

General Zoology

Lab Supplement

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General Zoology

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Biol 1413 Lab Orientation

The laboratory portion of this course is designed to study anatomical details of animals in general or common examples of specific phyla more thoroughly than it is presented in lecture. This method of 'hands on' learning should also enhance and strengthen the knowledge you gain in lectures. Most of the time you will be working individually or in pairs.

There is sometimes not enough time in lab to go over each and every item that you are assigned. The lab is a designated time when you have access to materials that you will not have available during home study time. Some of the information assigned in lab you can learn at home, other items, particularly anatomical terms identified on dissected organs, animals and models and microscopic details viewed with a microscope can only be learned adequately in the lab room.

The lab period will begin with a short introduction and orientation to the material to be studied. I will assume that you have read the exercise before you come to lab. I will point out which models, preserved animals and slides we have available for the lesson as well as any changes to the procedures. The rest of the lab time is yours to begin learning the material, view any assigned slides and perform any dissections that are required.

All dissecting tools will be provided for you, you do not need to buy a dissecting kit. We have a small supply of latex gloves available for the dissections.

Lab Reports

Each student will complete a **Lab Report** (see Table of Contents) for the material covered in each of 4 Lab Practicals. Lab reports are at the end of each section of material for each practical (see Table of Contents).

Each **lab report** will include answers to specific questions from individual lab activities as well as general questions about the animal kingdom. You will also be asked to make sketches and observations about the slides and preserved materials that you are studying. You are also free to include any other materials (see below) that you think might be helpful to learn the information presented in the lab exercises and prepare yourself for the practical.

These Lab Reports will be due on the day of the practical covering the same material.

Drawings:

1. If you are sketching material ***without magnification*** or if you are switching back and forth between no magnification and slight magnification (eg. hand lens) you should draw a rectangular border around your sketch and indicate the actual size of the object being sketched.
2. if you are sketching material viewed through a **microscope** or a **dissecting scope**, trace a circular border in which to make your drawing (You might cut out a cardboard circle to use each time so they will be neatly done and all the same size). Make sure your drawing fills the circle to the same extent that the object actually appears through the microscope. Be sure to indicate the **magnification** being used for each sketch
3. More detailed information on drawing techniques can be found in the “Collecting and Preserving Methods” binder on the lab counter. If you want to try these more detailed directions, I’ll be happy to make you a copy of the article

What else you might want to include:

- Sketches of slide materials, models or preserved materials that will help you to study for the practicals. Any sketches should be labeled appropriately
- You might also want to include comments on the appearance or difficulty in finding and/or identifying the materials for study
- Any personal observations you made while completing the exercise or studying the material
- Special points to be aware of while reviewing the lab

Remember that the function of these reports *should be* to help you organize your lab material and to facilitate learning it for the practical.

General Zoology Animal Collection

You will make a small animal collection consisting of 5 different animals, from 5 different phyla or subphyla. *You will NOT get these items back so please don't include a keepsake or treasure that you want to hold onto.* ACC will provide nets, vials, jars, preservative, insect pins, some labels, etc. The goals for this collection are to:

- Learn to visually recognize some of the animals common to the area
- Learn something about the ecology and behavior of these animals
- Learn how to use identification manuals and keys
- Become acquainted with the taxonomy and classification of animals, and
- Learn how to properly preserve and label museum specimens

You will be given more information on proper preservation and presentation of specimens in lab. You might also want to consult some Identification keys for the kinds of animals that you are interested in collecting. The animal collection will be worth 50 points and is due the Monday of the last week of classes.

Your grade for the collection will be based on the following criteria:

- diversity and originality of your collection
- ability to follow **correct** procedures for preserving and displaying specimens as described in the materials
- quality of the preservation technique
- accuracy of identification (usually to species) & common name

You do not need to kill anything to make this collection. Some examples of the kinds of collections you can make:

soil and leaf litter organisms
aquatic organisms
shells
skeletons and/or skulls
nests, burrows, tunnels, etc
plaster casts of footprints or tracks
photographs
parasites
fossils

The preservation method that you choose depends on the type of collection that you do. For example:

Permanent Slides: are used for small or microscopic animals

70% alcohol/10% formalin: is used for most invertebrates including insect larvae, larger invertebrates and some vertebrates will need to be injected

Study Skins: for birds and mammals

Dried Specimens: for bones, shells, nests, etc

Pinned Specimens: adult insects are generally dried on insect pins and mounted in an insect box

Each and every specimen must be properly labeled. The type and location of the label depends on the kind of collection and preservation that you do. All labels must include the following information:

Collection Locality (including nearest city)

Date of collection

General Habitat (eg. woods, pond, soil, treebark, grass, etc)

Scientific Name & Common Name

Your Name

When in doubt ASK THE INSTRUCTOR.

Animals Preserving Techniques

A Shortened Summary

(More detailed instructions and suggestions can be found in the "ZOOLOGY ANIMAL COLLECTION AND TECHNIQUES" binder in 701)

We can provide **containers, vials or bags** along with **preservatives** for your collection.

We have several dozen **identification guides** for many kinds of central Texas animals. You can also find ID guides at the PIN Library and most public libraries in Austin. You can also find quite a lot of information by searching the web

More information on proper collecting and preserving techniques are in a binder in the labroom

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More detailed Information on preserving various kinds of specimens:

A. Animals collected live:

Most invertebrates except those listed below:

Kill and preserve in jars of 10% formalin solution or 70% alcohol (ethyl or isopropyl; make label with India ink and place **inside** jar

Most insects except butterflies, moths and dragonflies:

Kill in killing jar or freezer; pin properly; allow to dry; label should be no larger than 1"x1/2" and placed on pin below insect

Butterflies, moths and dragonflies:

Kill in killing jar or freezer; pin and arrange wings on spreading board or piece of styrofoam; allow to dry; label should be no larger than 1"x1/2" and placed on pin below insect

Vertebrates except for birds and mammals (e.g.: fish, frogs, salamanders, lizards, snakes, turtles)

kill in freezer; fix and preserve in jar of 10% formalin solution; use syringe to inject formalin solution into the body cavity in several places; make label with India ink and place **inside** jar

Birds and Mammals:

Hunt following all applicable state and federal laws; prepare a "study skin" using the techniques outlined in the 'ZACT' manual mentioned above; a label no larger than 1"x3" is attached by string to rear leg

B. Animals collected dead but in good condition:

Most invertebrates and lower vertebrates:

Preserve in jars of 10% formalin solution or 70% alcohol; label as above

Insects:

If they are freshly dead, use above procedures; if they are long dead and dried out you will need to place them in a "relaxing chamber" to soften them up so they can be pinned and arranged; label as above

Birds and Mammals:

"roadkills" in good condition can be skinned and study skins prepared as above

Skull or Skeletal mounts:

Flesh can be removed by several means such as boiling, staking near fireant hill or using dermested beetles; once bones are defleshed they can be placed in a bleach or hydrogen peroxide solution to whiten; allow to dry; place in bag or box with complete label tied to skull if possible

C. Nests, Feathers, Eggs, Racks, shells, feathers:

Clean up as much as possible and place in bag or box with complete label

D. Footprints and Burrows:

Use plaster of Paris to pour into print, allow to set then remove and clean off; place in bag or box with label

E. Photographs:

Should be original photographs; most 'good' photographs will need a telephoto lens for vertebrates or close-up lenses for small invertebrates and insects - the specimen should take up a substantial part of the frame and be easily recognizable

Biology Lab Safety Procedures and Information

Health and safety are paramount values in science classrooms, laboratories and field activities. You are expected to learn, understand and comply with ACC environmental, health and safety procedures and agree to follow the ACC science safety policy. You are expected to conduct yourself professionally with respect and courtesy to all. You can read the complete ACC science safety policy at: http://www.austincc.edu/sci_safe/

All safety policies and procedures apply to scheduled lab classes as well as open labs.

Consequences for not complying with safety procedures:

1. You will not be able to participate in a lab activity if:
 - a. you are late for class and have missed safety training specific for that day's lab or field activity;
 - b. you have forgotten your personal protective equipment;
 - c. you refuse to wear personal protective equipment;
 - d. you have not followed safety policies and procedures for that lab or field activity.
2. You may be withdrawn from the class and not reinstated if:
 - a. you missed required safety training at the beginning of the semester;
 - b. you repeatedly fail to follow lab safety policies and procedures.
3. You may be expelled from ACC if you thoughtlessly or intentionally jeopardize the health or safety of another individual.

Emergencies

If there is a life-threatening emergency (fire, major chemical spill, explosion, injury):

1. Report the situation and your specific location (campus, room) by using the safety phone in a lab classroom; it will automatically connect you to ACC Police Dispatch (location of safety phone _____) calling 222 from any ACC phone to reach ACC Police Dispatch calling 512-223-7999 from a cell phone or non-ACC phone to reach ACC Police Dispatch
2. Evacuate if necessary:
 - a. take your personal belongings with you if possible;
 - b. on your way out, close but do not lock the classroom door;
 - c. go to the designated rally point for your campus and building.
Directions to nearest exit: _____
Location of rally point: _____

In the event of an extreme emergency or impending threat, ACC Emergency Alert can send critical voice and text messages to your cellphone. Verify and update your ACC Emergency Alert information. For non-emergency calls, dial 512-223-1231.

Safety Equipment and How to Use It:

- Information about chemicals used in this laboratory can be found in Material Safety Data Sheets (MSDSs) and in a chemical inventory located _____.
- The emergency gas shut-off for this lab is located: _____. Shut off the gas immediately if gas nozzles or valves are damaged or if there is a fire.
- Fire extinguishers are located: (1) _____
(2) _____.

To use a fire extinguisher:

- 1) twist the pin and then pull it out of the handle
- 2) hold the end of the hose and point it at the base of the fire

3) squeeze the handle

→ Fire blankets are located: (1) _____.
(2) _____.

If you are on fire, stop, drop and roll. Let someone else to get the fire blanket.

→ A safety shower is located _____. If you spill a significant quantity of chemical, especially an acid or base on yourself immediately stand under the shower and pull the handle. Disrobe. The instructor will evacuate the room and close the doors for your privacy. Someone of your gender will stay to help you. Stand under the shower for at least 20 minutes. You will be given clothing after the shower.

→ An eyewash is located _____. If a chemical is splashed or rubbed into your eyes you must use an eyewash for at least 20 minutes with your eyes held open. Someone will help you with this.

→ If a person is experiencing electrical shock from touching wires or equipment, use a belt or other non-conducting material to pull them away from the electrical source.

→ First aid kits are located: (1) _____.
(2) _____.

a. Only minor cuts and burns will be treated in the lab. Serious injuries must be treated in a medical facility. Emergency Medical Services (EMS) will be called if you are injured and are unable to take yourself to a medical facility.

b. The instructor must fill out a report describing your injury.

Personal Protective Equipment (PPE)

1. Required when biological, chemical or physical hazards are present on the lab benches, open shelves or counters:

a. Safety Eyewear

*You must wear non-tinted safety eyewear (safety glasses or goggles) marked Z87 when directed to do so by the lab instructor or lab safety instructions.

*You must bring your protective eyewear with you to every lab class. If you forget your eyewear and the lab room does not have a pair to loan to you, you will not be able to participate in the lab and may forfeit your lab grade for that day. ACC cannot guarantee that loaned safety glasses or safety goggles are uncontaminated by microbes or chemicals.

*People who wear contact lenses must wear goggles and may not wear safety glasses.

b. Gloves – You will be provided with nitrile gloves for handling biohazards and hazardous chemicals. Please notify the instructor if your skin is irritated by these gloves.

c. Shoes – Shoes must cover the top, front and sides of your feet. They must be impervious to liquids.

d. More specific requirements may exist for labs in which unique hazards are present (for example: BSL2 organisms or physical hazards such as sharps, open flame, UV light, pressurized gases, or liquid nitrogen).

2. Recommended when biological, chemical or physical hazards are present on the lab benches, open shelves or counters:

a. Apron or Lab Coat – You may be instructed to wear an apron or lab coat over your clothes when handling biohazards or hazardous chemicals.

b. Wear natural fiber clothing for any lab activity involving open flame (synthetic material

- melts onto skin in a fire).
- c. Before putting on gloves remove watches, rings, and bracelets that could either puncture the glove from the inside or interfere with rapid removal of the gloves.
- d. Tie back long hair. e. Do not wear clothing with long, loose sleeves.

Waste Disposal

You must precisely follow the waste disposal procedures. Never dispose of anything in lab without prior direction from the instructor.

- Hazardous chemical waste containers are located:
 - solids _____
 - liquids _____
- Biohazard bags are located: _____ →
- Sharps containers are located: _____ → Glass
- (rinsed test tubes and broken glass) disposal boxes are located: _____
- Regular trash containers are located: _____

Lab Conduct

- 1) At the beginning of any class held in a lab room, do not enter the room until your instructor is present. Wait in the hall, even if the door is open.
- 2) Do these things:
 - *follow all procedures in manuals, in handouts, and as given by the instructor;
 - *store backpacks, coats, and other personal items as directed;
 - *report broken glass and chemical spills to your instructor immediately.
- 3) Do NOT do these things:
 - *come to class while intoxicated or while under the influence of drugs that impair your ability to safely perform the lab or field activity;
 - *horse around or perform unauthorized experiments;
 - *eat, drink, or chew (tobacco or gum);
 - *bring drinks or food (even in closed containers) into the lab;
 - *pipet by mouth; taste chemicals or directly smell chemical fumes.

Lab Hygiene

- Clean up your individual work area/equipment and community work areas/equipment (e.g., sinks, balances).
- Put lids back on bottles and containers immediately after use.
- Do not put excess chemicals back into original containers.
- Dispose of chemicals and waste only as directed by the instructor.
- Turn off equipment as instructed.
- Wash your hands prior to leaving lab.
- Assume that chemicals used in lab are corrosive or irritating. If at any time chemicals come into contact with your skin wash the affected area immediately.

Standard / Universal Precautions

Diseases such as HIV and hepatitis can be transmitted from person to person through contact with human blood or other body fluids. Follow the Standard or Universal Precautions whenever exposure to human body fluids is possible:

- Consider all body fluids (saliva, blood, urine, feces, vomit) to be potentially infected with a harmful pathogen.

→ Do not touch or come into contact with anyone else's body fluids.

Student Accident Insurance

All students enrolled in lab classes are covered by Student Accident Insurance that pays for injuries occurring from school sponsored activities related to the class. It does not pay for illnesses such as allergies or the flu, or fainting. All faculty and students should read the guidelines at: <http://www.austincc.edu/offices/environmental-health-safety-and-insurance/student-insurance>. You can also download the claim form from this location.

Chemical Hazard Labels

- *Label all containers and test tubes as directed.
- *Inform your instructor immediately if a label is damaged in any way.
- *Read all labels and pay special attention to hazard information.

A typical chemical hazard label conveys two kinds of information: 1) the category of the hazard (flammable, toxic, reactive, or corrosive) and 2) the level of the hazard.

There are three types of labels: 1) GHS (Globally Harmonized System - the international system of hazard identification), 2) diamond-shaped hazard labels, and 3) bar-shaped hazard labels.

GHS labels are found mostly on primary containers, the jars or packages in which the chemical manufacturer packaged the chemicals. The GHS system labels include icons that warn you about the major type or types of hazards associated with the chemical. (see next page)

Most of the containers you use in lab are secondary containers such as flasks, test tubes, jars, and beakers. Secondary containers will have either the diamond shapes or the bar shapes. In both of those labels the category of hazard is represented by a color and the level of the hazard is represented by a number.

1. Hazard categories are coded by color:

red	fire hazard, flammability
blue	health hazard, toxicity
yellow	reactivity
white diamond	provides more specific information about the hazard
white bar	identifies protective equipment (PPE) required to handle chem.

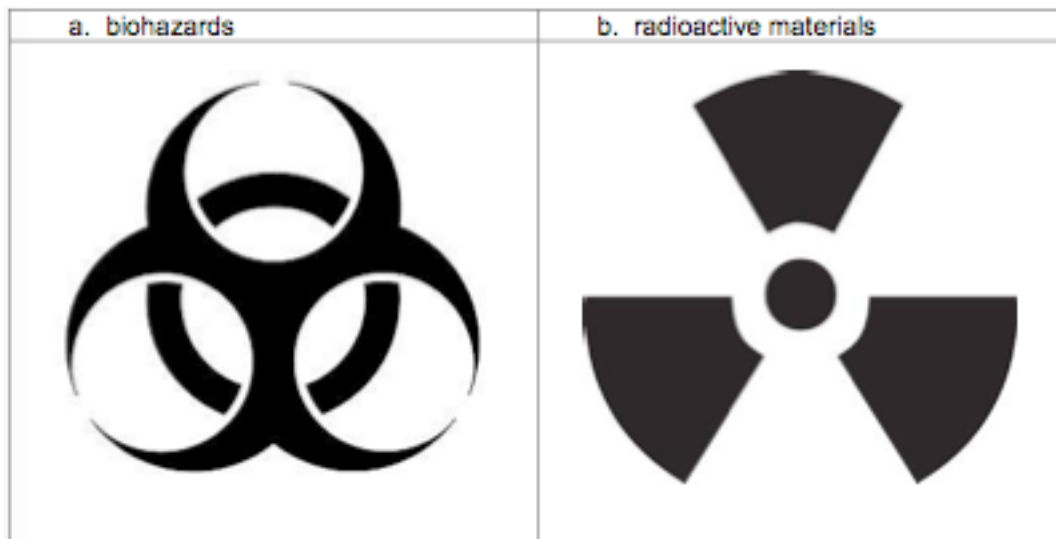
2. Hazard level is coded by a number:

0	1	2	3	4
minimal	slight	moderate	severe, serious	extreme

3. Refer to the training poster in your lab for examples.



Other types of hazard warning labels you must recognize are:



Laboratory Safety & Equipment

Familiarized yourself with the various supplies and equipment in the labroom. Keep this sheet accessible throughout the semester.

Assume the blackboard is at the “front” of the room and the windows are on the “left” side

	Describe The Specific Location of Each
latex gloves	
safety glasses/goggles	
eyewash station	
sinks	
disinfectant spray bottles	
paper towels	
biohazard bag	
glass disposal boxes	
deionized water spigots	
fire extinguisher	
first aid kit	
hazardous materials spill kit	
dissecting kits	
blank slides & coverslips	

Fundamental Lab Skills & Use of Microscopes

(Smith & Schenk: Fundamental Laboratory Skills, Chapter 1)

1. Body Symmetry, Body Planes and Body Regions [1st Ex 1-7; 2nd Ex 1-6]

-familiarize yourself with the terms related to symmetry (**assymetry, radial symmetry, bilateral symmetry**); planes of dissection (**sagittal, transverse and frontal planes**) and directional terms (**anterior – posterior, dorsal – ventral, medial – lateral, proximal distal**)

2. Basic Dissection Techniques [1st Ex 1-6; 2nd Ex 1-5]

-read closely the rules for basic dissection techniques; make sure you understand them

3. The Compound Microscope [1st Ex 1-3; 2nd Ex 1-2]

-familiarize yourself with the basic "anatomy" of the microscope and general functions of the following parts: **ocular, objectives, stage, mechanical stage, revolving nosepiece, condenser, illuminator, iris diaphragm, light switch, course & fine focusing knobs**

-be able to define **magnification** and determine the magnification produced by each objective

-be able to find and focus on prepared slides at all magnifications from scanning to high power

-be able to make "wet mounts" and find and focus at all magnifications [1st Ex 1-4; 2nd Ex 1-3]

4. The Dissecting (Stereoscopic) Microscope [1st Ex 1-5; 2nd Ex 1-4]

-familiarize yourself with the basic "anatomy" of the dissecting scope and general functions of the following parts: **eyepiece, magnification knob, stage, overhead & substage light switches, focusing knob**

-be able to focus, adjust the magnification, and adjust the light

-know when it is best to use this scope as opposed to the compound microscope

Additional Lab Report Suggestions:

-Magnification of scanning, low and high power

-Make some rough sketches of the things you view under both scopes, be sure to label each sketch and to indicate magnification used; note any unusual characteristics or features

-If you want to experiment with different kinds of drawing techniques read reprint D in the *Zoology Animal Collections and Lab Techniques* folder

Animal Cells & Tissues

(Smith & Schenk; Cells & Tissues, Chapter 2)

I. Animal Cells [Ex 2-1]

Procedure:

1. General Features of Animal Cells
 - a. **model:** animal cell
 - observe the animal cell model and be able to identify the structures below:
cell membrane, cytoplasm, nucleus, organelles, mitochondria, ribosomes, endoplasmic reticulum
 - b. **wet mount:** cheek cell
 - prepare a wet mount of your cheek cells as instructed and identify all cellular structures visible
 - c. **slide:** unfertilized starfish eggs [Ex 2-1]
2. List the major structures or organelles you found in the cell model and the general function of each in the space provided in your lab report.

II. Animal Tissues [Ex 2-2]

Procedure:

1. read introductory materials for general tissues and each of the 4 tissue types.
2. **Epithelial Tissues**
 - line surfaces, both internal and external; function: protection, secretion, absorption, filtration; secrete cuticles, exoskeletons, shells, etc
 - tightly packed cells
 - a. **slide:** epithelium simple squamous oral smear
 - slide:** simple cuboidal epithelium (fig 2.3b)
 - slide:** epithelium columnar cell sec (fig 2.3c)
 - Observe and be able to recognize these slides as examples of squamous epithelial tissue
3. **Connective Tissues**
 - support, storage, transport, protection
 - identified by its kind of matrix and fibers present
 - a. read the introduction for connective tissues in general and for each of the four specific kinds below.
 - b. observe the 4 kinds of connective tissues below and be able to recognize them as types of connective tissues:

- i. Areolar: **slide:** mammal areolar tissue spread (fig 2.9)
-"glue" to hold other tissues together
- ii. Adipose: **slide:** adipose tissue, sec (fig 2.8)
-fat storage
- iii. Bone: **slide:** bone dry ground human cs (fig 2.7)
-rigid support
- iv. Vascular tissue: **slide:** frog blood smear (H.O.)
-transport of nutrients, wastes, oxygen, hormones, etc

4. Muscle Tissues

- movement both internal and external, both **voluntary** and **involuntary**
- elongated spindle-shaped cells

- a. **slide:** skeletal muscle tissue teased (fig 2.13)
-Recognize the slide below as an example of muscle tissue

5. Nervous Tissues

- conduct impulses (transmit information)
- cells with large central area and several processes extending away from it

- a. **slide:** mammal motor neuron nerve cells smear (fig 2.15)
-recognize the slide below as nervous tissue

6. Make a sketch of one example of each of the four major animal tissue types in the space provided on your lab report

Additional Lab Report Suggestions:

- how difficult is it to distinguish between the different tissue types
- what are the common features of each major tissue type
- what are some of the major functions of each of the tissues you looked at?

Animal Organs and Organ Systems

Of all kingdoms of life, animals have achieved the greatest level of structural organization. All animals are **multicellular**. Most animals have organized these cells into discrete **tissues** with a distinctive structure and function. Also, most animals have used these tissues to construct various **organs** and **organ systems** to perform the common activities of life.

Human Organ Systems Overview

a. Skeletal System

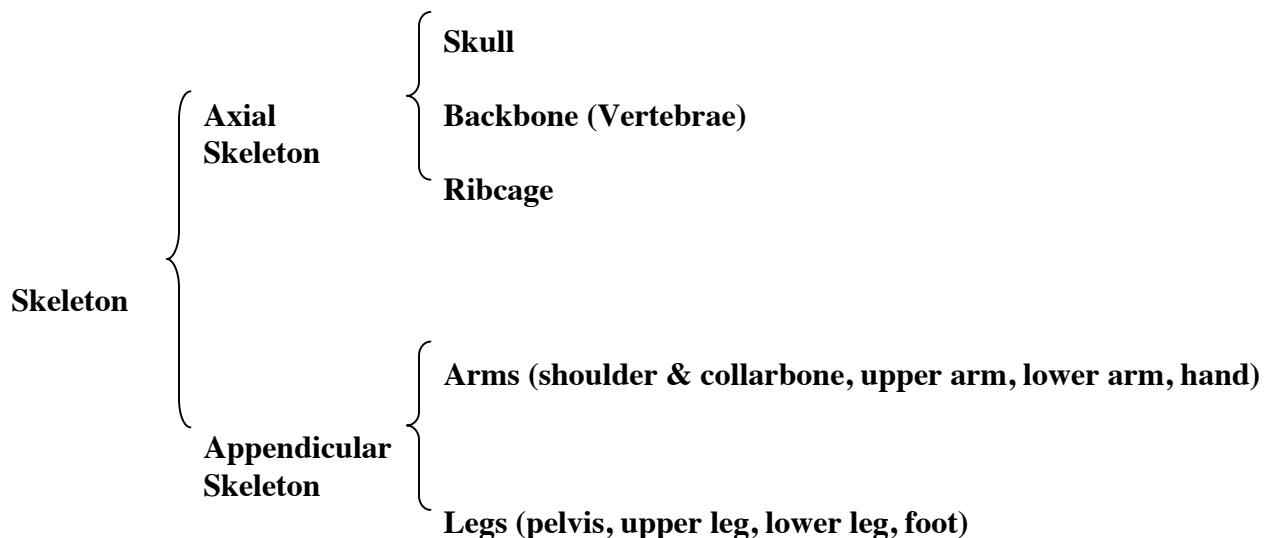
each individual bone is a separate **organ** of the skeletal system (eg. **humerus**, **radius**, **femur**, etc.)

General Functions

1. Support (particularly on land)
2. Movement (along with muscular system)
3. Protection of certain vital organs (eg. brain, heart, reproductive organs, etc)
4. Mineral storage (eg. calcium & phosphorus)

The skeletal system serves several important functions the most obvious of which are structural support and protection of vital organs. The skeleton also serves as a reservoir for important minerals such as calcium and phosphorus. In addition, red blood cells are produced in bone marrow.

Aquatic animals require little support against gravity but terrestrial animals have invented a variety of support structures that not only counteract the forces of gravity but may play an important role in movement as well.



Procedure:

1. identify the subdivisions of the human skeleton, listed above, on the model available

2. look at the skeletons available and be able to distinguish between the axial and appendicular skeletons

b. The Muscular System

each individual muscle is a separate organ of the muscular system (eg. **biceps**, **triceps**, **gastrocnemius**. etc.)

General Functions:

1. movement
2. Posture & Stability
3. Communication (taking, body language, etc)
4. Control of Body Temperature

Movement is one of the most distinctive characteristics of animals. Most animals move at least sometime in their life cycle. Movement is usually based on some kind of **muscle tissue**, often working against bones and joints. In humans there are over 600 different muscles that are attached by tendons to bones across a moveable joint. Most voluntary movements require the coordination of several muscles at the same time.

There are many types of movements that have been described in animals such as swimming, 'jet' propulsion, flying, burrowing, walking and running and each requires specific adaptations to be most efficient.

Procedure:

1. observe the models of human muscles, find the '**lats**'(=latissimus dorsi), '**pecs**'(=pectoralis major & minor), '**biceps**'(=biceps brachii), '**triceps**'(=triceps brachii), '**quads**'(=quadriceps femoris (includes rectus femoris and others)), '**glutes**'(=gluteus maximus), '**sixpac**'(=rectus abdominus)
2. describe the movement produced by each of these muscles

c. Endocrine System

eg. **pituitary gland, thyroid gland, pancreas**

General Functions:

1. Control of long term activities: growth, metabolism, reproduction & development

Generally the hormones of the endocrine system regulate long term or cycling processes of growth and development while the nervous system coordinates activities that require immediate responses to environmental conditions.

Procedure:

1. Locate and identify three of the major human endocrine glands listed below on the torso models

pituitary gland → master gland of body; helps coordinate function of other endocrine glands

thyroid gland → regulates overall rate of metabolism or chemical processing by body cells. Some OTC “diet pills” contain extracts from animal thyroid glands to boost metabolism

pancreas → helps to maintain a constant level of sugar in the blood. Sugar is the main energy food that cells need to carry out their work. Diabetes is a malfunction of this gland causing blood sugar levels to drastically increase and resulting in many physiological malfunctions

d. Nervous System

Central Nervous System vs Peripheral Nervous System, brain, cerebrum, cerebellum, brainstem, spinal cord, cranial nerves, spinal nerves

General Functions

1. Coordination and control of all body activities
2. Rapid responses to emergency situations
3. Perception & interpretation of sensory information
4. (in humans) Higher level thought processes; planning, abstract thought, memory, learning, speech

Animals are more physically active than members of any other kingdom and therefore require a significantly greater degree of coordination and control for their complex systems. In addition to **hormones**, which are also found in the other (less active) kingdoms, most animals have some form of **nervous system**.

In humans, the nervous system is subdivided into a **Central Nervous System** (the **brain** and the **spinal cord**) and the **Peripheral Nervous System** (the **nerves** branching from the brain and spinal cord). Nerve cells of the PNS that are bringing information to the brain are called sensory neurons. Nerve cells that are taking information away from the brain out to muscles and glands are called motor nerves.

Procedure:

1. Observe the display of the cat nervous system and Identify the **CNS & PNS**.
2. Find the following general regions on the model human brain;

Brain Stem → controls vital life functions such as heartbeat, breathing, consciousness

Cerebellum → helps coordinate and control voluntary muscle movements and posture

Cerebrum → gives us conscious perception of our major senses; abstract thinking and

planning; language and speech; learning & memory

3. Observe how the spinal cord connects to both the brainstem and the main nerves of the body to “direct traffic” to and from the brain.

e. Sense Organs

eyes, ears, taste buds, smell, touch, balance organs

General Functions:

1. monitor the outside world and the internal environment to allow the body to respond quickly and effectively to any potential dangers or threats

Animals must be able to monitor both their internal and external environments and to react and respond to the information that they collect. A diverse array of sensory organs has evolved in the animal kingdom ranging from simple cells to elaborate sensory organs. The Central Nervous Systems of animals process and use only one kind of information, electrochemical impulses, to coordinate and control all body systems. Each sensory cell is essentially a transducer and must be capable of converting a specific kind of input into an electrochemical impulse. Sense organs can be classified according to nature of the sensory information that they process:

photoreceptors → convert light energy into nerve impulses

chemoreceptors → convert various chemicals in air or water into nerve impulses

mechanoreceptors → convert mechanical movements such as vibrations of air or water, pressure, and touch to nerve impulses

thermoreceptors → converts heat or cold into nerve impulses

Procedure:

1. Name and describe the main functions of the major human sense organs
2. Identify which type of the receptors above you would expect to be found in the sense organs for vision, smell, taste, touch, hearing, and orientation

f. Circulatory System

eg. heart, arteries, capillaries, veins

General Functions:

1. Delivers food and oxygen to cells
2. Removes carbon dioxide and wastes from cells
3. transports hormones to target cells
4. maintains salt/water balance and acid/base balance
5. protects body from pathogens

Multicellular organisms must be able to get nutrients and oxygen to individual cells and get rid of wastes and carbon dioxide. In small animals simple diffusion can easily move things from place to place. Larger animals require some kind of circulatory system to do this.

The circulatory system consists of a muscular pump, the **heart**, and plumbing, **arteries, capillaries and veins**. In simple animals the heart is a simple pumping vessel, in birds and mammals the heart is a double pump with two distinct circuits of blood flow; the **pulmonary circuit** and the **systemic circuit**. The heart first pumps blood to the **lungs or gills** to pick up oxygen and release carbon dioxide. The oxygenated blood then returns to the heart and is pumped into the **systemic circuit** which branches to every other organ in the body to deliver oxygen and nutrients. The **capillaries** are the microscopic vessels that are the actual sites of exchange of materials. Capillaries are found in virtually all organs of the body and are never more than a millimeter away from any body cell.

Procedure:

1. Study the preserved cow heart and human heart models and note the following:
the **4 pumping chambers; 2 atria and 2 ventricles**
the **1-way valves** that insure blood can circulate only in 1 direction
and the **4 major blood vessels** attached to the heart
veins bringing blood back to the **atria**
arteries taking blood away from the **ventricles**
2. Follow the **pulmonary circuit** from the ventricle of the heart through arteries to the lungs and back to the atria of the heart through veins
3. Follow the **systemic circuit** from the ventricle of the heart through arteries to all other parts of the body, then back to the atria of the heart through veins

g. Digestive System

eg. mouth, throat, esophagus, stomach, small intestine, large intestine, liver, gall bladder, pancreas

General Functions:

1. physical and chemical digestion of food
2. absorption of released nutrients
3. collect & eliminate undigested wastes

The digestive system is essentially a long hollow tube which has been modified along its length to form organs responsible for processing and absorbing food. In addition, several accessory organs such as the liver, gall bladder and the pancreas are associated with the alimentary canal.

Procedure:

1. Locate the main digestive organs on the models available:
mouth, throat, esophagus, stomach, small intestine, large intestine, anus, liver, pancreas
2. Which organs above are most important in **digestion**?

3. Which organs above are most important in **absorption** of nutrients?

h. Respiratory System

eg. nose, throat , voice box (=larynx), trachea, bronchi, lungs, diaphragm

General Functions:

1. O₂ and CO₂ exchange between blood and air
2. speech and vocalization
3. sense of smell

Virtually all animals require free oxygen gas (O₂) for respiration. And since animals are considerably more active than members of other kingdoms they require a greater supply of oxygen to generate energy.

The respiratory system is a collection of continuously branching tubes, held open by bands of **cartilage** that allows air to move into and out of the lungs. Inside the **lungs** the open tubes terminate at clusters of sacs called **alveoli**. These are the actual sites of gas exchange. they are surrounded by capillaries. and together provide a considerable surface area for gas exchange.

Also, just below the throat is an enlarged area called the **larynx**, or voice box. By forcing air over a thin sheet of muscles and adjusting the tension of the muscles we can produce various sounds including those related to emotions, crying, laughing, and speech.

nose → throat → voice box (larynx) → trachea → bronchial tree → alveoli

Procedure:

1. Locate the **nose, throat, voice box, trachea, and bronchial tree** on the torso model
2. Identify the **alveoli** on the appropriate model and explain its significance to gas exchange
3. Locate and identify the **diaphragm** or “breathing muscle”

i. The Excretory (Urinary) System

eg. kidneys, ureter, urinary bladder, urethra

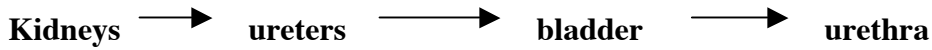
General Functions:

1. removal of metabolic wastes & toxins
2. elimination of excess nutrients & excess hormones
3. regulation of blood volume & pressure
4. regulation of electrolytes & body pH

Animals require some means to discard unwanted **metabolic wastes**. In small, simple animals this is usually done through the body wall with no specific excretory organs or structures. Metabolic wastes are removed by simple diffusion from individual cells. In the more complex animals some sort of processing system is required to collect and rid the body of metabolic wastes such as various

minerals and salts, excess water and nitrogen wastes. The excretory system usually works closely with the circulatory system to collect and rid the body of its wastes.

The metabolic wastes that our cells produce diffuse into the blood and are taken to the kidneys for disposal. The basic strategy is that wastes and other materials present in excess quantities must be removed from the blood. Kidneys selectively regulate concentrations of dissolved wastes and other substances in the blood. This regulation process is accomplished by filtering the dissolved substances out of the blood. Later, certain constituents are selectively reabsorbed back into the blood. The final filtrate, urine, passes out of the organism through ducts and an organ called the urinary bladder which temporarily stores the urine.



Filtering the blood and urine formation occurs in the kidneys. Each kidney is a collection of 1000's of tiny **nephrons**. Each nephron processes a small amount of blood to extract metabolic wastes and excess nutrients from the blood and sends it to the bladder for storage and later elimination.

Procedure:

1. Identify the kidneys, ureters, bladder and urethra on the models available

j. Reproductive System

male: penis, testes, glands

female: ovaries, oviducts, uterus, vagina

General Function:

1. producing offspring
2. propagation of the species

Most animals reproduce both asexually and sexually. Animals show many of the kinds of reproduction studied earlier in the class. Humans and other mammals are somewhat unusual in that they only produce offspring by sexual reproduction. The main human reproductive organs are described in the table below.

Male Reproductive Organs		Female Reproductive Organs	
organ	general function	organ	general function
Testes	produce sperm and sex hormones	ovaries	produce eggs and sex hormones
Internal conducting passageways	direct semen to female reproductive system	oviduct	fertilization of the egg
Glands	produce semen to protect and nurture sperm cells	uterus	Development of child
urethra in penis	internal fertilization	vagina	internal fertilization

Procedure:

1. Identify the main reproductive organs listed above on the models available
2. Know the functions of each

Additional Lab Report Suggestions

- List each of the major organ systems, the major functions of each and name two different organs of each

Animal Reproduction

Most animals can reproduce both **asexually** and **sexually**. Asexual reproduction produces genetically identical copies (ie. clones) while sexual reproduction produces genetically unique offspring. There are advantages and disadvantages to both types of reproduction that will be discussed in lecture. In this laboratory exercise and demonstration you will learn to recognize and identify the general type of reproduction (asexual or sexual) that is occurring and some of the specific examples of each.

Examples of Asexual Reproduction

Asexual reproduction makes identical copies (clones) of the parent. Only a single parent is required and the process is much quicker than in sexual reproduction. Asexual reproduction is beneficial when resources are abundant.

Budding: A very common type of asexual reproduction especially in **colonial** animals is budding. In budding a new offspring begins as an outgrowth of the parent and may either remain attached and form a colony or break away and begin an independent life.

Slide: *Hydra* budding (Fig 3.1)

Preserved sponges

Fragmentation: Some animals spontaneously break into many separate pieces which then regrow into a complete animal.

Illustrations

Polyembryony (twinning): A type of asexual reproduction in which the embryo or larva (resulting from sexual reproduction) then clones itself into separate individuals. For example armadillos typically produce 4 identical offspring from a single fertilized egg. In some parasitic animals each different larva is able to clone copies of itself. This allows a single egg to produce 100's of potential offspring and enhances chances that at least a few will be able to find a new host to complete their life cycle. In humans this process occurs occasionally to produce identical twins.

Slides: redia; or redia & cercaria (1st Fig. 8.10; 2nd Fig 9.9)

Illustrations

Regeneration: This process is most commonly used not as a form of reproduction but to replace missing or damaged parts. Some organisms have great powers of regeneration while others can only regenerate simple cells and tissues. Humans for example regenerate all their bone tissue about every 7 years and all their blood cells about every 4 months. In other animals, such as lizards and arthropods, tails or whole limbs can be replaced. Starfish can regenerate new "arms" when one is broken off and sometimes a single arm can regenerate an entire starfish.

Preserved: regenerating starfish

Examples of Sexual Reproduction

Normally, sexual reproduction involves the fertilization of a female's egg by a male's sperm. Sexual reproduction results in genetically unique individuals or offspring. Sexual reproduction provides much of the genetic variation required for evolution and adaptation. Most variations in sexual reproduction depend on where the gametes come from or whether the developing egg has been fertilized or not.

Monoecious Animals (Hermaphrodites): Monoecious organisms are those containing both male and female reproductive organs. About 15% of animals, especially those that are sessile (nonmotile) or parasitic, tend to be hermaphrodites. Use the illustrations provided to find examples of male and female organs in each of the items below

Slide: *Clonorchis sinensis* wm (1st Fig. 8.10; 2nd Fig 9.8)

Preserved: earthworm (1st Fig. 11.5; 2nd Fig 12.5)

Dioecious Animals: These are organisms that produce *either* male *or* female reproductive organs and gametes but never both at the same time.

Protandry: is the ability in some animals to switch their sex based on environmental cues such as changes in temperature.

See some examples and illustrations on demonstration

Preserved: *Crepidula* shells

Sexual Dimorphism: Sometimes it is impossible to distinguish the male from the female of a species by outward appearance. In other dioecious animals the males and females are not identical, but differ in appearance, thus showing dimorphism. For example, in most invertebrates the male is usually smaller than the female, while in vertebrates the female is usually the smaller one. In addition to size, dimorphism may also result in differences in structures and color between genders. In birds the male is usually more brightly colored. What would be the advantages and disadvantages of such differences?

Slide: *Schistosoma* male and female wm

Preserved: *Ascaris* male and female (1st Fig 9.4; 2nd Fig 10.4)

Parthenogenesis ('virgin birth'): With the exception of a suspected supernatural intervention 2000 years ago, this process only regularly occurs in nonhuman animals, both vertebrates and invertebrates. In these cases the unfertilized egg is able to develop even though it has not been fertilized by a sperm. Most rotifers, brine shrimp and some social insects such as bees and ants regularly reproduce this way. Some higher animals such as fish and frogs can also sometimes reproduce in this way.

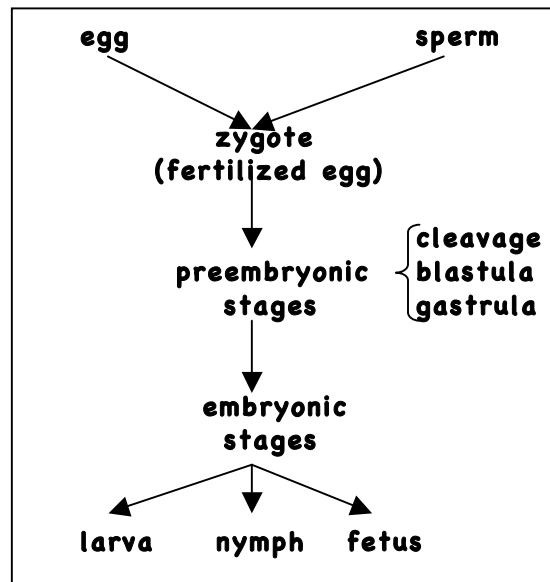
Slide: Rotifers (2nd Fig 10.7)

Additional Lab Report Suggestions

→ how can YOU distinguish between each of the terms below on the slides and illustrations provided?

Animal Development

All living organisms exhibit some form of growth and development. Members of the animal kingdom have the most complex developmental cycles of any living organism. The sequence of discrete, recognizable stages that these organism pass through as they develop from the formation of a **zygote** (the fertilized egg) to the sexually mature adult are referred to as its **developmental cycle**. Animal development can be subdivided into several sequential processes: **gametogenesis, fertilization, preembryonic development, embryonic development** and **post embryonic development**. Embryonic development includes the processes of **growth, determination, differentiation** and **morphogenesis**.



1. Gametes.

The gametes are produced by the process of meiosis which differs from mitosis in that only one of each chromosome ends up in the cells after division. The male gamete, the sperm, is small and almost always flagellated. The female gamete is usually large since it contains yolk, and spherical.

Slides: sperm smear, frog sperm flagella H&E, bird sperm IH/Eosin (HO)

Slide: Graafian follicle sec (Fig. 3.9)

Slide: starfish unfertilized eggs (Fig 4.2A)

-Be able to distinguish between sperm and eggs and to find the following structures on slides and illustrations:

for sperm identify: **head, tail (flagellum)**

for egg identify: **cell membrane, nucleus**

2. Fertilization. [Ex 4-1]

At fertilization only a single sperm penetrates and fertilizes the egg to produce a **zygote**. The egg and sperm each contribute a set of chromosomes so that the fertilized egg then has a pair of each chromosomes, one set from the male parent and the other set from the female parent. To prevent

additional sperm from penetrating the egg a fertilization cone is produced to produce the original sperm into the egg quickly. Then a fertilization membrane expands around the egg and pushes away and “locks out” other sperm cells.

Slide: starfish unfertilized egg wm (Fig. 4.2a)

Slide: starfish fertilized egg wm (Fig. 4.2b)

-Be able to distinguish between unfertilized and fertilized eggs

3. Preembryonic Development. [Ex 4-1]

Almost immediately, the zygote begins to divide to produce a multicellular embryo.

a. Cleavage.

The first identifiable period of development occurs as the fertilized egg begins to divide. These early divisions are called **cleavage divisions** and each cell produced is an identical genetic copy of the zygote and is called a **blastomere**. At this stage each blastomere has the potential to become a complete embryo.

Slide: starfish early cleavage wm (Fig. 4.2)

-observe the slide of starfish eggs in early cleavage and be able to distinguish this stage from those that follow

-note 2, 4, 8 cell stages; each cell is called a **blastomere**

b. Morula:

Continued division leads to a solid ball of cells called the **morula**.

Slide: starfish late cleavage wm (Fig. 4.2G)

-identify the **morula** stage. How does its size compare with that of the fertilized egg?

c. Blastula:

Cell division continues until the embryo becomes a hollow ball of cells. If the embryo is spherical as in starfish it is called a **blastula**; The cavity inside the blastula is called the **blastocoel**.

Slide: starfish blastula wm (Fig. 4.2H)

-Identify the **blastula** and distinguish it from other embryological stages

-hollow ball of cells

-blastocoel

d. Gastrula:

In the gastrula, a depression forms at one end of the embryo, cells move in to form a saclike pouch. The embryo is now essentially two layered. The cavity of this new pouch is called

the **archenteron** (or **gastrocoel**) which is surrounded by the original, now much smaller **blastocoel**. The archenteron opens to the outside through the **blastopore**. The blastopore will eventually become either the **mouth** or the **anus** of the adult animal. By this time the individual cells of the embryo are beginning to **differentiate** into 3 embryonic tissue layers; the **ectoderm**, the **mesoderm** and the **endoderm**. The ectoderm will eventually become the skin and nervous system. The mesoderm will become the skeletal system, muscular system and circulatory system. And the endoderm will develop into the respiratory and digestive system. A cell removed at this stage can no longer develop into a complete embryo.

Slide: starfish gastrula wm (Fig. 4.3C,D)

- Identify the blastula and distinguish it from other embryological stages.
- Note: the **blastocoel**, **archenteron (gastrocoel)**, and **blastopore**

4. Embryo

After the three embryonic tissue layers are formed in the gastrula the immature animal is referred to as an **embryo**. During embryonic development the organs and organ systems form. By the end of the embryonic stage all tissues and major organs have formed.

Slide: chick embryo 72 hours (HO)

Model: human embryo

- Note: on the chick embryo and locate the **brain**, **heart**, **limb buds**, **eye**

The animal embryo may next develop into any of several forms such as **larvae**, **nymphs**, or **fetuses**. Further development varies considerably in different animal groups. Some examples are given below.

5a. Larvae.

In many animals, the embryo soon develops into a free living **larval form**. Larvae are an immature stage which move and feed independently and often have no resemblance at all to the adult of the species. While each phylum or class often has its own characteristic larvae, there are a few larval forms that are found in more than one phylum. Similar larvae imply similar ancestry; indicating that the taxa are relatively closely related. Many groups of animals have characteristic larval stages. A few examples are illustrated below:

i. Planula larva.

A simple multicellular, oval larva with no discernable organs, its surface is covered with cilia for movement common in jellyfish and some flatworms

Slide: *Aurelia* planula wm (HO)

ii. Nauplius larva.

A triangular larva with three pairs of jointed appendages, eyespots, and digestive organs. Nauplii are larvae of crustaceans such as shrimp and crabs

Slide: nauplius, barnacle wm (HO)

iii. Glochidia larva.

Glochidia are larvae of freshwater clams that are parasitic on the gills of fish until they mature and fall to the sediment and begin life as freeliving clams. Note the large 'teeth' that they use to attach to their hosts.

Slide: mussel glochidia wm (HO)

iv. Caterpillars, maggots, grubs and tadpoles (HO)

are examples of larvae that look and feed quite differently than the adults that they become (butterflies, flies, beetles and frogs, respectively)

Preserved: Caterpillars, maggots, grubs & tadpoles (HO)

5b. Nymphs:

Nymphs are immature stages of animals that at least somewhat resemble the adult of the species and that live and feed independently

Preserved: mayfly, dragonfly, stonefly, roach nymphs

5c. Fetus:

In addition to embryonic development, vertebrates (higher animals) produce an immature stage that does resemble the adult but that is usually completely dependent on the mother (or enclosing egg) for nutrition and protection.

Preserved: misc vertebrate fetuses

Illustrations: human fetal development

Models: Human fetus

Some Animal-Like Protists

(Smith & Schenk, Protists; 1st Chapter 5; 2nd Chapter 6)

Protists are single celled or colonial eukaryotes. Some members of the group have characteristics that are also found in animals. In this lab we will investigate some of the more animal-like protists to better understand the origin of the Animal Kingdom from simpler life forms.

General Characteristics of animal-like protists (Protozoa):

- single celled organisms, some colonial
- no cell wall but some secrete a "shell" of silica or calcium carbonate or a flexible pellicle
- mostly heterotrophs
- many with specialized organelles for a variety of functions
- move by flagella, cilia, pseudopodia, or are non motile
- inhabit a diverse array of habitats and include freshwater and marine forms to soil dwelling, symbiotic and parasitic forms.

Lab Objectives:

- be able to recognize both living and preserved examples of the protozoa
- be able to recognize and identify protozoans in various samples of pond, lake and river water samples
- be able to classify both living and preserved members as instructed
- be able to recognize and identify selected organelles and structures as indicated
- be able to describe the ways that protozoa move; compare and contrast their methods.

Use Depression Slides for Live Protozoa

Use "Detain" if Necessary to Slow them Down

[2 pts extra credit: if you bring in a water sample containing protists on the SECOND day of this lab exercise]

Procedures:

-add sketches of some of the protozoa you look at to spaces provided in your lab report; indicated the organisms method of locomotion and label any organelles you were able to see on your sketches.

1. The "amoebas" [1st Ex 5-6; 2nd Ex 6-3]

a. Read the introductory material

b. **Slide:** *Amoeba proteus* (1st fig 5.26; 2nd fig 6.13): **Live:** *Amoeba* sp. (1st fig 5.26; fig 6.13),

-Identify the following structures in *Amoeba*: **nucleus, food vacuoles, pseudopodia**

c. Observe and be able to describe the movement in living specimens

d. be able to recognize slides and living representatives of this group

e. **slides:** Radiolaria wm, Foraminifera wm, Foraminifera strew, fossil foraminifera;

-Distinguish between radiolarians and foraminiferans

-these are 2 different kinds of shelled amoebas; Radiolaria construct a silica shell, Foraminiferans construct a shell of Calcium carbonate.

2. The “flagellates” [1st Ex 5-1; 5-5; 2nd Ex 6-1]

- a. **Slide:** *Euglena* wm (1st fig 5.2; 2nd fig 6.2)
-Identify the following structures in *Euglena*:: **flagellum, nucleus, chloroplast**
- b. **Slide:** dinoflagellates wm (2nd fig 6.5 & 6.6)
- b. **Slide:** *Trypanosoma gambiense* sm (1st fig. 5.3; 2nd fig 6.3)
- c. **Slide:** *Volvox* sexual stage wm (1st fig 5.22)
-be able to recognize slides available as examples of flagellates
- c. **Live:** Termites (if available), *Volvox* sp. (1st fig 5.22), pond water; hay infusion
-from the live materials above be able to recognize examples of flagellates

3. The “ciliates” [1st Ex 5-2; 2nd Ex 6-2]

- a. **Slide:** *Paramecium* wm (1st fig 5.9; 2nd 6.9); **Live:** *Paramecium* sp.
-Identify the following structures in *Paramecium*:: **macronucleus, micronucleus, pellicle, cilia, oral groove, trichocysts, food vacuoles, contractile vacuoles**
- b. **Slides:** *Stentor* wm, *Vorticella* wm (1st fig 5.12; 2nd fig 6.12); **Live:** *Paramecium*, *Stentor*, *Spirostomum*, *Vorticella*
- recognize representatives as ciliates
- c. If possible observe the feeding behavior of any live member of the group
- d. If possible observe the "startle response" in **Live:** *Vorticella* (1st fig 5.12; 2nd fig 6.12)
- e. Slides: *Paramecium* fission wm (1st fig 5.10; 2nd fig 6.10), *Paramecium bursaria* conjugation wm (1st fig 5.11; 2nd fig 6.10)
-Distinguish between the two major types of reproduction in *Paramecium*: asexual reproduction = **fission**, and sexual reproduction = **conjugation**

4. The “apicomplexans” or sporozoans [1st Ex 5-2; 2nd Ex 6-2]

- a. **Slide:** *Plasmodium vivax* smear (1st fig 5.8; 2nd fig 6.8)
-Recognize various stages (but you don't need to name each stage) in the life cycle of *Plasmodium*, the malaria parasite

Additional Lab Report Suggestions:

- Observe the living specimens. Note their means of locomotion, how they move, how fast they move
- Did you observe any feeding activity
- How many different kinds of organelles could you find in the live protozoa? In the prepared slides?

The Animal Kingdom

The largest kingdom in terms of the number of different kinds of species is the **Animal Kingdom** (Metazoa). Animals are represented by a very diverse array of sizes, shapes and forms from very simple to extremely complex, including the “human animal”. All animals are multicellular heterotrophs. Most animals have cells differentiated into highly complex tissues and organs. Whereas plants had tissue systems and relatively simple vegetative and reproductive organs, animals have complex tissues forming organs and elaborate organ systems. The greater specialization of cells and tissues increases the efficiency by which animals can carry out life’s basic processes and allows for almost limitless opportunities for evolutionary variations and adaptations to numerous kinds of habitats and environmental conditions.

Members of the Animal Kingdom are distinguished by sharing the following major characteristics:

- 1. multicellular, eucaryotic organisms**
- 2. cells with no cell wall or chloroplasts and more mitochondria**
- 3. cells differentiated into complex tissues: epithelial, connective, muscular, nervous**
- 4. tissues differentiated into complex organs and organ systems.**
- 5. heterotrophic nutrition (herbivores, carnivores, saprobes)**
- 6. most are much more active and have a much higher metabolism than members of any other kingdom**
- 7. require free oxygen for energy production**
- 8. extra energy usually stored as fats & oils**
- 9. most are motile at some point in their life cycle**
- 10. reproduce both sexually and asexually**, animals show a great diversity in kinds of reproduction. some with well developed alternation of generations.
- 11. most have a relatively complex developmental phase** including an embryonic or a larval stage as they progress from zygote to adult
- 12. most have fairly elaborate behaviors** to enhance their survival within their habitat

There are about 36 distinct phyla within the animal kingdom, many of these phyla contain only one or a few species, yet differ enough from other animals that they are given their own distinct “category”.

Above are listed some of the largest, most common, or most recognizable groups of animals; categorized roughly in order of increasing complexity. The simplest animals, sponges, do not even have true tissues or organs, the most complex animals, the vertebrates, have elaborately developed organ and organ systems. Familiarize yourself with the phyla below and be able to recognize representatives from each one.

A simple way to categorize animals is as **invertebrates** (= animals without backbones) and **vertebrates** (=animals with backbones). The vertebrates are the most familiar animals to most people. But notice that, by far, most animal species are invertebrates while the vertebrates are found in only a single phylum of animal.

The major animals phyla:

Phylum: Porifera [Sponges]	}	invertebrates (animals without backbones)
Phylum: Cnidaria [Jellyfish & Corals]		
Phylum: Platyhelminthes [Flatworms]		
Phylum: Nematoda [Roundworms]		
Phylum: Rotifera [wheel animals]		
Phylum: Mollusca [Molluscs]		
Phylum: Annelida [Segmented Worms]		
Phylum: Arthropoda [Arthropods]		
Trilobita		
Chelicerata (spiders, scorpions)		
Crustacea [lobster, crab, crayfish, shrimp]		
Uniramia [centipedes, millipedes, insects]		
Phylum: Echinodermata [Echinoderms]		
Phylum: Chordata [Chordates]		
Agnatha (lampreys, hagfish)	}	vertebrates (animals with backbones)
Chondrichthyes (sharks and rays)		
Osteichthyes (bony fish)		
Amphibia (frogs, salamanders)		
Reptilia (snakes, lizards, turtles)		
Aves (birds)		
Mammalia (mammals)		

A Key to Some Common Animal Taxa

It is relatively easy to identify most commonly found animals into their proper phylum and even class by using only some of the major external or obvious internal characteristics of a specimen. Most identification is done using a **dichotomous key** in which you are presented with a choice. The results of each choice directs you to a new choice. The process continues until you arrive at the appropriate **taxon**. When using any key, however, you must be aware of its limitations; what are the limitations of the key below?

- 1a.** Body covered with numerous small pores, radially symmetrical or irregular, one or more large openings.....**Phylum Porifera**
- 1b.** Not as above, if pores present they are in 5 rows, usually symmetrical, usually with digestive tract.....**2**

- 2a.** Body with radial or biradial symmetry.....**3**
- 2b.** Body with bilateral symmetry.....**10**

- 3a.** Body mostly soft and gelatinous, cylindrical or umbrella shaped or sometimes spherical, body parts usually in divisions of 4, 6, or 8.....**Phylum Cnidaria**.....**4**
- 3b.** Body usually hard and spiny or with leathery skin, body parts in multiples of 5, some with branched tentacles, rows of tube-feet usually visible.....**7**

- 4a.** Body gelatinous, umbrella or bell shaped.....**5**
- 4b.** Body cylindrical, with tentacles surrounding the mouth, usually sessile, sometimes individuals very small, colonial, and embedded in stone-like or leather-like secretions.....**6**

- 5a.** Small to microscopic, with 4 or 8 canals radiating out from center of body.....**Class Hydrozoa**
- 5b.** Large, sometimes with scalloped margins, branching canals.....**Class Scyphozoa**

- 6a.** Body small to microscopic, usually in plant-like branching colonies.....**Class Hydrozoa**
- 6b.** Much larger, ring of tentacles often retracted or not easily visible.....**Class Anthozoa**

- 7a.** Body with no arms, hard skeleton sometimes with a thin soft “skin” or no rigid skeleton but body wall leathery and flexible.....**8**
- 7b.** Body with arms radiating out from center, no distinct head, skeleton of hard plates covered by thin soft skin.....**9**

- 8a.** Body spherical or flattened disc with moveable spines extending from surface.....**Class Echinoidea**
- 8b.** elongated leathery, sac-like body with branching tentacles at one end.....**Class Holothuroidea**

- 9a.** Arms sharply set off from a central ‘disc’, no grooves or tube feet visible on underside of arms.....**Class Ophiuroidea**
- 9b.** Arms not sharply set off from central area, arms with deep grooves filled with tube feet on ventral surface of arms.....**Class Asteroidea**

- 10a.** Body with internal skeleton, including skull of bone and/or cartilage, If no apparent bone then body with 5 or 6 distinct pairs of gill slits on each side near the head.....**32**
- 10b.** No distinct internal skeleton, no distinct skull or vertebrae.....**11**
- 11a.** Body slender, wormlike or leaflike with no obvious segments, no shell and no appendages.....**12**
- 11b.** Body not as above, if wormlike then having appendages or segments or both.....**17**
- 12a.** Body flattened, no proboscis extending from mouth.....**Phylum Platyhelminthes...13**
- 12b.** Body cylindrical in cross-section, covered in tough cuticle.....**15**
- 13a.** Body long ribbonlike and apparently segmented with segments getting larger at hind end, from end an attachment organ with hooks and/or suckers.....**Class Cestoda**
- 13b.** Body not as above, mouth and digestive tract present.....**14**
- 14a.** Round suckers present, sometimes with hooks, around mouth and about a third of the way down the body, body often leaf-like in shape.....**Class Trematoda**
- 14b.** No attachment organs present, head sometimes triangular, two 'eyes' sometimes present....**Class Turbellaria**
- 15a.** Body relatively thin and narrow, mouth, often with three 'lips' and/or syringe-like' stylet at anterior end, 'lateral lines' visible through the cuticle on each side of the animal.....**Phylum Nematoda**
- 15b.** Not as above.....**16**
- 16a.** Body extremely long and narrow, often coiled, often dark reddish color, hind end with 2 or 3 lobes....**Phylum Nematomorpha**
- 16b.** Body much shorter and wider, mouth with spiny proboscis.....**Phylum Acanthocephala**
- 17a.** Small, body slender and torpedo shaped with lateral and caudal fins, mouth with numerous bristles and spines.....**Phylum Chaetognatha**
- 17b.** Not as above.....**18**
- 18a.** Body soft and unsegmented, some may secrete one or more shells.....**19**
- 18b.** Body definitely segmented, sometimes wormlike, with or without paired appendages.....**25**
- 19a.** Soft, unsegmented body with no external rigid covering**20**
- 19b.** Body soft and unsegmented and completely or partially enclosed by 1 or 2 shells or covered on the dorsal surface by several plates.....**21**
- 20a.** Soft, unsegmented body with large eyes, with arms and tentacles surrounding mouth and extending from head, may have a flexible or rigid endoskeleton**Phylum Mollusca, Class Cephalopoda**
- 20b.** soft wormlike unsegmented body with distinct head containing 2 pairs of tentacles.....**Phylum Mollusca, Class Gastropods**

- 21a.** Animal with a single shell.....**22**
- 21b.** Animal with 2 or more shells (valves).....**23**
- 22a.** Shell tubular, straight or slightly curved and open at both ends.....**Phylum Mollusca, Class Scaphopoda**
- 22b.** Shell usually coiled, spiral, or tentlike, distinct head with 1 or 2 pairs of antennae, dark colored radula inside mouth used to scrape algae.....**Phylum Mollusca, Class Gastropoda**
- 23a.** Animal completely enclosed by two shells (valves).....**24**
- 23b.** Shell consists of 8 dorsal plates, ventrally surrounded by a leathery mantle, in some the mantle completely covers and obscures the plates.....**Phylum Mollusca, Class Polyplacophora**
- 24a.** Animal completely enclosed by two shells (valves)(dorsal and ventral), the ventral shell usually larger, long stalk extends out of the hinge surface of the shell for attachment, or if soft tissue is gone a prominent hole visible where the stalk would have exited.....**Phylum Brachiopoda**
- 30b.** Animal complete enclosed by two lateral shells (valves) joined by ligamentous hinge, right and left paired gills, thick muscular foot able to extend out from between the two shells, no thick stalk for attachment but may by numerous thin strong threadlike fibers for attachment.....**Phylum Mollusca, Class Bivalvia.**
- 25a.** Body wormlike and obviously segmented along its length, if it has appendages on any segments they are short and flaplike and not “jointed” appendages.....**Phylum Annelida... 26**
- 25b.** Segmented body covered by rigid plates surrounding each segment, some segments with paired jointed appendages.....**Phylum Arthropoda.....28**
- 26a.** Each segment with a pair of flaplike appendages and conspicuous bristles (setae) and spines.....**Class Polychaeta**
- 26b.** Each segment without appendages or conspicuous spines.....**27**
- 27a.** Body with numerous apparent segments, round suckers at each end of animal or sometimes just at the posterior end, a pair of small eyes usuall visible on the anterior end.... **Class Hirudinea**
- 27b.** No suckers present, no appendages, some spines present but may be inconspicuous.....**Class Oligochaeta**
- 28a.** Body elongated, with trunk consisting of many similar segments bearing paired appendages, head with paired eyes and one pair of antennae.....**29**
- 28b.** Body not as above.....**30**
- 29a.** Most apparent body segments with two pairs of legs each.....**Class Diplopda**
- 29b.** Most body segments with one pair of legs each, first body segment behind the head with prominent “poison fangs”.....**Class Chilopoda**
- 30a.** Body usually divided into three parts - a head, thorax and abdoman, conspicuous head with large compound eyes and one pair of antennae, three pairs of walking legs on thorax.....**Subphylum Hexapoda**
- 30b.** Body divided into 2 major parts – a cephalothorax with eyes, mouthparts and walking legs, and a thorax.....**31**

- 31a.** Two pairs of antennae (one pair might be inconspicuous), usually large compound eyes, usually more than 4 pairs of walking appendages on cephalothorax and also appendages on the abdomen.....**Subphylum Crustacea**
- 31b.** No antenna, 4 pairs of walking legs on cephalothorax.....**Subphylum Chelicerata**
- 32a.** Aquatic species, with or without scales, body with rigid and or moveable fins.....**33**
- 32b.** Not as above.....**35**
- 33a.** Aquatic species, mouth without closable jaw, no paired fins on body...**Class Agnatha**
- 33b.** Aquatic species, mouth with closable jaw, usually with two pairs of fins.....**34**
- 34a.** Aquatic species, cartilaginous skeleton, mouth ventral, placoid or toothlike scales or no scales, 5 to 7 pairs of prominent gill slits near the head, paired fins only slightly moveable.....**Class Chondrichthyes**
- 34b.** Aquatic species, usually with bony skeleton, with or without scales, if scales not placoid scales, single opening for gills, covered by bony operculum, both pairs of fins freely moveable.....**Class Osteichthyes**
- 35a.** Skin with scales at least in some areas.....**36**
- 35b.** Skin without scales.....**37**
- 36a.** Skin covered with horny, epidermal scales, sometimes covering bony plates, paired limbs usually with 5 toes or limbs absent, lungs, not gills.....**Class Reptilia**
- 36b.** Most of skin covered with feathers, scales on legs only, forelimbs adapted for flying, toothless, horny beak.....**Class Aves**
- 37a.** Skin usually covered with fur, in some hair is very scarce but still present, skin usually with sweat, oil and scent glands, females with mammary glands to nurse young.....**Class Mammalia**
- 37b.** Skin naked (no scales, feathers or fur), often moist or slimy, sometimes dry and warty.....**Class Amphibia**

Name: _____

Identifying Animal Phyla

Use the key provided to identify different animals that are provided for you. Complete the table below. Use the animal classification guide to find a common name. Turn in this sheet at the end of the lab.

	Sequence used to identify animal	Phylum	Subphylum or Class (if listed)	Common Name of Taxon
specimen #	1b→4b→7a→8a	Echinodermata	Asteroidea	starfish
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Identification of Some Common Freshwater Invertebrates

1a. Animal with obvious jointed legs or antennae (Phylum Arthropoda)	22
b. Animal without obvious jointed legs (may have stubby unjointed “legs”)	5
2a. With 3 pairs of legs	Class Insecta (adults and nymphs)
b. Clearly with more than 3 pairs of legs	3
3a. With 4 pairs of legs, no antennae; Class Arachnida (spiders, mites)	4
b. Usually with 5 or more pairs of legs and 2 pairs of antennae	25
4a. Body divided into 2 distinct sections	Order Aranea (spiders)
b. Body not obviously divided into 2 distinct sections	Order Acari (mites)
5a. Microscopic, with segmented body with 4 pairs of knoblike legs bearing claws at their tips	Phylum Tardigrada (water bears)
b. Not as above	6
6a. Body covered by a shell	7
b. Body without a shell	8
7a. Body covered by 1 shell, usually coiled or spiral	Class Gastropoda (snails)
b. Body covered by 2 distinct, hinged shells	20
8a. Individuals growing in colonies or spongelike masses growing on rocks and twigs	9
b. Individuals not growing in colonies	10
9a. Colonies with pores, often green, irregular shapes	Phylum Porifera (sponges)
b. Not as above; individuals of colony distinct, flowerlike with numerous tentacles; or gelatinous mass; some can be quite large	Phylum Bryozoa (moss animals)
10a. Body soft, umbrella-like and translucent, free swimming by rhythmic contractions; Phylum Cnidaria;	Class Hydrozoa (jellyfish)
b. Not a jellyfish	11
11a. Most of body with distinct segments	12
b. Body not segmented	16
12a. With distinct head with eyes, antennae and jaws; legs present or absent; Phylum Arthropoda;	Class Insecta (insect larvae)
b. Without a distinct head	13
13a. Body often flattened, with a sucker at one end Phylum Annelida;	Class Hirudinea (leeches)
b. Not as above, without a sucker	14
14a. Microscopic, front of body with two wheellike corona that appear to spin as the animal feeds; back of body appears as a segmented, telescoping leg with 2 “toes” that are used for attachment	Phylum Rotifera (wheel animals)
b. Larger animals, not microscopic; easily visible to the unaided eye; features not as above	15
15a. Body very elongated and worm-like, without distinct	

- head or legs; Phylum Annelida;
- b. Body not as above; *may* have wartlike “legs”, hooklike jaws and/or siphonlike tail
Phylum Arthropoda; Class Insecta;
- 16a.** With tentacles at one end (around mouth)
Phylum Cnidaria;
- b. Without tentacles
- 17a.** With elongated whiplike proboscis (tongue) extending from mouth
- b. Body elongated and wormlike
- 18a.** Microscopic; not easily visible without magnification
- b. Much larger and easily visible to unaided eye
- 19a.** Body elongated, soft and delicate, flattened, often with eyespots, tends to ball up when disturbed; Phylum Platyhelminthes;
- b. Body extremely long, thin, and wire-like, often tangled into a knot
- 20a.** Microscopic; with jointed legs and/or antennae protruding from shells as it swims Phylum Arthropoda; Class Crustacea;
- b. Larger animals with 2 hard shells usually tightly closed; often with brown barklike periostracum covering outer surface of shell and pearly layer on the inside; Phylum Mollusca;
- 21a.** Microscopic; flattened body, usually with spines on its surface, and with a forked tail end; gliding movement
- b. thin wormlike body that tapers at both ends, no distinct head, makes whiplike, side to side movements
- 22a.** Body appears to be enclosed in a shell, with no distinct head
- b. Not as above
- 23a.** Usually with a large pair of antennae, often branched, extending from front of body, large eye clearly visible
- b. Not as above
- 24a.** Entire body clearly segmented, pair of long antennae usually extending at right angles to the body
- b. Not as above
- 25a.** Small, arching segmented body with many paired
- b. Large animals, at least several inches long, pair of prominent “pinchers toward front end, two distinct pairs of antennae
- Class Oligochaeta** (earthworms)
- Order Diptera** (fly larvae)
- Class Hydrozoa** (hydras)
17
- Phylum Nemertinea** (proboscis worms)
18
- 21
19
- Class Turbellaria** (planarians)
- Phylum Nematomorpha** (horsehair worms)
- Class Crustacea-Ostracods** (seed shrimp)
- Class Bivalvia** (clams)
- Phylum Gastrotricha**
- Phylum Nematoda** (roundworms)
- Class Crustacea-Ostracods** (seed shrimp)
23
- Class Crustacea-Cladocera** (water fleas)
24
- Class Crustacea-Copepoda** (copepods)
2
- Class Crustacea-Amphipoda** (amphipods)
- Class Crustacea-Decapoda** (crayfish)

Identifying Common Freshwater Invertebrates

1. Examine the water samples available in the lab room.
 - a. collect a drop of water or sediment from the bottom of the container and make a wet mount to examine on your compound microscope
 - b. Also, carefully examine any small stones, leaves etc for signs of larger organisms. Then use forceps to pick them up and place them in the small dish provided. Now use the dissecting scope or magnifying glass to investigate these larger critters

2. Now use the key provided to identify 5 different organisms that you collected. You will usually be trying to identify the animal to **Phylum** or **Class** (review the categories used by taxonomists to categorize living organisms) Use the same technique that you used to identify the leaf specimens several weeks ago and follow the dichotomous key as far as you can go. Then complete the table below. Generally, the common name is given in parentheses and the formal name is in bold face.

Animal	Sequence used to identify it	Common Name	Formal Name of Animal Group
specimen #	1a→2b→3a→4b	water mites	Order Acari (a kind of arthropod)

Name: _____

Due Date: _____

Lab Report for Practical #1: 'Introduction' to 'Survey of Animal Phyla'

I. Introduction and Lab Safety

1. What do YOU see as the three most important items related to lab safety in the Zoology lab?

2. Why is the proper collecting and labeling of animal specimens so important to the study of zoology?

3. How can making lab sketches REALLY (ie. no b.s.) help you in learning about animals – give specific reasons?

II. Microscopy

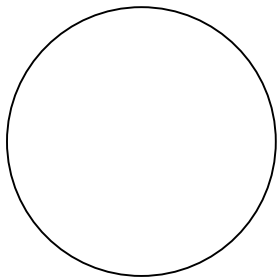
4. What are the differences between a compound microscope and a dissecting scope? What are the advantages of each? Which one is easier to use?

5. What is the actual magnification when using the:
 - scanning lens

 - low power lens

 - high power lens

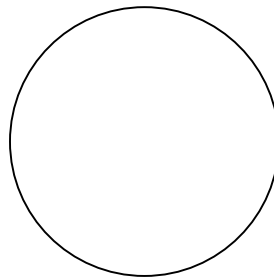
6. Select a slide and make a sketch below of what it looks like under each of the two kinds of scopes



Microscope

Slide: _____

Magnification: _____



Dissecting Scope

Slide: _____

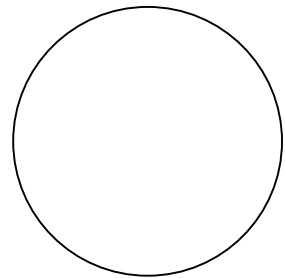
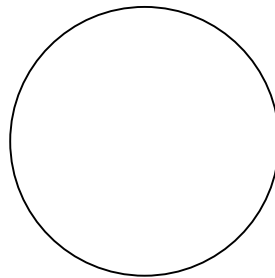
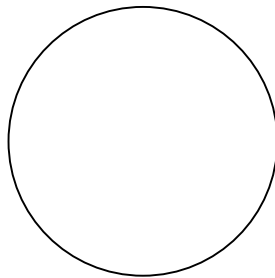
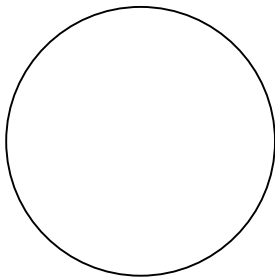
Magnification: _____

III. Animal Cells, Tissues, Organs & Organ Systems

7. Animal cell organelles:

8. which of these were you able to find in the living cell

9. Make a sketch of one example of each of the 4 major kinds of animal tissues



tissue: _____ tissue: _____ tissue: _____ tissue: _____

Magnification: _____ Magnification: _____ Magnification: _____ Magnification: _____

10. List of major human organ systems.

IV. Animal Reproduction and Development

11. how can YOU distinguish between each of the terms below on the slides and illustrations provided?

budding

fragmentation

polyembryony

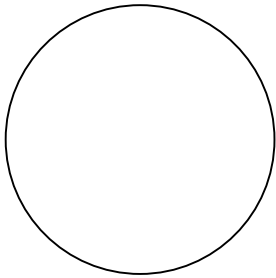
monoecious

protandry

parthogenesis

12. Select an animal you are familiar with and name and describe the stages it will progress through from **fertilized egg** to **adult**

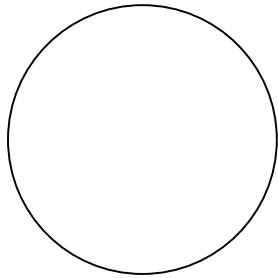
V. Some Animal – Like Protists



Name: _____

Loco: _____

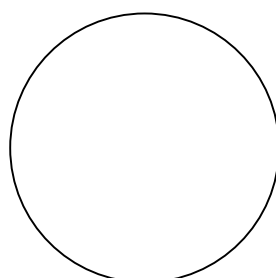
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Name: _____

Loco: _____

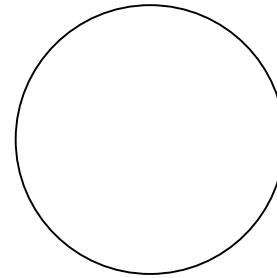
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Name: _____

Loco: _____

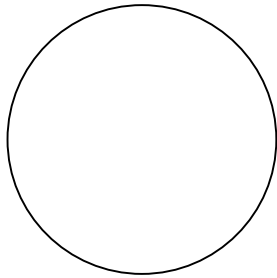
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Loco: _____

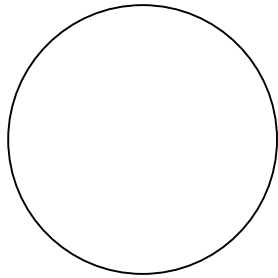
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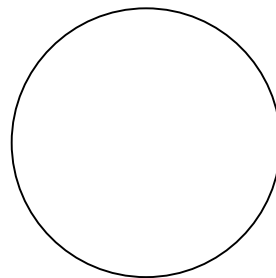
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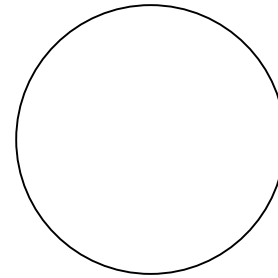
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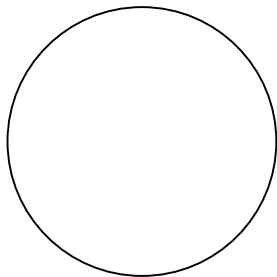
Magnification: _____



Name: _____

Loco: _____

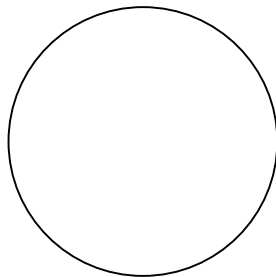
Magnification: _____



Name: _____

Loco: _____

Magnification: _____



Name: _____

Loco: _____

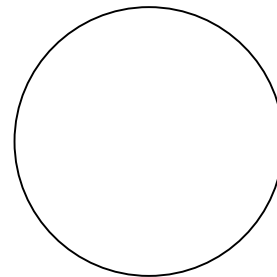
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Loco: _____

Magnification: _____



Name: _____

Loco: _____

Magnification: _____

VI. The Animal Kingdom - General

[Practice Identifications already submitted]

Porifera (Sponges)

(Smith & Schenk, Sponges; 1st Chapter 6; 2nd Chapter 7)

Identifying Characteristics of Phylum:

- most primitive animal phylum
- no true tissues (sponges are at the “cellular level” of organization)
- simple body plan with pores and water channels

Major Classes of the Phylum:

Class: Demospongiae (Commercial Sponges)

- skeleton of spongin fibers; commercial sponges; *Spongilla*

Class: Calcarea (Calcareous Sponges)

- skeleton of calcium carbonate spicules; *Scypha (=Grantia)*

Class: Hexactinellida (Glass Sponges)

- skeleton of siliceous spicules; Venus flower basket

Cell Types and Characteristic Structures:

pinacocytes	-flattened epithelial cells
choanocytes	-(collar cells) create water currents in canals and chambers
mesohyl	-gelatinous matrix with scattered cells
spicules	-made of calcium carbonate, silica or fibers of spongin
gemmules	-internal asexual buds in freshwater species

Body Organization (canal systems):

Ascon body type	-incurrent pores; spongocoel lined with choanocytes; osculum
Sycon body type	-ostium; incurrent canals; radial canals lined with choanocytes; spongocoel; osculum
Leucon body type	-pores; incurrent canals; radial canals; flagellated chambers with choanocytes; osculum

Procedures:

1. Read introductory material on sponges in lab manual.
2. As you read through the lab material and make your observations make some sketches of slides, preserved and demonstration material available on your lab report. Label as appropriate.
3. Sponge Anatomy [1st Ex 6-1; 2nd Ex 7-1]
 - a. read information on general anatomy.
 - b. **slide: *Scypha* cs & *Scypha* mls**
 - study sections and know: **spongocoel, radial canals, incurrent canals, pinacocytes, choanocytes, ostium, osculum**
 - Compare your slide to (1st fig 6.7; 2nd fig 7.6); how many of the cell types illustrated (choanocytes, porocytes, amoebocytes, pinacocytes) can you actually see on your slide?
4. Reproduction in sponges
 - a. **slide: Gemmules, wm**
 - recognize **gemmules of freshwater sponge**

-are they for sexual or asexual reproduction?

5. Spicules – The Sponge Skeleton: [1st Ex 6-2; 2nd Ex 7-2]

a. **slides:** *Scypha* spicule strew

-shows spicules of calcium carbonate

Sponge Skeleton wm (1st fig 6.8; 2nd fig 7.9)

-shows spongin fibers

preserved: *Euplectella* skeleton

-shows skeleton of silical fibers

- read info and know of the kinds of supporting structures including **spicules**

- you will look at prepared slides rather than making wet mounts

Demonstrations:

- Observe the variety of sponges, preserved and illustrated, and be able to recognize which of the three types of canal systems each demonstrates
- Observe the variety of sponges, preserved and illustrated, and be able to recognize to which of the major classes each of them belong
- Note the symbiotic crabs trapped within the venus flower basket (class: hexactinellidae), how did they get there and why are they there?
- Observe the holes made by boring sponges (class: demospongiae) and draw a few examples

Additional Lab Report Suggestions:

- View the examples of glass sponge and commercial sponges under dissecting scope; try to distinguish between the skeleton of silica fibers and that of spongin fibers; make sketches to illustrate the difference
- Make notes on the types of reproduction in sponges
- Describe in words the major differences between the different types of body organization; what are the similarities?

Cnidaria (Jellyfish & Corals)

(Smith & Schenk, Cnidarians; Chapter 7)

Identifying Characteristics of Phylum:

- two true tissue layers (=germ layers (tissue level of organization)
- alternation of generations: polyp and medusa; asexual and sexual reproduction
- many colonial species
- gastrovascular cavity with mouth, no anus
- hydrostatic skeleton
- nerve net and simple receptors
- cnidocytes with nematocysts for capturing prey

Cell & Tissue Types and Characteristic Structures:

- | | |
|------------------------------------|--|
| epitheliomuscular cells | -form epidermis |
| nutritive-muscular cells | -form gastrodermis which lines GVC |
| mesoglea | -is a gelatinous layer between the two tissue layers above |
| cnidocytes (stinging cells) | -contain harpoon-like nematocysts |

Body Organization:

- | | |
|-----------------------|--|
| polyp | -saclike with tentacles |
| medusa | -umbrella-like with tentacles around edge |
| colonial forms | -may have polyps specialized for feeding or reproduction |

Major Classes:

Class: Hydrozoa

- most with polyp and medusa stage with polyp dominant; many colonial;

Class: Scyphozoa (Jellyfish)

- most with polyp and medusa stage with medusa dominant;

Class: Cubozoa (Box Jellyfish)

- box like shape, the most poisonous jellyfish

Class: Anthozoa (Sea Anemones & Corals)

- polyp stage only; many colonial; calcium carbonate exoskeleton;

Procedures:

Read introductory descriptions and discussions of cnidarians.

A. Class Hydrozoa

1. Solitary Hydrozoans: external structure (1st fig 7.4 & 7.5; 2nd fig 8.4 & 8.5):

a. **slide:** *Hydra* budding,wm or *Hydra* budding adult wm

- know: **basal disc, tentacles, body, hypostome, mouth, buds, gastrovascular cavity**

2. Hydrozoan Section showing tissue layers (1st fig 7.6; 2nd fig 8.6):

a. **slide:** *Hydra* cs & *Hydra* ls

-know: **epidermis, gastrodermis, mesoglea, gastrovascular cavity**

-draw and label some of the cell types seen on these slides in the spaces provided in your lab report

3. Investigation of Cnidarian Feeding Behavior in living *Hydra* [1st Ex 7-4; 2nd Ex-5]

-use “deep depression slide” or small dish.

a. Habitat & Behavior: observe movements and startle reactions

b. Feeding Behavior:

-if possible, observe how the hydra feeds on zooplankton

c. Cnidocytes and nematocysts

-after observing behavior and feeding in hydra transfer the hydra to a regular microscope slide and cover with coverslip. Add one drop of methylene blue to one side of the coverslip. While watching through the oculars touch a small piece of paper towel to the opposite side of the coverslip to draw in the methylene blue. As the dye reaches the animal it should discharge its nematocysts.

4. Reproduction in Hydra

a. **slide:** *Hydra* adult w bud, wm (1st fig 7.5; 2nd 8.5)

-observe and recognize asexual: Budding

b. **slides:** *Hydra* spermaries, wm (1st fig 7.6 – 7.7; 2nd 8.7) or *Hydra* testes wm; *Hydra* ovaries, wm *Hydra* spermaries & ovaries, sec

-Be able to visually recognize and distinguish between male and female specimens in both whole mount and cross section

-be able to identify ovaries and testes in wm and cs

5. Colonial Hydrozoans (*Obelia*)

a. **slide:** *Obelia* hydroid, wm (1st fig 7.10; 2nd fig 8.10)

-know: **hydranths, gonangia, hydrotheca, gonotheca, coenosarc, perisarc, mouth, tentacles, gonopore**

b. **slide:** *Obelia* medusa, wm (1st fig 7.11; 2nd fig 8.11)

-know: **medusa as sexual stage** and how it is produced on the gonangium

c. **slide:** *Pennaria* & other hydroid colonies

-recognize slides and preserved materials as examples of Hydrozoa

d. **preserved:** *Physalia*

-colonial hydroid that superficially resembles a jellyfish

-compare to illustrations available and note the different kinds of specialized individuals that make up the colony

6. Hydrozoan Medusae

a. **preserved:** *Gonionemus*

- *Gonionemus*: compare the appearance of the preserved animal with the illustrations in your lab manual

B. Scyphozoa (True Jellyfish) [1st Ex 7-2; 2nd Ex 8-2]

1. **preserved:** moon jellyfish, *Aurelia* (1st fig 7.13; 2nd fig 8.13)

- know: **oral arms, mouth, stomach, circular canal, radial canal, tentacles, gonads, rhopalium**

2. Life cycle of *Aurelia* : **slides:** misc *Aurelia* life cycle slides (HO)

- be able to recognize the stages in the production of medusae; the **scyphistoma, strobila** and **ephyra**
- Be able to visually recognize the **planula** as the characteristic larval form of this phylum

3. **preserved:** misc jellyfish

- be able to recognize as members of the Scyphozoa

C. Anthozoa (Sea Anemones & Corals) [1st Ex 7-3; 2nd Ex 8-3]

1. **preserved:** *Metridium* (1st fig 7.15-7.16; 2nd fig 8.15-8.16)

- dissect preserved specimen as described in lab manual
- know: **oral disc, basal disc, tentacles, mouth, pharynx, septum, septal filament, acontia, gastrovascular cavity**

2. **slide:** *Metridium* cs (=xs)

- find as many of the structures listed above (9a) as you can on the slide

3. **preserved:** misc. coral specimens

- be able to recognize and distinguish between **hard corals** and **soft corals**.

Demonstrations:

- Other Hydrozoa: can you distinguish between medusae of the class hydrozoa and those of the class Scyphozoa?

EC. Phylum Ctenophora (Comb Jellies) to distinguish this closely related phylum from the Cnidaria [2nd Ex 8-4]

Additional Lab Report Suggestions:

- What evolutionary advances do they have over the sponges?
- How easily can you distinguish between polyps and medusae? in solitary animals? in colonial animals?
- What type of symmetry is evident? Do all members of the phylum show the same type of symmetry?
- Are all the examples of the phylum easily recognized as belonging to the Cnidaria?

Platyhelminthes (Flatworms)

(Smith & Schenk, Flatworms, 1st Chapter 8; 2nd Chapter 9)

Identifying Characteristics of Phylum:

- three true tissue layers (*triploblastic*)
- bilateral symmetry
- no body cavity (*acoelomate*)
- some simple organs & organ systems; no skeletal, circulatory or respiratory systems
- simple excretory system of tubules with “flame cells”
- incomplete or no digestive tract
- most hermaphroditic
- many highly specialized parasitic forms
- most parasitic forms with complex life cycles including one or more *intermediate* hosts and one or more larval forms

Cell Types and Characteristic Structures:

- epidermis**
- parenchyma tissue**
- gastrodermis**
- “flame cells” (protonephricia)**
- circular and longitudinal muscle layers** around body wall

Body Organization:

- flattened body
- some simple organs & organ systems: eg. digestive, nervous, excretory, reproductive
- trematodes, monogenea and cestodes greatly modified for parasitic lifestyle
- tapeworms with *scolex* for attachment; buds *proglottids*
- fluke life cycle: egg → miracidium → sporocyst → redia → cercaria → adult**
- tapeworm life cycle: egg → cysticercus (bladder worm) → adult**

Classification:

- Class: Turbellaria** -free living, mostly aquatic; *Dugesia, Bipalium*
- Class: Trematoda** -parasitic liver and blood flukes; *Clonorchis*
- Class: Monogenea** -mostly external parasites of fish, *Protopolystoma*
- Class: Cestoda** -tapeworms; *Taenia*,

Procedures:

Read introduction and descriptions of flatworms in the lab manual.

A. Turbellaria (Planarians)

1. **live:** *Dugesia* (= *Planaria*), A Live Planarian (1st see Ex 8-4; 2nd see Ex 9-4)

a. Note general external appearance

- know: **head, eyes, auricles**

b. Observations Locomotion & Feeding Behavior

c. Perform the experiment on “photosensory behavior” as described in your lab manual. Record your results in your lab report.

2. **slide:** *Planaria* inj wm (1st fig 8.3 & 8.4; 2nd fig 9.5)

a. find the following terms on the whole mount: **eyespot, gastrovascular cavity, pharynx, mouth, auricle**

3. **slide:** *Planaria* through 3 regions, cs (1st fig 8.5; 2nd fig 9.7)

a. locate the following on transverse sections of *Planaria*: **epidermis, mesoderm, gastrodermis, gastrovascular cavity, pharynx, nerve cord**

b. Be able to recognize which of three regions a section is from; (anterior, pharyngeal or posterior)

c. use illustrations to understand the basic structure of the nervous, excretory and reproductive systems (1st figs 8.4 & 8.7; 2nd fig 9.4 & 9.6)

B. Flukes: Class Trematoda [1st Ex 8-2; 2nd Ex 9-2]

1. **slide:** *Clonorchis sinensis* wm (1st fig 8.8; 2nd 9.8) The Chinese Liver Fluke

-Know: **oral & ventral suckers, mouth, pharynx, gastrovascular cavity, uterus, ovary, testes, yolk glands**

2. **slide:** *Fasciola hepatica* wm (1st 8.9; 2nd 9.9) The sheep liver fluke

••• *Use dissecting scope only!* •••

-Compare general structure with that of *Clonorchis*

-Use illustrations to identify: **Oral and ventral sucker, mouth, yolk glands, testis, ovary, uterus**

3. **slides:** *Schistosoma mansoni* male wm; *Schistosoma* male & female wm; *Schistosoma* female wm. the human blood fluke (HO)

-be able to distinguish between male and female

- recognize them as blood flukes

4. **slides:** cercaria; wm; redia wm; redia & cercariae, wm (1st fig 8.9; 2nd 9.10)

-Be able to recognize these as a larval form of trematodes

C. Class Monogenea (ec)

1. **slide:** monogenetic trematode, *Protopolystoma* wm

-*Protopolystoma* is a frog parasite

-Note general appearance and distinguish from other classes of flatworms

-Know: **anterior sucker, mouth, intestine, uterus, anal suckers, hooks**

D. Tapeworms (Class Cestoda) [1st Ex 8-3; 2nd Ex 9-3]

1. **slides:** *Taenia solium*, scolex, wm; *Taenia pisiformis* mature proglottid, wm; *Taenia pisiformis* gravid proglottid, wm (1st fig 8.11 & 8.12; 2nd 9.11 & 9.12)

-Know: **scolex, suckers, hooks, uterus, testes, vas deferens, genital pore, ovary, yolk gland**

- know the difference between a **mature** and a **gravid** proglottid

2. Cestode larvae; Cysticercus larva (bladderworm) (HO)

a. **slide:** *Taenia pisiformis* cysticercus (HO)

***** Use dissecting scope only!*****

-Be able to recognize it as a larval form of tapeworms

EC. Phyla Mesozoa, Acoelomorpha and Nemertea (Ribbon Worms)

-observe the illustrations and specimens of ribbon worms on display and be able to distinguish them from the other “worm phyla” you have seen in this section

Demonstrations:

- Planarian Organ Systems - note the various organs and organ systems found in these flatworms:
 - digestive system:** highly branched to deliver nutrients to tissues in the absence of a circulatory system; also note it is an incomplete digestive tract with a mouth but no anus.
 - excretory system:** paired tubules "powered" by ciliated 'flame cells' which drain to the outside of the animal
 - nervous system:** paired ventral nerve cords with collateral connecting branches and ganglia (=brain) in head; specialized sense organs with photoreceptors (eye spots) and chemoreceptors (auricles)
 - muscular system:** with both circular and longitudinal muscles in body wall
 - reproductive system:** well developed
- Other examples of the class Turbellaria; all are free living
- Trematode life cycle: note the many larval stages, you observed a cercaria in your lab activities

- Cestode life cycle: most tapeworms have a single larval form the cysticercus or bladder worm.

Additional Lab Report Suggestions:

- Describe some of the special adaptations seen in the parasitic classes that enhance their ability to find and survive in a host
- How do the larval forms of the trematodes and the cestodes differ and how do their life cycles differ?

Extra Credit Phyla

Observe and be able to identify the extra credit phyla on display

Nematoda (Roundworms)

(Smith & Schenk, Roundworms , 1st Chapter 9; 2nd Chapter 10)

Identifying Characteristics of Phylum:

- freeliving and parasitic worms with elongated cylindrical body tapered at both ends
- three true tissue layers
- has a body cavity that is a pseudocoelom (cavity incompletely lined with mesodermal tissues) that serves as *hydroskeleton*
- external nonliving cuticle secreted by epidermis
- complete digestive tract with mouth and anus
- exhibits eutely (the number of cells is constant in each species)

Cell Types and Characteristic Structures:

epidermis (=hypodermis) usually *syncytial* and secreting a flexible **cuticle**
three true tissue layers; mesoderm forms **longitudinal muscle layer** lining the body wall
no muscle tissue associated with intestine
gastrodermal cells line intestine

Body Organization:

- round, nonsegmented, tubular body tapering at both ends
- no distinct head apparent
- characteristic "S" - like movements as longitudinal muscles in body wall work against hydrostatic skeleton
- presence of a **body cavity** and a complete digestive tract creates "tube within a tube" body design
- strong muscular **pharynx** (tripartite in cross section) is not eversible

Classification:

(A very large yet poorly known phylum in which the taxonomy has not been clearly worked out)

Procedures:

1. Read description and discussion of roundworms in the lab manual.
2. Nematode Anatomy: *Ascaris*, the intestinal roundworm [1st Ex 9-1; 2nd Ex 10-1]

Before pinning your specimen use your dissecting scope to determine front from back and dorsal vs ventral side of the animal. Pin animal in tray dorsal side up using one pin at the extreme anterior and another posterior. Submerge the specimen in water. Use a pin or dissecting needle to make a longitudinal incision along the entire length of the animal. Carefully open and pin the sides of the animal to the tray.

- a. **preserved:** *Ascaris lumbricoides* (1st fig 9.4 & 9.5; 2nd 10.4 & 10.5)

-general features: know: **spicules, mouth, lips, anus, vulva, cuticle, lateral line**

-internal structure (follow dissecting instructions provided); know:

both: **pseudocoel, excretory canals, pharynx, intestine**

female: **vagina, uteri, oviducts, ovaries**

male: **ejaculatory duct, seminal vesicle, vas deferens, testis**

- b. **slides:** *Ascaris lumbricoides* male, cs; *Ascaris lumbricoides*, female, cs,
or *Ascaris* male & female (1st fig 9.6; 2nd fig 10.6)

-transverse Sections of *Ascaris*: know: **cuticle, epidermis, longitudinal muscles, pseudocoel, dorsal & ventral nerve cords, excretory canals (=lateral lines), intestine**

-female: **uteri, oviducts, ovaries**

-male: **testis, vas deferens, seminal vesicle**

3. Locomotion in the Vinegar Eel: *Turbatrix aceti* [1st Ex 9-2; 2nd Ex 10-2]

- a. **live:** vinegar eels

-place a drop of culture on a slide and cover with coverslip

-Note characteristic thrashing movement

-lift the coverslip and add a measure of fine sand, replace the coverslip. How does the movement of the animal differ with the sand present?

-Be able to recognize these animals as nematodes

-Know: **mouth, pharynx, intestine, anus, distinguish between male and female**

(To study their anatomy you may need to add a drop of *detain* to a slide)

4. Other Nematodes

-use illustrations on hand outs to examine slides and preserved material to recognize other species of nematodes

-know the diseases they cause and the basic aspects of their life cycle

- a. **slide:** *Trichinella spiralis* encysted larva, wm: Trichina worm: *Trichinella spiralis* (1st fig 9.2; 2nd fig 10.2)

-Be able to recognize the encysted larva

- b. **slide:** *Enterobius vermicularis*,wm: Pinworm *Enterobius vermicularis*

- c. miscellaneous roundworm parasites:

-**biosmount:** dog heartworm (1st fig 9.1; 2nd fig 10.1), hookworm (*Necator* & *Ancylostoma*), whipworm (*Trichurus*), *Toxocara* (filarial worm; dog and cat roundworm)

EC. Phyla Nematomorpha (horsehair worms), Kynorhyncha, Loricifera and Priapulida

-observe any illustrations and specimens (if available) and be able to recognize each phylum

Demonstrations:

- Body Cavities: be able to distinguish between the acoelomate, pseudocoelomate and eucoelomate condition
- General Nematode Anatomy: may help you to identify some of the assigned structures in your specimens
- Observe other roundworms that are on display and be able to recognize the phylum and the diseases each is associated with if any

Additional Lab Report Suggestions:

- Make observations on the movement of the vinegar eels both with and without the sand grains
- Make some drawings and observations of nematodes that you have collected from soil/root samples

Rotifera (Rotifers)

Identifying Characteristics of the Phylum:

- Body cavity a pseudocoelom
- cuticle or caselike **lorica** arranged in segment-like rings or plates
- body without cilia except for its characteristic ciliated crown, the **corona**
- complete digestive tract with mouth and anus
- dioecious but in some species male is unknown or degenerate, many are parthenogenetic

Cell types and characteristic structures:

- syncytial epiderms
- most structures in rotifers are syncytial; but nuclei show constancy in numbers
- three true tissue layers
- characteristic feeding structure is a ciliated **corona**
- pharynx modified into jawlike **mastax**

Body Organization:

- all small, less than 3 mm with great diversity in body shape depending on mode of life
- in most body divided into head, trunk and tail (or foot)

Procedures:

1. Living rotifers if available [2nd Ex 10-3]

- use illustrations from text and handouts to study rotifers
- be able to identify rotifers in a freshwater sample
- note their method of locomotion and feeding
- note: **corona, mastax, toes, segmented body**

2. **slide:** rotifers, wm (2nd fig 10.7)

- Examine prepared slide of a rotifer and be able to identify the following: **corona, foot, mastax, digestive tract, reproductive tract**

E.C. Phyla: Gnathostomulida and Micrognathozoa

- observe illustration and be able to recognize examples of each phylum.

Additional Lab Report Suggestions

- Label your sketches with as many of the anatomical terms above as you can identify
- List as many ways as you can think of that rotifers are similar to Nematodes

Acanthocephala

Phylum Acanthocephala (Spiny-Headed Worms)

Identifying Characteristics of the Phylum:

- Body cavity a pseudocoelom
- cylindrical retractable proboscis with rows of spines
- adults are endoparasites of vertebrates, juveniles in arthropods
- no digestive tract
- dioecious

Body Organization:

- long cylindrical body with spiny proboscis

Procedures:

1. Read background material in text and lecture notes; compare materials available to illustrations provided and be able to recognize the phylum
2. **preserved:** *Macracanthorhynchus*, an acanthocephalan
 - The species is parasitic in the intestine of pigs, the larvae develop in beetle grubs which are eaten by pigs to complete the life cycle
 - Examine preserved specimen and be able to recognize the phylum
 - Using a dissecting scope, locate and identify the spiny proboscis that is characteristic of the phylum
3. **slide:** Acanthocephala, wm; Another species of acanthocephalan
 - Examine prepared slide and identify the following structures: **retractable proboscis with hooks; proboscis receptacle; ligament sac**

E.C. Phyla Gastrotricha, Cyclophora and Entoprocta

- study illustrations and slides (if available) and be able to recognize representative of each of these “minor” phyla

Procedures:

1. Read background material in text and lecture notes; compare materials available to illustrations provided and be able to recognize the phylum
2. Observe living specimens (if available) and note their appearance and movement

-compare their movement to planarians and vinegar eels

3. **slide:** Gastrotrichs, wm (if available)

-examine prepared slides of a gastrotrich and identify: **mouth, pharynx, adhesive gland, scales**

Lab Report Suggestions:

→ Describe the similarities and differences between acanthocephala and nematomorpha

→ make a diagram of the general life cycle of a horsehair worm and an acanthocephalan

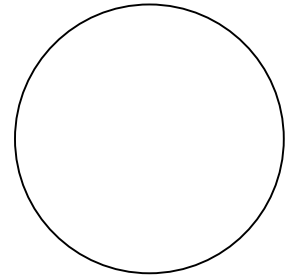
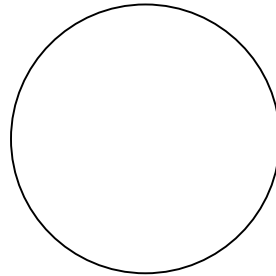
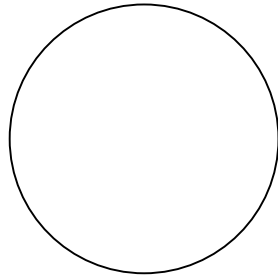
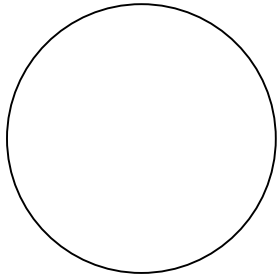
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Lab Report for Practical #2: 'Sponges' to 'Rotifers'

I. Porifera

1. sponge anatomy:



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Name: _____

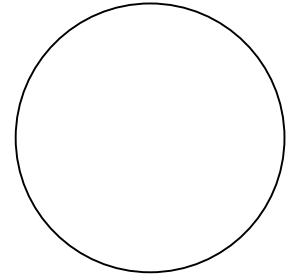
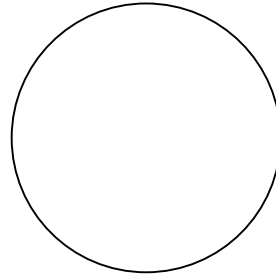
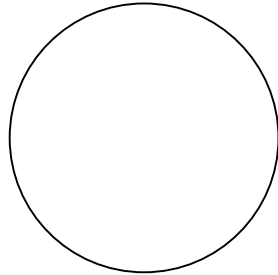
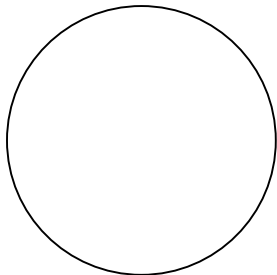
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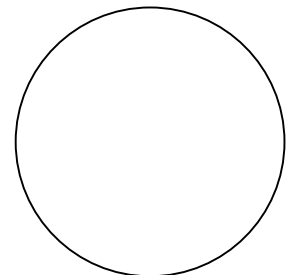
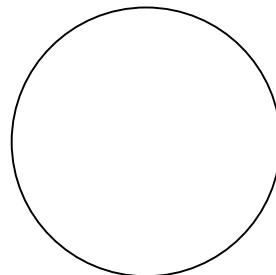
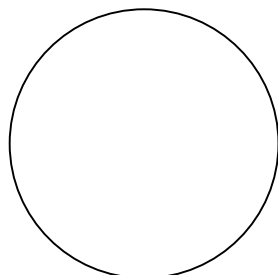
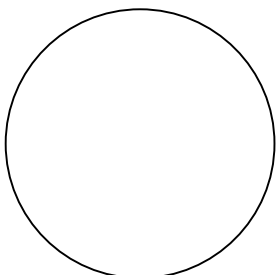
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II. Cnidaria

2. some cell types in Cnidaria



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3. Describe and summarize the various behaviors that you observed with the living hydra:
4. How does hydra move?
5. Describe the life cycle of a typical jellyfish?
6. What **tissues** are found in Cnidaria?
7. What **organs** are found in Cnidaria?
8. Anatomy Sketches of the three classes of Cnidaria
9. How exactly do “comb jellies” differ from jellyfish?

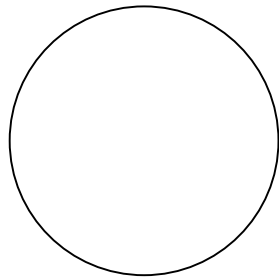
III. Platyhelminthes

10. Describe how planarians move and feed.
11. Describe how planarians react to bright light.

12. Name three organs found in Platyhelminthes that were **not** found in Cnidaria

13. Review the list of adaptations to parasitism as presented in lecture and name any that **ARE NOT** always found in the examples of Trematodes or Cestodes that you have seen in lab.

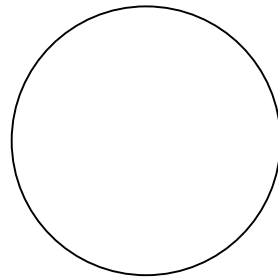
14. Name & Sketch one larval form of Trematodes and one of cestodes



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larva: _____

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Class: _____

larva: _____

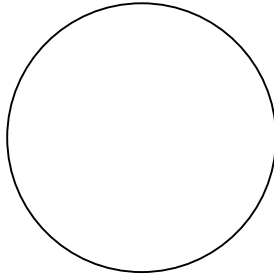
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IV. Nematoda

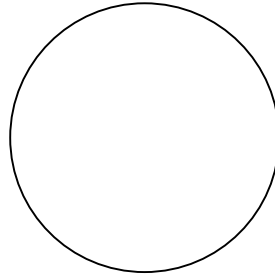
15. a. Compare the movement of the vinegar eel with that of the planarian; how do they differ.

b. Compare the movement of the vinegar eel on the slide with and without the sand.

16. a. How specifically does the internal anatomy of the male *Ascaris* differ from that of the female; how are they similar?



male cs



female cs

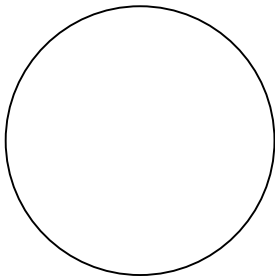
b. Based on what you have learned about the internal anatomy of roundworms, was the movement you saw in the vinegar eel “side to side” or “up and down”, explain.

17. Describe the variation in external anatomy between the other nematodes presented in the lab as either slides, preserved specimens or illustrations. What specific characteristic was most variable?

18. What is the advantage of a **pseudocoelom** over the **acoelomate** condition

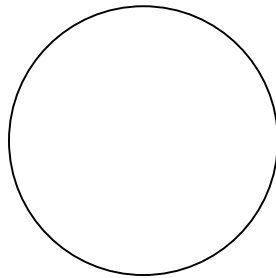
V. Rotifers

19. Sketch 3 different kinds of rotifers from slides and living specimens. Label the appropriate anatomy on one of your illustrations.



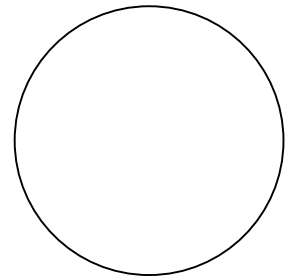
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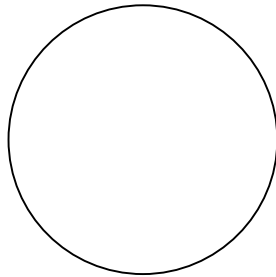
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20. Describe movement and feeding in live rotifers.

VI. Acanthocephala

21. List the major similarities and the major differences between the Rotifers and the Acanthocephalans base on your observations in lab.

22. Draw the proboscis of an acanthocephalan:



Name: _____

Magnification: _____

23. Can you distinguish between the male and the female on the slides? Explain.

Mollusca (Molluscs)

(Smith & Schenk, Molluscs, 1st Chapter 10; 2nd Chapter 11)

Identifying Characteristics of Phylum:

- triploblastic with true coelom
- bilateral symmetry; some with secondary asymmetry
- soft, usually unsegmented body consisting of anterior *head*, ventral *foot* and dorsal *visceral mass*
- body usually enclosed by thin fleshy *mantle*
- mantle usually secretes hard external *shell*
- complete digestive tract, many with a *radula*; a rasping or scraping feeding organ
- respiratory system consists of gills in aquatic forms or "lung"-like chamber in terrestrial forms
- most with open circulatory system; body cavity (coelom) a haemocoel
- marine forms with characteristic *trochophore* larva; freshwater bivalves with *glochidia* larva

Cell Types and Characteristic Structures:

- shell consists of three layers, from outside - in, **periostracum**, **prismatic layer** and **nacreous layer**
- characteristic **trochophore** larva
- distinctive **radula** used as main feeding tool in most groups

Body Organization:

- body usually consists of anterior **head** with **radula**, ventral muscular **foot** and dorsal **visceral mass** containing most internal organs, and **gills**
- almost all molluscs have the basic molluscan features; shell, mantle, foot, gills, radula and head but they have been variously modified in each class

Classification:

- Class: Monoplacophora
- Class: Aplacophora
- Class: Polyplacophora (Chitons)**
- Class: Scaphapoda (Tusk Shells or Tooth Shells)**
- Class: Bivalvia (Clams)**
- Class: Gastropoda (Snails)**
- Class: Cephalopoda (Octopi and Squid)**

Procedures:

Read description and discussion of molluscs in the lab manual.

A. Class Polyplacophora; Chitons (H.O.)

1. **preserved:** *Katharina*

- use illustrations provided to locate the following structures: **mantle, girdle, head, mouth, gills, foot shell plates**

- observe also the large chiton on display in which the mantle completely covers the shell plates

B. Class Scaphopoda; Tusk Shells

-use illustrations provided to recognize the distinctive shells of this class of molluscs

C. Class: Bivalvia: Clams & Mussels (1st Ex 10-1; 2nd Ex 11-2)

1. **preserved:** clam shells and fragments; The Mollusc Shell (H.O.)

-external structure: know: **hinge, umbo, growth lines**

-use a hand lens to see shell layers on some of the broken shells; know and distinguish between:
periostracum, prismatic layer, nacreous layer

2. **preserved:** clam & clam anatomy **model** (fig 10.5 – 10.7); The Freshwater Clam, internal structure

-follow the instructions in your lab manual to locate these structures: **anterior and posterior adductor muscles, pallial line, teeth, mantle, incurrent & excurrent siphons, pericardium, heart, visceral mass, foot, gills, labial palps, mouth, digestive gland, intestine, gonads,**

3. **slide:** mussel gills, cs (1st fig. 10.8; 2nd fig 11.8)

-note structure and arrangement of gills in preserved clam

-make wet mount of gill section and note its microscopic structure

4. Dissection of Living Oyster (if available). Find and identify structures as directed. Use the illustrations provided in your handout and in the lab. [Text below excerpted from: Roberts, Boudreaux, Harman, Causey. 1963. **Laboratory Manual for General Zoology, Part Two**, 2nd Ed. WC Brown. Dubuque, IA]

A standard oyster knife must be inserted into the hinge and twisted, breaking the hinge ligament. Then the knife is slipped between the shells, scraping on one shell so as to dislodge gently the attachment of the adductor muscle (refer to Figure 16 for location of hinge and adductor muscle). The free valve is lifted off, leaving the live oyster in the other shell. Normally the oyster is permanently attached by the left shell, and the smaller right shell serves as a lid. Immerse the oyster in sea water (if available) after opening.

General Observations: Referring to Figure above, locate the **heart** inside the **pericardium**. It may be possible to see it beating inside the cavity, after the **mantle** of the exposed side is cut off. Identify the **adductor muscle** (there is no anterior adductor muscle or foot in an adult oyster); identify the dorsal, ventral, anterior and posterior regions; the **palps**; the **anus** just above the adductor. Note the two kinds of tissue in the adductor. The crescentic, smaller, more posterior region is the **locking muscle**; it contracts slowly but has great strength and endurance. The main part of the adductor muscle is the **closing muscle**; it snaps the shell shut but rapidly fatigues. The **mantle** of one side is joined to the other side just behind the muscle and the upper part of the mantle is not united with the mantle of the other side as in the clam.

If available, place a little powdered carmine on the gills and the mantle, note the direction of movement of the particles after they become trapped in **mucus**. How does this movement help in feeding?

Open the **pericardium** (this cavity is practically all that is left of the coelom) and watch the heart beat. Inject dilute India ink or carmine suspension into the ventricle and trace the course of the two arteries as the colored fluid is pumped into them. Can you find the ciliated nephrostomes which lead to the metanephridia (**kidneys**)?

Natural History of *Crassostrea virginica* in Louisiana

a. Spawning. The sexes are separate, and fertilization is external. Many eggs and sperm are liberated into the water when temperature and salinity of the water are optimal (20° C. and 20 ppt. salt). The ciliated larvae swim freely, but they must eventually attach, or “set,” on a suitable substratum.

b. Setting. The young oysters attach to clean, solid objects such as shells, mangrove roots, pilings, boat bottoms, etc. Many perish because they do not find a suitable substratum.

c. Growth and Habits. Except during the hottest months, growth conditions in Louisiana waters are nearly ideal. Oysters are sexually mature at 9-10 months (shell is 1.5” long). At two years they are large enough to be harvested. If the water becomes unfavorable (too fresh, too saline, too warm, too muddy) the oyster can keep its shell closed (3-4 days in the summer, a month in the winter). Feeding is by filtration of microscopic organisms, as in the clam.

d. Enemies That Feed on the Oyster. The oyster drill (*Thais*), a large snail, destroys large numbers (sometimes the total crop) in waters of salinity over 15 ppt. The blue crab (*Callinectes*) and stone crab (*Menippe*) can destroy an oyster by inserting a claw into the open shell, thus allowing the oyster to clamp down and chip the edges of its own shell. *Stylochus*, a polyclad flatworm, destroys spat (i.e., recently set young oysters) and young oysters. At least one protozoan (*Nematopsis*) is injurious to oysters. *Dermocystidium*, a fungus, is the most serious cause of disease. The salt water drum (a fish) crushes the shell and eats the oysters.

e. Enemies That Damage the Shell but Do Not Attack Living Tissues. Mudworms (*Polydora*), boring sponge (*Cliona*), boring clam (*Martesia*). An oyster that cannot maintain watertight closure usually succumbs to the effects of silt and sudden changes in salinity.

f. Guests Which Are Usually Harmless. These grow on the shell and include specimens of several phyla. Cnidaria: colonial Hydrozoa and Anthozoa (sea anemones and corals). Annelida: *Neanthes* and other polychaetes. Mollusca: sessile clams (attached by a byssus) and snails. Chordata: tunicates, or sea squirts. Bryozoa: fairy lace! Protozoa: many species. Arthropoda: various small crustaceans.

-know: **shell, adductor muscle, gills, mantle, mouth, anus, palps, intestine, pericardium, heart**

-know the general ecology and life history of oysters

5. Bivalve Reproduction (H.O.)

a. note reproductive structures in preserved clam as assigned; **gonads, excurrent siphon**

- b. make a wet mount of gonadal tissue and determine whether eggs or sperm are present
- c. be able to recognize a **marsupium or brood chamber**(if present) in preserved clams
- d. **slide:** mussel glochidia, wm
 - be able to recognize the **glochidia** larva of freshwater clams
- e. **slide:** *Patella* trochophore
 - be able to recognize a **trochophore** larva from slide

D. Class Gastropoda (H.O.)

1. Live Snails [2nd Ex 11-1]
 - note structures and behaviors if live specimens are available
 - observe movement in the living snails or slugs as available; how do they compare with living animals of other phyla that you have seen previously?
 - observe how the snail uses its radula to scrape algae
2. **preserved:** *Helix*; A Pulmonate Land Snail (H.O.)
 - surface anatomy: use illustrations provided and those in your text to identify the following structures: **shell, apex, growth lines, head, foot, tentacles, eyes, mouth**
3. **preserved:** *Limax*; A Slug (H.O.)
 - surface anatomy: use illustrations provided and those in your text to identify the following structures: **eyes, tentacles, mantle, pneumostome**
4. **slide:** snail radula wm (H.O.)
 - recognize radula as characteristic molluscan feeding structure

E. Class Cephalopoda: Squid & Octopuses [1st Ex.10-2; 2nd Ex. 11-3]

1. Observe the **squid biosmount** and find as many of the structures listed below (#2) as you can.
2. **preserved:** squid & fresh squid (if available) (1st fig. 10.10; 2nd fig. 11.10)
 - External anatomy; know: **head, arms, fins, mantle, chromatophores, locking cartilages, funnel, eyes, cornea, sucker cups, tentacles, mouth, beak, radula**
3. Internal Anatomy (1st fig. 10.11 – 10.13; 2nd fig. 11.11 – 11.14)

-follow dissection instructions to find the following structures: **mantle cavity, visceral mass, gills, brachial hearts, systemic heart, ovaries or testes, nidamental glands** (in female), **retractor muscles, ink sac, stomach, cecum, intestine, anus, pen**

-which of the above structures are easier to see in the fresh squid compared to the preserved squid?

-the additional information below might also be helpful in locating some of the important structures of the squid:

Squids are adapted for quick swimming and a predatory way of life. The **shell** is reduced, the **mantle** very muscular, and the **foot** is highly modified.

Note the **head** which is surrounded by 8 **arms** and 2 longer **tentacles**. The long streamlined body is covered by the tough, muscular **mantle**. The spotted condition of the mantle is due to pigment cells called **chromatophores** which enable the squid, and other cephalopods, to change color quickly. Look inside the mantle to see the **mantle cavity** and the **visceral mass** (the grouping of internal organs). Find the **funnel**, a muscular tube which lies in the ventral side of the mantle in the **collar** (or neck) region. The sudden contraction of the circular muscles of the mantle forces a stream of water out through the funnel and gives the squid its jet propulsion. Which way would it move? The mantle ends in a partially free collar-like edge. The **funnel** is open at both ends and conducts water, egg or sperm, ink and metabolic wastes from the mantle cavity to the outside. Find the three **locking cartilages** at the edge of the mantle. Where does water enter the mantle cavity?

Note that two of the two **tentacles**, are greatly elongated and act as retractile grasping organs. The other arms hold prey while it is bitten by the hooked beaks. In mature males the left member of the 5th pair of arms is modified for the transfer of spermatophores to the female during reproduction. With a hand lens, study the **suckers**. How do you think they function? The **radula** and **beak** are in the **mouth** at the center of the arms. Compare the squid radula with the snail radula observed previously.

Locate the **eyes** on the head and identify the **cornea** of the eye. Inside the eye are the iris, pupil and lens. In life the lens and cornea are as clear as glass. This camera type eye is similar in function to a human eye.

After opening the mantle (as directed in your lab manual above) to reveal the **visceral mass**, locate the end of the **intestine** with the **anus** near the inner opening of the funnel. Lying in the anterior third of the mantle cavity are the **gills**. The end of the mantle cavity, opposite the head is occupied by the **gonad** and the **stomach**.

Most specimens are females. In mature females a large part of the visceral mass is covered by a pair of large whitish **nidamental glands** which secrete the jelly in which the eggs are laid.

The **pen** is a long thin chitinous rod slightly beneath the inner surface of the mantle. It is an internal skeleton secreted by the mantle and is homologous with the external shell of other molluscs. Compare the pen of a squid with the cuttlebone of a cuttlefish and the shell of a nautilus.

4. an octopus is on display.

-Is its mantle as muscular as that of the squid.

-Find the funnel, how many arms are there?

-Does an octopus move the same way as a squid?

Demonstrations:

- Mollusc anatomy: use the additional figures to help identify the anatomical features you are responsible for.
- Diversity of Molluscs: be able to recognize the classes of each of the figures, preserved and fresh specimens and shells available
- Comparison of cephalopod eye to vertebrate eye (2nd fig. 11.16)

Lab Notebook Suggestions:

- Observe and describe the movement, feeding and behaviors of living representatives as available

EC: Brachiopoda, Ectoprocta and Phoronida

A. Phylum: Brachiopoda (Lamp Shells)

1. **Brachiopods** are an ancient group of marine organisms superficially resembling bivalve molluscs but in which the shells are dorsal and ventral instead of lateral and most of which are attached to the substrate by a **pedicel**

a. **Preserved:** *Lingula*, *Terebratella*; **Fossils:** miscellaneous

- Examine the preserved and fossil specimens and identify the **lophophore** where present
- Note the conspicuous **pedicel** on *Lingula*
- Distinguish between brachiopods and mollusca; how can you tell the difference using the specimens of each you have seen in lab?

B. Phylum: Ectoprocta (Bryozoa, Moss Animals)

1. Ectoprocts are an ancient group of colonial, freshwater and marine organisms that superficially resemble hydroid colonies. Each member of the colony, called a **zooid**, lives in a tiny chamber called a **zoecium**; some colonies form 'moss-like' encrustations on seaweed, shells or rocks, others form growths that resemble seaweed.

a. **slides & preserved materials:** *Plumatella* wm; *Pectinatella* wm; *Bugula* wm; **Fossils:** miscellaneous

- Pectinatella* is a colonial species found in lakes and ponds fossil bryozoa that sometimes secretes a gelatinous layer in which the zooids are embedded
- identify: **zooids, lophophore**
- Plumatella* & *Bugula* are colonial forms that superficially resemble the hydroid *Obelia*; how can you tell these two completely different organisms apart?
- Closer examination reveals a complete digestive tract as well as other organ systems
- These animals filter water using a ciliated **lophophore** as do the bryozoans

b. **slide:** Bryozoa statoblasts

- Freshwater ectoprocts can asexually reproduce via **statoblasts**; a dormant stage protected by a thick chitinous shell which floats. They are produced in late summer-fall. The colony dies, the statoblasts overwinter and then generate a new colony in the spring.

C. Phylum : Phoronida

- observe the illustrations on display and be able to recognize the phylum

Phylum: Annelida

(Segmented Worms)

(Smith & Schenk, Annelids , 1st Chapter 11; 2nd Chapter 12)

Identifying Characteristics of Phylum

- cylindrical elongated **segmented** bodies; segments divided by **septa**
- well developed true coelom
- closed circulatory system** with one to several hearts and dorsal and ventral vessels
- more efficient excretory system of **nephridia**
- well developed muscular system with circular and longitudinal muscle layers around both the body wall and the GI tract
- more efficient digestive system with **typhlosole** to improve absorption
- nervous system of paired ventral nerve cord with segmental ganglia
- cephalization** with increased development of brain and anterior sense organs (this trait is only seen in the largest class of the phylum the Polychaetes, it has been lost in the other two classes)
- marine members with **trochophore** larva

Cell Types and Characteristic Structures

- setae** = thin chitinous bristles used in feeding, burrowing, and locomotion
- clitellum** = glandular swelling used during sexual reproduction and to produce a cocoon for eggs
- parapodium** =biramous appendages used in locomotion and respiration
- prostomium** =a triangular mass of tissue located on top of the first complete segment encircling the mouth (=peristomium)
- chlorogogue cells** =functions analogous to liver; stores nutrients, manufactures blood cells, helps in body defense and helps to remove metabolic wastes

Body Organization

- body elongated, wormlike with repeating, septate **segments (metameres)**
- body wall** cs: **cuticle, epidermis, circular muscle, longitudinal muscle, peritoneum**
- distinct **head** in polychaetes, not in oligochaetes or hirudineans
- paired appendages (=parapodia) in polychaetes, not in oligochaetes or hirudineans

Classification

Class: Polychaeta (marine worms)

- many segments and many **setae** per segment
- lateral appendages = **parapodia**
- distinct head

Class: Clitellata

Subclass: Oligochaetes (earthworms)

- few setae per segment
- clitellum
- no head or parapodia

Subclass: Branchiobdellida (EC)

Subclass: Hirudinea (leeches)

- dorsoventrally flattened
- false segmentation, all with 34 true segments

- no head, or parapodia or setae
- temporary clitellum during reproductive season
- predators or parasitic

Class: Echiura (EC)

Procedures:

Read the introductory material.

A. Class Polychaeta (Sandworms & clamworms) [1st Ex. 11.1; 2nd Ex 12-1]

1. **preserved:** *Nereis* (1st fig. 11.2; 2nd fig. 12.2) The Clamworm

- external anatomy: **identify: head, prostomium, jaw, teeth, pharynx, palp, tentacles, ocelli (eyes), parapodium, setae**

2. **slide:** *Nereis* parapodium, wm (1st fig 11.3b; 2nd fig 12.3b)

- identify: **acicula, setae**

3. **slide:** *Nereis* cs. (1st fig. 11.3a; 2nd fig. 12.3a)

- Observe the slide of a polychaete cross section and compare it to illustrations in text and lab materials to identify the following structures: **cuticle, hypodermal cells, circular and longitudinal muscle, peritoneum, coelom, intestine, dorsal and ventral blood vessels, ventral nerve cord, parapodium**

4. **preserved:** *Aphrodite*; **preserved:** *Chaetopterus*; Other Polychaetes

- observe the variety of body shapes and sizes of specimens available
- can you recognize the polychaete traits in each
- which traits have been significantly modified in *Aphrodite* and *Chaetopterus*?

5. **slide:** trochophore larva

- observe the **trochophore larva** as a characteristic larval form of most marine annelids

B. Class Hirudinea (Leeches); [1st Ex 11-2; 2nd Ex 12-3]

1. **preserved:** leeches (1st fig. 11.11; 2nd fig 12.11); external anatomy, know; **oral and caudal sucker, mouth, annuli (=false segments)**

2. **slide:** leech, wm; internal anatomy

- study the slide and find the external structures above; **oral and caudal sucker, mouth, annuli, anus**

-also use illustrations provided to find the following internal structures: **pharynx, intestine, testes, seminal vesicles**

C. Class Oligochaeta (Earthworms) [1st Ex 11-2; 2nd Ex 12.-2]

1. living earthworm and aquatic worms (if available)

-observe use of hydrostatic skeleton in burrowing in the earthworm; can you describe the motion

-note movement in all live specimens and compare to the movement of other “worms” you have observed in previous labs

-for the aquatic worms; note the segmentation and prominent setae on each segment; note how the worms move; can you see any sense organs? Can you see any internal organs, if so, which ones

2. **model:** earthworm & **preserved:** *Lumbricus terrestris*; external structure (1st fig. 11.4; 2nd fig. 12.4)

- identify: **prostomium, mouth, clitellum, anus, paired setae on each segment**

3. **model:** earthworm & **preserved:** *Lumbricus terrestris*; internal structure (1st figs 11.5 – 11.8; 2nd fig. 12.5 – 12.8)

-compare to illustration in lab manual and on demonstration to identify: **pharynx, esophagus, crop, gizzard, intestine, ventral nerve cord, septae between segments, seminal vesicles, seminal receptacles, dorsal blood vessel, aortic arches (=hearts), nephridia**

4. **slides:** earthworm posterior or earthworm composite cs (1st fig. 11.9; 2nd fig. 12.9); earthworm cross section

-know: **epidermis, circular muscle, longitudinal muscle, coelom, dorsal & ventral blood vessels, paired ventral nerve cords, intestine, typhlosole**

5. **slide:** earthworm nervous system

-compare to illustrations on handouts & on demonstration and be able to identify:

brain (=suprapharyngeal ganglia), paired ventral nerve cord with segmented ganglia

6. **model:** earthworm & **slide:** earthworm nephridium, wm

-use (1st fig. 11.9; 2nd fig. 12.9) and other illustrations provided and note the structure of the excretory system of earthworms & the nephridium

-identify: **the funnel, (nephrostome), tubule, bladder, excretory pore**

7. reproduction in earthworms

-see text and material on display in the lab to understand and be able to describe the process of reproduction in earthworms

D. Echiura (Spoon Worms) (ec)

-observe the illustrations provided and be able to recognize the class

Demonstrations:

- Earthworm Anatomy:
 - Use these illustrations to help you locate the structures listed above and to understand the relationships between organ systems
- Earthworm Circulatory and Excretory Systems.
 - With the presence of a true coelom and mesodermal tissue lining both the body wall and the outside of the intestine note the elaborate development of the closed circulatory system and its association with the paired nephridia for excretion and osmoregulation
- Other Oligochaetes
 - be able to recognize members of the class
- Other Hirudineans
 - be able to recognize members of each class

Lab Notebook Suggestions:

- What major characteristics can you use to distinguish between each of the classes
- of what advantage is the typhlosole

EC. Sipuncula (Peanut Worms)

Phylum: Sipuncula (Peanut Worms)

Sedentary, benthic marine worms showing no segmentation or setae. Body plan generally consists of a retractile **introvert** or proboscis, and a muscular **trunk**

Procedures:

1. Examine the illustrations, preserved materials, fossils and slides as available to learn more about the phylum
2. **Preserved:** *Sipunculus*
 - recognize animal as a sipunculid
 - identify the **proboscis** (introvert) with **tentacles** and **mouth** and **trunk** of the animal

Arthropoda I

(Subphyla: Trilobita, Myriopoda)

(Smith & Schenk, Arthropods , (1st Chapter 12; 2nd Chapter 13)

Identifying Characteristics of the Phylum

- hardened chitinous exoskeleton
- paired jointed appendages; anterior appendages modified into feeding structures
- segmented body
- reduced coelom is a haemocoel with dorsal heart
- complete digestive tract
- well developed nervous system with paired ventral ganglia and well developed sense organs
- muscles in bundles rather than layers

Cell Types and Characteristic Structures

terga = dorsal plates of exoskeleton (singular = tergum)

sterna = ventral plates of exoskeleton (singular = sternum)

chitin = a major component of the exoskeleton made of carbohydrate and protein

feeding appendages: **chelicerae, mandibles** or **gnathobases**

respiratory organs: **gills, book gills, tracheae** or **book lungs**

excretory organs: **coxal glands** (= **antennal glands, maxillary glands, green glands**) or **malpighian tubules**

sense organs: **ocelli, simple eyes, compound eyes, antennae, statocysts, tactile hairs, chemoreceptors, tympanum**

Body Organization

varies in each subphylum, see below

Classification (part):

Subphylum: Trilobita

body plan: head, thorax, pygidium

compound eyes

antennae

mandibles for feeding?

branched (biramous) appendages

respiration by gills?

able to roll up like pill bugs

once most common arthropod, now completely extinct

Subphylum: Myriopoda (centipedes, millipedes)

body plan: head, long trunk

lack compound eyes

single pair of antennae

mandibles for feeding

unbranched legs on most segments

respiration by tracheae

Procedures:

1. Read introduction and general discussion of arthropods in the lab manual.
2. Subphylum Trilobita: [2nd Ex 13-4] & (HO):

a. **specimens:** trilobite fossils & **illustrations**

The trilobite body consists of three parts; the **head** (cephalon), **thorax** and **pygidium**. All three parts are subdivided longitudinally into three **lobes**, hence the name “**trilobite**”. The **head** bears a pair of prominent **compound eyes** and a pair of segmented **antennae** (although these are rarely preserved). The lateral margins of the head often extend into lateral **spines**.

The **thorax** consists of flexible segments covered with hardened plates. The plates often bear lateral, and sometimes also dorsal, spines for protection. The flexible thorax allowed most trilobites to curl up like “pill bugs” for protection. Each segment bears a pair of jointed walking legs although these, also, are rarely preserved.

3. Subphylum Myriopoda: [1st Ex 12-3; 2nd Ex 13-4 & 13-5]

a. **preserved:** centipedes (1st fig. 12.6; 2nd fig. 13.7); Centipedes

Centipedes and **Millipedes** are, anatomically, some of the simplest living arthropods. Their body consists of a **head** and **trunk**. **Centipedes** are generally **predators**.

The centipede body is generally **dorso-ventrally flattened**. On the **head** are a pair of prominent **jointed antennae**. The eyes consist of two clusters of **simple eyes (=ocelli)**. The primary feeding appendages are a pair of prominent **mandibles**. On the first body segment the paired limbs are modified into **poisonous fangs** for subduing prey.

The long **trunk** consists of many similar flattened **segments**. Each segment consists of two prominent hardened plates of **chitinous exoskeleton**; on the dorsal side of each segment is a **tergum**, on the ventral surface is the **sternum**. Between the plates is a more flexible area that has not been hardened.

Each segment has a pair of **segmented legs**. The last two segments of each leg are the **tarsus** and the **pretarsus**. The **last pair of legs** are usually much longer and extend past the rear of the trunk and bearing defensive **hooks**.

b. **preserved:** millipedes (1st fig. 12.7; 2nd fig. 13.8); Millipedes

Millipedes are generally **scavengers**. The millipede body is usually **round in cross-section** (although the smaller millipedes in central Texas are often flattened and superficially resemble centipedes). Like the centipedes, the millipede head bears a pair of **segmented antennae** and two clusters of **simple eyes (=ocelli)**. **Mandibles** are used for feeding. The rounded body segments are surrounded by a hardened **tergum**, the sternum is greatly reduced. Most body “segments” (actually 2 fused segments) bear **two pairs of walking legs**.

Demonstrations:

- Evolutionary relationships between the Arthropod subphyla

- note the diversity that has arisen from a single ancestral form
- Contribution to world species diversity by the Arthropod phylum
 - note that more than three fourths of all animal species are Arthropods and most of that in the subphylum Insecta
- The Arthropod Exoskeleton
 - note how hinges and muscle attachments are formed
- Be able to recognize members of these two subphyla
 - some sheets may be useful in your dissections

Disposal:

Return the horseshoe crab, spider and scorpion to designated buckets when you are through;
do not discard!

Lab Notebook Suggestions:

- What are the main visible characteristics that distinguish these two subphyla?
- What are the typical habitats that of these two subphyla

Arthropoda II

(Subphylum: Chelicerata)

Subphylum: Chelicerata: (spiders, horseshoe crab, scorpions, mites, ticks)

body plan: cephalothorax, abdomen

most lack compound eyes

no antennae

chelicerae for feeding (no mandibles)

four pairs of unbranched legs

respiration by gills, book lungs, book gills or tracheae

Procedures:

1. Read introduction and general discussion of arthropods in the lab manual

2. Class Merostomata: (Horseshoe Crabs) [1st Ex 12-1; 2nd Ex 13-2]

a. **preserved:** *Limulus*; The horseshoe crab (2nd fig. 13.5)

- external anatomy only; read the description in your lab manual and know: **cephalothorax, abdomen, telson, simple eyes, compound eyes, carapace, chelicerae, pedipalps, walking legs, mouth, gnathobases, operculum, gills**

b. also read & follow a further description of the horseshoe crab below:

The horseshoe crab, *Limulus*, has existed on earth for more than 200 million years (since the Triassic). It is often called a living fossil because its form has changed little since that time. Its ancient contemporaries once included dinosaurs, toothed birds, and ammonites (giant shelled cephalopods)

The body of the horseshoe crab is divided into a **cephalothorax** and **abdomen** and a long spinelike **telson**. Observe the dorsal surface of the animal. Note the hood-shaped **carapace** that extends over the sides of the animal. Note the two small median **eyes (ocelli)** and the much larger, more lateral **compound eyes**.

Dorsally on the abdomen are 6 pairs of dorsal depressions that mark the locations of internal **apodemes** (inner extensions of the exoskeleton) which serve for attachment for some of the muscles that move its appendages on the ventral surface. Note also the **moveable spines** on the lateral margins of the abdominal segments.

Turn your specimen over and observe the appendages on the ventral side. Located on the cephalothorax are the following: a pair of small **chelicerae**. The second pair of appendages are the **pedipalps**, which, in the female horseshoe crab, are chelate and resemble the walking legs. In the male, the pedipalps are clawed. Next are 4 pairs of **chelate walking legs**. The first (basal) segment of each walking leg is enlarged and covered with stiff spines to form a group of **gnathobases** that surround the **mouth**. These gnathobases help to masticate food and push it into the mouth. The last pair of walking legs are known as the “**digging legs**” and looks

different from the preceding three. Several pairs of **flattened spines** are attached to several of the more terminal segments.

The remaining appendages are on the abdominal segments. The first pair are fused together to form a broad **genital operculum** which bears the genital openings. This operculum also protects 100's of thin sheetlike **book gills**.

The **anus** is located near the beginning of the **telson**.

c. **slide:** *Limulus* larva

- be able to recognize as larva of horseshoe crab; it is NOT a trilobite!

- note superficial similarity to Trilobites

d. recognize sea scorpions as members of the chelicerates

3. Class Arachnida (Spiders, Scorpions, Ticks, and Mites) [1st Ex 12-2; 2nd Ex 13-3]

a. **preserved:** *Argiope*, The Garden Spider: (H.O.); external anatomy only (you should use a dissecting scope or hand lens)

The garden spider (*Argiope*) is one of the largest, most noticeable spiders and is found throughout the United States. It builds its web in sunny places in gardens and tall grasses.

You will need your dissecting scope to find the structures below. The spider is very fragile so handle it carefully. Notice the hard **exoskeleton** with an abundance of **sensory bristles** (hairs) on all parts of the body. Notice that there is almost no visible segmentation in the body of most spiders. The body is divided into two regions, the anterior **cephalothorax** and the **abdomen**. They are joined together by a slender **pedicel**.

Most spiders have six to eight **simple eyes** (=ocelli). Their eyes are found on the dorsal surface of the cephalothorax toward the anterior end. Examine the mouthparts and identify the **chelicerae** with retractable **fangs**. Near the chelicerae are another set of feeding appendages, the **pedipalps**. The pedipalps look somewhat like walking legs but they are much smaller. The pedipalps are used for holding and manipulating the prey. In male spiders the pedipalps are modified to transfer sperm to the genital opening of the female during copulation.

On the ventral surface of the cephalothorax are 4 pairs of segmented **walking legs**. The legs terminate in **claws** and a tuft of hairs.

On the ventral surface of the **abdomen** note a structure called the epigynum which marks the female **genital openings**. On each side of the genital opening are small slits that are the openings to the **book lungs** used for respiration. At the posterior end of the abdomen, on the ventral surface are three pairs of **spinnerets**. On the tips of the spinnerets are openings to glands that produce **spider silk**. The silk is liquid until it leaves the spinnerets and gets exposed to air. The silk then becomes a tough solid thread.

-also be able to identify and recognize the two dangerous spiders; the **black widow** and the **brown recluse**

- b. **preserved:** scorpions (HO); refer to illustrations and descriptions included in this handout and your text

The scorpion body is made up of a **cephalothorax** (=prosoma) and an **abdomen** (=opisthosoma). The abdomen is further subdivided into a wide segmented **preabdomen** (=mesosoma) and a much narrower, tail-like **postabdomen** (=metasoma) which ends in a **stinger** (=barb).

On the front of the cephalothorax are two small pincher-like **chelicerae**. Dwarfing the chelicerae are two large **chelate** (“pincher-like”) **pedipalps** that are used for capturing and manipulating the prey. On the dorsal surface of the cephalothorax are several pairs of **simple eyes** (=ocelli), including one median pair and 2 to 5 pairs of lateral eyes. Four pairs of **walking legs** are located on the underside of the cephalothorax.

The underside of the **preabdomen** (=mesosoma), just behind the last pair of walking legs, are a large pair of comb-like **pectines**. Each pectine consists of three rows of chitinous plates and a series of toothlike projections. The pectines seem to be **sensory structures** used to explore the surface under foot and may also be used by male scorpions to select a suitable mating site. Medial and anterior to the pectines is a lid-like **genital operculum** that covers the genital pore. Also on the undersurface of the preabdomen are pairs of slits (stigma) on each segment that open into **book lungs**.

- c. Mites & Ticks (HO)

While mites and ticks share some anatomical similarities mites are generally much smaller than ticks; averaging about 1mm in diameter. Probably the most distinctive feature of the group is the lack of any apparent segmentation of the body; cephalothorax and abdomen are completely fused together and the entire body is covered with a single shield-like **carapace**. The portion of the body carrying the mouthparts is referred to as the **capitulum**. The **chelicerae** and **pedipalps** are attached to the capitulum. Tiny, **simple eyes** (=ocelli) are located on the dorsal surface of the carapace. 4 pairs of **walking legs** are on the underside of the body.

-**slide:** *Demodex*, wm;

-the follicle mite, *Demodex* lives in hair follicles and oil glands of the human forehead

-it is a commensal, not a parasite; recognize it as a mite & as a chelicerate

-**slide:** *Dermatophagoides*, dust mite wm

-dust mites are common in the dust of houses and are a common cause for allergic reactions to dust, recognize it as a mite & as a chelicerate

-**slides:** Lone star tick wm, mite & tick wm

-compare the general anatomy of the mites & ticks

- d. **preserved:** pycnogonids; (Sea Spiders) (HO)

Pycnogonids are mostly small spiderlike marine animals. The body is often long and narrow and is distinctly segmented. the **head** (=cephalon) bears a cylindrical **proboscis**. On each side of the proboscis are **chelicerae** and **pedipalps** (=palps). Near the back of the head is a small tubercle that bears 4 **simple eyes** (=ocelli). Behind the head is a **trunk** of 4 to 6 cylindrical segments. On these trunk segments are usually a small pair of **ovigers** (=ovigerous legs, possibly used for cleaning and to carry eggs) and four to six pairs of **walking legs**.

-refer to illustrations and descriptions in handouts and your text

- be able to recognize it as a Chelicerate

Disposal:

Return the horseshoe crab, spider and scorpion to designated containers when you are through;
do not discard!

Lab Notebook Suggestions:

- What anatomical features do members of the Chelicerata have in common?
- What are the typical habitats of Chelicerates

Arthropoda - III

(Subphylum: Crustacea)

(Smith & Schenk, Arthropods , 1st Chapter 12; 2nd Chapter 13)

Subphylum Crustacea: (crabs, shrimp, crayfish, barnacles, pill bugs, water fleas)

body plan: cephalothorax, abdomen, tail
compound eyes
two pairs of antennae
mandibles for feeding
branched (biramous) appendages
respiration by gills
only living subphylum that is mostly aquatic

Procedures:

1. **Class Malacostraca** [Ex 12-5; 2nd Ex 13-6]

a. **preserved:** crayfish; *Procambarus*:

-external anatomy (1st fig. 12.9 – 12.11; 2nd fig. 13.10 – 13.13):

know: **cephalothorax, rostrum, antennae, compound eyes, abdomen, telson, carapace, gill chambers, gills, copulating swimmerettes, openings to oviducts and seminal receptacle**

-appendages; dissect and be able to recognize each major appendage and its parts as described in your lab manual: **antennae, mandibles, maxillae, maxillipeds, cheliped, walking legs, copulatory swimmerettes, other swimmerets, uropod**

-Internal Anatomy (1st fig. 12.12 – 12.16; fig. 13.14 – 13.18)

dissect as described in your manual and know: **heart with ostia, mandibular muscles, green gland, brain, cardiac stomach, gastric mill, digestive gland, mandibular muscles, gonads, intestine, antennal gland, flexor muscles of abdomen**

b. **live:** crayfish (if available)

-observe the feeding behavior of the crayfish:

How does the animal approach the food? What is the position of the antennae? Are they in motion? Does it seem to use its eyes much? What is the position of the chelipeds? How does the animal walk? How is the abdomen placed?

How is the food held? Is it all taken at once or are small pieces torn off? Which appendages do the tearing? What are the pereopods used for in feeding? What is the function of the

mandible (does it tear or chew)? How do the maxillae move? What is the function of the maxillipeds? Are the pleopods used for feeding?

Gently touch the animal with a blunt probe. What is its response? Does it react slowly? What structure is used for this movement? What is the function of the uropods and telson?

c. **slide:** *Gammarus* wm; **preserved:** amphipods (HO)

Amphipods have a clearly segmented body that is **flattened laterally** and curved into an arching shape. The body consists of a **head, thorax** and **abdomen** and they completely lack a carapace. The head contains two pairs of **antennae** and a pair of **eyes**. The animal uses its legs for movement, not its antennae as in the crustaceans described above. Usually the thorax is not clearly distinct from the abdomen and both bear pairs of a variety of different kinds of appendages including **walking legs** and **swimmerets**.

-note characteristics of class

-note amphipods are laterally compressed

d. **preserved:** pill bugs; isopods (HO)

Isopods are the only major group of crustaceans that have adapted to land. Pill bugs or sow bugs also have a clearly segmented body as amphipods do, but are compressed dorsoventrally. They are able to roll up their body for protection. Their body consists of a **head, thorax** and **abdomen**. The **head** bears two large **antennae** and a pair of **compound eyes**. The **thorax** bears six or more pairs of **legs** and **gills** that must be kept damp to extract oxygen from the air. The last few segments of the body are the **abdomen** but they are not distinctly set off from the thorax.

-Be able to recognize examples of other members of the class on display

2. Class Branchiopoda

a. **slide:** *Daphnia*, wm; **Cladocera (water Fleas)**

A common micro-crustacean in freshwaters. The body is compressed laterally with no obvious segmentation. The body consists of a **head** and a **thorax**. Two large branching **antennae** extend from the **head** and are used for swimming and food gathering. In many species is a tapering projection called a **rostrum** between the two antennae. The head also bears a large prominent **compound eye**. The **thorax** is covered by a transparent bivalved **carapace**. Additional **paired appendages** are visible under the carapace. The **digestive tract** should be clearly visible through the carapace and thoracic wall. Careful observation may reveal a beating **heart** dorsal to the digestive tract in live specimens. A **brood chamber** with developing **eggs** may also be visible dorsal to the intestine and posterior to the heart.

b. **live:** *Daphnia*; A water flea: (1st fig 12.23; 2nd fig. 13.25) and HO

-use depression slide or small dish to observe movement and behavior of living specimen

-locate the **antennae, compound eye, GI tract** in the living animal

-observe swimming behavior of live specimens

- be able to recognize crustacean characteristics of the animal

c. **live:** (if available); **Tadpole shrimp** (HO)

-their carapace forms a large dorsal shield making them look somewhat like horseshoe “crabs” (Chelicerata)

-note their swimming behavior, **biramous appendages**, two pairs of **antennae** and three **eyes**

-Be able to recognize examples of other members of the class on display

3. **Class Ostracoda (seed shrimp)**

a. **slide:** ostracods wm; (HO)

Ostracods are another group of small aquatic (mostly freshwater) crustaceans. They are usually found in benthic habitats on sediment or vegetation. Ostracods also have lost much of their obvious segmentation. The entire animal, including the **head**, is enclosed within a bivalved **carapace**. At the front of the animal are the **antennae**. Near the base of the antennae are small **compound eyes**. Other **appendages** can usually be seen within, or slightly extending from the carapace.

4. **Class Maxillipoda**

a. **slides:** copepod; *Cyclops* wm; *Cyclops* egg sacs; (HO)

Copepods represent the largest group of small crustaceans. Copepods are mainly marine. The body is clearly segmented into a **head, thorax and abdomen**. The **thorax** and **abdomen** are also each distinctly segmented. In some copepods the head and some of the first thoracic segments are fused into a **cephalothorax**. One or both pairs of **antennae** are greatly enlarged and usually held at right angles to the body; these are used for swimming. At the point on the head or cephalothorax where the antennae attach is what looks like a **single eye** (one common genus of copepod is *Cyclops*). Several pairs of **jointed appendages** are found on the **thoracic** segments. The segments of the **abdomen** are usually much smaller and distinct from the abdominal segments. The last abdominal segment often has a pair of **filaments** (rami) extending from it. Female copepods are often seen with a pair of **egg sacs** beside the abdomen.

b. **preserved:** barnacles (HO)

-note shell secreted by barnacle somewhat resembles some mollusc shells

-Be able to recognize examples of other members of the class on display

5. Crustacean Larval Forms

a. **slides:** barnacle nauplius; cypris; zoea, *Squilla* larva, *Lucifer* larva;

-observe the slide indicated and be able to recognize the **nauplius** larva and the **cypris** larva as larval forms of Crustacea

Demonstrations:

- Crayfish anatomy – some sheets may be useful for your dissection
- Subphylum: Crustacea
 - be able to recognize members of this subphylum and the three major classes

Arthropoda - IV

(Subphylum: Hexapoda)

(Smith & Schenk, Arthropods , 1st Chapter 12; 2nd Chapter 13)

Classification:

Subphylum: Hexapoda (insects)

body plan: head, thorax, abdomen
compound eyes
single pair of antennae
mandibles for feeding
three pairs of unbranched legs
two pairs of wings
respiration by tracheae
includes only invertebrates that can fly

Procedures:

1. **preserved:** grasshoppers; [1st Ex. 12 – 6; 2nd Ex 13 – 7]

a. External anatomy (1st fig. 12.18; 2nd fig. 13.20)

-know: **head, thorax, abdomen, compound eye, antennae, ocelli, labrum, mandibles, wings, walking legs, typanum, spiracles, cerci, ovipositor**

b. Internal anatomy (1st fig. 12.19 – 12.21; 2nd fig. 13.21 – 13.23)

-know: **crop, gastric caecae, stomach, intestine, malpighian tubules, ovaries, testes** (may not be visible)

2. **slide:** compound eye insect sec Mason stain:

-the compound eye of arthropods is made up of repeating units called **ommatidia**. each ommatidium consists of a **lens**, a transparent **crystalline cone**, and **visual cells**. The compound eye produces a mosaic image of light and dark spots that produce only a very poor image but is excellent at detecting motion nearby.

3. **slide:** spiracle & trachea insect larva, wm

-note **spiracle** and branching **trachea**

-note rings/ridges on **trachea** to keep tubes open

Diversity of insect anatomical features. As you look at the slides below note the variation and diversity of each organ; how the same part can be modified in a variety of ways to perform different functions:

4. **Modifications of Insect Mouthparts.** While all insects have the same basic set of mouthparts; they can be modified in a great variety of ways to facilitate an insect's specific mode of feeding: be able to identify the method of feeding by the set of mouthparts shown; also be able to identify the specific mouthparts mentioned below.

a. **slide:** grasshopper mouthparts

-the mouthparts of grasshoppers are specialized for **chewing**. The **mandible** cuts off and grinds the food; the **maxilla** and **labrum** push food into the mouth

b. **slide:** butterfly proboscis

-the mouthparts of butterflies and moths are specialized for **siphoning**. They form a long tube that can unroll to feed on nectar. Most of the tube is made from the **maxillae**.

c. **slide:** *Culex*, wm

-the mouthparts of mosquitoes, cicadas, aphids, leafhoppers, lice & fleas are specialized for **piercing & sucking**. The **labrum**, **mandible** and **maxilla** are modified into a long syringe-like beak that can be easily inserted into a plant or animal to feed on fluids/blood

d. **slide:** *Musca domestica* wm

-the mouthparts of nonbiting flies (eg. houseflies) are specialized for **sponging** liquids. The mandible and maxilla are reduced and nonfunctional. the large spongy **labium** extends from a proboscis to sop up food

5. Insect Leg types

a. **slide:** Insect Leg Types, wm

-note how the same basic parts are modified in a variety of ways; the structure of the legs is an important characteristic for classification. Be able to name one distinctive feature in each of the insect legs shown. Can you guess the main function of each?

b. **slide:** honeybee legs, wm; (HO)

-Honeybees are some of the most important plant pollinators. Their legs are specialized for collecting pollen. Compare their general shape to those of the grasshopper. How are they different?

-compare to illustrations provided and find the following structures

- use a dissecting scope to compare to those of the grasshopper, note:

Pollen Brushes - stiff haired, on most proximal tarsal segment of fore and middle legs

Antenna Cleaner - at junction of tarsus and tibia of foreleg

Pollen Comb - rows of stiff hairs in inner surface of first tarsal

segment of hind legs

Pollen Basket - on outer surface of tibia of hind legs

6. **slide:** Insect Wing Types

-note the variation and diversity of wing types in insects; certain wing types are characteristic of specific insect orders. Be able to name one distinctive feature of each of the wings shown.

7. **slide:** antennae types, wm

-note the variation in structure of the antennae, some of these characteristics are important in identifying orders and species of insects. Be able to name one distinctive feature of each of the antennae shown

8. **slide:** Honey Bee Stinger

-the ovipositor, for most insects is used to lay eggs. However in some social insects (ants, bees, wasps, etc) the ovipositor of the sterile workers is modified into a stinger for protection

-recognize the stinger as a modified ovipositor; compare to ovipositor of female grasshopper – How do they differ?

9. Insect Development. Observe the demonstration materials to understand insect development

-be able to distinguish between **incomplete** and **complete metamorphosis**

-observe the variety of body forms for various immature insects and compare them with their mature counterpart. which are examples of complete metamorphosis and which are examples of incomplete metamorphosis

slide: Mosquito life cycle wm.

be able to identify the stages of complete metamorphosis on this slide.

10. Observe the examples and illustrations of insect symbioses on display. Be able to name the general kind of symbiosis and to explain the specific roles of the organisms involved in each example.

11. Use the key and illustrations provided to identify various insect specimens to the correct **order**.

Demonstrations:

- Insect camouflage and mimicry, note the examples illustrated
 - Grasshopper Anatomy
- use these illustrations to help you identify the anatomical features of the grasshopper

Lab Notebook Suggestions:

- What are the similarities and differences between the hexapods (insects) and other subphyla of Arthropods
- What characteristics do ALL insects have, which are modified and how in each of the major orders.
- Compare insect respiratory system, excretory system and sensory structures to those same systems in the other subphyla of Arthropods.

A Key to the Common Orders of Adult Insects

The following key is arranged in couplets or pairs of choices. Read both choices and choose the one that best fits your specimen, then move to the couplet of the number indicated. Continue with each couplet until you find the order of your insect. Remember that this key is designed for the most common traits of the most common orders. Also, it is not appropriate for immature or larval forms. It is possible to have a specimen that does not "fit" the key. You will need to use a more detailed key to identify such insects.

1a. With no apparent wings.....**20**

1b. Wings present, rigid had hard to detect-come together in a straight line down center of back and completely cover abdomen.....**2**

2a. Appears to have one pair of wings.....**3**

2b. Two pairs of wings.....**5**

3a. Hind wings reduced to tiny knobs (halteres; tip of abdomen without 2 or 3 threadlike tails.....**Diptera** (flies & mosquitoes)

3b. Wings not as above.....**4**

4a. Rigid front wings meet in a straight line down the middle of the back and completely cover and hide the hind wings when at rest.....**Coleoptera** (beetles)

4b. Wings thin and transparent with many veins and crossveins; hind wings, if visible at all, much smaller than forewings; tip of abdomen with 2 or 3 threadlike tails.....**Ephemeroptera** (mayflies)

5a. Front and hind wings have similar texture.....**6**

5b. Front wings a rigid or leathery, completely, or almost completely covering clear hind wings.....**16**

6a. Wings large and covered with powdery scales; mouthparts usually a long coiled up tube.....**Lepidoptera** (butterflies and moths)

6b. Wings not covered with powdery scales; mouthparts not a coiled tube.....**7**

7a. At rest, wings slope downward (rooflike) from the midline of the insect.....**8**

7b. Wings not held "rooflike" at rest.....**11**

8a. Wings opaque and covered with tiny hairs; antennae as long or longer than body.....**Trichoptera** (caddisflies)

8b. Wings hairless.....**9**

9a. Mouthparts in the form of a rigid beak; antennae often short and bristly; in some the body may look like a "thorn".....**Hemiptera** (cicadas and hoppers)

9b. Mouthparts not in the form of a rigid beak; antennae not short and bristley, body never looks thornlike.....**10**

10a. Wings with many crossveins.....**Neuroptera** (lacewings)

10b. Wings with many fewer crossveins.....**Psocoptera** (bark lice)

11a. Front and hind wings similar in size and shape.....**12**

11b. Front and hind wings different in size and or shape.....**14**

- 12a.** Antennae very short and bristley; eyes large; abdomen long and slender.....**Odonata** (dragonflies and damselflies)
- 12b.** Antennae never short and bristley.....**13**
- 13a.** Wings held flat over abdomen when at rest; last abdomina segment not enlarged.....**Blattodea** (Termites (once in their own order - Isoptera))
- 13b.** Wings not held flat over abdomen when at rest; head long and beaklike; males with the last abdominal segment enlarged like a scorpion's stinger and held over the body.....**Mecoptera** (scorpion flies)
- 14a.** Body very soft; without a narrow "waist" between thorax and abdomen.....**15**
- 14b.** Body relatively hard; often with a narrow waist.....**Hymenoptera** (bees and wasps)
- 15a.** Hind wings wider than front wings and folded underneath forewing like a fan; two long filaments (cerci) extending from end of abdomen.....**Plecoptera** (stoneflies)
- 15b.** Hind wings much smaller than front wings, not folded underneath forewing like a fan.....**Ephemeroptera** (mayflies)
- 16a.** Mouthparts in the form of a rigid "beak"; front wings with clear tips that overlap at rest.....**Heteroptera** (true bugs)
- 16b.** Chewing mouthparts; front wings without clear tips.....**17**
- 17a.** Rigid front wings meet in a straight line down the middle of the back and completely cover the hind wiings as rest.....**Coleoptera** (beetles)
- 17b.** Front wings not as above.....**18**
- 18a.** Head clearly visible from above.....**19**
- 18b.** Head at least partially hidden from above by a hood-like cover (pronotum); very long filamentous antennae.....**Blattodea** (cockroaches)
- 19a.** Front legs raptorial, strong with prominent spines for grasping prey; hind legs long and slender.....**Mantodea** (mantids)
- 19b.** Front legs without spines or with weak spines; hind legs adapted for jumping.....**Orthoptera** (grasshoppers and crickets)
- 20a.** With narrow "waist" between thorax and abdomen.....**Hymenoptera** (ants)
- 20b.** Not narrow wasted.....**21**
- 21a.** Body extremely hard and flattened laterally.....**Siphonaptera** (fleas)
- 21b.** Not as above.....**22**
- 22a.** Body flattened top to bottom; narrow head smaller than thorax; large abdomen.....**Phthiraptera** (lice)
- 22b.** Not as above.....**23**
- 23a.** Body long thin and "pencil-like; forelegs larger than other two pairs.....**Orthoptera** (walkingsticks)
- 23b.** Small, softbodied, whitish animal with small eyes and short antennae.....(**Blattodea** (termites (formerly Isoptera))

Name: _____

Identifying Insect Orders

Use the key provided to identify different insects that are provided for you. Complete the table below. Turn in this sheet at the end of the lab.

Insect	Sequence used to identify it	Insect Order	Common Name
Sample #	1b→9a→10a→11a	Diptera	Mosquitoes & Flies

Onychophora & Tardigrada

Phylum: Onychophora (Velvet Worms)

Velvet worms are caterpillar-like animals of tropical forests. They share many characteristics of both Annelids and Arthropods. They capture prey by shooting a sticky slime from **slime glands** which quickly hardens around the prey.

1. Preserved: *Peripatus*

Using the dissecting scope examine the preserved specimen of *Peripatus*. The body is caterpillar-like, has a “velvety” surface and is covered by a thin chitinous **cuticle**. On the **head** are a pair of **antennae** and a small pair of **simple eyes (ocelli)** at the base of the antennae. Also find the ventrally directed **mouth**. The mouth is surrounded by **lips** and contains the **jaws**. Lateral to the mouth are a pair of **oral papillae** which bear sensory tubercles.

The body (**trunk**) is ringed by annuli on which there are rows of **tubercles**. Along the body there are pairs of stubby, unjointed **legs** that end in short **claws**. The posterior end, extending beyond the last pair of legs, bears the terminal **anus**.

2. Slide: *Peripatus* cs

Internally the body cavity is a **hemocoel**, part of an open circulatory system. Blood is pumped by a dorsal tubular heart to blood sinuses in the hemocoel. It contains a digestive tract and two **slime glands** anteriorly. Respiration is by a **tracheal system** with numerous **spiracles** opening to the outside. Excretion is through pairs of **nephridia** as in annelids

-Note **epidermis, muscle layers, slime glands** (if visible), **dorsal vessel** and paired **ventral nerve cord**

Phylum: Tardigrada (Water Bears)

Water bears are microscopic organisms that live in water films surrounding mosses and lichens. They have the unusual capacity to enter a state of suspended animation called **cryptobiosis** to withstand harsh conditions

1. Slide: *Hypsibius* wm

-Cylindrical unsegmented body enclosed in a flexible **cuticle** with four pairs of short, stubby, **unjointed legs**, each of which is armed with **claws**

-Note **mouth, legs, eyespots, reproductive system, and digestive system** on slide

Name: _____

Due Date: _____

Lab Report for Practical #3: Molluscs to Arthropods

I. Molluscs

1. Make a table that compares and contrasts the molluscan features; head, shell, mantle, foot in the five classes of molluscs you studied in lab & lecture.

2. What is the value of **chromatophores** to molluscs; give specific examples.

3. Describe how snails move and feed.

II. Brachiopods & Ectoprocts

4. How, specifically, do Brachiopods differ from Bivalves?
5. How are Brachiopods and Ectoprocts similar, be specific?

III. Phylum Annelida

6. List as many functions as you can for the parapodia of polychaetes (use textbook, webnote, lab book and websites to collect your information)
7. What organ systems are repeated in each segment of an annelid?
8. How exactly do the three main classes of annelids DIFFER from each other?

9. Define the following terms:

Typhlosole

Trochophore

III. Investigating Annelid Locomotion

Follow the instructions in your lab manual and record the data you collect in the tables below.

Table 12-2: Locomotor Properties of Blackworms in Moist, Terrestrial Environments:

Treatment	Stimulus	Movement	Direction	Description
Posterior stroked	Strong			
Head stroked	Strong			
Posterior stroked	Weak			
Head stroked	Weak			

Table 12-3: Locomotor Properties of Blackworms in Moist, Underwater Environments:

Treatment	Stimulus	Movement	Direction	Description
Posterior stroked	Strong			
Head stroked	Strong			
Posterior stroked	Weak			
Head stroked	Weak			

10. Summarize the differences and similarities between blackworm movements in terrestrial and aquatic environments.

IV. Arthropoda

11. Define the following terms:

malpighian tubules

chitin

ocelli

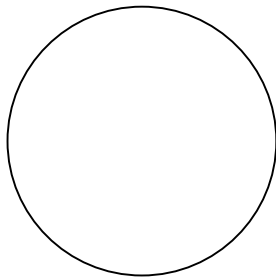
tympanum

pectines

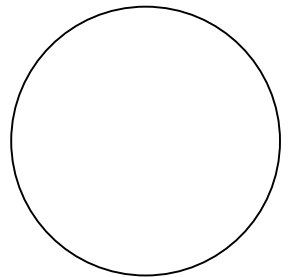
cephalothorax

12. List all the ways you can think of how centipedes differ from millipedes.

13. Draw and describe the differences in structure and function between **chelicerae** and **mandibles**.



chelicerae



mandibles

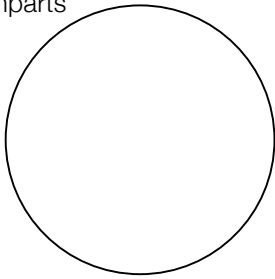
14. List all the different kinds of respiratory organs found in Arthropods and name a specific animal that has each.

15. What is the difference between **pedipalps**, **chelipeds**, and **chelate walking legs**?

16. Name one **distinctive** anatomical feature for each of the major classes of Crustaceans; the **Malacostraca, Branchiopoda, Ostracoda, Maxillipoda**, and name one common example of each.

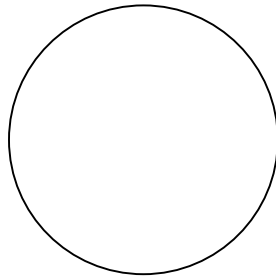
17. Sketch three different kinds, each, of insect mouthparts, leg types, wing types and antennae types:

mouthparts



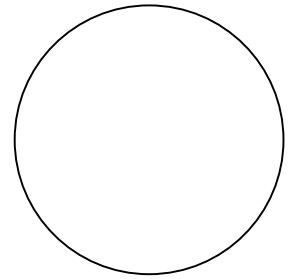
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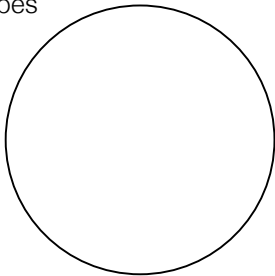
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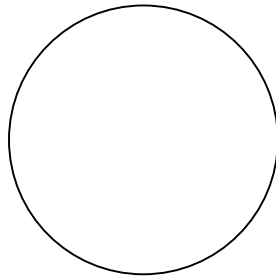
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leg types



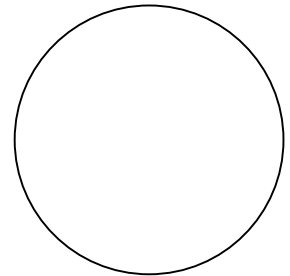
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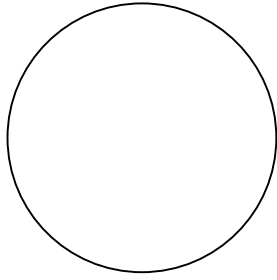
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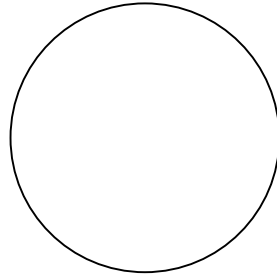
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wing types



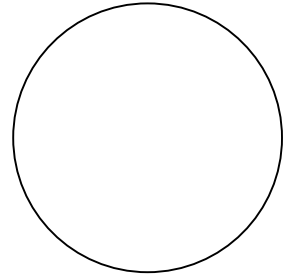
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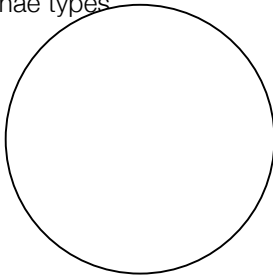
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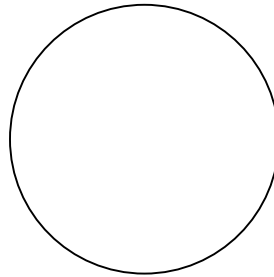
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antennae types



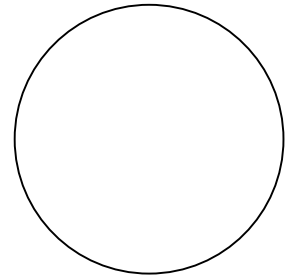
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18. Explain why there are such differences in each of these structures.

V. Phototaxis in Cladocerans

Graduated Cylinder [20 ml volumes]	No light	Low Intensity Light		High Intensity Light	
		Light Above	Light Below	Light Above	Light Below
80 - 100					
60 - 80					
40 - 60					
20 - 40					
0 - 20					

19. Summarize your Results:

Phylum Echinodermata

(Smith & Schenk, Echinoderms, 1st Chapter 13; 2nd Chapter 14)

Identifying Characteristics of the Phylum

- radial (pentamerous) symmetry in adult; larva is bilaterally symmetrical
- unique water vascular system
- all marine
- deuterostomes
- endoskeleton of calcium carbonate ossicles
- dioecious
- free swimming bipinnaria larva
- well developed regenerative abilities (asexual reproduction)
- extensive and diverse fossil record with many extinct classes

Cell Types and Characteristic Structures

- endoskeleton** composed of numerous **ossicles**, separate or fused to form a **test**
- water vascular system**: **madreporite**, stone canal, circular canal, radial canals (usually along **ambulacral grooves**), **tube feet** (=podia)
- pedicellariae**
- dermal gills** (=dermal branchiae)

Body Organization

- adult radially symmetrical, usually with five part (pentamerous) symmetry, or multiples of 5's
- no distinct head or brain (no cephalization)
- circulatory system greatly reduced and replaced, in function, by water vascular system

Classification

Class Asteroidea (starfish)

"star-shaped" with tapering arms and with flexible skeleton of many separate calcareous plates

Class Ophiuroidea (brittle stars)

star shaped but with distinct central disc and thin arms lacking tube feet

Class Echinoidea (sea urchins, sand dollars)

skeleton of fused plates forming "test", body covered with moveable spines

Class Holothuroidea (sea cucumbers)

endoskeleton greatly reduced or absent, softbodied animals elongated or wormlike with circle of tentacles at oral end

Class Crinoidea (sea lilies)

flowerlike with central calyx and branching arms; some sessile and attached to substrate by stalk

Procedures:

Read the introductory material.

A. Sea Stars (Class Asteroidea) [1st Ex. 13-4; 2nd Ex 14 – 4]

1. **preserved *Asterias***; The Common Starfish external anatomy (1st fig. 3.16; 2nd fig. 14.6)

-follow instructions to find: **central disc, arms, oral & aboral surfaces, madreporite, spines, pedicellariae, dermal branchiae, ambulacral groove, tube feet, spines, mouth**

2. internal anatomy of the starfish (1st fig. 13.7 – 13.10; 2nd fig. 14.7 – 14.10)

-dissect as instructed in lab manual to find the following structures: **coelom, pyloric stomach, digestive glands (=pyloric caecae), cardiac stomach, gonads, nerve ring, radial nerves, madreporite, stone canal, ring canal, radial canals, ampullae, tube feet**

3. **slides:** starfish ray, cs; starfish ray ls: section of starfish arm:

-know: **coelom, gonads (if visible), pyloric caecum, ambulacral groove, radial canal, radial nerve, tube feet, ossicles**

B. Brittle Stars (Class Ophiuroidea) [1st Ex 13-2; 2nd Ex 14-2]

1. Read summary in lab manual.

2. **preserved** specimens: external anatomy only:

-compare to illustrations provided and find: oral & aboral surface, **central disc, arms, ossicles & plates, bursal slits** (contain **bursal sacs**), **mouth**

C. Sea Urchins, Sand Dollars (Class Echinoidea) [1st Ex 13-3; 2nd Ex 14-2]

1. Read summary in lab manual.

2. urchin and sand dollar tests:

-using the illustrations & dried specimens provided note that the skeleton of echinoids consists of **calcareous plates** firmly cemented together into a **test**.

-identify the **oral surface** and **aboral surface**. On the aboral surface note the **madreporite**, the opening for the **anus**, and 5 larger openings called **genital pores**.

-along the sides of the urchin test and on the aboral side of the sand dollar note the **ambulacral area** with holes for the extension of **tube feet**.

-on the sand dollar test note the **lunules**.

-observe the 5-jawed “**Aristotles Lantern**” of the sea urchin on display.

3. Preserved sea urchin: external anatomy

-compare to illustrations provided to find: **test (of fused ossicles) , moveable spines, pedicellariae, tube feet, ambulacral regions, mouth, Aristotle’s Lantern**

-place the preserved specimen under the dissecting scope and locate some of the **pedicellariae** around the base of the moveable spines. Observe the numerous pedicellaria. In this urchin species they resemble flat discs on fleshy stalks. Compare them to the illustrations provided.

4. preserved urchins: internal anatomy

-using a pair of sharp scissors, insert the pointed end into the opening around the mouth and make an incision from there to the anus on the aboral surface. The test will begin to crumble in this area. With forceps gently break off pieces of the test until you have exposed the organs inside (about 1 third of its surface)

-use scissors to cut around the circumference of the sea urchin to divide into roughly equal oral and aboral portions (see illustration provided). Now locate and identify the **Aristotle's Lantern, esophagus, stomach, intestine, and gonads** within.

D. Sea Cucumbers (Class Holothuroidea) [1st Ex 13-5; 2nd Ex 14-5]

1. read introductory material.
2. **preserved** sea cucumbers: external anatomy; know: **mouth, oral tentacles, rows of tube feet (=podia), cloacal opening**
3. follow directions for dissection and find: **coelom, gonads, longitudinal muscles, retractor muscles, pharynx, esophagus, stomach, intestine, mesentery, cloaca, respiratory tree**
4. follow additional instructions below to find structures indicated:

The body wall of the sea cucumber is thick and leathery. A ring of **oral tentacles** surrounds the **mouth**. Five rows of **tube feet** extend down the long axis of the body. At the aboral end is the opening to the **cloaca**.

Dissect the sea cucumber as directed in your lab manual and pin the animal open on a dissecting tray. *Locating the internal organs will require some **delicate handling** since many of the internal organs are easily torn.* Filling up most of the body cavity (**coelom**) are the orange, tubular **gonads**. With your forceps, carefully pull away as much of the gonads as you can without damaging any of the other organs (*usually about one half to two thirds can be quickly and easily removed in this way*). Notice the bands of **retractor muscles** attached to the front of the animal and the **longitudinal muscles** running down the length of the inner body wall. There are also numerous finer muscles that attach to the **cloaca** and **respiratory tree**. Locate the **digestive tract** and follow it from mouth to **cloaca**; Just inside the **mouth** is a short **pharynx**. Behind the pharynx is a short **esophagus** and then an even shorter **stomach** followed by a long, coiled **intestine**. A portion of the intestine is supported by a thin, sheetlike **mesentery** attaching it to the body wall. A **muscular cloaca** connects to the end of the intestine. Two very thin and delicate **respiratory trees** branch off of the cloaca and extend along the inner body wall toward the mouth.

E. Sea Lilies, Feather Stars (Class Crinoidea) [1st Ex 13-1; 2nd Ex 14-1]

1. read material in your lab manual

2. recognize as a unique class of echinoderms

F. Echinoderm Development [Ex 4-1]

1. review information on animal development.

Fertilization

- Be able to distinguish between fertilized eggs and preembryonic developmental stages

Cleavage.

- each cell is called a **blastomere**

Morula

Blastula

- internal cavity called the **blastocoel**

Gastrula

- the **blastocoel**, **archenteron (gastrocoel)**, and **blastopore**

2. **slide:** bipinnaria larva: **Echinoderm Larval Stage** (fig. 4.3)

- be able to recognize the **bipinnaria larva** as the main larval form of echinoderms

- note that it is bilaterally symmetrical

3. **slide:** young starfish wm (fig. 4.3)

- the young starfish is the radially symmetrical postlarval stage of echinoderms that forms directly from the bipinnaria larva

- note the development of the endoskeleton and the ambulacral grooves in the arms

Demonstrations:

- The Classes of Echinoderms

illustrations, dried & preserved specimens,
fossils

-be able to distinguish between the different classes and to classify the various fossil and extant specimens available

Disposal:

*Dispose of dissected starfish in “scraps” bucket

*DO NOT discard other specimens, return brittle stars, sea urchins and sea cucumbers to proper dish or bucket

Notebook Suggestions:

- How, specifically, do members of each class differ from each other in anatomy; ie. what structures are unique to each class or absent in each class.
- How do echinoderms differ from the annelid-mollusc-arthropod group?
- Draw a pedicellaria
- Draw tube feet

EC: Chaetognatha & Hemichordata

Phylum: Chaetognatha (Arrow Worms)

Procedures:

Plankton samples

1. Arrow Worms are small, voracious, marine, planktonic predators with elongated wormlike body with paired **fins** used for flotation
2. **Preserved:** *Sagitta*: identify the following: **head** with **teeth** and curved **spines** used to seize prey, a **trunk** with **paired fins**, and a '**postanal**' tail
3. **Preserved:** Plankton Samples

-make a wet mount with a SMALL drop of the sample provided. identify the arrow worms in the sample.

-what other animal phyla that you have studied are represented in the plankton sample?

Phylum: Hemichordata (Acorn Worms)

Procedures:

1. Acorn Worms are marine, worm-like bottom dwellers; some are colonial and live in tubes, others are sedentary. Most members of the phylum are ciliary mucous feeders.

2. **Preserved:** *Dolichoglossus*

The mucous-covered body is divided into a tonguelike **proboscis**, a short **collar**, and a long **trunk**. A row of **gill pores** on the anterior **trunk** open into **gill chambers** which connect to the **pharynx** via **gill slits**; water moves into mouth to the pharynx, through the gill slits to the gill chambers and out the gill pores.

3. **Fossil:** Graptolites

-These are fossils of a small group of hemichordata that were apparently much more abundant in earlier geologic ages. They are important "index fossils" for geologists dating rocks

-examine the fossils and be able to recognize them as Hemichordates

Chordata I

Lower Chordates & Subphylum: Vertebrata – Class Agnatha

(Smith & Schenk, Tunicates & Cephalochordates, 1st Chapter 14; 2nd Chapter 15 & Chapter 16)

Identifying Characteristics of the Phylum

- dorsal, hollow, tubular nerve cord
- notochord for support
- paired gill (pharyngeal) slits
- segmentation in some systems
- most with postanal tail
- deuterostome development

Body Organization and Characteristic Structures

- cartilaginous notochord for support in larva, adult or both
- pharynx used for filter feeding and/or respiration
- dorsal tubular nerve cord at some stage of development
- post-anal tail at some stage of development

Classification:

Subphylum: Urochordata (Tunicates)

- solitary or colonial; microscopic to 1 ft in diameter
- motile larvae with dorsal nerve cord and notochord
- adults sessile and lacking these characteristics
- no cranium or braincase

Subphylum: Cephalochordata (Lancelets)

- burrow in sand; active swimmers
- elongated, streamlined, fishlike animal with all chordate characteristics in adult stage

Subphylum: Vertebrata (vertebrates)

- all chordate characteristics in either the embryonic or adult form
- well developed cephalization
- endoskeleton with cranium enclosing the brain and vertebrae enclosing the spinal cord
- segmental spinal column enclosed in vertebrae
- most with distinct head, neck, trunk, tail

Procedures:

A. Subphylum: Tunicata (Urochordata)

1. Tunicates (Subphylum Tunicata): [1st Ex 14-1; 2nd Ex 15-1]

- read the introductory material.
- planktonic tunicates: **Slides:** *Salpa*; *Doliolum*; *Oikopleura*

-look at each of the slides and try to find as many of the following structures as you can:
tunic, incurrent and excurrent siphons, gill slits, pharynx, gill slits, digestive tract, anus, muscle bands

c. sessile, benthic tunicates: **Preserved:** golden star tunicate; Halocynthia (sea peach); Boltenia (sea potato); Molgula (sea grape); Ciona (sea vase); “sea pork”

-examine the preserved specimens of sessile tunicates and use the illustration in your lab manual (1st fig. 14.4; 2nd fig. 15.4) and handouts to find the following structures:
incurrent & excurrent siphons, tunic, atrium, pharynx, stomach, intestine anus

d. **Slides:** Ascidian tadpole; ascidian swimming tadpole: Ascidian Larvae (1st fig. 14.5; 2nd fig. 15.5)

-know: **adhesive papillae, branchial basket, intestine, atriopore, notochord**

B. Subphylum Cephalochordata

1. Lancelets (Subphylum Cephalochordata): [1st Ex 14-2; 2nd Ex 15-2]

a. read the introductory material.

b. **Slide:** *Amphioxus* immature, wm: (1st fig. 14.6 – 14.8; 2nd fig. 15.6 – 15.8)

-know: **rostrum, oral cirri, notochord, fin rays, myomeres, dorsal nerve cord, pharynx, gill slits, hepatic caecum, intestine, anus**

c. **Slides:** *Amphioxus* representative cs; *Amphioxus* composite cs; *Amphioxus* 4 regions cs (1st fig. 14.9; 2nd fig. 15.9)

-cross section through pharyngeal region: **skin, epidermis, dermis, dorsal fin, fin ray, myomeres, dorsal nerve cord, notochord, pharynx, gill slits, gill bars, atrium, gonads, metapleural fold, ventral aorta**

-cross section through intestinal region: **dorsal fin, fin ray, dorsal nerve cord, notochord, myomere, dorsal aorta, intestine, ventral fin**

C. Subphylum Vertebrata Class Agnatha (Jawless Fish) [2nd Chapter 16]

1. The Adult Lamprey (H.O.): **Preserved Specimens; plastimount**

a. external anatomy; (2nd fig 16.2 & 16.3)

-use illustrations provided to find: **dorsal fin, caudal fin, rasping teeth, eyes, median nostril, gill slits, lateral line, anus**

b. internal anatomy; (2nd fig. 16.5) Use the plastimounts and sagittal sections.

-observe the prepared sagittal sections to find the internal anatomy: **notochord, brain, spinal cord, myotomes, digestive tract, oral hood, mouth, tongue, esophagus, intestine with typhlosole, pharynx, liver, gonad, kidneys, heart**

2. Compare the external features of the lamprey with those of the **hagfish** on display. List as many differences as you can find.
3. Observe the **conodont** fossils on display. Be able to recognize what they are and how they relate to the body of agnathans
4. Observe the **illustration** of the skeleton of two agnathans; the lamprey and the hagfish

-note the **notochord, dorsal** and **caudal fins** with **fin rays** and the **cartilages** (=branchial basket) that support the **gill arches** between each gill slit.

5. Lamprey Larva, Ammocetes: **Slide**: Ammocetes, wm (2nd fig. 16.7)

a. know: **oral tentacles, eye, caudal fin, myotomes, gill pouch, notochord, brain, spinal cord, intestine, cloaca**

Demonstrations:

- Similarities between the larvae of Hemichordates and Primitive Chordates
- Deuterostome Evolution & Generalized Chordate
- Vertebrate Relationships
- Representative Urochordates (tunicates)
- Metamorphosis in Tunicates
- Representative Cephalochordates
- Phylum Chordata; Class Agnatha

Notebook Suggestions:

- How do sessile and planktonic tunicates differ from each other
- How does the anatomy differ between larval and adult tunicates
- Compare tunicate larvae with lamprey larvae; what are the similarities, what are the differences

Disposal:

Do not discard, return preserved animals to bucket

Chordata II

Subphylum Vertebrata:

Classes: Chondrichthyes & Osteichthyes

(Smith & Schenk, Cartilaginous Fishes, 1st Chapter 15; 2nd Chapter 17 & Bony Fish, 1st Chapter 16; 2nd Chapter 18)

Subphylum Vertebrata: General Characteristics

- all chordate characteristics
- enlarged brain enclosed in brain case
- segmental spinal column enclosed in vertebrae
- most with distinct head, neck, trunk, tail

Classification:

Class: Agnatha (previous lab)

Class: Chondrichthyes (cartilaginous fishes; sharks & rays)

- cartilaginous endoskeleton
- biting jaws
- paired appendages
- tough, leathery skin usually with placoid scales
- two chambered heart
- mostly marine

Class: Osteichthyes (bony fishes)

- bony skeleton with bony operculum over gills
- two chambered heart
- dermal scales
- homocercal tail
- paired nostrils
- largest class of living vertebrates

Procedures:

A. Class: Chondrichthyes (cartilaginous fishes; sharks & rays) [1st Ex 15-1; 2nd Ex 17-1]

1. Read introduction to Cartilaginous Fishes.

2. The Dogfish Shark; **preserved:** shark

a. External Structure (1st fig. 15.3; 2nd fig. 17.3)

-Know: **head, trunk, tail, pectoral fins, pelvic fins, dorsal fins, clasper (on male pelvic fins), caudal fin, eyes, spiracle, nostril, mouth, lateral line, gill slits, cloacal opening, urogenital papilla**

b. Internal Structure: (1st fig. 15.4 – 15.10; 2nd fig. 17.4 – 17.12)

-dissect as described and find structures indicated: **3-lobed liver, gall bladder, pancreas, stomach with rugae, duodenum, ileum with spiral valve (=valvular intestine), colon, spleen, testes, seminal vesicle, ovaries, oviduct, uterus, kidneys (~mesonephric duct), heart, gills, aorta (=dorsal aorta), rectal gland, cloaca**

c. shark skeleton: **preserved:** shark skeleton

-examine the shark skeleton. Use illustrations provided to identify the **axial & appendicular skeleton, skull, vertebral column, dorsal fins, caudal fin, pectoral girdle & fins, pelvic girdle & fins**

d. placoid scales & skin: **slides:** dogfish placoid scales wm; dogfish skin cs

-be able to recognize **placoid scales** as characteristic of Chondrichthyes

e. compare accompanying illustrations of shark skeleton, skin, heart, and brain with those of the perch below and note anatomical differences between the two classes

B. Class: Osteichthyes (bony fishes) [1st Ex. 16 – 1; 2nd Ex 18-1]

1. read introductory material about bony fish.

2. Perch: **preserved:** perch

a. external structure: (1st fig. 16.4; 2nd fig. 18.4)

-know: **eyes, mouth, nostrils (=external nares), operculum, dorsal fins (2), caudal fin, pectoral fins, pelvic fins, anal fin, lateral line, anus**

b. internal structure (fig. 16.5 – Fig. 16.11)

-know: **pharynx, heart (ventricle), gills, myotomes (=myomeres), gill slits, teeth, tongue, swimbladder, stomach, pyloric (digestive caeca, liver, spleen, intestine, rectum, anus, ovary, testes, kidneys**

c. skin (body wall) of fish; **slide:** fish skin, sec

-compare to illustration provided and note **epidermis, dermis, bony scales** and **connective tissues**

d. scales: **slide:** scale types, wm

-use illustrations provided to be able to recognize the variety of scales characteristic of bony fish

-be able to distinguish them from placoid scales of cartilaginous fish

e. fish skeletal system; **perch skeleton** (1st fig. 16.3; 2nd fig. 18.3)

-compare to illustration and distinguish between: **axial** and **appendicular skeleton**, **vertebral column**, **skull**, **operculum**, **pectoral fins**, **pelvic fins (2)**, **dorsal fins**, **caudal fin**

f. observe the preserved fish available and describe how they might live based on their shape and appearance. record your suggestions in your lab report.

g. fish heart (Carp); **heart biosmount**

-compare to illustration and observe that the fish heart consists of two major chambers; one **atrium** and one **ventricle** and that blood flows in a **single circuit**

h. fish brain (Carp); **brain biosmount**

-compare to illustration and note small **cerebrum**, **optic lobes** (attached to **optic nerves** and **eyes**), **cerebellum**, and **brain stem**

Demonstrations:

- The Evolution of Jaws: Understand the origin of jaws from agnathans
- Shark Anatomy
- Perch Anatomy
- Fish Skeletal System
- Gills of Bony Fish
- circulatory systems of sharks and bony fish
- Examples of the Class Chondrichthyes
- Examples of the Class Osteichthyes

Chordata III

Subphylum Vertebrata:

Class: Amphibia

(Smith & Schenk, Amphibians (1st Chapter 17; 2nd Chapter 19))

Classification:

Class: Amphibia (frogs and salamanders)

- reproduction tied to water, many adults live on land
- immatures undergo metamorphosis to adult
- bones denser and stronger than those of fish
- two pairs of appendages: pectoral and pelvic
- some respiration through lungs
- most with smooth moist skin without scales

You will dissect two amphibians in this exercise. The “mud puppy” or *Necturus* is an example of a **generalized** amphibian. The frog is a much more common, but a much more **specialized** example of amphibian.

Procedures:

1. Read introductory material.

2. *Necturus* (waterdog or mudpuppy)

a. **preserved:** *Necturus* - External Structure;

-The body is divided into head, trunk and tail regions. On the **head**, locate the **eyes, mouth, nares (nostrils)**

-*Necturus* spends its life in water and therefore has **external gills** as its main respiratory organ

-Notice the small size of the **legs**, also notice that the legs are directed laterally rather than beneath the body

b. *Necturus* skeleton

-The skeleton of *Necturus*, a salamander, is more representative of the generalized amphibian (& reptile) skeletal plan.

-Note the general features below:

a. The vertebrate skeleton is subdivided into the **axial** (skull, vertebrae, rib cage) and **appendicular** (pectoral & pelvic girdles and appendages) skeletons

b. the **vertebral column** provides a rigid framework for muscle action especially the leg muscles.

- c. abdominal organs are suspended from the **axial skeleton** which bears most of the body weight.
- d. the short leg bones support the animal and (barely) lift it off the ground

c. *Necturus* - Internal Anatomy; **preserved**: *Necturus*

Place the animal on its back with the head toward you. If the specimen has not been already been dissected make an incision through the body wall, just below the **pectoral girdle** and to the right of the midline. Cut posteriorly to the **pelvic girdle**. Be careful not to damage the internal organs as you cut the body wall.

Pull the cut open to expose a long **liver** extending most of the length of the incision. Between the lobes of the liver is a prominent **gall bladder**. Dorsal to the liver is a long muscular **stomach** which leads to the **small intestine**. Lift the stomach to the right and note the **spleen** attached by **mesentery** to the lateral surface of the stomach. Dorsal and lateral to the stomach are two very thin, sac-like **lungs**. Look for the **pancreas** next to the duodenum just below the stomach. Find the **ovaries** (or **testes**) near the posterior end of each lung. Follow the small intestine posteriorly to the short **large intestine**. The large intestine leads to the **cloaca** which is a common receptor for digestive wastes, excretory wastes and reproductive cells. The **urinary bladder** is on the ventral side of the large intestine. The **kidneys** are on the dorsal wall of the body cavity dorsal to the large intestine.

3. **Frogs** [1st Ex 17 – 1; 2nd Ex 19-1]

- a. **preserved**: frog – external structure (1st fig 17.3; 2nd fig 19.5)

-Know: **head, trunk, forelimbs, hind limbs, eyes, nostrils, eyelids, nictitating membrane, tympanic membrane (ear drum), anus**

- b. **preserved**: frog; internal anatomy (1st fig. 17.8 – 17.11, fig 17.14 – 17.16; 2nd fig. 19.10 – 19.13, fig 19.16 – 19.18)

skip muscular system

-know: **internal nares, tongue, heart, lungs, stomach, small intestine, large intestine, liver, gall bladder, kidney, fat body, ovary, testis, urinary bladder**

- c. **slide**: amphibian skin, cs

-use illustration provided and those from your text to find: **epidermis, dermis** and numerous **mucous glands**

- d. **slide**: frog skin pigment cells wm

-on the second slide note the branching **chromatophores** which give many amphibians their skin color patterns

- e. **frog skeleton** (1st fig. 17.4; 2nd fig. 19.6)

-compare the **axial** and **appendicular** skeletons of the frog to the salamander (*Necturus*); What are the similarities and differences?

-compare the **pectoral** and **pelvic appendage** bones of the frog with those of the salamander. Note that the pelvic girdle of the frog is reinforced for jumping by three strong bones (the **ilia** and a central **urostyle**) used for attachment of the leg muscles.

-how, specifically, has the frog skeleton been modified for jumping?

4. **heart plastimount;** Amphibian Heart

-The heart of amphibians is three chambered;
with a **right** and **left atrium** and a single **ventricle**

-Compare the hearts of the frog with that of the fish in the plastimount display. What are the advantages of the extra chamber? Does the circulation pattern differ between amphibians and fish with only a two chambered heart.

5. **brain plastimount;** Amphibian Nervous System

-Compare the brain of the frog with that of the perch in the plastimount display. Is the **cerebrum** of the frog and turtle relatively larger or smaller than that of the fish?

-note the especially the changes in the **olfactory bulb** (smell), **optic lobes** (vision), **cerebrum** and **cerebellum**

6. **frog development;** Grass Frog Life History Demonstration

-observe and be able to describe the changes that occur from: fertilized egg → larva → metamorphosis → adult

Demonstrations:

• Representative Amphibians - be able to recognize the class of each of the animals on display

Notebook Suggestions:

→ As we study each of the major vertebrate classes compare the structure, function and efficiency of each of the systems. What changes are occurring as we progress through the simplest to the more complex classes?

→ Can you see any advantages to these changes?

→ Which features are simply specializations for the animal's particular lifestyle and which represent evolutionary advances first appearing in a particular vertebrate class?

Chordata IV

Subphylum Vertebrata:

Class: Reptilia

(Smith & Schenk, Reptiles (1st Chapter 18; 2nd Chapter 20))

Classification:

Class: Reptilia (snakes, lizards, turtles)

- reproduction not tied to water
- skin covered with *epidermal* scales; impermeable to water & air
- heart usually three but sometimes four chambered
- all respiration through lungs
- lay amniote eggs

Procedures:

1. Read introductory material.

2. **Preserved boa constrictor hide & misc. shed snake 'skins'**

unlike the scales of fish which are under the epidermal layer of skin (dermal scales), the scales of reptiles are epidermal scales. This outermost layer of skin & scales must be shed periodically to allow for growth and to rid the body of ectoparasites. Since reptiles grow throughout their lives they generally shed throughout life

-note the difference between the preserved **hide** (epidermis & dermis) vs the shed surface layers of scales and **epidermis**.

3. **slide:** reptile skin, cs

-Note that the skin of a typical reptile has been thickened and waterproofed with the addition of **epidermal scales**. Note that the scales are on the surface of the epidermis rather than under the epidermis as they were in fish skin

4. Turtles & Tortoises [1st Ex. 18.1; 2nd Ex 20-1]

Turtles are the only vertebrate with such protective armor. The turtle shell consists of large **scales** (=scutes) covering hard bony **plates** derived from the ribs. The scutes may show growth rings.

The shell consists of an upper **carapace** fused to a lower **plastron**. In some turtles the plastron is hinged to completely enclose the turtles head. The mouth of a turtle consists of a **beak** but no teeth.

a. read introductory material.

b. **preserved:** turtle; external anatomy

-locate and identify the **shell, carapace, plastron, scutes (=scales), eyes, ears, beak, nostrils**

c. **turtle skeleton & shell** (1st fig 18.5; 2nd fig. 20.4 & 20.5)

-What bones make up the **carapace**?

-distinguish between the **axial** and the **appendicular** skeletons

-note the attachment of the limbs to the axial skeleton, how is it different than in neoturus

d. **preserved**: turtle; internal anatomy (1st fig 18.6 – 18.11; 2nd fig 20.6 – 20.11)

-dissect as directed and find the following structures: **pericardial sac, heart, right and left aorta, trachea, esophagus, liver, urinary bladder, cloaca, esophagus, stomach, intestine, gall bladder, kidneys, lungs, ovaries, oviducts, uterus, testes**

5. Snakes & Lizards [1st Ex. 18-2; 2nd Ex 20-2]

Snakes and lizards are closely related, the main difference being the presence of limbs in lizards. Internal differences include, in snakes, a greatly expandable esophagus, only 1 lung and no urinary bladder.

a. read introductory material.

b. **preserved**: snake; external anatomy (1st fig. 18.12; 2nd fig. 20.12 & HO)

-locate and identify: **head, mouth, eyes, nostrils, cloacal opening**

c. **snake skeleton** (1st fig. 18.13; 2nd fig. 20.13)

-Compare the snake skeleton with the two amphibian skeletons that you examined in the last lab

-Note the absence of an **appendicular skeleton**.

-Note the structure of the snake jaw, how is it modified?

d. **preserved**: snake; internal anatomy (1st fig. 18.14 - 18.17; 2nd fig. 20.14 – 20.19)

-follow instructions for dissection and find: **trachea, lung, esophagus, ventricle, atrium, stomach, liver, intestine, kidneys**

6. Alligators & Crocodiles [1st Ex. 18-3; 2nd Ex 20-3]

a. read introductory material.

b. **alligator skull** (compare to illustrations provided)

-in amphibians and in most reptiles the **nasal passages** open directly into the mouth but some reptiles, such as alligators, have a **secondary palate** which separates the nasal passages from the mouth cavity. Note also that the **teeth** are all conical. In reptiles, teeth are replaced throughout life.

- c. note 4 chambered heart of alligators (1st fig 18.21; 2nd fig. 20.21) and its comparison to mammal and bird hearts

7. **heart plastimount;** Reptile Heart

- The hearts of both amphibians and most reptiles are three chambered; with a right and left atrium and a single ventricle
- Compare the heart of the reptile with that of the fish and amphibian in the plastimount display.
- Does the circulation pattern differ between tetrapods and fish?

8. **brain plastimount;** Reptile Nervous System

- Compare the brains of the turtle with that of the perch and frog in the plastimount display. What are the differences?

Demonstrations:

- Representative Reptiles - be able to recognize the class of each of the animals on display in pictures and preserved
- The Amniotic Egg - note the general structure of the **amniotic egg**. Be able to name and describe the general functions of the **four extraembryonic membranes**. What is the advantage of this type of egg over that produced by fish and amphibians.

Notebook Suggestions:

- As we study each of the major vertebrate classes compare the structure, function and efficiency of each of the systems. What changes are occurring as we progress through the simplest to the more complex classes?
- Can you see any advantages to these changes?
- Which features are simply specializations for the animal's particular lifestyle and which represent evolutionary advances first appearing in a particular vertebrate class?

Chordata V

Subphylum Vertebrata

Class: Aves

(Smith & Schenk, Birds (1st Chapter 19; 2nd Chapter 21))

Classification:

Class: Aves (birds)

- warmblooded; higher metabolic rate
- pectoral appendages modified into wings for flight
- feathers replace scales over most of body surface
- bones of skeleton reduced, hollow and fused to decrease weight while maintaining strength
- respiratory system with extensively branching air sacs
- oviparous; lay eggs

Procedures:

1. read introductory material.
2. **pigeon skeleton, misc. bird skulls**; Skeletal System (1st fig. 19.3; 2nd fig. 21.4)
 - be able to identify the following bones: **axial skeleton, skull, vertebral column, ribs, sternum, vertebrae, sternum, keel, synsacrum, appendicular skeleton, pectoral girdle, clavicles, wish bone, humerus, radius, ulna, carpals, metacarpals, phalanges pelvic girdle, femur, tibiotarsus, tarsometatarsus, phalanges**
3. **preserved: pigeon & study skins**; External Anatomy HO
 - a. use illustrations provided to find the following structures: **crest, eyes, bill, nostrils, ear, throat, primaries, secondaries, thigh, tarsus (=shank), scales, toes, claws, vent, tail.**
 - b. Compare the external features with the figure of the skeletal system:
 - note that the **primaries** are attached to the third segment of the wing supported by the **metacarpus**, and the **secondaries** are on the second wing segment supported by the **ulna**.
 - Note also that the "**thigh**" is equivalent to the "drumstick" of a chicken; the true thigh is close to the body beneath the contour of the feathers.
 - Also, the **tarsus**, which acts as the functional equivalent to our "shin" is actually homologous to our foot.
 - note that most of the bones, especially skull bones, tend to be thin and light yet strong. many are fused together. Most of the trunk vertebrae are rigid rather than allowing the flexibility that we have in our own backbone. Yet the vertebrae of the neck are extremely flexible for greater freedom of movement of the head.

4. **preserved:** pigeons; Internal anatomy (1st fig. 19.4 – 19.6; 2nd fig. 21.9 – 21.11)

-Follow the dissection procedures described in your lab manual. read the discussion and find:
mouth, tongues, esophagus, crop, gizzard, small intestine, liver, pancreas, cloaca, bronchi, syrinx, lungs, four-chambered heart, aorta, superior & inferior vena cava, kidneys, ureters, testes, ovary

-read the description below for additional information:

The respiratory system begins at the **external nares** (nostrils) which open into the **nasal passageways**. From these air passes into the **pharynx** or throat area. At the bottom of the pharynx the digestive system separates from the respiratory system.

Air passes through the **glottis** into the **trachea**. Birds have no larynx or voice box. Just before the trachea splits into two **bronchi** is an enlarged muscular area called the **syrinx**. The **syrinx** takes the place of the voice box in birds and helps to produce their typical vocalizations. The **bronchi** enter the right and left **lungs** which consist of small air tubes called **parabronchi** from which **air capillaries** branch. This design creates a much larger respiratory exchange surface than that found in the lungs of amphibians or reptiles. It is in the air capillaries where gas exchange actually occurs. slice a thin piece of the lungs off and view it under to dissecting scope to view the parabronchi and air capillaries. In birds, several pairs of **air sacs** branch off of the lungs and take up much of the space of the body cavity. Try to identify the **cervical, thoracic** (2 pairs, anterior and posterior) and **abdominal air sacs**. A nonmuscular **diaphragm** separates the **thorax** from the **abdomen** but ventilation of the lungs is achieved by alternate compression and expansion of the air sacs from movements of the sternum and ribs.

In birds, the **four-chambered heart** is completely developed, with two **atria** and two separate **ventricles**. The heart is essentially a double pump which pumps blood through each of the two separate circuits of bloodflow, the **pulmonary circuit** and the **systemic circuit**. In the pulmonary circuit, blood leaves the **right ventricle** through the **pulmonary artery** and goes to the **lungs**. Once the blood has been oxygenated in the lungs it returns to the heart, specifically, the **left atrium** through the **pulmonary veins**. The systemic circuit begins as blood is pumped from the **left ventricle** out the **aorta** to the rest of the body. Systemic blood returns to the **right atrium** by way of the **superior** and **inferior vena cava**.

5. **assorted feathers & study skins** (1st fig. 19.7; 2nd fig. 20.12)

-Identify the following kinds of feathers on illustrations and materials provided: **contour feathers, down feathers, semiplums**

-Identify the parts of a contour feather: **quill, shaft (=rachis), vane, barbs, barbules**

6. **beaks and feeding type; various specimens & illustrations**

-Using the figures available determine the feeding preference of the specimens available.

-How easy is it to determine what a bird eats based solely on the size and shape of its beak?

7. **slide:** bird skin, sec.

-Find the **epidermis** and **dermis**.

-Is the feather an epidermal or a dermal structure; is it more closely related to the scales of a fish or the scales of a reptile? Why or why not?

8. **vertebrate brains biosmount**

-Compare the structure of a bird's **brain** with those of the other vertebrate groups you have studied. Overall, the brain is considerably larger compared to lower vertebrates of comparable size or mass.

-Note the increase in relative size of the **cerebrum**. Most of this increase is related to processing of **visual stimuli** and development of complex **instinctive behaviors** particularly those related to reproduction. The enlarged **optic lobes** reflect the increased importance of the sense of vision. The **cerebellum** is large and well developed in birds and relates to their flying ability and the coordination of muscles that flight entails.

Demonstrations:

- Flight, Feathers and Energy Consumption
- The Bird Respiratory System
- cross section of ostrich leg bone - note density compared to comparable mammal bone

Notebook Suggestions:

- Make comparisons with representatives of the other vertebrate classes in terms of skeletal systems
heart and circulatory system
brain and nervous system and senses
- What anatomical modifications are most important in allowing birds to fly?
- How closely do birds resemble reptiles; do you see any similarities?

Disposal:

Return the pigeon to the bucket – **DO NOT DISCARD**

Phylum Chordata VI

Subphylum Vertebrata

Class: Mammalia

(Smith & Schenk, Mammals (1st Chapter 20; 2nd Chapter 22))

Classification:

Class Mammalia (mammals)

- mammary glands
- four chambered heart
- muscular diaphragm
- homeothermy
- hair derived from epidermis
- with claws, nails or hoofs
- viviparous with placental attachment to mother during development

Procedures:

1. Read introductory material.
2. **slide:** hairy skin of mammal, **model:** human skin; Mammalian skin
 - Observe the slide & model of skin and compare to illustrations provided. Know: **epidermis, dermis, stratum corneum, hair follicle, hair shaft, oil glands, sweat glands, arrector pili muscle**
 - use your microscope to observe and diagram several of the mammal fur specimens available.
3. Modifications of Mammalian Hair
 - a. **Misc. horns & antlers**
 - Observe and distinguish between horns and antlers. **Horns** are produced mostly in hoofed animals and grow around a core of bone throughout the animals life. The tough, horny layer surrounding the bony core is *homologous* to the hair you saw under the microscope. In contrast, the **antlers** of deer, elk, caribou, etc. are made of bone. As they first begin growing they are covered with a layer of "fuzzy" or hairy epidermis called **velvet**, which eventually falls away. Antlers are shed and regrown annually. They are not homologous to the keratinized horn above.
 - b. **preserved armadillo**
 - The protective flexible **carapace** and **scutes** of the armadillo are formed from fused hairs.
 - c. **porcupine quills**

-Porcupines and hedgehogs have thick sharp hairs called **quills** that they use for defense. While the porcupine cannot "shoot" its quills, they do break off easily once embedded in the attacker.

4. Skeletal System

a. **human & cat skeletons** (1st fig. 20.3; 2nd fig. 22.3)

-Know: **axial skeleton, skull, vertebrae, ribs, sternum, appendicular skeleton, pectoral girdle, shoulder blade, clavicle, humerus, radius, ulna, carpals, metacarpals, phalanges, pelvic girdle, femur, tibia, fibula, tarsals, metatarsals, phalanges**

b. **bat skeleton**

-Identify the bones of the pectoral appendages of the bat and note how they have been modified to form the support for the wings.

-Compare the skeletal structure of the bat wing with that of the bird.

c. **mole skeleton**

-Compare the structure of the forelimb of a mole with that of the cat, human and bat. Moles spend their lives digging underground tunnels searching for food

-Be able to identify the bones and note the modifications for digging.

d. **various skulls; secondary palate**

-Note how the bony extension of the **maxilla** bone forms a **secondary palate** in mammals which separates the **nasal passages** from the **mouth**. This makes respiration more efficient in these warmblooded animals which require plenty of oxygen.

-In the sectioned skulls, note the relative size of the nasal cavity versus the brain cavity; also note the dramatic change in the relative size of the brain cavity in primates (including humans) compared to the nasal cavity

-Compare this with skulls from amphibians, reptiles and birds as available.

e. **malleus, incus, stapes; Ear bones**

-In mammals the sense of hearing is well developed due partly to the presence of three **ear ossicles** the **malleus** (hammer), **incus** (anvil) and **stapes** (stirrup) instead of just one, the **columella** (homologous to the stapes) common in amphibians, reptiles and birds. These additional ear bones evolved from some of the extra jaw bones found in reptiles.

f. mammalian penis bone

g. **mammal skulls; feeding adaptations**

-Just as the beaks of birds are modified for various feeding types, the teeth of mammals are variously modified for various types of foods.

Carnivorous mammals typically have large canines to hold onto prey, sharp incisors to cut pieces of flesh and pointed premolars to help chew meat.

Herbivores typically have small canines or no canines, nipping incisors and broad flat premolars and molars for grinding the tough plant fiber before swallowing.

Omnivores' teeth share some of the characteristics of both feeding types.

-Observe the teeth in the various skulls and determine whether the animal is a **carnivore** (a meat eater), an **herbivore** (a plant eater) or an **omnivore** (eats both plant and animal foods).

5. The Fetal Pig [1st Ex 20-2; 2nd Ex 22-2]

a. **preserved:** fetal pig; External anatomy (1st fig. 20.4; 2nd fig. 22.4):

-Know the following structures: **head, trunk, thorax, abdomen, forelimbs (pectoral appendages), hindlimbs (pelvic appendages), mouth, eyes, ears, snout, nostrils, vibrissae, neck, umbilical cord, mammae, urogenital opening, genital papillae (female), scrotum (male)**

b. **preserved:** fetal pig; Internal anatomy (1st fig. 20.7 – 20.19; 2nd fig. 22.8 – 22.18)

-we will not skin the pig to study the muscles. For internal anatomy follow the dissection instructions in your manual.

-use bone cutters (not a scalpel) to cut into the corners of the mouth.

-Digestive System (mostly): **teeth, salivary glands, hard palate, soft palate, tongue, pharynx, thymus gland, esophagus, thoracic cavity, peritoneal cavity, liver, gallbladder, stomach, pancreas, small intestine (including duodenum), large intestine (including caecum, colon)**

-Respiratory System: **epiglottis, larynx, trachea, bronchi, diaphragm, lungs, alveoli**

-Muscular System: skip

-Urogenital System: **kidneys, ureter, bladder, urethra, ovary, uterus, vagina, genital papilla, testes, vas deferens, penis**

-Circulatory System: **pericardial cavity, heart, 4-chambered heart, atria, ventricles, valves, pulmonary artery, aorta, vena cava, pulmonary circuit, systemic circuit**

6. Miscellaneous mammalian tissues and organs

a. **slide:** mammal lung, sec

-the mammal lung is the most efficient of vertebrates. Million of microscopic sacs called **alveoli** combine to produce a large surface area for gas exchange.

b. **preserved:** cow heart

-the large size of the cow heart should make it relatively easy to find the **atria, ventricles, AV valves, semilunar valves, aorta, pulmonary artery, pulmonary veins and vena cava**

c. **vertebrate heart plastimount**

-compare the four chambered heart of mammals to the hearts of the other vertebrate classes already seen

d. **cat nervous system**

-Study the preserved cat nervous system and distinguish between the **central** and **peripheral nervous systems**

e. **model:** human brain

-Find: **cerebrum, cerebellum, brain stem, olfactory bulb, pituitary gland**

-How is the human brain different from the brain of other mammals

7. **Human Evolution Demonstration**

Observe the illustrations and materials showing & describing some of the major stages in human evolution. Be able to describe some of the major changes that occurred to the human body during our early evolutionary history.

***Ardipithecus ramidus* ("Ardi") [4.4 MY ago]**

probably several distinct species
lived in the woodlands of E Africa
~4' tall, weighed ~110 lbs
had long arms, short legs with opposable toes
spent most of their time in trees; ate, slept and raised young in trees
but could easily walk on 2 legs and carry food in arms
was probably in direct line of descent to us

***Australopithecus* sp. (eg. Lucy) [4.2 -2.3 MY ago]**

several species known (eg. "Lucy" & Taung Child), some not necessarily in direct line of descent to us
4' tall, ~50 lbs
no dramatic increase in brain size; slightly larger brain than modern monkeys and apes (relative to size)
relatively small canines and incisors
bipedal primates
lived in open grasslands (eg. Lucy & footprints); still probably spent time in trees
walked upright (bipedal), ground walker
→ better vision in grasslands
→ frees hands for weapons and harvesting

relatively long arms

Homo habilis [2 – 1.5 MY]

earliest "human" fossils (same genus as us)
existed same time as *Australopithecus*, shares many of same traits
large increase in relative brain size
more delicately built
tooth size decreased as brain size increased
→ largely vegetarian diet to more carnivorous
females ~ 1/2 as large as males
→ males probably had harems as do apes
genetic evidence indicates ancestral "fur" was shed; we became "naked apes"
was a tool user

Homo erectus (eg. Peking Man) [1.8 MY – 30,000 yrs ago]

distinctly different from *Australopithecus* → much more similar to us:
skeleton similar to ours
close to our size, ~5' tall, ~100 lbs;
males and females similar sizes
similar stride → more efficient than *Australopithecus*
wider ranging than *Australopithecus* → first hominids to migrate out of Africa
show dramatic increase in brain size → brain case (700-1100cc) → like us
their skull is thick and massive, large jaws and teeth, no chin
were hunters: plenty of game, more grasslands then, killed elephants, rhinos,
antelopes, bears, hippos and giant babboons
used simple stone implements
sometimes stampeded game into marshes or over cliffs
1st ancestor to tame fire; all before "ran from it"
probably had limited speech ability; fossil evidence suggests that areas of the brain
responsible for language existed over 500,000 years ago

Homo floresiensis (the "Hobbit") [95,000 - 13,000]

recently discovered in a cave on a remote island in Indonesia
lived with pygmy elephants & Komodo dragons
upright, bipedal, large feet!
~ 3.3' tall, weighed ~55 lbs
longer arms than modern humans, big feet
small brained
used fire and made tools
hunted large game → required communication and planning
may have evolved directly from *H. erectus*
modern humans didn't reach the island until ~11,000 years ago so we don't think the
hobbits interacted with modern humans

Homo neanderthalensis (Neanderthal Man) [600,000 – 30,000]

mainly in Europe and near east; earliest fossils from England and Germany
more heavily built, very strong
protruding face, low skull, heavy brow
brain capacity slightly larger than us
used tools,
cared for invalids
buried their dead with weapons, food & flowers → belief in afterlife, had language;
communication and culture became more important

72,000 – 42,000 yrs ago: humans began wearing clothing

***Homo sapiens* (Cro Magnons, Modern Humans) [150,000 – present]**

H. erectus, *H. floresiensis*, *H. neanderthalensis* & *H. sapiens* and possibly 1 or 2 more species coexisted for 1000's of years

H. erectus & neanderthals disappeared abruptly about 34,000 yrs ago,

H. floresiensis disappeared ~13,000 yrs ago

physically indistinguishable from us

less massively built than Neanderthals

made far better tools: knives, awls, chisels, engravers, spears, harpoons, fishhooks, needles, etc

cave paintings → more developed intellect, abstract thought, more cooperation

Demonstrations:

- Various illustrations of mammalian diversity
- Mammalian anatomy.
- Internal anatomy of the cat

Disposal:

Do not discard the fetal pigs, return them to the bucket

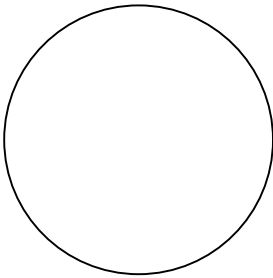
Name: _____

Due Date: _____

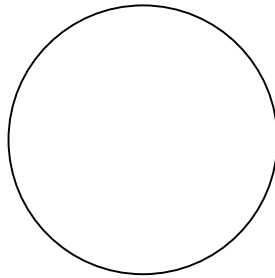
Lab Report for Practical #4: Echinoderms to Chordates

I. Echinoderms

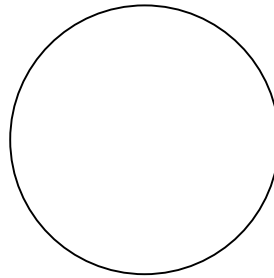
1. Sketch the following echinoderm structures:



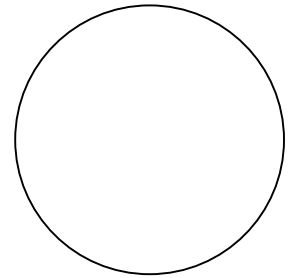
madreporite



dermal branchiae



pedicellariae



bipinnaria

Magnification: _____ Magnification: _____ Magnification: _____ Magnification: _____

2. Describe the following echinoderm structures:

digestive gland

ambulacral groove

bursal sacs

ossicles

test

3. Describe the differences in structure and function of the **tube feet** in each of the classes of Echinoderms that you observed in the lab.

II. Chaetognatha & Hemichordata

4. Sketch an arrow-worm from the plankton samples and label appropriately.

5. What Hemichordate characteristics are shared by chordates?

III. Chordates

6. What is the **major anatomical difference** in the nervous and circulatory systems of Chordates compared to all the major invertebrate phyla we have previously studied.

7. Distinguish between **gill slits** and **gill arches**.

8. Define or describe the following chordate structures:

atrium

notochord

myomeres

cloaca

spiracle

9. Compare and contrast the distinctive features of each of the 3 fish groups; agnatha, chondrichthyes & osteichthyes.

10. Describe the habitat and lifestyle of 5 of the preserved fish based on their shape.

11. How, specifically does the structure of the **skin** differ in the major classes of vertebrates?

12. Make a table with 2 columns that list all the **internal organs** that you actually located in your dissections of the shark, perch, frog, necturus, turtle, snake, pigeon and fetal pig; a. that were found in every specimen, b. that were only found in one of the specimens.

13. List as many specific ways and you can think of in which the anatomy of a bird is adapted to flight.
14. How do mammal teeth differ from teeth in the other classes of Vertebrates?
15. Sketch and label the heart of a shark and the heart of the fetal pig.
16. The waxy protein **keratin** is an important structural component in the skin of reptiles, birds and mammals. List as many structures made mainly of keratin as you can think of in each of the three classes:
- Reptiles:**
- Birds:**
- Mammals:**
17. Label, diagram and describe the various fur samples and examples of modified fur specimens.
(continue on the next page)

17. How does the overall structure of the brain differ in the major groups of mammals? Which parts of the brain changed the most and how does that affect the behaviors and activities of each group?