Universidad de Navarra

Pharmacokinetic model-based drug development (MIDI)

Guía docente 2026-27

PRESENTATION

Overview: The low effectiveness associated to a high cost in the development of new drugs is a proven fact. The percentage of new compounds in clinical development that achieve the market is very low, and that percentage is even lower in the case of new agents in pre-clinical development.

The increase in the efficiency during the development of new therapeutics agents currently represents a big challenge, as it has been acknowledged in the new initiative promoted by the Food and Drug Administration (FDA) called the "*critical path"*, where new tools and strategies are suggested with the goal of optimizing drug development (*http://www.fda.gov/ScienceResearch /SpecialTopics/CriticalPathInitiative/default.htm*).

One of the recommended strategies consists in the application of the concept of ***model-based drug development***, which is based on the quantitative analysis of the pharmacological response. That analysis integrates the principles of **pharmacokinetic/pharmacodynamic population modelling** which are embedded in the emergent discipline of pharmacometrics, which, currently represents the most demanding expertise in R&D by pharmaceutical industry.

Degree: Master´s degree in drug Research, Development and Innovation

Module 2: Drug Development

Study Area: Preclinical and Clinical Development

Type: Core subject

Credits: 3 ECTS

Language: English

Lecturers: José Ignacio Fernández de Trocóniz Fernández *Pharm D, Ph D*

Professor responsible: Iñaki F. Trocóniz *Pharm D, Ph D*

Departament/School: Pharmaceutical Technology and Chemistry // School of Pharmacy and Nutrition

Location: Room 10

Schedule: CALENDAR

LEARNING OUTCOMES (Competencies)

BC7: The students know how to apply the knowledge acquired and their ability to solve problems in new or uncertain environments within broader (or multidisciplinary) contexts related to their area of study.

BC9: The students know how to communicate their conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way.

BC10: The students will have acquired learning abilities that will permit them to continue studying in a self-directed and autonomous manner.

GC2: The students will learn how to carry out work on a team, forming part of multidisciplinary teams and collaborating with other professionals linked to the area of research.

GC4: Identify and know how to create strategies and actions aimed to achieve the planned objectives and concrete the required resources accordingly, in the field of the pharmaceutical company.

GC5: Learn the current techniques and trends related to drug research, development and innovation.

GC6: Acquire critical ability to make the necessary decisions and adapt to new situations that may arise in the field of pharmaceutical and related companies.

SC3: Apply the methodology of the development of mechanistic computational models to the optimization of studies during the clinical phases of drug development

PROGRAM

Theory

Pharmacometrics

- Fundamental concepts on pharmacokinetics, pharmacodynamics and disease modelling.
- Role of pharmacometrics in the development of new drugs

Pharmacokinetic/Pharmacodynamic Modelling

- Application of the physiological-based pharmacokinetic modelling in the early stages of drug development
- Models describing the time course of drug action “in vivo”
- Models for disease progression, baseline response and placebo effects

Population approach

- Inter-individual and residual variability
- Prognostic factors (commonly called covariates)
- Covariate models
- Interpretation of the covariate significance

Model evaluation/validation

- Goodness of fit plots
- Simulation based diagnostics

Tools in pharmacometrics

- Non-linear Mixed effects models
- R framework
- Monolix

Practice

A population pharmacokinetic/pharmacodynamic/Disease model for an antibiotic will be developed. Once built, the model will be used to explore, in silico, the probability of target attainment.

A mechanistic Target Mediated Disposition model will be generated to interpret the in vivo time course of IL-13 after subcutaneous administration of two monoclonal antibodies. The final objective will be to indicate the most optimal compound for future developments in the therapeutic area of respiratory.

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EDUCATIONAL ACTIVITIES

Theoretical lectures & seminars (*in situ*): 20 hours

Most relevant aspects of the subject will be addressed using the blackboard and powerpoint presentations as main teaching methodologies, encouraging the active participation of the student in each session.

Seminars bridging the gap between the theoretical and practical sessions will illustrate the role and impact of modelling and simulation in concrete cases in drug development.

Through the ADI computer tool, the students will have access to documentation and the possibility of solving continuous assignements throughout the course period.

Practice: 12.5 hours

The practical exercises will be held in a computer room and individually.

Each student will receive the manual where the objectives will be presented, as well as the instructions required to use the software and the computer environment.

The follow-up of the activities will be done through questions included in the manual that the student will have the opportunity to answer individually during and after the sessions.

Tutorials: 0.5 hour

At least one (individual & voluntary) meeting between the student and the lecturer is recommended.

Personal study: 30 hours

Equivalent to 1 hour for each theoretical/seminar (in situ) hour.

Written evaluation: 2 hours

ASSESSMENT

Continuous evaluation accounts for 10% of the final qualification, and will evaluate the interest and participation of the student

Ordinary call

Theoretical classes and seminars

Represents 60% of the final qualification and will consist of multiple-choice questions (3 points), problem-solving exercises (5 points), and graphical interpretation of time profiles of systemic drug levels and pharmacological response (2 points).

Practical classes

It constitutes the 30% of the final qualification and will be obtained from the evaluation of a slide-deck summarizing the methodology used and most relevant results found after performing the practical exercises.

Second call

Written exam represents 100 % of the final qualification and will consist of multiple-choice questions (3 points), problem-solving exercises (5 points), and graphical interpretation of time profiles of systemic drug levels and pharmacological response (2 points).

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Special Needs

Students with special educational needs must contact the Faculty/School's Study Coordination Office in advance to obtain authorization for accommodations (for example, more time for exams). This authorization must be sent by the student to the professor. It is recommended that this be done at the beginning of the semester.

ATTENTION

Please note that any attempt at fraud, copying, plagiarism, or other irregular behavior constitutes a serious infraction, as defined in Title IV "Rules of Academic Discipline for Students" within the System of Rules on Coexistence at the University of Navarra (Rules on Coexistence UNAV).

OFFICE HOURS

Dr. José Ignacio Fernández de Trocóniz (itroconiz@unav.es)

- Office **0F14** Building **Sciences. Ground floor**
- **Office hours**: To be determined with the professor

BIBLIOGRAPHY & RESOURCES

Lecture slides, questions and answers are provided to the students through the ADI platform together with the data and background required to develop the practical exercises

Selected bibliography

Books

- Kimko HC and Duffull SB. Simulation for designing clinical trials. A pharmacokinetic-pharmacodynamic prespective. Marcel Dekker, Inc. New York 2007.Localízalo en la Biblioteca
- Gabrielsson J and Weiner D. Pharmacokinetic & pharmacodynamic data analysis: concepts and application. 4rd edition. Swedish Pharmaceutical Press. Stockholm. 2006.Localízalo en la Biblioteca
- Ette EI and Williams PJ. Pharmacometrics. The science of quantitative pharmacology. John Wiley & Sons, Inc. New Jersey. 2007.Localízalo en la Biblioteca ; Localízalo en la Biblioteca [Recurso electrónico]

Articles

- Liping Zhang, Vikram Sinha, S. Thomas Forgue, Sophie Callies, Lan Ni, Richard Peck and Sandra R. B. Allerheiligen. Model-Based Drug Development: The Road to Quantitative Pharmacology. Journal of Pharmacokinetics and Pharmacodynamics 33: 369-393 (2006).
- R.Lalonde, K G Kowalski, M M Hutmacher, W Ewy, D J Nichols, P A Milligan, B W Corrigan, P A Lockwood, S A Marshal, L J Benincosa, T G Tensfeldt, K Parivar, M Amantea, P Glue, H Koide and R Miller. Model-based Drug Development**:** State of the Art**.** Clinical Pharmacology & Therapeutics 82: 21-32 (2007)
- Vaishali Sahasrabudhe1, Timothy Nicholas, Gianluca Nucci, Cynthia J Musante and Brian Corrigan. Impact of Model- Informed Drug Developmenton Drug Development Cycle Times and ClinicalTrial Cost. Clinical Pharmacology and Therapeutics (2025). https://doi.org/10.1002/cpt.3636