Membrane Transport

Facilitative Diffusion

Membrane Transport

Examples:

- Facilitative Diffusion
  - Ionophore
  - Maltoporins
  - GLUT1 transprter
  - Aquaporin
  - Selective ion channel for potassium (K-channels)
- Active Transport
  - Primary (1°)
    - Na^+/K^+
    - ABC
  - Secondary (2°)
    - Na^+/Glc
    - Bicarb/Cl^-
    - Lactose/H^+
  - Group Translocation
    - Bacterial phosphotransferase system (PTS)

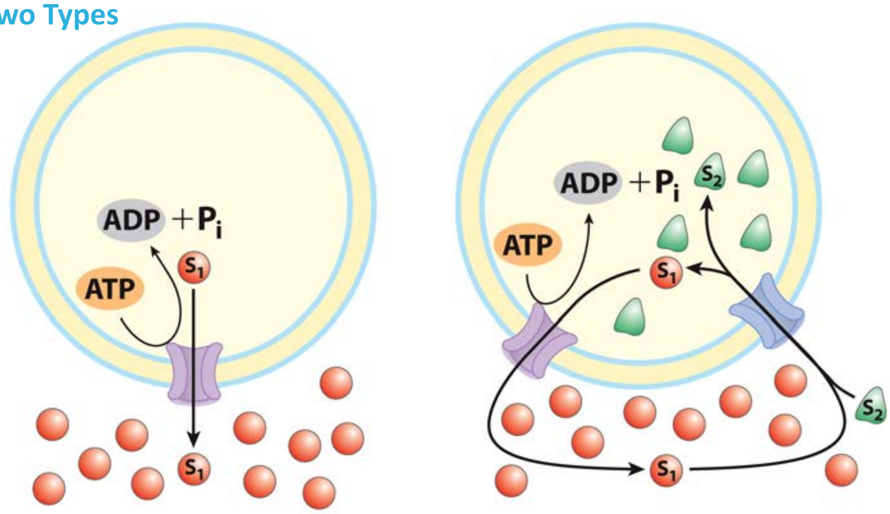
Membrane Transport

Active Transport

Membrane Transport

Examples of Active Transport

Two Types



(a) Primary active transport (b) Secondary active transport

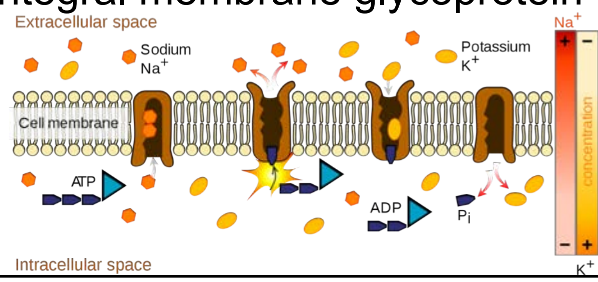
Membrane Transport

One of the best and most important examples of Active Transport (primary):

The **sodium–potassium (Na^+–K^+) pump** is primary active transport.

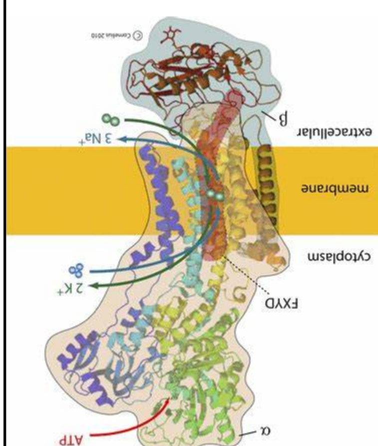
Found in all animal cells.

The pump is an integral membrane glycoprotein (an antiporter).

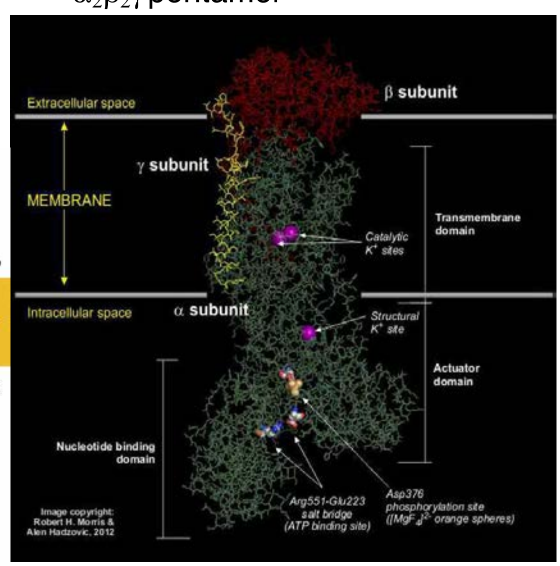


Membrane Transport

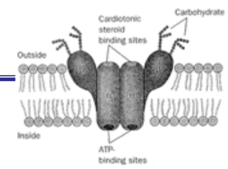
Sodium–potassium (Na^+–K^+) pump



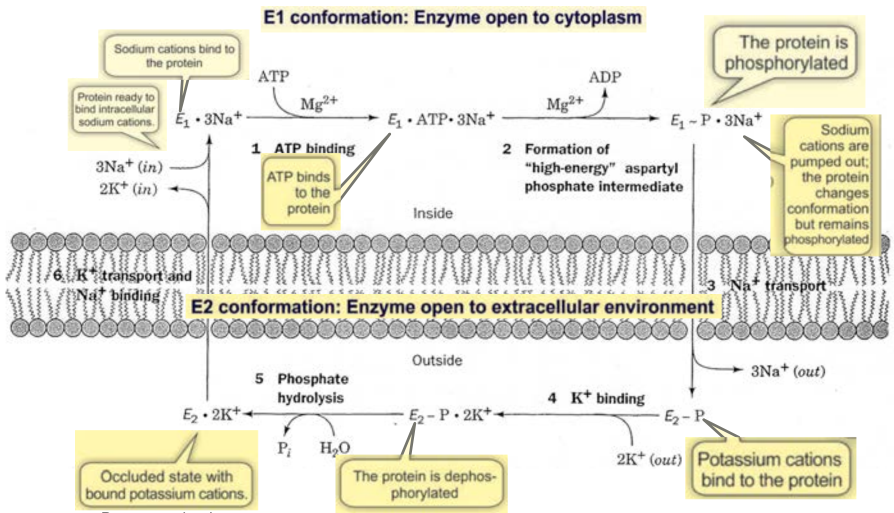
$\alpha_2\beta_2\gamma$ pentamer



Membrane Transport



Sodium–potassium (Na^+–K^+) pump



Due to β subunit

Membrane Transport

Sodium–potassium (Na^+–K^+) pump

Potassium binding causes change to E1, which then causes P_i hydrolysis

https://www.youtube.com/watch?v=I3JuKOm1a0M cartoon

Membrane Transport

Sodium–potassium (Na^+–K^+) pump

Calls secondary active transport "facilitative diffusion"

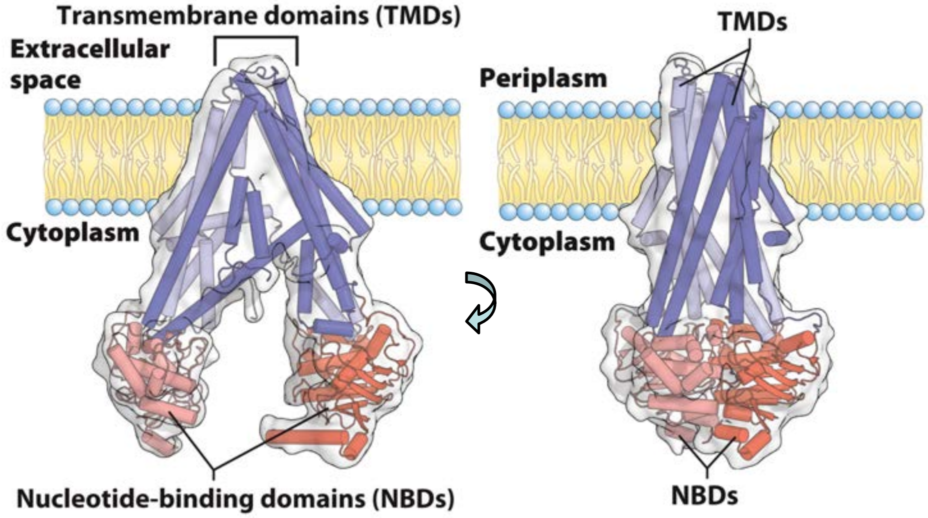
https://youtu.be/IKoKjCL27mA Khan academy

Membrane Transport

Sodium–potassium (Na^+–K^+) pump

video https://youtu.be/1zvnsrKQ2Jg

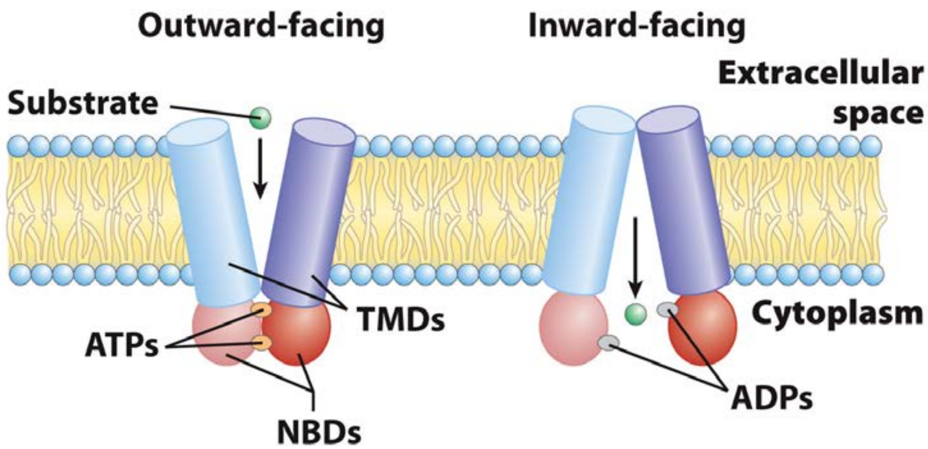
Membrane Transport



ABC Transporters Use ATP Hydrolysis to Drive Transport of Substrates OUT

Membrane Transport

ABC Transporters Use ATP Hydrolysis to Drive Transport of Substrates IN

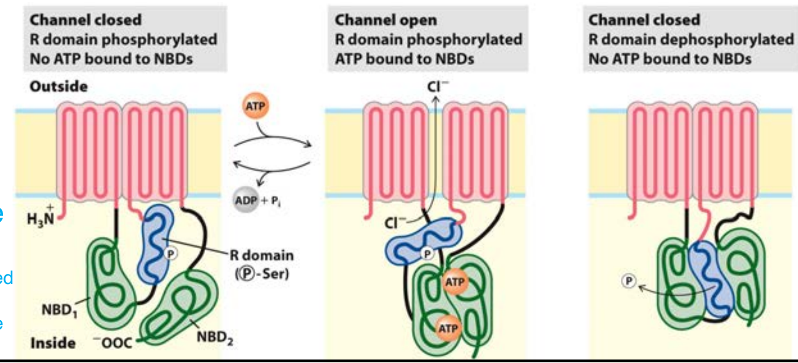


Membrane Transport

Failure of ABC-Transporters Can Lead to Human Disease

- Mutations in the human CFTR transporter (an ABC-type transporter-like channel for chloride ions)(cystic fibrosis transmembrane-conductance regulator) result in the human disease cystic fibrosis.
- Single-amino-acid mutations can render the protein misfolded and/or unable to transport chloride ions, resulting in an imbalance of water across the membrane.

Regulated Facilitative Diffusion
- Phosphorylated by PKA
- Puts it in cycle

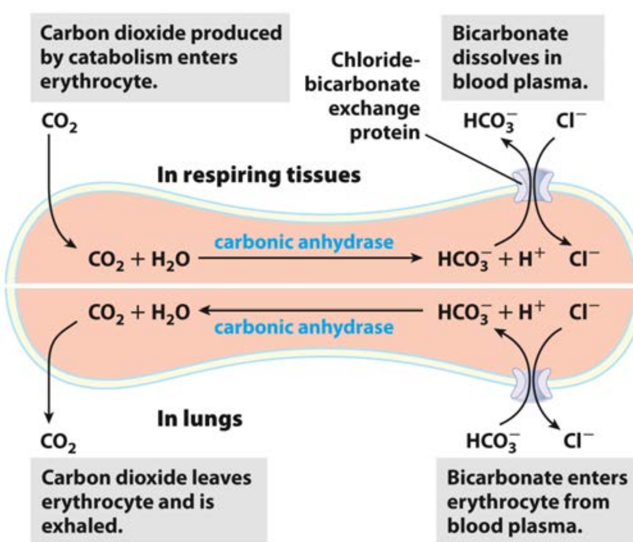


Membrane Transport

Examples of Secondary Active Transport

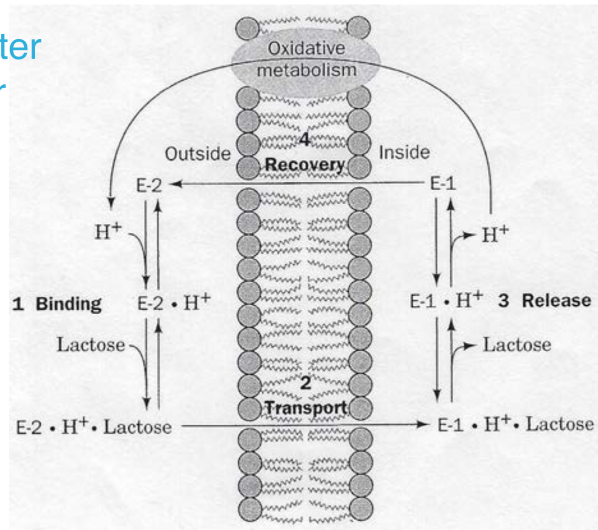
Bicarbonate Transporter is an Antiporter

Maintains the electrochemical potential across the membrane



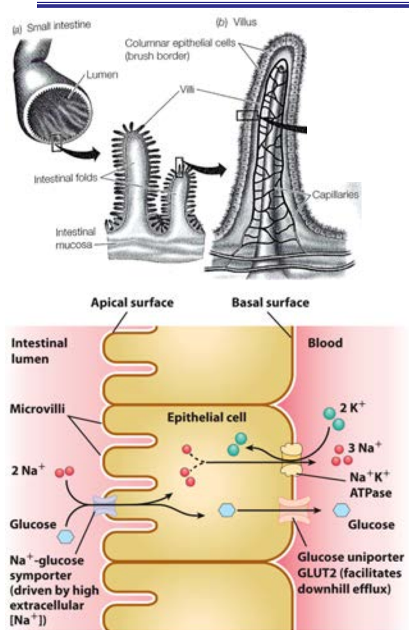
Membrane Transport

The bacterial Lactose Transporter is an Symporter



Uses the power of a proton gradient across the plasma membrane

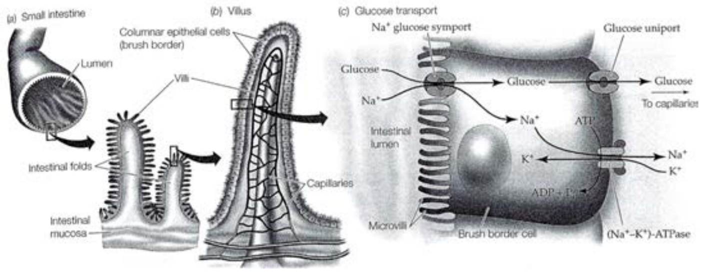
Membrane Transport



Efficient Import of Glucose uses Multiple Glucose Transporters

- A Na^+-glucose symporter and a glucose uniporter operate on opposite sides of epithelial cells to facilitate movement of glucose from the intestine to the blood.
- Uses the Na/K gradient set up by "the pump."

Membrane Transport



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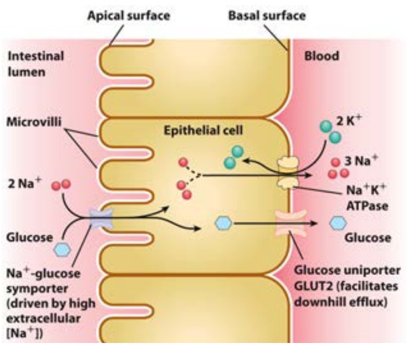

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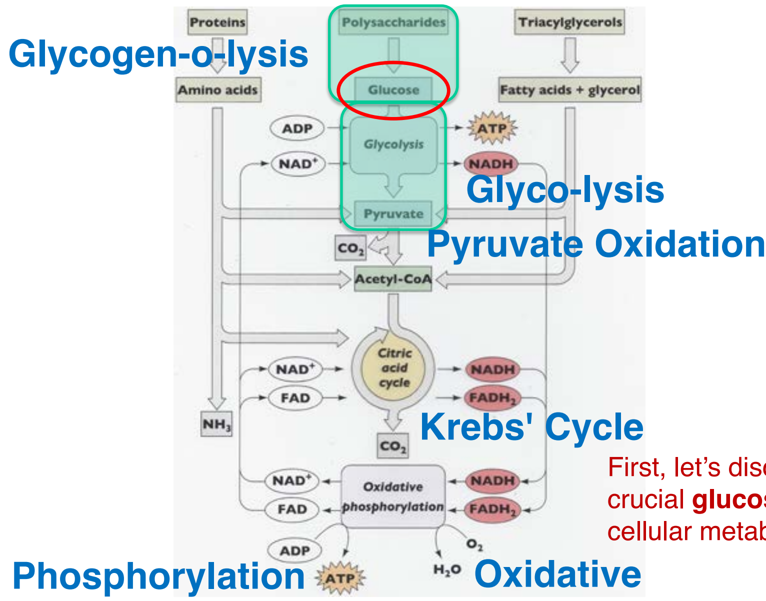
Membrane Transport

Summary

We learned that:

- membrane proteins play a important functional role in the transport of solutes across the membrane
- Transport is mediated or non-mediated.
- In mediated transport there is a facilitative diffusion mechanism or an active transport mechanism
- active transport is either primary or secondary
- Primary active transport of solutes across membranes requires ATP
- The most important and one of the best examples of primary active transport is the Na/K ATPase.
- Secondary active transport but can be accomplished in many different ways, but uses the potential energy established by primary active transport

CATABOLISM



First, let's discuss how crucial **glucose** is for cellular metabolism

CATABOLISM

Glucose Importance:

- Glucose is an excellent fuel.
  - yields good amount of energy upon oxidation
    - –2840 kJ/mol glucose (–678 kcal/mol)
  - can be efficiently stored in the polymeric form
  - Many organisms and tissues can meet their energy needs on glucose only.

- Glucose is a versatile biochemical precursor.
  - Many organisms can use glucose to generate:
    - all the amino acids
    - membrane lipids
    - nucleotides in DNA and RNA
    - cofactors needed for the metabolism of EVERYTHING
    - IOW, EVERYTHING!!

CATABOLISM

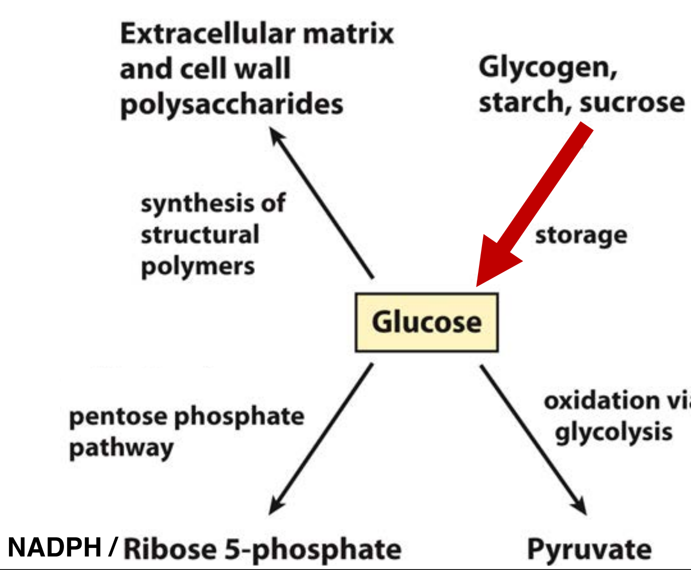
Glucose Utilization:

- Storage
  - can be stored in the polymeric form (starch, glycogen)
  - used for later energy needs
- Energy production
  - generates energy via oxidation of glucose
  - short-term energy needs
- Production of NADPH and pentoses
  - generates NADPH for use in relieving oxidative stress and synthesizing fatty acids, amino acids, etc. (anabolism)
  - generates pentose phosphates for use in DNA/RNA biosynthesis
- Structural carbohydrate production
  - used for generation of alternate carbohydrates used in cell walls of bacteria, fungi, and plants

CATABOLISM

Glucose Utilization: Four Major Fates of Glucose

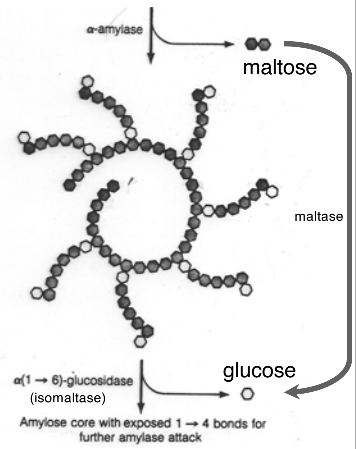
What if you need **glucose** for cellular metabolism and energy?



Glucose is Stored for Later Use as Glycogen (animals) or Starch (plants)

- Glycogen/starch are branched polymers of $\alpha(1 \rightarrow 4)$-linked glucose with $\alpha(1 \rightarrow 6)$ linkages (glycogen every 8-12 glucose units; starch every 24-30 glucose units).
- Glycogen storage occurs mainly in the liver and muscle.
- Starch storage occurs mainly in the leaves

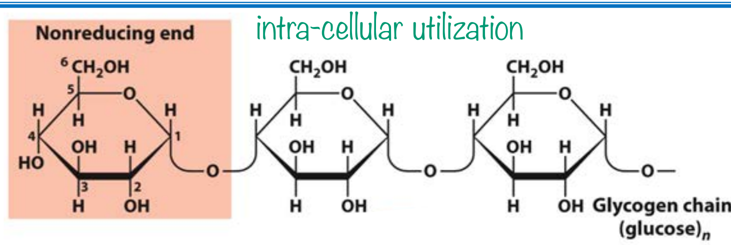
Digestion



Digestion *versus* intra-cellular utilization

Glycogenolysis is performed mainly by Glycogen Phosphorylase

intra-cellular utilization



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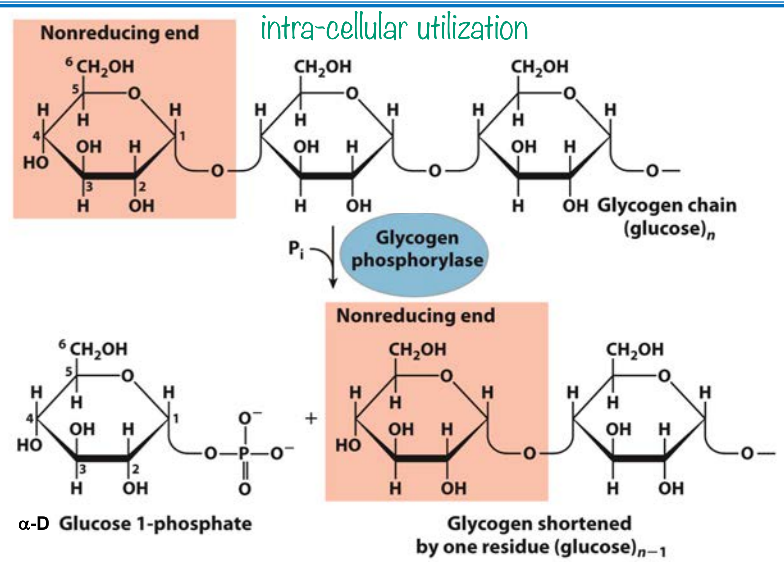

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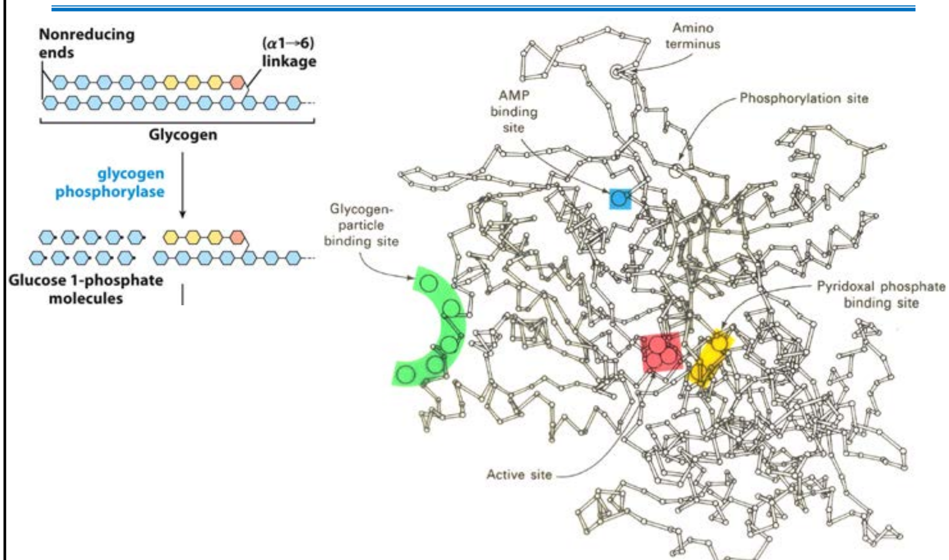
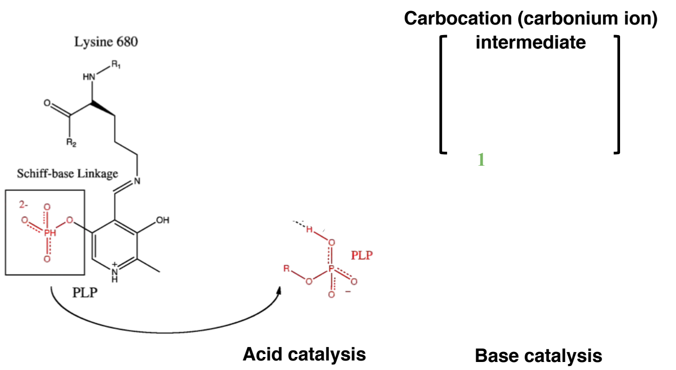


Glycogenolysis is performed mainly by Glycogen Phosphorylase

Mechanism



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Mechanism