# MECHANISMS OF DEGENERATION AND REGENERATION (AB00003)

## 1. lingua insegnamento/language

English

## 2. course contents

Coordinator: Prof. ANDREA PAPAIT

Year Course: 1° Year

Semester: I Semester

CFU/UFC: 9

Modules and lecturers:
- CELLULAR BASIS OF DEGENERATIVE PROCESSES (AB000030) - 1 cfu - ssd BIO/13
Prof. Marco Demaria

- CELLULAR BASIS OF DEGENERATIVE PROCESSES (Lab) (AB000031) - 1 cfu - ssd BIO/13
Prof. Andrea Papait, Dr. Elsa Vertua, Dr. Pietro Romele
- CELLULAR BASIS OF REGENERATIVE PROCESSES (AB000034) - 3 cfu - ssd BIO/13
Prof. Chiodelli Paola, Nicolas Villaescusa Francisco Jose, Andrea Papait
- ENVIRONMENTAL TOXICANTS IN TISSUE DEGENERATION (AB000033) - 2 cfu - ssd BIO/07
Prof. Riccardo Marzuoli
- INFLAMMATION IN TISSUE DEGENERATION (Inflammaging)(AB000032) - 2 cfu - ssd MED/04
Prof. Giovambattista Pani

## 3. bibliography

*The course will be focused on very recent breakthroughs in the field. For this reason, most of the reference literature will be derived from reviews and original research articles published in the last 3 years. This material will be provided to the student in advance and discussed during the course. Where necessary, students will be provided with supplementary teaching material in the form of books and book chapters.*

## 4. learning objectives

*The goal of the course is to give the student a detailed understanding of the cellular processes that lead to degeneration as a result of aging or exposure to environmental stress, as well as an understanding of the mechanisms that lead to regeneration. This will be studied in the context of both physiological and pathological processes, and a major focus will be the understanding of the mechanisms leading to restoration of tissue homeostasis. The Laboratory on "Cellular basis of degenerative processes "aims to provide the students practical laboratory skills on the different protocols for induction and validation of cellular senescence in cultured cells.*

*Upon completion of the integrated course, the student must demonstrate that he or she has acquired the following objectives.*

> ***- Knowledge and Ability to Understand -*** *Demonstrate knowledge of the major molecular mechanisms that cause cellular senescence, cell death and other cellular states that respond to tissue degeneration. Ability to assess the effects of degenerative events in*

*pathological events related to aging and cancer. Understanding of the mechanisms involved in restoration of tissue homeostasis, and how they fail during pathologies. The student must use the skills they have learned in the course to demonstrate their understanding of how to interpret the images and data contained in scientific articles and to explain them to the Lecuters.*

***- Applied knowledge and understanding skills -*** *demonstrate the ability to adequately interpret and understand the application of experimental biotechnology by mastering their use and developing the critical capacity for their most appropriate application in both the fields of diagnostic and research. Specifically, the student will learn how to read and interpret a scientific protocol for induction and validation of cellular senescence in cultured cells*

***- Autonomy of judgment -*** *know how to integrate the knowledge and skills learned in the different modules and acquire critical and design skills in order to independently carry out observations and experiments based on the laboratory activities learned.*

***- Communication skills -*** *to be able to describe clearly and unambiguously, using correctly the technical language specific to the analytical methodologies learned, the protocols learned during laboratory activities. The student will also develop the ability to work in groups and clearly communicate their knowledge or research results, both to an audience of specialists and to a wider audience of non-specialists.*

***- Ability to learn*** *- independently select appropriate sources for the development of experimental protocols, drawing on advanced texts and telematic resources.*

## 5. PREREQUISITES

*It is necessary for students to have acquired knowledge related to the basic disciplines provided in the three-year degree courses preparatory to this graduating class, with special reference to theoretical aspects and acquisition of basic laboratory practical experience in the following disciplines: Biochemistry, Molecular Biology, Cell Biology and Genetics.*

## 6. teaching methods

*The teaching methodology is based on theoretical-practical exercises and experimental activity, laboratory exercises, and complements standard teaching with activities marked by active learning, such as: "problem-based learning," "self-learning," and "case study,", presentation of a scientific work selected from recent literature (Journal Club).*

*The teaching methods used in this course are designed to enable the student to pursue the educational objectives, by virtue of the following characteristics:*

*- Knowledge and Ability to Understand- Lectures will systematically cover all the topics listed in the detailed syllabus below, dwelling on the most relevant and indispensable aspects, so as to provide students with the complete picture of the integrated topics and the correct study method to strengthen theoretical-practical knowledge*

*- Autonomy of judgment - the active learning methods implemented in this course will give the student the ability to design an experiment and develop ideas independently to solve a scientific question.*

*- Communication skills - active learning methods will be implemented to enable the student to acquire communication skills aimed at clearly presenting scientific work, communicating in appropriate technical language the methodologies learned and the results of their research.*

*- Ability to learn - the use of supplementary learning materials, including in the form of articles from the international scientific literature, will enable the student to continue studying mostly self-directed or independently.*

*Where the continuation of the COVID-19 emergency makes it necessary to deliver distance learning activities, the course will be delivered via live streaming sessions on the telematics platforms available in the university (Microsoft Teams and Blackboard).*

**7. other informations**

*Lecturers are available for reception by appointment after contacting them by email:*

*Andrea Papait: andrea.papait@unicatt.it*

*Marco Demaria: m.demaria@umcg.nl*

*Riccardo Marzuoli: riccardo.marzuoli@unicatt.it*

*Giovambattista Pani: giovambattista.pani@unicatt.it*

*Francisco Nicolas Villaescusa: franciscoj.nicolas2@carm.es*

*Paola Chiodelli: paola.chiodelli@unicatt.it*

***NOTE ON STUDENTS' RESPONSIBILITY***

*The responsibility for learning falls increasingly on students, as they advance through the course; hence, ultimately, the commitment and the dedication to learn must come from them.*

*As members of the Università Cattolica S. Cuore learning community, students are expected to respect the intellectual property of course instructors. All course materials presented to students are the copyrighted property of the course instructors and are subject to the following conditions of use:*

*1) Students may not record nor reproduce lectures or any other classroom activities, unless differently specified by the instructor; however, they may use the recordings for their own course-related purposes only.*

*2) Students may not reproduce and/or post any course material provided by the instructors online or distribute them without the advance written permission of the course instructor and, if applicable, of any students whose voice or image is included in the recordings.*

*3) Any students violating the conditions described above may face academic disciplinary sanctions. As members of a learning community, students are expected to respect the time and efforts of their fellow classmates. Therefore, the use of social media and other electronic distractions that can disrupt the concentration of other students in the classroom is NOT allowed.*

***NOTE ON ACADEMIC INTEGRITY AND CHEATING POLICY***

*The principles of truth and honesty are fundamental to the educational process and the academic integrity of the University. All students have a right to expect fair and honest evaluation of their work. CHEATING UNDERMINES THIS EXPECTATION AND WILL NOT BE TOLERATED.*

*Students must avoid the following misconduct behaviors that are considered as cheating:*

*DO NOT exchange ID badges to collect presence among classmates who cannot attend a lecture.*

*DO NOT share answers of quizzes during exams.*

*Any student found by the instructors to be cheating will receive a failing grade for the exam or other graded work, and will be reported to the Course's Coordinator and Instructors' Committee. The instructors may, at their discretion, decide to give a failing grade for the course in severe cases of academic dishonesty.*

**8. methods for verifying learning and for evaluation**

*The examination grade will be the result of the weighted average of each of the four modules. Honors will be awarded, subject to the achievement of 30/30 in each module, to students who have demonstrated a superior level of subject knowledge and depth with autonomy of study, appropriateness of language and excellent communication skills.*

*The objective of the examination thus organized is to assess the student's acquisition of the following skills and knowledge:*

*- Knowledge and ability to understand - of the appropriate level of knowledge of the topics covered in the program and the main methodologies acquired;*

*- Applied Knowledge and Ability to Understand - of scientific methodologies and their applications in relation to different biological problems;*

*- Autonomy of judgment - of the ability to develop an appropriate methodological approach in relation to different biological problems;*

*- Communication skills - of the appropriate language property and correct technical/scientific terminology;*

*- Ability to learn - of the ability to investigate and address issues of biological interest independently and through appropriate experimental approaches.*

*Where the continuation of the COVID-19 emergency makes it necessary to conduct teaching activities remotely, learning assessments will be based on distance interviews through the use of the telematics platforms available in the university (Microsoft Teams and Blackboard).*

**9. program**

***< Cellular Basis of Degenerative Processes >***

Damage accumulation

Hallmarks of aging

Cellular senescence as a central hub for degeneration

Maladaptive functions of senescent cells

Heterogeneity of senescence

Elimination of senescent cells in degenerative pathologies

***< Cellular Basis of Degenerative Processes (Lab)>***

Induction of cellular senescence

Senescence-associated -galactosidase Staining

Molecular analysis of senescence-related protein (p53, p21, p16 and senescence-associated secretory phenotype)

Principles of quantitative analysis: development and validation of a bioanalytical method

***< Cellular Basis of Regenerative Processes >***

The influence of environment on regeneration

Reintegrative process in regeneration

Pathways involved in regeneration (EMT process, BMPs, Wnt/b-catenin, FGF/FGFR, TGF-ß)

Molecular targets for tissue regeneration.

Changes in Regenerative Capacity during Aging

Angiogenesis

Metabolic reprogramming

Diabetes and pathological consequences on tissue regeneration

Diabetes, angiogenesis and its regulation in tissue regeneration

***< Environmental toxicants in Tissue Degeneration >***

Introduction to environmental pollution and environmental toxicants: human exposure pathways and dose-response relationships; bioaccumulation and biomagnification.

Air pollutants in the troposphere: carbon monoxide, nitrogen oxides, sulphur oxides, tropospheric ozone, volatile organic compounds, particulate matter (PM10 and PM2.5).

Water and soil pollutants: fertilizers and pesticides.

Environmental heavy metals: Arsenic, Chromium, Lead, Mercury.

Persistent Organic Pollutants (POPs). Fugacity and mass balance model by Mackay and Paterson.

From environment to food: the case of PCBs contamination in Brescia.

***< Inflammation in tissue degeneration (Inflammaging) >***

Acute and chronic inflammation: the basics
Outcomes of chronic inflammation: fibrosis and cancer
Chronic inflammation in ageing (Inflammaging):

- Molecular Inflammaging: DNA Damage Response, Organelle Stress and mTOR
- Cellular Inflammaging: replicative senescence and SASP
- Systemic Inflammaging: sources and mechanisms

Diseases associated to or consequence of Inflammaging