

Breaking Down the Barriers

"Hey, Ben, come here. I need your help in the kitchen."

"What are we going to do, Daddy?"

"I need to practice for Mrs. Anderson's class tomorrow."

"OK."

"Wash your hands first."

Ben scampers to the bathroom, holds his hands under the running water for two seconds, and hurries back. The youngest of my four sons, Ben has just turned seven. He joins me at the butcher-block table, climbing up on a wooden stool so he can see more easily. He's inherited my father's large head, and his wispy blond hair flies in all directions. His blue eyes shimmer with anticipation. He's a cute kid, I think. He's also a very wet kid.

"Ben, please go back to the bathroom and turn off the faucet. And don't forget to dry your hands."

"But there's no towel in the bathroom."

He's right. I forgot, once again, to put a hand towel in the bathroom. I grew up thinking that hand towels, usually decorated with flowers or butterflies, were the responsibility of the woman of the house, but I've discovered that even this all-male, post-divorce household needs hand towels.

After I give Ben a towel (it's actually a dish towel, but we don't care), he returns to the kitchen table. He's my test subject, helping me practice a chemistry experiment I plan to do in his first-grade classroom tomorrow.

I pour enough whole milk in a cereal bowl to cover the bottom of the bowl. Then I get out small vials of food coloring.

"Daddy, let me do it."

"I'll do the first one. Then you can try. You have to squeeze the little bottle very gently. See. Like this. You want to let just one drop of coloring fall into the bowl... OK. I put a green drop in one corner of the bowl. Do you want to try it with the blue?"

"I want to do the red. It looks like blood."

"OK. Be very careful now. Just give it a little squeeze. Let one drop fall into another corner of the bowl."

I reach out to help Ben with this delicate operation, but he pushes me away.

"I can do it. Let me do it."

Ben squeezes the bottle, and five drops flood into the bowl. Two more land on the table.

"Oops."

"Ben, let's wipe up the mess. Then we'll try again."

I wipe the food coloring off the table, but the red stain has already started to seep into the wood. Oh well, it's a small price to pay in the service of science.

"Hey, Daddy. Look at me. I'm bleeding!" Ben laughs, showing off his red-stained fingers.

Maybe it wasn't such a good idea to let Ben handle the food coloring. He hasn't developed those fine motor skills yet. But that's just the sort of information I was hoping to gain from this practice session. It's one thing to let my own kids walk around stained, but I'm not sure if Mrs. Anderson will be pleased with a whole class of red hands.

I take firm control of the food-coloring bottles, and we start over again. Ben pours the milk this time, not spilling a single drop. I carefully place four drops, each of a different color—red, yellow, green, and blue—into the four quadrants of the bowl.

We stare at the drops. They're just sitting there, suspended in the milk. Each drop is an island.

"Cool," says Ben.

The first time I did this experiment for myself, nearly ten years ago, I was surprised that the drops of food coloring didn't mix with the milk. I had expected a liquid kaleidoscope of color or a bowl of boring brown.

I hadn't considered, however, the fact that milk and food coloring are different liquids and that there might be some barriers to mixing them together. I knew the old adage that oil and water don't mix, but I hadn't considered that lots of other things don't mix either. Milk, with its fats and proteins, behaves a lot like oil. And food coloring is more than 99% water.

Gazing now at the four isolated drops of color in the bowl of milk, I realize that my whole life is full of things that don't mix easily with each other. Why am I so surprised? If oil and water don't mix, why should I have expected work demands and family responsibilities to mix easily? Or chemistry and creative writing? Or the daily concerns

of an at-home Dad and a working Mom? Or my dreams of Nobel Prizes and my dreams of family picnics?

As Ben and I stare at the islands of bright color floating in a sea of white milk, I can feel the isolation of the individual colors.

"Daddy, is that it? Are we done? Can I go play with my Legos now?" Ben has apparently not wandered off into a metaphorical wilderness like his father. He's spent ten seconds gazing at a bowl of milk. That's more than enough for him.

"No, Ben. The best part is coming. Can you grab that dishwashing liquid by the sink?"

Ben grabs the bottle of Joy. "Hey, look at me. I've got Joy. She's yellow and smells like lemons."

Joy is the name of the woman who served as a nanny for my kids since we first moved to Minnesota from Washington, D.C., eight years ago. While Ben's Mom was working long hours and traveling extensively as a consultant and I was trying to carve out a part-time career as a freelance science writer, Joy would provide childcare during the day. Now that the kids are all in school during the day, Joy still comes several evenings a week to help me cope with the chaos of sports practices, dinner, homework, music lessons, and community meetings. In honor of my kids' affection for her and her indispensable role in the household, the dishwashing liquid of choice in our family has always been lemon-fresh Joy.

"Squeeze out a drop and let it fall right into the middle of the bowl," I tell Ben. "Be careful. Just add one drop. See what happens."

Before Ben can try it, we're joined by two creatures attracted by the sense that something important is about to happen.

Midnight, our black cat, jumps silently up on the kitchen table. He eyes the bowl of milk, apparently ignoring my iron-clad safety rule that "we don't eat or drink chemistry experiments."

Nelson, my nine-year-old, brandishes a plastic light saber. "I am Darth Vader. Surrender to the Dark Side," he growls in his deepest stage voice.

"Nelson, look what I did," says Ben.

Nelson and Midnight peer into the bowl.

"Cool," says Nelson, still using his Darth Vader voice.

Midnight keeps his thoughts to himself, but I know what he's thinking. I quickly grab him so can't ruin our experiment or turn his pink tongue to a scary shade of bright blue. I put him on the steps heading down to the basement and close the door.

Ben explains our experiment to Nelson, with confident authority. Nelson's third-grade class will do the same experiment next week.

"OK, guys, it's time to add the soap," I proclaim. "But you've got to promise not to tell the kids in your class what happens. I want them to see it for themselves."

Ben squeezes out a drop of soap. It plops into the middle of the bowl. Immediately, the colored drops recoil from the center of the bowl, fleeing to the sides of the bowl, trailing smears of color. The islands spread and lose their sharp definition.

"Awesome!" Ben yells. As we watch, the colors swirl ever so slightly, approaching each other, yet remaining separate.

"Can I try it?" Nelson asks, forgetting for now that he's Darth Vader.

We set up another bowl of milk, and Nelson gives it a try. Planning to improve on his brother's performance, Nelson adds the drops of red and blue together, hoping for a purple drop. Then he adds two yellow drops on the other side of the bowl. "Look," he proclaims. "Minnesota Viking colors."

"Look at mine," Ben begs. "It's alive."

The colors in Ben's bowl are still undulating and swirling, even several minutes after he added his one drop of Joy.

"Let's try it again," I suggest. Opening up the refrigerator, I pull out a half-gallon container of skim milk and a pint of cream. "We're going to see if we get the same results with these."

Before long, the kitchen table is covered with bowls—eight of them, each filled with a rainbow of colors.

"Whoa! What's going on here?" William, my sophisticated seventh-grade son, enters the kitchen. He's seen quite a few of my chemistry activities before, but I don't think he's seen this one. He's very curious, but needs to maintain his nonchalance.

"That's a lot of milk." Pause. "That's a lot of food coloring." Pause. "Let me guess. This is a chemistry experiment." Long pause. "OK, I give up. What are you doing?"

Now we've got William hooked, too. Ben, Nelson, and I set up the demonstration for William. Instead of adding a whole drop of Joy this time, however, I take a toothpick and dip it into a drop of soap. Now, I've got a thin layer of soap coating the tip of the toothpick. I touch the toothpick to the center of the bowl of milk, wait for the swirl of

colors to engage my seventh-grader's jaded mind, and prepare to launch into an explanation.

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I plan to give my boys a simple, straightforward explanation of how soap works. But as I begin to describe the chemistry of milk and soap, my mind's eye travels into the bowl of milk. The rest of the world disappears, and I'm swimming in a sea of molecules, a snorkeler suspended above a coral reef. Clusters of whitish fat molecules bob on the waves, gently parting as I glide forward. A team of water-soluble vitamins darts around me like a school of angelfish. Beneath me I spot a large protein molecule; it's a majestic stingray winging its way home.

While reading about and practicing this chemistry experiment the past several days, the beauty and complexity of milk and soap have awakened the alchemist, poet, and philosopher in me. The splendor and order of the physical world hint at lessons that might apply on a more spiritual plane, if only I can distill their meaning. Yet even as I feel the connection between the physical and spiritual worlds strengthening in my mind, I'm aware of another presence. A stern chemistry professor stands resolutely in the rational corner of my mind, arms tightly folded on his white lab coat. "Just stick to the chemistry, Randy. You're a scientist."

Milk is actually a very complex food composed of over 100,000 different molecular species. Seen through a microscope, it's made up of little round spheres floating in a sea of water. The little round spheres are globules containing fat (and also oils, proteins, sugars, and fat-soluble vitamins). These fat globules are hydrophobic

("water-fearing") and don't like to mix with water. Because the globules are less dense than water, many of these spheres rise to the surface of the bowl of milk.

The dyes in food coloring are hydrophilic ("water-loving"), so they don't dissolve into or combine with the fat globules. When the drops of food coloring are added, they find themselves trapped in the crowd of fat globules on the surface of the milk.

Soap molecules have a unique property. One end of the molecule is hydrophobic, and one end is hydrophilic. Like a seasoned diplomat at a summit meeting, a genial hostess at a cocktail party, or a parent mediating a sibling quarrel, the soap molecule can operate in both worlds at once, bringing together molecules that would normally avoid each other. When we dip the soapy toothpick in the bowl, the soap molecules quickly spread across the surface, changing the structure of the milk and altering the surface tension. In the presence of the soap molecules, many of the fat globules collapse and mix freely with the water, thus freeing the food coloring to also mix freely.

That's how soap works. It can break down a stain of fats, oils, or proteins and allow these materials to dissolve in water. It can break down individual barriers and encourage cooperation. It can bring bitter enemies to the bargaining table and restore peace throughout the land.

In the bowl of milk, the isolated colors now dance, play, and merge. Their yearning for community has been answered. They join together, ready to paint a picture of beauty and truth.

All these miracles result from the simple fact that soap is able to operate at the same time in two worlds.

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As I launch into this archetypal tale of enemies, battles, and heroic deeds at the molecular level, I can see my children's eyes begin to glaze over. Ben slips off his stool and sneaks away to his Legos. Nelson picks up his light saber and heads off to slay a Jedi Knight. Only William remains; he wants to try a few experiments on his own now that he's endured Dad's lecture.

Erik, my teenager, pokes his head up from downstairs and stares suspiciously at the bowl lineup. "When's dessert? Did you guys already eat the ice cream?"

All the bowls that we own are spread out on the kitchen table, full of different combinations of milk, food coloring, and soap. The colors in the bowls look relaxed and at peace. They've been mingling with each other, finding some balance and harmony. I wish my life felt like that.

I don't want to disturb these works of art, but reality is intruding. I have to supervise homework, finish the laundry, and revise an article that my editor expects by noon. It's going to be another exhausting evening.

I had foolishly hoped to find a quiet moment to read a chapter in that self-help book recommended by someone in my divorce support group. I'm sure the chapter would have discussed the importance of making time for myself. Maybe tomorrow...

My kids are going to be clamoring for dessert very soon. If I put the bowls in the dishwasher, the wash cycle will take 30 minutes, and the bowls will then be too hot for ice cream. I'm going to have to wash them by hand. I'm glad I bought an extra bottle of Joy earlier today.

As I ease my hands into the warm, soapy water in the sink, I think about my Dad. His self-appointed job after every family dinner was to wash the dishes. Every evening, he'd be standing at the sink, engaged in his ritual. First, he'd put on an apron and pull on yellow rubber kitchen gloves. Then he'd scrape the plates, rinse them off, and stack them on the counter to the right of the sink. After running the garbage disposal, he'd plug the sink with the stopper and start filling it with hot water. He'd squirt in the dishwashing soap—Ivory liquid from an opaque white bottle. The glasses and silverware would be washed first, then the plates. Finally, he'd tackle the pots and pans. As each item was washed, he'd dunk it twice in a sink full of hot rinse water and then stack it carefully into the rack to the left of the sink.

He never left the dishes to air dry. Sometimes he'd turn on the radio and dry the dishes himself, excusing me to do homework or play ping-pong with my brother. Sometimes he'd ask me to dry them as he washed. As we worked side by side, he'd talk to me about school or tell me a story from his childhood. I secretly enjoyed these chances to talk with him, but I never let it show.

This short period after dinner was one of the best times of the day. Order was being restored to the kitchen and to the world. My father was performing one of his well-defined roles. During the day, he worked as a university professor. In the evening, he washed dishes in the kitchen. On weekends, he mowed the lawn. In the summer, we took a two-week camping trip, and he washed the dishes in two green plastic tubs. The water for dishwashing (and bathing) was heated over the Coleman camp stove, and he still used the Ivory soap from the white bottle. His world—and my world—was solid, ordered, and predictable.

What happened to that world?

My eyes blur just a bit. It must be a chemical reaction to the soap.

I reach for another dirty bowl and continue washing.

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Making Milk Rainbows

Materials needed for this experiment:

- Bowl (a cereal or soup bowl works well)
 - Milk (skim milk, whole milk, half-and-half, and/or cream)
 - Food coloring (at least two different colors)
 - Dishwashing liquid
 - Toothpick
1. Start by pouring enough milk in the bowl to cover the bottom of the bowl to a depth of about an inch.
 2. Carefully place four drops of food coloring, each of a different color—red, yellow, green, and blue—into the four quadrants of the bowl.
 3. Observe the drops of color in the milk for at least ten seconds. How much movement is there?
 4. Carefully add a single drop of dishwashing liquid to the center of the bowl. You can either add the drop directly from the soap bottle or you can dip the toothpick into the liquid soap and then touch the soap-covered toothpick tip into the milk.
 5. Observe the drops of color in the milk for several minutes.
 6. After several minutes, add another drop of soap.

7. Repeat the experiment, changing one of the steps. See below for some variations you can try.

Variations:

- Use milk of varying fat content (e.g., skim milk, whole milk, or heavy cream)
- Try different combinations or patterns of colors. Combine two colors to make a new color.
- Add a drop of cooking oil instead of a drop of soap. Or try adding a crystal of laundry soap.
- Use a bowl or container of a different shape.
- Try touching the soap-covered toothpick to the center of a drop of food coloring.
- Use the tip of a knife instead of a toothpick. Try a fork.

Cautions:

- Remind children (and adults) not to eat or drink their chemistry experiments.
- Food coloring makes powerful stains on furniture, clothes, and skin. Use carefully.