Use of Algae to Determine Water Quality

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Goal:

To Observe and identify certain types of algae associated with water pollution.

To learn the problems caused by an abundance of a particular type of alga.

To learn how the algal genus pollution index is used to determine the level of organic pollution in a water sample.

Materials

Prepared slides of the following genera of algae:

Anabaena	*Batrachospermum*	*Closterium*
Euglena	Mixed diatoms	*Navicula*
Oscillatoria	*Pandorina*	*Rivularia*
Scenedesmus	*Spirogyra*	*Staurastrum*
Stigeoclonium	*Volvox*	

Procedure

1. Observe each type of algae with the compound microscope. Make the observations with the power of magnification listed beside the description of the algae. Some types of algae must be observed under high power, while others require only low power magnification.

Some of the algae have been stained to show the detail of the algal cells. The colors seen under the microscope are not the natural color of the cells.

2. Sketch the shape of one of the alga cells. DO NOT try to sketch all of the cells in the field of vision. If the alga forms filaments or colonies, sketch the shape of one strand or group of alga cells. Show any detail that would help identify the cell type.

3. Read the background information given on each type of alga and answer the questions in the analysis section.

Background Information

Volvox. [low power]
Volvox forms a sphere of 500 or more cells, which can be seen without using a microscope. The cells have two flagella that move the colony through the water. *Volvox* reproduces by forming daughter colonies that can be seen as darker spheres within the colony. An excess of nitrogen encourages the growth of *Volvox* and may cause "blooms" during the summer months. During blooms in the shallow ponds at fish hatcheries, the large numbers of *Volvox* cause damage to the gills of young fish. When present in large numbers *Volvox* gives water a fishy odor.

Staurastrum [low power]
The spike-like projections on the cells increase the surface area and improve the algae's ability to float.

Blooms of *Staurastrum* have created odor problems in the drinking water supplies of several cities. The odor is described as grassy.

Navicula: [high power]
Navicula is a member of the group of algae called diatoms. The hard cell walls of diatoms do not decompose when the cells die. The remaining skeletons of the cells create problems when they clog the filters at water treatment plants. Their cigar or boat shape can easily identify *Navicula*. Clean water has relatively low populations of many different species of diatoms. As water becomes polluted, the variety of diatoms decreases, but the population of pollution tolerant types increases.

***Anabaena*: [high power]**
Anabaena is capable of causing odor problems even when its population is very small. When present in larger numbers the odor may resemble that found in a pigpen. The odor is thought to be due to the death and decay of some of the alga cells. The filaments of *Anabaena* appear as chains of tiny grapes. *Anabaena* is a blue-green alga that can fix its own nitrogen. Because of its nitrogen-fixing ability, it does not need water that is polluted with high levels of nitrates or organic matter. *Anabaena* produces a chemical that is toxic to many species of animals. Blooms of *Anabaena* have been associated with skin rashes in humans. Blooms of blue-green algae have also caused the death of livestock drinking the water and have caused fish kills.

***Pandorina*: [high power]**
Pandorina occurs in groups of 8, 16, or 32 cells. The cells have two flagella that roll the colony of cells through the water. When present in large numbers this alga gives the water a "fishy" odor.

Mixed Diatoms: [low power]
These tiny boxes of various shapes are the cell walls of diatoms. Diatoms prefer cold water and are more abundant during the spring and fall. It is during these months that they create headaches for the operators of water treatment plants. The diatoms are killed by chlorine, which is added to the water as it enters the treatment plant. The silica boxes do not break down and must be filtered out of the water. Diatoms are the major cause of clogged filters at water treatment plants.

***Closterium*:** [low power]
Large populations of *Closterium* may develop within a few weeks creating a bloom in lakes in the southern states. It creates filter-clogging problems.

Spirogyra: [low power]
Normally green in color, the chloroplast of *Spirogyra* is twisted like a spiral staircase. Mats of *Spirogyra* filaments float just beneath the surface of the water. A bloom causes a grassy odor and clogs filters at water treatment plants.

Rivularia: [low power]
The slimy covering on rocks or submerged aquatic plants may be colonies of *Rivularia.* When the filaments break off of the attached colony, they clog filters at water treatment plants.

Stigeoclonium [low power
Although small populations of this alga can be found attached to rocks in clean streams, it is abundant in water with high levels of organic matter. It is the most common type of algae found on trickling filters at sewage treatment plants, and is responsible for cleaning the water by removing nutrients.

***Batrachospermum*:** [low power]
This alga is found in shaded areas of reservoirs that contain soft water. *Batrachospermum* will not live in

water that is constantly exposed to the sun. It lives only in cold water that has low levels of organic materials. Thus it is an indicator of "clean water." It creates a problem when large growths in irrigation canals slow the flow of water.

Euglena: [high power]
Many authorities consider *Euglena* as the most tolerant genus of organic pollution. It is commonly found in farm ponds, lagoons where sewage is treated, and other bodies of water with high levels of nitrogen. Sometimes a red pigment hides the chlorophyll. In 1997, a section of the Laguna Madre of Tamaulipas was blood-red with a bloom of *Euglena.*

***Oscillatoria*:** [low power]
The name of this alga refers to the movement that is characteristic of living filaments. Filaments slowly oscillate or glide back and forth in the water. *Oscillatoria* is considered to be the group of alga that is the second most tolerant of organic pollution. It is commonly found with Euglena in lagoons and other water with high levels of nitrogen.

Scenedesmus. [high power]
This group of algae is the most widely distributed of all freshwater alga. It can live in water with low levels of pollution or in lagoons used for sewage treatment or industrial waste. The cells in a colony of *Scenedesmus* are always parallel to each other. There may be one or two rows of cells.

The Pollution Index (Palmer 1969)

Scientists developed a method to determine the level of organic pollution by studying the algae present in a sample of water. A pollution index factor of 1 through 5 has been assigned to each of the 20 types of algae that are most tolerant to organic pollution. Types of algae most tolerant of organic pollution were assigned a factor of 5. Less tolerant types were assigned a lower number.

Algal Genus Pollution Index (Palmer 1969)

Genus	Index	Genus	Index
Anacystis	1	*Micractinium*	1
Ankistrodesmus	2	*Navicula*	3
Chlamydomonas	4	*Nitzschia*	3
Chlorella	3	*Oscillatoria*	5
Closterium	1	*Pandorina*	1
Cyclotella	1	*Phacus*	2
Euglena	5	*Phormidium*	1
Gomphonema	1	*Scenedesmus*	4
Lepocinclis	1	*Stigeoclonium*	2
Melosira	1	*Syndra*	2

If there are 5 or more cells of a particular kind of algae on a slide, the alga must be identified and recorded. The index numbers of the algae are then added. Any algae that are not listed have a pollution factor of zero.

If the pollution index score is 20 or more, the score is evidence of high organic pollution. A score of 15-19 indicates probable organic pollution. Lower scores usually indicate less organic pollution, but they may also occur if something is interfering with algae growth.

Toxic chemicals, such as chlorine, will kill algae growing in water with high levels of organic pollution.

If "clean water" types of algae are absent, a low pollution index score may not be accurate.

Analysis

Draw the required sketch to the left of the questions.

Volvox.

1. If you found an abundance of *Volvox* in a water sample, what would this tell you about the water quality?

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2. What two problems might this abundance cause?

Staurastrum:

3. What problem does this alga sometimes cause?

Navicula:

4. What problem is caused by an abundance of this type of diatom?

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5. What characteristic of diatoms causes this problem?

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6. Would you expect to find a great variety of diatoms in polluted water? Explain.

Anabaena*:*

7. Give two problems caused by Anabaena.

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8. If an alga bloom is caused by Anabaena is this evidence that the water is polluted with organic waste? Explain.

***Pandorina**:*

9. What problem is caused by this type of algae?

Mixed diatoms:

10. What is the major problem caused by diatoms?

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11. Do you think that diatoms are a bigger problem for water treatment plants in the northern states or the southern states? Explain why.

***Closterium**:*

12. What is the major problem caused by blooms of *Closterium?*

Spirogyra:

13. How can *Spirogyra* be easily identified?

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14. Give two problems caused by blooms of *Spirogyra.*

Rivularia:

15. Which would you most likely find in a swift stream --- *Spirogyra* or *Rivularia?* Why?

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16. What problem caused by *Spirogyra* is also caused by *Rivularia ?*

***Stigeocionium**:*

17. What does an abundance of this alga tell us about the quality of the water?

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18. In what way is this alga useful?

***Batrachospermum**:*

19. List the characteristics of water in which you would find this alga growing.

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20. What problem does this alga cause?

***Euglena**:*

21. What would an abundance of this type of alga indicate about the quality of the water?

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22. At first, a bloom of this alga might not be recognized as an alga bloom. Why?

Oscillatoria:

23. What would an abundance of this type of alga indicate about the quality of the water?

***Scenedesmus**:*

24. Is this alga a good indicator of water quality? Explain.

The Pollution Index

For each of the following water samples, determine the pollution index, and indicate the level or organic pollution.

Sample A.

17	*Spirogyra*
8	*Euglena*
3	*Rivularia*
10	*Staurastrum*
12	*Closterium*
	Pollution Index Value

Level of pollution:_____

Sample B.

3	*Volvox*
8	*Navicula*
7	*Pandorina*
10	*Scenedesmus*
20	*Euglena*
2	*Stigeoclonium*
12	*Oscillatoria*___
	Pollution Index Value

Level of pollution:_____

Which sample contains the highest level of organic matter?
