Algal Awareness: Identification of Common Algal Species

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Funded by the NSF Research Experiences for Teachers:
Shaping Inquiry from Feedstock-to-Tailpipe program at the University of Kansas, summer 2010
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Learning Experience Description:

Students will procure water samples from a local source, by utilizing a container to collect water from the edge of a pond. The water sample should then be filtered to capture any large filamentous pond scum, invertebrates and vertebrates, in which students will view under a microscope, along with the filtrate.

KU Bioscience Connection:

Scientists and engineers at the University of Kansas are currently working on biofuel production that has the potential to solve a multitude of energy problems, currently associated with petroleum. Biofuels provide a renewable fuel that is carbon-neutral, and by utilizing algae for a feedstock, marginal land could be utilized to grow this algae, which is a win-win solution for our future energy needs.

Background Information:

The teacher needs to be familiar with microscopy and have access to available resources (microscope, slides, pond water samples and/or specimens available for purchase). Students will need to be familiar with the proper care and use of microscopes and knowledgeable in how to utilize coarse and fine adjustments for various magnifications. In addition, students should also be familiar with how to make a wet mount slide of specimens.

Grade Level:

Grade 9-12 This activity could be used at all grade levels with necessary modifications, given the availability of proper equipment.

Duration of Learning Experience:

The length of exploration could be 1-3 days. Opportunities exist for ongoing research projects. Once students start to explore the micro-world of the pond water, their curiosity is piqued as to the variety of life that exists. Students can become experts on selected organisms and try to culture specific wild species, to create an environment on which to introduce grazers to feed, and

note the change, day to day. By monitoring the conditions of their tanks and the drama within, students can gain a deeper awareness and appreciation of the ecological relationships.

Pre-visit Classroom Information:

Students should be familiar with the use of the microscope and experimental methods.

How algae is playing a role in biofuel research, and how this technology has the potential of revolutionizing fuel production.

Post-Visit Classroom Information:

The students will be aware of the "KU Feedstock to Tailpipe" biofuel research program, which is an exciting program advancing the knowledge of utilizing algae as a source of renewable fuel. Students will be able to understand the various types of algae and relate the production of algae as a feedstock for biofuel source to serve the world's energy needs.

Content / Topic

This lesson will provide students an opportunity to explore (inquiry) the diversity of life in a pond of water, taxonomy/ classification of organisms, which serves as the starting point for further investigations… nutritional needs, food chain/web interactions and how algae's photosynthetic process drives the food chain as a producer of available energy and is seriously researched as an alternative energy source to the petrochemicals.

Vocabulary

Feedstock	Autotroph (producer)	Cyanobacteria
Nutrient Stream	Heterotroph (consumer)	Chlorophyta
Algae	Phytoplankton	Desmids
Photosynthesis	Zooplankton	

Content Standards, Benchmarks, and Indicators Addressed:

Science Standards

Standard 1: Science As Inquiry Grades 8-12

Science As Inquiry – The student will develop the abilities necessary to do scientific inquiry and develop an understanding of scientific inquiry.

Benchmark 1: The student will demonstrate the abilities necessary to do scientific inquiry.

Indicator 1: The student actively engages in asking and evaluating research questions.

▲ Indicator 2: The student actively engages in investigations, including developing questions, gathering and analyzing data, and designing and conducting research.

▲ Indicator 3: The student actively engages in using technological tools and mathematics in their own scientific investigations.

Standard 3: Life Science Grades 8-12

Life Science – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 1: The student will demonstrate an understanding of the structure and function of the cell.

Indicator 1: The student understands cells are composed of a variety of specialized structures that carry out specific functions.

▲ Indicator 2: The student understands cell functions involve specific chemical reactions.

Indicator 4: The student understands some plant cells contain chloroplasts, which are the sites of photosynthesis.

Benchmark 4: The student will understand the interdependence of organisms and their interaction with the physical environment.

▲ Indicator 1: The student understands atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.

Indicator 2: The student understands energy is received, transformed and expended in ecosystems.

▲Indicator 3: The student understands the distribution and abundance of organisms and populations in ecosystems are limited by the carrying capacity.

Indicator 4: The student understands organisms cooperate and compete in complex, interdependent relationships.

Indicator 5: The student understands human beings live within and impact ecosystems.

1. The essential chemical elements for life circulate in the *biosphere* in characteristic paths known as biogeochemical cycles (e.g., cycles for water, nitrogen, carbon, oxygen, etc).

2. a. Radiant energy that enters the biosphere is balanced by the energy that leaves the earth into space as radiant energy, primarily heat.

b. Transfer of energy through a series of organisms in an ecosystem is known as a food web.

c. Organisms and ecosystems expend energy, much of which is released as heat, to maintain a high state of internal order.

3. a. The carrying capacity is determined by the availability of matter and energy, and the ability of the ecosystem to recycle materials.

b. Living organisms produce more offspring than environmental resources can support, resulting in a competition for resources.

4. These relationships include:

a. predator-prey relationships.

b. symbiotic relationships (parasitism, mutualism, commensalisms).

5. a. Humans modify ecosystems as a result of population growth, technology, and consumption.

b. Human modifications of habitats through direct harvesting, pollution, atmospheric changes, and other factors affect ecosystem stability.

Teacher Notes:
The life science standards provide a framework for a variety of courses in the life sciences. Ecology concepts are key to understanding life; these indicators provide a framework for local curriculum for courses such as biology, botany, and zoology.

Learning Science in the Outdoors: Varied experiences in the outdoors make natural processes less abstract and are critical to developing scientific literacy. Teachers are encouraged to create outdoor learning experiences for their students.

Benchmark 5: The student will develop an understanding of matter, energy, and organization in living.

Indicator 1: The student understands living systems require a continuous input of energy to maintain their chemical and physical organization.

▲ Indicator 2: The student understands the sun is the primary source of energy for life through the process of photosynthesis.

1. Without the input of energy, all matter tends toward more disorganized states. With death and the cessation of energy intake, living systems rapidly disintegrate.

2. a. Plants and other photosynthetic organisms use energy to make organic compounds biochemical reactions.

b. The energy in these compounds is used to assemble larger molecules with biological activity, including proteins, DNA, carbohydrates, and fats.

c. These molecules serve as sources of energy for the plants themselves and for many other organisms through food webs.

▲ Indicator 3: The student understands food molecules contain biochemical energy, which is then available for cellular respiration.

Benchmark 7: The student will demonstrate an understanding of the diversity of structure and function in organisms.

Indicator 1: The student understands differences in structure and function among organisms and can identify the characteristics of relevant life forms.

▲Indicator 2: The student understands that homeostasis is the dynamic regulation and balance of an organisms internal environment to maintain conditions suitable for survival.

▲Indicator 3: The student understands that living things change following a specific pattern of developmental stages called life cycles.

Indicator 4: The student understands that in complex organisms there is a division of labor into specific body systems i.e., respiration, digestion, nervous, endocrine, excretion, circulatory, reproductive, immune, skeletal and muscle.

1. a. Major structural differences among organisms include unicellular and multicellular, plants and animals, and invertebrates and vertebrates.

b. Common functions include digestion, respiration, excretion, locomotion, communication and reproduction.

2. a. These systems interact with one another to maintain homeostasis.

b. Relate the organs and their functions to the body system.

3. understands taxonomy is the systematic way in which organism are placed into a hierarchical classification system, according to their physical and genetic characteristics and their evolutionary history.

4. a. All organisms are classified into one of a number of kingdoms, the broadest taxonomic category.

b. All organisms are classified into a number of intermediate categories, of which species is the most specific.

▲ = High School Assessed Indicator
Learning Experience Objectives:

Technology Standards Addressed:

Standard 5: Science and Technology Grades 8-12

Students will develop microscopy skills necessary to view specimens utilizing a compound microscope and computer skills to access available algae taxonomy keys for identification.

Science and Technology – The student will develop understandings about the relationship between science and technology.

Benchmark 1: The student will develop an understanding that technology is applied science.

1. The student understands technology is the application of scientific knowledge for functional purposes.

2. The students understand creativity, imagination, and a broad scientific knowledge base are required to produce useful results.

3. The student understands that science advances new technologies.

Learning Experience Objectives:

The students will develop observation skills so as to identify common organisms that inhabit a drop of pond water, and utilize internet resources for further analysis.

The students will gain an understanding of how science works by becoming actively engaged in a research project of their design.

Required Materials:

Compound Microscope
Deep well/depression/concave microscope slides
Microscope cover slips
Pond water
Eye dropper
Instructions to collect data
Data collection worksheet (observations)

Prepared slides in kit: Spirogyra, Chlorophyta, Chlamidomonas, Nostoc, Anabaena,

For Further studies:
Cultures of Green algae, Ankistrodesmus, Pediastrum

Lab Safety:

1. When in lab, put on safety goggles, gloves and lab apron.
2. Follow proper safety procedures while making wet mount slides.
3. Avoid skin contact with organisms.
4. Clean lab station and dispose materials as directed by your teacher.
5. Always wash your hands thoroughly before you leave lab.

Water collection:
Follow WATER SAFETY RULES if collecting from pond, stream, river or lake.

Note: Know source of water supply (do not use septic ponds or closed areas).

Technology Connection:

Students will use microscopes to view organisms in pond water samples, and utilize internet sources for identification.

Anticipatory Set:

How does one go about selecting the perfect species of algae for lipid production and then how does one optimize its growth? One needs to determine its nutrient requirements, preferred place to live (habitat) and what and if predators may exist that would eat…the crop of algae.

How hard could it be… growing algae? It's everywhere! But one needs the right species and to find the right conditions--so is it easy coming up with the next big thing (energy source) that has the potential to displace/replace petrochemicals? Well….NO!

In this activity, students will have the opportunity to see what's in a drop of pond water, get acquainted with a number of known species (in prepared slides and in living cultures) and then later have an opportunity to conduct experiments to optimize algal growth.

Step-by- Step Procedures:

1. Collect pond water samples from an available source, on school property if possible. Note: Students take ownership of their personally procured specimens.
2. Filter the water as soon as possible to concentrate and capture the zooplankton which can skew results by grazing on the phytoplankton. Pour water through a nylon hose.
3. In the lab, make a wet mount slide of the pond samples, by placing a drop of water to fill the well and place coverslip on top of slide.
4. Record your observations (draw and describe). Identify organisms as phytoplankton or zooplankton utilizing the pond identification sheet for quick reference.

5. Compare your findings with those of other classmates. How do they differ? How do they compare?

Accurate observations are necessary in the process of science and provide qualitative data. In the identification of algae, one may access following web-based sites:

http://silicasecchidisk.conncoll.edu/carolinakey_Information.html

http://silicasecchidisk.conncoll.edu/Algal-Ed_finished.html

http://www.lifesciences.napier.ac.uk/algalweb/alweb2.htm

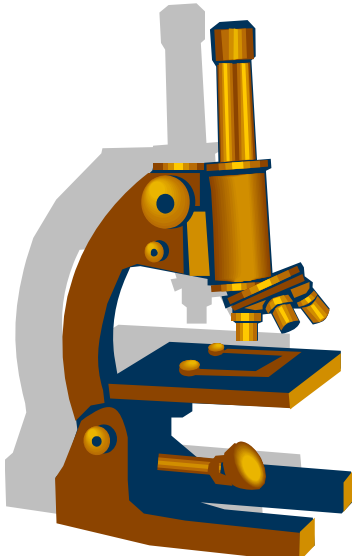
6. Prepared slides provide students an opportunity to identify species with relative ease, since organisms are labeled, stained and fixed forever allowing for consistent student observations of various structures. Students make observations of the prepared slides on data paper. Also, purchased algae cultures (order information is provided at the end of this section).

Assessment:

Student data sheets with detailed drawings and descriptions of organisms will be posted for viewing. Students may also take pictures of the organisms with a digital camera through the ocular and post.

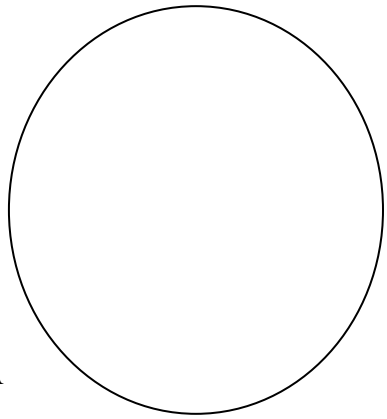
Closure (Reflect Anticipatory Set)

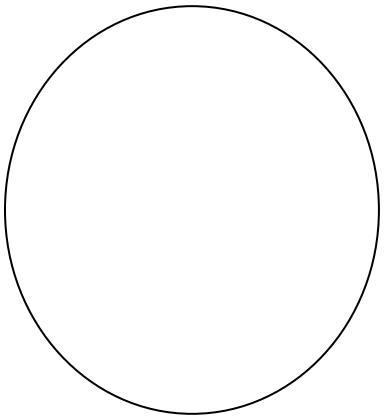
Seeing living organisms in the drop of pond water provides students with a more sense of discovery and allowing for interaction. Living organisms (cyanobacteria and algae) are dynamic, thus setting the stage by providing students opportunities to further design and conduct experiments to enhance their growth in the laboratory.



DATA

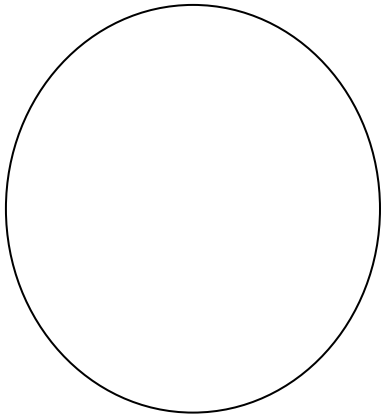
Prepare 3 different slides of the pond water samples. Draw your observations in the circles provided, the first on low power, then secondly on a higher magnification. Label the magnification you used below each circle. Please include a short description of what you see.

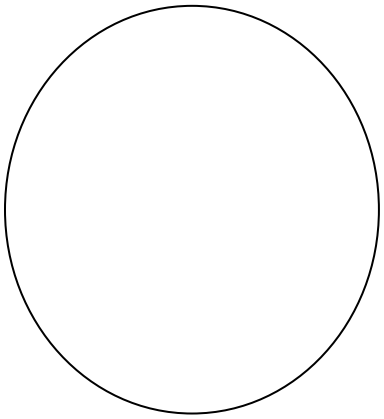


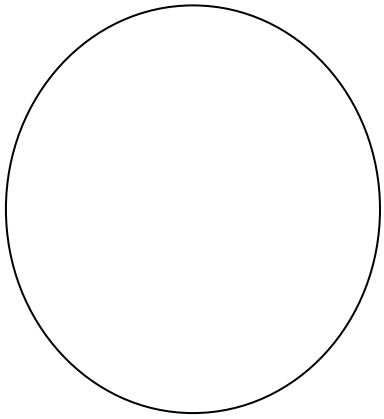


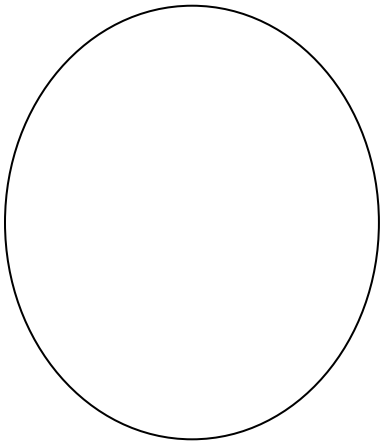
DATA

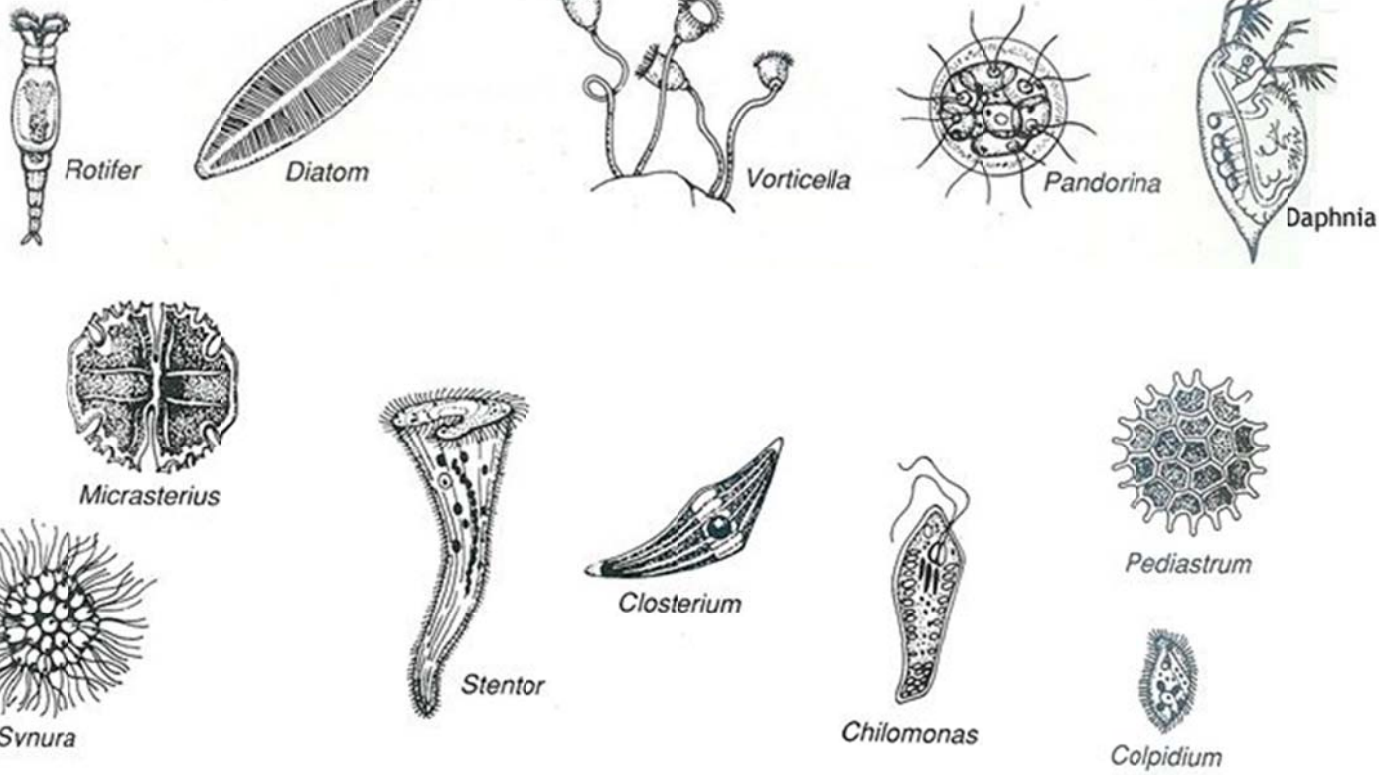
Observe 4 prepared slides, and 2 live algae cultures. Draw your observations in the circles provided, and label the circles with organism and power of magnification used. Please include a short description of what you see for each one.

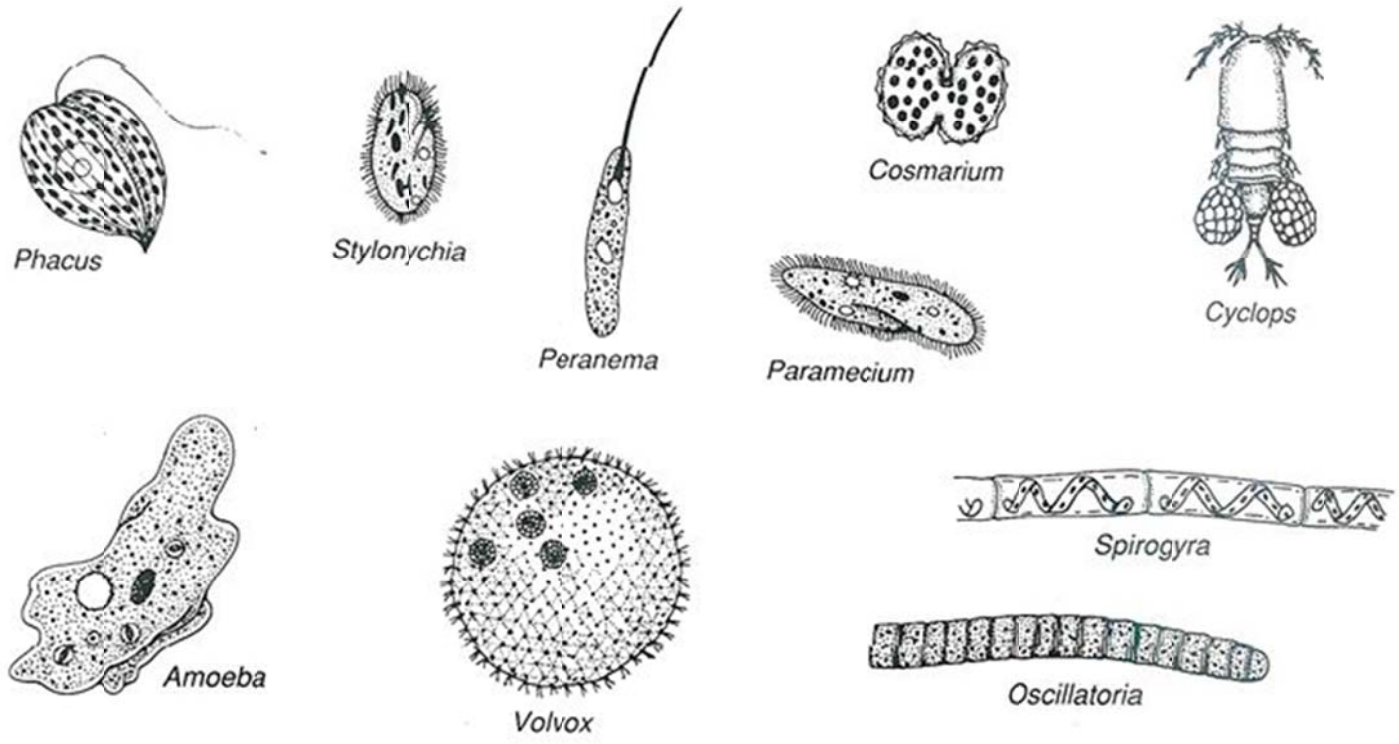









Rotifer
Diatom
Vorticella
Pandorina
Daphnia
Micrasterius
Stentor
Closterium
Chilomonas
Pediastrum
Synura
Colpidium



Pond Water Worksheet is available at
http://www.biologycorner.com/worksheets/pondID2.html

Algae Awareness Materials Kit

Company: Carolina Biological

4 - Deep well, Depression , or Concavity slides

Concavity Slide, Carolina, 25.4 x 76.2 mm, 1.2-1.5 mm, 2 Cavities 15 x 0.8 mm, Item # 632205, $2.75 each, from Carolina Biological,
http://www.carolina.com/product/concavity+slide%2C+carolina%2C+25.4+x+76.2+mm%2C+1.2-1.5+mm%2C+1+cavity+15+x+0.8+mm.do?keyword=depression+slides&sortby=bestMatches

Coverslips

Coverslips, Plastic, 22 x 22 mm, Box 100, Item # 632900. $3.85 each, from Carolina Biological, http://www.carolina.com/product/plastic+coverslips.do?keyword=Coverslips&sortby=bestMatches

Company: Fisher Scientific

4 - Prepared Slides – Algae

Microscope slide, Spirogyra, vegetative, Catalog # S10487, Triarch, No.:2-30CC $4.95 each, from Fisher Scientific, www.fishersci.com

Altay Scientific* Protista Microscopic Slides > Chlamidomonas flagella; FSandFG stain Catalog # S99251, $3.65 each, from Fisher Scientific, www.fishersci.com

Microscope slide, Green algae, Chlorophyta , Catalog # S10491, Triarch No.:2-14A, $5.85 each, from Fisher Scientific, www.fishersci.com

Fisher Science Education* Fungi Microscopic Slides > Anabaena; Wholemount Catalog # S99241, $3.65 each, from Fisher Scientific, www.fishersci.com

Company: Carolina Biological

Algae Culture

PLEASE USE THE COUPON PROVIDED TO ORDER LIVE ALGAE WHEN READY.

Algae Survey Mixture, Living, Item # 151216, $12.65 each, from Carolina Biological, http://www.carolina.com/product/living+organisms/protists/algae+cultures+and+sets/algae+survey+mixture%2C+living.do?sortby=ourPicks#

Algae Culture booklet (comes with the Algae Survey Mixture above)

Additional Experimentation:

Green Algae, Living, Ankistrodesmus, Item # 151955, $6.95 each, from Carolina Biological,

http://www.carolina.com/product/living+organisms/protists/algae+cultures+and+sets/ankistrodesmus%2C+living.do?sortby=ourPicks

Green Algae, Living, Pediastrum, Item # 152430, $8.95 each, from Carolina Biological, http://www.carolina.com/product/living+organisms/protists/algae+cultures+and+sets/dunaliella+salina%2C+living.do?sortby=ourPicks