Reactions and enzymes

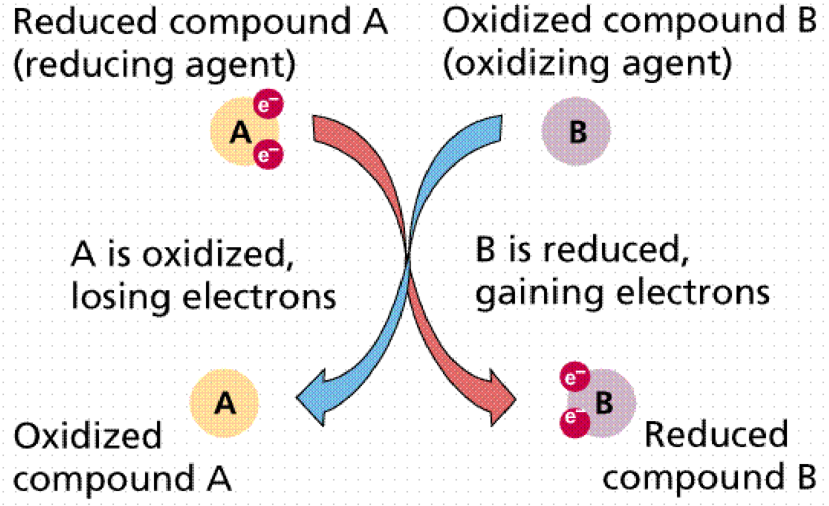
1. ***Energy is transfered***
2. ***Electron is transfered***
3. ***Water molecule can be a participant***
4. ***Metabolic pathways***
5. ***Enzymes***

<u>Energy is transfered</u>

- **Exergonic reaction:** energy-generating reaction (reaction gives energy)
- **Endergonic reaction:** energy-consuming reaction (reaction uses energy)

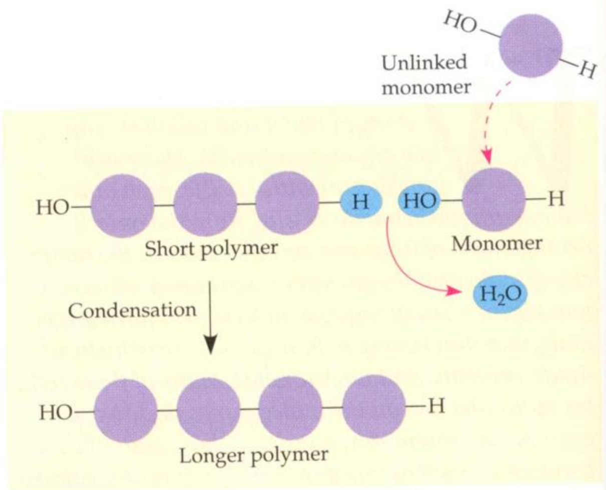
<u>*Electron is transfered*</u>

- **Oxidation:** reactant (A) loses electrons, reactant is oxidized
- **Reduction:** reactant (B) gains electrons, reactants is reduced
- **Oxidant= oxidizing agent (B):** reactant gaining electron
- **Reductant (A):** reactant losing electron

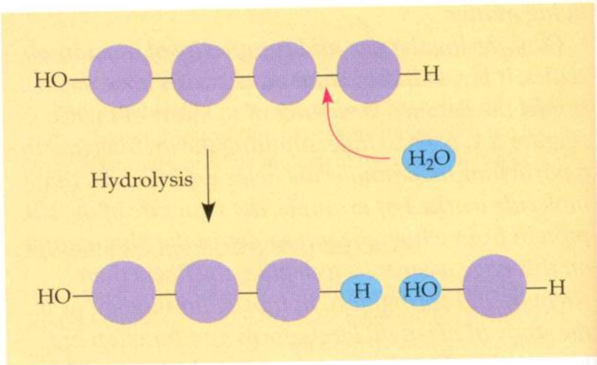


Water molecule can be a participant

- **condensation (dehydration):** formation of a bond between 2 reactants accompanied by formation of a H_2O molecule, eg. peptide bond formation, ester bond formation
- **hydrolysis (hydration)**: breakdown of a bond accompanied by breakdown of a H_2O molecule, eg. breakdown of peptide bond, breakdown of ester bond



(a) Condensation synthesis (dehydration) of a polymer



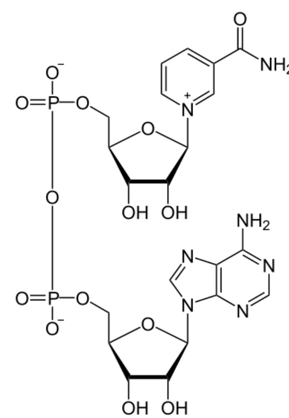
(b) Hydrolysis of a polymer

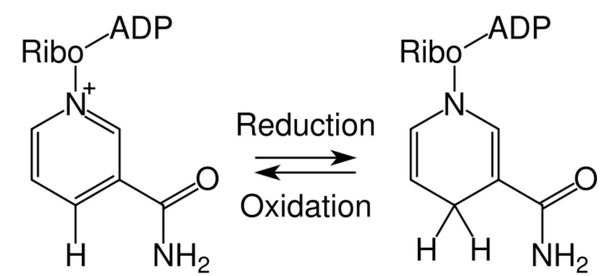
Metabolic pathways

- a series of individual chemical reactions in a living system
- product of one reaction in a pathway serves as the reactant for the following reaction
- always accompanied by energy transfer and electron transfer (electron transporters are involved eg. NAD)

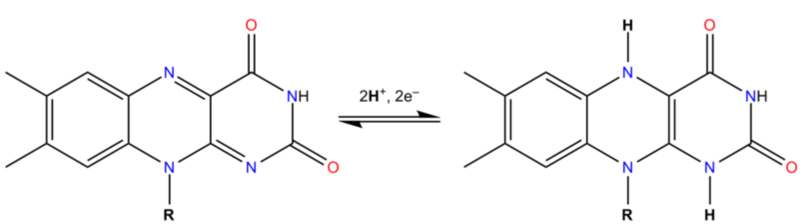
Nicotinamide adenine dinucleotide

Wikipedia





$$NAD^{+} + H^{+} + 2e^{-} \longrightarrow NADH$$



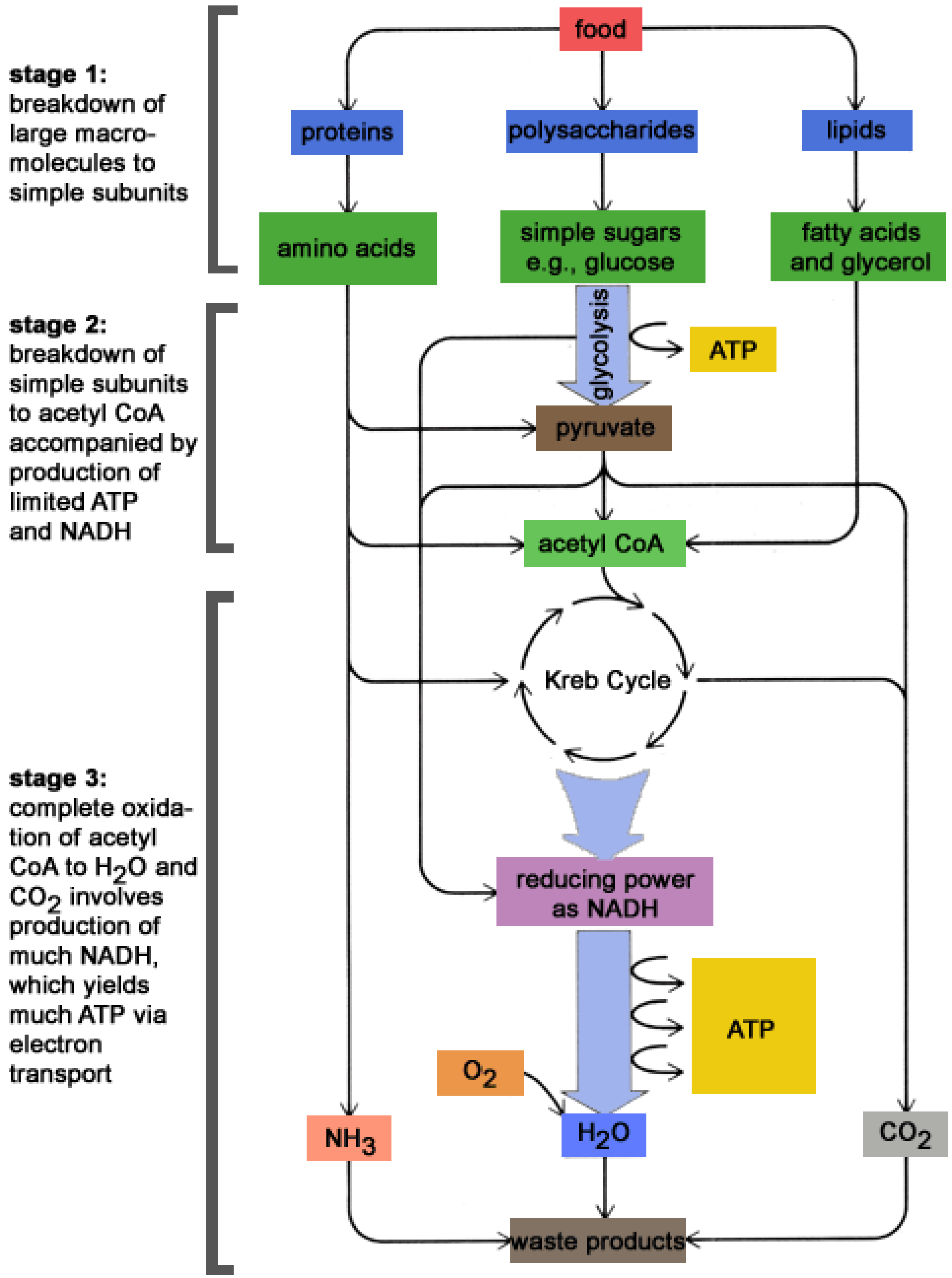
flavin adenine dinucleotide (FAD)

Wikipedia

Metabolic pathways

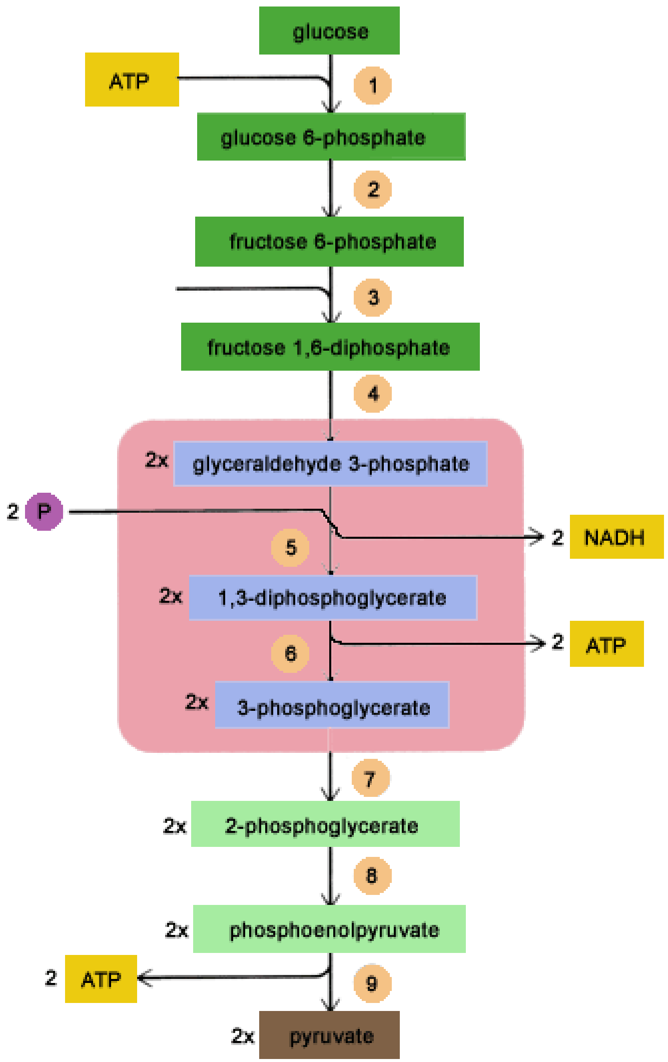
- **anabolic pathway= biosynthetic pathway**: synthesis (production) of a molecule
  - needs energy (eg. energy of sunlight or ATP)
  - reactants are reduced
  - example:

    photosynthesis: synthesis of glucose from CO_2 and water in plants (needs energy of sunlight)
- ***catabolic pathway:*** breakdown of a molecule
  - produces energy (ATP, heat)
  - reactants are oxidized
  - examples:
    - biological oxidation of glucose (aerobic cellular respiration): breakdown of glucose into CO_2 and water
    - Fermentation (anaerobic cellular respiration): breakdown of glucose into lactate and CO_2

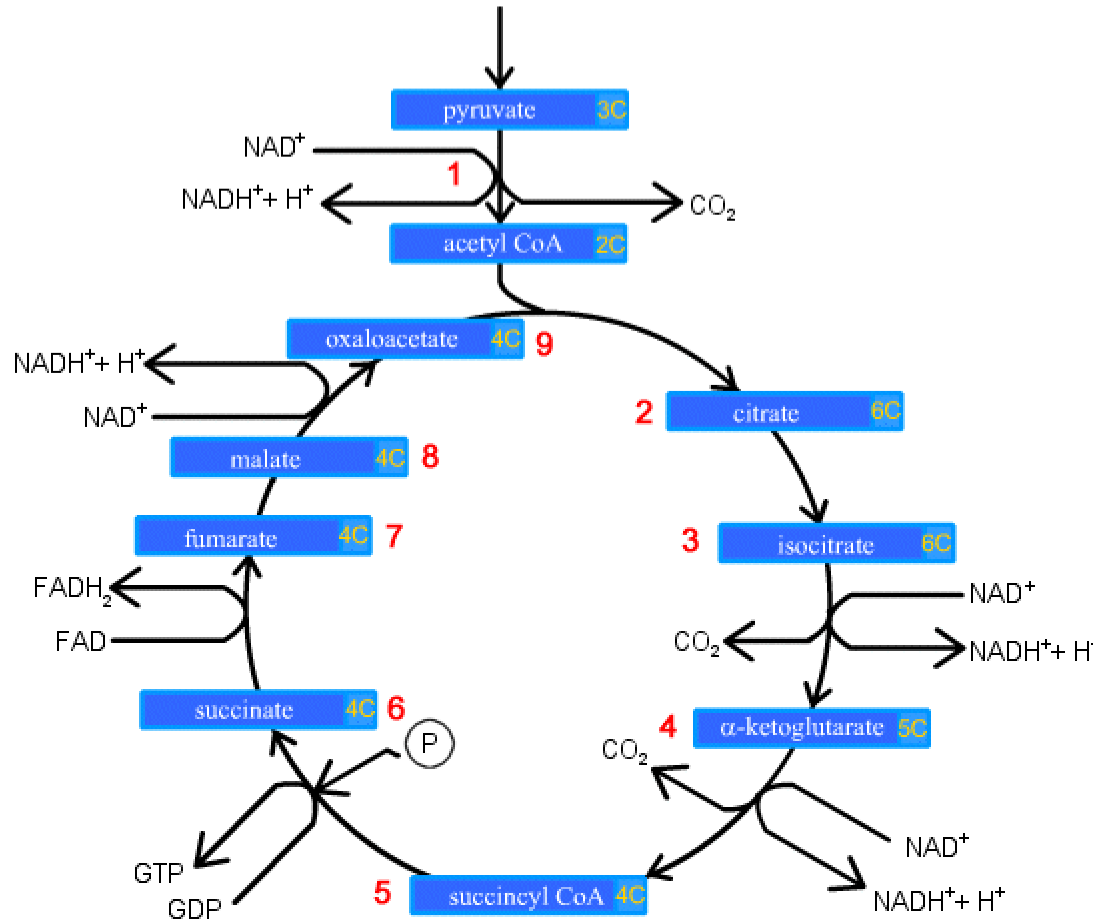


$$1\ C_6H_{12}O_6 = 6\ CO_2 + 6H_2O + 36\ ATP$$

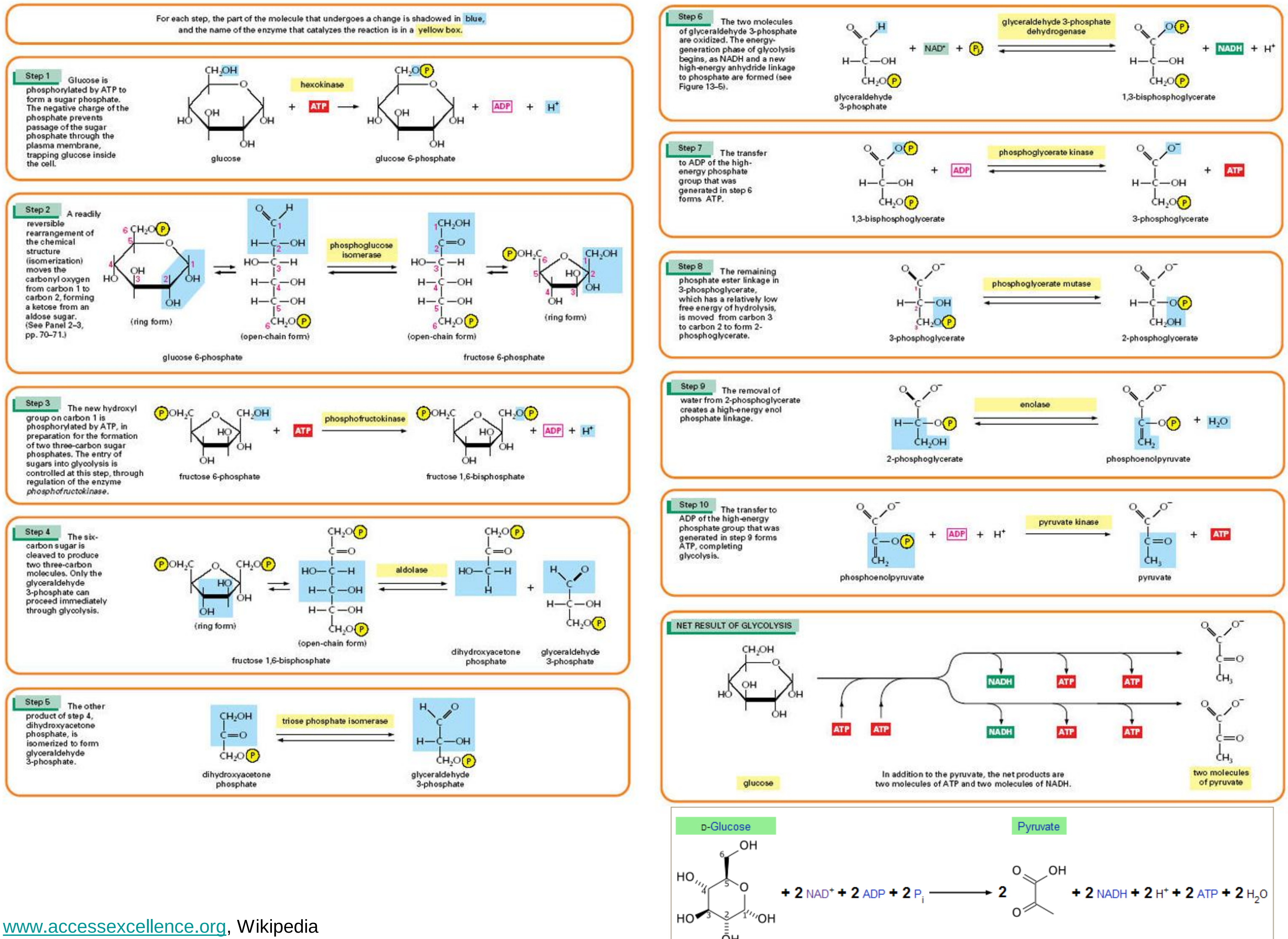
Glycolysis



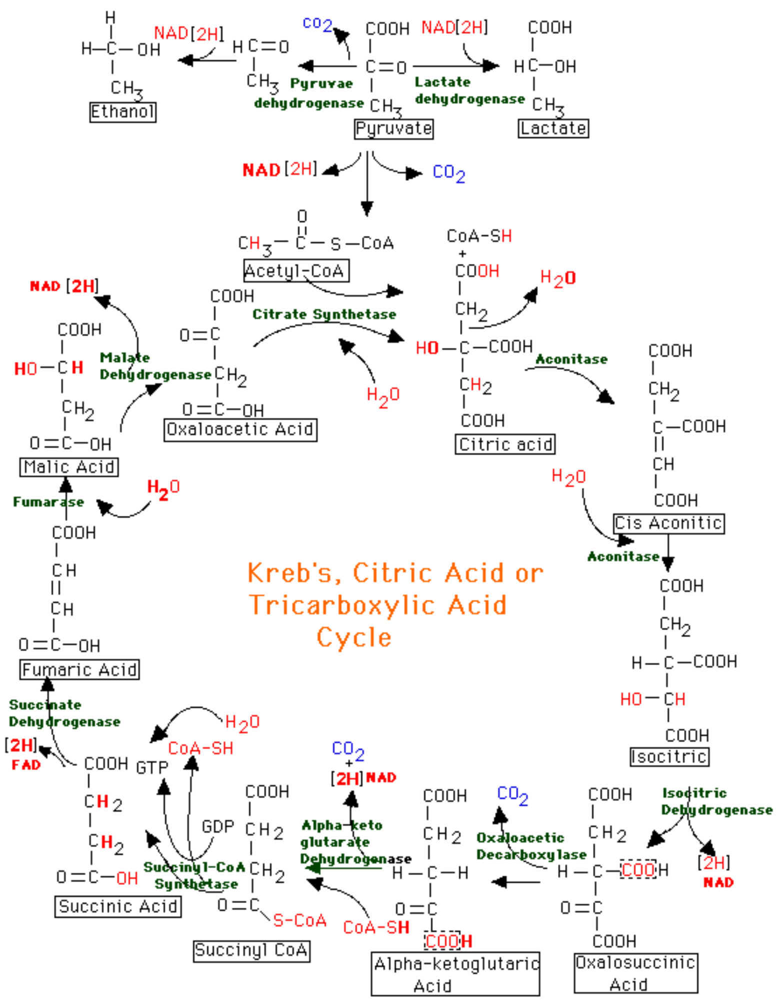
Krebs cycle/citrate cycle

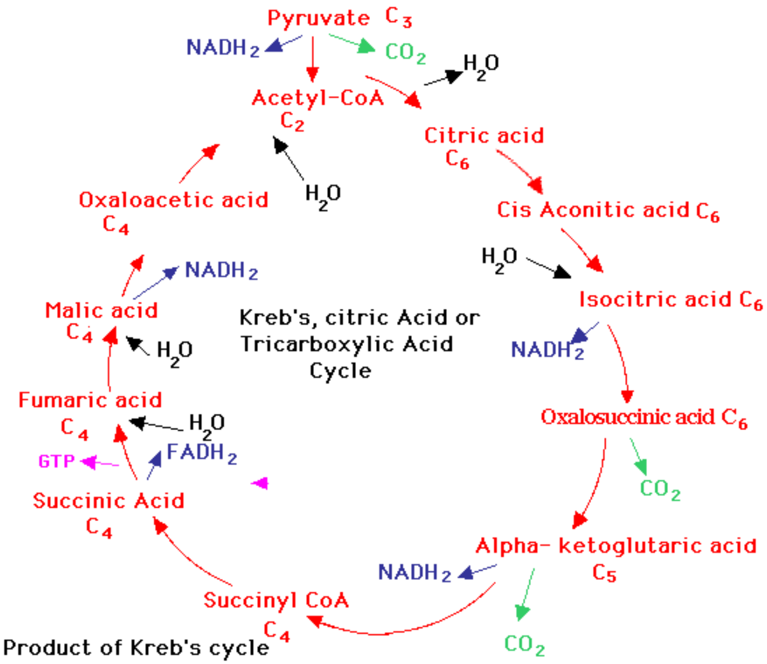


Panel 13–1 Details of the 10 steps of glycolysis



www.accessexcellence.org, Wikipedia





Product of Kreb's cycle

	One Cycle	Two Cycles	Energy
1.	Three CO_2	Six CO_2	
2.	4 $NADH_2$	8 $NADH_2$	24 ATP
3.	1 $FADH_2$	2 $FADH_2$	4 ATP
4.	3 H_2O	6 H_2O	
5.	1 GTP	2 GTP	2 ATP
		Total	30 ATP for Kreb
		Glycolysis	8 ATP 6 are from NADH

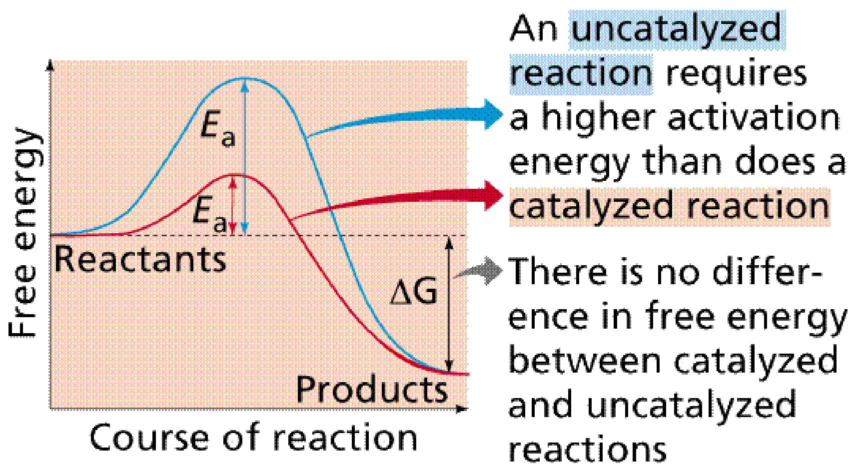
$$C_6H_{12}O_6 + 6O_2 + 6H_2O \rightleftharpoons 6CO_2 + 12H_2O$$

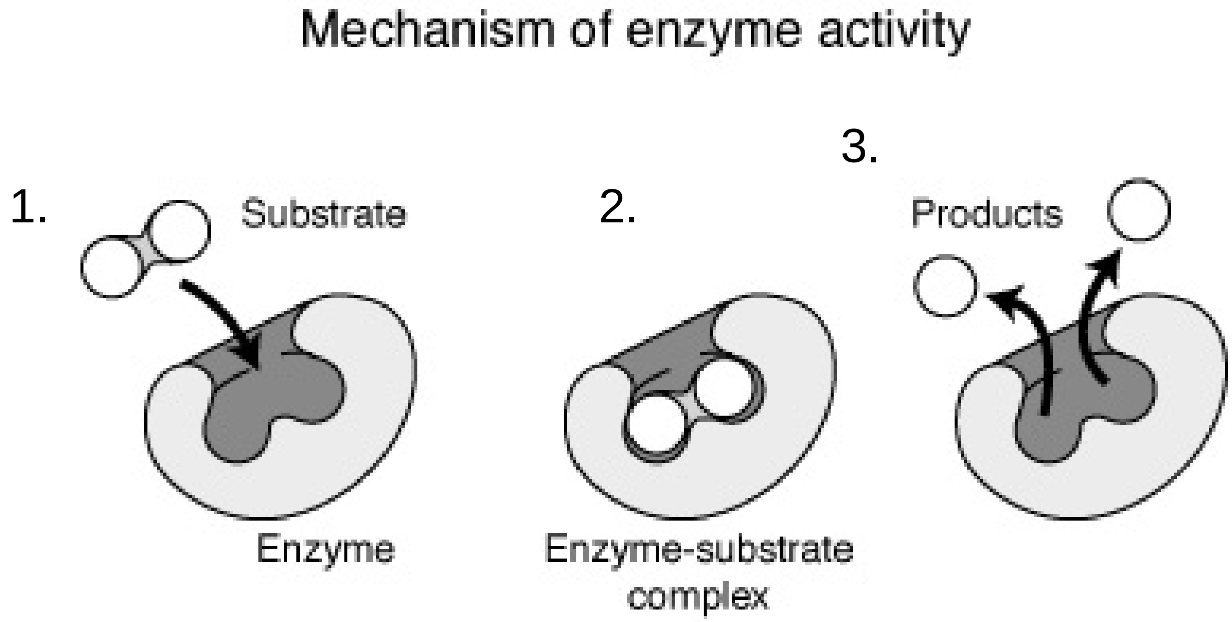
www.uic.edu/classes/bios/bios100/summer2003/krebsfull.htm

Enzymes=biocatalysts

- reaction is faster at the presence of an enzyme (even 10 000 times faster)

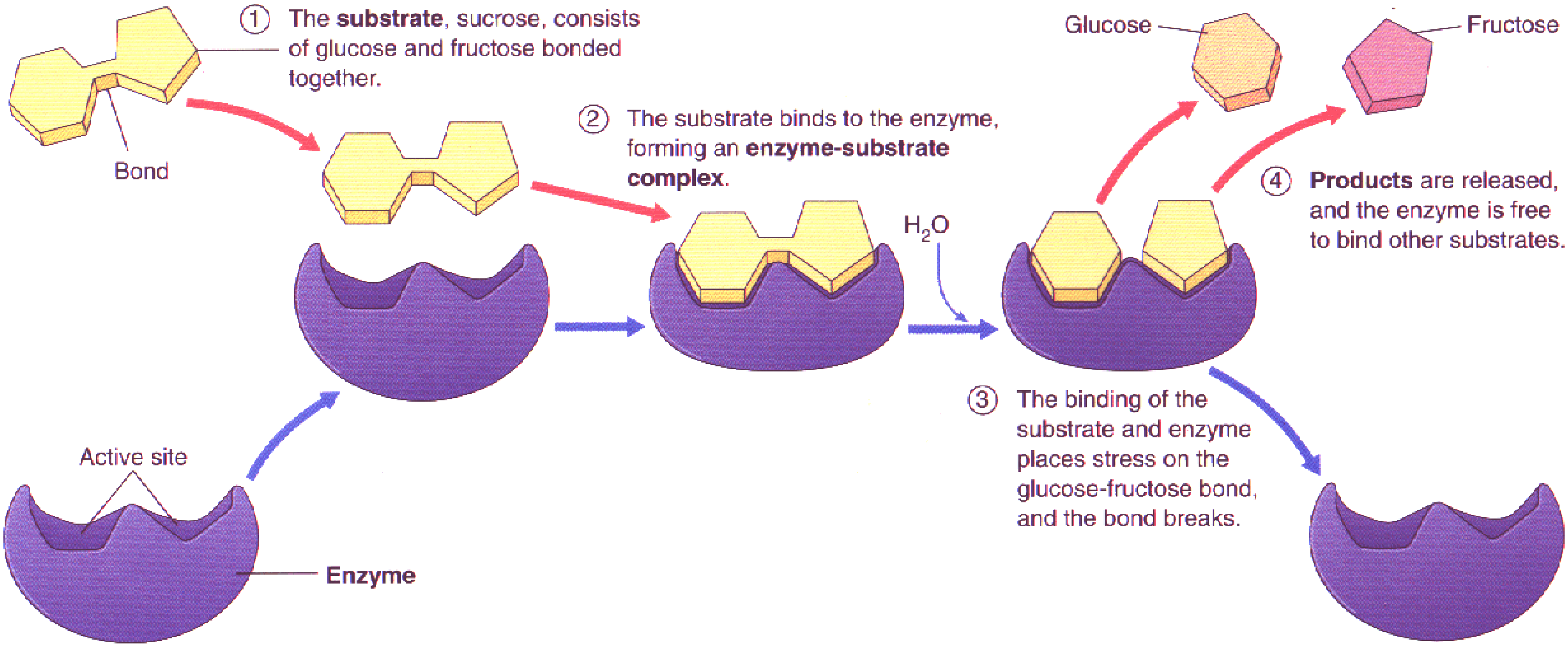
- reaction needs less activation energy at the presence of an enzyme (even 10 times less)





1. **reactant (=substrate) binds to the active center (or site) of the enzyme (<u>„lock and key” model)</u>**
2. **chemical reaction is performed (substrate is chemically modified) in enzyme-substrate complex: product is made**
3. **product leaves enzyme**
4. **enzyme can bind substrates again**

Hydrolysis of sucrose



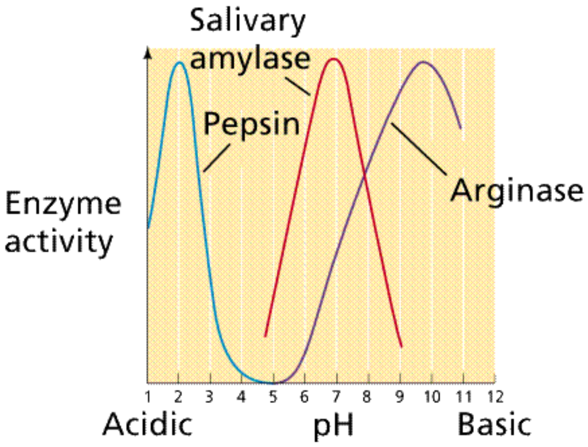
ghs.gresham.k12.or.us

1. chemically <u>proteins</u> (some enzymes are chemically RNA, eg. peptidyl transferase)

2. Holoenzyme (eg.holoenzyme for DNA synthesis=replisome)

3. Coenzymes (eg. coenzyme A), electron transporters (eg. NAD, FAD)

4. sensitivity for pH and temperature

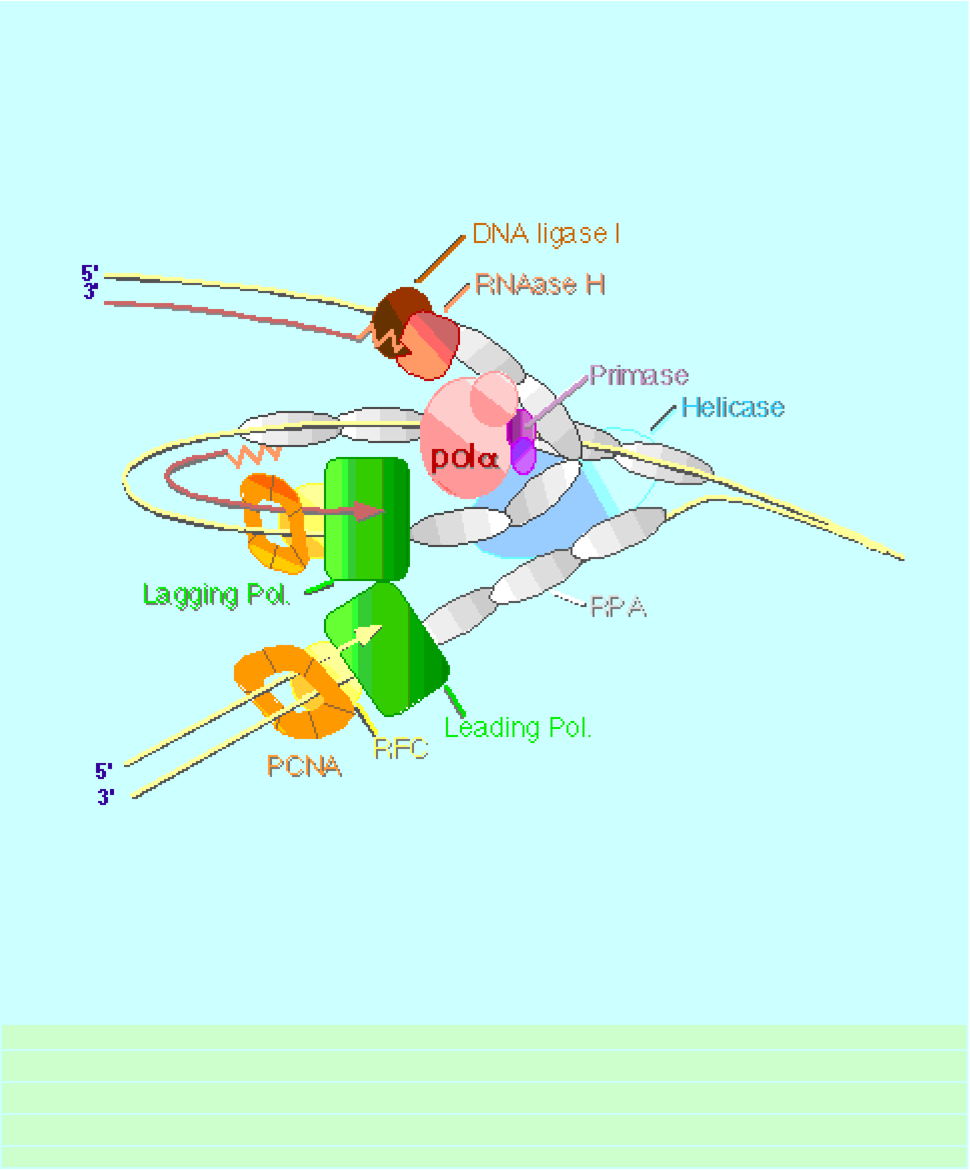


5. Scientific name: name of substrate+name of reaction+ASE (eg. Glycogensynthase)

6. examples:

- digestive enzymes: catalyze breakdown of nutrients in digestive system eg.: amylase (breakdown of carbohydrates) pepsin (breakdown of proteins), lipase(breakdown of lipids)
- biosynthetic enzymes: DNA polymerase (synthesis of DNA), RNA polymerase (synthesis of RNA), peptidyl transferase (synthesis of proteins)

replisome



DNA ligase I
RNAase H
5'
3'
Primase
Helicase
polα
Lagging Pol.
RPA
Leading Pol.
RFC
PCNA
5'
3'

Albinism=hypomelanism

Connie Chiu