BIOLOGY: Viruses

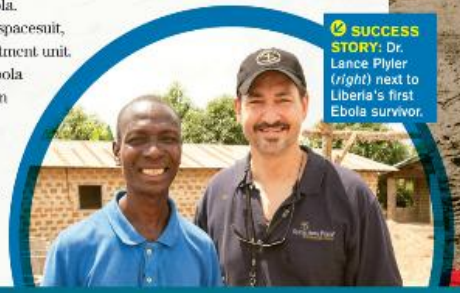
BATTLING EBOLA

A physician's firsthand account of the fight against the killer virus

At a hospital in the West African nation of Liberia, Dr. Lance Plyler steps into a protective suit. He pulls on rubber boots, a double layer of rubber gloves, and goggles. Co-workers check to make sure nothing is exposed—not even a strand of hair. One mistake could cost Plyler his life. That's because he is preparing to treat patients infected with one of the world's deadliest viruses—Ebola.

Looking like he's wearing a spacesuit, Plyler steps into the Ebola-treatment unit. Anyone suspected of having Ebola in this area is *quarantined* in an attempt to keep the virus from infecting others. All beds are full, and the staff scrambles to clean up after patients who are

Continued on p. 8



SUCCESS STORY: Dr. Lance Plyler (*right*) next to Liberia's first Ebola survivor.

CONTROLLING CONTAMINATION: A member of the Liberian Red Cross is disinfected with chlorine after handling a suspected Ebola victim.

ANATOMY OF AN OUTBREAK

Scientists first identified the Ebola virus in 1976 during an outbreak in Central Africa. It killed 280 people—almost 90 percent of those infected. Some species of fruit bats carry the virus, so scientists think outbreaks may begin when hunters butcher animals that have been infected by bats, or when people eat food contaminated with bat droppings.

Some species of fruit bats can carry Ebola.

Biologists think *patient zero*, the first infected person, in the current Ebola outbreak was a 2-year-old boy who died last December in Guinea—a place Ebola had never struck. Unsuspecting people then carried the virus from his tiny village of Meliandou to other villages. By March, when health-care workers realized an Ebola outbreak was under way, the disease had spread out of control.

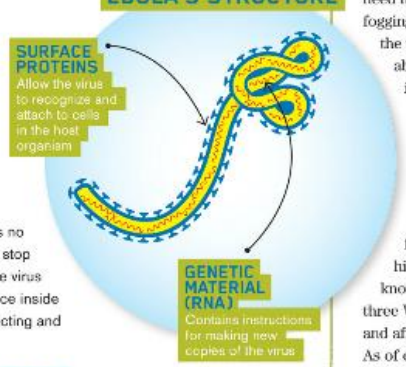
WATCH A VIDEO ABOUT EBOLA

CLICK FOR 4 BONUS SKILLS SHEETS

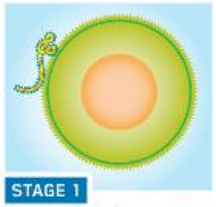
HOW THE EBOLA VIRUS WORKS

Viruses are about a hundredth the size of human cells. They can replicate only inside living cells of other organisms. Some viruses, like measles and smallpox, can be defeated with vaccines and drugs. So far, there's no tested medication to stop Ebola in humans. The virus replicates quickly once inside the body, rapidly infecting and destroying cells.

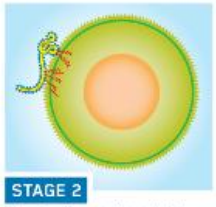
EBOLA'S STRUCTURE



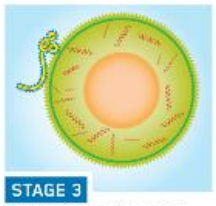
VIRUS LIFE CYCLE



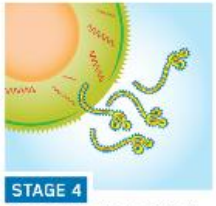
STAGE 1
Once the Ebola virus reaches the host cell, it uses surface proteins to attach.



STAGE 2
The virus's genetic material (RNA) goes inside the host cell.



STAGE 3
The virus's genetic material takes over the host-cell machinery, making copies of itself.



STAGE 4
After the virus has replicated, newly formed virus particles break off from the host cell and can go on infecting more cells.

vomiting and have diarrhea. Families aren't allowed to visit loved ones who are quarantined. When Plyler checks on a sick child, he finds that she has died alone. Plyler feels as if someone has punched him in the gut.

But he can't waste time. Other patients need his care, and his goggles are already fogging with sweat. The temperature inside the treatment center has climbed well above 38°C (100°F). It's even hotter inside his suit, and he can work in it only a short while longer before becoming exhausted. Outside, workers have no choice but to turn away sick people; there aren't enough health-care workers available.

Plyler and his colleagues are fighting the worst Ebola outbreak in history. The deadly virus—which has no known cure—has spread wildly through three West African countries (*see map, p. 7*) and affected several others around the world. As of early November, the virus had already killed nearly 5,000 of the more than 13,500 people believed to have been infected, and the epidemic showed no signs of slowing.

A HORRIFYING DISEASE

This nightmare virus catches victims by surprise. "Like so many viral infections, it just starts out with flu-like symptoms," says Andrea Marzi, a virologist at the National Institutes of Health's Rocky Mountain Laboratories in Montana. But as the virus *replicates* and spreads through the body, the symptoms become unbearable. Victims burn with high fevers and experience excruciating head and muscle aches. Vomiting and diarrhea won't stop, and in the advanced stages, blood vessels leak. "Since the virus is everywhere in your body," says Marzi, "it will cause you in the end to develop multi-organ failure, and then you basically die of shock."

With few hospitals and health-care workers in poor West African countries, the Ebola outbreak went undetected from December 2013—when researchers believe the first person got sick in Guinea—until March 2014. By then, the virus had spread to large cities. "People come to the hospitals, but they're full," says Margaret Harris, a public-health doctor at the World Health

ILLUSTRATIONS BY KATE HINDLEY

AIRPLANE BIOCONTAINMENT UNIT

American doctor Kent Brantly and health-care worker Nancy Writebol became sick with Ebola in Liberia and were flown back to the U.S. for treatment. They were so contagious that they needed to fly in a specially engineered containment unit, like the one below, to protect others on board from catching the virus.

PLANE RIDE HOME: Dr. Kent Brantly flew from Liberia to Atlanta for Ebola treatment.

COURTESY OF REUTERS (BIOCONTAINMENT UNIT); CDC (PLASTIC ROOM); NIAID (PROTECTIVE GEAR); JESSICA MCGOWAN/GETTY IMAGES (BRANTLEY); JIM MCMAHON (MAP)

Organization. "So they go back home and infect their community."

Plyler, an internal-medicine specialist from North Carolina, is a medical director at the relief organization Samaritan's Purse. In June, he flew to Liberia to help fight the epidemic.

ON THE FRONT LINES

Plyler worked closely with Kent Brantly, an American doctor whom he hired to oversee the hospital's Ebola units. Their team worked long hours. But since there's no cure, they could only treat the symptoms.

They gave patients fluids to prevent dehydration, provided medication to control fever, and replaced lost *electrolytes*—minerals contained in body fluids. They hoped that patients would stay alive long enough for their immune systems to mount a defense against the virus.

FACT:

EBOLA ISN'T NEARLY AS CONTAGIOUS AS MEASLES AND MANY OTHER VIRUSES.

CLICK TO SEE HOW EBOLA COMPARES WITH OTHER VIRUSES

"You have to fight discouragement and depression because you're investing so much work into these patients," says Plyler, "and many of them die despite your best efforts." Then there's the danger involved with being a health-care worker like Plyler: They're at great risk of contracting Ebola.

It may sound like Ebola is easy to catch, but experts emphasize that the virus can't spread unless a person is in direct contact with body fluids—like vomit, urine, or blood—of someone with the disease. The virus isn't contagious unless a person has symptoms of Ebola, like a fever. But doctors like Plyler and Brantly are often in direct contact with Ebola patients. By early November, 523 health-care workers had become infected—and 269 had died.

Continued on next page

MAKING THE ZMAPP DRUG

Dr. Lance Plyler made the decision to give ZMapp to Kent Brantly. The drug may have saved Brantly's life. ZMapp hasn't been tested enough to know if it's safe and effective in humans, but it has shown enough promise that scientists are racing to produce more doses. How scientists develop the drug may surprise you: It's grown in tobacco plants.

STEP 1

Scientists inject the leaves of a tobacco plant with a virus that's altered to fight Ebola. Tobacco plants were chosen because they're known to be vulnerable to viral infection. Once inside the plant, the virus can replicate rapidly.

STEP 2

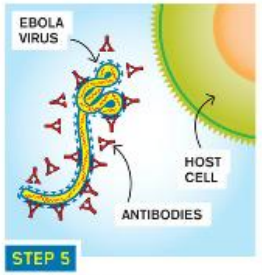
The plant's leaves turn yellow as it becomes sick from the virus. The plant produces Ebola *antibodies* to fight off the virus.

STEP 3

The antibodies are extracted from the plant and purified.

STEP 4

The purified solution is measured out into the correct dosage of ZMapp for humans. Then an IV can deliver the drug into the Ebola patient's veins.



STEP 5

Antibodies from ZMapp surround the Ebola virus, stopping it from invading the patient's cells. If the drug works as intended, the patient is protected from Ebola.

CORE QUESTION

Based on Dr. Lance Plyler's experience, what do you think it's like to treat someone who has Ebola?

In July, Brantly developed a fever. Concerned that he'd caught Ebola, he quarantined himself in his home in Liberia. Plyler sent a sample of his friend's blood to a lab and hoped for the best. When Plyler read the text message with the results, he was overcome with grief. His friend had Ebola.

A TOUGH DECISION

As Brantly's fever rose, Plyler made calls to see if anyone had ideas about how to save his friend. He learned of an experimental drug called ZMapp, which contains *antibodies* to combat Ebola. The drug had worked in monkeys but had never been tested in humans. It might cause terrible side effects. But it could also be his friend's best chance to survive.

A lab in West Africa had just enough ZMapp to treat one person. Plyler requested to have the drug flown to him. Once it arrived, he wasn't just afraid for Brantly's life; he was also terrified of the decision he was about to make—whether or not to give the untested drug.

FACT:

A PERSON INFECTED WITH EBOLA MAY NOT SHOW ANY SYMPTOMS FOR 21 DAYS.

CLICK TO SEE THE STAGES OF EBOLA INFECTION

But Brantly's fever skyrocketed, and his body was shaking uncontrollably. Plyler was sure his friend was dying, so he grabbed the first dose of ZMapp. With no time to put on his protective suit, he handed the drug to a doctor who was already suited up. She connected it to an IV, which delivered the medicine directly into one of Brantly's veins.

Within hours, Brantly grew stronger. However, another infected health-care worker, American Nancy Writebol, was in bad shape. Plyler split the ZMapp doses between them before both were flown to an isolation unit at Emory University Hospital in Atlanta, Georgia (*see Airplane Biocontainment Unit, p 9*). Emory is one of four hospitals in the U.S. with specialized isolation units designed for treating diseases like Ebola. ZMapp's manufacturer sent additional doses to Emory so both patients could finish treatment. A few weeks later, Plyler got great news: Brantly and Writebol had fully recovered.

Without further testing, no one knows whether ZMapp is effective in humans or if the two successes were a fluke. The San Diego, California, company that developed ZMapp is scrambling to make more doses. But the process is slow, since the antibodies are manufactured in plants that need time to grow (*see Making the ZMapp Drug, above*). Scientists are also accelerating research on other drugs and on *vaccines* to protect people from Ebola.

WORLDWIDE THREAT

West Africa isn't the only area in need of Ebola medication. Doctors diagnosed the first case of Ebola in the U.S. on September 30. The patient, who later died, was a man who'd traveled to Dallas, Texas, from Liberia before his symptoms appeared. The virus spread to two nurses who treated him. At least 17 Ebola cases have been treated in countries outside of West Africa, including Germany, Spain, France, and the United Kingdom. Health-care workers monitor anyone who comes in contact with these patients to help stop the disease from spreading further.

Meanwhile, Plyler is back in the U.S. organizing more health-care workers to go to West Africa. He hopes to return to finish the fight. "There's not a better feeling than to know that you're helping people in a desperate situation," he says.

—Jacqueline Adams

SEAN GALLUP/GETTY IMAGES (STEP 3); SHUTTERSTOCK (STEP 4); ILLUSTRATION BY KATE FLYNNOS (STEP 5); ISOSTOCK/REX USA (PROTECTIVE GEAR)