VNIVERSITAT DE VALÈNCIA

Course Guide
43101 Free radicals and oxidative stress in biomedicine

COURSE DATA

Data Subject	
Code	43101
Name	Free radicals and oxidative stress in biomedicine
Cycle	Master's degree
ECTS Credits	3.0
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
2142 - M.U. en Aproximaciones Moleculares CC Salud 12-V.2	Faculty of Biological Sciences	1	First term

Subject-matter

Degree	Subject-matter	Character
2142 - M.U. en Aproximaciones Moleculares CC Salud 12-V.2	2 - Metabolic regulation and integration	Obligatory

Coordination

Name	Department
O'CONNOR BLASCO, JOSE ENRIQUE	30 - Biochemistry and Molecular Biology
SAEZ TORMO, GUILLERMO	30 - Biochemistry and Molecular Biology

SUMMARY

Free Radicals (FR) are defined as molecular structures with a given number of unpaired electrons in its latest energy layer. This configuration, called paramagnetic, give them high reactive properties and allow them to interact with a large number of biomolecules to which oxidatively modify and alter their biological function. Under controlled conditions, these changes play physiologically metabolic regulation processes of gene expression by acting as signaling molecules. However, excessive production of FR can distort the mechanisms that maintain cell homeostasis compromising their integrity and functional viability by a mechanism known as "**oxidative stress**" (OS). In the aerobic organism most FR and other reactive species are produced by the reduction of molecular oxygen monovalent resulting reactive oxygen species (ROS, reactive oxygen species). To counter the reactive ROS, aerobic cells have evolved thanks to the induction of antioxidant systems and mechanisms specifically designed for the metabolism of these reactive species to more stable and safe structures. Oxidative stress occurs when ROS exceed the capacity of antioxidant mechanisms.

OS underlies the pathophysiology of degenerative diseases and especially those that are related to the aging process, among which stands out for its biomedical importance, inflammatory, cardiovascular disease, cancer and neurodegenerative diseases. In all these processes are described significant alterations of various antioxidant systems and shows the depth of ROS formation. The clinical applications of this research area have already been released through various experimental tests.
At present there are different systems for the study of OE including different biochemical and molecular assays as well as imaging and fluorimetric techniques.
In the course free radicals and oxidative stress in Biomedicine, will review the basics, biological and clinical implications, and the methods to identify ROS formation and antioxidant mechanisms. Through laboratory sessions and workshops, the student will get familiar with the conceptual aspects of OS, and its pathophysiological implications, the techniques and methods for analysis and study within the biomedical context.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

None.

OUTCOMES

2142 - M.U. en Aproximaciones Moleculares CC Salud 12-V.2

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Conocer en profundidad y comprender la organización a nivel molecular de células, sistemas y procesos de relevancia en las Ciencias de la Salud.
- Conocer en profundidad y comprender las bases moleculares de la enfermedad.

- Conocer en profundidad y comprender las metodologías de investigación básica aplicables a las Ciencias de la Salud.
- Tener capacidad de analizar y sintetizar un problema.
- Tener capacidad de comunicación oral y escrita en una segunda lengua científica.
- Tener capacidad de localizar información.
- Tener capacidad de desarrollar un trabajo interdisciplinar.
- Conocer y comprender los conceptos básicos y las aplicaciones en investigación básica y clínica del estudio de los Radicales Libres y Estrés Oxidativo en Biomedicina.
- Conocer, comprender y aplicar en la práctica las técnicas de estudio de los Radicales Libres y Estrés Oxidativo en Biomedicina en situaciones relacionadas con la investigación básica y clínica.
- Aprender a identificar, manejar y presentar adecuadamente en informes y exposiciones públicas, conocimientos existentes sobre el estudio de los Radicales Libres y Estrés Oxidativo, usando como vehículo la lengua inglesa.
- Aprender a identificar, manejar y presentar adecuadamente en informes y exposiciones públicas, conocimientos existentes sobre aspectos básicos y clínicos de señalización intercelular e intracelular, usando como vehículo la lengua inglesa.

LEARNING OUTCOMES

1. To know and understand the basics of free radicals and oxidative stress.
2. Identifying the mechanisms that produce ROS and their molecular interactions in both normal and pathological conditions.
3. To knowing the molecular variability of antioxidant defense systems, distribution and mechanism of action.
4. Achieving the proper knowledge about the pathophysiological and clinical implications of EO and methods of study.
5. To get skills for exhibiting scientific presentations regarding the biomedical aspects of EO.

DESCRIPTION OF CONTENTS

1. Introduction to the study of oxidative stress. An historical overview

We describe the most representative data about scientific advances made around pure oxygen, the first observations related to their toxicity and their achievement towards the definition of oxidative stress.

2. Types of reactive species and their formation mechanism

There are various reactive species or free radicals whose formation is due to different mechanisms. The reactivity of these species is due to the presence of unpaired electrons in their last layer energy, which allows them to interact with numerous molecules and induce the modification of their biological function.

3. Molecular oxygen reactive species. The univalent reduction of molecular oxygen

One of the most important mechanisms in the formation of reactive species is the monovalent or sequential reduction of oxygen, also known as partial or incomplete reduction.
This is an alternative route to that reduction which is carried out by the catalytic action of cytochrome oxidase as the last step in the electron transport chain. The monovalent reduction of oxygen is the primary source of radicals and / or reactive oxygen species (ROS) which are responsible of the oxidative stress process.

4. Mechanism of action of oxygen free radicals and its regulatory effects on signal transduction pathways

Reactive oxygen species (ROS) have high reactivity constants and their different affinity to cellular biomolecules results in different modifications of both its structure and its function. This interaction also affects transcription factors and, therefore, the translation mechanisms and signaling pathways of molecular processes involved in cell proliferation and differentiation.

5. Antioxidant systems. Classification and mechanisms of action

It defines antioxidant molecule and its importance for the maintenance of homeostasis of aerobic cells. It will review the different classifications that are managed according to mechanism of action, origin, nature and its cellular distribution. The study of specific characteristics of different antioxidants toward reactive oxygen species completed this section.

6. Molecular interactions of free radicals. Concept of oxidative stress is molecular biomarkers

The study of molecules capable of oxidative modification by reactive oxygen species and their impact on cellular metabolic environment.
T define the concept of oxidative stress, and its biomedical importance. The most representative biomarkers will be reviewed.

7. Oxidative stress in special physiological processes. The fetal-neonatal transition

The exhibition of a special physiological condition as most representative example of the importance of oxidative stress and antioxidants in the normal development of aerobic beings. The fetus-neonate transition as an experimental and clinical model.

8. Molecular tools for the study of oxidative stress

It will review the various methods available for the experimental study of oxidative stress.
Spectrophotometric techniques, physicochemical and chromatographic tools cytometric identification of choice for reactive species and oxidative modification products.

9. Pathophysiological aspects and implications of oxidative stress

We review the pathophysiological implications of oxidative stress as a mechanism underlying the pathogenesis of degenerative diseases. Will review the most representative pathologies where this phenomenon contributes to the initiation and progression of these diseases.

10. The oxidative stress products emerging as clinical markers

Update on the diagnosis and predictive value of markers of oxidative stress in clinical pathology. Description of the oxidation products as emerging molecular markers of cardiovascular and neoplastic diseases.

11. Practical Seminars

Seminar 1: The oxidation of cysteine. An example of free radical formation and oxidative stress.
Seminar 2: Oxidative stress in cardiovascular disease and related processes.
Seminar 3: Oxidative stress in cancer.
Seminar 4: Cytomic analysis of oxidative stress.
Seminar 5: Integration of techniques in the study of oxidative stress.

12. Practical work

Each student will write a paper on practical application of oxidative stress in research or diagnosis, choose from the list will be proposed by the teacher at the beginning of the course, with specific instructions for its preparation. The work will be delivered before the end of the semester.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	20,00	100
Group work	10,00	100
Development of group work	25,00	0
Study and independent work	20,00	0
TOTAL	**75,00**	

TEACHING METHODOLOGY

The subject is devised to be developed to face and no face.
Actual teaching of this subject will be made by the following methodological approaches: lectures, seminars and sessions tutoring assistance.
In the lectures will present an overview of the topic, with special emphasis on the key concepts. At the same meeting it will indicate the most appropriate resources for a deepening of the subject so that students complete their education in the same. The student will solve technical and experimental

examples representing basic aspects of the subject taught.

EVALUATION

Assessment of student learning will be made by assessing the following sections:
1. Theoretical exam, test type to be held in the classroom. This test will be worth up to 50% of the final grade.

2. Work oral presentation on an aspect of the agenda that will be worth up to 40% of the final grade.

3. Student interest in the subject, expressed as participation in organized discussions, the answers to the questions you ask the teacher during the sessions, tutoring assistance to personal and / or any other type of activity carried out by the student in relation with the subject. Of these concepts can be achieved up to 10% of the final grade for the course.

REFERENCES

Basic

- Lodish, H et al. (2007) Molecular Cell Biology. Chapter 20: Cell-to-Cell Signaling: Hormones and Receptors. WH Freeman
- Dennis, EA, editor (2003) Handbook of Cell Signalling. Elsevier.
- Helmreich, EJM (2001) The Biochemistry of Cell Signalling. Oxford University Press
- Bender DA, Radicales libres y nutrientes. En: Harper. Bioquímica ilustrada. McGraw Hill 28º edición. 2010, pag. 482.
- Biogerontología Médica. Sastre J., Pamplona R., Ramón J. editores. 2009 Ergón , Madrid.
- Halliwel B. and Gutteridge JMC. Free Radicals in Biology and Medicine. 4th edition. Oxford University Press 2007
- Baynes JW. Oxígeno y Vida. En: Bioquímica Médica. Baynes JW. Dominiczak MH. Editores. 2ª Edición, Elsevier Mosby 2008.
- Cortese-Krott, M.M, Anne Koning A., Kuhnle, A.G.C., Nagy P., Christopher P, Bianco, C.L., Pasch, P, Wink, D.A., Fukuto, J.M., Jackson, A.A., van Goor, H., Olson, K.R., and Feelisch M. The Reactive Species Interactome: Evolutionary Emergence, Biological Significance, and Opportunities for Redox Metabolomics and Personalized Medicine ANTIOXIDANTS & REDOX SIGNALING Volume 27, Number 10, 2017 Mary Ann Liebert, Inc. DOI: 10.1089/ars.2017.7083
- Jones, D.P. and Sies, H. The Redox Code ANTIOXIDANTS & REDOX SIGNALING Volume 23, Number 9, 2015 DOI: 10.1089/ars.2015.6247

Additional

- Antioxidants: http://www.nlm.nih.gov/medineplus/antioxidants.html
- Society for Free Radical Biology and Medicine: http://www.sfrbm.org/

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

In the event that the health situation so requires:

A) Face-to-face teaching will be replaced by online teaching, through synchronous or asynchronous presentations by teachers of the teaching materials, using the tools made available to teachers and students in the Virtual Classroom.

B) The tutorials will be carried out exclusively telematically.

C) The final evaluation of the subject will be done through an online test.