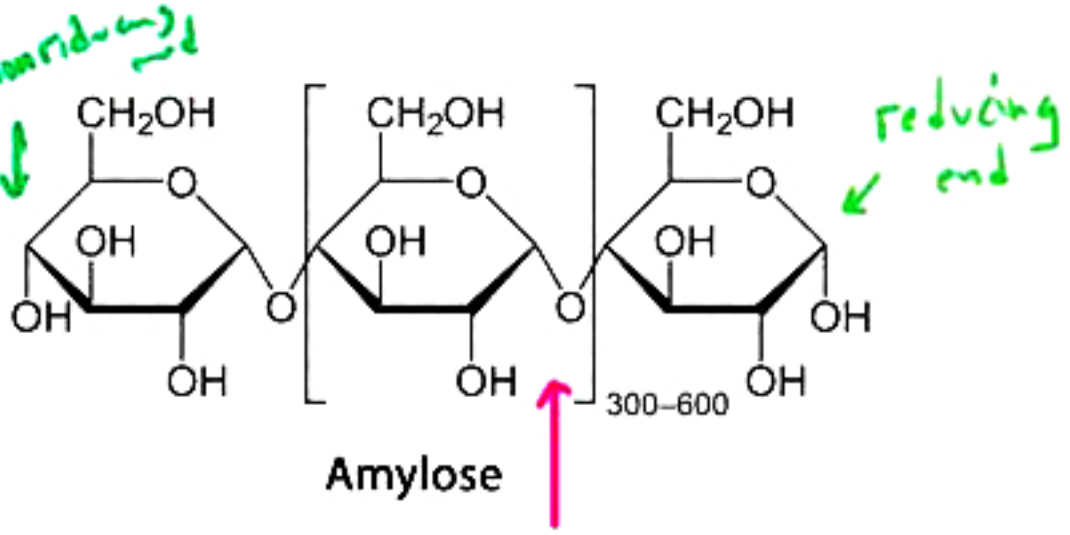
Module 12

Glycogen Metabolism

Session Slides with Notes

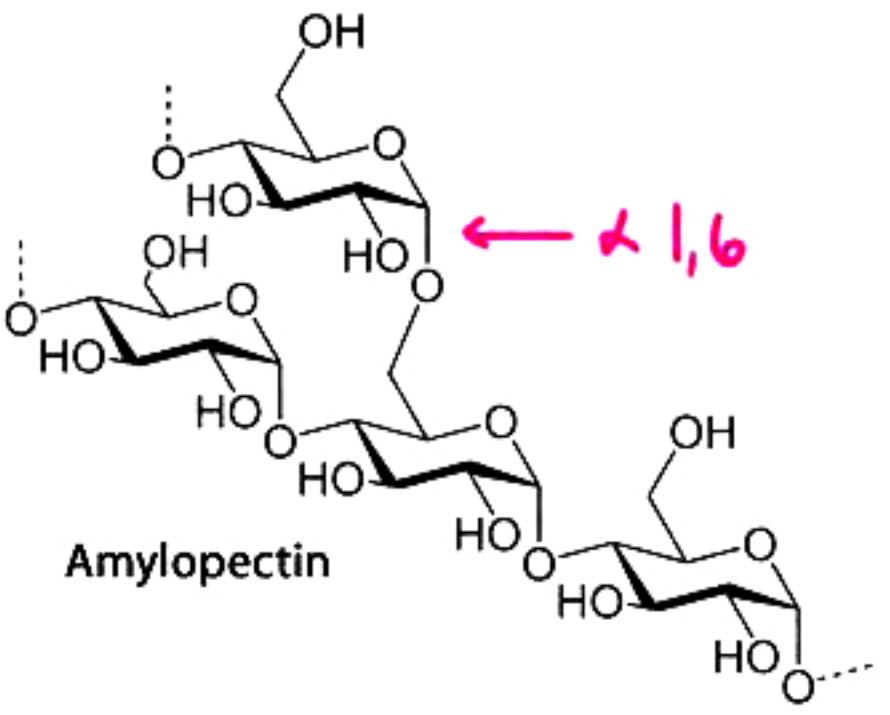


Amylose

reducing end

α 1,4

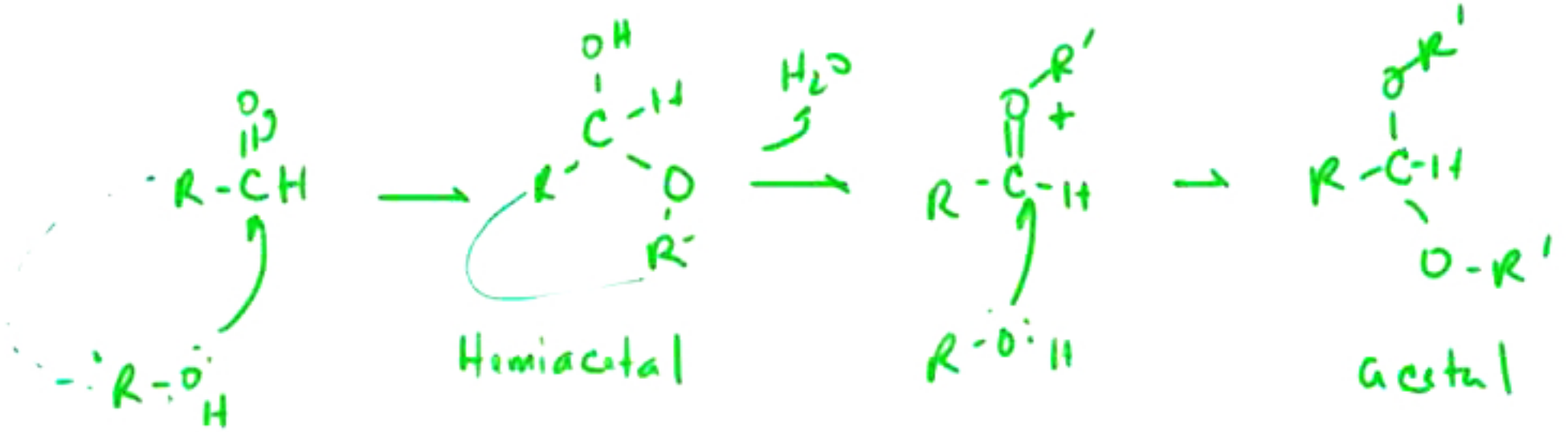
like glycogen



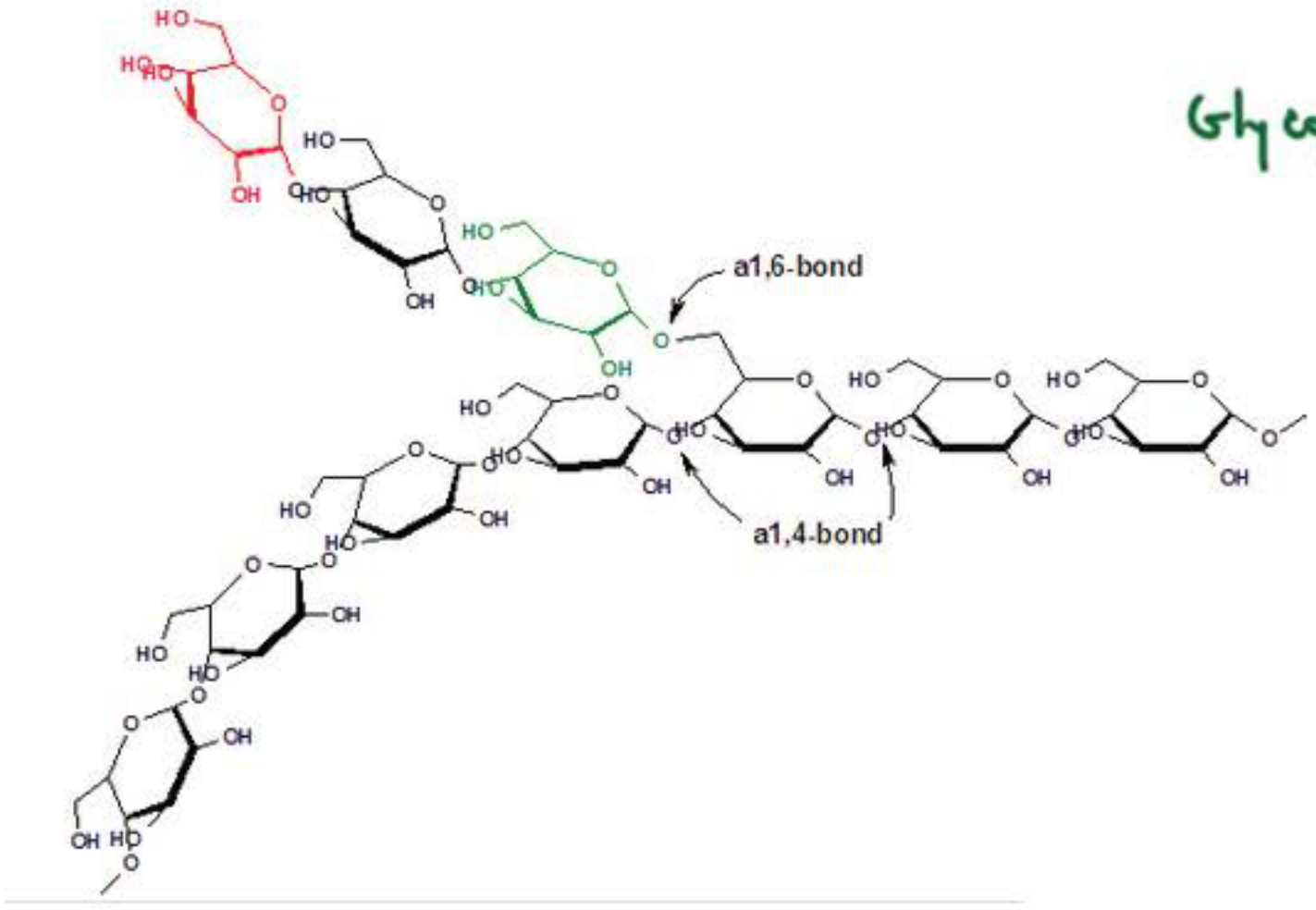
Amylopectin

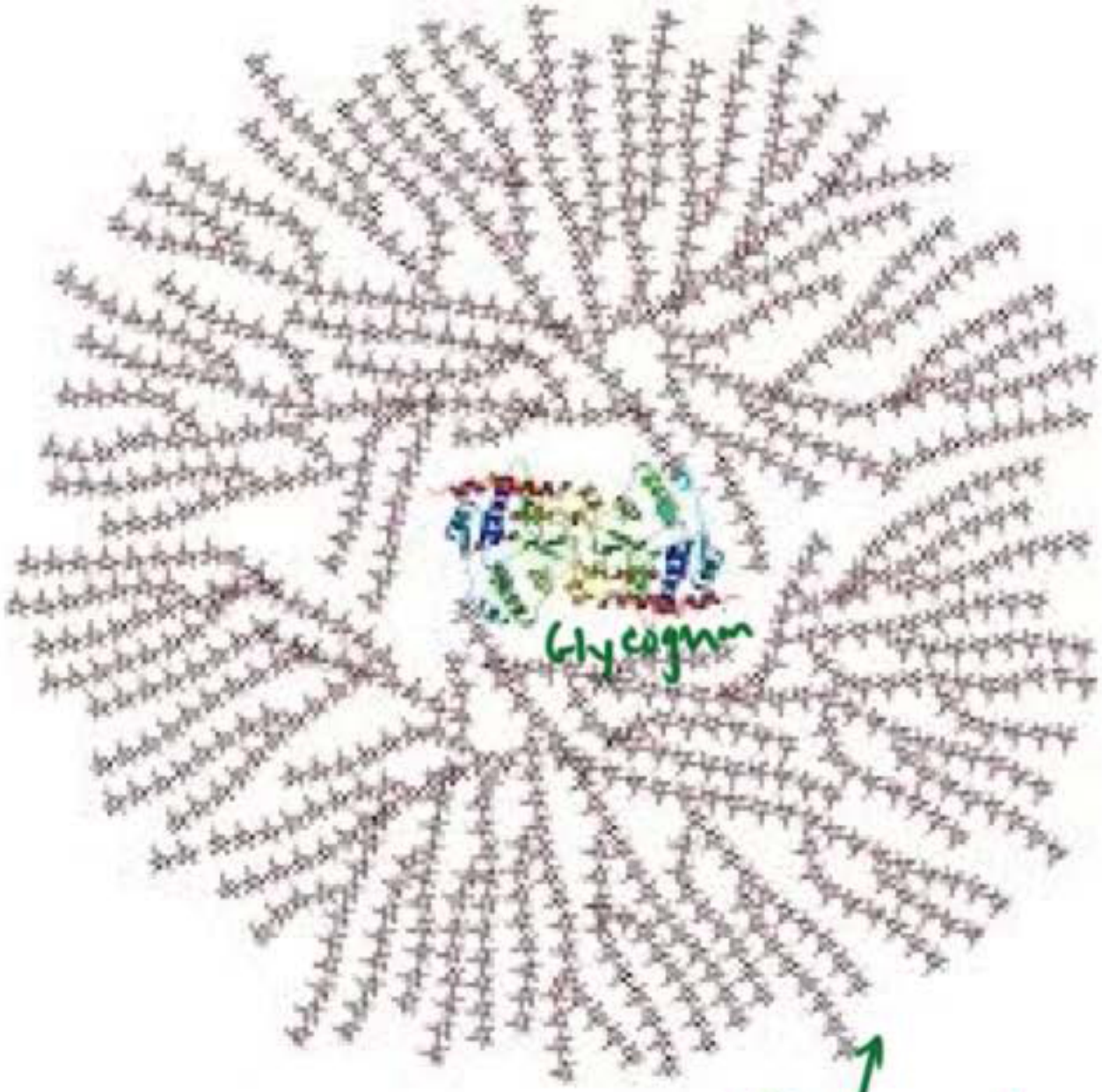
α 1,6

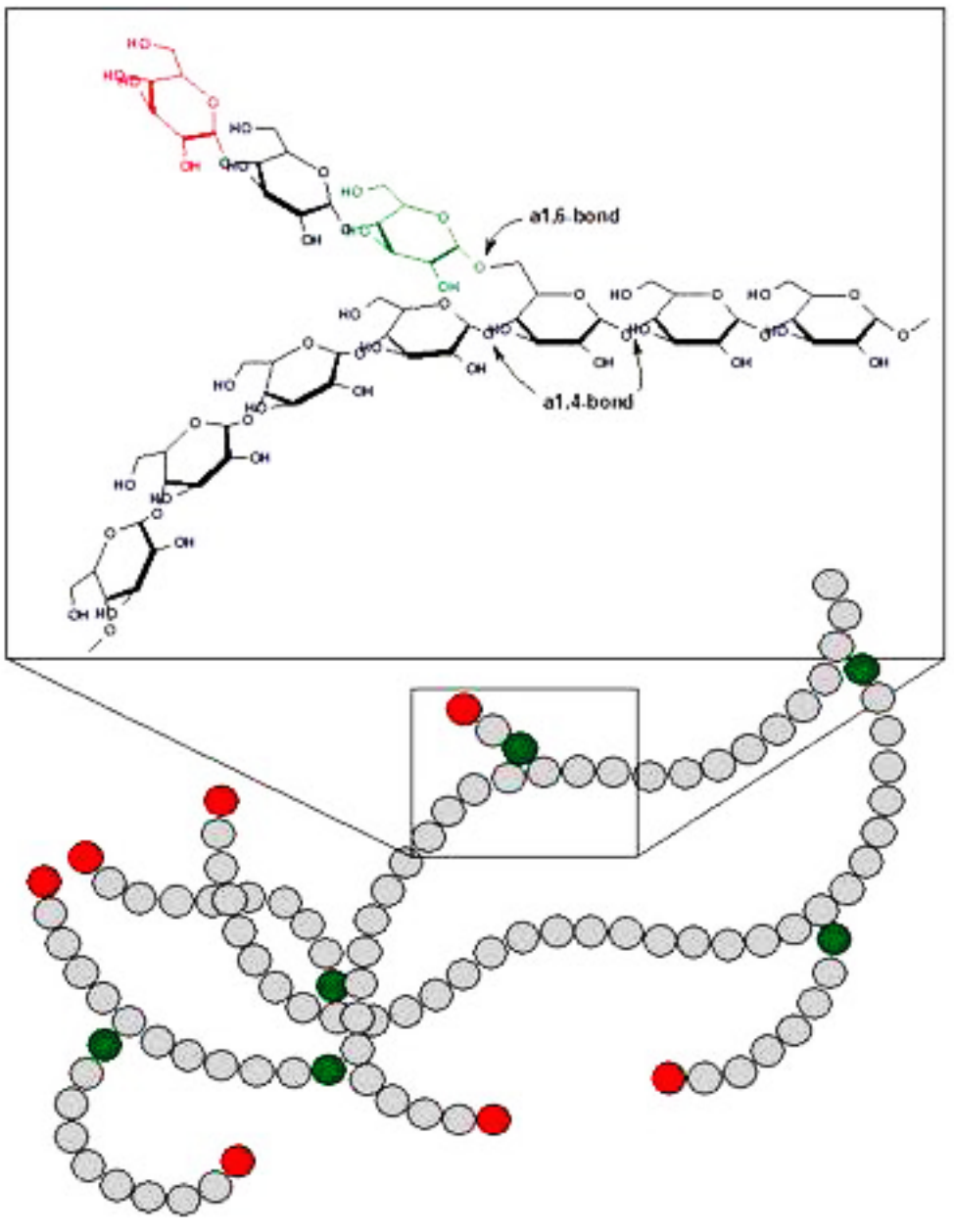
plant starch.s

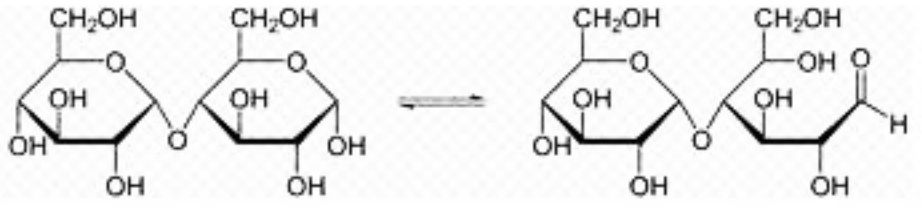


Glycogen

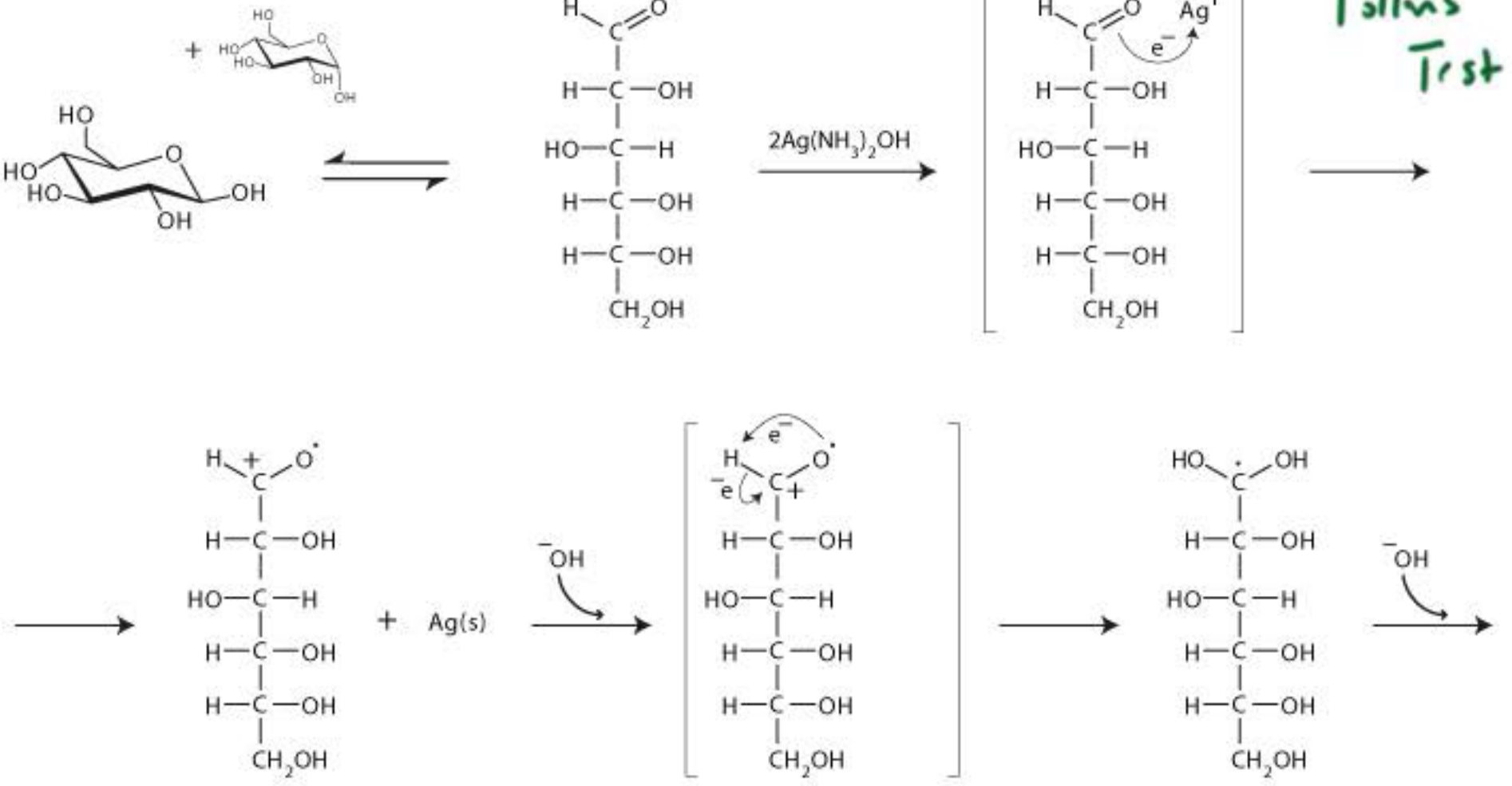



Liver
and
Muscle
Glycogen
nonreducing
ends

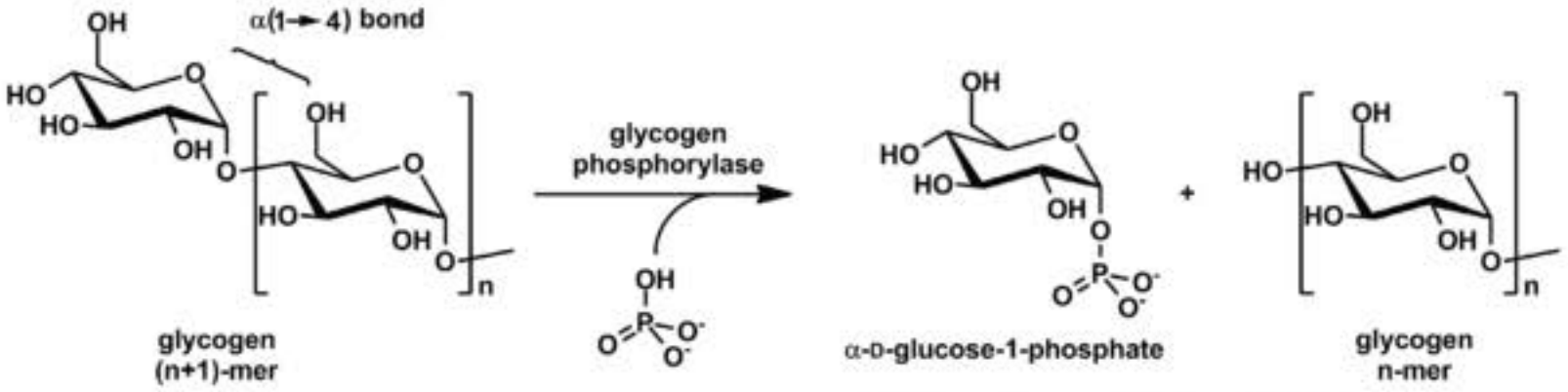

a1,6-bond
a1,4-bond



Tollens Test



Glycogen Phosphorylase (multisubunit allostric enzyme



Glucose 1 Phosphate → (phosphoglucomutase) → glucose 6 phosphate → (glucose 6 phosphatase) → glucose

- also debranching enzyme and transferase

ΔG° is ⊕

$\Delta G = \Delta G^\circ + 2.3RT \log Q$

$\ominus \quad \oplus \quad \ominus$

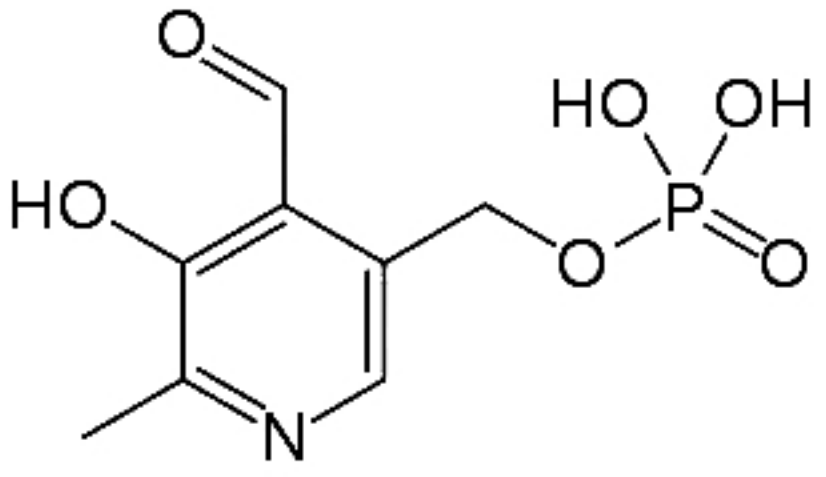
$\Delta G = \Delta G^\circ + RT \ln Q$

$\ln X \leftarrow$ natural logarithm (base e)

$\log X \leftarrow$ common logarithm (base 10)

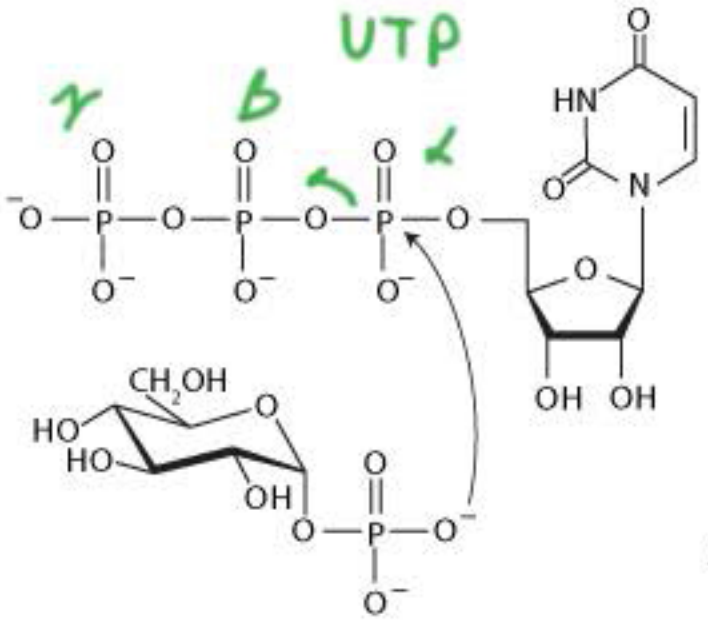
at physiology $Q = \frac{[G1P]}{[P_i]} \sim \frac{1}{1000}$

PLP

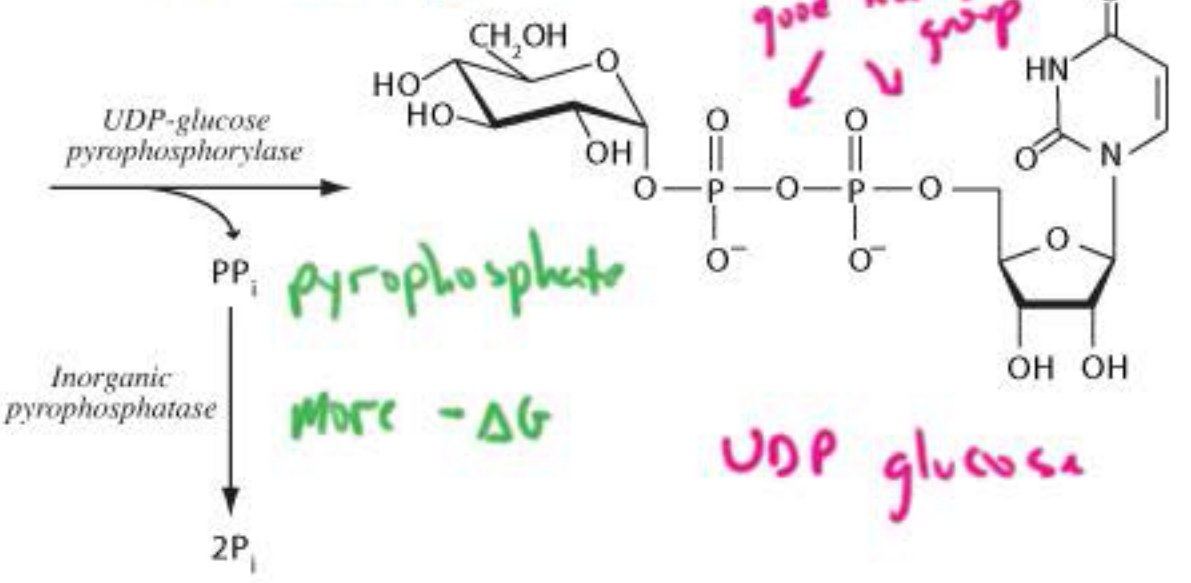


$$\text{glycogen}_{(\text{n residues})} + P_i \rightleftharpoons \text{glycogen}_{(\text{n-1 residues})} + \text{glucose-1-phosphate}$$

Glycogen Synthesis starts with activation of glucose as UDP glucose



Glucose 1 Phosphate
(Cori ester)

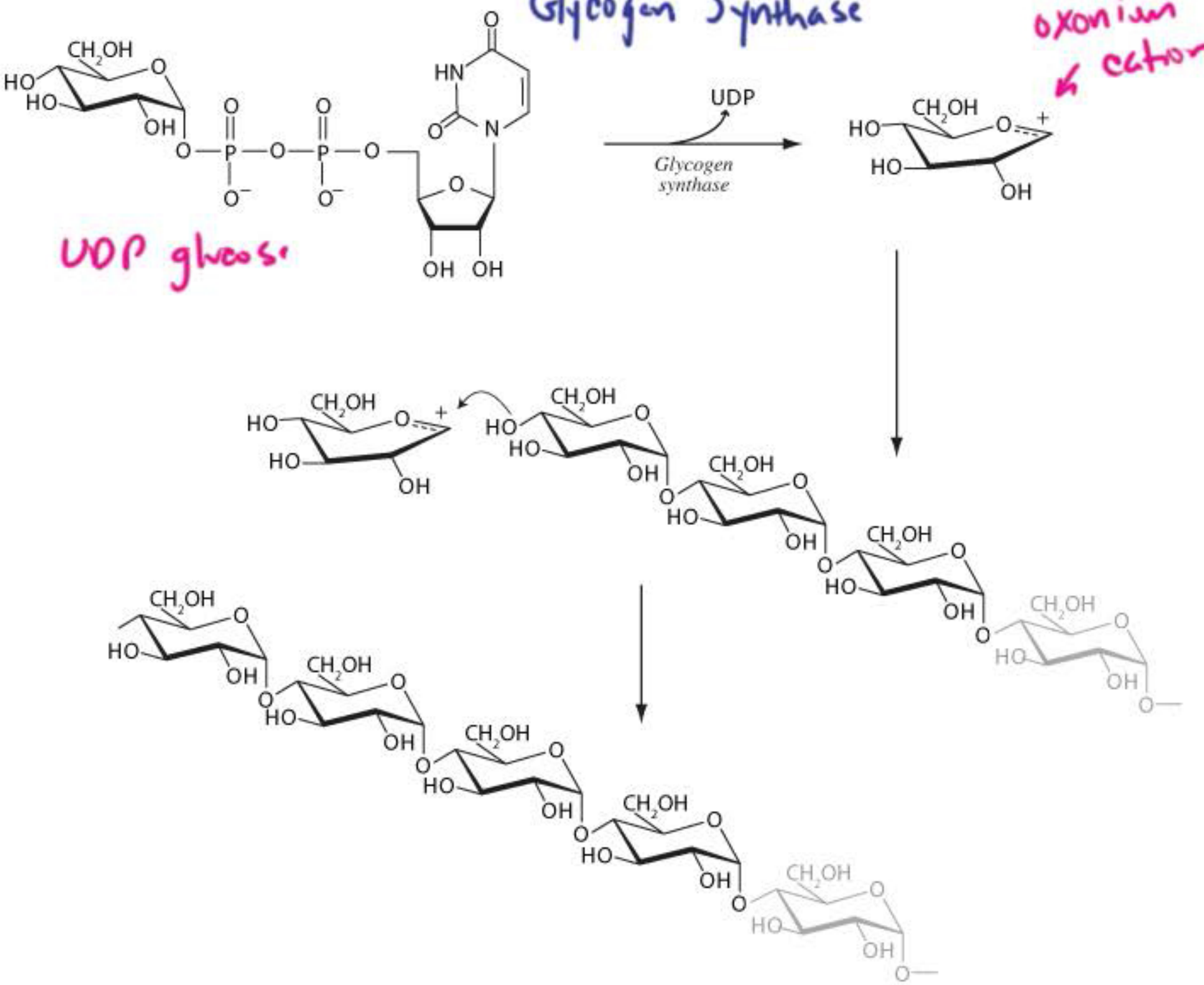


UDP glucose

Glycogen Synthase

oxonium cation

UDP glucose



Covalent modification by kinase

phosphorylase kinase

Phosphorylase b → **Phosphorylase a**

R State — OFF

2 ATP → 2 ADP

PP1

protein phosphatase

T State — Really OFF

2 ATP → 2 ADP

PP1

Really ON (g protein coupled receptor)

ON

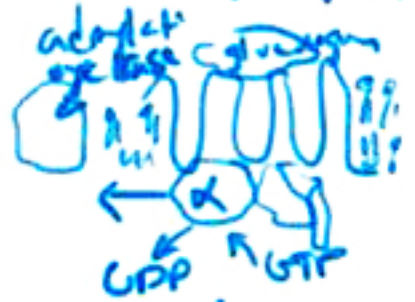
○ = active site

● = phosphorylation

allosteric regulation

AMP ↑

GCP ↓



glucagon

↓

GPCR

↓

α subunit activate adenylate cyclase

↓

2nd messenger → cAMP

↓

Protein Kinase A

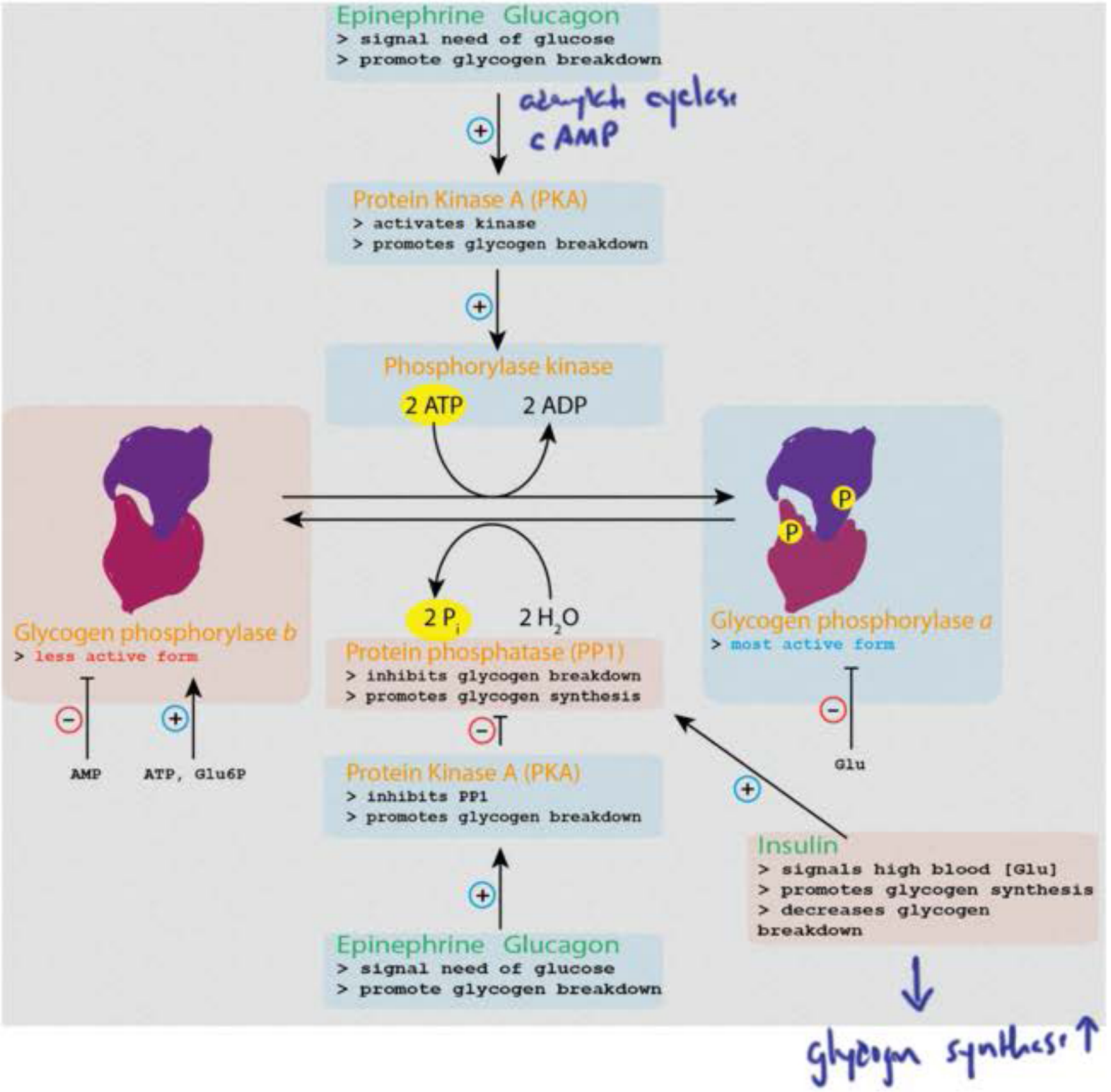
↓ pyruvate dehydrogenase

protein phosphatase ↓

phosphorylase kinase ↑

transcription factor for PEP carboxykinase ↑

(etc.)


Epinephrine Glucagon
> signal need of glucose
> promote glycogen breakdown
adenylate cyclase
cAMP
Protein Kinase A (PKA)
> activates kinase
> promotes glycogen breakdown
Phosphorylase kinase
2 ATP
2 ADP
Glycogen phosphorylase b
> less active form
AMP
ATP, Glu6P
2 Pi
2 H2O
Protein phosphatase (PP1)
> inhibits glycogen breakdown
> promotes glycogen synthesis
Protein Kinase A (PKA)
> inhibits PP1
> promotes glycogen breakdown
Epinephrine Glucagon
> signal need of glucose
> promote glycogen breakdown
P
P
Glycogen phosphorylase a
> most active form
Glu
Insulin
> signals high blood [Glu]
> promotes glycogen synthesis
> decreases glycogen breakdown
glycogen synthesis ↑

Glycogen
Synthase