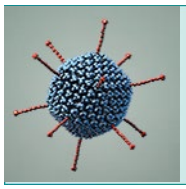

Virus Explorer

hhmi | BioInteractive

Click & Learn
Student Worksheet

INTRODUCTION

What do the flu, HIV, and coronaviruses have in common, and how are they different? You'll learn more about these and other viruses in the *Virus Explorer* Click & Learn. In the Click & Learn, you can explore the structures and biology of 10 different viruses, as well as how these viruses impact humans and other organisms.

PROCEDURE

Follow the instructions as you proceed through the Click & Learn, and answer the questions in the spaces provided.

1. Open the *Virus Explorer* Click & Learn and click on the "About" tab at the bottom. Use the information in this tab to answer the following questions.

   a. List **four** ways in which viruses can differ from each other.

   b. In the table below, describe what each abbreviation in this Click & Learn means.

Abbreviation	**Description**
nm	
bp	
ss	
ds	

2. Close the "About" tab and return to the main page. Find the "**i**" icon next to each viral characteristic across the top. Click on each icon to learn more about that characteristic, then answer the associated question below.

   a. **Envelope:** The envelope is an outer layer that some, but not all, viruses have. How does an envelope form?

   b. **Host(s):** From the virus's perspective, why is the host important?

   c. **Genome Type:** What are **four** characteristics of viral genomes that may vary among viruses?

d. **Transmission:** Define the terms "vector" and "zoonotic."

e. **Vaccine Availability:** What is one advantage of being vaccinated against a particular virus?

3. Click the viral characteristics across the top of the main page to classify and learn more about the viruses. Use what you learn to answer the following questions.

   a. What is one difference between the rabies virus and the influenza A virus?

   b. Of the 10 viruses shown, which is the only one that infects plants?

   c. List **three** characteristics that adenoviruses, T7 virus, and papillomaviruses have in common.

   d. As of 2020, a new coronavirus called SARS-CoV-2 has been in the news. There have been many efforts to develop a vaccine for this coronavirus. Why is this virus of particular concern?

   e. Which **two** viruses infect all the vertebrates included in the Click & Learn?

   f. Of the 10 viruses shown, which is the only one that infects bacteria?

   g. List **four** specific characteristics that human immunodeficiency virus (HIV) and Ebola virus have in common.

   h. List **four** specific characteristics that HIV and Ebola virus do *not* share.

4. Find the **+** icon next to each virus's name. Click on each icon to learn more about that virus, then answer its associated question(s) below.

   a. **Rabies:** People often think that you get the rabies virus from dogs. Why is this understanding incomplete?

b. **Influenza A:** Influenza viruses have a segmented genome. Why is having a segmented genome an advantage for these viruses?

c. **HIV:** HIV infects cells in the immune system. Why is this a disadvantage for the infected person?

d. **Ebola:** What animal is associated with Ebola virus outbreaks?

e. **Tobacco mosaic virus (TMV):** Name one characteristic of TMV that none of the other viruses in the Click & Learn have.

f. **Adenovirus:** What are **three** of the many conditions that adenoviruses can cause in humans?

g. **T7 virus:** The replication cycle of T7 virus has several things that none of the other virus replication cycles include. What is one of these things?

h. **Papillomavirus:** What is the common name for papillomas?

i. **Zika:** Why is Zika virus of great concern to pregnant women?

j. **Coronavirus:** What are the names of two coronaviruses that caused outbreaks in humans *before* 2020?

EXTENSION: Size, Scale, and Proportion (How Big Is a Virus Anyway?)

Click on the "Show Relative Sizes" button at the bottom of the main page in the *Virus Explorer* Click & Learn. Use the diagram that is shown to answer Question 1. Note you will need a calculator for some later questions.

1. The white scalebar at the bottom of the diagram represents 100 nanometers (nm). Use this scalebar to make the following estimates.
   a. About how long (tall) is TMV?

   b. What is the approximate diameter of human immunodeficiency virus (HIV)?

   c. What is the approximate diameter of Zika virus?

How big are these viruses compared to other things? To find out, we'll calculate how big different things are when measured in nanometers, then compare them to the sizes of these viruses. First, read through the following example, then answer the questions below.

Example

A small paperclip measures about 3 centimeters (cm) in length. Let's calculate the length of the paperclip in several different units.

How long is the paperclip in **millimeters (mm)**? There are 10 mm in 1 cm. So, the paperclip's length in mm is:

$$3\text{ cm} \times \frac{10\text{ mm}}{1\text{ cm}} = \frac{3 \times 10\text{ mm}}{1} = \mathbf{30\text{ mm}}$$

How long is the paperclip in **micrometers (µm)**? There are 1,000 µm in 1 mm. So, the paperclip's length in µm is:

$$30\text{ mm} \times \frac{1{,}000\text{ µm}}{1\text{ mm}} = \frac{30 \times 1{,}000\text{ µm}}{1} = \mathbf{30{,}000\text{ µm}}$$

Finally, how long is the paperclip in **nanometers (nm)**? There are 1,000 nm in 1 µm. So, the paperclip's length in nm is:

$$30{,}000\text{ µm} \times \frac{1{,}000\text{ nm}}{1\text{ µm}} = \frac{30{,}000 \times 1{,}000\text{ nm}}{1} = \mathbf{30{,}000{,}000\text{ nm}}$$

So, a paperclip that measures 3 cm in length is 30,000,000 nm long — much bigger than the viruses you measured!

2. A single grain of salt measures 0.5 mm in width. Calculate this width in the following units. Show your work.
   a. micrometers (µm)

   b. nanometers (nm)

3. The average human skin cell measures 30 µm in diameter. Calculate this diameter in the following units. Show your work.

   a. millimeters (mm)

   b. nanometers (nm)

4. If you lined up human skin cells side by side, how many would fit along the length of the paperclip in the example above? Justify your answer by showing your calculations. (*Hint:* Use your response to Question 3.)

5. If you lined up TMV particles end to end, how many would fit along the length of the same paperclip? Justify your answer by showing your calculations. (*Hint:* Use your response to Question 1.)

6. If you lined up TMV particles end to end, how many would fit across the diameter of the average human skin cell? Justify your answer by showing your calculations. (*Hint:* Use your responses to Questions 1 and 3.)

7. An individual virus binds to the surface of a cell, hijacks the cellular machinery inside, and replicates itself, sometimes thousands of times. Based on what you've learned about the size, scale, and components of a virus, explain how a virus is able to accomplish this. Justify your answer with scientific reasoning.