Department of Molecular Biotechnology and Health Sciences

Book Research Lines

- Bachelor's Degree in Biotechnology
- Master's Degree in Molecular Biotechnology
- Master's Degree in Biotechnological and Chemical Sciences in Diagnostics
INTRODUCTION

The Book has been produced in Italian and English with the main purpose of illustrating the main Lines of Research of the faculty members of the courses of study pertaining to the Department of Molecular Biotechnology and Health Sciences: Bachelor's Degree in Biotechnology, Master's Degree in Molecular Biotechnology and Master's Degree in Biotechnological and Chemical Sciences in Diagnostics.

The Book contains in the first part the Lines of Research of the faculty members of the four sections of the Department (Biology, Chemistry, Hematology and Immunology) and in the second part the Lines of Research of faculty members of other Departments of the University of Turin who teach in the three courses pertaining to the Department of Molecular Biotechnology and Health Sciences.

The index also allows interactive browsing: simply click on the Research Line to be referred to the relevant page.

To contact faculty members, please consult the University directory (https://rubrica.unito.it/) through which their contact information (email and office number) can be obtained.

The Book is not exhaustive, but it gives an overview of the main Lines of Research related to teaching activities.

All students are invited to the BiotechLab day scheduled on September 27, 2022, from 2:30 pm to 5:30 pm during which it will be possible to speak directly with representatives of the various Research groups.

Wishing you a good browsing, we look forward to seeing you there on September 27!

Prof. Franco Novelli Director of the Department of Molecular Biotechnology and Health Sciences
Prof. Marina Marchisio Deputy Director for Teaching of the Department of Molecular Biotechnology and Health Sciences
Prof. Paola Defilippi President of the Bachelor's Degree in Biotechnology and Master's Degree in Molecular Biotechnology
Prof. Enzo Terreno Referring professor of the Master's Degree in Biotechnological and Chemical Sciences in Diagnostics
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BIOLOGY SECTION
Adaptor proteins in synaptic plasticity
Teacher: Prof. Paola Defilippi PO Applied Biology
Collaborators: Dr. Alessandro Morellato, Post Doc

Research lines
Protein-protein interactions are essential for the construction of the dendritic spine, whose alterations are involved in the onset of multiple cognitive deficits. The p140Cap and SKT family of proteins are well expressed in neurons, with an enrichment in synaptic structures. Thanks to cellular and transgenic animal models, we study their role in the remodeling of the dendritic spine and their interactors. Furthermore, with differentiation experiments from human pluripotent cells we want to understand their involvement in the physiology and pathology of human neurons.

Projects:
1) Role of the p140Cap protein in the control of tumor microenvironment
2) Role of the p140Cap protein in drug resistance
3) Role of the p140Cap protein in cell metabolism
Computational genomics and gene networks - Interactions and gene networks
Teacher: Prof. Emilio Hirsch - SSD: BIO/13

Research lines

Role of PI3K in signalling pathway and human diseases

• Role of Class II PI3Ks in vesicular trafficking

• Impact of Class II PI3Ks in cell division and breast cancer progression

• Regulation of Class II PI3Ks during cytokinesis and senescence

• Employment of genetically-engineered animal models to study human diseases
Development of the neuroendocrine system

Migration, differentiation and vulnerability of GnRH gonadotropic neurons, in different models.
Teachers: Prof. Giorgio Merlo; Prof. Patrizia Bovolin (University of Turin, Department of Systems Biology); Prof. Astrid Saraceni (University of Turin, Department of Systems Biology)

Research lines

The hypothalamic gonadotropic neurons are fundamental for sexual maturation and fertility. We are studying their migration, their differentiation, their connectivity and their sensitivity to the harmful effects of exposure to environmental and food contaminants known as Endocrine Disruptors. We are using both the mouse and the zebrafish models.

1 place available for internship + master degree thesis
Gene expression control in tumour biology and heart auto-immunity
Teacher: Prof. Valeria Poli - SSD: BIO/11

Research lines

Gene expression control in tumour biology and heart auto-immunity, with a focus on the inflammatory axis IL6-STAT3

- Mechanisms of cross-talk between tumor cells and Cancer Associated Fibroblasts (CAFs) in breast cancer.
- Identification and functional validation of regulatory networks and novel therapeutic targets in breast cancer.
- Non-canonical roles of STAT3 in the endoplasmic reticulum to regulate apoptosis resistance in breast cancer.
- Disentangling the relationships with tumor microenvironment in prostate cancer to better model and target tumor progression via the analysis of CAFs and tumor cells/organoids derived from high risk patient samples.
- Validation and improvement of cancer neoantigen vaccines efficacy.
- Role of STAT3 and complement in heart auto-immunity, exploring innovative therapeutic options for auto-immune myocarditis
Hallmarks of Aging: molecular basis of ageing-associated syndromes
Teacher: Prof. Andrea Graziani - SSD: BIO/11

Research lines

Cell signaling in cancer-induced immune escape and cachexia

- Mechanisms of tumor-induced immune escape and immuno-aging:
  - Role of Diacylglycerol kinase alpha and SAP/SH2D1A in TCR and CAR-T ubiquitination and trafficking at the cell surface.
  - Role of Diacylglcyerol kinase alpha in regulating microtubules dynamics and energetic metabolism in antigen-activated T cells

- Mechanisms of tumor-induced cachexia:
  - Role of tumor-induced factors in the deregulation of nerve-muscle interactions and the onset of resistance of skeletal muscle to beta-adrenergic signaling.
  - Role of tumor cells senescence in driving cachexia and mRNA splicing deregulation
Heme dynamics and mitochondrial metabolism in physiology and pathology
Heme is the prosthetic group of key enzymes/proteins involved in several functions including oxygen transport and storage, cytochrome activity and mitochondrial metabolism. The major aim of our work is to understand how heme homeostasis (with a focus on heme synthesis and heme trafficking) affect cellular energetic metabolism in both physiologic and pathologic processes. Main research projects are:

- Heme dynamics in tumor initiation and progression
- Heme dynamics in muscle function
- Heme dynamics in hepatic response to dangerous stimuli
Heart Engineering & Developmental Genomics et al (HEDGe lab)
Research lines

Chromatin Biology
- The TTN locus as a gene model to study the relationship between chromatin structure and function
- The functional role of inter-chromosomal chromatin interactions

Heart Development & Disease
- Congenital heart disease due to impairment of chromatin organization dynamics in the developing myocardium
- Mechanisms behind the cardioprotective pathway downstream of Melusin

Technology Development
- Phenotype-agnostic functional screens with barcoded shRNA and CRISPR perturbations deconvoluted by single cell genomics

Cellular agriculture
- Self-sustaining and cheap to differentiate stem cells for cultivated seafood and meat
Intellectual Disability and the model in pluripotent stem cells

Investigating Intellectual Disability in vitro, with models linked to altered control of cytoskeleton.
**Teachers:** Prof. Giorgio R Merlo; Dott. Carla Liaci; Prof. Luciano Conti (Trent University, Molecular and Systems Cell Biology)

**Research lines**

The control of cytoskeleton is KEY for cellular processes such as migration, axonogenesis, synaptogenesis and plasticity of neurons during development. Some forms of Intellectual Disability are due to mutations that alter this delicate control via GTPases. We have introduced two mutations in pluripotent stem cells, in order to study the early steps in development and clarify the cellular mechanism at the basis of these pathologies.

1 place available for internship + master degree thesis
MicroRNAs and their link with adhesion and metabolism in breast cancer and melanoma progression
Teacher: Prof. Daniela Taverna
Collaborators: Dr. Francesca Orso; Dr. Lorena Quirico; Dr. Martina Coco

Research lines

- Identification and characterization of microRNAs (miRNAs) involved in tumor breast cancer and melanoma progression and their involvement in adhesion and metabolism.

- miRNAs as therapeutic targets: preparation and evaluation of oligonucleotide-based tools that can be administered in vivo for pre-clinical studies such as stabilized anti/pre-miRNAs and aptamers conjugated with anti/pre-miRNAs.

https://www.mbc.unito.it/en/research/research-areas/basic-and-applied-research/micrornas-and-adhesion-molecules-involved-tumor
Physiopathology of Heme in the Nervous System

New insights from the study of heme metabolism
Teacher: Prof. Deborah Chiabrando (RTDB)

Collaborators: Dr. Francesca Bertino (PhD student); Dr. Elisa Quarta (PhD student)

Research lines

Heme is a crucial molecule regulating different biological processes, ranging from oxygen sensing to the regulation of cell metabolism and signaling pathways. Our major research interests include:

1) Heme trafficking during the development of the nervous system
2) Identification of the molecular mechanisms underlying human neurodegenerative diseases due to mutations in the heme exporter FLVCR1
3) Dissecting the mechanisms of mitochondrial heme export/dynamics
4) Heme trafficking in brain pediatric tumors
PI3K Signaling in Cardiovascular and Pulmonary Disease
Teacher: Prof. Alessandra Ghigo - SSD: BIO/13

Research lines

● Cardio-Oncology:
  ○ Study of the molecular mechanisms underlying the cardiotoxicity of anti-cancer treatments (e.g., radiotherapy and chemotherapy).
  ○ Identification of pharmacological targets for the prevention and the treatment of anti-cancer therapy-related cardiotoxicity, with a major focus on PI3K.

● Obstructive and Restrictive Airway Diseases:
  ○ Study of the molecular mechanisms underlying obstructive (Cystic Fibrosis, Chronic Obstructive Pulmonary Disease, Bronchiectasis) and restrictive (Idiopathic Pulmonary Fibrosis) airway diseases.
  ○ Validation of new therapeutic targets for the treatment of obstructive and restrictive airway diseases, with a major focus on PI3K.
Protein-protein interactions and human cancer signalling

The p140Cap protein’s role in breast cancer and neuroblastoma
The group identified and characterized at genetic and functional level adaptor proteins that build molecular platforms downstream the signals generated by integrins and/or tyrosine-kinase receptors. Among these, the p130Cas and p140Cap scaffold proteins have been extensively studied in cellular and animal models, providing evidence of their role in controlling the molecular signaling leading to cytoskeletal organization, cell motility and invasion, key mechanisms for cellular cancer progression.
Role of chaperone proteins in cancer progression and in cardiac diseases
The role of chaperone proteins in cancer progression and in cardiac diseases

CANCER:
- Chaperone role in cancer
- Extracellular chaperones and tumour microenvironment

HEART AND MUSCLES:
- Chaperone role in cardiac metabolism and signaling
- Chaperones as player in muscular atrophy

GREEN:
- Heat shock proteins as biomarkers of climate change in Alpine ecosystems
Stem Cell Biology

Role of mTOR signalling pathway in epithelial stem cells and cancer therapeutic responses
Research lines

- Role of mTOR signaling in epidermal stem cells
- Role of mTORC2 signaling in melanoma therapeutic resistance
- Role of mTORC2 signaling in breast cancer stem cells
Targeting metabolic symbiosis in cancer
**Teacher:** Prof. Paolo Ettore Porporato  
**Collaborators:** Dr. Alessio Menga

**Research lines**

We will address the role of iron metabolism in fueling tumor growth and body wasting in lung cancer, with a particular focus on the alteration of mitochondrial metabolism and tumor aggressiveness.
Understanding Kras-driven biology and tumorigenesis
Teacher: Prof. Chiara Ambrogio

Research lines

• Characterizing in vitro and in vivo the KRAS signalosome
• RAF kinases localization at the membrane: a key feature to sustain oncogenic mapk activity?
• Drug screening and mechanisms of resistance
Cancer cell signaling
Teacher: Prof. Miriam Martini, PhD (Responsabile Scientifico) - SSD BIO/13
Collaborators: Dr.ssa Maria Chiara De Santis, PhD (postdoc); Dr. Andrea Costamagna (postdoc); Damiano Abbo, Msci (PhD student), Noemi Ghiglione, Msci (PhD student); Anastasia Bushunova, MD (PhD student), Martina Sicuro, BSci (undergraduate).

Research lines
Pancreatic cancer biology

• Characterization of glutamine sensing mechanisms and therapeutic perspectives

• Study of molecular mechanisms regulating mTOR signaling pathways

• Identification of cell of origin of pancreatic ductal adenocarcinoma (PDAC)
CHEMISTRY SECTION
Brain Networks

Imaging of brain circuits and connectivity
Research lines

• Brain networks
  o Development of neuroimaging methods, particularly Magnetic Resonance Imaging, for the study of brain connectivity and its derangement in neuropsychiatric disorders. We combine advanced imaging techniques, image analysis and modeling to identify markers of brain disease and response to therapy.
Design of PROTACs
Design of PROTACs

- Development and application of experimental and computational strategies for optimizing PROTACs in terms of "drug-like" properties
- De novo design of PROTACs directed against validated oncology targets
Diamond Lab

Nanodiamonds for bioimaging
Teacher: Prof. Angelo Bifone

Research lines

• Optically Detected Magnetic Resonance
  
  o Development of novel imaging probes based on color centers in nanodiamonds for Magnetic Resonance spectroscopy and imaging.
Mass Spectrometry Laboratory
**Teachers:** Prof. Claudio Medana; Prof. Federica Dal Bello

**Research lines**

**Peptides quantification:** Endogenous peptide identification and quantification in biological matrices; **Allergens:** Protein allegens analysis in Novel food; **Protein/peptides Biomarker research** by SPE/digestion/SDS page/top down/bottom up approaches and nanoHPLC-HRMS

**Bioactive compounds analysis:** identification and quantification of small molecules in vegetable matrices; **Biomarker discovery:** research of new metabolites in biological pathways by SPE/LLE and HPLC-MS/MS (trip quad) with Chemometrics approaches
**Research lines**

**Volatile organic compounds:** Drinking water pollutants (Sample prep/Purge & Trap extraction); Quantitative analysis by GC-MS (EPA8260); **Heavy metals:** Drinking water pollutants (quantitative analysis by ICP-MS); **Inorganic ions:** Drinking water micro components; Quantitative analysis by IC-conductivity; **Toxins:** Freshwater toxins by LC-MS/MS (triple quad)
Thesis tutor:
Prof. Claudio Medana
Prof. Federica Dal Bello
Dr. Riccardo Aigotti

PhD Students
Alberto Asteggiano
Enrica Mecarelli
Sandra Vietti Michelina
Sandra Zeaiter

Undergraduate students
Alessandra Bui
Anabel Marani
Marta Librizzi
Valentina Schiavo

and

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In Our Lab
- GC-MS (gas chromatography - ion trap mass spectrometry, EI, CI sources)
- HPLC-IT MS (liquid chromatography – MS, ion trap analyzer, ESI, APCI sources)
- UPLC-TQ MS (liquid chromatography – MS, triple quadrupole analyzer, ESI, APCI sources)
- HPLC-OT MS (nano liquid chromatography – HRMS, orbitrap analyzer, nESI, h-ESI sources)
- Sample preparation (Purge&trap/SPE/SPME)
- Elemental analysis (ICP-MS)
- Inorganic ion analysis (IC, ion chromatography)
### Collaborations

**Main collaborations @ UniTO**
- Prof. Paola Calza, Dept. of Chemistry
- Prof. Ivan Norscia, Dept of Life Sciences and Systems Biology
- Prof. Manuela Aragno, Dept of Biological and Clinical Sciences
- Various researchers, Dept Molecular Biotechnology

**Other collaborations**
- Istituto di Ricerche Farmacologiche Mario Negri IRCCS, Milano, Italy
- Azienda Ospedaliero-Universitaria sede «Le Molinette»
- IZS Piemonte, Liguria, Valle d’Aosta
- Ospedale Maggiore di Novara, Nefrologia

**International collaborations**
- Paolo Giacobini PhD, INSERM, Lille
- Prof. Elisabetta Boeri Erba, IBS, Grenoble
- Prof. M.J. Lopez Munoz, RJC University, Madrid, E
- Prof. B. Kuch, University Stuttgart, D
- Prof. K.W. Schramm, Helmholtz Inst., Munich, D

**International academic agreements**
- Prof. Silvia Balbo, School of Public Health, University of Minnesota, USA
Mathematics in the field of Biotechnology

DELTA Research Group
Digital Education for Learning and Teaching Advances
Digital Education for Learning and Teaching

Advances RESEARCH GROUP
Teacher: Prof. Marina Marchisio

Collaborators: Dott.ssa Alice Barana; Dott.ssa Giulia Boetti; Dott.ssa Francesca Casasso; Prof. Alberto Conte; Dott.ssa Cecilia Fissore; Dott. Francesco Floris; Dott.ssa Valeria Fradiante; Dott.ssa Marta Pulvirenti; Ing. Sergio Rabellino; Dott. Fabio Roman; Dott. Matteo Sacchet; Dott.ssa Daniela Salusso

Research lines

• Integrated Digital Learning Environments and Learning Analytics in Open Educational Practices
• Adaptive, inclusive and data driven digital methodologies for learning and teaching scientific disciplines
• Computational Mathematical Models for Biotechnologies
• Biostatistical Methods applied in Biotechnology and Medicine

Students for year: 2
Mechanisms of permeation of molecules through mucus barriers

- Synthesis and applications of bio-inspired hydrogels
- Mucus and pathogens
- Permeability
Research lines

The focus of our laboratory is on basic mechanisms by which mucus barriers exclude, or allow passage of different drugs and pathogens (bacteria, viruses). It hopes to provide the foundation for a theoretical framework that captures general principles governing selectivity in mucus, and bacterial biofilms. In collaboration with the Politecnico of Milano the Lab’s works on synthetic gels that mimic the basic selective properties of biological gels like mucus.

Collaborations: Politecnico Milano, Università di Pavia, Bac3Gel (Lisbon), KTH (Stockholm)
Molecular Imaging group

Development of innovative diagnostic tools

• Imaging & therapy
• Imaging Contrast Agents
• Imaging metabolism
• Image analysis
Teacher: Prof. Enzo Terreno
Coworkers: Dr. Francesca Garello; Dr. Martina Capozza

Research lines

• Development of an MRI-guided theranostic protocol to boost, by acoustic stimulation, the anticancer drug release from liposomes in preclinical tumor models.
• Synthesis of targeted near infra-red (NIR) fluorescent probes for image-guided surgery and photodynamic therapy to improve cancer treatment.
• Development and validation of nuclear probes for PET/CT and SPECT/CT for tumor diagnosis and theranostics.
• Preparation of innovative nanosystems for $^{19}$F Magnetic Resonance Imaging (MRI).
Teacher: Prof. Simonetta Geninatti Crich
Coworkers: Dr. Simona Baroni; Dr. Diego Alberti; Dr. Valeria Bitonto; Dr. Sabrina Elkhanoufi; Dr. Sahar Rakhshan;
Dr. Sebastiano Micocci

Research lines

• Design and validation of novel therapeutic agents based on Boron Neutron Capture Therapy for treating Alzheimer Disease and Pleural Mesothelioma.
• Development of new radical-based probes to monitor enzymatic activity associated with inflammation and tumorigenesis
• Innovative MRI-based diagnostic techniques for determining tumor margins and aggressiveness in conservative surgery in breast and prostate cancer.
Research lines

Paramagnetic Imaging Contrast agents:
The study of paramagnetic metal (Gd, Fe, Mn) complexes starts from the synthesis of differently functionalized metal-based probes and continues to their relaxometric characterization for the in depth elucidation of the relationships between structure and dynamics of paramagnetic metal complexes and the determinants of their proton relaxation enhancement. Moreover, all the new probes are tested for their specific function in vitro (at the cellular level) and/or in vivo (in specific animal models) as Magnetic Resonance Imaging Contrast Agents.

Specific research lines include the study of:
Small-molecular weight metal complexes: Unspecific hydrophilic chemicals to visualize tumor perfusion or abnormalities in organ function or as responsive agents to tissue microenvironment parameters. A specific focus on the in vivo Gd-retention issue is also pointed out.
Blood-pool agents: metal-complexes functionalized with hydrophobic moieties which enable the binding to human serum albumin in order to increase relaxivity and the retention time in blood vessels. These complexes find application also in quantitative assessments of tumor angiogenesis by exploiting DCE-MRI (Dynamic Contrast Enhanced-MRI) approaches.
Macromolecular agents: metal-complexes are incorporated in high molecular weight systems either as part of supramolecular assemblies (liposomes, micelles, different nanoparticles) and as multimers of metal-complexes (dimers, tetramers, dendrimers).
**Research lines**

- Development of nano-based imaging probes for early diagnosis and treatment of tumor in preclinical cancer murine models
- Innovative CEST probes based on $^{31}$P detection
- Development of ligand/anti-ligand *in vitro* assays
Teacher: Prof. Francesca Reineri
Coworkers: Dr. Carla Carrera; Dr. Erika Cerutti; Dr. Ginevra Di Matteo

Research lines

Imaging metabolism:
all the diseases are associated with altered metabolic processes (e.g. the Warburg effect in cancer). We develop new imaging tools that allow to detect metabolism in vivo.

Hyperpolarized contrast agents for MRI:
MRI is a powerful diagnostic tool, but it suffers from low sensitivity. Hyperpolarization allows to increase the MR signals of some metabolites, so that we can observe metabolic processes in vivo, using magnetic resonance.
**Teacher:** Dr. Walter Dastrù

**Research lines**

- Dynamic Contrast Enhanced Magnetic Resonance Imaging
- Development of software for the analysis of MR images
Research lines

- Design of innovative contrast agents for Magnetic Resonance Imaging (MRI) and for photoacoustic imaging (PAI);

- Imaging of tumor microenvironment (pH, vascularization, hypoxia...) by Magnetic Resonance Imaging, Optical Imaging and Photoacoustic Imaging;

- Development of “smart” nanosystems for theranostic (targeted therapy & imaging) and for the development of in vitro bioanalytical assays.
Photodynamic Therapy & Photobiology
Research lines

1) Photodynamic Therapy (PDT) is an innovative and non-invasive therapeutic procedure for the treatment of superficial skin cancer and infectious diseases. The PDT is based on the photocatalytic generation of singlet oxygen by a laser irradiation of a dye, specifically delivered to the cancerogenic target cells. In our lab we perform: NIR dyes photophysical characterization by UV-Vis, steady-state, time-resolved fluorescence and fluorescence anisotropy spectroscopies. The kinetics and thermodynamics dye-protein binding parameters are in detailed investigated by stopped-flow fluorometer.

2) We use dyes to perform cancer biomarker detection in physiological samples (e.g. serum, urines) for liquid biopsy. Collaborations: MOF Lab UniTO, DBIOS UniTO, Saragoza University
Prediction of pathogenic mutations and design of therapeutic strategies
Research lines

Rare diseases

- Use of computational methods to rationalise the pathogenicity of mutated proteins through the use of bioinformatics and molecular modelling software
- Virtual drug design strategies to identify molecules capable of restoring lost functionality
Protein nanoparticles
Research lines

NanoMugs are multifunctional nanoparticles, intrinsically glycosylated, mucoadhesive and able to incorporate drugs. The one pot synthesis method allows to obtain completely functional nanoparticles within approximately 12 hours (lab scale). In one single product NanoMugs enclose a triple effect:

• Persistence in the site of infection because mucoadhesive.
• Bacterial and viral engagement by glycan-mediated binding.
• Targeted drug delivery and release; molecules with different molecular weight, charge and chemistry can be efficiently loaded during the synthesis. Drugs can be released over time because not covalently bonded to NanoMugs.
• Collaborations: Politecnico Milano, Università di Pavia, KTH (Stockholm).
HEMATOLOGY SECTION
Translational research in B-Cell Lymphomas
Research lines

• Molecular biomarkers investigation in the context of mantle cell lymphoma, follicular lymphoma and Waldenström macroglobulinemia.
• Identification of baseline prognostic and predictive biomarkers.
• Minimal residual disease (MRD) monitoring.
• Non-invasive diagnostic tools (i.e. “liquid biopsy”)
• Main technologies employed are: quantitative-Real Time PCR, Droplet Digital PCR and Next Generation Sequencing to target both genomic rearrangements (e.g. immunoglobulin VDJ, Bcl1/IGH, Bcl2/IGH) and mutations (e.g. MYD88, TP53, EZH2 and others).

Teachers: Dr. Simone Ferrero; Dr. Daniela Drandi; Dr. Elisa Genuardi

Number of students who can be accepted: variable 1-2 year. Possibility of compilative, experimental and clinical research thesis
Computer Science

Bioinformatics
**Research lines**

- Development and validation of bioinformatics tools for omics data analysis

- requirements:
  - Basic programing in R or Python.
Experimental Oncology and Genetics and Therapy of Cancer

CeRMS

Città della Salute e della Scienza di Torino

The lab mainly focuses on tumors driven by oncogenic alterations of the Anaplastic Lymphoma Kinase (ALK) gene, such as translocations and activation mutations in Anaplastic Large Cell Lymphoma (ALCL), Non-Small Cell Lung Cancers (NSCLC) and other type of solid tumors including neuroblastoma.
Research lines

• Mechanisms of transformation in ALK-driven tumors to define new therapeutic vulnerabilities and to find innovative treatments
• Discovering and validating novel mechanisms of resistance to targeted therapy in ALK-driven tumors
• Role of microenvironment in response to ALK inhibition in ALK-driven tumors
• Dissecting the role of RHO GTPases in lymphomagenesis
• Pathological role of AID in lymphomas and leukamias

Number of students who can be accommodated: 1-2/year
Novel therapeutic approaches for hematological malignancies

Our aim is to identify and validate new therapeutic targets to enhance the efficacy of current pharmacological therapies.
Research lines

- Functional screenings using shRNA, CRISPR/Cas9 and drug libraries to identify novel therapeutic targets.
- Validation of novel therapies in a panel of cell lines from hematological neoplasms and co-cultures to better represent the tumor microenvironment.
- Ex-vivo and in-vivo validation on patient-derived tumor cells, zebrafish and mouse models.
- Definition of molecular mechanisms regulating cell response to therapy.
- Exploitation of nanoparticles for targeted drug delivery selectively to tumor cells.

Number of available positions for stage and experimental thesis: 1+1
OncolImmunology

The complex interaction between cancer and the immune system and how to exploit it for the design of anti-cancer treatments
Teachers: Prof. Federica Cavallo; Prof. Elena Quaglino; Prof. Laura Conti

Research lines

- Immunotargeting of xCT as an anti-cancer strategy
- Dissecting the contribution of xCT in the complex crosstalk between cancer and immune system
- Interaction of xCT with the mTORC2/AKT pathway
- Role of Chondroitin Sulfate Proteoglycan (CSPG)4 in melanoma and osteosarcoma
- Anti-CSPG4 vaccination in client-owned dogs affected by malignant melanoma or osteosarcoma
- Role of Teneurin (TENM)4 in breast and colon cancer progression
- Immunotargeting of TENM4 as an anti-cancer strategy
- Role of Toll-like Receptor (TLR)2 in the cross-talk between breast cancer and the local microbiota
- Development of theranostic nanosystems for TLR2 targeting in breast cancer
Regenerative Medicine and extracellular vesicle lab
Research lines

Regenerative effect of EVs, with particular attention to cargo (miRNA, proteins) in models of chronic kidney damage or oncological disease.

Development of diagnostic tests based on urinary EVs as predictors of renal regenerative reserve.

Effect of bioproducts of mesenchymal stem cells (EVs, mitochondria) in pre-transplant organ perfusion
The overall goal of the research group is the characterization of the immune response in pancreatic cancer patients to develop new immunotherapeutic strategies.
Teachers: Prof. Paola Cappello; Dr. Claudia Curcio; Prof. Francesco Novelli

Team members: Dr. Alessandro Scagliotti, Dr. Silvia Brugiapaglia; Dr. Giorgia Guadagnin; Dr.ssa Giorgia Tiberi; Dr. Ermes Candiello

Research lines

- Characterization of the antibody response in pancreatic cancer patients
- Analysis of cell-mediated response in pancreatic cancer patients
- Development of pre-clinical models to design new therapeutic strategies
- Characterization of the IL17A and IL17F’s role in the progression of pancreatic ductal adenocarcinoma
- Identification of novel immuno check-point molecules

Number of students who can be enrolled: 1
Research groups from other Departments
Air Quality and Human Health
Research lines

Air pollution and Human Health

The activity mainly consists in the development and application of experimental models with the aim of acquiring laboratory evidence on the human health impacts of air-dispersed environmental mixtures.

The methods applied include microbiology and cellular/molecular biology assay:

Evaluation of the effect of airborne fine particulate exposure on in vitro cellular models by studying the alteration of genetic profiles, the expression of genes involved in DNA repair mechanisms, various cytotoxicity end points;

Evaluation of human exposure to airborne bacterial endotoxins;

Study of the biological component of the aerosol with cultural and biomolecular methods and evaluation of the associated effects on human health.
Biochemistry of cell metabolism
Biochemistry of cell metabolism

**Teacher:** Prof. Francesca Silvagno

SSD: BIO/10
Lines of research

1. Cancer metabolism
   The aim of our research is to modulate the mitochondrial respiratory activity to reduce cancer cell growth. By different approaches, we investigate the effects of molecules and extracellular stimuli able to shift the metabolic balance towards the oxidative catabolism of nutrients, at the expenses of the biosynthetic pathways necessary for proliferation. Our latest studies focus on:
   The effects of vitamin D on mitochondrial activity. Experimental models: keratinocytes, cancer cell lines, models of epithelial-mesenchimal transition
   The environmental clues driving TGF beta signaling in epithelial-mesenchymal transition of pancreatic cancer
   The signaling pathways of estrogens and SERMs modulating the mitochondrial respiratory activity of breast cancer cell lines
   The effects of extremely-low frequency electromagnetic fields (ELF-EMF) on mitochondrial activity and cancer cell proliferation, with the aim of proposing a new technological approach in oncology (in collaboration with Politecnico di Torino).

2. Tissue metabolism
   We investigate the effect of temperature on mitochondrial metabolism and the role of amino acid availability on protein expression.

3. Nutraceuticals
   We characterize the efficacy of some natural molecules on metabolism and tissue health. We study the effects of galactooligosaccharides in several tissues (in collaboration with the Institut Agricole Régional, Aosta, Italy), the activity of melatonin in tissue regeneration (in collaboration with Banca della Cute, AOU Città della Salute e della Scienza, Torino, Italy), and the antioxidant and anti-inflammatory properties of natural compounds.
Cancer Cell Biology

Cell dynamics, metabolic reprogramming and molecular signalling in 3D cancer cell models.
Teachers: Dr. Valentina Monica, Prof. Luca Primo, Prof. Alberto Puliafito  SSD: BIO/10

Collaborators: Dr. Barbara Peracino (DSCB), Dr. Laura di Blasio

Research lines

• Generation and characterization of 3D cellular models, including organoids derived from human tissues and cell aggregates.
• Development and improvement of imaging-based quantitative approaches for studying 3D cultures at cellular and molecular level.
• Exploiting metabolic reprogramming in patient-derived organoids and cancer cells.
Characterization and evolution of
-swine virome
-canine microbiome during delivery
Teach**ers:** Prof. Luigi Bertolotti; Prof. Ugo Ala; Prof. Mario Giacobini - SSD: VET/05

**Research lines**

Genetic, phylogenetic and evolutionary characterisation of pathogens (viruses and bacteria)

- Viral discovery and metabarcoding
  - Analysis of genomic sequences, using NGS techniques
  - Analysis of the structures of populations of infectious agents
- Molecular epidemiology
  - Host-pathogen interaction characterization
  - Phylogenetic evolution
Determinants of rare neurodevelopmental disorders
Research lines

Determinants of rare neurodevelopmental disorders

- Study of morpho-functional alterations underlying autism spectrum disorders by using multidisciplinary approaches:
  - role of pathogenic mutations in the development, maturation and plasticity of cortical neuronal circuits
  - role of the CDKL5 gene in processes underpinning myelin organization, intercellular communication mediated by extracellular vesicles (exosomes) and in the regulation of epigenetic and gene expression processes

- Study of the effects induced by environmental pollutants on neuronal and synaptic maturation
  - impact of exposure to sub-toxic doses of herbicides on neurotransmission
  - role of herbicides in neurodegenerative disease (e.g.: Parkinson’s Disease)

https://neuroen.campusnet.unito.it/do/gruppi.pl/Show?_id=38jd
Development of GC-MS and LC-MS/MS analytical methods for clinical and forensic investigations
Research lines

- Application of the state-of-art mass spectrometric techniques for: (1) targeted and untargeted cancer metabolomics from various biological matrices, (2) toxicological analyses of challenging alternative biological matrices (e.g., hair, oral fluid, dried blood spots), (3) workplace and roadside drug testing, (4) doping control.
- Development and application of machine learning strategies for data exploration, classification, class modelling, regression and interpretation.
- Trace analysis for forensic purposes.
Development of Imaging biomarkers

The Research Unit of Torino of the IBB-CNR is focussed on:

• Novel imaging-based approaches for characterizing tumor microenvironment and response to therapy in preclinical tumor murine models

• Design of new MRI/Optical Imaging probes for cell labelling and for quantifying the expression of molecular targets overexpressed in tumoral and/or viral pathologies

• Identification and validation of new biomarkers for early diagnosis of liver diseases and of post-transcriptional regulation of gene expression in human gastrointestinal tumors
Teacher: Prof. Dario Longo  
**Collaborators:** Dr. Antonella Carella (post-doc); Dr. Feriel Romdhane (post-doc); Dr. Alessia Corrado (PhD student); Dr. Elisa Pirotta; Dr. Riccardo Gambino; Dr. Francesco Gammaraccio; Dr. Kranthi Kandula

**Research lines**

- Development of imaging-based approaches for assessing tumor microenvironment properties (acidosis, vascularization, hypoxia) in preclinical cancer murine models
- Exploiting MRI-based techniques for non-invasive assessment of response to novel anticancer drugs in murine models
- Investigation of pH imaging as a novel biomarker for evaluating cancer aggressiveness and invasion and for monitoring renal functionality
Teacher: Dr. Valeria Menchise

Research lines

• Design of Gd(III)-based probes for cellular labelling and Molecular Imaging through Magnetic Resonance Imaging.
• Design and synthesis of peptides for ligand/antiligand analysis.
• Multimodal(MRI/OI) diagnostic procedure that relies on the use of structure based designed nanosystems, properly planned to quantify the expression of molecular targets, overexpressed in tumoral and/or viral pathologies, such as CA IX and CA XII and RBD of Sars-Cov2 Spike protein.
Research lines

Through a multidisciplinary approach including advanced molecular techniques such as RNA-seq and large-scale proteomics, as well as in vitro and in vivo studies, the two main and current research areas regard:

• Identification of circulating extracellular vesicles-based biomarkers for the early diagnosis of liver diseases.
• Studying post-transcriptional regulation of gene expression, in particular investigating the molecular mechanisms underlying the role of the RNA binding proteins and splicing factors, ESRP1 and 2, in the development of human gastrointestinal cancers.
Development of innovative immunochemical methods of analysis

- Lateral Flow Immunoassay
- Enzyme-linked immunosorbent assay
Teacher: Prof. Laura Anfossi
Collaborator: Dr. Fabio Di Nardo

Research lines

- Application of immunochemical techniques for measuring a variety of substances for clinical, environmental and food analysis.
- Prototype development: from the immunogen design to the development and validation of a working immunoassay, through i) the preparation of reagents (protein/enzyme conjugates, gold colloidal-labelled immunoreagents); ii) optimization of key parameters (reagent feature/amount, reaction times...); iii) establishment of fit-for-purpose extraction protocols from complex matrices.
Identification of molecular biomarkers and novel therapeutic targets in cancers
Teacher: Prof. Ymera Pignochino - SSD: BIO/11

Research lines

1. miRNA da esosomi plasmatici come marcatori predittivi di risposta alla terapia a bersaglio molecolare con imatinib nei tumori stromali gastro-intestinali (GIST)

2. Approcci di sequenziamento di nuova genezione per l’identificazione di biomarcatori predittivi di risposta alla terapia sperimentale con trabectedina e inibitori di PARP1 nei sacomi dei tessuti molli –studio traslazionale e clinico di fase II

3. Sviluppo di nuove combinazioni di chemio-targeted e immuno terapia in modelli preclinici di sarcomi dei tessuti molli


5. RNA circolari nel tumore polmonare non a piccole cellule: ruolo funzionale e potenziali applicazioni nella diagnosi precoce
Integrated Laboratory Techniques – Molecular Biology
Teacher: Prof. Ferdinando Di Cunto - SSD: BIO/11

Research lines

Study the functions of microcephaly genes and their role in brain tumors

- Role of microcephaly genes in mitosis
- Role of microcephaly genes in DNA damage
- Study of microcephaly genes as drug targets
- Computational approaches for the study of human disease genes
Laboratory of Immunogenetics, Department of Medical Sciences
Head of the Laboratory: Prof. Ada Funaro

Collaborators: Dr. Erika Ortolan; Dr. Enza Ferrero; Dr. Yuliya Yakymiv; Dr. Sara Marchisio

Research lines

• Study of the molecular mechanisms underlying the interaction between tumor cells and the microenvironment with particular reference to the role of ectoenzymes and cell surface receptors in models of skin cancers, acute myeloid leukemia and myeloma, using a multidisciplinary approach that includes functional in vitro assays, biochemistry of proteins, confocal microscopy, flow cytometry

• Identification of new potential pathways and therapeutic targets for the design of novel targeted therapies

Available place: 2
Microbiome and Human Health

Department of Public Health and Pediatric Sciences.
Research lines

Human microbiome in the personalised medicine

Investigations on the human microbiome with particular reference to the evaluation of indicators for dysbiosis and development of chronic diseases. The activity consists in the collection and analysis of human biological samples (faeces, saliva, nasopharyngeal swab) with the aim of determining the composition of the microbiota and its modulation in relation to the exposure profiles and final health conditions. The methods include microbiology and molecular biology tools.

Health-literacy and citizen engagement: Investigations on the dissemination of knowledge and the use of personalized services for mapping the human genome and/or microbiome.
The microbiome and its influence on the circadian rhythm
Teachers: Prof. Ugo Ala; Prof. Luigi Bertolotti; Prof. Mario Giacobini - SSD: BIO/13

Research lines

Gene Regulatory Networks and post-transcriptional regulation

- Analysis of conserved gene co-expression networks
  - Functional analysis of coding and non-coding transcripts
  - Disease Genes prediction

- Microbiome
  - 16S rRNA Gene Sequencing and Shotgun metagenomics
  - Human and Animal Microbiomes
Molecular Biochemistry
**Referent Teacher:** Prof. Riccardo Taulli  -  SSD: BIO/10

**Other teachers & associates:** Dr. Francesca Bersani; Dr. Francesca Picca

**Research lines**

- Defining the mechanisms of adaptation to molecular therapies in lung cancer
- Generation and characterization of a tumor organoid platform to evaluate the efficacy of new therapeutic approaches in thoracic malignancies
- Dissecting the molecular circuits responsible of the trans-differentiation from lung adenocarcinoma to neuroendocrine microcytoma
Neuronal plasticity, neuronal circuits and sex-biased differences in emotional, cognitive and metabolic disorders
Research group

**Teacher:** Prof. Carola Eva

**Collaborators:** Dr. Alessandra Oberto RU; Dr. Ilaria Bertocchi RTDA; Dr. Antonino Casila PhD student

### Research lines

- Perineuronal nets: a new therapeutic target for fragile X syndrome
- Neuronal plasticity and neuroinflammation in a murine model of developmental and epileptic encephalopathies
- Role of NPY-Y1R system on sexually dimorphic vulnerability to metabolic syndrome and cognitive disorders
Physiology of Reproduction
Teacher: Dott. Paola Toschi - SSD VET02

Anatomy and physiology of animal models course

Research lines

- Early placenta development (sheep model):
  Establishment of an in vitro model to study trophoblast differentiation during early pregnancy.
  Establishment of an in vitro model to study different strategies of placental adaptation under stressed condition, with a main focus on autophagy.

- Maternal nutrition and offspring development (sheep/bovine model):
  Physiological and epigenetic modification in somatic tissue and gametes of offspring exposed to in utero maternal undernutrition
Physiopathology of neural stem cells
Research lines

1. Development and functions of the rodent and human cerebellum. Employed approaches: sc/snRNaseq and high resolution histology;
3. Rodent and human glia: differentiation potential, role in brain physiology and pathology.

Further information at: https://www.nico.ottolenghi.unito.it/eng/Research/Research-Groups/Physiopathology-of-neural-stem-cells
Plant Genetics
**Teachers:** Prof. Cinzia Comino; Prof. Lorenzo Barchi - SSD: AGR/07

**Research lines**

- **Plant functional genomics:** *application of the cutting edge technologies (RNA-seq, Bisulfite sequencing, metabolic engineering, genome editing) to carry out functional genomics studies in plants.*

- **Structural genomics and bioinformatics:** *study of the genomes of economical important crops cultivated in Italy (as eggplant, pepper and artichoke), to identify key genes for breeding, to provide information on mechanism underlying crop evolution, fruit characteristics, and to move forward a pan-genome view of the species.*

- **Safeguard and enhancement of biodiversity in crop species:** *developing of sustainable conservation strategies of crops through the exploitation of the in-situ and ex-situ conserved materials.*

- **Development of genetic maps, QTL analyses and genome wide association studies in crop species:** *genetic linkage maps development, QTL analyses and genome wide association analyses are key tools widely used in plant genetics and breeding to carry out genome analysis, as well as to identify genomic regions associated with agronomic and qualitative traits useful in marker assisted selection (MAS) programs.*
Plant pathology and sustainable crop protection
**Teachers:** Prof. Davide Spadaro

**SSD:** AGR/12

**Research lines**

- Fungal and bacterial diseases of fruit and nut trees, vineyard and cereals
- Postharvest diseases of fruit and vegetables
- Mycotoxins and mycotoxigenic fungi
- Epidemiology of plant diseases
- Diagnostics, surveillance and monitoring of plant pathogens
- Sustainable crop protection
- Microorganisms for biological control
- Plant, air and soil metabarcoding and metagenomics
- Fungal pathogen genomics and transcriptomics
Principles of plant and microbial biotechnologies
Teachers: Prof. Luisa Lanfranco - SSD: BIO/01 (3 CFU)

Research lines

**Plant-microbe interactions**

- Study of plant-microbe interactions with particular attention to the arbuscular mycorrhizal (AM) symbiosis
  - Molecular mechanisms underlying the colonization process, including the role of small RNAs
  - Impact at local and systemic level of the AM symbiosis on the host plant and responses to stresses
  - Role of apocarotenoids - strigolactones and zaxinone – on plant growth and biotic interactions
  - The virome of AM fungi
Research lines

Soil Microbial Ecology and Bioremediation

- Study of complex microbial ecosystems and the influence on environment and artificial systems.
  - Biodiversity as in function of soil management
  - Microbial processes involved in fertility and land production
  - Microbial Ecology in Bioremediation systems Ecologia microbica di sistemi di biorisanamento
  - Microbial biofilms
Quality of the sludge, produced by waste water treatment or organic fraction municipal solid waste treatment, and human health impact
Research lines

Biological risk of bio-solids produced by the treatment of organic solid waste and/or wastewater

Evaluation of the presence and persistence of pathogens (bacteria and viruses);
Evaluation of the methanogenic component;
Evaluation of the presence and persistence of resistome.

The activity mainly consists in the development and application of experimental models with the aim of acquiring laboratory evidence regarding the reduction of the biological risk associated to the sludge produced by the waste treatment plants (organic solid and liquid).

The methods applied include environmental microbiology, cellular and molecular biology protocols.
Theranostic in Nuclear Medicine: from diagnosis to therapy

Molecular imaging and radionuclide therapy
Research lines

- Principles of Radiopharmacy and set up of new radiopharmaceuticals
- Biomarkers extraction by Molecular Imaging with Positron Emission Tomography (PET)/computed tomography (CT) in oncology and neurology
- Advanced Molecular Imaging analysis
- Radiomics

Teacher: Prof. Deandreis Désirée - PA MED/36, Department of Medical Sciences
To see or not to see: organic chemistry applied to chemical biology

• Synthesis and application of fluorescent probes in bilayer membranes, nucleic acids and their derivatives

• Synthesis and studies of molecular photoswitches for photopharmacology

• Synthesis of natural plant hormones for biomedical applications

• Development of biocatalytic processes in sustainable conditions
Research lines

- Synthesis and photophysical characterization of novel biocompatible fluorophores.
- Phospholipids membrane bilayer investigation by fluorescent probes in artificial liposomes as model of cell membrane.
- Synthesis and functionalization of emissive nucleobases and their biological derivatives.
- Synthesis of fluorescent probes for nucleic acids and enzymatic processes investigation.
- Synthesis and photophysical evaluation of molecular photoswitches for photopharmacology and drug delivery.
- Synthesis and characterization of natural molecules of biological interest.
- Cascade biocatalytic processes development in eutectic mixture.