1 Viruses

Viruses outnumber cellular life

Estimated 10^{31} viruses (greatest biodiversity on earth)

$>$ 95% of ocean biomass is microbial and about 20% of ocean microbes are destroyed each day by viruses

→ Major player in carbon / oxygen cycles regulating the atmosphere

Bacteriophages that infect *vibrio cholera* may be an important factor in regulating cholera outbreaks and pandemics

Viruses can infect all types of life forms (animals, plants, bacteria, archaea)

→ Every living organism studied has at least 1 virus associated with it

1.1 Types of Viruses

1. Zoonosis

   Coronavirus

   Rabies

   Ebola

2. Forever Viruses (Infect more than 50% of the population)

   HSV1 (Herpes Simplex Virus 1)

   HIV (Human Immunodeficiency Virus)

3. Viruses and Cancers

   HBV (Hepatitis B)

   HCV (Hepatitis C)

   HPV (Human Papilloma Virus)

1.2 Drug Resistance

Viruses are becoming multi-drug resistant

→ Bacteriophages may be used when antibiotics become ineffective

Ex: Clinical use of bacteriophage therapy for *Mycobacterium chelonae* infection

1.3 Coevolution

8% of our genome is virus (LTR retro-transposons)

→ Retroviruses inject their own genome into hosts

1.4 Syncytin-1

Endogenous retroviral envelope protein

1. Derived from ancient virus
2. Retained its fusogenic properties
3. Participates in trophoblast fusion and the formation of a syncytium during placenta morphogenesis

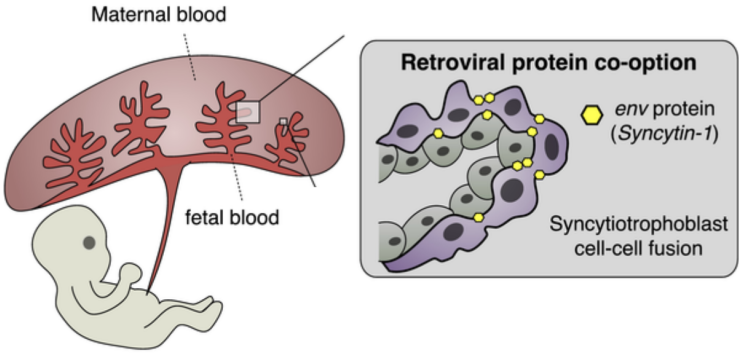

Figure 1: Use of syncitin-1 during pregnancy

1.5 Tobacco Mosaic Disease: A Mysterious Infection (1886)

The agent can be transferred between plants (A bacteria? A toxin?)

1892: Found capable of permeating porcelain Chamberland filters (something bacteria could not do)

→ Diatomaceous earth filters which hold back all bacteria

1898: Martinus Beijerinck reevaluated Dmitri Ivanovsky's findings

1.5.1 The Tobacco Mosaic Virus (TMV)

1935: TMV was the first virus to be visualized using electron microphotograph

By Wendell Stanley (Namesake of Stanley Hall)

1.6 What is a Virus?

1. Infectious, obligate parasite
2. Comprises genetic material (DNA or RNA)
3. Surrounded by a protein coat and/or envelope derived from host cell membrane

1.6.1 Viruses have vast differences in size

Forms:

1. Virion: Form of virus outside cell
2. Infected Cell

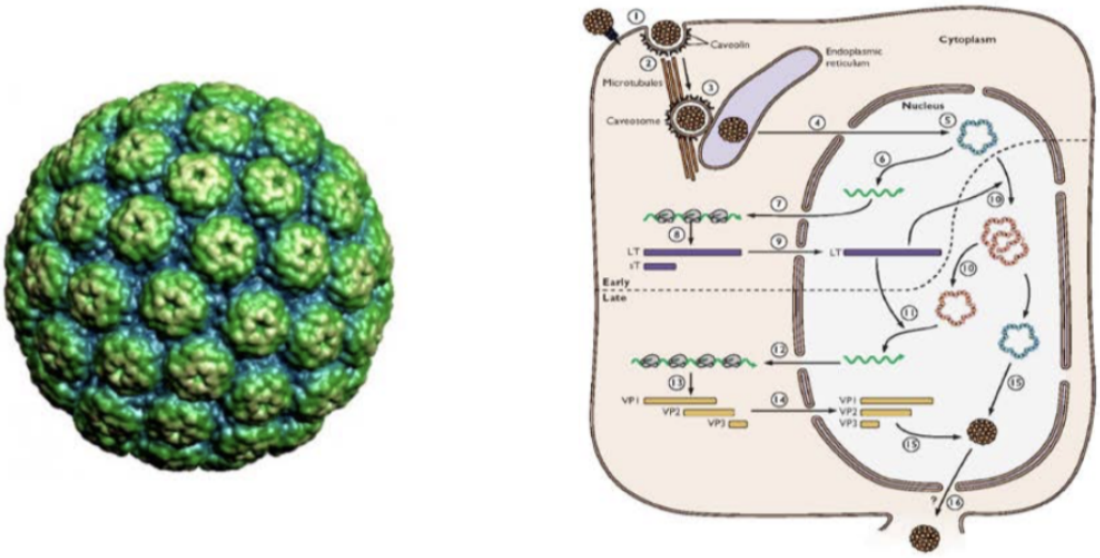

Figure 2: Virion vs. Infected Cell (Not to scale)

1.7 Stages of Viral Infection

1. Attatchment
2. Penetration
3. Uncoating
4. Replication
5. Assembly
6. Release

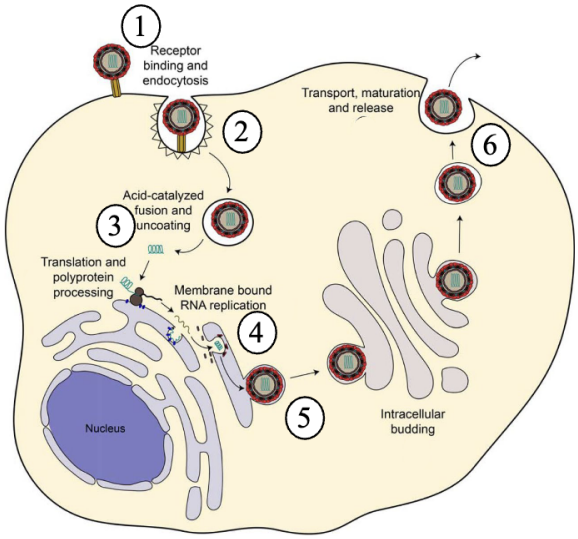

Figure 3: Stages of a viral infection

Hundreds of progeny virions can be produced from a single infections virus particle

1.8 Viral Genome

Viruses have about 1 million times less genetic information than the genomes of most plants and animals they effect

Viruses must do a lot with only a small amount of genetic information

1. Take over cellular machinery to mass-produce viral proteins (replicate viral genome)
2. Avoid eradication by immune system
3. Keep infected cell alive long enough to complete replication cycle

1.8.1 Mutations

Viruses mutate **a lot**

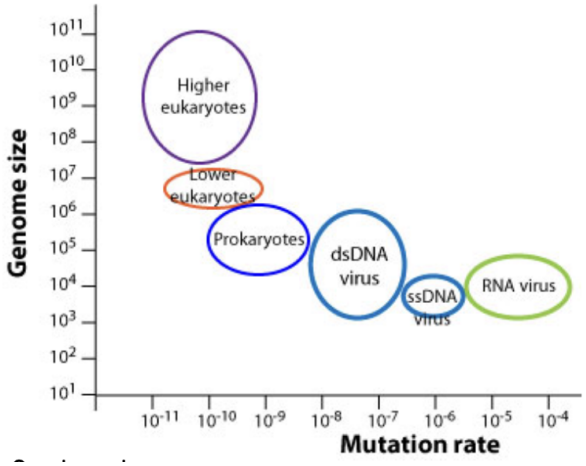

Figure 4: Quasi-species adaptability

The phenotype of the mutation can be neutral, advantageous, or deleterious

More mutations per genome → More chances for a deleterious protein

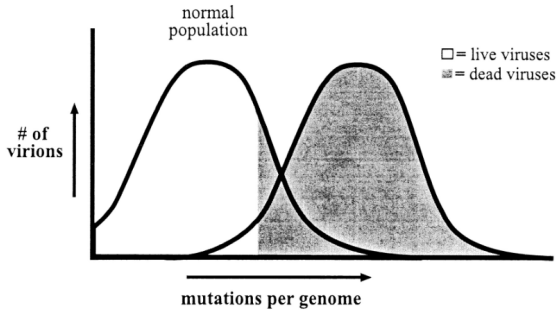

Figure 5: Model of Error Catastrophe

Molnupiravir: Antiviral forcing SARS-CoV-2 to mutate more ('lethal mutagenesis')

→ Error Catastrophe

1.9 Not All Viruses are Bad?

1. Some grasses can only grow at > 50°C when infected with a virus

2. Herpesviruses can provide protection against *listeria* infection

    Immune system is already activated

2 Wider Connections

Viruses are important to the study of molecular and cell biology by providing simple systems which can manipulate and investigate the functions of cells

1. Tumor suppressors
2. Proto-oncogenes
3. DNA replication
4. Gene expression
5. Vaccines
6. Splicing
7. Gene therapy
8. CRISPR