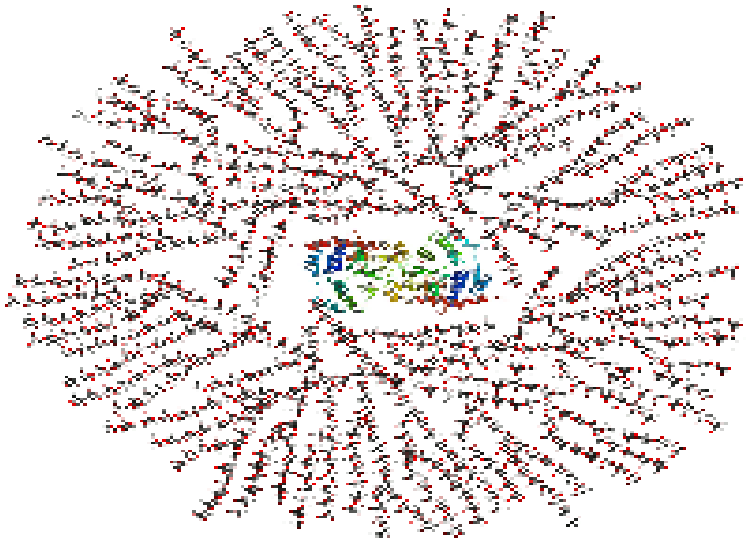
Glycogen

Microorganisms have the capacity to utilize a variety of nutrients and adapt to continuously changing environmental conditions. Many microorganisms, including yeast and bacteria, accumulate carbon and energy reserves to cope with the starvation conditions temporarily present in the environment. Glycogen biosynthesis is a main strategy for such metabolic storage, and a variety of sensing and signaling mechanisms have evolved in evolutionarily distant species to ensure the production of this homopolysaccharide. At the most fundamental level, the processes of glycogen synthesis and degradation in yeast and bacteria share certain broad similarities. However, the regulation of these processes is sometimes quite distinct, indicating that they have evolved separately to respond optimally to the habitat conditions of each species. (Wilson WA.,*et al* 2010)

Glycogenis a polysaccharide that is found in animals and is composed of a branched chain of glucose residues. It is stored in liver and muscles. It is an energy reserve for animals. It is the chief form of carbohydrate stored in animal body. It is insoluble in water. It turns red when mixed with iodine. It also yields glucose on hydrolysis.



Schematic 2-D cross-sectional view of glycogen. A core protein of glycogenin is surrounded by branches of glucose units. The entire globular granule may contain approximately 30,000 glucose units

Bacterial polysaccharides

Bacterial polysaccharides represent a diverse range of macromolecules that include peptidoglycan, lipopolysaccharides, capsules and exopolysaccharides; compounds whose functions range from structural cell-wall components (e.g., peptidoglycan), and important virulence factors (e.g., Poly-N-acetylglucosamine in *S. aureus*), to permitting the bacterium to survive in harsh environments (e.g., *Pseudomonas aeruginosa* in the human lung). Sutherland, I. W. (2002).

Polysaccharide biosynthesis is a tightly regulated, energy-intensive process and understanding the subtle interplay between the regulation

and energy conservation, polymer modification and synthesis, and the external ecological functions is a huge area of research. The potential benefits are enormous and should enable for example the development of novel antibacterial strategies (e.g., new antibiotics and vaccines) and the commercial exploitation to develop novel applications. Ullrich M (editor) (2009). Rehm BHA (editor). (2009).

Some bacteria produce intracellular nutrient storage granules, such as glycogen, polyphosphate, sulfur or polyhydroxyalkanoates. These granules enable bacteria to store compounds for later use. Certain bacterial species, such as the photosyntheticCyanobacteria, produce internal gas vesicles, which they use to regulate their buoyancy to achieve optimal light intensity and/or nutrient levels. Yeo M, Chater K (2005).

IN certain conditions, bacteria accumulate relatively large amounts of polyglucose compounds with properties similar to those of animal glycogen[1].An interpretation of bacterial

“glycogen” production is that it provides a food and/or energy reserve for the organisms in unfavorable environments; in other words, bacteria rich in glycogen should survive longer than bacteria without such reserves. Dawes, E. A. , and Ribbons, D. W.((1962)

Bacterial capsular polysaccharides

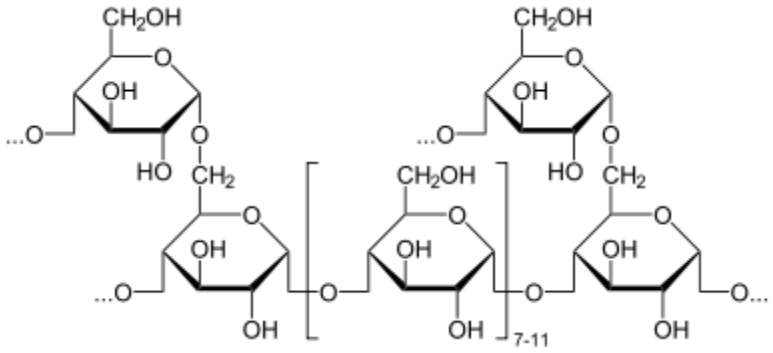
Pathogenic bacteria commonly produce a thick, mucous-like, layer of polysaccharide. This "capsule" cloaks antigenicproteinson the bacterial surface that would otherwise provoke an immune response and thereby lead to the destruction of the bacteria. Capsular polysaccharides are water soluble, commonly acidic, and have molecular weights on the order of 100-1000 kDa. They are linear and consist of regularly repeating subunits of one to six monosaccharides. There is enormous structural diversity; nearly two hundred different polysaccharides are produced by E. coli alone. Mixtures of capsular polysaccharides, either conjugatedor native are used as vaccines.

Bacteria and many other microbes, including fungiand algae, often secrete polysaccharides as an evolutionary adaptation to help them adhere to surfaces and to prevent them from drying out. Humans have developed some of these polysaccharides into useful products, including

xanthan gum, dextran, welan gum, gellan gum, diutan gum and pullulan.

1. Most of these polysaccharides exhibit interesting and very useful visco-elastic properties when dissolved in water at very low levels. This gives many foods and various liquid consumer products, like lotions, cleaners and paints, for example, a viscous appearance when stationary, but fluidity when the slightest shear is applied, such as when wiped, poured or brushed. This property is referred to as pseudoplasticity, or shear thinning.(Varki A, *et al*(2008).

Glycogensynthesis



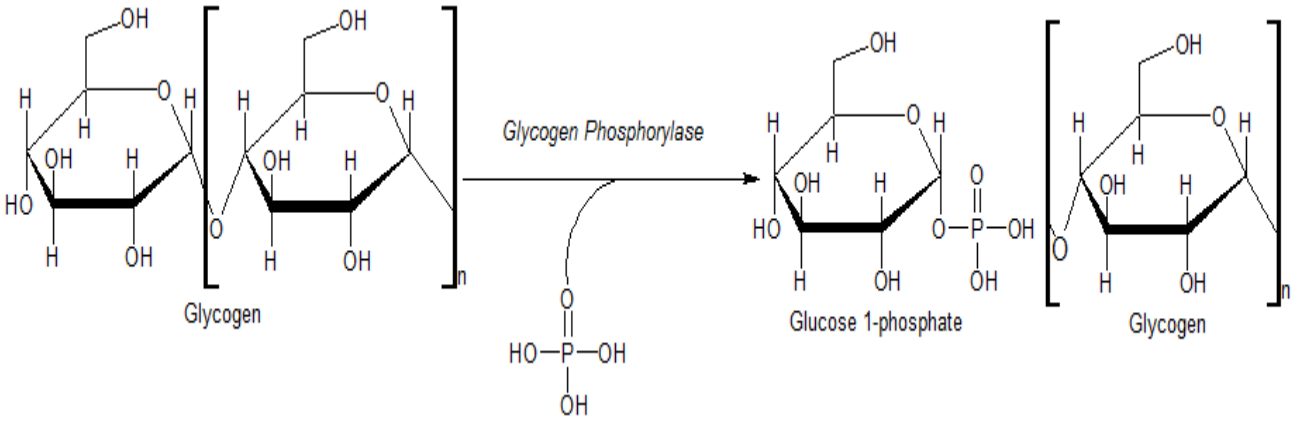
Glycogen Structure Segment

Glycogen synthesis is, unlike its breakdown, endergonic. This means that glycogen synthesis requires the input of energy. Energy for glycogen synthesis comes from UTP, which reacts with glucose-1-phosphate, forming UDP-glucose, in reaction catalyzed by UDP-glucose pyrophosphorylase. Glycogen is synthesized from monomers of UDP-glucose by the enzyme glycogen synthase, which progressively lengthens the glycogen chain with (α1→4) bonded glucose. As glycogen synthase can lengthen only an existing chain, the protein glycogeninis needed to initiate the synthesis of glycogen. The glycogen-branching enzyme, **amylo (α1→4) to (α1→6) transglycosylase**, catalyzes the transfer of a terminal fragment of 6-7glucose residues from a nonreducing end to the C-6 hydroxyl group of a glucose residue deeper into the interior of the glycogen molecule. The branching enzyme can act upon only a branch having at least 11 residues, and the enzyme may transfer to the same glucose chain or adjacent glucose chains.(Guo H, Yi W et al 2008)

Glycogen breakdown

Glycogen is cleaved from the nonreducing ends of the chain by the enzyme glycogen phosphorylase to produce monomers of glucose-1-phosphate, which is then converted to glucose 6-phosphate by phosphoglucomutase. A special debranching enzyme is needed to remove the alpha(1-6) branches in branched glycogen and reshape the

chain into linear polymer. The G6P monomers produced have three possible fates:



- G6P can continue on the glycolysis pathway and be used as fuel.
- G6P can enter the pentose phosphate pathway via the enzyme Glucose-6-phosphate dehydrogenase to produce NADPH and 5-carbon sugars.
- In the liver and kidney, G6P can be dephosphorylated back to Glucose by the enzyme Glucose 6-phosphatase. This is the final step in the gluconeogenesispathway.

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