



The serine family.
One source,
many opportunities.



About Evonik

In 2014, our approximately 33,000 Evonik employees produced sales of €12.9 billion and an operating result (EBITDA) of €1.9 billion. Around 78 percent of sales are generated outside Germany, providing convincing evidence that our business is global. Our business activities are aligned with three global mega-trends: besides resource efficiency and globalization, our focus is also on the key growth sector of health and nutrition. Here, the pharma industry is part of the strategic core business of Evonik, and it has been for several decades. As Evonik our track record builds on 50 years of experience in the production of pharmaceutical-grade products. Our Health Care Business Line is firmly embedded within the Evonik Group, enabling us to promise our customers stability and staying power – essential for building long-term partnerships.

Serine – a vital amino acid for human health

First isolated in 1865 from protein present in silk, serine derives its name from the Latin *sericum*, meaning silk. Being proteinogenic, serine is one of the 22 amino acids in the human genetic code. The human body needs serine to function at its best, both physically and mentally. As a non-essential amino acid, it does not have to be added to our diet from an outside source, but is produced by our own metabolism. Sometimes, that is not enough.

To our partners in the healthcare, nutrition and pharma industries, serine is a key component in developing and manufacturing a wide spectrum of

active pharmaceutical ingredients (APIs) and supplements. The efficacy of the treatments and drugs they develop depends on the highest standards of purity. That is why they choose Evonik.

More than five decades at the sharp end of the business have shaped us into the expert in essential and non-essential amino acids, enabling us to deliver consistent quality reliably – around the world.



Serine was first obtained from silk protein, a particularly rich source, in 1865 – hence its name, derived from the Latin for silk, *sericum*.

Natural and synthetic serine – the best of both worlds from one source

Over the past 20 years, Evonik Industries has continuously and consistently refined its amino acid product offering, including the entire spectrum of serine products and derivatives.

L-Serine

L-Serine occurs naturally and is involved in many biological processes of the human metabolism. For instance, it is essential to cell proliferation and brain development. It also plays a crucial role in inhibiting pain signals. And as a natural moisturizing agent, L-Serine is an important skin nutrient.

Because of its biological importance, L-Serine is much in demand for healthcare applications, including:

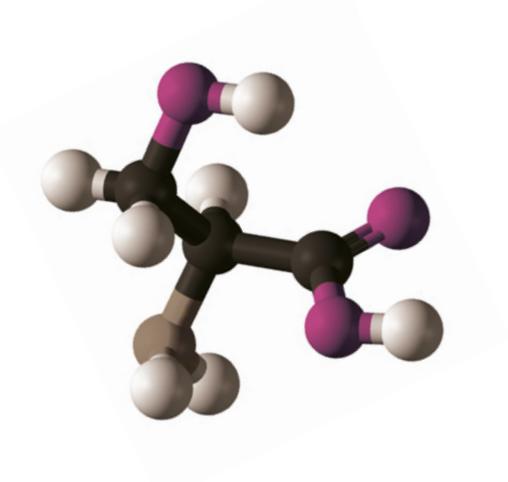
- Parenteral and enteral nutrition
- Pharma compound synthesis
- Cell culture media preparation
- Cosmetics



D-Serine, DL-Serine and further derivatives

As the non-naturally occurring version of serine, D-Serine is used as a building block for the synthesis of many APIs. Its efficacy is proven in the treatment of tuberculosis and epilepsy, and as a neuromodulator in therapies for depression.

Other derivatives, such as DL-Serine and L-Serine methyl ester are also used as building blocks for API synthesis and to enhance the effectiveness of medications designed to treat conditions as varied as iron deficiency, Parkinson's disease and high blood pressure. Our unique setup in biotechnology and synthesis enables us to offer all serine-derived building blocks for a host of APIs.



Serine-based active pharmaceutical ingredients (APIs)

API (example)	Serine-based API building block	Application
Aktiferrin	DL-Serine	Iron deficiency
Benserazide	DL-Serine	Parkinson's disease
Cycloserine	D-Serine	Tuberculosis
Edivoxetine	D-Serine	Depression
Lacosamide	D-Serine	Epilepsy
Phosphatidyl serine	L-Serine	Loss of concentration and memory capacity, dementia, ADD/ADHD
Ramipril	L-Serine methyl ester	High blood pressure

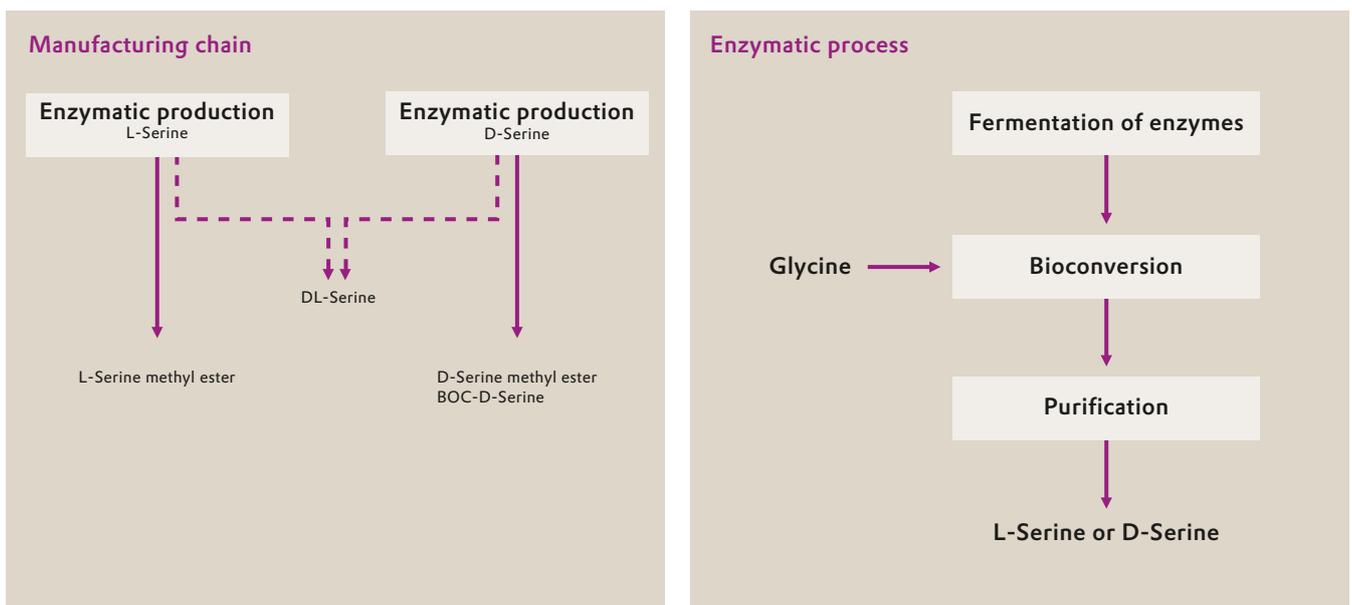
The list of APIs shown here is not exhaustive and serves as an indication of the spectrum of applications for Evonik's serine family

The Evonik manufacturing process for serine

For many decades, Evonik Industries has been purifying serine to the highest quality standards required by the pharmaceutical industry. As part of our effort to push boundaries continuously in purity, quality and reliability, and to do so sustainably, we are developing a proprietary enzymatic process for the synthesis of L-Serine, D-Serine and DL-Serine.

Our strong expertise in biotechnology is an important asset in this process.

Our production facility is running with the capacity to supply L-Serine, D-Serine and DL-Serine at the multiple ton scale for all grades – from technical to full Good Manufacturing Practice (GMP).



Our capability – your advantage

At Evonik, our full backward integration of manufacturing processes and complete control of the entire supply chain are the best guarantee for:

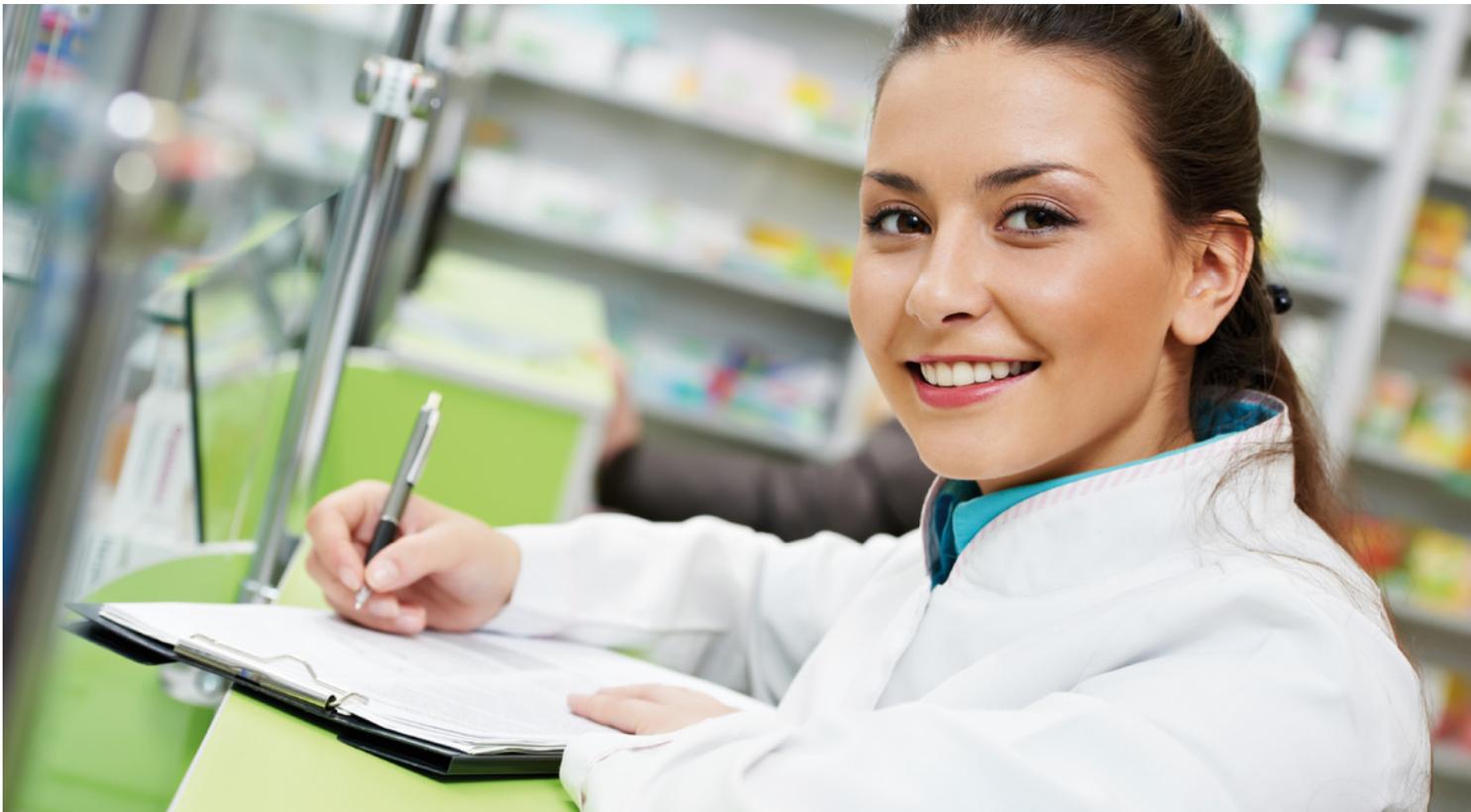
- Supply security
- Consistent quality
- Competitive pricing

Our Serine family – already subject to the highest quality-control standards – meets the strictest regulatory requirements:

- Compliance with US, European and Japanese pharmacopoeias and the FCC
- Certificate of Suitability of Monographs of the European Pharmacopoeia (CEP)
- Drug Master Files (DMFs) in several countries
- Kosher and halal certification
- Compliance with the HACCP food safety standard

The manufacturing, processing and storage facilities at Evonik are routinely audited by health authorities (the US FDA, French Health Authority ANSM, etc). Just as important is the scrutiny of our customers' auditing teams.

We can leverage our experience in DMF and cGMP compliance, combined with our technical know-how, into a competitive advantage for our customers. Also, our broad and deep technological platform enables us to translate expertise into large-scale, on-demand production of serine derivatives, such as BOC-D-Serine, D-Serine methyl ester and further derivatives.



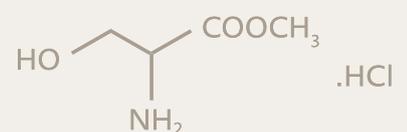
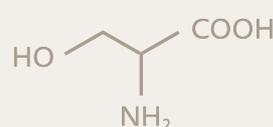
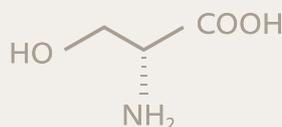
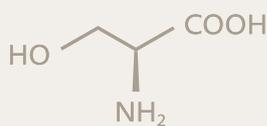
Technical data

L-Serine

D-Serine

DL-Serine

L-Serine Methyl ester hydrochloride



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We look forward to showing you the value we can add to your business.

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You can also contact us with your questions and enquiries via our website:

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There you will find details of your local contact.



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