UAB
Universitat Autònoma de Barcelona

Mind and Brain I

Code: 106578
ECTS Credits: 6

2024/2025

Degree	Type	Year
2504392 Artificial Intelligence	FB	2

Contact

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

No prerequisites are required.

Objectives and Contextualisation

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, cellullar 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.

Competences

- Act within the field of knowledge by evaluating sex/gender inequalities.
- Communicate effectively, both orally and in writing, adequately using the necessary communicative resources and adapting to the characteristics of the situation and the audience.
- Identify, understand and analyse the fundamental characteristics of neural mechanisms and human psychological and cognitive processes and relate them to the processes of automatic intelligent systems.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Work independently, with responsibility and initiative, planning and managing time and available resources, and adapting to unforeseen situations.

Learning Outcomes

1. Analyse sex/gender inequalities and gender bias in the field of knowledge.
2. Communicate effectively, both orally and in writing, adequately using the necessary communicative resources and adapting to the characteristics of the situation and the audience.
3. Identify the main anatomical and histological characteristics of the nervous system, as well as the cellular, molecular and electrophysiological bases of chemical synaptic transmission.
4. Relate the different mechanisms and types of synaptic plasticity to cognitive and behavioural plasticity, and in particular to learning and memory.
5. Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
6. Understand information processing mechanisms in terms of both the synaptic and neural systems.
7. Understand the main techniques for recording and stimulating neural activity, as well as their usefulness and limitations.
8. Understand the main techniques for recording perception in terms of behaviour and cognitive systems (psychophysics), as well as their usefulness and limitations.
9. Understand the neurobiology of hearing and its implications and applications in the field of artificial intelligence.
10. Understand the neurobiology of somatosensory systems and their implications and applications in the field of artificial intelligence.
11. Work independently, with responsibility and initiative, planning and managing time and available resources, and adapting to unforeseen situations.

Content

1. Introduction: The interrelationship between neuroscience and artificial intelligence
- Biological brains and artificial intelligence
- Applications of artificial intelligence in neuroscience and in 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

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practicals	4	0.16	2, 3, 5, 6
Master classes	24	0.96	3, 4, 6, 7, 8, 9, 10
Seminars	22	0.88	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Type: Supervised			
Tutoring (group and individual)	20	0.8	1, 3, 4, 5, 6, 7, 8, 9, 10
Type: Autonomous			
Study	50	2	3, 4, 6, 7, 8, 9, 10, 11
Team work	21	0.84	2, 5, 11

The methodology includes several types of activities. Master classes, seminars and laboratory practicals, as well as supervised and autonomous activities, will be scheduled

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

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evidence 1. Follow-up activities	30%	4	0.16	1, 3, 4, 6, 7, 8, 9, 10, 11
Evidence 2. Team report based on scientific papers	20%	2	0.08	1, 2, 4, 5, 6, 7, 8, 9, 10, 11
Evidence 3. Partial exam	15%	1	0.04	3, 6, 7, 8
Evidence 4. Final exam	35%	2	0.08	1, 3, 4, 6, 7, 8, 9, 10

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, team presentations and reports, as well as exams.

The learning evidences that the student must deliver will refer to the contents and competences worked in the theoretical classes and seminars, and in the laboratory practicals.

The evaluation system is organized in four evidences, each of which will be assigned a specific weight in the final grade:

- Evidence 1. Follow-up activities based on exercises completed in class as well as via moodle: 30%

- Evidence 2. Team work based on scientific papers: 20%

- Evidence 3: Partial exam, by the middle of the semester: 15%

- Evidence 4: Final exam, at the end of the semester, which will include contents of the full subject: 35%

Subject passed
The subject is passed when the student obtains a grade equal to or greater than 5 and has presented evidences with a weight of at least 65% of the total grade of the subject.

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) to have a mark equal to or greater than 3.5 points and less than 5 points.

The recuperation will consist of an exam about all the subject, that will contain questions about all the theoretical contents, as well as the resolution of practical exercises. The maximum grade that can be obtained in the course, in case of overcoming the recovery, will be Approved (5).

Subject 'not evaluable'

A student who has given learning evidences with a weight lower than 4 points (40%) will record in acts as "non-evaluable".

Single assessment act

This subject does notoffer 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).

Eysenck, MW & Keane, M.T. (2020). Cognitive Psychology. A student's book (8th Edition). Psychology Press.

Macpherson T, Churchland A, Sejnowski T, DiCarlo J, Kamitani Y, Takahashi H, Hikida T. Natural and Artificial Intelligence: A brief introduction to the interplay between AI and neuroscience research. Neural Netw. 2021 Dec;144:603-613. doi: 10.1016/j.neunet.2021.09.018.

Websites

https://www.ebrains.eu/

https://www.neuroanatomy.ca/

http://lifesciencedb.jp/bp3d

Software

Neurosim Release 5

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

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	711	English	first semester	afternoon
(PLAB) Practical laboratories	711	English	first semester	afternoon
(PLAB) Practical laboratories	712	English	first semester	afternoon
(TE) Theory	71	English	first semester	afternoon