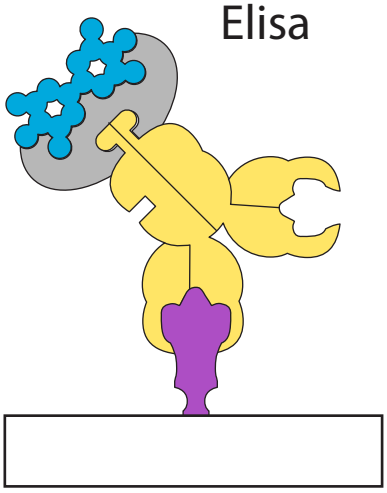
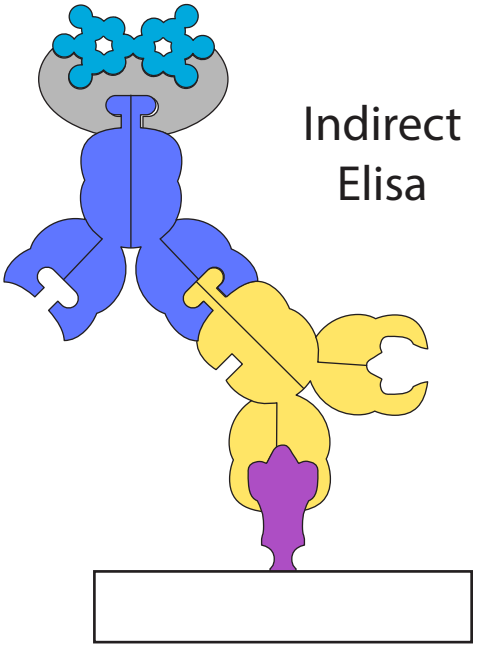
Antibody Diagnostics Modeling Kit

ELISA Setups

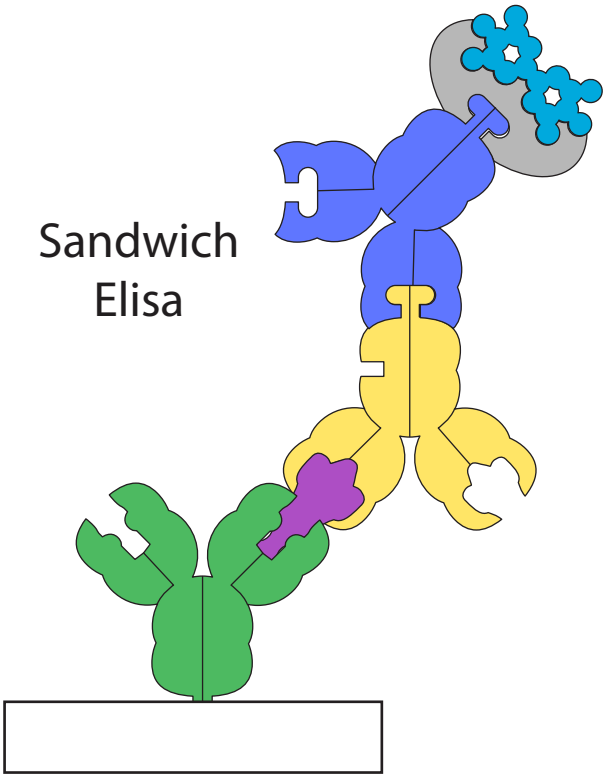
Direct Elisa



Indirect Elisa



Sandwich Elisa



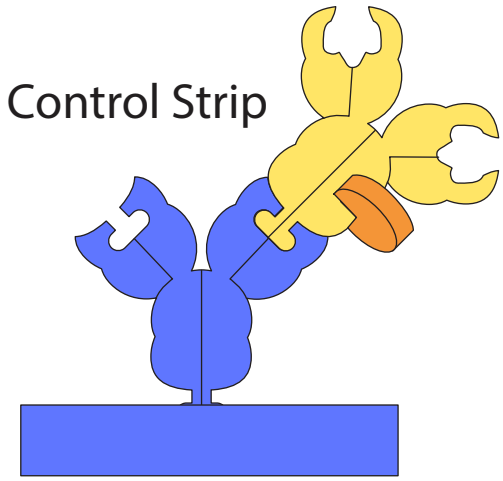
Step 1: populate the Elisa well (white circle) with purple antigen sample (for direct and indirect) or green antibody with antigen (for sandwich)

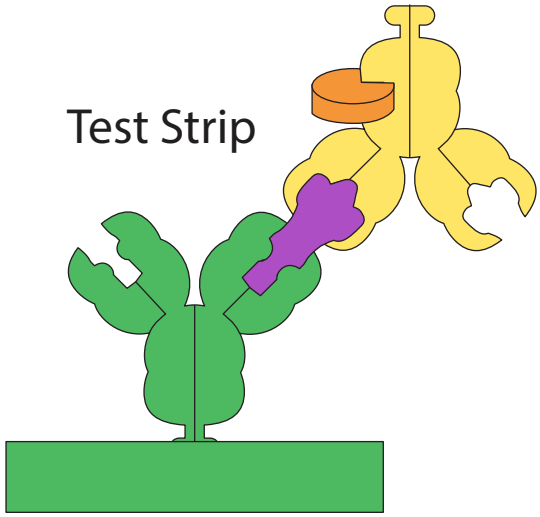
Step 2: Wash over elisa well with yellow antibody (with gray/cyan marker molecule for direct... and no marker molecule for indirect and sandwich)

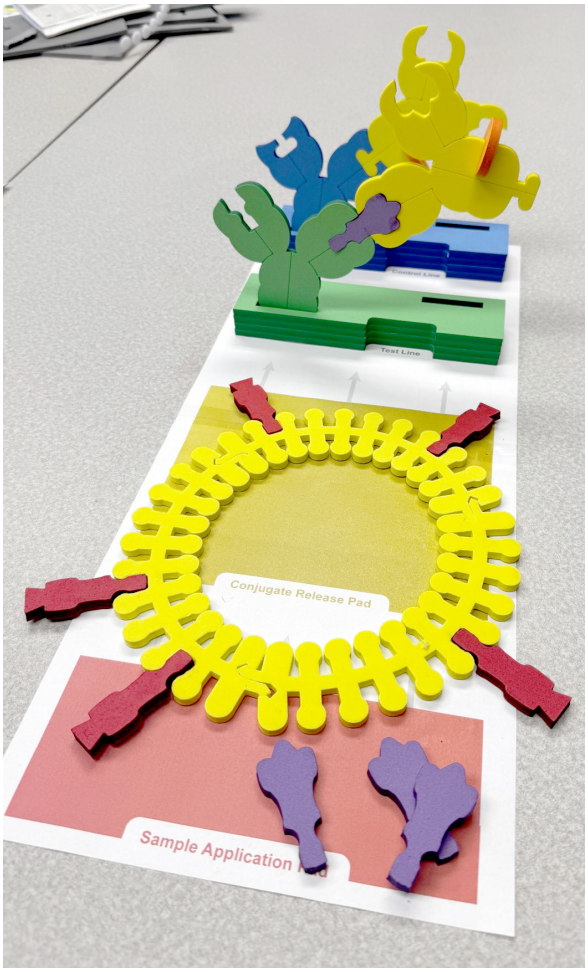
Step 3: Wash over elisa well with blue antibody with marker molecule (only for indirect and sandwich).

Antibody Diagnostics Modeling Kit

Lateral Flow Setup







Step 1: populate the yellow region with yellow free-moving antibodies (with the orange/gold circle attached), green test strip with stationary green atnibodies and the blue control strip with stationary blue antibodies.

Step 2: load your "sample". Have some students load 1x virus with purple surface proteins (the target of the flow test) and others load 1x virus with red surface proteins (a different virus not being targetted)

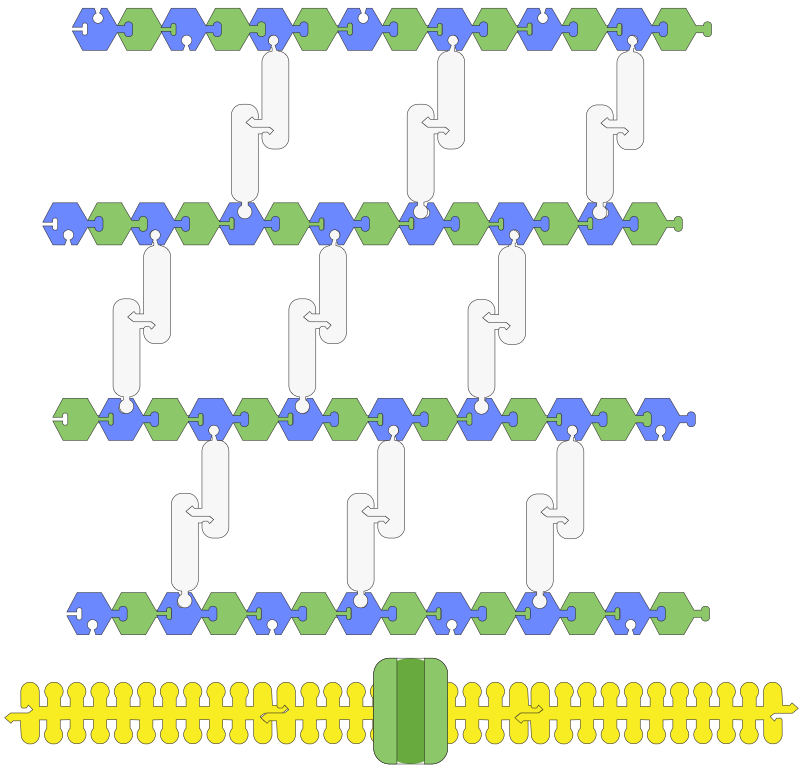
Step 3: Pretend to wash the sample with detergent to dissolve the membranes and leave the red/purple surface protein antigens free-floating.

Step 4: Model the flow of the antigens past the yellow antibodies (some of which grab on to the purple antigen) and past the control and test strips.

Step 5: Have students record/share results.

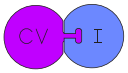
Bacterial Membrane Kit

Basic Setup



Gram Positive

- single membrane
- multiple peptidoglycan layers (green/blue/white)
- use violet/iodine or safrinin to model staining, with gram+ soaking in more than gram-

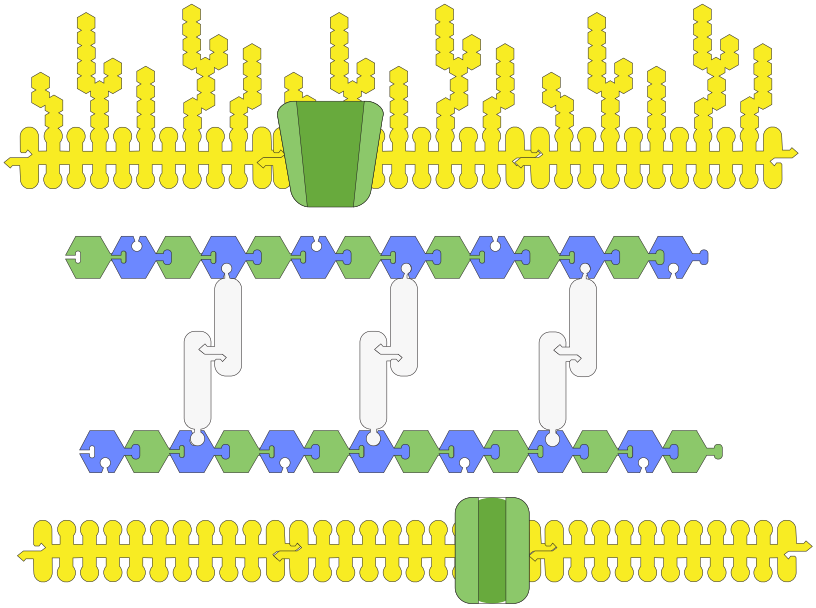


Crystal Violet

Iodine



Safrinin

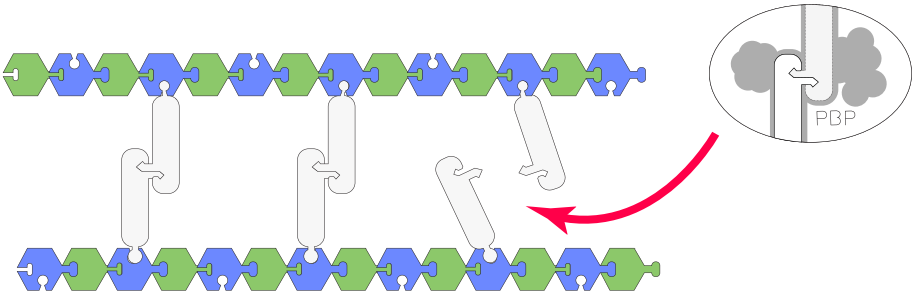


Gram Negative

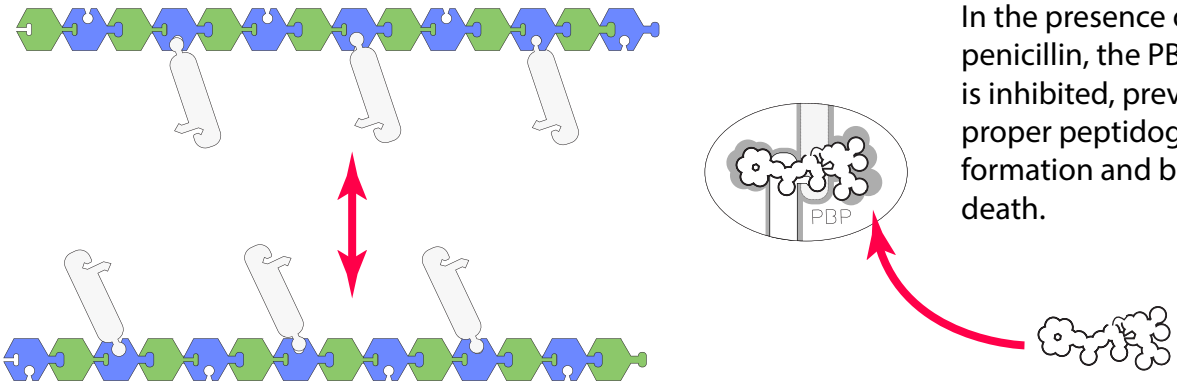
- double membrane, with outer membrane being liposaccharides
- thin peptidoglycan layers (green/blue/white)
- use violet/iodine or safrinin to model staining, with gram+ soaking in more than gram-

Bacterial Membrane Kit

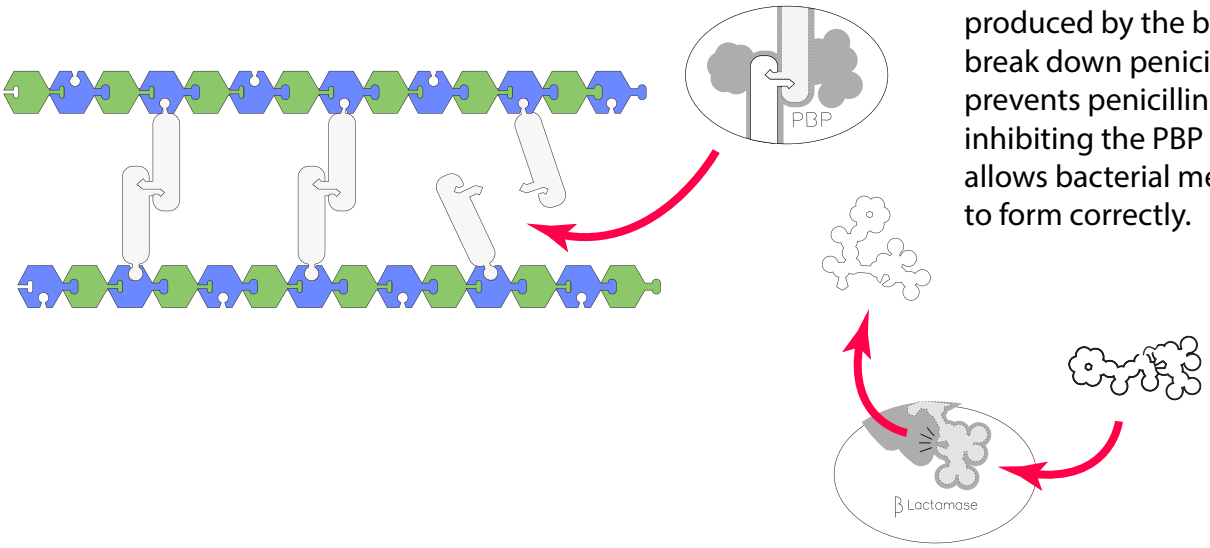
Penicillin Story



The PBP enzyme joins the peptide portion of the peptidoglycan layers, allowing for the formation of the bacterial membrane.



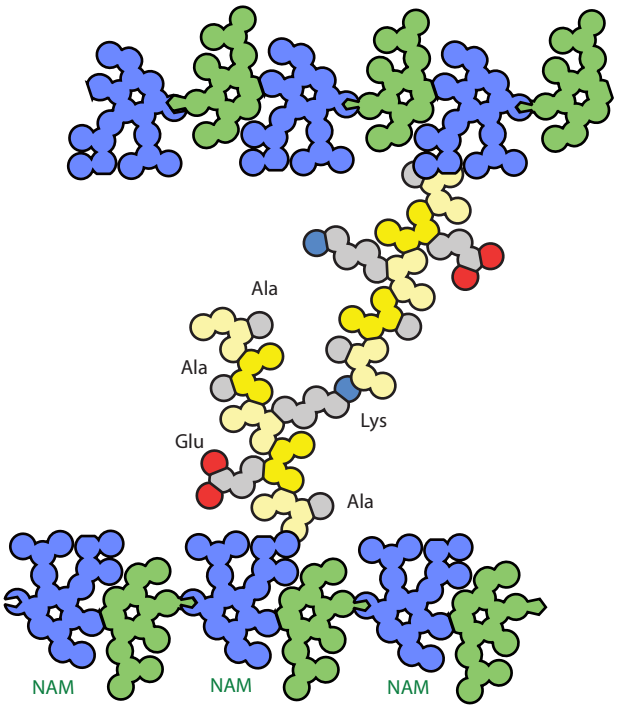
In the presence of penicillin, the PBP protein is inhibited, preventing proper peptidoglycan formation and bacterial cell death.

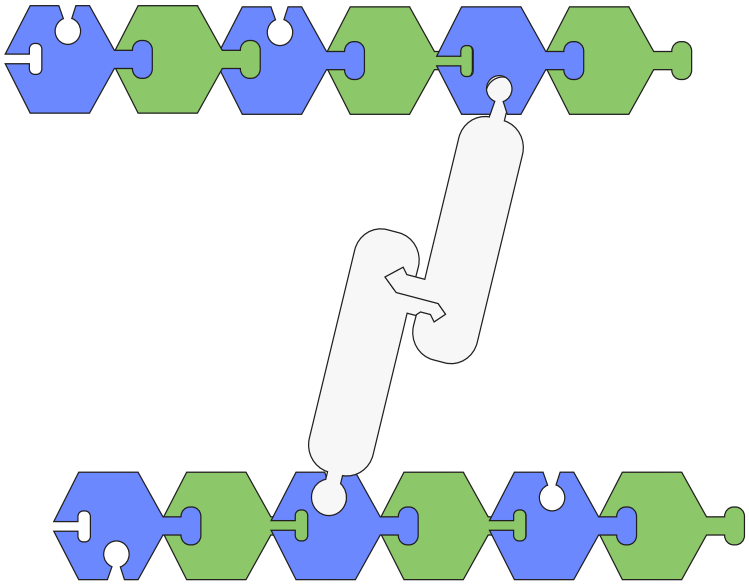


The beta lactamase protein is produced by the bacteria to break down penicillin. This prevents penicillin from inhibiting the PBP protein and allows bacterial membranes to form correctly.

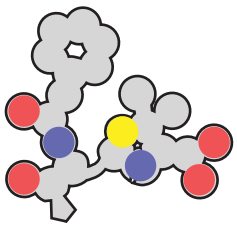
Bacterial Membrane Kit

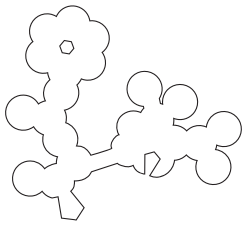
More Details





The pieces are very schematic, and so a more detailed view may be fitting for some higher level courses (ie: the graphic above-left). There are also more detailed steps in the function of the PBP protein, which were ignored to keep things simple... specifically, the removal of a terminal alanine that allows for the iso-peptide bond between the lysine and terminal carboxilic acid group.

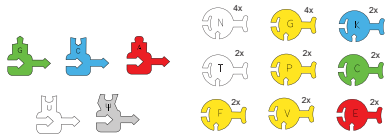


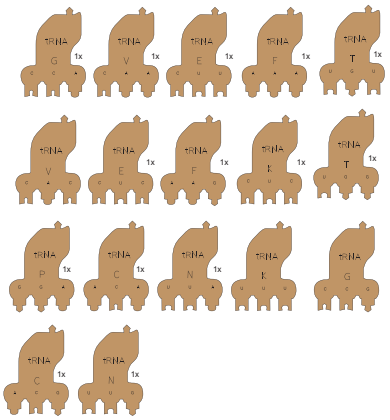


The penicillin was also simplified to white, but can be turned into CPK coloring with sharpies/markers. Shown left is the correct coloring with gray=carbon, red=oxygen, blue=nitrogen and yellow=sulfur.

Vaccine Design Challenge Kit

Basic Setup





Step 1: using foam nucleotides, create the Wuhan SARS Cov-2 Spike Protein sequence (ten codons from the real 2020 gene)

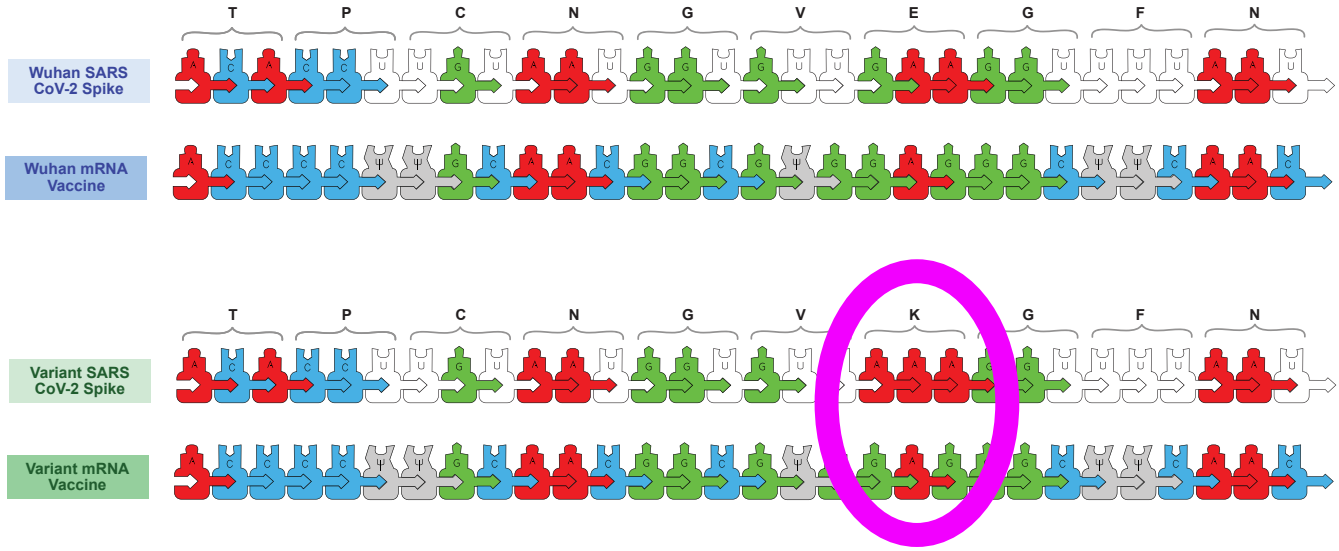
Step 2: translate that seqeunce into protein.

Step 3: Make a second foam nucleotide sequence representing the mRNA vaccine sequence... with pseudouridines (gray) and optimized codon usage (using the codon chart with usage percentages shown). Translate the seqeunce again to make sure it produces the same protein seqeuence.

Step 4: Edit the original Wuhan sequence with the varient mutation (GAA to AAA in codon 7). Translate the sequence to see a single amino acid change (Glutamic Acid (E) to Arginine (K)).

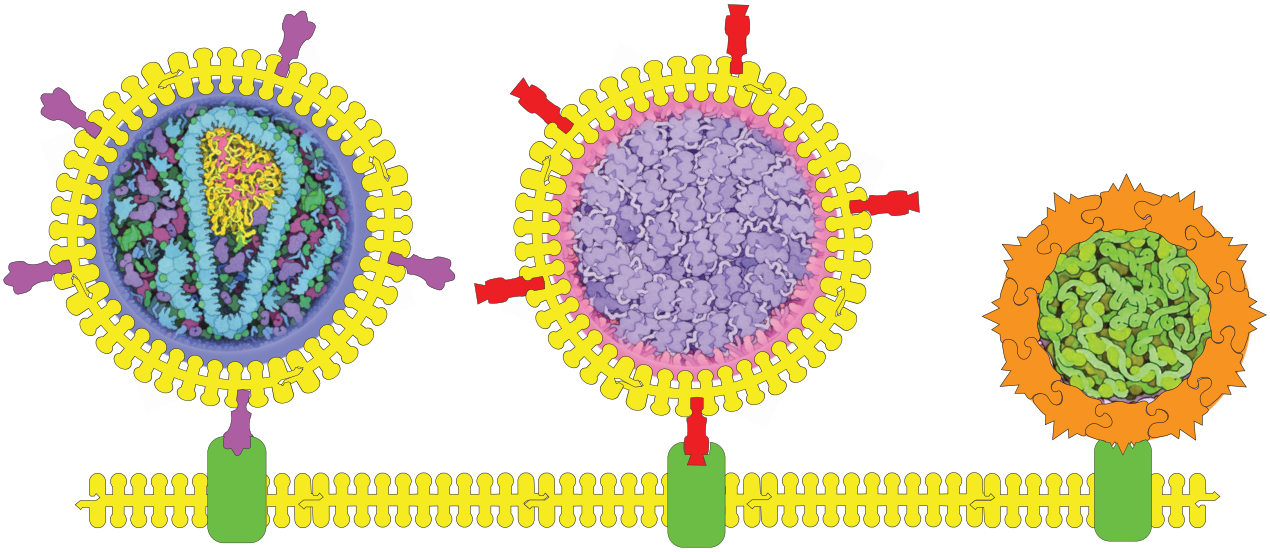
Step 5: Have students update their mRNA vaccine sequence to target this new variant virus.

NOTE: not required... but might be a good time to bring the FGIK kit back out to review protein synthesis.



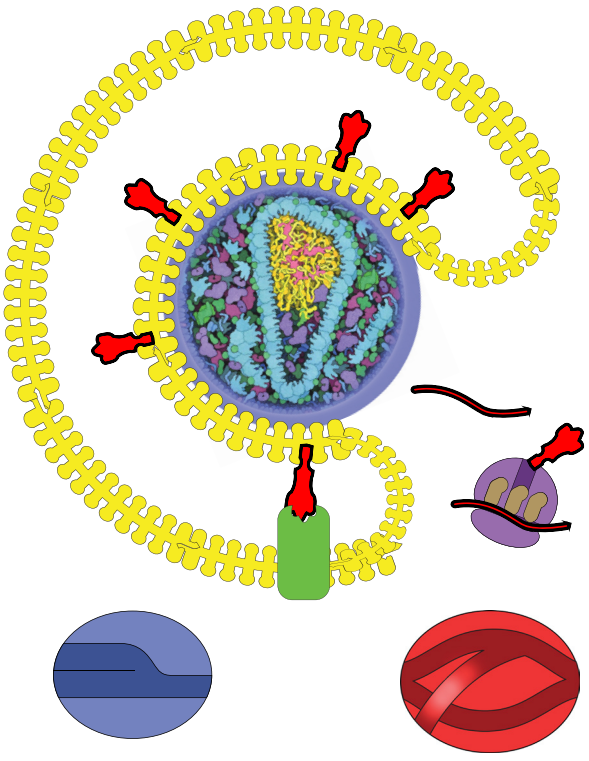
Virus Immunity and Infection Modeling Kit

Virus Structure and Infection Process



Three viruses can be built... two envelop viruses (purple or red envelop proteins) and one capsid virus (orange capsid proteins). Each has a pairing host cell surface receptor (green) for modeling virus docking.

Printable David Goodsell backgrounds can be used (HIV genome above left, Influenza virus genome above middle, AAV virus genome above right). Or included pieces of string can be used, allowing students to model the movement of the genome.



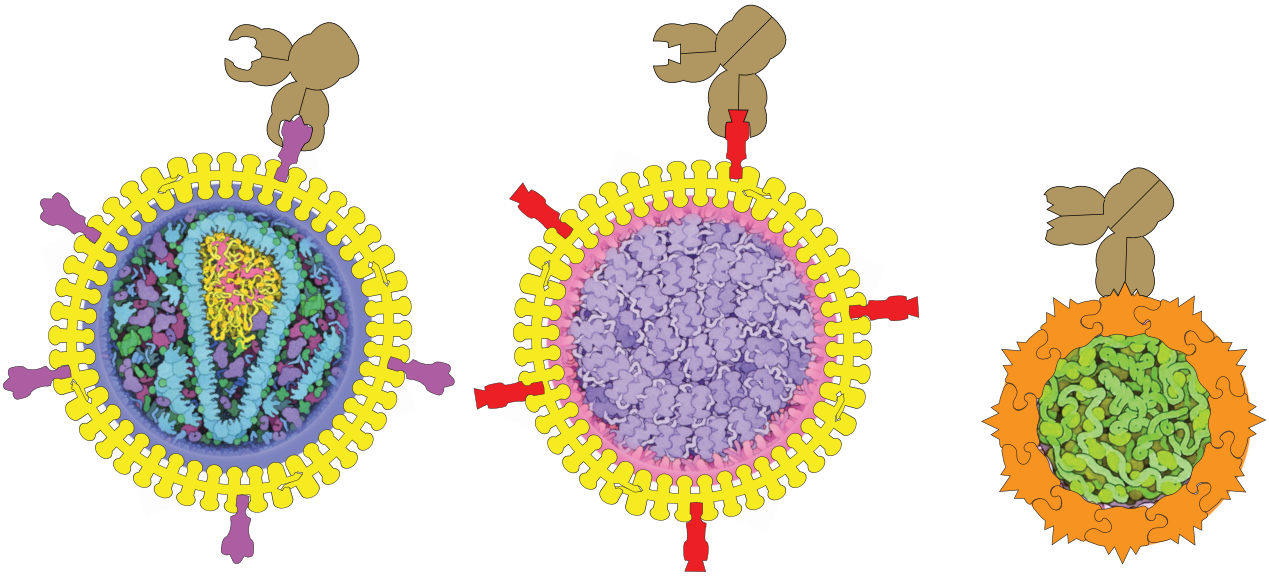
If suitable for your classroom, more detailed virus infection processes can be modeled using the printable ribosome, RNA polymerase and reverse transcriptase shapes.

For example, detailed influenza virus steps include:

- virus attaches to host cell receptor (green)
- entire virus is endocyctoced
-virus membrane and endocytosed vesicle membrane fuse, releasing genome.
-viral genome is replicated by viral RNA polymerase and the viral proteins are translated by host cell ribosomes
-Viral genomes and proteins are trafficked to the cell surface and bud away from the host cell.

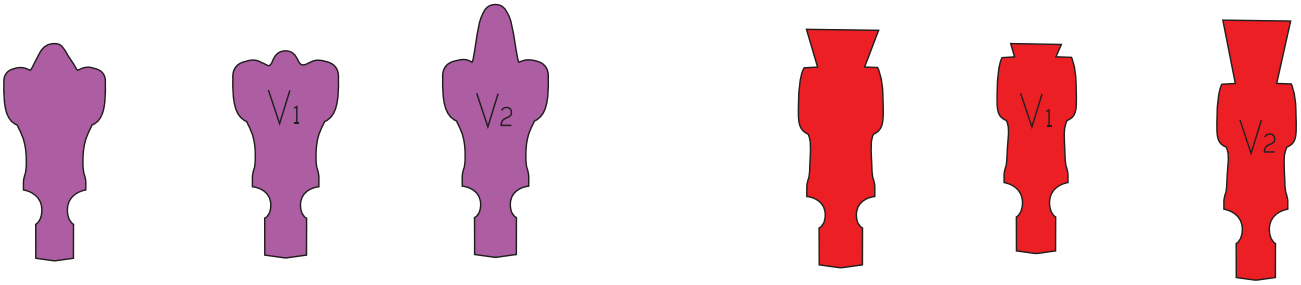
Virus Immunity and Infection Modeling Kit

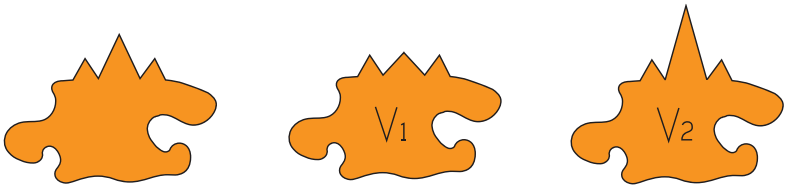
Antibody Binding and Seasonal Variants



Each virus pairs with a specific antibody (tan).

There are two seasonal variants for each virus type, representing antigenic drift over time (with V1 and V2 labels) These may still "fit" or be recognized by the antibody... but the fit is clearly not as perfect. Challenge students to see the nuance in mutations and drift, discussing how different a virus needs t o become before it no longer can be targetted by existing antibodies or prevented by a past vaccine.





Blood Type Modeling Kit

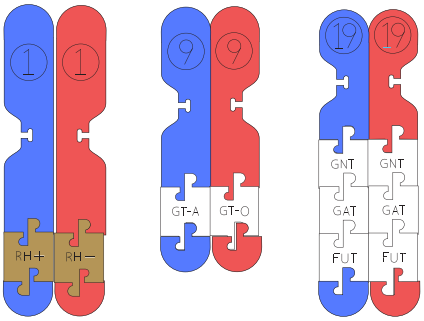
Creating the Blood Cell Membrane

TEACHER CHROMOSOME SETUP:

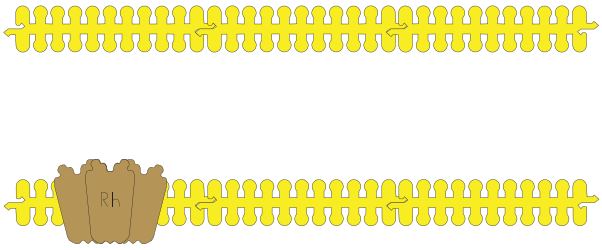
-Set up variety in the room for chromosome 1, with some students being homozygous for RH+, some homozygous for RH- and some heterozygous.

-Set up variety in the room for chromosome 9, with options being A-A, A-O, A-B, B-B, or OO (this can also be a neat punnet square activity).

-All student groups should have identical chromosome 19, with all three genes (GNT, GAT and FUT) present.



(an example set of chromosomes)



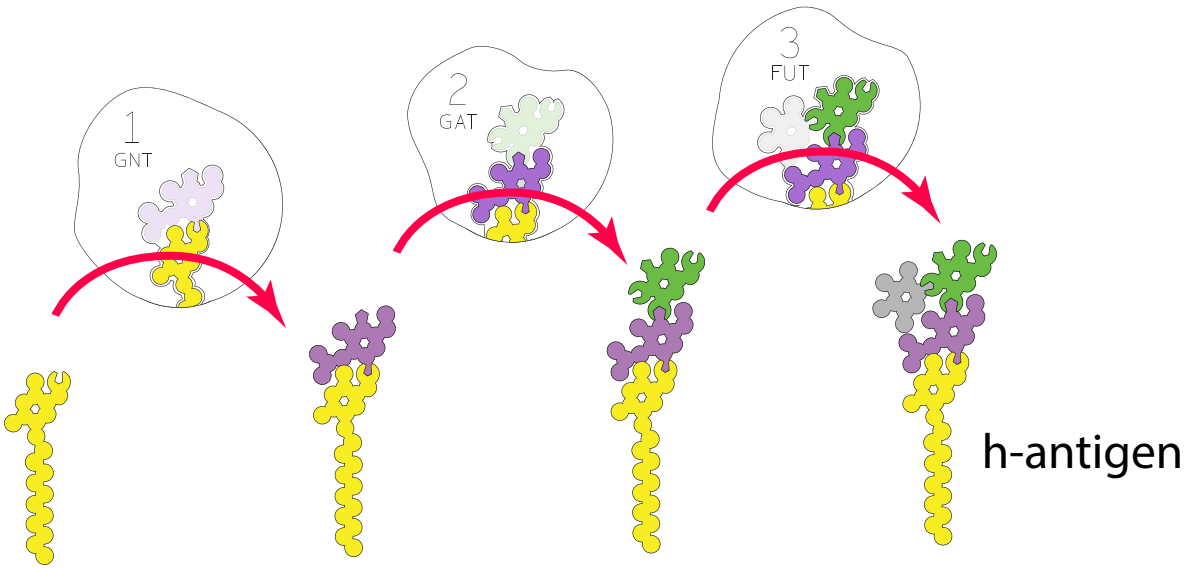
STUDENT STEPS:

Step 1: create the membrane of a red blood cell using yellow membrane pieces (can be a line or curled into a circle/cell)

Step 2: Review chromosome 1. If you are homozygous or heterozygous for RH+, add the RH protein to your membrane. If you are homozygous for RH-, do not add it.

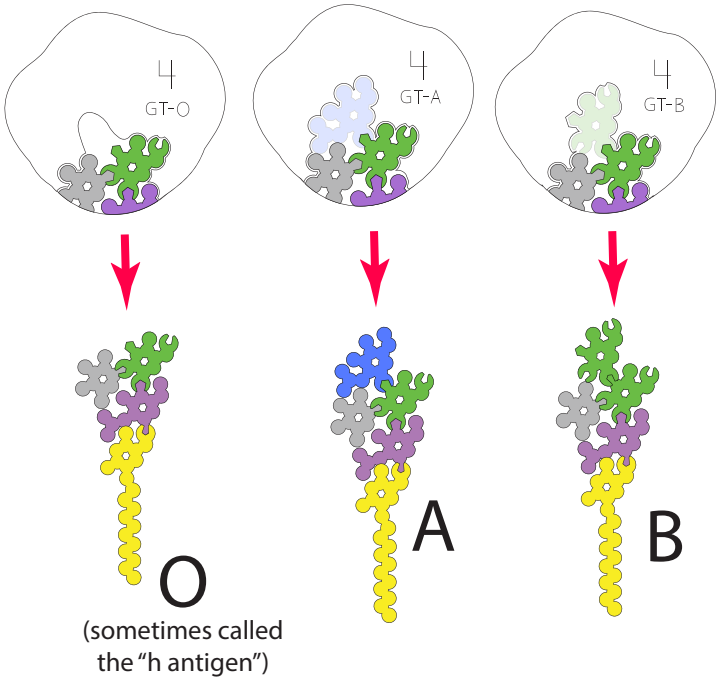
Step 3: Review chromosome 19 (every student should have GNT, GAT and FUT genes). Use the translated enzyme pieces to build (in three steps) the basic root lipo-sugar (sometimes called the "h-antigen")

We recommend making three copies of this basic h-antigen. and adding them to your membrane.



Blood Type Modeling Kit

Creating the Blood Cell Membrane



STUDENT STEPS:

Step 4: Review chromosome 9 (there should be variety in the classroom). Use the translated enzyme pieces to finish building the lipo-sugars.

-If students are O-O, they will make no further modifications to their three sugars.

-If students have an A enzyme, they will convert one of their three h-antigen into an A lipo-sugar.

-If students have a B enzyme, they will convert one of their three h-antigen into an B lipo-sugar.

Step 5: Explore what antibodies your blood would not have present (any atnibodies that would match your red blood cell surfaces. Note, no one should have the gray antibody, as every student group should have at least one standard O lipo-sugar (aka, h-antigen), and therefore not have the gray antibody present.

Transfuse your blood by keeping your antibodies and swapping your blood cell surface with another group. Would the transfusion cause an immune response or would it be safe?

