

The Future is CRISPR

*Using models to teach Genetic Engineering and
CRISPR Technology*



Why Me?



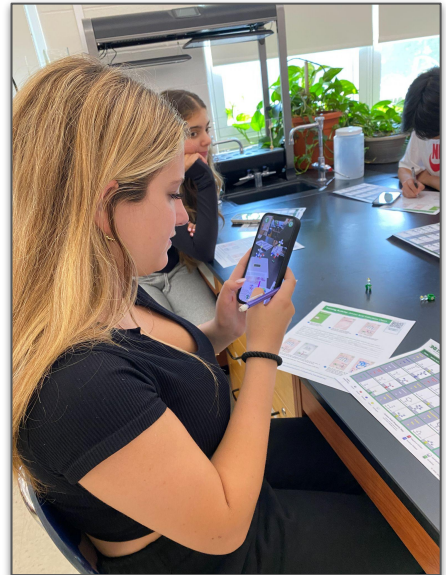
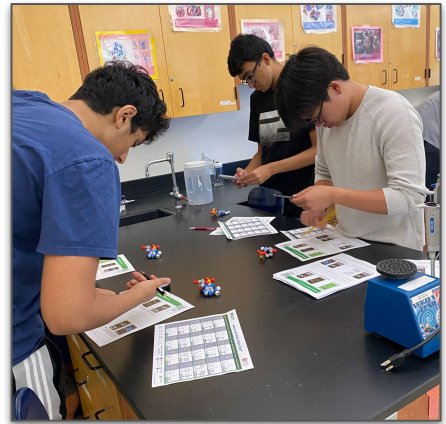
Diane Sigalas

- Biotechnology Teacher at Livingston High School - Livingston, NJ
- Curriculum Developer
- M.Ed: Educational Leadership
- Cohort 2- Science and Ethics of Genome Engineering with MSOE
- Model Teacher with 3D Molecular Designs

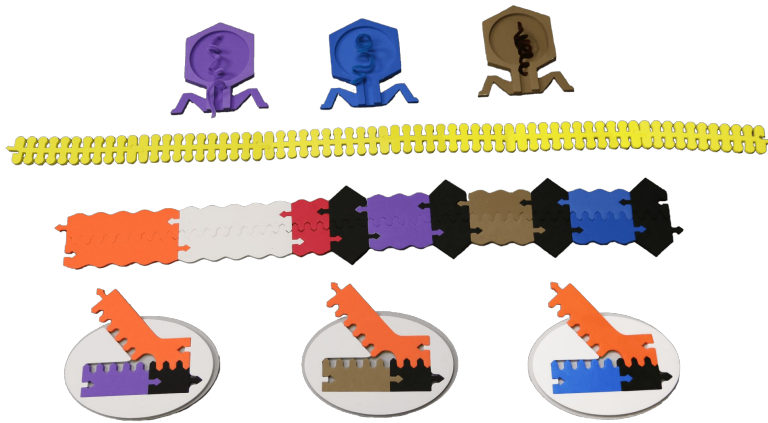


The AR Future!

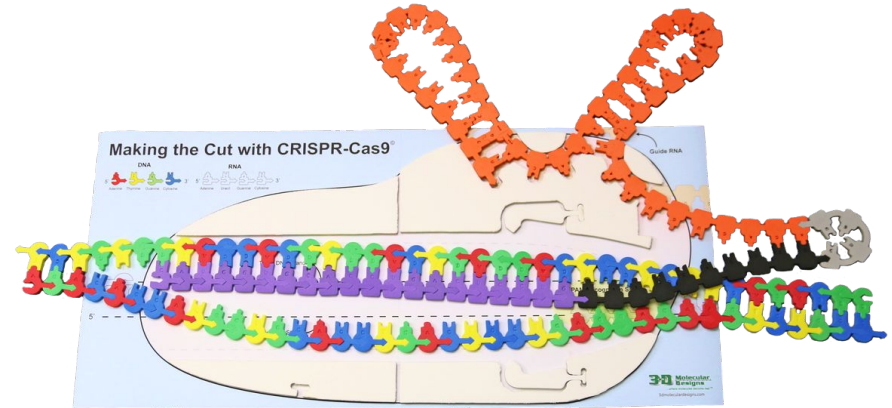
- Come visit us today at **Booth 6 & 7** to grab an **AR DNA model!**
- Be a part of this amazing new venture to bring **AR technology** into the classroom - and **engage your students like you never imagined!**



The Dynamic Duo



Adaptive Immunity Kit
(AIK)

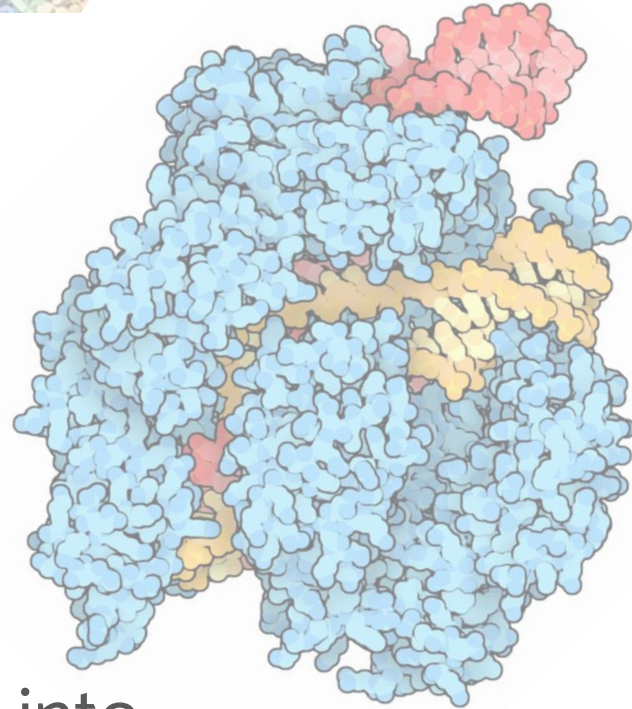


Making the Cut with
CRISPR-Cas 9
MCC

Workshop Learning Goals



- Get excited about the benefits of modeling.
- Practice how to use the kit
- Realize how incredibly amazing **(and understandable!)** CRISPR research is!
- Identify places where you could incorporate CRISPR based science into your curriculum.



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
Analyze & Interpret Data	Structure and Function	
Construct Explanations	System and System Models	
Engage in Arguments from Evidence	Scale, Proportion, and Quantity	

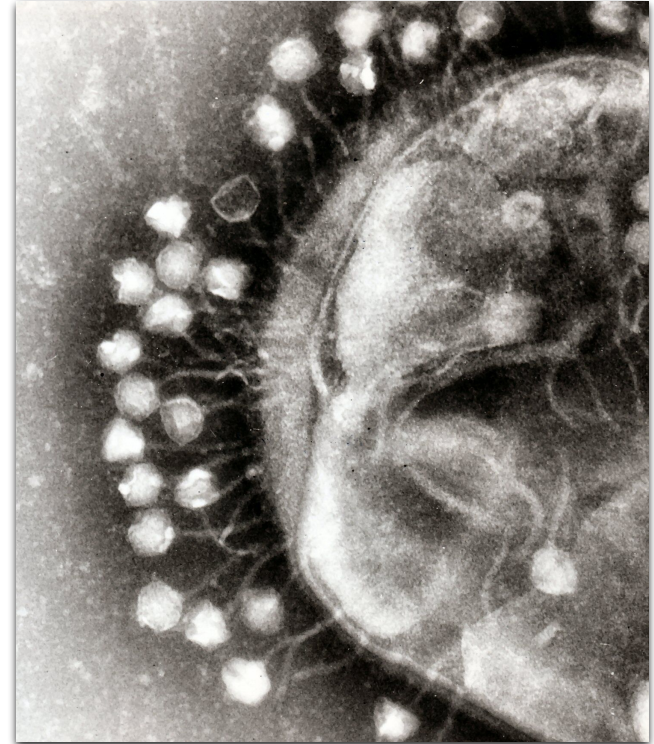


It is one **gigantic festival of NGSS-ness!** They all honestly fit. It just depends what route you choose to go with your kids.

Attack of the Phages

From the dawn of time, viruses have evolved along side of their host. As one entity develops a new offensive tactic, the other responds with a new defensive maneuver.

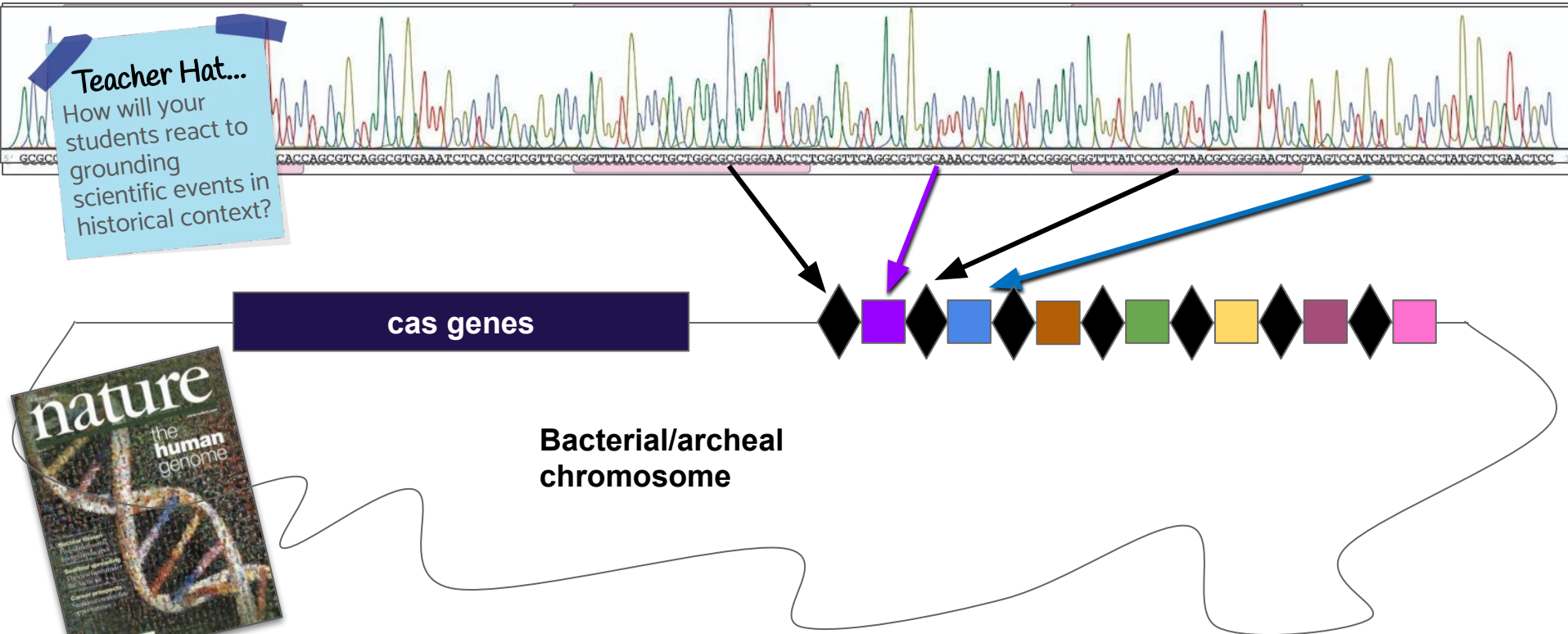
Pictured to the right is a bacterial cell with a halo of attacking phages eagerly ready to infect it. It is from these seemingly simplistic organisms that a new frontier of science is evolving before our very eyes.



Acronyms on acronyms

Teacher Hat...

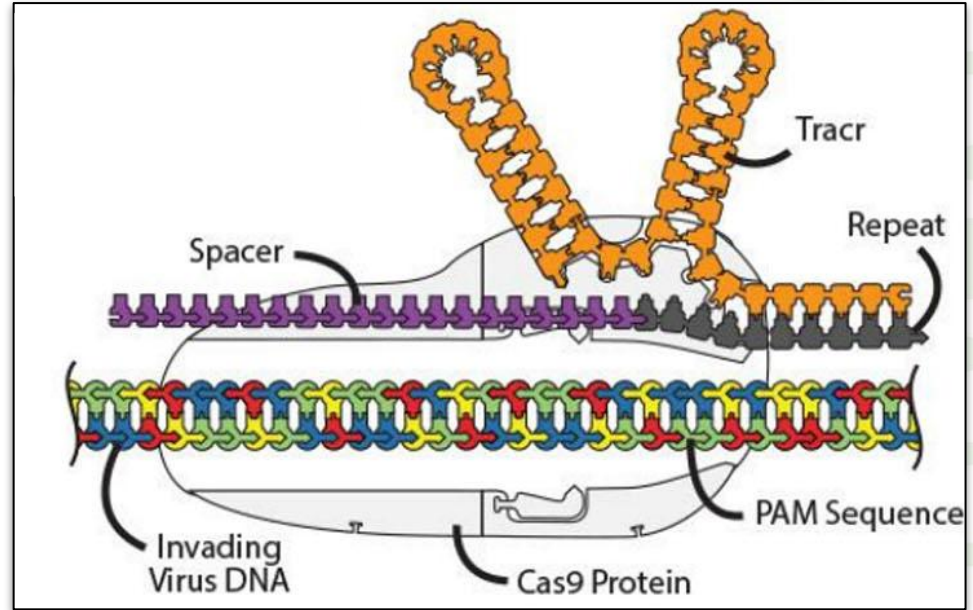
How will your students react to grounding scientific events in historical context?



Let's **wonder** a little... shall we?

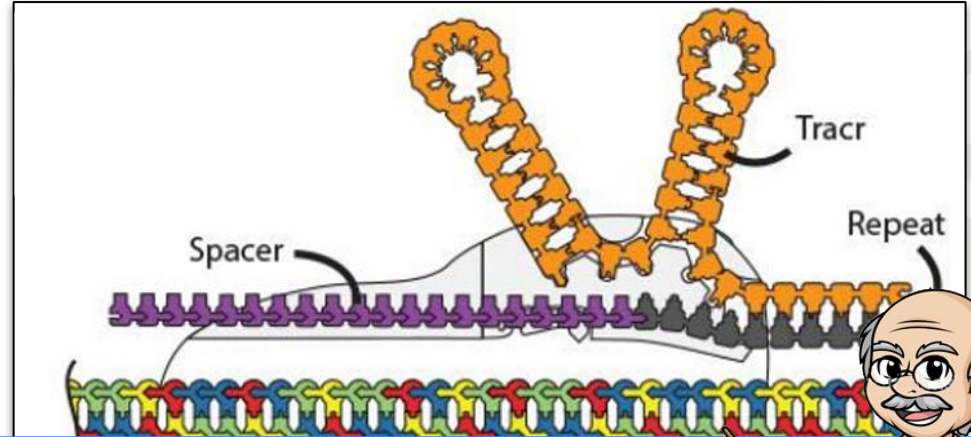
Before we even begin,
what interactions do
you see?

Who is touching who?
What do you notice?



Just who are these pieces?

Let's go over just who these pieces are and what they do in this system pictured to the right:



- **tracrRNA**
- **Spacer**
- **Repeat**
- **cas9 Protein**
- **Viral DNA**
- **PAM Sequence**

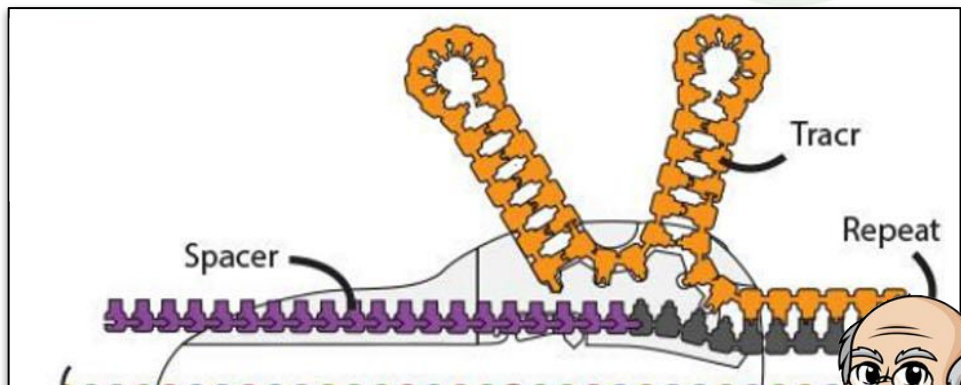
Let's pause.

Turn to your neighbor... discuss, re-explain, find a question you want to ask.



Time for a little **wonder** again

Now that you know who is who and what they do...



Who is touching who
Why do you think the
parts are touching

Let's pause.

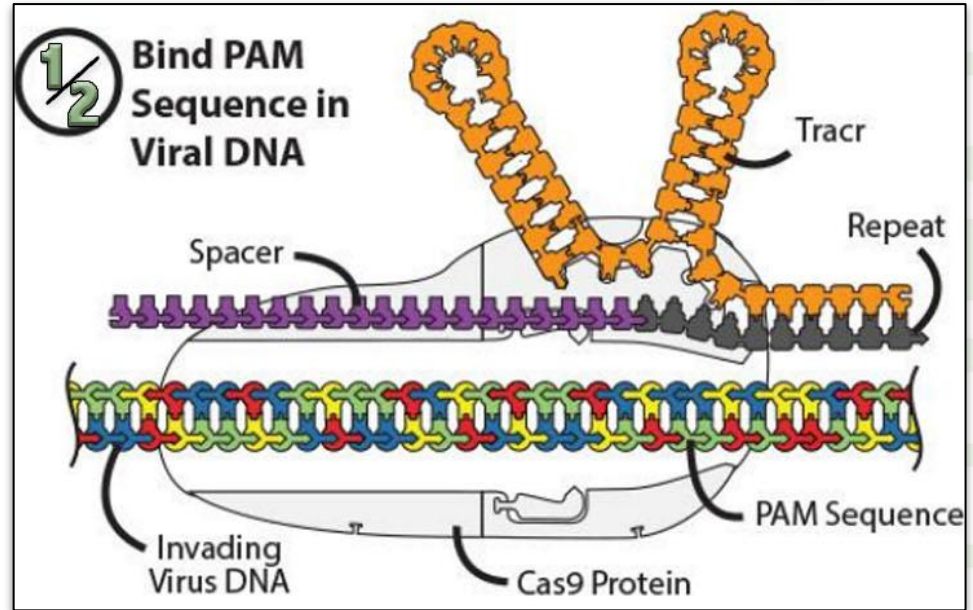
Now look at the 3D model at your table. How do you see these schematic foam pieces interacting in the 3-dimensional version? Does this change your answer?



Step One: Bind PAM

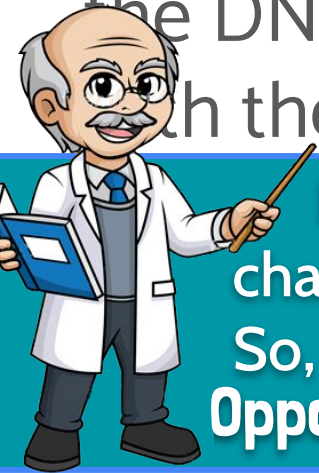
Let's **explore** how the **system works!** First, the DNA will bind to the cas9 protein at a **PAM sequence**,

Think of this like the **AUG start codon** with transcription!

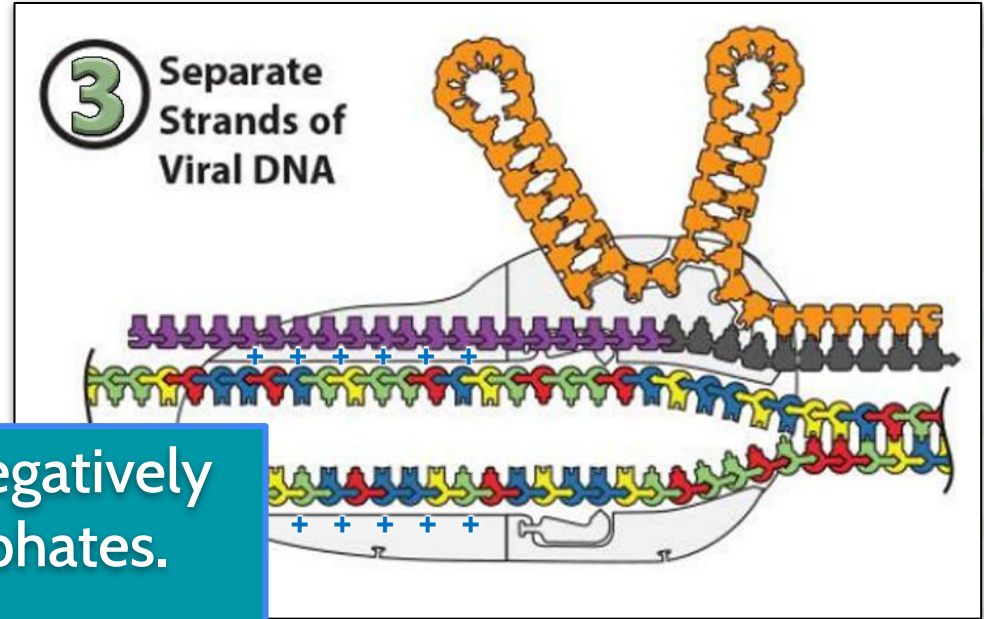


Step Two: Keep em' Separated!

Then, there are positive amino acid residues along where the DNA interacts with the cas9 protein.



Remember, DNA is negatively charged due to the phosphates. So, positive... negative...
Opposites attract! Open Sesame!

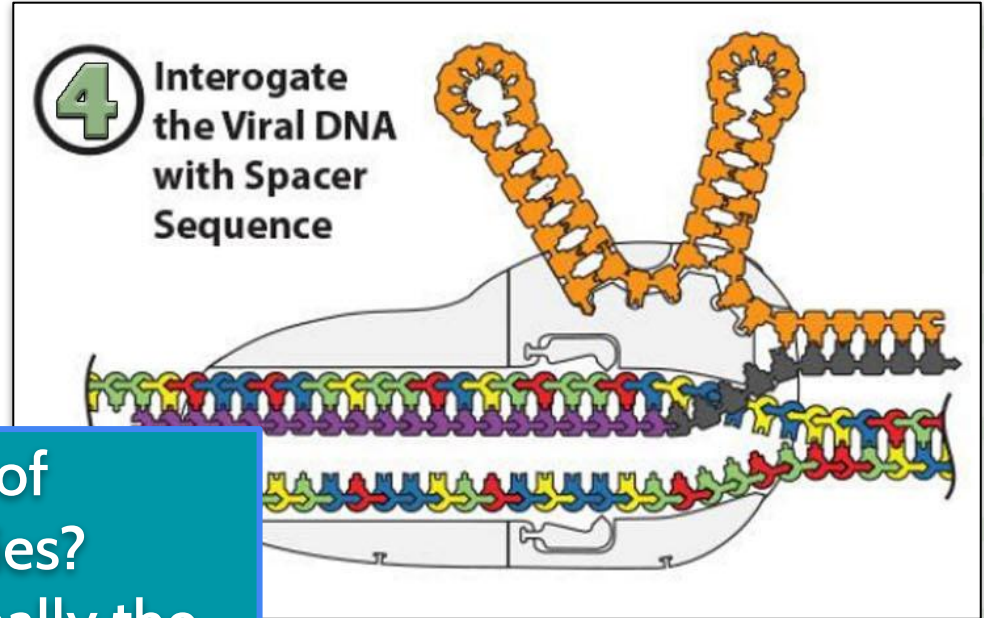


Step Four: Interrogation Time

Then, the bacterial CRISPR/cas9 system will use the spacer sequence from a previous phage attack to **interrogate the**



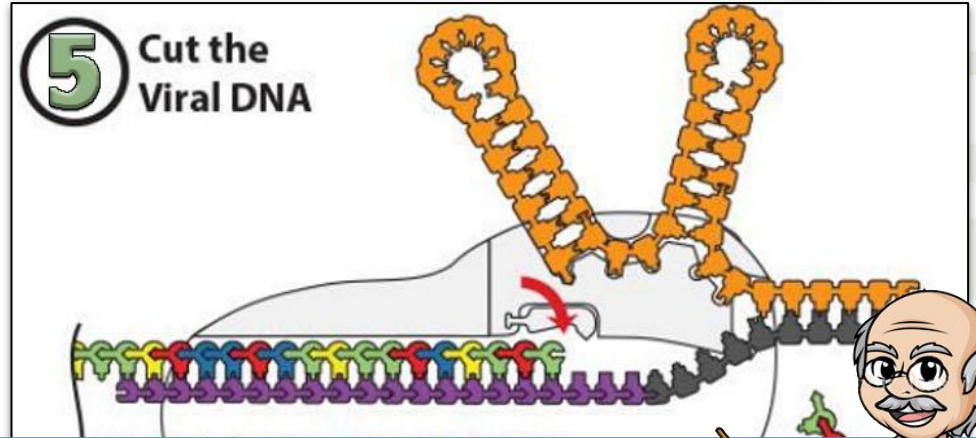
Does this remind you of anything in our own bodies? Remember... this is originally the **bacterial immune system...**



Step Five: Break it Up!

Finally, if the spacer sequence matches the invading DNA strand - time to cut it! Two endonucleases will

create a double strand break in the DNA. Think about how this will affect the DNA...?



Next question...

How could we use this model to help **explain** how CRISPR works to our students?



What could this look like

- Levels?
- Integration into lessons?
- How much do you want to open the floodgates?



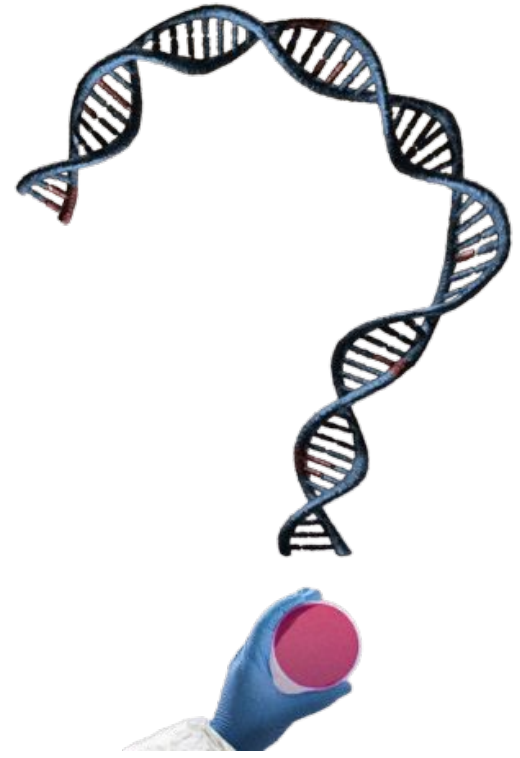
But floodgates are so much fun

Stopping at this point has its purpose... but leaves out on all of those questions the students have...



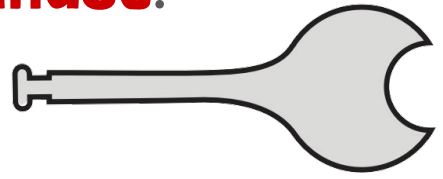
What do you wonder about with the future of CRISPR?

What do your students wonder about?
What are their big questions?

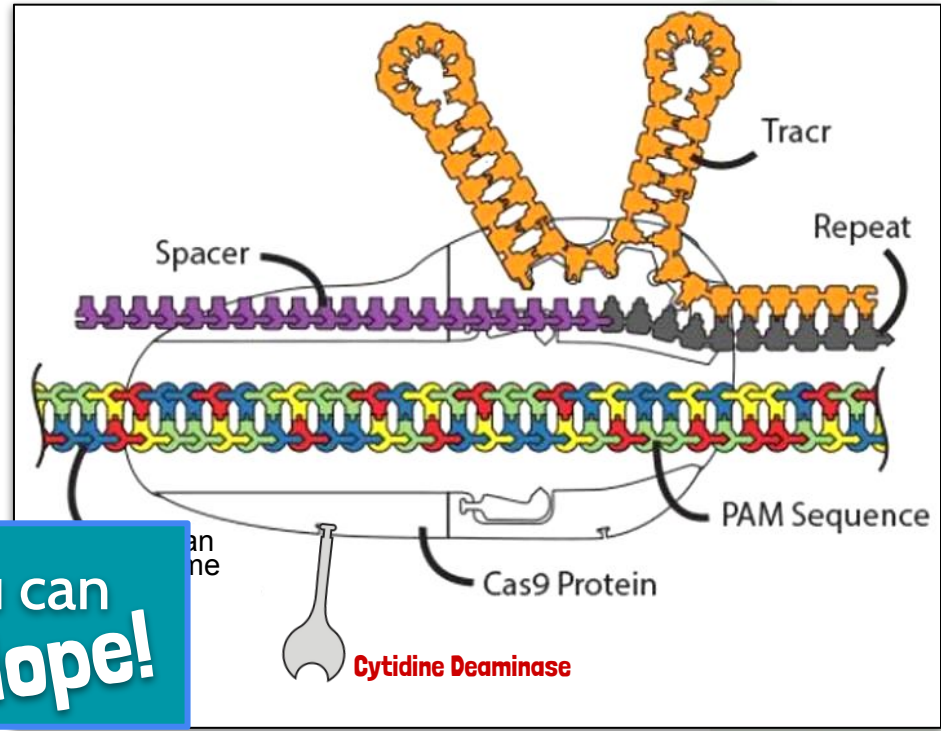


A tiny little add-on

We can attach a little protein called a **cytidine deaminase**.

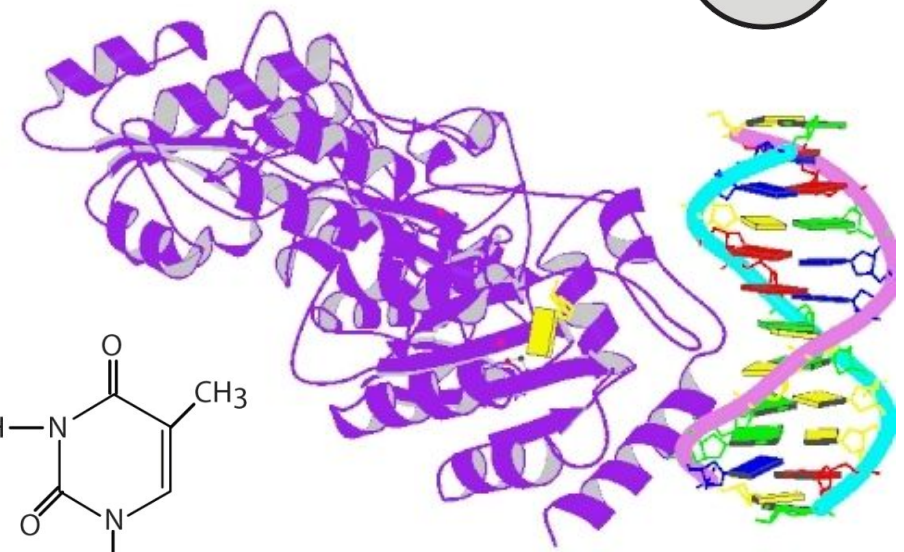
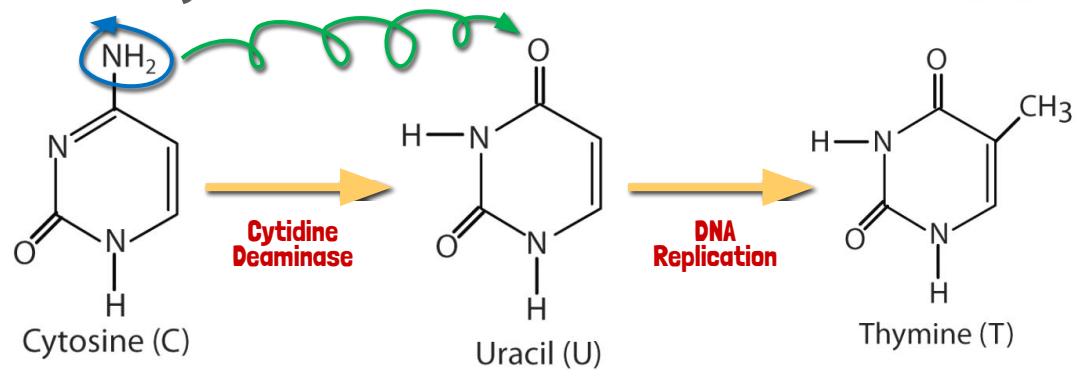
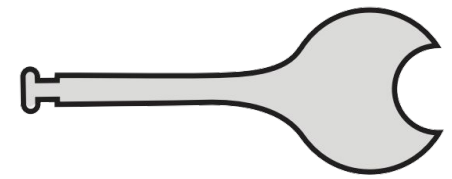


Is this the only thing you can add on to a cas protein? **Nope!**



Cytidine Deamin...what?

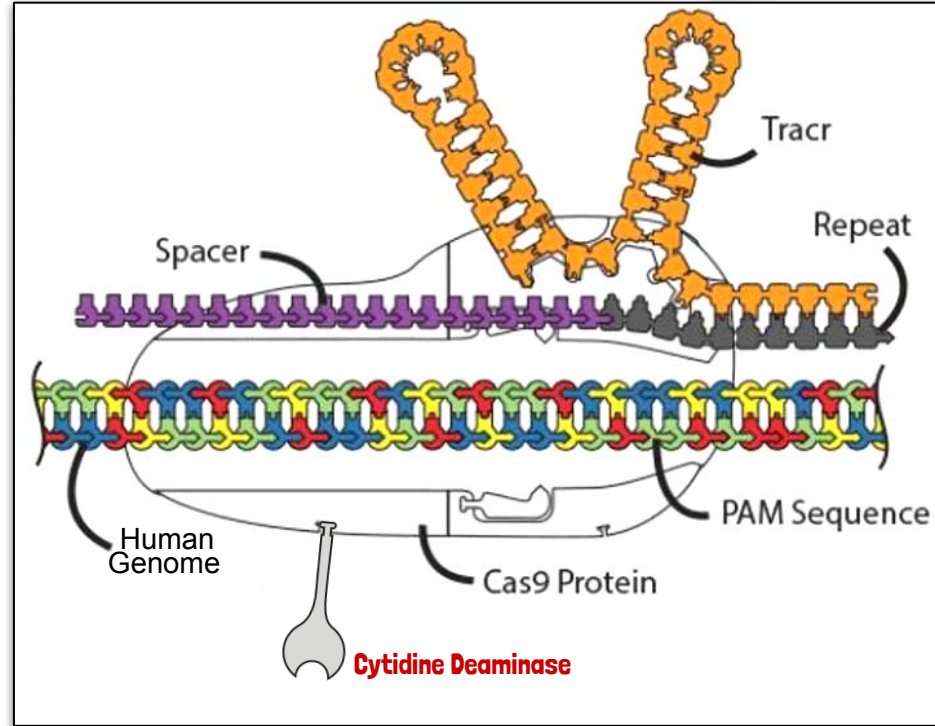
Cytidine deaminases are one of the proteins responsible for all of the diversity in our antibodies.



So let's go back...

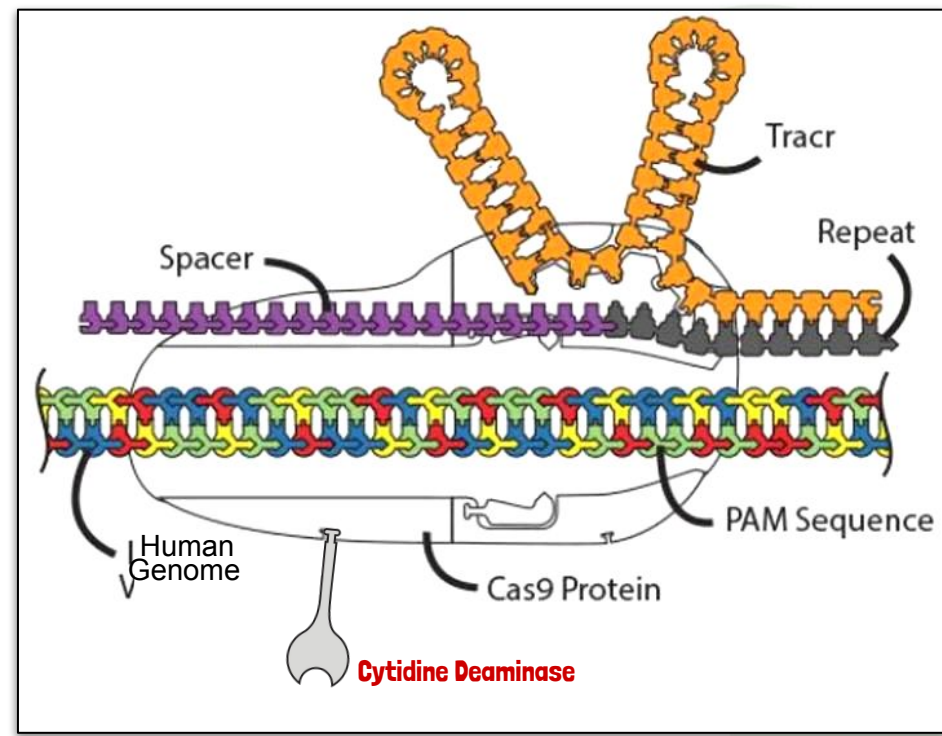
Looking again at our sequence, is there a **C** in reach of our cytidine deaminase that we can change to a **U**?

Awesome, now if that **U** changes to a **T**... how would **DNA polymerase 1** respond?



What did you just do?

That is the much simplified description of what **Matthew Porteus** is doing to cure sickle cell anemia!

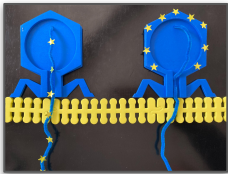


Sequencing Ideas

- Depends on what your course sequence.
- Biotechnology I - Bioethics Unit
 - Adaptive Immunity & Basics of Structure
- Biotechnology II - Modifications that can be made to the system
 - System modifications (protein & genomic)
 - Use as a testing modality



The Buffet of Options:

Middle School	High School <i>CP</i>	High School <i>Honors</i>	High School <i>Elective</i>	AP Bio	Collegiate Level
Teacher demo model the Adaptive Immunity Kit as a way to illustrate protein formations.	Student model the Adaptive Immunity Kit. Teacher demo model the Making the Cut Kit <i>Can also be used for teacher demo Hershey/Chase experiment!</i> 	Student model the Adaptive Immunity Kit Connect to diversification of Ig molecules. Student model the Making the Cut Kit. Can also be used for student discovery/modeling of the Hershey/Chase experiment.	Student model of the Adaptive Immunity Kit. Student model the Making the Cut Kit. Base editor design project. Teacher demo the the MCC kit for base editing. Connections back to Sickle Cell and various other diseases are possible!	Student model of the Adaptive Immunity Kit. Student model the Making the Cut Kit. Student developed extensions/parallels to VDJ recombination with Ig development.	Student model of the Adaptive Immunity Kit. Student model the Making the Cut Kit. Base editor design project. Teacher demo the the MCC kit for base editing or PRIME editing. With lit review extension to ways it is being used in current research.

Student Thoughts



Meet Brian!



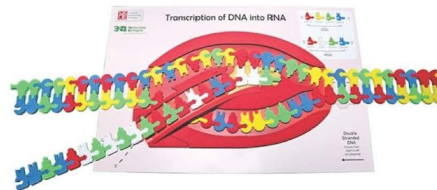
Brian took Biotech 1, and is now a sophomore at Drew University

I just want to let you know that I was talking with my bio professor the other day about CRISPR and genomic modifications. I not only understood what they were saying but could add in.



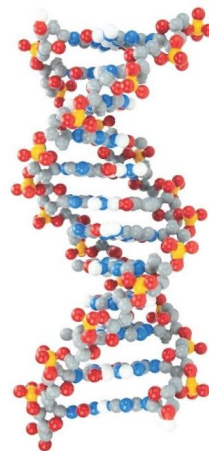
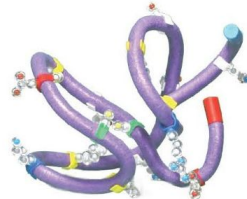
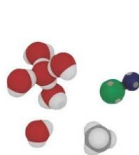
Disinfecting

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

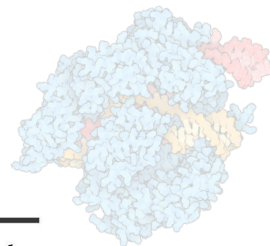


None of the above products appeared to damage our materials except for hydrogen peroxide, which discolored vinyl stickers, placemats and nucleotide sequence maps.

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.

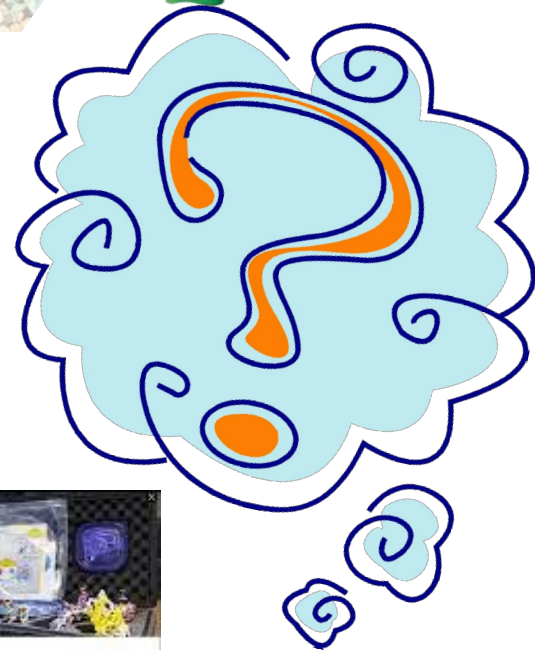
So... Now What?



- 3DMD website for resources

3dmoleculardesigns.com

- Lending Library



Ready for a life altering experience?

A screenshot of the 3d molecular designs website homepage. The header includes the logo, a search bar, and navigation links for "About Us", "Home", "Our Cars", "Info", and "My Account". Below the header is a navigation menu with "Kits & Models", "Classroom Resources", "Professional Learning", "Custom Models", and "About Us". The main content area features a purple sidebar for "Professional Learning" and a large image of people working with molecular models. Below this is a section titled "The Power Of Modeling" with a video thumbnail and descriptive text.

Professional Learning

Join us to connect with current science content and education pedagogy throughout the year. On line or in person, you'll learn a lot, have fun, and become part of a network of dedicated educators. Explore our offerings below.

The Power Of Modeling

Physical and conceptual models provide experiences for inquiry and provide student questions. These questions invite conversations, debates, and investigations. Grasping and complexity through modeling can make the difference between a student struggling and that

Wrapping Things Up

Thank you for attending!



Thank You



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