

**Computer modelling and simulation for improving human health
October 23-24, 2008
Brussels, Belgium**

Chairs:

**Georgios Stamatakos, National Technical University of Athens (EU side)
Tom Deisboeck, Massachusetts General Hospital (US side)**

Rapporteur:

Ilias Iakovidis (European Commission, ICT for Health, Deputy Head of Unit)

First Transatlantic Workshop on Multiscale Cancer Modeling

1. Summary of the workshop

On October 23-24, 2008 the **First Transatlantic Workshop on Multiscale Cancer Modeling**^{1, 2} took place in Brussels, Belgium, EU within the framework of the ICT BIO 2008 event³ organized by the European Commission (EC). The workshop was supported by the US National Institutes of Health (NIH) – National Cancer Institute (NCI) and the European Commission (EC). Important organizational roles were played by the EC funded research project *Advancing Clinico-genomic Trials on Cancer (ACGT)*⁴ and in particular by its action *Technologies and Tools for In Silico Oncology*⁵ as well as by the NCI funded research project *Center for the Development of a Virtual Tumor (CViT)*⁶. The event was technically co-organized and co-chaired from the EU side by Georgios Stamatakos, PhD (National Technical University of Athens, NTUA) and from the US side by Tom Deisboeck, MD (Massachusetts General Hospital, MGH). The main goals of the workshop were to present cutting edge modeling methods, results, validations and visions related to cancer simulation at all levels of biocomplexity as well as to foster intercontinental research interactions and collaborations on this highly prioritized subject. Following each presentation, a fruitful discussion with the participants (>100 participants in the workshop) took place. At the end of the two day event the NCI and EC representatives along with the Chairs wrapped up the conclusions. The workshop was webcasted live from the Charlemagne building of the European Commission in which it was hosted.

2. Quick summary of the different presentations

The event started with introductory talks on intercontinental research policy and collaboration which were delivered by Dan Gallahan, NCI, and Ilias Iakovidis, EC. Both speakers stressed the special focus of the respective organisations on *multilevel cancer modeling* research. Tom Deisboeck, MGH, and Georgios Stamatakos, NTUA delivered introductory talks on the technical content and the potential scientific, technological and clinical implications of the workshop. Scientific presentations by ten US and ten EU invited speakers had been planned and delivered with the exception of one due to force majeure. The titles of the presentations along with the presenters names were as follows.

1. Complex Events and Emergence in Cancer Systems

Sylvia Nagl, Ph.D. [EU]

2. Temporal and Spatial Scales of Premalignant Clones in Cancer

E. Georg Luebeck, Ph.D. [US]

3. Multi-scale Modeling of Functional and Disfunctional Intracellular Modules of Oncogenic Relevance

Ravi Radhakrishnan, Ph.D. [US]

4. Genetic Instability in Cancer: Thresholds and Catastrophes

Ricard Sole, Ph.D. [EU]

5. Ab Initio Computational Modeling of Tumor Spheroids

Roberto Chignola, Ph.D. [EU]

6. Modelling Somatic Evolution and Aspects of Vascular Tumour Growth

Philip Maini, Ph.D. [EU]

7. In silico Modeling of Solid Tumour Growth and Vascularization

Gabor Szekely, Ph.D. [EU]

8. Multi-scale Simulation of Tumor Cell Adhesion: At the Interface of Statistical Mechanics and Cell Biology

Muhammad H. Zaman, Ph.D. [US]

9. Computational Modeling Identifies Morphologic Predictors of Tumor Invasion

Vittorio Cristini, Ph.D., FAAN [US]

10. Do Tumour Invasion Strategies Follow Basic Physical Laws?

Caterina Guiot, Ph.D. [EU]

11. The Evolution of Metastasis

Carlo Maley, Ph.D. [US]

12. Mathematical Approaches to Modeling Immune-Cancer Dynamics

Lisette de Pillis, Ph.D. [US]

13. Building Tumor Models Using GGH Modeling and CompuCell3D

James A. Glazier, Ph.D. [US]

14. Multiscale Modelling of Colorectal Cancer and Vascular Tumour Growth

Helen Byrne, Ph.D. [EU]

15. Multiscale Mathematical Modelling of Vascular Tumour Growth

Mark Chaplain, Ph.D. [EU]

16. Multi-scale Agent-based Cancer Modeling

Thomas S. Deisboeck, M.D. [US]

17. Clinical Requirements Regarding In Silico Oncology

Norbert Graf, M.D. [EU]

18. Predictive Multi-scale Modeling of Glioma Growth and Invasion in Individual Patients

Kristin Rae Swanson, Ph.D. [US]

19. Clinically Oriented Cancer Multilevel Modeling Based on Discrete Event Simulation

Georgios Stamatakos, Ph.D. [EU]

The original workshop program along with contact data of the speakers and the organizers can be found on the Conference website¹. Short outlines of the supporting projects ACGT/Workpackage 8⁵ and CViT⁶ were also presented by the Co-Chairs. The event concluded with final remarks made by Dan Gallahan, Ilias Iakovidis and Tom Deisboeck including the announcement of the publication of a book which will contain representative parts of the material presented during the event. The conclusions of the workshop were presented by Georgios Stamatakos. They are summarized as follows:

The workshop turned out to be a real success since it provided a great opportunity for a good number of distinguished investigators from both coasts of the Atlantic to get to know each other, to be informed on different multiscale cancer modeling approaches, to highlight different modeling goals, to point out different modeling priorities, to present different tools, methods, results and validation techniques and all that in the inspiring context of the ICT BIO 2008 event. During the entire workshop it was made clear that appropriate combinations of multilevel cancer models could provide much higher potential for both understanding cancer and optimize its treatment than isolated modeling efforts. In this context G. Stamatakos suggested that the idea of a "mosaic" made up of many modeling pebbles might serve as a much better modeling strategy metaphor than a "monolithic modeling masterpiece". Such an approach would dictate strong, positive and even enthusiastic interactions and collaborations among cancer modelers. The workshop provided an excellent opportunity for the initiation of such interactions.

The Organizers along with the Participants expressed their hope that the fruitful and exciting interaction among investigators from both coasts of the Atlantic would continue beyond the workshop time frame and would lead to quite concrete and tangible results primarily to the benefit of the suffering cancer patient. They also expressed their hope that the event would prove to be the first one in a series of transatlantic workshops on multiscale cancer modeling to take place on both continents. Subsequently they expressed their warmest thanks to both NIH-NCI and the European Commission for the co-organization of the event, their critical financial support and still more for their strong commitment to foster the advancement of multiscale cancer modeling as an integral part of cancer research. Finally they expressed their gratitude to the speakers and the whole audience for turning a vision of sitting together, exchanging views and experiences in person, working together, and forming an intercontinental alliance against cancer into reality.

References

¹ http://ec.europa.eu/information_society/events/ict_bio/2008/ta-cancer-wkshp/index_en.htm

² http://ec.europa.eu/information_society/events/ict_bio/2008/docs/ictbio2008background.pdf

³ http://ec.europa.eu/information_society/events/ict_bio/2008/index_en.htm

⁴ <http://www.eu-acgt.org/>

⁵ <http://eu-acgt.org/acgt-for-you/researchers/in-silico-oncology.html>

⁶ <https://www.cvit.org/>

3. Discussion & overall conclusions

The event was attended by a large number of basic science and technology researchers, clinicians, industry representatives and research policy makers from across the globe. Numerous questions provided the opportunity for in depth discussions of a wide range of issues spanning from concrete mathematical modeling questions to the extent of the involvement of clinicians in the process of cancer modeling and validation. From the clinical point of view of special interest was the presentation made by Norbert Graf, MD, University of Saarland regarding the clinical expectations of *in silico* oncology.

Overall conclusions

The interaction between participants from both continents proved particularly stimulating in terms of both the advancement of science and the emergence of intercontinental *research groups* with the aim of quantitatively understanding and modeling the hypercomplex *natural phenomenon* and *disease* of cancer. Supporting patient individualized cancer treatment optimization is obviously the central long term goal of the endeavour.

A textbook on this transatlantic collaboration in "Multiscale Cancer Modelling" research is planned to be published in the Chapman & Hall-CRC 'Mathematical and Computational Biology Series' by end 2009.