Glycogenolysis

Glycogenolysis is the breakdown of glycogen to glucose (mainly in the liver). Hepatic glycogenolysis adds glucose to the blood for maintaining the blood sugar level inspite of variations in the food intake and during the first 24 hours of fasting.

Glycogen degradation and synthesis are relatively simple biochemical processes. Glycogen degradation consists of three steps: (1) the release of glucose 1-phosphate from glycogen, (2) the remodeling of the glycogen substrate to permit further degradation, and (3) the conversion of glucose 1-phosphate into glucose 6-phosphate for further metabolism. The glucose 6-phosphate derived from the breakdown of glycogen has three fates: (1) It is the initial substrate for glycolysis, (2) it can be processed by the pentose phosphate pathway to yield NADPH and ribose derivatives; and (3) it can be converted into free glucose for release into the bloodstream. This conversion takes place mainly in the liver and to a lesser extent in the intestines and kidneys.

Progessive biochemical steps

1.*Phosphorolysis of α-1,4 glycosidic bonds*

i.**Glycogen phosphorylase** catalyzes the phosphorolysis of α-1,4 glycosidic bonds in the stored glycogen with the help of iorganic phosphate (HPO_4^{2-}). This enzyme breaks the α-1,4 glycosidic bonds between successive glucose residues starting from the nonreducing end of an outer chain of glycogen molecule and releases one glucose 1-phosphate molecule at each step.

ii.Restriction in enzyme activity—This enzyme cant not cleave the α-1,6 glycosidic bonds at the branching point of glycogen chain. This enzyme stops acting on a branch when only 4 glucose residues are left in it.

2.*Debranching of shortened branch*

i.Glycogen debranching enzyme acts on the shortened branch, left after glycogen phosphorylase action and removes the branch.

ii.Pattern of activity of debranching enzyme—

α-1,4— α-1,4 glucan transferase and amylo-1,6-glucosidase activities. These two activities are shown in the table below—

Debranching enzyme	Mode of action
α-1,4— α-1,4 glucan transferase	i.This activity cleaves the last α-1,4 glycosidic bond before the α-1,6 glycosidic bond at the branching point of the shortened branch. ii.Released trisachharide from that branch transfer to another branch and joins the trisachhraide to the latter by a new α-1,4 glycosidic bond.
Amylo-1,6-glucosidase	The α-1,6 glycosidic bond holding the last glucose residue of the shortened branch, is next hydrolyzed by amylo-1,6-glucosidase activity, releasing that glucose as free glucose.

Reactions of glycogen phosphorylase and debranching enzyme are repeated on either branches of the glycogen molecule.

3.*Formation of glucose-6-phosphate*

i.**Phosphoglucomutase** next isomerizes glucose-1-phosphate to glucose-6-phosphate in presence of Mg^{2+} and catalytic amounts of glucose 1,6-biphosphate. The enzyme transfers a **phosphate** group from its phosphorine residue to the C^6-hydroxymethyl group of glucose 1-phosphate, changing the latter to a glucose 1,6 biphosphate intermediate.