

Invertebrates

1. Pre-lab Reading

Chapter 27 “Introduction to Animal Diversity” Biology, OpenStax College

Chapter 28 “Invertebrates” Biology, OpenStax College

2. Purpose and Objectives

The purpose of this investigation is to examine representatives of several phyla of invertebrates.

Upon completion of this lab, you should have an understanding of

1. the phylogenetic relationships of animals
2. the characteristics of animals
3. characteristics used in animal classification
4. the morphology and behavioral characteristics of various invertebrate phyla representatives.

3. Safety Guidelines

1. Review the proper use of the microscope.
2. Handle all glassware with care.
3. Clean all materials used as well as clean lab bench where you worked.
4. Put all equipment back in its proper place.
5. Wash hands before leaving the lab.

4. Introduction

The animal kingdom is enormously rich in its diversity. Animals are distinguished from other types of organisms in that they are multicellular heterotrophs.

The cells found in animals lack cell walls and the multicellular body is held together with structural proteins, one of the most abundant being **collagen**. In addition, cells are held together by unique intercellular junctions: **tight junctions**, **desmosomes** and **gap junctions**. Most animals also possess two types of tissues distinctive to the animal kingdom, nervous tissue and muscular tissue. These tissues are responsible for sensory perception and movement.

Sexual reproduction is found in most animals. The diploid stage dominates. For most animals flagellated sperm fertilize nonmotile eggs forming a zygote that undergoes **cleavage** (a series of mitotic divisions) eventually giving rise to a hollow ball of cells called a **blastula**. **Gastrulation** then occurs in which this ball of cells indents on one side to form a cavity called the blastopore. During gastrulation distinct cell layers (germ layers) form which later give rise to various tissues and organs. Diploblastic animals have two cell layers at this stage, an outer ectoderm layer and an inner endoderm layer. Many animals are triploblastic and develop ectoderm, endoderm and a middle layer, the mesoderm. From this point, development can vary among animals. Some will gradually develop into adults over a period of time while others pass through a cycle of changes known as **larval stages**. A larva is morphologically distinct from the adult and eventually undergoes **metamorphosis** where it is transformed into the adult.

Animals are classified into various phyla in part based on the following basic characteristics:

- Presence or absence of true tissues
- Number of germ layers (diploblasts vs. triploblasts)
- Body plan – protostome vs. deuterostome
- Structure of body cavity – acoelomate, pseudocoelomate, coelomate
- Symmetry (spherical, radial, bilateral)
- Segmentation (repeating series of parts from anterior to posterior)

In this lab exercise, you will examine representatives of several invertebrate phyla. Invertebrates are animals that lack a backbone. Ninety-five percent of the

organisms classified in the animal kingdom are invertebrates, the bulk of which are arthropods. Your book will be a useful tool in reviewing invertebrate phyla.

5. Sponges

Sponges have traditionally been classified in the Phylum Porifera. Current classification schemes divide these organisms into at least three groups/phyla. All sponges are aquatic and most live in marine environments. They are asymmetrical or radially symmetrical and sessile (non-motile and attached to a substrate). Sponges are the simplest animals and lack many of the features seen in more evolved forms. They have no distinct tissue types, and lack a true gut and nervous system. Sponges are classified according to the type of **spicule** (little spike) that provides support to body of the sponge. Spicules can be made of calcium carbonate (**calcareous sponges**) or silica (**glass sponges**). Some sponges lack spicules and instead have a support system consisting of a fibrous protein called **spongin**, a type of collagen. These are used as bath sponges.

Sponges are sessile filter feeders (suspension- feeders). Water is drawn into a central cavity (**spongocoel**) through numerous pores. Lining the inside of the spongocoel are specialized cells called collar cells (**choanocytes**). Food is engulfed by collar cells from the water that flows constantly through the pores and out the **osculum**, a large opening at one end of the sponge. Two additional cell types are found in sponges: epidermal cells and amoeboid cells. The epidermal cells cover the outer surface of the sponge while the amoeboid cells receive food from the collar cells and digest and distribute nutrients to both collar and epidermal cells. The amoeboid cells are also the site of spongin or spicule synthesis and are **totipotent** (can give rise to all other cells).

Procedure

1. Examine a preserved sponge or a live specimen, if available. Note the large opening (**osculum**) through which water is expelled from the spongocoel.

2. Describe the physical characteristics of the sponge(s) provided.

6. Cnidaria

Cnidarians include corals, sea anemones, and jellies and most live in marine environments. Their basic body plan is relatively simple, consisting of a **gastrovascular cavity** which is a sac with a central digestive compartment and an opening that serves both as a mouth and an anus. This body plan exists in two forms: the **polyp** (asexual phase) and the **medusa** (sexual phase). Polyps are cylindrical sessile forms with tentacles that have specialized cells for catching prey. Medusas are flattened, upside-down versions of polyps where the tentacles extend downward from the oral cavity. Many cnidarians live only as polyps or medusas while the lifecycle of some includes both forms.

Hydra are freshwater organisms that exist in the form of a polyp. Being sessile organisms, they attach themselves to the substrate by a **pedal disc**, sometimes referred to as a foot.

Procedure

1. Examine a live specimen of hydra (*Hydra littoralis* or brown hydra), with a stereoscope. Make a drawing of the organism and label tentacles and mouth.
2. How many tentacles does this species of hydra possess? Where is the mouth located?
3. Touch one of the tentacles very gently with a dissecting needle. What happens?
4. Note if any specimens contain outgrowths or swellings. These are buds that will give rise to new hydras.
5. Obtain a wet-mount slide of a hydra and examine a tentacle using a compound microscope. **Label** the stinging cells (**cnidocytes**) that appear as swellings on the tentacles. These cells contain capsules (**nematocysts**) that can discharge a barbed or poisonous thread used in defense and in capturing prey.

7. Platyhelminthes (flatworms)

Flatworms can be found living in marine, freshwater, and damp terrestrial environments and include many parasitic species in addition to free-living species. While structurally more complex than cnidarians, most flatworms still have a gastrovascular cavity with a single opening (tapeworms are the exception, lacking a digestive tract altogether and obtaining nutrients via absorption). The flatworms are acoelomate and lack both a circulatory and respiratory system. Due to their shape, all cells are close enough to the body surface for gas exchange to occur.

In this exercise, you will examine a species of *Planaria*. These flatworms can be found in freshwater or marine environments, though the species you are examining live in freshwater. They feed on protozoa, small crustaceans, snails or other worms.

Procedure

1. Examine a living specimen of *Planaria*. Notice how it is flattened dorsoventrally (the dorsal side is the back, ventral is the “belly”) and exhibits **cephalization** (has a definite head region).

2. Identify the following features:

Eyespots: light-sensitive areas that do not form images

Auricle: lateral projection containing nerve endings sensitive to touch and to chemicals

Pharynx: an extension from the midventral surface of the body; the mouth is at the free end of the pharynx

Gastrovascular cavity: a branched cavity where digestion is completed

3. Phototaxis (response to light):

Write a **hypothesis** about whether *Planaria* prefer a light or dark environment. Also write a **null hypothesis** for this experiment. Note that the null hypothesis postulates

that the variable you are testing will have no effect. Write a **prediction for the null hypothesis**.

Cover half of your dish with a dark cloth. Count the number of *Planaria* on each side of the dish and record these in your lab book. You may have to count the total and get the number in the dark by subtraction. Do the *Planaria* exhibit positive or negative phototaxis?

4. Note the mode of locomotion. Planarians have cilia on their ventral surface and numerous glands that secrete a mucous material used to aid in their movement.
5. Place a small piece of meat in the watch glass and watch the planarian's reaction carefully. Describe how a planarian feeds.
6. Using either a live specimen or a prepared slide, draw a *Planaria*, labeling its anterior and posterior ends, eyespot, auricles, and gastrovascular cavity.

8. Nematoda (round worms)

Nematodes, also known as roundworms, live in all aquatic habitats and in damp environments such as soil, plant tissues, and the body tissues of animals. They are pseudocoelomate, unsegmented and cylindrical in shape with a tapered end. Nematodes have a complete digestive tract but lack a circulatory system.

Many species are parasitic and include pinworms and hookworms. Nematodes are also responsible for trichinosis, which can be acquired by eating undercooked pork, and elephantiasis. In this exercise, you will examine a mixture of soil dwelling nematodes that do not cause human disease.

Procedure

1. Examine the nematodes under a compound microscope. Nematodes have longitudinal muscles but lack circular muscles. Describe how they move.
2. Try to observe the tubular digestive tract. You may also be able to see some of the reproductive organs. Consult your text for a diagram of a nematode illustrating the brain, digestive tract and reproductive organs. **Draw and label the parts** that you are able to see.

9. Mollusks

There are more than 150,000 species of mollusks that include snails, slugs, clams, oyster, squid and octopi. Many inhabit marine environments, some are found in freshwater, and some live on land. All mollusks have a three-part body: a muscular **foot** (used primarily for movement), a **visceral mass** (where most internal organs are located) and a **mantle** (thin tissue enclosing the visceral mass that may also secrete the shell). In squid and octopuses, the foot has evolved into tentacles that are used in the capture of prey. The mantle may extend beyond the visceral mass, forming a fluid-filled cavity where the gills, anus and excretory pores are found. Many mollusks have an organ called a **radula** which is used in feeding. It contains backward-curved teeth that extend from the mouth and slide back and forth scraping up food into the mouth.

A. Class Gastropoda

Procedure

1. Examine the snails in the fish tank. Locate the snail's foot and describe how it moves.
2. If possible, locate the snail's radula and describe how it appears to function.

10. Annelids

Annelids are segmented worms, with bodies divided into a number of segments, both externally and internally, that gives them an overall ringed appearance. Segmentation, which is also found in the Arthropods and Chordates (including humans), allows for improved control of movement and specialization of function in body regions. Annelids are bilaterally symmetrical and most have a true coelom, a complete digestive tract, and nervous system. There are approximately 150,000 species of annelids living in fresh water, marine water and damp soil environments. They range in size from 1 mm to the unbelievable 3 m giant Australian earthworm. The most familiar annelid is the earthworm, which has a closed circulatory system and contractile pumps called aortic arches. *Lumbriculus variegatus*, also known as the blackworm, is found in shallow water environments in North America and Europe.

11. Arthropods

Arthropods are segmented coelomates with a hard exoskeleton made of **chitin** and paired, jointed appendages. This phylum contains far more species of animals than any other. Members of this group include spiders, scorpions, ticks, millipedes, centipedes, insects and crustaceans. Many arthropods have a well-developed central nervous system with a brain and a ventral paired nerve cord. The circulatory system is open.

A. Class Crustacea

Most crustaceans live in marine or freshwater environments, though some, like the pill bug (roly poly) live on land. Crustaceans are the only group of arthropods with two pair of antenna. This group includes lobsters, shrimp and crayfish in addition to smaller organisms that comprise **zooplankton**, small organisms that are an important food source for whales and other large suspension-feeders.

Procedure

1. Obtain a sample of brine shrimp (*Artemia salina*). These are marine crustaceans that comprise zooplankton. Describe their appearance. How big are they? How do they move? How do they interact with one another?
2. Make a simple drawing of a brine shrimp. Label the eye, swimming legs (phyllopods) and body segments.

B. Other Arthropods

1. Observe the preserved insects, arachnids, millipedes and centipedes.

12. Conclusion and Summary

1. Create a **table** that summarizes the following characteristics for the hydra, planaria, nematodes, and brine shrimp:
 - symmetry type
 - cephalization
 - true segmentation
 - complete or incomplete digestive tract
2. Describe how a sponge obtains its food.
3. What advantages do the following characteristics give to animals that have them: complete digestive tract, cephalization, segmentation?
4. Calculate chi square for the Planaria phototaxis experiment. Use half the total number of planaria for the expected number in both light and dark samples.
5. Based on the chi square calculation, do the Planaria data support your hypothesis? Do you reject or fail to reject the null hypothesis?

NOTES