Covid-19 vaccine science

December 10, 2020

- 1. Operation Warp Speed
- 2. How does it work?
- 3. Should I get it?
- 4. History of "cell lines" in research.

Operation Warp Speed:

April 2020

 Public interagency + private partnership to facilitate and accelerate the development, manufacturing, and distribution of COVID-19 vaccines, therapeutics, and diagnostics.

 Congress allocated nearly \$10 billion for Operation Warp Speed through the <u>Coronavirus Aid, Relief, and</u> <u>Economic Security (CARES) Act</u> • May 15, 2020



Operation Warp Speed: The players

- <u>Pfizer-BioNTech</u> \rightarrow \$ 2 billion promised in July
- <u>Moderna</u> \rightarrow \$ 483 million in June
- <u>AstraZeneca</u>-University of Oxford and Vaccitech \rightarrow \$ 1.2 billion in June
- Johnson & Johnson (Janssen Pharmaceutical)
 - "to Supply 1 Billion Vaccines Worldwide."

- <u>Novavax</u> \rightarrow \$ 1.6 billion promised in July *if successful*
- Sanofi and GSK \rightarrow \$ 2.1 billion in July

We need antibody against Covid-19 "spike protein."



The messenger: mRNA codes for proteins.





Image ref: lumenlearning.com

Covid-19 vaccine is based on...

mRNA codes **spike protein**:

- 1. Pfizer BioNTech
- 2. Moderna

Adenovirus carries the **spike protein**:

- 1. AstraZeneca
- 2. J&J/Janssen



- Pfizer[®] Moderna[®]

Success

- ~95% response.
- Safety was closely • monitored.
- First large scale \bullet vaccine using mRNA technology.

UNDERSTANDING mRNA VACCINES

To build an mRNA vaccine, scientists only need access to the genetic sequence of SARS-CoV-2, and not the actual virus.



Our scientists have focused on the

can use to make the "spike" protein.

genetic sequence for the virus's "spike'" protein, which can then be

used to synthesize an mRNA sequence, instructions that the cell

BioNTech and Pfizer have begun testing four versions of mRNA vaccines in humans to determine whether it is safe and effective and the immune response is sufficient.



The synthetic mRNA is then packaged in a lipid nanoparticle (LNP) that serves as a "delivery vehicle" shuttling the instructions to our cells.

mRNA LNP



Once inside the cells, the cellular machinery follows the mRNA instructions to produce the viral protein, which is then displayed on the surface of the cell and stimulates the immune system to mount a response.



Cell

Or maybe... • AstraZeneca [®]

- J&J ®

Designing a vaccine

January - March 2020

- January 2020: SARS-CoV-2 sequence available
- Vaccine design commences
- SARS-CoV-2 spike protein inserted into Ad26 vector
- Multiple vaccine candidates constructed
- March 2020: Validated with pre-clinical testing to identify lead candidate



Johnson-Johnson

How some COVID-19 vaccines use human fetal cell lines:

- HEK-293, a kidney cell line widely used in research and industry that comes from a fetus aborted in about 1972.
 - AstraZeneca.
- PER.C6, a proprietary cell line owned by Janssen Pharmaceuticals of Johnson & Johnson, developed from retinal cells from an 18-week-old fetus aborted in 1985.
- Used as mini "factories" \rightarrow adenoviruses \rightarrow to carry spike protein.
- Univ. of Pittsburgh (HEK-293) produces protein of the virus...same idea.

What are immortalized "cell lines" ?

- Sentinel example featured in HBO's "The Immortal life of Henrietta Lacks."
- Industry took cervical cancer cells and grew them in the lab.
 - No consent. No compensation.
 - Thousands of research experiments used HeLa cells from 1951 until today.
 - DNA sequence published in 2013.
 - Family eventually aware.

Feds, family reach deal on use of DNA information

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■ 1 of 4 | This 1940s photo shows Henrietta Lacks. In 1951, a doctor in Baltimore removed cancerous cells from Lacks without her knowledge or consent. Those cells eventually helped lead to a multitude of medical treatments and formed the groundwork for the multibilion-dollar biotech industry. Less ∧

Some 60 years ago, a doctor in Baltimore removed cancer cells from a poor black patient named Henrietta Lacks without her knowledge or consent. Those cells eventually helped lead to a multitude of medical <u>Skloot, Rebecca</u> (2010), <u>The Immortal Life of Henrietta Lacks</u>, New York City: <u>Random House</u>.

Ritter, Malcolm August 7, 2013. "Feds, family reach deal on use of DNA information". <u>Seattle Times</u>.

Take home thoughts

- The mRNA technology used by Pfizer & Moderna appear to be safe and effective without use of fetal cell lines.
- J&J/Janssen and AstraZeneca/Oxford U. vaccines using a more traditional carrier virus delivery mechanism are still under study and use fetal cell lines early in their vaccine production process.
- The use of immortalized cell lines was dramatized by the true story of HeLa cells, but continues to receive relatively minimal attention.