3D Educational Resources

LEARN ABOUT THE HUMAN BODY!

The human body is an amazing living machine. It contains complex organs that perform all sorts of functions that work together to keep us alive. Find out more about how they do this in a series of fun mini-activities and demonstrations.

ONTARIO CURRICULUM LINKS

Through this activity, you and your students will use an anatomical model to go through a series of mini-activities and demonstrations about our body's organs. This activity can be connected to multiple aspects of the school curriculum, our suggested link is:

- Grade 5: Science (Human Organ Systems)

Grades
5 – 9

Age Range
8 – 14 years

MATERIALS

- 1 measuring cup
- 1 tablespoon (15 mL)
- 2 bowls (around 1 L each)
- 1 ruler
- 1 measuring tape
- 750 mL vinegar
- 1 3D printout of the anatomical model or 3D files of the anatomical model and software* to view the files
- 1.65 m yarn
- 900 mL water

* Note: There are many free programs available to view the 3D files. Some examples include Sketchup Make (https://www.sketchup.com/download/all) and 3D Builder, which is included with Windows 10.

INSTRUCTIONS

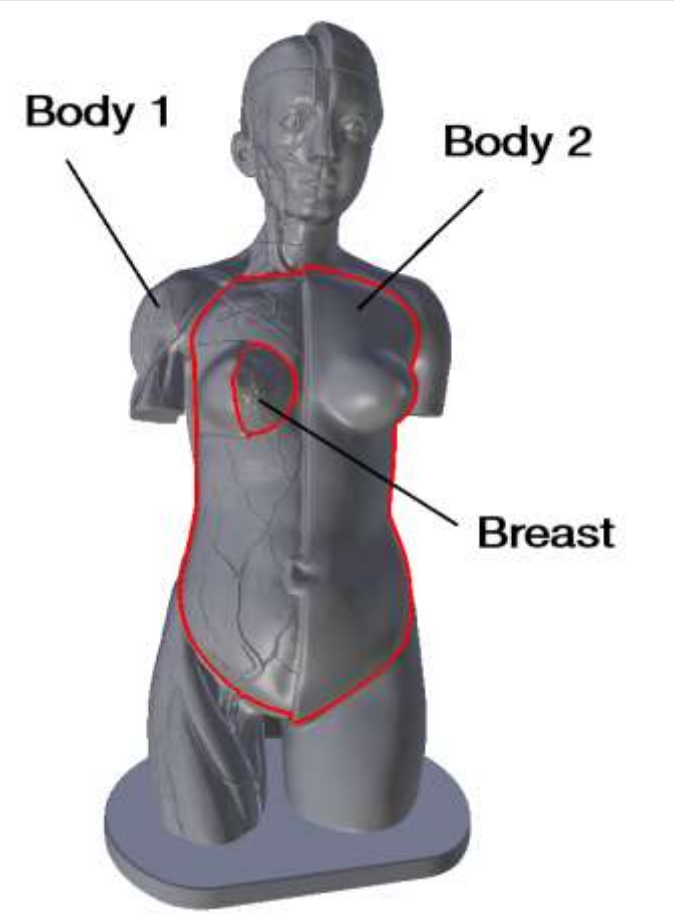
These activities can be done either with a 3D printed anatomical model or through viewing the 3D model with a computer program. Feel free to add your own contributions and explore parts of the model not covered in this document.

Assembling the Anatomical Model

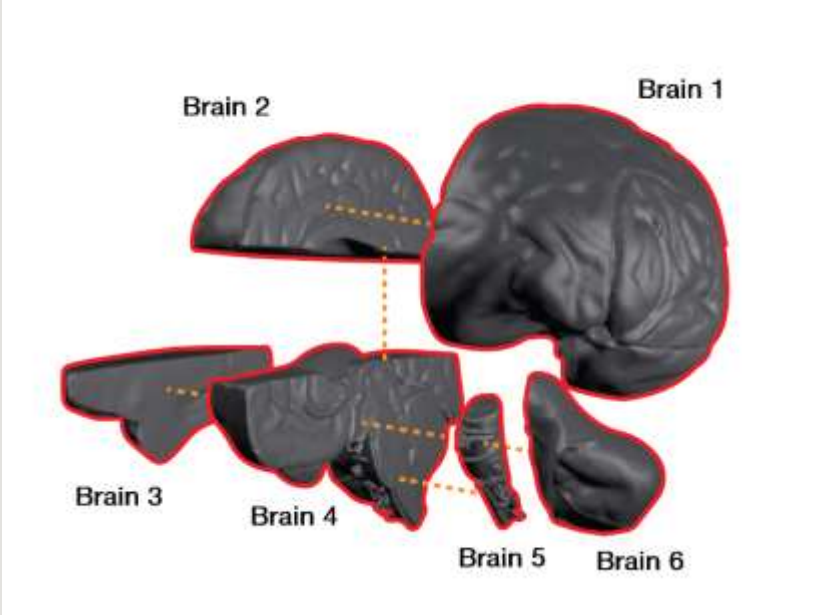
If you are having trouble putting together the anatomical model, you can find below a series of diagrams that should help you out. These images also contain the names of the pieces that will be used in this activity. In addition, a video of the anatomical model being put together can be found at:
https://www.youtube.com/watch?v=2eD7MRTpFtc

Note: To attach the pieces together you can use a substance like adhesive putty or poster tack.

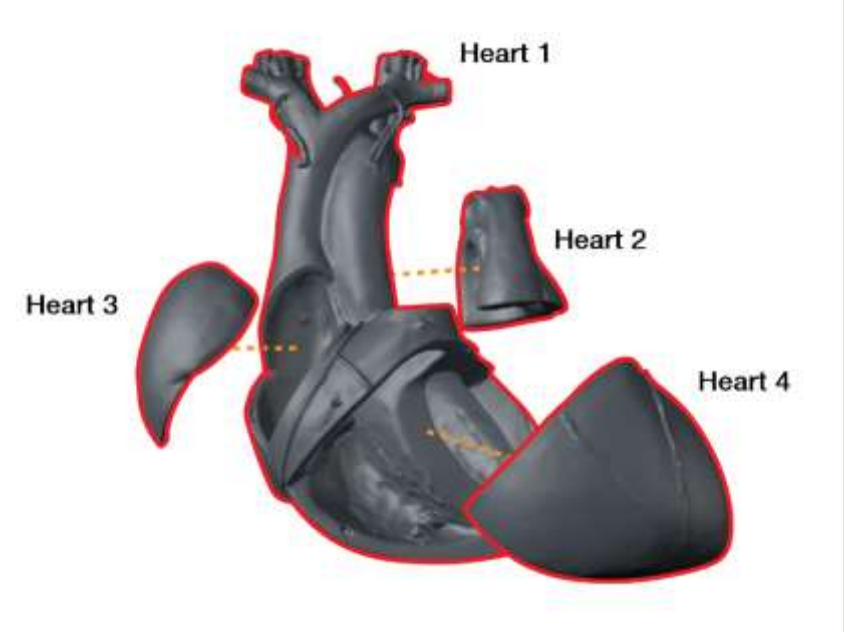
Overall Body - Outside



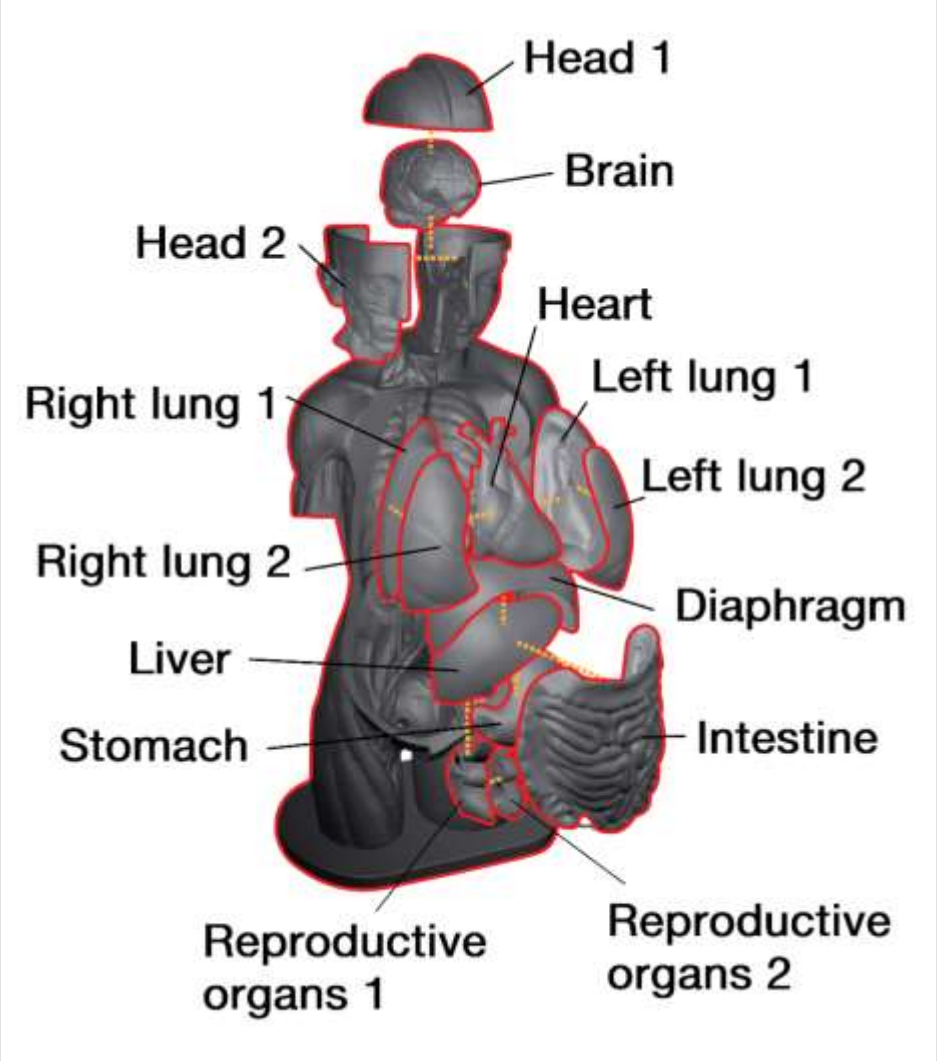
The Brain



The Heart



Overall Body - Inside



Suggested order of construction:

1. Diaphragm, liver and stomach
2. Completed reproductive organs
3. Intestine
4. Right lung 1 and left lung 1
5. Completed heart
6. Right lung 2 and left lung 2
7. Head and completed brain

THE BRAIN

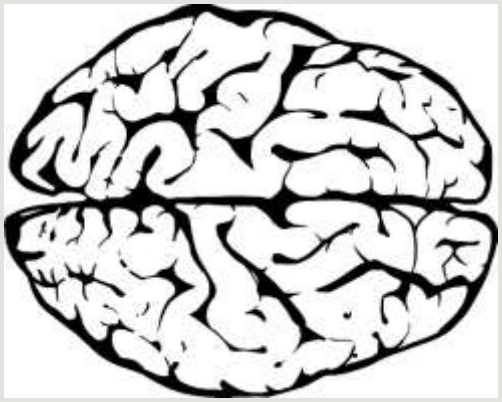
Pieces of the model

- Brain 1
- Brain 2
- Brain 3
- Brain 4
- Brain 5

Background information

You can think of the brain as the control centre of the body. It directs voluntary and involuntary movements and it allows humans to form thoughts, emotions and make plans for the future. The human brain is very complex and is one of the main things that distinguishes us from other living organisms.

If you take a look at the surface of the human brain it'll look folded and wrinkly (see image below). In an actual brain, this folding only occurs in the upper couple of millimetres. This part of the brain is called the cerebral cortex. The folding allows the cortex to preform many of the more complex actions that we see in humans, such as strategic planning and multitasking. We also see similar folding in certain other mammals, such as pigs and dolphins. You and your class can find out just how much folding occurs in the demonstration below!



Activity/Demonstration

Materials needed

- 4 letter-sized (8.5 " x 11 ") pieces of paper
- Tape
- 3D printout of brain

Instructions

1. Hold up 4 pieces of paper taped together and show it to your class.
2. Inform your class that, when unfolded, the cerebral cortex of a human would have the same surface area of the 4 pieces of paper (which is approximately 2322 cm^2).
3. Have your class take a look at the brain model, can they guess the size of the unfurled cerebral cortex of the 3D model? It would have an area of approximately 514 cm^2, which is slightly smaller than a letter-sized piece of paper.

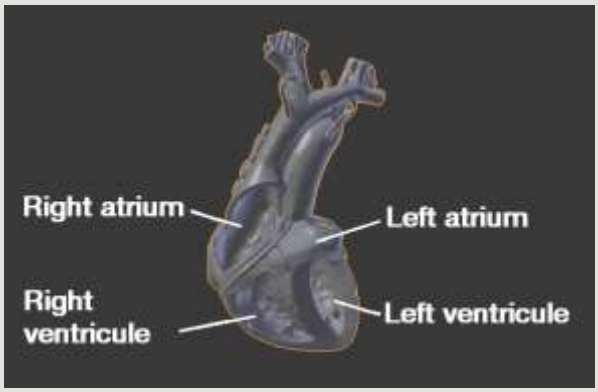
THE HEART

Pieces of the model

- Heart 1
- Heart 2
- Heart 3
- Heart 4

Background information

The heart is the organ that is responsible for moving blood through the body. This is very important because without this movement, useful materials (such as oxygen and nutrients) could not reach the rest of the body and waste products produced by the body's cells (such as carbon dioxide) could not be taken away.
To accomplish this, the human heart is divided into a right and a left side. Each side is then divided into two chambers (the atrium and ventricle) and the two chambers work together to act like a pump. So, in total, the heart consists of four chambers which form two pumps, one on the left and one on the right. We've labelled the four chambers on the "Heart 1" piece in the image below.



The way that the heart works is that deoxygenated blood (blood with low levels of oxygen) enters into the right atrium. It then moves into the right ventricle before it is pumped to the lungs. At the lungs it becomes oxygenated (filled with oxygen), at which point it returns to the heart through the left atrium. Similar to before, the blood then goes to the left ventricle, before it is pumped to the rest of the body. Because it needs a lot more force to pump the blood through the entire body the left ventricle tends to be stronger than the right one.
To keep human alive and healthy, the heart needs to pump an enormous amount of blood throughout your body. How much blood? You and your class can find out in the activity below.

Activity/demonstration

Materials needed:

- 2 bowls (approximately 1 L)
- 900 mL water
- 1 tablespoon (15 mL)

Instructions

1. Check to see if anyone in your class can guess how much blood a heart pumps in a day. A healthy adult human heart at rest will beat at around 70 beats per minute, which translates to pumping 7200 litres of blood in a day!
2. Show your class the model of the 3D heart. Can anybody guess how much blood the 3D model heart could pump out? It can pump out around 1300 litres per day or about 900 mL per minute.
3. Measure out 900 mL of water into one of bowls to show your class how much this is. If we assume that a heart beats 70 times per minute, this means that each beat of the 3D model heart will transport around 13 mL of blood. Give one of your students a tablespoon (which is 15 mL) and see if they can transfer all 900 mL of the water into the second, empty bowl, in a minute.

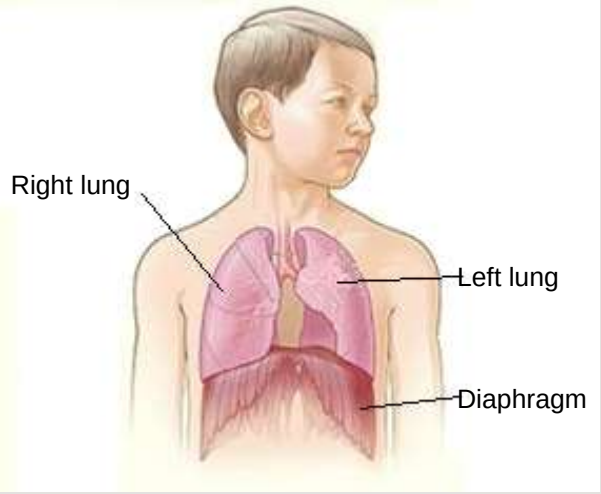
THE LUNGS AND DIAPHRAGM

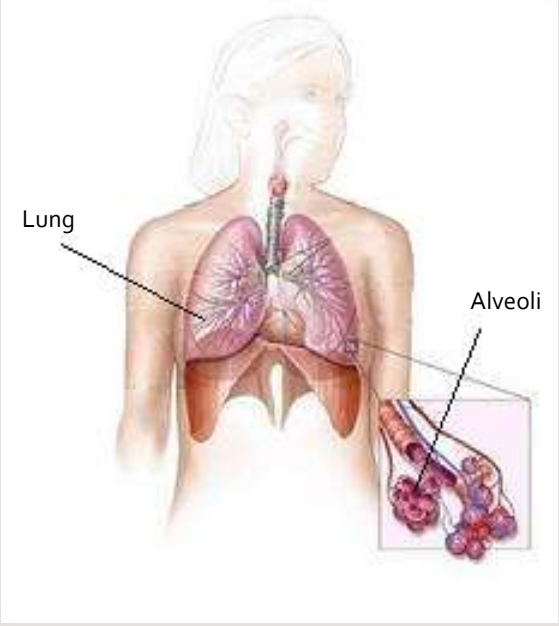
Pieces of the model needed

- Right Lung 1
- Right Lung 2
- Diaphragm
- Left Lung 1
- Left Lung 2

Background information

The lungs are responsible for putting oxygen into blood. This is, obviously, very important as we need oxygen to survive. On a very broad basis, the lungs work by filling themselves with air (which contains oxygen) and transferring the oxygen to deoxygenated blood (blood without a lot of oxygen). To explain how this is accomplished, let's start with the diaphragm. The diaphragm is a flat, dome-shaped muscle that is found just beneath the lungs (see image below). When this muscle is contracted, it flattens, which in turn causes the chest to expand and air to enter the lungs (inhalation). Alternatively, when it relaxes, the opposite occurs and air exits the lungs (exhalation).





When you inhale, the air enters your lungs, goes through various passageways and eventual ends up in many small thin sacs called alveoli (see image below). On the surface of each alveoli there are a lot of blood vessels. Oxygen can diffuse (or move) from the air in the alveoli into the blood vessels and carbon dioxide will diffuse from the blood into the air. This is how our blood gets oxygenated and how we can get rid of carbon dioxide. In a typical adult, there are a lot of alveoli in your lungs, about 300 million of them. The surface area of the all of the alveoli added together would be about the size of a tennis court!
Humans have two lungs to accomplish all of these tasks. Have you or your class ever wondered if they are the same? Find out in the demonstration below.

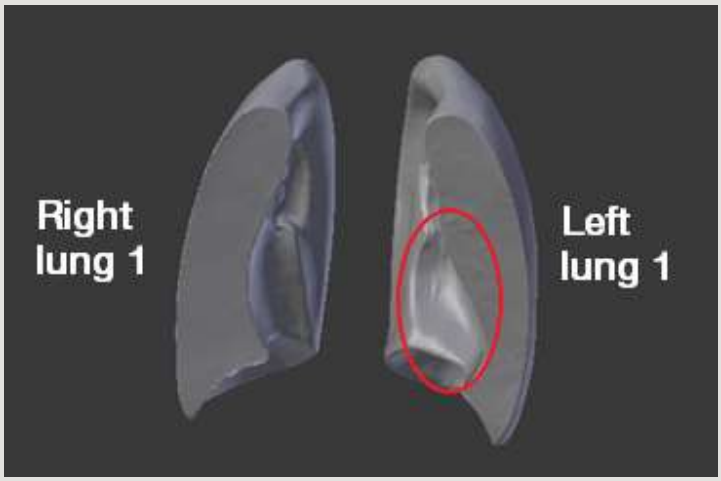
Activity/demonstration
Materials needed:

- 3D printed lung

Instructions

1. Have your class take a look at the left and right 3D model lungs. Hopefully they notice that they are pretty big organs!
2. Next have your class compare the size of the left and right lungs. What do they notice?

   One thing they may notice is that the left lung has a somewhat large empty space in it. Can they guess why this space is there? This space is called the “cardiac notch” and it is where the heart of a person is located. It is also why, even though the right lung is a bit shorter than the left lung, the right lung has a larger volume. An image of “left lung 1” and “right lung 1” can be found below with the cardiac notch circled in red.



STOMACH AND LIVER

Pieces of the model needed

- Stomach
- Liver

Background information

Both of these two relatively large organs are involved in the digestion of food. The stomach is where the food arrives after it has been chewed and swallowed. Here the food is broken down. This process is both mechanical, through contractions of the stomach which churn and knead the food, and chemical, through secretions of enzymes and stomach acid (also called gastric acid). Most of the food is not absorbed in the stomach, though some iron and highly fat-soluble substances can be. The end product produced by the stomach is called “chyme”, which is then transported to the small intestine.

The liver also plays an important role in digestion. One of its main functions is to produce a liquid called bile. Bile is transported to the small intestine where it helps with the absorption of fats. Another well-known function of the liver is that it helps detoxify some of the things that a person eats (such as alcohol). The liver is the largest gland in the body, it weighs a bit over 1 kilogram in a healthy adult. It also has the amazing ability that, when damaged, it can regrow! There is a limit to this regrowth, though, so too much damage means that an individual will need a transplant.

Do you and your class want to learn more about stomach acid? In the activity below, you and your class can run some interesting experiments to see what types of things stomach acid can break down

Activity/demonstration

Materials needed

- 250 mL Vinegar
- 1 coated pill (such as coated aspirin)
- 1 bowl
- 1 uncoated pill (such as uncoated aspirin)
- Small pieces of different types of food

Instructions

1. Pour 250 mL of vinegar (or any substantial amount) into the bowl.
   pH is a measure of how acidic a liquid is, the lower the number the stronger the acid. Stomach acid has a pH between 1 – 3, while vinegar (acetic acid) has a pH of 2. Thus, while they are not exactly the same, vinegar can be used as an approximation of stomach acid.
2. Put in different pieces of food into the vinegar to see what is broken down and what is not. You can also try stirring the vinegar to simulate the churning that goes on in the stomach.
3. An interesting thing to try is to put in the coated and uncoated pills. The uncoated pill should dissolve relatively quickly, whereas the coated one will dissolve slowly. Researchers have used this characteristic to design pills so that they dissolve (and thus be absorbed) at certain points of the digestive system.

THE INTESTINES

Pieces of the model

- Intestine

Background information

The intestine is found just underneath the stomach and it is where most of the digestion of food takes place. It is also where digested food is either absorbed by the body or is made into feces so that it can be expelled. The intestine is divided into the small intestine and the large intestine. The small intestine is connected to the stomach and it is where most of the digestion and absorption of the food takes place (pictured below).

After the small intestine comes the large intestine (pictured left). The large intestine is larger in diameter but shorter in length. Note that while it cannot be seen in the image, the large intestine is also found along the left side of the small intestine (which is on the right side of the image). The large intestine is the main place where water and salts are absorbed. In addition, bacteria complete the digestion of the food and produce the B vitamins and vitamin K that the human body needs. Anything not absorbed by the large intestine is eventually expelled out of the body as feces.

To accomplish all of these tasks, the intestine needs to be pretty long! How long is it? Find out more in the activity below.

Activity/demonstration

Materials needed

- Yarn (1.65 m)
- 1 scissors
- 1 measuring tape

Instructions

1. Explain to your class the role that intestines play. You can inform them that, when unwound, the intestine of an individual would measure around 7.5 metres (6 metres for the small intestine and 1.5 metres for the large).
2. Show your class the model of the intestine, what do they notice? One of the main things that they should notice is how folded up it is. This is so that all of the intestines can fit inside a human body.
3. See if your class can guess the length of 3D printed intestine if it was unwound. It would have a length of around 1.65 metres! To give your class a sense of this length, measure out 1.65 metres of yarn and compare it to the height of your students. Alternatively have two of your students go up to the front of the class and stand 1.65 m away from each other.

Ingenium – Canada's Museums of Science and Innovation has more than 110 000 artifacts in its collection, including many ones related to anatomical models. You can explore other objects in the collection at: ingeniumcanada.org/ingenium/collection-research/collection.php.