C5ISR CENTER STEM@Home

Welcome to STEM@Home!

As we maneuver the challenges of the COVID-19 epidemic, we strive to continue to make STEM accessible to all.

The STEM@Home Newsletter is intended to be a resource to provide engaging and educational activities that can be done with minimal materials and a whole lot of imagination.

In this Issue...

Issue 27

Brain Teaser: Number Maze

Fill the grid with the numbers 1 to 36 to make a path in sequential order, going horizontally or vertically. You may not connect the numbers diagonally.

	15	10	9	8	
17					6
18		12	3		1
19		25	26		30
20		36			31
	22		34	33	

Solution on Page 3

SHARE YOUR STEM!

Visit the C5ISR Center on Facebook to post a photo of your child completing one of the STEM@Home Activities.

#C5ISRCenterSTEM

Facebook.com/DEVCOM.C5ISR

CORRECTION: In issue 26, our STEM Spotlight of Dr. Kimberly Foor misstated her position as Strategic Initiatives Officer.

Dr. Kimberly L. Foor serves as an International Tech Transfer Specialist, International Programs (IPOC) for the C5ISR Center.

Introducing Ms. Kathleen Maxwell

Name:

Ms. Kathleen Maxwell

Job Title:

C5ISR Center Chief of Staff

Length of Time as an Army Civilian: 27 1/2 Years

Education:

Bachelor of Science in Business Administration, Concentration in Accounting – Monmouth College, West Long Branch, N.J.

Master of Business Administration – Monmouth University, West Long Branch, N.J.

How does your job support the U.S. Soldier? As the Chief of Staff for an Army research and development center, my job is to make sure that all of the pieces are in place to support the engineers and scientists who design and develop the latest and greatest technology for our Soldiers. That means leading all the different staff offices that keep our organization running and making sure all the resources our engineers and labs need are in place – specifically resources like money, buildings, and, most important, people.

What is a typical day or a week like for you? I can honestly say that in my job, there is no such thing as typical. More than anything, I have to be flexible and adaptable. Every morning, I start out with a plan of what I am going to do, but I always know that I am going to have to divert from that plan to help solve the problems that occur during the day. In the end, just like our engineers, my job is to solve problems.

What drew you to the STEM field originally? When I graduated college with a degree in accounting, I didn't really know anything about working as an Army civilian. It wasn't the typical career path for an accountant, but when I got the opportunity, I was intrigued to learn how my degree could be applied to serving our Soldiers and our country. I have really loved working for the Army, and I would encourage anyone, no matter what field you choose to study, to look at the possibility of working as an Army civilian.

Why is STEM important to our national security and our national future? Not only is it critical to make sure our Soldiers always have the most advanced technology at their disposal, but it is also important to make sure that our country is recognized for its technological dominance. Just like in school, nobody wants to pick a fight with the strongest kid in the room. We need to make sure we maintain our presence as a technological leader, and building our future STEM workforce is critical to succeeding.

How should students further their interests in a STEM field? Everywhere around you are chances to solve problems and make improvements. For example, my daughter Kayla rides horses competitively, and one of the things she has to do when she trains is to bring her saddle back and forth to and from lessons. After seeing a video online of a saddle rack made from PVC pipe, she was able to recreate that design, test it, and make improvements. She might tell you that all she was doing was making it easier to be ready for her riding lessons, but really, she was being an engineer. So, while classes and clubs are great, every time you look at a problem and figure out a way to solve it, you are learning about STEM.

What is the most important STEM-related innovation you've witnessed in your career? The most important innovations for the way we work and the way we live are the collaboration tools and mobile technology we use every day. Imagine if COVID-19 had happened before we had the ability to communicate and collaborate through tools like Teams or Zoom. So many things that have slowed down during this time would have had to stop altogether. So while this time has been difficult, innovative tools such as these have helped make it easier.

What is your favorite technology for personal use? My favorite personal technologies are anything that makes life more convenient. For example, the radio-frequency identification chips used for things like the Disney Magic Bands. Using one little band, you can get fast passes for rides, pay for snacks, and access your hotel room – and you can control it all from an app on your phone. The fact that I can get a Dole Whip or Mickey ice cream bar and reserve my spot for the fireworks, all while scheduling my fast pass for Space Mountain, and then access it all from a little bracelet on my wrist – that is an outstanding use of personal technology.

What is the next great technological frontier? I think we are going to continue to see more and more advances in artificial intelligence (AI) as time goes on. The ability of machines to predict what people need and then execute that without guidance is going to be a major game changer. That being said, I think as AI grows, it will be more and more important to pay attention to the human element of things to make sure that there is balance, so our reliance on technology does not lead to skill loss.

Why is it important for engineers and scientists to engage with STEM Outreach? It is so important for all of the members of our workforce to be out there talking not only about the amazing technology being developed in the Army but also showing young people that there are ways to support our military and our nation without being a Soldier. Working in STEM isn't limited to being an engineer or a scientist. No matter what you want to study, there is a place for you in STEM, and there is a place for you as an Army civilian.

STEM Challenge

SAFETY FIRST! You Must Have Adult Supervision To Complete This Activity.

MATERIALS:

- 3 plastic bottles (710 mL) with caps, labels removed.
- 4 bendy straws
- 3 cups of water
- Red food coloring
- Tape
- Modeling clay
- Drill or other sharp item for making holes in the caps

Build a Functioning Heart Model

In this simple model, the first bottle is the atrium of the heart, the second bottle is the ventricle, and the third bottle represents either the lungs or the body. You can label each bottle. Our fingers function as the valves of the heart.

Directions:

1. In the first bottle cap, make two holes that are the same size. You want the holes to be just big enough for the straws to slide through.
2. In the second cap, drill one hole that is straw sized and a smaller second hole.
3. If any of the holes are too large, use modeling clay to make them the correct size.
4. In a pitcher, mix water and food coloring to create your "red blood." This can be done "by eye" and does not require exact measurements.
5. Stretch and bend the two straws to create a 90-degree angle. Slide one straw into the other straw (pinch one to make it smaller so it slides in), then tape up the joint. Repeat with the second set of straws.
6. Place your three bottles on the table. Fill the first two with your "blood" to about 80% full. Leave the third one empty.
7. Place the cap with one straw hole and one small hole on the first bottle. Place the cap with two straw holes on the second bottle. Leave the third, empty bottle without a cap.
8. Carefully slide the straws through the bottle caps. Place clay or play dough around the straw bases on the middle bottle to make an airtight seal with the bottle cap. You are now ready to put your heart model to work!

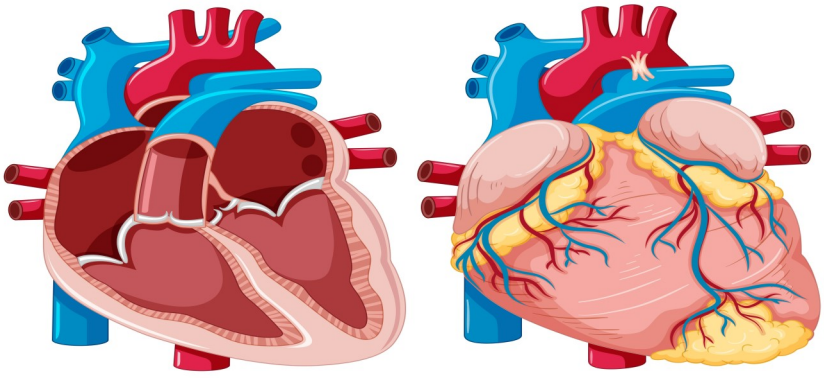
To make your heart model work:

1. Pinch the straw between the atrium and ventricle bottle. Squeeze the middle bottle, and watch your "blood" squirt out into the body.
2. Keeping the middle bottle "squeezed," move your fingers, and pinch the straw between the ventricle and body. Now release the middle bottle, and watch your blood move from the atrium into the ventricle.
3. Repeat, to pump blood from the atrium, into the ventricle then out to the body!
4. Once your blood in the atrium gets too low, you can take blood from the body and add it back into the atrium. Then start again.

The science explained:

This heart model shows how blood flows in one direction through the heart chambers. We have four chambers in our heart: the right and left atrium, and the right and left ventricle. Blood will flow in only one direction – into the heart, to the lungs to be oxygenated, back into the heart, then back out into the body. The four valves of our heart are important for ensuring this one-way blood flow. Watch carefully as you do the work of the valves when you pinch the straws. What happens to the liquid in the straws?

We have four heart valves. The tricuspid and mitral valves are located between the atrium and ventricle. The aortic and pulmonary valves control blood flow out of the ventricles into the arteries. When you pinch the straw between the first two bottles, you are mimicking the tricuspid or mitral valves. When you pinch the second straw, you are mimicking the aortic or pulmonary valves.



Ask an adult to Share your STEM on Facebook.

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21	22	35	34	33	32

Solution to puzzle on P. 1

STEM IN THE NEWS

Pre-Historic Marine Animal Had a Leg Up on Evolution

A major milestone in evolutionary history happened about 370 million years ago. Certain fish species converted its fins into limbs and transformed its respiratory organs for air breathing. But how did these creatures breathe while still in water? A new study has found evidence of advanced breathing organs in 450-million-year-old sea creatures called trilobites.

Trilobites were a group of prehistoric marine animals that looked like a cross between a horseshoe crab and a millipede. Even though they are now extinct, they were particularly successful in terms of evolution and survived for more than 250 million years, which was longer than the dinosaurs. Using new technology and a rare set of fossils, scientists from the University of California Riverside can now show that trilobites actually breathed oxygen and are able to explain how they did so. These findings were recently published in the scientific journal *Science Advances* and are a huge piece of the evolutionary puzzle.

Until recently, trilobites were thought to have respiratory systems like crustaceans, with a nonfunctioning/non-respiratory upper leg. However, this new research discovered that the marine animal's upper leg functioned as a gill and used these gills that hung off of their upper leg to breathe. These findings help to place trilobites more securely on the evolutionary tree for arthropods (a group of animals with large exoskeletons) .

The research was partly possible due to fossils that were preserved in an unusual way. More than 22,000 species of trilobites have been discovered, but the soft parts of the animal, including the legs, are only visible in about two dozen. These were preserved in pyrite, or fool's gold, which was key in getting these readings. A CT scanner allowed scientists to identify the differences in density between the pyrite and surrounding rock. This type of machine also allowed scientists to see the fossils without having to drill into the rock containing the specimen. Also, the CT scanner provided a better picture of the small gill structures that would have been difficult to see even using a microscope. From there, a 3-D model of the fossil was created. Even though trilobites have been studied since the late 1800s and CT scans have previously been used to examine fossils, this was the first study to use this kind of technology to examine this part of the animal.

The scientist could see how blood would have filtered through the chambers of these structures, picking up oxygen along the way. These structures appear quite similar to the gills of modern arthropods, like lobsters and crabs.

Trilobites, like crabs, shrimp, and some lobsters, were scavengers. This means that they searched the ocean, finding whatever they could to eat. Trilobites used spikes on their lower legs to grab and grind their food. Above those spikes were additional structures that some scientists and biologists originally theorized were used for swimming and digging. In the past, there was a debate about the function of these structures because some argued that the upper leg was not a great location for a breathing structure. The scientists continue to research and study how early life developed and evolved.

Sources and Resources:

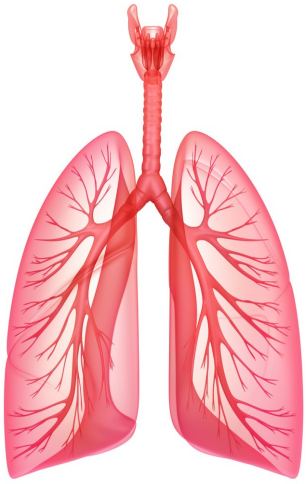
advances.sciencemag.org/content/7/14/eabe7377

www.thehindu.com/sci-tech/science/breathing-trilobites/article34290701.ece

STEM Activity/Challenge

Materials:

- A plastic bottle
- A straw
- An elastic band
- Scissors
- 2 balloons
- Play dough



How Do Your Lungs Work?

The lungs are an essential organ to all mammals. The lungs are part of our breathing system, which has two functions:

- Ventilation – the movement of air into and out of the lungs.
- Gas exchange – gases are exchanged between tiny sacs called alveoli and blood.

Directions:

1. Carefully cut your bottle to about half the size.
2. Tie a knot in one end of one balloon, and cut off the bigger end.
3. Stretch the balloon around the bottom of your plastic bottle.
4. Put a straw in the neck of the other balloon, and secure tightly with the elastic band, but not so much that you crush the straw. The air must flow through, so test it with a little blow through the straw to see if the balloon inflates.
5. Put the straw and the balloon into the neck of the bottle, and secure it with the play dough to make a seal around the bottle. Again, make sure that you don't crush the straw.
6. Hold the bottle, and pull the knot of the balloon at the bottom. What happens?

You should find that the balloon inside the bottle inflates, and as you let go, the balloon deflates.

SAFETY FIRST! You Must Have Adult Supervision To Complete This Activity.

The Science Explained

As the knotted balloon is pulled, it creates more space inside the bottle. Air then comes down the straw and fills the balloon. When you let go of the knot, the space no longer exists, so the air from the balloon is expelled, making it deflate.

Inside the lungs are a network of tubes that allow air to pass though. Air is warmed, moistened, and filtered as it travels through the mouth and nasal passages. It then passes through the network of tubes, eventually reaching tiny sacs called alveoli, which are where gas exchange occurs.

This lung model demonstrates how our lungs work. Air is taken in through the mouth and nose, then passes down the windpipe and into our lungs. The diaphragm at the bottom of our chest moves down to create more space. As we breathe out, the diaphragm raises again. The knotted balloon represents the diaphragm, and the balloon inside the container the lung. That's how lungs work!