CNIC Cicerone Program:

Laboratory internships at the CNIC for university students during the summer months

List of Scientists and Research Lines 2020

Research line 1: Mechanical protein unfolding as a main contributor to the elasticity of the myocardium and muscle-mimicking biomaterials

Research Group: Molecular Mechanics of the Cardiovascular System

Supervisor: Jorge Alegre-Cebollada

Summary: The new concept that mechanical protein unfolding is behind the elasticity of tissues such as the myocardium has been proposed based only on indirect observations. Here, we plan to use a combination of techniques to observe, for the first time, protein unfolding as a main contributor to the elasticity of muscle tissue. Our new approach will also be applied to the design of smart biomaterials that mimic the elasticity of muscle tissue. This is an interdisciplinary project that borrows concepts and techniques from fields such as instrument development, protein biochemistry, polymer physics, single-molecule methods, and material science. For more information about our group, please visit: More information at: https://www.cnic.es/en/investigacion/molecular-mechanics-cardiovascular-system

Research line 2: Molecular events leading to the development of familial cardiomyopathies

Research Group: Molecular Mechanics of the Cardiovascular System

Supervisor: Jorge Alegre-Cebollada

Summary: The human heart is a formidable mechanical machine that pumps thousands of liters of blood every day. We are far from understanding how the heart works at the molecular level, and much less so how diseases of the heart develop. Following an interdisciplinary approach that includes protein biochemistry, biophysics, animal models and human clinical research, we plan to uncover how point mutations in cardiac proteins lead to life-threatening cardiomyopathy. More information at: https://www.cnic.es/en/investigacion/molecular-mechanics-cardiovascular-system

Research line 3: Role of A-type lamins and progerin in aging and cardiovascular disease

Research Group: Molecular and Genetic Cardiovascular Pathophysiology

Supervisor: Vicente Andrés

Summary: Cardiovascular disease (CVD) is the main cause of morbimortality, in part due to the progressive aging of our societies. CVD and aging are much accelerated in Hutchinson-Gilford progeria syndrome (HGPS), a rare genetic disorder caused by the expression of progerin, a mutant form of lamin A which is also expressed at low level in tissues of non-HGPS individuals. The CICERONE student will learn about mechanisms through which A-type lamins and progerin regulate CVD and aging. More information at: https://www.cnic.es/en/investigacion/molecular-and-genetic-cardiovascular-pathophysiology

Research line 4: In vivo analysis of vascular development in mice
Researh Group: Molecular Genetics of Angiogenesis
Supervisor: Rui Benedito
Summary: The group investigates different aspects of vascular biology using advanced mouse models and imaging technologies. We generated several new mouse lines that will allow us to induce precise genetic modifications during angiogenesis. The Cicerone student will be involved in a project to identify the best transgenic animals and do a pre-evaluation of the function of specific genes during the cardiovascular system development. The work will involve handling of mice and dissection, state-of-the-art imaging techniques, as well as molecular and cell biology techniques. More information at: http://www.cnic.es/en/desarrollo/angiogenesis/index.php

Research line 5: Role of endurance training in early disease development in arrhythmogenic right ventricular cardiomyopathy (ARVC)
Research Group: Inherited cardiomyopathies
Supervisor: Juan A. Bernal
Summary: Inherited cardiomyopathies are a major health problem. Our interest lies in defining the interaction between different disease-causing mutations (with arrhythmogenic right ventricular cardiomyopathy [ARVC] as a paradigm) and exercise as a factor that lead to disease progression. To study the effect of exercise on mice carrying the most prevalent ARVC-associated mutated gene (*PKP2*). Using ARVC models, we will analyze whether the **myocardial abnormalities** in animals expressing mutant PKP2 **induce genetic changes** in response to exercise. More information at: https://www.cnic.es/en/investigacion/inherited-cardiomyopathies

Research line 6: Mechanistic studies on ventricular wall development and cardiomyopathy
Research Group: Intercellular Signaling in Cardiovascular Development & Disease
Supervisor: José Luis de la Pompa
Summary: Live imaging and lineage labelling to study how the differentiation of cardiac ventricles is initiated with the appearance of trabeculae, that will later become part of the ventricular wall through the process of compaction. This process depends on NOTCH signaling and its alteration leads to cardiomyopathy. Is there a common genetic substrate for cardiomyopathies? Are sarcomere genes required for compaction?
Keywords: Heart development/mouse/Ventricles/Crispr-cas9 gene edition/signaling/live imaging/cardiomyopathy
More information at: https://www.ncbi.nlm.nih.gov/pubmed/?term=de+la+pompa+JL
https://www.cnic.es/en/investigacion/intercellular-signaling-cardiovascular-development-and-disease

Research line 7: Signaling during cardiac valve morphogenesis and disease.
Research Group: Intercellular Signaling in Cardiovascular Development & Disease
Supervisor: José Luis de la Pompa
Summary: Defective cardiac valve development giving rise to bicuspid aortic valve that is one of the most common congenital heart diseases. The molecular mechanisms regulating fusion of the primitive cushions to give rise to the mature valve leaflets is poorly understood. Mouse models, molecular/cell biological/image analysis of valve development/function. Valve disease samples/biomarkers validation.
Keywords: Heart development/BAV/mouse/Crispr-cas9 gene edition/signaling/live imaging/CAVD

More information at: https://www.ncbi.nlm.nih.gov/pubmed/?term=de+la+pompa+JL
https://www.cnic.es/en/investigacion/intercellular-signaling-cardiovascular-development-and-disease

Research line 8: Understanding how mechanical signals are propagated into the cell
Research Group: **Mechanoadaptation and Caveolae Biology**
Supervisors: Miguel Ángel del Pozo / Asier Echarri
Summary: In mechanically stressed cells, such as cardiomyocytes or endothelial cells, the plasma membrane contains small invaginations, named caveolae, that protect cells from mechanical stress, preventing cardiovascular pathologies. The mechanical stress induces major changes at the plasma membrane, actin filaments and even at the genome structure. How these complex changes are coordinated and interconnected is not well understood. The student will focus on understanding how cells receive mechanical signals by caveolae at the plasma membrane and how these signals are propagated throughout cell, up to the nucleus, and reprogram the cell structure and function.
More information at: https://www.cnic.es/en/investigacion/mechanoadaptation-and-caveolae-biology
scientific report of the group can be downloaded from:
https://www.cnic.es/sites/default/files/files/attachments/2019/06/scientific_report_2018_lo.pdf

Research line 9: Mitochondrial performance in heart disease
Research Group: Functional Genetics of the Oxidative Phosphorilation System (GENOPHOS)
Supervisor: Jose A. Enríquez
Summary: Our laboratory researches the mammalian mitochondrial electron transport chain (MtETC) and H+-ATP synthase, which together constitute the oxidative phosphorylation (OXPHOS) system. We view this system as a functional entity, and use a range of approaches aimed at determining its role in health and disease. We are particularly interested in the role of the OXPHOS system in the development of the cardiovascular system, its relevance to ischemia-reperfusion, and its influence on microvascular blood flow.
More information at: https://www.cnic.es/en/investigacion/functional-genetics-oxidative-phosphorilation-system-genophos

Research line 10: Cardiovascular health promotion in children and adolescents
Research Group: Cardiovascular Health and Imaging
Supervisor: Rodrigo Fernández Jiménez
Summary: Our group focuses on cardiovascular disease prevention. Specifically, the CICERONE student granted in our group will learn about school-based health promotion programs targeting elementary and secondary students in Spain, including but not limited to trial design and data collection/cleaning aspects, statistical analysis, literature review and manuscript drafting. The student will have the opportunity to collaborate with the research team on ongoing research tasks and to formulate and develop his/her own research ideas. More information at:
https://www.cnic.es/en/investigacion/cardiovascular-health-and-imaging

Research line 11: Structural Characterization and Wave Propagation Dynamics during Atrial Fibrillation.

Research Group: Advanced Development in Arrhythmia Mechanisms and Therapy Laboratory.

Supervisor: David Filgueiras Rama
Summary: The main objective of the project is to characterize wave propagation dynamics generated by reentrant patterns of activation (rotors), and the structural and functional changes that enable atrial fibrillation (AF) to persist at different progression stages. The objective involves the identification and analysis of functional and structural parameters, bringing together experimental and clinical tools for interpretation and decision-making. The multidisciplinary and translational design of the project includes the study of an *in vivo* model of that resembles clinical progression of the arrhythmia
More information at:
https://www.cnic.es/es/investigacion/desarrollo-avanzado-sobre-mecanismos-terapias-arritmias

Research line 12: Acquired mutations in immune cells as a driver of atherosclerotic cardiovascular disease

Research Group: Hematovascular Pathophysiology Laboratory
Supervisor: José J. Fuster
Summary: Age is the greatest risk factor for cardiovascular disease (CVD), the leading cause of death worldwide. Despite this, we have an incomplete understanding of how aging promotes CVD. In this regard, acquired mutations in blood and immune cells are emerging as a new risk factor for cardiovascular disease, and as a shared pathophysiologic mechanism of CVD and cancer. The CICERONE student will contribute to experimental studies that intend to examine how mutant immune cells contribute to atherosclerotic CVD. By doing this, he/she will get exposed to many research techniques (e.g. histology, flow cytometry, immune cell culture), and will also be introduced to the use of mouse models in cardiovascular research. More information at:
https://www.cnic.es/en/investigacion/hematovascular-pathophysiology
https://www.ncbi.nlm.nih.gov/pubmed/29420212

Research line 13: Environmental factors as modulators of the effects of acquired mutations on inflammation

Research Group: Hematovascular Pathophysiology Laboratory
Supervisor: José J. Fuster
Summary: The accumulation of acquired mutations in blood and immune cells is an inevitable consequence of the aging process. A few of these mutations confer a competitive advantage to the mutant cell, leading to its clonal expansion, a process termed clonal hematopoiesis. This phenomenon is an important modulator of inflammation and a shared risk factor for cardiovascular disease and cancer. Virtually everyone acquires clonal hematopoiesis-inducing mutations, but the clonal expansion of the mutant cells occurs only in some individuals, for mechanisms that remain unknown. The CICERONE student will contribute to experimental studies that will examine how environmental factors (e.g. diet, pollutants, drugs) modulate the clonal expansion of cells carrying specific mutations. By doing this, he/she will be exposed to many basic research techniques (e.g. immunofluorescent staining, flow cytometry, immune cell culture), and will also be introduced to the use of mouse models in biomedical research. More information at:
https://www.cnic.es/en/investigacion/hematovascular-pathophysiology
https://www.ncbi.nlm.nih.gov/pubmed/29420212

Research line 14: Exploring the Role of Hypoxia in Cardiac Regeneration
Research Group: Cardiovascular Imaging and Population Studies
Supervisors: Valentín Fuster / Silvia Martín Puig
Summary: Ischemic cardiomyopathy is the leading cause of mortality and the only effective therapy for chronic heart failure is cardiac transplantation, pointing to the urgent need of developing new strategies to improve cardiac function. One innovative approach aims to stimulate the recovery of the damaged myocardium through division of the endogenous cardiomyocytes by activation of intrinsic mechanisms of regeneration occurring naturally during the postnatal period in mice. It has been reported that hypoxia stimulates myocardial regeneration while oxidative stress will impair it. However, the detailed molecular mechanisms connecting low oxygen tensions and cardiac regeneration remain poorly understood. In this project, we will investigate the importance of HIF signaling in cardiac proliferation and regeneration using conditional mouse models of gain and loss of function in cardiomyocytes. The influence of HIF pathway in cell cycle, metabolic reprogramming, inflammatory and fibrotic responses and angiogenesis, as well as its effect on cardiac function and recovery upon injury in neonates and adults will be assessed. Moreover, we will determine the activation of HIF at different ages in human samples in collaboration with pediatric cardiac surgeons in an attempt to establish the regenerative window in the human heart. More information at: https://www.cnic.es/en/investigacion/cardiovascular-imaging-and-population-studies

Research line 15: Novel mitochondria-targeted therapies for cancer therapy-induced cardiotoxicity (MATRIX)
Research Group: Translational Laboratory for Cardiovascular Imaging and Therapy
Supervisors: Borja Ibáñez / Eduardo Oliver
Cancer therapy-induced cardiac toxicity is affecting up to 30% of cancer treated patients thus resulting in severe heart failure and premature death. We have recently demonstrated that imbalanced mitochondrial dynamics in cardiomyocytes results in a phenotype recapitulating cardiac toxicity induced by cancer treatment, including metabolic reprogramming and ultimately heart failure. Building on these data, we will study the mechanisms leading to mitochondrial failure in cardiac toxicity and use the knowledge obtained to develop novel therapies. More information at:
https://www.cnic.es/en/investigacion/translational-laboratory-cardiovascular-imaging-and-therapy

Research line 16: Arrhythmogenic Mechanisms in Short QT Syndrome
Research Group: Cardiac Arrhythmia
Supervisor: José Jalife
Summary: Short QT syndrome (SQTS) is a rare inheritable disease that is associated with arrhythmias and sudden cardiac death (SCD). Effective therapy for prevention of SCD is lacking. This project will define molecular mechanisms of SQTS caused by three different mutations in one gene. We will first demonstrate that in-vivo cardiac-specific expression of one of three gain-of-function mutant KCNJ2 genes (D172N, E299V and M301K) in transgenic mice recapitulates the SQTS3 phenotype by differentially decreasing the QT interval and resulting in arrhythmias and SCD in a genotype specific manner. We will then generate human induced pluripotent stem cell-derived cardiomyocytes (hiPSC-CMs) from patients with each of the mutations and use CRISPR-Cas9 gene editing to rescue the normal phenotype of the cells. Accomplishing successfully our objectives should allow development of scientifically based therapies for the prevention of SCD in patients with SQTS and other cardiac arrhythmogenic diseases, with enormous positive implications for public health. More information at:
https://www.cnic.es/en/investigacion/cardiac-arrhythmia

Research line 17: Innovative therapies for the treatment of cardiomyopathies
Research Group: Molecular regulation of heart failure
Supervisor: Enrique Lara-Pezzi
Summary: Arrithmogenic right ventricular cardiomyopathy type 5 (ARVC5) is a rare and devastating disease for which there is no cure. ARVC5 is caused by the p.S358L mutation in the gene TMEM43. We have developed an ARVC5 mouse model that expresses the mutant protein and faithfully reproduces the human disease. Using this mouse, we have identified the major mechanisms of action of the mutant protein. In this new translational project, we will use the acquired knowledge to develop new therapeutic tools to tackle this disease. More information at: https://www.cnic.es/en/investigacion/molecular-regulation-heart-failure

Research line 18: Alternative splicing in subclinical atherosclerosis
Research Group: Molecular regulation of heart failure
Supervisor: Enrique Lara-Pezzi
Summary: As part of the PESA project, a flagship project at CNIC, we have unveiled that atherosclerosis appears subclinically (with no symptoms) much earlier than previously anticipated and with a very high prevalence. The molecular mechanisms and predictors of subclinical atherosclerosis are far from being completely understood. In particular, the role of different protein isoforms generated by alternative splicing (AS) and the role and regulation of AS itself in the disease are poorly understood. In this new project, we will analyse the association of AS with subclinical atherosclerosis and other determinants of the disease. More information at: https://www.cnic.es/en/investigacion/molecular-regulation-heart-failure

Research line 19: T cells as precision cardiovascular medicine
Research Group: Regulatory Molecules of Inflammatory Processes
Supervisor: Pilar Martín
Summary: T lymphocytes are pivotal in the development of cardiovascular disease (CVD) and have been shown to be altered in blood and cardiovascular tissues during their progression. Regulatory T (Treg) cells have a protective role in the development of atherosclerosis, acute myocardial infarction and myocarditis, being $CD4^+$ Th17 cells critical for the development of these CVD. Our group studies the therapeutic and diagnostic performance of these cells, and derived microRNAs, in the management of CVD. More information at: http://www.cnic.es/es/inflamacion/moleculas/index.php

Research line 20: Maintenance of skeletal muscle homeostasis and functional diversity within the muscle stem cell quiescence state
Research Group: Tissue Regeneration Laboratory
Supervisor: Pura Muñoz-Cánoves
Summary: This Research Project aims to investigate how stemness is maintained in quiescent stem cells throughout life. This is crucial to maintain organ and tissue regenerative capacity in mammals. Our recent studies in skeletal muscle stem cells (satellite cells) of healthy aged mice have shown a loss of the bona fide quiescent state as an underlying mechanism of their functional (regenerative) decline (Nature 2014 and 2016) with aging. In this Research Project, the candidate will investigate: 1) the primary causes of the quiescence loss in aged stem cells; and 2) potential strategies for stem cell rejuvenation and regenerative improvement. The proposed Research Project is enclosed and complements the ongoing Project “Tissue regeneration and aging: the decisive quiescent stem-cell state” (EC-H2020-STEM-AGING-

ERC 741966). We expect that completion of these objectives will provide new fundamental knowledge on stem-cell biology, regeneration and aging. The CICERONE student will contribute to experimental studies that will examine some of the described objectives. By doing this, he/she will be exposed to many basic research techniques (e.g. immunofluorescent staining, flow cytometry, immune cell culture), and will also be introduced to the use of mouse models in biomedical research. More information at: https://www.cnic.es/en/investigacion/tissue-regeneration

Research line 21: Targeted pro-resolving nanoimmunotherapy to treat atherosclerosis
Research Group: Nanomedicine and Molecular Imaging
Supervisor: Carlos Pérez Medina
Summary: Our research integrates molecular imaging into nanomedicine development, both for evaluating in vivo behavior and non-invasively monitoring treatment and efficacy. We exploit the natural ability of our nanoplatforms to interact with myeloid immune cells to selectively deliver inflammation pro-resolving drugs and promote atherosclerosis regression. You will be involved in the generation of a library of pro-resolving nanoformulations as well as in their *in vitro* characterization and *in vivo* evaluation in a mouse model of atherosclerosis. More information at:
https://www.cnic.es/en/investigacion/nanomedicine-and-molecular-imaging

Research line 22: The antibody immune response during atherosclerosis
Research Group: B Lymphocyte Lab
Supervisor: Almudena R Ramiro
Summary: In our lab we are interested in the mechanisms regulating the generation of antibodies and their functional relevance during the immune response as well as in pathological contexts, including cancer and autoimmunity. Here, we aim at getting insights into the role of the antibody immune response during atherosclerosis, with the ultimate goal to find new biomarkers and therapeutic avenues. More information at:
https://www.cnic.es/es/investigacion/biologia-linfocitos-b

Research line 23: Molecular basis of aortic diseases: Mouse models, omics and gene therapy approaches.
Research Group: Gene regulation in Cardiovascular Remodelling and Inflammation
Supervisor: Juan Miguel Redondo / Marta Toral
Summary: We have identified new genes and mechanisms that mediate aortic diseases including Marfan syndrome (Nature Communications 2018; Nature Medicine 2017a; Nature Medicine 2017b). We have generated a number of mouse models to characterize gene expression programs implicated in aortic disease. We are using approaches based on lentiviral delivery *in vivo* to induce or regress disease (Trends Mol Med 2018), and to validate mediators identified in the human disease by proteomics and transcriptomics. More information at:
https://www.cnic.es/en/investigacion/gene-regulation-cardiovascular-remodelling-and-inflammation-0

Research line 24: Calcineurin (CN) in cardiovascular disease
Research Group: Gene regulation in Cardiovascular Remodelling and Inflammation
Supervisor: Juan Miguel Redondo / Paula Yunes
Summary: We have found that genes regulated by CN play a major role in cardiac hypertrophy, inflammation and vascular wall remodeling (*FEBS J 2019;*;*Mol Cell* 2009; *Blood* 2011; EMBO J 2014;*J Exp*

Med 2011; *EMBO Mol Med* 2013; *JMCC* 2017). We will elucidate the mechanisms underlying these pathologies using mice conditionally deficient for CN, as well as adeno-associated viruses to knock down these calcineurin-regulated genes *in vivo*. More information at:
https://www.cnic.es/en/investigacion/gene-regulation-cardiovascular-remodelling-and-inflammation-0

Research line 25: Role of macrophage nuclear receptors in cardiac homeostasis and injury.
Research Group: Nuclear Receptor Signaling
Supervisor: Mercedes Ricote
Summary: Activation of the immune system is a good candidate for triggering tissue regeneration; however, the molecular pathways that directly link the immune system to myocardial regeneration remain poorly understood. In this project, we will focus on the role of macrophage nuclear receptors in cardiac homeostasis, and in the inflammatory response after myocardial infarction. We will use tissue-specific knockouts, transcriptomics, epigenomics, in vivo imaging, and the latest techniques in cell-fate mapping to unravel the role of macrophages in cardiovascular physiology. More information at: https://www.cnic.es/en/investigacion/nuclear-receptor-signaling

Research line 26: Bioinformatic analysis of the transcriptional regulation of nuclear receptors in macrophages.
Research Group: Nuclear Receptor Signaling
Supervisor: Mercedes Ricote
Summary: Our laboratory is using genome wide studies to decipher the contribution of nuclear receptors to the macrophage functions and the pathogenesis of human diseases. The project will focus on analysis of data derived from the application of chromatin immunoprecipitation coupled to massively parallel sequencing (ChIP-Seq) and high throughput transcriptomic data to build pathway models for differentially regulated genes that will help us to define the molecular mechanism of nuclear receptor actions in macrophage biology. The student will need some prior knowledge of R and/or Python programming. More information at: https://www.cnic.es/en/investigacion/nuclear-receptor-signaling

Research line 27: Role of p38MAPK in metabolic diseases
Research Group: Stress kinases in Diabetes, Cancer and Cardiovascular Disease
Scientist/Supervisor: Guadalupe: Sabio
Summary: Metabolic syndrome is a medical disorder defined by the co-occurrence of obesity, impaired glucose tolerance, dyslipidemia and hypertension. Stress activated protein kinases have been shown to control both obesity by itself and diabetes associated to obesity. These stress kinases are activated by several MAPK activated kinases (MKK). We want to investigate the role of MKK3 in this process and the molecular mechanism by which this kinase could affect diabetes.
More information at:
https://www.cnic.es/en/investigacion/stress-kinases-diabetes-cancer-and-cardiovascular-disease

Research line 28: p38MAPK in heart physiology
Research Group: Stress kinases in Diabetes, Cancer and Cardiovascular Disease
Scientist/Supervisor: Guadalupe: Sabio
Summary: The p38 MAPK pathway transduces a variety of extracellular signals regulating cellular responses to stress, being implicated in cell proliferation, differentiation and apoptosis. Its implication in the development of human diseases it is being deeply studied. Four p38 MAPK family members have

been identified: p38α, β, γ and δ. Preliminary data from our laboratory show that these kinases may control cytokine production during acute and chronic inflammatory processes. Moreover, studies with genetically modified mice made in our laboratory confirm that p38MAPKs have a role in the development of the heart. Our main objective is to determine if the regulation of the p38MAPK signaling pathway could have beneficial effects in the cardiac response to exercise.
More information at:
https://www.cnic.es/en/investigacion/stress-kinases-diabetes-cancer-and-cardiovascular-disease

Research line 29: High-resolution Imaging of isolated exosomes
Research Group: Intercellular Communication in the Inflammatory Response
Supervisor: Francisco Sánchez-Madrid
Summary: Our proposal aims to image isolated exosome subpopulations under TIRF and super-resolution microscopes. We have already developed the use of TIRFm to analyze isolated nanovesicles, allowing the observation of single exosomes [1]. We will now implement the use of STORM as a tool to increment the XY resolution to 20-50 nm to visualize different components (mitDNA and miRNA) inside the isolated exosomes. This will be complemented with exosome activity in recipient immune cells.
Torralba et al., Priming of dendritic cells by DNA-containing extracellular vesicles from activated T cells through antigen-driven contacts. *Nature Commun*. DOI: 10.1038/s41467-018-05077-9
More information at: https://www.cnic.es/en/investigacion/intercellular-communication-inflammatory-response

Research line 30: Immune receptors sensing tissue damage in inflammation and immunity
Research Group: Immunobiology
Supervisor: David Sancho
Summary: We are analyzing the role of specific dendritic cell receptors sensing tissue damage in models of infection, inflammation and cancer. We use a combination of approaches at the cellular, biochemical and in vivo level, including analysis of disease models in animals deficient on the receptors. The student will learn many techniques working in vitro (cell culture, molecular biology, biochemistry, flow cytometry and Immunology techniques) and will learn to analyze models of disease in vivo.
More information at: https://www.cnic.es/es/investigacion/inmunobiologia

Research line 31: Metabolic plasticity instructs immune cell function
Research Group: Immunobiology
Supervisor: David Sancho
Summary: The student will help to explore how sensing infection and tissue damage affects the metabolism on dendritic cells and macrophages. Moreover, we are exploring how mitochondrial metabolism drives T cell, dendritic cell and macrophage function. The student will learn many techniques working in vitro (cell culture, biochemistry, flow cytometry, cell metabolic assays, and Immunology techniques) and will learn about the in vivo models that we are developing in the lab to address this problem. More information at: https://www.cnic.es/es/investigacion/inmunobiologia

Research line 32: Cardiac Development and Regeneration
Research Group: Genetic Control of Organ Development and Regeneration
Supervisor: Miguel Torres
Summary: The student will work on the study of molecular and cellular pathways that regenerate the heart. The work will focus on mechanisms that activate cardiomyocyte proliferation and in the characterisation of endogenous Cardiomyocyte populations with proliferative capacity. The competitive

advantage of genetically modified cardiomyocytes will be studied in the context of stimulation of the heart regenerative ability. The student will use both in vitro and in vivo approaches. The model of study is the mouse and a variety of techniques will be used, including histology, gene expression analysis, protein detection, advanced microscopy and image analysis.
More information at: https://www.cnic.es/en/investigacion/genetic-control-organ-development-and-regeneration

Research line 33: Mechanisms of Organ Patterning
Research Group: Genetic Control of Organ Development and Regeneration
Supervisor: Miguel Torres
Summary: The student will work on the study of molecular and cellular pathways that allow the formation of proper organ morphological patterns. The work will focus on mechanisms that activate regulate tissue regionalisation and polarity. The work will focus on the role of transcription factors of the homeodomain family in regulating target genes essential for organ patterning. The student will use both in vitro and in vivo approaches. The model of study is the mouse and a variety of techniques will be used, including histology, gene expression analysis, protein detection, advanced microscopy and image analysis. More information at: https://www.cnic.es/en/investigacion/genetic-control-organ-development-and-regeneration

Research line 34: Advanced computational methods for the analysis of post-translational modifications
Research Group: Cardiovascular Proteomics
Supervisor: Jesús Vázquez
Summary: We are working in "open search" algorithms that allow true hypothesis-free identification and quantification of any post-translational modification from high-throughput mass spectrometry-based proteomics. In this project, we aim to develop semisupervised approaches to the interpretation of the data and to integrate the quantitative information in large-scale experiments. We will apply these developments to study subclinical atherosclerosis in animal and human models.
More information at: https://www.cnic.es/en/investigacion/cardiovascular-proteomics