

ADVANCED KIT

# Breathing Robots

Designing Robots to  
Demonstrate the Respiratory System

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INTERACTIVE 5E LESSON

UBTECH  
EDUCATION

## LESSON

# Breathing Robots

### DRIVING QUESTION

How does our respiratory system work?

### DESCRIPTION

During this lesson, students will research the parts that make up the respiratory system to better understand how oxygen enters our body and carbon dioxide exits it. They will then build and code a robot to demonstrate this process using a diagram they create.

### LEARNING GOALS

#### STUDENTS WILL:

- **DISCUSS** the role of the respiratory system in the body.
- **COLLECT** information on the respiratory system/path throughout the body.
- **UTILIZE** that information to create a simulation.
- **BUILD** and **CODE** a robot to create a simulation of the respiratory system.

### STANDARDS

- **NGSS: MS-LS1-3:** Use arguments supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
  - **Wisconsin CTE Standard 4C1:** Students will think and work creatively to develop innovative solutions to problems and opportunities.
  - **Wisconsin CTE Standard 4C3:** Students will communicate and collaborate with others to accomplish tasks and develop solutions to problems and opportunities.
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### GETTING STARTED

#### TIME ESTIMATE

3-4 sessions (60 minutes each)

#### MATERIALS

- UKIT Advanced
- Butcher block paper
- Markers, pens, crayons, or colored pencils
- Small item to represent oxygen
- Small item to represent carbon dioxide
- Laptops or Chromebooks
- Optional: Tape that can be used on the floor

## LESSON RESOURCES

- ["5 min Cardio HIIT Workout"](#)
- [Respiratory System Diagram](#)
- [Respiratory System Table](#)
- ["Travel through the Respiratory System - Fun Science for Kids"](#)
- ["Your Lungs & Respiratory System"](#)
- [uCode](#)

## VOCABULARY

<b>CARBON DIOXIDE</b>	a heavy colorless gas that does not support combustion, dissolves in water to form carbonic acid, is formed especially in animal respiration and in the decay or combustion of animal and vegetable matter, is absorbed from the air by plants in photosynthesis, and is used in the carbonation of beverages
<b>OXYGEN</b>	a chemical element that constitutes 21% of the Earth's atmosphere, that is capable of combining with all elements except some noble gases, that is active in physiological processes of almost all known organisms, and that is involved especially in combustion
<b>RESPIRATORY SYSTEM</b>	a system of organs functioning in respiration and in humans consisting especially of the nose, nasal passages, pharynx, larynx, trachea, bronchi, and lungs

## TEACHER PREP

- Review lesson plans and lesson links to make sure they are still working. Several different videos can be substituted depending on your school access.
- Ensure available devices have the Arduino IDE app installed and uCode is accessible through a web browser. Chrome is preferred.
- Determine student pairs or groups for this lesson.
- If time permits, build a MoveBot and program it to pick something up and move it to a new location. This will be expected of students during this lesson, so it will help you troubleshoot if they run into issues.

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## 5E LESSON PLAN

### ENGAGE

Use the first five minutes of class to work out, something that will get the students breathing a little harder than they normally would. YouTube has some excellent five-minute HIIT workout videos that get students moving. [This is one](#) I like to use.

Once you complete the video, discuss how breathing wasn't something they were thinking about before the video, but on completion of the video, they are feeling and thinking about their breathing. They have an accelerated breathing rate because their body/cells need more oxygen to produce more ATP (adenosine triphosphate), or energy.

### EXPLORE

Using the [Respiratory System Diagram](#) and [Respiratory System Table](#), have students research how the **RESPIRATORY SYSTEM** works and what body parts/organs are included in this system. You could show the video "[Travel through the Respiratory System](#)," have students read "[Your Lungs & Respiratory System](#)," or just allow students time to research the topic on their own or in small groups.

Once students have completed their research, have them work in groups to create a labeled diagram of the respiratory system on butcher block paper. This diagram needs to be large enough for the MoverBot to travel through it. Make sure students draw and label the **nasal cavity, pharynx, larynx, trachea, lungs, bronchioles, bronchi, alveoli, and diaphragm**.

If you are unable to use butcher block paper, you could also create the diagrams right on the floor using tape. The only problem will be that it will need to remain there, as they will need to work on it for a few days.

### EXPLAIN

Students should be able to communicate with each other, and you, about how the respiratory system works. Their explanation should include how **OXYGEN** travels through the body.

*For example: When we breathe in, we are collecting the air around us, which includes oxygen. It travels through our body in this order: nasal cavity, pharynx, larynx, trachea, lungs, bronchioles, bronchi, and alveoli. From there, it gets distributed throughout the body, and the lungs then collect the **CARBON DIOXIDE** that has built up and needs to be exhaled.*

### ELABORATE

Ensure each group of 2-4 students has a laptop or Chromebook with access to uCode and a way (USB or Bluetooth) to connect to their MoverBot once it is built. Students can access the build instructions for the MoverBot by clicking the **UKIT Advanced Build Book** in the pop up, scrolling down until they find MoverBot, and clicking **Start building**.

Once they have a completed robot, students will need to program the MoverBot to move through the diagram acting as a breath. The robot will need to pick up a small object that represents oxygen from outside the body and travel through the body system in the correct order until it reaches the alveoli. Once there, it will need to release the oxygen, gather the small object representing carbon dioxide, and reverse the process back out into the air.

### EVALUATE

Students should demonstrate their model for you. Their Moverbot should pick up oxygen in the area around the body. It should then travel through the nasal cavity, pharynx, larynx, trachea, lungs, bronchioles, bronchi, and alveoli. Then, it should drop off the oxygen, pick up carbon dioxide, and travel back out along the same path it came.

## DIFFERENTIATION

### SIMPLIFY THIS LESSON

- You can review the human body system together.
- You could have students run the sample code for their robot.

### TAKE THIS LESSON TO THE NEXT LEVEL

- Students could go into detail about how the respiratory system is so closely tied to the circulatory system.
- Have students see if they can code the robot to create a continual loop like our body does with breathing.

## CROSS-CURRICULAR EXTENSIONS

### MATH/CODING

- The code blocks used in the sample code incorporate number inputs such as servo numbers, angles of rotation, and wait time in milliseconds. Math and/or coding lessons that cover these concepts could be covered prior to this lesson or built into this lesson.

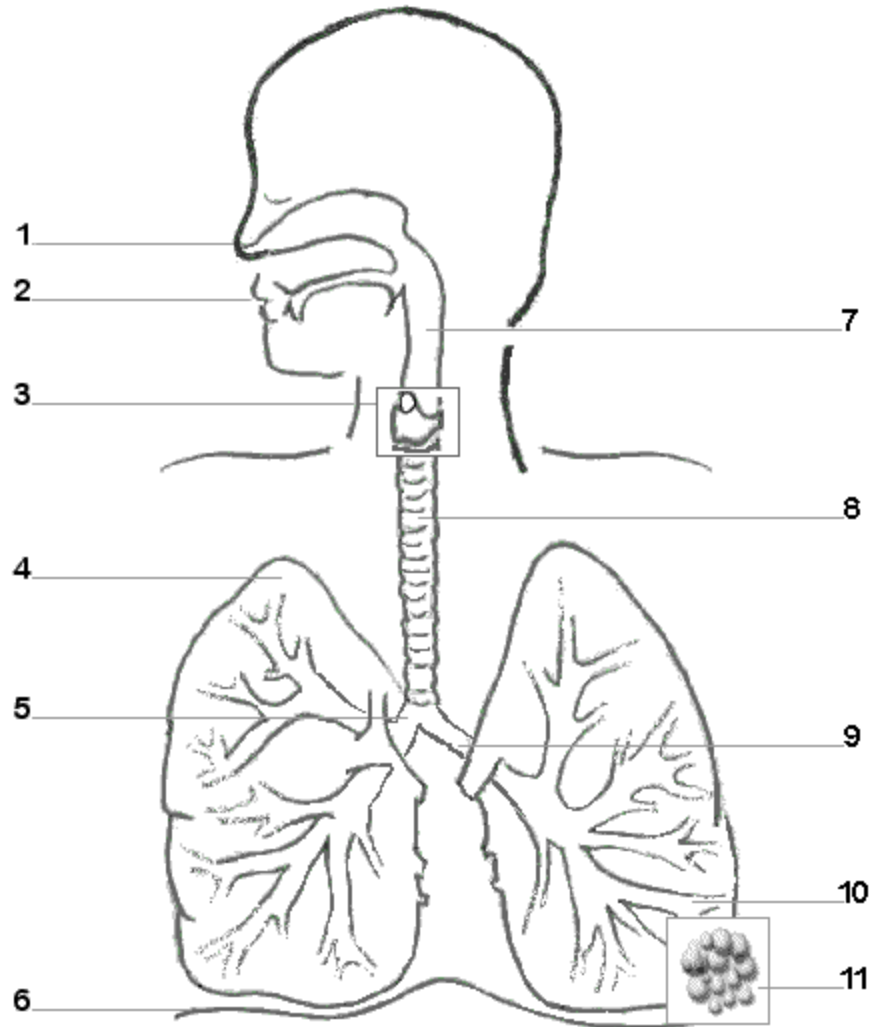
### SCIENCE

- Additional lessons that expand on the NGSS standards covered in this lesson could be covered prior to or after this lesson, built into this lesson, or added to the unit.

## STUDENT RESOURCES

### RESPIRATORY SYSTEM DIAGRAM

Reference this diagram as you complete the Respiratory System Table.



#### Word Bank

trachea	bronchiole	alveoli	left bronchus
right bronchus	diaphragm	lung	pharynx
nasal cavity	larynx	mouth	

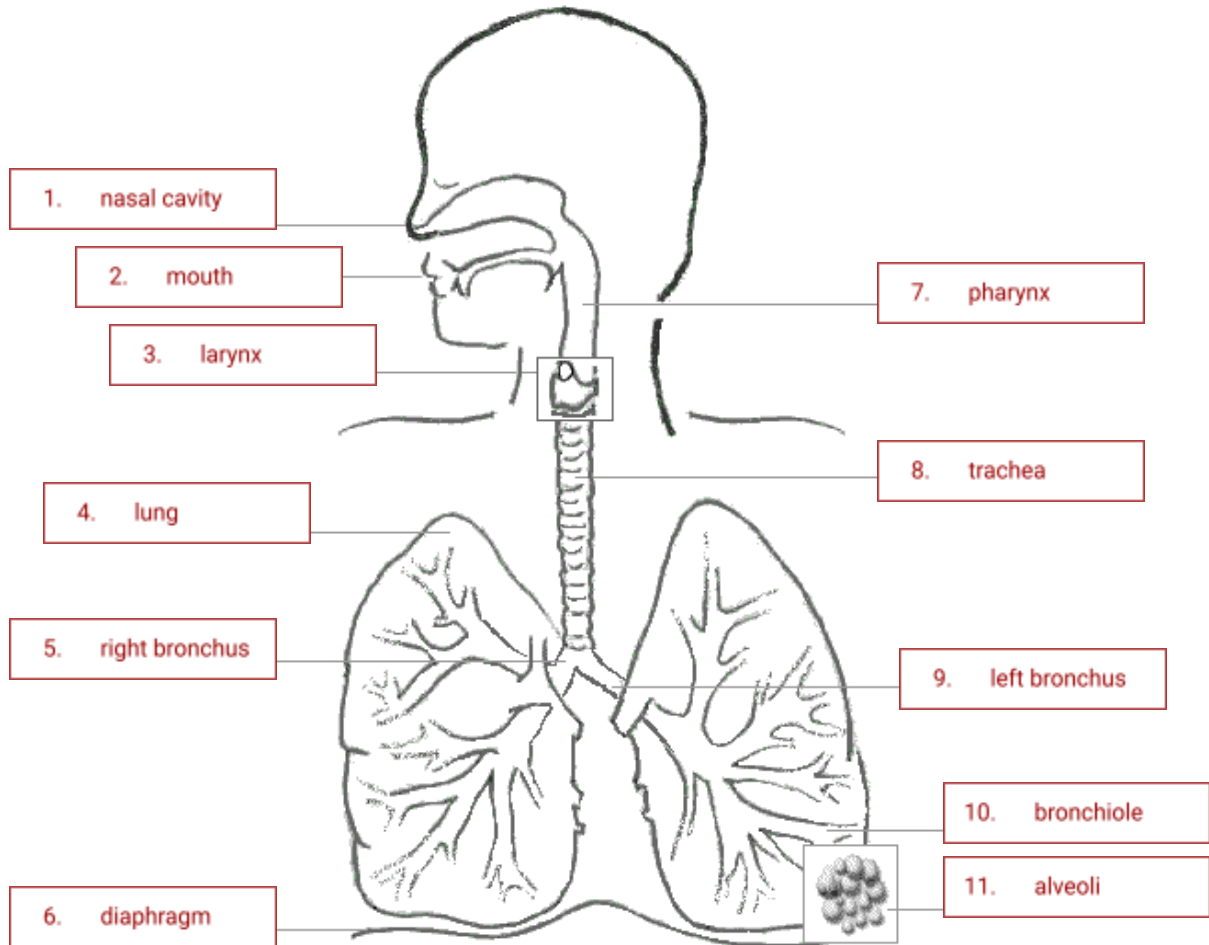
## RESPIRATORY SYSTEM TABLE

Complete this table using the Respiratory System Diagram.

#	NAME OF ORGAN OR BODY PART	DESCRIPTION AND FUNCTION
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

## TEACHER RESOURCES

### RESPIRATORY SYSTEM DIAGRAM ANSWER KEY





## RESPIRATORY SYSTEM TABLE ANSWER KEY

#	NAME OF ORGAN OR BODY PART	SAMPLE DESCRIPTIONS
1	nasal cavity	A nose is a nose is a nose. Smelling, tasting, and breathing all start here. The size, location, mucous lining, and tiny hairs (cilia) inside help prevent foreign objects from entering and trap large air impurities before being drawn farther into the respiratory system. Achooo! Out with the bad...bugs and carbon dioxide.
2	mouth	Mouth breathing can also be remembered as “the big gulp,” or “Plan B” for air entry. Like the nose, it has many functions. It is the starting point of the digestive system as well as a secondary inhaler and exhaler.
3	larynx	The larynx has three main functions: 1) a passageway for air, 2) a valve to close off the air passage from the digestive one (the epiglottis) like a hinged trap door, and 3) a voice box.
4	lung	The lungs are the essential organs of respiration. The main function of the lungs is to exchange carbon dioxide for oxygen and vice versa. Each lung is enclosed separately within two membranes, like a balloon inside a bag inside a bag.
5	right bronchus	There are two main bronchi (Latin plural of <i>bronchus</i> ): the right and left, each leading to a lung. If you accidentally breathe, or aspirate, a very small piece of food that gets past the trachea, it is most likely to fall and be pulled into the right main bronchus. If a peanut gets this far, what do you think could happen?
6	diaphragm	This muscular structure acts as a floor to the chest (thoracic) cavity as well as a roof to the abdomen. It helps to expand and contract the lungs, forcing air into and out of them.
7	pharynx	The pharynx is shared with the digestive system from the tongue down to the epiglottis. Food goes on down the esophagus, and air passes on through the trachea – but never both at the same time!
8	trachea	This armored tube allows air to pass beyond the larynx to where it divides into the left and right bronchi. The protective Cs of cartilage also provide protection to the digestive system’s esophagus right behind it.
9	left bronchus	The left one has a sharper bend due to the presence of the heart and major blood vessels directly underneath it.

10	bronchiole	Each bronchus divides and subdivides into smaller and smaller branches, the bronchioles, just like tree branches that get smaller as they grow up and out. By the time the air has reached here from outside, it has been warmed up to body temperature, filtered, and moisturized.
11	alveoli	These tiny air cells, or sacs, are the leaves of our respiratory tree. They resemble bunches of grapes and are the link between the respiratory and circulatory systems. Gas exchange happens here – I'll trade you fresh oxygen (O <sub>2</sub> ) for your used carbon dioxide (CO <sub>2</sub> ). Now, trace the route of the old air back out to the nose.
<b>Additional information that could be shared with students</b>		
throat	The throat includes all the structures lying in front of the spinal column including the mouth, tongue, pharynx, tonsils, larynx, and trachea.	
trachea, bronchi, and bronchioles	These three portions of our airways also have rings of muscle along their length as well as glands lining them. These glands produce mucus that traps particles of dirt. Eventually, this sticky stuff and its trapped dirt are coughed up and cleared out. With asthma, these sensitive muscles tighten, making all the airways smaller and more difficult to breathe through, and excessive mucus is produced, sometimes flooding the airways.	

## 5E LESSON PLAN MODEL

The 5E model is based on active learning that is meant to help students build their understanding of new ideas and experiences, with the teacher taking on a facilitator role. The teacher will introduce the concept and then allow students to take the lead as they go through the 5Es listed below.

<b>ENGAGE</b>	Sparks student interest; creates a personal connection to the lesson; assesses prior knowledge; students reflect and ask questions
<b>EXPLORE</b>	Allows students to develop their own understanding of the topic; incorporates hands-on activities
<b>EXPLAIN</b>	Offers students opportunities to share what they have learned; Can they answer the driving question?
<b>ELABORATE</b>	Invites students to apply new knowledge and gauge the impact of that knowledge on prior understanding; allows students to solidify the connection between prior and new knowledge
<b>EVALUATE</b>	Provides time for students to reflect on the lesson; assesses student learning and understanding

## WORKS CITED

"5 Min Cardio HIIT Workout for Fat Loss." YouTube, uploaded by Group HIIT, 1 Dec. 2016, [www.youtube.com/watch?v=XGtjACeyHtc](http://www.youtube.com/watch?v=XGtjACeyHtc).

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KidsHealth Medical Experts. "Your Lungs and Respiratory System." KidsHealth, [kidshealth.org/en/kids/lungs.html](http://kidshealth.org/en/kids/lungs.html). Accessed 9 Apr. 2022.

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