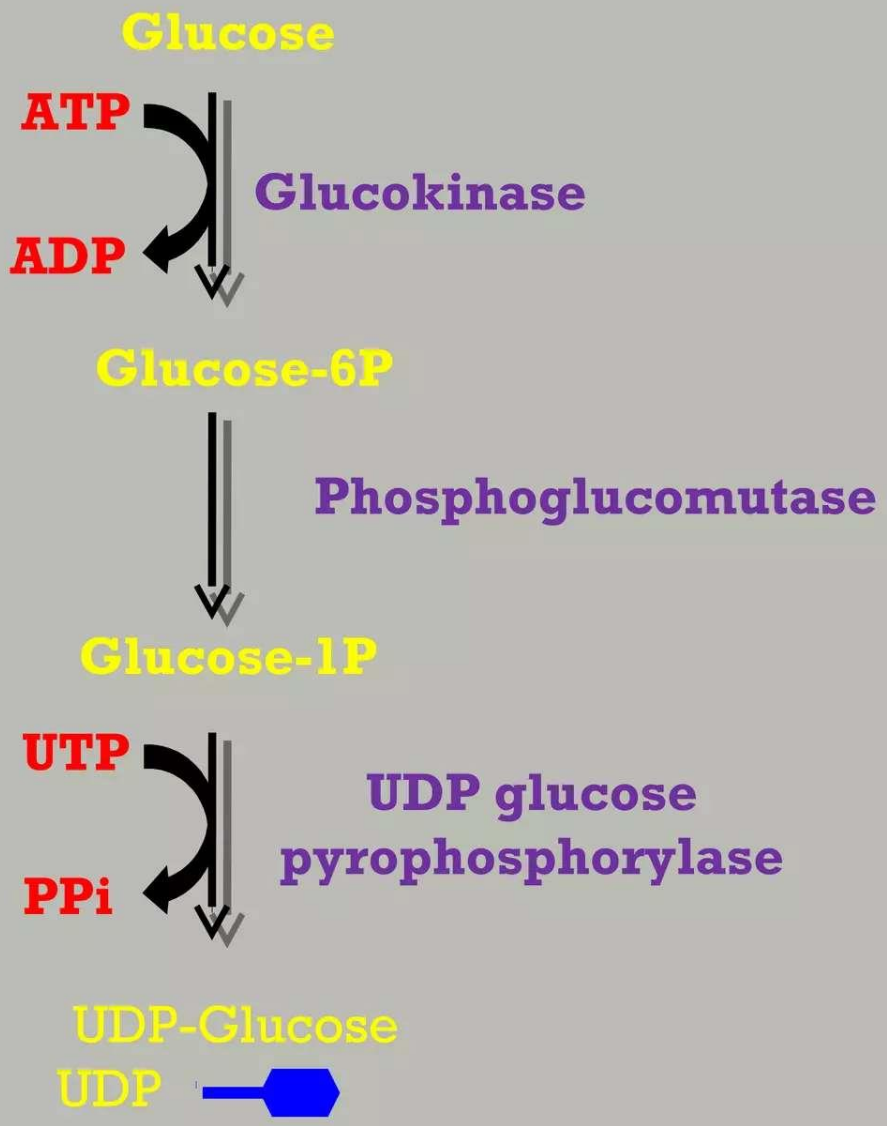
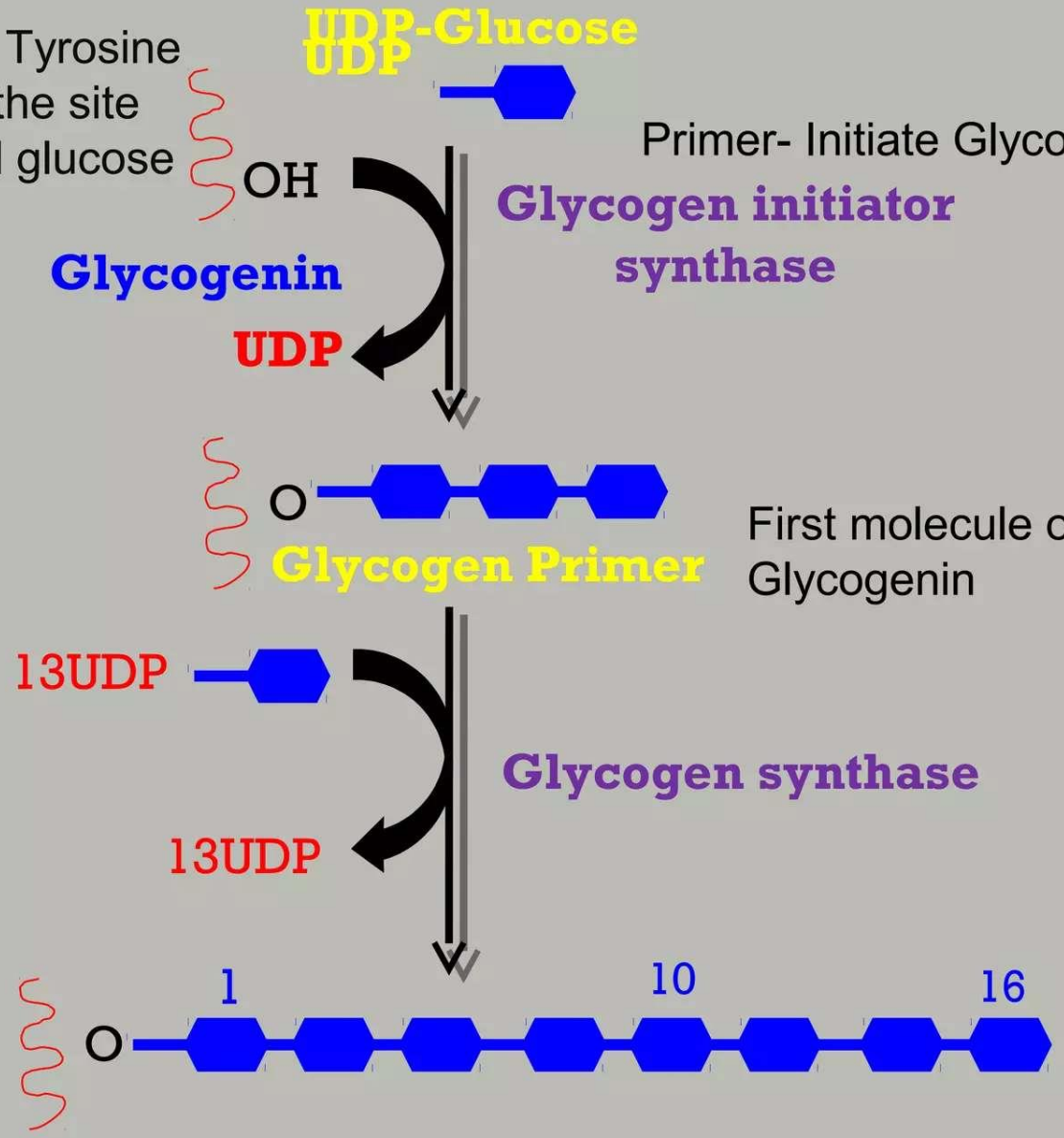
Glycogenesis

- **The synthesis of glycogen from glucose is called as glycogenesis.**
- **Glycogenesis takes place in the cytosol & requires ATP and UTP(Uridine triphophate), besides glucose.**
- **Steps:**
- **Synthesis of UDP-glucose:**

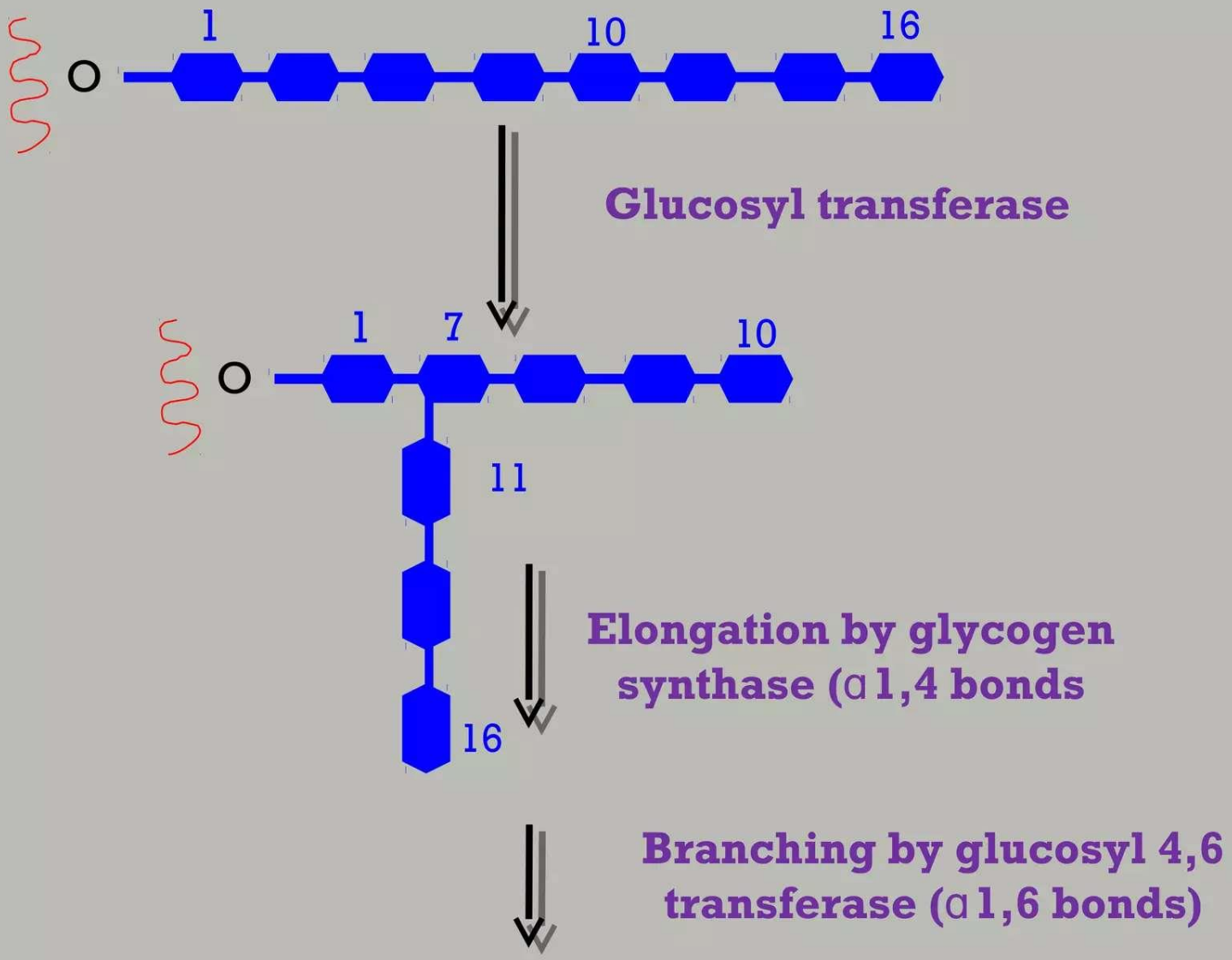

Glucose
ATP
ADP
Glucokinase
Glucose-6P
Phosphoglucomutase
Glucose-1P
UTP
PPi
UDP glucose
pyrophosphorylase
UDP-Glucose
UDP

-OH Group of AA Tyrosine Of Glycogenin is the site at which the initial glucose Is attached.



Primer- Initiate Glycogen Synthesis

First molecule of Glucose to Glycogenin


1
10
16
Glucosyl transferase
1
7
10
11
16
Elongation by glycogen synthase (α1,4 bonds
Branching by glucosyl 4,6 transferase (α1,6 bonds)

Glycogen

- **Synthesis of UDP-glucose:**
- **The enzymes hexokinase (in muscle) & glucokinase (in liver) convert glucose to glucose 6-phosphate**
- **Phosphoglucomutase catalyses the conversion of glucose 6-phosphate to glucose 1-phosphate.**
- **Uridine diphosphate glucose (UDP-glucose) is synthesized from glucose 1-phosphate & UTP by UDP-glucose pyrophosphorylase.**

Requirement of primer to initiate glycogenesis

- A small fragment of pre-existing glycogen must act as a 'primer' to initiate glycogen synthesis.
- A specific protein 'glycogenin' can accept glucose from UDP Glucose.
- The hydroxyl group (OH) of the amino acid tyrosine of glycogenin is the site at which the initial glucose unit is attached.

- **The enzyme glycogen initiator synthase transfers the first molecule of glucose to glycogenin.**
- **Then glycogenin itself takes up a few glucose residues to form a fragment of primer which serves as an acceptor for the rest of the glucose molecules.**

Glycogen synthesis by glycogen synthase

- **Glycogen synthase is responsible for the formation of 1,4-glycosidic linkages.**
- **This enzyme transfers the glucose from UDP-glucose to the non-reducing end of glycogen to form α- 1,4 linkages.**

Formation of branches in glycogen

- **Glycogen synthase can catalyse the synthesis of a linear unbranched molecule with α-1,4 glycosidic linkages.**
- **Glycogen is a branched tree-like structure.**
- **The formation of branches is brought about by the action of a branching enzyme, namely glucosyl -4-6 transferase.**

- **This enzyme transfers a small fragment of 5 to 8 glucose residues from the non-reducing end of glycogen chain (by breaking α-1,4 linkages) to another glucose residue where it is linked by α- 1,6 bond.**
- **This leads to the formation of a new non-reducing end, besides the existing one.**
- **Glycogen is further elongated & branched, by the enzymes glycogen synthase & glucosyl 4-6 transferase.**

Function of glycogen in liver and muscle

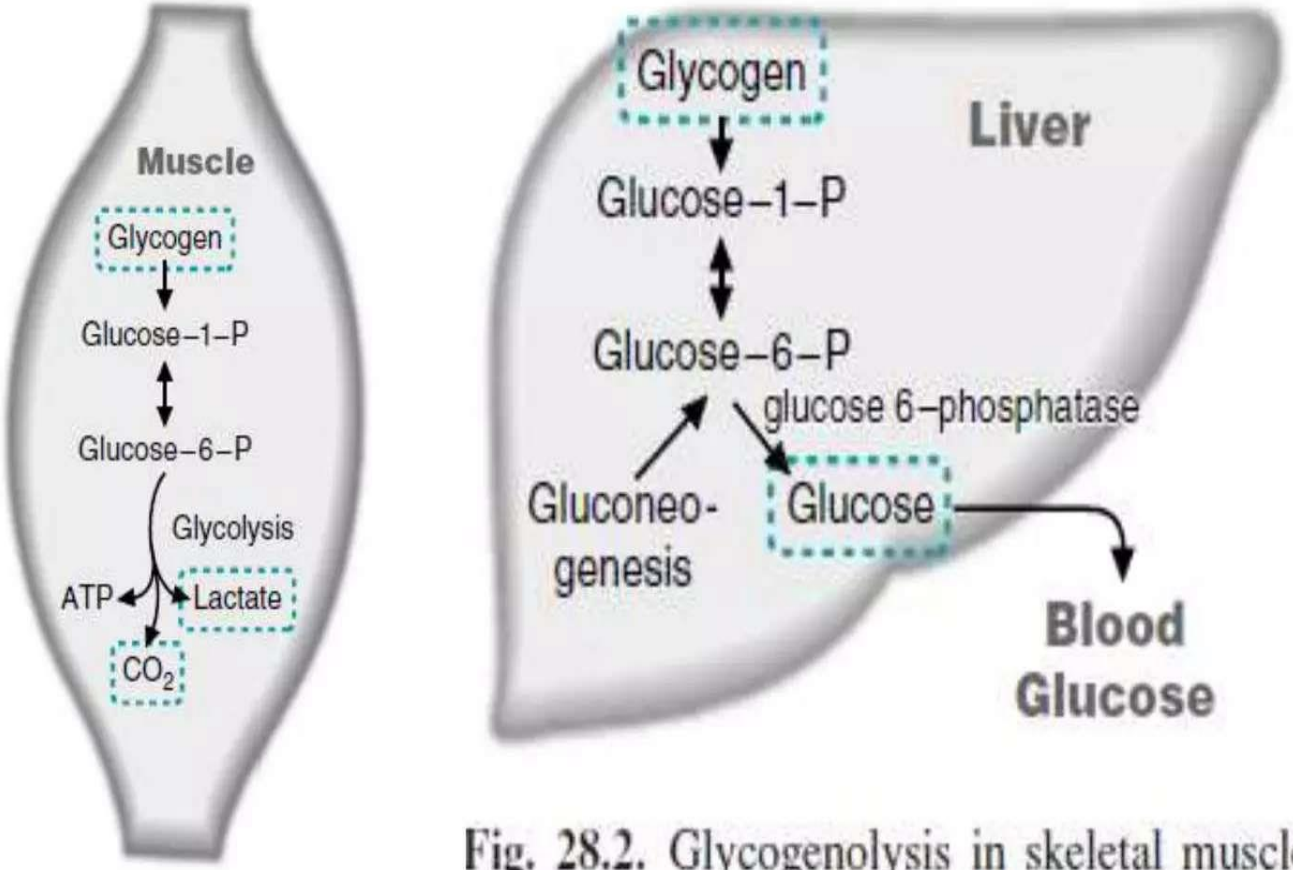


Fig. 28.2. Glycogenolysis in skeletal muscle

Regulation of glycogenesis

Glycogenesis is regulated by a number of factors, including:

- **Blood glucose levels**

  High blood glucose levels trigger glycogenesis, while low blood glucose levels inhibit it.

- **Hormones**

  Insulin stimulates glycogenesis, while glucagon and epinephrine inhibit it:

  ✓ Insulin: Activates glycogen synthase, which increases glycogen synthesis in the liver and muscle.

  ✓ Glucagon: Inhibits glycogen synthase and activates glycogen phosphorylase, which breaks down glycogen in the liver.

  ✓ Epinephrine: Activates glycogen breakdown in the liver and skeletal muscle.

- **Energy state of the cell**

  In skeletal muscle, AMP inhibits glycogenesis and triggers glycogenolysis.

- **Phosphorylation**

  The activity of glycogen synthase and glycogen phosphorylase is regulated by phosphorylation, which is controlled by enzymes under the control of hormonal activity.

- **Calcium ions and cAMP**

  These act as secondary messengers, which is an example of negative control in glycogenesis.