ARCTIC MARINE SCIENCE CURRICULUM

MODULE 3

LIVING ORGANISMS

LAB MANUAL

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Prepared for:
Fisheries and Oceans Canada
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Prepared by:
AIMM North Heritage Tourism Consulting
with
Prairie Sea Services, Bufo Incorporated and Adrian Schimnowski

MODULE 3

LAB MANUAL

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LAB 1 - BACTERIA

OVERVIEW

Bacteria are microorganisms that cannot be seen with the naked eye unless they are in colonies and grown on a sterile agar plate. With a good microscope, that has the capability of 400x magnification, we can see small colonies of bacteria on a microscope slide. This lab will enable you to compare Blue-Green Algae (cyanobacteria) and other types of bacteria. As these organisms are very small and difficult to see even with good microscope, care should be taken in the preparation of wet mounts of the bacteria provided.

PURPOSE

To prepare wet mounts of bacteria.
To observe and draw diagrams of the bacteria available in this lab.
To compare cyanobacteria with other types of bacteria.

MATERIALS

Prepared slides of Anabaena and/or Nostoc
- A nutrient broth or agar petri dish sample of bacteria
- Optional methylene blue stain
- Microscope slides and cover slips

Microscope

Metric ruler

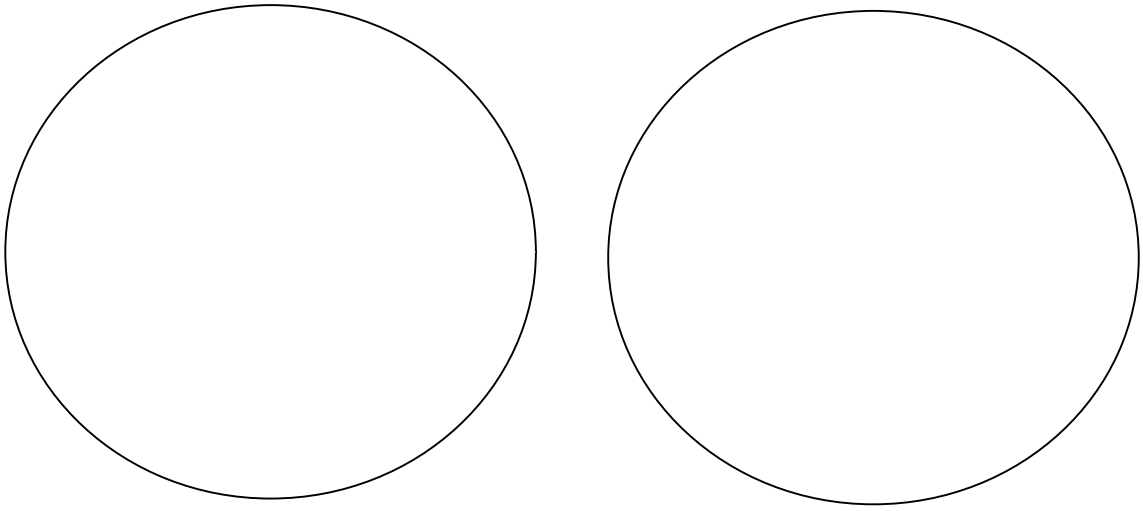
PROCEDURE

1. Use the low power on the microscope to locate a strand of *Anabaena.*
2. Sketch a diagram of what you see.
3. Carefully switch to high power after you have centered the strand of bacteria you are viewing in the center of the field of view. Look for cell parts within the cell.
4. Complete the first three rows in the data table.
5. Use the circle provided to draw a single cell exactly as it appears in the field of view. Measure the length of the *Anabaena* cell in millimeters and record this length in the table.
6. To find the actual length of the cell, multiply by 0.0035. Add this to the data table.
7. Using a clean toothpick, take a very small piece of one of the bacterial colonies growing in the agar or nutrient broth provided by your teacher.
8. Place the bacteria sample on a clean microscope slide and spread around with the end of the toothpick.
9. Add a cover slip to the slide and then repeats steps 1 to 6 with this bacterial sample.

OPTIONAL ACTIVITY

1. Before adding the cover slip, stain the bacterial sample using methlyene blue.
2. Repeat steps 1 to 6

Draw diagrams of bacteria in the circles.



DATA TABLE

	ANABAENA	**BACTERIUM**
Shape of cells		
Single cell or colony		
Colour		
Length of diagram		
Actual length of cell		

QUESTIONS

1. Which organism produces it's own food?

2. To which kingdom do all these organisms belong? How do you know?

3. Observe other bacteria and make a comparison.

LAB 2 - ALGAL PLANTS

OVERVIEW

Plants are not always large and found living in soil. Many forms are microscopic and live in water. Regardless of their size or where they might live, all plants have one characteristic in common: they are all capable of making their own food through photosynthesis. In order to use this process, plants need a green pigment called chlorophyll. The plants you are about to study are no exception, however, other pigments like brown and red often mask their green colour.

PURPOSE

To observe two different species of green algae.
To diagram and compare these green algae to each other.
To observe an example of brown and red algae and compare them to green algae.

MATERIALS

*Wherever possible, collect specimens from the ocean for use in this lab.

- **Ulothrix*, preserved
- **Spirogyra,* preserved
- **Zygnema,* preserved

*Brown algae

- *Red algae
- Microscope
- Glass slides
- Cover slips
- Eye dropper

PROCEDURE

Part A: Green Algae

Ulothrix

1. Prepare a wet mount of preserved *Ulothrix* for viewing under the microscope.
2. Observe the algae under both low and high power objective lenses.
3. Note the following parts shown in *Figure 1*.
    a) Green, horseshoe shaped chloroplasts
    b) Nucleus
    c) Cell wall
    d) Filament

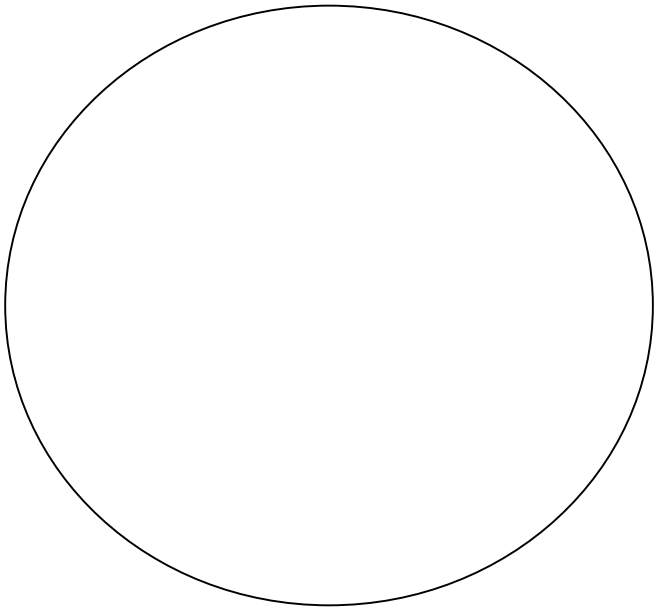
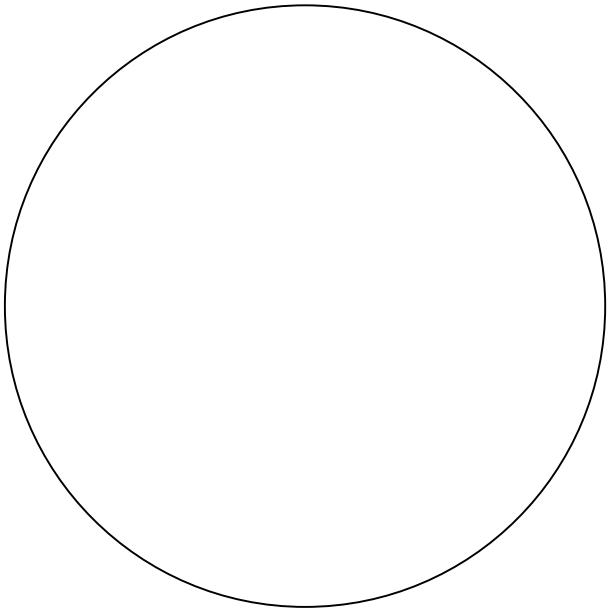


Figure 1: Ulothrix

Ulothrix is a common thread-like alga. Its short cells each contain a single nucleus and a large girdle-shaped choloroplast. It forms a hairy covering on rocks in cool streams and similar places. Each filament is attached to the rock or other solid object by a basal cell or holdfast, which is narrow, elongated and generally lacking in chlorophyll.

Spirogyra

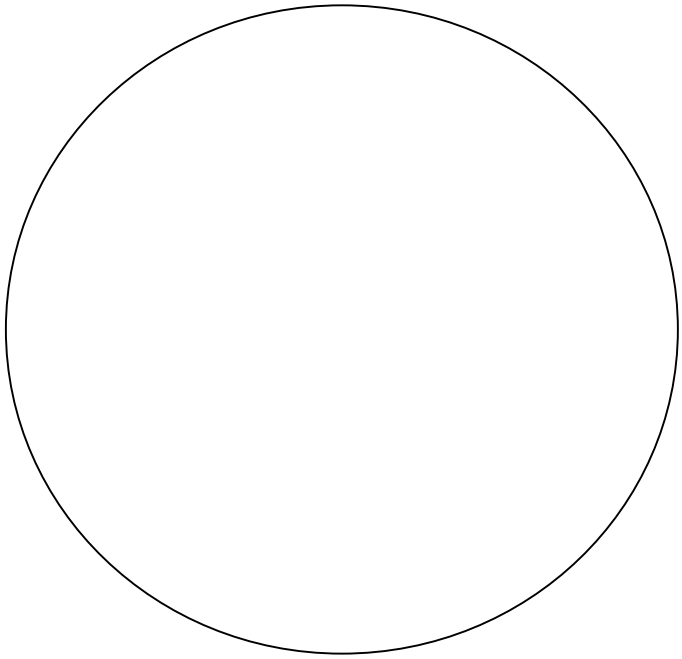
1. Prepare a wet mount of preserved *Spirogyra* for viewing under the microscope.
2. Observe the algae under both low and high power objective lenses.
3. Diagram one or two cells of *Spirogyra* in the space provided. Note the shape of its chloroplasts. Use high power to draw the algae.
4. Label these parts on your diagram: cell wall, green chloroplast, nucleus, and single cell unit.
5. Describe the shape of the chloroplast.
6. Describe the colour of its chloroplast.
7. Describe the complete shape of the algae.



Spirogyra is a freshwater colonial green algae. It is usually found floating in lakes or ponds. In deep, cold springs and pools, *Spirogyra* forms very large green clouds that are several meters in diameter. In shallow warm water, many filaments of *Spirogyra* will grow together to forma thick mat in the water. Each filament of the algae contains many identical cells. There are no specialized cells in Spirogyra. The chloroplasts in this algae are ribbon-shaped structures which form spirals throughout the each cell.

Zygnema

1. Prepare a wet mount of preserved *Zygnema* for viewing under the microscope.
2. Observe this alga under both low and high power objective lenses.
3. Diagram one or two cells of *Zygnema* in the space provided. Note the shape of its chloroplasts. Use high power to draw this alga.
4. Label these parts on your diagram: cell wall, green chloroplast, nucleus, and single cell unit.
5. Describe the shape of the chloroplast.
6. Describe the colour of its chloroplast.
7. Describe the complete shape of the algae.

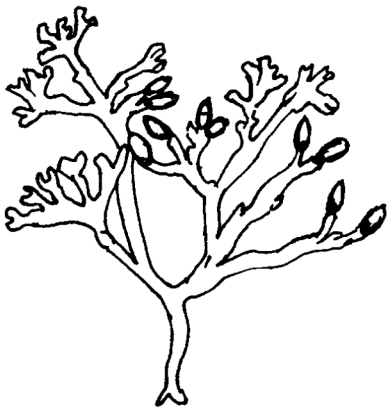


Zygnema is forms branchless filaments in freshwater environments. *Zygnema* grows best in 'hard' water (high amounts of iron, or magnesium, or calcium) lakes or in shallow ponds that contain high concentrations of organic material. The filaments in the algae sometimes form pale green, cottony masses.

Part B: Red and Brown Algae

Most red and brown algae grow in marine habitats. Most red and brown algae are multicellular and all have nuclei within their cells. They are often found clinging to rocks along the ocean shores by a special structure called a holdfast.

For this part of the lab you will need to find samples of red and brown algae. If samples are not readily available then use *Figure 2* to answer the questions.



Brown Algae

Red Algae

Figure 2: Examples of Brown and Red Algae

QUESTIONS

1. Define the following terms:
   a) Photosynthesis

   b) Macroscopic

   c) Holdfast

2. List three ways that the green algae studied here are alike.

3. List two ways that the green algae studied here are different.

4. List two ways that brown or red algae differ from the green algae studied.

5. Compete the following chart.

	SPIROGYRA	**FUCUS**	**DASYA**
Chlorophyll present?			
Major colour			
Nucleus in each cell?			
Macroscopic or microscopic			
Habitat			

LAB 3 - PLANKTON LAB

OVERVIEW

In the material presented in the Student Guide, you were introduced to a number of microorganisms that inhabit water. These organisms may be either photosynthetic (producers) called phytoplankton or herbivores (primary consumers) called zooplankton. If you remember some of them have the capacity to swim but it is over-shadowed by their dependence on the movement of water currents to move them about. In this lab, you will collect and identify some of these organisms.

PURPOSE

To find out what plankton are found in water.
To observe what they have in common.
To collect and identify marine and/or freshwater plankton.

MATERIALS

- Microscope
- Slides
- Cover slips
- Lens paper
- Collecting bottles
- Eye dropper
- 1.5% methyl cellulose solution
- Paper towels
- Collecting nets

Prepared Slides

Phytoplankton

- blue-green algae
- algal protists (flagellates, dinoflagellates, diatoms)
- other algae

Zooplankton

- protozoan protists (ciliates, flagellates, sarcodinans)
- rotifers
- crustaceans

PROCEDURE A: STUDY OF PREPARED SLIDES

Complete the table provided below for all the organisms.

ORGANISM	PHYTOPLANKTON	ZOOPLANKTON	GROUP	SKETCH
Asterionella	Phytoplankton		Diatom	

Your sketch should be as neat as possible to catch the distinguishing features of the organism that you have been viewing. The group represents whether the organism is a blue-green algae, rotifer, etc.

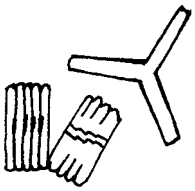
PROCEDURE B: IDENTIFICATION OF LIVING PLANKTON

For this part of the lab, your teacher will have collected water samples containing planktonic organisms. Complete the information on each organism in the table that follows:

1. Use the eyedropper to get a drop of the water that contains an organism.
2. Prepare a wet mount of the water drop but do NOT include a cover slip. If the organism is too large and / or too motile for a plain microscope slide, then a deep welled slide should be used.
3. Use the low power objective lens first to observe the organism. If the organisms are swimming too fast then add a drop of the methylcellulose solution. This will reduce the activity on the slide without killing the organism.
4. Now add a cover slip and repeat the observation under, low, medium, and if possible, high power.
5. Next decide the group to which it belongs and record on the data table.
6. Use the identification guide on the next page to find the formal name of the organism. Record this also on the data table.
7. Sketch a careful diagram of the species to illustrate the characteristics of the organism you are viewing.

DATA TABLE

Phytoplankton

ORGANISM GROUP	DIAGRAM
Diatom (Tabellaria)	
Zooplankton	
ORGANISM GROUP	**DIAGRAM**

ANSWER THE FOLLOWING QUESTIONS:

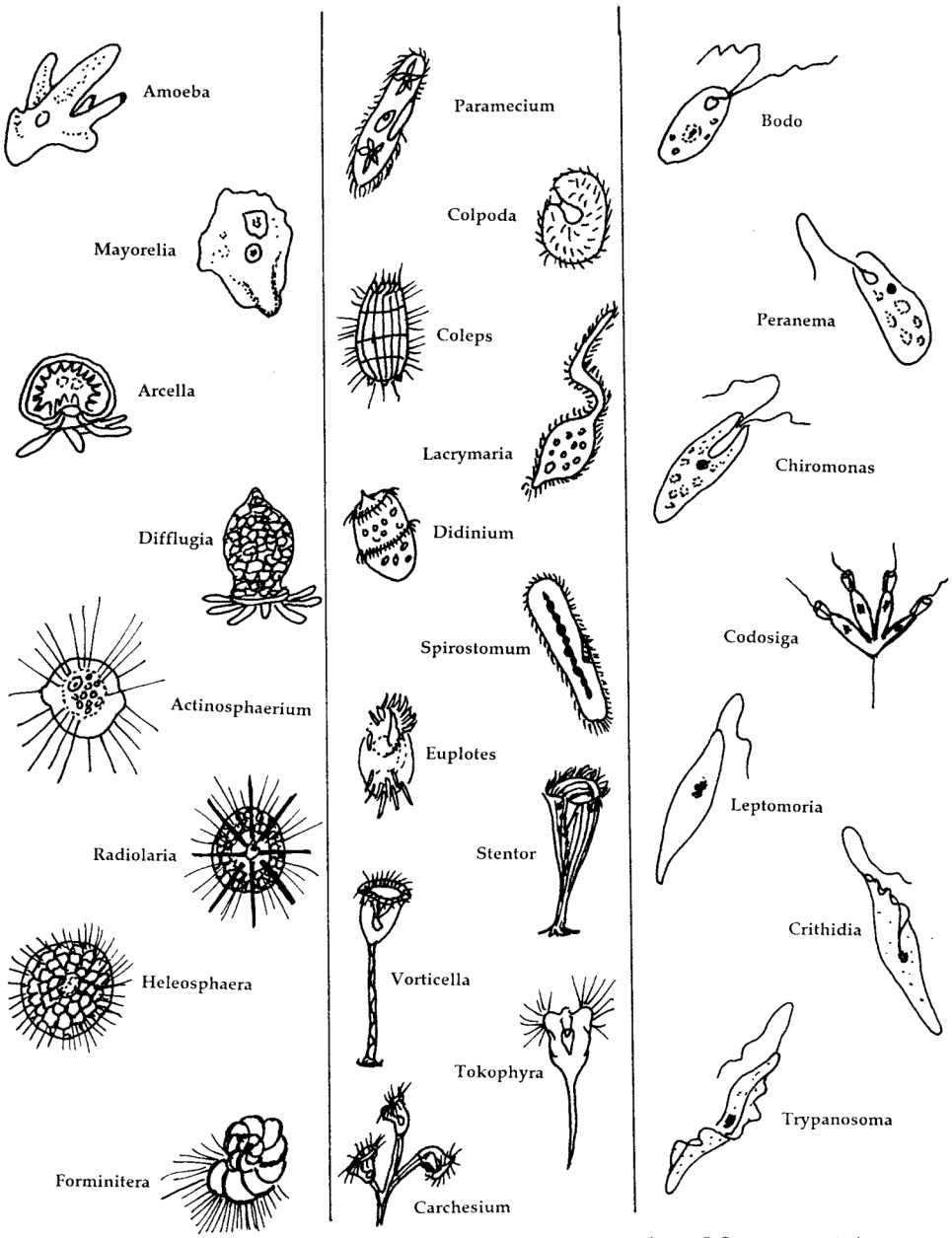
1. What major differences are there between zooplankton and phytoplankton?

2. Were you able to determine the grouping of all the organisms? If not, then provide an explanation.

3. Speculate what organisms might be next in the food chain.

4. What general conclusion can be made from this lab?

The following are some examples of Protista:



Group A: Some representative sarcodinans. What do they have in common?

Group B: Some representative ciliates. What do they have in common? How do they differ from

Group C: Some representative flagellates. How do they differ from other flagellates in the kingdom

LAB 4 - THE BRINE SHRIMP EXPERIMENT

INTRODUCTION

Saltwater monkeys? Growing in an aquarium? In 1960, a toy inventor and lover of science named Harold von Braunhut brought fame to a species of tiny creatures commonly known as brine shrimp. Obviously not "monkeys", brine shrimp are a species of small marine animal. As a food source for small fish, they play an important part in many food chains. Since they are found in a variety of saltwater locations, they often face different level of salinity (concentrations of salt).

Even in the ocean, salinity levels fluctuate. This happens in estuaries, where fresh river water mixes with salty seawater. Is also happens in warm and cold latitudes, where evaporation or freezing can draw off freshwater, leaving saltier solutions behind. Is it possible that these varying salt concentrations can affect animal productivity?

In this investigation, you will examine whether different salinity levels have an effect on the hatch rate of brine shrimp cysts ("eggs"). To keep within the shrimp's range of tolerance for salinity (the upper and lower limits between which an organism function best), vary the salt concentrations in small steps from that suggested on the instructions that come with the cysts. Levels should always be between 5 g and 30 g of salt per 1 L of water.

Background Information:

Brine shrimp are invertebrates, closely related to shrimps, crabs and lobsters. They are found in salty waters worldwide. The most common commercial species comes from Great Salt Lake, Utah. Brine shrimp live in waters with salt content as high as 25%. Consequently, the shrimp have few predators and lots of food. The cyst is an egg-like formation that contains a single embryo in a state of suspended metabolism, an extremely important adaptation as salt lakes often dry up during droughts. When the rains return, the cysts absorb water and release the first growth stage larva. During this stage (12 hours) the larva lives off its yolk reserves. Then it molts, shedding it's covering and emerge in the second stage. Now it feeds on small algal cells and detritus. They molt about 15 times before becoming 10-mm long adults.

DESIGNING AN EXPERIMENT

Purpose

After reading the Introduction, write a question that you will try to answer. State the question in a testable form.

Hypothesis

Predict what you think you will observe. This should include a relationship between the independent and dependent variables. Write a hypothesis explaining your prediction. State your reasons.

Experimental Design

Design an experiment to test your hypothesis. Read the instructions that come with the brine shrimp, look closely at the cysts, then plan your experiment by answering the following questions:

1. What steps will you take to answer the question you posed? Be specific. Remember, brine shrimp cysts are extremely tiny.

2. What variable(s) will you change?

3. What will you use as your control?

4. What will you measure?

5. How will you record your measurements?

6. How will you report your findings?

MATERIALS

Decide on the materials you will need to complete the experiment, and list them in your notebook.

PROCEDURE

1. Show your experimental plan and list of materials to your teacher. With your teacher's approval, begin the experiment.
2. Record any changes you make to your plan as you proceed.
3. Record all observations.

ANALYSIS AND INTERPRETATION

Analyze your results by answering the following questions:

1. What was the answer to your question?

2. Was your hypothesis supported or rejected?

3. What variables did you keep constant during the experiment?

APPLICATIONS/IMPLICATIONS FOR DAILY LIFE/LINK TO AREA OF STUDY

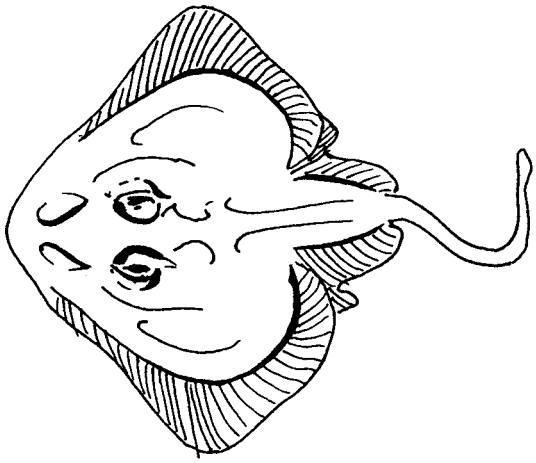
Comment on how your findings relate to daily life or to what you have learned previously in your study of water and marine systems.

LAB 5 - DICHOTOMOUS FISH KEY

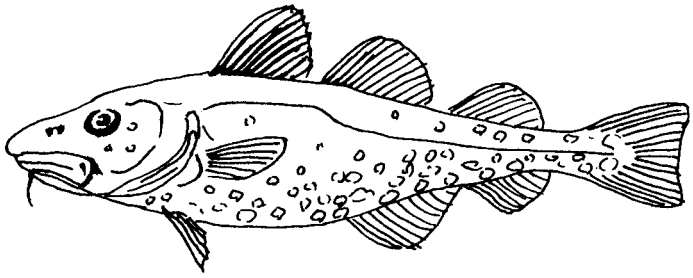
A dichotomous key is designed to identify organisms. The process is based on a series of two questions about the morphology of an organism. The answers to these questions direct you to other questions in the key. Each set of questions is designed to differentiate between characteristics of different species. As you answer the questions you are led down one path or another until the organism is identified. The examples provide include the following Arctic fish: skate, flounder, burbot, carp, cod, sturgeon.

Answer the questions on page 25 to guide you through the process of identifying the fish in the photographs that follow. The fish are not drawn to scale.

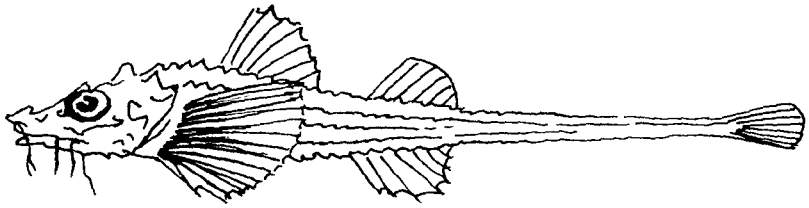
Raja radiate Donovan, 1808 THORNY SKATE



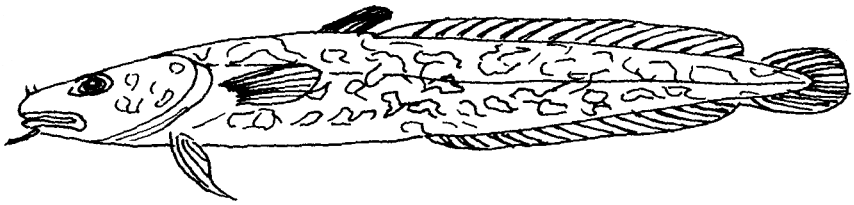
Gadus ogac Richardson, 1836 GREENLAND COD



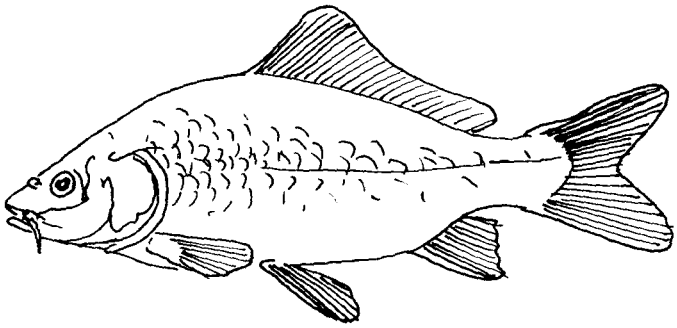
Agonus decagonus Bloch and Schneider, 1801 ATLANTIC POACHER



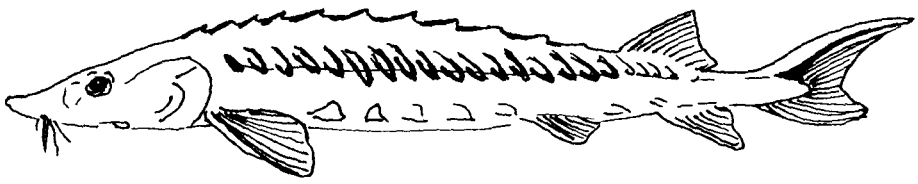
Lota lota BURBOT



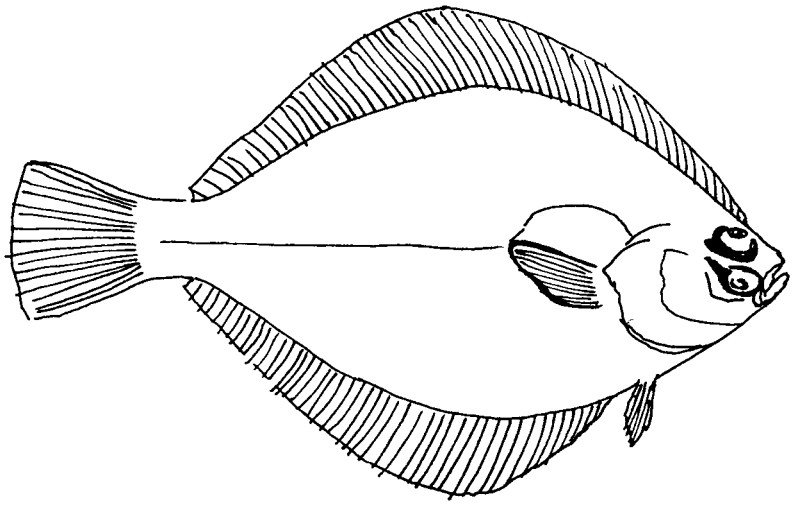
Cyprinus carpio CARP



Acipenser fulvescens STURGEON



SOLE



1.	A	A body kite-like in shape (if viewed from the top)	Go to statement	2
	B	A body not like-like in shape (if viewed from the top)	Go to statement	3
2.	A	A body that is covered by spiny thorns.	Thorny Skate	
	B	A body that does not have spiny thorns.	Go to statement	9
3.	A	A head that has a single set of barbels	Go to statement	4
	B	A head that does not have a single set of barbels.	Go to statement	6
4.	A	An eel-like body	Go to statement	7
	B	Does not have an eel-like body.	Go to statement	5
5.	A	A body with three dorsal fins.	Greenland cod	
	B	A body that does not have three dorsal fins.	Go to statement	8
6.	A	A body with a very long thin tail	Atlantic poacher	
	B	A body not having a very long thin tail	Go to statement	10
7.	A body having a long dorsal and anal fin		Burbot	
8.	A fish not having any pectoral fins		Carp	
9.	A fish having a short caudal tail.		Flounder	
10.	A fish with no anterior dorsal fin.		Sturgeon	

LAB 6 - FISH ANATOMY LAB

OVERVIEW

Fish are cold-blooded aquatic vertebrates whose streamlined bodies aid in swimming. They are characterized by having fins for swimming, gills for breathing, and hearts with only two chambers.

The skeleton of some fish, such as sharks, is made of cartilage. This is the same tough material that gives shape to the human nose and ears. In more advanced types of fish, the skeleton is made of bone. Bony fish are covered with scales, which help water flow over their bodies.

In this lab, you will dissect a bony fish.

PURPOSE

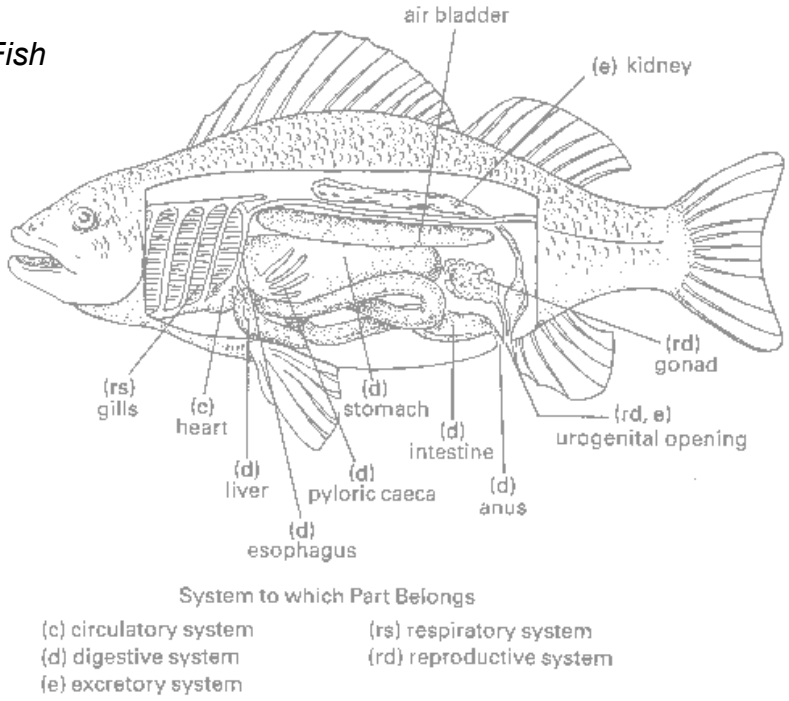
To become familiar with the anatomy of a bony fish.

MATERIALS

- Sample of bony fish
- Forceps
- Plastic bag
- Scissors
- Scalpel
- Dissecting probe
- Dissecting microscope
- Dissecting pins
- Dissecting pan
- Slide

PROCEDURE

Figure 3: Anatomy of a Fish



PART A: EXTERNAL ANATOMY (Refer *Figure 3*)

1. Place the fish in a dissecting pan lined with wet paper towels. Examine the head region. On each side of the mouth is a semicircular flap called the operculum, which covers the gills. Water enters the mouth, flows over the gills, and leaves through the opening covered by the operculum. The fish breathes by absorbing oxygen dissolved in the water through its gills.
2. Locate the fish's nostrils. Inside the nostrils are olfactory organs, which detect chemical substances dissolved in the water. Insert a probe into one of the fish's nostrils. Open the mouth to see if the probe comes into the mouth.
3. Examine the fish's types of fins. Each fish species will have some specialty fins but most type of fins are similar on all fish. On its back there will be three dorsal fins. On its tail is the caudal fin. On its ventral (under) side will be two anal fins, (near the anus), and the pelvic fins. Just behind the fish's head are the pectoral fins.
4. Find the fish's lateral line, a series of grooves along its skin that run nearly the length of the fish. Cells in the lateral line are sensitive to vibrations in the water. This enables the fish to tell if another animal is moving through the water.
5. Use forceps to remove a scale from the fish. Put the scale on a slide and observe it under a dissecting microscope.
6. The concentric rings are lines of growth. As the fish grows, the scales grow larger. Because the cold-blooded fish grows slowly at low temperatures, the growth lines are formed close together during winter. Each winter's growth lines appear as a ring on the scale. So, you can approximate the age of the fish by counting the rings.

QUESTIONS – EXTERNAL ANATOMY

1. Does the nostril lead into the mouth?

2. Do the nostrils play any role in the fish's breathing? Why or why not?

3. How could the nostrils aid the fish in smelling?

4. In each of the boxes below, draw one of the fish's eight fins. Draw the anterior dorsal fin in box I and proceed clockwise around the fish. Label each fin.

5. Which of the above fins are paired (identical fins on each side of the body)?

6. Fish use the dorsal and anal fins for stability and to stay upright. Based on their structure and position, what do you think the other fins are used for?

7. Draw a fish scale, showing the growth lines.

8. According to the growth lines, how old is the fish?

9. Using *Figure 4*, label the nostril, operculum, lateral line, and fins.

PART B: INTERNAL ANATOMY

Respiratory System

1. Using scissors, cut the operculum off of one side of the fish to expose the gills.

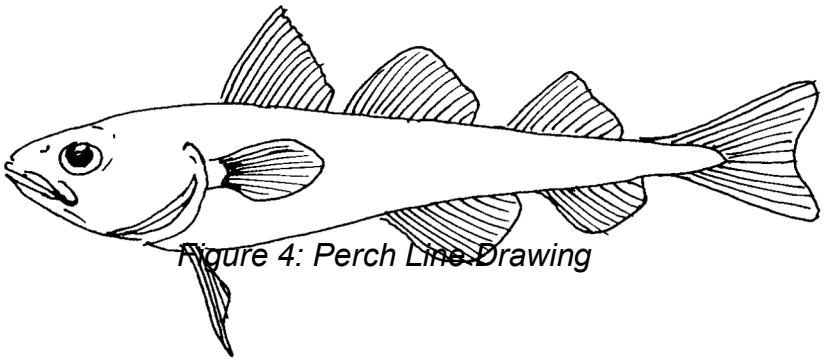


Figure 4: Perch Line Drawing

Each gill consists of feathery filaments attached to a gill arch.

2. Remove a portion of one gill by cutting it with scissors at its point of attachment to the arch. Examine the feathery structure.

NOTE: Cut carefully to avoid destroying the organs beneath the body wall. To expose the fish's internal organs, you will cut out a section of the muscular body wall. With sharp scissors, make an incision close to the anus. Cut forward to the gills (where you removed the operculum). From the top of the gill area, cut along the body to a point above your first incision. Cut downward to the incision. Carefully remove the flap of body wall, using a scalpel if necessary.

QUESTIONS – RESPIRATORY SYSTEM

1. How many gills do you find?

2. How does the feathery structure of the gills aid in gas exchange?

Circulatory System

The fish's two-chambered heart lies ventral to, just behind, the gills. Veins carry blood to the upper chamber, the atrium. The blood then flows into the larger chamber, the ventricle. Ventricle muscles pump the blood through arteries to the gills, where it exchanges carbon dioxide for oxygen. The arteries then channel blood, carrying food absorbed from the intestine and oxygen, throughout the body.

Digestive System

Food enters the digestive tract through the fish's **mouth.** It passes through the throat like **pharynx** into the **esophagus,** the tube that leads to the stomach. The stomach's capacity is increased by several pouch like structures called pyloric caeca. After being partially digested in the stomach, the food enters the winding intestine. Digestion is completed there, with the aid of the bean-shaped liver. Undigested food is removed through the anus.

Use your probe to trace the digestive tract, starting at the esophagus. You may have to push aside the liver and gills to see the esophagus.

QUESTIONS – DIGESTIVE SYSTEM

1. How do you think the pyloric caeca aid the stomach in digestion?

Excretory System

Lying just beneath the spine are the kidneys, which appear as dark masses of tissue. The kidneys absorb waste products from the blood. The waste is excreted as urine through the urogenital opening, just behind the anus.

Reproductive System

The fish's reproductive organ, or gonad, is located above the intestine and leads into the urogenital opening. In a female fish, the organ is a large yellow mass of tissue called the ovary. In a male, the organ is a smaller, whitish mass of tissue called the testis.

Between the gonad and the kidneys is a sac called the air bladder. The fish uses the air bladder to regulate its position in the water. So, it plays an important part in the fish's ability to live and swim in the water. The fish inflates the air bladder with gases produced in the blood. As the amount of gas in the bladder changes, the fish's vertical position in the water changes.

When you have finished your dissection, wrap the fish in the paper towels and dispose of it as instructed by your teacher. If time remains in your class period, you might wish to perform the follow-up dissection before disposing of the fish.

QUESTIONS – REPRODUCTIVE SYSTEM

1. Is your fish a male or a female?

2. If the amount of gas in the bladder increases, what do you think happens to the fish's position?

3. What function does the air bladder perform?

ANALYSIS

1. Write the system (or systems) to which each structure listed below belongs. (Systems: respiratory, circulatory, digestive, excretory, reproductive.)

	SYSTEM		SYSTEM
Anus		Mouth	
Arteries		Ovary	
Esophagus		Pharynx	
Gills		Pyloric Caeca	
Heart		Stomach	
Intestine		Testis	
Kidneys		Urogenital Opening	
Liver		Veins	

2. The fish's mouth and pharynx are wide and its esophagus is elastic. What does the nature of these structures indicate about the fish's feeding?

3. Some fish, such as sharks and rays, do not have air bladders. How must they maintain their vertical position in the water?

EXTENSION

Using scissors, cut away the body wall between the fish's eyes until you reach the skull. With a scalpel or razor blade, carefully scrape away the top portion of the skull. This should expose the brain and anterior portion of the spinal cord. These organs are part of the fish's nervous system. Draw the brain, showing the lobes.