

Degree programme	Type	Course
Bachelor in Artificial Intelligence	OB	4

Contact lecturer

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Prerequisites

No prerequisites are required.

Group languages

You can consult this information at the [end](#) of the document.

Objectives

The general aim of this course intends that the students understand how the nervous system works, which are the neural bases of cognitive processes, and the bidirectional relationship between neuroscience and artificial intelligence. Taking into account the former considerations, this course will be addressed to the following specific aims:

1. To know and understand the anatomical, cellular and molecular foundations of information processing in the nervous system.
2. To understand the mechanisms of plasticity in the nervous system, from the synaptic level to experience-dependent functional multimodal reorganization.
3. To know and understand the neural bases of sensory processing at multiple levels of the nervous system.
4. To know and understand the neural bases of learning and memory, and emotions.
5. To know the main techniques for the recording and stimulation of neural activity, and to identify the practical applications based on artificial intelligence.

Learning outcomes

- KM27 (Describe the anatomical underpinnings of the neural systems that underpin the basic cognitive processes of information processing, memory, and learning.) Describe the anatomical underpinnings of the neural systems that underpin the basic cognitive processes of information processing, memory, and learning.
- SM28 (Relate concepts of cognitive processes and human neural mechanisms to the design and analysis of machine learning and reasoning algorithms.) Relate concepts of cognitive processes and human neural mechanisms to the design and analysis of machine learning and reasoning algorithms.
- SM29 (Apply artificial intelligence techniques to the analysis of data obtained through neural activity recording techniques and understand their implications for cognitive neuroscience) Apply artificial intelligence techniques to the analysis of data obtained through neural activity recording techniques and

understand their implications for cognitive neuroscience

Contents

1. Introduction: The interrelationship between neuroscience and artificial intelligence
 - Bioinspired artificial intelligence
 - Applications of artificial intelligence to neuroscience and to the study of behavior and mental functions.
2. Structure and function of the nervous system: Molecular, cellular and synaptic levels
 - 2.1. The cells of the nervous system
 - 2.2. Membrane potential, action potential and synaptic transmission.
 - 2.3. Mechanisms of synaptic plasticity.
 - 2.4. Biological neural networks.
3. Structure and function of the nervous system: systems level.
 - 3.1. Main divisions of the nervous system and their organization.
4. Techniques for recording and stimulation of neural activity
 - 4.1. Electrophysiological techniques of stimulation and recording of neuronal populations and individual neurons
 - 4.2. Calcium imaging techniques
 - 4.3. Optogenetics
 - 4.4. Structural and functional neuroimaging.
 - 4.5. Neural interfaces
5. How the brain perceives the world.
 - 5.1. General organization of the sensory systems
 - 5.2. Transduction and codification in the somatosensory systems
 - 5.3. Transduction and codification in the auditory system
6. How the brain learns, remembers and forgets
 - 6.1. Memory systems in the brain: Neural bases of the implicit and explicit systems
 - 6.2. Memory, extinction, forgetting and synaptic plasticity

7. Biological bases of motivations and emotions

7.1. Components of emotions

7.2. Neural bases of emotion expression and comprehension

7.3. The reward neural system and its alterations. Addictions

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Study, preparation and implementation of activities	89	3.56	KM27, SM28, SM29
Online and in-person consultation	52	2.08	KM27, SM28, SM29
Theoretical teaching	0	0	KM27, SM28, SM29

In the 2026-27 academic year, this subject will not be taught in person, due to a modification in the curriculum. This subject will only be offered to students enrolled in previous courses who did not pass it. Therefore, the teaching methodology will consist of tutorials when the student requires them and online activities.

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.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Follow-up activities	30	4	0.16	KM27, SM28
Final exam	35	2	0.08	KM27, SM28
Report based on scientific papers	20	2	0.08	SM28, SM29
Partial exam	15	1	0.04	KM27

The evaluation of this subject is carried out continuously. The evaluation has a clear formative function.

The competences of this subject will be evaluated by means of: follow up activities, written and oral presentation, as well as exams.

The learning evidences that the student must deliver will refer to the contents available in Moodle.

- Evidence 1. Ongoing activities based on exercises that will be carried out throughout the semester: 30%.

Feedback through Moodle or in tutorials as soon as each activity has been carried out.

- Evidence 2. Oral presentation and defense of a report based on scientific articles: 20%.

Feedback through Moodle or in tutorials on weeks 15 and 16.

- Evidence 3. Partial exam, which will be held in the middle of the semester: 15%.

Feedback in tutorials after publication of the grades.

- Evidence 4. Final exam, which will be held at the end of the semester and will include content from the entire subject: 35%.

Feedback in tutorials after publication of the grades.

Subject passed

The subject is passed when the student meets the following two conditions:

a) has obtained a grade of at least 5 points (out of 10) when all the evidences are considered

b) has obtained a score of at least 4.5 points (out of 10) in Evidence 4.

If these two conditions are not met, the grade on the academic transcript will be the weighed sum of the grades of the four evidences if this summation is lower or equal to 4.5, and 4.5 otherwise (thus, the maximum grade available for students not fulfilling the two criteria will be 4.5).

Recuperation

To be allowed to opt for resit the student has to fulfill the following requisites: 1) having presented evidences with a weight of at least two thirds of the total grade of the subject; 2) having a mark equal to or greater than 3.5 points and lower than 5 points.

The recuperation will consist of an exam about all the subject. The maximum grade that can be obtained in the course, in case of overcoming the recovery, will be 5.

Subject 'not evaluable'

A student who has given learning evidences with a weight lower than 4 points (40%) will have a "non-evaluable" label in the transcript of records.

Single assessment act

This subject does not offer the possibility of taking a single assessment (single assessment act).

Bibliography

Books and papers

Carlson, N.R.; Birkett, M.A. (2017). Physiology of Behavior, Global edition. Pearson Education (both paperback

and online versions are available in the library).

Cohen Y, Engel TA, Langdon C, Lindsay GW, Ott T, Peters MAK, Shine JM, Breton-Provencher V, Ramaswamy S. Recent Advances at the Interface of Neuroscience and Artificial Neural Networks. J Neurosci. 2022 Nov 9;42(45):8514-8523. doi: 10.1523/JNEUROSCI.1503-22.2022.

Jeon I, Kim T. Distinctive properties of biological neural networks and recent advances in bottom-up approaches toward a better biologically plausible neural network. Front Comput Neurosci. 2023 Jun 28;17:1092185. doi: 10.3389/fncom.2023.1092185

Websites

<https://www.ebrains.eu/>

<https://www.neuroanatomy.ca/>

<http://lifesciencedb.jp/bp3d>

Software

Neurosim

<https://www.st-andrews.ac.uk/~wjh/neurosim/index.html>

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this [link](#). To access the information, you will need to enter the course CODE