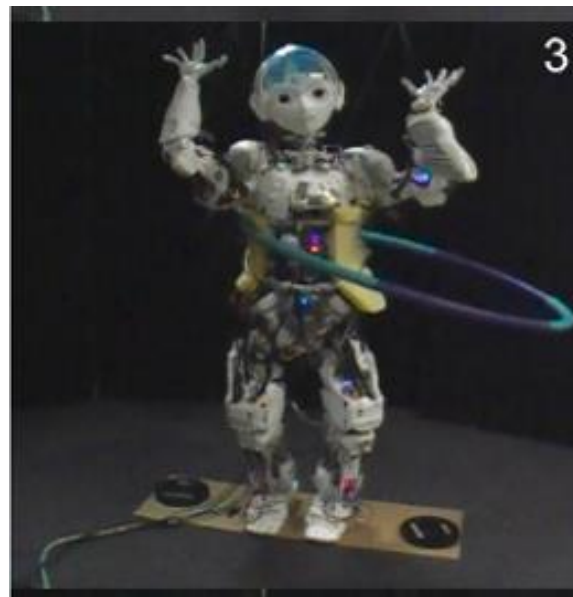
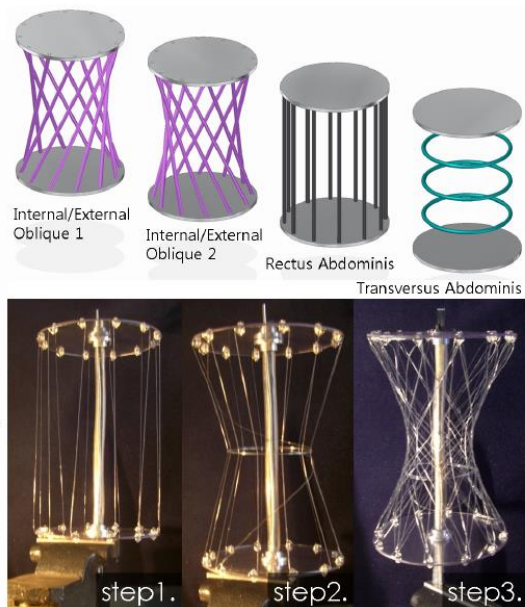


Creating the belly muscles – Cardiff Science Festival activity

There are four belly (or abdominal) muscles that protect our internal organs (such as the lungs, heart and liver) and help us perform common movements such as moving from side to side, crunches and breathing.

- **Transversus abdominis** (trans-ver-sus ab-dom-in-is)
- **Rectus abdominis** (rec-tus ab-dom-in-is)
- **External oblique muscles** (oblique is said o-bleak)
- **Internal oblique muscles**

These muscles are very important in hula hooping and researchers are studying them in detail to create robots that can hula hoop. You can see in the pictures below how scientists replicated the 4 belly muscles (on the left) inside the robot on the right to try to make it hula hoop.



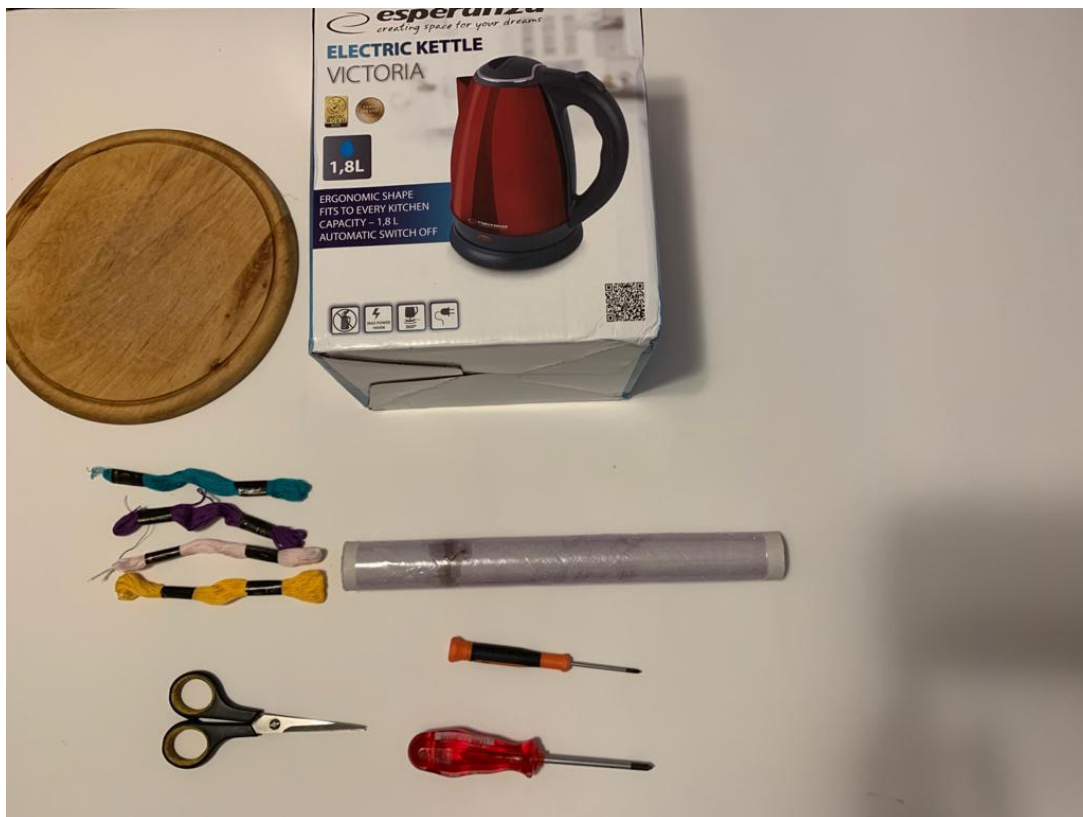
(Kekehashi, Y. et al. 2011. The trials of hula hooping by a musculo-skeletal humanoid KOJIRO nearing dancing motions using the soft spine. IEEE-RAS International Conference on Humanoid Robots , pp. 423–428. doi: 10.1109/Humanoids.2011.6100902)

You can learn more about the science of hula hooping at our Cardiff Science Festival Session on Friday 19th February 2021 <https://www.cardiffsciencefestival.co.uk/en/events/the-secret-science-of-hula-hooping>

Activity

Materials you will need:

- some cardboard (either from old boxes or any food cupboard packaging). Make sure you have enough to cut 2 equal circles and draw a clock face on them
- a tube – either from used tin foil or cling films, or you can tape together toilet paper rolls
- a hard surface such as a wooden chopping board
- a plate or anything circular to draw circles on your cardboard. You can choose how big you want your clock on your own
- 4 strings in different colours
- a pair of scissors
- a skewer and/or a small screwdriver or a hole punch
- a marker pen
- Super Glue



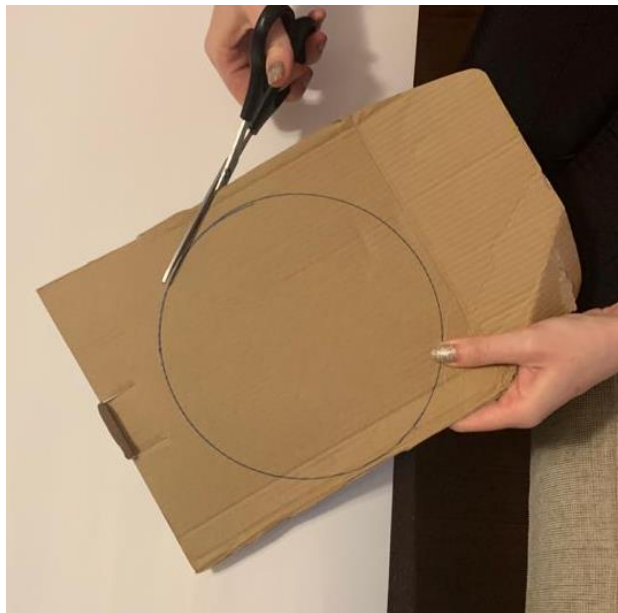
Steps:

Step 1 – Preparing your circles

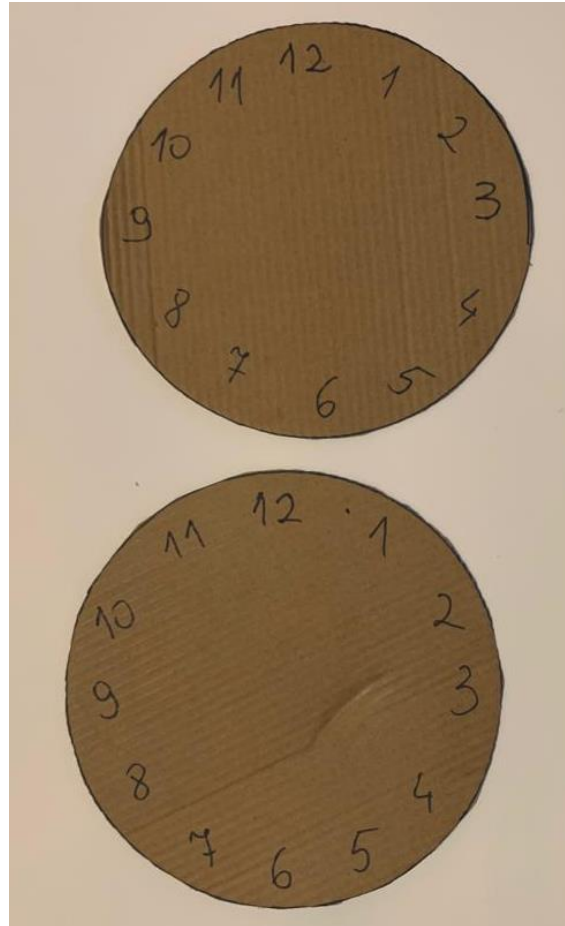
- Start by choosing a plate/bowl or anything in the shape of a circle. Use it to draw two circles on your cardboard with a marker pen.



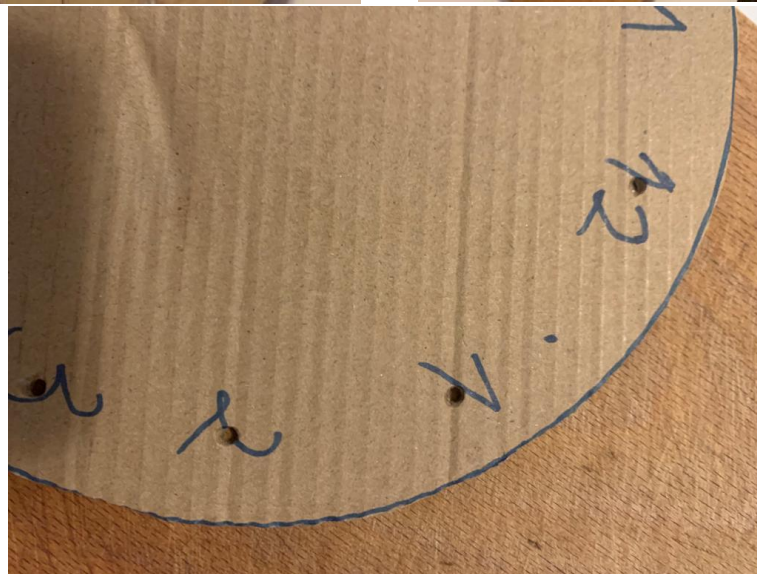
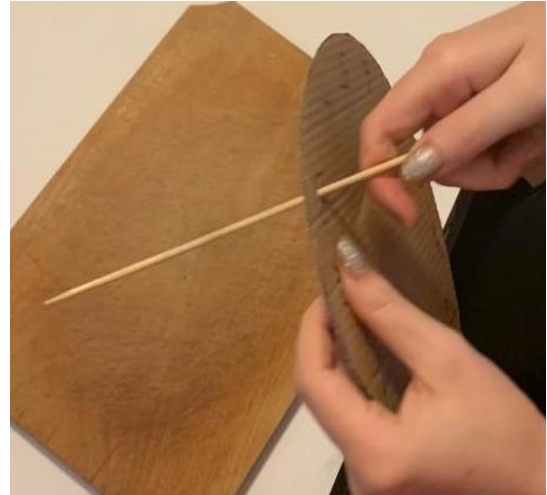
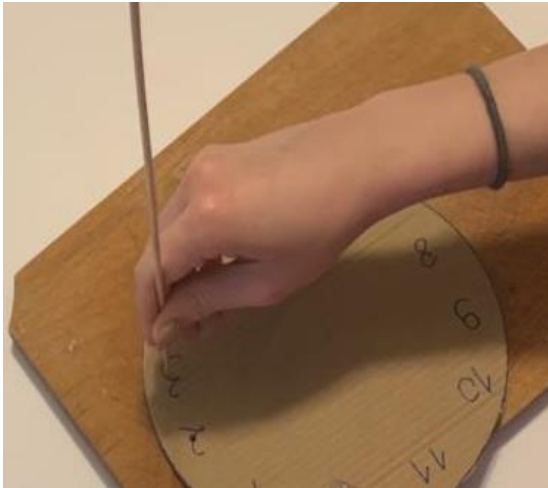
- Use a pair of scissors to cut these circles. Make sure an adult is there to help you with this part.



- Draw a clock face on both of your circles. This will help you align the strings to better understand the way belly muscles are placed in our body



- Place your circles on a hard surface, such as a wooden chopping board. Make sure an adult is there to help you with this part. Using a thin screwdriver, skewer or hole punch, punch small holes over each number on your clock. Don't worry too much about the holes position, just try to ensure you punch them in the same place on both cardboard circles.

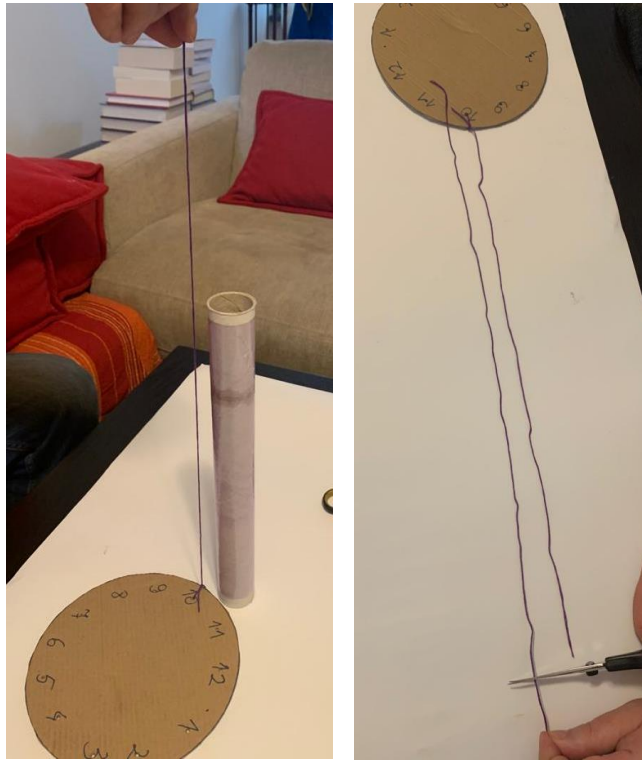


Step 2 – Creating the muscles

- Choose one of the circles (we will call this the **1st circle** or **top circle**) and put a string through one of the holes and tie a knot on the opposite side as shown below:



- Place your tube next to it to and cut the string when its length is about 5 to 10 cm longer than the tube. Use this string to measure all of your other strings and cut them to be of equal lengths.

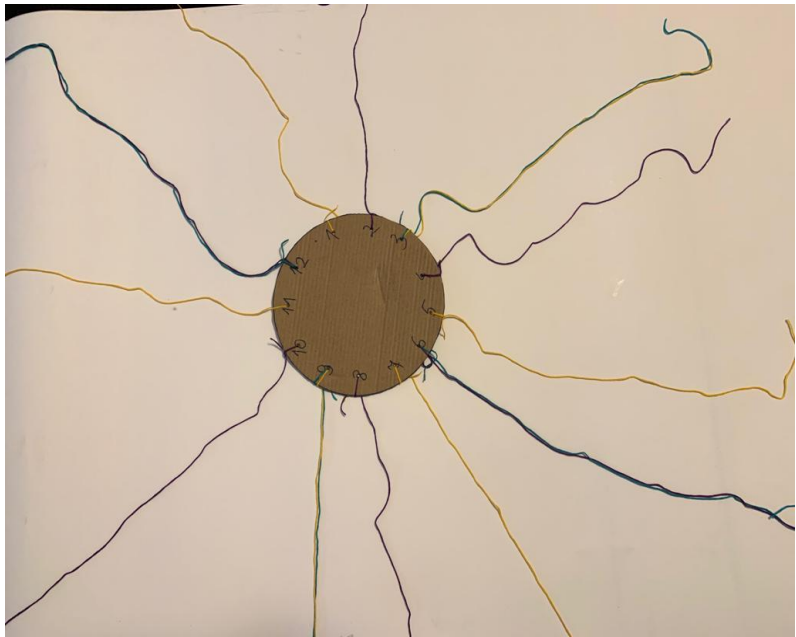
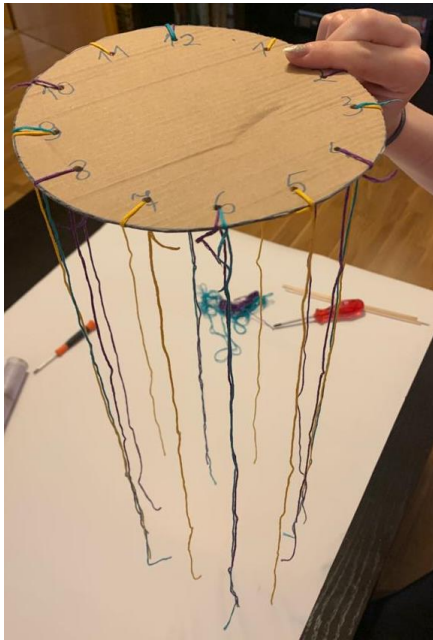


- You will need 4 strings of each colour (16 strands in total)
- In our experiment, we used these string colours for each muscle:
 - **blue for the rectus abdominis muscle**
 - **purple for the internal/external oblique 1**
 - **yellow for the internal/external oblique 2**
 - **pink for the transversus abdominis**
- If your strings are different colours from ours, make a note of which colour you are using for each muscle to not get confused with our explanation!

Place your strings through the 1st circle in this order:

- **Blue strings at numbers 12, 3, 6 and 9.**
- **Yellow strings on uneven numbers (1,3,5,7,9 and 11)**
- **Purple string on even numbers (2,4,6,8,10 and 12)**

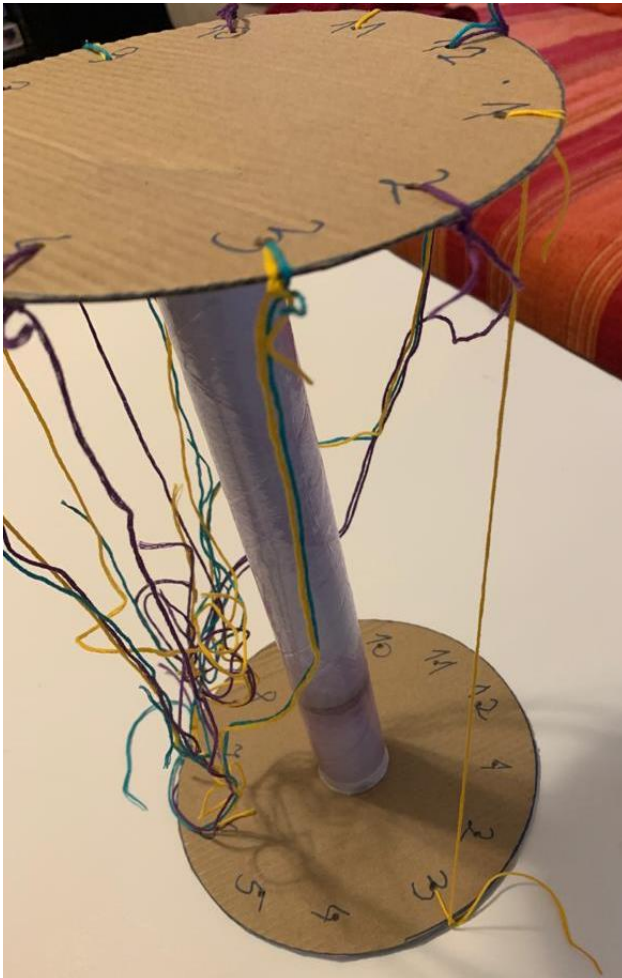
The **pink strings** will be used later.



Step 3 – Aligning the spine (clingfilm tube)

In this activity, the tube represents the human spine. We need to make sure this is properly aligned with our strings before tying the strings to the other circle (we will call this the **2nd circle** or **bottom circle**).

Mark the center of both your circles. Glue the tube (clingfilm tube) to the upper circle. Once the glue is dry, align the bottom circle so that the two clock faces are aligned, e.g. number 12 is aligned with number 12, number 3 is aligned with number 3, etc. and glue the bottom circle to the tube, see the picture below.





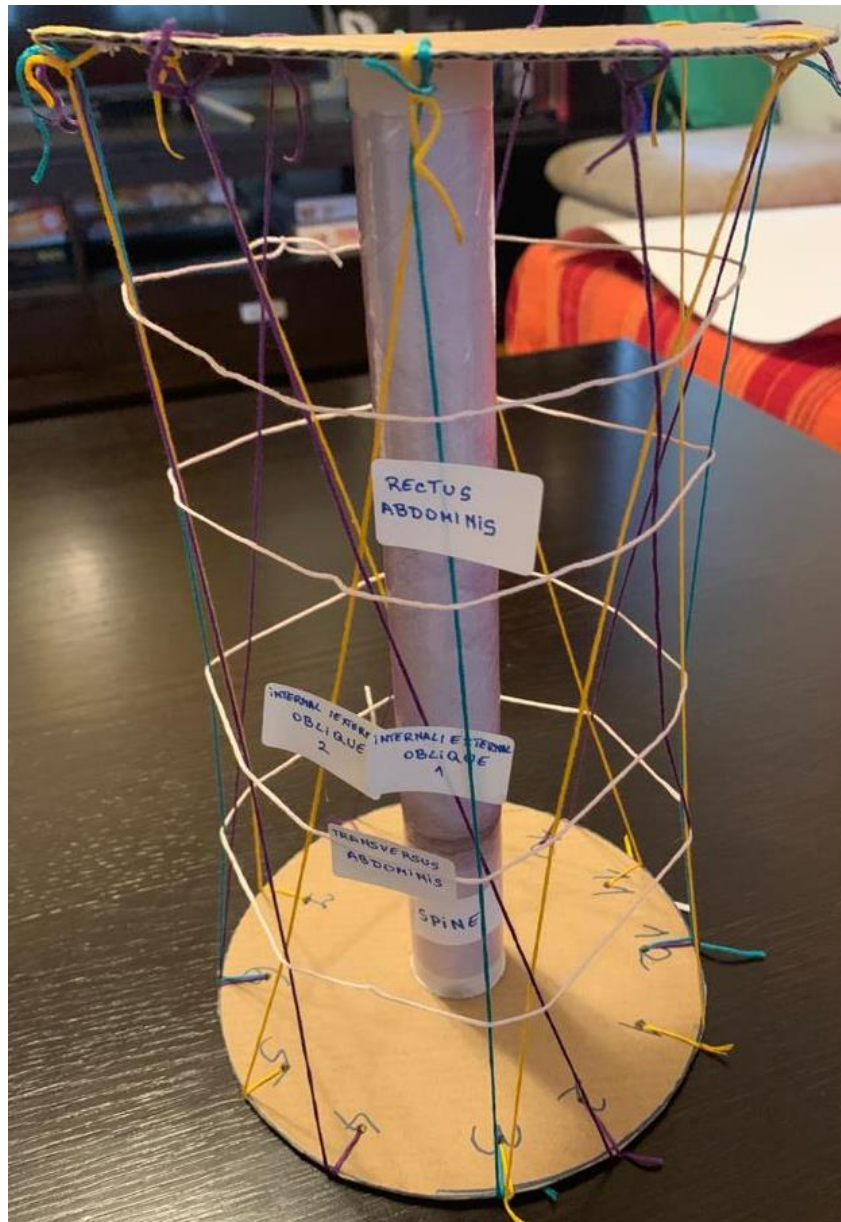
- When the glue is dried (this may be over night), tie all of your strings in the following way:
 - **The yellow strings** from the 1st circle (top one) need to be matched with the next uneven number on the 2nd circle (bottom one):
 - the yellow string from number 1 from the 1st circle will be tied to number 3 on the 2nd circle.
 - the yellow string from number 3 from the 1st circle will be tied to number 5 on the 2nd circle.
 - the yellow string from number 5 from the 1st circle will be tied to number 7 on the 2nd circle.
 - the yellow string from number 7 from the 1st circle will be tied to number 9 on the 2nd circle.
 - the yellow string from number 9 from the 1st circle will be tied to number 11 on the 2nd circle.
 - the yellow string from number 11 from the 1st circle will be tied to number 1 on the 2nd circle.
 - **The purple strings** from the 1st circle (top one) need to be matched with the next even number on the 2nd circle (bottom one):
 - the purple string from number 2 from the 1st circle will be tied to number 4 on the 2nd circle.
 - the purple string from number 4 from the 1st circle will be tied to number 6 on the 2nd circle.
 - the purple string from number 6 from the 1st circle will be tied to number 8 on the 2nd circle.
 - the purple string from number 8 from the 1st circle will be tied to number 10 on the 2nd circle.
 - the purple string from number 10 from the 1st circle will be tied to number 2 on the 2nd circle.
 - **The blue strings** need to be matched to the same quarter number on both circles:
 - the blue string from number 12 from the 1st circle will be tied to number 12 on the 2nd circle.
 - the purple string from number 3 from the 1st circle will be tied to number 3 on the 2nd circle.

- the purple string from number 6 from the 1st circle will be tied to number 6 on the 2nd circle.
- the purple string from number 9 from the 1st circle will be tied to number 9 on the 2nd circle.
- Tie the four pink strings around the other strings, leaving an approximately equal distance

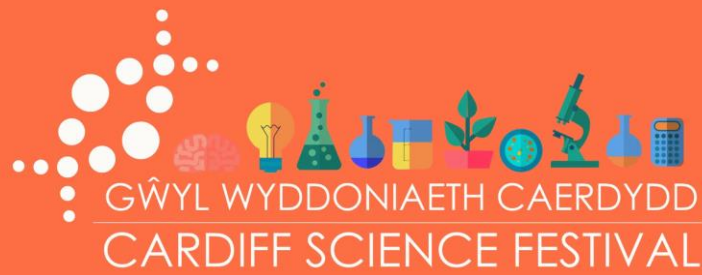


Congratulations, you have just created your own abdominal muscles!

If you have some labels or post it notes, you can also label each of your muscles and the spine:



Please share your creations with us on Twitter @CdfScienceFest and Facebook @CardiffScienceFest and use the tag #CardiffScienceFestival



Task for Cardiff Science Festival live session – Can you be a scientist/researcher?

Scientists and researchers have to understand the role of the object they are studying in order to invent new products that improve our lives. Now you have the chance of being a scientist/researcher by looking up what do these muscles do. Together with your parents, read online or in books about the belly (or abdominal) muscles and try to answer the following questions:

- 1. What motion do the internal and external oblique help with?**
 - **Twisting the trunk (or moving from side to side)**
 - **Crunching**
 - **Sit-ups**

- 2. By working out which muscle, would you get a six-pack?**
 - **Internal oblique**
 - **External oblique**
 - **Rectus abdominis**
 - **Transversus abdominis**

- 3. Which muscle helps stabilizing the trunk and can be contracted when you want?**
 - **Internal oblique**
 - **External oblique**
 - **Rectus abdominis**
 - **Transversus abdominis**

Join us on Friday, the 19th of February, from 2 to 3 pm to show us your belly muscles model and find out how many questions you have answered correctly. The link to the event is below, hope to see you there 😊

<https://www.cardiffsciencefestival.co.uk/en/events/the-secret-science-of-hula-hooping>