Q&A DNA, FETAL CELLS & VACCINES: WHAT YOU SHOULD KNOW

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The idea of vaccines containing fetal cells or fetal DNA can be troublesome. For some, such as Catholics, concerns are often related to the use of fetal cells because the Catholic Church does not condone abortions. For others, the concerns are based on more general religious or personal beliefs. In the case of the Catholic Church, The Pontifical Academy for Life, the Vatican's major policymaking body, examined the issue of congregants accepting vaccines made using fetal cells. Their decision expressed a preference that vaccines be made without the use of fetal cells when possible, but they determined that Catholics who accept these vaccines are "morally justified" in doing so because of a lack of alternatives and the greater need to protect one's children and those who are in contact with the children. **Despite this decision, we understand that some individuals, regardless of which religion they practice, have concerns and questions relevant to this topic. This Q&A addresses some of the most common questions we receive.**

Q. Why are cells used to make vaccines?

A. Viruses are simple organisms. They usually only contain a few proteins and genes (DNA or RNA). As a result, they do not have the machinery needed to reproduce on their own. Therefore, viruses need to infect cells and use the cells' machinery to make more of themselves. This means that to study viruses — or make vaccines — scientists need cells in which the viruses reproduce. Different viruses cannot use any type of cell to reproduce, so an important part of viral research is figuring out which type of cell each virus favors.

Watch an animation that shows how viruses reproduce, *bit.ly/3wDqM7W*.

Q. Why were fetal cells used to make vaccines?

A. Scientists were originally studying fetal cells to understand the aging process. However, scientific collaboration and a challenge in vaccine development led to the use of fetal cells in vaccine development. Specifically, scientists had found a potentially cancer-causing virus, called simian virus 40 (SV40), in the polio vaccine, which was made by first growing polio virus in monkey kidney cells. It was called SV40 because it was the 40th monkey virus identified. Ultimately, SV40 was shown not to cause cancer in polio vaccine recipients, but that understanding took time to evolve. In the interim, vaccine scientists realized that because viruses need cells in which to grow, they had to be sure that SV40 or other harmful viruses would not be introduced in future vaccines. Serendipitously, one of the most prominent scientists studying aging, Leonard Hayflick, was working down the hall from two prominent vaccine scientists, Hilary Koprowski and Stanley Plotkin, at the Wistar Institute in Philadelphia. Together, the trio realized that because fetuses are not typically exposed to viruses in the womb, their cells offered a way to ensure that future viral vaccines did not inadvertently contain other viruses that might be harmful to people.

In addition to being free of potentially contaminating viruses, fetal cells offered another benefit for vaccine development. Because vaccines target viruses that infect people, the human viruses used to create vaccines grow best in human cells.

Q. Which vaccines use fetal cells?

A. Vaccines made using fetal cells include:

- Chickenpox (varicella)
- COVID-19 (viral vector versions, such as J&J/Janssen and AstraZeneca)
- Hepatitis A
- Rabies (one version, known as Imovax®)
- Rubella (the "R" in the MMR vaccine)

No other vaccines, including influenza and COVID-19 mRNA vaccines, are made using fetal cells.

Q. Do vaccines that use fetal cells require additional abortions?

A. No. Once cells are prepared from their original source, they can be maintained indefinitely in the laboratory. The process of maintaining these cells is commonly referred to as "cell culture" or "cell passage."

Cell culture involves growing cells in specialized containers in a sterile, temperature-controlled environment. Nutrients that encourage cell growth are added to the containers, and as the cells replicate and fill the surface of the container, scientists divide them into new sterile containers and add fresh ingredients. Periodically, they will also store some of the new cells in special freezers, called liquid nitrogen freezers. These freezers maintain temperatures of –190 degrees Celsius (–310 degrees Fahrenheit). Storage of the cells at this extreme temperature allows them to survive but remain biologically inactive. So, when scientists need a fresh supply of cells, they can thaw some and again start growing new cells. In this manner, the supply of cells is virtually limitless. As a consequence, additional abortions are not necessary. The fetal cells used to make vaccines today were first isolated in the 1960, 1970s, or 1980s depending on the vaccine.

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Q. Do fetal cells contain DNA? What is DNA?
A. All human cells, including fetal cells, contain DNA, which stands for deoxyribonucleic acid. DNA is a blueprint that provides instructions for our cells so they can function properly, meaning they can make proteins and enzymes, communicate with other cells, and more.

DNA is protected in a compartment in each cell, called the nucleus. The nucleus is like the air traffic control station, overseeing all activity in the cell from a protected place while ensuring that the cell accomplishes its work in an orderly manner.

Q. Is fetal cell DNA contained in vaccines?
A. Because vaccine viruses go through several steps of purification and because DNA does not withstand these processes very well, any components of DNA that remain are highly fragmented and minimal. When DNA from the production process has been measured in vaccines, it was only present in picogram quantities. A picogram is one-trillionth of a gram (0.000000000001). As such, this small amount of fragmented material is not able to cause damage or interact with our own DNA.

Q. Can fetal cell DNA alter our DNA?
A. No. Because the chickenpox, hepatitis A, rabies (one version), and rubella vaccines are grown in human fetal cell lines, some people wonder if the DNA from the fetal cells could change a person's own DNA. However, when viruses grow in cells, the cells are usually broken open to release the new virus particles. This is what happens in our bodies when we have a viral infection, and it happens in the laboratory, too. In the body, some immune system cells function as vacuum cleaners to remove debris, including cells destroyed by a viral infection. In the laboratory, scientists use purification methods to get rid of the cell debris. Because DNA is a relatively fragile molecule, any DNA that might have survived the viral infection is destroyed during the purification process. As such, even small fragments of DNA that might remain would not be recognizable or have any ability to cause issues when injected with a vaccine.

Additional resources

Stanley Plotkin: Pioneering the use of fetal cells to make rubella vaccine (video), *hillemanfilm.com/stanley-plotkin* (This webpage also contains greater detail about the cell passage process.)

A Look inside the Lab: Liquid Nitrogen Freezer (video), *bit.ly/3PA1ijb*

The Vaccine Race: Science, Politics, and the Human Costs of Defeating Disease (book) — Meredith Wadman, Penguin Random House, 2017 (This book is summarized on the Vaccine Update website at *bit.ly/3Gd7rxn*.)

Q. Do mRNA vaccines contain DNA?
A. No. The Pfizer and Moderna COVID-19 vaccines use messenger RNA, or mRNA. These vaccines do not contain DNA. RNA stands for ribonucleic acid. Messenger RNA instructs cells on how to make proteins.

Q. Even though mRNA vaccines don't contain DNA, can these vaccines alter our DNA? Why not?
A. Since mRNA is a nucleic acid, like DNA, some wonder if the mRNA can be converted into DNA and become part of a person's DNA. This cannot happen for several reasons. First, the mRNA is released into the cell's cytoplasm, and it is processed there. DNA, on the other hand, is protected in a cell's nucleus. For a nucleic acid to enter the nucleus, the proper enzymes must be available. These enzymes are not delivered with the vaccine and are not typically found in the cytoplasm because then the nucleus would be more easily breached by any nucleic acid. Second, even if the mRNA entered the nucleus, it would first need to be converted to DNA, which would require another enzyme that is not available in the vaccine. This enzyme is called reverse transcriptase. Third, even if the mRNA did get converted to DNA and enter the nucleus, a different enzyme, called integrase, would need to be available for the new DNA to become part of the individual's DNA. Integrase is not delivered with the vaccine nor is it readily available in a cell. As such, it is impossible for an mRNA vaccine to change a person's DNA.

Q. Do viral vector vaccines contain DNA?
A. Yes. Viral vector vaccines, like the J&J/Janssen and AstraZeneca COVID-19 vaccines, deliver DNA. The COVID-19 vaccines contain DNA that represents the spike protein of SARS-CoV-2, the virus that causes COVID-19.

The vaccine DNA enters the cell's nucleus where it is converted into mRNA. The mRNA is then sent to the cell's cytoplasm to be used as a blueprint for making the spike protein, which is then recognized as something the immune system needs to respond to by generating a coordinated immune response.

Q. Can viral vector vaccines alter our DNA? If not, why not?
A. Since DNA from the vaccine enters the nucleus, where our own DNA resides, one might wonder how we know that our DNA is not being altered. Because the viral vector that delivers the vaccine cannot replicate, it does not have necessary enzymes, such as integrase, that would be required for vaccine DNA to be incorporated into our own DNA. Interestingly, even if the DNA was able to incorporate itself, it is important to realize that the vaccine is not delivered to cells that are part of a germ line, meaning cells that would be involved in reproduction.

This information is provided by the Vaccine Education Center at Children's Hospital of Philadelphia. The Center is an educational resource for parents, the public and healthcare professionals and is composed of scientists, physicians, mothers and fathers devoted to the study and prevention of infectious diseases. The Vaccine Education Center is funded by endowed chairs from Children's Hospital of Philadelphia. The Center does not receive support from pharmaceutical companies. *22176-06-22.*

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