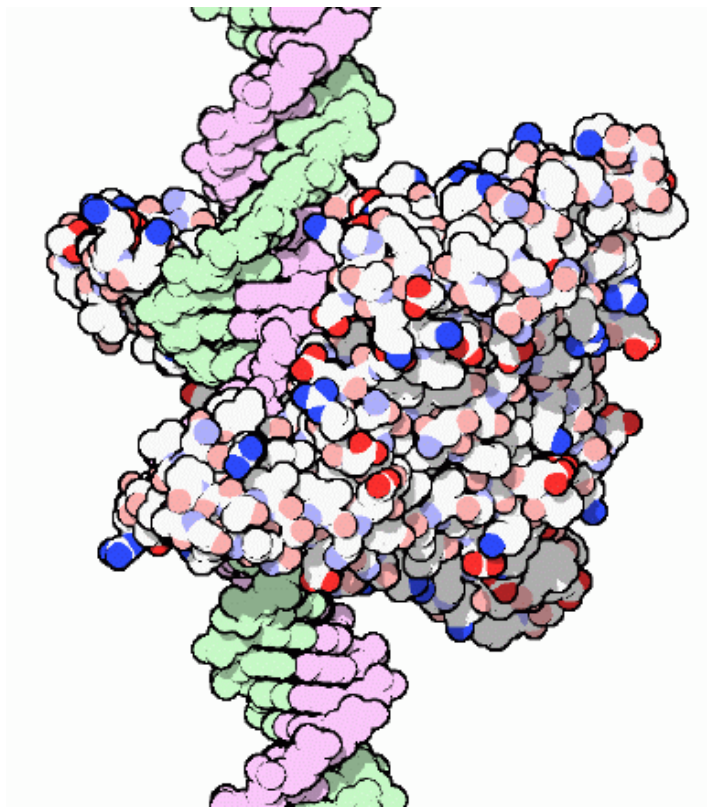
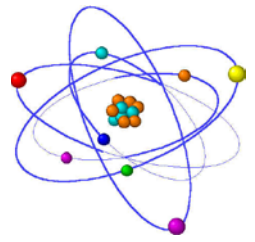


# Biological Reactions: Rates and Enzymes



# Enzymes

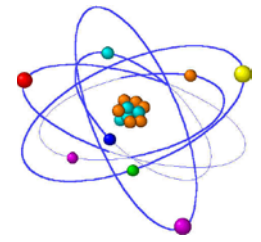
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*Enzymology* is the study of enzymes

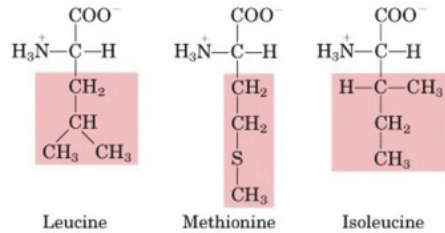
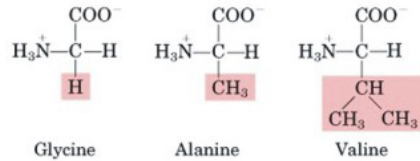
- Increase reaction rates
  - How long does cell division take?
  - How many chemical reactions take place in that time?
- Dampen requirement for harsh conditions
  - Condensation reactions require very basic pH
- Confer a high degree of chemical specificity for reactions
  - Why doesn't cellobiose get hydrolyzed by amylase
- Enables control/regulation of chemistry
  - How does the cell know when to use lipids for energy instead of sugars?

# Proteins

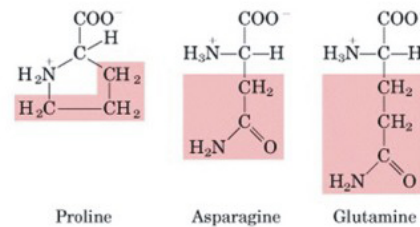
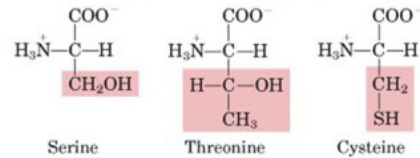


## Twenty standard Amino Acids

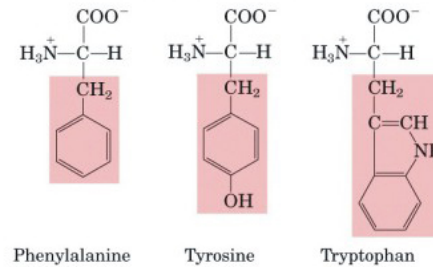
### Nonpolar, aliphatic R groups



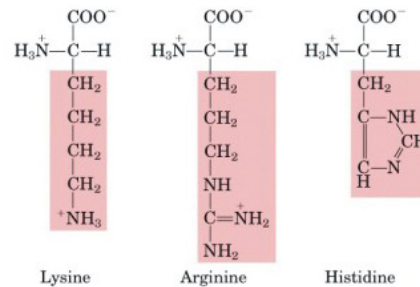
### Polar, uncharged R groups



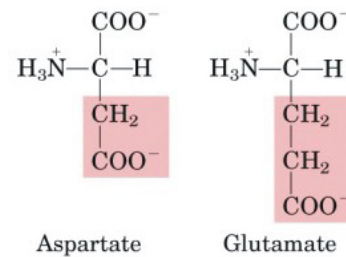
### Aromatic R groups



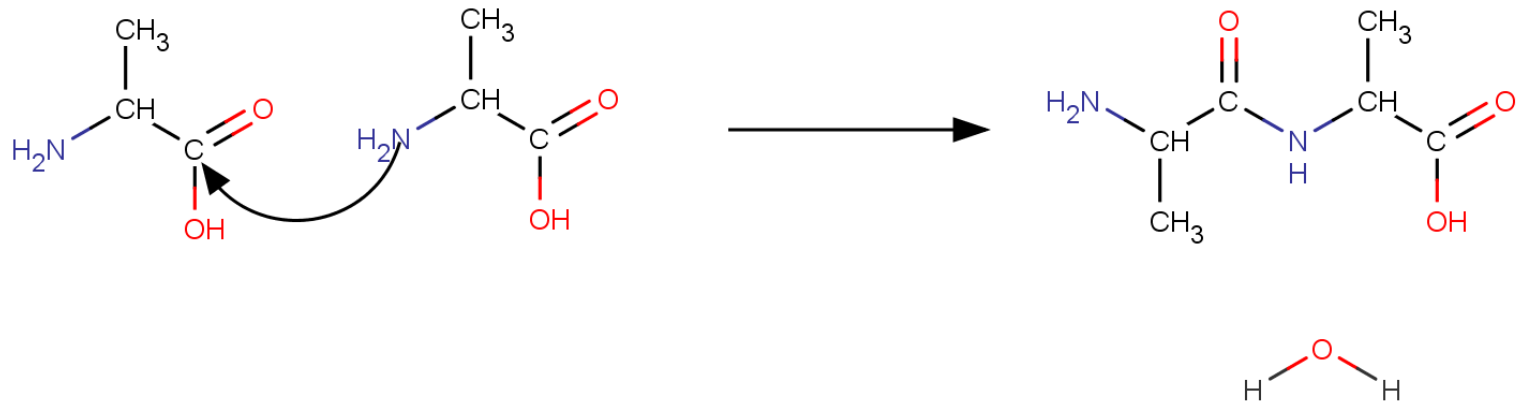
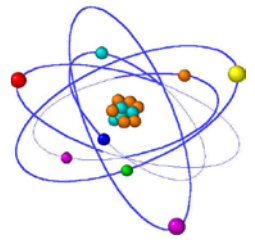
### Positively charged R groups



### Negatively charged R groups

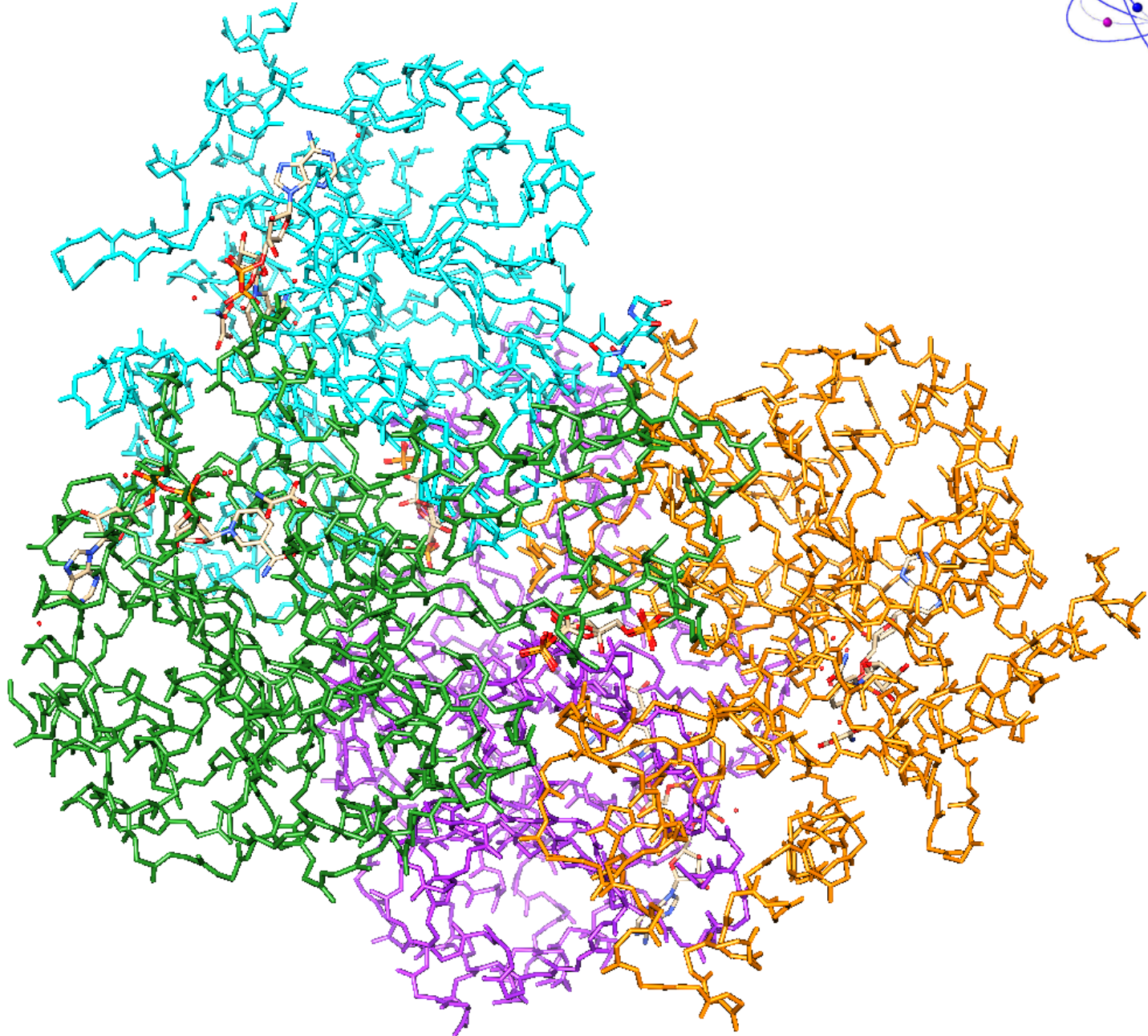
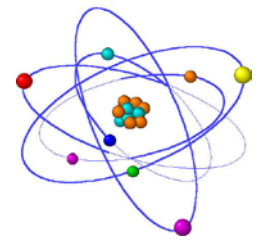


# Proteins



# Proteins

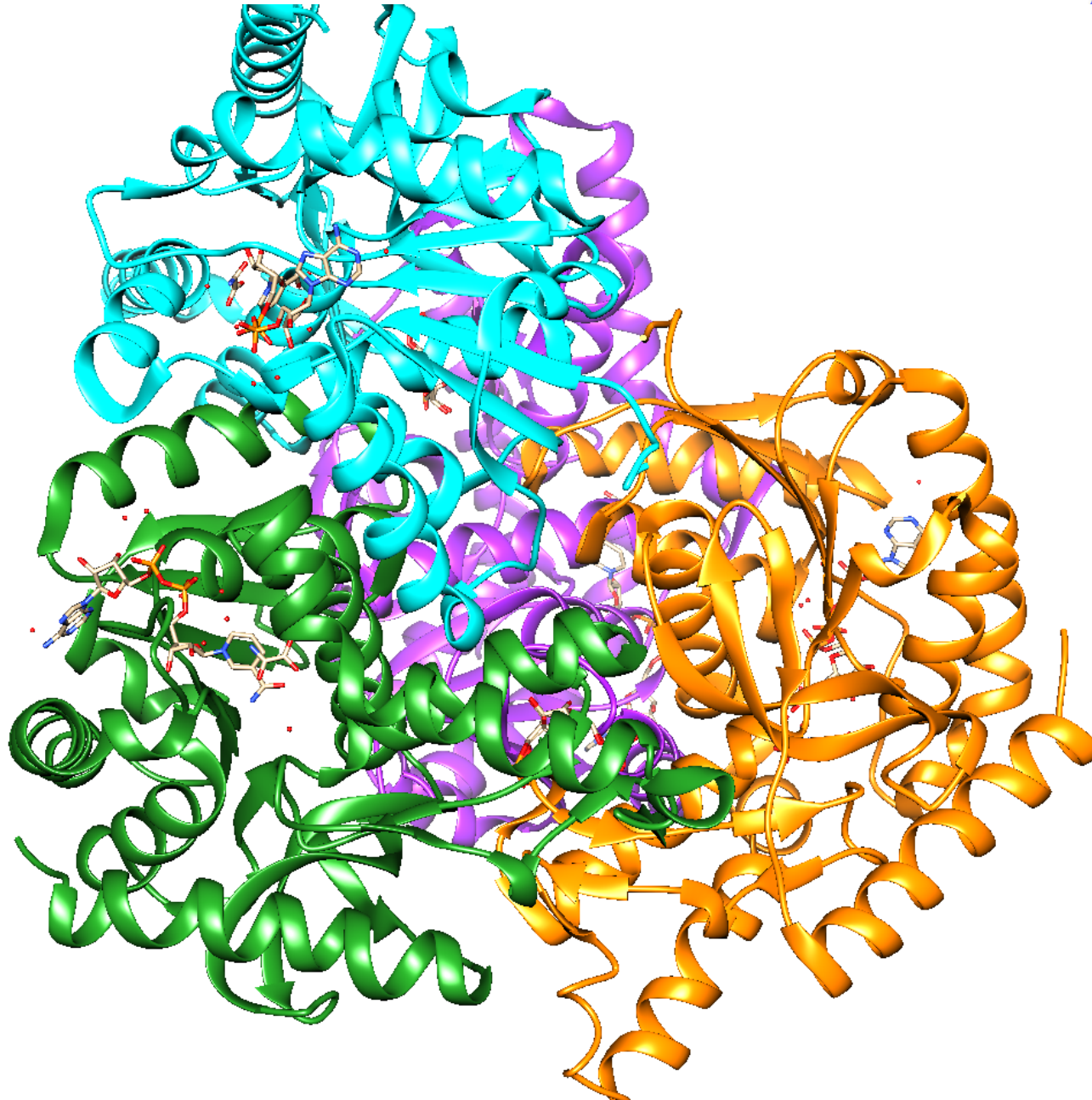
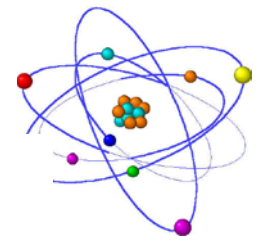
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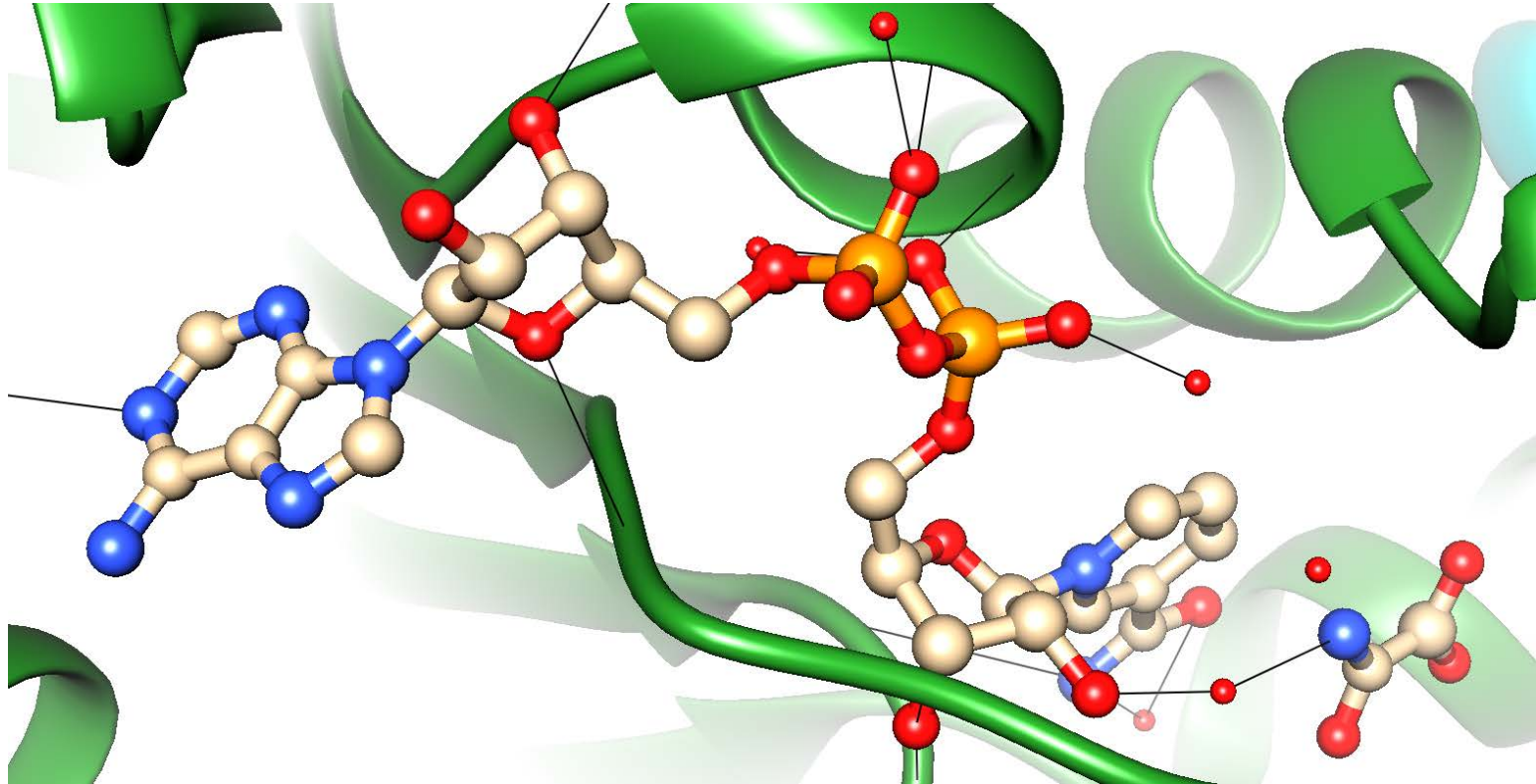
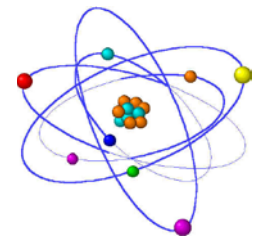
# Proteins

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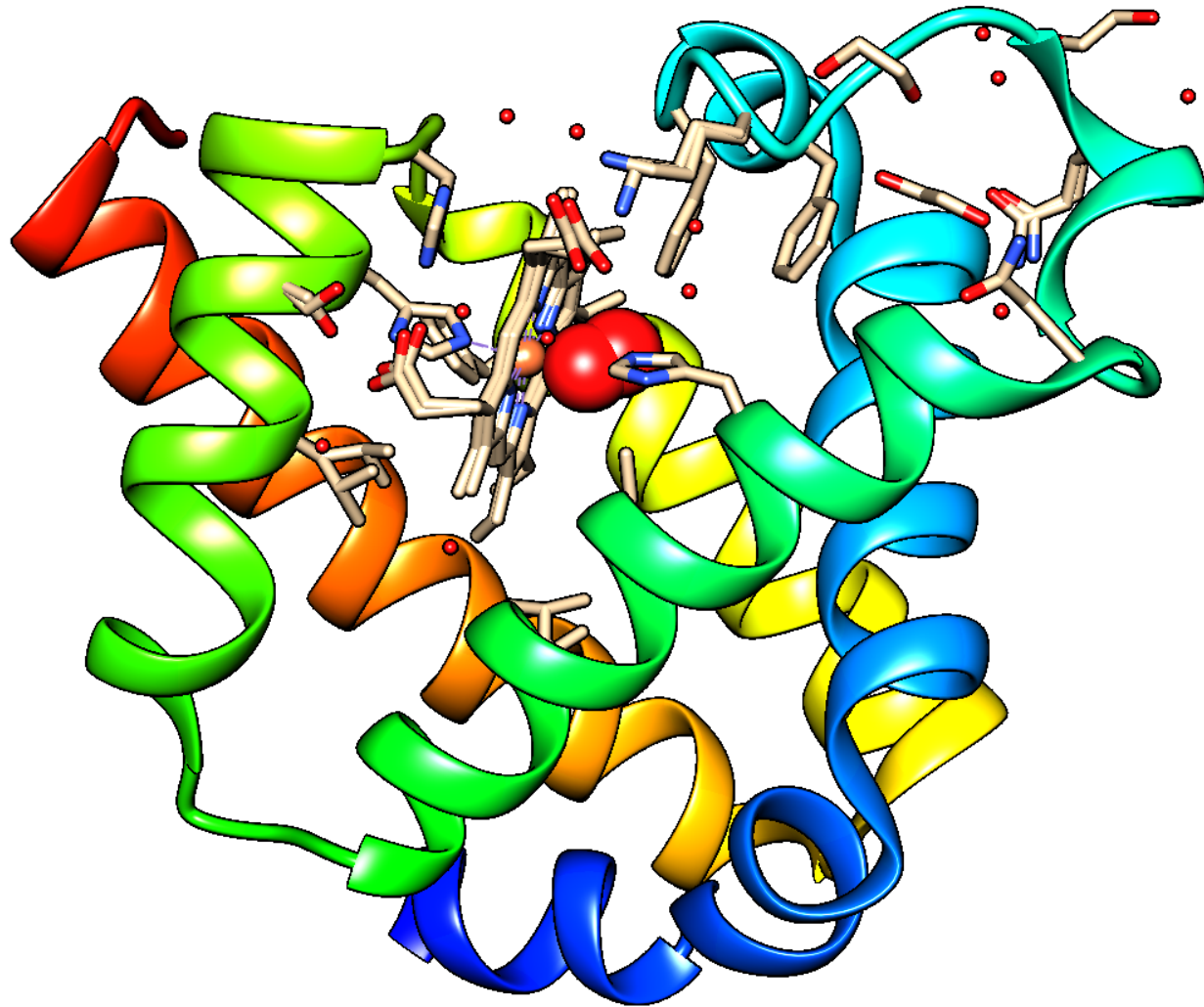
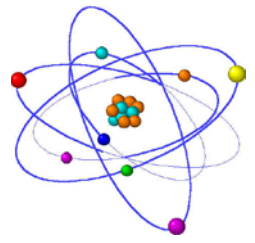
# Proteins

---



# Myoglobin

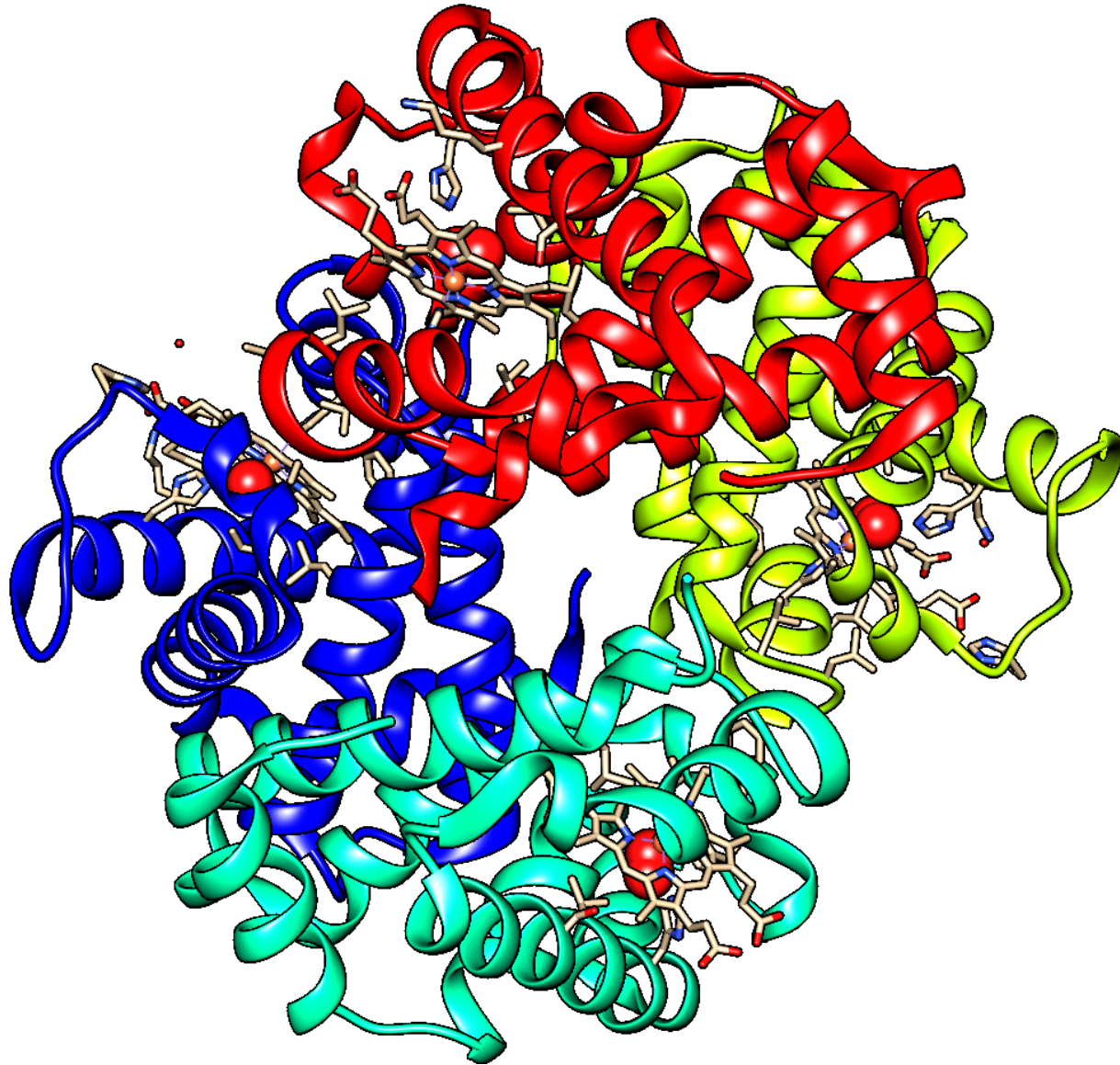
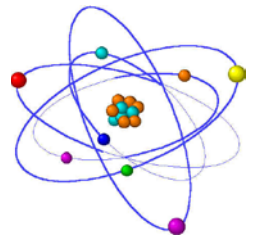
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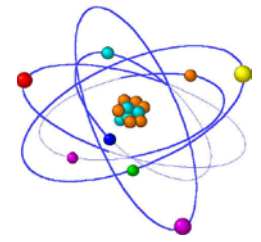


# Hemoglobin

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# Substrate Specificity



**Lock and Key Hypothesis:** *the specificity of an enzyme (lock) for its substrate arises from their geometrically complementary shapes*

Recognition through functional groups

- Hydrophobic regions
- H-bonding patterns
- Ion pairing

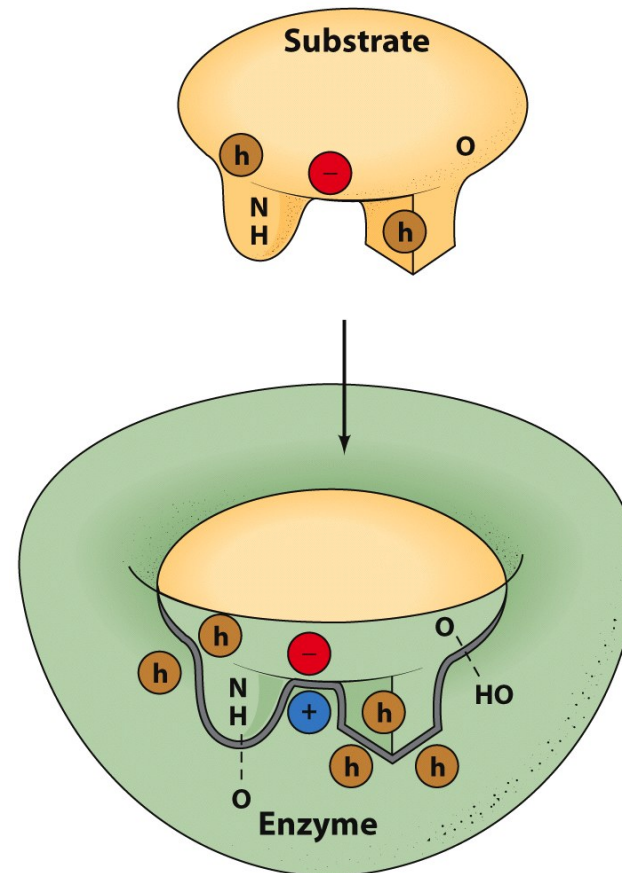
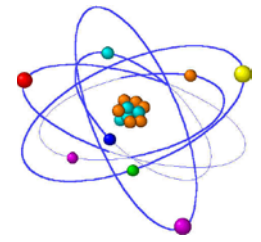


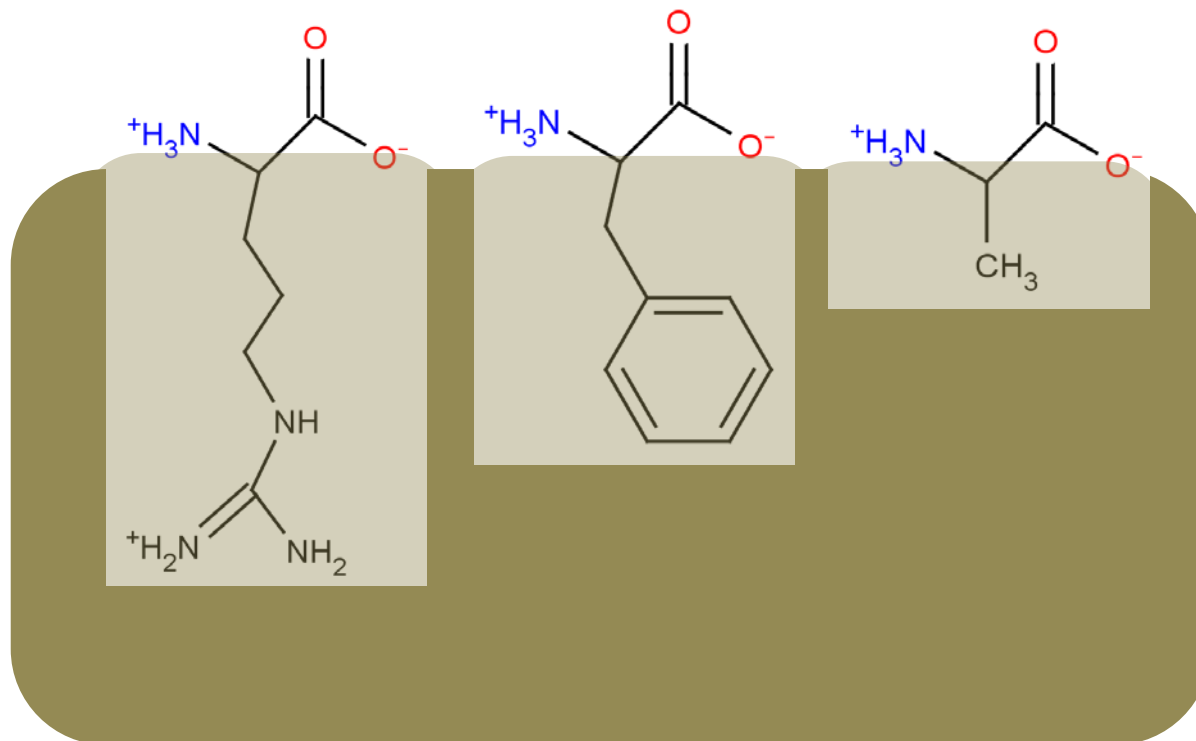
Figure 13-1  
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# Substrate Specificity

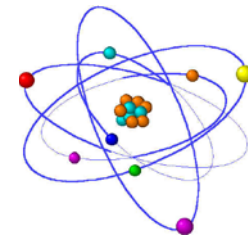


**Lock and Key Hypothesis:** *the specificity of an enzyme (lock) for its substrate arises from their geometrically complementary shapes*

Size/shape specificity



# Molecule Polarity



## Polar bonds

C-O

C-N

C-F

O-H

N-H

S-O

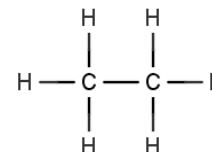
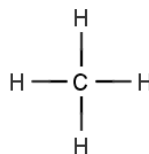
P-O

## Non-Polar bonds

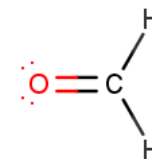
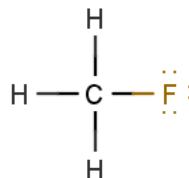
C-H

X-X

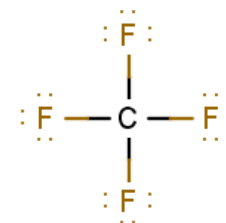
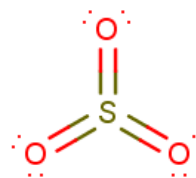
A molecule that does not contain any polar bonds is non-polar



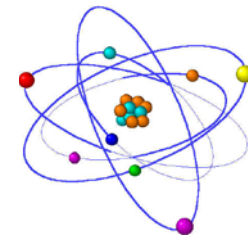
A molecule CAN be polar if it contains at least one polar bond



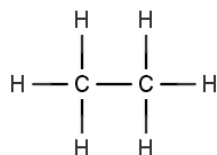
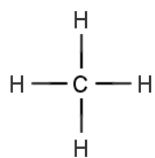
If a molecule has ONLY polar bonds, it may be non-polar



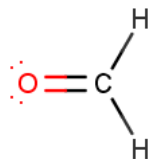
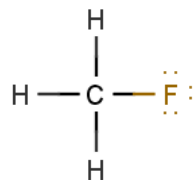
# Intermolecular Forces



These are the forces that hold molecules together  
(not to be mistaken with bonds)

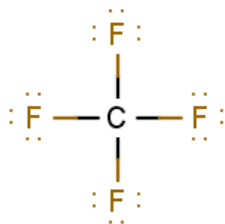
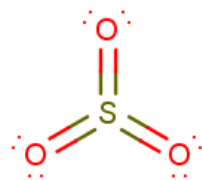


London Dispersion Forces – ALL molecules



Dipole-Dipole – Only polar molecules

Ion-Ion – only charged molecules

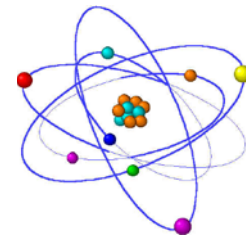


H-bond – only if a molecule has:

O-H    N-H    F-H



# Reaction Rates



Rates are a measure of how much change per time

**$[A]$  = The concentration of A**

Measure of amount  
per volume



$$\text{speed} = \frac{\text{Change in place (distance)}}{\text{time}}$$

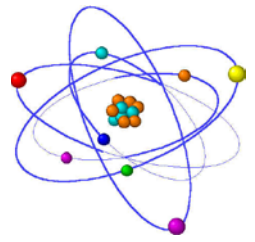
$$\text{reaction rate} = \frac{\text{Change in concentration}}{\text{time}}$$



**$\Delta$  = Change**

$$\text{rate} = \frac{\Delta[C]}{\Delta\text{time}}$$

# Enzymes are Catalysts



- Increase reaction rates
  - How long does cell division take?
  - How many chemical reactions take place in that time?

