ITQB PhD Program 2012
Advances in Chemistry and Structural Biology
Program:

13 Jan (Fri)

10h00-11h00: **Chemistry: A Brief Survival Guide for Itqbetians**
José Artur M. Simões

1 – Stability

11h20-12h20: **Chemistry: A Brief Survival Guide for Itqbetians**
José Artur M. Simões

2- Change

14h00-15h00: **Chemistry: A Brief Survival Guide for Itqbetians**
José Artur M. Simões

3 – Structure

16 Jan (Mon)

9h30-10h45: 11h15-12h30: **Protein structure and function**
Margarida Archer

- From sequence to structure:
  Amino acids: the building blocks of proteins
  Four levels of protein arrangement
- From structure to function:
  Proteins are the most versatile macromolecules in the cell
  The structural basis of protein function. Examples

11h15-12h30: **Metal ions in Biology**
Miguel Teixeira

1. The multiple functions of metals in biological systems
    - Catalysis
    - Structure
    - Charge transport
    - Biominerals
2. Essential elements and examples of metalloproteins
3. Metal uptake, storage, homeostasis

14h30-18.00 **Chemistry Tutorials**

17 Jan (Tue)
9h30-10h45: **Lipids and membranes**
Nuno Santos

11h15-12h30: **Nucleic acids**
Alekos Athanasiadis

14h30-18.00 **Bioinformatic tools**
Bioinformatic Unic, IGC

18 Jan (Wed)

9h30-10h45: **Introduction to spectroscopy**
Ricardo Louro

11h15-12h30: **Metals in Medicine: Pride and Prejudice**
Carlos Romão

-metal drugs? Why and why not?
-principles of metal drug design
-examples of current metal based drugs
-new areas of metal based therapy

14h30-15h30: I**ntroduction to NMR spectroscopy**
Pedro Lamosa

- Basic principles of NMR spectroscopy
The nuclear magnetic momentum
The Zeeman energy levels
Signal measurement
- Properties of the NMR signal and derived information
Chemical shift, signal multiplicity and spin-spin coupling carry structural information.
Signal relaxation carries dynamical information.
Signal intensity is quantitative
The nuclear Overhauser effect.

16h00-17h15: **NMR spectroscopy in biological research**
Pedro Lamosa

- 1H-NMR and chemical exchange
- 13C-NMR and isotopic enrichment
- In vivo NMR
- Protein-metabolite, protein-protein interactions
- Small molecules structure determination
- Protein structure determination

19 Jan (Thu)
9h30-10h45: **UV spectroscopy**
Eurico Melo

1. Techniques existing in ITQB
1.1. Steady-state absorption spectrophotometry
Parts of a spectrophotometer
Traps and more common errors
1.2. Steady-state fluorescence
Parts of a spectrofluorimeter
Traps and more common errors
1.3. Time-resolved phosphorescence – room temperature
reaction kinetics
rotational diffusion of proteins
1.4. Fluorescence recovery after photobleaching
molecular lateral diffusion measurements

2. Important techniques that do not exist in ITQB
2.1. Time-resolved fluorescence
Single photon counting, deconvolution, single exponentials
2.2. Time-resolved absorption spectrophotometry
Laser photolysis (ns)
Pump & probe (ps – fs)

11h15-12h30: **Fluorescence and microscopy (FCS and FRET)**
Manuel Prieto

14h30-18.00 **Chemistry Tutorials**

20 Jan (Fri)

9h30-10h45: **Protein and small molecule crystallography**
Isabel Bento

- How is a crystal structure determined?
- Crystallization of proteins and small molecules
- Why do we need crystals?
- Methods used in crystallization
- Crystal handling and freezing
- Crystal symmetry
- Why do we need X-rays?
- X- diffraction – Brags Law
- X-ray sources
- Diffraction data
- Resolution of the diffraction data
- Quality of the diffraction data
- Phase problem in crystallography
- How o solve the phase problem
- Model building and refinement

- Interpretation of Structural models
- Accessing Structure quality

11h15-12h30: **Biomolecular Modelling**
Cláudio M. Soares

- Current biomolecular modelling methods.
- Molecular mechanics / dynamics methods and applications.
- Molecular Docking methods and applications.
- Continuum electrostatics methods and applications

14h30-16h00: **Protein Structure Prediction**
Cláudio M. Soares

- Protein folding and protein structure prediction.
- Ab initio methods and applications.
- Comparative modelling methods and applications.
- Threading methods and applications.

23 Jan (Mon)

9h30-12h30 – **Vibrational spectroscopy – Tutorial**
Smilja Todorovic

Vibrational spectroscopy: an atomic scale analytical tool
Part I Theory
Molecular vibrations
Basics of the vibrational spectroscopy
FTIR and Raman experimental set up
Analysis of the spectra
Transmission vs. ATR FTIR
Raman vs. resonance Raman spectroscopy
Surface enhanced vibrational spectroscopy: SERR and SEIRA
Vibrational spectro-electrochemistry
Time – resolved vibrational spectroscopy

Part II Applications of vibrational spectroscopy and imaging in the studies of:

i) organic molecules
ii) ionic liquids
iii) (matallo)proteins
iv) whole cells

14h30-18h00- **Protein Folding and tutorial**
Cláudio M. Gomes

- Thermodynamics of protein folding
- Kinetics and mechanisms of protein folding
- Biophysical tools to monitor protein stability

A round-table discussion on research reports on protein misfolding diseases: Each group selects one paper for careful reading and everybody browses the other five papers. Each student should be prepared able to orally outline in a few minutes the rationale and major claims of their assigned paper, during a round table discussion. The discussion of the paper will be combined with a lecture, during which each group, with the guidance of the instructor, will be challenged to explain for e.g. how their paper contributed to clarify a particular topic. Note: student presentations will not be performed.

24 Jan (Tue)

9h30-10h45: **Introduction to Mass Spectrometry**
Ana Coelho

-Mass spectrometry: general description of the metodology and of some applications
-Mass spectrometers and their components:
-Ionization methods:
-Classification of the ionization methods
-Description and application of the soft ionization methods: electrospray and MALDI
-Mass analysers:
-General description of the more common mass analysers: limitations and advantages
-Description of the ions separation process in ion traps and time-of-fligth
-Tadem mass spectrometry experiments
-How to perform them in different types of mass analysers
-Interpretation of MS/MS spectra
-Mass spectrum parameters:
-m/z resolution
-Accuracy
-Sensitivity
-Mass range
-Isotope cluster
-Monoisotopic and average mass

11h15-12h30: **Mass Spectrometry applications - protein identification**
Ana Coelho

-Contribution of MS data for the characterization of small molecules and proteins
-Experimental strategies for protein identification using MS data:
-Peptide mass fingerprinting
-Peptide Fragmentation information from LC-MS/MS and MALDI-TOF-TOF experiments
-Database search and "de novo" sequencing
-Protein identification criteria

14h30-18h:00: **EPR spectroscopy**
Miguel Teixeira

- Basic Principles of EPR
- EPR as a probe for metal centres, catalytic mechanisms, ligand binding
- EPR of cells, membranes and purified systems
- The need of complementary techniques in Biological Spectroscopy

25 Jan (Wed)

9h30-11h30: **Tutorial - Molecular visualisation**
Cláudio M. Soares, António M. Baptista, Bruno Victor, Sara Campos

- Building a small molecule using pymol
- Building a polypeptide chain
- Using several molecular representations
- Producing publication quality molecular images

12h00-12h45 **SCAN**

14h30-18h:00: **Surface Plasmon Resonance – Fundamentals, Implementations & Applications**
João Fonseca, BioSurfit

At present, Surface Plasmon Resonance (SPR) sensors have became essential tools for characterization and quantification of boiological interactions. SPR technology is now being commercialized in multiple domains, namely high troghput screening to medical diagnostics.

This lecture provides a first tutorial introduction into the field of SPR sensors. Firstly, the fundamental principles of Surface Plasmon Resonance are detailed, covering the electromagnetic theory of surface plasmons, the theory of SPR sensors and including an analysis of molecular interactions at SPR sensor surfaces. Secondly, we review the state-of-the-art in the development SPR sensors, including aspects related to optical instrumentation and surface functionalization. Finally, we present multiple applications examples of SPR sensors, from high-end R&D molecular interaction diagnostic tools to point of care blood diagnostic products.

26 Jan (Thu)

9h30-12h30: **Tutorial - How to interpret X-ray Crystallographic Data**
Pedro Matias

In this tutorial the selected manuscripts will be discussed and the structures reported therein used as practical examples. Additionally, a few web sites related with macromolecular crystallography will accessed as examples on how to retrieve macromolecular structure information and how to interpret that information.

14h30-18h00: **Hands-on tutorial; Protein Structure Prediction**
Cláudio M. Soares, António M. Baptista

- Predicting the structure of two proteins.
- Making mutations and predicting their effect.

27 Jan (Fri)

Case studies