Universitat Autònoma de Barcelona

**2023/2024**

# Mind and Brain I

Code: 106578
ECTS Credits: 6

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2504392 Artificial Intelligence | FB | 2 | 1 |

## Contact

Name: Margalida Coll Andreu

Email: margalida.coll@uab.cat

## 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

Elena Martin Garcia

## Prerequisites

No prerequisites are required, but mention to knowledge acquired in the first-year course "Cognitive Processes" will be often done.

## 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. An introduction: The interplay between neuroscience and artificial intelligence

2. Structure and function of the nervous system: Molecular, cellullar and synaptic levels.

2.1. The cells of the nervous system

2.2. Resting and action potential

2.3. Synaptic transmission

2.4. Synaptic plasticity

3. Structure and function of the nervous system: Main neuroanatomical regions and circuits

4. Techniques for neural recording and stimulation

5. How the brain perceives the world

5.1. General organization of the sensory systems

5.2. The somatosensory systems

5.2.1. Somatosensory receptors and pathways

5.2.2. Transduction and codification in the somatosensory systems

5.3. The auditory system

5.3.1. Auditory receptors and pathways

5.3.2. Transduction and codification in the auditory system

6. How the brain learns, remembers and forgets

6.1. Classification of memory types

6.2. Neural bases of implicit and explicit memories

6.3. Recall, extinction, forgetting and synaptic plasticity

7. The biological bases of motivation and emotions

7.1 Definition of motivation and emotion

7.2. Components of emotions

7.3. Neural bases of comprehension and expression of emotions

7.4. Neural reward system and its alterations. Addictions

## Methodology

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.

## Activities

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Laboratory practicals | 4 | 0.16 | 6, 2, 3, 5 |
| Master classes | 24 | 0.96 | 6, 9, 10, 8, 7, 3, 4 |
| Seminars | 22 | 0.88 | 1, 6, 2, 9, 10, 8, 7, 3, 5, 4 |
| Type: Supervised | | | |

| | | | |
|---|---|---|---|
| Tutoring (group and individual) | 20 | 0.8 | 1, 6, 9, 10, 8, 7, 3, 5, 4 |
| Type: Autonomous | | | |
| Study | 50 | 2 | 6, 9, 10, 8, 7, 3, 4, 11 |
| Team work | 21 | 0.84 | 2, 5, 11 |

## Assessment

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 offers the possibility of taking a single assessment (single assessment act), provided that authorization has been received from the School of Engineering. The single assessment act implies that the student submits all the assessment evidences in a single day, within the period of final exams. Therefore, students who take the single assessment act must take the partial exam (evidence 3, 1 hour), the final exam (evidence 4; 2 hours) and the oral presentation of evidence 2 (30 minutes) on the same day. In addition, the student will be required to hand in (if he/she has not done it yet) the activities included in Evidence 1 and the written parts of Evidence 2 also on the same day.

As for evidence 2, this will be done as a team work whenever there is more than one student doing the single assessment act, and individually otherwise.

The students doing the single assessment are not exempt from attending the lessons, including the laboratory practicals.

The requirements to pass the subject and to be able to take the recovery test are the same as for the rest of the students.

## Assessment Activities

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

## 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.neuroanatomy.ca/

http://lifesciencedb.jp/bp3d

## Software

Neurosim Release 5

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