General Properties of Enzymes

How enzymes differ from ordinary chemical catalysts	faster, milder conditions, specific, regulatable
Class 1: Oxidoreductase	Catalyze Redox Reactions
Class 2: Transferases	Transfer of functional groups
Class 3: Hydrolases	Hydrolysis Reactions
Class 4: Lyases	Group elimination to form double bonds
Class 5: Isomerases	Isomerization
Class 6: Ligases	Bond formation using ATP hydrolysis
Cofactors	Can be metal ions or coenzymes. Substances that increase the rate of enzymes in their reactions.
Coenzymes	Are chemically changed, organic, must be regenerated. Can be cosubstrates or prosthetic groups.
Cosubstrates	dissociate from enzyme
Prosthetic groups	permanently associated with enzyme
Free energy of activation ΔG^{++}	free energy of transition state minus free energy of reactants. When this variable is larger, the reaction is slower.

Enzyme Inhibition

Competitive Inhibitor	Binds at substrate binding site. Reduces concentration of free enzyme available for substrate. Ex: Aspartic Protease
Uncompetitive Inhibitor	The inhibitor binds to the enzyme-substrate complex but not to the free enzyme. Distorts SUBSTRATE OCCUPIED active site.
Mixed/-Non-competitive	Compounds that bind to the free enzyme AND to the enzyme-substrate complex

Catalytic Mechanisms

1. Acid Base Catalysis	Ex: RNase, activity is affected by pH
Acid Catalysis	enzyme gives substrate a proton
Base Catalysis	enzyme takes proton from substrate
Amino acids that act as acids	Asp, Glu
Amino acids that act as bases	Arg, Lys, His
2. Covalent Catalysis	Nucleophilic attack on substrate by enzyme, resulting in temporary covalent bond formation
Nucleophilic groups	Have electrons, want proton
Electrophilic groups	Have protons, want electrons

Catalytic Mechanisms (cont)

3. Catalysis through proximity and orient-ation	bring substrates into contact, freeze out relative rotational and translational motions in transition state
4. Catalysis through binding transition state	strained version of substrate fits in enzyme better than unstrained substrate
	This implies that you can inhibit with a transition state analog
5 Metal ion catalysis	the unique electronic properties of the metal ion facilitate the reaction.
Serine Proteases	catalyze peptide bond hydrolysis (breakage) in target proteins.
	proximity and orientation effects, acid–base catalysis, covalent catalysis, electrostatic catalysis, and transition state stabilization.
Chymotrypsin	Binds Bulky hydrophobic side chain, cleaved by trypsin
Trypsin	Binds positively charged side chain, cleaved by enteropeptidase

Catalytic Mechanisms (cont)	
Elastase	Binds neutral, small side chains, cleaved by trypsin

Reaction Kinetics	
To find the mechanism of an enzyme	measure kinetics, use X-ray crystalography
K, rate constant	the rate of an elementary reaction is proportional to the frequency by which the reacting molecules come together. The proportionality constant is k
V, Reaction Velocity	the instantaneous rate of appearance of product (or disappearance of substrate).
Order	the molecularity of a reaction, i.e. the number of molecules that must simultaneously collide to generate a product.
First Order	A -> P, linear
Second Order	A + A -> P
Third Order	A + B -> P
KS	measure of enzyme affinity for its substrate
Km	the concentration of substrate which permits the enzyme to achieve half Vmax
Bisubstrate reactiona	usually group transfer reactions

Reaction Kinetics (cont)	
Sequential reactions	All substrates must combine with the enzyme before reaction can take place and products released.
Ordered	order matters
Random	order does not matter
Ping Pong Reaction	One or more products are released before all substrates have been added. • The two substrates do not encounter one another on the enzyme surface.