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# Understanding the Purpose of Every Nucleotide in the Comirnaty (Pfizer-BioNTech) Vaccine, a Hands-on Activity for Virtual Presentations

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Works for me

This protocol is published without a DOI.

Harley King Workspace

USG Fall 2020 BSCI:414

1 more workspace

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SUBMIT TO PLOS ONE

## ABSTRACT

I was invited to give a STEM-related virtual presentation at a high school. I wanted to discuss the exhilarating science behind novel COVID-19 mRNA vaccines, and I wanted students to complete a hands-on activity. I chose the Pfizer-BioNTech vaccine (Comirnaty) because a whole semester's worth of molecular biology is wrapped in a nice liposomal package. I discuss mRNA background, differences in DNA vs RNA and features of the vaccine using the slides. Students print the 4 page worksheet that accompanies the presentation. In addition to the worksheet, I invite students to bring 6 different colored markers, tape and scissors. The markers are used to color the 4,284 bases and their function.

## References

- 1) [Reverse Engineering the source code of the BioNTech/Pfizer SARS-CoV-2 Vaccine](#)
- 2) [RNA Vaccines And Their Lipids](#)
- 3) [Exploring the Supply Chain of the Pfizer/BioNTech and Moderna COVID-19 vaccines](#)

[Pfizer\\_vaccine.doc](#) [RNA\\_processing\\_and\\_the\\_Pfizer\\_vaccine.pptx](#) [Pfizer\\_vaccine\\_seq\\_AGCU\\_and\\_RNA\\_activity.pdf](#) [Pfizer\\_vaccine\\_SEQ\\_with\\_pseudouridylyl.pdf](#)

## PROTOCOL CITATION

Harley King 2021. Understanding the Purpose of Every Nucleotide in the Comirnaty (Pfizer-BioNTech) Vaccine, a Hands-on Activity for Virtual Presentations. **protocols.io**  
<https://protocols.io/view/understanding-the-purpose-of-every-nucleotide-in-t-br3am8ie>



## KEYWORDS

COVID-19, STEM, SARS-CoV-2, High School, Science Presentation, Hands-on activities, activities, mRNA, Pfizer, BioNTech

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## IMAGE ATTRIBUTION

Many images are used in the presentation. Image sources can be found in the speaker notes.

## CREATED

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46914

MATERIALS TEXT

printer, coloring or marking pens, tape, scissors, handout

DISCLAIMER:

This views, presentation and opinions presented are my own and not those of my employer.

BEFORE STARTING

Have students print 4 page worksheet and bring 6 coloring pens/makers/highlighters, tape and scissors.

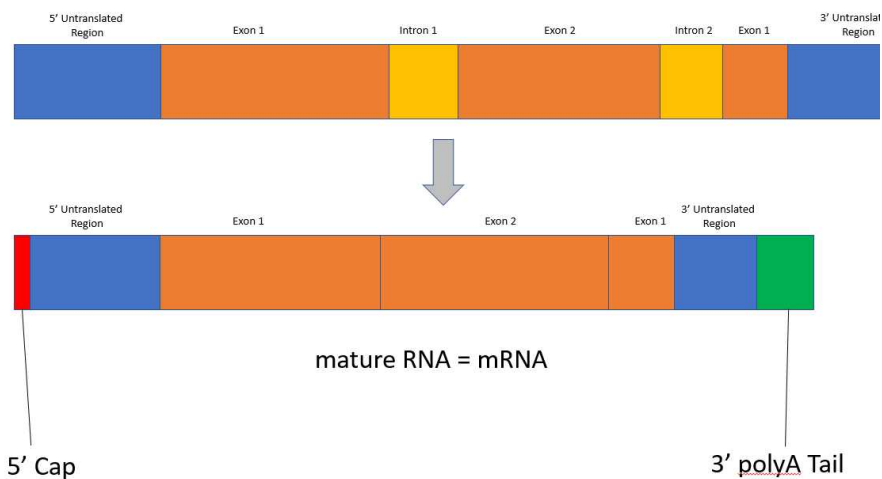
### Discuss RNA

- 1 The role of RNA in biology's central dogma.



RNA plays a role in the central dogma of biology.

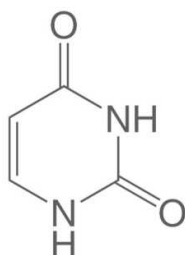
- 2 DNA vs RNA
- 3 The processing of protecting RNA (5' cap and polyA tail) and its translocation to the cytoplasm.
- 4 ACTIVITY
  1. Use a red pen and draw a vertical line at the beginning of the 5' UTR. This represents your protective RNA cap.
  2. Use a marking pen and draw a vertical line at the end of the 3' UTR. This represents your protective polyA tail.
  3. On your printout, fold the introns back (or scissors to cut them out) Use tape to link the exons.



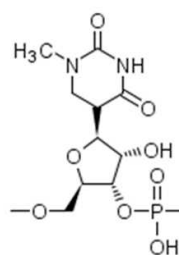
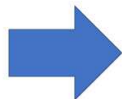
Students can excise introns with scissors, splice exons with tape and use marking pens for the 5' cap and 3' polyA tail.

#### Comirnaty Novelties

- 5
  1. RNA vaccine
  2. RNA wrapped up in a liposome
  3. RNA is data uploaded to cells
  4. Uracil transformed into 1-methyl-3'-pseudouridylyl



uracil



$m^1\Psi$  = 1-methyl-3'-pseudouridylyl

Uracil is made less immunogenic by substituting pseudouridylyl.

- 6 Liposomes dispersed in body find dendritic cells.

#### Process of mRNA Becoming a Vaccine

- 7
  1. Liposomes containing mRNA bind with dendritic cells and release their payload.
  2. mRNA is translated.
  3. SARS-CoV-2 Spike protein translocates to the endoplasmic reticulum due to signaling peptide.
  4. Expresses on cell surface and presented to CD4 T-cells in lymph nodes.
  5. Stimulates immunogenic response; antibodies bind spike protein.

#### 8 ACTIVITY

1. Use the handout and nucleotide numbers to identify the bases and their functions in the Pfizer Vaccine.

## 2. Can you find the AUG start codon?

Element	Description	Position
cap	A modified 5'-cap1 structure (m <sup>7</sup> G <sup>+</sup> m <sup>3</sup> -5'-ppp-5'-Am)	1-2
5'-UTR	5'-untranslated region derived from human alpha-globin RNA with an optimized Kozak sequence	3-54
sig	S glycoprotein signal peptide (extended leader sequence), which guides translocation of the nascent polypeptide chain into the endoplasmic reticulum.	55-102
S protein_mut	Codon-optimized sequence encoding full-length SARS-CoV-2 spike (S) glycoprotein containing mutations K986P and V987P to ensure the S glycoprotein remains in an antigenically optimal pre-fusion conformation; stop codons: 3874-3879 (underlined)	103-3879
3'-UTR	The 3' untranslated region comprises two sequence elements derived from the amino-terminal enhancer of split (AES) mRNA and the mitochondrial encoded 12S ribosomal RNA to confer RNA stability and high total protein expression.	3880-4174
poly(A)	A 110-nucleotide poly(A)-tail consisting of a stretch of 30 adenosine residues, followed by a 10-nucleotide linker sequence and another 70 adenosine residues.	4175-4284

Use markers to color each block of nucleotides in the handout.