



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Date: 02 May 2007

Copies to: Website

GOSPEL School Programme and Syllabus

Modules:

Biological Chemoreception
Sampling and Analytical Measurements
Sensing Devices
Electronics and Signal Processing
Information Processing
Applications in Chemical Sensing

Date:

16:00 30 September 2007
16:00 5 October 2007

Location:

Europa Beach Hotel, Crete

Equipment requirements:

Participants should bring with them a laptop pre-loaded with R and with SDK for electronics demo board. Information will be provided nearer the time.



Timetable

Sunday 30 September	Monday 1 October	Tuesday 2 October	Wednesday 3 October	Thursday 4 October	Friday 5 October
	Biological Chemoreception I (3)	Analytical Measurements I (3.5)	Analytical Measurements II (2) Devices II (1)	Electronics and Signal Processing I (3)	Electronics and Signal Processing II (2) Laboratory Exercise (electronics) (1)
Overview lecture and round table (2) Introductions and expectations (1)	Biological Chemoreception II (4)	Devices I (3)	Devices III (1) Group Exercise (sampling/devices) (3)	Information Processing (2) Laboratory Exercise (info processing) (2)	Information Processing II (2) Laboratory Exercise (info processing) (2)
Fun with odour (ice breaker) (1)	Meet the lecturers (1)	Gender and career planning (1)	Applications I (olfaction) (1)	Applications II (sensors) (1)	Concluding remarks (1)
			Social dinner		

Each lecture hour is 45 minutes presentations, 15 minutes questions or discussion.



Lecturers

Sunday 30 September	Monday 1 October	Tuesday 2 October	Wednesday 3 October	Thursday 4 October	Friday 5 October
	Persaud Montmayeur	Graf Mielle	Papamichail	Malcovati Ferrari	Malcovati Maloberti Reverter Malcovati Reverter
Persaud	Persaud Montmayeur Rospars	Graf	Briand Briand Mielle Graf	Perera Gutierrez	Perera Gutierrez
Mielle	All	Briand	TBC	Ulmer	All
			Social dinner		



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Description

02/2007

Overview of Artificial Olfaction

Responsible GOSPEL School
Member of staff responsible Krishna Persaud

Level PhD
Methods of delivery Lecture, Exercise
Private study
Tutorial and master classes 1

Total study hours 1+1

Module learning outcomes

Knowledge and understanding Describe the basic elements of biological and artificial olfaction systems and the relationship between perception and measurement.

Intellectual skills Understand the role of the different components of olfactory systems as the basis for the following modules.
Understand the various factors which affect human olfaction.

Practical skills None



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Syllabus

02/2007

Overview of Artificial Olfaction

Overview of biological and artificial olfaction

Main components of biological and artificial olfaction systems; similarities and differences.

Fun with olfaction

Practical exploration of human olfaction.



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Description

02/2007

Biological Chemoreception

Responsible	GOSPEL School
Member of staff responsible	Krishna Persaud, Jean-Pierre Montmayeur, Jean-Pierre Rospars
Level	PhD
Methods of delivery	Lectures
Private study	1
Tutorial and master classes	1
Total study hours	7+2

Module learning outcomes

Knowledge and understanding	Describe the chemical stimuli, signal transduction, signal processing and information processing mechanisms found in biological chemoreception, and the concepts that can be transferred into the design of artificial sensing systems
Intellectual skills	Understand the characteristics of physicochemical characteristics of molecules that are important chemical stimuli Understand the basis of biological receptors, ligand binding and transduction Understand the role of molecular biology in elucidating chemoreception mechanisms Understand the concepts of quality, intensity and hedonic scaling in perception of chemical stimuli Understand the concepts that can be transferred from biological chemoreception to artificial sensing systems Understand the elements and concepts in biological systems which can be transferred to sensor devices
Practical skills	None



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Syllabus

02/2007

Biological Chemoreception

General biology of olfaction and taste	Chemical Stimuli, concept of isosterism, quantitative structure-activity relationships, olfactory anatomy and physiology, olfactory transduction
Biological concepts in olfaction	The main olfactory system, anatomy of the peripheral olfactory system, signal transduction in olfactory neurons, cloning and features of the odorant receptor genes, combinatorial coding, use of genetics to visualise olfactory circuits, the accessory olfactory system
Biological concepts in taste	Anatomy of the taste system, signal transduction in taste bud cells, taste receptors, bitter, sweet, umami, drosophila taste receptors
From biological chemoreception to artificial sensing systems	Concepts of detection, recognition, discrimination of complex mixtures of chemicals, odour quality, odour descriptors, hedonic scaling
Translating biological systems to artificial systems	Concepts of array based sensing, signal processing, chemometrics and neural networks
Modelling Chemoreception	Modelling the hierarchy of information processing
Biosensing	Biosensors, bioinspired and biohybrid systems



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Description

02/2007

Sampling and Analytical Measurements

Responsible	GOSPEL School
Member of staff responsible	Nikos Papamichail, Patrick Mielle
Level	PhD
Methods of delivery	Lectures
Private study	
Tutorial and master classes	Jointly with Devices module.
Total study hours	5.5
Module learning outcomes	
Knowledge and understanding	Methods of chemical sampling and analysis
Intellectual skills	Understanding of basic thermodynamics and its role in transport of material. Understanding of the role of sampling in artificial olfaction. Understanding of practical approaches to sample capture, concentration and delivery. Understanding of dynamics of measurements and validation approaches. Understanding of separation methods for greater specificity. Understanding of the capabilities of different analytical instrumentation for reference measurements.
Practical skills	See Devices module



Module Syllabus

02/2007

Sampling and Analytical Measurements

Physical principles	Interaction of analyte with capture/sensor material. Thermodynamics.
Odour detection and sampling	State of the art and detection limits. Relationships between sensory and analytical measurements. Presenting sensors with real-life samples. Extraction methods and pre-separation.
Headspace analysis, enrichment methods	Partitioning; static and dynamic headspace; direct thermo-extraction. Pre-concentration, solid phase microextraction, purge and trap, thermal desorption and pervaporation. Special samples such as wine, brandies and edible oils. Activity coefficients.
Practical systems	Time-intensity measurements: aroma and odour release, breath by breath analysis. Sensor fusion. Feasibility studies and method validation for sensor systems.
Chromatographic methods and mass spectrometry	Gas chromatography and detection systems (FID, ECD, MS). Principles, applications and instrumentation for mass spectrometry: ion sources (EI, CI, FI, FD, ESI) and mass analysers (quadrupole, time of flight)
Spectroscopy and liquid analytes	HPLC. Optical spectroscopy: UV, IR, absorbance, fluorescence, luminescence, atomic emission, atomic absorption. Overview of electrophoresis and electrochemistry.
Group Exercise	See Devices module.



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Description

02/2007

Sensing Devices

Responsible GOSPEL School
Member of staff responsible Danick Briand, Markus Graf

Level PhD
Methods of delivery Lectures, Group Exercise
Private study
Tutorial and master classes 3

Total study hours 5+3

Module learning outcomes

Knowledge and understanding Sensors and transducer devices - their principles and fabrication
Potential of microfabrication for the realisation of sensing systems

Intellectual skills Basics for sensors development
Relating the characteristics of the sensing devices to the measurement requirements
Understanding the performances and limitations of current gas sensing technologies
Ability to define the potential applications and benefits of microsystems technology for AO

Practical skills None



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Syllabus

02/2007

Sensing Devices

Introduction to gas sensors	Calibration curve, sensitivity, basic definitions
Gas sensing materials	Absorbents (polymers), thermodynamics Catalytic Metal-oxides emf
Sensor realization	Architecture of gas sensors, materials and transducers Brief description of the technological realization Gas sensing characteristics and performances
Introduction to microfabrication and microsensors	Thin films processing; micromachining. Miniaturised gas sensors and arrays CMOS compatibility Encapsulation and packaging
Micro-analytical instruments	Components and systems: GCs, IMS, IR, preconcentrators, ChemLab...
Group Exercise	Choice of sampling techniques and sensors to solve an applicative problem



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Description

02/2007

Electronics and Signal Processing

Responsible	GOSPEL School
Member of staff responsible	Piero Malcovati, Vittorio Ferrari, Ferran Reverter
Level	PhD
Methods of delivery	Lectures, Laboratory Exercise
Private study	
Tutorial and master classes	1
Total study hours	5+1

Module learning outcomes

Knowledge and understanding	Describe the principles of electronic circuit interfaces to various transducers
Intellectual skills	Define a common language and a general background for sensor interface circuits, understand the specification requirements for interfacing technologies to different measurement scenarios Understand the measurement requirements appropriate to the chosen transducer technology and select the most suitable circuit solution Understand the principles of operation of a broad range of interface circuits Understand the principle of operation and design challenges of data converters Understand how to interface different kind of transducers to microcontrollers
Practical skills	Interface microcontrollers to sensors



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Syllabus

02/2007

Electronics and Signal Processing

Sensor Interface Circuits	Basic concepts and definitions for sensor interface circuits, integrated microsystems basics, system partitioning
Front-End Electronic Interface Circuits I	Front-end circuits for different kind of transducers (voltage output, current/charge output, resistive and capacitive sensors)
Front-End Electronic Interface Circuits II	Oscillators, piezoelectric read-out systems for chemical and biological sensors
Data Converters	A/D and D/A converters for sensor applications
Microcontrollers and digital signal processing	Interfacing sensors and transducers to microcontrollers
Laboratory	Practical example of microcontroller programming for sensor application



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Description

02/2007

Information Processing

Responsible GOSPEL School
Member of staff responsible Alex Perera, Agustin Gutierrez

Level PhD
Methods of delivery Lectures, Laboratory Exercises
Private study
Tutorial and master classes 4

Total study hours 4+4

Module learning outcomes

Knowledge and understanding Data exploration, modelling and evaluation of results

Intellectual skills Understand mathematical representation of data.
Understand data evaluation language.
Apply techniques for visualization and understanding of the inner structure of experimental data.
Know how to select appropriate technique given the features of data and each processing method
Provide with an general overview of linear and non-linear machine learning techniques.
Understand fundamental properties of each technique

Practical skills Data visualization.
Data and model interpretation.



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Syllabus

02/2007

Information Processing

Introduction to pattern recognition I	Overview on signal processing in chemical sensors. Uncertainty. Multivariate measurements. Data visualization. Introduction to multivariate analysis. Linear/Non-Linear techniques.
Introduction to pattern recognition II	Introduction to classification. Linear Regression techniques. Validation issues. Drift compensation techniques.
Non-linear pattern recognition I	Introduction to Nonlinear processing. Introduction to Neural networks.
Non-linear pattern recognition II	Kohonen Maps, Fuzzy Inference Systems, Support Vector Machines
Laboratory exercise	Linear analysis, classification, validation, clustering
Laboratory exercise	Artificial Neural Networks, Kohonen Maps, Support Vector Machines



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Description

02/2007

Applications in Chemical Sensing

Responsible GOSPEL School
Member of staff responsible Heiko Ulmer, tbc

Level PhD
Methods of delivery Lectures
Private study
Tutorial and master classes

Total study hours 2

Module learning outcomes

Knowledge and understanding Understanding of the effort needed to produce a practical sensing solution for an analytical problem

Intellectual skills System integration; appreciation of commercial factors
Application exploration; quantification of 'quality' indices

Practical skills None



Network of Excellence
General Olfaction and Sensing Projects
on a European Level

Institute of Physical and Theoretical Chemistry, University of Tuebingen

Module Syllabus

02/2007

Applications in Chemical Sensing

Case Study 1

Development of a low-cost, high volume sensing system for the automotive industry

Case Study 2

Use of olfaction and olfactory measurements in product development and quality control