

MATERIAL RESOURCES AND SUPPORT AVAILABLE FOR DOCTORATES

The centers affiliated to this Programme (Center for Plant Biotechnology and Genomics and the Technical School of Agricultural, Food and Biosystems Engineering) are equipped with the appropriate infrastructures and equipment to allow the development of the lines of research included in the Proposed doctoral programme. These centers house research laboratories where doctoral students can carry out their activity, and are equipped with the adequate laboratory equipment to work in areas ranging from biochemistry, biotechnology, physiology, to molecular biology, genetics, pathology, microbiology, and molecular ecology. Examples of the **basic equipment** in research laboratories are thermal cyclers for DNA amplification, electrophoresis systems for DNA and protein analysis, visible and ultraviolet spectrophotometers, precision balances, pH meters, centrifuges and ultracentrifuges, thermostatic baths, stirring and homogenizing systems, as well as -80°C and -20°C refrigerators and freezers for the conservation of biological materials.

In addition, some laboratories have equipment that allows the development of more specific analysis, including luminometers, microscopes (optical and confocal), autoclaves, electroporators, hygrometers, atomic absorption spectrophotometers, HPLC or flow cytometry devices up to a sophisticated micromanipulation and electrophysiology equipment. The laboratories have adequate personal space for students, both for carrying out experimental work (bench space and cabinets to store all laboratory material and chemical products) and for studying (work tables and cabinets with availability of computers with suitable software and internet connection). In addition, the affiliated centers have a series of general services or facilities that are described below and that are suitable for the training of the doctoral student and the development of their research activity. Both, in the research laboratories and in the general services of the centers there is technical support staff that greatly facilitates the research activity of students.

Description of the Facilities of the Center for Plant Biotechnology and Genomics

The **CBGP** is a mix center of excellence between the UPM and the National Institute for Agricultural and Food Research and Technology (INIA/CSIC) that has received the Severo Ochoa Center of Excellence accreditation. The CBGP is located in the CEI Montegancedo of the UPM in Pozuelo de Alarcón (Madrid) and consists of a Main Building of 7391 m² and two annex buildings: the Plant Cultivation Laboratory + Greenhouses (542 m² + 1200 m², respectively) and a 850 m² building for the location of singular infrastructures (fermenters, etc.). These facilities make the CBGP the Research Center in the area of Plant Biology / Agriculture with the largest built surface area in Spain. The main building of the CBGP has:

- 2.500 m² of research laboratories (including office space for researchers)
- 1.500 m² of laboratory research services (sterilization, microscopy, proteomics, genomics, metabolomics, etc.)
- 700 m² of general service laboratories (warehouse, sample preservation laboratories (4°C , -80°C , etc.)
- 2.700 m² of other services (administration, meeting rooms, auditorium, cafeteria, library, etc.)

1) Infrastructures and singular R&D equipment of the centers affiliated to the Programme for the development of the research activity of the Doctoral Programme

In addition to the general facilities / techniques available in each of the affiliated centers, and indicated above, it is worth highlighting some infrastructures R&D equipment that allows the development of the lines of research related to the Postgraduate Programme.

1.1) Facilities for Plant Cultivation The Centers attached to the Doctoral Programme have important facilities for plant cultivation. The **Center for Plant Biotechnology and Genomics** (Campus CEI Montegancedo) has a 542 m² Plant Cultivation Laboratory (LCP) where there is a space (120 m²) for the handling and preparation of plant material, including a chamber for sowing and stratification of plants (4°C) and a laboratory to inoculate the plants with different microorganisms (pathogens or symbionts). The LCP of the CBPGP also has 350 m² of plant cultivation surface distributed in phytotron-type cultivation chambers (open and non-viewable) suitable for use with different types of plant species. These phytotrons and others available in the main building also allow in vitro culture. Adjacent to the LCP and connected to this laboratory there is a greenhouse that occupies a surface area of 1200 m², divided into 13 separate compartments of 47 m² each, one of which is used for growing transgenic plants (Biological Safety Level P2)

The CBGP facilities also have a type **P2 facility for the confined use of genetically modified organisms** (notification A / ES / 12 / I-03) that allows the confined use of low-risk genetically modified organisms (GMOs). The center also hosts a **P3 laboratory** in the main building to work with **high-risk pathogens**.

Las instalaciones del CBGP cuentan además con una **instalación de tipo P2 de utilización confinada de organismos modificados genéticamente (notificación A/ES/12/I-03)** que permite la utilización confinada de organismos modificados genéticamente (OGMs) de bajo riesgo. El centro además dispone de un **laboratorio P3** en el edificio principal para trabajar con patógenos de alto riesgo.

In the Practice Fields of the **School of Agricultural, Food and Biosystems Engineering** (ETSIAAB, CEI Moncloa Campus), the **Department of Biotechnology-Plant Biology** has two greenhouses of 250 and 350 m², and other conventional greenhouses with control of light and temperature, and shade houses, and 2 hectares of test fields.

1.2.) Facilities for the cultivation of Microorganisms

The CBGP has the **equipment and facilities necessary for the cultivation and management of microorganisms**. There are research groups that work with symbiotic bacteria, or plant pathogens, as well as yeasts and phytopathogenic fungi. The center has adequate facilities for the sterilization of culture media, growth (on a small and large scale, even with 200-liter capacity fermenters) and handling of all the above-mentioned microorganisms. Microorganism culture facilities are also available at the **ETSIAAB**.

1.3.) Research Support Services and "Omic"Technology Platforms

The CBGP is equipped with the necessary equipment for the application to the Biotechnology of Plants and Associated Microorganisms of **the new "omic" technologies related to Genomics, Proteomics, Metabolomics and as well as a Microscopy service**. The services available, which have associated specialized technical personnel, have, among others, the following equipment:

- **Microscopy Service:** It consists of a state-of-the-art Leica TCSP8 Spectral Confocal Microscope, optical microscopes (normal and inverted) and fluorescent loupes, and accessory equipment for sample processing and preparation.
- **Genomics Service:** It has 4 qPCR equipment, equipment for genotyping using High Resolution Melting (HRM), devices for hybridization and microarray processing, and robotics equipment for the automation of the screening of DNA and yeast libraries (one hybrid).
- **Proteomics Service:** The services available include 2D protein electrophoresis, peptide fingerprint analysis, spot picking, digestions and obtaining spectra and molecular masses using MALDI-TOF.

- **Metabolomics Service:** State-of-the-art platform for High Throughput (HT) analysis consisting of an ESI-type MS-MS system and associated nano-LC and UPLC. The platform also has CG-MS.

- **Bioinformatics Services:** There are two high-capacity centralized servers for genomics studies (assembly of genomes) and microbiome determination. In addition, the center has access to the CesViMa Supercomputing service located on the Montegancedo campus.

The CBGP also has a laboratory dedicated to the **cultivation and handling of animal cells**, with a 37°C chamber with assisted CO₂, laminar flow hood and flow cytometer as well as a plant electrophysiology laboratory, with the necessary facilities to record intracellular electrical currents in plants and in oocytes of *Xenopus laevis*. As auxiliary services to support research, the center has a centralized service for the washing and sterilization of laboratory material

The Department of **Biotechnology-Plant Biology** has teaching and research facilities at the ETSIAAB. It is also worth mentioning the maintenance of a **plant germplasm bank**, a world pioneer and which currently maintains and renews a collection with more than 10,000 accessions of wild plant taxa, whose facilities are currently being renovated. In addition, the teaching and research laboratories that have been recently renovated maintain **adequate facilities for techniques based on PCR, in vitro cultivation, micropropagation and cryopreservation of plants, as well as the study of the physiology of seeds.**

The **Genetics Teaching Unit** (Department of Biotechnology) has several **collections of germplasm** of commercial and wild varieties of **wheat and barley** as well as a collection of germplasm of **Brachypodium distachyon** (BdUPM), a promising model plant to address genetic and genomic studies in cereals. These collections are available to the international scientific community.

These facilities must be added to those available at the **INIA/CSIC Collaborating Centers.**

2) Library, documentary resources and scientific seminars

Currently, the UPM has a Library service that has 17 service points, each in a School or Faculty, and the European Documentation Center, CEYDE. The physical space is organized into three campuses from which the university community is equally served (students, professors, researchers, and administration and services staff). Specifically, the centers attached to the Doctoral Programme have general access to the Internet and libraries, both online access and on a physical basis on paper, with the most relevant journals and documentary resources from the different fields of research. The **CBGP also has Internet access to a wide catalog of scientific journals through the services provided by the INIA/CSIC.** The Center has seminar rooms equipped with screens and connections to cannons for the projection of images and videos that facilitate the holding of group seminars and other types of scientific discussion forums. In addition, the Center actively collaborates with the Doctoral Programme, including its **cycle of Seminars** as part of the training activities. This series of Seminars is of recognized prestige in the area of Plant Biotechnology in Spain and calls for national and international speakers of excellence. The percentage of international speakers in the CBGP Seminar Programme is equal to or greater than 30%. This activity covers the AF6 indicated above. Likewise, the CBGP organizes specific scientific conferences, such as the [Workshop in Plant Biology Frontiers](#) to which doctoral students have access in order to complement their training

3) Services and facilities of the UPM to support research

There is access to more sophisticated services available at **other research centers** located on the Montegancedo campus belonging to the UPM, such as:

- Biomedical Technology Center (CTB), holding electron and confocal microscopy devices as well as devices for processing high-resolution images.
- Supercomputing and Visualization Center of Madrid (CeSViMa), dedicated to massive information storage, high-performance computing and advanced interactive visualization.
- Comprehensive Home Automation Center (CeDint), which groups together different lines of research related to communication and computer engineering.

- Technological Innovation Support Center (CAIT) that promotes the exploitation of the results of the R&D activity and serves as a stimulus to the innovative process in the business ecosystem close to the UPM. The **biennial R&D&I Technology Transfer Course** is held at its facilities, which is offered by the Doctorate Programme within its training activities (AF5).

Likewise, through the research groups there is access to external services that are required for the development of the doctoral student's research activity (mass genome sequencing services, RNA, protein purification and analysis ...), located in other research centers outside the UPM, either in Technology Parks or research centers located both in the Community of Madrid and in other international institutions.

4) Other UPM services useful for the Doctoral Programme

4.1.) Institutional Tele-teaching Platform of the UPM

The Universidad Politécnica de Madrid, through the Tele-Education Cabinet (GATE), has implemented the Institutional Tele-Teaching Platform, based on the open software Moodle. This resource is very interesting for the Doctoral Programme as a management, communication and information platform between the Directorate of the Doctoral Programme and doctoral students, directors and tutors of doctoral theses.

4.2.) UPM Audiovisual and Multimedia Resources Service

The GATE of the UPM provides support for teaching and research in relation to audiovisual and multimedia content and technologies available to the entire scientific community, such as:

- The assembly and maintenance of **videoconference systems** in the centers attached to the Doctoral Programme (ETSIAAB and CBGP) for teaching activities and research meetings.
- Support for the **recording and editing of audiovisual montages** for teaching and research purposes

4.3) UPM reprographic services

These services are necessary for the publication of books and posters for the dissemination of experimental results obtained by doctoral students in scientific meetings and conferences.