

Genome Engineering (I003113)

Course size *(nominal values; actual values may depend on programme)*

Credits 3.0

Study time 90 h

Course offerings in academic year 2026-2027

A (semester 2)

English

Gent

Lecturers in academic year 2026-2027

Pauwels, Laurens

LA25

lecturer-in-charge

Offered in the following programmes in 2026-2027

[Master of Science in Bioscience Engineering: Cell and Gene Biotechnology](#)

crdts

3

offering

A

[Exchange Programme in Bioscience Engineering: Cell and Gene Biotechnology \(master's level\)](#)

3

A

Teaching languages

English

Keywords

Gene editing, DNA repair, CRISPR/Cas systems, gRNA design, base editing, prime editing, recombinases, transformation, detection of gene edits, doubled haploids, apomixis, gene drive, regulation and intellectual property for gene editing.

Position of the course

The ability to precisely alter the genome of pro- and eukaryotic organisms represents one of the most profound technological revolutions in modern biotechnology. Whereas classical breeding and mutagenesis are largely unguided processes, contemporary genome engineering techniques now enable genetic modifications to be designed and implemented with unprecedented accuracy. This course provides an in-depth understanding of the molecular mechanisms underlying genome editing, the role of DNA repair, and recent innovations such as base and prime editing. Attention is also given to the practical aspects of genome engineering, including gRNA design, delivery systems, and methods for detecting and quantifying genome modifications. While the primary focus is on plant applications, examples from micro-organisms, insects, yeast, and (farmed) animals are also discussed. The complementarity and impact of genome editing on plant breeding and related methods (such as doubled haploids and apomixis) are explored. Finally, the course addresses current regulatory developments and the intellectual property framework surrounding genome editing. The course aligns with the courses Plant Biotechnology, Functional Plant Biology, Plant Breeding, and Applied Genetics, but distinguishes itself through its emphasis on design-oriented reasoning, mechanistic depth, and focus on current technological advances in genome engineering.

Contents

CH1. Introduction to Genome Engineering with an historical evolution from meganucleases, ZFN and TALEN to the emergence of CRISPR/Cas systems. CH2. Molecular mechanisms of DNA damage and their relation to genome editing. CH3. CRISPR/Cas: structure, function, and variants (e.g. Cas12a). Mechanisms of DNA recognition and cleavage activity; gRNA structure and off-target analysis. CH4. Advanced Genome Modification Techniques. Base editing, prime editing, bridge editing, CRISPRi, CRISPRa, recombinases (Cre/FRT), transposase-based gene editing. CH 5. Design and Implementation of Genome Editing. Design principles for gRNAs, multiplexing strategies, and relation to delivery methods for plants. CH 6. Detection and Quantification of Genome Modifications. PCR-based detection, digital

PCR, amplicon sequencing, and NGS approaches. CH 7. Commercial Applications of Genome Engineering in Plants and other organisms. CH 8. Haploid induction, doubled haploids, apomixis, and the impact of genome editing on plant breeding. CH 9. Genome Editing in Other Organisms. Applications in microorganisms, insects (gene drives), and (farmed) animals. CH 10. Regulation and Intellectual Property International regulations, patents on technologies, patents on plants, and plant breeders' rights.

Initial competences

Genome Engineering builds on the competences obtained in Cellular and Molecular biology, Gene Technology and Molecular Diagnostics and Toepagete Genetica.

Final competences

- 1 Students understand the molecular mechanisms underlying genome editing and the role of DNA repair pathways in generating genetic modifications.
- 2 Students can explain, compare, and evaluate different genome engineering technologies in terms of their applications and limitations.
- 3 Students can design an appropriate genome editing strategy for a given gene and organism, including the selection of gRNAs, delivery methods, and analytical techniques.
- 4 Students can interpret experimental results of genome modifications and assess the efficiency and specificity of editing methods.
- 5 Students can critically analyse current developments in scientific literature and patents on genome engineering and assess their societal and economic implications.
- 6 Students can scientifically argue about the impact of genome editing on plant breeding, biotechnological innovation, and regulation.
- 7 Students can discuss biosafety regulations related to environmental release of gene edited crops.
- 8 Students can assess the technical and economic feasibility of a genome editing project.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture, Independent work

Extra information on the teaching methods

The course includes one or more guest lectures by a genome engineering expert from a non-plant research field and/or experts in doubled haploid breeding. Students also take part in a workshop where they design a complete genome engineering project (from initial concept to validation of genomic changes) and prepare an individual written report. In a limited number of interactive paper discussion sessions, the class analyzes a recent scientific article and/or patent with active participation of each student.

Study material

Type: Slides

Name: Course material

Indicative price: Free or paid by faculty

Optional: no

Available on Ufora : Yes

Additional information: All course materials (Powerpoint presentations, scientific articles and patent applications) will be shared with the students through the corresponding UFORA page.

References

Course content-related study coaching

Additional information can be obtained by email, UFORA or through personal contact with the teacher before or after the classes.

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Oral assessment, Written assessment

Examination methods in case of periodic assessment during the second examination period

Oral assessment, Written assessment

Examination methods in case of permanent assessment

Participation, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is not possible

Extra information on the examination methods

Periodic: Oral assessment, Written assessment with open-ended questions;

Permanent: Participation of workshop and interactive paper discussion, peer and/or self assessment, assignment

Calculation of the examination mark

The evaluation of the theory counts for 4/5, the permanent evaluation of the independent work and participation for 1/5.

The permanent evaluation score of the first exam session stays valid for the resit. Students who eschew one or more parts of the assessment can no longer obtain a pass mark for the course unit. Should the final mark be higher than 10/20, it will be reduced to the highest non-tolerable mark (i.e. 7/20).