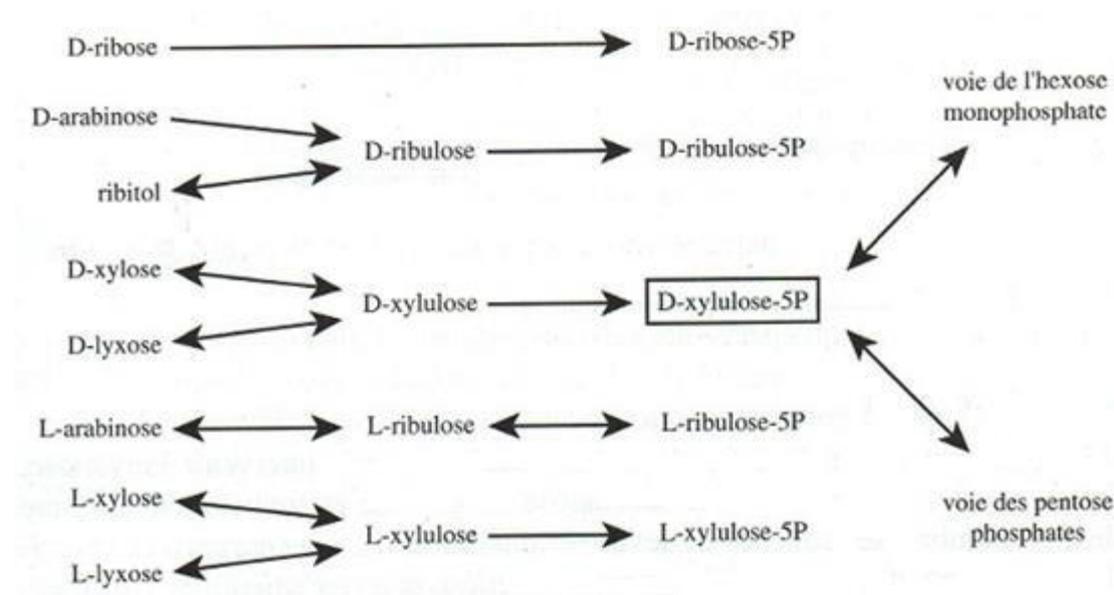


Catabolism of Other Sugars

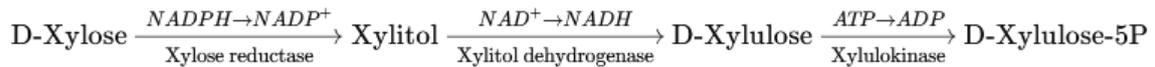
Microorganisms are capable of metabolizing a wide variety of sugars through specific enzymatic pathways. These catabolic processes transform different sugars into key intermediates such as glucose-6-phosphate, fructose-6-phosphate, or xylulose-5-phosphate, which are then funneled into the glycolytic pathway or the pentose phosphate cycle.

1- Catabolism of pentoses

The catabolism of pentoses has been extensively studied in Enterobacteria and Lactobacilli. Regardless of the pentose being metabolized, its degradation leads to the formation of D-xylulose-5-phosphate (D-xylulose-5P), which is then metabolized either via the hexose monophosphate pathway (pentose phosphate cycle) or the pentose-phosphate pathway (in heterolactic bacteria) with the involvement of phosphoketolase. Depending on the initial pentose, isomerases, transketolases, and transaldolases act to convert it into xylulose-5P.



In yeasts, the assimilation of xylose involves an additional intermediate step through xylitol formation:

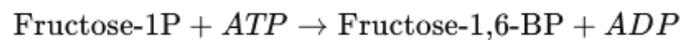


2- Catabolism of fructose

Fructose can be oxidized or phosphorylated depending on the microorganism. In *Acetobacter cerinus* (strictly aerobic), D-fructose-NADP-5-oxidoreductase oxidizes fructose into 5-keto-D-fructose:



In *Escherichia coli*, *Zymomonas*, or *Clostridium*, fructose is phosphorylated first to fructose-1-phosphate (Fru-1P) and then to fructose-1,6-bisphosphate (Fru-1,6-BP):



The resulting fructose-1,6-bisphosphate then enters the glycolytic pathway.

3- Catabolism of Mannose

Mannose can be catabolized through two different mechanisms: a cyclic mechanism and a non-cyclic mechanism. Both mechanisms occur for the D-isomer, whereas the L-isomer appears to be catabolized only through the non-cyclic pathway.

In the cyclic mechanism (observed in *Aerobacter aerogenes*), D-mannose is phosphorylated to mannose-6-phosphate, which is then converted to fructose-6-phosphate and subsequently metabolized via glycolysis. The phosphorylation of mannose occurs by transferring a phosphate group from glucose-6-phosphate to mannose. The glucose-6-phosphate is then regenerated either by the isomerization of mannose-6-phosphate into fructose-6-phosphate or by the direct phosphorylation of glucose through the action of glucokinase.

The utilization of L-mannose involves the non-cyclic mechanism. In this case, L-mannose is first converted into L-fructose by an isomerase. The resulting fructose is then phosphorylated to fructose-1-phosphate, which is cleaved into dihydroxyacetone phosphate (DHAP) and L-glyceraldehyde. These intermediates are subsequently metabolized via the glycolytic pathway.

Mannose can be degraded through two mechanisms: a **cyclic pathway** and a **non-cyclic pathway**.

For the D-isomer, both mechanisms exist, while the L-isomer is degraded only via the non-cyclic route.

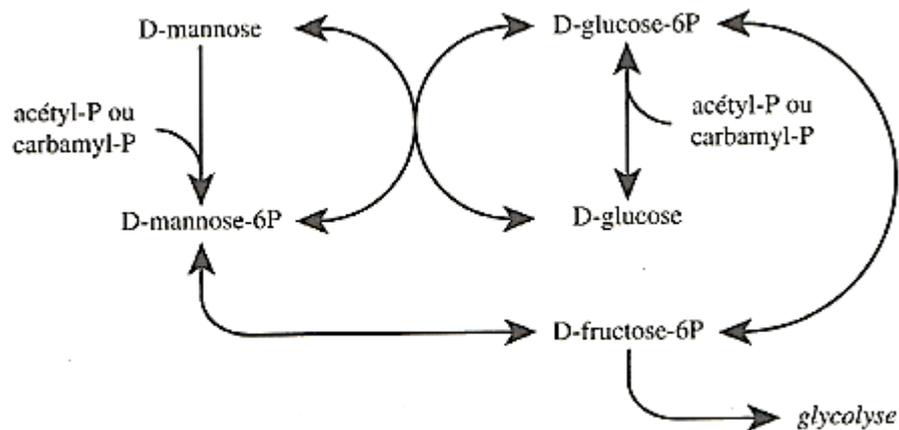
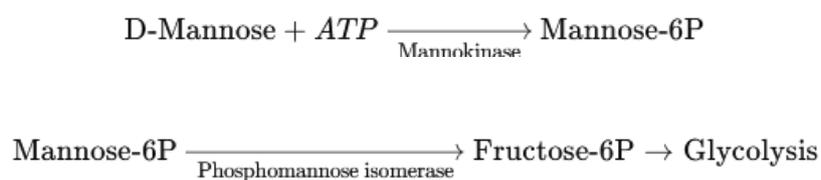


Figure 14 ■ Métabolisme cyclique du mannose

(a) Cyclic Mechanism



(b) Non-Cyclic Mechanism (L-Mannose Utilization):



The resulting intermediates are metabolized through glycolysis.

4- Catabolism of Sucrose

Sucrose is first hydrolyzed into glucose and fructose by the enzyme invertase, which is widely present in yeasts (*Saccharomyces cerevisiae*, *Candida utilis*), molds (*Aspergillus niger*, *Penicillium chrysogenum*), and bacteria (*Clostridium pasteurianum*, *Streptococcus*):



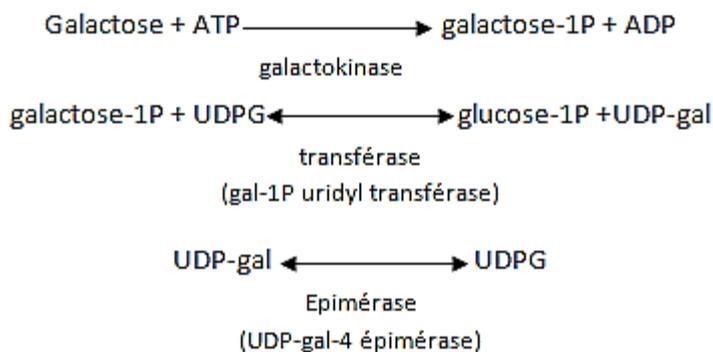
In yeasts and molds, hydrolysis occurs outside the cell, whereas in many bacteria (*Bacillus subtilis*, lactic acid bacteria), sucrose is transported into the cell as sucrose-phosphate and then hydrolyzed into glucose-6P and fructose.

Some bacteria, such as *Bacillus subtilis* and *Zymomonas*, possess levan sucrase, which polymerizes fructose units to form **levans**:



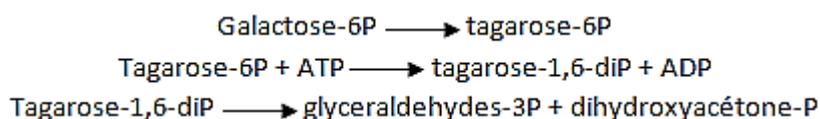
5- Catabolism of lactose and galactose

Many microorganisms possess β -galactosidase, including yeasts (*Kluyveromyces*, *Candida*), molds (*Aspergillus*), and bacteria (*E. coli*, *Lactobacillus*, *Bacillus*). After the hydrolysis of lactose, the released glucose is metabolized through one of the previously described pathways. The galactose, on the other hand, is degraded—particularly in yeasts—via the Leloir–Kalckar pathway. It is first phosphorylated and then converted into glucose-1-phosphate (glucose-1P), a metabolite that can be directly utilized by the cell after isomerization into glucose-6-phosphate (glucose-6P). The isomerization reactions involve the participation of uridine diphospho-glucose (UDPG) and uridine diphospho-galactose (UDP-Gal).



Métabolisme du galactose par la voie de Leloir

In *Escherichia coli*, lactose metabolism depends on a specific permease and follows the Leloir pathway, as in yeasts. In *Lactobacillus casei*, lactose is phosphorylated by a phosphotransferase system to form lactose-6-phosphate (lactose-P), which is then cleaved inside the cell into glucose and galactose-6-phosphate (galactose-6P). The subsequent metabolism proceeds through the tagatose pathway.



The tagatose pathway is also utilized in *Staphylococcus aureus* for the metabolism of lactose and galactose.

6- Catabolism of maltose

Maltose is generally hydrolyzed into two molecules of glucose by the enzyme maltase (also known as glucoamylase). In *Escherichia coli*, maltose metabolism involves a transglycosylation reaction, which forms intermediate maltodextrins before being converted into glucose that enters the glycolytic pathway.

