Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Zoology

Course Code: ZOC 106

Course Title: Biochemistry and Metabolic processes

Unit: 03

Module Name: Carbohydrate Metabolism: Glycogenolysis

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Notes:

GLYCOGEN is a homopolymer of glucose, containing up to 55-60,000 glucosyl residues. It consists of linear chains of glucose linked by α– (1,4) glycosidic bonds. The chains are highly branched, with α–(1,6) branch linkages occurring every 8-10 residues.

The end of the molecule containing the free anomeric carbon (free aldehyde group) is called the reducing end, and the other end is called the nonreducing end.

GLYCOGENOLYSIS is the degradative pathway that mobilizes stored glycogen in liver and skeletal muscle. It is not a mere reversal of the anabolic pathway i.e. Glycogenesis. Glycogen breakdown is enhanced when glucose concentration & energy levels are low. The primary product during degradation is glucose 1-phosphate, obtained by breaking α(1→4) glycosidic bonds. Free glucose is released from each α (1→6)-linked glucosyl residue.

STEPS OF GLYCOGENOLYSIS

- **Shortening of chains/ Glycogen phosphorolysis**
- **Removal of branches**
- **Conversion of glucose 1-phosphate to glucose 6-phosphate**
- **Free glucose formation**

SHORTENING OF CHAINS/ GLYCOGEN PHOSPHOROLYSIS

This step includes the rupture of α1→4 glycosidic bonds by insertion of a phosphate at carbon 1 of glucose unit at the non-reducing ends of the chain. This step catalysed by ***glycogen phosphorylase*** yields Glucose-1-phosphate. It utilizes inorganic phosphate (Pi) instead of phosphate from ATP. Phosphorolysis stops four glucose residues before an α1→6 junction. The resulting structure is called a limit dextrin, and phosphorylase cannot degrade it any further.

REMOVAL OF BRANCHES: Branches are removed by the two enzymic activities of a single bifunctional protein, the **"DEBRANCHING ENZYME".**

***Oligo-α(1→4)→α(1→4)-glucan transferase*-** removes the outer three of the four glucosyl residues attached at a branch which are transferred to the nonreducing end of another chain. Thus, an α(1→4) bond is broken and an α(1→4) bond is made, and the enzyme functions as a 4:4 transferase.

Amylo α1→6-glucosidase- removes the remaining single glucose residue in an α (1→6) linkage by hydrolysis to yield free glucose.

The glucosyl chain is now available for degradation again by glycogen phosphorylase until four glucosyl units from the next branch are reached.

Conversion of Glucose-1-phosphate to Glucose- 6-phosphate

Glucose-1-phosphate is converted into Glucose-6-phosphate by ***Phosphoglucomutase***. This is the reverse reaction that produces G-1-P in glycogenesis. In the liver, glucose 6-phosphate is transported into the endoplasmic reticulum (ER) by glucose 6-phosphate translocase.

FREE GLUCOSE FORMATION

The last stage of glycogenolysis is the hydrolysis of Glucose-6-phosphate to glucose and inorganic phosphate. The glucose 6-phosphatase catalyses this reaction. It is the same enzyme used in the last step of gluconeogenesis. The glucose then moves from the endoplasmic reticulum to the cytosol. Hepatocytes release glycogen-derived glucose into the blood to maintain blood glucose levels until the gluconeogenic pathway is actively producing glucose.