GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Gene Technology and Molecular Diagnostics (I002522)

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

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 1)	English	Gent	practical
			lecture
			seminar

Lecturers in academic year 2024-2025

Kyndt, Tina	LA25	lecturer-in-charge
De Mey, Marjan	LA25	co-lecturer
Van Damme, Els	LA25	co-lecturer

Offered in the following programmes in 2024-2025	**crdts**	**offering**
Bachelor of Science in Bioscience Engineering	6	A

Teaching languages

English

Keywords

Cloning techniques, expression vectors, cDNA- and genomic libraries, DNA-, RNA- and protein-analysis techniques, PCR applications, molecular markers, gene isolation, gene- and genome analysis

Position of the course

Molecular biotechnology is being used to specifically alter organisms and therefore the DNA sequence must first be cloned. On the other hand a variety of molecular techniques is being used to study living organisms or to identify individuals or specific characteristics. A plethora of molecular methods have been optimised and others are being developed constantly.This course will describe and discuss a variety of molecular techniques explaining the basic concepts but also following the latest trends.

Contents

Content

I INTRODUCTION
I.1 Genome
I.2 Transcriptome
I.3 Gene expression
I.4 Basic techniques for DNA-analysis
I.5 Basic principles recombinant DNA
II DNA HYBRIDISATION
II.1 General principles of hybridisation
II.2 What to use as probe?
II.3 Allele-specific probes for SNP detection
II.4 Array or chip technology
II.5 Labels and detection
III PCR & Q-PCR
III.1 Basic principles PCR
III.2 Specificity, accuracy and contamination in the context of PCR
III.3 Technical variants of PCR
III.4 Non-PCR-based amplification methods
III.5 Semi-quantitative PCR, Q-PCR and droplet digital PCR (ddPCR)

III.6 Colony PCR
III.7 PCR for diagnostics
IV HIGH THROUGHPUT SEQUENCING
IV.1 NGS or 2nd generation sequencing: based on amplified single molecule sequencing
IV.2 Next Next generation Sequencing or Third generation sequencing: single molecule sequencing
IV.3 Comparing different sequencing methods
IV.4 Applications of high throughput sequencing
V ANALYSING GENETIC VARIATION BY STUDYING DNA POLYMORPHISMS
V.1 MOLECULAR MARKERS AND POLYMORPHISMS
V.2 Protein markers
V.3 DNA markers
V.4 Typical target regions used for diagnostics
V.5 Applications of molecular marker techniques
VI RECOMBINANT DNA
VI.1 Restriction enzymes
VI.2 Other enzymes: ligases, kinases and phosphatases, nucleases, polymerases,
VI.3 Ligation and transformation
VI.4 cDNA and cDNA libraries
VI.5 Genomic libraries
VI.6 Clone analysis
VII DNA ASSEMBLY METHODS
VII.1 The challenge in DNA assembly
VII.2 The traditional multiple cloning site approach
VII.3 Modern DNA assembly methods based on restriction enzymes
VII.4 Modern DNA assembly methods based on homology
VIII CLONING VECTORS AND THEIR APPLICATIONS
VIII.1 Basic vectors and vectors for special applications
VIII.2 Modern cloning techniques
VIII.3 Expression vectors for the production of proteins
VIII.4 Expression vectors for the production of metabolites
IX ANALYSIS OF PROTEINS
IX.1 Extraction and purification of proteins
IX.2 Protein electrophoresis
IX.3 Detection and quantitative determination of proteins with the help of antibodies
IX.4 Yeast two-hybrid
IX.5 Tandem affinity purification
IX.6 In vitro transcription and translation systems
IX.7 Proteomics and mass spectrometry
X GENOME EDITING
X.1 Genome editing using homology-directed recombination
X.2 Genome editing using CRISPR/Cas
XI FUNCTIONAL GENETICS
XI.1 Libraries and cloning
XI.2 Picking up a gene based on sequence similarity
XI.3 Finding interesting genes based on expression pattern or protein characteristics
XI.4 Starting from an interesting mutant: forward genetics
XI.5 Genome sequences and their annotation
XI.6 Reverse genetics
XI.7 Analyses on protein level
XII GENE EXPRESSION ANALYSES
XII.1 Run-on or Run-off analysis of RNA
XII.2 Steady state analyses: RNA-extraction
XII.3 Analyzing transcripts trough hybridisation
XII.4 Transcriptome analysis through sequencing
XII.5 RT-qPCR
XII.6 Analyzing gene expression in an organism
XII.7 Reporter genes
XII.8 Protein analysis

Exercises:
1 PC-practicum
2 PCR, RT-PCR and Q-PCR, reporter genes

Initial competences

Gene Technology and Molecular Diagnostics builds on certain learning outcomes of course unit Biochemistry and Molecular Biology ; or the learning outcomes have been achieved differently

Final competences

1 to have knowledge on genome structure and genetic diversity at the molecular level
2 to utilise techniques for analysis of DNA, RNA and proteins with interpretation of the results
3 to have insight in genome structure, gene structure, gene expression and regulation of gene expression
4 to know the techniques for expression of inactivation of genes
5 to search and analyse DNA sequences in data bases, to search for data in other scientific data bases
6 to execute tasks on DNA and RNA analysis in the frame of a scientific problem
7 to be able to select the best analytical molecular technique for the analysis of a problem
8 to be able to recognise the most important elements on a DNA-vector and to understand the function of it
9 to work accurately in molecular lab experiments and to critically analyse the results
10 to be able to critically compare the advantages and disadvantages of different molecular analysis techniques
11 to know correct terminology in molecular genetics and recombinant DNA
12 to ethically reflect on opportunities and problems associated with DNA analysis
13 to be aware of possibilities of molecular techniques and the importance of communication to society
14 to have an idea about the possible job profiles for bio-engineers in cel and gene biotechnology
15 to be able to understand and compare the high throughput sequencing techniques
16 work in a team for experimental work and reporting

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, Practical

Extra information on the teaching methods

The course notes can be bought at VLK. Thee slides are distributed for free via UFORA.

Study material

None

References

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Course content-related study coaching

Additional information or explanation can be obtained by personal contact or by email or the electronic learning platform and during the excercises.

Assessment moments

end-of-term and continuous assessment

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

Oral assessment, Written assessment with open-ended questions

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

Oral assessment, Written assessment with open-ended questions

Examination methods in case of permanent assessment

Participation, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Calculation of the examination mark

Theory: period aligned evaluation: 80%
Exercises: non-period aligned evaluation: 20%

Students who eschew period aligned and/or non-period aligned evaluations for this course unit may be failed by the examinator.
Students that are legally absent for some practical exercises do not have to catch this up later, but can get some theoretical questions to be answered. Illegal absence to the practical exercises will lead to a total score (theorie+exercises) of maximum 9/20, regardless of the score for the theory.
If less than 9/20 is scored for one of the 3 parts (2 theory parts and 1 practical), one cannot pass this course anymore. If the total score would be more than 10/20, this score will be reduced to the highest non-pass score.