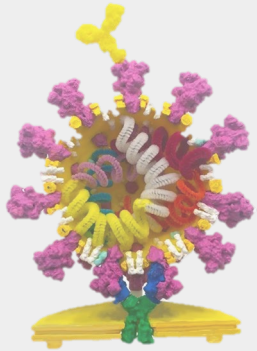
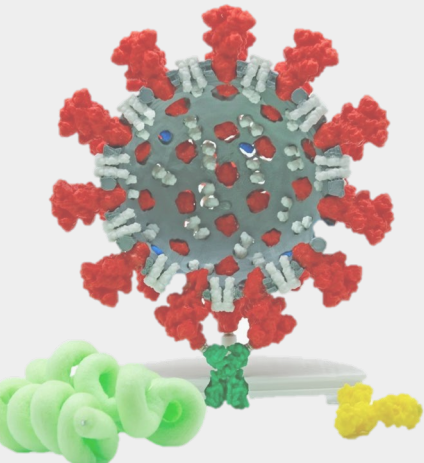
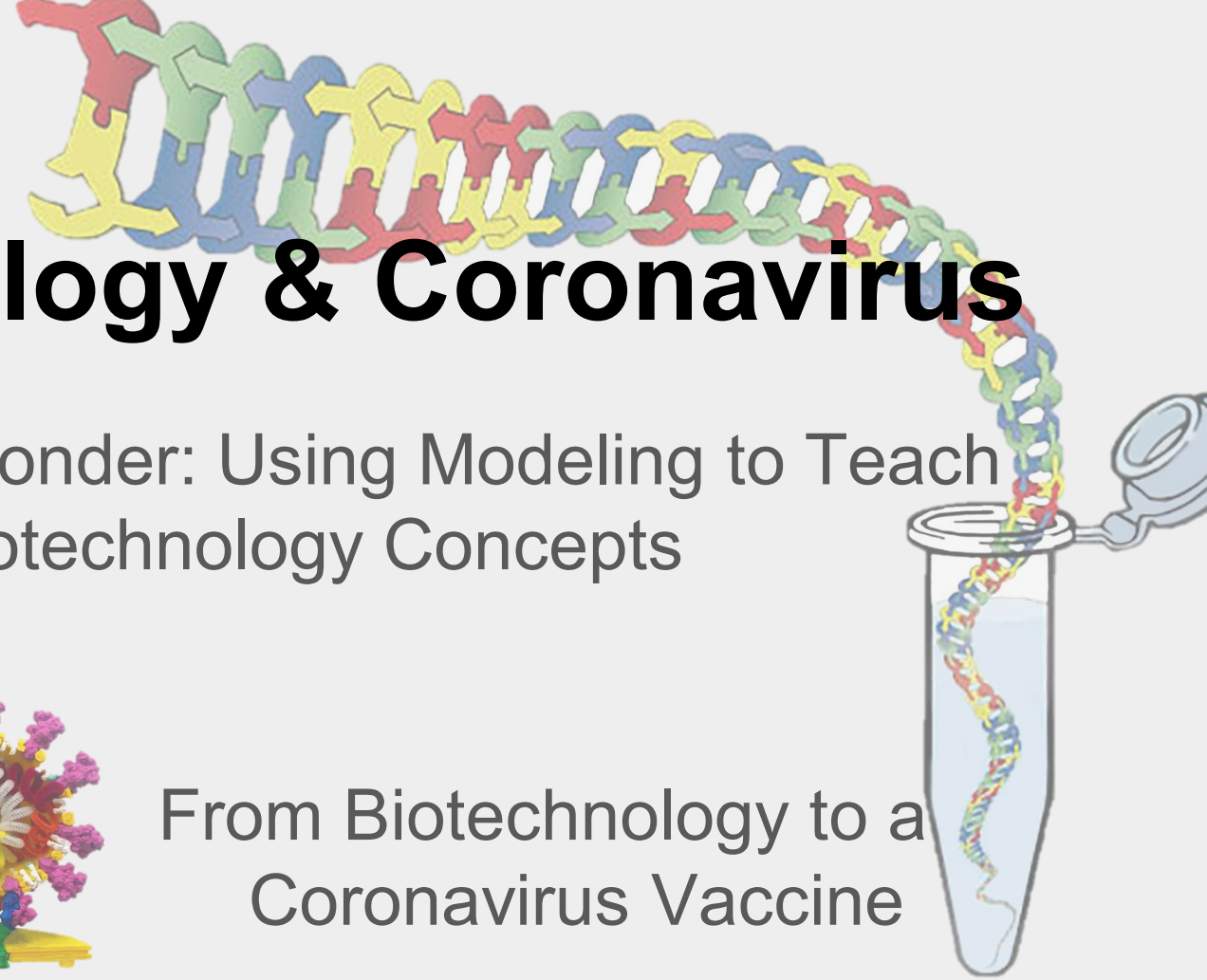


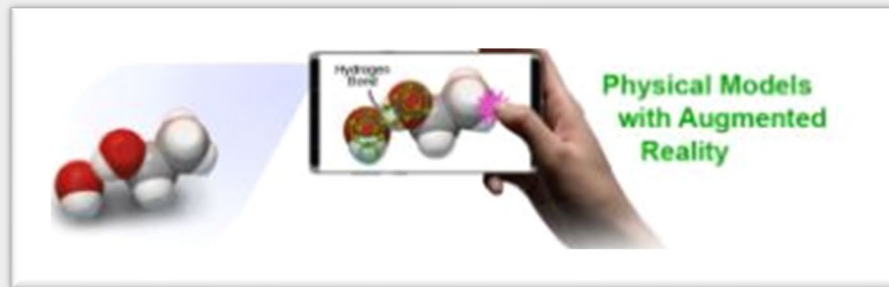
Biotechnology & Coronavirus

The One Kit Wonder: Using Modeling to Teach
Biotechnology Concepts

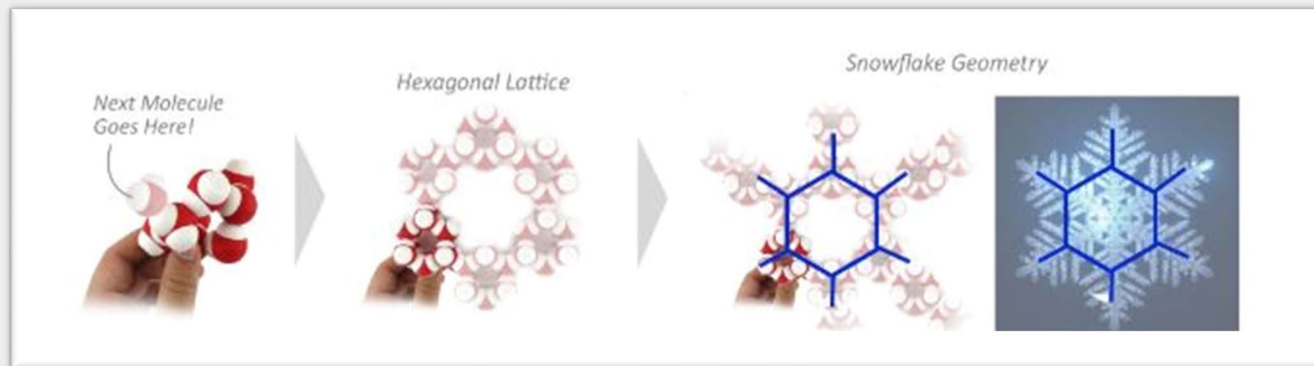
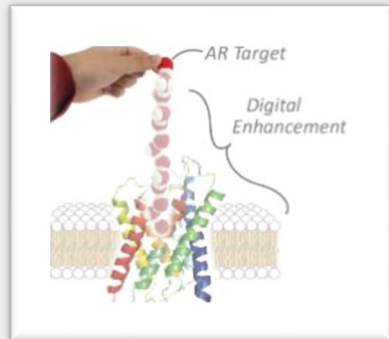


From Biotechnology to a
Coronavirus Vaccine





Augmented Reality



[Home](#) > [Biotechnology & Coronaviruses Webinar Resources](#)

[Email](#)
[Print](#)

Biotechnology and Coronaviruses Webinar

2021 Webinar Series Resources

[Student Modeling Packs](#)

[Digital Modeling Resources](#)

[Free Teacher Resources](#)

Use code **WEBINAR20** for 20% off most products!

Biotechnology and Coronaviruses Webinar

Wednesday, April 28, 2021

The video recording will be posted shortly after the webinar.

Diane Sigalas, M.Ed., Livingston High School

Tim Herman, PhD, MSOE Center for BioMolecular Modeling

[Session Resources](#)

Center for BioMolecular Modeling Resources

- [Lending Library](#)
- [Modeling Resources](#)
- [Virtual Modeling the Molecular World](#) June 22-26, 2021

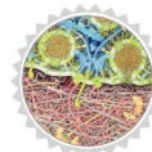
3D Molecular Designs' Products

- [Biotechnology Kit](#)
- [Nucleotide Student Modeling Pack](#)
- [Coronavirus Models](#)
- [Antibody Student Modeling Pack](#)

Free 3D Molecular Designs' Resources

- [Free Biotechnology Kit Teacher Resources](#)
- [Free video and modeling series The Science of Coronavirus](#)

Certificate of Participation



Name

Participated in

Proteins & the Protein Folding Problem
Wednesday, February 17, 2021, 6:00 PM Central

Tim Herman

Tim Herman, Ph.D.
Center for BioMolecular Modeling



Center for
BioMolecular
Modeling

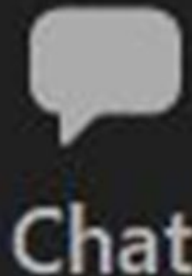
Diane Herman

Diane Herman
3D Molecular Designs



MSOE Center for BioMolecular Modeling
<https://cbmm.msoe.edu>

3D Molecular Designs
www.3dmoleculardesigns.com





Diane Sigalas

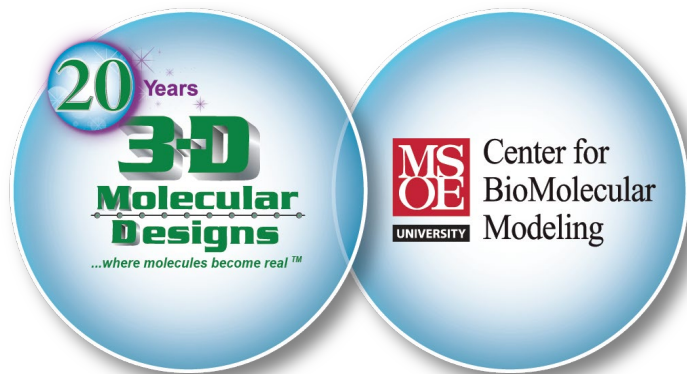
Livingston High School,
Biotechnology I & II

Montclair State University in
Montclair, New Jersey

Master's degree in Educational
Leadership at The College of
New Jersey.

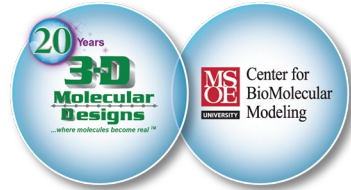
The One Kit Wonder

Using models to teach biotechnology concepts



In order to model later... -

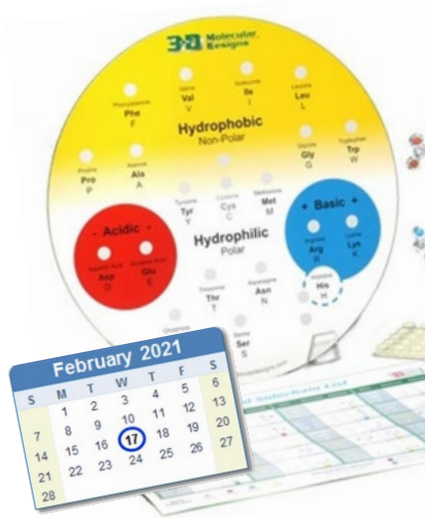
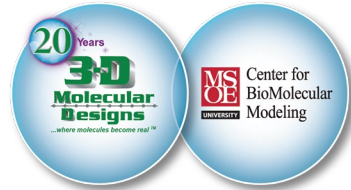
Building dsDNA



Assemble the following section of dsDNA
using the colored nucleotides



The Big Three

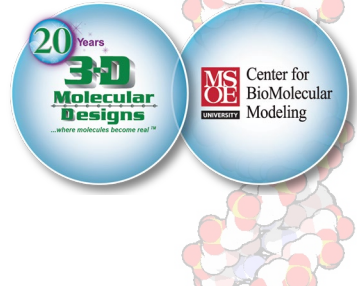


Amino Acid



Genetic Engineering Kit

Biotechnology Kit



Contents:

- Grey & Colored Nucleotides
- Dideoxynucleotides
- Primer sequences
- Cell Membrane Pieces

Concepts You Can Address:

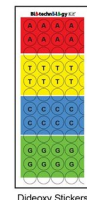
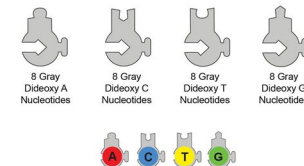
- PCR / Gel Electrophoresis
- Sanger Sequencing
- Restriction Enzymes
- Bacterial Transformation
- Semi-Conservative Replication



Biotechnology Kit®



Apply the stickers to the dideoxy pieces



WARNING:

CHOKING HAZARD — This product contains small parts and should be kept out of the reach of children under the age of 3, because the parts or their pieces may present a choking hazard to small children.

CAUTION:

This is a science education product, not a toy. It is not intended for children under 5 years old.

Lessons and activities at 3dmoleculardesigns.com/Teacher-Resources/Biotechnology-Kit.htm

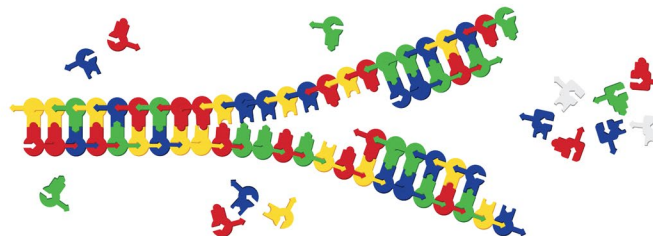
What we are using today



Biotechnology Kit
BTK-01



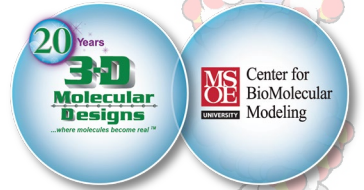
Nucleotide Modeling Pack



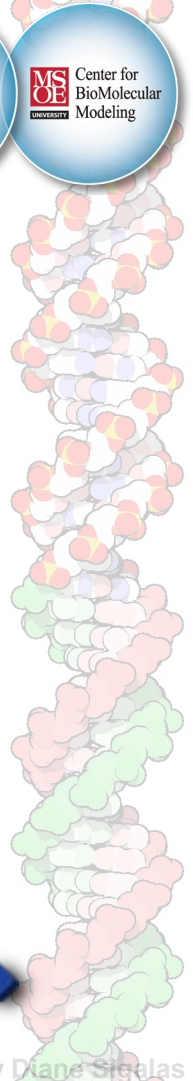
3-D Molecular Designs
...where molecules become real™

Nucleotide Student
Modeling Pack
NSMP

Workshop Learning Goals



- Leave with ideas how this kit will already fit into your curriculum and increase student learning/mastery of topics.
- Practice one application of this kit (PCR).
- Get excited about the benefits of modeling.

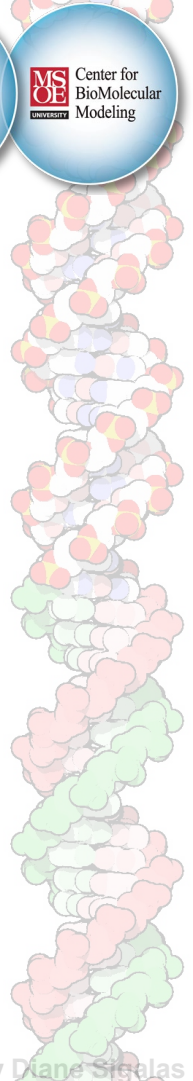


NGSS Connections

SEPs	CCCs	DCIs
Asking Questions and Defining Problems	Patterns	LS3: Heredity: Inheritance and Variation of Traits - LS3.A / LS3.B
Developing and Using Models	Cause and Effect: Mechanism and Explanation	LS1: From Molecules to Organisms: Structures and Processes - LS1.A
	Structure and Function	
	System and System Models	
	Scale, Proportion, and Quantity	



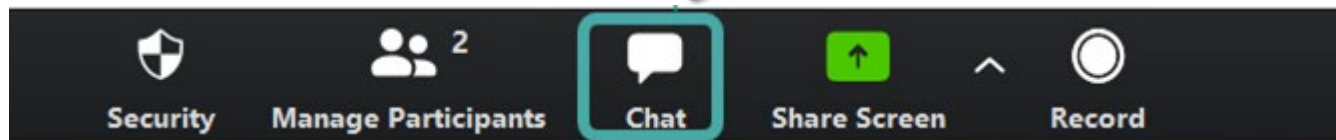
These are also included in the slides next to the content.



Let's get that chat going!



*How do you
currently teach
PCR in your
classroom?*



Polymerase chain reaction - PCR

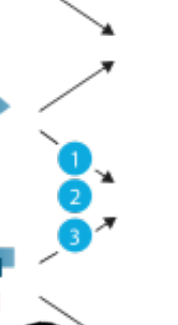
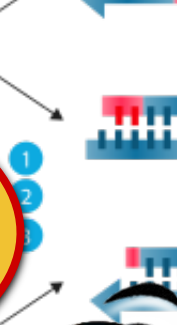
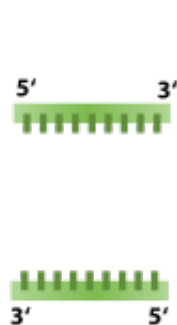
original DNA
to be replicated

5' 3'

3' 5'

DNA primer

nucleotide

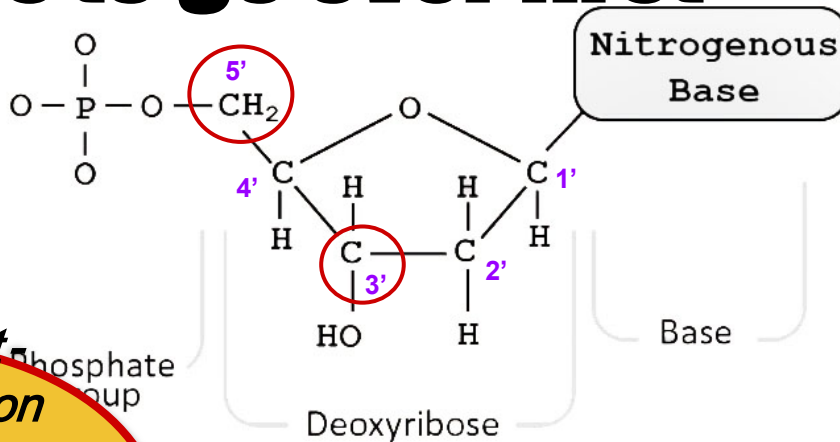


*How well do the
kids do with this
topic? How do
you know they
“get it”?*

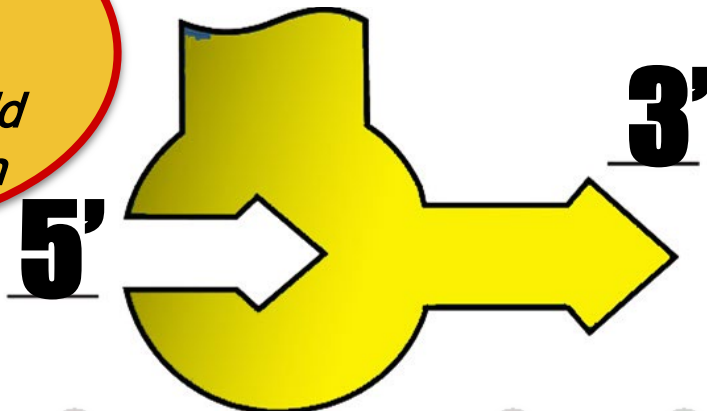
- 1 Denaturation at 94-96°C
- 2 Annealing at ~68°C
- 3 Elongation at ca. 72 °C



A few things to go over first



At this point, depending on what kits you have, the students should be familiar with this.



Time to model it! - Building dsDNA

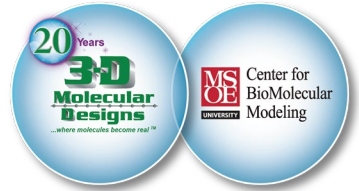
Assemble the following section of dsDNA using the colored nucleotides



Option: Save time by pre-assembling



Time to model it! - Building primers

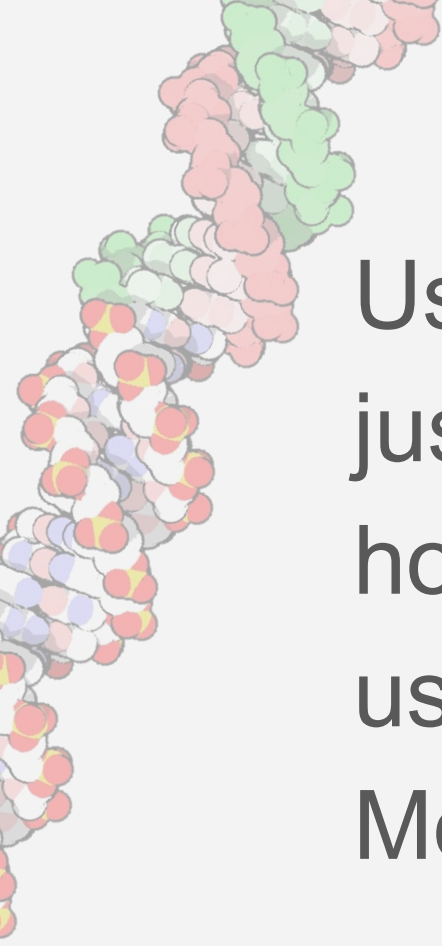


- Tonight we are going to model two cycles of PCR
- Make two separate piles for Primer 1 and Primer 2.
*To work with the Student Modeling Pack you received we are going to use **RNA nucleotides** to represent the primers.*
 - Primer 1: **AAGU**
 - Primer 2: **UCCG**

You will need three of each.
- Separate your DNA nucleotides, but keep them off to the side

Differentiation possibilities here

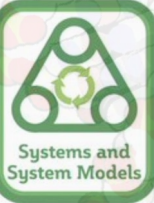
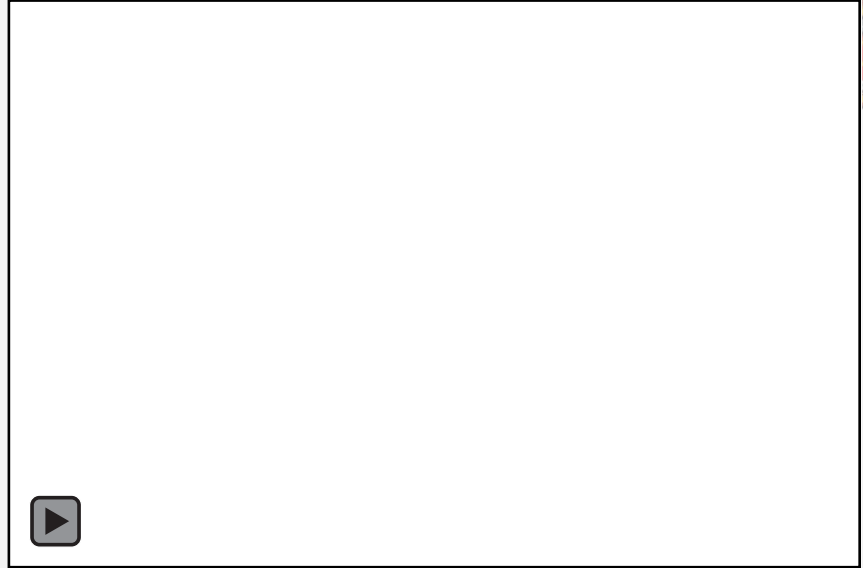




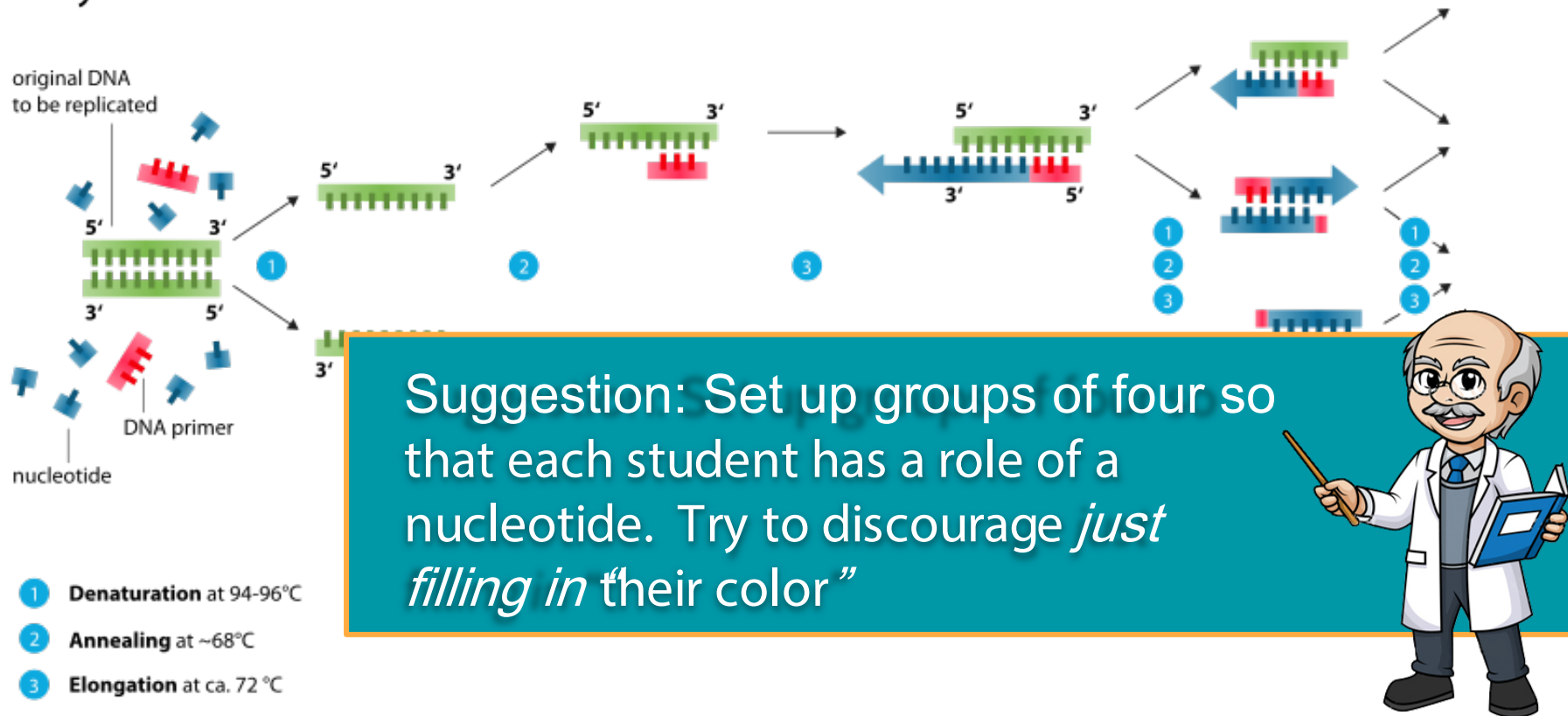
Using the dsDNA and “primers” you just made - we are going to explore how the students can model PCR using the Nucleotide Student Modeling Packs from 3DMD!

Model Time - **Basic PCR**

- **Denature** the double stranded DNA (dsDNA).
- **Anneal** the primers.
- **Extend** the sequence by adding free nucleotides (dNTPs) to the 3' end of Primer 1 and Primer 2.



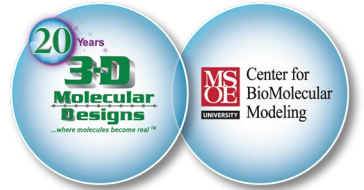
Polymerase chain reaction - PCR



Suggestion: Set up groups of four so that each student has a role of a nucleotide. Try to discourage *just filling in "their color"*



Let's get that chat going again!

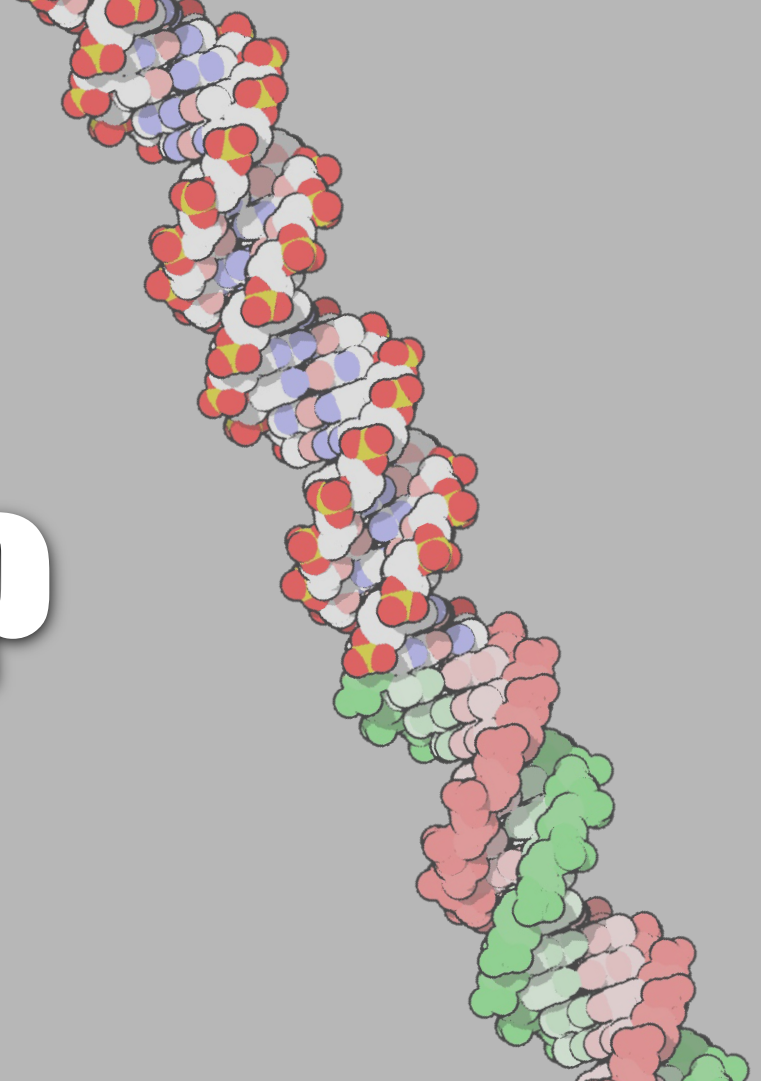


Thinking about how you just modeled PCR, what questions do you think your students would ask after exploring PCR like this?



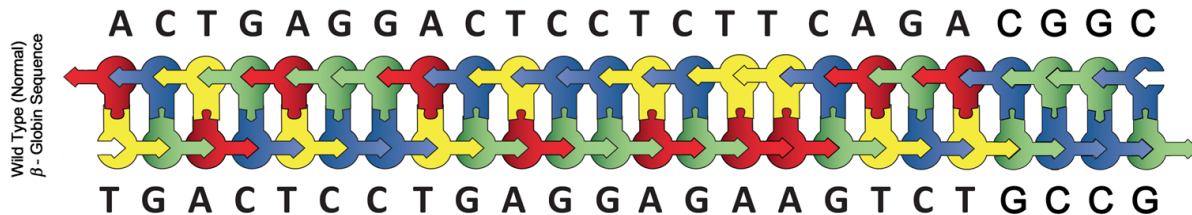
What else can you do?

What other PCR related concepts can
you explore with this kit?

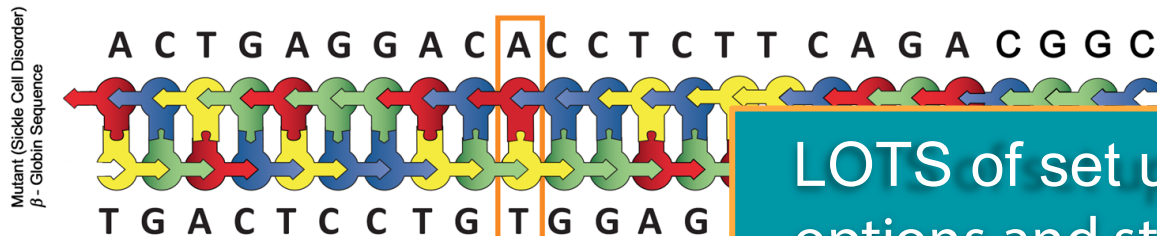


Taking it further : Modeling PCR as a Medical Tool

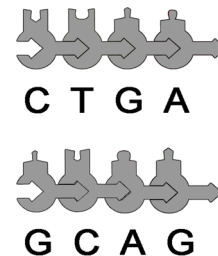
Assembly Guide



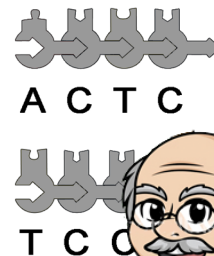
Site of point mutation
for sickle cell anemia



Primer Set 1



Primer Set 2



LOTS of set up. But I have options and student suggestions from my own kiddos for you!



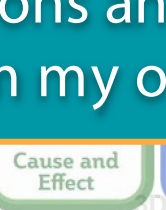
Patterns



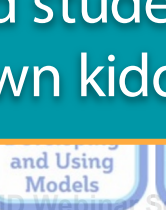
Systems and
System Models



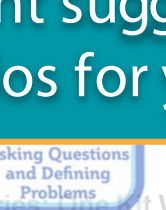
Proportion,
and Quantity



Cause and
Effect



and Using
Models



Asking Questions
and Defining
Problems

Taking it further : Connections to SARS-CoV-2

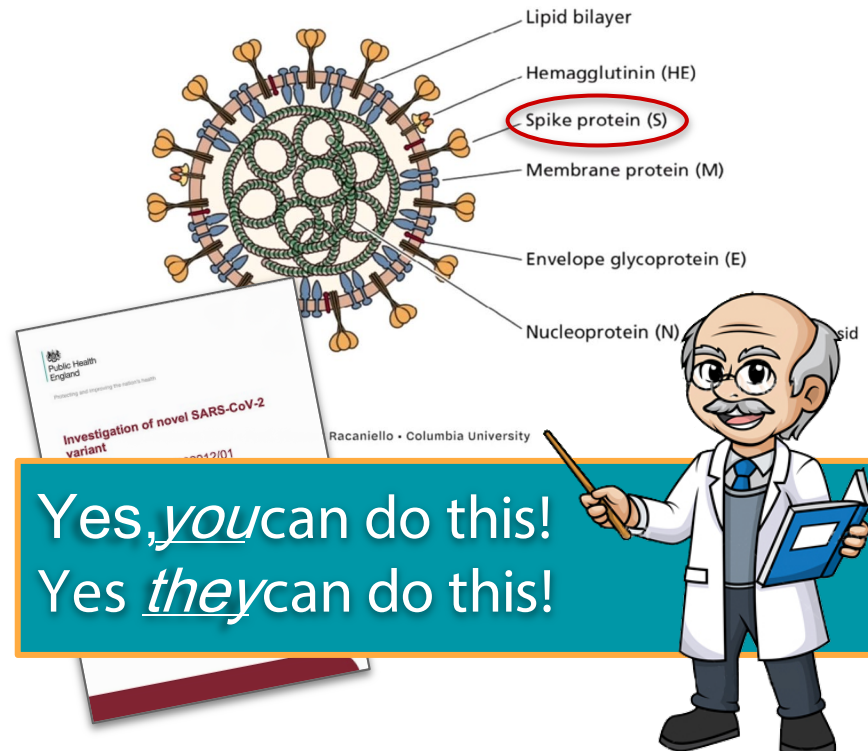


Designing PCR Tests:

Challenge your students. Can they figure out how the PCR tests are designed and how they work?

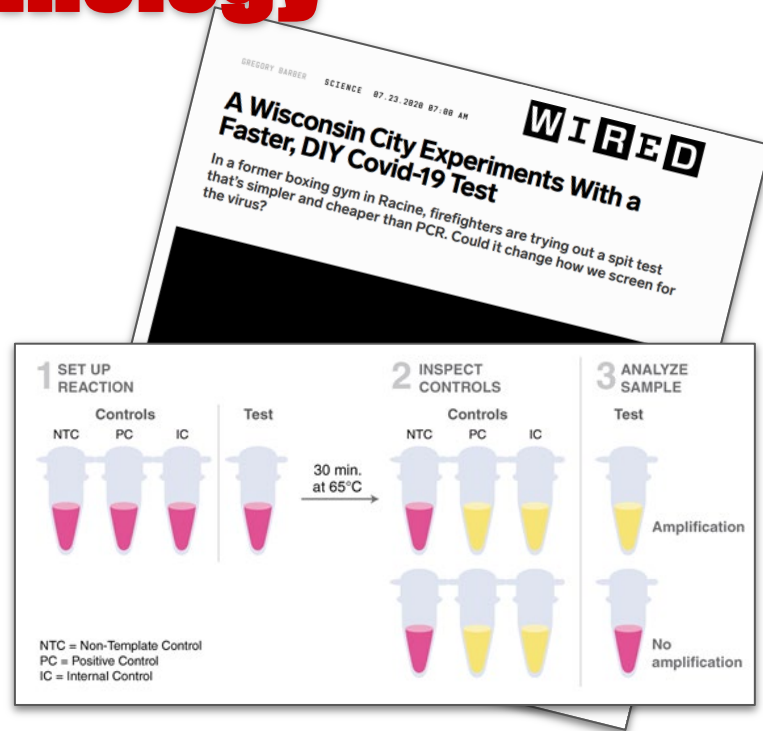
What is an S-Dropout?:

Ultimate challenge - Where did this language come from?



Taking it further : Extensions to new technology

If thermocyclers are expensive...: What could be changed to make there less of a need to have drastically changing temperatures in a traditional PCR protocol?



The Buffet of Options:

Middle School	High School <i>CP</i>	High School <i>Honors</i>	High School <i>Fo.Sci.</i>	AP Bio	Collegiate Level
Teacher Demo How SARS-CoV-2 tests work	Basic PCR modeling (<i>student</i>) How SARS-CoV-2 tests work	Basic PCR modeling <i>PCR as a Medical Tool</i> (<i>designing primers</i>) How SARS-CoV-2 tests work	Basic PCR modeling Extension to <i>PCR as a Forensic Science Ecological Tool</i>	Basic PCR modeling <i>PCR as a Medical Tool</i> (<i>designing primers</i>) How SARS-CoV-2 tests work S Dropout Investigation	Basic PCR modeling Designing a SARS-CoV-2 PCR test S Dropout Investigation LAMP PCR

What else is there?

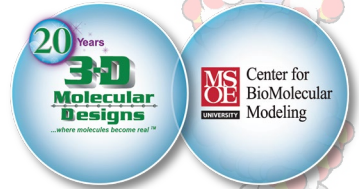
Things you can model



PCR

- *Medical and Forensic Science Applications*

- Sanger Sequencing
- Restriction Enzymes
- Bacterial Transformation
- Semi-Conservative Replication

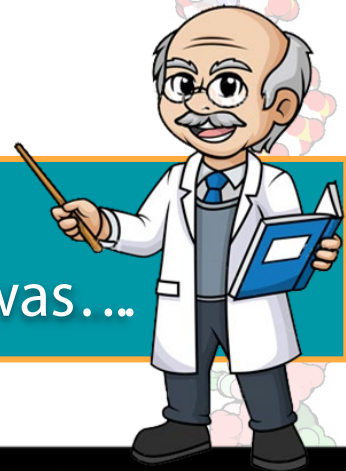


What did my kiddos think?

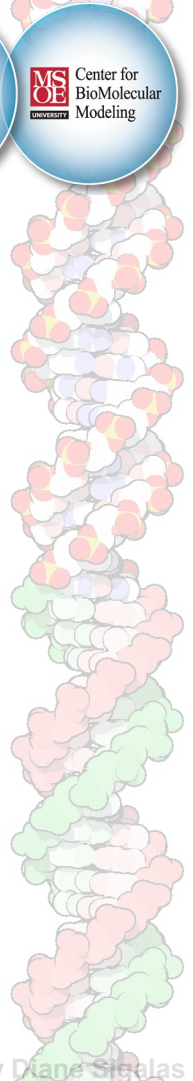
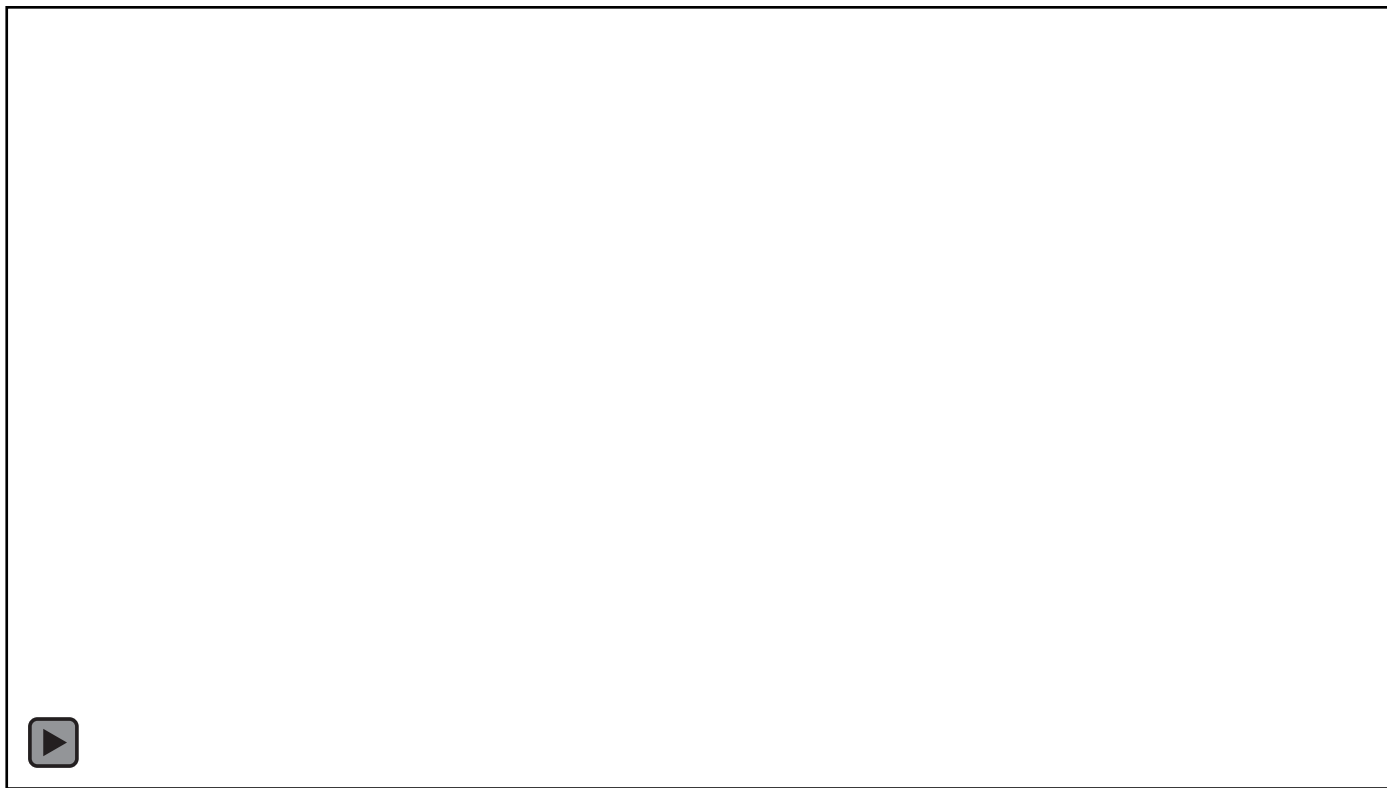
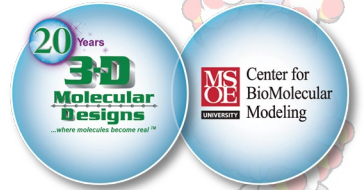
- Increased understanding.
- Lasting access to the information.
- Connections to current
- Increasing scientific liter

Drumroll please:

My *favorite* comment was...



What did my kiddos think?



Kits Used/Referenced Today

Biotechnology Kit **BTK-01**



Nucleotide Student Modeling Pack **NSMP**



Nucleotide Modeling Pack

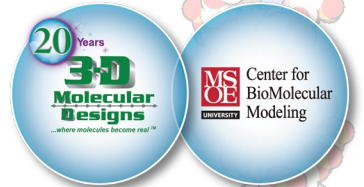
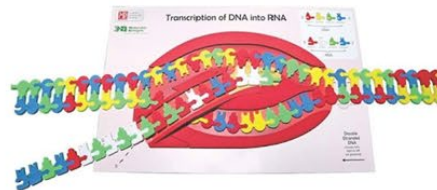


A big one for you! An at home kit for your kids!



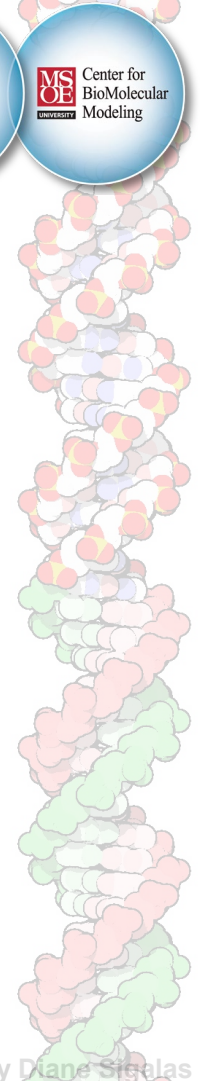
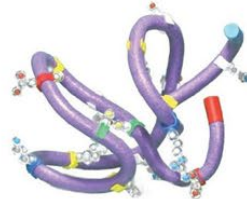
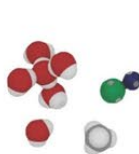


Disinfecting 3D Molecular Designs' Kits



Our kits include parts made of plastic, magnets, foam, foam-covered wire and vinyl. We tested a variety of cleaning products:

- Commercial Disinfectant Spray
- Residential and Commercial Disinfectant Wipes
- Isopropyl Alcohol
- Soap and Water
- Bleach (It may leave a white residue that can be rubbed away, particularly on foam.)
- Hydrogen Peroxide



None of the above products appeared to damage our materials except for hydrogen peroxide, which discolored vinyl stickers, placemats and nucleotide sequence maps.

We recommend you test a small amount of your organization's sanitizer on a small area of all your 3DMD products and let it set for 24 hours to confirm it won't cause damage.

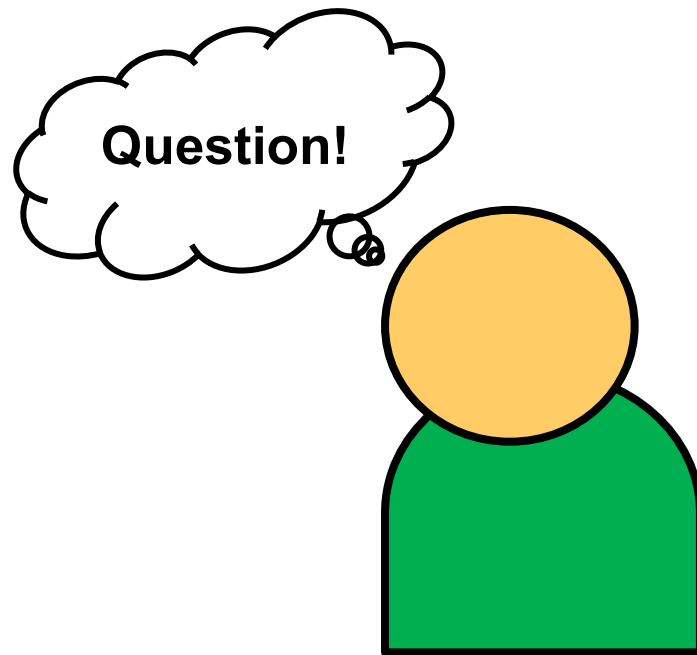
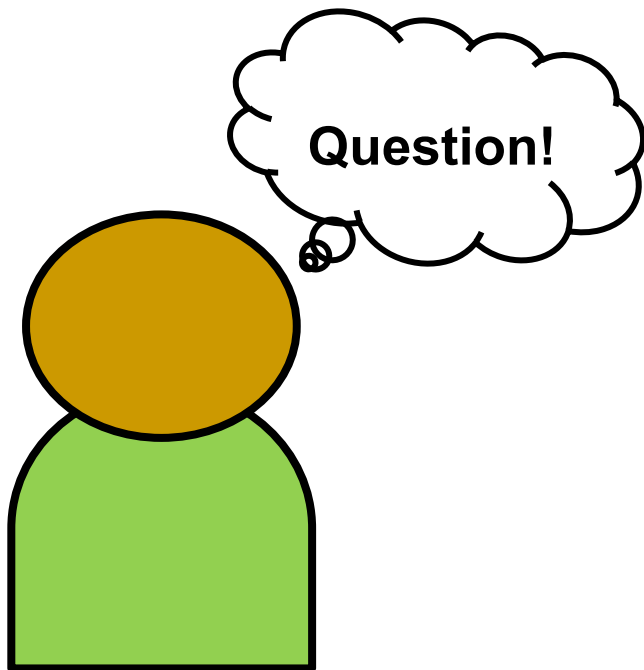
Do not use any of the above items on the cardstock materials that 3DMD includes in some kits.

A recent study found the COVID-19 coronavirus can survive up to 24 hours on cardboard.

Visit [cdc.gov/coronavirus](https://www.cdc.gov/coronavirus) for more guidance on cleaning and disinfecting with EPA-approved products, and for the latest research on how long coronavirus lives on paper and other surfaces.

Wrapping Things Up

Thank you for attending!



Thank You



Diane Sigalas

dsigalas@livingston.org



<https://www.linkedin.com/in/diane-sigalas/>



@LancerBiotech



From Biotechnology to a Coronavirus Vaccine

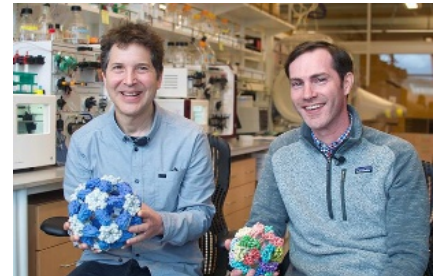


New Approaches to Vaccine Developments: *a preview....*

1. **Katalin Kariko** and mRNA vaccines.



2. **David Baker** and ultra-potent,
multivalent nanoparticle flu vaccines.



Kati Kariko and the perseverance of women research associates



<https://www.nytimes.com/2021/04/08/health/coronavirus-mrna-kariko.html>

<https://www.cnn.com/2020/12/16/us/katalin-kariko-covid-19-vaccine-scientist-trnd/index.html>

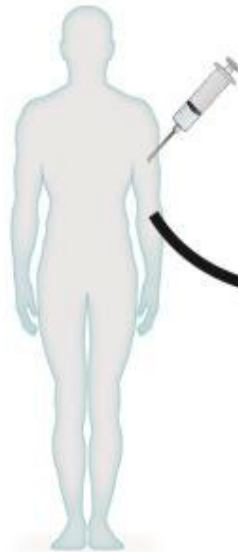
Formulation

mRNA modifications → translation **vs** (self)-adjuvancy



naked mRNA
vs
mRNA (lipid)
nanoparticles

mRNA vaccination



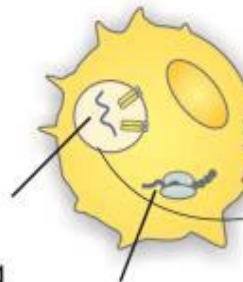
In vivo delivery

local **vs** systemic

extra- & intracellular
barriers

Mode of action

mRNA-
danger
sensing



MHC pathways
co-stimulation

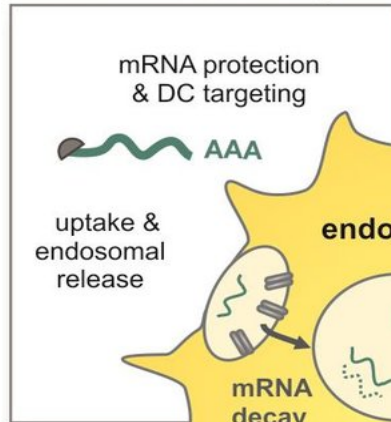
**T cell
activation**

Type I IFNs

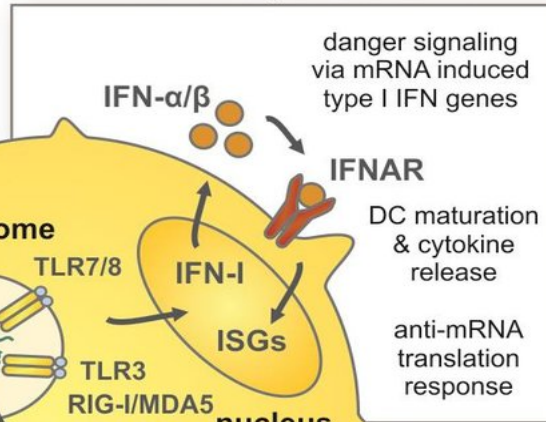
in situ antigen
production

antiviral immunity
vs anti-mRNA activity

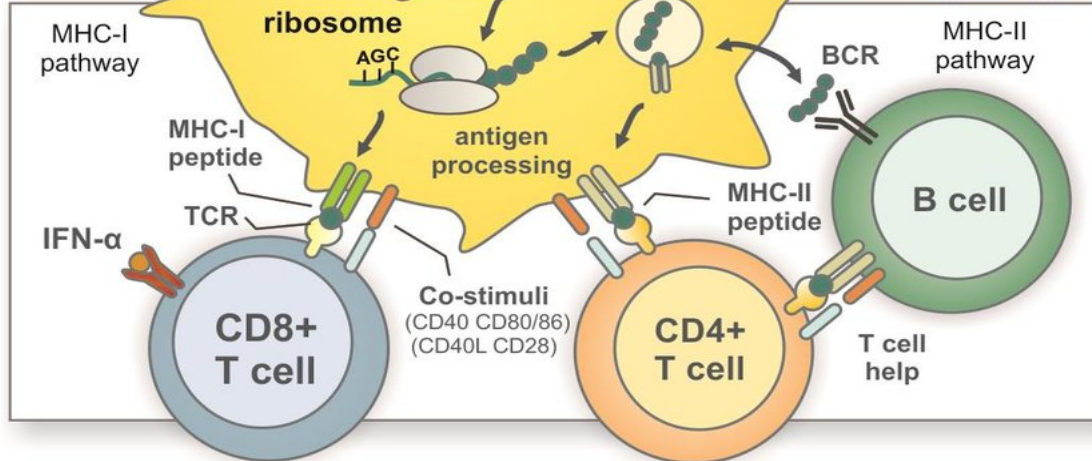
1. mRNA delivery



2. Self-adjvant effect



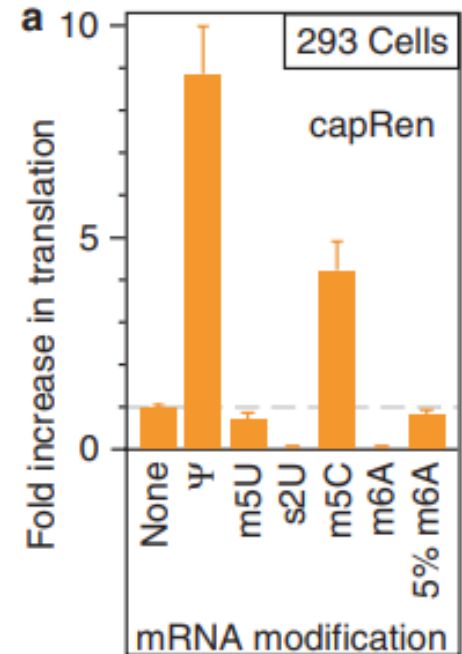
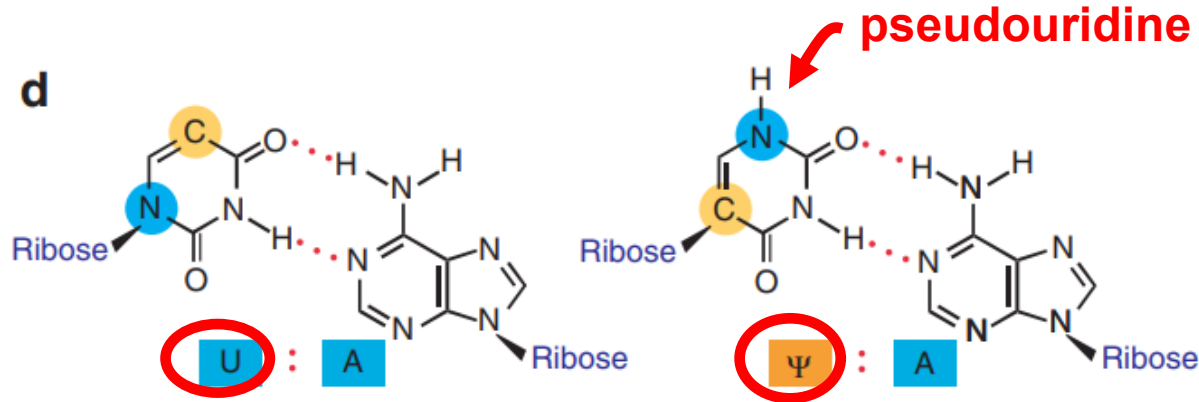
3. Antigen signal



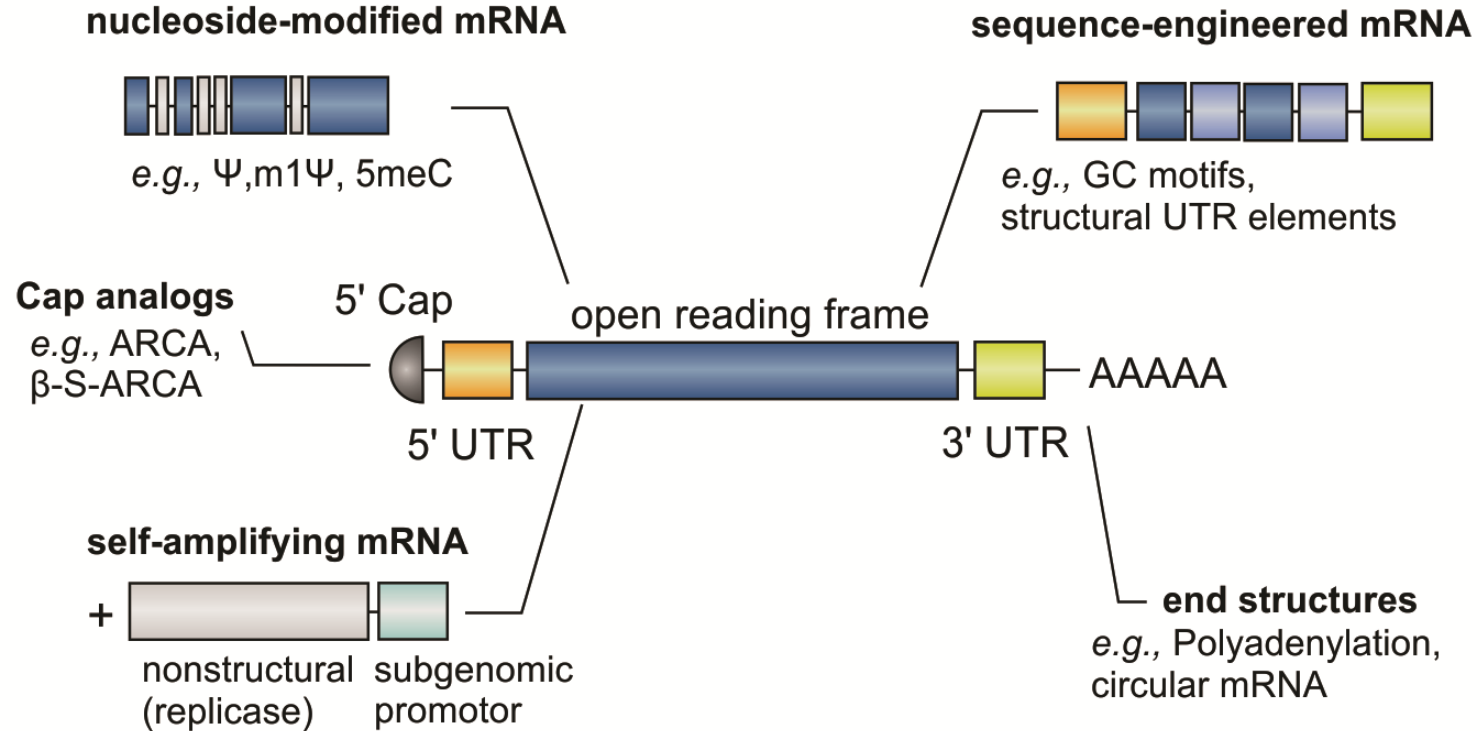
Incorporation of Pseudouridine Into mRNA Yields Superior Nonimmunogenic Vector With Increased Translational Capacity and Biological Stability

Katalin Karikó¹, Miromi Muramatsu¹, Frank A Welsh¹, János Ludwig², Hiroki Kato³, Shizuo Akira³ and Drew Weissman⁴

Molecular Therapy vol. 16 no. 11, 1833–1840 nov. 2008

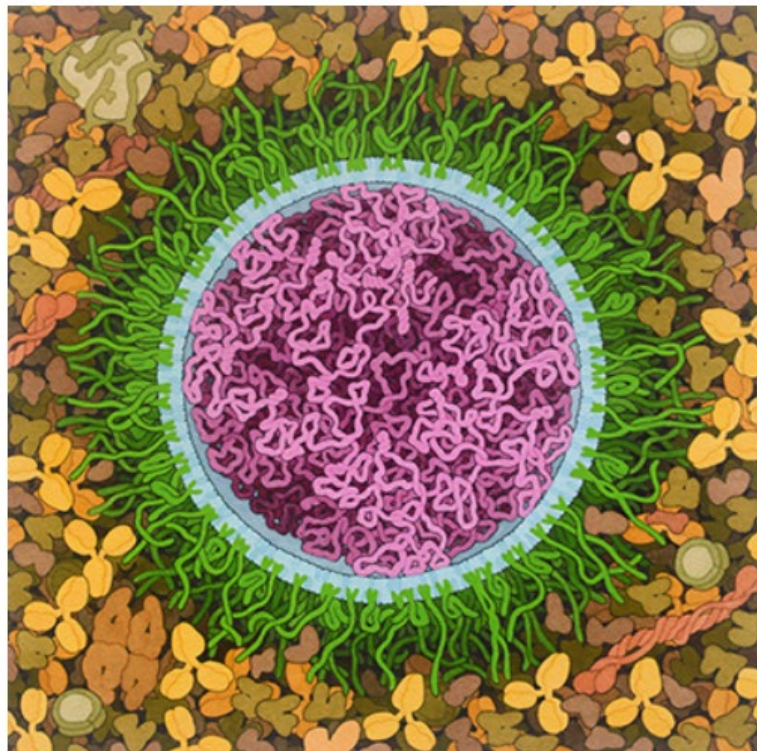


IVT mRNA & modifications



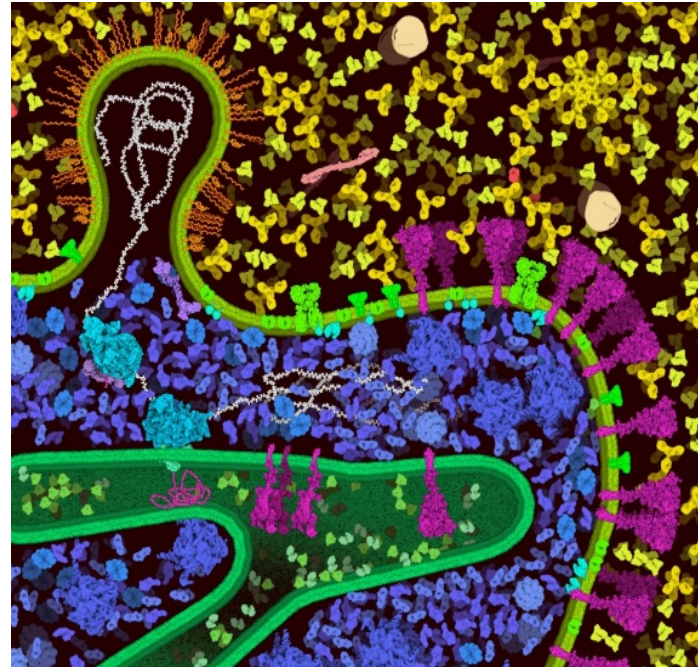
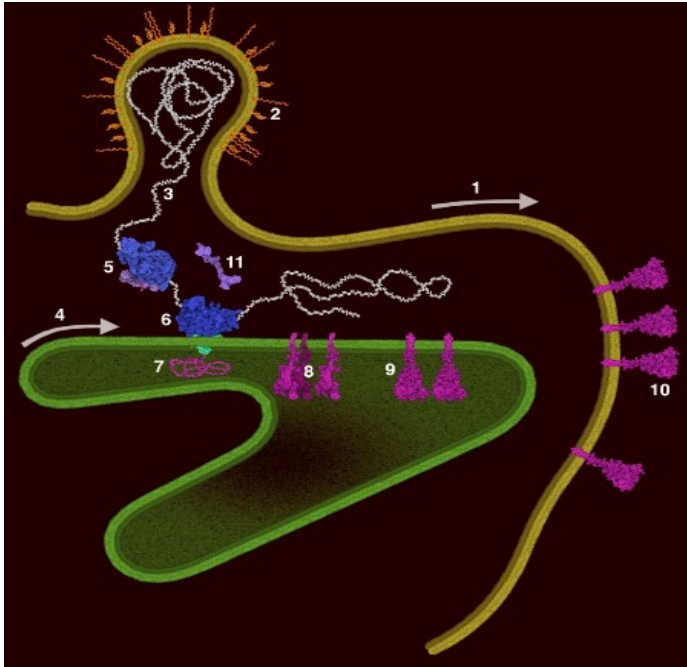
The modRNA sequence of the vaccine is 4,284 nucleotides long.^[76] It encodes the full-length spike protein of Sars CoV-2. It consists of a five-prime cap; a five prime untranslated region derived from the sequence of human alpha globin; a signal peptide (bases 55–102) and **two proline substitutions** (K986P and V987P, designated "2P") that cause the spike to adopt a prefusion-stabilized conformation**a codon-optimized gene** of the full-length spike protein of SARS-CoV-2 (bases 103–3879); followed by a 3'untranslated region (bases 3880–4174) for increased protein expression and mRNA stability^[78] and a poly(A) tail. **The sequence contains no uridine residues; they are replaced by 1-methyl-3'-pseudouridylyl.**^[76]

SARS-CoV-2 mRNA Vaccine, 2020



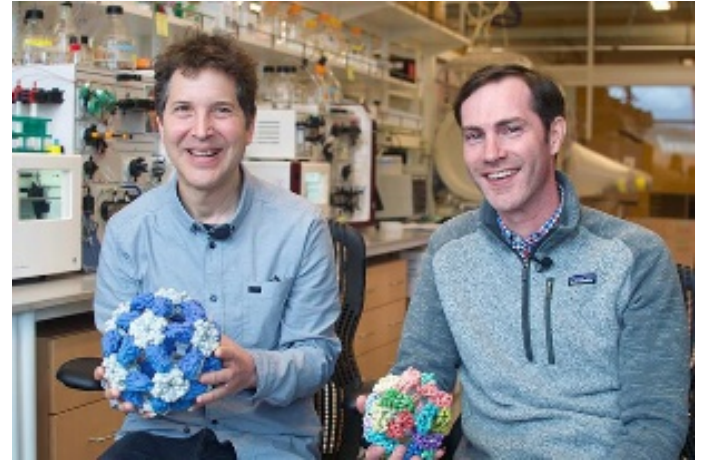
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David Goodsell's CellPaint



<https://ccsb.scripps.edu/cellpaint/2021-cellpaint-contest/>

David Baker founder of the Institute for Protein Design



Self-Assembling Nanomaterials and Vaccines

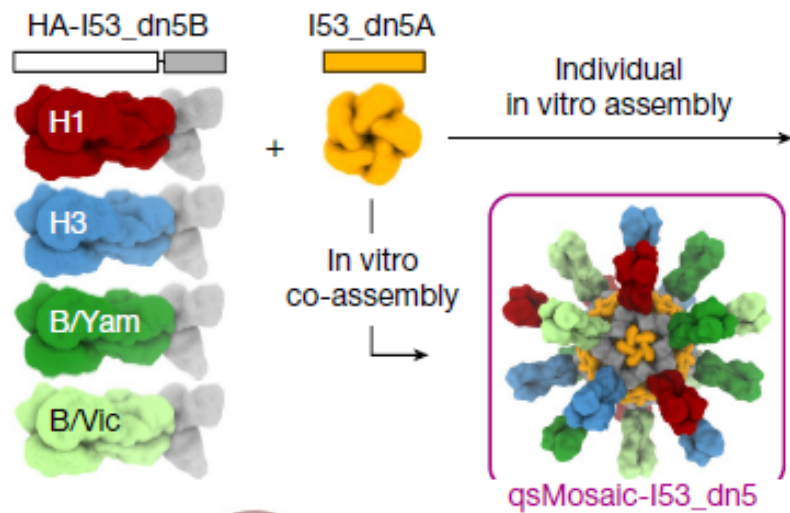
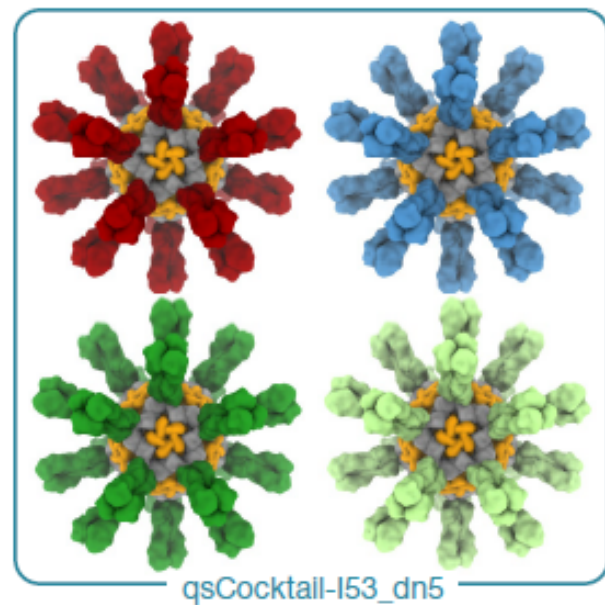
David's TedTalk <https://www.ipd.uw.edu/audacious/>

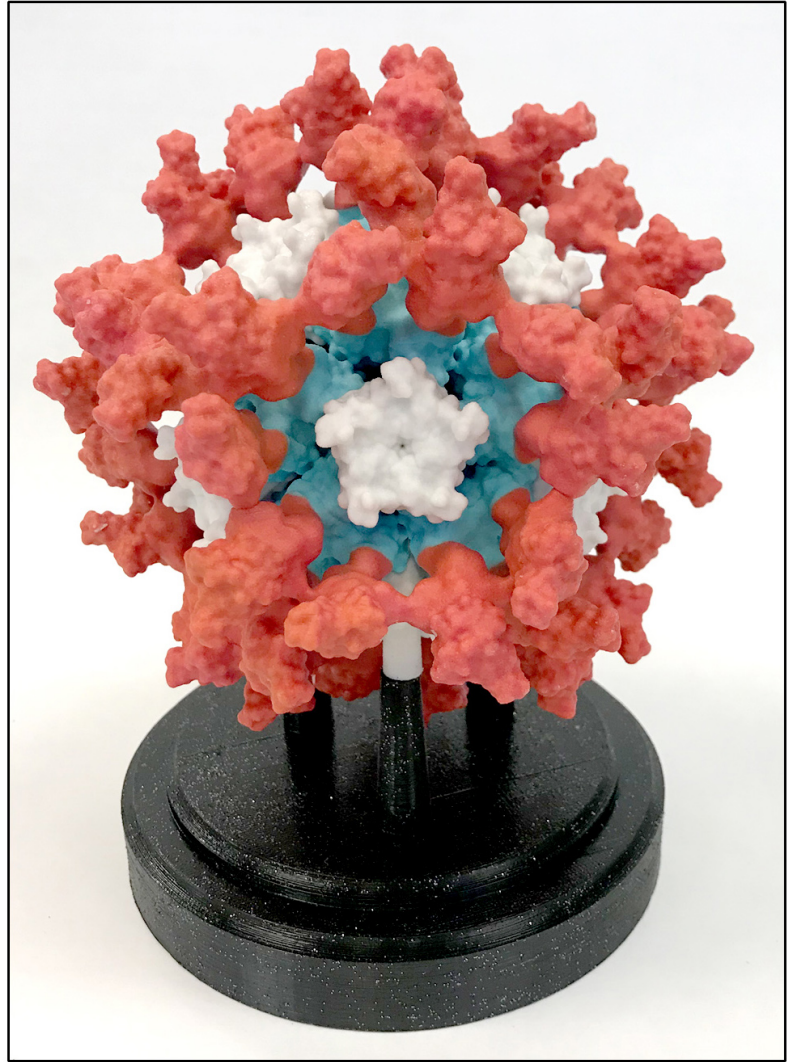
Quadrivalent **influenza nanoparticle
vaccines induce broad protection**

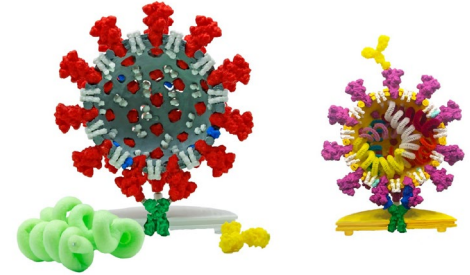
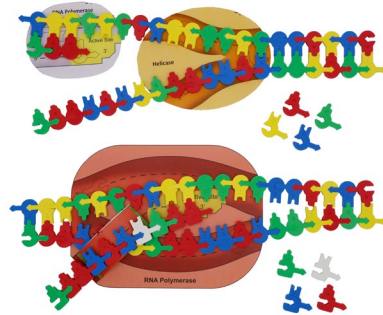
<https://www.nature.com/articles/s41586-021-03365-x>

**Elicitation of Potent Neutralizing Antibody
Responses by Designed Protein
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<https://www.cell.com/action/showPdf?pii=S0092-8674%2820%2931450-1>

a**c**





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