Master Drug Discovery and Safety

Dr. Chris Vos, programme director
Dr. Maikel Wijtmans, master coordinator
Stefan Dekker, M.Sc, study advisor
Contents

- Drug Discovery and Safety
- Programme
- Research and traineeships
- Practical matters
- Admission requirements
Drug Discovery, Safety and Development

Drug Discovery & Development - Timeline

- Drug Discovery: 10,000 Compounds (~6.5 years)
- Preclinical: 250 Compounds
- Clinical Trials: 5 Compounds (~7 years)
- FDA Review (~1.5 years)
- 1 FDA Approved Drug
Drug Discovery and Safety Research

- Unique chemical focus on early drug discovery research

**Specialists**
- Organic chemists
- Computational chemists
- Pharmacologists
- Toxicologists
- Analytical chemists
- …
Specialisations in Master DDS

- Drug Discovery and Target Finding
- Drug Disposition and Safety Assessment
- Computational Medicinal Chemistry and Toxicology
- Drug Design and Synthesis
- Biomarkers and Clinical Chemical Analysis
Specialisations in Master DDS

- Drug Discovery and Target Finding
  - Pharmacology
- Drug Disposition and Safety Assessment
  - Toxicology
- Computational Medicinal Chemistry and Toxicology
  - Modeling
- Drug Design and Synthesis
  - Organic chemistry
- Biomarkers and Clinical Chemical Analysis
  - Analytical chemistry
Profiles

• **O:** Research profile

• **E:** Education profile

• **C:** Communication profile

• **M:** Management profile

Profiles
You also need to choose for a profile. There are four profiles: research, social, communication and education. Each specialization and profile combination can be tailor-made to your personal requirements. You can choose between the following profiles:

• Research: focuses on Drug Discovery and Safety research. With this profile you gain experience for a career in research, both in the university (PhD) as in the pharmaceutical industry.

• Social: focuses on policy-analysis, management and entrepreneurship. This profile enables you to combine your background in Drug Discovery and Safety with applications or management in industry.

• Communication: focuses on science communication theory and research, as well as on practice. This profile provides you with special training for a job in science communication. Please note this profile is partly in Dutch.

• Education: provides you training as a teacher in chemistry for Dutch pre-university level (VWO) or vocational education (HBO) level. Please note this profile is partly in Dutch.

At the initial planning stage of your Master's, you can define your own programme in consultation with the Master's coordinator. Each specialization and profile combination includes a balance between compulsory courses, optional courses and research training. Visit our study guide to find out more about our four profiles.
Profiles

- **O: Research profile**
  With this profile you gain experience for a career in research, both in the university (PhD) as in the pharmaceutical industry.

- **E: Education profile – Highschool Chemistry teacher**
  provides you training as a teacher in chemistry for Dutch pre-university level (VWO) or vocational education (HBO) level. Please note this profile is partly in Dutch.

- **C: Communication profile – Editor at LU**
  focuses on science communication theory and research, as well as on practice. This profile provides you with special training for a job in science communication. Please note this profile is partly in Dutch.

- **M: Management profile**
  focuses on policy-analysis, management and entrepreneurship. This profile enables you to combine your background in Drug Discovery and Safety with applications or management in industry.
Profiles

- O: Research profile
- E: Education profile
- C: Communication profile
- M: Management profile

2 year research
• Drug Discovery and Safety
• Programme
• Research and traineeships
• Practical matters
• Admission requirements
Master programme O-profile

Flexible programme
120 ECTS in total
2 years
Context courses: broader Drug Research

Project Drug Design & Synthesis

Project Chemical Biology

Drug Action

ADMET

Absorption, Distribution, Metabolism, and Excretion – Toxicity

(Principles of Pharmacochemistry)

Mandatory for people without VU BSc FAR. Not accessible to people with VU BSc FAR
Specialisation courses: in-depth

- Compulsory Courses: 24-30 ECTS
- Compulsory Courses within track: 12 ECTS
- Optional Courses: 18-24 ECTS
- Major Project: 42 ECTS
- Academic Skills: 6 ECTS
- Literature Thesis: 12 ECTS

Depends on specialisation

12/120 ECTS
Traineeship

Major traineeship

Minimum 42/120 ECTS
Optional/elective courses

- Traineeship company
- Traineeship abroad
- Extension major traineeship
- Minor traineeship
- Electives
Optional/elective courses

Compulsory Courses
24-30 ECTS

Compulsory Courses within track
12 ECTS

Optional Courses
18-24 ECTS

Major Project
42 ECTS

Academic Skills
6 ECTS

Literature Thesis
12 ECTS

Academic skills
Scientific writing
Business
Ethics
Tutoring students
Clinical trials
.....
# The first half year

*If no prior courses in drug chemistry*

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<thead>
<tr>
<th>Period</th>
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<th>Course (EC)</th>
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<td></td>
<td>ADMET (6)</td>
<td>Compulsory course</td>
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<td></td>
<td>Physical-organic chemistry (6)</td>
<td>Track specific</td>
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<tr>
<td>2</td>
<td>Nov – Dec</td>
<td><strong>Course 1 (6)</strong></td>
<td>Track specific</td>
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<td><strong>Course 2 (6)</strong></td>
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<td>3</td>
<td>Jan</td>
<td><strong>Drug action (6)</strong></td>
<td>Compulsory course</td>
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<td>4</td>
<td>Feb – Mar</td>
<td><strong>Computational design and synthesis of drugs (6)</strong></td>
<td>Compulsory course</td>
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<td>5</td>
<td>Apr – May</td>
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<tr>
<td>6</td>
<td>Jun</td>
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*If no prior courses in drug chemistry
Contents

• Drug Discovery and Safety
• Programme
• Research and traineeships
• Practical matters
• Admission requirements
• Centered around theme ‘life/health’
• Traineeship possibility
Specialisation DDTF

*target finding/medicinal chemistry*

VU fragments

Fragments

Small molecules

Nanobodies/VHHs
Specialisation DDTF
*target finding/medicinal chemistry*

Small molecules
Nanobodies/VHHs
Specialisation DDTF
*target finding/medicinal chemistry*

Cellular Signal

Cellular Response

Health vs Disease

Track-specific courses
Specialisation DDTF

target finding/medicinal chemistry

Cellular Signal

Cellular Response

Health vs Disease

Track-specific courses

Chemical Biology (Sept-Oct)
Drug Action (Jan)
High Throughput Screening (Nov-Dec)
Specialisation DDTF

target finding/medicinal chemistry

Cellular Signal

Cellular Response

Health vs Disease

Small molecules

Nanobodies/VHHs

Chemical Biology (Sept-Oct)

Drug Action (Jan)

High Throughput Screening (Nov-Dec)

Signaling in Health and Disease (Nov-Dec)

Track-specific courses
1) Synthesis of biologically relevant organic molecules (ligands)

Using the toolbox of all organic chemistry reactions....
Specialisation DD&S

Design and synthesis

1) Synthesis of biologically relevant organic molecules (ligands)
Using the toolbox of all organic chemistry reactions....

2) Integration with molecular modeling
Design & synthesis: virtual screening, structure-based
Specialisation DD&S

*Design and synthesis*

1) Synthesis of biologically relevant organic molecules (ligands)

*Using the toolbox of all organic chemistry reactions....*

2) Integration with molecular modeling

*Design & synthesis: virtual screening, structure-based*

3) Radiochemistry & peptide chemistry

*Isotope labeling, peptide synthesis*
Specialisation DD&S

Design and synthesis

1) Synthesis of biologically relevant organic molecules (ligands)

Using the toolbox of all organic chemistry reactions....

2) Integration with molecular modeling

Design & synthesis: virtual screening, structure-based

3) Radiochemistry & peptide chemistry

Isotope labeling, peptide synthesis

Track-specific courses

Physical-Organic Chemistry (Sept-Oct)
Synthetic Approaches in Medicinal Chemistry (Nov-Dec)
1) Studying, understanding, predicting protein-drug binding/interaction
Kinases, esterases, Cytochrome P450s, proteases, nuclear receptors, etc.

Optimizing and designing drugs

Predicting (un)wanted metabolite formation
1) Studying, understanding, predicting protein-drug binding/interaction
Kinases, esterases, Cytochrome P450s, proteases, nuclear receptors, etc.

Optimizing and designing drugs

Predicting (un)wanted metabolite formation

2) Method and model development
Virtual screening, protein design, force field development, free energy methods, etc.
Specialisation CMCT
computational modeling

1) Studying, understanding, predicting protein-drug binding/interaction
Kinases, esterases, Cytochrome P450s, proteases, nuclear receptors, etc.

2) Method and model development
Virtual screening, protein design, force field development, free energy methods, etc.

Optimizing and designing drugs
Predicting (un)wanted metabolite formation

Track-specific courses

- Computer-Aided Drug Design & Virtual Screening (Nov-Dec)
- Biomolecular Simulation in Medicinal Chemistry and Toxicology (Apr-Jun)
Molecular mechanisms of chemical induced cellular perturbations

**Disciplines:**
- Biochemistry
- Analytical chemistry
- Cell biology
- Genetics

**Research topics:**
- Expression studies of human enzymes in cell lines and yeast
- Drug metabolism studies: bioactivation vs. inactivation
- Population diversity
- Chemical induced cell stress and adverse reactions (hepatocytes, cell lines)
- Development of novel *in vitro* models (e.g. iPS-derived kidney cells)
- Adverse Outcome Pathways
Specialisation DDSA
Molecular Toxicology

Molecular mechanisms of chemical induced cellular perturbations

Disciplines:

Biochemistry
Analytical chemistry
Cell biology
Genetics

Research topics:

• Expression studies of human enzymes in cell lines and yeast
• Drug metabolism studies: bioactivation vs. inactivation
• Population diversity
• Chemical induced cell stress and adverse reactions (hepatocytes, cell lines)
• Development of novel in vitro models (e.g. iPS-derived kidney cells)
• Adverse Outcome Pathways

Track-specific courses

Drug-induced Stress and Cellular Response (Nov-Dec)
Advanced Molecular Toxicology course (Apr-May)
1) Find proteins associated with particular diseases
   *Biomarkers*

2) Study interactions between drugs and proteins

3) Quick & accurate measurement large numbers of biological samples
   *Chromatography, Mass Spectrometry, High-Throughput Screening*
1) Find proteins associated with particular diseases
   *Biomarkers*

2) Study interactions between drugs and proteins

3) Quick & accurate measurement large numbers of biological samples
   *Chromatography, Mass Spectrometry, High-Throughput Screening*

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**Track-specific courses**

Bio-analysis & clinical diagnostics (Apr-May)
Specialisation BCCA
bioanalysis & diagnostics

1) Find proteins associated with particular diseases
   Biomarkers

2) Study interactions between drugs and proteins

3) Quick & accurate measurement large numbers of biological samples
   Chromatography, Mass Spectrometry, High-Throughput Screening

Track-specific courses
Bio-analysis & clinical diagnostics (Apr-May)
2 out of 4:
   Omics-approaches in molecular clinical diagnostics (Sept-Oct)
   Protein analysis (Sept-Oct)
   High throughput-screening (Nov-Dec)
   Mass spectroscopy (Nov-Dec)
Contents

• Drug Discovery and Safety
• Programme
• Research and traineeships
• Practical matters and career perspectives
• Admission requirements
Alumni symposium DDS 17-01-2018

13.30 – 13.40 – Welcome

13.40 – 14.10 – Sandra Ortega Ugalde, MSc
PhD candidate @ Molecular Toxicology, VU & Molecular Microbiology, VU
https://www.linkedin.com/in/sandra-ortega-ugalde-2291693b/
Highlight: “Research in an academic environment”

14.10 – 14.40 – Jelle Reinen, PhD
Study Director In Vitro ADME @ Charles River
https://www.linkedin.com/in/jellereinen/
Highlight: “From Academia to Industry”

Break

15.00 – 15.30 – Ewald Edink, PhD
Lecturer in Chemistry @ Hogeschool Inholland
https://www.linkedin.com/in/ewald-edink-98167910/
Highlight: “From Research to Education”

15.30 – 16.00 – Marcel Out, MSc
Medical Advisor @ ViV Healthcare
https://www.linkedin.com/in/outmarcel/
Highlight: “Medical Advisory & Healthcare”

16.00 – 17.00 Networking & drinks
Career prospects

45% Scientific research

- Rob Leurs
  Professor Medicinal Chemistry, VU

25% Management

- Ronald Korthouwer
  Internationaal productmanager KRKA

10% Policy & advice

- Patricia Baede
  Head registration Kinesis Pharma

5% Education

- Cindy van Dam
  Teacher chemistry

10% Clinical studies

- Roos Oostendorp
  Clinical Trial Officer Mundipharma
Career prospects
Practical matters

• Periods (8-8-4-8-8-4)
  – Exam week at end of each period
  – 1 resit per course per year
Practical matters

• Periods (8-8-4-8-8-4)
  – Exam week at end of each period
  – 1 resit per course per year

• First semester: average 6 contact h/course/week
Practical matters

• Periods (8-8-4-8-8-4)
  – Exam week at end of each period
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• First semester: average 6 contact h/course/week

• Mandatory courses: ca. 6 books, ca. 300 euro
Practical matters

• Periods (8-8-4-8-8-4)
  – Exam week at end of each period
  – 1 resit per course per year

• First semester: average 6 contact h/course/week

• Mandatory courses: ca. 6 books, ca. 300 euro

• Personal contact teachers
Practical matters

- Classes in W&N part of campus, research in O|2
Practical matters

• Classes in W&N part of campus, research in O|2

• Classes, tutorials, self-study (e.g. slidecasts)
  – No practical courses, *basic skills in bachelor*
  – Lab experience: traineeship(s) (internal, external)
Practical matters

• Switch specialisation?
  – Admission based on one specialisation
  – Before start semester 2
Switch specialisation?
- Admission based on one specialisation
- Before start semester 2

UvA/VU collaboration
- DDS is VU programme
- Elective courses from Chemistry Joint Degree

Elective courses from Life Sciences
If bachelor FAR (pharmaceutical sciences VU), you are admitted.

Otherwise: admission board to evaluate candidate for a specific track.
Admission requirements

* Similar relevant programmes need to cover the required knowledge stated below for students to be eligible in the Master Drug Discovery and Safety. The Master’s coordinator will determine if you meet these requirements.

1. **Biochemistry, molecular biology, cell biology and pharmacology**, including techniques such as protein expression, purification, mutagenesis. An indication of the expected knowledge is given by textbooks *Essential Cell Biology* (Alberts et al.), chapters 1-16, and *Introduction to Medicinal Chemistry* (Patrick), chapters 1-18.

2. **Pharmacokinetics, enzyme kinetics and pharmaceutical toxicology**. An indication of the expected knowledge is given by textbook *Pharmacology* (Rang & Dale), chapters 1-10 & 21-26.

3. **Analytical chemistry**, including techniques such as HPLC, spectrophotometry, fluorimetry, NMR, mass spectrometry. An indication of the expected knowledge is given by textbook *Quantitative Chemical Analysis* (Harris), chapters 1-10, 17-25.

4. **Organic chemistry**, including practical laboratory experience with organic chemical techniques. An indication of the expected knowledge is given by textbook *Organic Chemistry* (Clayden et al.), chapters 1-30. For Drug Discovery and Target Finding only chapters 1-4 are expected knowledge.

5. **Physical chemistry**. An indication of the expected knowledge is given by textbook *Physical Chemistry for the Life Sciences*. Peter Atkins and Julio de Paula, chapters 1-4.

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Admission requirements external

• No premaster

• Not guaranteed: assessment coordinator, advice to exam committee

• Deficiencies?
  – Mandatory course Principles of Pharmacochemistry
  – Up to 12 ECTS deficiency courses in MSc program
  – Tailoring

Note: Master DDS is all about molecules
More info? MSc coordinators

Biomarkers & Clinical Chemical Analysis
Dr. Henk Lingeman: h.lingeman@vu.nl, tel: 20 59 87539

Computational Medicinal Chemistry & Toxicology
Dr. Daan Geerke: d.p.geerke@vu.nl, tel: 20 59 87606

Drug Design & Synthesis
Dr. Maikel Wijtmans: m.wijtmans@vu.nl, tel: 20 59 87603

Drug Discovery and Target Finding
Dr. Marco Siderius: m.h.siderius@vu.nl, tel: 20 5987564

Drug Disposition and Safety Assessment
Dr. Jan Commandeur: j.n.m.commandeur@vu.nl, tel: 20 5987595
The information stand at the information market
- Master student Target Finding
- Master student Design and Synthesis

Or

Contact me:
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E: sj2.dekker@vu.nl
Any questions?