BIOCHEMISTRY

Glycogen metabolism

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Chapter Description

- Overview

  This chapter covers the synthesis and degradation of glycogen.

- Expected Outcomes

  You should be able to understand overall the metabolism of glycogen with minor overview on the complex regulation of glycogen metabolism.

- Other related Information

  Some relevant questions been provided for improving your understanding of the topic. You are expected to search for external sources for information to adequately answer the questions. All pictures and figures within this chapter categorized as creative commons for the purpose of education only.

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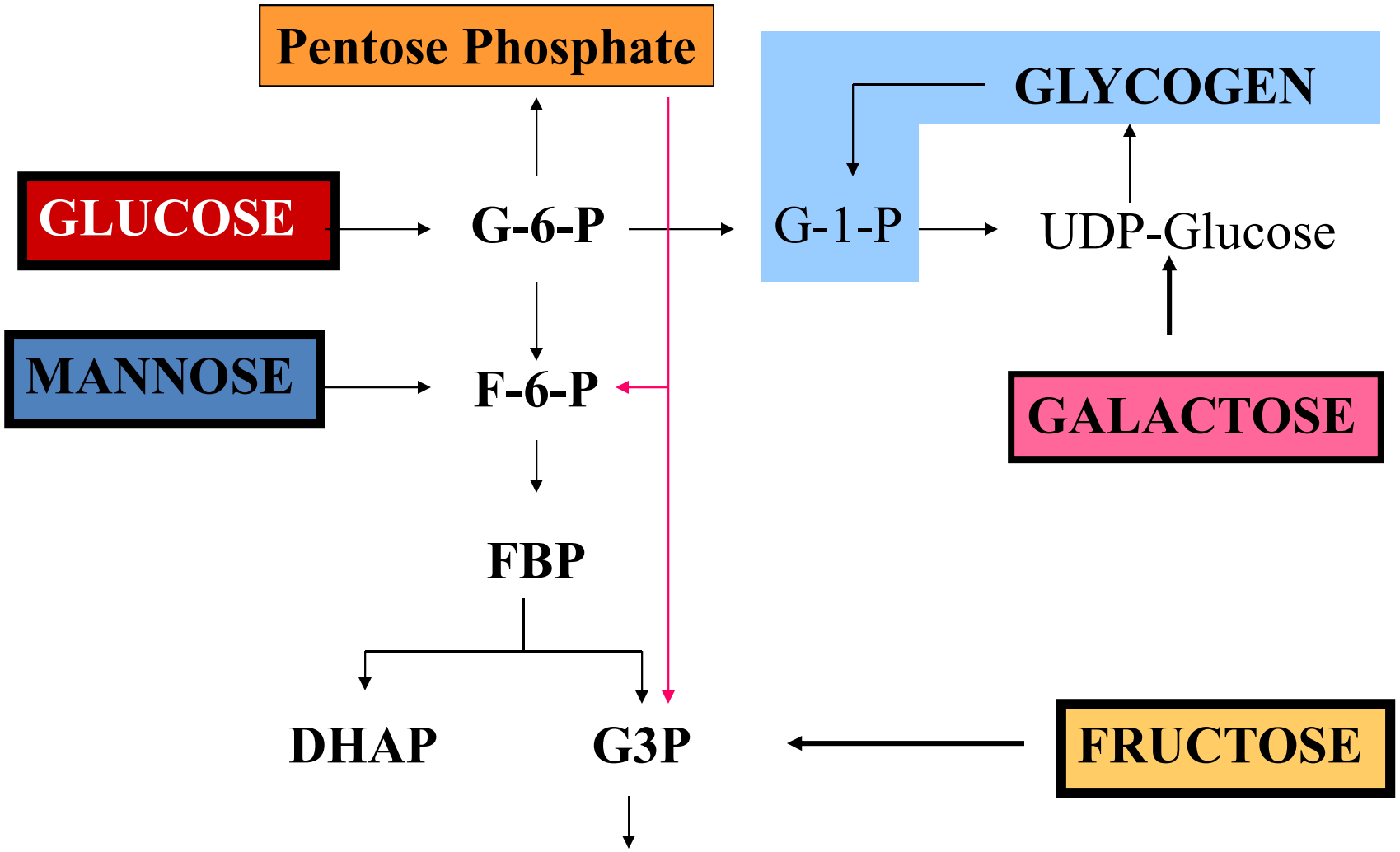
http://ocw.ump.edu.my/course/view.php?id=485

Anaerobic Energy Metabolism



GLYCOGEN SYNTHESIS

- ACTIVATION OF D-GLUCOSE
- GLYCOSYL TRANSFER
- BRANCHING

GLYCOGEN SYNTHESIS ENZYMES

- UDP-glucose pyrophosphorylase
  - forms UDP-glucose
- Glycogen Synthase
  - major polymerizing enzyme
- Amylo-(1,4-1,6)-transglycosylase
  - forms branches

ACTIVATION

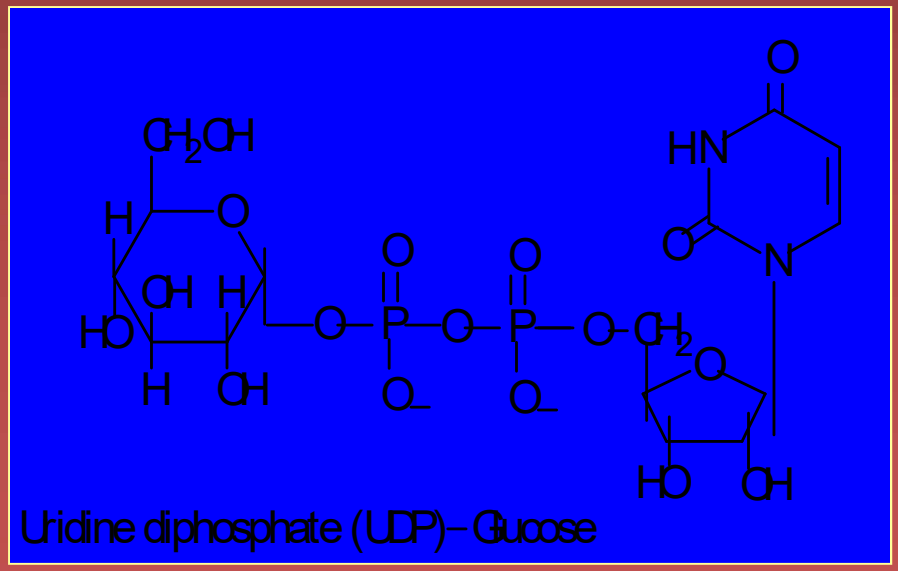
UDP-GLUCOSE

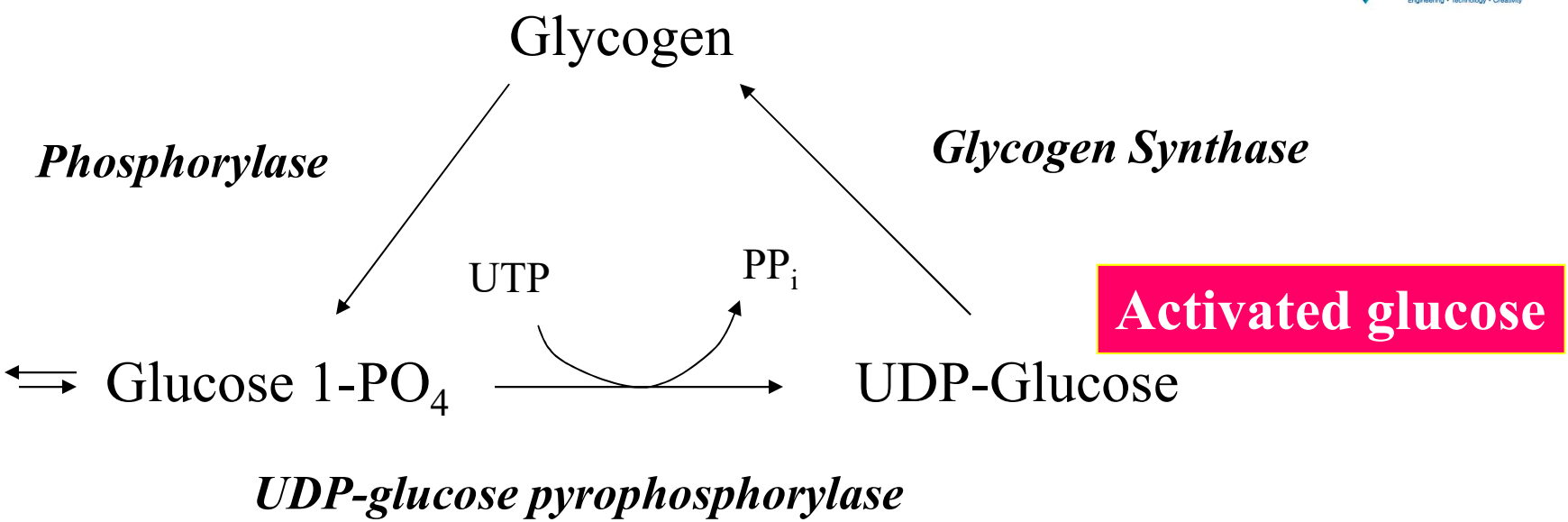
G-1-P + UTP ⟶ UDP-GLUCOSE + PPi

UDP-Glucose pyrophosphorylase

↓

2 Pi





$\Delta G^{o'}$(kJ mol^{-1})

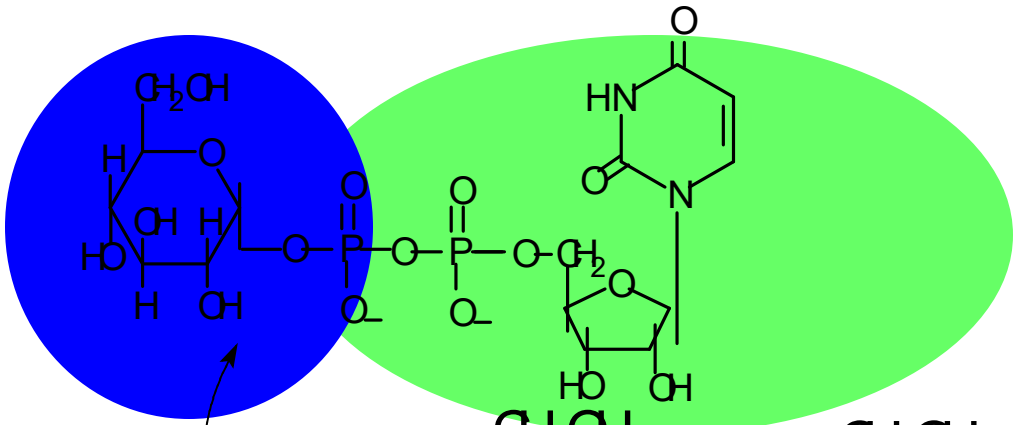
$$\text{Glucose 1-PO}_4 + \text{UTP} \rightleftharpoons \text{UDP-Glucose} + \text{PP}_i \qquad \sim 0$$

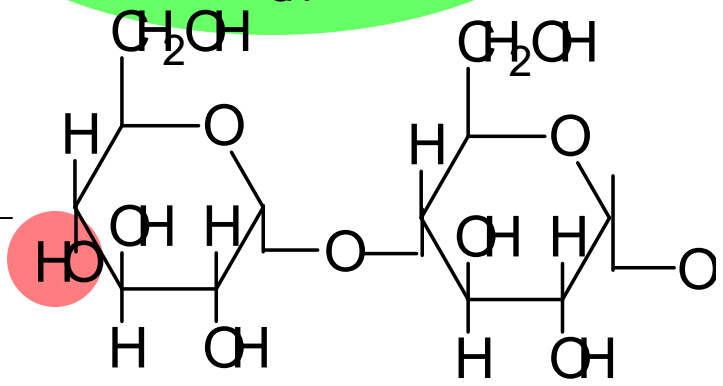
$$\text{H}_2\text{O} + \text{PP}_i \rightarrow 2\ \text{P}_i \qquad -33.5$$

$$\text{Glucose 1-PO}_4 + \text{UTP} + \text{H}_2\text{O} \rightarrow \text{UDP-Glucose} + 2\ \text{P}_i \qquad -33.5$$

The hydrolysis of pyrophosphate drives this reaction

GLYCOSYL TRANSFER

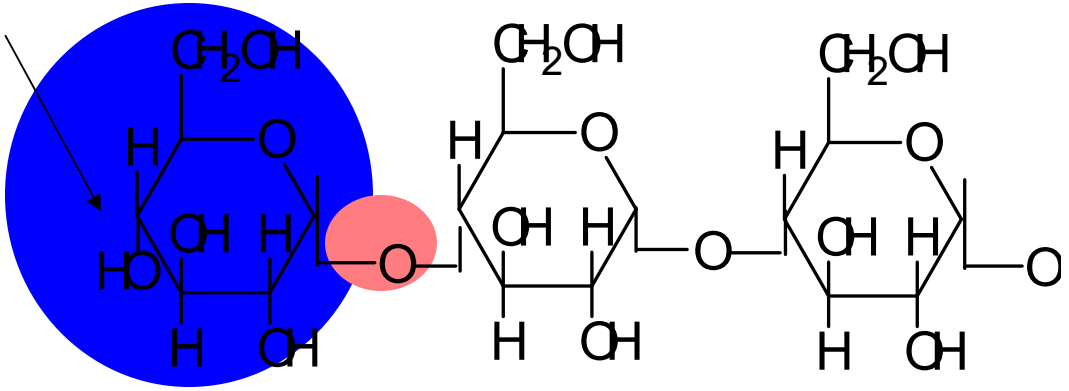




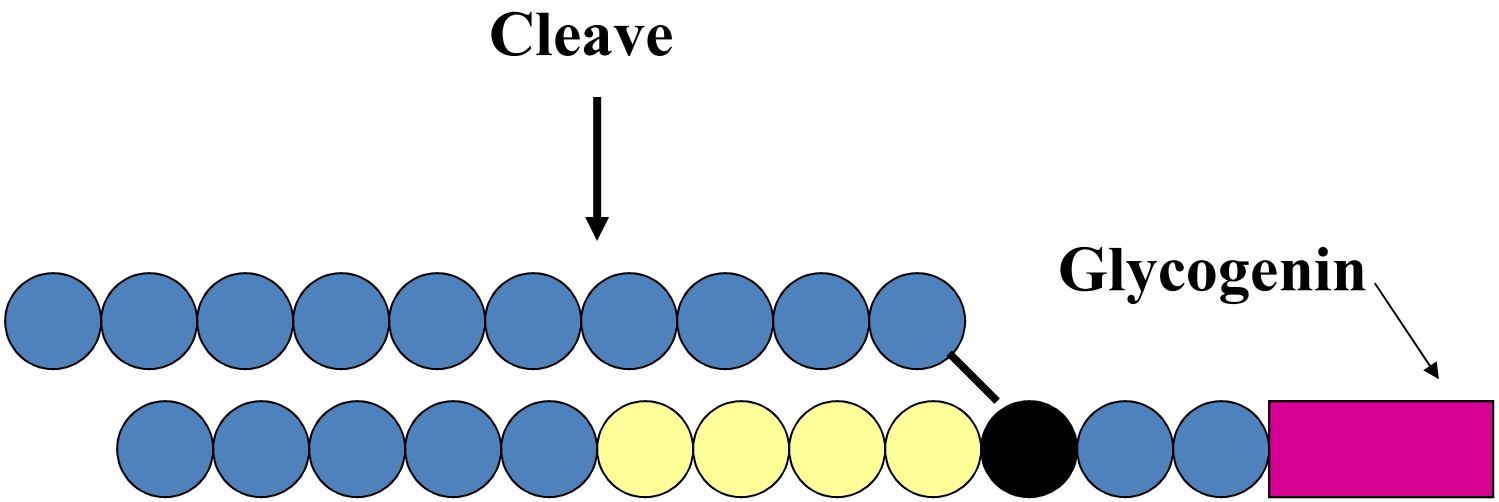
UDP

NON-REDUCING END

NEW



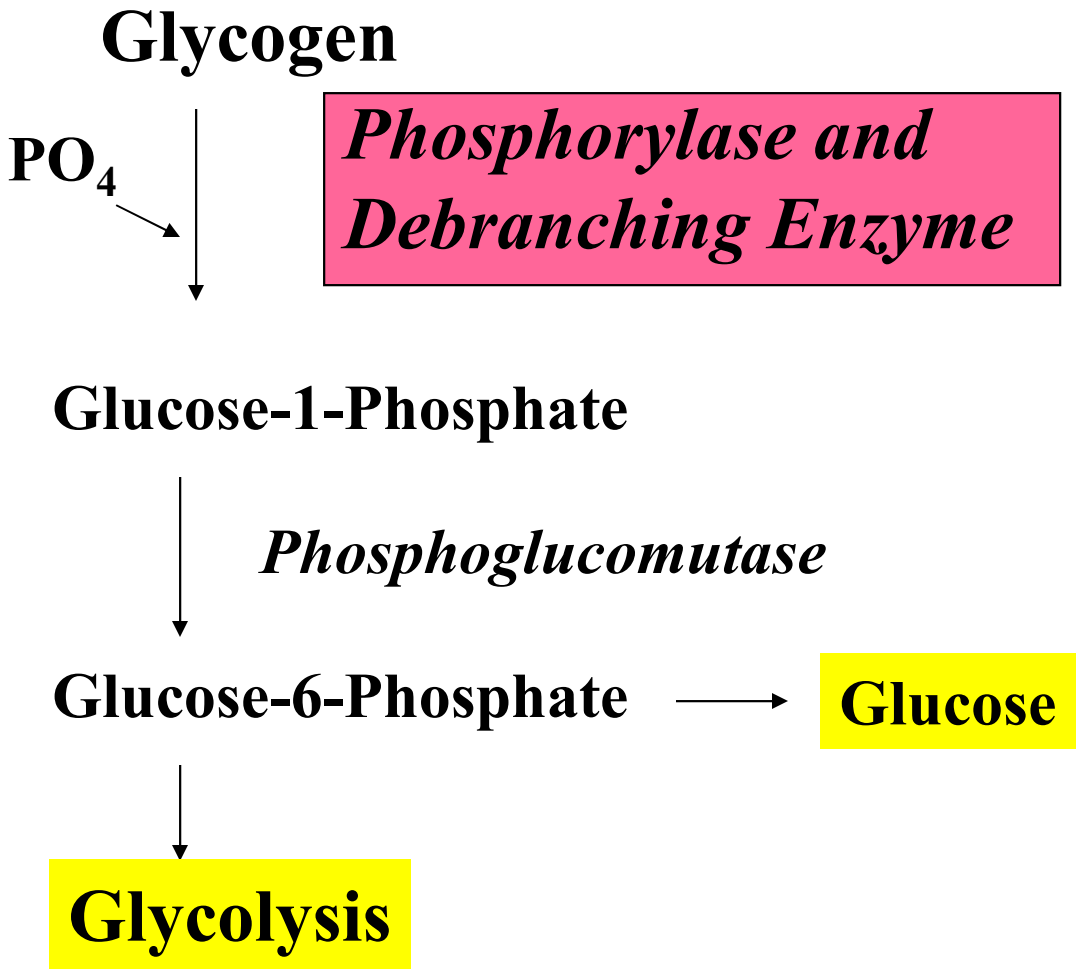
BRANCHING



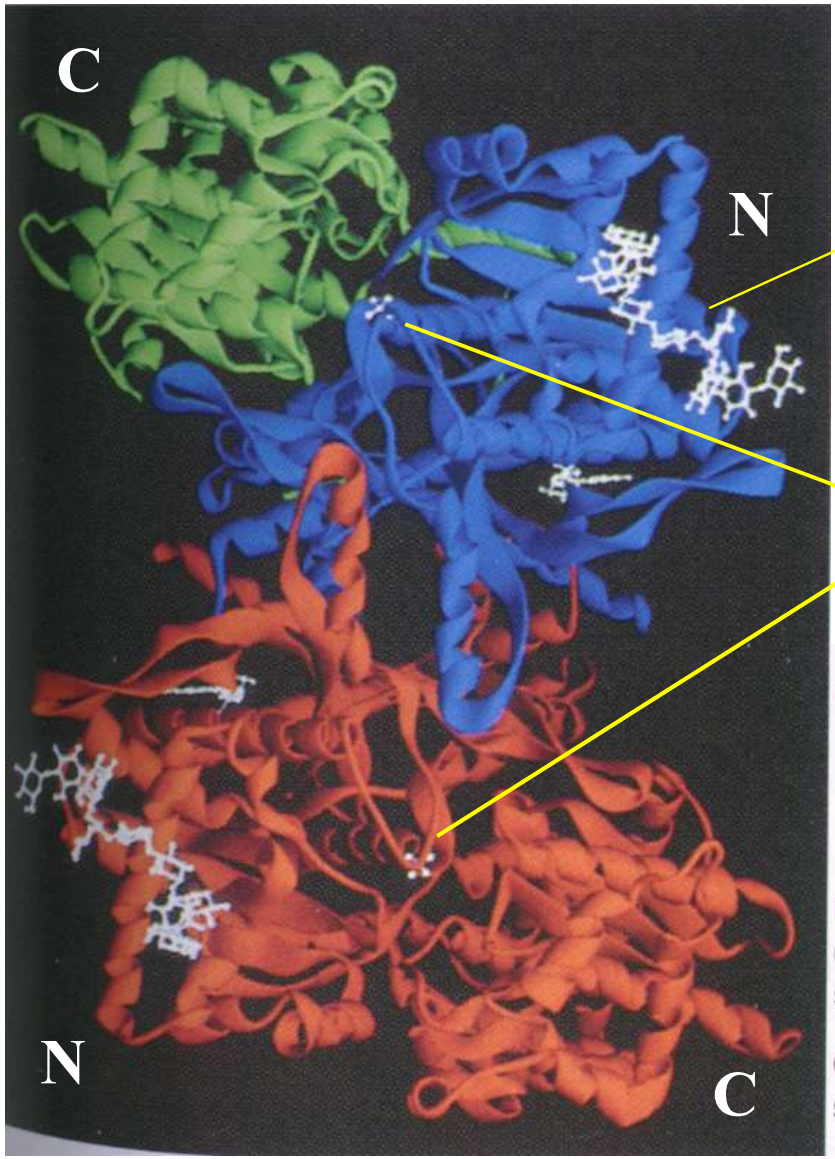
Amylo-(1,4 →1,6)-transglycosylase

Branching Enzyme

Glycogen Breakdown



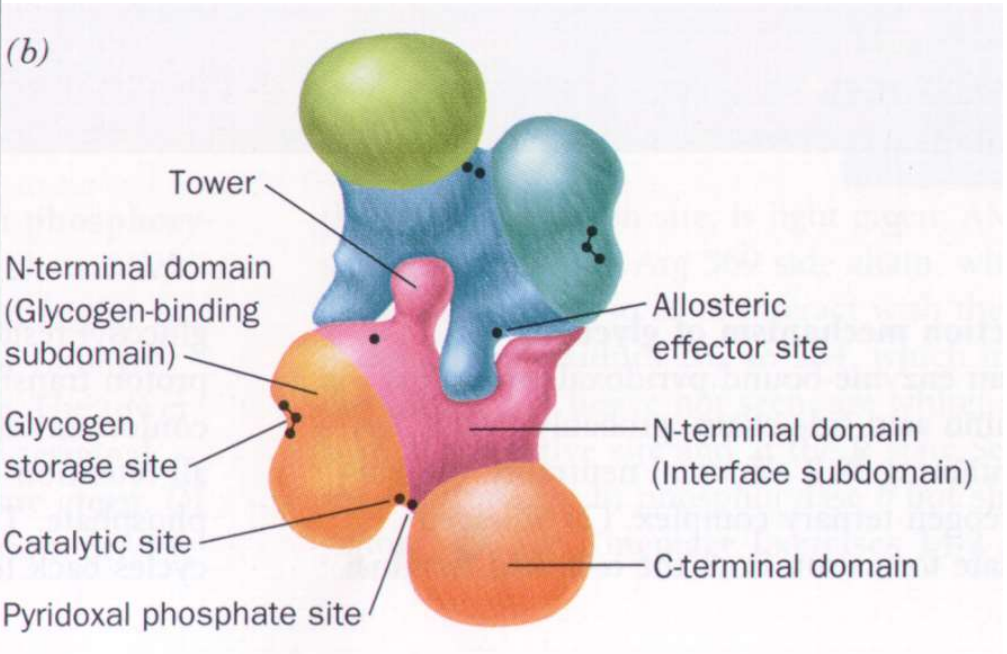
Take home: Glycogen contributes glucose to glycolysis and to blood glucose (Liver)



Glycogen Storage Site

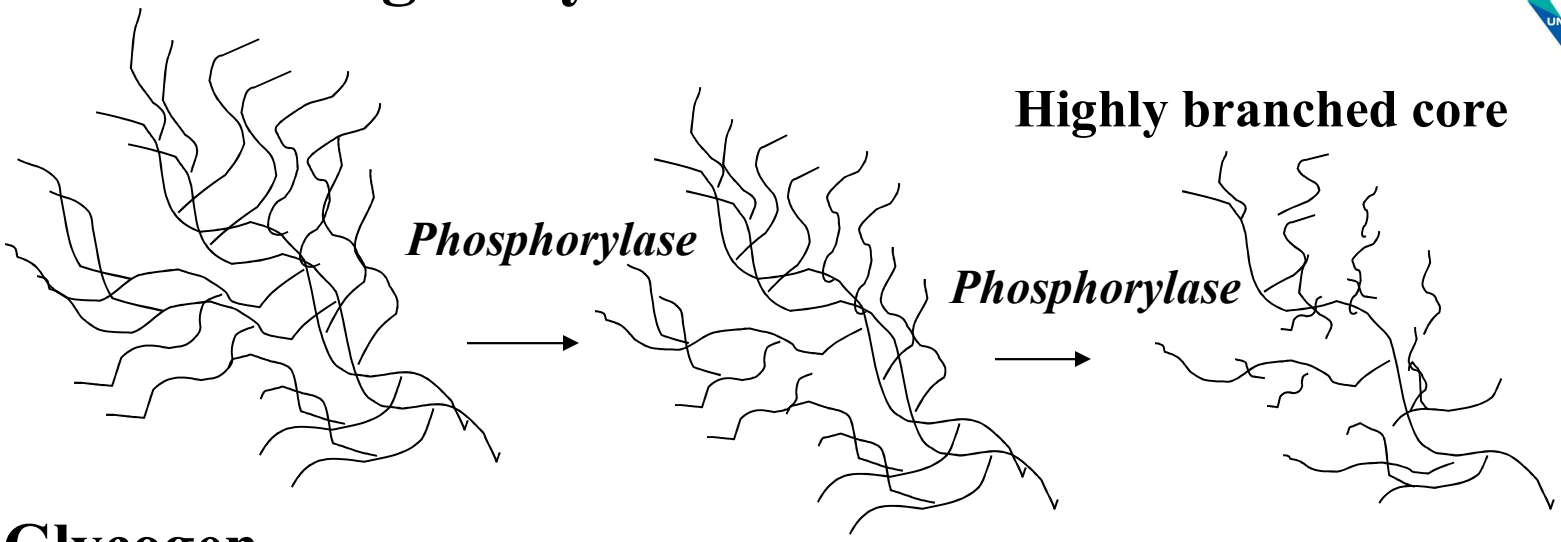
Can accommodate on 4-5 sugars

Pyridoxal 5'-PO_4 at active sites

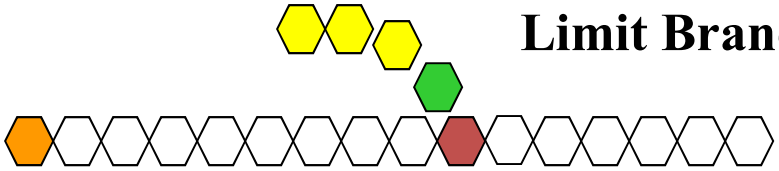


Glycogen Phosphorylase

Debranching Enzyme

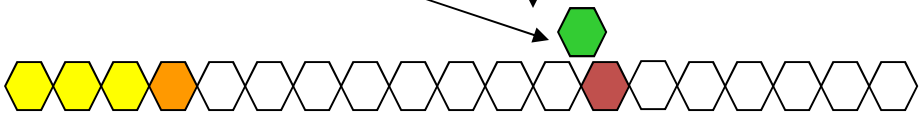


Glycogen



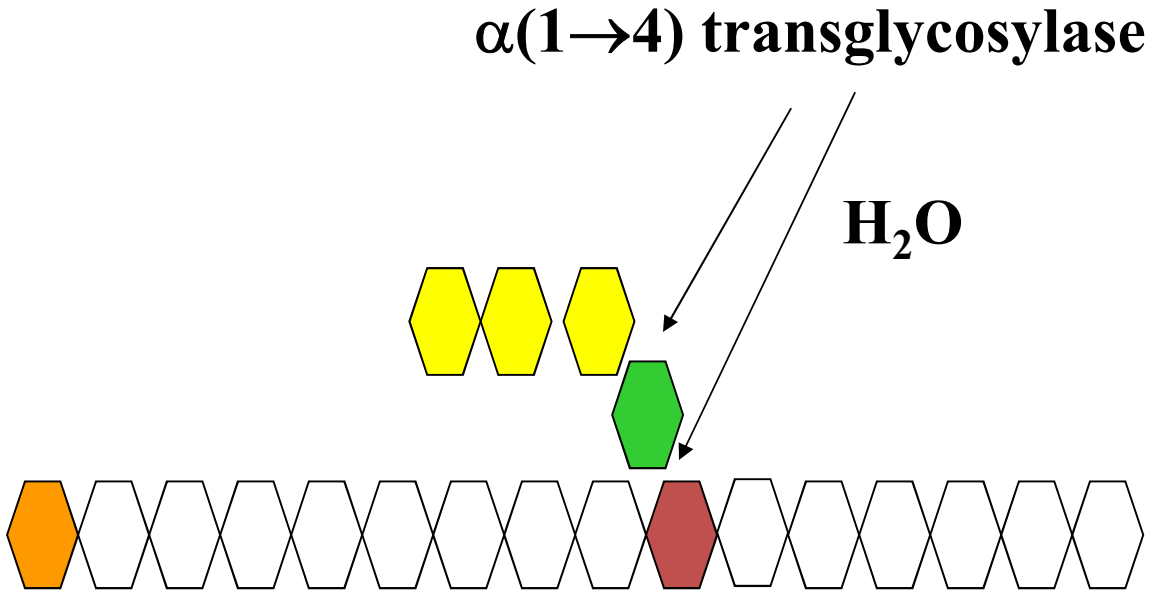
Limit Branch

α(1→4) transglycosylase



D-glucose

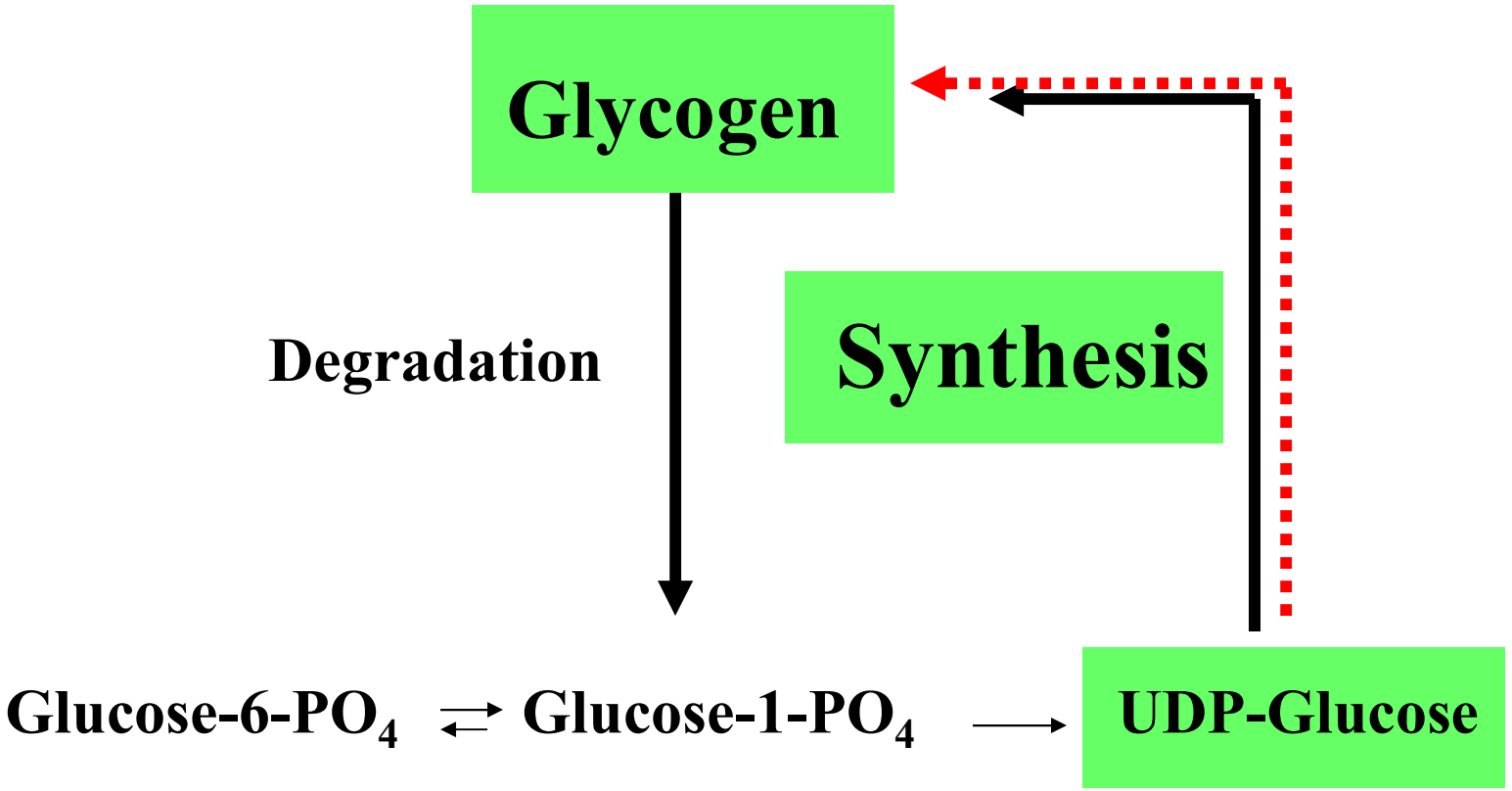
Debranching Enzyme



Straight Chain

D-glucose

Glycogen Synthesis



Regulation of Glycogen Metabolism

- Protein Kinases
- Protein Phosphatases
- cAMP
- G proteins
- Calcitonin
- Insulin, glucagon, and epinephrine

Basics of Metabolic Homeostasis

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***Rule*: A shift away from a dynamic steady-state evokes factors to restore the steady-state.**

***Rule*: Restoring steady-state requires modulating the activity of a rate-controlling enzyme(s) in the pathway**

Enzyme activity can be modulated by:

1. **Covalent modification**
2. **Changes in pathway [S] or enzyme cofactors**
3. **Allosterism (Vmax or Km)**
4. **Hormonal intervention**
5. **Enzyme turnover**

References:

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Biochemistry, 4th Edition	Donald Voet and Judith C	Wiley and Co	2011
Google with keyword of biochemistr	Various Online Biochemi	various	
Concepts in Biochemistry, 2nd ed	Boyer, R	Brooks/Cole/Thomsc	2002