The Canada Science and Technology Museum
presents

The Science of Sports

Section 2
The Human Body

CANADA SCIENCE AND
TECHNOLOGY MUSEUM

Canada

Introduction

The field of physiology, which includes the study of the mechanisms and requirements of organ systems, has changed the world of sports. Specially formulated supplements, sports drinks, and performance-enhancing hormones were originally created for high-performance athletes; however, many of them have now become available to everyone.

This section explores the respiratory, circulatory and musculoskeletal systems, as well as why sweat is important in regulating body temperature. The information presented to students will not only give them more insight into how physical activities affect the human body, but will also help them to make informed decisions about consumer products and performance-enhancing substances in the future.

This section includes the following components:

2.1. The Respiratory System
2.2. The Circulatory System
2.3. The Musculoskeletal System
2.4. Sweat and Why It's Important

Distinctive icons throughout this exploration guide indicate key features, helping you to navigate your way through the text quickly and efficiently.

 **Classroom Activity**	 **Discussion or Assignment Topic**
 **Deeper Study**	 **Website to Visit**

Activity Resources

Many of these activities require students to conduct research online. Worksheets for all activities are included at the end of this section. Teachers may request a package containing answers for the more complex activity sheets by e-mailing **virt_prog@technomuses.ca**. Please allow one to two weeks for a reply.

Activities

Activity 2.1. The Respiratory System

(Suitable for Grades 4 to 6)

In order to stay alive, all animals—humans included—need to breathe oxygen. The respiratory system is responsible for getting oxygen into the body. Once inside, this gas will eventually migrate into the bloodstream, which will transfer it to muscles and organs. Oxygen is necessary for life, because it reacts with the sugars and fats in the foods we eat, producing energy that our bodies can use.

Concepts

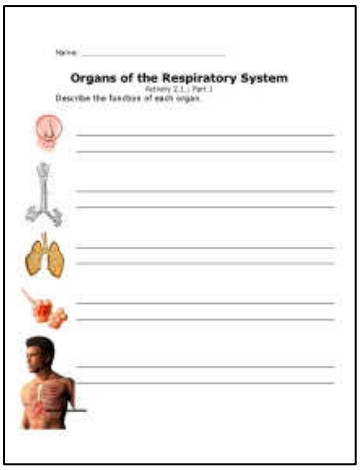
Respiration starts with the contraction of a muscle called the diaphragm. This contraction causes the chest cavity (the space inside the ribcage) to expand, allowing air to rush in (for more information on this, please see **Part 2: Building a Breathing Simulator**).

Air enters our bodies through the mouth and nose, which are both connected to the trachea by the larynx. Small particles in the air are filtered out—trapped in small hairs or mucus along the way.

The trachea separates into two bronchi, each directing air to a lung. Inside the lungs, the bronchi divide into many smaller tubes, through which the air will have to pass.

Finally, air reaches the alveoli, which are tiny air sacs. These sacs are lined with small blood vessels called capillaries. It is at this stage that the oxygen passes from the alveoli into the bloodstream. Blood vessels then carry the oxygen-rich blood to the heart, where it is pumped throughout the body.

For more information on the respiratory system and its organs, please visit the following website:
http://www.nhlbi.nih.gov/health/health-topics/topics/hlw/system.html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Organs of the Respiratory System

Activity 2.1.: Part 1

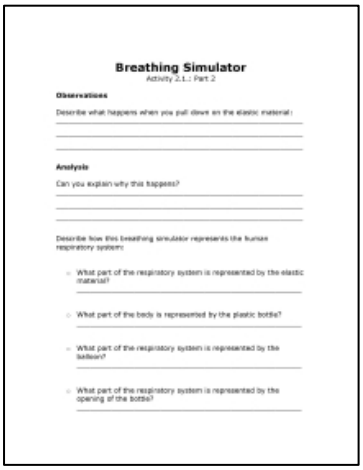
Describe the function of each organ.

Part 1: Organs of the Respiratory System

Objective: To identify and explore the major organs of the respiratory system.

1. Give each student a copy of the activity sheet. Students will describe the function of each organ by either referring to textbooks or the Internet, starting with the websites listed below.

http://science.nationalgeographic.com/science/health-and-human-body/human-body/


Breathing Simulator

Activity 2.1.: Part 2

Observations

Describe what happens when you pull down on the elastic material:

Analysis

Can you explain why this happens?

Describe how this breathing simulator represents the human respiratory system:

- What part of the respiratory system is represented by the elastic material?
- What part of the body is represented by the plastic bottle?
- What part of the respiratory system is represented by the balloon?
- What part of the respiratory system is represented by the opening of the bottle?

Part 2: Build a Breathing Simulator

Objectives:

a) To understand how oxygen enters the body.
b) To understand that air is matter, and will occupy a given volume.

To make a breathing simulator, students will need to follow the instructions listed in the activity sheet. Each student or group of students will need:

- A 1L or 2L empty pop or water bottle (stronger plastics work better)
- A balloon
- Duct tape
- A large piece of elastic material (such as a large balloon that has been cut open, or an elastic exercise band)

Students can be encouraged to bring in pop or water bottles from home to recycle for this activity.

As they are constructing their breathing simulator, students should note their observations on the activity sheet. After the activity, ask students to share and explain their observations.

Explanation: The elastic material, placed at the bottom end of the bottle, acts as a diaphragm: when it is stretched, it expands the chest cavity (the space inside the bottle). This creates an area of low air pressure (there are fewer air molecules by unit of volume inside the bottle). The air pressure on the outside of the bottle is now higher than that on the inside.

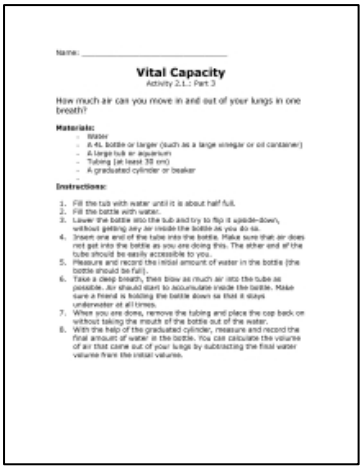
Air from the outside will therefore try to enter the bottle in order to equalize the pressure, inflating the balloon which has been placed over the bottle's spout. The end result should be equal air pressure inside and outside of the bottle.

This concept is also useful for understanding flight. For more information on air pressure, please visit the following website:

http://www.asc-csa.gc.ca/eng/educators/resources/spacesuit/pressure_life.asp

Other Activity: You may also wish to show students the breathing animation on this website:

http://teachhealthk-12.uthscsa.edu/studentresources/AnatomyofBreathing3.swf



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Vital Capacity

Activity 2.1.: Part 3

How much air can you move in and out of your lungs in one breath?

Materials:

- Water
- A 4L bottle or larger (such as a large vinegar or oil container)
- A large tub or aquarium
- Tubing (at least 30 cm)
- A graduated cylinder or beaker

Instructions:

1. Fill the tub with water until it is about half full.
2. Fill the bottle with water.
3. Lower the bottle into the tub and try to flip it upside-down, without getting any air inside the bottle as you do so.
4. Insert one end of the tube into the bottle. Make sure that air does not get into the bottle as you are doing this. The other end of the tube should be easily accessible to you.
5. Measure and record the initial amount of water in the bottle (the bottle should be full).
6. Take a deep breath, then blow as much air into the tube as possible. Air should start to accumulate inside the bottle. Make sure a friend is holding the bottle down so that it stays underwater at all times.
7. When you are done, remove the tubing and place the cap back on without taking the mouth of the bottle out of the water.
8. With the help of the graduated cylinder, measure and record the final amount of water in the bottle. You can calculate the volume of air that came out of your lungs by subtracting the final water volume from the initial volume.

Part 3: Measuring Vital Capacity

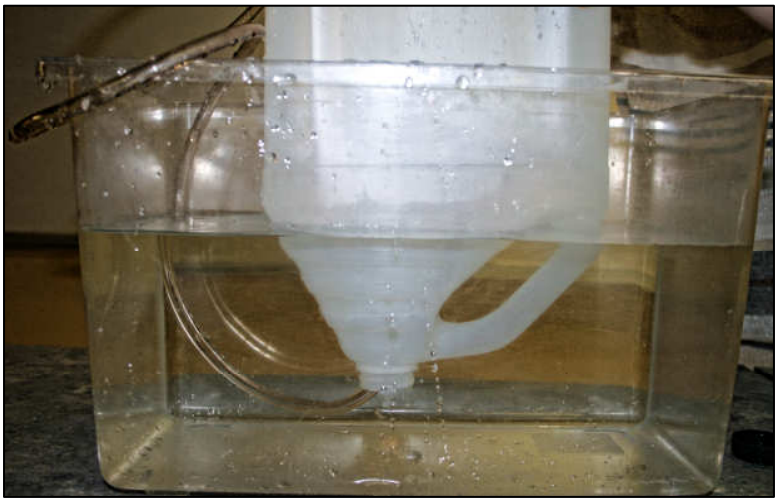
Objectives:

a) To understand that there is a limited amount of air that can be moved in and out of the lungs.
b) To understand that air is matter, and will take up space inside the ribcage.

In general terms, vital capacity* refers to the amount of air a person can move in to and out of the lungs with each breath. Vital capacity is dependent on the volume (or size) of the lungs.

1. Using the directions on the activity sheet, have each student measure their own vital capacity. For this activity, each student or group of students will need:
   - Water
   - An empty 4L bottle or larger (such as a large vinegar or oil container)
   - A large tub or aquarium
   - Tubing (at least 30 cm)
   - A graduated cylinder or beaker

2. Ask students to record their observations.



***Note on Vital Capacity:** Vital Capacity (VC) is the volume of air a person can move in to and out of the lungs by first inhaling the largest possible volume of air, then exhaling the largest possible volume of air. There is always a certain amount of air left in the lungs called Residual Volume (RV). Total lung capacity is equal to the VC plus the RV. Since it is not possible to determine the Residual Volume in this activity, the total lung capacity is not addressed here.

Interesting fact: People born at higher altitudes will have a naturally higher lung capacity (and bigger lungs) than those living at lower altitudes. This is because there is less oxygen at high altitude, and the body must breathe in more air in order to absorb enough oxygen to function.

Name: _____

The Effects of Exercise

Activity 2.1.: Part 4

Have a friend record how many breaths you take during a span of 20 seconds. Complete the table below.

	Number of breaths taken in 20 seconds	Calculated number of breaths per minute (60 seconds)
At rest (time = 0)		
After 5 minutes of jogging		
After 10 minutes of jogging		
After 15 minutes of jogging		
5 minutes after stopping		
10 minutes after stopping		

On another sheet of paper, make a graph of your findings, using the example below as a guide:

Number of breaths per minute

Time

After making your graph, what can you say happens to the number of breath per minute when you exercise?

_____

_____

Why do you think this happens?

_____

_____

Part 4: Effects of Exercise

Objective: To observe that a person's breathing rate is not constant—it will adjust to the amount of oxygen needed by the body.

1. In pairs, have students record the number of breaths per minute at rest, every 5 minutes as they are jogging, and every 5 minutes after they have stopped exercising.

2. Ask them to record their findings on the activity sheet.

3. With the data they have collected, students will be able to graph the number of breaths per minute over time.

Activity 2.2. The Circulatory System
(Suitable for Grades 4 to 6)

The circulatory system includes the heart, arteries, veins and blood. It is responsible for providing muscles and vital organs with oxygen and nutrients. The circulatory system is closely monitored in high-performance athletes. Heart rate is used, for example, to determine how hard an athlete has been working.

Concepts
In the lungs, blood will acquire oxygen and release carbon dioxide. The blood is then brought back to the heart, where it will be pumped out to the rest of the body. The blood vessels that carry oxygenated blood are called arteries. The arteries branch off into smaller vessels to transport blood to all parts of the body. The smallest blood vessels are called capillaries; these surround muscles and organs, and are the means by which oxygen leaves the blood and enters other tissues. At the same time, carbon dioxide from the tissues enters the bloodstream and is carried back to the heart by veins.

Blood is made up of several different components: plasma (mostly water and nutrients), white blood cells (which are a part of our immune system), and red blood cells. Red blood cells contain a pigment called hemoglobin, which is responsible for getting oxygen from the lungs to the muscles and organs. Some athletes cheat by injecting red blood cells into their bodies in order to increase the amount of oxygen that reaches their muscles. This can improve their performance and endurance, but can also result in higher blood viscosity, leading to heart conditions or clotting. This practice is commonly called “blood doping” and is both illegal and dangerous.

Some athletes will try to boost their red blood-cell count naturally by training at high altitude. In these areas, the concentration of oxygen in the air is decreased, which results in lower amounts of oxygen in the circulatory system. This stimulates the body to produce more red blood cells. When the athlete returns to a lower altitude, they will have a higher count of red blood cells than if they had trained with the same intensity and regularity at the lower altitude.

For more information about the circulatory system, please visit the link below:

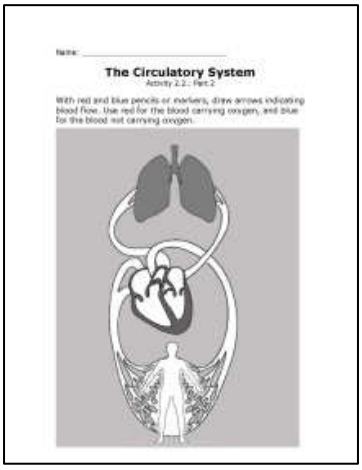
http://library.thinkquest.org/5777/cir1.htm

Part 1: What is Blood?

Objective: To discover that blood is not just a liquid, but a suspension of cells and nutrients.

Classroom Demonstration: Blood is made of several components, such as plasma (mostly water and nutrients), red blood cells (responsible for bringing oxygen to cells and eliminating carbon dioxide), and white blood cells (a system of defence that fights infections as part of our immune system). To demonstrate that blood is not just a liquid but really a suspension of various cells, you can create an analogous mixture as a class demonstration.

To do this, take a 1L clear container and add 550 mL of water (you can add a sprinkle of salt and sugar, as these are also present in the plasma). Next, add 440 mL of sand (each grain represents a red blood cell), and finally 10 mL of small white beads (as small as possible) to represent white blood cells. Close the lid of the bottle or container and shake. Voila: blood!


Name: _____

The Circulatory System

Activity 2.2.: Part 2

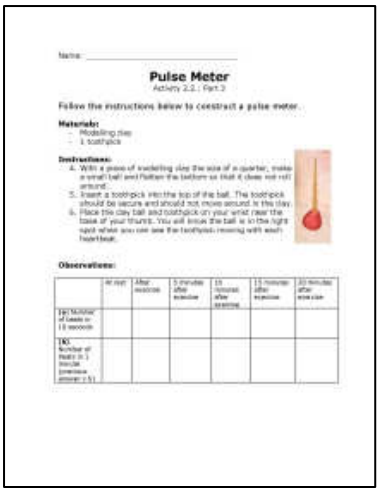
With red and blue pencils or markers, draw arrows indicating blood flow. Use red for the blood carrying oxygen, and blue for the blood not carrying oxygen.

Part 2: Organs of the Circulatory System

Objective: To identify and explore the major components of the circulatory system.

1. Give each student a copy of the activity sheet. Ask them to trace the flow of blood through the heart, arteries and veins.
2. Students should understand that the heart pumps blood to both the lungs and the body. The blood returning from the body through the veins contains very little oxygen. The heart pumps this blood to the lungs, where oxygen is added. The oxygenated blood then returns to the heart, where it is pumped to the rest of the body.
3. There are many animations on the Internet illustrating blood flow. Students can explore the websites below to fill in their activity sheet.

http://www.neok12.com/Circulatory-System.htm



Pulse Meter

Activity 2.2 : Part 3

Follow the instructions below to construct a pulse meter.

Materials:

- Modelling clay
- 1 toothpick

Instructions:

4. With a piece of modelling clay the size of a quarter, make a small ball and flatten the bottom so that it does not roll around.
5. Insert a toothpick into the top of the ball. The toothpick should be secure and should not move around. In this step, ...
6. Place the clay ball and toothpick on your wrist near the base of your thumb. You will know the ball is in the right spot when you can see the toothpick moving with each heartbeat.

Observations:

	At rest	After exercise	5 minutes after exercise	10 minutes after exercise	15 minutes after exercise	20 minutes after exercise
(A) Number of beats in 10 seconds						
(B) Number of beats in 1 minute (previous answer x 6)						

Part 3: Making a Pulse Meter

Objective: To calculate heart rate.

Athletes will frequently monitor their heart rates to determine how hard they have been exercising. As it is sometimes difficult to find a pulse, students can construct a device that will make the task easier. Each student will need:

- Modelling clay (about the size of a quarter)
- 1 toothpick

1. Students should follow the instructions on the activity sheet to construct their pulse meter.
2. Ask each student to calculate their heart rate per minute. Students should be able to count the number of beats for 10 seconds, and then calculate their heart rates in beats per minute.
3. Athletes often measure their recovery time—the time it takes for the heart rate to return to its normal resting rate. Have students do a vigorous activity for 20 minutes (e.g., an obstacle course, climbing the school stairs as fast as they can, etc.). Afterwards, get each student to measure their heart rate. Repeat at five-minute intervals. Students should record this data on their activity sheets.

Additional Online Resources: For more information on the circulatory system, please visit these websites:

http://kidshealth.org/kid/htbw/heart.html#

http://bio-alive.com/animations/anatomy.htm

Long-Term Assignment

Throughout the school year, for instance every two weeks, have students measure their heart rate recovery times. As students are required to do some physical activity each day, they may be able to lower their recovery times by the end of the school year.

Activity 2.3. The Musculoskeletal System

(Suitable for Grades 4 to 6)

The musculoskeletal system includes muscles, bones, ligaments and tendons. All of these work together to allow the human body to move. In this section, students will learn about muscle contraction and reflexes. They will also explore how muscles and bones work together to function as simple machines.

Concepts

The underlying structure of the human body is made of bones. Bones give us our form, allow certain movements, and protect our internal organs. Muscles attach to the bones, allowing the bones to move as the muscles expand and contract.

The human skeleton, as it is located inside the body, is called an endoskeleton. This is different from an exoskeleton, which is located outside the body as in many insects. Bones are composed of cells and calcium. Just like muscles, bones are living tissues that require oxygen and nutrients. Bones are constantly being broken down and rebuilt. Just as our muscles get larger with more exercise, our bones can be modified to respond to physiological needs (although this process is much slower).

Ligaments are tissues that link one bone to another. Tendons, on the other hand, attach muscles to the skeleton. Ligaments and tendons work with bones and muscles to allow movement of the body.

Classroom Discussion: Ask your students if they know which bones (or group of bones) act as support in our bodies (for example: the spine); which bones act as protection (for example: the ribcage); and where in our bodies bones allow for movement (the joints). Write down the students' answers on the board. You can use a picture or poster of the human skeleton to help students during this discussion.

For more information about the anatomy of muscles and bones, please consult the following links (please note that these links are intended for teachers only and are not suitable for students).

http://training.seer.cancer.gov/anatomy/

http://www.nlm.nih.gov/medlineplus/tutorials/muscles/op309103.pdf

http://kidshealth.org/parent/general/body_basics/bones_muscles_joints.html

Part 1: Reaction Time

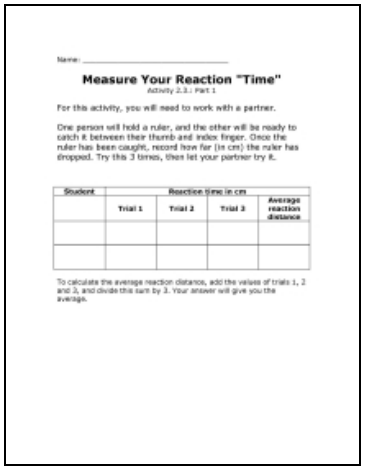
Objective: To learn about how our muscles are stimulated, and the importance of reaction time in sports.

The contractions and expansions of muscles are controlled by the nervous system. If you wanted to lift an apple, for example, your brain would send a message to the nerves in your arm, which would signal the muscles to expand and contract until the apple was securely in your hand.

Sometimes, the message to activate your muscles does not need to come from the brain. This is called a reflex. In the case of a reflex, the message will come from nerves in your spinal cord. The reaction time will be much shorter, as the message does not need to travel as far.

There are many ways to test the time it takes for the brain to process a stimulus (something seen or felt), before sending a message to the muscles to expand or contract:

1. In a big field, have students arrange themselves in one line. Make sure everyone can hear you. Tell them that when you say "green light" they should run forward, and if you say "red light" they should stop in their tracks. Students will discover how long it takes them to stop after they hear "red light." You can also try saying "red light" twice to see how many students start running, as they will be expecting to hear "green light".
2. The game of baseball is also a great way to have students test their reaction times, as well as the coordination between their eyes, brain and muscles.



Name: _____

Measure Your Reaction "Time"

Activity 2.3.: Part 1

For this activity, you will need to work with a partner.

One person will hold a ruler, and the other will be ready to catch it between their thumb and index finger. Once the ruler has been caught, record how far (in cm) the ruler has dropped. Try this 3 times, then let your partner try it.

Student	Reaction time in cm			
	Trial 1	Trial 2	Trial 3	Average reaction distance

To calculate the average reaction distance, add the values of trials 1, 2 and 3, and divide this sum by 3. Your answer will give you the average.

3. On way to test reaction time is to have one student catch a ruler that another student drops into their hand, and measure in centimetres how far the ruler dropped. This distance is representative of the reaction time. The longer the distance, the slower the reaction time. Have each student measure this distance, and record the data in a table. For students who have a fast reaction time, you can ask them if they participate in any sports that would require this skill—perhaps are a hockey goalie or a handball player.

For more information about the importance of quick reaction times in sports, please visit this website:

http://www.exploratorium.edu/hockey/save1.html

Part 2: Muscles and Bones as Levers

Objectives:

a) To explore the different classes of levers.

b) To understand that some of our bones and muscles can work together as levers.

Muscles and bones work together to keep the body upright, to lift the weight of each limb and, when needed, lift, push or pull other objects. Some of our muscles and bones form simple machines called levers. A simple machine is a device that helps us perform work (to move an object for a certain distance) with less force.

A lever consists of a straight rod and a pivot point called the fulcrum. When one part of the lever is acted upon by a force (i.e., a push or a pull), the other part can move a weight (an object). There are three different classes of levers, each with varying positions for the force, the weight and the fulcrum.

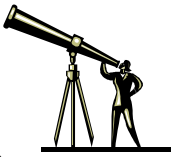
1. Make a Class 1 lever, with an eraser as the fulcrum and a ruler as the rod. Use this lever to lift something like another eraser. You can have all students do this with you at the same time. Discuss with students where the weight was placed, where the force was applied, and where the fulcrum was placed.
2. With the same materials, make a Class 2 lever and a Class 3 lever. Descriptions of different classes of levers are available at the following link:

http://www.enchantedlearning.com/physics/machines/Levers.shtml

Classroom Discussion: Ask students what we use levers for, and if they have ever used one in everyday life. They may mention teeter-totters, wheelbarrows, catapults or various toys. However, all humans (and animals) use levers everyday, as their bodies are full of them. Ask them if they can think of examples in the body.

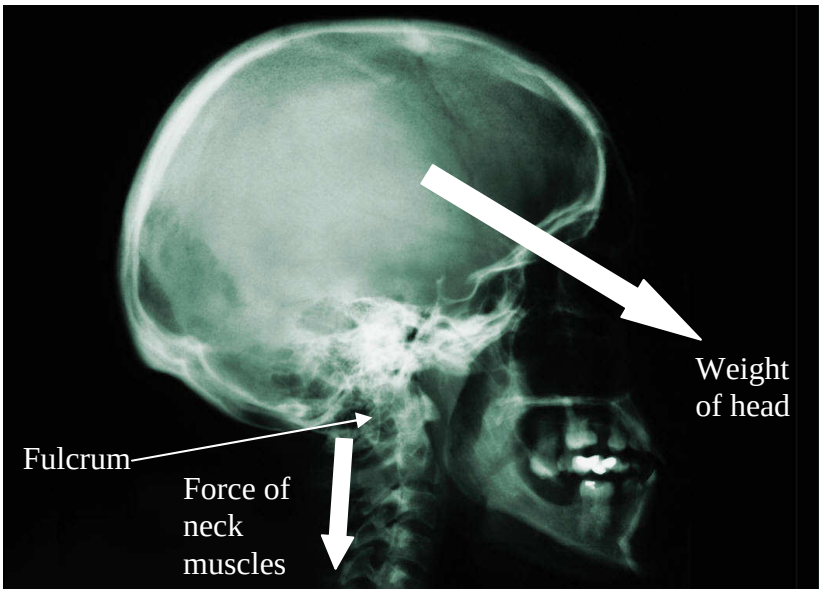
Most levers in the human body are Class 3 levers. Class 3 levers are not as good at lifting large weights, but they are useful in another capacity: increasing speed at the extremity of the lever, which allows for faster movements.

Deeper Study: Levers in the Human Body



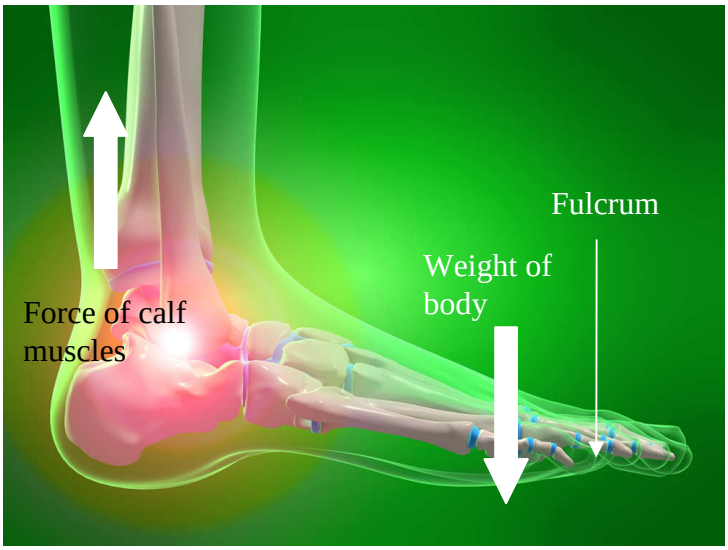
Class 1 Lever

Ask students if they can find a Class 1 lever in their bodies. In a Class 1 lever, force is applied on one side of the fulcrum, while the weight is on the other side, just as in a teeter-totter. After allowing students time to explore, tell them that a great example is the neck. The fulcrum is the joint connecting your head to your neck, the weight is your head, and the force is applied by the muscles in your neck.



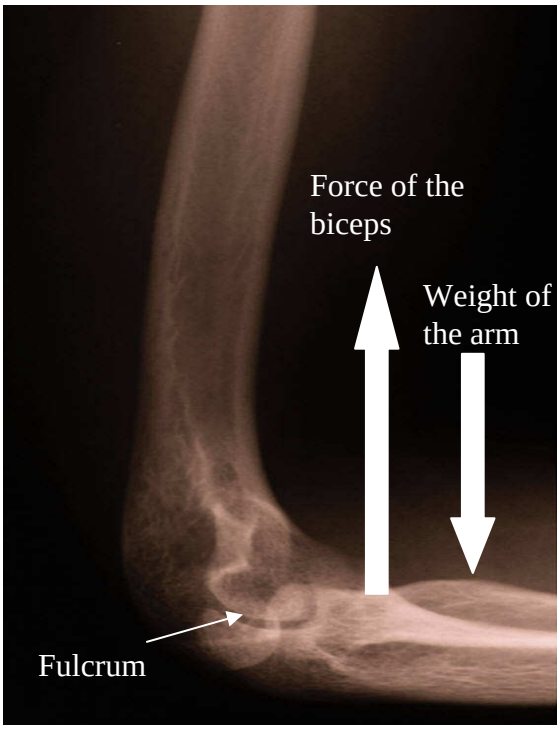
Class 2 Lever

Ask students if they can find a Class 2 lever in their bodies. In a Class 2 lever, the weight is placed between the force and the fulcrum, just like in a wheelbarrow. After allowing the students time to explore, ask everyone to get on their tippy-toes. Ask them where, in their feet, they think the fulcrum is. The answer should be “the toes”. Ask them what they think the weight is; the answer should be “the weight of the entire body”. You can ask them where they feel the pressure of their weight. The answer should be “very close to the fulcrum” (i.e., their toes). Ask them where the effort is coming from—in other words, which muscles do they feel contracting. The answer should be “the calf muscles”.



Class 3 Lever

Ask students if they can find a Class 3 lever in their bodies. In a Class 3 lever, the effort is exerted between the fulcrum and the weight. Have students explore this principle on their own for a bit. If you want to give them a hint, ask them to lift something heavy in one of their hands. Have them observe where the weight is, where the fulcrum is, and what muscles are doing the work. They should find the fulcrum at the elbow joint; the weight is the weight of their arm, plus whatever they are holding in their hand. The effort is made by the bicep. If they have observed closely, they will notice that this muscle is attached in front of the elbow joint—meaning between the weight and the fulcrum—making this system a Class 3 lever.



Part 3: Levers in Sports

Name: _____

Levers in Sports

Activity 2.3.: Part 3

For a sport of your choosing, answer the questions below.

Sport: _____

Describe at least one way in which a player uses a lever:

Is this lever part of the player's body?

Describe where the fulcrum, the rod, the force and the weight are in relation to one another:

Make a diagram, including all the things mentioned in the last question:

How does this lever increase the ability of the player to perform?

What would happen if the player could no longer use the lever? Would they still be able to play?

Objective: To demonstrate that levers are integral parts of our daily activities.

Sports often incorporate equipment that acts like a lever, such as a hockey stick. In the school gym, ask each student to shoot a puck towards a net. Ask them what the rod of the lever is, where the fulcrum is, and where the effort is made. Have students play ball hockey *without* sticks; in other words, using only their hands. Afterwards, discuss the advantages and disadvantages of a longer lever.

If your gym is equipped with flat, square trolleys, you can also try the following activity. Ask each student to sit on a trolley, lined up facing the wall with at least two metres between each other. The goal is for students to roll across the gym, propelling themselves by using their hands as oars. Explain that they are using their arms as levers.

Research Assignment: Ask students to choose a sport that makes use of levers or other simple machines. Have them complete the activity sheet and present their findings to the class. Their research could start with these websites:

http://www.exploratorium.edu/hockey/shooting1.html

http://www.olympic.ca/en/sports/

http://www.olympic.org/sports

Activity 2.4. Sweat and Why It's Important

(Suitable for Grades 4 to 7)

Glands are organs that secrete substances either into the bloodstream (these are called endocrine glands), or into body cavities and onto the surface of the body (these are called exocrine glands). Endocrine glands can secrete chemicals called hormones, which travel through the bloodstream and alter the function or metabolism of the cells that receive them. On the other hand, sweat glands are exocrine glands, as they secrete a mixture of water and salts onto the surface of the skin.

In this section, students will learn about the importance and composition of sweat, and will take a critical look at sports drinks.

For more information about sweat and the endocrine system, please visit the links below:

http://kidshealth.org/kid/talk/yucky/sweat.html

http://kidshealth.org/parent/general/body_basics/endocrine.html

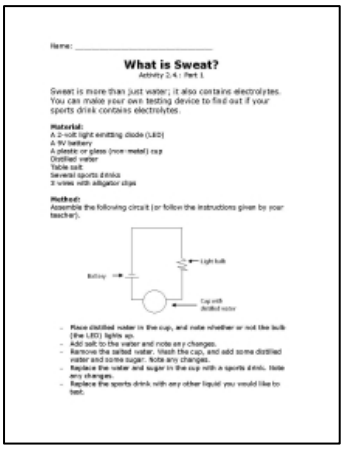
Classroom Discussion: Engage all students in strenuous physical activity for at least 20 minutes. Afterwards, in a group discussion, have students describe all the changes that their bodies underwent during the activity (for example: rapid breathing, faster pulse, redness in the face, perspiration, fatigue, etc.).

Hopefully, some students will have noticed that they perspire during heavy physical activity. Ask students why they think this happens, and note all of their hypotheses on the board for everyone to see. You can discuss how the students would go about testing these hypotheses.

After this brainstorming session, you can tell students that sweat is used to cool down the body when it is exerting itself. There are glands underneath the skin that secrete this liquid. Ask the students if they can think of why a liquid on the surface of the skin would help to cool it down.

Classroom Demonstration: To demonstrate the answer, take two medium balloons: one filled with air, and the other filled with water. Using a Bunsen burner or a barbecue lighter, direct the flame close to the bottom of the air balloon. Ask students what they think will happen. The balloon should pop, because the flame will melt the rubber.

Do the same with the water-filled balloon and ask students what they think will happen this time. The balloon should not pop. The balloon stays intact because the heat from the flame gets absorbed by the water. The water molecules 'use' the heat from the flame to change from a liquid state into a gaseous state. The same thing happens to our bodies when we sweat. The sweat on our skin will use the heat from our bodies to help it evaporate, thus leaving our bodies cooler.



Name: _____

What is Sweat?

Activity 2.4 - Part 1

Sweat is more than just water; it also contains electrolytes. You can make your own testing device to find out if your sports drink contains electrolytes.

Material:
A 2-volt light emitting diode (LED)
A 9V battery
A plastic or glass (non-metal) cup
Distilled water
Table salt
several sports drinks
3 wires with alligator clips

Method:
Assemble the following circuit (or follow the instructions given by your teacher).

- Place distilled water in the cup, and note whether or not the bulb (the LED) lights up.
- Add salt to the water and note any changes.
- Remove the salted water. Wash the cup, and add some distilled water and some sugar. Note any changes.
- Replace the water and sugar in the cup with a sports drink. Note any changes.
- Replace the sports drink with any other liquid you would like to test.

Part 1: What is Sweat?

Objective: To explore the properties of electrolytes.

Ask students what they think sweat is made of. If they have ever tasted a drop of their own sweat, they know that it is slightly salty. Sweat contains many substances including salts that form electrolytes in water. Sports drinks often contain salts to replenish the body's supply.

Electrolytes help maintain the balance of fluids inside and outside cells. Without their presence, it would be difficult to get water into the cells, even if you drank a lot of it.

Students can explore the conductive properties of electrolytes by following the instructions on the activity sheet. For this activity, each team of students will need:

- A 2-volt light emitting diode (LED) or small light bulb

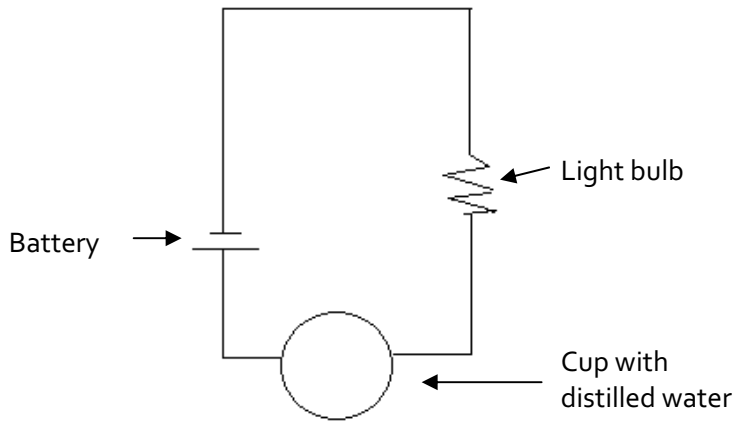
(available in most electronics stores)

- 3 wires with alligator clips

(available in most electronics stores)

- A 9V battery
- A plastic or glass (non-metal) cup
- Distilled water
- Table salt
- Several sports drinks

Students will have to build the following circuit:



Concepts

Electrolytes are atoms that carry an electrical charge—either positive or negative. Electrolytes will make a substance, such as water, electrically conductive. Electrolytes are present in our blood and other bodily fluids, such as sweat and tears. They help regulate the amount of water inside and outside our cells, as well as fulfilling many other functions.

For instance, table salt (NaCl) separates into two different types of electrolytes in water: Na^+ and Cl^-. These two electrolytes are found in the body, and are important to ensure that the water we drink makes its way into the cells that need it.

When we sweat, the salt in our body gets depleted. This is why many sports drinks include salt.

Name: _____

Making Your Own Sports Drink

Activity 2.4 : Part 2

Follow the instructions below to make your own sports drink.

3. Name your sports drink and draw a logo.

4. Base:

1L of water
1/2 cup (80 ml) of sugar
¼ tablespoon (4 ml) of salt

5. Flavours and colours:

This is the time to get creative! You can use many things to flavour and colour your drink, but make sure you are not adding too much sugar or salt.
For example, you could add:

- Vanilla, orange, banana or any other type of extract.
- Unsweetened water flavouring (the type that comes in powdered form)
- Small amounts of food colouring

4. Sell your product:

Give a brief presentation to your class. Tell them what makes your sports drink unique and better than all the others.

5. Taste test:

Taste your own sports drink, and taste the sports drinks made by your classmates, to determine which one is best. Make sure you ask your teacher's permission first.

Part 2: Sports Drinks

Objective: To understand the components of sports drinks, and to think critically about how they are marketed.

Sports drinks are typically made with three main ingredients. Firstly, they contain water to rehydrate the body after excessive perspiration. Secondly, they contain sugar for taste and energy, and to accelerate the rate at which water is absorbed by the body. Thirdly, they contain salt to replenish electrolytes.

Students can follow the instructions on the activity sheet to create their own sports drink. For this, each student or team of students will need:

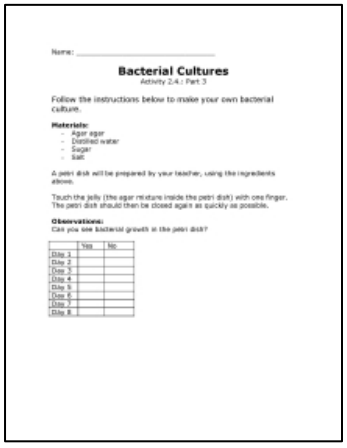
- 1L of water
- 45 ml (3 tablespoons) of sugar
- 4 ml (1/4 tablespoon) of salt

In addition, students can choose flavours and colours for their drinks. They can use many things to flavour and colour their drink, but make sure that they do not add too much sugar or salt. For example, they could add:

- vanilla, orange, banana or any other type of extract.
- unsweetened water flavouring (the type that comes in powdered form)
- small amounts of food colouring

Afterwards, ask students to think of creative ways to advertise their products such as:

- creating a poster
- recording a radio ad
- creating a short TV commercial



Name: _____

Bacterial Cultures

Activity 2.4 : Part 3

Follow the instructions below to make your own bacterial culture.

Materials:

- Agar agar
- Distilled water
- Sugar
- Salt

A petri dish will be prepared by your teacher, using the ingredients above.

Touch the jelly (the agar mixture inside the petri dish) with one finger. The petri dish should then be closed again as quickly as possible.

Observations:
Can you see bacterial growth in the petri dish?

	Yes	No
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		
Day 8		

Part 3: Why Does Hockey Gear Stink?

Objective: To illustrate that bacteria live on our skin. It is these bacteria, accumulating in hockey gear, that cause an unpleasant odour.

Ask students if they have ever noticed that hockey equipment (or any other sports equipment) develops a strong odour after several uses.

Sweat itself does not stink; it is the bacteria living on the

skin's surface, or on pieces of sports equipment, that causes an unpleasant odour. By following the instructions on the activity sheet, students will be able to see the colonies of bacteria that live on their skin.

For this activity, each student or team of students will need:

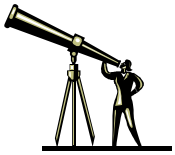
- 1 new (sterile) petri dish prepared with:
  - Agar-agar (a powder found in health food stores or from science suppliers)
  - Water
  - Sugar
  - Salt

(For best results, replace with salt and sugar with LB broth or another 'bacteria food' available at a low price from science suppliers)

You will need to prepare the petri dishes in advance. To prepare the petri dish:

- Follow the directions on the agar-agar package and dilute it in boiling water.
- Add sugar and salt while the mixture is still boiling.
- Pour the agar mixture into a petri dish or small bowl. Cover and refrigerate until jelly-like.

After students inoculate the petri dish, it can take a few days for the colonies of bacteria to become visible.



Extension Activity (Grade 7): Some glands, called endocrine glands, release substances such as hormones into the bloodstream. Hormones are natural chemicals found in the body. They induce changes in the metabolism of specific parts of the body. For example, adrenaline is a hormone that can increase heart rate, constrict blood vessels, etc. Some athletes will illegally supplement their bodies with certain hormones in order to boost their performance. There are many risks attached to this type of activity. Students can research a few common hormones that are used as performance enhancers.

Some common examples include:

- Human growth hormone (HGH)
- Anabolic steroids
- Erythropoietin or Hematopoietin (EPO)

Other, lesser-known performance-enhancing hormones include:

- Human Chorionic Gonadotrophin (HCG)
- Adrenocorticotropic hormone (ACTH)
- Tetrahydrogestrinone (THG)
- Glucocorticosteroids

For more information about performance-enhancing hormones, please visit the links below:

http://kidshealth.org/teen/food_fitness/sports/steroids.html#

http://teens.drugabuse.gov/facts/facts_ster1.php

http://www.wada-ama.org/en/Education-Awareness/Youth-Zone/Get-the-Facts/

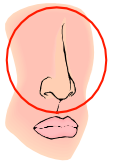
Students should describe what these hormones are, what they do in the body normally, why they are used as performance enhancers (benefits), as well as the risks related to using them.

Name: _____

Organs of the Respiratory System

Activity 2.1.: Part 1

Describe the function of each organ.



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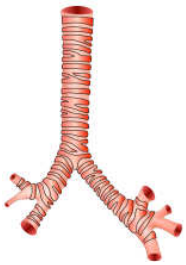

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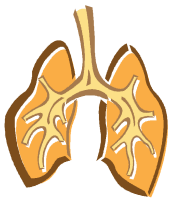

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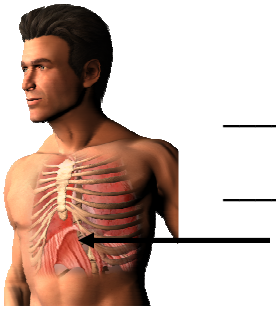

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_____

Name: _____

Breathing Simulator

Activity 2.1.: Part 2

Observations

Describe what happens when you pull down on the elastic material.

_____

_____

_____

Analysis

Can you explain why this happens?

_____

_____

_____

Describe how this breathing simulator represents the human respiratory system.

- What part of the respiratory system does the elastic material represent?

  _____

- What part of the body does the plastic bottle represent?

  _____

- What part of the respiratory system does the balloon represent?

  _____

- What part of the respiratory system does the opening of the bottle represent?

  _____

Name: _____

Vital Capacity

Activity 2.1.: Part 3

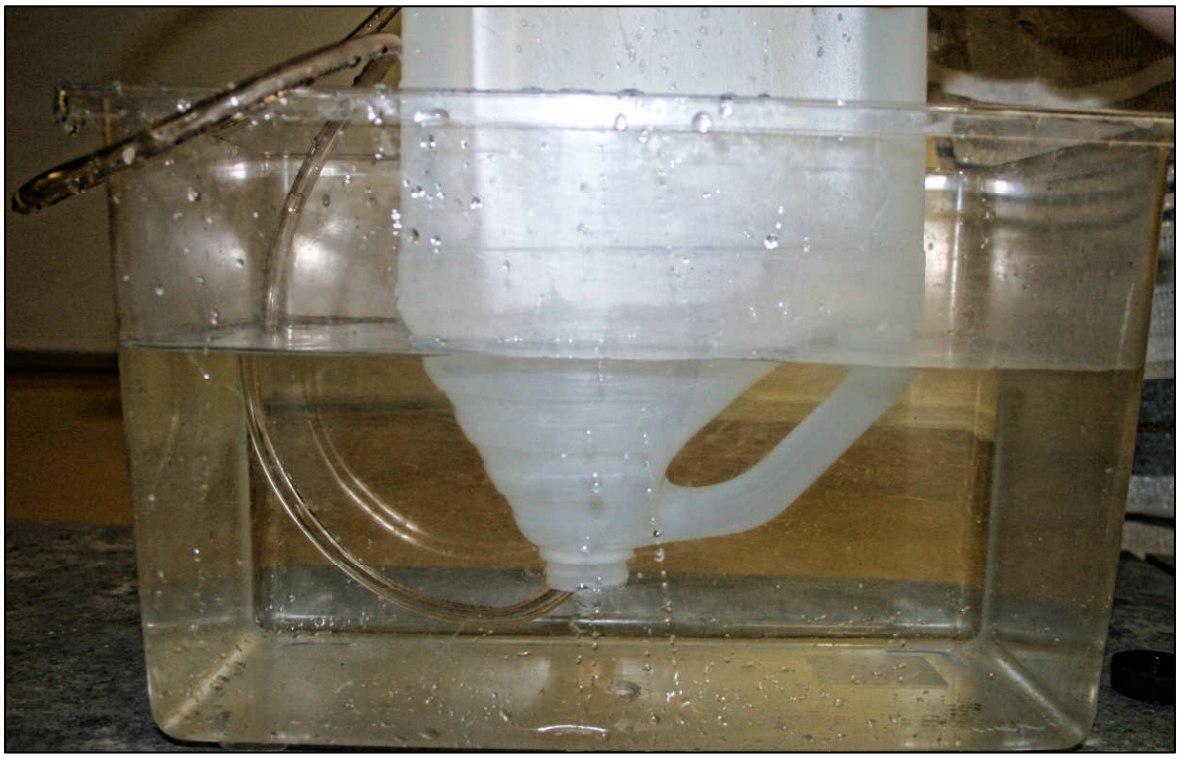
How much air can you move in and out of your lungs in one breath?

Materials:

- Water
- An empty bottle with a volume of at least 4L (such as a large vinegar or oil container)
- A large tub or aquarium
- Tubing (at least 30 cm)
- A graduated cylinder or beaker

Instructions:

1. Fill the tub with water until it is about half full.
2. Fill the bottle with water.
3. Lower the bottle into the tub and flip it upside-down without getting any air inside the bottle.
4. Insert one end of the tube into the bottle, making sure that no air gets into the bottle. The other end of the tube should be easily accessible to you.
5. Measure and record the initial amount of water in the bottle (the bottle should be full).
6. Take a deep breath, and then blow as much air into the tube as possible. Air should start to accumulate inside the bottle. Make sure that a friend is holding the bottle down so that it stays underwater at all times.
7. When you are done, remove the tubing and place the cap back on the bottle without taking its mouth out of the water.
8. With the help of the graduated cylinder, measure and record the final amount of water in the bottle. You can calculate the volume of air that came out of your lungs by subtracting the final water volume from the initial volume.



Observations:

Name	Initial water volume (mL)	Final water volume (mL)	Air volume/ lung capacity (mL)

Name: _____

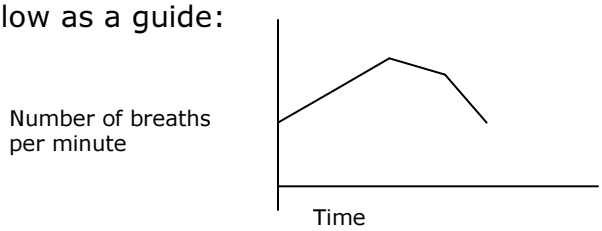
The Effects of Exercise

Activity 2.1.: Part 4

Have a friend record how many breaths you take during a span of 20 seconds. Complete the table below.

	Number of breaths taken in 20 seconds	Calculated number of breaths per minute (60 seconds)
At rest (time = 0)		
After 5 minutes of jogging		
After 10 minutes of jogging		
After 15 minutes of jogging		
5 minutes after stopping		
10 minutes after stopping		

On another sheet of paper, draw a graph to present your findings using the example below as a guide:



According to your graph, what happens to the number of breaths per minute when you exercise?

_____

_____

Why do you think this happens?

_____

_____

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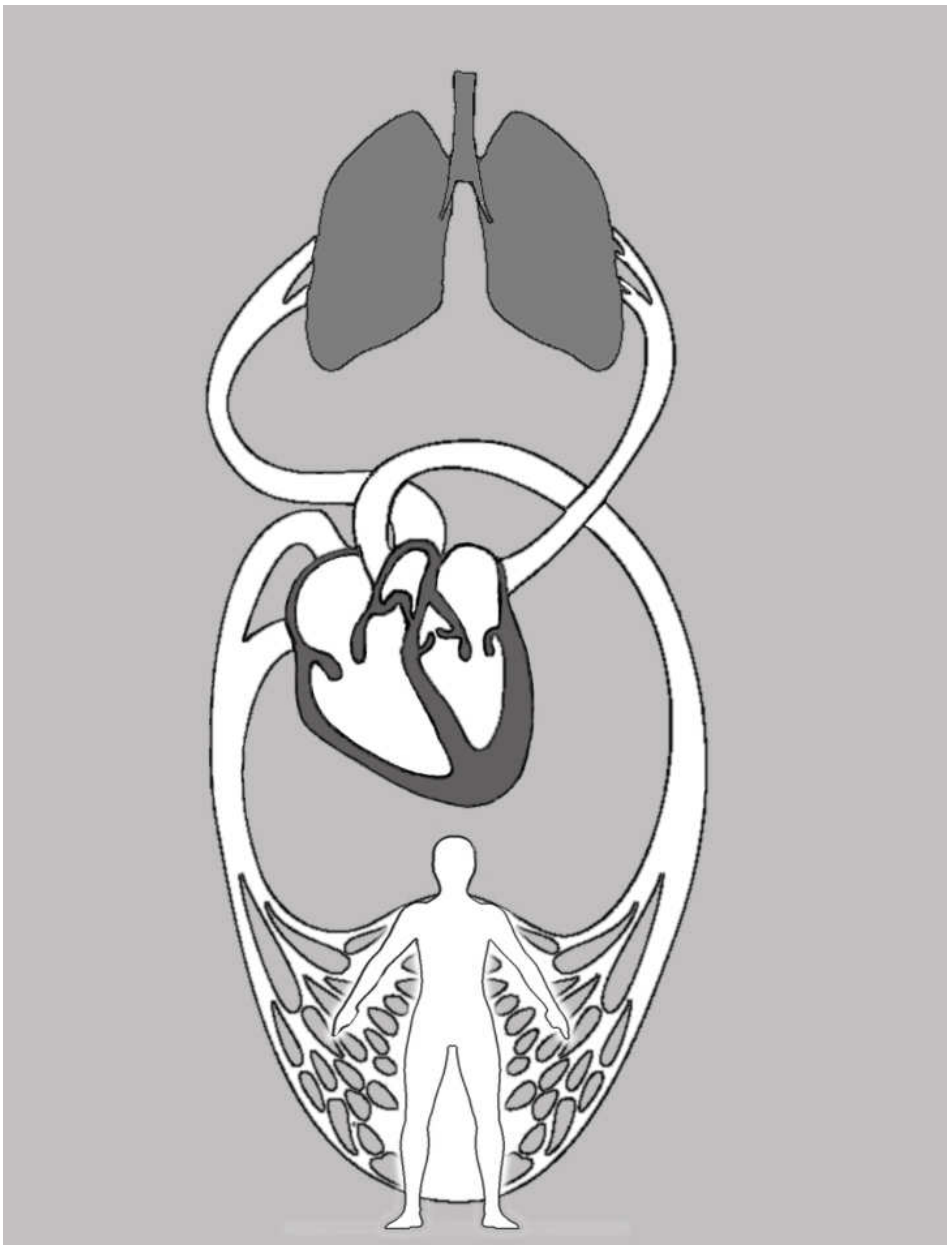
The Circulatory System

Activity 2.2.: Part 2

Using red and blue pencils or markers, draw arrows indicating the flow of blood. Use red for the blood carrying oxygen, and blue for the blood not carrying oxygen.



Name: _____

Pulse Meter

Activity 2.2.: Part 3

Follow the instructions below to construct a pulse meter.

Materials:

- Modelling clay
- Toothpick

Instructions:

1. Use a piece of modelling clay the size of a quarter to form a small ball and flatten the bottom so that it does not roll around.
2. Insert a toothpick into the top of the ball. The toothpick should be secure and should not move around in the clay.
3. Place the clay ball and toothpick on your wrist near the base of your thumb. You will know the ball is in the right spot when you can see the toothpick moving with each heartbeat.

Observations:

	At rest	After exercise	5 minutes after exercise	10 minutes after exercise	15 minutes after exercise	20 minutes after exercise
(a) Number of beats in 10 seconds						
(b) Number of beats in 1 minute (previous answer x 6)						

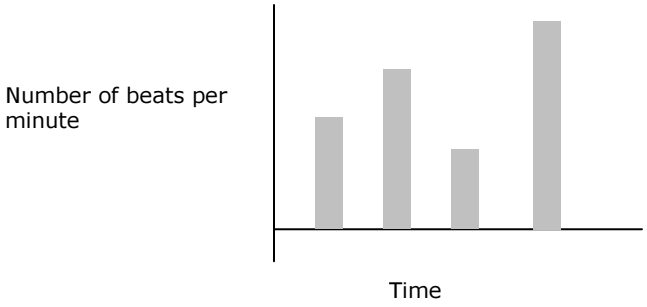
Name: _____

Pulse Meter

Activity 2.2.: Part 3

Results:

On a separate sheet of paper, graph the beats per minute (section b) over time. You can use the example below as a guide.



Analysis:

What happens to the heart rate (beats per minute) as you increase the duration of exercise?

_____

_____

_____

_____

Why do you think this happens?

_____

_____

_____

_____

Name: _____

Measure Your Reaction 'Time'

Activity 2.3.: Part 1

For this activity, you will need to work with a partner.

One person will hold a ruler, and the other will be ready to catch it between their thumb and index finger. Once the ruler has been caught, record how far (in cm) the ruler has dropped. Try this 3 times, and then let your partner try it.

Student	**Reaction 'time' in cm**			
	Trial 1	**Trial 2**	**Trial 3**	**Average reaction distance**

To calculate the average reaction distance, add the values of trials 1, 2 and 3, and divide this sum by 3. Your answer will give you the average.

Name: _____

Levers in Sports

Activity 2.3.: Part 3

For a sport of your choosing, answer the questions below.

Sport:_____

Describe at least one way in which a player uses a lever:

_____

_____

Is this lever part of the player's body?

_____

_____

Describe where the fulcrum, the rod, the force and the weight are located in relation to one another:

_____

_____

_____

Draw a diagram, including all the elements mentioned in the last question:

How does this lever increase the player's ability to perform?

_____

_____

What would happen if the player could no longer use the lever? Would they still be able to play?

_____

_____

Name: _____

What is Sweat?

Activity 2.4.: Part 1

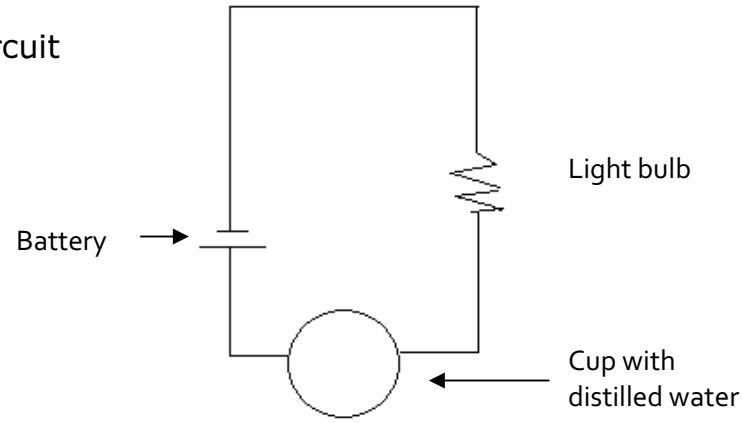
Sweat is more than just water—it also contains electrolytes. You can make your own testing device to find out if your sports drink contains electrolytes.

Material:

- A 2-volt light emitting diode (LED) or small light bulb
- A 9V battery
- A plastic or glass (non-metal) cup
- Distilled water
- Table salt
- Several sports drinks
- 3 wires with alligator clips

Method:

Assemble the following circuit (or follow the instructions given by your teacher).



- Place distilled water in the cup, and note whether or not the light turns on.
- Add salt to the water and note any changes.
- Remove the salted water. Wash the cup, and add some distilled water and some sugar. Note any changes.
- Replace the water and sugar in the cup with a sports drink. Note any changes.
- Replace the sports drink with any other liquid you would like to test.

Name: _____

What is Sweat?

Activity 2.4.: Part 1

Observations:

	Distilled water	Distilled water + salt	Distilled water + sugar	Sport drink	Other liquid
Does the light turn on?					

Analysis:

When did the light turn on? What substance had to be present?

_____

_____

_____

_____

Why do you think this substance is present in sports drinks?

_____

_____

_____

_____

Name: _____

Making Your Own Sports Drink

Activity 2.4.: Part 2

Follow the instructions below to make your own sports drink.

1. Name your sports drink and draw a logo.

2. Ingredients:

- 1L of water
- 45 ml (3 tablespoons) of sugar
- 4 ml (¼ tablespoon) of salt

3. Flavours and colours:

Get creative! You can use many things to flavour and colour your drink, but make sure you are not adding too much sugar or salt.
For example, you could add:

- Vanilla, orange, banana or any other type of extract.
- Unsweetened water flavouring (the type that comes in powdered form)
- Small amounts of food colouring

4. Sell your product:

Give a brief presentation to your class. Tell them what makes your sports drink unique and better than all the others.

5. Taste test:

With your teacher's permission, taste your own sports drink, and sample sports drinks made by your classmates to determine which one tastes the best.

Name: _____

Bacterial Cultures

Activity 2.4.: Part 3

Your teacher will provide you with a petri dish that contains a special jelly where bacteria can grow.

Open the petri dish, touch the jelly in the dish with one finger, and then close the dish as quickly as possible (to avoid any bacteria, besides that on your finger, from getting into the dish).

Observations:
Can you see bacterial growth in the petri dish?

	Yes	No	If yes, describe what you see
Day 1			
Day 2			
Day 3			
Day 4			
Day 5			
Day 6			
Day 7			
Day 8			