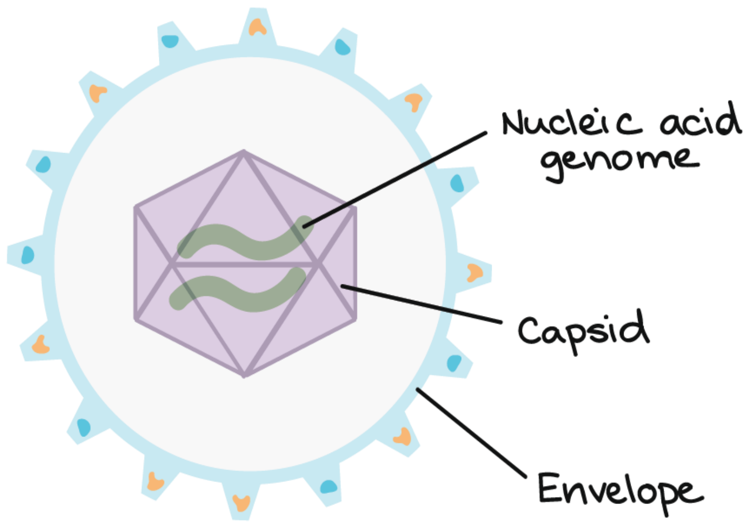
CATALySES Action Research Proposal 2018

Conceptualizing the Virus



Suzanne Banas, Ph.D.; NBCT

South Miami Middle Community School

Miami, Florida

sbanas@dadeschools.net

Using student produced conceptual models (drawings) to communicate an in depth understanding of a concept

Abstract: The abstract should summarize your action purpose and methods. It should have a 150 word limit.

Rationale:
Based on my district pacing guides, the first nine weeks is ecology, then the second nine weeks is evolution. So, I plan the emerging pathogens concepts as a transition between the two. Evolution tends to be a controversial topic so using the talk of virus to engage students in the study of evolution through a real life scenario that affects the human health. In addition, this will be the first time that 10th grade biology (with an EOC) is taught in my middle school. These 8th grade honors students (12 year old), took 9th grade honors physical science as 7th graders, as well an algebra (with an EOC). They have missed the traditional middle comprehensive science, so have not gotten the basic contextual content for biology. Since biology is a required EOC, I am concerned that I ensure they have the necessary material and abilities to be successful in the EOC.

Students need to be able to demonstrate an in depth understanding of concepts. People receive information, process the information, and respond to it accordingly many times each day. This sort of processing of information is essentially a conceptual model (or mental model) of how things in our surrounding environment work. (MacKay) Using concept maps or conceptual modeling will allow my students to “draw” what they have learned. Conceptual Models are great to use when introducing a topic. It gets students interactively involved with its creation, evaluation, and refinement of their conceptual models. Teachers can ask questions that guide their students in the development process.

Intervention:
Our district has a baseline assessment as well as topic tests. The first topic is ecological systems will be taught without conceptual models. The next topic is evolution, which will be taught using the conceptual model drawings at various intervals throughout this topic. Each student’s topic test questions and answers will be compared to the appropriate baseline questions and answers.

Students need to be able to demonstrate an in depth understanding of concepts. People receive information, process the information, and respond to it accordingly many times each day. This sort of processing of information is essentially a conceptual model (or mental model) of how things in our surrounding environment work. Using concept maps or conceptual modeling will allow my students to "draw" what they have learned. Conceptual Models are great to use when introducing a topic. It gets students interactively involved with its creation, evaluation, and refinement of their conceptual models. Teachers can ask questions that guide their students in the development process.

A conceptual model is a representation of a system, made of the composition of concepts which are used to help people know, understand, or simulate a subject the model represents. It is also a set of concepts. It is important to make that students can be actively engaged in their understanding and learning the physical world by constructing, using, or choosing models to describe, explain, predict, and to control physical phenomena. In this way, students might not need to memorize course materials or equations for their classes. It is important for students to begin learning how to develop conceptual models of how things work for several reasons: (1) Development of conceptual models is first step in developing more detailed quantitative models. (2) Interactive development of conceptual models can be used very effectively as an engagement in the learning environment. (3) For some topics, having students participate in the development and validation of conceptual models tends to help them understand different physical processes is a worthwhile learning objective.

Data collection and analysis:
Since this lesson is using conceptual models and the changes students make to them as thy learn, the revisions are what is evaluated. You can also count the additions and deletions (changes) students make. Using rubric/checklist (Appendix B), evaluate if the student(s):

Students will produce a conceptual model (drawing) with ongoing revisions of the knowledge of materials.

Rubrics/checklist. By reviewing the contents of the conceptual model drawings, the teacher will be able to see the changes from the student revisions. Checking off to endure the student drawing included the accurate components. Tallying the changes, as well as the number of items on the drawings can be quantified.

In addition, Since I will be able to have a baseline assessment as well a topic tests to compare the effectiveness of conceptual modeling drawings.

Students will be communicating their conceptual model drawings, this is also a form of assessment.

The activities themselves are a form of formative assessment

Connections to CATALySES summer institute: Describe the specific UF CATALySES Institute connections.

Literature cited:

Cooper, Scott (2003) Translation simulation; University of Wisconsin-La Crosse. Retrieved from: https://serc.carleton.edu/introgeo/conceptmodels/examples/13567.html

Dimitris Karagiannis, Heinrich C. Mayr, John Mylopoulos (eds.), Domain-Specific Conceptual Modeling: Concepts, Methods and Tools, Springer, 2016.

D.W. Embley and B. Thalheim (eds.), The Handbook of Conceptual Modeling: Theory, Practice, and Research Challenges, Springer, 2011.

D. Hestenes (1993, 2017), Modeling is the Name of the Game: conceptual models and modeling in science education. A new introduction in 2017, and at the end, a historical note, synopsis of what happened since 1993, and bibliography.

D. Hestenes, Modeling Theory for Math and Science Education, In R. Lesh, P. Galbraith, C. Hines, A. Hurford (eds.) Modeling Students' Mathematical Competencies (New York: Springer, 2010).

Introduction to Virus Khan Academy: https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-immune-system/a/intro-to-viruses licensed under a CC BY-NC-SA 4.0 license.

Images : CC BY-NC-SA 4.0 license. https://creativecommons.org/licenses/by-nc-sa/4.0/

MacKay, Bob What Are Conceptual Models? Clark College Physics and Meteorology. Retrieved from: https://serc.carleton.edu/sp/merlot/biology/conceptmodels/index.html

Permissions: none that I am aware of.

LESSON PLAN Banas

TITLE: Conceptualizing the Virus

KEY QUESTION(S):

- What a virus is. The structure of a virus and how it infects a cell.
- Factors that affect Human Health
- Understanding the basic concepts of evolution through Human health and emerging pathogens

SCIENCE SUBJECT: Biology

GRADE AND ABILITY LEVEL: Biology, all levels

SCIENCE CONCEPTS:
Cell theory, component of a cell, cell membrane as a highly selective barrier, components of a virus, mechanisms of evolution, life cycle of a virus, mutation, genetic recombination, ecology of a virus, human health, emerging pathogens,

OVERALL TIME ESTIMATE: 3-5 days (50 minute periods)

LEARNING STYLES: Visual, auditory, and or kinesthetic.

VOCABULARY:

1. **bacteria** are small and single-celled, but they are living organisms that do not depend on a host cell to reproduce.
2. **capsid** or protein shell of a virus
3. **capsomers** proteins join to make units, which together make up the capsid
4. **cell lyses** bursts
5. **endocytosis** in which the membrane folds inward to bring the virus into the cell in a bubble
6. **envelope** a lipid membrane, virus envelopes can be external, surrounding the entire capsid, or internal, found beneath the capsid
7. **genome** genetic material
8. **genome replication** or DNA replication is the biological process of producing two identical replicas of DNA from one original DNA molecule
9. **gene expression** is the process by which information from a gene is used in the synthesis of a functional gene product. These products are often proteins.
10. **host cell** (1) A cell that harbors foreign molecules, viruses, or microorganisms. For example, a cell being host to a virus. (2) A cell that has been introduced with DNA (or RNA).
11. **microbes** an extremely small living thing that can only be seen with a microscope

12. **nucleic acid** are small biomolecules, essential to all known forms of life. They are composed of nucleotides, which are monomers made of three components: a 5-carbon sugar, a phosphate group and a nitrogenous base. Examples are: double-stranded DNA, double-stranded RNA, single-stranded DNA, or single-stranded RNA
13. **phage** bacteriophage: a virus that infects bacteria
14. **protein** A viral protein is both a component and a product of a virus. Viral proteins are grouped according to their functions, and groups of viral proteins include structural proteins, nonstructural proteins, regulatory, and accessory proteins. Viruses do not code for many of their own viral proteins, but rather, they use the host cell's machinery to produce the viral proteins they require for replication
15. **virus** is a tiny, infectious particle that can reproduce only by infecting a host cell.
16. **viral lifecycle** is the set of steps in which a virus recognizes and enters a host cell, "reprograms" the host by providing instructions in the form of viral **DNA** or **RNA**, and uses the host's resources to make more virus particles

LESSON SUMMARY:
Through using conceptual model drawings, students will communicate a change in their understanding of what a virus is and the process of replication of a virus. This is to encage students in the introduction of evolution. Various other virus conceptual model drawings will be used throughout the study of evolution.

STUDENT LEARNING OBJECTIVES WITH STANDARDS:
The student will be able to...

1. Produce an accurate model of a virus is made up of a DNA or RNA genome inside a protein shell called a **capsid**. Some viruses have an internal or external membrane **envelope**.
2. Apply conceptual knowledge that viruses are very diverse and will generate an organization drawing of the different shapes and structures, have different kinds of genomes, and infect different hosts.
3. Create a conceptual model of the life cycle of viruses as they reproduce by **infecting** their host cells and reprogramming them to become virus-making "factories." As well as how they evolve.

SC.912.L.14.6   Explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspectives of both individual and public health.

SC.912.L.16.7 Describe how viruses and bacteria transfer genetic material between cells and the role of this process in biotechnology.

MATERIALS:
ESSENTIAL: chart paper for groups (3-4) or large paper for individuals
Colored markers or colored pencils
Virus video **https://www.khanacademy.org/science/biology/biology-of-viruses/virus-biology/v/viruses**
SUPPLEMENTAL: ability to copy (or photograph) conceptual models (drawings) so can evaluate the changes students make as they learn.

BACKGROUND INFORMATION:
Information below is from the Khan Academy: https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-immune-system/a/intro-to-viruses

A **virus** is a tiny, infectious particle that can reproduce only by infecting a host cell. **Viruses** "commandeer" the host cell and use its resources to make more viruses, basically reprogramming it to become a virus factory. Because they can't reproduce by themselves (without a host), **viruses** are not considered living. Nor do **viruses** have cells: they're very small, much smaller than the cells of living things, and are basically just packages of **nucleic acid** and **protein**. Still, **viruses** have some important features in common with cell-based life. For instance, they have nucleic acid genomes based on the same genetic code that's used in your cells (and the cells of all living creatures). Also, like cell-based life, **viruses** have genetic variation and can evolve. So, even though they don't meet the definition of life, **viruses** seem to be in a "questionable" zone. Even though they can both make us sick, **bacteria** and **viruses** are very different at the biological level. **Bacteria** are small and single-celled, but they are living organisms that do not depend on a host cell to reproduce. Because of these differences, bacterial and viral infections are treated very differently. For instance, antibiotics are only helpful against bacteria, not viruses.
There are a lot of different **viruses** in the world. So, **viruses** vary a ton in their sizes, shapes, and life cycles. If you're curious just how much, I recommend playing around with the **ViralZone** website. Click on a few **virus** names at random, and see what bizarre shapes and features you find!
Viruses do, however, have a few key features in common. These include:

- A protective **protein** shell, or **capsid**
  The **capsid**, or protein shell, of a virus is made up of many protein molecules (not just one big, hollow one). The proteins join to make units called **capsomers**, which together make up the capsid. **Capsid proteins** are always encoded by the **virus genome**, meaning that it's the virus (not the host cell) that provides instructions for making them
- A nucleic acid genome made of DNA or RNA, tucked inside of the capsid
  All **viruses** have genetic material (a **genome**) made of nucleic acid. You, like all other cell-based life, use **DNA** as your genetic material. **Viruses**, on the other hand, may use either **RNA** or **DNA**, both of which are types of nucleic acid. We often think of DNA as double-stranded and RNA as single-stranded, since that's typically the case in our own cells. However, **viruses** can have all possible combos of strandedness and **nucleic acid** type (**double-stranded DNA, double-stranded RNA, single-stranded DNA, or single-stranded RNA**). Viral genomes also come in various shapes, sizes, and varieties, though they are generally much smaller than the **genomes** of cellular organisms. Notably, DNA and RNA viruses always use the same genetic code as living cells. If

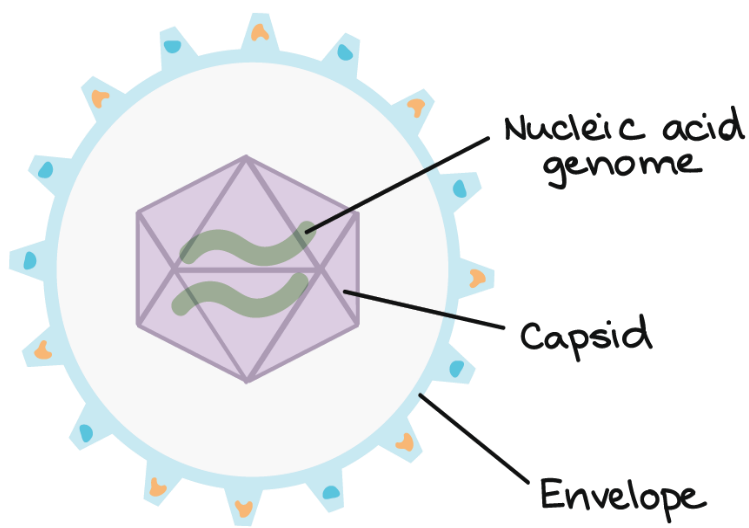
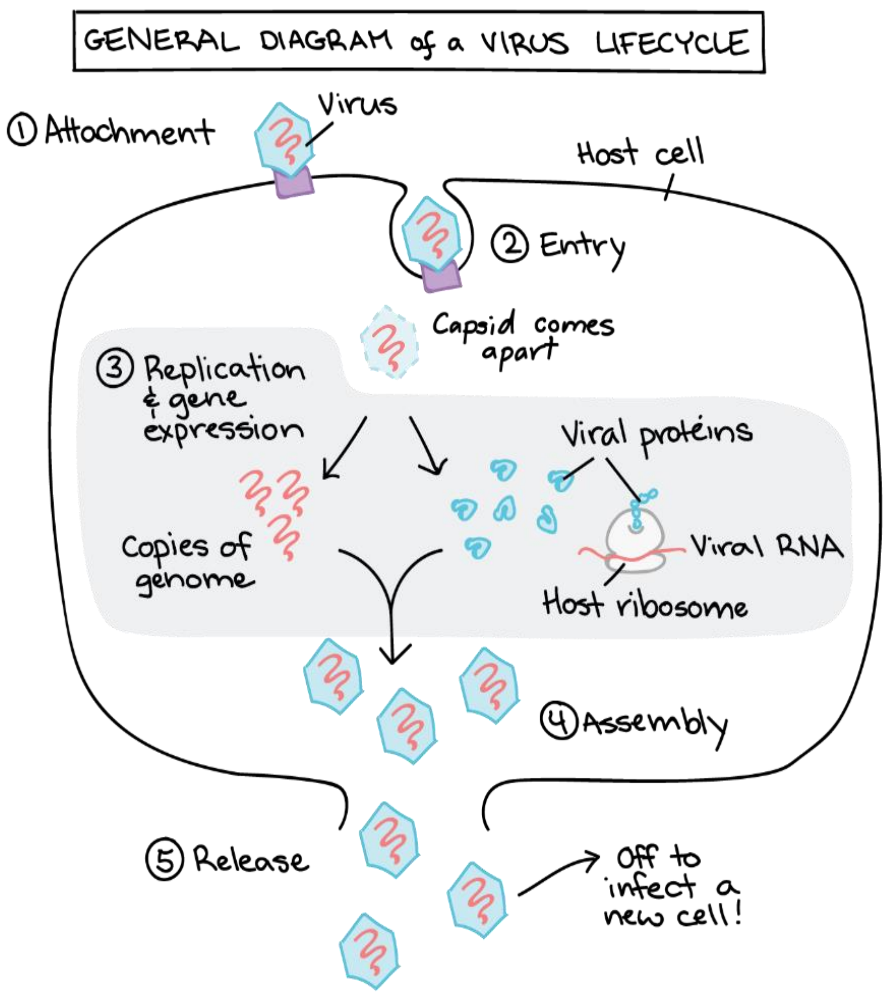


Figure 1 Diagram of a virus. The exterior layer is a membrane envelope. Inside the envelope is a protein capsid, which contains the nucleic acid genome. Image modified from "Scheme of a CMV virus." by Emmanuel Boutet, CC BY-SA 2.5. The modified image is licensed under a CC BY-SA 2.5 license.

they didn't, they would have no way to reprogram their **host cells**!

- A layer of membrane called the **envelope** (some but not all viruses)
  In addition to the **capsid**, some **viruses** also have a lipid membrane known as an **envelope**. **Virus** envelopes can be external, surrounding the entire **capsid**, or internal, found beneath the **capsid**. **Viruses** with envelopes do not provide instructions for the envelope lipids. Instead, they "borrow" a patch from the host membranes on their way out of the cell. Envelopes do, however, contain proteins that are specified by the virus, which often help viral particles bind to host cells
  Steps of a viral infection, illustrated generically for a virus with a + sense **RNA genome**.

1. Attachment**. Virus** binds to receptor on cell surface.
2. Entry. **Virus** enters cell by **endocytosis**. In the cytoplasm, the **capsid** comes apart, releasing the **RNA genome**.
3. **Replication and gene expression**. The **RNA genome** is copied (this would be done by a viral enzyme, not shown) and translated into viral **proteins** using a host ribosome. The viral proteins produced include **capsid proteins**.
4. Assembly. **Capsid proteins** and **RNA genomes** come together to make new viral particles.
5. Release. The **cell lyses** (bursts), releasing the viral particles, which can then infect other **host cells**.



PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

Day 1 Pre Assessment

THINK (20-30 minutes)

1. Either give each student a large sheet of white paper or small groups (3-4) students chart paper, colored markers or colored pencils
2. Ask the student(s) to draw *" What is a Virus?"* provide no explanation or assistance, you want to "see" what they know prior to instruction.
3. Ask the student(s) to *"Label their drawings/models"*
4. On another sheet - Ask the student(s) to draw *"The life cycle/ how virus reproduce/replicate?"*
5. If working individually, they should not talk or share, small groups can 'share' among themselves but not with others

SHARE (15 minutes)

1. Post the images around the room
2. Have each student or each group share their drawings
3. If enough time, they can revise their drawings, BUT use different colors, so you can 'see' changes (10 minutes)
4. Collect drawing (conceptual models)

***NOTE: Make copies or photographs of these initial drawings, so that you can evaluate the changes/ revisions the students make as they learn new knowledge ***

Day 2 Introduction to new knowledge (30-40 minutes)

1. Decide as an educator whether to show the video in class (23 minutes) with discussion, **OR** flip the video as home learning and have a discussion in class
2. https://www.khanacademy.org/science/biology/biology-of-viruses/virus-biology/v/viruses
3. Students should take notes, since they will be revising their drawings but not on the drawings.

Day 3 or Home Learning

THINK (20 minutes)

1. From the notes, students revise their drawings

Day 3 in class

SHARE (35 minutes)

1. Post the images around the room
2. Have each student or each group share their drawings
3. Have student(s) or student group ask clarifying questions of others
4. If enough time, they can revise their drawings, BUT use different colors, so you can 'see' changes (10 minutes)
5. Collect drawing (conceptual models)

Appendix A: Information for the Lecture/Discussion to increase conceptual knowledge

ADVANCE PREPARATION:

1. Watch the video first to decide what parts or all you will share, how you will view it (all at once or stop and start) or flipped it to home learning.

ASSESSMENT SUGGESTIONS:

Since this lesson is using conceptual models and the changes students make to them as thy learn, the revisions are what is evaluated. You can also count the additions and deletions (changes) students make. Using rubric/checklist (Appendix B), evaluate if the student(s):

1. Produce an accurate model of a virus is made up of a DNA or RNA genome inside a protein shell called a **capsid**. Some viruses have an internal or external membrane **envelope**.
2. Apply conceptual knowledge that viruses are very diverse and will generate an organization drawing of the different shapes and structures, have different kinds of genomes, and infect different hosts.
3. Create a conceptual model of the life cycle of viruses as they reproduce by **infecting** their host cells and reprogramming them to become virus-making "factories."

EXTENSIONS:

- Evolution of Virus (Khan Academy) https://www.khanacademy.org/science/biology/biology-of-viruses/virus-biology/a/evolution-of-viruses

- Create a 3-D model of a virus

RESOURCES/REFERENCES:

Acheson, N. H. (2007). Introduction to virology. In Fundamentals of molecular virology. (1st ed., pp. 1-17). Hoboken, NJ: Wiley.

Pierson, T. C. (2012, November 2). The flavivirus lifecycle. In Labs at NIAID. Retrieved from https://www.niaid.nih.gov/research/ted-c-pierson-phd

Pithovirus. (2016, March 26). Retrieved May 10,2016 from Wikipedia: https://en.wikipedia.org/wiki/Pithovirus.

Purves, W. K., Sadava, D. E., Orians, G. H., and Heller, H.C. (2003). Viruses: Reproduction and recombination. In Life: the science of biology (7th ed., pp. 258-263). Sunderland, MA: Sinauer Associates.

Racaniello, V. (2013, September 6). How many viruses on Earth? In Virology blog: About viruses and viral disease. Retrieved from http://www.virology.ws/2013/09/06/how-many-viruses-on-earth/.

Raven, P. H. and Johnson, G. B. (2002). The nature of viruses. In Biology (6th ed., p. 667). Boston, MA: McGraw-Hill.

Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., and Jackson, R. B. (2011). A borrowed life. In Campbell biology (10th ed., pp. 392-393). San Francisco, CA: Pearson.

Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., and Jackson, R. B. (2011). Structure of viruses. In Campbell biology (10th ed., pp. 394-395). San Francisco, CA: Pearson.

Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., and Jackson, R. B. (2011). Viruses replicate only in cells . In Campbell biology (10th ed., pp. 395-403). San Francisco, CA: Pearson.

Suttle, C. A. (2007). Marine viruses - major players in the global ecosystem. Nat. Rev. Microbiol.,. 5(10), 801-12.

Virus. (2016, May 4). Retrieved May 10, 2016 from Wikipedia: https://en.wikipedia.org/wiki/Virus.

Weitz, J. S., and Wilhelm, S. W. (2013, July 1). An ocean of viruses. In The scientist. Retrieved from http://www.the-scientist.com/?articles.view/articleNo/36120/title/An-Ocean-of-Viruses/.

How big are genomes? (n.d.). Retrieved from http://www.weizmann.ac.il/plants/Milo/images/How%20big%20is%20the%20genome120112Clean.pdf.

Zimmer, C. (2013, Feb 20). An infinity of viruses. In The loom: A blog by Carl Zimmer. Retrieved from http://phenomena.nationalgeographic.com/2013/02/20/an-infinity-of-viruses/.

APPENDIX A

Information below is from the Khan Academy: https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-immune-system/a/intro-to-viruses

Introduction to Virus

Scientists estimate that there are roughly 10^{31} **viruses** at any given moment. That's a one with 31 zeroes after it! If you were somehow able to wrangle up all 10^{31} of these **viruses** and line them end-to-end, your **virus** column would extend nearly 200 light years into space. To put it another way, there are over ten million times *more* **viruses** on Earth than there are stars in the entire universe. Does that mean there are 10^{31} **viruses** just waiting to infect us? Actually, most of these **viruses** are found in oceans, where they attack **bacteria** and other **microbes**. It may seem odd that **bacteria** can get a **virus**, but scientists think that *every* kind of living organism is probably host to at least one virus!

What is a virus?

A **virus** is a tiny, infectious particle that can reproduce only by infecting a host cell. **Viruses** "commandeer" the host cell and use its resources to make more viruses, basically reprogramming it to become a virus factory. Because they can't reproduce by themselves (without a host), **viruses** are not considered living. Nor do **viruses** have cells: they're very small, much smaller than the cells of living things, and are basically just packages of **nucleic acid** and **protein**. Still, **viruses** have some important features in common with cell-based life. For instance, they have nucleic acid genomes based on the same genetic code that's used in your cells (and the cells of all living creatures). Also, like cell-based life, **viruses** have genetic variation and can evolve. So, even though they don't meet the definition of life, **viruses** seem to be in a "questionable" zone.

How are viruses different from bacteria?

Even though they can both make us sick, **bacteria** and **viruses** are very different at the biological level. **Bacteria** are small and single-celled, but they are living organisms that do not depend on a host cell to reproduce. Because of these differences, bacterial and viral infections are treated very differently. For instance, antibiotics are only helpful against bacteria, not viruses.

Bacteria are also much bigger than **viruses**. The diameter of a typical **virus** is about 20 – 300 nanometers (1nm = 10^{-9} m)[4]. This is considerably smaller than a typical *E. coli* bacterium, which has a diameter of roughly 1000 nm! Tens of millions of viruses could fit on the head of a pin.

The structure of a virus

There are a lot of different **viruses** in the world. So, **viruses** vary a ton in their sizes, shapes, and life cycles. If you're curious just how much, I recommend playing around with the **ViralZone** website. Click on a few **virus** names at random, and see what bizarre shapes and features you find!

Viruses do, however, have a few key features in common. These include:

- A protective **protein** shell, or **capsid**
- A nucleic acid genome made of DNA or RNA, tucked inside of the capsid
- A layer of membrane called the **envelope** (some but not all viruses)

Let's take a closer look at these features

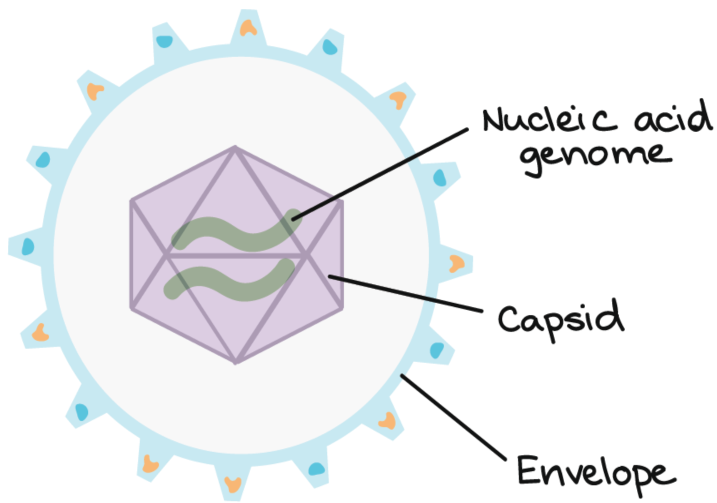


Figure 2 Diagram of a virus. The exterior layer is a membrane envelope. Inside the envelope is a protein capsid, which contains the nucleic acid genome. Image modified from "Scheme of a CMV virus." by Emmanuel Boutet, CC BY-SA 2.5. The modified image is licensed under a CC BY-SA 2.5 license.

Virus capsids

The **capsid**, or protein shell, of a virus is made up of many protein molecules (not just one big, hollow one). The proteins join to make units called **capsomers**, which together make up the capsid. **Capsid proteins** are always encoded by the **virus genome**, meaning that it's the virus (not the host cell) that provides instructions for making them.

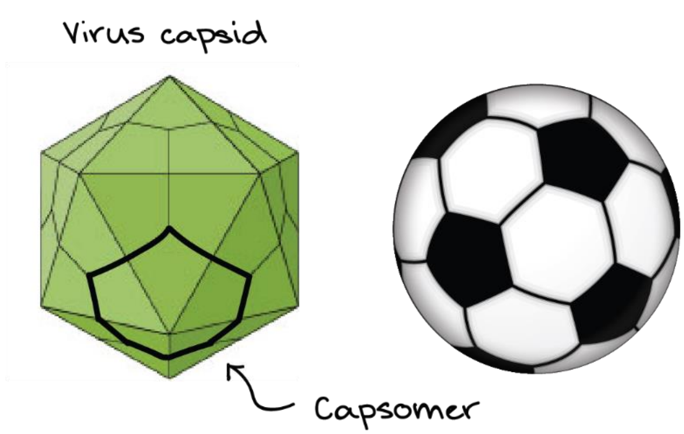


Figure 3 Comparison of a soccer ball with a virus capsid. The hexagons are one type of capsomer while the pentagon are another type. Both types of capsomer are assembled from individual virus proteins.

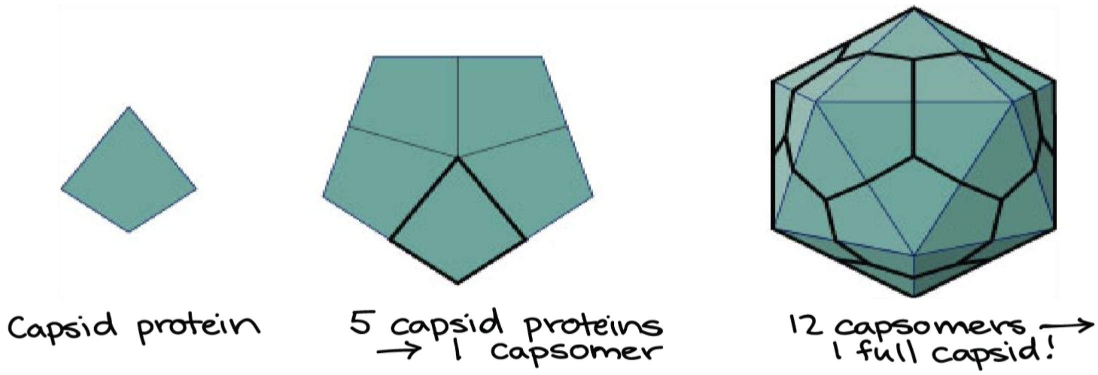


Figure 4 Left panel: modified from "Parvoviridae virion," by ViralZone/Swiss Institute of Bioinformatics, CC BY-NC 4.0. Right panel: "Soccer ball," by Pumbaa80, CC BY-SA 3.0.

Capsids come in many forms, but they often take one of the following shapes (or a variation of these shapes):

1. **Icosahedral** – **Icosahedral capsids** have twenty faces, and are named after the twenty-sided shape called an icosahedron.
2. **Filamentous – Filamentous capsids** are named after their linear, thin, thread-like appearance. They may also be called rod-shaped or helical.
3. **Head-tail** –These **capsids** are kind of a hybrid between the filamentous and icosahedral shapes. They basically consist of an **icosahedral** head attached to a **filamentous** tail.

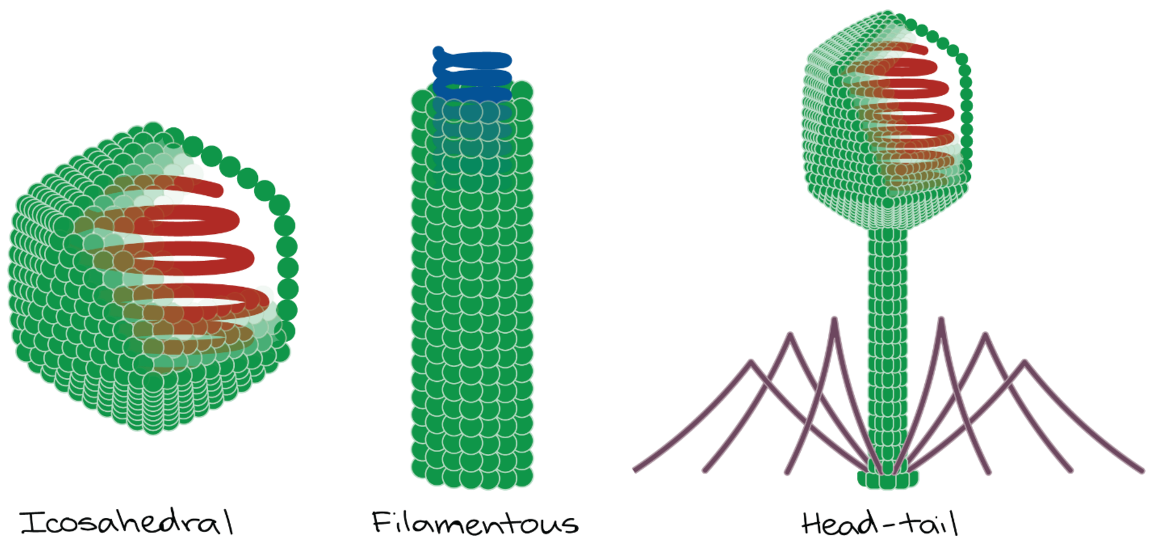


Figure 5 Image modified from "Non-enveloped icosahedral virus," "Non-enveloped helical virus," and "Head-tail phage," by Anderson Brito, CC BY-SA 3.0. The modified image is licensed under a CC BY-SA 3.0 license.

Virus envelopes

In addition to the **capsid**, some **viruses** also have a lipid membrane known as an **envelope**. **Virus** envelopes can be external, surrounding the entire **capsid**, or internal, found beneath the **capsid**. **Viruses** with envelopes do not provide instructions for the envelope lipids. Instead, they "borrow" a patch from the host membranes on their way out of the cell. Envelopes do, however, contain proteins that are specified by the virus, which often help viral particles bind to host cells.

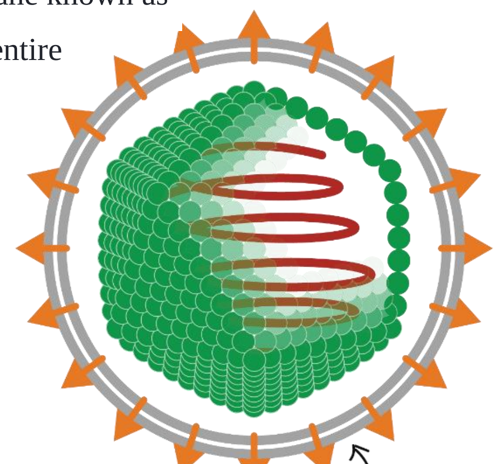


Diagram of enveloped icosahedral virus.

Figure 6 Image modified from "Enveloped icosahedral virus," by Anderson Brito, CC BY-SA 3.0. The modified image is licensed under a CC BY-SA 3.0 license.

Virus genomes

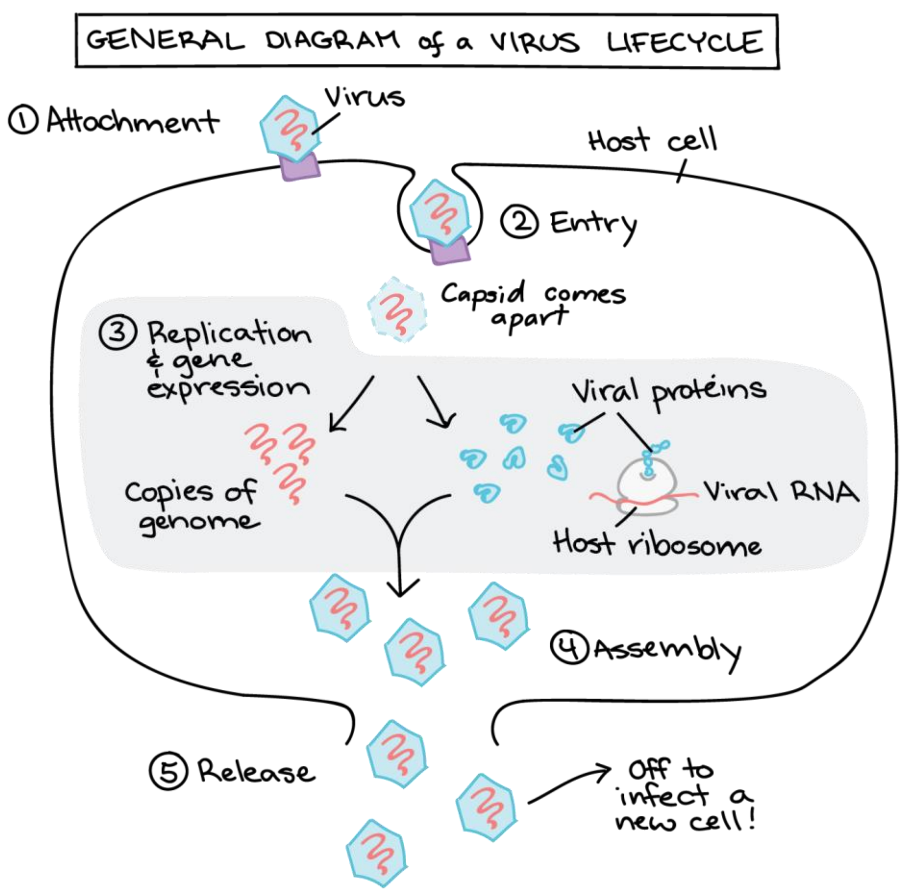
All **viruses** have genetic material (a **genome**) made of nucleic acid. You, like all other cell-based life, use **DNA** as your genetic material. **Viruses**, on the other hand, may use either **RNA** or **DNA**, both of which are types of nucleic acid. We often think of DNA as double-stranded and RNA as single-stranded, since that's typically the case in our own cells. However, **viruses** can have all possible combos of strandedness and **nucleic acid** type (**double-stranded DNA, double-stranded RNA, single-stranded DNA, or single-stranded RNA**). Viral genomes also come in various shapes, sizes, and varieties, though they are generally much smaller than the **genomes** of cellular organisms. Notably, DNA and RNA viruses always use the same genetic code as living cells. If they didn't, they would have no way to reprogram their **host cells**!

What is a viral infection?

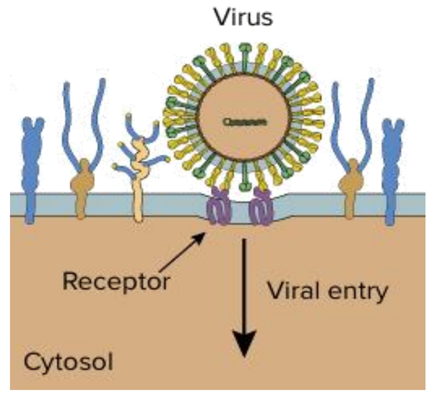
In everyday life, we tend to think of a viral infection as the nasty collection of symptoms we get when catch a **virus**, such as the flu or the chicken pox. But what's actually happening in your body when you have a **virus**? At the microscopic scale, a viral infection means that many viruses are using your cells to make more copies of themselves. The viral **lifecycle** is the set of steps in which a virus recognizes and enters a host cell, "reprograms" the host by providing instructions in the form of viral **DNA** or **RNA**, and uses the host's resources to make more virus particles (the output of the viral "program").For a typical **virus,** the lifecycle can be divided into five broad steps (though the details of these steps will be different for each **virus**):

Steps of a viral infection, illustrated generically for a virus with a + sense **RNA genome**.

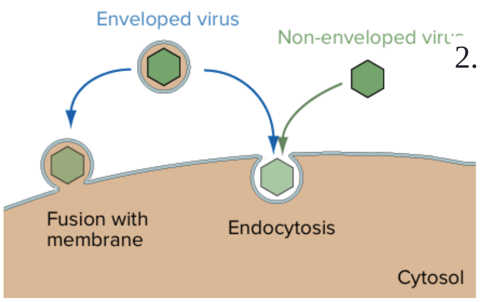
1. Attachment**. Virus** binds to receptor on cell surface.
2. Entry. **Virus** enters cell by **endocytosis**. In the cytoplasm, the **capsid** comes apart, releasing the **RNA genome**.
3. **Replication and gene expression**. The **RNA genome** is copied (this would be done by a viral enzyme, not shown) and translated into viral **proteins** using a host ribosome. The viral proteins produced include **capsid proteins**.
4. Assembly. **Capsid proteins** and **RNA genomes** come together to make new viral particles.
5. Release. The **cell lyses** (bursts), releasing the viral particles, which can then infect other **host cells**.



1. **Attachment.** The **virus** recognizes and binds to a **host cell** via a receptor molecule on the cell surface.

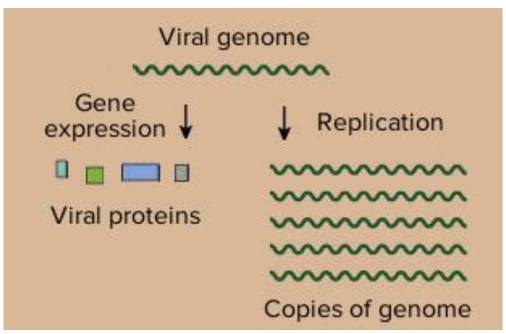


Virus binding to its receptor on the cell surface.



2. **Entry**. The **virus** or its genetic material enters the cell.

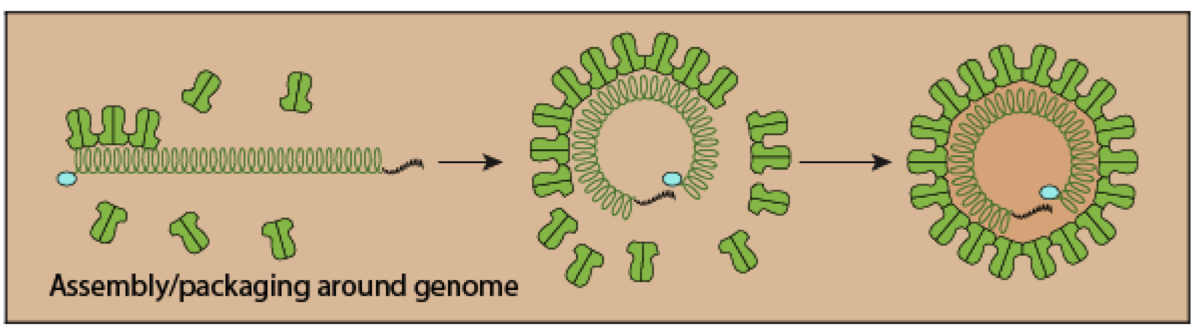
Routes of entry include **endocytosis** (in which the membrane folds inward to bring the virus into the cell in a bubble) and direct fusion of the viral particle with the membrane, releasing its contents into the cell.



3. **Genome replication and gene expression.** The viral genome is copied and its genes are expressed to make viral proteins.

The viral **genome** is copied, and its genes are also expressed to make viral proteins.

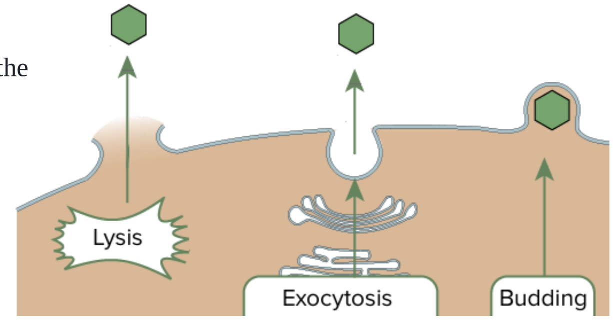
4. **Assembly.** New viral particles are assembled from the **genome** copies and viral **proteins**.



Proteins of the capsid assemble around the viral **genome**, forming a new viral particle with the genome on the inside (encased by the **capsid**).

5. **Release.** Completed viral particles exit the cell and can infect other cells.

Viruses may exit through lysis of the cell, exocytosis, or budding at the plasma membrane.



The diagram shows how these steps might occur for a **virus** with a **single-stranded RNA genome**. You can see real examples of viral lifecycles in the articles on bacteriophages (bacteria-infecting **viruses**) and animal **viruses**.

APPENDIX B

1.

Produce a model of a virus		Pre	Post
capsid	Inside the membrane		
	labeled		
DNA or RNA genome	Inside the capsid		
	labeled		
membrane envelope	internal		
	external		
	labeled		
Overall drawing model	colorful		
	neat		
	Appears all members contributed		

2.

Different shapes and structures			Pre	Post
Capsid shapes	Shows different shapes			
	Icosahedral	Drawn		
	(20 faces)	labeled		
	Filamentous	Drawn		
		labeled		
	Head-Tail	Drawn		
		labeled		
envelopes	external			
	internal			
	Contain proteins			
	labeled			
genome	Nucleic acid labeled			
	Labeled DNA	single strand		
		double strand		
	Labeled RNA	single strand		
		double strand		
Overall drawing model	colorful			
	neat			
	Appears all members contributed			

3.

life cycle of viruses		Pre	Post
Shows host cell			
Attachment	Virus on cell surface		
	labeled		
	Step 1 labeled		
Entry	Shows entry by endocytosis		
	Labeled		
	Shows capsid coming apart		
	labeled		
	Releasing genome		
	Labeled genome (DNA/RNA)		
	Step 2 labeled		
Replication & gene expression	Genome copied		
	Shows genome (DNA/RNA)		
	labeled		
	Shows translated viral proteins using host ribosomes		
	labeled		
	Capsid proteins produced		
	labeled		
	Step 3 labeled		
Assembly	Capsid proteins & genomes come together		
	New viral proteins		
	Labeled		
	Step 4 labeled		
Release	Cell lyses (burst)		
	labeled		
	Releasing new viral cells		
	Labeled		
	Step 4 labeled		
Overall drawing model	colorful		
	neat		
	Appears all members contributed		

Effectiveness of collaboration with team members and class.			
Expert	Proficient	Intermediate	Beginner
Extremely Interested in collaborating in the simulation. Actively provides solutions to problems, listens to suggestions from others, attempts to refine them, monitors group progress, and attempts to ensure everyone has a contribution.	Extremely Interested in collaborating in the simulation. Actively provides suggestions and occasionally listens to suggestions from others.	Refines suggestions from others. Interested in collaborating in the simulation. Listens to suggestions from peers and attempts to use them. Occasionally provides suggestions in group discussion.	Interested in collaborating in the simulation.
Effectiveness of presenting the conceptual model			
Extremely interested in presenting the material on the conceptual model drawing. Provides accurate information related to the drawing	Excellent in presenting the material on the conceptual model drawing. Provides some information related to the drawing	Moderately presented the material on the conceptual model drawing. Provides some but not all accurate information related to the drawing	Shared, with little interest. Did not cover related material