MODELLING THE COMPLEXITY OF THE IMMUNE SYSTEM

One-day satellite meeting of the European Conference on Complex Systems
Barcelona, September 16-20 2013

The adaptive immune system is a perfect example of what we mean by biological complexity. It has been studied for decades, yet our understanding of how its components orchestrate its function is still limited, partly because in the past not all its biological components were known and partly because we did not have the necessary quantitative tools. Its medical relevance is clear, in the context of infections, of (auto)immune diseases and because of mounting evidence for its role in cancer. Recent years have witnessed a surge of interest in mathematical and computational models of the immune system. This satellite meeting aims to bring together researchers from different disciplines, with complementary tools and perspectives, to consolidate what is now understood about the functioning of the immune system, exchange new experimental and theoretical results, initiate new collaborations, and to create a roadmap for the future development of the field.

DATE:

September 19th 2013

INVITED SPEAKERS:

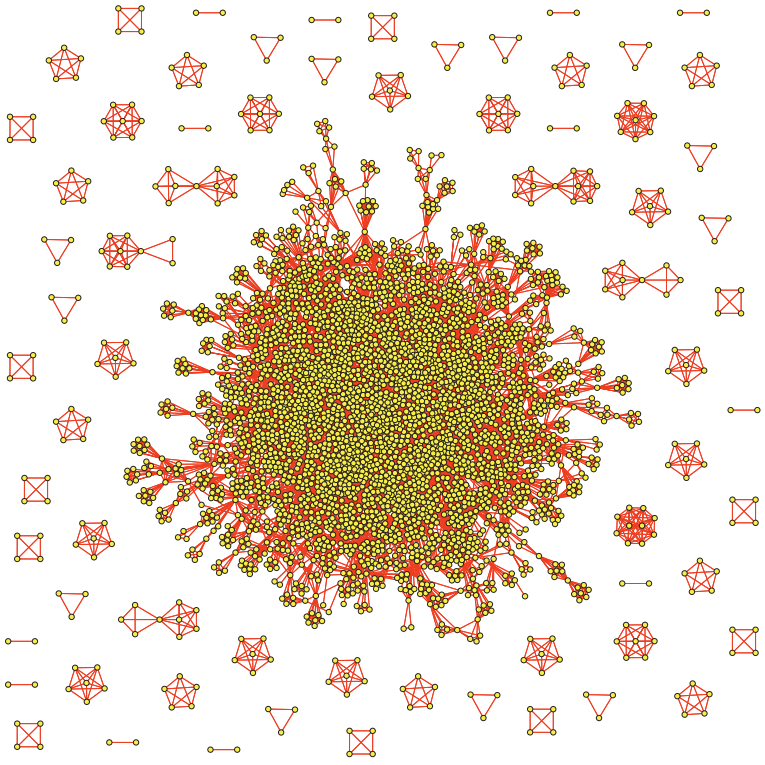
Carmen Molina-Paris (University of Leeds)
Deborah Dunn-Walters (King's College London)
Marcello Delitala (Politecnico di Torino)
Pietro Liò (University of Cambridge)
Rossana Scrivo (Università di Roma)

TOPICS:

Immune networks and their topology
Learning and memory in immune networks
Dynamics of the immune response
Immune system and ageing
Tumour-immune interaction

ORGANISERS:

A Barra (Sapienza Università di Roma)
E Agliari (Università degli Studi di Parma)
ACC Coolen (King's College London)
A Annibale (King's College London)



IMPORTANT DATES:

Registration for main conference	July 20
Abstract submission deadline for posters	July 31
Abstract submission deadline for talk	July 31
Author notification for talk	August 9
Late registration for main conference	September 16

DETAILED INFORMATION ON THE SUBJECTS

Immune networks and their topology. Modeling the immune system is a challenging task from many perspectives. It consists in analyzing ensembles of different components (B cells, helpers, etc.), interacting in a hyper-dilute way and embedded in a dynamical network arising from competitive signaling (eliciting and suppressive cytokines, etc.). From a statistical mechanics perspective, this can be described through multipartite spin glasses on finite connectivity topologies. An objective of this satellite is trying to understand topological features of the whole lymphocyte set, particularly emphasizing relations between connectivity and synchronization of the immune response, and further possible links between connectivity and autoimmunity or other dis-regulations of the system.

Learning and memory. Neural and immune systems exhibit evident and remarkable similarities: both are able to learn, memorize and think (in fact, the immune system learns how to fight new antigens, memorizes previously encountered antigens and selects the best strategy to cope with pathogens). Highlighting structural analogies between immune and neural networks can substantially contribute to formulating a systemic theory for the immune response. Receptor editing and affinity maturations are ways of learning that open a cascade of questions on the structure of the antibody repertoire: which is the minimal length of an epitope to be recognized by B Cell Receptor, still avoiding dangerous unwanted autoimmune manifestations? Which is the structure of the mature repertoire and to what extent it can be described through maximum entropy approaches? Is it possible to define bounds on computational storage of immune networks and how parallel processing of information is achieved in immune systems? A main goal of the meeting is to bring together people with a strong immunological background and people with a strong background in the statistical mechanics of neural networks looking for a synergic interaction.

Dynamics of the immune response. A main challenge of the meeting is to achieve progress in quantitative predictions of the immune response performed by the adaptive branch of the immune system, after either primary or secondary exposure to antigen(s). The adaptive response displays a widespread dynamics acting on several timescales (ranging from seconds for intracellular signaling to days for intercellular coordination and even months for long term memory) and this requires proper techniques of theoretical and experimental investigations. Indeed, describing phenomena on different timescales through out-of-equilibrium statistical mechanics is a field of theoretical physics which is still under development, hence an interaction between the two communities, immunologists and physicists, can suggest reciprocally which strands may be more interesting to be followed in order to improve the predictive capabilities of quantitative immunology.

Immune system and ageing. Ageing has some important negative effects on the immune system as evidenced by the relative high rate of autoimmune phenomena and development of cancerous units in aging populations. In fact, the accumulation of free-radicals, by-products, molecular cross-linking, debris from, e.g. lysis of infected cells, and so on, may preclude a firm binding between molecules and/or a slowdown in recognition processes. Otherwise stated, a progressive increase in randomness leads to bad signalling. Statistical mechanics is able to formalize and control this kind of "noise" towards a better comprehension of this such disfunction. Due to the progressive growth in human life span and related costs afforded by the Public Health, this is an issue deserving particular attention and will be consistently addressed in this meeting.

Tumor Immune interaction. Cancer immunosurveillance refers to the acting of lymphocytes as sentinels in recognizing and eliminating deranged cells, which are continuously and unavoidably arising due to mutation during the huge number of duplications daily occurring in a healthy body. This control activity is fundamental to keep regular cellular homeostasis, yet as the system ages, its capabilities in managing malignant cells diminishes and the production of these cells increases; this results in a more likely failure of immunosurveillance, possibly giving rise to pathologies. Interactions among immune cells and cancerous cells are far from being understood but rich datasets from clinicians and in-vitro experiments are nowadays available allowing for more realistic modeling. Exchanging ideas on this field is another focus of the satellite.

PROGRAMME

A programme of the meeting, electronic registration details, and a list of participants can be found at: www.qbio.kcl.ac.uk/IMMB/ECCS13/

FINANCIAL SUPPORT

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THE ORGANISERS

Adriano Barra
Dipartimento di Fisica, La Sapienza Università, Roma

Elena Agliari
Dipartimento di Fisica, Università degli Studi di Parma & INFN, Gruppo Collegato di Parma

Ton Coolen
Inst for Mathematical and Molecular Biomedicine, King's College London & London Inst for Mathematical Sciences

Alessia Annibale
Institute for Mathematical and Molecular Biomedicine & Department of Mathematics, King's College London