

OUR BODY

THE UNIVERSE WITHIN



OUR BODY - THE UNIVERSE WITHIN

Educator's Guide Grades 9-12

- I. Instructions on Planning a Visit
- II. Guide to the Exhibit
- III. Frequently Asked Questions
- IV. Before Visit Activities
 - i. Letter to educator
 - ii. Introduction to Human Systems Worksheet
 - iii. Macromolecule Identification
- V. During Visit - Activities for Systems
 - i. Description of exhibit
 - ii. Suggested Related topics
 - iii. Fun Facts
- VI. After Visit
 - i. Digestive Enzyme Activity
 - ii. Circulatory Lab Activity
 - iii. Health & Exercise Plan
 - iv. Discussion Questions
 - v. Actual or Virtual Dissection



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Dear Educator,

Have you ever wondered where your liver was located? Or what smoker's lung looks like? Or how your muscles perform when you run? These and more questions will be answered through **OUR BODY - THE UNIVERSE WITHIN**. **OUR BODY - THE UNIVERSE WITHIN** is a scientific, educational exhibit comprised of over 200 specimens that have been preserved using a method known as polymer impregnation.

OUR BODY -THE UNIVERSE WITHIN literally as well as figuratively goes "under the skin," revealing the complexity of the human body and allowing visitors an up-close, 3-dimensional look at their inner make-up. Rather than use models of the human body, **OUR BODY - THE UNIVERSE WITHIN** uses actual human bodies to provide the general public a look at what normally only doctors and scientists are allowed to see first-hand, making this a once in a lifetime experience. The goal of **OUR BODY - THE UNIVERSE WITHIN** is that visitors leave with a deeper understanding of the body's form and function and a stronger appreciation for staying fit and healthy.

"Your body is your shrine and this is your chance to learn more about that shrine," said Professor Enhua Yu of Beijing University. "**OUR BODY - THE UNIVERSE WITHIN** provides a precious opportunity to see for oneself the very delicate structures both inside and outside the human body.

Visitors will be able to explore the body parts that allow them to think, to breath, to move and the 'freeways' that circulate the blood that keeps the motor in constant motion."

Polymer impregnation is a relatively new method of preservation whereby bodily fluids are replaced by liquid plastic, which is then hardened to create a solid, durable anatomic specimen that will last indefinitely. Most importantly, the process leaves even the finest, most delicate tissue structures virtually intact, down to the microscopic sphere, making the process invaluable for medical study. Prior to the invention of polymer impregnation, the only method for preservation of cadavers for medical study was storage in formaldehyde, making the dissection and study of human bodies cumbersome. Polymer impregnation results in specimens that are not only versatile and easy to handle, but are truly authentic. **OUR BODY - THE UNIVERSE WITHIN** relies on the generosity of body donors, individuals who gave their legal consent that upon their death, their bodies could be used for educational purposes in the exhibition.

Visitors to **OUR BODY - THE UNIVERSE WITHIN** will be introduced first to the human body as a whole, and then taken through each of the body's major systems to see how each functions and relates to other systems. First up is the frame that holds a person together – the musculoskeletal system – using a body in simulated motion to demonstrate how various muscle groups work together to keep a body in motion. From there, one will see the central nervous system, with the brain as the "control room" from which all motor impulses flow. Exhibits on the digestive and respiratory systems show how a person eats and breathes, while cardiovascular display shows the intricate system that carries blood from the heart (arteries) and back to the heart (veins).

It is recommended that teachers prepare students for their visit using the educational materials available on our website (<http://www.ourbodytheuniversewithin.com>). Included are activities designed for grades 5-8 and 9-12. To book your field trip, please contact The Orlando Science Center (<http://www.ocs.org>).

Sincerely

BEFORE YOUR VISIT

- Read Letter to Educator and Frequently Asked Questions
- Discuss visit with students and chaperones. Use the frequently asked questions to guide your classroom discussions.
- Use the “Before Your Visit” Activities to familiarize your students with human anatomy. These include;
 - Guided Reading and Associated Questions
 - Detection of Macromolecules Laboratory Activity

DURING YOUR VISIT

- Encourage your students to use their student guides and the written descriptions at each exhibit to guide their journey. Encourage students to write down any questions for discussion later.
- Use OUR BODY - THE UNIVERSE WITHIN Scavenger Hunt

AFTER YOUR VISIT

- Complete the classroom activities with your students
 - Digestive Enzymes Laboratory Activity
 - Circulatory Lab Activity
- Share your students impressions with OUR BODY - THE UNIVERSE WITHIN (add contact e-mail)
- Encourage your students to explore interests further using additional resources
- Consider a virtual or actual animal dissection.

PRE-VISIT CLASSROOM ACTIVITY - MEET THE HUMAN BODY

Use the guided reading activity and matching worksheet as an in-class activity to introduce your students to the basic functions of the body systems and the organs they are likely to see. The matching worksheet can also be used as an assessment tool.

INTRODUCTION TO THE HUMAN BODY – ANSWER KEY

DIRECTIONS: MATCH THE BODY SYSTEM WITH ITS PRIMARY FUNCTION

E	1. Musculoskeletal system	A. Responsible for transport of materials around the body.
D	2. Central Nervous System	B. Responsible for gas exchange or bringing oxygen into the body and releasing carbon dioxide.
F	3. Peripheral Nervous System	C. Responsible for filtering waste from the blood.
G	4. Digestive system	D. Responsible for processing information from nerves & senses. The control center for the body.
B	5. Respiratory system	E. Responsible for movement and support of the human body.
A	6. Cardiovascular system	F. Responsible for transmitting information from nerves throughout the body to the brain.
C	7. Urinary system	G. Responsible for breaking larger molecules into smaller to obtain nutrients

INTRODUCTION TO THE HUMAN BODY

The human body is composed of many organs and glands that work together in body systems. Each system relies on the others to function. The brain serves as the control center for all of the systems. It is important to understand the primary function of each system and how they all work together.

How can humans move? The answer can be found in the musculoskeletal system or a combination of the muscles and skeleton. What exactly are muscles? Muscles are made up of cells that contract and relax back to their original size. Tiny microscopic fibers in these cells slide past each other. These movements require a lot of energy, which comes from the chemicals found in the food you eat. Without food and specific nutrients, your muscles wouldn't be able to make the energy they need to contract. Some muscles are known as "voluntary" or ones that you can think about moving. Other muscles, like the ones in your heart, move automatically, what we call involuntary movements, and are controlled by your brain.

Your brain and spinal cord make up your central nervous system. Together, they control your body -- but it's the brain which is Commander-in-chief. So what is a brain? The human brain is wrinkled, soft and a little wet. It doesn't look like much, but it's made of more than 10 billion nerve cells and over 50 billion other cells and weighs less than 3 pounds! It monitors and regulates unconscious bodily processes like breathing and heart rate, and coordinates most voluntary movement. Can you think of any movements or bodily processes that are both automatic as well as voluntary? Need a hint? Take a deep breath. You have just controlled breathing by sending a message from your brain to the muscles that control the lungs. Do you always have to think about breathing? The answer is no. Your brain controls breathing without you thinking about it.

The peripheral nervous system is the network of nerves that pass along messages back and forth from the central nervous system to the other parts of the body. What are nerves? They're the thin threads of nerve cells, called neurons that run throughout your body. Bundled together, they carry messages back and forth just the way that telephone wires do. Sensory nerves send messages to the brain and generally connect to the brain through the spinal cord inside your backbone. Motor nerves carry messages back from the brain to all the muscles and glands in your body.

What do we need to make those muscles work? The answer: chemical energy and nutrients from the food we eat and the digestive system is responsible for getting them. Digestion begins with your first bite. By chewing, your mouth breaks down larger pieces into smaller one and mixes your food with chemicals in saliva to make them even smaller. Your tongue then pushes the food to the back of your throat. The food then travels down your esophagus, with some help from your muscles, until it reaches the stomach. Once in the stomach, the food is mixed with stomach acid and is sloshed around by muscle contractions, breaking the food into even

smaller pieces. The small pieces of food travel into the small intestine, where nutrients are absorbed and transported to the bloodstream. Any leftovers in the small intestine move into the large intestine where water is recycled to be used in other parts of the body. The leftovers are about 1/3 of its original size when it entered the intestines. The drier leftovers are now brown and expelled out the anus. You know the rest!

Wow that was a long trip! Now let's take a deep breath and discuss the respiratory system. All the cells in your body require oxygen. Without it, they couldn't move, build, reproduce, and turn food into energy. How do you breathe? You breathe with the help of your diaphragm and other muscles in your chest and abdomen. When your diaphragm pulls down, it leaves more space for your lungs to expand and changes the air pressure. When the air pressure is greater outside, air moves in to the lungs or you inhale. When your diaphragm relaxes, the cavity gets smaller and the air is pushed up and out of your body. The nose is where it all starts; where the air is filtered (there is a reason for nose hairs). The air flows through the windpipe past the vocal cords and the travels into one of the two lungs. Tubes inside the lungs or bronchi branch into smaller tubes with small sacs at the end. These sacs connect the respiratory system with the circulatory system. Oxygen is transported onto red blood cells and waste products like carbon dioxide are removed and exhaled out of the body. The bloodstream transports oxygen to all of the cells in the body.

The cardiovascular or circulatory system is one of the most important systems in the human body. Made up of the heart, blood and blood vessels, the circulatory system is your body's delivery system. Blood moving from the heart, delivers oxygen and nutrients to every part of the body. On the return trip, the blood picks up waste products so that your body can get rid of them. Your heart is a muscle about the size of a clenched fist. It contracts and relaxes some 70 or more times a minute while you're resting and even more when you are exercising. It squeezes and pumps blood through its chambers to all parts of the body. The blood travels through a pipeline of blood vessels. The tubes that carry the blood away from your heart are called arteries. These hoses carry blood pumped under high pressure (your blood pressure) to smaller branched tubes called capillaries. The tubes that carry the blood back to the heart are called veins.

As the pipeline through the body, the bloodstream carries waste products along with nutrients and oxygen. The bloodstream is filtered by the urinary systems, which removes excess water and fluids. The kidneys are primarily responsible for this filtering process and the production of urine. Urine is the stored in the bladder and released from the body.

SOURCES: THE YUCKIEST SITE ON THE INTERNET (<http://yucky.discovery.com/index.html>)

Name _____

Period _____

Date _____

INTRODUCTION TO THE HUMAN BODY

DIRECTIONS: MATCH THE BODY SYSTEM WITH ITS PRIMARY FUNCTION

- | | |
|------------------------------------|--|
| _____ 1. Musculoskeletal system | A. Responsible for transport of materials around the body. |
| _____ 2. Central Nervous System | B. Responsible for gas exchange or bringing oxygen into the body and releasing carbon dioxide. |
| _____ 3. Peripheral Nervous System | C. Responsible for filtering waste from the blood. |
| _____ 4. Digestive system | D. Responsible for processing information from nerves & senses. The control center for the body. |
| _____ 5. Respiratory system | E. Responsible for movement and support of the human body. |
| _____ 6. Cardiovascular system | F. Responsible for transmitting information from nerves throughout the body to the brain. |
| _____ 7. Urinary system | G. Responsible for breaking larger molecules into smaller to obtain nutrients |

Identification of Macromolecules

Objective: To identify various nutrients/macromolecules present in a given food samples by running chemical tests using appropriate reagents.

Introduction: In this lab, you will learn how to test various nutrients present in a given food sample. Biological molecules can be classified into four major groups

Carbohydrates

Lipids

Proteins

Nucleic Acids

Each of these molecules have unique characteristics and important roles in all living things. Detection of these organic molecules is an important first step.

Part I: Establishing the controls

Each test will be completed twice. The first time you will conduct the experiment with a known sample. The second time you will conduct the experiment with water. Record your results (the color change) in the appropriate columns on the data sheet. The known samples are the positive control (we see the reaction); while water is a negative control (we don't see a reaction).

Part II: Identification of Unknowns

Now that you have identified a positive and negative reaction, use your results to identify your unknown substance. Record results in the appropriate columns on the data sheet.

Indicators for the Food Sample – Please use appropriate safety procedures for this laboratory activity

To test for the presence of proteins: Biuret Solution

1. Put 10 drops of your sample in a test tube
2. Add 3 drops of biuret
3. Shake and observe

To test for the presence of simple sugars: Benedict's Solution

1. Place 3 ml of your sample in a test tube
2. Add 10 drops of Benedict's solution
3. Heat in a water bath for 5 minutes and observe.

To test for the presence of starch: Iodine

1. Put 5 drops of you sample on a watch glass.
2. Add 2 drops of iodine
3. Mix and observe.

To test for the presence of lipids: Emulsion Test (a Lipid Paper Test is commercially available also)

1. Add 20 drops of your sample to a test tube
2. Add 20 drops of absolute ethanol to sample
3. Shake vigorously to dissolve lipid
4. Add an equal amount of cold water (a cloudy white suspension should form in the presence of a lipid)

To test for the presence of Vitamin C: Indophenol

1. Place 4 drops of your food sample on a watch glass
2. Add 2 drops of indophenol
3. Stir and observe

To test for the presence of salt: Silver Nitrate

1. Place 4 drops of your food sample on a watch glass
2. Add 3 drops of silver nitrate

Results and Observations – Record Color Change

Macromolecule	Indicator	Positive Control	Negative Control
Protein	Biuret		
Simple Sugar	Benedict's		
Starch	Iodine		
Lipid	Ethanol		
Vitamin C	Indophenol		
Salt	Silver Nitrate		



UNKNOWN SAMPLE RESULTS

Now you will be given a mystery solution that contains one or two nutrients. Your job is to determine which one or two of the nutrients are in your unknown solution.

To identify the macromolecules, you will need to use the indicators from the previous experiment. Pay careful attention to your results, and determine whether or not each nutrient is present in your unknown. Use the results from the positive and negative controls as a comparison.

Test Conducted	Color Change	Positive or Negative
Biuret		
Benedicts		
Iodine		
Emulsion		
Indophenol		
Silver Nitrate		

Conclusion: My unknown sample contains the nutrients

Name _____

Period _____

Date _____

THE UNIVERSE WITHIN Scavenger Hunt

Directions: Complete the scavenger hunt while touring THE UNIVERSE WITHIN.

I. The Musculoskeletal System Word Scramble

1. ticncootnar_____

2. sbneo_____

3. ulcsme_____

4. tngmilea_____

5. otenkesl_____

II. The Brain or Central Nervous System

Name the sense and the part of the body responsible for transmitting the message to the brain. Can you trace the messages route to the brain?

Sense	Body Part Responsible

III. The Peripheral Nervous System – Can you find these words?

D U E C M E R A L K O W P U X
W R S X V Q E G G C T X M I E
R V O R A V V M S A R C V Y L
N T E C I H Y H R S Q W L F F
Z N N M L B U F G H R J D D E
C K G C O A E T P C R E T R R
B Z O R F I N H M Y P G N H O
T E B N I H R I B Z W H L H V
C Z X I W E C Y P W C A K U H
N Q G W A O H P U S V D M H F
J N Z T B H V H N I T P L B L
C O E R A R F I B E R H V T Z
D F V Z M L A O W Z O O D P W
S U O N H O Y I L N K G F G E
G P D N E Z U H N B H I R K A

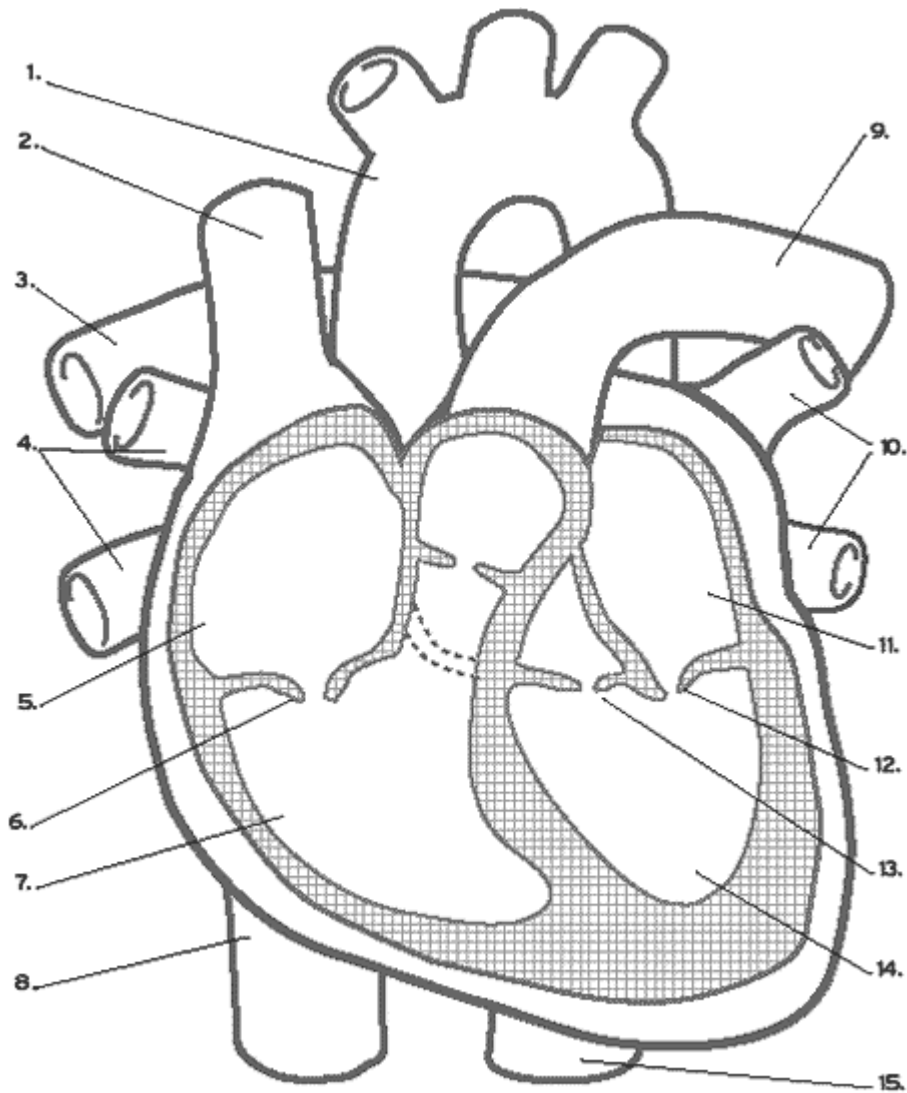
Brain
Spinal Cord
Fiber
Reflex
Nerve

IV. Digestive System – Diagram the path your food takes through the digestion process. Include the mouth, esophagus, stomach, small and large intestine

V. Respiratory System – Using a Venn diagram, compare the healthy and unhealthy lungs on display.

VI. Cardiovascular System – Label as many parts of the heart as you can.

Heart Diagram



VII. Urinary System – Name the different waste products filtered out by the urinary system. How many can you get?

AFTER YOUR VISIT ACTIVITIES

HERE ARE SOME LABORATORY ACTIVITIES TO FOLLOW UP ON YOUR EXPERIENCE WITH OUR BODY – THE UNIVERSE WITHIN

DIGESTIVE ENZYME LABORATORY ACTIVITY

CIRCULATORY SYSTEM LABORATORY ACTIVITY

ANIMAL DISSECTION (ACTUAL OR VIRTUAL)

- FETAL PIG DISSECTION (AP BIOLOGY CURRICULUM)

THERE ARE SEVERAL LABORATORY ACTIVITIES AVAILABLE ON-LINE .

SOME SUGGESTIONS INCLUDE

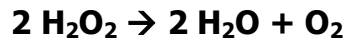
1. BUILD A STETHOSCOPE
2. BUILD A LUNG
3. SYSTEM MODELS OR MURALS
4. COMPARING THE RELATIONSHIP OF BODY PARTS
5. REVIEW GAME USING HUMAN FACTS



Enzyme Investigation

The enzyme catalase speeds up the breakdown of hydrogen peroxide (H₂O₂) and oxygen gas (O₂).

The reaction is described by the following equation:



Problem

How does the concentration of an enzyme affect the rate of a reaction?

Objective

Perform a controlled experiment to draw a conclusion about the function of enzymes.

Materials

Each laboratory group should have these ingredients:

1. Potato extract solutions (Catalase can also be found in other food sources, such as liver)
2. 1% hydrogen peroxide solution
3. 8 50-mL beakers
4. Distilled water
5. Filter paper disks
6. Forceps
7. Paper towels

Procedure

1. Catalase is found in potato extract. Using 5 of the 50-mL beakers prepare the 5 solutions of potato extract that are described in the table shown. Label each beaker to indicate the percentage of potato extract in the solution.
2. Label each of the remaining 3 beakers H₂O₂. Pour 23 mL of the 1% hydrogen peroxide solution into each beaker.
3. Using the forceps, dip a filter paper disk into the beaker labeled 0% potato extract. Keep the disk in the solution for 4 seconds, and then remove it.
4. Place the disk on a paper towel for 4 seconds to remove any excess liquid.
5. Using the forceps, transfer the filter paper disk to the bottom of one of the beakers labeled H₂O₂. The enzyme in the potato extract catalyzes the formation of bubbles of oxygen gas, which causes the disk to rise to the surface.
6. Release the filter paper disk. Have one person in your group measure how long it takes for the bubbles to carry the disk to the top of the beaker. Record the time in the data table similar to the one shown on the next page.
7. Repeat steps 6 two more times, using the other two beakers labeled H₂O₂.
8. Repeat steps 3 to 7 for each of the four remaining potato extract solutions.

9. Calculate the average rising time for each of the potato extract solutions. Record this information in your data table.

Solution Potato Extract Distilled Water

Solution	Amount of Potato Extract	Amount of Distilled Water
0% Potato Extract	0 ml	20 ml
25% Potato Extract	5 ml	15 ml
50% Potato Extract	10 ml	10 ml
75% Potato Extract	15 ml	5 ml
100% Potato Extract	20 ml	0 ml

DATA TABLE

Beaker	Rising Time Trial 1	Rising Time Trial 2	Rising Time Trial 3	Average Rising Time
0% Potato Extract				
25% Potato Extract				
50% Potato Extract				
75% Potato Extract				
100% Potato Extract				

DATA ANALYSIS

Graphing: Identify the following prior to constructing your graph.

Independent Variable _____ Range of Values _____

Dependent Variable _____ Range of Values _____

Construct a graph (either by hand or on the computer) that plots the concentration of potato extract (on the X axis) versus the average rising time (on the Y axis).

Discussion Questions

1. Suppose you had dipped a filter paper disk in a 30% potato extract solution. Using the graph, predict how long it would take this disk to rise to the top of a beaker of H_2O_2 .
2. How does the concentration of the enzyme affect the rate of the breakdown of hydrogen peroxide? Use the results of this experiment to justify your answer.
3. Using the materials from this laboratory, discuss how enzymes function. Be sure to identify the substrate, enzyme, and product.

More to Explore

Enzyme activity is essential to life processes. Additional areas for exploration include

- Affect of temperature on enzyme activity
- Affect of pH on enzyme activity
- Affect of enzyme or substrate concentration on rate of reaction

Lactose intolerance can be the result of a malfunctioning enzyme (lactase). Design an experiment to test for lactase activity. This lab can be performed using over the counter lactose intolerance aids.

Pulse Rate Laboratory Activity

Introduction

The circulatory system functions to deliver oxygen and nutrients to the tissues for growth and to remove metabolic wastes. The heart pumps blood through a circuit that includes arteries, capillaries, and veins. One important circuit is the pulmonary circuit where there is an exchange of gases within the alveoli of the lung. With increased exercise several changes occur within the circulatory system to increase the delivery of oxygen to actively respiring muscle cells.

PULSE RATE MEASUREMENT EXERCISE

The following series activities will involve some physical exertion in an attempt to study pulse rate relationships. **CAUTION:** Do not attempt these exercises in the physical activities could aggravate a health problem.

Part 1: Standing Pulse Rate

1. The subject should stand at ease for two minutes.
2. At the end of this time take your partner's pulse. Count the number of beats for 30 seconds and multiply by 2. Record this data in the data sheet provided.

Part 2: Reclining Pulse Rate

1. Work in pairs. One partner, the subject, should recline for five minutes quietly on the laboratory bench.
2. The subject should remain quiet and reclining for the next test!! While staying reclined and quiet, the other partner should determine the subject's resting pulse rate. Record this data in the data sheet provided.

Part 3: Baroreceptor Reflex

1. The resting subject should now stand up.
2. At this time the other partner should immediately determine the subject's pulse rate. Record this data in the data sheet provided.

Repeat Part 2 and Part 3 switching lab partners

Part 4: Stress Test -- Endurance

1. The subject should do 30 pushups, 30 sit-ups or 30 jumping jacks rapidly.
2. Immediately upon the completion of this exercise, measure the pulse for 15 seconds and multiply by 4.
3. Measure the pulse rate every subsequent minute until the pulse rate returns approximately to the level observed in Test 1. Record all pulse rate values in reference to the time after exercise. The time needed to return to a resting pulse rate is called cardiac recovery time.

PULSE RATE DATA

Exercise	Individual Pulse (Beats/min)	Partner Pulse (Beats/min)
Part 1 – Standing Pulse Rate		
Part 2 – Reclining Pulse Rate		
Part 3 – Baroreceptor Reflex		
Part 4 – Stress Test		
Pulse after exercise		
Pulse after 1 min		
Pulse after 2 min		
Pulse after 3 min		
Pulse after 4 min		
Pulse after 5 min		

Data Analysis and Conclusions

1. Graph the data for Part 4 (Pulse Rate versus Time). Be sure to label your graph appropriately.
2. What is your cardiac recovery time and how did it compare to your lab partners?
3. Explain why heart rate differs when measured in a reclining position and in a standing position.
4. Why is cardiac recovery time lower in an athlete than in a physically unfit person?
5. Why must an athlete exercise harder or longer to achieve a maximum heart rate than a person who is not physically fit?
6. Explain why the pulse rate which is measured from an artery provides a heart rate measurement.

Internet Resources

The Yuckiest Site on the Internet	http://yucky.discovery.com/index.html
Kids Health Organization	http://www.kidshealth.org /
National Institutes of Health—The Visible Human Project	http://www.nlm.nih.gov/research/visible/visible_human.html
BBC Human Senses	http://www.bbc.co.uk/science/humanbody/tv/humansenses
Innerbody	http://www.innerbody.com/htm/body.html
Grey's Anatomy	http://www.bartleby.com/107/
Organ System Pathology	http://www-medlib.med.utah.edu/WebPath/ORGAN.html
Virtual Pig Dissection	http://www.whitman.edu/biology/vpd/