

| <u>What we know</u> | <u>What we don't know</u> | <u>What we want to find out</u> |
|---|---|---|
| All living materials are made up of one or more cells | Structure of a virus | Are viruses considered living or non-living? |
| The basic difference between a plant and an animal cell | Organelles found in a virus | Functions of viruses |
| The definition of life | How is the virus first formed? | How do viruses reproduce? |
| | How is the virus designed to cope with its function | Why do viruses want to be in RNA form although it is more reactive? |
| | Different types of viruses | Does the viral coat substitute for viral double stranded DNA? |
| | | What is uncoating? |
| | | Why some doesn't have envelope while some other do |

A221: Microbiology

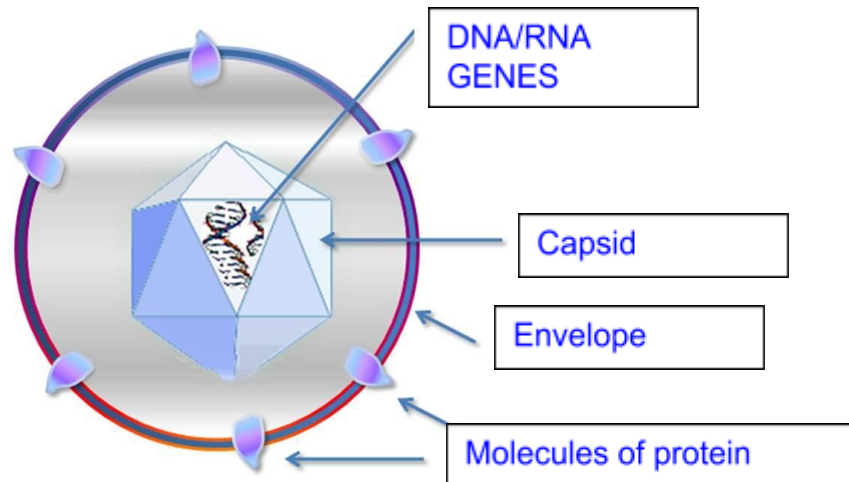
Problem 10: A Matter of Life

WORKSHEET

Question 1

Fill in the blanks in Figure 1 to indicate the **components that make up a virion**.

Figure 1



- a) Recall the differences between prokaryotic and eukaryotic cell in Problem 6, and complete Table 1 below for comparison of prokaryotic cell, eukaryotic cell and virion. Does a virion belong to **prokaryotes** or **eukaryotes**?

Table 1

| Components | Prokaryotic cell | Eukaryotic cell | Virion |
|-----------------------|--|---|---|
| Genetic material | Present (DNA) | Present (DNA) | Present (DNA/RNA) |
| Nucleus | Absent (single chromosome located in the nucleoid) | Present | Absent |
| Endoplasmic reticulum | Absent | Present | Present |
| Ribosomes | Present | Present | Absent |
| Membrane | Absent | Present (cell membrane) | Present in extracellular virus and absent in non-virus |
| Cell Wall | Present | Present for plant cells and absent for animal cells | Absent but have protein coat to contain the genetic materials |
| Size in general | 0.1-10um | 10-100um | 20-250 nm |

- b) With the help of this short article, summarize the difference between “**virus**” and “**virion**”.

Virion vs Virus.jpg

Virion is used to describe the infectious virus package that is assembled. It is the extracellular form of the virus that is released from one cell and binds to another surface of another cell.

Virus is the biological entity in all its stages and the general characteristics that differentiate it from another infectious entry.

virus: a submicroscopic infectious organism, now understood to be a non-cellular structure consisting of a core of DNA or RNA surrounded by a protein coat

virion: a single individual particle of a virus (the viral equivalent of a cell)

c) Based on the information you have input into Table 1, deduce how viruses are being **classified in general**? Read this [link](#) for more information.

- By the type of nucleic acid (DNA/RNA, Single-/Double-stranded) they contained
- Based on shape: filamentous, isometric (or icosahedral), enveloped, and head and tail.
- Based on the viral replicative cycles of the virus

Question 2



In Problem 6, light microscope was used for the viewing of bacteria.

a) Can a virus be viewed under light microscope as well? Why?

No, generally a virus cannot be viewed under a light microscope because the size of a virus is smaller than bacteria.

b) Table 2 below is a comparison between **light microscope** and **electron microscope**. Fill in the blanks to make the comparisons.

Table 2

| | Light Microscope | Electron Microscope |
|--|---|---|
| |  |  |
| Illuminating source | Incandescent | Electron beams |
| Minimum size of microorganism viewable | >0.2um (200 nm) | 0.2nm |

| | | |
|--------------------------|--|-----|
| Ability to view bacteria | Yes | Yes |
| Ability to view viruses | No (with the exception of some large virion of the poxvirus family) | Yes |

Question 3

- a) With reference to Figure 1 above, which are the virion structural components that are made up of proteins?

Capsid, Molecules of protein

- b) Recalling what you have learnt in A104 Biology, which organelle in a cell is responsible for the synthesis of proteins?

Ribosomes

- c) With reference to Table 1 above, does a virion have ribosomes?

No, a virion does not have ribosomes.

- d) Can the viral structural components that are made up of proteins as suggested in Part a) be synthesized by the virion? If not, how are these components being synthesized?

No, the viral structural components cannot be synthesized by the virion because they lack protein synthesis machineries. These components are being synthesized by replication, transcription and translation after the virus infect a suitable living host cell.

Question 4

A virus makes use of cell processes to replicate. The video links below shows how DNA viruses replicate in cell.

<https://www.youtube.com/watch?v=ulut0oVWCEg>

<https://www.youtube.com/watch?v=7KXHwhTghWl>

- a) Generally, the replication of DNA and RNA viruses are relatively similar. Figure 2 below demonstrates a general **replication cycle of an RNA virus** in eukaryotic cell. Fill in the blanks to illustrate the series of steps involved in viral replication.

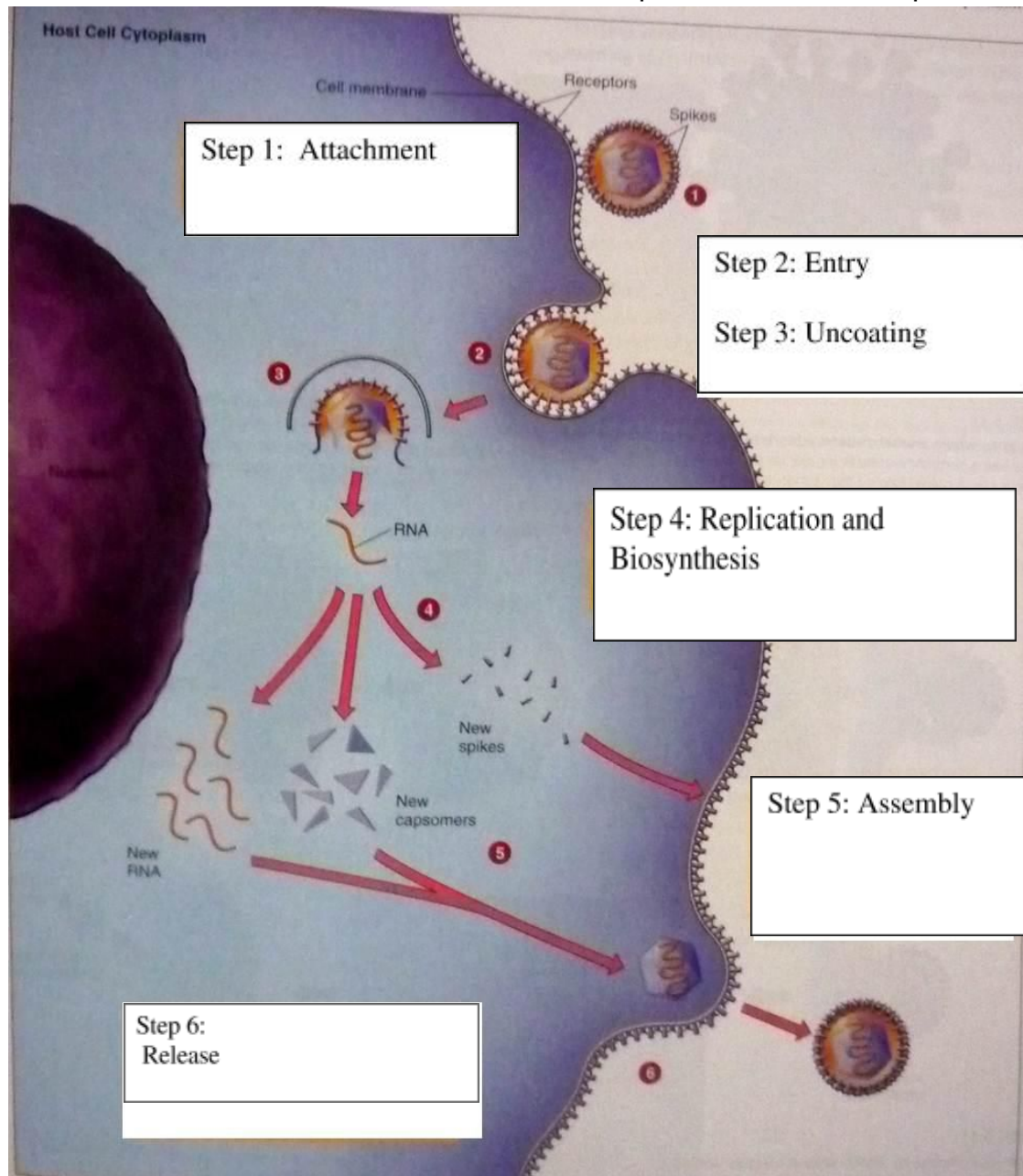


Figure 2

- b) Fill in Table 3 below to elaborate on processes that happened during each steps involved in the replication of virus.

Table 3

| | Name of step | What happens during the step |
|--------|---------------------|---|
| Step 1 | Attachment | The virion attach to the host cell by specific binding of its proteins to the receptors on the surface of the target cell . |
| Step 2 | Entry | The virion is engulfed into a envelope and enters the host cell. |
| Step 3 | Uncoating | The envelope (if any) and protein coat of the virus is removed and the DNA of the virus is freed into the cytoplasm or nucleus. |
| Step 4 | Biosynthesis | Under the control of viral genes, the host cell synthesize the basic components of the viral protein shells and viral protein (i.e. capsid and viral envelope). |
| Step 5 | Assembly | Basic viral components are assembled to into a nascent viral particle . Viral genetic material will be package within the capsid, formed by many units of proteins . _____ are inserted into the host cell membrane for viral envelope. (Note that not all viruses have envelope, hence this step might not be present for non-enveloped viruses). |
| Step 6 | Release | Enveloped virus _____ from the host membrane, carrying away an _____ with _____. This complete virion is ready to infect another cell. |

- c) After understanding how virus replicate within host cell, explain the **purpose** a virus is trying to achieve by infecting a host cell.
Reproduction

- d) The figure in Part a) shows the replication cycle of a virus in eukaryotic cell. There are also viruses that infect prokaryotic cells. What kind of viruses **infects bacteria**? What are the basic components that make up such viruses?

Bacteriophages are viruses that infect bacteria. The basic components of bacteriophages are the base plate, the head (capsid), tail fibers, sheath, collar.

- e) Figure 3 below shows the general replication cycle of **viruses that infect bacteria**. Fill in the blanks illustrate the series of steps involved in replication of viruses that infect prokaryotes.

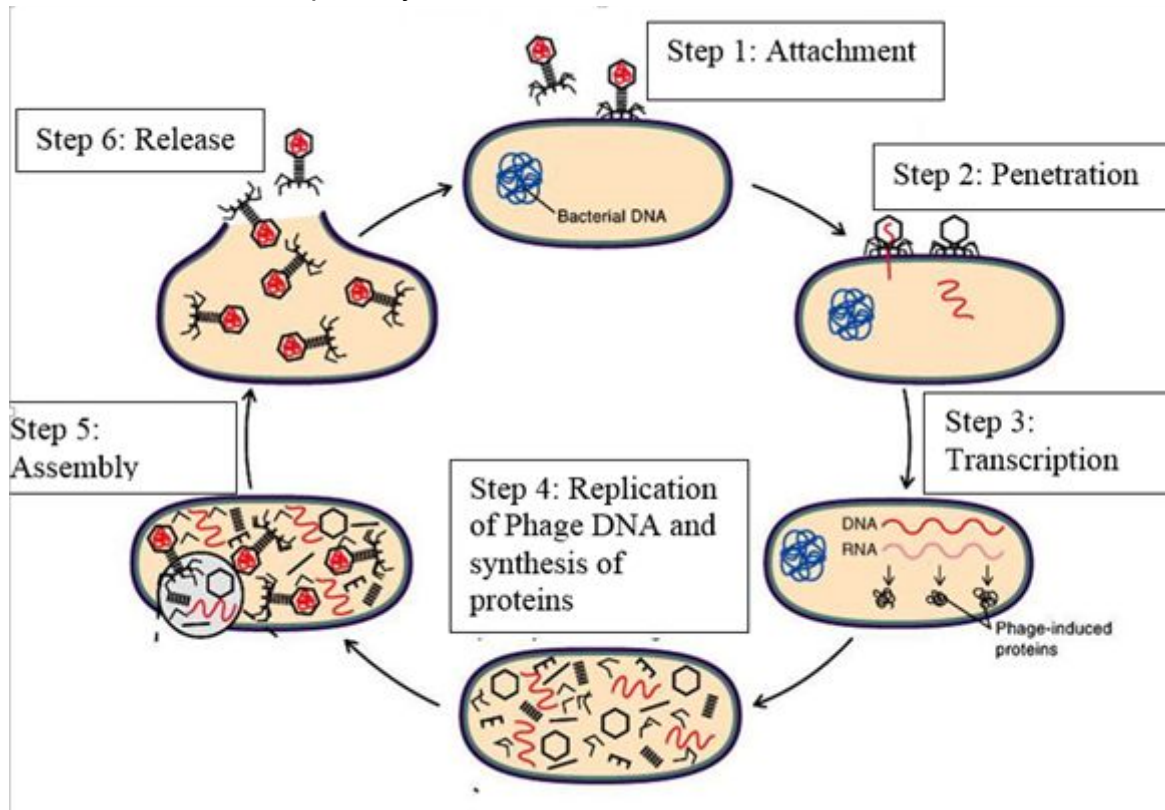
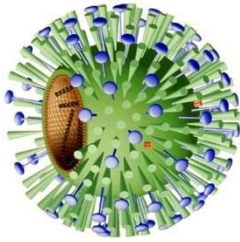
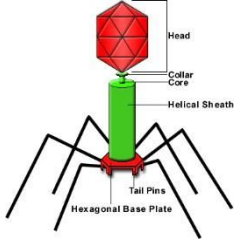


Figure 3

1. **Attachment**: The phage attach to specific receptors on the cell wall of bacteria
2. **Penetration**: Following attachment, phage DNA is injected into the bacterial cell, leaving the phage coat outside
3. **Transcription**: Phage DNA is transcribed, producing phage mRNA, which is translated to phage proteins
4. **Replication of Phage DNA and synthesis of proteins**: Phage coat proteins, other protein components, and DNA are produced separately while host DNA is degraded.
5. **Assembly**: Phage components are assembled into mature virions
6. **Release**: Bacterial cell lyses and releases many infective phages

Question 5

- a) Complete the table below to make comparison between the **attachment of viruses** that infect eukaryotic cells and prokaryotic cells respectively.

| | Virus that infects eukaryotic cell | Virus that infects prokaryotic cell |
|---|---|---|
| |  |  |
| First step of replication | Attachment | Attachment |
| Structural component of virus responsible for first step of replication | Attachment Proteins (glycoproteins) | Binding protein of the tail |
| Example of where host cell receptor are found | Cell membrane | Bacterial cell wall |

- b) Can a virus that infects eukaryotic cell also infects prokaryotic cell?

No, a virus that infects eukaryotic cells cannot infect prokaryotic cells.

- Translation carried out by ribosomes are different in prokaryotes and eukaryotes.
- Viral entry is dependent on cell surface features and would be incompatible for eukaryotic viral entry into prokaryotic cells, and vice versa

- c) The table below illustrates 2 different types of viruses that affect different eukaryotic host species.

| | Iridovirus | Influenza virus |
|--------------|--|---|
| Host species | Mainly invertebrates like insect, but also limited vertebrates like fishes | Mainly vertebrates including human and other vertebrates. |

- i) Do you think Iridovirus will be able to infect vertebrates?

Yes

- ii) What determines the **range of host** that viruses are able to infect?

It is define as the types of organisms another organism can successfully infect or colonise. This is due to the specific receptors found on the host cellular surface, which determines whether these viruses can attach to the host specifically. Specificity of viral attachment proteins to receptors on host cell

Question 6

Viruses can also be grown in the laboratory as described in <https://www.boundless.com/microbiology/textbooks/boundless-microbiology-textbook/viruses-9/culturing-viruses-120/tissue-culture-of-animal-viruses-620-3505/>.

How are viruses grown in the laboratory?

Swabs will be put in a vial containing virus transport medium, while bodily fluids and tissues will be placed in a sterile container. The specimen is then inoculated into several different types of cell culture depending on the nature of the specimen and clinical presentation. The maintenance media should be changed after one hour or the next morning. The inoculated tubes should be incubated at 35-37 degree celsius in a rotating drum ((rotation is optimal for isolation of respiratory viruses and result in an earlier appearance of the cytopathic effect (CPE) for many viruses. If stationary tubes are used, it is critical that the culture tubes be positioned so that the cell monolayer is bathed in nutrient medium

Going further (Optional)

1. Different types of viruses possess different kinds of genetic material. As such, the method by which the genetic material of viruses is replicated varies accordingly. Complete the table below to compare the location of genome replication and viral protein synthesis for DNA viruses and RNA viruses that infect eukaryotic cells.

| | DNA viruses | RNA viruses |
|--------------------------------------|--------------------|--------------------|
| Location of viral genome replication | | |
| Location of viral protein synthesis | | |

2. How are viruses quantified in the laboratory?

Counting the number of viruses in a specific volume to determine concentration.

References:

<http://serc.carleton.edu/microbelife/yellowstone/viruslive.html>

<http://hypertextbook.com/facts/2000/IlyaSherman.shtml>

<http://biology.about.com/od/virology/ss/viruses.htm>

<http://www.microbeworld.org/types-of-microbes/viruses>

<https://www.boundless.com/biology/textbooks/boundless-biology-textbook/viruses-21/virus-infections-and-hosts-137/steps-of-virus-infections-552-11762/>.

~End of Worksheet~