Final Report

Frontiers in Microbiology

Envisioning a Curriculum Unit for High School Biology

Department of Energy Grant No. DE-FG02-04ER63809

Resubmitted by BSCS
May, 2009

Executive summary

Microbiology is undergoing a quiet revolution. Techniques such as polymerase chain reaction, high throughput DNA sequencing, whole genome shotgun sequencing, DNA microarrays, and bioinformatics analyses are greatly aiding our understanding of the estimated one billion species of microbes that inhabit the Earth. Unfortunately, the rapid pace of research in microbiology stands in contrast to the much slower pace of change in educational reform.

Biological Sciences Curriculum Study (BSCS) hosted a two-day planning meeting to discuss whether or not a new curriculum unit on microbiology is desirable for the high school audience. Attending the meeting were microbiologists, high school biology teachers, and science educators. The consensus of the participants was that an inquiry-based unit dealing with advances in microbiology should be developed for a high school biology audience. Participants established content priorities for the unit, discussed the unit's conceptual flow, brainstormed potential student activities, and discussed the role of educational technology for the unit.

As a result of the planning meeting discussions, BSCS staff sought additional funding to develop, disseminate, and evaluate the *Frontiers in Microbiology* curriculum unit. This unit was intended to be developed as a replacement unit suitable for an introductory biology course. The unit would feature inquiry-based student activities and provide approximately four weeks of instruction. As appropriate, activities would make use of multimedia. The development and production processes would require about two years for completion.

Unfortunately, BSCS staff was not able to attract sufficient funding to develop the proposed curriculum unit. Since there were some unexpended funds left over from the planning meeting, BSCS requested and received permission from DOE to use the balance of the funds to prepare background materials about advances in microbiology that would be useful to teachers. These materials were developed and placed on the BSCS Web site (http://www.bscs.org).

1.0 Background and Significance

Our planet contains creatures that “breathe” metals and can survive extreme temperatures, acidity, alkalinity, and salinity. By almost any measure, microbes are vital to the health of the Earth. The most abundant component of the Earth’s biomass is ocean-sediment dwelling bacteria. In terms of numbers, the biggest contributor is ocean dwelling viruses. Microbes are the oldest living things on Earth. They were evolving for nearly three billion years before the emergence of the first visible organisms. It is the microbes that generated the Earth’s geochemical cycles and work today to maintain the oxygen in the atmosphere.

Despite their importance, microbes are second class citizens in biology’s hierarchy. We tend not to notice microbes unless they can help us, as in the process of fermentation, or hurt us, as with pathogenic species. This explains why many advances in microbiology are associated not with basic research but with industry or healthcare. The rest of the time microbes are easy to overlook; out of sight, out of mind. Recent progress in microbiology however, challenges us to overcome our bias against the invisible.

Traditionally, advances in microbiology depended on the ability to grow bacteria in culture. This meant that research was mostly confined to studies that used a limited number of species and only those species that could be successfully cultured. Today, techniques such as whole-genome shotgun sequencing enable researchers to investigate microbial diversity without the need to grow thousands of different species in the laboratory. A recent study by Craig Venter and coworkers sampled the waters of the Sargasso Sea (Venter et al. 2004). Even though this part of the Atlantic Ocean is nutrient poor, Venter’s group found abundant microbial life. Using whole-genome shotgun sequencing they sequenced DNA from at least 1800 different species, including 148 putative new species. They also sequenced over 1.2 million new genes. Such an approach holds great promise for exploring the largely unknown boundaries of microbial diversity.

The Human Genome Project spurred the development of high throughput DNA sequencing. To date, the complete genomes of over 200 microbes have been sequenced and hundreds more will become available in the near future. Analyses of these genomes are changing our concept of the tree of life and expanding our view of where life can be found. A phylogenetic tree based on molecular data reveals that plants and animals occupy but a couple of twigs on the branch labeled Eukarya (Nee 2004).

Microbial sequence data represent a treasure trove for researchers at universities and companies interested in a wide variety of applications to fields such as medicine, agriculture, evolution, biotechnology, and environmental science. This treasure is being mined using the tools of bioinformatics. Bioinformatics is leading a shift away from the reductionism that characterized molecular biology of the last century and toward a more holistic approach. Technologies such as DNA microarrays permit scientists to glimpse the dynamic nature of microbial genomes, examining the expression of thousands of genes at a time, as opposed to the traditional piecemeal approach.

Considering that biologists often slight the importance of microbes, it is not surprising that science teaching does so as well. High school biology classes convey very little of the revolution occurring in microbiology. The vast majority of high school textbooks treat microbes as they did a generation ago. Students continue to learn the anatomy of bacteria. They learn how bacterial cells differ from the cells of plants and animals. Little new information about their ubiquity, diverse metabolisms, and environmental impacts is included. At the same time, textbooks stress the diseases caused by a small minority of microbial species. In the context of biotechnology, bacteria are mentioned as useful for cloning genes but they are not discussed as subjects worthy of study in their own right. Students do not appreciate why governments, foundations, and biotechnology companies are investing huge sums of money to understand how microbes, including bacteria, viruses, fungi, protozoa, and microalgae, function or how they affect our health and environment.

Throughout the last 35 years, the molecular genetic perspective has helped to integrate many of biology's sub disciplines. This process began with the advent of recombinant-DNA technology and is now being propelled by genomics. According to the *National Science Education Standards*, molecular and evolutionary biology are among the "small number of general principles that can serve as the basis for [high school] teachers and students to develop further understanding of biology." A curriculum unit on microbiology also can help meet one of the goals set forth in *The Microbe Project: a Report from the Interagency Working Group on Microbial Genomics* (2001). Goal 3, outlined in the report, promotes public education to increase awareness of the power and importance of microbial biology in their lives.

2.0 The Frontiers in Microbiology Planning Meeting

The purpose of the planning meeting was to bring together microbiologists, science educators, and high school biology teachers to discuss developing a curriculum module dealing with advances in microbiology. Assuming that the participants agreed that such a unit was desirable, the aim was to

- establish which topics to include;
- establish the sequence of presentation;
- brainstorm potential student activities; and
- discuss the role of educational technology for the unit.

BSCS hosted the two-day meeting which was held at the Summerfield Suites hotel in Gaithersburg, MD during June 17 and 18, 2004. Attending the meeting were four microbiologists, three science educators, and six high school biology teachers (see Appendix 1, Participant List).

2.1 The Role of Replacement Units

After the welcome and introductions, the meeting began with a presentation by BSCS executive director Rodger Bybee and BSCS Science Educator Mark Bloom (see Appendix 2, Meeting Agenda). They reviewed the meeting agenda and outlined the objectives for the meeting. Dr. Bybee then discussed the role of replacement units in science education. He began by outlining the problem of an already too full curriculum. As the name suggests, replacement units are intended to replacement some portion of the curriculum already being taught. This is in contrast to supplemental units that are designed to be taught in addition to the extant curriculum. Perhaps not surprisingly, the teacher participants agreed that designing the microbiology unit as a replacement unit was the preferred option. Replacement units also offer the advantage of allowing teachers to “sample” a new teaching strategy such as inquiry based units without completely revamping their curriculum. Dr. Bybee commented that in order for replacements units to realize their potential, the following conditions must be met:

- Teachers must have access to quality replacement units.
- Teachers must have professional development to learn how to implement the units.
- Teachers must have opportunities to use the units and then reflect on their experiences.

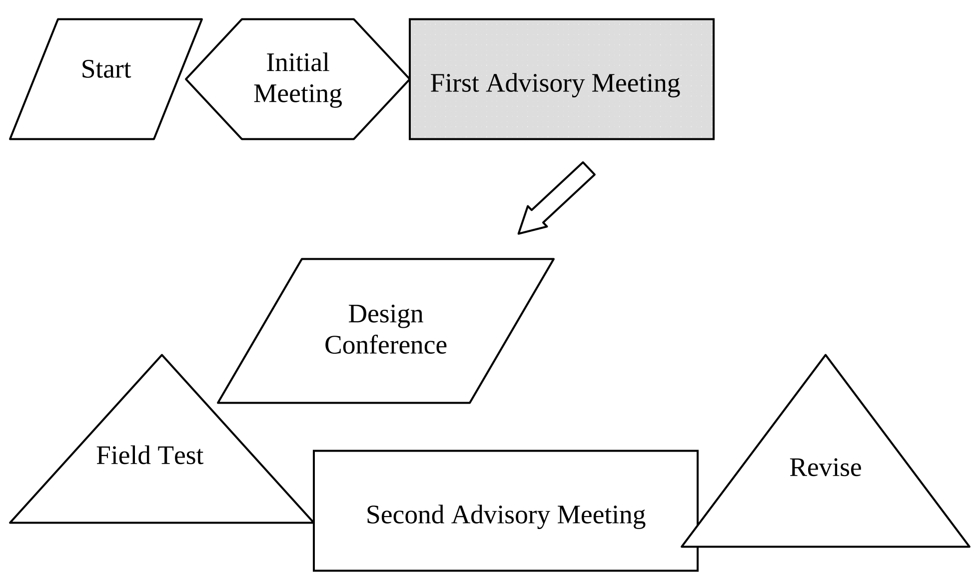
2.2 The BSCS Curriculum Development Process

Dr. Bloom then described the BSCS process for developing replacement units (see Figure 1). After an initial meeting with the funder to clarify the scope of the project, BSCS staff meets with an Advisory Committee. This group is composed of scientists having relevant expertise, teachers who instruct the target audience, and science educators from the BSCS staff. The objectives of the first advisory committee meeting are to:

- Establish content priorities
- Determine the conceptual flow for the unit
- Brainstorm student activities
- Discuss the role educational technology

The planning meeting discussed in this report is analogous to the first advisory committee meeting described above. As depicted in Figure 1, following the first advisory committee meeting, BSCS staff organizes a design conference. This second group also is composed of a mixture of scientists, teachers and BSCS staff. Typically, some participants will be members of both the advisory committee and the design team. This helps provide some continuity to the development process. The objective of the design conference is to review the outcomes of the first advisory committee meeting and use them to guide the development of detailed outlines of the student activities that will be developed for the unit. Members of the design team insure that BSCS curriculum developers will have access to needed resources such as data, images, and relevant research papers. Following the design conference, BSCS staff fully develops a field-test version of the unit.

Figure 1. The BSCS Curriculum Development Process



A group of teachers, separate from those serving on the Advisory Committee and Design Team, is recruited to field test the unit at various locations across the country. BSCS staff strives to achieve diversity among the field-test sites with respect to:

- rural, urban, and suburban settings;
- student ethnicity;
- teacher experience; and
- geography.

Formative evaluation data is collected from teachers and students who participated in the field test. This data is collected and analyzed by BSCS staff from our Research and Evaluation Center. At this point, BSCS staff organizes a second meeting of the Advisory Committee. At this meeting, BSCS staff presents the results of the field-test evaluation. The objective is to identify which parts of the unit worked and which parts did not. The committee makes recommendations for revising the unit. Using the recommendations of the Advisory Committee as a guide, BSCS staff revises the unit and prepare it to enter the production process.

2.3 The 5E Instructional Model

"If I hear, I forget.   If I see, I remember.   If I do, I understand."
Chinese proverb

Dr. Bybee described the 5E instructional model developed at BSCS and used over the past 20 years (Bybee 1997). The 5Es are Engage, Explore, Explain, Elaborate, and Evaluate. Dr. Bybee, presently the executive director of BSCS, and other BSCS staff conceived this model in the late 1980s as the pedagogical framework for BSCS's elementary school program, *Science for Life and Living*. Since that time, the BSCS staff has used that framework to develop four other full-year science programs: *Middle School Science & Technology* (an integrated science program for middle school science), *BSCS Biology: A Human Approach* (a program for high school biology), and *BSCS Science T.R.A.C.S.* (an elementary school program), and *BSCS Science: An Inquiry Approach* (an integrated science program for high school). In addition, the 5E instructional model has found broad acceptance nationwide as a model for constructivist teaching and learning across the disciplines. For example, three states (Alabama, Maryland, and Texas) support the use of the 5E instructional model in their state level curriculum guides. The model is used in science methods classes at the university level (Herron and Sheetz, 1999, 2000) and has remained a central feature of *Science for Life and Living* in its Australian adaptation, a project supported by the Australian Academy of Science. BSCS uses the 5E instructional model in the design of other curriculum modules under development for the National Institutes of Health.

2.4 Microbiology and Science Education

Joe McInerney gave a short presentation that described why microbiology is so important to science education. He listed some of the practical and conceptual aspects of the discipline that should be addressed in high school curricula (see Table 1).

Table 1. Important Practical and Conceptual Aspects of Microbiology

Practical	*Conceptual*
Public health	Evolution
Drug development	Systematics/taxonomy

Bioremediation	Biodiversity
Bioterrorism	Gene discovery
DNA sequencing technology	Cell structure and function
Comparative genomics	Ecological relationships
Industrial applications (including cheese, wine, and beer)	Gene expression and regulation
Environmental biology	

McInerney then presented selected state education standards that relate to teaching microbiology. The standards differed considerably from state to state. Although some states made little mention of microbiology specifically, their standards always include concepts about cells, genetics, cycles, and ecology that relate directly to the concepts listed in Table 1.

2.5 Recommendations from Meeting Participants

Need for a high school microbiology unit—Participants agreed that there was a need for a high school unit on microbiology. It was recognized that in most cases, biology teachers are struggling with curricula that are already too full. Increased requirements for testing students and adherence to state education standards also present challenges for teachers who would like to add new content to their biology courses. Keeping these challenges in mind, the participants recommended that a microbiology unit, tentatively titled *Frontiers in Microbiology*, be developed. This unit should contain no more than four weeks of instruction. A longer unit will be too difficult for teachers to implement. It should, to the extent possible, articulate with existing curricula and function as a replacement unit. It further was recommended that the unit be taught toward the end of the school year. This placement will allow the unit to serve as a review for concepts taught during the year. It also means that students will have an adequate background to participate in reasonably sophisticated student activities. Some teachers likely will choose to use the unit as part of a second year elective course in microbiology, genetics, molecular biology, or biotechnology.

Major themes of the unit—Dan Drell from the Department of Energy sat in for the meeting's initial discussion. He proposed five major themes that a high school unit on microbiology might address. After some discussion it was decided to merge two of his suggested themes. This would allow for one theme to be covered during each week of instruction. The four themes of the unit are:

1. Microbes and the Nature and History of Science
   Although the history of microbiology is relatively brief, it has important connections to virtually all of the major themes of biology as listed in the *National Science Education Standards* (NRC 1996). The invention of the microscope illustrates the nature of science and its relationship to technology. The discovery of cells, including bacteria led to the emergence of microbiology as a field of study. The roles played by microbes in the manufacture of beer, wine, and cheese are elucidated. The concept of infectious disease is developed. Historical examples of microbes' impacts on humans such as the black plague can be explored. Scientific themes and questions from the beginning of microbiology can be traced and be applied to problems of today.

2. Importance and Relevance of Microbes

Because microbes are invisible, most people, including teachers and students, tend to underestimate their importance. Beyond their connections to disease, microbes play critical roles in our environment. They are critical to global processes such as carbon and nutrient cycling, nitrogen fixation, and ocean chemistry. Furthermore, microbes provide the foundation for most food chains. Humans have use microbes for many purposes. For thousands of years microbes have been used in the production wine, beer, and cheese. Various forms of bacterial metabolism produce useful products such as acetone, ethanol, methane, and hydrogen. Biotechnology uses bacteria as vectors to transfer DNA from one species to another and as factories to produce bioengineered products. Microbes can degrade or reduce a wide variety of chemical compounds and are finding increasing applications to bioremediation. Microbes also present a number of societal and ethical issues as well. In the area of health care, misuse of antibiotics lead to the appearance of pathogenic bacteria that are multiply drug resistant. Bioengineered microbes may present problem if released into the environment or may used as agents of bioterrorism.

3. <u>Diversity, Evolution, and Plasticity of Microbes</u>
   Microbes are pervasive. There are an estimated one billion different species including at least one thousand that are pathogenic to humans. Microbes can survive in nearly every environment on Earth. They grow at temperatures from -3ºC to 121ºC, at pHs from less than 0.7 to greater than 12, at pressures of less than one atmosphere to over 230 atmospheres, and over a wide range of salt concentrations. An important characteristic of microbial evolution is horizontal gene transfer. This process allows pieces of DNA to be transferred between individuals of the same species and even to members of other species. These DNA fragments have been likened to genetic email and can make up nearly 25 percent of a microbe's genome. Horizontal gene transfer complicates our ability to use genomic sequence data to establish evolutionary links. Taxonomy as it related to microbes is ever-changing. As more microbial genomes are sequenced, comparative genomics is providing us with additional evolutionary insights. Microbes are everywhere, numerous, and have fast generations times. For these reasons microbes have been agents of change throughout the history of life on Earth.

4. <u>Genomics and Systems Biology</u>
   The sequencing of a microbial genome produces the "source code" for that organism's programming. Analysis of the genome sequence leads to that cell's "part's list." Using this data, scientists can now investigate how these parts function, are regulated, and interact to form biochemical pathways. The sum of the parts is greater than the whole. In the context of a cell, interactions between the parts lead to emergent properties that are not found among the parts themselves. Gene modified organisms are being used to investigate the minimum number of genes necessary for a free-living cell to survive. As more eukaryotic genomes are sequenced, it becomes possible to use a more holistic approach when investigating how microbes interact with larger organisms.

Potential student activities—Participants provided brief descriptions for a number of potential student activities. The question of using educational technology was discussed. It was argued that since much of the current research in microbiology makes use of bioinformatics, some type of technology should be part of the unit. The consensus was that Web-based activities made the most sense. Using the Web is becoming increasing common at high schools. Web activities can be similar to those created for DVD but they offer several advantages:

- Anyone with Internet access can use the materials
- Web activities can be updated easily.
- Web activities can make use of existing dynamic databases.
- Web activities can link to other sites that provide additional information.

This section contains brief descriptions of potential student activities. It will be the task of the participants at a future design conference to develop the actual activities. The descriptions provided here are meant to jumpstart that effort. Regardless of which ideas are developed into activities, they will be inquiry based and use the 5E instructional model.

Participants suggested the following student activities:

What If… ?

Students address questions such as:

"What would the world be like without microbes?"
"What would happen if all the Earths' microbes suddenly died?
"What if the number of microbes on Earth suddenly doubled?"

These questions are designed to elicit students' prior knowledge about the topic. The questions may be addressed again at the unit's conclusion. Teachers can see how students' understanding changed as a result of participating in the unit's activities.

Microbiology's Greatest Hits

Students encounter an important question from microbiology and trace its answer from mythical understanding, to a simple model, to an evidence-based explanation. Such questions may be posed through readings, such as from the *Microbe Hunters*, or by computer simulations.

Biodiversity? Deal Me In!

Each student selects a card from a deck of "critter cards." Each card contains data regarding a single species. The organisms on the cards are selected so that they represent a suitable cross section of the different types of organisms we want to address. Another requirement is that the complete genome for the organism be available. Information on each card may include:

- Micrograph of the organism
- Scientific name
- Size of genome
- Description of the environment it inhabits
- Connections, if any, to humans (may include disease, symbiosis, or biotechnology)

Students must access research about their organism and write a report or construct a poster about their findings. The organism on each card will be paired with another that it has an important relationship with in nature. Students share their findings with their classmates and based on this information attempt to find their "microbiology partner."

Building Trees

Students form small groups and investigate how to use bioinformatics tools to construct phylogenetic trees. To construct their tree, each group uses sequence data from the organisms on their "critter cards" (see above activity). Trees are constructed by comparing sequence data from the same gene across organisms. Students also investigate how their tree changes when they use a different gene for comparison.

If You Can't Stand the Heat …
This activity is designed to stress the importance of proteins in general and their adaptation to extreme environments in some microbes. Students first investigate the stability of a bacterial DNase enzyme and contrast it to the much more resilient RNase from the same species. They then examine the amino acid sequence and three-dimensional structures of DNA polymerases from *E. coli* and *T. aquaticus.* Students make predictions regarding the reasons for the heat stability exhibited by the *Taq* polymerase and test them using bioinformatics analysis.

How Small Can You Get?
Students explore the minimum number of genes required for life. They compare the genome from several bacterial species that span a range from free living to obligate parasite. To make the task easier, students manipulate suites of genes that relate to different functions. They discover that bacteria that live as obligate parasites can get by with smaller genomes because some essential gene products are provided by their host.

The Evolution of Bioethics
Students investigate an historic series of experiments such Jenner's on smallpox and vaccination. Students use a role playing scenario to debate the ethical issues regarding these experiments in the context of a modern Institutional Review Board. They vote whether or not to allow the experiments to proceed. Only after the vote do students learn the historical nature of the experiments. They compare and contrast bioethics of the past and present.

Teacher background material—Participants agreed that teachers using the unit would benefit from being provided with additional background material that relates to the student activities. This information would be intended for their professional development and should not be used as the basis for lecture notes. Topics that will be considered for this section include:

- Origin of life on Earth and terra forming
- Microbes and the history and nature of science
- Taxonomy and the concept of three domains
- Microbes in extreme environments
- Microbe communities and biofilms
- Microbes and geochemical cycles
- Microbial genomes
    - Plasticity
    - Metagenomics
    - Plasmids
    - Horizontal gene transfer
- Genome sequencing and bioinformatics
- Emerging and re-emerging diseases
- Bacteria and antibiotic resistance

- Microbes and bioterrorism
- Microbes and ELSI issues

3.0 Recommendations from BSCS Based on Meeting Outcomes

Taking into account the outcomes of the planning meeting for the *Frontiers in Microbiology* curriculum unit, the staff of BSCS concluded the following:

- BSCS should seek funding to develop the *Frontiers in Microbiology* curriculum unit.
- The unit should be directed to a high school audience (grades 10-12)
- The unit should be able to function as a replacement unit in an introductory biology course.
- The unit should be able to function as a review at the end of the school year.
- The unit should be able to be incorporated into a second year elective course in biology.
- The unit should provide for approximately four weeks of instruction.
- The unit should feature inquiry-oriented student activities.
- Some activities should be Web-based.
- The unit will be developed using the BSCS development process
- The unit will require about two years for completion of the development and production processes.
- The unit will cost approximately $600,000 over the two year period.

4.0 BSCS Web Proposal

BSCS staff used the remainder of the term of the grant to raise funds to develop the *Frontiers in Microbiology* curriculum unit. Unfortunately these efforts met with limited success. Since there were some unexpended funds left over from the planning meeting, BSCS requested and received a no-cost extension to the grant from DOE. This additional time was used to prepare teacher background materials about advances in microbiology. These materials were developed and placed on the BSCS Web site in 2006. The material can be accessed from the http://www.bscs.org:

- Click on the Center for Curriculum Development
- On the left side of the screen, mouse over the label, "Center for Curriculum Development"
- A menu appears, select "High School 9-12"
- On the next menu, select "Other Supplemental Programs"
- On the last menu, select "Frontiers in Microbiology"

4.1 *Frontiers in Microbiology* Web Content

The *Frontiers in Microbiology* portion of the BSCS Web site includes

- a brief introduction;
- a microbiology content update. This content is functionally equivalent to the teacher background section needed for the proposed curriculum unit; and
- a microbiology resources list.

More complete descriptions of these elements follow.

4.2 Introduction

The introduction contrasts the current state of microbiology education in high school classrooms with discoveries being made by researchers. The argument is made that although microbiology is an exciting fast moving area of biology, it is not being communicated to high school students. Discoveries in the field are impacting many areas of society including healthcare, food production, and bioremediation. It seems likely that in the future, microbiology will be of increasing relevance to students' lives.

4.3 *Frontiers in Microbiology* Teacher Background

This section represents teacher background material that would be incorporated into the proposed unit. This information is intended for teachers' professional development and is not intended to be used as the basis for class lectures. The content includes the following sections

- Microbes and the Origin of Life
- Microbes and Extreme Environments
- Microbes and the Three Domains
- Microbe Communities
- Microbes' Influence on Earth
- Microbial Genomics
- Microbes and Humans
- Microbiology Education

4.4 Microbiology References and Resources

This section lists references that articulate with the teacher background material. A link is provided to The Waksman Foundation for Microbiology (a long-time supporter of BSCS teacher workshops). They have developed a series of hands-on microbiology activities for the K-12 classroom. The activities are indexed by grade level and are linked to the National Science Education Standards.

4.5 *Frontiers in Microbiology* Web Statistics

Frontiers in Microbiology debuted on the BSCS website in April 2006, following a feature announcement on the cover of the March 2006 BSCS eLetter. In that month, the introduction page was the 5th most visited page on the BSCS website, with 2,110 visitors. The Frontiers section remained in the top 20 most-visited pages from April through July.

Website visitors to the *Frontiers in Microbiology* section were tracked using two statistics programs – Infront WebWorks from April 2006 through Feb 2007, and Google Analytics from March 2007 through 15 May 2009. From April 2006 through Feb 2007, the Frontiers web section recorded 13,447 visitors, averaging 1,222 per month. With the transition from Infront WebWorks to Google Analytics, tracking switched from the number of visitors to the number of unique pageviews. From March 2007 through 15 May 2009, Google Analytics recorded 8,785 pageviews to the Frontiers section.

5.0 References

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Appendix 1
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June 16 – 18, 2004

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Appendix 2
AGENDA
Planning Meeting
Frontiers in Microbiology
June 16-18

Wednesday, June 16

7:00 pm	Group dinner at Timpano's restaurant

Thursday, June 17

9:00 am — Rodger Bybee, Executive Director, BSCS
- Welcome and introductions of participants
- Introduction to the meeting

9:15 am — Mark Bloom, Science Educator, BSCS
- Review of agenda
- Meeting objectives
- Future development of proposed curriculum unit

9:30 am — Rodger Bybee and Mark Bloom
- Science education and the role of replacement units
- The BSCS development process
- The 5E instructional model

10:00 am — Joe McInerney, Executive Director, The National Coalition for Health Professional Education in Genetics
- Microbiology in Biology Education

10:45 am — Break

11:00 pm — Group discussion
- What are the major scientific topics to include?
- What is the conceptual flow for the unit

12:00 noon — Lunch

1:00 pm — Continue group discussion

1:45 pm — Travel to The Institute for Genomic Research (TIGR)

2:00 pm — Tour of TIGR

3:00 pm — Break

3:30 pm — Claire Fraser, President and Director, TIGR
- "An Uncertain Call To Arms"

4:15 pm — Adjourn

Friday, June 18

9:00 am	Overview of the day
9:15 am	Group discussion • Potential student activities • Role of educational technology
10:30 am	Break
11:00 am	Continue group discussion • Support materials for teachers • Professional development for unit • Dissemination of unit
12:00 noon	Lunch
1:00 pm	Adourn