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Glycogen Metabolism

Glycogen is polymer of glucose unit linked by α-1,4-glycocidic linkage.

The excess glucose which is available after body regular need, can be stored in body tissue/cells.

The formation & utilization of glycogen in body with the help of enzymatic system is called glycogen metabolism.

- Glycogenesis (Glucose → Glycogen)
- Glycogenolysis (Glycogen to glucose)

Glycogenesis:- It is the pathway for the formation of glycogen from glucose. This is energy consuming pathway which take energy in the form of ATP and UTP

Location: Cytosol of muscle and liver cells.

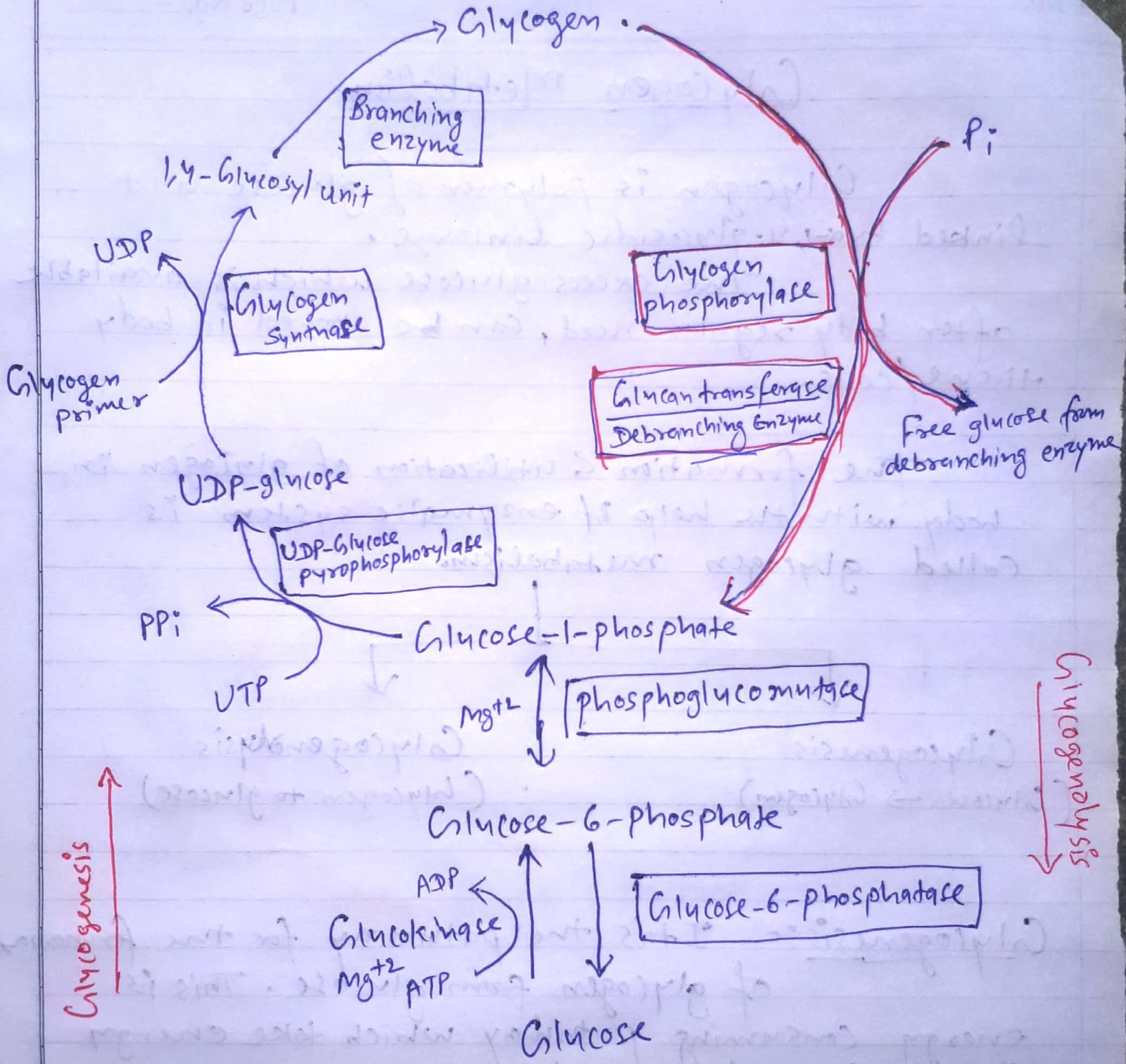


Figure :- → Glycogen metabolism (Both Glycogenesis & Glycogenolysis)

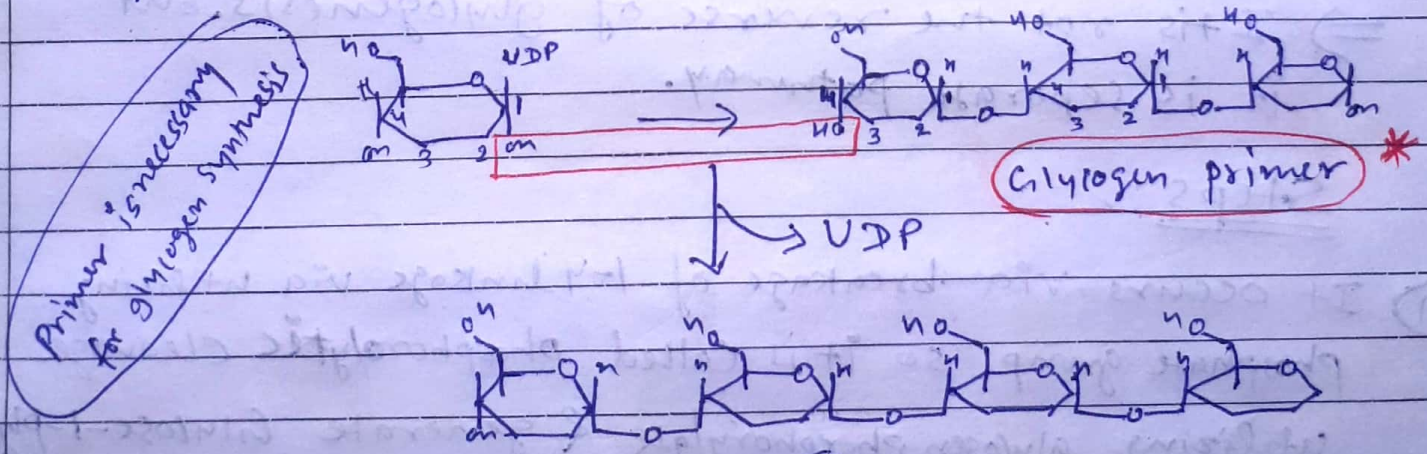
Glycogenesis :- Reaction Steps

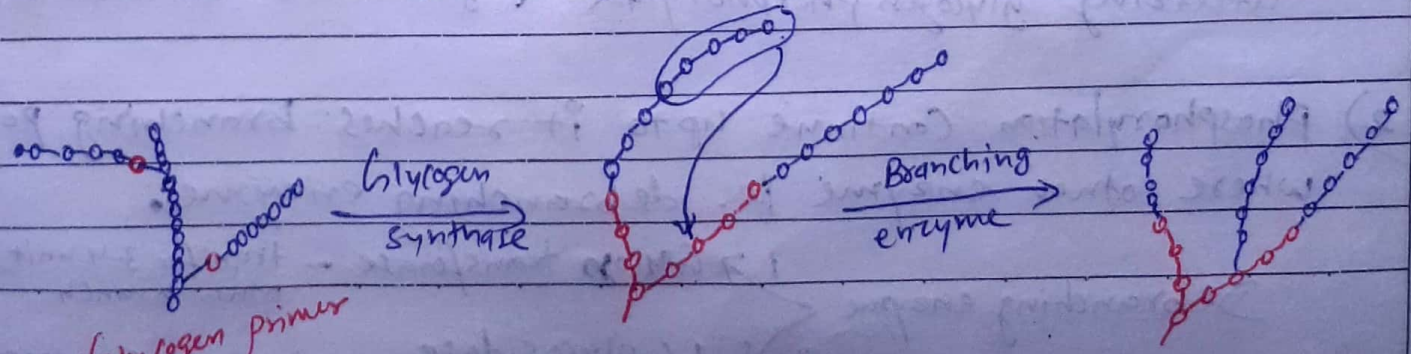
1) Glucose phosphorylate to glucose-6-phosphate catalysed by glucokinase (in liver) & Hexokinase (muscle).

2) Glucose-6-phosphate converted to glucose-1-phosphate by phosphoglucomutase (only change in the position of PO4 group)

3) Glu-1-phosphate react with UTP to form UDP-Glucose & pyrophosphate release by UDP-Glucose pyrophosphatase enzyme.

4) Now glycogen synthase enzyme transfer the glucose monomer from UDP-Glucose to 4th position of the glycogen primer to form α-1,4-glycosidic linkage





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5) The step-4 continue up to the chain elongated to a minimum of 11 monomers. After that second enzyme branching enzyme transfer a portion of 1,4-chain (Min 6-7 monomer residue) to a neighbouring branch to form 1,6-glycosidic linkage

6) the branch again grow with 1-4-linkage using UDP-Glucose unit and further branching by 1-6-linkage.

Glycogenolysis :- degradation of glycogen to glucose-6-phosphate and glucose in muscle and liver respectively.

⇒ It is not the reverse of glycogenesis. but it is seperate pathway.

Steps :-

1) It occurs via breakage of 1-4 linkage via utilizing phosphate group so it is called phosphorolytic cleavage. utilizing glycogen phosphorylase & generate Glucose-1-phosphate

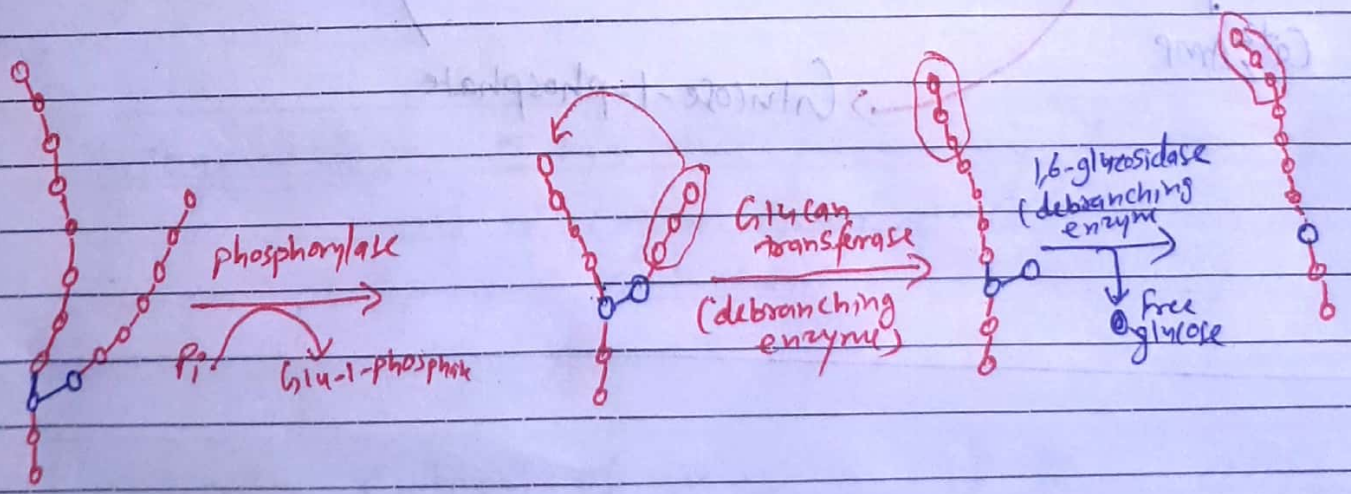
2) Phosphorylation continue up to it reaches branching point. where other enzyme i.e. debranching enzyme.

Debranching enzyme (it have two function)
- 1 → Glycogen transferase – transfer 3-4 unit to other branch
- 2 → 1,6-glycosidase → break 1-6 linkage

3) The combined action of phosphorylase & debranching enzyme lead to complete breakdown of glycogen to glucose-1-phosphate & free glucose.

4) Glucose-1-phosphate is converted to glucose-6-phosphate by phosphoglucomutase enzyme. This is reversible reaction & utilized in both glycogenesis & Glycogenolysis.

5) Glucose-6-phosphate to glucose reaction only happened in liver because the enzyme Glu-6-phosphatase only found in liver: so this glucose diffuse from hepatic cell to blood & required to maintain blood glucose level in humans.



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Regulation of Glycogen metabolism:

- Hormonal
  - → Epinephrin → liver & muscle → Glycogen breakdown ↑
  - → Glucagen (in liver) → Glycogen breakdown ↑
  - & ~~adre~~ ↓ Glycogen synthesis
- Enzymatic (Allosteric regulation)
  - → Glycogen Synthase
  - → Glycogen phosphorylase