



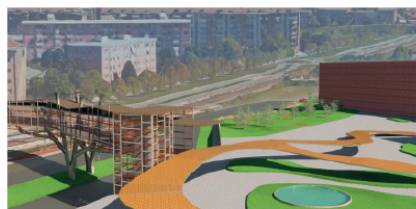
UNIVERSITÀ DEGLI STUDI DI TORINO

CITTÀ DELLE SCIENZE

From nature to technology

December 2016

Scientific and strategic project for the establishment of a new University Campus in Grugliasco





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Abstract

Italiano

Il documento nasce a supporto del progetto “Città delle Scienze” promosso dall’Università di Torino, che prevede la costituzione di un nuovo polo scientifico nella città di Grugliasco (Città Metropolitana di Torino) attraverso l’aggregazione di 6 Dipartimenti, di cui 2 già situati a Grugliasco (Scienze Agrarie, Forestali e Alimentari, Scienze Veterinarie) e 4 attualmente collocati a Torino (Chimica, Fisica, Scienze della Vita e Biologia dei Sistemi, Scienze della Terra).

Questo documento mette in luce i principali benefici e i molteplici effetti derivanti dalla realizzazione del progetto.

In primo luogo si sottolinea come le attività istituzionali dell’Università (ricerca, didattica e terza missione) potranno integrarsi efficacemente con le potenzialità di sviluppo derivanti dalla vicinanza di 6 Dipartimenti, per arrivare a creare un centro scientifico di eccellenza, innovativo e competitivo.

Un centro attrattivo per imprese, potenziali investitori e stakeholder strategici (come autorità locali, altre università, istituti di ricerca etc.) - che abbia un impatto significativo nel sistema socio-economico e culturale - a livello locale, nazionale e internazionale.

L’aggregazione in un unico polo creerebbe un “contesto ideale e fecondo” di ricercatori, docenti, tecnici e studenti che provengono da campi di studio diversi: nuove possibilità di cooperazione e interazione, nascita di collaborazioni strategiche per progetti di ricerca e programmi interdisciplinari, sviluppo di strategie di ricerca e obiettivi comuni per massimizzare i risultati e incoraggiare la raccolta di finanziamenti, condivisione di strumenti tecnici e laboratori all’avanguardia.

La definizione di questi possibili scenari si lega allo stato attuale dei 6 Dipartimenti coinvolti nel progetto: la seconda parte del documento presenta infatti una descrizione analitica di ciascuno di essi, con informazioni su didattica e ricerca, coinvolgimento in progetti nazionali e internazionali, collaborazioni con le imprese, creazione di start-up e spin off, deposito di brevetti. Lo scopo di quest’analisi dettagliata è di fornire un quadro complessivo di riferimento (anche in un’ottica comparativa), mettendo in luce le best practices già esistenti e che possono essere ulteriormente sviluppate.

La parte conclusiva del documento propone infine alcune linee di sviluppo di potenziali filoni di ricerca comuni ai Dipartimenti, prefigurando possibili prospettive e previsioni derivanti dalla condivisione delle risorse nella Città delle Scienze.



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English version

The document is finalized to support the project “Città delle Scienze” promoted by the University of Turin, whose main goal is to build up a new scientific hub in the territory of Grugliasco (Turin area). The hub will include 6 Departments, out of which 2 are already located in Grugliasco town (Agricultural, Forest and Food Sciences and Veterinary Sciences) and 4 are currently situated in Turin city center (Chemistry, Physics, Life Sciences and Systems Biology, Earth Sciences).

This document shows the main benefits and the multifaceted impacts deriving from the project’s implementation.

Firstly, the traditional University institutional activities (research, training and third mission) would benefit from the territorial proximity between the 6 Departments, as this aggregation would translate into an innovative and competitive scientific center of excellence. It would attract the interest of enterprises and companies, potential investors and strategic stakeholders (i.e. local authorities, other universities, research institutions etc.) - with a relevant impact on the socio-economic and cultural system - both at a local, national, and international level.

The aggregation would create an ideal and fruitful context for researchers, teachers, technicians and students belonging to different fields. As a matter of fact, new opportunities of cooperation would be opened, strategic partnerships for research projects and interdisciplinary programs would be built up and joint research strategies would be set-up to maximize results and encourage financial investments, thanks to the sharing of advanced and up-to-date labs and technical instruments.

Secondly, the expected outcomes of the project are strictly linked to the current state of the involved Departments. The second part of the document is therefore devoted to describe each of them, providing information about teaching and research activities, involvement in national and international research projects, collaborations with companies, creation of start-ups and spin-offs and deposit of patents. The purpose of this detailed analysis is to provide a comprehensive reference framework (in a comparative perspective) to highlight both the existing best practices and what could be further developed and enhanced.

Lastly, the conclusions indicate possible development paths and common research drivers to be followed, outlining perspectives and foresight resulting from the resource pooling of *Città delle Scienze*.



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Città delle Scienze

Scientific and strategic project for the establishment of a new University Campus in Grugliasco

This document outlines the project for the constitution of the ***Città delle Scienze***, a campus of the University of Turin to be built in the outskirts of Turin, in the territory of Grugliasco, where two of its large Departments are already located.

The campus would include **Department buildings, common teaching facilities and accessory services for students and for businesses related to the University mission**. This document describes the main drivers and motivations of the project, the Departments involved and their activities.

Introduction

University, territory and innovation

The project for the settlement in Grugliasco of a **new scientific hub** is an attempt to create an ideal context for the development of potential synergies between the already existing Departments of:

- a. Agricultural, Forest and Food Sciences
- b. Veterinary Science

and the scientific Departments now based in Turin, namely:

- c. Chemistry
- d. Physics
- e. Life Sciences and Systems Biology
- f. Earth Sciences.

The idea of setting-up a new sciences hub comes from the deep conviction of the positive effects that a unique and shared site of research, teaching, start-up and company activities could have in the socio-economic and cultural system. It could generate great benefits in terms of innovation for the Piedmont Region, the metropolitan area of Turin and the host city, Grugliasco.

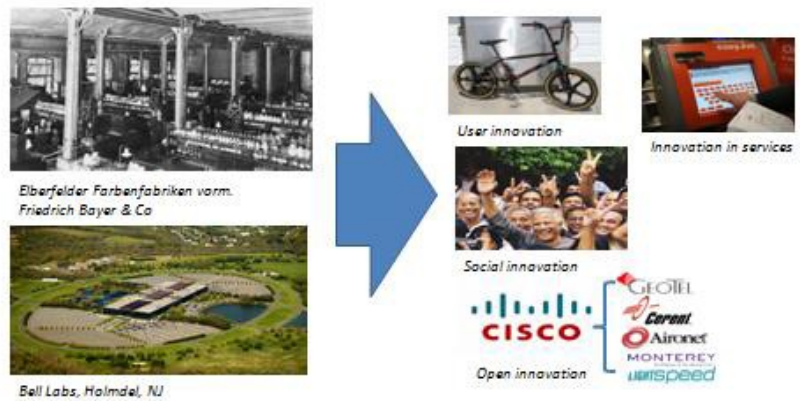
In terms of the *contribution of universities to business innovation*, Professor Emeritus John Goddard of the Innovation Charity NESTA¹ points out that the way innovation takes place is changing. We are moving from a linear model to a co-production model, which highlights the important role of users, service, open and social innovation. (2015).

¹ For more information, please visit www.nesta.org.uk.



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The way we innovate is changing

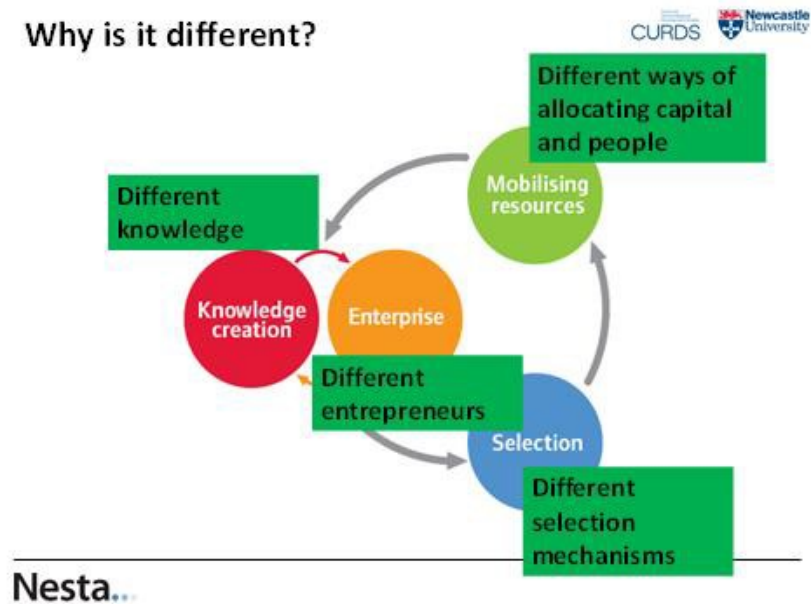


Nesta..

Figure I

The new model for innovation involves a wider range of knowledge inputs, additional entrepreneurs and different selection mechanisms and ways to allocate capital and people for projects.

Why is it different?



Nesta..

Figure II



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In this framework, the role played by convergent objectives between University and local institutions could be strategic and play a key role in social innovation, knowledge dissemination and economic impact.

It should also be taken into account that the Universities are called on to redefine their social role, and rethink themselves under the different following dimensions (Goddard 2016):

1. Be **actively engaged** with the wider world as well as with the local community of the place in which they are located
2. Take a **holistic approach** to engagement, seeing it as an institution-wide activity, not confined to specific individuals or teams
3. Have a strong **sense of place**, recognising the location's role in forming the identity of the institution
4. Have a **sense of purpose**, understanding not just what they are good at, but also what they are good for.
5. Be **willing to invest** in order to have impact beyond the academy
6. Be **transparent and accountable** towards their stakeholder and the wider public
7. Use **innovative methodologies** such as social media and team building in their engagement activities with the world at large.

All of these aspects are legible in Città delle Scienze project, and in the next paragraphs, they are converted in reasons, values and strong points to support the project.

Reasons for supporting the project

Strategic objectives of such aggregation

The main objective of the *Città delle Scienze* is to foster **efficiency, attractiveness and competitiveness** of the University of Turin scientific Departments **in the fields of research, teaching and industry collaboration**, through the exploitation of synergies and resource pooling.

As a consequence, such developments may strengthen the **Third Mission activities** of the University of Turin, giving a wider impact to the generation, use and application of knowledge and other university capabilities outside academic environments in the fields involved.

We can examine the main objective more in depth, by way of example, to give evidence of the different benefits the aggregation can lead to.

Efficiency

- Allow an efficient use of shared teaching and research facilities and of administrative and technical services
- Promote **interdisciplinary programs**, integrated activities and publications
- Increase forms of **interaction and cooperation** with companies, territorial agencies, research



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institutes, universities and other strategic stakeholders (e.g. Regione Piemonte, Area Metropolitana, Comune di Grugliasco), keeping up the existing ones

- Find common **research strategies** between the Departments in order to maximize the results

Attractiveness

- Create an **attractive environment for companies, investors** (including foreigners) and new talented researchers
- Host entrepreneurial activities within the **research facilities**
- Show the results to highlight the added value of interdisciplinary projects in order to **increase financial investments** (e.g. EU or regional funds)

Competitiveness

- Create a **Research Centre of excellence** that could become an international reference in these fields of Science
- Develop and strengthen the Research through the use of **advanced and updated labs and instruments**
- **Industrialize research** results and foster industrial assignments.

Benefits of such aggregation

The aggregation in a hub of sciences merges and concentrates the efforts of its affiliated Departments and helps them to become more competitive in Research, Academic activities, Third Mission, partnerships and external collaborations.

The hub increased efficiency in bringing together and managing outstanding resources creates an effective **critical mass** that makes it highly competitive in taking on innovative research projects.

The hub can be considered as a group of researchers working together and sharing resources and efforts for common objectives.

In Research Activities

Nowadays science has become more complex, so it is very hard for individual researchers to develop Knowledge “products” that answer all the questions the society poses to them. Strengthening interdisciplinary, collaborative and curiosity-driven research initiatives is the starting point to lead to innovations, new developments and solutions to social problems. Hubs are useful to advance promising areas of research from the earliest stages to the point of commercialization, involving multidisciplinary teams to develop and deliver high- profile science projects.

Promoting **synergies** and **integration** across the sciences determines a better understanding of the social needs and therefore an improved ability to find practical solutions. On the other hand, integration between different Departments fosters the combination between basic and applied research, in order to accelerate scientific discovery related to critical issues and societal challenges.

Regarding the **use of structural and instrumental endowments**, we can also find space to make efficiency: *Città delle Scienze* aims to gradually integrate and aggregate all the activities, tools, laboratories, facilities, databases and networks of the scientific Departments.



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An extraordinary pool of **technical and instrumental resources, core facilities and advanced research labs** would be available to a broader base of potential users (one example among others: the instrumental equipment of the Dept. of Chemistry now dispersed on two locations², would be accessible also to the research groups of Agricultural Sciences and Systems Biology).

Focusing on the **local scientific community**, we can highlight the hereunder-significant benefits of the project *Città delle Scienze*:

- **High quality of research** guaranteed by strong and **daily interconnections** between researchers, faculty and students, which would promote fruitful synergies between different scientific disciplines, Departments and fields of research, with a consequent increase of scientific collaborations, maximization of research outputs, easier and faster dissemination of the scientific results
- **Increased sustainability and functionality** of the new research infrastructures set-up for the Grugliasco Campus and of those already developed by the DSV and DISAFA; increased role and effectiveness of the inter-departmental centres
- **Sharing of infrastructures, technological equipment and experimental facilities** (buildings, rooms, laboratories, common spaces etc.) to guarantee efficiency and reduce the expenses of the University
- Creation of a new generation of scientists trained in a collaborative and dynamic research environment
- Promotion of the **local research internationalization** – merging international research networks, promoting mutual interconnections between researchers and fostering international mobility programs.

In Academic Training

Città delle Scienze may also have positive effects on the academic training side both in the planning phase and in daily teaching moments: **proximity of spaces and rooms** helps teachers and students to make a more efficient use of time, classrooms and the expensive teaching laboratories.

Sharing a common area has also positive impacts on the **educational offer**, making it easier to organize parallel Degree courses, Master and Doctoral programs, Summer Schools, educational events, etc. improving **multidisciplinarity and interdisciplinarity** activities.

Furthermore, sharing classrooms and infrastructures in one single Campus would increase the attractiveness for students and researchers, making it easier to reach it with public transport.

Focusing on the features of University of Turin, we can highlight some significant benefits of *Città delle Scienze* aggregation project:

² Buildings in Via Pietro Giuria (TO) and Via Quarello (TO), approx. 9 km apart.



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- **Increased visibility**
- **Reduced fragmentation** of human, economical and research resources
- **Rationalization** of both teaching and research activities – avoiding overlapping courses and promoting interdisciplinarity
- **Improved attractiveness** of University of Turin
- **Increased interaction** towards other local Universities (Politecnico di Torino, Università degli Studi del Piemonte Orientale Amedeo Avogadro etc.).

Third Mission

The Departments are also involved in activities of Third Mission. In this perspective, they are committed to communicating and disseminating knowledge through a **direct relationship with the region and with all its stakeholders**. The third mission enhance the knowledge of scientific discoveries through different activities:

- Production of patents and the management of intellectual property rights
- Application of research and/or consultancy for third parties, organizing periodic training courses for technical staff of companies and research institutions
- Creation of spin-off companies
- Increasing "public engagement" and museum activities.

Città delle Scienze may benefit the regional, national and international business community and may support initiatives in the development of technology transfer, providing relevant opportunities for the **academic and industrial spheres**, in order to take advantage of their mutual interaction.

Imagining social and economic positive impacts on the local territory, we can highlight some significant benefits of the *Città delle Scienze* aggregation project:

- Increased number of **collaborations with local direct stakeholders** and beneficiaries thanks to the services provided by *Città delle Scienze* (e.g. analytical laboratories, kennel, vet ambulatories, slaughterhouse etc.)
- Creation of **new networks** between local actors with complementary skills and roles
- **More public engagement** activities
- **Development of the metropolitan area** and promotion of the Piedmont competitiveness
- **Creation of jobs**, new businesses and positive economic impact on the area.

Partnerships and collaborations

Technologies can move to the private sector by bringing together leading scientists to collaborate on critical challenges and making opportunities to connect them with the local industry.



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The hub can act as a **‘match-making’ service** between companies and researchers, connecting the Departments’ research potential, expertise and resources with the local industries and institutions (agencies etc.).

This form of partnership can be a model of how academic institutions and industry can work together to deliver better answers to global science challenges.

Concerning the collaboration between the University and the private sector (also SMEs) we can highlight some significant benefits of the *Città delle Scienze* aggregation project:

- **Better understanding of the technological innovation needs** of the territory and consequent strengthened network between local companies and the University
- **Better interaction** between pure research, applied research and production for the market
- Fostering the development of applied research (market-driven) in order to **enable local SMEs** to get quickly results for their economic growth
- Development of **university-industry relations**
- **Raising of the technological quality** of the local enterprises
- **Technical assistance** to companies and organizations.

Policy convergences

The research areas of the Departments involved in the project reflect the policy priorities defined by the **2015-2020 National Program for Research**³. They are also in line with the policy behind the European Union Program for Research and Innovation **Horizon 2020**.

This means that the University of Turin shares the international and national strategy according to which common problems should be solved by collective efforts.

Indeed, a **challenge-based approach** will bring together resources and knowledge across different fields, technologies and disciplines. This will cover activities from research to trade with a new focus on innovation-related activities carried out to face the following **social challenges**:

1. Health, demographic change and wellbeing;
2. Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy;
3. Secure, clean and efficient energy;
4. Smart, green and integrated transport;
5. Climate action, environment, resource efficiency and raw materials

³ More information is available at http://www.istruzione.it/allegati/2016/PNR_2015-2020.pdf.



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As Figure III shows, they perfectly match with the main impact areas of the involved Departments.



Figure III: Areas of impact of the “Città delle Scienze” project.

Present day successful research and innovation activities transcend the traditional boundaries among disciplines (Chemistry, Physics, Biology, etc.) and grow through interactions and connections among them.

Each of the involved Departments is active in several of the above fields, though multidisciplinary research and a network of collaborations which encompasses the **academia and other public agencies of all sizes**, as shown in Figure IV. The final section of the present document (“Achievements, Perspectives and Foresight”) builds on these problem-driven competences of the Departments.

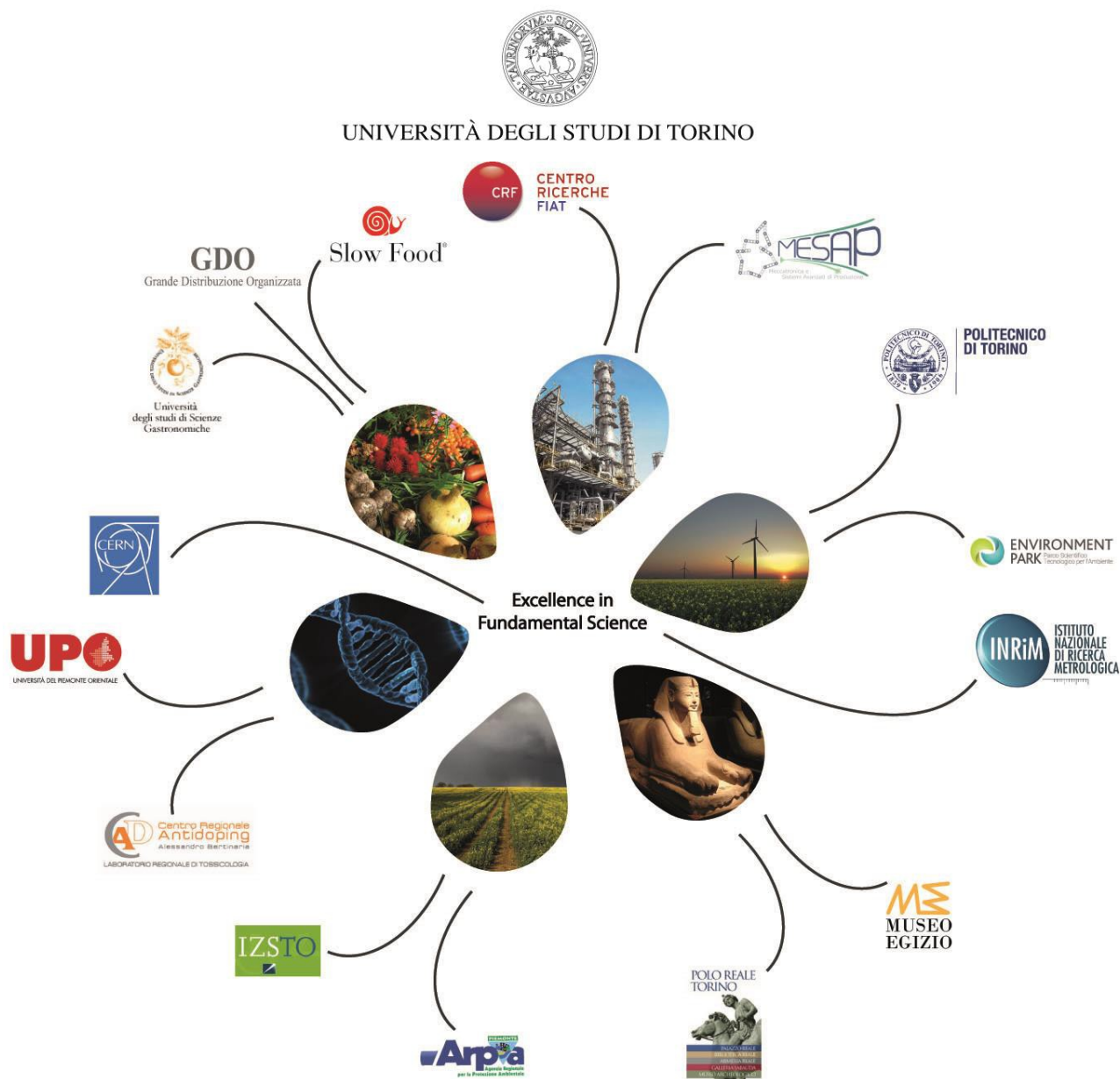


Figure IV: *Examples of existing collaborations with regional institutions.*

From the match of these two aspects, we can provide evidence, through some examples, of the **cross-cutting competencies of the Departments** involved in the *Città delle Scienze* Project, as shown in the figure shown below (Figure V).



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Cross-cutting competencies of the Departments





Impact Departments	Land, Environment & Resources	Agri-Food	Biology & Health	Materials. Chemicals and Manufacturing	Energy	Cultural Heritage
AGRICULTURAL, FOREST AND FOOD SCIENCES 	Agriculture, biomass production, landscape	Food production, sustainability, food engineering economics and management	Food&health	Agricultural machinery, food plants, packaging for food products. Chemicals for crop protection	Biomass production, energy from agro-wastes	Traditional food and agriculture
VETERINARY SCIENCES 	Agricultural ecosystems	Food production, sustainability, food economics and management, animal welfare, food safety	One health, Food Safety	Livestock Equipments, Biomedical materials		Traditional food and breeding, Diagnostic techniques, History of sciences
CHEMISTRY 	Pollution control and remediation, chemistry of resources, recycling, soils, waters and atmosphere	Food chemistry, phytochemistry	Biological chemistry	Materials science and technology; chemical industry, nanotechnology	Bioenergy, energy from wastes, solar energy	Diagnostics and restoration
PHYSICS 	Models of land, water and atmospheric systems	Modeling of climate impacts on agriculture	Biophysics and Physics applied to Medicine	Materials Science and technology, nanotechnology	Energy systems modeling	Diagnostic techniques
LIFE SCIENCES AND SYSTEMS BIOLOGY 	Ecology mycology, microbiology	Food biochemistry, food microbiology	Development biology, fundamental cellular biology	Natural based bioactive products	Bio-energy	Microbiology of natural materials
EARTH SCIENCES 	Natural and water resources, land management, natural risks, landscape engineering	Soils and water dynamics		Natural materials, artificial materials from geo-resources		

Figure V: Department/Areas of impact matrix



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Furthermore, in 2009 the Piedmont Region set up 12 Innovation hubs in the territory- the so called “***Poli di innovazione***”- both in traditional sectors as well as in high-tech sectors, in order to support the competitiveness of SMEs, in different domains. Some of them fit perfectly with *Città delle Scienze* project, particularly:

- **Agrifood**
- Bio-Technologies & Bio-Medical, **BiopMed**
- **Sustainable Chemistry**
- New Materials - **Innomat**
- Renewable Energy & Bio-Fuels - **Polibre**
- **Renewable Energy Systems & Components**
- Renewable Energy & Mini-Hydro Plants - **Enermhy**
- Textile - **Po.in.tex**

Again, we can see that the positive outcomes of the integration of the Departments perfectly fits with the strategic areas and priorities identified by the **Piedmont Regional Strategy Policy (S3)**.⁴

⁴ For more information, please visit http://opens3.regione.piemonte.it/cms/dwd/S3_draft_piemonte.pdf.



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Unito, numbers and main results

State of the art of UniTo participation in competitive funding programs

Since 2007 the UniTo researches belonging to the prospected Città delle Scienze have engaged in more than **400 national and international research projects** for an overall income of **49,6 million Euros** in the following research areas: energy, environment, food, life sciences, nanotechnologies, etc.

Participation in EU and international projects

Considering the 7th EU Framework Programme (**FP7**), UniTo-Città delle Scienze researchers were involved in **45 projects** (out of 115 of the entire UniTO) for an overall funding of about **10 million Euros**. Within **H2020**, UniTo Città delle Scienze reserachers are currently involved in **11 projects** (out of 42) for an overall income of almost **3 million Euros**. Worth mentioning also about **30 projects funded by other European funding programmes** such as CIP (Intelligent Energy Europe), the Joint Technologies/Programming Initiatives (JPI Facce, JPI Water), as well as transversal programmes concerning cross-cutting activities (networking, dissemination, piloting, best practices) such as Interreg Alcotra, Interreg Alpine Space, COST and Life+ for almost **4 million Euros**.

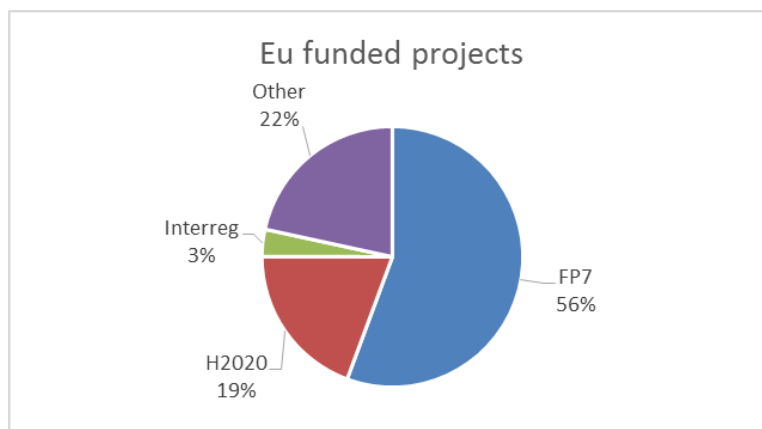


Figure VI: *European funded projects since 2007, from a budget perspective.*

All research activities funded by the European Commission (and its Directorates-General) are **collaborative research projects** in which the interdisciplinary approach, the involvement of local authorities, companies and policy makers are essential factors. All projects have a substantial impact on the territory in terms of economic and social benefits: resources were invested in research and development, patent and prototyping activities, business incubation but also exchange of best practices,



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training, collaborations with companies and local authorities, contributing substantially to the growth of the Piedmont ecosystem.

The chart below provides a snapshot of the European funds received by Unito Città delle Scienze researchers from 2007 up to November 2016, according to the thematic areas that correspond to European priorities (**Energy, Environment, Food, Life Sciences, Nanotechnologies and raw materials, Transport as well as other funded project on Public Engagement**).

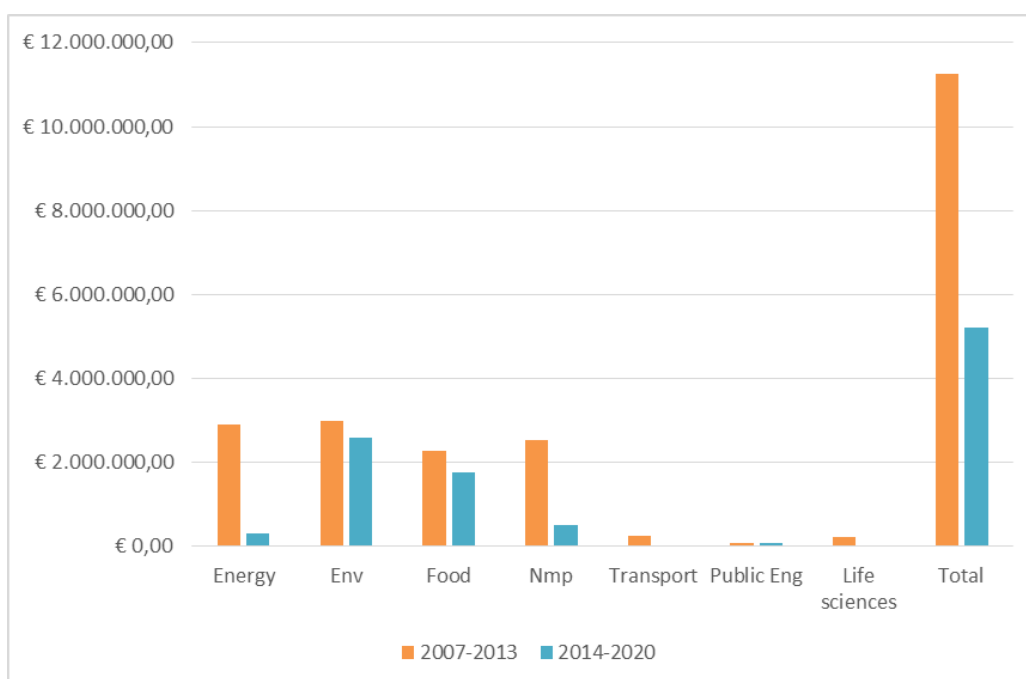


Figure VII: European funded projects in FP7 and H2020 with a perspective on budget and European priorities.

UniTo Città delle Scienze researchers **coordinate 20 projects in all the priorities** mentioned above, that includes both collaborative (just to mention the most relevant from the budget perspective, the Agroinnova EMPHASIS and PLANTFOODSEC in the food priority, SSH2S in energy etc.) and mobility projects (i.e. VitriMetTech in nanotechnology, ALPINE FRAGMENTATION in environment etc.). Worth mentioning is also a project coordinated by the Department of Agricultural, Forestry and Food Sciences in the frame of the Life+ programme.

The Department of Physics also participates in a project funded through the European Research Council (ERC) in the FP7 (BIHSNAM, Bio-inspired Hierarchical Super Nanomaterials). Of particular relevance also a COST Network titled STREAM (Strigolactones: biological roles and applications) coordinated by the Department of Chemistry.

In november 2016, the consortium **FoodConnects**, in which UniTo participated since its establishment in 2015, turned out to be the winner of the international selection for the establishment of a new Knowledge and Innovation Community (KIC) on Food funded by the European Institute of Innovation and Technology (EIT). The KIC will be fully operational from 2017 and over the next seven years, the 50 partners will invest close to 1.2 billion euros matched with up to 400 million euros financed by the EIT.



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Its mission is to empower a trusted multi-stakeholder community that includes best-in-class research institutions & educators, market-leading businesses, technology innovators, advanced farmers and consumers. Together they aim at a fundamental transformation of the food system to meet the global demands of present and future generations.

In general, the chart shows that in the first two year of the new programming period (2014-2020), UniTO has been funded for a total amount equal to one half of the previous one (2007-2013). This gives a sign of an increasing capacity of the University to attract resources at international level, to create winning transnational partnerships, and to be competitive in an international context.

Participation in national and regional projects

At the **national** level, **353 grants for projects** were awarded in the period 2007-2016 to Unito Città delle Scienze Departments for an overall income of **32,6 million Euros**.

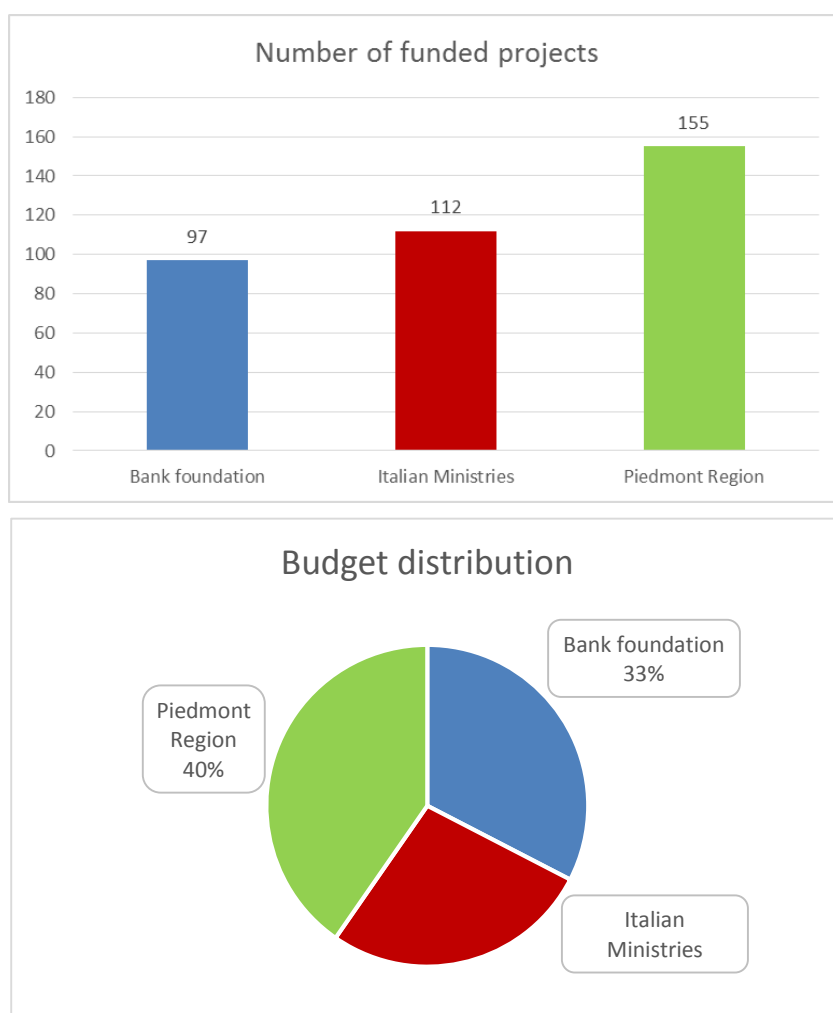


Figure VIII: Number of projects funded by national/regional entities and budget distribution.



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In particular, both the highest number of **national grants** and the highest **income** (43%) comes from the **Piedmont Region** with **144 projects** for more than **13 million euros**.

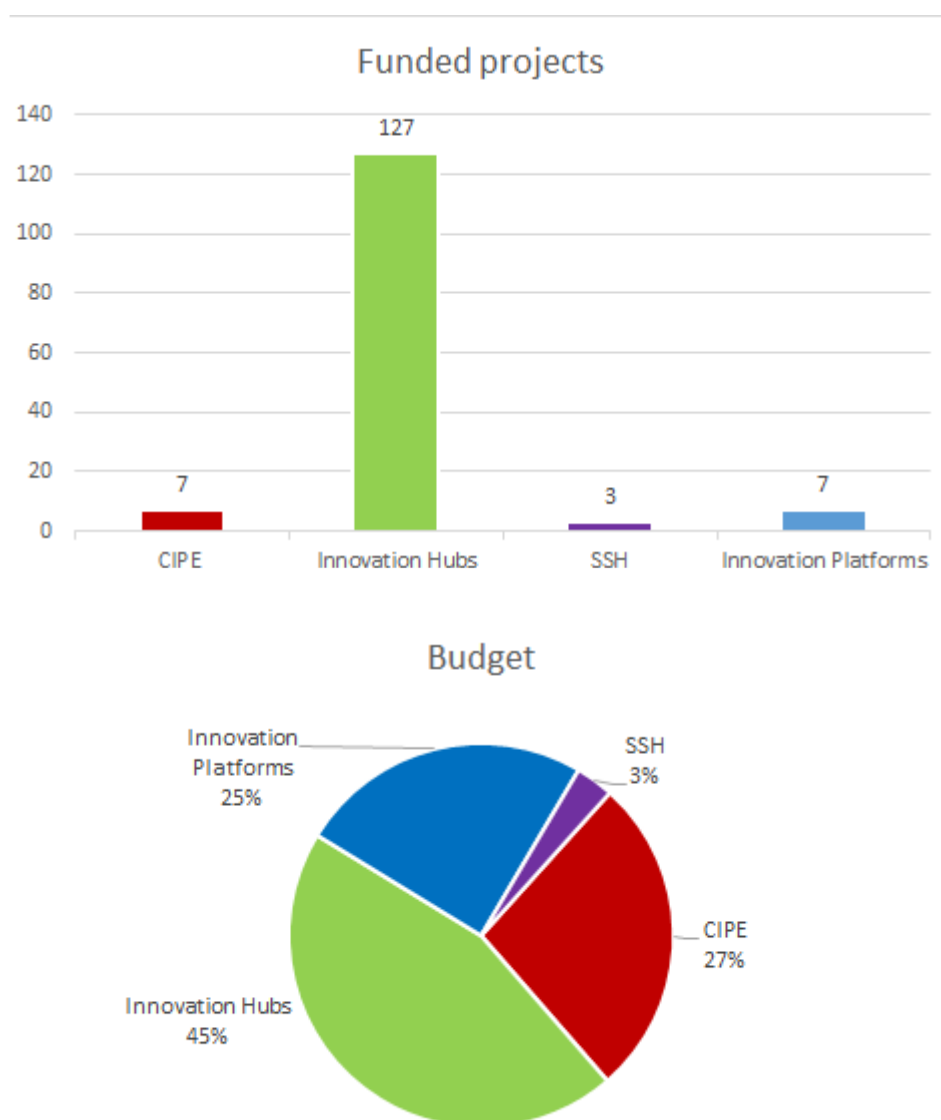


Figure IX: Number of projects funded by Piedmont Region and budget distribution.



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In this framework, the Departments involved in *Città delle Scienze* have implemented 127 projects within the call “*Poli di innovazione/Innovation Hubs*” in cooperation with Piedmont companies.

Innovation Hub projects 2007-2013

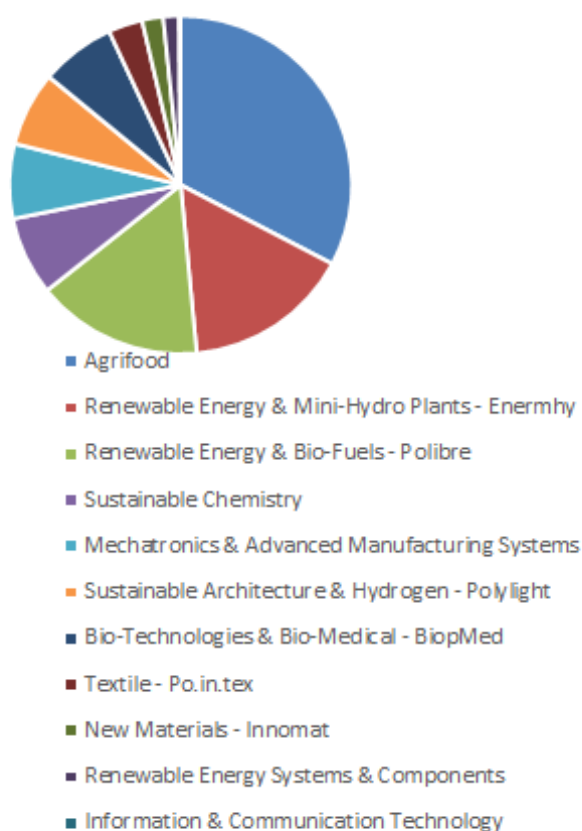


Figure X: *Projects distribution in Innovation hubs.*

Considering the thematic areas in which UniTO is involved at national level, the following chart offers evidence of the allocated budget. The highest income derives from **Food** area (26%) followed by **Life Sciences** (20%), **Nanotechnology** (14%), **Environment** (14%), **Sciences** (14%) and **Energy** (8%) areas.



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Funding for scientific area

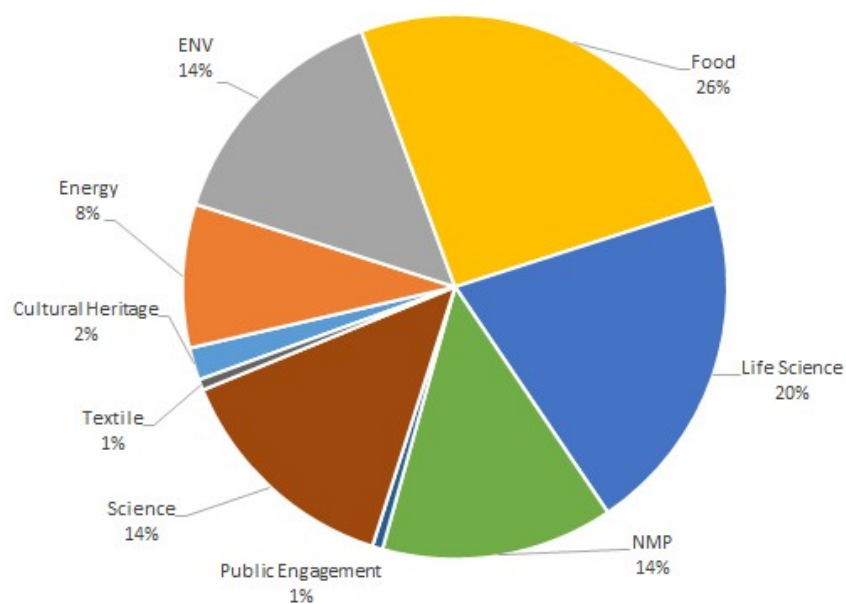


Figure XI: *National projects, scientific areas of applications.*

Considering specifically the Life Science area, most projects (19 out of 27) are related to basic health research (e.g. animal health, drug delivery, new material for diagnosis etc.) while the remaining ones are basic food research (i.e. cellular and molecular mechanisms of plants).



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Highlights of UniTo Third Mission activities

Given to the amplitude and potential relevance of the topic as a whole, this document will only highlight a selection of UniTo Third Mission activities, limited to those concerning the application and exploitation of knowledge generated by academic staff.

Patents and Technological Transfer

Professors and Researchers of the Departments involved in the *Città delle Scienze* pole have demonstrated a good inclination to patent their discoveries. Over the time frame 2006-2015, 80 patent applications have been submitted by UniTo academic staff. The following figure shows information on the scientific domains of such patents.

Departments	N.Patents
AGRICULTURAL, FOREST and FOOD SCIENCES	9
VETERINARY SCIENCE	10
CHEMISTRY	29
PHYSICS	3
LIFE SCIENCES AND SYSTEMS BIOLOGY	29
Total	80

Figure XII



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State of the art of UniTo industrial and institutional collaborations

Particularly intense interactions have occurred between UniTo and a number of industrial and institutional partners, roughly accounting for an income of **almost 7 million Euros** solely for the **year 2014**, not considering scientific partnerships within competitive funded projects.

Departments	Commercial	Institutions (excluding competitive grants)	Total Income
AGRICULTURAL, FOREST and FOOD SCIENCES	2.545.164,25	48.150,00	2.593.314,25
VETERINARY SCIENCE	1.896.942,23	124.202,72	2.021.144,95
CHEMISTRY	1.024.315,99	186.704,36	1.211.020,35
PHYSICS	88.105,46	260.670,08	348.775,54
LIFE SCIENCES AND SYSTEMS BIOLOGY	502.997,47	184.155,00	687.152,47
EARTH SCIENCES	79.280,86	17.000,00	96.280,86
Total	6.136.806,26	636.727,16	6.773.533,42

Figure XIII: *Economic revenue of industrial and institutional collaborations in 2014.*



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UniTo “Spin-Off” companies

The Departments belonging to the *Città delle Scienze* pole have developed **20 spin-off companies in the last decade (2006-2015)**⁵. Since 2007, UniTo has set up a business incubator (2i3T - www.2i3t.it) that has generated 48 start-up companies. The table below shows the fields in which they work.

Departments	N. Companies
AGRICULTURAL, FOREST and FOOD SCIENCES	5 <i>(1 in collaboration with Chemistry)</i>
VETERINARY SCIENCE	3
CHEMISTRY	4 <i>(1 in collaboration with DISAFA)</i>
PHYSICS	4
LIFE SCIENCES AND SYSTEMS BIOLOGY	2
EARTH SCIENCES	2
Total	20

Figure XIV

⁵ For details and more information, please refer to the section dedicated to the Departments.



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Bibliometric parameters

(source SCIVAL)

Bibliometric parameters have become an important part of modern assessment of academic productivity. These parameters exist for the purpose of evaluating authors and journals. One of the most reliable sources to make comparative analyses is SciVal, an analysis tool based on a worldwide bibliographic database.

Below we present some data and trends of the University of Turin in the past years using SciVal.

	2011	2012	2013	2014	Overall
Città delle scienze	1.063	1.139	1.262	1.144	4.608

Figure XV: Overall number of publications in the period 2011-2014.

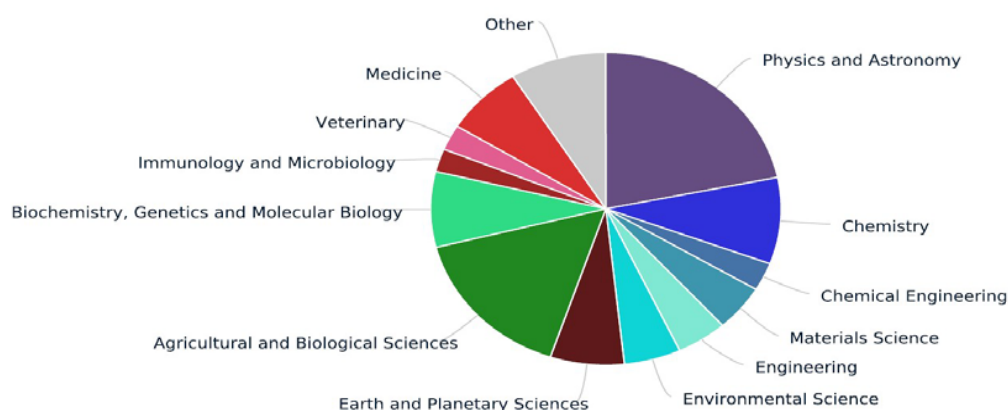


Figure XVI: Publications by Subject Area.

	2011	2012	2013	2014	2015	Overall
Città delle scienze	49,2	52,7	47,8	47,6	49,1	49,3

Figure XVII: Percentage of papers that are published in the top 10% of the most-cited journals.



Evaluation metrics are designed to facilitate cross-institutional benchmarking globally by ensuring that research management information can be compared with confidence. Some parameters, called Snowball metrics, have been defined and agreed upon by research-intensive universities and are used, in SciVal, in order to perform comparisons.

Here, we present two of the most meaningful indicators to make comparison.

- **Outputs in Top Percentiles (snowball metric)** which are the publications of a selected entity that have reached a particular threshold of received citations. In particular, this metric indicates how many publications are in the top 10% of the most cited publications.

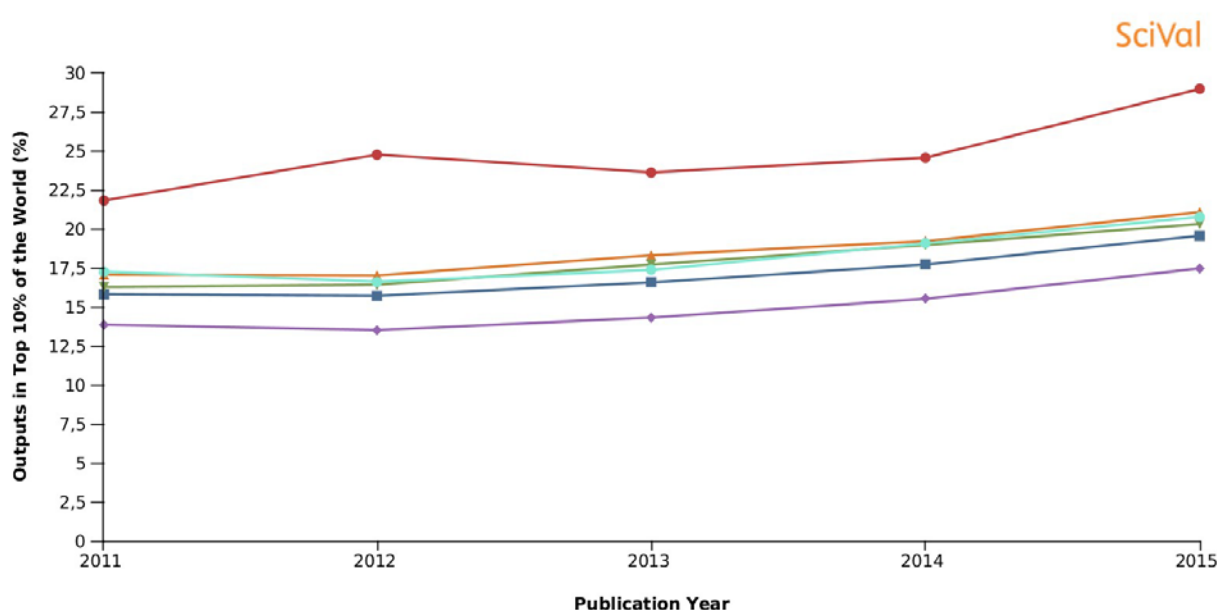


Figure XVIII: *Outputs in Top 10 of the World vs. Publication Year.*

Chart Legend

—●— Città delle Scienze [Group of Researchers] —●— EU28 - European Union [Group of Countries] —■— France [Country]
—▲— Germany [Country] —▼— Italy [Country] —◆— United Kingdom [Country]

Metric Details

y-axis: **Outputs in Top 10% of the World (In top 10% of World, %)**

Types of publications included: all. Self-citations included: yes. Field-weighted: no

x-axis: **Publication Year**



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- Publications in Top Journal Percentiles (snowball metric) which are the set of an entity's publications that have been published in the world's top journals. In particular, this metric indicates how many publications are in the top 10% of the most-cited journals.

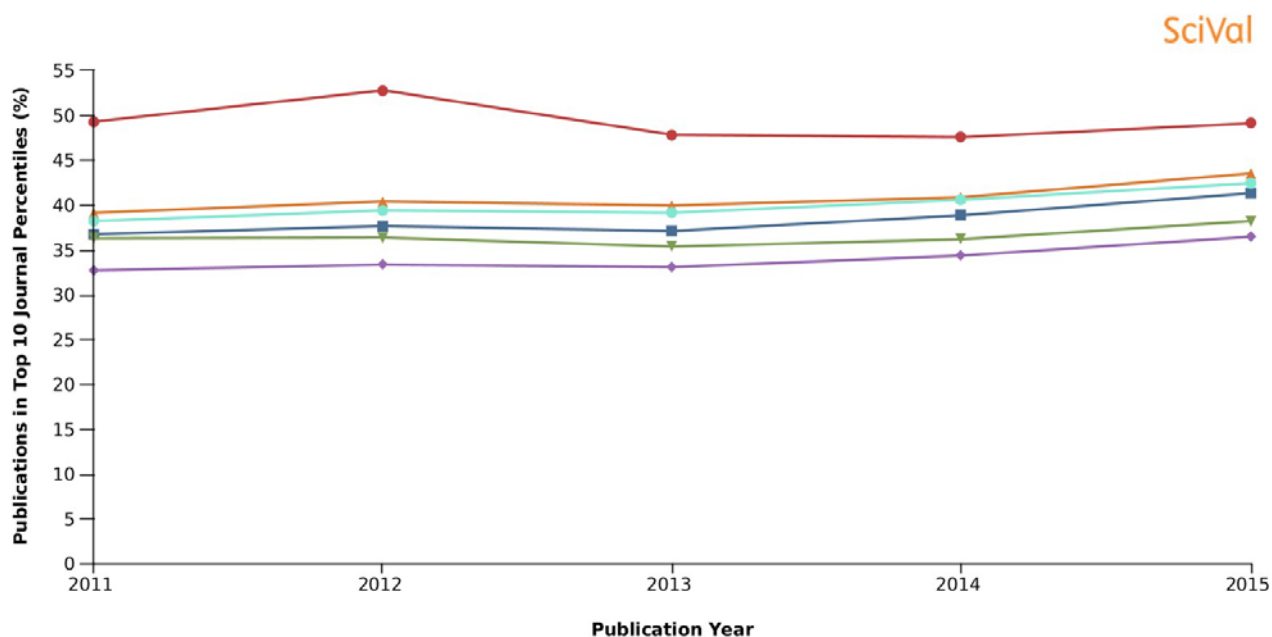


Figure XIX: Publications in Top 10 Journal Percentiles vs. Publication Year.

Chart Legend

—●— Città delle Scienze [Group of Researchers] —◆— EU28 - European Union [Group of Countries] —■— France [Country]
—▲— Germany [Country] —▼— Italy [Country] —○— United Kingdom [Country]

Metric Details

y-axis: **Publications in Top 10 Journal Percentiles (In top 10% of Scopus Sources, %)**

IPP. Types of publications included: all.

The percentage of the Publications in Top Journal Percentiles is calculated using only the publications that have a SNIP, SJR or IPP value.

x-axis: **Publication Year**



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The “Città delle Scienze” Departments hosts 27 Researchers out of the 100 “Top Italian Scientists”, as shown in figure XX:

Macro-Area	Number of Top Italian Scientists
CHEMISTRY	9
NATURAL & ENVIRONMENTAL SCIENCES	2
PHYSICS	16
Total	27

Figure XX: According to VIA-Academy (evaluation of Top Italian scientists & academics using Google Scholar database) there are 27 authors belonging to Città delle Scienze Project in the Top Italian Scientist Ranking. Source: VIA-Academy.

Publications: some highlights from the Departments

1. J. Adam et al. (ALICE Collaboration). Precision measurement of the mass difference between light nuclei and anti-nuclei **Nature Physics** 11 (10): 811-814 (2015)
2. An extremely bright gamma-ray pulsar in the Large Magellanic Cloud **Science** 350 (6262): 801-805 (2015)
3. V. Khachatryan et al. (CMS Collaboration & LHCb Collaboration). Observation of the rare $B_s^0 \rightarrow \mu^+ \mu^-$ decay from the combined analysis of CMS and LHCb data, **Nature** 522, 68–72 (2015)
4. Combined Measurement of the Higgs Boson Mass in pp Collisions at $\sqrt{s}=7$ and 8 TeV with the ATLAS and CMS Experiments, **Physical Review Letters**, 114, 191803 (2015)
5. S. Chatrchyan et al. (CMS Collaboration). Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC, **Physics Letters B** 716 (1): 30–61 (2012)
6. CMS Physics Technical Design Report, Volume II: Physics Performance **Journal Of Physics G** 34, 6 (2007)
7. M. Cirelli et al. Minimal dark matter, **Nuclear Physics B** 753 (1), 178-194 (2006)
8. H. Falcke et al. Detection and imaging of atmospheric radio flashes from cosmic ray air showers **Nature** 435, 313-316 (2005)
9. F. Barbero et al. Ants Make Distinctive Sounds that Are Mimicked by a Butterfly Social Parasite. **Science**, 323 , 5915 : 782- 785 (2009)
10. F. Neri et al. Dnmt3L Antagonizes DNA Methylation at Bivalent Promoters and Favors DNA Methylation at Gene Bodies in ESCs. **Cell** 155, 1: 121-134 (2013)
11. R.M Quam et al. Early hominin auditory ossicles from South Africa **PNAS (Proceedings of the National Academy Of Sciences) of the United States Of America**, 110, 22 : 8847-8851 (2013)
12. S. Sandrone et al. Weighing brain activity with the balance: Angelo Mosso's original manuscripts come to light. **Brain** 137: 621-633 (2014)
13. P. Accornero et al. Met Receptor Acts Uniquely for Survival and Morphogenesis of EGFR-Dependent Normal Mammary Epithelial and Cancer Cells **Plos One** 7: e44982-e4494 (2012)



14. L. Ferreri et al. Pattern of Tick Aggregation on Mice: Larger Than Expected Distribution Tail Enhances the Spread of Tick-Borne Pathogens **Plos Computational Biology** 10: 1-12 codice ISSN: 1553-7358 (2014)
15. E. Cattaneo & L. Bonfanti. Therapeutic potential of neural stem cells: Greater in people's perception than in their brains? **Frontiers In Neuroscience** 8: 1-3 (2014)
16. F. Riccardo et al. CSPG4-specific immunity and survival prolongation in dogs with oral malignant melanoma immunized with human CSPG4 DNA **Clinical Cancer Research** 20: 3753-3762 (2014)
17. M. Raule et al. PA28ab Reduces Size and Increases Hydrophilicity of 20S Immunoproteasome Peptide Products **Chemistry & Biology** 470-480 (2014)
18. F. Ferrini et al. Morphine hyperalgesia gated through microglia- mediated disruption of neuronal Cl⁻ Homeostasis **Nature Neuroscience** 16: 183-192 (2013)
19. F. Ferrini and Y. De Koninck. Microglia Control Neuronal Network Excitability via BDNF Signalling **Neural Plasticity** 2013: 1-11 (2013)
20. D.J. Klionsky et al. Guidelines for the use and interpretation of assays for monitoring autophagy **Autophagy** 8: 445-544 (2012)
21. L. Battaglia et al. Solid Lipid Nanoparticles for Potential Doxorubicin Delivery in Glioblastoma Treatment: Preliminary In Vitro Studies. **Journal Of Pharmaceutical Sciences** 103: 2157-2165 (2014)
22. S. Gligorovski et al. Environmental Implications of Hydroxyl Radicals ([•]OH) **Chemical Reviews**, 115, 24, 13051-13092 (2015)
23. A. Rimola et al. Silica Surface Features and Their Role in the Adsorption of Biomolecules: Computational Modeling and Experiments **Chemical Reviews**, 113, 6, 4216-4313 (2013)
24. T.M. McDonald et al. Cooperative insertion of CO₂ in diamine-appended metal-organic frameworks **Nature**, 519, 7543, 303 (2015)
25. M. Chiesa et al. EPR Characterization and Reactivity of Surface-Localized Inorganic Radicals and Radical Ions **Chemical Reviews**, 110, 3, 1320-1347 (2010)
26. F. Reineri et al. Use of Labile Precursors for the Generation of Hyperpolarized Molecules from Hydrogenation with Parahydrogen and Aqueous-Phase Extraction **Angewandte Chemie. International Edition**, 50, 32, 7350-7353 (2011)
27. D. Rubatto et al. Yo-yo subduction recorded by accessory minerals in the Italian Western Alps. **Nature Geoscience**, 4(5), 338-342 (2011)
28. P.M. Benson et al. Laboratory simulation of volcano seismicity. **Science**, 322 (5899), 249-252 (2008)
29. M.E. Alfaro et al. Nine exceptional radiations plus high turnover explain species diversity in jawed vertebrates. **PNAS (Proceedings of the National Academy of Sciences) of the United States of America**, 106(32) 13410-13414 (2009)



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The Departments

The following section collects the main data on the Departments involved in the “Città delle Scienze” project.

Department	Professors	Associated Professors	Assistant Professors	Post-docs	PhD Students	Technicians	Administrative staff
Agricultural, Forest and Food Sciences	21	40	49	46	62	51	41
Veterinary Science	19	29	45	6	35	48	25
Chemistry	16	29	34	28	68	24	26
Physics	21	32	26	33	75	19	13
Life Sciences and Systems Biology	9	22	25	12	46	33	21
Earth Sciences	3	25	20	10	25	16	11

Figure XXI: *Personnel actually involved in the Departments (2015 updated)*



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Department of Chemistry - DHC

1. The scientific objective of the Department of Chemistry at “Città delle Scienze”

The scientific contribution of the Department of Chemistry to the project “*Città delle Scienze*” is fostering and strengthening the MULTIDISCIPLINARITY and the **INTERDISCIPLINARITY OF RESEARCH** through a VISION of CHEMISTRY as a **CONNECTING DISCIPLINE**. In fact, Chemistry is a global science and CHEMICAL RESEARCH is rapidly expanding in a way that transcends traditional boundaries between disciplines and industrial sectors. Chemistry Department promotes the transition from linear to circular economy, making our city a more competitive and sustainable place to live. Department’s industrial outputs have high-valued **ECONOMIC BENEFITS** also beyond the chemical industry (e.g. increasing manufacturing productivity and products quality and safety, reducing industrial waste etc.) and also transform our everyday lives for the better. Chemical scientists are in fact designing drugs that improve human health, building diagnostics to enhance the efficiency of healthcare, revolutionising materials, developing new clean-energy technologies for a smart, sustainable and inclusive growth, supporting industry to improve production processes for tackling the challenge of an increasing global consumption of non-renewable resources.

2. The Department

The Department was established in 2012 as a result of the recent innovation of the Italian University system. Its **STAFF** includes about **250** professors, researchers, technicians and administrative employees. The doctorate students and post-doc researchers are about one half of the staff.

2.1. Research Activities

Research funding and activities: a total budget of around 6M€ per year is managed by the Department of Chemistry. Main funding sources are the private sector (>1M€ for 2014) and EU (0.5M€ per year, average in the last 10 years). In particular, the research activities are focused on the following topics:

- Chemistry for Advanced Materials and Nanomaterials
- Chemistry for Agrochemical and Food
- Chemistry for Environment
- Chemistry for Health and Life Sciences
- Chemistry for Energy
- Chemistry for Cultural Heritage

Main Research outputs: new knowledge is the primary product of chemical research but **COMMERCIALIZING AND LICENSING TECHNOLOGIES** that arise from basic research in the chemical sciences are non-negligible aspects of the work carried out by scientists at the Department. Besides high-ranking scientific publications (see Bibliometric parameters section), the Department’s performance is considerable also as regards the strong and raising connection with international and local **INDUSTRIAL PARTNERS**, as well as the participation in **HIGH-TECH OPEN LABS** to support SMEs in designing and performing complex experiments to realize dramatic gains in innovation and productivity.



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2.2. Teaching activities

Teaching activities at the Department of Chemistry involve about **1.500 students** organized in: bachelor's degrees, master degrees and PhD studies. The courses are designed to provide basic education in the plurality of chemical disciplines but above all to allow the GRADUATES EMPLOYMENT IN A VARIETY OF INDUSTRIES AND SERVICES, where chemistry represents a key enabling technology, responding to the needs of key sectors of the economy with wide implications at the regional and national levels.

Bachelor degrees: the Department delivers two Bachelor's degrees which provide students with the basic knowledge in inorganic, organic, physical, analytical, industrial, materials and biological chemistry from a theoretical to a practical point of view. The CHEMICAL IMPLICATIONS on the environment, the sustainable development, the "green chemistry" and the legislations related to chemical substances are also studied.

Master degrees: the Department delivers five specialized master degrees in both chemical and materials sciences with the aim of providing students with an advanced background on designing innovative scientific and technological solutions in a variety of chemical products and processes. MULTIDISCIPLINARY COMPETENCE on biology, biochemistry, pharmacy, physical, geophysical, toxicological and legislative fields is guaranteed. Private chemical companies as well as research institutes and consultancy services, can profit from the generated knowledge. The graduate students stand out for the elevated professional competence ON SOPHISTICATED INSTRUMENTAL TECHNIQUES and the scientific and technical rigour in the EVALUATION OF THE LEGAL IMPACT OF HUMAN ACTIVITIES AND BEHAVIOURS. The degree courses consider THE INDUSTRIAL SELECTION AND USE OF MATERIALS, both in relation to the environment and to production in the European context. An educational Erasmus-Mundus program for the use of large scale facilities in Materials Science is active at present, with the possibility of internships in foreign research laboratories.

PhD courses: the Department's PhD program aims to train creative and competent scientists in the field of chemical sciences and technologies, through the ANALYSIS AND STUDY OF SCIENTIFICALLY RELEVANT PROBLEMS both in fundamental and applied science.

2.3. Prestigious International Awards and Honors

Agency	Member of the Department
Academy of Europe - Chemical Sciences Section	Prof. S. Bordiga
Alexander von Humboldt-Foundation	Prof. E. Giamello

Figure XXII



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2.4. Facilities and Equipment

The Department of Chemistry and individual research groups collectively maintain a MULTI-MILLION EUROS INVENTORY OF STATE-OF-THE-ART INSTRUMENTATION that is constantly being updated. In addition, it is worth to mention the recent joint acquisition (2016) of two 600 MHz NMR spectrometers. Below the major ones:

- **Synthesis Facilities** (organic homogeneous and heterogeneous catalysis, green chemistry processes, purification and a complete characterization of all the new synthesized compounds, low temperature and inert atmosphere reactions, dewars, chiral HPLC -analytical and semiprep, Chemical Vapor Reactions - CVR, high power X ray source for synthesis and post-synthesis treatments, green chemistry processes, target oriented synthesis, equipment for low temperature and inert atmosphere reactions).
- **Vibrational and Electronic Spectroscopies** (more than 40 vibrational and electronic spectrometers, including FTIR, micro-FTIR, Raman and confocal micro-Raman; the electron microscopy facility is equipped with an UHR-TEM (300 kV) equipped with an X- ray energy dispersive spectrometer (X-EDS), a variable pressure SEM also equipped with EDS system and a conventional SEM with EDS microanalysis etc.).
- **Magnetic Resonance Spectroscopies** (6 liquid/solid NMR and 4 EPR spectrometers including a 600 MHz NMR and a Pulsed EPR/ENDOR Spectrometer operated at 9.5 and 35 GHz)
- **X-ray diffraction** (5 state-of-the-art instruments for single crystal and powder diffraction analysis are operated under standard and special configurations, including different anticathodes, parallel beam technique, rotating capillary stage, flat spinner and Schultz goniometer. Low and high temperature devices are available).
- **Separation and analytical Techniques** (i.e. more than 30 chromatographic systems - MPLC, HPLC, GCMS, LC-MS, ionic, and electrophoretic chromatography, 4 ICP-MS/AAS, and a dozen calorimetric and thermogravimetric including TGA, also on-line with FTIR and GC-MS, adsorption calorimetry. Scintillator counters for α , β and γ emitting radioisotopes are also available).
- **Computational Facilities** (2 large arrays of computer work stations -14, 24 and 74 knots)
- **Teaching Laboratory Facilities** (material characterization including DSC, FTIR, TGA, and BET and liquid-state NMR systems are available to undergraduate students during lab courses).

2.5. Collaborations with industries

The overall number of industrial collaborations of the Department is currently more than **50 ongoing contracts**. The collaboration with industries has further improved in 2016 reaching an overall budget of about 2 M€.

2.5.1. Patents

Researchers affiliated to the Department have developed a good attitude to patent their discoveries. In



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the period 2010-2015, 26 patent applications have been submitted (4 patents per year on average).

2.5.2. SPIN-OFF and START-UP companies

Research activities and projects developed at the Department of Chemistry resulted also in the establishment of spin-offs of the University of Torino. The mission and main features of 3 of them are listed in the following table:

Company	Description	Website
STRIGOLAB SrL	Synthesis and distribution of organic molecules, including strigolactones analogues	www.strigolab.eu
TitaC	Preparation, characterization and application of TiO ₂ nanomaterials for photocatalytic and photovoltaic uses and of sustainable carbon-based materials	www.titac.it
TwoCare	Proprietary oxide-based dental implants	www.twocare.it

Figure XXIII

2.5.3. Ongoing major industrial collaborations with companies

The industrial collaborations of the Department reflect the wide ranging contribution of chemistry to a diversified array of industrial sectors. Among the main industrial contractors we cite:

Company	Field	Website
Aziende chimiche riunite Angelini Acraf	Pharmaceutical	www.angelini.it/wps/wcm/connect/it/home
CENTRO RICERCHE FIAT S.C.P.A.	Automotive	www.crf.it
ENEL	Energy	www.enel.it
ITINERA	Infrastructure Construction	www.itinera-spa.it
ITT Italia S.r.l.	Automotive	ittmotiontechnologies.com/Home/
RSA S.r.l.	Environmental remediation	www.rsa-srl.it
SPEA ingegneria europea S.P.A.	Infrastructure construction	www.spea-engineering.it

Figure XXIV



Very relevant for the Department scope and budget are also the collaborations with SMEs often catalyzed by the “**Poli di Innovazione**” regional innovation initiative. The Department provides SMEs research support, feasibility studies and complex measurement services.

2.5.4. Ongoing major scientific collaborations with territorial agencies

Agency	Field	Website
ALPS Enterprise Europe Network	Business and innovation	www.to.camcom.it/ALPS
ARPA Piemonte	Environment	www.arpa.piemonte.gov.it
ARPA Val d'Aosta	Development of innovative methods for the quantitative determination of asbestos	www.arpa.vda.it
Centro Regionale Antidoping	Analytical & Forensic Toxicology - Clinical Chemistry	www.antidoping.piemonte.it
Environment Park	Environment	www.envipark.com
INRIM - Istituto Nazionale di Ricerca Metrologica	Metrology	www.inrim.it
WHO/IARC - International Agency For Research on Cancer	Participation in the writing of several IARC Monographs on the Evaluation of Carcinogenic Risks to Humans	www.who.int/ionizing_radiation/research/iarc/en/

Figure XXV



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Department of Life Sciences and Systems Biology - DBIOS

1. The scientific objective of the Department of Life Sciences and Systems Biology at “Città delle Scienze”

The scientific contribution of DBIOS to the project “Città delle Scienze” consists in its HIGH-LEVEL RESEARCH EXCELLENCE in a wide range of areas in fundamental biology, together with specific **APPLICATIONS IN VARIOUS FIELDS**, from bio-nanotechnology, plant health, food sensors, global change, renewable energy, biodiversity and cultural heritage conservation. **STRATEGIC EXPERTISE IN COLLABORATION WITH INDUSTRY** is therefore developed.

2. The Department

DBIOS's STAFF includes 58 professors/researchers, 53 administration/technical staff, 37 PhD students and 14 Post-docs about 250 researchers. Other than the research scientific laboratories, the Department also encompasses RESEARCH STRUCTURES OF NATIONAL INTEREST. These include the Botanic Garden, part of the University of Turin Museum networks – It hosts a collection of about 2500 plant species (Orto Botanico, <http://www.ortobotanico.unito.it>) and a collection of about 6000 fungi (<http://www.mut.unito.it>). The collection works according to the ISO 9001 standards and is recognized at international level (ECCO and WFCC). The collection joins the Microbial Resource Research Infrastructure (MIRRI) to provide facilitated access to high-quality microorganisms.

Moreover, since 1950 a group of **CNR** researchers have been working closely with the staff and Professors of this Department in the field of plant and fungal biology, despite having administrative autonomy. The collaboration is governed by agreements that define the mode of interaction and the physical presence of the CNR group in the University.

The following operational units: “UO1 FISIOLOGIA VEGETALE”, “UO 2 MICOTECA”, “UO3 LICHENOLOGIA” are certified Quality System according to the UNI EN ISO 9001: 2008 standard for the following fields of activities: research, design and development in the field of plant and fungal biology for industrial, food, environmental and cultural heritage applications.

2.1. Research Activities

DBIOS focus its INTERDISCIPLINARY RESEARCH ACTIVITY on a wide range of themes that are currently central in the international scientific debates, such as:

- Plant Biology and Health
- Food safety
- Food sensors and bio-nanotechnology
- Genetics
- Neuroscience
- Cardiovascular physiology
- Conservation of natural and cultural heritage from bio-indicators to biodiversity



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- Environmental sustainability
- Bioremediation and conservation based on the use of plants and fungi with their industrial and pharmaceutical applications
- Ethic of human-animal relationship

Research funding and activities: from 2013 to 2015 DBIOS has raised 0.8 M€ in research infrastructures, around 2 M€ in research projects from the EU and from national and regional funding agencies and around 1 M€ in external funding from third parties.

The research activities are focused on the following scientific areas:

- LIFE & HEALTH: cardiovascular biology, cell and molecular biology, health and environment, microbiology and virology, neurobiology, plant biology and interactions.
- BIOCHEMISTRY & BIOTECHNOLOGY: protein engineering and enzyme biotechnology, nanobiotechnology, natural products, nutrition and microbial biotechnology, renewable resources and green biochemistry.
- ECOLOGY & EVOLUTION: basic and applied ecology, basic and applied ethology, biodiversity and systematics, conservation biology and cultural heritage, evolutionary genetics and zoology, human evolution and environment interactions.

Main Research outputs: scientific article, patents, services and facilities

2.2. Teaching activities

DBIOS runs with an integrated and multidisciplinary approach 3 bachelor's degrees, 6 master degrees and 2 PhD courses in biological and natural sciences and biotechnology, including Food Science and Nutrition, with the contribution of colleagues of DISAFA, DSV, Earth Sciences, Chemistry and Physics Departments. A total of **3000 students** attend the Department with an annual recruitment rate of around 1000. In synergy with DISAFA, it organizes the master degree in Plant Biotechnology. Besides, DBIOS is strongly involved in international cooperation with developing *African Caraibic Pacific* countries through:

- a master joint title with the University of Comoros, and is beneficiary of EU edulink grants for Higher Education together with DISAFA
- the project EGALE "Gathering Universities for Quality in Education" Contract n. FED/2013/320-117 Programme de Coopération ACP-EU pour l'enseignement supérieur (EDULINKII) EuropAid/132023/D/ACT/ACPTPS.

Bachelor's degrees

- Biological Sciences (enrolled students 2015/16: 669)
- Natural Sciences (enrolled students 2015/16: 354)
- Science in physical education and sports (enrolled students 2015/16: 1376)



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Master Degrees:

- Cellular and Molecular Biology (enrolled students 2015/16: 122)
- Environmental Biology (enrolled students 2015/16: 117)
- Science and Sustainable Management of Natural System (enrolled students 2015/16: 32)
- Evolution of animal and human behaviour (enrolled students 2015/16: 89)
- Industrial Biotechnology (enrolled students 2015/16: 58)
- Food Science and Human Nutrition (enrolled students 2015/16: 42)

PhD courses:

- Biology and Applied Biotechnology
- Pharmaceutical and Biomolecular Sciences
- Neurosciences
- Complex Systems

2.3. Prestigious International Awards and Honors

Agency	Member of the Department
Accademia dei Lincei	Prof. P. Bonfante
American Society for Biochemistry and Molecular Biology	Prof. Sadeghi

Figure XXVI

2.4. Facilities and Equipment

Biochemistry/molecular biology equipment

- Liquid chromatography coupled with mass spectrometry (LC-MS) for the separation of non-volatile substances.
- Stopped flow system SF-61SX2/DX2 for the study of rapid reaction kinetics
- Bruker Model Tensor 27 FT-IR Spectrometer, FT-IR Microscope ATR Objectives for structural studies
- Plasma cleaner (Emitech K1050X), Glove box, single-channel e multi-channel potentiostat (Autolab + Software GPES3) for electrochemical measures of redox enzymes and electroactive analytes
- ÄKTA protein purification systems, PhastSystem electrophoresis for protein structure determination by x-ray crystallography
- Isothermal titration calorimetry and differential scanning calorimetry (Microcal iTC200) for the label-free in solution study of biomolecular interactions of small molecules, proteins, antibodies, nucleic acids, lipids and other biomolecules
- High performance DNA sequencing facility (NextSeq500 and MiSeq) with applications such as



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targeted gene sequencing, metagenomics, small genome sequencing, whole genome sequencing, targeted gene expression, amplicon sequencing, exome sequencing, RNA-Seq, ChIP-Seq

Microscopy

- Confocal Laser Microscopy
- Transmission electron microscopy
- Time-lapse Fluorescence Microscopy
- Time-lapse confocal microscopy imaging
- Live-cell imaging microscopy/MEA for multi-electrode array recordings
- Laser capture microdissection equipment (Leica Microsystems) useful in the fields of genomics, transcriptomics, proteomics, metabolomics

Climate chambers:

- MUT - *Mycotheca Universitatis Taurinensis* (fungal collection) - According to the Best practises about biosafety and biosecurity and Quality Management System, fungi are preserved in a restricted area (code controlled access) monitored by data logger where only authorized staff is allowed to enter. In this locked area, fungi are preserved in different conditions (cryopreservation in ultra-low temperature freezer, lyophilization and active growth) to guarantee their stability and long-term preservation.
- Field station - Research field station in the Primary Raining Forest of Maromizaha (Madagascar)

2.5. Collaborations with industries

The overall number of industrial collaborations of the Department is currently around 20 ongoing contracts. It has further improved in 2014-2015 reaching an overall sum of 0,8 M€.

2.5.1. Patents

Researchers affiliated to DBIOS have developed a good attitude to patent their discoveries. In the period 2010-2015, 28 patent applications have been submitted.

2.5.2. SPIN-OFF companies

Company	Description	Website
BIOSFERED S.R.L.	Plant extracts - biochemistry and analytical chemistry	www.biosfered.com
TwoCare	Proprietary oxide-based dental implants - Biomaterial	www.twocare.it

Figure XXVII



2.5.3. Ongoing major industrial collaborations with companies

Company	Field	Website
C.I.B.M.	Environment	www.cibm.it
Evergreenbios Srl	Biotechnology	www.evergreenbios.com
Ferrero Trading Luxembourg	Environment	www.ferrerocareers.com/luxembourg
FIAT POWERTRAIN TECHNOLOGIES	Environment	www.fptindustrial.com
GNOSIS S.p.A.	Biotechnology	www.gnosis-bio.com
ICR S.p.A.	Life and health	www.icrcosmetics.com
LAVAZZA SpA	Agrifood	www.lavazza.it
MEDA Pharma S.p.A	Life and health	www.medapharma.it
SEAcop S.r.l.	Environment	www.seacop.coop
Soremartec S.r.l.	Agrifood	www.ferrerocareers.com
TECNART s.r.l.	Cultural Heritage	www.tecnart.unito.it

Figure XXVIII

2.5.4. Ongoing major scientific collaborations with territorial agencies

Agency	Field	Website
ARPA Liguria	Environment	www.arpal.gov.it
ARPA Valle Aosta	Environment	www.arpa.vda.it
Ente di gestione area metropolitana di Torino	Environment	www.parchireali.gov.it
Ente di gestione delle aree protette delle Alpi Cozie	Environment	www.parchialpicozie.it
Ente di Gestione delle Riserve Pedemontane e delle Terre d'Acqua	Environment	www.riservepedemontaneterredacqua.it
Environment Park	Bioremediation - Environment	www.envipark.com
Fondazione Mach		www.fmach.it



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IPSP Istituto Protezione Sostenibile Piante	Environment	www.ipspp.cnr.it
ISPA UOS di Torino CNR		www.ispacnr.it/unita-territoriale-di-torino
ISPRA		www.isprambiente.gov.it
Istituto Zooprofilattico	Bioindicators - Life & health	www.izsto.it
Parco Natura Viva Garda Zoological Park S.r.l.	Environment	www.parconaturaviva.it
Protocollo di Intesa Aree Protette del Po Collina Torinese	Environment	www.parchipocollina.to.it
Regione autonoma Valle d'Aosta	Public Institution	www.regione.vda.it
Regione Piemonte	Public Institution	www.regione.piemonte.it
VIT-INNOVA Regione Autonoma Valle d'Aosta		www.regione.vda.it

Figure XXIX

In particular, the Department has a strong collaboration with the following Environment Parks:

- Ente Parco Nazionale Gran Paradiso
- Parco Fluviale Po e Orba
- Parco Naturale del Marguareis
- Parco Naturale delle Capanne di Marcarolo
- Parco Natura Viva Garda Zoological Park S.r.l.
- UIZA - Unione Italiana dei Giardini Zoologici e degli Acquari
- Parco Naturale Mont Avic
- Parco Regionale Alpi Cozie



UNIVERSITÀ DEGLI STUDI DI TORINO

Department of Physics - DIFIS

1. The scientific objective of the Department of Physics at “Città delle Scienze”

The role of DIFIS in the project “Città delle Scienze” is to contribute its HIGH-LEVEL OF RESEARCH EXCELLENCE in various fields of FUNDAMENTAL research, as well as specific expertise in various fields of APPLIED physics, from materials science to complex systems, which could be of interest for interdisciplinary research. Additionally, the Department can contribute a number of **RESEARCH INFRASTRUCTURES** that can be of joint interest for fundamental and applied research, including **HIGH-PERFORMANCE COMPUTING FACILITIES**, which are nowadays fundamental in any research field.

2. The Department

DIFIS consists of 80 professors/researchers and 35 administrative/technical staff, as well as about 30 postdocs and 45 PhD students. It works in close cooperation with many national and international universities and research centers, namely:

- Istituto di Fisica Nucleare (INFN)
- Consiglio Nazionale delle Ricerche (CNR)
- Istituto Nazionale di Astrofisica (INAF)
- Istituto Nazionale di Ricerca Metrologica (INRiM)
- European Organization for Nuclear Research (CERN)

2.1. Research Activities

Research funding and activities: a total budget of about 16 M€ was managed in the period 2012-2014 by DIFIS; (of which nearly 9 M€ dedicated to research). External funding in this period amounts to about 3.6 M€). The research activities are mainly focused on the following areas:

- Physics of fundamental interactions (theoretical and experimental)
- Astrophysics and astroparticle physics
- Physics of complex systems
- Environmental physics, geophysics and fluid physics
- Medical physics
- Solid-state physics
- Cultural heritage

Main Research outputs: the scientific output of the Department of Physics is characterized by a high percentage of excellent publications (about 80%) and corresponding values of research quality indicators, so that **DIFIS is in the top 5% on a national scale**. Among the large universities, it is ranked in second place overall after the University of Padua. Research has a vast international outreach.



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2.2. Teaching activities

Teaching activities are offered by the Department itself and the School of Natural Sciences. DIFIS also contributes to courses for secondary school teachers (Percorsi Abilitanti Speciali -PAS and Tirocini Formativi Attivi -TFA).

Bachelor's degrees in Physics, Optics and Optometry, Science and Technology of Materials, Preservation and Restoration of Cultural Heritage

Master degrees in Physics, Physics of Complex Systems, Materials Science, Materials science for Cultural Heritage.

PhD courses in Physics and Astrophysics, Chemistry and Materials Science, and Complex Systems for Life Sciences.

2.3. Facilities and Equipment

- **High-Performance Computing Cluster** to be installed in the Department in 2016 as part of the “Open Access Labs” initiative. The cluster will complement the current infrastructure provided by the Department together with the INFN Centro di Calcolo, which is part of the GARR network (the Italian Research & Education Network), and be accessible to other University Departments, as well as external users.
- **Linear Accelerator** (Linac Elekta SL 25 MV) installed in 2016 and dedicated 100% to research. It can be used as a monochromatic electron source at energies from 4 to 18 MeV, or as a gamma source, or can be modified to provide a confined thermal neutron field, providing applications in medicine, cultural heritage, material studies etc.
- **Hydrometeorological laboratory Turlab** is a 5m diameter tank that can rotate with periods ranging from 600 to 3 seconds. The tank can be filled up with any suitable fluid up to 75 cm. Stereographic camera equipment and a laser installed in the vertical sidewall can monitor the turbulent behavior of the fluid and reconstruct its 3D movement and turbulence. The main use of this laboratory is the simulation of the behavior of atmospheric fluid, using similarity theory, in different conditions that can be set up at the beginning of the experiment.
- **Meteorological station:** on the roof of the institute of physics is installed, since twenty years, a professional meteorological station that detects the main meteorological data: temperature, humidity, wind direction and speed, precipitation, pressure, solar radiation. The raw data are made available on the web
- **Solid State Physics Lab** including a x-ray photoelectron spectroscope for surface analysis, a thin film deposition system, systems for electronic characterization of semi and super-conductor materials, an Atomic Force Microscope, a new Clean Room (class 10000) for material processing



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(CVD oxidation, furnaces for thermal annealing), material micro-fabrication with a focused high-power pulsed laser and functional (electrical/optical) characterization

- **X-Ray imaging and thermoluminescence dating lab.** This equipment falls within the program "open lab": it is available to external users for a fee, and is included in the MESAP - Polo di innovazione della Meccatronica e dei Sistemi Avanzati di Produzione della Regione Piemonte - "Laboratorio in Rete" project.

2.4. Collaborations with industries

DIFIS's main focus is not on applied physics and therefore collaborations with industries are limited at the moment. However, a number of contacts and established collaborations exist, mainly in the field of Solid State Physics, Electronics, Medical Physics, Cultural heritage, Optics and Optometry. Not including contributions to PhD studentships, the total from private funding in the period 2012-2015 is about 175 k€

2.4.1. Patents

Researchers affiliated to the Departments of Physics have developed 3 patents, in the period 2010-2015.

2.4.2. SPIN-OFF companies

Company	Description	Website
DETECTOR	DE.TEC.TOR. designs, customizes and manufactures high precision particle detectors for on-line beam monitoring and daily quality assurance in advanced radiation therapy	www.detector-med.com
DIXIT	DIXIT builds medical applications, taking advantage of the latest web technologies	www.dixitsolutions.com
I-SEE	Radiation therapy, Detector Simulation and Design	www.i-seecomputing.com
TECNART	Diagnostics applied to Cultural Heritage	www.tecnart.unito.it

Figure XXX

2.4.3. Ongoing major industrial collaborations with companies

Company	Field	Website
Crisel Instruments	Solid State Physics	www.crisel-instruments.it
Federottica	Optics	www.federottica.org



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IREN	Didactical activities	www.gruppoiren.it
RAI	Signal processing	www.rai.it
SELEX GALILEO SPA	Electromagnetism	www.selexgalileo.com
Thales Alenia Space Italia S.p.A.	Materials science - Radiation protection	www.thalesgroup.com/en/italy/italy
Vishay	Solid State Physics	www.vishay.com

Figure XXXI

2.4.4. Ongoing major scientific collaborations with territorial agencies

Agency	Field	Website
ARPA Weather Centre Piemonte	Climate physics	www.arpa.piemonte.gov.it
ASL TO2	Radiation protection	www.aslto2.piemonte.it
Centro Conservazione e Restauro "La Venaria Reale"	Cultural heritage	www.centrorestaurovenaria.it
CNR Istituto per la protezione sostenibile delle piante	Radiation protection	www.ipsp.cnr.it
Deutscher Wetterdienst	Climate physics	www.dwd.de
FIAT Research Centre (CRF)	Solid State Physics	www.crf.it
INRIM	Radiation protection	www.inrim.it
Soprintendenza of Piemonte and Valle d'Aosta	Cultural heritage	www.sato-archivi.it

Figure XXXII



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Department of Agricultural, Forest and Food Sciences - DISAFA

1. The scientific objective of the Department of Agricultural, Forest and Food Sciences at “Città delle Scienze”

Within a holistic approach the scientific contribution of DISAFA to the project “Città delle Scienze” is to **INTERACT** with the other scientific Departments to find practical solutions to the 21ST CENTURY CHALLENGES specifically in the **AGRI-FOOD** (some of FAO Millennium Goals food production and transformation), **FOREST ECOSYSTEM** and **RENEWABLE ENERGY** sectors.

2. The Department

The DISAFA is currently the main Piedmont's research centre in the fields of agriculture, forest and Food Sciences. Its premises are based in the already working **Grugliasco Campus** which lies a few km outside of Torino and occupies an area of about 30 hectares. The total surface area of the Departmental space is 8000m² and the total area of research laboratories for analysis is 3400 m². Moreover, there is a specialized lab of Crop Protection Technology: 500 m² test centre for development and certification of sprayer machinery is active. The Department consist of 111 professors/researchers and 94 administrative/technical staff.

2.1. Research Activities

Research funding and activities: from 2013 to 2015 a total budget around 19M€ per year was managed by DISAFA.

The research activities are focused on the following areas:

- plant production and pathology
- food production and microbiology
- forest, natural resources and environment
- plant genetic
- agricultural and biosystems engineering

The main scientific objectives to be reached are:

- to produce food of improved quality and health by economically and environmentally sustainable advanced technologies and methodologies;
- to exploit and manage forest and agrarian environments to maintain biodiversity, promote ecological equilibrium, and preserve natural resources and landscape;
- to develop food technologies that build and maintain links between the land and agrarian products to enhance their value;
- to expand renewable energy utilization to tackle the challenges of climate change.

Main Research outputs: scientific articles, patents and spin-off, reports, extension services.



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2.2. Teaching activities

Inside the **Grugliasco campus**, the SAMEV (School of Agriculture and Veterinary medicine) has 26 classrooms with a seating capacity ranging from 15 to 300 places; most of them are in the main building. Students improve their practical skills in educational laboratories and experimental fields.

Bachelor's degrees in Agricultural Technology and Science; Forest and environmental Science; Food Sciences; Viticulture and Enology

Master degrees in Agricultural Science; Forest and Environmental Science; Food Sciences and Viticulture and Enology (European Consortium EMAVE); Animal Science; Plant Biotechnology; Park, Gardens and Landscape (inter-institutional agreement with the University of Genova)

PhD course: "Agricultural, Forest and Food Sciences" as part of the *Doctoral School of Sciences and Innovative Technologies*.

2.3. Facilities and Equipment

The number and the quality of DISAFA facilities have enormously improved since the de-location of the Department in the **Grugliasco campus**. The main facilities are:

- **Climate chambers** with 140 m², support experimental studies under environmentally controlled conditions.
- **Greenhouses** situated not only at the Grugliasco Campus (450 m²), but also at the experimental centres and farms.
- **Experimental Farms** situated in Tetto Frati (Carmagnola) with long-term experiments.
- **Open access lab** situated at the Grugliasco Campus equipped with IRMS and ICPMS.
- **Chemico-physical labs** situated at the Grugliasco Campus equipped with facilities for plant, soil and food analysis (LC-MS-MS, GC-MS, PCR, DGGE, FT-NIR, LDS-PCS, XRD etc.); specific labs for colloidal surface analysis and mineralogy; microbiology, food technology; genetic, plant physiology, plant pathology.
-

2.4. Collaborations with industries

The overall number of industrial collaborations is 180 reaching an overall sum of 3,8 M€. The following lists deal with the research contracts of major impact (2014-2015).

2.4.1 Patents

Researchers of DISAFA have developed 9 patents in the period 2006-2015.



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2.4.2. SPIN-OFF companies

Company	Description	Website
GRAPE	Activity in vineyard and oenology production	http://www.grapesrl.it/
HORIZON	Environmental service, soil bioremediation	http://www.horizon.to.it/
STRIGOLAB	Synthesis and distribution of organic molecules, including strigolactones analogues (with Chemistry Dpt)	www.strigolab.eu
UP TO FARM	Supply services and development of innovative products for the sustainable use of recyclable resources in agriculture	http://www.uptofarm.com/
AGRINEWTECH	A.N.T. – AgriNewTech Ltd is a spin-off of the University of Torino in the field of agricultural and environmental biotechnologies	http://www.agrinewtech.com/

Figure XXXIII

2.4.3. Ongoing major industrial collaborations with companies

Company	Field	Website
Danstar-Lallemand	Dry yeast	www.birramia.it/materie-prime-per-birra/lieviti/secchi/danstar.html
Basf Italia	Functional crop care	www.basf.com
Bayer Crop Science	Crop production and agro chemistry	www.cropscience.bayer.it
DOW Agriservice	Crop production and agro chemistry	www.dowagro.com
Syngenta	Crop production	www.syngenta.com
Soremartec-Ferrero	Agro food	www.ferrerocareers.com
Fontanafredda	Wine production	www.fontanafredda.it
Agriphar Italia	Crop production and agro chemistry	www.agripharitalia.it
Centrale del latte Torino	Food	http://centralelatte.torino.it/



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KWS Italia	Crop production	www.kws.it
Monterosa 2000	Tourism	www.monterosa-ski.com
SATAP	Motorway	www.satapweb.it
Bacardi-Martini B.V.	Beverage	www.martinierossi.it
CRPA	Agriservice	www.crpa.it

Figure XXXIV

2.4.4. Ongoing major scientific collaborations with local agencies

Agency	Field	Website
Regione Piemonte	Public Institution	www.regione.piemonte.it
Regione Liguria	Public Institution	www.regione.liguria.it
Regione Lombardia	Public Institution	www.regione.lombardia.it
Regione Valle d'Aosta	Public Institution	www.regione.vda.it
Turin municipality	Public Institution	www.comune.torino.it

Figure XXXV



UNIVERSITÀ DEGLI STUDI DI TORINO

Department of Veterinary Science - DSV

1. The scientific objective of the Department of Veterinary Science at “Città delle Scienze”

DSV can contribute to the **TECHNOLOGICAL INNOVATION** and **DEVELOPMENT OF LIVESTOCK ENTERPRISES, AGRI-FOOD, PHARMACEUTICAL** and **CLINICAL** facilities through training, science popularization and technical assistance.

2. The Department

DSV includes 93 full professors, associate professors and researchers, 73 administrative and technical staff and over 100 PhD students, fellows, contractors and interns. Noteworthy is the number of **AGREEMENTS WITH PUBLIC AND PRIVATE BODIES** through which the Department structures its scientific/cultural programme. These benefits go to applied research, as a **HUB OF TECHNOLOGICAL INNOVATION FOR THE COMPANIES IN THIS SECTOR**. It works in close cooperation with the ISPA · Institute of Sciences of Food Production.

2.1. Research Activities

Research funding and activities: a total budget around 27 M€ was managed in the last 3 years (2013-2015) by DSV, of which 16M for its research activities. The research ranges includes:

- animal health, husbandry and reproduction
- livestock products for human consumption and processing of animal products
- food safety, drugs and pollutants, impacts on the environment and human health, biosafety
- impact of livestock on the territory and the economy of agro-livestock enterprises.

Main Research outputs: Scientific articles, reports, patents.

2.2. Teaching activities

Bachelor's degrees

- Production and Management of Domestic and Wild Animals
- Biotechnology
- Risk Prevention in Work Environment

Master degree in Veterinary Medicine

PhD and post-graduation courses:

- Research Doctorate in Veterinary Science for Animal Health and Food Safety
- Postgraduate School in Bovine Clinics; Postgraduate School in Swine pathology; Postgraduate School in Inspection of food of animal origin; Postgraduate School in Animal Health and Animal Productions; Postgraduate School in Meat Hygiene and technology



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- Second level master in “Quality, food safety and sustainability of milk production chain”; Second level master in “Food Science, Technology and Human Nutrition - Michele Ferrero”.

2.3. Prestigious International Awards and Honors

Agency	Member of the Department
CIHR-Institute of Neurosciences, Mental Health and Addiction, Canada - Brain Star Award 2013	Prof. F. Ferrini

Figure XXXVI

2.4. Facilities and Equipment

Open access facilities:

- **RIA lab:** A RIA lab is equipped with beta and gamma counters for the measurement of radioactive isotopes and is authorized for the use of [³H], [⁴⁵Ca], [¹²⁵I], [³²P].
- **NGS Lab:** Recently, the Illumina MiSeq next generation sequencing platform has been obtained. All the researches belonging to the Department can access to this resource as well as all the University researches upon request.
- **Cell and molecular biology labs; histology, histochemistry and immunohistochemistry labs; food microbiology and food chemistry laboratories; physiology lab** (with electrophysiology, calcium imaging, FRET)
- **FACS labs**, haematology and clinical chemical lab; **immunology, virology, bacteriology, parasitology and mycology laboratories; reproduction lab** (embryo transfer, seminology)
- **Microscopy units** (optical, fluorescence, confocal, time-lapse, TEM)
- **MALDI-TOF lab**, protein chemistry and 2D electrophoresis labs
- **Necropsy rooms.**

The research activity and services are expressed also through the facilities of the **Veterinary Teaching Structure (SDSV)**. Services are provided by:

the clinical section:

- the University Teaching Hospital (including generic surgeries, the specialist clinics, the operating rooms, radiological diagnostics, MRI, CT, Admissions, ER).
- the Municipal Kennel of the City of Grugliasco with its Hospitality Therapeutic Center
- the Centre for Unconventional Animals (CANC)
- the Mobile Clinics.

the livestock and food hygiene section:

- The Teaching Farm



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- the Slaughter and Meat slicing plant, provided since 2009 with the CE stamp with the approval number G7U1Q, which conducts regular slaughtering activities and provides a slaughter service for experimental use.
- facilities for animal testing within the livestock area authorized by the Ministry of Health. The application scope of the experimentation involves also activities related to human medicine, not directly applicable in hospitals (e.g. bone implants, cardiovascular implants, etc.).

2.5. Collaborations with industries

The Department has a significant number of industrial collaborations: the following lists deal with the contracts of major impact.

2.5.1. Patents

Researchers affiliated to the Department have developed a good attitude to patent their discoveries. In the period 2008-2015, 10 patent applications have been submitted.

2.5.2. SPIN-OFF companies

Company	Description	Website
In3 Diagnostic	Diagnostic kits for the control of animal infectious diseases	www.in3diagnostic.com
Life and device	Service provider specialized in studies on cardiovascular implantable prosthesis, artificial organs and, more widely, on biological interfaces	www.lifeanddevice.com
SAFOOD	Laboratory analyses to certify food regulatory compliance or to identify illegal animal treatments with growth promoters.	www.safood.info

Figure XXXVII

2.5.3. Ongoing major industrial collaborations with companies

Company	Field	Website
Abington Park Veterinary Group	Ambulatory services and veterinary clinics	http://abingtonvets.co.uk
Agrolabo	Medical/pharmaceutical	www.agrolabo.it
AVAP Pinerolo	Ambulatory services and veterinary clinics	www.avap-pinerolo.it
Biraghi	Food	www.biraghi.it



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Bracco Imaging (Bracco Group) Research and Development	Medical/pharmaceutical	http://corporate.bracco.com/it-it/il-gruppo
Centrale del Latte di Torino	Food	http://centralelatte.torino.it
CEVA (France)	Medical/pharmaceutical	www.ceva.com
Clinica Veterinaria Nerviano	Ambulatory services and veterinary clinics	www.cvnsrl.it
Clinica Veterinaria Ponente	Ambulatory services and veterinary clinics	www.clinicaveterinariaponente.it
Clinica Veterinaria Roma Sud	Ambulatory services and veterinary clinics	www.veterinariaromasud.it
Conad	Large Retail Company	www.conad.it
Coop	Large Retail Company	www.e-coop.it
Esselunga	Large Retail Company	www.esselunga.it
Fatro	Medical/pharmaceutical	www.fatro.it
Ferrero – SOREMARTEC	Food	www.ferrerocareers.com/italy
Ferrero Mangimi	Livestock	http://mangimiferrero.it
Ferrero SpA	Food	www.ferrero.it
FullBrand	Brand Innovation	http://www.fullbrand.it/
General Motors Powertrain	Automotive	http://www.gmpowertrain.com/PowertrainOverview.aspx
Inalpi	Food	www.inalpi.it
Istituto Ricerche per le Tecnologie Agroalimentari	Medical/pharmaceutical	www.irta-ricerche.it
Lenti –RuggerSpA	Food	http://lenti.it
Merck	Medical/pharmaceutical	www.merck.it
Mondial Pet Distribution S.P.A	Livestock	www.mondialpetdistribution.com
MSD	Medical/pharmaceutical	www.msd-italia.it
Natural Code	Livestock	www.zooitaly.it
OASMIA (Sweden)	Medical/pharmaceutical	www.oasmia.com
Pharmalink international limited	Medical/pharmaceutical	www.nutraingredients.com
Raspini	Food	www.raspinisalumi.it



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Trackysat	Shipping companies	http://www.trackysat.com/
Sorin	Medical/pharmaceutical	www.livanova.sorin.com
Vetoquinol S.A	Medical/pharmaceutical	www.vetoquinol.com
Zoetis	Medical/pharmaceutical	www.zoetis.it

Figure XXXVIII

2.5.4. Ongoing major scientific collaborations with territorial agencies

Agency	Field	Website
Associazione Centro Cicogne e Anatidi	Zoo and parks	www.cicogneracconigi.it
Candiolo, Molinette, San Luigi, CTO	Hospital	
Centro di Riabilitazione Equestre Vittorio di Capua	Hospital	www.riabilitazionequestre.it
Centro Ippico Militare di Torino	Public institution	www.esercito.difesa.it
EDISU	Public institution	www.edisu.piemonte.it
Ente Parco Nazionale del Gran Paradiso	Zoo and parks	www.pngp.it/ente-parco
Istituto Europeo di Oncologia	Hospital	www.ieu.it
Istituto Ortopedico Rizzoli	Hospital	www.ior.it
Istituti Zooprofilattici Sperimentali	Public institutions	
Municipality of Grugliasco	Public institution	www.comune.grugliasco.to.it
Polizia a Cavallo di Torino	Public institution	www.poliziadistato.it
Regione Piemonte	Public Institution	www.regione.piemonte.it
Regione Valle d'Aosta	Public Institution	www.regione.vda.it
Safaripark	Zoo and parks	www.safaripark.it
Zoom	Zoo and parks	www.zoomtorino.it

Figure XXXIX



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Department of Earth Sciences - DES

1. The scientific objective of the Department of Earth Sciences at “Città delle Scienze”

The scientific contribution of the Department of Earth Sciences to the project “Città delle Scienze” is to foster increasing KNOWLEDGE ON GEOLOGICAL PROCESSES, occurring both at depth and surface of Planet Earth. From this, Earth scientists come to understand not only the planet's structure and history but also (by encompassing the fundamental interactions between land, life, water and air in making up the total Earth System) to help predicting and managing its future, in particular for:

- Sustainable use of ground water
- Risk assessment and mitigation of natural hazards
- Climate and environmental evolution
- Exploitation of natural resources.

2. The Department

DES, the reference Piedmont and Valle d'Aosta Department for Earth Sciences studies, is one of the eight Earth Sciences Departments of the Italian University system. Its research activity is focused on the study of the geological processes operating at different scale within the Earth system. Attention is devoted to the dissemination of the generated scientific and technological knowledge as well as to the practical applications to the economic and social system. DES consists of 48 professors/researchers and 27 administrative/technical staff. 24 PhD students and 10 post-Docs are currently active.

2.1. Research Activities

Research funding and activities: a total budget around 2.8 M€ was managed in the last 5 years (2011-2015) by DES for its research activities. In particular, the research activities are focused on the following topics:

- Earth Sciences
- Natural and Environmental Sciences
- Chemistry and Materials Science
- Cultural Heritage

Furthermore, DES is active in the areas of PE10 - Earth system science, ERC Panel including: Palaeontology, Analysis of sedimentary basins, Structural Geology and Tectonics, Physical Geography, Geology applied to preservation of land and environments and to the exploitation of natural resources, Environmental and applied Mineralogy, Petrography, Volcanology, and Geophysics.

Main Research outputs: scientific articles, geological and geothematic maps, services and facilities.

2.2. Teaching activities

Teaching activities at the DES involve about 275 students organized in: bachelor degrees, master degrees and PhD studies.



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Bachelor degrees:

- Degree in Geological Sciences
- Natural Sciences
- Sciences and Technology of Materials
- Chemistry and Chemical Technologies
- Techniques of Accident Prevention in the Workplace.

Master degrees:

- Science in Applied Geology
- Environmental Biology
- Science of Natural Systems
- Evolution of Animal and Human Behaviour
- Science and Technology of Materials
- Geography and Regional Science
- Cultural Heritage
- Conservation and Restoration of Cultural Heritage

PhD courses:

- Earth Sciences programme

2.3. Prestigious International Awards and Honors

Agency	Member of Department
American Mineralogical Society of America	Prof. Cámara Artigas

Figure XL

2.4. Facilities and Equipment

Open Labs:

- X-ray Powder Diffraction and X-ray Single-Crystal Diffraction Labs. The Labs perform investigations on the structure of organic, inorganic and metallorganic materials (from small-molecules to macromolecules) at high and low temperature.
- Scanning Electron Microscopy & Microanalysis (SEM-EDS) Lab. The Lab allows morphological observations/imaging, quantitative chemical analysis on polished samples and semiquantitative chemical analysis on unpolished/untreated samples of crystalline materials; spatial correlation image-analysis (Point & ID), and EDS compositional mapping.



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- Transmission Electron Microscopy & Microanalysis (TEM-EDS) Lab. The Lab allows crystallographic characterization and semiquantitative chemical analysis of nanoscale crystalline materials.

2.5. Collaborations with industries

The overall number of industrial collaborations of the Department is currently around 30 ongoing contracts.

2.5.1. SPIN-OFF companies

Company	Description	Website
AG3	Geothermal and natural resources sustainable planning, exploitation and management; remote sensing	www.ag3.unito.it
IMAGEO S.r.l.	GIS and Geomatic Laboratory; 3D geomechanic modelling; study and monitoring of landslides; photogrammetric surveys with drone helicopter	www.imageosrl.com

Figure XLI

2.5.2. Ongoing major industrial collaborations with companies (since 2012)

Company	Field	Website
Centro Servizi Lapideo S.c.p.A.	Geology and Geoengineering	www.csl-vco.it
Cristellotti e Maffei S.n.c.	Mineralogy, Cultural heritage	www.cristellottiemaffei.it
CRT	Mineralogy, geophysics, geology, hydrogeology	
Fassa Bortolo s.p.a.	Geology, Geo-engineering, geophysics,	www.fassabortolo.com



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Fondazione per la
Conservazione ed il
Restauro dei Beni
Culturali

Geology

www.centrorestaurovenaria.it

Pestarena s.r.l.

Ore Deposit studies, Geo-
engineering, environmental
geology

Società Apuana Marmi
(SAM srl)

Ore deposit studies, geo-
engineering

Theolab S.p.A.

Geology

www.theolab.com

Figure XLII

2.5.3. Ongoing major scientific collaborations with territorial agencies

Agency	Field	Website
AIPO (Agenzia Interregionale per il Fiume Po)	Geo-technical, Geo-mechanic	www.agenziainterregionalepo.it
ARPA Piemonte	Environmental geology	www.arpa.piemonte.gov.it
Associazione Ecomuseo dell'Anfiteatro Morenico di Ivrea	Geology	www.ecomuseoami.it
Associazione Micromineralogica Italiana	Mineralogy	www.amiminerals.it
ATO 5 (Territoriale Ottimale n.5 Astigiano Monferrato), Società Consortile SERVIZI IDRICI ASTIGIANO MONFERRATO S.I.A.M.	Hydrogeology and Environmental geology	http://ato5astigiano.it



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Camera Di Commercio Industria Artigianato Agricoltura Del Verbano Cusio Ossola	Geo-engineering	www.vb.camcom.it
CNR-IRPI	Geomorphology / Structural Geology	www.irpi.cnr.it
Comune di Tavagnasco	Geology	www.comune.tavagnasco.to.it
Comunità Montana Alpi del Mare	Geophysics	www.cmalpidelmare.org
Comunità Montana Bassa Valle di Susa	Geomorphology and geoheritage	www.cmbvallesusa.it
Consorzio Futuro in Ricerca	Geology	www.cieffeerre.it
Ente Parco Nazionale Val Grande	Geomorphology	www.parcovalgrande.it
PNGP Parco Nazionale Gran Paradiso	Geomorphology	www.pngp.it
Regione Autonoma Valle d'Aosta	Geo-engineering and geotechnics / Geomorphology/ Geology and Geophysics	www.regione.vda.it
Regione Piemonte	Hydrogeology and environmental geology / Energy	www.regione.piemonte.it

Figure XLIII



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InterDepartmental Centres

Being the Departments physically separated, several platforms for reaching ambitious scientific goals and supporting interdisciplinary and collaborative research activities have been created. Namely:

1. **NIS - Nanostructured Interfaces and Surfaces**

The NIS Centre merges the activities of about 90 researchers (permanent staff) working in the areas of Chemistry, Physics, Pharmacy, Biology and Earth Science, with a focus on **nanotechnologies of surfaces and interfaces**. The centre pursues mainly fundamental research in fields with high technological potential, but also applied research in collaboration with industries of all sizes. The NIS Centre operates both by supporting Departmental laboratories, and by managing its own shared laboratories, where Open Access to instrumentation and lab space is pioneered since 2003. The scope of collaborations and services offered is broad, ranging from experimental research programs to scientific support to technical management. NIS is running a large number of domestic and EU funded projects. It also organizes the nationally renowned series of “NIS Colloquia” seminars, informal and free meetings of high scientific profile.

2. **The Scansetti Center - InterDepartmental Center for the Study of Asbestos and Other Toxic Particulates**

It comprises 7 Departments covering different fields: Earth sciences, Petrology and Mineralogy; Chemistry & Material Science; Botany; Biology & Biochemistry; Biomedicine & Oncology; and Occupational Medicine. The Center is a reference in RESEARCH AND EDUCATION in the field of particle toxicology (asbestos, silica, PM, metal and metal oxides, and nanoparticles) and nanotoxicology, devoted to the ASSESSMENT OF THE IMPACT of nanotechnologies on HUMAN HEALTH AND THE ENVIRONMENT. It cooperates with many private companies through finalized scientific researches. Close cooperation is established with local and international institutions, including: Regione Piemonte, ARPA Piemonte, ARPA Valle d'Aosta, ARPA Liguria, INAL, ASL, ISPESL, International Agency for Research on Cancer –IARC; Canadian Health Ministry; International Life Sciences Institute-ILSI, USA, Eurosil, Belgium, Institut National de Recherche et de Sécurité –INRS, European Space Agency, ESA).

3. **CRISDI - InterDepartmental Center of Diffractometric Crystallography**

Its scope is to spread the knowledge about diffractometric crystallography, a crucial field for the development of many branches of scientific research related to chemistry, physics, geology, environment and biology. Its major objectives are:

- to spread the knowledge about diffractometric crystallography, an enabling technology for the development of many branches of scientific research related to chemistry, physics, geology, environment and biology;



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- to coordinate the access to state of the art diffractometric instruments at the University of Torino.

4. **RES VIVA - Interuniversity Research Centre on Epistemology and History of Life Sciences**

The Interuniversity Research Centre on Epistemology and History of Life Sciences was founded in 2006. Its main goals are:

- to support and promote disciplinary and interdisciplinary research on history and philosophy of life sciences, encompassing applied science issues;
- to promote joint projects and cultural exchanges with Universities, Research Centres and other scientific institutions;
- to promote of students, researchers and professors exchange programs in the context of National and International cooperation agreements.

The Centre collects funding mostly from outside the University and aims at connecting the world of research to the world of work, by raising the qualitative standards both of operational and theoretical capacity of senior and doctoral students, science technicians and young researchers.

5. **IRIS - Interdisciplinary Research Institute on Sustainability**

The Interdisciplinary Research Institute on Sustainability is an Inter-University Centre constituted by the University of Turin (Department of Animal and Human Biology and Department of Economics "Cognetti de Martiis") and the University of Brescia (Department of Social Studies). It includes among its members University lecturers and researchers from various institutions as well as independent scholars who share in the interest of entering into dialogue and learning from each other about the complex and often controversial themes of sustainability.

6. **NatRisk - Research Centre on Natural Risks in Mountain and Hilly Environments**

The Research Centre on Natural Risks in Mountain and Hilly Environments is a network devoted to basic, experimental and applied research, and to the dissemination in the field of prevention and management of natural disasters in mountain and hilly environment.

7. **CISAO - Centre Interdépartemental de Recherche et Coopération Scientifique et Technique avec les Pays du Sahel et de l'Afrique de l'Ouest**



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The Centre develops cooperative projects aiming to increase food safety, and to improve the living conditions of rural people and the conservation of natural resources in developing Countries.

8. **Agrinnova** - Centre of Competence for the innovation in the agro-environmental field
Established at the University of Torino in 2002, the Centre of Competence for the innovation in the agro-environmental field, carries out basic and applied research, knowledge and technology transfer, life-long learning and communication on up-to-date topics in the agro-environmental and agri-food sectors. It has several national and international collaborations, with public Institutions and the private sector. The Centre possesses extensive facilities including laboratories, experimental fields and greenhouses and hosts two National Certified laboratories, one for testing agrochemicals efficacy, the second for Diagnostics of plant pathogens.

9. **Agorà Scienza** - InterUniversity Center for the dissemination of scientific culture and the public engagement in science

The InterUniversity Center for the dissemination of scientific culture and the public engagement in science has been established in 2006. Currently, the 4 Universities of Piedmont Region are partners of the Centre: Università di Torino, Politecnico di Torino, Università del Piemonte Orientale and Università di Scienze Gastronomiche. It promotes awareness among post-graduate students and young researchers towards the social implications of science and the importance of communication. It involves citizens in the public debate on science-related issues, carries on social studies and communication of science actions, and realizes innovative pedagogical projects in science for students and teachers. It fosters the interaction between school and the research world and the dissemination of the scientific culture among the public and most notably the young people.



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Achievements, perspectives and foresight

Main inter-disciplinary research drivers of the new Sciences hub

1. Agrifood

An adequate and specialized research is needful to face a highly interdisciplinary topic relationship between food and health, in order to deal with the changes that have fostered the ageing and quality of life. It requires the involvement of expertise from different fields of study, ranging from the production of raw materials to processing technologies, chemical and microbiological analysis, engineering biotechnology and medicine.

In Piedmont there are excellent skills at the academic level, in terms of Public Research Institutions and companies, but they often operate as separate systems, and only sometimes in contact with each other.

Building an interactive system, in which these different skills can meet for dealing with the overall aim of health and well-being of the person, could be a successful challenge.

In our country, where the industrial structure is highly diversified, there is the pressing need and the urgency to develop a coordinated effort of research and pre-competitive technology (but not only), to the nutritional area, which has become effectively strategic.

We can identify the following potential research areas, following the food chain:

- Modeling of climate impact on agricultural production
- Agricultural production, through agriculture management, precision farming and high efficiency
- Food processing technologies
- Bioenergy and green chemistry (bio-factories)
- Packaging, storage, traceability and safety of food production
- Food chemistry and food chemistry analysis
- Chemical, physical and biological control methods
- Microbiology and food hygiene and safety
- Nutraceuticals, nutrigenomics and functional foods
- Biotechnology
- Biomedical sciences
- Bio-economy

These areas are totally aligned with the National Italian Specialization Strategy in the field of 'Health, Nutrition and quality of life', established by the Italian government, which identifies four pillars in the agri-food research:

- Development of precision farming
- Nutraceuticals, nutrigenomics and functional foods
- Systems and technologies for packaging, storage, traceability and safety of food production
- Bioeconomy

They also fit perfectly to the guidelines pointed out by the Piedmont Region in the Smart Specialization Strategy approved by the European Commission about the area of "Health and wellbeing", whose main issues are related to:

- Traceability, identification and authentication of food products



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- Innovation in terms of quality and safety in plant and animal production
- Innovation, safety and quality assurance of the food supply chain processes
- Innovation in packaging and packing
- Innovative approaches to the marketing of products in the food chain
- Reduction of the environmental impact
- Optimization of the use of soil and water resources, of the reuse of by-products
- Optimization of the energy and rationalization of production and distribution processes in the food chain
- Technologies and innovative approaches for precision farming and precision livestock
- Innovation in terms of mechanization of farming practices, efficiency and safety of agricultural machinery

Innovative solutions for selective crop protection and for improving crop yield under stress management (drought, nutrient deficiency, soil degradation, climatic constraints) are new issues as well as probiotics and nutraceuticals, textile substrates and specialty materials for agrifood applications, environmental and eco-efficient processes.

In more details, we can identify four drivers of studies and research:

Precision agriculture

Uptofarm srl



Food safety and quality

Slowfood

Centro Regionale Antidoping
"A. Bertinaria"

FESR 

A.S.L.

IZS

Università di Scienze Gastronomiche



Agrifood



Horizon 2020/COST

Consiglio Nazionale delle Ricerche

Consorzio di tutela del Barbera d'Asti

Strigolab Srl

Grape Srl



Biotechnologies, Nature inspired Fertilizers and Bio-masses



Food packaging



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A. Automation, robotic and ICT for precision agriculture

This topic involves the Departments of Agriculture, Forest and Food Sciences, Chemistry and Mathematics

Precision agriculture and mechatronic development are one of the most promising answers to face the new economic, environmental and social scenario for the third millennium.

The goals are the production cost reduction, the increasing of the productivity and quality together with the preservation of the environment, the security for the professionals involved.

Precision agriculture concerns all the factors of agro-forest productive process: fundamental steps are electronic innovation, automation and robotic and ICT. Different technologies are used from satellite localization to advanced mechatronic, from artificial vision to the big data.

Research activities shall include:

- The identification and remote control of cropland using drones;
- The systems for the punctual and specific site distribution of fertilizer and pesticide with machines able to modulate their distribution and the control of seed plantation;
- The precision land mapping of crop production and distribution;
- The robotic application in greenhouse and plants nursery;
- The developing of machines for the wood biomass production.

This area of studies has a direct evidence in different final achievements. Many of them developed in collaboration with private companies.

A1.Publications:

- a. **E. Dinuccio ,P. Balsari ,F. Gioelli, S. Menardo** Evaluation of the biogas productivity potential of some Italian agro-industrial biomasses. *Bioresource Technology*, 101, 3780-3783 (2010)
- b. **L.Comba, P.Gay, J.Primicerio, D.Ricauda Aimonino** Vineyard detection from unmanned aerial systems images. *Computers and Electronics in Agriculture*, 114, 78-87 (2015)
- c. **E.F. Miniotti, M. Romani, D. Said-Pullicino, A. Facchi, C. Bertora, M. Peyron, D. Sacco, G.B. Bischetti, C. Lerda, D. Tenni, C. Gandolfi, L. Celi** Agro-environmental sustainability of different water management practices in temperate rice agro-ecosystems. *Agriculture, Ecosystems and Environment*, 222, 235-248 (2016)
- d. **C. Aghemo, A. Albertino, R. Gobetto, F. Spanna** Correlation between isotopic and meteorological parameters in Italian wines: a local-scale approach. *Journal Of The Science Of Food And Agriculture* 91, 2088-2094 (2011)
- e. **C. Aghemo, A. Albertino, R. Gobetto** Isotopic analysis and H-1- NMR spectroscopy for traceability and discrimination of Italian wines. *Magnetic Resonance In Food Science: An Exciting Future. Book Series: Royal Society of Chemistry Special Publications*, Ed. Renou, JP; Belton, PS; Webb, GA 332, 30-35 (2011)



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- f. **C. Aghemo, A. Albertino, R. Gobetto, C. Lussiana, A. De Maria, D. Isocrono** Piedmont olive oils: Compositional characterization and discrimination from oils from other regions. *European Journal Of Lipid Science And Technology*, 114, 1409–1416 (2012)
- g. **A. Albertino, A. Barge, G. Cravotto, L. Genzini, R. Gobetto, M. Vincenti** Natural origin of ascorbic acid: Validation by C-13 NMR and IRMS. *Food Chemistry* 112, 715-720 (2009)

A2. Industrial collaborations with Ecomembrane srl Company (Gadesco-Pieve Delmona(CR) and under the EU-Agrobiogas project, supported by the Sixth Framework Programme of the European Commission, a floating system (1000m² of surface) that allows for the recovery of biogas and the reduction of gas emissions (ammonia, methane and carbon dioxide) was planned and installed.

A3. Spin-off : Uptofarm srl supplies services and develops innovative products for the sustainable use of recyclable resources in agriculture. It offers R&D services to farms and agribusiness companies aimed at reducing and reusing waste in agriculture, reducing nutrient emissions from field and farm structure, increasing efficiency of resource use. Moreover, Uptofarm offers services for innovation.

A4. European and National projects: A collaboration of Departments of Chemistry, DISAFA and Agroinnova with **Azienda BAVA – Castiglione Falletto**. MASGRAPE 2007-2009 (Regione Piemonte): “Adoption of a multidisciplinary approach to study the grapevine agroecosystem: analysis of biotic and abiotic factors able to influence yield and quality”. The project aim was to support the wine industry during vineyard management and winemaking by a set of tools including isotopic techniques and ¹H and ²D NMR measurements:

- a. Carbon balance and displacement during Piedmont’s grapevine lifecycle
- b. Correlation between climatic factors and the quality of the must, to predict in advance the quality of wine
- c. Correlation between vegetative-productive balance and wine quality.

B. Systems and technologies for food safety and quality

This topic involves the Departments of Agricultural, Forest and Food Sciences, Veterinary Science, Life Sciences and Systems Biology, Chemistry, Physics and Mathematics

In last years a growing interest of public opinion has been targeted to the food products. In particular, as regards food safety and traceability several research areas have been exploited:

- detection of mycotoxins and biogenic amines in food of animal origin;
- development of novel biomolecular tests for the identification of major zoonotic parasites, foodborne pathogens, spoilage and beneficial bacteria;
- determination of bacterial genetic determinants for resistance to sanitizers and their link with antimicrobial resistance;
- identification of biomarker of illicit treatments in food producing animals through traditional, biological and biomolecular assays;



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- study of the effects induced by environmental contaminants in food producing animals;
- determination of the effects of climate change on crop growth and quality.

The research topics are included in the 2014-20 National Programme for Research, particularly in relation to food safety, and in line with the European Union programme for research and innovation Horizon 2020 (Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and bio-economy).

Another important problem for the Italian food system is the imitation of the products so-called “Italian sounding”. An efficient system of traceability requires the development of:

- Automatic systems for product identification (radiofrequency technologies)
- Analytical methodologies for the traceability process validation (analytical traceability)
- Productive and logistic management for reducing the disposal of a single food component or processed food
- innovative biomolecular techniques for animal species identification in dairy products, raw and canned food
- biomolecular techniques for the traceability of poultry chain
- Analytical methodologies for monitoring drug resistant bacterial species from farm to fork
- GMP/GAP application for the implementation of production quality.

This area of study has a direct evidence in different final achievements in UniTo:

B1. Publications:

- a. **F.Dabbene, P.Gay, N.Sacco** Optimisation of fresh-food supply chains in uncertain environments, Part I: Background and methodology. *Biosystems Engineering*, 99/3, 348-359 (2008)
- b. **F.Dabbene, P.Gay, C.Tortia** Traceability issues in food supply chain management: a review. *Biosystems Engineering*, 120, 65-80 (2014)
- c. **M. Vincenti, F. Girolami, P. Capra, M. Pazzi, M. Carletti, G. Gardini, C. Nebbia** Study of dexamethasone urinary excretion profile in cattle by LC-MS/MS: comparison between therapeutic and growth-promoting administration, *Journal of Agricultural and Food Chemistry*, 57, 1299-1306 (2009)
- d. **F.T. Cannizzo, P. Capra, S. Divari, V. Ciccotelli, B. Biolatti, M. Vincenti** Effects of low-dose dexamethasone and prednisolone long term administration in beef calf: chemical and morphological investigation, *Analytica Chimica Acta*, 700, 95-104 (2011)
- e. **C. Nebbia, P. Capra, M. Leporati, F. Girolami, G. Barbarino, S. Gatto, M. Vincenti** Profile of the urinary excretion of prednisolone and its metabolites in finishing bulls and cows treated with a therapeutic schedule, *BMC Veterinary Research*, 10, 237 (2014)
- f. **L. Mandrile, G. Zeppa, A.M. Giovannozzi, A.M. Rossi** Controlling protected designation of origin of wine by Raman spectroscopy. *Food Chemistry*, 211, 260-267 (2016)
- g. **S. Prino, F. Spanna, T. La Iacona, M. Sanna, C. Cassardo** Measurement and parameterization of stomatal resistance and transpiration of leaves on the basis of



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meteorological Nebbiolo | [Misura e parametrizzazione della resistenza stomatica e della traspirazione delle foglie di Nebbiolo in funzione delle grandezze meteorologiche]. **Italian Journal of Agrometeorology** (2008)

h. **Cocolin L, Nucera D, Alessandria V, Rantsiou K, Dolci P, Grassi MA, Lomonaco S, Civera T.** Microbial ecology of Gorgonzola rinds and occurrence of different biotypes of *Listeria monocytogenes*. *Int J Food Microbiol*, 133(1-2):200-5 (2009)

i. **A. Dalmasso, K. Rantsiou, L.Cocolin, MT. Bottero** Development of a biomolecular assay for the identification of *Listeria* at species level. *Foodborne Pathog Dis.* 7(5):565-71 (2010)

j. **F. Martin; A. Kohler, C. Murat, R. Balestrini, P.M. Coutinho, O. Jaillon, B. Montanini, E. Morin, B. Noel, R. Percudani, B. Porcel, A. Rubini, A. Amicucci, J. Amselem, V. Anthouard, S. Arcioni, F. Artiguenave, J.M. Aury, P. Ballario, A. Bolchi, A. Brenna, A. Brun, M. Buee, B. Cantarel, G. Chevalier, A. Couloux, C. Da Silva, F. Denoeud, S. Duplessis, S. Ghignone, B. Hilselberger, M. Iotti, B. Marcais, A. Mello, M. Miranda, G. Pacioni, H. Quesneville, C. Riccioni, R. Ruotolo, R. Splivallo, V. Stocchi, E. Tisserant, A.R. Viscomi, A. Zambonelli, E. Zampieri, B. Henrissat, M.H. Lebrun, F. Paolocci, P. Bonfante, S. Ottonello, P. Wincker,** Perigord black truffle genome uncovers evolutionary origins and mechanisms of symbiosis. *Nature* 464 (7291): 1033-1038 (2010)

B2. Industrial collaborations, with

- a. **Trustech S.r.l., Floramo Corp. srl, Crisel** for the development of new toxicological tools for detecting the illicit usage of β 2 -agonists in meat for human consumption was developed within the EU project BE-FREE
- b. **Centro Regionale Antidoping “A. Bertinaria”** a long term cooperation between academia and regional public bodies has been established (**Regione Piemonte, Health authorities and the Departments of Chemistry, Veterinary Sciences; Istituto Zooprofilattico of Piemonte, Liguria e Valle d'Aosta; ASL TO3; ASL CNI**). The regulatory and control nature of the consortium excludes direct industrial cooperation with stockbreeder associations and food producers.
- c. **Ecomembrane srl Company** (Gadesco-Pieve Delmona(CR) and under the EU-Agrobiogas project, supported by the Sixth European Framework Programme (FP6)
- d. **ISAGRO**
- e. **GEOL**
- f. **ETICA**
- g. Large retail companies (**Coop, CONAD**) for food quality management systems
- h. School and hospital canteens for food quality and safety assessment.

B3. Spin-off:

SAFOOD: it provides several accredited laboratory analyses to certify food regulatory compliance or to identify illegal animal treatments with growth promoters. It offers specialized services and innovative techniques (e.g. qPCR, biosensors, ELISAs), to identify frauds in animal feeds and live animals or meat residues.



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B4. Patents:

2008: Procedimento e kit per la rilevazione della somministrazione di sostanze estrogeniche esogene nei bovini. Inventors: **B.Biolatti, S.Divari, R.De Maria** Brevetto n. TO2008A000526

2013: Procedimento Per La Rilevazione Di Trattamento Con Desametasone In Animali Destinati Al Consumo Alimentare. TO20120119 IT, **B.Biolatti, F.T. Cannizzo, S. Divari**.

B5. European and national projects:

“BE-FREE” EU-project (P.O.R. - F.E.S.R. 2008/2014) was addressed to the development of a user friendly device, supplied with a microfluidic system and a software controller, to detect the presence of β 2 –adrenergic agonists in the meat for human consumption, after illicit administration of these drugs.

“Innovative approaches for the control of poultry production chain”; project funded by Compagnia di San Paolo; amount: 312000 euro.

C. Biotechnologies, Nature inspired Fertilizers and Bio-masses

This topic involves the Departments of Agricultural, Forest and Food sciences, Life Sciences and Systems Biology, Earth Sciences and Chemistry

Increasing climate and land-use changes at the global and local scales needs researches and applications to find long lasting solutions for a sustainable development.

The knowledge of biodiversity, from bacteria to fungi, plants and animals and of their relationships with the abiotic factors are the base to provide tools for quality evaluation, restoration and monitoring for a sustainable management in agriculture, forestry and other land-uses, as well as in more or less polluted or degraded areas. These highly interdisciplinary topics, considering the relationships between biotic and abiotic factors, as well as the soil at their interface, requires the involvement of expertise from different fields of studies, from biodiversity related to all groups of organisms, to climate, geology and pedology, natural and agricultural resource management, biotechnologies, including the reproduction and multiplication of biological materials and chemical analyses.

In Piedmont there are excellent expertise in these fields but, as highlighted elsewhere, they operate in separate systems, which are often not in contact with each other and are not efficiently connected to the agricultural and industrial systems. Building an interactive system that will interconnect the research and the productive systems is needed to face the future challenges both in economy and ecology.

We can identify the following potential research areas:

- Evaluation of the environmental quality (air, soil, water), in terrestrial and aquatic ecosystems by the use of bioindicators;
- Estimation of Environmental Impact Assessment (EIA);
- Pest Risk Analysis (PRA) for exotic species (fungi, plants and animals);
- Monitoring indoor and outdoor environmental quality both in terrestrial and aquatic ecosystems;
- Estimation of the economic value of natural capital and ecosystem services;



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- Bioremediation of polluted areas and polluter industrial wastes;
- Ecological restoration of disturbed or degraded ecosystems;
- Restoration of degraded urban or extraurban environments.

This area of studies has a direct evidence in different final achievements in UniTO:

C1. Publications:

- A. Moglia, S. Lanteri, C. Comino, L. Hill, D. Knevitt, C. Cagliero, P. Rubiolo, S. Bornemann, C. Martin** Dual Catalytic Activity of Hydroxycinnamoyl-Coenzyme A Quinate Transferase from tomato allows to Moonlight It in the Synthesis of Both Mono- and Dicafeoylquinic Acids. *Plant physiology*, 166, 1777-1787 (2014)
- I. Ferrocino, R. Di Cagno, M. De Angelis, S. Turrone, L. Vannini, E. Bancalari, K. Rantsiou, G. Cardinali, E. Neviani, L. Cocolin** Fecal microbiota in healthy subjects following omnivore, vegetarian and vegan diets: culturable populations and rRNA DGGE profiling. *Plos One*, 10, e0128669 (2015)
- D. Scaglione, S. Reyes-Chin-Wo, A. Acquadro, L. Froenicke, E. Portis, C. Beitel, M. Tirone, R. Mauro, A. Lo Monaco, G. Mauromicale, P. Faccioli, L. Cattivelli, L. Rieseberg, R. Michelmore & S. Lanteri** The genome sequence of the outbreeding globe artichoke constructed de novo incorporating a phase-aware low-pass sequencing strategy of F1 progeny. *Nature Scientific Reports*. 6, 19427 (2016)
- F. De Filippis, N. Pellegrini, L. Vannini, I.B. Jeffery, A. La Storia, L. Laghi, D.I. Serrazanetti, R. Di Cagno, I. Ferrocino, C. Lazzi, S. Turrone, L. Cocolin, P. Brigidi, E. Neviani, M. Gobetti, P.W. O'Toole, D. Ercolini** High-level adherence to a Mediterranean diet beneficially impacts the gut microbiota and associated metabolome. *Gut*, in press (2015)
- E. Artuso, E. Ghibaudi, B. Lace, D. Marabello, D. Vinciguerra, C. Lombardi, H. Koltai, Y. Kapulnik, M. Novero, E.G. Occhiato, D. Scarpi, S. Parisotto, A. Deagostino, P. Venturello, E. Mayzlish-Gati, A. Bier, C. Prandi** Stereochemical Assignment of Strigolactone Analogues Confirms Their Selective Biological Activity. *Journal of Natural Products*, 78, 2624-2633 (2015)
- M. Cohen, C. Prandi, E.G. Occhiato, S. Tabasso, S. Wininger, N. Resnick, Y. Steinberger, H. Koltai, Y. Kapulnik** Structure-function relations of strigolactone analogs: Activity as plant hormones and plant interactions. *Molecular Plant*, 6, 141-152 (2013)
- S.R. Stazi, M.C. Moscatelli, R. Papp, S. Crognale, S. Grego, M. Martin, R. Marabottini** A Multi-biological Assay Approach to Assess Microbial Diversity in Arsenic (As) Contaminated Soils. *Geomicrobiology Journal*, pp. 1-10. Article in Press (2016)
- S. Ghignone, A. Salvioli, I. Anca, E. Lumini, G. Ortu, L. Petiti, S. Cruveiller, V. Bianciotto, P. Piffanelli, L. Lanfranco, P. Bonfante** The genome of the obligate endobacterium of an AM fungus reveals an interphylum network of nutritional interactions. *The ISME Journal*, 6(1): 136-145 (2012)
- C.N. Kanchiswamy, M. Malnoy, M.E. Maffei** Bioprospecting bacterial and fungal volatiles for sustainable agriculture. *Trends in Plant Science*, 20: 206-211 (2015)



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C2. Industrial collaborations, with

- a. **G2P-SOL** (under the Project H2020.SFS-2014-2015/ number 677379) 'Linking genetic resources, genomes and Phenotypes of Solanaceous crops
- b. The **Consorzio di tutela del Barbera d'Asti** and other Piedmonts wine producers (under EU project WildWine) an autochthonous yeast strain has been selected for wine making of the *barbera* grape. At present the yeast strain is used at level of wineries
- c. Ongoing cooperation with **ACEA Pinerolese SpA** on the extraction of humic substances from compost to remove arsenic from Piedmont rice field waters

C3. Spin-off:

- a. **Grape Srl** mission is to supply services and to develop innovative products for enology and wineries
- b. **Strigolab Srl** mission is to produce innovative plant molecules for agricultural applications.
- c. **Biosfered Ltd** mission is to produce plant extracts identified and titrated with the latest techniques of mass spectrometry

C4. Inventions:

- a. **Yeast** recombinant production of homologous of *avenanthramide* Inventors: Moglia Andrea; Comino Cinzia; Lanteri Sergio. Approved by Unito Patent Committee. Italian patent request presented on 21/02/2014 Number : TO2014A000143, Università degli Studi di Torino (PRIN 2010-2011).
- b. **Globe artichoke sequencing genome** (<http://www.artichokegenome.unito.it>) Solanaceous crops sequencing genome.c. Developing of functional foods enriched by probiotics microorganism and effect of the diet on human microbiota. c. Cheese production obtained by rennet of plants origin. d. Wine production without sulfite

C5. European and national projects:

- a. **COST FA1206** "STREAM - Strigolactones: biological rules and applications" - EU project
- b. **SLEPS** (Signaling role of Strigolactones at the interface between plants, microorganism and changing environment; Chemistry + DISAFA + DIBIOS), **StriTools** "Smart molecular tools from the plant hormones Strigolactones to improve crop yields" (Chemistry + DISAFA) - UniTo project
- c. **MicroBusters** – An integrated approach for the treatment of micropollutants: oxidation, membrane technologies and new adsorbing materials" (finanziato con top-priority) - UniTo project
- d. Ongoing cooperation between UniTO and **SME "ACEA Pinerolese"** - EU Project, H2020 RISE (Mat4Treat)



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D. Systems, materials and technologies for food packaging

This topic involves the Departments of Agricultural, Forest and Food Sciences, Veterinary Science and Chemistry

Packaging plays an important role in food industry dealing with food safety, marketing and the shelf-life of the products. Planning a new product for packaging requests many competences: chemical, science of materials, food technologies and engineering. The effect of the interactions between groups of materials and articles intended to come into contact with food and product is fundamental. Specific attention must be paid for the products that ripen during the stocking.

Another item is the study of new machines and technologies for the packaging. Important research findings have allowed for developing new products and new ways of sale, i.e. ham or salami sliced and packed in modified atmosphere.

2. Earth, Natural Resources and Environment

The correlation-interaction between Earth system and the Environment has become a key-point to foster a continuous improvement in terms of quality of life for human beings (i.e. “well-being”), through a full comprehension of complex natural-anthropic processes and a sustainable exploitation of large scale geo-resources. So ambitious targets require development of a highly integrated knowledge underlying a know-how that actually yields cultural/technologic advancements impacting upon daily life aspects.

Among the strategic goals aimed, it's worth mentioning risks assessment (geo- and environmental hazards), eco-system dynamics understanding and steering, non-conventional use of raw materials in large scale industrial processes and null-waste manufacturing, natural materials integration in past/present ornamental architectural context, optimization of the hydro-thermal natural resources exploitation to meet with societal needs, advanced territory bio/geo-monitoring.

In this view, expertise involvement stretches from laboratory oriented activities to field exploration-sampling and micro-/macro-modelling, and requires a synergic multi-cultural combination of pieces of knowledge that are traditionally ascribed to biology, chemistry, geology, mathematics and physics, with a contribution from social-economic sciences to harmonize the transfer of scientific issues to society.

Although excellent skills are available in Piedmont at Universities, Public Research Institutions, Cultural Institutions (in particular Museums) and industrial companies, they often lack a multi-cultural platform aiming at translating these skills and culture into practical solutions. In this light, a fragmented but lively and rich culture, that ranges from academy to producing platforms, can be valorised and brought to its full potentiality of impact by making research and pre-competitive-technology meet to give an answer to societal and industrial needs, involving the complex and highly self-correlated macro-system of Earth-Environment-Nature. We can identify the following potential research areas:

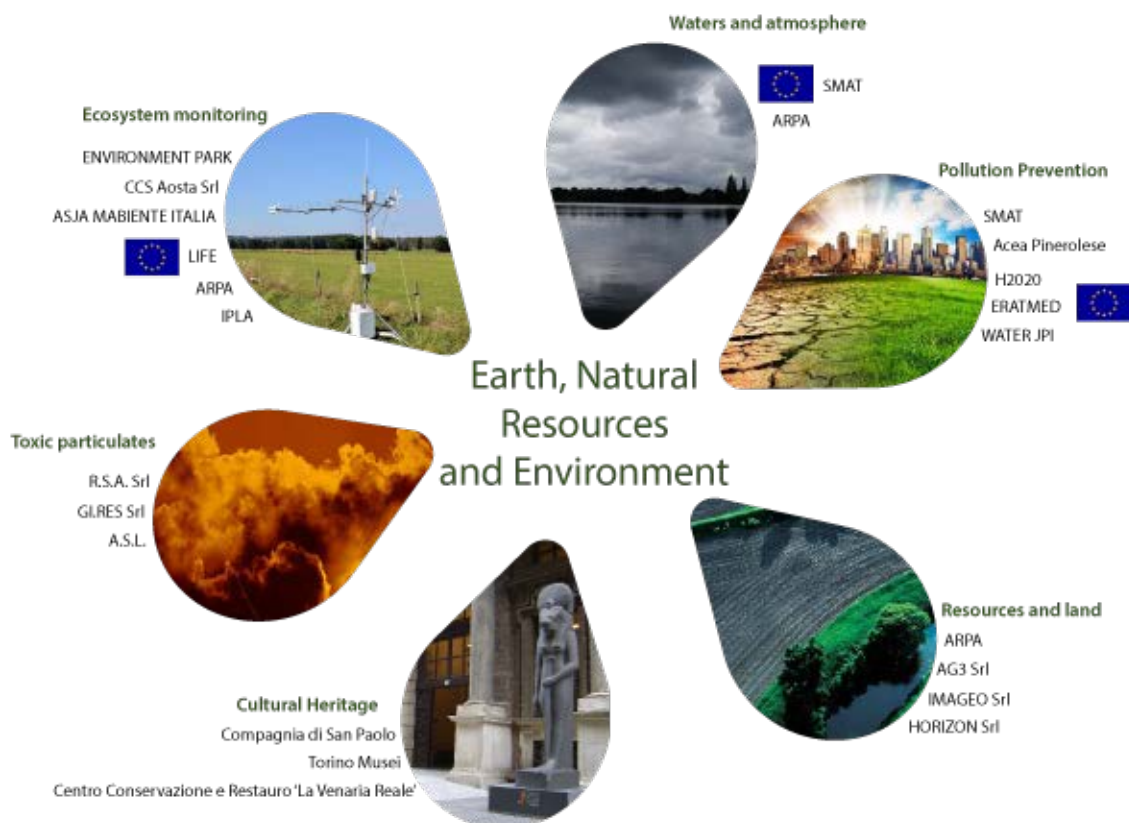
- Large- to micro-scale geological processes in the Earth crust and upper mantle
- Geo-risks assessment



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- Hydrogeology and hydro-cycle
- Territory monitoring of morphologic- and eco-dynamics, and development of related databases
- Evolutionary processes from large scale fossil deposits. Large scale collections and museums: traceability of evolution, from past to future
- Geothermal resources exploitation via innovative technologies
- Ornamental stones and gems: quarrying, processing, preservation and restoration
- Geo-materials/secondary-raw-materials in building and ceramic industry, to boost low-temperature/low-CO₂-emissions innovative processes
- Waste management: landfill policy and large scale re-cycling/re-use in manufacturing
- Hazardous natural materials: detection and inertization
- Analysis of diffusion of pollutants in the atmosphere
- Cultural heritage: archaeometric studies, reconstructing technologies and processes to optimise conversion/restoration

Such investigation lines are totally aligned with the European Research Council Panels PE10-Earth System Science, PE4-Photochemistry and PE4-Environment Chemistry, and they fit well into the guidelines pointed out by the Piedmont Region in the Smart Specialization Strategy (S3) approved by the European Commission about the area of Energy and clean Technologies.





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E. Chemistry of waters and the atmosphere

This topic involves the Departments of Earth Science, Chemistry, Life Science and System Biology

The research on the chemistry of waters and the atmosphere deals with both the understanding of the natural functioning of these environmental compartments, and on the biogeochemical cycles that involve emerging pollutants in the compartments themselves. Within the Department of Chemistry, particular attention is devoted to the degradation processes of pollutants induced by sunlight.

E1.Publications:

- a. **S. De Laurentiis, V. Buoso, V. Maurino, C. Minero, D. Vione** Optical and Photochemical Characterisation of Chromophoric Dissolved Organic Matter from Lakes in Terra Nova Bay, Antarctica. Evidence of Considerable Photoreactivity in an Extreme Environment. *Environ. Sci. Technol.* 47, 14089-14098 (2013)
- b. **Marchisio, M. Minella, V. Maurino, C. Minero, D. Vione** Photogeneration of Reactive Transient Species Upon Irradiation of Natural Water Samples: Formation Quantum Yields in Different Spectral Intervals, and Implications for the Photochemistry of Surface Waters. *Wat. Res.* 73, 145-156 (2015)
- c. **S. Gligorovski, R. Strekowski, S. Barbati, D. Vione** Environmental Implications of Hydroxyl Radicals ($\cdot\text{OH}$). *Chem. Rev.* 115, 13051-13092 (2015)
- d. **P. Calza, D. Vione, F. Galli, D. Fabbri, F. Dal Bello, C. Medana** Study of the Photochemical Transformation of 2-Ethylhexyl 4-(dimethylamino)benzoate (OD-PABA) under Conditions Relevant to Surface Waters. *Water Res.* 88, 235-244 (2016)

E2.Industrial collaborations.

Main activities with industrial partners are devoted to:

- a. Sunlight-induced degradation of pesticides in aqueous matrices (LAV)
- b. Development of a software for the modeling of surface-water photochemistry (iMpronta).

E3.European and national projects:

PNRA - Progetto Antartide. Biogeochemical cycles of pollutants in surface-water and atmospheric compartments in the Antarctica.

PHOTONIT - Phototransformation and photonitration processes of aromatic compounds in surface waters: Environmental significance and impact on living organisms", PIIF-GA-2008-219350.

F. Pollution Prevention and Remediation Technologies

This topic involves the Departments of Chemistry and Physics

New technologies are urgently needed for the abatement of emerging pollutants such as innovative



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industrial chemicals, new-generation pesticides, pharmaceuticals and personal care products. These compounds have a widespread occurrence in the natural environment because the existing wastewater treatment plants are unable to remove them effectively, basically because they were not designed to this purpose. Detailed studies regarding pollutant diffusion in the atmosphere can be performed, both in urban and in extra-urban areas. Treatment methods based on advanced oxidation technologies (Fenton and photo-Fenton processes, heterogeneous photocatalysis) are promising solutions to the problem of the abatement of emerging contaminants. These techniques may allow improvements in both wastewater treatment and the reuse of wastewater in agriculture.

F1.Publications:

- a. **M. Minella, G. Marchetti, E. De Laurentiis, M. Malandrino, V. Maurino, C. Minero, D. Vione, K. Hanna** Photo-Fenton Oxidation of Phenol with Magnetite as Iron Source. *Appl. Catal. B: Environ.* 154-155, 102-109 (2014)
- b. **L. Demarchis, M. Minella, R. Nisticò, V. Maurino, C. Minero, D. Vione** (2015) Photo-Fenton Reaction in the Presence of Morphologically Controlled Hematite as Iron Source. *J. Photochem. Photobiol. A: Chem.* 307-308, 99-107.
- c. **P. Avetta, A. Pensato, M. Minella, M. Malandrino, V. Maurino, C. Minero, K. Hanna, D. Vione** Activation of Persulfate by Irradiated Magnetite: Implications for the Degradation of Phenol under Heterogeneous Photo-Fenton-Like Conditions. *Environ. Sci. Technol.* 49, 334-342 (2015)
- d. **P. Avetta, S. Berto, A. Bianco Prevot, M. Minella, E. Montoneri, D. Persico, D. Vione, M. C. Gonzalez, D. O. Martire, L. Carlos, A. Arques** Photoinduced Transformation of Waste-Derived Soluble Bio-based Substances. *Chem. Engineer. J.*, 274, 247-255 (2015)
- e. **M. Minella, E. Sappa, K. Hanna, F. Barsotti, V. Maurino, C. Minero, D. Vione** Considerable Fenton and Photo-Fenton Reactivity of Passivated Zero-Valent Iron. *RSC Advances*, 6, 86752-86761 (2016)
- f. **C. Gionco, M.C. Paganini, E. Giamello, R. Burgess, C. Di Valentin, G. Pacchioni** Cerium-doped zirconium dioxide, a visible-light-sensitive photoactive material of third generation *Journal of Physical Chemistry Letters*, 5, 447-451 (2014)
- g. **Bertolaccini, L., Alemanno, L., Rocco, G., Cassardo, C.** Air pollution, weather variations and primary spontaneous pneumothorax, *Journal of Thoracic Disease*, 2(1), 9-15 (2010)

F2.Industrial collaborations:

Main activities with industrial partners are devoted to:

- a. Development of techniques for the abatement of pollutants from raw water used in the production of drinking water (SMAT).
- b. Use of materials derived from solid wastes for the decontamination of wastewater (ACEA Pinerolese).



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F3.European and national projects:

MOTREM: Integrated Processes for MONitoring and TReatment of EMerging Contaminants for Water Reuse. EU-Water JPI. Development of new technologies for wastewater decontamination.

PHOTOMAT: TUNABLE MATERIALS: PREPARATION, CHARACTERIZATION AND INVESTIGATION OF PHOTOCATALYTIC ACTIVITY OF NEW HIBRID MATERIALS. FP7-PEOPLE 2012-IRSES. Development of new hybrid materials for water treatment.

MAT4TREAT: New materials for water treatment. H2020-MSCA-RISE-2014.

IRRIGATIO: Assessing the chemical/microbiological contamination and productivity in the agricultural production chain of model fruit species grown under irrigation with different kinds of reclaimed wastewater. EU-ERANETMED.

G. Geological and Pedological studies for the sustainable use of natural resources and for the protection of the land and the environment

This topic involves the Departments of Earth Science and Agricultural, Forest and Food Sciences.

This area of studies has a direct evidence in different final achievements:

G1. Publications:

- a. **A.M. Ferrero, G. Forlani, R. Roncella, H.I. Voyat** Advanced geostructural survey methods applied to rock mass characterization. *Rock Mechanics and Rock Engineering*, 42 (4), 631-665 (2009)
- b. **M. Maggioni, D. Godone, P. Höller, L. Oppi, S. Stanchi, B. Frigo, M. Freppaz,** Snow gliding susceptibility: the Monterosa Ski resort, NW Italian Alps. *Journal of Maps*, pp. 1-7 (2016)
- c. **S. Stanchi, G. Falsone, E. Bonifacio, E.** Soil aggregation, erodibility, and erosion rates in mountain soils (NW Alps, Italy) *Solid Earth*, 6 (2), pp. 403-414 (2015)
- d. **E. Borgogno-Mondino, G.Fabietti, F. Ajmone-Marsan** Soil quality and landscape metrics as driving factors in a multi-criteria GIS procedure for peri-urban land use planning. *Urban Forestry & Urban Greening*, 14, 743-750 (2015)
- e. **N. Giordano, C. Comina, G. Mandrone** Laboratory scale geophysical measurements aimed at monitoring the thermal affected zone in Underground Thermal Energy Storage (UTES) applications. *Geothermics*, 61, 121-134 (2016)
- f. **N. Giordano, C. Comina, G. Mandrone, A. Cagni** Borehole thermal energy storage (BTES). First results from the injection phase of a living lab in Torino (NW Italy). *Renewable Energy*, 86, 993-1008 (2016)
- g. **D.A. De Luca, M. Lasagna, S.E.D. Castagna** Eutrophication of Piedmont Quarry Lakes (North-Western Italy): Hydrogeological Factors, Evaluation of Trophic Levels and Management Strategies. *J. Environmental Assessment Policy and Management*, 17 (4), 1550036-1550056 (2015)
- h. **E. Rapisardi, S. Di Franco, M. Giardino** Italian Civil Protection 2.0: Towards a Resilient Information Management Framework. In: Lollino, G., et al. (eds.) *Engineering Geology for Society and Territory - Volume 7: Education, Professional Ethics and Public*



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- Recognition of Engineering Geology. Springer International Publishing, 175-180 (2014)
- i. **M. Giardino, L. Perotti, M. Lanfranco, G. Perrone** GIS and geomatics for disaster management and emergency relief: a proactive response to natural hazards. *Applied Geomatics*, 3, 33-46 (2012)
 - j. **A.M. Ferrero, M. Migliazza, R. Roncella, E. Rabbi** Rock slopes risk assessment based on advanced techniques. *Landslides*, 8, 221-231 (2011)
 - k. **L. De Bernardi, D.A. De Luca, M. Lasagna** Correlation between nitrate concentration in groundwater and parameter affecting aquifer intrinsic vulnerability. *Environmental Geology*, 55, 539-558 (2008)
 - l. **S. Bonetto, M. Fornaro, C. Oggeri** Geo-surveying for safe underground mining in gypsum deposit in Monferrato basin (Italy). In: Cardu, M. et al (eds.) *Proceedings of the fifteenth International Symposium on mine planning & equipment selection (MPES)*, 382-387 (2006)

G2. Industrial collaborations, with

- a. **Fassa Bortolo SpA**: Applied studies about carsick phenomena in gypsum quarries, geotechnical studies about stability condition in quarrying activity
- b. **Società Apuana Marmi Srl**: Physical, chemical and mineralogical characterization of Carrara marble quarry waste.

G3. Spin-off:

- a. **AG3 Srl** focused on geothermal and natural resources sustainable planning, exploitation and management; remote sensing.
- b. **IMAGEO Srl**. A **spin-off** grown among UniTO researchers: a GIS and Geomatic Laboratory whose mission is focused on: 3D geomechanic modelling; study and monitoring of landslides; photogrammetric surveys with drone helicopter.
- c. **HORIZON Srl** focused on Environmental services and soil bioremediation.

G4. European and national projects: under the “Programme de Coopération ACP-UE pour l'Education Supérieure – Edulink II, is come to light **R.U.S.S.A.D.E. - Réseau des Universités Sahéliennes pour la Sécurité Alimentaire et la Durabilité Environnementale**. The project consists in the organization of a higher education course (master level) for training and specialization of professionals who can be locally inserted in the institutions (public agencies, universities or other educational institutions of various levels), NGOs, businesses, etc. that are involved in the field of rural development. The Master was open to students from different educational paths (agronomists, veterinarians, livestock, graduates in biology, physical geography, environmental sciences, natural sciences) from the partner Countries as well as from other Countries of the Sahelian C.I.S.A.O. Network (Centro Interdipartimentale di Ricerca e Cooperazione Tecnico Scientifica with the countries of Sahel and West Africa, UniTO).



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H. Mineralogical and petrologic applications for Materials Science, Cultural Heritage and the environment

This topic involves the Departments of Earth Science and Chemistry

H1. Publications:

- a. **R. Arletti, L. Gigli, F. Di Renzo, S. Quartieri** Evidence for the formation of stable CO₂ hydrates in zeolite Na-Y: Structural characterization by synchrotron X-ray powder diffraction. *Microporous and Mesoporous Materials*, 228, 248-255 (2016)
- b. **A. Borghi, V. Berra, A. D'Atri, G.A. Dino, L.M. Gallo, E. Giacobino, L. Martire, G. Massaro, G. Vaggelli, C. Bertok, D. Castelli, E. Costa, S. Ferrando, C. Groppo, F. Rolfo** Stone materials used for monumental buildings in the historical centre of Turin (NW Italy): architectonical survey and petrographic characterization of Via Roma. In: Pereira, D. et al. (eds.) *Global Heritage Stone: Towards International Recognition of Building and Ornamental Stones*. Geological Society, London, Special Publications, 201-218 (2015)
- c. **A. Dino, P. Clemente, M. Lasagna, I. Passarella, F. Ajmone Marsan, D. De Luca** Industrial chance to recover residual sludge from dimension stones in civil and environmental applications. In: Lollino, G., et al. (eds.) *Engineering Geology for Society and Territory - Volume 5, Urban Geology, Sustainable Planning and Landscape Exploitation*. Springer International Publishing, 1309-1313 (2015)
- d. **F. Rolfo, P. Benna, P. Cadoppi, D. Castelli, S.E. Favero-Longo, M. Giardino, G. Balestro, E. Belluso, A. Borghi, F. Camara, R. Compagnoni, S. Ferrando, A. Festa, M.G. Forno, F. Giacometti, F. Gianotti, C. Groppo, B. Lombardo, P. Mosca, G. Perrone, R. Piervittori, G. Rebay, P. Rossetti** The Monviso Massif and the Cottian Alps as symbols of the Alpine chain and geological heritage in Piemonte, Italy. *Geoheritage*, 7, 65-84 (2015)
- e. **E. Ferrero, M. Giardino, F. Lozar, E. Giordano, E. Belluso, L. Perotti** Geodiversity action plans for the enhancement of geoheritage in the Piemonte region (north-western Italy). *Annals of Geophysics*, 55, 487-495 (2012)
- f. **R. Arletti, C. Fiori, M. Vandini, G. Vezzalini** Mosaic glass from S. Pietro (Rome): Manufacture technique and raw materials employed in late 16th century Italian glass. *Archaeometry*, 53, 364-386 (2011)
- g. **R. Giustetto, O. Wahyudi, I. Corazzari, F. Turci** Chemical stability and dehydration behavior of a sepiolite/indigo Maya Blue pigment. *Applied Clay Science*, 52, 41-50 (2011)
- h. **M. Serra, A. Borghi, E. D'Amicone, L. Fiora, O. Mashali, G. Vaggelli, L. Vigna** Black and red granites in the Egyptian Antiquity Museum of Turin: A mineralogical-petrographic and provenance study. *Archaeometry*, 52, 962-986 (2010)
- i. **G. Chiari, R. Giustetto, J. Druzik, E. Doehne, G. Ricciardi** Pre-columbian nanotechnology: Reconciling the mysteries of the maya blue pigment. *Applied Physics A: Materials Science and Processing*, 90(1) 3-7 (2008)
- j. **E. Zanella, L. Gurioli, G. Chiari, A. Ciarallo, R. Cioni, E. De Carolis, R. Lanza** Archaeomagnetic results from mural paintings and pyroclastic rocks in Pompeii and Herculaneum. *Physics of the Earth and Planetary Interiors*, 118, 227-240 (2000)



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H2. Industrial collaborations, with **Pestarena Srl** oriented in the studies about environmental remediation and exploitation of Pestarena Gold mine (Valle Anzasca)

H3. European and national projects: under the 2013-2016 (RBFR12CLQD) FIRB, the Department of Earth Sciences developed **ImPACT - Impose Pressure and Change Technology**. Starting from zeolites (microporous crystalline solids with well-defined structures), the project studied the behaviour of molecules and porous materials under the combined effects of applied pressure, spatial confinement and constraints in morphology, aiming at creating novel classes of hybrid functional materials for technological applications under the convention between Compagnia di San Paolo and UniTO is grown PROGEO-Piemonte.

The **PROGEO-Piemonte** project used an innovative approach for the management and enhancement of the geological heritage of the Piemonte Region. Nine “geothematic areas” have been identified for representing the geodiversity of the Piemonte Region, whose integrated analysis allowed further knowledge to be acquired on the geological history, climate change, natural hazards, land use and georesources of this territory. This knowledge has been disseminated through the identification of geological sites, the enhancement of museum collections, the activation of educational projects with the schools, exhibitions.

I. Health and environmental issues raised by respirable toxic particulates

This topic involves the Departments of Earth Science, Chemistry, Life Science and System Biology, Veterinary Science and the Scansetti Center (Interdepartmental Center for the Study of Asbestos and Other Toxic Particulates)

The Center is a reference in RESEARCH AND EDUCATION in the field of particle toxicology (asbestos, silica, PM, metal and metal oxides, and nanoparticles) and nanotoxicology, devoted to the ASSESSMENT OF THE IMPACT of nanotechnologies on HUMAN HEALTH AND THE ENVIRONMENT. It cooperates with many private companies through finalized scientific researches. Close cooperation is established with local and international institutions, including: Regione Piemonte, ARPA Piemonte, ARPA Valle d'Aosta, ARPA Liguria, INAL, ASL, ISPESL, International Agency for Research on Cancer –IARC; Canadian Health Ministry; International Life Sciences Institute-ILSI, USA, Eurosil, Belgium, Institut National de Recherche et de Sécurité –INRS, European Space Agency, ESA)

11. Publications:

- a. **F. Turci, S. E. Favero-Longo, C. Gazzano, M. Tomatis, L. Gentile, M. Bergamini** Assessment of asbestos exposure during a simulated agricultural activity in the proximity of the former asbestos mine of Balangero, Italy. *Journal of Hazardous Materials*. 308, 321-327 (2016)
- b. **F. Turci, R. Compagnoni, F. Piana, L. Delle Piane, M. Tomatis, B. Fubini, M. Bergamini** Geological and Analytical Procedures for the Evaluation of Asbestos-Related Risk in Underground and Surface Rock Excavation. In *Engineering Geology for Society and Territory-Volume 5* (pp. 619-622). Springer International Publishing (2015)
- c. **A. Pacella, M. Fantauzzi, F. Turci, C. Cremisini, M.R. Montereali, E. Nardi, D. Atzei, A. Rossi, G.B. Andreozzi**, Surface alteration mechanism and topochemistry of



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- iron in tremolite asbestos: A step toward understanding the potential hazard of amphibole asbestos. *Chemical Geology*, 405, 28 – 38 (2015)
- d. **F. Turci, M. Tomatis, I.G. Lesci, N. Roveri, B. Fubini** The iron-related molecular toxicity mechanism of synthetic asbestos nanofibres: a model study for high-aspect-ratio nanoparticles, *Chemistry-A European Journal*, 7, 350- 358 (2011)
 - e. **S.E. Favero-Longo, D. Castelli, B. Fubini, R. Piervittori** Lichens on asbestos-cement roofs: Bioweathering and biocovering effects. *Journal of Hazardous Materials* 162, 1300-1308 (2009)
 - f. **F. Turci, E.S Favero-Longo, M. Tomatis, G. Martra, D. Castelli, R. Piervittori and B. Fubini** A biomimetic approach to the inactivation of chrysotile fibres. *Chemistry-A European Journal*; 13, 4081-4093 (2007)
 - g. **S. Daghino, F. Turci, M. Tomatis, A. Favier, S. Perotto T., Douki, B. Fubini** Soil fungi reduce the iron content and the DNA damaging effects of asbestos fibers *Environ. Sci. Technol.* 40, 5793-5798 (2006)
 - h. **L. Poggio, B. Vrščaj, R. Schulin, E. Hepperle, F. Ajmone Marsan** Metals pollution and human bioaccessibility of topsoils in Grugliasco (Italy). *Environmental Pollution*, 157 680-689 (2009)
 - i. **E. Bollo, F.E. Scaglione, M. Tursi, C. Schröder, G. Degiorgi, E. Belluso, S. Capella, D. Bellis** Malignant pleural mesothelioma in a female lion (*Panthera leo*). *Res Vet Sci.* Aug;91(1):116-8 (2011)

12. Industrial collaborations. Main activities with industrial partners were devoted to:

- a. Impact assessment of asbestos presence on the realization of infrastructural works
- b. Safety procedures, monitoring plans, environmental protection

13. Spin-off: Gi.RES s.r.l. a spin off society of CNR, participated by GDP consultants and IGG-CNR about the hazard and risk quantification of natural occurrence of asbestos (NOA).

J. Ecosystem monitoring and management for sustainable development

This topic involves the Departments of Life Sciences and Systems Biology, Agriculture, Forest and Food sciences, Earth Science and Chemistry

A sustainable development is based on the knowledge of environmental features, monitoring the dynamics of species and ecosystems responding to climate and land use changes. Bio-based innovative techniques (bioremediation, screening of pollutants, restoration ecology) play an important role in facing the new challenges.

Increasing climate and land-use changes at the global and local scales needs researches and applications to find long lasting solutions for a sustainable development.

The knowledge of biodiversity, from bacteria to fungi, plants and animals and of their relationships with the abiotic factors are the base to provide tools for quality evaluation, restoration and monitoring for a sustainable management in agriculture, forestry and other land-uses, as well as in more or less polluted or degraded areas. These highly interdisciplinary topics, considering the relationships between biotic and abiotic factors, as well as the soil at their interface, requires the involvement of expertise from different fields of studies, from biodiversity related to all groups of organisms, to climate, geology and



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pedology, natural and agricultural resource management, biotechnologies, including the reproduction and multiplication of biological materials and chemical analyses.

In Piedmont there are excellent expertise in these fields but, as highlighted elsewhere, they operate in separate systems, which are often not in contact with each other and are not efficiently connected to the agricultural and industrial systems. Building an interactive system that will interconnect the research and the productive systems is needed to face the future challenges both in economy and ecology.

We can identify the following potential research areas:

- Evaluation of the environmental quality (air, soil, water), in terrestrial and aquatic ecosystems by the use of bioindicators
- Estimation of Environmental Impact Assessment (EIA)
- Pest Risk Analysis (PRA) for exotic species (fungi, plants and animals)
- Monitoring indoor and outdoor environmental quality both in terrestrial and aquatic ecosystems
- Estimation of the economic value of natural capital and ecosystem services
- Bioremediation of polluted areas and polluter industrial wastes
- Ecological restoration of disturbed or degraded ecosystems
- Restoration of degraded urban or extraurban environments.

J1.Publications:

- a. **M. Negro, G. Vacchiano, R. Berretti, D.E Chamberlain, C. Palestini, R. Motta, A. Rolando**, Effects of forest management on ground beetle diversity in alpine beech (*Fagus sylvatica* L.) stands. *Forest ecology and Management*, 328: 300-309 (2014)
- b. **B. Anastasi, F. Spina, A. Romagnolo, V. Tigini, V. Prigione, G.C. Varese** Integrated fungal biomass and activated sludge treatment for textile wastewaters bioremediation. *Bioresource Technology*, 123: 106-111 (2012)
- c. **M. Galvagno, G. Wohlfahrt, E. Cremonese, M. Rossini, R. Colombo, G. Filippa, T. Julitta, G. Manca, C. Siniscalco, U. Morra di Cella, M. Migliavacca** Phenology and carbon dioxide source/sink strength of a subalpine grassland in response to an exceptionally short snow season. *Environmental Research Letters*, 8 (2): 25008-25018 (2013)

J2.Industrial collaborations:

EcoBioQual srl, A.N.T. Ltd (AgriNewTech Ltd), Burgo Ardennessa (Belgium), Kungliga Tekniska Hogskolan (Sweden), Environment Park (Italy), CCS Aosta Srl (Italy), Asja Ambiente Italia (Italy), Agoren.



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J3.Spin-off:

VIVISOIL, a spin-off society that proposes a limitation in the use of pesticides, fertilizers and herbicides that reduce microbial biodiversity in soil.

BIOSFERED Ltd. mission is to produce plant extracts identified and titrated with the latest techniques of mass spectrometry.

J4.European and National projects:

- FP7-INFRASTRUCTURES No. 312251 - MIRRI project is aimed to the creation of a pan-European research infrastructure that provides access to certified collections of microorganisms, their derivatives (DNA, RNA, metabolites, etc.) and the relative information about the physiology and genetics of these organisms.

- LIFE Carabus project includes innovative actions, aimed to integrate the issues of environmental protection with the land planning and sustainable development.

The project aims to reduce the threat of extinction of the species *Carabus olympiae* by establishing a model of forest management aimed at the restoration of habitats while obtaining economic resources useful to the preservation of the species.

- LIFE Xero-Grazing (DBIOS and DISAFA) on environmental quality and biodiversity conservation in grasslands

- CRT project (DBIOS, DISAFA, DSV and DSSPP) on the creation of a unique UNITO platform to joint together and harmonize all the main microbial collections that will become the core of a regional system.



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3. Green Chemistry, sustainable energy and advanced materials

In line with EU goals, the objective of Green Chemistry is to trigger the development of biobased industries, through a holistic approach to innovation, aimed at revitalizing chemistry in the name of environmental, social and economic sustainability. In particular it aims to facilitate the transition from a product-based economy to a system-based economy, starting from the valorization of local areas and the collaboration of the different public and private stakeholders. The objective is to maximize the impact of research and innovation, to meet world challenges in a synergic way and to channel resources towards common goals.

The major and most recent player in the field is the National Technological Cluster of Green Chemistry which was founded by the three major industrial players representing the entire Italian chemical industry and its vocation to sustainability and innovation. The DCH, DISAFA, DBIOS and DES are active partners of the aforementioned CLUSTER and have already developed synergic activities alongside with local industries, SMEs, research centers, foundations, regional innovation centers and many other entities all members of the National Cluster and active in the promotion of innovation and technology transfer.

Expected impacts coming from the aggregation of the Departments in Città delle Scienze, in the field of Green Chemistry and Advanced Materials are:

- increase in industrial research activities in Piedmont region;
- attraction of investments in Research & Development activities
- spin-off from research activities;
- improvement of infrastructures and research facilities
- training of highly-specialized professionals in support of productive sectors and local areas;
- introduction of new bio-based products
- increase of direct and indirect employment, connected with the development of biomaterials;
- new opportunities for the relaunch of agricultural economy for the cultivation of biomass (for example, valorization of marginal lands);
- know-how growth of the partners involved in the implementation of research projects;
- impacts generated by the application of technological solutions developed by the projects both in terms of new products/processes and in terms of improving performances;
- economic impact on the local areas in terms of development of the sectors affected by the proposed innovations (new-generation technologies for the production of biochemicals and biomaterials);



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Green Chemistry



Mossi & Ghisolfi
Novamont SPA "A. Bertinaria"
Syngenta
Strigolab srl
Grape Srl
Poli di Innovazione regionali
Horizon 2020/COST

Green Chemistry, sustainable energy and advanced materials

FP7 MIT INRIM

Life and Device
TiTaC srl
Cogne Acciai
Zschimmer e Schwarz Italiana S.p.a.
Buzzi Unicem S.p.a.
Italcementi S.p.a.
Thales Alenia Space S.p.a.
Eni S.p.a.
Centro Ricerche FIAT

Advanced materials



Polo di Innovazione regionale Energy and Clean Technologies
FP7
Haldor Topsøe A/S
Versalis S.p.A.
Centro Ricerche FIAT

Sustainable energy

K. Green Chemistry

This topic involves the Departments of Earth Science, Chemistry, Life Science and System Biology

The development of **bioeconomy and sustainable supply chains** based on locally produced biomasses requires a complex network of actors and a shared expertise. Interdisciplinarity is intrinsic to bioeconomy and a close cooperation in a network of complementary research and industry stakeholders is crucial to its success.

This network comprises agricultural and wood biomass producers of all sizes and the industrial sector, including the traditional chemical industry. The current trend sees this industry not as a competitor of bioeconomy, but rather as one of its main drivers, thanks to technologies for the **integration of sustainable raw materials in traditional industrial process**.

Research institutions play a crucial role in this integration. The Departments of Chemistry, DISAFA, DBIOS, DES are already locally aggregated in a "Green Chemistry Cluster" and participate as a single actor to the National Green Chemistry Cluster SPRING.



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The collaborations among these Departments and the territory spans the following subjects.

Concerning GREEN PRODUCTS:

- Recovery and reclaiming agricultural and wood residues for the production of monosaccharides, levulinic, lactic and glycolic acid, γ -valerolactone, secondary biologically active metabolites, functional nutrients.
- Recovery of humic substances from digested bio-wastes by means of basic hydrolysis processes and their use as raw materials for the production of bio-based chemicals (fertilizers, animal feed additives, surfactants, emulsifiers, photosensitizers, nanostructured materials).
- Bioplastics from digested bio-wastes and lignin wastes
- Biodegradable lactic acid oligomers and lactic-glycolic acid co-oligomers (also for drug delivery purposes)
- Sustainable and functional packaging materials for increased post-harvest value

Concerning GREEN EXTRACTION TECHNIQUES:

- Ultrasound (acoustic and hydrodynamic cavitation) pre-treatment of biomass for the production of high added value intermediates: terpenoids, polyphenols, carotenoids, etc.
- Microwave techniques for steam distillation and subcritical water extraction of essential oils, pectins and other high added-value heat sensitive substances (alternative to organic solvents)
- Optimization of biomass fractionation with respect to cellulose, hemicellulose, lignin

Concerning GREEN PROCESSING:

- Homogeneous catalysis (organic Brønsted strong acids, sulphonimides)
- Enzymatic catalysis (conversion of catechol for the production of poly-amides, biohydrogen production)
- Metabolic and protein engineering for the production of biofuels
- Heterogeneous catalysis (solid acids and superacids – zeolites, sulphated oxides, supported metal nanoparticles) for hydrogenation, alkylation, oxidation and isomerization reactions.
- Homogeneous and heterogeneous Photocatalysis for synthetic purposes: glycerol upgrade, hydrogen production, CO₂ activation. See also the chapter “Sustainable Energy”.
- Organocatalysis for solvent-free production of peptides.
- Analysis of pyrolysis processes

K1.Publications:

- a. **S. Tabasso, G. Grillo, D. Carnaroglio, E. C. Gaudino, G. Cravotto** Microwave-Assisted gamma-Valerolactone Production for Biomass Lignin Extraction: A Cascade Protocol, *Molecules*, 21 (2016)
- b. **V. Prigione, I. Grosso, V. Tigini, A. Anastasi and G. C. Varese** Fungal Waste-Biomasses as Potential Low-Cost Biosorbents for Decolorization of Textile Wastewaters, *Water*, 4, 770-784 (2012)



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- c. **M. Arizzi, S. Morra, M. Pugliese, M. L. Gullino, G. Gilardi, F. Valetti** Biohydrogen and biomethane production sustained by untreated matrices and alternative application of compost waste, *Waste Management*, 56, 151-157 (2016)
- d. **D. Massa, D. Prisa, E. Montoneri, D. Battaglini, M. Ginepro, M. Negre, G. Burchi** Application of municipal biowaste derived products in Hibiscus cultivation: Effect on leaf gaseous exchange activity, and plant biomass accumulation and quality, *Scientia Horticulturae*, 205, 59-69 (2016)
- e. **Manzoli, F. Menegazzo, M. Signoretto, D. Marchese** Biomass Derived Chemicals: Furfural Oxidative Esterification to Methyl-2-furoate over Gold Catalysts, *Catalysts*, 6 (2016)

K2.Industrial collaborations.

Isagro, Novamont, Syngenta, Acea Pinerolese, Biochemtex, Materbiotech, GNOSIS SpA, BIOCHEMTEX SPA (Italy), INNOVHUB (Italy), TEINT FIL sarl (France), IMD technologies (Lithuania), Radici Chimica S.p.A (Italy), Teknologian tutkimuskeskus VTT (Finland), Novamont SPA(Italy)

K3.Spin-off:

Strigolab srl, Grape

K4.European and national projects:

EnvironBOS (Isolation, Characterization and screening of environmental applications of Bio-Organic substances obtained from urban biomasses) Project id: 269128.

STABIWINE (Use of biopolymers for sustainable stabilization of quality wines) Project id: 314903.

"Bioconversion of lignocellulose industrial waste into building blocks for greener technologies" passed the first stage selection procedure of the H2020-NMBP-2016-2017 – Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing; Biotec-02-2016 Bioconversion of non-agricultural waste into biomolecules for industrial applications.

L. Sustainable energy

This topic involves the Departments of Chemistry and Life Science and Systems Biology

Sustainable energy research develops at the crossroad of chemistry, physics and biology. In addition to the research activities on biomasses described in the previous chapters of this project, specific research efforts on the fundamental science and technologies underlying sustainable energy systems is pursued in the Departments of the Città delle Scienze. New and more efficient processes, new materials and improved fuel technologies are at the core of this area of research, which relies on a strong tradition of studies in Catalysis and Materials Science.

The main subjects of research are:

- CO₂ separation, capture and activation



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- Hydrogen production and storage
- Natural gas and biogas processing
- Catalysis for the fuels industry
- Photovoltaics
- Thermoelectric materials.

Specific contributions from the Departments of the Città delle Scienze are:

- Design, Synthesis and characterization of novel adsorbents for CO₂ and Hydrogen based on Metal Organic Frameworks (in collaboration with University of California Berkeley and University of Oslo)
- Catalytic conversion of CO₂ to organic carbonates on inorganic microporous basic catalysts and poly-ionic liquids;
- Theoretical and experimental study of hydrogen storage in light Metal Hydrides LiBH₄ and MgH₂.
- Photoelectrochemical hydrogen production on nanostructured photocatalysts;
- Hydrogen production with hybrid inorganic-biochemical cells
- Methanol to gasoline catalysis for the valorization of natural gas
- Novel Dye-sensitized solar cells (novel dyes and cell concepts)
- Thermoelectric materials for automotive energy recovery.

L1.Publications:

- K. Sumida, D. Stuck, L. Mino, J.D. Chai, E.D. Bloch, O. Zavorotynska, L.J. Murray, M. Dinca, S. Chavan, S. Bordiga, M. Head-Gordon, J.R. Long** Impact of Metal and Anion Substitutions on the Hydrogen Storage Properties of M-BTT Metal-Organic Frameworks. *Journal of the American Chemical Society*, 135 (3), 1083-1091 (2013)
- M. Baricco, M.W. Rahman, S. Livraghi, A. Castellero, S. Enzo, E. Giamello**, Effects of BaRuO₃ addition on hydrogen desorption in MgH₂. *Journal of Alloys and Compounds*, 536, S216-S221 (2012)
- M. Corno, E. Pinatel, P. Ugliengo, M. Baricco** A computational study on the effect of fluorine substitution in LiBH₄. *Journal of Alloys and Compounds*, 509, S679-S683 (2011)
- T.M. McDonald, J.A. Mason, X.Q. Kong, E.D. Bloch, D. Gygi, A. Dani, V. Crocella, F. Giordanino, S.O. Odoh, W.S. Drisdell, B. Vlaisavljevich, A. L. Dzubak, R. Poloni, S. K. Schnell, N. Planas, K. Lee, T. Pascal, L. W. F. Wan, D. Prendergast, J. B. Neaton, B. Smit, J. B. Kortright, L. Gagliardi, S. Bordiga, J. A. Reimer, J. R. Long** Cooperative insertion of CO₂ in diamine-appended metal-organic frameworks. *Nature*, 519 (7543), 303-+ (2015)
- F. Sordello, C. Minero** Photocatalytic hydrogen production on Pt-loaded TiO₂ inverse opals. *Applied Catalysis B-Environmental*, 163, 452-458 (2015)
- S. Morra, F. Valetti, V. Sarasso, S. Castrignano, S.J. Sadeghi, G. Gilardi** Hydrogen production at high Faradaic efficiency by a bio-electrode based on TiO₂ adsorption of a new FeFe⁻-hydrogenase from *Clostridium perfringens*. *Bioelectrochemistry*, 106, 258-262 (2015)



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- g. **U. Olsbye, S. Svelle, M. Bjorgen, P. Beato, T. V. W. Janssens, F. Joensen, S. Bordiga, K. P. Lillerud** Conversion of Methanol to Hydrocarbons: How Zeolite Cavity and Pore Size Controls Product Selectivity. *Angewandte Chemie-International Edition*, 51 (24), 5810-5831 (2012)
- h. **F. Bella, C. Gerbaldi, C. Barolo, M. Gratzel** Aqueous dye-sensitized solar cells. *Chemical Society Reviews*, 44 (11), 3431-3473 (2015)
- i. **A. Castellero, C. Fanciulli, R. Carlini, G. Fiore, P. Mele, F. Passaretti, M. Baricco, M.** Effect of processing routes on the synthesis and properties of Zn₄Sb₃ thermoelectric alloy. *Journal of Alloys and Compounds*, 653, 54-60 (2015)
- j. **V. Poliotto, S. Morra, S. Livraghi, F. Valetti, G. Gilardi, E. Giamello** Electron transfer and H₂ evolution in hybrid systems based on [FeFe]-hydrogenase anchored on modified TiO₂ *International Journal of Hydrogen Energy*, 41, 10547-10556 (2016)

L2. Industrial collaborations.

Centro Ricerche FIAT S.C.P.A., Versalis S.p.A. (Eni S.p.a.), Haldor Topsøe A/S

L3. European and national projects:

SSH2S (Fuel Cell Coupled Solid State Hydrogen Storage Tank) Project id: 256653

BOR4STORE (Fast, reliable and cost effective boron hydride based high capacity solid state hydrogen storage materials) Project id: 303428

ECOSTORE (Novel Complex Metal Hydrides for Efficient and Compact Storage of Renewable Energy as Hydrogen and Electricity) Project id: 607040

MATESA (Advanced Materials and Electric Swing Adsorption Process for CO₂ Capture) Project id: 608534

NANOMOF (Nanoporous Metal-Organic Frameworks for production) project id: 228604

FLYHY (Fluorine substituted High Capacity Hydrides for Hydrogen Storage at low working temperatures) Project id: 226943

INNOVASOL (Innovative Materials for Future Generation Excitonic Solar Cells) Project id: 227057.

M. Advanced materials

This topic involves the Departments of Chemistry, Physics, Life Science and Systems Biology and Veterinary Science

The studies on materials for the energy sector described in the previous chapter stem from a more general long standing tradition in materials synthesis and characterization at the University of Torino. This tradition dates back to pioneering studies on molecule-surface interactions, which have gradually evolved into an international leadership in the field of experimental and theoretical studies of gas-solid interactions. Characterization of materials interaction with advanced *in situ* and *in operando* spectroscopic techniques, both at the lab scale and at synchrotron facilities, is the core of this field of research. **The main applications are to be found in industrial catalysis.**

In recent years, this research focus on the chemistry of surfaces has found new energies in the interdisciplinary collaborations between chemists, physicists and biologists gathered in the NIS (Nanostructured Interfaces and Surfaces) Inter-Department Centre (see above). Within these



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collaborations a decade of work on nanostructured materials has flourished. Among the main interdisciplinary fields we could cite **nano-fabrication of functional surfaces, surface-cell interactions** (with particular regard to neurons), **nanocomposites, functional nanostructured polymers, novel carbon based structures, nanoarrays for biotechnological applications**. Novel superconducting materials, such as oxides like $\text{Bi}_2\text{Sr}_2\text{CaCu}_2\text{O}_{8-\delta}$ (Bi-2212) are investigated. These are also relevant to the energy sector through various applications like energy transmission systems, energy generation systems (asynchronous generators), and energy harvesting systems.

A second direction of research in local materials science is **advanced metallurgy**. Torino groups are leaders in the field of metallic glasses, with contributions both to the fundamental theory underlying their formation, as well as to their industrial applications. Recently, this research line has led to the development of novel nanoporous metals with peculiar chemical and spectroscopic properties.

Another direction of research is represented by biomedical materials, focusing on studies for cardiovascular implantable prostheses, artificial organs and biological interfaces.

Finally, it is worth mentioning a cross-cutting research field affecting all areas of materials research in Torino: the development of algorithms and programs for ***ab initio* quantum mechanical modeling of solids**. The CRYSTAL code is both a fundamental reference in this field and a commercial success, with hundreds of licenses distributed worldwide at academic and industrial research institutions.

M1.Publications:

- a. **S. Bordiga, C. Lamberti, F. Bonino, A. Travert, F. Thibault-Starzyk** Probing zeolites by vibrational spectroscopies. *Chemical Society Reviews*, 44 (20), 7262-7341 (2015)
- b. **S. Bordiga, E. Groppo, G. Agostini, J. A. van Bokhoven, C. Lamberti** Reactivity of Surface Species in Heterogeneous Catalysts Probed by In Situ X-ray Absorption Techniques. *Chemical Reviews*, 113 (3), 1736-1850 (2013)
- c. **F. Picollo, S. Gosso, E. Vittone, A. Pasquarelli, E. Carbone, P. Olivero, V. Carabelli** A New Diamond Biosensor with Integrated Graphitic Microchannels for Detecting Quantal Exocytic Events from Chromaffin Cells. *Advanced Materials*, 25 (34), 4696-4700 (2013)
- d. **F. Trotta, M. Zanetti, R. Cavalli** Cyclodextrin-based nanosponges as drug carriers. *Beilstein Journal of Organic Chemistry*, 8, 2091-2099 (2012)
- e. **M. Zanetti, A. Anceschi, G. Magnacca, G. Spezzati, F. Caldera, G.P. Rosi, F. Trotta** Micro porous carbon spheres from cyclodextrin nanosponges. *Microporous and Mesoporous Materials*, 235, 178-184 (2016)
- f. **S. Cravanzola, G. Haznedar, D. Scarano, A. Zecchina, F. Cesano** Carbon-based piezoresistive polymer composites: Structure and electrical properties. *Carbon*, 62, 270-277 (2013)
- g. **M. G. Poletti, L. Battezzati**, Electronic and thermodynamic criteria for the occurrence of high entropy alloys in metallic systems *Acta Materialia*, 75, 297-306 (2014)



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- h. **E. M. Paschalidou, F. Celegato, F. Scaglione, P. Rizzi, L. Battezzati, A. Gebert, S. Oswald, U. Wolff, L. Mihaylov, T. Spassov** The mechanism of generating nanoporous Au by de-alloying amorphous alloys. *Acta Materialia*, 119, 177-183 (2016)
- i. **R. Dovesi, R. Orlando, A. Erba, C. M. Zicovich-Wilson, B. Civalleri, S. Casassa, L. Maschio, M. Ferrabone, M. De La Pierre, P. D'Arco, Y. Noel, M. Causa, M. Rerat, B. Kirtman** CRYSTAL14: A Program for the Ab Initio Investigation of Crystalline Solids. *International Journal of Quantum Chemistry*, 114 (19), 1287-1317 (2014)
- j. **A. Fantuzzi, L.H. Mak, E. Capria, V.R. Dodhia, P. Panicco, S. Collins and G. Gilardi** "A new standardised electrochemical array for drug metabolic profiling with human cytochromes P450". *Anal. Chem.*, 83, 3831–3839 (2011)
- k. **M. Castellino, V. Stolojan, A. Virga, M. Rovere, K. Cabiale, M.R. Galloni, A. Tagliaferro, A. Chemico** Physical characterisation and in vivo biocompatibility assessment of DLC-coated coronary stents. *Anal Bioanal Chem.* Jan;405(1):321-9 (2013)
- l. **M. Atzori, E. Morra, L. Tesi, A. Albino, M. Chiesa, L. Sorace, R. Sessoli** Quantum Coherence Times Enhancement in Vanadium(IV)-based Potential Molecular Qubits: The Key Role of the Vanadyl Moiety *J. American Chemical Society*, 138, 11234-11244 (2016)

M2.Industrial collaborations:

The CRYSTAL code is commercially distributed by **AETHIA-HPC Software Engineering Srl** (www.aethia.com).

Thales Alenia Space S.p.A. (advanced metallurgy and carbon materials), **Cogne Acciai Speciali** (metallurgy), **Roquette Corporate** (green chemistry), **Ahlstrom Turin S.p.A.** (paper additives), **Centro Ricerche FIAT S.C.P.A.**, **Italcementi S.p.A.** (photochemical cements), **Zschimmer e Schwarz Italiana S.p.A.** (tensides), **Sive S.p.A.** (coatings), **Evonik Industries AG & Haldor Topsøe A/S** (catalysis), **Sorin S.p.A**, **GNOSIS S.p.A**, **BIOCHEMTEX S.p.A** (Italy), **INNOVHUB** (Italy), **TEINT FIL sarl** (France), **IMD technologies** (Lithuania), **Radici Chimica S.p.A** (Italy), **Teknologian tutkimuskeskus VTT** (Finland), **Novamont S.p.A.**(Italy).

M3.Spin-off:

TiTaC srl (<http://www.titac.it/>) Applied materials science for the construction sector.

Life and Device (<http://www.lifeanddevice.com>) A service provider, specialized in studies on cardiovascular implantable prosthesis, artificial organs and, more widely, on biological interfaces.

M4.European and national projects:

AccMet (Accelerated Metallurgy - the accelerated discovery of alloy formulations using combinatorial principles) Project id: 263206.

VitriMetTech (Vitrified Metals Technologies and Applications in Devices and Chemistry) project id: 607080.



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Nanotwinning (Increase in opportunities for strategic collaboration in the field of nanotechnology via twinning of IOP with institutions of European Research Area) Project id: 294952.

PHOTOMAT (Tunable materials: preparation, characterization and investigation of photocatalytic activity of new hybrid materials) Project id: 318899.

ILSES (Metal nanoparticle interactions with bioorganic molecules and their applications in biosensing) Project id: 612620.

SetNanoMetro (Shape-engineered TiO₂ nanoparticles for metrology of functional properties: setting design rules from material synthesis to nanostructured devices) Project id: 604577.

Bioconversion of lignocellulose industrial waste into building blocks for greener technologies passed the first stage selection procedure of the H2020-NMBP-2016-2017 – Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing; Biotec-02-2016 Bioconversion of non-agricultural waste into biomolecules for industrial applications.



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4. Animal health

This topic involves the Departments of Veterinary Science

The research ranges in the various fields of Veterinary Science including:

- animal health (health and welfare of livestock and pets),
- the study of the impact of zoonoses on the environment and human health,
- antimicrobial resistance,
- all aspects of animal husbandry,
- genetics applied to livestock;
- animal reproduction.

The research topics are included in the 2014-20 National Programme for Research, particularly in relation to antimicrobial resistance, and in line with the European Union programme for research and innovation Horizon 2020 (improving the control of infectious epidemics and foodborne outbreaks through the rapid identification of pathogens).





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4.1.Publications:

- a" **L. Bertolotti, E. Muratore, C. Nogarol, C. Caruso, L. Lucchese, M. Profiti, L. Anfossi, L. Masoero, S. Nardelli, S. Rosati** Development and validation of an indirect ELISA as a confirmatory test for surveillance of infectious bovine rhinotracheitis in vaccinated herdes. *BMC Vet Res.* 8;11:300 (2015)
- b. **A. Trisciuglio, S. Zanet, G. Mareello, F. Chiesa, DM Nucera, M. Bergallo, MS. Gennero, E. Ferroglia** The use of loop-mediated isothermal amplification improves *Toxoplasma gondii* detection in wildlife. *J Vet Diagn Invest.* 27(6):754-7. (2015)
- c. **P. Accornero, S. Miretti, F. Bersani, E. Quaglino, E. Martignani, M. Baratta,** Met Receptor Acts Uniquely for Survival and Morphogenesis of EGFR-Dependent Normal Mammary Epithelial and Cancer Cells, *PLOS ONE*, 7, (2012).
- d. **P. Accornero, S. Miretti, F. Bersani, E. Quaglino, E. Martignani, M. Baratta** Pattern of Tick Aggregation on Mice: Larger Than Expected Distribution Tail Enhances the Spread of Tick-Borne Pathogens. **Plos One**, 7 (2012)
- e. **L. Ferreri, M. Giacobini, P. Bajardi, L. Bertolotti, L. Bolzoni, V. Tagliapietra, A. Rizzoli, R. Rosa** Plos Computational Biology 10: 1-12, (2014)
- f. **P. Peretto,** Therapeutic potential of neural stem cells: Greater in people's perception than in their brains, *Frontiers in Neuroscience*, 8, 79 (2014)
- g. **E. Cattaneo, L. Bonfanti** CSPG4-specific immunity and survival prolongation in dogs with oral malignant melanoma immunized with human CSPG4 DNA. *Frontiers In Neuroscience* 8: 1-3 (2014)
- h. **F. Riccardo; S. Iussich; L. Maniscalco; S. Lorda Mayayo; G. L. Rosa; M. Arigoni; R. De Maria; F. Gattino; S. Lanzardo; E. Lardone; M. Martano; E. Morello; S. Prestigio; A. Fiore; E. Quaglino; S. Zabarino; S. Ferrone; P. Buracco; F. Cavallo** PA28ab Reduces Size and Increases Hydrophilicity of 20S Immunoproteasome Peptide Products. *Clinical Cancer Research*, 20: 3753-3762 (2014)
- i. **F. Raule, N. Cerruti, N. Benaroudj, R. Migotti, J. Kikuchi, A. Bachi, A. Navon, G. Dittmar, P. Cascio** Morphine hyperalgesia gated through microglia-mediated disruption of neuronal chloride homeostasis. *Chemistry & Biology* : 470-480 (2014)
- j. **F. Ferrini, T. Trang, Theresa-Alexandra M. Mattioli; S. Laffray; T. Del 'guidice, LE Lorenzo, A. Castonguay, N. Doyon, W. Zhang, Antoine G. Godin; D. Mohr, S. Beggs, K. Vandal, JM Beaulieu, CM Cahill, MW Salter; Y. De Koninck** Solid Lipid Nanoparticles for Potential Doxorubicin Delivery in Glioblastoma Treatment: Preliminary In Vitro Studies. *Nature Neuroscience* 16: 183-192 (2013)
- k. **Battaglia; M. Gallarate; E. Peira; D. Chirio; E. Muntoni; E. Biasibetti; Mt. Battaglia L, Gallarate M, Peira E, Chirio D, Muntoni E, Biasibetti E, Capucchio MT, Valazza A, P.P Panciani, M. Lanotte, D. Schiffer, L. Annovazzi V. Caldera, M. Mellai, C. Riganti**, Solid lipid nanoparticles for potential doxorubicin delivery in glioblastoma treatment: preliminary in vitro studies. *Journal of Pharmaceutical Sciences* 103: 2157-2165 (2014).

4.2. Industrial collaborations with companies in the medical/pharmaceutical sector (CEVA (France), OASMA (Sweden), Fatro, Zoetis, Merck, MSD, Agrolabo, Bracco Imaging (Bracco Group) Research and Development (Suisse), Pharmalink international limited.



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4.3. Spin-off

In3 Diagnostic: it develops diagnostic kits based on the most updated scientific research and offers a innovative platform of laboratory assays for the control of animal infectious diseases.

4.4. Inventions

-Patent n.: MO2014A000083 (31/3/2014). "Nanoparticelle lipidiche solide per veicolare farmaci antitumorali oltre la barriera emato-encefalica, in particolare per il trattamento dei tumori cerebrali.", Inventors: Battaglia Luigi, Gallarate Marina, Peira Elena, Chirio Daniela, Muntoni Elisabetta, Gastaldi Lucia, **Biasibetti Elena**, **Capucchio Maria Teresa**, **Valazza Alberto**, Panciani Pierpaolo, Lanotte Michele, Schiffer Davide, Annovazzi Laura, Caldera Valentina, Mellai Marta, Riganti Chiara.
- Patent n. EP15167043: "Kit and in vitro method for identifying Bovine Herpes Virus 1 infections" Inventors: **Rosati Sergio**, **Profitti Margherita**, **Bertolotti Luigi**

-Patent number: 102015000088978 (30/12/2015) "MOLECOLE DI ACIDI NUCLEICI CODIFICANTI PROTEINE CHIMERICHE CSPG4 E RELATIVI USI TERAPEUTICI UNIVERSITA' DEGLI STUDI DI TORINO"; Inventors: Cavallo Federica, **Buracco Paolo**, Riccardo Federica, Arigoni Maddalena, Quaglino Elena, Calogero Raffaele Adolfo, Ferrone Soldano

4.5. European and national projects

- Progetto CRC2013: sviluppo di un metodo diagnostico applicabile su pool di latte per la sorveglianza sanitaria dell'IBR nelle aziende bovine piemontesi
-Progetto di Ateneo-San Paolo 2012, Project title: "The cross-talk between peptidergic and non-peptidergic primary afferent fibers in chronic pain: neurotrophic factor and peptide signaling".
-2011: progetto Compagnia di San Paolo: "Tyrosine kinases receptors in canine osteosarcoma: molecular targets for innovative therapeutical strategies". Amount: 318000 euro
-Progetto di ricerca di Ateneo – anno 2011. "Sviluppo di nanoparticelle lipidiche solide (SLN) quali veicoli di farmaci antineoplastici per il miglioramento della terapia farmacologica del glioblastoma".
-NEURALSTEMIMAGING Project. (VII PQ) Imaging of the neural stem cell origin, proliferation, and fate within the stem cell niches of the mammalian brain.
-EU COST Action TD1303 European Network for Neglected Vectors and Vector-Borne Infections (EURNEGVEC) <http://www.eurnegvec.org/>
-EU COST Action TD1404 Network for Evaluation of One Health Initiatives (NEOH) <http://neoh.onehealthglobal.net/>
-2011: Project funded by the Ministry of Science and Innovation of the Spanish Government: Influence of the progesterone receptor in the tumor suppressor role of canine mammary carcinoma myoepithelial cells: in vivo and in vitro studies. Project number AGL2011-025553. Amount 78650 euro.



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4.6. The relation with 'One World, One Health' approach

“One Health is the integrative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and the environment. Together, the three make up the One Health triad, and the health of each is inextricably connected to the others in the triad. Understanding and addressing the health issues created at this intersection is the foundation for the concept of One Health” [American Veterinary Medical Association].

One Health recognizes that the health of people is connected to the health of animals and the environment. The goal of One Health is to encourage the collaborative efforts of multiple disciplines-working locally, nationally, and globally-to achieve the best health for people, animals, and our environment.

A One Health approach is important because 6 out of every 10 infectious diseases in humans are spread from animals.

The aim of One health approach is to learn about how diseases spread among people, animals, and the environment.

There are many examples that show how the health of people is related to the health of animals and the environment. For instance, some diseases can be shared between animals and people. These diseases are known as zoonotic diseases.

Animals also share our susceptibility to some diseases and environmental hazards. Because of this, they can serve as early warning signs of potential human illness.

One Health is not a new concept, but it has become more important in recent years. This is because many factors have changed interactions between people, animals, and our environment. These changes have led to the emergence and reemergence of many diseases.

(<https://www.cdc.gov/onehealth/>)

In conclusion, the aggregation of Departments of the University of Turin discussed in this document, appears as strictly related to a second settlement of the same university, named *“Parco della Salute”*. They both are scientific hubs which concern about health issues at various levels and in different research fields, that may be integrated in a common driver-development framework.

In this perspective can be set up the integrated vision “One World one Health”: a vision in which health-care is pursued dealing with the human, animal and environmental one.

This ambition finds an effective convergence in these two major hubs of the University of Turin: *“Città delle Scienze”* for the environmental and animal health-care and *“Parco della Salute”* for the human health-care.



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Legend of Acronyms

- DISAFA – Department of Agricultural, Forest and Food Sciences
- DHC – Department of Chemistry
- DSV – Department of Veterinary Sciences
- DIFIS – Department of Physics
- DES – Department of Earth Sciences
- DBIOS – Department of Life Sciences and Systems Biology
- SAMEV – School of Agriculture and Veterinary medicine
- NIS - Nanostructured Interfaces and Surfaces Center of Excellence
- CRISDI - InterDepartmental Center of Diffractometric Crystallography
- IRIS - Interdisciplinary Research Institute on Sustainability
- NatRisk - Research Centre on Natural Risks in Mountain and Hilly Environments
- CISAO - *Centre Interdépartemental de Recherche et Coopération Scientifique et Technique avec les Pays du Sahel et de l'Afrique de l'Ouest*