

Central dogma student's guide add-on: mRNA vaccines

Review:

Today's lab activity demonstrated the central dogma of molecular biology, one of the most fundamental ideas in the field of biology. Not only does the central dogma make life as we know it possible, but it is also essential for biological innovations, like the mRNA vaccines.

Most vaccines expose your immune system to a weakened or nonfunctional virus or viral parts, so your immune system learns to recognize that virus and develops antibodies for future use. If you later become infected with that virus, your body will have already developed the antibodies to fight it, and the virus will be defeated before you ever know you were infected.

mRNA vaccines work a little differently. Instead of directly presenting a viral protein to the immune system, these vaccines introduce the mRNA that will be used by the body's own cells to create the viral protein.

Interpreting results:

Using your results from the lab and what you learned from it, answer the following questions. (Hint: for more background information on mRNA vaccines to help you think about these questions, read our DNAdots article on mRNA vaccines)

1. What process does creating the viral protein from mRNA represent? Transcription or translation?
2. In the lab activity:
 - a. What fluorescent color indicated the presence of mRNA?
 - b. What fluorescent color indicated the presence of protein?
 - c. What fluorescent color change is most representative of how viral proteins are created from mRNA?
Circle the right option and justify your answer.
 - i. No signal to green
 - ii. No signal to red
 - iii. Green to red
 - iv. Red to green

Explain your reasoning:

Critical thinking:

1. One advantage of mRNA vaccines is that mRNA is easier to produce than protein. What process creates mRNA? Transcription or translation?
2. In what molecule is the genetic information used to create the mRNA stored?

3. What fluorescent color change from the lab activity represents how biotech companies produce mRNA from instructions found in DNA? Circle the right option and justify your answer.
- No signal to green
 - No signal to red
 - Green to red
 - Red to green

Explain your reasoning:

4. One misconception about mRNA vaccines is that they can change our DNA. Knowing how genetic information flows in the central dogma, explain why the mRNA cannot change our DNA.
5. Another reason why the mRNA vaccines won't change our DNA because mRNA is very short-lived inside our bodies and degrades quickly. What visual evidence from the lab supports the fact that mRNA degrades quickly, while proteins are longer lived?
6. In the cell, DNA is used to code for mRNA, and then mRNA is translated into protein. One of the drawbacks of mRNA vaccines is that the mRNA is not very stable at room temperature. But DNA is very stable at room temperature. Nucleic acids delivered using nanoparticles only enter the cytoplasm. Knowing this, would a DNA-based vaccine delivered using nanoparticles work? Why or why not?

Advanced:

Some scientists think we should be spending time and money developing vaccines for diseases that may in the future become pandemics so that we are ready when they come. Other scientists think time and money are better spent working on vaccines for very rare diseases that currently infect humans. If you were in charge of distributing money to vaccine researchers, who would you be more likely to fund: someone studying a disease that may (or may not) become a pandemic, or someone studying rare diseases that people are currently infected with?