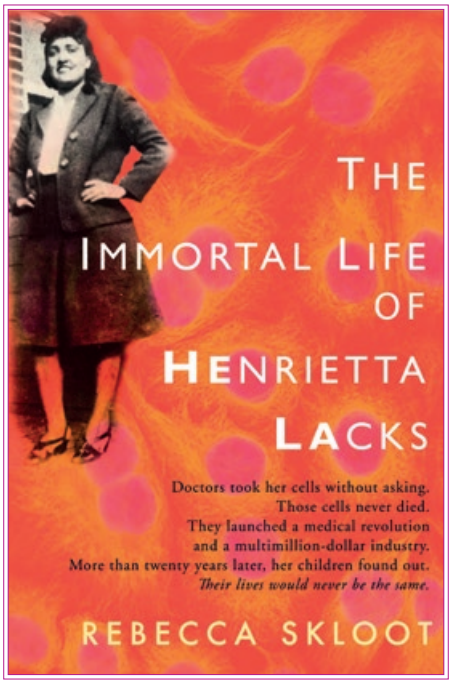
By Tereza Pultarova

HeLa Cells: Immortal Space Travellers



Rebecca Skloot revealed the whole story behind the HeLa cells in her bestselling book "The Immortal Life of Hernietta Lacks." – Credits: Manda Townsend

It was early April 1961. As 27 year old Yuri Gagarin and 26 year old Gherman Titov were getting ready for the historic first manned spaceflight, still unaware of which of them would be chosen to fly first, a team of microbiologists from the Institute of Experimental Biology of the Soviet Academy of Medical Sciences were keen not to miss this excellent opportunity. The upcoming event meant they could send some new experiments into orbit and start answering the question: what effect does space environment have on cells and tissues? It was not simple scientific curiosity driving them. Everyone involved in the nascent space program was aware that such information would be vital if any future long duration exploration and maybe even colonization of outer space by humans were to be considered.

Among the samples they prepared for the journey were cultures of bacteria Escherichia Coli and human cancerous cells known as HeLa. Despite the reality of the Cold War, the team led by microbiologist N. N. Zhukov-Verezhnikov had acquired vials of HeLa cells from their American colleagues several years earlier. In fact, these cells made it to space prior to Gagarin, as they were on board the satellite Korabl-Sputnik 2 in 1960 [1].

HeLa cells were known since 1951 when George Gey, a scientist from the John Hopkins University Medical Center in Baltimore, US, managed to turn tissue taken from a cervical tumor of a 30 year old African American woman into the first immortal line of human cells.

First Cells to Survive in Lab

George Gey was the head of tissue culture research at Hopkins. He aimed his scientific efforts at keeping human tissue cultures alive indefinitely. Such a line of cells would be continuously dividing and replenishing itself. The cell line, descending from one original sample, would never die, and each generation would be identical to the previous one, making it a perfect standardized subject for scientific research in human microbiology. By 1951, each of his attempts had failed.

That year, cervical cancer expert Richard TeLinde approached him and both men started working together. TeLinde's goal was to compare cellular characteristics of healthy cervical tissue with those of carcinomas in different stages of progress, in order to see whether the more invasive tumors differ from the less invasive ones on a microbiological level.

The deal was that TeLinde would supply Gey with tissue samples of patients his colleagues were operating on and Gey would culture them. Among the tissue samples that landed in Gey's laboratory in 1951 were two taken from a 31 year old African American woman named Henrietta Lacks – one containing healthy cervical tissue, the other one a tiny piece of her cervical tumor.

While the normal cells didn't survive long, those taken from the cancer began dividing at a remarkable rate, doubling every 24 hours. They weren't merely surviving, they were thriving! Soon, George Gey knew he had achieved a break through success – he had created the first ever immortal line of human cells! Taking the first two letters of the donor's first name and surname, the scientist named the cell line HeLa. Within months, Gey's team started growing HeLa cells in large quantities and distributing them for free to every researcher who expressed interest; a new era of breakthroughs in cellular biology commenced.

Who knows whether George Gey realized that the woman whose cells enabled him to achieve the greatest highlight of his career died that very same year. As super-fast as the cells were propagating in culture, cancer was spreading in Henrietta's body.

> These cells made it to space prior to Gagarin

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She died without knowing that she entered science history books, her identity only revealed to the general public more than two decades later. In the 1950s, a patient's consent to provide tissue for scientific purposes wasn't needed and so Henrietta, as well as her family, was completely unaware that she had donated to science. Perhaps, she wouldn't even have understood.

Henrietta Lacks

Mother of five, Henrietta was an illiterate descendant of slaves. She was born and raised at the same Virginia tobacco farm where her captive ancestors used to live and work. According to available sources, she was one of ten children of Eliza and John Randall. Her mother died when Henrietta was just four years old, while giving birth to her youngest sibling.

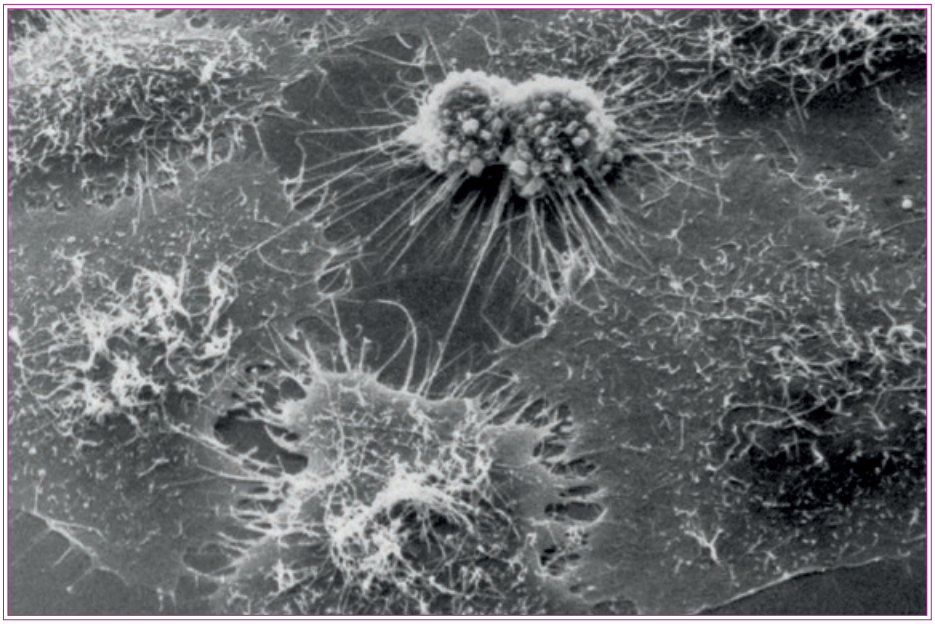
After Eliza's death, John Randall felt incapable to look after his large family. He took the children to Clover, Virginia, and left them with various relatives. Little Henrietta ended up living with her grandfather.

In 1941, she married her cousin David Day Lacks and later moved with him and their two eldest children to Maryland. Three more children followed during the next ten years, with the youngest one being born only four months before Henrietta was diagnosed with cancer.

It was January 1951 when she decided to go to the John Hopkins Hospital, the only medical facility in the region that treated African Americans. After giving birth, she started experiencing unusual bleeding. Her doctor discovered a small tumor on her cervix and prescribed a treatment with radium tubes. During a surgical procedure when the tubes were inserted, the surgeon also removed those two small tissue samples that were sent to the laboratory of Dr. George Gey.

In spite of the treatment, her condition was deteriorating rapidly. In August, she was admitted to and remained in the hospital until her death two months later. The post-mortem examination revealed that cancer had managed to spread throughout her body.

While her family was burying her body in an unmarked grave in her hometown of Clover, Virginia, scientists in the John Hopkins Hospital were already sending vials with her cells to researchers working on a polio vaccine. By 1954, these cells were being commercially mass produced and sold to scientists around the globe.



Electron microscopy image of HeLa cells dividing. – Credits: National Institutes of Health

Cells of Henrietta Lacks made it to space almost a year before Yuri Gagarin, here pictured during a 1964 visit to Malmö, Sweden. Credits: Sydsvenskan

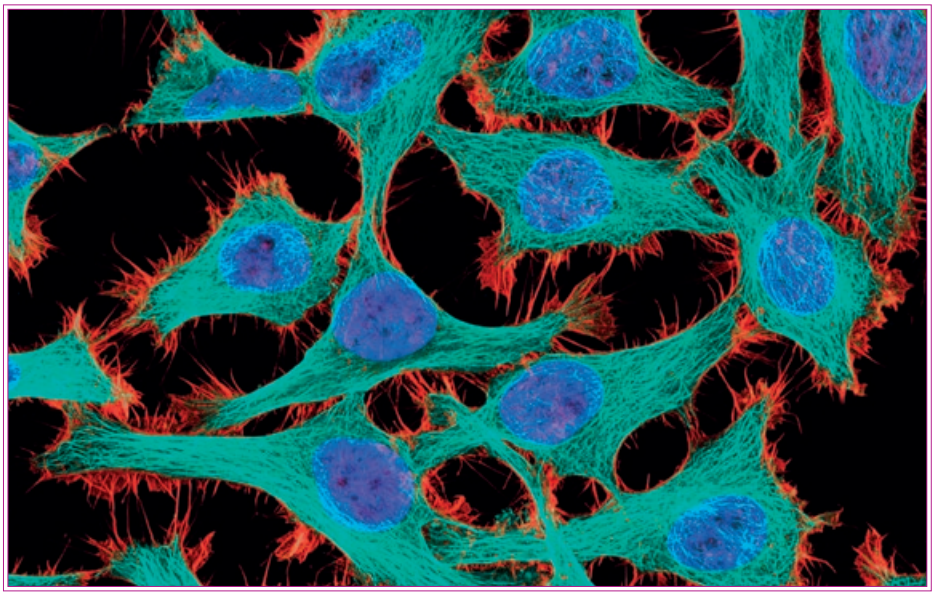
Medical Breakthroughs

Polio vaccine, research into cancer, AIDS, virology, effects of radiation and toxic substances, gene mapping – HeLa cells enabled researchers worldwide to push the frontier of human cellular biology a giant leap forward. According to Rebecca Skloot, author of the critically acclaimed 2010 book "The Immortal Life of Henrietta Lacks," more than 60,000 scientific articles have been published about research performed on HeLa cells.

Though today they are not the only immortal human cell line available, HeLa cells are still massively popular. It was on HeLa cells that scientists first examined human cell division in detail. These were the first human cells to be cloned, the first to enable accurate calculation of chromosomes, first to be centrifuged, to travel under the sea and into space. In 1965 scientists fused these cells with mouse cells and created the first cross-species hybrid. Remarkable achievements were made possible thanks to a woman who herself wasn't even able to write.

HeLa Cells in Space

When Yuri Gagarin successfully completed the first orbit and landed safely in Saratov, the USSR celebrated the glorious triumph over ▸▸



This 2-photon fluorescence 300x image of HeLa cancer cells won 12th place at the Nikon Small World 2011 competition. - Credits: Thomas Deerinck and Mark Ellisman, NCMIR, UCSD

their rival in the space race, the United States. The small container with cells of an unknown American woman was probably of interest only to Dr. Zhukov-Verezhnikov and his colleagues.

As Gagarin's flight lasted merely one hour, no special effects on the viability, proliferation, or morphology of HeLa cells were observed post-flight. Some interesting information started showing up later on, after the cells hitched a ride in 1962 on Vostok 4, in 1963 on Vostok 5 and 6, in 1964 on Voskhod 1, and on Zond 5 in 1968. Some discrepancies occur in the publicly available data from these missions, though.

Rebeca Skloot claims in her book that what space researchers found "was disturbing: in mission after mission, noncancerous cells grew normally in orbit, but HeLa became more powerful, dividing faster with each trip." However, as pointed out by Ari N. Schulman in an article entitled "What is the body worth" published in The New Atlantis, the results were not all that straightforward. Based on the information available in a Soviet paper published in 1964 and Katherine J. Dickson's "Summary of Biological Spaceflight Experiments with Cells," it seems that even though there were several cases when the proliferation and viability of HeLa cells increased after spaceflight, there was a similar number of occasions where these properties were unchanged or even decreased.

This of course doesn't belittle the importance of the first immortal human cell line to take flight in the history of space microbiology.

> "Mission after mission, HeLa became more powerful, dividing faster with each trip"
>
> R. Skloot

Some sources suggest that HeLa Cells were also on board of the 1960 US satellite Discoverer 18, but no significant effects were observed post flight.

Ethical Issues

When journalists started inquiring about the origin of the HeLa cells, they were frequently given false clues. The woman who provided the tissue was claimed to be called Helen Larson or Helen Lane. It was only in 1973 when Henrietta's name was leaked to the press. At that time, the Lacks family was still living in complete poverty in Baltimore and southern Virginia. Despite the fact that the biotechnology industry had made billions from the cells of Henrietta, the Lacks weren't even able to afford health insurance.

In fact, the only time when researchers actively reached out to the Lacks was to ask them to donate blood for genetic testing. The dangerously viable HeLa cells, being able to survive on gloves, hands, dust particles, or unsterilized laboratory equipment, had contaminated other cellular cultures and researchers wanted to find genetic markers to help them sort out the HeLa cells from the rest.

Exposing the background of the story initiated a broad public discussion about patients' rights and ethics of tissue research and business. Despite certain controversy, the family has never been offered any compensation.

In 1970, George Gey, the man who created the first immortal human cell line from the cervical tumor of Henrietta Lacks, was diagnosed with pancreatic cancer. According to Rebecca Skloot, he asked the surgeons who were scheduled to perform a procedure to remove his tumor to cut out a small piece of the cancerous tissue from his liver. His wish was to create his final immortal legacy – a cell line cultured from his own cells. But that wish was not fulfilled. After cutting open his body, the doctors discovered that cancer had already spread to the lymph nodes, lungs, and heart. It was too late for him; no operation could have saved his life. To Gey's great chagrin, the doctors didn't take any tissue sample. He entered the history books, but wasn't allowed to live on as a part of the research to which he had devoted his whole life. This privilege was meant to stay with Henrietta.

[1] Dickson, Katherine J. 1991. Summary of biological spaceflight experiments with cells. ASGSB Bulletin 4(2):151-260.

Astronaut Frank de Winne works with the cell biology experiment facility in the Japanese laboratory KIBO. – Credits: ESA