Sjef Barbiers
Meertens Institute (Royal Netherlands Academy of Arts and Sciences) and Utrecht University, PO Box 94264 1090 GG Amsterdam

On the limits of language variation in Europe

One of the founding principles of the European Union is respect for the diversity of the Union's languages: "European languages are equal in value and dignity and form an integral part of European culture and civilisation". The Union promotes measures to safeguard its unique linguistic diversity. This linguistic diversity is unique indeed and characteristically distinguishes Europe from continents like North America and Australia, which have one strongly dominant language for the whole area. The European Commission distinguishes 20 official languages in the EU (http://ec.europa.eu/education/policies/lang/languages/index_en.html), and the very informative BBC website on European languages mentions 40 main languages for the whole of Europe (http://www.bbc.co.uk/languages/european_languages/index.shtml).

Impressive though these numbers may be, they are a gross idealisation and underestimation of the real linguistic diversity in Europe. Counting languages is usually based on political criteria. There are no decisive linguistic criteria to distinguish one language from another or to distinguish languages from dialects. Counting languages often involves standard languages, but a standard language is a social construct, a partially artificial language based on a dialect that enjoys a privileged political status among the dialects in a particular area. Europe may be a collection of distinct states, it is not a collection of distinct languages. Rather, it is a continuum of countless dialects that may vary from place to place.

This continuum of dialects provides an ideal laboratory for linguistic research, the primary goal of which is not so much to safeguard linguistic diversity as to describe and understand it. This can be done from two complementary perspectives. One is to explain patterns of variation on the basis of language-external factors, such as historical, social and geographic conditions. This will reveal the historical, social and geographic limits of language variation. The other is to explain patterns of variation on the basis of language-internal factors, i.e. properties of particular languages and natural language in general. This will reveal the linguistic limits of variation and hence provide insight in the human language faculty as a cognitive module.

We have now entered a new era in the study of linguistic variation in various respects. Traditional dialectology was mainly concerned with lexical and phonological differences (i.e., variation in words and sounds) between closely related dialects. Microsyntactic differences, i. e. variation between dialects in the rules according to which words are combined into phrases and sentences were thought to be non-existent or to have disappeared. As a matter of fact, there was a widely-accepted belief that languages can be syntactically different but dialects cannot. The Syntactic Atlas of the Dutch Dialects (SAND; Barbiers et al. 2005) shows convincingly that there is a wealth of syntactic variation in the Dutch language area (which includes The Netherlands, the Dutch speaking part of Belgium and a small part of north-west France), involving more than 100 syntactic variables in 267 dialects of Dutch. It is to be expected that the syntactic variation in other European dialect families is overwhelming too, but this is yet to be discovered.

The large scale investigation of syntactic microvariation as is being carried out in the European Dialect Syntax project (Edisyn; 2005-2010; EURYI Award ; ESF) enables us to test two leading and closely related hypotheses in syntactic research, namely that language is compositional, i.e. every part of a sentence contributes to the semantic interpretation (Frege 1960), and that language is economical (Chomsky 1995). Both hypotheses predict that there should be no superfluous elements in a sentence. However, the SAND research reported on

above shows that the dialects of Dutch are full of doubling phenomena that do not occur in the standard language, and the same has been reported more informally for other dialect families. These doubling phenomena include doubling of subject pronouns (Flemish: '**She** eats **she** an apple', Wh-words (Northern-Dutch: '**Who** do you think **who** I met?'), negation (Southern-Dutch: 'I eat **no** soup **no** more'), relative pronouns, auxiliaries, inflection etc.

Doubling phenomena show that there is more to syntax than just combining the meaning of individual words into complex meanings. The first results of the European Dialect Syntax project reveal that all syntactic doubling patterns in European dialects obey the same two restrictions: (i) the second (rightmost) element in a doubling construction cannot be less specified than the first element; (ii) content words (i.e. verbs, adjectives, nouns) cannot be doubled, functional words (e.g. prepositions, deteriners, numerals, auxiliaries) can. What also needs to be explained is why doubling phenomena seem to be much more common in dialects than in standard languages, a surprising fact given the received wisdom that there are no linguistic criteria to distinguish between dialects and standard languages.

The study of syntactic microvariation in the European dialect continuum furthermore enables us to discover correlations between syntactic variables and to test correlations that have been put forward in the literature on the basis of a very limited number of dialects/languages/speakers. This is important, because we want to understand why certain syntactic properties are constant within one dialect family, whereas they may vary between closely related dialect families. Thus, although the 267 investigated dialects of Dutch show an enormous syntactic variation, none of them allows the word order *Ik heb gezien hem* 'I have seen him', while this is the only possible order in the dialect family of English, which is closely related to Dutch.

Large scale syntactic microvariation research would not be possible without the methodological and technological innovations that have become available in recent years. Methodologically, we borrow from modern sociolinguistic research to avoid accomodation and task effects, thus standardizing the method of data collection, and also from generative research, to make sure that we do not just get to know what is possible in a certain dialect but also what is impossible. On the technological side, the original spoken data and their linguistically annotated transcriptions are made available in an on-line research tool, i.e. a database that comes with a search engine and cartographic software, enabling researchers to visualize the geographic distribution of syntactic variables and potential correlations between these variables. Such a research tool has already been developed in the Dutch-Belgian SAND project (http://www.meertens.nl/sand/). In the European Dialect Syntax project we will develop a distributed network of databases with a common search engine. Google Earth will be integrated in the cartographic component.

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Mirjam Ernestus
Max Planck Institute for Psycholinguistics, Wundtlaan 1, 6525 XD Nijmegen, The Netherlands

Acoustic reduction in European languages

In spontaneous conversational speech, words are often pronounced much shorter than their citation forms would suggest. Thus, English *ordinary* may be pronounced as *onry,* Dutch *namelijk* "namely" as *naamk,* and German *mit dem Bus* "with the Bus*"* as *mimbus.* Even though acoustic reduction is ubiquitous in everyday speech, it has received little attention in the (psycho-) linguistic literature. Furthermore, automatic speech recognition systems run into problems with acoustic reduction. In my presentation, I will provide an overview of what we know about acoustic reduction, and of the research that I envision to carry out in my EURYI-project.

Nearly all research on the production of acoustic reduction has been dedicated to the deletion of single sounds in Germanic languages (e.g., the absence of *t* in English *perfec_memory*). This research has shown (1) that deletions can arise as a consequence of co-articulation and (2) that deletions are more likely the greater the word's a priori probability and its probability in the local sentential context. With respect to comprehension, we know that listeners tend to restore not only missing sounds but even complete syllables. For this restoration to occur, meaningful context is necessary. Thus, Dutch listeners understand the reduced form *naamk* only if it is presented in a complete sentence, and they are then convinced to hear the citation form *namelijk*. Current psycholinguistic models cannot account for these data.

My EURYI-project will both deepen and broaden the research on acoustic reduction. On the one hand, it will investigate how various structural characteristics of a given language, such as its rhythm, its sound inventory, and the structures of its words, contribute to degree of reduction (in speech production) and to the comprehension of reduced words. This part of the project will be mainly based on two pairs of related non-Germanic languages (Estonian versus Finnish, and French versus Spanish), which differ greatly in their structural properties from the languages studied so far. On the other hand, the project will investigate in depth how the details of the acoustic signal and how contextual information affect the production and comprehension of acoustic reduction, on the basis of Dutch, English and these same four languages. My research method will be three-pronged, combining quantitative corpus-based analyses with psycholinguistic experimentation and computational modeling.

The overall aim of the project is to develop computational psycholinguistic models of speech production and comprehension that can deal with everyday spontaneous speech. Data and models will inform work on automatic speech recognition.

Jordi Bascompte
Integrative Ecology Group, Estación Biológica de Doñana, CSIC, Apdo. 1056, Sevilla-410, Spain

The architecture of biodiversity

The mutualistic interactions between plants and the animals that pollinate them or disperse their fruits have molded the organization of Earths's biodiversity. While the bulk of studies on mutualistic interactions have focused on highly specialized, pairwise interactions, there is almost no information on how mutualistic interactions are shaped in species-rich communities. I will review our recent and present research aimed at filling this gap by using tools and concepts from the theory on complex networks. These results unambiguously conclude that mutualistic networks are highly **heterogeneous** (the bulk of species have a few interactions, but a few species have many more interactions than expected by chance); **nested** (specialists interact with proper subsets of the species generalists interact with); and **asymmetric** (if, for example, a plant species interacts strongly with an animal species, the animal interacts weakly with the plant). Networks of mutualistic interactions are thus neither randomly assembled nor organized in compartments arising from tight, parallel specialization. Both ultimate ecological properties such as species abundance and past evolutionary history seem to explain such network patterns. The reported network architecture has far-reaching consequences for species persistence and coevolution.

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Ove Christiansen
Aarhus University, Department of Chemistry, Langelandsgade 140, 8000 Aarhus C, Denmark

Quantum molecular dynamics

According to 20th century science the behaviour of molecules, such as their distribution of electrons and the motions of the atomic nuclei, is dictated by the laws of quantum mechanics. We describe some of the challenges of a theoretical description of the molecular world in the sense of using the basic laws to predict the behaviour of molecules.

Many theoretical methods have been developed over the years for calculating various molecular properties in a broad sense with the aid of computers. However, due to the very fast increase in complexity with the number of degrees of freedom, accurate computational approaches based on only quantum mechanical laws and no empirically adjusted parameters has traditionally been limited to molecular systems with a relatively small numbers of atoms. This has been a major obstacle to the study of the motions of, and interactions between, most real world molecular systems.

My research programme aims at developing new formulations, theories and computational methods for the application of quantum mechanical calculations to systems involving many atoms.

Angelos Michaelides
London Centre for Nanotechnology, University College London, London WC1E 6BT, UK, and The Fritz-Haber Institute of the Max-Planck Society, Faradayweg 4-6, Berlin 14195, Germany

Atomic-scale simulations of water-solid interfaces

There are few molecules, if any, more important than water. Yet remarkably little is known about how it interacts with solid surfaces, particularly at the all important atomic-level. This is true despite widespread general interest and compelling environmental and economic incentives. For example, water-solid interactions play a crucial role in the activity of fuel cells, the chemistry of the troposphere, global warming, corrosion, catalysis, and so on. With quantum mechanical computational approaches, specifically density functional theory, we have been working at putting our understanding of water-solid interfaces on a much firmer footing. In this talk some recent highlights of our work in this area will be discussed. First the properties of water hexamers - the smallest 'building blocks' of ice – on a number of metal surfaces will be discussed. A particular focus will be placed on how the competing influences of substrate reactivity and water cluster-substrate epitaxial mismatch conspire to yield a rich variety of (novel) ice-like structures. Second, the adsorption and reaction of water with common salt and clay mineral surfaces will be discussed.

Alexey Rak
Max-Planck-Institute for Molecular Physiology, Otto-Hahn-Strasse 11, 44227 Dortmund, Germany (rak@mpi-dortmund.mpg.de)

Structural insight into Rab biogenesis.

Rab proteins represent the largest branch of the Ras superfamily of small GTPases, with at least 60 Rab proteins identified in the human genome. Rab GTPases are central and multifunctional regulators of vesicular membrane transport controlling both the exo- and endocytic pathways. Rab proteins are believed to determine the specificity of docking and fusion of intracellular compartments by functioning as signals for assembly of macromolecular machinery controlling those events. Mutations in the Rab GTPases or interacting proteins have been implicated in a number of human diseases, ranging from immunologycal disorders to blindness. Moreover, in a number of vascular, lung, and thyroid diseases as well as in some cancer forms the over-expression of several Rab GTPases is observed and correlates with the disease progression.
We have recently determined a number of structures of Rab GTPases in complexes with their specific regulators in order to assemble a comprehensive model for the structural basis of RabGTPase interaction with other proteins throughout their functional cycle. As the primary method, we choose protein X-ray crystallography, which is the only method that can provide detailed information about structure of macromolecular complexes on the atomic level.

Nikos Tagmatarchis
National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, Vassileos Constantinou 48 Avenue, Athens 116 35, Greece

Multifunctional Carbon-based Nanostructured Materials: Azafullerenes, Nanotubes and Nanohorns

Carbon-based nanostructured materials such as *azafullerenes*, *nanotubes* and *nanohorns* attract the focus of considerable research and scientific interest. This is because each of them can be differently used as a probe to address the role of dimensionality and confinement in materials at the nanometer scale.

Azafullerenes are derived upon substitution of a carbon atom with nitrogen, in fullerene spheres. Since nitrogen possesses one extra electron as compared with carbon, azafullerenes are considered as molecular metals. In the parent hydroazafullerene $C_{59}HN$, the highly acidic hydrogen can be easily removed either in the solid-state or in solution, thermally or photochemically. The generation of azafullerenyl radical $C_{59}N^{\bullet}$ opens the way for the construction of a plethora of azafullerene derivatives for diverse purposes.

Nanotubes as 1-D molecular wires possessing delocalized -electrons, exhibit unusual electronic, mechanical and adsorptive properties, while showing high electron mobility. Polyelectrolytic blocks combined with nanotubes assist high dispersion in aqueous media. Moreover, such polyelectrolyte-nanotube hybrids act as templates for the *in-situ* formation of monodispersed nanoparticles at the ionic sites generating novel nanostructures potentially useful for managing charge-transfer processes in photochemical cells for water splitting and reduction of CO_2 to fuels.

Nanohorns present features similar to the ones of fullerenes (at sites near the conical-shaped tip) and nanotubes (at sites located away from the conical tip). However, nanohorns are morphologically different from nanotubes as they i) possess a conical-shaped tip, ii) are much shorter in length, and iii) aggregate in spherical superstructures. Moreover, nanohorns accept electrons and more importantly, can readily diffuse them along the cone main axis, with almost negligible loss of energy. Therefore, nanohorns can be utilized as electron-acceptors towards the formation of miniature hybrid materials with organic electron-donors, for managing electron-transfer processes in the nanometer scale.

Recent advances on the construction of novel carbon-based nanoarchitectures that exhibit intriguing charge-transfer properties will be presented. Motifs for the realization of these nanoensembles, utilizing either covalent or non-covalent interactions such as supramolecular stacking and/or complementary electrostatic interactions will be described.

Mihai Barboiu
Adaptative Supramolecular Nanosystems Group, Institut Européen des Membranes,
Place Eugene Bataillon CC047, 34095 Montpellier, Cedex 5, France

Dynamic Supramolecular Materials

The chemistry of membrane transport systems of interest for molecular information transfer, has been extensively developed during the last twenty years. The membrane selectivity may be induced either by carrier molecules or by transmembrane channels. From the mechanistic point of view, we use carriers which self-assemble in functional aggregates which would present combined (hybrid) intermediate features between the former carrier-monomers and the resulted pseudo-channel-forming structures. Thus, we therefore studied the membrane transport properties in liquid or in solid materials and bilayers and vesicles of such supra-molecular and organic-inorganic hybrid polymers resulted by the dynamic self-assembly of the hydrogen-bonded urea-crown ethers or organic functional molecules. The present results show that the self-organization properties in the membrane phase may provide the first evidence for the possible hybrid transport carrier *vs.* channel mechanisms in correlation with self-assembly properties of the heteroditopic receptors. It results an increase of the extractability of salts in the liquid membrane phase due a synergetic extraction of cations and anions, but the salt transport rate is less effective due the lower rate of diffusion of higher supramolecular aggregates. *These dynamic self-organized systems can be tested in liquid membranes, bilayer membranes, mesoporous structures materials or "frozen" in a polymeric hybrid matrix by sol-gel process, opening the door to the design of a novel class of organic-inorganic nanomembranes.*
The hybrid membranes successfully formed transport patterns so as to enable efficient translocation events. Moreover, the present system is the first example of a hybrid nanomaterial where the concept of self-organization and a specific function (generation of specific translocation ionic pathways in a hybrid solid) might in principle be associated.
The combined features of structural adaptation in a specific hybrid nanospace and of dynamic supramolecular selection process make the membranes presented here of general interest for the development of a specific approach toward nanomembranes of increasing structural selectivity.

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Massimiliano Cavallini
CNR-ISMN Bologna, Research Section on Nanotechnology of Multifunctional Materials, Via P. Gobetti 101 I-40129 Bologna, Italy

Dynamics of Molecules on Organic Transistors (DYMOT)

DYMOT is a strongly interdisciplinary project that will require the integration in a team of young researchers with backgrounds ranging from solid state physics, to chemistry, from software engineering to biology.
Main objective of the proposal DYMOT is to develop a new integrated approach suitable for investigating the dynamics of nanostructures, low-dimensional systems, aggregates and single (bio-)molecule on a surface in real time. Dynamics at surfaces is relevant to many aspects of molecular, polymeric and soft matter, in general:

- nucleation and growth;
- self-assembly and self-organisation;
- wetting/dewetting transitions;
- bi- and multi- stability;
- phase transitions and non-equilibrium thermodynamics;
- chemical sensing;
- molecular recognition at surfaces;
- charge and energy transport;
- molecular motors and actuators;
- hybridisation probe-target;
- transitions between hyerarchical structures of biomolecules;
- cell activity.

These material and biological phenomena are also at the basis of nanotechnology-based applications, from sensing, to thin film and coatings technology, electronics and optoelectronics, catalysis, information storage, bio-medical diagnostics.

The sensing principle of the DYMOT device is the interaction of a charged or polarizable species (es. biomolecule) with the organic semiconductor which is readily accessible to the molecules from the environment.
This interaction does not need to be strong and neither requires the adsorbate to be conductive itself. It is enough to cause a perturbation in the highest population of charge carriers at the upmost layer of the ultra thin film, being the charge mobility in organic field effect transistors exponentially sensitive to the charge carrier density. Thus, electrostatic interactions at the level of few charges or polarisation effects due to the presence of the adsorbate with respect to a “blank” (reference) transistor will make possible to monitor the occurrence of adsorption events either in the change of the threshold voltage or in the change in the transconductance.

DYMOT requires a variety of materials with different functionality and processability: organic semiconductors (vacuum-sublimable, solution processable), metals and metal precursors, polymer blends, probes, targets, self-assembly monolayers, chemical grafting precursors.
A major aspect of DYMOT will be the fabrication of the device. This requires the fabrication of the bottom-electrode field effect transistors, their connection to the outside world, and finally the integration of a mask or device to confine and place the system of interest (termed molecules of interest from now on) in the active region (channel) of the device on top of the organic semiconductor.

Svetlana V. Berdyugina
Institute of Astronomy, ETH Zurich, Switzerland

Molecular diversity in the cosmos

Molecules are found in a large variety of astronomical objects, ranging from comets in the Solar system to galaxies at high redshifts. They are a major component of the interstellar medium and constitute giant molecular clouds. They are detected in the atmospheres of the Sun, red dwarfs and giants, brown dwarfs and giant planets and allow for studying their physical properties, including temperature, chemical compositions and magnetic fields. The goal of my EURYI Award project is to develop a new field in stellar astrophysics aiming at studying solar and stellar magnetism by means of molecular spectro-polarimetry. In the presence of a magnetic field many molecular lines exhibit the Zeeman effect and, thus, are useful to diagnose cool magnetized stellar atmospheres. We extend the theory of molecular interactions with magnetic fields and develop novel diagnostic techniques for studying solar and stellar magnetic fields, including sunspots, small-scale magnetic field concentrations and turbulent magnetic fields on the Sun, direct measurements of magnetic fields in spatially unresolved starspots and fully convective stars, and magnetism of cool white dwarfs with strong fields which are not yet achieved in laboratories.

Päivi Törmä
University of Jyväskylä, Nanoscience Centery, P.O.Box 35, 40014 JYU

Nanoscale quantum systems interacting with fields: ultracold gases and molecular electronics

We discuss theory of ultracold Fermi gases, especially pairing in gases with unequal numbers of atoms for the two pairing components, or unequal masses. FFLO type features and various shell structures are found for gases confined in a harmonic trap. Studies of ultracold Fermi gases are expected to shed new light on the nature of superfluidity and superconductivity.
We also discuss experiments on trapping and attaching 100 nm scale DNA molecules using electromagnetic fields, and especially, using a carbon nanotube as a nanoscale electrode in this process. Such a technique could be used in assembly of future molecular electronics circuits.

Jakob Reichel
CNRS UMR 8552, Ecole Normale Supérieure, Paris, Cedex 05, France

Atom Chips: Integrating atomic coherence

New and exciting physics is currently emerging at the interface of ultracold atomic and condensed matter physics.
Atom chips provide an experimental link between the two areas.
I will give an overview of the subject and describe experiments in which Bose-Einstein condensates are coupled to optical and nanomechanical resonators on a chip.

Arno Rauschenbeutel
Institute for Applied Physics, University of Bonn, Wegelerstr. 8, 53115 Bonn, Germany

Using Ultra-Thin Glass Fibres as a Quantum Laboratory

Glass Fibres play an important role in many areas of everyday life: They have numerous applications in medicine and industry and, owing to their enormous capacity for transmitting information, they have become the backbone of the modern information society. In addition, the design and production of novel types of glass fibres is currently one of the most active fields in research. As an example, so-called “photonic fibres” can be used to convert ultra-short laser pulses into a special rainbow spectrum – a discovery, for which the German physicist Prof. Dr. Theodor W. Hänsch was awarded the 2005 Nobel Price in Physics. Motivated by such high-tech applications, a race has begun amongst researchers, realizing glass fibres with ever more extreme and specialized designs.

In parallel, another exciting development has taken place in the field of quantum optics: Using laser light, it has become possible to control and manipulate the state of atoms and molecules down to the quantum level. This has led to a revolutionary paradigm change in our notion of the microscopic world. We have in fact entered a new era, leaving the role of mere observers and turning into “quantum engineers”. In particular, features of the quantum world, formerly considered as merely paradoxical, have become everyday reality in the laboratory.

The aim of the work I will be presenting is to make these two worlds meet: We seek to carry out quantum optical experiments with atoms and molecules on the surface of ultra-thin glass fibres. Such fibres provide an extreme confinement of the guided light field, making it possible to realize a strong and controlled interaction between light and matter at the ultimate microscopic level. The entry of quantum mechanics into glass fibre technology has the potential of opening the route towards a whole new class of applications. It should, e.g., become possible to build atomic switches for light fields or to realize novel light sources, needed for quantum cryptography, quantum communication, and quantum information processing.

François Taddei
Génétique Moléculaire Evolutive et Médicale Faculté, de Médecine "Necker - Enfants Malades", Université René Descartes-Paris V, Paris, Cedex 15, France

Extended Genetics: extended phenotypes, extended environment and extended inheritance

Classical genetics postulates that by knowing the genotype and environment the phenotype can be predicted. To explain how natural selection can select for genes involved in the construction of spider web or beaver's dam, Richard Dawkins suggested describing such modifications of the environment as *extended phenotypes.*
Work perfomed on bacteria shows that even with a constant genotype and a constant external environment a large variability can still be observed and that there is some heritability of these effects. By taking into consideration not only the external environment of the cell but also the internal environment, i.e. by looking at the environment of DNA (extended environment) rather than only at the environment of the cell, one could describe many more of the behaviors of cells including aging of symmetrically dividing organisms such as E. coli.
Thus one could take into account cytoplasmic inheritance as a part of *extended inheritance*. The latter should also include the fact that the modification of the external environment by organisms can be long lasting. Organisms can modify the environment in which they live in ways that can benefit them, (adapting the environment rather than only adapting to the environment), a phenomena described as niche construction by Odling-Smee and colleagues. Thus, offspring can find themselves in an external environment constructed by previous generations (ecological inheritance).
Evidence that gut bacteria, such as E. coli, are able to use such strategies to manipulate their environment (including us...) for their benefit will be presented. Niche construction can be even more efficient when the initial modification of the environment triggers an autocatalytic process that can propagate like an epidemic. If time allows, discussion will show that humans are not only victims of bacterial niche construction causing disease, but that they are also experts in such autocatalytic niche construction strategies.

Zsuzsanna Izsvák
Max Delbrück Center, Berlin-Buch, Robert Rössle Str. 10. 13125, Berlin, Germany

Regulation and Application of Transposable Elements in Vertebrates

Transposons are mobile genetic elements that are ubiquitous in nature, and make up significant fractions of genomes. Active transposons that move via a DNA intermediate (as opposed to retroelements) are essentially missing in vertebrate species, due to their mutational inactivation over evolutionary time. The resurrected ancient fish transposon, called *Sleeping Beauty* (SB) efficiently transposes in a wide range of vertebrate cells, including humans. SB is a unique experimental tool to address questions related to the mechanism of transpositional DNA recombination, as well as the intricate molecular interactions between the transposon and the host cell. My research is aimed at surveying different cellular factors involved in DNA replication, repair, damage-signalling and cell-cycle regulation for their potential roles in establishing a successful transposition event. Since transposon activity is usually down regulated in the host organism, my team manipulated the transposon to generate hyperactive mutants by *in vitro* evolution. In addition, the target site selection of the transposon was modified to achieve targeted transposition into predetermined loci, or chromosomal regions. In the last copule of years, SB opened up new possibilities for the development of transposon-based genetic/genomic technologies in vertebrates. My research is aimed to extend our understanding of the principal molecular processes involved in cellular responses to DNA transposition, and contribute to the development of safe and efficient molecular tools for genetic manipulations, such as gene discovery or gene therapy in vertebrates.

Frederic Geissmann
INSERM, Laboratoire d'étude du système des phagocytes mononucléés, IFR Necker-Enfants Malades, Université René-Descartes Paris-5, Hopital Necker-Enfants Malades, 149 rue de Sèvres 75015 Paris, France.

Biology of the mononuclear phagocyte system

Cells of the mononuclear phagocyte system (MPS) - i.e. monocytes, macrophages and dendritic cells - develop in the bone marrow, circulate in the blood, and form networks within all tissues. They are involved in the scavenging of dying cells, pathogens, and molecules through a variety of cellular processes, such as phagocytosis and endocytosis using pattern recognition receptors. In addition, they exert many specialized functions that are critical for development, tissue homeostasis, inflammation, and the defense against infection.
We are developing experimental models, in the mouse and in human, toward 3 aims : i) to identify the progenitors for the various cells of the MPS in mouse and human, and the genes and external cues that control their differentiation, ii) to describe and explain the functions of blood monocytes, and their contribution to the MPS, and iii) to investigate the pathophysiology of histiocytoses, a group of tumoral and immunologic diseases of the MPS in humans.

Etienne Koechlin
Université Pierre et Marie Curie, Paris, France

How do humans decide to act?

The lateral prefrontal cortex (LPFC) subserves cognitive control, i.e. the ability to select actions in relation with internal states of the agent. In this talk, I will describe a theory describing the overall architecture of human lateral prefrontal functions underlying cognitive control and based on recent neuroimaging results. We develop an information-theoretic approach to cognitive control that explains how cognitive control works as a unitary function though operating through multiple, interacting functional components implemented in distinct LPFC regions. We show that the LPFC implements three major temporal dimensions of control, namely the synchronic, diachronic and polychronic dimension, from posterior to polar LPFC regions. Furthermore, we show that within the synchronic dimension, the posterior LPFC regions, i.e. Broca's area and its right homologue, form a modular control system operating according to the hierarchical structure of action plans. Thus, the theory especially suggests a basic segregation between two embedded prefrontal executive systems involved in the hierarchical and temporal organization of action and thought.