

C FEATURING:

HOW YOUR IMMUNE SYSTEM WORKS AND HOW VACCINES ASSIST YOUR IMMUNE SYSTEM IN FIGHTING VIRUSES, LIKE THE CORONAVIRUS

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Want to understand how vaccines work? We're going to break it down for you.

Then we'll cover the biology of the coronavirus.

And then we'll explain how your immune system fights the coronavirus and how in that fight.







HUMAN BIOLOGY 101 What are DNA, RNA, and proteins? DNA, RNA, and proteins are the basic building blocks of all life. DNA is a code, kind of like computer code.

DNA is trapped and protected in the nucleus of a cell. It cannot leave the nucleus.















HUMAN BIOLOGY 101

- RNA is a set of instructions for making proteins.
- There are many kinds of RNA.
- For now let's focus on messenger RNA (known as mRNA).
- When a section of DNA is decoded, it's transcribed into mRNA.









HUMAN BIOLOGY 101

mRNA is translated into protein. Proteins are the building blocks that make up all our different organ systems.

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PROTEIN 7

MESSENGER RNA





A HUMAN CELL:



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HUMAN BIOLOGY 101

mRNA travels out of the nucleus into a cell's cytoplasm.

Cytoplasm is a gel-like substance outside the nucleus.

But, it's a one-way street.

Once mRNA leaves the cell nucleus, it can't get back in.









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HUMAN BIOLOGY 101

Some life forms are more complicated than others. Humans are the most complicated life form. We're made of DNA, RNA, and proteins.

Viruses, like the coronavirus, are very simple lifeforms.

Each coronavirus particle is basically a strand of RNA surrounded by an envelope of protein.

Notice the Spike protein studding the virus envelope.

SPIKE PROTEINS

ENVELOPE





HOW CORONAVIRUSES INFECT AND MULTIPLY



HOW CORONAVIRUSES INFECT AND MULTIPLY

People infected with the coronavirus release it into the air when they breathe, cough, talk, or sing.



The coronavirus travels through the nose and mouth into the lungs, where it infects your cells.



PARTICLES INFECT UNGS

CORONAVIRUS DROPLETS 3 AEROSOLS







How CORONAVIRUSES INFECT AND MULTIPLY

The Spike protein is like a key that unlocks and opens a door into your cells.

The Spike protein attaches to ACE2 receptors on the surface of your cells.

The ACE2 receptors are like the door knobs on your cells. The Spike protein allows the coronavirus to penetrate and infect your cell.



E HUMAN CELLE







HOW CORONAVIRUSES INFECT AND MULTIPLY

The coronavirus then hijacks your cells to turns them into little factories, each making more coronavirus.

The new coronaviruses then bud from your cells.

Little bits of the virus, including the Spike protein, coat the surface of infected cells, making it recognizable to the immune system.





How THE IMMUNE SYSTEM FIGHTS A CORONAVIRYS



HOW THE IMMUNE SYSTEM FIGHTS & CORONAVIRUS

T-cells are part of your immune system.

When your T-cells see Spike protein on the surface of infected cells, they target and kill these infected cells.



HOW THE IMMUNE SYSTEM FIGHTS & CORONAVIRUS

B-cells are also part of your immune system.

When B-cells see Spike protein, they make antibodies. These antibodies bind to the Spike-protein on the surface of the virus and neutralize the virus.



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How THE IMMUNE SYSTEM FIGHTS & CORONAVIRUS

When you're naturally infected with coronavirus, it's a race between the virus and your immune system.

The virus multiplies as fast as it can. It takes time for your immune system to see the virus and launch a counterattack.



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How THE IMMUNE SYSTEM FIGHTS A CORONAVIRUS

When the virus is faster than your immune system, you can get very sick and even die.





How THE IMMUNE SYSTEM FIGHTS & CORONAVIRUS

When your immune system is faster than the virus, you may have only mild symptoms or none at all.









Vaccines protect you against disease by teaching your immune system to recognize an infectious pathogen (like viruses and bacteria) before you're exposed to that pathogen.





Meet the coronavirus.

It is a live, wild virus, and can make you really sick.







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How VACCINES WORK

Live, attenuated virus vaccine

These vaccines are made of live but weakened virus.

They won't make you sick, but they can teach your immune system how to spot viruses like them.



How VACCINES WORK Inactivated, killed vaccine These vaccines are made of dead virus. They won't make you sick either, but can teach your immune system how to spot viruses like them.





Subunit vaccines (aka recombinant / polysaccharide / conjugate vaccines)

These vaccines are made of one piece of the virus — one specific virus protein, like the coronavirus Spike protein.

The virus protein is produced synthetically in a lab.

It won't make you sick, but it can teach your immune system to recognize the virus.

The Novavax vaccine is a subunit Spike protein vaccine.



VACCINATED B-CELL IKE

PROTEIN





messenger RNA (mRNA) vaccines

These vaccines are made of an oily, fatty envelope surrounding mRNA.

But instead of carrying all of the coronavirus mRNA, these vaccines only carry the mRNA for the coronavirus' Spike protein.

The Pfizer and Moderna COVID vaccines are mRNA vaccines.

MRNA For Spike Protein

OILYFATTY COATING





HOW VACCINES WORK

messenger RNA (mRNA) vaccines

The mRNA in these vaccines gives your cells the instructions to make Spike protein.

By itself, the Spike protein won't make you sick, but it can teach your immune system to recognize the coronavirus.

























How VACCINES WORK messenger RNA (mRNA) vaccines mRNA is fragile. This is why mRNA vaccines need to be frozen at ultra cold temperatures.





messenger RNA (mRNA) vaccines

Once inside the body, mRNA doesn't last long.

This is why you need a second dose 3-6 weeks after your first dose.

The mRNA lasts just long enough to teach your immune system to recognize the coronavirus.





CELL NUCLEUS



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How VACCINES WORK

messenger RNA (mRNA) vaccines

Remember that your DNA is protected inside the cell nucleus.

mRNA can't travel into the cell nucleus, so mRNA vaccines can't change your DNA.

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Meet the adenovirus.

It's another live, wild virus, not related to the coronavirus.

The adenovirus can give you the common cold, sore throats, pink eye, or diarrhea.







Adenovirus vector vaccines (aka non-replicating virus vector)

But the adenovirus can be "gutted" of its genetic material.

Without those "guts," it can't multiply. So it can't make you sick.



Adenovirus vector vaccines (aka non-replicating virus vector)

The adenovirus' genetic material can be replaced with code for coronavirus Spike protein.

It won't make you sick, but it can teach your immune system to recognize the coronavirus.

The Johnson & Johnson and AstraZeneca COVID vaccines are adenovirus vector vaccines.

Now you know:

- The basics of human biology
- How viruses infect cells
- How the immune system fights viruses
- How vaccines support the immune system.

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