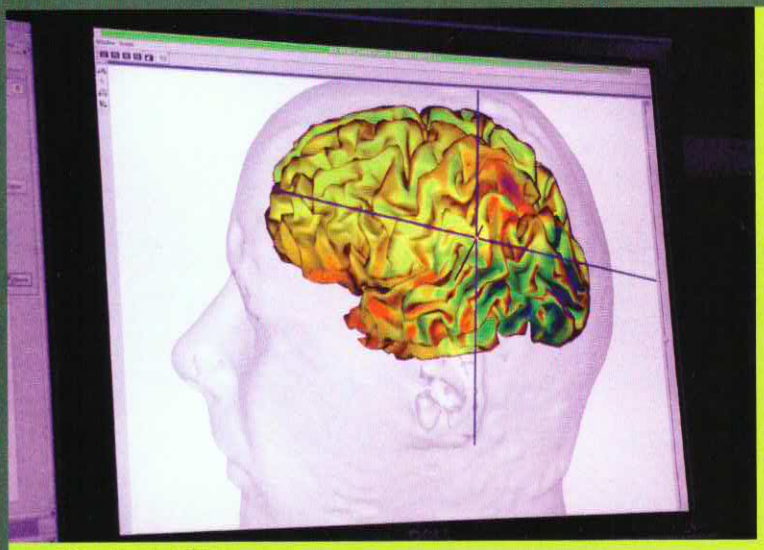
# MATHEMATICAL MODELING ACROSS DOMAINS



© Pierre Kitmacher/UPMC

**UPMC is actively looking to boost innovation through combined expertise from different disciplines. Modeling and simulation research laboratories offer exceptional synergies when combined with other domains.**

## THE ICS

The **Institute for Scientific Computation and Simulation** (ICS) is a center of research, expertise and training in scientific computing, operating a wide range of allocated computational resources and high-performance 3D visualization devices.

This center provides a structure for multidisciplinary teams for collaborative projects in scientific computing. It stimulates, supports and promotes the development of innovative computational methods, to allow the multidisciplinary teams to achieve significant scientific breakthroughs.

Inspired by the model of European and international academic centers of excellence, the institute consists of three components:

i) A scientific computing center for research, expertise and transfer

ii) A training/learning center that ensures the dissemination of good practices in scientific computing

iii) A service and support unit dedicated to software administration of computational resources at UPMC.

## MATHEMATICAL AND COMPUTER MODELING OF COMPLEX SYSTEMS – UMMISCO

The UMMISCO, under the joint supervision of IRD and UPMC, has partner teams in France, Africa and Southeast Asia. The thematic applications in modeling research conducted in this laboratory are linked to the major scientific priorities of the IRD. Sciences of complexity are undergoing rapid development, motivated by global issues (ecology, public health, social stability). UMMISCO's major challenge is to model these complex systems, whose behavior at a given scale is the product of interactions between a large number of entities at a smaller scale.

Partner centers are in Morocco with Cadi Ayyad University of Marrakech, two locations in Senegal, at the University Cheikh Anta Diop of Dakar and at the University Gaston Berger of Saint-Louis, in Cameroon with the University of Yaoundé 1 and in Vietnam with the Francophone Institute for Informatics in Hanoi.

## CENTRE FOR INNOVATION IN BIOMEDICAL IMAGING - CIIB

The Centre for Innovation in Biomedical Imaging (CIIB) aims to integrate multidisciplinary research for the development, validation, and transfer of new multimodal and multi-scale biomedical imaging technologies for the early diagnosis, estimation of disease progression and treatment evaluation. It shares research facilities for measuring and modeling within the CIIB teams, and co-supervises master's students and doctoral candidates. The CIIB also participates in the dissemination of knowledge and ensuring the transfer of clinical and industrial developments.

## PARAMETRIC IMAGING LABORATORY

This laboratory is located at the Cordeliers Biomedical Research Centre, with research activity centered on the biomedical applications of ultrasound, within the following fields of predilection: ultrasonic methods for bone characterization, high frequency imaging (small animal), functional imaging of contrast and the characterization of biological or biomimetic systems of nanometric size.

UPMC
SORBONNE UNIVERSITÉS

# COMBINING MATHEMATICS AND MEDICINE

© Pierre Kitmacher/UPMC

## CROSS-DISCIPLINARY MASTER'S SPECIALIZATION

The UPMC mathematics department offers courses in mathematical modeling related to biosciences and several research teams host PhD/post-doc students.

**Mathematics Applied to Biological & Medical Sciences: a Second-year Master's Specialization:**
This course is centered on stochastic and deterministic analysis tools, simulation, and modeling for life sciences. It covers issues of basic biology and biomedical applications. This course is designed for both the training for researchers in the field of "Mathematics for biology" and preparation for direct employment in the biotechnology sector.

## ACTIVE RESEARCH PROJECTS

The Jacques-Louis Lions Laboratory has developed research activity in several teams on modeling and high-performance computations applied to life sciences. The BANG project studies cancer modeling (a joint effort by UPMC/INRIA and in contact with the *Institut Universitaire du Cancérologie*) and the REO project that models biofluids and miomechanics (a joint UPMC/INRIA effort). Partnerships with neurosciences and developmental biology have also been developed.

## BANG: THE RESEARCH PROJECT

The BANG research team is a joint INRIA/UPMC project. It combines researchers in applied mathematics, computer science, statistical physics and medicine, studying application domains related to biology and medicine, and to fluid dynamics for geophysics.

Of particular interest for the BANG project are problems of mathematical biology related to cell movements and cell population growth, in particular for healthy or cancer cells, subject to intact or disrupted physiological control, and to the possible restoration of this normal control by drugs. The team is also developing methods to optimize cancer pharmacotherapeutics from a molecular systems biology point of view, and simultaneously, to represent tissue growth in health or pathology, i.e., under normal or disrupted control, in a multiscale setting, in particular toward modeling for regenerative medicine.

Research topics of the BANG project include partial differential equations, ordinary differential equations, methods of statistical physics, numerical algorithms and applications to:

- Cell division cycle modeling for healthy and cancer cells
- Aggregation-fragmentation models for prion and Alzheimer's diseases (ANR TOPPAZ)
- Cell chemotaxis and cell aggregation
- Molecular cancer pharmacotherapy and its optimization
- Individual-based models of tissue and tumor growth
- Numerical Analysis, Geophysics and Ecology (ANGE)

## THE REO PROJECT

The REO project team is working on the numerical simulation of biological flows. Its main objectives are:

- To model of blood flows in large vessels and air flows in the respiratory tract
- To design and analyze efficient and robust numerical methods for such flows
- To develop numerical software to assist in making medical decisions and to improve existing medical devices

REO's research themes cover direct and inverse modeling and computational methods for:

- Fluid-structure interaction problems: interaction blood / arteries or cardiac valves
- Cardiac electrophysiology and electro-mechanical coupling
- Aerosol deposition in the respiratory tract

www.upmc.fr

**Pierre and Marie Curie University**
Office of International Relations
4, place Jussieu - 75252 Paris cedex 05
Tel. +33 (1) 44 27 30 65
Fax. +33 (1) 44 27 75 67
**relations.internationales@upmc.fr**

UPMC SORBONNE UNIVERSITÉS

UPMC-VPRI - November 2012