GLYCOGENOLYSIS {degradation}

.3 Enzymes.

- glycogen phosphorylase - rate limiting enzyme.
- $\alpha(1,4) \rightarrow \alpha(1,4)$ glucan transferase.
- Debranching enzyme (α 1,6 -glucosidase).

1. Glycogen phosphorylase.

- It removes glucose as glucose -1 -phosphate from glycogen.
- PLP is the prosthetic group.
- Sequentially hydrolyse α 1,4 linkage till it reaches a glucose residue, 3 - 4 glucose units away from the branching point
- Does not cleave α 1,6 linkage at branching point.

- The glycogen so formed is known as limit dextrin which cannot be further degraded by phosphorylase.

Debranching enzyme.

- The branches of glycogen are cleaved by two enzyme activities present on a single polypeptide called debranching enzyme, it is a bifunctional enzyme.

α (1, 4) → α (1, 4) glucan transferase.

- Transfer a trisaccharide (3 glucose) unit from one branch to the other, exposing the 1,6 branch point.

α 1,6 glucosidase.

- Hydrolyse the remaining glucose unit held in 1,6 - linkage at the branch point.

. This glucose unit is released as free glucose.

. after removal of branch point, glycogen phosphorylase proceed it's action on linear chain.

. Through the combined action of glycogen phosphorylase and debranching enzyme, glucose 1- phosphate & free glucose in a ratio of 8:1 are produced. 8:1

Glycogen (n)

↓ phosphorylase. (Pi)

Glycogen (n-1) + glucose - 1 - phosphate

↓ phospho - gluco - mutase.

glucose - 6 - phosphate.

↓ glucose - 6 - phosphatase.

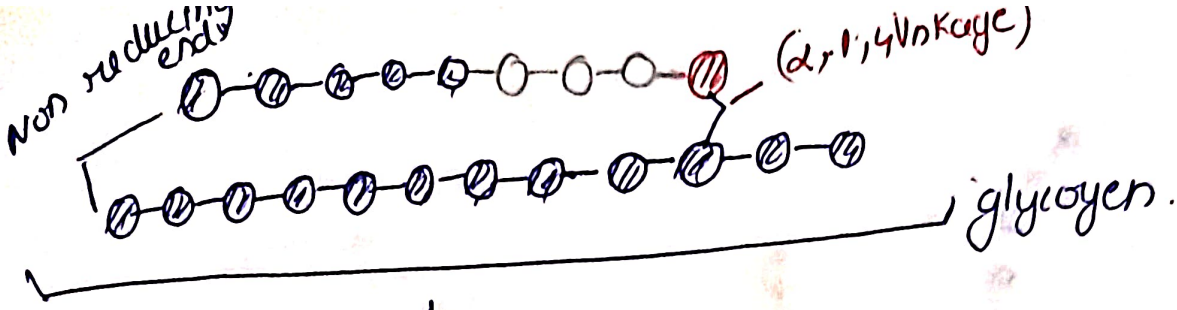
glucose

Glucose 6

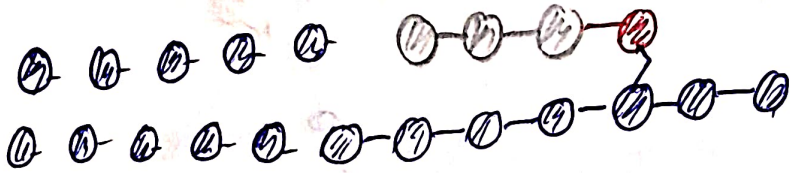
- Glucose 1- phosphate is converted to glucose -6 -phosphate by phosphoglucomutase.
- The fate of glucose -6- phosphate depends on the tissue.
- Hepatic glucose -6- phosphatase hydrolyses glucose, -6 -phosphate to glucose.
- The free glucose is released to blood stream.

Muscle lacks Glucose -6- phosphatase.

- muscle will not release glucose to blood stream.
- provide ATP for muscle contraction via glycolysis.



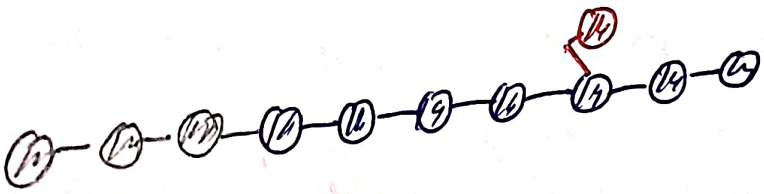
glycogen phosphorylase.



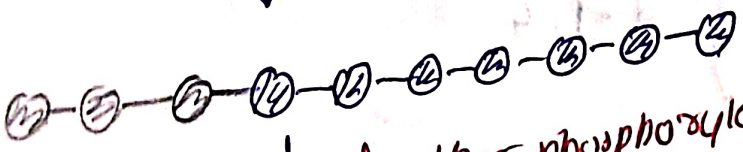
glucose-1-phosphate molecules

Transferase.

→ glucose-1-P



α-1,6-glucosidase → glucose.



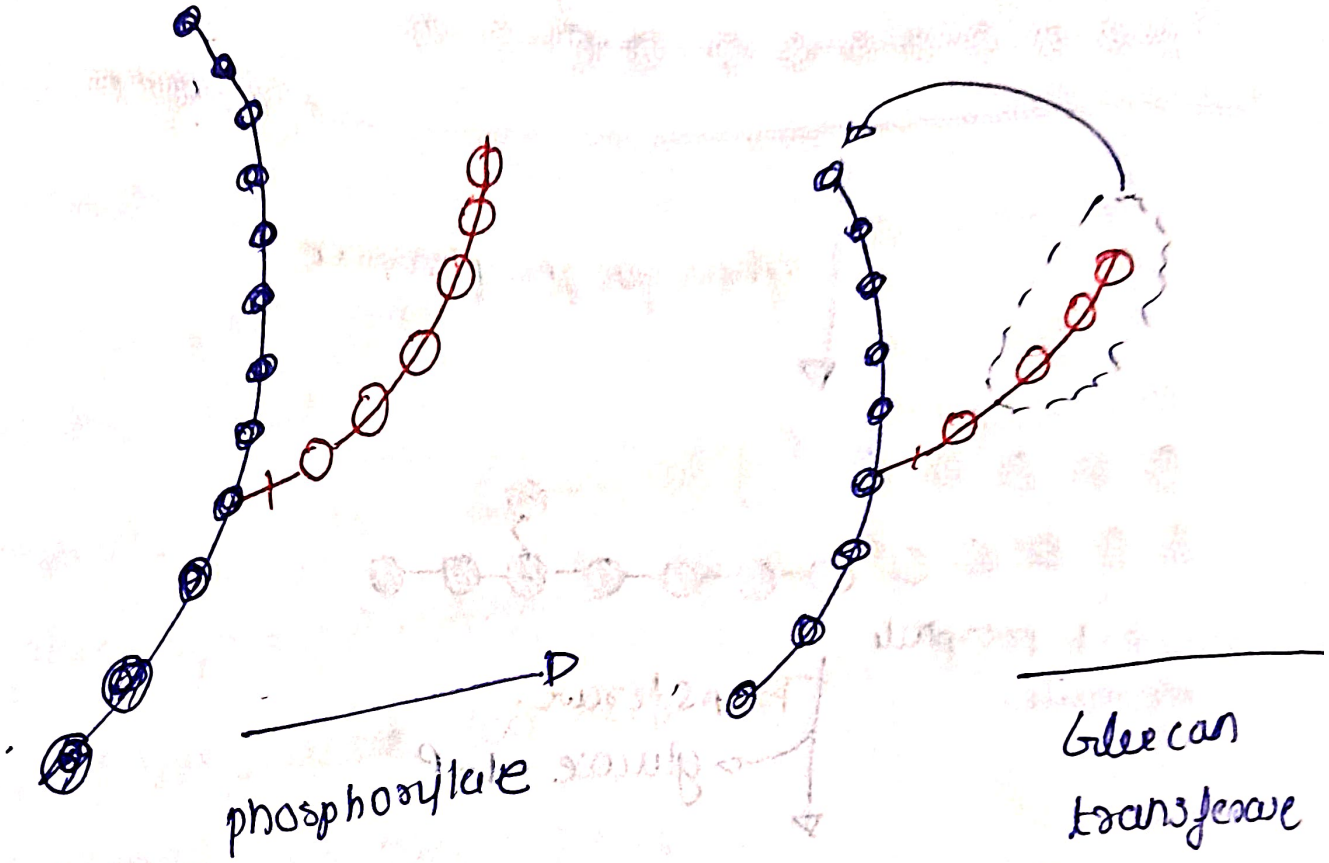
Further phosphorylase action.

Glucose-1-P.

phosphoglucomutase

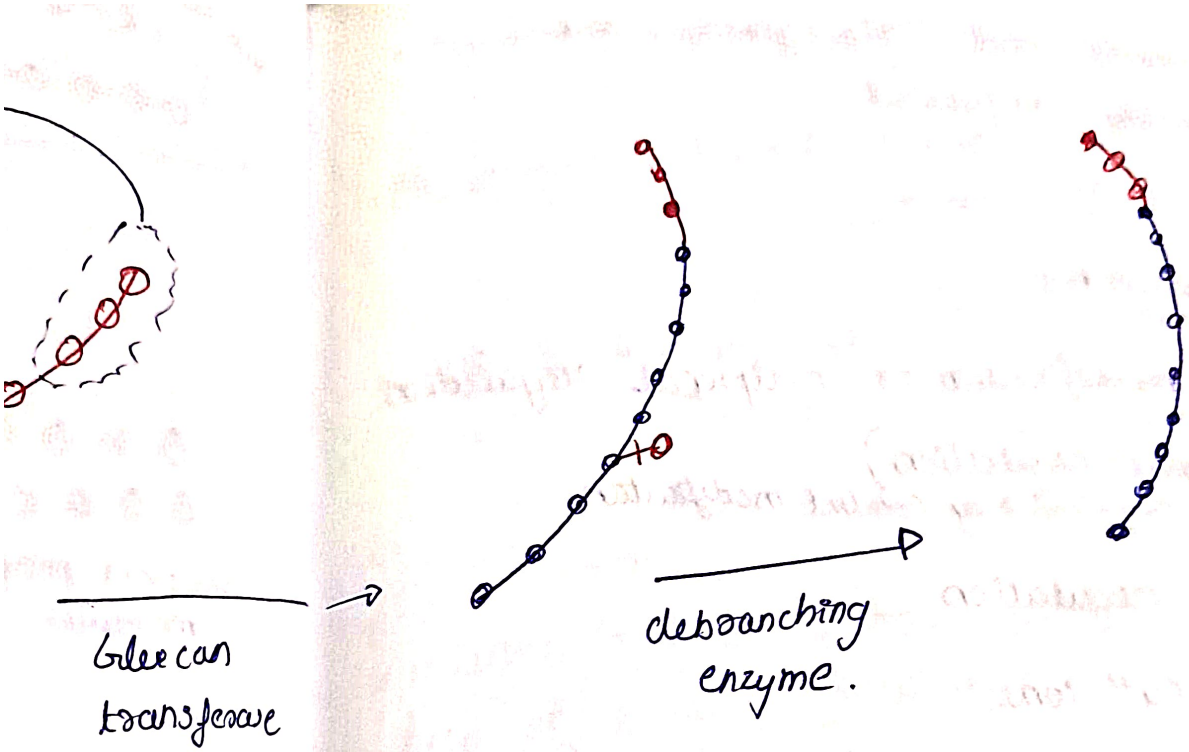
G-6-P → glucose.

glucose-6-phosphatase.



⬡—⬡ } -glucose residue joined by
⬡—⬡ } α-1,4

⬡+⬡ } residue joined by
α 1,6



ed by

- Glycogenesis and glycogenolysis are reciprocally regulated.

REGULATION BY.

* Covalent modification or reciprocal regulation. (Hormonal regulation)
reciprocal regulation by covalent modification.
* Allosteric regulation
* Role of Ca^{2+} ions.

Covalent Modification (Hormonal regulation)

- Hormones act through cyclic AMP (second messenger) mediated cascade.
- Glycogenesis : Key enzyme is Glycogen synthase.

• Stimulus - Hyperglycemia.

• Phosphorylated form : Inactive.
{glycogen synthase b).

• ~~Activated~~ phosphorylated form : active.
{glycogen synthase a)

• Insulin enhances dephosphorylation with the help of protein phosphatase.

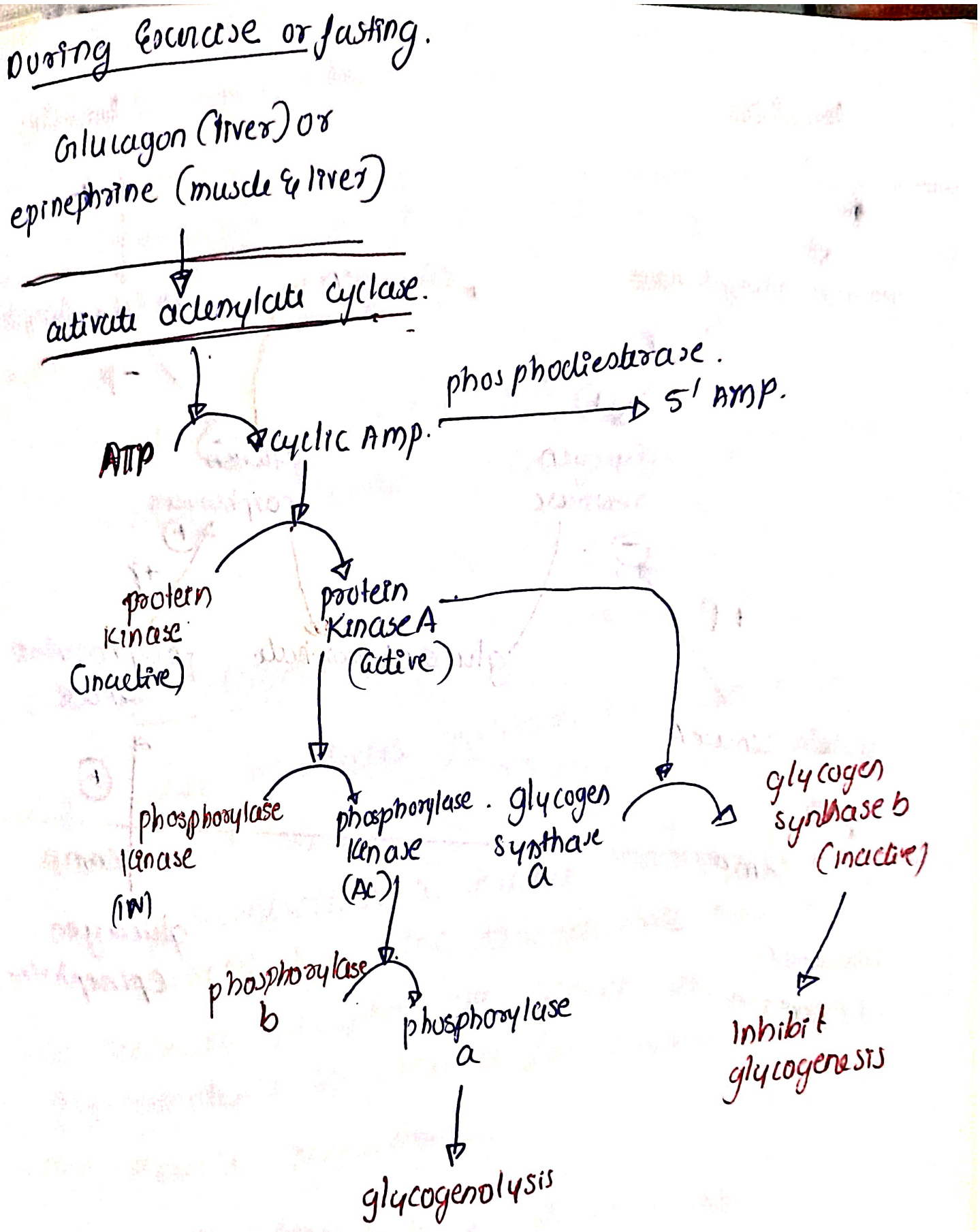
- Specific protein kinases bring about phosphorylation and protein phosphatases cause dephosphorylation.

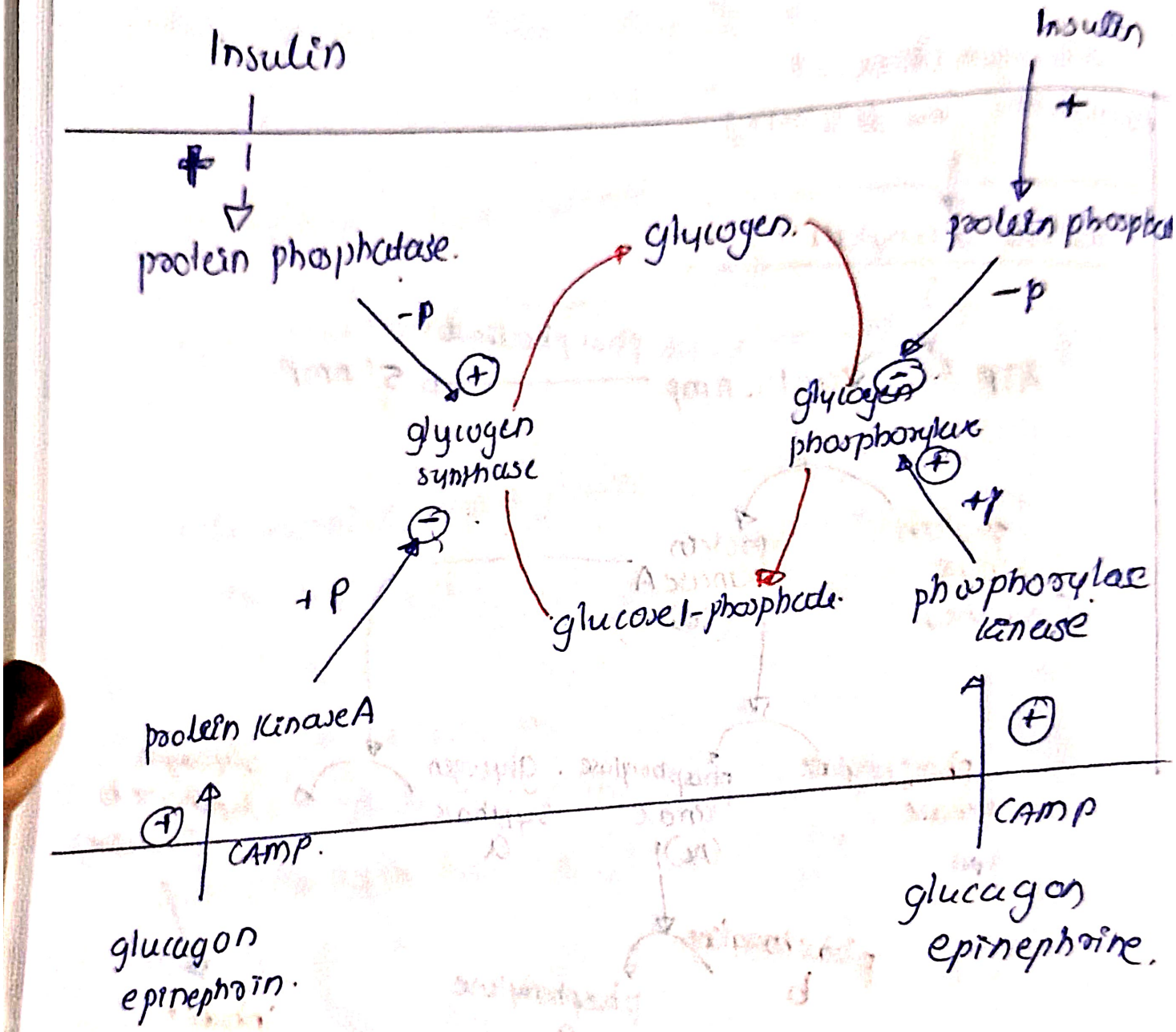
Glycogenolysis: Key enzyme is glycogen phosphorylase.

- Stimulus: hypoglycemia.
- phosphorylated form: active (phosphorylase a)
- dephosphorylated form – inactive. (phosphorylase b)

- Hormones epinephrine and glucagon can activate liver glycogen phosphorylase; but glucagon has no effect on the muscle.

During Exercise or fasting.




Insulin
Insulin
+
protein phosphatase.
-P
glycogen.
protein phosphat
-P
glycogen synthase
glycogen phosphorylase
+
+P
+
glucose 1-phosphate.
phosphorylase kinase
protein kinase A
+
cAMP.
+
cAMP
glucagon epinephrin.
glucagon epinephrine.

Allosteric regulation.

- glycogen synthase is activated by glucose-6-phosphate.
- glycogen phosphorylase.
  - allosteric activator: AMP
  - Allosteric inhibitors: Glucose-6-phosphate, ATP.

Role of calcium ions.

- Ca^{2+} also regulates glycogen breakdown in muscle
- During contraction in skeletal muscle, Ca^{2+} is released from the sarcoplasmic reticulum.
- Ca activate phosphorylase kinase and activate glycogenolysis in muscle for providing energy for muscle contraction.
- Ca & Ca dependent kinases phosphorylate glycogen synthase & inhibit glycogenesis.