Virus classification and life cycle activity

For reference

Transcription: Krasner p 131

Translation: Krasner p 132 - 135

Genetic code: Krasner p 135

A virus is an obligate intracellular parasite, meaning that it absolutely must be inside a cell in order for it to replicate. Without a host cell, the virus cannot make more copies of itself, as it does not have the proteins and enzymes that do the work of copying the genetic material and proteins that make up a virus.

All viruses have a minimum structural requirement of a nucleic acid (genetic material) surrounded by a protein coat, called a capsid. Some viruses have an additional lipid layer surrounding the protein coat, called an envelope. The proteins on the outside of the virus bind to the target host cell and allow the virus to enter the cell. Once it has entered the cell, the virus hijacks the host cell's nucleic acid replication and protein synthesis machinery. The host cell turns into a virus-making factory.

DNA and RNA are the two types of nucleic acids (genetic information storage molecules). The central dogma states that the genetic information stored in DNA is transcribed into RNA, and the information stored in RNA is translated into an amino acid code to make proteins (DNA -> RNA -> Protein). Unlike prokaryotes and eukaryotes that store their genetic information as DNA (which is then transcribed into RNA and translated into proteins), viruses can carry their genetic information as DNA or RNA. The major differences between DNA and RNA viruses are in how the host cell processes the genetic information.

Though there are minor variations based on a virus's biology, most viruses will undergo similar replication processes in the host cell. To complete its life cycle (i.e. to make more copies of itself), a virus must first bind to the cell surface and gain entry. Once inside, the protein coat is removed in a step called "uncoating." This releases the nucleic acids that can then be copied and used to make more protein coats using the host cell's DNA and RNA replication and protein synthesis machinery. The new copies of the nucleic acid and the new protein coats are assembled into new viral particles inside the host cell. In the final step of a viral life cycle, the mature virus is released from the host cell, to go on to infect new hosts.

You will be given a virus to analyze. You will uncoat your virus and determine which type of virus it is according to the type of nucleic acid present in the capsid. Then, you will construct a flowchart or diagram of how the host cell will process the nucleic acid to make the protein for the capsid and how the host cell will replicate the nucleic acid.

The host cell must process the viral genetic information for two purposes related to viral replication: to produce proteins based on the genetic information from the virus, and to replicate the nucleic acid sequence. Because the virus can only use the host cell machinery to make copies of itself, viral nucleic acid replication and viral protein synthesis must abide by the same set of rules as the host cell.

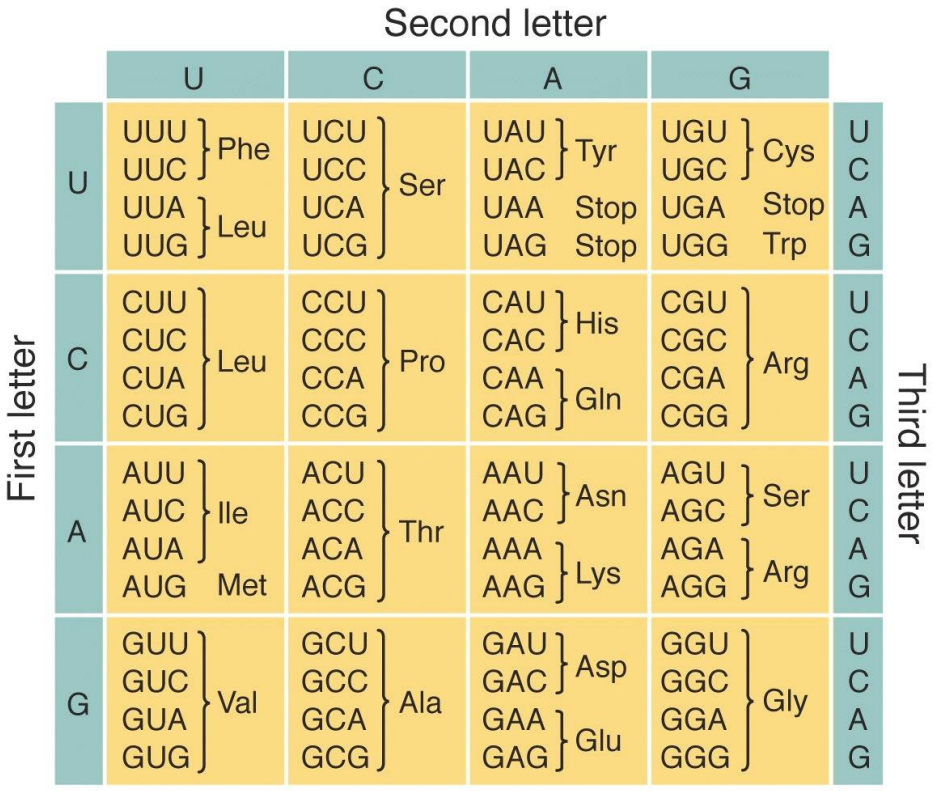
1) To make viral proteins, the viral nucleic acid must be in a form that the host cell can recognize. According to the central dogma, the cell can only translate RNA sequences into protein.

2) The cell reads RNA sequences in sets of 3 nucleotides, called codons. The host cell will only start translation when a start codon (the sequence AUG) is present. The viral nucleic acid must use the same codons for the same amino acids as the host cell.
3) Nucleic acid replication requires a template strand. The strand is read by an enzyme in the cell that will match A to T (or A to U) and G to C. The template strand (A) therefore sets the sequence of the new strand, but the new strand does not have the same sequence as the template strand (A). At the same time, the new strand can be used as another template strand (B) to recreate the original template strand (A) sequence.
4) The final viruses are made of proteins that are coded within the viral nucleic acid sequence and new copies of the viral nucleic acids that are in the same form (DNA or RNA, single-stranded or double-stranded) as the original virus.

The following viruses are represented in this activity:

virus	**nucleic acid**
Hepatitis C	positive-strand ssRNA
Measles	negative-strand ssRNA
Parvovirus B19	ssDNA
Rotavirus	dsRNA
Variola	dsDNA

The Genetic Code



Viral Classification Activity - To be turned in by the end of class today

1. Write your virus number here: _____

2. Does your virus have an envelope?

3. Is this a single-stranded or double-stranded virus?

4. Is this a DNA or RNA virus?
   DNA sequences are made up of **A**denine, **G**uanine, **C**ytosine, and **T**hymine.
   RNA sequences are made up of **A**denine, **G**uanine, **C**ytosine, and **U**racil.

5. From your nucleic acid sequence and the genetic code table above, identify the RNA **coding** sequence (i.e. the RNA sequence that will be translated to protein) for the first 5 amino acids of your capsid protein. Write this positive-sense sequence below:

   ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

6. If you have an RNA virus, is it positive-sense (the same sequence used for translation to protein) or negative sense (the complimentary sequence)?

7. Based on the nucleic acid present in your virus, which of the 5 viruses did you get?

8. Below, draw a diagram that shows how the sequence of your virus is used to express viral proteins. Remember that proteins can only be synthesized in the host cell using an RNA template, so be sure to explain how your nucleic acid is turned into the correct RNA sequence if necessary.

9. Draw a diagram that shows how the viral nucleic acid is used to produce new copies of the viral nucleic acid to be packaged into new virions. Be sure that your final sequence and nucleic acid structure are exactly the same as what you found in your original viral particle. Remember that you can only synthesize new nucleic acid sequences with a template!

10. After identifying your virus based on the type of nucleic acid it carries, complete the virus life cycle chart for your virus. On the back of your chart, gather the life cycle information for another virus from another group. Turn this chart in at the beginning of the next class.

Variola Virus
dsDNA

ATG CTA CGA GTA CGG ACA CTG CTT ATA CTT TGC ACC TTT GTA GTG ATT TGA
TAC GAT GCT CAT GCC TGT GAC GAA TAT GAA ACG TGG CCC CAT CAC TAA ACT

M L R V R T L L I L C T F V V I stop

Parvovirus B19
ssDNA

ATG CCG CCG GTC GCC GCC GGT AGG CGG GAC TTC CGG TAC AAG ATG GCG GAC TGA

M P P V A A G R R D T R Y K M S D stop

Rotavirus
dsRNA

AUG GCG AGU CUG AUA UAC CGG CAG CUA UUA ACA AAC UCG UAC ACU GUG GAU UGA
UAC CGC UCA GAC UAU UAG GCC GUC GAU AAU UGU UUG AGC AUG UGA CAC GUA ACU

M A S L I Y R Q L L T N S Y T V D stop

Hepatitis C virus
(+)ssRNA

AUG AGU ACA AAC CCU AAG CCU CAG CGU AAA ACU AAA CGG AAU ACU AAU CGU UGA

M S T N P K P Q R K T K R N T N R stop

Measles Virus
(-)ssRNA

AUG AGU CCU CAG AGG GAU AGA AUC AAU GCU UUC UAU AAA GAC AAU CCU CAU UGA
UAC UCA GGA GUC UCC CUA UCU UAG UUA CGA AAG AUA UUU CUG UUA GGA GUA ACU

M S P Q R D R I N A F Y K D N P H stop

Virus 9

ATG CTA CGA GTA CGG ACA CTG CTT ATA CTT TGC ACC TTT GTA GTG ATT TGA
TAC GAT GCT CAT GCC TGT GAC GAA TAT GAA ACG TGG CCC CAT CAC TAA ACT

M L R V R T L L I L C T F V V I stop

Virus 28

ATG CTA CGA GTA CGG ACA CTG CTT ATA CTT TGC ACC TTT GTA GTG ATT TGA
TAC GAT GCT CAT GCC TGT GAC GAA TAT GAA ACG TGG CCC CAT CAC TAA ACT

M L R V R T L L I L C T F V V I stop

Virus 49

ATG CTA CGA GTA CGG ACA CTG CTT ATA CTT TGC ACC TTT GTA GTG ATT TGA
TAC GAT GCT CAT GCC TGT GAC GAA TAT GAA ACG TGG CCC CAT CAC TAA ACT

M L R V R T L L I L C T F V V I stop

Virus 87

ATG CTA CGA GTA CGG ACA CTG CTT ATA CTT TGC ACC TTT GTA GTG ATT TGA
TAC GAT GCT CAT GCC TGT GAC GAA TAT GAA ACG TGG CCC CAT CAC TAA ACT

M L R V R T L L I L C T F V V I stop

Virus 96

ATG CTA CGA GTA CGG ACA CTG CTT ATA CTT TGC ACC TTT GTA GTG ATT TGA
TAC GAT GCT CAT GCC TGT GAC GAA TAT GAA ACG TGG CCC CAT CAC TAA ACT

M L R V R T L L I L C T F V V I stop

Virus 44

ATG CCG CCG GTC GCC GCC GGT AGG CGG GAC TTC CGG TAC AAG ATG GCG GAC TGA

M P P V A A G R R D T R Y K M S D stop

Virus 51

ATG CCG CCG GTC GCC GCC GGT AGG CGG GAC TTC CGG TAC AAG ATG GCG GAC TGA

M P P V A A G R R D T R Y K M S D stop

Virus 55

ATG CCG CCG GTC GCC GCC GGT AGG CGG GAC TTC CGG TAC AAG ATG GCG GAC TGA

M P P V A A G R R D T R Y K M S D stop

Virus 64

ATG CCG CCG GTC GCC GCC GGT AGG CGG GAC TTC CGG TAC AAG ATG GCG GAC TGA

M P P V A A G R R D T R Y K M S D stop

Virus 91

ATG CCG CCG GTC GCC GCC GGT AGG CGG GAC TTC CGG TAC AAG ATG GCG GAC TGA

M P P V A A G R R D T R Y K M S D stop

Virus 1

AUG GCG AGU CUG AUA UAC CGG CAG CUA UUA ACA AAC UCG UAC ACU GUG GAU UGA
UAC CGC UCA GAC UAU UAG GCC GUC GAU AAU UGU UUG AGC AUG UGA CAC GUA ACU

M A S L I Y R Q L L T N S Y T V D stop

Virus 5

AUG GCG AGU CUG AUA UAC CGG CAG CUA UUA ACA AAC UCG UAC ACU GUG GAU UGA
UAC CGC UCA GAC UAU UAG GCC GUC GAU AAU UGU UUG AGC AUG UGA CAC GUA ACU

M A S L I Y R Q L L T N S Y T V D stop

Virus 24

AUG GCG AGU CUG AUA UAC CGG CAG CUA UUA ACA AAC UCG UAC ACU GUG GAU UGA
UAC CGC UCA GAC UAU UAG GCC GUC GAU AAU UGU UUG AGC AUG UGA CAC GUA ACU

M A S L I Y R Q L L T N S Y T V D stop

Virus 38

AUG GCG AGU CUG AUA UAC CGG CAG CUA UUA ACA AAC UCG UAC ACU GUG GAU UGA
UAC CGC UCA GAC UAU UAG GCC GUC GAU AAU UGU UUG AGC AUG UGA CAC GUA ACU

M A S L I Y R Q L L T N S Y T V D stop

Virus 66

AUG GCG AGU CUG AUA UAC CGG CAG CUA UUA ACA AAC UCG UAC ACU GUG GAU UGA
UAC CGC UCA GAC UAU UAG GCC GUC GAU AAU UGU UUG AGC AUG UGA CAC GUA ACU

M A S L I Y R Q L L T N S Y T V D stop

Virus 21

AUG AGU ACA AAC CCU AAG CCU CAG CGU AAA ACU AAA CGG AAU ACU AAU CGU UGA

M S T N P K P Q R K T K R N T N R stop

Virus 22

AUG AGU ACA AAC CCU AAG CCU CAG CGU AAA ACU AAA CGG AAU ACU AAU CGU UGA

M S T N P K P Q R K T K R N T N R stop

Virus 32

AUG AGU ACA AAC CCU AAG CCU CAG CGU AAA ACU AAA CGG AAU ACU AAU CGU UGA

M S T N P K P Q R K T K R N T N R stop

Virus 57

AUG AGU ACA AAC CCU AAG CCU CAG CGU AAA ACU AAA CGG AAU ACU AAU CGU UGA

M S T N P K P Q R K T K R N T N R stop

Virus 77

AUG AGU ACA AAC CCU AAG CCU CAG CGU AAA ACU AAA CGG AAU ACU AAU CGU UGA

M S T N P K P Q R K T K R N T N R stop

Virus 17

UAC UCA GGA GUC UCC CUA UCU UAG UUA CGA AAG AUA UUU CUG UUA GGA GUA ACU

M S P Q R D R I N A F Y K D N P H stop

Virus 19

UAC UCA GGA GUC UCC CUA UCU UAG UUA CGA AAG AUA UUU CUG UUA GGA GUA ACU

M S P Q R D R I N A F Y K D N P H stop

Virus 75

UAC UCA GGA GUC UCC CUA UCU UAG UUA CGA AAG AUA UUU CUG UUA GGA GUA ACU

M S P Q R D R I N A F Y K D N P H stop

Virus 81

UAC UCA GGA GUC UCC CUA UCU UAG UUA CGA AAG AUA UUU CUG UUA GGA GUA ACU

M S P Q R D R I N A F Y K D N P H stop

Virus 84

UAC UCA GGA GUC UCC CUA UCU UAG UUA CGA AAG AUA UUU CUG UUA GGA GUA ACU

M S P Q R D R I N A F Y K D N P H stop

	Particle #	Virus Type
1	1	rotavirus
2	5	rotavirus
3	9	variola
4	17	measles
5	19	measles
6	21	hepatitis C
7	22	hepatitis C
8	24	rotavirus
9	28	variola
10	32	hepatitis C
11	38	rotavirus
12	44	parvovirus
13	49	variola
14	51	parvovirus
15	55	parvovirus
16	57	hepatitis C
17	64	parvovirus
18	66	rotavirus
19	75	measles
20	77	hepatitis C
21	81	measles
22	84	measles
23	87	variola
24	91	parvovirus
25	96	variola

Particle #	Virus Type
21	hepatitis C
22	hepatitis C
32	hepatitis C
57	hepatitis C
77	hepatitis C
17	measles
19	measles
75	measles
81	measles
84	measles
44	parvovirus
51	parvovirus
55	parvovirus
64	parvovirus
91	parvovirus
1	rotavirus
5	rotavirus
24	rotavirus
38	rotavirus
66	rotavirus
9	variola
28	variola
49	variola
87	variola
96	variola