Investigations into the Microbial World: Introducing Middle School Students to Concepts in Microbial Ecology. A GK-12 Experience.

Carl L. Rosier[a], Melodee Burreson[b], Jann Clouse[b], Carol Brewer[c], and Matthias C. Rillig[ad].

[a]Microbial Ecology Program, Division of Biological Sciences, The University of Montana

[b]Target Range School, Missoula County Public Schools

[c]Organismal Biology and Ecology, Division of Biological Sciences, The University of Montana

[d]Institut fuer Biologie Freie Universitat Berlin, Berlin, Germany

Introduction

•Typical middle school students maintain the misconception that microorganisms are agents of disease (Blair and Bowen 1996; Simonneaux 2000; Byrne 2003).

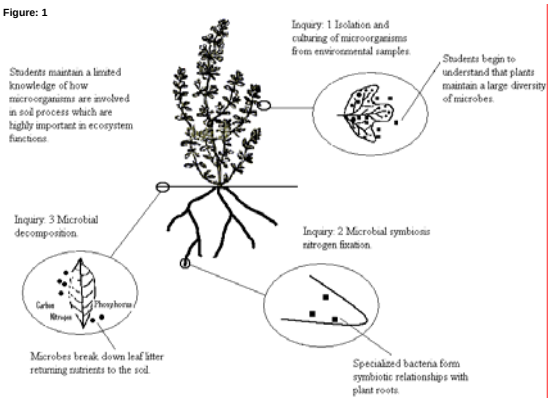
•What most students do not understand, is that while microbes are agents of infection and illness, microorganisms also provide a wide assortment of products and services that are useful to both humans and ecosystem functions.

•Many microbial processes are ideal for student investigations (Wise 2005).

•The purpose of this project was to develop three investigations (Figure: 1), that will aid middle school students (6th-9th) in gaining a greater understanding of the positive aspects of microorganisms.

•These inquires are designed as easy to do investigations with limited expense and address the National Science Education Standards.

Figure: 1



Investigation 1; where do microorganisms live?

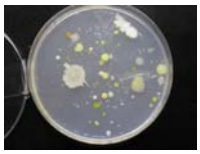
***1. Content standard A*: Abilities necessary to do scientific inquiry, Understanding scientific inquiry**

***2. Content standard C:* Diversity and adaptations of organisms**

Most middle school students have a limited idea of where microorganisms grow or what a colony of bacteria may look like (Blair and Bowen 1996; Simonneaux 2000; Wagner and Stewart 2000).

This inquiry is designed to have students make predictions about habitats that support high and low microbial diversity. The students then test their predictions by exploring and sampling familiar habitats in their school and schoolyard.

Instructor Jann Clouse discusses possible sampling areas with students.



Student isolated sample from investigation 1

Investigation: 2 Do microorganisms help plants grow?

***1. Content standard A*: 1) Abilities necessary to do scientific inquiry, 2) Understanding scientific inquiry**

***2. Content standard C:* 1) Structure and function in living systems, *2)* Diversity and adaptations of organisms**

***3. Content standard E:* Understanding about science and technology**

Most middle school students will have limited knowledge of symbiotic relationships (Weber 1995).

This inquiry builds on the knowledge from the first inquiry that microorganisms are everywhere and introduces students to *Rhizobium/* legume symbiosis.

Students explore symbioses by observing *Rhizobium* nodule formation on legumes. Students will determine if commercial *Rhizobium* inoculants are more successful at root colonization than non-treated garden soil.

Student prepares soil Sample for investigation 2

Investigation: 3 Do microorganisms recycle?

***1. Content standard A*: Understanding scientific inquiry**

***2. Content standard B*: Properties and changes of properties in matter**

***3. Content standard C:* Structure and function in living systems**

Middle school students will not have considered the importance of microorganisms in decomposition (Byrne 2003).

Typically microorganisms are considered spoilers of food rather than ecosystem recyclers. In addition most students will have the misconception that when an organic compound decays it disappears (Leach et al. 1992; Hogan and Fisherkeller, 1996; Grotzer and Basca 2003).

The goal of this inquiry is to introduce students to the concept that microorganisms are responsible for breaking material down into its simplest components.

Several students add organic material to aerobic digesters

Instructor Mel Burresson observes student findings at conclusion of microbial recycling investigation

Conclusion

•Through this series of experiments students learn that microorganisms are instrumental in several life processes.

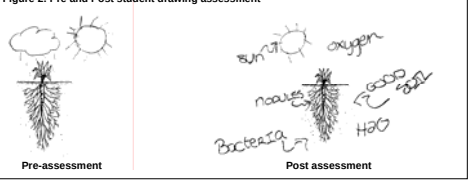
•In order to determine the effectiveness of these inquires in changing students' misconceptions about microorganisms: students were asked to either draw or use words to describe what factors (above and below ground) they thought were important for plant growth and survival (Figure 2).

•in 52% of the post assessment drawings students indicated that microorganisms were important in plant growth/survival.

•An additional post assessment was conducted in order to determine what specific lessons the students learned through out the academic year.

•Results from this assessment suggest that students have attained a greater understanding of the presence and importance of microorganisms.

Figure 2: Pre and Post student drawing assessment



Pre-assessment **Post assessment**

Literature Cited

Blair, B., and Bowen, W., 1996. American Biology Teacher 58 (7): 418-419

Byrne, J. 2003. www1.phys.uu.nl/esera2003/programme/pdf%5C018S.pdf

Grotzer, T. A., and Basca, B. B., 2003. Journal of Biological Education 38 (1): 16-29.

Hogan, K., and Fisherkeller, J., 1996. Journal of Research in Science Teaching 33 (9): 941-970

Leach, J., Konicek, R., and Shapiro, B.1992. Paper presented at the Annual Meeting of the American Educational Research Association. Simonneaux, L. 2000. International Journal of Science Education 22 (6): 619-644.

Wagner, S.C, and Stewart, R. R., 2000. The American Biology Teacher 62 (8): 588-592.

Weber, E.C., 1995. 50th Annual Meeting of the Soil and Water Conservation Society, Des Moines, IA (USA), 6-9 Aug.

Wise, E.S. 2005. Montessori life 17 (1): 38-40.

Acknowledgments

•C.L.R. M.B. J.C. and C.A.B. were supported by the University of Montana ECOS program with funding from NSF GK-12 grant to C.A. Brewer.
•M.C.R. acknowledges funding for this research from the National Science Foundation (DEB).
•We also thank Gabby and Gavin Rosier for their help and expertise in developing several of our investigations.