Comparative Vertebrate Physiology Lab Manual

Comparative Vertebrate Physiology Lab Manual

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Contents

This is where you can write your introduction.

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I.

Hematology Lab

Introduction

Blood work is essential to let doctors know if there are any diseases or abnormal conditions in their patients. It helps check organ function, like the liver, thyroid, and more. There are multiple tests that are used to test specific organs, blood levels, and hormone levels in the body. Chemistry panels are used to determine a patient's overall health. Many medical practices also use CBC tests, which accounts for the amount of cells in somebody's blood. We will be comparing dog and human blood levels today. We will also be determining everyone's blood type. (WARNING: if you are uncomfortable with getting your blood drawn, you do not have to, but the more results, the better. It would also be wise to bring a snack for those of you that are participating in this lab.)

Equipment & Materials

- Syringes
- EDTA tubes
- Blood typing kit
- Cortisol machine and counterparts
- Wright's staining kit
- CBC machine

Pre-Lab Questions

1. What are the different blood types? What makes them different?

2. What does a hematocrit test? What does CBC stand for and what does it test?

3. What is cortisol and how is a normal number maintained? What is the normal range of cortisol?

4. Why is erythropoietin so important in the body?

5. What are the steps for a Wright's stain? What are the different blood cells (I.e. lymphocytes, neutrophils, basophils, platelets, erythrocytes)?

Activity 1

Get your blood drawn. We will then be using Wright's stain to determine what kind of cells you have in your body.

Steps:

1. Prepare blood on a microscope slide. Allow to air dry.
2. Place on a stain rack.
3. Cover slide in stain with undiluted staining solution.
4. Let stand for 2-3 minutes.
5. Add an equal amount of buffered water.
6. Rinse smear with water until the edges of the slide are a pinkish color.
7. Blot dry carefully.

Name	Cell Types

Activity 2:

When your blood was drawn for the blood typing part, describe your blood. What color was it? Was it super liquefied? Regardless of your answer, describe what this means in terms of your health.

Activity 3:

Compare the CBC values of Memphis, Pepper, and Gidget.

Are there any elevated values? If so, define them and what this means in regards to their health.

If there are no elevations, choose at least 5 values and explain what they mean and what they test for.

Name	Cell and Value	Cell and Value	Cell and Value	Cell and Value	Cell and Value
Pepper					
Gidget					
Memphis					

Activity 4:

Compare cortisol values in our three animals. Describe what their value means.

Name	Cortisol Value	Description
Pepper		
Gidget		
Memphis		

Activity 5:

Obtain a hematocrit from each member in your group. Discuss what your value means.

(Notice the length of the column of the packed cells and divide it by the length of the whole column of blood. Take this hematocrit and multiply it by 100%.)

Name	Hematocrit %

Activity 6:

Place blood samples in a well plate. An antigen plasma will be used for each blood type. Gently stir the concoction for 30 seconds. (Remember to use a different stirring stick for each sample.)If the blood and plasma show agglutination, then that antigen is not compatible with your body.

Name	A antigen	B antigen	Rh factor

Post-Lab Questions

1. How does blood type testing work?

2. Was the hematocrit higher in males or females? Explain your answer.

3. CBC gives you information about the cell types in blood, what disorders can this test detect?

4. Based on your blood type, what blood can you receive?

5. What does a Wright's stain test for?

2.

Senses and Hormonal Effects on Physiology Lab

Introduction

It is no secret that all animals use their senses to navigate around the world in a way that benefits them. However, variation occurs either because of age, genetics, or the need of a sense in that area. In this lab this variation will be tested through a high frequency hearing test, as well as touch sensitivity. In the first case, hearing ability can decrease because of natural decrease in hearing ability with age, or because of damage due to loud noises. We'll test touch sensitivity on different body parts.

For the second part of this lab, hormones and pheromones will be tested. Ants communicate greatly through pheromones in their daily lives, whether it is to find resources, inform of danger or communicating an action necessary. Mammals also use pheromones to communicate with others. In addition, internal communication within the body occurs using hormones. We will be using rats to test this out. Because rats are highly sociable animals, hormone and pheromone production will occur based on the interaction received.

Pre-Lab Questions

1. What is the hearing range of a human and what frequencies are lost with age?

2. Name one part of the body that is relatively precise at detecting touch, and one that is relatively poor at detecting touch. Explain why the difference occurs.

3. Name one other group of animals beside ants that uses pheromones to communicate. What kind of information can they learn through pheromones?

4. Explain the functions of testosterone, estrogen, oxytocin, and cortisol as it relates to social behaviors in mammals.

5. Explain modulatory communication in ants, or any other social insects.

Equipment

- Sonic Tone Generator
- Phone
- Headphones
- Calipers
- Syrup
- Lavender Oil
- Pipets
- Water dish
- Water
- 6 rats of different ages and sexes
- Cage for rats

Activity 1: Hearing range test

Hypothesis 1: Ability of hearing higher frequencies will decrease with age.

Download an app called "Sonic Tone Generator" on your phone. Connect headphones to your phone, record the highest frequency that is audible to you. Some phones have a limited range of playable frequencies, but if your model allows it, headphones might not be necessary. When playing the sound, record the last tone that you hear instead of the last "noise". This is because some sound artifacts may occur when playing the frequency, such as when first pressing the button.

Name	Age	Highest frequency heard in Hz	Average time each day exposed to loud noise (headphone usage, machinery, etc.)

Activity 2: Touch sensitivity

Hypothesis: Fingertips will be more accurate than other parts of the body tested.

Grab a pair of calipers and take turns conducting the experiment. Decide who the test subject will be and have them sit with their eyes closed, while the tester touches the calipers to their skin. Record the length at which the subject stops feeling like there is two points, and instead starts feeling as if there is only one. Periodically touch only one point of the caliper on the skin so it is harder to guess how many points are present. Try it out on fingertips, back of the hand and shoulder area.

Name	Fingertip in mm	Back of hand in mm	Shoulder in mm

Activity 3: Ant and pheromones

Hypothesis 1: Putting an obstacle on an ant trail will disturb the existing and new pheromone trails, especially if it's a strong smell.

Hypothesis 2: Ants will change their behavior through modulatory communication in response to stimuli.

Grab some syrup, water in a container and the lavender oil bottle. Go outside and locate an accessible trail of ants. Block the existing path of ants by dripping the water across the path. Observe the behavior as they find a new path. Once the water dries, observe if the ants resume their previous path. Repeat the same with lavender oil.

On a different part of the ant trail, put three syrup drops on the ground close to the trail so the ants can find it. Make sure the drops are similar in size and are apart enough to draw a small circle around them. Leave the first drop for control, drip water around the second syrup drop, and lavender around the third syrup drop. Observe the behavior again. Lastly, physically disturb one of the ants and observe how it communicates about the event with others.

Event	Ant behavior observed (be as precise as possible)
Water blocking an existing path	
Water drying after blocking an existing path	
Lavender blocking an existing path	
Lavender drying after blocking an existing path	
Syrup with nothing around it	
Syrup surrounded by water	
Syrup surrounded by lavender oil	
Physical disturbance	

Activity 4: Rat Communication

Hypothesis: A more confident rat will respond to newly introduced rats of different age and sex with more enthusiasm than a less confident rat.

Six rats will be used in this lab and the behavior of a known confident and a known less confident rat towards new rats will be observed. First, the less confident rat will be put into the animal observation room. A cage with a familiar, more confident rat will be set in the room, and the behavior of the less confident rat towards it will be observed from the outside for 5 minutes. Repeat with a cage containing a young female, middle-aged female, older female and an older male. Next, cage the less confident rat and observe the behavior of the confident rat towards new rats.

Rat type	Confident rat	Less confident
Less confident male rat	Familiar with each other	xxx
Confident male rat	xxx	Familiar with each other
Young female		
Middle-aged female		
Older female		
Male old		

Post-Lab Questions

1. Did the maximum detectable frequency decrease with age? If any outliers occurred, explain how the average amount of noise per day can cause this difference.

2. Which part was best at detecting touch? How is this related to daily function?

3. Did ants return to the past trail after it was previously, but no longer blocked by water? What about lavender oil? Explain how this can disrupt the ants besides creating a physical barrier.

4. Did ants seem to get "infected" with following or doing a certain behavior? How was this information passed between the ants and which body part was used?

5. Relate to how the rats interacted back to hormones. How might this hormones provoke or suppress certain behaviors seen?

3.

Aerobic vs Anerobic Exercise Lab

Introduction

Aerobic exercises are exercises that can be done continually for extended periods. Anerobic exercises are ones that involve short bursts of intense activity. Generally aerobic exercise is better for building endurance while anerobic exercise is better for building muscle, and strength. Aerobic means “with oxygen” and uses the air we breath to produce energy. With anerobic exercise you require energy more quickly than it can be yielded by aerobic means can provide, so limited stores of energy are used, for example from within your muscles. This lab will examine the different effects of each type of exercise on our heart rates and respirations.

Prelab Questions

1. What are 3 examples of aerobic exercises?

2. What are 3 examples of anerobic exercises?

3. What type of exercise do you predict will raise respirations and heart rate higher? Why?

4. Roughly how long can and anerobic exercise be maintained? Aerobic?

Equipment list

- 2 Hydro bikes (or bicycles on land)
- Pulse oximeters
- E-bike with speedometer
- Lake with buoys and open areas for jogging, and steep surfaces such as a boat ramp

Methods

Collect a resting heart rate and respiration rate: place a pulse oximeter on your finger to get your heart rate and have a partner count your respirations.

Pulse:

Respirations:

Activity 1: Hydro biking

Bike out to the buoy and back with a controlled sustainable pace then immediately recheck and record your heart rate and respirations

Hypothesis: Heart rate and respiration rate will increase for a short time before returning to normal.

Pulse:

Respirations:

Activity 2: Sprinting

Sprint as quickly as possible to a destination and back along a flat area then record your heart rate and respirations

Hypothesis: Heart rate and respirations will increase more significantly and for a longer period of time before returning to normal

Pulse:

Respirations:

Activity 3: Run/jog uphill

Run quickly to a destination uphill then record your heart rate and respirations

Pulse:

Respirations:

Hypothesis: Heart rate and respirations will increase even more significantly and for a longer period of time before returning to normal, compared to the flat sprinting

Activity 4: Dog Sprint

Record the resting heart rate of the dog then have it sprint a short distance while recording its speed with an e-bike. Then count and record its respirations and heart rate.

Pulse:

Respirations:

Hypothesis: Compared to humans, dogs will be in better shape, illustrated with smaller increases in heart rate and breathing rate over the same distance at roughly the same speed. May vary with lifestyles.

Activity 5: Human vs. dog

Have a couple of the fastest runners sprint the same distance while recording their speed. Record the speed of the runners and the speeds of the dogs. Attempt to record video of the runners as they pass, particularly filming striding legs.

Dog speed:

Runner speed:

Hypothesis: Human runners will have much greater stride length (and much longer legs); dogs will have much faster strides/minute.

Post Lab Questions

1. Did the hydro bike or sprinting rase the heart rate and breathing more? Explain.

2. Did heart rate and respirations always change together? Why or why not.

3. Was it harder to run uphill or on a flat surface? Why?

4. Did the dogs' respirations and heart rates raise similarly to humans? Why or why not?

5. Could the dogs outrun the humans? Why or why not?

6. Sketch the class graph for heart rate after aerobic and anaerobic exercise.

4.

Homeostasis Lab

Introduction

Maintaining aspects of your internal environment and/or plasma within a certain range is known as homeostasis. These aspects of your internal environment include pH, salinity, oxygen levels, carbon dioxide levels, temperature, etcetera. Many aspects of plasma are necessary to allow cells to maintain their integrity; cells also require transportation of molecules across the cell membrane. In this lab, we will demonstrate the importance of the surface area to volume ratio, some aspects of diffusion and osmosis, and the speed with which your body breaks down asparagus and transports asparagusic acid into your urine.

Pre-lab Questions

1. What is expected to happen to an animal cell when there is a higher saline concentration inside the cell rather than outside the cell?

2. Which is likely to cook faster: brownies with a high surface-area-to-volume ratio or brownies with a low surface-area-to-volume ratio? Why?

3. During osmosis, is the water transported through the semi-permeable membrane or is the sugar?

4. What type of blood vessel in your body has the highest surface-area-to-volume ratio? Why is the high surface-area-to-volume ratio of this blood vessel beneficial to you?

5. True/False: the salinity inside a freshwater fish is the same as the salinity of the water it is in because the two have reached an equilibrium.

Equipment & Materials

- Brownie mix for each student group, plus eggs and oil
- Pans of different sizes and shapes
- Solar ovens (can be homemade, many directions available online)
- Foil for solar ovens
- Drinking water, preferably in identical bottles, enough for each student
- Asparagus, at least 3 stems per student
- Dialysis tubing
- String to tie off tubing

- Molasses (can be diluted with water in a 50/50 mixture)
- 2-250 ml beakers for each student group
- Starch solution
- I-KI stain

Methods

Activity 1

Drink a bottle of the water provided during this first portion of the lab exercise to help ensure equal hydration of all lab participants, for best results with asparagusic acid.

You have been given a certain amount of brownie mix, add the appropriate amount of water and one egg, mix, and place into a pan. A wide variety of pans should be used among the groups, to ensure a variety of surface area to volume ratios. Cook outside in a solar oven until a fork poked gently in the center comes out with little or no raw dough attached. Record the baking time. Cool, and measure the surface area and volume and record below. Eat!!

Activity 2

Once food is consumed, your body transports the nutrients across membranes and into your blood plasma. In this experiment, we will be boiling asparagus for about 5-7 minutes until tender. Every willing participate will eat at least 3 pieces, noting the time eaten. Start a timer from the moment of consumption to the time of urination during which the smell of asparagus is detected. Asparagus contains asparagusic acid which is broken down into

mercaptan, which can be quickly transported from the blood into urine, giving the distinct smell.

Activity 3

We will make artificial cells out of dialysis tubing (a semipermeable membrane) and fill them with artificial cytoplasm. Use the supplied dialysis tubing, which must be soaked in water and then rubbed between the fingers to open. Tie off one end with string, then cut the other end about 8 inches further. Fill the open tube with the supplied "cytoplasm" and tie it off. Take a picture of the "cell" when finished, and then drop it into the "plasma." Repeat, making another cell filled with starch mixture. Drop the second "cell" into the plasma mixture as well.

After thirty minutes, take another picture of the first "cell" you made, and describe the change under RESULTS.

Was any similar change noted in the second cell? Now add about ten milliliters of IKI to the "plasma" outside the second cell, observe, and report the change after thirty minutes.

What nutrient does Iodine-Potassium Iodide detect?

Activity 4

Do the supercool supercooling experiment: Try rapping a supercooled water bottle on a tabletop and observe the ice crystals that form immediately. Why didn't they form before the rapping?

Results

Activity 1: Brownies

Cooked brownie SA/Vol ratio in centimeters:
Time to cook:
Fastest brownie to cook SA/Vol ratio in centimeters:
Time for fastest brownie to cook in minutes:

Activity 2: Asparagus

Time asparagus was eaten:
Time odor was detected:
Time elapsed between asparagus eaten and odor detected:
Fastest time:

Activity 3: Dialysis Tubing "Cells"

Notable difference between first picture and picture after thirty minutes of diffusion or osmosis:
Change that occurred to second cell after IKI was added:

Post-Lab Questions

1. Why is dialysis tubing a relatively accurate representation of an animal cell membrane? What is missing? Why did the starch not

flow out of the tubing? What nutrient is stained blue by potassium iodide?

2. Which has a higher surface area to volume ratio: a hamster or an elephant? Therefore, which loses heat more easily? Which has much greater food needs FOR ITS SIZE?

3. The surface-area-to-volume ratio gets smaller as a cell gets…

4. Why do freshwater fish never have to drink yet they frequently urinate?

5. Through what process did the glucose from the brownies you ate go from your stomach lumen to your blood plasma? Draw the most relevant part of the process.

6. List every process that occurred between you eating asparagus and finally smelling it in your urine. Why don't some people smell it at all?

7. Sketch the class graph of surface area to volume ratio vs cook time for brownies. What is an rsquared value? What does it mean?

8. Which brain structure often is most closely associated with maintaining homeostasis in vertebrates?

9. What does the supercooling experiment reveal about fish that swim in very cold water? How is it possible for some fish to swim in water that is below freezing?

5.

Heat, Human Proprioception, and Visual Perception Lab

Introduction

Human proprioception is the ability to sense body position relative to what is around you. Proprioception allows us to rely on our muscles to send signals to our brain about where they are in space and what they are capable of in that position.

There are five main taste receptor types: sweet, salty, sour, bitter, and umami. Each receptor is more abundant on different areas of your tongue and detect different things. Four of them are quite obvious; sweet detects sweet, sour detects sour, and so on. The umami receptor detects proteins.

There are many different types of perception. We perceive smell, taste, space, direction just to name a few. The way we perceive things is based on signals that travel through the nervous system. These signals can result in physical reaction or the release of chemicals.

Metabolic rate is the amount of energy that an organism expends within a certain amount of time. Metabolic rate increases exponentially with body temperature and smaller animals have higher metabolic rates. This is because the smaller the heart of the animal, the more blood circulation is needed.

Pre-Lab Questions

1. Where are each of the receptor types located/more abundant on your tongue?

2. Do you get any sensory information from your muscles? Explain.

3. How well will the mice be able to handle changes in their metabolic rate? Explain.

4. What does the left side of the brain specialize in? What does the right side of the brain specialize in?

Equipment and Materials

- mberry Miracle Fruit Tablets
- Beef Jerky
- Lemons
- Limes
- Milk Chocolate Bars
- Dark Chocolate Bars
- Salt & Vinegar Chips
- Pin the Tail on the Donkey Game
- Tape Measure

- Massagers
- Blindfolds
- 12-15 Adult Mice
- Metabolic Chambers (Mice Submarines)
- 12-15 Adult Goldfish
- Beakers
- Thermometers
- Computer
- Projector/Monitor

Activity 1: Effect of "mberry" on Taste Receptors

Goal: Figure out which receptor(s) the mberry is affecting.

- Retrieve an mberry tablet and cut it in half. Put one of the halves on your tongue and roll/move it over all areas of your tongue, like a mint, until it is fully dissolved. You may take the other half of the tablet home. After the tablet is fully dissolved, obtain one piece of each of the following foods: beef jerky, lemon/lime, milk chocolate, dark chocolate, and salt & vinegar chip. Eat each food and be sure to make note of any unusual tastes and significant observations. Record your observations in the table below.

Food	Taste observations/notes

Activity 2: Pin the Tail on the Donkey

Hypothesis: Group 2 will be less accurate than Group 1 because their muscle proprioception had been altered; tricep muscles would signal that the muscles are longer than they actually are.

The class will be spilt into two groups.

- **Group 1 Instructions:** Each member will be able to look at the game set up before being blindfolded. After the participant is blindfolded, they will try to pin the tail on the donkey. Each student gets one attempt. Using a tape measure, the distance between the pinned tail and the target will be measured and recorded.
- **Group 2 Instructions:** Each member will be able to look at the game set up before being blindfolded. After the participant is blindfolded, they will try to pin the tail on the donkey while another student is using a massager to massage the triceps muscle on the back of their arm. Each student gets one attempt. Using a tape measure, the distance between the pinned tail and the target will be measured and recorded.

You can copy the recorded data in the tables below.

Group 1	
Student	Pinned tail distance from target

Group 2	
Student	Pinned tail distance from target

Activity 3: Metabolic Rate Relationships – Mice and Goldfish

Hypotheses:

- *The goldfish will demonstrate an exponential relationship between heat and metabolic rate.*
- *The metabolic rate of the mice will result in a* "V" *shape relationship between heat and metabolic rate due to their small TNZ.*

Part I: Mice in Submerged Metabolic Chamber

- Mice will be placed into metabolic chambers that will act as airtight submarines. The chambers will be submerged into water that is below, above, and at room temperature and the metabolic rate of the mice will be measured and recorded by measuring the amount of oxygen consumed in mL per minute.

- The instructor will help to set up the metabolic chambers and place the mice inside.
- Using the thermometer that is in the chamber, measure and record the temperature every 30 seconds in the corresponding table.

Room Temperature (C)	
Time Intervals	Temperature (C)
First interval (30s)	
Second interval (60s)	
Third interval (90s)	
Fourth interval (120s)	

Below Room Temperature (C)	
Time Intervals	Temperature (C)
First interval (30s)	
Second interval (60s)	
Third interval (90s)	
Fourth interval (120s)	

Above Room Temperature (C)	
Time Intervals	Temperature (C)
First interval (30s)	
Second interval (60s)	
Third interval (90s)	
Fourth interval (120s)	

Part II: Goldfish Metabolic Rate

- The metabolic rate of the goldfish will be measured by

monitoring their gills and counting the number of breaths they take per minute.

- First, use a thermometer to measure the temperature of the water in the bag containing the fish, record this temperature as the room temperature. Set a timer for 30 seconds and count the number of times you see the gill flaps move, this is their breath. Multiply your number by two and record it in the corresponding table.
- Repeat this process in beakers containing cold and warm water. Measure and record the temperatures in the tables below.
- When transferring the goldfish into the beakers, do not drop/dump out the fish. Use a fish net to gently scoop up the fish and carefully transfer the fish into the beaker.

Water Temperature	Breaths per Minute
Room temp. (C)	
Cold temp. (C)	
Warm temp. (C)	

Activity 4: Color Distinction

Hypothesis: Participants will be slower naming/saying the actual colors than they are reading the names of the colors.

- Participants will watch a video that will display the name of a color written in different colors. Say the color not the word. Try to say them as fast as you can.
- After there have been at least three participants, we will discuss what is happening.

Activity 5: Ballerina Video Perception

Goal: Figure out why this video is about perception and that the ballerina is not actually changing direction.

NOTE: For this activity, do not communicate or work with your peers.

- Everyone will watch a video of a ballerina spinning via the projector/monitor.
- Use the stopwatch function on your phone to time yourself.
- Once the video starts, start your timer.
- As you are watching the video, you will see the ballerina change the direction in which she is spinning. When you see her change direction, stop your timer and record your time below.

Time When the Ballerina Changed Direction:

- After everyone has recorded their time, we will share and discuss the times recorded.

Post-Lab Questions

1. Based off of your taste observations and notes, which taste receptor(s) was affected by the mberry? Explain.

2. Which group from Activity 2 was more accurate or closer to the target on average?

3. What was happening to the signals that were being sent from group 2's triceps muscles?

4. Using your collected data, draw a graph showing the metabolic rates for both the mice and the goldfish. Give a brief explanation and summary of your graphs.

5. Why did people have a hard time saying the color rather than the word?

6. How do you know that the ballerina isn't actually changing direction?

6.

Endocrine/Sex Lab

Introduction

As we have learned, pheromones are chemicals produced by one individual that influences the behavior of another individual. The use of pheromones is utilized by many organisms, apart from birds. Mammals can use pheromones to mark territory, communicate emotions, and to signal when they are ready to mate. In this lab, behavioral response to chemicals will be observed in male and female rabbits.

Intraspecific competition is when animals of the same species compete. In some instances, this competition is for mates. Males may mitigate this competition through mate-guarding. This is when a male stays in very close proximity to a female during fertile days or after copulation. This can ensure that the female only mates with him or increases the chance that his sperm will be the sperm that fertilizes the female. For this experiment, mate-guarding will be prompted for rice fish.

Sex hormones may play a role in pain perception. There are contradicting studies that claim that estrogen and testosterone influence pain. Some studies claim that estrogen, in higher levels, can increase pain tolerance by the release of endorphins that bind to brain cell receptors. These endorphins regulate how the pain is managed. Other studies say that testosterone dulls pain by stifling excitatory brain pathways, whereas estrogen blocks inhibitory pathways that can lessen pain sensing. Emotional response from

these hormones may also have an impact on how humans react to pain.

Pain, for this lab, will be simulated by measuring heart rate through exposure to ice water and to spice. Temperatures within the range of under 15°C to over 43°C can invoke feelings of pain. Response to temperatures are regulated by the activation of transient receptor potential channels (TRP channels). TRPA1 is activated in more extreme cold to indicate potentially dangerous temperatures. Capsaicin, the chemical in peppers responsible for the feeling of spiciness, increases membrane permeability and activates TRPV1, which detects heat. Capsaicin is interpreted as extreme heat, which is why it can cause feelings of pain.

Materials

- Male rabbits
- Female rabbits
- Urine from both rabbits
- 6 stuffed rabbits
- Testosterone
- Human pheromones
- Enclosures for rabbits
- 20 rice fish
- Large tank
- 3 small tanks
- Dividers for the small tanks
- Pulse oximeters
- Plain corn chips
- Franks Red Hot
- Tabasco
- Cholula
- Sriracha
- Topatío

- Mild Pace Salsa
- Plastic tubs
- Ice
- Water

Pre-Lab Questions

1. What organ is frequently used to detect pheromones and where is it typically located?

2. Give an example of mate-guarding in a species other than rice fish. Why might this be advantageous for that species?

3. What are induced ovulators?

4. Will the number of action potentials increase or decrease with increasing spice?

5. Explain what is happening to membrane potential in response to capsaicin.

Activity 1

Stuffed bunnies will be treated separately with nothing, pregnant rabbit urine, female urine, male urine, testosterone, and human pheromone.

One at a time, the male and female rabbits will be allowed to interact with the stuffed bunnies.

Record the behavior of each rabbit in response to each of the stuffed bunnies.

Sex of rabbit	Stuffed bunny treatment	Observations
Male	Control	
	Pregnant urine	
	Female urine	
	Male urine	
	Testosterone	
	Human Phero	
Male	Control	
	Pregnant urine	
	Female urine	
	Male urine	
	Testosterone	
	Human Phero	
Female	Control	
	Pregnant urine	
	Female urine	
	Male urine	
	Testosterone	
	Human Phero	
Female	Control	
	Pregnant urine	
	Female urine	
	Male urine	
	Testosterone	
	Human Phero	
Female (pregnant)	Control	
	Pregnant urine	
	Female urine	

	Male urine	
	Testosterone	
	Human Phero	

Activity 2

Each of 4 tanks will have different combinations of males and females. On one end, 4 quadrants will be drawn. For 10 minutes, observe the behavior of the fish in each tank. Pay special attention to which quadrants the fish spend time in.

Tank 1: Female in Section 1, males in the middle and Section 3.

Sex/placement of rice fish	Behavior observations
Middle male	
Section 3 male	
Female	

Tank 2: All female fish

Placement of rice fish	Behavior observations
Middle	
Section 1	
Section 3	

Tank 3: All male fish

Placement of rice fish	Behavior observations
Middle	
Section 1	
Section 3	

Tank 4: Male in Section 1, females in the middle and Section 3

Sex/placement of rice fish	Behavior observations
Middle male	
Section 1 female	
Section 3 female	

Activity 3

1. In groups of 2-3, fill a tub with ice water. Each person will submerge a hand in the ice water until it becomes too uncomfortable. Do not exceed 5 minutes. (This is not a competition, please be mindful of your body, and do not hurt yourself for the sake of our lab). Heart rate should be measured every 30 seconds until the person removes their hand. The final heart rate will be recorded.

Recording interval	Heart rate:
Resting:	
Interval 1:	
Interval 2:	
Interval 3:	
Interval 4:	
Interval 5:	
Interval 6:	
Interval 7:	
Interval 8:	
Interval 9:	
Interval 10:	
Removal Time:	

2. Eat a chip dipped in each of the hot sauces. Each hot sauce has a different Scoville unit. Begin with the lowest unit and work your way up. Record your heart rate before you eat it, as you eat it, and after. Give yourself some recovery time between each tasting.

Hot sauce and Scoville unit	Heart rates
Pace Salsa 25-50 SHU	Before: During: After:
Frank's Red Hot 450 SHU	Before: During: After:
Tabasco 700 SHU	Before: During: After:
Cholula 1,000 SHU	Before: During: After:
Sriracha 2,200 SHU	Before: During: After:
Topatío 3,000 SHU	Before: During: After:

Post-Lab Questions

1. Which of the stuffed bunnies were the male rabbits more interested in and why? What about the females?

2. Which group of rice fish exhibited mate-guarding? What actions were observed that showed this behavior?

3. Did heart rate increase as discomfort increased?

4. Was there a difference in time of hand removal or heart rate for males vs. females in the pain activities? Do you think this was due to an emotional or hormonal response?

5. Draw and label a sensory neuron.

7.

Gas Transport, Breathing, and Hemoglobin Loading Lab

Introduction

Hemoglobin is a kind of oxygen-transport pigment evolved by animals. It can easily bind and unbind oxygen, therefore making it an effective transport unit for large multicellular organisms. By providing a way for the body to carry oxygen other than simply allowing it to dissolve into the blood, hemoglobin increases the oxygen-carrying capacity of the blood. The circulatory system carrying the blood is dependent upon the heart. The heart works as a pump, and the beating of the heart involves a contraction called systole and relaxation called diastole. Blood pressure is also produced by the heart, causing blood to flow through the system. The highest pressure at the time of the heart's contraction is called systolic pressure, and the lowest pressure reached during relaxation is called diastolic pressure.

In this lab, we will be evaluating the effects of external stimuli on internal processes such as blood pressure, heart rate, oxygen saturation, and the galvanic skin response.

Equipment & Materials

- LabQuest
- LabQuest Blood Pressure Cuff Extension

- Pulse Oximeter
- BIOPAC Disposable Electrodes
- BIOPAC Electrode Lead Set
- BIOPAC EDA setup
- BIOPAC Student Lab System

Pre-Lab Questions

1. How does oxygen bind to hemoglobin?

2. What does systolic pressure measure? What about diastolic? What is a normal systolic and diastolic pressure in young adult humans?

3. Why is blood pressure measured in mmHG?

4. In which two locations in the body does gas exchange occur?

5. What are the pulse oximeters measuring, other than heart rate?

Activity 1: Blood Pressure and Stressful Stimuli

For our first activity, we'll be evaluating how outside (stressful) stimuli affect blood pressure. Connect the sensor to the first

channel of the LabQuest2. Make sure to work with a partner so you can easily and accurately measure your blood pressure.

1. Connect the Blood Pressure Sensor to the interface. Attach the rubber hose from the cuff to the connector on the sensor.
2. Wrap the cuff firmly around your partner's arm, approximately 2 cm above the elbow. The two rubber hoses from the cuff should be positioned over the bicep muscle (brachial artery) and not under the arm. Important: The person having his or her blood pressure measured must remain still during data collection—no movement of the arm or hand during measurements.
3. Begin data collection.
4. Quickly and repeatedly squeeze the bulb to inflate the cuff on your partner's arm. Continue inflating the cuff to a pressure between 150 and 170 mm Hg. A meter in the data-collection software will display the live pressure readings from the sensor. When the maximum pressure is reached, set the bulb pump down onto the table. The built-in pressure release valve will slowly deflate the cuff.
5. After the pressure drops to 50 mm Hg, you may press down on the pressure release valve to release any air left in the cuff. Have one partner measure the blood pressure for the other, then switch. Measure for each of the three following steps: before holding the snake, while holding the snake, and after. Record your data below.

Name	Bp Before	Bp During	Bp After

Activity 2: Blood Pressure and Calming Stimuli

For the second activity, we will be measuring blood pressure before and after doing yoga. Use the same steps from the first activity to set up the LabQuest and use before and after doing yoga.

Name	Bp Before Yoga	Bp After Yoga

Activity 3: Oxygen Saturation

For this activity we will measure our blood's oxygen saturation levels before and after three different activities. First, use a pulse oximeter to measure your oxygen saturation beforehand. Then, take one of the paper bags and take deep breaths in it for 1 minute. If you feel lightheaded or otherwise unwell, feel free to stop! Then find your oxygen saturation again.

Name	Oxygen Saturation Before	Oxygen Saturation After

Next, take your oxygen saturation before and after holding your breath for as long as you can. Don't push yourself too hard, just do what you comfortably can. Do three different trials and record the difference in percent oxygen from before and after for each. Give yourself a minute after each test to recover before starting again.

Name	Trial 1	Trial 2	Trial 3	Average

Finally, we will be performing aerobic exercise to see its effect on our oxygen saturation. Measure your oxygen saturation first, then do 30 jumping jacks, and measure again.

Name	Oxygen Saturation Before	Oxygen Saturation After

Activity 4: Biopac

For this activity we will be evaluating how well we can consciously and intentionally affect processes controlled by the autonomic nervous system.

1. Turn on the laptop with the downloaded BIOPAC program.
2. Plug in the BIOPAC both into a power source and into the laptop. Then flip on the switch on the back of the BIOPAC.
3. Click on the BIOPAC icon.
4. Select Lesson 14 (L14) Biofeedback.
5. Allow the file to stay "Noname" and click okay. Click "use it". When it asks for the adobe update, click no.
6. Then, follow the online prompts.

Spend the first 30 seconds thinking stressful, negative thoughts and trying to raise GSR and heart rate, and the other 30 seconds calming down, thinking positive and optimistic thoughts to lower GSR and heart rate. After collecting data, click suspend, then done, and then choose to analyze current data. Scroll over the graphs to find the lowest and highest values for each of the following on the table.

Name	Lowest GSR (EDA)	Highest GSR (EDA)	Lowest Heart Rate	Highest Heart Rate

Post-Lab Questions

1. Did holding the snake affect blood pressure? If so, did it make blood pressure rise or fall, and why?

2. Similarly, how did doing yoga affect blood pressure? Did it make blood pressure rise or fall? Why?

3. Did the aerobic exercise lower oxygen saturation? Would you expect anaerobic exercise to have the same or a different result?

4. Was it possible to heighten or lower GSR and heart rate by consciously thinking about it? Why or why not?

5. Physiologically speaking, how does being calm lower blood pressure and vice versa?

8.

Respiratory Responses, Mammalian Diving Response, and Circulation Lab

Introduction

Our respiratory system is a network of organs and tissues that help us breathe. Some of the main organs include our airways, lungs, and blood vessels. It works with the circulatory system to increase blood flow, and oxygen delivery to contracting muscles. Blood vessels in the human body spread from your head, all the way to your toes. Arteries carry the blood away from the heart, while veins carry the blood back to the heart. The mammalian diving response is also known as the diving reflex. It's when physiological responses when they get immersed underwater that overrides the homeostatic reflexes. This basically means that when they are underwater, they reject the reflex to breathe. In the experiments below we will be observing respiratory responses, circulation, and mammalian diving responses.

Equipment and Materials

- Spirometer
- Pregnancy suit
- Bucket
- Ice or Ice Packs
- Pulse oximeter

- Frogs
- Probe

Pre-Lab Questions

1. Would the resting heart rate of a chihuahua be slower or faster than that of a great dane? Why?

2. Where does the Weddell Seal store most of its oxygen that allows it to dive for longer periods than humans can?

3. Do the lungs expand or compress when diving to deep levels?

4. What happens to circulation with increased vigorous exercise? Where is most of the blood sent through?

5. What is the mammalian diving response? What is bradycardia?

We will be participating in a few activities that will demonstrate the relationship between heart rate and breathing rate as well as the effect of exercise on both heart rate and breathing rate. We will also

attempt to replicate the mammalian diving reflex and its physical effects.

Activity 1: Lung Capacity

We will attempt to relate lung capacity to age, gender, and level of activeness. Only using one breath, blow into the spirometer as hard as you can. The spirometer will show you your lung capacity. You will also determine your level of activeness on a scale of 1-5 according to the following classifications:

1- not very active; never work out
2- somewhat active; work out on occasion
3- active; work out about 3 times a week
4- very active; work out almost every day
5- athletic; work out every day

Name	Gender	Age	Level of activeness	Spirometer number

Activity 2: Pregnancy Suit Run

In this activity we will look for a relationship between heart rate and breathing rate as intensity of exercise increases. We will also be looking for any differences due to age. Each student will test their heart rate and breathing rate before and after running up two flights of stairs while wearing a pregnancy suit. First take your resting heart rate and breathing rate. Then start on the third floor and jog or walk up the stairs until you get to the fifth floor. Take breathing and heart rate at top of the stairs. Go back to the third floor and

wait until your heart rate has lowered almost to resting. Put on the pregnancy suit and walk back up to the fifth floor. Measure heart rate and breathing rate again.

Heart Rate:

Name	Age	Resting heart rate	Heart rate after first run	heart rate after run with pregnancy suit

Breathing Rate:

Name	Age	Resting breathing rate	Breathing rate after first run	Breathing rate after run with pregnancy suit

Activity 3: Mammalian Diving Response

For this activity we will try to replicate the mammalian diving response. Each student will hold their breath for 30 seconds (or for as long as comfortable) and record heart rate after the 30 seconds. Then submerge your face (up to your temples) into ice water and hold your breath for another 30 seconds. Use a pulse oximeter to record your pulse at the end of the 30 seconds. For those who do not want to submerge the face into ice water, ice packs can be placed on the forehead and neck while holding your breath for 30 seconds.

Resting heart rate:

Heart rate while holding breath in normal conditions:
Heart rate after face submerged in ice water (or ice pack):

Activity 4: Frogs and Muscle Fibers

In this activity we will be observing the muscle fibers at work in a frog. In a confined area, we will chase each frog around the room using a probe or other object and count the number of hops until the frog becomes fatigued and stops hopping away. This should demonstrate the fast glycolytic muscle fibers in the legs of frogs.

Post-Lab Questions:

1. How much was your lung capacity? Did age, gender, or level of activeness affect your lung capacity? What differences were there between you and your classmates?

2. Did the weight of the pregnancy suit increase or decrease your heart rate or breathing rate? Was it similar to the jog up the stairs without the pregnancy suit?

3. Did you predict your heart rate would increase or decrease when your face was submerged in ice water? What were your findings?

4. What was the average number of hops a frog did? How long did it take before they became fatigued? What does it have to do with glycolytic muscle fibers?

9.

Membrane Transport, Heat, and Neuron Function Lab

Introduction

Eggs are a great way to study the movement of substances through cell membranes because an egg is essentially a giant cell surrounded by a double plasma membrane. In this lab, we will explore the movement of water through the egg membrane with eggs whose shells have been previously dissolved with vinegar.

Neurons or nerve cells send and receive signals from your brain and central nervous system. There are three main types of neurons that work together to help your body respond to stimuli: sensory neurons, motor neurons, and interneurons. Sensory neurons are triggered by external chemical or physical inputs, such as heat, light, sound, touch, smell, and taste. They carry this information to your brain and spinal cord. Motor neurons allow the brain and spinal cord to communicate with muscles, organs, and glands across your body. Some motor neurons carry signals between your spinal cord and muscles, and others carry signals between your brain and spinal cord. The most common type of neuron are interneurons. They function as intermediaries to pass signals between sensory and motor neurons and are found in your brain and spinal cord.

In this lab, we will explore different types of neuron functions, including spinal reflexes, and conscious reacting to stimuli. We will be measuring neuron speed and reflex magnitude and using various methods to see what might increase or decrease the speed and magnitude.

Most animals must regulate their body temperatures. Many animals thermoregulate using behaviors such as basking or retreating to the shade, and huddling together for warmth. Some animals have adapted insulation or water evaporation mechanisms to help them thermoregulate. In this lab, we will be exploring the two main types of insulation that mammals have evolved. All mammals have skin covered in hair that helps them regulate their body heat. Others, especially marine mammals, rely on large amounts of blubber to act as insulation against frigid waters. Other animals have some of both. In this lab, we will explore the differences and similarities of blubber and fur as insulation and their relative efficiency.

Materials

- Tape measures (1 per group)
- Infrared thermometers (1 per group)
- Masking tape
- Rulers (2-3)
- Scales or balances (2-3)
- Vernier Labquest 2 (1 per group)
- Vernier Go Direct Dual-Range Force Sensor and Reflex hammer accessory kit. (1 per group)
- Vernier Go Direct EKG Sensor (1 per group)
- Electrode tabs (6 per group)
- De-shelled eggs (2 per group)
- Different types of animal fur (1 per group)
- Slabs of animal fat (1 – 2 of different thicknesses)

Pre-Lab Questions

1. Describe the reflex arc (pathway the neurons travel) for the patellar reflex.

2. What is the difference between a spinal reflex and a conscious reaction?

3. Briefly describe the functions of motor neurons, sensory neurons, and interneurons.

4. How does fur act as an insulator for animals?

5. What are two ways that blubber helps animals keep warm?

Activity 1

Egg Membrane Transport via Osmosis.

Hypothesis: The egg placed in the water solution will swell, and the egg placed in the corn syrup solution will shrink. (Experiment 1)

Experiment 1 – Egg membrane transport via osmosis.

1. At the beginning of lab, obtain 2 eggs whose shells have previously been dissolved using vinegar.
2. Carefully weigh each egg (they are very fragile) and record weight in table 1, and on a piece of masking tape.
3. Place each egg in a small beaker and label the beakers with the eggs' starting weight.
4. Into one beaker, pour water until it completely covers the egg.
5. Into the other, pour corn syrup until the egg is completely covered.
6. Record the time.
7. Take the 2 beakers to your table and let them sit.
8. At the end of lab, record the time, and carefully take the eggs out, dry them off and weigh them. Record the final weights in table 1 and determine the change in weight.
9. Calculate rate of change of weight using the starting and ending times.

	Starting Weight (g)	E
Egg 1 (Corn syrup)		
Egg 2 (Water)		

Starting time:
Ending time:
Rate of change: (Corn syrup):
(Water):

Activity 2

Reflex Speed and Magnitude

Hypotheses:

- Reaction time to an auditory stimulus is slower than spinal reflex speed. (Experiments 1 and 2)
- Leg length is negatively correlated with normal patellar reflex speed and magnitude. (Experiment 2)
- Age is negatively correlated with normal patellar reflex speed and magnitude. (Experiment 2)
- Vigorous exercise of the quadriceps muscle will reduce the patellar reflex speed. (Experiment 3)
- Reinforcement on one side via holding a weight will increase patellar reflex magnitude. (Experiment 4)
- Reinforcement on both sides via the Jendrassik maneuver will increase patellar reflex magnitude. (Experiment 4)
- Reflex reinforcement on one side is less effective at increasing the patellar reflex magnitude than reinforcement on both sides. (Experiment 4)

Setup

1. Measure the leg length of each person in your group from the top of the hip joint to the floor (in cm). Record this data, and ages below.

Group Member's Name	Age	Leg Length (cm)

2. Attach the reflex hammer to the Go Direct Dual-Range Force sensor according to assembly instructions that come with the reflex hammer accessory kit.
3. Connect and set up the sensors.

    - Turn on your Labquest 2 using the power button on the top left. Wait for it to boot up.
    - Be sure your Go Direct Dual Range Force sensor is set to the +-50 N on the front of the sensor. Then plug it into the CH 1 slot on the left-hand side of the Labquest. You should see a red box appear on the screen labeled 'Force'. (If you don't see this box after waiting a minute and unplugging and plugging it back in again, click on 'sensors' on the top, then click 'sensor setup', click on 'channel 1', Scroll down to find 'force' and click the down arrow, then select the 'dual range force 50N', then click 'ok' twice. Now you should see the red box and when you push on the sensor, the numbers should get more and more negative).
    - Plug the Go Direct EKG Sensor into the USB slot on the left-hand side of the Labquest 2. You should see a blue box appear labeled 'GDX: EKG'.
    - Tap the red 'force' box on the screen and check the box next to 'reverse'. Then place the sensor flat horizontally on the table, click the red 'force' box again, and select 'zero'.
    - Tap the blue 'GDX: EKG' box on the screen, select 'Sensor Channels'. Deselect the 'EKG' channel and select the 'EMG Rectified' channel.

4. Set up data collection mode:

    - Tap 'Mode' in the top right, and change 'Rate' to 100 samples/s, and change 'Duration' to 45 s.
    - Tap 'ok'.

5. In a sitting position, for each person in your group, attach two

electrode tabs above the knee of the subject along the line of the quadricep muscle. The first should be approximately 2 inches above the patella, and the second should be about 5 inches above the patella. Attach a third electrode tab about halfway down the shin.

6. Choose two people from your group to be a part of the first experiment (conscious reaction speed), have the first person sit comfortably in a chair with their legs dangling freely above the ground, and attach the red and green EKG leads to the electrode tabs above the knee with the red lead closest to the knee, and the green further away. Attach the black ground lead to the electrode tab on the lower leg.
7. Write the person's name next to 'Subject 1' in Table 2.1.
8. You are ready to begin data collection.

Experiment 1: Conscious Reaction Speed to Auditory Stimulus

1. Note: any time you collect data for someone, be sure to make a note of whose data it is, so that we can get accurate data correlations between leg length, age, and reflexes.
2. Collect conscious reaction speed from the first member of your group. NOTE: read through entire step before collecting data).

    - Have the subject close their eyes and relax.
    - Tap the play button in the lower left-hand corner to begin recording data.
    - Hit the reflex hammer against the desk or something else that will make a noise.
    - As soon as they hear the sound, the subject should kick his or her foot out.
    - Continue collecting samples for the 45s duration. Aim to

collect data for 10 – 15 kicks during the 45 seconds.

3. Determine the time between striking the table with the reflex hammer and the contraction of the subject's quadriceps muscle.

    - On the labquest 2, tap on the graph as close as possible to the beginning of the first spike on the Force graph.
    - Use the arrow key to toggle forward until you reach the very beginning of the spike. (You'll see the little black circle on the graph start to move up.)
    - Record the time of the beginning of the spike (from bottom right of screen) in Table 2.1. (Note, there will be some normal up and down fluctuation, what we want here is the very beginning of the spike, not the normal ups and downs.)
    - Continue toggling forward until the little circle on the EMG Rectified graph begins to move up in the first spike. This represents the beginning of the quadricep muscle contraction. Record this time in Table 2.1.

4. Compute the ΔTime (in ms) for each kick and then the average for all 10 kicks.
5. Complete steps 1 and 2 with the second subject. Write their name under 'subject 2' in Table 2.1. Record their data in the bottom half of table 2.1.

Table 2.1

Subject 1:	Kick 1	Kick 2	Kick 3	Kick 4	Kic
Time of stimulus					
Time Muscle Contraction					
ΔTime (ms)					
Subject 2:	Kick 1	Kick 2	Kick 3	Kick 4	Kic
Time of stimulus					
Time Muscle Contraction					
ΔTime (ms)					

Experiment 2: Normal Reflex Speed and Magnitude

1. Collect normal patellar reflex speed and magnitude from all members of your group. (Note: read entire step before collecting data).

    - Have the subject close his or her eyes and relax. Write their name next to the appropriate 'subject' in table 2.2.
    - Click the play button in the lower left corner to begin collecting data.
    - Tap the reflex hammer briskly against the subject's patellar

tendon just below the patella. If this does not elicit a reaction, try aiming toward other areas of the tendon until a good reflex is obtained.
    - Continue collecting reflex samples for the duration of the 45 seconds. Aim for 10-15 samples.

2. Determine the time between striking the patellar tendon and contraction of the quadriceps muscle, and reflex magnitude.

    - Following the same steps as in experiment 1 step 2 to record time data in table 2.2 with this added step:
    - For each kick, continue toggling forward after you get the time of muscle contraction until the circle reaches the highest point of the spike on the EMG rectified graph. This represents the magnitude of the reflex. Record the value (mV) in Table 2.2.

3. Repeat steps 1 and 2 for each member of your group.

Table 2.2

Subject 1	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5	Kick 6	Kick 7	Kick 8	Kick 9	Kick 10	Avg.
Time of Stimulus											
Time of muscle contraction											
ΔTime (ms)											
Magnitude (mV)											
Subject 2	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5	Kick 6	Kick 7	Kick 8	Kick 9	Kick 10	Avg.
Time of Stimulus											
Time of muscle contraction											
ΔTime (ms)											
Magnitude (mV)											
Subject 3	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5	Kick 6	Kick 7	Kick 8	Kick 9	Kick 10	Avg.
Time of Stimulus											
Time of muscle contraction											

ΔTime (ms)											
Magnitude (mV)											
Subject 4	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5	Kick 6	Kick 7	Kick 8	Kick 9	Kick 10	Avg.
Time of Stimulus											
Time of muscle contraction											
ΔTime (ms)											
Magnitude (mV)											

Experiment 3: Effect of Exercise on Reflex Speed

1. Collect patellar reflex speed after exercise of the quadriceps muscle from two members of your group.

    - Disconnect the EKG leads and have the first subject do 10-15 jump squats.
    - Have the subject then sit comfortably in the chair with his or her legs dangling freely and close their eyes.
    - Repeat method from experiment 2 step 1 to collect patellar reflex speed samples. Aim for 10-15 kicks over the 45s duration.
    - Following the instructions from experiment 1 step 2, determine time of stimulus and time of muscle contraction

and record data in Table 2.3
    - Calculate average speed for all 10 kicks.

2. Repeat step 1 for a second member of your group. Record data in the bottom half of Table 2.3.

Table 2.3

Subject 1	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5	Kick 6	Kick 7	Kick 8	Kick 9	Kick 10	Avg.
Time of Stimulus											
Time of muscle contraction											
ΔTime (ms)											
Subject 2	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5	Kick 6	Kick 7	Kick 8	Kick 9	Kick 10	Avg.
Time of Stimulus											
Time of muscle contraction											
ΔTime (ms)											

Experiment 4: Effect of Jendrassik Maneuver on Reflex Magnitude

1. Choose two people from your group to take part in this experiment.
2. Have the first subject sit comfortably on the chair with their legs dangling freely and close their eyes. Then have them perform the Jendrassik maneuver by interlocking flexing both sets of fingers into a hook-like position, and then interlocking them together in front of the chest, pulling outward toward the elbows without breaking contact at the fingers.
3. Using the same method from the previous experiments, obtain reflex magnitude data.
4. Determine magnitude for each trial, and calculate the average magnitude across all 10 trials, and record in table 2.4.

    - Using the stylus, click and drag on the graph to select an area that encompasses the entire first spike of the EMG rectified graph.
    - At the top of the screen, select 'Analysis', then select 'Statistics' and check the box next to 'EMG Rectified'.
    - On the right-hand side, under 'statistics' scroll down to find the 'Max' mV value. This represents the magnitude of the reflex.
    - Record in table 2.4.
    - Do the same for the next 9 samples (Note: you will have to deselect and reselect 'EMG Rectified' under 'statistics' each time you select a new area, otherwise the statistics will not change to the new selection.)
    - Calculate the overall average between the 10 samples.

5. Repeat steps 2 – 4 with the second subject.

Table 2.4

Subject 1	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5
Magnitude (mV)					
Subject 2	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5
Magnitude (mV)					

Experiment 5: Effect of One-sided Reinforcement on Reflex Magnitude

1. Use the same two subjects for this experiment that you did for the last one.
2. Obtain a weight of about 5 lbs. Have the subject hold it in their hand to the side like they are setting up to do a bicep curl. One side of their arm muscles should be tense, and the other side should be relaxed. Have them sit in the chair with their legs dangling freely and their eyes closed.
3. Follow the same steps as before to obtain reflex magnitude data.
4. Determine the magnitude (max mV) value of each reflex following the steps from experiment 4 step 4. Record data in table 2.5.
5. Calculate the average magnitude of the 10 kicks and record in Table 2.5.
6. Repeat steps 1 – 3 to collect data from a second subject.

Table 2.5

Subject 1	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5
Magnitude (mV)					
Subject 2	Kick 1	Kick 2	Kick 3	Kick 4	Kick 5
Magnitude (mV)					

When you have finished this activity, please come, and enter your averages from each experiment into the excel spreadsheet at the front of the room so that we can graph the class's data.

Activity 3

Effectiveness of different types of animal insulation.

Hypotheses:

- Thickness of fur is positively and linearly correlated to insulation ability. (Experiment 1)
- Thickness of fat is positively and linearly correlated to insulation ability. (Experiment 2)
- Fur is more effective at insulating than the same thickness of fat. (Experiments 1 and 2).

Experiment 1: Effectiveness of Fur as an Insulator.

1. Obtain a fur from the back of the classroom.
2. Lay it flat on the table and record the thickness (cm) here:

_____ (note: some don't lay flat, just do your best to get an accurate thickness from the skin to the edge of the fur)

3. Obtain an icepack and lay the fur flat over the icepack on the desk (be sure that the ice pack is making contact with the skin, if your skin is from an entire animal, try to get the ice pack inside so that you can measure cold transference over just one layer of skin/fur).
4. Use an infrared thermometer to take the temperature on the top of the fur every 30 seconds for the first 6 minutes, and record data in table 3.1. Do not touch or move the fur during this time. Try to aim for the same spot from the same angle each time.
5. Calculate the average rate of change of temperature for the first 6 minutes (in °C/min) by subtracting your value from 6 minutes from your starting value, and then dividing by 6.
6. Enter your data into the Excel spreadsheet at the front of the classroom.

Table 3.1

Starting Temperature: _____

Time	0:30	1:00	1:30	2:00	2:30	3:00
Temp (°C)						

Rate of change of temperature: _____

Experiment 2: Effectiveness of Fat as an Insulator.

1. Obtain a block of fat from the back of the classroom.

2. Lay it flat on the table and record the height (cm) here: _____
3. Obtain an icepack and lay the fat over the icepack on the desk.
4. Use a heat gun to take the temperature on top of the fat every 30 seconds for the first 6 minutes, and record data in Table 4.2
5. Calculate the average rate of change for the first 6 minutes.
6. Enter data into the excel spreadsheet at the front of the room.

Table 4.2

Starting temperature: _____

Time	0:30	1:00	1:30	2:00	2:30	3:00
Temp (°C)						

Rate of change of temperature: _____

Post-Lab Questions

Activity 1

1. Describe the changes you observed in your eggs through the lab. Did they grow or shrink? Why?

Activity 2

1. Which was faster: the patellar reflex or the speed of reaction to an auditory stimulus? Why?

2. Was there a difference in the reflex speed after working the quadriceps muscle? Why or why not?

3. Is there a correlation between age and reflex speed? If so, was it positive or negative? What causes this correlation?

4. Was there a correlation between leg length and reflex speed? If so, was it positive or negative? Why do you think this would be the case?

5. Was the magnitude of the reflex higher or lower than normal with reinforcement? Why?

6. Was there a difference between the magnitudes of the reflex with reinforcement on both sides versus just one side? Why do you think this might be the case?

7. Was there a correlation between age and magnitude of the patellar reflex? If so, was it positive or negative? Why?

Activity 3

1. Look at the graph comparing fur and fat insulation. For the same thickness, did the fat or fur cool down more slowly?

2. Using what you have learned about fat vs. fur insulation effectiveness, would it be more effective for terrestrial mammals to use fur or fat as an insulation? What about marine mammals?

3. Sea otters, a marine mammal, have the densest fur of any living mammal. They can have upwards of a million hairs per square inch of their body. Why do they have such thick fur when they live in the water?

IO.

Skeletal Muscle Lab

Introduction

The most famous aspect of skeletal muscle is its ability to contract and ultimately create movement. Skeletal muscles are involved in both producing and stopping motion, like opposing gravity to sustain posture. To keep a body level or balanced in any and all positioning, subtle, continual changes of the skeletal muscles are performed. Veins abound in every skeletal muscle, supplying it with nutrients, oxygen, and waste export. Additionally, the axon branch of a somatic motor neuron serves every muscle fiber in skeletal muscle, signaling the fiber to contract or relax. Skeletal muscle can only move when it receives a signal from the nervous system, unlike cardiac and smooth muscle which move involuntarily.

In this lab, we will explore the protein make up of muscles as well as the different capabilities of muscle contractions, and ultimately what factors can affect muscle fibers and contraction. We will be measuring EMGs from muscle contraction and comparing muscle stimulation in different environments.

Equipment & Materials

- Shrimp
- Limes
- Cilantro

- Avocados
- Red Onions
- Roma tomatoes
- Hot sauce
- Chips
- Salt
- CAMRY Electronic Hand Dynamometer
- LabQuest 2 App
- Electrodes
- EKG/EMG Sensor
- Timer
- Measuring tape
- STIM Machine
- Squat Rack/Heavy weights
- Tandem Sport Vertical Challenger

Pre-Lab Questions

1. What is denaturing of proteins? What results from this process?

2. What does EMG stand for? What does it measure?

3. Describe the steps of a muscle contraction.

4. What is muscle fatigue? What is (or isn't) happening in terms of contractions?

5. What is Post Activation Potentiation (PAP)?

Activity 1: Ceviche

Hypothesis: Acidic conditions will denature proteins just as effective as heat.

Place shrimp and/or fish in large mixing bowl. Add lime juice, lime zest, and salt, then toss to make sure shrimp is evenly coated. Set aside for 15 minutes (less and the shrimp won't 'cook', more and the shrimp will become too tough). Every 5 minutes, take one piece of shrimp and cut it open to measure cooking. Record data in table 1 below. Meanwhile, add any other ingredients provided you would like in your ceviche. When the shrimp is done (you can test the doneness of the shrimp by taking a small piece and cutting it open – if it is opaque most of the way through, then it is considered done).

Shrimp Observations

Time in Lime Juice (mins)	Appearance
5	
10	
15	
20	
25	

Activity 2: Grip Strength & EMGs

Hypothesis: EMGs will increase with grip strength.

Acquire a CAMRY electronic hand dynamometer, LabQuest App with EKG sensors, and electrodes. Connect the EKG sensor into the LabQuest, then turn on the LabQuest. Choose 'New' from file menu. Place one electrode approximately 5 cm from your wrist and another 10 cm from your wrist. The third electrode can be placed on your bicep. Connect the green lead to the electrode closest to your wrist, the red lead on the adjacent electrode on your forearm, and the black lead on the electrode on your bicep. Using the stylus pen, follow these instructions to set up data collection on the LabQuest 2 App:

1. On the meter screen, tap sensors and then select sensor setup.
2. Tap the appropriate channel, scroll down the list of sensors, and tap Qubit.
3. Select q-S207 EKG/EMG and tap OK.
4. Tap OK again to return to the meter screen.
5. Change data-collection rate to 500 samples/s.
6. Zero the EKG sensor before collecting data.
7. Tap table and choose New Calculated Column from the Table menu.
8. Enter the Name (Column Rectified EMG or CR EMG) and Units (mV).
9. Select Aabs(X) as the Equation Type.
10. Select Potential for the Column for X.

Now, set up the hand dynamometer. Push the on button once to turn it on, then again to select gender and age. The middle two buttons (ARROWS up/down) allow you to select a different user. Then press (ON/SET) button to cycle between gender and age of the selected user, and edit the values using the arrows. When you are ready you can hit the (START) button to test your handgrip.

Once both the LabQuest and hand dynamometer have been set

up, you are ready to begin data collection. Make sure your arm is resting comfortably on the table top. Using the same arm that is connected to EKG sensors, pull the CAMRY electronic hand dynamometer and begin data collection. Repeat this process an additional two times for a total of three attempts, then average the attempts and record below.

Participant Information

Participant	Age	Sex

Force vs EMG

Participant	1st EMG	1st Force	2nd EMG	2nd Force	3rd EMG	3rd Force	Average EMG	Average Force

Average EMG: mV

Average Force: kg

Activity 3: Muscle Fatigue in Dominant vs Non-dominant Arm

Hypothesis: Muscle fatigue will occur faster in subjects' non-dominant arm.

Using your dominant hand on the electronic hand dynamometer, squeeze the trigger as hard as you can for as long as you can. Time how long it takes for the reading on the screen to hit 50% of the

initial reading of force. Repeat this process an additional 2 times for a total of three, then average your time in seconds. Repeat this entire exercise with your non-dominant hand, and compare the results.

Dominant hand

Participant	1st attempt(s)	2nd attempt(s)	3rd attempt(s)	Average(s)

Average: s

Non-Dominant hand

Participant	1st attempt(s)	2nd attempt(s)	3rd attempt(s)	Average(s)

Average: s

Activity 4: STIM Machine Muscle Contraction

Hypothesis: Larger muscles (more muscle mass) will require less stimulation from the STIM machine in order to contract.

First, we will need to calculate our body fat percentage. Visit this link to calculate. You will need to input your age, weight, height, and neck and waist measurements. Click calculate; this is your body fat percentage. Take this percentage and subtract it from 100%; this is your lean mass. Now, convert your percentage into a decimal (move

the decimal point two places to the left) and times it by your body weight. This is your lean body weight.

Lean body weight: lbs

Sit or lay down on a table next to a STIM machine with your legs stretched out in front of you. Under the supervision of athletic trainers or Jaci, attach the 4 electrode pads to the 4 quadricep muscles on one leg. Attach the STIM machine connecters to the pads, ensuring the colors of the connectors are alternating with the red attachment starting closer to the knee. Turn on the STIM machine, and select Russian stimulation. Then, using the knob on the machine, slowly increase the amount of stimulation until your partner's quad contracts.

**PLEASE START AT A SMALL NUMBER AND SLOWLY INCREASE – STARTING TOO HIGH OR GOING TOO FAST CAN RESULT IN CRAMP OR OTHER INJURY.

Record the number on the screen in the table below, and repeat these steps twice more. Average the recordings.

Stimulation of Quadriceps

Participant	Quadriceps measurement	1st Attempt	2nd Attempt	3rd Attempt	Average

Average stimulation needed for contraction:

Activity 5: Post Activation Potentiation (PAP) & Vertical Jump

Hypothesis: Students will increase their vertical jump after performing a heavy strength exercise.

Perform a vertical jump test 3 times, recording the height below and averaging all three attempts. Then, perform 3 squats at 85% of your 1RM (1 rep max) at the designated squat rack. Allow yourself to rest for 3-5 minutes, then attempt the vertical jump test 3 more times. Record your new attempts and average all three again. Record your data below.

Jump height (cm) before PAP

Name	Jump 1	Jump 2	Jump 3	Average

Rest time: mins

Jump height (cm) after PAP

Name	Jump 1	Jump 2	Jump 3	Average

Post-Lab Questions

1. How did lime juice 'cook' the shrimp? Why would this only work on fish muscle?

2. In our class data, did the force of grip strength correlate with the amount of EMGs present? Why is this important?

3. Did males or females have a higher grip strength? Did age play a part?

4. In our class, which hand fatigued faster: the dominant or non-dominant? Why is this important?

5. In our class data, did muscle mass have an effect on stimulation required for contraction?

6. What real world implications do muscle mass and STIM contraction have?

7. In our class data, were students able to jump higher after performing a heavy exercise? Why or why not?

II.

Diagnostic Urinalysis and Respiratory Gases Lab

Introduction

Urine is typically a sterile liquid by-product of the body which is excreted by the kidney. A urinalysis is a common clinical test because urine can be used as a diagnostic tool to detect disease conditions. We will learn and measure the various characteristics of urine and analyze these findings to determine any possible abnormalities.

Pre-Lab Questions

1. What disorders can be identified using a diagnostic urinalysis?

2. What is the principal nitrogenous waste in mammals?

3. How much urine volume is excreted in a day?

4. Are proteins or blood normally found in urine? If they are present, how might they get there?

5. If the urine sample tests positive for ketones and glucose, for what disease should the patient be checked?

Activity 1: Urinalysis

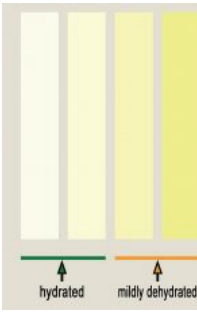
Materials

- Urine cups
- Urine dipstick
- Microscope Slides
- Slide cover
- Microscope
- Test tubes
- Wooden Sticks

Visual Exam

Physical characteristics can be applied to urine including color, turbidity, smell, pH, and density.

- Color: Urine can be a variety of colors, usually shades of yellow, and can vary depending on diet and concentration of urine. Drinking more water reduces the concentration of urine and makes it lighter. Abnormal urine colors can be the result of a disease, medications, or the result of eating certain foods. Red urine can occur when blood is present and can be an indicator of disease or damage to some part of the urinary system.
- Smell: Fresh, healthy urine has a mild smell while aged or infected urine has a stronger smell, like ammonia or sulfur. Urine of diabetics may be sweet or fruity due



"Urine Hydration char
licensed under CC BY-

to presence of ketones or glucose.
- Turbidity: The turbidity of a urine sample is subjective. Excess turbidity results from particles in urine which can be identified in the microscopic sedimentation examination as increased cells, urinary tract infection, or obstruction.
- Obtain a specimen jar and collect a sample of your own urine.
- Note the color of the urine and the smell.

Characteristic	Normal	Sample
Color and turbidity	Pale yellow to deep yellow/clear	
Odor	Sweet, ammonia, sulfur	

How many liquids have you drank today? How much of that was water?

What observations can you make on the color of your urine?

Chemical Exam

- pH: Normal pH range of urine is 4-8 but much variation comes from diet. High protein diets result in more acidic urine while vegetarian urine diets result in more basic urine. People experiencing burning with urination with no indication of a UTI are given suggestion to raise the pH of their urine by changing their diet and drinking more water.
- Density: The specific gravity of urine is the ratio of the weight of volume of the urine compared with the weight of the same volume of DI water. The SG of DI water is 0.001 and normal urine ranges from 0.001-0.035.
- Leukocytes: WBC's
- Nitrites: Nitrites aren't usually found in urine. They are associated with the presence of gram-negative bacteria that can convert nitrate into nitrite. The presence of nitrites can be suggestive of a UTI.
- Protein: Protein molecules are too large to pass through the glomerular filtration barrier, the first part of urine formation process of blood filtration in the kidney, so protein is undetectable in a healthy person. When protein can pass through this barrier, it is known as proteinuria. Proteinuria can be caused by many things like damage or disease to the glomerular filtration barrier, hypertension, kidney damage or stones, and diabetes.
- Glucose – Glycosuria is glucose in the urine which can occur in pregnancy or patients taking corticosteroids. It can also be

indicative of diabetes but is not normally in urine.

- Ketones – Ketones are chemicals that are formed during the abnormal breakdown of fat and are not normally in urine. Ketones may result from prolonged vomiting, fasting or starvation, individuals on a diet, or individuals with poorly controlled diabetes resulting in diabetic ketoacidosis.
- Bilirubin and Urobilinogen: Bilirubin is produced when red blood cells are broken down.
- It's transported in the blood to the liver, where it's processed and excreted into the gut and makes up part of bile. In the gut, bacteria transform the bilirubin into urobiligen. It is normal for urine to contain urobiligen but not bilirubin. Bilirubin in the urine may be an indicator of a breakdown of red blood cells, indicating liver disease or a problem with drainage of bile into the gut, like gall stones.
- Hemoglobin: Hematuria, blood in the urine, can be macroscopic or microscopic. Macroscopic being large volumes of blood in the urine that changes the color or microscopic being undetectable to the naked eye so chemical strips are used to identify it. Blood in the urine can be the result of kidney disease, kidney stones, anticoagulation disease, menstrual blood, or UTI.
- While wearing gloves, dip the chemstrip into your urine and wait one minute before reading the results.
- Read the results of the chemstrip and input into the table.

Test	Result	Significance (normal or if abnormal, possible cause)
Acidity (4.5 – 8.0)		
Specific gravity (1.001 – 1.035)		
PH		
Protein		
Glucose		
Ketones		
Urobilinogen		
Bilirubin		
Blood		

Microscopic

- Red Blood Cells: kidney disease, urinary tract infection, a drug reaction, or cancer.
- White Blood Cells: infection or inflammation in your urinary tract.
- Epithelial Cells: Normal to see a few, but an excessive amount can indicate UTI
- Bacteria: UTI

1. Pour 1 mL of your urine into a test tube, place in centrifuge and spin urine for 5 minutes at 1,500 rpm
2. Decant off supernatant and use the wooden stick to stir the pellet
3. Drag the pellet down the test tube and place a drop onto the slide.
4. Place a slide cover on top of the drop of sediment and tilt the slide until the sides are dried
5. Observe the slide under the microscope at low and high power

and note observations

Cell types	Average number seen per movement of frame
RBC	
WBC	
Epithelial	
Bacteria	
Other (sediment/ crystals)	

Activity 2: Diagnostic Urinalysis

Perform the same tests as Activity 2 using an unknown urine sample

Which sample will you be analyzing?

Visual Exam

1. Obtain a specimen jar and collect a sample of the unknown urine.
2. Note the color of the urine and the smell.

Characteristic	Normal	Sample
Color and turbidity	Pale yellow to deep yellow/clear	
Odor	Sweet, ammonia, sulfur	

Chemical Exam

1. While wearing gloves, dip the chemstrip into your urine and wait one minute before reading the results.
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Test	Result	Significance (normal or if abnormal, possible cause)
Acidity (4.5 – 8.0)		
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Protein		
Glucose		
Ketones		
Urobilinogen		
Bilirubin		
Blood		

Microscopic Exam

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2. Decant off supernatant and use the wooden stick to stir the pellet
3. Drag the pellet down the test tube and place a drop onto the slide.
4. Place a slide cover on top of the drop of sediment and tilt the slide until the sides are dried
5. Observe the slide under the microscope at low and high power and note observations

Cell types	Average number seen per movement of frame
RBC	
WBC	
Epithelial	
Bacteria	
Other (sediment/ crystals)	

Post Lab Questions

1. What did you notice about the color of your urine? How does this relate to the amount of water you've had today?

2. How would you diagnose the patient with the unknown urine sample? What is your reasoning?

3. What would most likely be the cause of a urine sample with a positive test for nitrites, leukocytes and a slightly higher than normal pH?

4. What dietary habits may cause an acidic urine sample (more acidic than normal)? What would cause a basic urine sample?

5. Elevated levels of urobilinogen and bilirubin may indicate problems with what organ?

Sample	Specific gravity	pH	Leukocytes	Nitrite	Protein	Glucose	Ketones	Urob
Control	Normal = 1.01 – 1.040	Normal = pH 5–9 Avg. = 6	Normally Negative Positive = >25 cells/ µL	Normal = <0.05 mg/dL Positive = >0.05 mg/dL	Normal = <30 mg/dL Positive = >30 mg/dL	Normal = Negative Positive = >90 mg/dL	Normal = <10 mg/100 mL Positive = >10 mg/100 mL	Norm <0.4 Posit >0.4
A								
B								
C								
D								
Yours								
Causes								