Chemistry of Life

As substrate concentration increases, the velocity of the reaction increases up to its saturation point.
At low substrate concentration, the rate of reaction is directly proportional to substrate concentration.
At high substrate concentration, the rate of reaction reaches V_{max}.

Enzyme Inhibitors

Enzyme inhibitors are compounds which restrict enzyme activity.

Reversible enzyme inhibitors: temporary inhibition effect.
> Competitive: competes directly with the substrate for the active site. Usually share structural characteristics of the substrate, described as substrate analogues. They bind to the active site but do not react. Increase in K_m.
> Non-competitive: binds to an alternative site on the enzyme, inducing a conformational change in the structure of the active site. Decrease in V_{max}.
> Uncompetitive: prevents activity of the enzyme once the substrate has bound to the active site. When the substrate binds, a new binding domain is made for the uncompetitive inhibitor. Uncompetitive inhibitors work best when substrate concentrations are high. Decrease in V_{max} and K_m.

Irreversible enzyme inhibitors: permanent inhibition effect. Bind tightly to the enzyme and dissociate slowly.
> Transition state analogues: inhibitor binds to produce a stable structure which is chemically and structurally similar to the transition state of the enzyme.
> Suicide substrates: inhibitory substrate analogues which produce a highly reactive product resulting in damage to the active site.

Acids and Bases

Brønsted-Lowry Definitions

An acid is a proton donor.
A base is a proton acceptor.
Amphoteric compounds can accept and donate protons.

Conjugate Acid-Base pairs differ by one proton.

Polyprotic acids have more than one proton to donate.

Strong acids almost completely ionise and donate almost all of their protons; weak acids only partially ionise.
Strong bases almost completely ionise, they are strongly attracted to protons and almost all of the molecules of the base bind with protons; weak bases are only weakly attracted to protons.

Neutralisation

Acid + Base > Salt + Water

Ion Product of Water

Water is an amphoteric compound.
The equilibrium constant (K_w) is represented by

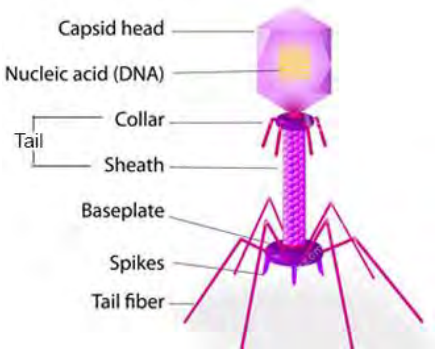
$$K_w = [H_3O^+] \times [OH^-]$$

K_w is the ion product of water, represented by 1×10^{-14} at 25°C.

Viruses

Infectious agents. Smaller than bacteria. Have genetic material, can replicate and evolve, but are unable to do so on their own.

Nucleocapsid:
> May be RNA or DNA. May be single or double stranded.
> May be circular, linear, or segmented.
> Surrounded by protein layer.
> No envelope.



Viriods are tiny plant pathogens, made of small circular ssRNA.

Prions are infectious agents composed of only proteins.

Bacteriophages

Large, complex viruses which infect bacteria. Double-stranded DNA genome is linear and contained within the head of the bacteriophage. This is a lytic virus, meaning it kills the host cell. It can become latent and integrate into the genomic DNA.

DNA Viral Replication

ds and ssDNA viruses need to enter the nucleus in order to replicate and be transcribed to produce viral RNA for protein synthesis. Some viruses use the host cell's polymerases to replicate their DNA, whilst some viruses encode their own. The cell must be in S phase.

RNA Viral Replication

ds and ssRNA viruses replicate in the cytoplasm. Positive sense ssRNA genomes can act as mRNA and be directly translated. dsRNA and negative sense ssRNA genomes require a viral RNA polymerase protein to transcribe the RNA into the complementary strand.

Retroviruses

Retroviruses are positive sense ssRNA viruses. Reverse transcriptase synthesises a DNA product from the RNA template for integration into the host chromosome.

Viral particles may leave the cell by budding, producing a viral envelope out of the host cell's membrane; exocytosis, use of the cell's vesicles to adhere to the membrane and release its contents; and apoptosis, where viral particles escape a cell as it dies.

Virus Life Cycle

>Attachment.
>Penetration.
>Uncoating.
>Biosynthesis.
>Assembly.
>Release.