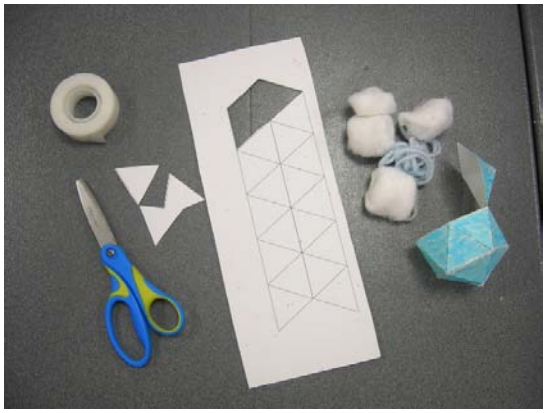

Viral Packaging

Getting the most bang for your genomic buck

Solve the problem that took viruses millions of years by efficiently fitting nucleic acid and proteins into a small package.

Materials & preparation
For each model (1-2 students) you need:
card stock or other heavy paper
2-3 feet of yarn
6 extra-large cotton balls
scissors
tape
triangle template (20 equilateral triangles whose sides are 1.5 inches long)

Copy the template onto the cardstock. Two should fit on a 8.5" x 11" sheet.

To do and notice
Cut out the 20 equilateral triangles.
Try to tape them back together so that they completely enclose the yarn and cotton balls.

What's going on?

Viruses are composed of nucleic acid genomes and interior proteins that are surrounded by a protective protein shell, or **capsid**. Instead of making a shell out of one giant protein, viruses typically utilize many identical copies of the same protein that come together to form the capsid. This way, the virus can economically use one gene to repetitively make many small proteins instead of needing to devote a large portion of its genome for a large protein shell. You may have found a shape that uses several triangles to make a container to hold the yarn (nucleic acid) and protein (cotton balls). The majority of viruses, whether or not they have an envelope, are composed of triangular protein subunits that associate to form a 20-sided **icosohedron**. This shape helps the virus to minimize its surface area to volume ratio, which allows it to carry the most genetic material and internal proteins inside a small protein shell.

Going further

Icosohedrons have 3 axes of rotational symmetry. Its 2-fold axis means that shape will look the same if it's rotated on this axis 180°. It also has 3-fold (120°) and 5-fold (72°) axes. Can you find these three axes of symmetry?

This model can also be used to illustrate the concept of **gene therapy**, which seeks to treat diseases caused by defective or deficient proteins by introducing genetic material as medicine. Instead of manufacturing and injecting a functional version of the protein, gene therapists modify viruses so that their genomes contain a correct copy of the gene that encodes for the diseased protein. Viral genes are deleted, so that when the virus, now a **viral vector**, enters the target cell, it produces correct copies of the therapeutic protein instead of creating new virions. Several clinical trials are currently in progress using gene therapy to treat a wide range of diseases including HIV, hemophilia, cancer, and "bubble-boy" disease.