Glycogen Metabolism

Biochemistry II

By

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- **SYNTHESIS OF GLYCOGEN (GLYCOGENESIS).**

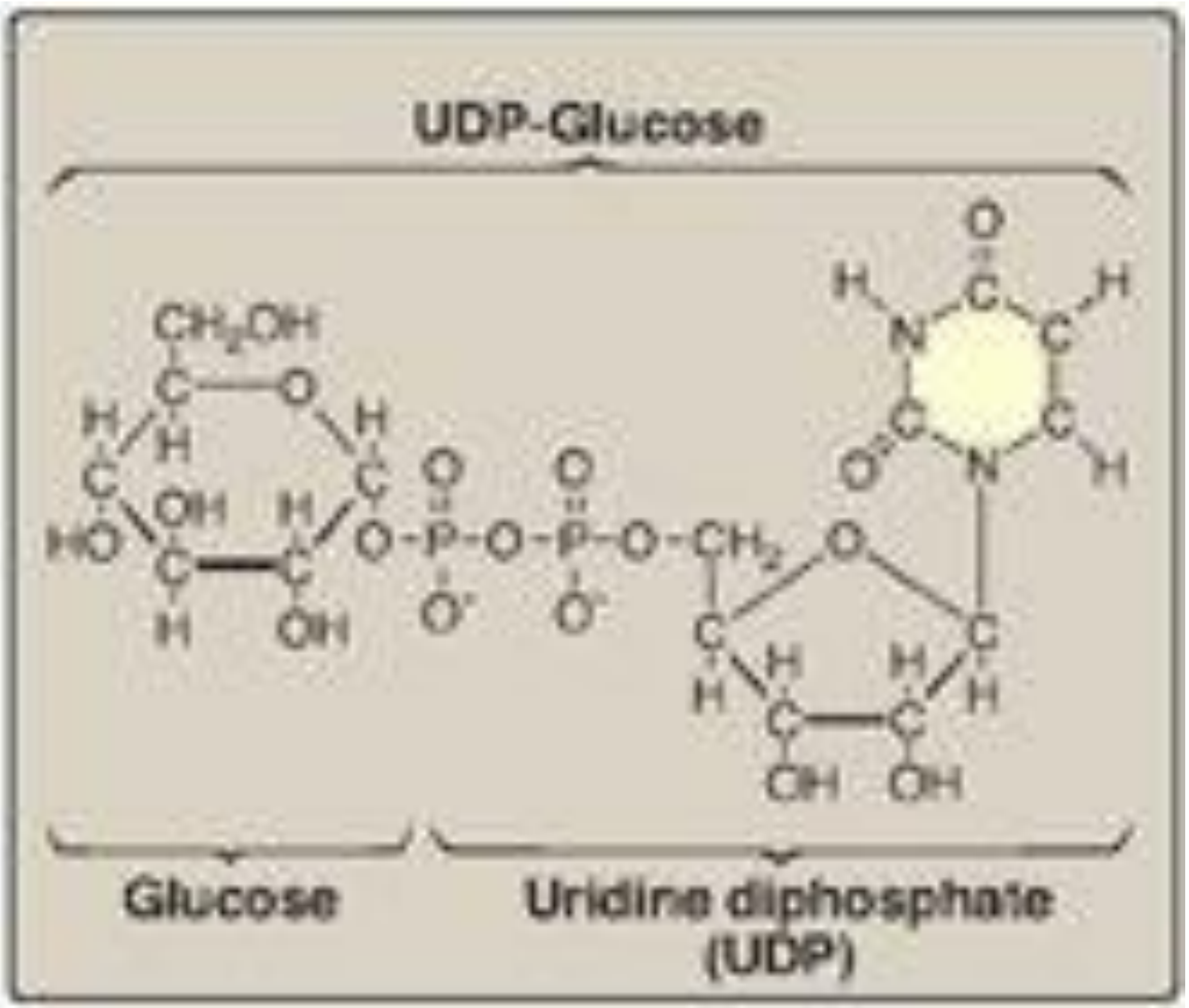
- **DEGRADATION OF GLYCOGEN (GLYCOGENOLYSIS)**

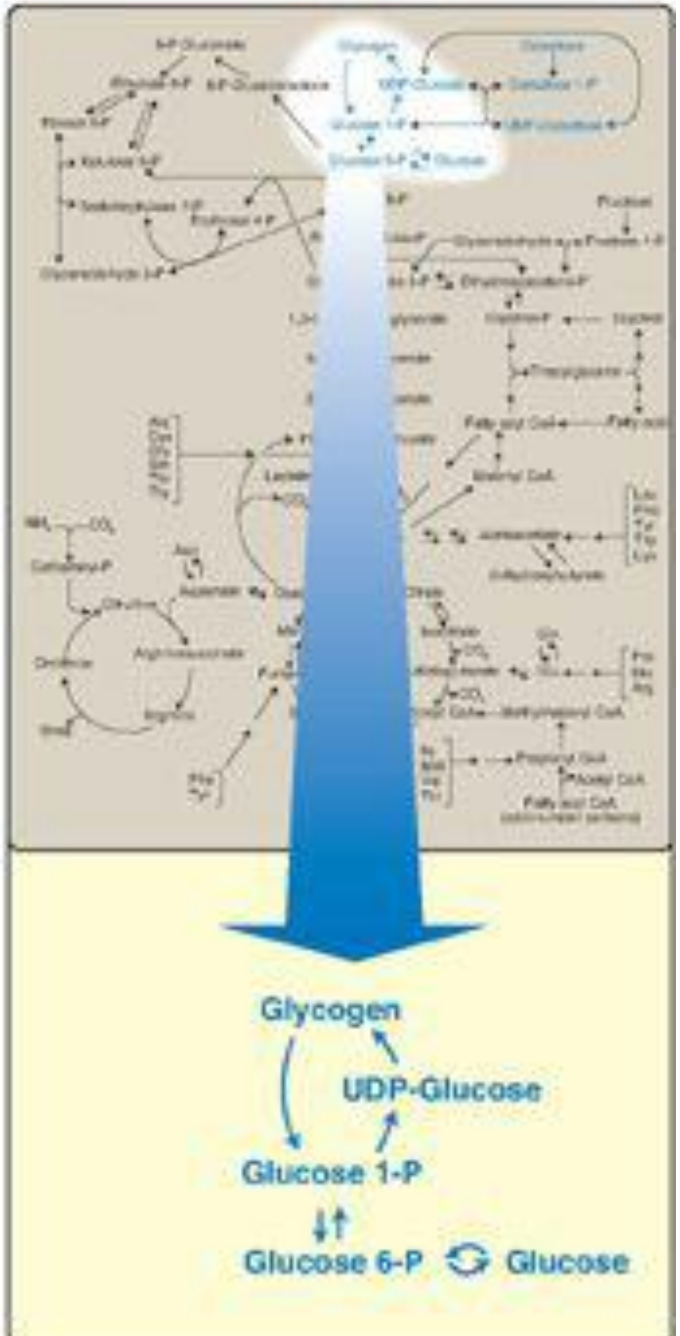
SYNTHESIS OF GLYCOGEN (GLYCOGENESIS)

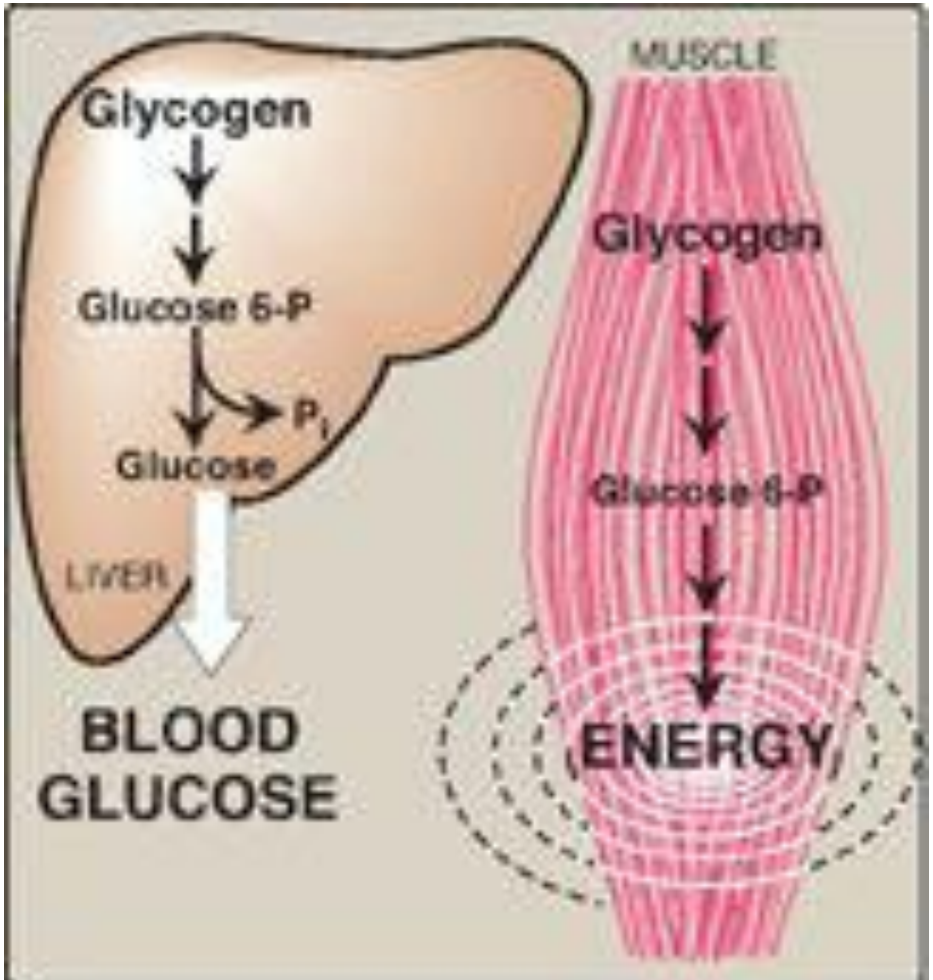
- Glycogen is synthesized from molecules of α-D-glucose.
- The process occurs in the cytosol

and requires energy supplied by ATP (for the phosphorylation of glucose) and uridine triphosphate (UTP).

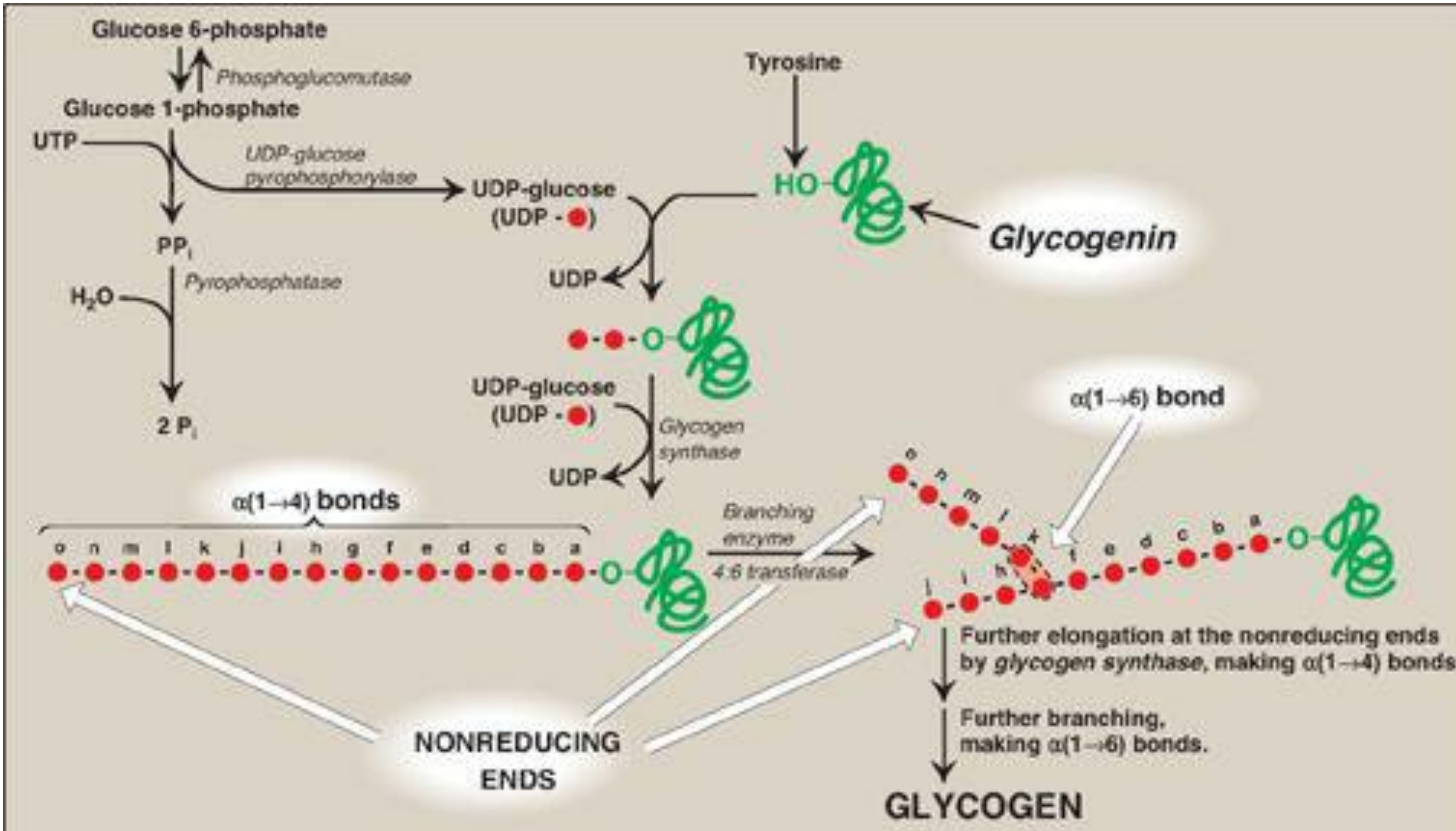
The structure of UDP-glucose, a nucleotide sugar



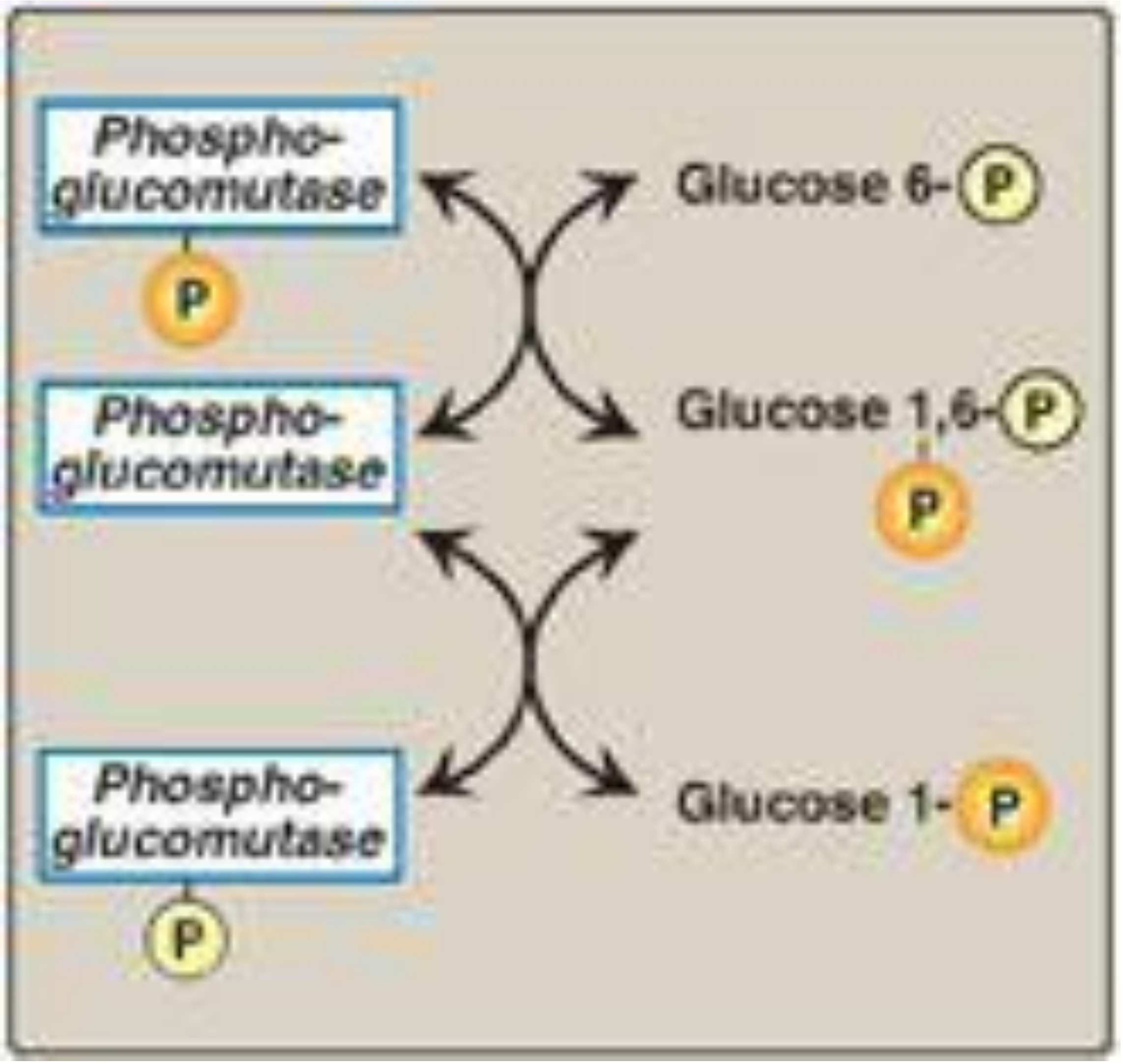

Glycogen
UDP-Glucose
Glucose 1-P
Glucose 6-P
Glucose


Glycogen
Glucose 6-P
Pi
Glucose
LIVER
BLOOD
GLUCOSE
MUSCLE
Glycogen
Glucose 6-P
ENERGY

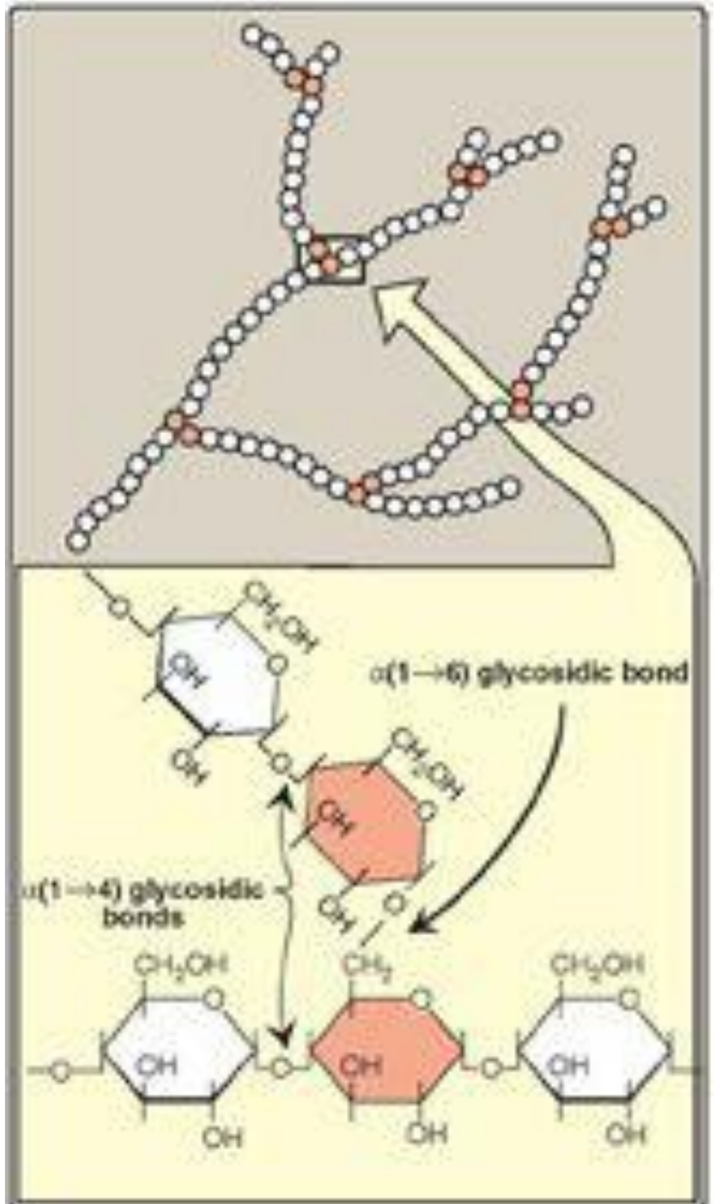
Glycogen synthesis.



Interconversion of glucose 6-phosphate and glucose 1-phosphate by phosphoglucomutase.



Branched structure of glycogen, showing α(1→4) and α(1→6) glycosidic bonds.



Synthesis of a primer to initiate glycogen synthesis

- Glycogen synthase makes the $\alpha(1\rightarrow4)$ linkages in glycogen.
- In the absence of a glycogen fragment, a protein called glycogenin can serve as an acceptor of glucose residues from UDP-glucose.
- A fragment of glycogen can serve as a primer in cells whose glycogen stores are not totally depleted.
- The side-chain –OH group of a specific tyrosine in the protein serves as the site at which the initial glucosyl unit is attached.

- the reaction is catalyzed by glycogenin itself via autoglucosylation, glycogenin is an enzyme.
- Glycogenin then catalyzes the transfer of the next few molecules of glucose from UDP-glucose, producing a short, $\alpha(1\rightarrow4)$-linked glucosyl chain.
- This short chain serves as a primer that is able to be elongated by glycogen synthase.

Elongation of glycogen chains by glycogen synthase

- Elongation of a glycogen chain involves the transfer of glucose from UDP-glucose to
- the nonreducing end of the growing chain, forming a new glycosidic bond between the
- anomeric hydroxyl group of carbon 1 of the activated glucose and carbon 4 of the
- accepting glucosyl residue. The enzyme responsible for making the $\alpha(1 \rightarrow 4)$ linkages in glycogen is glycogen synthase.

Synthesis of branches

- Branches are made by the action of the branching enzyme,
- amylo-α(1→4)→α(1→6)-transglucosidase. This enzyme removes a set of six to eight glucosyl residues from the nonreducing end of the glycogen chain,

- breaking an α(1→4) bond to another residue on the chain, and attaches it to a nonterminal glucosyl residue by an α(1→6) linkage, thus functioning as a 4:6 transferase.

- The resulting new, nonreducing end as well as

the old nonreducing end from which the six to eight residues were removed.

- A linear (unbranched) chain of glucosyl residues attached by $\alpha(1\rightarrow4)$ linkages. Such a

compound is found in plant tissues and is called amylose.

- In contrast, glycogen has branches located, on average, eight glucosyl residues apart, resulting in a highly branched, tree-like structure that is far more soluble than the unbranched amylose.

Reference

- Lippincott's
- Illustrated Reviews:
- Biochemistry
- Sixth Edition