Perry, 2000 - after Snook & Johnson

INVERTEBRATES

Lesson Plans

A Curriculum in Marine Sciences for Grades 4 - 8

UCLA OceanGLOBE

INVERTEBRATE LESSONS

Introduction to the Invertebrates

An invertebrate is any animal without a backbone. Invertebrates make up 95% of all species of animals on the earth, and the variety of invertebrates is enormous. Scientists group or "clas sify" all of these different types of animals into broad categories called phyla, on the basis of their patterns of symmetry and on the basis of their overall body plan. There are 5 particularly important invertebrate phyla (and another 23 or so less important phyla). The major invertebrate groups are classified as:

- Phylum Cnidaria: sea anemones, corals, and jellyfish
- Phylum Annelida: segmented worms
- Phylum Mollusca: clams, snails, and squids
- Phylum Arthropoda: lobsters, beetles, crabs, and flies and scorpions
- Phylum Echinodermata: sea urchins, sea cucumbers, and starfish

Various guidelines are used by taxonomists (zoologists who initially describe new species and classify animals) to establish the Classification System for the Animal Kingdom, just as librarians use a guideline, the Dewey Decimal System, for arranging books in a library. Pattern of symmetry is an important consideration for determining relationships at the phyletic level of classification, but symmetry alone does not provide sufficient information to determine phyletic status. For example, lobsters are bilaterally symmetrical, with a left side and a right side, with a front end and a rear end, and with a top side (called the "dorsal" side) and a bottom side (designated "ventral"). Since we ourselves exhibit this same set of relationships, bilateral symmetry does not seem to be particularly unusual, except that humans walk upright and we call our dorsal side our "back" and we call our ventral side the "front." All vertebrates, including people, are bilaterally symmetrical, and, indeed, so are most invertebrates. Lobsters and all of their millions of relatives, from butterflies to crabs and all other members of the Phylum Arthropoda, are also bilaterally symmetrical. But arthropods are not related to vertebrates, even though both groups exhibit similar patterns of bilateral symmetry. This is because arthropods and vertebrates have extremely different body plans, with different types of skeletons and muscles, and different patterns of plumbing. Vertebrates have internal skeletons of bone, whereas arthropods have external skeletons made of an animal plastic called chitin. The muscles that move our fingers lie outside of and around the bones of the hand, whereas the muscles that move the pincers of the claws of a lobster are inside the claw, beneath the chitinous shell, its external skeleton. The basic architecture of these two groups of animals is so different that they cannot have had a common ancestor, and so we classify arthropods and vertebrates as belonging to separate phyla, on the basis of both their body plans as well as their patterns of symmetry.

Worms are also bilaterally symmetrical, with a front end and a back end, with left and right, and a dorsal and a ventral surface. But worms don't have rigid skeletons, like crabs or cats. Instead they move by using hydraulic pressure, in the same way that the brake fluid in a car transmits the force of the driver's foot to the brake pads on the wheels. The muscles of a worm are located in the tube-like body wall. When these muscles contract they increase the hydraulic pressure of the body fluids inside the worm's body, extending the front end of the worm and permitting it to squeeze through holes between rocks and to burrow in the soil. Worms thus have unique body plans that indicate ancient ancestral relationships, and most worms are classified by taxonomists as members of the Phylum Annelida.

Clams and snails and squid, in the Phylum Mollusca, are also bilaterally symmetrical, with a left and right, a top and bottom, and a front and a back. But snails often have a twisted shell, producing a confusing dorsal symmetry, and clams don't have heads, so it is tricky (but rather fun) to figure out which is the front end and which is the back end of a clam. Clams and snails have external skeletons, like arthropods, but their external skeletons are not made of animal plastic. Instead the skeleton is constructed of calcium carbonate, the same material used for construction of bones, but the calcium carbonate in the shells of molluscs is deposited in a much harder form than bone, in the form of the minerals calcite and aragonite. Squids and octopus don't have external shells, but they have the same body plan exhibited by Nautilus, which does have a snail-like shell, so we include squids and octopus in the Phylum Mollusca also.

Members of the Phylum Cnidaria, the sea anemones and jellyfish, are not bilaterally symmetrical but instead they are oriented in distinctive radial patterns with tentacles in multiples of 4 or 6 around a central mouth. Their entire body plan is also unique, with a mouth and a stomach but no anus at all. Food captured by tentacles that ring the mouth enters the stomach cavity, and when the food is finally digested the remnants are expelled through the mouth. Cnidarians have exceptionally simple nervous systems, arranged radially around the mouth; they have no heart or any other complex organs. Some cnidarians, such as sea anemones and corals, live attached to the sea floor. Jellyfish, or medusae, can move through the water column because they have a rather unique, flexible "skeleton" formed of a jelly-like substance called "mesoglea," which stretches the radial muscles after each contraction, permitting rapid swimming. Cnidarians capture food with tiny stinging capsules, called cnidae or nematocysts, within specialized cells, called cnidocytes, on the tentacles. The current name of the phylum, "Cnidaria," emphasizes the importance of these stinging cells for the biology of this entire group of animals, and this name has replaced the more familiar phylum name Coelenterata.

Sea urchins, starfish, and sea cucumbers are members of a large assemblage of marine animals classified as members of the Phylum Echinodermata. Echinoderms all exhibit radial symmetry, but they are all structured exclusively in pentamerous patterns, with the 5 arms of starfish being the most distinctive expression of the 5-pointed, radial organization of the body plan. Sea urchin skeletons look almost perfectly round, but if one looks carefully, the holes and tubercles on the shell are clearly organized into pentamerous radial sectors. The skeletons of echinoderms are internal structures of carbonate, as are the skeletons of vertebrates, but the mineral in the skeletal ossicles is magnesium calcite. Sea urchins have rigid skeletons, with the mouth opening on the lower surface, called the "oral side", next to the surface of the sea floor, and with the anus upward, on the top of the body, called the "aboral" side. Sea cucumbers have tiny skeletal elements and a flexible body wall, but they are oriented differently, moving across the sea floor like huge worms, with the mouth, or oral end, at the front and the aboral end, with the anus, at the rear. In cross-section, sea cucumbers are obviously pentamerous and radial in their body plan, but now this 5-part symmetry is stretched out lengthwise, and, functionally, the sea cucumber looks like a fat, bilateral worm.

These 5 phyla are all distinctive and important groups of invertebrates, but within each group there are also distinctive subgroups, such as starfish as opposed to sea urchins. Taxonomists have categorized these distinctions by dividing each Phylum into Classes, Classes into Orders, Orders into Families, and Families into Genera. Finally, animals are sorted into unique species, the individuals of which reproduce only with one another. Every species is designated by a unique two-word Latin name, a genus and a species name. For example, the common two-spot octopus on our coast is formally named Octopus bimaculatus. Notice that the first word in the name begins with a capitalized letter, that the second word in the name is in small case, and that both the genus and species names are underlined. We need universal, scientific names for each species because people in different parts of a country, and in different countries, invariably use different, local names for the same species or similar names for different species. This would result in incredible confusion if we could not keep our information on each species in the right category. For example, if the books in the Library of Congress were all shelved at random, it would be difficult, if not impossible, for a historian to learn anything about the history of literature in Iceland. Just so, must we keep our zoological library in order, with all the species correctly named and properly classified.

CONCEPTS RELATED TO THE
CALIFORNIA STATE SCIENCE STANDARDS

7th Grade:

Structure and Function in Living Systems
The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function.

8th Grade:
Motion
The velocity of an object is the rate of change of its position.

Forces
Unbalanced forces cause changes in velocity

Investigation and Experimentation (all grades)

Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

a. Develop a hypothesis.

b. Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.
c. Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.
d. Communicate the steps and results from an investigation in written reports and oral presentations.
e. Recognize whether evidence is consistent with a proposed explanation.

f. Read a topographic map and a geologic map for evidence provided on the maps and construct and interpret a simple scale map.
g. Interpret events by sequence and time from natural phenomena (e.g., the relative ages of rocks and intrusions).
h. Identify changes in natural phenomena over time without manipulating the phenomena (e.g., a tree limb, a grove of trees, a stream, a hillslope).

CONCEPTS RELATED TO THE NATIONAL SCIENCE STANDARDS

EVIDENCE, MODELS, AND EXPLANATION

- Evidence consists of observations and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and designed systems. Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power. Models help scientists and engineers understand how things work. Models take many forms, including physical objects, plans, mental constructs, mathematical equations, and computer simulations.

MOTIONS AND FORCES

- The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.

FORM AND FUNCTION

- Form and function are complementary aspects of objects, organisms, and systems in the natural and designed world. The form or shape of an object or system is frequently related to use, operation, or function. Function frequently relies on form. Understanding of form and function applies to different levels of organization. Students should be able to explain function by referring to form and explain form by referring to function

SCIENTIFIC INQUIRY

- Different kinds of questions suggest different kinds of scientific investigations. Some investigations involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve seeking more information; some involve discovery of new objects and phenomena; and some involve making models.

- Current scientific knowledge and understanding guide scientific investigations. Different scientific domains employ different methods, core theories, and standards to advance scientific knowledge and understanding.

- Mathematics is important in all aspects of scientific inquiry.

- Technology used to gather data enhances accuracy and allows scientists to analyze and quantify results of investigations.

- Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific principles, models, and theories. The scientific community accepts and uses such explanations until displaced by better scientific ones. When such displacement occurs, science advances.

- Science advances through legitimate skepticism. Asking questions and querying other scientists' explanations is part of scientific inquiry. Scientists evaluate the explanations proposed by other scientists by examining evidence, comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations.

- Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data. All of these results can lead to new investigations.

INIVERTEBRATE VOCABULARY

Annelida	Phylum of segmented worms
antennae	A pair of jointed sense organs on the head of a crab, lobster, etc.
appendage	Any part of an animal coming from the main body trunk such as arms, legs
Arthropoda	Phylum of invertebrates having jointed appendages, segmented bodies, and an exosk eleton of chitin
bivalve	Mollusc with two shells
chitin	A complex carbohydrate material that forms the skeletal shell of arthropods
Chordata	Phylum of animals having a notochord and a nerve cord; contains a few types of in vertebrates
cilia	Minute hair-like projections
Cnidaria	Phylum of invertebrate animals having nematocysts, stinging cells
Coelenterata	An older name for the Phylum Cnidaria
Crustacea	A class of arthropods
Echinodermata	Phylum of invertebrates having pentamerous (5-part) radial symmetry
flagella	Whip-like structures on a cell
foot	A muscular structure of molluscs for locomotion
mantle	Tissue of a mollusc that secretes lime to create a hard shell
Mollusca	Phylum of invertebrates with soft, unsegmented bodies, usually protected by an exter nal shell
nematocyst	The stinging barb of cnidarians
operculum	A lid or cover for the opening of a snail’s shell
ossicles	Tiny skeletal plates and fragments made of calcite crystals on an echinoderm
pincers	Front claws on a crab

radula	A tongue-like toothed structure used by snails for chewing and rasping
regenerate	to grow a new body part to replace one that is lost
spicules	Needlelike rods of support that make a sponge stiff
stalk	Long slender support
swimmerets	Abdominal appendages of some crustaceans
tentacles	Long cylindrical tubes for feeding or feeling
univalve	Mollusc with only one shell

Activity #1 - Using a Dichotomous Key for Invertebrate Phyla

Objective:
Students will use a key to determine the phyla of invertebrates.

Materials:
- keys
- pictures of invertebrate organisms
- definition of terminology

Procedures:
1. Teacher puts a letter on back of each picture.
2. Students are broken into groups.
3. Each group gets a stack of pictures and uses the key to determine which phyla the animals belong to.
4. Students can use the definition sheet to help them with the key.
5. Teacher reviews the correct answers to the pictures.

Discussion:
A. Was the key helpful in identifying the invertebrates? Why?
B. Write the characteristics of each animal pictured, its phylum, and common name.
C. Would you change the identification key? How?

Taxonomic Key to the Major Invertebrate Phyla

Most taxonomic keys are "dichotomous," (two branches), which is to say they are written with a series of two choices to be made about the anatomy of an animal (or photograph of an animal) you are looking at. Keys are not made to be read from start to finish like a book or a poem. In each numbered series you should read both choices, determine which choice best applies to the specimen you are looking at, then go where the key tells you to go, often skipping other steps in between that don't apply.

1. Radial symmetry or asymmetry…………………………………………….……………2
   Bilateral symmetry…………………………………….……………………………4

2. Highly porous surface, not true tissues…………………………………**Phylum Porifera**
   Surface is not highly porous, true tissues present……………………………………..3

3. Exhibits pentaramous symmetry and tube feet…………………**Phylum Echinodermata**
   Lacks pentamerous symmetry and tube feet, possesses tentacles
   (with nematocysts)…………………………………….……………**Phylum Cnidaria**

4. Macroscopic colony of sessile, microscopic individuals, individuals ‹ 0.5 mm
   in size…………………………………………………..**Phylum Ectoprocta (Bryozoa)**
   Solitary or colonial in form, individuals of colony › 0.5 mm in size…………………..…5

5. Gelatinous………………………………………………………………………..6
   Not gelatinous……………………………………………………………………7

6. Solitary individuals with 8 rows of comb plates……………….……**Phylum Ctenophora**
   Solitary and/or colonial with incurrent and excurrent siphons, and a gelatinous exterior called a
   tunic.……………………..............………………………………..**Phylum Chordata**

7. Possesses segmentation……………………………………………………………..8
   Lacks segmentation……………………… ……………………………………….9

8. Exoskeleton with jointed appendages……………………………….**Phylum Arthropoda**
   No exoskeleton, appendages, if present, not jointed, segmented worm-like body, possibly in a tube (if
   in a tube, may have tentacles)………..................…………………**Phylum Annelida**

9. Possesses a foot, radula, arms and/or shell……………………………**Phylum Mollusca**
   Lacking all of above, dorso-ventrally flattened to a thickness of less than
   1 mm………………………………..……………………..**Phylum Platyhelminthes**

Note: This investigation may be enhanced by using the photographs found in the UCLA OceanGLOBE Beach Debris Guide. Download from:

http://www.msc.ucla.edu/oceanglobe/

VOCABULARY for INVERTEBRATE KEY

appendages Any part of an animal coming from the main body, trunk, such as arms, legs, antennae

asymmetry Having no symmetry

bilateral symmetry Having a body displaying two similar halves.

colonial A group of organisms of the same species living together.

dorsoventrally From back to front.

exoskeleton An external skeleton, shell.

gelatinous Looks like jelly.

nematocyst The stinging barb of coelentrates.

pentaramous symmetry Divided into five parts.

porous Full of tiny holes.

radial symmetry Having similar parts radiating from a central point.

radula A tongue-like toothed structure used in chewing and rasping.

segmented The division of the body into similar parts.

sessile Attached to one place.

siphon An extension of the mantle in molluscs for drawing water into the mantle cavity.

solitary By oneself.

tentacles Long cylindrical tubes for sensory reception or food capture.

Activity #2 - Using a Dichotomous Key for Shells

Objective:
Students will make observations of shells and specimens and determine the organism that inhabited the shell or the organism itself using a key.

Materials:
- shells (you will need to provide: sponge, coral, starfish, conch, auger turret, sea urchin spine, tusk shell, abalone, sand dollar, cowry, snail, scallop, clam, cockle, limpet, sea urchin)
- ruler
- dichotomous key to the shells (see next page)

Procedures:
1. Allow students time to examine items before passing out activity sheet.
2. Based on the outside of the items, order them from rough to smooth. Draw a picture of each item with as much detail as possible.
3. Use the dichotomous key to find out which animal belongs to each shell or specimen.

Discussion:
A. Was the key helpful in identifying each shell or specimen? Why?
B. What main differences did you notice in the different items?
C. Did the shell's size or shape help you determine which animal it belonged to? Explain.
D. Research what each animal looks like and draw a picture of it.

Dichotomous Key to some Shelled Invertebrates

The following are characteristics of the seashells and specimens in front of you. Use them to determine the animals' names.

1. Have a rounded or oval shape……………………………………………………..…..8
   Are not rounded………………………………………………………………….……2
2. Highly porous surface……………………………………………………….….…..3
   Surface is not porous…………………………………………………………….…4
3. Pliable…………………………………………………………………………sponge
   Hard………………………………………………………………….……….coral
4. Radial symmetry…………………………………………………….……..starfish
   Elongated shape…………………………………………………………….…….5
5. Spiral shell shape………………………………………………………………6
   Non spiral shape………………………………………………………………….7
6. Wavy edge across opening……………………………………………………..conch
   Rounded edge across opening…………………………………………...……auger turret
7. Long open tube…………………………………………………………….……….tusk
   Hard solid tube………………………………………………………sea urchin spine
8. Have several perforations in shell…………....……………………………………abalone
   Have none, one, or two holes in the shell………………………………….……..9
9. Have distinctive ribbed lines on shell……………………………………….…..10
   Are not ribbed…………………………………………………………………….…..11
10. Have ½ a hinge on back, were a part of a pair…………………………….……12
    No hinge…………………………………………………………………….……..13
11. Rounded with radial shape on surface………………………………………sand dollar
    Long opening looking like comb teeth……………………….……………………..cowrie
12. Very flat………………………………………………….………………….…..scallop
    Rounded……………………………………………….…………………….……..…14
13. Spiral in shape with an inner tube…………………………….…………….…..…snail
    Oval shape……………………………………………….…………………….….…15
14. Crossed pattern of radiating circles and lines………………..……………….………clam
    Very distinctive ribbed lines………………………………..……………….…..…cockle
15. Turquoise color inside of shell…………………………………..…………….……..limpet
    Knobs all over surface of shell with two holes……………………..…….……sea urchin

Investigation #3 - Making a Taxonomic Key

Introduction:

Southern California's abalone are large gastropod mollusks. Some species lived within the intertidal zone while most prefered subtidal ocean waters. Suddenly, during the 1990's, the abalone in the Pacific Ocean off southern California practically disappeared.

In this investigation you will work as a team of abalone taxonomists to examine and classify abalones based on the shell characteristics of four of the most common species.

Procedures:

Among the shell characteristics you might consider using for your key are:

NUMBER OF OPEN HOLES
HOLES ELEVATED OR FLAT
SHELL SMOOTH OR ROUGH
SHELLMARGIN SMOOTH OR ROUGH
MUSCLE SCAR PRESENT OR ABSENT
HOLES ROUND OR OVAL
COLOR OF SHELL EXTERIOR
ET CETERA

Work together as you carefully study the visible details of each species shell, make notes and eventually write a careful taxonomic key to identify the for different pictures: species A, species B, species C, and species D.

Discussion:

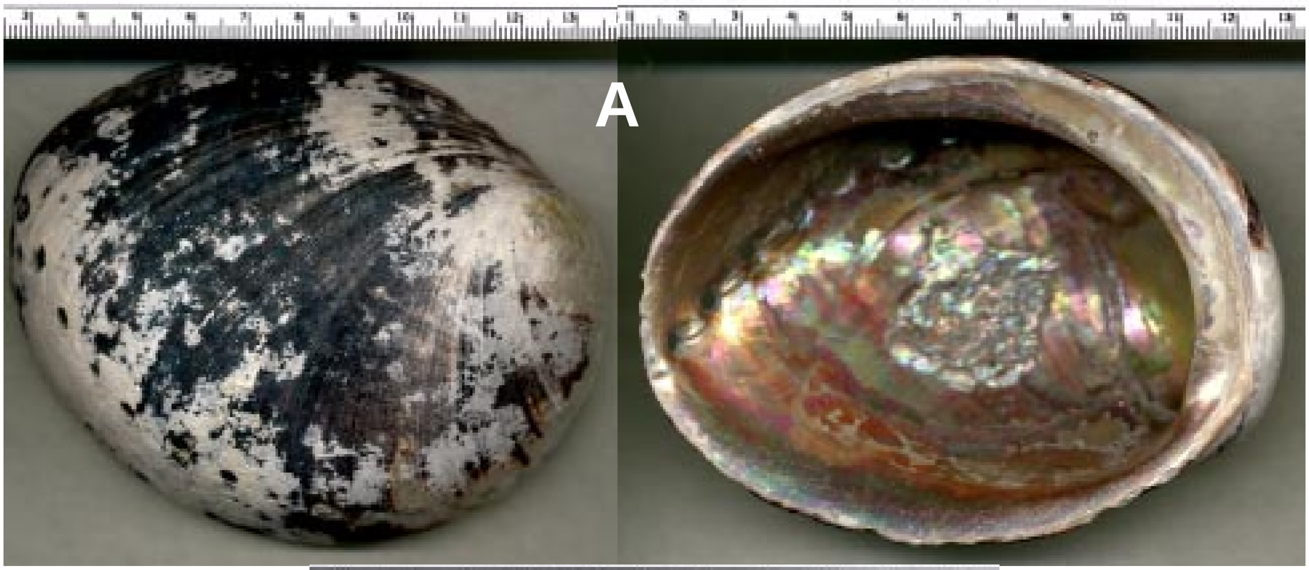
1. Which shell characteristics did you find most useful in creating your taxonomic key? Expain.

2. List several things about the shells that all the different species had in common.

3. Use an internet search engine to research the species of abalone that were historically found in southern California and their classification, then add their scientific names to your taxonomic key for species A, B, C and D. Discuss how the classification scheme you used compares to published schemes.

4. Use an internet search engine to research the current status of the sothern California abalone, and what things happened to these abalone populations. Be sure to cite your sources with a complete Bibliography of URL's and written publications used. Discuss options for possibly saving abalones and restoring their populations.

5. Research the native kelp forest habitat in which the abalone used to live. Find out what-ate-what and who-ate-who then put together a full page food web diagram for this ecosystem. What does this food web tell you about abalone conservation and restoration.



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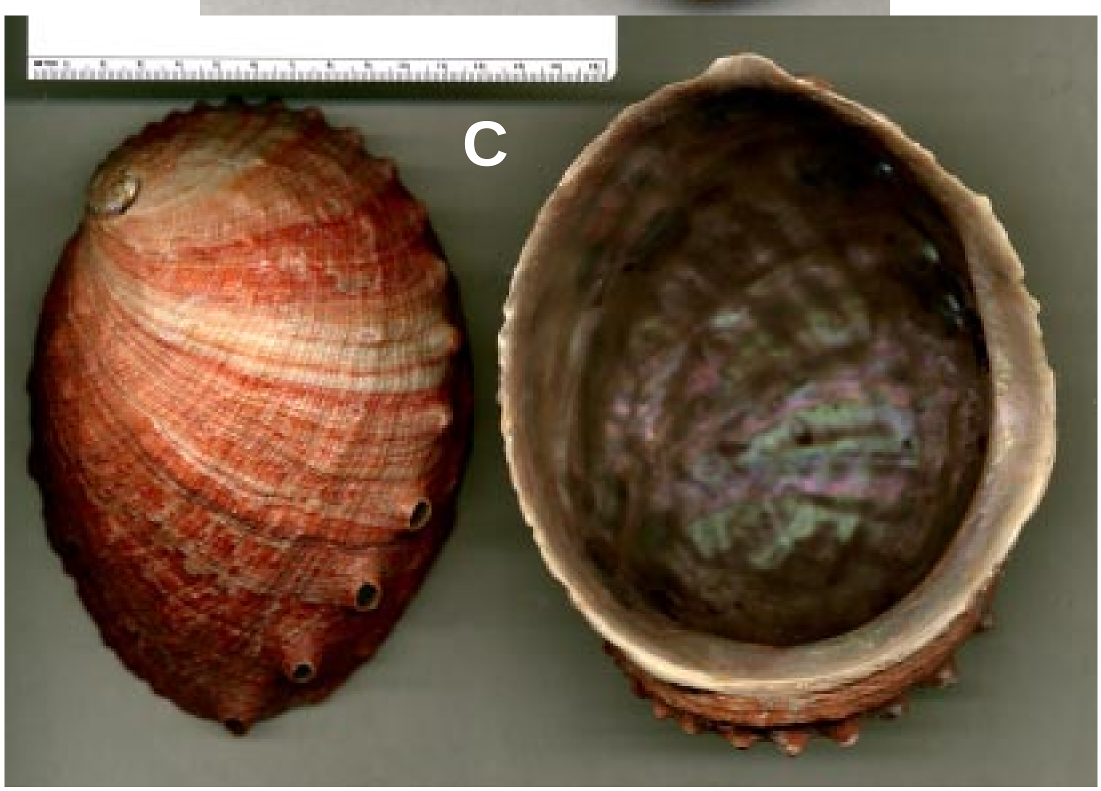

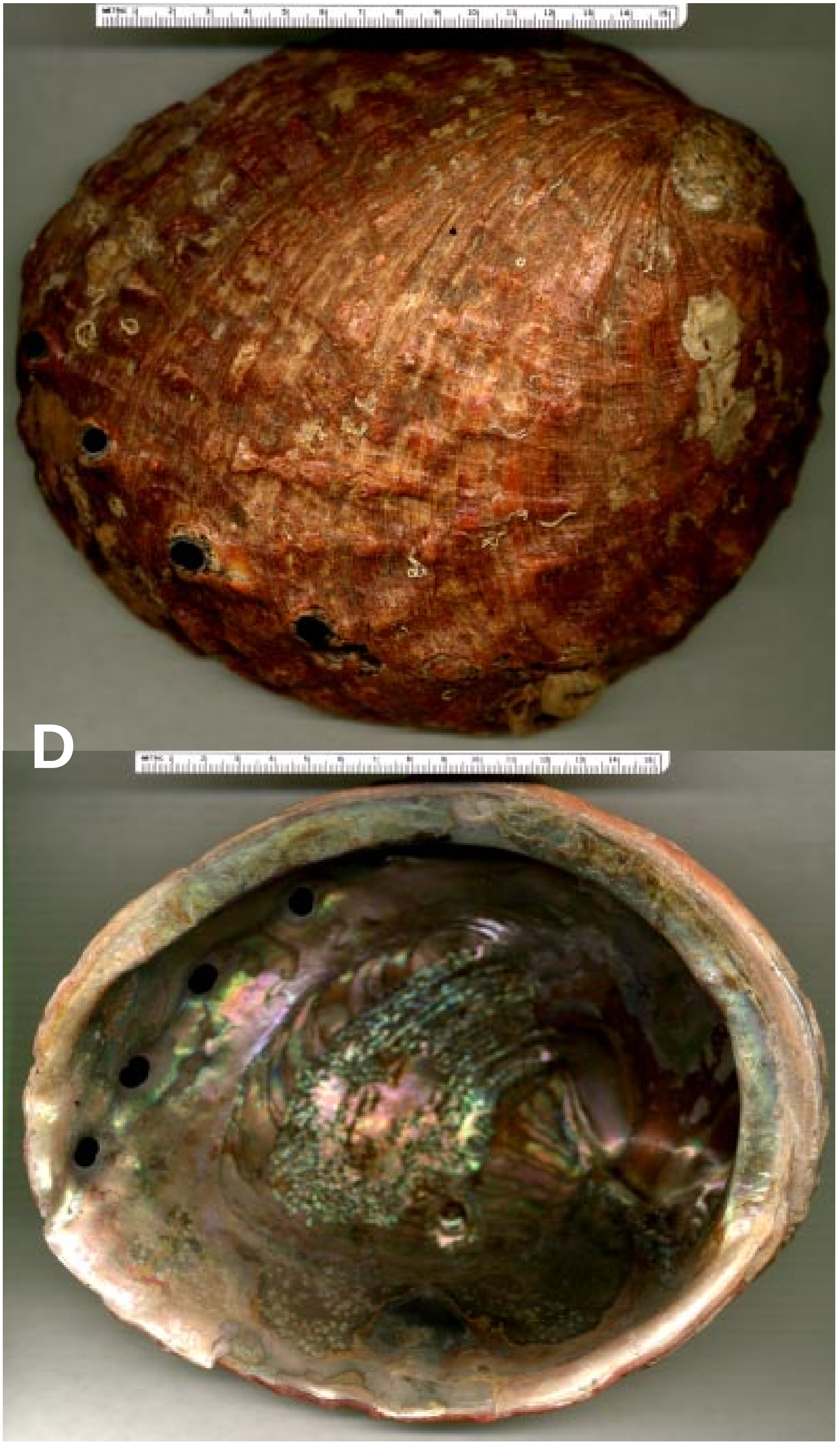
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Investigation #4 - Squid Races

Objective:
Students imitate squid propulsion using a balloon and experience Newton's third law: for every action there is an equal and opposite reaction. Various anatomical designs are tested and analyzed. Can be used to tie into several other physics concepts and calculations

Materials:
- balloons
- markers
- fishing line or string.
- drinking straws
- tape
- paper clips
- misc. cardboard, paper, plastic and other scraps of material
- stopwatches
- metric ruler or tape measure
- graph paper

(stopwatches, metric ruler or tape measure, graph paper: optional for math extension)

Procedures: (one squid balloon for each team of students)
1. Blow up a balloon of your choice but do not tie it. Twist the end of the balloon around a small paper clip to keep the air from escaping until the race begins.

2. Tape fins, stabilizers, tentacles and any other body features decided upon by your team to result in the squid that will move the fastest and travel the greatest distance. Tape drinking straw pieces to the dorsal (top) of the squid to act as guides that hold the contest string. Decorate the balloon to look like a squid. (Note: The open end of the balloon must be the rear of the squid!)

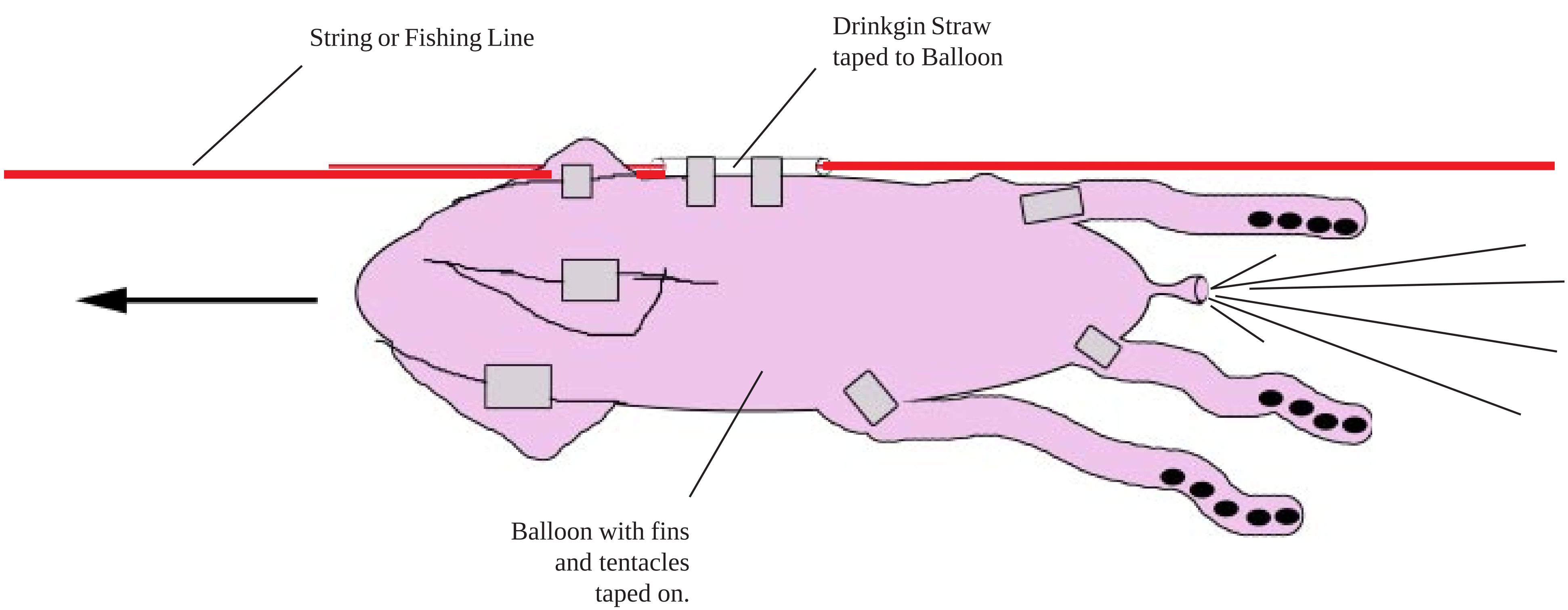
3. Stretch two strings or fishing lines across the room and tie both ends to the backs of the chairs or tape them to a wall.

4. Get ready to race two squids head-to-head, one on each string, by threading the string through the drinking straw guides. Assign a "timer" with a stopwatch for each squid.

5. When ready, release the paper clips and let the squids travel down the string. Time the travel, then use a metric measuring device and record the total distance travelled.

Discussion:
A. What is the propulsion system on a squid?
B. What caused the squid balloon to move forward?
C. Consider the balloon that won the race. What body modifications gave this squid the winning edge?
D. Draw a diagram of a squid and label its body parts.
E. How do the actual squid body features compare to those of the winning balloon?

Extension:
F. Calculate the speed of each squid using the time and distance. (Speed = distance/time)
G. Make a bar graph comparing the speed of each squid in the class.
E. What can we learn from this graph?



Exmple: Balloon Decorated as a Squid

Investigation #5 - Clam Anatomy

Objective:
Students will observe the inside and outside of a clam.

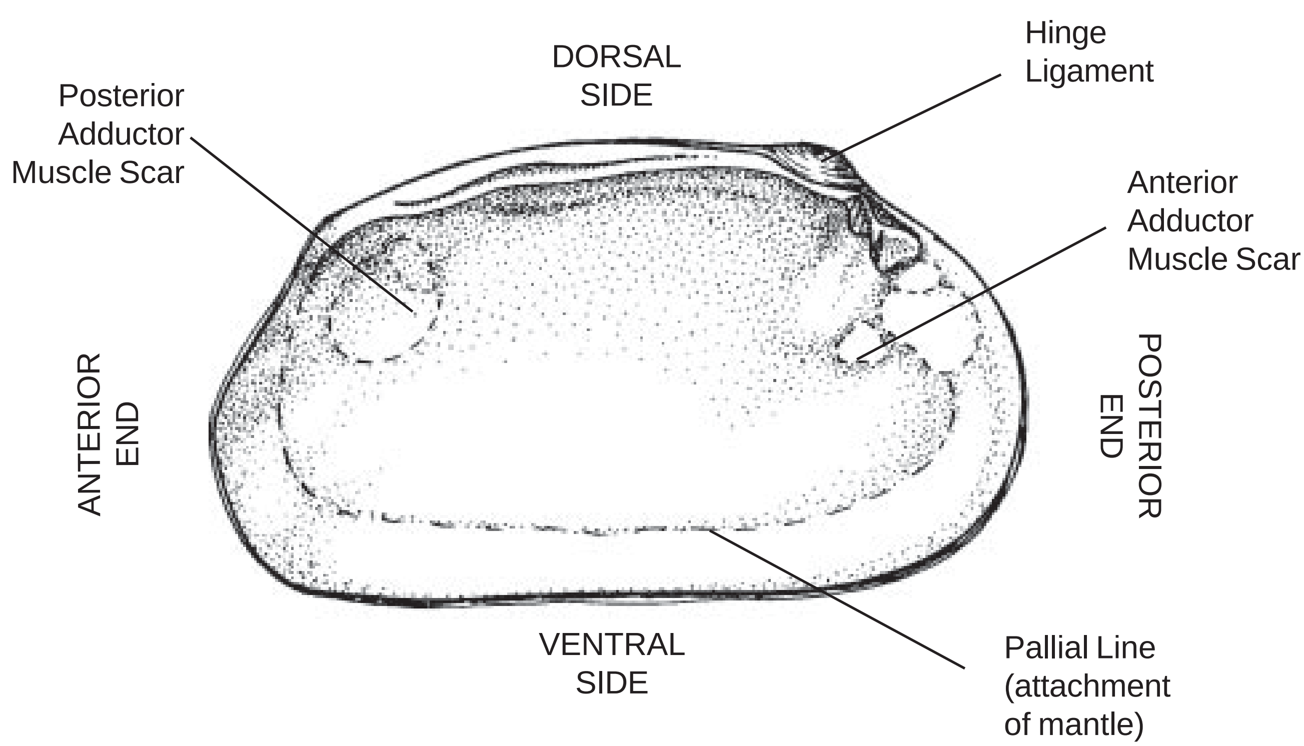
Materials:
- fresh clams (in shell)
- ruler
- data sheet
- tray
- two bamboo skewers
- clam diagrams

Procedures:
1. Teacher prepares clams ahead of time by placing in boiling water until the adductor muscles relax. (DO NOT overcook..) Snip the adductor muscle so the clam lies open.

Teacher's Note: Do the activity ahead of time to familiarize yourself with the clam's anatomy before the students participate.

2. Students work in teams of four to observe and take notes about their clams. They record their data on the sheet provided.

Discussion:
A. What did you learn from working on a fresh clam?
B. Was it easy or difficult to locate all the body parts? Why?
C. Would you rather study a diagram to learn about a clam or investigate a real clam? Explain.



Drawings courtesy of BIODIDAC.

Outside of the clam:

1). The soft body is protected by how many shells (valves)? ____________

2). Write a description of the shell's appearance: color, size, shape, etc.

3). Measurements of clam
Length _____________cm Width ___________________cm

4). Record your measurements on the class chart:
The largest clam is ___________cm wide and ______________ cm long.

The smallest clam is ____________ cm wide and _______________ cm long.

The average length of all clams measured by the class is _______________ cm

Inside of the clam:

1). The thin, whitish flesh lining is called the _______________.

The **mantle** encloses all the internal organs of the clam. It is also where new shell is made as the clam grows.

Locate the siphon according to your diagram. There are two openings, an excurrent and an incurrent siphon. As carefully as possible place a skewer down the incurrent siphon (away from the hinge). Take note of how and where the siphon enters the clam. Place a skewer down the excurrent siphon.

A. Which one of the skewers entered the clam more easily?
B. Where do the siphons end inside the clam?

Locate the following parts of your clam according to the diagram:
- adductor muscles
- gills
- mantle
- excurrent siphon
- incurrent siphon
- stomach
- mouth
- foot
- intestine

Lift the gills to find the stomach and intestines. Insert the skewer into the mouth and see that it empties into the stomach. Locate the foot that is used for digging. Check off the parts of the clam you found.

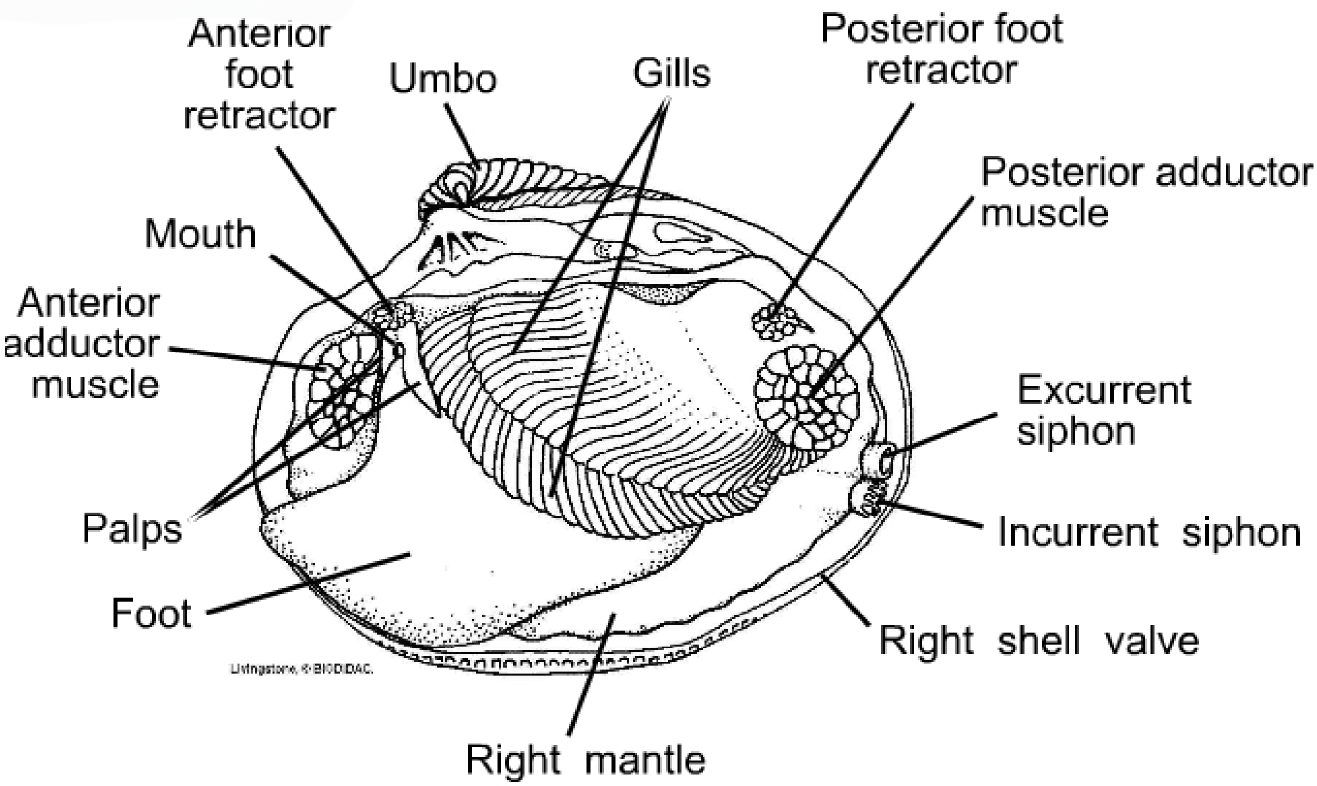
adductor muscles ______ ________ hinge ______ __________

mantle _____ __________ incurrent and excurrent siphons ______ ________

gills _____ __________ stomach ______ _________

mouth ______ __________ foot ______ ________

Write next to the body part if it is used for (P) protection, (E) eating, (B) breathing, or (M) moving



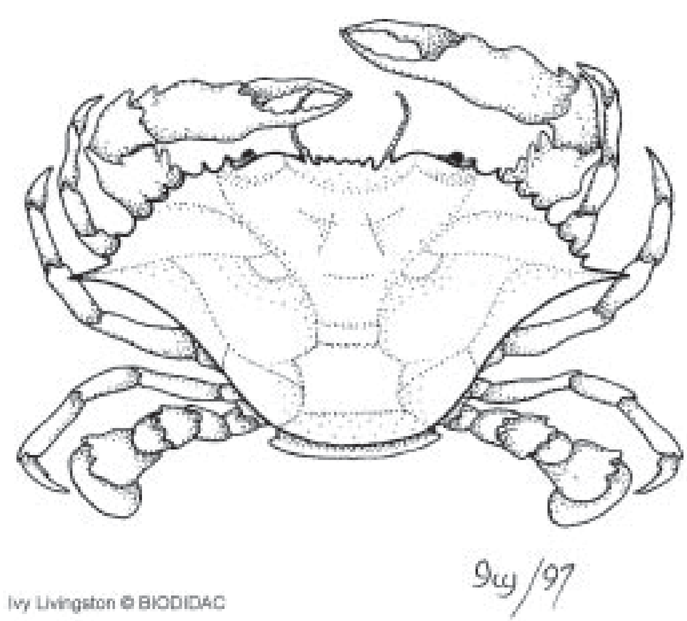
Investigation #6 - Crab Lab.

Objective:
Students will observe a crab and determine how its body structures and behaviors help it survive.

Materials:
- live crabs
- container for crabs
- ruler
- activity sheet
- aquarium with sand in bottom
- saltwater

Procedure:
1. When handling crabs grasp them across the back so you don't get pinched. Demonstrate your respect for living things.
2. The teacher can demonstrate where the swimmerets are found under the abdomen flap. Gently pull back the flap to observe the feather-like appendages. Females are larger because they need to carry eggs.
3. Students in groups of 3-4 observe their crab, answering questions about the crab's structure and behaviors. (See Worksheet)

Discussion:
A. What behaviors of the crab help it survive?
B. How does the crab's structure help it to survive?
C. What differences did you find between male and female crabs?
D. Research how different types of crabs have adapted in order to survive in their habitat.



1) How does the crab move?

2) How many appendages does the crab have?

3) Does a crab swim? How can you tell?

4) Can you tell if the crab is developing new appendages? Explain.

5) Place the crab in the container with sand and saltwater. Watch to see how the crab digs. Explain what the crab does.

6) How do you think a crab obtains food?

7) How does a crab eat? Place a piece of food in the container and watch. Describe what you see.

8) Draw a detailed picture of your crab. Label its parts.

9) How does water enter the crab's body?

10) What is the purpose of the water moving through the crab?

11) Determine which sex your crab is by looking at the triangular flap on the underside of the crab.

12) Measure your crab across its back in cm. and record on your paper and on the class chart. ______________cm.

Determine the width of the smallest and largest class crabs.

Smallest ________cm.

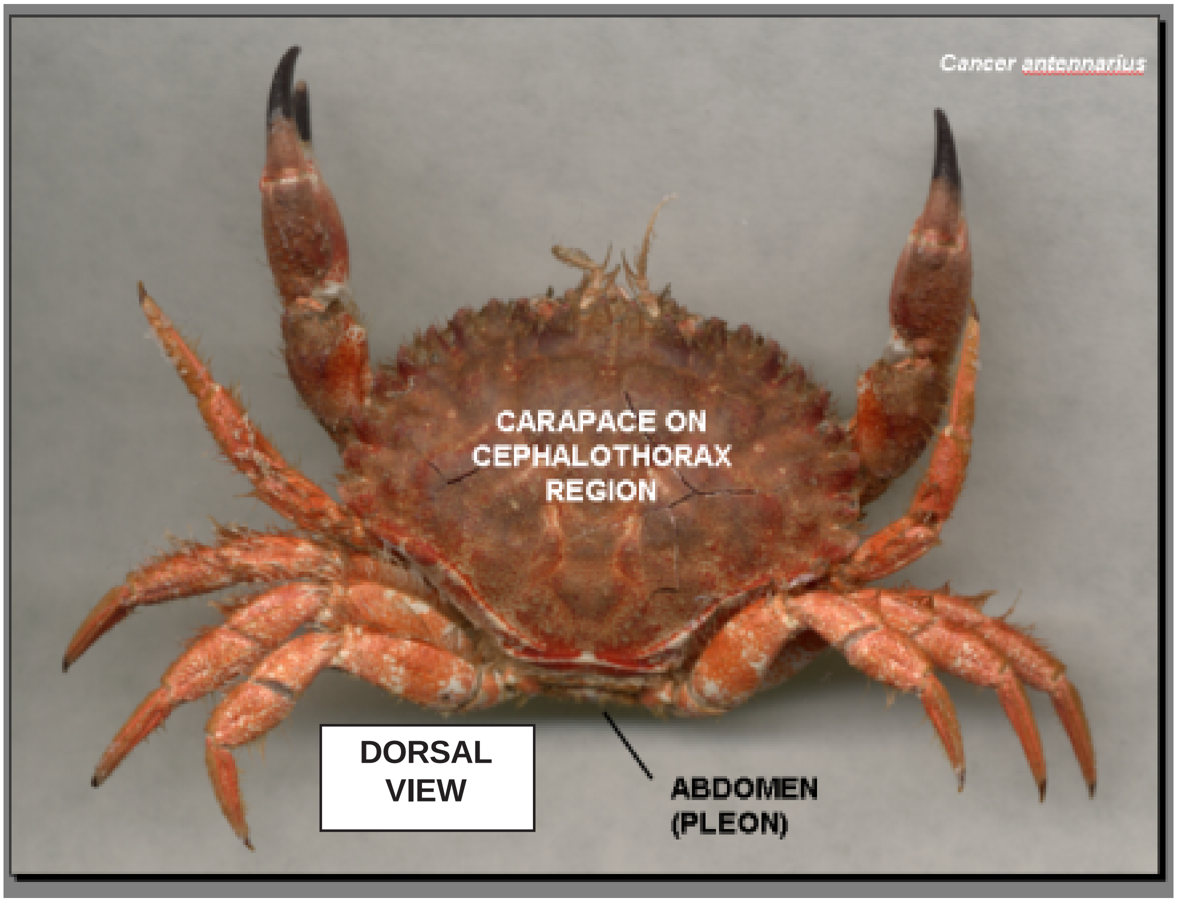
Largest _________cm.

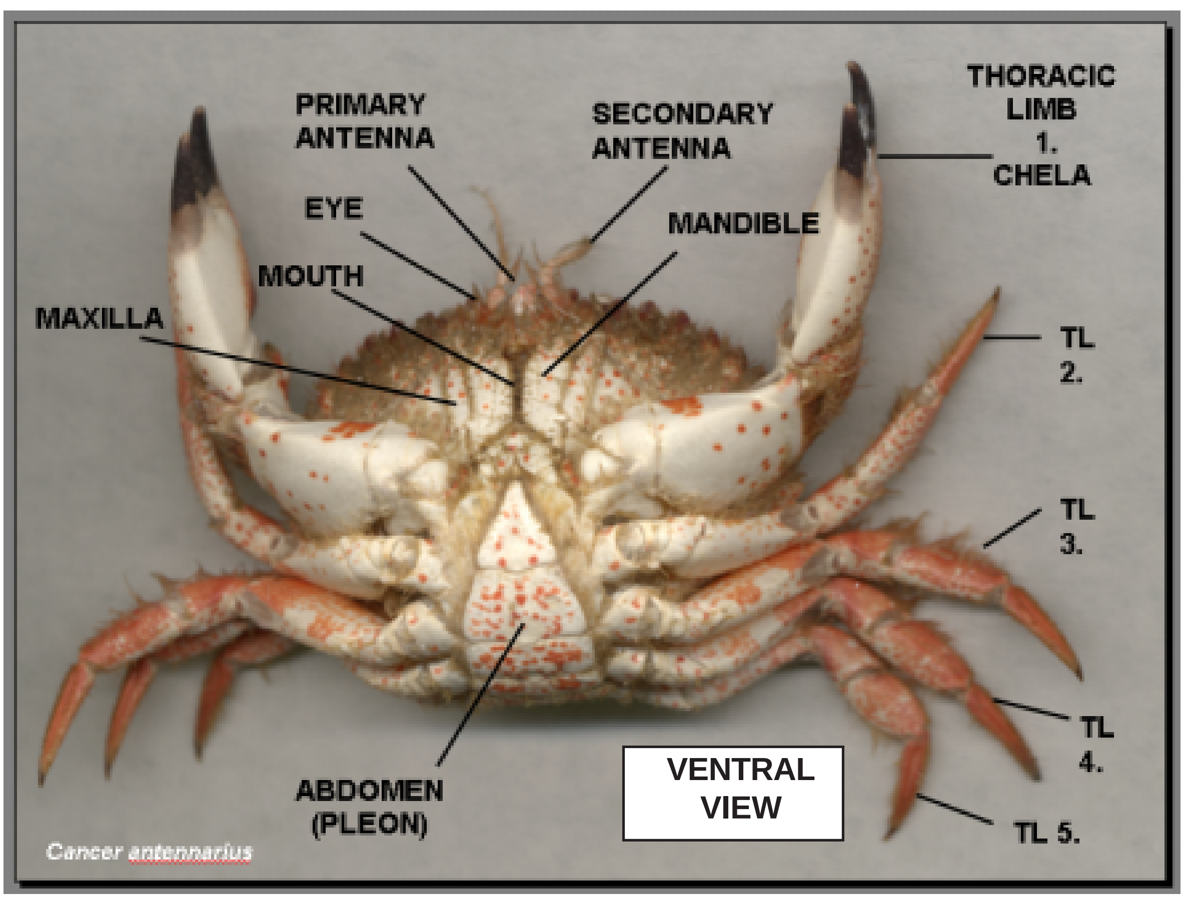
Class average __________cm.

13) Place a pencil in between the pincers. Lift the crab about six inches off the surface. Can the crab lift its own weight with one pincer? Explain.

14) Can you lift yourself off the ground with only one arm?

15) Who is stronger, the crab or you, in relation to your sizes?





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