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DELLE MARCHE

# 3D in vitro biotechnological models to study gut **MI**c**R**obiota Influence on bone **R**em**O**deling and **R**epair **(MIRROR)**

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# Supervisor: Prof. Monica Mattioli-Belmonte

**Full Professor** in Human Histology and Embryology, **Head of the MorpHis Lab** (DISCLIMO)- School of Medicine UNIVPM

Individual evaluator for projects (Future in Research, SIR, PRIN) on behalf of the MIUR and research products on behalf of ANVUR ; Member of a committee for a Lecturer position in Histology at the University of Barcelona. January 2019.

Supervisor for Degree Thesis and PhD Dissertation

**Main collaborations:** Piaggio Center University of Pisa; Rizzoli Orthopedic Center (Bologna); Polytechnic University of Turin; University of Bari; University of Modena and Reggio Emilia; University of Florence; University of Bologna; INSTM (National Interuniversity Consortium of Materials Science and Technology); 3R Center; Polytechnic University of Valencia..

*Co-author of more than 200 publications in the field of morphology, biomaterials, and tissue engineering.*
*https://orcid.org/0000-0002-2087-2776 (publication list; H-index = 45)*

**Research Keywords:** Stem cells, Biomaterials, Tissue engineering, Ageing, In vitro models

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- Biological Unit for the ERC – BOOST (GA 681798).
- CHETCH European Project in the 7th European Framework (MARIE CURIE ACTIONS - International Research Staff Exchange.

## National funding:

- "MIND PRIN 2010-2011 project (Protocol 2010J8RYS7)
- PNRR "Vitality"
- PoWer PRIN 2022 (Protocol 20222P2NAJD")

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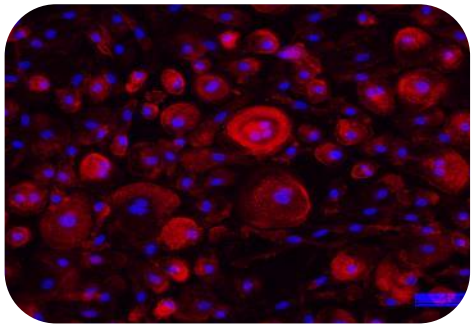
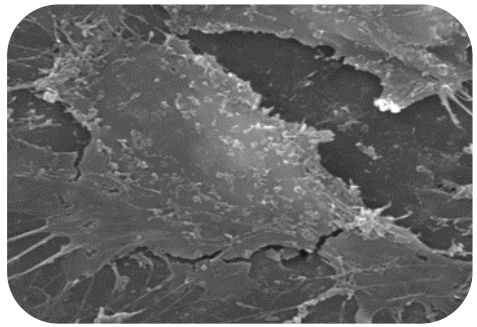
# Laboratory & Research Environment

The Histology Group (MorpHis Lab) is composed by two Associate Professors: (Prof M. Orciani and Prof. S. Marchi), one technician (Dr. G. Lucarini), 5 post-doc (Dr. C. Licini, , Dr. M. Di Vincenzo, Dr. G. Cerqueni, Dr. F. Marchegiani, Dr. N. Dhaouadi, Dr. L. Rao) and 2 PhD students (Dr. Dr. I. Nunzi and A. La Contana)



**Skills:** cell lines, primary cells or adult MSCs (harvested from different anatomical districts), monolayer and co-cultural approaches, morphological (light and electron microscopy) and molecular biology (qRT-PCR, WB) techniques, analysis of mitochondrial parameters.

**Equipment:** laminar flow hoods, Realplex qRT PCR, luminometer for $Ca^{2+}$ measurements, light and fluorescence microscopes, spectrophotometer with microplate reader, UVITEC, Synthecon rotary cell culture system, and Tomographic Microscope 3D Cell Explorer-FLUO by Nanolive.



**Facilities:** CLSM , SEM and TEM, FACS and Tecan Infinite Microplate Reader for fluorescent and bioluminescent assays.

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## Department of Clinical and Molecular Sciences (DISCLIMO)

**16 SCIENTIFIC AREAS**

BIOS-13/A MEDS-02/A
MEDS-02/B MEDS-02/C
MEDS-05/A MEDS-08/A
MEDS-09/A MEDS-09/B
MEDS-09/C MEDS-10/A
MEDS-10/C MEDS-18/A
MEDS-19/A MEDS-25/B
MEDS-26/A MEDS-26/D

**65 ACADEMICS**
**21 TECHNICIANS**

**14**
**RESEARCH LABORATORIES**

MARCHEBIOBANK

- 26 PhD STUDENTS
- 13 POST-DOC
- POST-GRADUATE STUDENTS (15 COURSES)

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**> 500**
**Publications (2021-2024)**

**11**
**CLINICAL RESEARCH UNITS**

**> 3 Mio EUR**
**RESEARCH INCOME**

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## Project Idea: 3D in vitro biotechnological models to study gut MicRobiota Influence on bone RemOdeling and Repair (MIRROR)

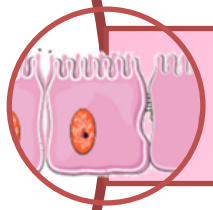
**Background:** The human gut microbiota (hGM) is essential for maintaining the host's physiological functions, impacting both the gut and remote organs, including bones. Research shows that dysbiosis (i.e., alterations in hGM composition) could lead to bone diseases like osteoporosis and osteoarthritis. These conditions affect millions and pose a serious health risk in an ageing population. The mechanisms and mediators of the hGM-gut-bone axis remain unclear, and the methods and tools for studying it are still being investigated. Multi-tissue culture systems may serve as effective in vitro tools for exploring multi-system human pathophysiological conditions, addressing limitations faced by traditional animal in vivo models.

**Aim:** The MIRROR project aims to develop independent 3D in vitro modules that model the hGM, gut, and bone, intended for use in a modular bioengineered multi-organ in vitro platform (MOP).

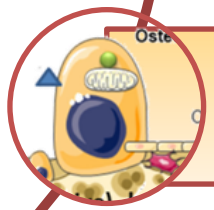
**Candidates** with experience in *in vitro models* for medical research, cell-based assays, tissue engineering, and biomaterials are encouraged to apply. This opportunity is ideal for individuals who value interdisciplinary collaboration and are dedicated to developing innovative solutions for biomedical applications. Other backgrounds relevant to the supervisor's expertise and project objectives will also be considered and evaluated

### Pillars of the research project:

3D *in vitro* model of the human GM by culturing the microorganisms on an electrospun gelatine structure



*in vitro* intestinal barrier (*i.e.* epithelial cells with appropriate apical and lateral specializations).




*In vitro* bone tissue replica (*i.e.* osteoblasts - and osteoclasts co-cultured on appropriate surfaces).

Each module will include a bioinspired scaffold, produced through advanced biofabrication technologies, in collaboration with the Centre Piaggio of the University of Pisa, capable of recreating the appropriate local microenvironment

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## Project idea - 3D in vitro biotechnological models to study gut MIcRobiota Influence on bone RemOdeling and Repair (MIRROR)

### Overall Goal

The project aims to develop **modular 3D in vitro models** of the **human gut microbiota–gut–bone axis**, contributing to:

Scientific advancement in **microbiota-mediated regulation of bone** remodeling

Innovation potential in **multi-organ in vitro platforms for biomedical research**

Strengthening European excellence in **tissue modelling**, bioengineering and microbiome science

### Specific Objectives

**Investigate** how human gut microbiota dysbiosis influences bone cell activity using engineered 3D constructs

**Develop** independent bioinspired modules (gut microbiota, intestinal barrier, bone tissue) using advanced biofabrication strategies

**Validate** the integrated multi-organ platform through functional assays on microbiota–gut–bone interactions

### Novelty & Interdisciplinarity

Combines expertise **in tissue engineering, advanced biofabrication, microbiome science and cell-based functional assays**

Introduces a **modular human multi-organ model as an alternative to animal studies**, with strong potential for both academic impact (mechanistic discoveries on the gut-bone axis) and non-academic relevance (preclinical testing, biomedical innovation)

### Expected Outcomes

High-impact scientific publications on microbiota–bone crosstalk

A validated **3D multi-organ in vitro platform (MOP**) replicating the human gut microbiota–gut–bone axis

New datasets, protocols, and biofabricated scaffolds

Enhanced scientific profile, interdisciplinary skills, and career opportunities for the MSCA fellow

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