

**ANSC/FSTC 607**  
**Physiology and Biochemistry of Muscle as a Food**  
**GLYCOGEN METABOLISM**

## I. Distribution of glycogen

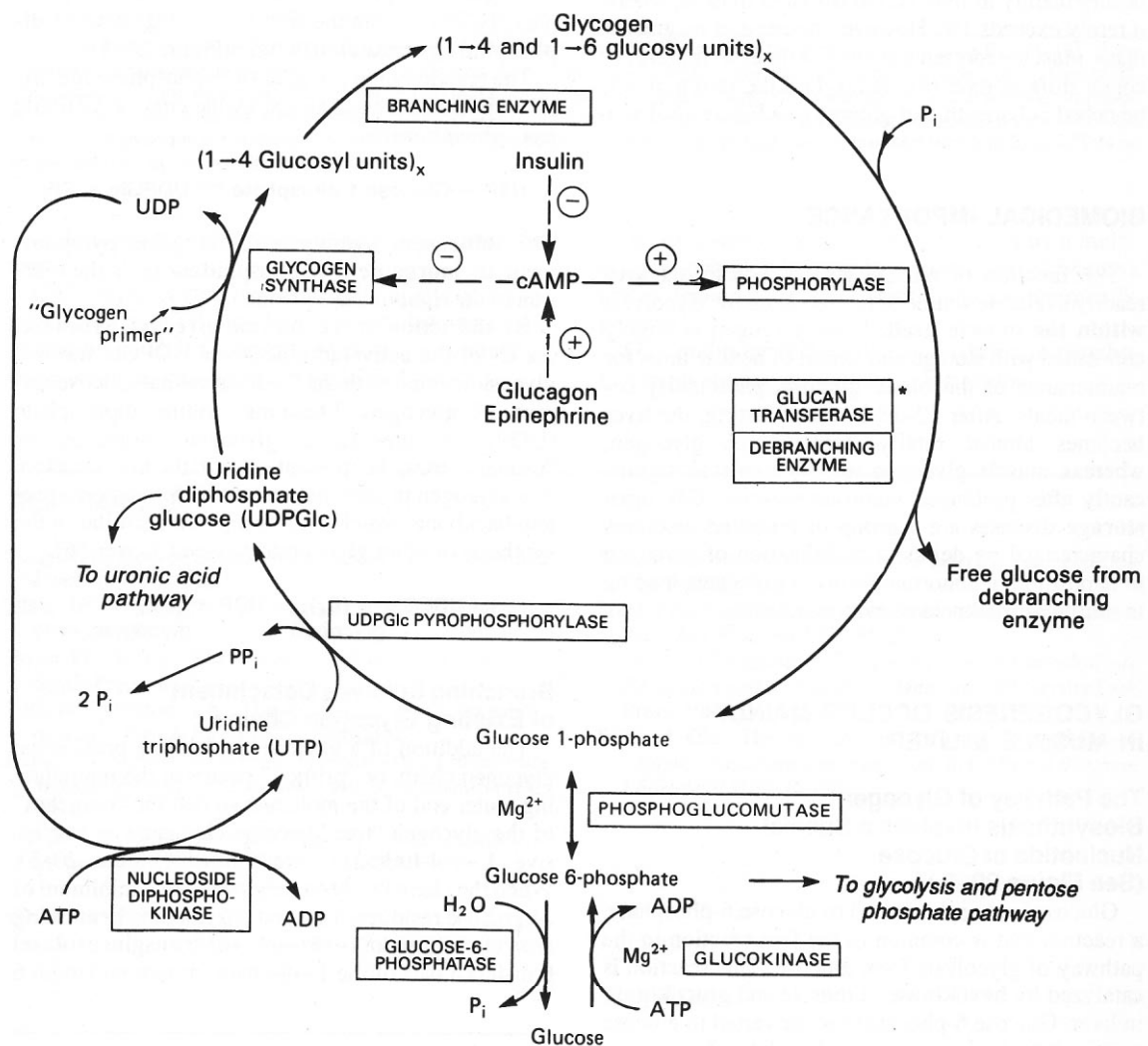
### A. Liver

1. Contains up to 6% glycogen.
2. Provides glucose for systemic metabolism.

### B. Muscle

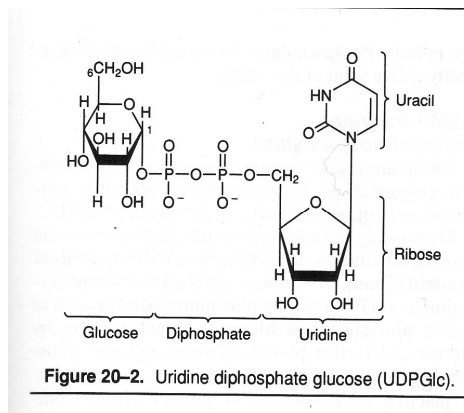
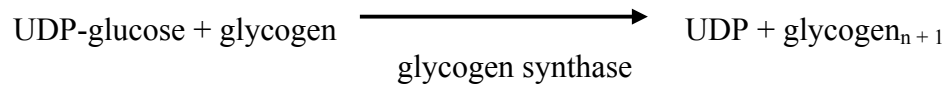
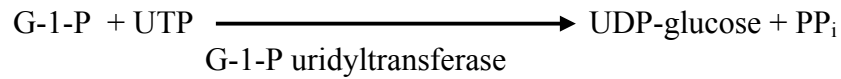
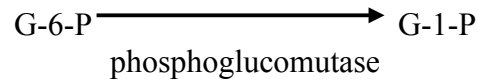
1. Rarely exceeds 1% (very consistent).
2. Because of muscle mass, muscle contains three to four times as much glycogen as liver.

## II. Overview of glycogen metabolism



### III. Glycogen synthesis

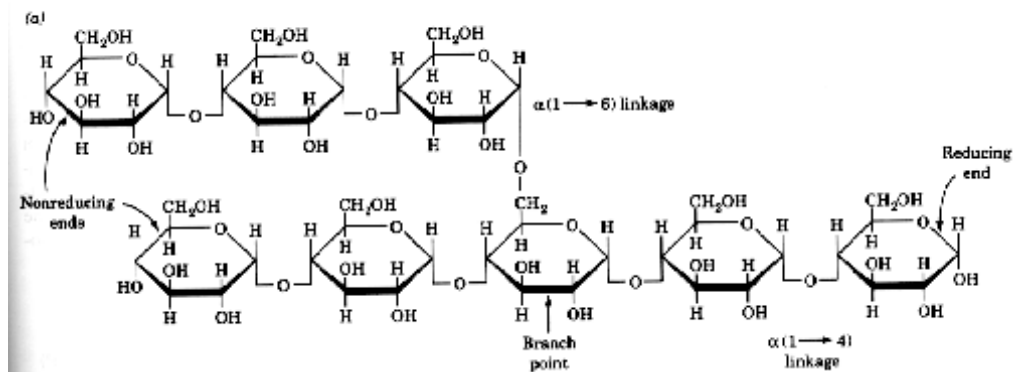
#### A. Reactions



#### B. Glycogen branching

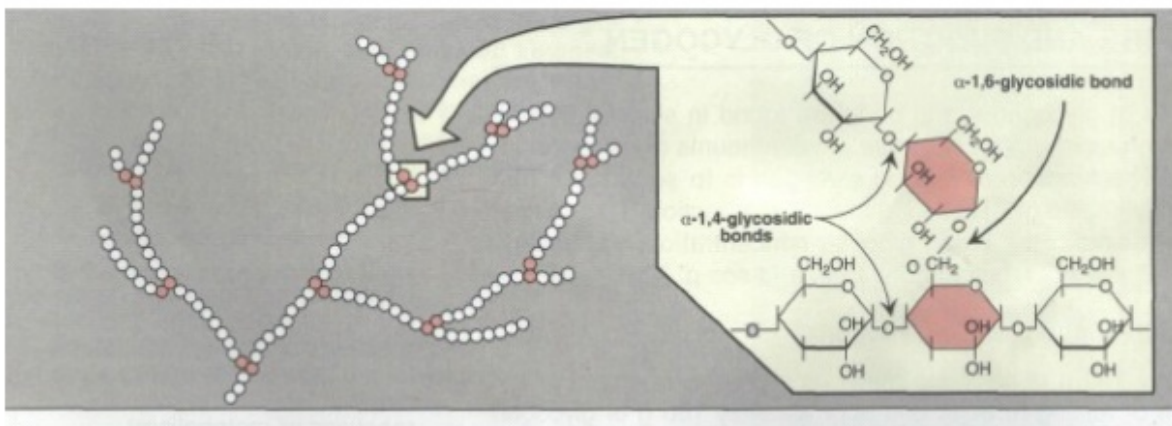
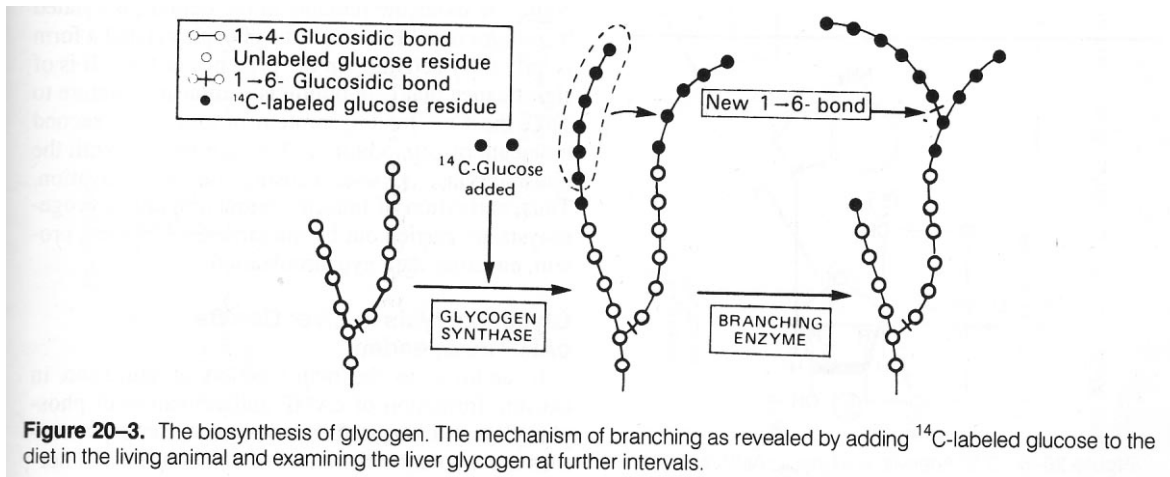
##### 1. Structure of glycogen

- Backbone consists of  $\alpha$ -1,4 glycosidic linkages.
- Branchpoints consist of  $\alpha$ -1,6 glycosidic linkages.



## 2. Mechanism of branching

- 11  $\alpha$ -1,4 glycoside residues are added to a chain.
- The terminal six residues are transferred to an adjacent chain in a  $\alpha$ -1,6 glycosidic linkage.



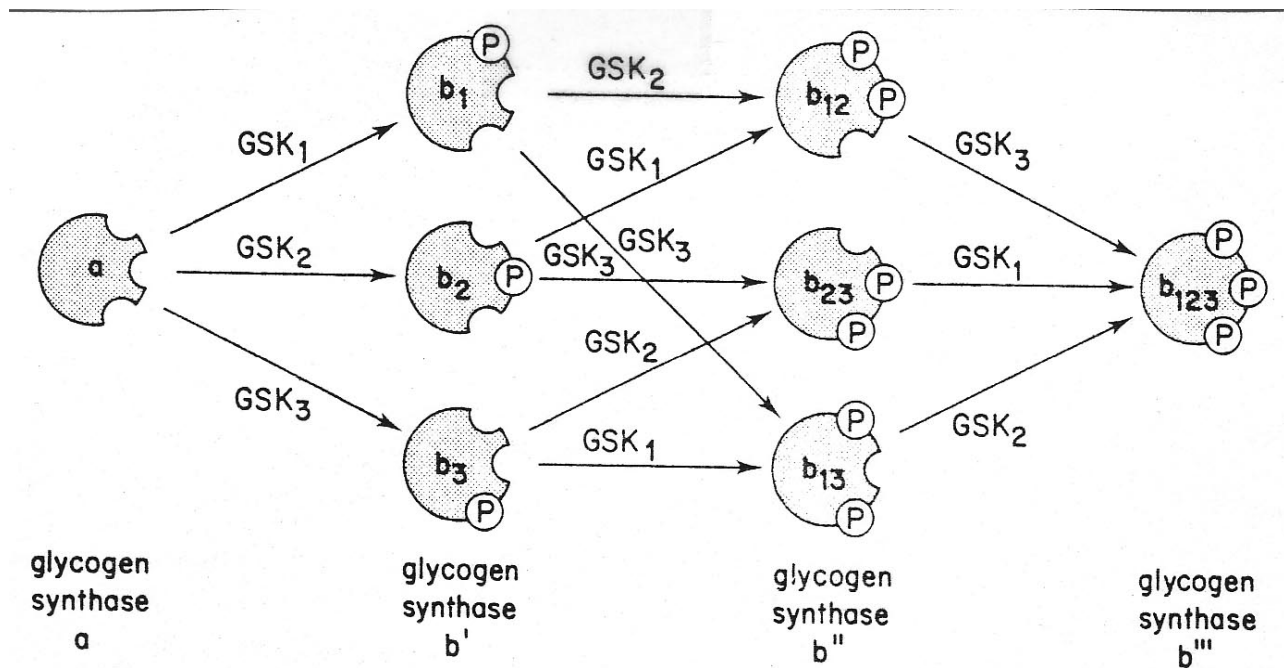
## C. Regulation of glycogen synthesis

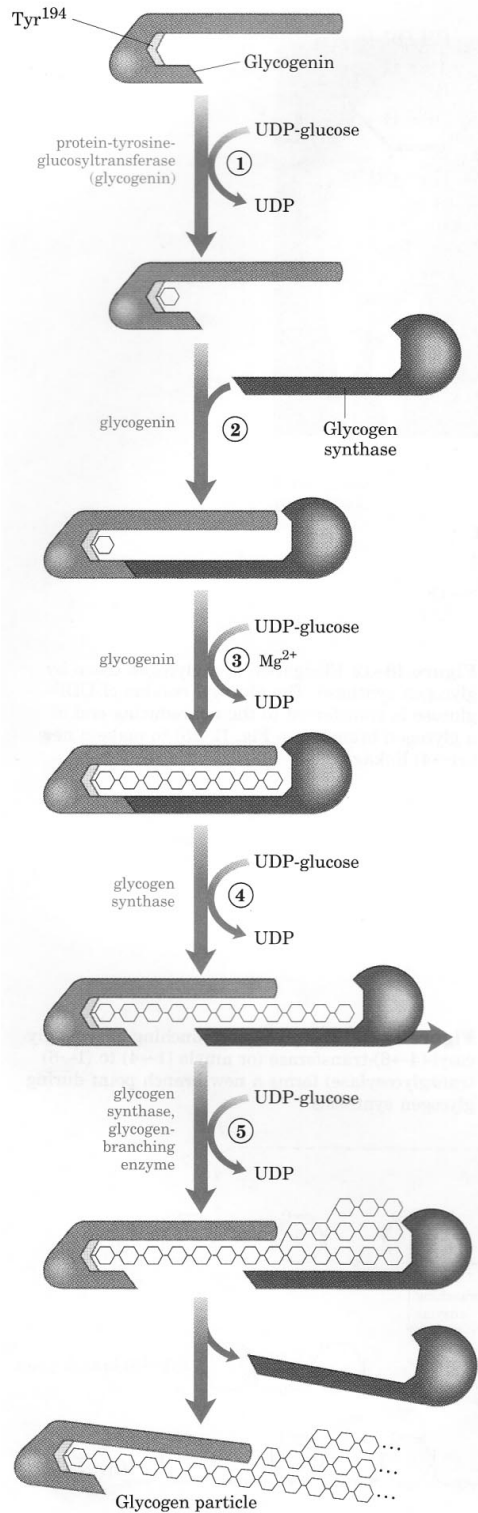
## 1. Phosphorylation of glycogen synthase via epinephrine

- GSK<sub>1</sub> (cAMP-dependent protein kinase) phosphorylates serine residues.
- GSK<sub>2</sub> (phosphorylase kinase) phosphorylates serine residues.
- GSK<sub>3</sub> (glycogen synthase-specific kinase) phosphorylates serine residues.

## 2. Action of insulin

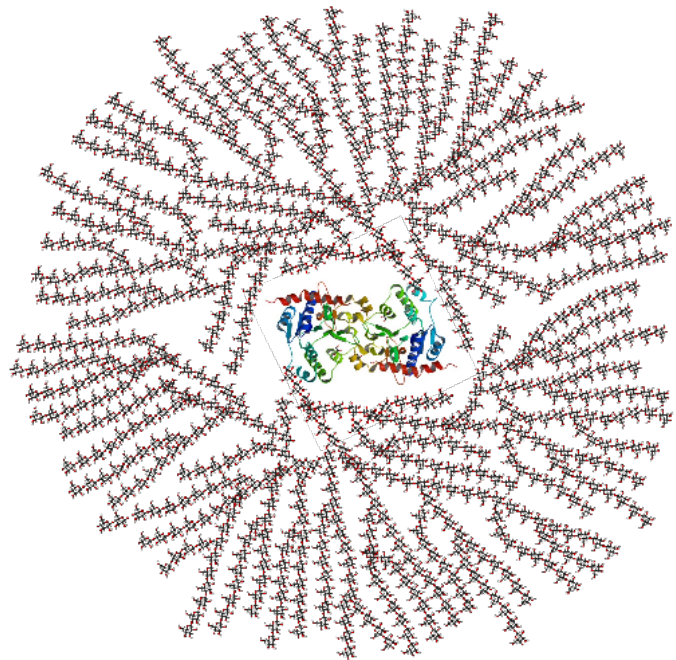
- Stimulates phosphatases.
- Provides G-6-P, which provides substrate.





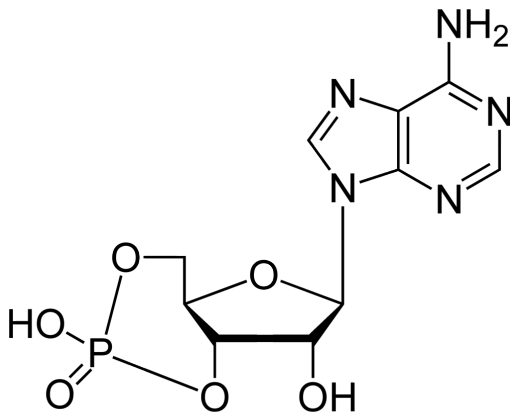
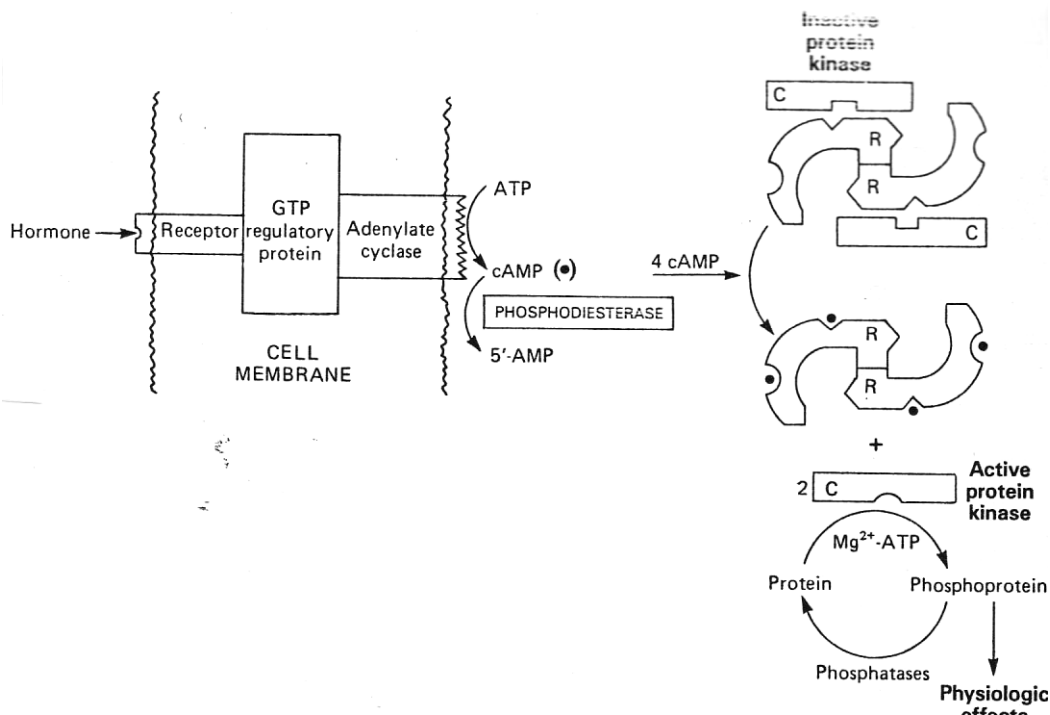
#### D. Role of glycogenin

1. Binds glucose residues
2. Serves as primer for glycogen synthesis.
3. Catalyzes synthesis of initial glycogen polymer: 8 residues are condensed, after which glycogen synthase extends the molecule.
4. Forms the core of the  $\beta$ -particle (55,000 glucose residues).
5. Cross-sectional view of glycogen

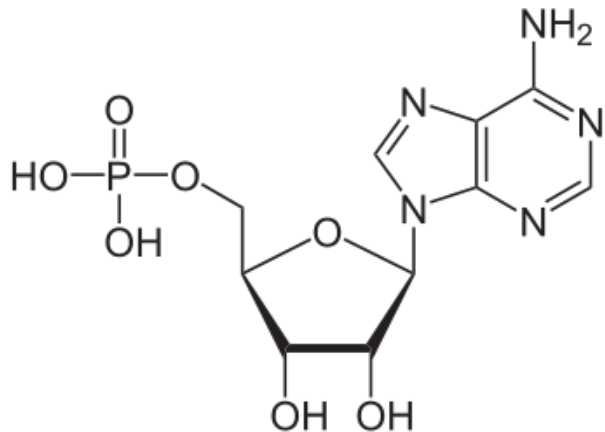


## V. Glycogen degradation

A. cAMP binds with regulatory subunit of protein kinase, frees catalytic subunit.

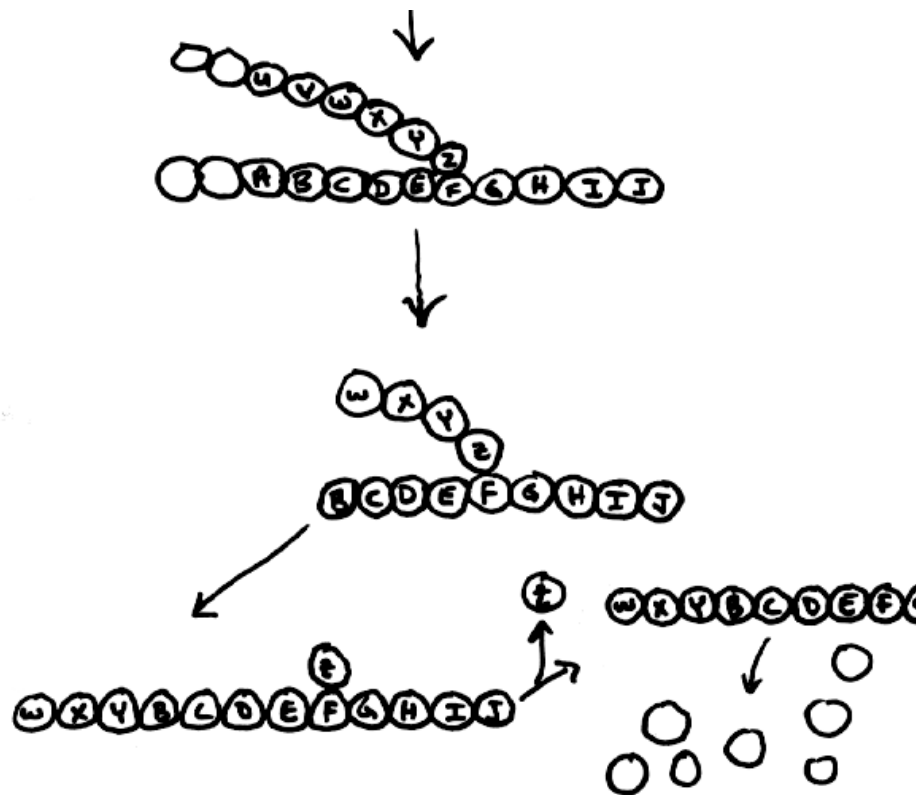
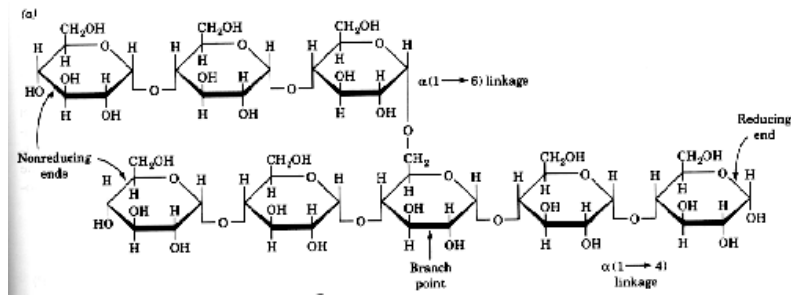


**Cyclic AMP (cAMP)**

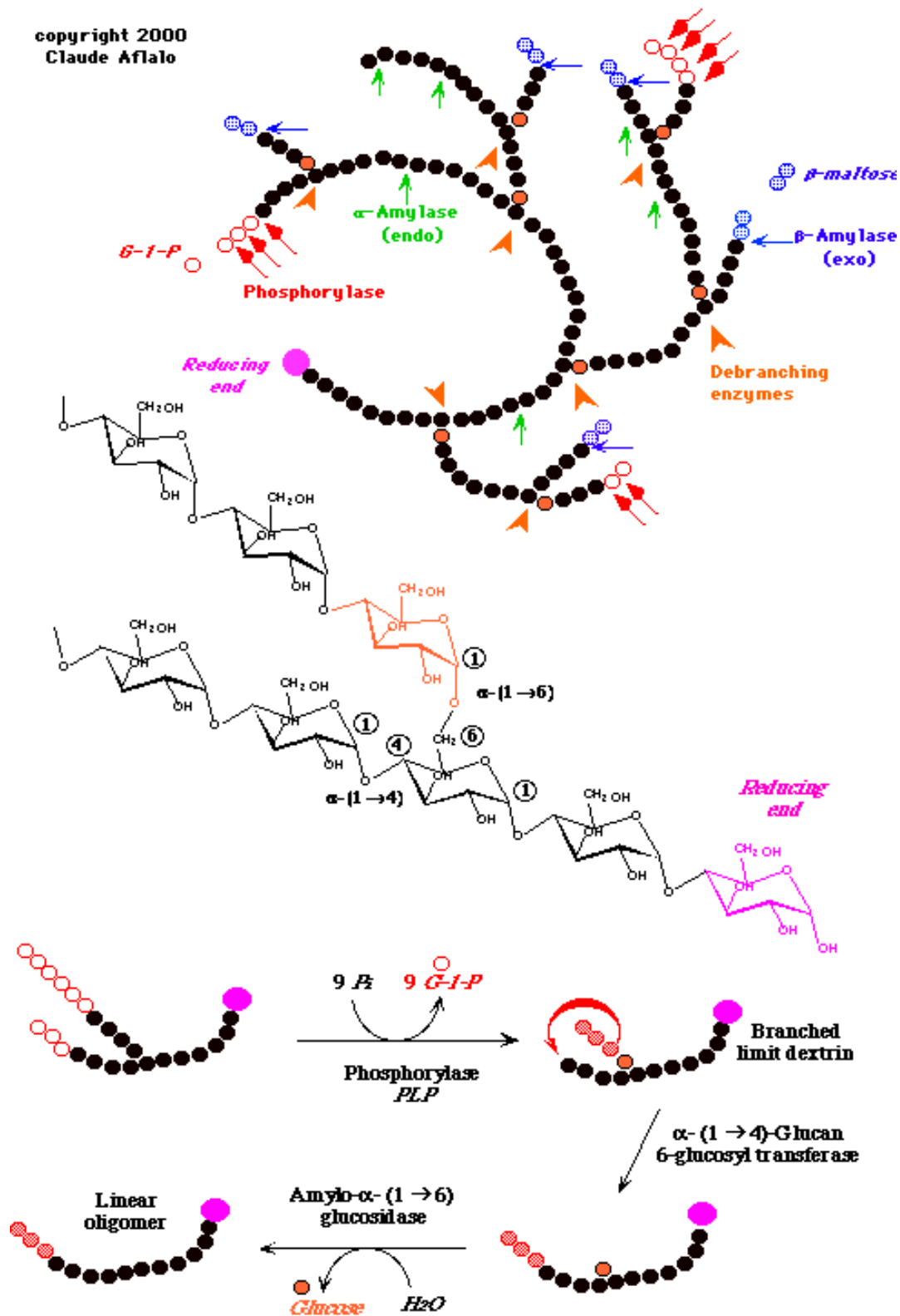


**5'AMP**

- B. Catalytic subunits (**protein kinase A**) phosphorylate **phosphorylase kinase**.
- C. Phosphorylase kinase phosphorylates **glycogen phosphorylase**.
- D. Glycogen phosphorylase adds phosphate groups to the 1-carbon of glucosyl residues of glycogen, producing G1P.
- E. This reaction also produces free glucose at branch points.



copyright 2000  
Claude Aflalo





#### **IV. Regulation of glycogen degradation**

A. Phosphorylase<sub>b</sub> activity modulated by:

1.  $P_i$ , AMP/IMP activate
2. ATP, G6P inhibit

B. Phosphorylase<sub>a</sub> activity modulated by glucose (inhibits).

C. Phosphorylase kinase activity regulated by calcium.

1. Concentration required for activation of phosphorylase kinase is lower for the phosphorylated form.
2. Concentration of calcium required for activation of phosphorylase kinase is that which yields half-maximal stimulation of myosin ATPase.

