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THE CENTER OF VACCINE CONTROVERSY: WI-38 CELLS

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The sharp smell of disinfectant permeates the air, the shiny white walls reflecting glaring fluorescent lights. Patients lie in sickbeds, and cap-wearing nurses buzz around the room. It's the 1940s, and the air sparkles with anticipation. Machines hum, with nurses and doctors bustling around patients lying in beds. All of a sudden, the lights flicker. The power has gone out! The machines stop their cheery tune, and an eerie silence hangs before the panicked cries of hospital workers ring in the air as they rush towards the floor containing iron lungs, where they frantically pump the bellows to manually work the machines.

But why the urgency and frenzy? What was so important about the iron lungs?

Laying within these large machines were patients infected with polio – a disease the caused detrimental paralysis in the appendages and lungs of its victim's body. Iron lungs were engineered to imitate lung movement and breathing, as the patient's lungs were too weak to function on their own.

Today, polio, alongside smallpox and measles, is on the verge of global eradication, with the United States being one of the many countries that have successfully exterminated the disease. Families can enjoy a life free of deadly illnesses that once immobilized and killed millions of infants, children, and adults. Society can enjoy a life free from fear of loved ones being snatched away from them in the blink of an eye.

But the world wasn't always free from the dark clutch of disease. Before the age of technology propelled the rapid advancing of modern medicine, there was not a family left unscathed by sickness. In most families, only a small handful of children would survive to adulthood. The 1800s reports a morality rate of 46.3%, and the 1950s reports a 21% from 1950-

1955 for children under five years (O'Neill, 2021, UN Dept. of Economic and social Affairs, 2019). Those who survived the odds would have encountered typhoid, measles, dysentery, or cholera, to name a few, emerging from adolescence with lasting scars and disabilities telling their stories of struggle and triumph. The spread of deadly diseases caused life expectancy to remain consistently low. In fact, 19th century life expectancy never rose above forty years old (Shaw-Taylor, 2020). Without proper preventions or cures and only superstitions, charlatans, and home remedies, anyone could be subject and exposed to a deadly disease.

In summary, disease has been around for as long as anyone, presently and historically, can remember. Today, we have developed extensive measures to combat the spread of illness, such as better septic systems, strict medical procedures, and an increase of hygiene awareness. But perhaps the strongest weapon that has been developed to fight disease is vaccines. Vaccination has been around for quite some time, first developed in the early 1600s, then progressing throughout the 20th century. However, vaccines were not popular, as they were new technology at that time, missing many crucial pieces that were yet to be discovered to improve its use.

As I began my research, I came across the topic of fetal cell vaccines. These vaccines are the source of much controversy, as they have been grown from a cell line harvested from an aborted fetus. When I first heard of these vaccines, I wondered if these cells were truly necessary to manufacture these controversial vaccines.

The most common cell line used is called WI-38, the main cell line that this paper will focus on. This cell line was harvested back in the 1960s, and research has taken me back to the 20th century to explore and study the race for a vaccine that would save millions of lives to this very day. The WI-38 cell line is indeed a source of controversy, yet these cells were necessary to

create the first safe and usable vaccines, and should be continued to be used to vaccinate children and infants today.

Background

To understand the importance of vaccines, let's take a look at diseases. In the Middle Ages, Bubonic plague, yellow fever, smallpox, amongst other diseases, devastated the population. The Black death itself killed 25 million Europeans, about one out of three people (Encyclopedia Britannica, 2021). Scores of native tribes in the new world were massacred not only by human invaders, but microscopic passengers who traveled across the Atlantic: sickness. During the industrial revolution, poor living conditions in overcrowded homes infested with cholera and scarlet fever led to thousands of deaths. Tuberculosis was reported to be responsible for 15% of deaths in Britain from 1848 and 1872 (Shaw-Taylor, 2020). Limited information and knowledge held people back, causing uncertainty in how to handle epidemics.

Now, specifically, what is a vaccine? According to the CDC, a vaccine is "preparation that is used to stimulate the body's immune response against diseases" (CDC, 2022). Most often made from weakened or killed viruses, vaccines stimulate the body's immune system to prepare for future infections. Vaccines are actually a targeted, specific method of diseases prevention. The beginning of vaccines is marked by the development of inoculation, or variolation, which preceded the first vaccines. This method was used widely throughout the 17^{th}-18^{th} centuries, specifically to combat smallpox epidemics, in which patients were infected directly with live smallpox (Haelle, 2018, p. 30).

The first vaccine, or more accurately, inoculation, was first studied by Edward Jenner. Jenner had overheard milkmaids discussing a certain curiosity: after contracting cowpox, the

girls seemed to be immune to smallpox. Eager to test out this hypothesis, Jenner then took swinepox-infected pus, a virus similar to cowpox, and injected it into his son through a small cut. After the boy recovered from the initial variolation, Jenner proceeded to infect him with smallpox, who did not develop any symptoms or infections of the sickness. Wanting to further this intriguing discovery, Jenner then performed this procedure in the arm of his gardener's son, who recovered with only a mild fever. Jenner had laid out the pathway for modern vaccines (Haelle, 2018, p. 31).

Another milestone in vaccine development can be found in Louis Pasteur, who developed a vaccine focused on rabies. Taking live rabies virus from a rabid dog, Pasteur injected the rabies sample into a rabbit, slightly weakening the virus. He then harvested the rabbit's now-infected spine, injected it into an uninfected rabbit, then repeating the process twenty times. The strength of the virus was chipped away each time the virus was passed on, until the pathogen was deemed safe to inject into the human body. This method of vaccine development is called "passaging" (Haelle, 2018, p. 33).

There are many types of vaccines, the most prevalent being weakened or killed vaccines. The former uses only live weakened pathogens and the latter utilizes completely inactivated virus or bacteria. Pasteur's vaccine is an example of a live vaccine. Weakened viruses cause an immune response from the body, but not enough to sicken the person too much. This method is used most commonly in the mumps or chickenpox vaccines (Feemster, 2008, p.8). Killed, or deactivated virus, are incapable in reproducing within the human body, but can still stimulate a response from the body's immune system. Other types of vaccines include recombinant (DNA), toxoid, or Messenger RNA (mRNA) vaccines, the last making its debut with the FDA's Emergency-Use Pfizer's COVID-19 vaccine (*HHS.Gov*, n.d.). There is still much research going

into improving vaccines and ensuring they are safe and up-to-date for the general population to use.

The CDC provides a complete suggested schedule for vaccination for children from birth to adulthood, covering vaccines for illnesses such as polio, influenza, measles, and varicella (CDC, 2022). By following the vaccine schedule, families can ensure not only their children's health, but the safety of the people around them. The idea behind this methodology is called herd immunization – vaccination is administered individually, but when communities work towards raising immunization rate, a majority of individuals are protected, preventing transmissions rates from becoming too high. Herd immunization ensures the health and safety of the whole community.

The story of infectious disease is intricately woven into history, and each story of the fight against disease reflects the perseverance of mankind's quest for health and safety. However, while the subject of vaccines and its history of disease combating is quite fascinating, this paper will focus specifically on the vaccines produced from aborted fetal cells, and center on the diseases that they have been used combat.

Polio

First recorded hundreds of years ago, poliovirus is described as "an enteric (intestinal) infection, spread from person to person through contact with fecal waste: unwashed hands, shared objects, contaminated food and water" (Oshinsky, 2005, p. 8). Polio epidemics were furious and merciless, with rivers, lakes, streams, septic systems, and public swimming pools being breeding grounds for the virus, especially in the summer. One of the most famous polio

victims, President Franklin D. Roosevelt, contracted polio after an afternoon swim at his summer lake house (Bookchin and Schumacher, 2004, pp. 1-3).

Before improved medical practices, poliovirus caused paralysis that was often irreversible and potentially life threatening. The CDC reports an average of 35,000 cases in the late 1940s (CDC, 2021). Certain polio caused damage to the brain stem, rendering the breathing muscles useless (Oshinsky, 2005, p. 9). This polio was the most dangerous, and overall polio accounts for a mortality rate of 2%-5% in children, and 15%-30% in adults (History of Vaccines, 2018).

The first polio vaccine was produced by Jonas Salk, a star researcher in the rising virology department. Salk used monkey kidney cells, a material favored by researchers at the time, as a host for polio. Using formaldehyde, a colorless and pungent gas, as a deactivator, Salk was able to kill off the polio virus within the sample, effectively bringing a new vaccine into a market that millions of people were desperate for. In the summer of 1954, after Salk's vaccine was approved for manufacturing and distribution, two million children in grade school were vaccinated with this new polio vaccine, marking the beginning of a new chapter of preventive vaccines (Bookchin, 2004, p. 41).

Things were seemingly looking bright for Salk's vaccine. However, the story does not end here. In 1955, year after Salk's vaccine was widely circulated administered to millions of children and adults, reports of vaccinated children with headaches, numbness, and inability to move their legs began popping up in hospitals across the U.S. In California, a total of six children were admitted into the hospital and confirmed to have polio within ten days of receiving their polio shots. Frantic parents pleaded with doctors to fix their children, but nothing could be done. Polio was irreversible. These children were cursed with the very calamity that Salk had

fought to protect them from. As polio is a high contagious disease, this disaster exploded into an epidemic. By the time the dust settled, Salk's vaccine had killed five Americans and paralyzed another 113 (Haelle, 2018, p. 37). Labeled the Cutter incident, Salk's vaccine was unsurprisingly pulled from shelves and essentially forgotten, and researchers continued to struggle in finding a proper method of vaccine development that would prevent the same disaster that endangered millions of Americans. But while scientists struggled with polio, a new danger arrived in the summer epidemics of the 1950s: rubella.

Rubella

Steve and Mary Wenzler were a joyful couple, both working as school teachers in Toms River, New Jersey, a rapidly growing town overflowing with school children. In 1964, during the peak of a rubella epidemic, Mary came down with a fever and a rash on her face, and after a trip to the doctor, was told she was infected with German measles. She recovered quickly, and about a month after her contacting rubella, her local family doctor revealed joyful news to the couple: Mary was expecting.

However, when Stephen Joseph Wenzler IV was born, hospital staff noticed that Stephen's pupils were white and milky instead of a healthy black. An ophthalmologist told Mary that her baby had cataracts in both eyes. Even after surgery removed Stephen's cataracts, his vision was extremely poor. As a young child, his vision was 10/200 with glasses on. To put this in perspective, Stephen could only see at ten feet an object a person with 20/20 vision could see two hundred feet away (Wadman, 2017, p. 185). Later on, it was realized Stephen was deaf, and also had serious heart complications.

Scores of children born during the mid-20th century, especially during rubella epidemics, had similar birth defects. It was discovered that the children infected with “congenital rubella syndrome”, or CRS, had mothers that contracted rubella during their first or second trimester of pregnancy. Latin for “little red”, rubella virus is only fifty to eighty-five nanometers in size, almost a thousand times smaller than the human cell, yet its effects on developing children were devastating. Infection in the mother begins in the nose and throat, then travels down to the placenta, infecting the growing embryo. The effects of CRS were less obvious than those of polio, rather they attacked the inner workings of the eye, ear, and heart, preventing the child’s crucial organs from growing normally (Wadman, 2017, p. 148). Meredith Wadman accurately summarizes this by writing “Rubella, an exclusively human virus no more than three millionths of an inch in diameter, was, it was at last quite plain for all to see, a menace to life in the womb.” (Wadman, 2017, p. 138).

The first vaccine efforts for rubella were headed by Merk & Co. Inc., a pharmaceutical company. They had begun early on in their research with a killed virus vaccine, but failed. Later in the 1960s, Merck tried once again, this time led by Maurice Hilleman, which grew weakened rubella in green African monkey cells and duck embryo cells (Wadman, 2017, p. 152). At the same time, researchers Stanley Plotkin and Philip Roxanne also began rubella vaccine. Roxanne’s vaccine was grown in dog kidney cells (Wadman, 2017, p. 232). Plotkin, on the other hand, opted to grow his vaccine through a fetal cell line instead. However, Merck’s duck vaccine and Roxanne’s vaccine were soon revealed to be dangerous, with numerous side effects and an overall lack of effectiveness.

Both the polio and rubella vaccines failed spectacularly; the vaccines failed to combat the diseases they were developed for, even worsening the situation and endangering thousands of

people. Scientists struggled in the race to develop vaccines without dire side effects. Right around the mid-1960s, however, Wistar Institute would raise a new vaccine contender that would forever change the course of vaccine development: WI-38 cells.

WI-38 cell line

In 1963, Swedish mother "Mrs. X" sought several doctors and surgeons for an abortion. Abortion had been legalized in Sweden in 1938, under strict stipulations, such as cases of rape or incest, or a possibility that the child could cause serious harm and damage to the mother. However, if a woman were able to convince two doctors to perform an abortion, she would be granted one (Wadman, 2017, p. 87).

The fetus taken from Mrs. X's abortion was sent to virologist Leonard Hayflick, who worked at the Wistar Institute of Anatomy and Biology, a lab well known for its founding family, which included Caspar Wister, a physician who wrote the U. S's first anatomy textbook (Wadman, 2017, pp. 27-28). During his research using fetal cells, Hayflick found that these cells were able to divide and multiply at extraordinary rates for an extended period of time. He pushed ahead in his research, hoping to utilize these cells for more versatile research purposes. Thus began the long journey and history of WI-38 cells and its controversial vaccines today. The cell line grown from the original has continued to be used in the varicella, rubella, hepatitis A, and a rabies vaccine today (Feemster, 2018, p.15).

Why WI-38 Cells?

Versatility and Abundance

Now that a complete background has been established, it is time to explore why these cells are so crucially needed today. As mentioned earlier, Hayflick spent much time studying and

perfecting his usage of the WI-38 cell line. Beginning with just a small amount of WI-38 cells, Hayflick discovered he could fill one beaker, then two, four, sixteen! The cells seemed to be dividing at an almost infinite rate, able to produce trillions of cells from one single fetus – an astonishing feat that no other cell – even adult humans – could possibly achieve.

After recording this amazing feat, Hayflick sought a way to preserve these cells. He transferred these cells to small bottles, placing them in a freezer for preservation. When he later retrieved and thawed the cells in the following weeks and months, he was astounded that the cells continued to multiply at the same rate. In fact, WI-38 cells are still in use and multiply to this very day, almost sixty years later. WI-38's exponential growth proves it to be incredibly versatile in its usage. According to Hayflick, just the floor of a pint-sized bottle containing about ten million cells in population could produce 10^{22}, ten sextillion, cells after they'd split fifty times. With only a pint of these cells at 14.2 billion cells an ounce, the cells could amount twenty-two million tons of cells (Wadman, 2017, p. 89).

Although this is only a theoretical maximum, requiring extreme care of the cells to attempt to replicate Hayflick's calculation, this is still an unbelievable number – one impossible to comprehend. For vaccine rates, especially, this number opens the doorway for innumerable possibilities. Meredith Wadman (2017) writes, "One way to think about it is this: the freshly harvested W1-38 cells covering the floor of just one of Hayflick's pint-size Blake bottles, expanded until they have doubled roughly twenty times, would produce 87,000 times more vaccine than is made by a typical vaccine-making company, setting out today to make one year's worth of a typical childhood vaccine that will ship to more than forty countries" (p. 89). The sheer number of cells that one fetal cell would be able to support the production of vaccines for millions of people for decades (Wadman, 2017, p. 89).

Compared to the other methods of producing vaccines, such as monkey kidney cells or liquified rabbit brains, fetal cells are the most abundant. Just one cell line allows millions of vaccines to be produced – not just for a single generation – but for generations on. These frozen cells still divide and reproduce at the same rate when thawed. They could also be shipped to thousands of scientists for hundreds of purposes, allowing many possibilities for the health research field. The usage of this cell line is much more common than anyone could have ever imagined, and the benefits that these cells have offered to society are incredible.

Using this cell line also eliminates the overuse of other outside sources. When developing the first polio vaccine, for example, monkey kidneys were used. Hundreds of thousands of rhesus monkeys were imported annually from Asia, where their organs were harvested and used for research. In 1955, it was recorded that two hundred thousand rhesus monkeys imported for research purposes, with Salk's lab reporting to have used about 50 monkeys weekly (Bookchin & Schumacher, 2004, p. 33). This only shows the minimum demand for rhesus monkeys. These monkeys were in such high demand that they were considered endangered at one point. Even with such high numbers, the kidney cells might not have even produced the hoped-for amount for general public distribution. But by using just one cell line, research has lasted for sixty years, reducing the thousands of animals needed for vaccine development.

WI-38 cells also serve as a better growth medium for vaccines because they are, of course, human cells. These cells react the same way normal human cells do, mimicking natural infection and providing a healthy environment for the virus to grow in. This method allows scientists to identify potential dangers in virus growth, eliminating any potential harms lurking in animal cells. According to Hayflick, Plotkin, and other researchers who worked with the WI-38

cell line, "The human diploid cell strains have also been shown to support the growth of almost all human viruses so far tested […]" (Hayflick et. al, 1961).

WI-38 cells are an abundant resource that science has utilized. Without these cells, the vaccine field would have continued to struggle finding proper sources to develop these vaccines, endangering millions of children each year. With an almost infinite supply, this single cell line has and can save lives for years to come. Being incredibly diverse in their purposes, WI-38 cells fill the empty void of vaccine development, further proving their necessity in epidemiology.

Safety

Now the most important aspect that must be studied when comparing the WI-38 cell lines: safety. Today, there is a long process before a vaccine can be approved for standard use. The FDA must first approve of the vaccine, then the vaccine is sent to be developed and tested on animals in labs. Once deemed safe, the testing then moves onto clinical trials on volunteers that the FDA also regulates and monitors. Finally, if the vaccine is licensed, they are monitored after distribution for any additional side effects (FDA, 2011).

However, this was not the case when the virology field was first expanding – there were few regulations in place, and whatever rules there were overlooked for the sake of the vaccine production speed and quantity. People were desperate for protection against deadly disease, and this desperation caused a serious oversight in safety protocols. This can be seen in the Cutter's incident, which occurred soon after Jonas Salk released his polio vaccine. Cutter's manufacturers grievously bypassed the steps to ensure polio was completely inactive before distribution.

The struggle with vaccines was mainly centered on the incorrect use of dangerous animal cells and growth mediums. The problems began with the use of formaldehyde. Salk had begun

his vaccine journey by discovering the virus could be deactivated by this pungent chemical, yet it proved to be less effective than he and other scientists had originally thought. This discovery caused hundreds of vaccine batches to be contaminated and therefore dangerous to distribute. Hundreds of Americans were infected with poliovirus, and thousands more were exposed.

Secondly, problems surrounded the host that was used. Debbie Bookchin in her book "The Virus and the Vaccine" covers the story of the polio vaccine disaster. As established earlier, monkey kidney cells caused near extinction of rhesus monkeys that were imported annually from Asia; however, there was a more serious problem overlooked in the usage of those kidneys. Rhesus monkeys were known to be aggressive and had a temperament. In 1938, bacteriologist William Brebner was bitten by a rhesus and experienced paralysis, first from his legs, then his upper body. He passed away seventeen days after the initial bite, choking to death (Bookchin & Schumacher, 2004, p. 33). Other researchers, after being scratched or bitten, also developed paralysis in their limbs, and eventually the death toll was accounted to was twenty-three (Hayflick, 1972).

Kidneys are a major component of the urinary system, cleansing and balancing the endocrine system. Their function is to clean and dispose of bodily waste, filtering salt, potassium, and other excessive minerals to balance their concentration in the body (NIDDK, n.d.). This makes kidneys a breeding ground for bacteria and other pathogens that pose potential dangers to the human body. By 1953, most scientists had begun using monkey kidneys almost exclusively for vaccine development research. While it might seem like careful thought was put into what should be used to grow these vaccines, the only reason, it seems, that kidneys were used in the first place was because they were accessible from dissection cuts and very easily removed from the body (Bookchin & Schumacher, 2004, p. 30).

It was discovered that these monkey kidneys were infected with Simian virus (SV-40), a virus that caused a cytopathic effect (CPE) within its host cells. CPE causes a change in cell structure, enlarging or causing vacuole effects, warping the cells from their original form. CPE infection also causes genetic and physiological changes, leading to harmful altercations within the host cell (Albrecht et. al, 1996). In lab samples, instead of growing smoothly on beaker and test tube walls, infected cells would clump up or splay thin streaks on the sides of the container. Live polio virus was able to hide within the clumped cells and avoid formaldehyde deactivation.

Scientists were less than concerned about this strange animal virus, christened virus B. However, despite their confidence in formaldehyde, SV-40 continued to be a harmful aspect of the monkey kidney cells. Scientists soon discovered that SV-40 was an oncogenic DNA virus, meaning that it had a possibility of causing cancer in its host cells. According to research, SV-40 infects both animals and humans, and is today specifically associated with primary brain and bone cancers, and lymphoma (Vilchez and Butel, 2004).

The rubella virus vaccine fared no better. Both Merck's duck vaccine, labeled HPV-77, and Roxanne's vaccine presented similar problems, though not as dire as Salk's polio vaccine. After an initial trial, it was reported that the 57% of women who received the vaccine developed rashes and suffered joint pain and swelling in their fingers, ankles, toes, wrists, and knees, two of which were in so much pain they were given steroids. Live rubella virus was found in fluid gathered from one volunteer's knee. Roxanne's vaccine produced similar concerns, with 56% of the volunteers' joints either swelling or causing pain. Plotkin's vaccine, on the other hand, displayed none of these side effects. For his test trial, he vaccinated sixty-one student nurses in Philadelphia hospitals, and none of them developed any of the side effects that Merck's and Roxanne's vaccines did (Wadman, 2017, p. 232). Merck's vaccines were dropped from

production, and Merck later turned to using Plotkin's rubella vaccine, using WI-38 cells to manufacture rubella vaccines to this very day.

Compared to the usage of animal cells, WI-38 cells had almost no complications at all. These cells were less passaged than the originals, and offered more possibilities in developing safe vaccines. According to Hayflick, Plotkin, Koprowski, and other researchers developing early vaccines, the cell line showed no signs of infection or irregularities for virus growth, unlike the monkey kidney cells used for polio (Hayflick et. al, 1961). The WI-38 cell line supported and was able to replicate human infection, while being able to avoid the safety hazards of using animal cells.

The Case Against WI-38 Cells

Vaccines made from the WI-38 cell line continue to be a source of controversy to this very day. There are many who object to these vaccines because they are developed from aborted fetal cells, insisting that there are alternatives to the research surrounding the vaccine development. Common arguments stem from the possibility of other methods of growth mediums, such as duck embryos and egg whites, which are commonly used in annual flu shots. After all, since there are so many different types of vaccines, surely there must be an alternative to using this cell line. However, one has to consider virus variation – each causes different responses in the human body. Each pathogen behaves differently; therefore, a separate approach must be taken to combat it. Kristen Feemster (2018) puts it best when she writes, "The ultimate goal is to produce antibodies that are specific to the pathogen but will not attack healthy cells in the body. These antibodies also need to target the right parts of the pathogen […]" (pp. 9-10). For example, a flu shot is developed differently from a rabies vaccine because of the different effects each virus triggers in the human body. Growth sources are extremely important when

developing vaccines that are safe and usable for the human body, especially if the materials used are foreign to the human body. Usage of animal cells raises potential concerns about lurking unknown pathogens, such as can be seen in the case of virus SV-40.

Another point to keep in mind is that the usage of fetal cells contributes to a solid foundation for virology. Because WI-38 cells are human cells, infection can be mimicked perfectly, giving scientists the opportunity to study and produce research that otherwise cannot be found using animal cells. Even using adult human cells can be risky, as there are bacteria and viruses that pose a threat to young children and infants who are given these vaccines. Using fetal cells provides a safer option for research to be conducted, as scientists can use knowledge related directly to a human's reaction to a pending vaccine.

Finally, let's address the topic of abortion. The basis of vaccine controversies centers on the argument that babies were aborted for the vaccines. People refuse to be injected with the cells of a fetus. I first want to point out that I believe that abortion is unbiblical and unethical. Abortion is a murder of an innocent human being, one that has not been given a chance at life, a chance that has been granted by God. Abortion procedures themselves are truly horrific, and this paper was not written for the purpose of supporting this act. I truly believe that God has created every human being in His image, for a purpose on this earth. Abortion is an act of taking a life prematurely, an atrocity that causes many to feel convicted about taking the vaccines that were developed, or researched with the WI-38 cells.

Mrs. X sought an abortion not for the purposes of research, nor was she involved in its research usage. WI-38 cells were harvested and used by the scientists themselves, who then utilized the cell line for research purposes. In addition, the cells used today are extremely distant from the original fetus. These cells have been preserved and grown in labs, far away from the

original abortion procedure. The cell lines themselves do not contain direct links to the original fetus, being thousands of generations away from the originals. In addition, the vaccines themselves do not contain the cells. They were a tool used in the development. Viruses were grown within the cells, and the infection kills the host cells. The infected cells are then filtered and processed so only the deactivated virus remains in the vaccine, which contains only minimal DNA residue.

Again, these cells are resource that science has utilized, used in labs to find ways to improve human health. Over the course of sixty years, this one cell line has saved millions. Because of the WI-38 cells, parents can live without the looming fear of diseases that threaten children's lives. Taking the vaccine is not participating in this act of sin – an event that occurred over sixty years ago. If each individual was vaccinated and protected from deadly disease, it would allow a dramatic increase in society's overall health.

The presence of these cells cannot be completely removed from society. Usage of the WI-38 cell line is more common than many might realize. Today, Tylenol, tums, and other common medicine has been tested and developed on fetal cells. The truth is that the use of fetal cells is very much ubiquitous, integrated into society in more ways than we might imagine. It would be difficult to completely remove the presence of these cells. They have been an integral part of society, sitting in our pantries and stocked at drug stores, groceries, Costco – lying in aisles we frequently pass by. Simply put, the usage of WI-38 cells is much more widespread – these cells are far removed from the original cells, and have continued to be used in life-saving vaccines.

Conclusion

Throughout history, sickness and disease have ravaged families and robbed them of their loved ones. But with the development of vaccines, millions of lives have been saved – countless families have been saved from the heartbreak and hardship of burying a family member. WI-38 cells have become a basis of vaccine research for human disease. Their versatility and abundance offer endless possibilities for research and studies, and because they are human cells, they provide a solid foundation for scientists to study and determine solutions to diseases. The cell line's use has continued to develop vaccines that have been administered to children and adults to this very day, with its amazing ability to continuously multiply even after sixty years. Secondly, WI-38 cells are able to cultivate samples that are free from dangerous pathogens lurking in animal cells. The safety that WI-38 cells offer cannot be overlooked.

Today, polio has been eradicated from the United States, the last known case directly originating from the U.S in 1979 (CDC, 2022). Rubella also has virtually disappeared from American shores, with surfacing cases related to only foreign parents. Today, Merck company is in charge of producing the MMR (measles, mumps, and rubella) vaccine, which is given in two doses to infants and young children (CDC, 2022). According to Meredith Wadman (2017), Merck received their current ampule of WI-38 cells in 2008, adding the last time they needed an ampule was 1995 (p. 347). WI-38 cells are still being used to produce the MMR vaccine, as well as the varicella (chickenpox), which is made by Merck as well, hepatitis A, and a rabies vaccine.

The WI-38 cell line has been a center of controversy ever since it was established. However, when one delves deeper into the research and history behind these cells, it is realized that these cells are needed in the development of life-saving vaccines. These vaccines developed

from these cells have saved and ensured millions of children's lives for the past sixty years, and will continue being a life-saving source to years to come.

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