香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Co-organized by Institute for Advanced Study & Division of Biomedical Engineering

## 3-Day Short Course

HKUST BME

# Physico-chemical Concepts in Immunology and Virology

## 4-6 December 2012

**Course Instructor: Prof. Arup Chakraborty**
Robert T. Haslam Professor of Chemical Engineering, Chemistry, Physics & Biological Engineering, MIT
Director, Institute for Medical Engineering & Science, MIT
US National Academy of Engineering
American Academy of Arts & Sciences
IAS Visiting Professor, HKUST

### Course Objective:

This three-day course is intended to educate physicists, physical chemists, and engineers about the basic concepts in immunology and describe how approaches rooted in the physical sciences can help address important immunological questions.

The primary goal of the course is to inspire physical and engineering scientists to work together with immunologists and virologists to advance our understanding of the immune response to pathogens and to harness that understanding in order to develop therapeutic protocols (such as vaccines).

Registration via BME Division URL http://bme.ust.hk

***Day 1***

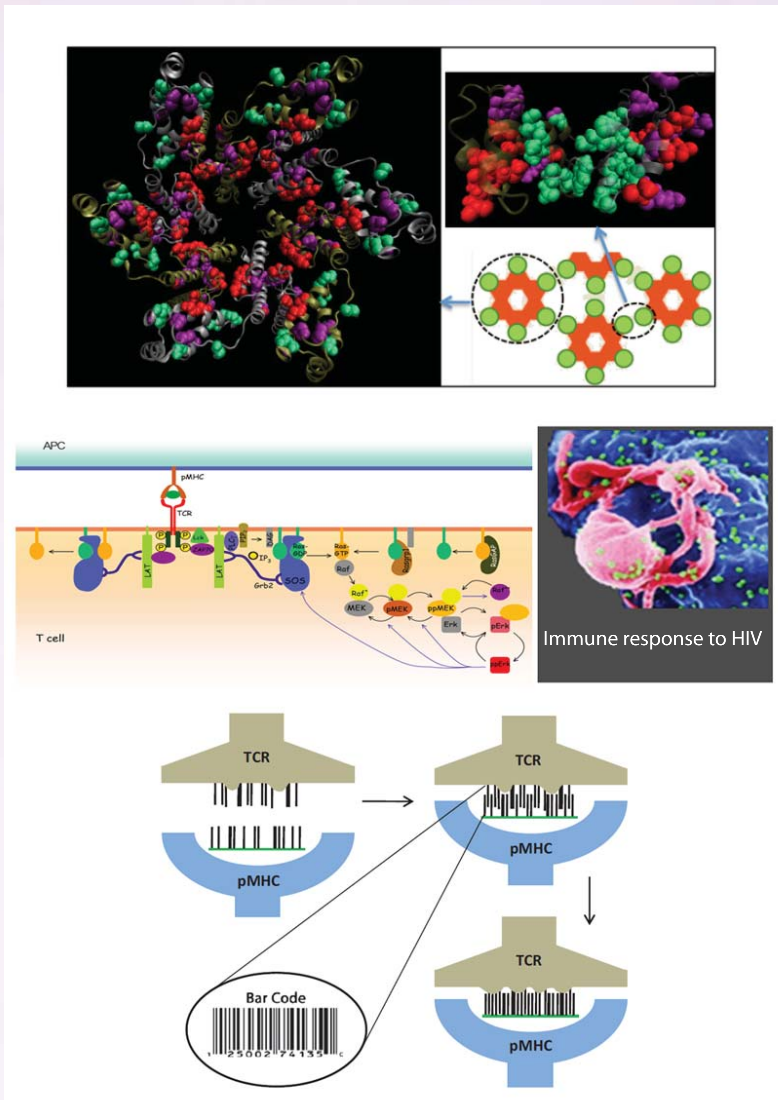
- **Basic concepts in immunology**
- **Cellular immune responses mediated by T lymphocytes (T cells) I**

***Day 2***

- **Cellular immune responses mediated by T lymphocytes (T cells) II**
- **Humoral immune responses mediated by B lymphocytes and Antibodies**

***Day 3***

- **Host-pathogen dynamics**
- **Case studies focused on adaptive immune response to human immunodeficiency virus (HIV); a special emphasis on bringing sophisticated theory, in vitro experiments, and clinical data together**




Venue: Room 2404 (lift 17/18)

http://ias.ust.hk
http://bme.ust.hk

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# 3-Day Short Course

# Course Outline

## December 4, 2012

*9:30 - 12:00* **Basic concepts in immunology:**
- The innate and adaptive immune systems and how they interact
- A focus on adaptive immunity
- Humoral immunity (e.g., B lymphocytes)
- Cellular immunity (e.g., T lymphocytes)

*12:00 - 1:30* **Lunch and interaction time**

*1:30 - 5:00* **Cellular immune responses mediated by T lymphocytes (T cells) I:**
- How T cells recognize the presence of a foreign pathogen
- How signaling in T cells translates recognition to function
- Challenges in understanding T cell signaling and its aberrant regulation
- Deterministic mathematical models for the T cell signaling network
- Importance of stochastic fluctuations, master equation-based models, and algorithms
- Case study showing the discovery of new aspects of the T cell signaling machinery by bringing together computational and experimental studies

## December 5, 2012

*9:30 - 12:00* **Cellular immune responses mediated by T lymphocytes (T cells) II:**
- How many types of T cells do you need to recognize diverse pathogens
- How long must the peptides be to cover self and foreign antigens
- Development of the T cell repertoire in the thymus
- How is T cell recognition of pathogens both specific and degenerate
- Theoretical and computational models for development of the T cell repertoire
- Case study on specific/degenerate T cell recognition of pathogens by bringing together concepts from spin glass physics, extreme value distributions, and experiments

*12:00 - 1:30* **Lunch and interaction time**

*1:30 - 5:00* **Humoral immune responses mediated by B lymphocytes and Antibodies:**
- Development of B cells
- Germinal center reactions and evolution of antibodies (affinity maturation)
- Mathematical models, continuum and stochastic, for antibody maturation

## December 6, 2012

*9:30 – 12:00* **Host-pathogen dynamics:**
- Basic concepts in host-pathogen interactions
- Dynamical equations for host-pathogen dynamics
- Virus evolution, stochastic and deterministic models
- Mapping viral evolution to Ising models in statistical physics

*12:00 – 1:30* **Lunch and interaction time**

*1:30 – 5:00* **Case studies focused on adaptive immune response to human immunodeficiency virus (HIV); a special emphasis on bringing sophisticated theory, in vitro experiments, and clinical data together.**
- Genetic determinants of HIV control
- Development of the fitness landscape of HIV (and other viruses) by bringing together statistical physics with clinical data
- Design of potent immunogens for a vaccine against *HIV*

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