# Agricultural Genetics

## Prof. Adriano Marocco; Prof. Alessandra Lanubile

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***.

The aim of the course is to provide students with a basic knowledge of: 1) the structure, organisation, function, and structural and epigenetic modifications of genetic material; 2) the transmission of qualitative hereditary traits, construction of genetic maps, and analysis of mutations; 3) population genetics; 4) the genetics of quantitative traits.

***Knowledge and understanding***

At the end of the course, students will be able to:

Describe the structure, DNA replication, mechanisms for correcting replication errors, and the organisation of DNA in eukaryotes and prokaryotes;

Describe the transcription and translation processes and the main aspects of gene expression regulation;

Outline the mechanisms of gene transfer in prokaryotes, and DNA and genomic technologies;

Describe the inheritance mechanisms of single genes, polygenes and cytoplasmic traits;

Know the mechanisms that generate genetic variability;

Outline the effect of the agents responsible for microevolution in populations;

Outline some of the application aspects of genetics to the genetic improvement of quantitative traits.

***Ability to apply knowledge and understanding***

At the end of the course, students will be able to:

Plan experiments for the genetic analysis of qualitative traits;

Perform statistical processing of experimental data;

Propose strategies for the mapping of simple traits and quantitative traits;

Know the effects of genetic, chromosomal and genomic mutations on the structure and function of the genome;

Demonstrate operational knowledge of the main techniques of DNA and genomic analysis, and genetic engineering.

***Autonomy of judgement, Communication skills e Learning ability***

At the end of the course, students will be able to collect and understand useful information aimed to make independent judgements and to communicate basic information on the topics of general and agricultural genetics.

Furthermore, the student will also have developed such learning skills to undertake further studies with a good degree of autonomy on the topics of applied genetics and agricultural biotechnology.

***COURSE CONTENT***

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| Module A | ECTS |
| Structure, replication and DNA organisation in prokaryotes and eukaryotes, transposable elements. | 1.0 |
| From DNA to proteins: genetic code, transcription, mRNA synthesis in eukaryotes, translation, gene mutations and their influence on the structure and function of proteins. | 0.5 |
| Control of gene expression at the transcriptional level in prokaryotes and eukaryotes, post-transcriptional, translational and post-translational. | 0.5 |
| DNA technologies: DNA cloning, applications of DNA technologies (diagnostics, fingerprinting, genetic engineering) and genome analysis (DNA sequencing, structural and functional genomics, systems biology). | 1.0 |
| *Tutorials*.  Application of molecular biology methods to nucleic acid analysis, including: purification and quantification of genomic DNA, primer design and amplification of specific genes by PCR, analysis of SSR markers, gene cloning in plasmid vectors. | 1.0 |
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| Module B |  |
| Meiosis: the mechanisms that produce genetic variability. | 0.5 |
| Mendel, genes and heredity, extensions to Mendel's laws, verification of genetic hypotheses; cytoplasmic inheritance and male-sterility. | 1.0 |
| Genes and chromosomes: association and recombination, execution of genetic maps, genes related to sex, chromosomal and genomic alterations. | 1.0 |
| Genetic changes within populations: mutation, selection, genetic drift, gene flow, inbreeding and heterosis. | 0.5 |
| Genetics of quantitative traits: polygenic inheritance, response to selection, development of mapping populations and their phenotypic and genotypic characterisation, QTL and association mapping methods. | 1.0 |
| *Tutorials*.  Problem solving covering formal genetics, genetic mapping, population genetics and quantitative trait genetics. | 0.5 |

***READING LIST***

P.J. Russell, S.L. Wolfe, P.E. Hertz, C. Starr, B. McMillan, *Genetica Agraria*, Integrated Edition edited by M. Busconi, C. Comino, G. Consonni, A. Morocco, A. Porceddu, E. Portis, R. Rao, EDISES, Naples, 2016.

S. Pimpinelli, *Genetica*, Casa Editrice Ambrosiana, Milan, 2014.

F. Lorenzetti, S. Ceccarelli, D. Rosellini, F. Veronesi, *Genetica Agraria*, Patron Editore, Bologna, 2011.

G. Barcaccia-M. Falcinelli, *Genetica e Genomica*, Volume 1, *Genetica generale*, Liguori Editore, Naples, 2008.

***TEACHING METHOD***

1. Theoretical frontal and dialogue-based lectures in which the key concepts of the subject are presented together with some application examples;
2. Frontal tutorials involving the resolution of formal genetics problems.
3. Students will conduct laboratory activities in groups of 12, which will involve applying molecular methods to the analysis of nucleic acids. At the end of the laboratory tutorials, students will have to take a written test of four open-ended questions which will be assessed as either right or wrong; if right, the student will earn one mark (1/30) towards their final mark.

***ASSESSMENT METHOD AND CRITERIA***

The exam is both written and oral: the written exam covers both modules. The test on module A consists of 2 open-ended questions and 4 closed-ended questions. The test on module B consists of 3 exercises and 2 open-ended questions. A minimum mark of 18/30 must be achieved to pass both written tests, in which will be assessed the student's level of detail, command of the language, reasoning ability, and communication skills; each test lasts 120 minutes. Failure to complete or pass the written tests will result in the student having to take the entire exam in oral form.

***NOTES AND PREREQUISITES***

Being introductory in nature, there are generally no prerequisites for attending the course. However, a basic knowledge of statistics, including probabilities, statistical tests, distributions, destructive parameters and variance analysis, will help the student prepare better.

Information on office hours available on the teacher's personal page at <http://docenti.unicatt.it/>.