Name: _____
Date: _____

Introduction to Microscopy

The use of microscopes allows us to view objects in great detail that are much too small to view with the naked eye. In the field of human biology, microscopes are key instruments to view the microscopic levels of human anatomy, such as tissues, cells, organelles, and molecules. Some microscopes are powerful enough to view objects at the atomic level! For this human biology course, we will utilize the **compound light microscope**, which will allow us to study tissues and cells. In this lab, you will be introduced to the proper use and care of this instrument that we will use throughout the course.

Learning Outcomes

After completing this lab activity, you should be able to

1. Identify the major parts of a compound light microscope
2. Explain the functions of the major parts of a compound light microscope
3. Describe the proper use and handling of a compound light microscope
4. Demonstrate how to properly view a prepared specimen
5. Prepare a wet mount microscope slide

The Compound Light Microscope

Eyepiece (Ocular)

Objective Nosepiece

Objective Lens

Stage Clips

Stage

Iris

Light Source

On/Off Switch

Light Adjustment knob

Course Adjustment knob

Fine Adjustment knob

Stage Knobs

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Structures of the microscope

Eyepieces: To view a specimen, look through the eyepieces. Eyepieces can be adjusted (moved together or apart) to suit the distance between your eyes. The eyepieces alone magnify objects 10x.

Objective nosepiece: The nosepiece swivels around in a circle to allow the changing of the objective lenses.

Objective lenses: There are three objective lenses that allow for increased magnification. Each objective lens is labeled with its magnification power; low = 4x, medium = 10x, high = 40x.

Stage: Holds the slide.

Stage clips: Keep the slide held securely in place.

Stage knobs: Allow for mechanical movement of a slide left/right or up/down.

Iris: Controls the level of light reaching the specimen.

Light source: Point where light is emitted from a small light bulb.

Focus knobs: Allow for focusing of the specimen. There is a **course adjustment knob**, which focuses objects in large increments and can be used when viewing specimens under the low or medium power objective lenses. There is also a **fine adjustment knob**, which focuses objects in small increments and should be used when viewing specimens under the high-power objective lens.

Light adjustment knob: Allows adjustment of the brightness of the light source.

Proper handling of a microscope

To ensure full functionality of the microscope, proper handling is very important! Here are a couple key steps to follow:

- Always remove/replace the microscope from its cabinet by holding it by the arm AND the base.
- If objective lenses, eyepieces, or slides appear to be dirty, use lens paper ONLY to wipe them down. Never use paper towels, clothing, etc., as these materials will scratch the lenses and slides.
- If the microscope does not appear to be functioning properly (e.g. won't turn on, knobs won't work, image won't focus, etc.) inform your instructor immediately.
- When removing slides from the stage set the objective lens to low power and open the stage clips.
- When putting microscopes away: turn microscope off, wrap power cord up, set to the low-power objective lens, and remove any slides from the stage. Make sure to place the microscope cover back on before placing back into the cabinet.

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Viewing an object

The purpose of the compound light microscope is to allow you to 'zoom in' on a specimen. The different objective lenses on the microscope allow you to choose what magnification you would like to view the image on.

Total Magnification Calculations

Complete the following table to find the total magnification for each objective lens.

Objective Lens	Eyepiece Magnification		Objective Magnification		Total Magnification
Low-power		x		=	
Medium-power		x		=	
High-power		x		=	

Data Table 1. Total magnification calculations

Activity 1: Viewing an object

For this activity, you will practice viewing a known specimen, and will explore how a microscope changes the image.

1. Obtain a Letter e slide.
2. Before viewing under the microscope, draw how you see the letter e on your slide with your naked eye.

3. Place your slide on the stage.
    a. Make sure your microscope is set to the low-power objective lens.
    b. Use the stage clips to hold your slide in place. Make sure to 'pinch' the slide in place; NEVER place the slide under the clips!
4. Center and focus your specimen.
    a. Use the stage knobs to move the slide left/right and/or up/down to center your letter e in the center of the field of view.
    b. Use the course adjustment knob to focus your letter e.

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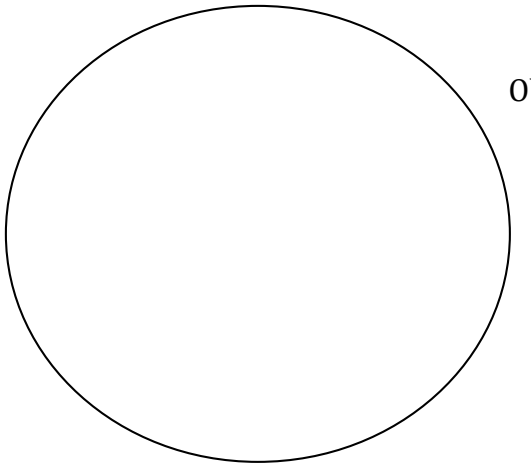
5. Draw what you see and answer the question below.



Object's Name: _____

Total Magnification: _____

How is the image you see different than what you saw with your naked eye?

_____

_____

6. Zoom in. Now that your object is centered and focused, you can increase the magnification by switching to the medium-power objective lens. You may need to make small adjustments to re-focus your object using the course and/or fine adjustment knobs.
7. Zoom in even further! With your specimen centered and focused on medium-power, you can now switch to the high-power objective lens. Again, you may need to make small adjustments to re-focus your object. It is very important that you only use the fine focus now when viewing objects on high-power.

Never use the course adjustment knob when using the high-power objective lens. This may cause the objective lens to slam into the slide, which can damage or break the objective lens and/or slide.

Field of view

When viewing objects, it is important to keep in mind the size of the specimen you are viewing. Because we are using the microscope to view objects that are not visible with the naked eye, we use small units of measure to indicate their size.

1 inch	=	2.54 cm
1 cm	=	10 mm
1 mm	=	1000µm

Table 1. Common units of measure in microscopy

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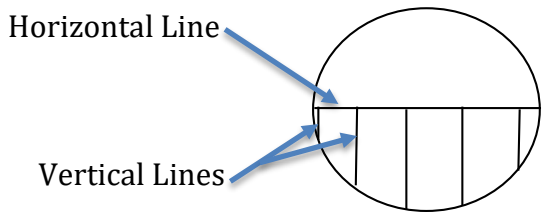
Activity 2: Determining the diameter of the field of view

1. Obtain a ruler slide.
2. Place your slide on the stage and view on low power.
3. Adjust the placement of your ruler so the horizontal line runs directly in the center of your field of view. Then align one vertical line at the very left edge of your field of view. See the field of view image below to help guide you with this step.



4. Count the number of vertical lines that fit in your field of view and record in the data table below. The space between each vertical line is equal to 1mm.
5. Repeat steps 3 & 4 for the medium- & high- power objective lenses.
6. Using the number of vertical lines you counted, determine the diameter in mm for each field of view and record in the data table below.
7. Convert the diameter in mm (millimeters) to µm (micrometers) and record in the data table below.

Objective Lens	# of vertical lines	Diameter in mm	Diameter in µm
Low-power			
Medium-power			
High-power			

Data Table 2. Record your observations and measurement conversions here.

What happens to the diameter of the field of view as you increase the magnification?

_____

_____

Depth of field

When viewing objects on a compound light microscope, the image produced is a 2D image (mono image), meaning we can only view one single layer of a specimen at a time. However, many of the specimens we will view in this class are 3D objects, such as cells. We can manipulate our object and view deeper/shallower objects by using the focus knobs.

Activity 3: Viewing 3D objects with a 2D microscope

1. Obtain a thread slide.
2. Place your slide on the stage and on low-power center and focus the specimen where all three threads in the slide cross each other.

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3. View the specimen on high power.
4. Using the fine adjustment knob, determine which color thread is on top, in the middle, and on the bottom.

List which color thread is in the following positions:

Top: _____ Middle: _____ Bottom: _____

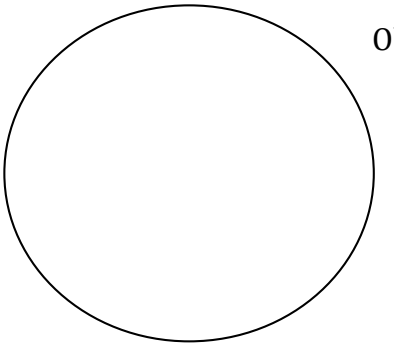
Viewing prepared slides

Some slides in this course will be already prepared for you and permanently fixed. These slides are reused over and over by many students. When instructed to use prepared slides, please keep in mind the following:

- Only obtain one slide at a time
- Never set slides on lab benches, lab reports, books, etc. The only place a slide should be set down in on the microscope stage or in the metal slide tray for storage.
- If a slide is dirty, use ONLY lens paper to clean it. Never use a paper towel, clothes, etc., as these materials will damage the slide.
- Always place slides back into the correctly labeled metal storage tray when you are done with them.

Activity 4: Viewing prepared slides

1. Obtain a prepared blood smear slide.
2. Place your slide on the stage.
3. Using the techniques you learned in the previous activities view the slide using the low, medium, and high- power objective lenses.
4. Draw what you see and answer the questions below.



Object's Name: _____

Total Magnification: _____

When viewing this sample on high-power, how many red blood cells (the small round pink dots visible on the slide) do you think you could line up end-to-end across the diameter of the field of view?

_____

Base on your answer above and what you learned in Activity 2, what size do you think each red blood cell is?

_____

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Making wet mount slides

Some slides for this course need to be prepared fresh by you. Depending on the specimen, preparing fresh slides usually requires different techniques such as stains, solutions, etc. For this activity, you will prepare a basic wet mount slide.

Activity 5: Preparing a wet mount slide

1. Obtain a new microscope slide.
2. Pull a hair from your head (or arm) using your fingers or a pair of tweezers.
3. Place the hair in the center of the microscope slide.
4. Add one drop of DI (deionized) water on top of the piece of hair.
5. Put a cover slip on top of the drop of water.
6. Place your slide on the stage.
7. Using the techniques you learned in the previous activities view the slide using the low, medium, and high- power objective lenses.
8. Draw what you see.

Object's Name: _____

Total Magnification: _____

9. When you are done viewing your wet mount slide, discard the entire slide into the sharps container.

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Biological Molecules

All living things are made up of atoms, the smallest unit of matter. These atoms can exist in living things as ions, such as sodium (Na^+) or potassium (K^+), as small molecules, such as water, or as large carbon-based molecules, also known as biological molecules. There are four major types of biological molecules found in living things: Nucleic Acids, Carbohydrates, Lipids, and Proteins. Carbohydrates, Lipids, and Proteins can be found as nutrients in the food we eat to provide us with the energy and raw building materials we need to survive.

Learning Outcomes

After completing this lab activity, you should be able to

1. Understand the basic chemistry of biological molecules
2. Describe the structure and function of the four classes of biological molecules
3. Explain how to identify the presence or absence of biological molecules in food materials.
4. Evaluate scientific claims of food products based on presence or absence of biological molecules in food materials.

An Introduction to Biological Molecules

Nucleic Acids: are made of monomers called nucleotides that make up the information storing molecules in our cells, DNA and RNA. While we consume nucleic acids when we eat other plants and animals, it is not something that we *must* consume in our diets, though the building blocks to make new nucleic acids are synthesized from materials we do consume. In this activity, we will not be testing for the presence of nucleic acids.

Carbohydrates: are used by living organisms as an important source of energy. The monomers of carbohydrates are called monosaccharides. Monosaccharides are made of carbon, hydrogen, and oxygen atoms in a 1:2:1 ratio. This ratio means that for every one carbon atom present, there are two hydrogen atoms and one oxygen atom present. Common examples of monosaccharides, also called simple sugars, are glucose, fructose, galactose, ribose, and deoxyribose. Sucrose, or table sugar and lactose, the sugar found in milk, are sugars made from two bound monosaccharides and are called disaccharides (meaning two sugars). To test for the presence of monosaccharides in a solution, we can use Benedict's Solution. In the presence of a monosaccharide, such as glucose, Benedict's Solutions turns from blue to orange when heated (orange is positive, meaning monosaccharides are present, and blue is negative, meaning no monosaccharides are present).

When many monosaccharides are bound together, the resulting molecule is called a polysaccharide (meaning many sugars). Several important polysaccharides include cellulose (fiber), starch, and glycogen. Iodine Solution can be used to test for the presence

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of polysaccharides, such as starch. In the presence of polysaccharides, the Iodine Solution turns from a yellowish brown color to dark blue (dark blue is positive, meaning polysaccharides are present, and yellowish brown is negative, meaning no polysaccharides are present).

Proteins: are made of monomers called amino acids, which are composed of atoms of carbon, hydrogen, oxygen, and nitrogen. Proteins are large and complex molecules that combine to form various components of living organisms such as muscle fibers, enzymes, and hemoglobin. Proteins are made from specific sequences of amino acids. A string of amino acid monomers joined together by peptide bonds is called a polypeptide. Biuret's Solution (Cu_2SO_4 + NaOH) can be used to test for the presence of protein. In the presence of protein, Biuret's Solution turns from blue to violet (violet is positive, meaning protein is present, and blue is negative, meaning protein is not present).

Lipids: are also made of carbon, hydrogen, and oxygen but the ratio of carbon, hydrogen, and oxygen atoms is not 1:2:1. Instead, lipids have a much greater number of carbon and hydrogen atoms with few oxygen atoms present. Their individual subunits (monomers) are fatty acids and glycerol. Lipids are organic compounds that do not dissolve in water. Examples include fats, oils, and the wax covering leaves.

The nonpolar bonds that form between the carbon and hydrogen atoms of a lipid cause them to be hydrophobic or "water repellent" molecules, as opposed to hydrophilic or "water loving" molecules. This attribute explains why water and oil do not mix. Bile salts can be used to test for the presence of a lipid. In the presence of a lipid-rich solution and water, bile salts form a distinct layer of clumped fats in the test tube (layer of clumps is positive, meaning lipids are present, and no layer of clumps is negative, meaning there are no lipids present. NOTE: There is no color change apparent for this test).

The large number of carbon to hydrogen bonds also serves to make lipids energy-rich storage molecules. One gram of a lipid stores twice as much energy as one gram of carbohydrate or protein. Lipids from animals are referred to as saturated fats and are solid at room temperature, whereas those found in plants are referred to as unsaturated fats, also known as oils, and are liquid at room temperature. Fats and oils are triglycerides, which are biomolecules that are composed of a glycerol and *three* fatty acids.

One important relative of triglycerides are phospholipids. Phospholipids differ in structure from regular triglycerides in that phospholipids are made of a glycerol and *two* fatty acids. A charged phosphate group replaces the third fatty acid. The arrangement causes phospholipid molecules to have both hydrophilic and hydrophobic regions. This feature also makes phospholipids an ideal structural component of cell membranes.

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Activity 1: Summary of Biological Molecules

After reading the information above, and using your knowledge from the lecture content on this topic, complete the following tables to summarize the information.

Biological Molecule	Monomer	Function(s)	Food Source(s)	Example
Nucleic Acids			----------	
Carbohydrates				
Lipids				
Proteins				

Data Table 1. Summary of structure, function, and examples of biological molecules.

Biological Molecule	Test Reagent	Positive Test Color (present)	Negative Test Color (absent)
Monosaccharide (Carbohydrates)			
Polysaccharide (Carbohydrates)			
Proteins			
Lipids			

Data Table 2. Summary of test procedures for biological molecules.

Testing for Biological Molecules

As noted above, each biological molecule listed in Data Table 2 can be tested for using the given test reagent and you can determine its presence or absence in a solution by a visible color or physical change. In the following activities, you will use positive and negative controls to help guide you in your determination of which biological molecules are present in your "McMush" solution. The "McMush" solution is the contents of a McDonalds Happy Meal (plain hamburger, French fries, apple slices, clear soda) blended up together (yum!).

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Activity 2: Are Monosaccharides Present?

1. Obtain 3 test tubes and label them numbers 1, 2, 3 with a wax pencil.
2. In tube 1, place 3 mL of glucose solution.
3. In tube 2, place 3 mL of distilled water.
4. In tube 3, place 3 mL of the McMush solution.
5. Add 5 drops of Benedict's solution to each tube.
6. Mix by holding the tube between the thumb and index finger of one hand and gently thumping the tube.
7. Place all three tubes into a 80°C water bath for 5 minutes.
8. Remove test tubes from the water bath using test tube tongs and place in rack.

Make sure to use the test tube tongs to remove your tubes from the water bath, the glass will be hot and can burn your fingers!

9. Record the color of each tube in the data table below.

Biological Molecule	Tube 1 Glucose	Tube 2 Distilled Water	Tube 3 McMush
Monosaccharide			

Data Table 3. Results of Activity 2

Activity 3: Are Polysaccharides Present?

1. Obtain 3 test tubes and label them numbers 1, 2, 3 with a wax pencil.
2. In tube 1, place 3 mL of starch solution.
3. In tube 2, place 3 mL of distilled water.
4. In tube 3, place 3 mL of the McMush solution.
5. Add 3 drops of Iodine solution to each tube.
6. Record the color of each tube in the data table below.

Biological Molecule	Tube 1 Starch	Tube 2 Distilled Water	Tube 3 McMush
Polysaccharide			

Data Table 4. Results of Activity 3

Activity 4: Are Proteins Present?

1. Obtain 3 test tubes and label them numbers 1, 2, 3 with a wax pencil.
2. In tube 1, place 3 mL of albumin (egg protein).
3. In tube 2, place 3 mL of distilled water.
4. In tube 3, place 3 mL of the McMush solution.
5. Add 10 drops of Biuret's solution to each tube. (NOTE: Biuret's solution is made up of Cu_2SO_4+NaOH. You have a bottle of each of these materials. To add the proper amount

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of Biuret's solution, add 5 drops of Cu_2SO_4 AND 5 drops of NaOH to each test tube). MIX CAREFULLY.

6. Record the color of each tube in the data table below

Biological Molecule	Tube 1 Albumin	Tube 2 Distilled Water	Tube 3 McMush
Protein			

Data Table 5. Results of Activity 4

Activity 5: Are Lipids Present?

7. Obtain 3 test tubes and label them numbers 1, 2, 3 with a wax pencil.
8. In tube 1, place 3 mL of vegetable oil.
9. In tube 2, place 3 mL of distilled water.
10. In tube 3, place 3 mL of the McMush solution.
11. Add a small scoop of bile salts to each tube.
12. Very carefully mix by placing your finger over the top of the tube and inverting 3–4x.
13. Record the color of each tube in the data table below

Biological Molecule	Tube 1 Vegetable Oil	Tube 2 Distilled Water	Tube 3 McMush
Lipid			

Data Table 6. Results of Activity 5

Clean-up

Please follow proper clean-up procedures.

1. Dump all test tube solutions for all activities down the sink.
2. Wash all test tubes in the sink. Make sure to get wax pencil markings off!
3. Dry test tubes and place them in the test tube racks.
4. Place all solutions back into caddies, and place caddies back on the main lab cart.
5. Spray and wipe down your lab bench area.

Data Analysis

Using the data collected from all activities, complete the questions below.

1. For activities 2 – 5, what was the purpose of Tube 1? Include your results in your explanation.

2. For activities 2 – 5, what was the purpose of Tube 2? Include your results in your explanation.

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3. Complete the table below to answer the following questions: Which biological molecules were present in McMush solution? How do you know? What is the mostly likely source of the molecule?

Biological Molecule	**Present or Absent?**	**How do you know (explain)?**	**Source of biological molecule**
Monosaccharide			
Polysaccharide			
Protein			
Lipid			

Data Table 7. Summary of all activity results and explanations.

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Case Study: Food claims – Miracle for my health or marketing ploy?

On the market today are many products that claim to have certain benefits to your health and performance. From soups that are good for your heart function to cereals that boost your immunity, these claims can be seen in almost every isle of the grocery store. Many of the claims made by these products are considered to be guidance or structure/function claims. One of the most purchased and consumed of these products are energy drinks. Are the claims that energy drinks make valid? According to the FDA website, "dietary guidance statements and structure/function claims are not subject to premarket review and authorization by FDA." So, how can you determine if these products really do what they claim? A scientific investigation of the product's ingredients can help!

Activity 6: An investigation into energy drinks

In this activity, you will use what you have learned about biological molecules to determine if the ingredients in an energy drink support the claims of the product.

1. Obtain an energy drink information sheet from your instructor.
2. Read through the basic energy drink information, including the ingredients and claims.
3. Research the main ingredients found in your energy drink. Describe what they are and what they do/their effects on the human body. Use the table below to help organize your data.

Ingredient	Effect on the Human Body

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4. In the table below, list the claims made by your energy drink. Then, using the data you have collected about the ingredients found in your energy drink, evaluate the claims of your energy drink.

Claim	Evidence	Claim Supported? (Yes/No)

5. Share your conclusions about the claims of your energy drink with another lab group.

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Name: _____
Date: _____

Cell Structure and Function

Cells are considered the smallest *living* unit. All living things are made of one or more cells. All cells share several characteristics, including the presence of genetic material (DNA), the ability to carry out metabolic processes and synthesize proteins, and the presence of a plasma membrane. There are two major types of cells, prokaryotic and eukaryotic. Several differences exist between prokaryotic and eukaryotic cells. One key difference is the absence or presence of membrane bound organelles, compartmentalized structures that carry out specific processes. Prokaryotic cells do not have organelles, so all processes happen in the cytosol, which is also where DNA is found. Eukaryotic cells do contain organelles, and are highly organized. This is most noticeable by the presence of a nucleus, the organelle that houses DNA. Eukaryotic cells can be classified as plant or animal cells. In this lab we will focus on animal eukaryotic cells, the cells that make up the human body.

Learning Outcomes

After completing this lab activity, you should be able to

1. Identify the major structures of a eukaryotic cell and explain their functions
2. Identify key structures of a eukaryotic cell under the microscope
3. Explain the regulation of movement of materials in and out of a cell

The Composite Eukaryotic Cell

When learning about eukaryotic cells and studying models, we typically see them as a composite model. This means that we see a model that has all the possible structures and organelles a eukaryotic cell might or can have. Some cells of the human body are similar to a composite cell, meaning that they contain almost every structure and organelle. However, in the human body different cell types have different functions and their function will determine which structures and organelles they have. For example, a skeletal muscle fiber (cell) can have thousands of mitochondria, while a red blood cell has no mitochondria!

Activity 1: Functions of organelles and other structures

Using what you have learned in this unit from lecture, your textbook, and any resources available in the lab, list the functions of the organelles and structures listed below.

Nucleus: _____

Ribosome: _____

Rough ER: _____

Smooth ER: _____

Golgi Apparatus: _____

Mitochondria: _____

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Lysosome: _____

Peroxisome: _____

Centrioles: _____

Cytosol: _____

Plasma Membrane: _____

In the introduction above, it was noted that the function of a cell determines what structures/organelles it has. The cells of the human body differ very widely in function, and so in structure. Why do you think a skeletal muscle fiber (cell) can have thousands of mitochondria, while a red blood cell has no mitochondria?

_____

_____

_____

_____

Activity 2: Drawing a composite cell

In the space below, draw the composite cell model available in the lab. Label the following structures:

☐Nucleus	☐Ribosome	☐Rough ER	☐Smooth ER
☐Golgi Apparatus	☐Mitochondria	☐Lysosome	☐Peroxisome
☐Centrioles	☐Cytosol	☐Plasma Membrane	

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Activity 3: Viewing a eukaryotic cell under the microscope

For this activity, you will view one of your very own cells under the microscope.

1. Obtain a new microscope slide.
2. Using a sterile toothpick, scrape the inside of your cheek.
3. Immediately rub the end of the toothpick on the center of your microscope slide.
4. Place the used toothpick into the biohazard container.

   Make sure to place your toothpick directly into the biohazard container. It contains your bodily fluids (saliva), and should not be set down on ANY lab surface!
5. Add one SMALL drop of methylene blue stain on your microscope slide, directly on top of where you rubbed the end of your toothpick.
6. Cover the drop with a cover slip.
7. Place your prepared slide onto the microscope stage.
8. View your cheek cells under high-power.
9. Draw what you see below. Label the following structures in your drawing: Nucleus, Cytosol, Plasma Membrane.

Object's Name: _____

Total Magnification: _____

10. When you are done viewing, place your microscope slide into the sharps container.

Movement of Materials

Cells are highly selective in what materials they allow in and out. The main structure that is responsible for this regulation is the plasma membrane. Whether materials can move in or out through the plasma membrane depends on their size, polarity, charge, and transport mechanisms.

Diffusion is a type of transport mechanism. Diffusion works based on the presence of a concentration gradient, where molecules move from areas of high concentration to areas of low concentration. **Osmosis** is a special type of diffusion where water moves from areas of high concentration to low concentration through a semipermeable membrane. The environment a cell finds itself in will determine the movement of water in or out of the cell. Cells like to be in an isotonic solution. An **isotonic solution** is one where there is the same amount of water inside the cell as outside of the cell, so there is no net movement of water. When cells find themselves in a **hypertonic solution**, water will move out of the cell to the

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surrounding environment. This is because a hypertonic solution has a lower water concentration than inside of the cell. This will cause a cell to shrivel up. When cells are in a **hypotonic solution**, water moves into the cell from the surrounding environment. A hypotonic solution has a higher water concentration than the inside of the cell, which causes the cell to swell up and possibly burst.

Activity 4: The artificial cell

In this activity, you will create a cell with a semipermeable membrane to test what materials can move in and out of the cell.

1. Obtain a piece of dialysis tubing (that has already been soaked by the instructor). This will act as a semipermeable membrane.
2. Close one end of the dialysis tubing off by placing a clamp on it.
3. Open up the dialysis tubing on the other end by rubbing it in between your fingers.
4. Fill the dialysis tubing with starch solution and close the bag by placing another clamp on the open end.
5. Weigh your artificial cell and record the weight in grams in Data Table 1.
6. Fill a beaker with DI water.
7. Add about 20 drops of Iodine solution to the beaker of water, until the water is yellowish in color.
8. Record the colors of the solution in the beaker and inside the artificial cell in Data Table 2.
9. Place the artificial cell in the beaker and let sit, undisturbed for at least 30 minutes.
10. After 30 minutes has passed, weigh your artificial cell again and record the weight in grams in Data Table 1.
11. Record the colors of the solution in the beaker and inside the artificial cell in Data Table 2 and answer the questions below.

Sample	**Beginning Weight**	**Final Weight**
Artificial Cell		

Data Table 1. Weight of artificial cell before and after activity.

Sample	**Color Before**	**Color After**
Beaker Solution		
Solution inside cell		

Data Table 2. Colors of solutions before and after activity.

Based on your observations in the data table above, what molecules moved in and/or out of the cell? How do you know?

_____

_____

_____

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Why didn't all the molecules move in and/or out to create a completely isotonic solution?

_____

_____

_____

Activity 5: The effects of the external environment on a cell

In this activity, you will expose cells to several different external environments to see how they respond.

1. Obtain 4 test tubes and using a wax pencil label them: 0%, 5%, 10%, and unknown.
2. Obtain a potato and using a potato corer, cut 4 potato cores. Try to make your 4 cores equal in size (length and width).
3. Weigh each potato core, and record these initial weights in grams in Data Table 3.
4. Place each core into one of the labeled test tubes from step 1.

   Make sure to place the correct cores into the correct tubes, so it matches your data table. If you mis-match your cores, your data will not turn out correctly!

5. Fill each test tube with the correct solution (matching the tube labels). Add enough solution to each test tube so the potato core is just submerged.
6. Place all tubes in a test tube rack and let sit for 1 hour undisturbed.
7. After 1 hour has passed, remove solution from tubes. The solutions can be dumped down the sink.
8. Weigh each potato core again, and record these final weights in grams in Data Table 3. Calculate the weight changes and answer the questions below.
9. Discard your potato cores into the potato waste collection bin. DO NOT place them into the regular trash can…..they will stink up the room!
10. Rinse your test tubes in the sink, dry, and place back on test tube racks.

Solution	**Initial Weight**	**Final Weight**	**Weight Change (final weight – initial weight)**	**% Weight Change (weight change/initial weight x 100)**
0 % Salt (DI Water)				
5% Salt				
10 % Salt				
Unknown				

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For each solution, list whether it was isotonic, hypertonic, or hypotonic to the potato cells and explain how you know.

0 % Salt: _____ Explanation: _____

5 % Salt: _____ Explanation: _____

10% Salt: _____ Explanation: _____

Unknown: _____ Explanation: _____

Based on your data, what % salt do you think the unknown solution contains and why?

_____

_____

_____

Potato cells behave the same way our own cells would in the test solutions. The unknown solution is the equivalent solution to that of an energy drink. Based on your data, if you were dehydrated, would drinking an energy drink help to hydrate you? Why or why not?

_____

_____

_____

_____

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Name: _____
Date: _____

DNA Structure and Function

Deoxyribonucleic Acid, DNA, is the set of instructions found inside cells that tells them what to become, what to do, and when to do it. In human cells (eukaryotes), the DNA is housed inside the nucleus, where its complex structure holds all of the genetic information that regulates cellular activities.

Learning Outcomes

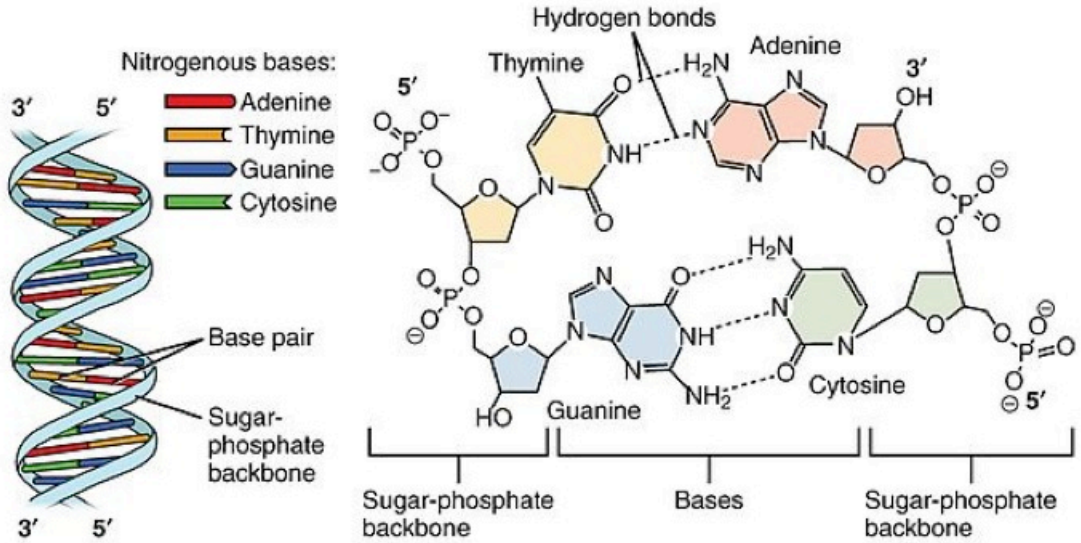
After completing this lab activity, you should be able to

1. Describe the molecular structure of DNA and RNA
2. Perform the process of transcription using models and on paper
3. Perform the process of translation using models and on paper

DNA as the genetic material

A DNA molecule is made of two strands that "complement" each other in the sense that the molecules that compose the strands fit together and bind to each other, creating a double-stranded molecule that looks much like a long, twisted ladder. Each side rail of the DNA ladder is composed of alternating sugar and phosphate group. The two sides of the ladder are not identical, but are complementary. These two backbones are bonded to each other across pairs of protruding bases, each bonded pair forming one "rung," or cross member. The four DNA bases are adenine (A), thymine (T), cytosine (C), and guanine (G). Because of their shape and charge, the two bases that compose a pair always bond together. Adenine always binds with thymine, and cytosine always binds with guanine. The particular sequence of bases along the DNA molecule determines the genetic code. Therefore, if the two complementary strands of DNA were pulled apart, you could infer the order of the bases in one strand from the bases in the other, complementary strand. For example, if one strand has a region with the sequence AGTGCCT, then the sequence of the complementary strand would be TCACGGA.

Molecular Structure of DNA



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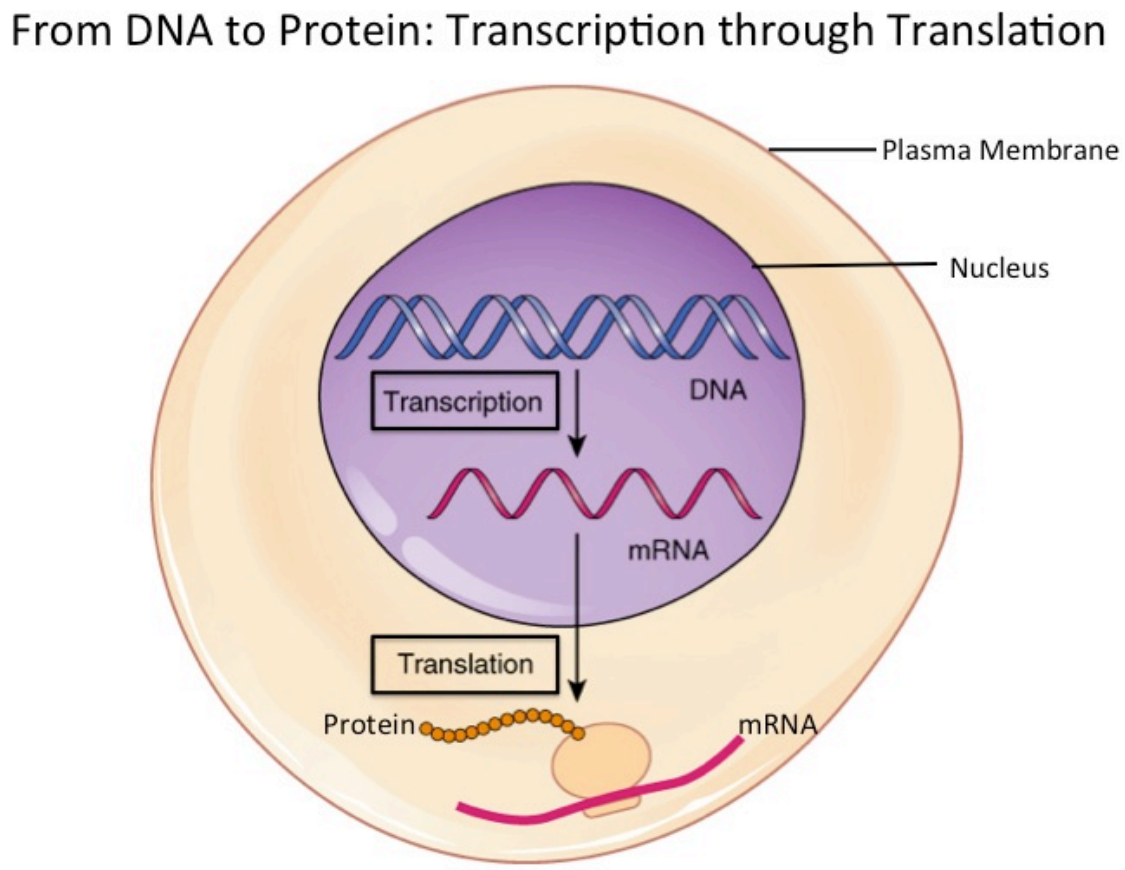
DNA stores the information necessary for instructing the cell to perform all of its functions. Cells use the genetic code stored within DNA to build proteins, which ultimately determine the structure and function of the cell. This genetic code lies in the particular sequence of nucleotides that make up each gene along the DNA molecule. To "read" this code, the cell must perform two sequential steps. In the first step, **transcription**, the DNA code is converted into a RNA code. A molecule of messenger RNA that is complementary to a specific gene is synthesized. The molecule of mRNA provides the code to synthesize a protein.

There are several different types of RNA, each having different functions in the cell. The structure of RNA is similar to DNA with a few small exceptions. For one thing, unlike DNA, most types of RNA, including mRNA, are single-stranded and contain no complementary strand. Second, the ribose sugar in RNA contains an additional oxygen atom compared with DNA. Finally, instead of the base thymine, RNA contains the base uracil. This means that adenine will always pair up with uracil during the protein synthesis process.

In the process of **translation**, the mRNA attaches to a ribosome. Next, tRNA molecules shuttle the appropriate amino acids to the ribosome, one-by-one, coded by sequential triplet codons on the mRNA, until the protein is fully synthesized. When completed, the mRNA detaches from the ribosome, and the protein is released.



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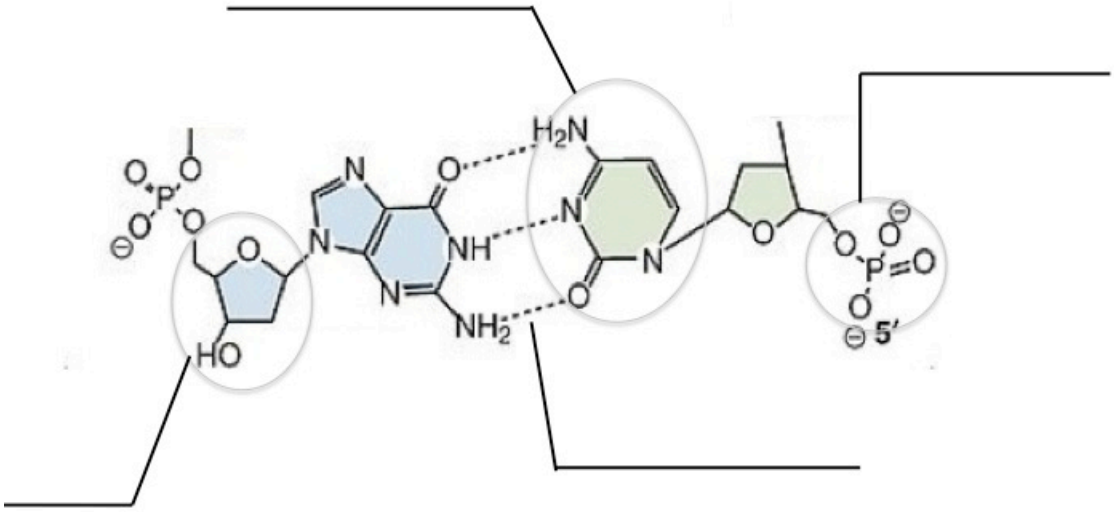
Activity 1: DNA and RNA Coding

Using what you have learned about the structure of DNA and RNA and the processes of transcription and translation, complete the following questions.

1. Label the following structures:



2. Complete the complementary DNA sequence for the following DNA strand:

3' A T A G C T G G A A T C G T C 5'

5' ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ 3'

3. Using the same DNA strand, complete the complementary mRNA strand:

3' A T A G C T G G A A T C G T C 5'

5' ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ 3'

4. With the codon charts provided in the lab, use the mRNA strand you developed above to create the amino acid sequence it codes for:

_____ _____ _____ _____ _____

Activity 2: Transcription and Translation Simulation

1. Using the kits provided in class, follow the instruction manuals to simulate the process of transcription and translation.

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Activity 3: DNA Isolation

Knowing about DNA and actually seeing real DNA are two very different experiences. For this lab activity, we will extract DNA from your very own cells, giving you real, tangible evidence that there is DNA inside all of your cells.

Harvesting your Cells

1. Obtain a cup with 10 ml of liquid and a clean test tube.
2. Label your cup and test tube with your initials.
3. Put the liquid in your mouth and swirl for about 30 seconds. While doing this, scrape your teeth against your cheeks to liberate as many cells as possible.
4. Spit the liquid and cells back into your cup.
5. Using a pipet, put 2-3 ml of your liquid and cells mixture into a test tube.
   a. DISGAURD INSTRUCTIONS FOR PIPET: The pipet now has your bodily fluid (saliva) on it and must be placed into a beaker of bleach.

Lysis of Cells/ Release of DNA

6. Add 1 ml of 25% soap solution to your test tube.
7. **SLOWLY AND GENTLY** invert the test tube 3 – 4 times. (DO NOT SHAKE)
8. Incubate the test tube in a 55°C water bath for 5 minutes.
9. Using test tube tongs, remove your tube from the water bath and **SLOWLY AND GENTLY** invert the tube 3 – 4 times.

Precipitating the DNA

10. Hold the test tube at a 45-degree angle and slowly add 5 ml of alcohol. Add the alcohol so it slowly runs down the side of the test tube into your solution.
11. At this point, you should have 2 layers in your test tube (cheek cell material on the bottom and alcohol on the top).
12. Hold the tube upright, and the DNA will precipitate out.

DNA Collection

13. Obtain a microcentrifuge tube.
14. Add 0.5 ml of alcohol to the microcentrifuge tube.
15. Place a clean glass-stirring rod into your test tube and carefully turn the rod in one direction in a swirling motion. This will cause your DNA to wrap around the rod.
16. Carefully remove the rod with the DNA and transfer it into the microcentrifuge tube containing alcohol.
17. Cap your microcentrifuge tube. You now have a sample of your very own DNA!

Clean-up

- Cups with left over liquid: Dump the liquid into the discard container with bleach and place cup into the regular lab trash.
- Test tube material: Dump any material in your test tube into the same discard container with bleach that left over fluid went into. Place the empty test tube into the basin with bleach.

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Date: _____

Mitosis & Meiosis

Cells are the smallest unit of living material. According to Cell Theory, all cells come from existing cells. This is possible through the two processes of cell division, Mitosis and Meiosis, which allow organisms to grow and reproduce.

Learning Outcomes

After completing this lab activity, you should be able to

1. Describe how every living cell gets a full set of DNA
2. Distinguish between the two processes of cell division
3. Explain how genetic diversity is generated through the process of Meiosis.

The Cell Cycle

Cells spend most of their time growing and preparing for cell division rather than dividing. A cell spends 90% of its time in Interphase, which consists of G1 (growth phase), S (synthesis phase), and G2 (growth phase), and only 10% on cell division, or mitosis (Figure 1). S phase is an especially important phase of the cell cycle, as this is when DNA replication occurs. After S phase, each cell has 2 full copies of DNA. The cell cycle is carefully regulated by genes. As the cell moves from phase to phase, genes direct cell activity, such as the synthesis of DNA, and assembling proteins into spindle fibers. Genes also act as stoplights at each step of the cell cycle, making sure each phase stops and starts at the proper time. If this regulation is lost, the result is cells dividing out of control, also known as cancer.

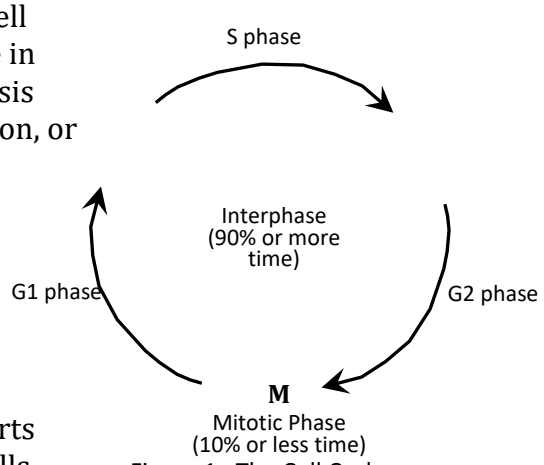

Figure 1. The Cell Cycle

Mitosis

In order for organisms to grow and repair themselves, they must be able to replicate their cells. The process that is responsible for this is known as Mitosis. Through the process of Mitosis one cell can produce two, genetically identical cells. The Mitotic phase can be broken into four major steps: Prophase, Metaphase, Anaphase, and Telophase (Figure 2). During Prophase, chromosomes condense, the nucleus starts to dissolve, and spindle fibers from the centrioles start to form. Metaphase is recognized by all of the chromosomes lining up at the equator of the cell, under the direction of the spindle fibers, which are connected to each chromosome at the centromere. Next, in Anaphase, we see the sister chromatids being pulled apart from each other to either pole of the cell, again under the direction of the spindle fibers. During Telophase, the nucleus starts to reform around each group of separated chromosomes. Once Telophase is complete, a process known as Cytokinesis occurs, which separated the cytoplasm of the two newly formed cells. The end result is two, genetically identical cells.

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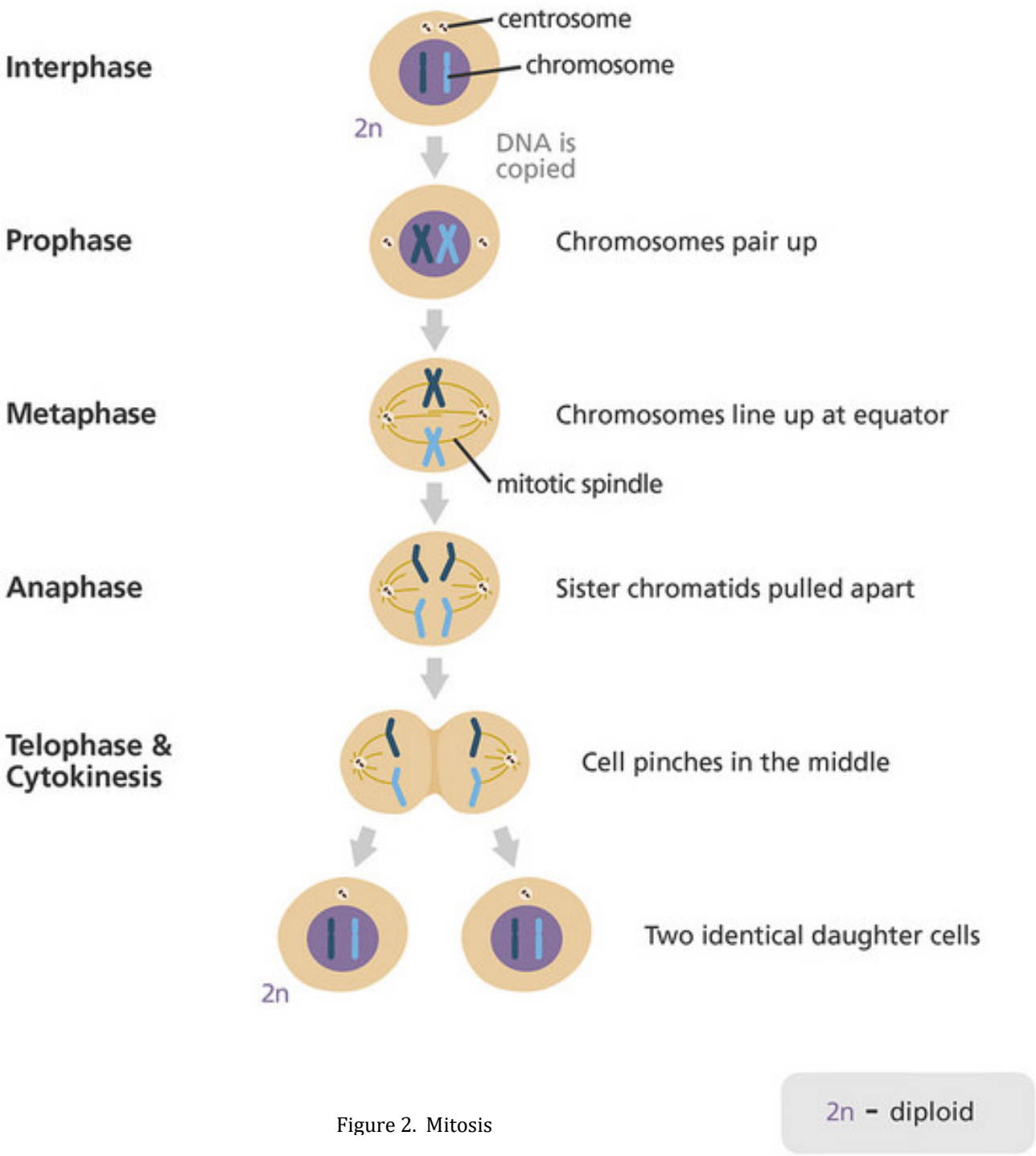

Figure 2. Mitosis

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Activity 1: Observing Lab Models

Replicated Chromosome

1. Study the model of the replicated chromosome available in the lab. Using the model and Figure 3 below, answer the questions below.

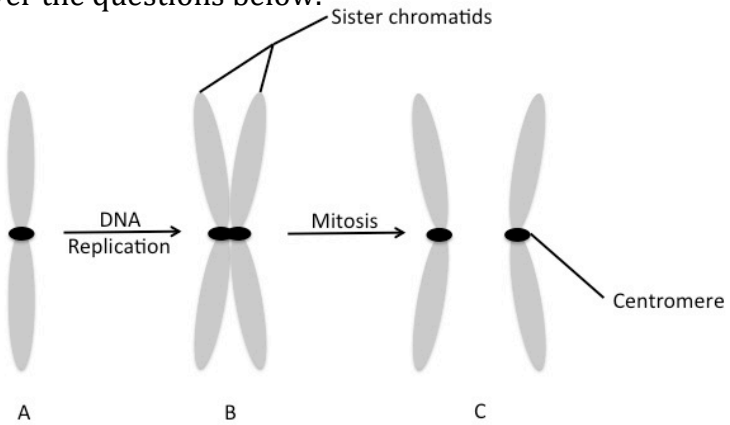

Figure 3. A chromosome is shown before DNA replication (A) when it consists of a single DNA molecule and after replication when the two copies of DNA molecules are held together at the centromere region (B). The centromere region is a constricted area of the chromosome where spindle fibers will attach during mitosis when they help separate sister chromatids and move them to opposite poles of the cell. Once the sister chromatids have separated they are each called chromosomes (C). The new chromosomes (C) are identical copies of the original chromosome (A).

During what phase of the cell cycle does DNA replication occur? _____

What structure holds sister chromatids together and also serves as a point of attachment for spindle fibers? _____

What phase of mitosis are sister chromatids separated from each other? _____

Why should sister chromatids actually be call "twin sister chromatids"?

_____

_____

Mitosis Models

1. Study the models of animal cells going through the process of Mitosis.
2. Identify each phase by mixing them up, then putting them into the correct order.

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Animal Cell Mitosis Microscope Slide

1. Obtain a white fish blastula slide.
2. Using your microscope skills, view the slide under high power.
3. Scan the microscope slide on high power to find cells in interphase and all phases of Mitosis. Draw each phase in the correct place below and answer the questions below.
    - You will be able to find all of these phases on the same slide!

Object: Interphase
Total Magnification: _____

Object: Anaphase
Total Magnification: _____

Object: Prophase
Total Magnification: _____

Object: Telophase
Total Magnification: _____

Object: Metaphase
Total Magnification: _____

Only a relatively small percentage of the white fish blastula cells are seen in the various phases of mitosis, while most are in interphase. How do you account for this?

_____

_____

Activity 2: Modeling the process of Mitosis

In this activity, you will model the process of mitosis using strings of beads to represent chromosomes. You will use only two pairs of chromosomes for this activity, even though there are 23 pairs of chromosomes in a human cell.

1. Get four long and four short strings of beads. Attach similar pairs together by their magnets. Each string of beads represents a chromatids and the magnet represent the centromere. You now have two pairs of homologous chromosomes, each consisting of two sister chromatids, to model the process of Mitosis.

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2. Using chalk, draw a nucleus surrounded by a plasma membrane (represented as two concentric circles) on the lab bench. Place your chromosomes inside the nucleus. This represents **prophase**.
3. Erase the nucleus (inner circle) and line up the centromeres of each chromosome in the middle of the cell. This represents **metaphase**.
4. Separate each pair of chromatids by moving each member of the pair to the opposite sides of the cell. This represents **anaphase**.
5. Draw a new nuclear membrane around each of the separated chromosome pairs. This represents **telophase**, the last phase in mitosis.
6. Redraw the plasma membrane so that you have two individual cells each with its own nucleus. This is **cytokinesis** (or the splitting of the cytoplasm).

Meiosis

Human reproduce through sexual reproduction, which mixes the DNA of a male and female to produce a brand new human. In order to do this, a female must donate half of DNA needed, while a male donates the other half. This requires the human body to produce gametes, or reproductive cells (eggs and sperm), that contain half the amount of DNA as a normal somatic (body) cell. The process responsible for producing gametes is known as Meiosis.

Meiosis is similar to Mitosis in that when cells enter Meiosis, they have gone through Interphase, and so have 2 copies of DNA (from S phase). It also goes through the stages Prophase, Metaphase, Anaphase, and Telophase, however, in Meiosis there are two rounds of division and is split into Meiosis I and Meiosis II, each of which goes through the four stages.

Meiosis I begins with Prophase I when chromosomes condense, the nucleus starts to dissolve, and spindle fibers from the centrioles start to form. Prophase I is the first stage of Meiosis where genetic variation is created due to a process called crossing over. During crossing over (Figure 4), homologous chromosomes come together and 'swap' pieces of their DNA, creating a new unique genetic code for that chromosome.

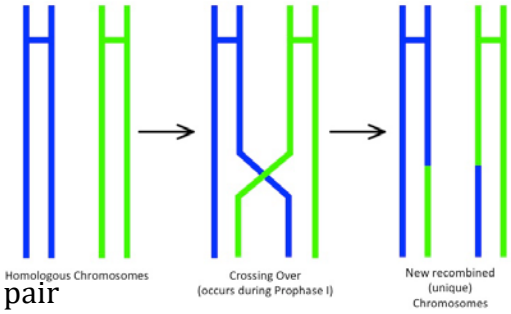

Figure 4. Crossing Over

Next is Metaphase II, when homologous chromosomes pair up together and line up at the equator of the cell. This is the second stage of Meiosis that genetic variation is generated. When the homologous chromosomes pair up, they do this independently of each other, and may line up differently every time. This process is called independent assortment. Once the homologous chromosomes have paired up, they are pulled apart to the poles of the cell by the spindle fibers during Anaphase II. Once separated, the nucleus starts to reform around each separated set of chromosomes during Telophase II and the one cell splits into two during cytokinesis to complete Meiosis I. The two newly formed cell then immediately begin Meiosis II, which resembles the process of Mitosis. It begins with Prophase II when chromosomes condense, the nucleus starts to dissolve, and spindle fibers from the centrioles start to form. Then, during Metaphase II chromosomes line up at the equator of the cell. This is the third stage where genetic variation is generated during Meiosis. Like in Metaphase I, the chromosomes line up independently of each other with no set arrangement, again in the process of independent assortment. Sister chromatids are then separated from each other to opposite poles of the cell by the spindle fibers during Anaphase II. A nucleus then reforms

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around the newly separated chromosomes during Telophase II and cytokinesis splits the cells into two. The result of Meiosis is four, genetically different cells, each with half the amount of DNA of a normal body cell.

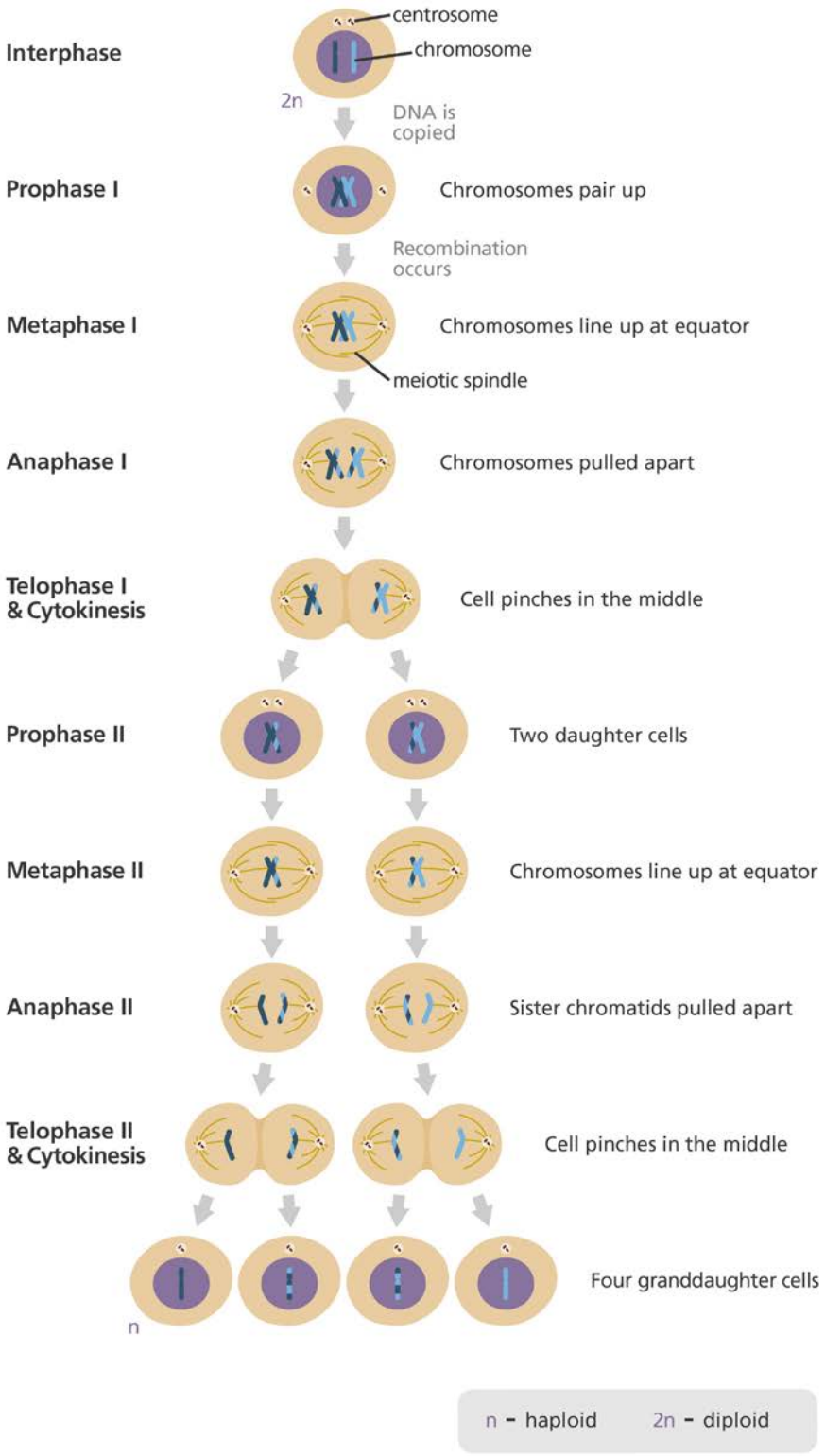

Figure 5. Meiosis

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Activity 3: Modeling the process of Meiosis

In this activity, you will model the process of Meiosis using strings of beads to represent chromosomes. You will use only two pairs of chromosomes for this activity, even though there are 23 pairs of chromosomes in a human cell.

1. Get four long and four short strands of beads representing two homologous chromosome pairs. Attach two of the long strands together by the magnets. Repeat with the other long strands and with the short strands. You should now have two pairs of homologous chromosomes, a long pair and a short pair.
2. Using chalk, draw a nucleus surrounded by a plasma membrane (represented as two concentric circles) on the lab bench. Place your chromosomes inside the nucleus. This represents **Prophase I**. This is the phase were crossing over occurs.
3. **Metaphase I**. Erase the nucleus (inner circle) and arrange the centromeres of the homologous pairs on opposite side of the middling of the cell. Members of each pair of homologous chromosomes should be lined up opposite each other. How they line up relative to the line is random in nature (independent assortment).
4. **Anaphase I**. Separate the two pairs of homologous chromosomes by moving each pair to opposite sides of the cell. Each chromosome still consists of two chromatids.
5. **Telophase I**. Draw a new nuclear membrane around each separated chromosome pairs.
6. Cytokinesis (splitting of the cytoplasm). Redraw the plasma membrane so that you know have two individual cells each with its own nucleus.
7. **Prophase II**. Erase the nucleus (inner circle) of each cell.
8. **Metaphase II**. Line up the centromere of the chromosomes at the midline of the cells.
9. **Anaphase II**. Separate the sister chromatids to opposite sides of the cell.
10. **Telophase II**. Draw a new nuclear membrane around each of the chromosome sets.
11. Cytokinesis. Redraw the plasma membrane so you now have four individual cells each with its own nucleus.

List the three stages of meiosis where genetic variation is generated, and list and explain the process at these stages that occurs.

Stage	Process (& explanation)
_____	_____
_____	_____
_____	_____

Why is it so important that each cell produced in Meiosis only gets half the amount of DNA as a normal body cell?

_____

_____

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Name: _____
Date: _____

Genetics

In humans, our DNA code (genotype) is inherited from parents to offspring, and most of these inherited traits can be observed through our physical appearance (phenotype). There are many tools we have to explore inheritance patterns in humans, many of which will be explored in these lab activities.

Learning Outcomes

After completing this lab activity, you should be able to

1. Apply genetics terminology to humans
2. Complete monohybrid and dihybrid crosses to determine possible offspring from genetic crosses.
3. Explain and determine inheritance patterns for traits that do not follow simple inheritance patterns.
4. Analyze pedigrees to determine inheritance patterns.
5. Determine your own genotype and phenotype of traits that follow simple inheritance patterns.

Genetics Terminology

Study the following terms related to genetics:
Allele – alternate form of a gene (trait)
Dominant allele – gene of allele pair that is expressed when present
Recessive allele – gene of allele pair that is expresses ONLY when it is both alleles of pair (is masked in the present of the dominant allele)
Genotype – the actual genes (GG-Homozygous dominant/Gg-Heterozygous/gg-homozygous recessive)
Phenotype – the physical appearance of the individual due to the expression of the genotype
Heterozygous – two different allele present (Gg)
Homozygous – two identical alleles present (GG or gg)

Activity 1: Practice with genetics terminology

1. Given the allele combinations below, list the genotype (homo dom, het, or homo rec).

AA _____ ff _____ kk _____

Bb _____ GG _____ Ll _____

Cc _____ HH _____ mm _____

Dd _____ Ii _____ nn _____

Ee _____ Jj _____ OO _____

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2. For each of the genotypes below determine what phenotypes are possible.

Widow's peak is dominant to straight hairline

WW _____

Ww _____

ww _____

Unattached earlobes are dominant to attached

UU _____

Uu _____

uu _____

Tongue rolling is dominant

TT _____

Tt _____

tt _____

Smooth chin is recessive to cleft chin

CC _____

Cc _____

cc _____

3. For each phenotype below, list the genotypes using alleles (use the letter of the dominant trait)

Freckles are dominant to no freckles

_____ Freckles

_____ Freckles

_____ No freckles

Dimples on face are dominant to no dimples

_____ Dimples

_____ Dimples

_____ No dimples

"Practice with genetics terminology" / A derivative from the original work

Simple (Mendelian) Inheritance

Some traits carried on autosomal chromosomes (pairs 1 – 22) are inherited on a single gene with the possibility of two alleles, dominant or recessive. Because these traits have an easy inheritance pattern to predict, they are known to follow a Simple, or Mendelian, Inheritance pattern.

Activity 2: Monohybrid crosses

One way to predict the inheritance pattern of a single trait the has a simple inheritance pattern is through the use of a Punnett Square. In this activity you will practice determining single trait, or monohybrid, inheritance using Punnett Squares.

1. Set up and complete the Punnett Square for each of the crosses listed below. Then, use your results to determine the possible genotypic and phenotypic ratios. For each, brown eyes are dominant to blue eyes.

Bb x bb

Genotypic Ratio: _____ : _____ : _____

(Homo Dominant) (Hetero-zygous) (Homo Recessive)

Phenotypic Ratio: _____ : _____

(dominant) (recessive)

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Bb x Bb

Genotypic Ratio: _____ : _____ : _____
(Homo Dominant) (Hetero-zygous) (Homo Recessive)

Phenotypic Ratio: _____ : _____
(dominant) (recessive)

BB x Bb

Genotypic Ratio: _____ : _____ : _____
(Homo Dominant) (Hetero-zygous) (Homo Recessive)

Phenotypic Ratio: _____ : _____
(dominant) (recessive)

For all of the following word problems, use Punnett squares to determine the correct answer. Show all of your work!

2. A tongue rolling female (TT) mates with a non-tongue rolling male (tt).

   What percentage of the children will be tongue rolling? _____

3. Show a cross of two heterozygous parents for tongue rolling (Tt).

   What percentage of the children will be non-tongue rolling? _____

   What percentage of the children will be tongue rolling? _____

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4. A heterozygous male for attached earlobes (Aa) mates with a homozygous attached earlobes female (AA).

   What percentage of the children will be homozygous dominant? _____

5. A homozygous attached earlobes female mates with a homozygous unattached earlobes male.

   What are the genotypes of the parents? _____ x _____

   What percentage of the children will also be homozygous (dominant or recessive? _____

   What is the genotype of all of the children? _____

6. Freckles are dominant to no freckles. Two people with no freckles mate……..

   What percentage of their children have no freckles? _____

7. A no freckles male mates with a female heterozygous for the trait.

   What percentage of the offspring will have freckles? _____

8. Two people heterozygous for freckles mate.

   What percentage of their children have freckles? _____

   What percentage of their children have no freckles? _____

"Monohybrid crosses" / A derivative from the original work

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Activity 3: Dihybrid crosses

Traits that follow a simple inheritance pattern are inherited independently of eachother, meaning offspring may end up with any possible combination of these traits. One way to predict the inheritance pattern of two traits that follow simple inheritance patterns is through the use of a Punnett Square. In this activity you will practice determining two trait, or dihybrid, inheritance using Punnett Squares.

Complete the following problems, showing all your work.

In humans, cleft chin is dominant to a smooth chin. Also, dimples on the face are dominant to no dimples. These letters represent genotypes and phenotypes for these traits:

CC = cleft chin	DD = dimples
Cc = cleft chin	Dd = dimples
cc = smooth chin	dd = no dimples

1. A male with genotype CCdd mates with a female with the genotype ccDd. The square is set up below. Fill out and determine phenotypes and proportions of offspring.

	Cd	Cd	Cd	Cd
cD				
cd				
cD				
cd				

How many out of 16 have cleft chin and dimples? _____

How many out of 16 have cleft chin and no dimples? _____

How many out of 16 have a smooth chin and dimples? _____

How many out of 16 have a smooth chin and no dimples? _____

2. Show the cross: CcDd x ccDd

How many out of 16 have cleft chin and dimples? _____

How many out of 16 have cleft chin and no dimples? _____

How many out of 16 have a smooth chin and dimples? _____

How many out of 16 have a smooth chin and no dimples? _____

"Dihybrid crosses" / A derivative from the original work

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Non-Mendelian Inheritance

Not all human traits follow a simple inheritance pattern. Some traits have multiple (more than two) alleles. Some traits exhibit codominance, where both the dominant and recessive alleles are seen in the phenotype, as seen in the human blood type. And some traits exhibit incomplete dominance, where heterozygotes have a phenotype 'in-between' dominant and recessive. For example, in flowers, red is dominant and white it recessive. Heterozygotes are pink.

Activity 4: Blood Typing – Multiple Alleles & Codominance

The human blood type is controlled by multiple alleles (A, B, O) and also exhibits codominance when the A & B alleles are present. In this activity you will practice applying these two principles by completing human blood type scenarios.

Complete the following problems, showing all your work.
Blood type is controlled by three alleles: A, B, O. A & B are codominant, O is recessive.

1. a) What are the two genotypes possible for a person who has A blood? _____ & _____
   b) What genotype does a person with AB blood have? _____
   c) What genotype does a person with O blood have? _____
   d) What are the two genotypes possible for a person who has B blood? _____ & _____

2. A man with type AB blood is married to a woman also with type AB blood.

   What percentage of their children will have:

   A blood? _____ B blood? _____ AB blood? _____ O blood? _____

3. A man with type B blood (BB) is married to a woman with type O blood.

   What blood type will all their children have? _____
   What is the genotype of their children? _____

4. A woman with type A blood (AO) is married to a type B (BO) person.

   What percentage of their children will have:
   A blood? _____ B blood? _____ AB blood? _____ O blood? _____

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5. A woman with type A blood is claiming that a man with type AB blood is the father of her child who is type B.

   Could this man be the father of the child? _____
   Assuming that he is the father, what must the mother's genotype be? _____

6. A man with type AB blood is married to a woman with type O blood. They have two natural children and on adopted child. Madison has type A blood, Buster has type B blood, and Bruce has type O blood.

   Which child was adopted? Explain. _____

   _____

"Blood Typing - Multiple Alleles & Codominance" / A derivative from the original work

Sex-linked Inheritance

Some human traits are carried on the sex chromosomes, most commonly on the X chromosome. (Remember females are XX, males are XY). Because these chromosomes are genetically different, inheritance patterns differ slightly from simple inheritance.

Activity 5: Sex-linked traits

In this activity, you will see how traits carried on sex chromosomes are inherited.

Complete the following problems, showing all your work.
In humans, color blindness is a sex-linked trait. Normal vision (B) is dominant to color blindness (b), which is recessive.

1. What are the sexes AND phenotypes of humans with the following genotypes:

   X^BX^b _____ X^BY _____ X^bX^b _____

   X^BX^B _____ X^bY _____

2. What are the genotypes of the following humans:

   Colorblind male _____ Normal vision female (heterozygote) _____
   Colorblind female _____ Normal vision male _____

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3. A colorblind female mates with a normal vision male.

What percentage of children are:
Colorblind male _____ Colorblind female _____
Normal vision male _____ Normal vision female _____

4. A normal vision homozygous female mates with a colorblind male.
What are the genotypes of the parents? _____ x _____

What percentage of children are:
Colorblind male _____ Colorblind female _____
Normal vision male _____ Normal vision female _____

5. A normal vision heterozygous female mates with a normal vision male.
What are the genotypes of the parents? _____ x _____

What percentage of children are:
Colorblind male _____ Colorblind female _____
Normal vision male _____ Normal vision female _____

"Sex-linked traits" / A derivative from the original work

Pedigrees

In human genetics, pedigrees are used to trace inheritance patterns of traits through multiple generations. In many cases, they are used to trace genetic diseases. Pedigrees can show the history of an inherited disease in a family and can also give insight for future generations.

Activity 6: Pedigree Analysis

In this activity, you will analyze several pedigrees to determine inheritance patterns.

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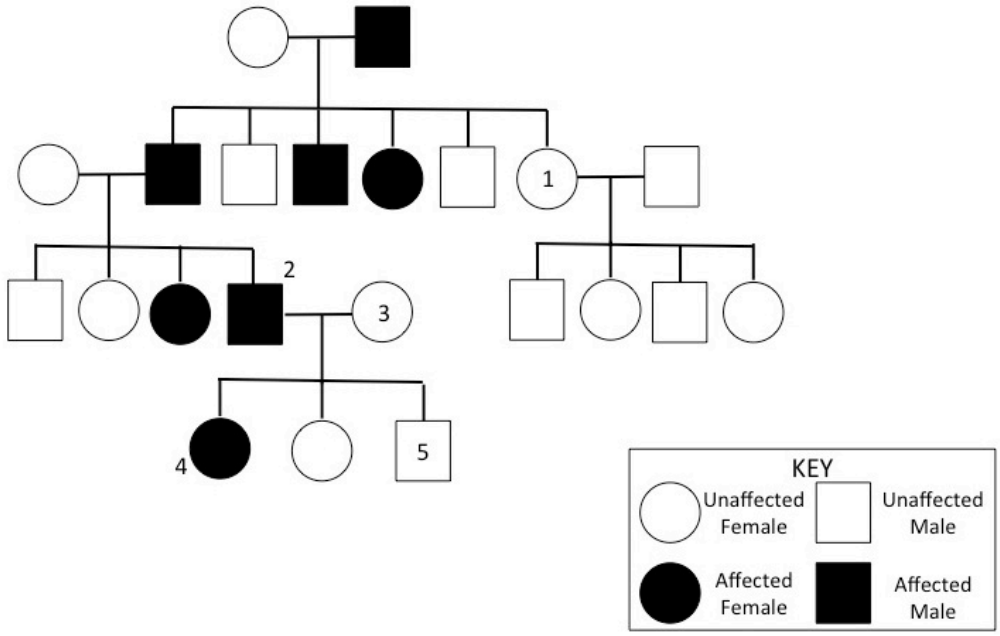
1. Use the following pedigree to answer the questions below.



What is the most likely mode of inheritance for this pedigree? (Choose from autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive)

_____

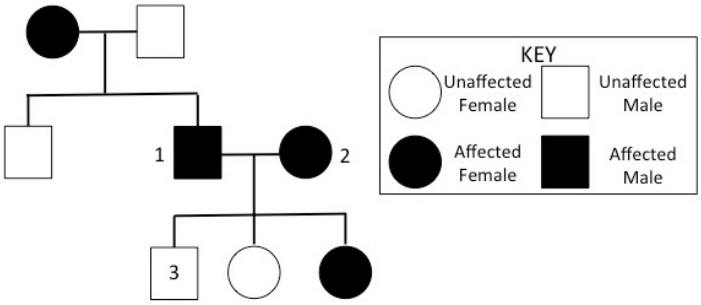
List all possible genotypes of individuals 1 – 5 in the pedigree using letter "A". Use the upper case letter for the dominant allele and the lowercase letter for the recessive allele.

1 _____ 2 _____ 3 _____ 4 _____ 5 _____

If individuals 2 & 3 have another son, what is the chance that this son would be affected?

_____

2. Use the following pedigree to answer the questions below.



What is the most likely mode of inheritance for this pedigree? (Choose from autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive)

_____

List all possible genotypes of individuals 1 – 3 in the pedigree using letter "B". Use the upper case letter for the dominant allele and the lowercase letter for the recessive allele.

1 _____ 2 _____ 3 _____

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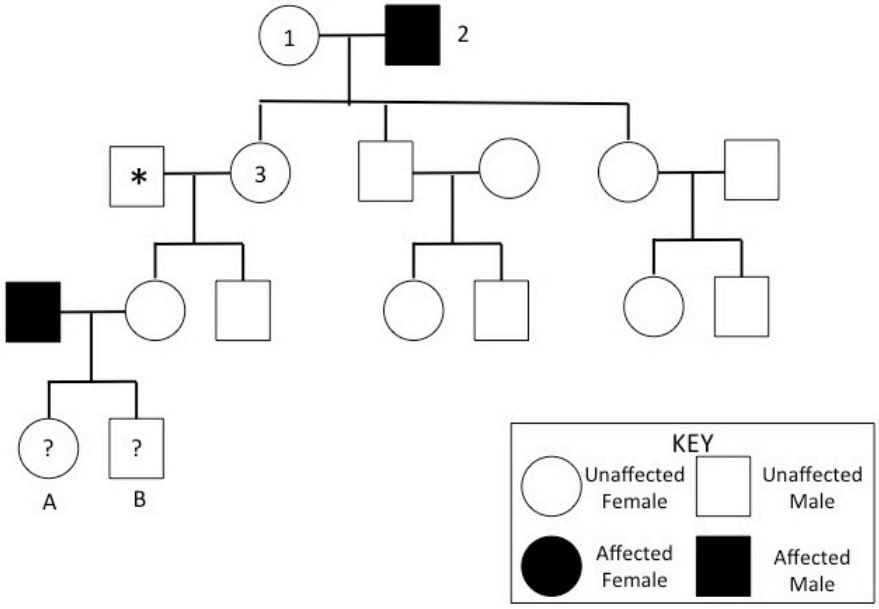
If individuals 1 & 2 have another daughter, what is the chance that this daughter would be affected?

_____

3. Use the following pedigree to answer the questions below. Assume that the individual marked with an asterisk (*) does not carry any allele associated with the affect phenotype.



What is the most likely mode of inheritance for this pedigree? (Choose from autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive)

_____

List all possible genotypes of individuals 1 – 3 in the pedigree using letter "D". Use the upper case letter for the dominant allele and the lowercase letter for the recessive allele.

1 _____ 2 _____ 3 _____

What is the probability of individual A being affected? _____

What is the probability of individual B being affected? _____

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Understanding your own genetics

Activity 7: What's your genotype?

In this activity you will use the terminology you have learned to apply it to your own genetics, and compare your own genetics to our class sample.

Complete the following table as an in-class activity.

Trait	Your Phenotype (physical appearance)	Your Genotype (Homozygous dominant, Heterozygous, Homozygous recessive)	Class Phenotype #s	Class Phenotype %
Tongue Rolling			____ of ____ Dominant ____ of ____ Recessive	_____ Dominant _____ Recessive
Earlobes			____ of ____ Dominant ____ of ____ Recessive	
Interlocking Fingers			____ of ____ Dominant ____ of ____ Recessive	
Dimples			____ of ____ Dominant ____ of ____ Recessive	
Widow's Peak			____ of ____ Dominant ____ of ____ Recessive	
Bent Little Fingers			____ of ____ Dominant ____ of ____ Recessive	
Hitchhikers Thumb			____ of ____ Dominant ____ of ____ Recessive	
Mid-digit Hair			____ of ____ Dominant ____ of ____ Recessive	
Freckles			____ of ____ Dominant ____ of ____ Recessive	
Blaze			____ of ____ Dominant ____ of ____ Recessive	
Palmar Muscle			____ of ____ Dominant ____ of ____ Recessive	

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Name: _____
Date: _____

Histology

All living things are made up of one or more cells. In the human body, these cells can come together to form tissues. Histology, or the study of tissues, allows us to understand how many different cells can come together to carry out one overall function. In the human body, there are four major groups of tissue types: Epithelial Tissues, Connective Tissues, Muscle Tissues, and Nervous Tissue. In this lab, we will explore all of these tissue types. We will also look at how tissues come together to form organs, and how organs form an organ system, by studying the integumentary system.

Learning Objectives

After completing this lab activity, you should be able to

1. Identify human body tissues under the microscope.
2. Know where the different human body tissues are found in the body.
3. Identify the structures of the integumentary system on models.
4. Identify skin and distinguish between its layers under the microscope.

Epithelial Tissues

Most epithelial tissues are essentially large sheets of cells covering all the surfaces of the body exposed to the outside world and lining the outside of organs. Epithelium also forms much of the glandular tissue of the body. Skin is not the only area of the body exposed to the outside. Other areas include the airways, the digestive tract, as well as the urinary and reproductive systems, all of which are lined by an epithelium. Hollow organs and body cavities that do not connect to the exterior of the body, which includes, blood vessels and serous membranes, are lined by endothelium (plural = endothelia), which is a type of epithelium.

Epithelial tissues provide the body's first line of protection from physical, chemical, and biological wear and tear. The cells of an epithelium act as gatekeepers of the body controlling permeability and allowing selective transfer of materials across a physical barrier. All substances that enter the body must cross an epithelium. Some epithelia often include structural features that allow the selective transport of molecules and ions across their cell membranes.

Many epithelial cells are capable of secretion and release mucous and specific chemical compounds onto their apical surfaces. The epithelium of the small intestine releases digestive enzymes, for example. Cells lining the respiratory tract secrete mucous that traps incoming microorganisms and particles. A glandular epithelium contains many secretory cells.

Epithelial tissues are classified according to the shape of the cells and number of the cell layers formed. Cell shapes can be squamous (flattened and thin), cuboidal (boxy, as wide as it is tall), or columnar (rectangular, taller than it is wide). Similarly, the number of cell layers in the tissue can be one—where every cell rests on the basal lamina—which is a simple epithelium, or more than one, which is a stratified epithelium and only the basal layer of cells rests on the basal lamina. Pseudostratified (pseudo- = "false") describes tissue with a single layer of irregularly shaped cells that give the appearance of more than one layer. Transitional describes a form of specialized stratified epithelium in which the shape of the cells can vary.

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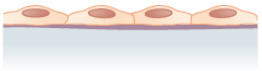
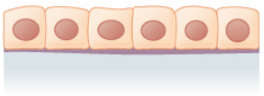
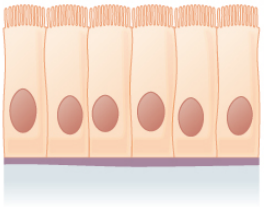
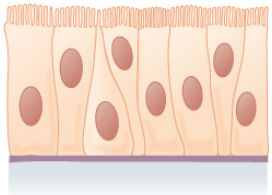
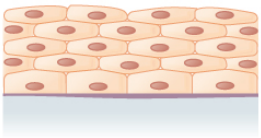
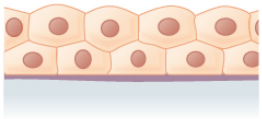
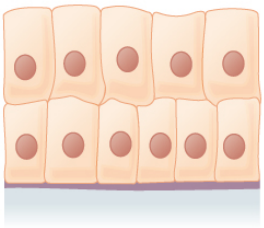
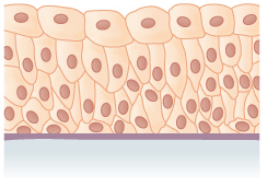
Summary of Epithelial Tissues

Cells	Location	Function
Simple squamous epithelium 	Air sacs of lungs and the lining of the heart, blood vessels, and lymphatic vessels	Allows materials to pass through by diffusion and filtration, and secretes lubricating substance
Simple cuboidal epithelium 	In ducts and secretory portions of small glands and in kidney tubules	Secretes and absorbs
Simple columnar epithelium 	Ciliated tissues are in bronchi, uterine tubes, and uterus; smooth (nonciliated tissues) are in the digestive tract, bladder	Absorbs; it also secretes mucous and enzymes
Pseudostratified columnar epithelium 	Ciliated tissue lines the trachea and much of the upper respiratory tract	Secretes mucus; ciliated tissue moves mucus
Stratified squamous epithelium 	Lines the esophagus, mouth, and vagina	Protects against abrasion
Stratified cuboidal epithelium 	Sweat glands, salivary glands, and the mammary glands	Protective tissue
Stratified columnar epithelium 	The male urethra and the ducts of some glands	Secretes and protects
Transitional epithelium 	Lines the bladder, uretha, and the ureters	Allows the urinary organs to expand and stretch

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Activity 1: Microscopic examination of epithelial tissues

In this activity, you will use the microscope to study the different types of epithelial tissues. View each tissue on either medium or high power (**if you're not sure which looks best, ask your instructor!). Draw each sample below and list where you would find the sample in the human body. Make sure to list your total magnification.

Object: Simple Squamous Epithelium

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Stratified Squamous Epithelium

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Simple Cuboidal Epithelium

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Simple Columnar Epithelium

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Pseudostratified Columnar Epithelium

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Transitional Epithelium

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

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Connective Tissues

As may be obvious from its name, one of the major functions of connective tissue is to connect tissues and organs. Unlike epithelial tissue, which is composed of cells closely packed with little or no extracellular space in between, connective tissue cells are dispersed in a **matrix**. The matrix usually includes a large amount of extracellular material produced by the connective tissue cells that are embedded within it. The matrix plays a major role in the functioning of this tissue. The major component of the matrix is a **ground substance** often crisscrossed by protein fibers. This ground substance is usually a fluid, but it can also be mineralized and solid, as in bones. Connective tissues come in a vast variety of forms, yet they typically have in common three characteristic components: cells, large amounts of amorphous ground substance, and protein fibers. The amount and structure of each component correlates with the function of the tissue, from the rigid ground substance in bones supporting the body to the inclusion of specialized cells; for example, a phagocytic cell that engulfs pathogens and also rids tissue of cellular debris.

The three broad categories of connective tissue are classified according to the characteristics of their ground substance and the types of fibers found within the matrix. **Connective tissue proper** includes **loose connective tissue** and **dense connective tissue**. Both tissues have a variety of cell types and protein fibers suspended in a viscous ground substance. Dense connective tissue is reinforced by bundles of fibers that provide tensile strength, elasticity, and protection. In loose connective tissue, the fibers are loosely organized, leaving large spaces in between. **Supportive connective tissue**—bone and cartilage—provide structure and strength to the body and protect soft tissues. A few distinct cell types and densely packed fibers in a matrix characterize these tissues. In bone, the matrix is rigid and described as calcified because of the deposited calcium salts. In **fluid connective tissue**, in other words, lymph and blood, various specialized cells circulate in a watery fluid containing salts, nutrients, and dissolved proteins.

Connective Tissue Examples

Connective Tissue Proper	Supportive Connective Tissue	Fluid Connective Tissue
Loose Connective Tissue • Areolar • Adipose • Reticular	Cartilage • Hyaline • Fibrocartilage • Elastic	Blood
Dense Connective Tissue • Regular Elastic • Irregular Elastic	Bone • Compact Bone • Spongy Bone	Lymph

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Activity 2: Microscopic examination of Connective tissues

In this activity, you will use the microscope to study the different types of connective tissues. View each tissue on either medium or high power (**if you're not sure which looks best, ask your instructor!). Draw each sample below and list where you would find the sample in the human body. Make sure to list your total magnification.

Connective Tissue Proper

Loose Connective Tissues

Object: Areolar

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Adipose

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Reticular

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Dense Connective Tissues

Object: Regular Elastic

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Irregular Elastic

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

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Supportive Connective Tissue

Cartilage

Object: Hyaline

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Object: Fibrocartilage

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Object: Elastic

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Bone

Object: Compact Bone

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Fluid Connective Tissue – Blood

Object: Blood

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

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Muscle Tissues

Muscle tissue is characterized by properties that allow movement. Muscle cells are excitable; they respond to a stimulus. They are contractile, meaning they can shorten and generate a pulling force. When attached between two movable objects, in other words, bones, contractions of the muscles cause the bones to move. Some muscle movement is voluntary, which means it is under conscious control. For example, a person decides to open a book and read a chapter on anatomy. Other movements are involuntary, meaning they are not under conscious control, such as the contraction of your pupil in bright light. Muscle tissue is classified into three types according to structure and function: skeletal, cardiac, and smooth

Comparison of Structure and Properties of Muscle Tissue Types

Tissue	Histology	Function	Location
Skeletal	Long cylindrical fiber, striated, many peripherally located nuclei	Voluntary movement, produces heat, protects organs	Attached to bones and around entrance points to body (e.g., mouth)
Cardiac	Short, branched, striated, single central nucleus	Contracts to pump blood	Heart
Smooth	Short, spindle-shaped, no evident striation, single nucleus in each fiber	Involuntary movement, moves food, involuntary control of respiration, moves secretions, regulates flow of blood in arteries	Walls of major organs and passageways

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Activity 3: Microscopic examination of Muscle tissues

In this activity, you will use the microscope to study the different types of muscle tissues. View each tissue on either medium or high power (**if you're not sure which looks best, ask your instructor!). Draw each sample below and list where you would find the sample in the human body. Make sure to list your total magnification.

Object: Skeletal

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Cardiac

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

Object: Smooth

Total Magnification: _____

Location(s) found in the human body:

_____

_____

_____

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Nervous Tissue

Nervous tissue is characterized as being excitable and capable of sending and receiving electrochemical signals that provide the body with information. Two main classes of cells make up nervous tissue: the **neuron** and **neuroglia**. Neurons propagate information via electrochemical impulses, called action potentials, which are biochemically linked to the release of chemical signals. Neuroglia play an essential role in supporting neurons and modulating their information propagation.

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Activity 4: Microscopic examination of Nervous tissue

In this activity, you will use the microscope to study the nervous tissue. View the tissue on either medium or high power (**if you're not sure which looks best, ask your instructor!). Draw the sample below and list where you would find the sample in the human body. Make sure to list your total magnification.

Object: Nervous Tissue

Total Magnification: _____

Location(s) found in the human body:

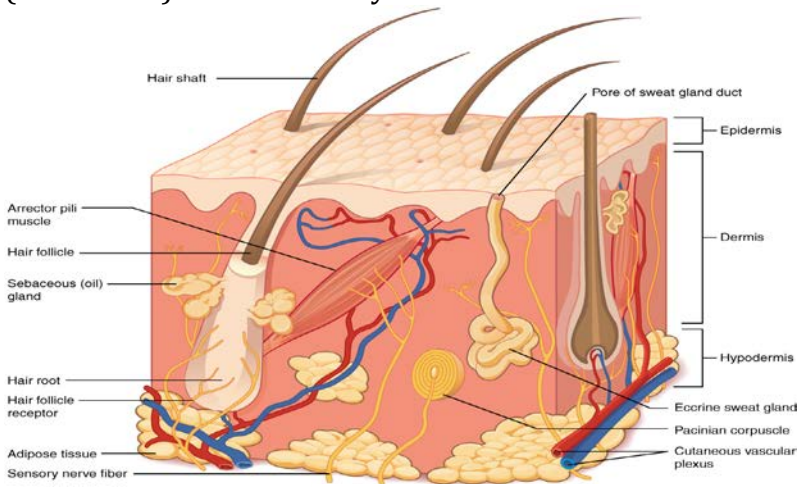
_____

_____

_____

The Integumentary System

The Skin, the largest organ in the body, and multiple accessory structures make up the integumentary system. Remember that an organ is made up of multiple tissues, and the skin is not exception to this mode of organization. The Skin has two main layers: the epidermis and the dermis. The epidermis is made up of keratinized stratified squamous epithelium. The dermis is made up of connective tissues, mainly dense irregular elastic connective tissue. It is in the dermis where most of the accessory structures of the integumentary system are found, such as: hair follicles, sweat glands, and sebaceous (oil) glands. It is also in the dermis where the vascularization (blood flow) and nervous system innervation is found.



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Activity 1: Study of the Integumentary System Model

Study the Integumentary System Model available in the lab. On the model, identify all of the following structures and answer the questions below.

Structures to identify:

☐ Epidermis	☐ Dermis	☐ Hypodermis	☐ Adipose Tissue
☐ Hair follicle	☐ Sensory Receptors	☐ Arrector Pili muscle	☐ Blood Vessels
☐ Sweat Gland	☐ Sebaceous Gland		

Name and describe three main functions of the integumentary system.

_____

_____

_____

The epidermis is made up of keratinized stratified squamous epithelium. What does it mean to be keratinized? Why is this important for the function of skin?

_____

_____

_____

Hair is mainly made up of dead keratinocytes (skin cells) that are full of keratin. If hair is technically a "dead" structure, why does it hurt when you pluck a hair out?

_____

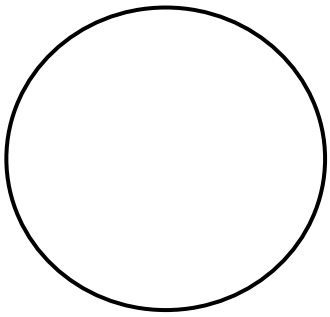
_____

Activity 2: Microscopic examination of skin

In this activity, you will use the microscope to study the skin. View it on either medium or high power (**if you're not sure which looks best, ask your instructor!). Draw the sample below. ***Label*** the epidermis and dermis.

Object: Human Skin

Total Magnification: _____



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Name: _____
Date: _____

The Cardiovascular System

The cardiovascular system is an essential system to maintain homeostasis in the human body. Its key function is to deliver nutrients to every single cell in the body and collect waste from those cells to be removed from the body. In order to do this, is has a vast 'railway' system through out the body consisting of blood vessels. For materials to constantly move through these vessels, there is a pump, the heart. In this lab we will study the cells, tissues, and organs that make up this system, along with exploring the effects of outside activities on the system.

Learning Objectives

After completing this lab activity, you should be able to

1. Identify cells and tissues belonging to the cardiovascular system under the microscope.
2. Identify the major anatomical structures of the heart.
3. Explain the effects of various physical movements/activities on heart rate and blood pressure.

Histology of the Cardiovascular System

The pumping action of the heart is made possible by the myocardium, the middle layer of the heart that is made up of cardiac muscle tissue. Cardiac muscle tissue is involuntary and has two key characteristics for identification under the microscope. First, it is striated, meaning it appears to have very small stripes running through it. This patter in created by the proteins inside the muscle cells that allow for contraction. The second characteristic is the presence of intercalated discs. These appear as somewhat of a 'zig-zag' dark line between cells, that represents a point where the cells are connected by gap junctions. Gap junctions are spaces in the plasma membrane that actually connect the cytoplasm of two cells together. This allows for very rapid communication between cells, which is the heart is essential to its function. When the cells of the myocardium contract, in order to be effective, they all need to contract together, in rhythm. For this to be possible, the intercalated discs allow for a signal from one cell to travel very quickly to other cells.

So what is the heart pumping? Blood. Blood is a fluid connective tissue that consists mainly of plasma and blood cells. Plasma is the liquid component that contains water, macromolecules, and ions. The main types of blood cells are red blood cells, white blood cells, and platelets. Each cell type has a unique function. Red blood cells are the main carrier of oxygen throughout the body. White blood cells serve as part of our immune system, by fighting off any foreign pathogens that enter the body. And platelets are a key component involved in blood clotting in the case of injury.

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Activity 1: Studying Cardiac Muscle Tissue under the microscope

1. Obtain a cardiac muscle tissue slide.
2. View the slide on high power.
3. Draw what you see below. Label the following structures: striations, intercalated discs

Object: _____

Total Magnification: _____

Activity 2: Studying Blood under the microscope

1. Obtain a blood smear slide.
2. View the slide on high power.
3. Draw what you see below. Label the following structures: red blood cells, white blood cell, platelet

Object: _____

Total Magnification: _____

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Activity 3: Blood Typing

Blood type is determined by the presence or absence of certain molecules, called **antigens**, on the surface of red blood cells. An antigen is a molecule or substance that causes an immune response. The antigens on a person's own body cells are recognized by their immune system as "self" antigens, and their immune system does not attack them. However, if a person is exposed to a blood type antigen that is different from their own blood type, the person's immune system will produce antibodies against the donor blood antigens. These **antibodies** can bind to antigens on the surfaces of transfused red blood cells (or other tissue cells), often leading to destruction of the cells by the immune system. There are approximately 30 known blood group systems in humans, but the ABO blood group system and the Rhesus (Rh) blood group system are the most important for blood transfusions.

The "A" and "B" of the ABO blood group refer to two antigens found on the surfaces of red blood cells. There is not an O antigen. Type O red blood cells have neither type A nor type B antigens on their surfaces, as listed in the table below. Antibodies are found in the blood plasma. The blood type of a person can be determined by using antibodies that bind to the A or B antigens of red blood cells.

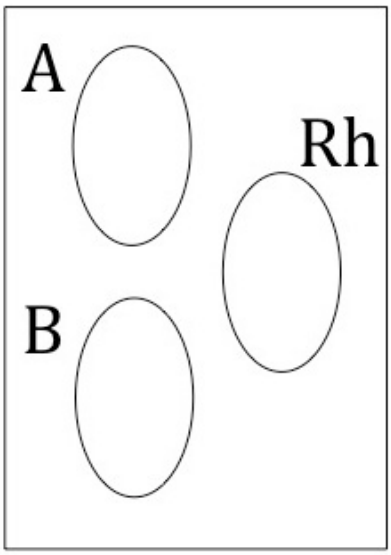
The Rhesus system is the second most significant blood group system for human blood transfusion. The most significant Rhesus antigen is called the RhD antigen. A person either has or does not have the RhD antigen on the surfaces of their red blood cells. This is usually indicated by adding either a "positive" (does have the RhD antigen) or a "negative" (does not have the antigen) suffix to the ABO blood group

Agglutination is the clumping of red blood cells that occurs when different blood types are mixed together. It involves a reaction between antigens on the surfaces of red blood cells and protein antibodies in the blood plasma. Mixing different blood types together can cause agglutination, a process that has been used as a way of determining a person's blood type.

"Blood Types - Advanced" by Douglas Wilkin, Ph.D. & Niamh Gray-Wilson, CK-12 is licensed under CC BY-NC 3.0

For this activity, you will use synthetic blood and blood typing kits to determine the blood types of the synthetic blood samples. You will be given all instructions in class to complete this activity.

Draw the results of your blood sample and answer the questions below:



What blood type is your sample? _____

Explain how you determined your sample's blood type.

_____

_____

_____

_____

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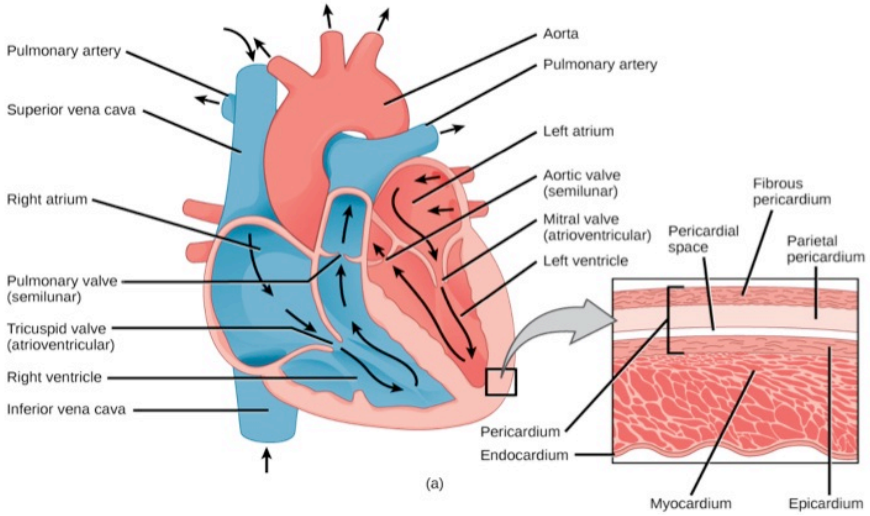
The Heart

The heart is a complex muscle that pumps blood through the three divisions of the circulatory system: the coronary (vessels that serve the heart), pulmonary (heart and lungs), and systemic (systems of the body). Coronary circulation intrinsic to the heart takes blood directly from the main artery (aorta) coming from the heart. For pulmonary and systemic circulation, the heart has to pump blood to the lungs or the rest of the body, respectively. In humans, the lungs are relatively close to the heart in the thoracic cavity. The shorter distance to pump means that the muscle wall on the right side of the heart is not as thick as the left side which must have enough pressure to pump blood all the way to your big toe.

The heart muscle is asymmetrical as a result of the distance blood must travel in the pulmonary and systemic circuits. Since the right side of the heart sends blood to the pulmonary circuit it is smaller than the left side, which must send blood out to the whole body in the systemic circuit. In humans, the heart is about the size of a clenched fist; it is divided into four chambers: two atria and two ventricles. There is one atrium and one ventricle on the right side and one atrium and one ventricle on the left side. The atria are the chambers that receive blood, and the ventricles are the chambers that pump blood. The **right atrium** receives deoxygenated blood from the superior and inferior **vena cava**. In addition, the right atrium receives blood from the coronary sinus, which drains deoxygenated blood from the heart itself. This deoxygenated blood then passes to the **right ventricle** through the **tricuspid valve** (also known as the right atrioventricular, AV, valve), a flap of connective tissue that opens in only one direction to prevent the backflow of blood. The valve separating the chambers on the left side of the heart valve is called the biscuspid or mitral valve. After it is filled, the right ventricle pumps the blood through the **pulmonary valve** (or right semilunar valve) into the **pulmonary arteries** to the lungs for re-oxygenation. After blood passes through the pulmonary arteries, the pulmonary valve closes preventing the blood from flowing backwards into the right ventricle. The **left atrium** then receives the oxygen-rich blood from the lungs via the **pulmonary veins**. This blood passes through the **bicuspid valve** (also known as the mitral valve or left atrioventricular, AV, valve) to the **left ventricle** where the blood is pumped through the **aortic valve** (left semilunar valve) out through aorta, the major artery of the body, taking oxygenated blood to the organs and muscles of the body. Once blood is pumped out of the left ventricle and into the aorta, the aortic semilunar valve (or aortic valve) closes preventing blood from flowing backward into the left ventricle.



" Mammalian Heart and Blood Vessels" by OpenStax is licensed under CC BY 4.0

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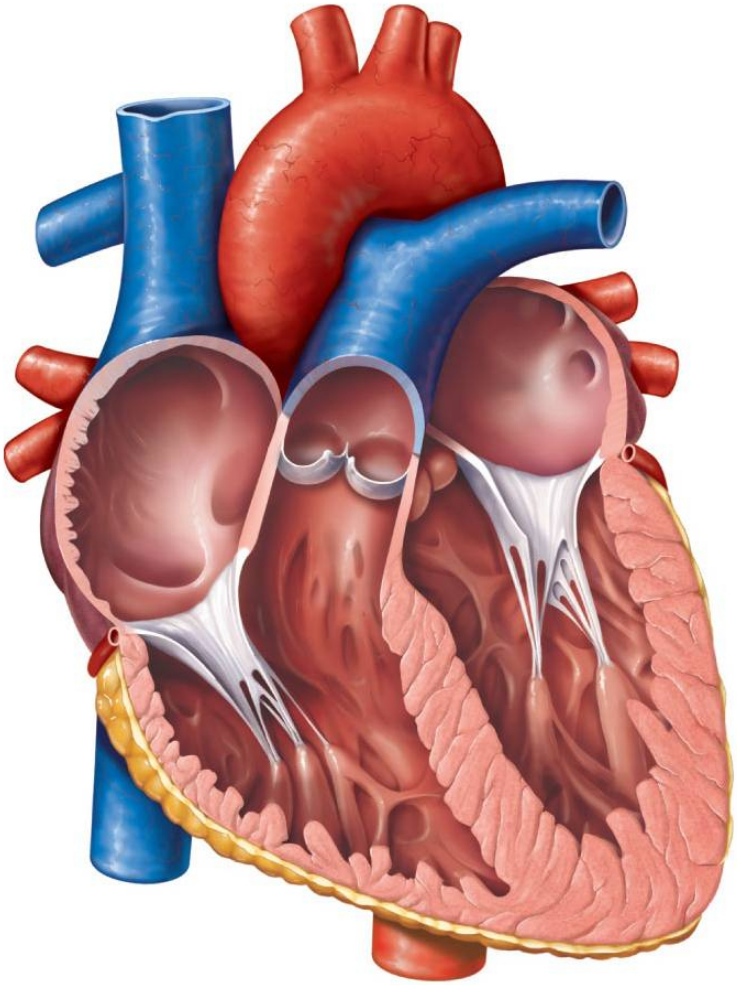
Activity 3: Identification of major anatomical structures of the heart.

Study the heart models available in the lab. On all heart models identify the following structures and label them on the image below.

☐Vena Cava	☐Aorta	☐Right Atrium	☐Left Atrium
☐Right Ventricle	☐Left Ventricle	☐Pulmonary Valve	☐Aortic Valve
☐Tricuspid Valve	☐Bicuspid Valve	☐Pulmonary Arteries	☐Pulmonary Veins



"Unlabeled Picture of the Heart" by DayDreamAnatomy is licensed under CC BY-NC 4.0

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Heart Rate

The circulatory system is responsible for the internal transport of many vital substances in humans, including oxygen, carbon dioxide, and nutrients. The components of the circulatory system include the heart, blood vessels, and blood. Heartbeats result from electrical stimulation of the heart cells by the *pacemaker,* located in the heart's inner wall of the right atrium. Although the electrical activity of the pacemaker originates from within the heart, the rhythmic sequence of impulses produced by the pacemaker is influenced by nerves outside the heart. Many things might affect heart rate, including the physical fitness of the individual, the presence of drugs such as caffeine or nicotine in the blood, and the age of the person.

As a rule, the maximum heart rate of all individuals of the same age and sex is about the same. However, the time it takes individuals to reach that maximum level while exercising varies greatly. Since physically fit people can deliver a greater volume of blood in a single cardiac cycle than unfit individuals, they can usually sustain a greater work level before reaching the maximum heart rate. Physically fit people not only have less of an increase in their heart rate during exercise, but their heart rate recovers to the resting rate more rapidly than unfit people.

HRs vary considerably, not only with exercise and fitness levels, but also with age. Newborn resting HRs may be 120 bpm. HR gradually decreases until young adulthood and then gradually increases again with age.

Maximum HRs are normally in the range of 200–220 bpm, although there are some extreme cases in which they may reach higher levels. As one ages, the ability to generate maximum rates decreases. This may be estimated by taking the maximal value of 220 bpm and subtracting the individual's age. So a 40-year-old individual would be expected to hit a maximum rate of approximately 180, and a 60-year-old person would achieve a HR of 160.

"Heart Rates" by OpenStax is licensed under CC BY 4.0

Activity 4: Heart Rate and Physical Fitness

In this activity, you will evaluate your physical fitness. An arbitrary rating system will be used to "score" fitness during a variety of situations. Tests will be made while in a resting position, in a prone position, as well as during and after physical exercise.

Important: Do not attempt this experiment if physical exertion will aggravate a health problem. Inform your instructor of any possible health problems that might be affected if you participate in this exercise.

Each person in a lab group will take turns being the subject and the tester. When it is your turn to be the subject, your partner will be responsible for recording the data on your lab sheet.

1. Connect the receiver module of the Heart Rate Monitor to LabQuest and choose New from the File menu.

2. On the Meter screen, tap Length. Change the data-collection length to 600 seconds. Select OK.

3. Set up the Heart Rate Monitor. Follow the directions for your type of Heart Rate Monitor.

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a. Grasp the handles of the Hand-Grip Heart Rate Monitor. Place the fingertips of each hand on the reference areas of the handles (see Figure 1).
b. The left hand grip and the receiver are both marked with an alignment arrow. When collecting data, be sure that the arrow labels on each of these devices are in alignment (see Figure 2) and that they are not too far apart. The reception range of the plug-in receiver is 80–100 cm, or 3 feet.

Figure 1

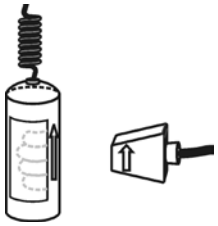

Figure 2

4. Start data collection. Determine that the sensor is functioning correctly. The readings should be consistent and within the normal range of the individual, usually between 55 and 80 beats per minute. When you have determined that the equipment is operating properly, stop data collection and proceed to Step 5.

Standing heart rate

5. Instruct the subject to stand upright for 2 minutes. Start data collection. When the 2 minutes have passed, record the subject's heart rate in Table 6.

6. Locate the subject's heart rate in Table 1 and record the corresponding fitness point value in Table 6.

Table 1			
Beats/min	Points	Beats/min	Points
60–70	12	101–110	8
71–80	11	111–120	7
81–90	10	121–130	6
91–100	9	131–140	4

Reclining heart rate

7. Instruct the subject to recline on a clean surface or table for 2 minutes. When the 2 minutes have passed, record the subject's heart rate in Table 6.

8. Locate the subject's heart rate in Table 2 and record the corresponding fitness point value in Table 6.

Table 2			
Beats/min	Points	Beats/min	Points
50–60	12	81–90	8
61–70	11	91–100	6
71–80	10	101–110	4

Heart rate change from reclining to standing

9. Instruct the subject to quickly stand up and remain standing still.

10. Immediately record the subject's peak heart rate in Table 6.

11. Subtract the reclining rate heart rate recorded in Step 6 from the heart rate in Step 9 to find the heart rate increase after standing. Locate the row corresponding to the reclining heart rate in Table 3 and use the heart rate increase value to determine the proper fitness points. In Table 6, record the fitness points. Stop data collection. Instruct the subject to rest for 2 minutes then proceed to Step 11.

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Table 3					
Reclining heart rate	Heart rate increase after standing				
	0–10	11–17	18–24	25–33	34+
50–60	12	11	10	8	6
61–70	12	10	8	6	4
71–80	11	9	6	4	2
81–90	10	8	4	2	0
91–100	8	6	2	0	0
101–110	6	4	0	0	0

Step test

12. Start data collection. Before performing the step test, record the subject's heart rate (Pre-exercise) in Table 6.

13. Perform a step test using the following procedure:
    a. Place the right foot on the top step of the stool.
    b. Place the left foot completely on the top step of the stool next to the right foot.
    c. Place the right foot back on the floor.
    d. Place the left foot completely on the floor next to the right foot.
    e. This stepping cycle should take 3 seconds to complete.

14. When five steps have been completed, record the heart rate in Table 6. Quickly move to Step 15.

Recovery rate

15. With a stopwatch or clock, begin timing to determine the subject's recovery time. During the recovery period, the subject should remain standing and relatively still. Monitor the heart rate readings and stop timing when the readings return to the pre-exercise heart rate value recorded in Step 11. Record the recovery time in Table 6.

16. Stop data collection.

17. Locate the subject's recovery time in Table 4 and record the corresponding fitness point value in Table 6. If the subject's heart rate did not return to within 10 beats/min from their pre-exercise heart rate, record a value of 6 points.

Table 4	
Time (sec)	Points
0–30	14
31–60	12
61–90	10
91–120	8

Step test for endurance

18. Subtract the subject's pre-exercise heart rate (from Step 11) from their heart rate after 5 steps of exercise. Record this heart rate increase in the endurance row of Table 6.

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19. Locate the row corresponding to the pre-exercise heart rate in Table 5 and use the heart rate increase value to determine the proper fitness points. In Table 6, record the fitness points.

Table 5					
Pre-exercise heart rate	Heart rate increase after exercise				
	0–10	11–20	21–30	31–40	41+
60–70	12	12	10	8	6
71–80	12	10	8	6	4
81–90	12	10	7	4	2
91–100	10	8	6	2	0
101–110	8	6	4	1	0
111–120	8	4	2	1	0
121–130	6	2	1	0	0
131+	5	1	0	0	0

20. Total all the fitness points recorded in Table 6. Determine the subject's personal fitness level using the scale below.

DATA

Table 6		
Condition	Rate or time	Points
Standing heart rate	beats/min	
Reclining heart rate	beats/min	
Reclining to standing	beats/min	
Pre-exercise heart rate	beats/min	
After 5 steps	beats/min	
Recovery time	seconds	
Endurance	beats/min	
		Total points:

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QUESTIONS

1. How did your heart rate change after moving from a standing position to a reclining position? Is this what you expected? How do you account for this?

2. How did your heart rate change after moving from a reclining position back to a standing position? Is this what you expected? How do you account for this?

3. Predict what your heart rate might be if you had exercised for twice the length of time that you actually did. Explain.

4. How does your maximum heart rate compare to other students in your group. Is this what you expected? How do you account for this?

5. Why would athletes need to work longer and harder before their heart rates were at the maximum value?

4. How do you evaluate your physical fitness? Do you agree with the rating obtained from this experiment? Explain.

5. Current research indicates that most heart attacks occur as people get out of bed after sleep. Account for this observation.

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EXTENSION

1. Using a sphygmomanometer, learn how to measure blood pressure. Compare a person's blood pressure when reclining, to that of the same person immediately after standing from a reclined position. Record your data below. Relate the change in blood pressure to the heart rate values measured when going from reclining to standing.

Activity 4: Heart Rate and Fitness is a ***Biology with Vernier*** lab activity.

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Name: _____
Date: _____

Maintenance Systems

The body is in a constant state of fluctuation due to both external and internal factors, but a key role that all body systems share is to maintain homeostasis, or an internal balance. All body systems do this, but in this lab we will focus on the respiratory, digestive, and urinary systems. Remember that structure determines function! So in this lab we will study the structures, including the histology and gross anatomy, of each of these systems to help gain a better understanding of the function and role these systems play in maintaining homeostasis. We will also evaluate how these systems interact with other systems to achieve this function.

Learning Objectives

After completing this lab activity, you should be able to

1. Identify cells and tissues belonging to the respiratory system under the microscope.
2. Identify and describe the structure and function of the major organs of the respiratory, digestive, and urinary systems.
3. Explain the effects of ventilation on the cardiovascular system.
4. Conduct a urinalysis and describe normal and abnormal results and their causes.

The Respiratory System

The respiratory system is an essential system to maintain homeostasis in the human body. Through the processes of inspiration (breathing in), this system brings in an essential molecule to the human body, oxygen. It not only brings in this oxygen, but also facilitates the movement of this oxygen into the cardiovascular system, where it can then be delivered to every cell in the body. Along with delivering this much needed material, the respiratory system allows for waste material, such as carbon dioxide, to escape the human body through the process of expiration (breathing out). Together, ventilation (or breathing) works to maintain the balance of these gases throughout the human body. If this balance is off, it can cause detrimental effects the entire human body. For example, if oxygen levels get low, cells do not receive enough to carry out cellular respiration, causing them to lose function and possibly die. If carbon dioxide levels get too high, this causes the pH in the blood to drop, leading to acidosis.

Anatomy of the Respiratory System

To understand the function of the respiratory system, we must first study its structure. In the following activities, we will study the gross anatomy and histology of this system.

Activity 1: Identification of the major organs of the respiratory system

Study the respiratory models available in the lab. On the models identify the following structures and label them on the image below.

☐ Larynx	☐ Trachea	☐ Primary Bronchi
☐ Right Lung	☐ Left Lung	☐ Alveolar Capillaries
☐ Alveoli	☐ Inspiration	☐ Expiration

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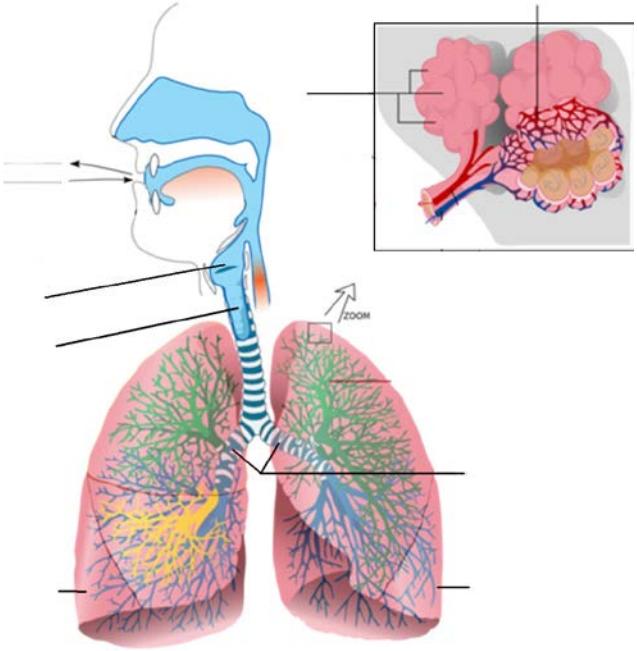

What epithelial tissue type would you expect to find lining the trachea? Explain your answer.

_____

_____

What epithelial tissue type would you expect to find lining the alveoli? Explain your answer.

_____

_____

Study the torso model or the available lung models in the lab. How do the right and left lung differ? What may account for this difference?

_____

_____

Activity 2: Studying tissues of the respiratory system under the microscope

1. Obtain a slide of the trachea.
2. View the slide on high power.
3. Draw what you see below. Label the following structures: pseudostratified epithelium, cilia

Object: _____

Total Magnification: _____

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What is the purpose of the cilia found in the trachea?

_____

_____

4. Obtain a slide of normal lungs.
5. View the slide on high power.
6. Draw what you see below. Label the following structures: simple squamous epithelium, alveolus

Object: _____

Total Magnification: _____

Interactions of the Respiratory System and Cardiovascular System

In this experiment, you will investigate the effect of altering the levels of oxygen and carbon dioxide on the rate at which the heart beats. Two different methods of ventilation will be used to investigate this phenomenon. The first method, *hyperventilation*, is when the breathing rate of an organism is greater than what is necessary for proper exchange of oxygen and carbon dioxide. This will be achieved by a period of rapid breathing by the test subject. The second method, *hypoventilation*, occurs when there is a decrease in ventilation without a decrease in oxygen consumption or carbon dioxide production by the body. True hypoventilation is usually the result of a disease. The test subject will simulate this condition by holding his or her breath for a period of time. Heart rate will be monitored using the Exercise Heart Rate Monitor.

Activity 3: Ventilation and Heart Rate

Each person in a lab group will take turns being the subject and the tester. When it is your turn to be the subject, your partner will be responsible for recording the data on your lab sheet.

1. Connect the receiver module of the Heart Rate Monitor to LabQuest and choose New from the File menu. If you have an older sensor that does not auto-ID, manually set up the sensor.
2. On the Meter screen, tap Length. Change the data-collection length to 120 seconds.
3. Set up the Heart Rate Monitor.

   a. Grasp the handles of the Hand-Grip Heart Rate Monitor. Place the fingertips of each hand on the reference areas of the handles (see Figure 1).
   b. The left hand grip and the receiver are both marked with an alignment arrow. When collecting data, be sure that the arrow labels on each of these devices are in alignment (see Figure 2) and that they are not too far apart. The reception range of the plug-in receiver is 80–100 cm, or 3 feet.

Figure 1

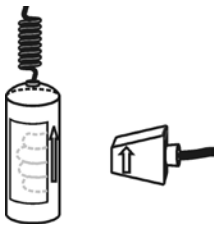

Figure 2

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4. Start data collection. Determine that the sensor is functioning correctly. The readings should be consistent and within the normal range of the individual, usually between 55 and 80 beats per minute. When you have determined that the equipment is operating properly, stop data collection and proceed to Step 5.

Part I: Hyperventilation

5. Collect data while the subject hyperventilates.
    a. Instruct the subject to sit still in a chair and breathe normally.
    b. Start data collection. After collecting data for 30 seconds, have the subject make rapid shallow breaths for the next 30 seconds.
    c. The subject should then breathe normally for the remaining 60 seconds.
6. When data collection is complete, a graph of heart rate *vs*. time will be displayed. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point, the heart rate values of each data point are displayed to the right of the graph.
7. Record the heart rate in Table 1 for every 10 second interval.
8. Store the data from the first run by tapping the File Cabinet icon.

Part II: Hypoventilation

9. Collect data while the subject hypoventilates.
    a. Instruct the subject to sit still in a chair and breathe normally.
    b. Start data collection. After collecting data for 30 seconds, have the subject take a large breath and hold it as long as possible. The subject should not hold his or her breath longer than 60 seconds.
    c. The subject should breathe normally for the remainder of data collection.
10. When data collection has finished, a graph of heart rate *vs*. time will be displayed. To examine the data pairs on the displayed graph, tap any data point. As you tap each data point, the heart rate values of each data point are displayed to the right of the graph.
11. Record the heart rate in Table 1 for every 10 second interval.
12. Graph both runs of data on a single graph. To do this, tap Run 2 and select All Runs.

DATA

Table 1

Time (s)	10	20	30	40	50	60	70	80	90	100	110	120
Hyperventilation												
Hypoventilation												

QUESTIONS

1. What happens to the heart rate during hyperventilation?_____
2. What happens to the heart rate during hypoventilation? _____
3. List several factors that you think may have caused the test subject's heart rate to change in each of the trials.

_____

_____

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4. What happens to the oxygen levels in your lungs during hyperventilation? Carbon dioxide levels?

_____

_____

5. In what way would the change in heart rate that corresponds with holding your breath be advantageous in other types of organisms? What organisms might commonly exhibit such an adaptation?

_____

_____

Activity 3: Ventilation and Heart Rate is a ***Biology with Vernier*** lab activity.

The Digestive System

The human digestive system has three main functions: digestion, absorption, and elimination. These three function work to maintain homeostasis in the body by taking in nutrients and making them available to every single cell in the body and also, by getting rid of materials not used by the body. Most of the food we take in contains biological molecules in their polymer form, which cannot be absorbed and travel around in the body. So, through the process of digestion, both mechanical and chemical digestion, the digestive system breaks the molecules down into their monomer form in order for them to be absorbed. Once materials have been absorbed they can travel through the blood stream to nourish the body. Not all organs of the digestive system actually touch food. Instead, some act as accessory organs. As food moves through the body and gets digested and absorbed it follows this path: mouth, esophagus, stomach, small intestine, large intestine. Any food material still in the system is then eliminated. In order for chemical digestion to be efficient, several accessory organs help the main organs. The liver produces bile, which emulsifies fat. The gallbladder stores the bile produced by the liver and releases it when food is moving through the system. The pancreas releases many enzymes, such as trypsin, pancreatic amylase, and pancreatic lipase, which all work to break down molecules. Working together, the main organs and the accessory organs of the digestive system maintain the body's overall homeostasis.

Anatomy of the Digestive System

To understand the function of the digestive system, we must first study its structure. In the following activities, we will study the gross anatomy of this system.

Activity 4: Identification of the major organs of the digestive system

Study the digestive models available in the lab. On the models identify the following structures and label them on the image below.

☐ Esophagus	☐ Stomach	☐ Small Intestine	☐ Large Intestine
☐ Liver	☐ Gallbladder	☐ Pancreas	☐ Mouth/Oral Cavity

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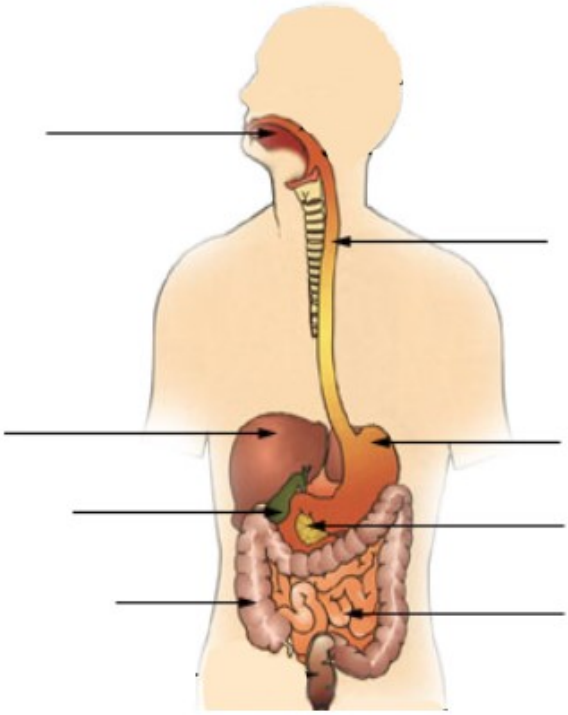

List the functions of the following digestive system organs:

Mouth/Oral Cavity: _____

Esophagus: _____

Stomach: _____

Small Intestine: _____

Large Intestine: _____

Liver: _____

Gall Bladder: _____

Pancreas: _____

The Urinary System

The main function of the urinary system is to eliminate the waste products of metabolism from the body by forming and excreting urine. Typically, between one and two liters of urine are produced every day in a healthy individual. Waste products removed from the body with the formation and elimination of urine include many water-soluble metabolic products. The main waste products are urea — a by-product of protein breakdown — and uric acid, a by-product of nucleic acid breakdown. Excess water and mineral ions are also eliminated in urine. Besides the elimination of waste products such as these, the urinary system has several other vital functions. These include: 1) maintaining homeostasis of mineral ions in extracellular fluid**;** these ions are either excreted in urine or returned to the blood as needed to maintain the proper balance, 2) regulating acid-base balance in the body; when pH is too low (blood is too acidic), for example, the kidneys excrete less bicarbonate (which is basic) in urine. When pH is too high (blood is too basic), the opposite occurs, and more bicarbonate is excreted in urine, 3) controlling the volume of extracellular fluids, including the blood, which helps maintain blood

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pressure; the kidneys control fluid volume and blood pressure by excreting more or less salt and water in urine.

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Anatomy of the Urinary System

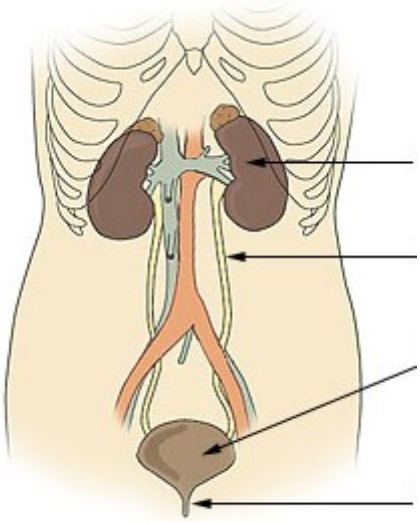
To understand the function of the urinary system, we must first study its structure. In the following activities, we will study the gross anatomy of this system.

Activity 5: Identification of the major organs of the urinary system

Study the digestive models available in the lab. On the models identify the following structures and label them on the image below.

☐ Kidneys ☐ Ureter ☐ Bladder ☐ Urethra

☐ Nephrons



The Production of Urine

Urine production occurs in the kidneys. Within each kidney, there are around one million nephrons. Nephrons are the functional unit of the kidneys and is where blood filtration occurs. As blood flows to a nephron it is selectively filtered to ensure homeostasis is maintained. To test overall kidney function (nephron function), a urinalysis can be done. In a normal urinalysis, a patient urinates into a collection receptacle. The urine is then tested using test strips. Test results for a patient with normal functioning kidneys can be seen in the data table below.

Material	**Normal Value found in Urine**
pH	~6
Protein	negative
Glucose Concentration	1 – 10mg/dL
Ketones	negative
Leukocytes	negative
Bilirubin	negative
Blood/Hemoglobin	negative

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What do values outside of the normal range indicate?

pH:

- If pH is too high (basic, 7 – 14): this can indicate conditions such as kidney failure, pyloric obstruction (in the stomach), respiratory alkalosis, vomiting.
- If pH it too low (acidic, 1 – 5): this can indicate conditions such as dehydration, starvation, acidosis, diabetic ketoacidosis; great environment for kidney stone formation.

Protein: Presence of proteins in the urine indicates kidney disease. The filters of the kidneys (in the nephrons) normally do not allow large material such as protein into the urine. If protein is present, it means this tissue that is filtering is damaged and is a sign of numerous kidney diseases that can lead to failure.

Glucose Concentration: If glucose concentrations are higher than normal, the most common cause is diabetes. Further testing may need to be done to determine if the cause if Type I or Type II diabetes.

Ketones: Ketones are the result of your body breaking down fat for energy, instead of glucose. When ketone levels are high, this can be an indication of diabetic ketoacidosis.

Leukocytes: Leukocytes are a type of white blood cell involved in the immune response. They are responsible to engulfing and removing any pathogens from the body. If leukocytes are present, it usually indicated some sort of urinary tract infection (UTI).

Bilirubin: Bilirubin is a bi-product of a process that occurs in the liver. Red blood cells are short-lived cells in the body and usually only stay in circulation for around 120 days. After this time, these cells are broken down and recycled. As a result of this break down, bilirubin is a bi-product that normally will be recycled and reused by the body without entering the blood stream. If there is any sort of liver damage, the bilirubin may find its way into the blood stream and then to the urine.

Blood/Hemoglobin: Blood in the urine can be an indication of a wide variety of issue. One of the most common is damage to the tissues of urinary organs (kidneys, ureters, bladder, urethra), which could be due to trauma or cancer. Blood can also indicate bladder infections, kidney infections, kidney stones, and many other kidney diseases.

Activity 6: Urinalysis

For this activity, you will test three sample of synthetic urine with medical test strips. Using the results, you will then evaluate whether results are normal or abnormal. If abnormal, you need to determine possible causes for the abnormal values.

1. Obtain a test strip, with tube to read results.
2. Pour sample synthetic urine into dish provided in the lab.
3. Place the test strip into the urine for 1 – 2 min.
4. Remove strip from urine sample and compare results with readings on strips container.
5. Record your results below.
6. Repeat steps 1 – 5 with two more samples.

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SAMPLE 1

Material	Values
pH	
Protein	
Glucose Concentration	
Ketones	
Leukocytes	
Bilirubin	
Blood/Hemoglobin	

Data Interpretation:

Are any of the materials outside of their normal range/values?

_____

_____

_____

What might these results indicate?_____

_____

SAMPLE 2

Material	Values
pH	
Protein	
Glucose Concentration	
Ketones	
Leukocytes	
Bilirubin	
Blood/Hemoglobin	

Data Interpretation:

Are any of the materials outside of their normal range/values?

_____

_____

_____

What might these results indicate? _____

_____

SAMPLE 3

Material	Values
pH	
Protein	
Glucose Concentration	
Ketones	
Leukocytes	
Bilirubin	
Blood/Hemoglobin	

Data Interpretation:

Are any of the materials outside of their normal range/values?

_____

_____

_____

What might these results indicate?_____

_____

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Name: _____
Date: _____

The Skeletal and Muscular Systems

All organ systems of the human body interact with one another to maintain homeostasis. Two of these systems that work very closely together are the skeletal and muscular systems. In fact, their interactions are so essential that the two systems are sometimes referred to as the musculoskeletal system. Individually these systems work to maintain homeostasis. Major functions of the skeletal system include support, mineral storage, and blood formation, while the muscular system produces movement, stabilizes joints, maintains posture, and generates heat. While the muscular system can produce many different types of movement in the human body, such as peristalsis, or the propelling of materials through the digestive system, and dilating or constricting blood vessels, some movements require the attachment of muscles to the skeleton to produce movement. Muscles that require this attachment are known as skeletal muscles and produce all of our voluntary movements, such as walking, turning your head, breathing, writing with a pencil, etc.

Learning Objectives

After completing this lab activity, you should be able to

1. Identify and describe the functions of the tissues of the musculoskeletal system.
2. Identify bones of the skeletal system and determine which division they belong to.
3. Describe how the structural arrangement of skeletal muscle fibers allows for muscle contraction.
4. Identify the major muscles of the human body.

Tissues of the Musculoskeletal System

There are many tissues that come together to allow for the overall functioning of the musculoskeletal. The following are a few of these tissues:

- Compact Bone: forms the outermost layers of bones; very strong and conducts stress from end to end of bone
- Spongy Bone: forms the inner portion of bones; allows for the light weight nature of bones and conducts stress from sides of bone
- Hyaline Cartilage: found at the ends of long bones; allows for comfortable articulation of two long bones
- Skeletal Muscle: found in voluntary muscles attached to the skeleton; fibers are multinucleated and striated due to arrangement of sarcomeres
- Dense Regular CT (Tendons/Ligaments): tissue that allows for connection of muscle to bone (tendons) or bone to bone (ligaments)

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Activity 1: Microscopic Examination of Musculoskeletal System Tissues

In this activity, you will use the microscope to study the different types of musculoskeletal tissues. View each tissue on either medium or high power (**if you're not sure which looks best, ask your instructor!). Draw each sample below and list where you would find the sample in the human body. Make sure to list your total magnification.

Object: Compact Bone

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Object: Spongy Bone

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Object: Hyaline Cartilage

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Object: Skeletal Muscle

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Object: Dense Regular Connective Tissue

Total Magnification: _____

Location(s) found in the human body:
_____
_____
_____

Now study the large model of compact bone available in the lab. Draw the model below and identify and label the following structures:

- ☐ Central Canal
- ☐ Lacunae
- ☐ Lamellae
- ☐ Canaliculi
- ☐ Osteocytes

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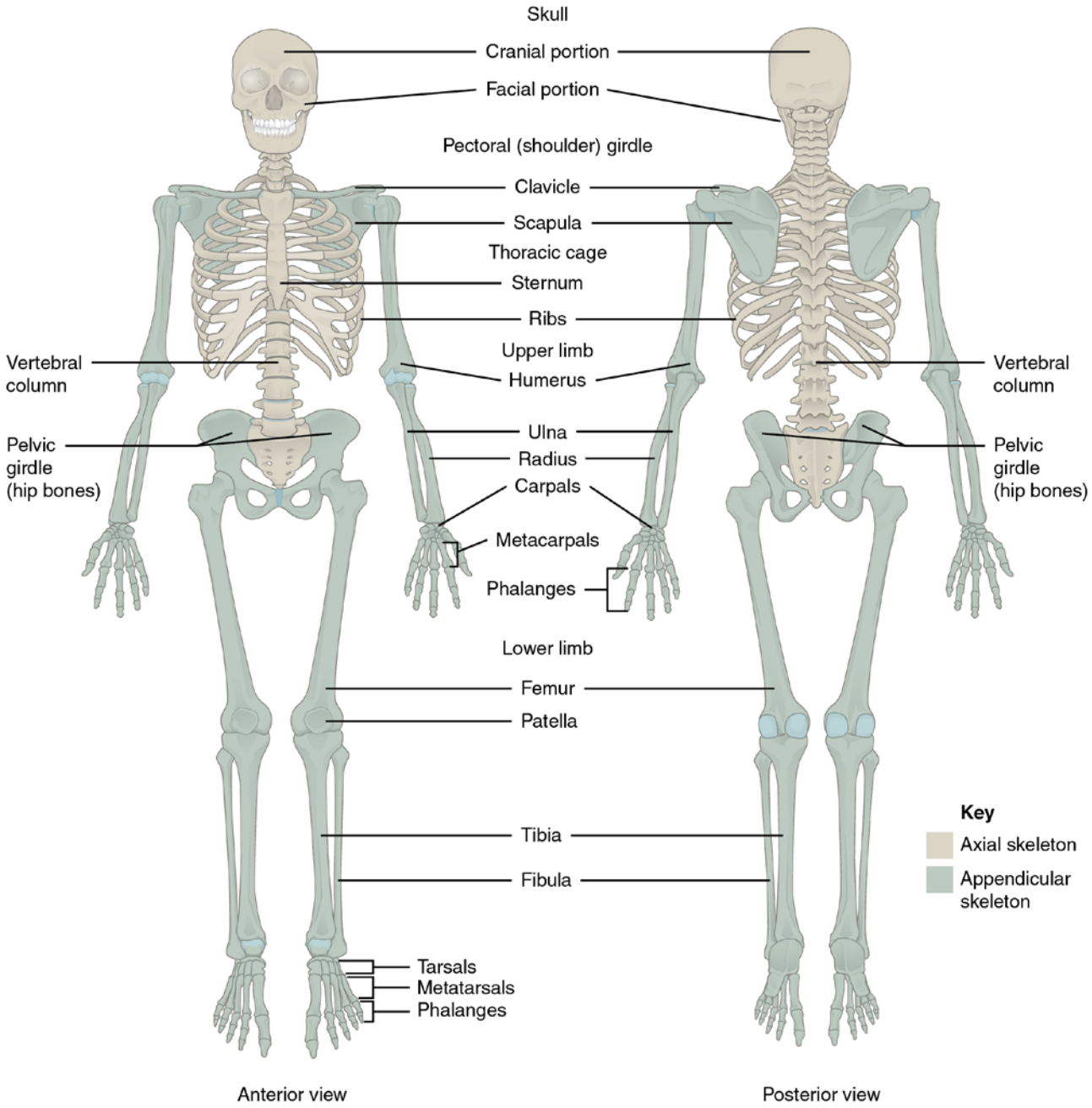
Bones of the Skeletal System

The skeletal system has two major divisions: the axial skeleton and the appendicular skeleton. The axial skeleton gets its name because it is at the 'axis' of the body. The bone groups that are in the axial skeleton are bones of the skull, vertebral column, and thoracic cage. The appendicular skeleton is all of the bones that 'hang off' of the axial skeleton. These bone groups are the pectoral girdles, upper limbs, pelvic girdles, and lower limbs.



"801 Appendicular Skeleton.jpg" by OpenStax Anatomy and Physiology is licensed under CC BY 4.0

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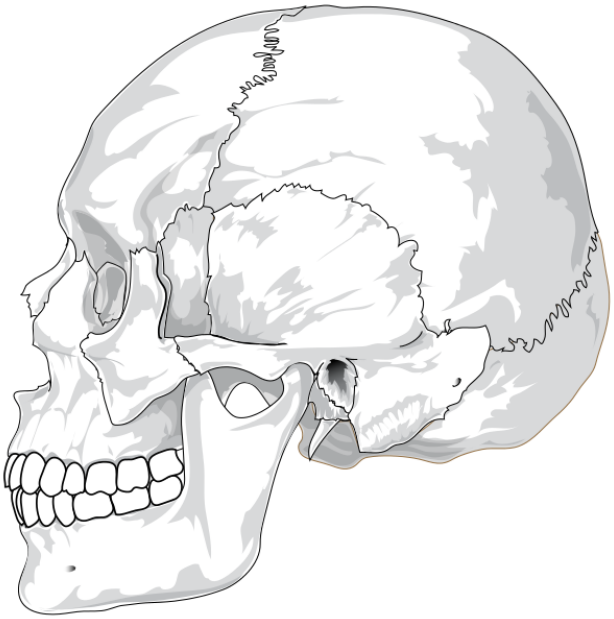
Activity 2: Identification of Bones of the Axial Skeleton

Study the bone models available in the lab. On all bone models identify the following bones and label them on the images below.

<u>Bones of the Skull</u>

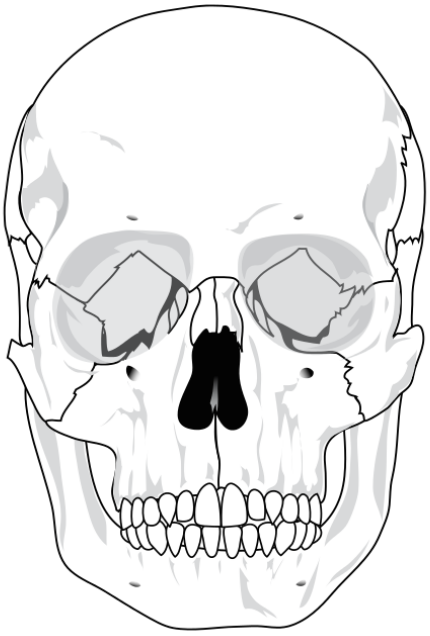
Cranial Bones

☐ Frontal Bone ☐ Parietal Bone (2x) ☐ Temporal Bone (2x) ☐ Occipital Bone



Facial Bones

☐ Mandible ☐ Maxilla (2x) ☐ Zygomatic (2x) ☐ Nasal Bone (2x)



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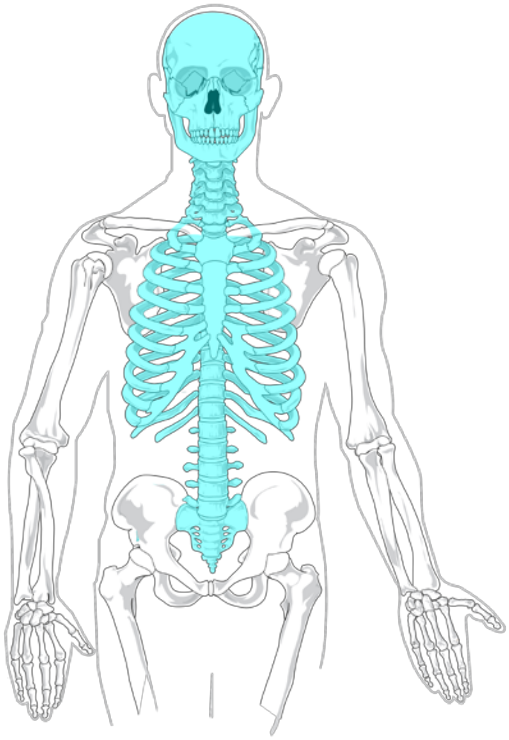
Bone of the vertebral column and thoracic cage

☐ Vertebral column ☐ Sacrum

☐ Sternum ☐ Ribs



Activity 3: Identification of Bones of the Appendicular Skeleton

Study the bone models available in the lab. On all bone models identify the following bones and label them on the images below.

Bones of the Pectoral Girdle & Upper Limb

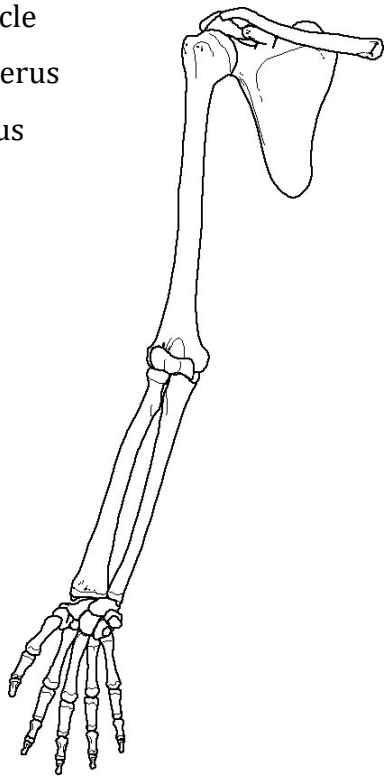
☐ Scapula

☐ Clavicle

☐ Humerus

☐ Radius

☐ Ulna



Bones of the Pelvic Girdle & Lower Limb

☐ Hip Bone

☐ Femur

☐ Tibia

☐ Fibula

☐ Patella

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Skeletal Muscles of the Muscular System

Skeletal muscles are under our conscious control and are the muscles that are attached to bone to produce movement. These muscles use bones as levers and pulleys to produce a variety of movements. In order for the muscles to move, or contract, a signal from the nervous system must stimulate them and that signal is generated by our conscious decision to carry out that movement.

Activity 4: Identification of the major muscles of the human body

Study the muscle models available in the lab. On all muscle models identify the following muscles. Use the keys and images provided in the lab to help guide you.

HEAD MUSCLES
- ☐ Frontalis
- ☐ Occipitalis
- ☐ Orbicularis oculi
- ☐ Orbicularis oris
- ☐ Zygomaticus
- ☐ Mentalis
- ☐ Buccinator
- ☐ Masseter
- ☐ Temporalis

NECK MUSCLES
- ☐ Sternocleidomastoid
- ☐ Stylohyoid

VERTEBRAL COLUMN MUSCLES
- ☐ Errector spinae

THORAX AND ABDOMEN MUSCLES
- ☐ Intercostals
- ☐ Diaphragm
- ☐ Rectus Abdominis
- ☐ External abdominal
- ☐ Internal abdominal oblique
- ☐ Transversus abdominus

PECTORAL GIRDLE MUSCLES
- ☐ Pectoralis Major
- ☐ Pectoralis Minor
- ☐ Serratus anterior
- ☐ Trapezius
- ☐ Latissimus dorsii

BRACHIAL MUSCLES
- ☐ Deltoid
- ☐ Biceps brachii
- ☐ Triceps brachii
- ☐ Brachialis
- ☐ Brachioradialis
- ☐ Triceps brachii
- ☐ Pronator teres
- ☐ Palmaris longus
- ☐ Extensor digitorum
- ☐ Extensor digiti minimi

PELVIC GIRDLE MUSCLES
- ☐ Sartorius
- ☐ Tensor fasciae latae
- ☐ Quadriceps
- ☐ Rectus femoris
- ☐ Gracilis
- ☐ Gluteus maximus
- ☐ Gluteus minimus
- ☐ Gluteus minimus
- ☐ Biceps femoris
- ☐ Rectus femoris
- ☐ Gastrocnemius
- ☐ Tibialis anterior
- ☐ Extensor digitorum longus

Muscle Contraction

Skeletal muscle is under your voluntary control, so when you decide to walk, you walk, or when you decide to shake your head, you shake your head. This is process is controlled by the nervous system, which sends a signal to muscle fibers to contract. Upon contraction, a muscle fiber shortens, pulling on the bone it is attached to, which produces movement. The unique arrangement of proteins inside a muscle fiber is what allows for this contraction to

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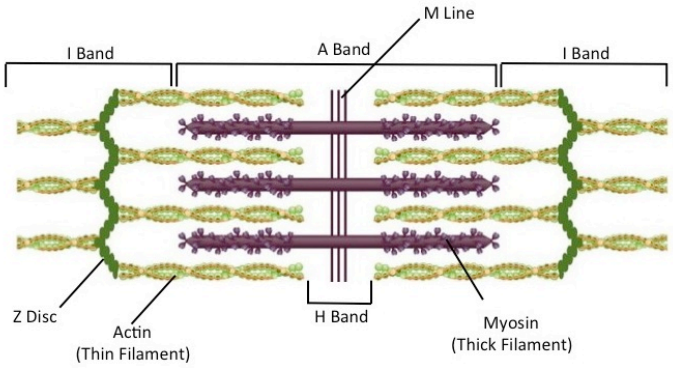
happen. The functional unit of a muscle fiber is known as a **sarcomere.** The detailed structure of a sarcomere can be seen below.



"1006 Sliding Filament Model of Muscle Contraction.jpg" by OpenStax Anatomy and Physiology is licensed under CC BY 4.0, modified by Whitney Menefee

The two main proteins involved in muscle contraction, actin and myosin, can be seen in the sarcomere above. Actin, also known as the thin filament, is anchored into place by structure called a Z disc. Myosin, or the thick filament, is anchored to the M line. The area where only actin is present is known as the I band. The area where myosin is present is known as the A band. Any area actin and myosin are both present is known as the zone of overlap, and when viewed under the microscope appears dark in color, or like a stripe, giving skeletal muscle its characteristic striations. The area surrounding the M line where there is no overlap is known as the H band. The above image represents a sarcomere at rest (not contracted). During muscle contraction, the myosin remains stationary, however attaches to the actin filaments and pulls them toward the M line.

Activity 5: Muscle Contraction

Study the image of a relaxed sarcomere on the previous page. Below, draw a contracted sarcomere.

What will happen to the following structures of a sarcomere during contraction:

I Band: _____

A Band: _____

H Band: _____

Z lines: _____

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Name:_____

The Nervous System

The nervous system allows the human body to respond very quickly to internal and external stimuli by receiving information from special sensory cells, integrating this information, and generating a response. Sensory cells responsible for monitoring the internal and external environment can be general, such as sensory receptors found in the skin, or special, such as cells that sense light. In the following lab activities, we will study the gross anatomy and histology of the nervous system. We will also investigate some general and special senses found in the human body.

Learning Objectives

After completing this lab activity, you should be able to

1. Identify and describe the major organs of the nervous system.
2. Identify neural tissue and neurons under the microscope.
3. Explain why some areas of the body are more sensitive than others.
4. Identify the major anatomical structures of the ear.
5. Identify the major anatomical structures of the eye.
6. Describe some common issues associated with the improper functioning of hearing and vision.

The Nervous System

The nervous system, which is illustrated in the sketch below, is the human organ system that coordinates all of the body's voluntary and involuntary actions, by transmitting electrical signals to and from different parts of the body. Specifically, the nervous system extracts information from the internal and external environments, using sensory receptors. Usually, it then sends signals encoding this information to the brain, which processes the information to determine an appropriate response. Finally, the brain sends signals to muscles, organs, or glands to bring about the response.

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Anatomy of the Nervous System

To understand the function of the nervous system, we must first study its structure. In the following activities, we will study the gross anatomy and histology of this system.

Activity 1: Identification of the major organs of the nervous system

Study the nervous system models available in the lab. On the models identify the following structures and label them on the image below.

Brain Model

☐ Cerebrum: ☐ Frontal Lobe ☐ Temporal Lobe ☐ Parietal Lobe ☐ Occipital Lobe

☐ Cerebellum

☐ Brain Stem: ☐ Pons ☐ Medulla oblongata

☐ Hypothalamus ☐ Spinal Cord

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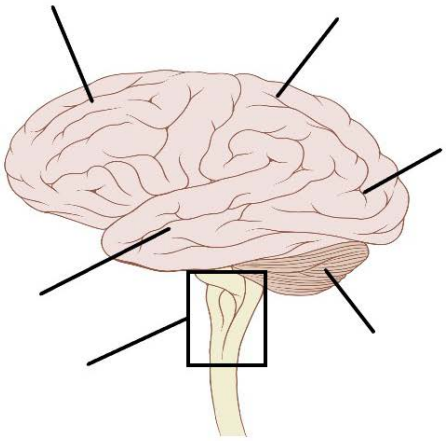
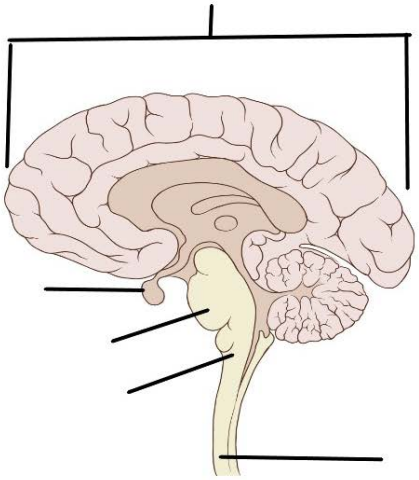


Superficial View



Sagittal View

"Brain: Superficial and Sagittal w/leaders" by Whitney Menefee, Reedley College is licensed under CC BY 4.0 / A derivative from the original work

List the functions of the following areas of the brain:

Cerebrum – Frontal Lobe: _____

Cerebrum – Parietal Lobe: _____

Cerebrum – Temporal Lobe: _____

Cerebrum – Occipital Lobe: _____

Cerebellum: _____

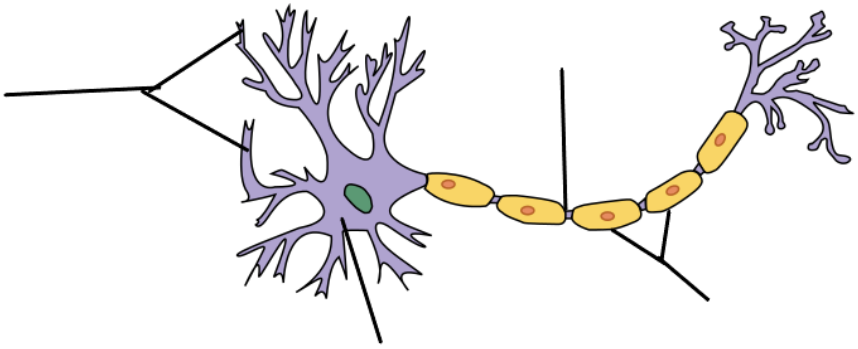
Brain Stem - Pons: _____

Brain Stem –Medulla Oblongata:_____

Hypothalamus: _____

Neuron Model

☐ Dendrites ☐ Soma (Cell Body) ☐ Axon ☐ Myelin Sheath



"Derived Neuron schema with no labels" by Dhp1080, svg adaptation by Actam is licensed under CC BY-SA 3.0

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List the functions of the following structures of a neuron:

Dendrites: _____

Soma (Cell Body): _____

Axon: _____

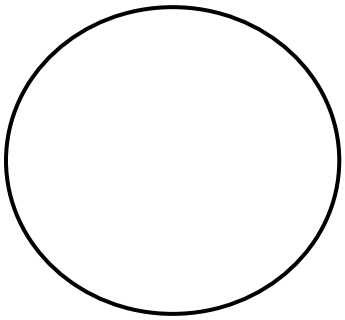
Myelin Sheath: _____

Activity 2: Studying neural tissue under the microscope

1. Obtain a neural tissue.
2. View the slide on high power.
3. Draw what you see below. Label the following structures: neuron – dendrites, soma, axon; microglia

Object: _____

Total Magnification: _____



General Sensory Receptors

General mechanoreceptors in the skin respond to touch, pressure, and vibrations. Areas of the skin that have more mechanoreceptors are more sensitive than other areas, which is why you might feel a mosquito land on your face, but not notice one that is on your arm.

Activity 3: Two-Point Touch Discrimination

1. Obtain a plastic caliper. The caliper can be closed to where the points are very close together or spread out so that the two points are farther away. You will use the points of the caliper to determine sensitivity. *Caution: Caliper can be sharp, you do not need to apply very much pressure.*
2. Have your subject close their eyes or look away so that they cannot see the caliper touch the skin. Start with the wrist and place the two points of the caliper as close together as possible and touch the skin. Gradually spread the points apart and test the subject until they note that they can feel TWO points. Use a ruler to measure the width in millimeters and record that value in the data table below.
3. Repeat this procedure for each of the areas on the data table for your subject, then switch so that you also have readings for yourself.
4. Once you have recorded all of your data, answer the questions below.

	Two-Point Distance (mm)	
Area of Body	Your Data	Your Partner's Data
Wrist		
Palm		
Back of Hand		

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Thumb		
Cheek		
Back of neck		
Upper arm		

Data Table 1. Two-Point Discrimination Data

Which part of the body do you think is the most sensitive? Explain your answer using your data.

Suggest reasons for these results. Consider why it might be important for some areas to be more sensitive than others.

"Investigation: Two-Point Touch Discrimination Test" is licensed under CC BY-NC-SA 4.0, modified by Whitney Menefee

Special Sensory Receptors

Humans have five special senses, which include hearing, balance (equilibrium), smell (olfaction), taste (gustation), and vision.

Anatomy of the Ear

The sensory receptors involved in hearing and balance are found in the inner ear. Both are mechanoreceptors, which respond to mechanical forces. In the case of hearing, these receptors are responding to the vibrations produced as sound travels through the air and fluid in the inner ear. To reach the inner ear, the vibrations must travel through (or be conducted by) structures of the outer and middle ear.

Activity 4: Identification of major anatomical structures of the ear

Study the ear models available in the lab. On all the ear models identify the following structures and label them on the image below.

- ☐ Auricle
- ☐ Malleus
- ☐ Ear Canal
- ☐ Cochlear Nerve
- ☐ Tympanum
- ☐ Incus
- ☐ Oval Window
- ☐ Round window
- ☐ Cochlea
- ☐ Stapes
- ☐ Semicircular canals
- ☐ Auditory Tube
- ☐ Vestibule

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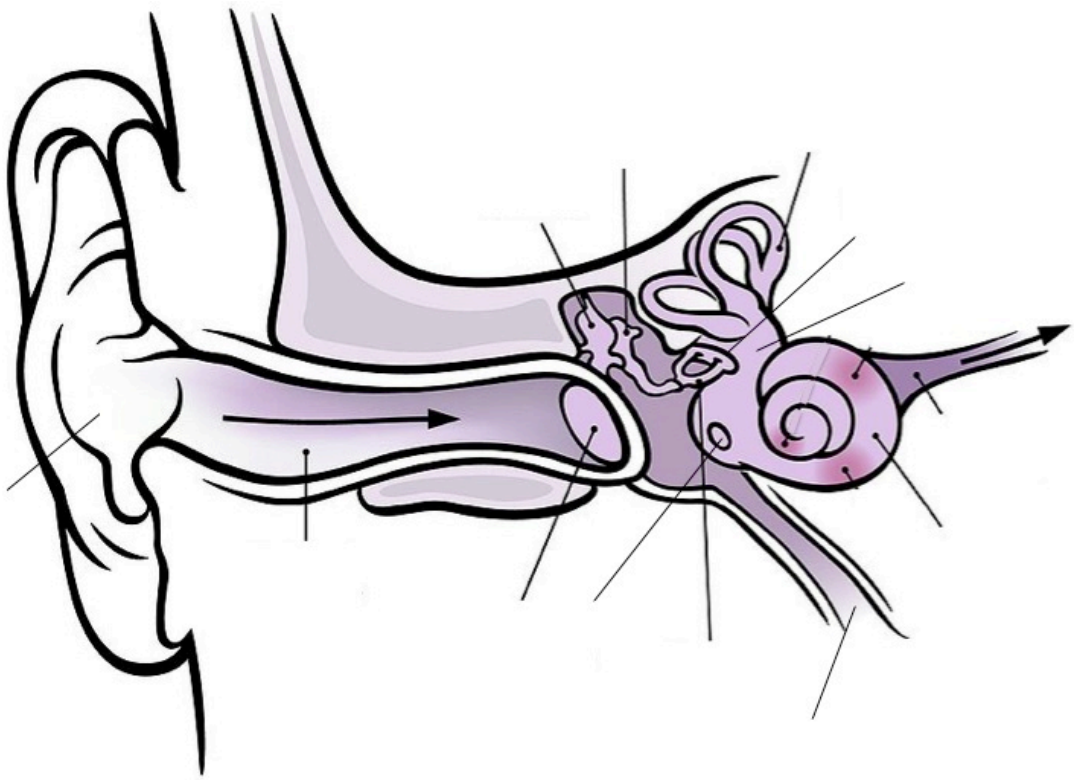

"Ear Anatomy Unlabeled" / A derivative from the original work

Activity 5: List the path of sound through the ear

Using the terms listed above in Activity 2, list the path of sound from outside the body in. NOTE: Omit the structures vestibule and semicircular canals from the list above. These structures of the ear are used for equilibrium only, not hearing.

_____Auricle_____ ➔ _____ ➔ _____ ➔

_____ ➔ _____ ➔ _____ ➔

_____ ➔ _____ ➔ _____ ➔

_____Auditory Tube_____

Activity 6: Hearing Tests

There are several different tests that can be done to test hearing. Both the Weber and Rinne hearing tests are used to check for conductive hearing loss, that is the loss of the ability for the auditory ossicles (malleus, incus, stapes) of the middle ear to conduct sound to the inner ear, where the sensory organs are.

Activity 6A: Weber's Test

1. Obtain a tuning fork.

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2. Strike the tuning fork and place it directly above your partner's head, equal distance from each ear.
3. Ask your partner to identify if they can hear the sound better in one ear or the other, or is the sound the same in both ears?
4. In people who have normal hearing, the tuning for should be heard equally in both ears. If the sound is heard better in one ear or the other, this may be a sign of conductive hearing loss.

Activity 6B: Rinne's Test

1. Obtain a tuning fork.
2. Strike the tuning fork and place it behind your partner's right ear, on the mastoid process.
3. Ask your partner to tell you when they can no longer hear the tuning fork.
4. When your partner indicates they can no longer hear the tuning fork, move the tuning fork directly next to their right ear (do not strike the tuning fork again).
5. Ask your partner if they can hear the tuning fork again.
6. Now repeat steps 2 – 5 on your partner's left ear.
7. In people with normal hearing, once they can no longer hear the tuning fork behind their ear and it is moved next to their ear they can hear it again. If you cannot hear the tuning fork when it is moved directly next to your ear, this may be a sign of conductive hearing loss.

Activity 7: Testing your Equilibrium

The majority of your equilibrium is sensed by the movement of fluid in the inner ear. However, other factors such as your vision and body position (sensed by proprioreceptors) can have an effect on you overall balance. In this activity, we will test your balance and determine what happens to your balance when we remove one of these factors.

1. With your partner, go up to the front of the room to the white board. Stand in front of the white board with your hands down at your sides. Have your partner draw a line on either side of you on the white board with a white board marker.
2. Stand still looking forward for one minute.
3. Have your partner watch your movements and record your amount of swaying relative to the stable lines on the white board in the table below. (Record amount of swaying as: No Swaying, Minimal Swaying, Much Swaying)
4. Repeat Steps 2 – 3 with your eyes closed.

	Eyes Open	Eyes Closed
Amount of Swaying		

Data Table 2. Your amount of swaying during the equilibrium test

What do your results tell you about the combined effects of vision and inner ear sensations on equilibrium?

_____

_____

_____

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Smell (Olfaction) and Taste (Gustation)

There are only five confirmed types of true tastes—sour, sweet, salty, bitter, and savory (also known as umami). Each of your different types of receptors binds to a specific structure of a "taste" molecule. For example, sour receptors respond to acids (H^+); salt receptors react to the metal ions in salts (such as the Na^+ in table salt); umami receptors respond to glutamate molecules (a type of amino acid); sweet receptors bind to simple sugars (glucose); and bitter receptors are triggered by alkaloids. Alkaloids are nitrogen-containing bases with complex ring structures which have significant physiological activity. Some examples of alkaloids are nicotine, quinine, morphine, strychnine, and reserpine. Many poisons are alkaloids, and the presence of receptors for the bitter taste at the back of the tongue may help to trigger the vomiting response.

Approximately 80–90% of what we perceive as "taste" is in fact due to our sense of smell (think about how dull food tastes when you have a head cold or a stuffy nose). At the beginning of this experiment you may not be able to tell the specific flavor of the candy beyond a general sensation of sweetness or sourness. Over time and once you unplug your nose, you may notice that as the candy dissolves, you can identify the specific taste. This is because some scent molecules volatilize and travel up to your olfactory organ through a kind of back door—that is, up a passage at the back of your throat and to your nose. Since we can only taste a few different true tastes, it's actually smell that lets us experience the complex, mouth-watering flavors we associate with our favorite foods.

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Activity 8: Testing the relationship between taste and smell.

1. Have your lab partner obtain a flavored candy. Make sure that you do not see what flavor candy your partner gets.
2. Close your eyes and have your partner hand you the candy.
3. Without looking at it, or smelling it, unwrap your candy.
4. Plug your nose and place the candy in your mouth.
5. Try to determine what flavor you have and tell your partner.
6. Now unplug your nose and try to determine what flavor candy you have. Tell your partner.
7. Record your results in the data table and answer the following questions.

	Flavor with Nose Plugged	**Flavor with Nose Unplugged**	**Actual Flavor**
Your Results			
Your Partner's Results			

Data Table 2. Results of testing the relationship between taste and smell.

Why was it so hard to identify the correct flavor when you plugged your nose?

_____

_____

_____

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Why do you think foods have a dull flavor, or sometimes no flavor, when you have a bad cold or stuffy nose?

_____

_____

_____

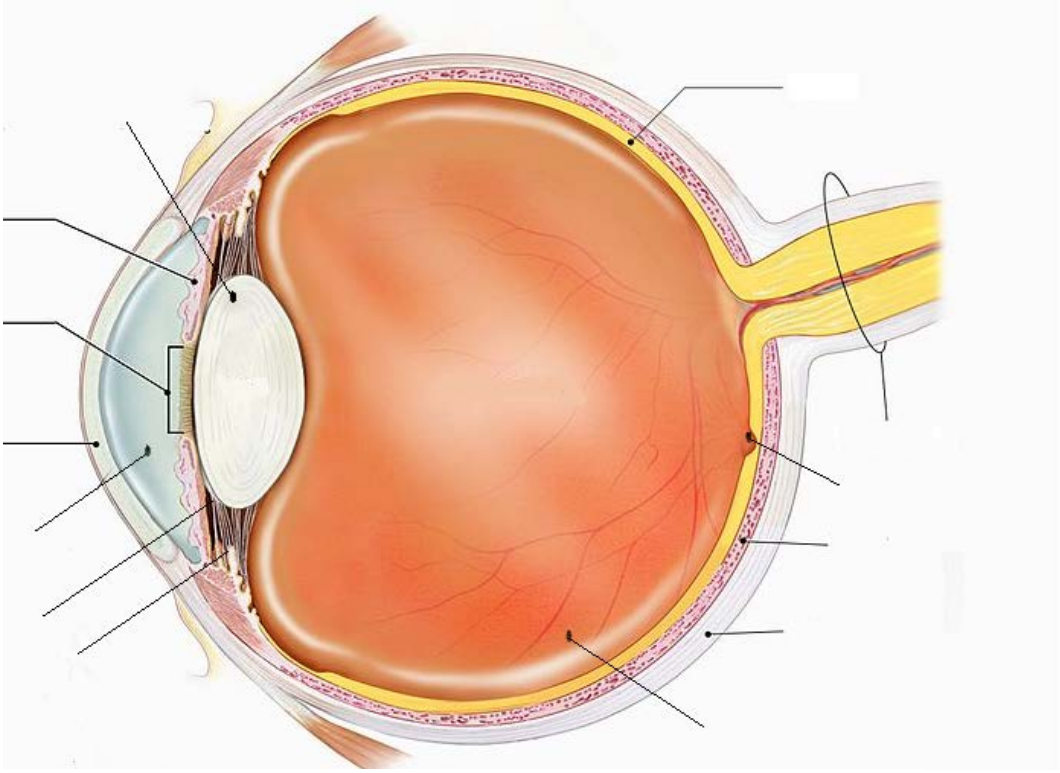
Anatomy of the Eye

The sensory receptors responsible for responding to light are located inside the eye in an area known as the retina. The human eye is a very complex with structures that have a variety of functions to support vision such as protection, providing nourishment, structural support, and focusing light. All of these structures and their functions contribute to clear vision.

Activity 9: Identification of major anatomical structures of the eye

Study the eye models available in the lab. On all the eye models identify the following structures and label them on the image below.

☐Lens	☐ Iris	☐Cornea	☐Sclera
☐Choroid	☐ Ciliary Body	☐Retina	☐Fovea Centralis
☐Blind Spot	☐ Optic Nerve	☐Anterior Chamber	☐Posterior Chamber
☐Posterior Cavity	☐Pupil		



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Activity 10: List the path of light through the eye

Using the terms listed above in Activity 6, list the path of light from outside the body in. NOTE: You will not use all of the structures listed above. Not all structures of the eye are involved in the transmittance of light.

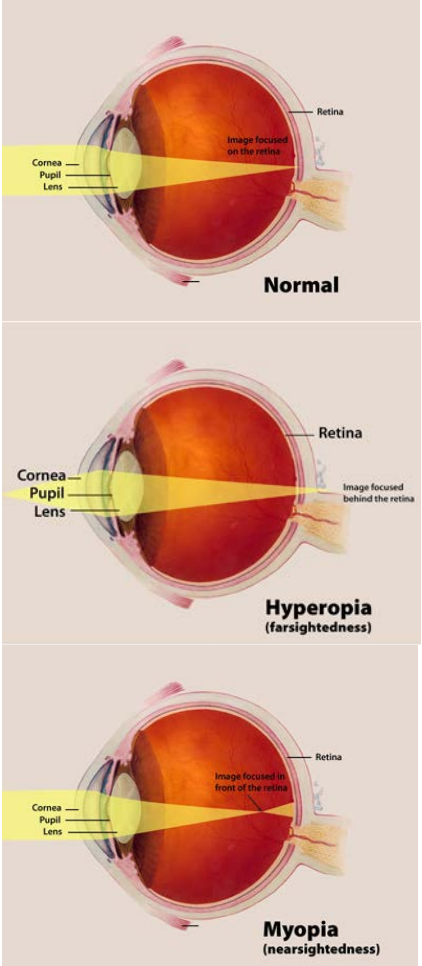
_____Cornea_____ ➔ _____ ➔ _____ ➔

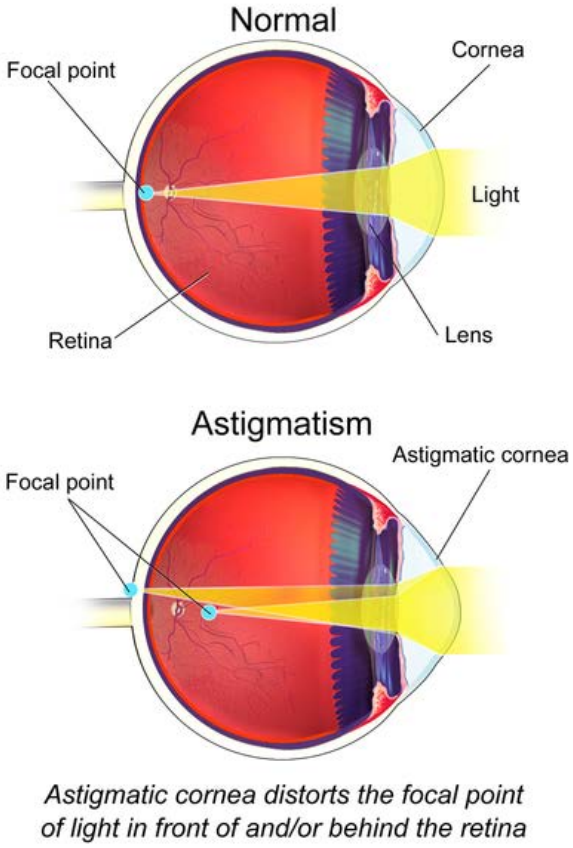
_____ ➔ _____ ➔ _____ ➔

_____Retina_____

Activity 11: Vision tests

If any structures of the eye are not the correct shape or are not functioning properly, this can lead to vision problems. Any issues with shape or function may hinder the eye's ability to focus light on the fovea centralis, which leads to poor or blurry vision. The images below shows some common structural issues of the eye which leads to poor or blurry vision.





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"Astigmatism" by Bruce Blaus is licensed under CC BY-SA 4.0

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Activity 11a: Test your visual acuity

A Snellen Eye Chart is used to test visual acuity, or the clearness/sharpness of your vision.

1. Stand 20 feet away from the Snellen Eye Chart.
2. Have you partner stand right next to the chart to judge acuity.
3. Read out loud the letters in the line labeled "20/20". Have your partner determine if you got all of the letters correct.
4. If you got all of the letters correct in the 20/20 line, read the next row down out loud. Continue reading the lines below until you no longer get all of the letter correct.
5. If you did not get all of the letters correct in the 20/20 line, read the next row up out loud. Continue reading all of the lines above until you get all of the letters correct.
6. Record your visual acuity in the table below by writing in the smallest line you can read with all the letters correct.
7. Now test the acuity of each eye individually by repeating steps 1 – 6, but cover or close one eye at a time.

Visual Acuity with Both Eyes	Visual Acuity of Left Eye	Visual Acuity of Right Eye

Data Table 3. Your visual acuity.

What do your results indicate? Normal vision is considered 20/20. This means that you can read what should normally be seen at 20 feet away. If you have 20/40 vision this mean you see from 20 feet what a person with normal vision can see at 40 feet.

What does your data indicate about your vision?

_____

_____

Do you have the same visual acuity in both eyes? Do you have better acuity when using both eyes or just one individually? What you think might account for these differences?

_____

_____

_____

_____

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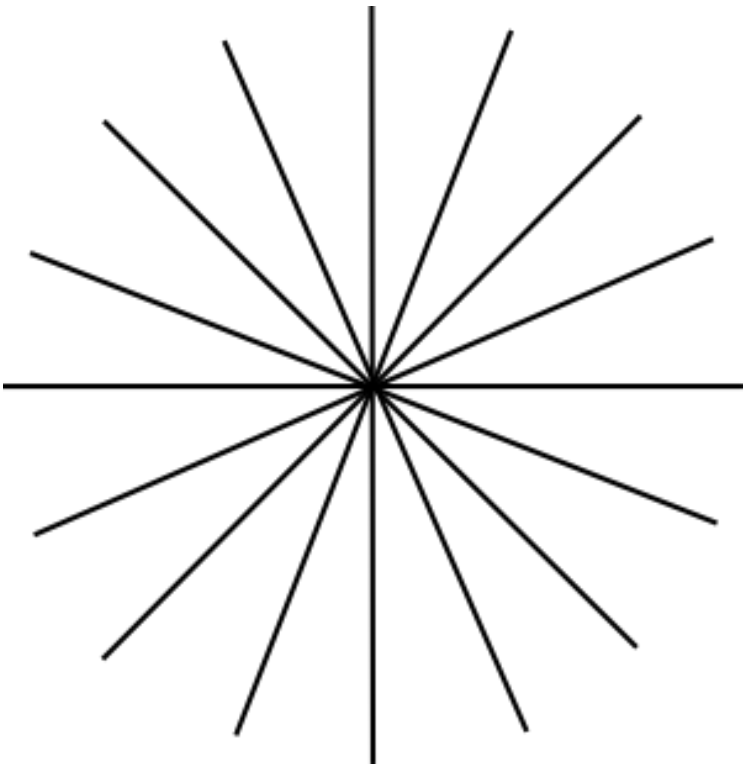
Activity 11b: Astigmatism eye chart

1. Hold the chart below about 12 inches away from your face.
2. Cover or close your left eye and look at the chart. How do the lines look? Are they all clear and sharp? Record your observations in the data table below.
3. Now repeat steps 1 – 2 while covering or closing your right eye.



	Left Eye	Right Eye
Are all lines clear and sharp?		

Data Table 4. Your test for astigmatism

What do your results indicate? If you have normal vision, you should see all of the lines clear and sharp, also all of the lines should appear equal distance apart. If this is not the case in one or both eyes, you may have astigmatism.

Disclaimer: While the tests conducted in this lab activity are the common tests done to check hearing and vision, they should not be used in this context to make a medical diagnosis. If you feel you have a hearing or vision problem, you are advised to see you doctor or optometrist.

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Name:_____
Date: _____

The Endocrine & Reproductive Systems

Learning Objectives

After completing this lab activity, you should be able to

1. Identify the major organs of the human endocrine system
2. List the hormones secreted by the major organs of the human endocrine system and explain their effects.
3. Identify the organs of the male and female reproductive systems and describe the key functions of these organs.
4. Discuss the female menstrual listing key events and structural changes.

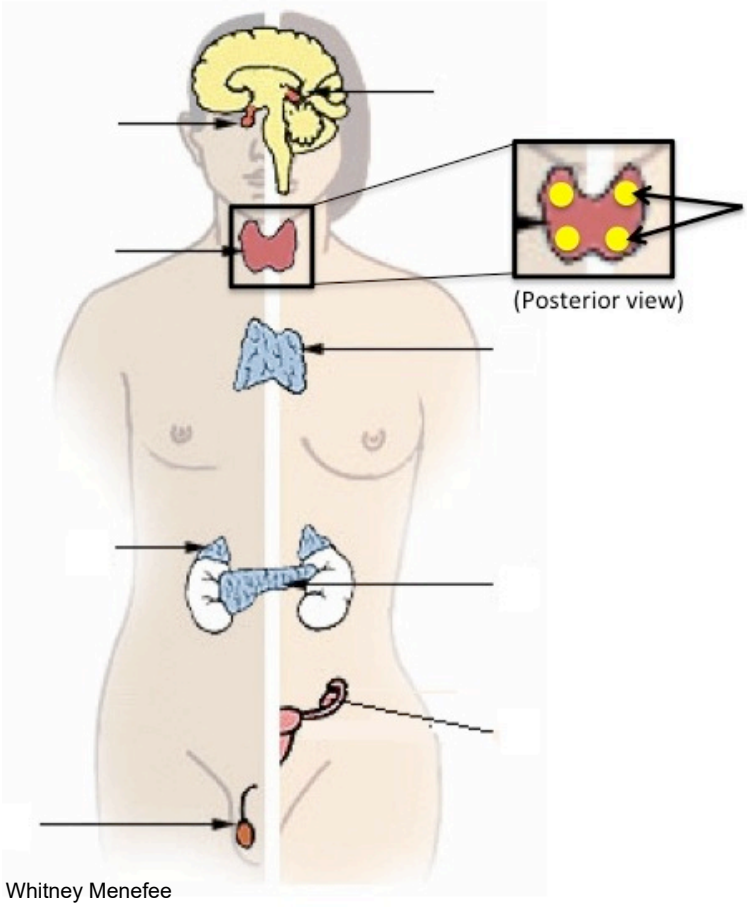
The Endocrine System

The Endocrine system is composed of organs whose functions are to release hormones (chemical signals) to maintain the overall homeostasis of the human body. These organs release their hormones out into the blood stream where they travel to their target cells. Once the hormones bind to their target cells, this triggers a response by the cell to change its function to achieve homeostasis of the body.

Activity 1: Endocrine Organs

For this activity you will identify and become familiar with the locations of the major endocrine organs found in the human body. On the image below, identify and label the following endocrine organs:

- ☐Pituitary Gland
- ☐Thyroid Gland
- ☐Adrenal Glands
- ☐Thymus
- ☐Parathyroid Glands
- ☐Pineal Gland
- ☐Pancreas
- ☐Gonads (testes/ovaries)



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Activity 2: Hormones

This activity will explore hormones, or the secretions of endocrine organs. Using your readings on Canvas, internet sources, and any other resources available in the lab complete the following table. For each organ, you will list the hormone it secretes, the hormone's target organ, and the hormone's effect(s).

Endocrine Gland	Hormone Secreted	Target Organ(s)	Effects
Anterior Pituitary			
Posterior Pituitary (from Hypothalamus)			
Pineal Gland			
Thyroid			
Parathyroid Glands			
Thymus			
Adrenal Glands			
Pancreas			

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The Reproductive System

Humans undergo sexual reproduction, or the combining of male and female gametes, to produce offspring. The reproductive system serves the main purposes of producing these gametes (eggs and sperm) and providing the necessary structures to allow for egg and sperm to combine in the process of fertilization.

The Male Reproductive System

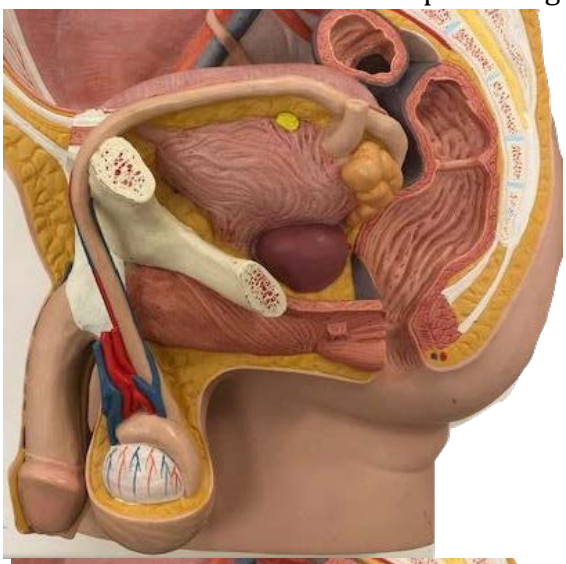
The male reproductive system functions to produce sperm and safely deliver this sperm to an egg in the female reproductive system. Sperm formation occurs in the gonads, or testes. The testes also act as an endocrine organ, releasing testosterone, a hormone that regulates sperm production and is responsible for secondary sex characteristics. The other structures of the system aid in the successful delivery of sperm to an egg.

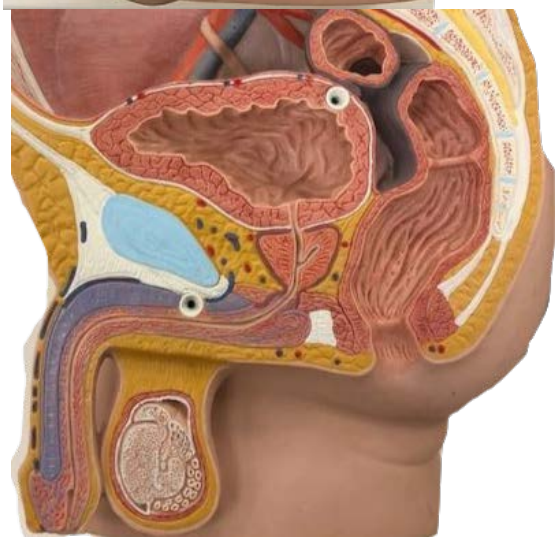
Activity 3: Major Organs of the Male Reproductive System

Study the male reproductive system models available in the lab. On all the models identify the following structures and label them on the images below.

☐scrotum ☐testicles ☐epididymis ☐vas deferens

☐urethra ☐penis ☐seminal vesicles ☐prostate gland ☐bulbourethral gland





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List the functions of the following male reproductive organs:

Scrotum: _____

Testicles: _____

Epididymis: _____

Vas deferens: _____

Urethra: _____

Penis: _____

Seminal Vesicles: _____

Prostate Gland:_____

Bulbourethral Glands: _____

The Female Reproductive System

The female reproductive system functions to produce eggs. Also, depending on the fate of an egg either to provide a safe environment for a fertilized egg to develop, or to shed this egg is if is not fertilized. The gonads (ovaries), like the male gonads, act as an endocrine organ to produce the hormones estrogen and progesterone, which are responsible for egg maturation and release, and preparation of the female body for a fertilized egg. Unlike the male gonadal hormone testosterone, which is released all the time, the female hormones are released in a cyclic fashion, which drive the ovarian and uterine cycles.

Activity 4: Major Organs of the Female Reproductive System

Study the female reproductive system models available in the lab. On all the models identify the following structures and label them on the image below.

☐Ovaries ☐Oviducts ☐Uterus ☐Cervix

☐Vagina

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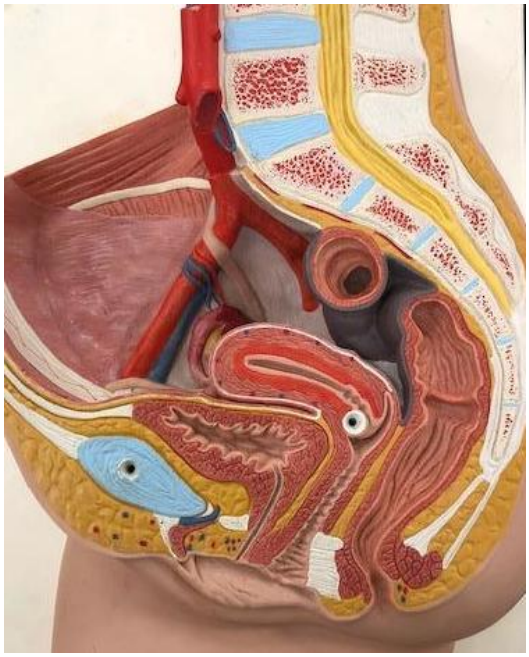

List the functions of the following female reproductive organs:

Ovaries: _____

Oviducts: _____

Uterus: _____

Cervix: _____

Vagina: _____

Activity 5: The Female Menstrual Cycle

The menstrual cycle refers to natural changes that occur in the female reproductive system each month during the reproductive years. The cycle is necessary for the production of eggs and the preparation of the uterus for pregnancy. It involves changes in both the ovaries and the uterus, and is controlled by pituitary and ovarian hormones. Day 1 of the cycle is the first day of the menstrual period**,** when bleeding from the uterus begins as the built-up endometrium lining the uterus is shed. The endometrium builds up again during the remainder of the cycle, only to be shed again during the beginning of the next cycle if pregnancy does not occur. In the ovaries, the menstrual cycle includes the development of a follicle, ovulation of a secondary oocyte, and then degeneration of the follicle if pregnancy does not occur. Both uterine and ovarian changes during the menstrual cycle are generally divided into three phases, although the phases are not the same in the two organs.

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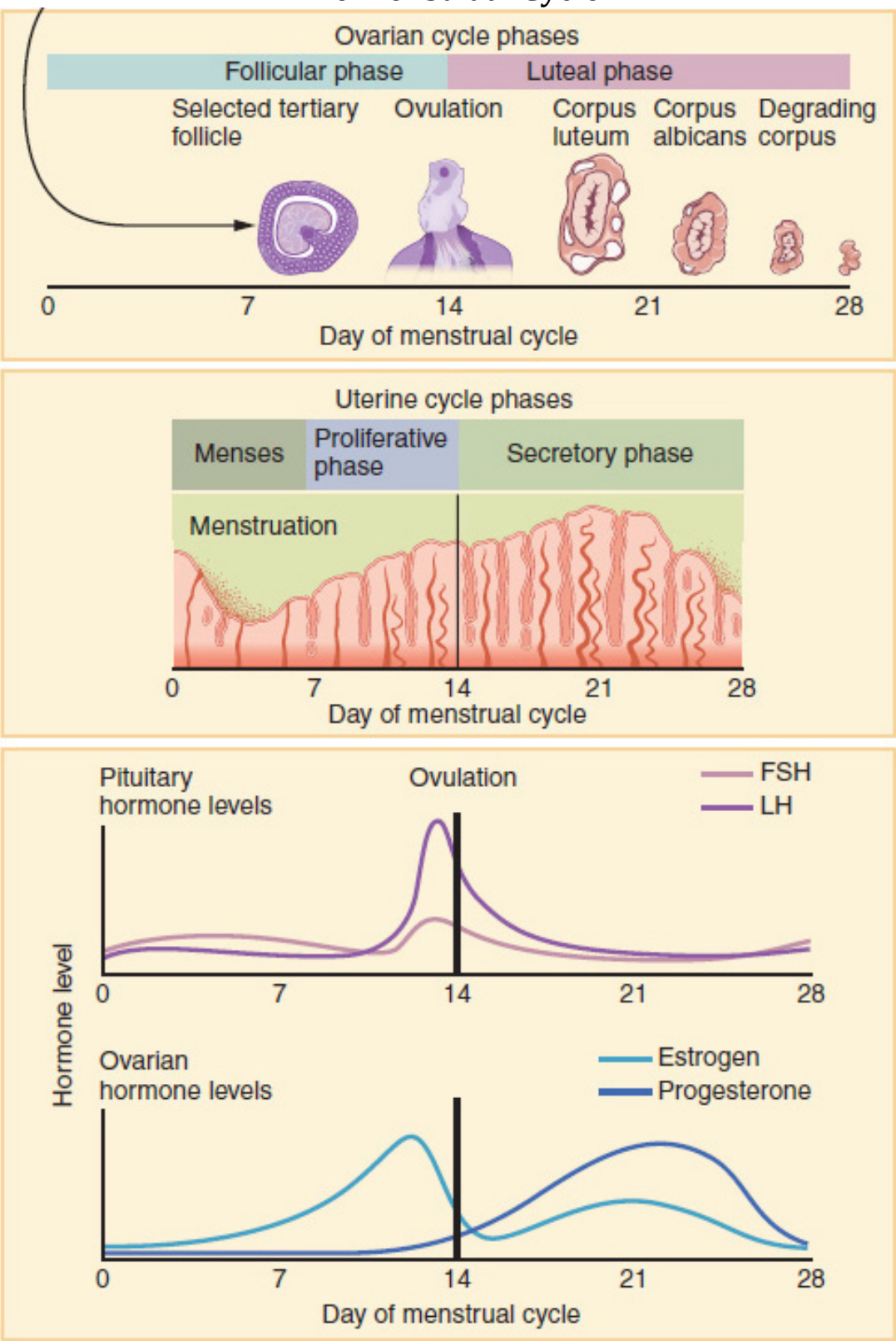
The Menstrual Cycle



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Use the image above, "The Menstrual Cycle", to answer the following questions.

1. What hormone do you think is responsible for causing ovulation? _____

2. After ovulation occurs, the empty follicle, corpus luteum, secretes which ovarian hormone?

   _____

   i. What effects do you think this hormone has on the uterus?

   _____

   _____

3. In the secretory phase of the uterine cycle, you can see the lining of the uterine lining becomes very thick and vascularized. Why do you think this is the case?

   _____

   _____

Hormones of the Reproductive System

As mentioned above, along with the production of gametes, the gonads of the reproductive system also act as endocrine hormones, releasing sex hormones.

Activity 6: Sex Hormones

This activity will explore the sex hormones released by the gonads. Using your readings on Canvas, internet sources, and any other resources available in the lab complete the following table. For each organ, you will list the hormone it secretes, the hormone's target organ, and the hormone's effect(s).

Endocrine Gland	Hormone Secreted	Target Organ(s)	Effects
Testes			
Ovaries			

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BIOL-5 - Human Biology

General Information

Author(s):	Cheryl Hesse
Proposal Start:	Spring 2018
Distance Education Approved:	Yes
TOP Code:	0401.00
TOP Code Name:	Biology, General
CIP Code:	26.0101
CIP Code Name:	Biology/Biological Sciences, General
SAM Code:	E = Non-occupational
Course Control Number:	CCC000438003
Curriculum Committee Approval Date:	09/14/2017
Board of Trustees Approval Date:	11/07/2017
External Review Approval Date:	11/07/2017
Course Description:	This course is an introductory human biology course that examines science and societal issues. This course emphasizes the structure of the human body and the functional interrelationships of the body's systems: integument, circulatory, digestive, respiratory, urinary, skeletal, muscular, nervous, endocrine, reproductive, and genetics.. ADVISORIES: English 1A and Mathematics 201. (A, CSU-GE, UC, I)
Submission Rationale:	

Faculty Minimum Qualification Requirements

Master Discipline Preferred:	Biological Sciences
Alternate Master Discipline Preferred:	No value
Bachelors or Associates Discipline Preferred:	No value
Additional Bachelors or Associates Discipline:	No value

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Course Development Options

Course Basic Skill Status	Allowed Number of Retakes	Grade Options
Course is not a basic skills course.	0	Pass/No Pass Letter Grade methods

☐ Allow Students to Gain Credit by Exam/Challenge

Rationale For Credit By Exam/Challenge	Retake Policy Description	☐ Allow Students To Audit Course
No value	No value	

Course Prior to College Level

Not applicable.

Associated Programs

Associated Program	Award Type
No value	No value

Transferability & Gen. Ed. Options

Request for Transferability	Transferability Status
Transferable to both UC and CSU	Approved

Reedley College	Categories	Transferability Status	Comparable Course
Area A - Natural Sciences (3 units)	Area A - Natural Sciences (3 units)	Approved	No Comparable Course defined

CSU-GE	Categories	Transferability Status	Comparable Course
B2 - Life Science	B2 - Life Science	Approved	No Comparable Course defined
B3 - Laboratory Activity	B3 - Laboratory Activity	Approved	No Comparable Course defined

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IGETC	Categories	Transferability Status	Comparable Course
5B - Biological Science	5B - Biological Science	Approved	No Comparable Course defined
5C - Science Laboratory	5C - Science Laboratory	Approved	No Comparable Course defined

Units and Hours

Summary

Minimum Credit Units	4	**Total Course In-Class (Contact) Hours**	108	**Total Student Learning Hours**	216
Maximum Credit Units	4	**Total Course Out-of-Class Hours**	108	**Faculty Load**	5.25

Detail

Weekly Student Hours

	In Class	Out of Class
Lecture Hours	3	6
Lab Hours	3	-
Activity Hours	-	-

Course Student Hours

Course Duration (Weeks)	18
Hours per unit divisor	54
Course In-Class (Contact) Hours	
Lecture	54
Lab	54
Activity	-
Total	108

Course Out-of-Class Hours	
Lecture	108
Lab	-
Activity	-
Total	108

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Units and Hours - Weekly Specialty Hours

Requisites

Advisory

ENGL-1A - Reading and Composition

1. a sophisticated introduction, multiple body paragraphs,
2. and conclusion
3. supporting details that exhibit critical thinking and use credible secondary sources
4. sentences that exhibit a command of the complex/compound with minimal comma splices, sentence fuses, fragments, and mechanics
5. writing in third person/universal
6. an avoidance of logical fallacies
7. demonstration of an awareness of purpose and audience
8. an avoidance of intentional and unintentional plagiarism

AND

Advisory

MATH-201 - Elementary Algebra

1. apply real number operations to simplify and factor algebraic expressions.
2. use graphic representation of an equation in two variables to solve appropriate problems.

Entrance Skills

Skill	Content Review
No value	No value

Limitations on Enrollment

Specifications

Methods of Instruction	Methods of Instruction Rationale

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Lecture

Lab

Hybrid (1-99% online, on-campus meeting(s) are required)

Labs are taught on campus

Demonstrations

Discussion

Role Playing

Small Group

Assignments

Reading Assignments
Sample reading assignments are from the textbook.

Lab Reports

Case Studies

Methods of Evaluation

Department Course Grade Determination Guidelines

Methods of Evaluation Rationale

10% Case Studies Project(s)
10% Quizzes
20% Final Exam
20% Laboratory Exams
20% Laboratory Reports
20% Exams

Equipment

Well equipped and supplied biological teaching laboratory. Access to LGI lecture rooms.

Textbooks

Author	Title	Publisher	Date	ISBN
Sylvia Mader	Human Biology, 14 ed.	McGraw Hill	2015	
Sylvia Mader	Laboratory Manual Human Biology, 14 ed.	McGraw Hill	2015	

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Learning Outcomes and Objectives

Course Objectives

- ✔ 1. read, analyze, evaluate, and discuss scientific method, the cell, and human levels of organization
- ✔ 2. learn the periodic table of the elements, the chemistry of the carbon atom, and the chemical structure of humans
- ✔ 3. analyze and interpret data on the homeostatic mechanisms within the human body
- ✔ 4. learn the cell's structure, function, and the cell cycle in relation to the multicellular human body
- ✔ 5. observe and document the structure and function of the human body by examining human body systems including: circulatory, digestive, respiratory, urinary, skeletal, muscular, nervous, sensory, endocrine, and reproduction
- ✔ 6. review classical and molecular genetics and learn the processes of replication, transcription, and translation
- ✔ 7. perform experiments, observe, and record data
- ✔ 8. study evolution
- ✔ 9. discuss social issues between humans and science
- ✔ 10. develop a vocabulary to effectively communicate information related to anatomy and physiology
- ✔ 11. summarize the levels of structural organization important to the human anatomy

CSLOs

BIOL-5 SLO1: demonstrate knowledge regarding the process of science and society, microscopy, and the cell	Expected SLO Performance: 100
BIOL-5 SLO2: identify human body levels of organization and homeostatic mechanisms	Expected SLO Performance: 100
BIOL-5 SLO3: demonstrate knowledge of the chemical basis of life	Expected SLO Performance: 100
BIOL-5 SLO4: evaluate scientific literature and current biological achievements	Expected SLO Performance: 100
BIOL-5 SLO5: apply the principles of genetics to humans and understand the outcome of normal and abnormal DNA	Expected SLO Performance: 100
BIOL-5 SLO6: describe the basic cellular, molecular and gross anatomy of tissues, organs and organ systems and explain the basic function of those tissues and organs that relate to the integument, circulation, digestive, respiratory, urinary, skeletal, muscular, nervous, endocrine, reproduction, genetics, and evolution	Expected SLO Performance: 100
BIOL-5 SLO7: identify and recall fundamental structures from anatomical models and slides using correct nomenclature and language	Expected SLO Performance: 100

Course Outline

Course Outline

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A. Science and Society: What basic characteristics do all living things share?
What is the evidence that living organisms share an evolutionary history?
Scientific method helps to gather information and leads to conclusions.
B. The Chemistry of Life
Basic chemistry used in the understanding of human biology. ie. Atomic elements, the carbon atom, bonding patterns of elements, and water, the essential compound of life.
The major macromolecules of life: carbohydrates, lipids, proteins, and nucleic acids.
C. The Cell: Eukaryotes vs. Prokaryotes.
The plasma membrane, intracellular structures, and functions and the cell cycle.
Human cells use cellular respiration and fermentation to generate ATP.
Mitosis, Meiosis: in normal and abnormal cases.
D. Human Body Organization and Homeostasis
The human body from the cell to its complex organ systems.
The skin as an organ system.
Internal homeostasis is maintained by negative and positive feedback mechanisms.
E. Maintenance of the human body: Circulatory System. Digestive System, Respiratory System, Urinary System. The structures and functions of the cells, organs, and related structures to the preceding systems.
F. Control and coordination of the human body: The Skeletal, Muscular, Nervous, Sensory, and Endocrine Systems. The structures and functions of the cells, organs, chemicals, and mechanisms of control of the human body.
G. Reproductive Systems: Structures of the male and female systems. The male system from production and delivery of the sperm.
The female system from production of the eggs, to conception, to nurturing of the embryo and fetus.
H. DNA: Structure and Function and Inheritance
The structure of DNA is nucleotides.
Demonstrate knowledge of replication, transcription, and translation.
Apply biotechnology techniques to cloning, recombinant DNA, and stem cell research.
Set up and perform genetic cross matches demonstrating Mendelian patterns of inheritance.
Create and interpret pedigree charts.
I. Evolution and Biodiversity
Natural Selection, artificial selection, mutations, and the Hardy-Weinburg Equilibrium.
The evidence for evolution: fossil record, biochemistry, comparative anatomy and embryology.
Ecosystems, Energy flow, conservation, and extinction of species.

Lab Outline
Lab: The Microscope and Scientific Method
Lab: Chemistry of the macromolecules of life.
Lab: The cell: its cycle, mitosis, meiosis
Lab: Human organization and histology: epithelial, connective, muscular, and nervous tissue.
Labs: Maintenance of the human body: Circulatory, Digestive, Respiratory, & Urinary Systems
Labs: Control and Coordination of the human body: skeletal, muscular, nervous, sensory, & endocrine
Lab: Reproduction: Meiosis: male and female
Lab: DNA — structure, function, and inheritance
Lab: Evolution and Biodiversity: examination of evolutionary evidence, ecosystems, extinction of species

Distance Education

Accessibility Federal and state regulations require that all online course materials must be made available in accessible electronic format. • The district, the college, the Office of Instruction, the DSPS office, the Office of

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Innovation, Technology Services, and instructor is aware the course must be in compliance with requirements regarding EIT (Electronic and Information Technology) pursuant to Section 508 of the Rehabilitation Act and provisions of California Government Code Section 11135. • The district, the college, the Office of Instruction, the DSPS office, the Office of Instructional Innovation and instructor agree to provide course content in an accessible electronic format. If you need support in creating accessible content contact the Office of Instructional Innovation at 559-638-0300 ext. 3152. In the box below, describe needed accommodations.

Requested mode of delivery and how it will be scheduled (separate approval is required for each distance education mode of delivery option) Live Interactive Presentation (2-way) 100% Internet-based (NO meetings can be required for this class) Hybrid - Internet with 1%-99% on-campus meetings Other, please explain

Hybrid

The reason(s) that this course is being considered for distance learning is/are (list all that apply in the box below.): To reach students in remote areas. To provide a specialty course for students. To recruit and support students. To serve the community and business institutions with special training. To serve students for whom face-to-face attendance is less suitable.

What adjustments to the ways in which the course is delivered or presented to students will be necessary in order to offer it in the distance learning mode?

online lecture/on-campus labs

List examples of regular and effective contact that may be used by the instructor of this course. Below are possible types of regular and effective instructor-student communication that an instructor could use with this curriculum. Examples of online class communication: LMS Announcements Chat Discussion Board Email Phone Text / App Text Telephone Schedule face-to-face meetings Conferencing Video Conferencing Facilitation of student-to-student contact Social Networking Sites Feedback on individual student work LMS wikis and blogs Publisher provided software blogs

What additional equipment and staff (if any) are necessary to support the course for students and instructors?

What are the contingency plans if access to the delivery system is interrupted?

What other pertinent information should be shared with the committee?

Global/Multicultural Materials

Global or International Material

We will be reading, evaluating, and discussing issues about human diseases in certain populations.

The topic of genetics will cover anomalies that have global effects and can be found in locations all over the world.

Multicultural Material

We will be reading, evaluating, and discussing issues about human diseases in certain populations.

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The topic of genetics will cover anomalies that have global effects and can be found in locations all over the world.

Pedagogical Course Cap

Pedagogical Course Cap

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Lab Practical #1 – Study Guide

Use this list of material to help guide your studying for your lab practical.

Lab 1 – Microscopy

- Identify the key parts of a compound light microscope: *eyepieces, arm, nosepiece, objective lenses, course-adjustment knob, fine-adjustment knob, stage, stage clips, stage control knobs, iris, light source, light adjustment knob*
    - Know the functions of all of the above structures.
- Determine the total magnification of a specimen using different objective lenses
- Explain why it is important to center and focus a specimen on the low power objective lens before switching to a higher power objective lens.

Lab 2 – Biological Molecules

- Be able to complete Data Table 1 without any additional information.
- Describe what tests can be done to test for the following biological molecules: *carbohydrates (starch and simple sugars), proteins, lipids*
    - Be able to complete Data Table 2 without any additional information

Lab 3 – Cell Structure and Function

- Identify the structures found in a eukaryotic cell: *nucleus, ribosomes, rough ER, smooth ER, golgi apparatus, lysosomes, peroxisomes, centrioles, mitochondria, cytosol, plasma membrane*
    - Know the functions of all of the above structures.
- Explain the procedure and results of Activity 4: The Artificial Cell
    - Describe what materials did/didn't move, and how you know
- Describe what would happen to potato cells in the following solutions: isotonic, hypertonic, hypotonic.

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Lab Practical #2 – Study Guide

Use this list of material to help guide your studying for your lab practical.

Lab 4 – DNA Structure and Function

- Describe the structure of DNA using the terms: *nucleotide, phosphate, pentose sugar (deoxyribose), nitrogenous base, A (adenine), T (thymine), C (cytosine), G (guanine), hydrogen bonds, antiparallel*
- Using a template strand of DNA, come up with the complementary strand
- Describe the process of transcription and translation.
    - Using a template strand of DNA come up with the coding mRNA strand.
    - Then using this mRNA come up with the protein sequence.
- Explain what the following solutions were used for in the DNA Isolation activity:
    - Soap solution
    - Alcohol

Lab 5 – Mitosis & Meiosis

- Identify the phases of Mitosis from Figure 2. Mitosis in the lab. Also, list key events of each phase.
- Identify the following structure on a **replicated chromosome model:** *sister chromatids, centromere*
- Identify all phases of Mitosis on the Mitosis models: *prophase, metaphase, anaphase, telophase*
- Identify all phases of Mitosis under the microscope when viewing a white fish blastula: *prophase, metaphase, anaphase, telophase*
- Identify the phases of Meiosis from Figure 5. Meiosis in the lab. Also, list key events of each phase.
- Compare and contrast the process of Mitosis & Meiosis

Lab 6 – Genetics

- Know the key terms used in genetics and be able to use these terms (see Activity 1)
- Complete Monohybrid crosses using Punnett Squares and be able to solve word problems
- Complete Dihybrid crosses using Punnett Squares and be able to solve work problems
- Solve word problems for patterns of non-medelian inheritance (multiple alleles & codominance)
- Solve word problems for sex-linked traits
- Be able to read and analyze pedigrees

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Lab 7 – Histology

- Describe key characteristics of all epithelial tissues.
- Identify the following epithelial tissues under the microscope AND name a location in the body where they are found:
    - Simple squamous
    - Stratified squamous
    - Simple cuboidal
    - Simple columnar
    - Psudostratified columnar
    - Transitional
- Describe key characteristics of all connective tissues.
- Identify the following connective tissues under the microscope. Know their classification AND name a location in the body where they are found:
    - Supportive Connective Tissues
        - Loose Connective Tissues
            - Areolar
            - Adipose
            - Reticular
        - Dense Connective Tissues
            - Dense Regular
            - Dense Irregular
    - Supportive Connective Tissues
        - Cartilage
            - Hyaline
            - Fibrocartilage
            - Elastic
        - Bone
    - Fluid
        - Blood
- Describe key characteristics of all muscle tissues.
- Identify the following muscle tissues under the microscope AND name a location in the body where they are found:
    - Skeletal
    - Cardiac
    - Smooth
- Describe key characteristics of nervous tissues.
- Identify nervous tissue under the microscope
- Identify the following structure on the **integumentary system model:** *Epidermis, Dermis, Hypodermis, Adipose Tissue, Hair model, sensory receptors, arrector pili muscle, blood vessels, sweat gland, sebaceous gland*
- Identify a skin sample under the microscope and be able to distinguish between the epidermis and dermis

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Lab 8 – The Cardiovascular System

- Identify the following structures of cardiac muscle tissue under the microscope: *striation, intercalated discs*
- Identify the following structures of blood under the microscope: *red blood cells, white blood cells, platelets*
- Be able to read the results of a blood typing test
- Identify the following structures on the **heart model:** *Vena Cava, Aorta, right atrium, left atrium, right ventricle, left ventricle, pulmonary valve, aortic valve, tricuspid valve, bicuspid valve, pulmonary arteries, pulmonary veins*

Lab 9 – Maintenance Systems

- Identify the following structures on the **respiratory panel model**: *nasal cavity, pharynx, larynx, trachea, bronchi, alveoli, right and left lungs (make sure you can tell the difference between a right and left lung)*
- Identify a tissue sample of the trachea (pseudostratified ciliated epithelial tissue) and identify the following structures: epithelial cells, cilia
- Identify a tissue sample of the lung (simple squamous epithelial tissue) and identify the following structures: epithelial cells, alveoli
- Describe the interactions of the respiratory system and the cardiovascular system
- Identify organs of the digestive system on a torso model and/or image: *esophagus, stomach, small intestine, large intestine, liver, gallbladder, pancreas*
    - For each organ, list their main function
- Identify organs of the urinary system on the urinary system model: *kidneys, ureters, bladder, urethra*
- Interpret the results of a urinalysis

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Lab Practical #3 – Study Guide

Use this list of material to help guide your studying for your lab practical.

Lab 10 – The Skeletal and Muscular Systems

- Identify the following tissues of the skeletal and muscular systems under the microscope AND name a location in the body where they are found:
    - Compact Bone
        - Identify the following cells: *osteocytes*
    - Spongy Bone
    - Hyaline Cartilage
        - Identify the following structures: *chondrocytes, lacunae*
    - Skeletal Muscle
    - Dense Regular Connective Tissue
- Identify the following structures on the **compact bone model**: *central canal, lamellae, osteocytes, lacunae, canaliculi*
- Identify the following bones and for each know if they are part of the axial or appendicular skeleton. Also, know if the bone occurs in a pair. Bones of the axial skeleton will be on an articulate model for the practical, bones of the appendicular skeleton may be articulated or out individually on the practical.

    - Frontal Bone
    - Parietal Bone
    - TemporalBone
    - Occipital Bone: foramen magnum
    - Mandible
    - Maxilla
    - Zygomatic
    - Nasal Bone
    - Vertebrae
    - Sternum
    - Ribs
    - Sacrum
    - Scapula
    - Clavicle
    - Humerus
    - Radius
    - Ulna
    - Hip Bone
    - Femur
    - Tibia
    - Fibula
    - Patella

- Identify the following muscles on all of the models available in the lab:

HEAD MUSCLES
- Frontalis
- Occipitalis
- Orbicularis oculi
- Orbicularis oris
- Zygomaticus
- Mentalis
- Buccinator
- Masseter
- Temporalis

NECK MUSCLES
- Sternocleidomastoid
- Stylohyoid

VERTEBRAL COLUMN MUSCLES
- Errector spinae

THORAX AND ABDOMEN MUSCLES
- Intercostals
- Diaphragm
- Rectus Abdominis
- External abdominal
- Internal abdominal oblique
- Transversus abdominus

PECTORAL GIRDLE MUSCLES
- Pectoralis Major
- Pectoralis Minor
- Serratus anterior
- Trapezius
- Latissimus dorsii

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BRACHIAL MUSCLES
- Deltoid
- Biceps brachii
- Triceps brachii
- Brachialis
- Brachioradialis
- Triceps brachii
- Pronator teres
- Palmaris longus
- Extensor digitorum
- Extensor digiti minimi

PELVIC GIRDLE MUSCLES
- Sartorius
- Tensor fasciae latae
- Quadriceps
- Rectus femoris
- Gracilis
- Gluteus maximus
- Gluteus minimus
- Gluteus minimus
- Biceps femoris
- Rectus femoris
- Gastrocnemius
- Tibialis anterior
- Extensor digitorum longus

- Know the structural arrangement of a sarcomere. Be able to label the following components: *I Band, Z line, A Band, M Line, H Band, Actin, Myosin*
    - Be able to identify if a sarcomere is relaxed or contracted
    - Know what happens to the sarcomere components when it goes from relaxed to contracted.

Lab 11 – The Nervous System: Senses

- Identify the following structures on a brain model: Cerebrum: *Frontal Lobe, Temporal Lobe, Parietal Lobe, Occipital Lobe; Cerebellum; Brain Stem: Pons, Medulla oblongata, Hypothalamus, Spinal Cord*
    - Know the function of each of the brain structures listed above
- Identify the following structures on an neuron model: *Dendrites, Soma (cell body), Axon, myelin sheath*
    - Know the function of each of the neuron structures listed above
- Identify the following structures on an ear model: *Auricle, Ear Canal, Tympanum, Malleus, Incus, Stapes, Oval Window, Cochlea, Vestibule, Semicircular canals, Round Window, Auditory Tube, Cochlear Nerve*
    - Trace the path of sound from outside the ear in
- Know what molecules our five taste receptors respond to.
- Identify the following structures on an eye model: *Cornea, Anterior Cavity, Iris, Ciliary Body, Pupils, Lens, Choroid, Posterior Cavity, Retina, Sclera, Fovea Centralis, Blind Spot, Optic Nerve*
    - Name the key function of the structure of the eye listed above
    - Trace the path of light from outside the eye in.
- Explain the following eye conditions: *Nearsightedness, Farsightedness, Astigmatism*

Lab 12 – The Endocrine and Reproductive Systems

- On a human body image identify the following endocrine organs: *pituitary gland, thyroid gland, parathyroid gland, pancreas, adrenal glands, thymus, pineal gland*
    - For each of the endocrine glands listed above, name the hormone it secretes, the hormones target organ, and its effect.
- Identify the following structures of the male reproductive system on sagittal section models: *Scrotum, testicles, epididymis, vas deferens, urethra, penis, accessory glands (seminal vesicles, prostate glans, bulbourethral gland)*
    - Know the main function(s) of each of the structures listed above.

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- Identify the main structures of the female reproductive system on sagittal section models: *Ovaries, oviducts (fallopian tubes), uterus, cervix, vagina*
    - Know the main function(s) of each of the structures listed above.
- Using the figures from the lab or the reading section "The Female Menstrual Cycle" on Canvas be able to label the phases of the uterine and ovarian cycles, the structures of the ovarian events and know their purpose.
- Know the major hormones secreted by the gonads and their functions:
    - Ovaries: *Estrogen, Progesterone*
    - Testes: *Testosterone*

Lab 13 – Pig Dissections

- Identify the major organ of the body: *Larynx, trachea, esophagus, thyroid, rib cage, sternum, lungs, heart, diaphragm, stomach, liver, gallbladder, pancreas, small intestine, large intestine, spleen, kidneys*

Lab 14 – Evolution: Natural Selection (Rock Pocket Mouse Activity)

- Describe how natural selection works.
    - Describe the results of this activity and how & why the rock pocket mouse population changed overtime.

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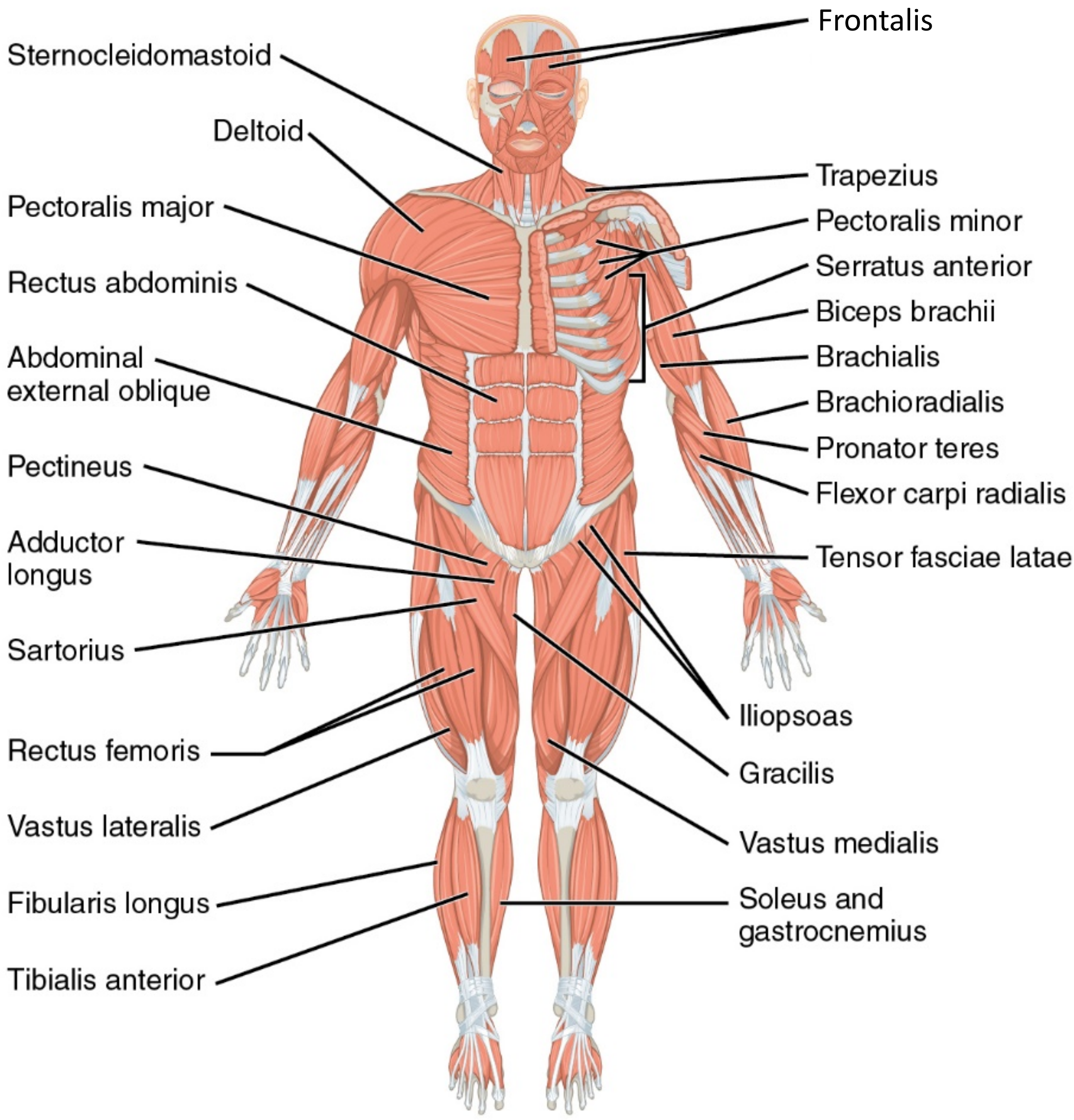

Major muscles of the body. Right side: superficial; left side: deep (anterior view)

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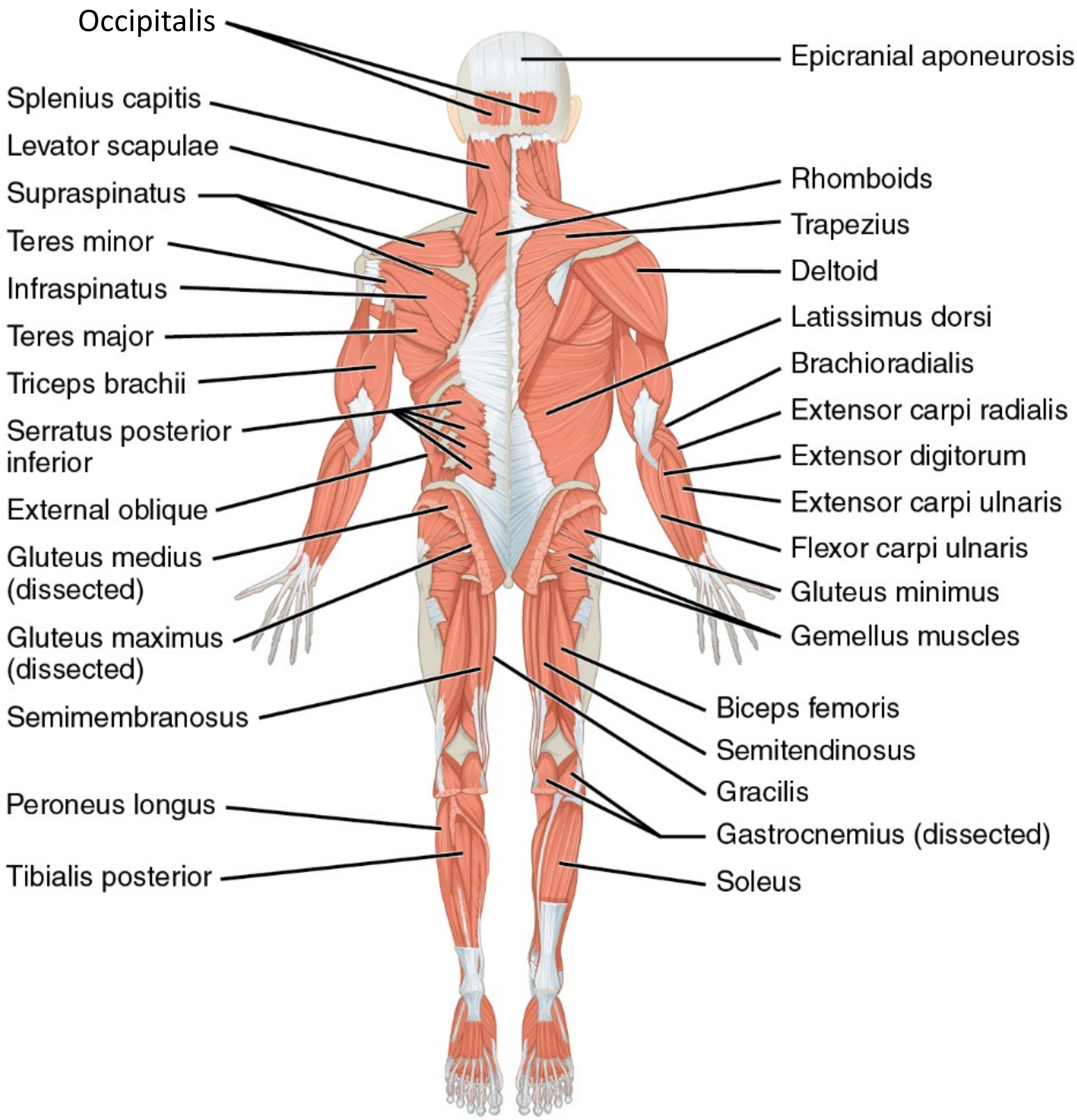

Major muscles of the body. Right side: superficial; left side: deep (posterior view)

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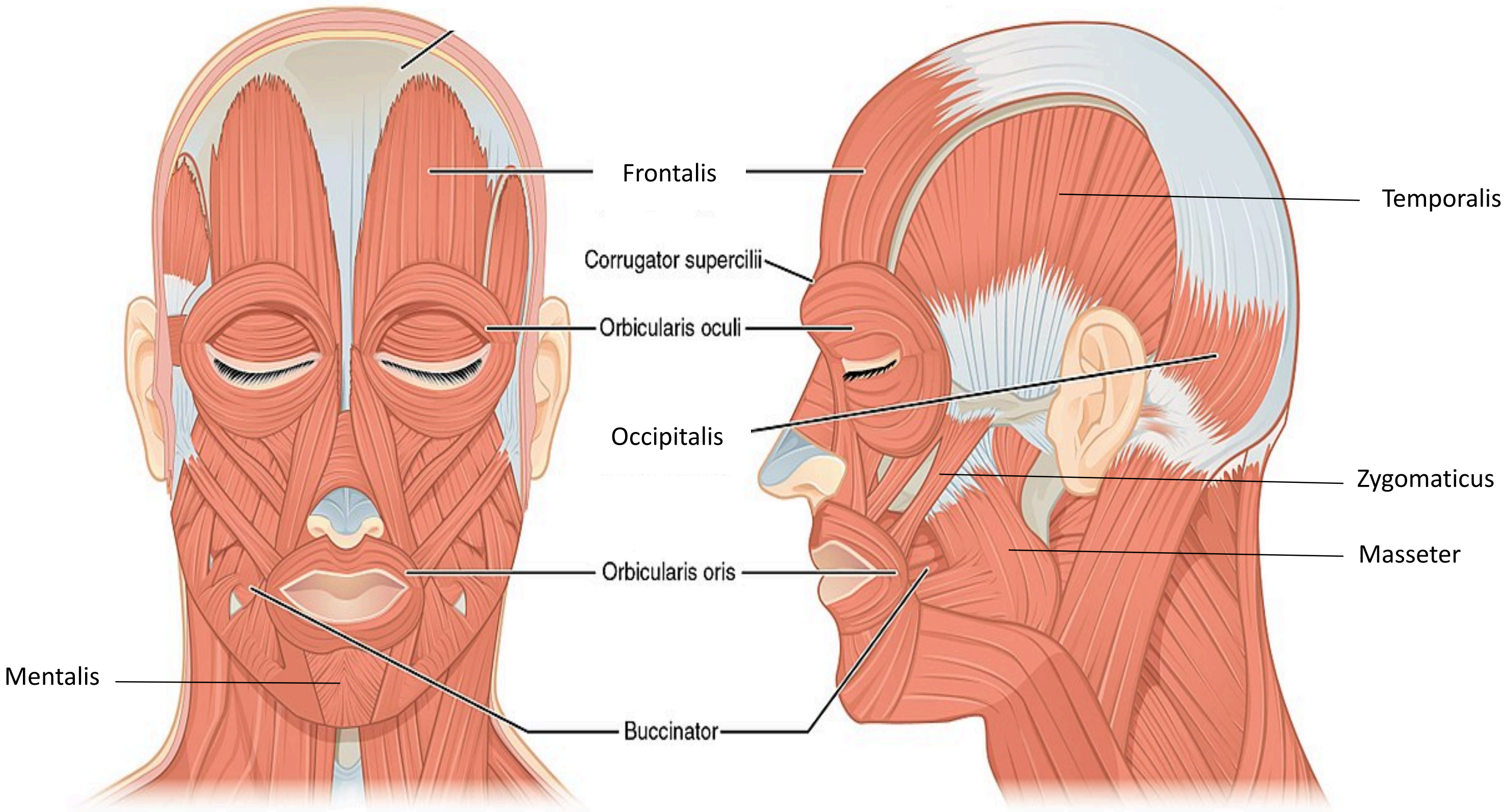

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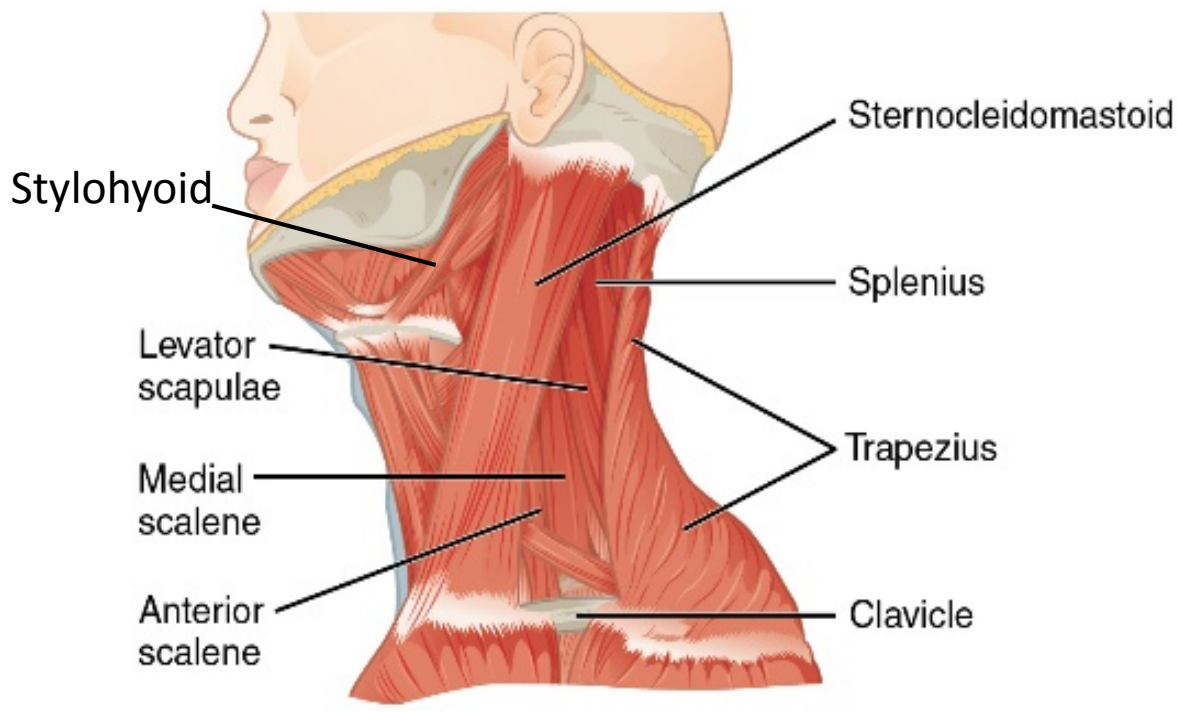
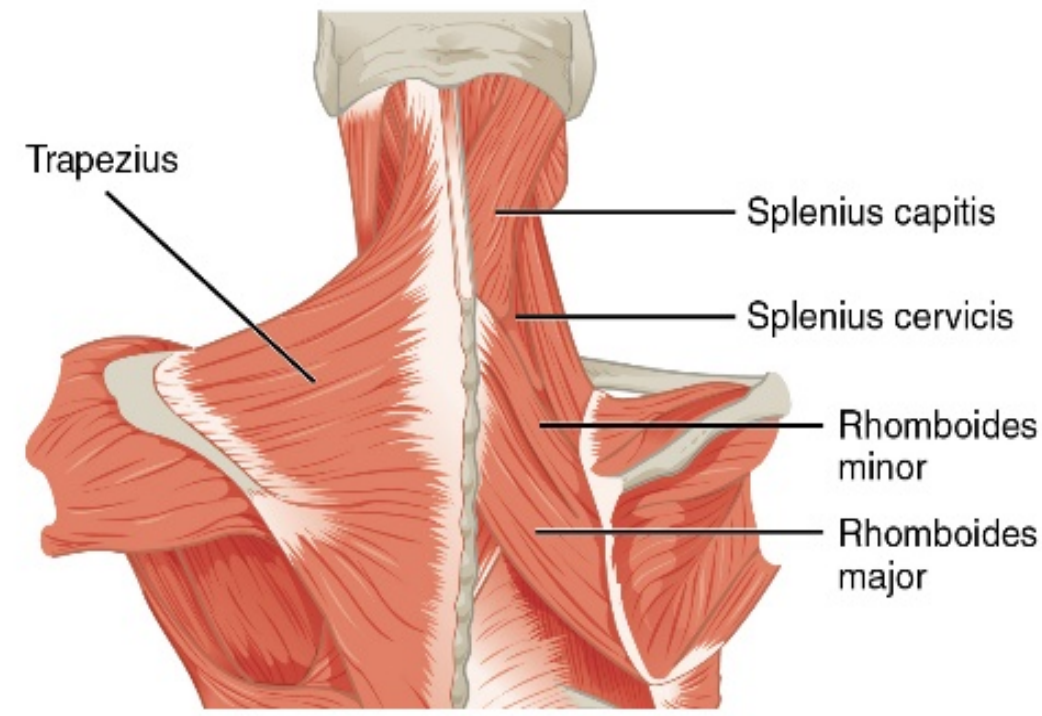
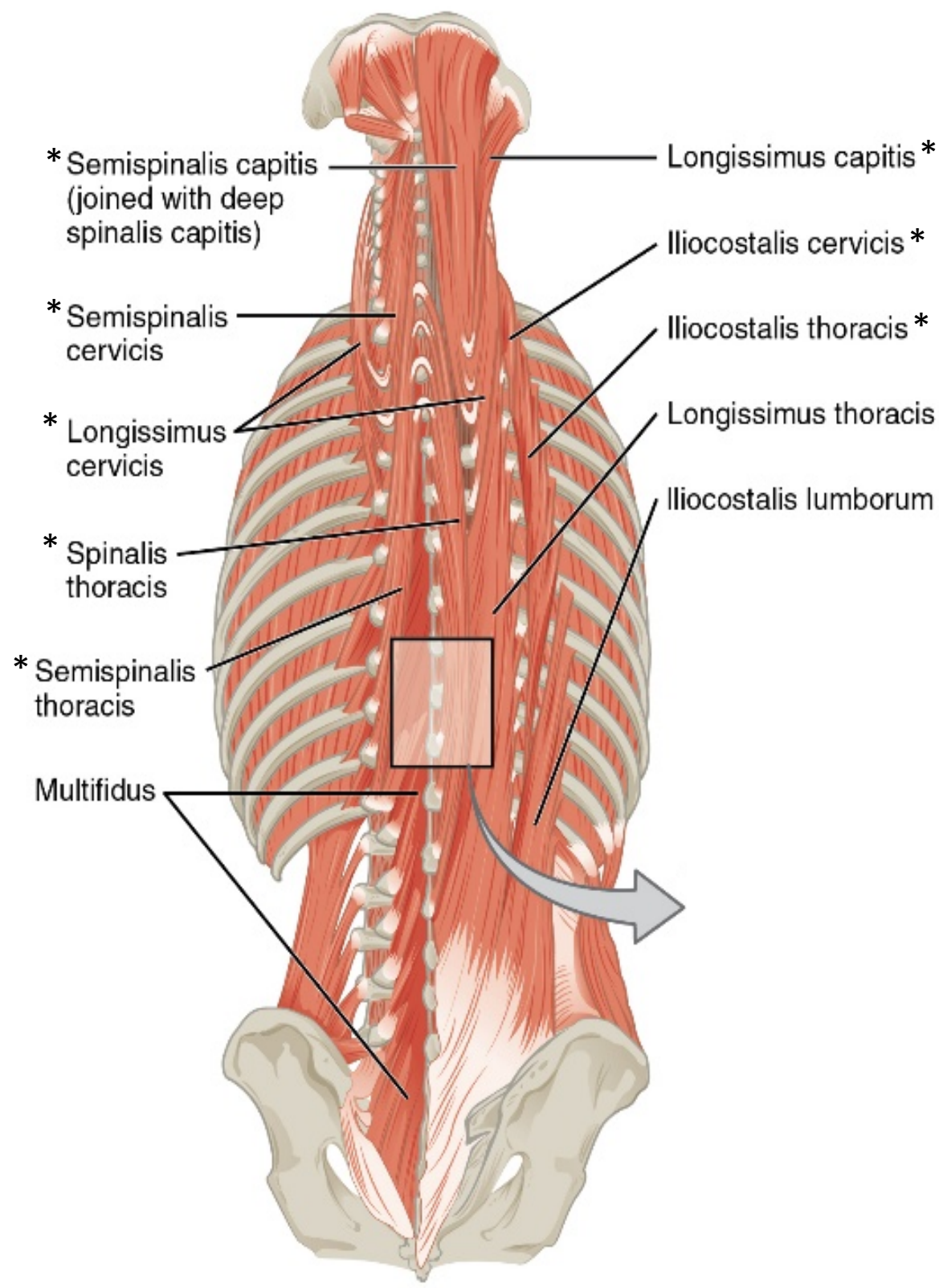


Muscles of the neck (left lateral view)



Superficial (left side) and deep (right side) muscles of the neck and upper back (posterior view)



Deep muscles of the back (posterior view)

*Errector Spinae (Muscle Group): This group of muscles are the deep muscles of the back and include all muscles that begin with iliocostalis, longissimus, and spinals. Together the muscles are called **Errector Spinae**.

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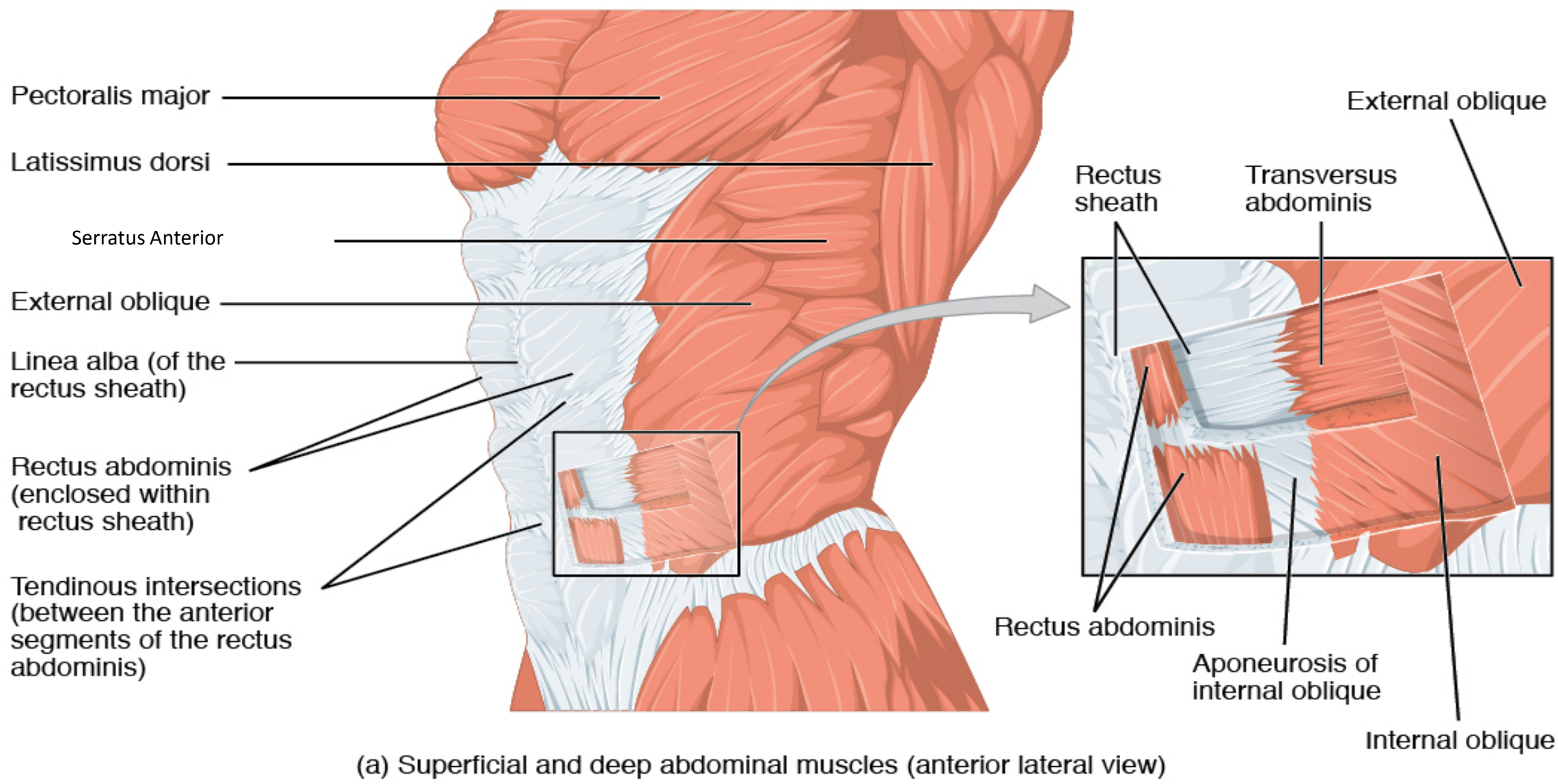
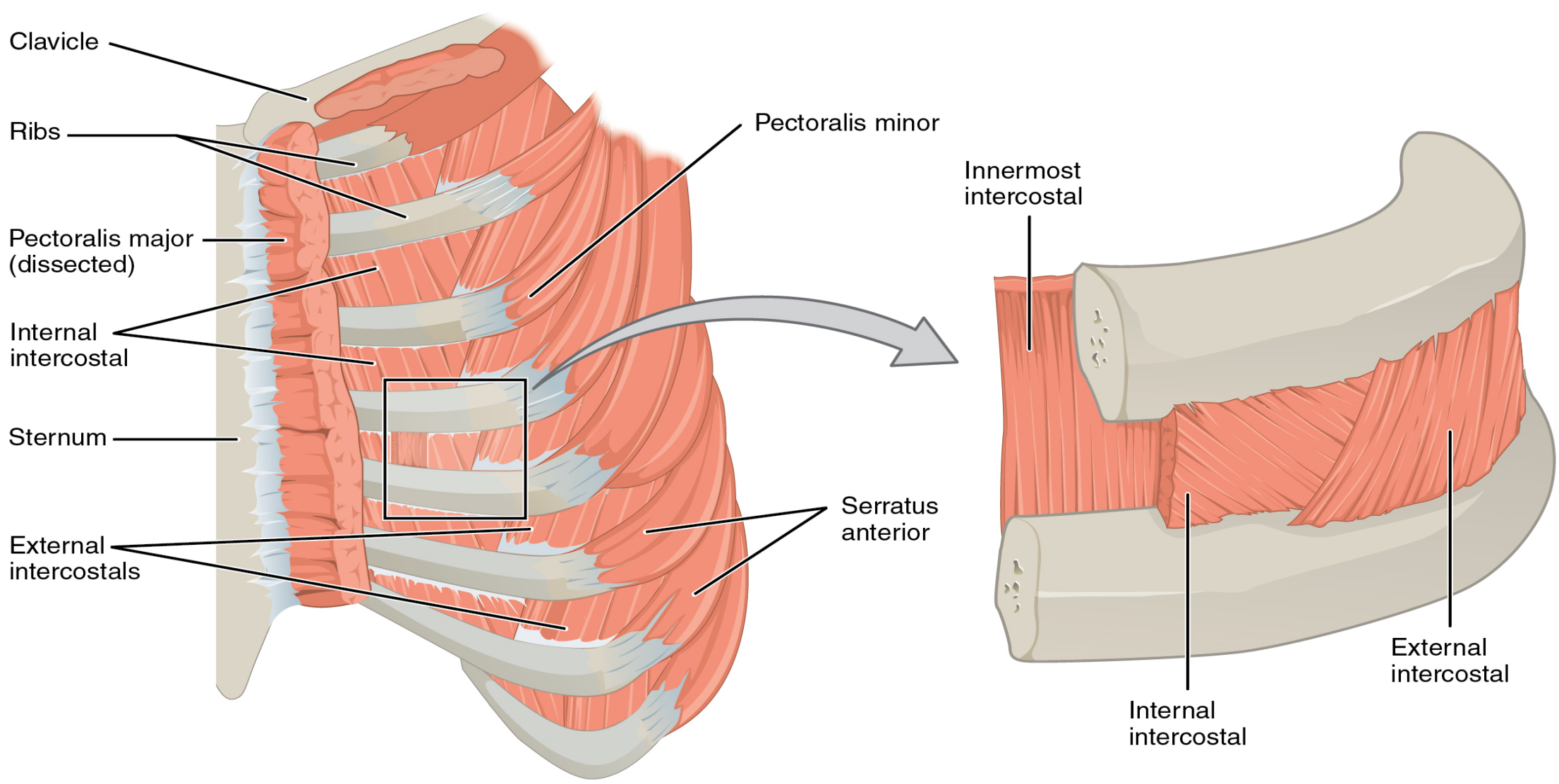


(a) Superficial and deep abdominal muscles (anterior lateral view)



Intercostal Muscles

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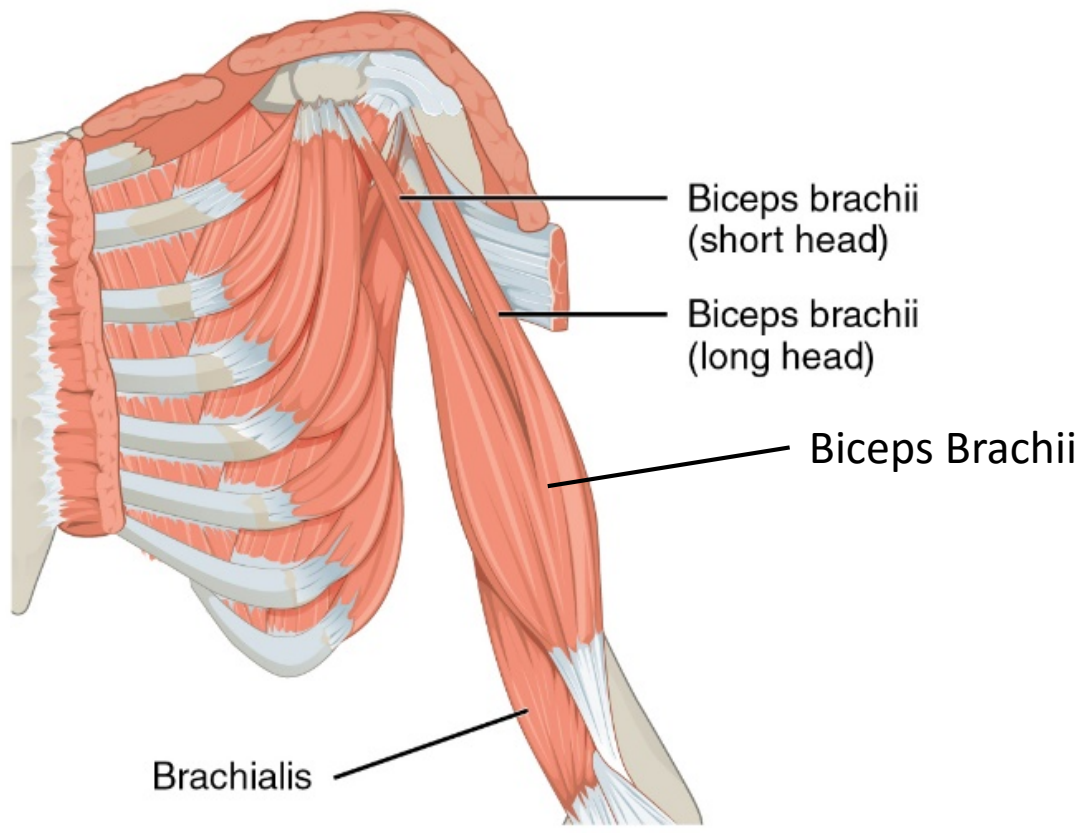
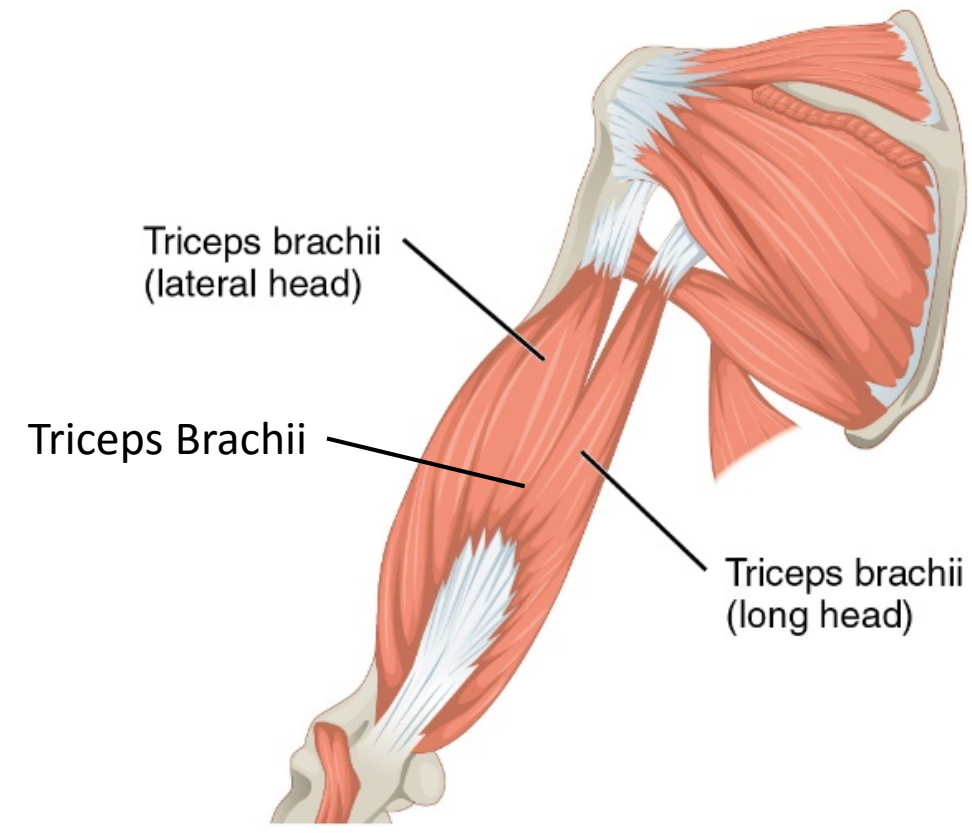
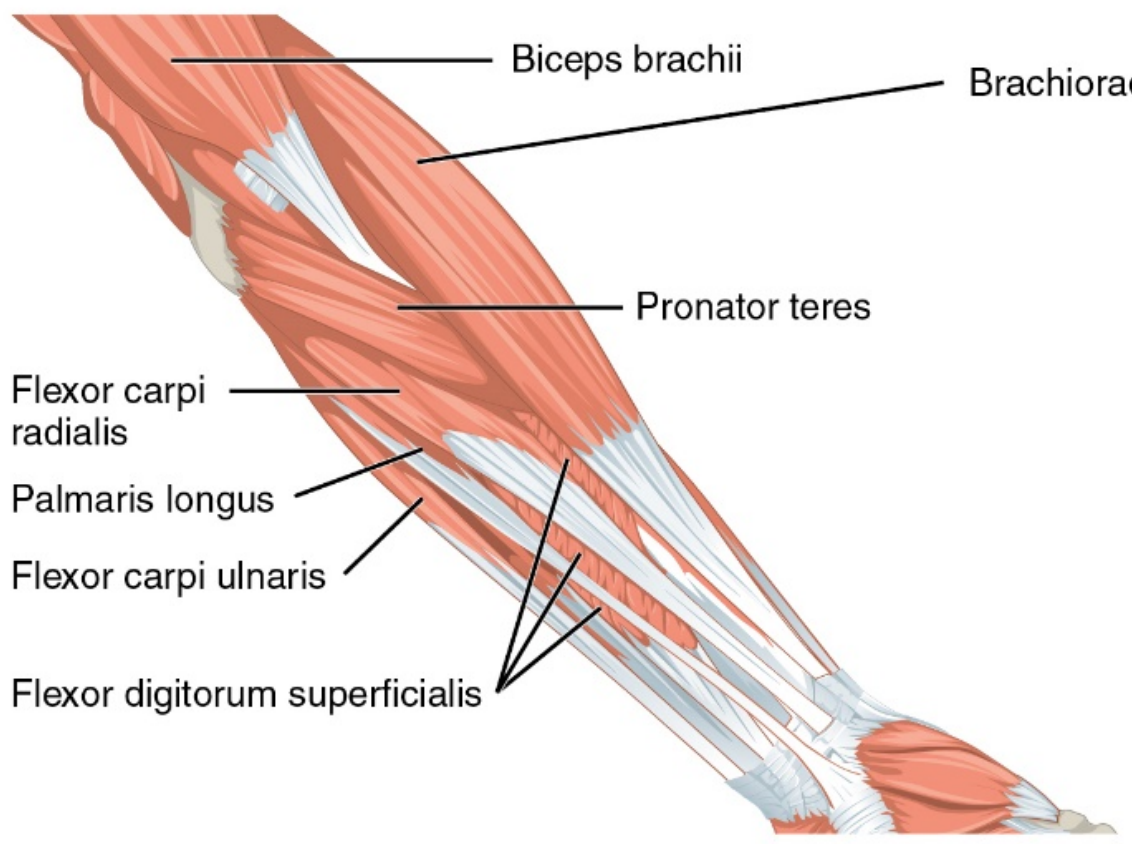


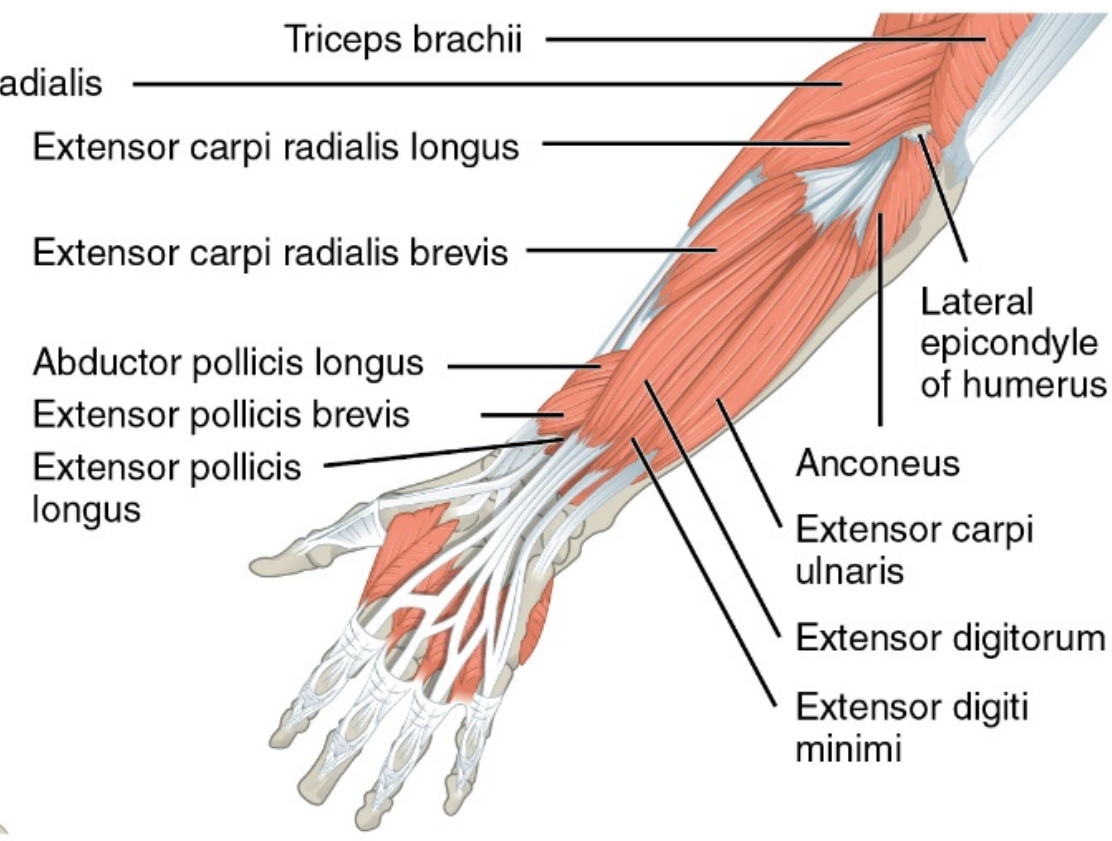
Left upper arm muscles (anterior lateral view)



Left upper arm muscles (posterior view)



Left forearm superficial muscles (palmar view)



Left forearm superficial muscles (dorsal view)

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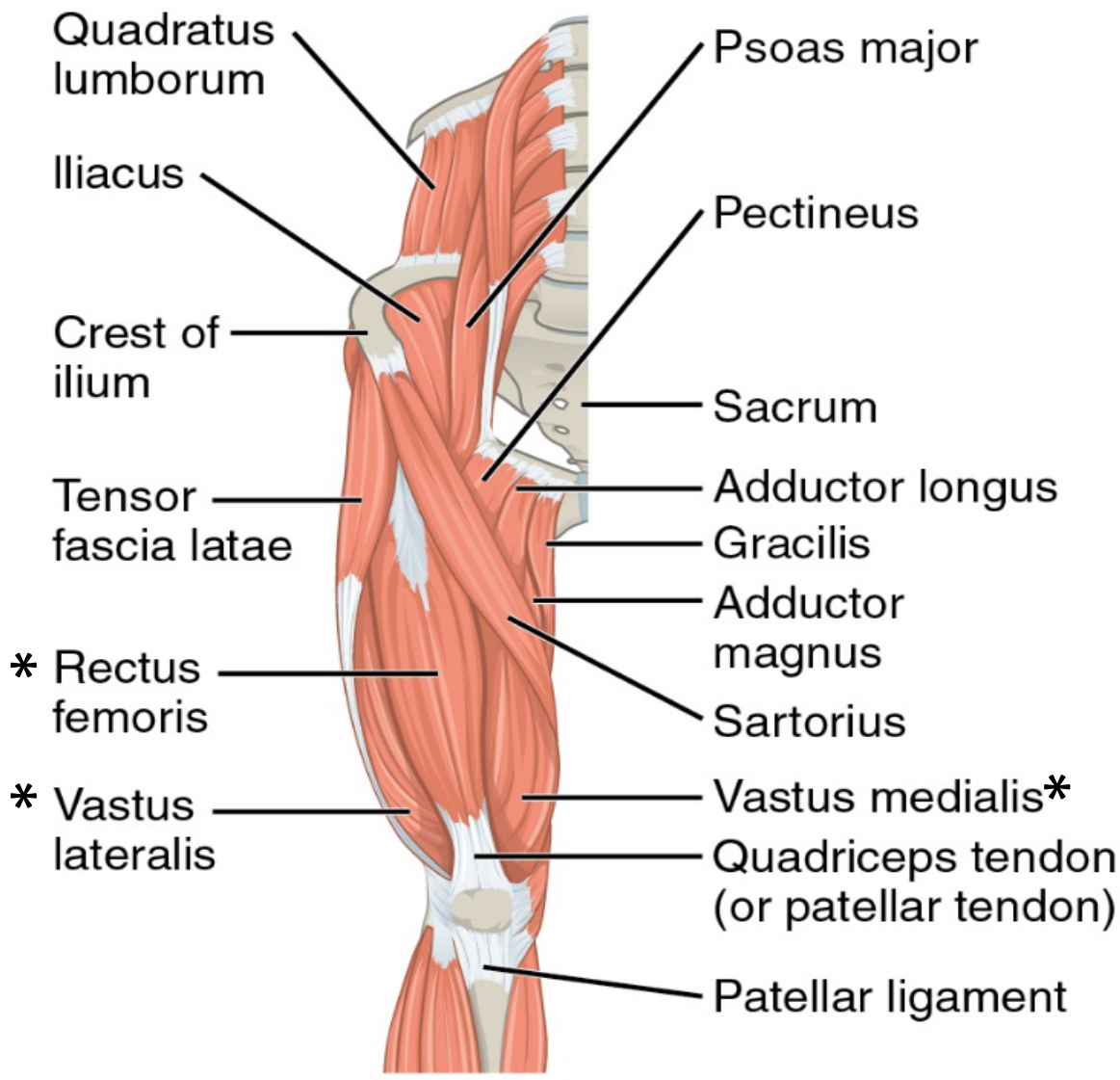
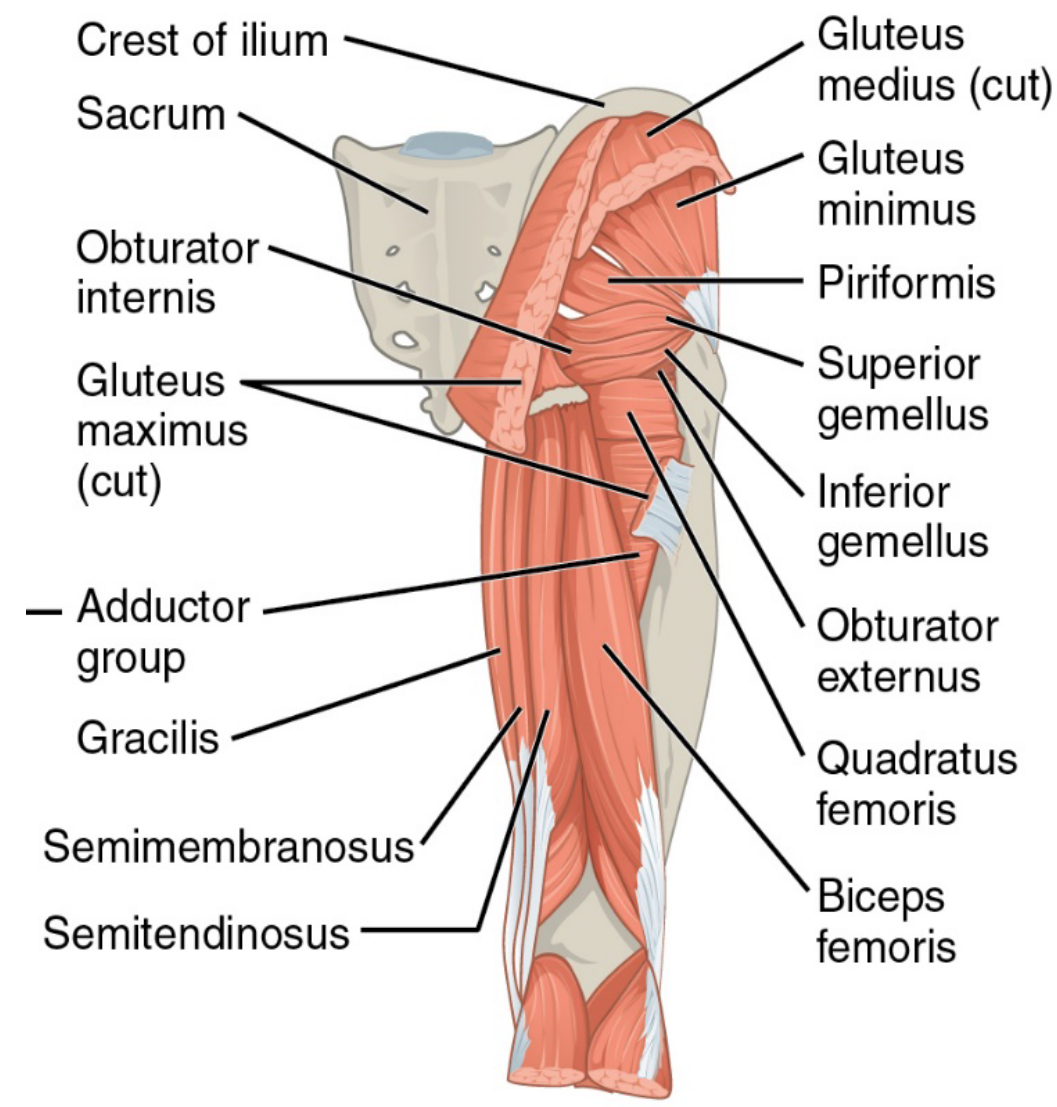
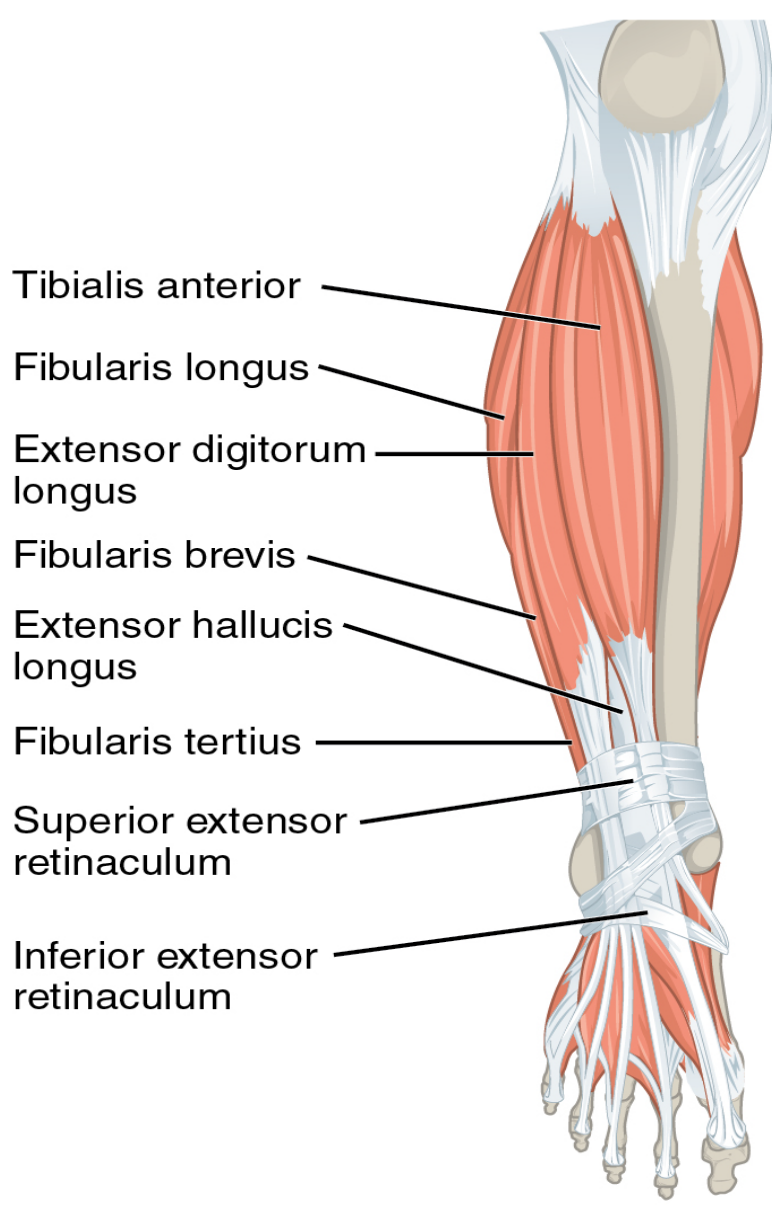


Superficial pelvic and thigh muscles of right leg (anterior view)

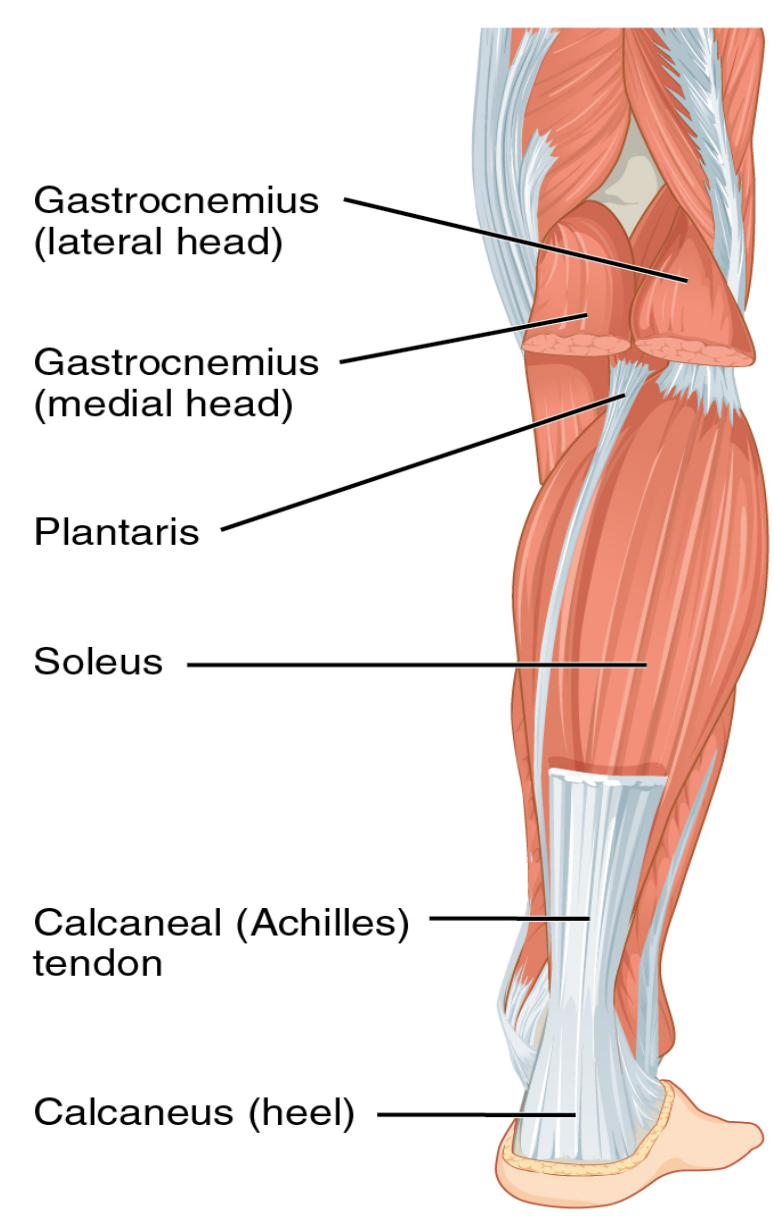


Pelvic and thigh muscles of right leg (posterior view)

*Quadriceps (Muscle Group):
This group of muscles make up the superficial muscle group of the proximal portion of the lower limb. The muscles included in this group are: Rectus femoris, Vastus lateralis, Vastus medialis, and Vastus intermedius (found deep to the Rectus femoris).



Superficial muscles of the right lower leg (anterior view)



Superficial muscles of the right lower leg (posterior view)

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