The Human Brain Project (HBP) is a European Commission Future and Emerging Technologies Flagship that aims to achieve a multi-level, integrated understanding of brain structure and function through the development and use of information and communication technologies (ICT). These technologies will enable large-scale collaboration and data sharing, reconstruction of the brain at different biological scales, federated analysis of clinical data to map diseases of the brain, and the development of brain-inspired computing systems.
The HBP is working to achieve an integrated, multi-level understanding of brain structure and function through the development and use of information and communication technologies (ICT)

The HBP’s ICT Platforms will allow neuroscientists, clinical researchers and information technology developers to perform diverse experiments and share knowledge, with a common goal of unlocking the most complex structure in the known universe. During the first two-and-a-half years (the Ramp-Up Phase), the HBP will collect strategic data, develop theoretical frameworks and perform the development work necessary to make the six ICT Platforms available for use by the scientific community in the Operational Phase. The HBP’s ICT Platforms are:

- Neuroinformatics (a data repository, including brain atlases)
- Brain Simulation (building ICT models and simulations of brains and brain components)
- Medical Informatics (bringing together information on brain diseases)
- Neurorobotics (testing brain models and simulations in virtual environments)
- High Performance Computing (this platform will support the other Platforms)
- Neuromorphic Computing (ICT that mimics the functioning of the brain)
- Neurorobotics (testing brain models and simulations in virtual environments)
- High Performance Computing (this platform will support the other Platforms)

The HBP was launched in 2013 and brings together more than 100 academic and corporate Partners in more than 20 countries. HBP research is organised into twelve Subprojects (SP), each broken down into Work Packages (WP) and Tasks (T), with well-defined goals and milestones. Six Subprojects are building the ICT Platforms, while the other six are gathering data, clarifying theory and controlling ethical aspects. An additional Subproject manages and coordinates the HBP.

With an unprecedented cross-disciplinary scope, the HBP’s goal is to catalyse a global collaborative effort to understand the human brain and its diseases and, ultimately, to emulate its computational capabilities.

The goal of SP6 is to deliver an Internet-accessible collaborative Platform for data-driven predictive reconstruction and simulation of brain models.

The Human Brain Project (HBP) Brain Simulation Platform will consist of a suite of software tools and workflows that allow researchers to reconstruct and simulate biologically detailed, multi-level models of the brain displaying emergent structures and behaviours. The Platform will make it possible to reconstruct and simulate models at different levels of description (abstract computational models, point neuron models, detailed cellular level models of neuronal circuitry, molecular level models of small areas of the brain, multi-scale models that switch dynamically between different levels of description), allowing experimentalists and theoreticians to choose the level of detail most appropriate to the questions they are asking and to the data and computing power available. The Platform is being designed to support continuous integration of biological data and implementation of biological principles, ensuring that the models become steadily more accurate and detailed as the Project proceeds. Tools developed for the Platform will allow researchers to collaboratively design and run in silico experiments to further validate the models and perform experiments and manipulations impossible in the lab. Such experiments will contribute to identifying the neuronal architectures underlying specific brain functions, to studies of the mechanisms underlying neurological and psychiatric disease and to the simplification of neuronal circuitry for implementation in neuromorphic technology. The Project will use these tools to reconstruct and validate first-draft models of different levels of brain organisation in mice and in humans. The ultimate goal is to develop multi-scale (simple to complex), multi-level (genes to whole brain) models of the mouse and human brains, in which different brain areas are modelled at levels of detail appropriate to the state of current knowledge and data, the computational power available for simulation and the needs of researchers.
1. Development of a Brain Builder that allows the specification and construction of models to be simulated. Important functions to be provided include automated workflows to reconstruct the whole brain, brain regions, microcircuits, neurons, glia and synapses. The Brain Builder is a key component of the Brain Simulation Platform, allowing collaborative reconstruction of brain models and collaborative planning and execution of *in silico* neuroscience experiments by groups of scientists working over the Internet.

2. Development of functionality to simulate the models specified with the Brain Builder, including software optimised for numerical simulation on different levels of detail. A simulation engine, the cellular simulator that builds on the Neuron software, will cover the range between quite detailed (compartmentalised, HH formalism) neuron models to point neuron models. The network simulator, derived from the existing NEST software, will be able to simulate large networks ranging from point neurons to more abstract box models or mean field models. STEPS provides the foundation for the molecular simulator, which will simulate subcellular signalling such as receptor induced cascades or more biophysically detailed membrane properties. Both engines will be ready by the end of the Ramp-Up Phase.

3. Linking the Brain Builder and simulation engine to the Neuroinformatics Platform and the High Performance Computing (HPC) Platform, making it possible to extract data from the Neuroinformatics Platform and export models to the HPC Platform for simulation or to the Neurorobotics Platform for closed loop experiments; delivery of a handbook on how to use the Platform to build and simulate brain models.

4. Molecular dynamic approaches to predict binding affinities between proteins and constrain kinetic rate constants.

5. Construction and testing of initial draft brain models at the molecular, cellular/microcircuit and brain region levels. Model specifications incorporate detailed knowledge of cell densities and types as well as constraints on long-range projections based on a broad range of experimental measurements (imaging data, electrophysiological measurements, etc.).
Methodology

The HBP is developing a suite of workflows and services allowing researchers from inside and outside the Project to collaboratively reconstruct and simulate models of the brain. These are “snap-shot” models, representing the multi-level structure of a brain at a given stage in its development. The models are generic, representing the mean state of individuals at that age. Individualisation is based on specific configurations of the generic model (e.g. configurations with altered parameters for brain size, numbers of neurons, etc.). Initial parameter values are based on statistical data from experiments and Predictive Neuroinformatics (see SP5) and validated against data from biological experiments. SP6’s hypothesis is that by “training” such models in closed-loop experiments, it will eventually be possible to build systems displaying realistic behavioural and cognitive capabilities. To achieve these goals the Brain Simulation Platform will provide the following functionality.

Brain Builder. The Brain Builder will make it possible to systematically reconstruct brain models of any species, at any age at any desired level of detail, using available data and biological principles. The same software will make it possible to model hypotheses of disease causation (e.g. absence of specific ion channels or receptors, pathological patterns of network connectivity). The Brain Builder will include tools to embed data from brain atlases, a “multi-scale slider” allowing modellers to vary the resolution of their models, as well as tools to set up closed-loop experiments and to deploy simulations to high performance computing Platforms. During the Ramp-Up Phase, the focus is on ensuring compatibility between the existing tool chain and the data set from the Neuroinformatics Platform as well as the Neurorobotics and HPC Platform. In particular, several software tools will be ready for use via the released simulation Platform. Such software for optimising model parameters such as ion channel densities, dendritic and axon morphology, etc. space, data mining tools, data standards and a generic “Atlas Builder,” which will make it possible to build, manage and query such atlases. In addition to this work, the Project will also create and manage a community-driven Wiki that provides an encyclopaedic view of the latest data, models and literature for all levels of brain organisation.

Brain simulation engines. The Platform will incorporate existing community-standard simulation engines for molecular, cellular and network level simulation and drive and complement their developments for the special needs of the HBP. During the Ramp-Up Phase, the focus is on ensuring compatibility between the existing tool chain and the data set from the Neuroinformatics Platform as well as the Neurorobotics and HPC Platform. In particular, several software tools will be ready for use via the released simulation Platform. The Platform will make it possible to build and simulate models representing the same tissue at different scales, and lay the foundations for studies of the relations between levels.

Molecular dynamics simulations. The HBP is developing a multiscale strategy for the prediction of kinetic and thermodynamic parameters required for the simulation of molecular networks. In the Ramp-Up Phase, SP6 researchers will employ modelling techniques at different levels of resolution to characterize the protein-protein and protein-ligand interactions, as well as enzymatic reactivity, involved in neuronal signalling pathways.

Brain models. The Platform will incorporate first draft models representing different levels of brain organisation. These include the following:

- Molecular-level models of neurons, glia and synapses
- Molecular-level models of synaptic plasticity, homeostasis and neuromodulation, and of neuro-vascular-glial coupling
- Cellular-level models of neural microcircuits in selected regions of the mouse brain
- Cellular-level models of whole brain regions and brain systems mixing point neurons

Detailed neuron models and first-draft models of the whole mouse brain with mixed point and detailed neurons

Detailed molecular-level models will be used to generate less complex models that are sufficiently simple to allow their integration in cellular level models. In the Ramp-Up Phase, SP6 is using the Brain Simulation Platform to validate the reconstruction process for building brain models at different levels of description:

The Brain Simulation Platform. Ultimately, the Platform will provide researchers with an internet-accessible Brain Simulation “Cockpit”, allowing them to perform in silico experiments investigating the relationships between different levels of biological organisation in the healthy and the diseased brain and preparing the way for the re-implementation of neuronal circuits in neuromorphic hardware. A professionally managed service centre will provide them with the necessary support and training. The Project will support a dynamic visitors programme for external scientists wishing to make use of these services in their own research. In the Ramp-Up Phase, SP6 is working toward making the Brain Simulation Platform public. In Month 18 it will be released to the HBP Partners, who will use and challenge the Platform functionalities. Based on the feedback received and planned extensions, the Platform will be made ready for release to the general neuroscience community in Month 30 and be continuously updated based on community feedback.
For modelling and simulation and development of related tools, SP6 uses the high performance capabilities supplied by SP7 (High Performance Computing Platform). Users will access the Platform via a single point of access (a web portal) shared among all the Platforms.

Computer Resources
Deliverables

MONTH 6 — REPORT
BRAIN SIMULATION
PLATFORM V1 - SPECIFICATION DOCUMENT

This report provides a detailed specification of the Brain Simulation Platform v1, the simulators incorporated in the Platform, and first-draft brain models. Additionally, the report specifies indicators of progress and target values for the indicators.

MONTH 12 — REPORT
BRAIN SIMULATION
PLATFORM V1 - SET-UP DOCUMENT

This report describes progress in the development of the Platform, the simulators incorporated in the Platform, and first draft brain models.

MONTH 18 — PROTOTYPE
BRAIN SIMULATION
PLATFORM V1 - PRELIMINARY RELEASE
FOR INTERNAL CONSORTIUM USE

The prototype, which will be available for use by members of the HBP Consortium, will comprise alpha releases of all the key components of the Platform including the brain builder, the simulators and first draft models of major regions of the mouse brain.

MONTH 30 — PROTOTYPE
BRAIN SIMULATION
PLATFORM V1

The prototype, which will include a portal providing access to the world neuroscience community, will comprise facilities for remote access together with fully functioning implementations of all the components of the Platform including the brain builder, the simulators and first-draft models of major regions of the mouse brain.

MONTH 30 — REPORT
BRAIN SIMULATION
PLATFORM V1 - DOCUMENTATION

The prototype will be accompanied by technical and user documentation—a Platform manual—facilitating use of the Platform by users within and outside the HBP Consortium and by a roadmap describing plans for future development in the Operational Phase of the Project.
Milestones

MONTH 6
- Software application to fit ion channel densities to reproduce any target electrophysiology, v1
- Brain Simulation Platform fully specified
- Requirements for user documentation and support for Neuromorphic Platform, guidelines for establishing alliances

MONTH 12
- Software to synthesise cellular morphologies, including projecting axons, v1
- Multi-scale cellular simulator (with a range of neuron models from point neurons to detailed neurons) v1
- First draft model of somatosensory cortex
- Identification of potential alliances on brain simulation

MONTH 18
- First draft predictions of drug binding affinities
- Advanced methods for automated cellular-level modelling of neurons
- Brain Simulation Platform v1 ready for internal release
- Guidebook for the use of the Neuromorphic Computing Platform – initial release

MONTH 24
- Multi-scale network simulator (with a range of network models from point neuron networks to box models) v1
- Refinement and testing of reaction rate constants and binding affinities predictions for protein-protein and ligand-protein interactions
- Hippocampus CA1

MONTH 30
- Multi-scale molecular simulator (with a range of models ranging from single molecule to molecular population models) v1
- First-draft predictions of rate constants and binding affinities for protein interactions in kinase cascades
- Molecular-level models of mouse neurons and synapses, models of neuro-vascular-glial coupling in mouse, models of mouse neural microcircuits, models of cerebellum, full neocortex and hippocampus
- Brain Simulation Platform v1 ready for community release
- Guidebook for the use of the Brain Simulation Platform
France
Centre National de la Recherche Scientifique – CNRS
École Normale Supérieure - ENS

Germany
Forschungszentrum Jülich GmbH – JUELICH
German Research School for Simulation Sciences GmbH – GRS
HITS GmbH – HITS

Israel
Hebrew University of Jerusalem – HUJI

Italy
Universita degli Studi di Pavia – UNIPV

Japan
Okinawa Institute of Science and Technology – OIST

Sweden
Kungliga Tekniska Högskolan – KTH

Switzerland
École Polytechnique Fédérale de Lausanne – EPFL

United Kingdom
University College London – UCL

United States
Yale University – YALE

www.cnrs.fr
www.ens.fr
www.fz-juelich.de
www.grs-sim.de
www.h-its.org
www.huji.ac.il

www.unipv.eu
www.ost.jp
www.kth.se
www.epfl.ch
www.ucl.ac.uk
www.yale.edu
Work Packages and Key Personnel

Subproject Co-Leaders

Henry MARKRAM, Jeanette HELLGREN-KOTALESKI

WP6.1 Data-driven reconstruction of brain models

The Brain Builder
Henry MARKRAM - EPFL

The Brain Atlas embedding module
Idan SEGEV - HUJI
Marc-Oliver GEWALTIG - EPFL

Support for closed loop experiments
Felix SCHÜRMANN - EPFL

Configuring & deploying simulations on supercomputers
Rebecca WADE - HITS

WP6.2 Brain simulation engines

The Molecular Simulator
Felix SCHÜRMANN - EPFL
Erik DE SCHUTTER - OIST

The Cellular Simulator
Felix SCHÜRMANN - EPFL
Michael HINES - YALE

The Network Simulator
Markus DIESMANN - JUELICH

Performance optimisation and benchmarking
Felix SCHÜRMANN - EPFL

WP6.3 Molecular dynamics simulation

Atomistic and coarse-grained model simulations
Richard LAVERY - CNRS

Hybrid QM/MM MD methods and atomistic MD
Paolo CARLONI - GRS

Brownian Dynamics - BD
Rebecca WADE - HITS

WP6.4 Initial brain models

Molecular-level models of neurons, glia and synapses
Jeanette HELLGREN-KOTALESKI - KTH

Molecular-level models of synaptic plasticity, homeostatic mechanisms and neuromodulation
Antoine TRILLER - ENS

Molecular models of neuro-vascular-glial coupling
Pierre MAGISTRETTI - EPFL
Alex THOMSON - UCL

Cellular models of brain regions
Egidio D'ANGELO - UNIPV

Cellular-level models of whole brain
Sten GRILLNER - KI

WP6.5 Brain Simulation Platform: integration and operations

Integration, website construction, maintenance and administration
Felix SCHÜRMANN - EPFL

WP6.6 Brain Simulation Platform: user support and community building

Brain simulation documentation and training
Felix SCHÜRMANN - EPFL

Industry collaborations & independent industry research
Henry MARKRAM - EPFL

WP6.7 Brain Simulation Platform: scientific coordination

Scientific coordination and support
Felix SCHÜRMANN - EPFL

SP6 Objective

"To deliver an Internet-accessible collaborative Platform for data-driven predictive reconstruction and simulation of brain models."
Henry Markram is the founder of the Brain Mind Institute, founder and director of the Blue Brain Project, and the coordinator of the Human Brain Project. After earning his Ph.D at the Weizmann Institute of Science (Israel), with distinction, he was a Fulbright scholar at the National Institutes of Health (USA), and a Minerva Fellow at the Max-Planck Institute for Medical Research, Germany. In 1995 he returned to the Weizmann Institute, becoming an Associate Professor in 2000. In 2002 he became a full professor at EPFL. Markram’s research has focused on synaptic plasticity and the microcircuitry of the neocortex, in which he has discovered fundamental principles governing synaptic plasticity and the structural and functional organisation of neural microcircuitry. Other key discoveries include the concept of Liquid Computing and the Intense World Theory of Autism. In 2005 he launched the Blue Brain Project to develop a data integration strategy for neuroscience that will play an important role in the HBP. Markram has published more than 100 papers and has an H-index of 53, one of the highest in his area of research and stage of career. Since 2002, Markram has spearheaded Switzerland’s ambition to become a world leader in High Performance Computing and to prioritise simulation-based research; these fields are now two of the three national research priorities declared by the Swiss government (http://www.ethrat.ch/en/section-general-news/successes-education-and-research-call-more-resources). Markram is also founder of Frontiers (frontiersin.org), a new model for peer-reviewed open-access publishing.

Jeanette Hellgren-Kotaleski holds an MSc in Engineering Physics, a Licentiate degree in Medical Sciences and a Ph.D. in Computer Science. Since her postdoctoral studies in systems biology at the Krasnow Institute, George Mason University, USA, she has been a full professor in Neuroinformatics at KTH since 2007. She is the coordinator of an international Erasmus Mundus joint Ph.D. programme involving Partners from Germany, UK and India and is the leader of the Swedish INCF node. Dr. Hellgren-Kotaleski co-directs the HBP Brain Simulation Subproject.

Paolo Carloni obtained his Ph.D. in Chemistry at the University of Florence in 1993. Until 2009, he was head of the Statistical and Biological Physics sector in SISSA (Italy), from where he moved to the University of Aachen (Germany) to lead the Computational Biophysics sector of the GRS at FZ-Jülich. Since 2012 he has been Director of the Computational Biomedicine lab (IAS-5) at FZ-Jülich. He has published more than 180 articles, and has supervised 25 Ph.D. theses in Computational Biophysics.
Egidio D’Angelo has a degree in medicine from the IRCCS C. Mondino. He has been a Fellow of the European Science Foundation, and was awarded the SIF prize for young physiologists by the Società Italiana di Fisiologia. He has been a visiting professor at the Universities of Heidelberg and Jerusalem, and an associate professor at the University of Parma. A full professor of physiology at the University of Pavia, where he teaches neuroscience, neurophysiology, and neuronal modelling, he also serves as director of its Ph.D. programme in physiology and neuroscience. He directs the Brain Connectivity Center for neuroscience research, IRCCS C. Mondino, the European Projects CEREBNET (ITN), and REALNET (ICT). An associate editor of the Journal of Physiology and of Functional Neurology, he is a member of the directors’ committee of the Italian Society for Neuroscience.

Erik De Schutter studied medicine in Belgium where he obtained his MD at the University of Antwerp, and subsequently specialised as a neuropyschiatrist. During his residency, his research focused on computational modelling of central pattern generation in leech. He subsequently became a research fellow at the California Institute of Science and Technology, where he developed the famous Purkinje cell model. He then joined the Theoretical Neurobiology group at the University of Antwerp where he focused on modelling and understanding synaptic plasticity and oscillations in the cerebellum and on software development for reaction-diffusion modelling and automated parameter searching. He subsequently joined OIST where he currently leads the Computational Neuroscience Unit and is involved with several international organisations promoting computational neuroscience. He is the president of the Organisation for Computational Neuroscience and a member of the governing board of the International Neuroinformatics Coordinating Facility (INCF).

Markus Diesmann has Ph.D.s from the Weizmann Institute, and The University of Freiburg in Germany. He has held assistant professor and group leader positions at the Max Planck Institute in Goettingen, Albert-Ludwigs-University in Freiburg and the RIKEN Brain Science Institute in Japan. Currently, he is professor of computational neuroscience at the University of Aachen and the director of the Institute of Neuroscience and Medicine (INM-6) at Computational and Systems Neuroscience at Research Center Jülich in Germany.

Marc-Oliver Gewaltig co-directs the Neurorobotics Subproject and leads the Neuroinformatics Section of the Blue Brain Project at EPFL in Lausanne. In his research, Dr. Gewaltig investigates the computational properties of the neocortical column in closed action-perception loops. He also has a strong interest in the computer science for large-scale neural simulations and is co-author of the neural simulation tool NEST (www.nest-initiative.org). Before joining EPFL in 2011, Marc-Oliver Gewaltig was Principal Scientist (2003-2011) and Project Leader (1998-2002) at the Honda Research Institute Europe in Offenbach, Germany, where he worked on detailed columnar models of information processing in the primate visual cortex and on learning and plasticity.
Sten Grillner has an academic background in medicine and neurophysiology and has been the director of the Institute for Neurophysiology and an active member and chairman of the Nobel Assembly, since 1986. He is also the founding chairman of the International Neuroinformatics Coordinating Facility (INCF) and a past-president of the Federation of European Neuroscience. Grillner has over many years reconstructed the neural circuits of the lamprey and is the world’s pioneer on simulation-based research. A member of several illustrious academies of science in both Sweden and the USA, he has received many awards including the prestigious Kavli prize in 2008. He has lectured on a wide variety of topics including computational neuroscience, bionic robotics and neuroethology. He is a member of the editorial boards of various international journals, and has served on the evaluation panels of many eminent academies including the Norwegian Research Council, the RIKEN Brain Science Institute and the German government’s Bernstein Centers. Dr. Grillner co-leads the HBP Neuroinformatics Subproject.

Michael Hines received his Ph.D. in Physics from the University of Chicago in 1975. He has been a medical research associate professor at Duke University and is currently Senior Research Scientist in the Department of Neurobiology at Yale University. His research - and the development of NEURON - is motivated by the need to maintain conceptual control of large simulations in neurophysiology. NEURON provides a framework for understanding the contributions of anatomy and biophysics to the function of neurons and neural circuits.

Richard Lavery is the Head of the bioinformatics group in the Institute of Biology and Chemistry of Proteins, Lyon. CNRS UMR 5086 / University of Lyon. He is an expert in molecular simulation and in particular in recognition processes involving biological macromolecules. His research targets the mechanisms of molecular recognition and assembly using both all-atom and coarse-grain models and exploiting grid and supercomputer resources.

Pierre Magistretti, MD, Ph.D. is the Director of the Brain and Mind Institute (BMI) at the EPFL and Director of the Center for Psychiatric Neuroscience at the University of Lausanne Medical School and Hospital (CHUV). The author of over a hundred and fifty publications, he has been elected to the International Chair 2007-2008 of the Collège de France, Paris, is a member of Academia Europaea and of the Swiss Academy of Medical Sciences, was the president of the Federation of European Neuroscience Societies (FENS) and is currently Secretary-General of The International Brain Research Organisation (IBRO). Since 2010, he has been Director of the National Center for Competence in Research (NCCR) of the Swiss National Science Foundation.
Felix Schürmann is adjunct professor at the École Polytechnique Fédérale de Lausanne and co-director of the Blue Brain Project. He studied physics at the University of Heidelberg, Germany, supported by the German National Academic Foundation. Later, as a Fulbright Scholar, he obtained his Master’s degree (M.S.) in Physics from the State University of New York, Buffalo, USA, under the supervision of Richard Gonsalves. During these studies, he became curious about the role of different computing substrates and dedicated his Master’s thesis to the simulation of quantum computing. He studied for his Ph.D. at the University of Heidelberg, Germany, under the supervision of Karlheinz Meier. For his thesis he co-designed an efficient implementation of a neural network in hardware. Now, at the Blue Brain Project, he oversees all computing-related aspects such as high performance computing, visualization, computing infrastructure and computational science and engineering processes.

Idan Segev is the David and Inez Myers Professor in Computational Neuroscience and the former director of the Interdisciplinary Center for Neural Computation (ICNC) at the Hebrew University of Jerusalem. He received his B.Sc (1973) in Math and his Ph.D (1982) in experimental and theoretical neurobiology, in the very same university. His work is published in reputed journals and he has received several important awards, some for his excellent teaching abilities. He takes a keen interest in the connection between art and the brain. Prompted by an encounter with ICNC researchers, he has recently co-edited an “Artists” book with original etchings by ten top Israeli artists. Segev, the world’s undisputed leader and a pioneer on model neurons, has been instrumental in theoretically ground automated building of model neurons in the Blue Brain Project.

Alex M. Thomson earned a BSc in Physiology at Bedford College, London, before moving to Bristol Physiology for her Ph.D. in muscle physiology. After two postdoctoral years in Bristol, she moved to the Physiology Lab in Oxford, with a Beit Memorial Fellowship. In 1985 she became Wellcome Lecturer at University College Cardiff. Here she began the paired recordings from synaptically connected cortical neurones that have become the hallmark of the lab. In 1988, she joined Royal Free Hospital Medical School, where, in 1998, she became Professor of Neurophysiology at the newly combined Royal Free and UCL Medical School. In 2002 she joined the UCL School of Pharmacy as Wellcome Professor of Pharmacology (2002-) and Head of Pharmacology (2002-2007).

Antoine Triller is responsible for the revelation that synaptic receptors are accumulated in front of the presynaptic zone (J. Cell Biol 1985). He then developed the use of quantum dots for single molecule tracking (Science 2003), considered by Science magazine as one of the ten breakthroughs of the year. He went on to suggest that the plasma membrane can be analysed globally using a formalism derived from statistical mechanics (Biophys J 2006, Phys Rev E 2009, Phys Rev Let 2011). With these tools, he was able to identify new mechanisms for the adaptation of inhibition to excitation involving PKC, CamK2 and calcineurin dependant phosphorylations (Neuron 2008, 2009) and to identify their molecular determinants (EMBO J 2011). He went on to demonstrate that integrins are key actors in the regulation of the tuning of excitation-inhibition coupling (Nat Neurosci 2010) and in the physiopathology of neurodegenerative diseases (Neuron 2010).
Rebecca Wade is an alumnus of the University of Oxford, where she obtained her B.A. Hons. in Physics, and D. Phil. in Molecular Biophysics. She then did her postdoctoral research in the USA in Houston and Illinois. She was a group leader in the Structural and Computational Biology Programme at the European Molecular Biology Laboratory (EMBL) in Heidelberg from 1992 to 2001. Since then she has led the Molecular and Cellular Modelling group at EML Research (now HITS). Since 2011, she has also held a Professorship in Computational Structural Biology at the University of Heidelberg.
THE HBP’S EMPHASIS ON COLLABORATION IS EXEMPLIFIED BY THE INTERDEPENDENCE OF ITS TWELVE RESEARCH SUBPROJECTS

SP6 will use its tools to build models of large-scale neuronal circuitry, leading ultimately to models of the whole mouse and human brains.

SP6’s Brain Simulation Platform will consist of a suite of collaborative software tools that allows researchers to build models of the brain at different levels of biological detail, and to predictively reconstruct and simulate the behaviour of the models on supercomputers. The tools build on the well-established Neuron, STEPS and NEST simulators, as well as on the results of EPFL’s Blue Brain Project. SP6 will use its tools to build and gradually improve models of large-scale neuronal circuitry, leading ultimately to models of the whole mouse and the whole human brain. Computer models of the brain are easy to observe and manipulate, and the models developed by SP6 will allow experiments that would be ethically or technically impossible in animals or humans. The availability of the models will make it easier for researchers to trace the causal mechanisms responsible for human cognition and behaviour and the way these mechanisms break down in disease. Scientists from outside the HBP Consortium will use the platform to develop their own brain models and to conduct their own experiments.