



Teacher's Guide for:
Heart Pumps

Note: All activities in this document should be performed with adult supervision. Likewise, common sense and care are essential to the conduct of any and all activities, whether described in this document or otherwise. Parents or guardians should supervise children. Rock-it Science assumes no responsibility for any injuries or damages arising from any activities.

NOTE: This is the transcript of a lesson that was videotaped during an actual Rock-it Science class with real students, not actors.

Contents:

Quick Reference Sheets:

- Intro:page 2
- Experiment: *Heart Pumps*page 4
- Equipment List: *Heart Pumps*page 5
- Story, Part 1: *Evil Mister Fred's Floating Continent*page 6
- Story, Endingpage 7

Video Transcript:

- Intro:page 8
- Story, Part 1 : *Evil Mister Fred's Floating Continent* page 11
- Experiment: *Heart Pumps* page 13
- Story Ending page 14

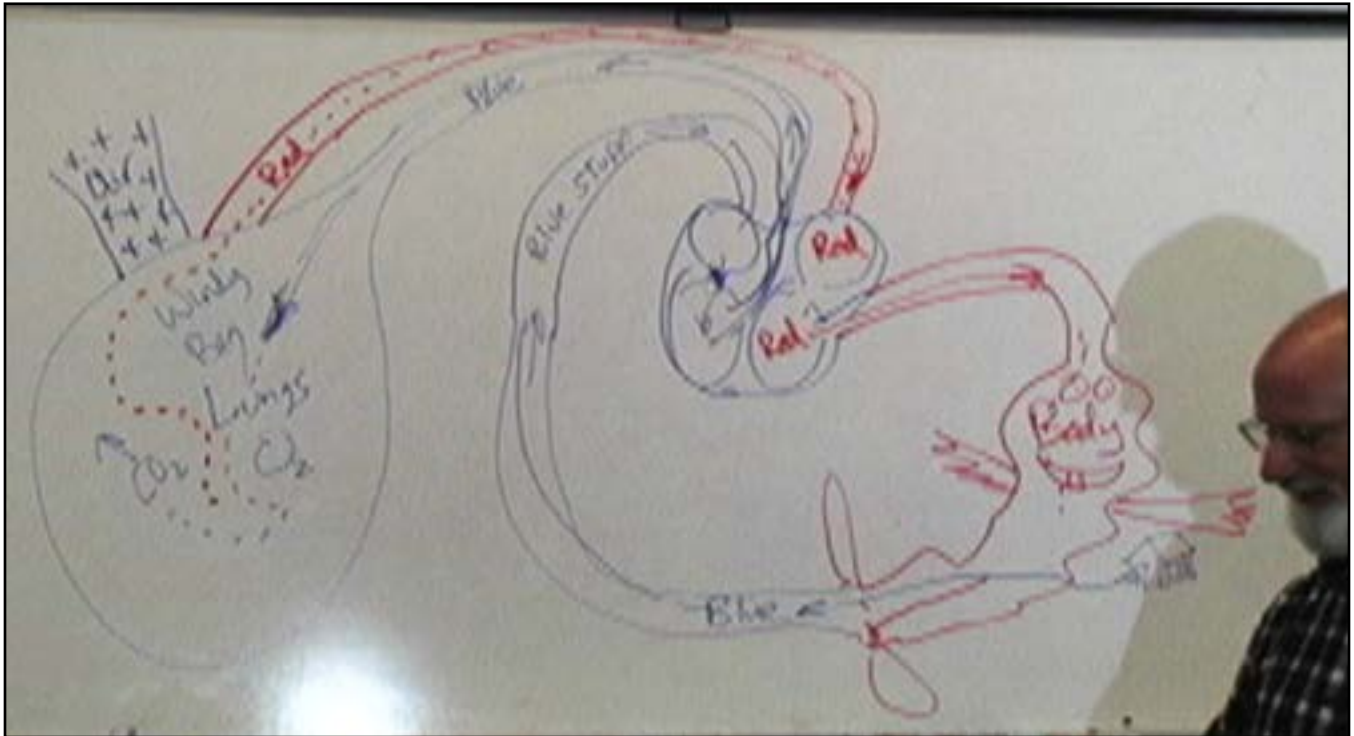
Title Page of Video:

Heart Pumps
A Rock-it Science Lesson
Filmed April 2011

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Intro Quick Recap:



- Suppose you're jumping on the trampoline and your heart falls out. You discover that it's connected to a lot of tubes.
- One tube has blue stuff inside that's heading toward the heart.
- Another tube behind it also has blue stuff and it's heading away from the heart. It goes to a windy bag.
- When stuff comes out of the windy bag, it changes color to red and connects to the other side of the heart. This is an artery.
- Then when it comes out of that side of the heart, it's still bright red, and it goes to all the parts of your body.
- When it's gone about halfway through, it starts to turn blue again. When it's all the way through, it's all blue again, and it goes back into the heart.
- The heart has 4 rooms. And 4 doorways. Two of them go between rooms, and two others lead to two of the tubes.
- When the blood guys first come back into the heart, they fill up the first room. Then the walls start squeezing them, a door opens, and they all get shoved into the second room.
- Then the door closes behind them, they get a really big squeeze, another door opens and they all get pushed through the tube to the windy bag – the lungs.
- They get to a place where the walls are really thin, and they hear a sound like air rushing in and out. And they give up their CO₂, suck in Oxygen, and turn red.

Intro Quick Recap:

- Then they go out through the red tube and enter the third room of the heart. Same thing happens. Walls squeeze in, the door opens, they zoom into the fourth chamber, and the door closes behind them.
 - Then they get squeezed again, the door opens, and they go out through the tube to the body.
 - When they get to the body, they find a house with starving children in it. So they give the kids some oxygen, and the kids get really happy and run off and play.
 - When the blood gives its oxygen to the kids, it turns from red to blue. Then it returns to the heart and goes through the process all over again.
 - The air that goes out of the lungs has a lot of positive charge on it. It's probably from the process where the blood is giving energy, oxygen, to the little kids, but we don't know for sure.
 - If you're in a room with a bunch of people and they're all exhaling, you're filling the room with positive charge. Then everybody starts to feel tired, because they like to have negative charge to make themselves go.
 - If you go to the mountains or the beach, there's lots of negative charge, so you feel good.
 - It's only in a room with a bunch of people that you feel bad. When you open the door and let in some fresh air, everybody feels better.
 - *[Show videos of beating hearts.]*
-

Experiment Quick Recap: "Heart Pumps"

Part One: Make a Squeaking Minion

- Students work individually.
- Teacher constructs a "minion" using a pump, two valves, and two hoses. When you squeeze it, the minion compresses, and when you let go it expands again.
- Without letting the students examine the teacher's model, ask them to each construct one of their own that works the same way.

Part Two: Connect Minions Together

- Once the students get their minion working, have them pair up and connect two of them.
- When you compress one minion, the other one should expand, and vice versa.
- When they have two minions working correctly, add another pair of students to the group and have them try to make a 4-way connection. If the students figure out that the minions should be connected in a circle, they'll be able to compress them in sequence.
- Have more students combine forces to assemble as large a group of minions as they can.

Part Three: Add Water (Demo)

- Teacher constructs a pair of minions using clear plastic tubing between them.
- Add water to the pumps so students can see how it flows between the minions when they're compressed.
- Add some food coloring to the water to make it more visible (optional)



Teacher builds a "minion."



Connecting multiple minions.



Water added.

Equipment List: "Heart Pumps"

Items needed for Instructor:

- Computer, projector, speakers, and screen to show videos of hearts pumping
- Two clear plastic tubes, approx. 24", to connect a pair of pumps
- Water
- Bucket for water
- Food coloring (optional)
- Floor mats for students to kneel on

Items needed for Students:

Consumables:

- None

Other (per student):

- Two plastic pumps for air mattresses (available in toy stores) *
- Two valves for each pump (these come with the pump)
- Two plastic hoses or plastic tubing (ONE hose comes with each pump, but students need TWO hoses each for the experiment.)

* "Bellows Hand Foot Pump Inflator"
(Comes with two valves and one hose.)
We found this item online at
<http://www.walmart.com/ip/46023082>

Prep Work:

- Put hot melt glue inside the lip of each valve to keep it from falling apart.
- Take apart pump components as shown below so students can discover by trial and error how they're meant to fit together.



Bellows units.

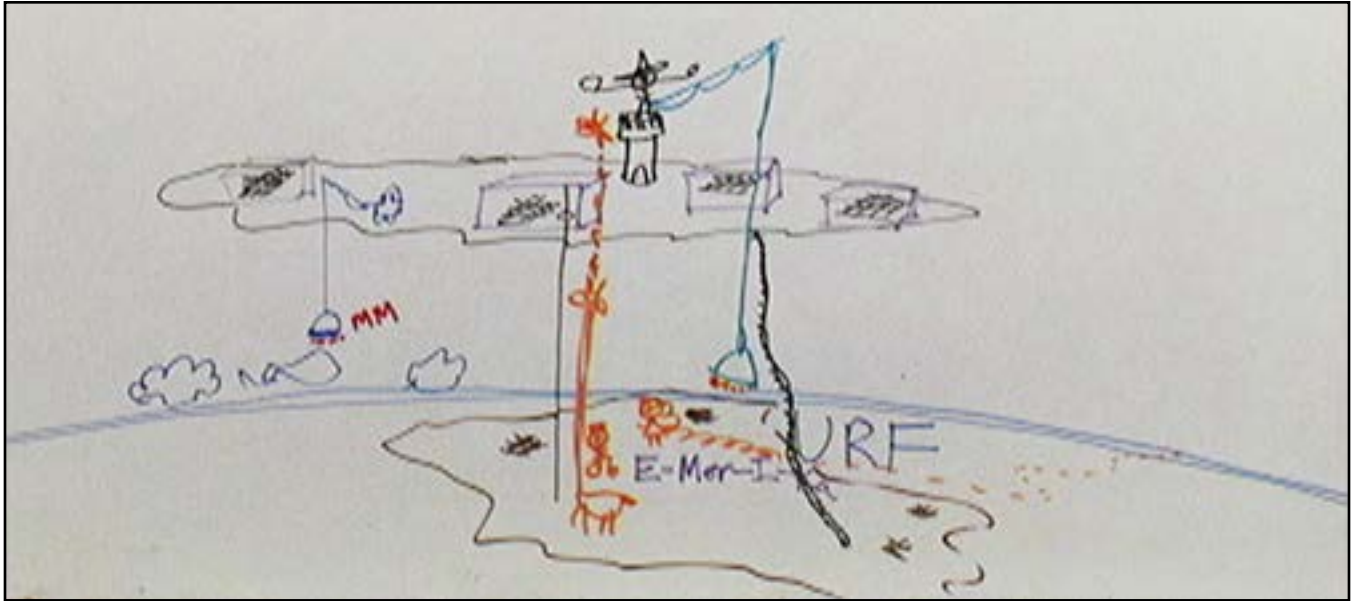


Valves



Hoses and clear plastic tubing.

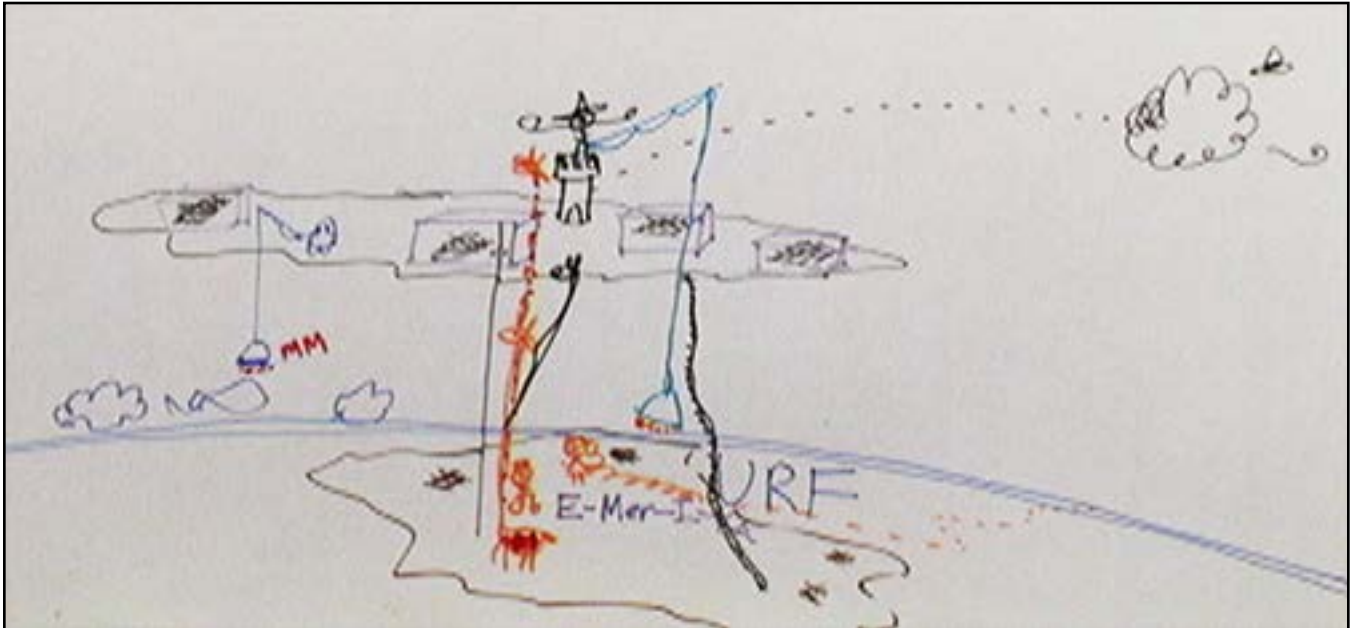
Story Recap: "Evil Mister Fred's Floating Continent"



Part 1:

- Jack and Jill live on the planet Urf, on a continent called E-mer-i-ka.
- Evil Mister Fred ordered a floating continent from the Acme Store of Everything.
- He put giant fish tanks over the cities to hold the air.
- Only Evil Mister Fred's friends could live there, and they had to pay a lot of money.
- In order to travel between his floating continent and the ground, Evil Mister Fred could fly on his vacuum cleaner. But his residents had to use a very tall rope ladder or a fireman's pole.
- The floating continent didn't have any clouds, so no rain and no water. No way to grow crops.
- Evil Mister Fred invented a food magnet -- a french-fry magnet. He hung it from a fishing pole, flew over a city, and grabbed all their french fries.
- The people on his continent got sick of french fries, so Evil Mister Fred made a pizza magnet, and he had the minions operate it.
- The minions pestered Evil Mister Fred for an M&Ms magnet until he gave in and made one.
- Eventually, Evil Mister Fred planned to steal all the food from the land below.
- Jack and Jill knew it wouldn't matter if they grew more food because Evil Mister Fred would just steal it.
- They called the Acme Store of Everything and ordered an extra tall giraffe. It was a hundred miles tall. But it wasn't quite tall enough to reach the continent.
- So Jack and Jill ordered a neck stretcher so the giraffe could reach.
- The giraffe started grabbing the food and throwing it down to Jack and Jill.
- But the giraffe was so tall he couldn't drink. If he bent down to drink, the water couldn't go up his throat, and he'd get dizzy. That would make him stagger around and accidentally step on cities.

Story Recap (cont.): "Evil Mister Fred's Floating Continent"

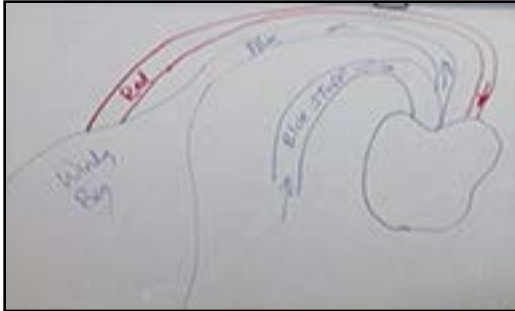


Ending:

- Giraffes have extra muscles in their necks to squeeze the blood up to their heads. It's kind of like having extra chambers in their hearts to squeeze the blood up and up.
- If you've ever hung upside down by your knees and felt the blood rush to your head, you know it can make you dizzy.
- The giraffe was getting dizzy, so Jack ordered a hundred hearts and tapped them into the giraffe's neck so they'd pump blood to its head.
- That worked, but then the giraffe wanted some nails to eat because the iron would make strong blood.
- Jack gave the giraffe a thousand pounds of nails to eat.
- Now the giraffe has all these extra hearts and iron in his blood, and he becomes really strong.
- The giraffe tells Evil Mister Fred to stop stealing food and give back what he had taken.
- Evil Mister Fred refuses.
- The giraffe grabs the edge of the floating continent and starts shaking it back and forth like a chew toy.
- Evil Mister Fred's castle flew off the continent and exploded.
- And they all lived happily ever after, except Evil Mister Fred.

Transcript: Intro

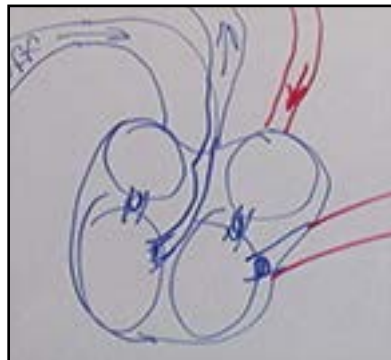
Suppose you're jumping on the trampoline one day and your heart falls out. And you discover that it's connected to a lot of tubes. There's a big fat tube that comes out at the top. And this one comes with blue stuff inside. And there's one that comes out kind of behind it, and it's got blue stuff, too. This stuff is all going that way *[draws arrow in vein]*. Now there's more blue stuff. If you poke a hole in it, it will squirt out more blue stuff.



Windy bag with red stuff coming out.

And this goes over to a big bag – a Windy Bag. And when the stuff comes out of the windy bag it changes colors. Now it's red. And it goes into the other side of the heart.

And then, when it comes out of that thing, it's still bright red, and it goes to all the parts of your body. It goes up to your head, down to your fingers, everywhere on your body. Into your eyes, and your mouth, and your hands, and your feet.



Four rooms with doorways.

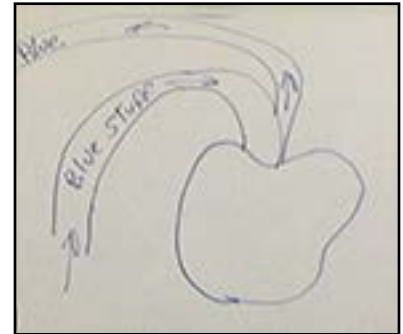
When it's gone about halfway through, it starts to turn blue again. When it's gone all the way through your whole body, it's all blue again, and it goes back into the heart.

And the heart has 4 rooms in it. And there are doorways between the rooms. *[Draws doorways. Two of them go between rooms, and two others lead to two of the tubes.]* So there are four doorways.

When the blood first comes in, all blue, it fills up this chamber. And the blood guys are going, "Yeah, we made it. We're back. I wonder what's going to happen now."

Then the walls start to squeeze on them – squееееeze – and they go, "Oh, boy, we're getting squished." And then somebody opens the door, and they all get shoved into this room. And they all fill it up. It's like being shoved into a commuter train. There are people shoving them in, shoving them in.

And then the door closes behind them – kaboom! -- and they go, "Uh-oh, now for the big squeeze." And the walls start to close in – scruuuushhhh – and they go, "Ahhhhh!"

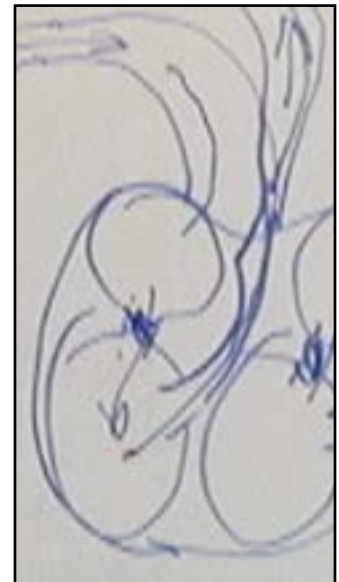


Heart and two tubes.

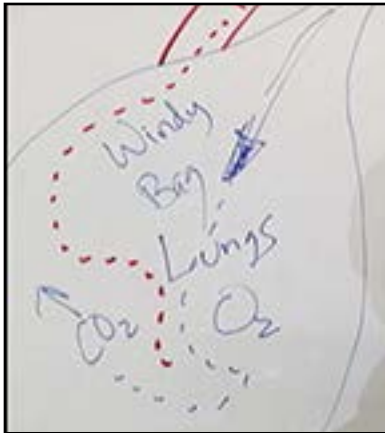
And then, when it comes out of that thing, it's still bright red, and it goes to all the parts of your body. It goes up to your head, down to your fingers, everywhere on your body. Into your eyes, and your mouth, and your hands, and your feet.



Red stuff goes from heart to body.



Blue stuff enters first room, gets squeezed into second room, then out through the top tube to lungs.

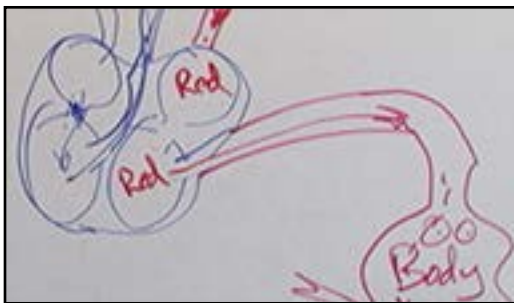


In lungs, blood trades CO₂ for oxygen, turns red, and leaves.

And just when they think they're going to get completely squished, this other door opens and they go, "Who-hoo!" And they all shoot out at high speed on this freeway over to the windy bag. Do you know what the windy bag is? *[Students respond -- lungs.]*

And the blue guys go into the lungs, and they get to some places where the walls are really, really thin, and they hear this whoosh, whoosh *[makes a sound like air rushing in and out]*. And they throw away their carbon dioxide. That goes out the window. And they suck in oxygen, and they turn red.

And when it's all bright red they say, "I'm leaving. I'm looking good now, I'm cool." So they're all full of energy here, all red. They come back into this side of the heart, and the same thing happens to them.



Red blood goes through heart to the body.

They come into this room and say, "Oh, boy, door's going to open." The walls start to squeeze, the door opens, and they zoom into this chamber, and then that door slams closed – kaboom!

And then they get squeezed – squishhhh – and then this door flaps open, and all the red guys go zoom out to the body.

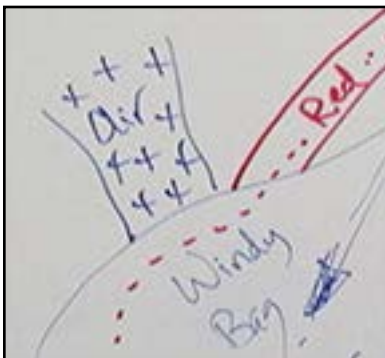
And now when they get to your body, they find a local house there, and there are starving children in the house. And they say, "Aww, poor starving children. Here, have some oxygen." So they give the kids some oxygen, and the kids say, "Who-hoo!" and they run off and they play soccer.



Blood gives oxygen to kids and turns blue.

Well, when the blood gives its oxygen to the little kids, it turns from red to blue. And then it goes and starts all over again.

And it's a neat thing. There's something else weird that goes on, too, because there's some electricity involved. In here in the lungs, the air that goes out has a whole bunch of positive charge in it. And you can blow on something that's negatively charged with a little bit of static electricity, and go whoosh *[blows]* -- and cancel the charge if it's negative.



Exhaled air has positive charge.

And people have always wondered, "Where did that positive charge comes from?" It's probably from the process where they're giving the energy, the oxygen, to the little kids, but we don't know for sure.

And this positive charge goes out. If you're in a room with a whole bunch of people and they're all going *[exhales deeply a few times]*, you're filling the room with positive charge. Then everybody starts to feel really tired, because they like to have negative charge to make themselves go.

If you go up into the mountains, there's lots of negative charge up in the mountains. And you jump out of your car and run around and say, "Yayyy!" because you feel good. If you go down to the beach, there's lots of negative charge at the beach. When you run around at the beach, you say, "Yayyy!" because you feel good.

It's only in a room with a bunch of other people that you feel bad. And then if you open the door and let some fresh air in, everybody goes, "Ah, finally!" Negative charge and fresh air make them feel good again. Well, today we're going to do some stuff related to hearts.

[Show students some videos of beating hearts (not included in this video.)]

Story: "Evil Mister Fred's Floating Continent"

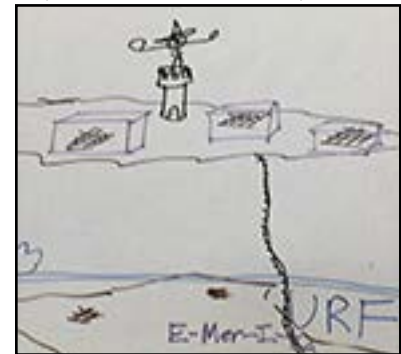
Let's suppose that Evil Mister Fred decides to create another level on Urf. So here's Urf. And Urf has blue sky, it's got land, it's got oceans, it's got clouds. And there's the land. It's got all the cities, and when you look from outer space, the cities just look like little blobs. At nighttime it looks really cool because you can see all the lights. We'll call it E-mer-i-ka.



Floating continent above URF.

And Evil Mister Fred said, "Ah, we can add another layer to this. We've got too many people down there anyway." So he called the Acme Store of Everything and he ordered another layer for Urf. And they sent a nice continent up here for him, floating in the air. And the continent had cities, and there wasn't a lot of air up there because it was up so high, so he had to order some place for them to store their air.

So he got a bunch of old fish tanks and he put fish tanks over the cities just so they could trap some air inside and everybody would have something to breathe. And this was a place for his minions to live, and all his friends. And he sold the property there on an exclusive basis. If you wanted to go live on Evil Mister Fred's continent, you had to be friends with Evil Mister Fred and you had to pay him a whole lot of money.



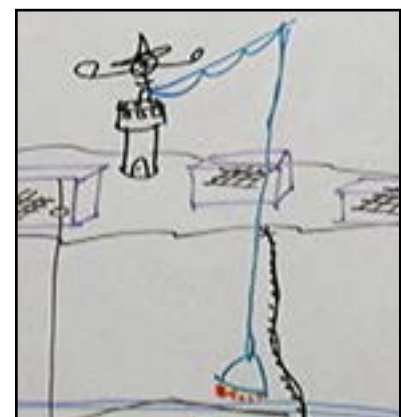
Fish tanks and rope ladder.

And his continent wasn't anchored very well. It tended to drift and float around depending on which way the wind was blowing. So he needed some way to get up and down. Well, for Evil Mister Fred it wasn't too hard, because he's got a flying vacuum cleaner. And he can just fly down, visit the ground, and come back up. Everybody else, though, didn't have flying vacuum cleaners, and they had to take the ladder. And you can imagine it's a pretty tall ladder. It was a rope ladder, all the way down to E-mer-i-ka. And these poor people would have to try to climb up this ladder.

Well, it's probably about a hundred miles high. So people got really strong arms and legs from climbing up and down the ladder. And if you're one of the exclusive people, you got to slide down the firemen's pole. There was this nice brass pole that went all the way down.

Well, it didn't rain up there. No clouds. No water. So they had to bring water up, and you can't grow food. They had to bring food up. So Evil Mister Fred invented a food magnet. And the food magnet involved nothing more than a fishing pole with this giant magnet on the bottom. And his favorite food was french fries.

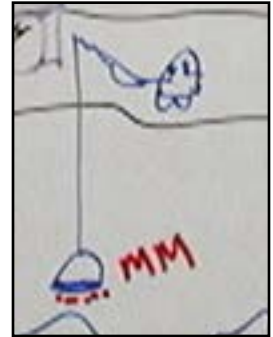
So he could fly over a city, turn on the magnet, and all the french fries would stick to the magnet. Here's a bunch of french fries stuck on it. And the people up above got more french fries than they ever wanted, until they were sick and tired of french fries. So then he had to get a few other magnets. He got a pizza magnet, so the minions could run the pizza magnet. Of course, the minions only wanted one certain magnet, and they kept bugging Evil Mister Fred, saying, "Come on, we want a magnet



French fry magnet.

for us! Give us one!" And Evil Mister said, "Oh, all right! If you guys just leave me alone, I'll give you one."

Of course, they want an M&M magnet because that's their favorite food. So they got M&Ms that they sucked from the land down below. Well, the people down there didn't like it when they saw Evil Mister Fred's continent floating overhead, because their food was going to get magnetized and sucked up into the air, and Evil Mister Fred was going to eat it all. In fact, that's exactly what he had in mind, to just float over, take up all the food they had on the entire continent up to his place and say, "So sad. Too bad. See you around." And off he'd go.



Minions' M&M magnet.



Jack and Jill.

Well, Jack and Jill are down there, and they say, "Well, we've got to grow more food. But if we grow it, Evil Mister Fred's just going to come by and steal it." So Jack and Jill said, "What we need is some way to get that food back again, because he doesn't need all that food. How could he possibly eat all that food?"

So Jack and Jill called the Acme Store of Everything and ordered a giraffe. It's an extra tall giraffe. A hundred-mile-tall giraffe. And they said, "Hey, giraffe, just stick your head up there when he comes by, and grab some of that food back for us." And the giraffe said, "Oh, I'm almost tall enough. I need to be just a little bit taller."

So they ordered a big stretcher for the giraffe and they stretched his neck way up. So now the giraffe can grab the food. And the giraffe said, "Yay!!" And he grabbed food off the continent and he'd throw it down to Jack and Jill. It's hard when he's throwing watermelons down. But most of the time they could catch it, and they had plenty of food.



Giraffe.

Well, the giraffe had a problem. He was so tall that he couldn't drink. If he stuck his head down to try and drink something, the water couldn't go up his throat. Plus, he would get dizzy all the time. The giraffe would go [swaying around], "Oh-oh, I'm getting dizzy!" And he'd start moving all over the place and accidentally stepping on cities, because he's a hundred-mile-tall giraffe. Imagine him stepping on your city. It could leave a big hole in the ground.

And Jack and Jill said, "We've got to find a better way to get that food and keep that giraffe from stomping all over us." If you were Jack and Jill, what would you do to solve the giraffe and food problem?

Imagination Time

[Students make suggestions] (THERE ARE NO WRONG ANSWERS! Whatever they say, you should reply: "That's a good idea," "They might do that," etc. After brainstorming, proceed with the experiments, then finish the story.)



Longer neck.

We'll leave this "To be Continued . . ."

Experiment: "Heart Pumps"

Part One: Make a Squeaking Minion

[Show student a pump.] Here's a minion after you step on him, and he becomes corrugated, and he's puffy, like this. And let's give him some binoculars so the minion can see. *[Insert two valves into holes in the pump.]* Now he can talk through his eyes. *[Squeeze the pump so it makes noises.]* And we'll stick some antennas on his eyes. *[Attach a plastic tube to each valve.]* And your job is to make one *[quickly takes apart the pieces before the students can get a good look at how they're connected]* just like that one, from these parts. Go!



Assemble a squeaking minion.

[Students select the pieces they want and put them together. Usually the pump doesn't work properly the first time. It either won't compress, or it will only compress but not expand again. It sometimes takes awhile for students to figure out which valves to use and how to insert them so that one side takes in air and the other side expels it. Sometimes they make it work by trial and error, just switching things around without noticing that the valves are doing different things. If they don't discover what the valves are doing, it will be harder to do the next part of the experiment.]

Part Two: Connect Minions Together

Try to hook two minions together. *[Students can either try to do this alone or with a partner. They need to discover that it only works if they connect the tubes so that the outflow from one pump goes to the inflow on the other one. When they get the right configuration, they can alternately squeeze and release each pump. This is a two-chambered heart.]*



Connecting multiple minions.

[If a student is really struggling, take just a pump with the two valves in it, and squeeze it close to the student's face so they can feel whether or not air is coming out of each valve. Then have them carefully examine the valves to see the difference between them.]

[Once there are at least two two-chambered hearts constructed, ask the students to combine them to make a four-chambered heart. As more pairs of pumps are assembled, have the students try to combine them into a heart with as many chambers as possible.]

Part Three: Add Water (Demo)

[To make the function of the pumps clearer, put water in two of the pumps and connect them so the students can see it passing through the tubes. If convenient, add some food coloring to make the water more visible.]



Water added.

Story End



Extra hearts in neck and nails in stomach.

I think giraffes have extra muscles in their necks to squeeze the blood up to their heads, so it's kind of like having extra chambers in their hearts to squeeze the blood up and up and up and up and up. That's a long way to squeeze your blood. Have you ever hung upside down by your knees on a bar? And the blood all goes into your head? It can make you dizzy. Well, imagine if you're a giraffe and you move your head all the way to the ground, and then you go up really fast. And you go, "Yahhhh!" You get all dizzy and faint.

So in our story, we have a giant giraffe that's helping Jack and Jill get their food back. And he's getting really dizzy. And Jill says, "Jack! We've got to do something." Jack said, "I have an idea!" So he called the Acme Store of Everything and he ordered about a hundred hearts. And he tapped them into the giraffe's neck so they'd help pump blood to the giraffe's head.

And then the giraffe said, "Oh, that worked pretty good! But there's still something I need." And Jack and Jill said, "What?" And the giraffe said, "Nails. I want to eat some nails." And Jack said, "Why do you want to eat nails?" And the giraffe said, "Nails have iron. Iron makes strong blood." So Jack gave the giraffe about a thousand pounds of nails, and he ate it. So now the giraffe's stomach is all full of nails.

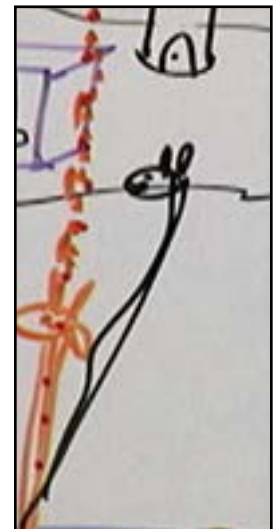
So now the giraffe has all these extra hearts, he's got iron in his blood, and he becomes really strong. And the giraffe said to Evil Mister Fred, "Evil Mister Fred, you give us our food back and you stop stealing it." And Evil Mister Fred says, "Says who?" And the giraffe said, "Says me!!"

And Evil Mister Fred said, "What are you going to do about it? Come on, you want to fight?" And the giraffe said, "I don't fight. You're too small." And the giraffe put his head down a little ways, and he grabbed the edge of Evil Mister Fred's floating continent in his mouth. And the giraffe said, "Oh, a chew toy!" And Evil Mister Fred said, "What are you doing?" And the giraffe said, "Just playing with your continent." And the giraffe started swinging his head back and forth. And Evil Mister Fred's continent started *[swaying wildly from side to side]*, and stuff started sliding off, down to E-mer-i-ka. And Evil Mister Fred said, "No! Stop! Please! Don't! Stop! Don't Stop!" And the giraffe said, "Okay, I won't stop."



Castle flies off and explodes.

And he gave it one really hard swing. And Evil Mister Fred's castle flew right off the continent and it exploded. And a little piece of mustache was seen flying off this way. And a sombrero was seen flying off into space. And they all lived happily ever after, except Evil Mister Fred.



Biting the continent.

End of Lesson