VIRAL ATTACK

NO. 1

The Story of Your Body's Incredible Defense System

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Sholly Fisch
Original script

Kelly Dolezal
The Story Behind the Scenes

Sabine Deviche
Illustration

James Baxter & Sabine Deviche
Coloring

Web version
http://askabiologist.asu.edu/viral-attack

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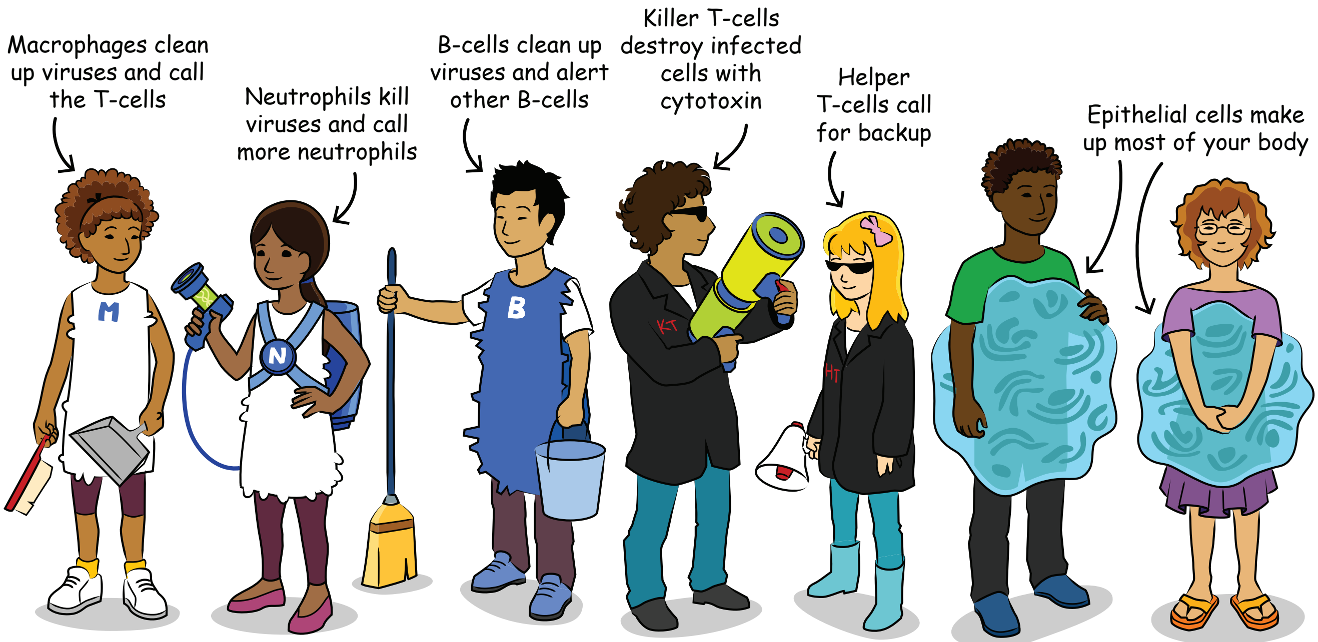


Prologue

There are battles that are fought each day around the planet. The invading forces are those of viruses and bacteria. Left alone they would take over and destroy every cell!

It is up to some key defense systems to battle and destroy these forces. Your immune system is one such defense system. A collection of special cells in your body are ready to attack any unwanted bacteria and viruses. Together these cells are able to seek out and destroy unwanted viruses and return your body to its normal working order.

Cast

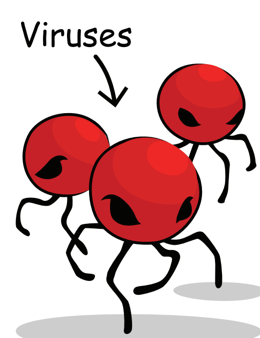
This story has young actors playing the role of the cells. Each cell has a special job that they do that helps our bodies do work and fight off infections, like those caused by viruses. As you will see there are many different cells that work together to fight off infections like viruses.

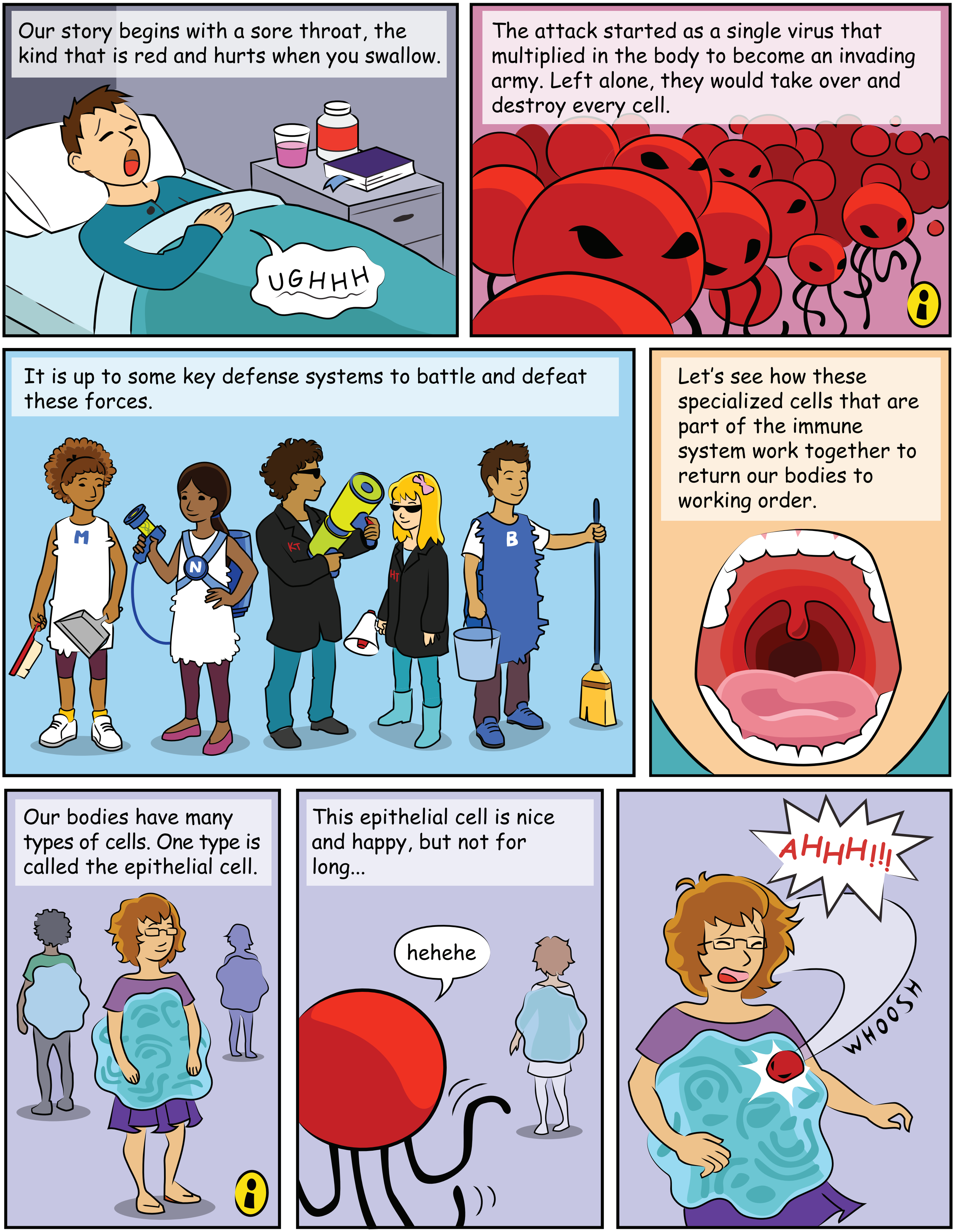
Learn more

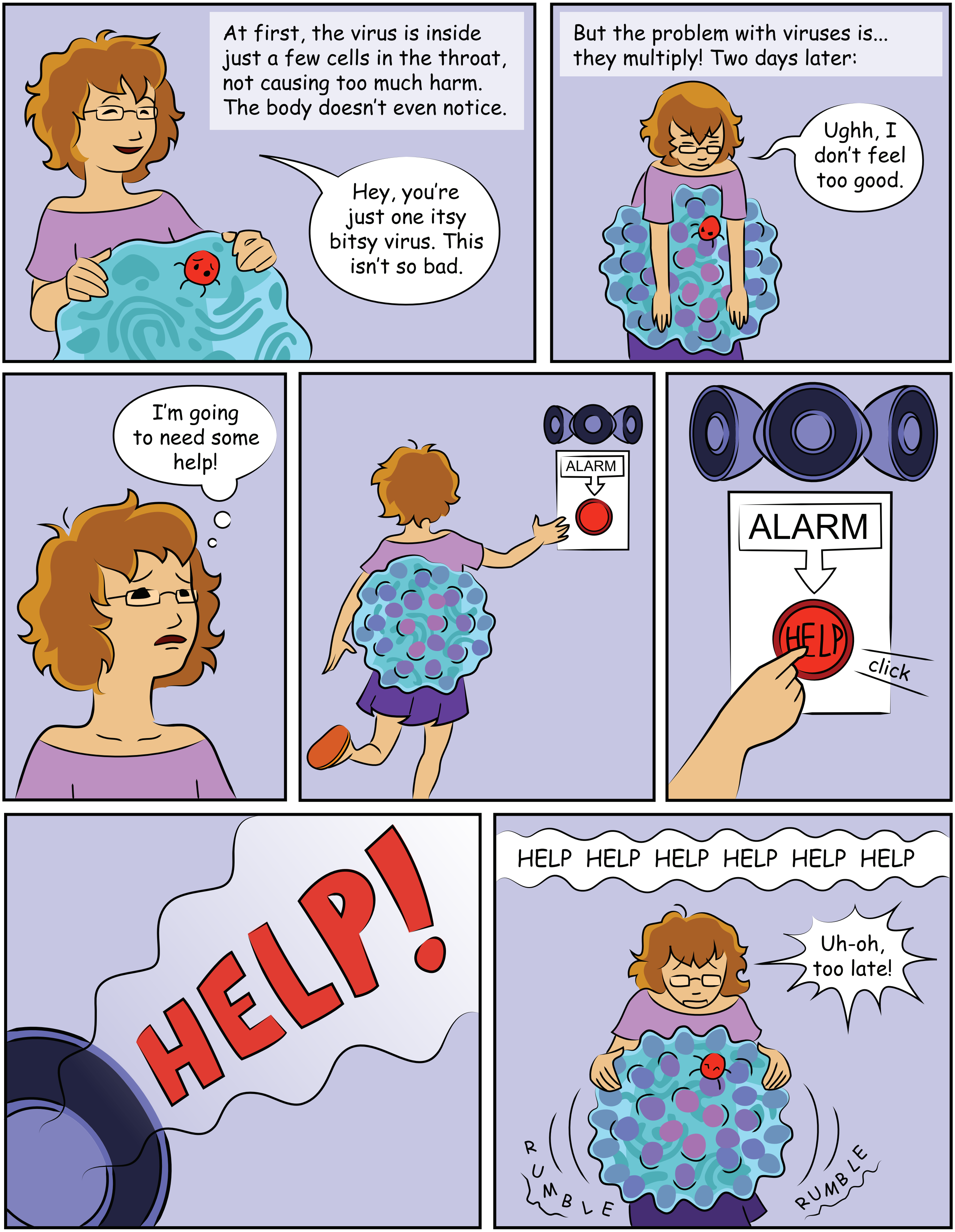
This icon lets you know that there is more you can learn about this topic in the Behind the Scenes story.

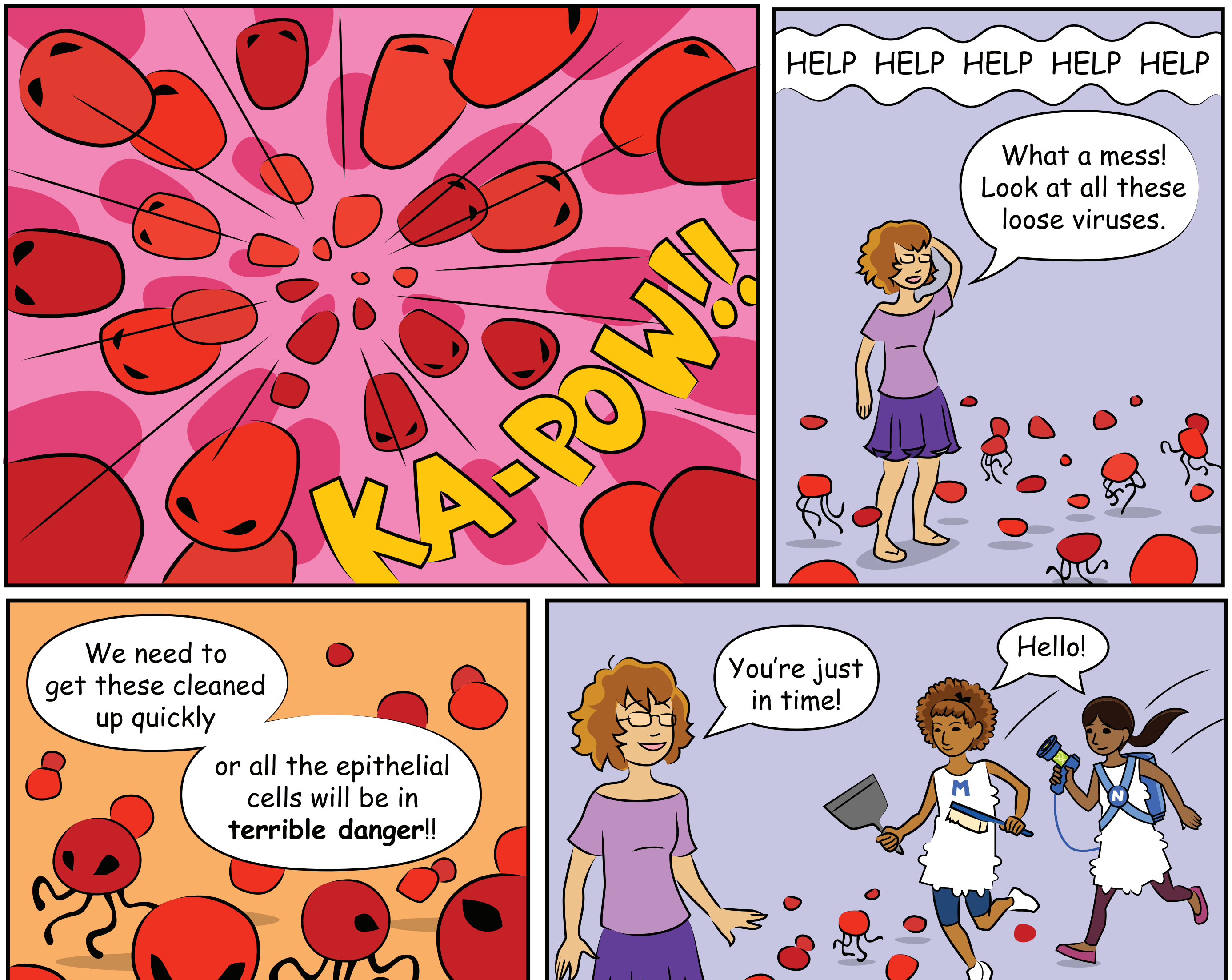
Words to know

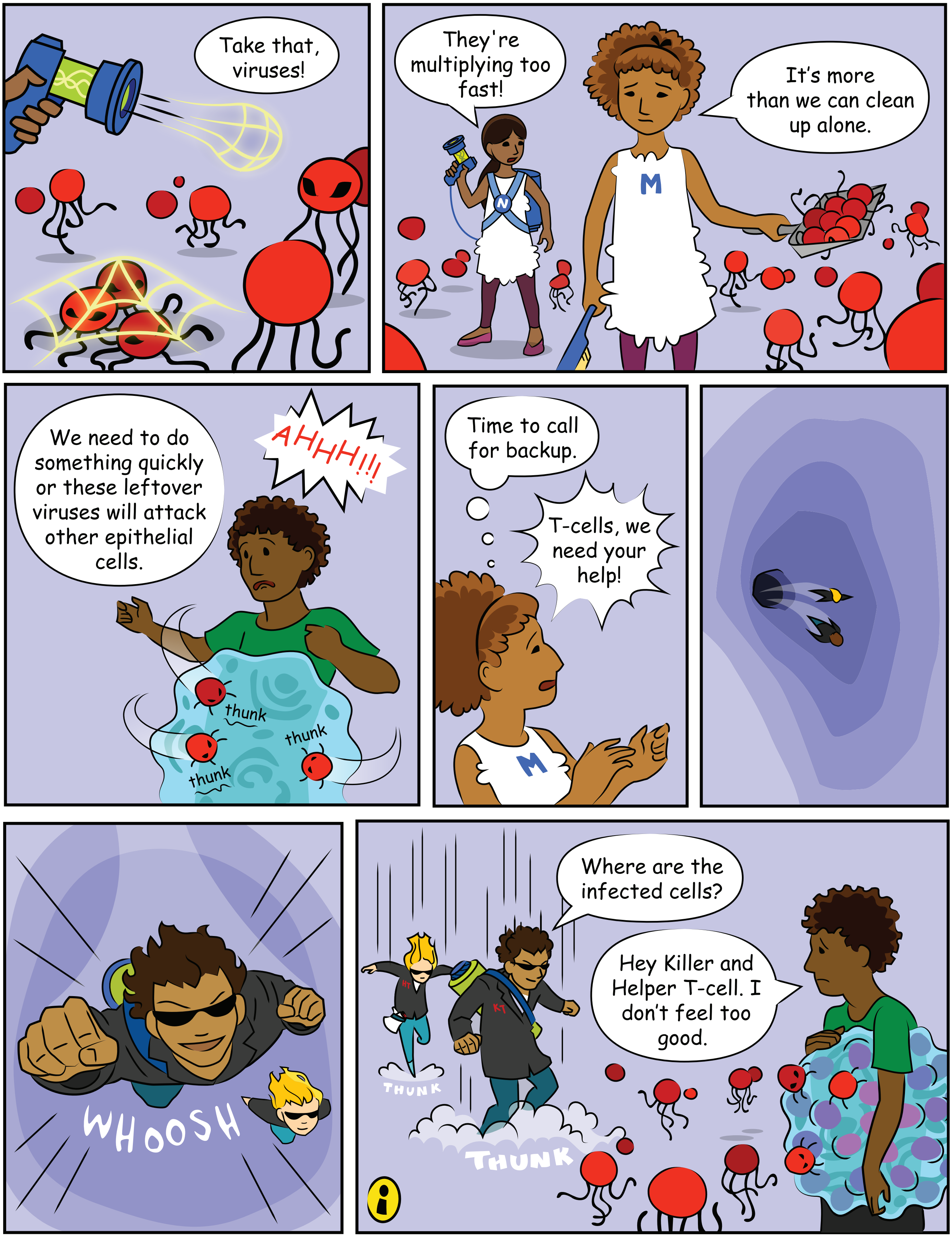
If you find a word you don't know that is blue, you can find out what it means by looking in the words to know on page 24.



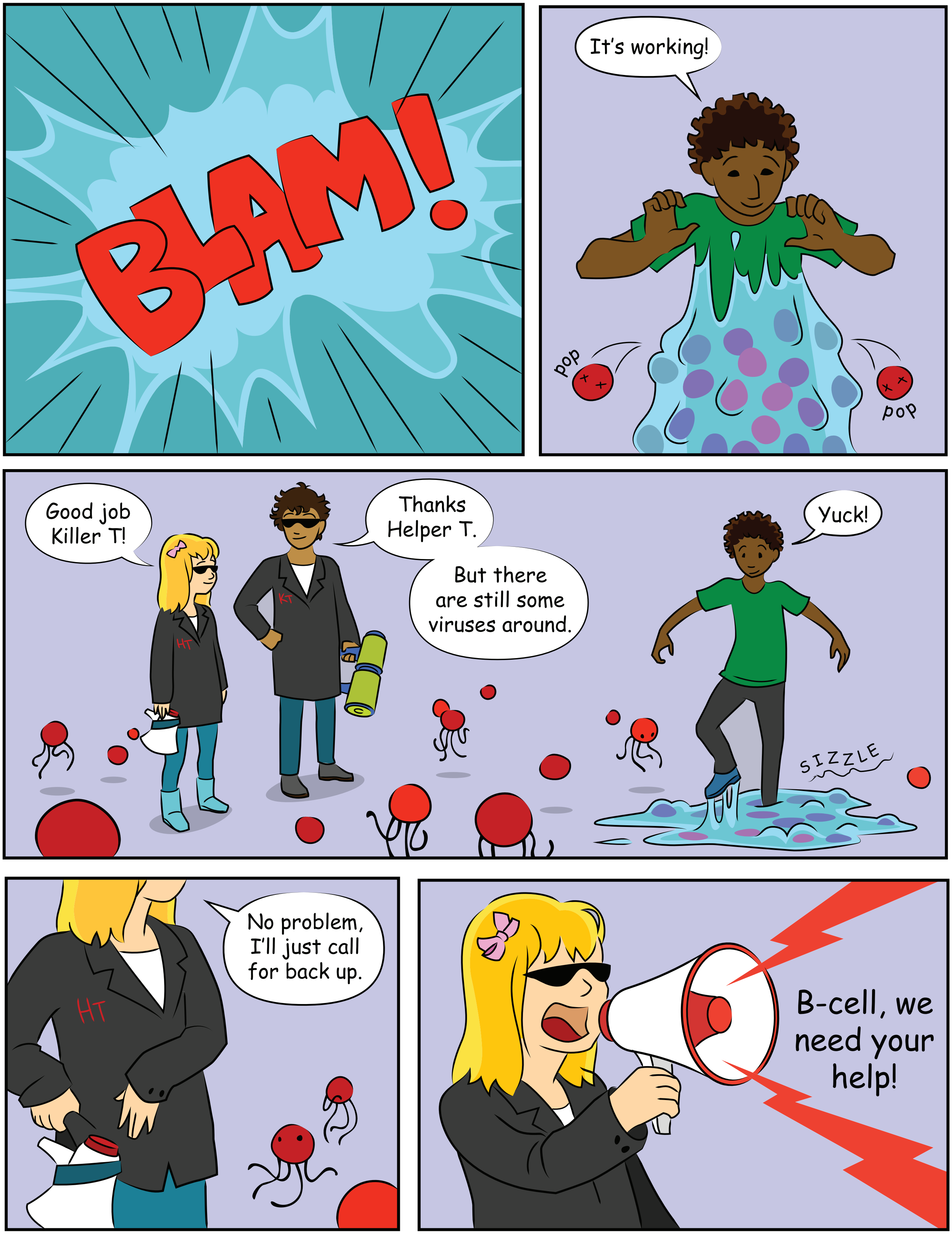

Our story begins with a sore throat, the kind that is red and hurts when you swallow.
UGHHH
The attack started as a single virus that multiplied in the body to become an invading army. Left alone, they would take over and destroy every cell.
It is up to some key defense systems to battle and defeat these forces.
M
N
B
Let's see how these specialized cells that are part of the immune system work together to return our bodies to working order.
Our bodies have many types of cells. One type is called the epithelial cell.
This epithelial cell is nice and happy, but not for long...
hehehe
AHHH!!!
WHOOSH

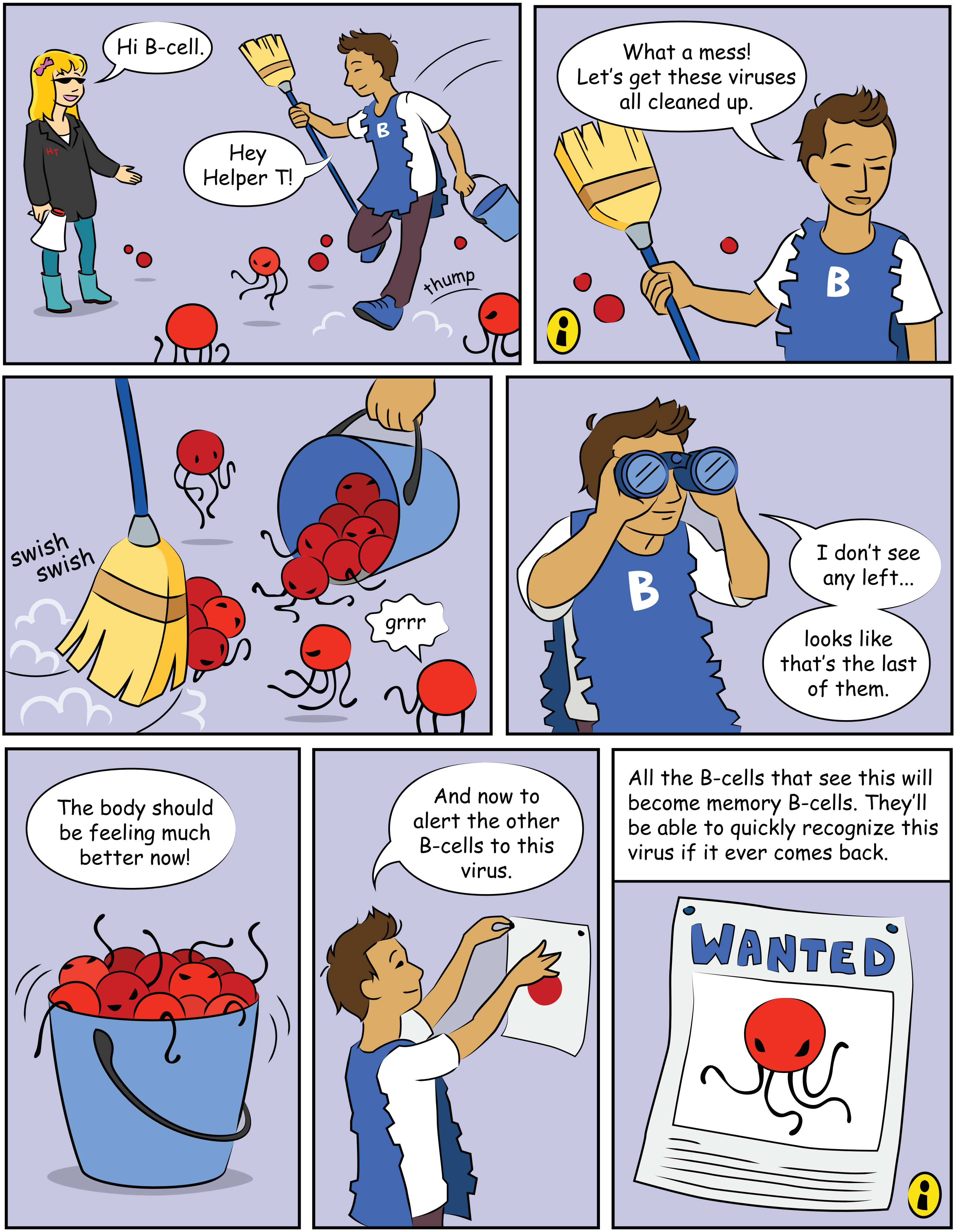

At first, the virus is inside just a few cells in the throat, not causing too much harm. The body doesn't even notice.
Hey, you're just one itsy bitsy virus. This isn't so bad.
But the problem with viruses is... they multiply! Two days later:
Ughh, I don't feel too good.
I'm going to need some help!
ALARM
ALARM
HELP
click
HELP!
HELP HELP HELP HELP HELP HELP
Uh-oh, too late!
RUMBLE
RUMBLE

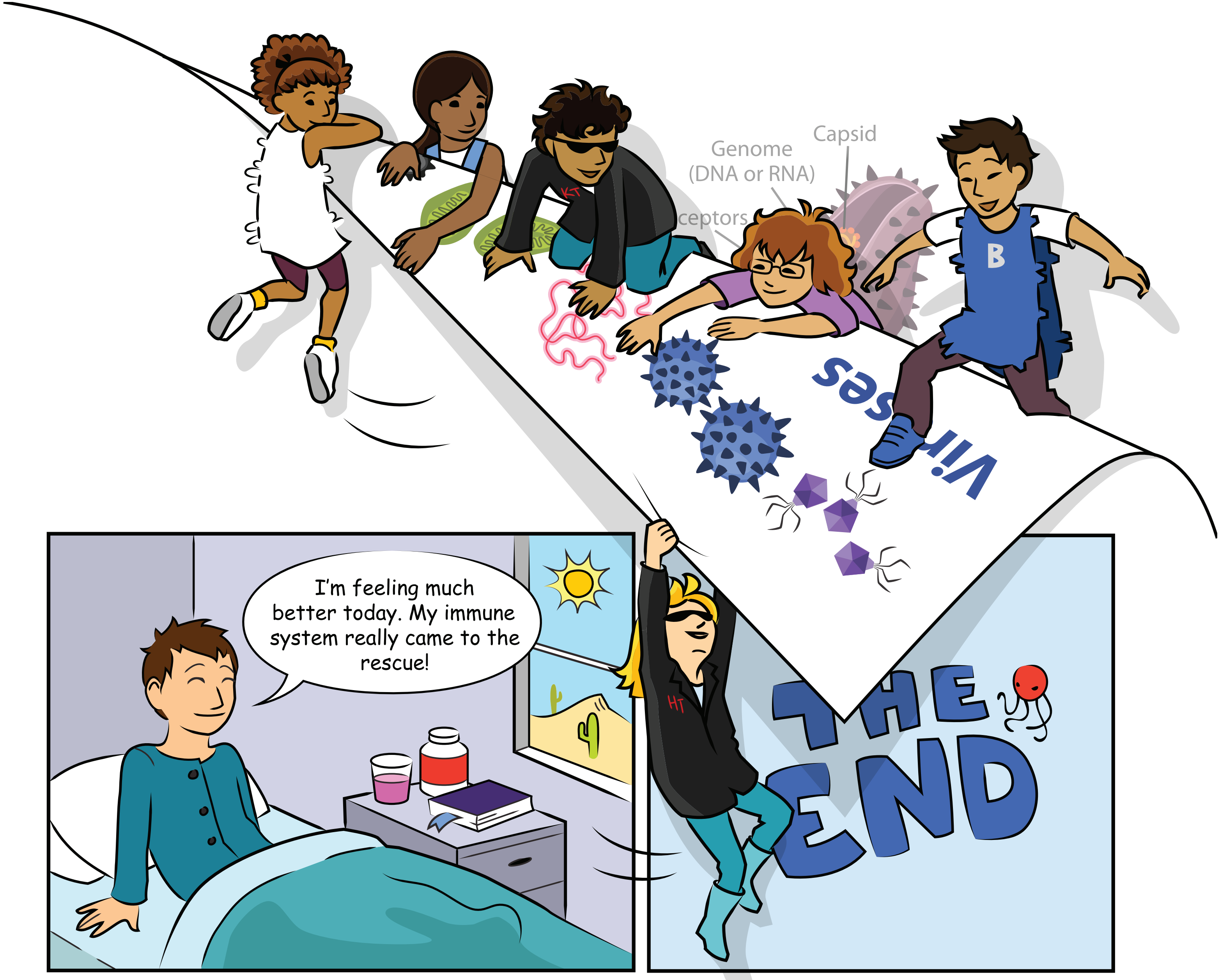

KA-POW!!
HELP HELP HELP HELP HELP
What a mess! Look at all these loose viruses.
We need to get these cleaned up quickly
or all the epithelial cells will be in **terrible danger**!!
You're just in time!
Hello!
We heard your alarm. I'm **Neutrophil**.
I'm **Macrophage**. We're members of the body's immune system clean-up crew.
Let's get this mess cleaned up!


Take that, viruses!
They're multiplying too fast!
It's more than we can clean up alone.
We need to do something quickly or these leftover viruses will attack other epithelial cells.
AHHH!!!
thunk
thunk
thunk
Time to call for backup.
T-cells, we need your help!
WHOOSH
Where are the infected cells?
THUNK
THUNK
Hey Killer and Helper T-cell. I don't feel too good.

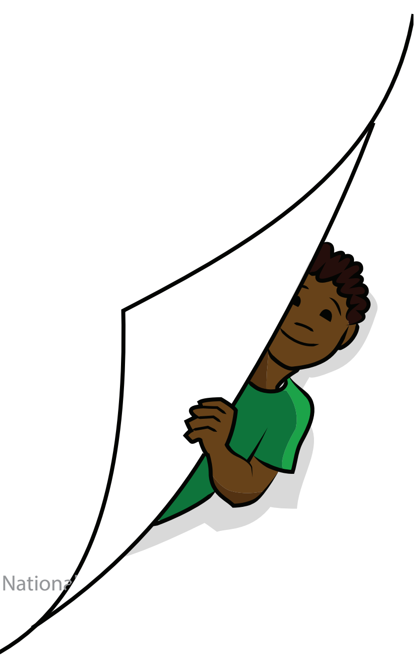
Looks like we're too late for this one.
He has too many viruses inside already.
Killer T, you'll have to destroy the cell.
It's the only way to stop more viruses from being released.
OK!
WHIRL
Viruses, meet my **cytotoxin gun**!
KT
click-click
CLICK
WHOOSH!!

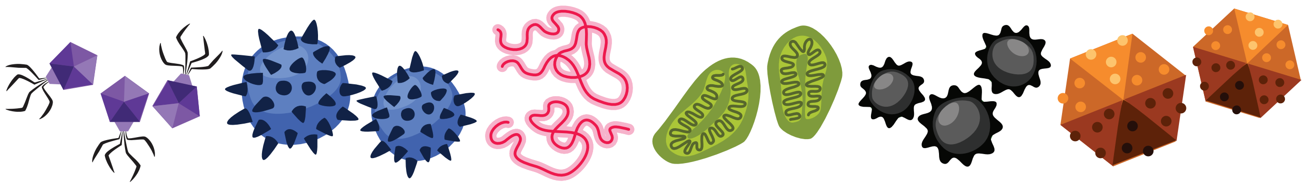

BLAM!
It's working!
pop
pop
Good job Killer T!
Thanks Helper T.
But there are still some viruses around.
Yuck!
SIZZLE
No problem, I'll just call for back up.
B-cell, we need your help!


Hi B-cell.
Hey Helper T!
thump
What a mess! Let's get these viruses all cleaned up.
swish swish
grrr
I don't see any left...
looks like that's the last of them.
The body should be feeling much better now!
And now to alert the other B-cells to this virus.
All the B-cells that see this will become memory B-cells. They'll be able to quickly recognize this virus if it ever comes back.
WANTED



The Story Behind the Scenes





Viruses

Remember the last time you had a sore throat, fever, or cough? There is a good chance that you felt sick because your body was fighting a virus, a tiny invader that uses your cells to copy itself. Viruses can infect every known living thing. Animals, plants, and even bacteria catch viruses. Bacteria or viruses that make other living things sick are called pathogens.

Even though we try to stay away from pathogens, many other bacteria and viruses are helpful. Bacteria that live in the oceans and soil are important to cycle nutrients in the environment. Other bacteria turn milk into yogurt or cheese for us to eat.

There are even some helpful viruses and bacteria that live inside you, called mutualists. Some viruses and bacteria inside you actually help guard your body against more dangerous infections, and other viruses can help plants survive cold or droughts better. Bacteria in your gut helps you digest your food and make vitamins you can't make yourself.

If we were able to see viruses with our eyes we would see that they are all around us. Luckily, your immune system can remove most viruses that make you sick. In some cases, doctors give us medicines that can slow down difficult viruses to help your immune system fight them.

Catching viruses

There are many ways viruses can get into the body. Insects, like mosquitoes, can spread some viruses between people they bite. More often, the viruses that cause colds come from infected people through a sneeze or cough. Once out, they can get in your body when you inhale them from the air or touch a surface they are stuck to.

There are ways to stay healthy and to keep others from getting sick from viruses. The best way is to wash your hands. The soap won't kill viruses, but it does help remove the oils and dirt they stick to so you can rinse them off your skin. When you are sick, you can protect others by covering your mouth and nose when you cough. Don't use your hands, because you can end up touching something and spreading the virus. Instead, use your upper arm and shoulder to cover your mouth and nose.

What does a virus look like?

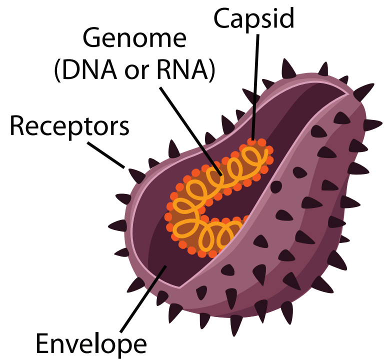
How big?

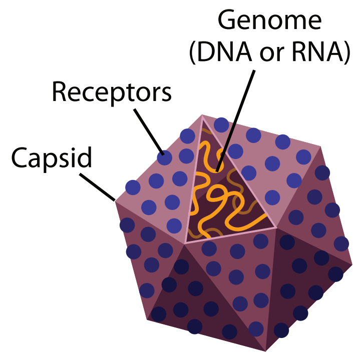
Think about this – even if we could magnify a cell until it was the size of a basketball, a virus would still only be about the size of a single period on this page.

Virus parts

The most simple viruses have only two parts: 1) a genome (DNA or RNA) that is a blueprint with instructions for making more viruses and 2) a capsid protein shell that protects the genome. Viruses also often have proteins called receptors that stick out of the shell, and help the virus sneak inside cells.

Many viruses that infect humans and animals also have an envelope, something like a cell membrane, around the capsid and genome. These are just the basics, though. Look at all of these different shaped viruses! Below are images taken with an electron microscope showing you just a few of the many different shapes of viruses.

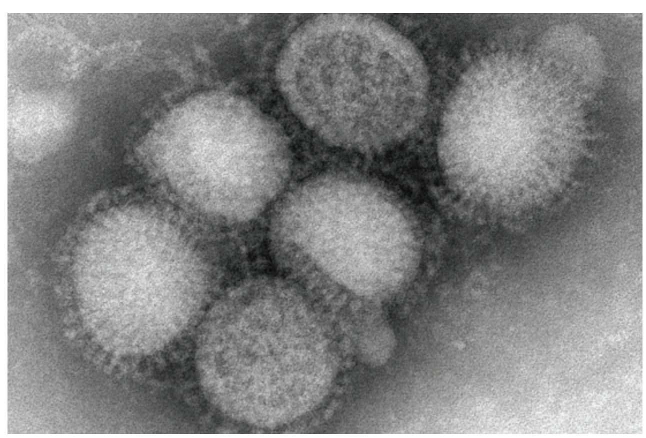





Marburg virions
CDC, E. Palmer, R. Regnery

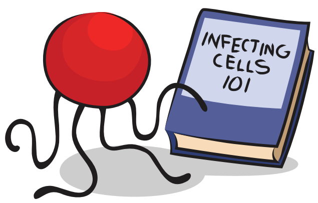

Ebola virus
CDC, F. Murphy


Vesicular stomatitis virus
CDC


Swine flu virus
CDC, C. S. Goldsmith, A. Balish

How does a virus work?

You might not think that simple viruses could take over your complex cells, but they do all the time. This is very important to viruses since they don't have the machinery to make copies of themselves. Instead, they trick your cells into becoming virus-making machines for them.



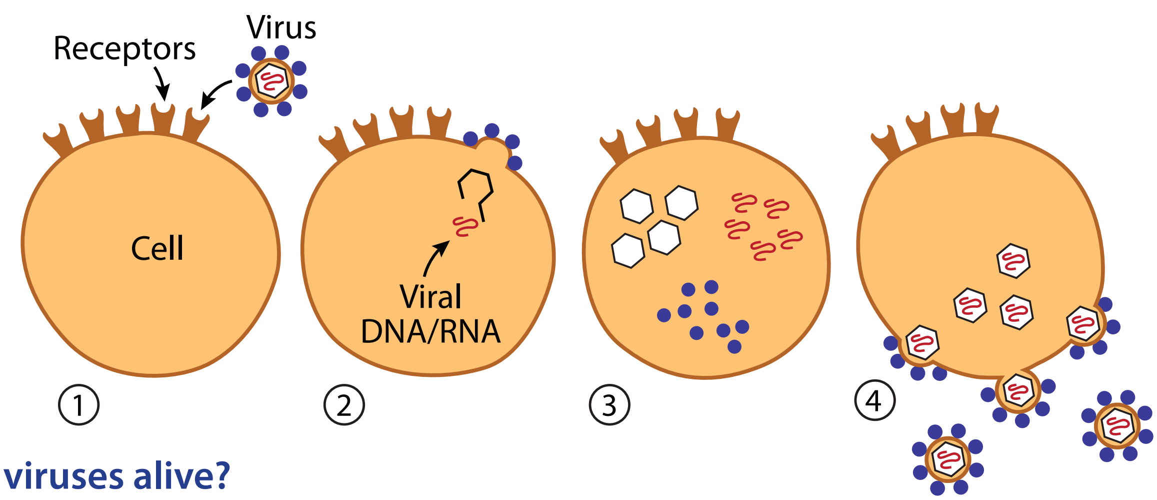
Getting inside the cell

Step one is to get inside a cell. Viruses enter the cell by tricking it into thinking it is something else that the cell needs. On the cell surface, there are sensors called receptors with shapes that fit with the shape of nutrients. When a matching receptor and nutrient lock together, the cell pulls them both inside.

A virus uses camouflage to trick the cell. Its capsid or receptor proteins look like nutrients the cell needs (1). When the virus receptor binds to the cell receptor, the cell thinks the virus is a nutrient, and pulls it in. Now, the cell is infected!

Making more viruses

Step two is to make more viruses. Once inside, the virus adds its genome blueprint to the cell. The cell doesn't know that the new blueprint is from the virus, so it follows the instructions to make virus parts (2). Now the cell has unknowingly become a virus factory (3). The virus parts come together to make full viruses that escape from the cell (4). Each new virus can infect another cell, repeating the infection cycle.



Are viruses alive?

Viruses seem very smart to trick your cells during infections, but are they actually alive? It's difficult to come up with one definition for life, but scientists agree on several characteristics that all living things share. Let's see how viruses stack up.

First, living things must reproduce. Although viruses have a genome, they need to take over the machinery of other living cells to follow the virus genome instructions. So, viruses cannot reproduce by themselves.

Next, all living things have metabolism. Metabolism means the ability to collect and use energy. Chemical reactions in your cells constantly change molecules into forms of energy we can use. The energy you use to run and jump came from breaking big food molecules into smaller pieces that can be used or stored in the cell. Viruses are too small and simple to collect or use their own energy– they just steal it from the cells they infect. Viruses only need energy when they make copies of themselves, and they don't need any energy at all when they are outside of a cell.

Finally, living things maintain homeostasis, meaning keeping conditions inside the body stable. Your body sweats to cool you down and shivers to warm you up if its temperature changes from 98.6 ° F. Millions of adjustments throughout the day keep your temperature and the chemicals in your body balanced. Viruses have no way to control their internal environment and they do not maintain their own homeostasis.

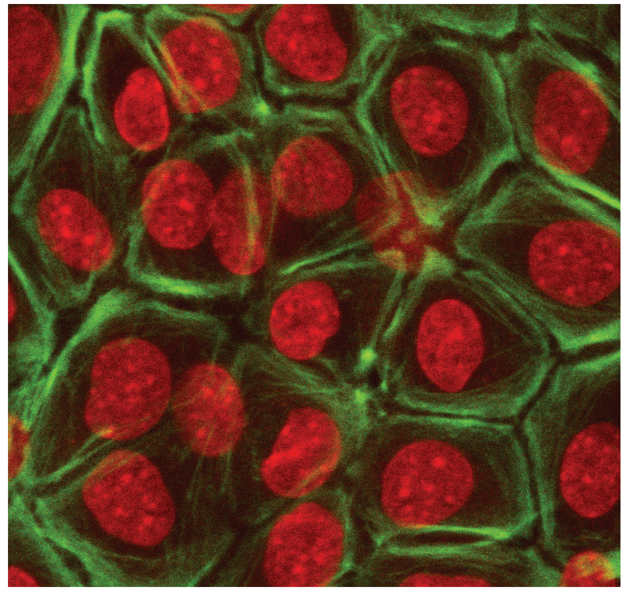
So, since viruses cannot reproduce on their own and have no metabolism or homeostasis, they are usually not thought of as truly alive. They do have a huge effect on living things during infections, though!

Epithelial cells

Where are epithelial cells?

Take a quick look at the skin on your hands. Even if you think your skin is one smooth surface, it is actually made of millions of epithelial cells that are tightly packed next to each other.

That's not the only place you find these cells. Epithelial cells also line the inside of your throat, intestines, blood vessels, and all your organs. They are a barrier between the inside and outside of your body and are often the first place that is attacked by viruses as they begin their invasion deeper into the body.



Stained epithelial cells by Page Baluch

What do epithelial cells do?

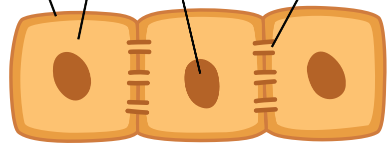
Epithelial cells are the safety shields of the body. Take another look at your hand. It is covered with epithelial cells that protect your body by being a barrier between your internal cells and the dirt and microbes in the environment. They also are able to stretch so you can move your fingers and arms into many positions. You can also thank your epithelial cells for making the sweat that cools you down when you're exercising or when it's hot outside.

Other epithelial cells help you experience your environment by having special sensors, called receptors, that collect signals. When you taste a favorite food or smell a flower, the receptors in these cells send the signal to your brain so you can enjoy every bite and sweet smell.

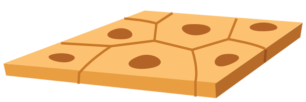
Once you swallow that bite of food, it travels down a path lined with epithelial cells. When it gets to your intestines, another set of epithelial cells absorbs and transports nutrients from the foods you eat and helps process it for energy your body can use. Converting food energy to energy your body can use is the work of molecules called enzymes. Once again, it is epithelial cells that make and secrete the enzymes in your stomach. Epithelial cells also secrete hormones into your blood vessels, mucus in your nose, and the breast milk which mothers feed their young.

What do epithelial cells look like?

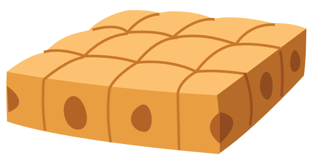
If you take a close look at epithelial cells using a microscope, you will see them tightly packed together. This helps make a protective barrier for our bodies. There are also some special door-like connections between each epithelial cell called gap junctions. The gap junctions are where the cells exchange nutrients. Unfortunately, sometimes viruses can use these doors to spread between cells, too!



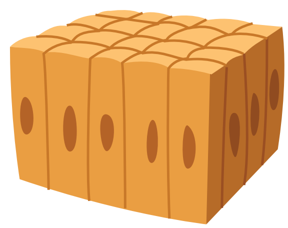
Epithelial cells come in different shapes depending on where in the body they're found. These shapes are called squamous, cuboidal, columnar, and ciliated columnar.



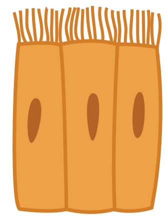
Squamous epithelial cells are flat and are found lining surfaces that require a smooth flow of fluid, such as your blood vessels. They also line areas that require a very thin surface for molecules to pass through, such as the air sacs in your lungs.



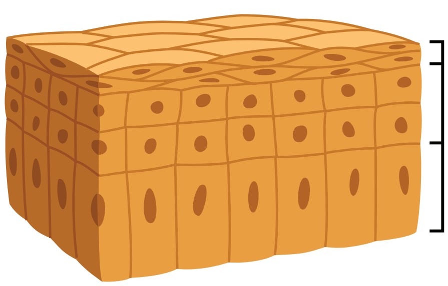
Cuboidal epithelial cells, as their name suggests, are shaped like cubes. These are typically found in tissues that secrete or absorb substances, such as in the kidneys and glands.



Columnar epithelial cells are long and thin, like columns. These are usually found in places that secrete mucus such as the stomach. They can also specialize to receive sensory information in places like taste buds on your tongue and inside of your nose.



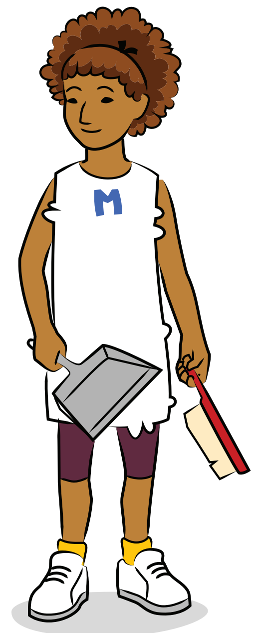
Ciliated columnar cells have their apical (or outside facing) surface covered with many tiny little hairs called cilia. These are used to push mucus and other particles along, making it flow in a specific direction.



In addition to these shapes, epithelial cells can be described as being either simple or stratified. These terms refer to how many layers are present. Simple tissue has only one layer of epithelial cells, while stratified tissue has many layers stacked on top of each other. Stratified cells are found in places that need to withstand a lot of wear and tear from their environment.

An example of this would be your skin, which is made up of many stratified layers of epithelial cells. As the top layer wears down, cells from the bottom layers constantly grow up to replace them.

Macrophages

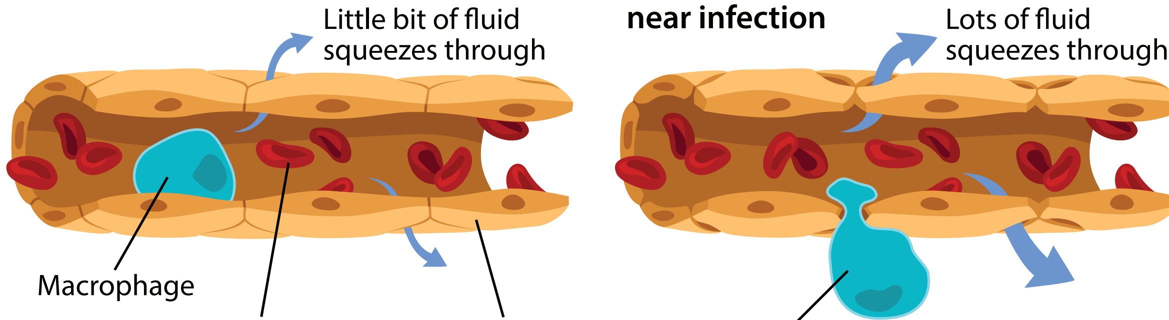


Early to the scene

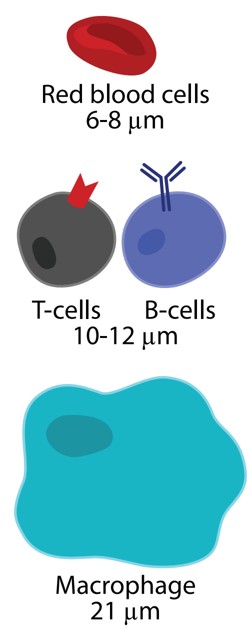
Macrophages, a kind of white blood cell, are one of the first types of cells at the infection (along with neutrophils). They get to the infection from your blood. Your blood looks like it is just a red fluid, but it has lots of other kinds of cells, too. There are red blood cells that bring oxygen to every part of your body and white blood cells that fight infections.

Getting to the scene

Infected or damaged cells, like the epithelial cells in our story, call for help by releasing chemicals that attract macrophages already in nearby blood vessels. These chemicals also open spaces between blood vessel cells. Macrophages can squeeze between the spaces to get to the action!



When cells call for help



Have you ever had a splinter that after a day or two felt painful, hot, and swollen? Your cells around the splinter were calling for help, and when the blood vessels let macrophages in the infected tissue, they also let some blood fluid seep into the area. This extra fluid and the chemicals released by infected cells can cause inflammation. This hurts, but actually helps your body fight infections better!

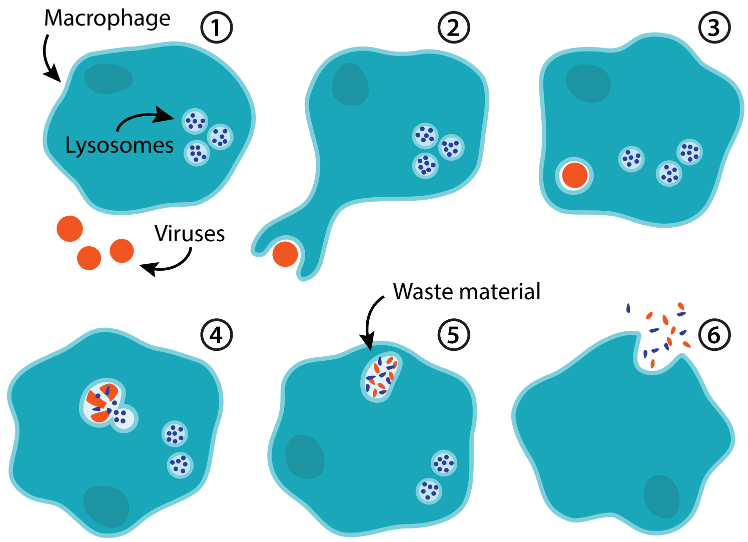
Bringing in more help

Macrophages and neutrophils work to keep the body clean of debris and invaders, but they also call for backup when an infection is too big for the two of them to handle alone. Other immune system cells, like the T-cells and B-cells in our story, are alerted that their help is needed by chemicals the macrophages release. Macrophages are also linked to the presence of other types of cells like basophils and eosinophils, which are most often involved in allergic reactions. These cells also help control the inflammation of tissues.

Big eaters

Think of macrophages as cell-eating machines. Their name actually means "big eater" in Greek. Macrophages are the biggest type of white blood cells - about 21 micrometers - or 0.00083 inches. Still too small to see with your eyes, but big enough to do the important job of cleaning up unwanted viruses, bacteria, and parts of dead cells.

Macrophages don't eat cells the same way you might eat your food. Instead, the eating machines engulf viruses and bacteria. This is called phagocytosis. First, the macrophage surrounds the unwanted particle and sucks it in. Then, the macrophage breaks it down by mixing it with enzymes stored in special sacs called lysosomes. The leftover material is then pushed out of the cell as waste.



Neutrophils

Early to the scene

Neutrophils are the most common type of white blood cell. They are also usually the first cells at the scene of infection. They are made in the bone marrow, and like other white blood cells, they travel through the bloodstream to the infection. Scientists are still trying to learn all the ways they are involved in fighting viruses. But one of the most important ways they help fight is by releasing chemicals.

Helping and hurting

Neutrophils fight off invaders in a number of ways. They can eat them, fire anti-microbial proteins at them, or set web traps outside of cells, to catch and kill them. But some of these weapons can also do damage to the cells that make up body tissues. A situation like this is called a trade-off. The help neutrophils offer is important to win the fight, but they also hurt at the same time that they help.

Bringing cells to the fight

Neutrophils also release chemicals that call more cells to the fight. This can happen throughout the body, or in a specific body tissue. It all depends on where the virus or microbe is attacking. When a fight happens in one area, tissue can get swollen and hot. This "inflammation" happens because cells and fluids are moving to the area and can cause tissue damage.

Keep it short

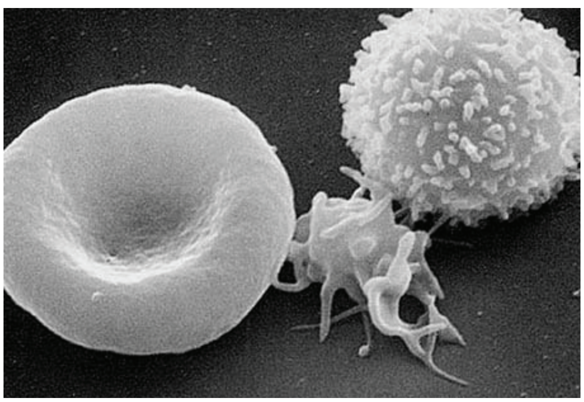
Because neutrophils both help and hurt during a fight against microbes, using them in battle is a bit of a balancing act. But their short lives help keep things under control. As long as the fight against the invaders continues, neutrophils are called to replace cells that die. But after the infection is under control, no more cells should be called. The remaining neutrophils will start to die soon. In most cases, they will be swallowed up by macrophages, so the area of infection will be clean.

T-cells

T-cells are a type of white blood cell that work with macrophages. Unlike macrophages that can attack any invading cell or virus, each T-cell can fight only one type of virus. You might think this means macrophages are stronger than T-cells, but they aren't. Instead, T-cells are like a special forces unit that fights only one kind of virus that might be attacking your body.

More than one kind of T-cell

There are two types of T-cells in your body: Helper T-cells and Killer T-cells. Killer T-cells do the work of destroying the infected cells. The Helper T-cells coordinate the attack.

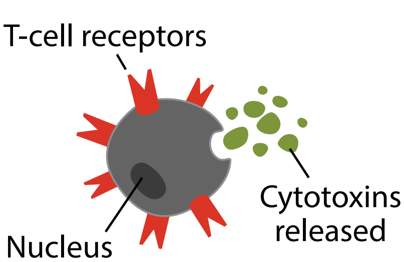


Picture taken with a scanning electron microscope of a T-cell (right), platelet that helps blood to clot (center), and a red blood cell (left). The bumps on the T-cell are T-cell receptors used to fight infections. From The National Cancer Institute.

Killer T-cells and antigens

Killer T-cells find and destroy infected cells that have been turned into virus-making factories. To do this they need to tell the difference between the infected cells and healthy cells with the help of special molecules called antigens. Killer T-cells are able to find the cells with viruses and destroy them.

Antigens work like identification tags that give your immune system information about your cells and any intruders. Healthy cells have 'self-antigens' on the surface of their membranes. They let T-cells know that they are not intruders. If a cell is infected with a virus, it has pieces of virus antigens on its surface. This is a signal for the Killer T-cell that lets it know this is a cell that must be destroyed.



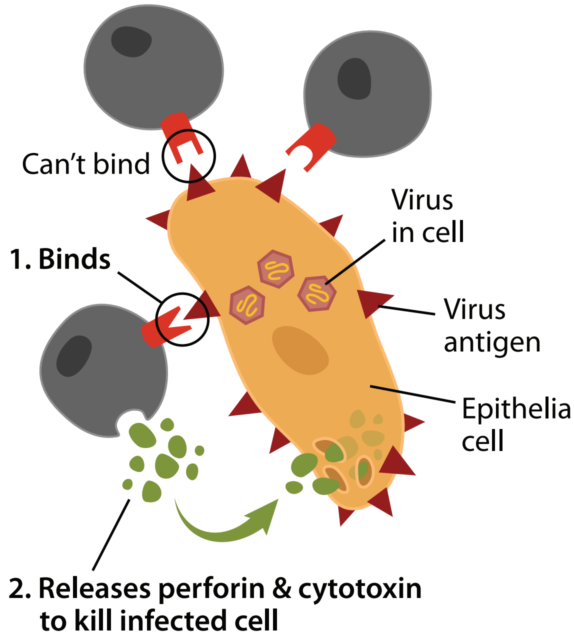
Anatomy of a T-cell

T-cells have many identical T-cell receptors that cover their surfaces and can only bind to one shape of antigen. When a T-cell receptor fits with its viral antigen on an infected cell, the Killer T-cell releases cytotoxins to kill that cell.

The key to finding infected cells

There are 25 million to a billion different T-cells in your body. Each cell has a unique T-cell receptor that can fit with only one kind of antigen, like a lock that can fit with only one shape of key. Antigens and receptors work a lot like a lock and key. Each of the 25 million to a billion different T-cells fit with a different shape of antigen. Most of these antigens will never get in your body, but the T-cells that patrol your body will recognize them if they do.

The T-cell receptor fits with its antigen like a complex key. When the perfectly shaped virus antigen on an infected cell fits into the Killer T-cell receptor, the T-cell releases perforin and cytotoxins. Perforin first makes a pore, or hole, in the membrane of the infected cell. Cytotoxins go directly inside the cell through this pore, destroying it and any viruses inside. This is why Killer T-cells are also called Cytotoxic T-cells. The pieces of destroyed cells and viruses are then cleaned up by macrophages.



Helper T-cells

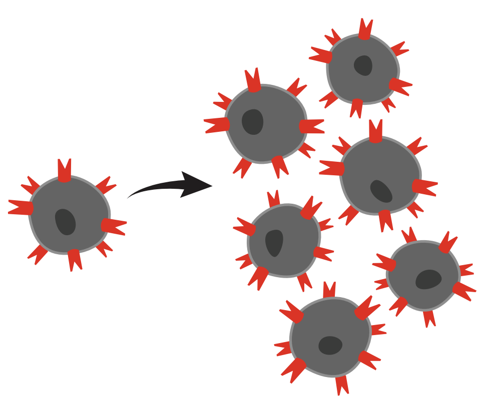
The other type of T-cell is the Helper T-cell. These cells don't make toxins or fight invaders themselves. Instead, they are like team coordinators. They use chemical messages to give instructions to the other immune system cells. These instructions help Killer-T cells and B-cells make a lot more of themselves so they can fight the infection and make sure the fight stays under control.

Building a bigger army for a particular invader

When a Helper T-cell sends out a chemical message, its matched Killer T-cell is alerted that there is a virus present. After a Killer T-cell finds and destroys an infected cell, this Helper T-cell message tells it to copy itself, making an army of Killer T-cells. Since only T-cells that can fight the invading virus are copied, your body saves energy and is still very good at killing the virus.

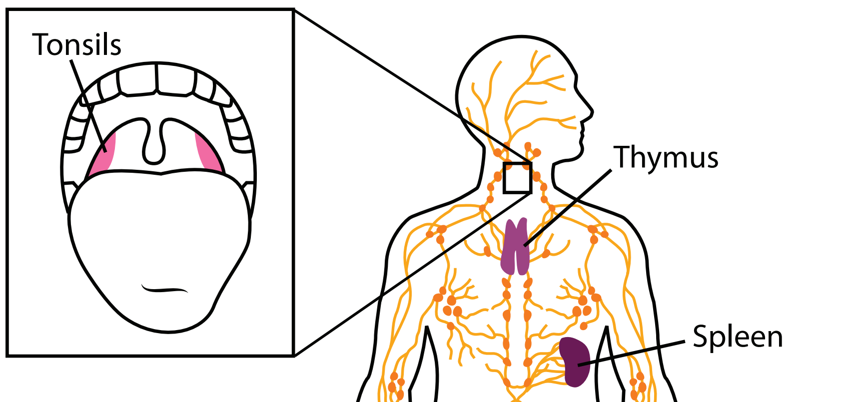
T-cell screening

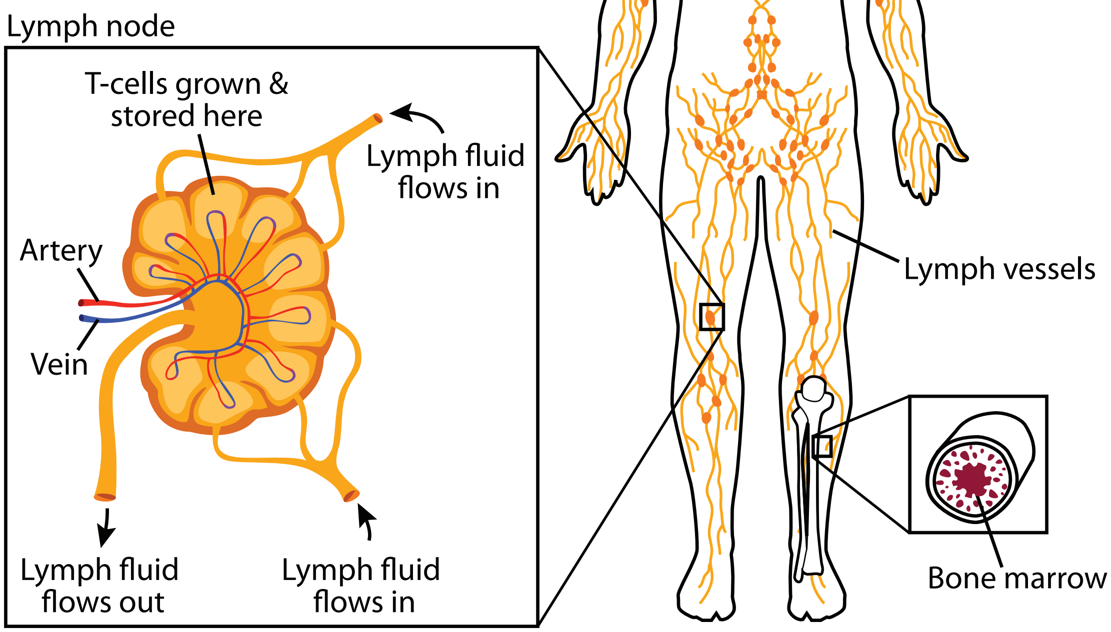
T-cells are made in the bone marrow, like all red and white blood cells. The name T-cell comes from the organ where they mature, the thymus. The thymus is just above your heart, and is about the size of a deck of playing cards. Since most T-cells are made when you're young, kids have a bigger thymus than adults. It is also where T-cells are screened to get rid of any that would attack the healthy cells in your body.



When a T-cell finds its virus match in your body, it makes many copies of itself to attack that virus.

The lymph system moves white blood cells around the body. It includes the lymph nodes, the thymus, spleen, tonsils, and bone marrow, where immune system cells grow and multiply.





Getting around the body

All white blood cells have two ways to get around the body. One way is through your blood vessels. The other way is through the lymph system.

The lymph system has vessels that move milky fluid and white blood cells around the body. Unlike your heart, which pumps your blood, the lymph system uses the movements of your body to push the lymph fluid around. This is one reason why it is good to be active and exercise.

Switching transportation systems

Most white blood cells are stored in the lymph system until they are needed to fight an infection. When a virus attacks, they can transfer into the blood vessels so they can quickly attack the viruses. This transfer happens in the lymph nodes, which are located throughout your body.

Lots of lymph nodes are in your legs, armpits, and neck. The last time you had a sore throat you probably felt enlarged places on one or both sides of your neck. This is where the T-cells and B-cells multiply and get ready to attack the virus.

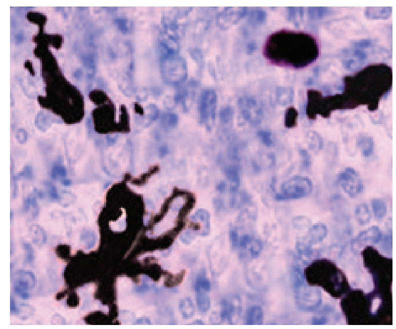
Other important parts of the lymph system where immune cells grow, multiply, and trap invaders are your bone marrow, thymus, spleen, and tonsils.

Cytotoxins

Cytotoxins are the chemical weapons that Killer T-cells use to destroy infected cells. Viruses take over healthy cells and trick them into making many more viruses. When those viruses get out, they can infect even more healthy cells. By killing infected cells before these viruses get out, cytotoxins protect your healthy cells.

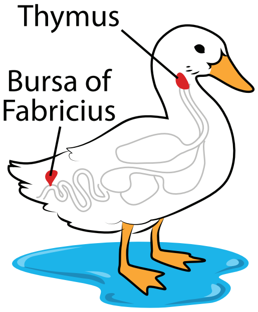
Different kinds of cytotoxins work in different ways. Some cytotoxins make holes in the cell membrane, so the inside of the cell is not protected from the outside. Without a full membrane, the cell dies. Cell death because of this kind of break in the cell membrane is called lysis.

Other cytotoxins turn on a program in the cell that causes it to self-destruct. This is called apoptosis. The dark spots in the picture are cells that have been destroyed by apoptosis. Macrophages, the first member of the body's clean up crew, remove these dead cells.



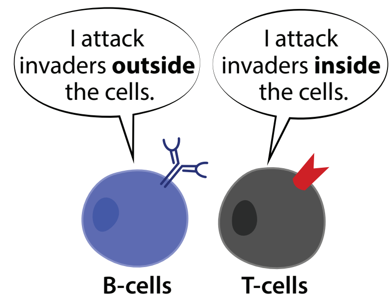
B-cells

You might think B-cells got their name because they are made inside your bones. It is true that most blood cells are made in-side the bone marrow, but that is not where the "B" in B-cells came from. Their name comes from the name of the place they were discovered, the Bursa of Fabricius. The Bursa is an organ only found in birds.



Unlike T-cells and macrophages, B-cells don't kill viruses themselves. In the Viral Attack story, the B-cell sweeps up the leftover viruses after the T-cell attack. Actually, B-cells are as important as T-cells and are much more than just a final clean-up crew. They make important molecules called antibodies. These molecules trap specific invading viruses and bacteria. Without this line of defense, your body would not be able to finish fighting most infections.

B-cell, T-cell, what's the difference?

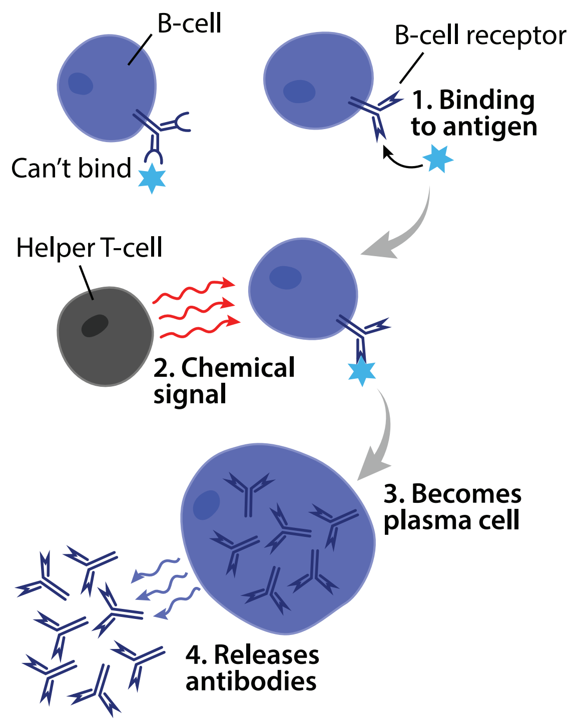


Just like T-cells, each B-cell has a receptor that will connect to only one antigen shape. And, like T-cells, B-cells that recognize self-antigens are destroyed, so they don't harm your body's healthy cells.

An important difference between T-cells and B-cells is that B-cells can connect to antigens right on the surface of the invading virus or bacteria. This is different from T-cells, which can only connect to virus antigens on the outside of infected cells.

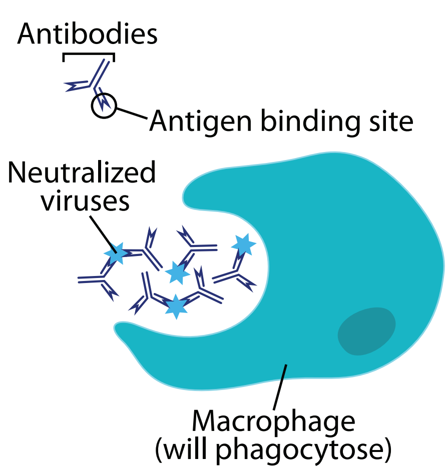
Your body has up to 10 billion different B-cells. They're too small to see with your eyes, but if you lined them all up, they'd be longer than 100 soccer fields. With so many different B-cells patrolling your body, you are ready to fight almost any invader.

B-cells become plasma cells



When a B-cell receptor connects to its specific antigen, a Helper T-cell releases chemicals that tell that B-cell to divide many times. This makes an army of B-cells with the perfectly shaped B-cell receptor to connect to the invader in your body.

Many of these B-cells quickly turn into plasma cells. Plasma cells make and release antibodies that connect to the same antigen as the original B-cell receptor. Plasma cells make thousands of antibodies per second, which spread throughout your body, trapping any viruses they see along the way.



What do antibodies do?

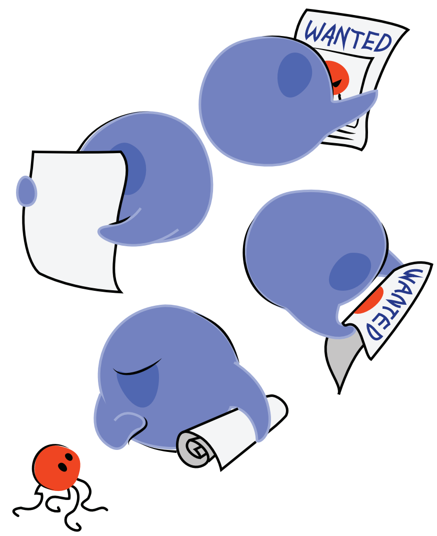
Antibodies trap invading viruses or bacteria in large clumps. This makes it easy for macrophages to eat them. Antibody-coated viruses are called "neutralized" because they can't infect your cells.

Even after you have fought off your infection, some antibodies stay in your blood. If that virus tries to infect you again, your immune system has a head start trapping it.

Memory cells

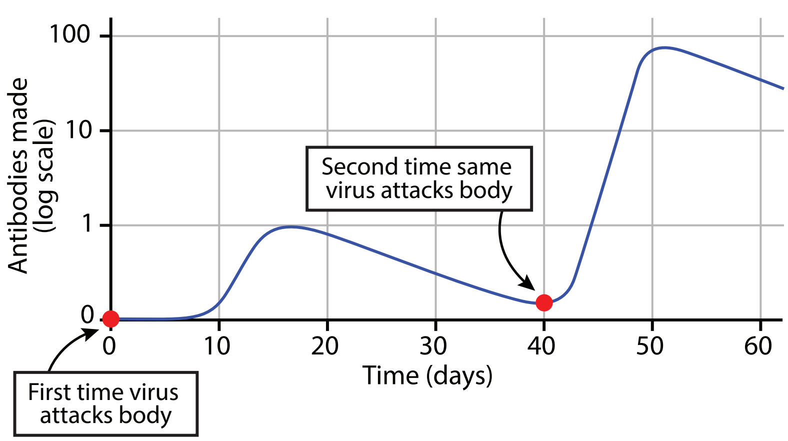
If your body fights a virus once, the same virus will probably try to attack again. After all the work it took to get rid of that first infection, it would be a shame to have to do it all over again. An amazing feature of your immune system is that it remembers the infections it has fought. This makes it much easier to fight the same virus or bacteria a second, or third, or fourth time.

A memory cell never forgets



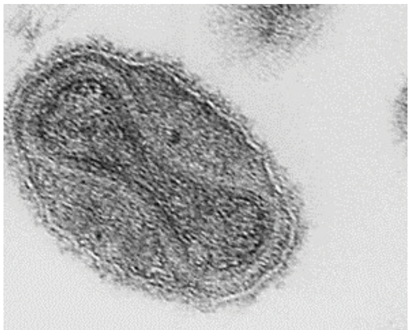
Toward the end of each battle to stop an infection, some T-cells and B-cells turn into memory T-cells and memory B-cells. As you would expect from their names, these cells remember the viruses or bacteria they just fought. These cells live in the body for a long time, even after all the viruses from the first infection have been destroyed. They stay in the ready-mode to quickly recognize and attack any returning viruses or bacteria.

Quickly making lots of antibodies can stop an infection in its tracks. The first time your body fights a virus, it can take up to 15 days to make enough antibodies to get rid of it. With the help of memory B-cells, the second time your body sees that virus, it can do the same thing in 5 days. It also makes 100 times more antibodies than it did the first time. The faster your body makes antibodies, the quicker the virus can be destroyed. With the help of memory B-cells, you might get rid of it before you even feel sick. This is called gaining immunity.

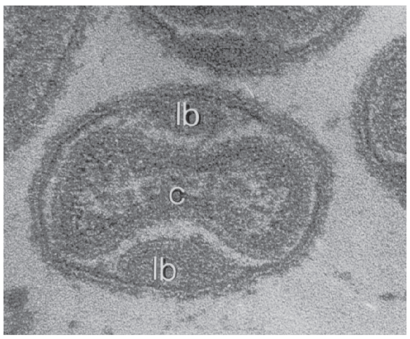


This graph shows how memory cells help you to better fight infections. At day 0, someone catches a virus. At day 10, her B-cells start making antibodies, and by day 15 she's made enough antibodies to destroy all the viruses. Now, she doesn't make any more antibodies, so fewer and fewer are left in her body.

At day 40, the same virus gets in her body again. Since she has memory B-cells prepared to fight, she can quickly make 100 times more antibodies than she did during the first infection.



Smallpox virus
CDC, F. Murphy, Sylvia



Cowpox virus
Cornelia Büchen-Osmond

Building memory cells without getting sick

If you get an infection, you can build up immunity to that specific virus. Another way to get immunity is to get a vaccine. Vaccines are very weak or dead versions of a virus or bacteria that prepare your memory cells to fight that specific virus or bacteria. Since vaccines help you gain immunity without getting sick, they are especially good protection for very dangerous illnesses.

Vaccinations in history

The first successful vaccine was against smallpox in 1796. Smallpox is caused by a very contagious and deadly virus. Back then, smallpox was especially scary because people knew so little about viruses, bacteria, or how the immune system works.

It was Dr. Edward Jenner who noticed that young women who milked cows usually caught cowpox, but rarely caught smallpox. He thought maybe getting cowpox prevented getting smallpox.

To test his idea, Dr. Jenner tried infecting people with cowpox on purpose, and then exposed them to smallpox. Amazingly, they didn't catch smallpox. He didn't know exactly how it worked, but we now know that cowpox and smallpox have antigens with similar shapes. This means that memory cells to fight cowpox can also fight smallpox. Because vacca means cow in Latin, Dr. Jenner called this type of disease prevention vaccination.

After Dr. Jenner's discovery, it became common to vaccinate everyone against smallpox. It has been so successful that since 1979 there have been no smallpox infections.

Today, we have many vaccines to protect us from getting sick. Most of these are shots, but some scientists are working on vaccines made in plants that you can eat. This might mean one day you won't get a vaccine shot, you'll just enjoy a vaccine smoothie!

Words to know

Antibody ***(ant-i-body):*** a molecule made by B-cells to trap foreign particles and microbes.

Apoptosis ***(ap-o-tow-sis):*** self-destruction of a cell.

Camouflage ***(cam-o-flaj):*** use of colors and patterns to blend into the surrounding area in order to hide.

Capsid ***(cap-sid):*** a protective shell around the genome of a virus.

Cell membrane ***(cell mem-brain):*** the outside layer of a cell that separates it from its environment.

Contagious ***(con-ta-gee-us):*** easy to catch from another person or animal.

Cytokine ***(sight-o-kine):*** a chemical released by cells in the immune system that helps coordinate an immune response by sending messages to specific cells.

Cytotoxins ***(s-eye-tow-tocks-ins):*** chemicals that kill cells.

Envelope ***(en-ve-low-p):*** part of a cell membrane that is stolen to become the outer layer of some viruses.

Enzyme ***(enz-eye-m):*** a protein molecule that can increase the rate of chemical reactions in the body.

Genome ***(jee-no-m):*** all of the genetic information of an organism (living thing).

Homeostasis ***(hoe-me-o-stay-sis):*** the ability to keep a system at a constant condition.

Hormones ***(horm-oh-n):*** chemical messages released by cells or glands in the body.

Immune system ***(im-mewn sis-stem):*** all the cells, tissues and organs involved in fighting diseases in the body.

Immunity ***(im-mew-nit-ee):*** having memory in the immune system to avoid getting a certain infection.

Inflammation ***(in-flam-a-shun):*** swelling and redness of tissue, normally near the site of an infection.

Lymph system ***(limf sis-stem):*** the network of vessels, tissues, and organs that immune cells use to move through the body.

Lysis ***(lie-sis):*** cell death because of damaged membranes.

Metabolism ***(met-a-bowl-is-um):*** the sum of all of the chemical reactions within the body. These include reactions related to eating, drinking, breathing, and getting rid of wastes.

Molecule ***(mol-e-cue-l):*** a chemical structure that has two or more atoms held together by a chemical bond. Water is a molecule of two hydrogen atoms and one oxygen atom (H_2O).

Mutualist ***(mew-chu-a-list):*** a virus or living thing that grows inside or alongside a living host, helping both of them grow better than if they were alone.

Pathogen ***(path-o-jen):*** a virus, bacterium, fungus, or parasite that infects and harms a living host.

Phagocytosis ***(fay-go-s-eye-tow-sis):*** the process used by some cells to engulf and digest foreign objects and dead cells in your body.

Plasma cell ***(plas-ma cell):*** an immune cell that comes from B-cells and makes and releases antibodies.

Prologue ***(pro-log):*** a section before a story or movie that introduces characters and important information.

Receptor ***(ree-cep-tor):*** a molecule that gets signals from the outside of cells by attaching to other molecules.

Secrete ***(se-kreet):*** to release any substance, molecule, or chemical from a gland or cell in the body.

Smallpox ***(small-pocks):*** a deadly disease that causes red bumps on the skin.

Vaccine ***(vak-seen):*** a treatment that lets you gain immune memory with antigens, or dead or weak viruses or bacteria, instead of from an infection.

Unique ***(you-neek):*** one of a kind.

Credits

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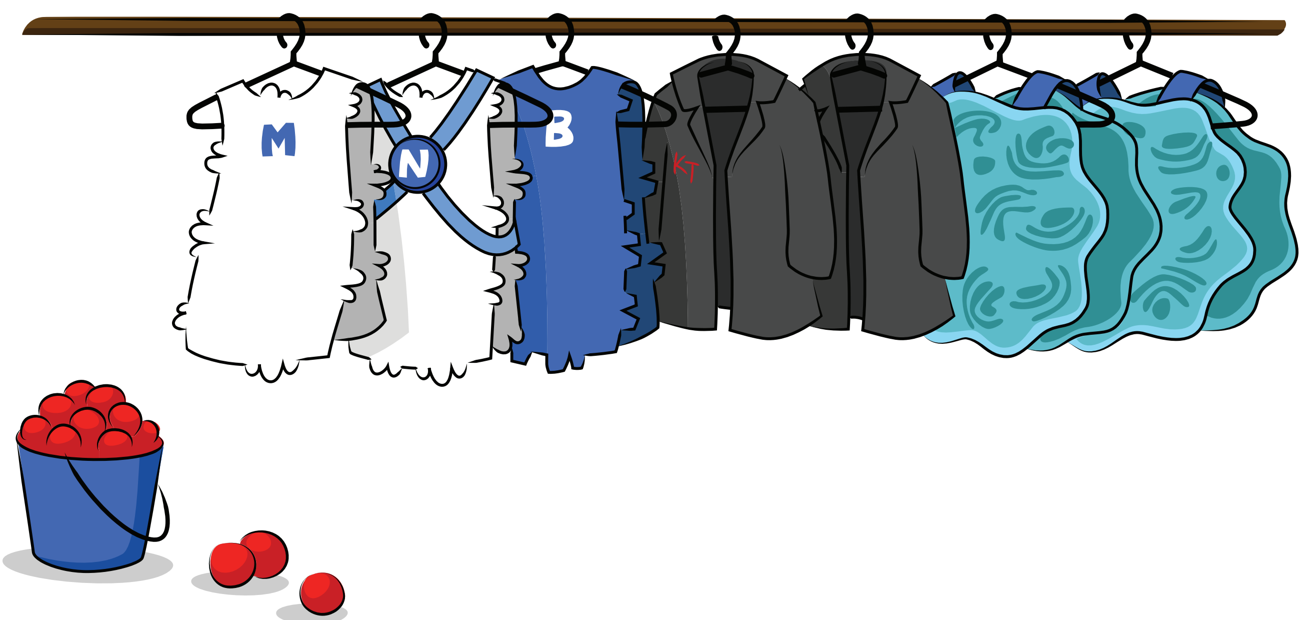
Plan your next visit to the Arizona Science Center and play the part of your favorite Viral Attack character in the live stage production of Viral Attack.



BODY DEPOT

The Arizona Science Center and Ask A Biologist have joined forces in building Body Depot, a place where you can learn about your amazing body. Visit Body Depot online at askabiologist.asu.edu/body-depot

MONSTER MANUAL

Read a real monster tale about the tiniest instruction manual that you carry around in each of your cells. Then try out Monster Maker, a fun game where you decode and build your own monsters. You can find it at askabiologist.asu.edu/monster-manual