

# Energy Metabolism of Starch: Biochemical Pathways Regulation and Nutritional Implications

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## Editorial

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The digestion of starch begins in the oral cavity and continues through the gastrointestinal tract:

Salivary  $\alpha$ -amylase hydrolyzes starch into maltose and dextrins. Pancreatic  $\alpha$ -amylase continues starch hydrolysis. Brush border enzymes, including maltase, sucrase, and isomaltase, break down disaccharides into glucose<sup>[2]</sup>. Glucose is absorbed into enterocytes via SGLT1 (sodium-glucose linked transporter 1) and transported to the bloodstream for cellular uptake.

### Energy Metabolism of Starch-Derived Glucose

Once glucose enters cells, it undergoes a series of metabolic pathways to generate ATP:

Occurs in the cytoplasm. Converts one molecule of glucose into two molecules of pyruvate. Net ATP production: 2 ATP per glucose molecule.  $\text{NAD}^+$  is reduced to NADH, which carries electrons to mitochondria. Pyruvate is transported into mitochondria and converted to acetyl-CoA by the pyruvate dehydrogenase complex. Produces NADH and  $\text{CO}_2$ . Acetyl-CoA enters the TCA cycle (Krebs cycle). Produces 3 NADH, 1  $\text{FADH}_2$ , and 1 GTP per acetyl-CoA. Releases  $\text{CO}_2$  as a waste product. Electrons from NADH and  $\text{FADH}_2$  enter the electron transport chain in the mitochondrial inner membrane. ATP is synthesized via ATP synthase using the proton gradient. Net ATP production from one glucose molecule: approximately 30–32 ATP<sup>[3]</sup>.

## ABSTRACT

Starch is the primary carbohydrate in human diets and a major source of energy. Its metabolism involves enzymatic breakdown to glucose, which enters pathways such as glycolysis, the tricarboxylic acid (TCA) cycle, and oxidative phosphorylation to generate ATP. This article reviews the biochemical processes involved in starch digestion and energy metabolism, regulation of key enzymes, and the implications of starch metabolism for nutrition and health. Understanding starch metabolism is essential for designing diets that optimize energy utilization and manage metabolic disorders such as diabetes.

## Keywords

Starch, Energy Metabolism, Glycolysis, Gluconeogenesis, ATP Production, Carbohydrate Metabolism

## INTRODUCTION

Starch, a polysaccharide composed of glucose units, serves as a major energy reserve in plants and a critical dietary carbohydrate for humans. It is present in foods such as cereals, potatoes, rice, and legumes. The human body metabolizes starch to produce energy in the form of adenosine triphosphate (ATP), which fuels cellular activities, including muscle contraction, nerve conduction, and biosynthetic processes.

Starch metabolism involves two major phases: digestion to release glucose and cellular energy metabolism where glucose is oxidized through glycolysis, the TCA cycle, and oxidative phosphorylation<sup>[1]</sup>.

## DIGESTION OF STARCH

## REGULATION OF STARCH METABOLISM

Starch-derived glucose metabolism is tightly regulated:

Catalyze the phosphorylation of glucose to glucose-6-phosphate, regulating glycolysis initiation. Rate-limiting enzyme in glycolysis, activated by AMP and inhibited by ATP and citrate. Regulated by phosphorylation and allosteric effectors such as NADH and acetyl-CoA. Control storage and mobilization of glucose in the form of glycogen. Hormones such as insulin and glucagon play crucial roles in coordinating starch metabolism according to energy demands <sup>[4]</sup>.

## NUTRITIONAL AND HEALTH IMPLICATIONS

Starch is a major source of caloric energy in human diets. Rapidly digestible starches lead to higher postprandial glucose spikes, while resistant starches have slower digestion and lower glycemic indices. Impaired starch metabolism contributes to hyperglycemia and type 2 diabetes. Resistant starch acts as prebiotic, improving gut health. Optimizing starch consumption is crucial for maintaining energy balance, preventing obesity, and managing chronic metabolic diseases <sup>[5]</sup>.

## CONCLUSION

Starch is a fundamental carbohydrate that provides energy through complex metabolic pathways involving glycolysis, the TCA cycle, and oxidative phosphorylation. Efficient starch metabolism ensures adequate ATP supply for cellular functions. Regulation of starch metabolism is vital for maintaining glucose homeostasis and preventing metabolic disorders. Understanding these pathways is critical for nutrition science, diet planning, and therapeutic interventions targeting energy metabolism and diabetes management.

## ACKNOWLEDGEMENT

None.

## CONFLICT OF INTEREST

None.

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