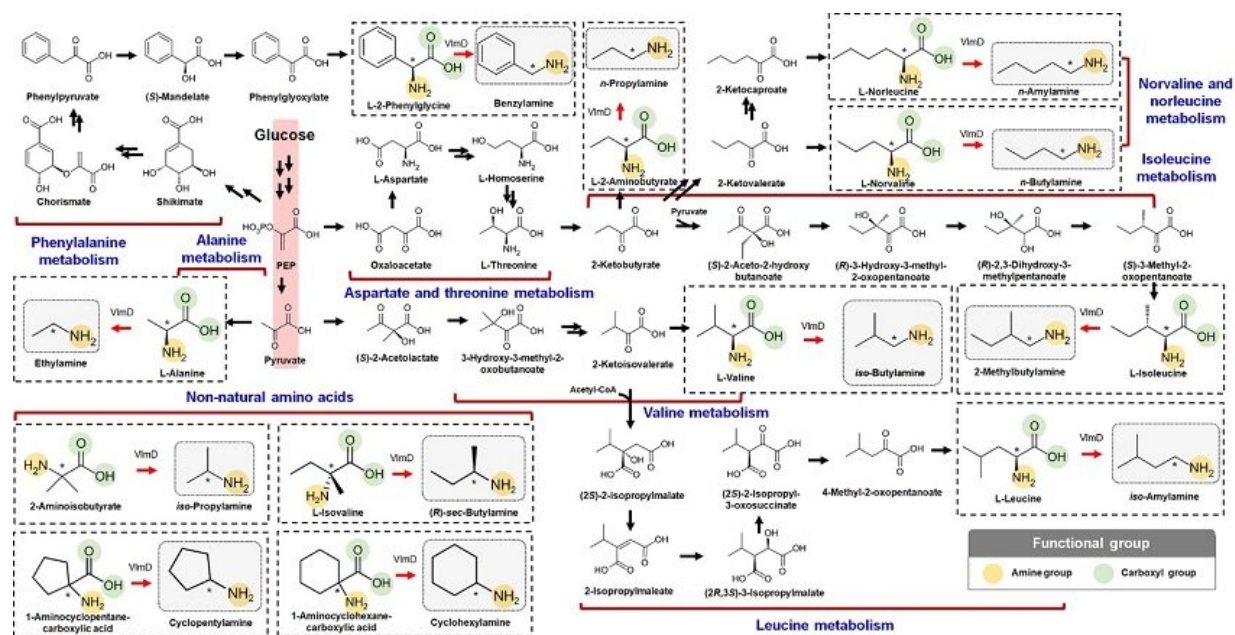


# Expanding the biosynthetic pathway via retrobiosynthesis

January 14 2021



Biosynthetic reactions constructed in *E. coli* for the in vivo production of 12 SCPAs. These 12 SCPAs were the ones shown to be produced by valine decarboxylase (VlmD) in vitro (dotted boxes). Amine and carboxylic groups shown in each dotted box are presented with yellow and green circles, respectively. Reaction center carbon atoms that are subject to chemical transformations are marked with asterisks. Glycolysis is indicated with a red background, which leads to the biosynthesis of 12 amino acid precursors. Multiple reactions are presented with two or more arrows. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

KAIST metabolic engineers present the bio-based production of multiple short-chain primary amines that have a wide range of applications in chemical industries for the first time. The research team led by Distinguished Professor Sang Yup Lee from the Department of Chemical and Biomolecular Engineering designed the novel biosynthetic pathways for short-chain primary amines by combining retrobiosynthesis and a precursor selection step.

The research team verified the newly designed pathways by confirming the in vivo production of 10 short-chain primary [amines](#) by supplying the precursors. Furthermore, the platform Escherichia coli strains were metabolically engineered to produce three proof-of-concept short-chain primary amines from glucose, demonstrating the possibility of the bio-based production of diverse short-chain primary amines from renewable resources. The research team said this study expands the strategy of systematically designing [biosynthetic pathways](#) for the production of a group of related chemicals as demonstrated by multiple short-chain primary amines as examples.

Currently, most of the industrial chemicals used in our daily lives are produced with petroleum-based products. However, there are several serious issues with the [petroleum industry](#) such as the depletion of fossil fuel reserves and [environmental problems](#) including global warming. To solve these problems, the sustainable production of industrial chemicals and materials is being explored with microorganisms as cell factories and renewable non-food biomass as raw materials for alternative to petroleum-based products. The engineering of these microorganisms has increasingly become more efficient and effective with the help of systems metabolic engineering—a practice of engineering the metabolism of a living organism toward the production of a desired metabolite. In this regard, the number of chemicals produced using biomass as a raw material has substantially increased.

Although the scope of chemicals that are producible using microorganisms continues to expand through advances in systems metabolic engineering, the biological production of short-chain primary amines has not yet been reported despite their industrial importance. Short-chain primary amines are the chemicals that have an alkyl or aryl group in the place of a hydrogen atom in ammonia with carbon chain lengths ranging from C1 to C7. Short-chain primary amines have a wide range of applications in chemical industries, for example, as a precursor for pharmaceuticals (e.g., antidiabetic and antihypertensive drugs), agrochemicals (e.g., herbicides, fungicides and insecticides), solvents, and vulcanization accelerators for rubber and plasticizers. The market size of short-chain primary amines was estimated to be more than 4 billion US dollars in 2014.

The main reason why the bio-based production of short-chain primary amines was not yet possible was due to their unknown biosynthetic pathways. Therefore, the team designed synthetic biosynthetic pathways for short-chain primary amines by combining retrobiosynthesis and a precursor selection step. The retrobiosynthesis allowed the systematic design of a biosynthetic pathway for short-chain primary amines by using a set of biochemical reaction rules that describe chemical transformation patterns between a substrate and product molecules at an atomic level.

These multiple precursors predicted for the possible biosynthesis of each short-chain primary amine were sequentially narrowed down by using the precursor selection step for efficient metabolic engineering experiments.

"Our research demonstrates the possibility of the renewable production of short-chain primary amines for the first time. We are planning to increase production efficiencies of short-chain primary amines. We believe that our study will play an important role in the development of

sustainable and eco-friendly bio-based industries and the reorganization of the [chemical](#) industry, which is mandatory for solving the environmental problems threatening the survival of mankind," said Professor Lee.

**More information:** Dong In Kim et al, Microbial production of multiple short-chain primary amines via retrobiosynthesis, *Nature Communications* (2021). [DOI: 10.1038/s41467-020-20423-6](https://doi.org/10.1038/s41467-020-20423-6)

Provided by The Korea Advanced Institute of Science and Technology (KAIST)

Citation: Expanding the biosynthetic pathway via retrobiosynthesis (2021, January 14) retrieved 3 May 2024 from <https://phys.org/news/2021-01-biosynthetic-pathway-retrobiosynthesis.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.