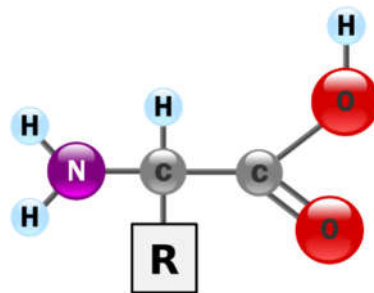


## BIOTECHNOLOGY ON AMINO-ACIDS

### What are amino-acids?

First of all, amino-acids are organic compounds containing both an amino group (NH<sub>2</sub>) and a carboxyl group (COOH) connected by a CH group with a specific R compound connected to the carbon in the middle. The generic formula for an amino-acid is H<sub>2</sub>N-CH-R-COOH.

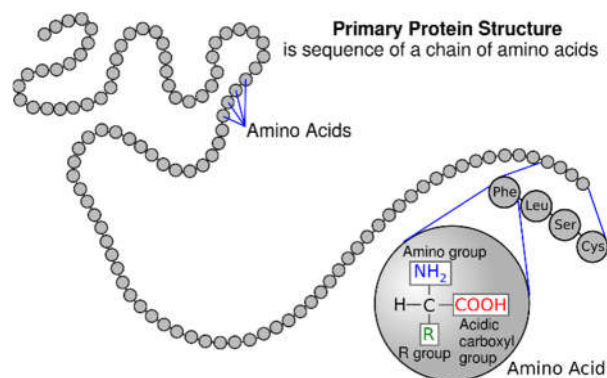
There are more than 500 amino-acids currently known, but only 20 of them appear in the human DNA as parts of the proteins. In fact, as they are the components of proteins, they are the second-largest compounds in human body.



<https://commons.wikimedia.org/wiki/File:AminoAcidball.svg>

The amino-acids differ from each other in the R group, which can be organic compounds alone or after a polymer chain. Based on the number of carbons in this chain, they are divided in classes using Greek alphabet letters.

As part of proteins, which make up cells and our whole body, the amino-acids are the most important basic components in our body and they are responsible for our metabolism in muscles, organs and the cells themselves. But they also have other functions: they are optimal for transportation or storage of nutrients, like water or fats, they can be oxidized to produce energy, or they can be used to synthesize other molecules used in our body, like neurotransmitters.



[https://upload.wikimedia.org/wikipedia/commons/thumb/3/38/Protein\\_primary\\_structure.svg/2000px-Protein\\_primary\\_structure.svg.png](https://upload.wikimedia.org/wikipedia/commons/thumb/3/38/Protein_primary_structure.svg/2000px-Protein_primary_structure.svg.png)

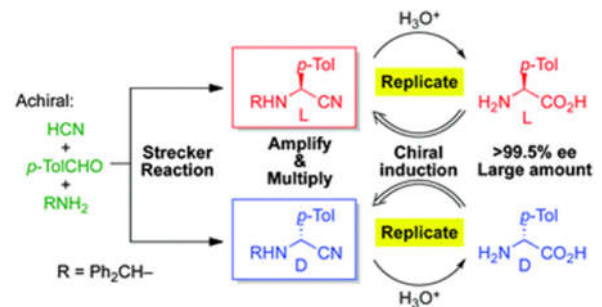
In fact, the best way to deliver amino-acids to our body is not by eating simple food, because the protein chains must be digested by the liver and it is a long and less effective way, but by eating pure amino-acids in integrators, because amino-acids get directly absorbed by our body and get in the circulation within 15 minutes.

Nine of the 20 amino-acids used in our proteins cannot be produced by our body, that is why we have to consume various types of food to integrate all of them. If special amino-acids are not available to our cells it could lead to metabolism diseases because some proteins are not produced anymore.

The first amino-acid has been discovered 1806 by the French chemists Louis-Nicolas Vauquelin and Pierre Jean Robiquet; the last one of the 20 common amino-acids has been discovered in 1935 by William Cumming Rose and he also discovered which are the essential amino-acids for the human body.

## How does the chemical production work?

The chemical production usually uses the Strecker-amino-acid-synthesis, also known as Strecker synthesis, where aldehydes (RCHO), ammonia (NH<sub>3</sub>) and hydrogen cyanide (HCN) react to form an α-amino-nitrile, which is subsequently hydrolysed to give the desired amino-acid.

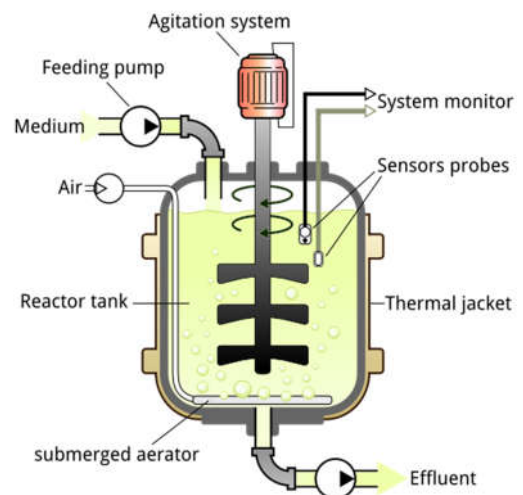


<http://pubs.rsc.org/en/content/articlelanding/2016/cc/c6cc05544c#!divAbstract>

## How does the biotechnological production work?

Biotechnological production of amino-acids consists in a synthesis process that goes through bacteria cultures and fermentation. The first bacteria used for the culture were E. Coli but then C. Glutamicum was discovered for the production of glutamic acid and it replaced Coli in all the other fields of amino acid production.

First of all, to make the bacteria capable of producing an amino acid, genetic engineering is used to transfer a certain gene into the bacteria DNA. Then, the bacteria are cultivated in a bioreactor with a substrate where they can ferment and give us the amino acids as a product, which are then separated from the other stuff using different techniques.



[https://commons.wikimedia.org/wiki/File:Bioreactor\\_principle.svg](https://commons.wikimedia.org/wiki/File:Bioreactor_principle.svg)

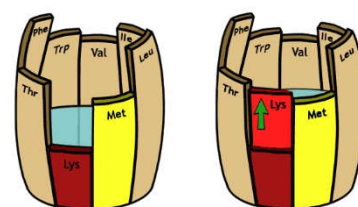
## What are the differences between the two methods?

In the chemical production, some of the reagents are toxic and it has to be catalysed in a particular way, while the biotechnological way may be slower but does not have any problems, it is easier and much more sustainable because it works as a part of the environment even if it is artificial. In the chemical way you also have to still renovate reagents while the biotechnological process is continuous and can be carried over for a long time with a stable production.

## What are they used for?

In first place, for the animals, essential amino-acids are used to feed them to increase the profit. In common animal food you have deficiency of some amino-acids, like Lysine, so by feeding them with these types of amino-acids you can control their health and meanwhile also increase the production with less food.

## Limiting Amino Acid

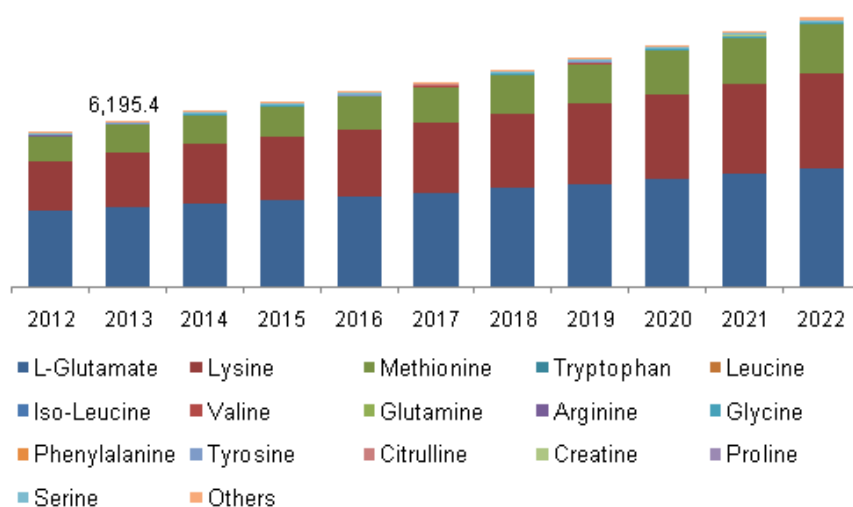


<http://www.nutrientsreview.com/wp-content/uploads/2014/10/Limiting-Amino-Acid.jpg>

They are also used to treat nutrient deficiency or increase energy in the human patients. Some non-proteic amino-acids are instead produced and used in the pharmaceutical industry because they can be converted to neurotransmitters, like tryptophan.

## Amino-acids in industry

The amino-acids industry is a field in development: in 2013 there were 6.19 million tons produced worldwide. The production is expected to grow continuously in the next years, especially for L-Glutamate, Lysine and also Methionine. There are various industries that are specialized in the amino-acids production: for instance Evonik Industries is a worldwide famous German company that uses biotechnological techniques to produce amino-acids for the animal food industry.



<https://www.grandviewresearch.com/industry-analysis/amino-acids-market>

In conclusion, amino-acids are one of the most important factors for life and we are not able to produce all of them by ourselves, so it is fundamental to have renewable and effective ways to produce them. The biotechnological way is by far the best method that can be utilized, because it uses natural instruments and it is quite self-sustainable. Manufactory is already using this method in the most part and research is also considered really important to further develop it in the best way possible. Biotechnology is already a big sector and it will grow faster than any other, as technology did in the past 20 years.