RESPIRATION

**Essential Question:** *Who's Coming to the Rescue?*

**Learning Targets:**

Students will:
- Build a model of the respiratory system.
- Explain the body as a system of interacting subsystems.
- Describe how respiratory distress affects heart rate.
- Create a graph to summarize data.

**Lesson Overview**

The adolescent skateboard accident patient is transported to the ER in this lesson. The ambulance arrives with two EMT’s at the Basic and Intermediate levels of training. Young Allied health professionals build a model of the respiratory system before completing a lab on respiratory distress that connects body systems and illustrates how labored breathing can impact heart rate. A computer-based extension invites them to look more closely at the ways body systems interact.
Lesson Agenda

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<td>Closure (10 min)</td>
<td>● An EMT and Me</td>
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</table>

Materials

- Young Allied Health Professional student packet
- The Respiratory System video (to project)
- Glue (one per table group)
- Colored pencils
- **Materials for exploration of respiration (one set per group):**
  - 2-liter bottle
  - 2 plastic drinking straws
  - 2 nine-inch balloons
  - One larger balloon
  - Play dough
  - 2 rubber bands
- **Materials for the Respiratory Distress Lab**
  - Procedure and Data Collection sheet (one per student)
  - Small, medium, and large straws (one per lab pair)
  - Timers (one per lab pair)
  - Respiratory Lab Graph (one per student)
- Controls, Variables, and Constants video (to project)

**FACILITATION NOTES**

**Narrative Arc.** This lesson and others in the unit take advantage of the first person narrative storytelling style. Have fun and get into character! The more each <Emergency Scenario> can be presented as if telling a story, the more engaged the audience will be. Work to avoid a stale
reading and lean towards bringing the information to life as in a conversation or a “reveal” of the next chapter. Think of creative ways to make the story your own.

**Background Knowledge.** Familiarize yourself with the process of respiration and how the body works to breathe. This lesson presents two ways of activating background knowledge on the Respiratory System—a non-computer and a computer option. Review both in advance and determine which option would be the best use of time for your students.

**Safety Consideration.** During the lab on respiratory distress, anyone who is sick or already has respiratory issues should not be the test subject. At any point, if the test subject gets light-headed, have them stop and take the respiratory rate and pulse.

**Lab Preparation.** Put students into groups of four prior to the class. Have materials for the lab separated ahead of time for each group.

**Data Interpretation.** Students may be in various stages of understanding experimentation and analyzing the results of data. Be prepared to offer more scaffolding or modeling than what is scripted in this lesson for some students or the whole class.

**ELL Students.** This is a vocabulary-intensive lesson. Focus on structures and processes, rather than having students learn definitions. Consider sheltered language protocols such as: pre-teaching simplified vocabulary, using a pictorial input chart, or offering an invitational group to support English language development. You can also choose to do the Brief Exploration of Respiration activity by making a single model to help illustrate the functional parts of the respiratory system (see below). Finally, the Guts and Bolts game provides a visual experience that focuses on function over terminology.

**Visual Model of the Lungs.** If choosing a Brief Exploration of Respiration activity, for each group gather the following materials: 2-liter bottle, 2 plastic drinking straws, 2 nine-inch balloons, one larger balloon, play dough, and 2 rubber bands. A single model can also be created to share with the class.

**IN ADVANCE**

- Prepare your lung model (if using). Gather materials. Remove labels and cut off the bottom of the 2 liter bottles. Watch videos to get a general idea for the process (actual instructions differ slightly). [https://www.youtube.com/watch?v=P_Cah94kYE](https://www.youtube.com/watch?v=P_Cah94kYE) (two lungs model), [https://www.youtube.com/watch?v=CBv2BqgAydE](https://www.youtube.com/watch?v=CBv2BqgAydE) (simplified model that requires only a straw).
- Preview The Respiratory System located at [https://www.youtube.com/watch?v=RPdGQ-A_ylM](https://www.youtube.com/watch?v=RPdGQ-A_ylM). It provides a humorous but educational explanation of the Respiratory System for
children. Laugh at the narrator with your students! It is a relatively short, comprehensive presentation that touches on the connection between the respiratory and circulatory systems. For a more academic video with additional vocabulary terms, see: https://www.youtube.com/watch?v=hc1YtXc_84A, Brain Pop (https://www.brainpop.com) also has a great library of educational videos that can be accessed through a school subscription.

☐ If using the computer option provided in this lesson to help students develop background knowledge on the Respiratory System, preview and play Guts and Bolts: https://www.brainpop.com/games/gutsandbolts/. You can reference the answer key provided in the Facilitator Documents as you move through the levels. It is recommended that you have students complete the first 5 levels only, though more advanced students may be able to get up to level 7.

☐ Review the Respiratory Distress Lab so you have a complete understanding of the lab.

☐ Preview the Controls, Variables, and Constants video found at https://www.youtube.com/watch?v=KaIOoN0EZ9c. You can show from 1:47-4:25 for the crucial information on variables. For an alternative video, which includes additional information about control variables, see: http://study.com/academy/lesson/identifying-interpreting-independent-dependent-variables.html (1:30-3:04).

☐ Create a model graph on your own to be clear about the expectations of the activity, as the graph has the potential to seem complicated for students. Drafting a model ahead of time will assist your explanations and provide support to students.


☐ An interactive diagram is available at: https://www.innerbody.com/image_card06/card94.html

☐ Know how to check your radial pulse:

The radial pulse is felt on the wrist, just under the thumb.
Vocabulary

<table>
<thead>
<tr>
<th>Content</th>
<th>Tier II</th>
</tr>
</thead>
<tbody>
<tr>
<td>respiration, respiratory rate, airway,</td>
<td>variable, transport, summary, assessment,</td>
</tr>
<tr>
<td>circulation, oxygen, diaphragm, bronchi,</td>
<td>probable, conduct, system, priority,</td>
</tr>
<tr>
<td>trachea</td>
<td>experiment, manipulate</td>
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Opening (5 min)

Emergency Ambulance Transport

As an Emergency Medical Technician, you arrive with sirens on your ambulance or by medical helicopter. It's a fast-paced experience; and you must enter the scene of the emergency with your brain ready for action. What has happened? Is the scene safe? Is the patient breathing? Is he bleeding out? What are the most critical injuries to address first? Time is of the essence.

1. **Ask**: Has anyone been present at an emergency scene or ridden in an ambulance?
2. **Invite** pairs to turn and talk and then share out a few of the stories.
3. **Share** the <Emergency Transport Scenario>.
4. **Ask** the YP’s to list some of the paramedic’s interventions to help the patient.
5. **Ask**: Who remembers the ABC’s of Emergency Response? Why are these so important?
   - **Listen for**: Airway, breathing, and circulation. The brain needs oxygen.

Work Time

A Brief Exploration of Respiration (15 min)

Today, you are going to learn about respiratory distress in a hands-on lab activity. Before we proceed, you will need to be familiar with the basic structures of the respiratory system. What are the parts of the respiratory system? What functions do they perform?

Today we are going to build a simplified model of our respiratory system that shows the interactions of the bronchi, lungs, and diaphragm as we breathe. This two-liter bottle represents...
our chest cavity. What might the two small balloons represent? (Lungs). The straws represent our bronchi, or two large tubes that connect our lungs to the trachea, or windpipe (touch windpipe). Follow along, and let's build a simplified respiratory system.

1. First, let's connect the lungs (hold up balloons) to the bronchi (hold up straws). Attach the balloons and secure them with the rubber bands.
2. Seal off the tops of the chest cavity with the play dough (where the lid would normally go). Insert your bronchi through the play dough through the bottom of the chest cavity.
3. Ask: Does anyone know what the muscle is called that expands and contracts as we breathe? (The diaphragm). The larger balloon represents the diaphragm. Stretch this out over the bottom of the bottle.
4. Now, let's make our respiratory system work. Pull down on the diaphragm. What do you notice? (The volume of the chest cavity increases, decreasing pressure and inflating the lungs). Take a deep breath and see if you can feel your diaphragm move down and your lungs expand.

Now, gently push the balloon in. What do you notice? (The balloon lungs contract as the volume of the chest cavity gets smaller and pressure increases).

Take a moment to draw a diagram of your respiratory system. Use the word bank and the basic terms to label the components. (Alternatively, have students attach labels to their model).

Alternative Activity: Review of Respiratory System (15 min)

Distribute the <Respiratory System Coloring Page> and colored pencils.

Today, you are going to learn about respiratory distress in a hands-on lab activity. Before we proceed, you will need to be familiar with the basic structures of the respiratory system. What are the parts of the respiratory system? What functions do they perform?

1. Invite students to close their eyes and inhale deeply, then exhale completely.

   o Ask: What are the structures of the respiratory system that work to make our bodies breathe?
   o Listen for: Lungs, trachea, nose, bronchi, mouth.
   o Ask: How do you think the respiratory system works to bring oxygen into your body?
   o Listen for: Answers will vary at this point.
3. In their student packets, students should write a summary of how the respiratory system works, using the vocabulary/labels from the coloring page and the information they learned from the video.

   o The YP's should color each part of the system a different color.
   o Encourage collaboration.

4. Invite volunteers to share out their completed work and summaries.

➢ The point is not for students to memorize the parts of the respiratory system, but to have a basic familiarity with the system's functions that will help them contextualize the Respiratory Distress Lab.

**Respiratory Distress Lab (20 min)**

You know that distressed breathing is a top concern in your emergency response work. A person can only live for about 3 minutes without oxygen. So, if your patient has an open airway (A), is breathing normally (B), and is not bleeding severely (C), you can slow down and take care of other injuries. Otherwise, you have to act fast to address the A, B, C's.

Today, we will explore the question, how does breathing affect circulation and the work of the heart?

1. Say: To complete the lab, you will need to find your pulse. To check your pulse at your wrist, place two fingers between the bone and the tendon over your radial artery—which is located on the thumb side of your wrist. Project a PowerPoint slide that contains a diagram for students to follow.
2. Explain that they will be conducting an experiment to collect data on the interconnectedness of the respiratory and circulatory systems.

   o Invite the young allied health professionals to join their assigned group of four.
   o Provide time for students to select their roles in their lab groups: lab director (conducts and oversees trials), test subject (participates in trials), data collector (keeps track of time and records data), and lab assistant (supplies straws, monitors safety of the test subject, and performs other tasks as needed).
   o Explain that they will work through the lab and record their data on the data chart.

3. With a volunteer, model measuring respiratory rate, or how many times someone breathes each minute, by watching the rise and fall of the volunteer's chest.
o **Demonstrate** finding the volunteer’s pulse: Instruct the young professionals to find their own pulse in their wrist or neck and to count the number of beats for 15 seconds.

o **Model** how to multiply this number by 4 in order to calculate the number of beats per minute (bpm).

4. **Distribute** the `<Respiratory Distress Lab: Procedure and Data Collection>`, the small, medium, and large straws, and the timer.

o **Model** the steps of the experiment in a "selected scenes" approach. Invite a volunteer to help you take your respiratory rate and pulse at rest. Go through quickly, just showing the actions for the Control Trial. Emphasize recording results.

o **Provide** time for students to work through the Control Trial. You will start and end the trials for the entire group.

5. After the control trial, **regroup** and model the Mild Respiratory Distress trial.

o **Provide** time for students to work through the Mild Respiratory Distress Trial.

6. **Repeat** the modeling and work time processes for the Moderate and Severe Respiratory Distress Trials.

7. With more independent groups, the lab director role can **take over** entirely if students are able to continue independently.

8. **Circulate** and **assist** groups as needed during each trial. When the data are collected, point out the blank graph in the lab packet.

**Data Analysis (15 min)**

The Health Sciences is an applied science, meaning it is used in the real world. Health Science involves knowing things about biology, chemistry, and physics, as well as understanding how to answer scientific questions. Those answers are often in the form of numbers, like your data tables from the lab exercise. These numbers then need to be analyzed, usually in the form of a graph. We are now going to interpret and analyze our data from the lab by creating a bar or line graph.

1. **Distribute** the `<Respiratory Distress Lab Graph>`.

2. **Point out** that the horizontal axis of the graph is the x-axis and the vertical axis of the graph is the y-axis. Highlight that this graph should have two y-axes labeled because two different data sources were collected: respiratory rate and pulse. They have different...
measurements and so need different bars/lines of reference.

3. **Model** how to plot two points of data on your graph on the projector or on the board.
   Show students how to plot points for a line graph and how to draw bars for a bar graph, so they can choose either format in their analysis.

4. **Project** the *<Controls, Variables, and Constants>* video. Show 1:47-4:25.

5. **Point out** that in this lab, we conducted an experiment because we actively manipulated variables.

6. **Ask:** *What are the variables in this experiment?*
   
   - **Use** equity sticks to call on a student to answer.
   - **Listen for:** *The size of the straw, exercise or no exercise, heart rate, and respiratory rate.*

7. **Provide** time for pairs to create their graphs.
   
   - Each person in the pair should have a completed graph, even if they are sharing their ideas.

8. **Circulate** and **help** the young professionals as needed.

### Writing to Learn (5 min)

1. **Distribute** the *<Respiratory Rate Reflection Questions>*.
2. **Tell** the young professionals that they should answer the reflection questions using their graphs.
3. When the reflection questions are answered, **invite** the lab groups to work together to share their answers and revise if needed.

### Guts and Bolts: Oxygen Through the Body (30 min- computer based)

You are a mad scientist trying to bring a machine to life! To do this, you will need to start with the fundamentals of constructing the various systems of the body. You begin with the respiratory system, which serves the purpose of getting oxygen to the body. It also connects to many other body systems. As you work to bring your machine to life, you will learn about these systems by focusing on their functions within the body. Moving through the challenges, you will want to take notes on the steps you have taken to build these systems, as they will start to work together in future steps.

*Pay attention to what needs to enter the organs and what is produced.*
1. **Direct** students to the *<Guts and Bolts>* site:

2. In their young allied health professional packets, students will **create** diagrams to reflect their work. They can use the blank diagram templates in their student packets for reference.

3. **Give** students time to explore the first five steps.

4. **Gather** their attention.

5. **Model** sketching a diagram (either on a PowerPoint or draw one up on the board).
   
   o **Highlight** making a key.

1. **Encourage** the YPs to continue exploring.

   o If the YPs experience frustration, encourage them to go back and repeat the previous step, taking notes.

1. **Circulate** and ask:

   o **What do the blue circles mean? The green pentagons? The yellow stars?**
   
   o **What is happening as the blood enters the lungs? As blood enters the stomach?**
   
   o **What do you notice about how these systems work together?**

➢ **The point of this activity is for students to have a basic familiarity of the system’s functions** that will help them contextualize the preceding lab and ongoing activities from the unit.

➢ **Diagramming functions and creating a key is a crucial processing step. Do not skip this.**

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**Closure (10 min)**

***An EMT and Me: Postcard Home***

*If you enjoy the thought of not only helping people, but also being on the front lines of medical care, entering an unknown situation, and figuring out the problem under pressure, then the job of EMT, paramedic, or emergency room nurse or doctor is for you. Each of those careers have varying levels of required training, from certification programs, to two-year or four-year colleges, or the commitment to get through medical school. In an emergency, the EMT and paramedic play very important roles, as their care can mean the difference between life and death. In this short closure activity, you will think about what elements of the EMT or paramedic career appeal to you—or don’t.*
When EMT’s are in college training, they participate in what’s known as “ride time.” This means they shadow a working EMT or paramedic to learn about the career and gain experience. In the past two lessons you have experienced a hint of the work of an Allied Health first responder by evaluating a patient and learning through the scenarios.

1. **Ask** the YPs to imagine sharing their experience as a first responder with a friend or family member.
2. **Invite** the YPs to create a postcard that describes the emergency situation and how they helped respond.
3. **Ask** the YPs to think of 2-3 things they might enjoy about the career of an EMT and a few things they might not like.
   - **Highlight** the scenarios and the poster of the EMT career as resources to find additional details and information.
   - **Model** the expectations projecting a poster slide and the postcard exemplar.
4. **Distribute** notecards and optional markers.
   - **Encourage** students to create an illustration on one side.
   - On the other side, students should **write** 2-3 things they enjoyed about the career of EMT, as well as a few things they may not have liked.
   - **Remind** them to include their name.
RESPIRATION: Who’s Coming to the Rescue?

Today’s Learning Objectives:

I can:

- Build a model of the respiratory system.
- Explain the body as a system of interacting subsystems.
- Describe how respiratory distress affects heart rate.
- Create a graph to summarize data.

The adolescent skateboard accident patient is transported to the ER in this lesson. The ambulance arrives with two EMT’s at the Basic and Intermediate levels of training. I will build a model of the respiratory system before completing a lab on respiratory distress that connects body systems and illustrates how labored breathing can impact heart rate. A computer-based extension will invite me to look more closely at the ways body systems interact.

Today’s Activities:

- Emergency Transport Scenario
- Activating Background Knowledge: The Respiratory System
- Respiratory Distress Lab
- Variable Debrief and Data Analysis
- Lenses on the Future: An EMT and Me
You are a member of a team of Emergency Medical Technicians (EMTs) from the City Emergency Ambulance Service. You are an Intermediate level professional EMT, and your colleague is a Basic level professional EMT. You were standing by in your ambulance when you received the call from Dispatch, “Calling City Ambulance #12. We have a report of a 13-year-old male, unconscious and bleeding outside the Big City Community Center.” You burst into action, siren wailing.

You arrive on the scene and see a first responder, the day camp director, caring for the patient. He summarizes the situation and his interventions and transfers care to you and your colleague. Because the patient remains unconscious, you are charged with loading him into the ambulance and transporting him to the Big City Emergency Hospital.

Next, you immediately insert a simple patent airway device into the patient’s mouth to keep his airway open and clear, an intervention that doesn’t guarantee survival, but makes it more likely. As you conduct a head to toe evaluation, you notice bruising around his eyes and ears, potential evidence of head trauma. You start an IV and then prepare the patient for transport. You remain in the back of the ambulance with the patient while your colleague turns on the sirens and drives towards the Big City Emergency Hospital.

As a paramedic, you can give interventions to patients almost like a doctor can. In the ambulance, you start the heart monitor to track vital signs. An ambulance nurse has called ahead to the Big City Emergency Hospital so that the team is ready to take over the care of the patient immediately upon arrival.
Respiratory System

During inspiration, air passes through the mouth and nose, down the throat, and through the trachea and bronchi to the lungs.

In the lungs, air travels through branching bronchioles which end in small clusters of microscopic sacs called alveoli.

Oxygen molecules are transferred from the alveoli into the bloodstream, and carbon dioxide moves out of the bloodstream and back into the respiratory tract where it is released through the mouth and nose during expiration.

1. sinus cavity
2. pharynx
3. larynx (voice box)
4. trachea (windpipe)
5. bronchi
6. lung
7. diaphragm: a muscular sheet separating the chest cavity from the abdominal cavity. It contracts to increase room in the chest cavity and draw oxygen into the lungs.
Guts and Bolts!

Directions: You are a mad scientist trying to bring a machine to life! To do this, you will need to start with the fundamentals of constructing the various systems of the body. You begin with the respiratory system, which serves the purpose of getting oxygen to the body. It also connects to many other body systems. As you work to bring your machine to life, you will learn about these systems by focusing on their functions within the body. As you move through the challenges, you will want to take notes on the steps you have taken to build these systems, as they will start to work together in future steps. Be sure to draw the correct paths for each step in the empty diagrams provided.

Notes:
Notes:
Notes:
STOP! There are many more systems that need to be added to bring our machine to life. For now, this gives you a general idea of how the **respiratory** and **circulatory** systems of the body function together.
# Respiratory Distress Lab: Procedure and Data Collection

## A. Control Trial

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Have the test subject sit and remain calm.</td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>Take the respiratory rate of your test subject. Use the back of your hand to feel each breath and count the number of breaths in 30 seconds. Multiply this number by 2 and record for “A. Control Trial for No Exercise” in Table 1.</td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>Take the pulse of your test subject. Find the radial pulse or the carotid pulse using your middle and index fingers. Count the number of beats in 15 seconds, then, multiply this number by 4 and record for “A. Control Trial for No Exercise” in Table 1.</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>Have the test subject exercise for 60 seconds. The test subject could try a variety of exercises: push-ups, jumping jacks, mountain climbers, jogging in place, etc.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>Immediately at the end of 60 seconds, have your test subject sit and take their respiratory rate and pulse. Record in “A. Control Trial for Exercise” in Table 1.</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>Have the test subject rest at least 2 minutes before starting the next step.</td>
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</table>

## B. Mild Respiratory Distress

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 7</strong></td>
<td>Have the test subject sit calmly and ONLY BREATHE through the LARGE STRAW for 60 seconds. The test subject will need to hold their nose closed to ensure they are only breathing through the straw.</td>
</tr>
</tbody>
</table>
Step 8
When the time is up, take the test subject’s respiratory rate and pulse. (Note: The test subject does not need to breathe through the straw while you are taking the respiratory rate or pulse). Record in “B. Mild Respiratory Distress for No Exercise” in Table 1.

Step 9
Have the test subject stand and jog in place for 60 seconds while ONLY BREATHING through the LARGE STRAW. The test subject may also do step-ups.

Step 10
IMPORTANT: IF AT ANY TIME THE TEST SUBJECT STARTS FEELING LIGHTHEADED OR IS SEVERELY SHORT OF BREATH, HAVE HIM OR HER STOP IMMEDIATELY AND SIT DOWN. TAKE THE RESPIRATORY RATE AND PULSE.

Step 11
Immediately at the end of 60 seconds, take the test subject’s respiratory rate and pulse. (Note: The test subject does not need to continue breathing through the straw while you are taking the respiratory rate or pulse). Record in “B. Mild Respiratory Distress for Exercise” in Table 1.

Step 12
Have the test subject rest, breathing normally (no straw) for at least 2 minutes before starting the next step.

C. Medium Respiratory Distress

Step 13
Repeat steps 7 – 12 using the MEDIUM STRAW. Record results in “C. Medium Respiratory Distress” in Table 1.

D. Severe Respiratory Distress

Step 14
Repeat steps 7 – 12 using the SMALL STRAW. Record results in “D. Severe Respiratory Distress” in Table 1.
# Health Sciences Module: Respiration

## Pathways to Prosperity Network

### 1. Control Trial – No Straw

<table>
<thead>
<tr>
<th></th>
<th>With No Exercise</th>
<th>With Exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respiratory Rate</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Pulse (BPM)</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>Respiratory Rate</strong></td>
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<td></td>
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<tr>
<td><strong>Pulse (BPM)</strong></td>
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</table>

### 2. Mild Respiratory Distress (Large Straw)

<table>
<thead>
<tr>
<th></th>
<th>With No Exercise</th>
<th>With Exercise</th>
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<tbody>
<tr>
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<td><strong>Pulse (BPM)</strong></td>
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</tbody>
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### 3. Medium Respiratory Distress (Medium Straw)

<table>
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<tr>
<th></th>
<th>With No Exercise</th>
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### 4. Severe Respiratory Distress (Small Straw)

<table>
<thead>
<tr>
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<th>With No Exercise</th>
<th>With Exercise</th>
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Respiratory Distress Lab Graph

Directions. Create a bar OR line graph summarizing your results from Table 1 in the grid below. Label your graph!
Respiratory Rate Reflection Questions

1. How did the straws represent different levels of respiratory distress?

____________________________________________________________________
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2. Describe how the respiratory rate was affected by mild, medium, and severe respiratory distress in this lab.

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____________________________________________________________________

3. Describe how the pulse was affected by mild, medium, and severe respiratory distress in this lab.

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Health Sciences Module: Respiration
Pathways to Prosperity Network
4. How did increasing respiratory distress impact the mental and emotional level of the test subject?

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

5. How did exercise impact the respiratory rate and pulse of the test subject?

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________
Facilitator Documents:

The radial pulse is felt on the wrist, just under the thumb

Respiratory Diagram Word Bank

Lungs

Diaphragm

Bronchi

Chest Cavity

Trachea (Windpipe)
Guts and Bolts Answer Key

This is for the teacher to reference during the Guts and Bolts activity. Students will have blank copies of this as part of their student packet.

Key Body System: Oxygen through the Body
You are a mad scientist trying to bring a machine to life! To do this, you will need to start with the fundamentals of constructing the various systems of the body. You begin with the respiratory system, which serves the purpose of getting oxygen to the body. It also connects to many other body systems. As you work to bring your machine to life, you will learn about these systems by focusing on their functions within the body. As you move through the challenges, you will want to take notes on the steps you have taken to build these systems, as they will start to work together in future steps.

Key

<table>
<thead>
<tr>
<th>Blue Circles</th>
<th>Oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow Stars</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>Green Pentagons</td>
<td>Nutrients</td>
</tr>
</tbody>
</table>

**Step 1:** First, we must pump oxygen into the machine via the blood “piping” system. Diagram with labels:
Step 2: **Oxygen** is transported to the machine via the blood piping system. **Carbon Dioxide** is also transported to the machine via a separate blood piping system. Finally, **oxygen, carbon dioxide, and nutrients** are all transported together via a third blood piping system. *Diagram with labels:*

![Diagram]

Step 3: Next, we must add the brain to our machine. **Oxygen, carbon dioxide, and nutrients** are all fed to the **brain** via the blood piping system. The brain then outputs **carbon dioxide**. *Diagram with labels:*

![Diagram]
**Step 4:** Now we are going to add the stomach and intestines to our machine. The stomach connects directly to the intestines. We also need to construct a pipe that leads out from the bottom of the intestines so there is a place to eliminate waste. When we eat, nutrients are transported into the stomach and intestines. Meanwhile, oxygen is pumped via the blood piping system into the intestines, which then output oxygen, carbon dioxide, and nutrients back into the body.
Step 5: Next, we need to add the lungs and diaphragm to the machine. The lungs are directly connected to the diaphragm. As oxygen enters the lungs, they expand, causing the diaphragm to contract. The oxygen is then released into the blood piping system. As carbon dioxide is transported from the blood piping system, the diaphragm expands so that the lungs can pump the carbon dioxide back into the air.

STOP! There are many more systems that need to be added to bring our machine to life. For now, this gives you a general idea of how the respiratory and circulatory systems of the body function together.

Health Sciences Module: Respiration
Pathways to Prosperity Network
For students who advance through steps 1-5 quickly and have time to tackle more, please reference the diagrams below:

**Step 6:** Combines steps 4 and 5.

**Step 7:** Shows how the respiratory and circulatory systems interact via the introduction of the heart.