

An atlas of human metabolism

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Published today in the journal *Science Signaling*, Metabolic Atlas (metabolicatlas.org) enables exploration of the most extensive mapping of human metabolism to date. Biochemical information and connectivity for thousands of reactions, compounds, and genes comprising human metabolism is presented with over 150 manually curated 2D maps and automatically generated 3D networks.

Metabolism is the collection of chemical reactions supplying the building blocks and energy necessary to sustain life. Studying the individual components of human metabolism and how they function as part of a connected system is therefore critical to improving health and treating disease. Metabolic Atlas serves as a database and investigative tool to study metabolism and support future research in human health and disease.

Metabolic Atlas is a knowledgebase of metabolism containing carefully curated information on individual metabolic components such as reactions, metabolites, and genes. Interactive maps allow users to visually navigate human metabolism at the level of entire cellular compartments or individual metabolic pathways. Gene expression data for 37 different tissue types from The [Human Protein Atlas](#) (HPA) can be overlaid on the 2D or 3D maps to visualize tissue-specific differences in metabolic gene expression. Furthermore, users can upload their own gene expression data to overlay on the maps.

Metabolic Atlas has also been integrated as part of the [Tissue Atlas](#) in HPA, providing a metabolic summary of proteins that describes their associated reaction pathways and cellular compartments. The [metabolic portion](#) of the Tissue Atlas presents 2D maps of pathways in which a protein participates, accompanied by a heatmap detailing the mRNA levels measured across different human tissue types.

The human biochemical content of the Metabolic Atlas derives from a new genome-scale metabolic model, Human1, which the authors developed in parallel with the web resource. Human1 enables integrative analysis of human biological data and simulation of metabolite flow through the reaction network.

The project is headed by Prof. Jens Nielsen in the Department of Biology and Biological Engineering at Chalmers University of Technology, and conducted in close collaboration with The Human Protein Atlas and National Bioinformatic Infrastructure Sweden (NBIS). "I am excited about establishment of the Metabolic Atlas as it will be an important platform for

future analysis of how human metabolism is changing during disease development, and hereby it can enable identification of novel biomarkers and drug targets”, explains Prof. Nielsen. The work was funded by the Knut and Alice Wallenberg Foundation (kaw.wallenberg.org/en).

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Metabolic Atlas

The Metabolic Atlas (HPA) is a program run by Prof. Jens Nielsen’s research group at Chalmers University of Technology. The program started in 2010 with the aim to identify all metabolic reactions in the human body, including mapping of active reactions in cells, tissues and organs. The new version of the Metabolic Atlas provides several different resources: (i) an updated genome-scale metabolic model for human cells. This model is based on merging information from several different previous models and is the most comprehensive model of human metabolism to date; (ii) a visualization tool that provides an overview of metabolism in human cells. Through overlay of data from the Human Protein Atlas or other sources it is possible to visualize different metabolic functions in different cells, e.g. in cancer cells versus normal cells; (iii) an interaction map that visualize how each enzyme is connected with other enzymes through sharing of metabolites; (iv) a proteome constrained metabolic model that enables predictive model simulation of human metabolism in different cells and tissues. Resources from the Metabolic Atlas has resulted in more than 100 research papers on human metabolism and it has resulted in the identification of novel biomarkers and potential drug targets. The program is funded by the Knut and Alice Wallenberg Foundation.

For more information, see: metabolicatlas.org

Human Protein Atlas

The Human Protein Atlas (HPA) is a program based at the Science for Life Laboratory (Stockholm) and started in 2003 with the aim to map all of the human proteins in cells, tissues and organs using integration of various omics technologies, including antibody-based imaging, mass spectrometry- based proteomics, transcriptomics and systems biology. All the data in the knowledge resource is open access to allow scientists both in academia and industry to freely use the data for exploration of the human proteome. Version 19 consists of six separate parts, each focusing on a particular aspect of analysis of the human proteins: (i) the Tissue Atlas showing the distribution of the proteins across all major tissues and organs in the human body; (ii) the Cell Atlas showing the subcellular localization of proteins in single cells; (iii) the Pathology Atlas showing the impact of protein levels for survival of patients with cancer; (iv) the Blood Atlas showing the profiles of blood cells and proteins detectable in the blood; (v) the Brain Atlas showing the distribution of proteins in human, mouse and pig brain; and (vi) the Metabolic Atlas showing the presence of metabolic pathways across human tissues. The Human Protein Atlas program

has already contributed to several thousands of publications in the field of human biology and disease and it has been selected by the organization ELIXIR (www.elixireurope.org) as a European core resource due to its fundamental importance for a wider life science community. The HPA consortium is funded by the Knut and Alice Wallenberg Foundation.

For more information, see: www.proteinatlas.org

Knut and Alice Wallenberg Foundation

The Knut and Alice Wallenberg Foundation is the largest private financier of research in Sweden and also one of Europe's largest. The Foundation's aim is to benefit Sweden by supporting basic research and education, mainly in medicine, technology, and the natural sciences. The Foundation can also initiate grants to strategic projects and scholarship programs.

For more information, see: kaw.wallenberg.org/en

Science for Life Laboratory

Science for Life Laboratory, SciLifeLab, is a research institution for the advancement of molecular biosciences in Sweden. SciLifeLab started out in 2010 as a joint effort between four universities: Karolinska Institutet, KTH Royal Institute of Technology, Stockholm University and Uppsala University. The center provides access to a variety of advanced infrastructures in life science for thousands of researchers creating a unique environment for health and environmental research at the highest level.

For more information, see: www.scilifelab.se