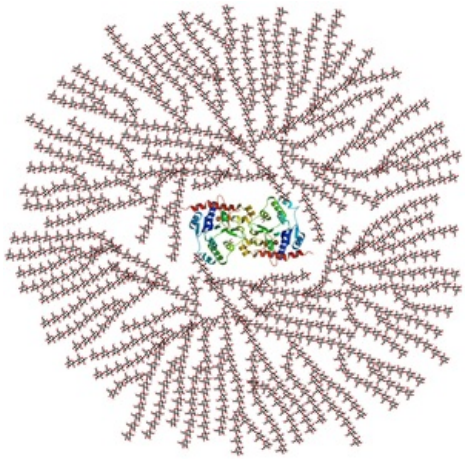
Glycogen

Glycogen is a **storage polysaccharide** of animals. It is an energy component of the body bridging the time between meals - it is synthesized after eating and the resupply of nutrients to the body, it is degraded during starvation and energy expenditure.



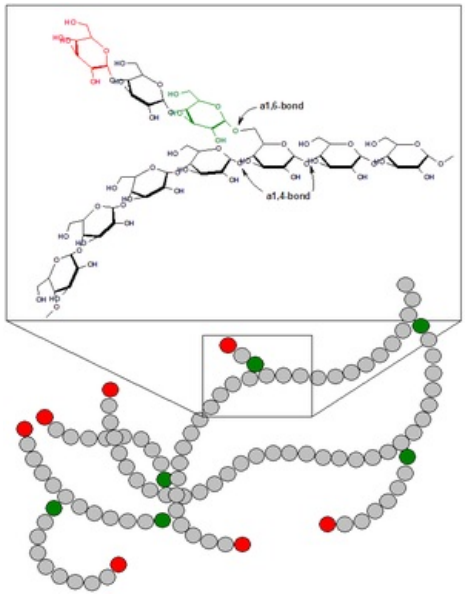
Glycogen structure

Glycogen structure

Glycogen is a polysaccharide with the structure of a branched left-handed helix, built from **D-glucose monomer**. The monomers are linked by an α1,4 bond on each branch, these branches are connected to other branches via an α1,6 bond. The entire structure is held together by a special anchoring protein, **glycogenin**. During both synthesis and degradation, different special enzymes were present, which gradually attach or detach glucose units from the overall structure.

Glycogen localisation

Organwise glycogen is densely localized in the **liver**, from where it can be easily mobilized, and because of this, its representation is highly variable. However, the liver accounts for only about 10% of the total glycogen content in the body. The main supply of glycogen in the body is therefore the **muscle** glycogen, which represents the absolute majority of the rest of the entire content. It is less represented in the muscle, but due to the much higher mass of the muscles than the liver, it exceeds the total representation. However, this glycogen is harder to mobilize, helps muscle work and never fully drops to zero.



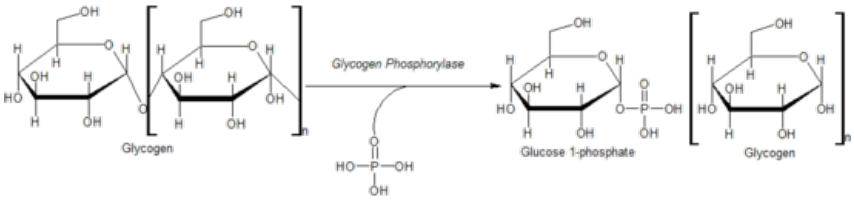
Bonds between monomers

At the **cellular level** glycogen is stored in the cytosol as 10–40 nm large **granules**, which can be seen on electrograms. These granules have a high density, contain glycogen, degradation and synthesis enzymes and reaction regulators.

Glycogenolysis

Glycogen is not broken down in traditional fashion by hydrolysis, but **phosphorolytically**. The product of such cleavage is **glucose-1-phosphate**. The reaction is irreversible in vivo:

- glycogen + H_3PO_4 → glucose-1-phosphate + glycogen (−1 monomer)
  - this reaction is catalyzed by **phosphorylase a** (glycogen phosphorylase) with the cooperation of pyridoxal phosphate
    - *the enzyme occurs in two forms – active phosphorylase a, inactive phosphorylase b*



Glycogen phosphorylase

Degradation begins at the non-reducing end of glucose with a hydroxide group at the fourth carbon. From there it continues until the reaction stops about 4 monomers before branching. The phosphorolytic enzyme cannot continue any further, so the linearizing enzyme **transferase** (α-1,4-transglycosylase), steps in, which transfers 3 monomers to the non-reducing end of the neighboring chain. This will leave a single glucose unit on the original chain, which will undergo hydrolysis by the same enzyme. Transferase thus has a **dual activity**.

About 10% of glycogen remains after degradation and serves as a primer for the synthesis of new glycogen.

The product glucose-1-phosphate is converted to **glucose-6-phosphate** with the help of **phosphoglucomutase** and can subsequently be changed to free **glucose** (*provided by glucose-6-phosphatase*).

Glycogenesis

Glycogen synthesis initiates from glucose-1-phosphate, which is combined with uridine triphosphate (UTP) catalyzed by the enzyme UDP-glucose diphosphorylase to form **uridine diphosphate glucose** UDP~G. It is the more energy-rich form that is able to attach to the non-reducing end of the glycogen unit.

Glycogen synthase thus gradually lengthens the chain with the help of a **branching enzyme** (amylo(1,4→1,6)transglycosylase).

Regulation

Allosteric regulation:

- phosphorylase b is activated by phosphorylation by the respective **kinase** to **phosphorylase a**, conversely it is inactivated by phosphatase,
  - reaction inhibitors are ATP, Glc-6-P, unbound glucose,
  - the activator of the reaction is AMP,
- **glycogen synthase** is set in the **in opposition to** as phosphorylase b – its function is suppressed by kinases, activated by phosphatases.

Hormonal regulation:

- **glucagon, adrenaline** – binds to cell surface receptors, **cAMP** in the role of second messenger activates the relevant kinase,
- **insulin** activates enzymes to degrade **cAMP**, thereby suppressing degradation.

Links

Related articles

- Glycogenesis
- Glycogenolysis
- Glycogenosis

Used literature

- LEDVINA, Miroslav, et al. *Biochemie pro studující medicíny. I. díl.* 2. edition. Praha : Karolinum, 2009. 269 pp. pp. 136-143. ISBN 978-80-246-1416-8.