Enzymes

- **Oxidoreductases**
  - **Dehydrogenase** → ex:
    - lactate dehydrogenase [pyruvate ⇒ lactate], [follows lock and Key model]
    - Alcohol dehydrogenase [Alcohol ⇒ Aldehyde]
    - Succinate dehydrogenase [Succinate ⇒ Fumarate]
    - [Transfering electrons in the form of H^+ or hydrogen atoms using electron carrier coenzyme (NAD, FAD, FMN)]
  - **Oxidase**
    - transfer Hydrogen atoms from the substrate ⇒ molecular Oxygen O_2 forming Peroxide as a BY-PRODUCT
    - ex: Glucose oxidase
  - **Oxygenase**
    - Catalyzes substrate Oxidation by molecular oxygen O_2 ; introducing O_2 to the substrate
    - Reduced product is H_2O not H_2O_2 [in monooxygenase reaction]
    - ex:
      - Monooxygenase [one oxygen atom is added]
      - Dioxygenase [2 oxygen atoms are added]
  - **Peroxidase**
    - catalyzing oxidation of a substrate by using Peroxide H_2O_2
    - ex → Glutathione peroxidase [It oxidize two GSH molecules in the presence of H_2O_2]
  - **Reductase**
    - Catalyzes the substrate reduction
    - ex: Glutathione reductase
  - **Hydroxylase**
    - It adds a hydroxyl group to the substrate
    - Not a type of Monooxygenase; cuz it adds "OH" and not from molecular O_2

- **Transfernase**
  - transfers functional group [P, C, S, N] from one substrate into other molecule
  - Examples
    - Kinase [It transfers Phosphate group] → ex: phosphofructokinase [PFK]
    - Transaminase
      - it transfer amino group from one amino acid → Keto acid
        [converting the amino acid into Keto acid, And the Keto into amino acid]
      - Interconversion of certain amino acids
      - example: Aspartate transaminase
        transferring the amino group from Glu to oxaloacetate to form Asp

        Glutamate + Oxaloacetate ⇌ Aspartate + α-Ketoglutarate

        * Asp level in blood is an indicator of liver health
          high level could be because →
          - liver cirrhosis
          - hepatitis

- **Hydrolases**
  - Catalyze cleaving bonds by using Water [OH^-, H^+] to being broken or fragment condensation
  - examples based on the bond they break
    - lipase
    - esterases
    - phosphatases
    - glycosiderases
    - proteases → Catalyze the proteolysis hydrolysis of peptide bond
  - Digestive enzymes are specific example
    - Trypsin cleaves the peptide bond of Lys, Arg
    - Chymotrypsin cleaves the peptide bond of BULKY AROMATIC amino acids [Trp, Tyr, Phe]
    - Elastase cleaves the bond of small UNCHARGED amino acids [Gly, Ala, Val]

- **Lyases**
  - can cleave C-C, C-N, C-O bonds by means other than hydrolysis or oxidation
  - leaving double bond, rings or adding molecule to a double bond
  - Examples
    - Dehydrases → removing H_2O to form a double bond ex: enolase [converting 2 phosphoglycerate into phosphoenolpyruvate]
    - Decarboxylases → replace COO^- group by a Hydrogen ex: pyruvate decarboxylase [converting pyruvate into acetaldehyde]
    - Synthases
      - adding molecule to a double bond
      - forming new C-C bond ex: citrate synthase [Adding Acetyl CoA to oxaloacetate to produce Acetate]
  - aldolase → breaks the fructose 1,6 Bisphosphate into Glyceraldehyde 3 Phosphate [GAP] and dehydroxyacetone phosphate DHAP

- **Isomerases** → intermolecular rearrangement
  - Types
    - isomerase [rearrange bond structure of a compound]
      - ex: Phosphoglucoisomerase → Glucose 6-phosphate ⇒ Fructose 6-phosphate
    - Mutase [transfer one Phosphate group from one atom to another]
      - ex: phosphoglycerate mutase → Glyceraldehyde 3-phosphate ⇒ Glyceraldehyde - 2- phosphate

- **Ligases** → form [C-C, C-N, C-O, C-S, C-Halogen]
  - accompanied by consumption of high energy from ATP or nucleoside triphosphate
  - ex:
    - synthetase
    - carboxylase → derive energy from high energy phosphate bond in ATP
    - DNA ligase

* synthase [energy from different source]

* synthetase [energy from ATP, high energy bond]

pyruvate + CO_2 + ATP —Carboxylase→ Oxaloacetate

Different Enzymes

- **Abzyme**
  - antibody working as enzyme
  - produced against transition state analogs
  - How?
    1. an animal is injected with a transition state analogs
    2. animal's body produce antibodies against it
    3. Binding with high affinity at specific points
    4. Mimicking an enzyme's active site around the transition state
  - example:
    - Cocaine esterase [degrades cocaine]
    - it has been developed by transition state complex
    - Monthly injected in addicted individuals by destroying cocaine in blood
    - Decreasing their dependence on cocaine.

- **Ribozymes**
  - RNA acting as enzyme
  - can be ribonucleoprotein
    [The RNA part is the catalyzing part]
  - examples
    - RNA splicing
    - Protein synthesis → Peptidyl transferase [It's a ribozyme : transferring the growing polypeptide chain from P to A position]