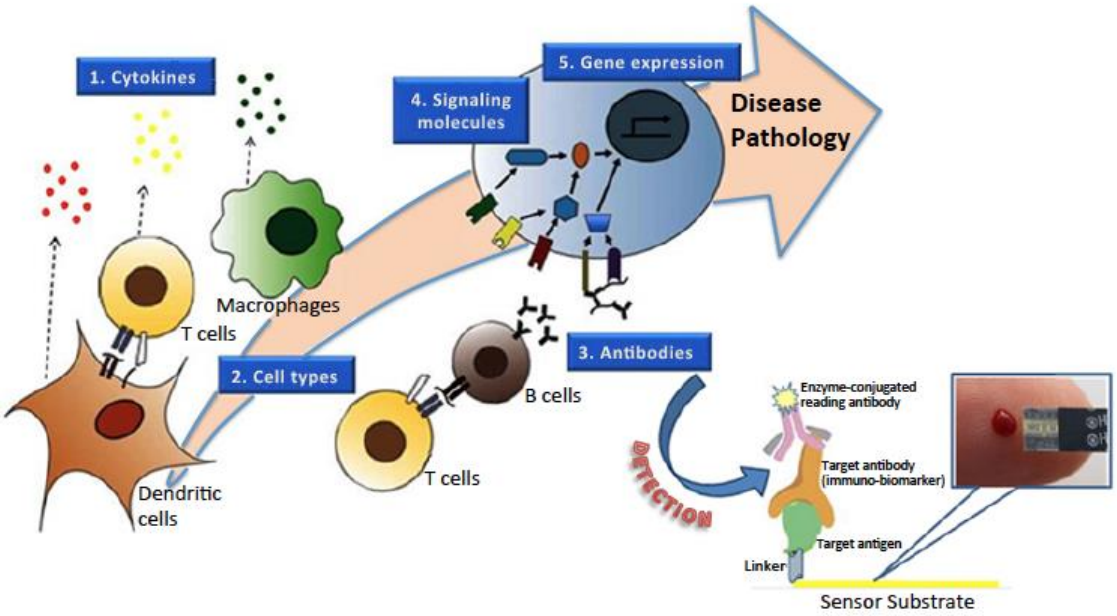
PhD in Chemical Sciences

Advanced Course



Chemical Sensors and Biosensors

Dr. Marco Giannetto

The contents of the course are intended to give an overview of the main chemical sensors and their mechanisms of signal transduction. Aspects concerning the materials used as substrates for the development of sensors, as well as the strategies employed for the immobilization of the receptive materials on the sensing substrates and the more interesting applicative aspects in biomedical, diagnosis and point-of-care, environmental and food safety areas will be also addressed and discussed.

Examples from literature as well as lecturer's relevant studies will be provided and discussed in depth.

The course is composed by 4 lectures of 2 hour time, distributed over two weeks, for a total of 8 hours, corresponding to 1 CFU.

The lecture titles and contents are:

1- Sensing devices as artificial sensory organs

How a sensor does work? A comparison among artificial and natural sensing processes. Definition of the components of sensing devices, characterization of chemical sensors and comparison of their performance with classic instrumental analysis; time- and space-resolution: this is the challenge!

2- Transduction mechanisms: from recognition event to signal generation

Classification of sensing devices as a function of the working and transduction mechanism; energy-conversion and limiting current systems, optical sensors, general overview on chemoresistive transducers and actuators. Semi-conductive materials from inorganic and organic matrices, conducting polymers, mass-sensitive piezoelectric devices, optical sensors.

3- Biological and bio-mimetic receptors at work: immunoenzymatic sensors, genosensors

Properties of bioreceptors as antibodies and enzymes; operating principle of competitive and non-competitive immunosensors; immunorecognition on chip; *lateral flow* ELISA test on disposable strips; genosensor for specific recognition of oligonucleotide sequencies by DNA-mimic probes.
Applications in clinical field; examples; clinical analyses, determination of antibodies and biomarkers related to disease in blood samples, pregnancy and ovulation tests; applications in clinical, environmental and food samples.

4- Nano-structured materials: present and future of chemical sensors

The fundamental role of nanostructured materials as active substrates for covalent and noncovalent immobilization of chemical and biological receptors; properties and sensoristic applications of metal nanoparticles, carbon nanotubes, nanotissues; dendrimers as 3D polymeric nanomaterials for signal enhancement. Discussion of examples from literature and lecturer's studies

The lectures will be held by Dr. Marco Giannetto, on the basis of his experience in the field of chemical sensors and biosensors based on different transduction mechanisms, ranging from potentiometric to amperometric as well as piezoelectric systems, documented by several peer-reviewed papers in

international journals on these topics (listed below). Marco Giannetto has recently promoted and organized the national meeting of the Interdivisional Group on Sensors of the Italian Chemical Society (GS2015- Parma, 15-17 june 2015). Marco Giannetto is author of more than 40 papers published on international peer-reviewed journals

List of lecturer's relevant publications on the subject:

1) Manfredi, M. Giannetto, M. Mattarozzi, M. Costantini, C. Mucchino, M. Careri, *Competitive immunosensor based on gliadin immobilization on disposable carbon-nanogold screen-printed electrodes for rapid determination of celiotoxic prolamins,* ANALYTICAL AND BIOANALYTICAL CHEMISTRY, 2016, In press

2) M. Giannetto, E. Umiltà, M. Careri, *New competitive dendrimer-based and highly selective immunosensor for determination of atrazine in environmental, feed and food samples: The importance of antibody selectivity for discrimination among related triazinic metabolites*. ANALYTICA CHIMICA ACTA, 2014, 806 197-203.

3) M. Giannetto, M. Mattarozzi, E. Umiltà, A. Manfredi, S. Quaglia, M. Careri, *An amperometric immunosensor for diagnosis of celiac disease based on covalent immobilization of open conformation tissue transglutaminase for determination of anti-tTG antibodies in human serum.* BIOSENSORS & BIOELECTRONICS, 2014, 62, 325-330.

4) A. Manfredi; M. Mattarozzi; M. Giannetto; M. Careri, *Piezoelectric immunosensor based on antibody recognition of immobilized open-tissue transglutaminase: An innovative perspective on diagnostic devices for celiac disease,* SENSORS AND ACTUATORS. B, CHEMICAL, 2014, 201, 300-307.

5) F. Bianchi; M. Giannetto; M. Careri, *Advances in molecular analysis of biomarker for autoimmune and carcinogenic diseases*, ANALYTICAL AND BIOANALYTICAL CHEMISTRY , 2014 406, 15-20

6) M. Giannetto, E. Maiolini, E. Ferri, S. Girotti, G. Mori, M. Careri, *Competitive amperometric immunosensor based on covalent linking of a protein conjugate to dendrimer-functionalised nanogold substrate for the determination of 2,4,6-trinitrotoluene.* ANALYTICAL AND BIOANALYTICAL CHEMISTRY, 2013, 405 (2-3), 737-743.

7) M. Giannetto, L. Elviri, M. Careri A. Mangia, G. Mori, *A voltammetric immunosensor based on nanobiocomposite materials for the determination of alpha-fetoprotein in serum*, BIOSENSORS & BIOELECTRONICS, 2011, 26, 2232-2236.

8) M. Giannetto, L. Mori, G. Mori, M. Careri, A. Mangia, *New amperometric immunosensor with response enhanced by PAMAM-dendrimers linked via self assembeld monolayers for determination of alpha-fetoprotein in human serum.* , SENSORS AND ACTUATORS. B, CHEMICAL, 2011, 159, 185-192.

9) M. Giannetto, G. Mori, F. Terzi, C. Zanardi, R. Seeber, *Composite PEDOT/Au Nanoparticles Modified Electrodes for Determination of Mercury at Trace Levels by Anodic Stripping Voltammetry.* ELECTROANALYSIS, 2011, 23, 456-462.

10) P.G. Mineo, L. Livoti, M. Giannetto, A. Gulino, S. Lo Schiavo, P. Cardiano, *Very fast CO2 response and hydrophobic properties of novel poly(ionic liquid)s.* JOURNAL OF MATERIALS CHEMISTRY, 2009, 19, 8861-8870.

11) M. Giannetto, A. Bello, M. Gennari, L. Marchiò, G. Mori, *New Membrane Electrodes Based on a Functionalized Tetraphenylborate Covalently Bound to the Polymeric Backbone.* SENSORS AND ACTUATORS. B, CHEMICAL, 2008, 133, 235-240.

12) M. Giannetto, A. Bello, G. Mori, R. Seeber, F. Terzi, C. Zanardi, *Optimization of the DPV potential waveform for determination of ascorbic acid on PEDOT-modified electrodes*, SENSORS AND ACTUATORS. B, CHEMICAL, 2007, 121(2), 430-435.

13) M. Giannetto, A. Bello, F. Bianchi, M. Careri, V. Mastria, G. Mori, M. Musci, *Potentialities of a modified QCM sensor for the detection of analytes interacting via H-bonding and application to the determination of ethanol in bread,* SENSORS AND ACTUATORS. B, CHEMICAL, 2007, 125, 321-325.

14) M. Giannetto, V. Mastria, G. Mori A. Arduini, A. Secchi, *New Selective Gas Sensor Based on Piezoelectric Quartz Crystal Modified By Electropolymerization of a Molecular Receptor Functionalized with 2,2'-Bithiophene,* SENSORS AND ACTUATORS. B, CHEMICAL, 2006, B115, 62-68.

15) M. Giannetto, C. Minari, G. Mori, *Potentiometric Determination of Non-Ionic Surfactants by Liquid Membrane Electrodes.* ELECTROANALYSIS, 2003, 15, 1598-1605.

16) M. Giannetto, G. Mori, A. Notti, S. Pappalardo, M.F. Parisi, *Calixarene-Poly(dithiophene)-Based Chemically Modified Electrodes*, CHEMISTRY-A EUROPEAN JOURNAL, 2001, 7, 3354-3362.

17) E.M. Bruti, M. Giannetto, G. Mori, R. Seeber, *Electropolymerization of Tetrakis(o-aminophenyl)porphyrin and Relevant Transition Metal Complexes from Aqueous Solution. The resulting Modified Electrodes as Potentiometric Sensors*, ELECTROANALYSIS, 1999, 11, 565-572.

18) M. Giannetto, G. Mori, A. Notti, S. Pappalardo, M.F. Parisi, *Discrimination beetween Butylammonium Isomers by Calix[5]arene-Based ISEs,* ANALYTICAL CHEMISTRY, 1998, 70, 4631-4635.