Amoebas & Temperature *Lesson Plan*

Students learn about a disease-causing organism that likes warm water.

Florida's Temperature and Its Effects on Amoebas

Lesson Summary: This lesson will expose students to some of the problems amoebas have caused to residents of Florida. Studies have shown that virulent strains of amoebas from the genera *Naegleria* and *Acanthamoeba* have the ability to grow at high temperatures, while non-virulent strains are unable to grow at normal or elevated body temperatures (Griffin, 1978).

Grade Level: Middle and High School Students (Grades 6–10)

Time Allotted: Three 50-minute class periods

Performance Objectives

References are to the Next Generation Sunshine State Standards (2007).

Science

SC.6.L.15.1	Students will be able to analyze and describe how and why organisms are classified according to shared characteristics with emphasis on the Linnaean system combined with the concept of Domains.
SC.912.L.15.6	Students will be able to discuss distinguishing characteristics of the domains and kingdoms of living things.

Language Arts

LA.910.4.2.2	Students will be able to record information and ideas from primary and/or secondary sources accurately and coherently, noting the validity and reliability of these sources and attributing sources of information.
LA. 910.2.2.3	Students will be able to organize information to show understanding or relationships among facts, ideas, and events (e.g., representing key points within text through charting, mapping, paraphrasing, summarizing, comparing, contrasting, or outlining).

Prior Knowledge

It is expected that students have prior knowledge of Linnaean classification system.

Activity 1a: To activate prior knowledge of Linnaeus's classification system, teachers can explain to students that the ability to classify things is a basic skill for scientists to learn. To get students to practice classification, teachers may assign the activity below:

Write the following on the board and then ask students to develop a hierarchical classification system.

- Hair clip
- Bobby pin
- Safety pin
- Rubber band
- Button
- Zipper
- Paper clip
- Screw
- Binder clip
- Nail

Note to Teachers:

1. Students might identify all the items as fasteners. They might further group nail and screw as fasteners for boards and hair clips, rubber bands and bobby pins as fasteners of hair. Please allow students to share their systems with the class.
2. To review or expand on why we classify living things, review Johnson and Raven, Holt, Florida Biology, listed in the reference section.

Activity 1b: To activate prior knowledge of the six kingdoms of life, teachers can show students pictures of a variety of familiar plants and animals. While showing students these organisms, teachers can ask students to identify the kingdom to which each organism belongs. As students become comfortable with this portion of the activity, teachers can then mix in images of fungi, bacteria, and various protists, including amoebas and paramecia. To get students to name the six kingdoms of life as they are currently identified, teachers can allow students to analyze the table below:

Table 1: Three domains and six kingdoms of classification

Domain	Kingdom	Characteristics				
		Cell type	Cell structure, material	Body type	Nutrition type	Examples
Bacteria	Eubacteria	Prokaryotic	Cell wall, peptidoglycan	Unicellular	Autotrophic and heterotrophic	Enterobacteria Spirochetes
Archaea	Archae-bacteria	Prokaryotic	Cell wall, no peptidoglycan	Unicellular	Autotrophic and heterotrophic	Methanogens
Eukarya	Protista	Eukaryotic	Mixed	Unicellular and multicellular	Autotrophic and heterotrophic	Amoebas Euglenas Kelps
Eukarya	Fungi	Eukaryotic	Cell wall, chitin	Unicellular and multicellualr	Heterotrophic	Yeasts Mushrooms
Eukarya	Plantae	Eukaryotic	Cell wall, cellulose	Multicellular	Autotrophic	Ferns Pine trees
Eukarya	Animalia	Eukaryotic	No cell wall	Multicellular	Heterotrophic	Birds Earthworms

Note: Taxonomic groups of organisms by G. Johnson and P. Raven, 2006, Holt, Rinehart and Winston, p. 417.

Analyzing the Data:

1. Which kingdom has cells that lack cell walls?
2. Which domain contains mixed cell structures? What does that mean?
3. How are the members of the domain Archaea similar to those of the domain Bacteria? Different?
4. How are the members of the domain Archaea similar to those in the domain Eukarya? Different?

Activity 1c: Questions for Further Class Discussion:

1. What characteristics qualify an organism as living or non-living?

2. How does the size of a living organism relate to its physical and behavioral characteristics?
3. What is a microbe?
4. How can microbes be harmful?
5. How can microbes be helpful?

Teacher's Role:
Upon answering the above questions, teachers should conduct a round table discussion activity to clarify any misconceptions or questions that were generated from the above questions.

Topic Overview

In this lesson, students will learn about problems that are associated with unicellular organisms such as the amoeba. Amoebas are members of the phylum Sarcodina, whose members are also called sarcodines. They are animal-like protists that use pseudopods for feeding and locomotion. Some of the most commonly studied sarcodines are found in the genus *Amoeba*, but there are other genera whose members also are referred to as "amoebas".

As the debate over global warming intensifies, climatologists have identified upward trends in global temperatures and now estimate an unprecedented rise of 2.0°C (or more) by the year 2100. Of major concern is that these changes can affect the introduction and dissemination of many serious infectious diseases (Patz et al., 1996).

The medical, as well as ecological, importance of amoebas is well known and some are known to cause illness and death in humans. For example, the free-living amoeba flagellate *Naegleria fowleri* is the causative agent of primary amoebic meningoencephalitis (PAM), a rapidly fatal disease of the central nervous system. In the United States, the disease generally is acquired while swimming and diving in freshwater lakes and ponds (Marciano-Cabral, et al., 2003). In addition, exposure to *Naegleria fowleri* and the associated disease can occur by total submersion in hot tubs, thermally enriched waters and poorly chlorinated swimming pools.

Other species are more or less benign co-residents in the digestive systems of humans and other animals. Some are known to cause problems, such as attacking the conjunctiva of our eyes. In marine ecosystems, *Radiolaria* and *Foraminifera* are significant members of communities, both as consumers and as producers. So-called "Naked amoebas" (as opposed to testate amoebas, which have simple shells) are major consumers of bacteria in soil ecosystems and are believed to occupy the same key roles that flagellates do in aquatic ecosystems (those of recycling bacterial productivity and ensuring nutrient regeneration and continued functioning of the ecosystem).

Key Vocabulary

Contaminate
To make impure (not pure) by contact or addition of something; to pollute or soil

Microbes
Microscopic organisms such as algae, animals, viruses, bacteria, fungi, and protozoa, some of which can cause disease

Naegleria fowleri
A free-living amoeba commonly found in the environment in water and soil

Primary Amoebic Meningoencephalitis (PAM)
very rare disease characterized by inflammation of the brain that is caused by exposure to the microorganism *Naegleria fowleri*

Materials

- Computer with internet access

References

The following documents are available in the Orange County Water Atlas Digital Library:

A Beginner's Guide to Water Management — Bacteria. Information Circular #106. 2003. Gainesville, FL: Florida LAKEWATCH.

Health Alert: Naegleria (Poster). 2008. Orange County Health Department. (Spanish version)

Musil, Robert K., et al. 2001. Death By Degrees: The Health Threats of Climate Change in Florida. Physicians for Social Responsibility.

Primary Amebic Meningoencephalitis --- Arizona, Florida, and Texas, 2007. Source: Centers for Disease Control and Prevention.

Raffel, T. R., Rohr, J. R., Paull, S.H., & Johnson, P.T.J. 2010. Toward a General Theory for How Climate Change Will Affect Infectious Disease. *Bulletin of the Ecological Society of America: Reports,* Oct. 2010 pp. 467-473.*

Other references:

Amoebas Public Service Announcement (video). 2009. Orange County Health Department.

Johnson, G., & Raven, P. (2006). Holt Biology. Orlando: Holt, Rinehart and Winston.

Marciano-Cabral, F., MacLean, R., Mensah, A., and LaPat-Polasko, L. (2003). Identification of *Naegleria fowleri* in Domestic Water Sources by Nested PCR. *Applied and Environmental Microbiology*, 69(10), p. 5864–5869.

Patz, J. A., Epstein, P. R., Burke, T. A. & Balbus, J. M. (1996). Global climate change and emerging infectious diseases. Journal of American Medical Association. (275) 217-223.

Schustera, F. L., and Visvesvarab, G. S. (2004). Free-living amoebae as opportunistic and non-opportunistic pathogens of humans and animals. *International Journal for Parasitology*, 34 pp. 1001–1027.

Procedure

Engage/Elicit

Students should read the article "Deadly Amoeba Lurks in Florida Lakes" and answer the questions following it. (Additional articles may be found by searching for "Naegleria Fowleri" in the online archives of the *Orlando Sentinel* newspaper: http://articles.orlandosentinel.com/keyword/naegleria-fowleri)

Explore

Have students read the following document, published by the Centers for Disease Control; it may be found in the Digital Library of the Orange County Water Atlas:

Primary Amebic Meningoencephalitis-Arizona, Florida, and Texas, 2007

After reading the document, answer these questions:

1. What are some of the noticeable trends from the case reports?
2. Prior to the 1950s, not many cases of PAM were reported. What may be some of the reasons for the apparent scarcity of cases?
3. In the document there is a chart showing the number of cases of PAM each year. Review it and identify the years when PAM infection was highest. What might account for the jump in reports of PAM in those years?
4. Preliminary results of the review of PAM cases in the United States during 1937-2007 by the CDC/CSTE Naegleria Workgroup indicates that PAM is a rare disease that primarily affects young male users of warm recreational freshwaters. What are some possible reasons for this?

Explain

1. What are some of the different measures taken by public health officials from many of the different agencies across the State of Florida to eliminate or reduce dangerous microbes from our water supply (both drinking and recreational)?
2. Is the incidence of *Naegleria fowleri* infection on the rise? How do you know?
3. What is the relationship between the rate of *Naegleria fowleri* infection and increases in Earth's temperatures? How do you know?
4. If climate change causes temperatures in Florida increase, what other disease-causing organisms might become more prevalent? Which of these are already present, but might increase their range? Which are now rare or absent?

Extend

1. Use the link below to draw students' attention to some of the problems of Naegleria Fowleri in Orange County waters: http://articles.orlandosentinel.com/keyword/naegleria-fowleri
2. Ask students to define the physical and biological characteristics that are important to consider when investigating amoeba (*Naegleria fowleri*). Information should include but not be limited to their kingdom, life cycle, morphology, nutritional mode and ecology.

3. Use the features on water atlas website to view temperature graphs of different bodies of water throughout Orange County. To do this:
    a. Choose "Download Data & Graphing" from the **Data & Mapping** dropdown menu bar of the Orange County Water Atlas.
    b. In Step 1, choose "Surface Water Quality"
    c. In Step 2, choose "Water Atlas" for **By Location**, "Water Body Type" for **By Site Info**, and "Parameter" for **By Sample Info**. Click **Submit**.
    d. In Step 3, check "Lake" under Water Body Type, and "Temperature, Water" under Parameter. Click **Submit**.
    e. In Step 4, choose 3 or 4 different monitoring stations for lakes that have a large number of samples over a long time span. Click **Give Me Selected Station Data**.
    f. Graph the Data. Choose the **Display Trendline** and **Add Benchmarks: Median** options. What are the similarities and differences in trends for the different lakes/stations? What might account for them? Do you see any anomalies in the data?
4. What measures of lake quality might vary directly/inversely with temperature? Why do you think so? Use the advanced graphing feature and experiment with graphing temperature and one other parameter (dissolved oxygen or total nitrogen, for example) for several different Orange County lakes to test your theory.

Exchange/Evaluate

1. Have students report their findings from the extended activity with the entire class.
2. Teacher should address new questions generated from the above activity using a whole class discussion format.

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