UNIVERSITÀ CATTOLICA del Sacro Cuore

Plant Physiology and Genetics

PROFF. ALESSANDRA LANUBILE-MATTEO BUSCONI

Module "Plant Physiology"

PROF. ALESSANDRA LANUBILE

Course aims and intended learning outcomes

The course is carried out in the 2nd term and consists of 3.5 CFU (28 hours) of lectures and 0.5 CFU (6 hours) of practical work. The course aims to: 1) illustrate the characteristics of plant cells; 2) describe the main features of primary and secondary tissues; 3) explain the anatomy of organs as leaves, stem and root.

Learning outcomes:

After successful completion of this course students are expected to be able to:

- explain the main structures of plant cells, more in detail, the components of primary and secondary cell wall, vacuole and plastids;
- describe the characteristics and the organization of different cell types that form meristematic, dermal, parenchymatic, mechanical, transport and secretory tissues;
- explain the primary and secondary structure of stem and root, the anatomy of leaves, highlighting the main differences between the different groups of plants;
- explain the activities of meristematic tissues, in particular how they differentiate into other types of tissues as they mature to generate adult tissues and organs;
- to identify through optical microscope observation the primary and secondary stem of Angiosperm and Gymnosperm plants, to distinguish dorsiventral and isobilateral leaves, to recognize Angiosperm mocot and dicot roots.

Course content

	CFU
Cellular level The plant cell, the cell wall, the endomembrane system, the vacuole, the plastids, the nucleus.	**1.0**
Tissue level Primary and secondary meristematic tissues, dermal, parenchymatic, mechanical, transport and secretory tissues.	**1.0**
Organ level The stem: primary body, formation of the fascicular and cork cambium, secondary body. The leaf: structure and arrangement, anatomy, modifications. The root: zonation pattern, anatomy, adaptations.	**1.0**
Plant reproduction systems, differentiation of stem, leave, root, flowers, seed and fruit.	**0.5**
Practical work Optical microscope observation of the tissues and the primary and secondary body of roots, stems and leaves.	**0.5**

Reading list

R.F. EVERT, Esau's Plant Anatomy, WILEY, HOBOKEN (NEW JERSEY), 2006

D.F. CUTLER, T. BOTHA, D.W. STEVENSON, Plant Anatomy: an applied approach, BLACKWELL PUBLISHING, MA (USA), 2008

Power point presentations will be made available during the course.

Teaching method

The teaching method will embrace the following activities:

1) Indoor classes where main course topics will be covered along with several applied examples.
2) Laboratory activities aimed at optical microscope observations of anatomical preparations of primary and secondary stem of Angiosperm and Gymnosperm plants, dorsiventral and isobilateral leaves, Angiosperm mocot and dicot roots. The frequency of practical work is mandatory.

Assessment method and criteria

The assessment consists in two written tests. The first written exam will take place after the cytology part and consists of 90 multiple-choice questions with students choosing from five possible answers, lasting 120 minutes. The second written exam consists in the optical microscope observation and detailed description of two histology slides of roots, stems and leaves, lasting 120 minutes. The final score will be the average of the two written tests. Pass mark is 18/30 out of 30/30.

Notes and prerequisites

The course does not need particular prerequisites.

Prof. Alessandra Lanubile is available to meet students after class at the Department of Sustainable Crop Production - Agronomy and Plant Biotechnology Area.

Module "Applied Genetics"

PROF. MATTEO BUSCONI

Course aims and intended learning outcomes

The module is carried out in the 2nd term and consists of 4.0 CFU (32 hours) of lectures and 1.0 CFU (12 hours) of practical work. The module is divided in two parts consisting of 2.0 CFU. The first part aims to: 1) illustrate the most basics knowledge on genetics; 2) explain the most important biological processes involving DNA and RNA (DNA replication, transcription and translation). The second part aims to present, in the form of seminars, the most important practical applications of DNA based knowledge and technologies to issues as agriculture sustainability and food traceability.

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Learning outcomes:

After successful completion of the module, students are expected to be able:

- to have the most important basic knowledge concerning DNA, the biological processes involving it and to describe them with a special focus on 1) the flow of the genetic information from the DNA to the proteins, 2) DNA replication, transcription ad translation, 3) the structure of DNA and chromosomes in both prokaryotic and eukaryotic organisms.
- to explain the different kinds of mutations, the mechanisms inducing mutations and the effects of mutations on the genetic code and on the phenotype of the organisms;
- to understand and to explain the use of DNA for the characterisation and preservation of plant biodiversity;
- to understand and to explain the use of DNA to improve classical breeding approaches to develop new plant varieties more adapted to changing evironmental conditions;
- to understand what Genetically Modified Organisms are, how GMOs can be produced and their importance for modern agriculture sustainability;
- to describe the use DNA markers for food traceability;
- to carry out a DNA extraction and a PCR reaction for analysing plant biodiversity.

Course content

	CFU
First part – Basics on genetics	**2.0**
DNA and the genome – composition, structure, organisation in chromosomes (nuclear and organellar chromosomes), DNA replication, viral, prokariotic and eukaryotic genomes	0.75
The transcription – the genetic code, the RNA, different kinds of RNAs, prokariotic and eukaryotic transcription;	0.5
The translation, from RNA to proteins;	0.25
Mutations – different kinds of mutations, mechanisms producing mutations, genetic and phenotypic consequences of mutations.	0.5
Second part – Practical applications of genetics and DNA knowledge	**2.0**
DNA based markers development, determination of the genetic fingerprint	0.25
DNA based traceability of plant based productions	0.25
Germplasm management, *Ex situ* and *In situ* preservation of plant biodiversity	0.5
Marker Assisted Selection for breeding purposes	0.25
Transgenesis, cisgenesis and genome editing	0.5
Improving cultivated varieties to increase a sustainable crop production and food quality	0.25
Practical work	**1.0**
Plant DNA extraction; evaluation and quantification of nucleic acids, PCR (Polymerase Chain Reaction)	1.0

Reading list

W.S. KLUG, M.R. CUMMINGS, C.A. SPENCER, PALLADINO M.A. Essential of Genetics, Pearson, 2017.

Papers from the scientific literature that will be provided by the teacher.

Power point presentations will be made available during the course before the beginning of each new topic.

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Teaching method

The teaching method will embrace the following activities:

1) Indoor class where main course topics will be covered along with several applied examples. Each new lesson, starting from the second oine, will begin with a 10 – 15 minutes refresher of the previous one to recall the main subjects previously addressed. Questions will be posed to stimulate discussion.
2) Laboratory practical activities and exercises aimed at understanding the use of DNA analysis to evaluate plant biodiversity. The different laboratory sessions will cover DNA extraction and evaluation, PCR analysis and evaluation of the results.

Assessment method and criteria

The assessment will take the form of a written test consisting of 32 questions regarding the basics and applicative aspects of genetics, lasting 120 minutes. It will consist of multiple-choice questions (1 point for each correct answer, 0 point for each wrong answer) with students choosing from five possible answers. Pass mark is 18/30 out of 30/30. A bonus mark (lode) will be awarded to those students who will correctly answer more than 30 questions.

The final mark out of thirty of the “Applied Genetics” module will be further averaged out (to give a mark out of thirty) with the mark obtained in the test of the “Plant physiology” module to obtain the final mark of the course Plant Physiology and Genetics.

Notes and prerequisites

The course does not need particular prerequisites.

Prof. Matteo Busconi is available to meet with students every day at the Department of Sustainable Crop Production - Agronomy and Plant Biotechnology Area.