Interactive map of metabolical synthesis of chemicals

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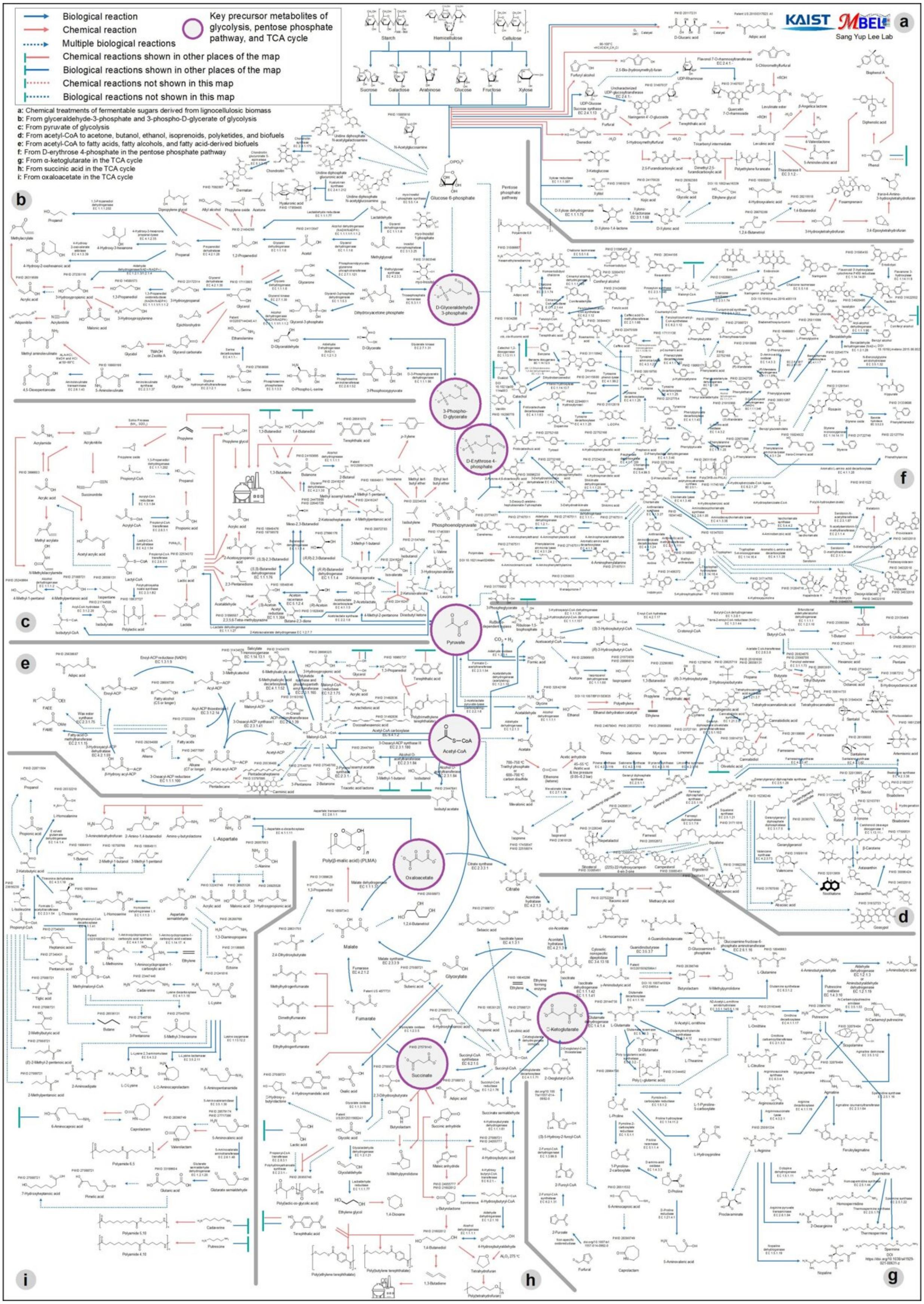
Biological reaction
Chemical reaction
Multiple biological reactions
Chemical reactions shown in other places of the map
Biological reactions shown in other places of the map
Chemical reactions not shown in this map
Biological reactions not shown in this map
Key precursor metabolites of glycolysis, pentose phosphate pathway, and TCA cycle
a: Chemical treatments of fermentable sugars derived from lignocellulosic biomass
b: From glyceraldehyde-3-phosphate and 3-phospho-D-glycerate of glycolysis
c: From pyruvate of glycolysis
d: From acetyl-CoA to acetone, butanol, ethanol, isoprenoids, polyketides, and biofuels
e: From acetyl-CoA to fatty acids, fatty alcohols, and fatty acid-derived biofuels
f: From D-erythrose 4-phosphate in the pentose phosphate pathway
g: From α-ketoglutarate in the TCA cycle
h: From succinic acid in the TCA cycle
i: From oxaloacetate in the TCA cycle
KAIST MBEL
Sang Yup Lee Lab

The interactive metabolic map of bio-based chemicals. Credit: KAIST Metabolic & Biomolecular Engineering National Research Laboratory

A research team comprised of Woo Dae Jang, Gi Bae Kim, and Distinguished Professor Sang Yup Lee of the Department of Chemical and Biomolecular Engineering at KAIST reported an interactive metabolic map of bio-based chemicals. Their research paper "An interactive metabolic map of bio-based chemicals" was published online in *Trends in Biotechnology* on August 10, 2022.

As a response to rapid climate change and environmental pollution, research on the production of petrochemical products using microorganisms is receiving attention as a sustainable alternative to existing methods of productions. In order to synthesize various chemical substances, materials, and fuel using microorganisms, it is necessary to first construct the biosynthetic pathway toward desired product by exploration and discovery and introduce them into microorganisms. In addition, in order to efficiently synthesize various chemical substances, it is sometimes necessary to employ chemical methods along with bioengineering methods using microorganisms at the same time. For the production of non-native chemicals, novel pathways are designed by recruiting enzymes from heterologous sources or employing enzymes designed though rational engineering, directed evolution, or ab initio design.

The research team had completed a map of chemicals which compiled all available pathways of biological and/or chemical reactions that lead to the production of various bio-based chemicals back in 2019 and published the map in *Nature Catalysis*. The map was distributed in the

form of a poster to industries and academia so that the synthesis paths of bio-based chemicals could be checked at a glance.

The research team has expanded the bio-based chemicals map this time in the form of an interactive map on the web so that anyone with internet access can quickly explore efficient paths to synthesize desired products. The web-based map provides interactive visual tools to allow interactive visualization, exploration, and analysis of complex networks of biological and/or chemical reactions toward the desired products. In addition, the reported paper also discusses the production of natural compounds that are used for diverse purposes such as food and medicine, which will help designing novel pathways through similar approaches or by exploiting the promiscuity of enzymes described in the map. The published bio-based chemicals map is also available online.

The co-first authors, Dr. Woo Dae Jang and Ph.D. student Gi Bae Kim, say that they "conducted this study to address the demand for updating the previously distributed chemicals map and enhancing its versatility."

"The map is expected to be utilized in a variety of research and in efforts to set strategies and prospects for chemical production incorporating bio and chemical methods that are detailed in the map."

Distinguished Professor Sang Yup Lee says that "the interactive bio-based chemicals map is expected to help design and optimization of the metabolic pathways for the biosynthesis of target chemicals together with the strategies of chemical conversions, serving as a blueprint for developing further ideas on the production of desired chemicals through biological and/or chemical reactions."

More information: Woo Dae Jang et al, An interactive metabolic map of bio-based chemicals, *Trends in Biotechnology* (2022). DOI: 10.1016/j.tibtech.2022.07.013

Published map: systemsbiotech.co.kr

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