Virus Structure and Types

A Level

Part A Structure

Viruses are acellular (noncellular) microbes that are much [ ] than cells. They are not classed as living organisms because they do not have their own [ ]. Because of this, they rely on host cells for reproduction.

All viruses consist of a nucleic acid (either DNA or RNA) surrounded by a protein coat (also called a [ ]). Some viruses have more complex structures e.g. the human immunodeficiency virus (HIV) is surrounded by a [ ] (outside the protein coat). The outer layer of a virus contains [ ], which enable the virus to bind to (and enter) a specific host cell.

Items:

lipid membrane **cisterna** **larger** **metabolism** **cell wall** **flagella** **genetic material** **capsid** **attachment proteins** **smaller**

Part B Types

Viruses can be classified based on the type of nucleic acid they contain, and how they reproduce. DNA viruses use the host cell to [ ] viral mRNA from their DNA, and then produce viral proteins from this. RNA viruses use the host cell to produce viral proteins from their RNA.

Some RNA viruses insert a DNA version of their genome into the host cell's genome. These viruses are called [ ]. The process of producing DNA from RNA is called [ ], and requires a viral enzyme called [ ]. HIV is an example of one of these viruses.

Viruses can also be classified by the kind of host cells they infect. A virus that infects bacterial cells is called a [ ].

Items:

proteins **transcription** **retroviruses** **viroid** **reverse transcriptase** **bacteriophage** **translate**

RNA polymerase **transcribe** **reverse transcription** **adenoviruses**

Physics. You work it out.

Viral Reproduction

A Level

P P P

One of the best-studied viruses is the lambda phage, a bacteriophage which infects *E. coli*. This virus can replicate through either the lytic cycle or the lysogenic cycle.

Part A The lytic cycle of the lambda phage

Drag the steps below (on the left) into the correct chronological order of the lytic cycle (on the right).

Available items

The virus attaches to the host cell membrane.

The virus takes over the cell machinery. Viral DNA is transcribed to produce viral mRNA, which is translated to produce viral proteins (including the protein coat of each virus). The viral DNA is also replicated to produce more copies.

The copies of viral DNA and the viral proteins assemble to produce new viruses.

The virus injects its DNA into the host cell.

The viruses cause lysis of the cell membrane, which releases the viruses out into the cell's environment, where they can infect other cells.

Part B The lysogenic cycle of the lambda phage

Drag the steps below (on the left) into the correct chronological order of the lysogenic cycle (on the right).

Available items

- If one of the host cells undergoes some kind of stress (e.g. starvation), the viral DNA in its genome is transcribed and translated to produce new viruses (i.e. the virus re-enters the lytic cycle).
- When the host cell replicates its genome and divides, the viral genome is replicated with it.
- The virus injects its DNA into the host cell.
- The virus attaches to the host cell membrane.
- The viral DNA is integrated into the DNA of the host cell, but is not transcribed and translated to produce new viruses. This is a form of viral latency.

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Retroviruses

A Level

P P P

Part A The definition

What is the definition of a retrovirus?

- A virus that has an RNA genome instead of a DNA genome.
- A virus that inserts a DNA copy of its RNA genome into the genome of its host cell.
- A virus that has a DNA genome instead of an RNA genome.
- A virus that inserts an RNA copy of its DNA genome into the genome of the host cell.

Part B The enzyme

What is the name of the enzyme that retroviruses use to make DNA?

Part C An example

Which of these is an example of a retrovirus?

- HIV
- Ebola virus
- SARS-CoV-2
- Lambda phage
- *E. coli*
- Tobacco mosaic virus

Part D Fill in the blanks!

After a retrovirus has made a [ ] copy of its [ ] genome (through the process of [ ]), this copy is inserted into the host cell's genome, and is now called a [ ]. If this copy is not transcribed, then no new viruses are produced. This is known as viral [ ]. This period may last years before the virus is reactivated and new viruses are produced.

Items:

provirus **previrus** **transcription** **DNA** **lysis** **reverse transcription** **latency** **RNA**

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Cell or Virus?

A Level

Part A What is it?

The table below gives information about different biological entities. Match the biological entity to the correct row.

Row	Contains	Does not contain	Identity
1	cell wall, ribosomes	nucleus	
2	mitochondria, central vacuole, cellulose cell wall	chloroplasts	
3	DNA, proteins	ribosomes, phospholipid membrane	
4	phospholipid membrane	cell wall, nucleus, nucleoid	
5	mitochondria, nucleus, chloroplasts	flagellum	
6	nucleus	cell wall	

Items:

human white blood cell **bacterial cell** **virus** **human red blood cell** **plant leaf palisade cell** **plant root cell**

Part B Differences between cells and viruses

Which of the followings statements are true?

- [ ] Viruses are much smaller than cells.
- [ ] Viruses are intracellular parasites. There are no cells that act as intracellular parasites of other cells.
- [ ] Cells can replicate their own genome. Viruses require a host cell to replicate their genome for them.
- [ ] All cells have DNA genomes and all viruses have RNA genomes.
- [ ] Viruses cannot evolve because they are not alive.
- [ ] Viruses do not contain any proteins.
- [ ] Cells carry out metabolic processes (like respiration) and viruses do not.

Part C Antibiotics

Why do antibiotics not work on viruses?

- ( ) Viruses have evolved antibiotic resistance as a result of antibiotics being used against them.
- ( ) Antibiotics block metabolic processes (e.g. protein synthesis) which viruses do not carry out.
- ( ) Antibiotics target non-human DNA, and viruses do not have DNA.
- ( ) Viruses are too small for antibiotics to bind to them.

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Virus Identification

A Level

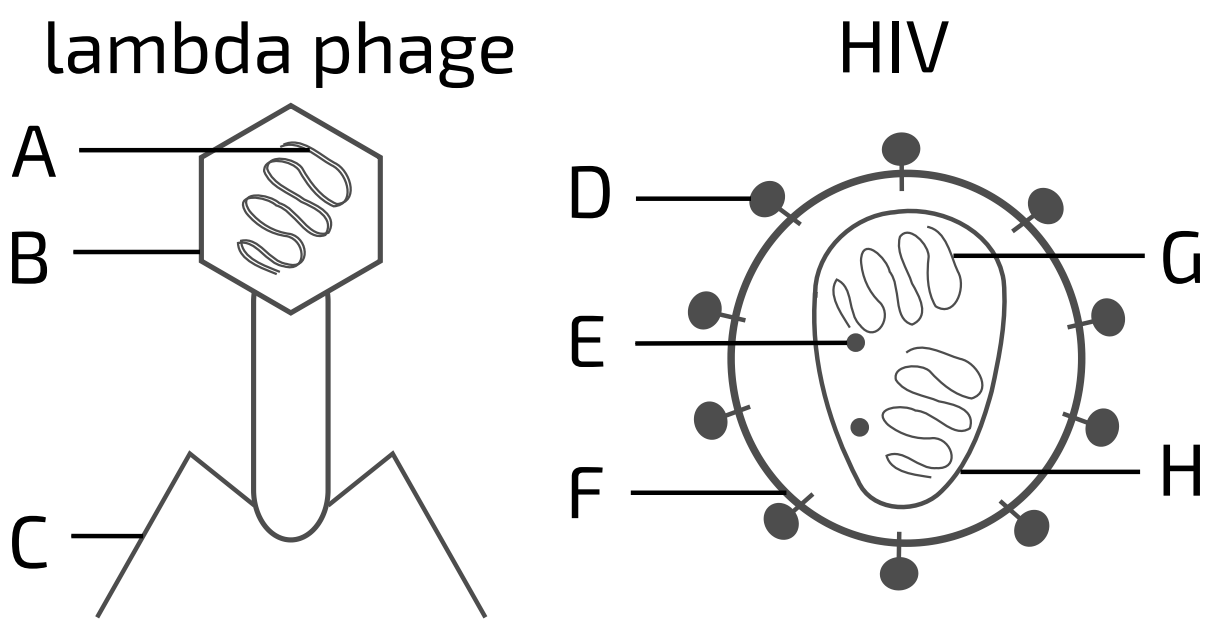

Figure 1: A diagram of two viruses: lambda phage and HIV.

Part A DNA

Which letter(s) in Figure 1 label(s) DNA? Select all that apply.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G
- [ ] H
- [ ] none of them

Part B RNA

Which letter(s) in Figure 1 label(s) RNA? Select all that apply.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G
- [ ] H
- [ ] none of them

Part C Capsid

Which letter(s) in Figure 1 label(s) a capsid? Select all that apply.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G
- [ ] H
- [ ] none of them

Part D Attachment proteins

Which letter(s) in Figure 1 label(s) attachment proteins? Select all that apply.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G
- [ ] H
- [ ] none of them

Part E Lipid membrane

Which letter(s) in Figure 1 label(s) a lipid membrane? Select all that apply.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G
- [ ] H
- [ ] none of them

Part F Enzyme E

Enzyme E catalyses the production of DNA from RNA. What is the name of enzyme E?

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Virus vs Host Cell Comparisons

A Level

C C C

SARS-CoV-2, the virus that causes COVID-19, infects a particular type of human cell called type II pneumocytes, which are found in the alveoli.

Answer the questions below to compare the virus to its host cell.

Part A Volume

The SARS-CoV-2 virus is spherical and has a diameter of $100\,\text{nm}$.

A type II pneumocyte is approximately cube-shaped and has a length of $9\,\mu\text{m}$.

How many times larger is the volume of the host cell than the volume of the virus? Give your answer to 1 sf.

[ ] times larger.

Part B Genome length

The SARS-CoV-2 virus has a single-stranded RNA genome that is approximately $30\,000$ bases long.

A type II pneumocyte, like all other diploid human cells, has a genome that is approximately 6×10^9 base pairs long.

How many times longer is the genome of the host cell than the genome of the virus?

[ ] times longer.

Part C Replication rate

An infected type II pneumocyte may produce up to 1000 copies of the SARS-CoV-2 virus over $10\,\text{hours}$.

How much longer would it take a type II pneumocyte to give rise to 1000 cells than to produce 1000 copies of of the virus, if each type II pneumocyte can only divide once every $24\,\text{hours}$?

Assume that no cell death occurs.

Give your answer to 2 sf.

[ ] times longer.

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