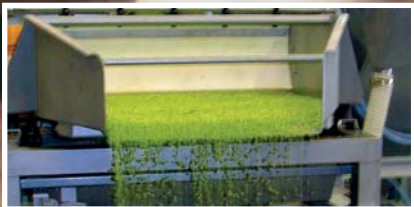
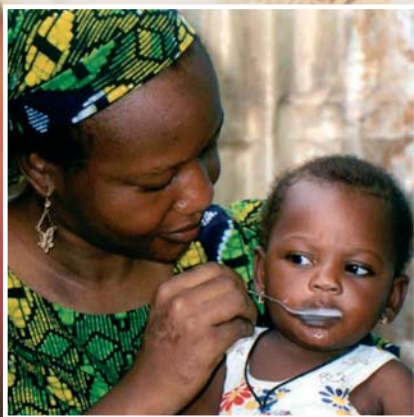


les dossiers **d'AGROPOLIS**

Expertise of the Agropolis scientific community

Food, Nutrition, Health



Agropolis

Agriculture • Food • Environment • Societies

Agropolis groups institutions of research and higher education in Montpellier and Languedoc-Roussillon in partnership with territorial communities, companies and enterprises in the region, and in close co-operation with international institutions. This scientific community has one main objective: the economic and social development of Mediterranean and tropical regions.

The role of Agropolis is that of an international agricultural university. It represents a significant potential for scientific and technological competence : 2000 research scientists and lecturers in more than 200 research units in Montpellier and Languedoc-Roussillon region including 500 scientists in 60 countries.

Agropolis offers a broad range of expertise focusing on research themes related to major social issues :

- Agronomy and Mediterranean and tropical agricultural production sectors,
- Biotechnology and food technology,
- Biodiversity, natural resources and ecosystems,
- Water, environment and sustainable development,
- Rural development and societies,
- Genomics and plant and animal integrative biology,
- Food and health,
- Food quality and safety.

Agropolis is a centre for the capitalisation and valorisation of knowledge, for training personnel and for technology transfer, it is a hub for visitors and international exchanges ; it promotes actions based on multilateral expertise and contributes to the scientific and technological knowledge needed for preparing development policies.

Research competences in the fields of Food, Nutrition and Health in Montpellier and Languedoc-Roussillon

The satisfaction of nutritional requirements and the qualitative improvement of agricultural and agri-food production that consumers expect depends on the creation of varieties adapted to sustainable production systems and selected for optimum nutritional intake.

The ability to preserve and develop the health investment represented by food and the satisfaction provided by the art of cooking is based on three types of knowledge:

- Knowledge of the macro constituents and micro components of plant and animal products, control of harvesting, storage and processing of products in ways that safeguard the most delicate nutrients;
- Investigation of the physiological, cellular and molecular mechanisms of nutrients and of their effects on the health of “healthy people” and on those exposed to pathological risk factors;
- The study of the consequences of eating habits for public health.

At Agropolis, more than 600 scientists are involved in the study of the relations between food, nutrition and health. In the context of European research, this Food-Nutrition-Health Research centre will play an important role in the fields of research listed here.

Food, Nutrition, Health

Optimisation of agriculture and breeding resources through the valorisation of food properties Page 4

Investigations of the mechanisms of action of food components at the molecular and cellular level and on animal models Page 12

The study of chemical or microbial contaminants of food Page 18

Study of the relations between Food and major pathological risk factors Page 22

Developing a nutritional approach in public health Page 28

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Disseminating scientific and technological culture to the general public Page 34

Topics covered by research teams Page 36

Education and training at Agropolis Page 38

List of abbreviations Page 46

Optimisation of agriculture *and breeding resources* through the valorisation *of food properties.*

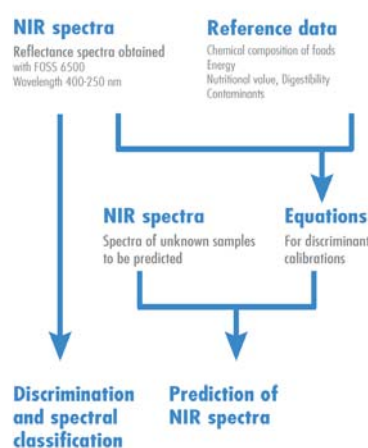
Over the past decade the whole context of agricultural and food production has changed. Improving the human Food depends on better valorisation of agricultural products. Given the permanent challenge of food safety and of the nutritional and organoleptic quality of food, it is important to develop tools and methods that will help improve our understanding of the raw materials that make up our food.

It is important to take into account not only the expectations of consumers - who are becoming more and more demanding - but also the quality of the raw materials and their suitability for processing. Being in control of reactions, of processes and of the equipment facilitates food conservation and the formulation of foods. To this end it is necessary to study the physical, chemical and functional properties, in particular the micro-constituents of the plants that provide our food. This has become possible thanks to

the development of genomics and advanced plant biotechnologies, bioproduct engineering, as well as analysis of natural substances.

Genomics and the genetic improvement of cultivated plants

Spectacular progress in molecular biology, bioinformatics and other technologies such as high speed sequencing and image analysis has resulted in a new field of research on genomics: genomics



Use of near- infrared spectroscopy (NIRS) for discrimination and prediction

Near InfraRed Spectrometry in the Food Laboratory

At the CIRAD EMVT Food Laboratory NIRS is used for the following tasks:

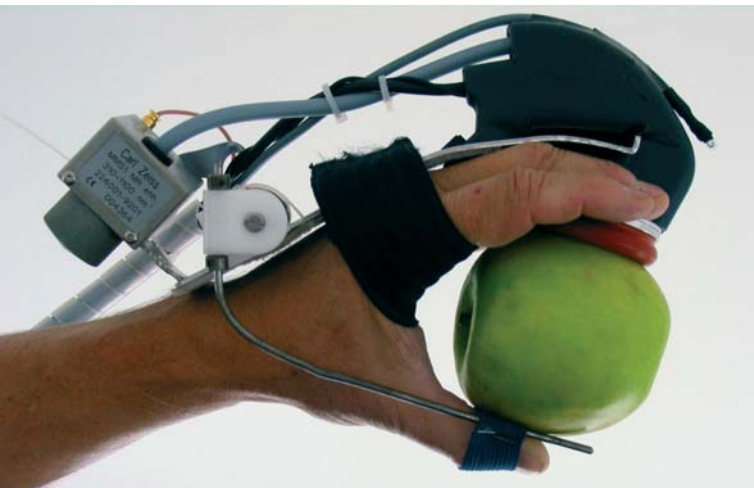
- To predict the chemical composition of samples of feedstuffs: raw materials, fodder, complete feed;
- To predict nutritional parameters (digestibility, energy) from food or faeces;
- To classify and discriminate sample populations on the basis of spectral information
- To conduct research on the prediction of (nutritional, sanitary) quality (milk quality, etc.) or of contamination of samples (contamination by mycotoxins, etc.).

The use of this tool in research is very promising. NIRS enables analysis of a large number of samples, allowing a demanding

experimental set-up: spatial and temporal monitoring, the study of variability of responses, etc.

With this tool, the laboratory enhances its own database (60 000 samples) and contributes to general classification tables for food (the AFZ/IO databank for feedstuffs containing more than one million results on 2 000 raw materials) as well as regional tables (local tables in Southern countries). These databases allow efficient management of feed and formulation of rations.

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Michel Crochon © Cemagref

GLOVE: a portable sensor including a miniature near-infrared spectrometer for measuring the sugar content of fruits in the field

Near InfraRed Spectrometry (NIRS) is a rapid, non-destructive analytical method that provides information on the composition and on the macroscopic structural properties of products (texture, granulometry, etc.). It is widely used in the agri-food industry for routine laboratory operations such as inspection of raw materials or finished products, as well as for on-line laboratory operations like the measurement of the water

NIRS in the field

content of dry products. However, despite its impressive analytical potential, its distribution in agri-food production is still relatively limited. This is due to the difficulty in calibrating the NIRS sensor correctly and lastingly. The cost of the equipment has also limited its use in agriculture. For several years now, the joint research unit Cemagref – Agro. M – Cirad ITAP has been studying this analytical technique from two angles: firstly, to design cheap tools compatible with agricultural specifications; and secondly, to develop mathematical methods to obtain robust calibration that is not sensitive to disturbance. Up to now the joint ITAP team has mainly worked on the use of NIRS for sorting fruit and vegetables in the framework of several European projects. Today, research is starting on its use in the field (measurement of the physiological characteristics and quality of the products) thanks to sensors that are portable, or can be loaded on an agricultural machine and are soon to be airborne (on drones). The joint ITAP team has developed cross skills, collaborates with many NIRS users within Agropolis and also contributes to the French NIRS federation via the Hélio-SPiR network (www.heliospir.net).

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enables us to draw up a list of the genes of an organism and to understand their regulation, functions and interactions. Within this framework, the joint research unit *Polymorphisms of Interest in Agriculture* is currently working on the genomics of monocotyledons (rice and wheat) and also of fruit-bearing woody plants and forest populations. The use of some of the tools that have been developed awakened interest in the detection or authentication of a number of different agricultural products (GMO, hard wheat/soft wheat, chestnuts).

The *Plant Biotechnologies and genetic resources programme* (Biotrop, Cirad) also uses the most recent technologies to profit from plant genetic diversity to enhance varietal improvement. This research programme develops new methods for the optimum management of genetic resources, facilitates the creation and identification of efficient genotypes (technological quality) and contributes to the rapid diffusion of selected varieties. The main focus of the research is on monocotyledons (cereals) and fruit-bearing woody plants.

Animal products, an important issue in southern countries

In the majority of southern countries, population growth, mass urbanisation, an increase in income, and changes in eating habits have led to a significant increase in the demand for animal products, especially for food of high nutritional value produced by stockbreeders and farmers. The intensification of production and profound modifications of marketing sectors are consequently inevitable. Nutrition and health are a vital component of intensification and must result in more productive breeding. Food produced by stock raisers can however be responsible for the transmission of zoonotic diseases as well as for the spread of animal diseases, which are serious public health issues in both southern and northern countries. Aside from price, quality (in the broadest sense of the term) also plays an important role in how consumers choose a product. It is in this context that the *Livestock Systems and Animal Products Research Unit* (Cirad) conducts research on the following topics:

- Analysis and modelling of animal performance and of zoo-economic productivity of herds;
- Analysis of market and non-market economic competitiveness of the stock production sectors;
- Knowledge, assessment and management of the health risks specific to products of animal origin based on the study of practices from producer to consumer throughout the sector;
- Analysis and forecast of the nutritional quality and safety of animal foodstuffs;
- Study of the impact of production quality on the productivity of the herd, on processing processes of animal products and on the efficiency of the sector as a whole.

In addition to the production of land animals, the production of living aquatic resources is also constantly increasing on a world scale. Demand for fish protein is very high in Africa and Asia and tropical aquaculture should provide the answer. It is in this context that the *Aquaculture and aquatic living resources management Research Unit* (Cirad) has developed two areas of research: biology and genomics of aquaculture species; improvement and sustainability of the sector and of fish farming systems. ...

Teams

UMR PIA

"Polymorphisms of Interest in Agriculture"

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research unit

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UPR 24 TROPICAL

"Food processing"

research unit

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UPR 33 IMPAQ

"Quality of tree crop products"

research unit

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UPR 45 QUALITER

"Qualification and territories" unit

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UMR 016

"Chemical Engineering and Bioproduct Elaboration"

joint research unit

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...continued on page 8

The agri-food sector in southern countries

The agri-food sector has been growing for a number of years in southern countries, although the organisational and technical level varies with the country and with local purchasing power. The sector has to face considerable organisational and technological constraints when trying to ensure a supply of healthy products to rural and urban markets and to meet the increasingly restrictive regulations and standards applied in northern countries. To understand the agri-food sector, one has to be able to understand the relations between production systems and consumption systems and to ensure social control of changes in local supplies. To achieve this objective, producers in southern countries need to learn how to enhance the value of their products, at the same time allowing consumers in southern countries to maintain existing behaviours or to find new frames of

reference in their eating behaviour. It is also necessary to ensure the safety of local food production units, to promote its qualities (organoleptic, nutritional and functional), and to create marketing strategies based on its diversity to attract consumers in northern countries.

Access to markets, the fight against poverty and the sustainability of production sectors are also major issues. In this context, the scientific challenges are to ensure that the production of tomorrow's food is based on sustainable agriculture, and on healthy nutrition taking into account consumers' concerns, as well as the entire food chain (production, genetic determinants and methods of cultivation, processing, preparation and consumption of food).

The main research topics of the *Food processing research unit* (UPR) are (i) characterisation of quality factors and control of the process of formalisation and conservation of the physical, chemical, nutritional, organoleptic

* Executive scientists, hospital doctors, research scientists and lecturers, engineers working on a full time basis are included.

Use of plant lipases to modify oils and fats

The growing market for enzymes (+ 8% / year) had already reached more than 30 billion Euros in 2004. Enzymes are increasingly used in food processing; they are usually of animal or microbial origin, especially lipases with improved physical and/or nutritional properties used in the manufacture of oils and fats. The range of different enzymatic processes used takes advantage of their different specificities (substrate selectivity, regioselectivity, typosselectivity, stereoselectivity) to manufacture oils and fats "biologically". Enzymatic responses take place easily without the development of coproducts, and the kinetics are simple to control.

Unlike traditional chemical catalysts, lipases enable the reaction to be controlled to obtain a predefined product by changing the composition and distribution of fats in the precise way desired. In the case of oils and fats, biocatalytic processes are used for the production of restructured triacylglycerols, fatty acid concentrates, esters, partial glycerides and bioactive molecules including interesterification, transesterification, hydrolysis, alcoholysis, acidolysis and esterification.

Despite their availability, low cost, ease of purification and in certain cases, very strong selectivity, plant lipases are currently not as widely used as biocatalysts as lipases of microbial or animal origin. Given this context, the aim of the *Lipid technology laboratory* is to draw attention to the potential use of these lipases as biocatalysts which can be produced from plant biomass.

Despite the problems involved in moving up from the laboratory to the pilot or industrial scale, the biocatalytic activities of raw plant materials offer a promising alternative to the use of microbial lipases, which are often genetically modified. In the near future, plant biocatalysts of this type are likely to be used in different bioprocesses to produce, among other things, high-value lipids with improved physical and nutritional characteristics.

For further information, see Villeneuve P. 2003. Plant lipases and their applications in oil and fats modification. *Eur. J. Lipid Sci. Technol.* 105(2003): 308-317.

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and functional qualities of the raw materials or products throughout the processing chain; (ii) development of technological stabilisation processes to ensure their microbiological stability, traceability, and their valorisation in harmony with consumer demands; (iii) evaluation and control of microbiological risks in food with the aim of guaranteeing healthy products, using an integral approach that takes the entire processing line into account. This research calls on different disciplines ranging from food sciences (physiology, nutrition, biochemistry, and chemistry), process engineering, and industrial engineering; it is organised in projects, by laboratory and as a function of the availability of pilot equipment and technological facilities.

The Research Unit *Quality of tree crop products* (UPR) provides knowledge,

tools and methods (i) needed for adaptation to the increasing demand for quality, (ii) in a way that ensures improvements in quality for the benefit of all the stakeholders in the sector including tropical producers, and (iii) and suited to the specificity of the agro-industrial products concerned particularly those made from perennial crops.

The unit *Qualification and territories* tries to answer two questions:

- Which systems allow specific resources (products, know-how, organisations, economic stakeholders) to be valorised in local development and in the differentiation of production processes ?
- What are the opportunities and risks involved in this process of product differentiation in the face of changing markets, and new standards and forms of distribution and consumption ?

ENSIA-SIARC is also concerned with tropical food product engineering taking into account all the specificities of the populations of southern countries. The aim is to analyse, understand and improve traditional processing in order to increase the supply of food on local markets in southern countries and to develop new processes that add value to local products intended for export. One area of research concerns the study of the impact of technological treatments on micronutrient bioavailability in the final food product. ...

Fermenter for primary fermentation of beer before secondary fermentation. The colour of the foam is due to tannins in the hops



Bio-products: engineering, bioprocessing and equipment

The overall goals of food industries are the optimisation of design and the control of processes and product quality, and the design and manufacture of new products. The methods used by food manufacturers include an integrated approach to transfer and to biological physical and chemical aspects, modelling with a view to optimisation and management of operations, and the use of artificial intelligence. Process engineering is an integral part of this industrial sector that now has to integrate a wide range of data concerning the environment, safety, the public image, etc. This implies all the scientific and technological knowledge needed to transform raw materials and energy into a product fit for human consumption. At the heart of this engineering science are the design, implementation and optimisation of industrial processes that change the state, the microstructure or the chemical composition of materials using chemical, catalytic or biochemical reactions linked with efficient methods for the separation of product components.

The research topic of the *Chemical Engineering and Bioproduct Elaboration*¹ joint research unit is linked with the control of formulation oriented to the structure of rheologically complex biological matrixes (gels, paste, biosolids, etc.) that have to respect specific objectives (gustatory and nutritional quality, etc.). Consequently analysis

of the processes cannot be conducted independently of analyses of changes in the structure and properties of the product during processing. The conversion of these molecular processes into macroscopic phenomenological laws that will enable control of the products' usual properties and functionality thanks to efficient technologies comprises this new "process-product-process" approach to process engineering. This approach also enables the development of tools to model processes leading to the definition of extrapolation criteria to calculate the size of and to control industrial systems. The main domains presently concerned by developments in this field are the creation of food and health biomaterials (divided solids for pharmaceutical use, drying or packaging of specific foods), of polymer films (materials with controlled porosity for packaging and insulation), as well as the processing of by-products of food processing for reuse.

The joint research unit *Agropolymer Engineering and Emerging Technologies IATE* studies the physical and physico-chemical processes of agromolecules, agropolymers or complex matrixes during processing and their effects on the structure, functional properties and quality of use. All the activities concerned with this research topic are complementary and correspond to the main stages in the processing of food products: dissociation of native structures with the generation of agropolymers, assembly of agropolymers with the development of complex structures, functionalisation of these structures and physico-chemical and

Teams

... continuation of page 6

UMR IATE

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UMR I212

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UMR 5635

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UMR ITAP

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UMR I083

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Laboratory of

"Botany, Phytochemistry and Mycology"
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microbiological stabilisation. They are focussed on three main lines of research:

- Line 1. Fractionation and particle engineering is concerned with the structural bases of grain and seed fractionation, the mechanics of the granular environment and their adhesion, the rheology of divided solids, processes for the separation and fractionation of tissues, and the hydration of the generated particles up to the formation of paste;
- Line 2 is concerned with active and functional macromolecular systems and the physico-chemistry and microstructure of protein-based or polysaccharide-based networks and co-networks; technological processes involved in the production of gels, pastes or films; and measurement and modelling of the transfer of solutes, water, gases and compounds in matrixes or complex foods. One important field of application is the packaging and conditioning of food, particularly edible, biodegradable

and/or bioactive materials (antimicrobial films, antioxidants, fruit and vegetables packaged in a modified atmosphere, etc.);

- Line 3 focuses on the control of the effects of stabilisation and functionalisation of “soft” technologies on components and food structures and their effects on the functionality and microbiological stability of products.

The joint research unit *Bioreaction engineering, bioproductions*¹ is concerned with biosynthesis and the production of useful biological molecules (heterologous proteins, bioconversion catalysts, metabolites, etc.). Research is carried out at the molecule or bioproduct level including isolation and biochemical characterisation and the study of functional properties. The unit is interested in biological tools (microorganisms and enzymatic systems) for the selection and/or genetic improvement of microorganisms that break down

plant substrates and/or produce molecules of interest. Biological response engineering enables processes to be controlled. The general fields of application of this research are the production of heterologous proteins, food fermentation, the production and characterisation of metabolites and active molecules that can be used in various industries as well as the development of inspection procedures for fermentation and bioproduction.

Significant progress has also been achieved in membrane processes thanks to the use of new membrane materials integrated into the process, to a better understanding of transfer and interfacial phenomena but also the use of processes coupling. The activities undertaken by the *European Membrane Institute* in connection with processes using liquids are, among others, the application of baromembrane techniques for the purification and/or concentration of

¹ This UMR belongs to the UMRI research department “Agro-ressources et procédés biologiques et industriels” (ARPB).
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Study of the biochemical composition, structure and properties of wheat grain to improve the nutritional value of cereal products

The wheat grain is a complex material composed of several tissues that have a different structure and composition (starchy endosperm, germ, and envelopes). The grain fractionation process (or milling) has been optimised to allow the manufacture of cereal products with good energetic value and technological properties, principally viscoelasticity. The aim of the milling process is to separate the starchy endosperm, which is mainly composed of starch and storage proteins, from the grain without contamination from the outer layers, and to reduce it to flour

or semolina. However, the majority of fibres and micro-nutrients (minerals, vitamins, molecules with anti-oxidant properties) are contained in the outer layers of the grain, mainly in the aleurone tissue, and are consequently absent in flours and semolina and thus also in cereal products. Possible improvements in the nutritional value of cereal products depend on controlling the isolation and fractionation of this tissue throughout the grain milling process. Current research in this laboratory aims at:

- Providing a detailed description of the composition and structure of wheat grain tissues and developing biochemical markers which will allow specific monitoring of grain tissue dissociation throughout the milling process;
- Characterising the physical properties of grain tissues (mainly mechanical properties) and identifying the compositional and structural basis of these properties;
- Developing new conditions to allow better isolation of the different tissues by improving the resolution of the processes and/or by acting at the interfaces of the tissues to be broken down.

S. Peyron © UMR IATE



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*Microscope view
of the cross section
of a wheat grain*

A



B



The oenological process goes from the grape (A) to the wine (B)

biological solutions and soluble foods by microfiltration, ultrafiltration and nanofiltration (concentration of orange juice for instance), osmotic evaporation for the concentration of thermosensitive products such as fruit juices and electromembrane techniques for the deacidification of sour tropical fruit juices.

On the subject of equipment engineering, the joint research unit *Information and Technologies for Agro-Processes* is concerned with the installation of new equipment for agro-processes in the context of sustainable agriculture and food production. Equipment engineering includes information acquisition systems as well as information exploiting systems for products or processing to help decision-making and control and consequently the optimisation of quality criteria. Research is also conducted to reduce pollution caused by the use of phytosanitary products including knowledge of the transport and the process of deposit of phytosanitary products, adaptation of these technologies and the development of alternative technologies. Finally, Cirad designs equipment integrating different aspects of sustainable systems (economic, sociological and ecological aspects) which are implemented in southern countries.

From grapes to wine...

Making wine is a very complex phenomenon. In order to understand the elements that influence wine quality, the Joint Research Unit *Sciences for Oenology SPO* focuses on three main lines of research. First, on the structural analysis and physico-chemistry of polyphenols and on the response mechanisms

responsible for their effect on organoleptic characteristics and product stability. The beneficial effect on the prevention of certain degenerative pathologies is studied. The second line of research is concerned with the physiology and genomics of "industrial yeast", i.e. *saccharomyce* strains adapted to the very particular and stressful fermentation conditions in oenology: very low pH, an initial environment that is very poor in nutrients but high sugar content and a high final ethanol concentration. The third line of research concerns the functional genomics of development and grape berry maturation. Special attention is paid to the biosynthesis of phenolic compounds, how they are affected by water stress, the thermoradiative environment of the bunch of grapes, and the transcription factors involved in the early response to abiotic stress. Equipment used in common by different teams is grouped in an analytic area (RIO platform for structural analysis and polyphenol interactions) and technical zone (rooms for sensory analysis and the analysis of volatile compounds).

Analysis of natural substances

The laboratory of *Botany, Phytochemistry and Mycology* focuses its research activities on natural plant substances (analyses and extraction processes) and their mode of action; to the substances being destined for use in pharmacy, cosmetology, and agronomy or in the agri-food sector. The team is particularly specialised in knowledge of polyphenols and metabolites which play a significant role in plants and humans.

Their biological activities concern both agronomy, and health (antioxidants, anti-inflammatory drugs, analgesics, antidiabetics, carcinostatics, etc.). In recent years, this specialisation has enabled the use of natural substances in cosmetology (*Christian Dior* Perfumes) as well as in agribusiness (SCALIME Company, Lyon) for recycling green waste and the creation of polyphenol-enriched extracts.

The team studies plant chemical reactions in response to biotic and abiotic stress as well as defence and communication mechanisms between partners (chemical signals). Research is conducted on the impact of biodiversity of dye-plants and their uses both as dyes and for medicinal purposes. An inventory of dye-plants has been created as well as a summary of indigenous plants potentially useful as dyes.

A *Botanical Garden of Dye-Plants* (Lauris, Vaucluse) was created in 2002 and contains more than 150 dye-plants. This has enabled conservation of a comprehensive set of living samples which are required by big art restoration laboratories, but is also much appreciated by other users. The garden also represents a significant resource for the discovery of natural substances of pharmaceutical, cosmetic or agri-food interest. ■

Investigations of the mechanisms *of action of food components* at the molecular and cellular level and on animal models

An individual's food preferences define the range of food and therefore the range of food components to which the organism will be regularly exposed (or which it will be deprived of). Research on cells and animals provides information about potentially active components and their mechanisms of action. Understanding their mechanisms of action is even more important than identifying the properties of food components. Cell culture, cell physiology and molecular biology, but also genomics, proteomics and metabolic technologies are employed to this end..

Food – an Investment for Nutrition and Health

Food science is indispensable for the study of ways to improve food conditions. This research field includes the study of the changes that food and food products undergo during domestic, artisan or industrial processing. Processing chains need to be optimised to better preserve the nutritional characteristics of food that contribute to health. The general research topics of the *Food and Nutrition* unit (UMI/Polytech' Montpellier) are the nutritional value of food and the effects of processes and technological treatments. In fact the formulation of appropriate food or which targets vulnerable groups or people with specific nutritional is based on knowledge of biologically active determinants and their bioavailability. The *Nutrition and Food* laboratory also studies these mechanisms at the molecular and cellular level. This experimental approach uses cell and animal models which enable analysis of the mechanisms in successive stages and sometimes involves the use of

molecular biology techniques. The laboratory is also engaged in studies on the health value of food, the preventive effects of antioxidants, and finally on interactions between food and the digestive tract, and bioavailability.

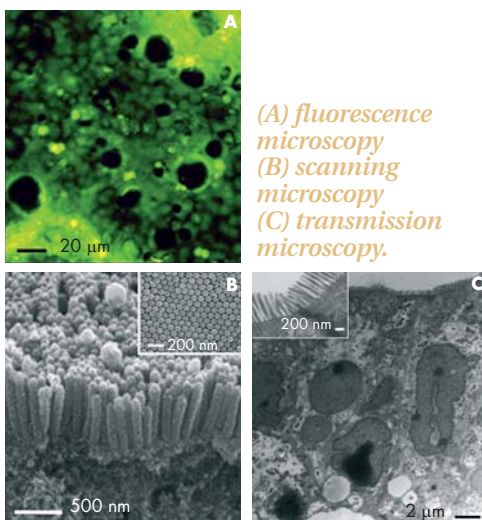
The contribution of nutrition to the understanding of biological regulations and cardiovascular diseases

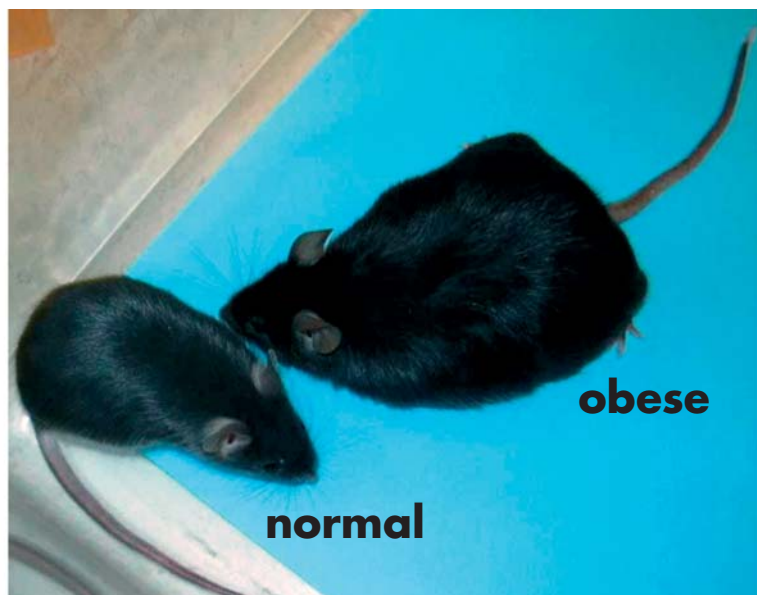
The *Nutrition and Atherogenesis* unit is at the interface of nutrition, biological regulation, and cardiovascular diseases. This laboratory conducts studies focussed on bioavailability and on the mechanisms of action of natural antioxidants (including polyphenols) which play a role preventing atheroma. These mechanisms involve chemical defence against the oxidant stress which occurs in atherogenesis, as well as specific interactions such as physico-chemical interactions

Cellular model for the study of the bioavailability of nutriment

The use in the laboratory of an *in vitro* digestive system coupled with the Caco-2 cell line from an adenocarcinoma of the human colon enables the majority of problems of bioavailability and bioaccessibility of micronutrients to be studied *in vitro*. This approach also helps locate these micronutrients in the cell, and, with the help of molecular biology tools, favours the impact of these micronutrients on cell differentiation. This type of experimentation can be monitored by transmission electron microscopy, scanning electron microscopy, or by epifluorescence microscopy.

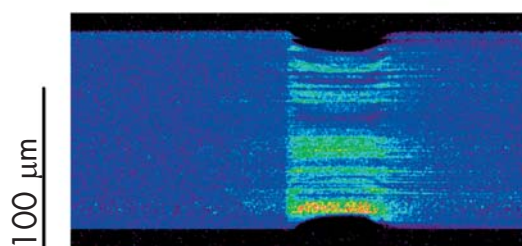
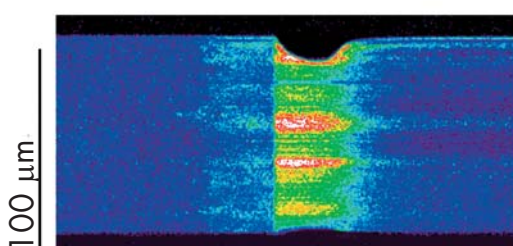
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A.M. Gomez U437 © INSERM

Photograph of a normal mouse (on the left) and an obese db/db mouse (on the right). db/db mice present a mutation of their leptin receptors that alters their feeling of satiety. These obese mice have type 2 diabetes and cardiovascular problems.



Images obtained by confocal scanning microscopy of a normal myocyte and a type 2 diabetes obese myocyte (db/db). The heart muscle cells of the obese mice contract less and the calcium signal is reduced.

500 ms

able to lead to the modulation of genes of interest (oxidized LDL receptors, prooxidant or antioxidant enzymes, etc.). Oxidant stress is also involved in other degenerative pathologies such as chronic renal failure, insulin resistance and age-related pathologies. Depending on the case, this research involves *in vitro* approaches using cell models, *in vivo* approaches using animal models (insulin resistance models) and nutritional interventions in man (healthy or patients) enabling tests to be carried out on a specific food (or drink), or on a nutritional ingredient of plant origin. The main goal is a better understanding of the positive relation suggested by epidemiological studies between a reduction in the risk of cardiovascular disease and consumption of natural antioxidant-rich food specific to the Mediterranean diet.

Specific Food (fatty acids) can correct certain heart rhythm disorders. It is also known that in Central Asia (Turkey) and in China, populations suffering from a nutritional deficiency in selenium suffer from arrhythmias with a risk of sudden death. The relations between

a given food model, nutrition, prevention and cardiovascular risk therapy thus provides one basis for research. The overall research objective of the *Physiopathology of the cardiovascular system* unit is to understand impairments of the cell excitability mechanism (ion motion) and of activation of the myocardial contraction mechanism (calcic signals, the sensitivity of contractile proteins to calcium) during heart failure. It is a frequent, disabling and inevitably fatal disease. Its prevalence is currently on the increase with the aging of the population, the emergence of type 2 diabetes and metabolic disorders. Coronary vasomotricity impairments are also tackled upstream in the context of heart failure of ischemic origin. The final goal is to develop therapeutic strategies that target the progression of the disease and the rhythm disorders which are often responsible for sudden death, including among patients whose heart pump has been satisfactorily stabilized by drugs. Correction of some aspects, such as rhythm disorders, by nutrition is conceivable. In addition, there is an increasing focus on the study

of diabetes and the cardiovascular effects of obesity. One of the laboratory's goals is to determine the calcic homeostasis characteristics in mice suffering from obesity-linked type 2 diabetes. These animals have a mutation of the leptin receptor (which normally triggers a satiety signal) and develop hyperglycaemia, hyperlipidemia and insulin resistance due to obesity. This research project aims to determine the origin of cardiac dysfunction in obesity-linked type 2 diabetes, focussing on the key role of Ca^{2+} , and taking into account differences between males and females. This kind of project could consequently lead to nutritional correction strategies. ...

Human genetics decodes sensory functions

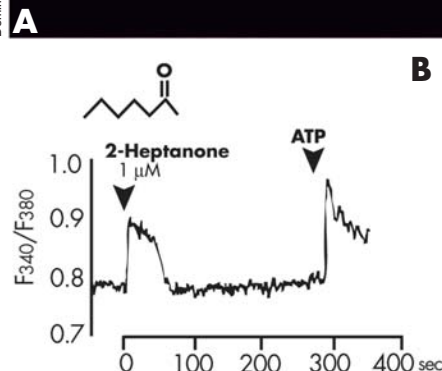
Chemical detection in mammals occurs in three different ways: olfaction, taste and communication by pheromones. The olfactory function is one of the topics studied by the *Molecular genetics of olfaction and cell biology* team of the *Institute of Human Genetics* (IGH). It allows the conscious perception of an odour when an odorous ligand is linked to an olfactory receptor (OR). Families of OR genes (about 1 000 members) are located on almost all the chromosomes in Man, but more than 60% of the genes are inactive pseudogenes. Evolution of the olfactory function is therefore correlated to the size of its functional family. In primates, an increase can be observed in the pseudogene fraction from new world monkeys to Man, whereas this rate is reduced in mice. It has also been shown that an OR is specific to a ligand family sharing common chemical characteristics. Moreover, ORs are deprived of signal peptides and do not spontaneously address the cell membrane when they are expressed in heterologous cell lines, which poses a problem for high-performance throughput screenings *in vitro*.

In order to understand how ORs effectively reach the *in vivo* cell membrane, the team also studies OR intra-cellular traffic and quality control so as to characterise the factors required for their normal expression.

For further details, see Gaillard et al., *Eur. J. Neurosci.*, 15, 409-18, 2002

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Dominique Giorgi © IGH



Understanding the relations between, hormonally dependent cancers and diabetes through knowledge of endocrinology

Research on carcinogenesis deals with data resulting from research on cell, organ or animal models, but also from studies on healthy humans and patients including some carried out at the population scale. These studies have evidenced the role of nutritional factors in the incidence or on the clinical expression of different cancers with varying degrees of certainty. Food factors can influence each stage of the development of a tumour, favouring or inhibiting it. These effects can be explained in many different ways: mutagenic or antimutagenic effects, antioxidant effects, an effect on the mechanisms of growth, proliferation and cell death by apoptosis, or an effect on the immune defence abilities of the organism. In addition, in hormonally dependent cancers, Food can play a physiological

role resulting in a change in the hormonal profile involved. Research projects are concerned with this kind of cancer, with environmental endocrine disrupters and their interference in human reproduction and carcinogenesis, and finally with hormone replacement therapy for menopause disorders and their consequences for cancerology. The research unit *Molecular and cellular endocrinology of cancers* focuses its research on the analysis of the transcriptional activation mechanisms of different nuclear receptors (α and β estrogens, androgens, retinoids and PPARs) in hormone sensitive or hormone therapy-resistant cells. Its second main research area is the study of the effects of nuclear receptor and of different hormone target genes and their antagonists in the main biological or cellular functions involved in carcinogenesis. Research on diabetes is also concerned with pancreatic and gastrointestinal endocrinology, and especially with the mechanisms which regulate synthesis, secretion and biological activities of peptides

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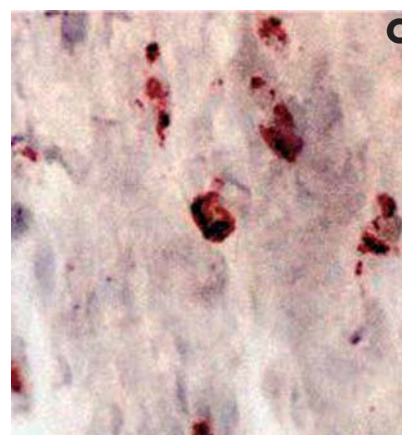
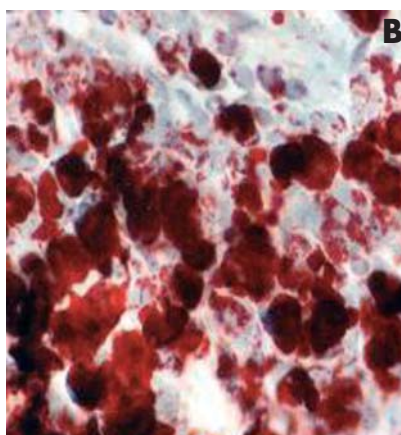
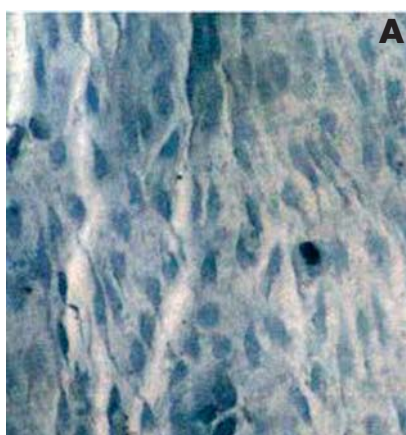
Expression and function of the odorant receptor in Mor912-93 Mice

A: membrane of HEK-293 receptor cells linked with « Green Fluorescent Protein » (in green) using an expression vector

B: after screening of odorant ligands, specific application of the receptor (heptanone) induces the calcium signal in HEK-293 cells loaded with FURA-2 (calcium binding ratiometric indicator)

similar to glucagons. Peptide endocrinology aims at understanding all the molecular, cellular and physiological mechanisms in which these molecules are involved and applying the data obtained in pharmacology and clinical studies. The research unit *Peptide endocrinology and gene regulation* focuses its entire activity on the study of the β cell secreting insulin. The functions of this cell are essential to the survival of the organism because it synthesizes the only hypoglycemic hormone involved in various kinds of diabetes: type 1 diabetes due to the autoimmune destruction of this cell, and type 2 diabetes, which presents an insulin secretion deficit as well as peripheral insulin resistance.

In the field of nutrition related to health, this unit has started a research programme on the beneficial effects of polyphenols present in wine on insulin-producing cells (with a particular interest in the metabolic effects of cyclic AMP / Protein-kinase A / Akaps and MAP-Kinases P44/42, which maintain the β cell population and are responsible for these cells' ability to respond to glucose, all these effects being related to the defects evidenced in type 2 diabetes). This research focussed on the general mechanisms (irrespective of the type of cell) by which polyphenols can modify relations between cell proliferation and apoptosis. ...



Pierre Besançon © UMII/Polytech

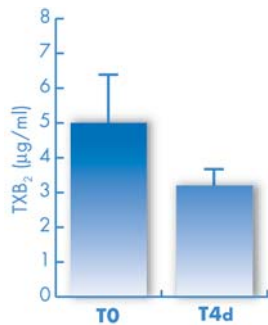
Model for studying atherosclerosis

The Syrian golden hamster model is used by the *Food and Nutrition* unit (UMII/Polytech) to study the antiatheromatous properties of phenolic compounds present in vine products. This experimental model was chosen for its cholesterol metabolism and it presents a lipoprotein profile identical to man. It also displays strong reactivity to antiatherogenic interventions. A Food with high cholesterol and saturate content was given to the animals for 12 weeks in order to induce oxidant stress. The Food was deficient in vitamin C and E as well as in selenium. The goal was to induce a response of the artery wall to stress (formation of lipid streaks, and emergence of atherosclerosis) and then to study the effect of this modulation with pure phenolic compounds or extracts produced by the wine industry.

As an example, the above illustrations show cross sections of the aorta of (A), a hamster with a normolipidic Food, (B) a hamster with a hyperlipidic Food presenting early atherosclerosis. (C) a hamster with the same Food plus resveratrol at a dose equivalent to that contained in two glasses of red wine consumed during a meal by a man weighing 70 kg.

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Possible antithrombotic role of black liquors in cardiovascular diseases



Changes in TXB₂ between T0 (before HT intake) and T4 (4 days)

Black liquors are olive fruit water, a by-product of “pressing” during the production of first cold pressing extra virgin olive oil. The study concerns the protective effect of a preparation rich in hydroxytyrosol (HT) on 5 patients with type I diabetes and exposed to increased cardiovascular risk. This polyphenol is the substance in olives and olive oil that has the highest antioxidant power.

On 4 consecutive days, measurements were performed on these patients on an empty stomach to test the effect of the administration of a daily HT quantity comparable to that present in a normal Food (7 to 15 olives). Measurements concerned lipid constants, vitamin E, beta-carotene, plasmic vitamin C, the total antioxidant capacity of plasma and its main determinants.

The excreted quantity of 8-isoPGF_{2α} (oxidation marker of the organism's lipids) was measured in the urine along with thromboxane B₂ (TXB₂, stable derivative of TXA₂) to assess the plasmic release of thrombocytic TXA₂ (indicator of platelet aggregability) that depends on thrombin.

The indicators of oxidative stress were not impaired by administration of HT. Vitamin E, beta-carotene, the total antioxidant capacity of plasma and its major determinants, the urinary marker of oxidation 8-isoPGF_{2α} were not significantly modified. A significant reduction (~50%) in TXB₂ production was observed.

Thus, HT intake in nutritional quantities during a period of four days does not appear to have a direct antioxidant effect, but can trigger a cellular effect leading to a reduction in the production of TXA₂ thrombocytes, a pro-aggregating and vasoconstrictor eicosanoid. This effect could be of a great interest in preventing thrombosis and microthrombosis phenomena and cardiovascular complications in diabetics.

For further information, read Léger et al., 2002. *Free Rad Biol Med*.

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... continuation of page 14

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The IGH, U540, U637 and U376

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Understanding the involvement of mitochondrions in the formation and development of tumours

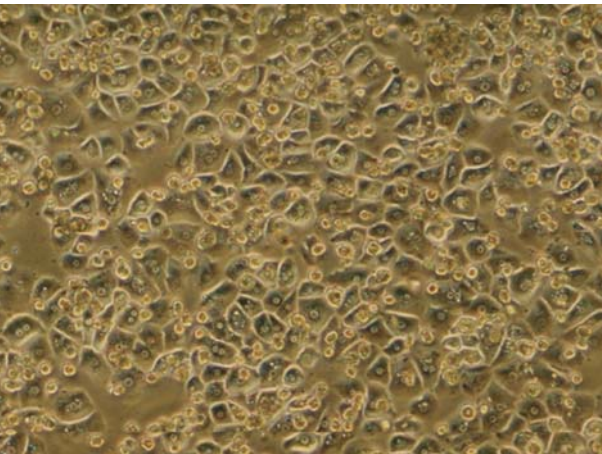
The general research topic of the joint research unit *Cell Differentiation and Growth DCC* is the regulation of the development of muscle tissue, which can present serious impairments especially during aging. Within this overall framework, one subject of special concern is the regulation of mitochondrial activity (mitochondrial genome transcription, respiratory chain activity, production of free radicals, etc.) via hormone receptors which are present in the organelle and were discovered by this research unit (thyroid hormone receptors, retinoid receptors). Current research has shown that the physiological importance of this pathway not only concerns energy metabolism, but also processes involved in the aging and transformation of cells. In fact, these studies show that the modifications of the action of this hormone targeting mitochondrions impair not only cell metabolism, but also essential processes such as

proliferation and cell differentiation. In some cases, they can also lead to cell transformation via the annihilation of antioncogenes. The production of free radicals appears to be involved in these processes. The problem of mitochondrion/nucleus signals is also being studied as is the problem of the characterisation of nuclear genes that are the target of organelle activity. *In vitro* approaches are used on cell cultures and *in vivo* approaches use animal models such as zebrafish and transgenesis techniques in mice.

Liver physiopathologies

The overall objective of the research unit *Hepatic physiology* is to develop different systems of normal and long-term primary cultures of highly differentiated hepatic cells in order to understand the mechanisms by which different forms of physiopathologies of the liver can affect its functions and differentiation processes. Research is focussed on two main topics: hepatic detoxification and infection by the hepatitis C virus. A new project based on an original methodology, combines basic and clinical research. ■

Recent results on liver pathophysiology



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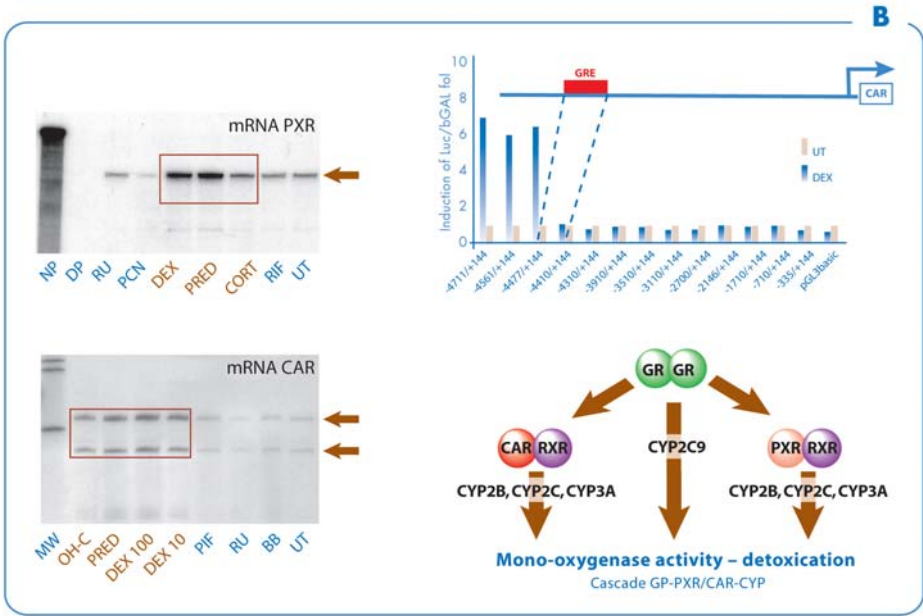
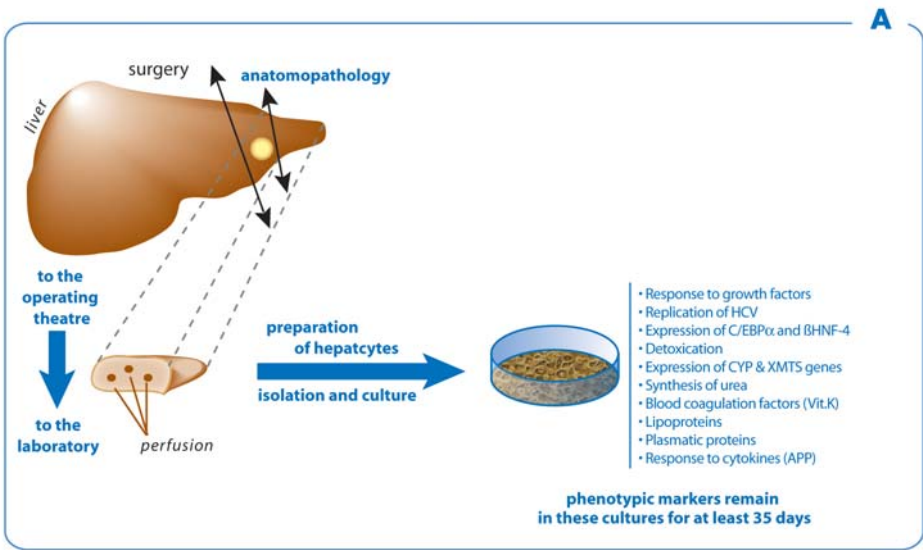
Culture of human hepatocytes

Research projects developed by the Inserm Unit 632 are based on an original model of primary culture of highly differentiated human hepatocytes. Hepatocytes are prepared from pieces of tissue excised during hepatic lobectomies.

Research on hepatic detoxification concerns the regulation of CYP gene expression (major stakeholders) and of the PXR and CAR nuclear receptors involved in this control. It has recently been shown that PXR, RXR and CAR are regulated by the glucocorticoid receptor (GR). Researchers then suggested the existence of a GR-PXR/CAR-CYP cascade. This cascade allows a better understanding of the modulations affecting the detoxification function.

Concerning hepatitis C virus infection, this unit is the first to have shown that hepatocytes from non infected patients isolated and then exposed to positive HCV patient serum were sensitive to the infection and permissive to the replication of the viral genome. In this model, interferon (IFN) has an inhibitive effect on viral replication. This model is used to screen new antiviral molecules and to characterise virus receptors on the human hepatocyte membrane.

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Primary culture of highly differentiated human hepatocytes. (A) Hepatocytes are prepared from pieces of tissue from hepatic lobectomies. (B). Detoxification. Studies focus on regulation of the expression of CYP genes and on PXR and CAR receptors involved in control of expression

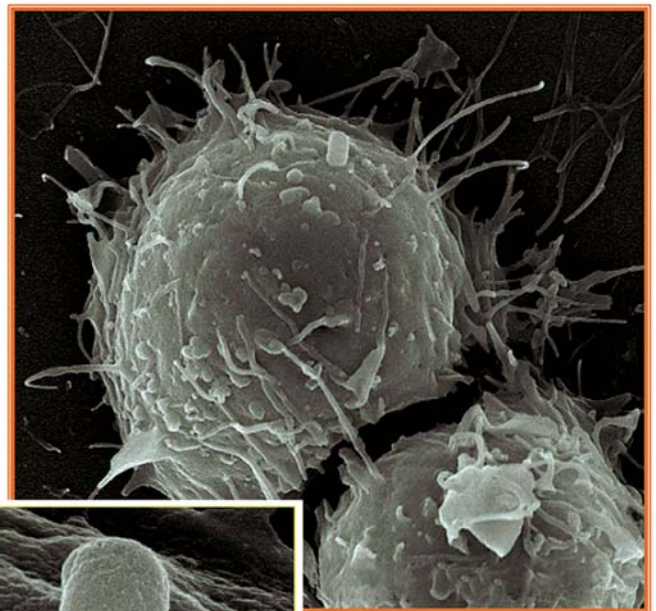
The study of chemical or microbial contaminants of food

Food contaminants, whether of chemical or microbial nature, are a major hazard for human and animal health. Food product safety became a widely reported worldwide concern with the appearance of a whole series of food crises such as BSE (mad cow disease) or scrapie. Pathogenic bacteria are also a serious public health problem. Chemical contaminants affect health, especially the hormonal system, and can lead to the appearance of hormonally dependent cancers. Current research should enable advances in the knowledge of the nature of contaminants, their mode of action, their consequences for health and finally for the formulation of prevention policies.

As their name suggests, contaminants are undesirable elements in food. However, a chemical substance or a microbial agent only becomes a contaminant when it poses a danger to health. Chemical contaminants are either the result of industrial pollution, of badly controlled agricultural practices or of processing of food and natural substances. Microbial contaminants are varied and their effects are well known, ranging from a simple skin rash to death; to cite a few examples: salmonellosis, listeriosis, gastritis due to *Helicobacter pylori*, or sterility due to *Chlamydia*, tuberculosis, and diarrhoea.

Study of the infective mechanisms of some pathogenic bacteria

The ideal solution would be to produce vaccines that are effective and easy to use. But pathogenic bacteria that develop intracellularly cause the host specific problems during immune response. Some of these bacteria avoid immune response altogether and develop chronically, tuberculosis being the best documented case, and brucellosis is an infection that also belongs to this category.



In vitro creation of the pathogen protein-prion form



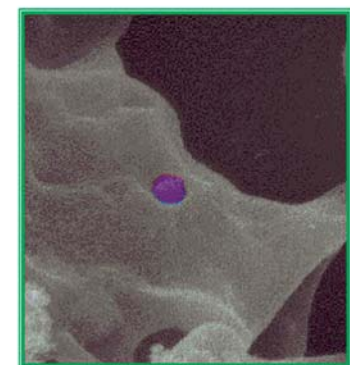
Jean-Pierre Liautard © UMR Microbiologie et pathologie cellulaire infectieuse

Amyloid fibre
obtained under pressure

In its pathological form (amyloid state) the protein-prion is associated with neurodegenerative disorders, and in particular bovine spongiform encephalopathy. In its “normal” form it exists in all mammals. Neither its precise physiological function, nor the mechanisms involved in its transformation into a pathogen agent are understood at the present time. Until now, the use of heat or chemical agents has not enabled the infectious form of this protein to be obtained *in vitro*. Different amyloid states have been created, but none had the infectious properties of those found in patients, and in fact, the *in vivo* change in structure requires specific conditions that

are difficult to reproduce *in vitro*. Studies conducted by the joint research unit *Microbiology and infectious cellular pathology* revealed the presence of “energy landscapes” and many alternative pathways that were accessible in certain physico-chemical conditions. High pressure used to disrupt the protein-prion energy landscape, associated with spectral analysis of UV absorption, revealed the presence of a large number of possible intermediate structures between the normal and the transconformed protein-prion. By modifying the temperature, pH and pressure conditions, researchers succeeded in obtaining the formation of one or other of these structures, stabilising them and reversing their formation. As a result, they obtained a preamyloid structure and an aggregate with amyloid fibres similar to the pathological one observed in patients’ brains. Experiments are in progress and should allow confirmation of the infectiousness of these structures. This research opens up therapeutic prospects for neurodegenerative pathologies which today are incurable.

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Scanning electron
microscope image
of the invasion
of macrophage (THP-1)
by *B.suis*

In these circumstances, it is difficult to produce effective vaccines. The goal of the joint research unit *Microbiology and infectious cellular pathology* is to use molecular tools to describe the mechanisms of infection and immune reaction. The unit studies the *Brucella* genes required for multiplication in the macrophage and their cellular targets to better understand how *Brucella* enters and multiplies in cells and avoids being attacked by the immune system. The unit also studies the molecular mechanisms that would allow efficient interference in the infection process. Control of the bacterial mechanisms that enable avoidance of host immune reaction is essential for the development of effective vaccine.

Study of prion proteins, agents of transmissible subacute spongiform encephalopathies

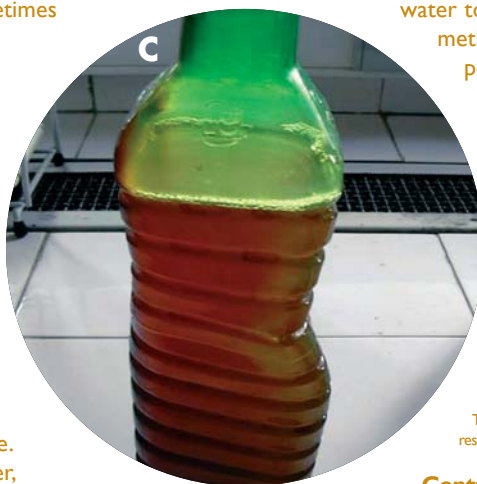
Transmissible subacute spongiform encephalopathies (prion diseases) form a group of neurodegenerative affections. In man, they take the form of Creutzfeldt-Jakob disease

and in animals, scrapie (trembling disease), and bovine spongiform encephalopathy (mad cow disease). These diseases have a unique feature in common: they can be transmitted genetically and through infection. The nature of their infectious agent has not yet been determined with certainty but it is an established fact that prion proteins (PrP) play a major role in their transmission. PrP and prions are consequently the only transmission model of ‘conformational’ information whose mechanisms are still not well understood, and, incidentally, nor are the normal and pathological functions of this protein. Research led by the joint research unit *Microbiology and infectious cellular pathology* has resulted in a patent for a method to eliminate the infectious agent of prion disease in flour, and its application is currently underway. From the point of view of more basic research, the nature of the prion infectious agent and the function of the normal protein in lymphoid cells are presently being identified. The protein can be produced by recombinant *E. coli*. It has already been sequenced and is identical to the BSE (bovine spongiform encephalopathy) cell protein.



Study of the behaviour of plastics in contact with foodstuffs

When food is in contact with a material, interactions can take place leading to the exchange of material. These phenomena, called migrations, are sometimes voluntary (wine ageing in oak barrels), but often result in organoleptic defects (corked taste) or sanitary defects (lead content in food). Also worth mentioning are Greek resinous wine or sardines in tin cans whose organoleptic modifications resulting from interactions are accepted by consumers. Concerned by potential medical problems, French public authorities introduced regulations at an early date (June 28th 1912). These regulations are reviewed and modified when new materials appear, but a regulation cannot be fully effective. To guarantee the safety of the consumer, we need to understand the mechanisms involved in these interactions before suggesting solutions for manufacturers and users.



The research carried out in the *laboratory of analytical chemistry* concerns the study of epoxy resins to cover wine tanks, water towers and pipes; the development of methods to assess the migratory potential of polymer materials designed to be in contact with water; and the absorption of aromas by plastics.

Conclusions have been drawn with respect to the relations between structure and migration, the behaviour of aging material in contact with hot water and irradiation, the improvement of official techniques for monitoring migrations using extraction techniques such as solid/liquid extraction, solid phase micro extraction and thermal desorption.

The Laboratory for Analytical Chemistry is part of the UMR 1083 joint research unit Sciences for Oenology SPO (Agro.M/Inra/UMI)

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Examples of interactions between materials and food (A) multilayer packaging of dietetic almond paste, of which the outside layer is made of polypropylene, the middle layer of copper (coloured pigments) and the inner layer of ionomeric resin. The arrow shows oxidation of the copper within the packaging. (B) Effect of a treatment based on solvent which dissolves epoxy resins. The apple on the left is untreated; the apple on the right was treated with xylene vapour (72 h). (C, on the right) a bottle of wine.

This protein could be used to produce antibodies specific to the infectious form and also to develop a diagnostic kit. In parallel, the scrapie prion is under study, along with the genetic susceptibility of the species. Several animal models have been shown to be effective for this research (hamster, mouse lemur and mouse). The *Biology of transmissible spongiform encephalopathies* programme of the *Institute of Human Genetics* comprises three main areas of research. Firstly, cellular biology and the normal and pathological metabolism of PrP are studied together with the mechanisms that induce neurodegeneration, which is the main feature of prion diseases. Secondly, understanding the mechanism of transmission of prions between cells and more generally between species is essential for an understanding of the mechanisms of the pathological conversion of PrP. Finally, the effect of different “drugs” on prion replication is being tested *in vitro* and *in vivo*. Cellular and genetic therapies are being developed and tested *in vivo*. ■

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Study of the relations *between Food and major* pathological risk factors

In recent decades economic development, the increase in purchasing power, breakthroughs in production, marketing and food distribution methods, have radically changed the food environment in both industrialised and developing countries. The abundance of food and the replacement of plant resources by proteins and animal fats have resulted in dietary imbalances. Research results have confirmed that these unfavourable eating habits promote the appearance of certain chronic diseases such as cardiovascular diseases, cerebrovascular accidents, certain cancers, sugar diabetes, obesity, gastrointestinal disorders and certain bone and joint diseases.

Nutritional factors (excess or deficiency) are not normally considered to be a direct cause of pathologies. However, they can play a role in their determinism. Today it is recognised that these diseases are multifactorial and result from the interaction between genetic and environmental factors (in particular food and sedentary lifestyle) which influence their development or clinical expression. Food factors can therefore be protective or, exactly the contrary, be risk factors involved in the determinism of these diseases. Research is currently underway to identify the risk and/or protective factors linked to diet in order to make recommendations and propose nutritional strategies to reduce the frequency of certain chronic diseases as well as to improve health and well-being.

Nutritional epidemiology

Biostatistical methods and epidemiology

In addition to its descriptive role, epidemiology enables us to explain the factors that link nutrition and food with certain pathologies (increase and decrease in the number of risk factors). Epidemiology is based on a multidisciplinary approach, bringing together biologists, nutritionists, pathophysiologicals and others involved in the field of health and nutrition. To obtain exploitable results, epidemiological studies also require examinations to be repeated over a period of several years, especially in modelling and statistics. Among other research topics, the



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*Case of obesity in the overseas
Department of Réunion*

*The study
of eating
behaviour
helps assess
health risks*



Jean-François Roche © Agropolis-Museum

epidemiology and statistics team of the *Public health, biostatistics, Epidemiology* research unit hopes to get an overview of risk and/or causal factors of chronic diseases - and in particular cancers - using approaches based on nutrition, genomics and proteomics. This team is in charge of the '*Cancer Centre of South West France*' (*Cancéropole du Grand Sud Ouest*) for epidemiology, and is responsible for managing the database and setting up tools for the federation of information and joint studies. The team is also responsible for the evaluation of the networks that exist in the Languedoc-Roussillon region (oncology, heart failure, polyarthritis, and insulin-dependent diabetes); it manages tumour registers in the Departments of Hérault and Gard as well as evaluating mass screening campaigns in Hérault. It thus has close institutional links with two registers: the regional health observatories, and local public health institutions. The team also works in collaboration with teams in Heidelberg (Germany) and Algeria.

Food and neurodegenerative diseases

Degenerative diseases are one of the most frequent disorders of the central nervous system, sadly notorious for their relative frequency, the severity of their symptoms, the disability they generate (Alzheimer's, Parkinson's diseases, Huntington's chorea, multiple sclerosis, etc.). Their gravity, which is often linked to the absence of treatment, makes them a terrible affliction and, due to their diversity, they can affect bone marrow and brain, and thus motricity as well as higher functions. These diseases can affect neurons and constituents of myelin, they may be limited to very distinct structures or may extend to the whole nervous system, and they can affect children and young adults or on the contrary, be linked with aging. Their mechanisms results in progressive and often inevitable degenerescence, hence the name "neurodegenerative disease".

The research field of the Nervous system pathologies: epidemiological and clinical research team (Inserm) is the development of etiological models on pathologies affecting the nervous system. Their research projects focus on both psychiatric and neurological pathologies, the two disciplines overlapping considerably as they share certain biochemical, genetic and clinical risk factors. Research is divided into five main lines including "*Epidemiological and Clinical Research into Neurodegenerative Diseases*". This research aims to identify risks factors and biological markers in neurological pathologies in order to develop etiological models which should enable populations at risk to be targeted and subsequently innovative prevention and treatment strategies to be developed and used at early stages of cognitive deterioration. The team is currently carrying out a longitudinal study on the aging brain based on a sample of the general population as part of a multicentre research programme that monitors 10 000 patients over 65 years old in three French regions: Bordeaux, Dijon, Montpellier (*The Three City Study* – 3C). The main goal is to analyse the link between vascular risk factors and normal and pathological cerebral ageing (vascular dementia, Alzheimer's disease, cerebrovascular accidents), and the interactions between different risks factors. Among the biological risk factors of normal and pathological ageing of the brain, the importance of oxidative stress is being assessed as a function of certain genetic risk factors. The impact of nutritional factors will be determined by a study of food habits associated with biological sampling (vitamins, fatty acids and biological peroxidation). The importance of food (which is closely linked with life style) for many biological parameters means a joint biological and nutritional approach is essential for the study of pathogenic aging mechanisms. Clinical research projects are also underway on Dementia with Lewy Bodies, predictive factors of Alzheimer's disease in Mild Cognitive Impairment, and the biological impact of food supplementation with antioxidants....

Website on food allergens and allergenic protein sequences



Food allergens belong to different categories of foods of plant origin (seeds, fruits and vegetables) and of animal origin (milk, fish, etc.). Information about allergens and allergenic protein sequences is available on several databases on the Internet but these are often incomplete or heterogeneous, because the data were acquired using different approaches and it is consequently difficult to

compare the results. However, the first standardized approach is now available on the Protall site.

An additional difficulty is that the allergenicity of a protein depends on the individual and his/her immune reaction. Advances in knowledge of the structure of food proteins and in immunogenetics consequently have to be taken into consideration.

IMGT, the international ImMunoGeneTics information system®, <http://imgt.cines.fr>, which was created in Montpellier in 1989, is an international reference for immunogenetics and immunoinformatics. IMGT is specialized in the analysis of immunoglobulins, T cell receptors, major histocompatibility complexes and other related proteins of the immune system. IMGT comprises 6 standardized and validated databases, 9 Internet tools and more than 8 000 HTML pages of Web resources. To meet the need for standardized data, IMGT offers a description of food allergens of plant origin. This standardization is all the more useful since most food allergens are identical to pollen allergens and display cross reactions. IMGT also provides a list of websites about food allergens. All this information is accessible on 'The IMGT Immunoinformatics Page', 'The IMGT Medical Page' and 'IMGT Lexique' at <http://imgt.cines.fr>.

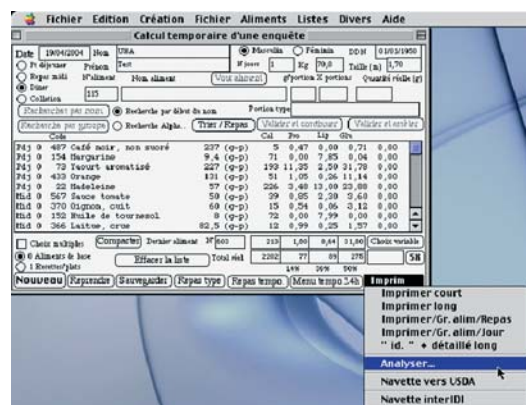
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IDI Software (Integrated Dietetic Information) For Macintosh and PC

IDI is a computational tool with multiple functions for:

- The calculation of the nutritional composition of dishes and recipes.
- Dietary surveys with fine-tuned qualitative and quantitative analyses. In addition to a classical food balance, the IDI software allows the calculation and on-line display of a choice of five nutrients next to each food. Macronutrients can be distributed and analysed as a function of the 21 basic food groups in the database. Other nutrients can be distributed in seven main groups (which can be modified). The ability to choose nutrients and to distribute food in groups ensures very flexible analysis.
- Compiling meals and standard meals (to respect dietetic indications), which is useful for individual prescriptions or interventional studies. An original algorithm has been developed to enable fine adjustment of macronutrients to match specific energy objectives.
- Another original approach enables a connection to be established between IDI and the USDA food composition table which is regularly updated and published on the Internet. This function enables the same calculations to be made for all the nutrients in the USDA base (the SR 16 database currently includes 125 nutrients). This link has been extended to the Canadian nutrient file (119 nutrients) and could also be extended to the food composition tables in other countries. Calculations can be exported in ASCII format for use with statistical software.

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International nutrition

To a greater and greater extent research on nutrition in southern countries has to take into consideration aspects that are specific to these countries (malnutrition due to deficiencies, nutrition infection, zoonoses) but also other aspects that are shared with northern countries (chronic diseases, environmental exposure to toxins through food).

The "Nutrition and Chronic diseases" team of the *Epidemiology and Prevention Research Unit* brings together researchers from the IRD and Inserm for epidemiological research on the following topics:

- Interactions between nutrition and infection. On the one hand, studies on the effect of micronutrient supplementation on the incidence

and severity of infectious diseases (malaria, pneumopathies), and on the other hand, relations between nutrition and infection in cases of HIV: the risk of HIV transmission during breast feeding and ways of reducing this risk, food and growth of children with HIV, and nutritional follow-up during triple therapies.

- Prevention of chronic diseases of nutritional origin and in particular in relation to malnutrition during childhood, and obesity. A method has been developed to measure physical activity in the general population by accelerometry which is now used during epidemiological studies.
- Study of the sanitary and nutritional impacts of environmental exposure to pollutants (heavy metals). A new programme on zoonoses and the sanitary safety of foods of animal origin is currently being developed by the "Infectious diseases" team.



*Dégénérescence
maculaire de la rétine*

The POLANUT study

POLANUT is a programme of nutritional epidemiology whose aim is to assess the nutritional requirements of people over 70. In addition to descriptive studies, this research unit also studies the impact of food on health. Many studies have recognized the influence of food on the incidence of chronic degenerative diseases which are the main cause of mortality in our society

particularly among the elderly. The role of food anti-oxidants (vitamins E and C, carotenoids) and of Omega 3 fatty acids in the prevention of cardiovascular disease and progressive dementing disorders (Alzheimer's and Best's disease, etc.) appears to be particularly promising. Another avenue of research concerns undernutrition in the elderly, a factor which is recognized to influence mortality and

which may also be involved in progressive dementing disorders. For each participant in the study, POLANUT collects different data on their general health status (cardiovascular diseases, diabetes, cancer, eye diseases, etc.), medication and life-style (tobacco, alcohol). POLANUT also includes biological research on anti-oxidant defences (vitamins A, E and C, carotenoids, anti-oxidant enzymes, trace minerals) performed by the Laboratory for Biology and Biochemistry of Lipids (Jean-Paul Cristol, CHU Lapeyronie). POLANUT will enable identification of the links between the contribution of different nutriment and the occurrence of chronic degenerative diseases and of death. In addition it will enable the study of the links between nutrition and anti-oxidant defences with the aim of improving our understanding of the mechanisms that link food and degenerative diseases.

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Clinical trials

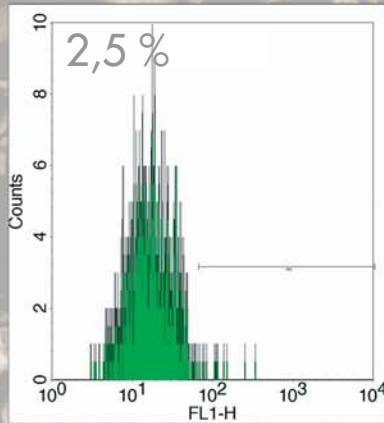
Chronic diseases and food

A healthy and varied food plays a major role in the prevention of type 2 diabetes which is the most common type of diabetes. Among those presenting the appropriate genetic conditions, obesity is the most significant risk factor for this form of diabetes. Overweight favours the expression of the disease in most diabetics. Preventional nutrition is essential in the case of diabetes, obesity and other metabolic disorders. The assessment of nutritional factors and of food consumption - required for nutritional trials and before a doctor writes a prescription - relies on the measurement of food consumption and food intake. Food surveys provide an analysis of the number of different nutrients consumed. However, this type of analysis is quantitative and does not provide information on the choice or on the quality of the food consumed, which can be achieved with health software, one of the tools used by the *IURC Human nutrition laboratory* which belongs to *CNRH Méditerranée*. This laboratory also studies the effect of some nutrients (vitamin E, proteins, etc.) on metabolism via supplementation or substitution. A study was carried out on obese patients with the aim of defining the proportions in which carbohydrates and monounsaturated fatty acids should be supplied as a function of fat distribution (android or gynecoid obesity) and associated metabolic disorders.

Food models, nutrition, prevention, cardiovascular and renal risk

Many different risk factors involved in the determinism of cardiovascular diseases have been identified: hyperlipidemias (hypercholesterolemia and hypertriglyceridemia), hypertension, nicotinism, obesity, diabetes, etc. Different foods and ways of life increase the risk of development of these diseases: the harmful effects of saturated fatty acids and dietary cholesterol, the "protective" effects of unsaturated, monounsaturated and polyunsaturated fatty acids, fibres, vitamins and antioxidant trace elements, polyphenols, vitamins B9, B6 and B12, among others. Dietary consumption of sodium plays a significant role in the cardiovascular system. Relations have been shown to exist between dietary sodium, hypertension and cardiac hypertrophy, and this is one of the research topics of the *Groupe Rein et hypertension* (IURC). In the model hypertension induced by renal artery stenosis in rat, the disappearance of cardiac hypertrophy in rats deprived of salt of cardiac hypertrophy usually observed in hypertensive animals with no limit to their salt intake, suggests that the sodium ion is a modulator of cardiac hypertrophy. Trials in progress on hypertension induced by the administration of angiotensin II, seem to confirm the preventive effect of limiting sodium intake on the development of cardiac hypertrophy associated with hypertension. As regards clinical investigation, one of the group's areas of expertise is the

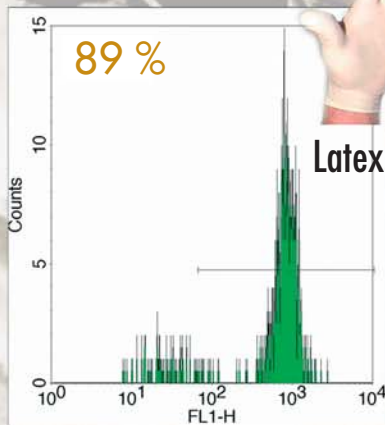
ability to undertake simultaneous analysis of renal, cardiac and metabolic parameters. Renal hemodynamic and functional abnormalities, and cardiac functional and structural abnormalities associated with essential hypertension are assessed in patients who have never previously received antihypertensive treatment, in contrast to the majority of existing trials which use patients who have stopped treatment. In these trials, the glomerular filtration rate and renal blood flow (isotopic clearances), microalbuminuria, left ventricular function and mass echography and nutritional and metabolic parameters (carbohydrate tolerance, plasmatic lipids, sodium and protein intake, etc.) are analysed simultaneously. It has also been shown that obesity is associated with glomerular hyper filtration and an increase in microalbuminuria in the case of hypertension. It has been established that insulin resistance is associated with glomerular hyper filtration and myocardial hypercontractility without hypertrophy. In addition to the major role played by blood pressure, left ventricular mass is directly influenced by sodium intake in both normotensive patients and hypertensive patients who have never received treatment. The impairment of hypertension target organs is therefore influenced at a very early stage by many different factors, some of which have been identified as cardiovascular risk factors. ...



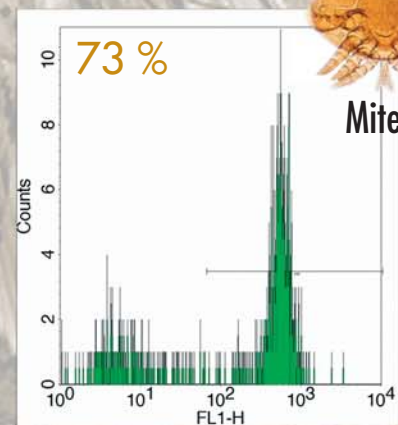
Expression of CDG³ protein in basophil cells of allergic patients exposed to different allergens

positivity threshold: over 15%

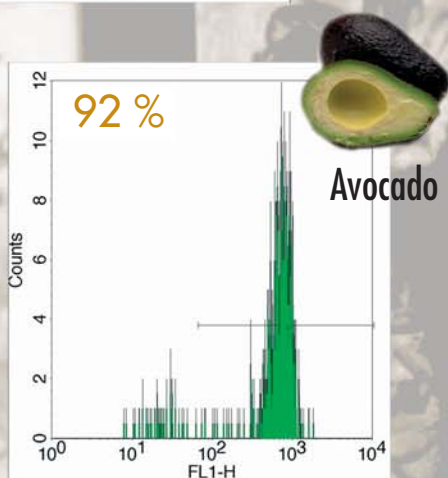
Resting cell



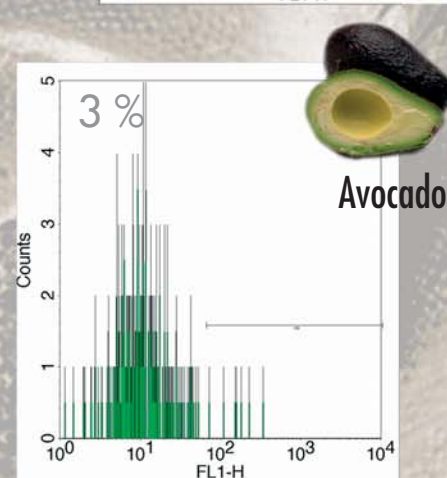
Latex



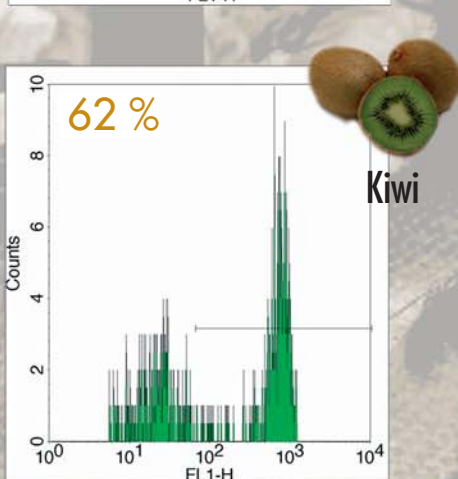
Mites



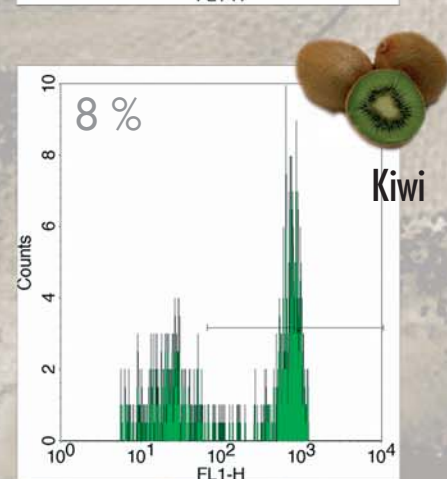
Avocado



Avocado



Kiwi



Kiwi

Subject A
allergies to food

Sujet B
allergy to house dust

Prevalence of Diabetes in New Caledonia

Type 2 diabetes (non insulin-dependent) is a pathology that can take epidemic proportions in some populations. It is linked to changes in the way of life caused by urbanisation. This disease represents a serious threat to public health because it can also lead to serious complications (renal failure, cardiovascular problems, etc.). To keep this "epidemic" under control, more knowledge is required of the factors that favour it, i.e. new collective practices (such as new dietary behaviour, sedentary lifestyle) as well as the predisposition of individuals or ethnic groups.

A diabetes prevalence survey in New Caledonia on 9 390 subjects aged from 30 to 59 years old (CALDIA study), showed that 9.1% of Europeans, 9% of Melanesians and 15.7% of Polynesians in New Caledonia were diabetics. In addition to their high rate of diabetes, Polynesians are also the ethnic group displaying highest rate of obesity, which is hardly surprising, since the link between excess weight and the risk of diabetes has been known for many years. However, complementary analysis in non-diabetic subjects in the framework of the CALDIA study showed that Polynesians had no biological sign of insulin resistance but to the contrary, that their ability to secrete insulin was lower than the two other ethnic groups. Consequently it seems that, unlike the usual pattern in which obesity induces insulin resistance eventually leading to pancreatic exhaustion, the risk of diabetes in Polynesians in New Caledonia is more likely linked to a primary defect in insulin secretion.



Two obese Polynesian women saunter nonchalantly down the road

Immunogenetics and food allergens

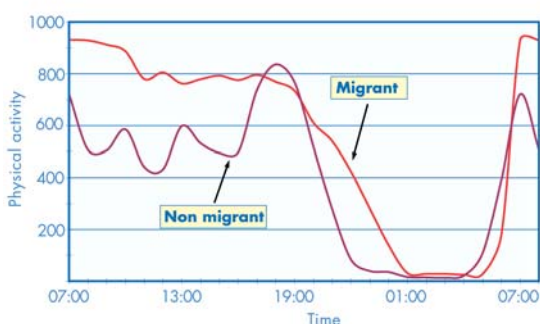
The frequency of food allergies has doubled in the last 5 years.

The prevalence of food allergies in the general population is estimated at 3.2 % in France. It is three times higher in children than in adults.

The *Immunopathology of inflammation* unit is currently characterising helper T lymphocytes Th1 and Th2 in asthma, which can be a respiratory symptom of food allergy corresponding to reactions of type I hypersensitivity. Banding techniques used in this laboratory associated with quantitative RT-PCR techniques, allow the simultaneous detection of intracytoplasmic cytokines and of membrane antigens. The analysis of a model of T lymphocyte differentiation from umbilical cord blood will enable reproduction *in vitro* of observations made in the bronchus of patients. ■

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Effects of urban migration migration on the usual physical activity and sleep habits of Senegalese teenagers



Physical activity and sleep according to migration status

From Garnier and Bénéfice Ann Hum Biol 2001

This study concerns the measurement of usual daily physical activity and sleep in teenagers originating from the same rural environment in Senegal. Some teenagers moved to Dakar to work as domestic servants, others remained in their

village and went to school and/or helped with housework. The study was carried out in an urban environment (Dakar) and in a rural environment (Niakhar) on a sub-sample of 80 teenagers in the framework of a follow-up study of growth during puberty involving a total of 406 teenagers. The nutritional status was estimated by anthropometrics; pubertal maturation by when menstruation occurred for the first time, and judgement of the breast development stage

(Tanner classification). The intensity and distribution of physical activity over time as well as hours and quality of sleep were measured by accelerometry. These teenagers presented growth retardation and puberty occurred later than in populations of the same age in industrialised countries. Migrants had a better weight status (+3.5 kg, about 7.7 lb) and more subcutaneous adiposis than non migrants. The reproductibility of physical activity and sleep duration measured by accelerometry was excellent but less good in the rural environment. The intensity of physical activity over 24 hours was high, higher in the urban environment than the rural environment. Migrants devoted more time to moderate and intense activities (5.9 vs. 4.0 hours). Non migrants slept and remained inactive for longer periods than migrants (8.8 vs. 7.8 hours). They also had more rest time (4.4 vs. 3.1 hours). Migrants at earlier stages of puberty were more active than other migrants. Conversely, non-migrant, teenagers had more intense physical activity when they became adults. Despite more intense physical activity entailing higher energy expenditure, migrants had a better nutritional status than non migrants, which can be explained by an improvement in their living and dietary conditions

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Developing a nutritional approach in public health

The food system is the meeting point of different policies that target different stakeholders (consumers, farmers, manufacturers, distributors, public authorities) as well as policies concerned with international trade and economics (trade and food aid), food safety (health and environment), food, and employment. These policies are created and experienced by private and public stakeholders at the local as well as the international scale. A clear understanding of the economic, sociological, legal and biological determinants of the food system is required for public policies in this sector, particularly the invention of new ways to intervene.

Today, more than half of the world population suffers from malnutrition, or diseases caused by deficiency and/or excess. Despite many efforts and some advances, the objectives that were set during the international summits in the 1990s to reduce the level of malnutrition are still far from being achieved. The complex causality of nutritional problems and their close links with political, socioeconomic, environmental factors and resources management mean we need to go beyond a classical biomedical approach or merely finding solutions to isolated problems. A more global, complex approach is needed, particularly in its application. The theoretical and practical foundations of many different policies and interventions need to be re-thought.

Food and nutrition in Southern societies

Knowledge of the frequency and distribution of nutritional problems, their causal factors and consequences, the evaluation of the effectiveness of interventions and analysis of their effects, are all pre-conditions for the formulation of decisions, policies and intervention programmes for public health and nutrition. Research led by the 'Nutrition, Food, Societies' research unit (UR 106, IRD) focuses on these aspects in southern countries and the UR 106 team is currently conducting research programmes in: (i) Nutritional and dietary transition; (ii) Epidemiology of micronutrient deficiency and control strategies in groups at risk; (iii) Epidemiology of growth retardation and intervention strategies in poor rural environments; (iv) Study of ways to improve the nutritional and sanitary quality of food; (v) Study of transfer conditions and assessment of food improvement strategies of groups at risk;

Jean-François Roche © Agropolis-Museum



Children are particularly exposed to overeating especially in Europe and North America

Yves Paris © IRD





Advertisements play a role in the nutritional transition which affects young people in particular and often leads to excess eating.

in which infections and nutritional deficiencies are in the majority to a profile in which chronic, degenerative diseases linked to food are in the majority). This epidemiological transition is one of the new health priorities in North African countries, which are presently faced with the double burden of infectious diseases and non-transmissible diseases with increasing cost for their health systems. The aim of the Tahina research project, which is financed by the European Union, is to improve management of the epidemiological transition. The project focuses on two

TAHINA Project

Epidemiological transition and its impact on health in North Africa

An epidemiological transition is currently underway in emerging countries and will also progressively appear in the least developed countries (involving a change from an epidemiological profile

types of complementary analysis: (i) characterisation of the epidemiological transition itself, its factors and consequences; (ii) analysis of the representation of the transition by stakeholders (professionals and decision-makers) and of related practices. The multidisciplinary programme includes several Montpellier teams (IRD, IAM.M, Cirad) and Belgian partners at the *Institute of Tropical Medicine (ITM)* in Antwerp, Tunisian partners at the *National Public Health Institute (INSP)* in Tunis and the *National Institute of Nutrition and Food Technology (INNTA)*, Algerian partners at the *National Public Health Institute (INSP)* in Algiers and at the University of Oran. Within the project framework, studies are focussing in particular on food consumption, physical activity and nutritional status of Tunisian adults in the context of the emergence of chronic diseases linked to food.

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(vi) Food policies: stakeholders, standards and behaviours. Different study frameworks are used including situational diagnosis (nutritional status, body composition, food consumption, physical activity), random controlled trials in real conditions. In North Africa, the objective was to recommend policies to prevent the occurrence of harmful consequences of the dietary transition. For example in Tunisia and Algeria, the European TAHINA Project, piloted by the IRD). In Vietnam and in other countries, a series of approaches were tested for the prevention and control of iron deficiency: a new plan for weekly iron supplementation system for infants, iron/folate supplements for women of child-bearing age and during pregnancy; iron enrichment of the condiment nuoc mam, etc. In Burkina Faso, the free, voluntary consumption of unrefined palm oil, which is rich in beta-carotene, was shown to have a beneficial effect on the vitamin A status of young children and their mothers in a region where this nutrient was not previously consumed. In Senegal, the effects of the national programme 'Community Nutrition' on the nutritional status of young children were analysed. In several countries, the introduction of complementary foods manufactured by local production units is currently being tested with the aim of improving the growth and the micronutrient status of infants.

Food behaviour object of science

Many factors determine food behaviour including individual psychosocial factors (neurobiological and psychopathological factors) as well as collective factors (the influence of family, of the culture). A type of food cannot be reduced to its nutrients: the study of food behaviour and eating disorders is at the interface of neurophysiological, psychosensory, sociocultural and emotional fields. Physiology, psychology and behavioural sciences, among others, are required to understand the different factors that influence these behaviours. Many environmental conditions are involved. It is clear that sensory qualities have a decisive impact on the choice of food and on the quantity of food eaten. Among other environmental factors, the social circumstances of the meal are also significant. Many different methodological tools are now available to reveal the actions and interactions that govern food behaviour in man. The department "*Marchés, entreprises et alimentation*" of IAM.M has three main research topics, one of which more specifically concerns consumers' food behaviour and expectations. In this framework, in addition to analysing the characteristics of food

and the behaviour of Mediterranean populations, the department has also coordinated a regional survey (*Nutritional Barometer 2002, INPEIS*). The food and health of secondary and grammar-school children were the targets of an awareness raising programme on eating habits that promote health. These analyses are an integral part of a second research topic: implementing monitoring of food behaviour and nutrition, particularly in Tunisia and in the Languedoc-Roussillon region, which is intended to be an information tool for decision makers. The nutritional health and food safety of the general population is also a topic of study in this department, which developed in collaboration with the FAO (*United Nations Food and Agricultural Organisation*) a cooperation project to study the role of local authorities in the local food supply and in food safety in Mediterranean cities. Another project deals with the epidemiological and food transition in southern Mediterranean countries including a case study in Tunisia and Algeria (the European TAHINA project which is being piloted by IRD). Finally, a project concerning food and nutritional safety in North Africa (in collaboration with IFPRI) is in preparation. ...



Food behaviour depends on individual and collective causal factors, here the family.

The research unit *Governance and Norms in Agricultural Markets* studies questions concerned with (i) conditions governing the creation of different types of regulation of markets for agricultural products, particularly the role and the place of the consumer, (ii) and the effect of these regulations, taking into account on the one hand « traditional » trade policies affecting quantities entering the market (quotas) and prices (subsidies or taxes), and, on the other hand, standardisation in the private and public sector, i.e. the drawing up of rules that define the characteristics of products to be exchanged and the conditions governing their production. These studies contribute firstly to reinforcing the capacities of southern countries (governments and stakeholders) to negotiate market regulation and to predict its effects, and secondly to inform decision makers in industrialised countries about the effects on southern countries of their trade and standardisation policies.

The *Markets, Organisations, Institutions and Operators' Strategies* joint research unit is concerned with problems linked with stakeholder strategies, irrespective of whether the stakeholders are private or public, individual (consumers) or collective (social groups for market and non-market production). This research unit also studies internal (firms) or peripheral (vertical and horizontal co-ordination) modes of organisation, the functioning of institutions (markets, regulations), applied to agri-food and rural agricultural systems in the Mediterranean-euro zone, Central and Eastern European Countries (CEEC) and in developing countries. The approach used borrows from different theoretical trends in institutional economics (transaction costs, agreements, evolutionism, ETC.) and management sciences (marketing and strategic analysis) along with certain aspects of socio-anthropological approaches.

Stakeholder strategies for farmers, manufacturers, distributors and public authorities

The second half of the 20th century was characterised by profound technico-economic changes (industrialisation, tertiarisation, liberalisation and globalisation of national economies), and societal upheaval (urbanisation, the transformation of population structures, migratory flows, an increase in women's economic activity and in the percentage of children in full-time education) which completely transformed the organisation of the agri-food sectors. The *Marchés, entreprises et alimentation* Department is interested both in the organisation and co-ordination between sectors and in stakeholder strategies. The analysis of agri-food sectors is an essential part of the study of agri-food systems as it helps reveal the significance of the rural-urban continuum in the distribution of food and agricultural products to the end consumer throughout the successive stages of processing and marketing. The department simulates medium-term developments including opportunities for increasing added value for civil society and private enterprises, and advises public authorities in sensitive areas such as upgrading, competition policy, standardisation and aid for innovation.

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Food legislation and consumption duty

Food is subject to frequent changes depending on technical progress in food manufacturing but also in the understanding of consumers' health hazards, which are sometimes inherent in certain foodstuffs. It is thus important to distinguish between relatively stable fundamentals and specific regulations which can be rapidly adapted when a new situation arises, which is the object of technical regulations. Food legislation that is complete and easy to apply consequently has two components which are a little different, although both deal with the same topics: basic law and regulations (or texts). In the agri-food sector, basic law has to deal with several different topics: the definition of primary goals, basic concepts and the scope of the law. It has to specify the competences required to enforce the law, to define its procedures, define the means to carry out inspections and analysis, their implementation and penalties. It defines the concept of norm, suggests principles for the regulation of additives, and procedures for use (for example for pesticides, antibiotics and other contaminants), as well as concept of tolerance related to their use, and regulations concerning packaging and

labelling. At the same time and in the same way as regulations, regulatory control deals with additional topics: general regulations, standards, the principles of food hygiene, food additives, pesticides, food packaging and labeling, as well as advertising information or allegations concerning food.

The majority of texts referring to food are dealt with in the "Code of consumption" which allows all the different administrative authorities to refer to the same text concerning their activities related to controls, and professionals to be sure they are familiar with all the texts connected with their activity. One of the research topics of the *Centre de Droit de la Consommation et du Marché* is the modernisation of the French code of consumption and more specifically with the legal obligations of food professionals (upstream traceability, preliminary control, manufacturing conditions, storage, transport and sale, follow-up obligations) and with the consequences of failure to respect these obligations. Particular attention is paid to the precautionary approach and its impact on European and international rules on freedom of movement. In France and abroad, the centre is not only responsible for research but also for drafting texts: codes, laws, decrees, etc.

Laws and policies for sustainable development

Sustainable development is a new concept in public policy and international law which applies to an increasing extent to State interventions and also raises significant social issues. The *Centre of studies and researches about transformations of Public Action* focuses its works on this topic in the disciplines of political science and public law. Analyses conducted using public policy methodology enable integration of legal disciplines as tools for legal actions. This approach enables a more detailed analysis of categories and the way the categories can change depending on the decision-making environment. The centre contributes to sectoral disciplines that are an integral part of the concept of sustainable development: food law, environmental law, legal anthropology, development and external trade laws, international public law, and so on. It provides expertise to international organisations (FAO, the Codex Commission, WAEMU – the West African Economic and Monetary Union, the European Union, etc.) in the institutional and normative domain. ■

Jean-Pierre Guyot © IRD



Preparation of fermented millet gruels in Ouagadougou (Burkina Faso) in a family production unit

CEREFER Project Sanitary and nutritional quality of fermented cereals in Africa

In Africa, large quantities of cereal-based fermented foods are produced in small family or artisan units. This traditional food is often used to prepare complementary food for infants. Although it is an established fact that lactic acid fermentation gives this food a better sanitary and nutritional quality, in practice it does not comply with the specific criteria required for the satisfaction of nutritional needs

of young children due to inadequate energetic density, low micronutrient availability, etc., nor does it guarantee satisfactory hygienic quality. The objective of the CEREFER research project, which is financed by the European Union, is to improve sanitary and nutritional quality by studying three local fermented foods, two millet-based foods in Burkina Faso and one maize-based food in Congo. The studies started with the characterisation of production methods and consumption patterns, and, after a validation stage when consumers will test the acceptability of the improved food, will continue with the study of methods of transfer of the modified processes to producers.

This project brings together specialists in nutrition, microbiology and food technology in a consortium set up by the University of Ouagadougou, a multidisciplinary research team in food and nutrition (EPRAN) in Congo, the University of Jaén in Spain, the University of Wageningen in Holland, and IRD in France.

Contact : Jean-Pierre Guyot,
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Transferring technologies to agri-food industries

As part of the Regional Centre for Innovation and Technology Transfer (CRITT, financed by a State-Region plan implementation contract) the TRIAL Pole facilitates the rapid growth of agri-food firms in Languedoc-Roussillon. At the interface between manufacturers and public and private resource centres, TRIAL promotes technological and economic partnerships that allow small and medium companies to be more reactive and competitive. TRIAL is a member of ACTIA (Association for Technical Coordination in the Agri-food Industry) and of the regional poles network, and a partner in ARIA-LR (Regional association of Agri-food industries of Languedoc-Roussillon).*

* Former TRIAL organisation is now part of Transferts LR
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Team

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Regional association of Agri-food industries of Languedoc-Roussillon (ARIA-LR)

Co-ordinator: Brigitte Bouillut,
aria-lr@agropolis.fr
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The mission of TRIAL Pole is to facilitate access to innovation by small and medium regional enterprises through the distribution of information (by ordinary mail, via its Website, technological platform) for the purpose of awareness raising and providing information on:

- Ongoing projects (feasibility studies, research/development) from needs analysis to the drawing up of specifications, from the identification of potential partners and the financing of research to the final transfer to the company (the aim being to *gain time and money and increase competence*)
- Technical expertise (diagnoses, coaching, etc.) on basic topics such as: nutrition and health, improving performance, management of joint products, and quality (the aim being to *provide solutions for technical problems*).

The nutrition and health project, which began in 2000, aims to raise the awareness of small and medium companies in Languedoc-Roussillon about nutrition, so that they integrate it into their product development strategies and thereby contribute to national public health policy (National Nutrition and Health Programme, PNNS).

Specific actions include:

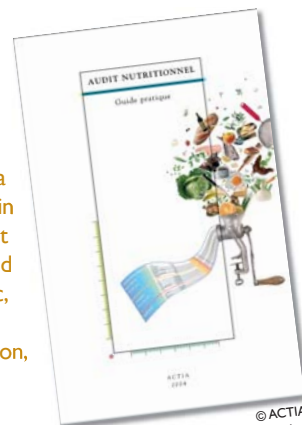
- Services to firms: targeted Internet watch (www.nutriaa.com), information meetings of the nutrition club (allegations concerning nutrition, enrichment, etc.), nutritional audits, regulations concerning labelling, collective action for the promotion of the Mediterranean diet, etc.
- Involvement in a regional network (Agropolis), a national network (Actia) that provided a practical guide to the 2004 nutritional audit; took part in a working group on the impact of technologies, and provided nutrition watch tools; and in European networks (Med Diet Net which is a network of technical centres for the Mediterranean diet).

Nutritional audit: a strategic tool for professionals

Aiming to improve and enrich an existing empirical methodology, the ACTIA practical guide (published in 2004) is the result of the sharing of experience between different experts, which formalizes the different stages of a nutritional audit.

A nutritional audit is an inventory of a given situation that allows a product to be repositioned in a given context - on a market, within a legal framework - with respect to a specific "consumer" target. It highlights the nutritional assets and weaknesses of the product, and provides decision-makers with reliable information about scientific, regulatory or marketing aspects. Manufacturers can then design effective strategies in terms of communication, positioning, validation, improvement, development, etc.

Contact : Danielle Lestang, lestang@transferts-lr.org



© ACTIA
Cover illustration:
Anne-Lise Dermenghem



Claude Corbier © Région Languedoc-Roussillon

Apple sorting equipment

Mediterranean diet: when pleasure is healthy

Since 2000 in partnership with the South-Eastern region of France and two professional federations (ARIA, FRIAA) TRIAL has been jointly co-ordinating a collective action supported by local public authorities (Regional councils, Draf, DRRT) aimed at promoting the “nutritional value of Mediterranean products”:

- The first action (PRIAM) was the study of the nutritional quality of 42 processed products that led to the publishing of a practical guide (ACTIA, 2003) enabling small and medium-size

companies to improve, create or increase the nutritional value of Mediterranean products;

- The second ongoing action is a 5-year framework research programme with multidisciplinary teams (nutritionists, technologists, socio-economists, etc.) in collaboration with regional companies, with a Mediterranean Standing Committee.

Contact : Danielle Lestang, lestang@transferts-lr.org

ARIA-LR (*Regional association of Agri-food industries of Languedoc-Roussillon*) is the communications and development structure of the regional agri-food sector. Its role is to federate all the industrial firms in this sector irrespective of their size, legal status or field of activity. The association is active throughout the Languedoc-Roussillon region. ARIA-LR works in collaboration with other institutions (public administrations, territorial authorities, professional organisations, local chambers of commerce, etc.).

Its missions are:

- To represent firms and the regional agri-food sector especially in contact with public authorities, national, regional and departmental institutions and more generally in the socio-economic context by providing an interface and more bargaining strength;
- To federate firms, to create links between managers and their associates, to network;
- To assist firms, especially through collective actions aimed at optimisation of performance or modernisation of methods, and to meet their needs.

Its actions concern the main fields on which agri-food firms' future depends:

- Quality, safety, environment, sustainable development
- Human resources, Education and training, employment, integration
- Agribusiness financing
- Strategy
- Development for export
- Internet – use of ICT
- Promotion, valorisation
- Grouped purchasing. ■



Jean-François Roche © Agropolis-Museum

Disseminating scientific and technological culture to the general public

In 1986, Louis Malassis, the founder of Agropolis, suggested creating Agropolis Museum for the dissemination of scientific and technical culture from the scientific community to the general public. The museum was designed as an institutional centre for cultural relations between the scientific community and the public. Today Agropolis Museum has many visitors. It collects and conserves documents and objects concerning agriculture and food around the world, thus contributing to conserving the international food and agricultural heritage.

Eating is indispensable for survival and humans have responded to this need with food systems, which are combinations of coordinated activities concerning the acquisition (gathering, hunting), production (cropping, animal rearing) processing (cooking, the food industry), and distribution of food. These systems have changed considerably over the years and also vary greatly throughout the world. The culture, technology, science and expectations of different people have determined the different systems.

Agropolis Museum has four main components:

- *The museum itself*, a centre of research, culture and communication on food systems of today and yesterday;
- *The cyber-museum* which extends the reach of the museum via the Web;
- *The animation department* which organises scientific and cultural events and travelling exhibitions.

- *The department for young people* which receives school groups and young people for events, awareness raising, educational workshops, and games.

A living museum

Because it's concerned with the present and the future - ways of eating food tomorrow are being invented today.

A social museum

Because food and agriculture are at the root of social and technical issues, the most important of which is the ongoing war against hunger.

A centre for scientific culture

Because today science is not only one of the most important motors of change but also perhaps one of the least well understood.

Its shared culture

Because culture and concern for the future are part of each and every one of us.

Savoirs partagés: debates about society

The aim of these debates is to:

- Disseminate and enhance scientific culture in Languedoc-Roussillon region
- Contribute to the dialogue between scientists and civil society
- Offer facilities to those interested.

The main topics are global challenges, societies, food and health all over the world, without distinction between southern and northern countries. Reports on retrospective exhibitions can be consulted at Agropolis Museum Web site.

Contact

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The cereal display in the 'World's food' exhibition

The permanent exhibitions tell the story of man's historical battle to obtain sufficient food and food of acceptable quality, and about the different types of food and agriculture in the world. They stimulate reflective thinking and debate about the exchange of eating habits and about the food inequalities in the world.

- *History of food and agriculture* portrays the three ages of food: the pre-agricultural age, the agricultural age and the agro-industrial age.
- *Farmers and farming over the world*: farmers in their homes talk about different systems of agriculture, their adaptation to productive environments in human societies subjected to economic and cultural development.

Permanent exhibitions

- *Agrarian landscapes*: a slide show describes the action of small farmers and hypothesizes about the future. The museum uses different cases to explain landscapes as a reflection of agricultural production systems.
- *World's food*: the different types of food, cereals, tubers, legumes, fats, meat, milk and dairy products, fruits and vegetables, luxury products, products with a local label, etc., are displayed with details on how they were cultivated, together with tools, processing techniques, conservation, economics, and links with health.
- *World's food* displays "cuisines" of the world gathering foods that satisfy people's nutritional needs and play a role in the culture of different populations. A 20-metre long fresco shows different ways of eating in the world, from eating for survival to rites and beliefs, table manners, social relations, opulence and poverty. Six different kitchens are shown with the tools used, the know-how, and table art.
- *Beverage of the world* is highlighted in a showcase demonstrating the knowledge and tools required to produce each group of drinks from water to alcoholic beverages.
- The "*Banquet de l'Humanité*" is an artistic way of drawing attention to the debate on food equality in the world. Eight food families – nutrient budgets developed by the FAO – are displayed around the banqueting table. The content of each person's plate is listed behind each diner, for there isn't room for everyone at 'nature's table' but those who are excluded are also present. The ancient war against hunger remains to be won.

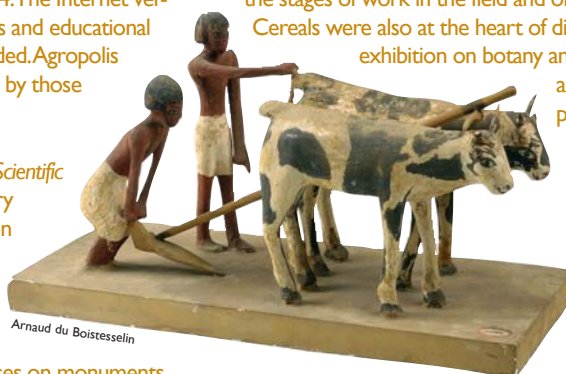
A virtual exhibition on the Agropolis Museum web site

Virtual exhibitions on the Agropolis Museum¹ web site are successful: 377 000 visitors and 1.5 million pages visited in 2004. The Internet versions of the permanent exhibitions, lectures debates and educational tools are widely consulted and frequently downloaded. Agropolis Museum is recognised as an indispensable resource by those interested in agriculture and food.

In collaboration with the French National Center for Scientific Research (CNRS) / Montpellier University laboratory on Egyptology and with the support of IAMM, and in the framework of a partnership with the Museum of Agriculture in Cairo, a virtual exhibition was organized on cereals and cereal products in Egypt. This project was successful because it filled a gap in information about ancient Egypt which mainly focuses on monuments and pharaohs but say little about the work of peasants.

Egypt has very beautiful illustrations that provide information on all the stages of work in the field and on the making of bread and beer. Cereals were also at the heart of different rites and religions. The exhibition on botany and the history of wheat was also very popular, as there are practically no popular works on arable crops.

¹ www.museum.agropolis.fr



Arnaud du Boistesselin

Model of a swing plough with two men and two oxen. Middle Kingdom (around 2 000 BC)

Coll. Cairo Museum of Agriculture - Inv. n° 1457

Topics covered by research teams

(march 2005)

Research units and teams are mentioned on the following chart in order of appearance in Agropolis file. Differentiation is made between teams with their programme referring to food or nutrition related to health (*yellow print*) and teams that collaborate to research projects or training sessions in the food,

nutrition and health fields or use tools, methods and models that may contribute to research in ANS fields (*white print*).

1. Food sciences, process engineering, technologies
2. Metabolism, Biology of food components, nutrition
3. Sanitary safety of food
4. Food and major pathological risk factors
5. Nutritional approach and public health
6. Valorisation, technologies transfer

Unit	Page	1	2	3	4	5	6	Specificities
UMR PIA « Polymorphisms of Interest in Agriculture » joint research unit (Agro.M/Cirad, Inra) J.-C. Glaszmann et Ph. Joudrier	5		•					
UPR 19 « Livestock Systems and Animal Products » research unit (Cirad) D. Richard	5							Animal feeding Zootechnics
UPR 20 « Aquaculture and aquatic living resources management » research unit (Cirad) J. Lazard	5							Animal feeding Aquaculture
UPR 24 TROPIQUAL « Food processing » research unit (Cirad) M. Reynès	7	•		•			•	Food and nutrition developing countries - Valorisation Technologies transfer
UPR 33 IMPAQ « Quality of tree crop products » research unit (Cirad) A. Rouzière	7	•		•		•	•	Food behaviours Valorisation – technologies transfer
UPR 45 QUALITER – « Qualification and territories » research unit (Cirad) D. Sautier	7						•	Agri-food economics Consumption duty - Valorisation
Ensia/Siarc F. Giroux	7	•		•			•	Valorisation – Technologies transfer
UMR 016 « Chemical Engineering and Bioproduct Elaboration » joint research unit (UMII/Cirad/Ensia-Siarc) A. Grasmick	8	•						
UMR IATE - « Agropolymer Engineering and Emerging Technologies » joint research unit (Agro. M/Inra/Cirad/ UMII) S. Guilbert	8	•					•	Valorisation – Technologies transfer
UMR 1212 « Bioreaction engineering, bioproductions » joint research unit (Inra/Agro. M/UMII) J.-P. Guiraud	9	•		•				
UMR 5635, IEM « European Membrane Institute » (UMII/CNRS/ENSCM) G. Pourcelly	11	•					•	Valorisation – Technologies transfer
UMR ITAP « Information and Technologies for Agro-Processes » joint research unit (Cemagref/Agro. M /Cirad) V. Bellon-Maurel	11	•		•			•	Prevention of microbial contaminants - Valorisation – Technologies transfer
UMR 1083 « Sciences for Oenology SPO » joint research unit (Agro. M/Inra/UMI) G. Albagnac	11	•	•					
Laboratory of Botany, Phytochemistry and Mycology » joint research unit (UMR 5175, CEFE, UM1) C. Andary	11	•	•				•	Nutritional allegations Valorisation – Technologies transfer
EA 3762 « Food and Nutrition » research unit (UMII/Polytech' Montpellier) P. Besançon	12	•	•	•				Nutritional allegations

Unit	Page	1	2	3	4	5	6	Specificities
EA 2993 « Nutrition and Atherogenesis » research unit (UMI/CHU) L. Monnier	12				•			<i>type 2 diabetes</i> <i>Obesity</i> <i>Cardiovascular diseases</i>
« Physiopathology of the cardiovascular system » research unit (Inserm/UMI) S. Richard	14				•			<i>Cardiovascular risks</i>
U540 « Molecular and cellular endocrinology of cancers » research unit (Inserm/UMI) J.-C. Nicolas	14		•					
U376 « Peptide endocrinology and gene régulation » research unit (Inserm/UMI) D. Bataille	15		•		•			
UMR DCC « Cell differentiation and Growth » joint research unit (Inra/Agro. M/UMII) G. Cabello	16		•		•			
U632 - « Hepatic physiology » research unit (Inserm/UMI) P. Maurel	16		•		•			
« Molecular genetics of olfaction and cell biology » team (IGH/CNRS) D. Giorgi	14	•					•	<i>Food behaviours</i> <i>Olfaction</i> <i>Valorisation</i>
UMR 431 - « Microbiology and infectious cellular pathology » joint research unit (Inserm/UMII) J.-P. Liautard	19			•				<i>Prion diseases</i> <i>Microbial contaminants</i>
Research Programme « Biology of transmissible spongiform encephalopathies » (IGH/CNRS) S. Lehmann	21			•				<i>Prion diseases</i>
EA 2415 – « Public health, biostatistics, Epidemiology » research unit (UMI/CHU) J.-P. Daurès	22-23				•	•		<i>Epidemiology</i>
CRLC – Centre Régional de Lutte contre le Cancer M. Gerber et P. Sennesse	23					•	•	<i>Nutritional Epidemiology</i> <i>Nutrition and cancers</i>
E0361 « Nervous system pathologies : epidemiological and clinical research » research unit (Inserm/UMI) K. Ritchie	23					•	•	<i>Epidemiology</i> <i>Neurodegenerative risks</i>
UR024 « Epidemiology and prevention » research unit (IRD) F. Simondon	24		•	•	•	•		<i>Food and nutrition</i> <i>developing countries Epidemiology</i>
« Human Nutrition » laboratory (UMI/CHU) L. Monnier	25		•		•			<i>Atherogenesis</i> <i>Cardiovascular risks</i>
EA 3127 « Groupe rein et hypertension » (IURC) A. Mimran	25				•			<i>Hypertension</i>
U454 « Immunopathology of inflammation » research unit (Inserm/UMI) J. Bousquet	27				•			<i>Allergies</i>
UPR 1142 Laboratoire d'ImmunoGénétique Moléculaire (LIGM) (CNRS/IGH) M.-P. Lefranc et G. Lefranc	23		•	•	•			<i>Allergens</i>
UR106 - « Nutrition, Food, Societies » research unit (IRD) F. Delpeuch	28	•		•	•	•		<i>Food and nutrition</i> <i>developing countries</i>
« Marché, entreprises et alimentation » Department (CIHEAM/IAMM) M. Padilla	29					•		<i>Agri-food economics</i>
« Governance and Norms in Agricultural Markets » Research unit (Cirad) N. Bricas	30					•		
UMR MOISA - « Markets, Organisations, Institutions and Operator's Strategies » joint research unit (Agro. M/IAM.M /Cirad/Inra/IRD) J.-L. Rastoin	30					•	•	<i>Agri-food economics</i> <i>Operator's strategies</i> <i>Valorisation – Technologies transfer</i>
EA 709 « Centre de droit de la consommation et du marché » (UMI) H. Temple	31			•	•	•		<i>Consumption duty</i>
CERTAP – « Centre of studies and researches about transformations of Public Action » (UP) F. Féral	31							<i>Consumption duty</i> <i>Public health policy</i>
Transferts LR H. Thiery	32			•	•		•	<i>Valorisation – Technologies transfer</i> <i>Innovation – Nutritional allegations</i>
ARIA LR – « Association Régionale des Industries Agroalimentaires du Languedoc-Roussillon » B. Bouillut	33			•			•	<i>Assistance for the economic development of agri-food industries</i>

Agropolis training and education

in the field of Food – Nutrition - Health

Agropolis, through its member institutions (universities, specialised colleges, professional training departments) offers a complete set of training opportunities, including:

- more than 80 degrees ranging from two years – Bac+2 – to eight

years – Bac+8 after completion of secondary education: technical degrees, “ingénieur” degree, BSc, MSc, PhD,)

- one hundred professional courses
- tailor-made training sessions upon demand

The following tables give details on degrees and courses related to the “Food – Nutrition – Health” sector (level, title and organising institutions).

Degrees

focused on « Food – Nutrition – Health »

level	degrees	title	institutions
Bac +2	DUT (Technical University degree)	Bioengineering Options: “dietetics” and “biological and food industries”	IUT (UMII)
	DU (Specific University degree)	Marketing of wine and agri-food products	UMI
		Biological traceability	CREUFOP (UMII)
	BTS (higher technical degree)	Viticulture - Oenology	Lycée Agropolis
		Sales engineering – drinks, wine, spirits	
Bac +3	Licence Professionnelle (BSc with professional scope)	Wine Marketing and Quality Labels	UMI / Agro. M
		Packing and Packaging of “BIOPACK” Products from living organisms	IUT (UMII)
	Licence (BSc)	Management Sciences - Specialisation: Trade and Sales Training in the Agri-food sector	UMI /Agro. M / IFRIA
Bac +5	DU (Specific University degree)	Medical dietetics	UMI
	« Ingénieur » degree	Specialisations (DAA): « Viticulture-Oenology », « Agri-food and Agribusiness », “Agro-managers”	Agro. M
		Specialisations “Food Industries in Hot Regions”	Ensia-Siarc
		Sciences and Technologies of the Food Industry	Polytech’ (UM II)
	Master Recherche (MSc)	Sciences and Technologies Mention Biology Health Specialisation: Biology Health	UMI/UMII
		Sciences and Technologies, major BGAE (Biology, Geosciences, Agro-resources, Environment) Specialisation: Bio-products and Control of Processing Processes	Polytech’ (UM II) / Agro. M
		Sciences and Technologies, majors Physics/Chemistry Specialisation: Materials Chemistry and Physico-chemistry	UMII
		Economy and Management Majors: Agri-food and Rural Economy Specialisation: Economy and Management of Rural, Agri-food and Agricultural Development	UMI /Agro. M
		Rural and Agri-food Strategies	UMI
	Master Professionnel (MSc with professional scope)	Sciences and Technologies, Mention BGAE (Biology, Geosciences, Agro-resources, Environment) Specialisations: “Animal Production in hot regions” and “Aquatic Bioresources in Tropical and Mediterranean environments”	UMII
		Sciences et Technologies - Mention Physique/Chimie - Spécialité « Physico-chimie Appliquée des Matériaux »	
		Sciences and Technologies Major Physics/Chemistry Specialisation: Applied Physico-chemistry of Materials	UMI / UMII

level	degrees	title	institutions
	Master Professionnel (MSC with professional scope)	Sciences and Technologies, major Biology and Health Specialisations: “Health Professions and Engineering”, “: Interface Chemistry Biology”, “Nutrition, Food, Public Health”	UMI / UMII
		Agronomy and agribusiness, Specialisation: “Agri-food Systems Quality in hot regions”	Agro. M/ Ensia-Siarc
		Marketing, Trade Specialisation: Trade and Distribution Engineering Training in Agri-food Sector	UMI / Agro. M/ IFRIA
	Master professionnel IUP (MSC with professional scope)	Sciences and Technologies, majors Physics and Chemistry Specialisation: Chemistry Bio Aromas, Perfumes and Cosmetology	UMI / UMII / ENSCM
		Sciences and Technologies, majors BGAE (Biology, Geosciences, Agro-resources, Environment) Specialisation: Biological traceability, Biodetection, Biodiversity	UMII
	Master of Science	Agri-food Companies, Sectors and Markets	IAM.M
		Policies and Public Choices in Agriculture and Diet	
		Mediterranean and Tropical Food Engineering	Ensia-Siarc
		Food Science and Technology (relocated in Thailand, provided in English)	
	DRT (Technological Research degree)	Industrial Process Engineering - Materials	UMII
		Bioengineering and Food Engineering	
		Health Engineering	UMI
	Other degrees	National Diploma of CEnology	UMI / Agro. M
		MBA Agri-business	IAM.M
		NATURA – Processing of Tropical Food Products	Ensia-Siarc
Bac +6	Mastère spécialisé CGE (Specialised post graduate degree)	Innovation Diet	Agro. M
		Agro-industrial Management	
		Integrated Risk Management in Agribusiness: food, environmental and professional risks	
Bac +8	Doctorat (PhD)	Several Graduate Schools allow the preparation of a PhD linked with the “Food – Nutrition – Health” theme (<i>see below</i>)	

Focused on other themes, but including a significant component related to the « Food – Nutrition – Health » theme

level	degrees	title	institutions
Bac +2	DUT (Technical University degree)	Biology	IUT (UMII)
	DEUST (Technical University degree)	Perfumes, aromas and cosmetics	UMII
Bac +3	Licence Professionnelle (BSc with professional scope)	Sciences and Technologies, major in chemistry, Chemistry, Perfumes, Aromas and Cosmetics	UMII
	Licence (BSc)	Sciences and Technologies, major biology	UMII
		Environment and Earth Sciences	
		Industrial Systems Engineering	UP
Bac+5	DU (Specific University degree)	Environment Sciences and Public Health	UMI
	Master Professionnel (MSC with professional scope)	Agronomy and Agribusiness Specialisation: Animal production in hot regions	Agro. M / Cnearc
		Agronomy and Agribusiness Specialisation: integrated cropping systems	Agro. M / Cnearc
		Agronomy and Agribusiness Specialisation: Vine and Wine	Agro. M / ENITAB
	Master Recherche (MSc)	Sciences and Technologies, majors Computer Science, Mathematics and Statistics Specialisation: Biostatistics	UMI / UMII / Agro. M
	Master Professionnel (MSC with professional scope)	Phytoresources	UP
		Sciences and Technologies, majors Computer Science, Mathematics and Statistics Specialisation: Biostatistics	UMI / UMII / Agro. M



Short non-degree courses

Short course modules

Institute	Courses
Agro. M	Relations Agri-food Industries / Mass distribution, new issues (3 days)
	Wine legislation: wine cellar administrative document keeping (2 days)
Agro. M Engineer's Second-year Optional Modules open to continuing vocational training	Agriculture, agribusiness and media (2 weeks)
	Let's talk wine (2 weeks)
	From field to plate: technical pathways and food quality (2 weeks)
	Food consumption (4 weeks)
	Industrial fermentations – Microbial biotechnology (4 weeks)
	I.C.T. in agriculture and agribusiness (4 weeks)
	Quality control in agribusiness and risk analysis (4 weeks)
	Foodstuff packing (4 weeks)
	"Green Bio-project": bioprocess design and implementation: from research to industrialization (4 weeks)
	Drinks (4 weeks)
	Financial management of Agroindustrial projects (4 weeks)
	Physico-chemical analysis of food for quality control and for the development of new foods (2 weeks)
	Microbiological Analyses: food safety (2 weeks)
Cirad	Chocolates sensory analysis (2,5 days)
	Become expert in cocoa (2,5 days)
	Workshop on coffee (4 days)
Ensia-Siarc	Fruit and vegetable processing in hot regions (2 weeks)
	Brewing – Malting (1 week)
	Starchy products and processing of tropical cereals (2 weeks)
	Processing of products of animal origin (2 weeks)
	Cane sugar industry (1 week)
	Food industrial engineering (3 weeks)
	Food economy (3 weeks)
	Agri-food equipment and maintenance in hot regions (2 weeks)
	Quality tools in agri-food companies (2 weeks)
	Agri-food projects in hot regions (4 weeks)
	Small agri-food company founding in tropical area (1 week)
	Practical work of agricultural products processing (4 weeks)
IAM.M	Agri-food systems (3 weeks)
	International development of food companies (2 weeks)
	Surveys methods and data analysis (2 weeks)
	Food sectors and markets (2 weeks)
	European Relations and public choices. Regional context and collective issues (2 weeks)
	Globalisation and agri-food geostrategies (3 weeks)
	Consumers' new expectations and their impacts on the marketing policy of companies (2 weeks)
	Modelling for the analysis of agricultural policies (2 weeks)
	International Standards and stakeholder strategies (2 weeks)
	Markets, policies et negotiations – analytical methods, research and preparation of study records (2 weeks)

Certifying training validated by a CESA (Certificate of Higher Studies in Agronomy)

Institute	Courses
Agro. M	Quality-Safety-Environment co-ordinator in agri-food industry (8 months)
	Co-ordinator of food company International development (8 months)

"Online" courses

A number of the IAM Master of Science courses are designed for online study
(<http://www.iamm.fr/html/acti/ens/default.html>)

Institute	Courses
IAM.M	Food system (135 hours) in collaboration with Agro. M
	Food behaviours and marketing (10 days) in collaboration with INA Tunis
	Globalisation and agri-food geostrategies (140 hours)

Flexible short in-house training

Ensia/Siarc provides flexible short training courses. These vocational training courses are organised at the request of companies and designed to meet their specific needs. They are the subject of a case-by-case study.

*Field study at the Montpellier
Engineering School of Agronomy / Inra
educational vineyard*



Graduate schools concerned with Food, Nutrition and Health

The PhD takes three years to prepare and is based on research work in a laboratory. All students who register for this PhD are also registered with a graduate school. The graduate schools group research units or host laboratories concerned with important research topics. In addition to the direct supervision of PhD students, they provide complementary education in the form of seminars, scientific lectures, and training modules throughout the three-year preparation period. The aim of these modules is to improve the students' scientific training and to prepare them for their future career.

Graduate school « *Biological and Industrial sciences and processes* »

This graduate school is organized jointly by the Universities of Montpellier I and Montpellier II, Agro. M and the university-level Engineering School of Chemistry of Montpellier (ENSCM).

It groups research units that allow the preparation of a PhD in the fields of food sciences and process engineering. The school belongs to the Agropolis agronomic and agri-food complex in Montpellier

The key topics are Foods, Water and Effluents, Quality, Safety and Hygiene, Oenology; Nutrition, Biotechnology, Bioproducts, Packaging, Extraction, Fermentation, Formulation, Modelling.

At the interface of Engineering Sciences and Life Sciences, this graduate school offers modules on formulation and structuring, lattices and emulsions, natural substances and materials, interactions and phenomena at interfaces, and the design, control and on-line monitoring of reactors.

The school enrolls around 40 new PhD students each year.

Contact

Graduate school « Biological and Industrial sciences and processes »

(UM I, UMII, Agro. M, ENSCM)

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Graduate school "Chemical and biological sciences for health"

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Graduate school "Economics and Management" (UM I, Agro. M)

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Graduate school

« *Chemical and Biological Sciences for Health* »

The Graduate school *Chemical and Biological Sciences for Health* groups all the research potential in Languedoc-Roussillon in the field of Biology and Chemistry directed towards health problems, from the chemistry of medication to clinical research. The school is supported by a number of major laboratories in the fields of genetics, development, biomolecules, cell biology and physiology.

In the field of health, this school is comparable with other big regional university centres both by the number and quality of theses produced and by the number of career opportunities it offers.

Graduate school

« *Economics and Management* »

The main mission of this graduate school organised jointly by the University of Montpellier I and the Agro Montpellier is to provide top-quality supervision of PhD students preparing a doctorate in economics and in management.

To this end, the school coordinates the training modules at the different stages of preparation for the PhD. It also facilitates the professional integration of its students and for this reason monitors the career development of its former students.

Finally, this graduate school is also involved in the development of international relations and in the scientific and cultural outreach of the Montpellier University and Research Centre. ■



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Reform of higher education in France

The object of the reform was to ensure the French higher education system conforms to the European university systems, and it is being implemented progressively since 1998. The new system is primarily geared to acquiring three levels of qualification, a Bachelor's degree acquired 3 years after the French school leaving exam (*Baccalauréat*), a Master's degree 5 years after the school leaving exam and a Doctorate (PhD) 8 years after the school leaving exam, at the same time maintaining intermediate levels. Courses are now organised in semesters and based on credits. The general adoption of the European system of transferable credits, the "European Community Course Credit Transfer System (ECTS)", and the description of the qualification obtained enables international recognition of the qualification. A Bachelor's degree is obtained on the basis of 180 European university credits and a Master's on the basis of 300 European university credits in such a way that the regulations governing the accumulation of credits guarantees the level of studies concerned. The reform should be in place throughout France for the beginning of 2005/2006 university year.

List of abbreviations

ACTIA	Association de Coordination Technique pour l'Industrie Agroalimentaire
Agro. M	École Nationale Supérieure Agronomique de Montpellier
ARIA-LR	Association Régionale des Industries Agroalimentaires du Languedoc-Roussillon
ARPB	Agro-Ressources et Procédés Biologiques
BTS	Brevet de Technicien Supérieur
Cemagref	Institut de recherche pour l'ingénierie de l'agriculture et de l'environnement
CHU	Centre Hospitalier Universitaire
CIHEAM	Centre International de Hautes Etudes Agronomiques Méditerranéennes
Cirad	Centre de coopération Internationale en Recherche Agronomique pour le Développement
CNAM	Conservatoire National des Arts et Métiers
CNEARC	Centre National d'Études Agronomiques des Régions Chaudes
CNRS	Centre National de la Recherche Scientifique
CREUFOP	Service de formation professionnelle continue de l'Université Montpellier II
CRITT	Centre Régional d'Innovation et de Transfert de Technologie
CRLC	Centre Régional de Lutte contre le Cancer
CRNH	Centre de Recherche en Nutrition Humaine
EA	Équipe d'accueil
ED	École doctorale
ENITAB	École Nationale d'Ingénieurs des Travaux Agricoles de Bordeaux
ENSCM	École Nationale Supérieure de Chimie de Montpellier
Ensia/Siarc	École Nationale Supérieure des Industries Agricoles et Alimentaires
	Département Industries Agroalimentaires Régions Chaudes
EPHE	École Pratique des Hautes Études
ESB	Encéphalopathie spongiforme bovine
ESCAIA	École Supérieure de la Coopération Agricole et des Industries Agroalimentaires
FAO	Organisation des Nations Unies pour l'alimentation et l'agriculture
GREF	Génie Rural des Eaux et des Forêts
HT	Hydroxy-tyrosol
IAM.M	Institut Agronomique Méditerranéen de Montpellier
IDI	Information Diététique Intégrée
IAA	Industries Agroalimentaires
IEM	Institut Européen des Membranes
IFPRI	<i>International Food Policy Research Institute</i>
IFR	Institut Fédératif de Recherche
IFRIA	Institut de Formation Régional des Industries Alimentaires du Languedoc-Roussillon
Ifremer	Institut français de recherche pour l'exploitation de la mer
IGH	Institut de Génétique Humaine
IMGT	<i>International ImMunoGeneTics information system</i>
INAT	Institut National Agronomique de Tunis
Inra	Institut National de la Recherche Agronomique
Inserm	Institut National de la Santé Et de la Recherche Médicale
IRD	Institut de Recherche pour le Développement
ISTOM	École Supérieure d'Agro-Développement International
IUP	Institut Universitaire Professionnalisé
IURC	Institut Universitaire de Recherche Clinique
IUT	Institut Universitaire de Technologie
LIGM	Laboratoire d'ImmunoGénétique Moléculaire
NATURA	<i>Network of European Agricultural (Tropically and subtropically oriented) Universities and scientific complexes related with Agricultural development)</i>
OGM	Organisme Génétiquement Modifié
OR	Récepteur olfactif
PECO	Pays d'Europe Centrale et Orientale
PME	Petites et moyennes entreprises
Polytech' Montpellier	École Polytechnique Universitaire de Montpellier (ex-ISIM)
PRIAM	Programme Interrégional Alimentation Méditerranéenne
PrP	Protéine du prion
PVD	Pays en voie de développement
SPIR	Spectrométrie proche infrarouge
T.I.C.	Technologies de l'information et de la communication
TRIAL	Centre de transfert de technologies agroalimentaires du Languedoc Roussillon (now <i>Transferts LR</i>)
UEMOA	Union Économique et Monétaire Ouest Africaine
UM I	Université Montpellier I
UM II	Université Montpellier II
UM III	Université Montpellier III
UMR	Unité mixte de recherche
UP	Université de Perpignan
UPR	Unité propre de recherche
UR	Unité de recherche
USDA	<i>United States Department of Agriculture</i>

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Agro. M
www.agro-montpellier.fr

Agropolis-Museum
www.museum.agropolis.fr

ARIA-LR
www.agroalimentaire-lr.com

Cemagref
www.cemagref.fr

CHU Montpellier
www.chu-montpellier.fr

Cirad
www.cirad.fr

Cnearc
www.cnearc.fr

CNRS
www.cnrs.fr

CRLC
www.valdorel.fnclcc.fr

Ensia-Siarc
www.ensia-siarc.agropolis.fr

CIHEAM/IAM.M
www.iamm.fr

Inra
www.inra.fr

Inserm
www.inserm.fr

IRD
www.ird.fr

IURC
www.iurc.montp.inserm.fr

Polytech' Montpellier
www.polytech.univ-montp2.fr

Transferts LR
www.transferts-lr.org

UM I
www.univ-montp1.fr

UM II
www.univ-montp2.fr

UM III
www.univ-montp3.fr

UPVD
www.univ-perp.fr

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