**ALCOHOL FERMENTATION**

**Ethanol fermentation**, also called **alcoholic fermentation**, is a [biological process](https://en.wikipedia.org/wiki/Biological_process) which converts [sugars](https://en.wikipedia.org/wiki/Sugar) such as [glucose](https://en.wikipedia.org/wiki/Glucose), [fructose](https://en.wikipedia.org/wiki/Fructose), and [sucrose](https://en.wikipedia.org/wiki/Sucrose) into [cellular energy](https://en.wikipedia.org/wiki/Adenosine_triphosphate), producing [ethanol](https://en.wikipedia.org/wiki/Ethanol) and [carbon dioxide](https://en.wikipedia.org/wiki/Carbon_dioxide) as by-products. Because [yeasts](https://en.wikipedia.org/wiki/Yeast) perform this conversion in the absence of [oxygen](https://en.wikipedia.org/wiki/Oxygen), alcoholic [fermentation](https://en.wikipedia.org/wiki/Fermentation) is considered an [anaerobic](https://en.wikipedia.org/wiki/Anaerobic_organism#Metabolism) process.

Ethanol fermentation has many uses, including the production of [alcoholic beverages](https://en.wikipedia.org/wiki/Alcoholic_beverage), the production of [ethanol fuel](https://en.wikipedia.org/wiki/Ethanol_fuel), and [bread](https://en.wikipedia.org/wiki/Bread) cooking.

In ethanol fermentation, (1) one glucose molecule breaks down into two pyruvates. The energy from this exothermic reaction is used to bind the inorganic phosphates to ADP and convert NAD+ to NADH. (2) The two pyruvates are then broken down into two acetaldehydes and give off two CO2 as a by-product. (3) The two acetaldehydes are then converted to two ethanol by using the H- ions from NADH, converting NADH back into NAD+

Biochemical process of fermentation of sucrose

The [chemical equations](https://en.wikipedia.org/wiki/Chemical_equation) below summarize the fermentation of sucrose (C12H22O11) into ethanol (C2H5OH). Alcoholic fermentation converts one [mole](https://en.wikipedia.org/wiki/Mole_%28unit%29)of [glucose](https://en.wikipedia.org/wiki/Glucose) into two moles of ethanol and two moles of carbon dioxide, producing two moles of [ATP](https://en.wikipedia.org/wiki/Adenosine_triphosphate) in the process.

The overall chemical formula for alcoholic fermentation is:

C6H12O6 → 2 C2H5OH + 2 CO2

Sucrose is a [dimer](https://en.wikipedia.org/wiki/Dimer_%28chemistry%29) of glucose and fructose molecules. In the first step of alcoholic fermentation, the enzyme [invertase](https://en.wikipedia.org/wiki/Invertase%22%20%5Co%20%22Invertase) cleaves the [glycosidic linkage](https://en.wikipedia.org/wiki/Glycosidic_bond%22%20%5Co%20%22Glycosidic%20bond)between the glucose and fructose molecules.

C12H22O11 + H2O + invertase → 2 C6H12O6

Next, each glucose molecule is broken down into two [pyruvate](https://en.wikipedia.org/wiki/Pyruvate) molecules in a process known as [glycolysis](https://en.wikipedia.org/wiki/Glycolysis).[[2]](https://en.wikipedia.org/wiki/Ethanol_fermentation#cite_note-stryer-2) Glycolysis is summarized by the equation:

C6H12O6 + 2 ADP + 2 Pi + 2 NAD+ → 2 CH3COCOO− + 2 ATP + 2 NADH + 2 H2O + 2 H+

CH3COCOO− is pyruvate, and Pi is inorganic [phosphate](https://en.wikipedia.org/wiki/Phosphate). Finally, pyruvate is converted to ethanol and CO2 in two steps, regenerating oxidized NAD+ needed for glycolysis:

1. CH3COCOO− + H+ → CH3CHO + CO2

catalyzed by [pyruvate decarboxylase](https://en.wikipedia.org/wiki/Pyruvate_decarboxylase%22%20%5Co%20%22Pyruvate%20decarboxylase)

2. CH3CHO + NADH + H+ → C2H5OH + NAD+

This reaction is catalyzed by [alcohol dehydrogenase](https://en.wikipedia.org/wiki/Alcohol_dehydrogenase) (ADH1 in baker's yeast).

 Glycolysis causes the reduction of two molecules of [NAD+](https://en.wikipedia.org/wiki/Nicotinamide_adenine_dinucleotide) to [NADH](https://en.wikipedia.org/wiki/Nicotinamide_adenine_dinucleotide). Two [ADP](https://en.wikipedia.org/wiki/Adenosine_diphosphate) molecules are also converted to two ATP and two water molecules via [substrate-level phosphorylation](https://en.wikipedia.org/wiki/Substrate-level_phosphorylation)