

**Neurochemistry**

Code: 100859  
ECTS Credits: 6

Degree	Type	Year	Semester
2500252 Biochemistry	OT	4	1

## Contact

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## Teaching groups languages

You can check it through this [link](#). To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

## Teachers

Jose Rodriguez Alvarez

Belen Ramos Josemaria

## Prerequisites

There is no official requirements, but it is recommended that students have completed most of the subjects of the first three courses of the Biomedical Sciences or Biochemistry degrees.

## Objectives and Contextualisation

In the context of molecular physiology, the Neurochemistry course is designed to understand the bases of function, physiology and pathology of the central and peripheral nervous system. This course includes the study of different cell types and regions involved in the function of the adult brain. The subject emphasizes the teaching of biochemical and cellular processes involved in the function and relationships of cells in the brain. A central point of the agenda is the knowledge of the different types of neurotransmission and molecular mechanisms that regulate the release of neurotransmitters and postsynaptic action (neuronal plasticity and gene expression). It focuses in molecular processes involved in metabolism, regulation and release of the major neurotransmitters (glutamate, GABA, acetylcholine, catecholamines, serotonin, neuropeptides and others), as well as their mechanisms of action in the postsynaptic cell. Finally, we will focus on the biochemical and pathophysiological mechanisms involved in brain diseases such as mental disorders and neurodegenerative diseases. The final objective is to examine the biochemical and molecular aspects of brain function in physiological and pathological conditions so that the student can develop critical reasoning about the nervous system.

The specific aims of this course are:

1. To understand the anatomical organization of the nervous system.
2. To understand the cellular organization of the nervous system.
3. Acquiring a global view of the cellular mechanisms involved in differentiation and function of cells in the nervous system
4. Understanding the importance of the blood-brain barrier and cellular compartmentalization in the context of the metabolism of nervous system.
5. To understand the molecular and electrical fundamentals responsible for the transmission of nerve impulses.
6. To know the molecular events at synapses and neurotransmitter storage, release and inactivation
7. To know the molecular structure and function of ion channels and membrane receptors for neurotransmitters
8. To know the basis of the metabolism and action of the main neurotransmitters
9. To understand the biochemical mechanisms involved in some diseases of the nervous system
10. Develop critical reasoning to deepen into scientific issues related to biochemistry of the nervous system

## Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Analyse and explain normal physiological processes and alterations in them on the molecular scale, using the scientific method.
- Collaborate with other work colleagues.
- Demonstrate an integrated vision of the function of hormones, neurotransmitters and growth factors in the control of gene expression and metabolism.
- Describe the structural, physiological and biochemical characteristics of the different types of cells and explain how their properties fit in with their biological function.
- Design experiments and understand the limitations of experimental approaches.
- Interpret experimental results and identify consistent and inconsistent elements.
- Introduce changes in the methods and processes of the field of knowledge to provide innovative responses to the needs and demands of society.
- Make an oral, written and visual presentation of one's work to a professional or non-professional audience in English and understand the language and proposals of other specialists.
- Manage information and the organisation and planning of work.
- Read specialised texts both in English and one's own language.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Take responsibility for one's own learning after receiving general instructions.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
- Understand the language and proposals of other specialists.
- Use ICT for communication, information searching, data processing and calculations.
- Write an article on a scientific or technical topic aimed at the general public.

## Learning Outcomes

1. Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
2. Collaborate with other work colleagues.
3. Describe the neuroendocrinological control of prolactin.

4. Describe the principal sub-types of neurotransmitter receptors and their most common pharmacology.
5. Describe the structural, functional and molecular factors that govern the functioning of the nervous system.
6. Design experiments and understand the limitations of experimental approaches.
7. Discern the biochemical bases of the most common pathologies of the nervous system and the action mechanisms of their principal treatments.
8. Explain the most important processes in neurotransmission: synthesis, storage and release of neurotransmitters.
9. Identify the principal actions of trophic factors and their receptors on neuron populations.
10. Interpret experimental results and identify consistent and inconsistent elements.
11. Introduce changes in the methods and processes of the field of knowledge to provide innovative responses to the needs and demands of society.
12. Make an oral, written and visual presentation of one's work to a professional or non-professional audience in English and understand the language and proposals of other specialists.
13. Manage information and the organisation and planning of work.
14. Map out the biochemical, anatomical and physiological features of the principal neurotransmitter systems and the possibilities for pharmacological intervention in these systems.
15. Read specialised texts both in English and one's own language.
16. Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
17. Take responsibility for one's own learning after receiving general instructions.
18. Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.
19. Understand the language and proposals of other specialists.
20. Use ICT for communication, information searching, data processing and calculations.
21. Write an article on a scientific or technical topic aimed at the general public.

## **Content**

### **CHAPTER I: FUNDAMENTS OF THE NERVOUS SYSTEM**

#### **1. ANATOMICAL ORGANIZATION OF THE NERVOUS SYSTEM**

Organization of the central and peripheral nervous system.

#### **2. CELLULAR ORGANIZATION OF THE NERVOUS SYSTEM**

Morphological, molecular and functional cell types of the nervous system: neurons and glial cells.

#### **3. HOMEOSTASIS OF THE NERVOUS SYSTEM**

Cellular compartmentalization and metabolism. Blood brain barrier. Cerebrospinal fluid.

### **CHAPTER II: OVERVIEW OF NEUROTRANSMISSION**

#### **4. NEUROTRANSMISSION IN THE NERVOUS SYSTEM**

Types of neurotransmission: chemical and electrical synapses. Structure and function of synapses. Calcium-dependent and -independent neurotransmitter release. Structure and cycle of synaptic vesicles. Structure and function of neurotransmitter receptors: ionotropic and G protein-coupled receptors and effectors. Desensitization of neurotransmitter receptors. Molecular mechanisms of synaptic plasticity

### **CHAPTER III: BASIS OF THE NEURONAL EXCITABILITY**

#### **5. BIOCHEMICAL AND ELECTRICAL BASES OF NEURONAL EXCITABILITY**

Electric transmission signal. Resting potential. Action potential.

Function and structure of ion channels. Local potential and neuronal integration.

## CHAPTER IV: MAIN NEUROTRANSMITTERS

### 6. TYPES OF NEUROTRANSMITTERS

Neurotransmitter systems: amino acids (glutamate and GABA), acetylcholine, catecholamines, serotonin, histamine, neuropeptides and others. General principles: neurotransmitter metabolism, storage, inactivation, receptors and brain pathologies associated with neurotransmitter systems.

## CHAPTER V: NEUROCHEMICAL AND PATHOLOGICAL MECHANISMS OF NEURODEGENERATIVE DISEASES

### 7. BIOCHEMICAL AND PATHOLOGICAL ASPECTS OF NEURODEGENERATIVE DISEASES

Alzheimer's disease (AD). Parkinson's disease (PD). Huntington's disease (HD). Amyotrophic lateral sclerosis (ALS).

## Methodology

The TEACHING METHODOLOGY consists of: 1) Theoretical classes, which will include both theoretical content classes and research seminars; 2) Commented self-learned exercises; 3) Seminars; and 4) Laboratory practices.

1. Master classes will be taught in the form of lectures to the group, in which the Professor will also comment on the material available for other activities, including materials for self-learning. Teaching material for the different activities will be provided basically through the UAB Virtual Campus. The teaching of the theoretical classes will be in person basis, and only in very specific circumstances online via Microsoft Teams.

2. Commented self-learned exercises: At the end of each chapter, the students will solve some theoretical-practical cases, called "Self-learned exercises", which will be written in English to the teacher in advance and will be discussed in class in English with classmates tutored by the teacher.

3. Seminars will consist of an oral presentation of the content of the laboratory practices and/or theoretical and practical cases related to the nervous system by the groups of alumni, preferably in English.

4. Laboratory practices consist in the design and performance of an experimental procedure of a scientific question related to the nervous system. Students will do the practical part in the lab tutored by a teacher and then must write a lab report. Additionally, students will be able to have specific tutorials. Laboratory practices are mandatory to examine and pass the course, with the exception of unique evaluation. The laboratory practices will be carried out in reduced groups in the laboratories of the Biochemistry Unit of the Dept. of Biochemistry and Molecular Biology of the School of Medicine (Medicine Building, Tower M2; Schedule: 15:00-19:00h), and partially NON-ATTENDANCE of personal work related to the experimental practice (bibliographic search, preparation of results, writing report, etc ...).

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

## Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Commented exercises	5	0.2	2, 5, 4, 7, 21, 19, 14, 8, 13, 9, 10, 15, 12, 17

Laboratory practices	12	0.48	1, 18, 20, 2, 5, 6, 21, 19, 14, 13, 10, 11, 15, 12, 17
Master classes	31	1.24	16, 5, 4, 7, 19, 14, 8, 9
Seminar/Oral presentation	6	0.24	20, 2, 5, 6, 7, 19, 14, 8, 13, 10, 15, 12, 17
Type: Supervised			
Preparation commented exercises	6	0.24	20, 2, 5, 4, 6, 7, 21, 19, 14, 8, 13, 9, 10, 15, 12, 17
Report lab practices and oral presentation	6	0.24	20, 2, 5, 4, 6, 7, 21, 19, 14, 8, 13, 9, 10, 15, 17
Tutorials	5	0.2	2, 5, 4, 6, 7, 19, 14, 8, 13, 9, 10, 12, 17
Type: Autonomous			
Personal study	72	2.88	20, 5, 4, 6, 7, 21, 19, 14, 8, 13, 9, 10, 15, 12, 17

## Assessment

The knowledge acquired will be evaluated in different tests in a continuous way, except for unique evaluation. At the end of all theoretical classes the student will be examined in a final exam consisting of a written test of 10 short questions of all the subject matter of the course. The final written exam will mean 50% (100% unique evaluation) of the mark of the subject, the rest will be given by the activities that have been done continuously throughout the course (see below). The final exam is compulsory and only students that fail can attend the recovery exam, keeping notes of the activities carried out throughout the course. The recovery exam will never be for a note to go up. The "non-evaluable" will reflect non-attendance to the final compulsory exam.

Format of the evaluations

Unique Evaluation:

- Final written exam: Students are not obligated to perform: laboratory practices, commented exercises and seminars/oral presentations, so their evaluation will consist of a final written exam the same moment and day of the exam of continuous evaluation, and if failed they will have the opportunity for a recovery exam.

Calculation of the final grade: 100% of the written final test.

Continuous Evaluation:

- Final written exam:

The obligatory written exam will consist of 10 short questions that the students will have to answer individually in approximately ½ page each one. In this test you can ask about any part of the subject that has been explicitly given or related to the theoretical classes, exercises commented, practices or seminars. The mark of the written exam will account for 50% of the final mark.

- Self-learning commented exercises:

Exercises that will be carried out during the class-by-class during classroom practices will consist of tutored self-study classes. The assessment will be done through tests written in English that aim to reflect the achievement of competences, as well as the knowledge of concepts explained in the theoretical classes. Each exercise will have a score of 1 to 10. The overall grade for these exercises will count 20% in the final grade.

- Laboratory practices:

Laboratory practices are mandatory. The evaluation of the lab practices will include the experimental procedures in the lab using standard and scientific methodology (ATTENDANCE in the lab) and the written report of the obtained results. The final score will correspond to 15% of the final grade of the subject. The

students will obtain the "Non-Valuable" qualification when the absence exceeds 20% of the programmed sessions o score = 0 in this activity.

- Seminars/Oral presentation:

Each group of students will present orally to the rest of the students and professors the results obtained in the laboratory practices or clinical or scientific cases that they have done. Students and teachers will be able to ask questions and the latter will evaluate the presentation of each student individually. The note of the seminar will correspond to 15% of the final grade. If the sanitary status does not allow it, then this part will be presented telematically.

Calculation of the final score: The final grade for the course will be calculated as follows: the grade for the final written exam will be 50% of the final grade for the course, while the grade for the continuous assessment exercises (commented exercises, laboratory practices and seminars) will represent 50% of the final grade for the course. Requisites to pass: In order to pass the course, the final grade of the course will be equal to or greater than 5 out of 10. It will also be essential to obtain at least 4.5 out of 10 points in the final written exam.

Recovery exam:

Students that do not pass the minimum score (total score of 5 and 4.5 score in the written exam) may voluntarily assist to a recovery test, the grade from which will replace the one obtained from the final written exam. The only recoverable assessment activity is the written exam, while the exercises, laboratory practices and seminars are NOT recoverable. The final grade for the course will be calculated as detailed in the previous section Calculation of the final grade. The recovery exam will give no the right to an Honors degree.

To participate in the recovery, students must have been previously evaluated in a set of activities, the weight of which is equivalent to a minimum of two thirds of the total grade for the subject or module. Therefore, students will obtain the qualification of "Not Evaluable" when the evaluation activities carried out have a weighting of less than 67% in the final qualification.

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final written exam	50% of the final score	3	0.12	5, 4, 6, 7, 19, 14, 8, 9, 10, 12, 17
Lab Practices	15 % of the final score	1	0.04	1, 18, 20, 2, 3, 5, 4, 6, 7, 21, 19, 14, 8, 13, 9, 10, 11, 15, 12, 17
Self-learned exercises	20 % of the final score	2	0.08	20, 2, 5, 4, 6, 7, 19, 14, 8, 13, 9, 10, 15, 12, 17
Seminars	15 % of the final score	1	0.04	16, 20, 2, 5, 4, 6, 7, 19, 14, 8, 13, 9, 10, 15, 12, 17

## Bibliography

To check disponibility of electronic documents, books and scientific journals at UAB library see:  
<https://ddd.uab.cat/pub/guibib/224929/bibrecdigitals.pdf>

### BOOKS

BASIC NEUROCHEMISTRY: Molecular, Cellular and Medical Aspects (Seven edition) 2005. Scott Brady; George Siegel; R. Wayne Albers; Donald Price.

<https://ebookcentral.proquest.com/lib/UAB/detail.action?docID=288993>

NEUROSCIENCE (5th edition) 2012. D Purves, GJ Augustine, D Fitzpatrick, WC Hall, AS LaMantia, LE White. Sinauer Associates, Inc.

<http://sites.sinauer.com/neuroscience5e/>

FUNDAMENTAL NEUROSCIENCE (4th Edition) (2013). Squire, LR, Berg, D., Bloom, F., du Lac, S., Gosh, A. and Spitzer, N. Academic Press, Elsevier Science.

<https://www.clinicalkey.es/#!/browse/book/3-s2.0-C20100650358>

MOLECULAR NEUROPHARMACOLOGY (2nd edition) 2009. EJ Nestler, SE. Hyman, RC. Malenka. McGraw-Hill Medical.

PRINCIPIOS DE NEUROCIENCIA (2001) (4ª edición). E.R. Kandel, J.H. Schwartz & T.M. Jessell. McGraw-Hill Interamericana

CELLULAR AND MOLECULAR NEUROPHYSIOLOGY (2015) (4a Edició). C. Hammond. Academic Press

<https://www.sciencedirect.com/book/9780123970329/cellular-and-molecular-neurophysiology>

ELECTRONIC RESOURCES: Real/animated videos

JoVe

<https://www.jove.com>

<https://www.jove.com/education/5/neuroscience>

<https://www.jove.com/research/journal/neuroscience>

## **Software**

Excel, Word, Microsoft Teams