Shen offers three potentially overlapping categories. First, Shen introduces *practical scientific literacy*, which is the application of science to the "practical" or basic problems humans face, such as food, shelter, and health (46–47). Second, *civic scientific literacy* should develop an individual's thinking so as to empower that individual to participate in the "democratic process of an increasingly technological society"; thus, civic scientific literacy is an awareness of science and its influence on and application within society and is "a cornerstone of informed public policy" (48–49). Third, Shen concludes with *cultural scientific literacy*, which targets college students by emphasizing science accomplishments (49).

Recognizing the need to make science more understandable and accessible to the general public, he suggests two means to achieve these goals: first, increase the public's familiarity of scientific information via the mass media, and second, make science more accessible in language and interest (48). For the first goal, Shen suggests that mass media serve as the outlet for science to broadcast scientific information, while for the second goal, science must be more accessible to the public by employing less-forbidding technical jargon, which Shen calls "ordinary-language science" (51).

Overall, Shen indicates that science benefits if society realizes the importance of science; in turn, society will respond favorably in respect to issues regarding science. Basically, Shen touts a science-appreciation approach to scientific literacy, one that makes nonscientists aware of science's impact on human history and society. Although Shen's recommendation of making science language less forbidding does support his idea of science's goodwill, his plan to educate the masses through media lacks specifics. In essence, his pedagogy relegates media as the promoter of science.

Alas, Shen seems more content with common sense rather than critical thinking. As a result, his goal for scientific literacy ends with only science familiarity.

Miller's Scientific Literacy. Surpassing Shen's call for mere scientific understanding, Miller recognizes scientific literacy as "the level of understanding of scientific and technological constructs needed to function as citizens in a modern industrial society" ("Conceptualization and Measurement" 243). In underscoring the overlap between science and technology and how these components are necessary to perform everyday tasks within an industrialized world, Miller advocates for a *civic* scientific literacy. The ultimate goal of such a literacy allows for citizens "to follow and make sense of public-policy issues involving science or technology" ("Conceptualization and Measurement" 244).

According to Miller, scientific literacy has two necessary components: scientific concepts and an understanding of the process of science. Examples of the first component would be a basic vocabulary and ideas such as *theory* and *evolution*, whereas the second component may be summarized as "an understanding that science bases its conclusions on evidence and reason" (Hobson 405; Miller, "Conceptualization and Measurement" 243). In essence, the second component is akin to an understanding of the scientific method. Miller contends that a civic scientific literacy, which is a lifelong process, can be attained through formal education—from high school through college. He insists that the maintenance and sustenance of a democratic society depends on its investment in and its level of scientific literacy ("Conceptualization and Measurement" 253).

To accomplish his vision of scientific literacy, Miller sees the need for more science education now for students in school—primary, secondary, and post-secondary grade levels—and use of the media (especially the Internet)—as the means to keep those out of school up-to-date with science. Unlike Shen, who views science education and scientific literacy as the responsibility of science, Miller views science education as the government's responsibility, and scientific literacy as the media's responsibility ("Civic Scientific Literacy: The Role of the Media" 54–57).

Although he acknowledges that the basis of scientific literacy reflects literacy itself, or the ability to read and write ("Civic Scientific Literacy" 45), Miller views those who have such ability as achieving only a functional level or threshold of scientific literacy. Yet, he offers no other definitive means of reaching any higher levels of scientific literacy. In the end, Miller advocates a need for more science education as it exists currently: a two-tier approach of vocabulary development and an understanding of the scientific method.

Zerbe's Scientific Literacy. Zerbe differs with these three ideas of scientific literacy and relies on a pedagogy that rests closer to the idea of literacy itself. In *Composition and the Rhetoric of Science*, Zerbe explains that science *is* scientific discourse (published and peer-reviewed scientific research) (20), and he emphasizes that the terms *science* and *scientific discourse* are interchangeable (23). Since scientific discourse is presented before an audience of peers, Zerbe labels it as *scientific rhetoric*, which is "discourse in which science is actually *performed*" (3, Zerbe's emphasis). Here, Zerbe means scientific knowledge is "shaped by interpretation, argument, and negotiation," and always contested (77). Scientific literacy concerns itself with learning to critique the way science uses language to create understanding; in other words, Zerbe sees scientific literacy as critical thinking regarding scientific discourse. (I will further develop this idea in Chapter 2.)

Zerbe also offers three levels of scientific literacy, with each level building on the previous level to become a "continuum of increasing theoretical robustness" (89). His first level, *autonomous literacy*, represents the most basic or functional level of scientific literacy. At this level, a person may know and understand basic scientific terms and concepts, but little more. Sadly, most science curriculum is structured to leave students at this level (91). If this information provides the base means to interpret science in society, then most nonscience majors have a poor foundation of science. In essence, Zerbe's autonomous literacy means that people in this group have no more than an exposure to science.

At Zerbe's second level, *critical literacy*, students are able to incorporate the basic scientific terms and concepts from the autonomous level into discourse in order to analyze, interpret, and explain science (92). With a critical literacy, students move beyond only reciting facts to translating them into their own words in order to think about these concepts. Essentially, students become aware of science, which allows students to recognize scientific issues in both their immediate community and the world (93).

At Zerbe's highest level, *ideological literacy*, students not only discern scientific issues but also are able now to engage actively in challenging science. Simply put, students are now empowered regarding science (95). Among his concepts of an ideological literacy, Zerbe stresses that since "science is fundamentally a discursive activity governed by rhetoric," it "can be interrogated and resisted when necessary" (98–99). Because of its use of rhetoric in its discourse, even nonscientists can approach science to question its arguments. And because of science's dominance in society, Zerbe emphasizes the need for all to attain this ideological literacy (100). Thus, to participate actively and accurately in a culture permeated by science, one must attain this level of scientific literacy.

A Rhetorical Solution. Of the four definitions of scientific literacy (see Table 1), I contend that Zerbe's definition—science as discourse—offers the strongest understanding

Table 1. Comparison of Scientific Literacy

	Definition/ Purpose	**Levels/ Categories**	**Attainment**
Shamos[1]	Need for public to interact with scientific issues; cannot be forced upon nonscientists.	1. Cultural 2. Functional 3. True	Unattainable; nonscientists cannot participate in science.
Shen[2]	Familiarity with science, technology, and medicine.	1. Practical 2. Civic 3. Cultural	Accessible through mass media and understandable language.
Miller[3, 4]	Allows citizens to monitor and understand scientific and technological issues.	1. Scientific concepts 2. Scientific method	Additional science education (funded by the government) and achieved by vocabulary development and understanding the scientific method.
Zerbe[5]	Critical thinking concerning scientific discourse.	1. Autonomous 2. Critical 3. Ideological	Using rhetoric of science to engage scientific arguments.

[1]Shamos, Morris H. *The Myth of Scientific Literacy*.
[2]Shen, Benjamin S. P. "Science Literacy and the Public Understanding of Science."
[3]Miller, Jon D. "Civic Scientific Literacy: The Role of the Media in the Electronic Era."
[4]Miller, Jon D. "The Conceptualization and Measurement of Civic Scientific Literacy for the Twenty-First Century."
[5]Zerbe, Michael J. *Composition and the Rhetoric of Science*.

of science as it is practiced while offering a reasonable means of attainment. Comparing these four scholars' views with science as it is practiced, Shamos sees science as a unique discipline that proves too difficult for the public to engage (23). Shen actually does not define science, but he does list its components to include basic and applied science, which includes technology and medicine (45). Miller, too, does not define science but explains that understanding it is a necessary component of current and future functionality in society. Only Zerbe deals with science as it is actually practiced through argumentation, demonstrating the rhetorical component of scientific literacy.

Shamos adamantly contends that nonscientists cannot attain scientific literacy, and any pedagogy that follows a traditional itinerary of basic science vocabulary, an understanding of science process, and an appreciation of science and technology cannot promote scientific literacy. Shen promotes only an understanding and appreciation of science. Miller sees more science education regarding scientific vocabulary and process as the means of attaining scientific literacy. Again, only Zerbe promotes a suitable means of attainment through rhetoric and as practiced through composition.

In his combination of rhetoric and composition, Zerbe is not distinguishing a new discipline but rather expressing how rhetoric is performed in scientific publications and, subsequently, in the classroom. Rhetoric and Linguistics professor James Williams clarifies that rhetoric and composition may be used to reference the multiple fields of "*rhetoric, rhetoric and composition, rhetoric-composition*, and *composition-rhetoric"* (1, Williams's emphasis). Thus, composition is an expression of rhetoric; similarly, scientific literacy cannot and should not be separated from a means to express such literacy.

Zerbe's attainment of scientific literacy holds true to the basic tenets of literacy—reading and writing—while promoting the critical engagement of science itself. In fact, Zerbe challenges rhetoric and composition instructors to promote more study and effective use and analysis of scientific discourse (46). Basically, Zerbe promotes the study of rhetoric of science as the means for attaining scientific literacy (13, 68–69).

CLARIFICATION, SCOPE, AUDIENCE, AND LIMITATIONS OF THIS STUDY

Clarification

Obviously, looking at Zerbe's work, I am not the first author to promote the use of rhetoric of science as a means to attain scientific literacy. However, I need to clarify the value of this study by reviewing a sampling of other scholars who have identified argumentation as a mean to attain scientific literacy, highlighting their ideas and focus, while pointing out their limitations and difference from my own approach To accomplish this task, I will note briefly seven frequently referenced works of several Science Education pioneers in this area.

First, as early as 1994, Science Education professors Rosalind Driver, Hilary Asoko, John Leach, Eduardo Mortimer, and Philip Scott observe that public science knowledge is socially constructed, and to learn about science in the classroom, science should be taught through social interaction (6). In their theory, this social interaction consists of the idea and examples of discourse and inquiry through a series of questions and answers (9–11), or a very primitive form of reasoning through argumentation.

Second, in 1998, Driver joins Education professor Paul Newton and Science Education professor Jonathan Osborne in "Establishing the Norms of Scientific Argumentation in Classrooms" to discuss argument as the central aspect of conducting science as well as science education (288). These authors also address the idea of science as a social interaction (289), observing that students enter science classes with preconceived worldviews on science. Additionally, the authors note that students often have difficulty in creating the arguments necessary to participate in such a curriculum as proposed because science instruction does not allow such participation by students (308).

Third, in their 2001 article "Enhancing the Quality of Argument in School Science," Science Education professors Osborne, Sibel Erduran, and Shirley Simon, and Martin Monk look at the need to teach school children to argue in a scientific manner, constructing arguments as scientists do. Although aimed at primary students, the authors adapt many features of British philosopher Stephen Toulmin's components of an argument, including the use of warrants. (I will briefly address Toulmin's components in Chapter 2.) Here, the emphasis is more on the formal structure of an acceptable argument necessary for science instruction.

Fourth, in their 2001 *Language and Literacy in Science Education*, Osborne works with science educator Jerry Wellington to declare that "learning science is as much learning how to *use* the language of science as it is learning the facts and definitions of science or its experimental procedures" (67, emphasis Osborne and Wellington). In their view, to be scientifically literate, students must be able to read and write scientifically (64). Although I do appreciate these authors' views that literacy is as much reading and writing as it is practice, I find their examination of argumentation too brief, with their emphasis more on verbal discussion than written arguments.

Fifth, in the 2004 *IDeas, Evidence and Argument in Science* (IDEAS) resource packet, Osborne, Erduran, and Simon develop a series of fifteen science lessons for classroom teachers to use in their science curriculum. These lessons are presented as simple science experiments where students are given a science problem (e.g., What will happen when a burning candle is covered?) to solve. Essentially, these examples allow the authors to apply their concepts of arguments in the science classroom. In some cases, students must conduct experiments related to the problem, or they must discuss the evidence given. More often, these lessons focus on either verbal discussion or written accounts in presenting the students' findings, with the students justifying their answers, rather than actual formal arguments.

Sixth, providing further research in connection with IDEAS, Simon joins with Science Education professor Katherine Richardson in 2009 to analyze the IDEAS curriculum, finding that such lessons require more instruction on argumentation ("Argumentation in School Science" 485–486). As in the IDEAS curriculum, students are required to present the outcomes of their experiments by constructing informal arguments through discussion of their reasoning.

Finally, in her 2009 article "Teaching and Learning Science as Argument," Psychology and Education professor Deanna Kuhn also incorporates argumentation as a means to teach science, not only to develop a "mastery of scientific concepts," but also to "engage in scientific discourse" (810). Interestingly, Kuhn's pedagogy involves allowing students to argue from their own knowledge base, advancing peer discourse to cultivate the process of argumentation (816). Kuhn appears more intent on the socialization of peer-to-peer discussion, dealing with the students' arguments and counterarguments rather than actual scientific arguments.

Although each of these examples emphasize the importance of argumentation in science instruction, my research differs from these predecessors in three very important factors. First, these scholars concentrate on elementary, middle school, or high school students rather than college nonscience majors as I do. Thus, the audience focus for these scholars is for a much younger audience, whereas I seek to work with, for the most part, more mature students. Second, these scholars neglect the rhetorical construct of the argument itself. In other words, although these scholars recognize the utilization and importance of scientific arguments, they do not look at the persuasiveness from the logic of the argument's rhetoric. Thus, they do not examine the importance of rhetoric of science as a tool to attain scientific literacy as I propose. Third, although some of these scholars actually implement a form of argumentation in their suggested pedagogies, none actually notes the connection between argument, rhetoric, and composition. Thus, I see an incomplete version of critical thinking as I will define in Chapter 2.

In all, I am indebted to these scholars and their work. If nothing else, they do demonstrate that the idea of argumentation as a means to attain scientific literacy has merit and requires additional study. Likewise, they also exhibit the variation of ideas regarding this concept. However, I will endeavor to fulfill the concepts as presented by Zerbe regarding scientific literacy.

Scope

Again, the purpose of this project is to explore critical thinking as it relates to scientific literacy for nonscience majors; the use of rhetoric of science provides a reasonable and practical pedagogy to develop critical thinking as a means to attain scientific literacy for this specific group. Rhetoric of science accomplishes two goals of scientific literacy: the careful analysis and evaluation of scientific arguments and the demonstration of critical thinking by creating new arguments as to why and how such arguments should be implemented at both a personal and societal level. As such, this project proposes that the study of the language used in scientific arguments and the application of this language reside better in a discipline that teaches rhetoric and composition.

Still, this study offers another opportunity: writing across the curriculum (WAC). As Writing professor Susan McLeod observes, WAC includes two distinctive approaches to education: discovery and rhetoric, with discovery understood as the process of learning and rhetoric meaning the discursive participation in academic disciplines (3). In this study, my view of using rhetoric of science to attain scientific literacy illustrates McLeod's definition of WAC. I will note this rhetorical connection with WAC again in chapters 4 and 5.

For now, to further demonstrate this connection to WAC, English Professor Heidi Estrem explains that writing produces "new thinking" (19); within Estrem's context, composition is a *threshold concept*—a transformative moment of learning for the student that causes a student to see an idea or an issue in a different way that permanently (and positively) changes the student's perception and actions. However, composition is not a solo experience; as English professor Andrea Lunsford notes, composition is a rhetorical activity, where the writer (here, the student) interacts with both the message (here, the text) and the audience (here, the reader) (20). In essence, in WAC, students express their learning from a new perspective in a different environment/discipline and share this learning process to a unique audience, demonstrating their learned experience and crossing realms. WAC provides both student evolution and involvement in new fields and social groups; truly, composition is a transformative process, both educationally and socially.

Audience

The audience for this project will be diverse. First, this project hopes to address the composition and rhetorical communities within English departments. For composition, this project hopefully will strengthen the ideology of writing across the curriculum, specifically within the realm of science. For the rhetorical communities, it is hoped that rhetoric will be restored to a more prominent role in academia. Second, recognizing that Communication departments also specialize in argumentation and rhetoric, hopefully, this project may open areas of communication to debate the need to broaden the realm of rhetoric, especially for teaching science. Third, this project hopes to interest Life Science departments, specifically those faculty who teach nonscience majors at the undergraduate level, demonstrating that written argumentation mirrors scientific thought while utilizing student belief as a core for understanding science. Although writing across the curriculum (WAC) already promotes writing in all disciplines, this project simply intends to advance that ideology for a stronger composition approach regarding scientific literacy.

Limitations

Although I have noted the inclusions of this study, there are also two clear limitations to this study. First, since science majors obviously have chosen science as their field of study and possible future career, they expect to be immersed in the language and culture of science. Thus, even at the undergraduate level, science majors should be expected to have some degree of familiarity with science's methods. However, nonscience majors are expected to attain literacy outside their "nonnative language" (Klymkowsky 197). Also, science instruction differs for nonscience majors since they lack experience and expertise in science, yet these students are still expected to learn and apply science both in school and in life (Cobern, "Science Education as an Exercise in Foreign Affairs" 289). In short, this project focuses primarily on nonscience majors.

Second, this study does not expect to supplant existing science courses within the Life Sciences; indeed, I see this study as being taught within English and Communication departments. The need for a basic knowledge of science remains, but teaching the assessment, evaluation, and creation of arguments may be accomplished best in those disciplines that focus on language instruction.

ORGANIZATION OF THIS STUDY

As I have presented thus far, much of the problem concerning scientific literacy arises from the lack of a functional and effective definition of the terms *science* and *scientific literacy*. In this chapter, I offer definitions for these two terms and answer the first two research questions of this study. Defining science as a means to produce arguments that communicate scientific findings to both the scientific community and the public allows for the acceptance that scientific literacy must evaluate these scientific arguments. Therefore, the goal of scientific literacy is critical thinking applied to scientific discourse, and it is necessary to understand how this critical thinking is developed regarding science.

In Chapter 2, I answer the next two research concerns of this study—defining *critical thinking* and explaining its attainment and arguing how rhetoric of science aids in the attainment of critical thinking—and offer that critical thinking as produced by scientific literacy is a rhetorical transaction by examining the intricate relationship between critical thinking, argumentation, and rhetoric of science.

If rhetoric of science is a viable means of evaluating and participating in scientific arguments, then I should see examples of this engagement in college science courses designed for nonscience majors; however, I doubt that this component of study exists in most science courses, and I address my next research question: If scientific literacy is not attained currently in undergraduate science nonmajor courses, how are these courses taught? Therefore, in Chapter 3, I look at nine separate nonscience majors courses throughout the United States, examining their textbooks, course syllabi, and laboratory exercises to discover if these courses actually engage in any evaluation of scientific arguments rather than teaching scientific facts.

After this survey of current college science courses, I offer my own ideas of a scientific literacy pedagogy to answer my final research question: What would an improved course to teach scientific literacy for nonscience majors look like? In Chapter 4, I examine Zerbe's proposed pedagogy and, in an attempt to correct the criticism raised regarding his lessons, develop a more precise critical reading and composition component, focusing more on rhetorical criticism to meet this goal.

In Chapter 5, I merely conclude this study with a brief review of its findings and a challenge for the future of rhetoric of science. In this chapter, I will focus on the collaborative nature of rhetoric within the academic institution as well as its history as a classical means of practicing citizenship.

CONCLUSION

To conclude this first chapter, I reference Sociology professor Noah Feinstein, who asks two specific questions concerning scientific literacy, seeking both a description and prescription of the issue: What does scientific literacy look like, and what should scientific literacy do (171)? As an educator, Feinstein's goals are not unlike what I have proposed in this chapter: the need to provide a working description and the need to define scientific literacy while providing a means to attain it.

As demonstrated in this brief introduction and background, scientific literacy for nonscience majors suffers from both a defective functional definition that should direct its goal for and instruction of this specialized group. In this chapter, I have proposed a study of using rhetoric of science to attain scientific literacy among nonscience majors. As I have defined it, science is practiced through argumentation (see Table 2).

Table 2. Definitions: Science and Scientific Literacy

Term	Definition
Science	A rhetorical practice via argumentation.
Scientific Literacy	Critical thinking regarding scientific arguments.

From this definition, I have examined four major scholars' definitions of the term *scientific literacy* and concluded that Zerbe best understands scientific literacy in relationship to the practice of science. In essence, studying the discourse of science, or the rhetoric of science, offers a logical and efficient means to teach science: science is argumentation, and scientific literacy is thinking critically about scientific arguments. By engaging scientific texts, students are not merely taught facts of science but rather are given the tools to develop inquiry in other disciplinary areas, not just science or scientific issues. In other words, this type of science education allows students to learn as scientists do, which is to engage in scientific discourse so that these students may study the claims and test the evidence offered in such arguments.

To demonstrate how such critical thinking may be accomplished requires a deeper understanding among the relationship with scientific literacy, argumentation, rhetoric, and rhetoric of science, and this understanding will be the focus of the rest of this study.

CHAPTER 2

CRITICAL THINKING AND SCIENTIFIC LITERACY

INTRODUCTION

Problem Statement

In the first chapter, I began my exploration of using rhetoric of science for nonscience majors to attain scientific literacy. In this chapter, I seek to answer two of my proposed research questions:

- If the goal of scientific literacy is critical thinking, what is critical thinking, and how is critical thinking attained?
- Is rhetoric of science useful in attaining critical thinking in scientific literacy? If so, how is rhetoric of science useful?

To answer these questions in this chapter, I continue my definition of terms—*critical thinking, argumentation,* and *rhetoric*—while examining the relationship between these terms and scientific literacy, focusing on why and how rhetoric of science can be ideal for nonscience majors regarding scientific literacy. In this chapter, I argue that critical thinking as related to scientific literacy is a rhetorical endeavor because of critical thinking's subject matter, purpose, and expected outcome. Examining the relationship between critical thinking and arguments should yield an effective definition of critical thinking as a result of scientific literacy. From these definitions, I will look first at defining rhetoric by using an Aristotelian viewpoint as derived from *Rhetoric* to consider rhetoric's purpose, its intended audience, and its tools. Then, I will define *rhetoric of science* to show why rhetoric of science is the logical methodology of critical thinking regarding scientific literacy.

Background

With its need for evidence and reasoning, Philosophy professor Harvey Siegel views science as the "home of critical thinking and the apex of rationality" (*Educating Reason* 91), while suggesting that the focus of science education should be "the study of reasons in science" (*Educating Reason* 113). Siegel's recommendation serves not as a call for the *what* of science content but rather as the need for the *how* of scientific reasoning. Here, Siegel means that it is not learning the facts of science that produces critical thinking but rather learning the process of conducting science—studying the reasoning behind science. As I noted in Chapter 1, scientific reasoning is conducted through scientific arguments.

Even though Siegel refrains from offering a formal education plan, he does propose the use of alternative methods available to teaching science, including using philosophy of science to demonstrate scientific reasoning (*Educating Reason* 112). To be clear, Siegel's understanding of philosophy of science is synonymous to rhetoric of science. This overlap of terms is acceptable and understandable. As Harris notes, no need exists to distinguish philosophy of science from rhetoric of science, since rhetoric of science is a "multidisciplinary enterprise." Indeed, scientific reasoning as described by either the *philosophy of science* or *rhetoric of science* is dependent upon rhetoric and leads to knowledge ("Introduction" xxv). The foundation of scientific critical thinking is rhetoric.

However, I must acknowledge that claiming that critical thinking is rhetorical is not an original idea. Science philosopher Paul Feyerabend claims that logic and rhetoric are interchangeable. With this view, Feyerabend proposes that contending with persuasion itself is the act of rationality (6). Feyerabend emphasizes that in all forms of critical thinking—including science—rhetoric provides the foundation to engage such persuasion. Although Feyerabend generally recognizes the close relationship among science, critical thinking, argumentation, and rhetoric, he does not examine formally this relationship. In this chapter, I intend to provide a starting point for this examination, which will *then* lead to the suggestion of a scientific literacy pedagogy in Chapter 4.

DEFINING CRITICAL THINKING AND ARGUMENTATION

Critical Thinking: Subject Matter

Similar to the term *scientific literacy*, *critical thinking* often elicits diverse meanings. For example, in his famous "Delphi Report," critical thinking scholar Peter A. Facione understands critical thinking "to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (3). Meanwhile, philosopher and educator Robert Ennis defines critical thinking as "*reasonable reflective thinking that is focused on deciding what to believe or do*" ("Critical Thinking: A Streamlined Conception" 6, Ennis's emphasis). Thus, while Facione focuses on an extensive list of criteria to judge, Ennis concentrates on a simpler notion of reflection and action. Although both Facione and Ennis exemplify the disparity of definitions, both hint at a common factor that is the focus—or as I consider, the subject matter—of all critical thinking.

To explain this point of subject matter, the root meaning of the term *critical* offers a starting point. The term *critical* itself derives from the Greek concept of *kritikos*, which simply refers to a judge rendering a verdict based on the better evidence presented from two arguments (Swatridge xi). From this beginning, I think that it is possible to define critical thinking first according to its subject matter and then according to its expected outcome. To be clear, all forms of critical thinking concern a common subject and a specific outcome.

First, critical thinking involves "thinking about thinking"; it is the evaluation of claims made by others (Moore and Parker 3). This premise points to the subject matter of all critical thinking: arguments. Undoubtedly, critical thinking focuses on arguments, both judging arguments made by others and the creation of arguments made by oneself (Swatridge xi; Barnet and Bedau 11). Indeed, in his criteria for critical thinking, Ennis notes that a critical thinker must be able to judge an argument ("Critical Thinking Assessment" 180). Yet, Siegel describes a critical thinker as one who is "*appropriately moved by reasons*" (*Educating Reason* 23, his emphasis). In both Ennis's and Siegel's views, critical thinking is forged through arguments, specifically the reasoning that connects the claim to its conclusion and the evidence used therein. More clearly, Education scholars Martin Davies and Ronald Barnett define criticality—the total characteristic of a critical thinker—in the context of arguments (15).

This connection between critical thinking and argument is logical if one considers that critical thinking and language go hand-in-hand; as critical thinking scholar Richard Paul explains, "There is no command of language separate from command of thought and no command of thought without command of language" (599). In other words, critical thinking is both applied to and expressed through language (Smith 106). However, to explain this connection between critical thinking and arguments and to further define critical thinking, I must first examine the term *argument*. Thus, to begin my definition of *critical thinking*, it is necessary to define the term in connection with *argument*; as I hope to demonstrate, critical thinking and arguments exist symbiotically.

Critical Thinking: Argument

According to Communication professor James A. Herrick, an argument is merely public reasoning intent on persuading an audience (*Rhetoric* 13). Granted, Herrick adapts a view of argument as practiced by the Ancients, but Herrick's view shortchanges an argument's potential and trivializes rhetoric's full intent. Indeed, Herrick's focus on the public exchange of reasoning actually limits the idea of an audience, which I will explain later when I discuss audience in more detail. To expand the concept of argument in terms of critical thinking, I would like to promote the idea of argument as the act of critical thinking.

Developing a definition of *argument* requires first clarifying what an argument is not, defining it in the context of critical thinking, and then conducting a brief historical review to define argument according to its purpose. To begin, I will define what an argument is *not* by first eliminating an overgeneralization of the term and then rejecting a more specific notion of the term.

First and generally, I disagree with the assertion made by English professors Andrea Lunsford, John Ruszkiewicz, and Keith Walters regarding an argument: everything is an argument. As these scholars define the term, an *argument* is "any text—written, spoken, aural, or visual—that expresses a point of view" (5). Although I have no problem with these scholars' attempt to extend the concept of arguments to be more than just written or spoken language—hence, arguments also can be aural such as song lyrics or visual such as advertisements—they omit the necessary parts of an argument in their zealousness to be inclusive. In other words, not everything is an argument, especially a point of view. As rhetorical scholars Joseph Williams and Gregory Colomb explain in their later work, *The Craft of Argument*, some forms of communication, such as negotiation, propaganda, and coercion, do not fulfill the criteria necessary to be called an argument; rather, these forms of communication serve as types of persuasion (12–13). To be fair, perhaps Lunsford, Ruszkiewicz, and Walters highlight the difference between explicit and implicit claims; however, as I will show later, even a claim is not enough to sustain an argument. Thus, the definition offered by Lunsford, Ruszkiewicz, and Walters would benefit greatly by being more exclusive or at least declaring the specific components needed to be an argument, which would include more than just an assertion or declarative statement.

Second and more specifically, an argument is not an adversarial verbal dispute or disagreement. In terms of critical thinking, an argument is not an event to win or lose. Here, I cannot help but note that perhaps Carl Rogers might be pleased with this idea of an argument. In his original idea of communication amidst differing factors, or listening with "understanding," (29), Rogers promotes a collaborative empathy. In short, his idea of argumentation is not a means of confrontation but rather a means to express differences with the assurance of actual listening and consideration; it is an attempt at reaching an arena of common ground. Yet, when speech coaches and school debate teams adopt his ideas as a ploy to win an argument, Rogers despises the approach, deeming such ploys as a "perversion" of his concepts (Teich 55). In this regard, I agree with Rogers: arguments should not always be a conflict that demands a victor.

Yet, an argument does require some contention concerning the arguments made by others. As Argumentation professor Douglas Walton explains, an argument attempts "to try to prove (or disprove) some claim that is subject to doubt or controversy" (255). Essentially, argumentation concerns itself with uncertainty, not facts (Zarefsky, *Argumentation: The Study of Effective Reasoning, Part 1* 11). It is this contention that provides the germination of critical thinking: the wrangling of an argument for proof, refutation, or clarification, that leads to resolution.

Yet, to define argument in the context of critical thinking, I am compelled to examine a historical view of argument from two scholars, with one scholar building on the other's foundation. Communication professor Daniel O'Keefe first advances the idea of argument as a process (the act of arguing) and a product (the argument itself) (121). Later, argumentation and rhetorical scholar Joseph Wenzel further develops O'Keefe's idea, adding procedure, or the means of conducting the argument; and product, or the actual argument itself, constructed by the parties involved ("Perspectives on Argument" 114–115). However, Wenzel assigns another dimension to his model: the overall argument consists of process (rhetoric), procedure (dialectic), and product (logic) ("Three Perspectives" 9).

Though I do not disagree directly with O'Keefe's process-product model, or Wenzel's addition of procedure as a third view of argument, their connected efforts do not go far enough to explain an argument. I especially will contend later with Wenzel's assignment of rhetoric, dialectic, and logic to these dimensions. First, if an argument can be a process, procedure, or product, I see the need for fulfillment of these perspectives: process, procedure, and product of *what*? Although O'Keefe and Wenzel limit their scope to just views concerning the communication of arguments (Wenzel "Three Perspectives" 9), I think that it can be extended to understand argument as the process, procedure, and product of critical thinking. In other words, if critical thinking focuses on arguments as subject matter, then, if I apply O'Keefe and Wenzel's ideas, an argument can be defined as the means by which critical thinking is realized, the act of critical thinking itself, and the outcome of critical thinking. More simply, critical thinking is carried out through argumentation (Zarefsky, *Argumentation: The Study of Effective Reasoning, Course Guidebook* 7).

Obviously, the terms *critical thinking* and *argument* are not synonymous, but rather the acts of both are dependent upon each other. Yet, if this relationship between critical thinking and argument—critical thinking occurs through and results in argument—is acceptable, I think that one more view of it becomes necessary to understand the components of arguments. In this case, I would like to adopt O'Keefe and Wenzel and then add to their alliteration with a fourth *p* to further define *argument*: purpose.

Essentially, I think that the purpose of arguments—specifically arguments to attain scientific literacy—can be reduced to two specific components. Stephen Toulmin and rhetorical scholars Wayne Booth, Gregory Colomb, and Joseph Williams offer a suitable insight of the first component.

First, Toulmin has devoted much of his research in analyzing the distinct components of an argument. Essentially, according to Toulmin, arguments may contain the following components: claim, grounds (evidence on which the claim is based; sometimes referred to as data), warrant (connecting the grounds to the claim), backing (relevant support for the grounds), qualifiers (limitations of the argument), and rebuttals (acknowledgement of opposition to the argument) (Toulmin, *The Uses of Arguments*; Barnet and Bedau 293–301; Herrick, *Argumentation* 40–41). Although I agree with Toulmin's expanded concept, I believe that Booth, Colomb, and Williams provide a more streamline overview of an argument than Toulmin does, distilling its essential components: claim, reason, and evidence (*Craft of Research* 108; Williams and Colomb, *Craft of Argument* 41). Yet, like Toulmin, Booth, Colomb, and Williams also endorse acknowledging and responding to opposing ideas. To further clarify, these components may be read as a *claim* based on *reason* supported by *evidence* (I will return to this formula in Chapter 4). In this abbreviated form, the emphasis of an argument—and its link to critical thinking—becomes clear: reasoning. Without reasoning, a claim is merely an opinion, an assertion (Damer 15). Without reasoning, evidence is merely a fact lacking cohesion to an idea; without reasoning, no argument exists. Thus, the first component of an argument is the idea of reasoning.

Included in the component of reason is the idea of inquiry, by which I mean the process of understanding. Inquiry runs the gambit from establishing the extent of the problem through analysis and developing a hypothesis to testing of possible solutions (Young, Becker, and Pike 73–75). As a process, inquiry involves the learning of facts to become versed in a subject or topic (Herrick, *Argumentation* 8). Inquiry does not merely ask who, what, where, when, why, and how, but it also considers a plan of action to arrive at the correct answer.

Yet, an argument requires another component. In their *New Rhetoric*, Perelman and Olbrecths-Tyteca explain that "*it is in terms of an audience that an argument* *develops*" (5, Perelman and Olbrecths-Tyteca's emphasis). To these rhetorical scholars, argumentation seeks to persuade an audience to agree with the claims and evidence presented. Thus, an argument must be conducted with someone—an audience—and the success of that argument depends upon the audience's acceptance of the claim, the evidence, the arguer, and the manner of delivery (Zarefsky, *Argumentation: The Study of Effective Reasoning, Part 1* 12).

In their description of an audience, Perelman and Olbrecths-Tyteca identify two categories: universal and particular. A universal audience is an ideal audience, made up of "all, normal, adult persons" who are rational and interested in the interlocutor,[1] the argument, and the outcome of the argument. Here, the argument's purpose is to convict "the mind through reason," and the universal audience is convicted by reason alone (Ray 363–364).

Unfortunately, a universal audience is only ideal because it is only an idea; the universal audience is an *imagined* audience, one that every interlocutor dreams of addressing (Perelman and Olbrecths-Tyteca 30–31). Thus, the universal audience "is a mental concept of the speaker" (Ray 363).

In actuality, though, the interlocutor usually faces a particular audience, a *real* audience composed of people with diverse backgrounds, education levels, and worldviews. In this setting, the interlocutor must not only anticipate the audience's diverse needs but also must carefully construct the argument as if the information is new

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1. Perelman and Olbrechts-Tyteca use *interlocutor* to include a broad range of a specific participant in an argument, which may refer to an arguer, a presenter, a teacher, a speaker, a panelist, or a debater.

to the audience. Even though the audience members compose a single audience, the interlocutor must deal with individual opposition (Perelman and Olbrechts-Tyteca 30–31). Here, the argument's purpose is persuasion "to move the will" (Ray 363); in contrast to the universal audience's conviction by reason, a particular audience must be persuaded to reason. In summary, a universal audience is one that focuses on reason alone, and as such, is not real. In Perelman and Olbrechts-Tyteca's view, the interlocutor will face a particular audience, one that must be persuaded by means other than logic; such an audience is a real audience, and the interlocutor must consider the needs of the individual audience members in the argument.

Additionally, the size of the audience is unimportant. As critical thinking scholars Richard Epstein and Carolyn Kernberger observe, an argument can be "an attempt to convince oneself" (5). Rhetorician Kenneth Burke also emphasizes this relationship between persuasion and quantity of the audience by declaring that a person can be his or her own audience if *persuasion* is involved (38, emphasis mine). The need of an audience indicates the need of persuasion, and, therefore, the second component of an argument is persuasion.

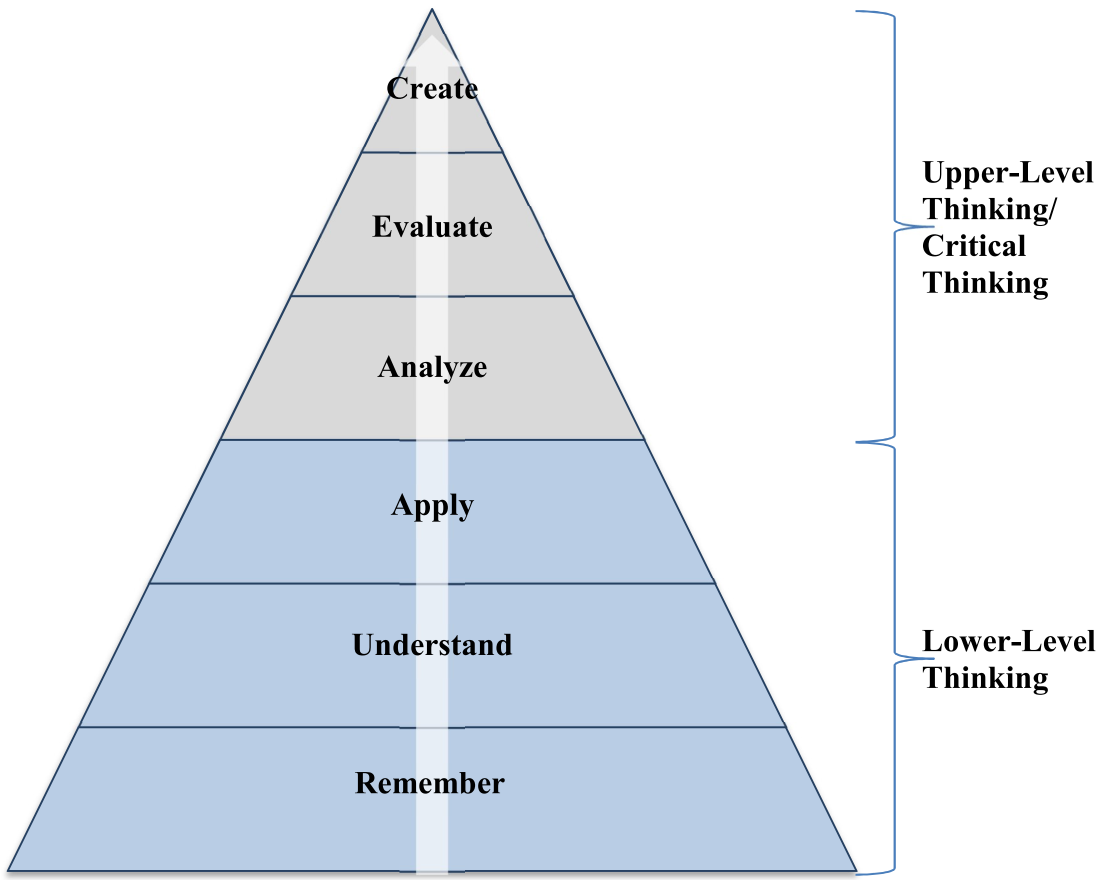
At this juncture, I am not attempting to classify arguments as one of the four Aristotelian categories—logical, dialectical, rhetorical, or sophistical refutations. Nor do I specifically go so far as Perelman to declare that all arguments are rhetorical arguments (*Realm of Rhetoric* ix, 162). Here, I merely attempt to demonstrate that all arguments include reasoning and persuasion and that these components are necessary for critical thinking, especially the critical thinking needed for scientific literacy. Nonscience majors are a particular audience, one that needs to be persuaded to think critically. And it is at this juncture that I must consider an address to the second component of critical thinking. However, I will return to the idea of reasoning and persuasion to explain how critical thinking occurs for a science nonmajor.

Critical Thinking: Outcome

So far, I have noted that critical thinking concerns itself with and results in argumentation for the purpose of reasoning and persuasion. It is this second aspect—the outcome of critical thinking—that spurs this next section. Specifically, critical thinking must include certain results or outcomes. Here, I consider two aspects of these outcomes: components and practice of critical thinking, with components leading to practice. As such, I think that these categories also describe the expected action.

If Siegel's claim that critical thinking is that the "*educational cognate* of rationality" (*Educating Reason* 32, Siegel's emphasis) is acceptable, then an educational perspective will be useful to understand the outcomes of critical thinking. Bloom's Taxonomy (or more correctly, the revised version of Bloom's Taxonomy) provides a descriptor of critical thinking categories. Fundamentally, the Revised Bloom's Taxonomy consists of six cognitive skills categories (*remember, understand, apply, analyze, evaluate,* and *create*) arranged from lower-order to higher-order thinking skills (Herreid, "Introduction" viii–ix; Adams 153; Krathwohl 214) and four knowledge categories ranging from concrete to abstract (*factual, conceptual, procedural*, and *metacognitive*) that intersect with each of the cognitive processes (Krathwohl 214). Although the knowledge categories relate to individual student learning within the cognitive skills and are certainly important, most educators emphasize, as will I, the cognitive skills alone. From this view, what stands out is the consideration of higher-level or critical thinking.

These cognitive skills are often referred to and illustrated as a pyramid, which underscores that thinking progresses from the lower-order to higher-order skills. Thus, remembering, understanding, and applying must be in place to achieve the higher-order thinking skills of analyzing, evaluating, and creating. These higher-order thinking skills are considered as critical thinking (Herreid, "Introduction" viii); accordingly, critical thinking does not occur unless one analyzes, evaluates, and creates (see Figure 2). As



Sources: Adams, Nancy E. "Bloom's Taxonomy of Cognitive Learning Objectives." *Journal of the Medical Library Association* 103.3 (2015): 152–153. Web. 07 Aug. 2015.
Krathwohl, David R. "A Revision of Bloom's Taxonomy: An Overview." *Theory into Practice* 41.4 (2002): 212–218. *JSTOR*. Web. 7 Aug. 2015.

Figure 2. Revised Bloom's Taxonomy: Levels of Thinking

Paul and critical thinking specialist Linda Elder summarize, "Critical thinking, then, has three dimensions: an analytic, an evaluative, and a creative component. As critical thinkers, we analyze thinking in order to evaluate it. We evaluate it in order to improve it (xx)." Reasoning includes remembering, understanding, and applying information, but it is not until one actually engages this information by analyzing, evaluating, and creating new information that critical thinking occurs.

Interestingly, *analyze* and *evaluate* are not synonymous terms; rather, analysis deals with the ability to compartmentalize and determine relationships within argument components, while evaluation deals with judgment of criteria and standards (Krathwohl 215). In fact, communication scholar David Zarefsky distinguishes between argument, analysis, and evaluation, claiming that arguments depend upon not only analysis but also appraisal (*Argumentation: The Study of Effective Reasoning, Part 2* 93).

Yet, the category of *create* poses another challenge and leads to the question, "Create what?" As Education professor David Krathwohl explains, *create* constitutes putting "elements together to form a novel, coherent whole or make an original product" (215); *create* simply indicates that the critical thinker takes the analysis and evaluation to create something new. Since I have already identified the subject matter of critical thinking (arguments), then it is fair to say that critical thinking occurs when one analyzes, evaluates, and creates arguments, including arguments that may reject, accept, or apply claims set forth in the original argument considered.

As I mentioned, components lead to practice, and using the Revised Bloom's Taxonomy, I think the differentiation of components and practice blur as indicated by the fact that the Revised Bloom's Taxonomy emphasizes the use of verbs to describe the expected outcome action for these components. In other words, *analyze, evaluate*, and *create* are both categories and actions. More importantly, critical thinking results in action. It is not enough for one merely to think critically; one also must do.

From the onset of this chapter, I have claimed that critical thinking needed to attain scientific literacy for nonscience majors is rhetorical. While presenting my evidence, I have defined *critical thinking* in relation to *argument*. In doing so, I have noted the inclusion of reasoning and persuasion (see Figure 3). To step from reasoning and persuasion to rhetoric would be a simple matter. Yet, as my earlier contentions will demonstrate, rhetoric deserves a more detailed investigation, specifically as it relates to scientific literacy.

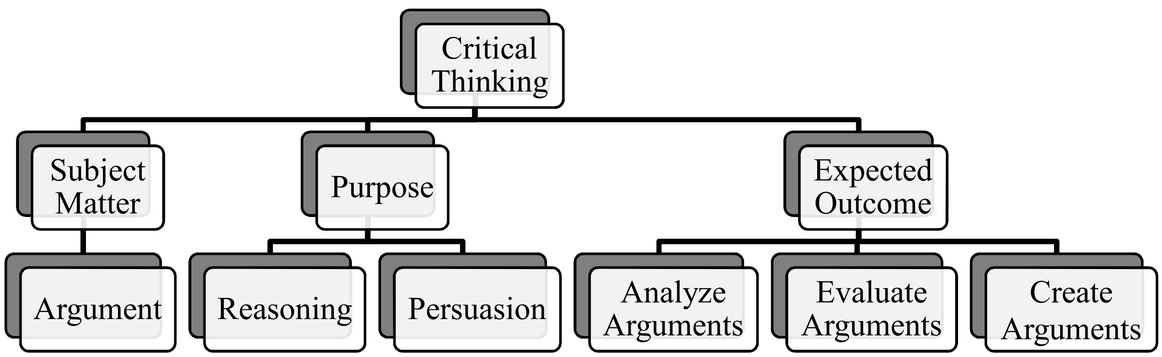


Figure 3. Components of Critical Thinking

As I noted, I resist Wenzel's application of rhetoric, dialectic, and logic to argument as process, procedure, and product, respectively. In this proposal, Wenzel has blurred three distinct categories as occurring within one argument. My contention with Perelman's oversimplification that all arguments are rhetorical arises from Perelman's departure from Aristotle's idea of the four argumentation categories, specifically Aristotle's distinction between rhetoric and dialectic as separate entities and the interaction of persuasion. I think that it is this relationship between rhetoric and dialectic *and* the use of persuasion that holds the key to understanding critical thinking in regards to scientific literacy. Therefore, I will subscribe to an Aristotelian explanation of *rhetoric*.

DEFINING RHETORIC: AUDIENCE, PURPOSE, AND TOOLS

In defining *rhetoric*, I begin by referring to Aristotle's own definitions of the term in his treatise *Rhetoric*. Here, I look specifically at two entries. In the first case, Aristotle describes rhetoric as it relates to dialectic, and in the second case, he describes it in relation to persuasion. In this way, I intend to define rhetoric according to its audience, its purpose, its basic tools, and its outcome. However, before I construct such a definition by limiting my source to only *Rhetoric*, I must acknowledge the problem of such a limitation.

Acknowledgement: Corpus Problem

Rhetoric often is criticized for its textual inconsistencies, and the current version of *Rhetoric* certainly has earned these concerns. As any reader of the corpus undoubtedly has seen, Aristotle at times seems confused, forgetful, or uncaring about his own idea and definitions. McAdon visits these textual problems several times, including his thorough examination of the enthymeme ("Probabilities, Signs, Necessary Signs, Idia, and Topoi: The Confusing Discussion of Materials for Enthymemes in the *Rhetoric*") and his extensive consideration of *pisteis* ("Two Irreconcilable Conceptions of Rhetorical Proofs in Aristotle's *Rhetoric*"). Gross and rhetorician Marcelo Dascal best summarize these issues as an "editorial jumble" (288).

Rhetorical historian Arthur Walzer and Communication professor Brandon Inabinet categorize the concerns with the corpus as follows: evolution of the text, editorial packaging, and the possibility of outside textual revisions (166–167).

Rhetorician George Kennedy subscribes to the first category, holding that the current corpus basically is the same text Aristotle had in his library at the time of the philosopher's death; essentially, the current text is a result of Aristotle's own revision from lecture notes to final package (*On Rhetoric* 17).[2]

Classicist William Fortenbaugh represents the thinking of the second category. Here, Fortenbaugh recognizes that the current version of *Rhetoric* is indeed the handiwork of Andronicus's editing (155–156); much of what we know or understand about *Rhetoric* (indeed, even what we attribute to Aristotle's own thinking on the subject) comes from Andronicus's work.

McAdon exemplifies the third category by proposing that Andronicus's editing went further than rearranging and combining of texts to the point of actually combining the rhetorical works of Theophrastus with those of Aristotle ("Strabo" 100). Thus, the current *Rhetoric* is more a work of multiple authors than Aristotle alone, which explains many of the inconsistencies.

In an attempt to resolve this troubled editorial history and the textual inconsistencies, Gross and Dascal claim that these issues do not diminish the concepts of rhetoric (288). Basically, Gross and Dascal indicate that current rhetorical tradition owes its existence to this text regardless of its history or problems. Although I am not comfortable with their ready acceptance, I cannot disagree with their inference that *Rhetoric* is the basic text from which rhetorical tradition arises, especially the modern

2. Ironically, in his Appendix II.B, Kennedy's own account of the transmission of Aristotle's library after Aristotle's death follows closely to McAdon's detailed history of these texts. However, Kennedy carefully avoids including the documented damage and the following edits and re-edits of Aristotle's library by stating that no evidence exists that Aristotle's *Rhetoric* was among these texts (*On Rhetoric* 307).

concept of Aristotelian rhetoric. So, although originality, consistency, and even authorship may be in question, the current text itself remains a core component of Aristotelian rhetorical tradition, and for that reason, I include its concepts.

Rhetoric: Audience

First, Aristotle defines rhetoric as "an *antistrophos* to dialectic" (1354a 1.1.1).[3] Here, Aristotle defines *rhetoric* according to its similarities. Indeed, throughout Book I alone, Aristotle describes the correlation between dialectic and rhetoric three different ways. First, rhetoric is a counterpart to dialectic (1354a, 1.1.1). Second, rhetoric is an offshoot of dialectic (1356a, 1.2.7). Third and finally, rhetoric is partly dialectic *and* resembles dialectic (1356a, 1.2.7).

According to Kennedy, dialectic was "the art of philosophical disputation" (*On Rhetoric* 28) and served as structured exercises for students to argue both sides of an issue, effectively learning to define and divide issues as well as discern appropriate authority (*A New History of Classical Rhetoric* 52). Dialectic progressed as a debate through a series of yes or no questions, with one student acting as the respondent and the other as the questioner (Raphael 154). But Aristotle first describes rhetoric as an *antistrophos* to dialectic. Although most scholars define *antistrophos* as *counterpart*, I think that Aristotle's word choice offers more detail to his meaning. The term *antistrophos* is derived from the term *antistrophē,* which, in Greek theatre, was a cue for the chorus to repeat the *strophē* (stanza), but with different words, which emphasized the meaning of the stanza (Brunschwig 35). In other words, the *antistrophē* (chorus) echoed,

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3. Unless otherwise noted, all references to Aristotle's *Rhetoric* are from the George A. Kennedy translation, *Aristotle: On Rhetoric* (New York: Oxford UP, 2007).

supported, emphasized, and explained the *strophē* (stanza). In theatre, both parts are important, but have different roles. In his description, Aristotle simply compares rhetoric to dialectic to distinguish the role of each. Hence, Aristotle indicates the contrast between rhetoric and dialectic to explain how they work within the context of each other. To exemplify this contrast and context, I refer to rhetorical scholars Michael Leff and Brad McAdon.

In "Rhetoric and Dialectic in the Twenty-First Century," Leff describes a simplified difference between rhetoric and dialectic, maintaining a delicate balance of cooperation and necessity among these means of reasoning. Briefly, Leff describes the differences as follows:

> (1) Dialectic deals with general, abstract issues, rhetoric with specific, circumstantial issues; (2) dialectic considers the relationship of propositions to one another and follows norms of logical rationality, while rhetorical argumentation considers the relationship between propositions and situations and follows norms that refer to appropriate social relationships; (3) dialectic proceeds through question and answer, and the interlocutors seek to persuade one another; rhetoric proceeds through uninterrupted discourse, and speakers seek to persuade the audience; and (4) dialectic employs unadorned, technical language, whereas rhetoric accommodates and embellishes language for persuasive purposes. (247)

In his approach, Leff highlights the differences, ascribing a more humanistic approach to persuasion with rhetoric while placing a more formal, technical, and seemingly procedural approach to dialectic. To Leff, rhetoric concerns itself with persuasion of an audience while dialectic deals with logic. Still, Leff warns against considering rhetoric and dialectic as “categorical opposites” (247); rather, both serve as a means of reasoning, intent on the situational needs created by the rhetor’s intentions and the audience’s needs.

In his seminal work “Rhetoric Is the Counterpart to Dialectic,” I believe that McAdon provides a strong and practical distinction between rhetoric and dialectic, offering greater clarity while imparting the need for both. In his clarification, McAdon notes that Aristotle “understands rhetoric to be an important part of his understanding of discourse, perhaps as important a part as his dialectic,” but also highlighting that these components must be “*understood within their intended purposes and intended participants and/or audiences*,” with dialectic providing the key to understand rhetoric (114, McAdon’s emphasis). To Aristotle, McAdon specifies that dialectic “deals with arguing and discussing, questions and answers” with a knowledgeable audience (128), whereas rhetoric provides “the available means for persuasion, to earn the trust or confidence” of an audience who cannot follow lengthy reasoning or is untrained (143). In short, McAdon observes that dialectic requires involvement among well-informed participants, while rhetoric allows the audience to merely pass judgment based on the persuasiveness of the rhetor, implying that dialectic works better to address the educated while rhetoric appeals to the ignorant. In summary, rhetoric provides the means for an uneducated or uninformed audience to participate in subjects outside that audience’s knowledge base, and it is this audience that leads to the understanding of rhetoric’s practical purpose. Rhetoric better serves the layperson. (Table 3 provides a side-by-side comparison of dialectic and rhetoric.)

Table 3. Aristotelian Comparison of Dialectic and Rhetoric

	Dialectic	Rhetoric
Issues[1]	General, abstract	Specific, circumstantial
Relationships[1]	Propositions to one another	Propositions and situations
Norms[1]	Logical rationality	Appropriate social relationships
Process[1]	Question and answer	Uninterrupted discourse
Persuasion[1]	Interlocutors seek to persuade one another	Speakers seek to persuade the audience
Language[1]	Unadorned, technical	Accommodates and embellishes for persuasive purposes
Purpose[2]	Arguments and discussions, questions and answers	Persuading, earning trust or confidence
Audience[2]	Knowledgeable	Unable to follow a lengthy argument, untrained

[1]Michael Leff, "Rhetoric and Dialectic in the Twenty-First Century," 247.
[2]Brad McAdon, "Rhetoric Is the Counterpart to Dialectic," 128, 143.

For scientific literacy, rhetoric provides a means for the layperson—here, the science nonmajor—to engage in scientific discourse. Rhetoric allows nonscience majors to participate in science.

Rhetoric: Purpose

As a second consideration, Aristotle implies a three-fold purpose for rhetoric. On one hand, Aristotle continues his definition by viewing rhetoric as "an ability, in each [particular] case, to see the available means of persuasion" (1355b, 1.1.1). Although I do not deny that this passage implies the *employment* of persuasion (indeed, in the creation of arguments, employment of persuasion is necessary, as I will discuss shortly), I think that Aristotle's understanding of rhetoric also emphasizes the *awareness* of persuasion in any given situation. If read this way, Aristotle's treatise seems more intent on describing the means to recognize when persuasion is being used rather than how to apply such persuasion. Essentially, I see Aristotle's definition including the view that rhetoric is a means of discernment.

As discernment, rhetoric can also be seen as a means of protection. Logicians Richard Epstein and Carolyn Kernberger note that the bombardment of "too much" information and influence necessitates critical thinking (11). In this case, rhetoric as discernment fulfills this particular requirement of critical thinking, serving as a means of assessment. Another way to view Epstein and Kernberger's concern may include rhetorician's Wayne Booth's concept of "rhetrickery," or the "whole range of shoddy, dishonest communicative arts producing misunderstanding—along with other harmful results" (11). To Booth, rhetrickery involves all forms of discourse that either intentionally or unintentionally misleads or misinforms. It is this need for protection that rhetoric as discernment provides. As rhetoric aids the uneducated with discernment, it also supplies this audience with the tools to achieve this discernment.

As a second purpose, as I hinted, rhetoric is also a means to persuade. To equate persuasion as rhetoric misinterprets the unique and complex nature of rhetoric itself. However, to see rhetoric as a means to create arguments is undeniable, since arguments by nature include and result in persuasion. Rhetoric persuades through argumentation (Herrick, *Rhetoric* 13). Indeed, it requires little effort to see Aristotle's *Rhetoric* as a how-to guide to produce arguments (Tindale, "Introduction" 6). In fact, Kennedy sees *Rhetoric* as a collection of lectures that Aristotle used for his students to teach public speaking, which later was refined into its current form (*On Rhetoric* 3).

Still, a third view exists, one that merges the views of rhetoric as discernment and persuasion. As Communication professor Gerard Hauser observes, rhetoric "is basic to public life" (43). In this view, Hauser regards rhetoric as a necessary practical device—both knowledge of rhetoric and skill to employ it—that serves the public as it engages in discourse. I will return to this view in my conclusion.

Although my focus at this point concerns the audience involvement of rhetoric, I will touch on the aspect of creating arguments when I deal with pedagogy (Chapter 4). Nevertheless, if rhetoric involves an audience as I contend, then tools must be available to engage in or judge public discourse; *Rhetoric* includes such tools.

Rhetoric: Tools

Rhetoric as discernment lends itself to Aristotle's examination of the three artistic proofs, or *pisteis*, and the enthymeme. If rhetoric addresses a specific audience as McAdon suggests, then these proofs may be considered as the means by which the audience engages arguments. I will view these proofs and the enthymeme as participatory tools of rhetoric. My purpose here is merely to identify and explain these tools rather than provide an extensive overview of them.

Missing from my list is paradigm, which I consider as sort of a rhetorical comparison or example. Although Aristotle states that logical persuasion comes only through paradigms and enthymemes (1356b, 1.2.8), he states that paradigms are a type of induction that the rhetor uses to ensure clarity. My point here is that the paradigm is an external tool offered outside of the audience (by the rhetor), whereas the artistic proofs and the enthymeme are internal tools produced by or with the audience. In other words, the proofs and the enthymeme invite audience participation. In this discussion, I am more interested in this internal deduction on the audience's part.

Aristotle labels the species of artistic proofs as *ethos*, *pathos*, and *logos*, with *ethos* referring to credibility or ethics, *pathos* indicating emotion, and *logos* meaning reason or logic; Aristotle insists that each of these proofs yields persuasion (1356a, 1.2.2–1.2.6). In Aristotle's observation, an audience is governed by more than one means of persuasion, with each proof sharing equal importance in convincing an audience. As Communication scholars Karlyn Kohrs Campbell, Susan Schultz Huxman, and Thomas R. Burkholder explain, "From the beginnings of rhetoric in classical antiquity, rhetoricians have understood that persuasion occurs through both argument and association, through the cold light of logic and the white heat of passion, through explicit values and subconscious needs and associations" (6). In *Rhetoric*, Aristotle acknowledges and embraces the diversity of reasoning within all humans. As English professor James Kinneavy explains, as long as humans are creatures governed by emotions that influence judgment, rhetoric is not only useful but also necessary (224).

Aristotle recognizes the makeup of the human mind, indicating that these components influence decisions. However, another way to view these proofs is that they are the means by which an audience judges an argument. In short, an audience judges an argument according to the credibility of the arguer, the emotions stirred, and the reasoning of the argument itself. The artistic proofs are as important to the audience as they are to the rhetor. The audience, not the rhetor, judges the effectiveness of an argument.

Aristotle explains that proofs are a type of demonstration (1355a, 1.1.11), or more specifically, as Kennedy notes, a scientific demonstration (*On Rhetoric* 33). And while introducing the artistic proofs, Aristotle also mentions the enthymeme, which he calls “the ‘body’ of persuasion” (1354a, 1.1.3), “rhetorical demonstration,” and the “strongest” of the proofs (1355a, 1.1.11). Remaining in the context of dialectic, Aristotle describes the enthymeme as a “sort of syllogism” (1355a, 1.1.11); where dialectic involves the syllogism, rhetoric uses the enthymeme. So, at its heart, the enthymeme can be considered as an argument; at its fullness, an enthymeme can be considered as a form of deductive argument (Kennedy, *On Rhetoric* 21; *Classical Rhetoric* 85). However, its relationship to dialectic seems to be the problem with and the key to understanding the enthymeme.

The remainder of *Rhetoric* does little to clarify the enthymeme. As Bitzer declares, “[T]he reader of Aristotle's *Rhetoric* will find no unambiguous statement defining the enthymeme” (“Enthymeme” 399). Because of this confusion, modern scholars disagree as to the actual definition of *enthymeme*. One view includes the often-repeated “truncated syllogism” (Spranzi 95; Ramage, Callaway, Clary-Lemon, and Waggoner 202). However, Bitzer counters that an enthymeme is not a truncated syllogism but rather an “incomplete syllogism” where the audience supplies the premise intentionally omitted by the rhetor (“Enthymeme” 407). In this sense, the enthymeme is a sort of fill-in-the-blank process involving the audience. Yet, as philosopher M. F. Burnyeat argues, Aristotle never mentions omission as a condition of the enthymeme, but rather stresses brevity (100). Indeed, Aristotle states that enthymemes “are drawn from few premises,” usually fewer than used in a syllogism (1357a, 1.2.13). This brevity occurs not for economy—ridding the argument of unnecessary information—but for ensuring audience agreement (Jackson and Jacobs 264). In this view, the enthymeme—a rhetorical deduction of sorts—remains faithful to the idea that rhetoric serves a specific audience—one that requires an abbreviated demonstration. Still, Bitzer is correct in his notion that an enthymeme involves a relationship between the rhetor and audience (“Enthymeme” 408). By this agreement, I simply mean that an enthymeme is constructed with the audience in mind and involves the audience’s participation to succeed.

This structured relationship may be understood better by examining the word *enthymeme* itself. As rhetorical scholars Arthur B. Miller and John D. Bee demonstrate, the root of *enthymeme*—*thymos*—literally translates to heart or soul, which means that an enthymeme involves the emotions (201–202). Thus, the basis of the enthymeme structure depends upon the emotions and beliefs of the audience. This understanding seems to fit with Aristotle’s own description of the enthymeme, which he states have the “ability to aim at commonly held opinions [*endoxa*]” (1355a, 1.1.11). Since at least one or more of its premises are drawn from the audience, the enthymeme is unique to and understood by that specific audience (Zarefsky, *Argumentation: The Study of Effective Reasoning, Part 1* 187). It is this team building that both allows the enthymeme to work and the argument to be successful. Perhaps Perelman bests summarizes this relationship: the argument modifies the “audience’s convictions or dispositions through discourse” by working together—the rhetor and audience—to develop a consensus of understanding (*Realm of Rhetoric* 11). The enthymeme has no power without audience influence; it is a social construct, built together by rhetor and audience.

Within this section, I have not tried to offer an exhaustive overview but merely to demonstrate that rhetoric is best understood in relation to an audience. Again, in defining rhetoric, I have tried to emphasize its need to involve the audience, and, as such, it can be seen as much as its reliance to audience participation to discern and judge persuasion as it is viewed as means to persuade. As Bitzer explains, the rhetor during discourse engages the audience so that the audience becomes the "mediator" of understanding ("Rhetorical" 4). I see this union as an equal partnership between rhetor and audience: persuasion cannot occur without the audience's permission, and the success of an argument rests solely on the relationship between the arguer and the audience. Rhetoric works both for the rhetor and the audience.

Rhetoric Outcome: Action

From rhetoric's audience, purpose, and tools, I have hinted at an outcome of rhetoric. To clarify this outcome, I offer Scottish philosopher George Campbell's understanding of rhetoric. In his *Philosophy of Rhetoric*, Campbell explains that rhetoric possesses four distinct purposes: enlighten the understanding, please the imagination, move the passions, or influence the will (1), or as Walzer clarifies, the rhetor seeks "to convince by appealing to the hearer's understanding, to please by appeal to the imagination, to move by appeal to the passion, or to persuade by appealing to the will" ("Campbell on the Passions" 79).

Although I have noted my own rhetorical purposes strictly from an Aristotelian view, Campbell's fourth component—influence the will—bears closer scrutiny and, as I hope to show, can be seen as a final outcome of rhetoric. Campbell sees rhetoric as connected to human nature, and in fact, reflects the relationship between communication and his era's fascination with philosophy (Bitzer, "Editor's Introduction" xxii–xxiii). In this context, Campbell's "influence the will" means that if the rhetor persuades the audience, then the audience is *persuaded to action* (Walzer, *George Campbell* 40. Thus, the outcome of rhetoric is to move the audience to action; successful rhetoric must be followed by action on the part of the audience. (See Figure 4.)

Likewise, critical thinking cannot occur without the audience's engagement of the argument at hand. Perelman echoes a similar thought, noting, "Argumentation very often aims at inciting action, or at least at creating a disposition to act" (*Realm of Rhetoric* 12). Without rhetoric, this engagement, and, thus, critical thinking, cannot occur. As an observation, rhetoric allows one the means to engage and create arguments; I understand rhetoric as the key to critical thinking. In the context of scientific literacy, rhetoric offers the means for noncience majors the ability and tools to analyze, evaluate, and create arguments regarding scientific topics.

Until now, I have discussed critical thinking, argumentation, and rhetoric in general terms, establishing their interaction and dependence on one another. But now, I must ask if rhetoric can lend itself to understanding science. If science is a product of arguments, then, yes, rhetoric seems ideal in aiding the public to address scientific arguments. If the goal of science education is scientific literacy, then rhetoric seems likely to also help attain this literacy, especially if the goal of scientific literacy is critical thinking, which I have attempted to show here as the means to analyze, evaluate, and create arguments. Fortunately, a specialized version of rhetoric does exist that deals specifically with science. At this point, I will define *rhetoric of science*.

DEFINING RHETORIC OF SCIENCE

To define *rhetoric of science*, I will look at the definition or understanding of the term from four pioneering concepts of the discipline. Then, I will seek to examine a more

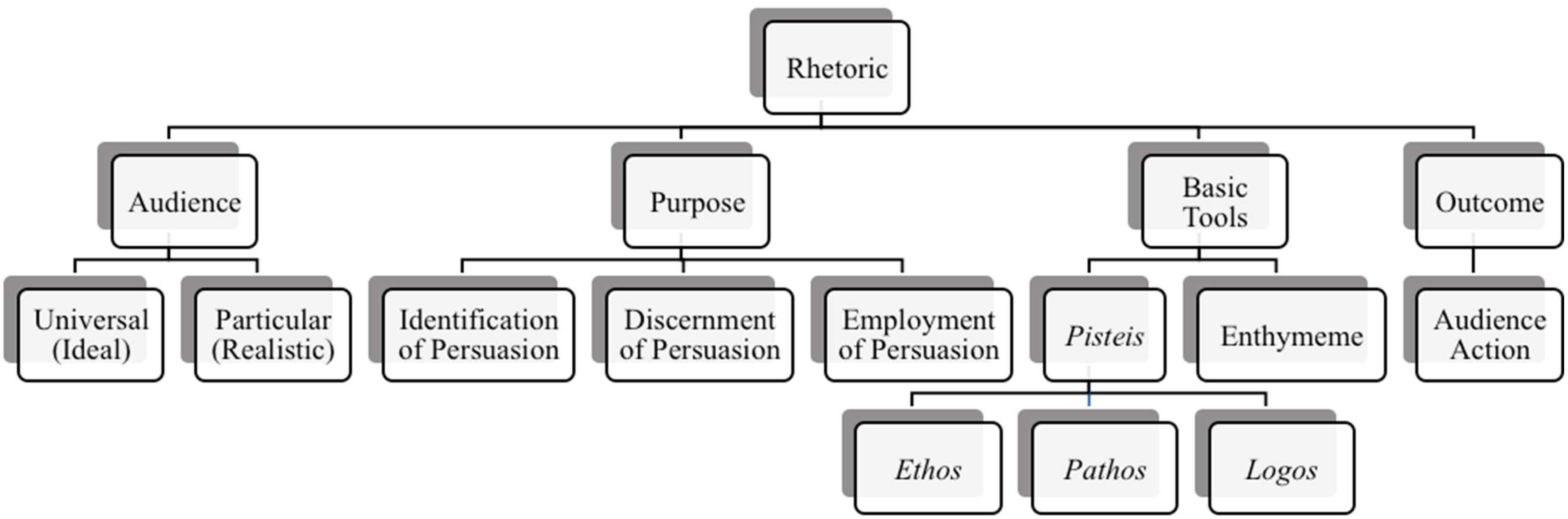

Figure 4. Basic Understanding of Rhetoric

unifying definition of the term that relates to scientific literacy and will return to Zerbe's intent of scientific literacy.

First, Gross expounds that rhetoric (here, meaning the arguments used in scientific texts) provides a "different though not inferior" means to produce scientific knowledge, utilizing the "texts, tables, and visuals of science" (*Starring the Text: The Place of Rhetoric in Science Studies* ix).[4] In this way, rhetoric uses written, spoken, and visual resources to help an individual construct meaning, serving as a bridge between information and learning; it is a means to utilize all available resources to communicate information. In this interpretation, Gross defines *rhetoric of science* according to its mechanics, or how persuasion occurs in scientific texts.

Second, Communication professor Lawrence J. Prelli sees rhetoric of science as the means of using rhetoric in "*creating* and *evaluating* scientific communication" (1). In his study, Prelli is more concerned with how scientific texts are created and presented; in essence, Prelli, like Gross, focuses on how science persuades through its texts.

In these views, Gross and Prelli demonstrate one of two perspectives of rhetoric of science: the study of scientific texts. However, works such as sociologists Bruno Latour and Steve Woolgar's *Laboratory Life: The Construction of Scientific Facts* and sociology professor Steve Fuller and science and technology professor James Collier's *Philosophy, Rhetoric, and the End of Knowledge: A New Beginning for Science and Technology Studies* demonstrate another concern of rhetoric of science: the field of science. In this second perspective, scholars study arguments that occur within the

4. In his earlier work, *The Rhetoric of Science* (1990), Gross relates rhetoric of science to a rhetorical analysis of scientific arguments (5). By 2006, he amended his idea (*Starring the Text* ix).

scientific community and arguments that arise with “outsiders,” or non-professional scientists that include “those completely ignorant of science” or those who “do not aspire to join the ranks of professional scientists” (Latour and Woolgar 19–20).

In a third definition of *rhetoric of science*, rhetorician Randy Allen Harris covers both of these aspects by breaking down the terms individually; thus, he defines *rhetoric of science* simply as “the study of suasion in the interpretation of nature” (“Rhetoric of Science” 284), or the study of how scientists argue to make knowledge; by *suasion*, Harris means both dissuasion and persuasion (“Introduction” xii).

To be fair, these scholars—and many other scholars who examine scientific rhetoric—address an important facet of rhetoric of science: how scientists persuade within their specific arguments. Obviously, to understand and evaluate arguments means one must understand how arguments work (Tindale, *Rhetorical Argumentation* 20). In their examinations, these scholars demonstrate that scientists succeed in their arguments because they understand how to persuade their audiences. In short, scientists succeed in rhetoric because they themselves are rhetors or rhetoricians. As Harris observes, “Scientists make knowledge because they are rhetors,” and they construct by means of dissent (“the immensely productive, back-biting, barking ways that scientists forge truth”) and assent (“the smoothly pervasive, communal, cooperative concert in which they arrange their truths into knowledge”) (“Assent, Dissent, and Rhetoric in Science”14). As a more direct example, John Angus Campbell declares Charles Darwin a “rhetorician of science” because of Darwin’s “accommodation of his message to the professional and lay audiences whose support was necessary for its acceptance” (“Charles Darwin: Rhetorician” 3).

From this observation that science requires the support of the laity arises my fourth offering of a historical view of rhetoric of science. Communication professors Philip C. Wander and Dennis Jaehne define rhetoric of science as possessing two purposes: a means that scientists use to communicate among themselves and means for the public to understand scientific facts as a citizenry (218). Here, Wander and Jaehne also acknowledge that science extends beyond the test tube boundaries of the laboratory; rhetoric of science is a means of communication among scientists and a means of communication from scientists to the nonscientist. Rhetoric of science serves two worlds: science and the laity.

Yet, to be useful for students to engage scientific arguments, rhetoric of science must do more than offer examples of scientific rhetoric. Clearly, to attain scientific literacy as I have described in Chapter 1, students must critically engage scientific arguments. And as I have discussed in this chapter, critical thinking requires students to create their own arguments. So, just as scientists must be rhetors or rhetoricians to argue successfully, so, too, students must be rhetors and rhetoricians to attain scientific literacy.

Therefore, I see rhetoric of science as going beyond the mere study of scientific persuasion; rhetoric of science must include the articulation of the findings and new information from such study. In this way, I agree with Zerbe's idea of rhetoric of science, which includes the study of scientific texts as well as the presentation of what is discovered within the study. Zerbe's scientific literacy fulfills the idea that I have presented in this chapter: critical thinking includes the analysis, evaluation, and creation of arguments.

As a means of clarification, Zerbe's understanding of *rhetoric of science* includes composition. Indeed, when Zerbe notes the use of "rhetoric and composition," he emphasizes that the critical thinking from scientific literacy must be communicated; thus, rhetoric and composition are not separate disciplines. In fact, as Composition professor Elizabeth Stolarek explains, composition as a discipline has been seen traditionally as a means to develop critical thinking using rhetoric (3). As I have implied, if students study arguments, then they must engage rhetoric; composition is simply the fulfillment of this engagement.

To demonstrate this symbiosis of composition (and subsequently, rhetoric) and critical thinking, I offer three points of evidence. First, as famed Composition and English professor Janet Emig observes, composition (or *writing* as she calls it) is the visual demonstration of learning by the student (123). In this respect, Emig confirms two components that I claim critical thinking requires: analysis and creation, or as she calls it, *synthesis* (127). However, I believe that Emig either merges the idea of analysis and evaluation as simply analysis, or she does not regard evaluation as a separate or necessary component. Nevertheless, Emig clearly implies the student's active involvement in critical thinking through composition.

Second, English, Composition, and Rhetoric professors Sharon Crowley and George Redman explicitly note the necessity of rhetoric in composition, unifying the connection of composition and rhetoric with critical thinking. Using the similar terms *analysis* and *synthesis* and these terms' definitions as Emig employs them, Crowley and Redman focus more on the rhetorical employment necessary to complete the process of composition. Here, Crowley and Redman insist on the rhetorical tradition of invention and the need for student expression, also accomplished by rhetoric (279). Additionally, these authors highlight the rhetorical relationship between writer and reader, or *ethos* and *pathos*, according to Crowley and Redman (280). Furthermore, the extended triune relationship amongst the writer (or student), the composition itself, and the reader (or audience) relies on rhetoric for unity and success (281). Because of this relationship, the creative portion of critical thinking is fulfilled as composition.

Third, Booth, Colomb, and Williams explain that composition allows the writer to remember, to understand, and to test one's thinking (11–13). It is in this physical act of composition that students consider the nuances of the argument not just for themselves but also for their audience; composition provides a visible record that allows both students and their audience to review, test, and strengthen an argument. In summary, composition is an expression of the critical thinking attained by scientific literacy; scientific literacy cannot be separated from the means to express such literacy.

CONCLUSION

Borrowing from Aristotle's infamous structure, Communication professor John Lyne states, "Rhetoric is the counterpart to ideology" (37). Lyne's revision indicates that rhetoric is similar to ideology in its methodology but differs in that rhetoric brings fulfillment of ideas. The completion of ideology requires the action that rhetoric provides.

In this chapter, I have attempted to offer a better understanding of the meaning of the terms *critical thinking*, *argument*, *rhetoric*, and *rhetoric of science* as they relate to scientific literacy (see Table 4). As I have tried to demonstrate, critical thinking is performed through arguments and brought into reality through rhetoric; in essence, critical thinking is a rhetorical endeavor that is conducted through arguments. If scientific

Table 4. Definitions: Critical Thinking, Argumentation, Rhetoric, and Rhetoric of Science

Term	Definition
Critical Thinking	The analysis, evaluation, and creation of arguments.
Argumentation	The act of critical thinking that includes the analysis, evaluation, and creation of arguments.
Rhetoric	The awareness and employment of the means of persuasion. A means of engaging and discerning persuasion.
Rhetoric of Science	The analysis, evaluation, and creation of scientific arguments through composition.

literacy is to be attained, it should be through the careful analysis, evaluation, and creation of scientific arguments; rhetoric of science provides a logical means to attain scientific literacy.

If the conclusions of this chapter have merit, then it should be expected that rhetoric of science is used in teaching science courses to attain scientific literacy. In the next chapter, I will explore this premise.

CHAPTER 3

HOW SCIENCE IS TAUGHT

INTRODUCTION

Purpose Statement

In Chapter 1, I established that the goal of science education is scientific literacy and that literacy should result in critical thinking. In Chapter 2, I defined critical thinking according to its subject matter (arguments), its purpose (reason and persuasion), and its outcome (analyze, evaluate, and create). In essence, scientific literacy should produce critical thinking, which is the critical analysis, evaluation, and creation of arguments about a scientific subject. As I propose, to attain scientific literacy involves the use of rhetoric, or specifically rhetoric of science as I have defined it.

Yet, as I noted in Chapter 1, one of the problems concerning scientific literacy is the failure to establish an obtainable purpose or educational outcome, which leads me to my next research question: If scientific literacy is not effectively attained currently in undergraduate science nonmajor courses, how are these courses taught? If arguments are the focus of such critical thinking, then science instruction for nonscience majors should be expected to incorporate scientific arguments and, subsequently, rhetoric of science. Since scientific literacy remains a concern, I argue that although science courses provide scientific information, these classes in general do not promote scientific literacy because they do not engage scientific arguments or employ an effective rhetoric of science.

To test this claim, in this chapter, I conduct a review of how instructors actually teach science at the undergraduate level, which requires a sampling of instruction and curricula, various textbooks, and laboratory exercises used in courses across the United States. Thus, this chapter examines if and how instructors incorporate critical reading of scientific arguments and composition in their students' educational experience. In short, I am curious as to the use of critical thinking and rhetoric of science—as I have defined the terms in Chapter 2—to attain scientific literacy in the undergraduate science class.

The Problem with Scientific Education

Education professor David Terry best expresses the problem with past and current science instruction: "The lectures, textbooks, and perfunctory laboratory activities that are typical of science education often leave students with incomplete or incorrect knowledge of scientific principles, underdeveloped intellectual skills, and little awareness of the influence of science on their lives" (31). As described by Terry, classroom instruction, textbooks, and laboratory exercises appear to be a cornerstone of science instruction, but these means of instruction do little for the attainment of scientific literacy.

Terry's concerns are not isolated as others have recognized similar problems related to lectures, textbooks, and laboratory exercises. As a general overview, the problem with using these traditional teaching methods include the following:

- Lectures
    - Given to large introductory classes with little opportunity for student interaction (Belzer, Miller, and Shoemake 32);
    - Work best when the audience wants to be at the lecture (geared more toward professional meeting than classroom instruction) (Pigliucci 277);
    - Follow the coverage of material given in textbooks (Moore, "Doing More" 260).

- Textbooks
    - Focus more on science facts than the process of science (Pigliucci 277);
    - Recount scientific achievements, expound on accepted theory, illustrate only successful application, and compare these applications with patent observations and experiments; present a glossy image of successes rather than the trial and error of true science practice (T. Kuhn 10).
    - Tell students what to think rather than teaching students how to think (Fuller and Collier 217).
- Laboratory exercises
    - Present step-by-step instructions to arrive at predetermined outcomes; remove open-ended inquiry (Pigliucci 278).

Generally, these traditional components are more about facts than arguments; in each of these overviews, science instruction is a very methodical production line of preset processes and outcomes. Specifically, this traditional format of science instruction prevents the very educational goals that science instruction strives to attain by denying students access to how science is actually performed; *science production via argumentation is missing*. Such instruction is passive, with students having little to no involvement in their own learning process (Moore, "What's Wrong with Science Education" 336; Pigliucci 227). In other words, students are given no opportunity for active participation—including analysis, evaluation, and creation—in the learning experience.

METHODS

Following Terry's lead, I focused on lectures (that I will expand to include classroom instruction), textbooks, and laboratory exercises. Thus, to understand how science is taught, I needed to review lectures, textbooks, and laboratory experiments. From these instructional means, my review considered the assignments and grading of students in these classes; I looked specifically for the use of scientific arguments and composition as a means to foster critical thinking as I defined in Chapter 2.

First, I chose the textbooks to facilitate the accompanying syllabi; picking the textbook first made finding syllabi using these texts easier. Fortunately, three book representatives from McGraw-Hill, Pearson, and Cengage graciously allowed a review of their top-selling introductory biology textbooks for nonscience majors. From this availability, the following criteria were used to select the texts:

- Texts must be used for nonscience majors at the undergraduate level.[1]
- Texts must be accessible (either by online or print review).
- Texts must have matching syllabi (available online).
- Texts must be used by more than one school (as proven by the availability of online syllabi).

After satisfying these criteria, the following three texts were chosen:

- Cecie Starr, Christine A. Evers, and Lisa Starr. *Biology: Today and Tomorrow without Physiology*. 3rd ed. Cengage Learning, 2010.

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1. This stipulation did not forbid the use of books that were also used in science major classes as long as the book in question was the required textbook in an undergraduate science nonmajor course.

- Mariëlle Hoefnagels. *Biology: The Essentials*. St. Louis: McGraw-Hill, 2013.
- Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, and Robert B. Jackson, eds. *Campbell Biology*. 10th ed. Pearson, 2014.

Within these texts, I looked for any content that leads to scientific arguments, rhetoric of science, and any writing assignments that might be considered the construction of arguments.

Second, using these textbook titles as a keyword search, I chose course syllabi that used these textbooks and that were available online. Hopefully, these syllabi would state the required textbook and schedule of required reading, instructional methodology (lectures and laboratory), and means of grading; grading could include testing (quizzes and exams), writing assignments, and an overlap with laboratory assignments.[2] Again, I searched for any incorporation of scientific arguments, rhetoric of science, and writing assignments that might be considered the construction of arguments about a scientific subject.

I decided that a sampling of three syllabi per textbook would be sufficient to conduct a satisfactory review. To locate online syllabi that required these texts, the following criteria were used:

- Syllabi must be accessible online.

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2. The syllabi used for this review offered only information concerning grading rather than assessment. As the Carnegie Mellon University Eberly Center for Teaching Excellence and Educational Innovation distinguishes between the terms, *grading* and *assessment* both refer to learning; however, grading focuses more on evaluating student performance concerning assignments (and may include components such as attendance, participation, and effort), while assessment concentrates more on improving student learning and educational practices ("Assessment and Grading").

- Syllabi must be used for nonscience majors at the undergraduate level.
- Syllabi must be a nationwide (not merely one geographic region) representation of colleges and universities.

After determining the criteria, the following syllabi were chosen for each of the textbooks:

- *Biology: Today and Tomorrow without Physiology* (3rd ed.)
    - Biology 101n (General Biology), Central Michigan University (Spring 2013)
    - Biology 100 (General Biology), New Jersey City University (Fall 2014)[3]
    - Biology 160 (Study of Life—Biology), Seattle Central Community College (Fall 2012)
- *Biology: The Essentials*
    - Biology 100 (BIOL 100), Imperial Valley College (Fall 2013)
    - Biology 1005 (Concepts in Biology), The University of Oklahoma (Fall 2013) (the instructor is also the author of this text)
    - USU 1350 (Integrated Life Science), Utah State University (Spring 2013)
- *Campbell Biology* (10th ed.)
    - Biology 115 (Cells and the Evolution of Life), The University of Idaho (Spring 2014)

3. Although this syllabus states that the course requires *Biology: Today and Tomorrow with Physiology*, 4th ed., the actual ISBN listed on the syllabus is actually for *Biology: Today and Tomorrow without Physiology,* 3rd ed. Additionally, the syllabus states, “Previous editions can be used.”

- Biology 1B (General Introduction to Organismal Diversity, Ecology, and Evolutionary Biology), The University of California at Berkeley (Summer 2014)[4]
- BISC 120 Lg. (General Biology), University of Southern California (Fall 2014)

Third, I used these syllabi to determine if a laboratory experience was required for the class. Within this sampling, labs were not always required for these introductory biology classes. For those classes that did require a laboratory component, I simply focused on any required writing that was a part of assessment.

RESULTS

Lectures and Classroom Instruction

As shown in Table 5, lectures constitute a cornerstone of science instruction. In each of the nine classes reviewed, each course utilizes a form of lecture—face-to-face or multimedia—as its main means of teaching. Within the nine classes reviewed, five of the classes offer a means for the students to interact with the information shared during the lecture. Three of these classes—Biology 101n, Biology 100 (New Jersey City University), and Biology 160—require students to participate in discussion regarding the lecture and assigned textbook readings. The other two classes—Biology 1005 and Biology 115—require students to engage class material using an i>clicker 2 device, which allows students to respond to true/false, yes/no, or simple multiple-choice

4. Intended for biology majors, but "is open to all qualified students" ("Biology 1B Learning Outcomes" 1).

Table 5. Classroom Instruction and Syllabi

Classroom/Syllabi	Classroom		Laboratory Component	Arguments		Grading			Rhetoric of Science
	Lecture	Interaction		Reading	Composition	Quiz	Exam	Writing	
Biology 101n, Central Michigan University (online)	Yes	Discussion	Yes (reports)	No	Possibly ("Critical Thinking")	Yes	Yes	Yes	No
Biology 100, New Jersey City University (online)	Yes	Discussion	No	Yes	Possibly ("Review, Critique, Relate")	No	No	Yes (term paper)	No
Biology 160, Seattle Central Community College	Yes	Discussion	Yes (exercises)	No	No	Yes	Yes	No	No
Biology 100, Imperial Valley College	Yes	No	Yes	No	No	Yes	Yes	No	No
Biology 1005, The University of Oklahoma	Yes	i>clicker 2	Yes	No	No	Yes	Yes	No	No
USU 1350, Utah State University	Yes	No	No	No	No	Yes	Yes	No	No
Biology 115, The University of Idaho	Yes	i>clicker	Yes	No	No	Yes	Yes	No	No
Biology 1B, The University of California at Berkeley	Yes	No	Yes	No	No	Yes	Yes	No	No
BISC 120 Lg., University of Southern California	Yes	No	Yes	No	No	Yes	Yes	Yes (exam long essays)	No

questions. Specifically, Biology 1005 uses the i>clicker 2 for laboratory exercises and pop quizzes.

Grading within these classes vary. Every class except Biology 100 (New Jersey City University) employs quizzes and exams as part of grading. These quizzes and exams may include short-answer, multiple-choice, and/or true-or-false questions, and short and long essays.

Only three classes require what may be considered as a writing component. For this category, I define writing as a means to display an answer to a question but not necessarily an argument. For categorization in Table 5, I distinguish between *writing* (written answers to questions) and *composition* (structured arguments that deal with rhetoric and display critical thinking). My distinction of terms is more than one of semantics. I make this distinction due to three reasons: history, purpose, and conformity.

First, I note a historical significance. English professor Allison L. Harl observes that Hugh Blair's belletristic ideology helped establish the close relationship between rhetoric and composition within the nineteenth century (28). Indeed, Rhetoric and Composition professor Nan Johnson confirms this connection and application in nineteenth century North America (11–13). At this juncture in history, the idea of rhetoric and the examination of, as well as the creation of, argumentation is firmly associated with composition.

Also, famed Composition scholar Charles Bazerman holds that modern collegiate composition has been linked historically with rhetoric; writing classes that deal with argumentation or the formal prescriptions of writing are labeled as composition (3–4); academic writing utilizes rhetoric (18). Here, Bazerman concerns himself with the formal use of composition in college as a means of critical thinking (his specific terminology is "shaping knowledge"); traditionally, college composition establishes this foundation for students not only in English and Communication courses, but also other disciplines.

Second, composition has a specific purpose. As English professors Donna Reiss and Art Young explain, the purpose for most first-year composition courses is to learn "academic discourse," or constructing writing as it pertains to a specific discipline (62). This concept provides composition with a more formal distinction that differentiates it from writing. Not only does composition concern itself with form and structure, but it also aligns itself with rhetoric.

Third, as I have already noted, Zerbe strongly promotes the union of rhetoric and composition as a singular entity and action. Composition remains a more formal structure of writing that concerns itself with the rhetoric presented in arguments, especially scientific arguments. In each of these reasons, rhetoric is not only a factor of composition but also the focus. It is by this differentiation between writing and composition that I make the following observations.

In the biological sciences class (BISC 120 Lg.) at the University of Southern California, students may compose "long essays" as a part of their exams. However, the syllabus offers no information as to the length or content of these essays, and this class has no other writing assignment within the classroom.

The second class, Central Michigan University's online BIO 101n course, requires students to engage one question from the "Critical Thinking" section each week while also responding to another student's response to a "Critical Thinking" question. In this assignment, students must give evidence as to why his or her answer or response was given. Although not quite a structured argument, the aspect of reasoning is present rather than submitting a simple answer found within the text.

The third class with a writing requirement—Biology 100 at New Jersey City University—actually assigns two distinctive writing assignments. First, students must produce a 1,500-word term paper on "any topic related to the human body" (Morales 1). Second, students must read fifteen science articles and write a one-page summary of the article in which students "review, critique, relate" the article's information. In this assignment, students may read scientific arguments or scientific issues within popular science publications. However, it is unclear if either assignment involves composing arguments. Rather, the intent of the first assignment seems to be a formal means for students to report on what is learned in the class within a specific topic, and the intent of the second assignment seems to familiarize students with current scientific issues and how these issues may be presented in the media.

Even with these examples of more extensive writing, these assignments do not fall within the formal design of composition as I have described the concept. Even so, I would be remiss without offering some praise for these assignments. Indeed, I appreciate Central Michigan University's BIO 101 online course, where students must engage their peer's responses to the assigned "Critical Thinking" questions, which involves some form of discourse. And while the syllabus does not elaborate on the meaning of "review, critique, relate" in New Jersey University's Biology 100 course, I acknowledge and applaud the instructor's use of science popularizations as acceptable readings, which encourages students to read about science issues from sources other than a textbook.

Textbooks

Despite Science Education professor Hans O. Andersen's 1992 prediction that textbooks would be replaced eventually (175), textbooks still remain a component for teaching science over twenty years later. Yet, if these texts contribute to scientific literacy as I have defined it, then I should find some form of engagement of scientific arguments and the construction of arguments as evidence of critical thinking.

Interestingly, *Biology: Today and Tomorrow without Physiology* reprints "Long Foraging Movement of a Denning Tundra Wolf," written by Paul F. Frame, David S. Hik, H. Dean Cluff, and Paul C. Paquet and published in the June 2004 edition of the journal *Artic* (Appendix III). Using this article as an example, the textbook notes specific components of the article such as the title, authors, abstract, introduction, and references. More importantly, the authors walk the reader through the actual construction of the argument within the article, including the introduction, which connects the problem studied and the hypothesis; the method, which conveys how the research was conducted; the results, which observe the data collected; and the discussion, where the authors interpret the data and offer a tentative theory of their findings.

Unfortunately, reprinting this scientific argument comes with three drawbacks. First, this article is labeled to show primarily the components of the article; the actual argument is a secondary aspect. Second, this example appears in the appendix, where most undergraduate students would not willingly go to read. Third, no syllabus that uses *Biology: Today and Tomorrow without Physiology* assigns this reading. Although *Biology: Today and Tomorrow without Physiology* shares an example of a scientific argument, the textbook does not teach how to engage a scientific argument, nor does any class assign this reading.

Still, as shown in Table 6, each of the three textbooks examined provides some form of a writing component. In *Biology: Today and Tomorrow without Physiology*, two writing components exist: "How Would You Vote" and "Critical Thinking." *Biology: The Essentials* offers "Write It Out." Within its chapter review, *Campbell Biology* provides "Synthesis/Evaluation" as part of its three-level means to test student understanding of the chapter content.

Table 6. Science Textbooks

Textbooks	Writing Component	Scientific Arguments		
		Reading	Composition	Rhetoric of Science
Biology: Today and Tomorrow without Physiology (3rd ed.)	1. How Would You Vote? (short answers) 2. Critical Thinking (short answers)	No	No	No
Biology: The Essentials	1. Write It Out (short answers or lists)	Yes	No	No
Campbell Biology	1. Test Your Understanding: Synthesis/Evaluation (short answers)	No	No	No

However, in each of these examples, the emphasis for these writing assignments is short-answer questions. In this context, students are invited to apply the information learned from the reading to answer simple questions concerning science information within that chapter.

To be fair, "How Would You Vote" in *Biology: Today and Tomorrow without Physiology* offers students a contemporary science situation, where students are asked to read about the issue on the publisher's website (*CengageNow.com*) and then vote on the question presented. Indeed, this type of involvement is similar to the idea of argumentation and critical thinking that I present, but, no syllabi examined indicate that students must either access the publisher website or answer the question.

Laboratory Exercises

Among the nine courses reviewed, only Biology 100 (New Jersey City University) does not require a laboratory component. For the other eight classes, the laboratory experience may include lab reports or lab write-ups, written observations and results of the laboratory exercises. However, the instructions for these forms of writing are not provided by the syllabi. Rather, some general guidelines and warnings were offered. For Biology 101n, students are instructed that work must be submitted in the form of sentences and paragraphs. Biology 115 warns that poor communication—misspellings, poor grammar or syntax, and faulty logic—will negatively influence grades. BISC 120 Lg. expects lab write-ups to include observations, drawings, and calculations.

ANALYSIS

As I indicated at the beginning of this chapter, I am interested in discovering the use of critical thinking and rhetoric of science to attain scientific literacy within the undergraduate science classroom. In the courses and materials, including textbooks, lectures, and laboratory exercises, examined in this review, rhetoric of science was not a focal point of instruction. Although Biology 100 (New Jersey City University) does introduce students to science information outside the textbook and classroom, the concepts of rhetoric of science or argumentation are never noted in the syllabus.

Overall, these classes indicate that the planned instruction for students is to establish a base knowledge of scientific information. The lectures and classroom instruction from the syllabi generally follow the textbooks' order and content, with the laboratory exercises providing hands-on examples to support the classroom instruction. Although some classes require student interaction by online discussion or electronic submission, this interaction seems to be short answer or multiple-choice, true-or-false, or yes/no responses, respectively.

The writing assignments do little to engage scientific arguments. To illustrate this point, the Week 1 homework assignments for Biology 101n involved students answering the Digging into Data question and one Critical Thinking question[5] from the chapter covered in the textbook. With a choice of six different peacock butterfly photographs, the Chapter 1 Digging into Data question tasks students with the following:

> The photographs below represent experimental and control groups used in the peacock butterfly experiment that was discussed in Section 1.7.
>
> See if you can identify the experimental groups, and match them up with the relevant control group(s). *Hint*: Identify which variable is being tested in each group (each variable has a control). (Starr, Evers, and Starr 17)

As an example of the Critical Thinking question choices, Question 3 in Chapter 1 asks students the following:

> Procter & Gamble makes Olestra and financed the study described in Section 1.7. The main researcher was a consultant to Procter & Gamble during the study.

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5. For Biology 101n, all Critical Thinking questions are conducted as a group project, with students not in the assigned group charged with reviewing the assigned group's response and commenting on this group's answer.

> What do you think about scientific information that comes from tests financed by companies with a vested interest in the outcome? (Starr, Evers, and Starr 17)

Both questions deal with experimentation, referencing the need for objectivity and the importance of testing experiment outcomes using an experimental group and a control group to account for possible variables that may alter test results (Starr, Evers, and Starr 12). These questions, however, demonstrate my claim that this type of writing is not critical thinking as I have defined the term: the short answers to these questions are retrievable from the text itself. Students are answering questions but not analyzing, evaluating, or creating arguments about scientific topics.

All three textbooks begin with a general overview of science and the scientific process and methods used by scientists to arrive at ideas and decisions, while discussing concepts such as inquiry, hypothesis, theory, and data. Also, all three textbooks provide similar topics concerning biology, including the basics of cells, genetics, evolution and diversity, plant and animal physiology, and ecology.

The writing components of these textbooks—questions posted as chapter reviews—involve true-or-false, multiple-choice, or short-answer questions—and reflect coverage and emphasis of these themes rather than scientific arguments. As a result, argumentation and rhetoric of science are not components of these texts.

For the classes that require lab reports, these assignments only provide an overview of the procedures and results of the laboratory exercises. Apparently, both experiments and reports are designed in such a way so that students will reproduce a predetermined answer. Essentially, students are merely spectators rather than participants in science. Here, the emphasis of the laboratory exercise is on observation, not scientific arguments.

Undoubtedly, core terms and concepts offer a foundation upon which a student may proceed with an understanding of science. But, these traditional forms of instruction fit better with the lower levels of the Revised Bloom's Taxonomy—remember, understand, and apply—rather than the upper levels that represent critical thinking—analyze, evaluate, and create.

CONCLUSION

Interestingly, Gross notes that learning comes first from self-persuasion, and then concludes with persuading others (*Rhetoric of Science* 3). Here, he acknowledges the limitations that Aristotle set for rhetoric while explaining the need for rhetoric in a field—science—that definitely practices rhetoric. Science may search for truth in nature, but the process of this search is undoubtedly rhetorical; it is this process of discovery—the engagement of scientific arguments—that requires rhetoric.

As Paul advocates, students should be involved actively with this process of science rather than mindlessly perform routine assignments; students must not only justify the claims found within scientific articles along the way but also involve others through persuasion (*Critical Thinking* 613). Critical thinking is not the memorization of facts but rather the process of persuasion of what to do with these facts.

In this light, I see current forms of scientific instruction as a means to advance students' scientific literacy as incomplete. In general, science instruction as shown in this review promotes learning facts but does little to promote critical thinking. To be clear, science courses reviewed in this *do* include writing assignments. But the writing involved in these courses is not what I would define as critical thinking needed for scientific literacy.

Within this chapter, I have distinguished between writing and composition; writing serves more as a means to provide simple answers, whereas composition emphasizes argumentation, which I see as the act of critical thinking. In writing arguments, students not only demonstrate knowledge learned but they also demonstrate "the ability to organize and explain that knowledge" (Fulwiler and Jones 48). In composing arguments, students fulfill the requirements of critical thinking by persuading others of new information.

If science instruction truly seeks scientific literacy, courses should focus on science in action—constructing arguments about scientific subjects. Any pedagogy designed to attain scientific literacy should be expected to focus on the rhetorical endeavor within scientific arguments. In the next chapter, I intend to demonstrate how such instruction can be accomplished.

CHAPTER 4

A SUGGESTED PEDAGOGY

INTRODUCTION

Problem Statement

As I have shown in Chapter 3, science instruction still follows a traditional pedagogy that emphasizes facts rather than critical thinking. As I asked earlier, “If a better method of instruction for scientific literacy for nonscience majors exists, what would such an improved course look like?” In *Composition and the Rhetoric of Science*, Zerbe offers a suggested pedagogy using four specific examples by which composition may promote scientific literacy.

In his offering, I emphasize the idea of *suggested*, meaning that Zerbe intends for his idea to serve as a launching point for composition instructors to develop their own curriculum. For this chapter and using Zerbe’s models as guides, I propose a pedagogy that utilizes rhetoric of science and has students read, analyze, and evaluate scientific arguments and then create new arguments that will help students attain scientific literacy as I have defined in this work. To accomplish this task, I will examine Zerbe’s ideas, identify his shortcomings, and offer suggestions or revisions to resolve those issues within his pedagogy while incorporating additions and alterations to his model.

Overview of the Problem

In brief, Zerbe’s four approaches involve various aspects of scientific discourse: scientific popularizations, scientific discourse of other cultures, scientific “classics,” and a study involving college-age student drinking (which I will address in more detail as I approach my own ideas on a pedagogy). In each of these general topics, Zerbe offers an approach to incorporate these examples of scientific arguments into a composition course. As I introduce my variations of Zerbe's approach, I will discuss his components in more detail.

As noted earlier, I agree with Zerbe's understanding of science as discourse and his means of attaining scientific literacy through rhetoric of science. However, Zerbe's proposal is not without criticism. In fact, John Angus Campbell and rhetoric and communication scholar Dale Sullivan observe four specific limitations to Zerbe's approach.

First, Campbell claims that Zerbe's pedagogy is limited by first-year composition students' scientific knowledge and the ability to create the experiments Zerbe prescribes. Here, Campbell reflects that even his own graduate students may find such pedagogy difficult. In other words, Zerbe's lessons are not audience appropriate.

Second, Zerbe limits himself by not including other available scientific pedagogy, especially in demonstrating the interdisciplinary use of such instruction. What Campbell means is that Zerbe thrusts students into the lesson without giving students any scientific background.

Third, Campbell notes that for a writing course, Zerbe surprisingly teaches very little of the basic mechanics of composition ("Rev. of *Composition*" 106–107). Basically, Campbell observes that Zerbe requires very little composition for what Zerbe describes as a composition course.

Finally, Sullivan observes what may be the most damning aspect of Zerbe's pedagogy: for composition instruction that proposes the use of rhetoric, it surprisingly suggests very little—if any at all—rhetorical criticism (294). Essentially, if rhetoric is the key to scientific literacy, then a scientific literacy course should focus on the rhetoric of science. Unfortunately, Zerbe neither includes a background of rhetoric of science, nor does he explain how a student may apply rhetorical criticism to the scientific arguments of the projects suggested.

I also agree with both Campbell's and Sullivan's concerns. Like Campbell, I find that much of Zerbe's solution involves ideas that may be too challenging for undergraduate nonscience majors, disconnected from other means of teaching science, and lacking in the basic instruction of composition. And like Sullivan, Zerbe seems to ignore the very need for rhetorical criticism. While his ideas are novel, his offering of these ideas seem haphazard and disconnected. Although I acknowledge that his topics are merely suggestions, Zerbe invites more development.

Yet, I do not believe that the gist of Zerbe's lessons should be rejected. Indeed, as Campbell finds Zerbe's proposal "ambitious and optimistic" ("Rev. of *Composition*" 105), I find Zerbe's efforts as a starting point for incorporating rhetoric of science to attain scientific literacy. Zerbe's goal is to demonstrate that rhetoric and composition are the means to scientific literacy, but Zerbe's actual lessons, as Campbell and Sullivan argue, do not fulfill the promise touted by Zerbe as his ideas are perhaps a bit overzealous. Thus, I suggest a pedagogy based somewhat on Zerbe's concepts, but, following the insights of Campbell and Sullivan, I will tweak these concepts to correct the shortcomings that Campbell and Sullivan note.

First, I intend to resolve the issue of rhetoric of science and rhetorical criticism that Sullivan notes. Here, I will present three ideas: a definition of rhetorical criticism, the need for such criticism in regards to scientific literacy (where I contend with Zerbe's argument against rhetorical criticism), and adaptable tools to aid students in identifying claims so that they may analyze and evaluate the evidence presented in scientific arguments as well as assist students in how to construct a persuasive argument in defending students' findings. Second, I will add a framework for a lesson in rhetorical criticism so that students may be able to work with scientific arguments. In this section, I will first explain Zerbe's original lessons and then revise these lessons, correcting the remaining issues that Campbell and Sullivan observe by adapting the lessons to something more appropriate for undergraduates, including more scientific background, and incorporating more composition. (To further expand on a base scientific knowledge and rhetoric of science for both the instructor and students, I offer an extended reading list in Appendix II, not unlike the list Zerbe provides in his work.)

RHETORICAL CRITICISM

Definition

As I have done in the first two chapters of this work, I need to define the concept before I can present an acceptable solution. Therefore, I will define *rhetorical criticism* for the purpose of this project. To do so, I will reference Richard Paul, argumentation theorist Scott Jacobs, David Zarefsky, and rhetorical scholar Sonja Foss, and then review the idea of argumentation as defined by Wayne Booth, Gregory Colomb, and Joseph Williams.

As I have already described, critical thinking in regards to scientific literacy concerns the analysis, evaluation, and creation of scientific arguments. For this consideration, perhaps Paul offers a simple but informative idea of criticism: critical reading, critical writing, and critical listening (601–602). As Paul explains his idea of criticism, I do not consider it as necessarily separate or sequential components but rather as an ongoing action demonstrative of critical thinking. Indeed, Paul's emphasis promotes students' active participation with the material presented, while reminding instructors of their responsibilities to help students with these actions (603).

To Paul, critical reading means to recognize the importance of delving into a new realm to become familiar with the vocabulary and concepts of that discipline and "question, organize, interpret, synthesize, and digest" what is read (601). Similarly, critical listening involves questioning, organizing, interpreting, synthesizing, and digesting what is *said*. Unfortunately, as Paul observes, most students resort to passive listening, which places the responsibility of thinking on the speaker (*Critical Thinking* 602). This passive nature is one that students are conditioned to expect and one that promotes the lower level of learning rather than the higher degrees of analysis, evaluation, and creation, and it is this last aspect—creation—that highlights Paul's critical writing.

To Paul, critical writing works with critical reading and critical listening. Critical writing reflects not only the author's or speaker's intent but also expresses meaning as determined by the reader or listener (Paul, *Critical Thinking* 601). Critical writing is the very act of creation, which demonstrates higher learning.

As a general concept of criticism, Paul emphasizes learning, which is integral in any concept of pedagogy, especially one involving critical thinking as scientific literacy requires. However, Paul does not formally include the aspect of rhetoric. Still, Paul's concept does not forbid the inclusion of rhetoric. Indeed, it is a simple matter to amend his concept to allow for rhetorical criticism. Thus, one needs to add a rhetorical analysis component to the mix.

For example, Jacobs notes the primary ingredient for his idea of argument analysis: assessing if the argument is effective in persuading, and if so, ascertaining how it is persuasive (264). In his view, Jacobs cuts directly to the efficiency and mechanics of an argument as it relates to persuasion. Jacobs's focus follows closely to my idea that rhetoric is a means of discernment, recognizing and examining the means of persuasion. Even more so, Jacobs includes evaluation of the argument: the effectiveness of these means of persuasion. This determination of effectiveness invites a closer examination of the means of persuasion. Here, I believe Zarefsky expresses the same rhetorical concerns as Jacobs while emphasizing the same critical thinking requirements as Paul. In *Rhetorical Perspectives on Argumentation*, Zarefsky balances "the relationships among the rhetor, the text, and the audience" and the evidence needed to support the claim made by the argument itself (8).

In these views on criticism, I have expressed Paul's highlighting of learning and action, Jacobs's interest in the effectiveness of an argument based on persuasion, and Zarefsky's concern with the connection between rhetor, argument, and the audience, while dealing with the argument's evidence. Each of these views is useful in defining rhetorical criticism, with Paul expressing the basic means of critical thinking and Jacob and Zarefsky reinforcing the connection between criticality and rhetoric.

In *Rhetorical Criticism: Exploration and Practice*, rhetorical scholar Sonja Foss offers another view, recognizing *rhetorical* criticism as the means to understand rhetoric by three distinct aspects, which I will describe as analyze, identify, and comprehend (6–

8). Essentially, the first step considers the message of the text; the second step investigates the rhetorical components (that Foss describes as *acts*—audience influence—and *artifacts*—the preserved argument itself) of the argument; and the third step looks at understanding the construction and implementation of the argument. In this approach, Foss looks more at the communicative impact of the argument, with emphasis on improving its effectiveness (*Rhetorical Criticism* 8).

Although I certainly recognize Foss's accumulated scholarship in the area of rhetorical criticism and appreciate her definition of rhetorical criticism, I see her definition as more of a process or how-to procedure for rhetorical criticism as she maps out its specific components. However, she does not fulfill what I see as critical thinking since she is more concerned with analysis that culminates in evaluation of the effectiveness of the argument.

In fact, what is missing in each of these concepts of criticism is the expression of this argument analysis and evaluation as an argument itself; they lack the creation of arguments. As I have argued throughout this project, scientific literacy requires the active participation of students; the rhetorical criticism needed for scientific literacy is the composition of arguments.

My emphasis on the creation of arguments can be justified in two ways. First, Humanities and Philosophy professor Susan Haack states, "The concepts of inquiry and evidence are intimately intertwined" (30). In other words, when one makes a claim, the audience expects evidence to support that claim. I believe that Zarefsky clarifies Haack's statement. To Zarefsky, argumentation that comes from rhetorical criticism provides the scrutiny that can prove the probability or improbability of these claims; it is a means of "empirical verification" ("Knowledge Claims in Rhetorical Criticism" 632). Rhetorical criticism tests argumentative claims through argumentation itself.

Second, argumentation theorist Wayne Brockriede contends that in order for rhetorical criticism to be useful, it must be in the form of an argument (165). Indeed, rhetorical criticism is useful as an argument because it requires that the arguer be informed and invites further investigation from others (173–174). Here, Brockriede notes that rhetorical criticism occurs both internally and externally. First, to construct any meaningful criticism, the rhetorical critic must be well read and knowledgeable of the argument under consideration. Second, the rhetorical criticism that arises promotes further examination, not only of the original argument but also of the resulting criticism; this second, external component is more useful as it strengthens the overall rhetorical examination with "the process of confrontation by argument and counterargument" (174). Again, rhetorical criticism must involve argumentation.

Still, the ideas Foss presents are useful for my purposes, especially in respect to the relationship between the argument and the audience. Hence, merging the ideas from Paul, Jacobs, Zarefsky, and Foss, and with an emphasis on student participation and the expression of critical thinking as I have previously explained, I define *rhetorical criticism* for scientific literacy as the active process that allows students to demonstrate critical thinking concerning scientific arguments, which includes the analysis and evaluation of a given scientific argument, and the creation of arguments that not only support this analysis and evaluation but also lead students to what needs to be done with this analytical and evaluative information.

Contention with Zerbe: The Need for Rhetorical Criticism in Scientific Literacy

My emphasis on rhetorical criticism differs from Zerbe's ideas regarding the need for rhetorical criticism in rhetoric of science. In short, Zerbe claims that rhetorical criticism is only interesting to a limited scholarly audience: those interested in rhetoric and composition. Whereas I contend that rhetorical criticism is necessary to engage arguments concerning scientific subjects, Zerbe argues that rhetorical criticism ignores "issues of pedagogy and literacy," which he defines as "the impact of scientific discourse on identity and culture" (37). In this context, I offer two reasons for my disagreement.

First, to be clear, Zerbe's pedagogy at times has first-year composition students conducting research that probably exceeds their abilities (as Sullivan argues), especially as nonscience majors. Thus, where Zerbe sees a need for more practice in rhetoric of science as actually practicing science in composition, I see the need for students actually practicing rhetoric of science in composition. At this point, Zerbe almost seems to forget his own definition of scientific literacy that involves scientific discourse. At this stage of the students' experience and education, rhetorical criticism, as I have defined it, seems a very logical starting point for undergraduate nonscience majors. Simply put, in a composition course for undergraduate nonscience majors, rhetorical criticism of scientific arguments fulfills Zerbe's idea of scientific literacy despite Zerbe's rejection of rhetorical criticism.

Second and more importantly, this rhetorical criticism involves what I see as a major concern of science: falsifiability. As science philosopher Karl Popper believes, scientific theories should be tested not to confirm them but rather to refute them (47–48); falsifiability is a practice in testing the theory's claim and evidence. As discussed in

Chapter 1, science is practiced as the presentation of arguments. Thus, rhetorical criticism—not just an analysis and evaluation of an argument but also the creation of arguments discussing what to do with this information from the analysis and evaluation—seems to me to be the very heart of practicing science.

Again, my definition of rhetorical criticism agrees with my definition of scientific literacy, my emphasis on critical thinking, and my definition of rhetoric of science concerning arguments. In the concerns that I have noted, my definition of rhetorical criticism that conforms to the analysis, evaluation, and creation of arguments is more akin to the heart of WAC and conducive to a composition pedagogy for first-year composition students who are nonscience majors.

Rhetorical Criticism of Scientific Arguments: Tools

Still, even with a definition of rhetorical criticism, undergraduate nonscience majors may require help in identifying the basic components of an argument, especially a scientific argument. To remedy this potential issue, I again reference Booth, Colomb, and Williams, whose understanding of an argument may be stated as a *claim* based on *reason* supported by *evidence*. As these scholars define the terms, a claim "asserts something that may be true or false and so needs support," reason supports the claim, and evidence supports the reason (110–111). To differentiate between reason and evidence, the authors see *reason* as the statement for the audience to accept the *claim* (often beginning with the word *because*), while evidence is any tangible proof—that which can been seen, touched, tasted, smelled, or heard—to support the claim. In short, Booth, Colomb, and Williams see the main claim of an argument as the thesis (110). However, I see the need of all these components as the thesis. Basically, their original understanding of an argument—

claim based on *reason* supported by *evidence*—serves also as the main thesis, which is the focus of the argument. Thus, for a rhetorical criticism of an argument, I see the need for students to recognize and identify these basic components in a scientific argument. In short, the first tool that I suggest will focus on identifying the claim of the argument, the reason for the claim, and the evidence that supports the reasoning for the claim. I offer the following worksheet as a suggested tool for students (see Figure 5).

In this first tool that I offer, I attempt to guide students in the locating and breaking down the author's (or arguer's) basic argument into its components; simply put, this worksheet attempts to aid students in discerning the means of persuasion through analysis and evaluation. Here, the worksheet reminds students of specific terms: *argument/thesis, claim, reason,* and *evidence* as defined by Booth, Colomb, and Williams. Next, the worksheet has students note the argument or essay title, with the author's name and the publication date, with the intent that this information lend itself to citation later.

The next major portion of the worksheet focuses on the thesis or main argument of the author's article or essay. Here, the worksheet has students break down the argument into its basic components: claims, reasons, and evidence. From this information, the worksheet has students write the exact or main argument in the essay or article.

On the second side of this first worksheet, analysis continues as the worksheet asks students to consider types of appeals in the argument; these appeals may duplicate some of the evidence listed on the first page. I see this second page as focusing more on

Terms:

Argument/Thesis:	A *claim* based on *reason* supported by *evidence.*
Claim:	A contestable sentence that asserts something that may be true or false and so needs support.
Reason:	Sentence(s) that support the claim (*because*).
Evidence:	Anything tangible (what can be seen, touched, tasted, smelled, or heard) that supports the claim.

Argument/Essay Title:

Author: **Publication Date:**

Claim(s)	**Reason(s) (*because*)**	**Evidence (based on)**

Main Thesis/Argument:

Figure 5. Rhetorical Criticism Worksheet

What appeals does the author use (these appeals may duplicate from the evidence on the first page)?

Appeals to Logic	Appeals to Authority	Appeals to Emotions

Is the author successful in persuading you by the evidence?

If yes, why?	If no, why not?	If no, how can the author strengthen the argument?

What does the author want you to do with this information in the argument?

Based on the evidence, what should you do with this information (what action should you take)? Why?

Figure 5. Rhetorical Criticism Worksheet (Continued)

the actual rhetorical aspects of the argument. Here, the worksheet allows students to consider how the author uses logical, authoritative, or emotional appeals to persuade.

The remainder of this worksheet attempts to aid students in evaluation, asking the following:

- Is the author successful in persuading you by the evidence?
    - If yes, why?
    - If no, why not?
    - If no, how can the author strengthen the argument?
- What does the author want you to do with this information in the argument?
- Based on the evidence, what should you do with this information (what action should you take)?
    - Why?

Here, the worksheet asks students to make a judgment concerning the argument itself. For example, students must now evaluate if the author has been successful with the means of persuasion offered in the argument. If the author has not been successful in persuading students, then students must consider by what means the author could strengthen the persuasion of the argument.

Next, the worksheet asks students to evaluate the intention of the author, or specifically, assess what the author expects the reader to do with the argument. Finally, the worksheet asks students to evaluate the evidence of the argument. At this point, students must evaluate what should be done with the author's argument. These final two points prepare students for action, or creation of an argument.

As I have discussed, critical thinking requires more than analysis and evaluation of an argument; students must create an argument with this information. Therefore, to help students create an argument, I propose a second worksheet (see Figure 6). As the first worksheet deals with rhetorical criticism of the original scientific argument, the second worksheet helps students continue the process of critical thinking by preparing the rhetorical criticism to create a new argument—what to do with this information. Again, at the beginning of this worksheet, I provide a reminder of the terms used by Booth, Colomb, and Williams: *argument/thesis, claim, reason,* and *evidence*.

Picking up where the last worksheet leaves off, this worksheet begins by asking students to consider the information from the argument previously read: What should be done (what action should be taken) with the information? This question may be considered as the beginning of inquiry, which leads to a second question: Why should the reader take this action? I see this second question as dealing with Booth, Colomb, and Williams's most challenging question leading to composition: So what (45)? Booth, Colomb, and Williams want students to justify the importance of the inquiry, especially for an audience. This question may also be posed this way: Why does the reader consider the action as necessary? From this question, students should begin the process of listing the reasons and possible evidence in relation to the claim needed for the next step in the process.

The next step is for students to formulate a thesis or general argument for a written response to the original scientific argument. At this point, the worksheet allows students to break down their thesis into claim(s), reason(s), and evidence(s), listing these points for review.

Terms:

Argument/Thesis:	A *claim* based on *reason* supported by *evidence.*
Claim:	A contestable sentence that asserts something that may be true or false and so needs support.
Reason:	Sentence(s) that support the claim (*because*).
Evidence:	Anything tangible (what can be seen, touched, tasted, smelled, or heard) that supports the claim.

What should you do with the information that you have (what action should you take)?

Why should you take this action?

What is your argument/thesis?

Claim(s)	**Reason(s) (*because*)**	**Evidence (based on)**

Figure 6. Argument Creation Worksheet

How will you persuade your audience/what appeals will you make (these appeals may duplicate from the evidence on the first page)?

Appeals to Logic	Appeals to Authority	Appeals to Emotions

What sources do you plan to use to support your argument?

Author	Title	Publication/Source	Date	Pages

What do you expect your audience to do with your argument? Do your claim, reason, evidence, and appeals lead to this action?

Figure 6. Argument Creation Worksheet (Continued)

Similar to the first worksheet, the students are asked to list the means of appeals (logic, authority, and emotions) that they expect to use in their argument. Of course, these appeals may be related to the evidence listed on the first page of this worksheet. Additionally, in keeping with the ideas of Booth, Colomb, and Williams, examining these appeals will allow students to acknowledge and formulate a response to opposing views and idea

The next section provides a space for students to record specific sources to utilize in their argument. This space may be used to introduce specific citation styles, which may be tailored to the instructor's class requirements.

The worksheet ends with a question that challenges the student to the importance of persuasion: What does the student expect the audience to do with this argument? This similarity to the first worksheet is intentional, which hopefully emphasizes that the student is held to the same stringent standard of rhetorical criticism. Here, the student needs to examine the foundations of the new argument for its effectiveness and make changes to improve such effectiveness.

As clarification, I offer two observations. First, these worksheets are not separate assignments, but two tools to complete one project. Again, the first worksheet aids in analysis and evaluation; the second worksheet aids in creation. The first worksheet helps complete the second worksheet. I do not specify that an assignment may not be extended, allowing students to read an argument and complete the first worksheet, which permits examination and discussion as well as guidance from instructors concerning students' understanding and progress. But, the assignment—and critical thinking— remains incomplete until an argument is made by students, with the second worksheet helping students organize the components necessary to form an argument.

Second, these worksheets are, of course, only limited tools designed to offer a starting point in rhetorical criticism— the formulation of an argument about a science subject. Depending on the instructor and the lesson, these tools may be altered. For now, I am only interested in presenting the tools, suggesting their use, and promoting the need and logic for rhetorical criticism. When I develop the individual pedagogies for this chapter, I will offer ideas as to how to incorporate these tools.

Earlier in this chapter, I noted the shortcomings of Zerbe's pedagogy as identified by Campbell and Sullivan. To address some of these weaknesses, I have defined rhetorical criticism and provided two suggested tools to aid students in conducting rhetorical criticism. Now, I must apply these tools to specific lessons to respond fully to Campbell and Sullivan's concerns. But first, I must explore Zerbe's ideas in more detail. In this next section, I will survey his suggested readings.

ZERBE'S PEDAGOGY

Background

In the second section ("Texts and Scenarios") of *Composition and the Rhetoric of Science: Engaging the Dominant Discourse*, Zerbe suggests possible ways to engage students in scientific thinking by studying scientific discourse, offering a succession of discourse to develop student critical thinking using composition. Additionally, he demonstrates "the range and usefulness of material available" for rhetoric/composition instructors (106). In his pedagogy, he offers four categories of lessons (see Table 7). In this section, I examine Zerbe's definition of these categories.

Table 7. Zerbe's Pedagogy

	Four Categories of Scientific Discourse			
	Popularizations of Science	Scientific Discourse of Another Culture	Classics	You Are What Science Says You Are
Types	Annotated Article Popularizations	Reading and Discussing Science on Weight Loss	Reading and Discussing an Environmental Science Classic	Cultural Context of Drinking Games
	Science Ethnography Popularizations	Cultural Context of the U.S. Weight-Loss Industry	Cultural Context of Population Control and Zoning	Writing Science about College Students' Drinking Games • Participant Observers at Social Gatherings • Looking at a Big(ger) Picture • Future Alcohol-Related Problems • Effectiveness of Educational Programs
	Armchair Scientist Popularizations	Writing Science about Weight Loss • A Comparison Study • A Possible Physiological Mechanism for Chi Kung • Cultural Specificity of Chi Kung	Writing Science about the Evolution of a Scientific Community	

Source: Zerbe, Michael J. *Composition and the Rhetoric of Science*. Carbondale: Southern Illinois UP, 2007. Print.

Popularizations of Science. In Chapter 5, Zerbe explores "Popularizations of Science," which includes three varieties: Annotated Article, Science Ethnography, and Armchair Scientist. As rhetorician Jeanne Fahnestock explains, whereas original science research targets peer audiences (other scientists in the same specialty), science popularizations result from a combination of published original research and interviews of the original researchers and familiarize the research to a nonscience audience ("Accommodating Science" 281–285). Essentially, science popularizations target nonscientists.

In this chapter, Zerbe introduces the instructor to the various texts available for student reading (106). Basically, Zerbe demonstrates the multitude of reading lists that can be created. In fact, the emphasis of this chapter is reading, familiarizing both instructors and students with the beginning of attaining scientific literacy. To Zerbe, an Annotated Article is "closest to the scientific research article" that not only targets the layperson but also "attempts to contextualize the article in terms of other research, especially research leading up to the article under scrutiny, and sometimes in terms of competing research as well" (108). Whereas an original science research paper, or peer-reviewed science publication, presents scientific arguments for scientists in a specific field, an annotated article targets the laity or other scientists not in that specific field; the annotated article reaches a more generalized, nonscientific audience. As an example of this type of popularization, Zerbe provides *A Century of Nature: Twenty-One Discoveries That Changed Science and the World*, a collection of articles from the journal *Nature* with accompanying essays that serve as commentaries.

In his second example of science popularizations, Zerbe explains that a Science Ethnography popularization is a narrative that "characterizes the specific people who perform the science" and how these people influence their specific scientific culture (113). These studies are usually lengthier and more detailed than annotated articles and serve as a means to familiarize nonscientists (and perhaps refamiliarize scientists) with the studies of these influencers of science (113). These works can exist as a mixture of history, biography, and research. As an example of an ethnography, Zerbe offers Stephen Jay Gould's *Wonderful Life: The Burgess Shale and the Nature of History* as an example, noting that this text demonstrates how science "can be clearly explained" (118). In this text, Gould re-examines how paleontology was presented by scientists and how the public perceived this information in the 1970s and 1980s. Drawing largely from primary research, Gould repackages the results and interpretations for easy understanding. Of the three examples, Zerbe prefers best Gould's *Wonderful Life* (115, 129).

For his final science popularization, Zerbe describes the Armchair Scientist as "one who reads or watches for informational purposes and who celebrates the science being performed—and science in general—with little if any kind of interrogation" (125–126). Of the three popularizations, the armchair scientist is furthest from the scientific research article (with the annotated article closest to scientific research) (125). The audience of this category consists of those who are not practitioners of the science described in these texts but may include scientists who are not direct practitioners of the field described in the popularization. Succinctly, the armchair scientist reads or watches this example as much for entertainment as for information, but does not engage the material.

Here, Zerbe suggests students read Dushkin's (McGraw-Hill) *Taking Sides* series, where the reader is exposed to contrasting views of various topics. Within each book, several questions specific to the topic under consideration are asked, and the book provides an essay that corresponds to either a yes/no or pro/con response. For science, Zerbe suggests *Taking Sides: Clashing Views on Controversial Issues in Health and Society*, *Taking Sides: Clashing Views on Controversial Environmental Issues*, and *Taking Sides: Clashing Views on Controversial Issues in Human Sexuality*. In these specific examples, the reader is exposed to the process of argumentation from opposing sides, allowed to consider different viewpoints, and compelled to choose a side from the contrasting views.

Using these texts as a teaching point, Zerbe indicates that popularizations "*invite* public participation in science" (129, Zerbe's emphasis). The language and the style of presentation allows the reader to not only understand but also analyze and evaluate the material presented. These texts are not textbooks but rather scientific discourse as explanation.

Scientific Discourse of Another Culture. In Chapter 6 of *Composition and the Rhetoric of Science: Engaging the Dominant Discourse*, Zerbe suggests that exploring cross-cultural issues regarding science may aid in scientific literacy. Here, Zerbe references Kinneavy's concept of *ethnoscience*. In *A Theory of Discourse*, Kinneavy explains that the term refers to how a specific culture views science; not all cultures view—or report—science. Thus, not all cultures prescribe to a Western view of science (78). In his application of this description of ethnoscience, Zerbe notes that although subjectivity always invades scientific discourse, the goal of such discourse should always be objectivity (130).

With this primer, Zerbe introduces his purpose of this chapter: He suggests a comparison of Western and traditional Chinese weight loss approaches (131). Since most Americans are aware of various Western weight loss plans, Zerbe sees this exposure to other cultures' means of conducting science as a way to study the idea of what is Western science, while understanding objective research by allowing students to compare a different culture with Western science.

For his comparison, Zerbe suggests that students read first two specific studies from the *New England Journal of Medicine*, "A Low-Carbohydrate as Compared with a Low-Fat Diet in Severe Obesity" and "A Randomized Trial of a Low-Carbohydrate Diet for Obesity," so that students may see how the West reports clinical trial studies. Then, to contrast these studies in weight loss, Zerbe suggests reading *Oriental Secrets to Weight Loss, Beautiful Skin and High Energy*, a Chinese method of weight loss through breathing techniques (Chi Kung) (137).

Classics. In Chapter 7 of *Composition and the Rhetoric of Science: Engaging the Dominant Discourse*, Zerbe insists that students should read texts that are considered as science classics, which he defines as scientific discourse that achieves a "Kuhnian paradigm shift" (150). By this description, Zerbe means that the scientific discourse represents a drastic change by which science is presented, perceived, and eventually practiced, characterizing the literary evolution needed to transform it from an obscure scientific publication to a memorable work that transcends even the domain of science (150–151).

Drawing on this idea of obscurity, Zerbe offers several examples that have not quite achieved the level of appreciation that their more famous counterparts have received. In this way, Zerbe attempts to extend students' reading to beyond well-known articles to a role of search, analysis, and evaluation of the often-overlooked scientific studies.

For his example, Zerbe recommends Eugene Odom's "The Strategy of Ecosystem Development." To defend his choice, Zerbe claims that Odum "helped to establish the contemporary environmental movement" with this study, breaking with traditional views that steer clear of social responsibility concerning environmental stewardship (151). As Zerbe explains, Odum's article presents itself as a valuable rhetorical tool in four ways:

1. It greatly varies from the typical IMRAD scientific argument structure.
2. It clearly explains the otherwise complicated relationship among "science, nature, and human society."
3. It successfully employs a more human tone that is "speculative and informal and at times apocalyptic"—all foreign to traditional scientific research--which involves the reader in the process of understanding and knowing ecosystems.
4. It finally attempts to broaden ecologists' research and use of other available areas of scientific research to improve ecologists' understanding of ecosystems. (152–153)

Zerbe wants students to identify how Odum's article differs from traditional scientific articles and why it should be considered as a classic. In a sense, Zerbe pushes the student to recognize several aspects of the rhetorical workings within a scientific article, especially one that changed science itself. Zerbe wants students to understand Odum's emphasis on the reader's action with the information at hand, not just for the ecologist but also for the nonscientist.

You Are What Science Says You Are. In Chapter 8 for his final pedogeological discussion, Zerbe suggests that students read about scientific studies specifically written about college students to establish firmly in the students' minds that science directly influences their lives. To demonstrate this influence, Zerbe advocates that students read researchers Brian Borsari, Dessa Bergen-Cico, and Kate B. Carey's "Self-Reported Drinking-Game Participation of Incoming College Students."

In this study, the researchers question whether or not students are exposed to drinking games prior to college enrollment (Borsari, Bergen-Cico, and Carey 150). Surveying 1,327 high school graduates over three years, the study shows that 792 (63%) of the respondents reported playing drinking games to "get drunk quickly," to "socialize and meet people," and to "control others or get someone else drunk" (151). In addition, the results imply that those who participate in drinking games prior to college are in danger of alcohol-related problems, but education may prevent or decrease heavy alcohol use on college campuses (153–154).

In this chapter, Zerbe presents what may be his most personal appeal for student reading. In "Self-Reported Drinking-Game Participation of Incoming College Students," college students are reading about themselves and how science is interested in their social interactions.

Within his three chapters of suggested pedagogy, Zerbe attempts a thorough but not exhaustive exposure of how rhetoric of science can help undergraduate nonscience majors attain scientific literacy through two stages: reading and practice. In this section, I have presented his selected sections and the reading portions of his pedagogies. In my next section, I look at revising his ideas.

REVISION OF ZERBE'S PEDAGOGY

As I have noted before in this chapter, Zerbe presents an impressive, if not challenging, *suggested* study for students. Such ambition surely invites criticism, as I have also addressed, mainly through Campbell and Sullivan. However, in Zerbe's defense, I emphasize again the term *suggested*, for I believe Zerbe attempts to demonstrate how such a composition course in using rhetoric of science to attain scientific literacy *can* be done, not a prescribed how it *must* be done. Therefore, I believe that Zerbe invites revisions to his premise.

In this section, I will attempt such a revision that will hopefully appeal to Campbell and Sullivan as well as future instructors. To complete this revision, I first will examine the number and length of assignments. Then, I will look at Zerbe's assignments based on his recommended readings. Finally, I will offer a reason for my revisions, using the worksheets to conduct rhetorical criticism.

As a caution, I will not complete the worksheets in this section due to subjectivity related to the new readings themselves, students' perceptions and needs, and instructors' flexibility. After all, these readings are arguments, meaning that they employ persuasion, which leads to a certain level of subjectivity. Again, I intend to help students engage rhetoric as I described earlier: a means of discernment and practice. Accordingly, different ideas and motives may present themselves to different students. The purpose here is to test these ideas through rhetorical criticism.

However, I will offer some general suggestions as to what may be seen from students on these worksheets. For example, I will attempt to address the main claim of these texts and some of the rhetorical devices used by the writers. Again, responses will vary according to the student and instructor.

Number and Length of Assignments

Before I begin my revision, I must address two points of structure: number of writing assignments and page length of the writing assignments. Of course, these points are connected, and my responses to them will be optional rather than mandatory.

First, Zerbe explicitly notes four specific lessons based on his own application in his Composition courses. However, he does not state that these lessons are the only four assignments for the semester. Yet, with the amount of reading and the extent of the assignments, it seems clear that this pedagogy is a semester-long course.

To finish this discussion of assignments, I must now address my second point focusing on that ever-lingering concern, the page length of the assignment. Zerbe only mentions one page-length assignment; in his assignment for drinking games, he suggests a 5-page essay (169), but he does not give a reason for this length.

Here, I offer two points of advice. First, I defer to departmental guidelines. Most colleges have their own set of requirements for each Composition course, which usually mandates either total number of pages or total number of words that each student should compose within the semester. My first piece of advice is to follow those guidelines.

Yet, I would be remiss if I did not offer at least some additional advice. In this case, I look at two scholars for direction. First, English professor Jillian Skeffington recommends "shorter, more frequent" assignments. For example, rather than one 4-page paper, students may produce instead two 2-page papers (29). Skeffington's reasoning for the shorter, more frequent paper allows for greater student focus on specific aspects of each assignment—including topic, type, or task—while also allowing the awareness and application of such writing in other areas (39–40).

Writing professor Joseph Teller also advocates for shorter writing assignments, but he emphasizes the need to promote more timely and frequent feedback ("Teaching Composition"). Teller's recommendation notes that if students have shorter assignments, then they can focus more on writing, while the instructor can respond quicker and more often to guide students.

Neither Skeffington nor Teller promote this brevity as a means to ease the rigor or lessen the complexity of assignments. Rather, both suggest more writing, more variety, and more instructor response. So, although I appreciate Zerbe's examples, I agree with Skeffington and Teller and advise that a shorter paper (500–600 words) may be better suited for the undergraduate nonscience major. Papers of this length improve the timeliness of the instructor's response, which gives students better instruction concerning their writing. The shorter assignment also allows the instructor the opportunity to increase the number of assignments, which means that students can be exposed to more examples of scientific discourse. However, the instructor may decide to assign shorter papers that culminate into a longer research paper. Again, the emphasis is on broader exposure for the student and quicker feedback from the instructor.

Popularizations of Science: Zerbe's Pedagogy

Again, Zerbe merely intends to introduce possible reading lists from the three types of popularizations of science—annotated, ethnography, and armchair scientist—drawing on the vast examples that exist. Although he does produce interesting examples, he does not provide an actual assignment.

If exposure to texts is Zerbe's purpose for this chapter—and it is—then he succeeds in his task. But if Zerbe means to demonstrate scientific literacy in this chapter alone, then he fails. Here, he never engages students past the point of reading. In his defense, Zerbe makes the first step in initiating students to scientific texts, especially understandable texts for the undergraduate nonscience major.

Surprisingly, Zerbe also rejects the use of science journalism as a source of reading, declaring that journalistic approaches are too brief, too simple, and more subjective than his idea of a proper science popularization (105–106). It may be that Zerbe does not consider science journalism as a primary source of science writing. Yet, some of the examples within the *Taking Sides* series cannot be considered as primary sources. In this case, I disagree with Zerbe; indeed, much of what students read, see, or hear of science may be from various forms of media or in the exact opposing-side format as seen in *Taking Sides*. It seems that such exposure should be included.

In fact, in "'But If It's in the Newspaper, Doesn't That Mean It's True?' Developing Critical Reading & Analysis Skills by Evaluating Newspaper Science with CREATE," biologist Sally Hoskins demonstrate that various forms of material can expose students to scientific issues, especially the media. Of course, Hoskins seeks to promote the CREATE (*C*onsider, *R*ead, *E*lucidate hypotheses, *A*nalyze and interpret the data, *T*hink of the next *E*xperiment) approach to teaching science (415–417), but she, like Zerbe, wants to prepare students to be scientifically literate. In her research, she opts to use sources that are not primary. Yet, she does not use rhetoric of science as a means to study such texts. Rather, she promotes the idea of using these texts to teach students how to conduct experiments to test the material's findings.

Still, Zerbe's shortcomings in his chapter are easily mended. The simplest solution logically would be to assign a writing assignment.

Popularizations of Science: A Revision

For my revision, I focus on what I consider as a better means to expose students to scientific arguments. Here, I agree with Zerbe's use of the *Taking Sides* series from his armchair scientist popularization of science. In these brief essays, the student should recognize current scientific topics presented in a familiar language and style. I suggest the topic "Is Sustainable Development Compatible with Human Welfare?" from *Taking Sides: Clashing Views on Controversial Environmental Issues*. From this topic, students will be asked to read both "Sustainable Development: The Ethics Support the Economics" by Dinah M. Payne and Cecily A. Raiborn, and "Wilting Greens" by Ronald Bailey.

Implementing the worksheets that I have presented, students first should identify the main claim (thesis), the reason for the claim, and the evidence offered in support of the claim. As a basic answer to the overall question, Payne and Raiborn confirm that, yes, businesses have an ethical duty to invest in and implement sustainable development. The argument presented by Payne and Raiborn depends greatly on the definition of *sustainable development* (24–25), but their main claim does not appear until after this exploration. In fact, students may offer that businesses should invest in and implement sustainable development as a main claim; the reason for this claim may be listed as *because* it is their ethical duty. However, the main claim and the reasons for this claim may be addressed as follows:

> Businesses and their managers should be concerned about sustainable development *because*
>
> - Businesses and their communities would not last without sustainable development.
> - Sustainable development may be a "megatrend" that could benefit businesses.

- As a “core competency,” sustainable development can be a means “to obtain a strategic competitive advantage.” (26–27)

The evidence for this claim and reason can be substantiated by noting the authors’ behavioral hierarchy list: basic, currently attainable, practical, and theoretical (29–31). So, the main thesis or argument for this essay could be stated as follows:

> Businesses and their managers should be concerned about sustainable development *because* businesses and their communities would not last without sustainable development; sustainable development may be a “megatrend” that could benefit businesses, and as a “core competency,” sustainable development can be a means “to obtain a strategic competitive advantage” *based on* basic, currently attainable, practical, and theoretical levels of behavior.

Concerning appeals, students may recognize that Payne and Raiborn cite several authoritative sources, referencing events such as the Rio de Janerio Summit, Kyoto Protocol, the 1987 World Commission on Environment and Development (24). The authors also mention the results of a 1996 survey (27). Organizations are also used as an appeal to authority, including “the World Trade Organization’s Committee on Trade and Environment, the World Business Council for Sustainable Development, the International Chamber of Commerce’s Commission on Environment, and the United Nations Environment Program” (32). Of course, students may decide that the structure of the argument itself may serve as an appeal to logic with these citations. Students may also sense an appeal to emotions, noting the authors’ warning that businesses that fail to create and implement sustainable development guidelines may be viewed negatively by the public (31) or Payne and Raiborn’s final connection of ethics with good business (33).

Instructors should expect that students' responses to the persuasive nature to vary. Hopefully, students will respond to the logical appeals or support their reasons to agree with any authoritative or emotional appeals. It may be helpful for the instructor to refer students to the original article as it appears in the *Journal of Business Ethics* to check citations for credibility of Payne and Raiborn's appeals to authority.[1]

Clearly, the authors seek business support and compliance with their proposal of levels of behavior to compel other businesses to follow their example (32–33). Yet, for students, the question arises as to what should be their actions with this information. Their answers should lead them to begin the second worksheet involving argument creation.

Before students can continue with this assignment, they must read the second essay, Ronald Bailey's "Wilting Greens." For this essay, students will utilize a second rhetorical criticism worksheet. Bailey begins his essay by quoting two environmental activists, Andrew Hewett and Steve Sawyer, as they admit defeat after two major environmental summits. Students should recognize Bailey's sarcastic tone from the title and referring to environmentalists as "the greens" (34). Bailey sees that the best way to relieve poverty and improve the environment is to allow and promote economic growth (34); a possible main thesis or argument may be stated as follows: Economic growth provides the best means to decrease poverty and improve the environment *since* the poor do not have the means on their own to alter their current economic condition or the

1. Dinah M. Payne, and Cecily A. Raiborn. "Sustainable Development: The Ethics Support the Economics," *Journal of Business Ethics* 32.2 (2001):157–168.

environment (34) *as explained by* Gar Smith and Sunita Narain (34–35); sustainable development actually limits the economy, which hurts the environment (35).

Bailey's appeals rely on quotes from environmental leaders and activists, which can be considered as appeals to authority. However, Bailey's underlying sarcasm and dire warning that the environmentalists' stance against economic progress harms both the environment and the people the environmentalists propose to help (36) may be considered as *pathos*. Students should be able to see that Bailey hopes that future summits also fail.

From these readings, students will consider both arguments and determine the better action (deciding if one argument is better supported by the evidence than the other argument) by creating their own argument from an analysis and evaluation of these contrasting essays. Using the argument creation worksheet, students will merge their information from the two essays and determine their own action. Students may find several issues or contention with each of the articles, or they may see a need to compromise with the two sides. However, as a suggestion, students may ask the following questions:

1. Do I agree with Payne and Raiborn?
    a. Why do I agree (what evidence supports this decision)?
    b. How can I apply this information?
2. Do I agree with Bailey?
    a. Why do I agree (what evidence supports this decision)?
    b. How can I apply this information?
3. Do I agree with both Payne and Raiborn and Bailey?

    a. If so, why do I agree with both points (what evidence supports this decision)?
    b. What compromise can I offer to merge these ideas?
4. Do I disagree with both Payne and Raiborn and Bailey so that I need to offer an alternate solution?
    a. Why do I disagree with both points (what evidence supports this decision)?
    b. What alternate idea can I offer?

From these questions, the students should be able to answer the first two questions of the argument creation worksheet. From their first two answers to this worksheet, students should be able to begin formulating their own argument to these essays, devising a claim backed by reasoning and supported by evidence.

In this second worksheet, I have provided a section for additional research. This section is optional based on the instructor's preference. I prefer the idea of requiring extra and outside research for students to instill a pattern of inquiry. For example, students may submit their additional research as annotated bibliographies during the semester, which would allow additional assignments. But, the instructor may decide to omit this section and have students rely only on the assigned readings for their evidence. Either way, students engage the argument(s) at hand and practice the critical thinking required for scientific literacy as described in this work.

Scientific Discourse of Another Culture: Zerbe's Pedagogy

To expose students to how science is presented in other cultures, Zerbe presents the idea of comparing Western science to traditional Chinese dieting strategies. First, Zerbe suggests that students read two specific studies from the *New England Journal of Medicine*, "A Low-Carbohydrate as Compared with a Low-Fat Diet in Severe Obesity" and "A Randomized Trial of a Low-Carbohydrate Diet for Obesity," so that students may see how the West reports clinical trial studies. To contrast these studies in weight loss, Zerbe suggests reading *Oriental Secrets to Weight Loss, Beautiful Skin and High Energy*, a Chinese method of weight loss through breathing techniques known as Chi Kung (137). From these readings, Zerbe suggests three projects: a comparison study between Western diets and Chi Kung, a physiological study of Chi Kung, and a cultural study.

A Comparison Study between Western Diets and Chi Kung. For the first project, Zerbe recommends that students propose their own comparative study of Western diets and the Chi Kung technique, with students explaining their choice of variables and limitations of such a study (146). Basically, one set of students would lose weight following a Western diet while another set of students would lose weight using Chi Kung.

As an alternative to this study, Zerbe suggests that students could compare studies of Chi Kung itself, with one group practicing the full program including diet and exercise while another group practices Chi Kung either with the diet or the exercises alone; in this variation, students would "narrow down a cause-and-effect mechanism" for weight loss (146).

A Physiological Study of Chi Kung. In the second study, Zerbe suggests that students propose an experiment that looks for a link between weight loss or gain and the enzyme cortisol, since research indicates that stress causes the body to produce cortisol, which causes fat storage in the body (146–147). Here, students would determine if Chi Kung actually eases stress, reduces cortisol production, and promotes weight loss. In this assignment, Zerbe also notes limitations to such a study, which would include examining other enzymes that could produce weight loss or exploring how cultural differences could impact enzyme production (147).

Cultural Specificity of Chi Kung. As a third project, Zerbe suggests that students conduct research from a cultural viewpoint: Students would compare the Chi Kung diet as practiced in the Chinese culture against an American diet. In this way, students may see how the Chi Kung diet would not work within an American culture due to American expectations of the symbiotic relationship between diet and exercise (148). To conduct such a study requires a two-part study. The first part requires the study of a group of people who practice a "fairly traditional Chinese lifestyle," and the second part would necessitate a group of people who live a traditional American lifestyle but practice Chi Kung (148).

Scientific Discourse of Another Culture: A Revision

This proposal of Zerbe serves as a prime example of one of Campbell's concerns: its requirements are probably beyond the abilities of first-year composition students. Indeed, it is probably beyond the abilities of most undergraduate nonscience majors.

Still, I do not dismiss the use of Chi Kung as a subject matter. Rather, I propose a rhetorical study of the promises made in media that students use daily: websites. To maintain the use of Chi Kung as a topic, I suggest that students access *Chinese Culture Homepage* (http://www.yutopian.com), a website that promotes the Chinese culture, and two of its specific links related to the Health link on the main site: *Oriental Secrets to*

Weight Loss (Weightloss) and Healing (http://www.yutopian.com/weight/) and the feedback related to this practice of weight loss (http://www.yutopian.com/weight /feedback.html). My suggestion for this assignment would be for students to consider Internet scientific information and the issue of logical fallacies. Hence, the research question for this paper would be as follows: Is this information believable (or should it be believed) based on the websites alone?

To prepare for any paper on this specific topic requires additional information. I suggest preparing students to understand logical fallacies and the idea of pseudoscience.

For logical fallacies, many options are available. I will offer three options. As a first offering, most first-year composition texts include a brief reading on logical fallacies as part of their content. For example, *The Little, Brown Handbook* (13^{th} edition) provides not only a general list and definition of the basic logical fallacies (193–198), but also extends the application to visual arguments as may be seen in graphics (203–204). Likewise, *Patterns for College Writing: A Rhetorical Reader and Guide with 2016 MLA Update* (13^{th} edition) offers a common core listing, definitions, and examples of logical fallacies (535–537).

Another option for students appears online. Sites such as Purdue's Online Writing Lab (https://owl.english.purdue.edu/owl/resource/659/03/) and Ali Almossawi's *An Illustrated Book of Bad Arguments* (https://bookofbadarguments.com) provide an accurate understanding of basic fallacies. The latter presents comical illustrations of these fallacies.

Or, instructors may choose to create a list specific for their class. Here, the list can be drawn from these examples or other similar online lists.

I also see the need to discuss pseudoscience for this lesson. Interestingly, Ecology and Evolutionary Biology professor Massimo Pigliucci with his student Matthew Johnson demonstrate in their survey results that science majors are more skeptical of pseudoscience than nonscience majors (547). Their study implies that nonscience majors are more susceptible to false or at least questionable claims that can be presented as science since they are less knowledgeable of science ideas and testing.

Siegel offers a simple yet effective definition of pseudoscience: "Beliefs which are held in spite of, or systematically protected from, contrary evidence" ("Rationality of Science" 15). Psychologists Rodney Schmaltz and Scott O. Lilienfeld further clarify the term, offering a list of "key warning signs" that may help identify pseudoscience:

- Psychobabble – Misleading scientific-sounding jargon.
- Anecdotal evidence – Quotes and testimonials rather than substantial evidence.
- Extraordinary claims rather than substantiation – "Implausible" assertions rather than "convincing evidence."
- Irrefutable or unfalsifiable claims – Claims that "cannot be measured or tested scientifically."
- Absence of connectivity to other research – Claims that disagree with proven research.
- Lack of peer-review – Research that has not been "safeguarded against error" by experts.
- Lack of self-correction – Despite refutation, the pseudoscience still persists. (1–2)

Although Siegel and Schmaltz and Lilienfeld provide what may be considered a more scholarly understanding of pseudoscience, I suggest another short yet illustrative lesson in recognizing pseudoscience: "Revolutionary New Insoles Combine Five Forms of Pseudoscience" from the satirical news website *The Onion*.[2] In this article, students see the workings of pseudoscience from a humorous viewpoint. Using the wonder product MagnaSoles, *The Onion* employs several of the key devices used in many pseudoscientific claims.

Using these resources, instructors may wish to present examples of pseudoscience, such as ESP, horoscopes, UFOs, or cryptozoology. Instructors may wish to have students offer additional examples of pseudoscience or have students even discuss why pseudoscience is so prevalent and dangerous.

Returning to Zerbe's original lesson, students may be asked to look at the website claims (http://www.yutopian.com/weight/feedback.html), choose one of the claims, and argue whether or not these claims fall into the category of pseudoscience, why the chosen claim classifies as a pseudoscience, and what alternative theory could explain the miraculous weight loss.

To analyze and evaluate the claims of the *Oriental Secrets to Weight Loss (Weightloss) and Healing* website, the main claim should be obvious: Chi Kung provides effective weight loss where other diets or weight loss plans fail. That students may find

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2. Although instructors may suggest students access this article via *The Onion*'s website (https://www.theonion.com/revolutionary-new-insoles-combine-five-forms-of-pseudos-1819565103), it appears in *Science and Society*, which I recommend as a part of my extended reading lists in Appendix II.

difficulty in finding reasons or evidence for this claim should be an indicator of a problem with the website and its products.

More troubling should be the appeals used in the second website (http://www.yutopian.com/weight/feedback.html). First, the site offers no credible or substantiated evidence to support its claims. Rather, the site submits testimonials from anonymous users who provide extraordinary claims. At best, these are appeals to emotions. The intent of *Oriental Secrets to Weight Loss (Weightloss) and Healing* can be seen as a means to sell a product. As to what to do with this information, hopefully, students may reduce their options to two: either conduct more research or reject the claims made by the site due to unverifiable evidence.

For their argument, students may take either of these options and compose an argument. For the former option, students would need to suggest how additional research may be conducted. For the latter option, students would need to focus on the fallacies the sites use to support their claim.

A third option is also possible. For this argument, students may wish to make the claim that as presented by these websites, Chi Kung may be considered as a pseudoscience. Siegel's definition and the Schmaltz and Lilienfeld's warnings should supply students with sufficient guidelines, and students should recognize similarities between the websites and "Revolutionary New Insoles Combine Five Forms of Pseudoscience."

My alternative lesson is not meant as an attack on Chinese culture or the practice of Chi Kung itself. Instead, the focus here is to teach students to confront claims in the media skeptically while teaching students to make logical decisions regarding the evidence.

Classics: Zerbe's Pedagogy

For this assignment, Zerbe opts for students to read lesser-known studies that demonstrate a paradigm shift. In this lesson, he recommends two projects. For his first assignment, Zerbe suggests a series of activities. First, he proposes that students debate the "tension" apparent in Odum's text: The very activities that are necessary for human survival, "reproduction, farming, storing water for drinking, and building shelter," also destroy the environment (165).

Second, students could evaluate local zoning rules and assess their impact on the environment (165–166). For this option, students should consider the relaxation of zoning rules and for what purpose these rules are altered.

Third, students could examine the "success and failures with regard to humanity's attempts to manage the environment" (166). These attempts would contain how the creation of dams, waterways, and boating and water recreation alterations impact the environment. Although not specified, these issues would include the introduction of invasive species to combat environmental perils, such as the use of kudzu as a means to stop erosion, or even how the expansion of feral animals disrupts urban and rural environments.

Finally, Zerbe suggests that students could assess and discuss the differences between Odum's view of ecosystems and traditional science's view of ecosystems (166). This study seems more an examination of Odum's "The Strategy of Ecosystem

Development," contrasting it against how ecosystems had been studied prior to his publication.

For the second project, Zerbe utilizes a writing assignment from his own courses, where he asks students to compose a "Crystal Ball" paper. In this assignment, students forecast "the most significant scientific or technological achievement of the next twenty years," including the influence this new accomplishment will have on various aspects of human life (167).

Classics: A Revision

Again, Zerbe is creative, but I question his use of an otherwise unfamiliar work as it arguably contradicts the very notion of what may be regarded as a scientific classic. Although I appreciate his intention to introduce students to new readings, I prefer Gross's approach to what may be deemed a classic: texts that are "revolutionary masterpieces," which are either "rhetorically powerful enough to provoke open revolt" or "rhetorically powerful ingenious enough to avoid it" (*Starring the Text* 63). Charles Darwin's *On the Origin of Species* fits this definition because of its historical significance and its ongoing ability to stir controversy, not within the scientific community but rather within society in general, and as Darwin presents it, a rhetorical means to alleviate controversy. Yet, it also fits Zerbe's need for a paradigm shift; Kuhn himself discusses how Darwin's argument serves as an example of a paradigm shift as well as functions as an aid to the laity's then-view of evolution (171–172).

Although most students probably have heard of Darwin's classic work, few have probably read it. With the introduction of evolution, instructors undoubtedly will encounter students' preconceived beliefs regarding Darwin's text. Science Education professor William Cobern recognizes that this mixture of worldviews and historical context provides a suitable backdrop—much like in Darwin's day—to teach evolution (297); such instruction requires instructors willing to "bridge cultures" (293). In fact, in "Teaching the Contexts: Why Evolution Should Be Taught as an Argument and How It Might Be Done," Campbell and Computer Science professor Taz Dougherty present a possible means to teach such a reading of *On the Origin of Species*, using students' beliefs as means to promote discussion and learning.

The focus of these authors remains fixed upon the historical aspect of Darwin's work, including the controversy that surrounded it when it was first published. Campbell and Daughtrey offer recommendations that employ the texts to study not just the theory and how Darwin focused on his audience but also scientific methodology and reasoning. In their pedagogy, Campbell and Daughtery concentrate on the rhetorical foundation of *On the Origin of Species*: Darwin presents it as an argument. Within their paper, the authors first examine the first four chapters of Darwin's text (28–32) and then show how entire sections of this material can be used to highlight various aspects of scientific research (32). For example, the authors note that the information could be treated as a pattern of evidence, a debate, and a visual staircase according to the chapter titles (28–29). In Chapter One alone, additional methodologies include asking the same questions that Darwin asks (origin of domestic flocks), using the same examples that Darwin presents (pigeons) (29).

With this pedagogy, I need to call attention to three points of concern. First, Campbell and Daughtrey target high school biology classes. Still, the focus on history and Darwin's text as an argument is appealing for any rhetoric of science course. Second, they limit their study of *On the Origin of Species* to the first four chapters. I will discuss this point later in my revision. Third and perhaps the most concerning point, this pedagogy is part of the "Teach the Controversy" movement (15), which carries with it the stigma of religious interference (Intelligent Design) in science instruction. However, Campbell and Daughtrey's purpose here is to teach evolution within an environment where the students with diverse worldviews can study the topic without feeling threatened; I do not see religious indoctrination within their pedagogy.

From these concerns, I appreciate the intention of their presentation—*On the Origin of the Species* as an argument—and I appreciate their limited focus to just the first four chapters of the text. In fact, I will implement these two points in my revision.

Reading *On the Origin of the Species* in its entirety for this class may be too time consuming for a class of undergraduates, let alone for a class that has other intensive readings for the semester. Like Campbell and Daughtrey, I suggest that students read the first four chapters only, where Darwin discusses his idea of natural selection and compares the theory to domestic breeding. It is within these four chapters that Darwin begins his argument, which is the focus of this lesson.

Additionally, I suggest three additional reading assignments: John Angus Campbell's "Charles Darwin: Rhetorician of Science" and "The Polemical Mr. Darwin," and Randy Moore's "The Persuasive Mr. Darwin." In "Charles Darwin: Rhetorician of Science," Campbell makes the case that Darwin creates a rhetorical work, demonstrating the devices that Darwin uses to appeal to a scientific community heavily influenced by religion (6). In "The Polemical Mr. Darwin," Campbell continues his examination of Darwin's argument, especially Darwin's use of the language of the day that incorporates religious ideology, which helps Darwin persuade his audience (376–377). In both studies, Campbell delivers a basic rhetorical study of Darwin. In “The Persuasive Mr. Darwin,” Moore provides an effective summary of the rhetorical strategies Darwin uses in his *On the Origin of the Species* (108–109) as well as a synopsis of the first edition’s chapters (110–111).

I find that all three are helpful aids and succinct primers to understanding *On the Origin of the Species* as an argument. In his articles, Campbell offers more detailed analyses and examples of Darwin’s rhetorical skill; interestingly, Campbell shows that Darwin establishes a trust with his readers since Darwin expects his readers to take an active role in the discussion presented in *On the Origin of the Species* (“Polemical” 386). Likewise, Moore acknowledges Darwin’s relationship with the audience, stressing Darwin’s careful employment of theology. In essence, both Campbell and Moore examine *On the Origin of the Species* as Darwin himself presents the material: Darwin creates “one long argument” (*Origin of Species* 612).

As a writing assignment, I stress studying the effectiveness of Darwin’s argument within the first four chapters of *On the Origin of the Species.* For the project, I suggest that the writing assignment focus *only* on the text *On the Origin of the Species* itself. As guidance, instructors may wish to pose the assignment in the form of a question: Based *only* on the first four chapters of *On the Origin of the Species*, does Darwin present an effective argument? My emphasis on the word *only* is intentional; I suggest that instructors remove any possible involvement of alternate materials, such as the Bible. Darwin gives ample examples of theological implications throughout his work; essentially, Darwin does an excellent job of bridging cultures as Cobern requests.

For the first worksheet, students may note that Darwin argues in Chapter 1 that variation in nature is possible because a similar approach can be seen when breeders and farmers purposefully match stock to produce a better variety. The rhetorical devices Darwin uses will be of particular importance for this worksheet and, eventually, the formation of students' arguments. For this section, students may look to the additional readings for assistance. For example, students may acknowledge Darwin's disarming conversational style throughout his work. Or students may offer Darwin's personal examples as evidence.

To answer the question regarding what does the author expect the audience to do with this information, students may express that Darwin expects his audience to *believe in* evolution. If this situation arises, instructors may wish to have students examine the difference between belief and acceptance, which is vital in Darwin's construction of his argument. Instructors may wish to ask, "Is Darwin demanding that you believe his argument or that you can see the *possibility* of his argument?" Here, I merely wish to diffuse any possible religious interruptions that may arise.

For the second worksheet, again, students should be able to draw not only from the primary reading but also Campbell's and Moore's contributions to help create an argument. If the purpose of this writing assignment is to determine the effectiveness of Darwin's argument, then instructors may wish to provide two possible arguments for their students:

1. If Darwin's argument is effective, why is it effective?
2. If Darwin's argument is ineffective, why is it ineffective?

Limiting students' options here may not only help them target the rhetorical component of the subject material but also reduce the possibility of religious intrusions. For example, students simply may express their thesis as Darwin's argument is effective *because* of the conversational tone he employs *as shown by* his personal discussion of raising pigeons. From this thesis, students should be able to construct a narrow argument from the reading materials.

You Are What Science Says You Are: Zerbe's Pedagogy

Using "Self-Reported Drinking-Game Participation of Incoming College Students," Zerbe suggests four possible ways that students could conduct their own continuation of this research:

1. Students could "act as participant observers" at drinking game parties, interact with the drinking participants, and determine either why students engage or avoid these drinking games.
2. Students could conduct "an informal, e-mail-based survey" (similar to the original study) that includes their own institution and other institutions, allowing for a better research base and uncovering "motivations and predictors" for more than one campus.
3. Students could further the original study's link between drinking games and the potential for future alcohol-related problems by contacting former college students.
4. Students could prepare a proposal to evaluate their institution's educational program (if available) that teaches "incoming students about the risks of playing drinking games." (177–180)

In his recommendations, Zerbe attempts to show students how science not only directly impacts their lives but also how they can conduct their own scientific studies. Despite Zerbe's aspirations, however, I see two major problems with his suggestions.

First, I see an issue of practicality: Can undergraduate students actually create and conduct such an experiment during a semester? Logistics include not only developing a strong survey tool (not to mention instruction in creating such a survey) but also establishing survey size, permission to conduct such a survey, launching the survey (email, phone calls, face-to-face, or mail), collecting the data, interpreting the data, and writing up the conclusions. Again, these studies may be too complex for undergraduate nonscience majors.

Second, again, Zerbe actually does not mention any composition for these activities. Rather, he advises that students gather information or collect data without any guidance as to how to compile this material. Once more, he needs a writing assignment.

You Are What Science Says You Are: A Revision

As alternatives to Zerbe's ideas, I offer two possible composition projects: an argument based on "Self-Reported Drinking-Game Participation of Incoming College Students" or an argument that proposes to improve the effectiveness of this study. Either composition project mandates the use of rhetorical criticism while engaging students in argumentation.

The first revision requires a simple analysis, evaluation, and creation of an argument of the original study. To employ the second rhetorical criticism worksheet (argument creation), instructors may ask students, "What should you do with this report?" Such a prompt may lead students to argue, "Educational institutions should invest more in educating students about drinking," adding their reasons why such investment is necessary with the evidence from the report to support their reasons. This type of assignment maintains Zerbe's original goal of relating science personally to students by exposing them to a published scientific study.

However, to improve the effectiveness of "Self-Reported Drinking-Game Participation of Incoming College Students," I advocate for a different aspect of rhetorical criticism: visual rhetoric. Specifically, I suggest that after students read the report, instructors ask them to complete the first worksheet with a specific focus: How can this study be more effective *visually*?

Professor of Learning Technologies Richard Lowe appeals for students' scientific visual literacy, noting that such literacy is vital in science education (1–2). Although Lowe's petition focuses on young children and the incorporation of technology to attain such literacy, I agree with his argument concerning not only employing visuals but also the appropriateness of how to use visuals. Borrowing from Lowe's idea, I suggest that students engage in visual rhetoric for this assignment.

For my purposes, I will define *visual rhetoric* as any device—imagery or design—that employs or aids persuasion. For example, any graphic or layout may represent or aid in an argument. Using this definition, students may consider how effective the table in "Self-Reported Drinking-Game Participation of Incoming College Students" is or how this report could be improved (more persuasive) with additional, relevant graphics.

My reason for incorporating a study of visual rhetoric with scientific discourse is simple: science has long used visual representation. Since the sixteenth century, science has used various forms of illustrations to convey meaning and enhance arguments (Gross and Harmon 2–6). From drawings to charts, these graphics have become a vital part of scientific argumentation. In fact, the creation and placement of visual data has increased in current scientific discourse (Gross, Harmon, and Reidy 231). With the advancement of technology, the use and variety of these graphics have evolved; their role has changed from one of commonplace to necessity. As Science Communication instructor J. Harrison Carpenter observes, “Clearly, scientists have taken full advantage of graphics’ capacity for efficient communication” (21). Scientists understand the importance of employing graphics as a means of persuading their audiences.

To complete their argument, students should look closely at the one table used in “Self-Reported Drinking-Game Participation of Incoming College Students.” In the first worksheet, students should indicate whether the table is persuasive to them, considering the statistical reporting of the survey information. Here, instructors may challenge the students with the following question: “How could you improve the graphic representation of this information to be more persuasive to you?” In this case, students’ arguments would focus on a different graphic—perhaps a different table or comparative bar chart from the information in the comment section of the report—and their defense for such a change. Since most word processing programs provide basic graphic capabilities, creating basic graphics poses no hindrance. To be clear, this argument would be the reason why the report needs a different graphic and the inclusion of this new graphic.

CONCLUSION

As I have noted in Chapter 1, Zerbe proposes a relationship of rhetoric of science with composition, a symbiosis with indistinguishable boundaries. In this chapter, I have examined Zerbe's original pedagogy concerning rhetoric and composition. Despite Zerbe's ambitious original pedagogy, I have noted some compelling reasons by Campbell and Sullivan as to how Zerbe's ideas fall short of his intended goals. Still, I proposed that Zerbe's basic idea—using rhetoric and composition can help attain scientific literacy through rhetoric and composition—serves as a useful challenge to create stronger instruction.

To accomplish this proposal, I have challenged Zerbe's dismissal of rhetorical criticism by defining the term as consistent with scientific literacy (see Table 8). Then, I offered two tools to aid in rhetorical criticism of scientific arguments and correspond to my idea of critical thinking as related to scientific literacy. The first tool was a worksheet that helps students in identifying the rhetorical components of a scientific argument—including analyzing the argument's claims, its reasoning to support the claim, and its means of persuasion—while evaluating the argument's overall effectiveness, focusing on these specific components. The second tool was a worksheet that took these considerations from the first worksheet with the intent to aid students in creating arguments as to how to apply this information, again, utilizing the rhetorical components of claim, reasoning, and evidence.

Table 8. Definition: Rhetorical Criticism

Term	Definition
Rhetorical Criticism	In terms of scientific literacy, it is the active process that allows students to demonstrate critical thinking concerning scientific arguments, which includes the analysis and evaluation of a given scientific argument, and the creation of arguments that not only support this analysis and evaluation but also what needs to be done with this analytical and evaluative information.

Then, I returned to Zerbe's original section of his pedagogy, reviewing the specific lessons and noting their shortcomings. To answer Campbell's and Sullivan's criticisms of Zerbe, I offered alternative lessons that employ the rhetorical criticism worksheets that I have created.

Throughout this chapter, I have tried to demonstrate—much as Zerbe has—that rhetoric of science in a composition course is a viable means of attaining scientific literacy. Like Zerbe, I have attempted to illustrate some of the many resources that are available to instructors.

As a final note, these modules are meant to extend beyond the classroom. For instructors and students to apply these lessons requires future symbiotic endeavors with Composition, the Life Sciences, and other disciplines.

CHAPTER 5

CONCLUSION

INTRODUCTION

Overview

In this project, I argue that for nonscience majors to attain scientific literacy, they must be taught to think critically about scientific arguments within scientific issues, and that a rhetoric of science course designed to teach students to understand the rhetorical characteristics of scientific arguments is a more pedagogically sound means of assisting nonscience majors to attain scientific literacy than the course designs in popular *Introduction to Biology* textbooks and their accompanying course syllabi. In supporting this claim, I focus on the relationship among five main terms—*science, scientific literacy, critical thinking, argumentation,* and *rhetoric*—that I use to define *rhetoric of science*. In Chapter 4, I define *rhetorical criticism*, which I see as essential to analyze, evaluate, and create arguments about scientific subjects.

In this final chapter, I will provide a summary of my work, a reminder of this project's limitations, and a recommendation for future application.

SUMMARY OF WORK

Chapter 1

In Chapter 1, I identified three problems concerning scientific literacy for nonscience majors as used in current scientific instruction: definition, purpose, and attainment. To begin this study, it was necessary to define science first to attempt a definition of scientific literacy. I defined *science* as a rhetorical practice via argumentation, which allowed me to define *scientific literacy* as critical thinking regarding scientific subjects.

Using this definition of *scientific literacy*, I claimed that Zerbe, out of all the scholars considered, best understood scientific literacy: science as argumentation, and scientific literacy as thinking critically about scientific subjects. Thus, he suggested that studying rhetoric of science offered a logical and effective means to teach science, allowing students to engage scientific texts.

To demonstrate how such critical thinking may be accomplished required a deeper understanding concerning its relationship with scientific literacy, argumentation, and rhetoric of science, which was the focus of the rest of this study.

Chapter 2

Building on Chapter 1, I attempted to show in Chapter 2 how well and logically critical thinking, argument, rhetoric, and rhetoric of science relate to each other and, in turn, relate to scientific literacy. Here, my evidence indicated that the subject matter of all critical thinking was arguments, and the goal of critical thinking (especially according to the Revised Bloom's Taxonomy) was to analyze, evaluate, and create arguments. Since critical thinking focused on arguments and resulted in the creation of arguments, argumentation itself was the very act of critical thinking.

Since arguments, especially scientific arguments, contain both reasoning and persuasion as basic components, critical thinking requires the means to engage these components. As I defined it, *rhetoric*—the awareness and employment of the means of persuasion and the means of engaging and discerning persuasion—provided such means. Following this thought, critical thinking needed in scientific literacy was a "rhetorical endeavor conducted through arguments." Then, it seemed reasonable that a specific rhetorical means to study scientific arguments would aid in scientific literacy. Fortunately, such a specific means existed: rhetoric of science. As I have presented, rhetoric of science offered a viable way to analyze, evaluate, and create scientific arguments needed for scientific literacy.

Chapter 3

If the critical thinking needed for scientific literacy was a rhetorical endeavor, then it seemed reasonable that science instruction would utilize some rhetorical study of scientific arguments. Unfortunately, as I discovered in Chapter 3, most science instruction for nonscience majors emphasized learning facts rather than thinking critically about science subjects. While many of the textbooks and syllabi that I examined included writing assignments, these examples of writing neither required the study of rhetoric nor did they fit with the idea of critical thinking needed for scientific literacy as I have defined it. In fact, I was forced to distinguish between writing—which I noted involved recording short answers—and composition—which closely aligns to Zerbe's ideology that involves argumentation. Between these two forms, composition emphasized the critical thinking required for scientific literacy.

Chapter 4

In Chapter 4, I applied this idea of critical thinking demonstrated through composition that emphasizes argumentation. Breaking from Zerbe, I saw rhetorical criticism as not only an acceptable but also a necessary means to practice critical thinking concerning scientific arguments. First, I introduced the concept of *rhetorical criticism*, which I defined as the demonstrative process of critical thinking concerning scientific arguments that included analyzing and evaluating a scientific argument so that students may create their own arguments that support this analysis and evaluation as well as lead the student to apply this information.

Next, I presented two tools for students to use when performing rhetorical criticism. The first tool assisted students in analyzing and evaluating arguments by breaking down the basic scientific argument according to its claim, its reasoning, and its evidence to support the claim and reasoning. The second tool allowed students to create the template of how they will construct their own written argument with the information garnered from the original argument. Then, returning to Zerbe's original idea of pedagogy, I implemented these tools to correct flaws in Zerbe's pedagogy by suggesting lessons that employed rhetorical criticism.

LIMITATIONS

As I have shown in Chapter 1, I see two major limitations to my study. First, I focus only on nonscience majors since science majors already have an informed interest and background in science. Second, my intention is not to replace science courses within Life Sciences but rather to offer a composition course within English and Communication departments. However, these limitations also lend themselves to my recommendations, which I address in this next section.

RECOMMENDATIONS

In his introduction to *Composition and the Rhetoric of Science: Engaging the Dominant Discourse*, Zerbe challenges composition instructors to protect science by remembering that it is, as a human activity, unpredictable at best and susceptible to attacks from irrational outside forces; teaching rhetoric of science as composition prepares future generations for such protection (13–15). Following this call to action, I envision that further research of implementing rhetoric, specifically rhetoric of science, to attain scientific literacy may find its way in other areas, including the possibility of partnering with other disciplines and academic departments as well as re-establishing a primary educational purpose of rhetoric. Essentially, I suggest two related applications of this study, with both suggestions accomplished through rhetoric and composition: increased interdisciplinary use and active citizenry.

Interdisciplinary Use

As English professor Stanley Fish describes, the problem in modern college education often is the strict compartmentalization of knowledge according to academic disciplines (15–16); interdisciplinary studies simply break down these boundaries and provide the means to connect these otherwise isolated academic disciplines while improving education (16). Whether established through specialization, tradition, politics, or money (Fish 15), these boundaries prove a challenging hurdle to breach. Even more pronounced is the barrier between the sciences (natural and social) and the humanities (all disciplines outside the sciences); here, as famed novelist and chemist C. P. Snow perceives, the problem for interdisciplinary studies becomes one of traditional and conceptual separation, with each discipline working independently and without interest for collaboration to the point of polarization (Snow 4–5). I find it ironic that Snow's occupations contradict the collegiate norms and his findings of the era in *The Two Cultures and the Scientific Revolution* while also foretelling what can be accomplished without the confines of disciplinary isolation.

It is this hope of connection, or better, collaboration, that I focus on in this first part of my recommendation. In fact, English professor Rebecca Nowacek hints at this same idea. She observes that a better way to consider interdisciplinary study is not seeing disciplines as isolated fields but rather as the *potential* to see the constraints present that separate disciplines along with the means to connect disciplines for the benefit of all areas of study (495–496); interdisciplinary study is an opportunity to expand cooperation between disciplines while improving student understanding and learning. As I have shown in this study, I believe that rhetoric and composition provide such a means.

As I note in Chapter 1, Harris disagrees that rhetoric of science is interdisciplinary, describing it instead as a "multidisciplinary enterprise" ("Introduction" xxv). In his view, the use of rhetoric of science already transcends any one domain and is employed by several disciplines. In a sense, Harris implies that rhetoric of science is not a means of connection but rather a universal means of communication. Perhaps his view is the ultimate goal of rhetorical study and use or at least the next evolutionary step in rhetoric: it is a public tool, belonging to no one discipline but existing in all.

Still, the territorial divides become even more stark when considering who or what department will teach such a composition course. As English professor Michael Carter explains, teachers in most other disciplines fear, among other problems, that teaching composition will take away from course content and that teaching composition truly belongs to the domain of English teachers (386). In the case of my own study here, I even suggest that such a course remain within English or Communication departments. However, if collaboration is to occur, these territorial boundaries must be broken or at least expanded.

Still, hope remains. Here, I make a historical reference that leads to a return to the heart of writing across the disciplines. In his view, James Fleming Hosic, the founder of the National Council of Teachers of English, reassured educators outside of English that they should have no fear of "encroachment" since the purpose of teaching English is to ensure "the correct and effective use of oral and written expression" in all disciplines by means of what he termed "co-operation" (24–25). I believe that rhetorical and composition historian Robert Connors's "The Rise of Technical Writing Instruction in America" illustrates both the concern of territoriality and the potential for cooperation.

As Connors explains, technical communication had a challenging history as a traditional engineering profession in need of assistance with its written communication. Although not a true hybrid course—indeed, depending on any particular point in its evolution as a course—technical communication could either be housed within the Department of Engineering or English. For example, just prior to the turn of twentieth century, several schools of engineering formed their own inhouse English departments to meet engineering's specialized communication needs (6). Still, these courses and their instructors were never accepted by either discipline's parent department, with both engineering and English departments and faculties looking down on these courses (7–8). Despite such hurdles, technical communication courses eventually grew, finding both a home in English departments and respect in both disciplines to the point that it became recognized as a professional field by the beginning of the 1980s (16–17).

My point here is that through several decades of experimentation and patience, these two disciplines eventually worked together to create not only a strong academic program but also a respectable profession. True, technical communication courses are often housed within the English department, but they exist as a collaborative effort between departments, with engineering prescribing the discipline guidelines and English enforcing the effective communication standards. In *Shaping Science with Rhetoric: The Cases of Dobzhansky, Schrödinger, and Wilson*, Communication professor Leah Ceccarelli notes similar ideas promoting interdisciplinary courses—specifically how the sciences and the humanities can work together—as proposed by Theodosius Dobzhanksy (*Genetics and the Origin of Species*), Erwin Schrödinger (*What Is Life?*), and E. O. Wilson (*Consilience)*. I agree with and appreciate Ceccarelli, who calls these examples *interdisciplinary inspirational* works (4), indicating that rhetoric (here, rhetoric of science) has the potential (and, as I add, the practicality) to connect different disciplines and how such connection can occur. (I mention *Shaping Science with Rhetoric: The Cases of Dobzhansky, Schrödinger, and Wilson* again in Appendix II as a suggested reading).

The collaboration between English and other disciplines, especially science, promotes another form of relationship. From a writing in the disciplines point of view, English professor David Russell posits that composition itself is a form of socialization within the disciplines (15). However, with composition and rhetoric, this socialization extends beyond one discipline, allowing the influence of rhetoric in composition to be both a means of communication and a unifying tool.

I see rhetoric and composition as a means to accomplish interdisciplinary studies, with these tools as a universal connector. It is in this context that I promote the expanded idea of English departments working with Life Sciences (and, eventually, other departments) to develop more detailed and specific composition courses that capitalize on the foundation that rhetoric and composition provides. This partnership will not only overcome the critical thinking and communication hurdles within science as described in my first chapter but also provide a much more important goal that lasts much longer than the course itself.

In conclusion, I see the application of this study as a means for future collaboration among all disciplines to better educate and prepare students for life. Rhetoric and composition exist as interdisciplinary means to develop the critical thinking necessary that enhances all education and students.

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APPENDIX A

CLASSROOM SYLLABI

INTRODUCTION

Overview

In Chapter 3 of this study, I provide a sampling of how science currently is taught in undergraduate nonscience major courses, looking at a variety of classes across the nation. In this appendix, I offer the syllabi of the classes used in this study.

As noted previously, I chose the following three textbooks for this study:

- Cecie Starr, Christine A. Evers, and Lisa Starr. *Biology: Today and Tomorrow without Physiology*. 3rd ed. Belmont, CA: Cengage Learning, 2010.
- Mariëlle Hoefnagels. *Biology: The Essentials*.St. Louis: McGraw-Hill, 2013.
- Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, and Robert B. Jackson, eds. *Campbell Biology*. 10th ed. Boston: Pearson, 2014.

Using these textbooks, I use the following class syllabi for this study:

- *Biology: Today and Tomorrow without Physiology* (3rd ed.)
  - Biology 101n (General Biology), Central Michigan University (Spring 2013)
  - Biology 100 (General Biology), New Jersey City University (Fall 2014)
  - Biology 160 (Study of Life—Biology), Seattle Central Community College (Fall 2012)
- *Biology: The Essentials*
  - Biology 100 (BIOL 100), Imperial Valley College (Fall 2013)

    - Biology 1005 (Concepts in Biology), The University of Oklahoma (Fall 2013)
    - USU 1350 (Integrated Life Science), Utah State University (Spring 2013)
- *Campbell Biology* (10th ed.)
    - Biology 115 (Cells and the Evolution of Life), The University of Idaho (Spring 2014)
    - Biology 1B (General Introduction to Organismal Diversity, Ecology, and Evolutionary Biology), The University of California at Berkeley (Summer 2014)
    - BISC 120 Lg. (General Biology), University of Southern California (Fall 2014)

This appendix provides these syllabi as they appeared online, in the order listed above.

CENTRAL MICHIGAN UNIVERSITY
GLOBAL CAMPUS
COURSE SYLLABUS

I. IDENTIFYING INFORMATION

Course: BIO 101n
Course Title: General Biology
CRN: 22210178
Term: Spring I
Location: Online
Course Dates: 1/7, 3/1/2013
Course Days and Times:
Prerequisites: None

Blackboard
Blackboard is a web-based learning management system licensed by CMU. Within Blackboard, a course website, also known as a *shell*, is automatically created for every CMU course. Face-to-face courses may or may not incorporate Blackboard, whereas Blackboard course shells are always used for online courses and will be available to you prior to the course start date. Seeing the course shell listed in Blackboard with *unavailable* adjacent to its title is an indication that your instructor has not made it available and is in no way indicative of registration status. To access Blackboard, open a web browser and enter http://blackboard.cmich.edu. After the site loads, enter your CMU Global ID and password in the respective spaces provided. Click the "login" button to enter Blackboard and then the link to the appropriate course to enter the course's Blackboard shell. If you need assistance, contact the IT Helpdesk at 989-774-3662 / 800-950-1144 x. 3662. Self-guided student tutorial resources are also available at http://www.cmich.edu/blackboard.

Instructor: Nancy Seefelt
Primary Phone Number: 989-774-2560
E-Mail Address: seefe1ne@cmich.edu
Availability: e-mail and by appointment
Academic Biography:
PhD - Michigan State University
MS - Central Michigan University
BS - Central Michigan University

II. TEXTBOOKS AND INSTRUCTIONAL MATERIALS

Order books from MBS at:
http://bookstore.mbsdirect.net/cmu.htm

Textbooks and Course Materials:
Title: **Biology Today and Tomorrow without Physiology**
Author: **Starr/Evers**
Edition: **3rd 10**
ISBN: **978-0-495-82752-8**
Publisher: **Brooks/Cole**
Required: **Yes**

III. COURSE DESCRIPTION

The study of living organisms. Fundamental principles of biology are integrated with local and global issues of current interest. Satisfies University Program Group II laboratory requirement. No Credit toward Biology major or minor. May be used toward satisfying the requirements of Integrated Science major or minor for Students seeking certification in Elementary education only. Students may only earn credit in one of the following: BIO 101, BIO 105, or BIO 110.

IV. COURSE GOALS AND OBJECTIVES

Upon successfully finishing this course, it is expected the student will be able to:

Figure 7. Biology 101n (General Biology), Central Michigan University (Spring 2013)

1. Make informed choices about biology and natural phenomenon that influence an individual's societal values, decision making, and lifelong interest. Assessment: exams, group discussion, written laboratory reports

2. Explain the mechanisms of evolution (including natural selection) as the biological explanation of life on earth and use examples to demonstrate how evolution unifies the other fields within biology such as genetics and ecology and can explain processes outside the realm of natural sciences. Assessment: written exams

3. Solve problems within biology and within life situations by applying the methods of scientific inquiry. Assessment: laboratory exercises

4. Apply knowledge of basic equipment and investigative tools to gather, interpret, and analyze biological data. Assessment: laboratory exercises, computer simulations

5. Discuss how complex biological systems (from the human body to ecosystems) can be understood by a critical evaluation of the fundamental components and their interrelationships. Assessment: written exams, group presentations

V. METHODOLOGY

The methodology of the online version of BIO101N will reflect the interactive technologies available through Central Michigan University's online environment. Presentation of the material will be in a variety of formats including narrated PowerPoint lectures of 1 – 15 minutes in length), and virtual experiments. Discussions and interactions will be facilitated through Discussion Board and other resources on Blackboard, and via e-mail and telephone.

Students will be given the opportunity to interact with one another. Any group projects (if any) will be presented virtually. Tests and quizzes will be taken via Blackboard with a time limit, non-copying and non-printing codes and security settings imposed to complete the test.

VI. COURSE OUTLINE/ASSIGNMENTS

Pre-Class Assignment:

Complete the pre-assignments and pre-class activities by the first Monday of class! These tasks are designed to help you get familiar with the Blackboard and build necessary foundation prior to the beginning of this course. Each task will only take 1-5 minutes of your time. There are two graded activities in the Week 0: Getting Started! (See Blackboard for details)

Course Outline:

Week 1 – Unit 1: The scientific method

- • Complete the Pre-assignments (if you have not done so!)
- • Read Chapter 1
- • View materials in the week 1 course material section
- • Complete Unit 1 Lab 1 and Unit 1 Lab 2 in the assignment section of Blackboard
- • Students in the Week 1 Critical Thinking group, respond to the Critical Thinking questions from chapter 1. Other students review the responses and comment.
- • Submit your Digging into Data answers for Chapter 1.

Week 2 – Unit 1: Evolution

- • Read Chapters 11 and 12
- • View materials in the week 2 course material section
- • Complete Unit 1 Lab 3 in the assignment section of Blackboard
- • Students in the Week 2 Critical Thinking group, respond to the Critical Thinking questions from Chapters 11 and 12. Other students review the responses and comment.

- • Submit your Digging into Data answers for Chapters 11 and 12.
    - • **Complete the Unit 1 exam**

Week 3 – Unit 2: Molecules and Cells

- • Read Chapters 2 and 3.
- • View materials in the week 3 course material section
- • Complete Unit 2 Lab 1 and Unit 2 Lab 2 in the assignment section of Blackboard
- • Students in the Week 3 Critical Thinking group, respond to the Critical Thinking questions from Chapters 2 and

  3. Other students review the responses and comment.

- • Submit your Digging into Data answers for Chapters 2 and 3.

Week 4 – Unit 2: Energy and Metabolism

- • Read Chapters 4 and 5.
- • View materials in the week 4 course material section
- • Complete Unit 2 Lab 3 in the assignment section of Blackboard
- • Students in the Week 4 Critical Thinking group, respond to the Critical Thinking questions from Chapters 4 and

  5. Other students review the responses and comment.

- • Submit your Digging into Data answers for Chapters 4 and 5.
- • **Complete the Unit 2 exam**

Week 5 – Unit 3: DNA

- • Read Chapters 6 and 7
- • View materials in the week 5 course material section
- • Complete Unit 3 Lab 1 and Unit 3 Lab 2 in the assignment section of Blackboard
    - • Students in the Week 5 Critical Thinking group, respond to the Critical Thinking questions from Chapters 6 and

  7. Other students review the responses and comment.

- • Submit your Digging into Data answers for Chapters 6 and 7.

Week 6 – Unit 3: Cellular Reproduction & Inheritance

- • Read Chapters 8 and 9
- • View materials in the week 6 course material section
- • Complete Unit 3 Lab 3 in the assignment section of Blackboard
- • Students in the Week 6 Critical Thinking group, respond to the Critical Thinking questions from Chapters 8 and

  9. Other students review the responses and comment.

- • Submit your Digging into Data answers for Chapters 8 and 9.
- • **Complete the Unit 3 exam**

Week 7 – Unit 4: Ecology

- • Read Chapters 16 and 17.
- • View materials in the week 7 course material section
- • Complete Unit 4 Lab 1 and Unit 4 Lab 2 in the assignment section of Blackboard
- • Students in the Week 7 Critical Thinking group, respond to the Critical Thinking questions from Chapters 16 and

  17. Other students review the responses and comment.

- • Submit your Digging into Data answers for Chapters 16 and 17.

Week 8 – Unit 4: Humans and the Planet

- • Read Chapter 18
- • View materials in the week 8 course material section
- • Complete Unit 4 Lab 3 and Unit 4 Lab 4 in the assignment section of Blackboard
- • Students in the Week 8 Critical Thinking group, respond to the Critical Thinking questions from Chapter 18. \
  Other students review the responses and comment
- • Submit your Digging into Data answers for Chapter 18.
- • Submit your Student Opinion Surveys.
- • **Complete the Unit 4 exam**

Assignment Due Dates:

All written work must be in sentence and paragraph form. No abbreviations are allowed (especially text-speak) and spelling and grammar count. Feedback will be provided within 3 – 5 days of completion.

Digging into Data: Each student will be responsible for answering the Digging into Data questions at the end of each chapter. Your answers must be submitted from the assignment area in Blackboard by 11:59pm Eastern Time the Sunday of the week in which you cover the respective chapter. All answers must be in complete sentences. Spelling and Grammar count. 5 points each.

Critical Thinking: Each student will be responsible for answering one question from the critical thinking section at the end of the chapter and responding to one question posted by a previous student. Your response can either be agreeing with the individual or not. If you agree with the person provide additional evidence as to why you agree, if you disagree support your reason for disagreeing. Only the first response to a Critical Thinking question will receive credit unless the additional posts are dissenting opinions. Your answer to the critical thinking question must be submitted to the discussion board by 11:59pm Eastern Time the Sunday of the week in which you cover the respective chapter. Your week to respond is indicated by the first digit in score you see in your grade book for the critical thinking question. For example, if you see the number 42 that means you must answer your critical thinking question during week 4. If you see the number 31 that means you answer you critical thinking question in week 3. Your response to the answer posted by another individual can be done during any week. **Do not post your name to these questions or the responses, only your number.** All answers must be in complete sentences. Spelling and Grammar count. 10 points each.

Laboratory reports: Each student must submit their written responses to the laboratories by 11:59pm Eastern Time the Sunday of the week in which the lab is assigned. All answers must be in complete sentences. Spelling and Grammar count. 10 points each.

Exams: Exams will be available beginning 8:00am Eastern Time on the Friday of the week the exam is scheduled. Each student must submit their exam by 11:59pm Eastern Time the Sunday of week in which the exam is scheduled. 100 pts each

Extra Credit - Two extra points may be earned by completing the feedback survey at the end of the course. Other opportunities for extra credit may be available during the course and will be announced accordingly.

Post-Class Assignment:

Near the end of the course, you will be asked to complete a feedback survey. This survey will allow you to earn 2 extra credit points.
No other post-class assignments will be required.

Student Involvement Hours:

This is NOT a self-paced course. A new topic is introduced each week with associated readings, discussions, assignments, and quizzes. Thus, it is critical that you schedule time for the course on a weekly basis. The course will require about 10 hours of your time each week. If you are not able to commit the time needed for this course, you may wish to consider taking the course at a different time.

It takes great effort to be a successful online student. You have to be self-motivated and selfdisciplined to keep yourself on schedule with reading, assignments, projects, etc. You do have to devote time from your busy family and work schedule to work on the course so you will not fall behind. The communication channel is always open between us, you, and among us. It is very important that we keep connected and interact with one another. If you have questions, please feel free to use email, discussion board, chat, or phone to contact us, or your classmates. Learning takes place in a community.

VII. CRITERIA FOR EVALUATION

Evaluation Criteria:
The points available for each assignment, lab, and exam are listed under the "Assignments" heading. Grades will be posted under My Grades in the Blackboard. I will provide and expect you to check feedback on your submitted assignments in your grade book. You must pass the laboratory portion (earning > 168 points from the total 280 possible points) to pass the class.

Grading Scale:
Grades are assigned on a straight scale, although I reserve the right to modify the scale as I see fit.

The following gradind scall will be used to determine your final grade:

92-100% = A	88-89% = B+	78-79% = C+	68-69% = D+	0-59% = E
90-91% = A-	82-87% = B	72-77% = C	62-67% = D	
80-81% = B-	70-71% = C-	60-61% = D-		

Late Assignments:

Assignments are due as indicated. Scores and feedback will be posted in the My Grades on Blackboard within one week. Late work will receive a 20% deduction for each day it is late with both Saturday and Sunday counting as individual days. Work more than three days late will receive a score of 0 unless it is pre-approved by the instructor.

Make-ups and Rewrites:
There will be no make-ups or rewrites in the course. Late assignments will be accepted with penalty and students have a three day time period when they can take exams at their convenience. However, if you have an issue regarding any requirement and/or due date, please contact via e-mail me as soon as possible.

VIII. EXPECTATIONS

Attendance and Participation:

1. Students are expected to complete the pre-assignments and tasks before the course starts.

2. Students are expected to check their e-mail and read the Announcements on Blackboard daily.

3. Students are expected to submit their assignments online through Blackboard.

4. Students are expected to participate in the weekly discussions.

Academic Integrity:

Because academic integrity is a cornerstone of the University's commitment to the principles of free inquiry, students are responsible for learning and upholding professional standards of research, writing, assessment, and ethics in their areas of study. Written or other work which students submit must be the product of their own efforts and must be consistent with appropriate standards of professional ethics. Academic dishonesty, which includes cheating, plagiarism and other forms of dishonest or unethical behavior, is prohibited. A breakdown of behaviors that constitute academic dishonesty is presented in the CMU Bulletin (https://bulletins.cmich.edu/).

Student Rights and Responsibilities:

Each member of the Central Michigan University community assumes an obligation regarding self conduct to act in a manner consistent with a respect for the rights of others and with the University's function as an educational institution. As guides for individual and group actions within this community, the University affirms the general principles of conduct described in the Code of Student Rights, Responsibilities and Disciplinary Procedures at https://www.cmich.edu/about/leadership/office_provost/dean/Pages/Code-of-Student-Rights.aspx.

IX. SUPPORT SERVICES AND OTHER REQUIREMENTS

Global Campus Library Services (GCLS)

CMU offers you a full suite of library services through its Global Campus Library Services (GCLS) department. Reference librarians will assist you in using research tools and locating information related to your research topic. The library's Documents on Demand office will help you obtain copies of the books and journal articles you need. Check out the GCLS website at http://ocls.cmich.edu for more information.

Reference librarian contact information:

1. By phone: (800) 544-1452.
2. By email: oclsref@cmich.edu
3. By online form: http://ocls.cmich.edu/reference/index.html#form

Documents on Demand office contact information:

1. By phone: (800) 274-3838
2. By email: docreq@cmich.edu
3. By fax: (877) 329-6257
3. By online form: http://ocls.cmich.edu/delivery/index.html

Writing Center

The CMU Writing Center is a free online service for all CMU students, providing help with grammar, citations, bibliographies, drafts, and editing of academic papers. Suggestions and feedback are typically provided within two business days. For additional information and to submit work, visit http://webs.cmich.edu/writingcenter/

ADA

CMU provides individuals with disabilities reasonable accommodations to participate in educational programs, activities and services. Students with disabilities requiring accommodations to participate in class activities or meet course requirements should contact Susie Rood, Director of Student Disability Services at (800) 950-1144, extension 3018 or email her at sds@cmich.edu, at least 4 weeks prior to registering for class. Students may find additional ADA information and forms at http://go.cmich.edu/support_services/academic/StudentDisabilityServices/Pages/default.aspx

Note to faculty: CMU Administration will notify you if applicable; otherwise, the student will provide a "Notification Letter to the Instructor" outlining the accommodations the student is approved to receive.

X. BIBLIOGRAPHY

Starr, Evars, and Starr. Biology: Today and Tomorrow 3rd edition. Brooks / Cole.

ISBN-10: 0495561576 ISBN-13: 978-0495561576

DR. HUM-MUSSER

BIOL 100Y BIOLOGICAL CONCEPTS

COURSE SYLLABUS Spring 2012
Section 003

WESTERN ILLINOIS UNIVERSITY

Lecture: M W F 11:00 - 11:50 AM Waggoner Hall 286
Lab: Th 10:00 - 11:50 AM Waggoner Hall 104

Course Description
A laboratory course recommended for nonscience majors, relating reproduction, heredity, evolution, ecology, and behavior to human life and the problems of society. This general education curriculum course does not count toward a major or minor in biology. IAI: L1 900L. 4 credit hours. No prerequisites or corequisites.

Required Text
Starr C, Evers CA, Starr L. 2010. Biology: Today and Tomorrow with Physiology (3rd edition). Brooks/Cole. Cengage Learning ISBN 978-0-495-56157-6
Barden-Gabbei LM, Anderson RV. 2008. Biological Concepts Laboratory. Cache House/Bluedoor, Eden Prairie, MN. ISBN 978-1-601-99061-7

Contact: sm-hum-musser@wiu.edu WG 352 Office Hours: M W F 10-11AM; Th 9-10AM 309 298 3191
I may be in lab (WG 354/276). If you cannot find me and need to meet with me, please make an appointment.

Peer mentor: Mr. Jeffrey Liles JP-Liles@wiu.edu

Lecture Course Objectives
Describe the science of biology including cell structure and division.
Describe the scientific method and develop critical thinking in data/information analysis.
Explain what genes are and how they work.
Describe evolution, natural selection, and community and behavioral ecology.
Explain cycles in ecosystems.
Describe reproduction and development.

Methods of Evaluating Student Progress
Lecture (~600 points):

Assignments, quizzes, attendance (variable points)	120 points
3 co-curricular activity written reports	30 points
3 Exams (100 points each)	300 points
Final Exam (150 points)	150 points

Lab (~154 points)

Lab homework (~ 4 points each)	56 points
Lab exercises (3 points each)	42 points
Lab quizzes (~ 4 points each)	56 points

Course grade: Lecture = 75% of grade and Lab = 25% of grade

+/- Grade system:	A = 93-100%	A- = 90-92%
B+ = 87-89%	B = 83-86%	B- = 80-82%
C+ = 77-79%	C = 73-76%	C- = 70-72%
D+ = 67-69%	D = 63-66%	D- = 60-62%
F = 0 – 59%		

Multiply your earned lecture percentage by 0.75, multiply your lab percentage by 0.25, and add these scores together for your overall course grade. You must pass the both the lab and lecture sections separately to pass the course. Departmental policy states that attendance and proper completion of the exercises count towards your lab grade. An absence is Excused if solid documentation is provided for: e.g. illness (your own),

Figure 8. Biology 100 (General Biology), New Jersey City University (Fall 2014)

death in the immediate family (sibling, parent, grandparent, child, spouse), and official university trips, military service obligations). Documentation will be required within 2 weeks of the absence for it to be considered an EXCUSED absence. For illness, you must provide a note from your physician. If you decide not to see your physician when you are ill, your absence will be counted as an Unexcused absence. You cannot make up a missed lab. If you have more than one UNEXCUSED lab session or more than three TOTAL lab absences, this will result in a final grade of "F" for the entire course, regardless of your points in lecture.

Course Requirements

1. Attendance and punctuality is required. If absent, obtain additional notes from another student/textbook.
2. All cell phones and laptops must be turned off/silenced & out of sight.
3. Reading of the textbook, lecture notes, & supplementary material is required. Course information, notes are on WesternOnline http://westernonline.wiu.edu When available, bring a copy of notes to class. Take notes during lecture and lab, follow along with the slides & textbook.
4. Exams will be multiple choice (require 2HB pencils), fill-in-the-blanks, short- & long-answer questions, drawing & labeling, and/or short essay. Exams will cover both lecture and lab material but will focus on material covered since the previous exam. Knowledge of prior terms/concepts will be expected & will not be redefined.
5. Unannounced quizzes will be given. There are no makeup exam/quiz/assignments
6. Keep backup copies of your assignments.
7. All course rules & policies, exam dates, & grading scale apply to all students equally.
8. Course information in available through WesternOnline, or through the students' WIU e-mail accounts.
9. Academic honesty is required. Cheating or plagiarism will result in 0 points for that exam/quiz/assignment. Students will conduct themselves with personal integrity & honesty. You should be familiar with & abide by the regulations in the WIU Policy manual, this syllabus and the Code of Student Conduct & the Student Rights & Responsibilities, & Student Academic Integrity Policy (http://www.wiu.edu/provost/policies/). You are expected to do your own work, be honest, do not be disruptive, be respectful of others, & actively participate. Breach of policy will be dealt with severely following the direction of the University & the instructor's discretion.
10. The time to be concerned about your grade is the first 14 weeks of class, not the last 2 weeks.

Learning is a group activity. The behavior of each person in class affects the learning outcomes of others.

Definition of Plagiarism: "Plagiarism is the theft of someone else's words, work, or ideas. It includes such acts as (1) turning in a friend's paper & saying it is yours; (2) using another person's data or ideas without acknowledgement; (3) copying an author's exact words & putting them in your paper without quotation marks; & (4) using wording that is very similar to that of the original source but passing it off as entirely your own even while acknowledging the source." V. E. McMillan in Writing Papers in the Biological Sciences (Bedford/St.Martin's Press,New York, pg 16). This includes information in written or audio information from online websites, textbooks or laboratory manuals, honors & masters theses, all writing assignments, & images.

Academic Accommodations - Notify the instructor for an accommodation requirement. Contact Disability Support Services at 298-2512 for special assistance in emergency evacuations (fire, tornado, etc.).

The syllabus and schedule is subject to change, including additional assignments, quizzes, etc.

Co-curricular activities require Dr. Hum-Musser's prior approval and may require proof of attendance.

1/18	Chapter 1 - Course Introduction, Science of Biology	No labs this week
1/20	Chapter 1, 2 Science of Biology, Molecules of Life	
1/23	Chapter 2 - Science of Biology, Molecules of Life	Lab week 1 – Metric/Microscopes
1/25	Chapter 26 - Reproduction and Development	
1/27	Chapter 26 - Reproduction and Development	
1/30	Chapter 3 - Cells and Subcellular Structures	Lab week 2 – STDs
2/1	Chapter 3 - Cells and Subcellular Structures	
2/3	Chapter 4 – Energy & Transport Across Cell Membranes	

2/6	Chapter 4 – Energy & Transport Across Cell Membranes	Lab week 3 – Reproduction
2/8	Chapter 8 - Cell Division: Meiosis	and Development
2/10	Chapter 8 - Cell Division: Meiosis	
2/13	Lincoln's birthday – no classes	
2/15	Exam 1 – Chapters 1, 2, 26, 3, 4	Lab week 4 – Cell Structure
2/17	Chapter 6 – DNA and Genes, Replication (#1 Co-curricular activity report due)	and Function
2/20	Chapter 6 - DNA and Genes, Replication	Lab week 5 – Cell Division
2/22	Chapter 7 - Translation	
2/24	Chapter 7 - Translation	
2/27	Chapter 9 - Inheritance	Lab week 6 - Genetics
2/29	Chapter 9 - Inheritance	
3/2	Chapter 10 – Biotechnology, Genetic Engineering	
3/5	Chapter 10 – Biotechnology, Genetic Engineering	Lab week 7 – Genetics Exercises
3/7	Exam 2 – Chapters 6, 7, 8, 9	
3/9	Cell Technology and Stem Cells	
	3/12, 3/14, 3/16 – Spring Break	
3/19	Cell Technology and Stem Cells	Lab week 8 – Human Heredity
3/21	Chapter 11 - Evolution	
3/23	Chapter 11 - Evolution	
3/26	Chapter 12 – Processes of Evolution, Trait variation	Lab week 10 – Molecular Genetics
3/28	Chapter 12 – Processes of Evolution, Trait variation	and Evolution
3/30	Chapter 13 – Early Life Forms	
4/2	Chapter 13 – Early Life Forms (#2 Co-curricular activity report due)	Lab week 9 – Ecology &
4/4	Chapter 15 - Human Evolution and Notion of Races	Population Growth
4/6	Chapter 15 - Human Evolution and Notion of Races	
4/9	Chapter 16 – Population Ecology	Lab week 11 – Population Ecology
4/11	Exam 3 – Chapters 10, 11, 12, 13	
4/13	Chapter 16 – Population Ecology	
4/16	Chapter 17 – Communities and Ecosystems	Lab week 13 – Population Ecology
4/18	Chapter 17 – Communities and Ecosystems	
4/20	Chapter 18 – Biosphere and Human Impact on the Biosphere	
4/23	Chapter 18 – Biosphere and Human Impact on the Biosphere	Lab week 12 - Migration
4/25	Biodiversity and Conservation	
4/27	Biodiversity and Conservation	
4/30	Behavioral Biology (#3 Co-curricular activity report due)	Lab week 14 - Behavior
5/2	Behavioral Biology	
5/4	Review for final exam	

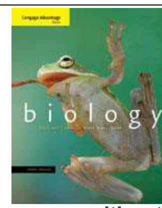
5/9 Wednesday – Final exam at 10:00-11:50 AM (1 hour 50 minutes) – Chapters 15, 16, 17, 18 Biodiversity, Behavior

Welcome to the Study of Life – Biology

This course is an introduction to the basic concepts of modern biology. We will start with the very building blocks of matter (atoms) and work our way up the organizational ladder exploring biological molecules, cells, tissues, organisms, populations, the origins of life, and finish with a study of how organisms interact with each other and their environment. The unifying themes that are woven into all of these units of study include the following:

- Living organisms are different (diverse) and similar (unity)
- Evolution accounts for the diversity and unity of life
- Structure and function are correlated at all levels of biological organization
- Cells are the basic building blocks of all organisms
- The continuity of life is based on the transfer of heritable information in the form of DNA from one generation to the next
- Organisms are interdependent with their environments exchanging matter and energy
- Feedback mechanisms regulate biological systems

**Adapted from Science for All Americans Project 2061 AAAS*

Instructor	Anna Davis, Ph.D., RYT
Office Hours	MWF 1:30-2 PM and by appointment
Office Location	SAM 415
Phone	The best way to reach me is via email
E-mail (preferred)	Anna.Davis@seattlecolleges.edu
Web Sites	http://www.seattlecentral.edu/faculty/adavis/ ANGEL: http://angel.seattlecentral.edu
Lecture: MWF	SAM 104; 2-2:50 PM
Lab: T Th	SAM 305; 2 – 3:50 PM
Textbook	  **Biology Today and Tomorrow without Physiology, 3rd or 4th editions** **Starr/Evers/Starr.** ***Used textbooks are fine too.*** **Please note ISBN below includes CourseMate and e-book access which is optional.** **4th edition: ISBN - 10** 1133365361 ISBN-13: 9781133365365 **3rd edition: ISBN-10**: 0-495-95949-9, **ISBN-13**: 978-0-495-95949-6 © 2010

General Expectations:

Eat, sleep, and take care of the basic life necessities before coming to class so that you can concentrate when we are together.
Be prepared to work hard and be fully engaged for the entire class, sharing your knowledge, insights and questions with other students in the class and your teacher.
Take personal responsibility for your education! Ask questions when you do not understand something and if you need extra help, please make an appointment to speak with me ASAP.
Complete assignments on time – ***missed labs and assignments cannot be rescheduled.***
Please check our online course delivery system daily for updates to our schedule, announcements, assignments.
Please silence all electronic devices before coming to class. If you text during class you will be asked to leave for the day.

ADA Statement: Students with documented disabilities requesting class accommodations or who require special arrangements in case of building evacuation should contact me at the beginning of the quarter (within the first two weeks of class). On your own or together we can set up an appointment with the Disability Support Counselor in room BE 1112 or Science and Math Counselor Stephen Simeona via email: ssimeona@sccd.ctc.edu to come up with a plan to support you throughout the quarter.

Figure 9. Biology 160, Seattle Central Community College (Fall 2012)

COURSE DETAILS

Course Structure: This is an online supported course. Content is divided into divided into 5 major sections: Cells, DNA, Evolution, Exploring Life, and Ecology. We meet 5x a week, 3x for lectures and discussion, 2x for lab.

Lectures and Discussion: Lectures and Discussion emphasize content that you will be required to learn. The textbook and online resources will support and supplement these in-class activities. It is good practice to read the text and all other assigned materials before the topic is discussed in class so that you are prepared to ask questions, and ready to engage in problem solving with peers. The instructor will often provide pre-lecture assignments that must be completed and submitted before lecture (either submitted online or as you walk in the class).

Labs: Weekly lab exercises must be completed during the scheduled lab session and attendance is mandatory since lab resources are only available during our scheduled lab time. Pre-labs must be completed and submitted prior to class to obtain credit. There is no partial credit for missed labs or lab assignments.

ANGEL: Our ANGEL website contains additional course materials including the lab assignments and study questions to help you prepare for quizzes and exams. You will need to be print labs and bring them to class. A course calendar, unit support materials (e.g. movies, articles), discussion board, and assignment drop boxes are also located on ANGEL. **You are required to check the website daily throughout the quarter.** http://angel.seattlecentral.edu.

Specific Student Responsibilities: You are expected to attend class and lab and participate as a fully engaged group member for all activities, check the class ANGEL site daily, turn in assignments on time (e.g. post to discussion board, homework, quizzes), and respond to any course emails within 24 hours throughout the quarter. Late assignments will not be accepted for credit. Note: Each student has one LATE PASS for homework. Details will be explained in class. If you miss a lecture, then it is your responsibility to obtain the lecture notes, assignments, and materials handed out in class. Please make friends early so that you have peer support for your learning. If you must miss class due to a prolonged illness or unexpected circumstance, you should notify the instructor as soon as possible.

Study Suggestions: This course covers a lot of material in a short period of time therefore it requires a strong commitment in order to succeed. ***Plan to attend every class and spend at least 5 - 10 additional hours per week studying. Your studies outside of class should include reading and studying your lecture notes, reviewing the online course materials, answering study questions, participating in discussions by providing thoughtful analyses of questions posed and studying laboratory materials. Studying is not just reading the book. Many successful students (3.5 – 4.0) form study groups, share notes and practice explaining concepts in writing and orally before exams as well as meet with their teacher if they need help.***

Additional Help: Tutors will be available in OPEN Lab to provide additional support (Days/Times TBA). Some anatomical models are available in the library.

Communication with the Instructor: *Please ask for help early and often if you are struggling*. During this course my top priority is to help you understand Biology. If you have any questions throughout the quarter please contact me immediately: in person during class, via the ANGEL Discussion Board, via ANGEL email or my school email **Anna.Davis@seattlecolleges.edu**. Additionally, you can make an appointment to meet with me privately outside of class. If you have questions, it is likely that other students do also. Everyone's learning benefits from students asking questions.

My response to you: For ANGEL questions, you should expect a response from me within 24 hours to a direct question or post to our Discussion Board (Monday-Friday). You should expect to receive your critiqued and graded work within 72 hours of the assignment deadline unless I post a message indicating otherwise.

Academic Honesty: The worst academic offenses are cheating and plagiarism. ***All exams and quizzes are independent works of the individual student.*** Please make sure you understand the definition of plagiarism as defined here: http://www.wpacouncil.org/node/9. The consequences for cheating and plagiarism can be as serious as failing the course, and in some instances, being kicked out of school.

Evaluation

Assessment Method	Point Value	%	Points
3 Exams	100 pts	37.5%	300
1 Cumulative Final Exam	200 pts	25%	200
4 Quizzes	30 pts	15%	120
8 - 12 Graded Homework Assignments (e.g. study questions, presentations, labs, etc. details will be provided)	10 - 30 pts	15%	120
Participation	60 pts	7.5%	60
			TOTAL = 800

Tests (Exams/Quizzes): There will be 4 quizzes and 4 exams (3 tests and a cumulative final). Tests are likely to include a mix of multiple choice, short answer and essay style questions as well as identification of structures studied in lab (e.g. cell structure).

The ***approximate*** dates of tests are listed in the course schedule.

There are no early, late, or makeup tests and no extra time is given for those arriving late to an exam except under extreme emergencies.

Quizzes are designed to take approximately 10-40 minutes, Exams and Final: approximately 1.5 hours.

All assessments are cumulative with emphasis on the most recent material.

Test Reflections: As part of this course you will be required to submit corrected responses to any missed exam/quiz questions and a brief reflection on why you missed the question (rubric will be provided). These are due in writing 2 days after assessments are returned to you. You may earn "recapture" points on the first 2 quiz reflections and for Exam 1 and 1 additional quiz of your choice. To recapture points, you must defend your corrected test answers in-person with Dr. Davis (this is highly encouraged). Up to 1/3 of missed points can be recaptured for each assessment.

If there is a mistake on the addition of your exam, please return it to your instructor immediately for a reassessment of the addition. If you are unsure/unhappy with the grading protocol, turn in a written explanation of the areas in question *no later than two days after the exam has been returned*.

Homework (Discussion Board posts/Assignments, etc.): There will be 8-12 graded homework assignments to reinforce your learning. Details will be provided. All homework must be submitted on time (in class or to the drop box associated with the assignment). **Late homework will receive no credit**. Each student receives one **late pass**. **Late pass** policy will be explained in class.

Grading/Assessment Policy: The final grade for this course will be a combination of your assessment scores (participation, homework, test scores, etc.). *******Dates for assessments are listed in the tentative schedule but note that the instructor reserves the right to alter the schedule, assignments, grading procedures, etc., at any point in time during the class, due to schedule conflicts, new/different assignments, new approaches, etc., based upon the instructor's professional judgment.***

Course Grade: Grades will be tentatively assigned as follows and follow the standards set by Central Seattle Community College:

4.0 = 95% 3.4 = 89% 2.8 = 79% 2.2 = 70% 1.6 = 61% 1.0 = 52%
3.9 = 94% 3.3 = 88% 2.7 = 78% 2.1 = 69% 1.5 = 60% 0.9 = 50%
3.8 = 93% 3.2 = 85% 2.6 = 76% 2.0 = 68% 1.4 = 59% 0.8 = 48%
3.7 = 92% 3.1 = 83% 2.5 = 74% 1.9 = 66% 1.3 = 58% 0.7 = 46%
3.6 = 91% 3.0 = 81% 2.4 = 73% 1.8 = 64% 1.2 = 56% 0.6 = 44%
3.5 = 90% 2.9 = 80% 2.3 = 71% 1.7 = 62% 1.1 = 54% 0.5 = 42% etc.

Course Outcomes (What students should be able to understand at the end of this course)

Identify the major themes of biology and list characteristics of living things.
Identify and distinguish the major characteristics of the domains and kingdoms of life
Demonstrate the methodology of scientific inquiry (observation, experimentation, data collection and data interpretation in problem solving and the generation of new knowledge).
Recognize that science is the study of the natural (physical) world and that science is based on common laws or principles and methods.
Describe the properties of carbon that make it the central component of organic compounds.
Compare the functions and chemical functional groups of the major groups of organic compounds: carbohydrates, lipids, proteins, and nucleic acids.
Demonstrate the special properties of water that support life.
Explain why the cell is the basic unit of life.
Compare and contrast properties of eukaryotic and prokaryotic cells.
Describe the structure and function of eukaryotic cell organelles.
Describe the fluid mosaic model of cell membrane structure in relationship to membrane function.
Describe how the first and second laws of thermodynamics relate to living systems.
Explain the chemical structure of ATP and its central role in metabolism.
Describe the relationship between enzyme properties and types and rates of chemical reactions.
Describe the processes of photosynthesis and how it is essential to all life
Describe aerobic cellular respiration and fermentation.
Describe the cell cycle and the process of mitosis.
Describe the process of meiosis.
Relate the contributions of Mendel to inheritance and solve inheritance problems using Mendel's principles.
Describe the chemical and physical features of DNA and the major scientific discoveries that led to this understanding.
Discuss the significance of chromosomes in inheritance and the transmission of genetic information from generation to generation.
Outline the flow of genetic information in cells, from DNA to RNA to protein and how this process may be controlled.
Explain the scientific origins of biotechnological developments and evaluate the implications of those developments.
Summarize evidence supporting the theory of evolution.
Explain why evolution is the central theme of all biology.
Explain how genetic variation and selection are the basis for evolution in a given environment.
Use various laboratory techniques and equipment to observe specimens and perform experiments.
Develop general skills used in scientific inquiry (e.g., observation, problem solving, hypothesis generation and testing).

Technology Access/Skills Required (Please see me ASAP if you need help with any of this)

Navigate web sites (download and read files from web sites)
Download and install software or plug-ins such as Adobe Reader or Flash
Use email, including attaching and downloading documents/files from emails
Save files in commonly used word processing formats (.doc, .docx, .rtf)
Copy and paste text and images on a computer
Save and retrieve documents and files on your computer
Locate information on the internet using search engines
Read, understand and agree to adhere to "netiquette" in all course communication as articulated here: http://www.online.uwc.edu/Technology/onlEtiquette.asp

Other Information:

Inclement Weather: Please sign up to receive Campus Alerts: https://alert.seattlecolleges.edu/LogIn.aspx
Library Resources - http://dept.sccd.ctc.edu/cclib/
Technology Help: http://seattlecentral.edu/it-services/student/index.php
Student Support Services: http://www.seattlecentral.edu/academic-assistance/index.php .

***Important Dates:**

Sept. 28	**Last day to withdraw with 100% refund (less $6).**
Oct. 5	**Last day to add/register; instructor permission required. Last day to change audit/credit status without instructor permission. Last day to withdraw without a "W" appearing on transcript and without instructor permission.**
Oct. 15	**Last day to withdraw with 50% refund. Instructor permission required.**
Nov. 16	**Last day to withdraw (no refund) or change audit/credit status; instructor permission required.**

Biology 160 (1024.04 Fall Quarter 2012)
*****Tentative Schedule**

Wk	Date		Lecture Topics	Reading	Lab Exercises
1	M	9/24	Intro/Brain Rules	Ch. 1 & 2	
	T	9/25			1. Lab Safety, Scientific Method
	W	9/26	Chemistry		
	Th	9/27			2. Chemistry
	F	9/28	**Class Cancelled and *Practice Quiz (Online)***		
2	M	10/1	Water and Biomolecules	Ch. 3 & 13.6	
	Tu	10/2			3. Microscope
	W	10/3	Macromolecules 2		
	Th	10/4			4. Cells
	F	10/5	Intro to Cells and ***Quiz 1***		
3	M	10/8	Cell Physiology	Ch. 4 & 5	
	Tu	10/9			5. Diffusion/Osmosis
	W	10/10	Energy		
	Th	10/11			6. Enzymes (Metabolism)
	F	10/12	Protein Synthesis and ***Quiz 2***		
4	M	10/15	DNA	Ch 5 & Ch. 6, 355-357, 377 – 379,	
	Tu	10/16			**TBD and Review Session**
	W	10/17	DNA		
	Th	10/18			***Exam 1***
	F	10/19	DNA		
5	M	10/22	Reproduction	Ch 6, 7 & 8	
	Tu	10/23			7. Protein Synthesis, DNA Extraction
	W	10/24	Meiosis		
	Th	10/25			8. Cell Division (Meiosis and Mitosis)
	F	10/26	Genetics I and ***Quiz 3***		
6	M	10/29	Genetics II	Ch. 9, 10 & 11	
	Tu	10/30			9. Antibiotic I; Inheritance Problems
	W	10/31	Evolution I		
	Th	11/1			10. Antibiotic II; Evolution
	F	11/2	Evolution II		
7	M	11/5	Origins of Life III	Ch. 12 & 13	
	Tu	11/6			11. Antibiotic III, Evolution Movies, Review
	W	11/7	Classification IV		
	Th	11/8			**Exam 2**
	F	11/9	Viruses, Prokaryotes		
8	M	11/12	Protista	Ch. 14	
	Tu	11/13			12. Protist
	W	11/14	Plants		
	Th	11/15			13. Plants I
	F	11/16	Plants and ***Quiz 4***		
9	M	11/19	Plants, Fungi	Ch. 15	
	Tu	11/20			14. Plants II, Fungi
	W	11/21	Animals		
	Th	11/22	HOLIDAY – No Class		15. HOLIDAY – No Class
	F	11/23	HOLIDAY – No Class		
10	M	11/26	Animals	Ch. 15 & 16	
	Tu	11/27			16. Animals
	W	11/28	Animals		
	Th	11/29			17. Animals
	F	11/30	Ecology		
11	M	12/3	Ecology	Ch. 17 & 18	
	Tu	12/4			**Exam 3**
	W	12/5	Ecology		
	Th	12/6			Review and TBD
	F	12/7	Open		
12	M - W	12/10 – 12/12	FINALS Week		**FINAL EXAM - Tuesday: 12/11 (1 pm – 3 pm)**

****Dates for assessments are listed in the tentative schedule but note that the instructor reserves the right to alter the schedule, assignments, grading procedures, etc., at any point in time during the class, due to schedule conflicts, new/different assignments, new approaches, etc., based upon the instructor's professional judgment.*

Charlotte Murray

Class Syllabus --- Biol. 100 --- Class Code 10216 --- 4 Units --- Tuesday & Thursday 6:30 to 9:40

Fall 2013 --- Schedule subject to tweaking ☺

Lec Date	Chapters	Lab Date	Subject & Page Numbers
Aug 20	1-- Sci. Study of Life, 2 – Chem. of Life	**Aug 22**	**Roots & Shoots pp 229-239**
Aug 27	2-- Continued & 3—Cells	**Aug 29**	**Leaves & Flower Parts pp 239-243**
Sept 3	8-- DNA Rep. and Cell Division, 9 Sexual Reproduction and Mitosis pg 154-160	**Sept 5**	**Mitosis and Lab Quiz pp 57-62**
Sept 10	4 – The Energy of Life 5-- Photosynthesis	**Sept 12**	**LAB EXAM**
Sept 17	5 –Continued, 6 -- How cells Release Energy	**Sept 19**	**Algae pp 171-181**
Sept 24	**LECTURE EXAM CHAP. 1-6, 8 and part of 9**	**Sept 26**	**Protozoa pp 185-193**
Oct 1	9 – Sexual Reproduction & Meiosis pg 160-169 10 – Patterns of Inheritance	**Oct 3**	**Cnidarians pp291, 293-297 Platyhelminthes pp303-310**
Oct 8	10—Cont, 12 – Forces of Evolutionary Change	**Oct 10**	**Annelida pp 325-333**
Oct 15	13 – Evidence of Evolution	**Oct 17**	**LAB EXAM**
Oct 22	14—Speciation and Extinction	**Oct 24**	**Crayfish pp 335-336 & 341-344**
Oct 29	**LECTURE EXAM part of 9 and 10, 12, 13,14**	**Oct 31**	**Grasshop0pers pp 346-350**
Nov 5	7 – Viruses etc. 125-133	**Nov 7**	**Starfish pp 351-354**
Nov 12	15 -- Evolution & Diversity of Microbial life 16 – Evolution & Diversity of Plants	**Nov 14**	**Amphioxus pp 359-360 & Frog 393-396, 405-406**
Nov 19	17- Evolution and Diversity of Animals	**Nov 21**	**Thanksgiving Break**
Nov 26	17 Continued	**Nov 28**	**LAB FINAL**
Dec 3	**LECTURE FINAL: Chapters 7, 15, 16, & 17**	**Dec 5**	**No Class**

HOME PHONE 760-357-2865 -- Call me when you need to but not before 7:30 a.m. or after 10:00 p.m.

E-mail: charlotte.murray@imperial.edu

TEXTS: Lecture: Biology, The Essentials: Marielle Hoefinagels

Lab: Laboratory Outlines in Biology VI: Peter Abramoff, & Robert G. Thomson

**** Bring colored pencils for the Lab. work

<u>IF YOU WANT OUT OF THIS CLASS YOU MUST DROP YOURSELVES !!!!</u> Failure to do so may mean a grade of "F"

Exams: Lecture exams are a combination of multiple choice, true false, short answer and essay questions.

Lecture Exams 3 @ 150-200 points each = 450-600 points (includes Final)

Lab exams 3 @ 80 points each = 240 points

Quizzes ± 10 @ 12-45 points each = 200 points → **Approx 1000 points possible**

Final grade is calculated as a percentage of the highest score in the class:

- **90% 100% is an "A"**
- **80%-89% a "B"**
- **70% - 79% a "C"**
- **60% - 69% a "D"**
- **59% and below an "F"**

Figure 10. Biology 100, Imperial Valley College (Fall 2013)

If a student is absent on a day when a lecture quiz or exam is given they must make-up that quiz or exam at the next meeting unless other arrangements are made.

Lab exams and the quiz cannot be made up because it takes several hours to set them up.

THINGS YOU MUST DO:

1. Purchase a pair of safety glasses. They can be purchased at the book store for about $5.00. We will need them when we start to do the dissection.
2. Go to web site: **http//forms.imperial.edu/machform/view.php?id=24** and complete the form for the lab safety information as required by the department. * Failure to complete the form may affect your grade.

There are no extra credit papers or work available, you need to learn what I want you to learn.

1. **You may record the class**
2. **NO cell phone on during class --- TURN THEM OFF OR TO VIBRATE!!!!**
3. **During exams and quizzes --- cell phones must be put away.**
4. **Be on time**
5. **No talking in class while I am teaching or you may be told to leave the class.**
6. **Any student with a documented disability, who may need educational accommodation, should notify me and the Disabled Student Programs and Services office (Room 2117 – 760-355-63120) as soon as possible.**
7. **Any student caught cheating or helping another student to cheat will be given a zero on the exam and may be reported to the administration for further action.**
8. **Important dates: Last day to Drop; Nov. 9, 2013**
9. **November 1, deadline to Petition for Graduation**

Course Description: ***Prerequisite: Math 091 or Math 090.*** This course is a comprehensive one semester general biology course, designed to provide students with an overview and understanding of the biology and taxonomy of organisms in all five Kingdoms. The class will focus on genetics, evolution, and species diversity.

My Course Objectives: Students will learn to use a microscope to identify various species of algae, protozoa, plants and animals. They will be able to describe various cellular processes like photosynthesis, aerobic cellular respiration, enzymatic reactions, mitosis, and meiosis. Students will acquire a general knowledge of genetics and how genetic information is passed on to offspring. Students will learn about the likely origin of life on Earth and how the original species underwent adaptation and evolution to give rise to life as we know it today. Students will be presented with a general review of all five Kingdoms with the greatest focus on eight animal phyla. The students will understand how over time phyla acquired characteristics that made them more advanced than those phyla without these characteristics.

STUDENT LEARNING OUTCOMES (SLOs)

INSTITUTIONAL STUDENT LEARNING OUTCOMES:

Students who complete a degree or certificate at Imperial Valley College will demonstrate competency in these five areas: communication skills, critical thinking skills, personal responsibility, information literacy, and global awareness.

COURSE STUDENT LEARNING OUTCOMES:

Students who complete Biology 100 with a grade of "C" or better will be able to:

1. Demonstrate an understanding of the steps of the scientific method. (ILO2)
2. Communicate an understanding of the various patterns of inheritance of genetic traits. (ILO1, ILO2)
3. Explain how the processes of natural selection influence evolution. (ILO1, ILO2)
4. Perform lab activities properly, and correctly analyze lab data. (ILO1, ILO2)

IVC COURSE OBJECTIVES

Upon satisfactory completion of the course, students will be able to:

1. Identify the basic characteristics of all living things.
2. Name basic chemical aspects that pertain to life and the concept of homeostasis.
3. Describe the sub-cellular components of the cell including their structure and function.
4. Explain the light and carbon reactions of photosynthesis.
5. Explain cellular respiration and its relations to the entire organism.
6. Demonstrate knowledge of the structure and function of DNA and RNA.
7. Explain protein synthesis and site the central dogma of cell biology.
8. Compare and contrast the fundamentals of asexual and sexual reproduction.
9. Define ecology and the overall impact of ecology to conditions in the environment.
10. Solve problems in general genetics and in human genetics and relate advances in genetics to social responsibility of geneticists.
11. Identify and relate the functions of the major systems of the human body; the interrelationship among body systems and nature of disease.
12. Classify organisms in the kingdoms of plants and animals, discuss their evolutions and their relationships.

BIOL 1005 – Concepts in Biology
Fall 2013

Concepts in Biology is a general-education, natural sciences course. It is an introduction to the life sciences, focusing on the structure and function of organisms and their relationship to the environment. Specifically, in this class we'll talk about the qualities that unify living things (chemistry, cell structure, metabolism), the qualities that make them different (genetics), the history of, and variation in, life (evolution, diversity), and what living things do with their time (ecology).

Instructor: **Dr. Mariëlle Hoefnagels**, Associate Professor, Biology and Microbiology/Plant Biology
Office: GLCH 224; phone number: (405) 325-5705
Office hours: Tues., Thurs. 8:30-10:00 a.m.; Wed. 2:00-3:00 p.m. (or by appt.)
Action center hours (Wagner 245): Mon. 6:00-8:00 p.m.
E-mail: *hoefnagels@ou.edu*

Laboratory instructors:

Billy Culver
Dept. of Biology
Office: Sutton 102
Phone number: 940-733-5246
E-mail: *bculv001@ou.edu*
Office hrs: Tues. and Thurs., 12:00-1:30 p.m. (GLCH 230/231); or by appointment

Krystal Gayler
Dept. of Microbiology and Plant Biology
Office: GLCH 035
Phone number: (405) 325-9092
E-mail: *krystal.k.gayler_1@ou.edu*
Office hrs: Tues. and Thurs. 12:30-1:30 (GLCH 230/231); Mon., Fri. 10:00-11:00 a.m. (GLCH 035) or by appointment

Class times:
Lectures: Tuesday, Thursday 10:30-11:45 a.m. AND Wednesday 3:30-4:20 p.m. (Dale Hall 112)
Laboratories: Tuesday OR Thursday 1:30-4:20 p.m. (GLCH 230/231)

Books and materials (required):

Text: *Biology: The Essentials*, 1st edition (2013) by Hoefnagels*. You may choose to buy a new softcover book or a customized softcover version of the book containing selected chapters (~$105). A used custom book is ~$79. New books should come with a Connect access card; used books may not. Alternatively, instead of a print book you can purchase an ebook (ConnectPLUS; $85). If you have a print book without Connect access, you can purchase Connect separately ($50). See below.

Laboratory Manual: *Symbiosis*, a customized lab manual for this class. Be sure to purchase the lab manual for BIOL 1005, not another class. You may not use a lab manual from a previous semester.

i>Clicker 2: You'll need this for most lectures and most labs. To register your remote in D2L, select the BIOL 1005 course, click **Content.** Click the **Register Your i>Clicker Remote** link, and enter your i>Clicker2 remote ID. Click Register, and you're done!

**All royalties earned from textbook sales at OU are donated to an OU textbook scholarship fund.*

Required or recommended websites:

Desire2Learn (D2L): *http://learn.ou.edu.* This is where you will register your i>Clicker remote, turn in your written assignments for lab, look for course announcements, and check your grades.

Connect: *http://connect.mcgraw-hill.com/class/m_hoefnagels_biol_1005_fall_2013.* This is where you will find the ebook and complete your weekly LearnSmart assignments and your unit homework assignments. Connect access is *required* for the course; you can buy it separately if you don't have a book with a code.

LON-CAPA: *http://lon-capa.ou.edu.* This is where you will complete pre- and post-lab assignments. Log in using your OUNet ID (4+4); your initial password is biol1005. Please change your password as soon as you log in.

Course web site: *http://faculty-staff.ou.edu/H/Marielle.H.Hoefnagels-1.* Among other things, you can find review sheets and old exams on my website.

Figure 11. Biology 1005, The University of Oklahoma (Fall 2013)

Grading:

Semester grades will be assigned according to the following scale (*subject to adjustment if necessary*): **A = 90% and above; B = 80‑89%; C = 70‑79%; D = 60‑69%; F = 59% and below.**

Point distribution:

Item	Number	Points (ea.)	Total Points
Midterm exams	3	100	300
Final exam	1	200	200
Laboratory			250
Pop quizzes	33 or more	3	100
LearnSmart assignments	14	5	80*
Unit homeworks	4	15‑20	70
TOTAL			**1000**

*Includes one 10‑point D2L "orientation" assignment due early in week 2

- **Midterm exams:** Format will be partly true/false and multiple choice (total of 75 points) and partly short answer (total of 25 points). Exams will emphasize material from lecture but may also include questions from lab.
- **Final exam**: Format will be entirely true/false and multiple choice. Fifty points (25 questions) will come from each of the four sections of the course.
- **Laboratories:** Most labs will include a LON‑CAPA pre‑ and post‑lab assignment. Most labs will also have clicker questions during the lab period (you will be allowed one lab‑specific "free pass" card for when you are in lab but forgot your clicker or your batteries die). In addition, many of the labs (marked ** in the lab schedule) have an additional assignment. Your TA will tell you the due dates for each assignment. A limited number of extra credit points will also be available.
- **Pop quizzes** will be unannounced and can occur at any time during lecture. Each will be worth 3 points, and most will require you to use your clicker. If I give more than the 33 needed to acquire 100 points, I will drop one or more of your lowest score(s).
- **LearnSmart assignments:** Each week, you will complete a small deck of LearnSmart "flashcard" modules on Connect. With few exceptions, each assignment will be available ONLY from *Thursday at noon to Monday at 10:00 p.m.* In addition, a 10‑point online assignment on D2L will help you register your clicker and register for LON‑CAPA and Connect.
- **Unit homework assignments:** Before each exam, a unit homework assignment consisting of interactive, integrative questions will be available on Connect until 9:00 p.m. on designated nights. Assignments for units 1 and 2 are worth 20 points; assignments for units 3 and 4 are worth 15 points each.

Make‑ups and late work:

Midterms: No make‑ups. However, the final exam will be structured in sections corresponding to each of the four sections of the course. If you miss one midterm exam, you will receive a score for that midterm equivalent to your score (percentage basis) on the corresponding portion of the final exam. In that case, you *may not* take advantage of the improvement policy described below. If you miss more than one midterm exam, you will receive for the first missed exam a score equivalent to the corresponding portion of the final exam, and a zero on subsequent missed exams.

Pop quizzes: The pop quizzes are designed to help you work with the material as it is presented in class; this purpose would be defeated if you were allowed to make them up. If we have more than 33 pop quizzes, however, I will drop one or more of your lowest pop quiz scores. Also, you will be allowed two use‑'em‑or‑lose‑'em "free passes" for when you are in lecture but forgot your clicker or your clicker's batteries die.

LearnSmart and unit homework assignments: No make‑ups; each will be available for several days (or longer). You are responsible for getting to a computer and completing each assignment on time.

Laboratories: Each LON-CAPA assignment will be available online. You are responsible for getting to a computer and completing each assignment on time. In addition, we do not have time or resources to develop make-up lab activities. Please also note that you *must* attend the lab section for which you are registered. If you must miss lab, please contact me or your teaching assistant *in advance*.

Final exam: University policy prohibits make-ups for final exams except for *emergencies* (personal illness or serious illness or death in immediate family) or *academic conflict* (more than two exams in one day or two at the same time). Please note that if you work, you are responsible for arranging your work schedule to enable you to attend the final exam. The University also prohibits early final exams, so check your schedule before booking travel.

In general: If you have missed labs or a large number of pop quizzes because you are ill or because of an extended family emergency, please provide written documentation on your first day back in class. (You can miss one midterm exam for any reason, so you do not need to provide documentation for that.)

Improvement policy: Suppose you have a lousy day and really mess up on one of the midterm exams. Not to worry, because you will have a chance to redeem yourself (*but only if you have not missed any midterms; see above*). As noted above, the final exam will be structured in sections corresponding to each of the four sections of the course. When I calculate your grade, I will compare your score (percentage of possible points) on each section of the final to your score on the corresponding midterm. If your score on one section of the final is higher than the corresponding midterm score, I will award you the difference. If you improve in more than one section, I will award you only the points for the single greatest difference. Note that *I will not take points away* if you happen to do worse on a section of the final than you did on the corresponding midterm!

Other policies:

Laptop computers: If you wish to use your laptop during lecture, please sit at the rear of the class so your screen does not distract students sitting behind you.

PLEASE do not use cell phones during class. Also, I encourage your enthusiasm and participation, but please do not socialize during class, as it is very inconsiderate of fellow students.

Exam re-grades: If you believe that a question on an exam was misgraded, you must bring it to my attention before the date of the next exam.

Academic integrity: Academic misconduct includes cheating, plagiarism, falsification of records, unauthorized possession of examinations, intimidation, and any other action that may improperly affect the evaluation of your performance. It also includes assisting others in any such act. Penalties may include grade penalties and disciplinary action from Office of Academic Integrity Programs. For more information, visit *integrity.ou.edu.*

Reasonable accommodation: Students with disabilities who require accommodations in this course should speak with me as early in the semester as possible. Students with disabilities must be registered with the Disability Resource Center (*drc.ou.edu*) before receiving accommodations in any course.

Religious observance: It is the policy of the University to excuse absences of students that result from religious observances and to provide without penalty for the rescheduling of examinations and additional required class work that may fall on religious holidays. Students who plan to observe a religious holiday should notify me as soon as possible to make arrangements for class work or rescheduling of examinations.

E-mail contact with the class: I occasionally e-mail the whole class at once to make announcements, send reminders, etc. You should therefore check your email frequently. *It is best if you use your OU email.* But if you use a different one, please follow these EASY instructions that will enable my e-mails to the class to reach you too (please note that OU does not guarantee email delivery to non-OU email accounts.):

1. Go to *account.ou.edu*
2. Log in using your OUNet ID (4+4) and password.
3. Click "Email information"
4. Enter the email address you use at "Forward your email account"

Please see the academic calendar (*www.ou.edu/content/enrollment/home/academic_calendar.html*) for a summary of important dates, including the last day to drop a class without a grade (Friday of week 2), the last day to drop with an automatic "W" (Friday of week 10), and the date after which you need to petition to the dean to drop any class (beginning the Monday of week 11). Please note that if you withdraw *after* week 10 (the automatic "W" date), I will give you a W for the class if you are earning a passing grade at the time of withdrawal. If you are failing, academic standards require that you receive an F.

DID YOU KNOW???? Universities expect you to spend 2-3 hours of study time OUTSIDE OF CLASS for *each credit hour*! There is a lot of material to cover in any introductory course, but you can do very well in any class if you decide to commit the necessary time to your education.

I Hope You Become a Better Student Because You Took My Class

My objective in this class is to help you learn something *real*, something that will stick with you long after you have taken your last exam in this class. But you don't learn real things by memorizing a bunch of vocabulary terms, regurgitating them on an exam, and forgetting them right away.

True, there will be new words to learn in this class, and being able to use those words will be a necessary part of your biology "toolbox." What will make this class meaningful and worthwhile, though, is applying your knowledge so that you can truly understand something on a deeper level. That's the kind of class I hope to teach, and that's the kind of student I hope you'll be. If you aren't used to studying that way, that's OK – the class provides tons of resources to help you find a way to be successful. This list of tips may help.

Come to class. But don't just bring your body; bring your mind too. If you just goof off or daydream while you're in class, you might as well not come. Stay alert and listen to the lecture. Students who have done well in past semesters can tell you that it's much easier to study for exams if you paid attention to the explanations in class.

Don't just memorize words. Make sure you *understand* the material – not just definitions, but also how the different concepts and ideas relate to each other. Try to explain ideas in your own words. Biology is complex, and this will take some time, but it is very rewarding once you "get it."

Test yourself on your lecture notes regularly (at <u>least</u> once a week). Use your book to fill in gaps as you review your notes. Make up your own questions about the material, including both the "big picture" and the small details. Set aside time once a week to do this! If you wait until you're studying for an exam, there will be a lot of stuff that made sense in lecture that just doesn't make sense anymore – even if you paid attention in class. Plus, you will find that each concept builds on the ones that came before it. If you learn it as you go along, ALL of the lectures will make a LOT more sense. I PROMISE.

Use old exams wisely. Although each exam follows essentially the same format, the questions differ from semester to semester. It is dangerous to just study the old exams instead of your notes! I suggest that you take blank exams, without your notes, to judge how well you know the material and to see what kinds of exam questions I ask. You can also learn a lot by explaining to yourself why each incorrect answer is wrong, not just why each correct one is right.

Realize that success follows effort. Think about something that you are good at. You got good at it because you put in a lot of time and effort. It's the same with being a good student – if you ask the very best students how they earn their grades, you will find out that they put in a lot of time studying. And the time they spend is efficient, meaning they are not just highlighting the text or getting distracted, with one eye on the TV and one hand on their iPhone. They are concentrating and doing activities that help them practice with and reinforce the material in their minds.

Get help when you need it. Ask questions as they arise – in lecture, in lab, by e-mail, during office hours, at the Action Center, or whenever you happen to see me on campus.

Also, check my website for tips written by many of the students who have earned an A in previous semesters!

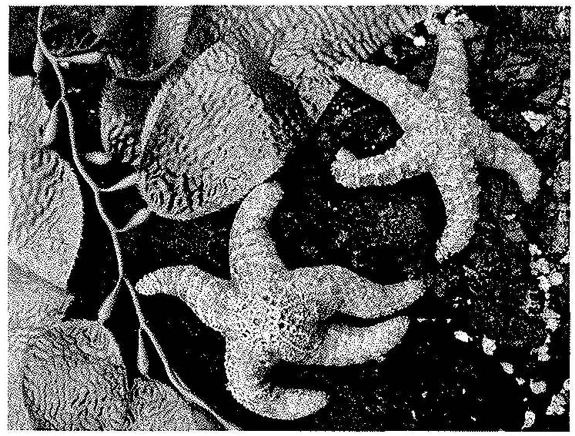
BIOL 1005 Lecture and Laboratory Schedule (subject to change)

Week	Date	Lecture Topic	Text	Lab Topic(s)
1	Tues. Aug. 20	Introduction: Course overview		Intro to Concepts labs
	Wed. Aug. 21	Scope and themes of biology	1.1, 1.2	
	Thurs. Aug. 22	Scientific inquiry	1.3	
2	Tues. Aug. 27	Essential cell chemistry: the basics	2.1	Process of sci. inquiry
	Wed. Aug. 28	More cell chem: bonds & molecules	2.2	AND Tools of science**
	Thurs. Aug. 29	More cell chemistry: water	2.3, 2.4	(Homework – 10 pts)
3	Tues. Sept. 3	Organic molecules	2.5	Using the microscope**
	Wed. Sept. 4	More organic molecules	2.5	(Homework – 5 pts)
	Thurs. Sept. 5	More organic molecules; membranes	2.5, 3.2, 3.3	
4	Tues. Sept. 10	Cell structure; begin metabolism	3.1, 3.4, 4.3	Digestion**
	Wed. Sept. 11	More metabolism	4.4, 5.1, 6.1	(Abstract – 15 pts)
	Thurs. Sept. 12	Catch-up and review for Midterm 1		
5	**Tues. Sept. 17**	**Midterm 1**		Chicken Wing Micro. Pt. 1**
	Wed. Sept. 18	What's DNA for? Protein synthesis	7.1-7.4	(Exper. design – 10 pts)
	Thurs. Sept. 19	More protein synthesis; mutations	7.5, 7.6	*Get pots & seeds for wk. 11*
6	Tues. Sept. 24	More mutations	7.6	Chicken Wing Micro. Pt. 2**
	Wed. Sept. 25	Viruses	7.7-7.9	(Abstract – 25 pts)
	Thurs. Sept. 26	More viruses; sexual/asexual repro.	8.1	*Get petri dish for next week*
7	Tues. Oct. 1	Binary fission, DNA replication	8.2, 8.3	Bacteria & disease
	Wed. Oct. 2	Mitosis, cancer	8.4-8.6	
	Thurs. Oct. 3	More cancer, meiosis	8.6, 9.2-9.4	
8	Tues. Oct. 8	More meiosis, Mendelian inheritance	9.5, 10.1-3	Fun with genetics!**
	Wed. Oct. 9	More inheritance	10.3	(Homework – 5 pts)
	Thurs. Oct. 10	Even more inheritance	10.6-7, 10.9	
9	Tues. Oct. 15	Nondisjunction; DNA technology	9.7, 11.1-4	Molec. phylogeny of plants**
	Wed. Oct. 16	Catch-up and review for Midterm 2		(Homework – 5 pts)
	Thurs. Oct. 17	**Midterm 2**		
10	Tues. Oct. 22	Intro. to and evidence for evolution	12.1, 13.1	Fossils **
	Wed. Oct. 23	More evidence for evolution	13.2-6, 17.12	(Worksheet & HW – 30 pts)
	Thurs. Oct. 24	Natural selection	12.2	*Meet at SNOMNH at 1:30*
11	Tues. Oct. 29	Other mechanisms of evolution; speciation	12.5-7; 14.1-2, 14.4	Flowers, fruits, and seeds**
	Wed. Oct. 30	Origin of life; prokaryotes	15.1-15.2	*Bring your plants!*
	Thurs. Oct. 31	Prokaryotes; origin of euks/multicell	15.3	(Homework – 5 pts)
12	Tues. Nov. 5	Protista; fungi	15.4-15.5	Animal diversity I**
	Wed. Nov. 6	Plants	16.1-16.5	(Homework – 5 pts)
	Thurs. Nov. 7	Animal diversity	17.1-17.4	
13	Tues. Nov. 12	More on animals	17.5-17.9	Animal diversity II
	Wed. Nov. 13	Still more on animals	17.10-11	
	Thurs. Nov. 14	Catch-up and review for Midterm 3		
14	**Tues. Nov. 19**	**Midterm 3**		Animal behavior **
	Wed. Nov. 20	The biosphere; biomes [MH at NABT]	19.1-19.3	(Presentation – 5 pts)
	Thurs. Nov. 21	Population dynamics [MH at NABT]	18.1-18.6	
15	Tues. Nov. 26	Community ecology	19.4-19.5	No labs!
	Wed. Nov. 27	Thanksgiving holiday		
	Thurs. Nov. 28	Thanksgiving holiday		
16	Tues. Dec. 3	More communities; ecosystems	19.6-19.7	Art and Ecology **
	Wed. Dec. 4	More ecosystems; human impacts	20.1-20.5	(Worksheet & pres. – 10 pts)
	Thurs. Dec. 5	Catch-up and wrap-up		*Meet at FJJMA*
Finals	**Fri., Dec. 13**	**Final Exam, 8:00-10:00 a.m.**		

** Lab has additional written or oral assignments. Check with your TA for details.

READ the Syllabus- it contains information that you are responsible for- check it first when you have a question regarding the class.

Syllabus: Integrated Life Science (USU 1350)
Section 3 - T/R
Spring 2013



Contact information: Instructor:
Vicki Rosen Phone: office
(435) 797-3694

Office: BNR 331
Email: vicki.rosen@usu.edu
Office hours: by appointment

Course website:
http://online.usu.edu- *Canvas*
What will you find here?
Powerpoints, Study Guides, Review Questions, Assignment requirements and more

Class Time and Location
TR 10:30-11:45 in MAIN 121

Undergraduate Teaching Fellow (UTF): Spencer Starley -email: §pencer.st_@ ggi&milll.usu.cdll
Office hours: Monday 3:00- 4:00 MAIN 207

Supplemental Instructor (SI):- Kyle Spackman email:packman34@y[!]}Q_o.com
Kyle's SI sessions: Monday 6:00-6:50 in MAIN 326
Wednesday 6:00-6:50 in MAIN 326

You may also attend SI sessions offered by Lauren Neuner; email: laurcn.ns:JlJW.r@aggiemail.usu.cdu the SI in my other section ofUSU 1350.
Lauren's SI sessions: Monday 5:00-5:50 in ENR 302
Wednesday 5:00-5:50 in AGRS 101

Required text and access code:
Biology tlte Essentials by Marielle Hoefnagels with access code

Objectives:
Students gain an understanding on how science works and the role science plays in today's society
Students gain an understanding of biological concepts
Students understand the role of technology in biology and how it impacts our lives
Students will develop skills in information literacy

Figure 12. USU 1350 (Integrated Life Science), Utah State University (Spring 2013)

Your grade is based on the total number of points you accumulate during the semester. Scores will be posted on *Canvas.* Once scores appear on *Canvas* you will have one week to ask any questions regarding your score. It is your responsibility to regularly check *Canvas* for scores.

Exams- 3 unit exams worth 100 points each

Your lowest score out of the 3 Unit exams will be dropped

The unit exams may contain review questions from previous material

Final exam worth 150 points-- You may not drop your final exam score.

The final exam will mainly cover material presented after the third chapter exam, but approximately 1/3 of the questions will be comprehensive

Exams: Exams are multiple choice. **You will need to supply your own 8 Y, x 11 scantron and number two pencil.** Exams will be based on material covered in class, the text book, online text resources, and any assigned readings or other assigned work. Notes, books, cell phones, calculators, headphones etc. are not allowed. You will need to have all of these materials put away. If any of these are found, your exam will be taken. Make sure cell phones are turned off.

There are no make-up exams: Because the lowest exam score is dropped, there will be **no make-up exams.** If you are unable to take the exam at the scheduled time due to a valid reason (which includes: university sponsored activities, military service, death or serious illness in your family) you may be able to take an exam early. You will need to contact me 48 hours in advance of the scheduled exam time to arrange to take the exam early. Be advised that if you take an exam early, it may be a different exam and different format then if you took the exam at the scheduled time. If you miss an exam, that will be the exam that will be the drop score. This includes missing an exam due to illness. Please, do not come to class if you are ill and contagious but use that exam as the one you can drop.

Remember- you may not drop the final exam score.

Quizzes- Print off the quiz form found on *Canvas* and have one with you in class at all times. Quizzes will be pop quizzes given in class or may be posted on *Canvas*. *Canvas* quizzes will have a time frame associated with them and will be announced in class and on *Canvas*. For all quizzes, you may use your notes, books, classmates, etc. to assist you. **You must be present** to take an in-class quiz. Your lowest quiz score will be dropped. If you miss a quiz, that will be the quiz that will be the drop score. This includes missing a quiz due to illness. Students who miss a quiz due to school sponsored activities or military service need to contact me immediately if they miss a quiz.

***Connect* Website Assignments** -There will be weekly assignments on the textbooks website. You must have purchased an access code to be able to do these assignments. It is the student's responsibility to keep track of assignments and to take note of due dates.

The website assignments have deadlines by which they must be submitted. If you miss a deadline, you will not be able to do the assignment. Reasons for missing a deadline such as "my internet connection went down; or my computer crashed right before the deadline" "or I couldn't get the site to work" will not be accepted. If you have technical problems with the site contact tech support on the Connect website. They are very helpful, but if you have waited until the last day and have problems, you will not be given an extension. Don't procrastinate. Make sure you do the assignment well before the deadline if you are concerned about this occurring.

Registration for online *Connect* assignments:

1. **Go to this online address:**
   http://comlect.mcgraw-hill.com/class/v rosen usu 1350 see3 tr spnng 2013
2. Click the register now button
3. Enter your email address
4. Enter your access code. If you do not have an access code, select "Buy Online", or you can "Start Free Trial" if you don't have and access code.
5. Complete the registration form, click "Submit"

There is a 21 day grace period before you have to pay for the access code. You will be able to start assignments right away even if you have to wait a few days before you can purchase a code.

Assignments

There may be other assignments or graded in-class activities during the semester. You will be given information on them as they become available.

Your scores will be posted on *Canvas*

By keeping track of your own scores you can calculate your grade at any point in the semester.

93-100% A	87-89% B+	77-79% C+	67-69% D+
90-92% A-	83-86% B	73-76% C	60-66% D
	80-82% B-	70-72% C-	Less than 60% F

Your grade is based upon the percentage you have earned. I will not adjust your grade. There is no extra credit in this class.

Final grades are rounded up. For example, if a student has 89.5% at the end of the semester, that will round up and the student will get an A-. If the student has 89.4% at the end of the semester, that will round down and the student will receive a B+. <u>Do not ask to get a different grade than what you earned.</u>

Students with physical, sensory, emotional or medical impairments may be eligible for reasonable accommodations in accordance with the Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973. All accommodations are coordinated through the Disability Resource Center (DRC) in Room 101 of the University Inn, 797-2444 voice, 797-0740 TTY, or toll free at 1-800-259-2966. Please contact the DRC as early in the semester as possible. Alternate format materials (Braille, large print or digital) are available with advance notice.

Cheating is not tolerated. Students who are caught cheating will receive a zero on that exam, an academic integrity violation report will be filed with the university, and there will be a notation on your transcripts indicating that you had an academic integrity violation. Refer to the university's academic honesty policy.

Tentative schedule for USU 1350-Integrated Life Science-Spring 2013 T/R section 3

The syllabus is a general guide for what and when we will cover certain topics. You are responsible for the material covered before each exam and any reading in the text or other assignments regardless of where or if it appears on the syllabus.

Day	Date	Topic	Text
T	Jan. 8	Characteristics of life and sci. method	Ch. 1 all
R	Jan. 10	Chemistry of life and water	Ch. 2 pgs. 21-38
T	Jan. 15	Organic cmpds	Ch. 2 pgs. 38-44
R	Jan. 17	Cells form and function	Ch. 3 all
T	Jan. 22	Cells and energy use	Ch. 4 all
R	Jan.24	Photosynthesis	Ch. 4 all; Ch. 5 all
T	Jan.29	Cellular Respiration	Ch. 6 all
R	Jan. 31	Unit 1 Exam	
T	Feb. 5	DNA; RNA; protein synthesis	Ch. 7 pgs. 113-120
R	Feb. 7	Gene expression and viruses	Ch. 7 pgs. 121-133
T	Feb. 12	From one cell to many- mitosis	Ch. 8 pgs. 139-148
R	Feb. 14	Mitosis out of control-cancer	Ch. 8 pgs. 148-151
T	Feb. 19	No Class- Attend Monday's schedule	
R	Feb.21	Meiosis	Ch. 9 all
T	Feb.26	Intro to genetics	Ch. 10 pgs. 171-188
R	Feb. 28	More genetics	Ch. 10 pgs. 189-191
T	Mar. 5	Unit2 Exam	
R	Mar. 7	DNA technology and stem cells	Ch. II all
T	Mar. 12	Spring Break- No Classes	
R	Mar. 14	Spring Break- No Classes	
T	Mar. 19	Intro. to evolution and microevolution	Ch. 12 all
R	Mar. 21	Evidence of evolution	Ch. 13 all
T	Mar. 26	Speciation	Ch. 14 pgs. 259-266
R	Mar. 28	Extinction	Ch. 14 pgs. 267-273
T	Apr. 2	Human evolution	Ch. 17 pgs. 346-352
R	Apr. 4	Unit3 Exam	
T	Apr. 9	Bacteria and fungi	h. 15 pgs. 281-287; 296-301
R	Apr. II	Population ecology	Ch. 18 pgs. 361-370
T	Apr. 16	Human population	Ch. 18 pgs. 371-375
R	Apr. 18	Communities and ecosystems	Ch. 19 pgs. 379-397
T	Apr. 23	Ecosystem cycles	Ch. 19 pgs. 398-404
R	Apr. 25	Preserving biodiversity & Sustainability	Ch. 20 all and lecture
R	May2	Final Exam 9:30 - 11:20	In regular classroom

BIOL 115 – CELLS & THE EVOLUTION OF LIFE
SPRING 2014
*subject to revision

Stacey Dunn, Ph.D.
Life Sciences South 260
208-885-4095
sdunn@uidaho.edu
Office Hours: Mon 1-2pm, Tues 1:45-2:45pm

CLASS TIME/LOCATION:
Lecture: MWF 8:30-9:20am in JEB 104
Lab: Days/times vary. All lab sections meet in LSS 356. You may only attend the lab section for which you are registered. You will receive contact and office hour information from your lab section's TA at the first lab meeting.

COURSE DESCRIPTION: In this course, you will be introduced to the cell, heredity and evolutionary processes. Additionally, you will be exposed to current research in the fields of cellular biology and genetics. In lab, you will synthesize concepts learned in class while learning practical laboratory techniques and skills. Specific topics to be introduced in this course include: chemistry of life, cell structure and function, meiosis and mitosis, inheritance, gene expression, and genome evolution.

LEARNING OUTCOMES:
Learn & Integrate: Students will synthesize previous biological knowledge with knowledge gained from lectures, homework and labs, to attain an understanding of the cell, heredity and evolutionary processes.

Think & Create: Students will synthesize and apply their knowledge of biological processes by forming hypotheses, conducting hands-on laboratory experiments and producing laboratory reports.

Communicate: Students will become conversant in the language used in biology, and will practice the language of biology during laboratories and in small groups. Students will practice scientific writing by producing laboratory reports.

Clarify Purpose & Perspective: Students will gain an understanding of cellular processes that support life (including human life), and how the genetic code informs life.

Practice Citizenship: Students will attain basic biological knowledge, which will allow them to make informed contributions to discussions of issues that impact humans and the environment, for ex: health and medicine, stem cell research, cloning, genetic counseling, evolution education, etc…

Figure 13. Biology 115, The University of Idaho (Spring 2014)

COREQUISITE: You must have passed or be currently registered in CHEM 101 or CHEM 111 to enroll in BIOL 115. If you drop CHEM 101 or CHEM 111, you will automatically be dropped from BIOL 115. No exceptions.

COURSE WEBSITE: https://bblearn.uidaho.edu/webapps/login/
The course website will include a copy of the syllabus, lecture and lab schedule and notes, assigned readings, access to MasteringBiology (required), links to online quizzes/follow-up assignments, links to tutorials (including BIONet and MasteringBiology) and supplementary material, current grades, additional lab materials, etc… This will also be my primary form of communication with you outside of class. Check the website often!

EMAIL:
I may communicate with you by university-sponsored email. Please be sure to check your email account often, and ensure that my email address is not blocked.

GRADING:
Four comprehensive exams @ 100 points each = 400 points
Ten online quizzes/follow-up assignments @ 10 points each = 100 points
Lecture participation (i>clickers) = 25 points
Lab assignments: points per assignment vary = 215 points
Lab participation = 15 points
Total = 755 points

GRADING SCALE:
Total ≥ 90% = A
90% > Total ≥ 80% = B
80% > Total ≥ 70% = C
70% > Total ≥ 60% = D
Total < 60% = F

EXAMS:
Exams will cover material from lectures, assigned readings, assigned content on MasteringBiology, and concepts covered in lab. The material we will cover builds upon itself. We will often refer back to concepts covered in previous lectures and units. For this reason, all exams are comprehensive, though the focus of each exam will be on the current unit. You will have four unit exams, each worth 100 points. There will also be an *optional* comprehensive final held during finals week. This final can be used to replace your lowest exam score, assuming that it increases your grade. It will not be counted if it lowers your grade. You will be given the opportunity to view your exams and ask questions about grading, however I do retain all exams in my possession. Be warned that I typically DO NOT curve individual exams, so please don't ask. I may *consider* a curve of final grades at the end of the semester, but only after *all grades* (including the final exam) have been counted. There is *no guarantee* that I will curve grades.

QUIZZES/FOLLOW-UP ASSIGNMENTS:
You will take a weekly quiz and follow-up assignment online in order to prepare you for the comprehensive exams. Questions will be similar to what may be found on exams. Quizzes will cover material from lectures, assigned readings, assigned content on MasteringBiology, and concepts covered in lab. All quizzes are comprehensive. Quizzes will be found online on the MasteringBiology/Bblearn website.

MasteringBiology is an adaptive online learning tool. Initially, you will take a quiz worth 5 points. Questions are chosen randomly from a pool of questions that I have assigned. If you score 90% or higher on your quiz, you will be exempt from the follow-up assignment and will automatically receive an additional 5 points for that assignment in the gradebook. If you score lower than 90% on the quiz, you will be led through an individualized follow-up assignment that focuses on your knowledge gaps. This system provides individualized feedback, so student follow-up assignments will vary. (Technology at its finest!) Follow-up assignments are worth 5 points each, based on completion.

Quizzes will open on Monday at 8:30am and close on Friday at 11:59pm. Follow-up assignments are due 48 hours later. It is your responsibility to finish the quiz and follow-up assignment before each closes. Keep in mind that computer/internet issues can arise, so it is in your best interest to plan ahead and take each quiz early in the week.

You will have one quiz/follow-up assignment per week, with the exception of Week 1 and exam weeks. There will be 10 quizzes/follow-up assignments total for the semester, plus one *optional* make-up quiz/assignment during dead week. This quiz can be used to replace your lowest quiz/assignment score or a missed quiz. Aside from the optional quiz during dead week, there will be *no make-ups* allowed for missed quizzes/follow-up assignments.

If you have trouble accessing Mastering Biology, contact me early in the semester! I can help ensure that you are registered and able to access the quizzes and homework. I will not reopen quizzes/homework for you if you have not contacted me about technical issues prior to the quiz deadline.

LECTURE PARTICIPATION (i>clickers):
Attendance at lectures is strongly recommended. We will be using the i>clicker system during lecture this semester as a way for you to engage with me and with the material. This will also be an opportunity for you to practice the types of multiple-choice questions that may show up on exams.

Early in the semester, I will distribute i>clickers to all students. Your i>clicker number will be tied directly to your student ID number. You are responsible for that i>clicker throughout the semester. The i>clicker is ON LOAN to you, and MUST BE RETURNED at the end of the semester or you will receive an automatic 0 for your lecture participation grade. If you drop the course, please return the i>clicker to me ASAP.

Your lecture participation grade will be based on *attempts* at answering questions posed in lecture, not on whether your answer is right or wrong. If you attend class regularly and attempt to answer at least 75% of the questions posed throughout the semester, you will receive 25 participation points. If you attempt less than 75% of clicker questions, your participation grade will be prorated.

There will be **no makeups** for i>clicker questions missed if you are absent from lecture (whether the absence is excused or not).

LAB ASSIGNMENTS:
The lab schedule can be found online on Bblearn. To prepare for lab, you are required to read each week's lab instructions and complete a pre-lab assignment prior to your lab meeting time. Pre-lab assignments are due at the start of each lab period; no late pre-lab assignments will be accepted. At the end of each lab meeting, you will need to check out with your TA. This is to ensure that you have completed all of the necessary steps in the lab, and that you are on the right track with your lab results. Final lab write-ups are due the following week at the beginning of your lab meeting time. Lab reports turned in during the first 24 hours after your normal lab meeting time will be reduced in value by 50%. Late lab reports will not be accepted after 24 hours following your normal lab meeting time. TA's will assign final lab report grades.

All assignments should be typed, and a hard-copy turned in to your TA, unless directed otherwise.

You should keep a 1.5 or 2-inch binder just for lab materials – i.e., your lab manual, pre-lab and post-lab assignments, and notes taken during lab. If you keep everything organized throughout the semester, you will have a useful guidebook from which to study for exams or to refer to in the future.

LAB PARTICIPATION:
Attendance at all lab meetings is mandatory. You will lose 3 participation points for arriving more than 10 minutes late to a lab meeting. You will lose 5 participation points for each lab meeting missed (up to three lab meetings total). Also, you will receive a 0 on the lab assignment for which you did not attend the lab meeting. Aside from mandatory attendance, your participation points are based on end-of-lab meeting checkouts (microscope returned in clean, working order; lab bench supplies reorganized and/or restocked; lab area cleaned up; etc…). Deduction of any lab participation points is at the discretion of your TA.

EXCUSED ABSENCES
Only students with written medical excuses from a doctor or written official university excuses will be allowed to make up missed exams, quizzes, or lab assignments. *Final acceptance of makeup work is at the discretion of the instructor.* Arrangements must be made at least ONE WEEK PRIOR to your absence in the case of known schedule conflicts (ex: participation in official university sporting events, course field trips, etc…), or makeup work will not be accepted. In the case of illness (with a valid doctor's note),

and under the instructor's final discretion, makeup work will be accepted if arranged before or immediately following the absence (i.e., the same day as the missed lab/exam). Makeup work may differ from the original quiz, exam or lab assignment.

GRADE DISPUTES:
If you feel that an exam or lab report has been graded incorrectly, you have 48 hours after receiving the graded assignment to dispute your score. You must return the exam or report to your instructor or TA, along with a written request for regrading. Final grade assignment is at the discretion of the instructor or TA.

COMMUNICATION:
Spelling, grammar, punctuation, logic and legible handwriting are critical elements of communication. You may lose points on quizzes, exams and/or lab assignments for misspelling, poor grammar or syntax, improper punctuation, flawed logic or illegible handwriting.

READINGS:
Reading assignments will be listed on the course website. These should be read ahead of time in preparation for the class time for which they are listed.
Required textbook: Reece *et al*. 2013. *Campbell Biology*, 10^{th} edition. Published by Benjamin Cummings (Pearson).

MASTERING BIOLOGY:
Required online material: *Mastering Biology* (Pearson) – access required. www.masteringbiology.com

LABORATORY:
Required lab manual: Dolphin *et al*. 2011. *Biological Investigations: Form, Function, Diversity & Process* custom manual, 9^{th} edition. Published by McGraw-Hill.
You need to bring this lab manual with you to each lab meeting, starting the week of January 20. Additional lab materials should be accessed and printed from Bblearn prior to lab meeting each week.

ACADEMIC HONESTY:
Refer to Article II of the UI Student Code of Conduct (http://www.uidaho.edu/DOS/judicialaffairs/studentcodeofconduct/articleii). Plagiarism or academic dishonesty will not be tolerated in any form. Offenses will lead to an F on the assignment or in the class, letters to your Department Chair and College Dean, and a formal complaint filed with the Dean of Students. Be aware than even one incident of academic dishonesty may result in expulsion from the university.

CLASSROOM BEHAVIOR
The following behaviors are rude to the instructor and fellow students, and are considered unacceptable behavior for class and lab: ringing cell phones, use of cell phones for talking or texting, web surfing, sleeping, reading extraneous material, chatting with neighbors, etc… The instructor or TA reserves the right to dismiss students from class

(with appropriate grade deduction for missed assignments) that display any of these behaviors. Repeated violations may result in an F on that day's quiz/exam/lab homework, an F in the course, and/or removal from the course.

UNIVERSITY OF IDAHO CLASSROOM LEARNING CIVILITY CLAUSE

In any environment in which people gather to learn, it is essential that all members feel as free and safe as possible in their participation. To this end, it is expected that everyone in this course will be treated with mutual respect and civility, with an understanding that all of us (students, instructors, professors, guests, and teaching assistants) will be respectful and civil to one another in discussion, in action, in teaching, and in learning. Should you feel our classroom interactions do not reflect an environment of civility and respect, you are encouraged to meet with your instructor during office hours to discuss your concern. Additional resources for expression of concern or requesting support include the Dean of Students office and staff (885-6757), the UI Counseling & Testing Center's confidential services (885-6716), or the UI Office of Human Rights, Access & Inclusion (885-4285).

ACADEMIC SUPPORT; TUTORING & COLLEGE SUCCESS

If you find that you need further assistance with course material outside of the classroom, you are encouraged to contact the Academic Support Office (http://www.uidaho.edu/studentaffairs/asap) or the Tutoring & College Success Office (http://www.uidaho.edu/studentaffairs/asap/tutoring-and-college-success).

DISABILITY SUPPORT SERVICES

Disability Support Services Reasonable Accommodations Statement: "Reasonable accommodations are available for students who have documented temporary or permanent disabilities. All accommodations must be approved through Disability Support Services located in the Idaho Commons Building, Room 306 in order to notify your instructor(s) as soon as possible regarding accommodation(s) needed for the course."

Phone: 208-885-6307
Email: dss@uidaho.edu
Website: www.uidaho.edu/dss

Please notify the instructor during Week One of classes if accommodations are required.

TENTATIVE SCHEDULE FOR **UNIT 1** (*subject to change!):

WEEK	**DATE**	**TOPIC/EVENT**	**READINGS**	**QUIZ DUE**	**LAB**
1	15-Jan	Introduction			No lab this week
	17-Jan	The big picture	Ch. 1	No quiz	
2	20-Jan	NO CLASS			Lab 1
	22-Jan	Chemistry of life	Ch. 2		
	24-Jan	Water and Life	Ch. 3	Quiz 1	
3	27-Jan	Water and Life			Lab 5
	29-Jan	Carbon and Life	Ch. 4		
	31-Jan	Carbon and Life		Quiz 2	
4	3-Feb	Large Biological Molecules	Ch. 5		Lab 6
	5-Feb	Large Biological Molecules			
	7-Feb	**EXAM 1**		No quiz	

FUTURE (TENTATIVE) EXAM DATES (*subject to change!):
Friday, March 7 – Exam 2
Friday, April 4 – Exam 3
Friday, May 2 - Exam 4
Friday, May 16, 7:30am-9:30am – Optional final exam

PLEASE REFER TO BLACKBOARD FOR CURRENT SCHEDULE (TOPICS, EVENTS, READING ASSIGNMENTS, QUIZZES/FOLLOW-UP ASSIGNMENTS, LABS, ETC...)!

COURSE SYLLABUS FOR BIOLOGY 1B
Summer 2014

Course Description: This course is a general introduction to evolutionary biology, ecology, and botany. It is intended for students majoring in the biological sciences, but is open to all qualified students. Students must take both Biology 1A and 1B to complete the sequence, and can take them in either order.

Course Website*: http://ib.berkeley.edu/courses/bio1b/* This website contains much of the information you will need for the course, including the lecture and lab schedules, links to the Webcast, and contact information. Please become familiar with this website.

bCourses: The lab reading material and assignments will be posted to the Resource section of the course bCourses site. Any lecture materials posted by the professors will be available in the Resource section. Grades and important announcements will also be posted to bCourses.

Lectures: M,Tu,W,Th 1 PM – 2:30 PM in 155 Dwinelle. Please note that the Biology 1B lecture is not webcast during the summer session.

Do not enroll in other courses scheduled for the same time as Biology 1B. Lecture midterms are given during the regularly scheduled class time and lab attendance is mandatory. You will not be given the exams at any other time than our published exam times.

Professors

Dr. Alan Shabel
Email: shabel@berkeley.edu
Office: 1114 VLSB

Note: If you have course related questions, please first contact your Lab Instructor.

Enrollment/Admin Coordinator (lab make-ups, student athletes, enrollment):

Brett Boltz
Email: bboltz@berkeley.edu
Office: 3057 VLSB
Phone: (510) 664-9865

Course Coordinator (academic issues, lab concerns):

Joshua Povich
Email: povich@berkeley.edu
Office: 2002 VLSB
Phone: 510-643-0448

Bio 1B Manager (academic misconduct, incompletes, DSP students)

Tamara Mau
tmau@berkeley.edu

Textbook: Campbell's *Biology* (Reece et al 9th or 10th edition) is the *recommended* text for

1

Figure 14. Biology 1B, The University of California at Berkeley (Summer 2014)

Biology 1B, it is not *required* this summer. The Campbell textbook is an excellent resource

2

for Bio 1B, and Professor Shabel strongly recommends that you keep up with the reading, but you do not have to buy the textbook. The campus bookstore offers textbook rentals, and there are many used copies of Campbell in circulation, so you might ask a friend if they have a copy.

The course schedule on the website lists the reading assignments for the 10th, 9th, and 8th editions of Campbell. Mastering Biology software is not required for Bio 1B.

Starting in Fall 2014, Bio 1A and Bio 1B will no longer use Campbell.

www.inkling.com also sells a nice digital version of the 9th ed. by the chapter or the whole book.

Laboratory Materials should be downloaded from bCourses before your lab and brought with you to lab. There are two lab sessions per week in the summer. You will need to download readings for each lab. You MUST read the posted material for all the exercises before coming to lab. There is not enough time to do it in class. Additionally, the reading will help you prepare for quizzes.

Lab Attendance: You are required to attend all your scheduled lab sections. If you miss a lab without an excused absence (see below), you will receive no credit for that lab and the associated assignments and quiz. If you know you are going to miss lab or if you miss lab due to illness or other emergency beyond your control, you must contact your Lab Instructor AND the Administrative Coordinator, Brett Boltz (bblotz@berkeley.edu). See the following details:

Lab Make-Ups: In the event that you must miss a lab with a qualifying excuse, Brett Boltz will authorize a lab make-up within the same week (M/Tu or W/Th) if possible. You must have a "blue lab make-up form" from Brett for entry to another lab session for make-up. Medical documentation is generally required to make up a lab if missing the lab is due to illness.
Excused Absences: In the event that you miss a lab and cannot attend a make-up lab within the same week, Brett can authorize an excused absence. *Excused absences are offered at the discretion of the Administrative Coordinator.* Excused absences are granted when qualifying documentation is provided. *If missing lab due to illness you must contact (email or phone) Brett Boltz **before** the end of the lab session you are missing.* Failure to contact the Administrative Coordinator before the end of your missed lab will disqualify you for a make-up lab and result in an unexcused absence. If too ill to contact Brett prior to the end of your lab session medical documentation will be required.
More than two unexcused absences may result in failing the course.

Quizzes: Quizzes will be given at the beginning of each lab period, except for the first lab period, the week of the Botany Lab Practical and before the field trip to the Botanical Garden, the last lab. If you are late to class, you will not be given additional time. Make-up quizzes will not be given. Your lowest quiz score of the semester, however, will be dropped.

Office Hours: You are encouraged to attend office hours to ask questions about the lecture material. Lab Instructors will hold an office hour once per week in **2195 VLSB**. You may attend any of the Lab Instructor office hours, even if they are not your section Instructor.

Times will be posted on the office door and on the online bCal calendar titled **Bio1B Office Hours**.

Professor Shabel's office hours will be posted.

Exams: Summer midterms are given at the same time and location as lecture 1-2:30 PM in 155 Dwinelle. There are three midterms. They are scheduled as follows:

MIDTERM #1: Thursday July 10th
MIDTERM #2: Monday July 28th
MIDTERM #3: Thursday August 14th

You will be able to review your graded exams in lab the week following the exam or during office hours up to 1 week past the exam date only. **You may not keep your exam. If you leave the exam room, lab room, or office hours with an exam** (digital or physical versions)**, it will be considered cheating and you will receive a 0 for that exam and may be prosecuted for academic misconduct.**

THERE ARE NO MAKE-UP EXAMS either before or after the scheduled exam time. If you miss one midterm due to illness, family emergency, etc., you must present a written, verifiable excuse to the Administrative Coordinator, Brett Boltz, as soon as possible. Your midterm grade will be pro-rated at the end of the semester.

If you have religious obligations that conflict with exam time please see Brett Boltz **at the beginning of the summer session** to make arrangements.

Grading: Your letter grade will be determined by the total number of points that you receive during the semester. The breakdown is as follows:

Midterms (3 exams at 150 pts each)	**=450 pts**
Lab	**=300 pts**
Total	**=750 pts**

Letter grades will be determined at the end of the semester. The cutoffs for letter grades are typically **A**-≥90%, **B**-≥80%, **C**-≥70%, **D**-≥60%, and **F**<60% and may be adjusted at the Professors' discretion.

Dropping or Withdrawing: For information about dropping or withdrawing from Summer Session courses please see the Summer Sessions website: http://summer.berkeley.edu/enrollment-changes/dropping-all-your-courses#how-do-I-drop

If you do not drop the course and do not attend you will receive an F.

Do not take this class Pass/Not Pass if you might need a letter grade in the future.

Study Groups and Tutoring: The Student Learning Center at the César E. Chávez Student Center offers study groups and drop-in tutoring specific to Bio 1B. Please see details at http://slc.berkeley.edu/biology-1b

Incomplete "I" Grades: To be eligible for an Incomplete, a student must complete at least half the course material with a passing grade of "C" or better and document evidence of the inability to complete the course. You have one semester to make up the work or the "I" becomes an "F". Students **currently** making up an "I" should e-mail Tamara Mau tmau@berkeley.edu ASAP.

Repeating the Class: If you passed the lab section of the class (>80%) but not the lecture in the past, you may qualify for "Lecture Only" status. However, you are required to attend the first lab meeting and it is advised that you attend the lab section regularly. To determine whether you qualify to repeat the class "Lecture Only," send the following information to Brett Boltz (bboltz@berkeley.edu):

Name, SID#, Semester you had Biology 1B and

Your section number and lab instructor when you previously took Biology 1B

You are required to make a brief appointment with Brett by Tuesday, **June 24th** to make it official.

Wait list students: All wait list enrollment is done on Tele-BEARS.

Switching sections and adding the class: Switching sections can occur on a very limited basis. You can switch into an open (space available) section on Telebears. This should be done by Friday June 20th at latest. If you want to switch into a *filled* section or time slot, you will need to find another student in that section or time slot to switch with. You can use the Forum tool on bCourses to post section switching requests to other enrolled students. Once you have found another student who will switch lab sections with you, both of you will have to see the Enrollment Coordinator at the same time and show your student IDs. Contact the Enrollment Coordinator (bboltz@berkeley.edu) to make an appointment and formalize the switch. All section switching must be completed by the end of the first week, Friday June 27th.

Working in groups: This approach has been very successful in Biology 1B. In lab, you will be divided into groups of two to four students. In general, all the students in the group will get the same grade on a lab exercise. Within each third of the course students are expected to have done equivalent shares of the work. You are encouraged to exchange e-mail addresses and to get together outside of class to exchange notes and study for tests. If you have trouble with a group member or your group as a whole, please talk to your Lab Instructor or the Lab Coordinator as soon as possible. All comments will be confidential.

Recommendations: If you expect to ask for a letter of recommendation, even a year or two from now, see your Lab Instructor at the beginning of the semester. Your Lab Instructor is your primary contact in this course and will get to know you better than anyone else. The Professors in the course are usually willing to co-sign a letter of recommendation that is written by a Lab Instructor.

DSP Students: If you have been issued a letter of accommodation from the Disabled Students Program (DSP), please see your Lab Instructor as soon as possible to work out the necessary arrangements. If you need an accommodation and have not yet seen a Disability Specialist, please do so as soon as possible. **It is not advisable to schedule classes so that you have back-to-back tests with extended time.** Any questions should be directed to Tamara Mau tmau@berkeley.edu

Undergraduate Student Instructors (UGSI): Students who have done well in the course and have been recommended by their Lab Instructor can become a UGSI. If you think that you might be interested in becoming a UGSI in the future, contact your Lab Instructor. Your obligations are a 3 hour weekly Lab Prep Meeting (Friday 1-4) and a 4 hour lab once a week for which you will receive 2 units of credit.

Cheating, Plagiarism, Keeping a Copy of a Midterm:
Students are not allowed to keep the midterms. Leaving the test room with your exam is considered cheating. Students who leave the exam room before the end of the exam period are required to turn in their examinations and will not be permitted to return. If you have a medical issue that may require you to take a break during the test, please contact the Administrative Coordinator well in advance of the test, medical documentation of your condition may be required. No calculators, phones, or other electronic devices are allowed during exams. All electronic devices must be off and stored out of site.

The UCB Division of Student Affairs provides definitions for what constitutes cheating and plagiarism here:

http://sa.berkeley.edu/conduct/integrity/definition

The UC Berkeley library website is also a resource for what constitutes plagiarism along with some links to information about how to avoid plagiarizing:

http://www.lib.berkeley.edu/instruct/guides/citations.html#Plagiarism

If you have questions about what constitutes plagiarism please read this information and follow-up with your lab or course instructors if necessary.

Cases of cheating will be reported to the Office of Student Conduct. Their standard procedure for dealing with first-time cheaters is: (1) An "F" in the class; (2) A letter in your file that identifies you as a cheater (this letter, upon request, will be sent to medical and graduate schools, employers, etc.); (3) Many hours of campus service; and (4) Risk of suspension or dismissal. It just isn't worth it. Please read Warning to Cheaters in the Announcements on our web page.

Working diligently and using your resources intelligently will allow you to master the material.

We hope that you enjoy your semester of Bio 1B!

BISC 120Lg MWF Lecture Syllabus, Fall 2014

General Biology: Organismal Biology and Evolution

~ May 5th version ~

Overview: This 4-unit biology course will present several key topics in evolution, ecology, environment, and the diversity of life. These topics will be covered in a series of weekly lectures (Monday, Wednesday, and Friday of each week) and one weekly laboratory section.

Faculty Instructors:
Dr. Suzanne Edmands, AHF 316, 213-740-5548, sedmands@usc.edu
Dr. Cornelius Sullivan, AHF 107C, 213-740-6712, csulliva@usc.edu
Dr. Wiebke Ziebis, AHF 334, 213-821-1198, wziebis@usc.edu

Lab Manager: Gorjana Bezmalinovic, ZHS 362, 213-740-6078, bezmalin@usc.edu

Textbooks:

Lecture
Campbell Biology 10th ed., 2014. (new textbooks come bundled with Mastering Biology™ which is recommended for studying but not required)

Laboratory
General Biology Laboratory Manual FALL 2014, BISC 120 & BISC 121 Courses, USC.
Adams & Crawley (2013). Van De Graaff's Photographic Atlas for the Biology Laboratory, 7th ed.
Pechenik. A Short Guide to Writing About Biology. 8th ed. (e-copy included with the USC custom textbook)

Website: https://blackboard.usc.edu/
(site for course materials, lecture notes, quizzes, additional readings, grades etc.)

Lecture times: M, W, F 9-9:50 A.M. THH 101 (=13004R), M, W, F 10-10:50 A.M. THH 101 (=13005R)

Laboratory times: Various times in ZHS 361, 363, 365 and 369

Office Hours:
Edmands: 11:30 A.M. – 12:30 P.M. Mondays and Wednesdays in AHF 316
Sullivan: 11:30 A.M. – 12:30 P.M. Mondays and Wednesdays in AHF 107C
Ziebis: 11:30 A.M. – 12:30 P.M. Mondays and Wednesdays in AHF 334

Lecture Quizzes: There will be twelve multiple choice quizzes to be completed on Blackboard (https://blackboard.usc.edu) during the semester. The quizzes will be posted at 12:00 P.M. (noon) on Fridays and will remain available until 9:00 A.M. the following Monday. Answers to quiz questions will be posted on Monday afternoons.

Exams: The lecture portion of this course will include three mid-term examinations and a comprehensive final examination. All examinations (mid-terms and final) may include multiple choice questions, fill-in answers, short answers, short and long essays,

Figure 15. BISC 120 Lg. (General Biology), University of Southern California (Fall 2014)

definitions, and quantitative problems. The final examination will include material composed of questions that integrate concepts developed throughout the course, both in the lecture and the laboratory portions. To be assigned a final letter grade at the end of the course, a student must take at least two mid-term lecture examinations and the final examination and have completed at least 75% of the assigned weekly laboratory activities. Any document associated with grading may be photocopied by the instructional staff.

Grading: After each examination, grade point cut-offs will be released. There is not an absolute number of points that predetermines a letter grade of A, A-, B+, B, B-, etc. The final letter grade for the course will be assigned on a curve, determined by the total number of points as given below.

The point system will total 1000 points, as follows:

Midterm 1 Lecture Examination	150
Midterm 2 Lecture Examination	150
Midterm 3 Lecture Examination	150
Lecture Quizzes	24
Final Lecture Examination (cumulative)	226
Laboratory Reports and Examinations	300

Laboratory scores will be normalized as explained in the laboratory syllabus in order to correct for possible differences in grading between teaching assistants (TAs).

Schedule of lecture topics (subject to modification of specific topics and reading assignments*):

Day	Quiz	Lecturer	Lecture		Readings
M Aug 25		Edmands	**1**	Course Introduction	Syllabus
W Aug 27		Sullivan	**2**	Overview – Medical Relevance	1.1
F Aug 29		Ziebis	**3**	Overview – Environmental Importance	52.1 (1144-1145)
M Sep 01				LABOR DAY HOLIDAY – NO CLASS	
W Sep 03		Edmands	**4**	Patterns of Inheritance	14.1-14.4
F Sep 05	Quiz 1	Edmands	**5**	Molecular Basis of Inheritance	15.1-15.3, 16.1
M Sep 08		Edmands	**6**	The Darwinian Revolution	22.1, 22.2
W Sep 10		Edmands	**7**	The Case For and Against Evolution	22.3
F Sep 12	Quiz 2	Edmands	**8**	Evolutionary Mechanisms I	23.1-23.2
M Sep 15		Edmands	**9**	Evolutionary Mechanisms II	23.3-23.4
W Sep 17		Edmands	**10**	Speciation	24.1-24.2
F Sep 19	Quiz 3	Edmands	**11**	Macroevolution	24.4, 25.5-25.6
M Sep 22		Edmands	**12**	Phylogenetic Systematics	26.1-26.3
W Sep 24		Edmands	**13**	Insights from Molecular Systematics	26.4-26.6
F Sep 26	Quiz 4	Edmands	**14**	Behavioral and Social Evolution	51.1-51.4
M Sep 29		Edmands	**15**	Conservation Genetics	56.1-56.2
W Oct 01		Edmands		**EXAM 1**	
F Oct 03	Quiz 5	Sullivan	**16**	Origins of Life	7.1-7.2, 25.1-25.4

M	Oct 06		Sullivan	**17**	Prokaryote Structure/Function Bacteria	27.1-27.2
					and Cell Membranes Nutritional and	7.3 -7.4
W	Oct 08		Sullivan	**18**	Metabolic Adaptations,	27.3-27.5
					Prokaryotic Phylogeny and Role in Biosphere	
F	Oct 11	Quiz 6	Sullivan	**19**	Viruses; Bacterial Viruses	19.1-19.2
M	Oct 13		Sullivan	**20**	Plant and Animal Viruses	19.2
W	Oct 15		Sullivan	**21**	Genomes and Their Evolution	21.1-21.4
F	Oct 17	Quiz 7	Sullivan	**22**	Protists Origin and Diversity	28.1- 28.6
M	Oct 20		Sullivan	**23**	The Fungi	31.1-31.3, 31.5
W	Oct 22		Sullivan	**24**	How the Plants Colonized Land	29.1-29.3
F	Oct 24	Quiz 8	Sullivan	**25**	Plant Structure and Diversity	30.1-30.4, 35.1-35.4
M	Oct 27		Sullivan	**26**	Plant Transport	36.1-36.5
W	Oct 29		Sullivan	**27**	Soil and Nutrition	37.1-37.3
F	**Oct 31**	Quiz 9	Sullivan		**EXAM 2**	
M	Nov 03		Ziebis	**28**	History of Animal Life on Earth	32 & 33
					Animal Diversity – Invertebrates 1	32 & 33
W	Nov 05		Ziebis	**29**	Animal Diversity – Invertebrates 2	32 & 33
F	Nov 07	Quiz 10	Ziebis	**30**	Animal Diversity – Invertebrates 3	32 & 33
M	Nov 10		Ziebis	**31**	Animal Diversity – Invertebrates 4	32 & 33
W	Nov 12		Ziebis	**32**	Animal Diversity – Invertebrates 5	32 & 33
F	Nov 14	Quiz 11	Ziebis	**33**	Vertebrates 1	34
M	Nov 17		Ziebis	**34**	Vertebrates 2	34
W	Nov 19		Ziebis	**35**	Vertebrates 3	34
F	Nov 21	Quiz 12	Ziebis	**36**	Vertebrates 4	34
M	**Nov 24**		Ziebis		**EXAM 3**	
W	Nov 26				THANKSGIVING HOLIDAY – NO CLASS	
F	Nov 28				THANKSGIVING HOLIDAY – NO CLASS	
M	Dec 01		Ziebis	**37**	Our Global Environment	52-56
					Ecology and Biosphere 1	
W	Dec 03		Ziebis	**38**	Ecology and Biosphere 2	52-56
F	Dec 05		Ziebis	**39**	Ecology and Biosphere 3	52-56
M	**Dec 15**				**FINAL EXAM**	
					9 A.M. lecture section from 11:00 am - 1:00 pm	
					10 A.M. lecture section from 8:00 - 10:00 am	

*Additional readings for specific lectures will be posted on Blackboard during the semester.

Course Policies

Policy on Re-grading Examinations

If you feel that an error was made in the grading of an examination, you need to do the following: 1) Check the answer key with your TA, 2) Prepare a printed statement explaining why you feel your grade was incorrect, 3) Submit your printed statement, Re-grade Request Form (downloaded from Blackboard) and your original examination to your TA within one week of the time the examination was returned to you. The TA will either handle the re-grade or consult with the professors. The entire exam will be re-graded and, as a result, your grade may increase or decrease from a requested re-grade. No frivolous reasons will be accepted for requesting grade changes; stated reasons for a grade change must be legitimate (e.g., error in totaling the score).

Policy on Missed Lecture Exams or Quizzes

Students in the 9am section must take the 9am exam and students in 10am section must take the 10am exam. Taking the wrong midterm or final will result in a score of zero.

No make-up examinations (or quizzes) will be given in this course. You may be excused from an exam only in the event of a documented illness or emergency. No other excuses for missing exams will be accepted. Students who wish to miss an examination for observance of a religious holy day should be aware of the University's policy on such absences, published at: http://orl.usc.edu/religiouslife/holydays/absences.html.

If you miss an exam or quiz due to medical illness you must present a valid medical excuse to the Lab Manager within 72h of the missed examination or quiz. The excuse cannot be to attend a dental appointment, a conference, or other similar reasons. The reason for missing an examination or quiz must be of a medical nature or totally unavoidable (e.g., a verified automobile collision on the day and time of the examination). Remember that the USC Student Health Center does not provide routine medical excuses. You should notify the Lab Manager in writing that you were seen by a physician, making sure that you include: 1) the physician's name and telephone number, and 2) a statement authorizing us to discuss with the doctor whether you were too ill to take the examination. Note that neither you nor the physician need tell us the nature of your illness. We will contact the physician and decide whether or not you have a valid excuse. If the excuse is valid, your grade for that examination will be pro-rated based on the average of your other comparable examinations and the class average for that particular test. An invalid excuse, or the excuse turned in late, will result in a score of zero for the examination missed.

If you miss the final examination and have provided a valid medical excuse to the Lab Manager (ZHS 362) within 72 hours of the examination time, a final course grade of incomplete (IN) will be recorded and you will be permitted to take a make-up final examination during the following semester.

Extra Credit

No extra credit will be given for special projects, etc.

Students with Disabilities

Students requesting academic accommodations based on a disability are required to register with the Office of Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Be sure that the letter is delivered to the Laboratory Manager as early in the semester as possible, preferably by September 5, 2014. DSP is located in STU 301 and is open from 8:30 a.m. to 5:00 p.m., Monday through Friday. The telephone number of DSP is 213-740-0776. If a student's approved accommodation is limited to extra time on examinations, the teaching staff of BISC 120 will provide the accommodation. For any other accommodation, such as a private room, translator, etc., students must make prior arrangements with the DSP office 2 weeks before the exam date. For more information please visit the following website: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html.

Statement on Academic Integrity

The instructors in this course strongly support the ethics of academic integrity. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00: http://web-app.usc.edu/scampus/1100-behavior-violating-university-standards-and-appropriate-sanctions/, while the recommended sanctions are located in Appendix A. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: http://www.usc.edu/student-affairs/SJACS/.

Website

Students are responsible for logging onto Blackboard (https://blackboard.usc.edu) and checking the course website on a regular basis. Postings on Blackboard will be an official source for announcements, course materials, lecture notes, grade postings and general discussions. Lecture quizzes will also be completed on Blackboard.

Changes in Lab or Lecture Section

During the first three weeks of class you are responsible for changing your laboratory sections by dropping your current section and adding your new choice through OASIS. You can switch into a new lab section only if it is open (if it has less than 20 students). If a lab section is currently closed you must wait until other students drop before you can switch into that section. No changes are allowed after the first three weeks of class (i.e., after two weeks of lab). You are responsible for printing out your grade report from Blackboard before changing sections, as scores may be irrevocably lost from the Blackboard system when students change sections. The same applies if changing lecture sections.

Gift Policy

No gifts or presents of any kind are permissible to give to any of the instructional staff.

Final Comments

No exceptions will be made to these policies under most circumstances. If you think that the instructor or TA has granted you any deviation from the policies in this document and associated course syllabus, you must obtain their written agreement to support that claim.

FALL 2014 BISC 120Lg INSTRUCTIONAL TEAM

For ANY administrative questions about ANY aspects of the lecture and laboratory portions of this course, please FIRST CONTACT the Administrative Teaching Assistant, Yukai Zhao (E-mail: yukaizha@usc.edu)

MWF instructors:	Dr. Suzanne Edmands Dr. Cornelius Sullivan Dr. Wiebke Ziebis	TH instructors:	TBA Andrew Gracey

Lab Manager: Gorjana Bezmalinovic

Teaching Assistants (TAs): TBA

Supplemental instruction (SI) leaders:	Jordan Hoese	(Attending ? lecture)
	Yuna Kim	(Attending ? lecture)
	Audrey Chai	(Attending ? lecture)
	Troy Sekimura	(Attending ? lecture)

SI study session times can be found at http://dornsife.usc.edu/supplemental-instruction once the semester starts.

Answers to students' frequently asked questions regarding this course can be found on Blackboard (https://blackboard.usc.edu) under Course Information in your lecture section.

BISC 120Lg LABORATORY SYLLABUS
FALL 2014

Lab Manager: Gorjana Bezmalinovic ZHS 362 Tel/Fax: 213-740-6078
E-mail: bezmalin@usc.edu
Office hours: Open door policy

Laboratory Schedule:

Lab #	Date	Laboratory	Lab Manual
	Aug 26 – Aug 29	NO LAB THIS WEEK	
1	Sep 2 – Sep 5	Introduction to BISC 120 labs Laboratory Safety and Skills	Chapter 1 & Appxs. A, B
2	Sep 9 – Sep 12	The Microscope	Chapter 2 & Appx. C
3	Sep 16 – Sep 19	Evolution	Chapter 3
		(Start the Petri plates!)	
4	Sep 23 – Sep 26	Bacteria*	Chapter 4
5	Sep 30 – Oct 3	Protists	Chapter 5
	Oct 7 – Oct 10	LAB EXAM 1	(Chapters 1, 2, 3, 4, & 5)
		(Antibiotics lab report due)	
6	Oct 14 – Oct 17	Plant Diversity I	Chapter 7
7	Oct 21 – Oct 24	Plant Diversity II	Chapter 8
		(Cut the planarians!)	
8	Oct 28 – Oct 31	Animal Diversity I: Invertebrates*	Chapter 9a
9	Nov 4 – Nov 7	Animal Diversity II: Echinoderms and Chordates	Chapter 9b
10	Nov 11 – Nov 14	Ecological Relationships	Chapter 10
		(Planaria Regeneration lab report due)	
	Nov 18 – Nov 21	LAB EXAM 2	(Chapters 7, 8, 9 & 10)
		(Lab manuals due!)	

	Nov 25 – Nov 28	NO LAB – THANKSGIVING
11	Dec 2 – Dec 5	Biodiversity Conservation Presentations

*Exercise for which 5-7 pages, type-written lab report is required.

The Lab Manager reserves the right to make some adjustments to the lab syllabus during the semester.

Required Textbook available at the USC bookstore:

General Biology Laboratory Manual FALL 2014, BISC 120 & BISC 121 Courses, USC. (Available at the USC bookstore after August 15, 2014.)

Recommended Textbooks:

Adams & Crawley (2013). Van De Graaff's Photographic Atlas for the Biology Laboratory, 7th ed.

Pechenik. A Short Guide to Writing About Biology. 8th ed. (e-copy included with the USC custom textbook).

LABORATORY POINT DISTRIBUTION

The laboratory portion (300 points) will count for 30% of your final course grade, distributed as follows:

Lab Quizzes (10 – 5 points each)	50 pts
Lab Manual (10 – 5 points each)	50 pts
Lab Reports (2 – 35 points each)	70 pts
Lab Exams (2 – 50 points each)	100 pts
Biodiversity and Conservation Biology Presentation	30 pts

LABORATORY PERFORMANCE GUIDELINES

1. You are required to attend all lab sessions. Any unexcused absences will seriously affect your evaluation. Come to lab on time. You are also to remain for the entire lab session or until excused by your instructor. Don't make other appointments for the time you are scheduled to be in lab.

Students who are within 10 points of a grade borderline at the end of the semester will be considered for an upgrade based on the following criteria: class participation, attendance, coming to office hours, and subjective evaluation by the TA, Lab Manager, and faculty.

2. Before you begin the lab exercise, make sure that you remove all unnecessary materials from your work area. At the end of the lab session, clean and return all supplies to their proper place, clean your work area, and slide your chair under the table. Check with your instructor before leaving.

NO EATING OR DRINKING IS ALLOWED IN THE LABORATORY UNDER ANY CIRCUMSTANCES.

3. LAB QUIZZES: Each student will take a quiz during the first 5 minutes of each lab session. Students who come late to lab without a legitimate and verifiable excuse will not be allowed to make up the quiz. Quizzes will consist of multiple choice questions and/or fill-in-the-blanks. Out of 5 questions, 3 will test you on the knowledge of the material you will be covering that day in lab, and the other 2 will test you on the results from the previous lab.

4. LAB WRITE-UPS: During each lab students need to record their results (drawings, observations, calculations) in their lab manual. Tables need to be filled and all post-lab questions answered. Each student is required to show his/her TA the lab manual before leaving the lab and obtain a signature. Lab manuals will be collected for grading at the end of the semester.

5. LAB REPORTS: Two lab reports will be written during the semester. Lab reports must be posted on Blackboard (Lab Reports turnitin link) and a hard copy turned in at the beginning of the lab session. Lab report guidelines will be posted on Bb (https://blackboard.usc.edu/) in the beginning of the semester.

6. LAB EXAMS: The two lab practical exams will test your understanding of the topics and exercises covered in the laboratory sessions. You will have a written portion and a practical portion (being able to use a microscope to identify different organisms). The first lab exam will cover material covered in labs 1 – 5, while labs 6 – 10 will be covered on the second exam.

Missed Lab Exam: It is your responsibility to be present on the days of the lab practical exams.

If you miss a lab practical exam due to a serious illness, you must present a valid excuse to the Lab Manager within 48 hours of the missed exam. A valid excuse is considered to be a statement that you were seen by a physician, the physician's name and phone number, and authorization for us to discuss with the physician whether you were too ill to take the exam, which we will do. Note that neither you nor the physician need tell us the nature of your illness. If you have a valid excuse, you will be allowed to take the exam in another lab section that week. If you do not have a valid excuse or fail to provide it within the allotted time, you will receive zero points for the missed lab practical exam.

7. MISSED LABS: If you miss a scheduled lab exercise due to illness or emergency, please contact immediately the Administrative TA Yukai Zhao at yukaizha@usc.edu to see whether it will be possible to make up the exercise by attending an alternative lab section. Please tell him what lab section you are in, who your TA is, and when you would like to make up the missed lab (days and times that would work best for you). For logistical reasons, it will not be possible to make up a missed lab exercise after Friday afternoon of the week in question. Therefore, students with labs scheduled on Fridays will have little or no alternative should they miss lab unexpectedly. Only a few requests for alternative labs can be accommodated, because few sections have available space. Thus, it is very important for you to attend your scheduled lab section.

Please note that no lab switching will be allowed during the week prior to a holiday. Athletes who must miss occasional labs for legitimate reasons should bring documentation to the Lab Manager well in advance, at least 2 weeks, to arrange alternatives. Students who wish to miss a lab for observance of a religious holy day should be aware of the University's policy on such absences, published at: http://orl.usc.edu/religiouslife/holydays/absences.html. Requests for such absences should be made by email addressed to the Lab Manager at least 2 weeks in advance of the absence. If the absence is approved, a reasonable accommodation will be determined.

8. BIODIVERSITY CONSERVATION PRESENTATION: Detailed instructions for preparing your presentation, including how points will be assigned, will be provided on Blackboard (https://blackboard.usc.edu/).

POSTING GRADES: You can find your lecture and lab grades on Blackboard: https://blackboard.usc.edu. Lecture exam scores are posted under LECTURE SECTION. All lab grades are posted under your LAB SECTION. Be sure to check for additional postings on a regular basis. It is the student's responsibility to notify his/her TA or Lab Manager ASAP in the event of any mistakes, so please check your scores on Blackboard weekly.

LABORATORY SCORE NORMALIZATION: The laboratory scores will be normalized at the end of the semester by the Lab Manager to correct for differences in grading between TAs. In this procedure, the mean total score of all students in each TAs labs is compared to the mean total score of the entire class and each student's score is adjusted.

STUDENTS WITH DISABILITIES: Students requesting academic accommodations based on a disability are required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP when adequate documentation is filed. The letter needs to be delivered to the Lab Manager as early in the semester as possible, preferably by Sep 5, 2014. For more information, you can visit the DSP office in STU 301 (8:30-5:00, M-F), call at 213-740-0776, email at ability@usc.edu, or go to their website: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html.

APPENDIX B

SUGGESTED READING LISTS

INTRODUCTION

Overview

In Chapter 4 of this work, I suggest a pedagogy to attain scientific literacy using rhetoric of science. This suggested pedagogy required several reading assignments specific to the lesson. In this appendix, I provide a more expanded background for both the instructor and student.

I will present these reading lists in two parts. First, I will present a suggested list for a background of scientific topics. Second, I will present a brief list to familiarize oneself with rhetoric of science. Within this second category, I will divide the list into three specific areas: definition and application, history, and case studies.

Limitations

This background reading is by no means an exhaustive list; rather, it is a primer overview. In Chapter 4, I mentioned several popularizations. Of course, the readings I suggest are subjective and can be expanded depending on instructor or student interest, timely events, or specific lessons. In this appendix, I have two specific agendas for this section. First, I hope to provide a general list to demonstrate the vast selection and flexibility of scientific topics that is available to the composition instructor. In this case, the instructor may select from these ideas or search for additional similar ideas to teach from his or her own interests, comfort, and strengths. Second, I hope to demonstrate further Campbell's allusion to additional available pedagogy, especially concerning scientific arguments and rhetorical resources.

SCIENTIFIC TOPICS

As I noted in Chapter 3, most of the textbooks examined covered major scientific ideas, ranging from evolution to ecosystems. In fact, these ideas are similar in the textbooks I reviewed. Such inclusion and similarity illustrate that science instruction recognizes common core topics.

Research scientist Robert Hazen and physics professor James Trefil also develop a list of science topics that they see as essential for scientific literacy. In their *Science Matters: Achieving Scientific Literacy* (see Table 9), these two scientists explain nineteen core scientific laws and concepts so that nonscientists can be familiar with these ideas (xix). The organization of this text begins with five basic scientific concepts that govern the remainder of the scientific ideas represented; each chapter headlines one of these concepts, states the basic guideline of the concept, and develop the concept for the reader. For example, the first chapter, "Knowing" highlights the following core idea: "*The universe is regular and predictable*" (3, Hazen and Trefil's emphasis). Throughout the chapter, the authors expand on the way science explains the natural world, melding history with definitions, and scientists with discoveries to give nonscientists both a basic vocabulary and a common knowledge of science fact. Like the textbooks, this book is an introduction to science from a scientific viewpoint.

A similar text to consider, science journalist Natalie Angier's *The Canon: A Whirligig Tour of the Beautiful Basics of Science* (see Table 10), relates basic scientific tenets to nonscientists through a collection of interviews and insights from scientists in various scientific fields. In this form of scientific popularization, Angier introduces many of the same scientific topics, concepts, and definitions as Hazen and Trefil do. However,

Table 9. *Science Matters: Achieving Scientific Literacy*

Chapter	Title	Major Concept
1	Knowing	*The universe is regular and predictable.*
2	Energy	*Energy is conserved and always goes from more useful to less useful forms.*
3	Electricity and Magnetism	*Electricity and magnetism are two aspects of the same force.*
4	The Atom	*All matter is made of atoms.*
5	The World of the Quantum	*Everything comes in discrete units and you can't measure anything without changing it.*
6	Chemical Bonding	*Atoms are bound by electron glue.*
7	*Atomic Architecture*	*The way a material behaves depends on how its atoms are arranged.*
8	Nuclear Physics	*Nuclear energy comes from the conversion of mass.*
9	The Fundamental Structure of Matter	*All matter is really made of quarks and leptons.*
10	Astronomy	*Stars experience a cycle of birth and death.*
11	The Cosmos	*The universe was born at a specific time in the past, and it has been expanding ever since.*
12	Relativity	*Every observer sees the same laws of nature.*
13	The Restless Earth	*Earth's surface is constantly changing, and no feature on Earth is permanent.*
14	Earth Cycles	*Earth operates in cycles.*
15	The Ladder of Life	*All living things are made from cells, the chemical factories of life.*
16	The Code of Life	*All life is based on the same genetic code.*
17	Biotechnology	*All life is based on the same chemistry and genetic code.*
18	Evolution	*All forms of life evolved by natural selection.*
19	Ecosystems	*All life is connected.*

Source: Hazen, Robert M., and James Trefil. *Science Matters: Achieving Scientific Literacy*. New York: Anchor Books, 2009. Print.

Table 10. ***The Canon: A Whirligig Tour of the Beautiful Basics of Science***

Chapter	Title	Major Concept
1	Thinking Scientifically: An Out-of-Body Experience	*The universe is regular and predictable.*
2	Probabilities: For Whom the Bell Curves	*Energy is conserved and always goes from more useful to less useful forms.*
3	Playing with the Scales	*Electricity and magnetism are two aspects of the same force.*
4	Physics: And Nothing's Plenty for Me	*All matter is made of atoms.*
5	Chemistry: Fire, Ice, Spies, and Life	*Everything comes in discrete units and you can't measure anything without changing it.*
6	Evolutionary Biology: The Theory of Every Body	*Atoms are bound by electron glue.*
7	Molecular Biology: Cells and Whistles	*The way a material behaves depends on how its atoms are arranged.*
8	Geology: Imagining World Pieces	*Nuclear energy comes from the conversion of mass.*
9	Astronomy: Heavenly Creatures	*All matter is really made of quarks and leptons.*

Source: Angier, Natalie. *The Canon: A Whirligig Tour of the Beautiful Basics of Science*. New York: Houghton Mifflin, 2007. Print.

Angier presents these ideas through the various fields of science, demonstrating the relationship between science and daily issues. For example, in her chapter on chemistry, Angier mixes a bit of history (such as fermentation), basic chemical facts (such as the separate toxicity of sodium and chlorine and the tasty yet safe yield of salt when these elements are joined), and timely topics (such as alcohol and sobriety), all connected with humorous anecdotes and insights (such as chemistry party tricks).

As a final example of basic science topics from which an instructor may draw, I offer another effort by Hazen and Trefil: *Great Ideas of Science: A Reader in Classic Literature of Science*. In this choice, Hazen and Trefil revisit and add to their earlier selections from *Science Matters*, expanding to twenty-five essential scientific topics.

With this expansion, the editors incorporate scientific essays specific to each of the represented scientific topics (see Table 11). For example, in Chapter 13, “The Ultimate Structure of Matter,” the editors illustrate the topic with the essays “The Positive Electron” by Carl D. Anderson, and “Large Hadron Collider: The Discovery Machine” by Graham P. Collins. Each of these topics and representative essays demonstrate science as a form of discovery while providing the reader with a scientific history.

As I explained earlier, these first selections offer a sampling of possible scientific topics for the instructor. However, the last example, *Great Ideas of Science*, bridges the gap between scientific topics and scientific arguments, which is where I focus my energy of scientific literacy instruction. In this collection of essays, Hazel and Trefil connect topics and essays as a written account of history. Still, the inclusion of these essays lacks any rhetorical context. Thus, Hazen and Trefil provide ample scientific topics while demonstrating the concepts of science and the connection with scientific literature, yet this collection provides no rhetorical study of the texts themselves.

RHETORIC OF SCIENCE

Definition and Application

In this next section, I believe that I will answer or at least offer an address to Campbell’s insistence that other forms of rhetorical pedagogies exist. Whereas my first section provides topical suggestions, my next selections will provide rhetorical application. For this consideration, I will look at a general rhetorical background and then a more specific rhetorical examination of scientific texts.

In this section, I provide a brief reading list that allows for a historical examination of the discipline. Here, I look first at texts that offer a foundational

Table 11. ***Great Ideas of Science: A Reader in Classic Literature of Science***

Chap.	Title	Chapter Essays
1	Science as a Way of Knowing	"On the Motion of the Heart and Blood in Animals," by William Harvey (1628)
		"On the Mode of Communication of Cholera," by John Snow (1855)
2	The Ordered Universe	"Almagest," by Claudius Ptolemy (c.100 AD)
		"On the Revolutions of the Celestial Spheres," by Nicolas Copernicus (1543)
		"Dialogues Concerning the Two Chief World Systems," by Galileo Galilei (1632)
		"A Discussion of Elliptical Orbits of Comets," by Edmond Halley (1715)
3	Energy	"An Inquiry into the Source of Heat Which is Excited by Friction," by Benjamin Thompson, Count Rumford (1798)
		"On the Secular Cooling of the Earth," by William Thomson, Lord Kelvin (1864)
4	Heat and the Second Law of Thermodynamics	"Experiments Done on the Degree of Heat of a Few Boiling Liquids," by Daniel Fahrenheit (1724)
		"Reflections on the Motive Power of Fire and on Machines Fitted to Develop that Power," by Sadi Carnot (1824)
5	Electricity and Magnetism	"Experiments and Observation on Electricity, Made at Philadelphia in America," by Benjamin Franklin (1751)
		"A Letter of Benjamin Franklin, Esq; to Peter Collinson F. R. S. Concerning an Electrical Kite," by Benjamin Franklin (1752)
		"The History and Present State of Electricity, with Original Experiments," by Joseph Priestley (1775)
6	The Theory of Relativity	"Relativity: The Special and General Theory," by Albert Einstein (1920)

Continued . . .

Table 11. *Great Ideas of Science: A Reader in Classic Literature of Science* (Continued)

Chap.	Title	Chapter Essays
7	The Atom	"New System of Chemical Philosophy," by John Dalton (1803)
		"The Relation Between the Properties and Atomic Weights of the Elements," by Dimitri Ivanovich Mendeleev (1869)
		"On a New Radioactive Substance Contained in Pitchblende," by Marie Sklowdowska Curie (1903)
8	Quantum Mechanics	"The Fundamental Idea of Wave Mechanics," by Erwin Schrödinger (1933)
9	The Chemical Bond	"Chemical Treatise on Air and Fire," by Carl Wilhelm Scheele (1777)
		"Electrochemical Researches on the Decomposition of the Earths; With Observations on the Metals Obtained from the Alkaline Earths, and on the Amalgam Procured from Ammonia," by Humphry Davy (1808)
10	Properties of Matter	"The Breakthrough: The Race for the Superconductor," by Robert Hazen (1988)
11	The Nucleus of the Atom	"Cathode Rays," by J. J. Thomson (1897)
		"The Scattering of α and β Particles by Matter and the Structure of the Atom," by Ernest Rutherford (1911)
12	The Ultimate Structure of Matter	"The Positive Electron," by Carl D. Anderson (1933)
		"Large Hadron Collider: The Discovery Machine," by Graham P. Collins (2008)
13	The Stars	"The Parallax of 61 Cygni," by Friedrich Wilhelm Bessel (1838)
		"Stellar Energy," by Henry Norris Russell (1939)
14	Cosmology	"Periods of 25 Variable Stars in the Small Magellanic Cloud," by Henrietta Swan Leavitt (1912)
		"A Relation Between Distance and Radial Velocity Among Extra-Galactic Nebulae," by Edwin Hubble (1929)

Continued . . .

Table 11. ***Great Ideas of Science: A Reader in Classic Literature of Science* (Continued)**

15	The Earth and Other Planets	"The System of the World," by Pierre Simon Laplace (1796)
		"Experiments to Determine the Density of the Earth," by Henry Cavendish (1798)
16	Plate Tectonics	"The Floors of the Ocean," by Bruce C. Heezen, Marie Tharp, and Maurice Ewing (1959)
		"Magnetic Anomalies Over Ocean Ridges," by Frederick J. Vine and Drummond H. Matthews (1963)
17	Cycles of the Earth	"Theory of the Earth, Volume 1 with Proofs and Illustrations, in Four Parts," by James Hutton (1795)
18	Ecology, Ecosystems, and the Environment	"An Equilibrium Theory of Insular Zoogeography," by Robert H. MacArthur and Edward O. Wilson (1963)
19	The Strategies of Life	"Oriatricke, or Physick Refined, the Common Errors Therein Refuted, and the Whole Art Reformed and Rectified," by John Baptista Van Helmont (1648)
		"The Families of Plants: With their Natural Characters, According to the Number, Figure, Situation, and Proportion of all the Parts of Fructification," by Carl van Linn. (Carolus Linnaeus) (1737)
20	The Living Cell	"Micrographia: Or Some Physiological Descriptions of Minute Bodies Made by Magnifying Glasses," by Robert Hooke (1665)
		"Cellular Pathology: As Based Upon Physiological and Pathological Histology," by Rudolf Virchow (1860)
21	Molecules of Life	"On the Artificial Production of Urea," by Friedrich Wöhler (1828)
22	Classical and Modern Genetics	"Experiments in Plant Hybridization," by Gregor Mendel (1866)
		"The Mechanism of Mendelian Heredity," by T. H. Morgan, A. H. Sturtevant, H. J. Muller, and C. B. Bridges (1915)
		"A Structure for Deoxyribose Nucleic Acid," by James D. Watson and Francis H. C. Crick (1953)

Continued . . .

Table 11. ***Great Ideas of Science: A Reader in Classic Literature of Science* (Continued)**

23	The New Science of Life	"Enzymatic Amplification of β–globin Genomic Sequences and Restriction Site Analysis for Diagnosis of Sickle Cell Anemia," by Randall K. Saiki and colleagues (1985)
		"Viable Offspring Derived from Fetal and Adult Mammalian Cells," by Ian Wilmut and colleagues (1997)
24	Evolution	"On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life," by Charles Darwin (1859)

Source: Hazen, Robert M., and James Trefil, eds. *Great Ideas of Science: A Reader in the Classic Literature of Science.* San Diego: Cognella, 2012. Print.

understanding of rhetoric of science and then texts that deal with the tools employed with rhetoric of science (see Table 12).

Table 12. Defining and Applying Rhetoric of Science

Title	Author(s)
A Rhetoric of Science: Inventing Scientific Discourse	Lawrence J. Prelli
The Rhetoric of Science	Alan G. Gross
Starring the Text: The Place of Rhetoric in Science Studies	Alan G. Gross
Science from Sight to Insight: How Scientists Illustrate Meaning	Alan G. Gross and Joseph E. Harmon
Metaphor and Knowledge: The Challenges of Writing Science	Ken Baake
Rhetorical Figures in Science	Jeanne Fahnestock

In Chapter 2 of this study, I attempted to define the term *rhetoric of science*. To formulate this definition, I briefly detailed several authors and their seminal works; I will list their works again as an available reading list. When I look at defining rhetoric of science as a discipline, I consider two authors as indispensable: Lawrence Prelli (*A Rhetoric of Science: Inventing Scientific Discourse*) and Alan Gross (*The Rhetoric of Science*). Both scholars concentrate on how science employs written, spoken, and visual forms of language to communicate with its audience. Both texts serve as a good start at understanding scientific rhetoric.

Prelli frames his explanation of rhetoric of science within the context of rhetoric: the language used to present an argument, especially within science, is based on the needs of the audience (12; 27–28); the success of any scientific argument depends on the audience. From this start, Prelli builds a careful study of scientific argumentation, relying on a very distinct Aristotelian (or at least Classical) concept of rhetoric to explain his case. Succinctly, Prelli effectively develops first the idea of rhetorical invention and then applies this idea to scientific discourse. If pressed to choose specific chapters of this book for students, sadly, I cannot make such limits as I deem the book in its entirety as necessary.

In *The Rhetoric of Science*, Gross begins by explaining rhetorical analysis regarding scientific prose, and his insights serve as a cornerstone of rhetoric of science studies. Then, by using high-profile scientists and scientific controversies—including Watson and Crick and DNA; Einstein and relativity; Copernicus and heliocentricity; Newton and optics; and Darwin and evolution—Gross develops a historical context of recognizing rhetoric within scientific language. Although the entire text offers a useful foundation of application, I specifically suggest using the first three chapters dealing with rhetorical analysis, analogy in science, and taxonomy, respectively, Chapter 5 ("Style in Biological Prose"), and Chapter 6 ("The Arrangement of the Scientific Paper") for an abbreviated focus.

Continuing with the understanding of rhetoric of science, I suggest four additional works that deal with distinct tools utilized within rhetoric of science, which I will describe as text, visuals, metaphors, and figures of speech. I will not go into the detail as I have with Prelli and Gross except to say that these additional texts provide a more detailed study of the specific mechanics of rhetoric of science. In the case of *Starring the Text: The Place of Rhetoric in Science Studies* and *Science from Sight to Insight: How Scientists Illustrate Meaning*, Gross furthers his original study, demonstrating the specific use of the text and graphics to construct and enhance scientific discourse.

Baake uses the idea of harmonics to explain how scientists employ metaphors within science. Like musical notes, words are combined with one other words to construct meaning and ideas as well as build emphasis and ensure understanding and adherence (8). Yet, Baake's study of metaphor links well with Fahnestock's exploration of figures of speech in *Rhetorical Figures in Science*. In her study, Fahnestock begins with metaphor and examines the following classical figures of speech as they relate to rhetorical construction in science: *antithesis*, *incrementum*, *gradation*, *antimetabole*, *ploche*, and *polyptoton*. To me, these texts work in tandem, often overlapping in study while enhancing the understanding of these linguistic devices.

History

In this section, I provide a reading list for a historical rhetorical examination of scientific arguments. In Table 13, I offer a general rhetorical history, or rather, historical examples of scientists and scholars who have recognized and remarked on the rhetorical impact on science. In Chapter 1, I mentioned two books—Kuhn's *The Structure of Scientific Revolutions* and Latour and Woolgar's *Laboratory Life: The Construction of Scientific Facts*—that argue the conduction of science is as much about persuasion as it is discovery. In Chapter 2, I noted Fuller and Collier's *Philosophy, Rhetoric, and the End of*

Table 13. Historical Impact of Rhetoric in Science

Title	Author(s)/Editor
The Structure of Scientific Revolutions (3rd ed.)	Thomas S. Kuhn
Laboratory Life: The Construction of Scientific Facts	Bruno Latour and Steve Woolgar
Philosophy, Rhetoric, and the End of Knowledge: A New Beginning for Science and Technology Studies	Steve Fuller and James H. Collier
English Science, Bacon to Newton	Brian Vickers (editor)
Shaping Science with Rhetoric: The Cases of Dobzhansky, Schrödinger, and Wilson	Leah Ceccarelli
Communicating Science: The Scientific Article from the 17th Century to the Present	Alan G. Gross, Joseph H. Harmon, and Michael S. Reidy

Knowledge: A New Beginning for Science and Technology Studies, which looks at the impact of scientific arguments within the context of the nonscientific world.

As a final companion piece to these three previous works, I suggest *English Science, Bacon to Newton*. In this collection of excerpts of the writings of seventeenth-century members of the Royal Society—including Francis Bacon, Robert Boyle, Henry Power, Robert Hooker, Thomas Sprat, John Wilkins, and Isaac Newton—editor Brian Vickers demonstrates the correlation between science and language. For example, in the highlight of the *History of the Royal Society*, Sprat especially illustrates how the discipline of science uses rhetoric—particularly metaphors—despite its claims to the contrary.

Each of these texts may serve as a general look at the importance of rhetoric as it relates to science. Similarly, as Hazen and Trefil and Angier offer what they consider as the essential tenets of science to establish a scientific foundation for the public, Kuhn, Latour and Woolgar, Fuller and Collier, and Vickers provide the basic connection between rhetoric and science. In these choices, I propose a simple starting point of the symbiotic relationship between rhetoric and science. As the scientific topic selections that I mention provide a history, so, too, do these rhetorical selections.

As a specific historical rhetorical examination of scientific texts, I recommend two examples, one that serves as an ethnographic example of rhetoric of science and one that examines the historical practice of rhetoric of science itself.

For the first example, I suggest Leah Ceccarelli's *Shaping Science with Rhetoric: The Cases of Dobzhansky, Schrödinger, and Wilson*, which I noted in my conclusion. In her work, Ceccarealli examines three scientists and their specific employment of rhetoric in their respective works: Theodosius Dobzhanksy's *Genetics and the Origin of Species*, Erwin Schrödinger's *What Is Life?*, and E. O. Wilson's *Consilience*. In her study, Ceccarealli demonstrates through careful rhetorical analysis how both Dobzhanksy and Schrödinger succeed in achieving agreement among their peers concerning the mutual benefits for interdisciplinary studies. In contrast, Ceccarealli shows how Wilson not only fails in his persuasion but also further alienates the sciences and humanities (2).

As for the second example, I suggest *Communicating Science: The Scientific Article from the 17th Century to the Present* by Alan Gross, Joseph Harmon, and Michael Reidy. In this text, Gross advances his ideas of rhetoric of science with Communication professor Harmon and Philosophy and History professor Reidy. Noting how each of the centuries deal with argumentation in general and style and presentation specifically, this work examines, as the title indicates, how the scientific article has evolved. In both of these works, students receive a general overview of rhetorical analysis concerning scientific argumentation, which can be most helpful in the study and understanding of scientific arguments themselves. Interestingly, among other observations, the authors demonstrate how the scientific article has served as the main source of communication for scientists, how these articles have developed the discipline of science, and how visuals have increased to advance scientific arguments (231). I find this book balances a historical overview and the specific application of critical analysis to written science. Although I suggest reading this work in its entirety, the undergraduate nonscience major may find the history a bit tedious. Thus, perhaps assigning the later chapters dealing with current scientific composition will be beneficial in recognizing the components and intent of modern scientific argumentation.

Again, I offer these choices, both scientific and rhetorical histories, as suggestions for a foundation. Depending on the course length, an instructor may not have the time to require these texts. In other words, these selections would be ideal course reading additions to provide a strong foundation of both science and rhetoric. However, these next texts offer more specific, vital suggestions to a scientific literacy course. I will divide these selections as follows: texts focusing on rhetoric of science as the subject, collections of rhetoric of science essays, and specific critical analysis of scientific arguments.

In *Starring the Text: The Place of Rhetoric in Science Studies*, Gross re-examines the application of rhetorical analysis from his earlier work, *The Rhetoric of Science*, including another look at Newton and Darwin. However, Gross establishes a more detailed connection between the rhetorical tradition and rhetoric of science. For this reason, I suggest Chapter 2, "The Justification of Rhetoric of Science," and Chapter 3, "The Kind of Rhetoric Science Is," as essential readings from this book.

Case Studies

No reading list would be complete without specific essays highlighting case studies involving rhetoric of science. In Chapter 4, I offer such case studies to supplement my pedagogy. However, in this section, I opt to list two specific collections of essays as a means to illustrate the additional resources available to both instructors and students.

First, the Landmark Essays Series has long been known for the collected anthologies of topical articles and publications; Volume Eleven (*Landmark Essays on Rhetoric of Science: Case Studies*) provides an excellent collection of selected rhetoric of science case studies. As Table 14 shows, editor Randy Allen Harris organizes his choices in this collection according to four major categories, which I describe as studies of famous rhetoricians of science ("Giants of Science"), famous controversies in science ("Conflict in Science"), famous public cases of science ("Public Science"), and famous examples of the means of writing science ("Writing Science").

I have already noted the use of Campbell's rhetorical studies concerning Darwin in Chapter 4, and Gross addresses Isaac Newton's *Opticks* in his other works, especially *Starring the Text*. Still, I find Harris's selections as a good primer regarding rhetoric of science case studies, written by scholars who may arguably be considered as giants themselves in such composition. Of particular interest, Harris's own introduction serves an informative overview for serious scholars, and I find Prelli's "The Rhetorical Study of Scientific Ethos" a good companion to my claim concerning rhetoric as a means of discernment. Overall, this volume is a necessary addition to a rhetoric of science library.

Table 14. *Landmark Essays on Rhetoric of Science: Case Studies*

Section	Chapter	Essay Title	Author(s)
Giants in Science	1	Charles Darwin: Rhetorician of Science	John Angus Campbell
	2	On the Shoulders of Giants: Seventeenth-Century Optics as an Argument	Alan G. Gross
	3	The Birth of Molecular Biology: An Essay in the Rhetorical Criticism of Scientific Discourse	S. Michael Halloran
Conflict in Science	4	Arguing in Different Forums: The Bering Crossover Controversy	Jeanne Fahnestock
	5	Punctuated Equilibria": Rhetorical Dynamics of a Scientific Controversy	John Lyne and Henry F. Howe
	6	The Rhetorical Construction of Scientific Ethos	Lawrence J. Prelli
Public Science	7	Dialectic and Rhetoric at Dayton, Tennessee	Richard M. Weaver
	8	The Role of Pathos in the Decision-Making Process: A Study in the Rhetoric of Science Policy	Craig Waddell
	9	Owning a Virus: The Rhetoric of Scientific Discovery Accounts	Carol Reeves
Writing Science	10	Reporting the Experiment: The Changing Account of Scientific Doings in the Philosophical Transactions of the Royal Society, 1665–1800	Charles Bazerman
	11	Text as Knowledge Claims: The Social Construction of Two Biology Articles	Greg Myers

Source: Harris, Randy Allen, ed. *Landmark Essays on Rhetoric of Science Case Studies*. Mahweh, NJ: Lawrence Erlbaum Associates, Inc., 1997.

More importantly, these collections serve as examples for other similar case study anthologies. Primary to selecting such a volume would be essay topics, organization of these essays, and recognized scholars in the field as authors of these selections.

Second, I recommend *Science and Society*, part of *Longman's Topics Reader* series, edited by English professor Richard Grinnell (see Table 15). In Chapter 4, I utilize "Revolutionary New Insoles Combine Five Forms of Pseudoscience" from this collection. Although the essays in this volume do not provide the rhetorical study of science issues as the selections Harris presents, they do offer an almost who's who of celebrated scientists and authors who argue scientific issues for the public. In fact, these essays may be considered more as examples of scientific popularizations. For example, in "Sex, Drugs, Disasters, and the Extinction of Dinosaurs," famed paleontologist Stephen Jay Gould uses his field and the popularity of dinosaurs to help the general public understand the importance of science while distinguishing between sound and haphazard scientific ideas and research.

Later in this anthology, *Popular Science* assistant editor Jenny Everett uses her own personal experience concerning her nine-year-old brother's foray into growth hormones to discuss human engineering in her essay, "My Little Brother on Drugs." In her discussion, she uses this topic to both enlighten the public and stir open discussion on a controversial topic.

Grinnell categorizes his selections into topical sections that are of public interest, including defining science, human behavior, environmental issues, and future scientific endeavors. In fact, Grinnell treats each essay as a lesson, posing considerations when reading the essay and questions for discussion after reading the essay. The collection itself is set up as a popular science textbook, demonstrating how science is advanced in the public sphere.

Table 15. *Science and Society*

Chapter	Section	Essay Title	Author
1	What Is Science	What Is Science?	George Orwell
		Alchemy	Lewis Thomas
		Why We Need to Understand Science	Carl Sagan
		Revolutionary New Insoles Combine Five Forms of Pseudoscience	*The Onion*
		Sex, Drugs, Disasters and the Extinction of the Dinosaurs	Stephen Jay Gould
		Science, Lies, and the Ultimate Truth	Barbara Ehrenriech
		Why Science Must Adapt to Women	Peggy Orenstein
		School Boards Want to “Teach the Controversy.” What Controversy?	Lawrence Krauss
		American Institute of Biological Sciences Ethics Statement	
2	Science and Human Behavior	Of Altruism, Heroism and Nature's Gifts in the Face of Terror	Natalie Angier
		The Strategies of Human Mating	David Buss
		You Dirty Vole	Gunjan Sinha
		Apes of Wrath	Barbara Smuts
		Whose Life Would You Save?	Carl Zimmer
3	Bodies and Genes	DNA as Destiny	David Ewing Duncan
		My Little Brother on Drugs	Jenny Everett
		Designer Babies	Sharon Begley
		The Year of the Clone?	Peter Singer
		Stripped for Parts	Jennifer Kahn
4	The Environment	Thinking Like a Mountain	Aldo Leopold
		Ice Memory	Elizabeth Kolbert
		Warm, Warmer, Warmest	Nicholas D. Kristof
		Will Frankenfood Save the Planet?	Jonathan Rauch
		Easter Island's End	Jared Diamond
		The Earth without People	Alan Weisman

Continued . . .

Table 15. *Science and Society* (Continued)

5	Frontiers	The Man Who Mistook His Girlfriend for a Robot	Dan Ferber
		The Next Brainiacs	John Hockenberry
		Will Drugs Make Us Smarter?	James Vlahos
		Launching the Right Stuff	Neil de Grasse Tyson
		How to Build a Time Machine	Paul Davies
		Pondering the Future of the Future	Fred Guterl

Source: Grinnell, Richard W., ed. *Science and Society*. Boston: Pearson/Longman, 2007. Print.

CONCLUSION

In this appendix, I have attempted to offer a very brief suggested reading list for instructors and students; it is by no means exhaustive or exclusive. Indeed, I am limited by space and time to create a more detailed listing of just the authors listed here in this appendix; I am indebted to these scholars for my own understanding and excursion into rhetoric of science. If nothing else, these suggestions will serve as a starting point and spur the desire for additional research and reading.