



# Between the Living and the Dead



by

**Kari Mergenhagen**  
University at Buffalo  
State University of New York

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I began my day at 8:00am, heading first to Biology class and then to English. Following a quick lunch with my best friend Jen, I went next to Biology lab, where we were learning about bacteria and viruses. I found myself totally lost in lab and realized I had better review the chapter in our textbook on bacterial viruses. It had been a long, tiring day, but after lab I headed back to my dorm determined to get in at least an hour's worth of studying.

Propped in bed, I took out *Biology: The Science of Life* and began to read about a type of virus called bacteriophage—"typically, it has a polyhedral head from which a lengthy tail extends...."

I closed my eyes, trying to imagine what a bacteriophage might look like. It amazed me that scientists could know so much about something so small. The T-4 bacteriophage was only 200nm long by 80 to 100nm wide, and it was considered to be one of the larger bacteriophages. Compared to an *Escherichia coli* bacterium, which was 3000nm long, the T-4 bacteriophage was minuscule.

Before I knew it, I had given into my exhaustion and was dreaming about the day's lab, with visions of bacteria and viruses dancing in my head....

*"Hey, Jen...wait up. I'll walk with you to lab," I called out to my best friend, who was one or two steps ahead of me in the hallway.*

*As we stepped out of the dorm, we saw that the once pleasant day had been transformed into a dismal evening, filled with a sense of foreboding. Thunder boomed ominously in the distance. I felt uneasy, as if something evil were lurking around the corner.*

*"Any idea what this lab is about?" Jen asked me, breathlessly. We had quickened our pace. It was not the type of night to take a leisurely stroll.*

*"I haven't a clue. All I know is that Dr. Phage calls this lab an experience stuck between the living and the dead—whatever that means. Why we have to go all the way to the stadium on a night like this, I haven't a clue." I pulled my coat tightly around and shuddered at the thought.*

*This was a special lab assignment. Only three students had been randomly selected to participate. I was thrilled when my and Jen's names had been called as two of "the chosen," but now, as I fought against the wind under a sky laced with lightning, I was feeling unnerved.*

*"You don't think Dr. Phage could change the weather to match the lab, do you?" Jen asked hesitantly.*

*"No, that's crazy," but I too was having some doubts about his intentions when we entered the stadium.*

*In the shadows of the darkness stood a mammoth sort of spacecraft-looking thing—straight out of a sci-fi movie. The top of it was an icosahedral shape—it had 20 sides! I later learned that this was called the capsid. Attached to this was a rod shaped tail with a retractable sheath. Strangely, the central tail core was completely hollow. At the base of the core were six long slender leggy-looking things that Matt, my T.A., said were tail fibers. At the end of the core was a spiked plate. This was Matt's second year as a teaching assistant for Dr. Phage, and his passion for biology was clearly evident in the enthusiasm and knowledge he shared.*

*Not far from this thing was another weird appearing object, held behind a glass gate. It looked like a giant bacterium, but it smelled like sewage. Needless to say, no one ventured too close, except for Paul, the third student chosen for this “special” lab.*

*“Yuuuuuuk,” Paul exclaimed. “That thing is a monster E. coli for sure. Last summer after a family reunion we all got sick from E. coli. For a unicellar organism, it sure is potent. Uncle Bob insisted that the only good burger was a rare one. I’ve never had such severe stomach cramps and then I....”*

*“Okay, okay, enough already,” Matt interrupted. “We don’t need a blow-by-blow history of your illness. Anyway, some strains of E. coli live in your intestine and provide you with vitamin K and B-complex.”*

*“If you say so,” Paul looked at Matt and shook his head, “but this E. coli was an intestinal bin Laden.”*

*We focused our attention back to the “space thing.”*

*“Hey, where is Dr. Phage? Shouldn’t he be here to tell us what to do?” Jen inquired. “And to explain this thing?”*

*“Dr. Phage got called away. Some of his paramecia got lost, and the entire lab has been turned upside down searching for them,” Matt explained. “This thing that so fascinates you guys is a T-even Bacteriophage. It’s pretty harmless to people. The host cell for this virus happens to be that E. coli over there.”*

*“Yeah, but look at the size of the E. coli compared to the bacteriophage. This virus is not only tiny, but the thing’s not even moving,” Paul argued. “Now, let me tell you, I’ve lived through an E. coli attack—it’s brutal.”*

*“Listen, guys. In this state, a bacteriophage is called a virion. It’s no more than a stationary organic particle,” Matt explained. “Why, the way Dr. Phage described it, this thing will just sit here pretty much in a dead, kind of dormant state, until an E. coli comes its way.”*

*Everyone was speechless as they stared in awe at the extraterrestrial-looking object that was actually a bacteriophage. Then, with a deafening crash of thunder, Mother Nature decided to release the full fury of her might and torrents of rain came down.*

*“C’mon, follow me,” Matt commanded.*

*Before we knew it, we were in the safe haven of the virion capsid. Interestingly, it was divided into subunits called capsomeres and basically contained only nucleic acid—168,895 base pairs of double stranded DNA, to be exact. What can I say—it was a long storm and we got bored, so we counted DNA base pairs.*

*We were discussing our predicament and how cell phones don’t work in a capsid, when we were shaken by a deafening rumble. We could feel the ground quiver beneath us. Peering through the capsid, we watched as one of the large stadium speakers smashed against the side of the glass gate. The freed E. coli glided over the storm water and bumped into one of the virion’s extended tail fibers. As if on cue, the bacteriophage was triggered into action.*

*“Hey guys, I’m outta here. This thing’s not dead. It’s moving,” Paul screamed.*

*“Hold on Paul,” Matt ordered as he grabbed him by the arm. “You wanna go out with the E. coli on the loose? Listen, buddy, you’re safer here. Calm down and watch. I think you’ll learn something.”*

*The sensors on the end of the bacteriophage tail seemed to recognize the chemical binding sites on the E. coli. I couldn’t believe what was happening. This was exactly what Dr. Phage had explained in*

lecture. He told the class that the tail fibers attach to a specific host, so the bacteriophage can only infect a bacterium for which it has a specific receptor. Before we knew it, the bacteriophage had contracted its sheath and forced its core through the cell wall of the *E. coli*. It was sort of like an injection shot.

Suddenly, Matt shouted, “Hold on for your lives! We’re about to feel what it’s like to be a syringe.”

The only thing we could grab was the DNA strand, and before we could even blink, we were injected inside the *E. coli*.

“Maaaahhhttt,” Paul whined. “Do you have any idea how sick we are all going to get...?”

“Paul, think about it. We’re inside the *E. coli*. It’s not inside of us. There’s no way we’ll get sick.”

“Matt, this bacteriophage didn’t do a thing. The inside of this *E. coli* looks very much alive, if you ask me,” Jen cried, visibly upset. “I’ve had a bad feeling about this lab all along. There’s an awful lot of activity going on. This place looks like a darn factory. There’s mRNA, tRNA, polypeptide bonds—I couldn’t understand it when I read about it, and now I have to live with it? Oh, we’re never going to get out of here—I just know it.”

“Calm down Jen. Give it twenty, maybe thirty minutes tops. A little patience, okay?” Matt tried to sooth Jen’s rattled nerves. “Jen, do you understand what the bacteriophage just did? It inserted genetic material from the capsid head into the hollow tail, and then the bacteriophage DNA traveled through the bacterial envelope into the *E. coli*. All this activity you’re seeing is the *E. coli*’s own DNA being sabotaged. This *E. coli* that we’re stuck inside is now a bacteriophage factory.”

We all sat in silence mesmerized by this process and then, as if by magic, the *E. coli* burst open and we were freed along with hundreds of newly manufactured T-even bacteriophages....

“Come on... wake up... wake up,” Jen said impatiently. “Do you have any idea how long you’ve been sleeping?! You promised to go over bacteriophages, remember...? I’ve made a list of things that I don’t understand.” Jen shoved a page of questions in front of me as I sat up and rubbed my eyes, trying to focus.

“Jen, we’ve got to find Dr. Phage and tell him—if bacteriophage can kill bacteria, maybe deadly bacteria can be controlled,” I muttered. It took me a minute to get my bearings. The dream seemed so real. But it couldn’t have been, unless I had encountered some sort of “Honey I Shrunk the Kids” machine or had hitched a ride on the “Magic School Bus.”

“Jen, don’t you remember being in the bacteriophage?” I asked, puzzled.

“Are you all right?” Jen asked with concern. “What are you talking about? Who’s Dr. Phage? We can go over this stuff tomorrow if you’re not up to it.”

“I must have dreamt everything,” I said, as I sat up and looked around the room, half expecting it to be filled with giant T-even bacteriophage.

“You sure have weird dreams,” Jen said, shaking her head. “You want to tell me about it?”

“No, you wouldn’t believe it if I did. Let’s get started, I’m sure I can answer most of your questions. I think I understand this stuff...now.”

## Jen’s Questions

1. What are some of the differences between a bacteriophage and a bacterium?

2. Why do most viruses that infect bacteria have tails, whereas most viruses that infect animals and plants do not?
3. What is the “life” cycle of a T-even bacteriophage?
4. What is the function of a virion?
5. Describe the structure of a T-even bacteriophage.
6. Could bacteriophage be used to combat bacterial diseases?
7. What type of energy is required for new bacteriophages to be assembled?
8. How many tailed bacteriophages are there, and where are they located?
9. Why are viruses not classified as living?
10. Are bacteriophages harmful to people?

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*Note: Once you’ve reached the site, click on “Begin” and then choose “How Do They Function?”*
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