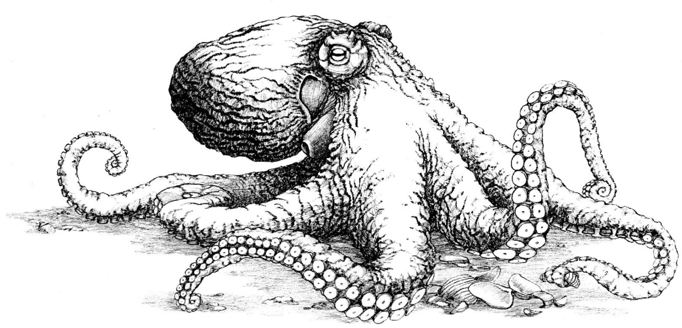
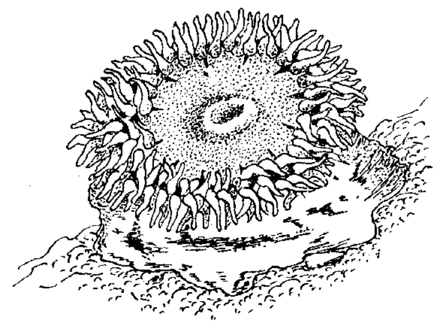
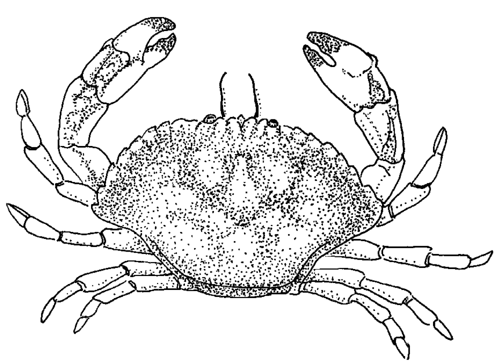
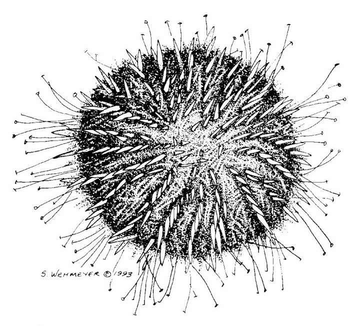
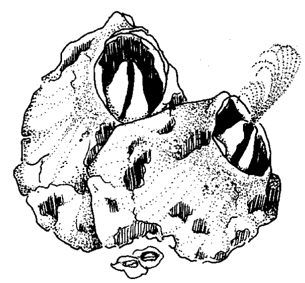
Phantastic Phyla











Lab Program Curriculum
Grades 9-12

OREGON COAST AQUARIUM

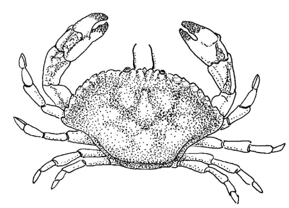
Program Description

This 45-60 minute lab program introduces students to the process of classifying organisms, using invertebrates from the phyla Arthropoda, Cnidaria, Echinodermata and Mollusca as examples. During this lab program, students will participate in an introduction to taxonomy given by one of the Aquarium's education staff members. Students will then visit four stations where they will study the characteristics of some marine invertebrates and learn how to classify each animal into its phylum group. Participating in this lab program and using the enclosed activities will help your students address the Oregon State Common Curriculum Goals and Benchmarks listed after the following before, during and after your visit suggestions.

Before your visit:

- Find out how much your students already know about the ocean environment by trying the activity **Recipe for an Ocean**, included in this packet.

- Review the enclosed **Vocabulary** list and background information to familiarize students with concepts that will be covered during their program.



Red rock crab

- Divide students into two groups and have each student put one of their shoes in each group. Have each group categorize the shoes according to like characteristics. When they're finished, have groups compare results. Explain to students that they have created a key, and discuss how this system is used to identify plants, animals, rocks, etc.

- Introduce taxonomy to your students by using the **Trying Out Taxonomy** activity.

- Introduce dichotomous keys to your students using the **Creature Classification** activity.

- Introduce the concept of adaptations, by using the **Tools of the Trade** activity included in this packet.

- Have your students research an animal from one of the four phyla and write one or two pages on what their life would be like as this ocean organism. What hazards would they face? How would they adapt to overcome these hazards? How would they ensure the survival of their species?

- Using the enclosed background information and **Roots of Scientific Names**, introduce students to scientific naming. Have students create organisms and use the list to develop scientific names to fit their creations, or provide students with pictures of unfamiliar organisms and have them come up with possible scientific names.

- Use the enclosed **Flash Cards** to introduce your students to some of the animals they will see at the Aquarium.

During your visit:

- Provide your students with copies of the **Oregon Coast Aquarium Student Guide Book**. A master copy of this booklet can be found in the self-guided materials.

- An **Oregon Coast Aquarium Chaperone Guide Book** is included in the self-guided materials as well. This guide book will allow your chaperones to more effectively direct their students as they use their own guides.

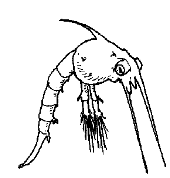
After your visit:

- If you are going to visit the tide pools, discuss the importance of putting animal's back the way they were found.

- To introduce discussion on environmental impact, try the enclosed **Dilemma Cards**.

- To create a visual representation of the harsh rocky intertidal environment, try the **Wave Wars** activity included in this packet.

- Use the **Building Better Bodies** activity to help your students understand the connection between habitat and characteristics/adaptations.



Crab zoea (larva)

- Assign further investigation of other organisms from each phylum discussed during the Aquarium lab.

- Have small groups of students choose a phylum and create an imaginary organism belong to that phylum. Ask them to be prepared to explain why their organism belongs in that particular phylum.

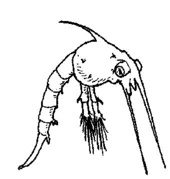
Invertebrates
Background Information

What is an invertebrate?

The invertebrates account for about 97 percent of all animal species and are extremely diverse in lifestyle, form and function. The only thing they all have in common, to set them apart from the vertebrates, is that they don't have a backbone. Invertebrates are almost everywhere, on land and in fresh and saltwater. No matter where they live, they are faced with certain challenges for survival. They must find a suitable habitat with plenty of food, avoid predators and reproduce successfully. Scientists have classified invertebrates in various groups based on their particular adaptations for survival. An **adaptation** is a characteristic, such as a body part, color pattern or behavior that helps an organism survive in its environment.

Life Cycle

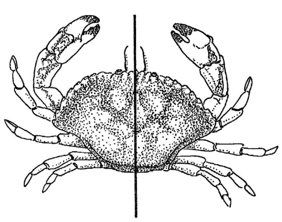
Most invertebrates spend the early part of their life with a totally different body form, living in a different habitat than they do as adults. Most marine invertebrates have microscopic **planktonic larvae** that hatch from eggs and live in the water column for a few hours to several weeks or months. After this free-floating period, the larvae change into their adult form. This process of changing form during development is called **metamorphosis**. Sometimes changes in body structure are very dramatic, such as a caterpillar becoming a butterfly or a barnacle changing from a free-floating larva to an adult attached to a surface by its head and surrounding itself with a hard shell.



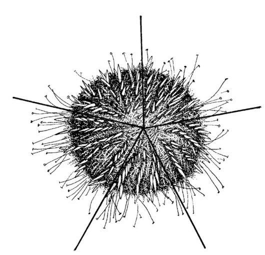
Crab zoea (larva)

Body Shape

Most invertebrates are symmetrical. A symmetrical organism has similar parts arranged on both sides of a central line or around a central point. The type of symmetry an animal has indicates its general way of life.



A bilaterally symmetrical animal can be divided into two halves, which are more or less a mirror image of each other. This makes locomotion more efficient, giving the animal the ability to move around and hunt for food rather that waiting for a meal to come their way. Common invertebrates with **bilateral symmetry** include crabs, shrimp and slugs.



A radially symmetrical animal is made up of similar parts around a central point, like the spokes of a wheel. Common invertebrates with **radial symmetry** include sea stars, sea urchins and sea anemones.

Protection

Marine invertebrates have a wide variety of fascinating adaptations to protect them from predators and other environmental challenges. Many animals, such as crabs and shrimp, have an **exoskeleton**. An exoskeleton is a hard external covering that can be molted for growth. Crabs will also use their claws for protection.

Other animals, such as snails, make themselves a **shell** that they carry with them and retreat into when threatened. A snail's shell is not considered an exoskeleton, so it is not molted as the snail grows. Instead it continues to grow as the snail grows.

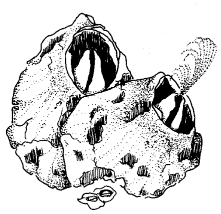
Many other animals, such as sea stars and sea urchins, have an **endoskeleton**. An endoskeleton is a hard internal skeleton. The endoskeleton on a sea star or urchin is also called a **test**. Most sea stars and urchins are also covered with hard **spines** that make them a more challenging meal.

Sea urchin

Sea anemones have no shells, spines or pincers; however they do possess an especially effective method of protection. Like their free-floating jelly relatives, they have the ability to **sting**. Their tentacles are full of tiny barbed and venomous structures called **nematocysts**. When something approaches or makes contact with the tentacles the nematocysts automatically fire and are injected into the tissue of the unlucky organism.

Feeding

Feeding styles and preferences also vary greatly among the invertebrates. As with any group of animals some are **carnivores** (meat eaters), some are **herbivores** (plant eaters) while other less discriminating eaters are **omnivores** (eat both plants and animals). Some are **deposit feeders**, and take in decaying organic material found on the seafloor. Some worms and some sea cucumbers are deposit feeders. Others are **suspension feeders** and feed on particles, including plankton, suspended in the water. Sea anemones and barnacles are examples of suspension feeders. Active **consumers** are the herbivorous **grazers**, like the sea urchins and most snails and limpets, the **predators** and the **scavengers** which all actively seek out their food.

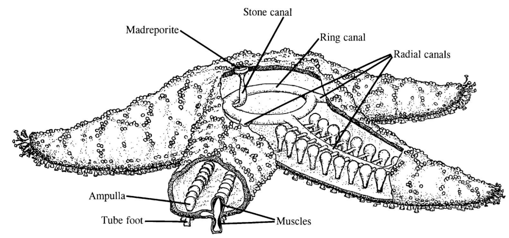


Barnacles

The following are examples of some unique invertebrate feeding adaptations:

- **Barnacles** sweep plankton into their protective shells using six pairs of feathery legs. They are attached by their head, so their mouth is deep inside the shell.
- **Sea stars** ingest their prey by either engulfing it with their stomach or by inserting their stomach inside the shell(s) of their prey. They will use their tube feet (hollow tubes ending in a suction cup) to pry open a mussel, insert their stomach and digest the soft flesh inside.
- **Mussels** pull in large quantities of plankton-rich water through a strawlike structure called a **siphon**. Once the food has been extracted, the water exits the mussel's body through the other end of the siphon.
- **Sea urchins** have five pointed teeth, configured in the shape of a star, that are used to scrape away tiny chunks of seaweed (algae*[AL-jee])*.They will use their tube feet to hold onto kelp (large brown algae) or grab a piece as it floats by.
- **Abalone** and herbivorous **snails** have a rough tongue, called a **radula** (*RA-dyoo-lah)* for scraping algae off the rocks or for consuming large pieces of seaweed. Some carnivorous snails will use their radula to drill a hole through the hard shell of their prey. Octopuses use their radula to scrape clean the shells of their prey.
- **Anemones** sting and paralyze their prey using their **nematocysts**. The tentacles pass the captured food to their stomach, which looks a lot like a belly-button. Anemones will pull in their tentacles and close up tightly while digesting a meal.

Locomotion



Crabs move quickly and efficiently using their five pairs of legs (claws are included as legs and often used in locomotion). Sea stars and sea urchins use **tube feet** to move and also to firmly attach themselves to the rocks in intertidal areas. Tube feet operate primarily on water power. These animals draw water into their bodies that is stored in canals that radiate out from a central ring. Each tube foot includes a suction cup on the end and a balloonlike bulb that is squeezed and released as the animal grabs hold and lets go. Sea anemones can move slowly on their "foot" which is actually a cluster of cells. Barnacles are permanently attached to the rock, shell or organism that they settled on as adults.

Invertebrate Classification and Characteristics

Taxonomy is the science of grouping organisms hierarchically according to similar structural characteristics. The broadest category of organisms is the **kingdom** of which there are five: Animalia, Plantae, Fungi, Protista and Monera. A kingdom is further divided in **phylum** groups. Each phylum is broken into **classes**, classes are broken into **orders**, orders into **families**, families into genera (singular: **genus**), and genera into **species** (singular: species). An organism's scientific name is their genus and species.

For example, humans are classified this way:

Kingdom: Animalia

Phylum: Chordata (The animals in this group all have a spinal chord.)

Class: Mammalia (Mammals have hair or fur and nurse their young.)

Order: Primate

Family: Homonidae (We are currently the only primates in this group.)

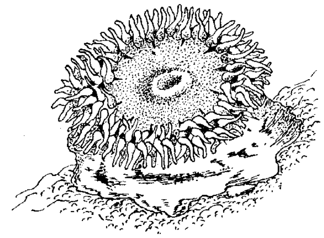
Genus: *Homo* (meaning "same")

Species: *sapiens* (meaning "wise")

There are many different invertebrate phylum groups, but for the purpose of this curriculum we will focus on the characteristics of five common groups: the **cnidarians** ("those that sting"), the **arthropods** ("jointed feet"), the **echinoderms** ("spiny skin") and the **molluscs** ("soft-bodied"). Other major invertebrate groups not discussed in this information section include the various worm and wormlike invertebrates, the sponges and the sea squirts (also called tunicates).

Cnidarians

The cnidarians *(nie-DAIR-ee-anz)* belong to the phylum Cnidaria (*nie-DAIR-ee-ah*) and include sea anemones, jellies (jellyfish) and corals. Cnidaria means “those that sting.”



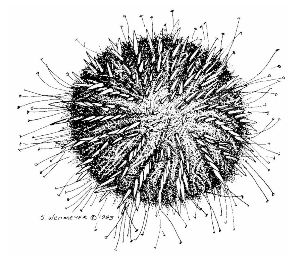
Giant green anemone

Members of this phylum share the following characteristics:

- Radial symmetry (can be cut like a pizza or pie)
- No head (therefore no brain)
- A ring of tentacles with a mouth in the center
- A two-way digestive system (what goes in the mouth, comes out the mouth)
- Stinging structures (nematocysts)
- Sessile polyp (i.e. sea anemone) and/or free-swimming medusoid form (i.e. jellyfish)
- Some are colonial (i.e. corals, hydroids, sea pens).

Echinoderms

The echinoderms *(ee-KIE-nuh-dermz)* belong to the phylum Echinodermata (*ee-KIE-nuh-der-MAH-tah*) meaning “spiny or hedgehog skin.” *Echinos* means “spiny” and *derma* means “skin.” The echinoderms include sea stars, sea urchins, sea cucumbers and sand dollars.



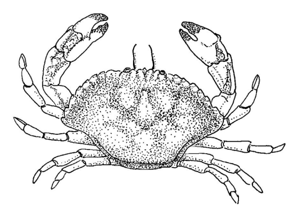
Purple sea urchin

Most members of this phylum share the following characteristics:

- Radial symmetry
- Endoskeleton made of calcium carbonate
- Water vascular system with tube feet
- No clear head or brain
- Simple nervous system
- Gut complete with mouth and anus (except brittle stars)

Arthropods

The arthropods ***(AR-thruh-podz)*** belong to the phylum Arthropoda *(ar-THRAH-poe-dah)* meaning “jointed feet.” More than 1 million arthropod species have been identified so far (both land dwelling and aquatic). That is 20 times the number of fish, amphibian, reptile, bird and mammal species combined. Crabs, shrimps, barnacles, ticks, spiders and insects are all arthropods.

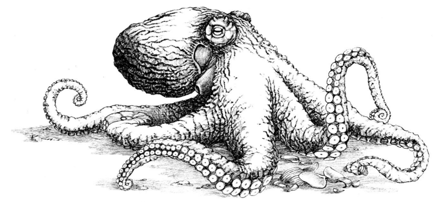


Red rock crab

Most members of this phylum share the following characteristics:

- Segmented body (usually paired appendages on each segment)
- A nervous system with a brain and a pair of nerve cords running the length of the body
- Exoskeleton, which is molted for growth
- Bilateral symmetry
- Jointed appendages

Molluscs



Pacific octopus

The molluscs *(MOLL-usks)* belong to the phylum Mollusca (*moh-LUSS-kah*) meaning "soft-bodied." Snails, slugs, clams, mussels, chitons, limpets, octopuses and squid are all molluscs.

Most members of this phylum share the following characteristics:

- Soft body that shows no signs of segmentation
- Muscular foot
- A mantle, which secretes a shell when a shell is present
- A mantle cavity—a protected area that is a fold of the mantle
- Gills suspended inside the mantle cavity
- Sharp, scraping tongue called a radula (not found in bivalves)

Taxonomy Background

Taxonomy is the science of grouping organism hierarchically according to similar structural characteristics. The broadcast category of organisms is the kingdom, of which there are five: Monera, Protista, Fungi, Plantae and Animalia. A kingdom is further divided into **phyla** (plural: phylum), each phylum is broken into **classes**, classes are broken into **orders**, orders into **families**, families into **genera** (singular: genus), and genera into **species** (singular: species).

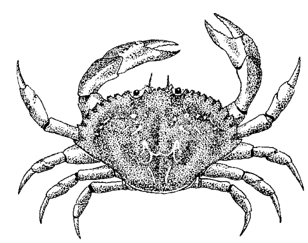
For example, Dungeness crabs are classified this way:

- **Kingdom:** Animalia
  - **Phylum:** Arthopoda
    - **Class:** Malacostraca
      - **Order:** Decapoda
        - **Family:** Cancridae
          - **Genus:** *Cancer*
            - **Species:** *magister*

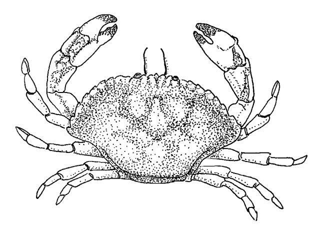
Scientists usually identify organisms by simply using the genus and species names. This system for classifying organism is called binomial nomenclature, which means “two names.” It is base on the work of the Swedish naturalist Carolus Linnaeus (1707-1778). The descriptive binomial name of a species is called its scientific name and is usually derived from Latin or Greek root. For example, the genus for a purple sea urchin in *Strongylocentratus*, which means “ball of spines,” and the species is *purpuratus*, which means “purple.” Genus and species names are italicized or underlined; the genus begins with a capital letter but the species name doesn’t.

In our everyday language we use common names, not scientific names, but this can get confusing. For one thing, common names don’t always give an accurate description of the organism—for example, a jellyfish is not a fish and a wolf-eel is not an eel. A second problem is that some organism have several common names. *Sebastolobus alascanus* is called a shortspine thornyhead by some, an idiot fish by other and a hooligan by still others. Finally, the same common name sometimes is used for different species. For instance, *Roccus saxatilis* is a rockfish if you live in Maryland, but on the west coast we have 63 species of rockfish and none of them is Roccus saxatilis. When scientists around the world call an animal by its scientific, they all know exactly which animal they are talking about.

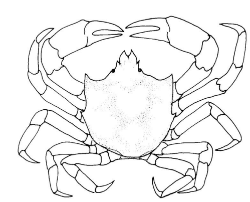
This handout offers the characteristics of some of the major multicellular marine invertebrate phylum groups. Since phylum characteristics describe a broad category of organisms, not all members of each group have every characteristic.



Dungeness crab
Cancer magister



Red rock crab
Cancer productus



Northern kelp crab
Pugettia producta

A Quick Guide to Taxonomic Groups

NOTE: Taxonomic groups are constantly being revised and are virtually never completely agreed upon. That said, here's one recent and heavily abridged version, listing the major phyla and their major subgroups. Groups are listed beginning with the simplest organisms.

(L = Latin meaning/G = Greek meaning)

Kingdom: Protista (sometimes Protoctista)

Gold brown algae

Phylum: Bacillariophyta (diatoms)
Phylum: Haptophyta (coccolithophores)
Phylum: Cryptophyta (kelp)

Green algae
Phylum: Chlorophyta

Flagellated protists
Phylum: Pyrrhophyta or Dinoflagellata (dinoflagellates)

Ameobalike protists
Phylum: Sarcomastigophora (radiolarians)
Phylum: Rhizopoda (foraminiferans)

Ciliated protists
Phylum: Ciliophora (ciliates)

Each of the above protist groups also contains other, unmentioned phyla (in some cases, many).

Kingdom: Animalia
Phylum: Porifera (sponges) – L: "pore bearing"

Phylum: Cnidaria – L: "those that sting"/G: "a stinging thread" or G: "hollow gut"
Class: Hydrozoa (hydroids) – G: "water animals"
Order: Siphonophora (includes the Portugese Man O' War)
Class: Scyphozoa (true jellies – moon jellies, sea nettles, etc.) – G: "cup animal"
Class: Cubozoa (box jellies)
Class: Anthozoa (anemones & corals) – G: "flower animals"

Phylum: Ctenophora (comb jellies, sea gooseberries, etc.) – G: "comb bearing"

Phylum: Platyhelminthes (flatworms, flukes and tapeworms) – G: "flat worm"

Phylum: Nemertea (ribbonworms) *or* Nemertina *or* Rhynochoceola

Phylum: Nematoda (roundworms) – G: "thread"

Phylum: Sipuncula (peanutworms)

Phylum: Mollusca – L: "soft"
- **Class:** Gastropoda (snails, slugs[nudibranchs], abalone) – G: "stomach foot"
- **Class:** Polyplacophora (chitons) – G: "many plate bearing"
- **Class:** Bivalvia (clams, scallops, mussels, cockles) – L: "two valved," G: "hatchet foot"
- **Class:** Scaphopoda (tusk shells) – G: "spade foot"
- **Class:** Cephalopoda (octopuses, squids, cuttlefish and nautilus) – G: "head foot"

Phylum: Annelida – L: "ring"
- **Class:** Polychaeta (scale worms, fireworms, planktonic worms . . .)
- **Class:** Oligochaeta (terrestrial worms)
- **Class:** Hirudinea (leeches) G: "leech"

Phylum: Pogonophora (deep sea tubeworms) – G: "beard bearer"

Phylum: Arthropoda – G: "jointed foot"
- **Subphylum:** Trilobita (trilobites)
- **Subphylum:** Chelicerata – G: "claw"
  - **Class:** Merostomata (horseshoe crabs)
  - **Class:** Arachnida (scorpions, spiders, ticks & mites) – G: "a spider"
  - **Class:** Pycnogonida (sea spiders) – G: "thick knees"
- **Subphylum:** Crustacea – L: "a crust"
  - **Class:** Branchiopoda (brine shrimps) – G: "gill foot"
  - **Class:** Ostracoda (seed shrimps) – G: "a shell"
  - **Class:** Copepoda (copepods) – G: "oar foot"
  - **Class:** Cirripedia (barnacles) – L: "hairy foot"
  - **Class:** Malocostraca – G: "soft shell"
    - **Order:** Stomatopoda (mantis shrimp) – L: "mouth foot"
    - **Order:** Mysidacea (opossum shrimps)
    - **Order:** Isopoda (includes pill [potato] bugs, wood lice)
    - **Order:** Amphipoda (includes beach hoppers [sand fleas], some whale lice, skeleton shrimp) – L: "both foot"
    - **Order:** Euphausiacea (krill)
    - **Order:** Decapoda – L/G: "ten feet"
      - **Suborder:** Dendrobranchiata (pelagic shrimps)
      - **Suborder:** Pleocyemata
        - **Infraorder:** Caridea (largest shrimp group)
        - **Infraorder:** Astacidea (crayfish, lobsters)
        - **Infraorder:** Palinura (spiny and slippers lobsters)
        - **Infraorder:** Anomura
          - **Superfamily:** Paguroidea (hermit crabs)
          - **Superfamily:** Galatheoidea (squat lobsters)
          - **Superfamily:** Hippoidea (mole crabs)
        - **Infraorder:** Brachyura (box, decorator, spider, cancer, mud, fiddler, pea, ghost, land, soldier and all those other crabs)

Subphylum: Uniramia

Class: Insecta (you guessed it . . .insects) – L: "an insect"/G: "six-footed"

Class: Diplopoda (millipedes)

Class: Chilopoda (centipedes)

Phylum: Brachiopoda (lamp shells) – G: "arm foot"

Phylum: Chaetognatha (arrow worms) – G: "bristle jaw"

Phylum: Echinodermata – G: "spine skin"

Class: Crinoidea (sea lilies and feather stars) – G: "lily-like"

Class: Asteroidea (sea stars) – G: "star-like" *or* Stelleroidea – L: "a star"

Subclass: Ophiuroidea (brittle stars) – G: "snake-like"

Order: Phrynophiurdia

Suborder: Euryalina (basket stars)

Class: Echinoidea (sea urchins) – G: "spine-like"

Class: Holothuroidea (sea cucumbers)

Phylum: Hemichordata (acorn worms) – G: "one-half string"

Phylum: Chordata – G: "string"

Subphylum: Urochordata *or* Tunicata (tunicates [sea squirts] and salps) – G: "tail string"

Subphylum: Cephalochordata (lancelets) – G: "head string"

Subphylum: Vertebrata (vertebrates)

Class: Agnatha (lampreys and hagfish – the "jawless" fishes)

Class: Chondrichthyes (sharks, skates and rays)

Class: Osteichthyes (bony fishes)

Class: Amphibia (frogs, salamanders & caecilians)

Class: Reptilia (reptiles)

Class: Aves (birds)

Class: Mammalia (mammals)

Phantastic Phyla
Vocabulary

If you can't find it here, try: http://www.mhhe.com/biosci/pae/glossaryt.html

abdomen *(AB-doh-men)*: the main division of the body behind the thorax of an arthropod

adaptation *(A-dap-TAY-shun)*: a characteristic, such as a body part, color pattern or behavior, that helps an organism survive in its environment

alga *(AL-guh)* [plural: **algae *(AL-jee)***]**:** a member of certain phyla of the kingdom Protista *(proe-TIS-tuh)* (once considered plants). Most seaweeds are algae.

annelid *(a-NELL-id)*: a member of the phylum Annelida *(a-NELL-ih-dah)*, worms that have a definite head, a well developed vascular, respiratory and nervous system and whose body is divided into a linear series of segments. Earthworms, sandworms, tube worms, clamworms and leeches are annelids.

anomura *(ANN-oh-MYOO-rah)*: an infraorder of "other" crabs (as opposed to "true" crabs) that includes hermit crabs and Alaskan king crabs

antenna *(an-TENN-ah)* [plural: **antennae *(an-TENN-ee)***]**:** a sensory appendage on the head of arthropods, or the second pair of the two such pairs of structures in crustaceans

anthozoan *(ANN-thuh-ZOE-un)*: a member of the class Anthoza *(AN-thuh-ZOH-ah)* in the phylum Cnidaria. An anthozoan's body consists of a column with a slit-shaped mouth at the top, bordered by nematocyst-filled tentacles, and a pedal disc on the bottom attaching the animal to the substrate. Anthozoans include sea anemones, corals and sea pens.

arthropod *(ARR-thruh-pod)*: a member of the phylum Arthropoda *(ar-THRAH-poe-dah)*, a group of invertebrates with segmented bodies and jointed appendages. Crabs, barnacles, shrimps, insects and ticks are arthropods.

asexual reproduction: reproduction by a single individual by budding, dividing or breaking

autotroph *(OTT-oh-trofe)*: an organism that makes its organic nutrients from inorganic raw materials by using an external energy source such as light energy

autotrophic *(OTT-oh-TROFE-ic)*: having the ability to synthesize food from inorganic compounds

bacterioplankton *(bac-TEER-ee-oh-PLANK-tun)*:

benthic *(BENN-thik)*: living in, on or within a substrate; the region near or on the bottom of rivers, lakes or the sea

bilateral symmetry *(bie-LATT-uh-rul)*: an arrangement in which the right and left halves of the body are mirror images of each other

binomial nomenclature *(bie-NOME-ee-ul NOE-men-CLAY-chur)*: a scientific system of naming organisms that uses a genus name and a species name

biolumninescence *(BIE-oh-LOOM-ih-NESS-ens)*: a method of light production by living organisms in which usually certain proteins (luciferins), in the presence of oxygen and an enzyme (luciferase), are converted to oxyluciferins, causing the organism to glow

biramous *(bie-RAY-muss):* referring to two-branched appendages on various crustacean species

bivalve ***(BIE-valv)*****:** a member of the class Bivalvia *(bie-VAL-vee-ah)*, a group of molluscs with a pair of shells hinged together. Clams, mussels and oysters are bivalves.

blastula ***(BLASS-tyoo-lah)*****:** an early stage in the development of an embryo, consisting of a sphere of cells enclosing a fluid-filled cavity (blastocoel)

brachyura ***(BRAKK-ee-YOU-rah)*****:** an infraorder of true crabs

broadcast fertilization: a method of reproduction in which eggs and sperm are released into the water, where fertilization and development occur

budding: asexual reproduction by formation of a new individual from a small bud on the parent organism

byssal ***(BISS-'l)*** **threads*****:*** strong, sticky threads secreted by some mollusks, used to attach the animal to the substrate.

calcareous ***(cal-CARE-ee-uss)*****:** containing calcium carbonate

camouflage ***(CAMM-uh-flazh)*****:** a behavior, shape, color or color pattern that helps a plant or animal blend in with its surroundings

carapace ***(CARR-uh-pace)*****:** in crustaceans, the hard part of the exoskeleton that covers the head and thorax

cephalization ***(SEFF-uh-luh-ZAY-shun)*****:** the concentration of important organs or functions on, in or near the head

cephalopod (***SEFF-uh-luh-pod)*****:** a member of the class Cephalopoda *(SEFFfuh-luh-POE-dah)* (meaning "head foot") within the phylum Mollusca

cerata ***(ceh-RAH-tah)*****:** projections from the body surface of nudibranchs

cheliped ***(KEE-lih-ped)*****:** in crustaceans, one of the limbs that end in pincerlike claws

chemoreceptors ***(KEEM-oh-ree-CEP-turs)*****:** hairs or other body parts that react to the presence of chemicals, for instance, chemicals given off by other animals

chitin ***(KIE-t'n)*****:** a material that forms part of an arthropod's skeleton

chiton ***(KIE-t'n)*****:** a member of the phylum Mollusca and the class Polyplacophora, with eight plates in place of a single shell

chlorophyll ***(KLORE-oh-fil)*****:** green pigment found in plants and in some animals, necessary for photosynthesis

chromotophore ***(croe-MAT-uh-fore)*****:** a pigment-containing cell that can be used by an animal to vary its external coloration

cilia ***(SILL-ee-ah)*****:** hairlike appendages that can move together in a waving motion, used by some simple animals for locomotion and by more developed animals for moving fluids within the animal

cirri ***(CIRR-eye)*****:** among barnacles, the featherlike appendages that are modified for food collection; among crinoids, the appendages used for walking and for clinging to solid substrates; among ciliated protozoans, a group of cilia that function as a single unit

cladogram ***(CLADD-oh-gram)*****:** a branching diagram showing the pattern of sharing of evolutionarily derived characters among species or higher taxa

class: the taxonomic group under phylum and above order

cloning: the ability of some organisms to create genetically identical copies of themselves asexually

cnidarian *(nie-DAIR-ee-un)*: a member of the phylum Cnidaria *(nie-DAIR-ee-ah)*, a group of invertebrates with baglike bodies, stinging cells and typically with tentacles. Cnidarians include hydroids, sea anemones, jellyfishes and corals.

cnidoblast *(NIE-doe-blast)*: the actual cell that holds the nematocyst of a Cnidarian

cnidocyte *(NIE-doe-site*): specialized stinging cell of a cnidarian

coelom *(SEE-lum)*: a fluid-filled body cavity

colloblast *(COLL-oe-blast)* cells: cells found in ctenophores *(TEEN-oh-forz)* that superficially resemble cnidarian nematocysts, but are sticky rather than barbed. Tentacles armed with colloblasts capture food.

colony: a group of organisms in which more or less distinct individuals live together and interact in mutually advantageous ways

commensalism: a symbiotic relationship in with the symbiont benefits without seriously affecting the host one way or the other

consumer: an organism that eats another organism

crustacean *(cruh-STAY-shun)*: a member of the class Crustacea *(kruh-STAY-shah)*, a group of arthropods with jointed legs, gills for breathing and usually a shell, which the animal must shed periodically in order to grow. Crabs, lobsters, beach hoppers, shrimps and barnacles are crustaceans.

ctene *(TEEN)*: (means "comb") an external longitudinal band of cilia that moves in waves

ctenophore *(TEEN-oh-fore)*: a member of the phylum Ctenophora *(teen-AH-for-ah)*, all of which are marine and most are planktonic. Ctenophores have radial body symmetry; a gelatinous, medusalike body; and, in some, colloblast cells. Sea gooseberries, sea walnuts and comb jellies are ctenophores.

cyanobacteria *(sie-ANN-oh-bac-TEER-ee-ah)*: the prokaryotic and generally photosynthetic organisms included in the kingdom Monera. Blue-green algae are cyanobacteria.

cytosome *(SITE-oh-zome)*: The cell body inside the plasma membrane

dactyl *(DAK-till)*: a modified body part, usually a foot or a leg

decomposer *(DEE-kum-POE-zer)*: an organism that causes the decay of dead plants and animals. Bacteria and fungi are decomposers.

deposit feeder: an animal that engulfs masses of sediments and processes them through its digestive tract

detritus *(dih-TRIE-tus)*: disintegrated material such as particles of uneaten food, fecal pellets and fragments of dead plants or animals

diatom *(DIE-uh-tahm)*: a single-celled, aquatic alga

dichotomous *(die-KAH-tuh-mus)* key: a method of identification in which a set of choices leads to the name of an organism

dioecious *(die-EE-shus)*: having separate sexes

dissolved organic matter (DOM): organic material produced by marine organisms released through either photosynthesis or excretion

dorsal *(DOR-sul)*:on the back, or upper, surface of a bilaterally symmetrical animal

ecdysis *(EK-dih-siss)*: the act of shedding dead skin, or in crustaceans, cyclical molting

echinoderm *(ee-KIE-nuh-derm)*: a member of the phylum Echinodermata *(ee-KIE-nuh-der-MAH-tah)*, a group of invertebrates with hard, spiny skeletons, radially symmetrical bodies and a water vascular system. Sea stars, sea urchins, sand dollars and sea cucumbers are echinoderms.

ecosystem ***(EE-coe-SIS-tum)*:** a community of organisms interacting with each other, plus the environment in which they live and with which they interact. An ecosystem includes nonliving components (minerals, soil, etc.), living components, and the climate

embryo: The early developmental stage in animals and plants that ultimately becomes an adult individual

endoskeleton ***(EN-doe-SKE-leh-tun)*:** an internal skeleton

epidermis ***(EP-ih-DUR-miss)*:** an outer layer of cells which , in animals, encloses the body in a continuous sheet

exoskeleton ***(EK-so-SKE-leh-tun)*:** a hard external covering

family: the taxonomic group below order and above genus

filter feeder: an organism that eats by filtering, or straining, small particles of food from the water

flagellum ***(fluh-GELL-um)*** [plural: **flagella** ***(fluh-GELL-ah)***]**:** the elongated appendage of certain organisms used in locomotion

food chain: a sequence in which organisms eat and are eaten, in a transfer of energy along the chain

ganglia ***(GAN-glee-ah)*:** nerve cells in a mass, separate from the brain or spinal column and used to transmit impulses

gastrolith ***(GAS-troe-lith)*:** a pebble or stone ingested and used in the stomach to aid digestion

gastropod ***(GAS-truh-pod)*:** a member of the class Gastropoda *(GAS-truh-POE-dah)*, a group of molluscs with a single broad foot. Snails, limpets, slugs and nudibranchs are gastropods.

gelatinous: jellylike

genus ***(GEE-nuss)*** [plural: **genera** ***(GEH-neh-rah)***]**:** a taxonomic classification; a group of similar species

gill: a respiratory organ used for uptake of oxygen and release of carbon dioxide in aquatic animals

gonad ***(GOE-nad)*:** a sexual gland that produces either eggs or sperm, and in some cases hormones

habitat: the place where an organism lives; its home

hemolymph ***(HEE-moe-limpf)*:** a circulatory fluid in some invertebrates that functions similar to blood and lymph in veterbrates

hermaphrodite ***(her-MA-fruh-dite)*:** an animal with both female and male reproductive organs at some point in its life

heterotrophic ***(HET-er-oe-TROFE-ic)*:** An organism that obtains its food from other organisms

holoplankton ***(HOLL-oe-PLANK-tun)*:** marine zooplankton that spend their entire lives in the plankton

hydroid ***(HIE-droid)*:** A colony of hydrozoan polyps, in the phylum Cnidaria

hydrozoan ***(HIE-droe-ZOE-un)*:** a member of the class Hydrozoa *(HIE-druh-ZOE-ah)* in the phylum Cnidaria. Colonial hydroids consist of a stalk with projecting polyps supported by a rigid envelope. Polyps of a hydroid colony are usually specialized for different functions such as feeding, reproduction and defense. Hydrozoans include hydroids, fresh-water hydras and the Portuguese man-o'-war.

instar ***(IN-star)*:** each of the various stages between molts

intertidal zone: the part of the shore between the highest high tides and the lowest low tides

invertebrate ***(in-VER-tuh-brut)*****:** an animal without a backbone

krill: shrimplike crustaceans that are the primary food of some whales and fishes

larva ***(LAR-vuh)*** [plural: **larvae** ***(LAR-vee)***]: an early developmental stage of an animal, which bears little or no resemblance to the adult

madreporite ***(MA-druh-PORE-ite)*****:** a sievelike, porous plate that enables fluid to pass in and out of the water vascular system in echinoderms

mandible ***(MAN-dih-b'l)*****:** a moveable mouthpart usually used for chewing: a jaw

mantle: in mollusk with shells, the portion of the body wall that lines and secretes the shell; in octopuses, squid and cuttlefish the mantle forms the body wall

maxilla ***(MAX-ih-lah)*****:** a type of jaw. A crustacean has two pairs of maxillae, located immediately behind the mandibles. The first pair are often termed maxillulae *(MAX-il-LOO-lee)* and the second pair are maxillae *(MAX-ih-lee).* Like the mandibles, the maxillae are modified to handle food.

maxilliped ***(max-ILL-ih-ped)*****:** in a crustacean, the first two or three pairs of thoracic appendages back of the maxillae. When they are turned forward, they aid in the handling of food.

mechanoreceptor ***(meh-KAN-no-reh-SEP-ter)*****:** a nerve organ that responds to touch or mechanical stimulus

medusa ***(meh-DOO-sah)*****:** the free-swimming, umbrella-shaped form of some cnidarians, with tentacles hanging down like a fringe

megalops ***(MEG-uh-lops)*****:** a larval stage just before the adult stage in marine crabs, when the eyes are very large, the number of appendages is complete and the abdomen is quite long

meroplankton ***(MER-oe-PLANK-tun)*****:** marine zooplankton whose larvae enter and leave the plankton at different points in the course of their development

mesoglea ***(MEZ-oe-GLEE-ah)*****:** the gelatinous middle layer of cnidarians and some sponges

metabolism: a group of processes that includes digestion, production of energy (respiration), and synthesis of molecules and structures by organisms; the sum of the constructive (anabolic) and destructive (catabolic) processes

metamorphosis ***(MEH-tuh-MOR-fuh-sis)*****:** a radical physical change occurring in the development of an animal

microbe: a microscopic orgnanism

micrometer: a millionth of a meter; also known as a micron

mixotrophic ***(mix-oe-TROFE-ic)*****:** animals that photosynthize in adding to consuming nutrients

mollusc ***(MOLL-usk)*****:** a member of the phylum Mollusca *(moh-LUSS-kah)*, a group of invertebrates with soft bodies often enclosed completely or partially by a mantle and a shell. Snails, clams, octopuses, chitons, slugs and nudibranchs are molluscs.

molt: the casting of hair, feathers, skin, horns, carapace and other parts just before their replacement

monera ***(moe-NARE-ah)*****:** the kingdom that include organisms characterized by the absence of a nucleus and membrane-bound organelles. Often called bacteria.

morphology: the form, structure and chemical composition, both internal and external, of organisms

mutualism: a type of symbiotic relationship in which both partners benefit from the association

nauplius ***(NOW-plee-us):*** a larval stage in lower groups of crustaceans having only three pairs of appendages and a single, median eye

nekton: actively swimming organisms, essentially independent of wave and current action; not plankton

nematocyst ***(neh-MA-tuh-SIST)*****:** (means "thread bag") stinging structures that cnidarians use to capture food and for protection

nemertean ***(neh-MUR-tee-un)*****:** a ribbon worm that burrows in the sand or mud

neuston ***(NEW-ston)*****:** organisms that live on the surface of the sea

niche ***(nich)*****:** the functional role and position of a species (population) within a community or ecosystem, including what resources it uses, how and when it uses the resources, and how it interacts with other populations

nucleus: cell nucleus; a spheroid body within a cell, contained in a double membrane, called the nuclear envelope, and containing chromosomes and one or more nucleoli. The genetic control center of a eukaryotic cell. The cell bodies of nerves within the central nervous system

oceanography ***(OE-shuh-NAH-gruh-fee)*****:** the study of the oceans and their biology, geology, chemistry and physics

olfactory ***(ole-FAK-tuh-ree)*** receptors: sense receptors that react to smell

omnivore ***(AHM-nih-vore)*****:** an organism that eats both plants and animals

operculum ***(oe-PER-cyoo-lum)*****:** the hard pad on the foot of some gastropod snail which is used to seal the opening of the shell

oral arms: ribbonlike appendages in the center of the underside of a medusa. Also called mouth arms.

order: the taxonomic group beneath class and above family

organism: a living thing, such as a plant or an animal

ossicle ***(AH-sih-k'l)*****:** a small bony structure in the ear, sometimes referred to as the "small bones"

oviparous ***(oe-VIH-pah-rus)*****:** producing eggs that hatch outside of the mother's body

ovulate ***(OV-yoo-late)*****:** the act of producing an egg that will later be fertilized

parasitism: a type of symbiotic relationship in which the parasite live on or in the host and benefits at the expense of the host

pedicellaria ***(PEH-dih-seh-LAIR-ee-ah)*****:** microscopic pincerlike structures around spines and gills of certain echinoderms for keeping their bodies free from debris; may also be used as defense against predators

pelagic (***peh-LA-jik)*****:** pertaining to the region that includes all offshore, or open water, areas of the ocean, from the low tide mark on out

pheromone ***(FER-uh-MONE)*****:** a chemical substance produced in an animal that will generate a behavioral response in other animals of the same species, e.g. attraction of the opposite sex

photic ***(FOE-tik)*** **zone:** the upper layer of the ocean, whre enough light filters through the seawater for phytoplankton to photosynthesisze; about the upper 100 feet

photosynthesis ***(FOE-toe-SIN-theh-sis)*****:** process by which green plants and some algae use the sun's energy to convert water and carbon dioxide into sugar and oxygen

phylogeny ***(fie-LAH-jun-ee)*****:** the origin and diversification of any taxon, or the evolutionary history of its origin and diversification, often presented in the form of a cladogram

phylum ***(FIE-lum)*** [plural: **phyla** ***(FIE-lah)***]: a taxonomic classification; a group of similar classes

physiology: a branch of biology dealing with the organic processes and phenomena of an organism or any of its parts or of a particular bodily process

phytoplankton ***(FIE-toe-PLANK-tun)*****:** photosynthesizing members of the plankton, mostly plants and algae

planktivore ***(PLANK-tih-vore)*****:** a animal that feeds on plankton

plankton ***(PLANK-tun)*****:** organisms suspended in water that drift with the currents and swim only weakly or not at all. Divided into **phytoplankton** *(FIE-toe-PLANK-tun)* (photosynthesizing members, mostly bacteria and algae) and **zooplankton** *(ZOE-PLANK-tun or ZOO-PLANK-tun)* (nonphotosynthesizing members, mostly animals and animal-like protists).

platyhelminthes ***(PLAT-ee-hel-MIN-theez)*****:** the flatworms, including flukes and tapeworms; most are marine

pleopod ***(PLEE-oe-pod)*****:** an abdominal appendage among some crustaceans that may be used in swimming, fanning water, respiration or reproduction. Decapod females carry their eggs on their pleopods.

pleuston ***(PLOO-ston)*****:** animals living on the ocean surface moved around by the wind; for example, Portuguese man of war or by-the-wind-sailors

polyp ***(POLL-ip)*****:** the sessile, stalk-like form of some cnidarians (or a stage in the life cycle of some cnidarians), attached to a surface at one end, with a circle of tentacles surrounding the mouth at the other end

poriferan ***(pore-IFF-er-un)*****:** a member of the phylum Porifera *(pore-IFF-er-ah)*, a group of invertebrates with simple, porous bodies. The sponges are poriferans.

predator: an animal that kills and eats other animals

prion ***(PRIE-on)*****:** an infectious bundle of proteins

protista ***(proe-TISS-tah)*****:** the kingdom that includes both unicellular and multicellar organisms with a true nucleus and membrane-bound organelles. Examples of protists include algae and protozoa.

protoctista: see protista

pseudopod ***(SOO-doe-pod)*****:** temporary projections found on ameobalike organisms used for movement

radial symmetry: an arrangement (round, star-shaped, etc.) of similar body parts around a central point

radula ***(RA-dyoo-lah)*****:** the filelike band of teeth that snails, chitons and many other molluscs use to scrape, tear and bore

repiration: the absorption of oxygen from the environment

Reynolds number (R_e): A number that is used to determine whether or not an organism qualifies as plankton. $R_e = \rho LV/\mu$, where ρ is the water's density, L is the animal's length, V is its velocity or speed, and μ is the viscosity of the water.

rostrum ***(ROSS-trum)*****:** the forward elongation of the carapace beyond the front of the head

salinity ***(suh-LIH-nih-tee)*****:** the amount of salts dissolved in water

scavenger: an organism that eats dead plants and animals or their parts

scyphozoan ***(SIE-fuh-ZOE-un)*****:** a member of the class Scyphozoa *(SIE-fuh-ZOE-ah)* in the phylum Cnidaria. In this class, the free-swimming medusa stage is dominant, represented by the adult jellyfish form. The polyp form is restricted to a small larval stage. Scyphozoans include the true jellies.

sedentary: having limited or no locomotion

sediment: matter that settles to the bottom of a liquid, or deposited by water, wind or glaciers

segmentation: divided into sections

sessile ***(SEH-s'l)*****:** a stationary organism attached to the substrate

silica ***(SILL-ih-cah)*****:** a mineral similar to glass that is the major component of the cell wall, shell, or skeleton of many marine organisms

siliceous ***(sill-IH-shus)*****:** containing silica

siphon ***(SIE-f'n)*****:** the tube or tubelike part of an animal's body through which water, air or food passes

siphonophore ***(sie-FONN-oe-fore)*****:** members of the cnidarian class Hydrozoa that exist as drifting colonies

species ***(SPEE-seez)*** [singular and plural]: a group of organisms that have common physical structures and can interbreed and produce fertile offspring

spicules ***(SPIH-kyoolz)*****:** spines, usually made of calcium or silica, that create the skeletal frame of a sponge

spongin ***(SPUN-jin)*** **skeleton:** a network of flexible fibers that make up the skeleton of a sponge (a natural bath sponge is actually the spongin skelton with all the living material removed)

spore: an asexual reproductive body, usually one-celled

substrate ***(SUB-strate)*****:** the surface (sand, rock, wood or even another animal) on which an animal lives

subtidal: below the lowest tides

suspension feeder: an animal that feeds by filtering out detritus or other particles suspended in the water around it

symbiosis: an intimate and prolonged association between two (or more) organisms in which at least one partner obtains some benefit from the relationship; parasitism, mutualism and commensalisms are the three types of symbiotic relationships

taxon: a group of organisms that are genetically (evolutionarily) related

taxonomy ***(tak-SAHN-uh-mee)*****:** the science of classifying or grouping organisms according to their morphological and physiological characteristics

telson ***(TEL-sun)*****:** the final segment in the body of an arthropod with special design, e.g., the broad tail of a lobster to help it escape, the stinging segment of a scorpion for defense

tentacle: a slender, flexible appendage. The tentacles of cnidarians are filled with nematocysts.

test: the shell, or covering, of animals such as sand dollars and sea urchins

thorax (***THOR-ax)*****:** the portion of the body between the head and the abdomen

torsion ***(TOR-shun)*****:** in gastropods, a twisting of the shell, mantle and viscera that brings the mantle cavity and gills to a forward position

toxin: a chemical that can be harmful to living things

trochophore ***(TROKE-oe-fore)*****:** a free-swimming ciliated marine larva characteristic of most molluscs and certain ectoprocts, brachiopods, and marine worms

trophic: pertaining to feeding and nutrition

tube feet: soft, hollow, movable extensions of some echinoderms' water vascular system, which aid in locomotion, feeding and grasping

urochordate ***(YOOR-oe-KOR-date)*****:** a member of the subphylum Urochordata of Pylum Chordata, which have all four chordate characteristics as larvae. Adults are sessile or planktonic. Sea squirts or tunicates are urochordates.

uropod ***(YOOR-oe-POD)*****:** the flattened lateral appendage of the last segment of the abdomen of the crustacean

vacuole ***(VAC-yoo-ole)*****:** a small cavity or space in the tissues of an organism, containing air or fluid

valve: in bivalves such as mussels, one of the two halves of the shell

veliger ***(VEE-lih-jer)*****:** the larval form of certain molluscs; develops from the trochophore and has the beginning of a foot, mantle, shell, and other structures

ventral ***(VEN-trul)*****:** pertaining to the underside of an animal's body

vertebrate ***(VER-tuh-brut)*****:** a member of the subphylum Vertebrata *(VER-tuh-BRAH-tah)*, a group of animals that have a segmented spinal column. Mammals, fishes, birds, reptiles and amphibians are vertebrates.

virioplankton: planktonic viruses

virus: a submicroscopic, noncellular particle composed of a nucleoprotein core and a protein shell; parasitic; will grow and reproduce in a host cell

viscera ***(VISS-er-ah)*****:** internal organs in the body cavity

viviparous ***(vie-VIP-uh-rus)*****:** producing young that are born live

water column: the area in the water between the ocean surface and the ocean floor

water vascular ***(VAS-kyoo-ler)*** **system:** a system of water-filled canals and structures (such as tube feet) in echinoderms, which aid in locomotion and food gathering

zoea ***(ZOE-ee)*****:** an early larval form of certain decapod crustaceans

zooplankton ***(ZOE-uh-PLANK-tun)*****:** nonphotosynthesizing members of the plankton, mostly animals

zooxanthellae (***ZOE-zan-THELL-ee*****):** a group of dinoflagellates that live in mutualistic relationships with some cnidarians. They promote high rates of calcium carbonate deposition in coral reefs.

Roots of Scientific Names

Root	Meaning	Root	Meaning
a (b or p)	away, from	e (x)	out,, without, from
a (n)	not, without	ect (o)	outside
acanth	thorn, spine	end (o)	within
actin	ray	ep (i)	on,upon,over
ad	toward, near	eu	good, true
alveoli	pit	eury	broad
amphi	both, double		
arch (eo)	beginning, first in time	fer	bearing
		fil	thread
arth (r)	joint		
		gastr (o or I)	stomach
bi	two	glom (er)	ball
bi (o)	life	gnath	jaw
blast	bud, sprout	gul	throat
brachi (o)	arm	gymn	naked
brachy	short	gyr (o)	ring, circle, spiral
branch (i)	gills		
bucc	cheek	haem	blood
		hal (o)	salt
cali (e or x)	cup	hemi	half
capit	head	hetero	other, different
caud	tail	hist (o)	web, tissue
cephal	head	hol (o)	whole, entire,
cerc	tail		complete, total
ceno	new, recent	homo	alike
chaet	hair, bristle	hypo	under
choan	funnel, tube	hper	above, beyond
chord	gut, string		
chrom	color	in	in, into, not,
coel	hollow		without
cten	comb	is (o)	similar, equal
cutis	skin		
cyto	hollow, cell, vessel	lecith	yolk
		loph	ridge, crest
de	down, away from	lumen	light
dent	tooth		
derm	skin	macr (o)	large
deuteron	second	mela	black
di	double, two	mere	part, segment
		meso	middle

OREGON COAST AQUARIUM

Root	Meaning	Root	Meaning
meta	ater, after, beyond	sarc (o)	flesh
mio	less	sclera (o)	hard
micr (o)	small	som (e or a)	body
mono (o)	one, single	squam (a)	scale
morph	shape	steg (o)	roof
		sten (o)	narrow, close, little
odont	tooth	stomat (o)	mouth
olig (o)	few	styl (i) or (o)	spike, stem
omni	all	sub	under, below
opisth	behind	super	above, over
orth (o)	straight	syn, sym	together, with
paleo	ancient	tel (e)	far
par (a)	beside, closely related to	teleo	perfect, entire
pect	comb	tetr (a)	four
peri	around, near	thec	case, container
phag	eat	therm (o)	heat
phil	loving	tri	three
phor	bear	trich (o)	hair, filament
phot	light	trop (o)	change, turn
phyl (o)	tribe	troph (o)	nutritive
platy	broad, flat		
plio	more	vas (o)	blood vessel
pod	foot	ventr (o)	belly
poly	many		
por (o) post	hole, passage	zo (o)	life
post	after, behind	zyg (o)	yoke, pair, union
prim (o)	first		
pro	before, in front of		
proso	forward, in front		
prot (o)	first in time, giving rise to		
pseud (o)	false		
plumo (n)	lung		
pyg	rump		
ram	branch		
retr (o)	backwards		
rhin (o)	nose		
rinch	beak, snout		

Recipe for an Ocean

Lesson at a glance:

This activity will inspire students to brainstorm the components that make up an ocean community and introduce them to the concepts of food chains and energy transfer.

Oregon State Benchmarks and Common Curriculum Goals

LIFE SCIENCE: (DIVERSITY/INTERDEPENDENCE)

- **Common Curriculum Goal:** Understand the relationships among living things and between living things and their environments.

  Content standards: Explain and analyze the interdependence of organisms in their natural environment.

  Grade 3 Benchmark: Describe a habitat and the organisms that live there.

  Grade 5 Benchmark: Describe the relationship between characteristics of specific habitats and the organisms that live there.

  - *Use drawings or models to represent a series of food chains for specific habitats. Identify the producers, consumers, and decomposers in a given habitat.*
  - *Recognize how all animals depend upon plants whether or not they eat the plants directly. Explain the relationship between animal behavior and species survival.*
  - *Describe the living and nonliving resources in a specific habitat and the adaptations of organisms to that habitat.*

  Grade 8 Benchmark: Identify and describe the factors that influence or change the balance of populations in their environment.

  - *Identify that sunlight is the major source of energy in most ecosystems and that energy then passes from organism to organism in food webs.*
  - *Identify populations of organisms within an ecosystem by the function that they serve. Differentiate between relationships among organisms including predator-prey, producer-consumer, and parasite-host.*
  - *Explain the importance of niche to an organism's ability to avoid direct competition for resources. Predict outcomes of changes in resources and energy flow in an ecosystem.*
  - *Explain how humans and other species can impact an ecosystem. Explain how the balance of resources will change with the introduction or loss of a new species within an ecosystem.*

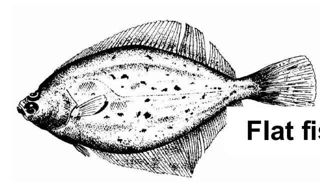
  CIM/CAM: Predict outcomes of changes in resources and energy flow in an ecosystem.

  - *Explain how humans and other species can impact an ecosystem*.
  - *Explain how the balance of resources will change with the introduction or loss of a new species within an ecosystem*.

Materials:

- ❑ Large sheet of paper and crayons or markers

  OR
- ❑ Chalkboard and chalk



Flat fish

Activity:

1. Explain to students that they are going to create a "recipe" for an ocean. Begin by asking students to name some ingredients in the ocean. As they come up with ideas write or draw them on a large sheet of paper. Make sure that sunlight is included in their recipe.
2. Once a good list has been compiled, point out the producers. Draw lines form the producers to the animals that eat them and explain the term consumers.

Continue until you've connected the entire list and formed a few complete food chains.

3. Ask students what decomposers are and where they should be drawn in. Ask them what the role of a decomposer is.
4. Explain that they have formed a cycle made up of producers, consumers and decomposers. Discuss the fact that this illustrates only a very small portion of the complex relationships among the organisms of the ocean.
5. Ask students what the role of humans might be in the cycles they have created.

<u>Summary:</u>

1. During your trip to the Aquarium, have your students find the components of the "recipe" they created and look carefully for those they may not have included.
2. Have them complete the ocean back at school.

Adapted from "Recipe for a Forest," *Sharing Nature With Children*, J. Cornell, 1979.

Assessment:

Recipe for an Ocean Collaboration Rubric

Student Name: ____

Category	4	3	2	1	Score
Contributions	Routinely provides useful ideas when participating in the group and in classroom discussion. A definite leader who contributes a lot of effort.	Usually provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard!	Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required.	Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate.	
Quality of Work	Provides work of the highest quality.	Provides high quality work.	Provides work that occasionally needs to be checked/redone by other group members to ensure quality.	Provides work that usually needs to be checked/redone by others to ensure quality.	
Attitude	Never is publicly critical of the project or the work of others. Always has a positive attitude about the task(s).	Rarely is publicly critical of the project or the work of others. Often has a positive attitude about the task(s).	Occasionally is publicly critical of the project or the work of other members of the group. Usually has a positive attitude about the task(s).	Often is publicly critical of the project or the work of other members of the group. Often has a negative attitude about the task(s).	
Focus on the task	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod, and remind to keep this person on-task.	Rarely focuses on the task and what needs to be done. Lets others do the work.	
Monitors Group Effectiveness	Routinely monitors the effectiveness of the group, and makes suggestions to make it more effective.	Routinely monitors the effectiveness of the group and works to make the group more effective.	Occasionally monitors the effectiveness of the group and works to make the group more effective.	Rarely monitors the effectiveness of the group and does not work to make it more effective.	

Trying Out Taxonomy

Lesson at a glance:

Students will demonstrate basic observation and classification skills as they sort objects by their characteristics. The primary objective of this activity is to prepare students to learn about taxonomy, the scientific classification of organisms.

Common Curriculum Goals and Benchmarks:

LIFE SCIENCE (ORGANISMS)

- Common Curriculum Goal: Understand the characteristics, structure and functions of organisms.
  Benchmark 1 (grade 3): Classify organisms based on a variety of characteristics.
  Benchmark 2 (grade 5): Describe basic plant and animal structures and their functions.

LIFE SCIENCE (HEREDITY)

- Common Curriculum Goal: Understand the transmission of traits in living things.
  Benchmark 1 (grade 3): Describe how related plants and animals have similar characteristics.
  ***CIM/CAM**: Apply concepts of inheritance of traits, including Mendel's laws, Punnett squares, and pedigrees, to determine the characteristics of offspring.*
  Analyze how living things have changed over geological time, using fossils and other scientific evidence.
  Recognize that, over time, natural selection may result in development of a new species or subspecies.

Unifying Concepts and Processes

- Common Curriculum Goal: Apply relationship concepts of population, equilibrium, force, interaction, field, structure and function, time and space and order.

Ben*chmark 1 (grade 3):* Identify structures that serve different functions.
Benchmark 2 (grade 5): Describe physical and biological examples of how structure relates to function.

Materials:

Step one:

- ❑ Inanimate objects for classification

Step two:

- ❑ Pictures of vertebrates that your students will be familiar with (be sure to include animals from each group: mammals, birds, reptiles, amphibians and fish)

Step three:

- ❑ Pictures of invertebrates from some of the major phyla: Arthropoda, porifera, Mollusca, Echinodermata and Cnidaria (include Annelida [major worm group] and Porifera [sponges] as well, if possible)
- ❑ Age-appropriate handout describing the major invertebrate phyla (included in this binder)

Background Information:

Taxonomy is the science of grouping organisms hierarchically according to similar structural characteristics. The broadcast category of organisms is the kingdom, of which there are five: Monera, Protista, Fungi, Plantae and Animalia. A kingdom is further divided into phyla (singular: phylum), each phyla is broken into classes, classes are broken into orders, orders into families, families into genera (singular: genus), and genera into species (singular: species). Sometimes taxonomists have felt the need for categories between these standard ones, giving rise to groups such as superclasses and subfamilies.

Taxonomy began as a way for scientists to better understand the relationships between the organisms they studied. This has been an ongoing process. As scientists continue to explore the natural environment they continue to learn more about currently described organisms and discover new organisms each day. While one goal of developing a taxonomic system may have been to simplify our understanding of the life we study, an absence of consensus among scientists as to exactly how things should be grouped has created much confusion.

Activity:

Note: Explain to your students that as they work in their groups they may not always completely agree about how to classify their organisms (scientists have been disagreeing about the taxonomy [scientific classification] of organisms for centuries). Students will find many different ways to classify each item and one way isn't always better than another. However, they will need to agree on how they will present their groups to the class.

Step one:

1. With younger students, you may want to begin this lesson by leading a class activity in which students classify different colored and sized shapes. This can be done on the board as a class or in small groups.
2. Define and discuss characteristics as a class. Use an inanimate object (such as a desk) as an example (compare the teacher's desk to the students' desks). Then carry the discussion a step further by discussing human characteristics and the characteristics that we share with other mammals (Mammalia is a class in the phylum Chordata, which includes all of the vertebrates).
3. When you are ready to begin the classification activity, divide your students into groups of a least three students each.
4. Give each group 10 to 20 objects and ask them to sort (classify) their objects into groups by their common characteristics. Characteristics for students to look for include: shape, size, color or function (ie. pens and pencils could be grouped together because they are both used for writing). *Object suggestions:* classroom supplies, candy or other food items, clothing, household tools (silverware, frying pan, Scotch tape, soap, etc.).
5. As the students group their items, have them write down the shared characteristics of the objects in each of their groups.
6. Tell students that they must be able to give reasons why they grouped their items the way they did.
7. Have students present and defend their classification system to the class.

Step two:

1. Give each group of students 15 or more pictures of familiar animals.
2. Ask them to list characteristics for each animal. They should list obvious visual characteristics, but they should also be able to draw from prior knowledge about each animal. For example, students may know how each animal moves, what it eats (herbivore or carnivore) or other adaptations for survival such as being warm or cold-blooded or having hair, scales or feathers.
3. Have them classify their animals based on their existing knowledge.
4. Conclude the activity with a discussion of the characteristics of each vertebrate group (fish [bony and cartilaginous], mammals, birds, reptiles, amphibians), so students can compare how they classified their organisms versus how scientists have classified them.
5. Define taxonomy (for older students) and discuss the advantages of classifying organisms by the characteristics.
6. Discuss taxonomic groups:
    a. For younger students you may only want to discuss the how plants and animals are divided into two kingdoms. Inside each kingdom there are many smaller groups. We belong to the group of animals that have backbones. Animals without backbones are divided up into lots of different groups. For example, insects are one group of invertebrates (animals without backbones).
    b. For older students introduce the major taxonomic groups: Kingdom, Phylum, Class, Order, Family, Genus, Species. A giant Pacific octopus is classified below as an example:
        - Kingdom: Animalia
            - Phylum: Mollusca (means "soft body")
                - Class: Cephalopoda (means "head foot")
                    - Order: Octopoda (means "eight feet")
                        - Family: Octopodidae
                            - Genus: *Octopus*
                                - Species: *dofleini* (a "Latinized" version of the name of the scientist who is credited with describing the giant Pacific octopus)

Step three:

1. Begin by asking students to define "invertebrate."
2. Tell them that unlike the animals they just classified, invertebrates have no backbone (some don't even have a brain) yet they still move, eat, reproduce and protect themselves from predators or harsh environmental conditions.
3. Give each group 25 or more pictures of invertebrates. They don't all have to be marine – land animals (snails, slugs and earthworms) and arthropods (insects, spiders . . .) could also be included. There are many images of the various marine phyla included with this activity and throughout this binder.

4. Explain to students that even scientists don't all agree about exactly how some of these animals should be grouped together, and that for this activity you are not looking for them to come up with the actual scientific groups, but rather recognize similarities among the animals.
5. Have students list visible characteristics for each group they've classified.
6. Have students present their groupings to the class by taping their pictures to the wall or a poster board.
7. Once all the groups are finished classifying their organisms and have come up with a list of characteristics for each group, go over the major invertebrate phyla and their characteristics.
8. Give students a handout with invertebrate characteristic information. The **Phylum Facts** sheets provided in this binder cover the mollusc, arthropod, echinoderm and cnidarian characteristics. Older students may benefit from the more detailed handouts included in this binder.
9. Use your teacher keys (for Cnidaria, Echinodermata, Mollusca and Arthropoda) to determine how well the students did while classifying their animals. Note: It can be difficult to classify a living thing from a picture alone. Ask students what they think might have helped them better classify these organisms. Look for the following answers: live animals, knowledge about their habitat, seeing them in action (eating, moving), DNA, etc.)
10. Move on to other invertebrate activities such **as Invertebrate Bingo**, **Marine Invertebrate Tools of the Trade** or the **A Few Words About Invertebrates** text and word search.

<u>Extensions:</u>

1. Have students create collages of animals in their correct taxonomic groups.
2. Have older students research an animal and find its phylum, class, order, family, genus and species.
3. Have students come up with a mnemonic device to help them remember the taxonomic groups. For example:

Kingdom – *King*
Phylum – *Philip*
Class – *came*
Order – *over*
Family – *from*
Genus – *Germany*
Species - *swimming*

Discuss how over the years scientists have had to add groups in between the main taxonomic groups to accommodate new knowledge and new animals. For example, subphylum, superclass, subclass, infraorder, suborder, etc.

Creature Classification

Lesson at a glance:

In this lesson, students will gain an understanding of how organisms are classified through the use of a dichotomous key.

Oregon State Benchmarks and Common Curriculum Goals

LIFE SCIENCE (ORGANISMS)

- **Common Curriculum Goal** (Organisms): Understand the characteristics, structure, and functions of organisms.
  Content Standard: Describe the characteristics, structure, and functions of organisms.
  Grade 3 Benchmark: Describe the basic needs of plants and animals.
  Grade 5 Benchmark: Classify organs by the system to which they belong.
  Grade 8 Benchmark: Describe and explain the relationship and interaction of organ systems.
    - Identify organ systems at work during a particular activity and describe their effect on each other.
    - Identify differences and similarities between plant and animal cells.
    - Recognize how structural differences among organisms at the cellular, tissue, and organ level are related to their habitat and life requirements.
- **Common Curriculum Goal** (Heredity)
  CIM/CAM*: Apply concepts of inheritance of traits, including Mendel's laws, Punnett squares, and pedigrees, to determine the characteristics of offspring.*
  Analyze how living things have changed over geological time, using fossils and other scientific evidence.
  Recognize that, over time, natural selection may result in development of a new species or subspecies.

Materials:

- Animal images provided in this packet
- Resources including the internet for researching animal characteristics

Background information:

In order to identify the scientific group that a certain organism belongs to, scientists use a shorthand guide based on external and internal characteristics. This guide is called a dichotomous key. Dichotomous means "two forks." Each step to keying out an organism is a simple "yes" or "no" answer to successive questions in a key.

Activity:

1. Discuss dichotomous keys with students. Explain to students that animals may have several similarities even though they are classified in very different categories, and that there is not necessarily one right answer.
2. To illustrate this concept, use the attached example of a key for identifying the orders of mammals native to the Oregon coast.
3. Next, hand out copies of the attached animal images.
4. As a class, brainstorm common characteristics of the animals to be classified.
5. Divide students into groups and assign each group two of the animals to research. Their task is to come up with a list of external and internal

characteristics. Suggest that students look at many features including body covering, appendages, means of locomotion and mode of reproduction.

6. Have students regroup when research activity is complete. As a class, have students share the characteristics they came up with for their two animals.
7. Students will be able to create a dichotomous key by comparing body parts, habitats and behaviors of all eight animals they are classifying. Remind students to begin with general questions and become progressively more specific.

Summary:

- Have each group of students compare its key to those produced by other groups. What characteristics did the students focus on to help them classify the organisms? Did everyone create the same key? How are the keys different?
- Discuss how an organism familiar to students might be identified using a key.

Oregon Coast Mammals Key

1a Forelimbs developed into leathery wings CHIROPTERA (bats)
1b Forelimbs not developed into wings ***(go to 2)***

2a Front limbs developed into paddlelike flippers; hind limbs absent; body ending in expanded horizontal fluke; blow hole (one or two nostrils); hairless or nearly hairless body CETACEA (whales, dolphins and porpoises)
2b Front and hind limbs present; body not ending in horizontal, expanded fluke; nostrils not on top of head; body covered with hair ***(go to 3)***

3a Front and hind limbs developed into flippers for swimming PINNIPEDIA (true seals and eared seals)
3b Front and hind limbs not developed into flippers for swimming ***(go to 4)***

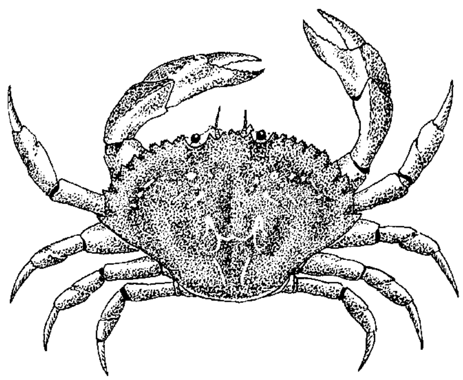
4a Toes ending in hooves; four toes on each foot ARTIODACTYLA (even-toed hoofed animals)
4b Toes usually ending in claws, not hooves ***(go to 5)***

5a Ears prominent, round, naked, thin, leathery, black; tail long, tapering, scaly, naked, prehensile; inside toes of hind feet large, lack claws, are more or less opposable to other toes MARSUPIALIA (pouched mammals)
5b Ears, if prominent, covered with hair; if naked, concealed in body hair. Tail usually well haired; if naked, not prehensile. Claws on all toes ***(go to 6)***

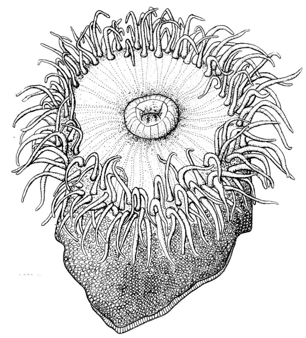
6a Snout highly flexible, protruding beyond mouth; small eyes, sometimes hidden by hair INSECTIVORA (insect eaters)
6b Snout normal, neither highly flexible nor protruding beyond mouth. Eyes usually large; if small, readily visible ***(go to 7)***

7a Fangs (canines), adapted for seizing prey, projecting far beyond other teeth CARNIVORA (flesh eaters)
7b Fangs absent; front (incisor) teeth well developed and separated from the molars by a wide gap ***(go to 8)***

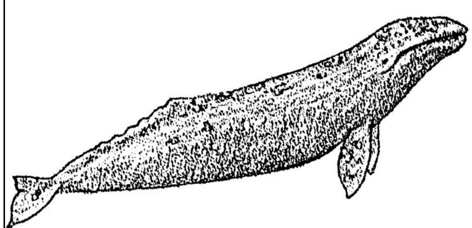
8a Ears proportionately long and narrow. Hind feet long, narrow and soles covered with dense hair; movement is characteristic hop of a rabbit. LAGOMORPHA (hares, rabbits and allies)
8b Ears proportionately small. Hind feet variously shaped but soles naked or nearly so; varied movement but not characteristic hop of a rabbit. Upper front teeth usually orange or yellow; if whitish, deep, longitudinal grooves absent RODENTIA (rodents)



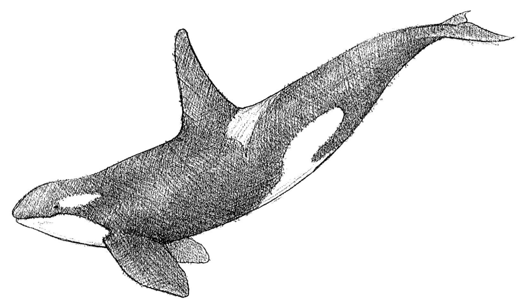
Dungeness crab



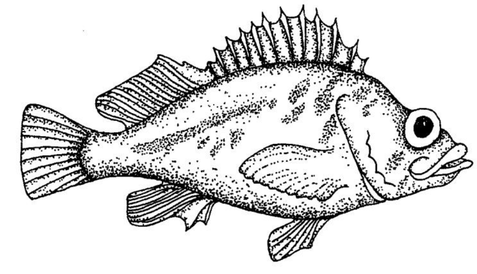
Giant green sea anemone



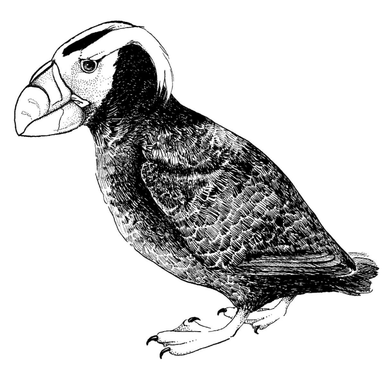
Gray whale



Orca or killer whale



Rockfish



Puffin

Key adapted from Maser, C., Mate B.R., Franklin, J.F., Dyrness, C.T. Natural History of Oregon Coast Mammals. General Technical

OREGON COAST AQUARIUM

Assessment:

Collaborative Work Skills: Creature Classification

Student Name: ______________________________

CATEGORY	4	3	2	1	Score
Contributions	Routinely provides useful ideas when participating in the group and in classroom discussion. A definite leader who contributes a lot of effort.	Usually provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard!	Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required.	Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate.	
Quality of Work	Provides work of the highest quality.	Provides high quality work.	Provides work that occasionally needs to be checked/redone by other group members to ensure quality.	Provides work that usually needs to be checked/redone by others to ensure quality.	
Problem-solving	Actively looks for and suggests solutions to problems.	Refines solutions suggested by others.	Does not suggest or refine solutions, but is willing to try out solutions suggested by others.	Does not try to solve problems or help others solve problems. Lets others do the work.	
Attitude	Never is publicly critical of the project or the work of others. Always has a positive attitude about the task(s).	Rarely is publicly critical of the project or the work of others. Often has a positive attitude about the task(s).	Occasionally is publicly critical of the project or the work of other members of the group. Usually has a positive attitude about the task(s).	Often is publicly critical of the project or the work of other members of the group. Often has a negative attitude about the task(s).	
Focus on the task	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod, and remind to keep this person on-task.	Rarely focuses on the task and what needs to be done. Lets others do the work.	

Monitors Group Effectiveness	Routinely monitors the effectiveness of the group, and makes suggestions to make it more effective.	Routinely monitors the effectiveness of the group and works to make the group more effective.	Occasionally monitors the effectiveness of the group and works to make the group more effective.	Rarely monitors the effectiveness of the group and does not work to make it more effective.	
Working with Others	Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.	Usually listens to, shares, with, and supports the efforts of others. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others, but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player.	

Marine Invertebrate Tools of the Trade

Lesson at a glance:

Students will understand and recognize some adaptations by comparing them to tools made and used by humans.

Common Curriculum Goals and Benchmarks:
unifying concepts and processes

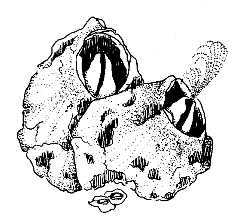
- **Common Curriculum Goal:** Apply relationship concepts of population, equilibrium, force, interaction, field, structure and function, time and space, and order.
  Benchmark 1 (grade 3): Identify structures that serve different functions.
  Benchmark 2 (grade 5): Describe physical and biological examples of how structure relates to function.
  Benchmark 3 (grade 8): Compare and contrast structures and functions in physical and biological examples.

LIFE SCIENCE (DIVERSITY/INTERDEPENDENCE)

- **Common Curriculum Goal:** Understand the relationships among living things and between living things and their environments.
  Benchmark 1 (grade 3): Describe the relationship between characteristics of specific habitats and the organisms that live there.
  ***CIM/CAM**: Apply concepts of inheritance of traits, including Mendel's laws, Punnett squares, and pedigrees, to determine the characteristics of offspring.*
  Analyze how living things have changed over geological time, using fossils and other scientific evidence.
  Recognize that, over time, natural selection may result in development of a new species

Materials:

- Marine invertebrate pictures and/or names on cards
- Human tools and other objects that represent marine invertebrate adaptations
- Blanket or sheet
- Table or floor space



Giant acorn barnacles

Activity:

Note: This activity works best as a review of the adaptations learned by your students throughout your unit.

1. Gather a collection of tools and other objects that represent marine invertebrate adaptations.
2. Before class, place the items under a blanket or sheet on the floor or on a table.
3. Give each student a picture and/or name of a marine invertebrate.
4. Explain to students that they will be looking at man-made items that can be compared to some marine invertebrate adaptations. Some of the tools simply look like a specific adaptation, while other tools actually serve a similar purpose for humans as they do for the animal with the adaptation.
5. Have the students sit down in a circle around the covered items. Everyone must be able to see the blanket or sheet.

6. Lift the covering off the items and give students three to five seconds to look at the items.
7. Quickly cover up the items.
8. Ask students to name an item that they saw that corresponds with an adaptation belonging to their assigned animal.
9. Pull out the items that the students identified.
10. Ask the student(s) holding the appropriate animal picture or name to describe why they think their animal has an adaptation that works like the tool.
11. Repeat the activity until all of the items have been seen and explained.

Comparison Examples:

Functions (“works like a . . .”) and appearances (“looks like a . . .”)

An **octopus’ beak** works like a **nutcracker** to crack open the shells of its prey. Octopuses eat crabs, snails, shrimps, mussels and other hard-shelled invertebrates.

Some molluscs, including snails, limpets, squids and octopuses, have a rough tongue called a **radula,** which works like a **file**. Octopuses and squids use their radula to scrape the flesh of their prey from their shells, while many snails and limpets use their radula to scrape algae off the rocks.

Invertebrates with **shells** benefit from the protection of their hard covering in many ways. It makes them more difficult to eat and also protects them from the harsh conditions of the environment such as crashing waves and rough rocky or sandy surfaces. Although humans have bones to protect internal organs and skin to protect us from diseases, we often engage in activities where we might need extra protection. **Helmets** should always be worn when riding a bike and **protective gear** is usually worn by football players. A **suit of armor** worn by a knight hundreds of years ago is similar to a crab’s exoskeleton – joints and all!

A barnacle has a thin exoskeleton covering its body, but that’s not quite enough, so it builds a **hard shell casing** to surround its entire body for extra protection. Its outer shell can be compared to a **stone castle** built to keep out the enemies of those who live within the castle walls.

Sea urchins have **five sharp teeth** (called Aristotle’s lantern) that they use to feed on kelp and other algae. However, some sea urchins can also use their teeth to scrape away at the rocks like a **chisel**, making a private tide pool where they are more protected from the crashing waves.

Most sea stars, sea urchins, sand dollars and sea cucumbers (the echinoderms) have **tube feet** to help them move, hold on and eat. Tube feet are soft, hollow tubes with a suction cup on the end. The suction cup can be compared to a **toilet plunger** or any other **man-made suction cup**; however, the tube foot structure actually works more like an **eyedropper** or **turkey baster** filled with liquid. It's the water pressure within the tube and tiny bulbs at the top of the tube in the animal's body that actually create the suction.

Octopuses, squids, cuttlefish and nautilus (the cephalopods) have **sucker discs** on the tentacles that help them to grab their prey. These discs can also be compared to the suction cup on a **toilet plunger**. Cephalopod suckers are different from tube feet because they rely on muscle contractions rather than water pressure for their suction. Sea anemones, jellies and corals can sting with their **nematocysts**. Nematocysts are stinging structures used to capture food and for protection. A nematocyst looks a lot like a **harpoon** or **dart** at the end of a thread.

Crabs, lobsters and some shrimps have **claws** to grab, hold and crush their prey. People will use **tongs** to grab food and **nutcrackers** to crush food, including crabs and lobsters.

Octopuses and their cephalopod relatives have a **beak** shaped like a parrot's beak that they use to crush and tear apart their prey. Since they use this beak for cracking through the hard shells of their prey, the cephalopod beak can also be compared to a **nutcracker**.

A **barnacle's feathery legs** and a **sea cucumber's feeding branches** work like tiny **nets** to trap the plankton on which they feed. Barnacle legs look a lot like **eyelashes**.

Sea urchins, sand dollars and some crabs and shrimps have bodies covered with **spines** that make them a difficult meal for many predators. Sea urchin spines look and feel just like **toothpicks**.

Summary:

1. Discuss how organisms are born with the adaptations that they need to deal with most environmental pressures and that they cannot always keep up with changes made to their environment by humans. For example: Tidepool invertebrates haven't entirely adapted to being walked on by curious humans.
2. Have students brainstorm things that they can do at home to help protect the marine environment and its inhabitants.

Extensions:

1. Have students create their own marine animal adaptation analogies.
2. Introduce evolution and discuss the theory of natural selection to help explain how marine invertebrates came to have these adaptations.
3. Use this activity as an introduction to similes and metaphors in a Language Arts unit.

Building Better Bodies

Lesson at a glance:

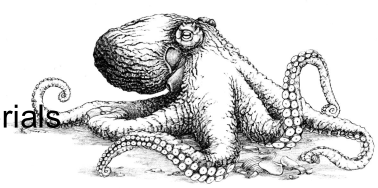
Students will design an imaginary organism that is adapted to survive in an ocean environment and create a diagram of the adaptations they have chosen to help their organism survive.

Oregon State Benchmarks and Common Curriculum Goals

LIFE SCIENCE (ORGANISMS)

- **Common Curriculum Goal** (Organisms): Understand the characteristics, structure, and functions of organisms.
  Content Standard: Describe the characteristics, structure, and functions of organisms.
  Grade 8 Benchmark: Describe the function of Organ systems.
  - Describe and explain the relationship and interaction of organ systems.
    - *Classify organs by the system to which they belong.*
    - *Identify organ systems at work during a particular activity and describe their effect on each other.*
    - *Recognize how structural differences among organisms at the cellular, tissue, and organ level are related to their habitat and life requirements.*
- Common Curriculum Goal (Heredity)
  ***CIM/CAM**: Apply concepts of inheritance of traits, including Mendel's laws, Punnett squares, and pedigrees, to determine the characteristics of offspring.*
  Analyze how living things have changed over geological time, using fossils and other scientific evidence.
  Recognize that, over time, natural selection may result in development of a new species or subspecies.

Materials:


Octopus

- ☐ Flash cards (found in this packet) or other reference materials
- ☐ Drawing tools (markers, pencils, paper)
- ☐ Paper
- ☐ Additional construction materials (cardboard, glue, construction paper, pipe cleaners, etc.)

Background:

An **adaptation** is a characteristic, such as a body part, color pattern or behavior, which helps an organism survive in its environment. Just as humans are adapted to a terrestrial environment, marine animals are adapted to deal with the many challenges faced when living in the ocean. For example, marine animals are either able to breathe in water or their body design is such that coming to the surface to take a breath is relatively effortless.

There are several different marine habitats, and each one challenges its residents' survival. For example, animals living in a rocky shore environment must contend with crashing waves and constantly changing tides, which leave tidepool residents vulnerable to predators, inconsistent food supply, weather and curious tidepooling humans.

Adaptations can be compared to human tools. For example, a whale's baleen works like a net or strainer as it collects the tiny plankton that makes up its diet. Every adaptation has a function that helps an organism survive. In order to survive an organism must have a way to acquire energy, some form of protection from environmental conditions or predators, and some way to reproduce.

Activity:

1. Begin by having students research one of the following marine environments:
   - rocky shore – a rocky coastline where the land meets the ocean
   - sandy shore – sand covered coastline formed by waves
   - kelp forest – near shore areas where dense forests of kelp grow; kelp forests are similar to a forest on land in many ways.
   - open ocean (pelagic zone) – ocean water from just offshore to mid-ocean (above 300 meters)
   - deep sea – open ocean below 300 meters
2. Once students have identified some of the environmental conditions of their chosen environment, have them list some of the adaptations they think would help their organism to survive in its habitat.
3. Students should then begin to diagram their new organism with the adaptations they have chosen or invented for their organism.
4. Students should label each of their organisms' adaptations and write a brief description of the adaptation and its function.
5. Once students have completed their diagrams, students should write a brief report about how their organism is adapted for survival in its environment.
6. Encourage students to compare their animal's adaptations to human tools.

Summary:

By examining some of the conditions to which marine organisms have adapted, students should gain a further appreciation of how certain organisms have adapted over long periods of time in order to survive.

Extensions/Assessment:

1. Have students create models of their organisms.
2. Have students do further research about the habitat they chose for their imaginary organism. Ask them to look for real organisms in that habitat that share adaptations similar to those of their imaginary organism and write a paper about them.

Wave Wars

Lesson at a glance:

Through this activity, students will gain a clear understanding of the tremendous force that waves of the Oregon shores put on the plants and animas that live here. Groups of students will work cooperatively to create an organism that will withstand the force of a simulated wave.

Oregon State Benchmarks and Common Curriculum Goals

PHYSICAL SCIENCE: FORCE

- **Common Curriculum Goal** Understand fundamental forces, their forms, and their effects on motion.
  Content standards: Describe fundamental forces and the motions resulting from them.
  Grade 8 Benchmark: Explain interactions between force and matter and relationships among force, mass, and motion.
  Describe and explain the effects of multiple forces acting on an object.
  Recognize and describe the motion of an object based on its mass and the force exerted on it.
  CIM/CAM: Recognize that waves of all kinds have energy that can be transferred when the waves interact with matter.

Materials

- ☐ Cloth bag or pillow case lined with a plastic bag and filled with seven pounds of birdseed or rice
- ☐ Masking tape
- ☐ Several sheets of card stock (manila folders cut in half work well)
- ☐ Scissors

Activity:

Begin by asking the class to brainstorm reasons why life in a tide pool might be difficult. Discuss the force of waves along the shores of the Oregon coast. Why are waves hazardous? Ask the students to imagine themselves as animals living on the rocky shore. The tide is coming in. How are they going to survive? How will they keep from being washed away? How would they change their body shape to better suit this environment?

Explain to the students that the animals of the rocky intertidal zone have developed ways to stay secured to the rocks and also to avoid being crushed by objects that come crashing in with the waves.

1. Divide the class into groups of three or four.
2. Give each group one 8 ½ "x 11" sheet of card stock, 1 ½ inches of tape, and scissors.
3. Explain that the challenge of reach group is to build a shape that will withstand the force of a high-energy wave. The "wave" is the seven-pound bag of birdseed or rice dropped from seven feet. Drop the bag once to give

students an idea of the force of this wave. Be sure each group understands that their shape does not have to look like a real plant or animal.

4. Give students about 20 minutes to create their “organism.”
5. Once each group has made an organism, ask them to record the following information:
    - A sketch and description of the shape.
    - A prediction as to whether or not they think their shape will survive and why?
6. Test the organisms by dropping the bag directly on each one from a height of seven feet. Alternate wave operators. Always have a student whose organism is not being tested be the operator.
7. When all the organisms have been tested, ask each group to record:
    - The results of the wave. What happened and why?
    - A sketch and description of their new shape. Were their predictions correct?

Summary:

1. Discuss the impact the wave had on each organism. Which ones survived? Which ones were crushed?
2. Using pictures, compare the newly created organisms to some common tidepool animals perhaps a few your students saw at the Aquarium. Explain how plants and animals have adapted in shape, size texture and behavior to survive in this harsh environment.
3. Many animals living in the intertidal zone have body shapes that can resist the force of constant wave impact. For example, a sea star’s body is flat and spread out over a wide area, and many species of barnacles create a hard volcano-shaped casing to protect their vulnerable bodies.
4. Many tidepool organisms have tough skin, spines or heavy shells to protect them form powerful waves.
5. Some tidepool animals have adaptations to keep them form being swept away by the waves. For example, sea stars have strong tube feet and mussels have tough, plastic-like threads to secure themselves to rocks.
6. Animals that move, such as sea stars, snails, limpets and chitons, can do so while remaining firmly attached to a surface with strong muscular or water vascular suction.
7. Flexibility is another helpful adaptation for animals and plants in the rocky intertidal zone. For example, leaf barnacles have flexible stalks that are sealed snugly in mussel beds, and seaweeds are also flexible enough to bounce back as the waves crash over them.
8. Animals that are not so well adapted to this environment take shelter form the force of the waves under the rocks or seaweed.

Extension:

1. Ask student which environment is calmer: the sandy beach or the rocky shore. Do they think the animals that live in these two environments are the same or different? What would some of the differences be? Which habitat do they think will have more animals? Why?
2. Compare the impact of waves on a protected coastline to that of a highly exposed coastline. This can be done using a one- to three-pound bag of birdseed to represent the exposed coastline. Try testing the organisms firs on a protected coast and then on an exposed coast.

Adapted from "The Wave." New England Coastlines. Boston: New England Aquarium. 1991.

Assessment:

Wave Wars

Student Name: ______________________________

CATEGORY	4	3	2	1	Score
Modification/ Testing	Clear evidence of troubleshooting, testing, and refinements based on data or scientific principles.	Clear evidence of troubleshooting, testing and refinements.	Some evidence of troubleshooting, testing and refinements.	Little evidence of troubleshooting, testing or refinement.	
Function	Structure functions extraordinarily well, holding up under atypical stresses.	Structure functions well, holding up under typical stresses.	Structure functions pretty well, but deteriorates under typical stresses.	Fatal flaws in function with complete failure under typical stresses.	
Scientific Knowledge	Explanations by all group members indicate a clear and accurate understanding of scientific principles underlying the construction and modifications.	Explanations by all group members indicate a relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by most group members indicate relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by several members of the group do not illustrate much understanding of scientific principles underlying the construction and modifications.	
Construction - Materials	Appropriate materials were selected and creatively modified in ways that made them even better.	Appropriate materials were selected and there was an attempt at creative modification to make them even better.	Appropriate materials were selected.	Inappropriate materials were selected and contributed to a product that performed poorly.	
Journal/Log - Content	Journal provides a complete record of planning, construction, testing, modifications, reasons for modifications, and some reflection about the strategies used and the results.	Journal provides a complete record of planning, construction, testing, modifications, and reasons for modifications.	Journal provides quite a bit of detail about planning, construction, testing, modifications, and reasons for modifications.	Journal provides very little detail about several aspects of the planning, construction, and testing process.	

Dilemmas

Lesson at a glance:

This lesson is designed to give students an opportunity to examine their values and beliefs related to the environment and to practice discussing environmental issues without placing judgments.

Oregon State Benchmarks and Common Curriculum Goals

CAREER RELATED CURRICULUM STANDARDS

PROBLEM SOLVING

Content Standard: Apply decision-making and problem-solving techniques in school, community, and workplace.

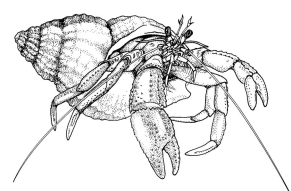
- **Criteria:**
- Identify problems and locate information that may lead to solutions.
- Identify alternatives to solve problems.
- Assess the consequences of the alternatives.
- Select and explain a proposed solution and course of action.
- Develop a plan to implement the selected course of action.
- Assess results and take corrective action.

CIM/CAM: Predict outcomes of changes in resources and energy flow in an ecosystem.

- *Explain how humans and other species can impact an ecosystem*.
- *Explain how the balance of resources will change with the introduction or loss of a new species within an ecosystem*.

Materials:

- Dilemma cards



Hermit crab

Background information:

Discussing environmental ethics can be difficult. There are many sides to every issue, and often the feelings for one position or another are strong. In presenting this activity to students, stress the importance of not placing judgment, and listening to perspectives other than their own. Understanding all sides can provide a bigger picture of the issues
It is not the intent of this activity to prescribe right and wrong answers for the students.

Activity:

1. Divide students into groups of four or five.
2. Give each group a dilemma card and have one member read the dilemma and give the choices o answers to the rest of their group.
3. Students in the group should decide on their own what their response would be. The have each group discuss their choices among themselves. Students should be able to defend their reasoning.

Summary:

Discuss each dilemma as a class. The final point is that there are several sides to any issue and usually there isn't one right answer. Stress the importance of gaining an understanding of all positions.

Extension:

Have students make up their own dilemmas regarding local or national issues

Adapted from "Ethi-reasoning," Project Aquatic, Boulder, Colorado, 1992.

Dilemmas

1. You have just cleaned your basement. On a dusty back shelf you discovered 10 cans of old paint and some very old pesticides and weed killers that you can't use. What will you do with them	4. You were fishing at a secluded lake and caught seven fish this morning. Now, its afternoon and the fishing has been great! You have caught five fish in one hour, all of which are on your string in the water and are bigger than this morning's fish. The law allows you to possess 10 fish per day. What should you do?
2. You are walking on the shore with a friend who is visiting you from the Midwest. Your friend sees a purple sea star she thinks is very beautiful. She tells you she wants to go into the tide pool and get it to take it home. What do you do?	5. You are on a field trip to the Newport bay front. Although you know it's not a good idea to feed the wildlife, some of your friends are tossing pieces of their tunafish sandwiches to the sea lions. What should you do?
3. You are an expert salmon angler. You always know where the BIG ones are. You're sanding on the side of a stream where you know the salmon run. On the far side of the stream you see a pool you just know has the BIG one in it, but to get there you must cross the stream. You know this is probably an area with salmon redds (nests), but no one from the Department of Fish and Wildlife is around and you're expected to come home with fish for dinner. What do you do?	6. You're on a charter boat with your family during your summer vacation. Your grandfather, a grumpy, stubborn man, is a heavy smoke and keeps throwing his plastic cigar butts over the side. What should you do?

Choices

4.

b. Continue to fish and keep all the fish.
c. Let the smallest fish you caught this afternoon go free and keep the big ones to stay within your limit.
d. Quit fishing and go for a hike.
e. Continue to fish but release them.
f. Other

1.

a. You know it's illegal, but you simply hide them in your garbage can with your other household waste and have taken to the county landfill.
b. Leave them in your basement.
c. Call the county to find out where to dispose of them safely.
d. Other

5.

a. Tell them that feeding the sea lions can harm the animals and ask them to stop.
b. Report their behavior to an authority on the dock.
c. Ask the teacher to ask them to stop.
d. Ignore them.
e. Other

2.

a. You notice that there are many sea stars and you think it won't hurt anything to take just one.
b. Offer to pull it off the rock and suggest you play Frisbee with it.
c. Explain that this animal won't be able to survive if she takes it home and suggest that she watch it here and then leave it in its habitat.
d. Yell at her and ask her how she would feel if someone picked her up and threw her out in the ocean
e. Other.

6.

a. Yell at him, call him an idiot and ask him if he hasn't heard of the MARPOL Protocol, the law prohibiting the dumping of all plastic wastes from ships at sea.
b. Ask the captain for a can, give it to your grandfather and politely ask him to use it for his cigarette butts.
c. Do nothing.
d. Tell your parents to tell your grandfather to quit smoking.
e. Other

3.

a. Go to the nearest house and ask to borrow their boat, knowing you'll be in the doghouse if you don't come home with fresh fish.
b. Put on your best lure, cast as close to the pool as possible and hope for the best.
c. Carefully walk through stream.
d. Go to the fish market for fish for dinner.
e. Other

Flash Card Notebook

Lesson at a glance:

This activity will allow students to identify some of the animals they will see at the Aquarium.

Oregon State Benchmarks and Common Curriculum Goals

LIFE SCIENCE (ORGANISMS)

- **Common Curriculum Goal** (Organisms): Understand the characteristics, structure, and functions of organisms.
  Content Standard: Describe the characteristics, structure, and functions of organisms.
  Grade 3 Benchmark: Describe the basic needs of plants and animals.

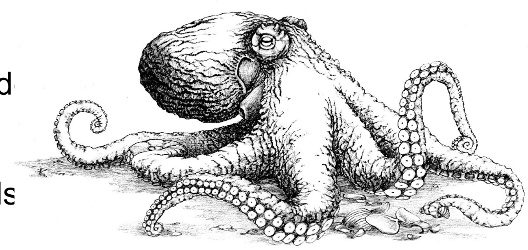
LIFE SCIENCE: (DIVERSITY/INTERDEPENDENCE)

- **Common Curriculum Goal:** Understand the relationships among living things and between living things and their environments.
  Content standards: Explain and analyze the interdependence of organisms in their natural environment.
  Grade 3 Benchmark: Describe a habitat and the organisms that live there.
  Grade 5 Benchmark: Describe the relationship between characteristics of specific habitats and the organisms that live there.
  CIM/CAM: Predict outcomes of changes in resources and energy flow in an ecosystem.
  - *Explain how humans and other species can impact an ecosystem.*
  - *Explain how the balance of resources will change with the introduction or loss of a new species within an ecosystem.*

Materials:

A copy of the flash cards for each student

- ☐ 25 solid colored 3x5 inch index cards for each stud
- ☐ Crayons
- ☐ Glue for each student
- ☐ Scissors for each student (or pre-cut the flashcards
- ☐ A hole punch
- ☐ Yarn or a binder ring



Octopus

Background information:

This activity will introduce the students to some of the animals they will see at the Aquarium during their visit.

Activity:

1. Hand each student a set of flashcards, index cards, glue and scissors (if appropriate).
2. Have the students attach their flash cards to the index cards with the picture of the animal on one side and the information on the opposite side.
3. Have the students color the pictures of the animals.
4. Have the students decorate two of the remaining index cards. These will be the cover of their notebook.

5. Place the remaining six index cards at the back of the picture cards and inside the cover.
6. Punch a hole in the left hand corner of each animal card. Tie the cards together using either yarn or a binder ring to complete the notebook.
7. During or following their visit to the Aquarium, have your students draw some of the other animals they saw at the Aquarium.
8. Have the students write interesting facts they learned on their trip on the opposite side of their picture.
9. Have the students share their notebooks with their classmates.

Summary:

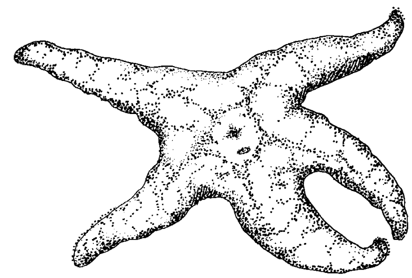
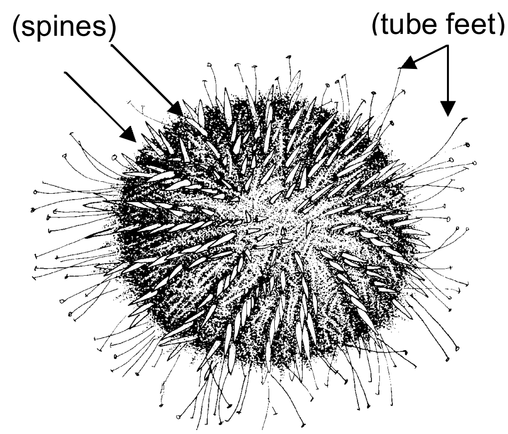
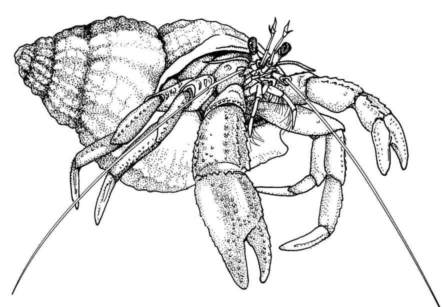
1. Review what the students learned about the animals at the Aquarium.

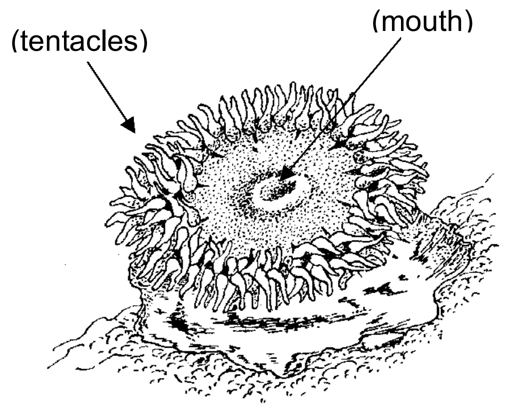
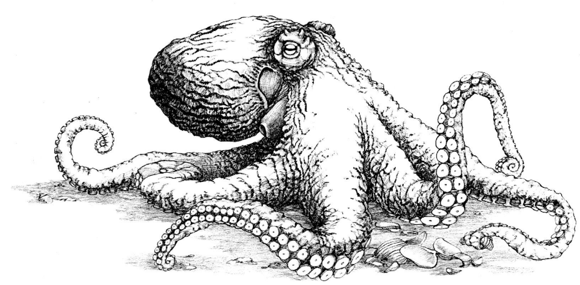
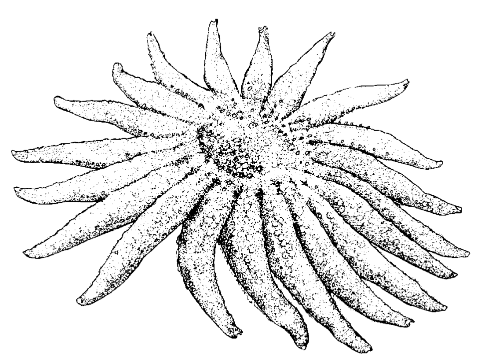
Continuation:

1. Have the students identify which animals are predators and which animals are prey animals. Can they create a food chain using the animals in their notebooks?

Assessment:

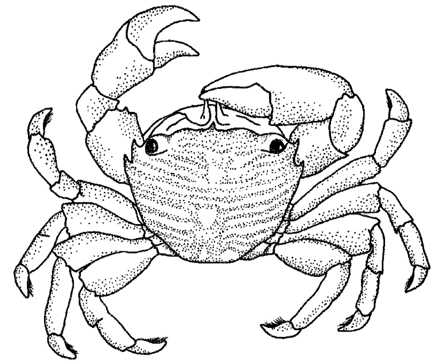
1. Have the students write a story about the animals in their notebook.
2. Have the students draw a picture of the animals in their notebook. Are they able to place the animals in their correct habitats? Are they able to label the animals in their drawing?

Ochre sea star **Size:** Up to 12 inches across from tip to tip. **Color:** They may be yellow, brown, orange, reddish, or purple. **Diet:** Mussels, barnacles, snails, limpets, and chitons. **Did you know?** Ochre stars have many tube feet used for moving and holding onto rocks and prey. The ochre star eats by holding onto the shell of its prey with its tube feet, then pushing its stomach out of its body and into the shell of its prey to digest the meat.	 OREGON COAST AQUARIUM
Purple sea urchin **Size:** Grow to about four inches across. **Color:** Purple. **Diet:** Urchins eat mostly kelp and other brown and red seaweeds. They will sometimes catch small animals with their tube feet. **Did you know?** A sea urchin's jaw is called Aristotle's lantern. The jaw has five teeth, and they are strong enough to scrape holes in the rocks for urchins to sit in. The holes also allow for the urchin to stay cool and wet when the tide goes out.	 OREGON COAST AQUARIUM
Hermit crab **Size:** Anywhere from an inch to over one foot wide. They usually pick a shell slightly bigger than their body so they can grow into it. **Color:** They vary in color, but most are brown and dull green with white patches. **Diet:** Hermit crabs are scavengers and will eat anything they can fit in their mouth, including dead animals, plants and sometimes even small fish. **Did you know?** When a hermit crab senses danger, it quickly pulls its whole body inside its shell for protection.	 OREGON COAST AQUARIUM

Giant green sea anemone **Size:** About seven inches across and 12 inches tall. **Color:** Bright green when they live in the sunlight. If they live where there is no sunlight, they may be almost white. **Diet:** Crabs, shrimp, small fishes, sea urchins and mussels. **Did you know?** They sting their prey with their sticky tentacles, pass it to their mouth and then digest it. You should never stick your finger inside an anemone's mouth because you might damage it.	 OREGON COAST AQUARIUM
Giant Pacific octopus **Size:** Arm span to about 16 feet; weigh from 10 to 200 pounds. The largest Giant Pacific octopus recorded had an arm span of over 27 feet – about as long as a classroom! **Color:** Red to reddish-brown. They can change their skin color and texture to help them blend in with their environment. **Diet:** Shrimps, crabs, scallops, abalones, clams, smaller octopuses and fishes. **Did you know?** Researchers consider the octopus to be the smartest of all invertebrates, with about the same intelligence as a house cat.	 OREGON COAST AQUARIUM
Sunflower sea star **Size:** Can grow to 50 inches wide. Sunflower stars begin life with five or six arms and grow more with age (up to 24). **Color:** Usually orange, purplish-gray, brown, red or yellow. **Diet:** Sea urchins, clams, snails, crabs, mussels and even other sea stars. **Did you know?** Sunflower stars are the largest and most active of the Pacific coast sea stars. They can move at a speed of four feet per minute and have about 15,000 tube feet to help them along.	 OREGON COAST AQUARIUM

Purple shore crab

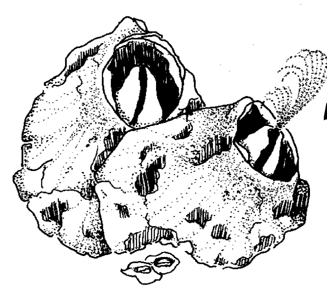
Size: About two inches wide.
Color: Usually purple with dark spots on the claws. Sometimes may be olive-colored or dark brown.
Diet: Purple shore crabs scrape green algae off the rocks and also eat dead animal matter.
Did you know? Often this crab is found hiding under rocks and will come out at night to look for food. When discovered, they will often walk sideways to escape and find a new hiding spot.



OREGON COAST AQUARIUM

Giant acorn barnacle

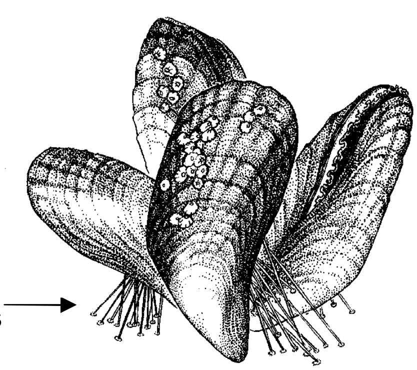
Size: Grow to be five inches tall and four inches wide.
Color: Outer shell is white; legs are pink.
Diet: Acorn barnacles use their feathery legs to sweep tiny, drifting plants and animals, called plankton, out of the water and into their mouth.
Did you know? Acorn barnacles are one of the world's largest barnacles. They can close up their volcano-shaped shell at low tide to keep from drying out and open it up again so that they can feed during high tide.



OREGON COAST AQUARIUM

Mussel

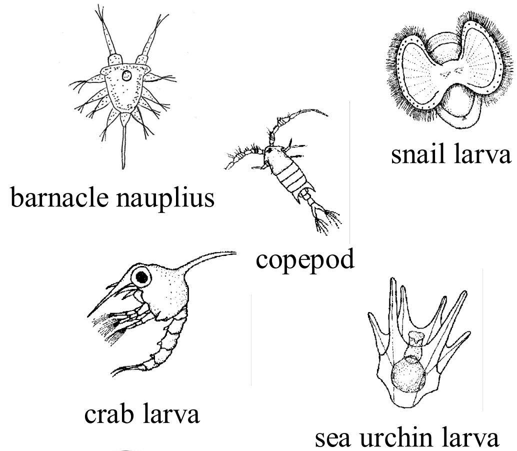
Size: Grow to 10 inches long.
Color: Blue-black with thin streaks of brown.
Diet: Mussels open their shell just a little bit to eat plankton and tiny, dead plants and animals (called detritus) drifting through the water.
Did you know? A mussel's predator is the ochre star. Other predators include shorebirds, gulls, crabs, snails, sea otters and humans. Mussels are firmly attached to the rocks by byssal threads. The byssal threads keep mussels from being swept away by crashing waves or strong currents.



OREGON COAST AQUARIUM

Zooplankton

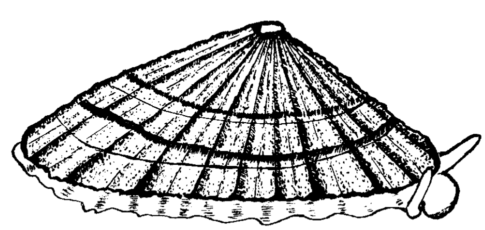
Size: Most zooplankton (animal plankton) are so tiny you need a microscope to see them.
Color: Most zooplankton are clear in color. Sometimes you can look through their bodies and see what they have eaten!
Diet: Zooplankton eat phytoplankton (plant-like plankton) or smaller zooplankton.
Did you know? Some zooplankton will grow up to become fishes, shrimps, crabs, octopuses, or other invertebrates. Jellyfish are the largest kind of zooplankton and can be up to 6 feet wide and 100 feet long (including tentacles).



OREGON COAST AQUARIUM

Keyhole limpet

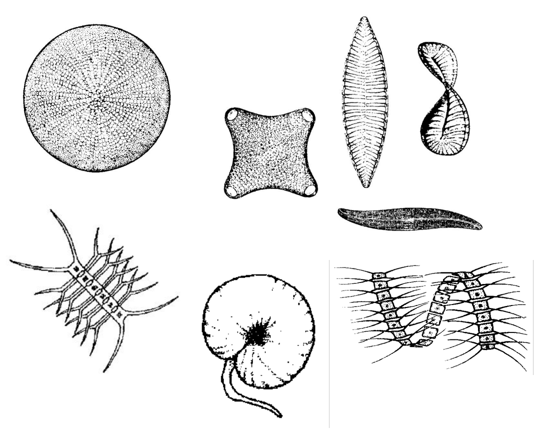
Size: Grow to about three inches long.
Color: Usually grayish, sometimes olive green with bluish-white markings.
Diet: It uses its rough, scraping tongue, called a radula, to feed on algae growing on the rocks.
Did you know? This animal has a soft body and a hard shell shaped like a volcano. It takes in water under the edges of the shell, passes it over its gills and out through the hole in the top of the shell. Waste, eggs and sperm are also released through this hole.



OREGON COAST AQUARIUM

Phytoplankton

Size: Phytoplankton are very small and can only be seen with a microscope. The largest is about one millimeter wide, about the width of a piece of thread.
Color: Varies from tan, yellow to greenish.
Diet: They don't eat! They get their energy from the sun – a process called photosynthesis.
Did you know? All phytoplankton are plantlike organisms that live near the surface of the water because they need a lot of sun. When there is a lot of phytoplankton in the water, it sometimes turns the ocean green, red or brown.



OREGON COAST AQUARIUM