

**Lesson name:** Structural changes in the life-cycle of Dengue Virus.

**Grade Level:** 9-12

**Lesson Description:** Students will learn about viruses in general and build 3-D models of mature and immature forms of a specific icosahedral virus (Dengue virus), to understand the use of symmetry and structural rearrangement in the virus life cycle. Students will read the Molecule of the Month feature on “Dengue Virus” (RCSB PDB July 2008) to understand viral infection and the quest for a vaccine.

**Objectives of lesson:**

Students will learn about:

1. Shapes and structures of proteins
2. Viruses: what they are composed of and their life cycle
3. The shapes of viruses and how they assemble
4. Viral infections and immunity

**Key Concept:**

- Proteins have specific shapes.
- Repeating units of the same protein (or a set of proteins) can create a closed symmetric shape. Viruses are composed mainly of some genetic material (RNA/DNA) enclosed in a protein shell (which is often highly symmetric).
- Viruses have limited space in their genome, so they use symmetry and multiple copies of one or a few types of subunits to create large shells.
- Viruses inject their genetic material into host cells and hijack their cellular machinery.
- Structural rearrangement of viral coat proteins is critical in the infection process.

**NJ core curriculum standards addressed by the lesson plan:**

- Life sciences: “Matter, energy and organization in living systems”, “Diversity and Biological Evolution” and “Reproduction and Heredity”
- Environmental studies: “Natural systems and interactions”
- Scientific process: “Safety”

**Time:**

50minutes to 1 hour

**Materials:**

*For background, concepts and additional reading:*

Computer with internet

RCSB PDB website ([www.pdb.org](http://www.pdb.org))

Molecule of the Month feature on “Dengue Virus”

Additional resources and links listed later

*For building 3-D models of viruses:*

Printouts of Flattened virus (PDB ID 1k4r and 1n6g), scissors, clear tape

*For assessment of students:*

Teacher assigned questions (Some possible questions are included in the Molecule of the Month feature on Dengue Virus). These questions may be revised, expanded or adapted to meet the needs of the class)

**Student assessment:**

The 3-D model(s) of icosahedral viruses: should have 20 faces and form a closed particle  
A summary paragraph: student should be able to clearly and correctly describe the composition and shape of viruses and how that relates to the 3-D model they created.  
They should be able to answer teacher assigned questions demonstrating and understanding of key concepts

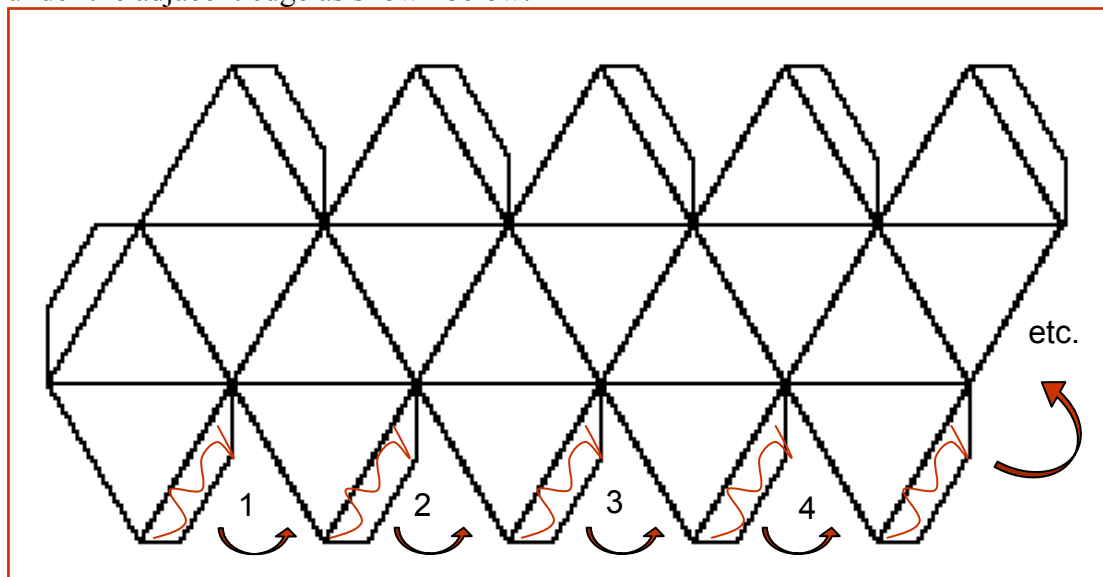
**Overview of lesson implementation:**

The teacher will briefly introduce students to the shapes of proteins using the Molecular machinery poster available from RCSB PDB. This can be followed by an introduction to Dengue virus: their composition, life-cycle, shapes and sizes all proteins that make up this virus. Since viruses have very small genomes they utilize symmetry to create the protein shells in which they package their genetic material. The teacher can show students the icosahedral shape and demonstrate how to make 3-D virus models. The students then make the 3-D virus models of the mature and immature virus particles in class and write a paragraph describing and comparing them. As a homework assignment, students can read the Molecule of the Month features on “Dengue virus” and answer the teacher assigned questions. For extra credit students may read the WHO laboratory biosafety guidelines to learn about safe practices while handling virus containing samples.

**Instructions for building 3-D icosahedral virus models:**

The paper model

Cut out the flattened virus models for the mature and immature virus particles and fold along all the links in the cutout. Start making the closed model by taping together the red shaded flaps under the adjacent edge as shown below:



Continue taping the edges till you can close the icosahedral virus.

**Sample questions to answer:**

See “Questions for Further Exploration” section in the Molecule of the Month feature on “Dengue Virus” (RCSB PDB, July 2008)

**Additional resources:**

<http://vipfdb.scripps.edu/>

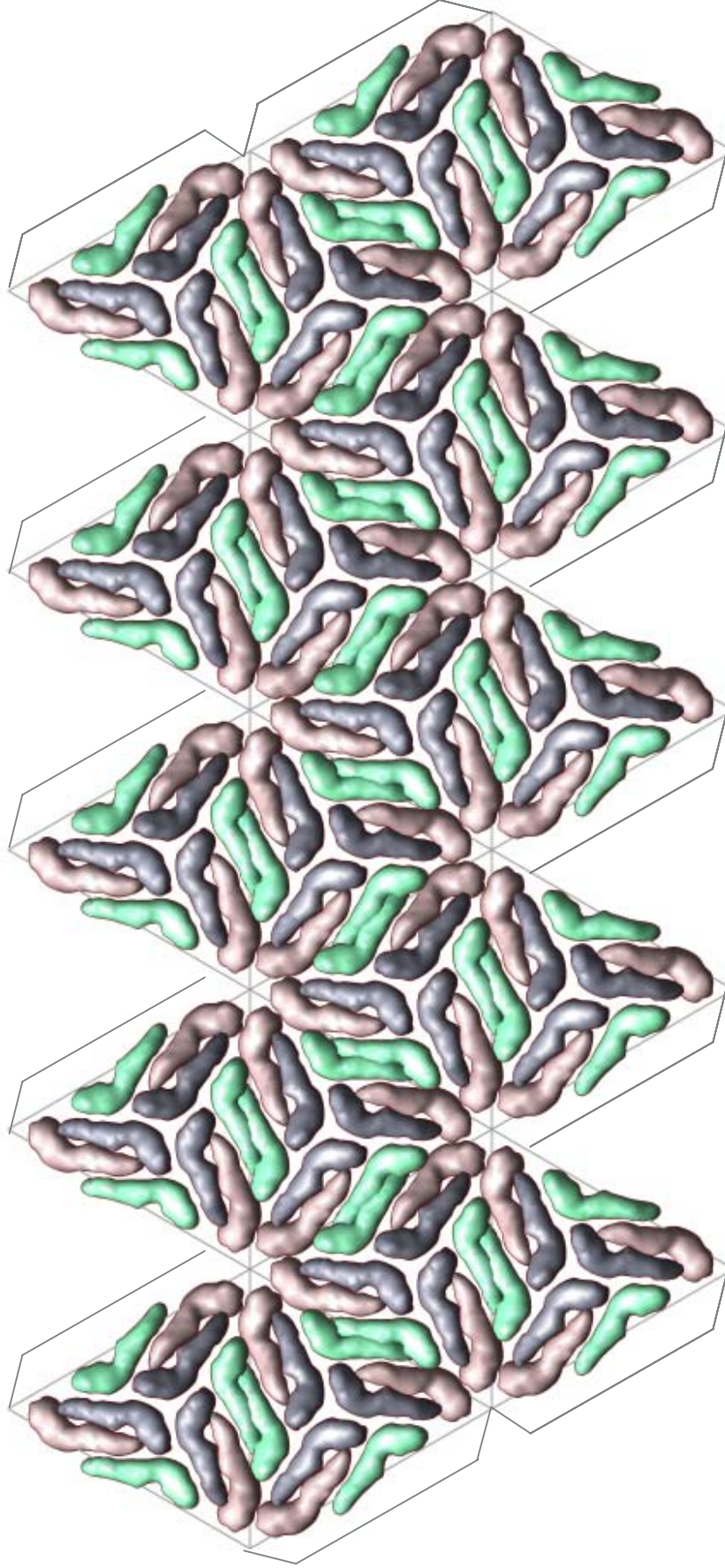
<http://virologyhistory.wustl.edu/>

<http://web.uct.ac.za/depts/mmi/jmoodie/welcome1.html>

References listed in the Molecule of the Month feature on “Dengue Virus” (RCSB PDB, July 2008)

[http://www.who.int/csr/disease/avian\\_influenza/guidelines/handlingspecimens/en/](http://www.who.int/csr/disease/avian_influenza/guidelines/handlingspecimens/en/)

# Mature Dengue Virus (1k4r)

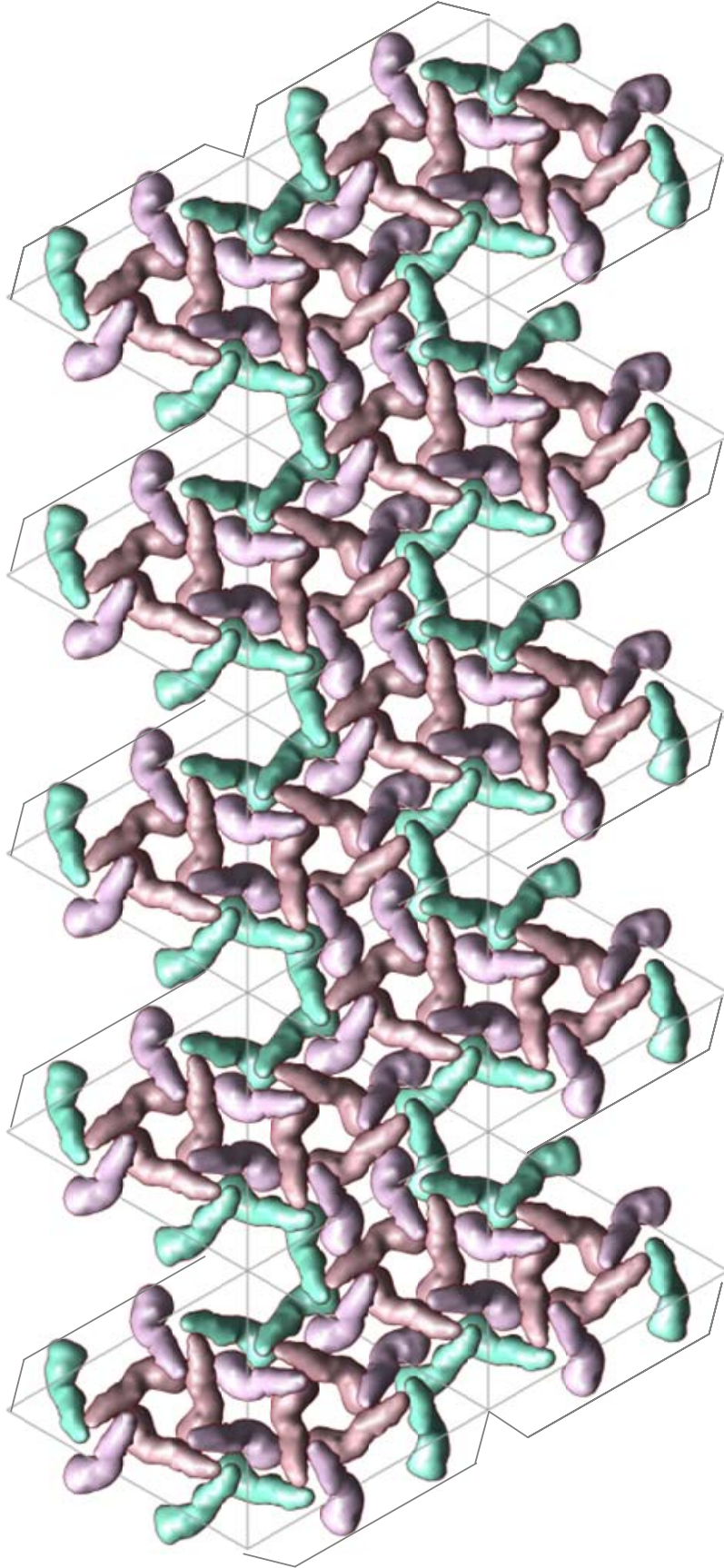


Life cycle of Dengue virus  
RCSB PDB, 2008

Structure of dengue virus: implications for flavivirus organization, maturation, and fusion. Cell. 2002 Mar 8;108(5):717-25.

# Immature Dengue Virus (1n6g)

Life cycle of Dengue virus  
RCSB PDB, 2008



Structures of immature flavivirus particles. EMBO J. 2003 Jun 2;22(11):2604-13.