ALLEN INSTITUTE for BRAIN SCIENCE

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ALLEN INSTITUTE PUBLISHES HIGHEST RESOLUTION MAP OF THE ENTIRE HUMAN BRAIN TO DATE

Allen Human Brain Reference Atlas provides first whole human brain cellular resolution dataset combined with neuroimaging and comprehensive mapping of brain regions

SEATTLE, WASH. — **September 15, 2016** — The Allen Institute for Brain Science has published the highest resolution atlas of the human brain to date in a stand-alone issue of the *Journal of Comparative Neurology*. This digital human brain atlas allows researchers to investigate the structural basis of human brain function.

“To understand the human brain, we need to have a detailed description of its underlying structure,” says Ed Lein, Ph.D., Investigator at the Allen Institute for Brain Science. “Human brain atlases have long lagged behind atlases of the brain of worms, flies or mice, both in terms of spatial resolution and in terms of completeness due to technical limitations related to the enormous size and complexity of the human brain. This large-scale focused effort aimed to create a large resource combining different data types at high resolution, and use these data to generate a comprehensive mapping of brain regions.”

Combining neuroimaging with cellular resolution histological analysis and expert structural mapping, “This is the most structurally complete atlas to date and we hope it will serve as a new reference standard for the human brain across different disciplines,” says Lein.

To create this modern atlas, the team at the Allen Institute partnered with Bruce Fischl, Ph.D. at Massachusetts General Hospital to perform magnetic resonance and diffusion tensor imaging on an intact brain before it was cut into slabs and serially sectioned to allow histological staining of individual sections. This imaging on the same brain created opportunities for linking fine molecular and cellular studies of the brain in health and disease with non-invasive neuroimaging studies.

The Allen Human Brain Reference Atlas aimed to advance human brain mapping by digitizing the histological data at true cellular microscopic resolution, creating a complete ontology of brain regions, and delineating all brain regions on a series of cross-sections through the brain. To image these sections, the Allen Institute team had to develop a new tile-based scanner that could image tissue sections the size of a complete human brain hemisphere at the resolution of roughly a hundredth of the width of a human hair. The atlas was drawn from a single postmortem brain obtained from a 34-year old female donor.

The Allen Human Brain Reference Atlas is an integrated, freely accessible online resource that allows users to navigate the brain and travel from the macroscopic scale of full brain sections to the level of individual neurons. “These features are common in reference atlases of model organisms such as mouse, but have been lacking in human, for which mappings nearly a hundred years old are still in common usage,” says Song-Lin Ding, M.D., Senior Scientist at the Allen Institute for Brain Science and lead author on the project.

"In this regard, the Allen Human Brain Reference Atlas represents a further departure from the classical atlases in its innovative publication format," says Patrick Hof, M.D., Editor-in-Chief of the *Journal of Comparative Neurology* and a participant in the project. "It is the only brain atlas to date to combine the rigor of a peer-reviewed scientific research paper with a presentation as a book format that includes the full set of annotated plates, open-access online availability of the resource with the ability to navigate and explore the details of any given area, and have programmatic access to the underlying data."

Creating this kind of atlas of the human brain is enormously resource-intensive and comes with a unique set of technical challenges, from acquiring specimens to sectioning the tissue and dedicating the time of expert anatomists to painstakingly annotate the data. The outcome is a community resource that is freely available as part of the suite of Allen Brain Atlas tools at brain-map.org.

"The opportunity now is to align our high-resolution atlas with other maps of the human brain, such as those that come from functional studies or studies of the cellular makeup of brain regions," says Lein. "Reference atlases provide a framework for integrating data types, and the combining of different studies is essential to get to the roots of brain function."

Publication reference: Ding, S.-L., et al (2016), Comprehensive cellular-resolution atlas of the adult human brain. *J. Comp. Neurol*. 524(16):3127–3481. doi:10.1002/cne.24080

About the Allen Institute for Brain Science

The Allen Institute for Brain Science is a division of the Allen Institute (alleninstitute.org), an independent, 501(c)(3) nonprofit medical research organization, and is dedicated to accelerating the understanding of how the human brain works in health and disease. Using a big science approach, the Allen Institute generates useful public resources used by researchers and organizations around the globe, drives technological and analytical advances, and discovers fundamental brain properties through integration of experiments, modeling and theory. Launched in 2003 with a seed contribution from founder and philanthropist Paul G. Allen, the Allen Institute is supported by a diversity of government, foundation and private funds to enable its projects. Given the Institute's achievements, Mr. Allen committed an additional $300 million in 2012 for the first four years of a ten-year plan to further propel and expand the Institute's scientific programs, bringing his total commitment to date to $500 million. The Allen Institute for Brain Science's data and tools are publicly available online at brain-map.org.

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