Science Activity & Video Series

Volume 10: Biology

Includes detailed project steps, explanations and key concepts, tips & tricks, and access to instructional videos.

Designed by real scientists for our future generation.

A collection of quick and inexpensive science experiments designed to amaze and educate kids about the wonderful world around us!

Guaranteed to get your kids excited to do real hands-on science like a pro.

Supercharged Science

www.SuperchargedScience.com

Thank You for purchasing the *Homeschool Science Activity & Video Series.*

I hope you will find it to be both helpful and insightful in sparking young minds in the field of science!

INTRODUCTION

Do you remember your first experience with *real* science? The thrill when something you built yourself actually *worked*? Can you recall a teacher that made a difference for you that changed your life?

First, let me thank you for caring enough about your child to be a homeschool parent. As you know, this is a huge commitment. While, you may not always get the credit you deserve, never doubt that it really does make a difference.

This book has free videos that go with it to show you step-by-step how to do each experiment. You can view the videos at:

www.superchargedscience.com/opt/savs10-opt/

Access code: ESCI

Go to this page now so you can get a preview of the videos.

Think of this activity book as the "Idea Book", meaning that when you see an experiment you really like, just take it and run (along with all its variations).

For example, if you find yourself drawn to launching rockets with more and more fins, go for it! Or if you'd like to combine rockets with the wings of an airplane, grab the tape and start creating your inventions. You're the pilot of this adventure!

A Word About Safety… make sure you work with someone experienced when you're working with new stuff you're unsure about. Just use common sense—If it seems like it could be dangerous, ask for help.

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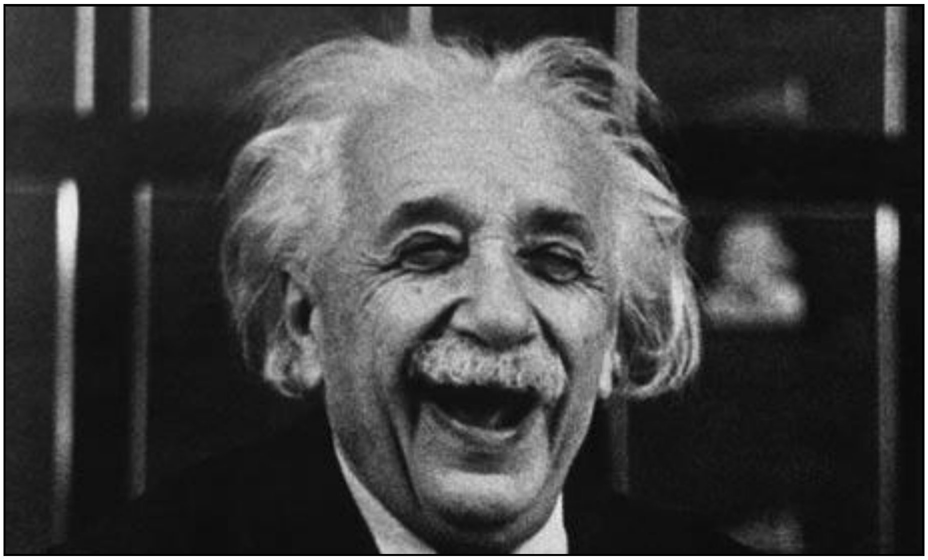
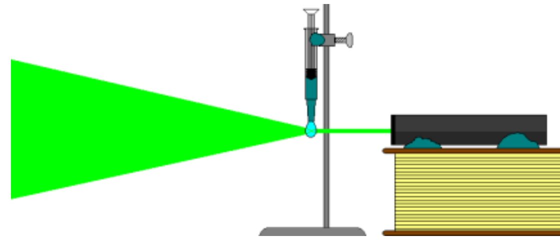
"Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand."

~Albert Einstein



LASER MICROSCOPE



Activity

Did you know that you can use a laser to see tiny paramecia in pond water?

We're going to build a simple laser microscope that will shine through a single drop of water and project shadows on a wall or ceiling for us to study.

Materials

- red laser (watch video for laser tips)
- large paperclip
- rubber band
- stack of books
- white wall
- pond water sample (or make your own from a cup of water with dead grass that's been sitting for a week on the windowsill)

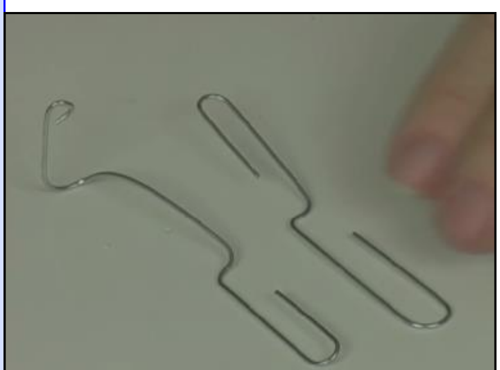
Experiment

To start with, watch the video for this experiment:

www.superchargedscience.com/opt/savs10-opt/

Access code: ESCI

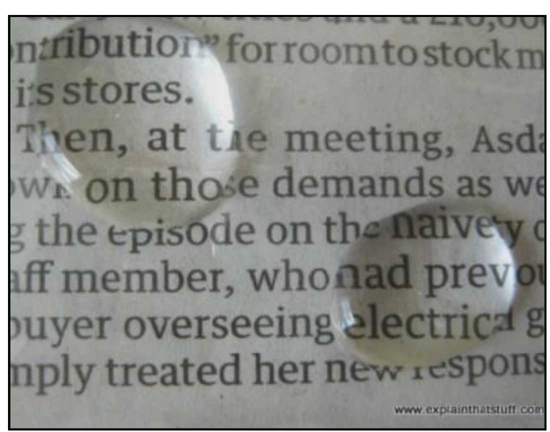
1. Get a sample of pond water. You can get some from a nearby still-water pond or puddle, or grow your own by adding grass clippings and fallen leaves to a jar of water and leave it on a windowsill for a week.
2. Bend your paperclip into a shape like the one on the right in the image below. Now create a small loop like the one on the left. This loop will hold your drop of water in the laser beam.
3. Wrap your rubber band several times around the laser pointer.



4. Insert the non-loop end under the rubber band so that when you turn on your laser, the beam goes right through the paper clip loop. You will need to bend and tweak the paper clip position to make this work.
5. Do not rubber band the laser in the 'on' position. Lasers are actually meant to have a momentary 'on' that gets pushed only when needed so the laser doesn't burn out too quickly.
6. Dip the loop (*not* the laser) in the water sample.
7. Turn off the light and turn on your laser and aim it at the wall. Steady the laser on a pile of books.
8. Depending on your sample, you may be able to see protists, paramecium, and more!
9. To focus the image, adjust your distance from the wall. For greater magnification, pull further away from the wall.

What's Going On?

Inside your loop, you have a drop of water that is fatter in the middle than at the edges.



This makes the water act as a lens as it bends the light passing through it, just like a hand held magnifying lens.

By shining a laser though a drop of water, we can see the shadows of objects inside the water.

It's like playing shadow puppets, only we're using a highly concentrated laser beam instead of a flashlight.

If you're wondering how a narrow laser beam spreads out to cover a wall, it has to do with the shape of the water drop. Water has surface tension, which makes the water want to curl into a ball shape. The ball thins out where it's attached to the wire and bulges up in the center.

At this point, the water acts like a convex lens, which magnifies the light and spreads it out.

As the list passes through the water, it changes direction, the same way sunlight goes through a prism.

A green laser will give you a brighter image, but a red laser will work just as well in a dark room.

Questions to Ask

1. Does this work with other clear liquids?
2. What kind of lens occurs if you change the amount of surface tension by using soapy water instead?
3. Does the temperature of the water matter? What about a piece of ice?
4. Does this work with a flashlight instead of a laser?

Do lasers hurt eyes?

Magnifying lenses, telescopes, and microscopes use this idea to make objects appear different sizes by bending the light.

You'll often see warnings about never pointing telescopes, magnifying lenses, or lasers into your eyes.

If you've never used a hand-held magnifying lens to focus the energy onto a dead leaf, you have to give it a try! Just be sure to do this on a flame-proof surface (like cement) with adult help.

This activity will show you the REAL reason that you should never look at the sun through anything that has lenses in it.

When you concentrate the sun's energy to a single point, the leaf burns. This is exactly what happens at the back of your eye with focused sunlight and laser beams. Never look at intense light with your naked eyes.

Extracting DNA

Activity

DNA is the genetic material that has all the information about a cell. DNA is a long molecule found in the formed by of two strands of genes.

We're going to learn how to extract DNA from any fruit or vegetable you have lying around the fridge.

Materials

- pumpkin OR apple OR squash OR bananas OR carrots OR anything else you might have in the fridge
- dishwashing detergent
- 91% isopropyl alcohol
- coffee filter and a funnel (or use paper towels folded into quarters)
- blender
- clear glass cup

Experiment

To start with, watch the first video for this experiment at:

SuperchargedScience.com/savs10.htm
Access code: ESCI

Step 1: First, grab your fruit or vegetable and stick it in your blender with enough water to cover.

Add a tablespoon of salt and blend until it looks well-mixed and like applesauce. Don't over-blend, or you'll also shred the DNA strands!

Step 2: Pour this into a bowl and mix in the detergent. Don't add this in your mixer and blend or you'll get a foamy surprise that's a big mess.

You'll find that the dishwashing detergent and the salt help the process of breaking down the cell walls and dissolving the cell membranes so you can get at the DNA.

Step 3: Place a coffee filter cone into a funnel (or use a paper towel folded into quarters) and place this over a cup.

Filter the mixture into the cup. When you're done, simply throw away the coffee filter. Note: Keep the contents in the cup!

Step 4: Be careful with this step! You'll very gently (no splashing!) pour a very small about of alcohol into the cup (like a tablespoon) so that the alcohol forms a layer above the puree.

Step 5: Observe! Grab your compound microscope and take a sample from the top. You'll want a piece from the ghostly layer between the puree and the alcohol – this is your DNA.

What's Going On?

If the cell has a nucleus, the DNA is located in the nucleus. If not, it is found in the cytoplasm.

DNA carries two copies—two "alleles"—of each gene. Those alleles can either be similar to each other (homozygous), or dissimilar (heterozygous).

Veggies and fruits are made of water, cellulose, sugars, proteins, salts, and DNA. To get at the DNA, you first need to get inside the cells and separate it out from the other parts. The blender breaks up the fibers that hold the cells together.

The salt and detergent are added next so they can break down the cell walls. Cell walls of plants are made of cellulose. Inside that cellulose is another cell wall (cell membrane). This membrane has an outer later of sugar and an inner layer of fat.

The detergent is a special molecule that has an attraction to water and fats (which is why it works to get your dishes clean).

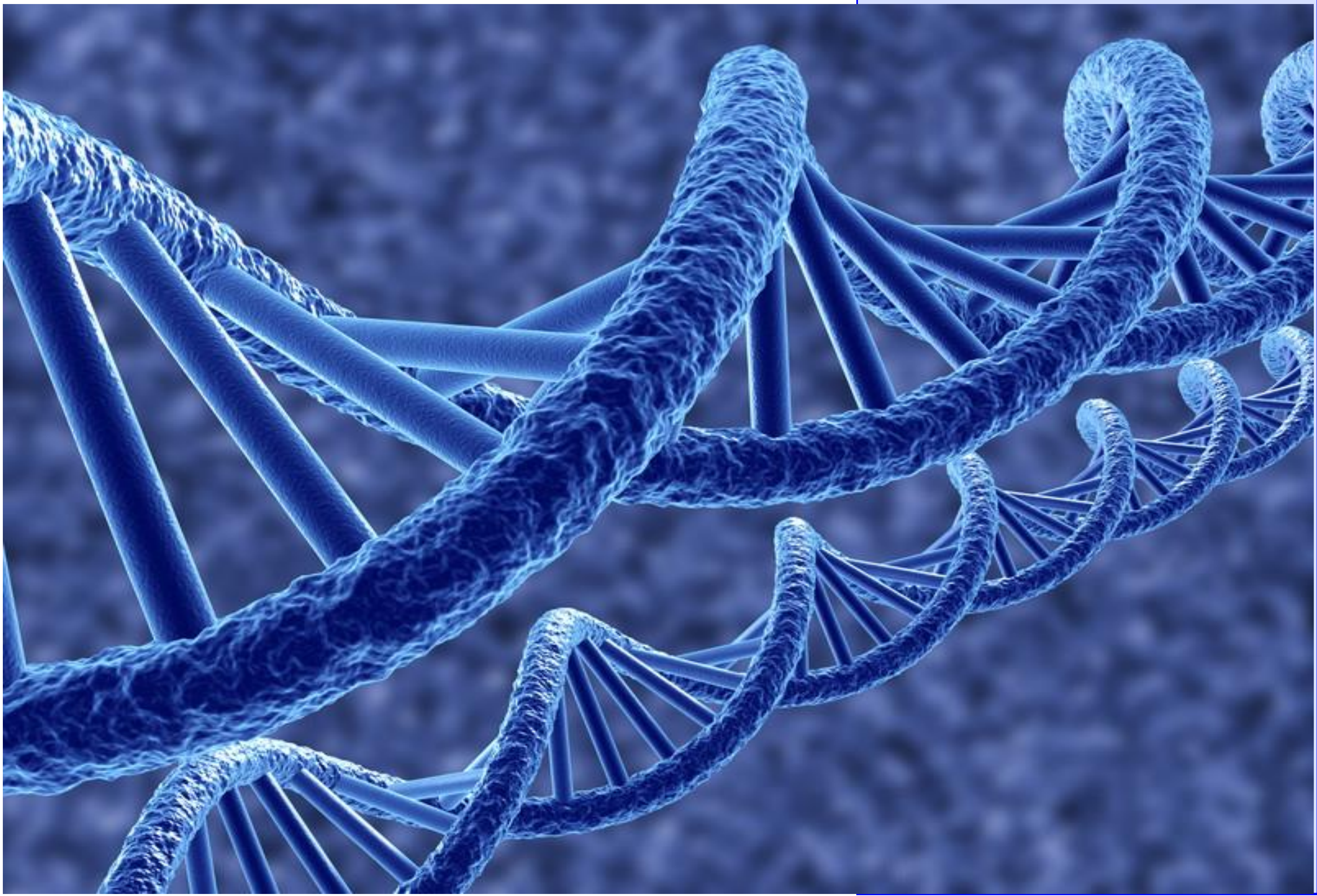
The end of the molecule that is attracted to fat attaches to the fat part of the cell membrane. When you stir up the mixture, it breaks up the membrane (since the other end likes water). It wedges itself inside and opens the cell up… which causes the DNA to flow out.

Since DNA dissolves in water, it stays in the vegetable juice. When alcohols is added, the DNA “comes out” of solution as the ghostly white strands seen at the bottom of the alcohol layer.

Questions to Ask

1. What are fruits and veggies made of?
2. What does DNA stand for?
3. What is DNA?
4. What is a gene?
5. Describe the structure of DNA.
6. What other fruits or veggies work for this experiment?

Enjoy and have fun!



Measuring a Molecule

Activity

Molecules are the building blocks of matter. You've probably heard that before, right? But that does it mean? What does a molecule look like? How big are they? Let's find out.

Materials

- liquid dish soap
- chalk dust
- medicine dropper
- pie pan
- ruler
- water
- calculator

Experiment

To start with, watch the video for this experiment:

www.superchargedscience.com/opt/savs10-opt/

Access code: ESCI

While you technically can measure the size of a molecule, despite the fact it's usually too small to do even with a regular microscope, what you can't do is see an image of the molecule itself.

The reason has to do with the limits of nature and wavelengths of light, not because our technology isn't there yet, or we're not smart enough to figure it out.

Scientists have to get creative about the ways they do about measuring something that isn't possible to see with the eyes.

Here's what you do:

Step 1: Place water in the pie pan and sprinkle in the chalk dust. You want a light, even coating on the surface.

Step 2: Place dish soap inside the medicine dropper and hold it up.

Step 3: Squeeze the medicine dropper carefully and slowly so that a single drop forms at the tip. Don't let it fall! (Image on p.9, middle right)

Step 4: Hold the ruler up and measure the drop. Record this in your data sheet. (Image on p.9 lower right)

Step 5: Hold the tip of the dropper over the pie pan near the surface and let it drop onto the water near the center of the pie pan.

Step 6: Watch it carefully as it spreads out to be one molecule thick!

Step 7: Quickly measure and record the diameter of the layer of the detergent on your data sheet.

Step 8: Use equations for sphere and cylinder volume to determine the height (which we assume to be one molecule thick) of the soap when it's spread out. That's the approximate width of the molecule!

What's Going On?

What you've done in this experiment is taken a small sphere of soap, and made it flatten itself out to a disk that is one molecule thick. The chalk dust is only there so that you can actually see this happening.

When you let the drop hit the surface of the water, due to the structure of the molecules, they repel each other as much as possible. Because of this, we can easily measure the thickness of the soap disk on the surface.

The total volume of the drop does not change during the experiment (the act of releasing the drop doesn't change how much soap is in the drop). So the volume of the spherical soap is the same as the volume of the discus soap.

Use the following equation for the volume of a sphere to calculate the total volume. Remember that the radius is just half the diameter!

$$V = \frac{4}{3}\pi r^3$$

Now that we know the total volume of soap, how can we calculate the thickness of one molecule of soap?

The disk that formed on the surface of the water is just a really flat cylinder, so if we have an equation for the volume of a cylinder, we can solve for the height (or thickness)! Use the following equation where *r* is the radius of the disk and *h* is the height (or thickness).

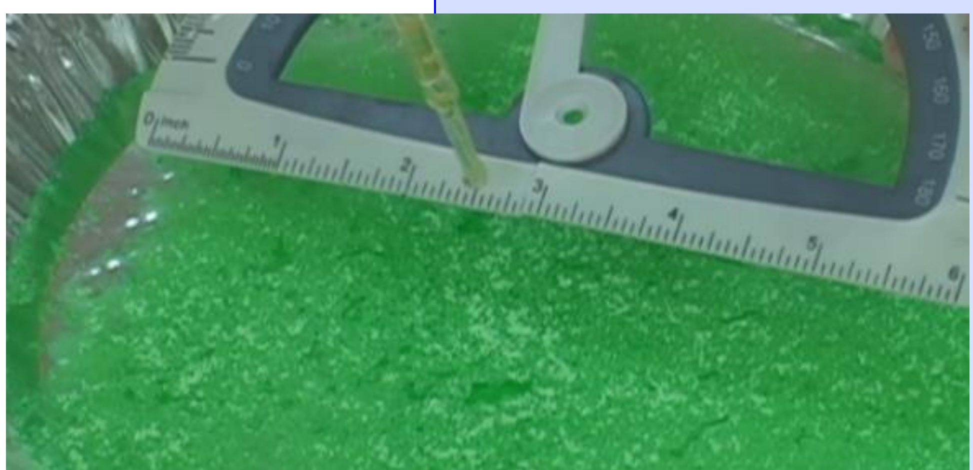
$$V = \pi r^2 h$$

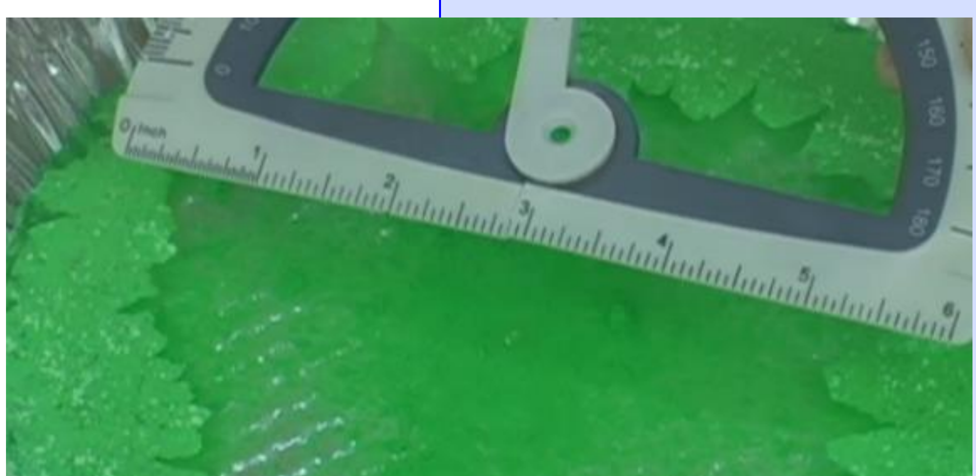
Questions to ask:

Oil spills (*image at right is an oil spill on a beach*) are a big problem on a larger scale. Since water and oil repel each other so much, when a large amount of oil is spilled in the ocean, a huge area is affected.

In 2010, an oil platform (named Deepwater Horizon) spilled 780,000 m^3 of oil into the Gulf of Mexico. If all this oil spread out to an area of 100,000 m^2, how thick would one molecule of the oil be?

(Answer at the bottom of this page… don't peek yet! Give it your best shot first.)





Answer: 24.8 µm or 2.48×10^{-5} m

OSMOSIS & DIFFUSION

Activity

Osmosis is how water moves through a membrane. A carrot is made up of cells surrounded by cell membranes. The cell membrane's job is to keep the cell parts protected. Water can pass through the membrane, but most things can't.

Materials

- 3 large carrots
- Sharp knife (be careful!)
- Cutting board
- Glass
- Salt (3 Tbl)
- Water
- String
- Food coloring

Experiment Part 1:

To start with, watch the video for this experiment:

www.superchargedscience.com/opt/savs10-opt/

Access code: ESCI

We're going to do two experiments on a carrot: first we're going to figure out how to move water into the cells of a carrot. Second, we'll look at how to move water within the carrot and trace it. Last, we'll learn how to get water to move out of the carrot.

Step 1: Cut the tip off of a carrot (with adult supervision).

Step 2: Place the carrot in a glass half full of water

Step 3: Place the carrot somewhere where it can get some sunshine.

Step 4: Observe the carrot over several days.

To notice: When surrounded by pure water, the concentration of water outside the carrot cells is greater than the concentration inside. Osmosis makes water move from greater concentrations to lesser concentrations. This is why the carrot grows in size—it fills with water!

Step 5: Re-do the four steps above in a new cup, and this time put several (10-12) drops of food coloring into the water.

Step 6: With the help of an adult, cut the carrot in half length-wise.

What's going on?

The carrot itself is a type of root—it is responsible for conducting water from the soil to the plant. The carrot is made of cells.

Cells are mostly water, but they are filled with other things like organelles, the nucleus, and so forth.

Water always moves through cell membranes towards higher chemical concentrations. For example, a carrot sitting in salt water causes the water to move into the salty water.

The water moves because it's trying to equalize the amount of water on both the inside and outside of the membrane.

The act of salt will draw water out of the carrot, and as more cells lose water, the carrot becomes

soft and flexible instead of crunchy and stiff.

You can reverse this process by sticking the carrot into fresh water. The water in the cup can diffuse through the membrane and into the carrot's cells. If you tie a string around the carrot, you'll be able to see the effect more clearly!

Now let's make water move OUT of the carrot using osmosis. Here's how you do it:

Experiment Part 2:

Step 1: Snap the carrot in half and tie a piece of string around each piece of carrot (make sure they're tied tightly).

Step 2: Place each half in a glass half full of warm water.

Step 3: In one of the glasses, dissolve the salt.

Step 4: Leave overnight.

Step 5: The next morning pull on the strings. What do you observe?

What's going on?

The salt-water carrot shrunk while the non-salt-water carrot bloated!

This is because of osmosis. Carrots are made up of cells. Cells are full of water. When the concentration of water outside the cell is greater than the concentration of water inside the cell, the water flows into the cell.

This is why the non-salt-water carrot bloated. The concentration was greater outside the cell than inside. The concentration of water was greater inside the salt-water carrot than outside (because there was so much salt!) so the water flowed out of the cell. This made the salt-water carrot shrink.

Questions to Ask:

1. What happens if you try different vegetables besides carrots?
2. How do you think this relates to people? Do we really need to drink 8 glasses of water a day?
3. What happens (on the osmosis scale) if humans don't drink water?
4. Use your compound microscope to look at a sample and draw the cells (both before and after taking a bath in the solution) in your science journal.
5. What did you expect to happen to the string? What really happened to the string?
6. Which solution made the carrot rubbery? Why?
7. Did you notice a change in the cell size, shape, or other feature when soaked in salt water? (Check your journal!)
8. Why did we bother tying a string? Would a rubber band have worked?
9. What would happen to a surfer who spent all day in the ocean without drinking water?
10. What do you expect to happen to human blood cells if they were placed in a beaker of salt water?

GENETICS: TRACKING TRAITS

Activity

Why do families share similar features like eye and hair color? Why aren't they exact clones of each other? These questions and many more will be answered as well look into the fascinating world of genetics!

Materials

- Paper and pencil
- Two different coins
- Scissors
- Glue or Tape

Experiment

To start with, watch the video for this experiment:

www.superchargedscience.com/opt/savs10-opt/

Access code: ESCI

Let's get started!

Step 1: Creating the Parent Generation

First you're going to create the genetic make-up of the parents. You'll want to watch the video on how I created the data table (the link above also has a link so you can download a copy).

Take out the Genetics Data Table, and flip the first coin to create the genetic profile for the mother. Flip the coin and in the Mother's Hair trait column, write D for dominant if the coin reads heads, and R for recessive if tails in the table.

Flip the coin again. In the Mother's Hair trait column right after the first trait, write D for dominant if the coin reads heads, and R for recessive if tails in the table.

If you flipped heads the first time and tails the second, you'd write "DR" in the Mother's Hair box. Continue this process for all of Mother's traits. You should have two letters in each box for the entire column.

Repeat these steps for Father. When you've completely filled out Mother's and Father's columns, you've completed the paternal genetic profile.

Now you're ready for the next part...

Step 2: The Child

Will the child be a boy or a girl? To determine this, flip the second coin. Heads for a boy, tails for a girl. After this is decided, circle boy or girl under "child 1" on the Genetics Data Table.

Now the first coin will represent the gene from the mother and the second coin will represent the gene from the father.

Start with the Hair trait: Flip both coins. If the first coin is tails, take the first trait from the mother. If the first coin is heads, take the second trait.

For example, if the first coin is tails, and the mother's code is DR, then write "D" in the child one column for hair.

Do the same thing for the father's traits with the second coin.

For example, if the second coin is heads, and the father's code is DR, then

write "R" in the Hair Trait column of child 1.
By the end of this step, child 1 should have one letter from the mother, and one letter for the father in child 1's hair trait column.

Use the same steps used to find the genetic code for the hair trait to find the code for the rest of the traits. By the end all the traits should have one letter from the mother's genetic code and one letter from the father's genetic code.

Step 3: What the Child Looks Like
Grab a sheet of paper and start drawing the child. If the genetic code for a trait has a "D" in it, then the dominant trait is used.

For example, if the hair color is DD, DR, or RD then the hair color is dark. If the hair color code is RR, then the hair color is light. Draw the traits on your paper!

You can repeat this for as many children as you would like in your family.

Step 4: Make another family and compare!

Are all families alike? What if you try this process again for another family? Do you see any similarities or differences? Do similar features come from dominant genes? Do differences come from recessive genes? What other traits would you include? Write this in your science journal!

What's Going On?

In fact, most similarities should come from the dominant genes because they are expressed more often. The recessive genes are expressed less often, so the create the differences.

A gene is a unit of information that can be passed along. Genes are made of up DNA. Alleles are the variant (alternate) forms of a gene. Each gene resides at a specific location on a chromosome in two copies, one copy of the gene from each parent, but the copies are not necessarily the same. Alleles are the copies that are genes that differ from each other.

Questions to ask

1. What is the difference between a genotype and a phenotype?
2. What is a dominant trait?
3. What is a recessive trait?
4. Why don't traits simply average out in offspring? For example, why does a tall plant crossed with a short plant not yield a bunch of average-sized plants?
5. In this activity, what percent of the children expressed the dominant allele of each trait?

Teaching Science Right

Hopefully these activities have given you a small taste of how science can be totally cool AND educational.

But teaching homeschool science isn't always easy.

You see, there's a lot more to it than most traditional science books and programs accomplish. If your kid doesn't remember the science they learned last year, you have a problem.

What do kids really need to know when it comes to science?

Kids who have a solid science and technology background are better equipped to go to college, and will have many more choices once they get out into the real world.

Learning science isn't just a matter of memorizing facts and theories. On the contrary, it's developing a deep curiosity about the world around us, AND having a set of tools that lets kids explore that curiosity to answer their questions.

Teaching science in this kind of way isn't just a matter of putting together a textbook with a few science experiments and kits.

Science education is a three-step process (and I mean teaching science in a way that your kids will really understand and remember). Here are the steps:

1. Get kids genuinely interested and excited about a topic.
2. Give them hands-on activities and experiments to make the topic meaningful.
3. Teach the supporting academics and theory.

Most science books and programs just focus on the third step and may throw in some experiments as an afterthought. This just isn't how kids learn.

There is a better way. When you provide your kids with these three keys (in order), you can give your kids the kind of science education that not only excites them, but that they remember for many years to come.

Don't let this happen to you… you buy science books that were never really used and now your kids are filling out college applications and realizing they're missing a piece of their education—a REALLY big piece. Now *that's* a setback.

So what do you do?

First, don't worry. It's not something that takes years and years to do. It just takes commitment.

What if you don't have time? What I'm about to describe can take a bit of time as a parent, but it doesn't have to. There is a way to shortcut the process and get the same results! But I'll tell you more about that later.

Putting It Into Action

Step one: Get kids genuinely interested and excited about a topic.

Start by deciding what topic you want your kids to learn. Then, you're going to get them really interested in it.

For example, suppose I want my 10-year old son to learn about aerodynamics. I'll arrange for him to go up in a small plane with a friend who is a pilot. This is the kind of experience that will really excite him.

Step two: Give them hands-on activities and experiments to make the topic meaningful.

This is where I take that excitement and let him explore it. I have him ask my friend for other chances to go flying. I'll also have my friend show him how he plans for a flight. My son will learn about navigation, figuring out how much fuel is needed for the flight, how the weight the plane carries affects the aerodynamics of it, and so much more.

I'll use pilot training videos to help us figure this out (short of a live demo, video is incredibly powerful for learning).

My son is incredibly excited at this point about anything that has to do with airplanes and flying. He's sure he wants to be a pilot someday and is already wanting flying lessons (he's only 10 now).

Step three: Teach the supporting academics and theory.

Now it's time to introduce academics. Honestly, I have my pick of so many topics, because flying includes so many different fields. I mean he's using angles and math in flight planning, mechanics and energy in how the engine works, electricity in all the equipment on board the plane, and of course, aerodynamics in keeping the plane in the air (to name just a few).

I'm going to use this as the foundation to teach the academic side of all the topics that are appropriate.

We start with aerodynamics. He learns about lift and drag, makes his own balsa-wood gliders and experiments by changing different parts. He calculates how big the wings need to be to carry more weight and then tries his model with bigger wings. (By the way, I got a video on model planes so I could understand this well enough to work with him on it).

Then we move on to the geometry used in navigation. Instead of drawing angles on a blank sheet of paper, our workspace is made of airplane maps.

We're actually planning part of the next flight my son and my pilot buddy will take. Suddenly angles are a lot more interesting. In fact, it turns out that we need a bit of trigonometry to figure out some things.

Of course, a 10-year old can't do trigonometry, right? Wrong! He has no idea that it's usually for high school and learns about cosines and tangents.

Throughout this, I'm giving him chances to get together with my pilot friend, share what he's learned, and even use it on real flights. How cool is that to a kid?!

You get the idea. The key is to focus on building interest and excitement first, then the academics are easy to get a kid to learn.

Try starting with the academics and...well, we've all had the experience of trying to get kids do something they don't really want to do.

The Shortcut

Okay, so this might sound like it's time-intensive. If you're thinking "I just don't have the time to do this!" or maybe "I just don't understand science well enough myself to teach it to my kid." If this is you, you're not alone.

The good news is, you don't have to. The shortcut is to find someone who already specializes in the area you want your kids to learn about and expose them to the excitement that persons gets from the field.

Then, instead of you being the one to take them through the hands-on part and the academics, use a solid video-based homeschool science

program or curriculum (live videos, not cartoons).

This will provide them with both the hands-on experiments and the academic background they need. If you use a program that is self-guided (that is, it guides your kinds through it step-by-step), you don't need to be involved unless you want to be.

I'm partial to the "e-Science" program from SuperchargedScience.com (after all, I'm in it), but honestly, as long as a program uses these components and matches your educational goals, it should be fine.

Your next Step should be to take a look at how you're teaching science now and simply ask "Is my kid getting the results I want from his or her science education?"

After this, consider how you can implement the three key steps we just talked about. Either go through the steps yourself, or use a program that does this for you.

If you want to learn more about how to teach science this way, we regularly give free online tele-seminars for parents. To learn more about them, visit:

SuperchargedScience.com/freeteleclass.htm

My hope is that you have some new tools in your homeschool parent toolbox to give your kids the best start you can in life.

Again, I want to thank you for taking the kind of interest in your child that it takes to homeschool. I know it's like a wild roller coaster ride some days, but I also know it's worth it. Have no doubt that the caring and attention you give to your child's education today will pay off many fold in the future.

My best wishes to you and your family.

Warmly,

Aurora