

Gerbusters I

There are always a few moments of chaos in any class right after recess. No one's in a hurry to sit down and get back to work, so everyone mills around, dawdles, and takes the longest route back to their chairs. Miss Johnson's class was no exception. However, on top of the normal chaos, Gasparo, Giovanni, and Antonio danced and sang with abandon. In the middle of all this, several kids gathered around Melissa and Jennifer.

“Hey,” said Carl, “didn't I see you fly off on the backs of two cows?”

“Yeah,” Andrew chimed in, “where did you go on those cows?”

“Well,” said Melissa, “those cows were Dawn and Betsy, nice and intelligent cows. They flew us all the way to England and back about 200 years in time to see Dr. Jenner. He invented a vaccination that got rid of smallpox.”

“You mean you saw when shots were invented?” asked Carl. “I hope you stopped him before he invented them. That would be great! If shots were never invented, I’d never worry about getting one the rest of my life! Please tell me you stopped him.”

“We didn’t,” said Melissa. “And besides, I wouldn’t want to. We saw a boy named William die of the smallpox, and it was terrible. I’d rather get a shot than die like that.”

Just then Miss Johnson cleared her throat. “Okay, class,” she said, “let’s get going here. Sit down. And you violins settle down too, or we’ll stuff you in your cases.”

The violins danced to a window and sat on its sill and tried to sit still.

“We’ve got a special project to do before lunch. Uh, what’s the crowd about over there?” She looked at the crowd around Melissa and Jennifer.

Andrew spoke up. “We’re finding out where Melissa and Jennifer went. They flew away on some cows and were

gone the whole recess.”

“Yeah,” said Carl, “and they went back in time to when shots were invented and they blew it! They blew the last hope for kids around the world. They could have stopped the invention of shots! Just think of it. It would be heaven on earth.”

“Okay,” said Miss Johnson, “that’s enough Carl. I suppose you girls met Dr. Jenner then?”

Melissa and Jennifer both looked surprised. “You believe us?” asked Jennifer.

“Why certainly,” said Miss Johnson. “Why shouldn’t I. You’re both trustworthy girls. And I bet you asked him some questions, and he answered them all—that is, all but one. Right?” Miss Johnson had a twinkle in her eye.

“How did you know?” asked Melissa.

“Let’s just say I have my ways.” Miss Johnson smiled. “Would you like to tell the class the question you didn’t get answered? Or would you like me to?”

“You can say what the question was?” Melissa shot a look of surprise at Jennifer.

“Certainly. You wanted to know what changes in your body when you get a shot so that you can’t get sick. Right?”

“That’s right,” said Melissa. “Do you know the answer?”

“Yes,” said Miss Johnson, “a lot of scientists have worked for many years on that problem. Now we have a good idea what happens in your body when you get a shot, and why your body doesn’t get sick. In fact, that is just what we’re going to study next!”

“Oh no!” groaned Carl. “Talk about snatching defeat from the jaws of victory. Just when I hoped shots would disappear, now I have to study them! Tell me this is a bad dream.”

“I think,” said Miss Johnson, “that you’ll like the way we’re going to study them, Carl. You see, in just a few minutes our entire school will be invaded by students from Bonita School who are also learning about what happens in your body when you get a shot. The proper word for this study, by the way, is ‘immunology’, the study of your body’s immune system.” Miss Johnson went to the chalk board and wrote “immunology” and “immune system.” “The students invading us from Bonita will play the role of the bad things that can make you sick. Can anyone name a bad thing that makes you sick?”

Andrew raised his hand. “I know that viruses make

us sick. They give us colds, for instance.”

“That’s right,” said Miss Johnson. “Viruses are so tiny you need special microscopes to see them. And what they do when they get inside your body is vicious. Your body is made of trillions of little living units called cells. Some cells are blood cells, some are skin cells, some are muscle cells, and so on. What the virus does is get inside one of these cells. Once inside, it changes the cell so that it starts making hundreds of copies of the virus inside the cell. Pretty soon the cell gets full of these copies of the virus and bursts open, spilling out hundreds of new viruses. Of course, this kills the cell. These new viruses wander off to find new cells to invade, and the whole process starts over. As you can see, you don’t have to do this too many times before a lot of cells are dead. Who can think of another bad thing that makes you sick?”

Ian raised his hand. “I had strep throat, and I think the doctor told me it was bacteria that made me sick. Also, I saw on a TV commercial that bacteria cause . . .” Ian rolled his eyes “. . . bad breath.” All the kids giggled.

Miss Johnson smiled. “Bacteria do cause bad breath and strep throat. Bacteria are like tiny microscopic animals, made up of one or more cells, that reproduce them-

selves quickly. Just a few bacteria can turn into thousands of bacteria in a single day. Because they reproduce so quickly they can be a real threat to your health if they get inside your body. Also they can be a threat because they sometimes produce poisons. One of the most terrible diseases in human history, a disease called leprosy, is caused by bacteria. A leper can lose fingers, toes, nose—even life. Can anyone name another bad thing that makes you sick?”

The kids were stumped and no one raised a hand.

“Well, I’ll tell you about two more,” said Miss Johnson. “They are fungi and parasites.”

Just the names “fungi” and “parasites” sounded so awful that the some of the kids said “Eew!” and scrunched up their faces.

“They do sound bad,” admitted Miss Johnson. “But most fungi are not bad for you—only some of them are. A mushroom is a fungus.”

“No wonder I don’t like mushrooms,” said Carl.

“In fact,” said Miss Johnson, “your body allows one fungus, called candida, to grow inside your intestines to control the bacteria that grow there as well. These bacteria help you to digest your food. But remember that bacteria can reproduce themselves quickly, so the fungus is needed

in your intestines to keep the bacteria under control.”

“This is sounding worse all the time,” said Carl. “And I thought shots were bad. I had no idea I had thousands of little bacteria and fungi growing inside my belly. Do we have to talk about this before lunch?”

All the kids laughed, but not too hard since they were grossed out.

“I’m afraid the worst is yet to come,” said Miss Johnson. “Parasites are disgusting enemies of our health. One parasite is the Guinea worm. People get this parasite by drinking water that contains larvae of the Guinea worm. Once inside the body, the larvae mature to adult worms that can be more than a foot long. These worms then eat their way through the body of the person. A worm might eat all the way down the person’s leg. Sometimes the worm will poke its head out through the skin of the person, creating a large and painful sore. The only way to get rid of the worm is to catch its head when it pokes out of the skin and then slowly, over many hours or many days, wind the worm on a stick to pull it out of the victim’s body. But you can’t pull too hard or the worm will break, and the part left in your body will escape.”

The kids were so horrified by this, that the room was

silent for a few moments. Then Melissa spoke up. “Why do people drink water with larvae, if they know it will give them worms?”

“In many countries,” said Miss Johnson, “they don’t have the technology or resources to purify their water. So people are forced to drink the water that is available, or die of thirst. What is tragic is that a simple filter is all that’s needed. If people had access to a simple filter, and poured their water through the filter before drinking, all the Guinea worm larvae would be removed and the disease could be eliminated. World health organizations are working to make these filters available.”

Miss Johnson paused and then continued. “I’ll mention one more disease caused by parasites, and then we’ll plan how to stop the students from Bonita School from invading our school. The disease is called malaria, and it’s the most serious parasitic disease in the world today. A person gets malaria by being bitten by a mosquito that has the malaria parasite. Once inside a person’s body, the malaria parasite heads for the person’s liver and multiplies rapidly inside liver cells. A single parasite inside a single liver cell can make 40,000 copies of itself! The liver cells burst and the new malaria parasites head for the person’s

red blood cells. They burrow inside the red blood cells and once again make thousands of copies of themselves, bursting the red blood cells. Then the person gets bitten again by a mosquito, which drinks in some of the red blood cells that have been infected with malaria. Once the red blood cells are inside the mosquito, the malaria parasites burst the red blood cells and head for the mosquito's salivary gland, ready to go into the next person that the mosquito bites."

Jennifer looked upset. "I got a mosquito bite last night, right here on my leg. Will I get malaria?"

"Were you in a tropical jungle last night when you were bitten?"

"No," laughed Jennifer. "I was at Melissa's house."

"Then I don't think you have to worry." Miss Johnson smiled for a moment and then looked serious again. "Okay, down to business. We're going to be invaded soon and we must be prepared to stop the invasion. The invading kids are masquerading as viruses or as bacteria, we don't know which, and we have to be prepared for both possibilities. Also we don't know which viruses or which bacteria they will be, and we must prepare for several possibilities."

"Why are they invading us?" asked Carl. "And why

are we trying to stop them?”

“We’re doing this,” said Miss Johnson, “for two reasons. First it’s a practical way to learn how infections work and how your body fights them. The invaders will behave like real viruses or bacteria, and you will stop them, I hope, by behaving like real cells of the body’s immune system. But there’s a second reason. The school that wins gets a free day at Disneyland for all students!”

“All right!” said Carl, and the class stirred with excitement. “How do we win? Let’s get going!”

“To win,” said Miss Johnson, “you must work as a team. This class was chosen, of all classes in school, to play the role of immune cells. Other classes play other cells of the body. Now, if we’re a team, we need a team name. What about ‘Immunological League’?”

“No way,” said Andrew, “that’s dull and long. How about ‘Germ Fighters’?”

“I’ve got it!” said Melissa. “Gerbusters!”

“Yeah!” was the unanimous response.

“Okay,” said Miss Johnson, “Gerbusters it is. Now, first off, put these MHC identification bands on your left arms.” She opened a box containing bright yellow bands with thin dark stripes, like the stripes on packages in

stores. Each band displayed the letters “MHC.” She passed them around. “These bands identify you as members of our school. When the invaders from Bonita come, they’ll also have yellow MHC bands with black stripes. Their stripe pattern is different, identifying them as members of Bonita school.”

The kids wrapped the MHC bands around their arms. They had Velcro, making them easy to adjust.

“We’re doing this,” said Miss Johnson as the kids put on the bands, “to imitate the cells of your body. Every cell in, say, Melissa’s body has an identification tag on it that says ‘I’m a cell of Melissa’s body’. Every cell in Ian’s body has an identification tag on it that says ‘I’m a cell of Ian’s body’. And the tags on cells in Ian’s body are different from the tags on cells in Melissa’s body. So if a cell from Ian got inside Melissa, her body would recognize the wrong tag, and kill the cell.”

Melissa looked at Ian. “Nanny, nanny!”

“The only exceptions,” said Miss Johnson, “are red blood cells—they have no MHC tag.”

“This is hard, Miss Johnson,” said Andrew. “Look at all those stripes! How can we tell if a tag is from Bonita school or from ours?”

“Good question Andrew,” said Miss Johnson. Andrew looked around with a slight smile. “But before I answer I must tell you more. You see, everyone will wear **two** tags, not just one. Every cell of your body has another tag telling what it is—say a lung cell or a thyroid cell or a kidney cell. Mr. Norman’s class are the lung cells, so they all have the same second tag. Mrs. Wilbur’s class are the thyroid cells, so they all have the same second tag, but different from Mr. Norman’s class. And now for Andrew’s question. You won’t read the black stripes yourselves. We have special antigen scanners for that.”

Miss Johnson leaned down and lifted another box from behind her desk. She opened it, and held up what looked like a blow dryer. “This is an antigen scanner. This scanner is for . . .” Miss Johnson looked it over, “Ah yes, this scanner is for recognizing the measles virus. And this one here is for, uh, oh I see, yes for the mumps virus. And this scanner is for the polio virus. Oh, and this scanner here is for the *staphylococcus aureus* bacterium, and this one is for a *streptococcus* bacterium. Good, that’s all the different kinds of scanners we’re supposed to have. The other scanners in the box are for the same viruses and bacteria. You see, we’ll only look for these three kinds of viruses and

two kinds of bacteria.”

“You mean each scanner reads just one kind of stripe pattern?” asked Melissa.

“That’s right,” said Miss Johnson. “This scanner beeps if it runs across the stripe pattern for the measles virus. Otherwise it does nothing.”

“That’s stupid,” said Melissa. “Scanners at the store read all sorts of bar codes.”

“Seems a bit strange, doesn’t it?” said Miss Johnson. “But each cell of your immune system looks for one, and only one, kind of infection. One cell looks for measles viruses, another for mumps viruses, and another for *streptococcus* bacteria.”

“What if a cell that looks for measles runs into a *streptococcus* bacterium?” asked Melissa.

“It ignores the bacterium and looks for measles,” said Miss Johnson. “Another cell of your immune system, one that looks for *streptococcus*, must contact the bacterium before it can be recognized.”

“That could take a long time,” said Andrew. “I mean, it might be a long time before the right immune cell happens to run into the bacterium and your body realizes that something bad is happening.”

“You’re right, Andrew,” said Miss Johnson. “And if it does take a long time, then you might get pretty sick, because viruses and bacteria can multiply rapidly inside your body. The first time your body encounters a virus or bacterium it often takes a long time for your body to recognize the invader. But once your body has recognized the invader, it makes many copies of the immune cell that recognized the invader. That way the next time you’re attacked by that invader you will recognize it quickly, perhaps so quickly that you don’t get sick. And that is the answer to your question, Melissa, of how shots work. When you get a shot, you’re getting lots of copies of a dead virus put into your body. Since the virus is dead it won’t hurt you. But since the virus is in your body, your body learns to make a bunch of cells to recognize that particular virus. Then, when your body encounters a live virus of the same kind, it will recognize and destroy it before it makes you ill. Got that?”

“I’m not sure,” said Melissa.

“Don’t worry,” said Miss Johnson. “You’ll catch on as we try to stop the invaders from Bonita school. Now, Gerbusters, I need volunteers for the T team. I think three of you should do.”

Hands shot up around the room. Some kids put up both hands, and others used one hand to push the other up as high as possible. There were grunts and groans and “Me!”s and “Please, Please!”s all over the room. Miss Johnson smiled at the enthusiasm.

“Okay, Ian, you’re on the T team. You’ll be an inducer T cell. Come on up.”

Ian hopped from his desk, all smiles, and marched to the front. Hands and faces fell around the room.

“You’ll all get a chance,” said Miss Johnson. “Just hold your horses. Now Ian, did you catch what kind of T cell I said you’ll be?”

“Uh, I forget,” said Ian.

“Think hard, retard,” blurted Carl.

“One more outburst like that and you’re off to Mr. Whacksworth,” said Miss Johnson. “We’re the Germbusters, and we’ve got to work as a team to stop the infection from Bonita school and win the trip to Disneyland. You want that, don’t you?”

“Yeah!” said several kids. “Come on Carl, don’t mess it up.”

“Okay, okay” said Carl.

“Ian,” said Miss Johnson, “you are an inducer T cell.

That means you're a scout. You wander around school looking for . . . uh, let's see, how about the measles virus? Here. Here's the scanner that recognizes the measles virus bar code. Put it in your right hand like that, yes, and push the trigger with your finger to make it come on. Then you wave it over the black stripes of the bar code, just like the checkers at a store."

Ian waved the measles scanner over Miss Johnson's MHC arm band.

"Nothing happened," said Ian. "What's the matter with it?"

"Nothing's wrong," said Miss Johnson. "Your scanner only responds to the bar code for measles. Remember, each inducer T cell only looks for one kind of invader. So you and your scanner can recognize an invading student only if that student wears a measles arm band. When your scanner finds a measles arm band, it will make a beep, like this." Miss Johnson pulled out a measles arm band, waved Ian's scanner over it, and the scanner beeped.

"But what if none of the Bonita kids has a measles band?" asked Ian. "Then I won't find anything?"

"Right," said Miss Johnson. "Don't worry, we'll have other inducer T cells looking for other kinds of invaders.

Okay, I need a couple more inducer T cells.”

Soon Carmen was an inducer T cell looking for mumps, Melissa was one looking for polio. They had a good time for a minute waving their scanners over different arm bands, making loud beeps, waving their scanners over each other’s faces, and generally goofing off. Then Melissa whispered something to Carmen, they both giggled, and Melissa said, “I just want to try something. I’m going to see if Ian’s face is a polio virus.” The whole class giggled. Melissa took her scanner and, while the whole class watched, she slowly scanned Ian’s face from top to bottom. When she reached the bottom there was a loud beep, sending the class into riotous laughter. Some kids even started taunting, “Ian is a virus! Ian is a virus!” Ian took it all in good humor and laughed along with the class.

“How’d you do that?” he asked.

Melissa and Carmen both laughed. Then Melissa explained, “While I ran my scanner over your face, Carmen ran her mumps scanner over a mumps arm band. The beep was from her scanner, not mine.”

“That was a good one,” Ian admitted.

Miss Johnson smiled too, apparently enjoying the prank. She quickly got back to business. “Okay, now I

must give the inducer T cells an important piece of equipment.” She reached under her desk and found a medium-sized box. She opened it and pulled out what looked like a walkie-talkie. “This is an interleukin radio. Each inducer T cell gets one. Here’s what you do with it. Suppose you’re scouting around for an invader from Bonita. You find a suspicious-looking girl and run your scanner over her bar code. If the scanner beeps you’ve found an invader. You can’t stop the invader yourself though. That’s not your job. Instead you must call for help. That’s what this interleukin radio is for. Once you’ve spotted an invader, get on the interleukin radio first thing and call for help. We’ll send over a macrophage cell or a killer T cell, to help you. I’ll tell you in a moment how they’ll help. Got that?”

“Yeah,” said Ian, Melissa, and Carmen.

“If we’re supposed to act like inducer T cells,” said Carmen, “how come we’re carrying interleukin radios? Do inducer T cells have radios?” Carmen asked with a funny look on her face, and the class laughed.

“In a sense yes,” said Miss Johnson. “Though of course they aren’t like the ones you’re holding. Inducer T cells send a message when they find an invading virus, and this message makes other cells of your immune system

attack the virus. But inducer T cells use a chemical to send their message. Can you guess what the chemical is called?"

"Interleukin?" asked Carmen.

"That's right," said Miss Johnson. "Macrophage cells, killer T cells, and B cells, all need permission from inducer T cells before they attack viruses or bacteria. In your body this permission takes the form of a chemical called interleukin. We're using these interleukin radios instead."

"So," said Melissa, "no one can do anything to stop an invader until we give them permission over these interleukin radios?"

"That's right," said Miss Johnson.

"That makes us inducer T cells the most important team," said Carmen.

"I wouldn't say that," said Miss Johnson, "til I found out what the other teams do. And besides, we need teamwork to win the contest, not worries about who's important. And speaking of teamwork, lets get volunteers for the B team."

Hands popped up all over the room. Kids jumped up and down in their seats, groaning "Oh please! Oh Please!" Miss Johnson picked Andrew and Jennifer, who strutted to

the front of the room. Everyone else looked disappointed.

“Okay,” said Miss Johnson, “you are members of the B team. The B team looks for bacteria. Jennifer, you’ll look for, uh . . .” Miss Johnson fished through her box of scanners and pulled one out. “Yes, you’ll look for streptococcus, the bacterium that gives sore throats. And Andrew, you’ll look for staphylococcus, another nasty bacterium.” Jennifer and Andrew tested their scanners on arm bands til they found ones that made their scanners beep.

“Hey,” said Andrew, “just for fun, lets make our scanners beep at the same time!” This sounded like a good idea to all members of the T team and B team, so they each got an arm band that their scanner recognized, and waited for Andrew’s signal. “On three,” said Andrew. “One, two, three!” All ran their scanners at once. The result was amusing, since each scanner beeped a different tone. Together they beeped a funny disharmonious chord.

After this “music,” Carl raised his hand. “Why is one team called the T team and the other one the B team? Does B stand for bacterium?”

“Good guess, Carl,” said Miss Johnson. “Actually the names come from where the cells are made. B cells are made in your bones, in fact in the bone marrow. And T

cells are made in your thymus gland, which is right next to your heart. B for bone, T for thymus. By the way, B cells and T cells have different lifetimes. T cells live sixty or seventy years. Your body makes its T cells when you are young, and after that if you lose them you don't replace them. Eventually your T cells die of old age. And that's why, when you get older, your body can't fight off cancer and viral infections. It looks like we're programmed to die after a certain age, because our body's defenses are programmed to stop. B cells have shorter lifetimes than T cells ..."

Melissa, Ian, and Carmen, who were on the T team, shot smug looks at Jennifer and Andrew, who were on the B team.

"See," said Carmen, "I knew we were the most important."

"But," said Miss Johnson, "your body makes B cells all the time to replace ones that die."

"And I know why," said Andrew.

"Really?" said Miss Johnson.

"Yeah," said Andrew. "It's because B cells are so important. If T cells were as important as B cells then T cells would be replaced too. But they aren't." Andrew

and Jennifer shot smug looks back to Melissa, Ian, and Carmen.

“Okay kids,” sighed Miss Johnson. “Anyway, now that I’ve given the B team its scanners, I need to give them their interleukin radios.” She dug into her box, pulled out two radios, and handed them to Jennifer and Andrew. “Remember,” she said to them, “you can’t do anything to a bacterium until you get permission over these radios from a T cell.”

T team members gloated. “That’s right,” said Melissa, “just remember we’re the bosses.”

Jennifer ignored them and asked, “Once we get permission to stop a bacterium, how do we stop it?”

“Well,” said Miss Johnson, “real B cells dealing with real bacteria kill them. I don’t think parents of Bonita students want you killing their kids. And a real bacterium, if it infects your body, kills cells of your body. I don’t think your parents want Bonita school kids killing you. So we’ll do this instead. The invaders have red markers that wash off with soap and water. Instead of killing kids in our school they will mark them with a red ‘X’ using their markers. And instead of killing the invaders you will take away their red markers and bring them to this room.”

“But what if they won’t give them to us?” asked Andrew. “What if they just run away?”

“One rule,” said Miss Johnson, “is no running, and certainly no running away. Everyone must play by the rules. If someone doesn’t, it’s off to Mr. Whacksworth. The Bonita kids know this. So I don’t think you have to worry.”

“How do we know which side wins?” asked Melissa. This seemed the most important question, so the class hushed and listened as Miss Johnson replied.

“Here’s how we’ll know. There will be four invaders from the Bonita school. There are about 500 kids in our school. If the Gembusters stop all four invaders, taking away their red markers, before ten percent of our kids get marked, then we win. But if the invaders mark ten percent or more of our students before we stop them, then they win.”

“Ten percent,” said Melissa. “That means that they have to mark 50 kids. We’ll win, no problem!”

“I hope so,” said Miss Johnson. “But we must be careful. The invaders from the Bonita school have practiced, and they may have tricks up their sleeves. Of course we have a few up ours as well. In fact, it’s time to get

members for our last two teams, the macrophages and the killer T team. Since macrophages are big cells, we need two big kids to be macrophages.”

“That would be me,” said Carl in his lowest voice.

“And me,” said Billy in his lowest voice.

No one argued, so Miss Johnson waved them up to her desk and gave them interleukin radios. She also gave them white T-shirts with large neon-green letters saying “Mighty Macrophage” on the front and “Mess with a Macrophage and be Mincemeat” on the back.

“Hey, how come they get T-shirts and we don’t?” asked Carmen.

“Because we’re the most important team,” said Carl. “We’re the muscle that stops invaders.” The T and B teams scowled.

“The reason,” said Miss Johnson, “gets back to Andrew’s question. He asked what happens if invaders don’t give up their markers when they’re caught. Well, the invaders were told that if they’re caught by anyone wearing a T-shirt with the words ‘Mighty Macrophage’, then they must surrender their red markers. They must also surrender their markers if they are caught by someone wearing the T-shirt of the killer T team. And by the way, mem-

bers of the killer T team don't have to be big like the macrophages. Two more volunteers?"

Hands shot up, and Miss Johnson picked Elizabeth and Juan. They trotted up front and snatched their interleukin radios. Miss Johnson gave them white T-shirts with large neon-orange letters saying "Kamikaze Killer T" on the front and "Tangle with a T and be Terminated" on the back.

The voice of Mr. Whacksworth crackled over the intercom. "May I have your attention everyone. As your teachers have informed you, we're about to compete with Bonita. To win, it's important that all of you, except Miss Johnson's class, stay in your rooms for the next forty minutes. If anyone needs to use the bathroom, now's the time. You have five minutes before the competition starts. Follow your teachers' instructions, and good luck to our side!"

Several kids dashed off to the bathrooms and scurried back.