Anatomy & Physiology I
Lab Manual

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for

BIOL 2401
Anatomy & Physiology I

Laboratory Activities,
Homework and Lab Assignments
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Biol 2404 Lab Manual
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Biol 2402 Lab

The exercises in this manual are designed to enhance your understanding of anatomical structure and physiological principles discussed in lecture. The anatomical details of each body system more thoroughly than it is presented in lecture. While human models are also used, your core learning will come from your dissections, models and tissue studies. If you have a *real* moral objection to animal dissections then you should not take this course at ACC since you would not be able to learn some of the essential lab skills and would therefore be missing an essential part of the course. This method of 'hands on' learning should also enhance and strengthen the knowledge you gain in lectures.

At times you will be working individually, in pairs or in groups of three or four. Each lab period is loosely structured to begin with a short introduction to the exercise that highlights the activities of the day, what materials are available for use and any changes in procedures. After that you will work independently to learn the material.

There is never enough time in lab to go over each and every item that you are assigned. The lab is a designated a time when you have access to materials that you will not have available during home study time. Some of the information assigned in lab you can learn at home, other items, particularly anatomical terms identified on dissected organs, animals and models and microscopic details viewed with a microscope can only be learned adequately in the lab room. Experiments can only be done during lab time; they cannot be "made up" during open labs.

General Lab Rules:

1. **Read the lab exercise** before you come to lab. There is not time to review every aspect of each exercise or experiment and still give you time to work on your own. I will assume that you know what the exercise covers in general and I will only review changes or specific materials that you will use.

2. **Before each lab**, use the **terminology list** to mark the items in your manual's text and illustrations that you are responsible for learning.

2. **Read and memorize the laboratory safety rules** of the lab below. The preservatives are irritants and some of you may be allergic to them. Gloves must be used during dissections and will be provided. Your dissecting tools will be provided for you as well.

Dissections:

Dissections are an integral part of the anatomy lab experience. There is no substitute for handling and dissecting real tissues and organs as a way to learn anatomy:

Why Dissection?

"The value of the dissection is not how neatly the students manage to do it, but what they see while they are doing it. Plastic models and 2-dimensional pictures are no substitute for real, if preserved, tissues. One of the major revelations during a dissection is that skin, muscles, blood vessels and nerves are all held together by connective tissue. There is no other way to teach this. They see the distribution of lymph nodes and the way that the intestines are held in place by mesenteries. They see all the places where there is fat. They can pull on a

muscle and see the insertion move. This is hands-on, active learning at its best! Doing anatomy without dissection is like doing micro without bacteria! I know there are several reasons that people may object to dissection. I also know as an educator that it is a valuable and irreplaceable tool for learning structure."

-A&P Instructor

The term "dissection" means "to expose to view". Many beginning students assume that dissecting automatically means "cutting things up" but actual cutting is rare and then it will usually be done with scissors, not scalpels. Scalpels more often damage the material and make things harder to see and their use is discouraged in most cases. While you will occasionally use scissors to begin the process of dissection your primary tools of dissection will be forceps, blunt probes and fingers.

Any dissections will be performed as a group. Typically one person reads the instructions and one or two other students will actually do the dissection. Your instructor will be watching to ensure that this is a *shared* project. Rolls should be rotated frequently. Generally, the persons actually doing the dissection is the one who learns the material best.

Dissecting tools and gloves are provided in the student drawers. Any dissected materials to be discarded must be placed in the designated container; NOT in the sinks. You will be expected to rinse your dissecting tray, rinse and dry your pins and utensils and replace them where you found them, and clean off your counter with disinfectant spray.

FAILURE TO FOLLOW PROPER LAB & SAFETY PROCEDURES WILL RESULT IN A LOSS OF 1 POINT FROM YOUR TOTAL FOR EACH INFRACTION

Biology Lab Safety Procedures and Information

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

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

Consequences for not complying with safety procedures:

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

Emergencies

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

1. Report the situation and your specific location (campus, room) by using the safety phone in a lab classroom; it will automatically connect you to ACC

Police Dispatch (location of safety phone_____
calling 222 from any ACC phone to reach ACC Police Dispatch
calling 512-223-7999 from a cell phone or non-ACC phone to reach ACC Police Dispatch

2. Evacuate if necessary:
a. take your personal belongings with you if possible;
b. on your way out, close but do not lock the classroom door;
c. go to the designated rally point for your campus and building.
Directions to nearest exit: _____
Location of rally point:_____

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

Safety Equipment and How to Use It:

→ Information about chemicals used in this laboratory can be found in Material Safety Data Sheets (MSDSs) and in a chemical inventory located _____.

→ The emergency gas shut-off for this lab is located: _____. Shut off the gas immediately if gas nozzles or valves are damaged or if there is a fire.

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

To use a fire extinguisher:
1) twist the pin and then pull it out of the handle
2) hold the end of the hose and point it at the base of the fire
3) squeeze the handle

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

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

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

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

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

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

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

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

Personal Protective Equipment (PPE)

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

a. Safety Eyewear

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

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

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

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

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

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

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

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

b. Wear natural fiber clothing for any lab activity involving open flame (synthetic material melts onto skin in a fire).

c. Before putting on gloves remove watches, rings, and bracelets that could either puncture the glove from the inside or interfere with rapid removal of the gloves.

d. Tie back long hair. e. Do not wear clothing with long, loose sleeves.

Waste Disposal

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

→ Hazardous chemical waste containers are located:

solids _____

liquids _____

→ Biohazard bags are located: _____ → Sharps containers are located: _____ → Glass (rinsed test tubes and broken glass) disposal boxes are located:

_____

→ Regular trash containers are located: _____

Lab Conduct

1) At the beginning of any class held in a lab room, do not enter the room until your instructor is present. Wait in the hall, even if the door is open.

2) Do these things:

*follow all procedures in manuals, in handouts, and as given by the instructor;

*store backpacks, coats, and other personal items as directed;

*report broken glass and chemical spills to your instructor immediately.

3) Do NOT do these things:

*come to class while intoxicated or while under the influence of drugs that impair your ability to safely perform the lab or field activity;
*horse around or perform unauthorized experiments;
*eat, drink, or chew (tobacco or gum);
*bring drinks or food (even in closed containers) into the lab;
*pipet by mouth; taste chemicals or directly smell chemical fumes.

Lab Hygiene

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

Standard / Universal Precautions

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

→ Consider all body fluids (saliva, blood, urine, feces, vomit) to be potentially infected with a harmful pathogen.
→ Do not touch or come into contact with anyone else's body fluids.

Student Accident Insurance

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

Chemical Hazard Labels

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

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

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

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

Most of the containers you use in lab are secondary containers such as flasks, test tubes,

jars, and beakers. Secondary containers will have either the diamond shapes or the bar shapes. In both of those labels the category of hazard is represented by a color and the level of the hazard is represented by a number.

1. Hazard categories are coded by color:

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

2. Hazard level is coded by a number:

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

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

Other types of hazard warning labels you must recognize are:

a. biohazards	b. radioactive materials
	

Course Specific Procedures & Cautions (Biol 2401)

1. Do not bring food or drinks into the lab room.
2. Learn the locations of the vent switch, safety shower, extinguisher, glass disposal boxes, discarded tissue buckets, first aid kit and spill kits and be able to use each
3. Wash lab benches with lysol spray BEFORE and AFTER each lab period
4. Place your books beneath the lab bench, if you have a jacket or sweater there are hooks available on which to hang them. Keep your countertop clear of all but your lab manual and materials you are actually working with.
5. Check your lab stool to be sure the back is tightened
6. If you drop and break a beaker or other glassware do not pick it up, notify me and I'll take care of it.
7. If the floor is wet cover it with paper towels and notify the instructor
8. Follow the procedures as directed for proper handling and care of microscopes and slides
9. Do not have more than one or two prepared slides at your bench at any time.
10. Slides and coverslips that you prepare should be discarded in the glass disposal boxes, do not attempt to clean them ***(Do not discard any of the prepared slides)***.
11. Make sure the venting switch is on when dissections are being done.
12. Use latex or nitrile gloves while dissecting since the preservatives used can be quite strong and may be toxic.
13. Aprons are available as needed to protect your clothes, we recommend that you wear older clothes for lab.
14. Wash and dry any dissecting utensils that you used and return them to the case in your lab drawer.

15. Wash your hands after dissecting.

Assuming reasonable care and caution required for any lab procedure, exposure to preservatives will require special attention as you work in this lab:

Some specimens will be preserved in either 70% alcohol or 10% formalin. both solutions are irritants, some students may be allergic.

Overall, the hazard levels are low as long as the vents are on, you are wearing protective gloves, and you rinse your specimens well before dissecting or handling them.

Notify your instructor if you know you are allergic to these solutions

Your instructor will discuss additional precautions available in lab.

Laboratory Safety & Equipment

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

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

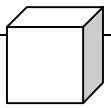
	Describe The *Specific* Location of Each
latex gloves	
aprons	
safety glasses/goggles	
eyewash station	
sinks	
disinfectant spray bottles	
paper towels	
biohazard bag	
glass disposal boxes	
deionized water spigots	
fire extinguisher	
first aid kit	
hazardous materials spill kit	
dissecting kits	
blank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

Units of Measurement and the Metric System

Biol 2401 Homework Assignment

(Jarzem, Ziser)

It is essential that people working in scientific and medical fields develop some facility with units of measurement including the ability to convert between different systems of measurement. Unlike the English (Apothecaries) system, conversions within the metric system are relatively easy; all being based on increments of 10.

Quantity	Metric Unit	Symbol	Approximate Equivalents
Length	millimeter	**mm**	thickness of dime or paper clip wire
	centimeter	**cm**	width of a paper clip
	meter	**m**	1 yard or 3 feet height of door is about 2m
	kilometer	**km**	0.6 miles distance you can walk in 12 minutes
Area	square centimeter	**cm^2**	area of this space: 
	square meter	**m^2**	area of a card table top
	hectare	**ha**	area of a football field including end zones
Volume	milliliter	**ml**	a teaspoon holds about 5 ml
	liter	**L**	about a quart
	cubic centimeter	**cm^3**	volume of this cube: 
	cubic meter	**m^3**	a cubic yard

Mass	milligram	**mg**	a grain of salt
	gram	**g**	3 small paperclips
	kilogram	**kg**	2.2 lbs weight of Webster's Collegiate Dictionary
	metric tonne	**mt** or **tonne**	1.1 tons a Volkswagen 'Beetle'
Energy	**centigrade**	**ºC**	0ºC = 32ºF; 100ºC = 212ºF
	Calorie	**Cal**	1 lb of fat stores 3500 Calories of food energy

Scientific Notation

Scientific notation is an abbreviated way to indicate very large or very small numbers. A number is expressed as a power of ten. For a very large number, the decimal place is moved to the left until there is only one digit to the left of the decimal; the number of places the decimal has been moved becomes an exponent of 10 which multiplies the digit. For very small numbers, the decimal place is moved to the right until there is one digit to the left of the decimal; the number of places the decimal has been moved becomes a negative exponent of 10.

To convert scientific notation to decimal notation, move the decimal point the number of places indicated by the exponent, to the left if a negative exponent, to the right if a positive exponent.

Prefixes and Symbols for Common Powers of Ten

unit			scientific notation	prefix	symbol
one billion	=	1,000,000,000	= 1×10^{9}	giga	G
one million	=	1,000,000	= 1×10^{6}	mega	M
one thousand	=	1,000	= 1×10^{3}	kilo	k
one hundred	=	100	= 1×10^{2}	hecto	h
ten	=	10	= 1×10^{1}	deka	da
one	=	1	= 1×10^{0}	---	---
one-tenth	=	0.1	= 1×10^{-1}	deci	d
one-hundredth	=	0.01	= 1×10^{-2}	centi	c
one-thousandth	=	0.001	= 1×10^{-3}	milli	m
one-millionth	=	0.000001	= 1×10^{-6}	micro	μ
one-billionth	=	0.000000001	= 1×10^{-9}	nano	n

Name:_____

Due Date:_____

The Metric System

Bio 2401 Lab Data Sheet

Making Conversions:

1. Fill in the **basic unit** of metric measurement and their standard abbreviations:

	Name of Unit	Abbreviation
length		
volume (liquid)		
mass		
food energy		
temperature		

2. Fill in the prefixes and their abbreviations:

	Prefix	Abbreviation
One Thousand		
One Hundred		
One Hundredth		
One Thousandth		
One Millionth		

3. Write these numbers in decimal form and in scientific notation:

	Decimal	Scientific Notation
Two Thousand		
Three Tenths		
Four Hundredths		
Five Thousandths		
Six Millionths		

Taking Metric Measurements:

1. measure and record the dimensions of your textbook, in **centimeters**; then convert your units to **millimeters**; then convert the units to **inches**. Be sure to show what ***conversion factor*** you used each time

Textbook dimensions	centimeters	cm to mm	millimeters	cm to inches	inches
Length		convert by:		convert by:	
Width		_____		_____	
Thickness					

2. **Each student** should use the balance provided to weigh each of the objects listed. If the object is not out you need to find it in the room. Record the weights in grams; then convert the units to kilograms:

	weight in grams	convert by:	weight in kilograms
paper clip			
1 pc notebook paper			
a 50 ml beaker		_____	
a pencil or pen			
a 10 ml graduated cylinder			
10 ml of water			

3. Reorganize the following sets of units in descending (largest to smallest) order by placing the appropriate letter in order in the boxes provided:

a. **A** =1 ml; **B** = 25 ml; **C** = 0.5 L; **D** = 250 ml; **E** =1.2 L; **F** = 50 ml

b. **A** =1 ml; **B** = 2 oz; **C** = 3 L; **D** = 0.5 gallons; **E** = 0.75 pints; **F** = 2 tsp

c. **A** = 2.3 lbs; **B** = 5 oz; **C** = 30 kg; **D** = 310 grams; **E** = 0.025 tons; **F** = 0.02 tonnes

Additional Work With Metrics:

1. Convert these numbers as indicated. Show your work including conversion factors and units (the first one has been done for you):

From:	To: *[show your work]*	Answer
0.45 L	**ml** **0.45 L x 1000 ml =**	**450 ml**
1250 ml	**L**	
0.065 mg	**g**	
3.7 km	**M**	
120 cm	**km**	
3.6 kg	**g**	
670 cm	**m**	
1250 g	**kg**	
0.15 L	**ml**	
120 mm	**cm**	
627 L	**ml**	

2. You have to give your dog medicine at a dose rate of 1.5 mg of medicine per kg of the dog's weight. The dog weighs 50 lbs. How much medicine should you give him? (Show your work)

Answer:

3. You have a fever and your temperature is 102 degrees Fahrenheit. **a**. What is your temperature in degrees Celsius? **b.** When your temperature returns to normal (98.6 degrees F) what is your temperature in Celsius? (Show your work)

a. Answer:

b. Answer:

4. You have a friend who is 64 inches tall. How tall is your friend:
(Show your work)
a. in centimeters?

Answer:

b. in millimeters?

Answer:

c. in meters?

Answer:

Convert the following numbers to scientific notation with only 1 place to the left of the decimal :

Decimal Notation	Scientific Notation
140,000	
9,650,000	
3250	
5.3	
275.33	

Convert the following to decimal notation from scientific notation:

Scientific Notation	Decimal Notation
4.5×10^{4}	
3.2×10^{-8}	
1.5×10^{9}	
6.23×10^{-12}	
3.0×10^{1}	

Scientific and Analytical Methods

Bio 2401 Lab

The Scientific Method: Disproving Hypotheses:

Scientific inquiry is an objective, problem-solving method. *Objective* means that it's not biased or influenced by someone's personal beliefs. Scientific inquiry can only be used to study phenomena that can be observed and measured, either directly, or using various instruments. It cannot be used to study things that cannot be observed or measured objectively.

The scientific method involves making observations; coming up with some logical explanation; making predictions based on those observations, and then testing those predictions with experiments. This may sound very technical and complicated, but it's a process you use everyday to some degree. For example, if you go to the parking lot after class and find that your car won't start (an observation) you immediately begin to think of possible explanations (hypotheses); the battery is dead, I'm out of gas, the starter is broken, an alien landed nearby and zapped my car with his e-m pulse neutralizing ray gun, etc.; there are literally an *infinite* number of possible explanations (some more logical than others).

You can't fix the problem unless you know what it is, so you start trying to eliminate some of the hypotheses. The 'alien ray gun' hypothesis is probably discarded fairly quickly (unless of course the alien is still there pointing a gun at you!) because there is nothing to suggest such an outlandish explanation is needed. Instead you go for the simpler, more easily tested possible explanations and attempt to verify or disprove them by experiment. Even if you are not using words like *observation, hypothesis, prediction,* and *experimentation* you are still scientifically evaluating your problem.

One possible test could be stated more scientifically as:

observation: my car won't start
hypothesis: maybe my battery is dead
prediction: if the battery is dead then the lights won't work or will be dim when I turn them on
experiment: turn on the lights, if they don't come on you accept your hypothesis and find a way to the auto parts store for a battery. If the lights do come on, you reject your hypothesis and think of a new one that you can test.

Notice, that you either *accept* or *disprove* the hypothesis, you can never 'prove' your hypothesis although we sometimes use that word loosely when we cannot disprove something. Proving hypotheses is not reasonably or practically possible. Scientists must always acknowledge that someone, somewhere, some time in the future may succeed in thinking up a new test that results in disproving any hypothesis. So a scientist tries to disprove the hypothesis in as many ways as s/he can think of. If all attempts to disprove the hypothesis fail, then the hypothesis is *probably* true.

If many scientists try to disprove the hypothesis in many different ways over a long period of time, and all fail to disprove it, then the probability that the hypothesis is true is very high indeed. This is one reason scientists must communicate their results to other scientists (ie. publish). We call these very well-tested hypotheses "scientific facts".

You may be tempted to react to this concept with cynicism: "You're telling me that nobody really knows *anything* for sure?"; "That somebody might come along at any time and disprove a *fact*?". Some may find this loss of certainty disturbing. However, we live our lives everyday basing decisions

on what is *probable*, not on absolute *certainties*. Most of the time, the *probable* is what actually happens. When the improbable happens, we adjust. For example, when I leave my home in the morning for work or school I think it is probable that all the traffic lights on my route are functioning correctly. I can't 'prove' this, but my experience tells me that the probability is high. Once in a while, I encounter a malfunctioning traffic light; i.e., my "hypothesis" isn't always correct. But it's correct enough of the time to be useful. When a light is not working properly, my "logical world" doesn't come crashing down, drivers adapt; accidents are rare even in these situations.

I can't personally prove that the sun will rise in the east tomorrow. But I believe the reports of human beings since the first cave drawings that it always has so far. I also find the current scientific explanations of *why* it happens very reasonable while I know that the older explanations of the sun moving around the earth have been disproven long ago. Though, technically, it is not a 100% certainty that the sun will come up in the east tomorrow, I'm pretty confident that it will; maybe even more confident than I am in properly functioning traffic lights!

You may feel that it is more difficult to look at scientific experiments from a 'disprove' point-of-view rather than a 'prove' point-of-view. It's a fairly complex way of thinking and requires a certain amount of mental gymnastics. However, once you get used to it, you will be a more skeptical *scientific* thinker and will be able to more effectively evaluate articles about the results of scientific experiments, or results that claim to be supported by scientific observations but are probably not.

In addition, understanding this business of 'disproving hypotheses' also gives you some insight into how scientists work and why science is fun to do. Science is much more interesting when you're trying to disprove something rather than always simply confirming what everyone already knows. After all, science is a very competitive activity. Scientists don't wake up in the morning and say, "I cant wait to get to the lab to repeat Dr. Frogfoot's experiments and show that she's absolutely right." More likely, the scientist is thinking something more like; "That Fran Frogfoot thinks she's such a hotshot! But she made some assumptions that I don't think are valid and I'll bet that her theory isn't quite as strong as she thinks it is. I can't wait to get to the lab and redo her experiments using this new information. If I can show she's wrong, the publication I can get out of it will sure be good for my career."

In formal scientific situations, hypotheses are tested in **controlled experiments**. Each experiment looks at the effect of one variable (the **independent variable**) on some event or condition (the **dependent variable**). The basic assumption is that the independent variable is controlling or causing some measurable change in the dependent variable. Also, our experiments must usually be kept simple: unless we use sophisticated experimental design and statistical methods, we can only test one independent variable at a time.

Experiments are performed on relatively small groups of organisms or things that are called **samples**. The sample is usually split into an **experimental group** and a **control group**. The independent variable is manipulated in the experimental group but not in the control group.

The **control** is used as a basis of comparison. Without one we could never show that changes in the dependent variable are caused by the independent variable. If, at the end of the experiment, the dependent variable for the experimental group differs from the dependent variable for the control group. then the difference is assumed to be caused by the independent variable.

Changes in the dependent variable are measured in both experimental and control groups during or after the experiment – measurements of these changes are called **data**.

After you finish an experiment how do you know whether or not you should accept or reject your hypothesis? You just compare the dependent variable for the experimental group with the dependent variable for the control group. If they are **significantly** different, the difference is assumed to be caused by the independent variable. **Statistical analyses** determine whether a difference is significant or not. This information tells you whether you should reject the original hypothesis or not.

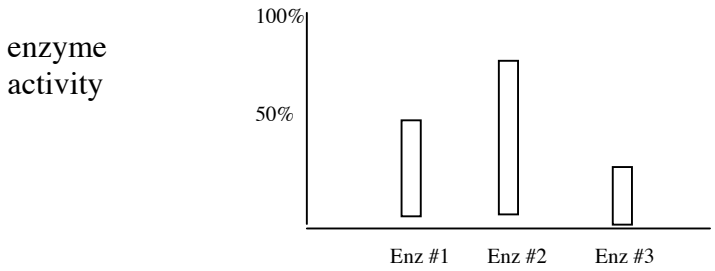
Two experiments: collecting and analyzing data:

In these experiments you will study the relationship between two variables, one of which will be heart rate. Everyone in the class will serve as both a control and a test subject. In order to test an hypothesis we will collect data from the class and analyze them statistically. With the results of this analysis we will either accept or reject our starting hypothesis.

Heart rate can be most easily measured by counting the number of pressure pulses in a major artery per unit of time. The radial and carotid arteries are the most easily used pulse points. Attempt to measure the pulse rate in your lab partner by pressing your first and second fingers firmly against either artery and count the number of pulses that occur in a minute. Would you expect everyone in class to have the same resting heart rate?. What factors might account for some of the variations that you find in the class?

These could form the basis of some hypotheses that you might want to test. For example, you might want to test the effects of gender, age, weight, exercise, smoking or something else on heart rate. Tests on some of these kinds of hypotheses can be set up as an "either/ or" or "experimental/ control" types of experiments with **discrete variables**; often with one set of data being the control set and the other being the experimental set.

If you are asked to graph discontinuous variables; e.g. experimental vs controls; bar graphs are preferred:

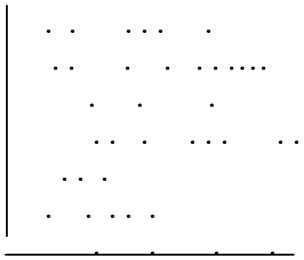


However, if you're interested in something like the effects of age, duration of exercise or weight on heart rate these are **continuous variables**. Instead of dividing the data into two groups you could plot the class data on a graph with one axis being the dependent variable and the other being the independent variable.

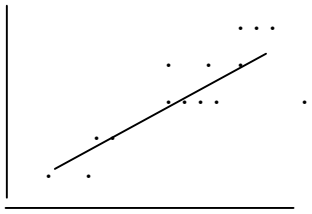
Best Fit Lines

When graphing continuous data on a graph it is often appropriate to attempt to visualize a "best fit" line through the points. Normally, we use a computer program to plot the line and to give us an idea of how well the line fits the data. In our labs we will visually estimate where such a line should go.

If the points are truly scattered and there is no clear indication of where a line might be drawn, then there is probably little or no relationship or correlation between the variables being studied



If, on the other hand, you can visualize a straight or curved line through the data points then you can draw a "best fit" line that approximates the relationship that you envision.



Continuous data points, however, don't always suggest a "straight line" as the "best fit". sometimes a curved line comes closer to the majority of data points. Ask your instructor for guidance when constructing a line through continuous data.

If the data *does* suggest a straight line as the "best fit", a straight horizontal or vertical line would indicate no correlation between the two and you would therefore have to reject the hypothesized relationship. A line with a **positive slope** (Fig 1 below) would indicate a positive correlation; a line with a **negative slope** (Fig 2 below) would indicate a negative or inverse correlation. Statistics could be used to verify or disprove whether a strong correlation actually existed.

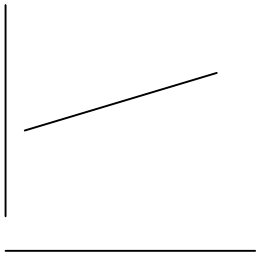


Fig. 1. A positive slope indicates a positive correlation

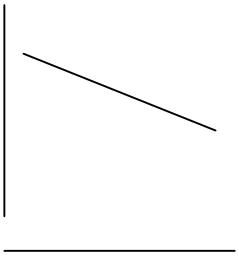


Fig. 2. A negative slope indicates a negative correlation

Most of the time when you draw graphs for your lab reports you will not be trying to draw a "straight line" through them but simply "connecting the dots". Only use the technique above if there is a specific question about a possible correlation between two continuous variables. Also note that unlike the illustrations above you should always have your graph labeled and indicated the units of measurement. See below for more information on "best fit" lines.

Significant Figures

Since a calculator often give answers in enough digits to fill its screen, students are often confused about how many units to actually include when reporting a calculation. Some even assume that adding

more decimal places makes a number "more accurate" when, in fact, too many decimal places actually cause a loss in accuracy and precision of the measurement. Generally, the number of significant figures to the right of the decimal that you report should never be more than that of the number with the fewest decimal places that was used in the calculation. In most cases in our labs, **one or two decimal places** will be used unless instructed otherwise.

Experiment #1: Control vs Experimental Groups

A. Select two characteristics or features that you believe might be related to each other in some way. Which variables you choose are up to you but one should be a "continuous variable" and the other should be a "discrete" variable with two categories. Also, you must make sure that you have enough "samples" in each group. Some examples of continuous variables you might choose: height, weight, age, breathing rate, pulse, GPA, courseload, etc. Some examples of discrete variables: male vs female, hair colors, eye colors, exercise vs nonexercise, breakfast vs no breakfast, caffeine vs no caffeine, smoking vs nonsmoking, etc

   Check with the instructor to determine how best to collect and record your data and then complete the table and questions below:

B. Decide on an hypothesis and identify your dependent and your independent variables.

C. Collect and record your data on the table below. Then perform the statistical analysis as directed on the same sheet with:

   n = number of individuals in each group
   $\mathbf{x_i}$ = an individual value (heart rate/minute)
   $\mathbf{\sum}$ = the sum of this group of values (sum of column)
   x = the mean (average) of the group of values
   $\mathbf{s^2}$ = the variance of the group; divide the sum of column 4 by (n-1)
   SD = the standard deviation; is the square root of the variance
   SE = the standard error of the group; = SD/ $\sqrt{n}$

1. collect control and experimental heart rates and enter them in the $\mathbf{x_i}$ column (column 2)
2. sum the $\mathbf{x_i}$ columns
3. calculate the means for the $\mathbf{x_i}$ columns
4. round off the mean you get to a whole number before proceeding
5. calculate the deviation from the mean for each value and enter it in column 3
6. square each deviation from the mean for each value and enter it in column 4
7. use column 4 to calculate the variance of the group, **s**
8. use the variance to calculate the standard deviation for each group
9. use the standard deviation to calculate the standard error for each group.
10. graph the mean and standard errors for the control and experimental groups with pulse rate on the vertical ("y") axis and a column each for your control and experimental sets on the horizontal ("x") axis. First enter a dot for the mean pulse rates in each group above each column label, then prepare error bars by drawing a vertical line through the mean that extends both above and below the mean by the value of the standard error.
11. We will not do a thorough statistical evaluation of our data. Instead, we can get a general idea of whether the differences between the control and experimental groups are statistically significant by looking at the error bars on the graph. If the error bars of the two groups overlap,

then the means of the two groups are probably not significantly different. If they don't overlap, then the means probably are significantly different from each other.

12. Use this information to decide whether or not to accept or reject your hypothesis.

Experiment #2: Testing with continuous variables

A. Select a continuous dependent and independent variable, heart rate must be one of these. Record your lab partners heart rate and write that value as pulses/minute in the table below. The subject should then write the other variable in the second column of the table; eg age, weight, height, length of nose hairs, etc

B. Decide on an hypothesis and identify your dependent and your independent variables.

C. Transcribe the data for each member of the class to the table on your data sheet

D. Now plot the data on your graph paper with the independent variable on the horizontal ("x") axis and the dependent variable on the vertical ("y") axis

1. Normally, we would use a mathematical program to generate a "best-fit" line for this data; you can simulate this process by drawing a straight line with a ruler such that it comes closest to the most data points on the graph.

2. We could further use statistical methods to determine the exact slope of the line and whether the slope is significant or not. Instead, just look at the line and decide if it is fairly horizontal or sloping one way or the other to a significant degree. Also, note whether the data clearly follow a line or whether they seem to be more or less randomly scattered on the graph paper. The less distinct and more difficult it is to draw a line through the data points, the less likely that there is a significant correlation between the two variables.

3. Use this information to accept or reject your original hypothesis.

Name:_____

Due Date:_____

Scientific and Analytical Methods

Biol 2401 Data Sheet

Experiment #1: Control vs Experimental Groups

What is your hypothesis?

What is your **dependent** variable (be as specific as you can)?

What is your **independent** variable (be as specific as you can)?

Attach your graph to this data sheet

Did you accept or reject your hypothesis. Write your conclusion below:

Experiment #2: Testing with continuous variables

What is your hypothesis?

What is your **dependent** variable?

What is your **independent** variable?

Attach your graph to this data sheet

Did you accept or reject your hypothesis. Write your conclusion below:

Data for Experiment #1: Control vs Experimental Groups

Control Group				Experimental Group			
1	2	3	4	1	2	3	4
	xi	$\bar{x} - xi$	$(\bar{x} - xi)^2$		xi	$\bar{x} - xi$	$(\bar{x} - xi)^2$
1				1			
2				2			
3				3			
4				4			
5				5			
6				6			
7				7			
8				8			
9				9			
10				10			
11				11			
12				12			
13				13			
14				14			
15				15			
16				16			
17				17			
18				18			
19				19			
20				20			
21				21			
22				22			
23				23			
24				24			
—				—			
∑		XXXX		∑		XXXX	
x				x			
s^2				s^2			
SD				SD			
SE				SE			

Data for Experiment #2: Continuous Variable

Subject	Independent Variable	Dependent Variable
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
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24		
25		

The Language of Anatomy
[Landmarks, Cavities, Planes]
Biol 2401 Lab

Lab Materials:

male & female surface landmarks models
various models

Lab Activities:

1. Define and give examples of the following directional terms:
   - superior/ inferior
   - anterior/ posterior
   - medial/ lateral
   - dorsal/ventral
   - proximal/ distal
   - superficial/deep

2. Use the models above to find and describe the location of common surface landmarks listed below
   - axial region
   - appendicular region
   - head, neck, thorax, abdomen, pelvis
   - nasal, orbital, oral, buccal, occipital, cervical, axillary, thoracic, umbilical, lumbar, sacral, gluteal, antecubital, brachial, antebrachial, pelvic, abdominal, lumbar, pubic, inguinal, femoral, patellar, popliteal, digital, calcaneal

3. Describe and recognize the variety of planes or sections on all many models in the lab that show various types of sections.
   - sagittal plane, midsagittal
   - frontal plane
   - longitudinal plane
   - transverse plane

4. Use appropriate models to locate the major body cavities and name organs found in each
   - Dorsal
     - Cranial
     - Spinal
   - Ventral
     - Thoracic
       - Pleural
       - Pericardial
     - Abdominopelvic
       - Abdominal
       - Pelvic

5. Study torso models and illustrations to be able to name which abdominal quadrants or regions various organs are found in.

   - upper right and left quadrate; lower right and left quadrate
     - epigastric hypogastric, umbilical
     - rt & lft hypochondriac, rt & lft lumbar, rt & lft inguinal

Organ Systems Overview

Biol 2401 Lab

Lab Materials:

Tables and Illustrations
Torso Models

Lab Activities:

1. Use models and charts to learn the major systems and some of the major organs of *each* organ system listed below.

Terminology:

Integumentary System
[the skin can be considered a membrane, a single organ or an organ system]

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

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

Nervous System
brain, spinal cord, each cranial nerve, each spinal nerve

Endocrine System
anterior pituitary gland, posterior pituitary gland, thyroid gland, pancreas, adrenal cortex, adrenal medulla, ovaries, testes

Circulatory System
heart, each individual artery and vein is a separate organ of the circulatory system
(eg. aorta, pulmonary artery, hepatic portal vein, etc.)

Lymphatic System
right lymphatic duct, thoracic duct, tonsils, spleen, lymph nodes

Immune System
[Specific cells and chemicals in virtually every body organ help to protect the body from pathogens]

Respiratory System
nose, pharynx, larynx, trachea, bronchi, lungs, diaphragm

Digestive System
mouth, pharynx, esophagus, stomach, small intestine, large intestine, liver, gall bladder, pancreas, mesenteries, teeth, salivary glands

Urinary System
kidneys, ureters, urinary bladder, urethra

Reproductive System
male: penis, scrotum, testes, epididymus, vas deferens, ejaculatory duct, urethra, seminal vesicles, prostate gland, bulbourethral glands
female: vulva, , mammary glands , ovaries, oviducts, uterus, cervix, vagina

The Microscope

Biol 2401 Lab

(Wayne, Ziser)

Lab Materials:

Slides:	Letter "e"
	colored threads
Lab Supplies:	dropper bottles of tap or DI water
	dropper bottles with IKI (Lugol's Iodine) solution
	flat toothpicks

Introduction

Only objects 0.1mm and larger can be visualized by the human eye. Because most microorganisms are much smaller than 0.1mm, a microscope must be utilized in order to directly observe them. In general, the diameter of microorganisms ranges from 0.2 - 2.0 microns

A **light microscope**, which uses light as a source of illumination, will be employed in this lab. There are several types of light microscopes. The type used in this course is a **bright-field** microscope, where the specimen appears darker against a bright background.

Care of the microscope

Observe the following precautions when using the microscope.

1. These microscopes are large and heavy. Always use *both hands* when carrying the microscope. One hand holds the arm while the other hand supports the base. Always carry the scope in an *upright* position. Do not bump the scope while removing it from the cabinet.

2. Several parts are loosely connected to the scope. When the dust cover is removed or if the scope is at an angle, the following parts may detach from the scope:

   Collector lens and blue filter (resting above the lamp),

   Rubber eye shields (these attach to the top of the eyepieces, the viewer's eyes rest on these shields.

   The eyepieces, themselves, may be loose in the eyepiece tubes. Always take care when removing the dust cover, and always carry the scope in an upright position.

Lab Activities:

1. Identify the major parts of the microscope and know the functions of each:

   Arm and base. All other parts of the microscope are attached to the arm or base.

   Mechanical stage: The platform on which the microscope slide rests and the clamping device that secures the slide.

Mechanical stage control knobs (x-y control knobs): These knobs, under the stage, move the stage front to back and the slide from side to side.

Lamp (illuminator). The lamp on/off switch is located on the base. The light intensity can be adjusted with the black dial on the other side of the base. The lamp should be adjusted to a medium level at the start of viewing.

Iris diaphragm: also adjusts the *amount* of light reaching the specimen. It is adjusted with a thin, black lever under the stage. It has a dramatic effect on the contrast observed in the specimen and may need to be adjusted frequently.

Eyepieces (Oculars): Magnification of 10X. The width between the eyepieces should be moved until a full circle (the viewing field) is visible with both eyes simultaneously.

Nosepiece: Holds the objective lenses.

Objectives: There are four objectives: 4X (red), 10X (yellow), 40X (blue), and 100X (white, oil immersion objective). The objectives are attached to a rotating **nosepiece** (nose turret).

> **The <u>total magnification</u>** is calculated by multiplying the ocular magnification and the magnification of the objective in use.

Condenser: The condenser is located directly beneath the stage. It gathers and conducts the light to the specimen. Although it can be raised and lowered with the condenser adjustment knob, the condenser should remain at its highest position.

Focusing knobs: located on both sides of the microscope.

> The larger, inner ***coarse adjustment knob*** moves the stage up and down much faster and farther than the smaller, outer ***fine adjustment knob***.

Pointer: the thick black bar that you see (located in the right eyepiece) is used to point out objects in the field of view.

2. Cleaning the microscope. Each time before you use your microscope:

> a. Clean all eyepieces and objective lenses with lens paper.
>
> b. Before use, clean each slide, top and bottom, with Kimwipes.

3. Define and understand the use of the following terms related to microscopy:

Contrast: the ability to distinguish objects from the background

Resolving Power: ability of a lens system to separate fine detail

Resolution: smallest resolvable distance between two objects

Field of View: the circular viewing area of a lens system.

Depth of Field: the vertical distance (thickness) of the specimen that is in sharp focus.

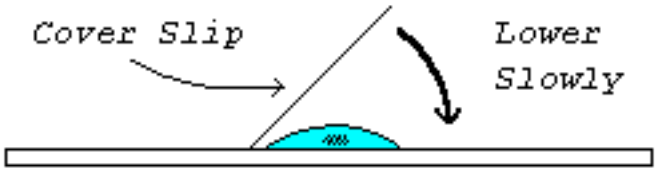
Working Distance: the distance between the objective lens and specimen when the specimen is in focus

Magnification: How large an object 'appears to be'; determined by multiplying the power of the ocular lens by the power of the objective lens in use.

4. Demonstrate proper focusing techniques and light adjustments at all magnifications and determine the **total magnification** you are using when viewing the two slides listed above

5. Demonstrate proper handling, use and care of the microscope and of prepared slides.

6. a. Make a **wet mount** of cheek cells following your instructor's directions and identify as many cellular structures as you can. (image: http://mrsdlovesscience.com/MICROSCOPEpgs/lifemicrowetmount.html)



b. Prepare a second wet mount of cheek cells but place them in a drop of IKI solution (Lugol's Iodine) instead of a drop of water. Compare with what you saw in the first wet mount.

7. Learn the meanings of the abbreviations below that are used on prepared slides:

wm	=	whole mount
sec	=	section of an organ or tissue; no specific kind of section designated
cs	=	cross section
ls	=	longitudinal section
sag	=	sagittal section
sm	=	smear → cells are spread out in a single layer across the slide
ts	=	teased → individual cells are pulled apart from each other on the slide

Diffusion and Osmosis

Biol 2401 Lab

(Wayne, Ziser)

You will be working in groups of 4 for this lab exercise.

Activity 1: <u>Observing the Diffusion of Dye Through Agar Gel</u>

Diffusion is the movement of a **solute** down a **concentration gradient**. The **rate** or speed of diffusion depends on temperature and the molecular weight of the solute. You will be measuring the diffusion rate of two solutes; potassium permanganate (MW=158g) and methylene blue (MW=320g) through an agar gel.

1. Use a sharpie to divide the agar plate in half. Label the bottom of one side PP (potassium permanganate) and the other MB (methylene blue)

2. Dip a glass rod into the potassium and transfer it to the appropriate side of the dish by touching it to the agar. Use a clean glass rod to place a drop of the other dye on the plate

3. Measure the diameter of each spot when you first place it onto the agar by placing the ruler under the plate and measuring the diameter then divide this by 2 to get the radius, this is time=0

4. Make additional measurements to determine the radius of each dye at 10 minute intervals for at least 30 or 40 minutes.

5. Record your data in the table on the data sheet

6. Make a graph (using graph paper) of your results; plotting the radius on the y-axis and the elapsed time on the x-axis.
   Make two lines on the same graph, one for Potassium Permanganate and another for the Methylene Blue.

Activity 2: <u>Observing Diffusion and Osmosis Through a Nonliving Membranes</u>

Dialysis tubing is a semipermeable plastic film and therefore simulates the semipermeable cell membrane. The tubing has already been cut to size and placed in a beaker of DI water to soften it up. This is an experiment in *both* diffusion *and* osmosis, both water and solutes could be moving across the membrane. You will be using **indicators** to test for the diffusion of solutes and the **change in weight** of the sac to test for the osmosis of water.

1. Label five 250 ml beakers #1-#5 with labeling tape. Fill the beakers with about 150 ml of the solutions listed in the "beaker" column of the **table** below.

2. Wearing latex gloves, lift the piece of tubing out of the beaker and clamp one of the orange plastic clamps onto one end of the membrane. ***(Do not discard these clamps at the end of the activity)***

3. Tease open the other end of the tubing (you now have a "bag" that is closed at one end) and add 10 ml of the solution indicated in the table below to each bag using a graduated pipette. This should fill each bag about half way.

4. gently squeeze out the air and clamp the top of the bag with the other orange clamp.

Fill the beakers and bags as follows:

Beakers		***Dialysis tubing bags***	
Beaker #1	***distilled water***	***Bag #1***	***40% glucose solution***
Beaker #2	***distilled water***	***Bag #2***	***10% NaCl solution***
Beaker #3	***distilled water***	***Bag #3***	***1% boiled starch solution***
Beaker #4	***10% NaCl solution***	***Bag #4***	***40% glucose solution***
Beaker #5	***distilled water***	***Bag #5***	***40% Polyethylene glycol***

5. blot each dialysis bag with a paper towel and place it on a weighing tray to weigh it. Record this beginning weight of each bag on your data sheet.

6. Place each bag in the designated beaker and note the time.

7. After one hour, remove the bags, blot them dry and weigh them as above.

8. Record the weights on your data sheet. *** Do not discard the bags or beakers!**

9. By means of fairly simple tests we can determine whether certain substances are present in a solution and, in this case, which have entered or left the dialysis bags. To determine whether glucose, starch or salt (NaCl) is present, you will use chemical **indicators** that reveal the presence of certain substances by changing color. (Note: you will <u>not</u> be testing for the presence of **polyethylene glycol**, however, it is a chemical that will not diffuse across the dialysis membrane).

   A. **Glucose and Simple Sugars**.
   Benedicts solution causes some sugars to turn green, yellow, orange or red when heated to boiling. The color of a positive reaction depends on how much sugar is present (green indicates low levels; red high sugar levels).

   To test for the presence of sugars: use a plastic pipette to transfer 1 ml of the solution to be tested into a small test tube. Place the test tube in boiling water for 3 minutes.

   B. **Starch**.
   Lugol's iodine (IKI) is a yellow liquid that when added to a solution containing starch turns dark blue to black. The more starch there is the darker the color.

   To test for starch: use a plastic pipette to transfer 3-5 drops of the solution to be tested in a well of the white porcelain spot plate. Add three drops of Lugol's Iodine (IKI) solution to the well.

   C. **Salt.**
   The addition of Silver Nitrate to a solution containing salt will cause a cloudy white precipitate to form.

To test for salt: use a plastic pipette to transfer 1 ml of the solution to be tested into a small test tube. Look for a white precipitate .

Summary of indicators:

Indicator	Color	Indicates
Lugol's Iodine (IKI)	yellow	absence of starch
	blue/black	presence of starch
Benedict's solution (when heated to boiling)	blue or no change after heating	absence of glucose
	green, yellow, orange, red graduated from not much glucose (green) present to a lot present (red)	presence of glucose
Silver Nitrate	clear	absence of sodium chloride
	cloudy white precipitate	presence of sodium chloride

10. Perform test for the presence of **glucose** in: Beaker and Bag #1 and #4
    Perform test for presence of **starch** in: Beaker and Bag #3
    Perform test for the presence of **salt** in: Beaker and Bag #2 and #4

11. Record your results in the table in your data sheet

Activity 3: <u>Osmometer Demonstration</u>

A piece of dialysis tubing has been stretched across the opening in the thistle tube on the side counter. Molasses has been added to the tube, and the tube, with the dialysis membrane has been placed in a beaker of DI water. Molasses consists of a disaccharide that is too large to diffuse through the membrane down its concentration gradient. Water however can still enter the membrane going down a *water concentration gradient*. The initial level of the molasses in the tube and the starting time is indicated as well. Any increase in the height of the molasses indicates water entering the tube.

1. use a ruler to measure the height of the molasses column above the starting line, in millimeters, approximately every 15 minutes for an hour and record this information on your data sheet.

2. graph the results placing time on the "x-axis" and height of the column on the "y-axis) of your graph.

Activity 4: <u>The Effects of Osmosis on Cells</u>

1. Take three microscope slides from your drawer.

   on the first slide use the dropper to place a drop of 10% saline (sodium chloride) solution

   on the second place a drop of physiological saline

   on the third slide place a drop of DI water

2. Now use a transfer pipette to place a small drop of blood on each of the 3 slides

3. Place a coverslip on each slide and view them under a microscope

4. On your data sheet sketch the appearance of the cells on each of the 3 slides and describe what has happened.

Activity 5: Observing the effects of molecular motion

1. Make a wet mount using a drop of **whole** milk. Observe the milk with the microscope using the 40X objective.

   It is not easy to see the motion that you are supposed to observe. Adjust the microscope for maximum contrast (experiment with reducing the light levels with the iris diaphragm lever) and make sure that the microscope focus is as sharp as possible.

   You should be able to see small transparent droplets. These are tiny droplets of "milk fat" that have been made very small by the homogenization process (so the fat will remain suspended in the milk rather than float to the top.) Be patient. Continue to observe the slide and you will probably suddenly see a subtle vibrating motion.

2. Record what you observed on your data sheet.

Disposal & Clean Up

At the end of each exercise be sure to properly dispose of your materials

blood slide, glass droppers → bleach container

Petri dish with agar → biohazard bag

clips for dialysis bag
nondisposable glassware } **→ clean and return to tray at your table**
filter and ring stand

dispose of paper towels, plastic transfer pipettes, etc in the trash receptacle

Wipe down tables with disinfectant

Name:_____

Due Date:_____

Diffusion and Osmosis

Biol 2401 Data Sheet

A. Observing the Diffusion of Dye Through Agar Gel

Time (min)	Diffusion of **Methylene Blue**		Diffusion of **Potassium Permanganate**
	radius of dye (mm)		**radius of dye (mm)**
0			
10			
20			
30			
40			
50			
60			

Was the diffusion rate constant for each time interval, for each dye? Explain.

Which substance had the fastest diffusion rate? Why? Explain.

B. Observing Diffusion and Osmosis Through a Nonliving Membranes

Weight of sac after one hour (gm)	Beginning Weight of sac (gm)	Change in weight of sac (+/- gms)	Indicator Tests	Test Results Fluid in Beaker	Test Results Fluid in Sac
			Silver Nitrate		

Now describe what happened in this experiment in terms of **diffusion** of salt and **osmosis** of water. M**ake a diagram** to illustrate what happened and use arrows to indicate the direction of movement of each substance

C. Osmometer Demonstration

Time from Start	Height of Column (mm)
0 min	
15 min	
30 min	
45 min	
60 min	

Is the increase in height constant for each time period? What factors might explain this?

D. <u>The Effects of Osmosis on Cells</u>

Draw, describe and explain the differences in the **appearance** of blood cells in each of the three solutions.

Explain what has occurred in **each** of the situations above in terms of **osmosis** and **hyper-, hypo-, and iso- tonic solutions.**

Dissection of the Fetal Pig

Biol 2401 Lab

In this course, we are primarily concerned with learning anatomical terminology as it pertains to the human organism. Ideally, human cadavers would provide the best subjects for examination. Lacking enough student volunteers, we are forced to make use of the fetal pig, *Sus scrofa*, as a fairly reasonable substitute.

These pigs are usually within one or two weeks of births and are obtained from the sows at the time of their slaughter. A sow produces, on average, eight piglets per litter, which are about 30 cm long at birth. Pigs have a gestation period of 112-115 days. In contrast, humans average one baby per litter, about 50 cm long at birth, and the human gestation period is about 275 days. Measure the length of your pig from snout to the base of the tail, in millimeters, and the use the graph provided in lab to estimate the **gestational age** of your fetal pig.

Review the general instructions for dissections on pages 3 & 4 of the course packet.

Obtain a pig and rinse it in the sink then place it in a dissecting pan for observation. These pigs have been injected through a slit in the neck with colored latex to highlight the blood vessels. In your dissection later, arteries will appear pink, veins blue. Begin your study by examining the surface features of the pig. Determine the possible orientations of the pig in terms of dorsal/ventral; anterior/posterior; superior/inferior; superficial/deep. Note from the illustrations provided that some of these terms have different meanings in 4 legged animals than in humans.

Note the **snout** with prominent **nostrils** and the **eyes** which may be sealed closed in smaller specimens. Also note the external ear or **pinna**. Notice the pig's short, stocky **neck** with its powerful muscles adapted for rooting. Posterior to the neck is the **thorax**. Palpate the **ribs** and **sternum** under the skin. In the **abdominal area**, note the **umbilical cord** with its injected arteries and vein. Along the sides of the ventral region are pairs of **mammary papillae**, commonly called teats or nipples, which become functional mammary glands only in mature females. The male is identified by finding the **urogenital opening** directly posterior to the attachment of the umbilical cord. Also posterior to the hind legs is the **scrotum**, a sac of skin that contains the **testes** in a mature male. In both sexes, the **anus** is directly ventral to the base of the **tail**. A female pig is recognized by the **urogenital opening** directly ventral to the anus that serves as a common opening for both the urinary tract and the vagina. Beneath the urogenital opening is a prominent **genital papilla**.

We will begin our study of the pig's digestive and respiratory systems by taking a close look at the mouth. Stick one point of the larger scissors into a corner of the pig's mouth and cut posteriorly through the **masseter** muscle for approximately 3.5 cm. Now make the same cut on the other side. Take the bone cutters and cut through the jaw bone on each side until the lower jaw can be opened enough to see the epiglottis (see below).

Now examine the mouth cavity and find the teeth, the **hard** and **soft palates** and the **tongue**. In the back of the mouth is a small protruding flap of cartilage called the **epiglottis** which prevents food being swallowed from entering the **glottis**. The glottis is the opening into the **larynx** (or voice box) that you will locate later in the throat area. Just behind the glottis is a space called the **pharynx** (or throat) That leads to the **esophagus**. You will find the esophagus later in your dissection.

Now, place the pig on its back in the dissecting tray. Get two pieces of string about 60 cm long. Tie one end of a string to the front foot and then pass the string under the pan and tie the other end to the opposite foot. Make sure the limbs are spread widely apart. Tie the hind legs in the same manner. Look at the illustration provided showing how to dissect the ventral surface of the pig. With the larger scissors make a shallow, midventral incision in the neck near the base of the lower jaw. insert the blunt edge of the scissors into the incision and cut posteriorly to within about 15 mm of the umbilical cord. Cut all the way through the body wall and at the same time lift the body wall toward you to avoid cutting into any internal organs. Avoid gouging by holding the scissors parallel to the surface of the abdomen. Next make a pair of incisions, each lateral to the umbilical cord and posterior teats.

Roll the strip of skin with the umbilical cord back slightly and locate the **umbilical vein**, then cut it. Examine the **abdominal cavity** and find the muscular **diaphragm** separating it from the **thoracic cavity**. Now make lateral incisions through the body wall just posterior to the attachment of the diaphragm. Follow the attachment of the diaphragm to the body wall all the way to the back muscles. Cut through the diaphragm on both sides where it attaches to the body wall. Carefully cut the membranes binding the thoracic organs to the ventral thoracic wall. Bend back the flaps of body wall and wash out any coagulated blood and fluid.

The **thoracic cavity** is partitioned to form two lateral **pleural cavities** containing the lobed **lungs**. A **pericardial sac** containing the **heart** is located between the pleural cavities. above and partly covering the heart is a large, brownish, elongated mass of tissue which is the **thymus gland**. Open the pericardial sac to expose the heart. Note that both the pericardial sac and the surface of the heart is made of **serous membrane**. Also note that the inner wall of the thoracic cavity and the outer surface of the lungs is covered in serous tissue. Distinguish between **visceral** and **parietal pleura** and **visceral** and **parietal pericardium**.

The serous tissue of the **abdominopelvic cavity** is called **peritoneum**. Again, distinguish between **parietal** and **visceral peritoneum**. Note also that serous membrane forms thin, clear **mesenteries** between many of the abdominal organs. These mesenteries are composed of two layers of peritoneum. Between the layers are connective tissue, blood vessels, and nerves that supply the various abdominal organs.

Just beneath the skin of the neck and several small strips of muscles is a large pair of **thymus glands** that extend down to the heart. Carefully lift the antrior portion of the thymus and find a “bulge” that is the **larynx**. Just beneath the larynx is an oval purplish mass which is the **thyroid gland**. Find the **trachea** which leads from the **larynx** and branches into three bronchi in the lungs.

Flip the left lung over to the right side being extremely careful to avoid disturbing the heart and associated vessels. Carefully remove enough parietal pleura to locate the **esophagus**. Trace the esophagus through the **diaphragm** and into the **peritoneal cavity** to find the **stomach** which is nearly covered by the left lobe of the **liver**. The **cardioesophageal valve** of the stomach is located at its juncture with the esophagus and closes upon swallowing to prevent gastric fluids from ascending into the throat. A **pyloric valve** separates the **stomach** from the **small intestine** and allows food to pass once it has been thoroughly mixed with gastric juices. Note the large **liver**, often blue for the latex dye. Lift the liver and examine its inferior surface to locate a greenish **gallbladder** embedded there. The **spleen** is a long fingerlike organ extending down the left side of the stomach. Note that it is proportionately larger than the human spleen. The **pancreas** is located along the ventral border of the stomach and often extends along several intestinal folds. Follow the coils of the **small intestine** and note the supporting mesentery loaded with blood vessels and lymph nodes. Cut open a section of the small intestine. Remove a portion of the velvety lining and prepare a wet mount. Observe your slide

under the microscope and note the numerous fingerlike **villi**. These villi help to increase the surface area of the intestine for the absorption of nutrients into the blood

Finally, the small intestine enters the **large intestine**, along one side. The **large intestine** is subdivided in the the **caecum**, **colon**, and **rectum** as is ours. The first part of the large intestine is a short blind sac called the caecum which extends down from the point where the small and large intestines join. Note that the pig caecum lacks an appendix. Make an incision in the **colon** opposite the entrance of the small intestine and find the papilla-like **ileocaecal valve**. The rectum is the terminal part of the large intestine and opens to the outside through the **anus**.

Carefully shove the intestines to one side. The **kidneys** lie dorsally, just inside the body wall, but outside the peritoneal cavity against the ventral surface of the back muscles (= retroperitoneal). Gently tear the peritoneal layer away without damaging the attached blood vessels. Note the **ureter** which exits each kidney near the attachment of the **renal artery** and **renal vein**. Trace the ureters posteriorly along the dorsal body wall. They will turn ventrally and enter the **urinary bladder**, an elongated sac between the two **umbilical arteries**. Trace the bladder into the **umbilical cord** where it continues as the allantoic stalk. After birth, the allantoic stalk degenerates.

If you have a male pig, you previously located the **testis** in the **scrotal sac**. The testes begin embryonic development in the body cavity immediately posterior to the kidneys. usually they descend into the paired scrotal sacs before birth. Open one of the sacs and find a **testis**. Examine the testis and find a band of tissue, the **epididymus**, which begins at the anterior end of the testis and proceeds posteriorly along one side of the testis to its most posterior point where it joins the **vas deferens** (=ductus deferens). The **penis** is located directly inside the urogenital opening of the male pig in the midventral strip of body wall that also contains the **urinary bladder**. Trace the **vas deferens** (ductus deferens) from the scrotal sac through the body wall, into the abdominal cavity. The vas deferens and associated nerves and blood vessels are referred to as the **spermatic cord**. Gently pull the spermatic cord and note that it slides through a minute opening in the posterior wall of the abdomen Locate the **urethra** and follow it posteriorly and then anteriorly to the **urogenital opening**.

In the female pig, find the **kidneys** and locate the paired **ovaries** posterior and ventral to them. They are loosely supported by thin **mesenteries**. The ovaries are connected by mesenteries to two, much coiled, projections called **uterine horns** which are extensions of the "Y"-shaped **uterus**. The uterus leads to the **urogenital opening** of the female pig.

Begin your study of the pig's circulatory system by removing any vestiges of the **pericardial sac** from the **heart**. Examine the heart and located a surface groove that is a line of demarcation between the **right** and **left ventricles**. Notice that the **left ventricle** is larger than the **right ventricle** and extends to the posterior tip of the heart. Running along this groove are **coronary arteries** and **veins** which are the major suppliers of blood to the heart. Next locate the two darker anterior flaps on the heart making up the **right** and **left auricles**, these are pouches containing the chambers called te **atria** that can expand when they fill with blood. The large whitish blood vessel attached to the anterior ventral surface of the heart is the **pulmonary artery** which supplies the lungs with blood. Immediately dorsal to the pulmonary artery and partially obscured by it is the **aorta** which leads outward from the heart then bends 180º to the left as it passes down toward the **diaphragm**. The **aorta** can be viewed by shoving the heart and lungs to the right. The pulmonary artery leads posteriorly and branches to the lungs. A short duct, the **ductus arteriosus**, connects the pulmonary artery with the aorta. The **ductus arteriosus** shunts fetal blood away from the lungs. After birth, the smooth muscles in the wall of this duct constrict and close off this shunt.

Return to the pleural cavity and cut away tissue in the neck to expose the aortic arch and its major branches. Locate the right and left **subclavian arteries** which take blood to the arms, and the right and left **carotid arteries** which take blood to the head.

Now look at the venous system. In the same area, the **anterior vena cava** receives blood from two **subclavian veins** that drain the arms, and two **jugular veins** that return blood from the head.

Locate the **abdominal aorta** and find the **renal arteries** that supply blood to the kidneys. Below the kidneys the aorta divides into two large arteries that supply blood to the lower torso and the legs. On each side of the urinary bladder are two **umbilical arteries** that can be traced to the **umbilical cord**.

The major veins that drain the legs join in the pelvic area to form the **posterior vena cava** which leads back to the heart. The posterior vena cava receives several large vessels as it progresses toward the liver. Trace the posterior **vena cava** into the liver. Also, trace the **umbilical vein** into the liver where it becomes a large **ductus venosus** that empties into the **posterior venal cava**. The ductus venosus degenerates after birth.

Disposal & Cleanup after Dissection:

1. after each dissection dispose of materials as below:

slides and coverslips	→	**glass disposal box**
dissecting scraps	→	**"scraps" bucket**
gloves, paper towels, etc	→	**regular trash**

2. spray and wipe down your table with disinfectant spray

3. clean off your dissecting tray and place on drying rack

4. rinse and dry your dissecting tools and pins and return them to their proper containers

The Cell & Cell Division

Biol 2401 Lab

Lab Materials:

Models:	animal cell
	mitosis plaque
Slides:	epithelium simple squamous oral smear
	wet mount of cheek cells
	sperm smear, human
	Human blood Wright's smear
	amphibian smooth muscle, teased
	animal mitosis fish blastodisc sec &
	fish blastodisc mitosis, sec

All living matter is composed of **cells**. The human body contains trillions of cells. The metabolism of living organisms, all their biochemical activities, takes place within cells and as a result of cellular activity. All cells arise from other cells by cell division.

All cells are surrounded by a **cell membrane** which encloses the **cytoplasm** (protoplasm) and various other internal structures. The cell membrane restricts passage of materials in and out of the cell and helps to protect the cells structural and functional integrity. Internally, floating in the cytoplasm, are various **organelles** (small organs), each with a specific function similar to some of the organs found in our bodies. A **nucleus** is found in almost all of our cells and is often the largest cellular structure present. The nucleus contains the genetic material, the **chromosomes**, which are made of **DNA** and control all metabolism. Most cells also contain **mitochondria** which contain most of the enzymes for extracting energy from organic foods, a chemical process called **respiration**. Additional organelles and cellular structures are listed in the lab activities below.

Lab Activities:

1. Study the cell model and identify the following organelles and structures:
   cell membrane
   cytoplasm
   nucleus & nucleolus
   organelles: ribosome, endoplasmic reticulum, golgi bodies, mitochondria, centrioles, lysosomes, cilia & flagella

2. Study the general **functions** of each cell structure and organelle listed above

3. Make a wet mount of cheek cells following your instructor's directions and identify as many cellular structures as you can

4. Compare some of the different kinds of cells (epithelium, blood, muscle and sperm) from the slides indicated above and describe their visible similarities and differences

5. Identify the stages of mitosis on prepared slides and models and be able to find good examples of each of the major stages of mitosis in the whitefish mitosis slides

   interphase, prophase, metaphase, anaphase, telophase

Human Tissues

Biol 2401 Lab

In multicellular organisms such as humans various groups of cells become **specialized** for specific functions. Some cells are responsible for movement, others for protection and still others for transferring food and oxygen throughout the body. None of these cells could survive independently from the others. Each has become specialized not only in function but in shape and internal makeup to perform a relatively few functions. Groups of cells with similar morphology and function are called **tissues**. Tissue cells are usually embedded in a noncellular **matrix**. The proportion of cells to matrix varies between tissue types. The matrix of many tissues also contains one or more kinds of protein **fibers** such as **collagen**, **elastin** and **reticular** fibers. All mammalian organs and organ systems are composed of just 4 basic or **primary tissue types**: **Epithelial, Connective, Muscular,** and **Nervous** Tissues. Each of these four primary tissue types can be further subdivided into several more specific tissue types.

Epithelial tissues line body surfaces and the lumen of all tubes and ducts within the body; including the digestive system, lungs, kidneys, exocrine glands, etc. Epithelial cells function in protection, filtration, secretion and absorption. They are packed tightly together with little or no intercellular matrix. Epithelium generally lacks a direct blood supply and is bound to underlying tissue layers by the basement membrane.

Connective tissue morphology is less well defined than the other 3 tissue types. Noncellular matrix material often accounts for a major portion of the space occupied by connective tissues. Tissue cells are scattered throughout the usually highly vascularized matrix. The matrix itself consists of an amorphous jelly-like collection of mucopolysaccharides which sometimes contain fibers of collagen or elastin. Connective tissue provides support in the form of cartilage and bone, stores fats in the form of adipose tissue, and transports oxygen and metabolic products as blood and lymph.

Muscle tissue is composed of elongated spindle shaped cells that can be up to a foot long arranged in layers or bundles. Each muscle cells (=muscle fiber) is bounded by a cell membrane called a sarcolemma. The cytoplasm inside is referred to as the sarcoplasm. Contractile threadlike organelles called myofibrils fill the interior of the cells.

Nervous tissue is made up of highly specialized cells called neurons whose primary job is to conduct impulses throughout the body for coordination and control of body activities. Another type of nervous tissue is neuroglia which supports, protects, insulates and nourishes the neurons.

Lab Activities:

1. Examine the slides of each of the four **primary** (basic) **tissue types** as assigned, make sketches of each and be able to distinguish them from each other

Primary and Specific Tissue Types	*Microscope Slides*
Epithelial Tissues	
Simple Squamous	human simple squamous epithelium, wm human squamous epithelium, sm human simple squamous epithelium, sec
Stratified Squamous	human palmar skin, sec
Simple Cuboidal	mammal simple cuboidal epithelium, sec human simple cuboidal epithelium, sec
Simple Columnar	amphibian simple columnar epithelium, sec human smooth muscle intestine, ls
Pseudostratified Columnar	pseudostratified columnar ciliated epithelium, sec
Muscle Tissues	
Striated (Skeletal, Voluntary)	human skeletal muscle adult, cs & ls human muscle types, sec
Smooth (Visceral)	amphibian smooth muscle, ts human smooth muscle intestine, ls human muscle types, sec
Cardiac	mammal intercalated disc, sec mammal cardiac muscle, sec human muscle types, sec
Nervous Tissues	
Neurons	mammal neuron motor nerve cells, sm
Neuroglia	----------
Connective Tissues	
Areolar	mammal areolar tissue spread
Adipose	mamal adipose tissue, sec
Reticular	reticular tissue, sec
Fibrous (Dense, Regular)	human white fibrous tissue tendon, ls
Fibrous (Dense, Irregular)	(skin)
Elastic	Mammal elastic tissue
Hyaline Cartilage	mammal hyaline cartilage, sec
Fibrous Cartilage	mammal fibrocartilage, sec
Elastic Cartilage	
Bone	human compact bone ground select, cs bone dry ground human, ls
Blood	human blood Wright's smear

2. Review the general functions of each specific tissue type you view

3. Locate and identify the specific kinds of epithelial tissues below on appropriate slides:
   simple squamous
   simple cuboidal
   simple columnar
   pseudostratified ciliated columnar
   stratified squamous
   transitional

4. Located and identify the specific kinds of connective tissues below on appropriate slides:
   areolar
   adipose
   reticular
   fibrous – dense regular
   fibrous – dense irregular
   elastic
   blood
   cartilage
   hyaline cartilage
   elastic cartilage
   fibrocartilage
   bone

5. Locate and identify the specific kinds of muscle tissues below on appropriate slides:
   skeletal (striated, voluntary)
   smooth (nonstriated, involuntary)
   cardiac

6. Located and identify the specific kinds of nervous tissue cells below on appropriate slides and models:
   neurons
   neuroglia

Tissues in Organs

Biol 2401 Homework Assignment

After discussing **primary** and **specific** tissue types in lecture and lab complete the following exercise on your own.

List 3 different **organs** that contain each of the specific tissue types in the table below. Remember, an organ is a group of tissues working together to perform a specific function. Refer to the **Organ System Overview** exercise that you studied earlier in this manual. Your text and lab manual gives you some suggestions but in some cases they do not mention specific *organs*; it may only mention a general location or a part of an organ. **Make sure you know whether the structure you are listing is actually an organ**.

Also, you must name ***specific organs***; for example 'humerus', *not* 'bones', or 'gluteus maximus' *not* 'muscles', or 'aorta', not blood vessels, etc.

There may be a few tissue types that you cannot find in 3 different organs, in those cases list as many organs as you can find.

Name:_____

due date:_____

Epithelial Tissues	
Specific Tissue Types	***3 Specific Organs***
Simple Squamous	
Simple Cuboidal	
Simple Columnar	

Muscle Tissues	
Specific Tissue Types	***3 Specific Organs***
Striated (Skeletal, Voluntary)	
Smooth (Visceral)	
Cardiac	

Nervous Tissues	
Specific Tissue Types	***3 Specific Organs***
Neurons	
Neuroglia	

Connective Tissues	
Specific Tissue Types	***3 Specific Organs***
Areolar	
Adipose	
Fibrous (Dense, Regular)	
Hyaline Cartilage	
Fibrous Cartilage	
Elastic Cartilage	
Bone	
Blood	

Body Membranes & Glands

Biol 2401 Lab

Lab Materials:

Diagrams and illustrations
sheep heart with pericardium
fresh knee joint (if available)
Torso Models and Male & Female Pelvic Models

Lab Activities:

1. Identify and be able to describe the structure and function of all membranes as indicated on models, preserved materials and figures
   - Mucous
   - Serous
   - Synovial
   - Cutaneous

2. Distinguish between visceral and parietal pleura, pericardium and peritoneum.
   - pleura: parietal, visceral
   - pericardium: parietal, visceral
   - peritoneum: parietal, visceral

3. Be able to recognize and identify the variety of exocrine and endocrine glandular cells and multicellular structures as instructed

The Integumentary System (Skin)

Biol 2401 Lab

Lab Materials:

Models: skin section models
skin section plaque

Slides: human scalp, hair shafts, ls
human palmar skin, sec
palmer skin silver human sec
mammal palmar skin sec

Lab Activities:

1. Describe and identify the three major layers of the skin: **epidermis, dermis and hypodermis** on the models available

2. Locate and identify the layers & sublayers of the epidermis and dermis on **models** of the skin.

Epidermis:	stratum corneum
	stratum lucidum
	stratum spinosum
	stratum granulosum
	stratum basale (=s. germinativum)
Dermis	papillary layer
	reticular layer

3. Locate and identify the layers and sublayers of the epidermis of the dermis, and the hypodermis on the slides above

Epidermis:	stratum corneum
	stratum lucidum
	stratum spinosum
	stratum granulosum
	stratum basale (=s. germinativum)
Dermis	papillary layer
	reticular layer
Hypodermis (=subcutaneous layer)	adipose tissue

4. Locate and identify the major histological features of a hair follicle and its associated structures on microscopic examination.

   Hair: follicle, root, shaft, bulb, hair papilla, sebaceous glands, arrector pili muscle

5. Determine which slides above will have **sweat glands** and which will have **oil (sebaceous) glands** and be able to recognize each on microscopic examination

   Glands: sweat glands, sebaceous glands

The Skeletal System

Biol 2401 LAB

Lab Materials:

slides: human white fibrous tissue, tendon, ls
mammal hyaline cartilage, sec
bone dry ground human, cs,

models and bones:
articulated skeleton
bone tissue model
sectioned long bones
skulls (natural bone & casts)
sagittal sectioned head
vertebral column with pelvis
ear ossicles (malleus, incus, stapes)
articulated arm and pectoral girdle
articulated leg and pelvic girdle
male and female pelvis models
articulated vertebral column
disarticulated bones; including sphenoid, ethmoid, vertebrae
sectioned skulls
xrays (if available)
fetal skull model
model of bone tissue section
trachea model
ear model

preserved material:
fetal pig skeletal preparation

Reminder: **Do not use pencils and pens to point to bones and bone markings; use the blunt or pointed probe in your dissection kit**

Lab Activities:

1. Study the microscopic structure of compact bone on the model & slide below;

model: bone tissue model

Identify: periosteum, haversian canal, Volkmann's canals, lamellae, canaliculi, lacunae, osteocytes, endosteum

slide: bone dry ground human, cs,
slide: bone dry ground ls.

Identify: haversian canal, lamellae, canaliculi, lacunae

2. Study the microscopic structure of the three specific kinds of cartilage on the slide below:

slide: mammal hyaline cartilage, sec
slide: elastic cartilage sec
slide: mammal fibrocartilage, sec

Identify: hyaline cartilage: matrix, lacunae, chondrocytes

3. Know the locations and kinds of cartilage in the human skeleton and internal organs

4. Be able to recognize fibrous connective tissue on the slide below:

slides: human white fibrous tissue, tendon, ls

5. Study the general terminology for types of bones and be able to recognize examples of each:
long, short, flat, irregular

6. Know the definition of each of the general kinds of **bone markings** (see table in text) and be able to give an example of each from the list of markings belos

7. Study the anatomy of a typical long bone and be able to identify the following terms:
epiphyses, diaphysis, medullary cavity, articular cartilage, periosteum, endosteum, spongy bone, compact bone, trabeculae, yellow marrow, red marrow

8. Distinguish between the bones of the axial and bones of the appendicular skeleton as listed below

9. Locate and identify the fontanels on the fetal skull model;
frontal (anterior), occipital (posterior), sphenoid, mastoid fontanels

10. Identify all the major bones and bone markings of the **axial skeleton** in both thee articulated skeleton, models and on individual bones as listed below.

General Skull Features: sutures: sagittal, coronal, squamous, lambdoidal; orbits; zygomatic arch

Bones & Markings of the Skull:

frontal: sinus, supraorbital margin
parietal
temporal: zygomatic process, mastoid process, styloid process, petrous portion, mandibular fossa, carotid canal, jugular foramen, external auditory (=acoustic) meatus, internal auditory (=acoustic) meatus
occipital: foramen magnum, occipital condyles
sphenoid: sella turcica, greater wing, lesser wing, sinus, optic foramen, orbital fissures
ethmoid: crista galli, cribriform plate, olfactory foramina, perpendicular plate, superior and middle nasal conchae, sinus
maxilla: alveoli in alveolar margin, palatine process, inferior orbital fissure, sinus
mandible: body, ramus, condylar process, mandibular foramen, coronoid process, alveoli in alveolar margin, mental foramen, mandibular notch
palatine
zygomatic: temporal process, zygomatic arch lacrimal: lacrimal canal nasal inferior nasal conchae
vomer
hyoid bone

Bones & Markings of the Vertebral Column:

vertebrae-general: body, vertebral arch, vertebral foramen, transverse process, spinous process, superior articular process, inferior articular process, intervertebral foramina intervertebral discs
cervical vertebrae: transverse foramen, atlas, axis: dens (=odontoid process)
thoracic vertebrae: rib facets
lumbar vertebrae
sacrum
coccyx

Bones and Markings of the Rib Cage:
sternum:
manubrium: jugular notch, clavicular notches, sternal angle
body
xiphoid process
ribs: costal cartilages, head, neck, body (=shaft), tubercle, costal groove; true ribs, false ribs, floating ribs

11. Identify all the major bones and bone markings of the **appendicular skeleton** in both the articulated skeleton and on individual bones as listed below.

Bones & Markings of the Pectoral Appendage:

Pectoral Girdle:
clavicle: sternal extremity, acromial extremity
scapula: spine, acromion, coracoid process, glenoid cavity (=fossa), medial border, lateral border, supraspinous fossa, infraspinous fossa, subscapular fossa

Upper limb:
humerus: head, anatomical neck, surgical neck, greater tubercle, lesser tubercle, body, deltoid tuberosity, capitulum, coronoid fossa, radial fossa, trochlea, olecranon fossa, medial epicondyle, lateral epicondyle

Lower limb:
radius: head, radial tuberosity, styloid process, ulnar notch
ulna: olecranon process, coronoid process, trochlear notch, radial notch, head, styloid process

Hand
carpals
metacarpals
phalanges

Bones & Markings of the Pelvic Appendages:

Pelvic Girdle:
os coxa (=coxal) bone: acetabulum, obturator foramen
ilium: iliac crest, anterior superior iliac spine, greater sciatic notch, iliac fossa,

auricular surface,
ischium: ischial tuberosity
pubis: pubic symphysis

Upper Limb:
femur: head, neck, greater trochanter, lesser trochanter, medial condyle, lateral condyle, medial epicondyle, lateral epicondyle, linea aspera
patella

Lower Limb:
tibia: medial condyle, lateral condyle, tibial tuberosity, medial malleolus
fibula: head, lateral malleolus

Foot:
tarsals:
talus
calcaneus
metatarsals
phalanges

Articulations and Body Movements

Biol 2401 Lab

Lab Materials:

articulated skeleton
models of hip, knee, shoulder and elbow joints
fresh beef joint (if available)
joint X-rays (if available)

Lab Activities:

1. Find and describe examples of each of the three major kinds of skeletal articulations on the skeletons and models available

2. Describe the major features and anatomy of a typical synovial joint

3. Identify major anatomical features on models of selected synovial joints as assigned from the list below:

a. Examples of Ball and Socket Joints

Ball shaped head of one bone fits in concave depression of another; allows movement around three or more axes, in three or more planes

Shoulder:

- note fit of ***glenoid cavity*** with ***head of humerus***,
- note ***ligaments*** enclosing the ***joint capsule*** (*see illustration*)

Hip:

- note fit of ***acetabulum*** with ***head*** of femur
- note attachment of ***ligaments*** between ***coxal bone*** and ***greater and lesser trochanters*** of ***femur***

b. Examples of Hinge Joints

Articulating heads of bones form hinge-shaped joint; permits movement around only 1 axis, in only 1 plane

Elbow:

- note fit of ***trochlea*** of humerus with ***trochlear notch*** of ulna
- note fit of ***olecranon process*** into ***olecranon fossa***
- note attachment of ***ligaments*** to ***medial and lateral epicondyles*** of humerus and ***head*** and ***olecranon process*** of radius and ulna, resp.. (*see illustration*)

Knee:

- note that the knee is the largest and most complex joint in body
- it allows flexion and extension and a little rotation
- note fit of femur onto ***articular surfaces*** of tibia
- note ***lateral and medial meniscus*** (fibrocartilage)
- note ***anterior and posterior cruciate ligament***

- note ***patella*** or kneecap embedded in ***ligaments*** and ***tendons***
- note numerous other ***ligaments*** enclosing the ***joint capsule***
- note also **collateral** and **patellar ligaments**

The Muscular System

Biol 2401 Lab

Lab Materials:

slides:	skeletal muscle, teased
	motor nerve endings, wm
models:	muscle cell model (3B; *Not* Somso)
	motor end plate model
	human torsos
	mini and half size human models
	sagittal heads
	eye model with extrinsic eye muscles
	respiratory system plaque
	muscular arms & legs
	male and female pelvis
	lymphatic system plaque
	any other models showing specific voluntary muscles

Lab Activities:

1. Identify the primary and specific tissue type on the slide of muscle; also note the striations and nuclei; understand what produces the striations

2. Identify the **muscle fibers, nerve fibers**, **synapse** and **motor end plate**s (neuromuscular junction) on the slide and the model of motor nerve endings

3. Identify the parts of skeletal muscle cells as seen on the muscle cell model:

   sarcolemma, sarcoplasm, nuclei, sarcoplasmic reticulum, myofibrils, sarcomere, thick and thin filaments, nuclei, T-tubules, motor neuron, motor end plate, neuromuscular junction, synapse, endomysium

4. On the motor end plate model identify:

   motor neuron, motor end plate, synaptic cleft, muscle cell

5. Study illustrations of a muscle organ to identify the structures below:

   fascicle, epimysium, perimysium, endomysium, tendon, aponeurosis

6. Recognize and identify the assigned human muscles & their functions on all models available

   note: extrinsic eye muscles are the 6 muscles attached to each eyeball (see senses chapter)
   note: not all muscle models show both the internal and the external intercostals
   note: not all muscle models show all three muscle layers of the abdominopelvic body wall

7. Identify these structures on models and illustrations:
   galea aponeurotica
   linea alba
   iliotibial tract
   calcaneal tendon

8. Recognize and identify the assigned cat muscles & their functions.

Note Differences Between Human & Cat Muscles:

→ **pectoralis major** - larger in human, smaller in cat
→ **pectoralis minor** - smaller in human, larger in cat
→ **pectoantebrachialis** – not present in human
→ **xiphihumeralis** – not present in human
→ **clavotrapezius, acromiotrapezius, spinotrapezius** – three muscles in cat, one muscle in human (trapezius).
→ **levator scapulae** – not present in human
→ **caudofemoralis** – not present in human
→ **gluteus maximus** – larger than gluteus medius in humans, smaller than gluteus medius in cat.
→ **sartorius** – wide muscle in cat, narrow muscle in human
→ **adductor femoris** – one muscle in cat, three muscles (adductor longus, adductor brevis, adductor magnus) in human
→ **epitrochlearis** – not present in human

Muscles of Human & Cat

Human Muscles	***Cat Muscles***
Muscles of the Head and Neck	
epicranius (frontalis belly; occipitalis belly)	
temporalis	
orbicularis oris	
orbicularis oculi	
extrinsic eye muscles (as a group)	
zygomaticus major	
masseter	**masseter**
	digastric
buccinator	
platysma	
temporalis	
sternocleidomastoid	**sternomastoid**
	cleidomastoid
	mylohyoid
	sternohyoid
Muscles of the Trunk	
rhomboideus major	
rhomboideus minor	**rhomboideus**
	subscapularis
	levator scapula
serratus anterior	**serratus ventralis**
	pectoantibrachialis
pectoralis major	**pectoralis major**
pectoralis minor	**pectoralis minor**
	xiphihumeralis
deltoid	**clavodeltoid**
	acromiodeltoid
	spino deltoid
trapezius	**clavotrapezius**
	acromiotrapezius
	spinotrapezius
	supraspinatus
	infraspinatus
	teres minor
latissimus dorsi	**latissimus dorsi**
erector spinae	
external intercostals	
internal intercostals	
external oblique	**external oblique**

internal oblique	**internal oblique**
transverse abdominis	**transversus abdominis**
rectus abdominis	**rectus abdominus**
	scalenius medius

Muscles of the Pectoral Appendage

	epitrochlearis
biceps brachii	**biceps brachii**
brachialis	**brachialis**
triceps brachii	**triceps brachii**
flexor carpi radialis	**flexor carpi radialis**
brachioradialis	**brachioradialis**
flexor digitorum	
extensor carpi radialis	**extensor carpi radialis**
extensor digitorum	**extensor digitorum**
palmaris longus	**palmaris longus**

Muscles of the Pelvic Appendage

gluteus medius	**gluteus medius**
gluteus maximus	**gluteus maximus**
psoas major	
iliacus	
	adductor femoris
adductor longus	
adductor magnus	
pectineus	
gracilis	**gracilis**
sartorius	**sartorius**
tensor fascia latae	**tensor fascia latae**
biceps femoris	**biceps femoris**
semitendinosus	**semitendinosus**
semimembranosus	**semimembranosus**
	adductor femoris
rectus femoris	**rectus femoris**
vastus lateralis	**vastus lateralis**
vastus intermedius	
vastus medialis	**vastus medialis**
gastrocnemius & achilles tendon	**gastrocnemius & achilles tendon**
soleus	**soleus**
tibialis anterior	**tibialis anterior**
peroneus longus	**peroneus muscles**
extensor digitorum longus	**extensor digitorum longus**

Introduction to iWorx & Labscribe Software

Biol 2401 Lab

(Wayne, Ziser)

Activity 1: <u>LabScribe Basics: Measuring your heartrate</u>

You will use the following procedure to collect heart rate data for each one in your group.

1. Start the program **(if the LabScribe software is on the screen skip to 2 below).**

    a. Double-click on the LabScribe icon on the desktop.

    b. From the Settings menu, choose Tutorial.

2. Familiarize yourself with menu bar at the top of the labscribe window:

    a. locate the "AutoScale" and add function buttons.

    b. locate the green Record button (upper right)

    c. locate the voltage value window below the record button.

    d. locate the time value to left of the record button.

    e. locate the Mark button and the comment entry line next to it.

    f. locate " Display Time" above the "AutoScale" button.

    g. locate the "+" and "_" buttons next to the "Autoscale" button.

3. Attach the plethysmograph transducer to the volar (fingerprint) surface of the subject's thumb or index finger to obtain a resting heart rate.

4. Record data and enter marks to identify each tracing.

    a. type "resting" in the marks box

    b. click record and then click the ENTER key on the keyboard. **Observe where the word "resting" appears on the tracing; this allows you to identify each individual's tracing.**

c. if you have wave forms as in 8b below, continue recording for about 30 seconds.

d. if you do not see waveforms, click "Autoscale" and the double mountain icon until you have normal waveforms. Continue recording for 30 seconds. If the waveforms are large or small the "+" and "-" tabs next to autoscale icon can also help to obtain a normal waveform.

e. click "stop" (upper right)

f. before leaving this section click the "Autoscale", double mountain icon, single mountain icon and note the effects they have on your tracing. **Note** the display time change as you click the double and single

g. type "hyperventilation" in the marks box and click the ENTER key on the keyboard

h. click "record"

i. tell the subject to start breathing very deeply (hyperventilate) for 15 seconds.

j. the subject should continue breathing normally after the hyperventilation period and after about 30 seconds, click Stop

5. Save the data:

a. use the scroll bar below the data window to review all of the data

b. from the File menu, choose 'Save As'

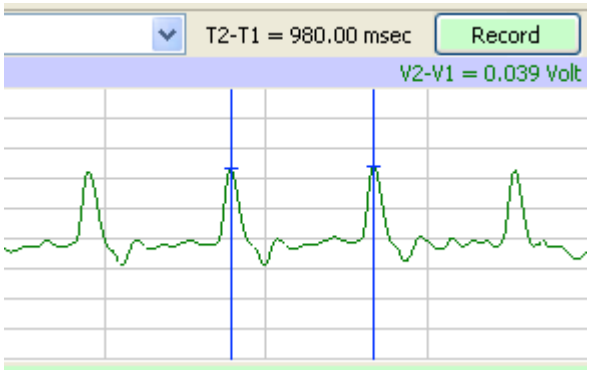
b. name the file "your name" and save it to the desktop

6. Analyze the data (Heart Rate and Amplitude)

a. To measure heart rate, select a waveform near the end of the 30 seconds of recording.

b. Select the double cursor icon.

c. Move the mouse to place the pointer on one cursor, click the mouse, holding down the button, and drag it to the peak of a wave, then release the button. **You can nudge (move) the cursor with arrow keys for fine adjustments.**



d. Repeat with the second cursor by dragging it to the peak of the next wave and obtain the value for T_2-T_1 in the top right corner of the screen, left the record button. This is the time interval between the two points selected.

e. Calculate heart rate with the following formula:

Heart Rate(beats/minute) = **60 ÷ duration of cardiac cycle**[1]

[1](time it takes for heart to complete one beat)

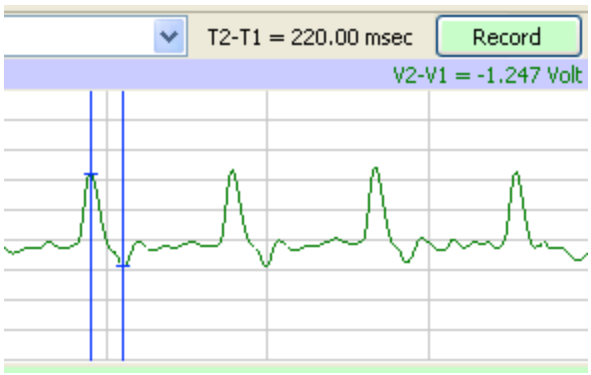
Place the data for the resting heart rate and hyperventilation heart rate in the appropriate tables.

f. To measure amplitude, select a waveform near the end of the 30 seconds of recording.

g. Select the double cursor icon.

h. Select a cursor with the mouse by holding down the button, and drag it to the peak of a wave, then release the button.

i. Then drag the second cursor to the next trough and read the value in volts in the pulse channel under the record button art the top right of the screen; this represents the **amount or amplitude of contraction. You can nudge (move) the cursor with arrow keys for fine adjustments.**



j. record this value in Amplitude Data Table

k. repeat steps a. through j. for hyperventilation HR and Amplitude

7. Print your data

    a. scroll to the “resting” mark and print (it will print the screen).

    b. scroll to the “hyperventilation” mark and print.

    c. add the name of the subject and turn in the recordings with your report.

Name:_____

Due Date:_____

Introduction to iWorx & Labscribe

Biol 2401 Data Sheet

Data for Normal Breaths

Heart Rate Data Table (normal)

	$T_2 - T_1$	Heart Rate
Resting		
Hyperventilation		

Amplitude Data Table (normal)

	$V_2 - V_1$
Resting	
Hyperventilation	

Data for Hyperventilation

Heart Rate Data Table (hyperventilation)

	$T_2 - T_1$	Heart Rate
Resting		
Hyperventilation		

Amplitude Data Table (hyperventilation)

	$V_2 - V_1$
Resting	
Hyperventilation	

Attach your recording to this sheet.

Frog Muscle Physiology

Biol 2401 Lab

(Wayne, Ziser)

The gastrocnemius muscle contains many individual muscle fibers. Each fiber has its own threshold and responds **'all-or-none'** when stimulated. Not all of the fibers in a muscle have the same threshold and so a stimulus applied to a muscle *organ* does not necessarily excite all the fiber within it. The **threshold** is that intensity (voltage) of stimulus which causes the fiber to contract. As the intensity (voltage) of the stimulus to the muscle *organ* is increased above the threshold, more and more muscle fibers are stimulated and the **'graded respons**e' of the organ increases. Eventually, however, stimulus intensity (voltage) is reached beyond which the response is constant. This stimulus, called the **maximal stimulus** marks the point where all of the fibers within the muscle organ are being stimulated and responding all-or-none. Stimuli above this maximal stimulus are called supramaximal stimuli. Stimuli below the threshold that do not initiate a mechanical response are called subthreshold stimuli.

The frog muscle is used in this laboratory exercise in place of mammalian muscle because of its tolerance to temperature change and handling. The results are similar to what would be seen in more carefully controlled mammalian experiments.

Preparation & Setup

A. Preparation of the Frog

After the frog has been doubly pithed you are ready to remove a muscle for testing. One of the largest and easiest muscles to obtain is the gastrocnemius of the lower leg.

Place the frog on a clean dissecting pan. Be sure that neither the pan nor the dissecting instruments have been contaminated with preservatives such as formaldehyde. You will be provided with pans and tools reserved specifically for the dissection of fresh materials.

It is not necessary to tie down the frog when using the femur clamp preparation. As the muscle is dissected assign one of your lab partners the task of frequently flooding the surgical area with frog ringers using a small beaker and disposable pipet. **The muscle must not dry out while dissecting or it will be useless.**

With forceps, lift the skin from one thigh and cut the skin completely around the leg using scissors. Pull the cut end back and peel the skin off the leg. Minimize the touching of the muscle tissue with contaminated dissecting equipment. Keep the area moist with frog Ringers. With a blunt probe or the blunt end of the forceps separate the body of the gastrocnemius from the underlying bone. The distal end of the muscle is attached to the Achilles tendon, a white to yellow strand of fibrous tissue. Loosen a portion of the Achilles tendon from the bone then insert a piece of thread about 10 inches long around the tendon and tie it securely. Cut the tendon distal to this knot. The proximal end of the gastrocnemius is attached to the femur. **Do not remove it from the bone.** Carefully remove all other muscles from the upper leg but leave the gastrocnemius attached. Then cut the lower leg bone (tibia) at or slightly distal to the "knee" joint with strong scissors or bone cutters. Cut the proximal end of the femur leaving at least one half inch of bone attached to the muscle. You should now have a preparation resembling that in the figure. With the proximal end of the gastrocnemius attached to the femur and the distal end attached to a portion of thread. This is the "muscle – bone preparation" you will use for your muscle physiology experiments. Connect the femur to the femur clamp as shown below.

B. iWorx Frog Skeletal Muscle Physiology Setup.

1. Make sure computer and iWorx interface (black box) are unplugged)

2. Attach the cable of the Displacement Transducer to the bottom channel 3 input plug

3. Insert the "stimulator cable" plug into channel 3 of the iWorx box (which is attached to the stimulator section of the iWorx interface)

4. Plug the computer power cord into the power outlet.

5. Plug the iWorx power cord into the outlet

6. Turn on the iWorx interface

7. Turn on the computer

8. After the computer has booted up, click on the Labscribe icon

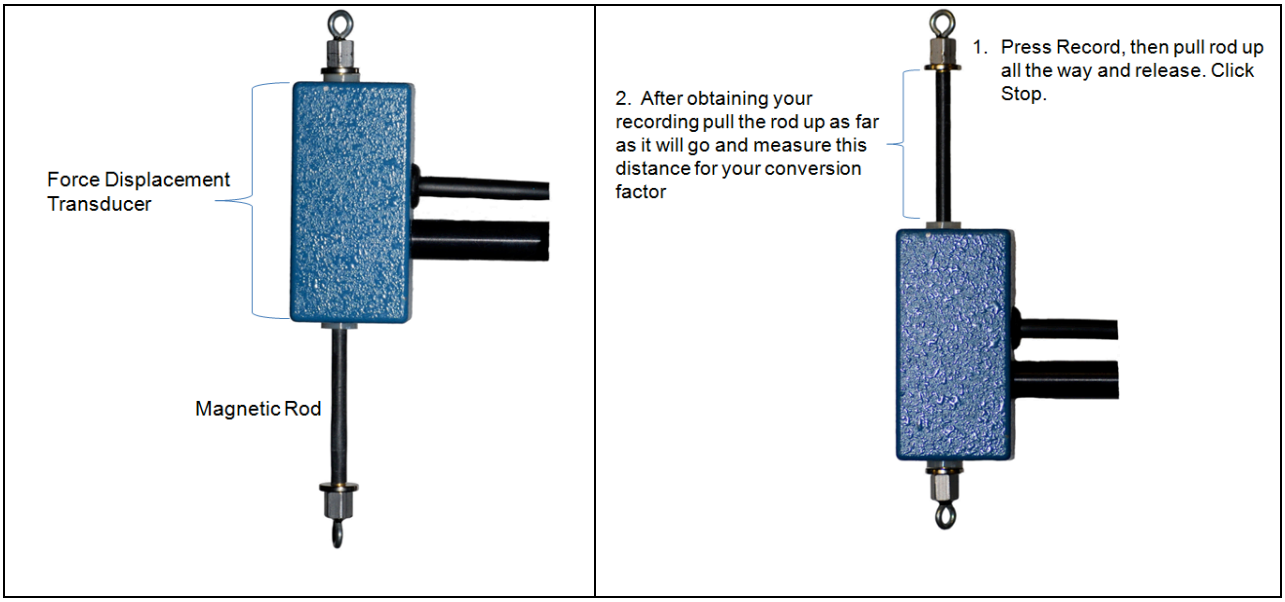
9. On the Main window, pull down the Settings menu and select the 'Skeletal Muscle-Summation-Tetanus-LS2' settings file.

10. After a short time, LabScribe will appear on the computer screen as configured by the 'Skeletal Muscle-Summation-Tetanus-LS2' settings.

[Your equipment is now ready for the experiment]

C. Standardize the movement of the transducer

(Start here if Labscribe is already set up)



1. When the transducer rod is pulled by the contracting muscle, the amplitude of the contraction will be given as "volts" in the upper right of the window as $V_2 - V_1$. Record the absolute value and ignore negative sign.

2. To convert this reading to actual millimeters of muscle contraction

   a. Click record.

   b. Pull the transducer rod as high as it will go and the release it.

   c. Click stop.

   d. Measure the actual distance that the rod moved (this is usually about 30-34 mm). See above illustrations.

   e. Click "autoscale" and "double" or "single mountain" icons as needed.

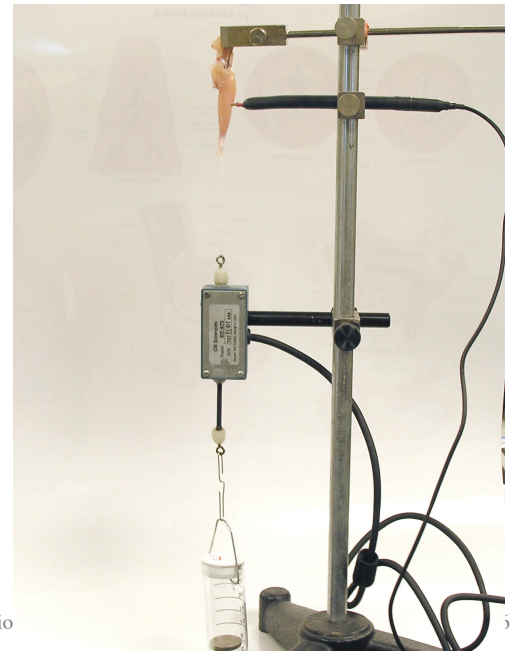
   f. Click the 2-cursor icon and measure the height of the deflection on channel 3 by placing the first blue line on the peak of the deflection and the second blue line on the baseline (valley) after the deflection has returned to its original position.

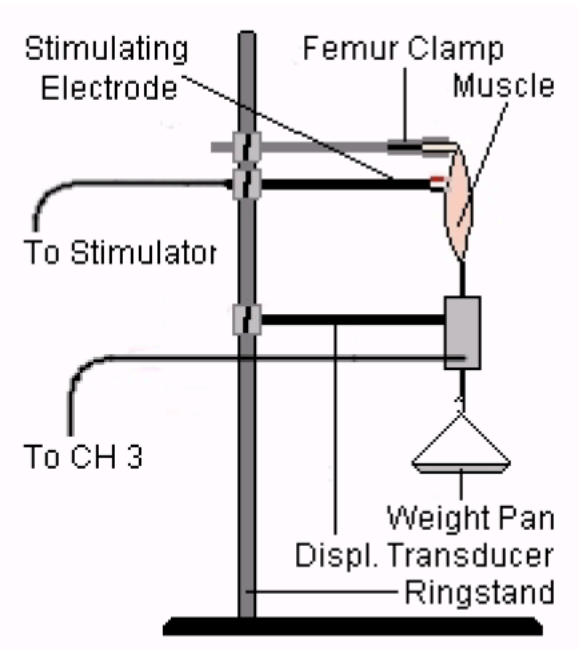
   g. Read and record the Volts reading above and to the right of the channel (ignore negative signs). This "voltage" reading is equivalent to the actual mm of movement measured by the ruler

   h. **Divide the mm of movement by the "voltage" to get a conversion factor.** This will allow you to determine the distance the muscle has contracted, which is necessary to calculate the work done by the muscle.

   i. Whenever you measure amplitude of a contraction in "voltage" you can now convert it to millimeters of contraction by multiplying this value by your **conversion factor** determined above.

D. Set up the frog muscle preparation:





1. Compress the femur in the femur clamp

2. Adjust the clamps so that the thread is vertical and the displacement transducer rod rests just on the upper stop with no slack in the thread; make sure the thread vertical

3. Position the stimulator electrodes so that they lie against the muscle about midway between the knee and the tendon; the two electrodes should not touch one another, but both must be in contact with the muscle

4. Place two nickels (10g) in the weight pan

5. Occasionally add frog ringers to keep the muscle preparation moist.

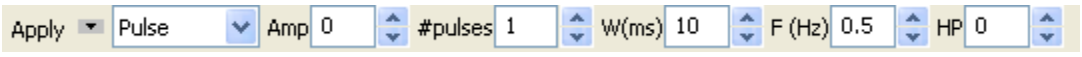
Exercises in Frog Muscle Physiology

Activity 1. <u>Determining the threshold stimulus.</u>

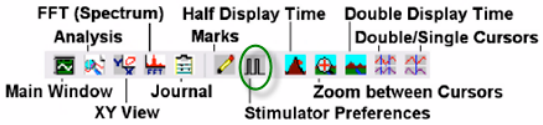
1. Set up the stimulator (select <preferences> in Edit menu) or use the stimulator panel and set the following:

   Pulse Width = 10 ms
   Delay = 50 ms
   Amplitude = 0 Volts
   Frequency = 0.5 Hz
   # of Pulses = 1

   The stimulator control panel is shown below. Don't forget to click "apply" after each change.



   If you don't see the stimulator control panel, click the stimulator icon shown circled in green and the stimulator control panel will be shown.



2. Type "0 v" in the 'marks box', click 'Record' to begin recording and press 'enter'. The stimulus and a record of the muscles response (if any) will be displayed in channel #3 and channel #4, respectively.

3. Quickly click 'stop'.

4. Click the <2 cursor> icon so that two blue vertical lines appear over the recording window.

5. Adjust the display time if needed and move the mouse to place the cursor on the left line, click the mouse and drag it to the peak of the first response wave (if there is one). Drag the second cursor, to the baseline after the response.

6. The value in the channel three title area, above and to the right of the channel three window is the value for the amplitude of contraction in volts at the stimulus voltage used. Record this value in the table on your data sheet.

7. Convert this amplitude 'voltage' to millimeters of contraction by multiplying it by the conversion factor determined in part **V** and record this value in the table in your data sheet.

8. Open the stimulator dialog box and change the stimulus amplitude to 0.25v. Don't forget to click apply after each change in the stimulator dialog box.

9. Repeat steps 2 through 7, this time typing .25 v in the 'marks' box before starting.

10. Repeat the above procedure increasing the voltage in 0.25 volt increments until you are stimulating the muscle with 5 volts.

11. Once you have completed your table you should be able to complete the observations below:

12. The threshold stimulus is the minimum stimulus needed to get any kind of a response from the frog muscle.

13. Record the threshold stimulus in the data section.

14. Use your data to make the required graphs as indicated in the data section.

Activity 2. <u>Timing the Muscle Twitch</u>

1. Set the stimulus voltage at the value you determined was the maximal stimulus (usually 3-4 volts)

2. Type "twitch" in the marks area; click 'Record' and quickly press 'enter' to mark the record and produce a single twitch

3. Click stop.

4. If necessary, right click after recording to invert trace.

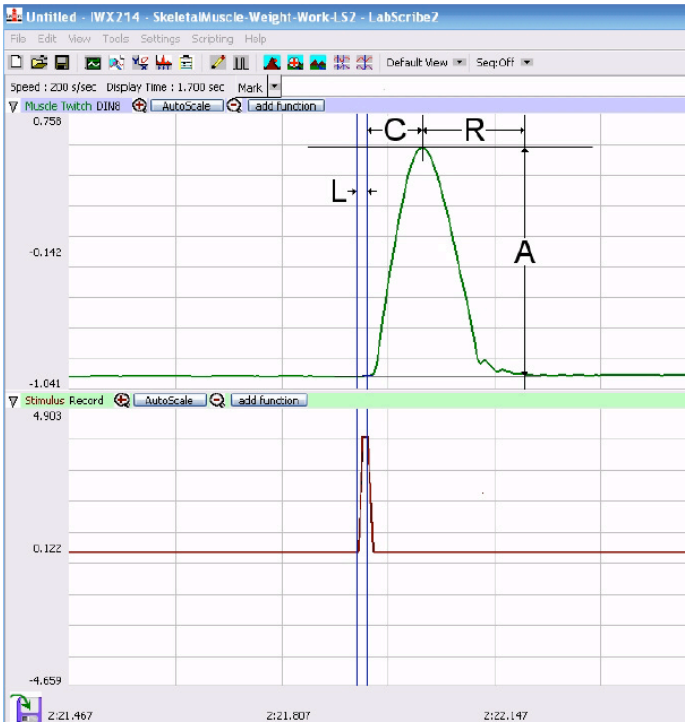
5. If necessary adjust the display time as needed by clicking the <half display time> icon or <double display time> one or more times to spread the wave form out to facilitate your analysis.

6. Scroll to the beginning of the section of data you want to investigate; click AutoScale if necessary.

7. Click the 2 cursor icon so that two blue vertical lines appear over the recording window and measure: in the diagram below L equals latent period, C equals contraction phase, R equals relaxation phase and A is the amplitude of contraction.

8. The amplitude of the twitch and convert it to mm as before.

9. The duration of the latent period: Place one cursor line at the stimulus mark (in window 4) and the other on window 3 just before a contraction begins and read T2-T1 in upper right corner of screen. This is the duration of the latent period in seconds.



10. Use the double cursors to measure the duration of the period of contraction in the same way

11. Use the double cursors to also measure the duration of the period of relaxation. Convert these values to milliseconds and record them on your data sheet.

12. Print a copy of this tracing for your group. Paste the graph in the data section of this lab exercise.

Activity 3. <u>Determining the Effect of Load on Skeletal Muscle</u>

Within limits, increases in the load (i.e., passive tension) placed on a muscle before it contracts results in corresponding increases in the strength of the contractions (i.e., active tension). There is however, a maximum tension that a muscle can exert, and beyond that limit, increases in load (passive tension) result in weaker and weaker contractions (active tension).

1. Set the stimulus voltage to produce maximal stimulus as determined previously (usually between 3 to 5 volts)

2. Reset stimulator settings to those used in part C on the previous page

3. With 2 nickels in the weight basket type “10 g” on the keyboard

4. Click ‘Record’ and press ‘Enter’ to mark the record and produce a single twitch.

5. Click Stop.

6. Add two more nickels (10 g) to the weight basket for a total of 20 g

7. Repeat the run as above (#3 & 4)

8. Continue increasing the weight in the weight basket in 10 g (two nickel) increments until there is no discernable contraction of the muscle

Data Analysis: Effect of load on muscle

9. Adjust the display time and autoscale as needed

10. Scroll to the beginning of this section of data or use the 'Marks' icon to find each of the above runs

11. Click the 2cursor icon so that two blue vertical lines appear over the recording window and for each twitch at each weight, measure the *amplitude* of the twitch both as a voltage measurement and after converting it to millimeters using your conversion factor and record on your data sheet

13. Calculate the "work done" for each weight that produced a measurable contraction of the muscle as:

work done (g-mm) = weight of load (g) X amplitude of contraction (mm)

13. Record this value in the table on your data sheet

Activity 4. <u>Observing Graded Muscle Response to Increased Stimulus Frequency</u>

1. Open the stimulator dialog box and change the number of pulses to 250, make sure the stimulus is still set to the maximal stimulus voltage as determined earlier, **use two (2) nickels in the weight basket.**

2. Type 0.5 Hz in the marks box; click 'Record' and press 'Enter' on the keyboard to mark your record.

3. Click 'stop'

4. Increase the frequency to 1, 5, 10 and then 20 Hz and repeat steps 2 and 3. Notice that the first few contractions increase in intensity even though the stimulus is the same. Notice also that at a certain frequency the muscle does not have sufficient time to fully relax so that the response does not return to baseline, this is *summation*.

5. Record the frequency at which summation first appears on your data sheet

6. Print a group copy of the tracing on your screen at this frequency

7. As you continue to increase the frequency of stimulation, notice that at some frequency there is no relaxation at all between each stimulus, this is *tetanus*.

Activity 5. <u>Inducing Muscle Fatigue</u>

Muscle fibers cannot continually lift. After a short time, the muscle will lose its ability to shorten and will ultimately fail. Due to the accumulation of waste products and the depletion of stored energy materials, a muscle is said to have lost its contractility and become fatigued.

1. Set the stimulator voltage to the maximal stimulus voltage as determined previously.

2. Set the number of pulses to "0". This will provide an infinite number of pulses.

3. Click record and observe the waveform produced. To see the effect of continuous stimulation the double mountain icon may have to be clicked several times to put much more data on the screen.

4. After several minutes or when the amplitude drops significantly, stop the recording.

5. Compress the data by using the double or single mountain icons.

6. Paste the recording where indicated in the data.

Activity 6. Inducing Treppe, or the Staircase Phenomenon (optional if time permits)

An interesting phenomenon can sometimes be seen during the early stages of a series of twitches. Upon application of a single stimulus of adequate intensity, the muscle contracts. With successive stimuli, it contracts a little more strongly by small increments, making this part of the myographic record appear like a staircase. For this reason, the effect has been called the "Staircase Phenomenon" or "Treppe". It is believed that the slight increase in temperature of the muscle fibers during contraction increases their contractility and that this may be the explanation for the increased strength of contractions.

1. Dissect and setup the gastrocnemius from the other leg.

2. Using a maximal stimulus as determined previously, stimulate the muscle with 5 stimuli set at a frequency of 1.

3. If you had time to do "Treppe" paste your recording where indicated in the data section.

Completing your report. Your lab report should have:

1. All data sheets completed

2. A graph of graded response and maximal stimulus

3. A graph of load versus work done

4. A printout of a muscle twitch with all phases of a twitch contraction labeled.

5. A printout showing summation.

6. A printout showing tetanus.

Cleanup and Disposal

1. Wrap frog and muscle preparation in paper towels or plastic bag provided and discard in trash can.
   !!!!!Do NOT place frog in scrap bucket for preserved material!!!!!

2. Clean all dissecting equipment with soap and water, blot dry with paper towels and return to tray

3. Disconnect the femur clamp from your station, rinse with DI water, and replace on the ring stand at your station

4. Wet a paper towel with DI water and wipe down the transducer, stimulator probes and clamps, blot dry with a paper towel

5. Turn off the iWorx station.

6. Remember to spray your work area with disinfectant before leaving the lab room.

Name:_____

due date:_____

group #:_____

Frog Skeletal Muscle Physiology

Biol 2401 Data Sheet

Conversion factor to convert "voltage" to mm of displacement: _____

Record the values in the table below:

stimulus voltage																	
contraction (volts)																	
contraction (mm)																	

stimulus voltage																	
contraction (volts)																	
contraction (mm)																	

Activity 1. Determining the Threshold Stimulus

At what stimulus voltage did a measurable contraction first occur?_____

Do all motor units have the same stimulus threshold? Explain

Activity 2. Timing the Muscle Twitch

Stimulus voltage used: _____ Amplitude of contraction (mm):_____

Durations of:

Latent Period (ms): _____

Period of Contraction (ms): _____

Period of Relaxation (ms): _____

1. Label the tracing of a twitch with each phase and the duration of each phase and paste where indicated.

Muscle Twitch

2. How do these values compare with the time intervals given in lecture or text? Explain.

3. Using the data from the previous section, make a graph placing stimulus voltage on the x-axis and the amplitude of contraction in millimeters on the y-axis. Paste the graph below.

Observing Graded Muscle Response to Increased Stimulus Intensity

4. Note the range of stimulus voltages in which you produced a graded response by the muscle. What is occurring in the muscle at this point?

5. The amount of contraction should peak and remain relatively constant at some stimulus voltage; this is your **maximal contraction** and **maximal stimulus voltage.** When the curve levels off you have reached maximal stimulus voltage. Estimate the maximal stimulus voltage from your graph and record it on your data sheet. Why can't the muscle contract any more since you are still increasing the stimulus after this point?

What was the stimulus voltage at maximal contraction? _____

6. What was happening to the muscle cells within the muscle as the stimulus voltage was increased up to maximal stimulus in terms of recruitment of motor units?

Activity 3. <u>Determining the Effect of Load on Skeletal Muscle</u>

Load (g)	Amplitude of Contraction (volts)	Amplitude of Contraction (mm)	Work Done (g/mm)
10 g			
20 g			
30 g			
40 g			
50 g			
60 g			
70 g			
80 g			

Did the amplitude of the contraction increase or decrease with increasing load? Explain.

Did the work done increase or decrease with increasing load? Explain.

Explain your results in terms of energy required, and the interplay between isotonic and isometric contractions.

Make a combined graph. For one data set plot the load on the x-axis and the amplitude of contraction in mm on the y axis. For the second data set plot load on the x-axis and work done on the y axis. **Paste the graph where indicated.**

Combined Graph

Activity 4. Observing Graded Muscle Response to Increased Stimulus Frequency

1. What was the frequency that produced summation? _____

2. What was the frequency that produced tetanus? _____

Activity 5. Inducing Muscle Fatigue

1. Did muscle fatigue occur? How was this determined?

2. Explain what is happening in the muscle cells during fatigue.

Activity 6. Inducing Treppe, or the Staircase Phenomenon

Optional. If this was attempted by your group, include the data and printout where indicated.

Inducing Treppe

Printouts for summation and tetanus should follow this page!!

The Nervous System

Biol 2401 Lab

Lab Materials:

slides:

mammal neuron motor nerve cells, smear
nerve cs & ls
spinal cord and ganglia cs [Wards/Turtox]

models:

neuron with Schwann cells
human brain
brain ventricles
sagittal sectioned head
heads of large torsos
brain stem
spinal cord cross sections
vertebral column with spinal column and spinal nerves
cross section of spinal cord in vertebrae with sympathetic ganglia
peripheral nervous system plaque

preserved materials:

human brain
sheep skull-sag sec
sheep brain
sheep meninges
cat nervous system biosmount

Lab Activities:

1. Recognize and identify the **cell body** and **processes** on the motor neuron slide.

2. Identify the structures and layers indicated on nerve cell model:

   neuron, cell body, axon, dendrite, axon hillock, axon terminal, synaptic cleft, neuroglia, Schwann cells, myelin, Nodes of Ranvier, neurilemma, endoneurium

3. Locate and identify the anatomical features of the human brain on all appropriate models:

   cerebrum:
   - **right and left cerebral hemispheres**
   - **transverse fissure**
   - **longitudinal fissure**
   - **lateral sulcus**
   - **central sulcus**
   - **parieto-occipital sulcus**
   - **precentral gyrus**
   - **postcentral gyrus**
   - **frontal lobe**
   - **parietal lobe**
   - **temporal lobe**
   - **occipital lobe**

insula
cortex
basal nuclei (=cerebral nuclei or basal ganglia)
corpus callosum
septum pellucidum
fornix
internal capsule

cerebellum:
right and left cerebellar hemispheres
vermis
cortex
arbor vitae

diencephalon:
epithalamus (pineal body, pineal gland)
thalamus
intermediate mass
hypothalamus
infundibulum
pituitary gland
mammillary bodies

brainstem:
midbrain (=mesencephalon)
corpora quadrigemina
superior colliculi
inferior colliculi
cerebral peduncles
pons
cerebellar peduncles
medulla oblongata
pyramids

4. Identify the surface features of the sheep brain, then make a midsagittal section to identify the internal structures as assigned below

Cerebrum: cerebral hemispheres, gyri, sulci, olfactory bulbs, olfactory tracts, optic nerves, optic chiasma, corpus callosum
Diencephalon: epithalamus (or pineal gland), thalamus hypothalamus, pituitary gland
Cerebellum: arbor vitae
Brain Stem:
midbrain
pons
medulla

5. Locate and identify the major layers and structures associated with the **meninges** on all appropriate models:

layers of meninges: dura mater, arachnoid layer, subacrachnoid space, pia mater
folds of meninges: falx cerebri, falx cerebelli, tentorium cerebelli

6. Meninges of sheep brain dissection: some of the sheep brains have the meninges still attached. Identify the three layers of the meninges on the preserved sheep brain.

   Also locate the falx cerebri and the tentorium cerebelli (the sheep meninges does not have a falx cerebelli)

7. Locate and identify the ventricles, canals, and capillary beds associated with the circulation of cerebrospinal fluid on appropriate brain models and preserved sheep brains:

   lateral ventricles, third ventricle, cerebral aqueduct, fourth ventricle, choroid plexuses, arachnoid villi (=arachnoid granulations)

8. Identify the major features on the models and slide of a cross section of the spinal cord; also note the three layers of the meninges on the cross section models

   central canal, posterior median sulcus, anterior median fissure, gray matter, white matter (tracts), anterior, lateral and posterior horns of grey matter

   meninges; dura mater, arachnoid layer, pia mater, subarachnoid space, epidural space

9. Review the difference between a **nucleus** and a **ganglion**; and between a **tract** and a **nerve**.

10. Distinguish between a **nerve** and a **nerve fiber**. Observe and recognize the microscopic anatomy of a **nerve** and its connective tissue coverings on illustrations:

    epineurium, perineurium, endoneurium, nerve fiber

11. Locate and identify the 12 pairs of cranial nerves on appropriate models:

Cerebrum:	**I. Olfactory Nerve** (filaments) (also: **olfactory bulbs, olfactory tracts**)
	II. Optic Nerve (also: **optic chiasma, optic tracts**)
Midbrain:	**III. Oculomotor Nerve**
	IV. Trochlear Nerve
pons:	**V. Trigeminal Nerve**
	VI. Abducens
	VII. Facial
medulla:	**VIII. Vestibulocochlear Nerve**
	IX. Glossopharyngeal Nerve
	X. Vagus Nerve
	XI. Accessory Nerve
	XII. Hypoglossal Nerve

11. Identify the major features on the models and slide of a cross section of the spinal cord that includes its attachments to each spinal nerve.

    dorsal root, dorsal root ganglion (sensory), ventral root (motor)

12. Identify the major groups of spinal nerves on nervous system plaque and the cat nervous system preparation

13. Find and be able to identify the major spinal nerve plexuses as available on models and illustrations

Cervical Plexus (C1 - C5)
Phrenic Nerve - innervates diaphragm

Brachial Plexus (C5 - C8, T1)
Radial, Medial & Ulnar Nerves

[T2 - T12 - No Plexus Formed]

Lumbar Plexus (L1 - L4)
Femoral & Saphenous Nerves

Sacral Plexus (L4 - S4)
Sacral Nerve

14. Locate and list the function of some of the major nerves arising from each plexus as discussed in lecture.

15. Locate and identify any parts of the autonomic system on models available

Sympathetic Branch: sympathetic trunks are comprised of fibers mainly from the **thoracic spinal nerves** which form a pair of "**chain ganglia**" anterior and lateral to the vertebral column

Parasympathetic Branch: individual fibers **from cranial nerves** III, VII, IX and X and **sacral spinal nerves** S2, S3, and S4. Innervation of most visceral organs is from fibers of the **Vagus (X) Nerve**

16. On the cat nervous system biosmounts:
    a. observe the general structure and interrelationships between the Central and Peripheral nervous systems;
    b. note the relationship between eyes, optic nerve and brain
    c. note the relationship between the brain stem and the spinal cord
    d. locate and identify the brachial and lumbosacral plexus
    e. locate and identify the **vagus nerve**

Disposal: When you have finished with your sheep brain dissection return whole and sectioned brains to their original buckets if undamaged. Otherwise place in "dissecting scraps" bucket. Rinse dissecting pans and place upsidedown on drying rack. Rinse and dry dissecting tools and return to your drawer.

Human Reflexes & Cranial Nerve Function

Biol 2401 Lab

(Wayne, Ziser)

Introduction

Reflex testing is an important diagnostic tool for assessing the condition of the nervous system. Distorted, exaggerated, or reflexes that are absent may indicate degeneration or pathology of portions of the nervous system, often before other signs are apparent.

If the spinal cord is damaged, then reflex tests can help determine the area of injury. For example, motor nerves above an injured area may be unaffected, whereas motor nerves at or below the damaged area may be unable to perform the usual reflex activities.

Closed head injuries, such as bleeding in or around the brain, may be diagnosed by reflex testing. The oculomotor nerve stimulates the muscles in and around the eyes. If pressure increases in the cranium (such as from an increase in blood volume due to the brain bleeding), then the pressure exerted on CN III may cause variations in the eye reflex responses.

Reflexes can be categorized as either autonomic or somatic. **Autonomic reflexes** are not subject to conscious control, are mediated by the autonomic division of the nervous system, and usually involve the activation of smooth muscle, cardiac muscle, and glands. **Somatic reflexes** involve stimulation of skeletal muscles by the somatic or voluntary division of the nervous system.

Most reflexes are **polysynaptic** (involving more than two neurons) and involve the activity of **interneurons** (or **association** neurons) in the integration center. Some reflexes; however, are **monosynaptic**(one synapse) and only involve two neurons, one sensory and one motor. Since there is a delay in neural transmission at the synapses, the more synapses there are in the reflex pathway, the more time that is required to ellicit the reflex.

It is important to compare each reflex immediately with its contralateral counterpart so that any asymmetries can be detected. Deep tendon reflexes are often rated according to the following scale:

- = reflex absent

+ = trace, or seen only with reinforcement

++ = normal

+++ = brisk

++++ = nonsustained clonus (i.e., repetitive vibratory movements)

+++++ = sustained clonus

Deep tendon reflexes are normal if they are 1 to 4 pluses, unless they are asymmetric or there is a dramatic difference between the arms and the legs. Reflexes rated as minus or more than three are usually considered abnormal.

Using the scale above rate each reflex and enter the data into the appropriate data table. Work in pairs to test each others reflexes but each student should record THEIR OWN responses on their data sheet.

Somatic Reflexes

Have your lab partner perform the following stretch reflexes (listed in table below) on you and record the results and answer the questions on your data sheet.

Activity 1: <u>The Patellar Ligament Reflex</u>

a. The patellar tendon reflex or knee-jerk reflex is a monosynaptic stretch reflex that assesses the nervous tissue between (and including) the L2 and L4 segments. It can be elicited by sharply tapping the patellar ligament (just below the knee) with the base of a Taylor hammer. Repeat with the other limb. Every member of the group should do this activity.

b. Test the effect of mental concentration on the patellar reflex by having the subject read a book that blocks their vision of their leg. Every member of the group should do this activity.

c. Test the effect of fatigue on the patellar reflex by having the subject exercise using the step provided. The instructor will demonstrate the use of the step and any safety issues that need to be explained. Only one member of the group needs to do this exercise but all groups should report the results on their data sheets.This step should only be done by a member of the group who feels capable of performing the exercise. Observe the reflex in both limbs.

Activity 2: <u>The Calcaneal Reflex</u>

The calcaneal reflex or Achilles or ankle-jerk reflex is a stretch reflex that assesses the nervous tissue between (and including) the first **two sacral segments**. It can be elicited by sharply tapping the calcaneal tendon (just above the ankle) with the base of a Taylor hammer. Repeat with the other limb. Every member of the group should perform this exercise.

Activity 3 <u>The Plantar (Babinski) Reflex</u>

The plantar reflex is a superficial spinal reflex that depends both on functional upper-level motor pathways and on the cord-level reflex arc.

In adults, stimulation of cutaneous receptors in the sole of the foot (as when testing the plantar reflex) usually causes the toes to flex and move together. Damage to the corticospinal tract (or incomplete myelination of the nervous system, as is the case with infants) produces Babinski's sign, an abnormal response in which the toes flare and the great toe moves in an upward direction.

Have the subject remove a shoe and lie on the floor or on the laboratory bench.

Draw the handle of a Taylor hammer or a cotton applicator stick along the lateral border of the subject's sole, starting at the heel and continuing toward the big toe (across the ball of the foot).

Activity 4: <u>The Biceps Reflex</u> (C5, C6)

Have the subject sit on the top of the lab bench with their hands resting on their legs. Place your thumb on the biceps tendon. Tap the first digit of your thumb with the reflex hammer. Note the response. Repeat for the other arm.

Activity 5: The Triceps Reflex (C7)

Have the subject sit on the top of the lab bench with their hands resting on their legs. Gently hold the subject's forearm with one hand and tap the triceps tendon above the elbow. Note the response. Repeat the reflex on the other arm. Describe the movement of the arm.

Activity 6: The Crossed Extension Reflex

With the subject's eyes closed and arms resting on the desk or lap prick the subject's index finger probe. What happens to the other hand. Explain.

Activity 7: Reaction Time of Acquired (Learned) Reflexes

a. Get a ruler or a yardstick. Hold the ruler near the end (highest number) and let it hang down. Have another person put his or her hand at the bottom of the ruler and have them ready to grab the ruler. They should not be touching the ruler. Tell the other person that you will drop the ruler sometime within the next 5 seconds and that they are supposed to catch the ruler between thumb and index finer as fast as they can after it is dropped. Record the level (centimeters) at which they catch the ruler. Convert the distance into reaction time. Test the same person 5 times (vary the time of dropping the ruler within the 5 second time period so the other person cannot guess when you will drop the ruler. Use the following formula to calculate reaction times:

$$t = \sqrt{\frac{2y}{g}}$$

In the formulas, t = time (in seconds); y = distance (in cm); g = 980 cm/sec^2 (acceleration due to gravity).

Record the reaction time in seconds in the table on your data sheet.

b. Repeat the above experiment, however, this time say a simple word each time you release the ruler. Select a specific word as the signal to catch the ruler. On all other words the subject lets the ruler pass through their fingers. Omit trials in which the subject totally misses the ruler. Record the distance and convert to time. Record the reaction time in seconds in the data table.

c. Repeat the test again to investigate the subject's response to word association. As you drop the ruler say word, for example "cold". The subject should respond with a word that he or she associates with the stimulus word, for example "hot" while catching the ruler. Record the reaction time in seconds in the data table. Record the number of times the subject misses the ruler below.

Autonomic Reflexes

Activity 8: Pupillary Light Reflex

In a dimly lit room, the subject should look out toward a wall until his/her eyes dilate. Observe for any irregularities or asymmetry. Measure the approximate pupillary size with a metric ruler and record the diameter on your data sheet. Be very careful near the subject's eyes.

The experimenter should place an index card or edge of hand on the bridge of the subject's nose to separate each eye's field of vision. Then the experimenter should bring a flashlight from the side to within 5 to 10 cm of the subject's face. Shine the light from the penlight flashlight into the left eye. As soon as the pupil responds remove the light. The response of both eyes should be observed. Record the response on your data sheet.

After allowing the subject's eyes to return to the pre-dilated state, the reflex should be repeated using the right eye. Note any differences as compared to the procedure followed in.

Activity 9: Pupillary Accommodation Reflex

a. Ask the subject to look into the distance

b. Then ask the subject to look at a pen or eraser end of a pencil brought to their nose.

c. If no pupillary changes are observed have the subject first focus on their thumb with their arm fully extended, then have them follow their thumb as it is brought to the tip of their nose. Record your results on your data sheet.

Activity 10: Convergence Reflex

a. Repeat the above experiment while observing the position of the eyeballs while moving the pen or eraser end of a pencil from a distant point (arm's length) to the tip of the subject's nose. What happened to the subject's eyeballs during the test? Record your results on your data sheet.

Activity 11: Ciliospinal Reflex

a. While observing the subject's eyes, pinch the skin on the left side of the back of the subject's neck. (If the ciliospinal reflex is weak or is not demonstrated, repeat the test by touching a small piece of ice to the same area of the subject's neck). Record your results on your data sheet.

Name:_____

due date:_____

Human Reflex Physiology
Data Sheet

1. Make a single diagram to show the interrelationships between the: **Central Nervous System, Peripheral Nervous System, Sensory Neurons, Motor Neurons, Somatic and Autonomic Motor Branches.**

2. What is a **reflex** and what are its basic components?

3. Distinguish between **somatic** and **autonomic** reflexes.

4. Distinguish between **spinal** and **cranial** reflexes.

Data Tables: Spinal Reflex Exercises

(Rate the response)

Test	Left Side	Right Side	Remarks
Patellar Reflex			
Achilles' Reflex			
Plantar Reflex			
Triceps Reflex			
Biceps Reflex			

Activity 1: The Patellar Ligament Reflex

a. What muscles are used to produce the movement of the lower leg?

b. Is the response greater or lesser than above? Explain your observations.

c. Observe the reflex in both limbs. Describe the effect of exercise below. Explain your observations.

Activity 2: The Calcaneal Reflex

What movement was observed?

Activity 3 The Plantar (Babinski) Reflex

What was the response? Was it normal?

Activity 4: <u>The Biceps Reflex</u>

Describe the movement of the arm.

Activity 5: <u>The Triceps Reflex</u>

Describe the movement of the arm.

Activity 6: <u>The Crossed Extension Reflex</u>

What happens to the other hand. Explain.

<u>Activities: Spinal Nerve Testing:</u> Use textbook or other sources to complete the chart

	Reflex	Receptor	Effector	Level of spinal Cord
1	**patellar reflex**			
2	**Achilles reflex**			
3	**biceps reflex**			
4	**triceps reflex**			
5	**crossed extensors**			
6	**plantar reflex**			

Activity 7: <u>Reaction Time of Acquired (Learned) Reflexes</u>

Trial	Catch Only	Catch after Signal	Catch with word association
1			
2			
3			
4			
5			
Mean (sec)			

How did your actual results compare with the expected, normal, reflexes? Note any discrepancies or variations in your responses and offer explanations.

Activity 8: <u>Pupillary Light Reflex</u>

Diameter Right pupil_____ Diameter Left pupil_____

What was the pupillary response to the flashlight in each eye?

Which division of the autonomic nervous system was active during the pupillary reflex?

Which cranial nerves were involved in the afferent and efferent limb of this reflex?

You should have observed a contralateral response. Explain how this happened.

Activity 9: Pupillary Accommodation Reflex

What was observed?

Which cranial nerves were involved in the afferent and efferent limb of this reflex?

Activity 10: Convergence Reflex

What happened to the subject's eyeballs during the test?

What muscles were involved?

What cranial nerve was involved?

Activity 11: Ciliospinal Reflex

What was the reaction of the left pupil?

What was the reaction of the right pupil?

How did the ciliospinal reflex differ from the pupillary reflex?

Activities: Cranial Nerve Reflexes: Use textbook or other sources to complete the chart

	Reflex	Cranial Nerve	Receptor	Effector	Results
1	**Pupillary Reflex**				
2	**Ciliospinal Reflex**				
3	**Accommodation Reflex**				
4	**Convergence Reflex**				

Fill in the chart below using the textbook or other sources.

Number and Name of Cranial Nerves		Loss of Specific Sensory Function	Loss of Specific Motor Function
I	Olfactory		
II	Optic		
III	Oculomotor		
IV	Trochlear		
V	Trigeminal		
VI	Abducens		
VII	Facial		
VIII	Vestibulocochlear		
IX	Glossopharyngeal		
X	Vagus		
XI	Accessory		
XII	Hypoglossal		

Sense Organs
Biol 2401 Lab

Lab Materials:

Slides:

Mammal vater-pacini corpuscle wm
cochlea guinea pig ls
mammal foliate papillae with taste buds, sec
eye monkey, ls

Models:

skin models
eye models
ear models
Cochlear duct cross section
sagittal section of head

Preserved Materials:

sheep eyes
temporal bone
ear ossicles

Other: penlights

Lab Activities:

1. Locate and identify examples of simple receptors of general sensation. These receptors are in the form of free nerve endings or sensory neurons encapsulated by connective tissue. Find the following receptors in the **skin models** using the illustrations provided:

Free nerve endings:	epidermis	pain, heat, cold
Encapsulated receptors:		
Merkel discs	papillary layer	light touch and pressure
Meisner's corpuscles	papillary layer	light touch, changes in texture
Pacinian corpuscles	reticular or subcutaneous	deep pressure, fast vibrations

2. Observe the slide of Pacinian corpuscles (vater-pacini corpuscles) and be able to recognize them and know their general function

3. Identify the location of the **olfactory epithelium** and its relationship to the olfactory bubs and the **cribiform plate** on the sagittal head model.

nasal cavity, olfactory epithelium, receptor cells, cribriform plate, olfactory bulb, olfactory tract

4. Recognize the histological structure of the papillae with **taste buds** on the taste bud slide:.

tongue, papillae, taste buds, taste (gustatory) cells, taste pore

5. Observe the slide of the monkey eye and be able to recognize:

sclera, cornea, choroid layer, ciliary body, suspensory ligaments, lens, iris, pupil, retina, macula lutea, fovea centralis, optic disc, anterior segment (including anterior and posterior chambers), aqueous humor, posterior segment, vitreous humor, optic nerve

6. Identify the following anatomical features of the eye on appropriate models:

extrinsic eye muscles (superior & inferior rectus muscles, superior and inferior oblique muscles; medial and lateral rectus muscles), eyelids, conjunctiva, eyelashes, lacrimal gland, nasolacrimal duct (tear duct)
sclera, cornea, choroid layer, ciliary body, suspensory ligaments, lens, iris, pupil, retina, optic disc, fovea centralis, aqueous humor, vitreous humor

7. Identify parts of the retina on microscope slides and on models

nervous layer: ganglion cell layer, bipolar cell layer, rods & cones pigmented layer

8. Section the preserved sheep eye as shown in the illustration provided. Use a scalpel or sharp point of scissors to first penetrate the sclera, then use scissors to cut the rest of the way around the eye (you might need a penlite to see some of the structures). Identify the following anatomical features of the eye on the preserved sheep eye:

sclera, cornea, choroid layer, ciliary body, lens, iris, pupil, retina, optic disc, vitreous humor

9. Identify the major anatomical features on the ear models provided.

outer (external) ear: pinna, external auditory canal, ceruminous (=wax) glands, tympanic membrane

middle ear: ossicles [malleus (hammer), incus (anvil), stapes (stirrup)], auditory (eustachian) tube, oval window

inner ear: bony labyrinth: vestibule, cochlea, semicircular canals, perilymph

membranous labyrinth: utricle, saccule, cochlear duct, semicircular ducts, endolymph, basilar membrane, vestibular membrane, Organ of Corti (in cochlear duct): hair cells, tectorial membrane

10. Recognize the histological structure of the cochlear duct including the Organ of Corti on cochlear duct section model and slide:

Organ of Corti (in cochlear duct): hair cells, tectorial membrane

11. Identify the mechanoreceptors for static and dynamic equilibrium on slides & illustrations available:

Maculae (in utricle and saccule): hair cells, otolithic membrane, otoliths
Ampullae (in membranous semicircular canals): crista ampullaris, cupula, hair cells

<u>Cleanup:</u> Place dissected sheep/cow eye in "dissecting scraps" bucket. Rinse pan and hang on drying racks at sinks. Rinse and dry dissecting tools and return to drawers. Return scaplels to instructor. If razor blades were used dispose of them in the "glass disposal" boxes

Sensory Physiology
Touch, Vision Hearing & Equilibrium
Biol 2401 Lab
(Wayne, Marieb, Ziser)

A. Touch (General Sensations)

Activity 1: <u>Plotting the Relative Density and Location of Touch and Temperature Receptors</u>

1. place 2 mall probes in a beaker of ice water and two in a beaker of 45º C water.

2. Use the stamp and ink pad to mark a grid ventral surface of the subjects forearm.

3. With the subject's eyes closed, remove one of the metal probes from the ice bath, quickly dry it with a paper towel and gently touch the probe to10 random squares in the grid. Have the subject note each time a cold sensation (not just a touch) was detected. Repeat the process with the second cold probe. Record on your data sheet the number of times the subject sensed the cold temperature after 20 tests.

4. Repeat the process with the heated probes and record the results on you data sheet.

5. Gently touch a thin bristle (Von Frey's hair) to 20 different areas of the square, and count the number of times the subject can feel the bristle. Record your results on the data sheet.

Activity 2: <u>Determining 2-point Threshold Using a Esthesiometer</u>

The density of touch receptors is measured by the two-point threshold test. The two points of a pair of adjustable calipers (esthesiometer) are simultaneously placed on a subject's skin with equal pressure, and the subject is asked if two separate contacts are felt. If so, the points of the divider are brought closer together, and the test is repeated until only one point is felt. The minimum distance at which two points of contact can be discriminated is the two-point threshold.

1. Begin with the calipers wide apart and the subject's eyes closed, determine the two-point threshold on the back of the hand. (Randomly alternate the two-point touch with one-point contacts, so that the subject will not try to second guess the examiner.)

2. Repeat this procedure with the face, back of hand, palm of hand, fingertips, lips, back of neck and anterior forearm.

3. Record the results in the table on the data sheets.

Activity 3: <u>Testing Tactile Localization</u>:

Touch localization is the ability to determine where exactly the skin has been touched.

1. With your eyes closed, have your lab partner touch the palm of your hand with a felt tipped pen.

2. Now, try to place the eraser of the pencil or the tip of the pen on the spot touched by your lab partner.

3. Have your lab partner measure the difference in distance between the two spots. Repeat the process two more times then average the distance of the 3 trials. Record the information on your data sheet.

4. Repeat the experiment on the back of the hand, a fingertip, the ventral surface of the forearm, and the back of the neck and ecord the results in the data tables.

Activity 4: <u>Testing Adaptation of Sensory Receptors</u>:

Adaptation is the ability of the sensory system to filter out old information and basically ignore it in an attempt to be prepared for new incoming sensory stimuli.

1. Close your eyes and have your lab partner place a coin on the ventral surface of your forearm. Note how long (in seconds) it takes for accommodation to occur. (When do you no longer feel the coin?) and record the time in the table on the data sheet.

2. After the sensation disappears, add three more coins of the same size on the first coin. If the sensation returns, note how long the sensation lasts and record the results in the data below.

Activity 5: <u>Demonstrating the Phenomenon of Referred Pain</u>:

Referred pain is the phenomenon of perceiving pain in one area of the body when another area is actually receiving the painful stimulus. This can result when there is convergence of afferent (sensory) fibers onto the dorsal horn relay cells in the spinal chord. We say that the pain is referred to the other area.

1. Have the subject place their elbow in a pan or shallow bucket of ice. Their arm should be relaxed with the forearm and hand out of the water. The subject's elbow should remain in the water for approximately two minutes.

2. Report any sensations that are felt in any other area but the elbow.

4. Record your results in the data table.

B. Vision

Activity 6: <u>Demonstrating the Blind Spot</u>:

The blind spot is the area on the retina without receptors and therefore any image that falls on this region will *NOT* be seen. It is in this region that the optic nerves come together and exit the eye on their way to the brain. To demonstrate this effect, look at the image on the card provided:

1. Close your left eye.

2. Place the card about 50 cm from your eye.

3. With your right eye, look at the +. Slowly move the card closer while staring at the +.

4. At a certain distance, the dot will disappear from sight. This is when the dot falls on the blind spot of your retina. Reverse the process. Record the distance in centimeters between your eye and the paper at which the + and dot disappears.

5. Repeat the process with your left eye and record your results

Activity 7: Testing Visual Acuity:

1. Stand 20 feet from the Snellen chart. If you wear glasses perform the test twice to get a corrected and an uncorrected value for each eye. *If you wear contact lenses, you do not need to record "uncorrected" values.*

2. Cover your right eye, and read aloud the letters of each row, beginning at the top.

3. The smallest row that can be read accurately indicates the subject's visual acuity in that eye.

4. Repeat the procedure with your left eye and record your results on the data sheet.

Activity 8: Testing for Astigmatism:

1. Stand 10 feet from the astigmatism chart. *(There are also several online versions of this test)*

2. Cover your right eye and stare directly at the middle of the chart while noting if any of the lines appear darker or greyer than others. Record your results on your data sheet.

3. Repeat the procedure with your left eye and record.

Activity 9: Testing For Color Blindness:

*The booklets are on the side counter (Do **NOT** look at the pages or pamphlet that interprets your results until you are finished with the test)*

1. Look at each of the 14 color plates and record the numbers you actually see *immediately* and record the number on your data sheet. If you cannot *immediately* see a number place an "x" in the box.

3. **After** each person in your group has taken the test, look at the key and record the number that "normal" subjects should see. Then use the information provided to interpret your results

Activity 10: Nearpoint Accommodation Test

The purpose of this test is to check for a change in the shape of the lens as a normal eye is focused for near vision. Accomodation decreases with age due to the loss of elasticity of the lens of the eye.

1. Obtain a meter stick and a small index card. Clearly write a word on the index card.

2. Place a meter stick against your laboratory partner's chin extending outward in a horizontal plane.

3. Have your partner close the left eye.

4. Begin with the index card at the very end of the meter stick. Slowly slide the index card closer along the meter stick until the subject can no longer see the word in sharp focus. This point is called **near point of accommodation**. Record the distance in cm on your data sheet.

5. Repeat the procedure with the right eye closed and record your results.

Activity 11: <u>Depth Perception</u>

1. Have the subject sit comfortably in a chair facing the lighted box about 8 feet away from the opening; adjust the chair to a height at which the subject can only see the two vertical rods inside, but not the top or bottom inside of the box.

2. Initially adjust the vertical rods so that they are furthest apart

3. Give the adjustment strings to the subject and, with both eyes open, ask them to try to align the two rods so that they are directly across from each other.

4. Repeat the process two more times and average the results on your data sheet. When you average, ignore any negative signs.

5. Repeat the process with the right eye closed, then with the left eye closed and record the results on your data sheet

5. Have the subject put on a pair of sunglasses and with both eyes open, repeat the test again and record the results on the data sheet.

C. Hearing

Activity 12: <u>Frequency Range of Hearing</u>:

*(For these tests use a rubber mallet or the heal of your hand to vibrate the tuning forks; DO **NOT** HIT THEM ON THE COUNTERS)*

1. Select three tuning forks; 128 for low frequency, 512 for medium frequency, and 4096 for high frequency.

2. Test each of the frequencies by tapping each tuning fork with the mallet and holding it about an inch from the subjects ear.

3. Record which frequency was heard most clearly and comfortably and which was heard least clearly.

Activity 13: <u>Rinne Test</u>

The Rinne test compares air conduction to bone conduction.

1. Gently hit the 512 Hz tuning fork with the rubber malet.

2. Place the butt of the tuning fork firmly on the mastoid eminence behind the left ear.

3. Have the subject indicate when they can no longer hear the vibration.

4. When that happens, immediately place the 'U' of the tuning fork approximately 1 inch from the ear without touching it.

5. Again, have the subject tell you when they can no longer hear it.

6. Repeat the test only this time begin with the ear and when the sound is no longer audible move the butt of the tuning fork to the mastoid eminence.

7. Repeat both sequence for the opposite ear.

8. Interpreting your results:

"+" = subject hears tuning fork again when placed next to ear canal after bone conduction is lost. Air Conduction is better than Bone Conduction. Air conduction usually persists twice as long as bone conduction.

"**-**" = subject hears the tone again by bone conduction after hearing by air conduction is lost. Bone conduction better than air conduction Suggests Conductive Hearing Loss.

Record the results of your tests (+/-) for each ear on your data sheet

Activity 14: <u>Weber Test</u>

A test for lateralization of sound.

1. Gently tap the 512 Hz tuning fork with the rubber mallet.

2. Place the butt of the tuning fork on the top of the subject's head in the midline and ask the subject where they hear the sound.

3. Interpretation: Normally the sound is heard in the center of the head or equally in both ears. If there is conductive hearing loss present, the vibration will be heard louder on the side with the conductive hearing loss.

D. Equilibrium

For these equilibrium tests you can work in groups of 3 or 4.

Activity 15: <u>Balance Test</u>

1. Have the subject walk a straight line, placing one foot directly in front of the other. Is the subject able to walk without undue wobbling from side to side? Did the subject experience any dizziness? Record the results on the data sheet.

Activity 16: <u>Romberg Test</u>

With the eyes open, three sensory systems provide input to the cerebellum to maintain truncal stability. These are vision, proprioception, and vestibular sense. If there is a mild lesion in the vestibular or proprioception systems, the patient can usually compensate with the eyes open. When the patient closes

their eyes, however, visual input is removed and instability can be brought out. If there is a more severe proprioceptive (dorsal white columns) or vestibular lesion, or if there is a midline cerebellar lesion causing truncal instability, the patient will be unable to maintain this position even with their eyes open. Instability can also be seen with lesions in other parts of the nervous system such as the upper or lower motor neurons or the basal ganglia, so these should be tested for separately in other parts of the exam.

1. Have the subject to stand still with their feet together (touching each other) and with their back to the chalkboard without touching it.

2. Make a mark on the board above the subjects head indicating the center of their head

3. Observe the subject for 1 minute and note any truncal instability (movements). Use horizontal chalk lines to measure any movement from side to side.

4. Repeat with the subject's eyes closed. Stay near the subject in case the subject begins to sway or fall. Note and measure any truncal instability.

5. Repeat the entire process this time with the subject with their shoulder toward the board to note any forward or backward motion.

6. Record your results on the data sheet.

Name:_____

Lab Partner:_____

Group:_____

Due Date:_____

Sensory Physiology

Biol 2401 Data Sheet

Touch (General Sensations)

Activity 1: <u>Plotting the Relative Density and Location of Touch and Temperature Receptors</u>:

Receptor Type	# Spots Tested	# Spots testing positive	% Positive
Touch			
Heat			
Cold			

How would you *expect* the percent positive of each receptor relate to the actual number of receptors of each present in this experiment?

Which of the three types of receptors appear to be most abundant? _____

On the basis of your observations and class results, what conclusions can you draw about the distribution and numbers of receptors on the skin for touch, heat and cold? How does the density of touch receptors compare with that of heat and cold receptors?

Activity 2: <u>Determining Two Point Threshold</u>

Record your results on the table below:

Body Area Tested	Two Point Threshold (mm)
Face	
Back of Hand	
Palm of Hand	
Fingertips	
Lips	
Back of Neck	
Ventral Forearm	

Which area was ***most sensitive*** to the test? _____

Which area was ***least sensitive*** to the test? _____

Are these the results you expected? Explain:

Activity 3: <u>Testing Tactile Localization</u>

Body Area Tested	Error (mm) Test One	Error (mm) Test Two	Error (mm) Test Three	Average Error (mm)
palm of hand				
fingertip				
ventral forearm				
back of hand				
back of neck				

Which area had the smallest error: _____ Which area had the largest error: _____

Explain your results:

Activity 4: <u>Testing Adaptation of Touch Receptors</u>:

Describe what happened:

a. duration for 1 coin:

b. duration for coin after moving it:

c. duration after adding 3 more coins:

Are the same receptors being stimulated with the 4 coins as for 1 coin?, Explain

Explain your results of the 'hair bending' test:

Activity 5: <u>Demonstrating the Phenomenon of Referred Pain</u>

Time of observation	Quality of Sensation	Location of Sensation
on immersion		
after 1 minute		
after 2 minutes		

What exactly is **referred pain**?

How does the localization of this referred pain correspond to the areas served by the ulnar nerve?

Vision

Activity 6: <u>Demonstrating the Blind Spot</u>:

Distance (cm) at which dot disappears: Left Eye:_____ Right Eye: _____

What is occurring when the 'dot' disappears?

Is the distance the same or different for each eye? Explain:

Activity 7: <u>Testing Visual Acuity</u>

Uncorrected: Left Eye:_____Right Eye: _____ Both Eyes:_____

Corrected: Left Eye:_____Right Eye: _____ Both Eyes: _____

What exactly do the two numbers in an acuity test mean; i.e., **interpret** the values for your uncorrected vision:

Is your corrected or uncorrected vision for both eyes any better or worse than for individual eyes? Explain.

Activity 8: <u>Testing for Astigmatism</u>:

Is astigmatism present (Yes/No): Right Eye:_____ Left Eye: _____

Activity 9: <u>Testing For Color Blindness</u>:

Ishihara plate number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**		**12**	**13**	**14**
number seen															
"normal" number seen															

Use the booklet or information sheet to **interpret** your results:

Activity 10: <u>Determining Near Point Accomodation</u>:

Near point (cm): Left Eye:_____ Right Eye: _____

What specifically is occurring at closer distances?

Activity 11: <u>Depth Perception Testing</u>

Experimental Treatment	+ or - Difference in millimeters			
	Test #1	Test #2	Test #3	Average
both eyes				
right eye				
left eye				
with sunglasses				

Explain any differences between your average results:

Hearing

<u>Activity 12: Frequency Range of Hearing</u>

Which of the three frequencies (L,M,H) was heard most clearly: _____

least clearly: _____

Explain why:

<u>Activity 13: Rinne Test</u>

air conduction(bone 1st then air): Left Ear: _____ Right Ear: _____

bone conduction (air 1st then bone): Left Ear: _____ Right Ear: _____

Interpret your results:

Activity 14: Weber Test

Explain the results of your test

Equilibrium

Activity 15: Balance Test

Describe and explain your results

Activity 16: Romberg Test

Describe the results and explain their cause:

back to blackboard – eyes open

back to blackboard – eyes closed

side to blackboard – eyes open

side to blackboard – eyes closed