Animal Contributions to Human Health

Fat Dogs and Coughing Horses
High School Curriculum
Grade 9

PURDUE UNIVERSITY

SEPA SCIENCE EDUCATION PARTNERSHIP AWARD
Supported by the National Institutes of Health

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The project described is supported by a Science Education Partnership Award (SEPA) from the Office of Research Infrastructure Programs (ORIP), a component of the National Institutes of Health (NIH).

NIH . . . *Turning Discovery Into Health*

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Curriculum Overview

Fat Dogs and Coughing Horses
9th Grade Science Curriculum

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Brief Summary of Unit

This unit provides a new and exciting way to teach standard concepts within the discipline of biology using veterinary science as the context. The scientific method, the use of compound and dissecting microscopes, animal diversity, life cycles, cells, biochemistry, and the social implications of the biological sciences are just a few of the concepts covered within the scope of this instructional unit. People of all ages have firsthand (sometimes painful) knowledge of pets, family members, or themselves being sick, having to take medications, or needing to undergo medical procedures. This common ground provides a starting point for launching into complex discussions about the similarities between humans and other animals as well as how advances in medical care positively impact both people and their animals. Using a real-world, practical application approach increases both the relevancy of the concepts and students' interest in engaging with the material.

Goals

The goals of this project are to teach 9th grade biology students the role animals play in keeping people healthy by:

1. Helping students understand that all organisms-humans and other animals such as dogs and horses - are made of the same "stuff" (cells, macromolecules, and molecules).

2. Due to the relatedness of all life, pharmaceuticals produced for humans can be tested on non-human animals, and medical procedures perfected in non-human animals can then be applied to humans. The results of this testing are healthier pets, livestock, and humans.

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Academic Standards

Common Core Standards

Reading Standards for Literacy in Science

9-10.RS.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text

9-10.RS.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific context relevant to grades 9-10 texts and topics.

9-10.RS.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific problem.

Indiana Academic Standards

9th Grade Health and Wellness Standards

HW.1.1 Document how personal behaviors can impact health.

HW.1.2 Explain the interrelationships of emotional, social and physical health.

HW.1.5 Formulate ways to prevent or reduce the risk of health problems.

HW.1.7 Summarize the benefits and barriers to practicing healthy behaviors.

HW.7.2 Examine individual responsibility for improving health.

HW.7.3 Illustrate a variety of healthy practices that will maintain or improve health.

9th Grade Biology Standards

B.1.1 Recognize that and explain how the many cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions. Understand that different parts of the genetic instructions are used in different types of cells and are influenced by the cell's environment and past history.

B.1.2 Explain that every cell is covered by a membrane that controls what can enter and leave the cell. Recognize that in all but quite primitive cells, a complex network of proteins provides organization and shape. In addition, understand that flagella and/or cilia may allow some Protista, some Monera, and some animal cells to move.

B.1.3 Know and describe that within the cell are specialized parts for the transport of materials, energy capture and release, protein building, waste disposal, information feedback, and movement. In addition to these basic cellular functions common to all cells, understand that most cells in multicellular organisms perform some special functions that others do not.

Academic Standards (continued)

B.1.4 Understand and describe that the work of the cell is carried out by the many different types of molecules it assembles, such as proteins, lipids, carbohydrates, and nucleic acids.

B.1.6 Show that a living cell is composed mainly of a small number of chemical elements carbon, hydrogen, nitrogen, oxygen, phosphorous, and sulfur. Recognize that carbon can join to other carbon atoms in chains and rings to form large and complex molecules.

B.1.8 Understand and describe that all growth and development is a consequence of an increase in cell number, cell size, and/or cell products. Explain that cellular differentiation results from gene expression and/or environmental influence. Differentiate between mitosis and meiosis.

B.1.15 Understand and explain that, in biological systems, structure and function must be considered together.

B.1.17 Understand that and describe how the maintenance of a relatively stable internal environment is required for the continuation of life and explain how stability is challenged by changing physical, chemical, and environmental conditions, as well as the presence of disease agents.

B.1.20 Recognize that and describe how the human immune system is designed to protect against microscopic organisms and foreign substances that enter from outside the body and against some cancer cells that arise within.

The Scientific Method

Overview

The students will use the scientific method to work through an unknown disease/problem with a dog just as veterinarians and doctors do on a daily basis. If time permits, students will use various resources to create their own veterinary emergency scenarios in small groups, trade, and then use the scientific method to generate a hypothesis as to the cause as well as determine the type of experiment they would need to conduct to be sure they are correct.

Objectives

- The students will be introduced to the scientific method and how veterinarians use it to diagnose and treat animals.
- The students will understand the importance of generating hypotheses and conducting experiments, due to the fact that there are many ways to interpret data.

Materials

- Activity Sheet 1-2 Elephant Poem
- Computer, speakers, projector
- Video:" Buddy Visits the Veterinarian"
  Watch: http://www.vet.purdue.edu/engagement/sepa/buddysVetVisit.php
  Download: http://www.vet.purdue.edu/engagement/files/videos/buddy-visits-the-veterinarian.wmv
- Books or internet sites that describe common pet illnesses
- Paper and pencil
- Whiteboard, chalkboard, or chart paper

Procedure

1. Begin the lesson by asking students to think about a time they visited a veterinarian's office. Ask students to talk to someone next to them about why they took their pet to see the veterinarian and what the experience was like.
2. Ask the students to raise their hands if they think a veterinarian is a scientist. Give students an opportunity to share why or why not.

3. As a class, list the characteristics of a scientist. Guide the conversation towards the fact that scientists use a specific method to answer questions known as the scientific method.
4. List the steps in the scientific method on the board:
    a. Identify a problem
    b. Generate a hypothesis
    c. Conduct an experiment
    d. Observe the results
    e. Come to a conclusion
5. Show the video “Buddy Visits the Veterinarian”.
6. After the video, ask the following questions:
    a. *What is the problem/question at hand?*
    b. *What do we know?* (Take the time now to read the Elephant Poem - Activity 1-2)
    c. *What is our hypothesis?* (Have the class collaborate on what they feel is the most plausible explanation for Buddy’s ailments.)
    d. *What tools did the veterinarian use in his experiment?*
    e. *Was our hypothesis correct?*
7. Give students an opportunity to ask questions, being careful to address any misconceptions that might come up.

Extension Activity

If time permits, give the students time to work with a partner to create their own scenario similar to Buddy’s situation. Make sure to discuss what illness or condition the animal will have and what signs it will display. Provide access to books or the internet as sources of possible animal illnesses. Write down the scenario and then trade with another group. Next, ask each group to work through the first three steps in the scientific method using the new scenario. Allow students to use the same resources to scan for a possible diagnosis and determine how they could conduct an experiment to make sure they are correct. Once a hypothesis has been created, meet with the writers of the scenario to see if it was correct.

The Blind Men And The Elephant

by John Godfrey Saxe (1816-1887)

It was six men of Indostan to learning much inclined
Who went to see the Elephant (though all of them were blind),
That each by observation might satisfy his mind.

The first approached the Elephant, and happening to fall
Against his broad and sturdy side, at once began to bawl:
"God bless me! but the Elephant is very like a wall!"

The second, feeling of the tusk, cried, "Ho! What have we here
So very round and smooth and sharp? To me 'tis mighty clear,
This wonder of an Elephant is very much a spear!"

The third approached the animal and happening to take
The squirming trunk within his hands thus boldly up and spake:
"I see," quoth he, "the Elephant is very like a snake."

The fourth reached out an eager hand and felt about the knee,
"What most this wondrous beast is like is very like a tree,"

The fifth, who chanced to touch the ear said:
"E'n the blindest man can tell what this resembles most;
Deny the fact who can,
This marvel of an Elephant is very like a fan!"

The sixth no sooner had begun about the beast to grope,
The seizing on the swinging tail that fell within his scope,
"I see, " quoth he, "the Elephant is very like a rope."

And so these men of Indostan disputed loud and long,
Each in his own opinion exceeding stiff and strong,
Though each was partly in the right, and all were in the wrong.

Scientific Method

The Blind Men and the Elephant

Directions:

After you have read The Blind Men and the Elephant poem, complete the following questions.

1. What type of object did each man believe the elephant represented?

First:_____

Second:_____

Third:_____

Fourth:_____

Fifth:_____

Sixth:_____

2. How does the poem illustrate the importance of observation in the scientific method?

3. What do you think the moral of the poem is?

4. Do hypotheses have to be correct 100% of the time? YES or NO (Circle one)

Explain the answer.

The Compound Microscope

Overview

Many people use microscopes on a daily basis. Lab technicians, doctors, and veterinarians use them to diagnose diseases in people and in animals. Even though microscopes have been around for years, it is still one of the best "windows" into the world of disease.

There are many different types of microscopes. The compound light microscope is the most common instrument used today. It contains two lenses and a variety of knobs to resolve (focus) the picture. It is a rather simple piece of equipment to understand and use. In this lab, students will learn the proper use and handling of the compound microscope.

Objectives

- The students will demonstrate the proper procedures used in the operation of the compound light microscope.
- The students will prepare and use a wet mount.
- The students will determine the total magnification of the microscope.
- The students will develop a checklist to ensure proper handling of the microscope.
- The students will understand the importance of microscopes as a diagnostic tool in many careers.

Materials

- Activity 2-1: Compound Microscope Lab Instructions
- Compound microscope
- Glass slides
- Cover slips
- Eye dropper
- Beaker of water
- The letter "e" (cut from newspaper)
- Scissors
- Images of a dog cheek cell smear, dog blood smear, horse cheek cell smear, and horse blood smear at www.vet.purdue.edu/engagement/sepa/teacherSupplies.php
- Tick, ear mite, and pet/horse hair samples
- Plant cells
- Human blood smear

Procedure

1. Ask the students to raise their hands if they have ever used a microscope. Give students who have used a microscope the opportunity to share what they examined.
2. Explain to students that microscopes are used in many professions each day. Generate a list of careers that involve using microscopes together as a class.
3. Discuss the fact that “Micro” means **tiny** and “scope” means to **view or look at**. Does the meaning of the word fit the purpose of the tool?
4. Introduce the Microscope Mania lab and give each student or group a copy of the lab instructions (Activity 2-1).
5. Follow the procedures on the lab sheet to complete this lesson.
6. Wrap up the lesson by taking questions and asking students to write down the answer to the following question: “If you were in charge of teaching someone else to use a compound microscope, what would be the top three points you would want to share with them?”

Extension Activity

Ask students to write down on a piece of paper the year they think the compound microscope was invented. Ask students to share their guesses. Reveal that the correct answer is 1590. Next, ask students to research one of more of the following early innovators of the microscope using the internet or science books: Zaccharias Janssen, Antony van Leewenhoek, or Robert Hooke. Give students an opportunity to share what they learn about their particular person.

Microscope Mania

Introduction

Many people use microscopes daily. Lab technicians, doctors, and veterinarians use them to diagnose diseases in people and in animals. Even though it has been around for years, the microscope is still one of the best "windows" into the world of disease.

"Micro" means tiny, "scope" means to view or look at. There are many different types of microscopes. The compound light microscope is the most common instrument used today. It contains two lenses, which magnify, and a variety of knobs to resolve (focus) the picture. It is a rather simple piece of equipment to understand and use. In this lab, we are going to learn the proper use and handling of the microscope.

Objectives

- Demonstrate the proper procedures used in correctly using the compound light microscope.
- Prepare and use a wet mount.
- Determine the total magnification of the microscope.
- Develop a checklist to ensure the proper handling of the microscope.
- Understand the importance of the microscope as an important diagnostic tool in many careers.

Materials

- Compound microscope
- Glass slides
- Cover slips
- Eye dropper
- Beaker of water
- The letter "e" (cut from newspaper)
- Scissors
- Prepared Slides

Drawing Specimens

1. Use pencil - you can erase and shade areas
2. All drawings should include clear and proper labels (and be large enough to view details). Drawings should be labeled with the specimen name and magnification.
3. Labels should be written on the outside of the circle. The circle indicates the viewing field as seen through the eyepiece, specimens should be drawn to scale - ie..if your specimen takes up the whole viewing field, make sure your drawing reflects that.

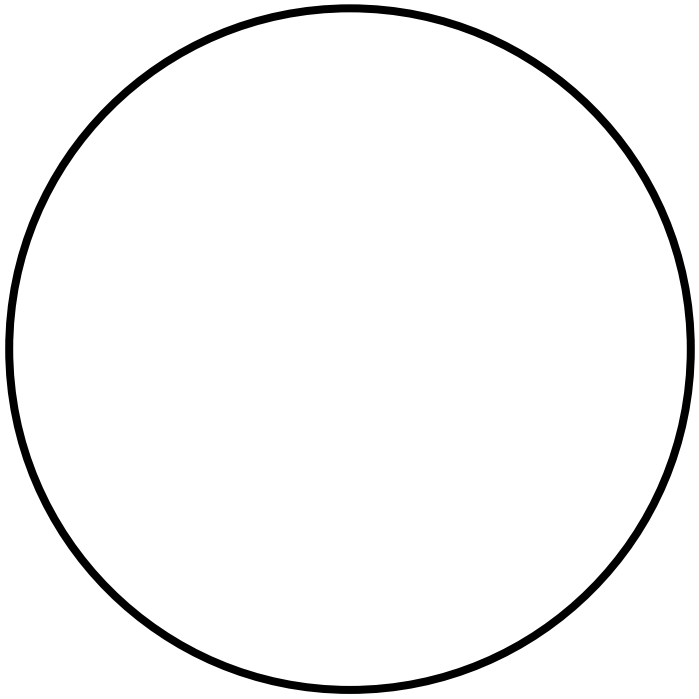
Procedures

I. Proper Handling of the Microscope

1. **Carry the microscope with both hands** - one on the arm and the other under the base of the microscope.
2. One person from each group will now go over to the microscope storage area and properly **transport one microscope to your working area**.
3. The other person in the group will **pick up a pair of scissors, newsprint, a slide, a cover slip and a toothpick**.
4. **Remove the dust cover** and store it properly. Plug in the scope. Do not turn it on until told to do so.

II. Microscope Usage "101"

1. With your scissors cut out the letter "e" from the newsprint.
2. Place it on the glass slide so as to look like (e).
3. Cover it with a clean cover slip. See the figure below:
4. Turn on the microscope and place the slide on the stage; making sure the "e" is facing the normal reading position (see the figure above). Using the course focus and low power, move the body tube down until the "e" can be seen clearly.
5. Draw what you see in the circle:



6. Describe the relationship between what you see through the eyepiece and what you see on the stage.

7. Offer an explanation of why this happened.

8. Look through the eyepiece, move the slide to the right. **What direction does the image move?**

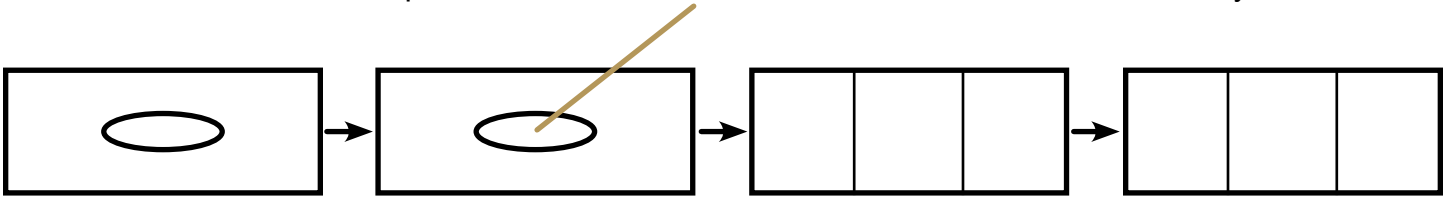
9. Now, move it to the lower left side of the stage. **What direction does the image move?**

10. Re-center the slide and change the scope to high power. You will notice the "e" is out of focus. **Do Not** touch the coarse focus knob, instead use the fine focus to resolve the picture. How does changing the magnification change what you see (once it is focus.)?

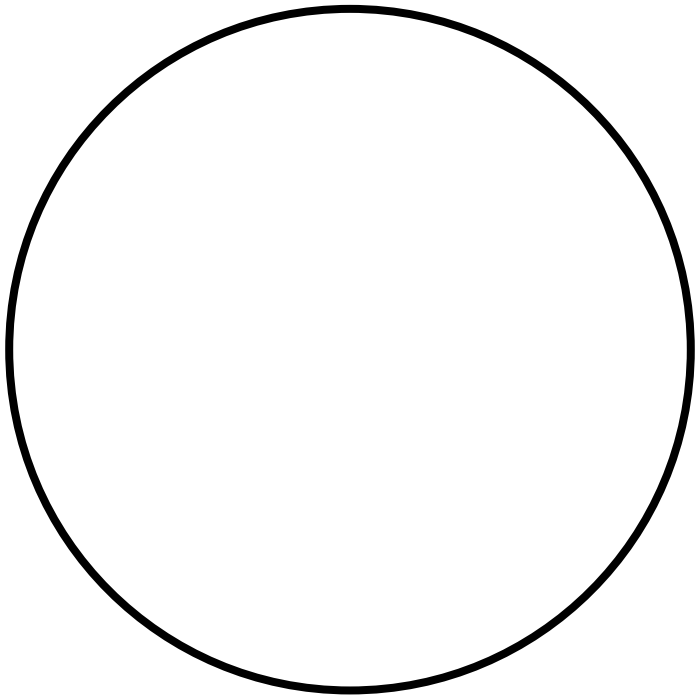
11. **Locate the diaphragm under the stage.** Move it and write down what happens to what you see.

III. Preparing a wet mount slide "101"

1. Throw away the letter e. Get a toothpick.
2. Have one person scrape the inside of their cheek with the toothpick. The other person should put one small drop of water on the slide.
3. Rub the toothpick in the water to allow the check cells to come off onto the slide.
4. Put a cover slip over the mixture.
5. Put a drop of blue dye at the corner of the cover slip and a piece of paper towel at the other side of the cover slip. This will "wick" the blue stain across the slide and stain your cells.

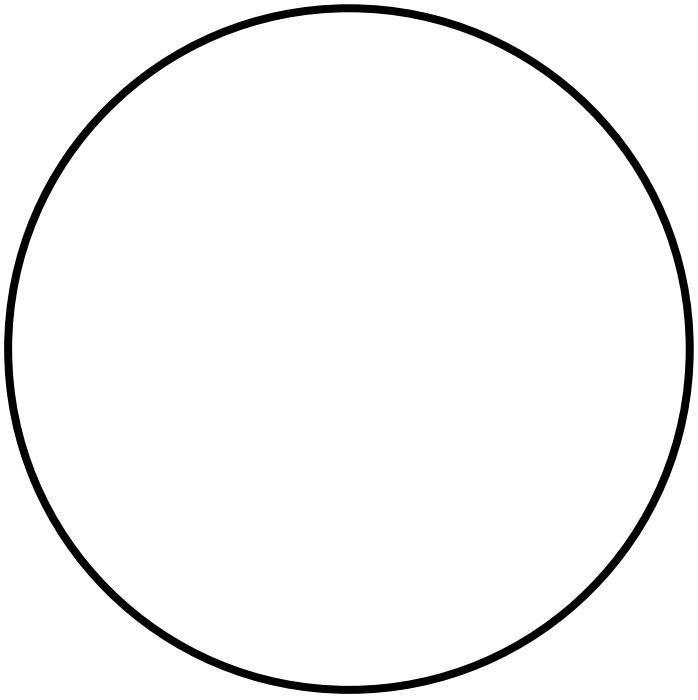


6. Draw what you see using the proper colors and **label the cell membrane, nucleus and cytoplasm.**

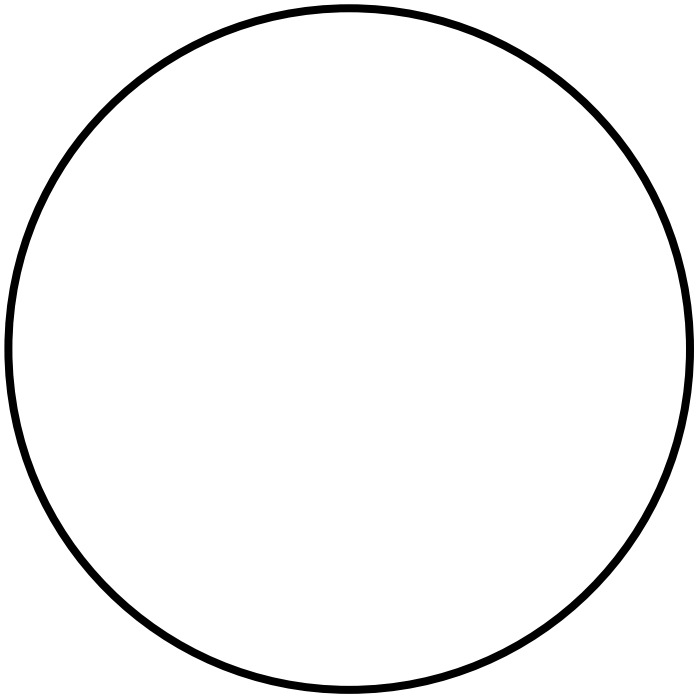


7. Get the prepared epithelial slide from *Canis lupis familiaris* (your pet dog) and *Equus caballus* (horse). Look at them under high power.

***Canis lupis familiaris* (your pet dog)**



***Equus caballus* (horse)**

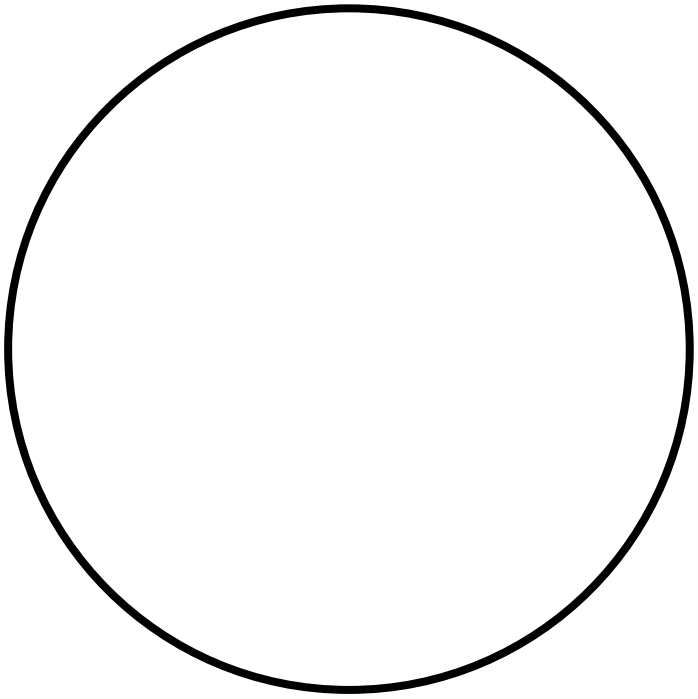


How do these compare to our the human slide?

IV. Plant Cells

1. With the forceps, peel off a very thin piece of skin from the inner, concave side on an onion section. (It should look like Plastic Wrap.)
2. Place this small piece of onion skin on the microscope slide and add one or two drops of iodine. If the onion skin is wrinkled or overlapped, use a toothpick to straighten it. Carefully place a cover slip over the onion skin.
3. Place the slide on the stage of the microscope and examine the onion skin under low power. Once you have found the onion cells under low power, switch to the medium power objective. Draw what you see below:

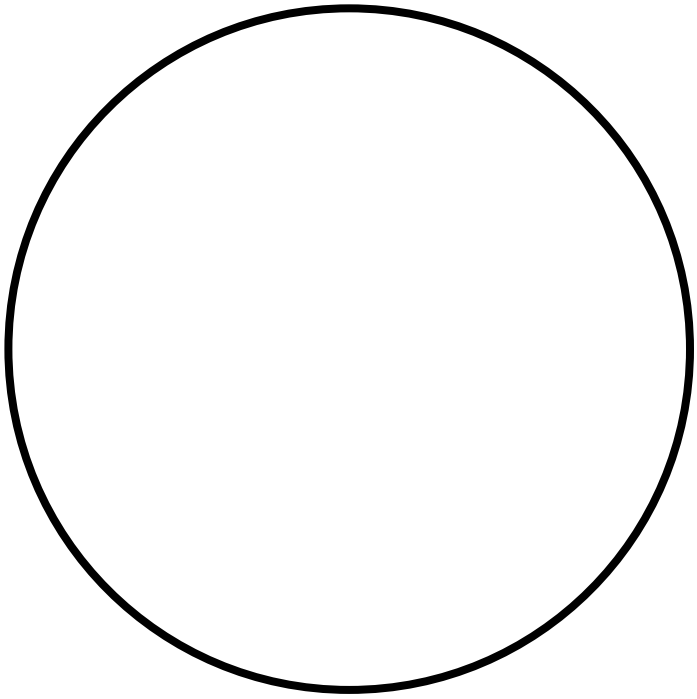
Medium Power



Onion Cell Medium Power

Magnification = _____

Switch to the highest objective and **draw** what you see and **label the cell wall, cytoplasm and nucleus.**



Onion Cell High Power

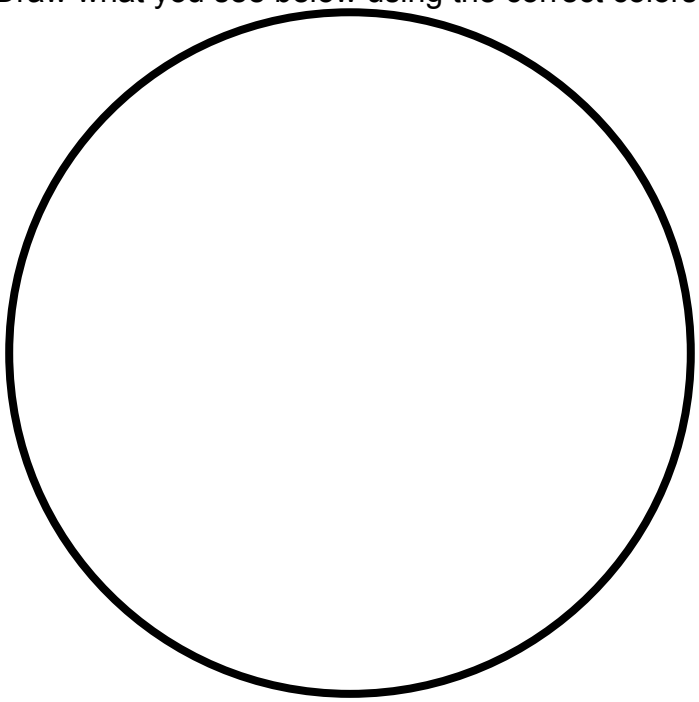
Magnification = _____

Describe what the onion cells looked like. Be descriptive.

V. Edolea of Leaf Slide

1. Obtain a sprig of the aquarium plant known as Elodea. Pull off a small leaflet and place the upper surface of the leaf down on a clean microscope slide. Flatten it out with the forceps.
2. Place a coverslip on top of the specimen.
3. Examine the cells under low power first, then Look at it under high power. Usually, in these cells, the nucleus is pretty hard to see due to the high number of chloroplasts. After studying the cells, **draw what you see** in your field of view below and **label the cell wall, cytoplasm and chloroplast in ONE OF THESE CELLS!**

Draw what you see below using the correct colors.



VI. Determining Total Magnification

1. Locate the numbers inscribed on the eyepiece and the low power objective and fill in the blanks below.

Eyepiece magification		Objective magification		Total magification
_____	X	_____	=	_____X

2. Do the same for the high power objective.

Eyepiece magification		Objective magification		Total magification
_____	X	_____	=	_____X

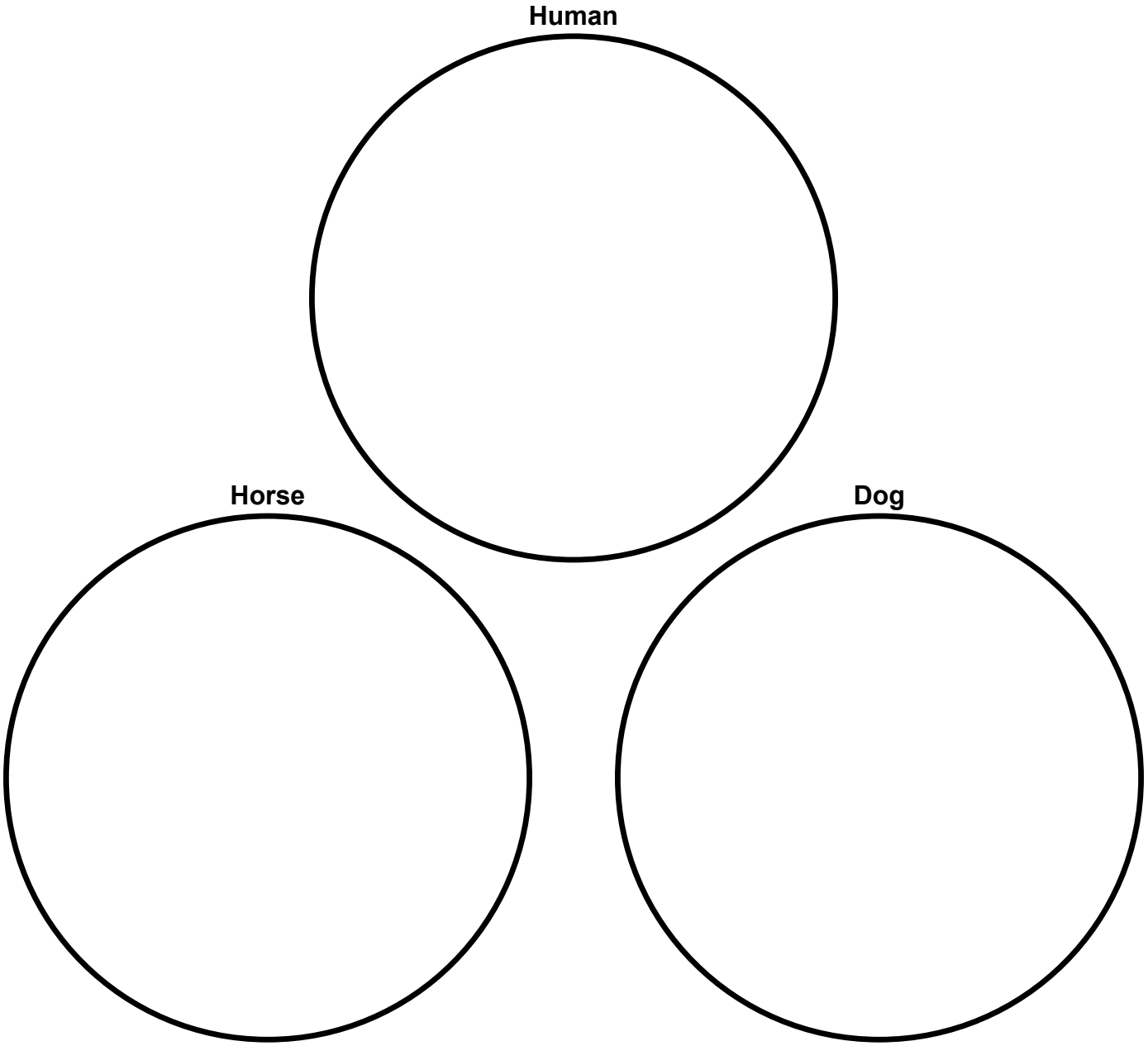
3. Write out the **rule for determining total magnification of a compound microscope.**

4. Remove the slide and rinse it off. Put it back with the other slides. The cover slip can be thrown away along with the toothpick.

VII. What a Veterinarian Might See

Blood

1. Obtain blood smears from the human, dog and horse. Look at each one individually and draw what you see in the correct circle. It is pink so make sure you get it focused on the proper thing. Eventually get it focused under high power. Draw what it looks like, using the correct colors, below.



2. How are they the same?

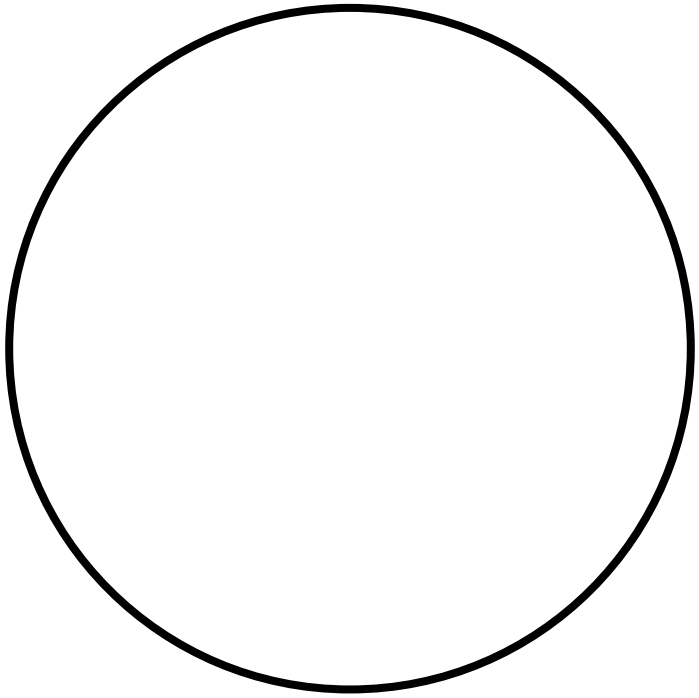
3. Do you see any differences?_____ (If yes, explain.)

4. What is the total magnification of this under high power?

5. Make a hypothesis as to what the red circles are that you drew.

Deer Tick

Draw a rough sketch of the tick



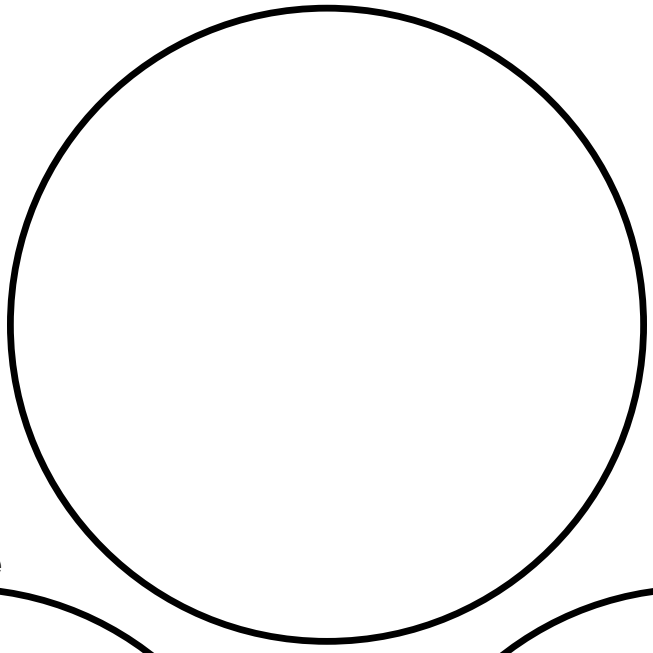
1. Why do ticks live on dogs?

2. What disease do ticks carry?

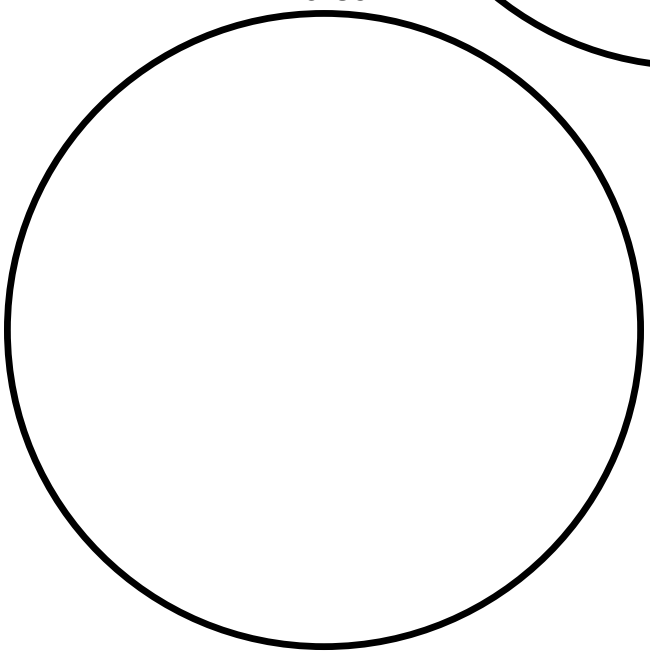
Ear Mites: A local veterinarian prepared this slide. Look at it under low power. What animal do you think these were found in?

Hairs: Gently pull out one of your hairs. Put it on the slide and put the small cover slip over it. Look at it under the microscope. Get a sample of dog hair. Look at it under the microscope. Draw what you see:

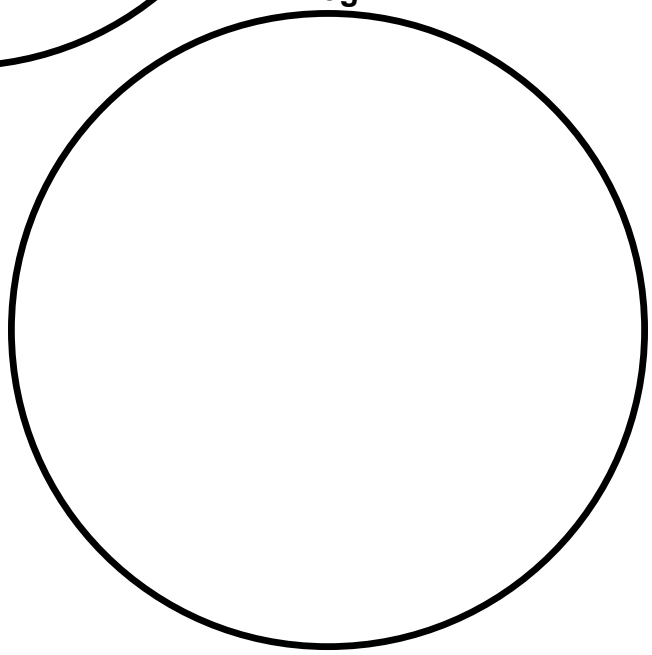
Human



Horse



Dog



1. How are these the same microscopically?

2. How are they different microscopically?

Freshwater Invertebrate Lab

Overview

A second tool that is useful in both veterinary medicine and human medicine is the dissecting microscope. The dissecting microscope doesn't have the magnification power of a compound microscope, but it can be used to study organisms that are macroscopic, yet still too small to see with the unaided eye. In this lesson we will help students learn to use a dissecting microscope by searching for tiny freshwater invertebrates in samples of pond water.

NOTE: In addition to the materials listed in the student lab entitled "Hunting for Freshwater Invertebrates", you will need to collect a couple of plastic buckets for pond water. It is best to collect water from a quiet swamp that is covered with an abundant growth of duckweed and full of luxuriant aquatic plants. Early fall or spring would be the best time to do this activity. Also listed in the materials section of the student lab is an item known as a foam-well slide. These slides will need to be constructed before the students do the lab. For instructions on how to make the foam-well slides refer to the following website:
http://www.eeob.iastate.edu/faculty/DrewesC/htdocs/toolbox-IV.htm

Objectives

- The students will demonstrate the proper procedures for correctly using the dissecting microscope.
- The students will prepare and observe a petri dish of pond water using the dissecting microscope.
- The students will identify common pond water micro invertebrates that are related to invertebrates that can cause diseases in humans and other non-human animals.

Materials

- Dissecting microscopes
- Glass petri dishes
- Plastic pipets
- Foam-well slides (see the note in the overview section above)
- Coverslips
- Pond water (see the note in the overview section above)
- Turkey baster
- Computer with internet access
- Projector
- PowerPoint presentation "Fresh Water Invertebrates"
  http://www.vet.purdue.edu/engagement/files/documents/sepa/Freshwater Invertebrates.pdf

- Activity Sheet 3-1: Some Freshwater Invertebrates You Might Find
- Activity Sheet 3-2: Lab Instructions
- Pour Person's Plankton Net: www.eeob.iastate.edu/faculty/DrewesC/htdocs/toolbox-II.htm

Procedure

1. Ask the students to review what we have learned so far about the scientific method and using compound microscopes.
2. Show the students a dissecting microscope and ask them to tell you how it is different from a compound microscope.
3. Explain that the dissecting scope is not as powerful as a compound microscope, but it is still very useful. Why might veterinarians want to use a less powerful tool?
4. Hand out the lesson notes entitled "Some Freshwater Invertebrates You Might Find" (Activity 3-1).
5. Explain that they will learn to use a dissecting microscope today by taking a safari through pond water to discover the secret lives of tiny creatures most people do not even know exist.
6. As a preview to the pond water lab activity, go through the PowerPoint presentation entitled "Fresh Water Invertebrates" with the students. It may be helpful to make an overhead transparency of each page of the lesson notes entitled "Some Freshwater Invertebrates You Might Find". You could then use a two-screen presentation, helping the students fill out the lesson notes on the overhead projector on one screen while showing the PowerPoint presentation on the second screen. This presentation is designed not to teach students everything there is to know about freshwater invertebrates, but to familiarize them with some of the fascinating tiny creatures that they will encounter in the lab. They will be amazed at what they will discover, and at the same time, they will master the use of the dissecting microscope.
7. Ask the students to follow the procedures listed on the lab entitled "Hunting for Freshwater Invertebrates" (Activity 3-2).
8. Take questions and give students a chance to share what they found with students sitting near them.
9. As a class, take a look at the online instructions for how to construct a "Pour Person's Plankton Net" at: www.eeob.iastate.edu/faculty/DrewesC/htdocs/toolbox-II.htm. Discuss why this might be useful.
10. End the lesson by asking students to complete the following analogy: compound microscopes are to _____as dissecting microscopes are to _____.

Extension Activity

Create a "how-to" book, webinar, or flow chart that explains how to use a dissecting microscope. Share your final product with a partner and ask them to check to see if any steps were accidently left out.

Some Freshwater Invertebrates You Might Find

I. Flatworms (_____)

II. Roundworms (_____)

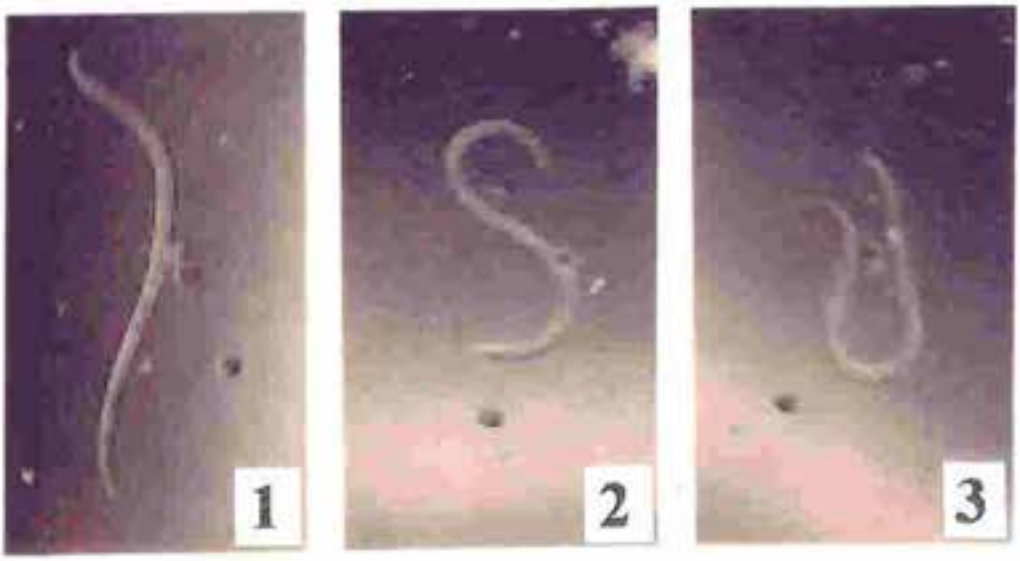


Image from Dr. Charlie Drewes

III. Leeches (_____)

IV. Lumbriculus (_____)

V. Clams (_____)

VI. Rotifers (_____)

VII. Ostracods (_____)

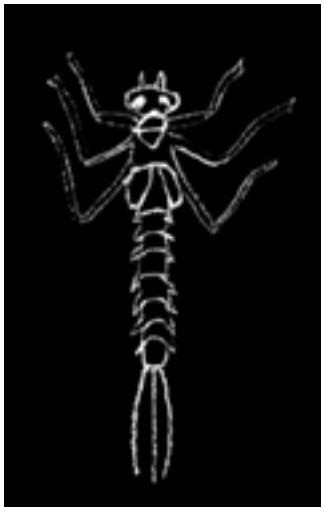
VIII. Copepods (_____)

IX. Scuds (_____)

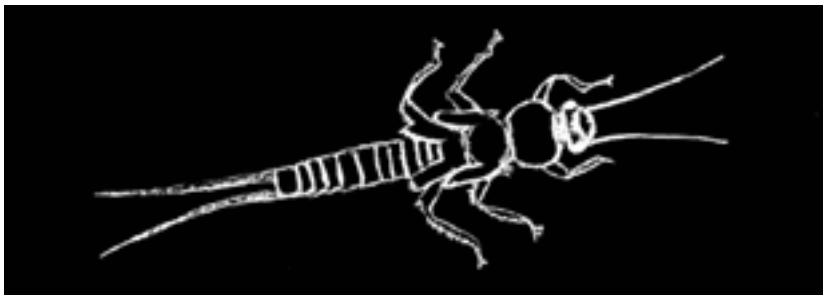
X. Daphnia (_____)

XI. Watermites (_____)

XII. Mayfly Nymphs (young) (_____)



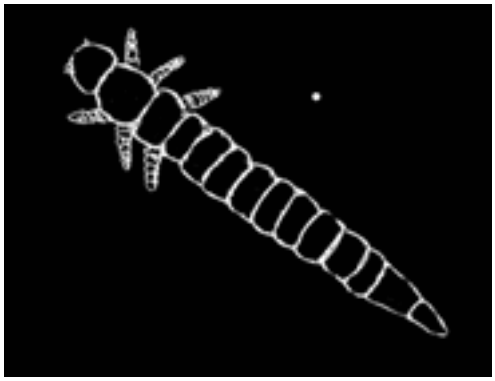
XIII. Stonefly Nymphs (young) (_____)



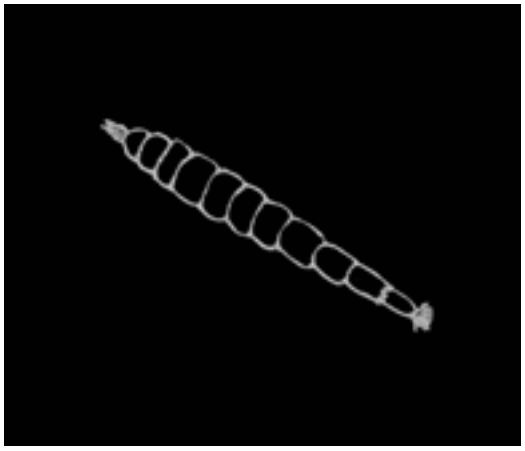
XIV. Dragonfly Nymphs (young) (_____)

XV. Cassidfly Larve (young) (_____)

XVI. Bettle Larvae (young) (_____)



XVII. Fly Larvae (young) (_____)



Hunting for Freshwater Invertebrates Lab

Introduction

Invertebrates are animals that do not have a backbone. Since we humans are vertebrates, we tend to pay more attention to the vertebrates of the world (humans, cats, dogs, cows, birds, etc.). In reality, more than 95% of all the species of animals on this planet are invertebrates! Invertebrates are fascinating organisms because they are so different from us in many ways, yet similar to us in some ways. In this lab you will take a safari through some pond water and identify some of the freshwater invertebrates living in it. Freshwater invertebrates are important because they make up some of the initial steps in many food chains.

Materials

- 1 binocular dissecting microscope with light source
- 1 glass Petri dish
- 1 plastic pipet
- 1 foam-well microscope slide
- 1 coverslip
- A source of pond water
- Turkey baster

Instructions

1. Using the turkey baster, place a small amount of pond water in a Petri dish.
2. Place this Petri dish under a binocular dissecting microscope and scan the Petri dish for tiny freshwater invertebrates. If you find an interesting specimen that's swimming too fast, suck the organism up in a plastic pipette and squirt it into a foam-well slide. Place a coverslip over the specimen and view it under the dissecting microscope.
3. Select four different kinds of invertebrates and carefully draw them in the spaces on the next page.
4. Using the identification materials in the lab, identify each of the four organisms that you draw. Under each specimen drawing, label it with its name.

Organisms you might find

Hydra, flatworms, roundworms, segmented worms such as lumbriculus (mud worms), segmented worms such as leeches, clams, bryozoans, rotifers, ostracods, copepods, scuds, daphnia, mites, insect larvae or nymphs.

Organism #1

Organism #2

Organism #3

Organism #4

Tiny Invertebrates That Can Make Our Animals (and US) Sick

Overview

In the last lesson students were introduced to various harmless invertebrate organisms. Today they will be introduced to small organisms that are not so benign and can make both animals and people sick and/or uncomfortable.

Objectives

- The students will examine harmful invertebrate organisms using microscopes and compare them with their non-harmful relatives.
- The students will research the life-cycle of a harmful invertebrate organism and create a poster to share with the class.

Materials

- Compound microscopes
- Preserved samples of a tapeworm
- Preserved sample of an Ascaris roundworm
- Preserved sample of heartworms
- Prepared slides of mites
- Prepared slides of deer ticks
- Nemata Collection. Burlington, NC: Carolina Biological Supply Company.
- Poster board or chart paper
- Markers
- Computer with internet access

Procedure

1. Prior to the lab, set up various stations with worm samples, prepared slides, and microscopes.
2. When students arrive, ask them to raise their hands if they have had a dog or cat that needed to be treated for fleas, ear mites, or heartworm. Ask students how they knew something was initially wrong with their animal and what treatments were eventually given to help their pet.
3. Explain that you have set up stations around the room with slides showing cross sections of a tapeworm, Ascaris roundworm, and heartworm as well as slides of mites and deer ticks. Their job is to examine each slide or sample and decide which of the organisms shown on the handout from Activity 3-1 these more harmful relatives are related to.

4. After the students have had the chance to examine the organism at each station, give the students an opportunity to share their answers and why they chose that particular relative.
5. Next, divide students into groups and assign each group a specimen from today's learning stations. Other organisms students could research include any roundworms found in animals, Dirofilaria immitis (heartworms found in dogs), whipworms, etc.
6. Each group is to research the life cycle of their organism using the internet and then create a poster illustrating it. The poster should include a title (which includes the name of the invertebrate), a picture of the life cycle, plus text to describe the life cycle as well as which types of organisms it can infect. Other product options for students could include the creation of a PowerPoint, Prezi, or 3-D model.
7. Ask each group to explain their organism's life cycle using the poster they created to the class.
8. Following the presentations, hold a discussion focusing on the following questions:
    a. What did each life cycle have in common?
    b. Which organisms cause disease directly?
    c. Which organisms transmit (rather than cause) disease?
    d. How can infection by each organism be prevented?
    e. If infection does occur, how can the animal be treated or cured?
9. End the lesson by taking questions and asking students to finish this statement: "If I were a flea, tick, or mite trying to avoid being removed from my animal host, I would….."

Extension Activity

Small harmful invertebrates have been a problem for humans in the past as well. Brainstorm a list of disease-causing invertebrates humans must deal with (e.g. mosquitoes, hook worms, bedbugs, and botfly). Create a wanted poster for your favorite invertebrate, listing where they are commonly found, and how to avoid contact with them.

Deer Ticks: Tiny Invertebrates that Transmit Lyme Disease!

Overview

Students will learn about a particular disease known as Lyme disease, which is transmitted by the deer tick. Lyme disease is caused by a bacterium called *Borrelia burgdorferi.* It is known as a spirochete because of its long, corkscrew shape. In this lesson, students will carry out a simulated enzyme-linked immunosorbent assay test (ELISA) on simulated patient blood, looking for antibodies associated with Lyme disease.

Objectives

- The students will learn the proper procedures for conducting an ELISA test.
- The students will come to the conclusion that the same blood test will work to detect Lyme disease in animals and humans due to the fact that both are made of the same basic materials.

Materials

- Deer tick / Lyme disease student poster from Lesson 4
- ELISA Simulation Kit (Lyme Disease scenario, page P-2)
- ELISA Simulation Student Guide (page S-1, comes with the Carolina Biological Supply Kit)

Procedure

1. Begin the lesson by asking students to talk to someone nearby for two minutes about what was covered in the last lesson.
2. Pull out the poster produced by the group that researched the deer tick/Lyme disease during lesson 4. (Before using it, make sure the information is accurate). Review the lifecycle of the deer tick together.
3. Explain to students that both veterinarians and human doctors need to draw a blood sample from the patient to test for exposure to certain suspected disease-causing organisms. Ask the students to raise their hands if they have had blood drawn in the past?
4. Ask the following question: “When that blood sample goes to the laboratory, what kinds of tests are conducted?” Tell the students that today they will learn about one particular test that can be performed to check for Lyme disease infection.
5. Using the ELISA Simulation Kit and the student directions contained within, work through the lab activity to test the blood samples of several “patients” for Lyme disease.

6. When finished, debrief with students about what they learned. Pose the following questions:
    a. Do you think this same blood test (ELISA test) would detect Lyme disease antibodies in non-human animals such as deer or cows? (The answer is yes)
    b. Why would this same test work on humans as well as other animals? (Humans and other animals are made out of the same stuff! In the next lesson, we'll find out just what that means.)
7. Ask the students to work in groups of three to answer the questions in the student guide that came with the kit. Discuss the answers together.
8. Finish the lesson by asking the students to complete the following statement: "The most important thing to remember when conducting an ELISA test is…"

Extension Activity

Give students time to research other types of blood tests that doctors and veterinarians use in addition to the ELISA test. Compare and contrast these techniques using a Venn Diagram.

All Living Things are Made of the Same "Stuff"

Overview

In lesson two, students learned just how similar the cells of different (seemingly unrelated) organisms are when viewed through the microscope. In this lesson, students will explore this concept even further by examining cells at the organelle level. Organelles are the structures within a cell that allow it to function.

Objectives

- The students will compare and contrast a human skeleton to a dog skeleton.
- The students will be introduced to organelles and their various functions.
- The students will construct models of molecules in order to understand their basic structure.
- The students will research basic information about cancer and how it grows and multiplies.

Materials

- Activity 6-1: "Dear Fido"
- Activity 6-1: "Dear Fido" - Teacher Answer Key
- Dog anatomy computer simulation (www.vet.purdue.edu/engagement/sepa/anatomy.htm)
- Activity 6-2: How the Cell Works
- Activity 6-3: Building Models of Molecules
- Computer and projector
- PowerPoint entitled "Cell Organelles"
  (www.vet.purdue.edu/engagement/files/documents/sepa/animal-cell-organelles.pptx)
- Activity 6-4: What is Cancer?
- Activity 6-4: What is Cancer? - Teacher Notes
- Electron micrographs of fibroblast mitochondrion of humans, dogs and horses
- Computers with Internet access
- Several bags of multi-colored gumdrops
- Several boxes of toothpicks
- Small stickers or masking tape
- Dog skeleton (including a skull)
- Human skeleton (including a skull)
- Glue or glue gun
- Mounting board
- Reference materials for looking up labeled diagrams of human skeleton
- Colored pencils and/or crayons
- 2x2 poster board

Procedure

1. Ask the students to brainstorm with a partner a list of ways humans and other living organisms are the same. After several minutes, ask each group to share three items from their list.
2. Remind students that we learned in the last lesson that both humans and animals can catch Lyme disease. The same bacterium makes both animals and humans sick. Ask the students why this is possible? [*Because we and our animals are made of the same "stuff".*]
3. The cells of all living things contain the same miniature working parts called organelles. The kinship of all life on earth goes even deeper than that. The cells and organelles of all living things are made up of the same kinds of molecules. This can be very beneficial. Drugs and medicines produced for animals can be used on humans, allowing scientists to test potential new drugs on animals.
4. Explain to students that in this lesson we will look closely at the anatomy, cells, organelles, and molecules that make up not only humans, but our non-human animal companions. Hand out the "Dear Fido" activity (activity 6-1) to each student or group. In this activity students will be comparing dog and human skeletons.

   NOTE: Before this lesson, using small stickers or masking tape, label the following bones on the **dog** and **human** skeletons (do NOT include the names on the labels, just the letters or numbers):

Dog	Human
A = radius	1 = pelvis
B = humerus	2 = cranium
C = cranium	3 = patella
D = femur	4 = humerus
E = tibia	5 = ulna
F = pelvis	6 = scapula
G = fibula	7 = clavicle
H = ulna	8 = radius
I = patella	9 = femur
J = phalanges (forelimb)	10 = phalanges (hand)
K = scapula	11 = fibula
	12 = tibia

5. Introduce the activity by asking the students the following questions:
   a. Do you have a dog?
   b. How well do you know your dog inside and out?
   c. How well do you know yourself inside and out?

6. Give students time to complete the activity. (*The teacher answer key for Activity 6-1 is on page 47.*)
7. Ask students to share what they found interesting or what surprised them.
8. Distribute Activity 6-2 and instruct students to follow the directions to complete part one.
9. Debrief with students and check for understanding.
10. Once any misconceptions have been addressed, ask students to complete part two of Activity 6-2.
11. Ask for a volunteer from each small group to explain the functions of one organelle to the whole class. Continue until all organelles have been explained.
12. As a follow-up to the "How the Cell Works" activity, show the students the PowerPoint presentation entitled "Cell Organelles". Explain that this presentation shows electron micrographs of key organelles in the cells of dogs, horses and humans.

    Optional: You might want to incorporate a guessing game into the presentation. See if the students can guess which organisms the different photographs came from. They will soon discover that on the level of cells and organelles, it is very difficult to tell a dog from a horse to a human.
13. Explain to students that molecules are two or more atoms joined together to form the building blocks of life. For example, the organelles examined earlier in this lesson were made of molecules. Many times doctors and veterinarians must study specific molecules carefully. Ask the students to complete the "Building Models of Molecules" (Activity 6-3) lesson.
14. Hold up each poster displaying the model of a molecule and discuss why each molecule is important. Possible questions might include:
    a. Why is O_2 important?
    b. Where does O_2 come from?
    c. Where are possible sources of CO_2 found?
    d. Take a look at glucose. When plants manufacture glucose (photosynthesis) where do you think they get the carbon atoms that eventually end up in the glucose molecule?
    e. Why are amino acid molecules important?

       Optional: Use children's plastic linking blocks of various colors (to represent amino acids). Demonstrate how proteins are built by linking the building blocks together end-to-end.
    f. Why are protein molecules important?

       Note: Point out that the antibodies they learned about in the ELISA lab are actually protein molecules (long strings of amino acids). Remind the students that there are millions of different kinds of protein molecules in all living things on earth. These proteins are all made of different combinations of only 20 different kinds of amino acids.

15. Reiterate to students that because all living things are made of the same kinds of molecules, drugs and medicines produced for humans can be tested on animals.

    Note: Before proceeding, make sure students have a basic understanding of the cell cycle. A suggested resource for explaining the cell cycle is linked below: www.biology4kids.com/files/cell2_mitosis.html

16. As the students to raise their hands if they know someone who has had cancer. Animals can have cancer as well. Ask the students if they think research on cancer in animals could be beneficial for treating cancer in humans? What about research on cancer in humans, being beneficial to animals?

17. Give students the handout for activity 6-4 entitled “What is Cancer?” Take the students to the computer lab and give them time to complete the web quest.

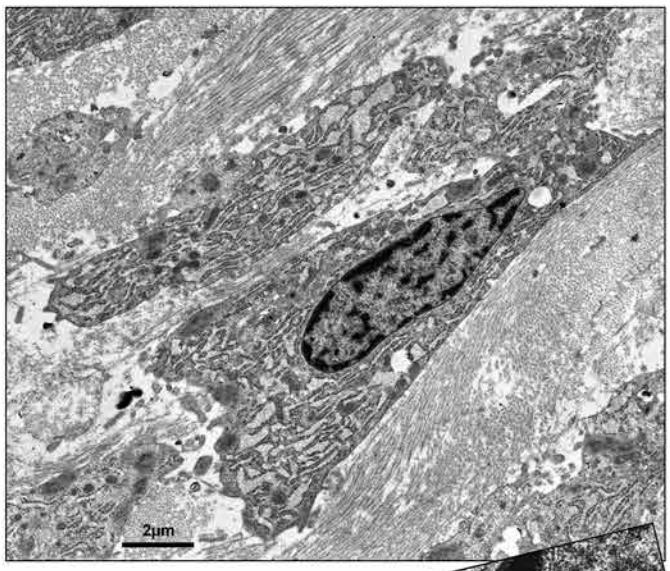
18. Debrief with students regarding what they discovered.

19. Read the Colorado State cancer article either as a class or independently.

20. To end the lesson, ask the students to write a paragraph explaining how this article provides an excellent example for demonstrating the similarities between humans and animals.

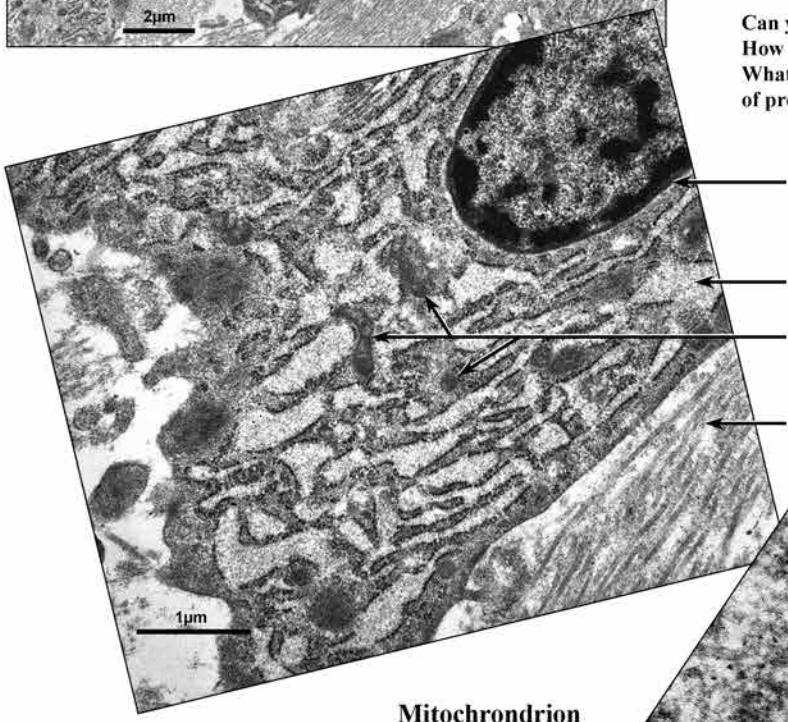
Extension Activity

Provide students with copies of the NIH SEPA book entitled Let’s Cure Cancer. Ask the students to read the book and complete the activities along the way. If time permits, students can write a report, construct a PowerPoint, or create a timeline about the history of cancer outlined in the book. A second option would be to ask students to follow-up with one of the researchers highlighted in the book to see what they are currently working on professionally. This could be conducted by searching the internet for recent publications by the individual or writing a personal letter asking questions related to their research.



Profiles of at least 10 collagen-producing cells (fibroblasts). These cells are actively generating a structural protein (collagen), seen in what appear to be "lakes & rivers" within the cytoplasm of each fibroblast. (Cells are shown magnified about x6,000.) Very near by are profiles of several mitochondria (thread-granules). These contain the functional proteins (enzymes) that generate from sugar & H_2O, the energy (ATP) that will fuel, in this case, the formation (synthesis) of collagen by the fibroblasts. Collagen is released into the space between cells (intercellular space) where it embraces & binds cells together.

Can you locate the 10 cells in the first picture?
How do you explain that not all fibroblasts reveal a nucleus in this picture?
What is the advantage of having the mitochondria so close to the site of protein synthesis? (See middle picture.)



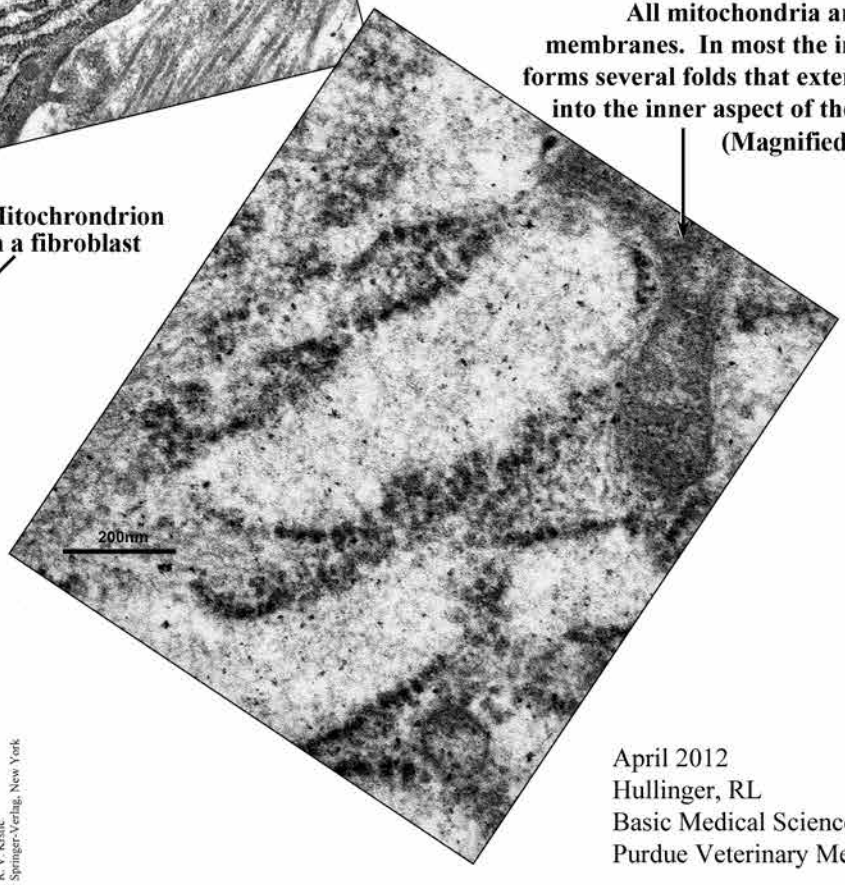
***Nucleus* of fibroblast**

Collagen accumulating in lumen of granular endoplasmic reticulum, after synthesis & before release to intercellular space

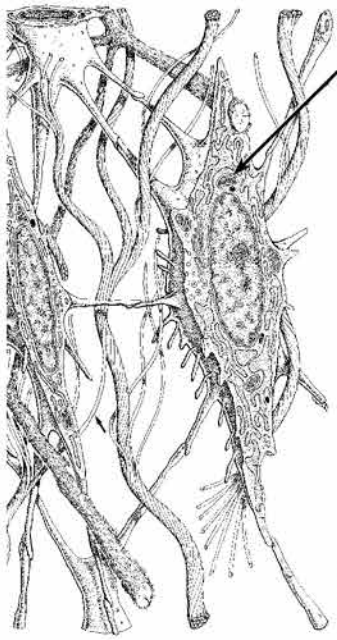
Mitochondria
(Mitochondria are shown magnified about x18,000.)

Collagen in intercellular space

All mitochondria are formed of two membranes. In most the inner membrane forms several folds that extend (like shelves) into the inner aspect of the mitichondrion. (Magnified about x76,000.)



Mitochrondrion in a fibroblast



Modified from Die Gewebe des Menschen und der Säugetiere. Ein Atlas zum Studium für Medizine und Biologen. 1984. R. V. Krstic. Springer-Verlag, New York

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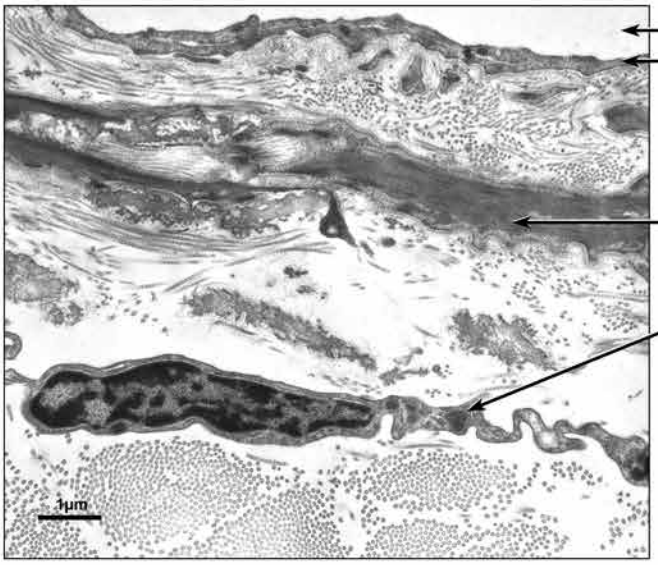


Lumen of small artery
Endothelial cell lining vessel (very thin)

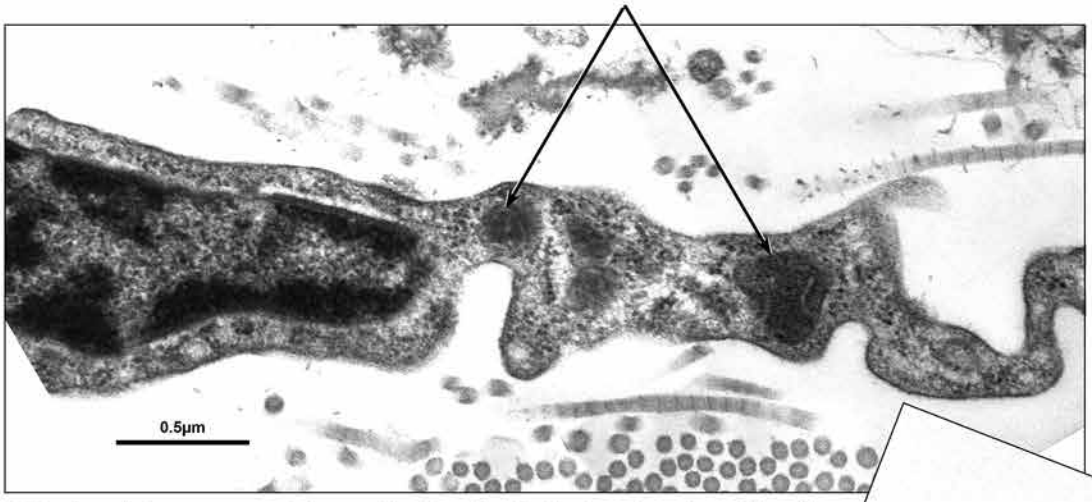
Smooth muscle cell

Mitochondrion (shown magnified about x5000.)

An inactive fibroblast is shown at the left & portions of the same cell are enlarged in the other pictures. This fibroblast forms a part of the wall of this small artery.

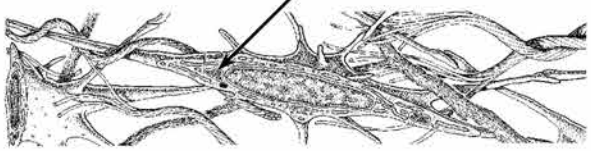
As the cell becomes more active, from where might the additional mitochondria asise?
Mitochondria are organelles. What is the meaning of the word organelle?

Mitochondria (shown magnified about x18,000.)



Mitochondria are present in nearly all cells; their structure is uniformly consistent among common mamalian species. The number of mitochondria vary with the activity of the cell, here the fibroblast of dog, horse, & human. Further the inner membrane foldings are also increased in the very active cell.

Mitochrondrion in a fibroblast (inactive)



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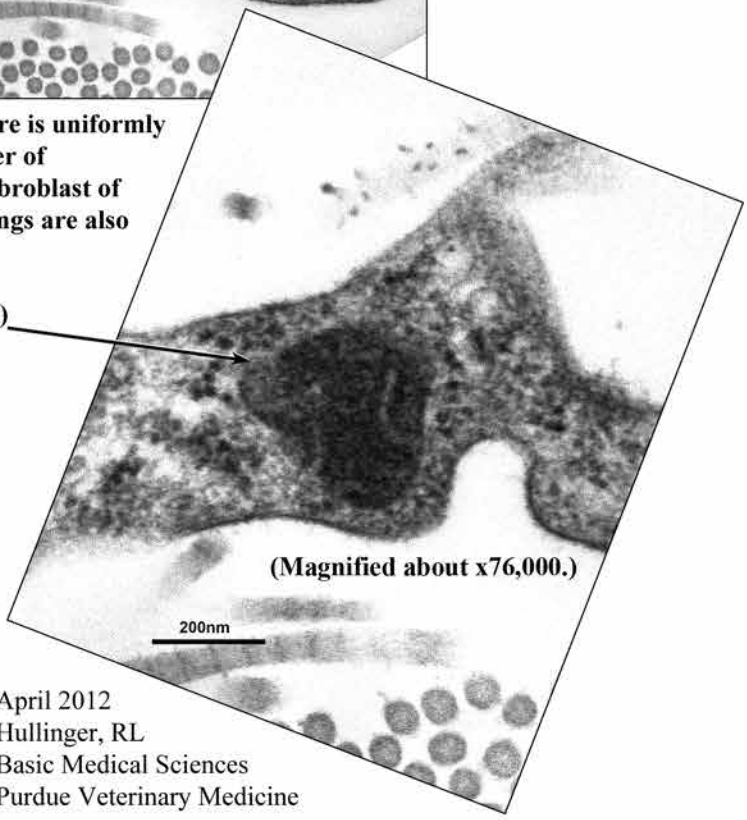

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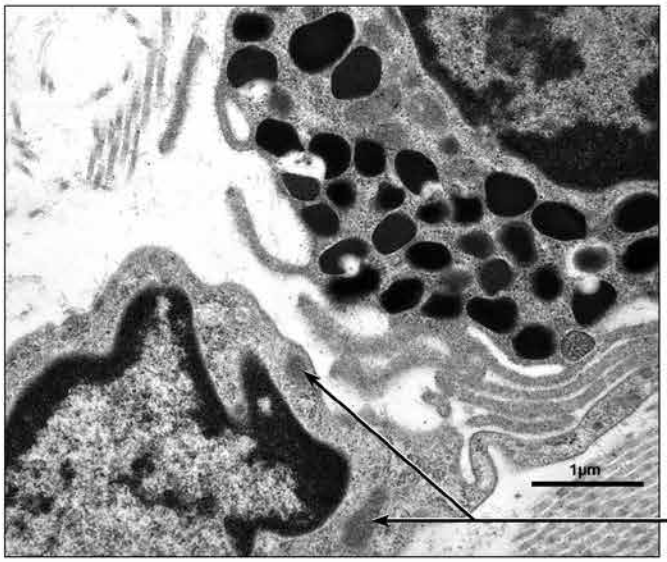
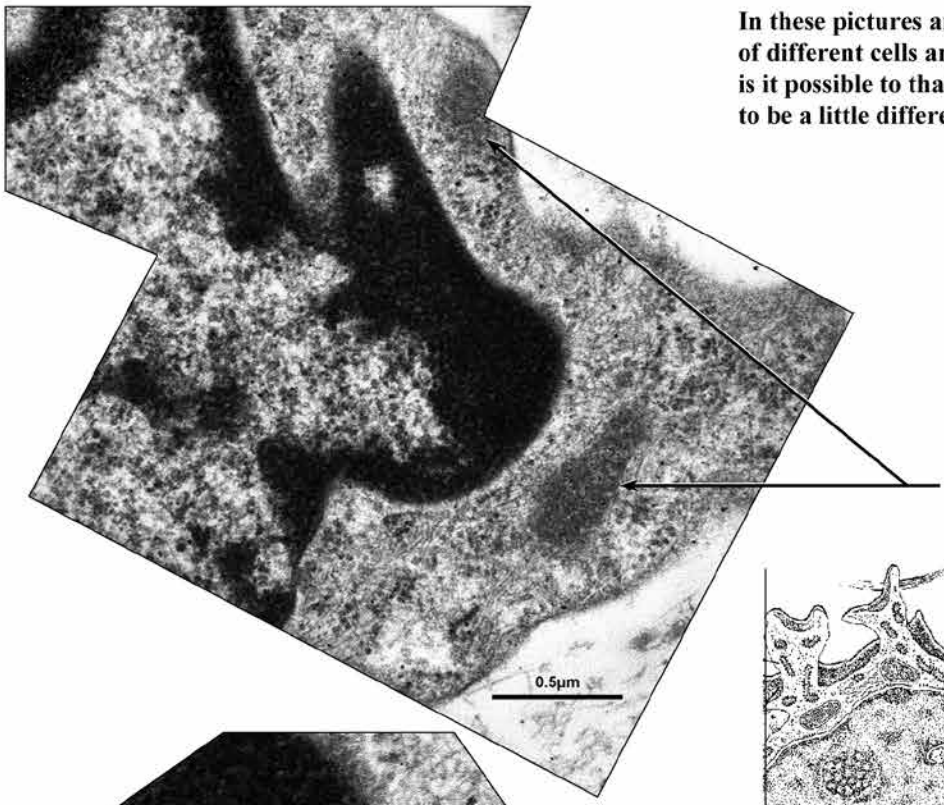


Profiles of two different types of cell are at the left - the one at the upper right is a mast cell; at the lower left is a fibroblast. The middle and lower pictures emphasize a mitochondrion of the fibroblast.

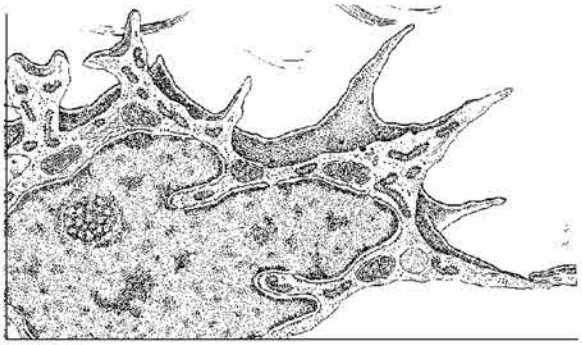
Assume the mitochondria shown in the portion of the two cells is representative. What do you conclude about the relative activity of the two cell types?

Mitochondria (shown magnified about x5,000)

In these pictures and the sketch there are mitochondria of different cells and different functional stages. How is it possible to that nearly every mitochondrion seems to be a little different from the others?



Mitochondria
(Mitochondria are shown magnified about x18,000.)



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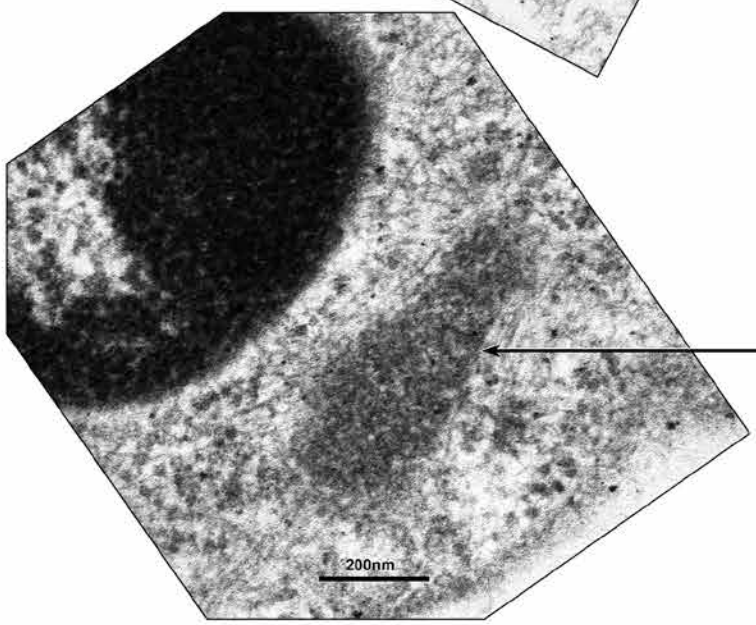

Mitochondrion
(Magnified about x76,000.)

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Dear Fido (or Max, or Sophie, or Buddy, or Molly), How am I Like Thee? Let Me Count the Ways

Introduction

Do you have a dog? If so, how well do you know your dog inside and out? How well do you know yourself inside and out? In this activity we will investigate some of the similarities between dogs and humans, specifically as seen in the skeleton.

Materials Needed

- Dog skeleton
- Dog skull
- Human skeleton
- Human skull

Reference materials for looking up labeled diagrams of human skeletons and Dr. Kevin Hannon's (Purdue Veterinary Medicine) dog anatomy computer simulation.

www.vet.purdue.edu/engagement/sepa/anatomy.htm

Instructions

1. Notice that certain bones in the the human skeleton have labels on them numbered from 1 through 11. Notice also that the dog skeleton has labels on various bones from A through K. Study the two skeletons carefully, and match the correct dog bone with its human counterpart by placing the letter of the dog bone in the blank next to the human bone that it matches.

    a. _____ pelvis

    b. _____ cranium

    c. _____ patella

    d. _____ humerus

    e. _____ ulna

    f. _____ scapula

    g. _____ radius

    h. _____ femur

    i. _____ phalanges (hand)

    j. _____ fibula

    k. _____ tibia

2. What similarities do you see between the dog pelvis and the human pelvis?

3. What differences do you see between the dog pelvis and the human pelvis?

4. How many pairs of ribs do dogs have?

5. How many pairs of ribs do humans have?

6. Locate the 7 cervical vertebrae in the dog skeleton. How many cervical vertebrae are there in the human skeleton?

7. Locate the 12 thoracic vertebrae in the dog skeleton. How many thoracic vertebrae are there in the human skeleton?

8. Locate the 7 lumbar vertebrae in the dog skeleton. How many lumbar vertebrae are there in the human skeleton?

9. Here's a **THOUGHT QUESTION**. Do you think a dachshund would have more vertebrae than other breeds of dogs? Why or why not?

10. Check out the human and dog skulls. How many teeth are there in the dog's skull?

11. How many teeth are there in the human's skull?

12. How do the dog's teeth appear to be adapted for the types of foods that dogs eat?

13. How do the human's teeth appear to be adapted for the types of foods that humans eat?

14. Going back to the skeletons, how many phalanges per limb do you see on the human skeleton? How about on the dog skeleton?

15. Going back to the dog and human skull, find the hole at the base of the skull where the spinal cord enters. This hole is called the **foramen magnum**. What do you notice about the position of the foramen magnum in the human skull as compared to the dog skull?

16. Thinking about your answer to question 15 above, what do you predict you might notice about the position of the foramen magnum in a chimpanzee skull? **Explain**.

17. Now it's time for you and your group members to really put your **craniums** together and do some **brain**storming!

    Again, examine carefully the differences and similarities between the dog and human skeletons. Try to come up with and explain three characteristics of the human skeleton that allow our species to walk upright.

Activity 6-1 Answer Key

1. Anatomy Matching
    a. F : pelvis
    b. C : cranium
    c. I : patella
    d. B : humerus
    e. H : ulna
    f. K : scapula
    g. A : radius
    h. D : femur
    i. J : phalanges (hand)
    j. G : fibula
    k. E : tibia
2. One possible answer would be that in both cases the legs are attached to the pelvis.
3. The human's is more bowl shaped while the dog's is longer and flatter.
4. 13
5. 12
6. 7
7. 12
8. 5
9. Dachshunds have the same number as all other dogs. They're STILL dogs.
10. 42
11. 32
12. They're shaped for ripping and tearing, as dogs are meat eaters. Long sharp canines are characteristic of predators.
13. Some are sharp for eating meat and some have more flattened surfaces for grinding plant material as humans are omnivores.
14. 5 on both human and dog skeletons
15. It is more centered in the base of the skull in the human.
16. It would be more centered in the base of the chimp's skull, as we are more closely related to chimps than we are to dogs.
17. Possible answers:
    Our backbone is S-shaped rather than C-shaped like the dog's.
    The position of the foramen magnum is more centrally located in the base of the human skull.
    Our pelvis is more bowl shaped rather than long and flat like the dog's pelvis.

How the Cell Works

(Adapted from "How the Cell Operates", by The Center for Applied Research in Education)

Introduction

A living cell is like a miniature factory – a factory that manufactures protein molecules. Figure 1 shows a diagram of a cell that produces protein molecules. Figure 2 shows a diagram of a factory where a computer, power plant, and little factory workers are compared to actual cell organelles. **By comparing Figure 1 with Figure 2, you will learn how the organelles of an actual cell work together to produce proteins.**

Figure 1

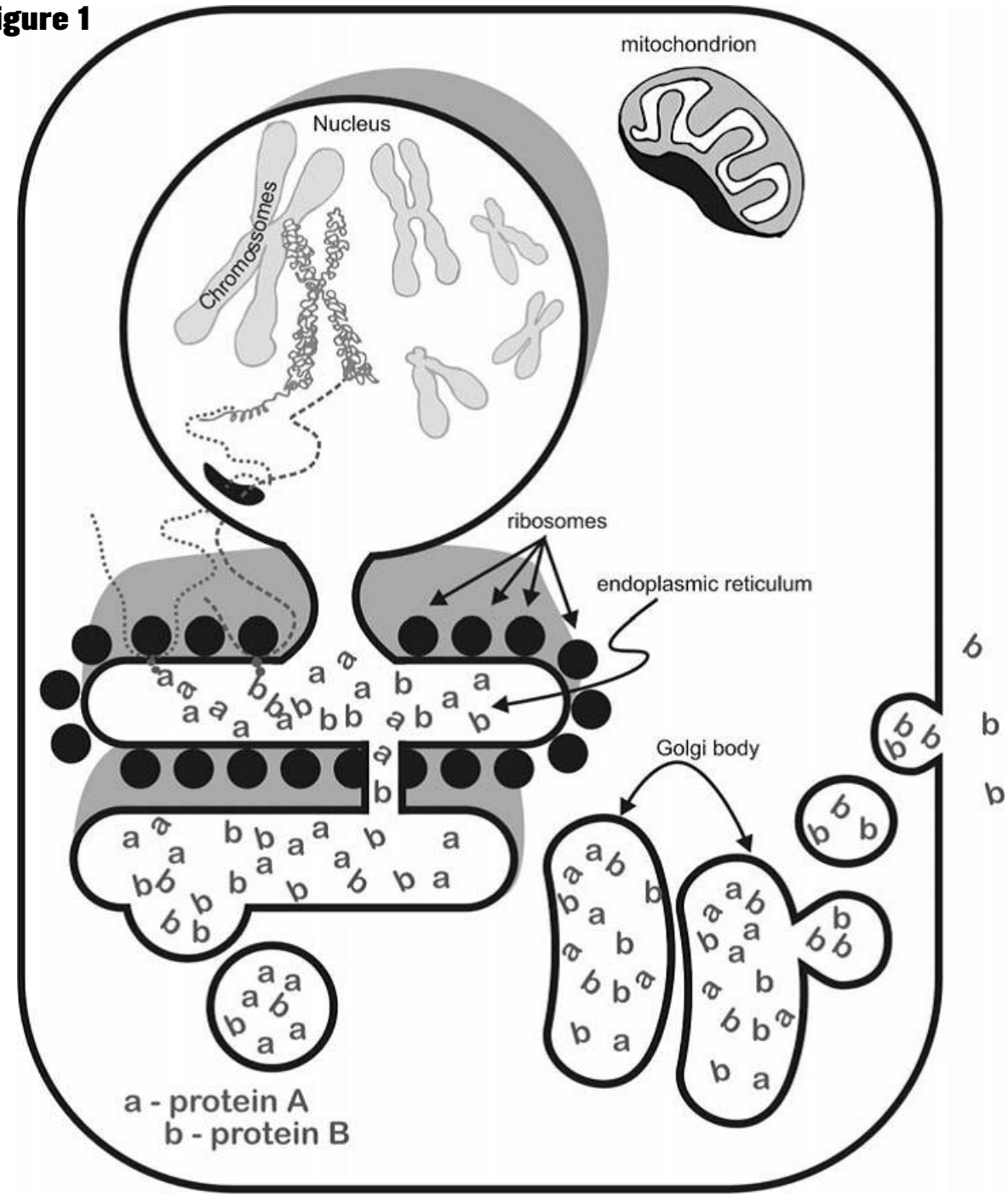
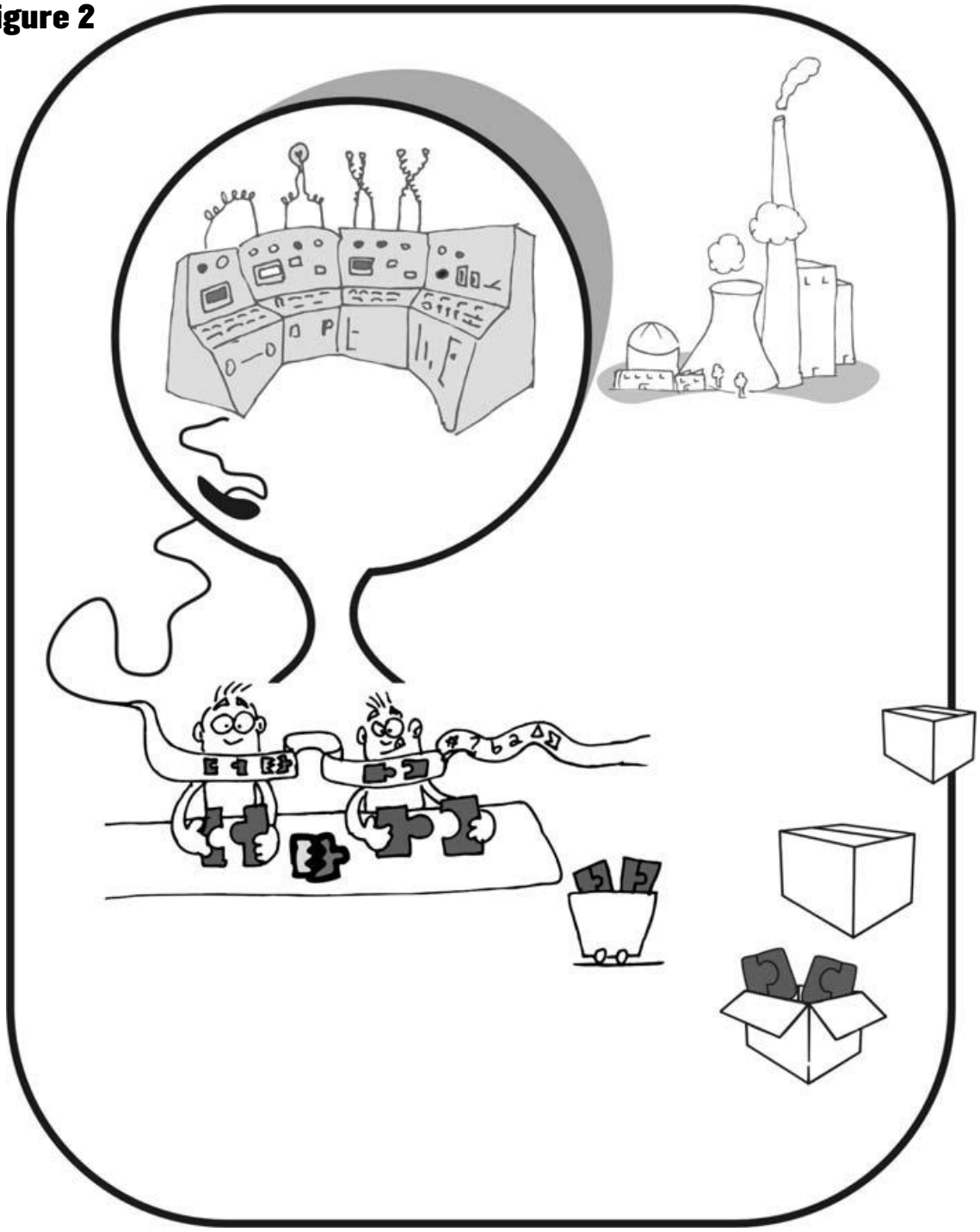


Figure 2



Part 1

Materials Needed

- Colored pencils

Directions

Using colored pencils color Figures 1 and 2 as follows:

- In Figure 1, color the chromosomes orange.
- In Figure 2, color the computer orange.
- In Figure 1, color the nucleus brown.
- In Figure 2, color the control room brown.
- In Figure 1, color the mitochondria yellow.
- In Figure 2, color the power plant yellow.
- In Figure 1, color the endoplasmic reticulum blue.
- In Figure 2, color the assembly line blue.
- In Figure 1, color the ribosomes green.
- In Figure 2, color the little workers green.
- In Figure 1, color the Golgi body red.
- In Figure 2, color the packaging area red.

Questions

1. The little workers in the factory in Figure 2 manufacture puzzles out of puzzle pieces. Color a few of the finished puzzles purple.
2. What molecules does the cell in Figure 1 manufacture?
3. Color a few of those molecules purple.
4. Based upon the color-coding you just did, write out the functions of the following cell organelles:
    a. chromosomes:
    b. nucleus:
    c. mitochondria:
    d. endoplasmic reticulum:
    e. ribosomes:
    f. Golgi bodies:

Part 2

Materials Needed (per group)

- One 2 foot by 2 foot sheet of white bulletin board paper
- Crayons: black, orange, brown, yellow, blue, green, red, and purple

Directions

1. Your teacher will divide the class up into groups of three.
2. Gather your group members around the 2 foot by 2 foot sheet of white paper.
3. Using the crayons, draw a diagram of a cell on your paper. Do NOT look back at the diagrams at the beginning of this activity sheet, because with three good minds working together in your group, I bet you will be able to "put your heads together" and do this activity without peeking at the diagrams! Include and label the following in your drawing:
    - cell membrane
    - cytoplasm
    - nucleus
    - chromosomes
    - mitochondria
    - endoplasmic reticulum
    - ribosomes
    - manufactured protein molecules
    - Golgi body
4. **Take turns teaching!** Using your drawing as a visual aid, the first group member should teach the other two group members everything he/she knows about the following:
    - cell membrane
    - cytoplasm
    - nucleus
5. The second group member should teach the other two group members everything he/she knows about the following:
    - chromosomes
    - mitochondria
    - endoplasmic reticulum

6. The third group member should teach the other two group members everything he/she knows about the following:
    - ribosomes
    - manufactured protein molecules
    - Golgi body
7. When you and your group members think you are ready, each group member should take out a blank sheet of notebook paper and individually write out a narrative description of how the cell works. Use the following terms in your essay:
    - cell membrane
    - cytoplasm
    - nucleus
    - chromosomes
    - mitochondria
    - endoplasmic reticulum
    - ribosomes
    - manufactured protein molecules
    - Golgi body

Building Models of Molecules Lab

J. Ruhl

Introduction - Purpose

Sometimes chemists and biochemists will build 3-dimensional models of molecules that they are studying. These models, because they are more realistic than 2-dimensional drawings, help them to better understand how the molecules are able to function the way that they do.

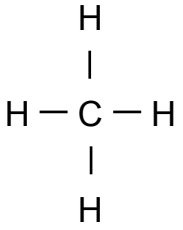
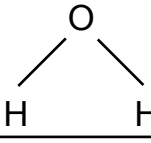
The purpose of this activity is to build 3-dimensional models of some biologically important molecules.

Materials

- gumdrops (several different colors)
- toothpicks
- glue or glue gun
- mounting board

Instructions

1. Using different colored gumdrops (for example, use black for carbon, white for oxygen, and red for hydrogen) to represent atoms, and toothpicks to represent bonds, build structural models of the following molecules:

Molecule	Chemical Formula	Structural Formula
oxygen gas	O_2	O = O
hydrogen gas	H_2	H — H
methane gas	CH_4	
carbon dioxide	CO_2	O = O = O
water	H_2O	
glucose	$C_6H_{12}O_6$	(see your textbook for a diagram)
the amino acid alanine	$C_3H_7O_2N$	(see your textbook for a diagram)

2. Glue your 3-dimensional models to a display board of cardboard or foam core board. Be sure to include a title, labels, and a key explaining what colors were used for the different types of atoms.

Activity #1: What is Cancer?

Cancer affects over 1.3 million people per year in the United States. Some cases of cancer are linked to lifestyles choices people make and others are not. You are going to take the time to research some of the facts associated with cancer.

Go to:
http://science.education.nih.gov/supplements/nih1/cancer/activities/activity2_animations.htm

Animation 1: Stages of Cancer

1. True or False. The rate and timing of cell division is normally precisely regulated by your body.
2. True or False. Chemical messengers between neighboring cells keep the rate of cell division equal to the rate of cell death.
3. True or False. Cells ALWAYS divide normally.
4. True or False. Cells can break free from the original tissue and move to other parts of the body.
5. It could be said that cells divide: in a controlled way or in an uncontrolled way.

Animation 2: Cell Cycle Clock

6. True or False. Scientists now know that the cell cycle clock helps to control cell division.
7. How many stages are in the cell cycle? 1 or 2 or 3 or 4
8. True or False. In G1 the cell stays the same size.
9. What gets copied during the S phase? Entire Nucleus or DNA
10. What does the G in G1 and G2 stand for? Growth or Gap
11. True or False. Cells ALWAYS go right back into the cell cycle and start dividing all over again.

Animation 3: PO and TS

12. True or False. Proto-Oncogens (PO) encourages a cell to grow and divide.

13. What gene inhibits (stops) cell division? PO or TS

Animation 4: Mutagens

14. True or False. According to their graph, if something has a high ability to cause a mutation, it will also have a high ability to cause cancer.

15. Do all cancers fit this simple model? YES or NO

Animation 5: PO and TS mutations

16. True or False. If a PO becomes an O it can cause excessive division.

17. True or False. If a TS becomes inactive, cells will not divide.

18. Smoking bans in public places are being debated all across this country; even in our town. Take a side on this issue and write a well-developed paragraph as to your viewpoint on this controversial topic. Include statistics or data to support and give validity to your viewpoint

Now go to: **http://www.cancer.org/Cancer/CancerBasics/what-is-cancer**

to answer the following questions:

1. How do ALL cancers start?

2. What important cellular component gets damaged in cancer cells?

3. What normally happens to a cell that has damage to its genetic material?

4. What is metastasis?

5. Using terms from the chapter on the cell cycle and cancer information you have just learned about, write a well-developed paragraph that illustrates the connection between cancer and the cell cycle. Be thorough and specific.

Activity #2: How is Fido Going to Help Humans?

Cancer research is a huge area of research across the world. There is even groundbreaking research being done close to home by scientists at the Purdue University Center for Cancer Research. Many of you may be familiar with or heard of the Mayo Clinic or the National Cancer Institute and would agree that they are doing research on the causes of human cancers, but did you ever stop to think that the growth on your pets back or the tumor on her mammary gland could prove to save human lives!

1. Read the article printed from the Colorado State University Website. The link is below or a re-print of the article is provided for you. **www.colostate.edu/features/cancer-collaboration-cu.aspx**
2. After reading the article, do an Internet search and find an article that links animal cancer research and/or treatments and/or cures to humans.
3. Print the article; this will be turned in.
4. Read the article and write a synopsis of it. This should be a well-developed paragraph that highlights where the research is being done, what organizations / colleges / institutions / individuals are involved, what type of cancer is being targeted and what the link is to humans.
5. Staple the article to your synopsis and turn in.

Activity 6-4 Teacher Notes

1. This unit should come after discussing the cellular components and the cell cycle in detail. This lesson is very self-directed and will need very little teacher direction, if the students have a clear understanding of the cell cycle prior to introduction of it.
2. The first activity titled “Cancer” is a web quest that has students research the very basics of cancer using the Livestrong Website and Cancer.org.
3. After doing the Cancer web quest students should then do a second activity titled “How is Fido Going to Help People?” This lesson will illustrate how cancers detected in people’s pets are used in research to not only treat/cure the animal, but to also find treatments and cures for people. Cancer research centers, like the one at Purdue University, rely on the data that is gleaned from scientists that study animals and their diseases.

Ethics, Animal Testing, and Drug Development

Overview

No discussion about animal testing is complete without addressing the many ethical issues involved in this type of research. Students will debate the pros and cons of animal research and make a decision regarding the funding of a hypothetical drug research study.

Note: You may want to use the Think-Pair-Share technique for discussing the readings in this lesson. A description of Think-Pair-Share is located at www.readingquest.org/strat/tps.html.

Objectives

- The students will use online and print resources to become aware of the ethics involved in animal testing.
- The students will successfully answer questions about the procedures for and importance of the drug development process.
- The students will write a well developed paragraph defending their views on ethics, research, and drug development for a given scenario.

Materials

- Activity 7-1: Of Cures and Creatures Great and Small:
  http://www.scu.edu/ethics/publications/iie/v1n3/cures.html
- Activity 7-2: Ethics and Biology
- Activity 7-3: Eli Lilly Video discussion questions (one per group)
  Eli Lilly video: www.ciesc.k12.in.us/EpidemicChallenge/toc.htm
- Activity 7-3: Teacher Answer Key
- Computer with internet access
- Projector with speakers
- Guest speaker (Arrange for a guest speaker to visit the class in advance)
- Description of Think / Pair / Share found at this website: www.readingquest.org/strat/tps.html

Procedure

1. Begin the lesson by asking the students to recall what we have learned about the similarities between organisms so far in this unit. (e.g. The reason drugs and medical treatments designed for humans can be tested on non-human animals is because we are all made up of the same “stuff”)
2. Explain that on occasion controversies related to testing human drugs and products on animals do arise. Define controversy and ask students to read “Of Cures and Creatures Great and Small” (Activity 7-1).

3. Conduct a Think / Pair / Share or hold a class debate about the ethics of animal testing. Use the questions below to start the conversation.
    a. What is animal testing?
    b. Is animal testing necessary? Why or why not?
    c. Who might be against animal testing and what are their reasons?
    d. How do you personally feel about animal testing?
4. Ask students to read “Ethics and Biology” (Activity 7-2) independently. Their task is to read the scenario, decide if the project should be funded, and write a paragraph explaining their point of view.
5. Take questions and address concerns expressed by students.
6. Conduct a poll to determine how many students funded the project versus how many did not. Ask volunteers to justify the decision they made.
7. Invite the guest speaker to discuss how ethics related to research are observed at their work place. Allow time for questions.
8. Show the Eli Lilly video entitled “The Future Begins Yesterday” linked in the materials section.
9. Break the class into small groups to discuss the video and provide each group a printout of the discussion questions provided (Activity 7-3).
10. To end the lesson, ask students to quietly reflect on what has been discussed today. Give students several minutes to reply in writing to the following prompt: “Where do you fall on the following scale? Why?

1	2	3	4	5
Animal testing is wrong! It should stop now! There is no excuse!		I see the pros and the cons. I do not support it or object to it. I am on the fence.		Animal testing is right! It should continue! People are more important!

Extension Activity

Investigate the pros and cons of alternatives to animal testing and report on your findings through the creation of a PowerPoint, poster, or essay. Visit the Foundation for Biomedical Research website, www.fbresearch.org, and create a PowerPoint, poster, or essay about how animal research saves human lives.

Ethics and Biology

General ethical issues associated with public funding of research include: Does publicly funded research need to promise material social benefits? How can value be assigned to benefits in order to compare it to costs? Should research be supported if it does not promise equal benefits to all members of society? Other ethical issues will depend on the specific nature of the research projects considered. Issues raised by projects described in the lesson as written include: What restrictions should there be on research involving human or animal subjects? To what extent should environmental issues be considered in making funding decisions? Should decisions on funding be based only on the opinions of the majority of scientists? Should research be funded that could result in violating the civil rights of some group of individuals?

Read the following scenario about Rhesus Monkeys. Write a well-developed paragraph with reasons why you would or would not fund the proposal. Here are some questions that you can consider in your paragraph.

- Extent to which you think the research is important.
- Extent to which the research may result in public benefit or harm.
- Extent to which the research is necessary for the advancement of science.
- Extent to which the research is likely to improve the country's economy.
- Ways in which the research is likely to affect the environment.
- Whether or not it is important for the government to support this research.
- Whether or not the likely results justify the cost.

Testing An Experimental AIDS Drug On Rhesus Monkeys

A potentially highly effective new drug for treating AIDS patients has been developed. There is concern however that this drug may have several severe side effects in humans that would not occur in the usual laboratory animals like mice and rats in which it has been already tested. Before it is tested on humans ,the researcher proposes to test it on Rhesus monkeys. These monkeys, although rare and expensive have been used in research in the past because they are often very similar to humans in their toxic responses to drugs.

"The Future Begins Yesterday - Making Medicines, Improving Lives"

http://www.ciesc.k12.in.us/EpidemicChallenge/toc.htm

These questions could be done in small groups or as a class discussion.

Discussion Questions:

Introduction (4:25)

1. Why was Eli Lilly started by Colonel Eli Lilly?

2. How much money does Lilly spend per day on research/development?

3. How many molecules make it to market as a drug?

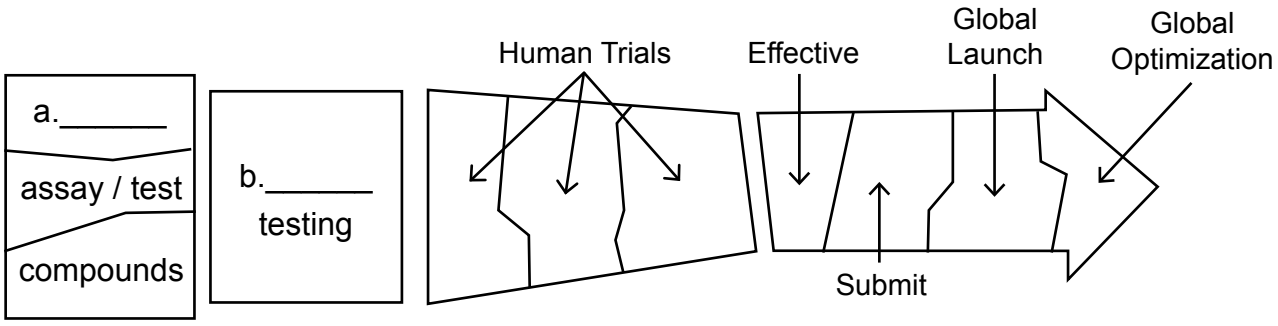
4. How long does it take from initial discovery to approved drug?

    a. Why do you think it takes so incredibly long?

5. Fill in the blank lines on the "rocket ship" model that was used in the video to explain the drug formulation process.

    a.

    b.



6. On this model, why are animal models used for testing?

Discovery Chemistry and In Vitro Biology (3:55)

1. Only _____in_____ (#'s) become a drug.
    a. Hypothesize as to why you think that is?

2. Something that dissolves another substance to form a solution is called a:

3. Explain how biology and chemistry work together.

4. What does "in plastic" mean?

5. What is another name for a test in a biology lab?

6. How many genes are in the human body?

In Vivo and Toxicology (4:20)

1. In vivo means _____ the organism.

2. _____ means the study of the effects of chemicals on an organism.

3. _____ mice are sterile or germ free.

4. Does Eli Lilly employee veterinary technicians?_____

5. Why would veterinarians want to monitor animals while they are awake and running about using the telemetry device?

Clinical Development (4:32)

1. Why do you think human subjects are monitored so closely during a drug trial?

2. Why would a clinical team, need such diverse people as a doctor, biostatistician, pharmacokineticist, project manager, pharmacologist and toxicologist?

Development and Manufacturing (4:21)

1. Why would a chemist be needed in the manufacturing of drugs?

Summary

1. After watching this video explain, in detail, why prescription medication is so expensive?

2. Why would this segment end by saying, “For someone with a science background, the sky is the limit!”?

Cloning

OVERVIEW

Cloning is often a hot topic for students because of the futuristic uses and abuses depicted in numerous science fiction films and comedies. Due to this fact, students may have received misinformation that needs to be corrected. In this lesson, students will learn why it is important to use laboratory animals that are genetically similar, and how cloning can be used to provide genetically identical copies of laboratory research animals.

OBJECTIVES

- The students will research the history of cloning through a web quest.
- The students will reflect on the Fat Dogs and Coughing Horses unit individually to create a list of the top three concepts learned.

MATERIALS

- Printout of Activity 8-1 “Cloning”
- Computers with Internet access
- Website: http://gslc.genetics.utah.edu/units/cloning/

PROCEDURES

1. Begin by referring back to previous lessons on the importance of laboratory animal testing in medical research. Ask the students the following questions: “Should lab test animals be genetically very similar? If so, why?”

   (Answer: In experiments of any kind, it is important to attempt to control all variables. If all of the research animals in a test group were different, there would be too many uncontrolled variables. If all of the animals in a test group were similar, we could be more confident of the experimental results.)

2. Pose the following question for students to ponder: “Why is it that all pedigreed German Shepherd Dogs are so alike genetically?”

   (Answer: German Shepherd Dogs – as all other breeds of dogs – have been selectively bred over many generations to be purebred.)

3. Explain to students that even though all German Shepherd Dogs are very similar genetically, no two German Shepherd Dogs are EXACTLY identical. The only exception is if identical twins were born. Ask the students if it is possible to create two organisms that are exactly alike in every molecular way. Why or why not?

   (Answer: Reproductive cloning)

4. Ask students to share what they already know or think they know about cloning. Responses could be recorded on a chart and then reexamined at the end of the lesson to see which were true and which were not true.
5. Give the students two or three minutes to discuss with a partner how researchers could use cloning when conducting animal testing in the laboratory. What would the benfits be?

   (Answer: All those pesky little variables could be controlled, and we could be even more confident of our test results.)
6. Introduce the Internet activity entitled “Cloning” (Activity 8-1). This fun, highly interactive website will engage the students and help them learn about the history and the techniques involved in reproductive cloning. Give students a majority of the class session to work alone or with a partner.
7. Take time to debrief with students and answer questions.
8. End the lesson and the unit by asking students to respond to the following prompt in writing: “The three most important things I learned from the ‘Fat Dogs and Coughing Horses’ unit were….”

EXTENSION ACTIVITY

If students are eager to learn more about veterinary science or careers related to human health, challenge them to research the types of jobs that are available and determine which they might consider pursuing in the future. Next, investigate what it would take to obtain the degree necessary to qualify for that job and which colleges offer such programs.

Cloning (Internet Activity)

Introduction

Cloning is a process in biology that has attracted a great deal of attention worldwide. In this activity you will go to various websites to explore and learn about cloning and how it is done.

Instructions

1. Go to the following website: **learn.genetics.utah.edu/content/tech/cloning**
2. Click on the link entitled "What is Cloning?" Answer the questions below as you explore that link.
3. Name two clones that you know.

    a.

    b.

4. Explain how cloning using the process of **artificial embryo twinning** works. Use the following terms in your description: early embryo, Petri dish, and surrogate mother.

5. Explain how cloning using **somatic cell nuclear transfer** works. Use the following terms in your description: somatic cell from adult sheep, egg cell from adult sheep, somatic cell nucleus, egg cell nucleus, surrogate mother, and Dolly the clone.

6. How is an embryo that is created by **artificial embryo twinning** different from an embryo that is created by **somatic cell nuclear transfer**?

7. **Now go back to the cloning homepage and click on the link entitled "Click and Clone". At this page you will be able to clone a mouse (a virtual lab activity) on the screen.**
8. Work through the cloning activity.

9. What five tools will you need to clone Mimi?

    a.

    b.

    c.

    d.

    e.

10. What mouse donated the egg?

11. What did you use the blunt pipette for?

12. What did you use the sharp pipette for?

13. What did you transfer into the **enucleated** egg?

14. What is the early embryo called when it is a ball of 16 cells?

15. What was the name of the surrogate mother mouse?

16. What was the name of the first mouse that was actually cloned in this way at the University of Hawaii?

17. **Now go back to the cloning homepage and click on the link entitled "The Clone Zone". As you work through this activity, answer the questions below.**

18. In what year were the first animals artificially cloned?

19. What animals were they?

20. How did Hans Spemann clone salamanders in 1902?

21. In 1952, Briggs and King cloned a frog by nuclear transfer. Where did they get the donor nucleus from?

22. Why are mammals harder to clone than amphibians?

23. Who cloned the first mammal?

24. What large mammal was cloned in 1987?

25. In 1996, what did the two little lambs, Megan and Molly teach us?

26. Compared to all of the cloning experiments up until 1996, what was so special about Dolly?

27. Neti and Ditto were two clones produced in 1997. What kind of animals were they?

28. In regards to cloning, what did the U.S. House of Representatives do in the year 2002?

29. **Now go back to the cloning homepage and click on the link entitled "Is It Cloning? Or Not?". Play the game, and when you get to the screen which shows your final score, either print out that screen and attach it to this lab, or (if you are working on a computer in the classroom) call the teacher over to look at your screen and sign off below.**

Score: _____ Teacher's Signature: _____

Master Materials List

Teaching Materials

- Activity Sheet 1-2: Elephant Poem
- Activity Sheet 2-1: Compound Microscope Lab Instructions
- Activity Sheet 3-1: Some Freshwater Invertebrates You Might Find
- Activity Sheet 3-2: Hunting for Freshwater Invertebrates Lab Instructions
- Activity Sheet 6-1: Dear Fido
- Activity Sheet 6-1: Dear Fido - Teacher Answer Key
- Activity Sheet 6-2: How the Cell Works
- Activity Sheet 6-3: Building Models of Molecules
- Activity Sheet 6-4: What is Cancer?
- Activity Sheet 6-4: What is Cancer? - Teacher Notes
- Activity Sheet 6-4: CU / CSU Cancer Article
- Activity Sheet 7-1: Of Cures and Creatures Great and Small
- Activity Sheet 7-2: Ethics and Biology
- Activity Sheet 7-3: Eli Lilly Video discussion questions (one per group)
- Activity Sheet 7-3: Teacher Answer Key
- Activity Sheet 8-1: Cloning
- Beaker of water
- Computer with internet access
- Dog skeleton (including a skull)
- Human blood smear
- Human skeleton (including a skull)
- Images of a dog cheek cell smear, dog blood smear, horse cheek cell smear, and horse blood smear:
  www.vet.purdue.edu/engagement/files/documents/sepa/Blood%20and%20Cheek%20Smears.ppt
- PowerPoint presentation “Fresh Water Invertebrates”
- PowerPoint presentation “Cell Organelles”
- Projector with speakers
- Whiteboard, chalkboard, or chart paper

Online Materials

- Dog anatomy computer simulation (www.vet.purdue.edu/engagement/sepa/anatomy.htm)
- Video: ”Buddy Visits the Veterinarian”
  (www.vet.purdue.edu/engagement/sepa/buddysVetVisit.php)
- Video from the website: www.ciesc.k12.in.us/EpidemicChallenge/toc.htm

- Website- www.eeob.iastate.edu/faculty/DrewesC/htdocs/toolbox-II.htm
- Website- www.readingquest.org/strat/tps.html
- Website- http://gslc.genetics.utah.edu/units/cloning/

Student Materials

- Books or internet sites that describe common pet illnesses
- Compound microscope
- Computer with internet access
- Cover slips
- Dissecting microscopes
- Eye dropper
- Foam-well slides
- Glass petri dishes
- Glass slides
- Plant cells
- Plastic pipets
- Pond water
- Reference materials for looking up labeled diagrams of human skeleton
- The letter “e” (cut from newspaper)

Materials to Purchase

- ELISA Simulation Kit (Lyme disease scenario, page P-2)
- ELISA Simulation Student Guide (Carolina Biological Supply Company)
- Glue or glue gun
- Gumdrops (Multi-colored / several bags)
- Markers / crayons / colored pencils
- Mounting board
- Nemata Collection (Carolina Biological Supply Company)
- Paper and pencil
- Poster board (2x2 / one for each student)
- Prepared slides of mites
- Prepared slides of deer ticks
- Preserved sample of an Ascaris roundworm
- Preserved sample of heartworms
- Scissors
- Stickers or masking tape
- Tick, ear mite, and pet/horse hair samples
- Toothpicks (several boxes)
- Turkey baster