

## Reactome: New features for enhanced pathway visualisation

Konstantinos Sidiropoulos<sup>1</sup>, Guilherme Viteri<sup>1</sup>, Cristoffer Sevilla<sup>1</sup>, Steve Jupe<sup>1</sup>, Peter D'Eustachio<sup>3</sup>, Lincoln Stein<sup>2,4</sup>, Peipei Ping<sup>5</sup>, Henning Hermjakob<sup>1,6</sup> and Antonio Fabregat<sup>1,7</sup>

<sup>1</sup>European Molecular Biology Laboratory, European Bioinformatics Institute (EMBL-EBI), Wellcome Genome Campus, Hinxton (UK), <sup>2</sup>Ontario Institute for Cancer Research, Toronto (Canada), <sup>3</sup>NYU Langone Medical Center, New York (USA), <sup>4</sup>Department of Molecular Genetics, University of Toronto, Toronto, (Canada), <sup>5</sup>NIH BD2K Center of Excellence and Department of Physiology, Medicine and Bioinformatics, University of California, Los Angeles, California, <sup>6</sup>State Key Laboratory of Proteomics, Beijing Proteome Research Center, Beijing Institute of Radiation Medicine; National Center for Protein Sciences · Beijing, 102206, Beijing (China), <sup>7</sup>OpenTargets, Wellcome Genome Campus, Hinxton (UK)

Reactome (<http://reactome.org>) is a free, open-source, curated and peer-reviewed knowledge base of biomolecular pathways. Pathways in Reactome are organized hierarchically, grouping related detailed pathways (e.g. Translation, Protein folding and Post-translational modification) into larger domains of biological function like Metabolism of proteins. While we provide a hierarchical pathway browser as a key element of the Reactome web interface, the relationships and connectivity between high-level pathways were previously not represented well. In addition, options for re-use of the manually laid out low-level pathway diagrams were limited, as they were only downloadable as PNG images.

Following intensive User Experience testing by external users, we implemented a series of major visual enhancements, to make Reactome more interactive and user-friendly:

1: In the detailed pathway diagrams, sub-pathways are now visually highlighted through shaded boxes.

2: Detailed pathway diagrams are now downloadable as PowerPoint™ slides, with pathway elements rendered as connected PowerPoint™ objects, allowing scientists to edit, modify, and re-use them to present their own pathway-related research results in presentations and publications.

3: The relationships between high level nodes in the Reactome hierarchy, for example between Adaptive Immune System, Innate Immune System, and Cytokine Signalling in Immune System, are now visualised through textbook-style diagrams developed by a professional illustrator. However, these diagrams are not static PNG images, but dynamic SVG graphics, allowing fast zooming and navigation, clicking to link to sub-pathways, as well as overlay of aggregated pathway analysis results. Both diagrams and their graphic components are open data and are released as a re-useable library for biomolecular visualisation to the scientific community.