KANSAS CITY PUBLIC SCHOOLS

The lab of MR.Q

KCMO PD Workshops - Scott McQuerry

Fall 2013

A Large Look at a Small World

SCIENCE PIONEERS

The lab of MR. Q

Stretching Out your Dinner

OR...

"Worm Races"

What you need:

- PAPER TOWELS
- PAPER-LINED DRINKING STRAWS
- MEASURING CUPS/SPOONS
- BOWL OF WATER

What to do:

THIS IS A VERY SIMPLE SCIENCE FAIR PROJECT!

FILL A BOWL WITH A MEASURED AMOUNT OF WATER. THE BOWL SHOULD BE ABOUT HALF-FULL.

TAKE ONE PAPER TOWEL AND LOWER ITS EDGE INTO THE WATER FOR TEN SECONDS. DO NOT FOLD THE PAPER TOWEL DURING THIS PROCESS. DEPENDING ON THE SIZE OF THE BOWL, YOU MAY NEED TO CUT THE PAPER TOWEL INTO QUARTERS!!!

REMOVE THE PAPER TOWEL FROM THE WATER AND MEASURE THE AMOUNT OF WATER THAT REMAINS IN THE BOWL. THEN, REPLACE THE AMOUNT OF WATER THAT WAS REMOVED BY THE PAPER TOWEL.

FOLD THE PAPER TOWEL INTO MULTIPLE LAYERS AND DIP ITS EDGE INTO THE WATER AGAIN FOR EXPERIMENTATION.

AN EXTENSION ACTIVITY INVOLVES THE USE OF THE PAPER WHICH COVERS DRINKING STRAWS: SCRUNCH THE PAPER AROUND A STRAW UNTIL IT IS TIGHTLY FOLDED TOGETHER. PLACE TWO OF THESE PIECES OF PAPER IN A SHALLOW DISH AND ADD A DROP OF WATER TO BOTH OF THEM SIMULTANEOUSLY. ONCE WET, THE PAPER "WORMS" WILL START TO UNFOLD AS THE WATER DIFFUSES THROUGH ITS STRUCTURE. YOU AND A FRIEND CAN "RACE" YOUR WORMS TO SEE WHICH ONE PASSES A FINISH LINE!

What's going on?

DURING DIGESTION, THE FOOD YOU EAT IS CHEMICALLY BROKEN DOWN AND ABSORBED BY THE SMALL INTESTINE. THE WALLS OF THE SMALL INTESTINE ARE FOLDED AND BENT INTO SMALL FINGER-LIKE PROJECTIONS (LIKE FOLDED PAPER) CALLED VILLI. THESE VILLI INCREASE THE AMOUNT OF SURFACE AREA ON THE SMALL INTESTINE THAT ABSORBS THE NUTRIENTS WE NEED TO LIVE. IT IS A COMMON MISCONCEPTION THAT THE STOMACH DIGESTS OUR FOOD....IT IS THE SMALL INTESTINES THAT DOES MOST OF THE WORK!

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IT'S TIME TO USE SOME BASIC KITCHEN INGREDIENTS TO WHIP UP A DISH I LIKE TO CALL...

The Cat's Meow

What you need:

- WHOLE MILK
- FOOD COLORING
- WATER
- COTTON SWABS
- SHALLOW DISH
- LIQUID SOAP

What's going on?

YOUR LIVER MAKES A LIQUID CALLED BILE, WHICH IS USED TO BREAK DOWN THE FAT IN YOUR FOOD.

IN THIS EXPERIMENT, YOU ARE USING ANOTHER CHEMICAL (SOAP) TO BREAK DOWN THE FAT THAT IS FOUND INSIDE THE MILK. SMALL PARTICLES OF SOAP TRY TO SURROUND OTHER CHEMICALS, LIKE FATS. WHEN THE SOAP SURROUNDS A FAT, IT TENDS TO BREAK APART THE FAT INTO SMALLER PIECES. THIS IS WHY YOU USE SOAP TO WASH YOUR HANDS AND CLOTHES. IT SURROUNDS THE "DIRTY" STUFF AND BREAKS IT APART SO THAT IT CAN BE CLEAN AGAIN!

THE FAT IS SO SPREAD OUT INSIDE THE MILK THAT THE SOAP CANNOT EASILY SURROUND IT! SO, IT SWIRLS AROUND AND AROUND TRYING TO SURROUND ALL OF THE FAT!

What to do:

POUR ABOUT ONE HALF INCH OF MILK INTO THE DISH.

ADD A COUPLE OF DROPS OF FOUR DIFFERENT FOOD COLORS AT THE EDGE OF THE CONTAINER. PLACE THE DROPS EQUAL DISTANCES FROM EACH OTHER. (IF YOU CAN IMAGINE THE DISH/PAN AS A CLOCK, PUT THE DROPS AT 3, 6, 9 AND 12 O'CLOCK.)

DIP THE TIP OF THE COTTON SWAB INTO THE SOAP AND INSERT IT IN THE CENTER OF THE CONTAINER OF MILK.

HOLD THE SWAB IN PLACE FOR A SHORT PERIOD OF TIME.

YOU SHOULD NOTICE AFTER A FEW MOMENTS THAT THE FOOD COLORING STARTS TO SWIRL AROUND INSIDE THE MILK.

Simulating the most frightening form of defense imaginable or…

You want me to fit that in there?!?!

A model of phagocytosis among white blood cells will be explored during this challenge.

Materials:

1 plastic shopping bag
1 pair of scissors
15 cm of string, large rubber band, or tape
4 pieces of wrapped candy, peanuts, raisins, or other item

Procedure:

With the materials in hand, the students are challenged to get the candy into their bag according to the following rules:

- The candy must enter through a solid part of the bag.
- The inside of the bag may not be directly open to the external environment (which means you cannot simply drop the candy into the bag.)
- The candies entering the bag must remain clustered together.
- You may work with your hands in the bag to act as the inside of a cell.
- All materials must be used

Explanation:

Back in Chapter 15, you learned that white blood cells are known as phagocytic cells due to their ability to consume foreign pathogens within the blood. Within the lymph nodes are specific types of phagocytes called **macrophages** which are very efficient at engulfing and destroying pathogens that find their way into the lymphatic system.

The main problem that one has to consider is how a cell such as a macrophage can ingest such large objects without the use of a mouth or other cavity to ingest such materials. Imagine having to ingest a beachball – how could it be done?

Macrophages utilize the process of **phagocytosis** in which the foreign object is engulfed entirely by the cellular membrane of the macrophage itself. This object is brought into the macrophage surrounded by a pinched-off area of its own cellular membrane. The macrophage's membrane is never opened up to the outside environment. If this were to occur, it would likely perish.

This activity is very similar to the actions of a macrophage within the lymph nodes of our bodies. The pictures below will help you solve the puzzle...

A view from inside of the bag...

Folding Matters

**adapted from the tryengineering.org website*

For Teachers:

The "Folding Matters" lesson focuses on how the process of folding has impacts on engineering and is evident in nature. Students consider many applications of folding such as parachutes, wings in a cocoon, heart stents, and solar panels in space. They work in teams to create a model out of everyday items of a solar panel that can be folded (for transport) and expanded (in space). Students design their solar panel on paper, build it for transport, and open or test it. All teams evaluate their results, reflect on their design, and present to the class.

Materials

Student Resource Sheets

Student Worksheets

Class Materials: aluminum foil box with metal rip bar removed for safety (note, the aluminum foil will be used as part of the student team materials) – each student team "solar panel" must fit into the empty aluminum foil box.

Student Team Materials: aluminum foil, tape, cardboard, rubber bands, ruler, popsicle sticks, plastic rods, straws, pipe cleaners, paper clips, glue, scissors, balsa wood, cotton balls, paper, fabric, and other classroom materials.

Procedure

1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider asking the students how they think a large parachute fits into a tiny backpack….have them consider whether they can fit more into a suitcase if everything is folded neatly, or if items are jumbled in a ball.
3. If internet access is available, have students read about the James Webb Space Telescope (http://jwst.gsfc.nasa.gov) and watch the animation showing how the engineers involved have planned how the telescope will have to unfold in space at http://jwst.gsfc.nasa.gov/resources/JWSTSpacecraftDeployAnimation-longversion.mov.
4. Teams of 3-4 students will consider their challenge, review available materials and develop a detailed drawing showing their solar panel including a list of materials.
5. Students next build their solar panel, and fit it into a standard box that foil is sold in (about 12.25 inches or 31 cm long by 2 inches or 5 cm square).
6. Teams then demonstrate the removal of their solar panel to the class, and observe the designs developed by other student teams.
7. Teams reflect on the challenge, and present their experiences to the class.

Student Resource:

Why Folding Matters

Folding and unfolding of materials is an important element in engineering design. Consider a telescope, where circles of metal have to fit neatly within the next in order to expand and be stored compactly. Parachutes are another example…they have to be folded in such a way to deploy properly but also to be stored in a compact back pack. The same is true of wings of a butterfly folded and growing in a cocoon. It is also true of solar panels that are used in space. Spacecraft have limited storage areas, so whatever is carried to space must be folded in a compact way and then deployed with an engineering system so the solar panels unfold and are functional. Heart stents work the same way…a small device is sent via a tube to the heart and then when released at the end of the tube it must unfold or open, and then function as engineered.

Unfolding the James Webb Space Telescope

The James Webb Space Telescope is a large, infrared space telescope. It will find the first galaxies that formed in the early Universe, connecting the Big Bang to our own Milky Way Galaxy. It will peer through dusty clouds to see stars forming planetary systems, connecting the Milky Way to our own Solar System.

It is a joint project of NASA, the European Space Agency, and the Canadian Space Agency. The project is working toward a 2018 launch date. Although engineers, scientists and manufacturers are still in the process of building all of the instruments that will fly aboard NASA's James Webb Space Telescope, they had to figure out long ago, how it was going to "unfold" in space. That's because the Webb Telescope is so big that it has to be folded up for launch.

An animation of how the telescope will open up in space once it achieves orbit, was created by the Image center at Northrop Grumman Aerospace Systems, Redondo Beach, California. The Webb Telescope is roughly 65 feet (21 meters) from end to end and about 3 stories high. "Animation helps designers and their colleagues to fully visualize and explain the complex motions required to deploy this observatory," said Mike Herriage, Webb Telescope Deputy Program Manager at Northrop Grumman. "And while it’s a visual tool, producing accurate animation is a technical challenge as well."

The Webb Telescope is extremely large and cannot fit in a rocket unless it is folded. It has a sunshield the size of a tennis court and an 18-segment mirror that looks like a honeycomb. Because of its large size, the telescope needs to be folded up to fit in the rocket. The sunshield will be compactly folded, much like a parachute, around the front and back of the telescope. The mirror segments are mounted on the "spine" or backplane of the telescope and the segments on the left and right sides of the honeycomb shape are folded in the rocket.

Once the Webb telescope is on its way to its final orbit, approximately 1 million miles from the Earth, engineers at Northrop Grumman will issue commands to the Webb Telescope to unfold it. "Think of the sunshield as five candy wrappers the size of a tennis court," said Mark Clampin, Webb Telescope Observatory Project Scientist at NASA’s Goddard Space Flight Center, Greenbelt, Maryland.

The first part of the telescope to unfold will be the solar panel, followed by the communications antenna. Next, the five layers of sunshield will drop into place from the front and back, spread out into a kite shape. The "secondary mirror support structure," an arm-like feature holding the secondary mirror assembly will then drop down from its folded center perch, and finally, the side mirror segments will be moved forward to form the complete "honeycomb."

More details are at http://jwst.gsfc.nasa.gov and you can watch an animation of the unfolding at http://jwst.gsfc.nasa.gov/resources/JWSTSpacecraftDeployAnimation-longversion.mov

Folding Matters

Student Worksheet:
Solar Panel Folding Challenge

Engineering Teamwork and Planning

You are part of a team of engineers given the challenge of developing a solar panel that can be folded into a box for shipping to the international space station. Your solar panel must be at 1 foot or about 30 cm, by 3 feet or about 90 cm in size when unfolded.

Research Phase

Read the materials provided to you by your teacher. If you have access to the internet, watch the video showing the planned folding of the James Webb Space Telescope at http://jwst.gsfc.nasa.gov/resources/JWSTSpacecraftDeployAnimation-longversion.mov

Planning and Design Phase

You were given a range of items to build with. Consider what materials you will need and in the box below draw your solar panel and include a parts list.

Materials you will need:

Presentation Phase

Present your plan and drawing to the class, and consider the plans of other teams. Be sure to watch what other teams are planning and consider the aspects of different designs that might be an improvement on your team's plan. You may wish to fine tune your own design at this phase.

Build it! Test it!
Next build your solar panel and fold it. You may share unused building materials with other teams, and trade materials too.

Presentation
Present your solar panel to the class and deploy it from the box. You should be able to open your panel to the full size you originally built, with no tears in the foil.

Reflection
Complete the reflection questions below:

1) How similar was your original design to the actual solar panel your team built?
2) If you found you needed to make changes during the construction phase, describe why your team decided to make revisions.
3) Which solar panel folding design of your class worked best? Why?
4) Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?
5) If you could have used one additional material (tape, glue, wood sticks, foil -- as examples) which would you choose and why?

Design and Build a Better Candy Bag

**adapted from the tryengineering.org website*

For Teachers:

The Design and Build a Better Candy Bag activity encourages students to work in pairs to design, build, and test a candy bag. Students will predict the volume and strength of their original design, sketch the design, create a model candy bag, and then test their bag using weight. After testing, students redesign their bag to improve it, and then retest. Student pairs make predictions, compare results, and discuss their findings.

Materials

Student Worksheet
Sketch paper and pencil
8” x 12” pieces of thin, plastic material (I suggest cutting either a plastic painters drop cloth or plastic sheeting)
Masking tape
Twine
Rulers
Scissors
Crayons
Scale, such as spring scale
Measuring cups
Books, various sizes of small bottles filled with water, bags of candy, blocks, or other objects to be used as weights
Items to check for weight, such as rice or candy

Procedure

1. Divide students into pairs and provide the Student Reference Sheet to each. (Note: This sheet can be provided as a reading homework assignment for the prior evening.)
2. Discuss the manufacture of paper bags, and provide several examples of bag designs to share. Ask students to compare the bag designs and guess which might hold the most volume and the most weight.
3. Provide each student with the Student Worksheets and review the project with the teams. Teams will:
    - design a candy bag with some form of handle
    - create a model of their bag design
    - predict the bag's volume and weight capacity
    - test the bag for volume and weight capacity
    - force the bag to fail with too much weight
    - redesign their bag with a goal of holding more weight
    - build a model of the improved design
    - test the second model
    - complete the student worksheet
    - present their finding to the class and
    - compare/contrast results

Student Resource:

Paper Bag History and Inventors

Over the years a variety of designs for candy bags have been created. They are built of a variety of materials (paper, plastic, cardboard) and are designed in a variety of shapes. A woman inventor from York, ME, named Margaret Knight (1838-1914) is credited with inventing a process for automatically folding and gluing paper to form the square or rectangular bottom of a paper bag. As a child, Margaret was often designing, or redesigning mechanical p arts for everything from kites to sleds. When she grew up, she initially worked at the Columbia Paper Bag Company in Springfield, MA. At the time, paper bags were folded and glued much like envelopes. After her work hours, Margaret began to design a machine part that would automatically fold and glue the square or rectangular bottoms needed for paper bags.

Finally, she came up with a design that she thought would work. She had a Boston machinist create an iron model of the part so that she could apply for a design patent. Initially, her design was ignored as the workmen in the factory questioned what a "woman would know about machine design." Margaret Knight did receive a patent for her machine in 1870, but she had to go through a lawsuit first with a man named Charles Annan who had attempted to steal her design and patent the machine himself! Now, Margaret Knight is often considered the mother of the grocery bag. She eventually partnered with a Newton, MA man and started a company in Hartford, CT in 1870 with her invention: the Eastern Paper Bag Company. Now, Margaret's machine is on display at the Smithsonian Institution in Washington, DC. Visit www.smithsonianlegacies.si.edu/objectdescription.cfm?ID=92 to view a photo of her machine.

Student Challenge

You and your partner are employees of the Sweet-Tooth Candy store. Recently your boss has learned that customers would like to have a candy bag that is attractive and more functional than the one they currently use when they shop in the store. Your boss has asked you to design and build a new and improved candy bag that is sturdy, functional, and attractive. She is interested in a candy bag that is able to hold maximum weight and that is attractive, but she has not specified minimum dimensions or the amount of weight the bag must hold.

You have learned that the design and construction method as well as materials used will determine the strength of a bag. You will want to test the strength of your candy bag and will redesign and retest as needed. Measurements may be taken to determine how to improve the strength of your candy bag and to estimate the volume or weight the bag will hold.

The Task

1) As a team, discuss and agree upon a design for your candy bag
2) Draw a sketch of your design in the attached Student Worksheet
3) Build a prototype candy bag based on your design. It must contain some form of handle
4) Calculate the approximate volume of the bag
5) Predict how much weight the bag might hold (Note: One 8 oz. bottle of water weighs 9.7 ounces)
6) Test the strength of your candy bag by holding the bag by the handles and placing weight in the bag until it breaks
7) Discuss and agree upon a redesigned candy bag
8) Draw a sketch of your new design in the attached Student Worksheet
9) Rebuild your prototype bag based on your agreed upon redesign
10) Test the strength of your improved candy bag design
11) Present your groups' findings to the class

Student Worksheet:
Design a Better Candy Bag

Candy Bag Designs I

In the box below, draw the candy bag your team agreed upon for your first design. Include how large it will be, a list of materials needed to construct it, and your estimate of how much weight it will hold.

Materials Needed:

Estimated Volume:

Estimated Weight The Bag Can Hold:

Actual Volume:

Actual Weight The Bag Can Hold:

Candy Bag Designs II

After you have tested your original design and added enough weight to break the bag, redesign your bag, and draw the new design in the box below.

How did this design differ from the prior design?

New Estimated Volume:

New Estimated The Bag Can Hold:

Actual Volume:

Actual Weight The Bag Can Hold:

Results

1) Once you have built your candy bag and tested it, complete the questions below.
   When you tested your prototype, what was the approximate volume of the bag?
2) How much weight did your bag hold?
3) Did you have to redesign your initial prototype?
   If so, why? What did you discover because of your redesign?
   If not, why do you believe your prototype worked so well the first time?
4) The one thing I liked about our design was…
5) The one thing I didn't like about our design was…
6) The one thing I would change about our design based on my experience is …
7) What technology, science, and mathematics concepts did you use when you designed the prototype?